SpatialAnalyzer

Instruments Manual

SpatialAnalyzer

Instruments Manual

2024.03.21

SPATIALANALYZER USER MANUAL

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

This Page Intentionally Left Blank.

Welcome

Congratulations on your purchase of SpatialAnalyzer, the world's leading portable metrology software platform. SpatialAnalyzer is a traceable, graphical metrology software package that can simultaneously communicate to virtually any number and type of dimensional measurement systems and perform complex analysis tasks with ease.

Spatial Analyzer (SA) is used in many high-profile applications throughout a wide array of industries, from manufacturing to science and research. Some of these industries include:

- Aerospace (aircraft and spacecraft)
- Shipbuilding
- Particle Accelerators
- Nuclear Energy
- Automotive
- Heavy Equipment
- Machining

You are about to embark on learning how to adeptly use the most powerful portable metrology software ever created.

About This Manual

This Instrument Manual is not intended to replace the recommendations of the hardware manufacturer in anyway. It is intended as a bridge to provide insights and facilitate accessing and utilizing to existing hardware capability from within SA. It should be considered a guide to SA's integration and control over hardware capabilities.

New River Kinematics (NRK) regularly updates this manual to incorporate the most recent updates and changes to SA. However, due to the fact that this manual is currently under development, and due to the rapid pace of NRK's software development, you may encounter out-of-date material. NRK is aware of this and is working to bring content up-to-date.

If you have any comments or suggestions for this manual, or if you notice any errata, please report them to support@kinematics.com.

Conventions

> **Note:** An important note that accompanies the text appears in a box like this.

A standard set of conventions have been established to help ensure that this document is easy to read. The established standards are described here:

The titles of windows and dialogs will appear like this: ***Best Fit Transformation***.

Menu choices appear like this: **Construct>Points>Enter**.

> ⚠️ **Warning:** A warning box, like this, will appear anytime there is information considered to be of a critical nature for either data integrity or measurement data accuracy. Failure to heed warnings could potentially lead to loss of data or incorrect results.

Checkboxes, dropdowns, and other control choices appear like this: *Show Scale Indicator in View*.

Button titles appear like this: Apply.

Keyboard combinations appear like this: `Ctrl+D`.

Named fields or boxes that subdivide areas of the user interface will appear like this: *Degrees of Freedom*.

> 💡 **Tip:** Tips or recommendations that include best practices or time-saving techniques will appear in a box like this.

Filenames appear like this: `License10734.met`.

Text that you should type in will appear like this: `Nominal`.

New terms will look like this: *Relationship Minimization*.

Hyperlinks or links to other locations in this document look like this: support@kinematics.com.

> ## *A Closer Look*
> Additional information that is not critical, but may be of interest to curious readers, is printed in an box like this.

WARNING: UNITED STATES COPYRIGHT LAW PROTECTS THIS MANUAL, ASSOCIATED SOFTWARE, ALGORITHMS, AND VISUAL CONTENT.

Instrument Quick-Starts

Sometimes all it takes is a basic overview of the process to get your feet on the ground and start measuring. This chapter is intended to provide the basic information you need to connect to your instrument and start the interface.

These instrument Quick-Start guides are designed to supplement the manufacturer's instrument device manuals by providing easy to follow steps to get instruments up and running and provide the instrument specific controls you need to know about your instruments operation within SA.

Connecting Essentials

SpatialAnalyzer (SA) has a unique structure. It cannot connect directly to an instrument. Instead it connects to an "interface" application that then talks to the physical hardware. This means that a communication pathway must be opened up between the SA application, the interface application and the physical device.

If you have any question as to whether your computer will have communication restrictions, try opening SA and navigating to **Help>Check My Computer.** This simple utility will run a quick check and let you know if there are any restrictions. It should give you a clean bill of health like this, or nothing much more than a firewall warning as shown here (Figure 2-1).

Figure 2-1. The Laser Tracker interface.
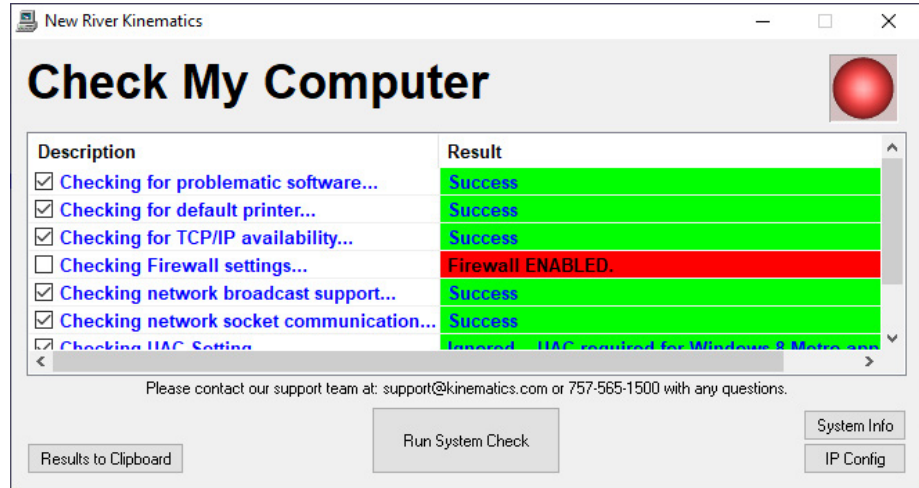
These are warnings only but may be useful in tracking down potential problems. When you first connect it is best to disable all security and simply establish a connection to the instrument first and then turn the security back on and deal with any restrictions that come up.

- **Problematic Software.** Checks for certain problematic software known to interfere with certain aspects of SA operation.

- **TCP/IP availability...** Verifies that network communication is not blocked.

- **Firewall settings...** Firewalls block communication between software packages. If the firewall is on you will probably need to add exceptions to it.

- **Network Broadcast support...** Ensures that your computer's network interface provides support for UDP broadcasting.

- **Network Socket Communication...** Ensures that your computer's network interface provides support for socket communication and that it is not blocked.

- **UAC Settings.** Checks your User Account Control settings (Windows 7 and later) to ensure they're not set too high.

- **Multi-Homed networking...** While multi-homed networks can work well when configured correctly they can also cause problems.

Laser Trackers

Communication

Laser trackers are use a TCP/IP connection to communicate between the instrument's built in controller and SA using the either the

SA Laser Trackers.exe or *SA Laser Tracker API DI.exe* applications.

Exceptions for these applications will need to be made in any active firewall as well as for the *Spatial Analyzer64.exe* application.

All the necessary drivers are built into the SA installation with the exception of the *Faro JRE* files (used to communicate with Faro trackers, (see "Faro Laser Trackers" on page 77)).

The steps to connect are as follow:

1. Find the IP of the Laser Tracker (this will differ using a wired or wireless connection)

2. Double check that your computer has a unique IP on the same network.

3. Open SA and add and instrument model (station plant) to connect to, and connect.

Connecting an Instrument in SpatialAnalyzer -

https://youtu.be/jGtFyMvhZ_0

IP Addresses.

Each tracker has a default IP address. If you have never connected before SA will assume you are using the default wired IP:

- Leica Trackers - Default: 192.168.0.1
- API Tracker - Default: 192.168.0.168
- Faro Tracker - Default: 128.128.128.100

Its always a good idea to first establish a connection through the manufacturer's tools first, discover the IP (and edit it if needed), and then connect to SA using this IP.

You can also open a windows Command Prompt and type: "ipconfig" and press enter to identify the IP addresses defined on your computer.

If your tracker is not on the default IP, you will need to tell SA the IP in the Connection dialog, refer to your tracker's quick start for detauls.

Laser Tracker Interface

The laser tracker interface is a very powerful standardised control used for configuration and operation of any tracker type. For more information on how to use the tracker interface start with "Laser Tracker Interface" on page 10. SA also offers a simplified instrument interface that is more tightly integrated into SA called the "Instrument Toolbar" on page 63.

For tracker specific quick start guides start here:

"Laser Tracker Quick-Start Guides" on page 67

Portable Arms

Communication

Each manufacturer will have its own arm driver that will need to be downloaded and installed in order to connect to the arm within SA. The tested arm driver used with the current version of SA is available on our download plage here:

https://www.kinematics.com/ftp/SA/Install/Driver%20Downloads/PCMM%20Arms/

The steps to connect are as follow:

1. Install the compatible arm driver from the manufacturer.

2. Open SA and add and instrument model (station plant) to connect to, and connect.

Arm scanners may require additional configuration. Refer to the quicks start guide for your arm for more details.

Portable CCM Arms Interface

The Portable CMM Arm interface is a powerful standardised control used for configuration and operation of all arm types. However, for most applications the integrated Instrument toolbar is the place to start for most arm applications (see "Instrument Toolbar" on page 194). For a full set of controls you will want to use the full instrument interface (see "Measuring With PCMM Arms" on page 159).

For a list of specific quick start guides start here:

"Portable CMM Quick-Start Guides" on page 196.

Total Stations and Theodolites

See Quick-Start section of the chapter on Measuring With Total Stations (see "Theodolite and Total Station Quick-Start Guides" on page 234).

Photogrammetry

See Quick-Start section of the chapter on Measuring With Photogrammetry (see "Photogrammetry Quick-Start Guides" on page 293).

Laser Radar Interface

See Quick-Start section of the chapter on Measuring with the Laser Radar (see "Measuring With Laser Radar" on page 355).

Room Scanners

See Quick-Start section of the chapter on Measuring with the Room Scanners (see "Room Scanner Quick-Start Guides" on page 385).

Laser Projectors

See Quick-Start section of the chapter on Measuring/Operating Laser Projectors. (see "Laser Projector Quick-Start Guides" on page 410).

This Page Intentionally Left Blank.

Measuring With Laser Trackers

Laser trackers are prolific portable metrology instruments. They have many uses for both short- and long-range high-accuracy measurements of both discrete and scanned point data. This chapter discusses how to properly and effectively measure with laser trackers in SA.

It also includes a set of specific guides for the use of specific models.

Note: For information on starting specific trackers refer to the Quickstart Guides at the end of the chapter.

This chapter covers laser tracker operation in detail. For a selection of quick start guides which provide a reference for connection and basic operation for specific trackers models refer to "Laser Tracker Quick-Start Guides" on page 67.

There are two ways to measure with laser trackers in SA. The first is through the conventional laser tracker interface, which provides access to advanced functionality and settings and allows complete control over the instrument, target definitions, and measurement modes. The second method is through the simpler Instrument Toolbar, which provides an easy-to-use, streamlined approach to laser tracker measurement.

You'll find that most tracker measurement can be carried out in the Instrument Toolbar, which provides accelerated workflow for common tasks such as discrete and stable point measurement and spatial scanning. However, when more control is needed—or when detailed settings or profiles need to be created or modified—the traditional laser tracker interface provides the ability to work at a deeper level.

We'll first cover the laser tracker interface in detail, then cover the Instrument Toolbar.

Laser Tracker Interface

SpatialAnalyzer's laser tracker interface (Figure 3-1) provides the operator with a great deal of control when measuring with a laser tracker device. The interface has five main sections: the menu and toolbar, target naming, measurement control, measurement profile control, and additional controls.
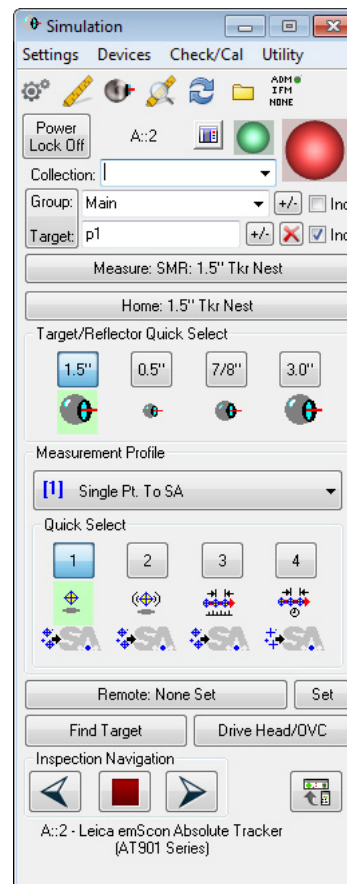
Figure 3-1. The Laser Tracker interface.

 At the top of the interface, an interface docking button ▦ toggles between docking the interface to the SA window or letting it float as a separate window. If the instrument interface is opened without running SA, or if the interface is run on a machine other than the machine running SA, this button is unavailable (as there would be no instance of SA on the computer to dock with). If more than one interface is running, docking an interface will replace any currently docked interface.

Interface Overview

Menus

Use the menus to get to detailed tracker settings, instrument monitoring utilities, compensation check routines, and other instrument-related utilities.

Toolbar

Figure 3-2. The tracker interface's toolbar.
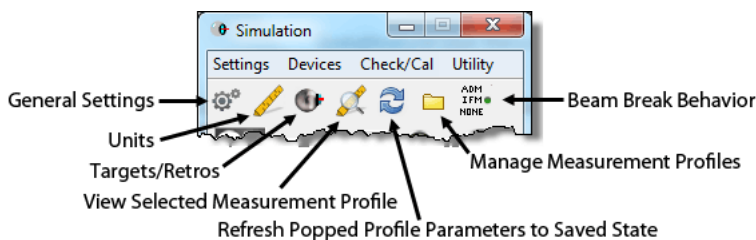
The toolbar (Figure 3-2) provides buttons for commonly-accessed areas of the instrument interface.

Status Indicators

Two colored status indicators (sometimes referred to as traffic lights) indicate the current status of the weather station and tracker beam.

Target Naming

Figure 3-3. Naming for measured targets.
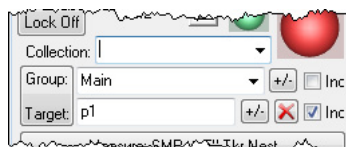
Controlling target names (Figure 3-3) is an important part of the tracker interface. Use this section to control how measured points are named and organized in the SA tree.

Measurement Control

Figure 3-4. Measurement buttons.
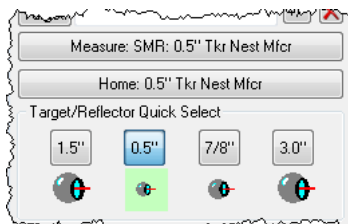
These controls (Figure 3-4) provide access to the critical measurement commands required for operating a laser tracker, including taking a measurement, returning the instrument to the home position, and setting the active target.

Measurement Profile Control

Figure 3-5. The measurement profile dropdown.
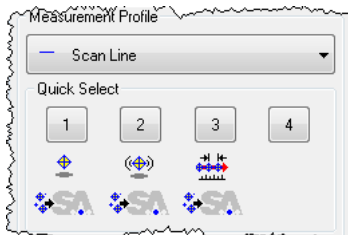
This section (Figure 3-5) allows you to quickly switch to any number of predefined measurement profiles. These profiles precisely control what's measured, how it's measured, and what's done with the mea-

surements once they come into the interface.

Additional Controls

Figure 3-6. Additional tracker controls.
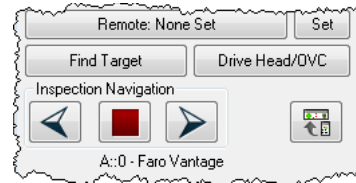
The additional controls (Figure 3-6) give you the ability to set and re-call remote home positions, perform ADM locks, drive the tracker ser-vos via a variety of different methods, switch to the Laser Tracker Tool-bar, and navigate an inspection in the SA Toolkit.

Collection/Instrument ID

When an instrument is added to an SA job, it is assigned an index number. The index (which, for a given collection, begins counting from zero) is used to associate measurements to instruments and also to differentiate one instrument from another, since multiple instru-ments (of the same type) are frequently added to a job to enable mul-tiple station surveys. The instrument index number is incremented by one as each new instrument is added to a collection. This text displays the connected instrument's collection, index number, and name.

Beam Status

The Beam Status indicates both the current state of the laser tracker beam, as well as the distance measurement technology being used (IFM vs. ADM). There are four possible states:

- **Green.** The tracker is locked onto the retroreflector, and the range data has been set using IFM (Interferometry) technology.

- **Green/ADM.** The tracker is locked onto the retroreflector, and the range data has been set using ADM (Absolute Distance Meter) technology.

- **Yellow.** The tracker has locked onto the retroreflector, but a valid distance measurement has not yet been attained.

- **Red.** The tracker is not currently locked onto the retrore-flector, and valid range data is not available.

Power Lock

For instruments that support Power Lock, this functionality can be toggled on and off by clicking the Power Lock button (Figure 3-7).

Figure 3-7. The Power Lock toggle button.

Target Naming

Figure 3-8. The collection, group, and target name for a measured point is specified here.
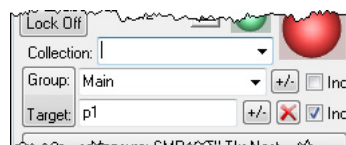
Each measured point in SA has a collection, group, and target name (Figure 3-8). This naming system is used for organizing measured data into logical groups. In general, before taking a set of measurements the target naming section should be filled out in order to measure points into the proper collections and point groups.

Collection

Enter the destination collection name for the resulting targets or geometries, or select an existing collection from the dropdown. If this field is left blank, the measurements will be placed by default into the active collection.

Group

To place measured targets into an existing point group, either type in the group name or select it from the dropdown. To place measurements into a new group, enter a new name into the field.

- **Increment/Decrement.** The Increment/Decrement button $\boxed{+/-}$ allows you to quickly increment or decrement the current group name by one. To increment a group, left-click this button. To decrement, right-click the button. If a group name does not have a numeric suffix, one will be added automatically.

- **Increment Checkbox.** The increment checkbox $\boxed{\checkmark}$ Inc specifies whether a group name should be automatically incremented at the completion of a measurement profile. If checked, then when a measurement profile completes the group name will automatically increment by one. Otherwise, the group name will not be changed at the completion of a measurement profile. This is perhaps most commonly used when measurement profiles are iterated.

Target

Enter a name for a specific target (measured point) into the *Target* field. This target name is automatically incremented after a measurement. If a target name does not have a numeric suffix, one will be added automatically. If the increment checkbox $\boxed{\checkmark}$ Inc is checked next to the

Group field, then the target name will reset to 1 after the group name has been incremented.

- **Increment/Decrement.** The Increment/Decrement button ⊞ quickly increments (left-click) or decrements (right-click) the target name by one. If incrementing and a target name does not have a numeric suffix, one will be added automatically.

- **Delete Last Point.** The Delete Last Point button ✖ will delete the most recently measured point, if it exists.

- **Increment Checkbox.** The increment checkbox ☑ Inc increments the point name when enabled, and leaves the point name as-is when disable. It is on by default (and is automatically turned back on every time you start the interface). Turn this off only if you intend to take multiple observations under the same point name.

Measurement Control

Figure 3-9. Controls for measurement.
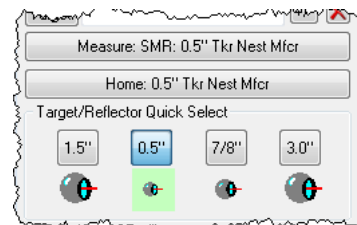
Measure

Triggers the active measurement mode, which can do anything from take a single measured point to trigger a scan. The name of the currently active target in the interface is listed on the Measure button.

Home

The Home button sends the instrument back to its home position and attempts to lock on the active reflector. The instrument interface will wait until it is able to successfully lock onto the reflector or the operator aborts the process. A successful lock on the reflector sets the beam status indicator to a green state.

Some trackers do not have a home position defined. In this case, this button will be grayed out.

Target/Reflector Quick Select

Since changing target definitions happens somewhat frequently when measuring with a tracker, the target/reflector quick select buttons allow you to assign up to four target definitions to quick-select buttons. Once defined, a simple left-click activates the new target, avoiding the need to navigate into the targets/reflectors dialog to activate a different target. For more on target definitions, see Targets and Retros below.

To Assign a Defined Target to a Quick Select Button:

▪ Right-click the desired button and select the named target from the list.

Measurement Profile Control
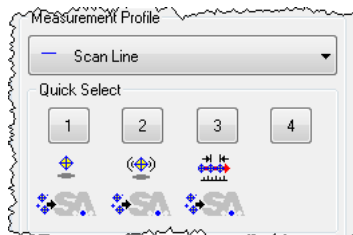
The *Measurement Profile* dropdown (Figure 3-10) allows you to select any of the saved profiles and set it as the active profile. After doing so, clicking the Measure button initiates that selected profile. There are also four profile quick select buttons, which allow you to easily assign a profile definition to each.

To Assign a Defined Measurement Profile to a Quick Select Button:

▪ Right-click a button and select the desired profile from the list.

For more on measurement profiles, see "Measurement Profiles" on page 25.

Additional Controls

Remote Home

> **Warning:** When setting a Remote IFM position, it is very important that the position be stable and free from vibration. Any movement relative to the tracker will increase error in the IFM distance measurements.

> **Warning:** When setting remote home positions, the tracker should be in IFM distance measurement mode.

A *remote IFM home* can be established in the laser tracker interface. A remote IFM home allows you to define a new "home" position which is used by the tracker for seeding the IFM distance value. This new position will have a stored IFM distance which will be used to initialize the tracker's range when locking onto this remote home position. The major advantage of this capability is that when working in a position that makes it difficult or time-consuming to access the tracker home position (such as when on scaffolding or far from the tracker), you can define a new home position. By pressing the Remote Home button, the tracker will point to the defined home position and wait for a retroreflector. Once a retro is acquired, the IFM distance value will be initialized by the stored value.

Note that when a remote home position is specfied the remote home button will contain the custom name of the remote home position.

To Define a New Remote Home Position:

1. Click the Set button. The ***Remote IFM Reset Positions*** dialog will appear (see Figure 3-11).

Figure 3-11. The dialog used for setting remote homing positions.
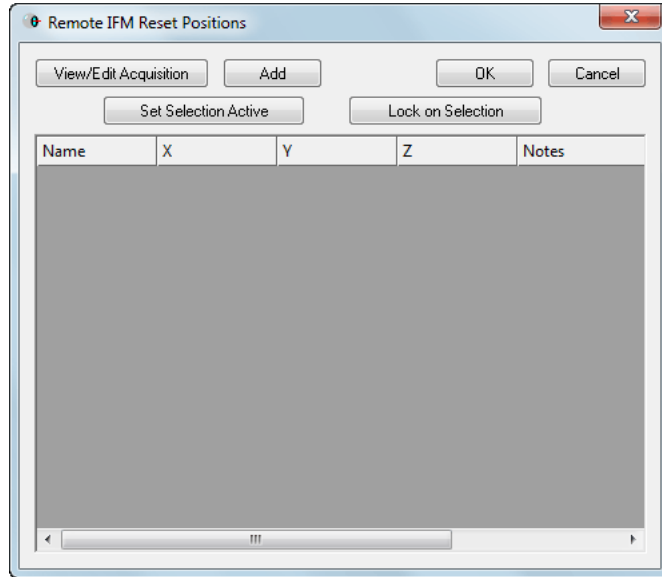
2. Place the retroreflector into a monument or other stable point of reference and click the Add button. The current position will be measured and added to the window.

3. Click the *Name* or *Notes* fields to add a custom name to the remote home position, or a custom note about the position (see Figure 3-12).

Figure 3-12. A remote home position has been set.
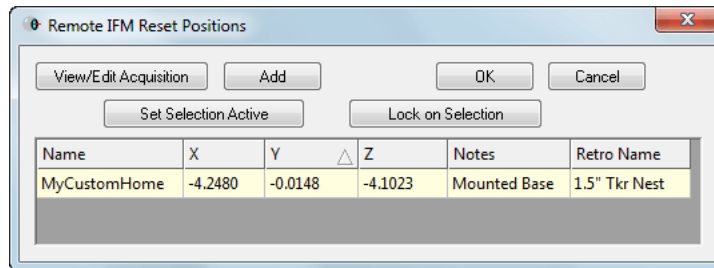
To Set a Remote Home Position as the Active Remote Home:

1. Click the Set button. The **Remote IFM Reset Positions** dialog will appear.

2. Select the remote home position you'd like to activate.

3. Click the Set Selection Active button.

4. Click the OK button. The Remote Home button will list the new active remote home position.

To Change How a Remote Home Position is Measured:

1. Click the Set button. The **Remote IFM Reset Positions** dialog will appear.

2. Click the View/Edit Acquisition button.

Figure 3-13. Changing the remote home acquisition method.

Parameter	Value
Points	1
Samples/Pt.	50
PPM Tolerance	20.000000
Sampling Freq...	50.000000
Sample On Co...	☐
Front/Back	☐
Send Ft/Bk Poi...	Separate Obs ▼
Auto-Outlier R...	☐
Auto-Outlier T...	3.000000
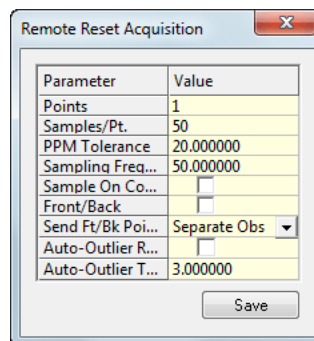
3. In the **Remote Reset Acquisiton** dialog (see Figure 3-13), choose the desired parameters for the remote home measurement. For more details on the specific parameters see "Measurement Profiles" on page 25.

4. Click the Save button.

To Point to and Lock on Any Specific Remote Home Position:

1. Click the Set button. The **Remote IFM Reset Positions** dialog will appear.

2. Select the row containing the desired remote home position to point at and lock on.

3. Click the Lock on Selection button.

To Delete a Remote Home Position:

1. Click the Set button. The **Remote IFM Reset Positions** dialog will appear.

2. Select any row containing the remote home position to delete.

3. Press the **Delete** key and confirm the deletion.

To Lock on the Active Remote Home Position:

1. Set the retroreflector into the nest/monument at the currently active remote home position.

2. In the tracker interface, click the Remote button. The tracker will point to the remote home position and lock onto the reflector.

Find Target

Note: Depending on manufacturer and proprietary methods, some trackers may not show the ADM indication after locking back on.

The Find Target button will force the tracker to spiral outward from the tracker's current pointing direction and lock onto the first reflector that it can find, using the Absolute Distance Meter (ADM) for the distance measurement. Once locked, the green beam status indicator with the "ADM" label will be displayed, indicating that range has been set via ADM.

To Lock Onto a Reflector Using ADM:

1. Point the tracker generally toward the reflector you'd like to lock onto. The closer the tracker is pointed to the center of the reflector, the faster the lock will occur.

2. Click the Find Target button and wait for the tracker to find and acquire the reflector.

To Adjust the Search Parameters for ADM Reset:

1. From the interface menu, select **Settings>Tracker>General Settings**, or click the Settings ⚙ button in the toolbar.
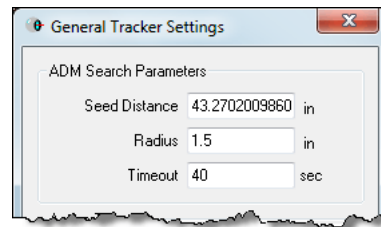
Figure 3-14. Changing the ADM Reset search parameters.

2. The *General Tracker Settings* dialog (Figure 3-14) will appear. The *ADM Search Parameters* section contains the applicable settings, which are described below.

- **Seed Distance.** Coupled with the **Radius** value, the **Seed Distance** is used to calculate the maximum horizontal and vertical angles for the tracker's spiral search. This value is typically set to the distance of the most recent measurement. As a general rule, if you have trouble locking onto a target, this value should be similar to the approximate distance from the tracker to the SMR.

- **Radius.** The outward distance (perpendicular to the line-of-sight) from the tracker's starting pointing direction that will be searched for a reflector.

- **Timeout.** If the tracker has not locked onto a reflector within this time limit (and if it is still searching), then the search will be aborted. This setting allows you to avoid a very long search operation if a large radius is used.

Drive Head/OVC

Clicking the Drive Head/OVC button opens a window giving you the capability to point the tracker using one of several manual methods, such as using the keyboard or mouse (Figure 3-15). If capable, camera-equipped trackers will display a video window when this mode is active.

Figure 3-15. Driving a tracker with the keyboard.
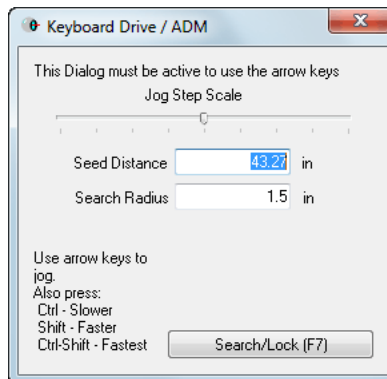
To Steer the Tracker to a Target:

Note: This method may vary depending on instrument manufacturer.

- With the *Keyboard Drive/ADM* dialog open, use the arrow keys to move the tracker beam.

Inspection Navigation

Three Inspection Navigation controls are available at the bottom of the tracker interface (Figure 3-16). These controls are designed to be used while trapping measurements, either as part of an inspection routine using the SA Toolkit or via other measurement trapping methods.

Figure 3-16. The Inspection Navigation controls.
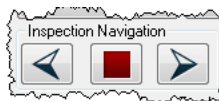
The left and right arrows jump to the previous or next feature for trapping, and the stop button stops all trapping operations.

Targets and Retros

When tracker measurements are taken, the planar and radial offsets are stored with the measured points. Since laser trackers aren't aware of the target or tooling being used, you need to keep the interface informed of which tooling you're using, so that the proper offsets can be assigned to measurements--and so those offsets can be accounted for when analyzing to surfaces or fitting geometry. The Targets/Retros button opens the *Reflectors and Targets* dialog (Figure 3-17) and provides the capability for defining new targets.

Figure 3-17. The Reflectors and Targets dialog.
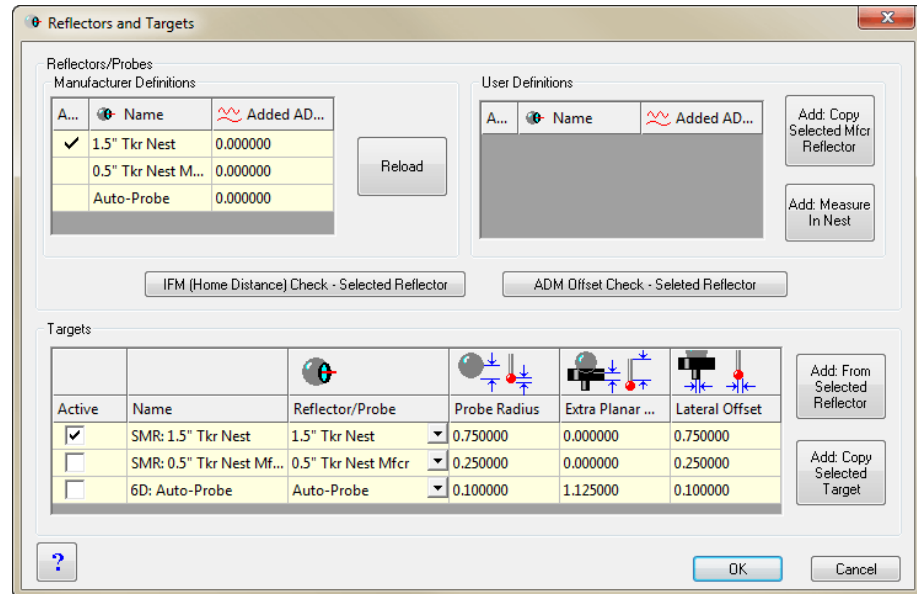
This dialog is divided into three main areas: Manufacturer Definitions, User Definitions, and Targets.

Manufacturer Definitions

Every laser tracker controller has a set of defined reflectors that the instrument supports. For example, trackers commonly support 1.5″, 0.875″, and 0.5″ SMRs, in addition to other peripheral devices. A tracker needs to know which defined reflector is being used for several reasons--one of which is that it tells the tracker which nest to return to when homing.

The list of manufacturer definitions is populated automatically when you open the dialog. In certain cases, the list may need to be refreshed. Clicking the Reload button will poll the controller and retrieve an updated list of manufacturer-defined reflectors. Note that this list may also include 6-DOF devices, mirrors, or other peripherals. Note that this list cannot be modified, and the selected reflector for the active target definition (see below) will be checked.

User Definitions

A user-defined reflector is essentially a manufacturer-defined reflector that has a custom measured ADM offset and/or a custom home position. ADM offset correction is applied when the difference in beam travel length when comparing the red laser to the ADM signal (due to refraction/dispersion) is significant. This is usually the case when the reflector has a clear windowed housing to protect the mirror, or when the reflective surface of the SMR is not the front face (the beam must travel through some material other than air before being reflected). ADM offsets apply a small correction to the measured distance value to account for the different behavior of ADM-wavelength signals.

There are two methods to create a user-defined reflector: Add: Copy Selected Mfcr Reflector or Add: Measure In Nest.

- **Add: Copy Selected Mfcr Reflector.** Creates a user-defined reflector using the same home position as the selected manufacturer reflector when the button is clicked.

- **Add: Measure In Nest.** Creates a user-defined reflector using a custom home position (nest).

Note: This option is not usable with FARO trackers.

To Create a User-Defined Reflector with a Custom Home Position (Non-FARO trackers only):

1. Lock the beam onto your custom reflector and place it into the custom nest.

2. From the *Targets and Retros* dialog, click the Add: Measure In Nest button.

3. When prompted, click Yes to measure.

4. A new user-defined reflector will be added to the table.

To Create a User-Defined Reflector Using an Existing Home Position:

1. Select the manufacturer-defined reflector whose home position you'd like to use from the *Targets and Retros* dialog.

2. Place your reflector in the appropriate nest, then click Add: Copy Selected Mfcr Reflector.

3. When prompted, click Yes to measure.

4. A new user-defined reflector will be added to the table.

To Delete a User-Defined Reflector:

1. Select the user-defined reflector.

2. Press the **Delete** key.

To Rename a User-Defined Reflector:

- Double-click the *Name* field for the user-defined reflector, and type in a new name, then press **Enter**.

To Measure an ADM Offset for a Custom Reflector:

1. Select the desired user-defined reflector in the *Reflectors and Targets* dialog and home on the reflector.

2. Click the ADM Offset Check - Selected Reflector button. The *ADM Check/Cal* dialog will appear (Figure 3-18).

Figure 3-18. Measuring ADM offset.
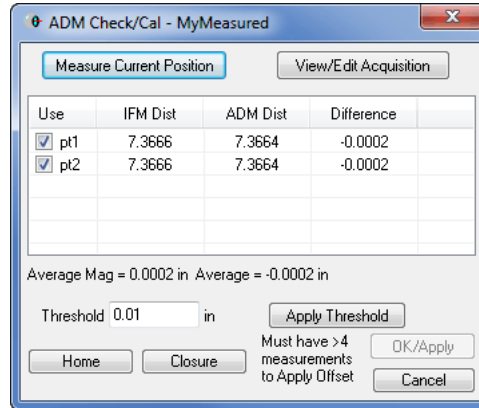
3. If desired, set the measurement parameters for the ADM check by clicking on the View/Edit Acquisition button. These parameters are similar to the Discrete Point Measurement acquisition settings (see below).

4. Place the SMR in several positions (at least 5) around the desired measurement volume, and click the Measure Current Position button in each. The tracker will take an IFM and ADM measurement, recording the difference for each observation.

5. Applying a threshold (by setting the *Threshold* setting and clicking the Apply Threshold button) will highlight any observations in which the difference between the IFM and ADM measurements exceeds the threshold.

6. To ignore any specific measurement for the ADM offset calculation, uncheck its **Use** checkbox. The Home button will send the tracker home, and the Closure button will measure closure on the tracker.

7. When you feel you have taken sufficient measurements, click OK/Apply to apply the calculated ADM offset to the reflector, or Cancel to close the window and discard changes.

Targets

The targets section lists all of the defined target configurations for the tracker. Target configurations consist of a selected reflector and any combination of measurement tooling. This tooling, along with the reflector, determines the total offset of your measurements.

For instance, a simple 1.5" SMR is a target configuration, as is a 7/8" SMR. A 1.5" SMR with pin nest is also a target configuration, as is a 6mm retro-probe or point probe. Each of these different configurations has a specified planar offset and lateral, or radial, offset.

After adding a target configuration, it will appear as a row in the *Targets* table at the bottom of the **Reflectors and Targets** dialog (Figure 3-19).

Figure 3-19. The new target definition is in the Targets table.

This table has a number of columns that describe the attributes of the target:

- **Active.** The checked target is currently active, and its offsets will be applied to any measurements.

- **Name.** The custom name for the target configuration.

- **Reflector/Probe.** The manufacturer- or user-defined reflector used by the target configuration.

- **Probe Radius.** The radius of the spherical reflector or probe.

- **Extra Planar Offset.** An additional offset that is applied in addition to the probe radius when planar offsets are used (such as fitting a plane). The total primary (planar) offset is the sum of the probe radius and extra planar offset. For example, when using a 1.5″ SMR with standard pin nest, the total offset is 0.75″ (Probe Radius) + 0.25″ (Extra Planar Offset) = 1.0″.

- **Lateral Offset.** The lateral (radial) offset to use when fitting circles and ellipses for features such as holes and pins. When using a purely spherical probe, the lateral offset is equal to the probe radius. For an edge nest, it's zero--and for a pin nest, it's equivalent to the shank radius.

To Define a New Target Configuration:

1. In the *Reflectors and Targets* dialog, select the desired manufacturer-defined or user-defined reflector from one of the top two tables, as appropriate.

2. Click the Add: From Selected Reflector button. The *Add Targets* dialog will appear (Figure 3-20).

Figure 3-20. Adding predefined targets.
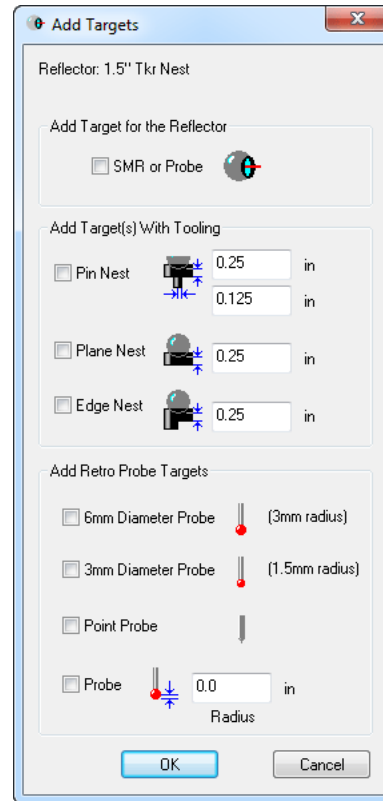
3.   From the options, pick one or more targets to define, then click OK. (For a definition of these options, see below).

4.   One or more new target definitions will be added to the *Targets* table, depending on the selected items.

When defining a new target, the **Add Targets** dialog provides several shortcuts for common tooling configurations.

-   **SMR or Probe.** Adds a separate target configuration entry for the individual probe/reflector only.

-   **Pin Nest.** Adds a target configuration for the selected reflector with a pin nest (you define the shank radius and planar offset.).

-   **Plane Nest.** Adds a target configuration for the selected reflector with a plane nest (you define the planar offset).

-   **Edge Nest.** Adds a target configuration for the selected reflector with an edge nest (you define the offset).

-   **6mm Diameter Probe.** Adds a target configuration assuming the use of a retro probe with a 6mm diameter probe.

-   **3mm Diameter Probe.** Same as 6mm Diameter Probe, except using a 3mm probe instead of a 6mm probe.

-   **Point Probe.** Same as above, except assuming a point probe (no offsets).

- **Probe.** Allows you to enter a custom retro probe radius.

In addition to selecting the predefined options, you can also manually modify the *Extra Planar Offset* and *Lateral Offset* columns to use any desired numeric value. You may even see negative values. As long as you remember that the total planar offset it the sum of the probe radius and extra planar offset, the numbers should always make sense. For example, if 1.5" SMR is the selected reflector for use with a retro probe with a point probe, then the probe radius will be 0.75" and the extra planar offset will be -0.75".

To Rename a Target Configuration:

1. Double-click the *Name* field for the desired target in the *Targets* table of the **Reflectors and Targets** dialog.

2. Type a new custom name, then press **Enter**.

To Delete a Target Configuration:

1. Select the desired target to delete in the *Targets* table.

2. Press the **Delete** key and confirm the deletion.

To Make an Editable Copy of a Target Configuration:

1. In the *Targets* table, select the target configuration to copy.

2. Click the Add: Copy Selected Target button.

3. A copy of the selected target configuration will be added to the table.

To Make a Target Configuration the Active Target:

> 💡 **Tip:** A faster way to activate a different target is to use the quick-select on the main interface.

- In the *Targets* table, check the **Active** checkbox next to the target configuration you'd like to activate.

Measurement Profiles

Measurement profiles are defined parameters for acquiring data (taking measurements), operating on that data, and then "doing something" with that data. For example, the most common and simplest measurement profile is one in which clicking the Measure button takes a single measured point. But there are many more capabilities, such as stable point or spatial scan acquisition modes, as well as many operations that can be performed on data (such as fitting geometry, creating cloud points, etc.). Measurement profiles are essentially custom presets. By defining your own custom presets for different tasks, you can easily switch from one profile to another and progress through pre-defined measurement profiles without taking time on the shop floor to adjust settings. This is most advantageous when performing repeated measurements of parts. Clicking the Measure button initiates a measurement profile, and it concludes when the profile is completed.

To edit or define new measurement profiles, click on the View Selected Meas Profile 🖌 button. This will open the **Meas Profile Parameters** window (Figure 3-21).
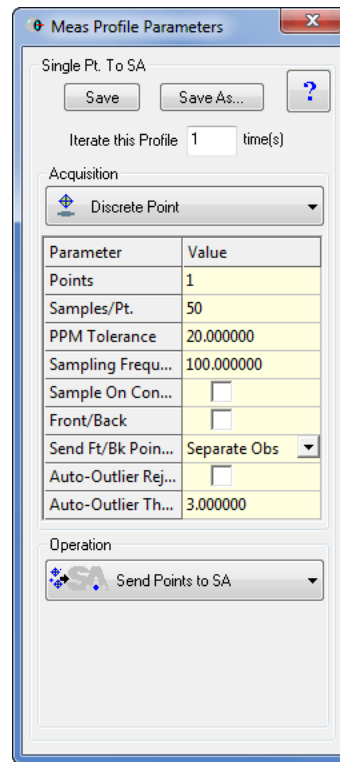
Figure 3-21. The Measurement Profile parameters.

If, after modifying the measurement profile parameters, you decide that you'd like to revert to the settings saved to the profile on disk, click the Refresh Popped Profile Parameters to Saved State button ⟳. At the top of the dialog is the name of the profile being viewed. In the screenshot above, it's *Single Pt. to SA*. There is a Save button to save the current settings and overwrite the existing profile, and a Save As button to save the settings as a new profile.

- **Iterate this Profile X times.** This setting will repeat the complete profile a given number of times.

To illustrate the profile iteration setting, consider an example in which you wish to measure a bolt hole pattern with 24 holes. Suppose you set a profile to measure points spaced by 0.1" around a bolt hole, then fit a circle and create a point at the center of that circle. Since you'd want to repeat that process for the remaining 23 holes, you'd set the interface to iterate the profile 24 times and measure the entire bolt hole pattern--all requiring you to press the measure button only once.

There are two major sections in the **Measurement Profile Parameters** dialog: *Acquistion* and *Operation*. The *Acquisition* section defines how measurement data is acquired, and the *Operation* section defines what is done with that measurement data once it's obtained. Details for these two sections are provided next.

Acquisition Modes

The acquisition section, as its name implies, determines how measurements are acquired by the tracker. You can measure a single point on command, measure points spaced by time or a distance, measure points on specified cross sections, and much more. The dropdown (Figure 3-22) allows you to specify the acquisition mode to use for the current measurement profile. When you select a mode, the parameters unique to that mode appear, which you can adjust as desired.

Figure 3-22. Choosing an acquisition mode.
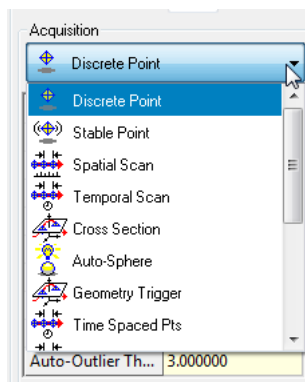
Each of the default primary acquisition modes is described below. For each measurement mode, only the parameters not already discussed will be covered.

Discrete Point (Fast/Standard/Precise Point on Leica trackers)

This mode acquires a single point when the Measure button is clicked. (For Leica trackers, Fast/Standard/Precise controls the length of time that samples are taken, since the sampling frequency is not configurable).

- **Points.** Specify the number of points you would like to measure. Leave the value at "0" to continue repeating measurements.

- **Samples/Pt.** The number of samples to average together in calculating a single discrete point. This is particularly useful for noisy environments, or cases in which vibration is encountered. This setting proportionately affects the time required for an individual measurement.

> **Note:** The number of samples cannot be directly configured on Leica trackers.

- **PPM Tolerance.** Sets the allowable RMS error for measurements based on the distance of the measurement from the instrument. For example, at the default value of 20 PPM, a measurement 7.21m from the instrument would have an allowable RMS error of 7.21m × (20/1,000,000) = 144.2 microns. If after collecting all samples for the point this allowable RMS is smaller than the actual RMS, a *Tolerance Exceeded* dialog will appear.

> **Note:** Sampling frequency on Leica trackers is constant and cannot be set explicitly.

- **Sampling Frequency.** The desired rate at which to take samples, in Hz. If this rate is not achievable by the instrument, the

closest value will be used. This rate inversely affects the time required to take a measurement. A higher frequency will result in faster measurement. Note that Sampling Frequency, in combination with the Samples/Pt setting, determines the duration of measurement. For example, a discrete point measurement at 50 samples/pt and 100 Hz will result in a measurement time of 0.5 secs.

- **Sample on Controller.** Specifies whether the samples are acquired on the tracker controller, or by the instrument interface. Acquiring samples on the controller will often permit a higher sampling frequency, but since SA does not have access to the individual sample data it cannot provide statistical information about the samples unless the controller makes it available.

- **Front/Back.** If checked, each measurement will consist of both front and back face measurements.

- **Send Ft/Bk Points As.** When measuring front face and back face, the individual face measurements can be sent as *Separate Obs*, in which case they become two separate observations under the target, or as *Single Avg Pt*, in which the front-face and back-face measurements are averaged together for a single observation.

- **Auto-Outlier Rejection.** If enabled, SA will perform outlier rejection on the samples (see *Auto-Outlier Threshold*, next).

- **Auto-Outlier Threshold.** The sigma value outside of which samples should be discarded. When measurement samples are collected, SA performs a statistical analysis and determines the standard deviation of the measurements. This value, specified in sigmas, indicates which samples should be thrown away and excluded from the samples used to calculate the average point coordinate. For example, a value of 3 indicates that all samples outside of 3 sigma should be tossed away.

Stable Point (Fast/Standard/Precise Stable Point on Leica trackers)

Stable Point acquisition mode waits for the reflector to move and then become stable again. Once stable for a specified period of time (2 seconds by default), a discrete measurement is taken. This cycle is repeated for as many points are specified in the profile. This acquisition mode is especially useful for single-operator environments, because the measure button only needs to be clicked once for the entire profile. (For Leica trackers, Fast/Standard/Precise controls the length of time that samples are taken, since the sampling frequency is not configurable).

- **Stable Space.** For stable point measurements, the diameter of a sphere that the probe center must remain inside to be con-

sidered stable for purposes of triggering measurement.

- **Stable Time.** For stable point measurements, the amount of time the probe center must remain inside the stable space to be considered stable for purposes of triggering measurement.

- **Measure When Beam Found.** This option is no longer used.

Spatial Scan

Spatial Scan measures points spaced by a specified distance. Each time the reflector moves the prescribed distance from the previous measurement, another measurement is triggered. Be aware that this distance will not be perfect, as hardware sampling rate, reflector speed, computer clock speed, network latency, and other factors introduce lag between when the prescribed increment is detected by the instrument interface and when a measurement is taken.

- **Start Trigger.** Indicates what trigger is to be used to start the measurement profile. After the Measure button is clicked, *Button/delay* delays the prescribed number of seconds (in *Delay Before Measuring* below) before measurement starts. *Button/stable* waits for the probe to move, then become stable again before triggering measurement.

- **Delay Before Measuring.** Used when *Start Trigger* is set to *Button/delay*, the number of seconds to delay before initiating the measurement profile.

- **Pause @ BeamBreak.** If active, the measurement profile will be paused if the beam is broken, and resumed when the beam is locked again.

- **Stop Trigger.** Indicates what event is used to signify the completion of the measurement profile. *# Points* stops measuring when the specified number of points is reached. *Beam break* stops measuring when the beam is broken. *Loop* stops measuring when the target loops back to its original measuring position, completing a closed loop.

- **Increment.** For spatial scanning modes, indicates the desired spacing between adjacent measurements.

Temporal Scan

Measurements are triggered at a specified time interval. Due to sampling frequency, latency, and other factors, there will be small discrepancies between actual and requested spacing.

Cross Section

Equally-spaced cross sections can be established along the X, Y, or Z axis of the working frame at a specified distance. These sections trigger a measurement as the probe crosses the plane.

- **Sampling Increment.** Indicates the spacing between adjacent samples.

- **Working Frame Axis.** The axis along which the planes should be located.

- **Axis Cross Value.** The position along the specified axis to locate the cross section.

- **Use Closest Point.** Indicates whether the closest point to the section should be used (raw measurement), or whether a point directly on the cross section should be used (interpolated between the closest point on each side of the plane).

Auto-Sphere

Spatially-spaced measurements will be taken, and when data is seen to be spherically distributed, SA will automatically fit a sphere to that data.

- **Fit Threshold.** A set of measured points must fit a sphere to better than this value to be considered a valid sphere.

- **Lock Radius.** If enabled, the resulting spheres must have the specified radius.

- **Lock Rad Value.** Specifies the radius to use when locking.

Geometry Trigger

Planes, cylinders, and spheres can be configured to act as measurement triggers such that when a probe crosses the specified geometry, a measured point is recorded.

- **Geometry Triggers.** Defines the geometry used to trigger measurement in *Geometry Trigger* acquisition. To define triggers, click the *None Set* box.

The **Make Geometry Crossing Triggers** dialog will appear when defining geometry triggers for this mode (Figure 3-23). There are three trigger types: planes, cylinders, and spheres. The Select button allows you to select existing geometry from the SA file to use as triggers. The Cartesian, Cylindric, and Concentric buttons provide options for using planes spaced along a Cartesian axis, Cylindrically rotated about an axis, or to create concentric cylinders. When *Draw In SA* is selected, the geometry will be physically created in the SA file.

There are two sampling methods for the geometry: *Closest Pt.* and *Interpolate*. Closest Pt. uses the closest sample to the geometry as the resulting measured point, whereas Interpolate creates a point directly on the geometry by interpolating between the closest samples on each side of the geometry.

Figure 3-23. Defining geometry triggers in the tracker interface.
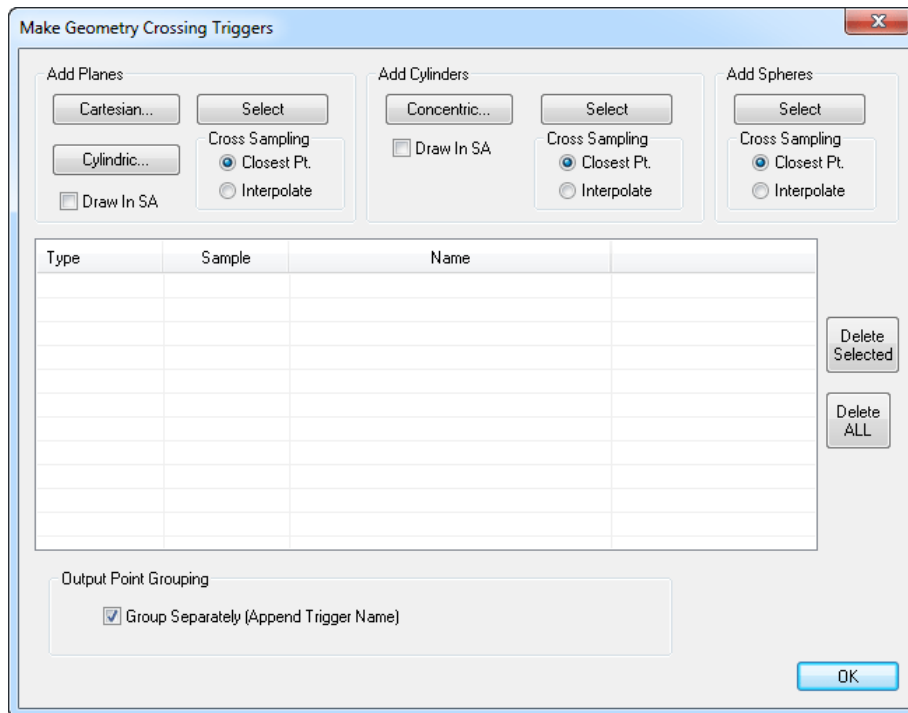
When *Group Separately (Append Trigger Name)* is selected, the measurements will be placed into separate point groups based on the specific geometry that triggered them.

Time-Spaced Points

Repeated discrete point measurements are taken spaced by a specified time. Note that this differs from Temporal Scan in that temporal scan has only a single sample per point and assumes that the target is in motion. Time-Spaced Points has a configurable number of samples and assumes that the target is stationary during the sampling process.

- **Time Between Points.** The time to wait between successive discrete measurements.

High Point

> **Warning:** Offset compensation is automatically applied to the high point, and its planar offset is set to zero. Points are shifted toward the axis when using *From Axis* and in the negative axis direction when using *Along Axis*.

Measurement samples are taken, and upon completion of the measurement, only the highest point along a frame axis or the farthest point from a frame axis is recorded.

- **Working Frame Axis.** The axis (*X*, *Y*, or *Z*) to check for a high point, and whether the check should be performed along that axis or radially from that axis.

Hidden Point

Two points are measured (A & B), and a third (hidden) C point is constructed automatically based on the first two.

- **Measure Time (secs).** The time to measure each point.
- **Bottom Pt Offset.** The distance from the bottom (B) point to the hidden point.
- **Planar Offset.** The desired planar offset for the resulting hidden point.
- **Radial Offset.** The desired radial offset for the resulting hidden point.

Edge Points

Developed primarily for sheet metal work, this mode allows you to drag a probe along a flat surface, and when it begins to fall off the edge, will create a point on the edge of the surface.

- **Edge Plane.** Defines the plane that the probe will be slid along.

Operations

Figure 3-24. Specifying the tracker interface's operation.
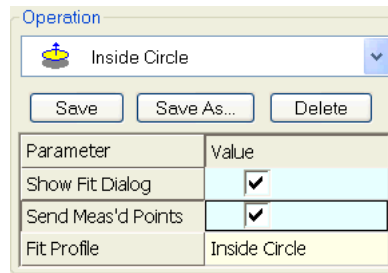
The *operation* specifies (Figure 3-24) what to do with the measurements once they are obtained. Here a user can decide whether to send the points directly to SA or perform another operation. One example is using the "Inside Circle" operation: this will perform a circle fit and show the fit dialog prior to sending measurements to SA. The advantage of this type of operation is that real-time processing of measurements can take place. That is, you can fit geometry to measurements and identify potential problems right at the time of measurement.

The different basic operations are described below. For each operation, only the parameters not already discussed will be covered.

Send Points to SA

Measured points are sent on to SA to be created as normal measured points in the job file. There are no settings for this operation.

Send Updates to SA

SA is updated with the latest measured position and orientation of the tracker and probe, but no measurements are created in the job file. There are no settings for this operation.

Send Cloud Points to SA

Similar to "Send Points to SA", except that instead of creating standard

measured points, SA creates cloud points. The major advantage of using this operation is seen when measuring a large number of points with a laser tracker (greater than ~20,000). For efficiency purposes, best practice when taking large volumes of data is to use cloud points, because the metadata associated with normal measured points consumes a large quantity of RAM.

- **Buffer Size.** The number of points to buffer in the interface before sending them over the network to SA. Only advanced users should modify this value, and only with good reason.

Poll Data

> **Note:** The Poll Data operation is only useful for certain (usually older) trackers. You only need to use it if you find normal update rates to be too slow for your application.

Certain trackers take a relatively long time to return a measurement update when asked. For applications that operate best with data supplied as close to real-time as possible (such as Trans-Track), you may find it preferable to put the tracker into the "Poll Data" operation instead of "Watch Update", which may yield faster updates.

Make A Circle

A circle is automatically fit to the measured data.

- **Show Fit Dialog.** When enabled, the geometry fit dialog will be displayed at the completion of the measurement profile.

- **Send Meas'd Point.** When enabled, measured points will be sent to SA in addition to the resulting circle.

- **Fit Profile.** The geometry fit profile to use for fitting the circle. Click the box to modify the profile (see the chapter on Geometry Fitting). Right-click to use an existing profile.

- **Projection Plane.** The data can be automatically projected to a plane prior to the circle fit. This is particularly useful when fitting a circle to data that may not be measured along a cylinder's cross-section. For details, see "Projection Planes" on page 35.

Make A Plane

A plane is automatically fit to the measured data.

- **Patch Shift.** Shifts the resulting plane an additional amount after compensating for probe offset.

Make A Sphere

A sphere is automatically fit to the measured data.

Make A Cylinder

A cylinder is automatically fit to the measured data.

Make A Line

A line is automatically fit to the measured data.

Auto Proximity

Used for certain auto proximity automatic measurement modes. Sends data to a command in SA to be interpreted.

Single Point Circles

> **Note:** This operation reduces accuracy when burrs or chamfers exist on the hole edge, or if the hole is out of round.

This operation is effective for measuring a hole with a single point. With a projection plane defined, place the probe into a hole and take a single measurement, and the resulting circle will be created based on the probe diameter and the degree to which the reflector sunk down into the hole.

- **Lock Radius.** Forces the circle to be locked to a specified radius.

- **Locked Radius.** The radius to use when *Lock Radius* is enabled.

- **Intersection Plane.** The plane defining the top surface of the hole can be selected from an existing plane by left-clicking this option, or measured as part of the operation by right-clicking this option. For details, see "Projection Planes" on page 35.

Patch Points

Projects all measurements to a specified plane.

3-Plane Point

Creates a point at the intersection of 3 measured planes (such as the corner of a box).

- **Plane1/Plane2/Plane3.** The three planes defining the corner to measure. Existing planes can be used by left-clicking this option, or measured as part of the operation by right-clicking. For details, see "Projection Planes" on page 35.

Send Frame Updates to SA

Updates SA on the position and orientation of a frame without actually creating any frames in the SA job. Offset frames and offset points can be sent as well. Sending frame updates requires a 6-DOF device.

- **Frames To Send.** You can send a *Raw Frame* (the frame from the device), an *Offset Frame* (a frame offset from the raw frame), or an *Offset Point* (the origin of an offset frame).

- **Offset Frame.** Click this parameter to define an offset frame to send. For more information, see "Offset Frames" on page 35.

Send Frames to SA

Constructs frames measured from a 6-DOF device in the SA job.

- **Frames To Send.** In addition to *Raw Frame*, *Offset Frame*, and *Offset Point* (described above), you can also send *Both Offsets* (offset frame and point), *Both Frames* (raw and offset frames),

Pt. & Raw Frame (offset point and raw frame), and *All* (raw and offset frames & offset point). Frames can be recorded either individually or in Frame Sets which can facilitate larger numbers and measurement rates.

Projection Planes

Certain operations (such as *Make a Circle* & *Make a Plane*) allow measurement data to be projected to a plane prior to the operation. Projection planes handle the settings for this.

To use an existing plane as the projection plane for a measurement operation:

1. Click the box next to *Projection Plane* in the operation's parameters.

2. Select an existing plane in the SA file.

The projection plane may also be measured as part of the operation.

To Measure The Projection Plane As Part Of A Measurement Profile:

1. Right-click the box next to *Projection Plane* in the operation's parameters. The **Plane Options** dialog will appear.

2. Pick the appropriate settings (see below), then click OK. The plane will be measured as part of the measurement operation.

   - **Regenerate in SA.** The measured fit plane will be created in the SA file.

   - **Remove from Profile.** If this option is checked and you click OK, the existing defined projection plane will be cleared.

   - **Fit To Points.** The specified number of points will be gathered as part of measurement to define the plane.

Offset Frames

Offset frames allow you to measure a raw frame with a 6-DOF device, then send an offset frame or point that is spatially offset from the raw frame. The offset frame maintains its relative position and orientation to the raw measured frame.

To measure offset frames, you must first measure and construct the offset frame itself. This frame will be transformed as part of the operation. Then, you must also measure the raw frame, which defines the delta from the reference to the offset frame. As the raw frame is updated and moved, the offset frame will be updated as well.

To Measure Offset Frames:

1. In the **Meas Profile Parameters** dialog, select a measurement operation supporting offset frames (*Send Frame Updates To SA* or *Send Frames To SA*).

2. Select the desired feature to send from the *Frames To Send* parameter.

3. Measure the offset frame.

4. Click the box next to *Offset Frame* in the measurement operation's parameters. The **Offset Frame** dialog will appear (Figure 3-25).

5. Click the 1) Select Offset Frame From SA button and select the frame to become the offset frame.

6. Click the 2) Measure Reference Frame To Offset button to measure the reference frame. The target must be a 6-DOF target.

7. If creating an offset point and you'd like the offset point to have a defined probe radius, enter it in the *3) (Optional) Enter probe radius for offset point* field.
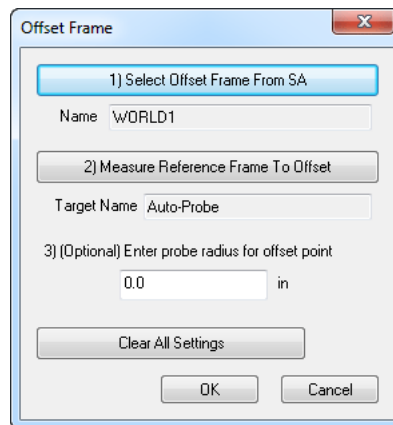
Figure 3-25. Defining an offset frame.

8. Begin measuring 6-DOF frames, and the offset frame will be updated automatically.

Managing Measurement Profiles

Measurement profiles can be managed (Figure 3-26) by clicking the Manage Profiles button in the Laser Tracker Interface. Here you can add and delete measurement profiles. Measurement profiles can also be imported and exported, allowing them to be transferred to another computer. This also serves as a great way to back up custom profiles.

To Delete A Custom Profile:

▪ Click a profile to select it, then click the Delete button.

To Create A New Profile Using Existing Acquisition/Operations:

1. Click the Add button, then enter a new profile name.

2. In the appropriate dropdowns, select the acquisition and operation to associate with the profile.

To Assign A Quick-Select Button To A Profile:

- Right-click a profile and select the desired button.

To Export Profiles To A File:

- Click the Export button, then select the desired filename and path for the .MSP file.

To Import Profiles From A File:

- Click the Import button, then select the .MSP file to import.

To Restore Measurement Profiles To Their Defaults:

- Click the Restore Defaults button.

Figure 3-26. Managing measurement profiles.
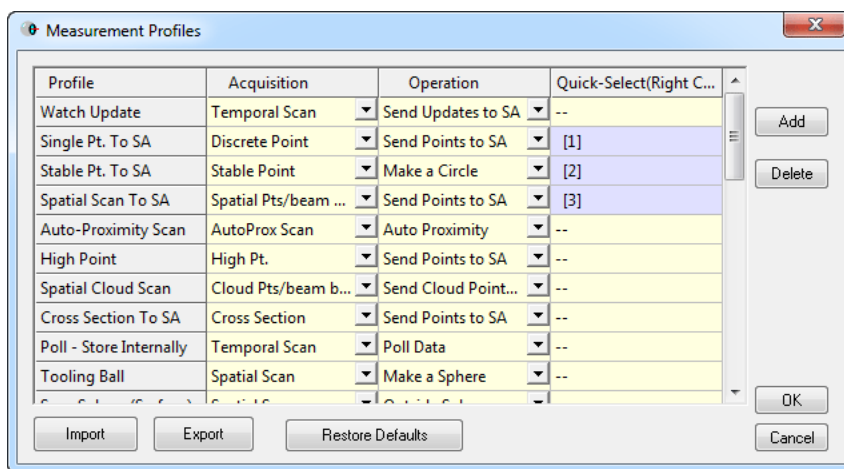
Settings

General Settings

Access to Search Parameters, Action Time Out settings and Tracker-specific Settings can be reached by clicking the General Settings button ⚙ or by selecting **Settings>Tracker>General Settings** from the interface menu. This opens the **General Tracker Settings** dialog (Figure 3-27).

ADM Search Parameters

- **Seed Distance.** Specifies the estimated distance to use when initiating an ADM search. This is generally updated automatically as measurements are taken and usually does not need to be manually modified unless there is large range variation relative to the last measured point and an ADM search to find a target is not successful.

- **Radius.** The radius from the starting pointing position (at a distance equal to the seed distance) at which to start searching. A larger value will initiate an ADM search over a larger cone.

- **Timeout.** If a target has not been found after this time has elapsed, an ADM search will be cancelled.

Action Time Out

- **Get Status.** After requesting the tracker's status, if a response hasn't been received after this time, the request will be cancelled.

- **Get System Info.** After requesting the tracker's system information, if a response hasn't been received after this time, the request will be cancelled.

- **Read Weather.** If a weather information request hasn't been received by this time, the request is cancelled.

- **Set Weather.** If a weather set operation isn't performed by this time, the operation is cancelled.
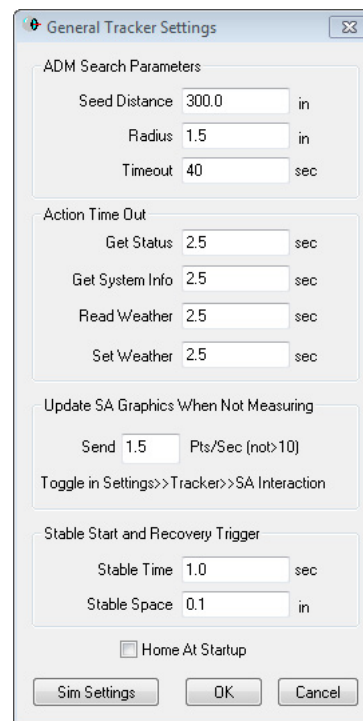
Figure 3-27. General tracker settings.

- **Send x Pts/Sec.** Indicates the frequency at which updates should be automatically sent from the tracker to the SA interface, even when not in a measurement.

- **Stable Time.** Sets the stable time (how long must the probe be stable before starting to measure?) used for stable measurement triggering (wait for move, wait for stable). This does *not* apply for Stable Point acquisition mode, which uses its own setting.

- **Stable Space.** Sets the size of a sphere within which the probe must remain to be considered stable for stable measurement triggering (not used for Stable Point acquisition mode, which has its own setting).

- **Home At Startup.** If disabled, the tracker will not go home

> **Note:** Some trackers may need to home at times, even if this option is disabled.

when the interface is started.

- **Sim Settings.** The label on this button will change depending on the specific instrument connected to the interface. Click it to access parameters specific to the connected hardware.

Units

Click the Units button ✎ to set the active units for the interface(Figure 3-28). When data is sent from the interface to SA, it is automatically converted into the active job units.
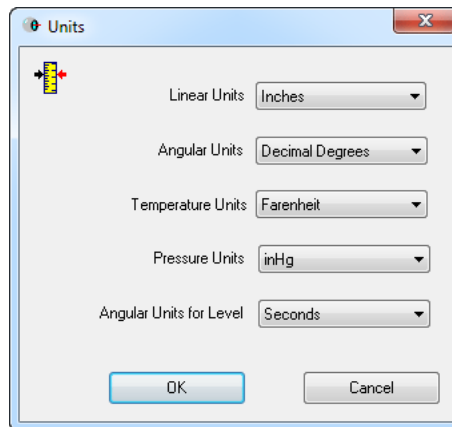
Figure 3-28. The tracker interface's Units dialog.

Function Keys

> ☞ **Note:** The instrument interface will not see function key presses unless it has focus, so be sure to click on the interface prior to attempting to use a function key.

Function keys can be assigned for different operations in the tracker interface (Figure 3-29). The operations that can be assigned to a function key include:

- Measure/Resume
- Watch Data
- Increment Group
- Change Face
- Find Target
- Remote Home
- Home
- Check Closure
- Motors Off
- Motors On
- Decrement Group
- Increment Target
- Decrement Target
- End Acquisition
- Iterate Quick-Select Mode
- Navigation Next

- Navigation Previous
- Navigation Stop
- Remove Last Point

To modify the function keys assigned in the interface, select **Settings>Fcn Keys** from the interface menu. The *Function Keys* dialog will appear (Figure 3-29).

To Change An Assigned Function Key:

- Select a new operation from the dropdown for the specified function key, then click OK.

To Restore Default Function Key Assignments:

- Click the Restore Defaults button.
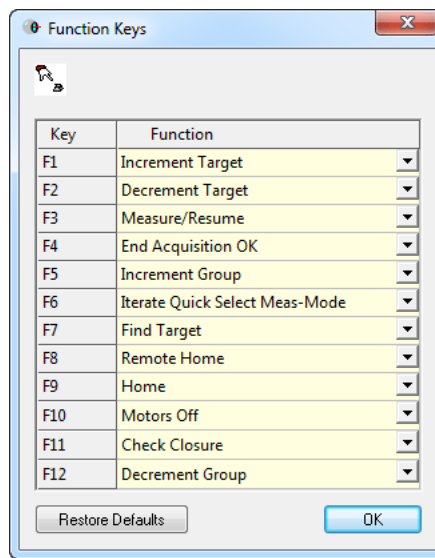
Figure 3-29. Defining function keys in the interface.

User Interface Settings

The verbosity of the tracker interface when displaying certain error message can be controlled using the *User Interface Settings* dialog (Figure 3-30), which is accessed by selecting **Settings>UI** from the interface menu.
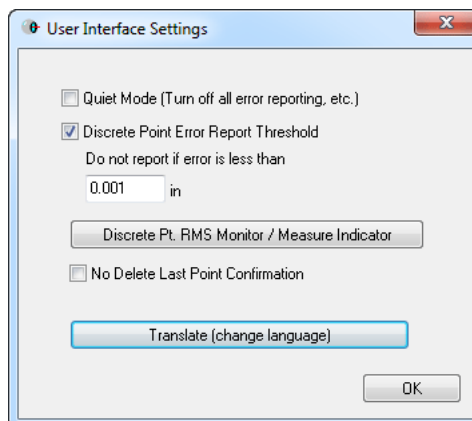
Figure 3-30. The User Interface settings dialog.

- **Quiet Mode (Turn off all error reporting, etc.).** When en-

abled, error messages such as RMS tolerance violations will be suppressed.

- **Discrete Point Error Report Threshold.** This setting controls the minimum limit for reporting an error indicating reflector movement during measurement. This error is normally triggered by the *PPM Tolerance* setting in the measurement profile's acquisition mode, and is based on distance from the tracker. However, measurements close to the tracker may trigger this warning even though the data is valid. This lower limit suppresses errors below the specified value.

- **Discrete Pt RMS Monitor/Measure Indicator.** Turns on the RMS Monitor (see "RMS Monitor" on page 41).

- **No Delete Last Point Confirmation.** When enabled, you will not be prompted to confirm deletion of points via the *Delete Last Point* button.

- **Translate (change language).** The tracker interface can be translated using a custom language, just like the SA interface.

RMS Monitor

The **RMS Monitor** (see "User Interface Settings" on page 40) is a window that can remain open and will display atop the SA interface when docked. It reports the RMS error for measurements when that measurement involves averaging of samples (such as discrete point or stable point acquisition modes).
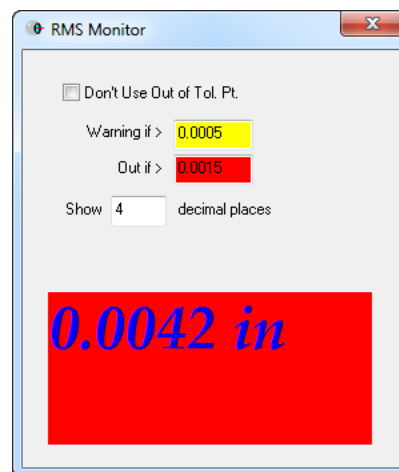
Figure 3-31. The RMS monitor indicating an out of tolerance measurement.

Two tolerances can be set: warning (yellow) and out (red). The RMS error of the previous measurement is displayed, along with the proper color code, to notify you that the previous measurement may have been noisy. The tolerances can be set to your preferred values.

- **Don't Use Out of Tol Pt.** When enabled, a point with an out-of-tolerance RMS value will not be recorded.

- **Show x decimal places.** Limits the displayed RMS value to the specified number of decimal places.

Beam Autoreset Mode

The behavior when the tracker loses a beam lock can be controlled by adjusting the *Beam Autoreset Mode*. There are three modes to choose from:

- **No Action.** When a beam lock is lost, the tracker will just stop and not attempt reset. This is generally only used with older legacy trackers.

- **Auto IFM.** When a beam lock is lost, the tracker will home and wait to lock onto the reflector in the home position using IFM distance measurement (not applicable to ADM-only trackers).

- **Auto ADM.** When a beam lock is lost, the tracker will stop head motion and wait for a beam lock, reacquiring using an ADM distance measurement.

To Change the Beam Autoreset Mode:

- From the interface menu, select **Settings>Tracker>Beam AutoReset>...**, or

- Click the Set Beam Break Behavior button in the interface to toggle between the three modes.

Tracker Pointing Behavior

When pointing a tracker at an existing point, the instrument can behave in one of two ways:

- The instrument can point to the point but not attempt an ADM reset, or

- The instrument can point and perform an ADM search to attempt to lock onto a nearby target.

To Change Tracker Pointing Behavior:

- From the interface menu, select **Settings>Tracker>SA Interaction>Point Laser>Point Only** or **Point and Attempt Reset**.

Updating Graphics While Not Measuring

> 💡 **Tip:** This option persists primarily for older legacy trackers. In general, it's best to leave this option on unless you have a good reason to turn it off.

The probe position, current shot line, and instrument graphics are always updated while measuring, however if you are not in the midst of measurement, you can choose whether or not you'd like the graphical view to automatically update when new data is received from the tracker.

This allows you to view updated Watch Windows without requiring

you to be in any sort of measurement mode, for instance.

To Update Graphics While Not Measuring:

- From the interface menu, enable **Settings>Tracker>SA Interaction>Update Graphics While Not Measuring**. Upon doing so, SA will begin receiving updates from the connected tracker.

Running "Watch Update" Automatically

> 💡 **Tip:** This setting is primarily for older legacy trackers. It is recommended to leave this setting off and leave "Update Graphics While Not Measuring" on unless you have a reason to do otherwise.

Older versions of SA required the tracker to be in an active measurement mode (such as "Watch Update") in order to receive updates to watch windows. This setting will automatically set the tracker to the "Watch Update" measurement profile (and initiate measurement) whenever a watch window is opened.

To Toggle Automatic "Watch Update" Mode:

- In the interface menu, select **Settings > Tracker > SA Interaction > Run "Watch Update" When Watch Window Opened In SA**.

Measurement Requests

Certain measurement commands, such as *Auto-Correspond With Proximity Trigger* and *Measure Nominal Points*, send measurement requests to the instrument interface. When these requests are received, the interface needs to know how to handle the request. These settings are controlled in one of two windows: *Single Point Parameter Measurement Requests* and *Auto-Proximity Profile Measurement Requests*.

Single Point Parameters

For commands that request discrete measurements (such as **Instrument > Locate > Measure Nominal Points**), the measurement settings are controlled by the single point parameters. These parameters are identical to those of the Discrete Point acquisition mode (see "Acquisition Modes" on page 27), but apply when measurements are initiated from SA itself.

To Access the Single Point Parameters:

- In the interface menu, select **Settings > Tracker > SA Interaction > Measurement Requests > Single Point Parameters**.

Auto-Proximity Profile

For commands that use auto-proximity modes, such as **Instrument > Automatic Measurement > Auto-Correspond With Proximity Trigger > Points**, the measurement parameters are controlled by the auto-proximity profile. These commands require some sort of temporal scanning acquisition mode. The specific measurement profile used for these commands can be modified.

To Change the Auto-Proximity Measurement Profile:

- In the interface menu, select **Settings > Tracker > SA Interaction > Measurement Requests > Auto-Proximity Profile**. Select the desired profile from the list.

Measurement Sound Controls

The measurement sounds produced by the tracker are not built into SA directly. Instead SA uses the windows system sounds. This makes it easy for an operator to edit sound selections based upon the needs of the operating environment. In order to edit the sound selection navigate to the Control Panel>Sound.

SA users the following sounds for measurement applications:

- **Asterisk.** Used when you lock onto target and the probe type is changed.

- **Exclamation.** Used when a successful measurement is made

- **Default Beep.** Used when an invalid selection is made.

- **Critical Stop.** Used to notify the operator of a Beam Break, RMS Error, or other error event.

The Weather Station

The Weather Station Status indicator (the smaller of the two colored lights) gives an indication as to the current status of the weather data coming into the interface.

Laser tracker measurements must be compensated using weather data to account for factors such as atmospheric index of refraction. Without doing so, the tracker's measurements would not be as accurate. The possible status indicators and their meanings are presented below:

- **Green.** A weather station (whether internal or external) is connected and sending data.

- **Yellow.** The tracker interface is set for manual input. This setting compensates measurements using manually entered weather data. The yellow color serves as a reminder that this data may need to be updated by hand.

- **Red.** The tracker's controller does not have valid weather data from an internal or external weather station (whichever is selected). This most likely indicates that the interface is not receiving weather data at all. Measurements should not be trusted when the weather status is red.

You can indicate whether you'd like weather data to come from the

tracker's internal weather station, an external weather station, or via manual input.

To Change the Source for Weather Data:

1. Double-click the weather station status indicator or choose **Devices>Weather>Set Up**. A *Weather Source/Settings* dialog will appear (Figure 3-32).

Figure 3-32. Setting the desired weather source.

2. Choose the desired source, then click the Set As Active Source button. Edit the settings for the current selection if necessary. Then click OK/Apply Values to Tracker. The options are listed below.

▪ **Manual Input.** Manually-entered weather data (Figure 3-33) will be sent to the tracker controller to be used for compensation. This weather data will continue to be used until updated manually again. When this option is selected and set as the active source, the *Edit/Confirm Settings* dialog will appear to allow you to set the weather values:
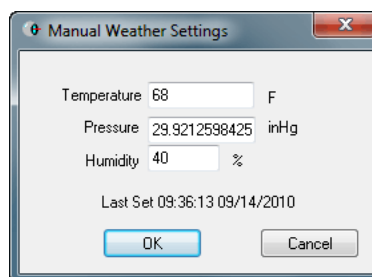
Figure 3-33. Entering manual weather data.

▪ **Tracker Internal Weather Station.** This setting will use the internal weather station integrated into the tracker. Typically, this setting is used when a weather station is either integrated into the tracker, or when a weather station connects directly to a tracker controller. This is the most common source for tracker weather data. When this option is selected, clicking the Edit/Confirm Settings button will allow you to view the weather station's values, but you cannot change them. After selecting this option, click the Set As Active Source button to apply the setting.

▪ **External Weather Station.** This setting allows you to use a

separate, independent weather station device for weather data. After selecting this option, you must first click the Set As Active Source button. This will bring up the ***External Weather Source*** dialog (Figure 3-34).
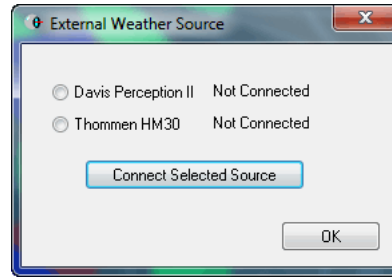
In this dialog, pick the desired device, then click the Connect Selected Source button. If connected correctly, the external weather station's values will be fed to the tracker controller for compensation. As with the Internal Weather Station setting, the Edit/Confirm Settings button will allow you to view (but not edit) the weather station's values.

You can view the current weather data to monitor the change in temperature, pressure, and humidity since the window was first opened. This provides a warning if environmental conditions have changed enough to indicate potentially bad data. The ***Weather Values/Deltas*** dialog shows this information, and this window can be left open while working.

Figure 3-35. Viewing the initial and current weather data alongside the deltas.

	Initial	Current	Delta	Units
Source	Simulated ...	Simulated ...		
Time	13:58:42	14:01:39	00:02:57	H:M:S
Temperature	67.5965	67.3230	-0.2735	F
Pressure	29.9240	29.9165	-0.0075	inHg
Humidity	40.0000	40.0000	0.0000	Pct. Rel.

To View Current Weather Information:

- In the interface menu, select **Devices > Weather > Current Values/Deltas**.

- Click the Reset button to reset the initial values to the current observations.

Level Measurement

Note: Some trackers are not equipped with level measurement devices.

All modern trackers either have a built in inclinometer or provide the ability to connect to an external level measurement device. These devices accurately read the gravity (level) direction at the instruments current position. This information can be used in either of two ways.

1. To compensate the recorded measurements (or change their

location) such that the measurements are reported relative to gravity prior to being recorded.

2. To passively record the orientation of the gravity vector as a measurement. This can be very useful as a direct reference for measurements or for constraining a network of instruments during alignment.

Level Compensation

Some trackers offer a level compensator which can be turned on or off. With a level compensator turned on all measurements are automatically adjusted such that the instruments base frame is aligned with the gravity vector and measurements can be directly compared to a level plane.

This compensation can be a convenience for an operator but it is important to remember that it takes place on the instrument before the data is sent to SA. Compensation is changing the relative position of the measurements in relationship to the instrument stations base frame so turning on or off the compensation requires a new instrument station.

The Influence of Level Compensation

Most laser trackers don't use or have a level compensator, so they always report data relative to the standing axis of the instrument. The difference between level compensated and the standing axis of the instrument models can be seen in SA as shown in the figure below (Figure 3-36).
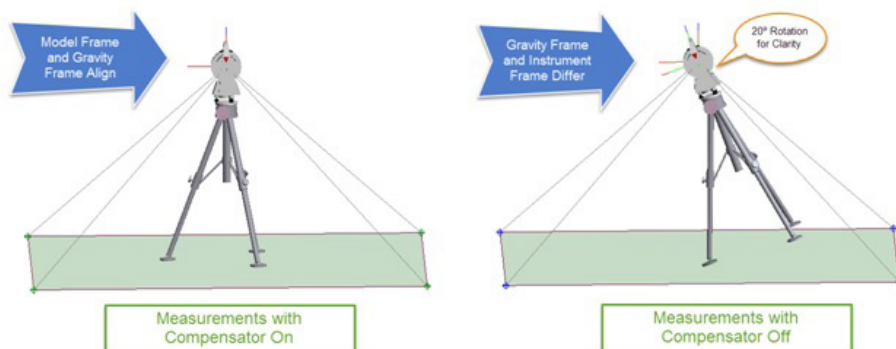
Figure 3-36. Comparison between compensated measurements and standard tracker level measurements.

The instrument model above on the left is using level compensation, so the data is automatically aligned to gravity. The base frame of the instrument and the gravity frame are pre-aligned. The instrument model above on the right isn't using level compensation, so its data is shown relative to the standing axis. Note that when the measurements are straightened using the level measurement the points are in the same location. However, the instrument models are in different

orientations. The uncompensated tracker model on the right reflects the true tilt of the instrument. This difference is often very slight, but can be clearly shown in the graphic above since the angular difference is exaggerated by 20^{0}.

Directly Measuring Level

A level measurement operation is typically taken in 4 separate head orientations or quadrants and the readings in each of the orientations are average to produce an accurate level measurement.

Note: An instrument's gravity frame will be associated with the instrument and will transform along with it.

When a level measurement is recorded, it is saved as a coordinate frame. It is created on the instrument's *base*—the "origin" of the instrument, and uses the instrument model frame for clocking. The Z-axis of this frame represents the measured gravity vector.

Saving a level measurement as a frame rather than a plane (which is an alternative convention) was done deliberately for a couple of reasons:

1. The measured level frame can easily be set as the working frame in the job, which sets all values to be reported relative to gravity.

2. By saving a gravity measurement as a frame it is easy to directly compare this frame with the Instrument's Base frame (created by Construct>Frame on Instrument> Base)

3. Multiple measurements can easily be averaged, using Construct>Frame>Average of Other Object Frames.

4. Degree of Freedom controls within an alignment reference frame components.

Level Measurement Settings

Note: These settings vary from one instrument to another.

Several settings can be adjusted for the level measurement (Figure 3-37) which affect how the measurement is acquired.

To Adjust Level Measurement Settings:

- From the interface menu, select **Devices > Level > Set Up**.

Figure 3-37. Modifying settings for level measurement.
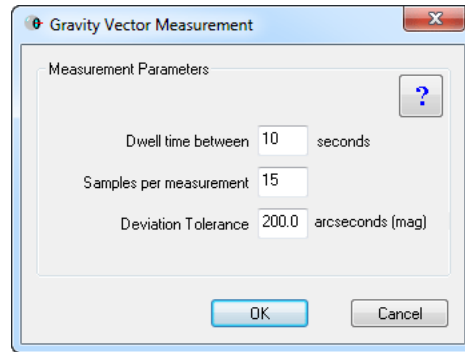
- ▪ **Dwell time between.** Sets the amount of time the tracker waits after positioning the head before taking level samples. This gives time for the bubble level to stabilize before measurement.

- ▪ **Samples per measurement.** The number of samples to average when measuring gravity.

- ▪ **Deviation Tolerance.** Samples that exceed the specified tolerance (as a magnitude) are not included in the averaging operation.

Monitoring Level

Monitoring level provides live readings from the level device and can be obtained by using the command **Devices>Level>Monitor**.

Monitoring level is useful for two primary reasons:

> **Note:** Some instrument OEMs have their own windows for monitoring level. SA will call these windows up in those cases.

1. To ensure that the inclinometer is in range for a level measurement.

2. Monitoring changes in level to determin if a station move is needed.

While extremely accurate inclinometers typically need to be approximately level in order to operate properly. The instrument must be manually adjusted until the inclinometer is reading in-range while a tracker's head rotates through a 360 degree rotation. The Level Monitor (Figure 3-38) displays 3 values:

TkrAz - Displays the current rotational angle of the trackers head in degrees. This value is typically counter clockwise from a standard starting location directly away from the home position.

LevelX - Displays the deviation in arc sections from vertical along the primary or X axis of the trackers level. This value is therefore a live reading along the X axis in the trackers current head rotation (TkrAz).

LevelY - Displays the deviation from vertical along the secondary or y axis of the trackers level, perpendicular the the X axis if available (API trackers typically only have a single axis level built in).

49

Figure 3-38. **Figure 3-38.** Monitoring a tracker's inclinometer.

The level values reported for the X or Y axis should not be trusted independantly because any variation in the mouting of the level device relative to the trackers rotational center will influence the readings. Best practices should include verifying the readings after a full 180 degree rotation and the average of these two readings used in estimating the actual deviation.

Level Monitor Controls

- **Update Rate.** Sets the rate at which updates are displayed in the interface.

- **Show X Decimal Places.** Controls the number of decimal places displayed in the window.

- **Alarm.** When enabled, the computer will beep and a message will be written to the log file when the specified angular tolerances are exceeded. The alarm will not sound when this window is closed.

- **Set Baseline.** When clicked, the current values become the baseline or "reference" for establishing deltas for out-of-tolerance determination.

- **Display Level Values.** The display is updated with raw level readings.

- **Display Deltas (Threshold).** Shows angular deltas instead of absolute angular values. The threshold controls the limit that sets off the alarm.

To Monitor The Tracker's Level:

- From the interface menu, select **Devices > Level > Monitor**.

To Measure Level With A Tracker:
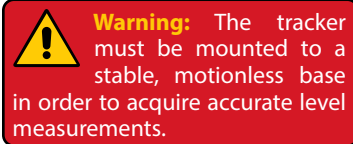
1. Ensure the tracker is equipped with an inclinometer or other leveling device.

2. After setting up the instrument on a stable mount, monitor its level indication by selecting **Devices > Level > Monitor** from the interface menu.

3. Manually adjust the tracker (using body or tripod adjustments) until the monitor consistently reads in-range for all azimuthal positions of the tracker head.

4. Close the level monitor and initiate measurement by selecting **Devices > Level > Measure** from the menus.

> ⚠️ **Warning:** The tracker must be mounted to a stable, motionless base in order to acquire accurate level measurements.

Monitoring Part Temperature

Some trackers are equipped with part temperature sensors which allow you to compensate for thermal expansion or monitor the part temperature and take action if environmental conditions might generate invalid measurements.

The *Part Temperature* dialog (Figure 3-39) is used for this purpose, and can be kept on-screen if desired.

- **Update Rate.** Sets the rate at which updates are displayed in the interface.

- **Show X Decimal Places.** Controls the number of decimal places displayed in the window.

- **Alarm.** When enabled, the computer will beep and a message will be written to the log file when the specified temperature thresholds are exceeded. The alarm will not sound when this window is closed.

- **Set Baseline.** When clicked, the current temperature reading become the baseline or "reference" for establishing deltas for out-of-tolerance determination.

- **Display Temperature Values.** The display is updated with raw temperature readings.

- **Display Deltas.** Shows the change in temperature from the baseline instead of the current temperature. The *Hi* and *Lo* thresholds control the limits that set off the alarm.

> ⚠️ **Warning:** The thresholds are temperature values, not delta values.

Figure 3-39. Monitoring a part's temperature.
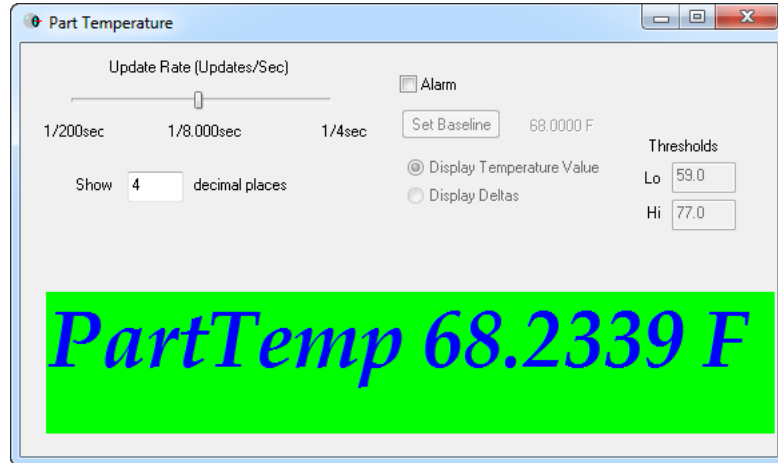
Instrument Checks

> ⚠ **Warning:** SA tracker interface checks are purely to gauge performance of the tracker. No actual compensation is applied to the instrument based on the checks.

The SA tracker interface has a number of check routines to verify performance of the tracker. It is important to note that none of these checks in the interface actually modify the compensation values for the tracker. The instrument manufacturer knows best how to compensate their own instrument, so actual modifications are performed in the OEM's tracker compensation software.

Two Face

The Two Face check (Figure 3-40) gives an indication of orthogonality of the azimuth and elevation axes in the tracker. It measures discrete positions from both the front and back faces, and presents the angular discrepancies in each measurement pair.

It is generally recommended that this check be performed with the instrument using IFM measurement mode to minimize distance error, although the primary purpose of this check is to gauge errors in the azimuth and elevation readings between the front and back faces. Instrument manufacturers provide recommended passing thresholds for instrument operation.

- **Check Current Location.** Takes a front- and back-face measurement at the current reflector position.

- **View/Edit Acquisition.** Provides control over how the measured point is acquired.

- **Threshold.** Angular values exceeding the provided delta threshold will be marked as out of tolerance.

- **Apply Thresholds.** Click this button to apply the specified thresholds to the data.

- **Warning Band.** A percentage of the threshold that triggers a warning indication.

- ▪ **Home.** Homes the tracker.
- ▪ **Remote.** Sends the tracker to the defined remote home position (if defined).
- ▪ **Closure.** Initiates a closure check. (Checks the current position of the target against the home position).
- ▪ **OK/Log.** Writes results to the log and closes the window.
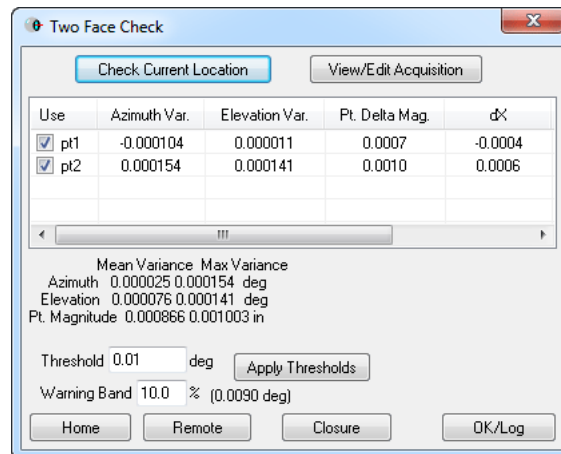
Figure 3-40. The Two Face check.

To Perform A Two-Face Check In SA:

1. From the interface menu, select **Check/Cal > Two Face.**

2. Home the tracker by clicking the Home button (IFM-enabled trackers only).

3. Track the target out to a puck and set it down.

4. Click the Check Current Location button. The tracker will acquire front and back measurements, then report the deviations between the two.

5. When finished, click OK/Log to log the results.

ADM Check

An ADM check is used to measure the difference between corresponding IFM and ADM distance measurements. A new ADM offset can be created and applied to a given reflector.

To Initiate an ADM Check:

1. From the interface menu, select **Check/Cal > ADM**.

2. For more information, refer to "User Definitions" on page 20.

IFM Check

IFM checks validate IFM distance measurements using a two-station method or scale bar. The check geometrically eliminates error based on expected birdbath position to give an indication of IFM distance error. All measurements must be obtained in IFM distance mode.

In the two-station check, two reference points are mounted in a fixed location. The tracker is placed between the two points (as close to the line connecting them as possible), and each reference point is measured. The tracker is then moved to a new position outside of both reference points, and the two points are measured again. Geometrically, one of these sets of measurements includes IFM error, whereas the other does not. The check involves determining the difference between both sets of measurements.

In the Scale Bar check, the tracker is only set up between the reference points, and the reference length of the scale bar is used as the baseline. The difference between the measurements and the scale bar length indicates IFM error.

To Perform an IFM Check:

1. From the interface menu, select **Check/Cal > IFM.**

2. Place the desired reflector in the home nest.

3. In the *Reflectors and Targets* dialog, selected the applicable reflector and click the IFM (Home Distance) Check - Selected Reflector button.

4. When the *IFM (BirdBath) Check/Cal* dialog appears (Figure 3-41), click the button appropriate to the check method you'd like to use.

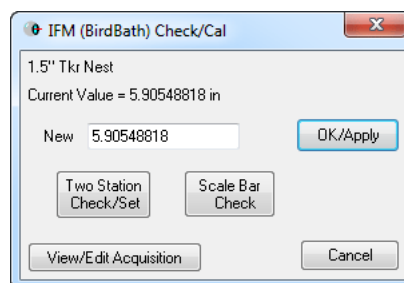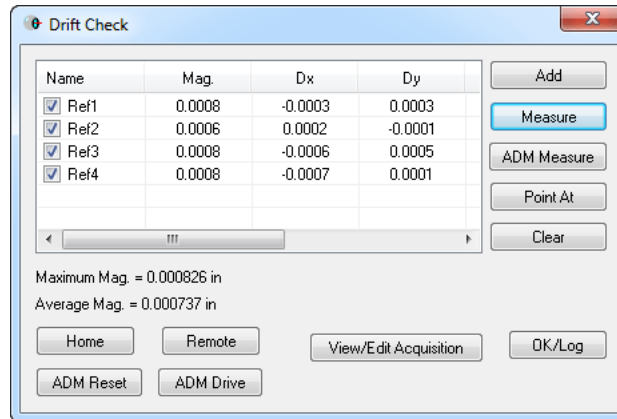5. Measure the points as indicated by the dialog.

Figure 3-41. Performing an IFM check.

Drift Check

Use this check to create a database of points for monitoring drift. SA keeps track of the nominal points, and when remeasured the deltas (as well as the distance measuring mode) are displayed (Figure 3-42).

Figure 3-42. Performing a drift check.

- **Add.** Adds a drift reference point to the set and measures its baseline position.

- **Measure.** Measures the selected reference point.

- **ADM Measure.** Measures the selected reference point using ADM distance mode.

- **Point At.** Points at the selected reference point.

- **Clear.** Clears the reference points from the list.

- **Home.** Homes the tracker.

- **Remote.** Sends the tracker to a remote home (if defined).

- **ADM Reset.** Searches for the target using an ADM search.

- **ADM Drive.** Use to drive the tracker head to a specific position.

- **View/Edit Acquisition.** Modifies the parameters used for acquiring the drift measurements.

- **OK/Log.** Closes the dialog and writes the results to the log file.

To Perform a Drift Check:

1. From the interface menu, select **Check/Cal > Drift**.

2. Click Add to add each reference point to the list, entering a name and measuring the point in the process.

3. At some point in the future, reopen the dialog, select a point, and click Measure. The deltas and distance measurement modes will be displayed for inspection.

4. When finished, click OK/Log to write the results to the log file.

Closure Check

The closure check (Figure 3-43) compares the measured home position to the defined home position.

- **Recheck.** Measures the reflector in the nest and compares the measured position to the reference position.

- **Log.** Writes the results to the log file.

- **View/Edit Acquisition.** Provides access to the discrete point parameters for measuring the point.
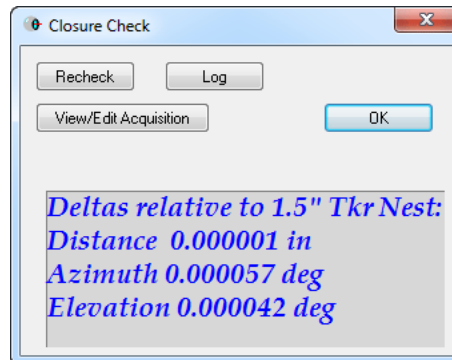

Figure 3-43. The Closure check.

To Perform a Closure Check:

1. Place the selected reflector into the home position (birdbath).

2. From the interface menu, select **Check/Cal > Closure**.

3. In the *Closure Check* dialog, click the Recheck button. The tracker will home on the reflector and take a measurement. Deviations should be very small.

Reflector Center Check

SMRs do not perfectly center the beam inside the sphere. Therefore, if the centering is slightly out, then taking multiple measurements while rotating the SMR in a nest will yield measurements that move slightly (runout). This test is particularly important if an SMR is dropped or jostled. It may appear fine, but the adhesive and reflective surfaces may have shifted on impact, putting the reflector out of tolerance.

Reflector center checks are carried out in the *Reflector Center Check* dialog (Figure 3-44). An initial measurement baseline point is acquired, then the test is started. Measurements are taken periodically as the SMR is rotated in the nest (ideally no rotation occurs while a specific point is being measured).

- **Set Baseline.** Measures the initial reference point for comparison.

- **Edit Baseline Acquisition.** Defines how the baseline (reference) point is acquired.

- **Edit Main Acquisition.** Defines how the comparison points are acquired.

- **Show X decimal places.** Indicates the number of decimal places to show in the results.

- **Cartesian.** Displays the results in Cartesian Coordinates.

- **Polar.** Displays the results in Polar Coordinates.

- **Measure at X second intervals.** Indicates how frequently measurements are taken.

- **Save Results.** Stores the results to the log file.

- **View Results.** Shows the results of the test.

- **Clear Results.** Removes test results to prepare for a new test.
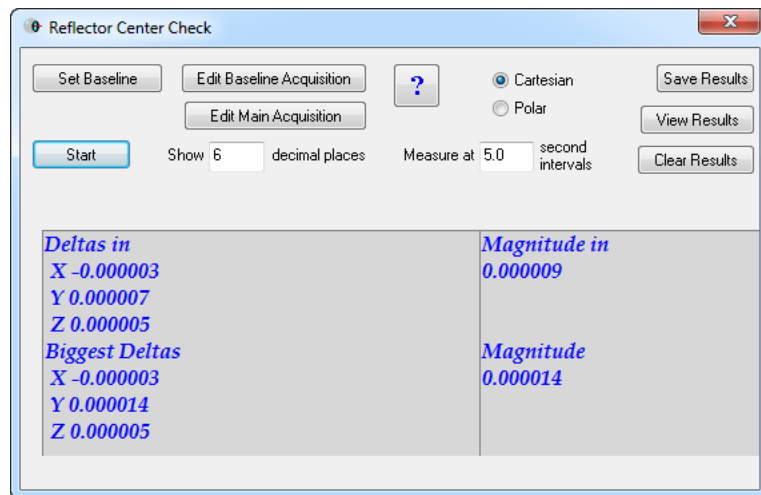
- **Start.** Initiates measurement of the reflector.

Figure 3-44. Performing a reflector center check.

To Perform a Reflector Center Check:

1. Place the reflector into a stable drift nest.

2. From the interface menu, select **Check/Cal > Reflector Center Check**.

3. In the **Reflector Center Check** dialog, click the Set Baseline button.

4. Click the Start button to begin measurement.

5. Between each measurement, rotate the reflector in the nest. The current and largest deltas relative to the baseline will be reported.

6. Click Stop when finished.

7. Click Save Results to log the results of the test.

Manufacturer-Specific Checks

The interface provides a convenient link to the manufacturer-provided checking and compensation routines. These compensation routines are the only place where true modifications to the instrument's compensation parameters are made.

To Access the OEM-Specific Checking & Compensation Routines:

- From the interface menu, select **Check/Cal > Tkr Specific (Mfcr)**.

Tracker Utilities

System Information

The **System Information** dialog (Figure 3-45) displays diagnostic tracker information, such as the SA tracker driver version, firmware and serial number, and OEM driver version information. This is primarily useful when diagnosing issues with SA customer support.
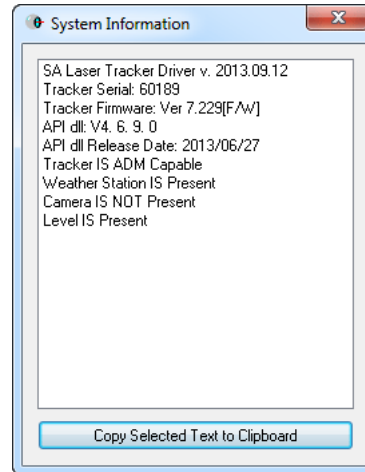
Figure 3-45. The tracker's vital system information.

To Display The Tracker's System Information:

- From the interface menu, select **Utility > System Info**.

Restarting the Laser Tracker

If you experience unexpected behavior, you can perform a warm (non powered-off) reboot of the tracker controller.

To Perform a Warm Reboot of the Tracker Controller:

- From the interface menu, select **Utility > Tracker Utilities > Restart Tracker**.

Reinitializing the Laser Tracker

Note: This is not available on all tracker brands.

You can issue a command from the tracker interface to reinitialize a laser tracker. The specific tasks performed during an initialization of a tracker are manufacturer-specific, but in general this can help resolve some accuracy and tracker performance issues.

To Reinitialize the Laser Tracker:

- From the interface menu, select **Utility > Tracker Utilities > Reinitialize Tracker**.

Manufacturer-Specific Utilities

You can access manufacturer-specific utilities directly through the tracker interface.

To Access OEM-Specific Utilities

- From the interface menu, select **Utility > Tracker Utilities > Tracker Specific**.

Tracker Status

You can view the overall status and health of the laser tracker by viewing the tracker's status (Figure 3-46). This typically includes information such as battery state of charge, ADM/IFM beam intensity, servo motor status, and other diagnostic functionality.

Figure 3-46. The tracker status dialog for an API Radian tracker.
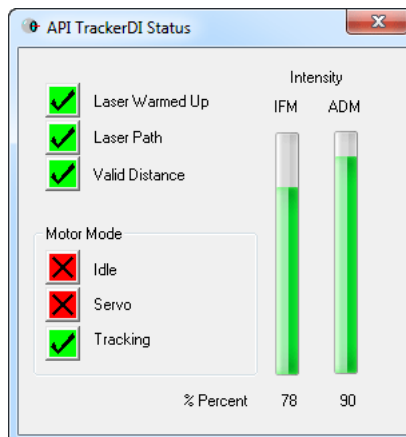
To View a Tracker's Status:

- From the interface menu, select **Utility > Tkr Status**.

Current Position

In the *Current Position* dialog (Figure 3-47), you can view the current position of the reflector in both Cartesian Coordinates (expressed relative to the working frame in SA) or Spherical Coordinates (expressed in the tracker's native frame).

Figure 3-47. Live data from the tracker.
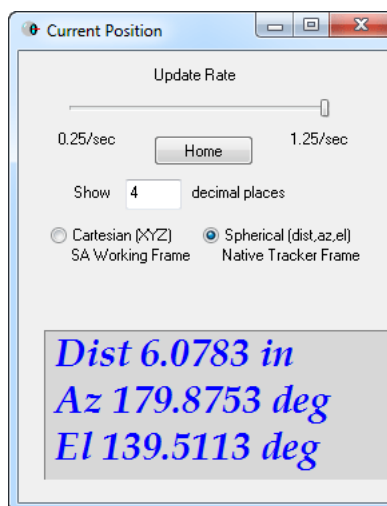
Importing Spherical Data

Occasionally, you may have measured data from a tracker that has been exported to an ASCII file. If this data is in spherical format (contains azimuth, elevation, and distance components), it can be imported and associated with a tracker. These imported points are auto-

matically treated as measured points (although they will not have any measurement metadata). The import dialog is shown in Figure 3-48.
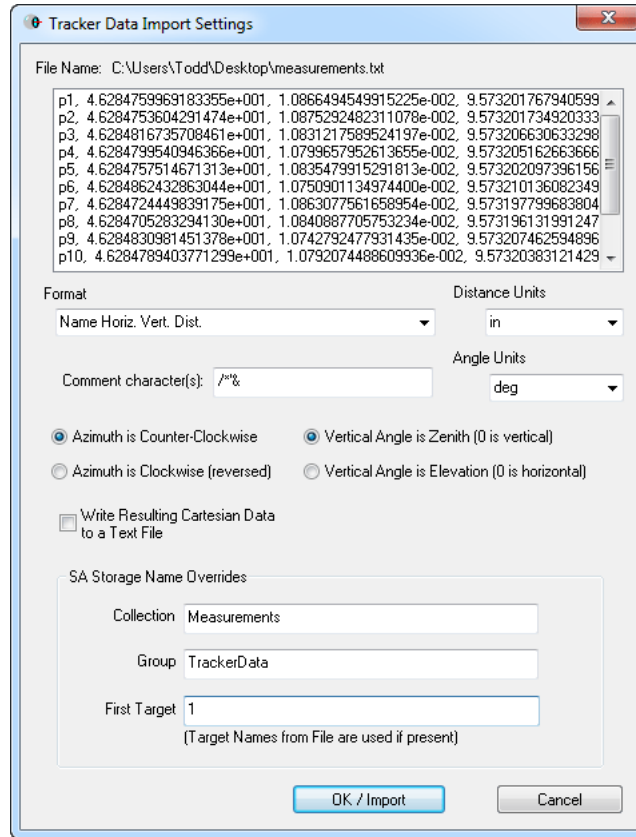
Figure 3-48. Settings for importing spherical data to a tracker.

- **Format.** Choose the appropriate format for the source data.

- **Distance Units.** The length units for the source data.

- **Comment Character(s).** Any lines starting with any of the provided characters are considered to be comments and are ignored.

- **Angle Units.** The angular units for the source azimuth and elevation angles.

- **Azimuth is Counter-Clockwise.** Specifies that the data was recorded on a tracker whose azimuth direction increases as the head rotates counter-clockwise as viewed from above.

- **Azimuth is Clockwise (reversed).** Specifies that the source data comes from a tracker whose horizontal angle increases as the head rotates clockwise as viewed from above (not common).

- **Vertical Angle is Zenith (0 is vertical).** Indicates that the

source spherical coordinate system has 0° pointing straight up (zenith referenced).

- **Vertical Angle is Elevation (0 is horizontal).** Indicates that the source spherical coordinate system has 0° level with the horizon.

- **Write Resulting Cartesian Data to a Text File.** Upon import, the points will be written out to a text file in Cartesian coordinates.

- **Collection.** The destination collection for the points.

- **Group.** The destination group for the points.

- **First Target.** The name for the first target. This name will be incremented for following targets. If the source data already has point names, this field is ignored.

To Import Polar ASCII Data:

1. From the interface menu, select **Utility > ASCII Import**.

2. Select the source file from the browser.

3. Choose the appropriate format, units, and options for the import, then click OK/Import.

Streaming Tracker Data Over The Internet

The tracker interface has the capability of streaming real-time measurement data (3-DOF or 6-DOF) over the internet, using UDP (User Datagram Protocol) broadcasting. Unlike TCP/IP network communications, UDP broadcasting does not require "handshaking" for data transmission. There is no guarantee that transmitted data is received, and it can be broadcasted "into the wild" so that any network device can listen to the broadcast.

UDP Data Streaming opens a vast array of possibilities for harnessing tracker data in custom ways. For example, you can write applications to intercept this tracker data and perform custom analysis for hardware control, or you could even write your own watch window.

There are a few limitations to keep in mind with regard to UDP Data Streaming:

- Data flows only in one direction—*from* the interface. You cannot transmit commands *to* the tracker interface.

- Data transmission is of course subject to some finite amount of latency. It will not be received "real-time" in a hardware sense.

Tracker data is transmitted as an ASCII-formatted packet. The format of the packet is dependent on settings in the *SA UDP Data Stream Properties* dialog (Figure 3-49).

Figure 3-49. Properties for setting up UDP Data Streaming from the tracker interface.
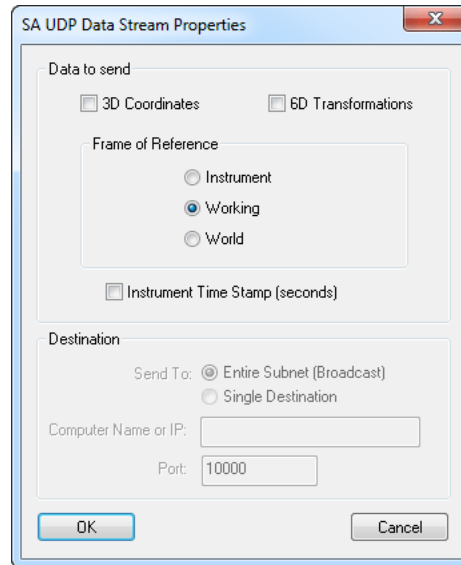
- **3D Coordinates.** Transmits 3-DOF (XYZ) data.

- **6D Transformations.** Transmits 6-DOF (XYZ, $R_X R_Y R_Z$) data.

- **Frame of Reference.** Data can be transmitted relative to the *Instrument* frame, the *Working* frame, or the *World* frame.

- **Instrument Time Stamp (seconds).** If the instrument supports it, time stamps can be transmitted along with the data. This is often an approximately millisecond-accurate timestamp from the tracker hardware indicating when the measurement was taken.

- **Send To.** The broadcast packets can be sent to the *Entire Subnet (Broadcast)* or to a *Single Destination*. In the former case, data is transmitted "to the wild" for any and all devices on the appropriate subnet to receive. In the latter, the data stream is routed to a specific IP address on the network.

- **Computer Name or IP.** Enter the IP address or computer name for the destination device (if broadcasting to a *Single Destination*).

- **Port.** Every UDP broadcast must be directed to a destination port. This is the port on which the receiving device must listen for the appropriate broadcasts.

Viewing The Upcoming Group and Target

When working with a tracker a long distance from the computer, it is difficult if not impossible to read the name of the next target that will be measured. Although this problem is addressed by the SA HUD settings, you can also open up a **Group and Target** dialog.

Figure 3-50. Viewing the upcoming group and target to measure.
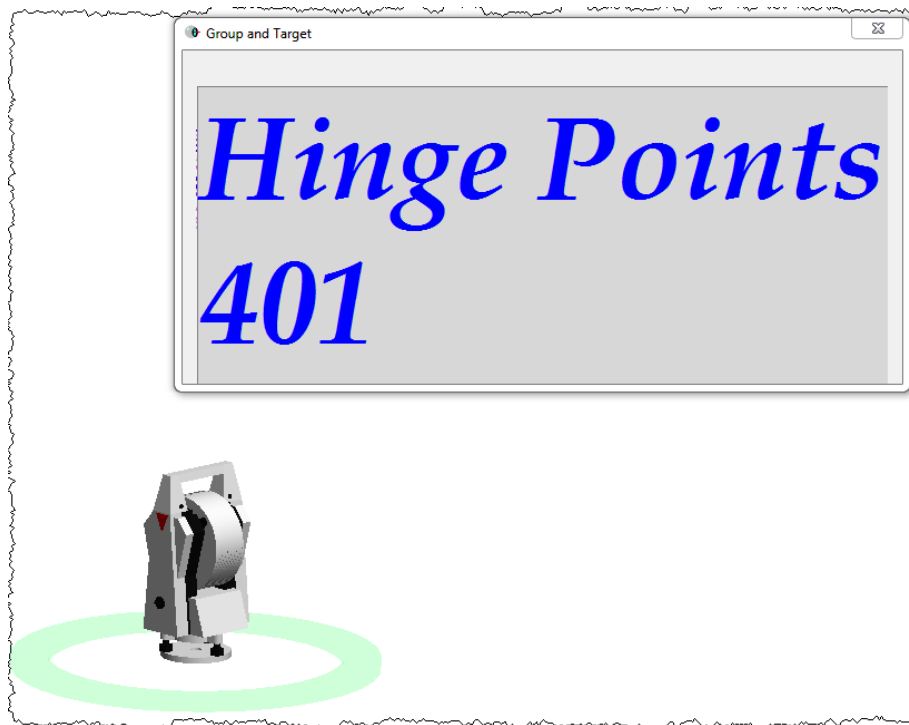
This dialog can be resized and positioned anywhere on screen, and will always display the group and target of the point that is about to be measured.

To View the Group and Target Window:

- In the tracker interface, click the button encompassing the `Group:` and `Target:` labels (Figure 3-51).

Figure 3-51. The Group and Target button.

Instrument Toolbar

The Instrument Toolbar (Figure 3-52) is a greatly-streamlined version of the laser tracker interface. Once properly configured, you'll likely find that the majority of your measurement work can be performed in this simpler interface.

Figure 3-52. The Instrument Toolbar for laser trackers.

To access the Instrument Toolbar from the tracker interface, click the Switch to Instrument Toolbar button 🖩. To switch from the Instrument Toolbar back to the tracker interface, click the Switch to Instrument Interface button 🖩.

The different functions of the Instrument Toolbar are described below.

Beam Status

A colored light (similar to the "traffic light" in the laser tracker interface provides feedback on beam state and measurement status. The different statuses indicated by the light are as follows:

Locked. The beam is locked on the target and valid distance information is being received.

Measuring. The tracker is currently measuring. (A glowing indicator spins in this mode).

No Valid Distance. The tracker is tracking the reflector, but a valid distance measurement is not available.

No Lock. The tracker does not have a lock on the reflector.

Waiting for Lock. A measurement mode has been initiated, but SA is waiting for a lock on the beam. (A glowing indicator spins in this mode).

Waiting for Move. A stable point measurement trigger is being used, and SA is waiting for the reflector to move. (A glowing indicator spins in this mode).

Waiting for Stable. A stable point measurement trigger is being used, and SA is waiting for the reflector to stabilize. (A glowing indicator spins in this mode).

Clicking on the beam status light will initiate a reflector search to lock on a target. It is equivalent to the Find Target button in the laser tracker interface.

Homing the Tracker

Click the Home button 🏠 to send the tracker to the birdbath for the currently-active reflector. This icon not available for trackers that have no home nest.

Driving the Tracker

Click the Drive Beam button 🕹 to drive the tracker head to the desired position. Drive operation is tracker-specific and described in "Drive Head/OVC" on page 18.

Toggling Motors

For instruments that support it, you can engage and disengage the tracker head motors by toggling the Motors button 🔴. (This icon is not shown for instruments that do not support motor toggling).

Tilt Compensation

Some instruments support tilt compensation. When turned on, the instrument automatically adjusts all measurements such that the standing axis of the instrument in SA is aligned with gravity. (That is, the instrument's internal reference frame is always oriented to gravity). For instruments that support this, the motor toggle button (see "Toggling Motors" on page 65) is replaced by a tilt compensator toggle button 🟢. Clicking this button toggles tilt compensation on and off.

Active Target

You can select the active target by clicking on one of the target quick-select icons (Figure 3-53).

Figure 3-53. The target quick-select buttons.

The reflectors are defined in the laser tracker interface (see "Targets and Retros" on page 19) or can be defined directly from the tracker toolbar. Right-clicking any of the four quick-select buttons will allow you to assign a different tooling definition to the button. You can also select **define new target** from the drop-down to create a new tooling definition.

Hovering the mouse cursor over a button momentarily will show a tooltip indicating the name of the target, and the offset (diameter if spherical, planar and radial if not) is displayed next to the quick-select buttons (Figure 3-54).

Figure 3-54. The planar and radial offsets are displayed, along with a target name tooltip.
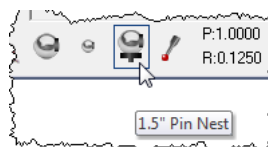
Point Naming

The name of the next measured point is displayed above the target quick-select icons. To change the name of the next selected target, click this field. This will open the *Instrument Interface Point Naming* dialog, allowing you to type a new collection, group, and target name.

Measurement Modes

The Instrument Toolbar has eight buttons, each corresponding to a specific measurement mode (Figure 3-55).
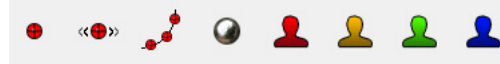
The first four buttons are assigned to Single Point, Stable Point, Spatial Scan, and Tooling Ball measurement modes, respectively:

- **Single Point.** Measures a discrete point when clicked.

- **Stable Point.** Waits for the reflector to move—then become stable—before measuring the point.

- **Spatial Scan.** Initiates a spatial scan measurement. The increment can be set by right-clicking the button.

- **Tooling Ball.** Initiates a spatial scan measurement, then fits a sphere to the points and creates a center point on the sphere. Both the spatial scan increment and the radius of the sphere fit can be controlled by right-clicking the button.

The last four buttons (denoted by the silhouette icons) are user-defined measurement modes. You can assign any measurement mode you've created in the laser tracker interface to these buttons by right-clicking them.

Measurement modes can be initiated with or without a beam lock. If started without a beam lock, SA will wait for a beam lock before starting measurement. While in a measurement mode, press the button again to stop the measurement mode.

To access a few additional parameters related to the first four measurement modes, right-click the target button.

Alarms

The Alarm button allows you to set a number of thresholds that will trigger an alarm while measuring. An alarm is intended to notify you that a measurement may not be trustworthy. High and low threshold alarms can be set for the following parameters:

- **Air Temperature.** If the specified air temperature range is violated, the alarm will trigger.

- **Air Pressure.** If the specified pressures are violated, the alarm will trigger.

- **Humidity.** If the ambient humidity exceeds the specified thresholds, the alarm will trigger.

- **Part Temperature.** If the part temperature (if the instrument is

equipped) exceeds the specified threshold, the alarm will trigger.

- **Level.** If the specified level range is violated (if the instrument is equipped with an inclinometer), the alarm will trigger.

- **RMS.** Turning on the *Discrete Point RMS Monitor* checkbox will display a warning if the *Warning* threshold is exceeded. The point will not be measured if the *Out Level* value is exceeded.

When an alarm is triggered, the alarm button will turn red and a blinking exclamation mark will appear.

Operational Checks

Clicking the Operational Checks button will take you to the manufacturer's operational checks.

Laser Tracker Quick-Start Guides

Automated Precision (API) Laser Trackers

API Trackers "Automated Precision (API)" on page 68.

Faro Laser Tracks

Faro Trackers "Faro Laser Trackers" on page 77

Hexagon and Leica Laser Trackers

Leica Trackers "Leica Laser Trackers" on page 87

- "Leica AT500" on page 87
- "Leica ATS600" on page 92
- "Leica AT9x0" on page 110
- "Leica AT40x" on page 121
- "Leica AT901" on page 126
- "Hexagon AS1 and AS1 XL Scanners" on page 134
- "Leica Absolute Scanner (LAS) 20-8" on page 144
- "Leica T-Scan Interface" on page 147
- "Leica Automation Interface" on page 156

Automated Precision (API)

API Radian (Pro) & Radian (Plus)/OmniTrack2

Figure 3-56. Radian & OT2

Hardware Setup

Set up the unit following the manufacturer's directions. The API Radian and OmniTrack2 trackers are networked TCP/IP connected devices and should be connected directly to a computer with an Ethernet crossover cable or through a network switch.

Connect the temperature probe and ensure that it is well clear of any external heat sources (such as the heat fan on the back of the power supply). Ensure that the instrument is powered on and that a reflector is in the home position at startup.

Software Setup

Each version of SA is built with the most current version of the API software development kit (SDK). This driver set provides the tools to interface with the instrument. Check the Readme file to see which SDK version is being used. No additional software installation is necessary.

Set the IP address on your computer to be compatible with the address set on the tracker. The default API IP address is: 192.168.0.168 with the subnet mask 255.255.255.0.

Starting the Interface

1. Select **Instrument>Add** and choose API Radian or API Omni-Track2 from the **Add Instrument to SA** dialog (Figure 3-57).

Figure 3-57. Adding a Radian tracker.
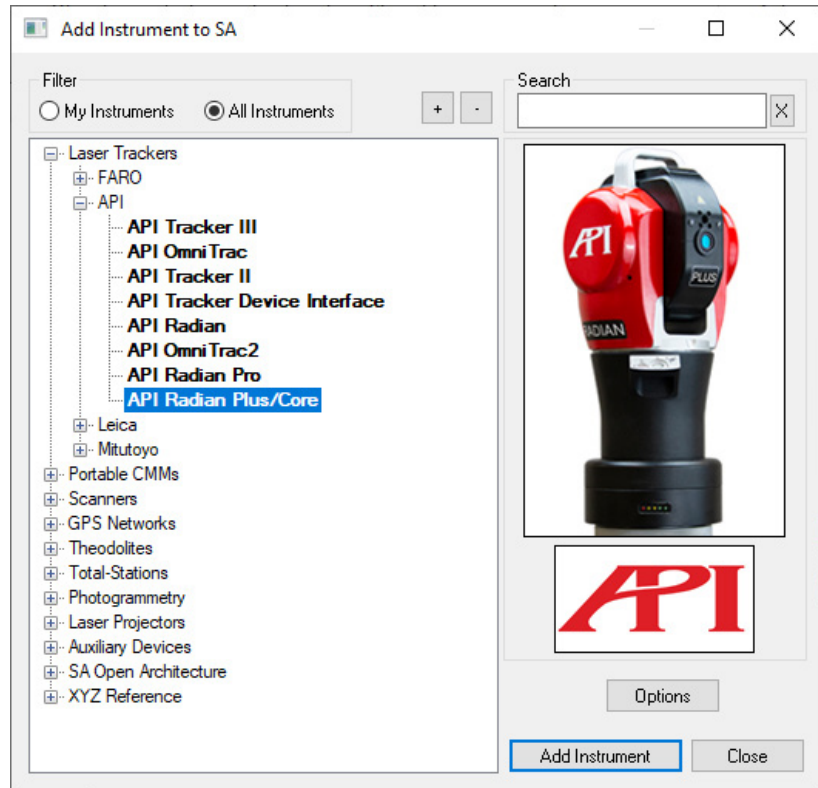
2. Run Interface Module without connecting (**Instrument>Run Interface Mode**) and choose *API Device Interface* (do not use the Laser Trackers interface for either the Radian or the Omnitrack2).

3. Within the **Connect to SpatialAnalyzer** dialog, select the instrument station (computer name, job name, Collection::Instrument Name: Serial Number) you wish to connect your instrument to from the network list.

4. In the **API_DI Connection** dialog, enter t he tracker's IP address (if different than the default) and use the Ping button to test the connection if needed. Once satisfied, click OK. The next time you connect this instrument to the instrument, you can just select *Run Interface and Connect*. This will utilize the last saved settings and automatically connect the instrument.

API Probe and Scanner Operations

SA supports the user of API's 6D peripheral probes and scanners including the In Intelliprobe 360, V-probe, V-probe2 and iScan3D.

Please refer to the current API user's manual for setup and calibration instructions.

Basic Probe Operations

The basic requirements for connecting and using any of the API probes are as follows (Figure 3-58).

Figure 3-58. Iprobe & Vprobe

1. Before connecting, ensure the probe has been fully unpacked, configured to communicate with the controller, and calibrated within API's software.

2. A *.prm file will be available with the probe and will have its serial number. It should be placed in the **C:\Analyzer Data\Persistence** directory.

3. Place a 1.5" inch reflector in the nest.

4. Run a virtual level measurement (**Check/Cal> Virtual Level**) (Figure 3-59). This will align the instrument with gravity, allowing the prove's integrated pendulum measurements to be correctly interpreted.
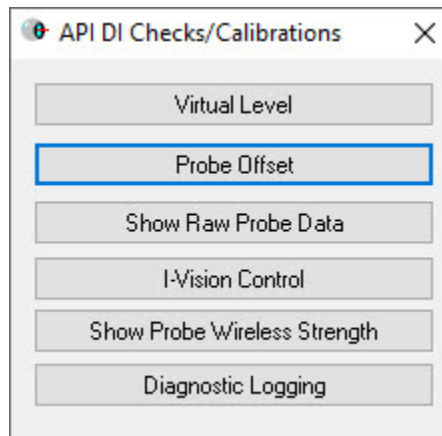

Figure 3-59. Check/Cal Menu

Important Notes on Virtual Level

A Virtual level operation is required in order to use any of API's peripheral devices that utilize a pendulum for operation (currently all) because it calibrates the system with respect to gravity.

Its important to realize that a Virtual Level operation is a system cal-ibration and will change the way in which measured points are re-corded and sent to SA. Comparing measurements before and after a level compensation would be similar to comparing different instru-ments to each other.

This means two things:

1. A level compensation should be performed after each instru-ment station move - prior to any point measurements.

2. If measurements have already been taken at an instrument plant, a *jump instrument* operation must be performed prior to performing a level compensation and taking additional measurements.

For more information about level measurements refer to the Instru-ments Chapter of the SA Users Manual.

Virtual Level Status

The Virtual Level status (in use, applied, succeeded, failed, etc.) is logged to the Instrument History in SA (as of SA 2023.2).

If a Virtual Level has been run, SA persists the transform. This allows you to reconnect if for some reason the interface is closed and you wish to reconnect. If the option to show this is set, you are asked if you'd like to use that transform (Figure 3-60). If you elect not to use it, you are also asked if you'd like to perform a new Virtual Level opera-tion.
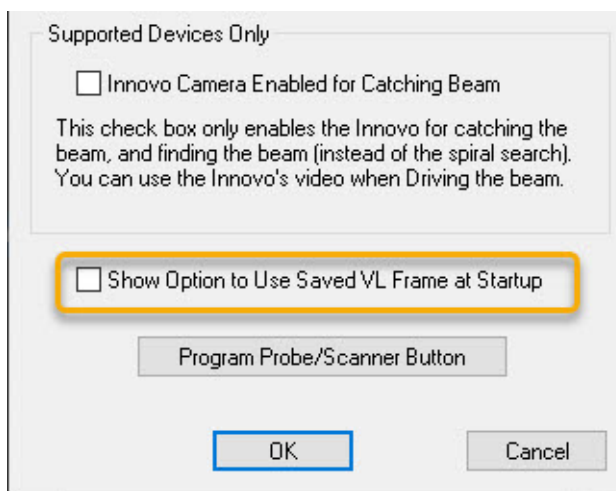

Figure 3-60. Option to save and persist virtual level measurements

This option is off by default because the same Virtual Level operation is also used for level frame measurements within SA as well.

However, if the tracker is moved for any reason, a new station and new Virtual Level operation is required.

Probe Measurement

In order to measure with the probe the following steps are necessary.

1. Set up the probe tip and perform calibrations as necessary (**Check/Cal>Probe Offset**)

2. The Probe target should be detected and assigned automatically.

3. Specific measurement profiles have been added for use with a probe and must be used to take data from the device (Figure 3-61). Start the measurement profile so that it is running in the background and then use the probe to trigger measurements.
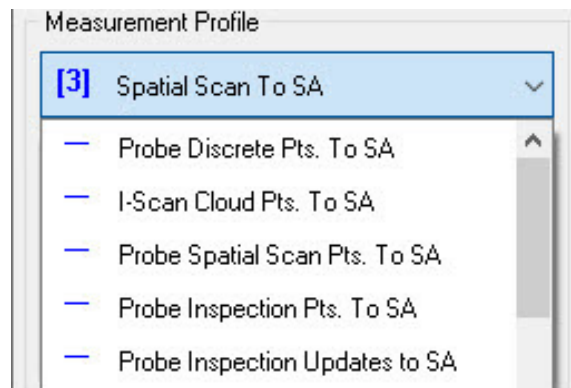
Figure 3-61. V-Probe (I-360) Measurement profiles.

- **Probe Discrete Pts To SA.** This profile offers an option to record a single measured point with each button press.

- **Probe Spatial Scan Pts to SA.** Offers the ability to perform a spatial scan with the probe.

- **Probe Inspection Pts to SA.** This performs a time based measurement (temporal scan) and sends point measurements to SA.

- **Probe Inspection Updates to SA.** This performs a time based measurement (temporal scan) and sends only updates to SA.

- **I-Scan Cloud Pts To SA.** This profiles is used with the iScan3D for cloud measurement.

Vprobe2 and iScan3D Button Operations

Starting in 2023.2 button events are now triggered using the probe. This means that, as long as the beam is NOT LOCKED ON to the probe/scanner you can use the probe's button to trigger different actions within SA. These actions are configurable for single press, double click and long hold (Figure 3-62):

Figure 3-62. While the beam is broken, the probe button can be used to configure the interface using the custom settings of your choice.
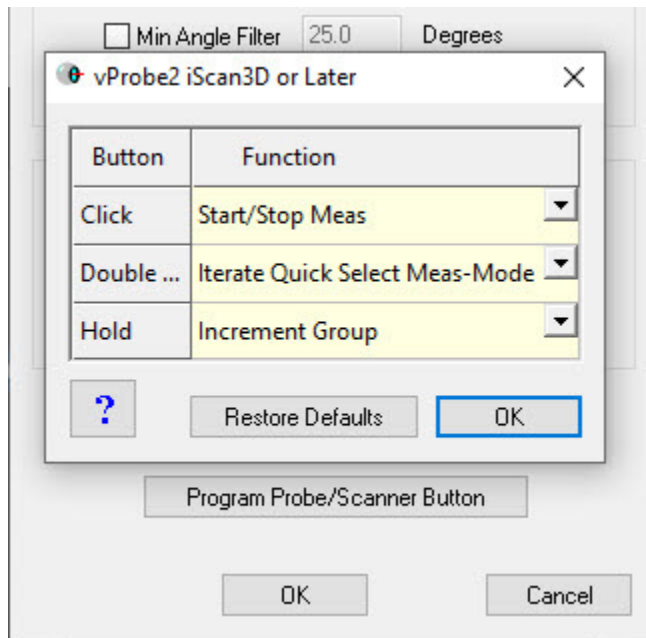
iScan3D Operation

Follow the prior probe setup instructions including running a Virtual Level operation(Figure 3-63).

Figure 3-63. iScan3D

If an iScan3D is detected at startup, 3 Measure Profiles will be set to the Quick Select Measurement Profiles:

- **I-Scan Cloud Pts To SA.** Used to scan with the iScan Scanner.

- **Probe Discrete Pts To SA.** Used to probe isolated point locations.

- **Probe Spatial Scan Pts To SA.** Used to scan using the probe in a stream of spatially separated points.

Probe detection is automatic. You should NEVER need to manually

select the iScan3D as the active Target. It is automatically recognized upon locking the beam on to it.

The measurement operation will automatically be switched to "Probe [M] L[L] T[D]" (M = H or V mount, L = probe length, D = probe dia.) upon initiating a probe measurement. It will automatically switch back to "iScan3D" when scanning cloud points.

Upon locking back on to an SMR after using the iScan3D, the active target will switch back to the last used SMR.

Cloud Thinning Options

Several cloud thinning options are available also through the API Device Specific settings. These include the ability to define a basic thinning factor and apply a scan line curve filter where more points are saved on tighter curves.
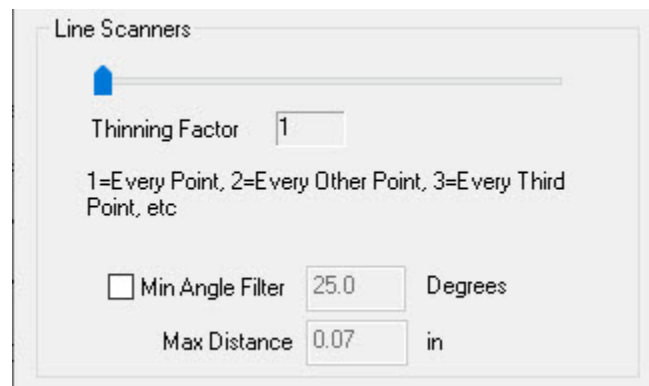
Figure 3-64. Several Scan thinning controls are available through the API_DI settings.

TTL Measurement

Externally triggered measurements are supported. This can be useful for synchronizing measurements with the operation of an additional device or between multiple instruments. To do so:

1. Double check that the ttl trigger source is plugged into the trigger port on the controller

2. Within the instrument interface go to **Settings >> Tracker >> General Settings** and hit API_DI, in the tracker specific settings toggle with the *TTL Trigger On* check box (Figure 3-65).

 The TTL trigger will take the place of your Sampling Frequency setting in any Temporal Scan acquisition until this option is un-checked.

3. Select a scan measurement profile with a *Temporal Scan* Acquisition mode, such as *Watch Update* and start the measurement profile.

4. Trigger measurements with the TTL signal.

A point is acquired at each 5-0V transition of the input TTL signal,

which should be connected directly to the instrument controller.

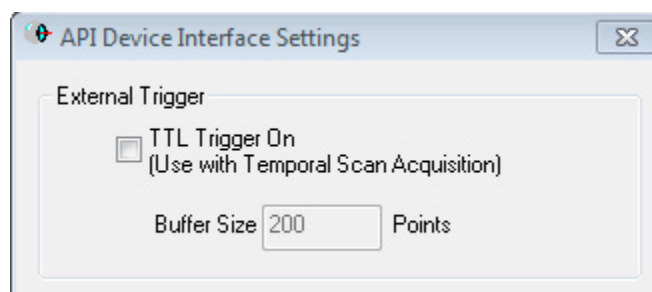Buffer control is also available for TTL triggered data. The buffer size can be set in the DI settings dialog and the buffer size is persisted (defaults to 200 pts.), but "TTL Trigger On" is turned off every time the interface is closed. The buffer for TTL data will send its remaining contents to SA if you finish the measurement with "Done", it will clear if you "Abort".

    * Requires tracker firmware version 5.170 (or later).

Figure 3-65. API TTL Trigger Controls in the Tracker Settings.

Running the Tracker Interface Separately

One of the unique features about SA's architecture is that the instrument interface can be run separately from SA. This provides a means to run multiple trackers independently on different machines while connect to a single SA for data storage. Doing so also provides the ability to separate the persistence files for individual trackers, as the persistence file will be saved in the directory as where the tracker interface is launched, as opposed to the *C:\Analyzer Data\Persistence* folder.

In order to run the SA Laser Tracker process separately some additional support files are required. These include the following files (Figure 3-66):

Figure 3-66. Required Files to run the SA Laser Tracker process independently from SA.

| Name	Date modified	Type
GeomfitDLLuvc10.dll	9/29/2021 11:44 AM	Application exten...
Linpack32.dll	8/18/2021 4:54 PM	Application exten...
MeasurementDLLuvc10.dll	9/29/2021 11:44 AM	Application exten...
NRKDLLuvc10.dll	9/29/2021 11:44 AM	Application exten...
SA Laser Tracker API DI.exe	9/29/2021 11:45 AM	Application
Surflibsvc10.dll	8/18/2021 4:54 PM	Application exten...
Tcl32.dll	8/18/2021 4:54 PM	Application exten...
TrackerDLLu_API_DI_vc10.dll	9/29/2021 11:44 AM	Application exten...
TrackerUnicode.dll	8/18/2021 4:54 PM	Application exten...
Xgeom32.dll	8/18/2021 4:54 PM	Application exten...
Xmath32.dll	8/18/2021 4:54 PM	Application exten...
Xmisc32.dll	8/18/2021 4:54 PM	Application exten...
Xtcl32.dll	8/18/2021 4:54 PM	Application exten...
Xtkr32.dll	8/18/2021 4:54 PM	Application exten...

API T3

The API T3 is a unique instrument in that it can be run with either of 2 separate interfaces. To run the T3 with the API Device Interface follow the procedure outlined for the Radian. To take advantage of the legacy interface follow the directions outlined below for connection to the API T2+. The parameter file is stored on the controller for the API T3 tracker. Like the API T2+, you will see a default location for a parameter file. In the case of the T3, this is only the location where a back-up copy of the parameter file will be written from the controller. To change this location, just press the Browse button in the tracker connection dialog.

API T2+

The parameter file, `[tkr serial#].prm` contains the kinematic correction info, home location, etc. for the tracker. For example, if your tracker serial number is 3827, the file name will be `3827.prm`. This file must be located successfully by the tracker initialization for the tracker to run. By default the parameter file should be located in `C:\ Analyzer Data\Persistence`. To change this location, just press the Browse button in the tracker connection dialog, as pictured in Figure 3-67.

Figure 3-67. The legacy API Connection window.
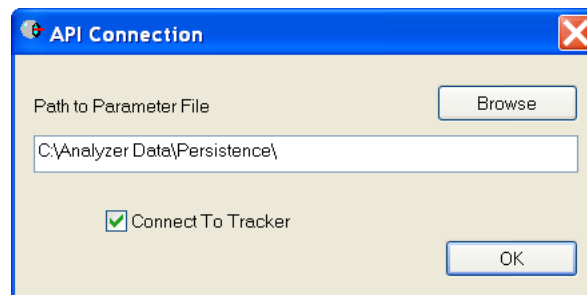
The parameter file is edited when an API calibration is run. Ensure that the file attributes are NOT set to *read only*.

You must have a working serial port for the connection to the tracker. Use the lowest available serial port number for the tracker connection.

Faro Laser Trackers

Faro Vantage / Faro Ion / Faro Xi

This guide applies to the setup of the Faro X, Xi, Ion and Vantage (including Vantage$^{S/E}$, Vantage$^{S6/E6}$ models).

Hardware Setup

Set up the unit following the manufacturer's directions.

Connect the temperature probe and ensure that it is well clear of any external heat sources (such as the heat fan on the back of the power supply). Ensure that the instrument is powered on and that an SMR is in the home position.

Software Setup

Faro trackers are networked TCP/IP connected devices and should be connected either to a wireless network or directly to a computer with an Ethernet crossover cable.

Set your computer's Local Network connection to be compatible with that of the Faro tracker. Faro trackers are shipped with a standard wired IP address of 128.128.128.100 (subnet 255.255.255.0). Wireless connections default to 169.254.4.115.

Download the latest java drive from: **http://www.kinematics.**

**com/ftp/SA/Install/Driver Downloads/Laser Trackers/
Faro/.** Extract the files to the C:\ drive. This should create a directory
structure with the Faro Java files contained in C:\FaroJRE.

Your JRE files must match your version of SA...

- Versions 2017.02.09 and older, use the Faro JRE v4.3
- Versions 2017.02.09 to 2018.07.11, use the Faro JRE v5.0.0.1
- Versions 2018.12.07 to 2019.11.21, use the Faro JRE v5.1.3.1
- Version 2020.04.09, use the Faro JRE v5.1.7.3
- Version 2020.07.20 and 2020.12.01 use the Faro JRE v5.1.8.3
- Version 2021.01 and newer use the Faro JRE v5.1.9.4 (required
to support the 6D probe2)

If you plan to use the video (overview) camera, you must also get the
'Faro Tracker Camera files.zip' file (version matching that of the JRE
Files). Unzip the file and follow the instructions contained in ReadMe
Faro Camera.txt. Note that cameras are wireless. If your camera
has the default IP address, you can set your PC's wireless connection's
address to 129.129.0.1.

Starting the Interface

1. Select **Instrument > Add** and choose the appropriate Faro track-
er from the **Add Instrument to SA** dialog (Figure 3-68).
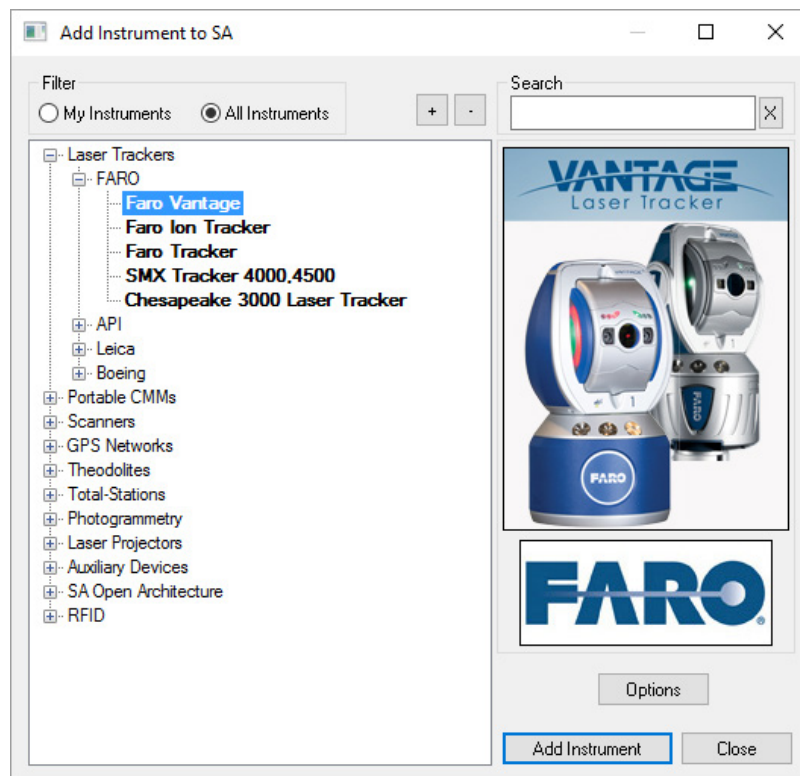

Figure 3-68. Adding a Faro tracker

2. Run Interface Module without connecting (**Instrument > Run Interface Mode**) and choose *Laser Trackers*.

3. Within the Connect to Spatial Analyzer dialog, Select the instrument station (computer name, job name, Collection::Instrument Name: Serial Number) you wish to connect your instrument to from the network list and press OK.

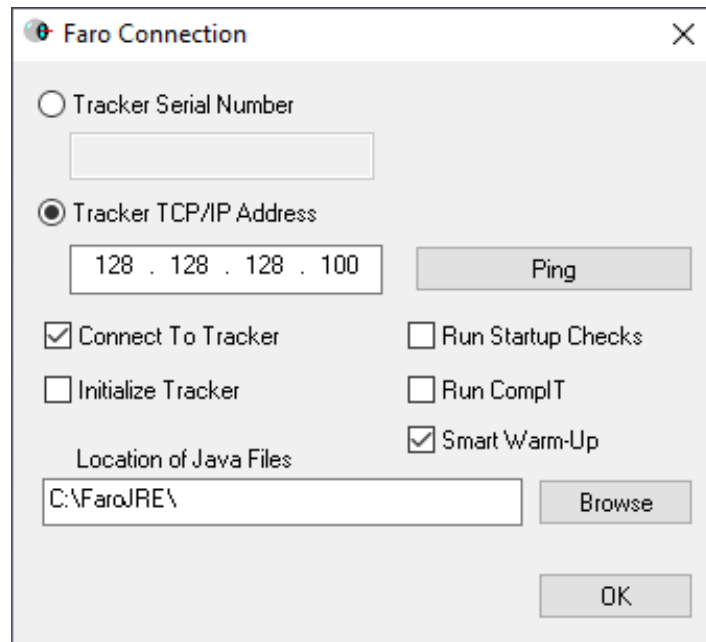4. This will bring up the ***Faro Connection*** dialog (Figure 3-69).

Figure 3-69. The Faro Connection dialog

5. Enter the tracker's IP address (if different than the default) and use the Ping button to test the connection if needed.

Once satisfied, click OK. The next time you connect this instrument to the instrument, you can just select *Run Interface and Connect*. This will utilize the last saved settings and automatically connect the instrument.

Notes on the connection process:

▪   The first 7 digits of the tracker serial number can also be used to find the tracker. When you use this method it will search for both a wired and wireless connection.

▪   To connect Wireless, be sure to connect your computer to the trackers wireless signal and use either the serial number or the wireless IP address which will something like 169.254.1.1 (not the wired default).

▪   If you have any trouble be sure to check your windows firewall. Exceptions need to be made for both the *Spatial Analyzer* and *SA Laser Tracker* applications.

The interface is now connected and ready for use. Please refer to the Measurements chapter of the manual for more details on the tracker

interface and instrument settings options.

Faro Specific Settings

Distance Mode

Beam rest can be manually overridden as needed. Choose between:

- **ADM Only.** This mode restricts beam tracking operations to ADM only.

- **IFM Only.** This mode restricts beam tracking operation to IFM only which requires a homing procedure each time the beam is broken.

- **IFM Set by ADM.** Faro's default mode which is a hybrid mode that provides accurate tracking using IFM and easy beam re-capture using ADM modes.

External Trigger Settings

- **External Trigger Settings.** The external trigger will apply to ANY measurement profile which has either a spatial or temporal scan as it's Acquisition.

When "External" is set (for the *Measurement Start Trigger* in the **Faro Tracker Settings**), points will be taken when the trigger is pulsed. The only requirements is that a profile must be started for the external trigger to be recognized which as an Acquisition mode of either spatial or temporal scan. The advantage of this design is that no adjustments to the measurement profile need to be made, and any profile will work (Figure 3-70).

- The trigger cable must be connected to the "Up" port on the tracker controller.

- 0 Volts on the trigger port implies take data and send the data in continuous mode (where as 5Volts indicates stop). So by default the external trigger is set to on and sending data and must be powered to stop sending data. This means that if there is no external trigger, the measurement will simply begin at the maximum temporal rate of the trackers.

Figure 3-70. Faro tracker settings including external trigger settings
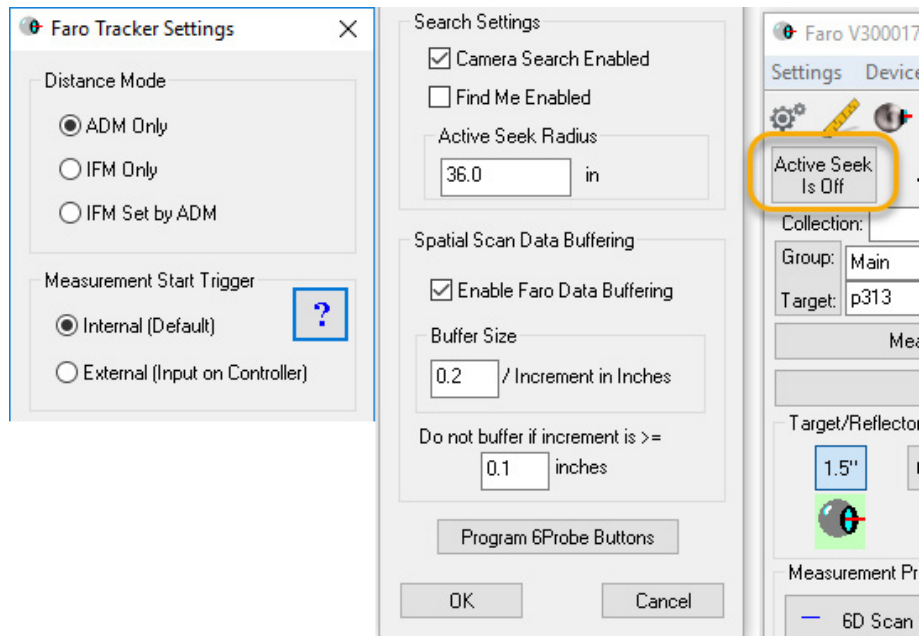
Search Settings

Faro's video camera is used is used for reflector acquisition and provides a couple of optional modes:

- **Camera Search Enabled.** This option enables camera search. Disabling this option is used to limit target search to a beam spiral search only.

- **Find Me Enabled.** This is similar to the "Gesture Recognition" setting and allows the tracker to snap to the moving target.

- **Active Seek Radius.** Active Seek can be set from main window (formerly "Smart Find") dialog if supported. The **Active Seek Radius** can be set to limit the search zone relative to the current beam position considered by the camera.

Spatial Scan Data Buffering

Data buffering was added to ensure that SA keep up with data delivered form the instrument. With a very tight scan increment this can be quite fast (~100Hz).

- **Enable Faro Data Buffering.** Provides a switch to enable or disable data buffer. If unchecked, behavior is unchanged from previous versions

- **Buffer Size.** Default is 0.2. At 0.2, for a spatial increment of 0.01" (2.54 mm), the buffer would be 0.2/0.01 = 20 pts. Another way to look at this is the Buffer Size means the number of inches worth of data that will get buffered. So at a value of 1.0 and a spatial increment of 0.01", the buffer size would be 1.0/0.01 = 100 pts, and with a point every 0.01", 100 of them takes up 1.0 inch.

- **Do not buffer if increment is >= .** This allows you to set a maximum increment for which buffering will occur. The default value is 0.1, meaning that when you set a spatial increment of 0.1" (2.54 mm) or higher, no buffering will occur.

Its important to know that this buffering happens on the Faro side, the interface will not receive any data until the buffer is filled. So for example, you cannot set a scan whose increment would result in a calculated buffer size of 100 points, and yet set a profile to stop at 20 points because it will not send data at all until 100 points have been recorded.

Specialty Targets

Windowed SMR Configuration

Windowed SMR's have an additional ADM offset, due to their glass front, which needs to be accounted for. This is done by building a target based upon the correct reflector definition (see "Targets and Retros" on page 19). Care should be taken to always use a target that is representative of the actual reflector being used or an error equal to the ADM constant may be seen in your measurements.

As stated in the Faro accessories manual, proper use of the windowed SMR requires sending it home when the target type is set correctly, otherwise an error will occur. This ensures the correct ADM offset is used. Additionally, when running startup checks or CompIT with the windowed SMR, you should be sure to send the tracker home afterwards, as these routines assume 1.5" standard SMR is being used. An additional homing operation should be performed to update the target definition.

Faro 6D Probe

Faro's 6D probe can be used within SA, using the Vantage^{S6} and Vantage^{E6} trackers. No additional driver installation is required. Compatible trackers will include a **6Probe** definition.

- The Faro 6Probe version 2 with exchangeable tips requires SA version 2021.01 or later.

The 6probe target detection is automatic but an initial connection and activation process must be performed each time the 6D Probe is powered on, and would go as follows:

1. Connect to the Tracker

2. Power on the 6D Probe Unit and catch the beam.

3. Press any button on the probe and wait (approx. 10-20 sec.) for the probe's "happy" beep and blue LED. If you have trouble getting the 6Probe to activate, try moving it farther from the tracker.

4. After the first successfully pairing of the 6Probe and tracker, you'll be asked if you want to pop the Probe Management UI to set the active probe tip. Hit "Yes", and select a tip that is Valid, or Calibrate at least one probe tip, and select it.

The probe is auto-detected once a probe tip is activated. When you lock back on to a 3D probe, the last used 3D probe will be set active for you. The pairing process will not be necessary again until the probe is powered down.

The follow status indicator lights may be displayed:

- **No Lights Flashing.** Press a probe button to begin the initial connection process.

- **Flashing Blue Lights.** A connection to the probe is being made... wait for completion.

- **Flashing Red Lights.** Connection attempt failed. Press a button to begin again.

- **Flashing Green Lights.** Success full connection has been established, waiting for tip selection. The Probe Management UI will open automatically to allow tip selection.

- **Solid Green Lights.** Ready to Measure.

Once configured, the probe is auto-detected and will be set simply by catching the beam. When you lock back on to a standard 3D reflector, the last used reflector (such as a 1.5" ball) will be set as active.

Tip selection and calibration is performed within the Faro utility window that can be displayed directly from the Home Button in the interface which will read Manage Tips when a 6probe is active (Figure 3-71). Also note that the name and diameter of the active probe definitions is displayed on the Measure button.

Figure 3-71. Tip Selection control from the "Home" button
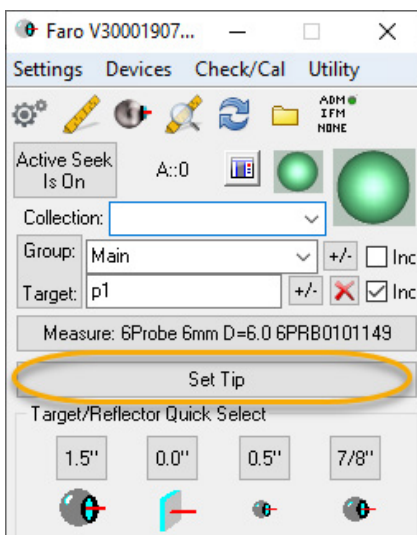
This utility is also accessible as a target definition within the Reflectors and Targets database, where the **6Probe** target functions as a button and provides access through a left click to Faro's Probe Management utility (Figure 3-72).

Faro's Probe Management utility provides:

- Ability to select directly for a list of defined probe tips. The 6Probe version 2 will recognize tips automatically when they are connected, but changes to the calibration or initial setup is still performed in this dialog.
- With the addition of the auto-detect tips this is typically not necessary but it is possible to define multiple tips for a holder.
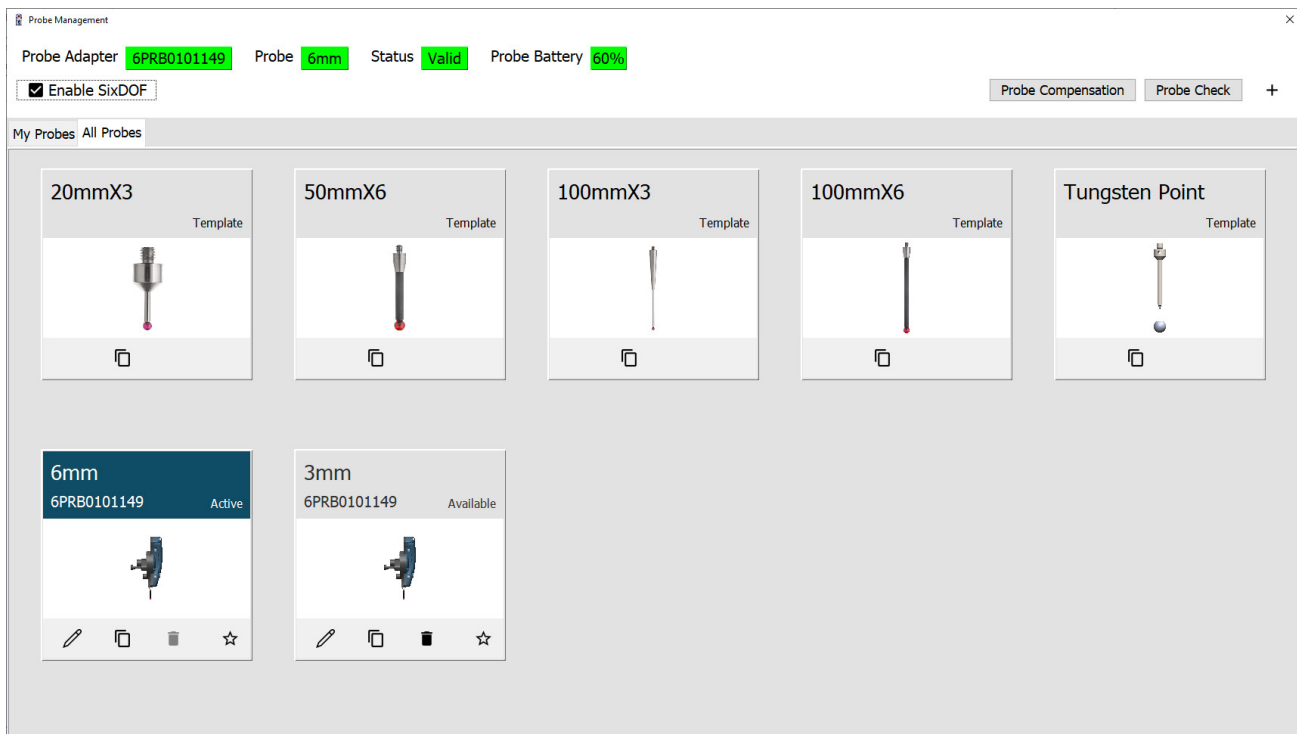- Probe Compensation options
- Probe Check options

Figure 3-72. Faro's Management UI or tip selection and compensation Tool.

Note that undefined tips will have an initial offset of -1 meter.

To program the 6Probe's buttons, just click on the "gear" icon (⚙), and then on the **Faro** button (Figure 3-73).

Figure 3-73. 6D Probe buttons can be configured as needed through the general setting.
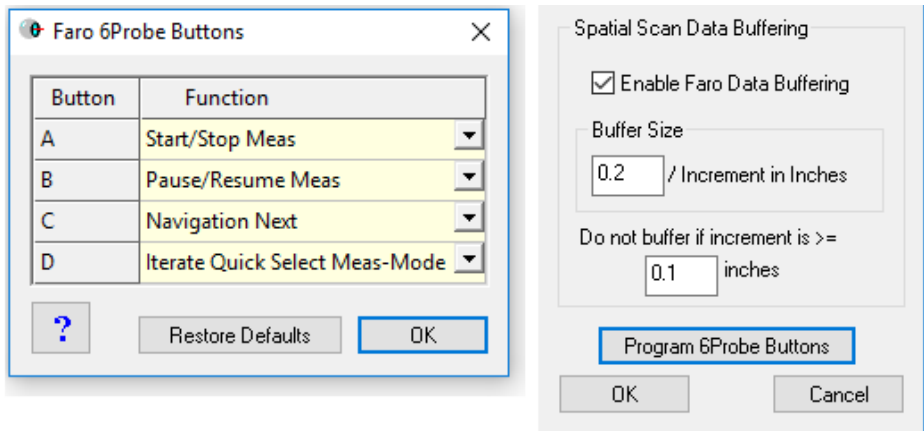
When set up for a given work flow, such as using the inspection task list, these buttons can be used to work for long periods without going back to the computer. In addition, the 6Probe can be used as a remote even when using and SMR.

A set of standard 6D measurement profiles will also be available with the 6D Probe (Figure 3-74).

Figure 3-74. Standard Set of 6D Measurement Profiles
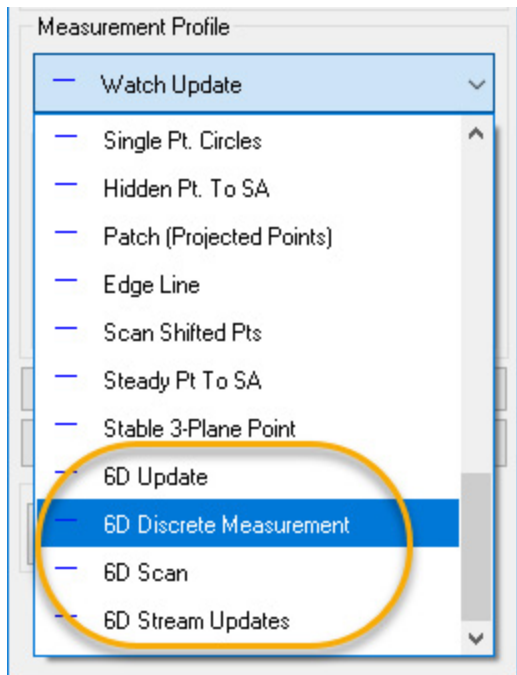
These provide a starting point for custom measurement profile development. 6D measurements send frame's to SA to graphically define position and orientation, which can be used in combination with regular point measurements (which also do save the probing information in the measurement details). For more information on defining measurement profiles (see "Measurement Profiles" on page 25).

Running the Tracker Interface Separately

One of the unique features about SA's architecture is that the instru-

ment interface can be run separately from SA. This provides a means to run multiple trackers independently on different machines while connect to a single SA for data storage. Doing so also provides the ability to separate the persistence files for individual trackers, as the persistence file will be saved in the directory as where the tracker interface is launched, as opposed to the *C:\Analyzer Data\Persistence* folder.

In order to run the SA Laser Tracker process separately some additional support files are required. These include the following files (Figure 3-75):

	Name	Date modified	Type
☐			
	GeomfitDLLuvc19.dll	9/29/2021 11:40 AM	Application exten...
	MeasurementDLLuvc19.dll	9/29/2021 11:40 AM	Application exten...
	NRKDLL64uvc19.dll	9/29/2021 11:34 AM	Application exten...
	NRKDLLuvc19.dll	9/29/2021 11:40 AM	Application exten...
☑	SALaserTrackersuvc19.exe	9/29/2021 11:41 AM	Application
	Surflibsvc19.dll	8/18/2021 4:54 PM	Application exten...
	TrackerDLLuvc19.dll	9/29/2021 11:41 AM	Application exten...
	TrackerUnicode.dll	8/18/2021 4:54 PM	Application exten...

Figure 3-75. Required Files to run the SA Laser Tracker process independently from SA.

Leica Laser Trackers

Leica AT500

Prerequisites

Tracker Pilot

Track Pilot is used for the primary tracker configuration. It is also necessary in order to run manufacturer checks and calibrations. If you don't have it, it can be downloaded from the instrument by opening a web browser and typing the Tracker IP.

While Tracker Pilot does not have to be installed in order to connect to the tracker with SA, they are intended to be used in conjunction and it is strongly recommended that the current tracker pilot is installed.

Network Configuration

The Leica AT500 connects via a wired Ethernet connection or a wireless connection.

The default wired Leica IP address is 192.168.0.1. This IP address can be changed within Tracker Pilot and Wifi can also be enabled there as well. The computer must be set to the same network with a unique IP address.

Starting the Interface

1. Select **Instrument>Add** and choose the Leica emScon AT500 from the Instrument List (Figure 3-76). This will add a tracker model to the job file to define an instrument plant.
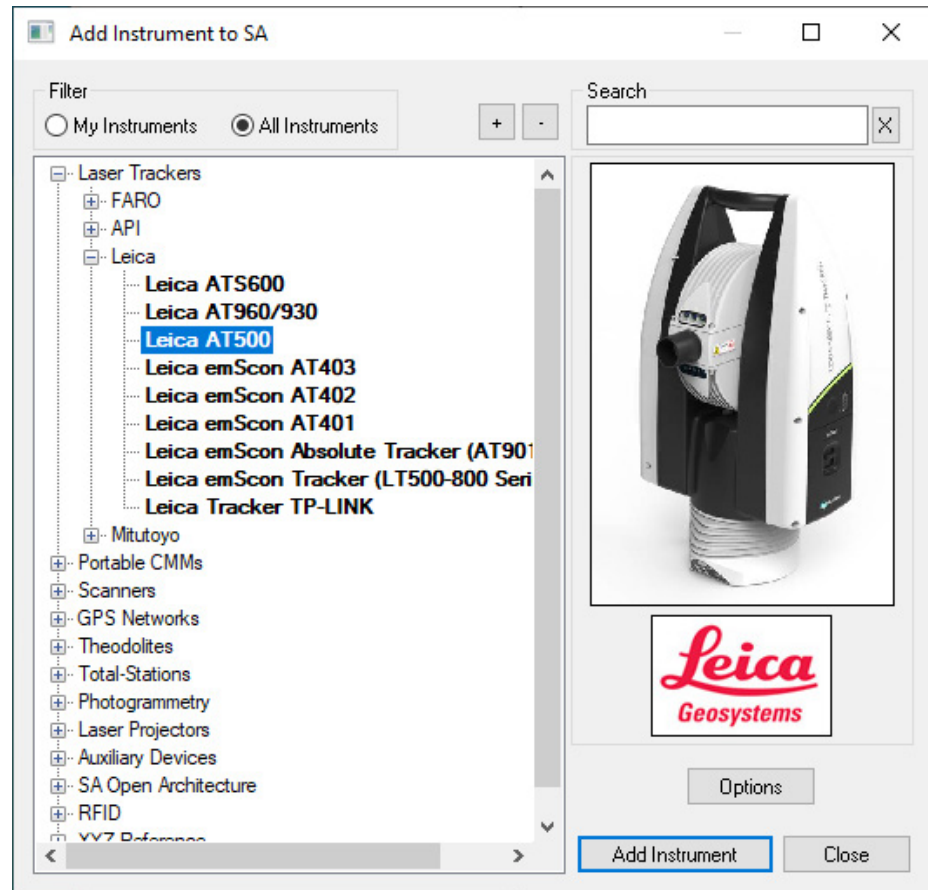

Figure 3-76. Adding an AT500 tracker station to SA.

2. Press Connect the *Instrument* tab of the ribbon to connect the interface to the tracker. You can also use the drop down and choose *Laser Trackers>Leica AT500*.

3. In the Connect to SpatialAnalyzer dialog, select the SA instrument model from the network list and press OK to continue.

4. Enter the tracker's IP address and use the Ping button to test the connection if needed (Figure 3-77). Once satisfied, click OK. The next time the interface is started, you can simply click the Run Interface and Connect 🏃 icon. This will use the last saved settings and automatically connect the instrument. The AT500 now also offers an IP detect button which will autmatically detect the IP of available trackers.

Figure 3-77. The Leica AT500 Connection dialog.
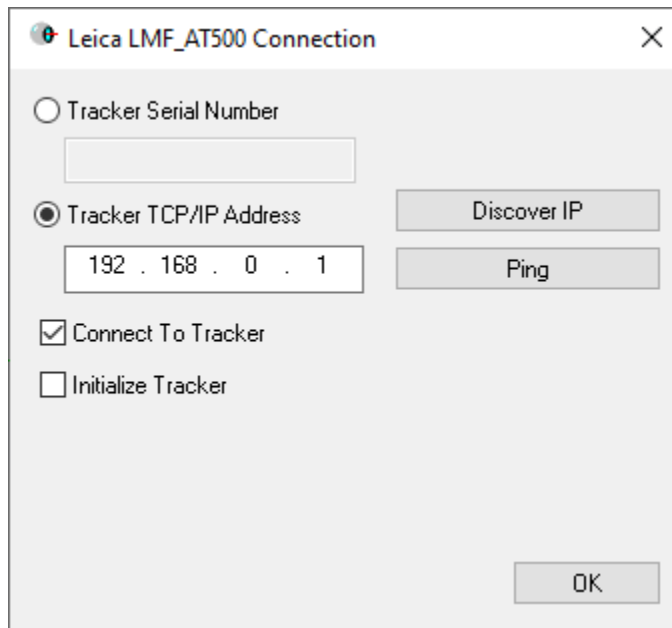
The interface should now connected and be ready for use. Please refer to the "Laser Tracker Interface" on page 10 for details on the laser tracker interface.

The Instrument Toolbar offers a subset of these capabilities, is available as a second docking mode, and will provide all the functions needed for general use(Figure 3-78):
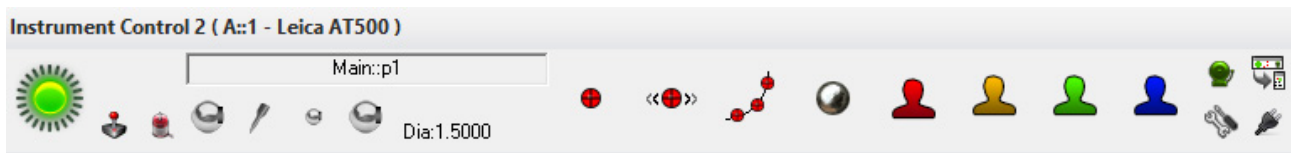

Figure 3-78. Instrument Control Toolbar is a simplified tracker interface to expand graphic space.
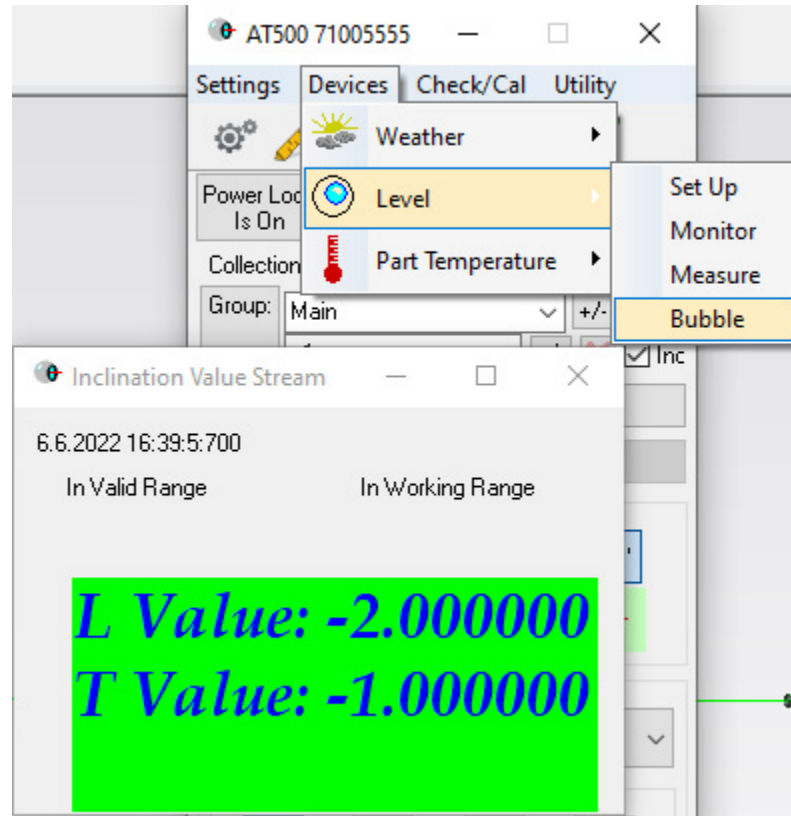
Most basic settings control are available directly within the interface, including tooling settings, measurement profiles, etc. The alarm clock icon provides direct access to current environmental and level settings and provides the ability to set alarms in order to receive notification when conditions change.

Measuring Level

The AT500 does not have an active compensator like Total Stations or the AT4x0 series trackers but rather offers the ability to directly measure level like the AT9x0 series trackers.

In order to measure level you need to first level the tracker within range. To do so the AT500 offers an options *Devices>Level>Bubble(*Figure 3-79)*.

Figure 3-79. Bubble level display which is used to help get the tracker leveled within range in order to perform precise level measurements.

Leica's Orient to Gravity (OTG) Operation.

An Orient to Gravity (OTG) Operation can be used to compensate a tracker's base frame with respect to gravity. Its important to realize that an OTG operation is a system calibration and will change the way in which measured points are recorded and sent to SA. Comparing measurements before and after a level compensation would be similar to comparing different instruments to each other.

This means that if you intend to perform an OTG there are two required conditions:

1. A level compensation (OTG) should be performed after each instrument station move - prior to any point measurements.

2. If measurements have already been taken at an instrument plant, a *jump instrument* operation must be performed prior to performing a level compensation (OTG) and taking additional measurements.

For more information about level measurements refer to the Instruments Chapter of the SA Users Manual.

Battery and Indicator Lights

The AT500 has a battery compartment within the head and has a bat-

ter indicator display on the side. From within the interface you can double click on the beam status light to get the current battery status for the unit(Figure 3-80). There there are also indicator lights regarding the WIFI status.

Figure 3-80. Battery compartment and indicator lights

B-Probe Plus Configuration and Use

The B-probe must be setup and calibrated within Tracker Pilot. Once defined on the controller a new target with the B-probe serial number will become available within the Reflectors and Targets database. To measure with the B-probe in SA. Add a target from the manufacturer definition section and set it as the active target in SA(Figure 3-81).

Figure 3-81. Adding a B-Probe Target to SA

91
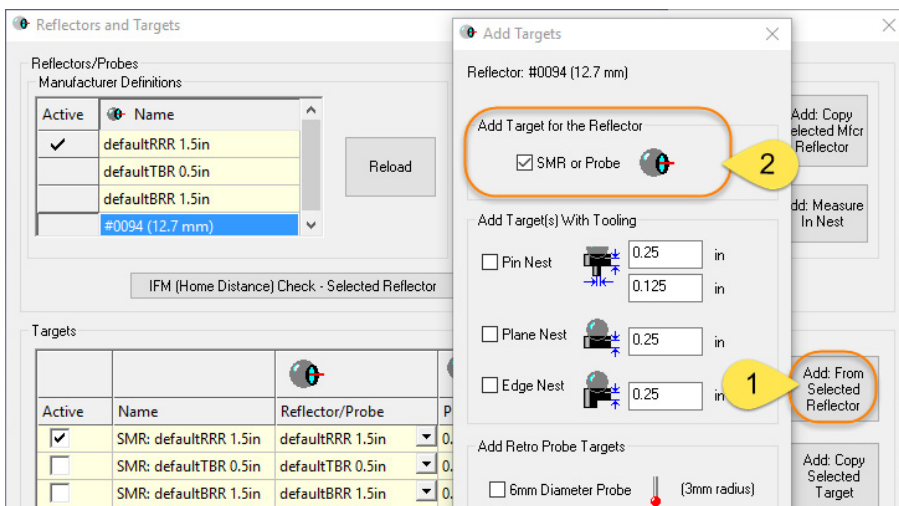
Leica ATS600

The Leica ATS600 is a unique instrument that combines both precision reflectorless measurement with the more traditional Laser tracker measurement capabilities.

Prerequisites

- All Leica trackers are shipped with 192.168.0.1 as the IP address as default. The Leica ATS600 also offer a wireless connection option which uses a different IP by default. Adjustments to the tracker's IP address should be made within Tracker Pilot.

- The current version of Tracker Pilot can be downloaded directly from the Laser Tracker Controller. To do so, open a web browser and type *http://192.168.0.1* in the search bar. This will open a link to the tools saved on the tracker controller. To learn more about configuring IP addresses, see the IP Address Basics section.

LMF Tracker DLL installation

If you have any trouble running the ATS you may need to update your .net framework and you can then try the following procedure:

1. Navigate to *C:\Analyzer Data\LMF_Deployment.*

2. Right-click on *deployLMF_showResults.bat* and select "Run as administrator".

Compensation

The ATS600 trackers and accessories can be compensated within Tracker Pilot (if you need the current Tracker Pilot you can browse directly to http://192.168.0.1 (or the trackers IP) and download Tracker

Pilot from the controller).

- Compensation Password: Expert (Full and Intermediate, ADM, Reflector Definition, Camera Compensation, etc.)

- Server Settings Password: Administrator (TCP/IP address, Time/ Date, etc.)

Starting the Interface

1. Select **Instrument > Add** and choose the respective Leica Tracker from the ***Add Instrument to SA*** dialog.
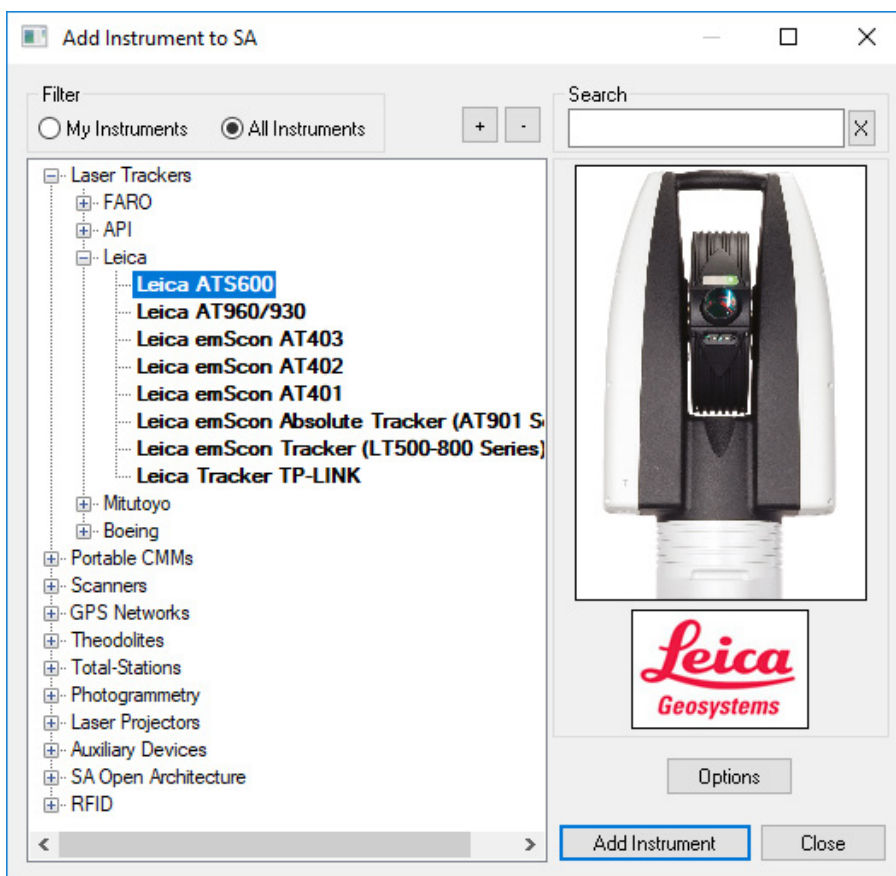

Figure 3-82. Adding a Leica ATS600 tracker.

2. Now run the instrument interface module using **Instrument > Run Interface Module** (with the drop down below the Connect button) and choose **Laser Trackers**.

3. Select the instrument model you want to connect to in your SA job from the network list and press OK to move to the connection dialog (Figure 3-83).
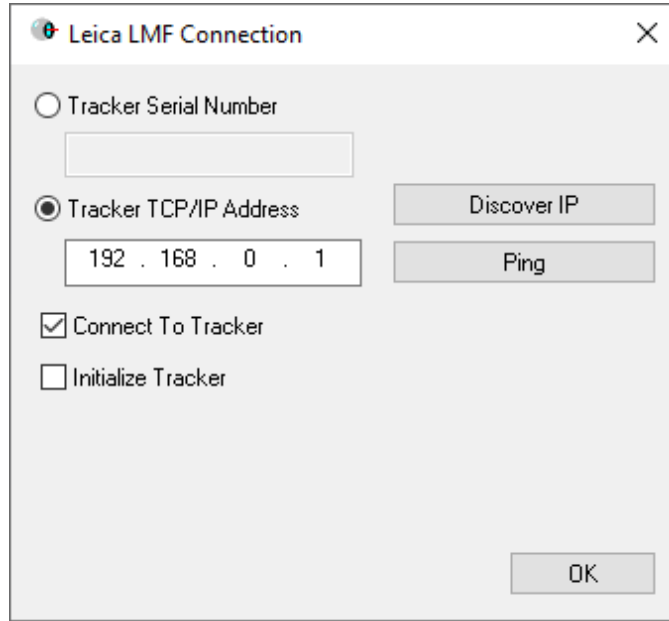
Figure 3-83. The Leica Tracker connection window.

Within the Connection dialog Enter the tracker's IP address, or use the IP discover utility, and use the Ping button to test the connection if needed. Once satisfied, press OK. The next time the interface is started, you can simply click the Run Interface by pressing Connect   . This will use the last saved settings and automatically connect the instrument. The interface is now connected and ready for use. Please refer to the Laser Tracker section for details on the laser tracker interface ("Laser Tracker Interface" on page 10).

ATS600 Overview in SpatialAnalyzer - https://youtu.be/xzm-1dcn22Y

Tracker Specific Settings

The ATS600 is a unique tracker in that it can take reflectorless surface measurements. It can also automatically scan tooling balls using a built in utility. To support this two unique functions, tooling definitions have been added:
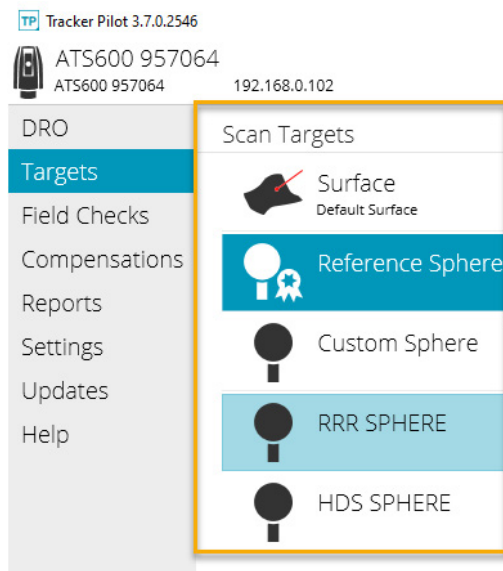
- **Retro: Surface.** Is used to measure surfaces directly.

- **Scan Target: Custom Sphere.** Is used to scan a tooling ball of a given diameter and returns the sphere center point. These target definitions are defined within Tracker Pilot and will then be available for use within SA (Figure 3-84).

Figure 3-84. Scan Targets

Basic Scan Operations

The Over View Camera (OVC) can be directly accessed from both the Toolbar (Figure 3-85) and the full instrument interface (Drive head/ OVC). Basic scan options can be performed directly from this control and do not require the use of any measurement profiles. This approach is simple in that you define a region and can immediately scan that region, but does not offer the ability to save regions or control additional filtering. These options are available as part of a measurement profiles definitions (see following sections.
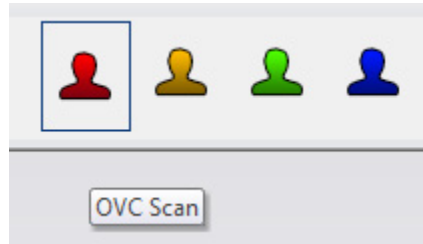
To perform a basic scan do the follow:

1. Open the OVC camera using the Drive Beam Icon (Figure 3-85).

Figure 3-85. Drive Beam Icon
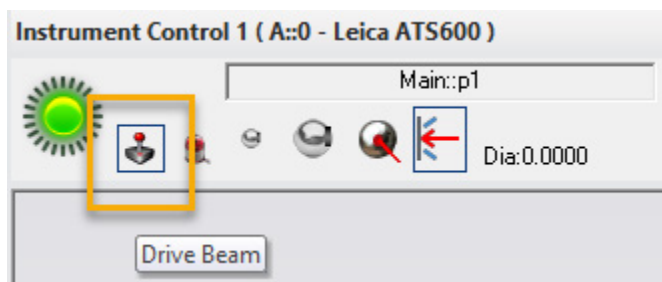
2. Define regions and lines as desired. See section below for more information on the OVC controls.

3. Press use the Red custom profile button (which is preset to OVC Scan for the ATS) to control start and stop of the scan.

95

Figure 3-86. OVC Scan Button

This same basic scan control can be accessed from the OVC button in the full interface as well.

When the OVC Scan button is pressed the tracker will measure *All* the regions defined on the controller, both lines and polygons. Therefore you need to remove any definition you do not want to directly use. Specific regions can be saved as part of a measurement profile for use later if needed. The greater controls and options for this are as follows.

This independent measurement process can also be directly accessed from the full interface using the Drive Head/OVC button. The Camera button will open the tracker OVC and the Scan button can be used to initiate a scan defined directly (Figure 3-87).

Figure 3-87. Drive Head/OVC Scan access
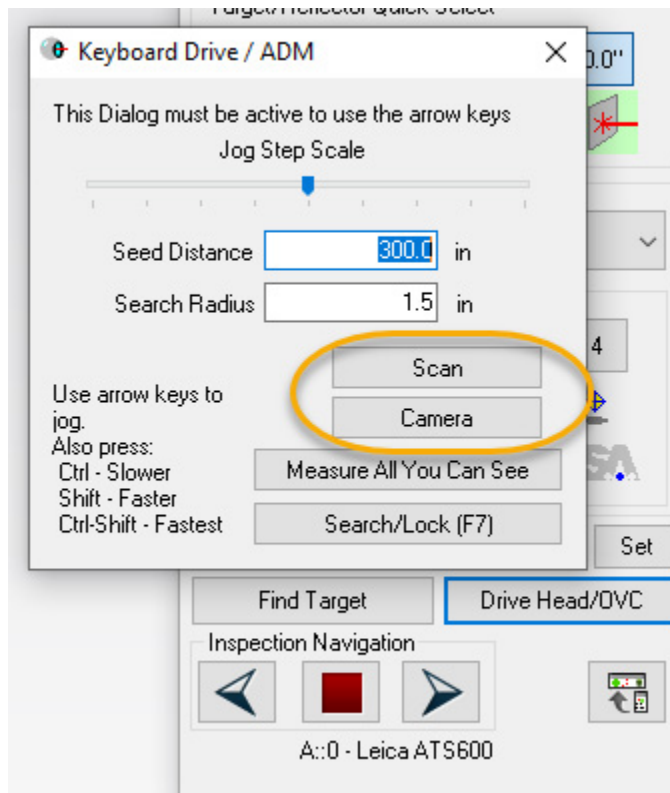
Saving Scan Region Definitions with Measurement Profiles

The definitions of scan Area and Line regions have been streamlined as follows:

- While the OVC is option, whatever is showing in the OVC will always be Measured, no matter how the OVC was opened (from a profile definition or from the Drive Head/OVC control).

- If you open the properties of a measurement profile using the edit icon 🔧 and the OVC using the Show Regions (or Show Lines) button, this will automatically push the saved scan regions from within the measurement profile to the OVC and the saved regions will be displayed. This will replace any regions previously defined on the OVC before the Show Regions (or Show Lines) button is pressed.

- With the properties dialog open you can edit the regions within the OVC and use them in the edited condition, but they will not be saved with the measurement profile until the measurement profile is saved. Any changes to the Area or Line scan definitions made within the OVC should be saved to a profile, using the Save button in the profile, before closing the OVC or the changes will be lost.

The ATS600 also offers 3 default measurement profiles that can be edited and saved with user defined region definitions:

- **Area Scans.** Provide the ability to define a boundary around a part or feature of interest and scan within that boundary.

- **Line Scans.** Define a line or Polyline that can be used to either scan along in a **Linear** mode (scanning along a line) or in rectangular regions along a lines path in a **CrossLine** mode.

- **Ring Scans.** All scanning in a full arc about the tracker.

Area Scans using Regions and Polygons or Perimeters

Three default Area Scan measurement profiles were added to support area scanning:

- **Area Scan Cloud.** This is the most commonly used profile. It provides full scan configuration and will return a point cloud.

- **Area Scan Points.** In cases where a scan needs to return points individually rather than a point cloud this profile can be used.

- **Area Scan Plane.** If a scan is intended to return a particular geometry the raw measurements this profile provides an example of how to use a scan to build a plane.

> 📎 **Note:** The Area San measurement profiles require a Retro: Surface target selection.
>
> **By request,** we force this target type to be set any time an Area Scan mode is active.

As always, these three are just default starting points, and you are free to define your own custom profiles. Note also that *Stable Point* measurement profiles also work very well with reflectorless measurements.

Regions used to define the extents of Area Scans are defined in advance as part of a measurement profile definition. To do so, select one

of the pre-defined **Area Scan** profiles as the active measurement profile and press the View Selected Profile button to edit the profile settings (see Figure 3-88).
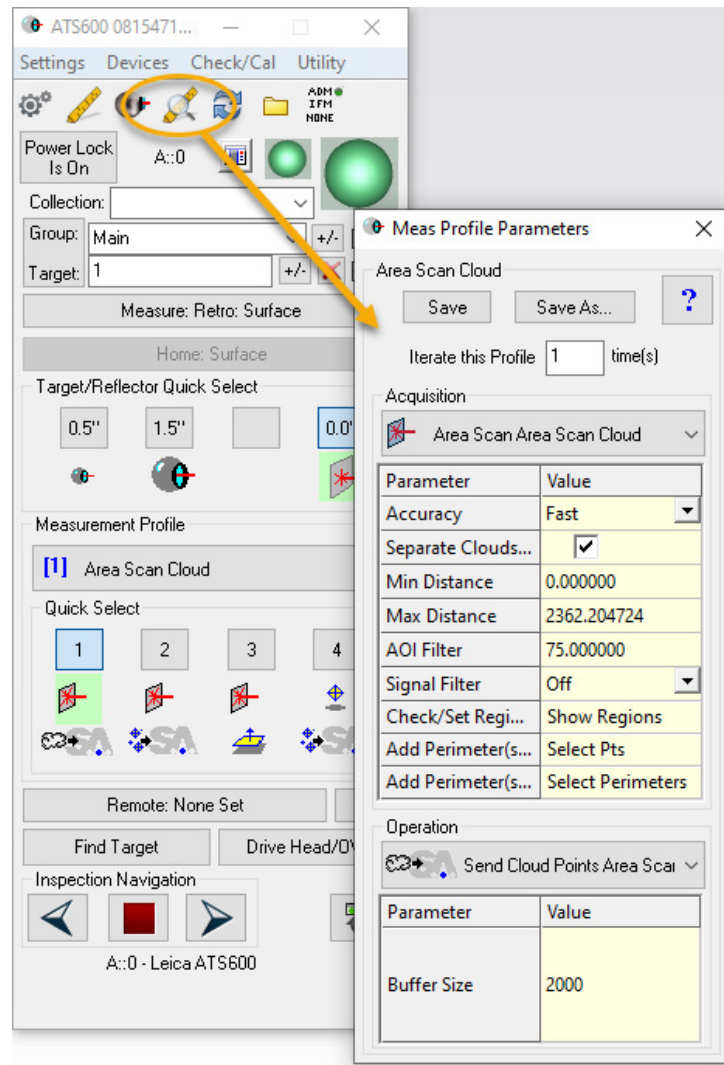

Figure 3-88. ATS Interface and Scan Profile configuration

An Area Scan profile offers the following settings:

- **Accuracy.** Set as Fast, Standard or Precise.

- **Separate Clouds.** This check box determines if separate clouds will be used for different perimeters.

- **Min Distance.** Defines a minimum limit such that data closer than this threshold will not be recorded.

- **Max Distance.** Defines a maximum limit such that data further than this threshold will not be recorded.

NOTE: You can move the tracker head to the desired position, and click directly in the profile grid on the *Min Distance* and *Max Distance* labels to make the tracker set these by measuring the distance to the surface where it is pointing.
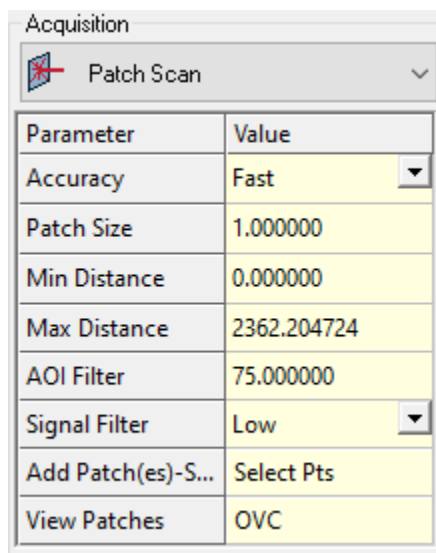
- **AOI Filter.** The Angle Of Incidence (AOI) filter will exclude data recorded on a surface at a greater angle in degrees than the set value.

- **Signal Filter.** This filter can be set to "Off, Low, Medium, and High" settings, and is based on a combination of broadening value and intensity.

- **Check/Set Regions - OVC.** The Value section for this Parameter operates as a button that will open the trackers OVC camera.

- **Add Perimeter(s) - SA.** The Select Pts option here will trigger a perimeter selection mode within SA in which an operator can select points to define a perimeter.

- **Add Perimeter(s) - SA Perimenters.** The Select Perimeters option here will trigger a perimeter selection mode within SA in which an operator can select predefined perimeters from SA.

Defining CAD Perimeters for Scan Areas in SpatialAnalyzer -

https://youtu.be/XYrh7-QyBU4

Patch Scans

The Patch Scan Cloud profile was added to facilitate auto-measure type operations where the reference points define the center of a patch of a give size. Selecting points from SA defines a collection of scan regions on the controller such that each point is scanned using a square patch.

Figure 3-89. Patch Scan Acquisition

From the Patch Scan profile window:

1. Select "Add Patch(es)-SA Pts" to select points from SA. Hit "Enter" to create the patches, and update the OVC if it is open.

2. Select "View Patches" to open the OVC to show your patches and control the region density, or to update the OVC with changed settings.

The patch size (length of square perimeter around each selected point, perpendicular to tracker line of sight) can be set here as well. Patches are shown in the OVC's Regions tab. Point to Point spacing and Grow/Shrink Width is set there, like it is for Area Scans (both are per-region parameters).

Note - Any pre-existing Patch perimeters are cleared when creating new ones, unlike perimeters in an Area Scan, where new perimeters are added, and existing regions are not cleared.

Line Scans using Lines and Polylines

Line definitions provide an alternative way to measure either in a linear progression or using a series of crossing lines perpendicular to a poly line. This measure mode is accessed using a **Line Scan** Acquisition (Figure 3-90).
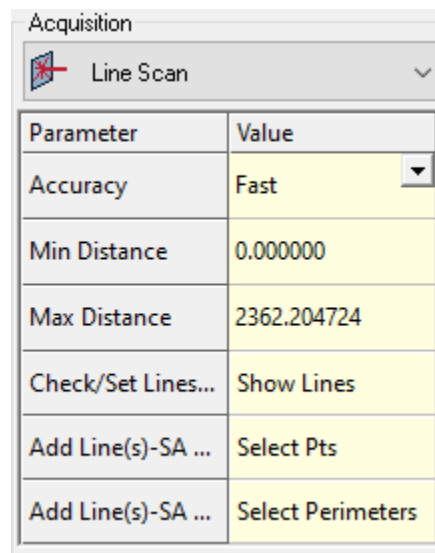

Figure 3-90. Line Scan Acquisition Parameters

A Line Scan profile offers the following settings:

- **Accuracy.** Set as Fast, Standard or Precise.

- **Min Distance.** Defines a minimum limit such that data closer than this threshold will not be recorded.

- **Max Distance.** Defines a maximum limit such that data further than this threshold will not be recorded.

NOTE: You can move the tracker head to the desired position, and click directly in the profile grid on the *Min Distance* and *Max Distance* labels to make the tracker set these by measuring the distance to the surface where it is pointing.

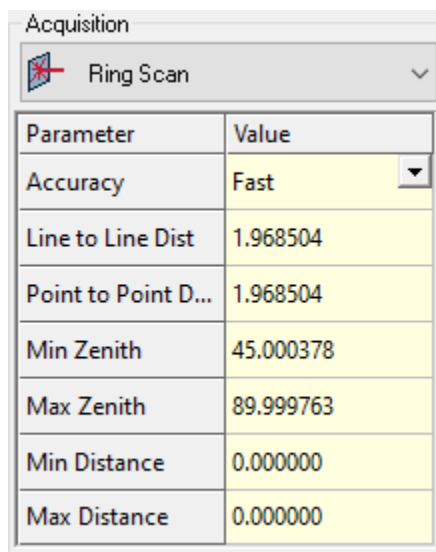- **Check/Set Lines - OVC.** The Value section for this Parameter

operates as a button that will open the trackers OVC camera.

- **Add Line(s)-SA Pts.** The Select Pts option here allows a user to select points directly from with SA for use in a Line Scan Region definition, once set, it is then viewable through the OVC.

- **Add Line(s)-SA Perims.** The Select Perimeters option here allows a user to select perimeters directly from with SA for use in a Line Scan Region definition. It builds a line for each side of the defined perimeter, and will be visibible through the OVC. Use the **Closed Perimeter** check box in the perimeter properties to add an additional polyline returning to the start, if desired.

*Note - Lines are saved as part of the measurement profile. To clear them out you will need to delete them from within the OVC and Save the measurement profile. You should then see a notification "*No Lines defined in Line Scan mode on the controller*". Re-opening the OVC will re-import any saved regions from the measurement profile.

Ring Scans

Ring Scan definitions provide a means to measure a full arc about the tracker. This is accomplished using a **Ring Scan** Acquisition (Figure 3-91). This is the only profile that does not offer access to the OVC. The ring scan definitions are defined only using a Zenith angle (zero being straight upward and 90 degree being straight outward from the tracker base) and a point/line spacing definition.

Figure 3-91. Ring Scan Acquisition Parameters

Parameter	Value
Accuracy	Fast
Line to Line Dist	1.968504
Point to Point D...	1.968504
Min Zenith	45.000378
Max Zenith	89.999763
Min Distance	0.000000
Max Distance	0.000000

A Ring Scan profile offers the following settings:

- **Accuracy.** Set as Fast, Standard or Precise.

- **Line to Line Distance.** Defines the distance between line or arcs about the tracker.

- **Point to Point Distance.** Defines the point spacing along a line or arc.

- **Min Zenith.** Defines the lower limit in the vertical angular range covered by the arc recorded by the tracker.

- **Max Zenith.** Defines the upper limit in the vertical angular range covered by the arc recorded by the tracker.

NOTE: You can move the tracker head to the desired position, and click directly in the profile grid on the *Min Zenith* and *Max Zenith* labels to make the tracker set these by measuring the vertical encoder of the tracker. The values are always in degrees. The current azimuth (horizontal angle) position of the tracker will not matter for this setting.

- **Min Distance.** Defines a minimum limit such that data closer than this threshold will not be recorded.

- **Max Distance.** Defines a maximum limit such that data further than this threshold will not be recorded.

NOTE: You can move the tracker head to the desired position, and click directly in the profile grid on the *Min Distance* and *Max Distance* labels to make the tracker set these by measuring the distance to the surface where it is pointing.

Defining Measurement Profiles for the ATS600 in SpatialAnalyzer -

https://youtu.be/5PWdwjhEs5E

Using the built in OverView Camera (OVC)

By using the video, and selection points from the image, a region can be defined. To do so perform the following steps:

1. In the *Check/Set Regions - OVC* (or *Check/Set Lines*) parameter Click on the Show Regions (or Show Lines) button in the Measurement Profile Acquisition. This will open the Leica Overview Camera (Figure 3-92).

2. Select the Add Region button and left-click in the graphics to define a polygon, use right-click to complete the polygon or Escape to cancel. A "Region" has a single set of point to point and line to line distance parameters. A tighter grid will result in a longer scan time.

3. Add additional polygons within a region definition through use of the Add Polygon button, if needed. Select a polygon and press green circle to toggle the polygon from interior/exterior in order to define exclusion zones.
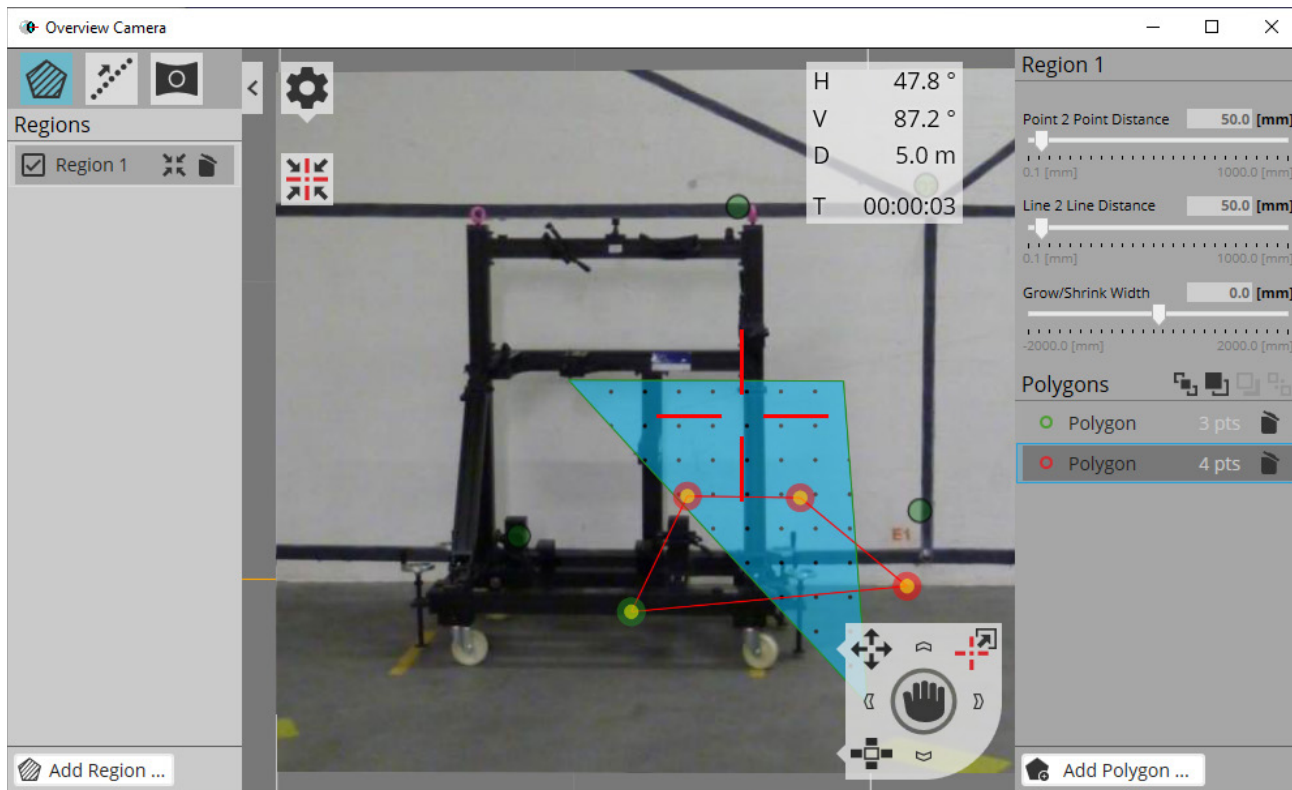
Figure 3-92. LeicaOverviewCamera and selection region

4. Add additional Regions to the OVC as desired to define regions with different point resolution as part of a single scan.

5. Close the OVC. This process will save the current region and polygon settings from the OVC to the active measurement profile.

Line profiles are defined the same way using the Line Scans tab. A "Line" is equivalent to a "Region" while a "Polyline" is equivalent to a "Polygon". The biggest difference is that the Line Scans profile can be defined with either (or both) Linear and CrossLine measurements.

Measuring points directly from the OVC camera

Measurements can be taken directly from the OVC camera using mouse clicks. This can be done using the play button in the drive control (Figure 3-93).
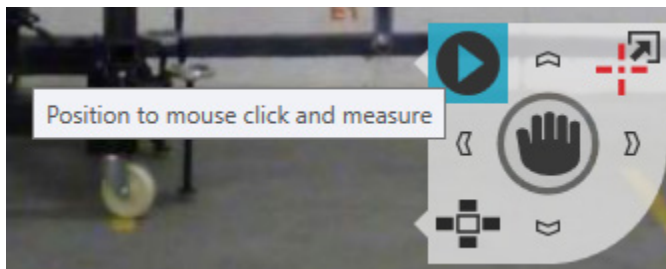

Figure 3-93. Direct Measurement from the OVC camera

Using 3D Region Definitions

The region definitions built either through the OVC (using the Set Distances option) or using a perimeter built from SA are 3D and defined in World coordinates. This allows you to define a set of regions from a CAD surface for example, save the profile, jump instrument and immediately measure with the same profile to scan the same region from a different perspective within the same job file. This can be very helpful in getting enough coverage for feature extraction.

Scan Data, Intensity, broadening and Color

Each cloud point returned from an ATS includes color information in Red, Green and Blue. These are used to indicate a quality matrix about the cloud point recorded.

- Blue and green together represent the ATS return intensity value. Higher blue and green values mean higher intensity (usually good).

- Red represents the broadening value. Higher red value means higher broadening (usually bad), meaning steeper incidence angles or beam splitting and deflection.

Both Intensity and Broadening values are in a range from 0-255. Leica's recommended filter settings for broadening are as follows:

- **Off.** Don't reject any red value's

- **Low filtering.** Reject red values > 170

- **Med filtering.** Reject red values > 42

- **High filtering.** Reject red val > 2

In general terms the broadening value is a measure of the return pulse in comparison to the start pulse. It the intensity and duration of return is compared and the continuity of this return is computed. As an example, the signal broadening from a split surface might look like this, where the full peak is the intensity but the difference in front and back signal define the broadening value:
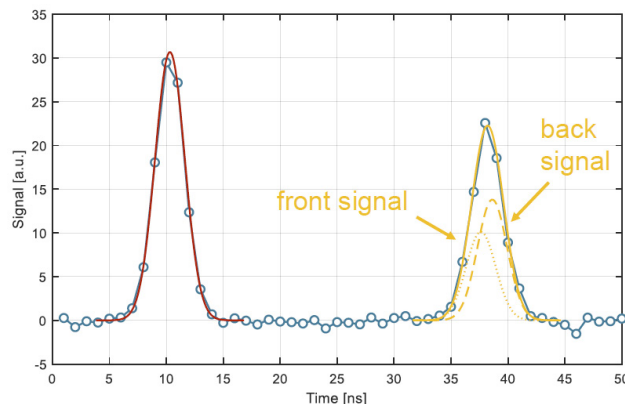

Figure 3-94. Broadening of a signal return.

As shown in the picture below. Removing regions with low intensity and higher red or broadening values can provide a helpful way of removing unwanted data (Figure 3-95).

Figure 3-95. Beforeandafterimage of color filtering

In order to filter out cloud points of a particular color right-click on the point cloud and select the **RGB Filtering** option.

 Using RGB Filtering with ATS600 in SpatialAnalyzer - https://youtu.be/m11ufArEkJU

Surface Vector intersection Measurements

The ATS refectorless measurement capability provides a means to precisely measure a point location on a surface. Vectors normal to that surface can be used to identify exactly where to measure on an actual part regardless of thickness variation. This corrects for a potentially significant shift in the location of the returned point depending on the incidence angle to the part if nominal points on the part are used rather than vectors. SVI (Surface Vector Intersection) measurements provides an aut-measure function which can be used for this type of application.

For settings, go to the Gear Tool ⚙ (General Settings) in the main tracker interface window, and hit [Leica ATS] button (Figure 3-96).

Figure 3-96. Controls for the Surface Vector Intersection measurements within the tracker interface.
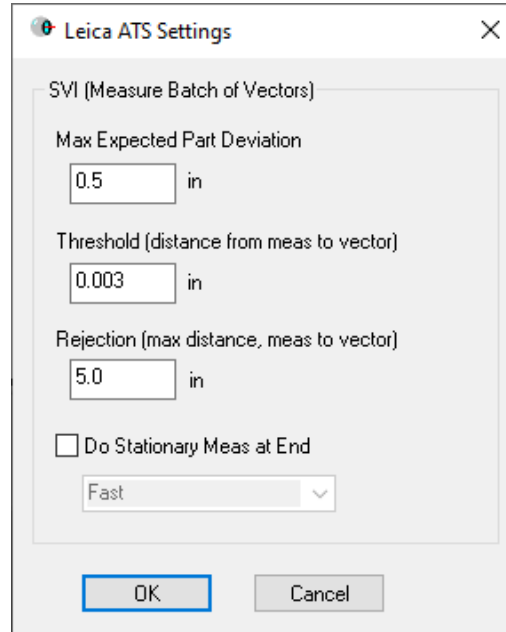
- **Max Expected Part Deviation.** Is the size of an initial 3-point search along the reference vector, and at least one of the positions must hit the part.

- **Threshold (distance from meas to vector).** Defines how close you want the search to get in order to yield a measurement whose distance from the vector is within that threshold.

- **Rejection (max distance, meas to vector).** Fail the measurement if this threshold is exceeded, and add a report to the Instrument History in SA, identifying the failed point. The addition will help to avoid the condition where the tracker cannot point to the expected intersection point, or along the search vector, and to diagnose it when it does happen.

- **Do Stationary Meas at End.** By enabling this option the live distance reading still guides to beam to the desired location, but rather than simply sampling the distance a more accurate point measurement is then triggered. This can be set to Fast, Standard or Precise surface point modes.

To initiate this measurement, just go to the SA Instrument menu, and select **Instrument>Automatic Measurement > Measure Batch of Vectors** (Figure 3-97).

Figure 3-97. Example set of SVI surface measurements at the specified vector locations
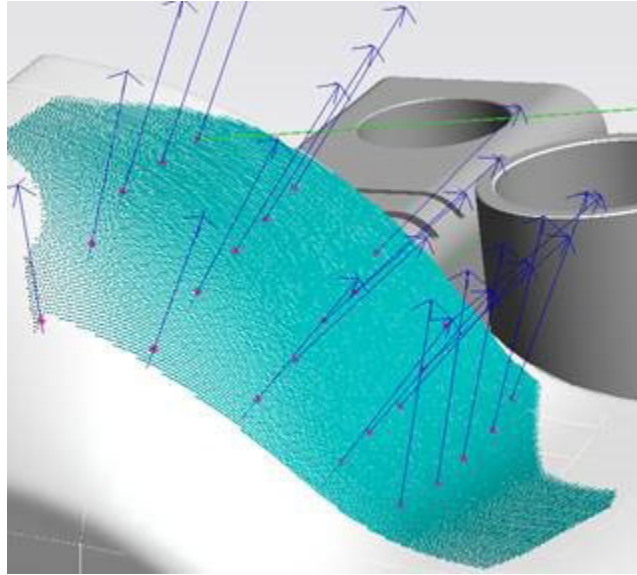
Measurement details will include the "Max Expected Part Deviation" and "Threshold" values used, and the resultant point's distance from the vector.

Surface Vector Measurements with ATS600 in SpatialAnalyzer -

https://youtu.be/QHjj5IP7J6s

Leica's Orient to Gravity (OTG) Operation.

An Orient to Gravity (OTG) Operation can be used to compensate a tracker's base frame with respect to gravity. Its important to realize that an OTG operation is a system calibration and will change the way in which measured points are recorded and sent to SA. Comparing measurements before and after a level compensation would be similar to comparing different instruments to each other.

This means that if you intend to perform an OTG there are two required conditions:

1. A level compensation (OTG) should be performed after each instrument station move - prior to any point measurements.

2. If measurements have already been taken at an instrument plant, a *jump instrument* operation must be performed prior to performing a level compensation (OTG) and taking additional measurements.

For more information about level measurements refer to the Instruments Chapter of the SA Users Manual.

Running the Tracker Interface Separately

One of the unique features about SA's architecture is that the instrument interface can be run separately from SA. This provides a means

to run multiple trackers independently on different machines while connect to a single SA for data storage. Doing so also provides the ability to separate the persistence files for individual trackers, as the persistence file will be saved in the directory as where the tracker interface is launched, as opposed to the *C:\Analyzer Data\Persistence* folder.

In order to run the SA Laser Tracker process separately some additional support files are required. These include the following files (Figure 3-98):

Figure 3-98. Required Files to run the SA Laser Tracker process independently from SA.

Name	Date modified	Type
GeomfitDLLuvc19.dll	9/29/2021 11:40 AM	Application exten…
MeasurementDLLuvc19.dll	9/29/2021 11:40 AM	Application exten…
NRKDLL64uvc19.dll	9/29/2021 11:34 AM	Application exten…
NRKDLLuvc19.dll	9/29/2021 11:40 AM	Application exten…
☑ SALaserTrackersuvc19.exe	9/29/2021 11:41 AM	Application
Surflibsvc19.dll	8/18/2021 4:54 PM	Application exten…
TrackerDLLuvc19.dll	9/29/2021 11:41 AM	Application exten…
TrackerUnicode.dll	8/18/2021 4:54 PM	Application exten…

MP support for Automation

In addition to the standard Laser Tracker MP support there are a couple of commands of note that will be directly helpful for the ATS:

- **Scan Within Perimeter.** Provides the means to select a set of perimeters and exclusion zones and directly scan them using the scan resolution specified resolution.

- **Scan CAD Faces.** Takes the scan within perimeter idea and applies it to a list of CAD faces. This command can include exclusion zones defined by holes in the selected CAD faces.

- **Edit Scan Perimeter Profile.** This command offers a means to edit an existing measurement profile and add a set of scan regions to it.

When using *Scan Within Perimeter*, the "**Parameter set name**" (A2) can be used to define the resolution of the scan. Enter a string for the **Parameter set name** as follows:

- **"uuPxx".** To set point to point (P) spacing only for an area scan.

- **"uuPxxGSWxx".** To set point to point (P) spacing and apply a Grow/shrink Width (GSW) to an area scan.

- **"uuPxxLWxx".** Line scan using the specified Point to Point distance (Pxx) and Line Width (LWxx).

- **"uuPxxLWxxLtoLxx".** Cross line scan using the specified Point to Point distance (Pxx), Line Width (LWxx), and Line to Line dis-

tance (LtoLxx).

- ▪ **"C or P.** You can append either C or P to any of the strings to enforce measurement using a Point Cloud (C) or a point group (P). Use "inP0.2C" for example to scan a point cloud with a 0.2 inch density.

Where "uu" can be either "mm" (millimeters) or "in" (inches). For example: entering a value such as "mmP10" would produce a scan with a 10mm spacing between the points within the specified perimeter.

In 2022.3 a dialog entry method has been added to simplify this process (Figure 3-99).
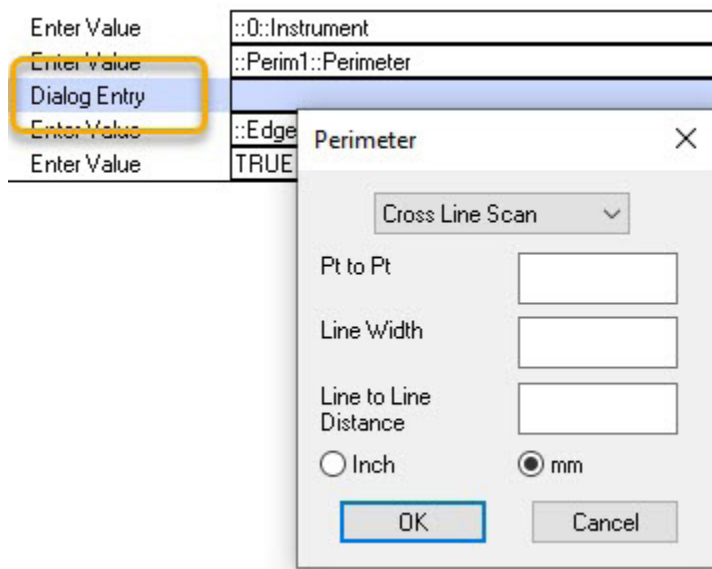
Figure 3-99. Dialog Entry

- ▪ **RGB Cloud Point Filter.** Can be used to adjust visibility of cloud point data based upon intensity and broadening values.

There **Instrument Operational Check** command "*camera view*" can be used to open the OVC and while open, **Configure and Measure** can be used to trigger measurements using the user defined OVC definitions, as long as it is used with the OVC still open. This is a means to have a user guide a measurement setup from MP.

Leica AT9x0

Prerequisites

- All Leica trackers are shipped with 192.168.0.1 as the IP address as default. The Leica AT960/930 also offer a wireless connection option.

- The current version of Tracker Pilot can be downloaded directly from the Laser Tracker Controller. To do so, open a web browser and type *http://192.168.0.1* in the search bar. This will open a link to the tools saved on the tracker controller. To learn more about configuring IP addresses, see the IP Address Basics section.

Compensation

The AT960/930 trackers and accessories can be compensated within Tracker Pilot (if you need the current Tracker Pilot you can browse directly to http://192.168.0.1 (or the trackers IP) and download Tracker Pilot from the controller).

- Compensation Password: Expert (Full and Intermediate, ADM, Reflector Definition, Camera Compensation, etc.)

- Server Settings Password: Administrator (TCP/IP address, Time/Date, etc.)

Starting the Interface

1. Select **Instrument > Add** and choose the respective Leica Tracker from the *Add Instrument to SA* dialog.

**Figure 3-100.** Adding a Leica AT960/930 tracker.
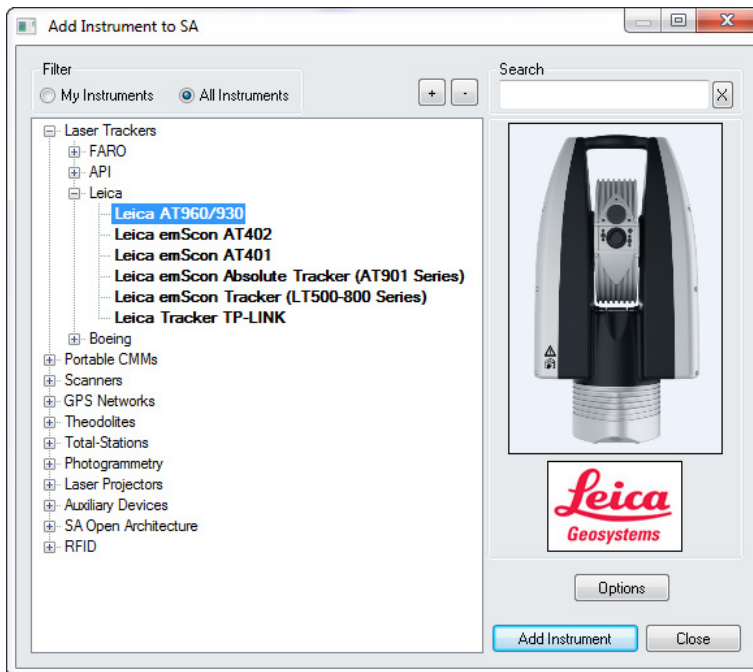
2. Now run the instrument interface module under **Connect (Instrument > Run Interface Module)** and choose **Laser Trackers**.

Figure 3-101. Selecting Laser Trakers from the Ribbon menu.
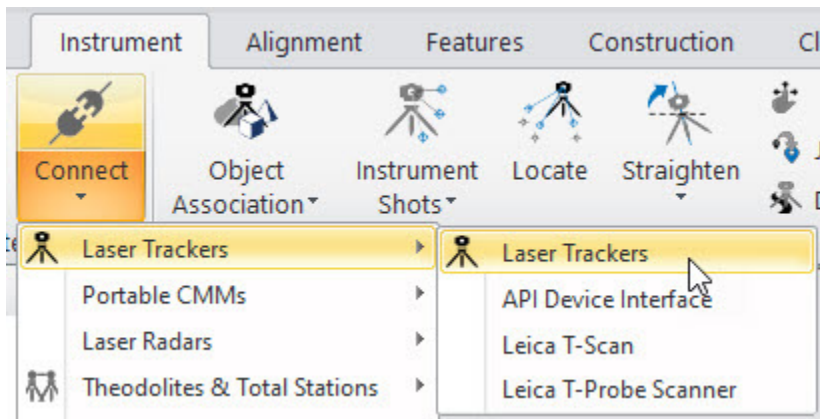
This will bring up a dialog with a list of available instrument models within SA to connect to. If you have a single instrument model adding in SA then on one will be shown within the Connect to SpatialAnalyzer dialog like this:

111

Figure 3-102. Connect to SA dialog where you pick the instrument model within SA to connect to.
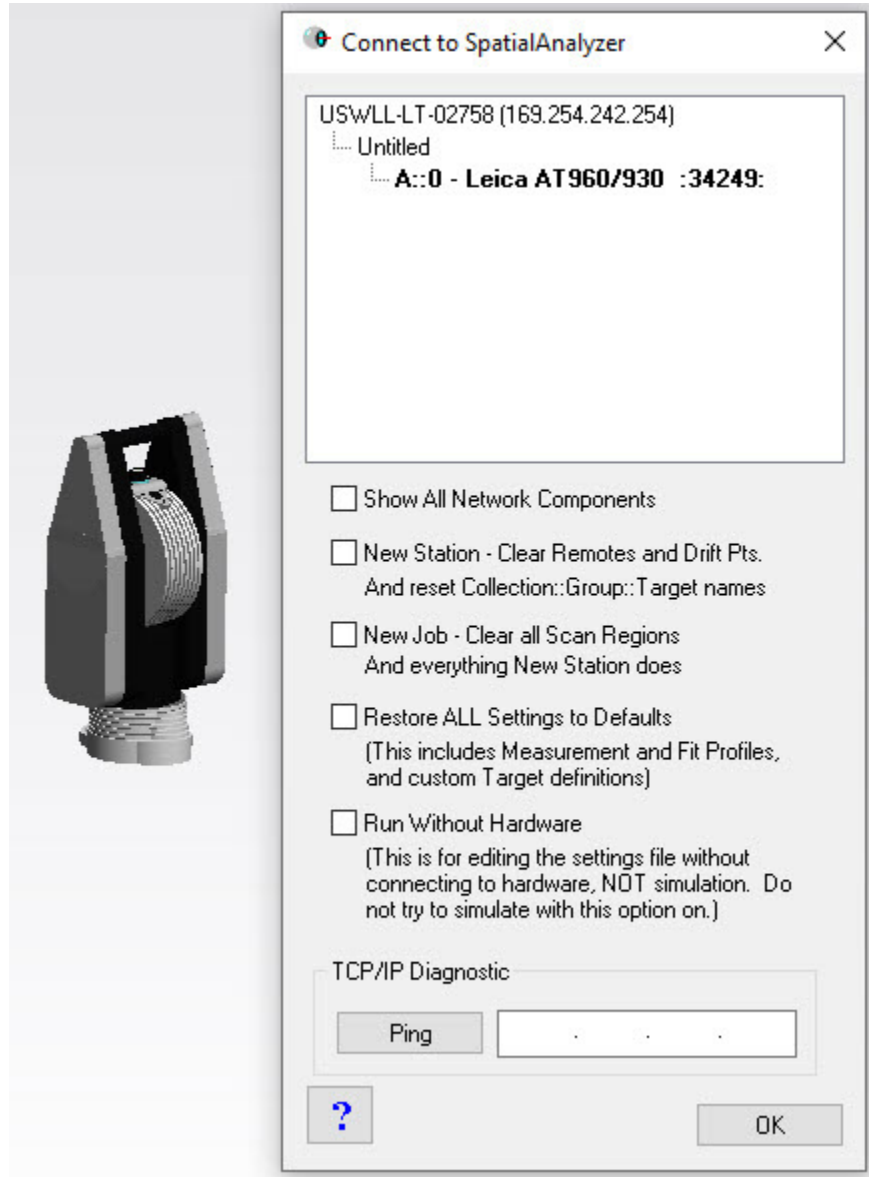
3. Select the instrument model from the Connect to SpatialAnalyzer dialog and press OK to continue to the instrument connection.

4. Within the Leice LMF Connection window, enter the tracker's IP address and use the Ping button to test the connection if needed. The AT960/930 also offers an IP discover utility.
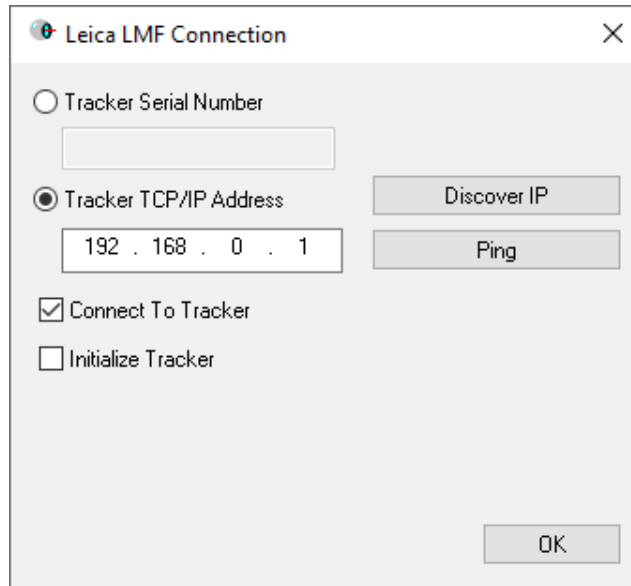
Once satisfied, press OK to connect. The next time the interface is started, you can simply click the Connect button (Run Interface and Connect 🏃 icon). This will use the last saved settings and automati-

cally connect the instrument. The interface is now connected and ready for use. Please refer to the Laser Tracker section for details on the laser tracker interface ("Laser Tracker Interface" on page 10).
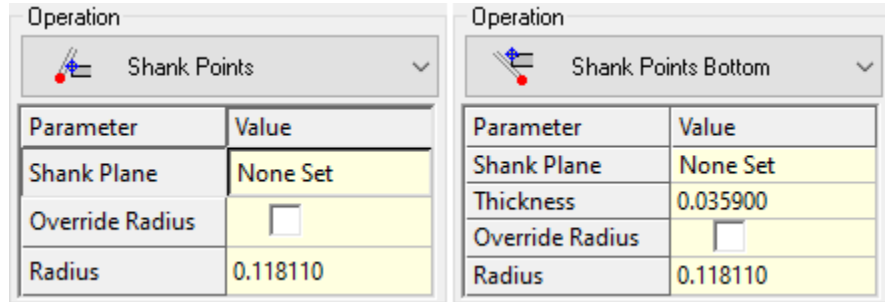
Tracker Settings

To access the custom settings, use **Settings > Tracker > General Settings** or press the ⚙ button. Then press the tracker specific button at the bottom.

6D Shank Measurements

With a calibrated shank tip attached to a T-probe (calibration is performed within Tracker Pilot), shank measurements can be taken for sheet metal applications, providing an edge measurement solution. *Shank Points* is a new Operation that can be used with any measurement acquisition mode(discrete, stable or scan). But two new measurement profiles have been added to support this application(Figure 3-104):

- **Discrete Shank Point.** This mode is the standard measurement of a point on an edge.

- **Discrete Bottom Shank Point.** This operation provides the same shank measurement option with the addition of a specified shift relative to the reference plane, designed to account for material thickness.

Figure 3-104. ShankMeasurement Profile Operations

Operation			Operation		
≼ Shank Points ⌄			⌄ Shank Points Bottom ⌄		
Parameter	Value		Parameter	Value	
Shank Plane	None Set		Shank Plane	None Set	
Override Radius	☐		Thickness	0.035900	
Radius	0.118110		Override Radius	☐	
			Radius	0.118110	

Shank Plane - measurements require a projection plane to be defined and use this plane definition to define the intersection point of the shank axis and the plane. The tilt of the probe relative to the plane is used to determine the point's offset in combination with the probe diameter.

This means that the cleanest offset is obtained by holding the probe perpendicular to the edge. Tilting the probe is fine but leaning it such that it trails along the edge (into or out of the paper in (Figure 3-105) should be avoided and could cause an overestimate of the offset.

Override Radius- the radius of the shank probe should be set as part of the calibration process but its default value can be changed within the measurement profile if needed, using this control.

Shank Measurements in SpatialAnalyzer -

https://youtu.be/hXnoj4ov1GA

Figure 3-105. Properorientationof the probe for accurate shank measurements
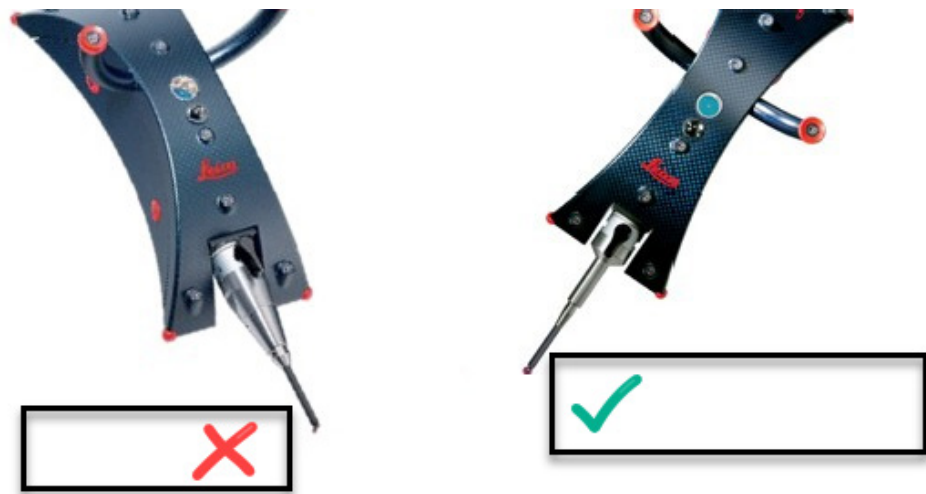
Proximity Measurements with a Shank Probe

Shank measurements can also be used with proximity triggers. This makes edge measurements easy to perform by allowing you to trigger points along an edge as you slide a shank probe along it.

To do so perform the following steps:

1. Build a vector group to be used for the proximity trigger process. Each vector in this vector group will be used as a trigger such that as the probe's axis crosses the vector a point will be triggered for you.

2. Enable *Use Shank* option within the Auto-Proximity Scan profile operation. This tells SA to use the shank point not the tip of the probe in the proximity calculation.
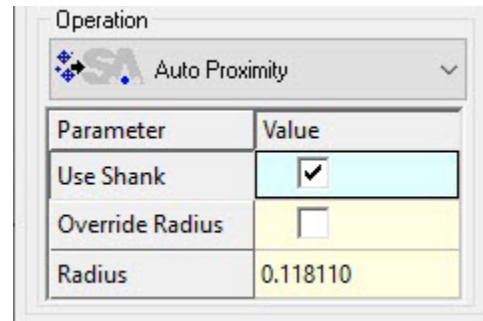

Figure 3-106. Auto Proximity Operation has an option to Use Shank which needs to be enabled.

3. Navigate to **Instrument>Automatic Measurement>Auto-Correspond with Proximity Triggers>Vectors**. Specify a tolerance zone to consider and a resulting group name and begin the operation.

Double check that the option to measure each point more than once within the proximity dialog is ***Enabled***. If you don't, it will simply take the first point that is within the proximity tolerance…on the approach and will not find the closest point to the vector intersection.

4. Slide the shank probe along the edge of the part to trigger measurements at each of the reference vector locations.

The point that is recorded is the closest point on the shank to the vector origin. Its important, therefore to have a good alignment. If the measure feature deviations significantly from the nominal the compensation can be affected.

Offset Frames for 6D Measurements

Its possible to define and utilize offset frames with a T-probe or T-mac. This allows you to take a 6D measurement, but record a frame that is spatially offset from its base position as the measurement. The offset frame utilizes a fixed transform relative to its position and orientation. Defining one is idea for scenarios where you are defining a tool tip on a robot for example.

There are two ways to define offset frames.

1. An offset frame can be defined and saved within a measurement profile. Additional details on this can be found in the section on measurement profiles here: "Measurement Profiles" on page 25.

2. An offset frame can also be defined as part of a target defini-
tion. This is important for multi-sided T-Mac's because it allows
measurements from each face to return a common transform.
It also provides an option to have the offset applied to all
measurements from this target.

There are several steps to defining a common offset frame for a T-Mac
which are as follows:

1. Rigidly mount the T-Mac as desired such that it is visible from
your instruments location. Then record or construct the de-
sired frame you wish to return from the measurement. This
may means measuring the end effector for the robot for ex-
ample. Ensure that the T-Mac and Robot do not move. Also
measure common points in case additional instrument sta-
tions will be required and a tie in will be necessary.

2. Lock onto the T-Mac and set the measurement profile to a 6D
Discrete Measurement profile (this will allow you to measure
an offset transform for the target definition).

3. Open the Reflectors and Targets database and click on the
manufacturer's definition to open the offset frame definitions
(Figure 3-107).
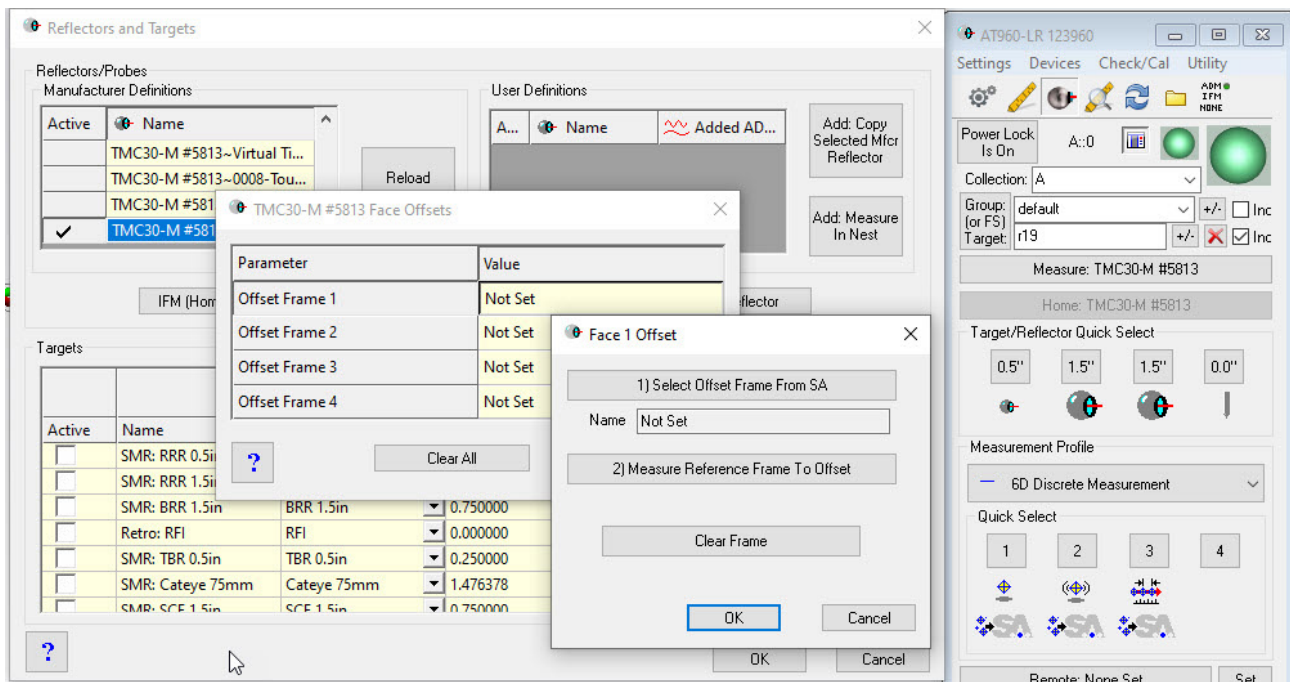
Figure 3-107. Setting an offset frame for Face 1 of a multi-sided T-Mac.

This dialog allows you to select from a list of offset frames (only a sin-
gle offset frame will be visible when locked onto a regular T-Mac or
T-Probe). Select the desired frame which corresponds to the desired
face and a familiar offset frame measurement dialog will open. You

can then select the offset frame and measure the current position to compute the offset definition.

4. Move the tracker without moving the robot to a new location and tie it in to the prior station. You can then add an additional offset frame for this T-Mac face. The process can be continued until each face of the T-Mac has been calibrated with offset frame definitions.

These offset frames will be persisted for each face of each reflector. You may clear a given offset frame by clicking its row in the grid and selecting (Clear Frame).

External Trigger Configuration

The external trigger settings are defined within a "Custom Triggers" measurement profile. These settings are shown conceptually in Figure 3-108 and as they appear in the measurement profile settings dialog in Figure 3-108.
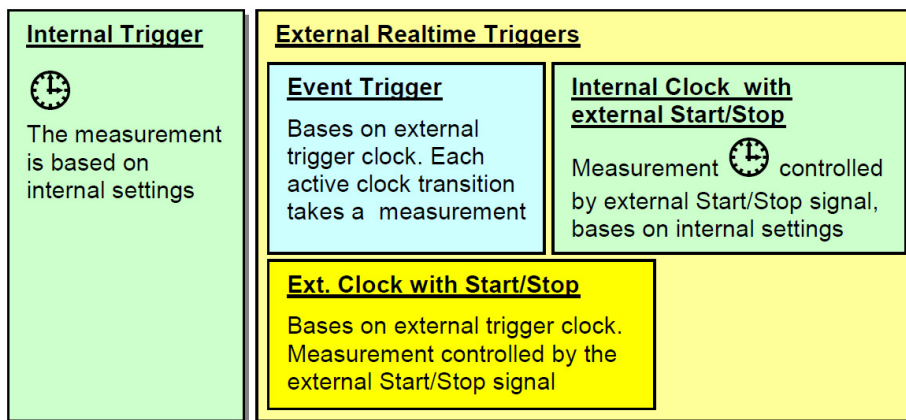
Figure 3-108. External Trigger Configuration

Figure 3-109. CustomProfileusedto
Enable External Triggering
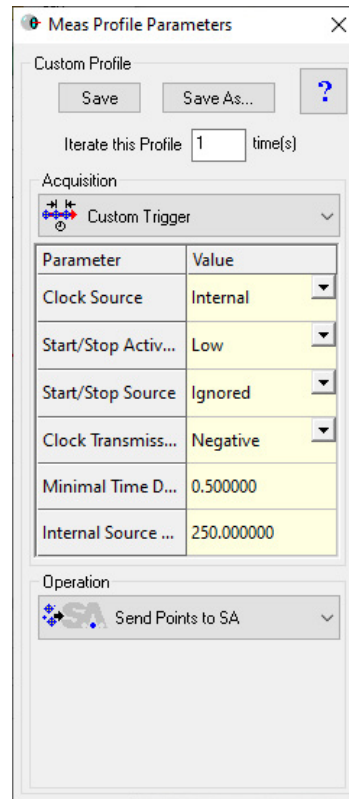
Measurement Profile Settings

External Trigger measurements can be performed using either of two basic methods:

1. Set the **Clock Source** to "Internal" and use the external trigger to control the start and stop of a scan at a give rate.

2. Set the **Clock Source** to "External" and trigger measurements exclusively with the external trigger.

Clock Source:

- **Internal (Internal Clock with External Start/Stop Signal).** Measurements will be triggered by the external start/stop signal on the trigger board. However, the measurement rate will be taken based on internal settings and is not synchronized to an external signal.

- **External (External Clock with Start/Stop Signal).** The measurement will be controlled by a start/stop signal on the trigger board. One transition of the clock signal (positive or negative depends on the configuration) triggers a measurement if the Start/Stop signal is active.

Start / Stop Active Level

- **Low/High.** The start/stop signal can be set either low or high active (for example, low active means that events are being

generated as long as the start/stop signal remains low).

Start / Stop Source

- **Ignored/Active.** This setting controls the subsequent response to the external trigger after a measurement operation has started. If ignored, the measurement will continue regardless of other triggers until the profile is stopped, while if active, the following trigger changes will start / stop the measurement.

Clock Transmission

- **Negative/Positive.** This defines the change in clock signal used for the trigger (negative transition or positive transition).

Minimal Time Delay

- **Delay Value.** This defines the maximum rate at which measurements can be taken (minimal delay between two consecutive measurements). Additional trigger signals sent faster than this preset delay will be ignored.

Leica's Orient to Gravity (OTG) Operation.

An Orient to Gravity (OTG) Operation can be used to compensate a tracker's base frame with respect to gravity. Its important to realize that an OTG operation is a system calibration and will change the way in which measured points are recorded and sent to SA. Comparing measurements before and after a level compensation would be similar to comparing different instruments to each other.

This means that if you intend to perform an OTG there are two required conditions:

1. A level compensation (OTG) should be performed after each instrument station move - prior to any point measurements.

2. If measurements have already been taken at an instrument plant, a *jump instrument* operation must be performed prior to performing a level compensation (OTG) and taking additional measurements.

For more information about level measurements refer to the Instruments Chapter of the SA Users Manual.

Running the Tracker Interface Separately

One of the unique features about SA's architecture is that the instrument interface can be run separately from SA. This provides a means to run multiple trackers independently on different machines while connect to a single SA for data storage. Doing so also provides the ability to separate the persistence files for individual trackers, as the persistence file will be saved in the directory as where the tracker in-

terface is launched, as opposed to the **C:\Analyzer Data\Persistence** folder.

In order to run the SA Laser Tracker process separately some additional support files are required. These include the following files (Figure 3-110):

Figure 3-110. Required Files to run the SA Laser Tracker process independently from SA.

Name	Date modified	Type
GeomfitDLLuvc19.dll	9/29/2021 11:40 AM	Application exten...
MeasurementDLLuvc19.dll	9/29/2021 11:40 AM	Application exten...
NRKDLL64uvc19.dll	9/29/2021 11:34 AM	Application exten...
NRKDLLuvc19.dll	9/29/2021 11:40 AM	Application exten...
SALaserTrackersuvc19.exe	9/29/2021 11:41 AM	Application
Surflibsvc19.dll	8/18/2021 4:54 PM	Application exten...
TrackerDLLuvc19.dll	9/29/2021 11:41 AM	Application exten...
TrackerUnicode.dll	8/18/2021 4:54 PM	Application exten...

Additional Connections

The AT960 can be used with a number of peripheral devices. For more information refer to the following quickstart guides:

- "Hexagon AS1 and AS1 XL Scanners" on page 134
- "Leica Absolute Scanner (LAS) 20-8" on page 144
- "Leica T-Scan Interface" on page 147

Leica AT40x

Prerequisites

Tracker Pilot

While Tracker Pilot does not have to be installed in order to connect to the tracker with SA, they are intended to be used in conjunction and it is strongly recommended that the current tracker pilot is installed. Track Pilot is used for the primary tracker configuration. It is also necessary in order to run manufacturer checks and calibrations.

Compensation

The Leica AT40x compensation is performed in the Leica Tracker Pilot application. This is supplied by Leica and should be performed before running the instrument in SA.

Figure 3-111. Running a compensation routine in TrackerPilot.
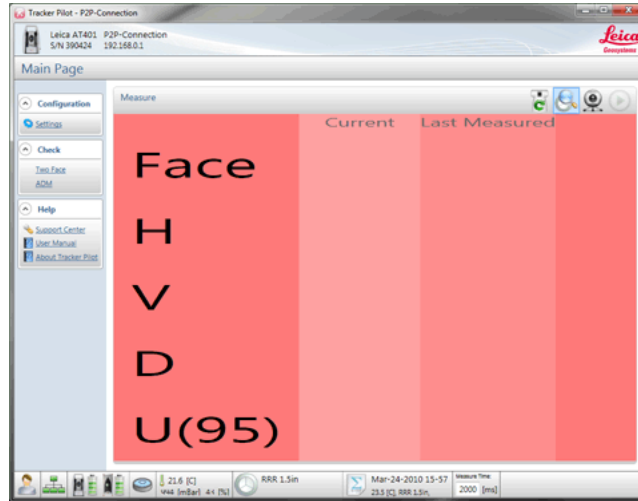
Network Configuration

The Leica AT40x connects via a wired Ethernet connection or a wireless connection. In either case, the IP configuration must be correct before the PC and instrument can communicate. The default wired Leica IP address is 192.168.0.1. The default IP address can be changed within Tracker Pilot. The computer must be set to the same network with a unique IP address.

Starting the Interface

1. Select **Instrument>Add** and choose the Leica emScon AT40x from the Instrument List (Figure 3-112).

Figure 3-112. Adding an AT401 tracker.
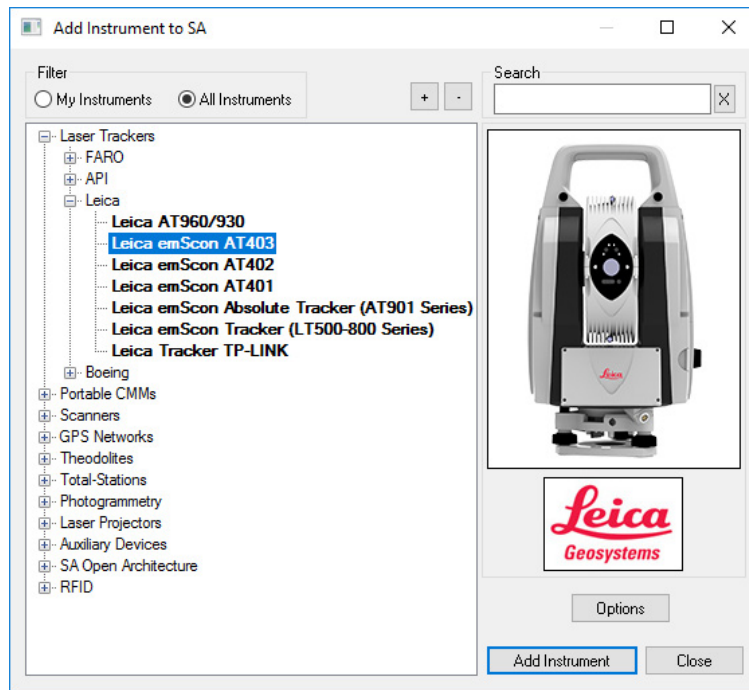
2. Now run the instrument interface module under **Instrument > Run Interface Module** and choose Laser Trackers.

3. In the Connect to SpatialAnalyzer dialog, select the SA instrument model from the network list and press OK to continue.

4. Enter the tracker's IP address and use the Ping button to test the connection if needed (Figure 3-113). Once satisfied, click OK. The next time the interface is started, you can simply click the Run Interface and Connect 🏃 icon. This will use the last saved settings and automatically connect the instrument. The At402 now also offers an IP detect button which will autmatically detect the IP of available trackers.

Figure 3-113. The Leica AT40x Connection dialog.
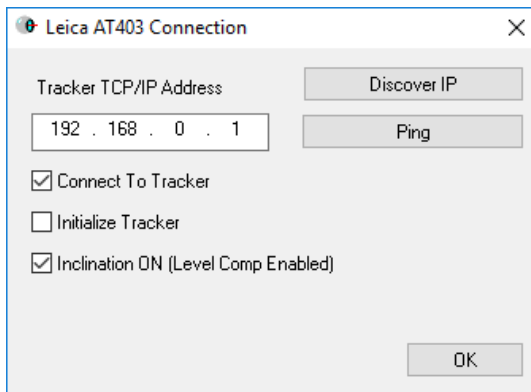
The interface should now connected and be ready for use. Please refer to the "Laser Tracker Interface" on page 10 for details on the laser tracker interface. For most applications the Instrument Toolbar will provide all the functions needed for general use:
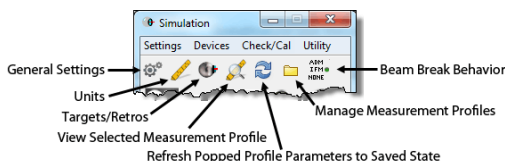
Figure 3-114. Instrument Toolbar. a simplified tracker interface

AT40x Settings

Most basic settings control are available directly within the interface, including tooling settings, measurement profiles, etc. The alarm clock icon provides direct access to current environmental and level settings and provides the ability to set alarms in order to receive notification when conditions change.

To access the AT40x's specific settings, from the full interface use **Settings > Tracker > General Settings** or press the ⚙ button. Then press the Tracker Specific button at the bottom. This will expose the AT40x's specific options (Figure 3-115).
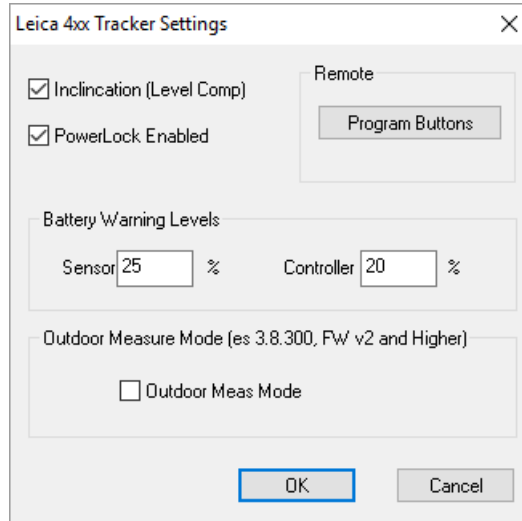
The AT40x utilizes a programmable remote (Figure 3-116). The function of the specific buttons can be customized here.
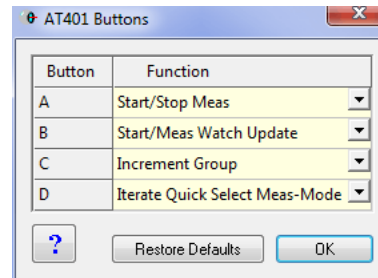
Stable Point Configuration

The AT40x trackers use a combination of traditional tracking and video tracking when a reflector moves faster than the beam can track. A quick beam break can trigger a quick switch between these modes. Depending on the camera calibration and distance, this switch in tracking modes can cause a jump in reported position. Stable point measurements to be triggered unexpectedly as a result. To avoid this you can adjust the stable point distance parameter saved within the stable point measurement profile.

The default values are:

- Stable space = 0.015"
- Min move dist = 0.0

You might consider larger values such as 0.5" for both parameters if this inadvertent point triggering becomes troublesome.

B-Probe Configuration and Use

The B-probe must be setup and calibrated within Tracker Pilot. Once defined on the controller a new target with the B-probe serial number will become available within the Reflectors and Targets database. To measure with the B-probe in SA. Add a target from the manufac-

turer definition section and set it as the active target in SA.

Figure 3-117. Adding a B-Probe Target to SA
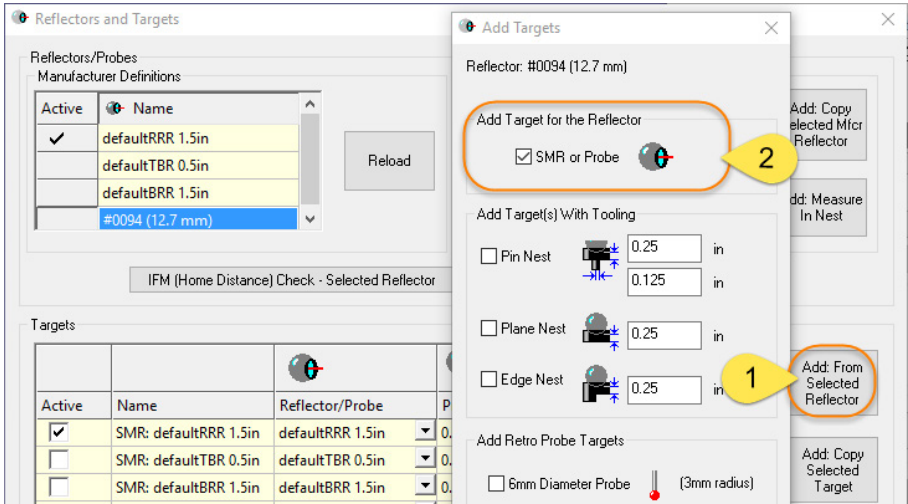
Leica AT901

Prerequisites

- Newer emScon controllers require a Leica dongle. Ensure that the dongle is installed on the controller's parallel port.

- All Leica trackers are shipped with 192.168.0.1 as the IP address as default. To learn more about configuring IP addresses, see the IP Address Basics section.

Compensation

The AT901 is an emScon tracker and accessories can be compensated per Leica through emScon (Figure 3-118). EmScon can be accessed via the shortcut on the desktop or use the following address http://192.168.0.1:8099/emscon/default.aspx. If your tracker address is not the standard 192.168.0.01, change that component of the address in your browser.

Figure 3-118. The main EmScon window.

- Compensation Password: Expert (Full and Intermediate, ADM, Reflector Definition, Camera Compensation, etc.)
- Server Settings Password: Administrator (TCP/IP address, Time/Date, etc.)

Starting the Interface

1. Select **Instrument > Add** and choose the respective Leica Tracker from the *Add Instrument to SA* dialog.

Figure 3-119. Adding a Leica tracker.
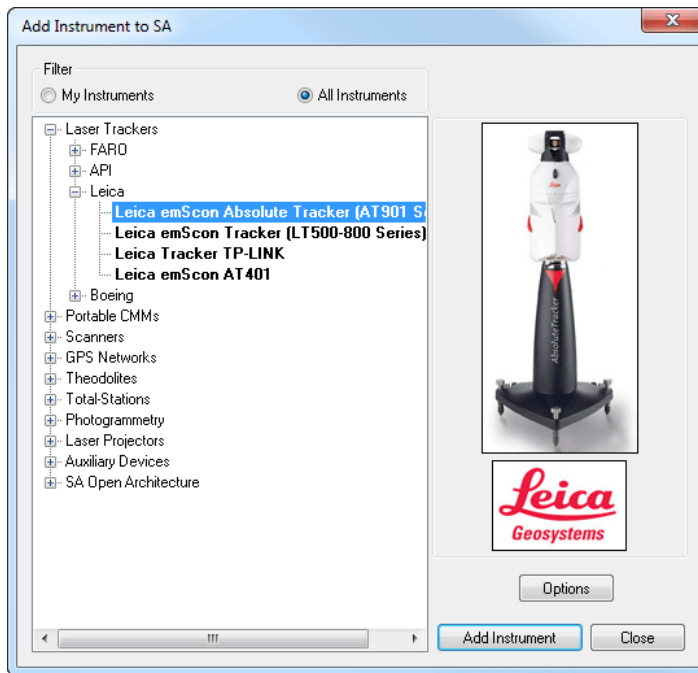
2. Now run the instrument interface module under **Instrument >**

Run Interface Module and choose **Laser Trackers**.

3. Enter the tracker's IP address and use the Ping button to test the connection if needed. Once satisfied, press OK. The next time the interface is started, you can simply click the Run Interface and Connect 🏃 icon. This will use the last saved settings and automatically connect the instrument. The AT960/930 also offers an IP discover utility.
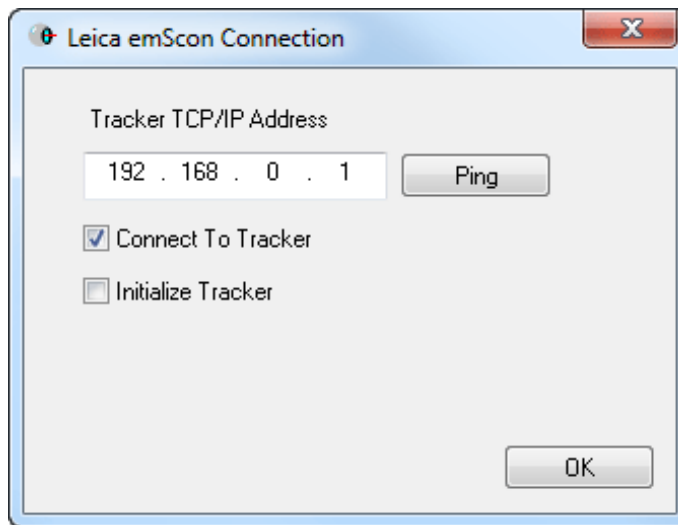
Figure 3-120. The Leica Tracker connection window.

4. The interface is now connected and ready for use. Please refer to the Laser Tracker section for details on the laser tracker interface ("Laser Tracker Interface" on page 10).

Tracker Settings

To access the custom settings, use **Settings > Tracker > General Settings** or press the ⚙ button. Then press the tracker specific button at the bottom. This will expose the Tracker options (Figure 3-121). These options reflect those that can be set in emScon. This dialog gives you access without having to enter emScon directly.

Figure 3-121. EmScon-specific tracker settings.
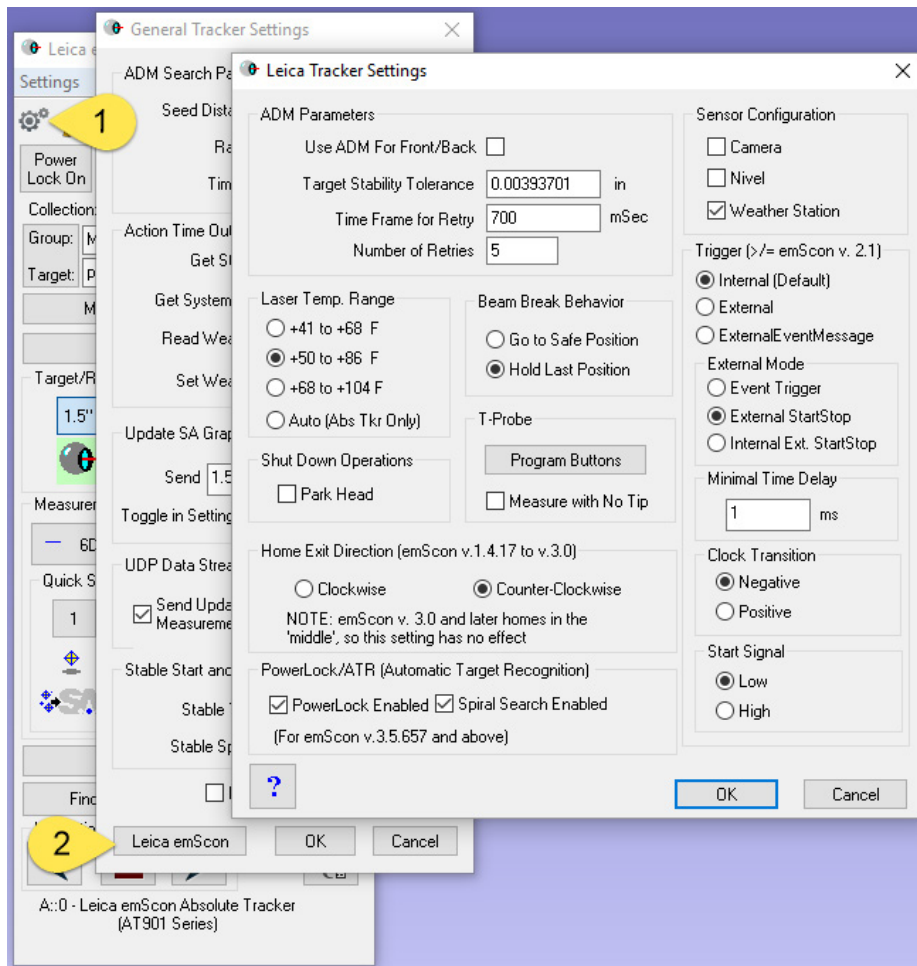
ADM Parameters

Parameters for recapturing the beam in ADM.

Sensor Configuration

Choose which peripheral devices are being used. Overview camera, Nivel Level and Weather Station.

Laser Temperature Range

Select the temperature range in which the tracker will be operating.

Beam Break Behavior

- **Go to Safe Position.** The head will point directly up toward the overview camera when the beam is broken.

- **Hold Last Position.** The beam will sit still when the beam is broken. This is needed for ADM beam break reset mode to work. If not, each time the beam is broken the tracker will return to its safe position.

T-Probe

- **Program Buttons.** This button brings up a control panel to

allow the operator to define what each button on the probe does. These buttons can be set to perform different operations as needed.

- Measurements without a tip are not allowed unless the check box in the properties pannel is checked.

Home Exit Direction

- Choose which direction for the tracker head to unwrap when leaving the birdbath.

PowerLock/ATR settings

Ability to turn on/off PowerLock and Spiral Search.

Tracker Status

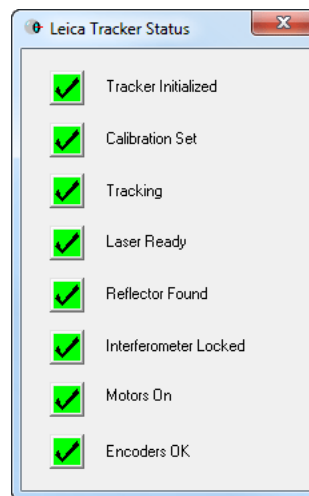To view the tracker status (Figure 3-122) go to **Utility>Tracker Status**.

Figure 3-122. The Leica Tracker Status dialog.

T-Probe

If you get a 'usage conflict' error when trying to use the T-Probe, run the emScon BUI. In it, there is a setting for stylus usage:

- Stylus required
- Stylus not required
- Compensated shank

For standard T-Probe usage, you MUST select 'stylus required'.

External Trigger Configuration

The external trigger settings are found within the Tracker specific properties dialog. These settings are shown conceptually in Figure 3-123 and as they appear in the tracker settings dialog in Figure 3-124.
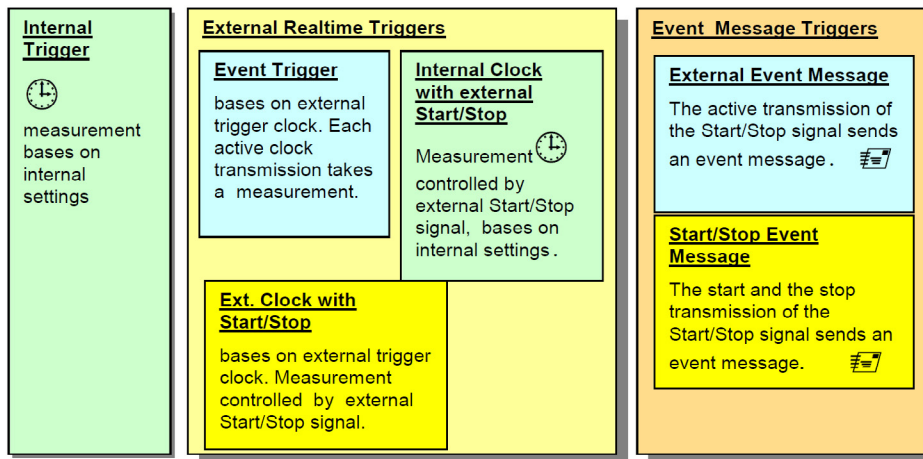
Figure 3-123. External Trigger Configuration

Trigger Settings

These settings enable external triggering and define the trigger type.

- **Internal.** Normal Operations (no external trigger set)

- **External.** Used to take "realtime" measurements triggered by external signal. Use this trigger type with Event Trigger if you want fastest response by running a Temporal Scan, and having the trigger grab a single-sample.

- **ExternalEventMessage.** This setting does not really measure, but instead it sends an event message to the application to trigger a measurement. For example, use this trigger type with Event Trigger to initiate an averaged discrete points when the trigger is activated.

Trigger Mode

These settings define the response to the trigger event.

- **Event Tigger.** In the event trigger mode each positive or negative transition (depending on the configuration) of the clock signal will take a measurement. In event trigger mode the Start/Stop signal will be ignored.

- **External StartStop (External Clock with Start/Stop Signal).** The measurement will be controlled by a start/stop signal on the trigger board. One transition of the clock signal (positive or negative depends on the configuration) triggers a measurement if the Start/Stop signal is active.

- **Internal Ext StartStop (Internal Clock with External Start/Stop Signal).** Measurements will be controlled by the external start/stop signal on the trigger board. The continuous measurement will be taken based on internal settings and is not synchronized to an external signal.

Trigger Definition

These settings control the signal definition used for the trigger.

- **Minimal Time Delay.** This defines the maximum rate at which measurements can be taken (minimal delay between two consecutive measurements). Additional trigger signals sent faster than this preset delay will be ignored.

- **Clock Transition.** This defines the change in clock signal used for the trigger (negative transition or positive transition).

- **Start Signal.** The start/stop signal can be set either low or high active (for example, low active means that events are being generated as long as the start/stop signal remains low).

* Both the above also apply to the TMAC Inspect touch probe, which must be run via the Leica Automation Interface.
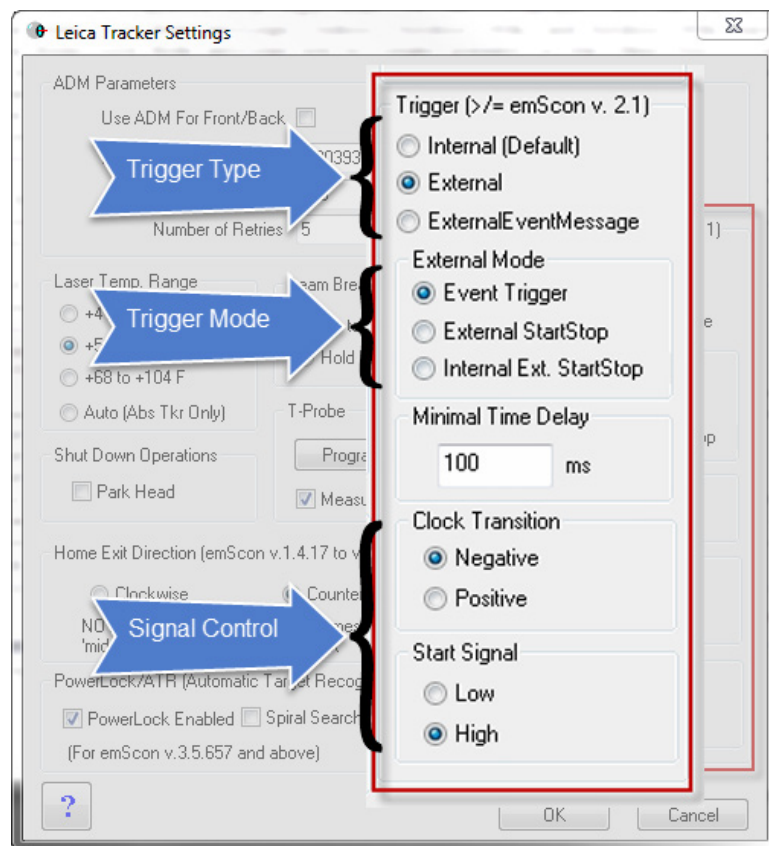
Figure 3-124. Trigger Settings

Running the Tracker Interface Separately

One of the unique features about SA's architecture is that the instrument interface can be run separately from SA. This provides a means to run multiple trackers independently on different machines while connect to a single SA for data storage. Doing so also provides the ability to separate the persistence files for individual trackers, as the persistence file will be saved in the directory as where the tracker in-

terface is launched, as opposed to the *C:\Analyzer Data\Persistence* folder.

In order to run the SA Laser Tracker process separately some additional support files are required. These include the following files (Figure 3-125):

Figure 3-125. Required Files to run the SA Laser Tracker process independently from SA.

Additional Connections

The AT901 can be used with a number of peripheral devices. For more information refer to the following quickstart guides:

- "Leica T-Scan Interface" on page 147

Hexagon AS1 and AS1 XL Scanners

Cable Connections:

1. The Hexagon AS1 Scanner connects to the Connect Box (CB21).

2. Connect the trigger cable, and ethernet cable from the CB21 to the Tracker Controller.

3. Connect the CB21 to the Host PC using the second Ethernet plug on the connect box.

4. Use the power jumper cable from the Tracker controller to the CB21, connect the CB21 directly to power.

Required Versions List:

AS1

AS1 FW Release*	CB21 FW *	AP21 FW*	AT960 FW requirement*	LMF requirement*	Release date	WRTL
1.3.0.1362	1.0.0.720	1.0.0.1987	2.1.0.325	1.8.0.2250	June 2021	NO
1.3.0.1362	1.1.0.288	1.1.0.1257	2.2.0.295	1.9.0.2538	May 2022	YES

Figure 3-126. Current hardware compatibility list for firmware versions.

- SA version 2022.2 includes LMF 1.9
- RDS version RDS v6.2.1 must be installed.

Required Versions List AS1 XL:

- SA version 2023.2 includes LMF 1.0
- RDS version RDS v6.3 must be installed.

Software configuration:

Computer Configuration:

- Verify that the Computer's Network Connect is set to 192.168.0.# (where # is >2 and <254)

- The Tracker IP defaults to 192.168.0.1

- The AS1 system = 192.168.0.2 (fixed address)

Tracker Pilot Configuration (first connection only):

- Connect to the tracker through Tracker Pilot

- Import the Scanner .emsys files which contain the AS1 face compensations and define the target.

- Then disconnect from Tracker Pilot to allow SA to connect.

RDS Configuration:

- Starting in RDS 6.0 The tracker interface will automatically configure RDS for the tracker when you catch the beam using the AS1 or LAS. But if you need to configure it manually, go to the Connections panel and configure RDS to run with the AT960 as shown in below (Figure 3-127).
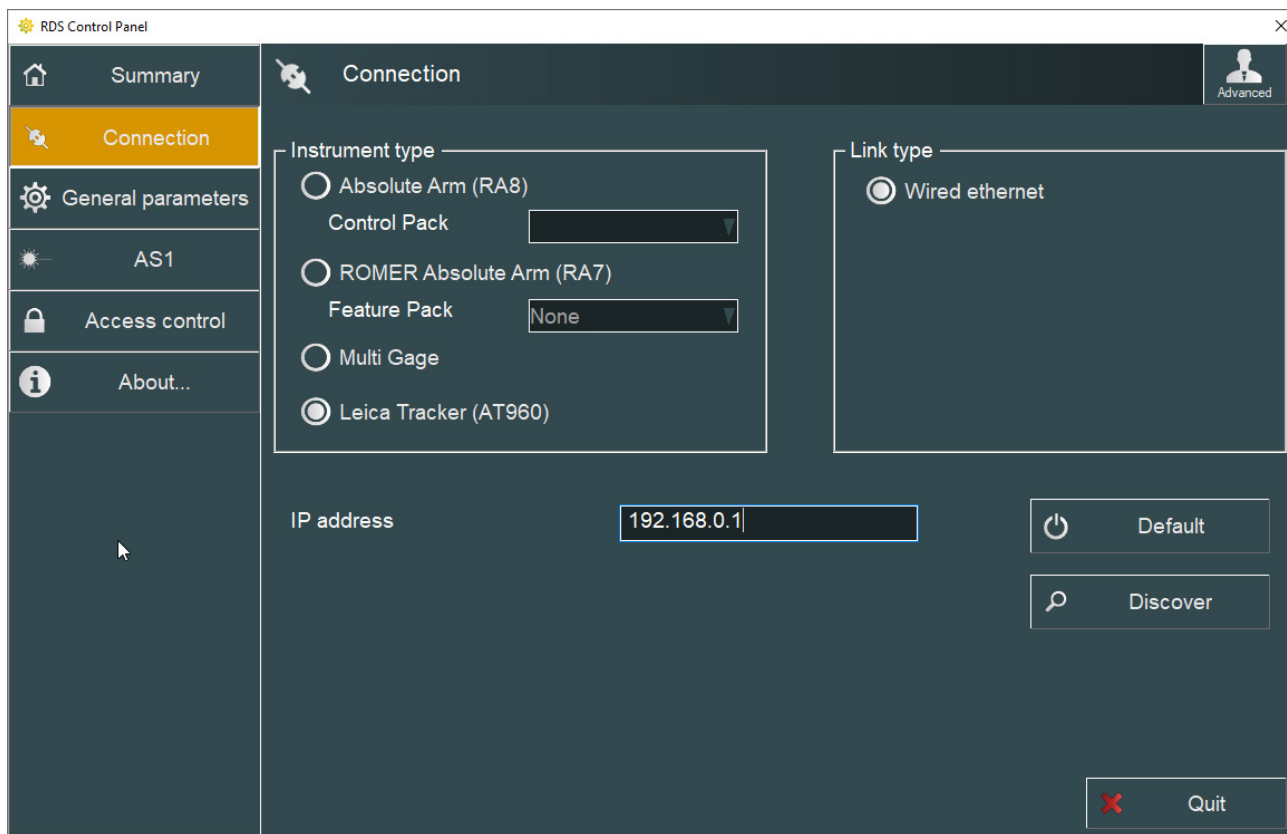

Figure 3-127. RDS Connection Configuration panel.

Connection Process:

- Connect to the AT960 following the standard connection procedure. For more details refer directly to the tracker Quick-Start guide (see "Leica AT9x0" on page 110)

Using the AS1 In SA

The laser tracker interface will detect the AS1 as a reflector type automatically when you catch the beam, just like a T-probe or T-mac is auto-detected.

The scanner will initialize as it connects, you will see a progress bar as that occures (Figure 3-128), and you should then be able to begin and stop scanning using the trigger button.

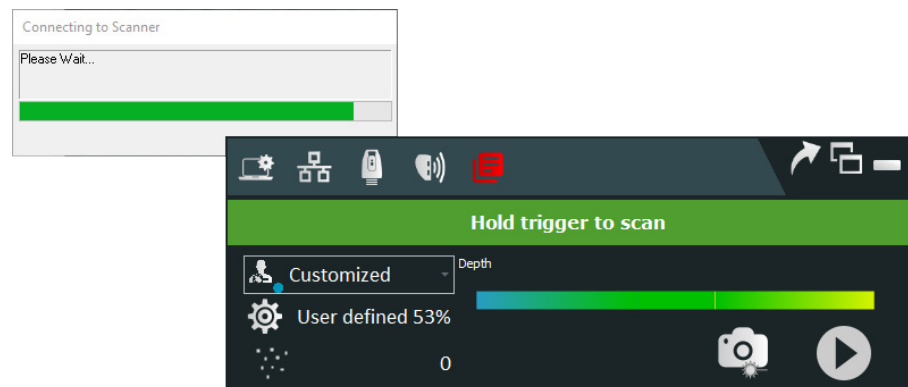**Figure 3-128.** SA's AS1 connection initialization window and RDS ready to measure dialog.

Cloud Naming

Cloud naming is based upon the "group" name specified in the tracker interface. By default the cloud name will increment automatically each time the Scanner Button is Released. This auto-incriminating can be turned on/off through the tracker settings menu (**Tracker>Settings>Leica AT960/930**).

Button Programming

The AS1 offers 4 programmable buttons and 2 additional predefined buttons. The button functions for these buttons can be edited as needed (**Tracker>Settings>Leica AT960/930**).

Programmable Operations:

- **A.** Increment Cloud Name
- **B.** Decrement Cloud Name
- **C.** Increment Feature Selection (used for trapping)
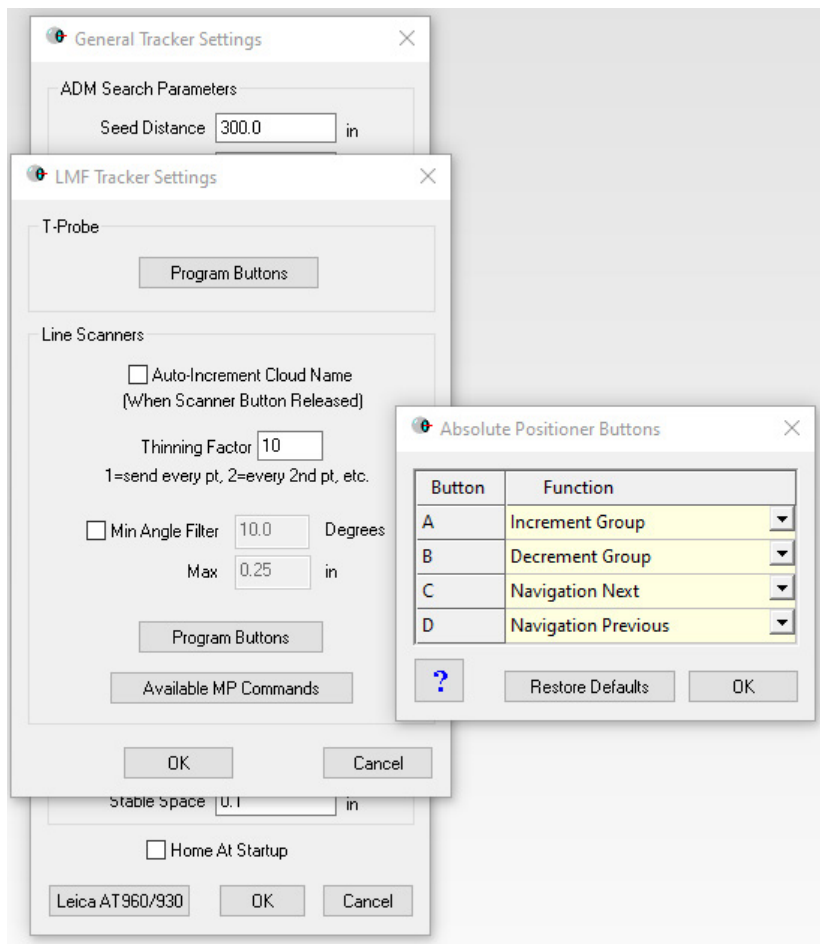- **D.** Decrement Feature Selection

Predefined Operations (these require an advanced login within RDS):

- **E.** Toggles Scanner's Active Scanning Profile

- ▪ **F.** Perform Auto-Exposure Compensation

The default operations are (Figure 3-129):

Figure 3-129. AS1 Scanner button customization controls.

Cloud Thinning and Filtering

The AS1 can produce a lot of data very quickly. Depending on the application this can be reduced in order to keep a job size smaller. RDS offers as set of data controls for Point Sampling, Scanning Speed and exposure on the AS1 page. These settings can be saved as a customized profile that are called by name from an MP and toggle through with the "E" button on the ASI (Figure 3-130).
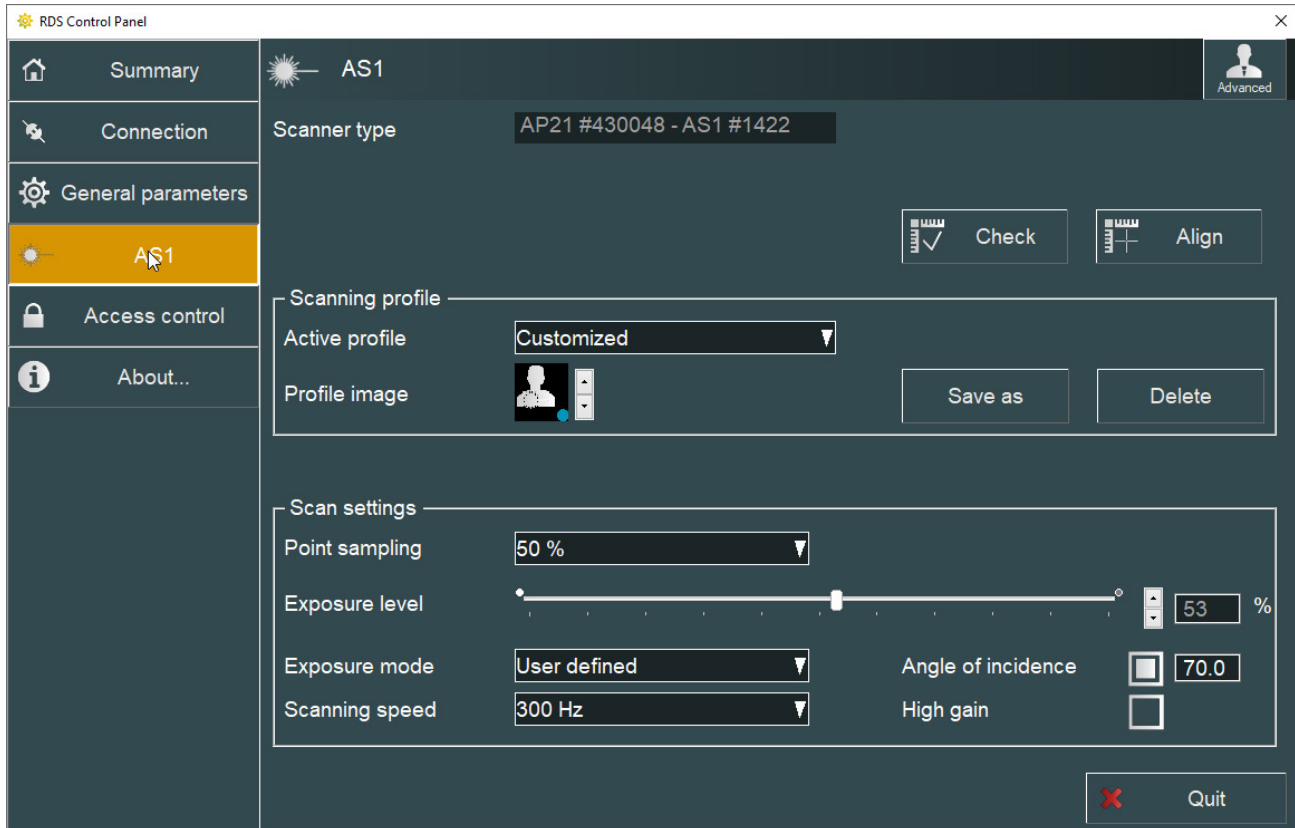
Figure 3-130. RDSAS1Configuration page where different scan modes can be defined

The tracker interface offers an additional level of control also in the *LMF Tracker Settings* dialog (Figure 3-129).

- **Thinning Factor.** This provides a means to decrease the density of the scans sent to SA. This can be helpful when dealing with slower computer performance or when looking to collection less data over a large area. It is particularly helpful when using a 300Hz scan is rate.

- **Min Angle Filter.** This is a more advance filter option that considers the curvature of a scan line. This provide a means to keep data on transitions and edges while filtering out excess data on flat, featureless regions. It offers two controls a *Minimum Angle* in degrees to define the flat regions, which considers the angle between 3 adjacent scan points in a progression along a scan line, and a *Max* distance value which ensures that points are returned within this maximum threshold. This ensures some data is returned on wide flat expanses (Figure 3-131).

**Figure 3-131.** Scan showing the results of using the Min Angle Filter
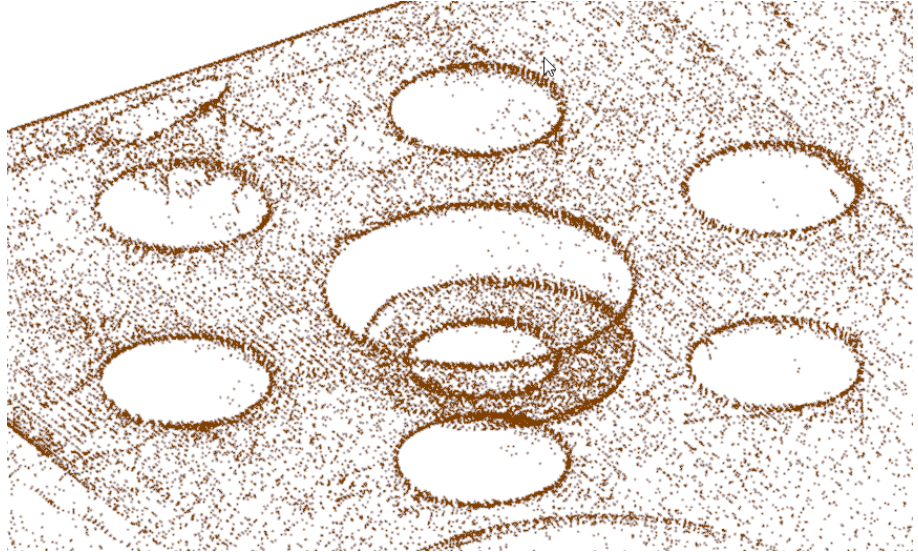
Proximity Triggers

Instrument >> Automatic Measurement >> Auto-Correspond with Proximity Trigger is supported with the AS1. No added controls or settings are needed. Just select the mode from the SA menu and set the desired parameters. SA will recognize the probe definition (which is set automatically when locked onto one of the AS1 reflectors) and just allow you to scan to collect auto-prox measurements.

Real-Time Meshing

Real-time meshing is a great way to visualize a scan during data acquisition. This is a mode that needs to be enabled through the User Options. From the Display tab select **Clouds & Mesh** and select **Mesh Display**. When working with the AS1 XL you will also want to open the defaults and set the mesh to **Fast & Smooth**. This option includes a larger *Half Life Length* settings that will improve the mesh results (Figure 3-132).

Figure 3-132. Real-Time mesh settings. The Fast & Smooth mode was added to improve XL scanning display.
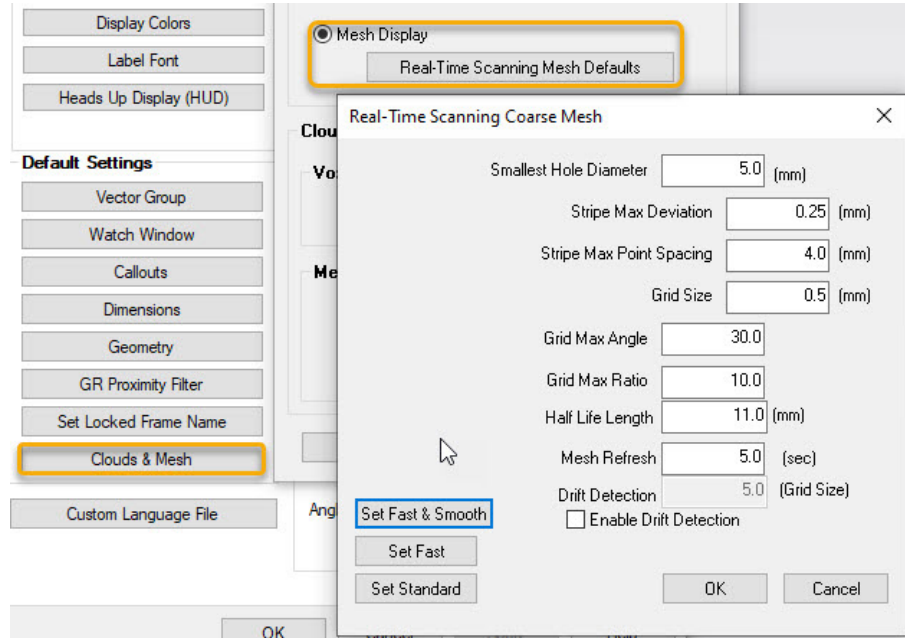
Available MP Commands

In addition to commands available for AT960 control, the AS1 can be controlled dynamically using a selection of string commands passed to the instrument using the command *Instrument Operational Check.* While connected to RDS you can access the available MP commands through the **Tracker>Settings>Leica AT960/930** (Figure 3-133).

Figure 3-133. Example list of available string command for MP based configuration.
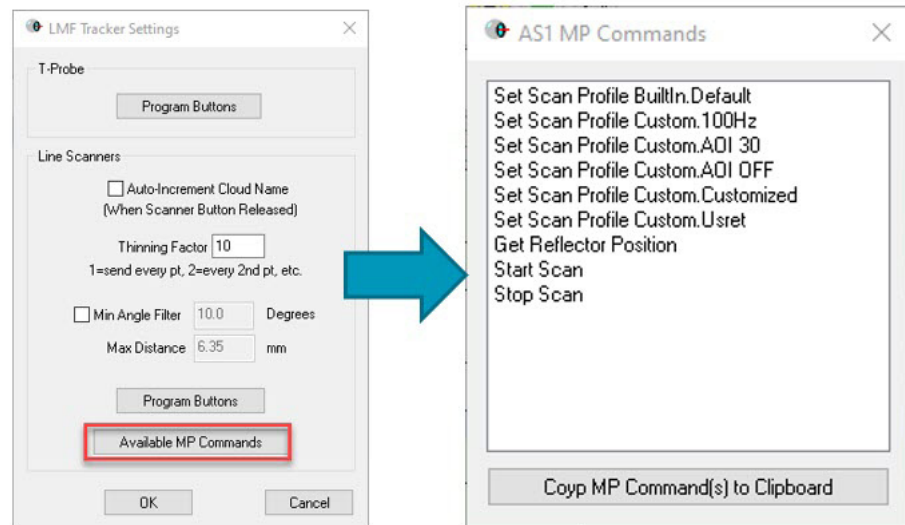
- **Set Scan Profile [].** Sets the Active Scanning profile to the specified definition.

- **Get Reflector Position.** Will return the XYZ location of the AS1 with respect to the current SA working frame.

- **Start Scan.** Initiates a scan.

- **Stop Scan.** Stops the currently active scan.

The list contains complete MP commands that can be copied directly using the Copy MP Command(s) to Clipboard button, and pasted directly into an MP.

The one thing to keep in mind is that the name of the Set Scan Profile strings correspond to the available Active Scanning Profiles defined within RDS and the resulting commands will then need to reflect those definitions on the system you are using.

Robotic Automation using the Leica AT960 with AS1 Scanner

A series of MP Command Strings have been added in support of the LMF.IO capabilities. These command strings can be used through the MP/SDK command **Instrument Operational Check.**

Connections:

- **Connect LMF IO [].** Establishes a connection to the CB21 (Control Box) at the IP address specified by [] ([] not part of string). This command, like all LMF_IO commands, will work whether connected to the AS1 via RDS, or to the AP21 via LMF. But the normal operating mode is with an RDS connection to the AS1 scanner. "AT960Simulator" can be used as an IP address to open the LMFIO simulator.

- **Disconnect LMF IO.** Removes the connection to the CB21 Digital IO Interface.

- **Is Robot Program Active.** Checks if a robot program is running. Returns "Success" if the RobotProgramActive I/O value is TRUE (1). Returns Partial success if RobotProgramActive I/O value is FALSE (0). Returns failure if SA cannot read the RobotProgramActive I/O value.

- **Send Robot Go [timeout].** Sets the RobotGo bit to 1. Waits for the robot program to set RobotPositionReached to 0 (the timeout is expressed in seconds) Set RobotGo back to 0

- **Wait For Robot Position Reached [].** Waits for the robot program to set RobotPositionReached to 1 (the timeout is expresed in seconds, 0 = no timeout!)

Switching control:

- **Switch to LMF/RDS.** This command forces a connection either to RDS or LMF (enter LMF or RDS). In addition to switching to the desired interface, this command will also deactivate the Auto Switching. If the connection to the specified interface is already established, this command will deactivate AutoSwitch-

ing and immediately return as success

- **Toggle LMF<>RDS AutoSwitching [].** This command toggles the Auto switching between LMF and RDS On and Off.

Basic status information:

- **Get Reflector Position.** This command records the position of the prism of the currently locked on face of the AP21. This command will create a point on the tree view with the name defined on the interface. This is normally used to define the lock-on positions.

- **AutoLock On/Off.** Toggle Powerlock On/Off. It works while being connected with either interface RDS/LMF

- **Valid Distance.** When locked on the AS1, this command will return success if the Scanner is ReadyTo Measure. Can be used before calling «Scan Start» to ensure that the scanner is Ready.

Scanning Controls:

- **Start Scan.** Starts the measurement, this is equivalent to pressing the trigger on the scanner.

- **Stop Scan.** Stops the measurement, this is equivalent to releasing the trigger on the scanner

- **Set Scan Profile [].** Sets the RDS scan Profile by name. The available profiles can be found on General Tracker Settings>Leica AT960/930>Available MP Commands (Figure 3-133).

- **Set Line Scn Thinning Factor [].** Sets the thinning factor for line scanners.

- **Toggle Line Scan Min Angle Filter On/Off.** Turns the curvature based filter on and off.

- **Min Angle Filter [] Degrees [] Max Distance mm.** Sets the parameters for the curvature based filter.

Addition Stand alone MP Commands

- **Get Instrument Target Status.** Returns the Name and SN of the AP21 and AS1. And which face is currently locked on. This command is used to verify wether the correct target and face is locked on. It works with both LMF and RDS

- **Point At Target.** Drives the tracker to the specified Target. Can be called while being connected with either interface RDS/LMF

Probing in an Automated Setup

For now it's recommended to Switch to LMF (using Instrument Operational Check «Switch to LMF»), when probing operations are performed. While being connected to LMF all existing commands are

working:

- Measure
- Position to Target
- Measurement Profile Selection
- Target Selection, etc...

Once probing is finished the user can switch back to RDS (using Instrument Operational Check «Switch to RDS»), to start the scanning operations.

The main disadvantage of this is that it takes some time to disconnect from one interface and connect to the other.

Wireless Real-Time Link

RDS 6.2 or later offers a Wireless Real-Time Link (WRT). This utility allows a user to replace the trigger cable between the tracker controller and CB21 box with a wireless connection. To enable this, two WRTL boxes are needed, one connected to the CB21 and one connected to the tracker controller and communication is established through RDS.

With multiple trackers in use at the same time there may be a need to change the change the Radio channel used for the connection. This can be done within RDS or by used the following MP commands:

- *Get WRTL Channel and Status. Returns the status of the connection and the assigned channel*
- *Set WRTL Channel. This command changes the current channel assignment to the specified value.*

Leica Absolute Scanner (LAS) 20-8

Cable Connections:

1. LAS scanner connects to the LAS controller
2. Connect both the trigger cable and the sensor cable from the LAS control to the Tracker Controller.
3. Connect both controllers via Ethernet to the host computer or network switch.

Requirements:

- AT960 with firmware V 1.2.0.4215 or newer
- RDS V4.1 RC3 or newer
- SA version 2016.02.18 or newer

Software configuration:

Computer Configuration:

- Verify that the Computer Network Connect is set to 192.168.0.# (>2 and <254)
- The Tracker IP defaults to 192.168.0.1
- The LAS system = 192.168.0.2 (fixed address)

RDS Configuration:

- Within RDS go to the Connections panel on the right hand tab and configure RDS to run with the AT960 as shown in below (Figure 3-134).
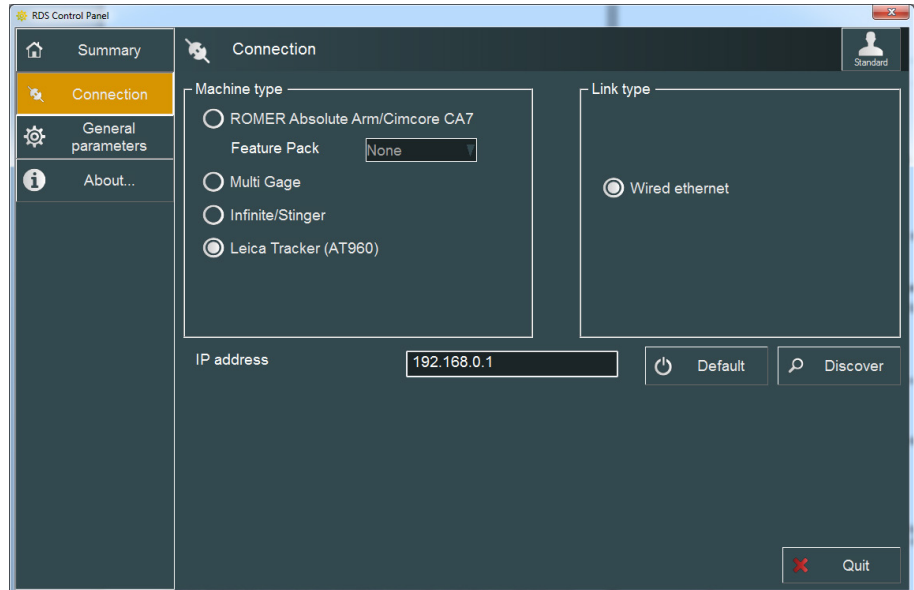
Figure 3-134. RDS Configuration.

Tracker configuration through Tracker Pilot:

- Ensure that the AT960 has the current firmware V 1.2.0.4215 or newer.

- Import the Scanner .emsys files which contain the LAS face compensations and define the target.

Connection Process:

- Connect to the AT960 following the standard connection procedure. For more details refer directly to the tracker Quick-Start guide (see "Leica AT9x0" on page 110)

Using The LAS

The laser tracker interface will automatically detect the LAS as a reflector type once all configuration is complete. This is done automatically just like a T-probe or T-mac is auto-detected.

The scanner will initiate as it connects and you should then be able to begin and stop scanning using the trigger button (Figure 3-135).
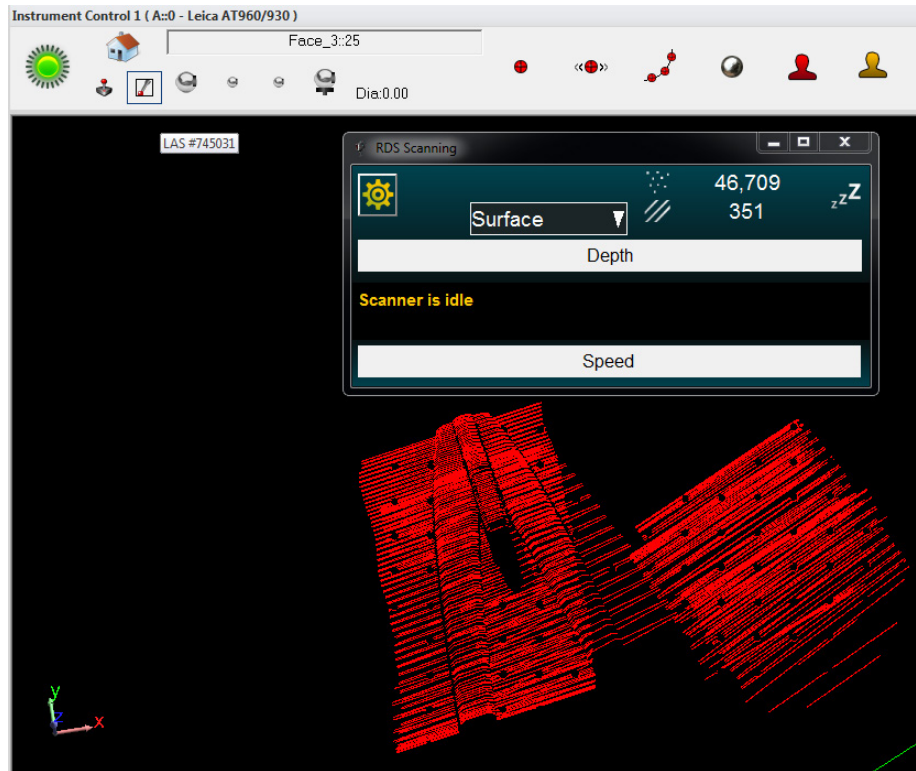
Figure 3-135. LASConnectioninSA.

Cloud Naming

Cloud naming is based upon the "group" name specified in the tracker interface. By default the cloud name will increment automatically each time the Scanner Button is Released. This auto-incrementing can be turned off through the tracker settings menu (**Tracker>Settings>Leica AT960/930**)

Proximity Triggers

Instrument >> Automatic Measurement >> Auto-Correspond with Proximity Trigger is supported with the LAS. No added controls or settings are needed. Just select the mode from the SA menu and set the desired parameters. SA will recognize the probe definition (which is set automatically when locked onto one of the LAS reflectors) and just allow you to scan to collect auto-prox measurements.

Leica T-Scan Interface

Hardware Setup

This Quick-start guide can be used for the initial setup of the Leica T-Scan5 system for operation within SA in conjunction with either an AT960 or AT901.

▪ Set up the unit following the manufacturer's directions. The AT960 users the MCA-47 cable between the T-Scan and Tracker controller's signal port (the trigger port is not used). The AT901 uses the MCA-36 cable which has a dual end for the tracker signal line and trigger connections . A single network cable should be connected from the computer to the t-scan controller and a second Ethernet cable connects the tracker and t-scan system along with a signal cable (Figure 3-136).
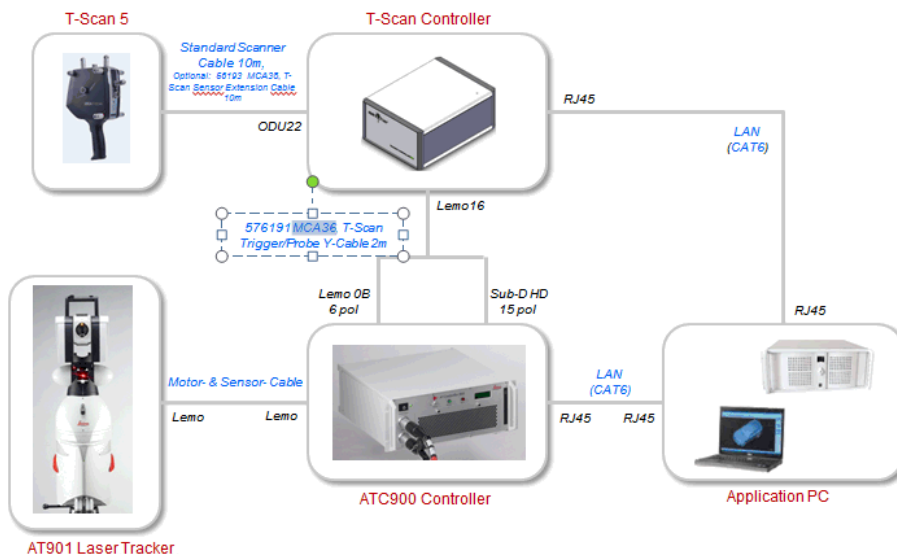

Figure 3-136. AT901CableConfiguration

▪ Ensure that you have the T-Scan License key to operate the sys-

tem.

- Ensure that you have the USB drive containing the *.mtx and *.emsys files (calibration files) which should also contain the Leica setup manuals and a version of the required software (T-Scan Collect or T-Scan Interface and TwinCat Engineering).

Tracker Configuration

The T-Scan target definition must be defined on the tracker controller. The procedure to do so depends on the tracker type:

- AT960 Configuration:

1. Open Tracker Pilot, and connect to the AT960 using the "Advanced" permissions (if you need the current Tracker Pilot you can browse directly to http://192.168.0.1 (or the trackers IP) and download Tracker Pilot from the controller).

2. Go to targets and ensure the T-Scan is defined. If not use the Import Targets button and browse to the *.emsys file for the t-scan provided on the USB disk.

3. Once defined Exit Tracker Pilot.

- AT901 Configuration:

1. Open the Emscon TransferTool, enter the tracker IP and press Test.

2. In the Transfer to emScon section press Parameter File and browse to the *.emsys file for the t-scan provided on the USB disk.

3. Save and Exit

Software Setup and Initial configuration

Download and install the current version of T-Scan Collect which can be found on our website here:

https://www.kinematics.com/ftp/SA/Install/Driver%20Downloads/Laser%20Trackers/Leica/TScan5/

The current version is: *T-Scan Collection 10.3.7.39*

Directory Setup:

1. Determine if you have a license key for either the T-Scan Interface or the full T-Scan Collect Software (Either one or the other should be installed as require but not both), and install the correct one on your machine.

2. Transfer the *.mtx files from the USB drive to the T-Scan directory. T-Scan looks for the files in a particular spot (C:\ProgramData\Steinbichler\T-SCAN\Calibration) you will need to build the Calibration directory and place the files in this folder.

TScanCol.ini Edit Process:

1. Within the C:\ProgramData\Steinbichler\T-SCAN\T-SCAN Interface 10.30\ folder (or T-Scan Collect 10.3 folder) you will find a file called "TScanCol.ini". Open and edit this file as follows (it's a long file so scroll through it to the correct section):

2. Verify the Specific IP address of your tracker (192.168.0.1 by default)

3. Enter the TrackerInterfaceType (EMSCON for AT901 or LMF for AT960)

4. Enter the ScannerAlignmentBaseName (such as LLS1100271). This number is on the front of the T-Scan.

5. Enter the AMSNETID for the T-Scan Controller. Which should be printed on the front of the controller (Such as 5.29.142.116.1.1)

6. Once complete save and close the TScanCol.ini file (see Figure 3-137).

Figure 3-137. TScanCol.ini file

Initial Network Configuration:

1. Configure your local area network connection as follows:

2. Go to Control Panel> Network and Internet> Network and Sharing Center

3. Open the Local Area Network Connection properties (ensure the cable is connected to the T-Scan Controller if you don't see it)

4. Go to the properties for the Internet Protocol Version 4 (TCP/IPv4)

5. Set the IP address to a static IP and use the following IP: 10.168.2.2XX (enter 201-250 only) and subnet 255.255.255.0.

TwinCAT Software:

1. Install the TwinCAT Engineering Software (which will manage the dual network communication between the tracker and the T-SCAN system). This software should be available on your USB drive, and is also on our webpage here:

https://www.kinematics.com/ftp/SA/Install/Driver%20Downloads/Laser%20Trackers/Leica/TScan5/

The current version is: *TC31-ADS-Setup.3.1.4020.32.exe*

2. From the Windows task bar launch the TwinCAT System Manager and select *Change AMS NetID* and configure it to talk to the T-Scan Controller. This will require a system restart (Figure 3-138).
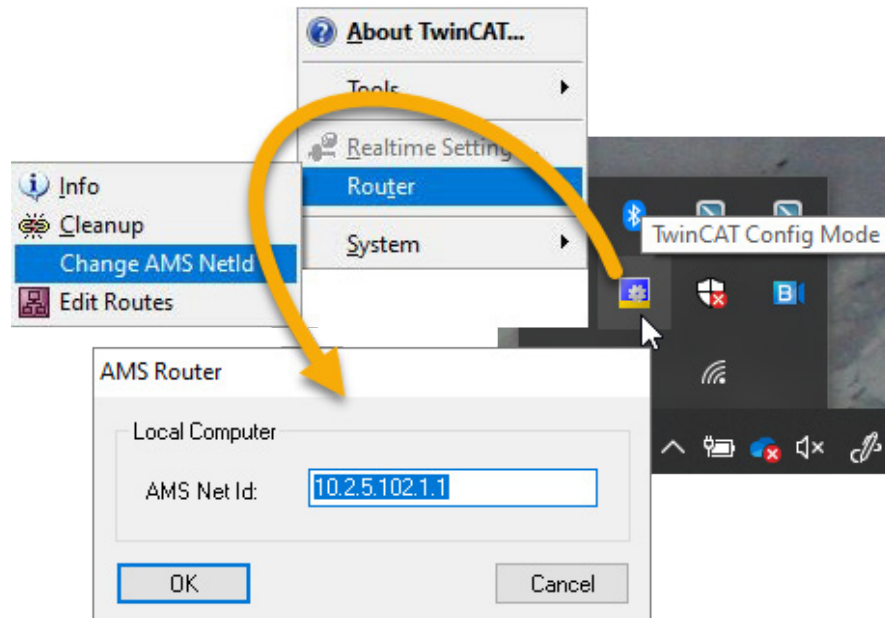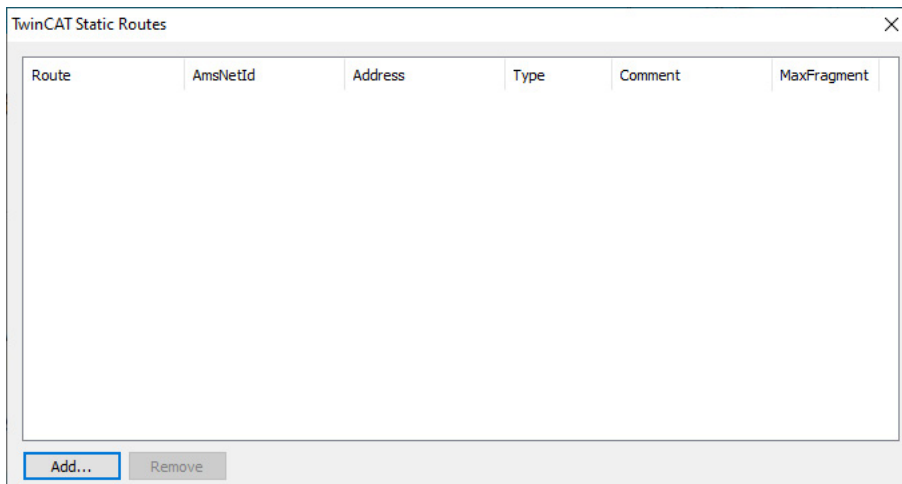

Figure 3-138. Setting the AMS NetID to talk to your controller.

3. Return to the **TwinCAT Config Mode** in the windows start menu and select **Router>Edit Routes** then choose Add...(see Figure 3-139):

Figure 3-139. TwinCAT System Manager and Target Selection.

4. Perform a Broadcast Search and look for the AMS NetID of the controller which should show up on the network list. When it does, select it and select Add Route (see Figure 3-140):
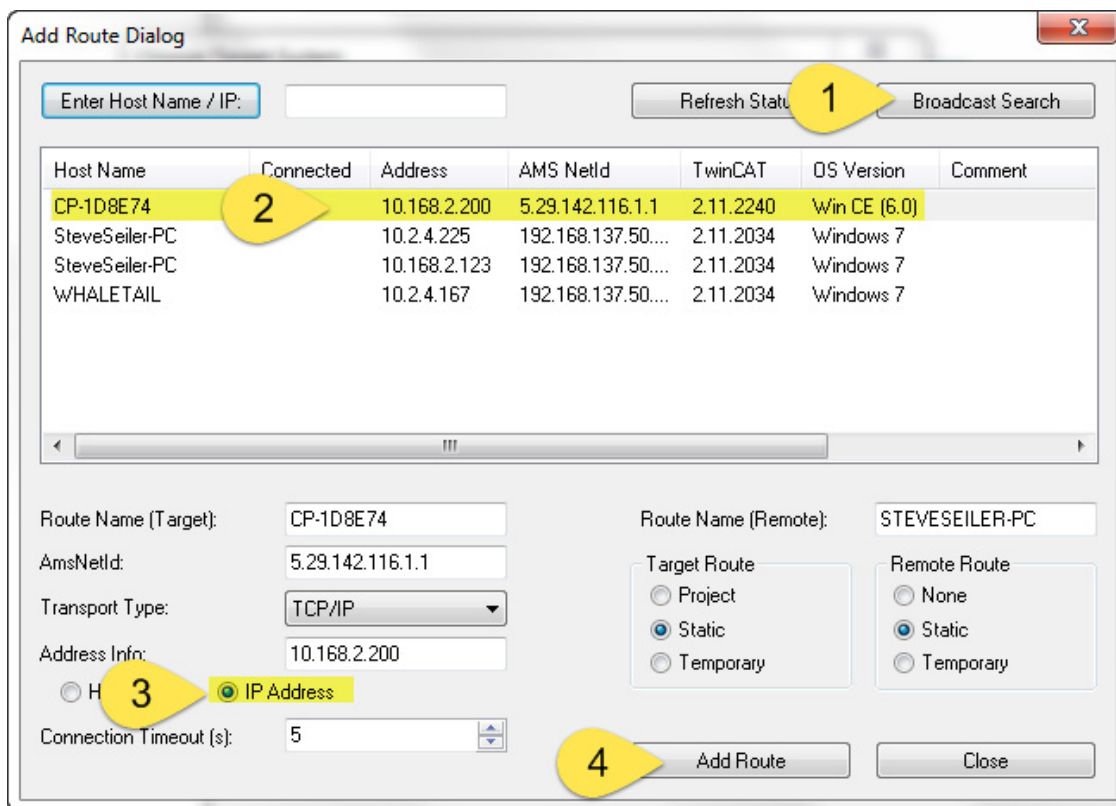

Figure 3-140. Route Selection

5. Enter the Login Information. The login selection depends on the controller you have (Figure 3-141).

Figure 3-141. T-Scan controller types.

For Rev 2.0 controllers by default you will enter "Administrator" for the User and "1" for the password, and make sure that the TwinCAD 2.x Password Format is unchecked (Figure 3-142)
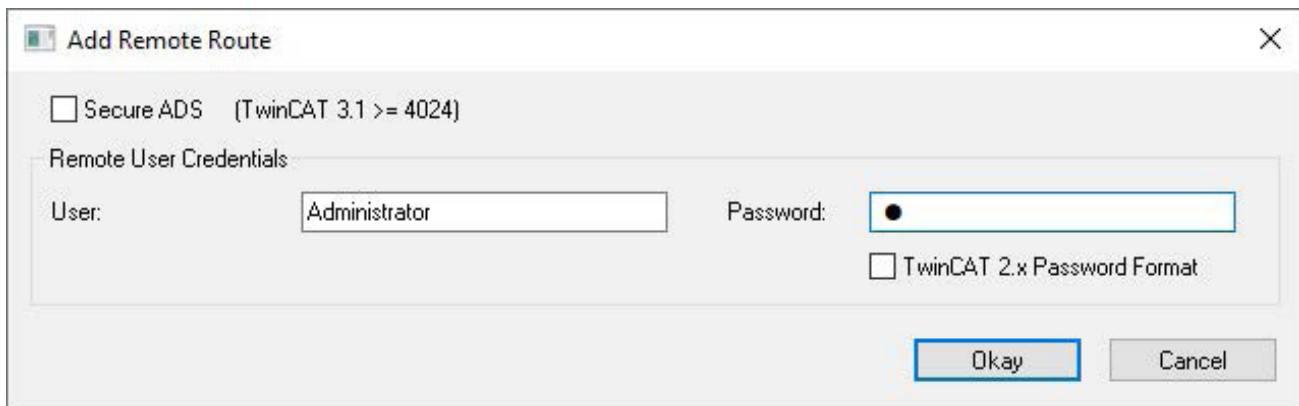

Figure 3-142. Rev 2.0 password entry.

For Rev 1.x controls leave both the User and the Password blank but check the TwinCAT 2.x Password Format check box. Then Press Okay.

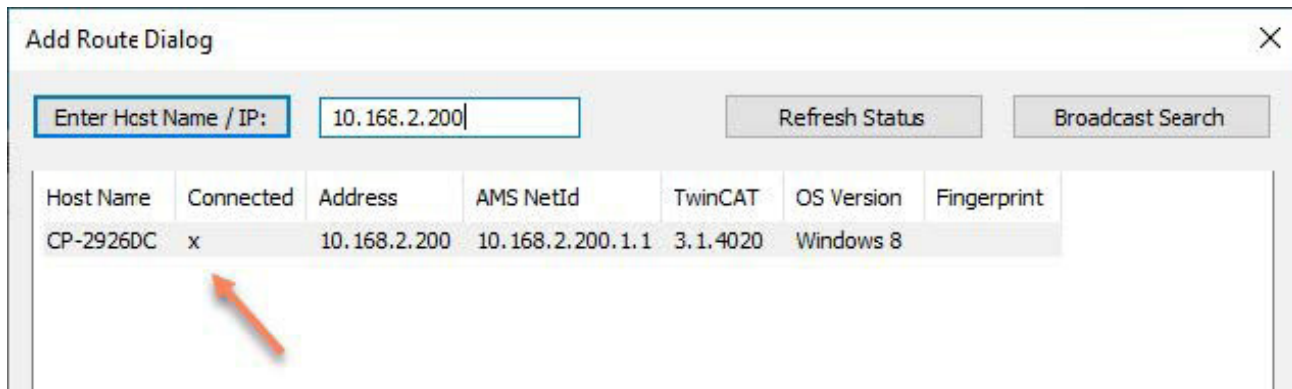The route should then be displayed and marked with an X in the route's selection dialog(Figure 3-143).

Figure 3-143. Connected status display.

Final Network Setup

1. Return to properties for the Internet Protocol Version 4 (TCP/IPv4)

2. Press Advanced and add a second IP (for the tracker). Enter 192.168.0.XXX (enter 2-250 for the IP), again using 255.255.255.0 for the subnet mask(see Figure 3-144).
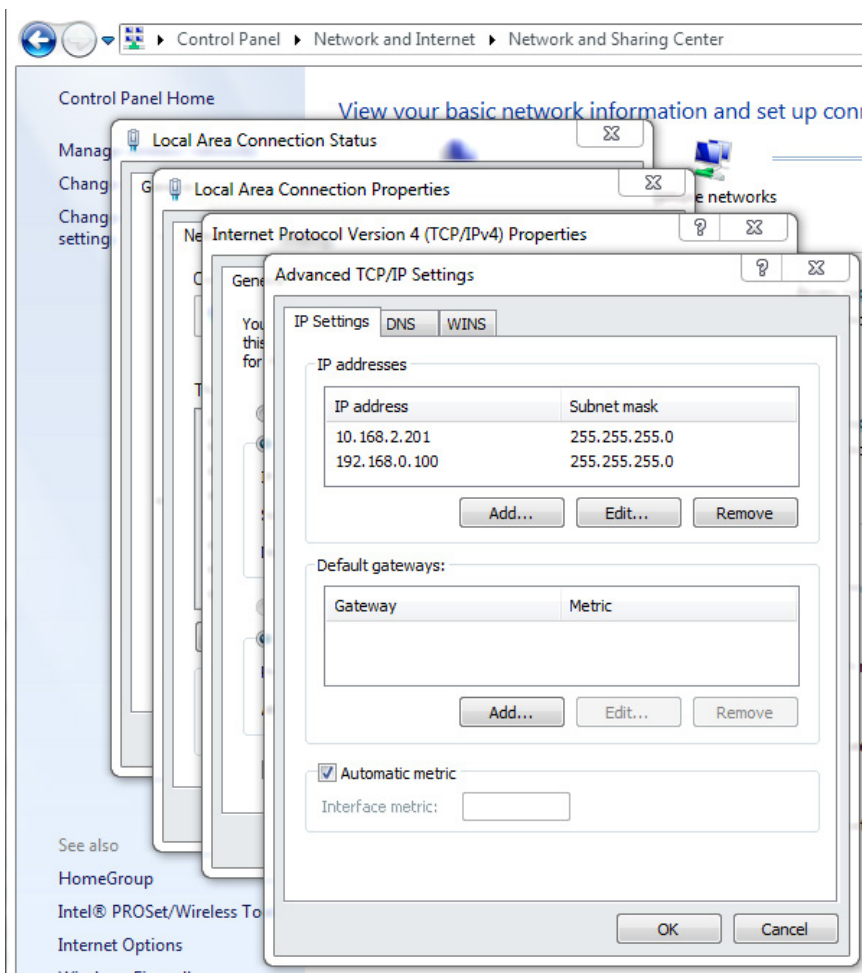

Figure 3-144. NetworkConfiguration settings

3. Click OK and close out of all dialogs and exit out of the network Sharing Center when done.

You can double check that you have a successful connection to both the T-Scan Controller and the Tracker and that the system is ready to go by opening T-Scan Collect directly. Once you see the Status indicator in the bottom right report a green connected status for both devices you can close T-Scan Collect and connect within SA.

Running the T-Scan Interface in SA:

1. Add the Instrument (Instrument>Add…) and choose the appropriate Leica Tracker (AT901 or AT960)

2. Start the Interface through the menu Instrument>Run Interface Module and choose Leica TScan. (Do not connect using the Laser Tracker Interface) (see Figure 3-145):
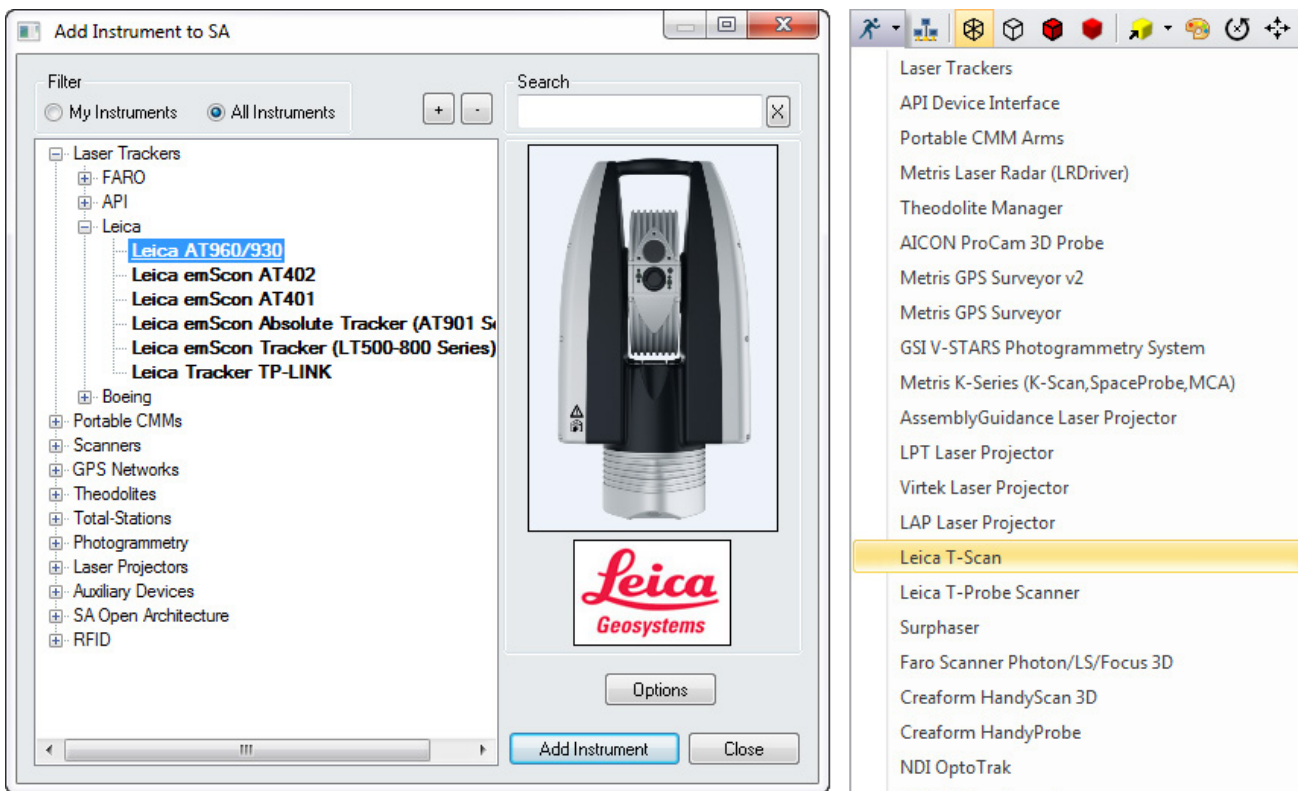
T-Scan Interface in SA:

When you start the Leica T-Scan interface it will automatically connect to either T-Scan Collect or the T-Scan Interface which will run in the background. The T-Scan interface in SA is designed to be as simple as possible while providing full control (see Figure 3-146):
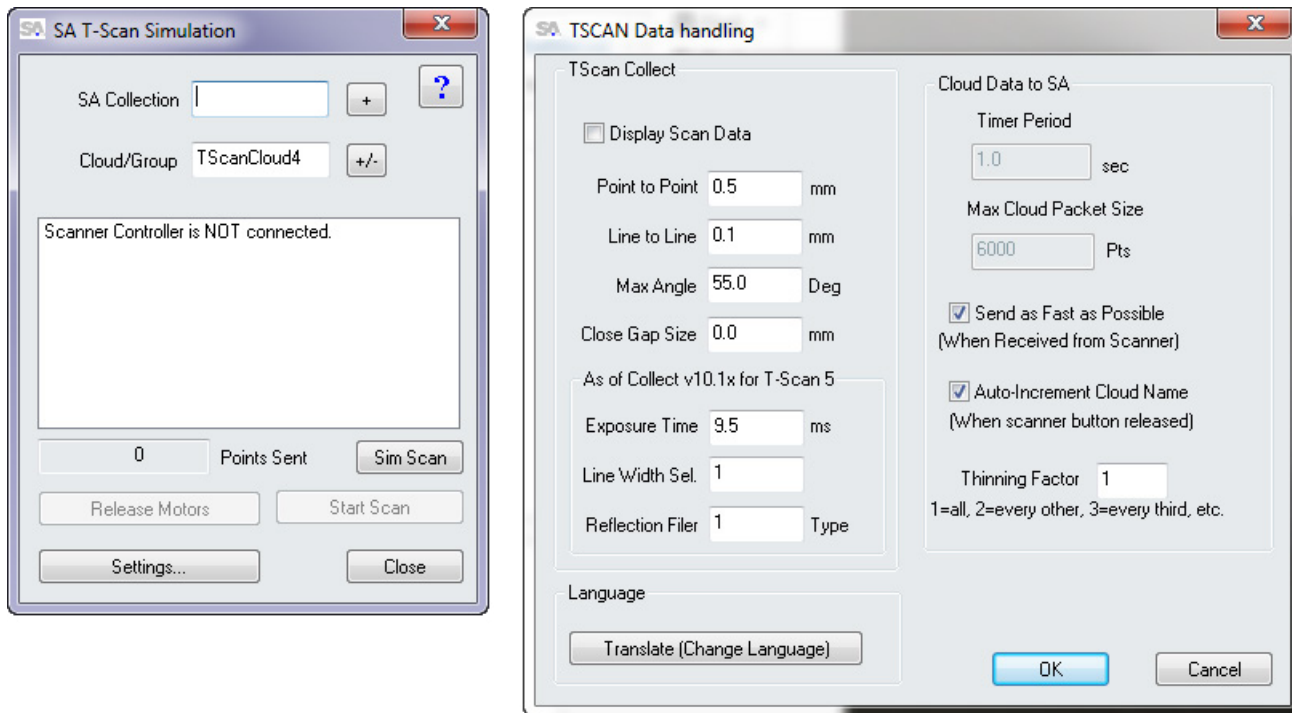
- Collection and Cloud Name control is provided and a new cloud name will be incremented automatically with each separate scan.

- A progress report will be displayed in the connection window

- T-Scan control is provided through the Settings button. Control for both the TS50 and the new Tscan5 is available in sections in the left hand column, the following Tscan5 controls are provided:

- **Exposure Time can be set manually from 0.25 to 20.0 milliseconds**

- **Line Width Set can be set from 0-12 (0=100%, 12=40%).** This reduces the width of the line as you increase the integer value (set as an integer for scripting purposes).

- **Reflection Filter intensity setting (1 = Standard, 2 = Low, 3 = Medium, 4 = High).** Again this value is set as a simple integer for easy scripting control.

T-Scan MP Controls SA:

Leica T-Scan	
Increment Group/Cloud Name	Increment the Current Group/Cloud Name by 1. This name is used for clouds when scanning.
Is Laser Locked	Succeeds if the laser is locked. Fails if not.
Set Scan Point To Point Distance []	Set Point to Point Distance to that designated by [] mm ([] not part of string)
Set Scan Line To Line Distance []	Set Line to Line Distance to that designated by [] mm ([] not part of string)

Leica T-Scan	
Set Scan Maximum Angle of Incidence []	Set Maximum Angle of Incidence to that designated by [] degrees ([] not part of string)
Set Scan Exposure Time []	Sets the scanner's exposure time , where [] is in milliseconds ([] not part of string). Use 0.25-20.0ms for T-Scan Collect version 10 and higher, or 0.01-9.98 ms for PROBEscan.
Set Scan Width Iteration []	Sets the width of the scan line where [] is a value from 1-12 ([] not part of string). 0=100%, 12=40% (decrements by 5%).
Set Scan Reflection Filter []	Sets the reflection filter type, where [] is a value between 1 and 4 ([] not part of string). 1 = Standard, 2 = Low, 3 = Medium, 4 = High.
Close Scan Gaps Up To []	Maximum allowable closed gap in mm ([] not part of string). Use 0.0 to disable this option.
Scanner Power On	Turns the scanner on (unavailable as of TScan Collect version 10.0).
Scanner Power Off	Turns the scanner off (unavailable as of TScan Collect version 10.0).
Start Scan	Begin a scanner measurement
Stop Scan	End a scanner measurement

Leica Automation Interface

Hardware Setup

Before starting the AIC driver, it's necessary to ensure that all hardware connections are complete:

- The AT-901 tracker controllers should be connected to the AIC hardware.
- The auxiliary device (T-Mac, T-Probe, external trigger, etc.) should be connected to the AIC hardware.
- The AIC hardware should be directly connected to the computer on which the interface will be run.

Starting the AIC Driver Manually

1. First, add up to four Leica AT-901 trackers to the SA job.

2. From the appropriate SA folder in the Windows Start Menu, navigate to Interfaces and select Leica Automation Interface (Figure 3-147).
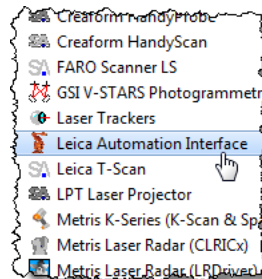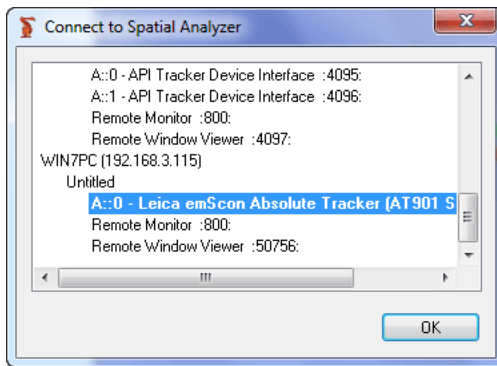

**Figure 3-147.** Starting the Leica Automation Interface.

3. In the **Connect** dialog, select the tracker you'd like to connect to (Figure 3-148).

Figure 3-148. Connecting to a tracker.

4. The Leica AIC Driver interface will appear, automatically connect to the AIC, and immediately be ready to use. Note that the AIC Driver will detect the current AI Controller's connection to hardware at the Multiplexer--it is the T-Scan in this case (Figure 3-149).

Figure 3-149. The AIC Driver window.
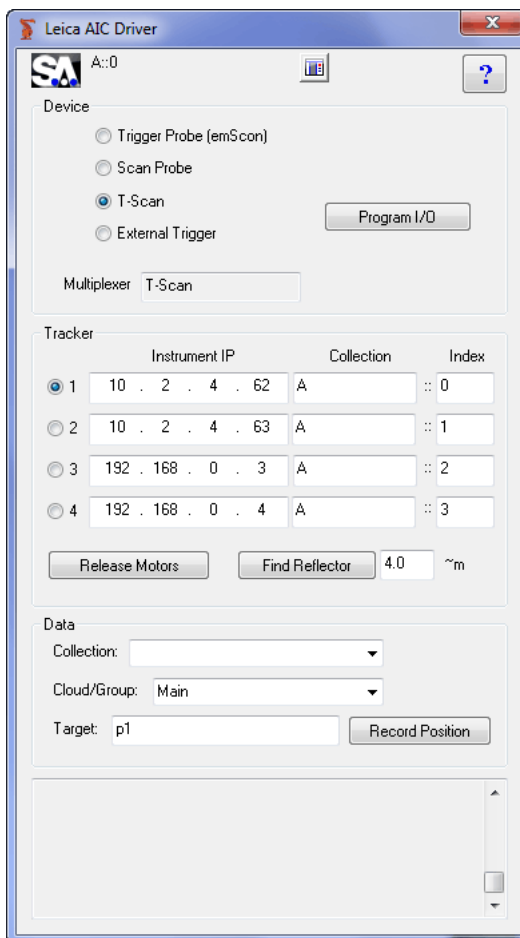
> 📎 **Note:** If we'd had a T-Mac connected, the MUX (multiplexer) would show T-Mac and the Device would be Trigger Probe.

Using the Interface

Each tracker in use requires an assigned IP address and collection/index, which indicates which instrument in the SA file is associated with the corresponding hardware. Use the radio button to switch between different trackers.

All settings appropriate to the current device will be automatically set. Measurement parameters can be set via Measurement Plans.

- The Record Position button is used to teach positions for automatically locking on the T-Scan via an MP command. The Collection::Group::Target name is used for the storage of the auto-lock position in SA.

- The Release Motors button will release the motors on the active tracker so that it can be pointed by hand.

- The Find Reflector button will initiate a search for a reflector in order to lock onto the selected device. The distance field next to this button is used to provide the controller with an idea on how far to search for the reflector based on its distance from the tracker.

Running the AIC Driver In Automation Mode

The Program I/O button is used to program the digital I/O signals for Automation Mode. In this mode, the AIC Interface expects to receive signals from the robot, and will send signals to the robot, for handshaking. The Program I/O button allows communication between the AIC interface and the device with which it is working--typically a robot. You can define the meaning for up to 6 input channels coming in from the robot, and up to 3 channels going out to the robot (Figure 3-150).
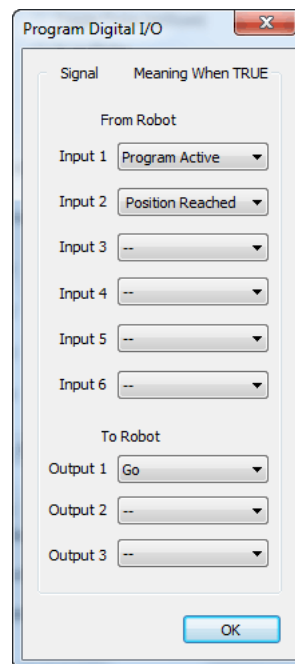

Figure 3-150. Programmingthel/0.

A series of **Instrument Operational Check** Measurement Plan command strings are available for interacting with the AIC in automation mode. Refer to the "MP Command Reference" document for details.

Measuring With PCMM Arms

Portable arms are ideal instruments when measuring small volumes where high accuracy is required and line-of-sight measurements are difficult to achieve. This chapter discusses how to properly and effectively measure with portable CMM arms in SA.

This chapter covers PCMM Arm operation in detail. For a selection of quick start guides which provide a reference for connection and basic operation for specific arm models refer to "Portable CMM Quick-Start Guides" on page 196.

There are two ways to measure with the ortable CMM Arms interface in SA. The first is through the conventional portable CMM Arms interface, which provides access to advanced functionality and settings and allows complete control over the instrument, target definitions, and measurement modes. The second method is through the simpler Instrument Toolbar, which provides an easy-to-use, streamlined approach to measurement.

Note: For information on connecting to a particular arm refer to the quick start section at the end of the chapter.

You'll find that most arm measurement can be carried out in the Instrument Toolbar, which provides accelerated workflow for common tasks such as discrete and stable point measurement and scanning. However, when more control is needed—or when detailed settings or profiles need to be created or modified—the traditional arm interface provides the ability to work at a deeper level.

We'll first cover the arm interface in detail, then cover the Instrument Toolbar. To skip on the the Instrument toolbar (see "Instrument Toolbar" on page 194).

Portable CMM Arms interface

The Portable CMM Arms interface (Figure 4-1) provides unified access to all measurement parameters associated with measurement using a PCMM arm. The arm interface is divided into three primary sections: Target and Geometry Naming, Measurement Modes, and Settings.

At the very top of the interface, an interface docking button ⬛ toggles between docking the interface to the SA window or letting it float as a separate window. If the instrument interface is opened without running SA, this button is unavailable (as there would be no instance of SA on the machine to dock with). If more than one interface is running, docking an interface will replace any currently docked interface.

Figure 4-1. The portable CMM arm interface.
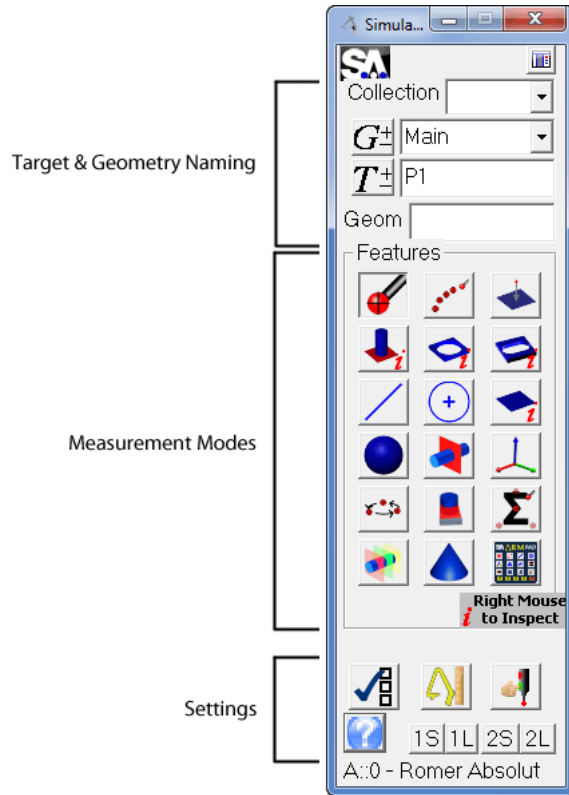
Target & Geometry Naming

Figure 4-2. Target and geometry naming.
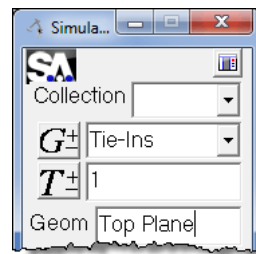
The Target & Geometry Naming section (Figure 4-2) is used to define how measured targets and constructed geometry will be named.

Collection

Measured targets and geometry constructed by the instrument interface are sent to SA. The Collection field is where you specify the destination collection for measured entities. If a collection name is not specified, entities are by default placed into the active collection.

Group Name

The point group name for measured targets is specified in the field next to the "G". To assign measured targets to a specific group, enter the name into the field. To assign measured targets to an existing point group, select it from the drop-down list, which shows all point

161

groups in the active collection.

To Increment the Current Group Name:

- Left-click the $G^{\pm}$ button.

To Decrement the Current Group Name:

- Right-click the $G^{\pm}$ button.

Target Name

Target naming is managed in the field next to the "T". Enter the desired target name in this field. After each measured target, this name will automatically increment by one.

To Increment the Current Target Name:

- Left-click the $T^{\pm}$ button.

To Decrement the Current Target Name:

- Right-click the $T^{\pm}$ button.

Geometry Name

The arm interface supports real-time geometry construction. The Geom field is used to name this constructed geometry. After each geometrical entity is constructed, this name will automatically increment.

Button Control

The SA Arm interface supports the use of button commands from the buttons equipped on the Portable Arm. These buttons can be assigned different functions in the Edit Arm Settings window. One common use of the arm buttons is to move through the different measurement modes, which makes it possible to change measurement methods without the need to return to the computer keyboard. (The SA ArmPad enhances this functionality even further).
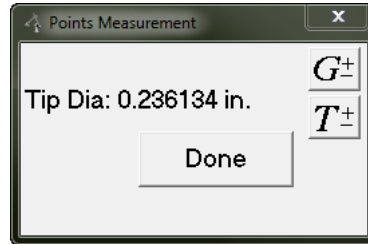
Measurement Modes

Measurement modes are extremely powerful and functional. They allow a user to take measurements and process data in one step. The arm interface supports 17 different measurement modes: Discrete Points, Stream Points, Patch (Projected Pt.), Pin, Hole, Slot, Line, Circle, Plane, Sphere, Section Cross, Frame, Batch (Guided Points), Scanner, Average Discrete Points, Geometry Trigger, and Cone. A special method for selecting measurement modes can be accessed as well. These modes are discussed below.

Discrete Points

Discrete Points mode is used to take individual measurements (Figure

4-3). When in this mode (signified by the appearance of the Points Measurement window below), the assigned Record button will take a measurement, and the assigned Delete Last button will delete the last measured point (if applicable). Point names will be incremented and decremented automatically.

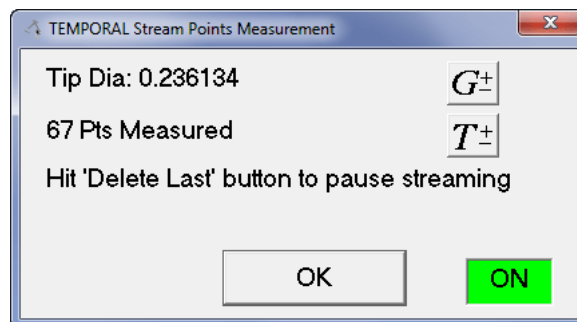**Figure 4-3.** This window indicates you are in discrete point measurement mode.

To manually increment/decrement the group or point name, left- or right-click the $G^\pm$ or $T^\pm$ buttons.

When finished with this mode, press the assigned Accept or Cancel buttons on the arm--or click the Done button--and the Points Measurement window will close, returning you to the interface.

Stream Points

Stream Points mode is used to take measured data at specific spatial or temporal increments (as specified in the Edit Arm Settings window). It is extremely important to recognize that the actual measured data will not be spaced by the specified increments exactly--the increment will be limited by such factors as the hardware's measurement update speed, the connection speed between the instrument and SA, the computer's performance, and the speed at which the probe is moved.

Figure 4-4. Streaming points temporally to the interface.

Note: The title of the measurement mode window will either say TEMPORAL or SPATIAL, depending on the currently selected mode.

When in this mode (signified by the appearance of Figure 4-4), pressing the assigned Record button will begin or continue measurement, and the assigned Delete Last button will pause measurement.

To manually increment/decrement the group or point name, left- or right-click the $G^\pm$ or $T^\pm$ buttons.

When finished with this mode, press the assigned Accept or Cancel button--or click the OK button--and the Stream Points Measurement window will close, returning you to the interface.

◆ Patch (Projected Pt.)

Patch (Projected Pt.) mode (Figure 4-5) will project measured points to a plane, with an optional offset (set in the Edit Arm Settings window). After starting this measurement mode, you can either select a plane to project to (by clicking the Select button) or you can measure plane points yourself by pressing the assigned Record button. Statistics for the measured plane will be displayed as you measure points. Note that you can delete a measured point by pressing the assigned Delete Last button, and the plane will automatically re-fit.
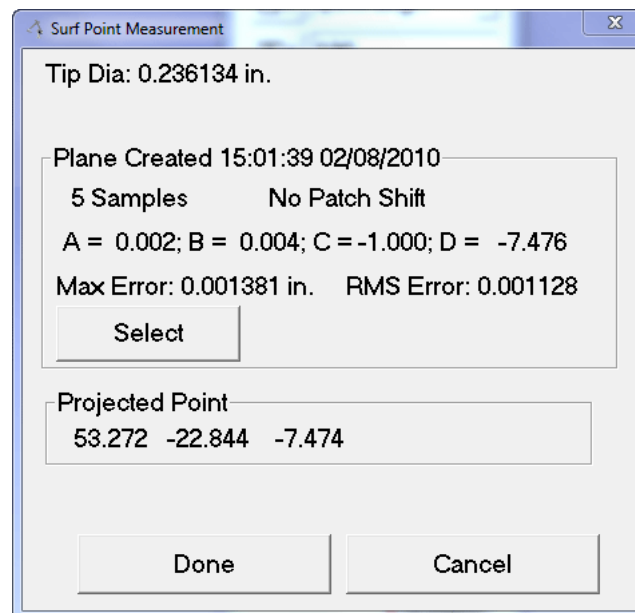
Figure 4-5. Patch projected point measurement.

When you've defined the plane, press the default Accept button to accept it. Every subsequent measurement will be projected to the selected plane (or offset plane). The projected point's coordinates will be displayed in the window with each measurement. When finished, press the assigned Accept or Cancel button--or click the Done button--and you will be returned to the interface.

⬇ Pin

Figure 4-6. Pin measurement mode.
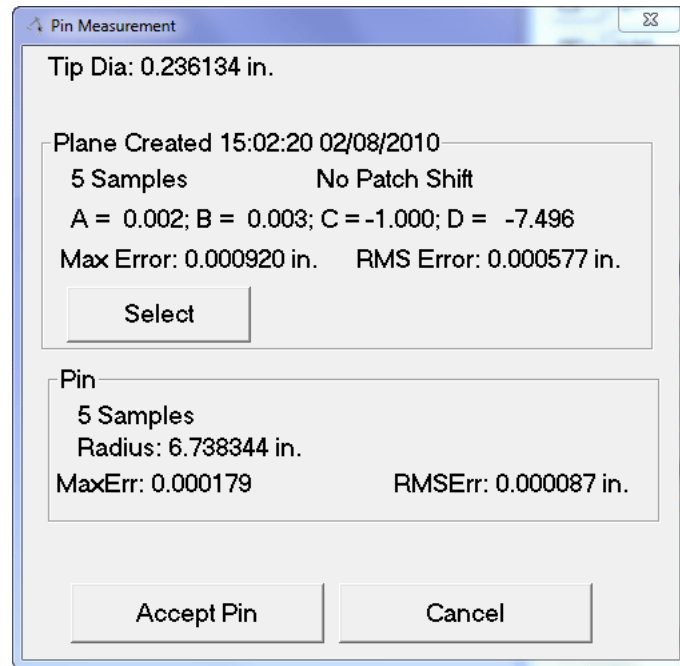
Pin mode (Figure 4-6) will project measured points on the outside of a cylinder to a plane, and create a circle representing the pin diameter. This is useful for determining, for example, the diameter of a pin. When in this mode, you first define the plane to which you'd like to project. As in Patch (Projected Pt.) mode, you can either select a plane to project to (by clicking the Select button) or you can measure plane points yourself by pressing the assigned Record button. Statistics for the measured plane will be displayed as you measure points. Note that you can delete a measured point by pressing the assigned Delete Last button and the plane will automatically re-fit.

Once the plane is defined, press the assigned Accept button to accept it. Subsequent measurements should be taken around the outside of cylindrical geometry (such as a pin or shaft), and these measured points will be projected to the defined plane. Once 3 measurements have been taken, statistics for the constructed circle (radius, fit error, etc.) will be displayed. To accept the Pin measurement, press the assigned Accept button or click the Accept Pin button. To cancel geometry creation, press the assigned Cancel button or click Cancel.

You can right-click this measurement mode button in order to inspect a pin feature that already has nominal geometry in your file. The inspect mode will compare your measured feature to the geometry selected as the reference. To inspect a pin, first right-click on the Pin button. When prompted, choose the circle to inspect. You'll then be prompted to measure plane points. After measuring and accepting the plane points, you'll be prompted to measure the pin itself. When complete, and after pressing the assigned Accept button, you'll get a
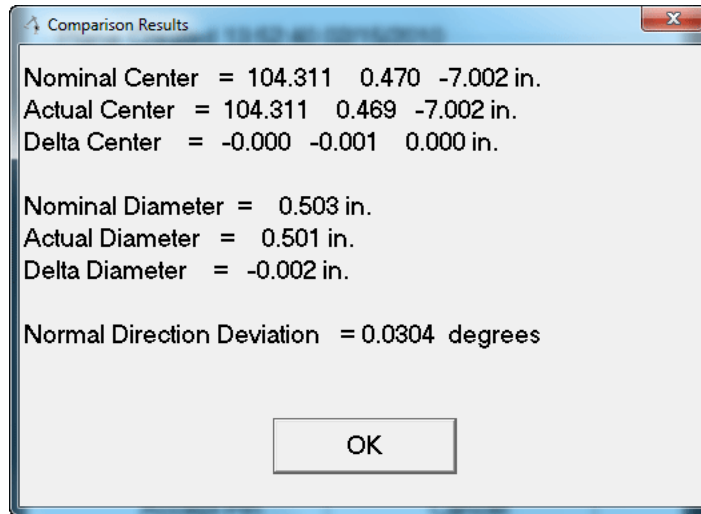
comparison of feature characteristics (Figure 4-7).

Figure 4-7. Comparison results.

Hole

Hole mode (Figure 4-8) will project measured points on the inside of a hole to a plane, and create a circle representing the hole diameter. When in this mode, you first define the plane to which you'd like to project. As in other modes, you can either select a plane to project to (by clicking the Select button) or you can measure plane points yourself by pressing the assigned Record button. Statistics for the measured plane will be displayed as you measure points. Note that you can delete a measured point by pressing the assigned Delete Last button, and the plane will automatically re-fit.
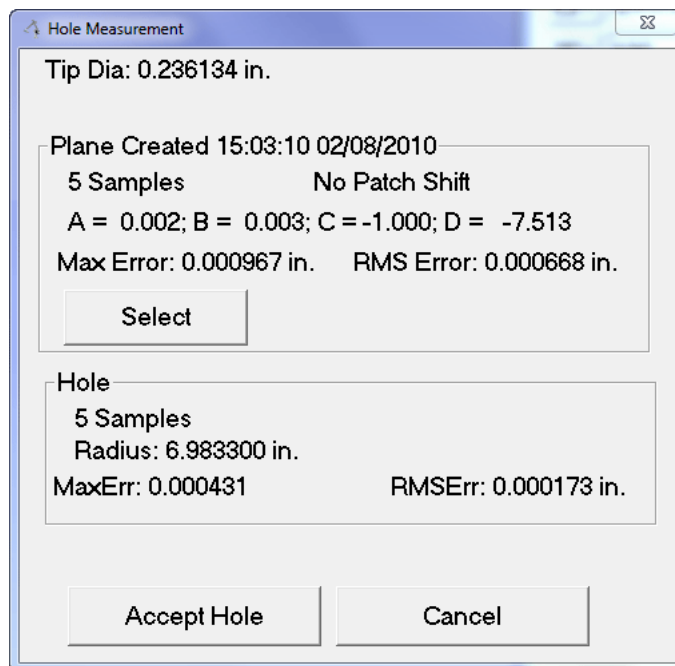
Figure 4-8. Hole measurement.

Once the plane is defined, press the assigned Accept button to accept it. Subsequent measurements should be taken around the inside of

cylindrical geometry (such as the inside of a hole or pipe), and these measured points will be projected to the defined plane. Once 3 measurements have been taken, statistics for the constructed circle (radius, fit error, etc.) will be displayed. To accept the Hole measurement, press the assigned Accept button or click the Accept Hole button. To cancel geometry creation, press the assigned Cancel button or click Cancel.

You can right-click this measurement mode button in order to inspect a hole feature that already has nominal geometry in your file. The inspect mode will compare your measured feature to the geometry selected as the reference. To inspect a hole, first right-click on the Hole button. When prompted, choose the circle to inspect. You'll then be prompted to measure plane points. After measuring and accepting the plane points, you'll be prompted to measure the hole itself. When complete, and after pressing the assigned Accept button, you'll get a comparison of feature characteristics (Figure 4-9).
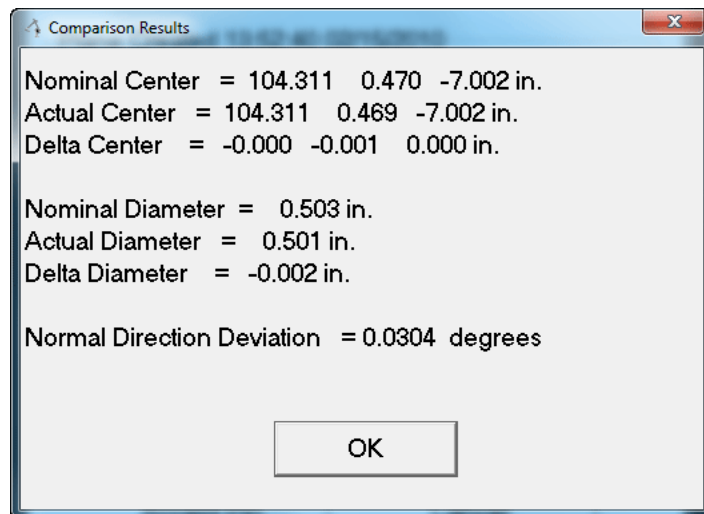
Figure 4-9. Comparison results.

Comparison Results

Nominal Center = 104.311   0.470 -7.002 in.
Actual Center = 104.311   0.469 -7.002 in.
Delta Center = -0.000 -0.001   0.000 in.

Nominal Diameter =   0.503 in.
Actual Diameter =   0.501 in.
Delta Diameter   = -0.002 in.

Normal Direction Deviation = 0.0304 degrees

OK

Slot

Slot mode (Figure 4-10) will project two measured inside diameters of a slot to a plane, and construct circles and a slot midpoint (if specified). When in this mode, you first define the plane to which you'd like to project. As in other modes, you can either select a plane to project to (by clicking the Select button) or you can measure plane points yourself by pressing the assigned Record button. Statistics for the measured plane will be displayed as you measure points. Note that you can delete a measured point by pressing the assigned Delete Last button and the plane will automatically re-fit.

Figure 4-10. Slot measurement mode.
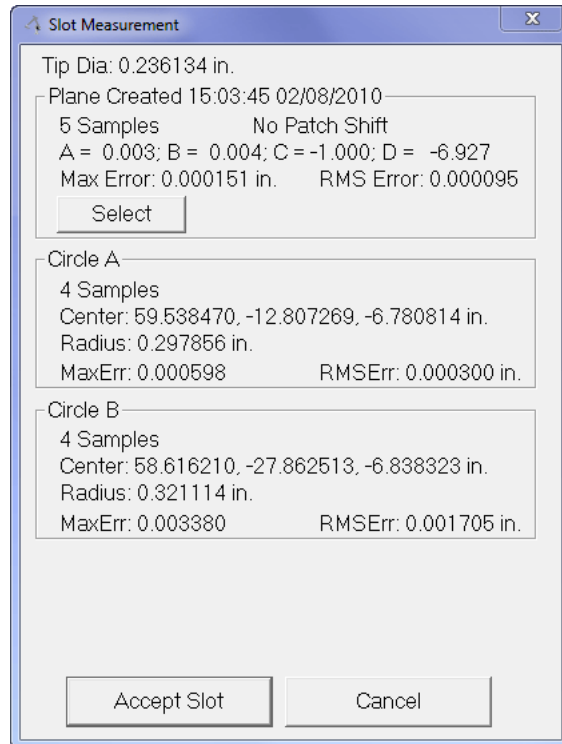
Once the plane is defined, press the assigned Accept button to accept it. You should then measure the points defining the inside diameter of one end of the slot (Circle A). Once 3 measurements have been taken, statistics for the constructed circle (radius, fit error, etc.) will be displayed. To accept the measurement, press the assigned Accept button. Next, measure the points defining the inside diameter of the other end of the slot (Circle B). To accept the slot measurement, press the assigned Accept button again, or click the Accept Slot button. To cancel geometry creation, press the assigned Cancel button or click Cancel.

╱ Line

Line mode (Figure 4-11) creates a best-fit line through a series of measured points. Once two points have been measured, statistics for the line and the fit will be displayed. The assigned Record button will take additional measurements, while the assigned Delete Last button will delete the previously measured point and re-fit.
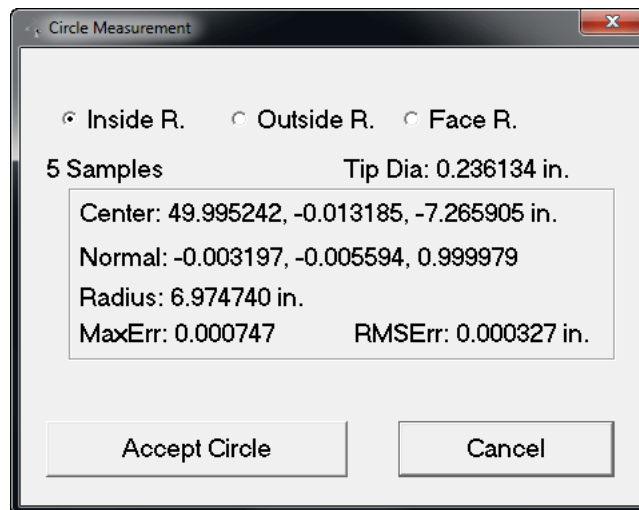
Figure 4-11. Line measurement mode.
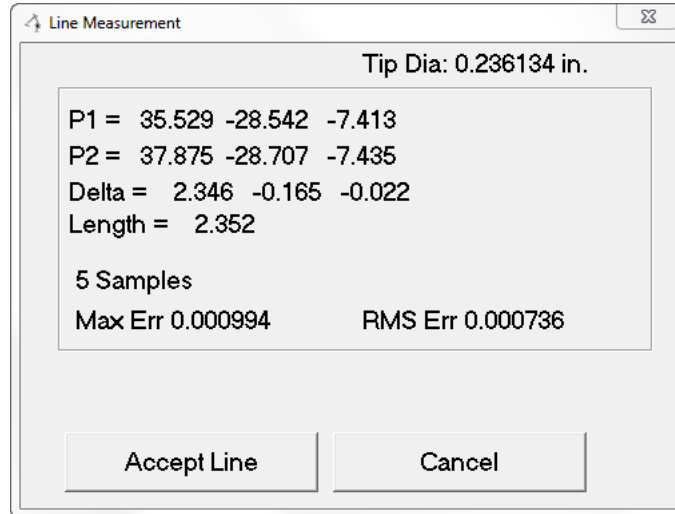
When finished measuring, press the assigned Accept button or click the Accept Line button. This will create a line in the SA job. To cancel the measurement mode, press the assigned Cancel button or click the Cancel button.

⊕ Circle

Circle mode (Figure 4-12) creates a best-fit circle to the measured points. The difference between this mode and Pin/Hole modes is that the measured points are not first projected to a plane. This mode allows you to specify whether you're measuring an inside radius (hole), outside radius (pin), or face radius (no offset). Probing direction is used to define the normal direction of the resulting circle. After 3 points have been measured, statistics for the fit of the resulting circle will be displayed. You can remove the previously-measured point from the fit by pressing the assigned Delete Last button.

Figure 4-12. Circle measurement mode.

When finished measuring points, press the assigned Accept button or click the Accept Circle button. To cancel geometry creation, press the

assigned Cancel button or click the Cancel button.

Plane

Plane mode (Figure 4-13) creates a best-fit plane to a series of measured points. Once 3 points are measured, the Plane Measurement window displays statistics for the fit and the resulting plane. The normal direction of the plane is determined by the probing vector. You can remove the previously-measured point from the fit by pressing the assigned Delete Last button.
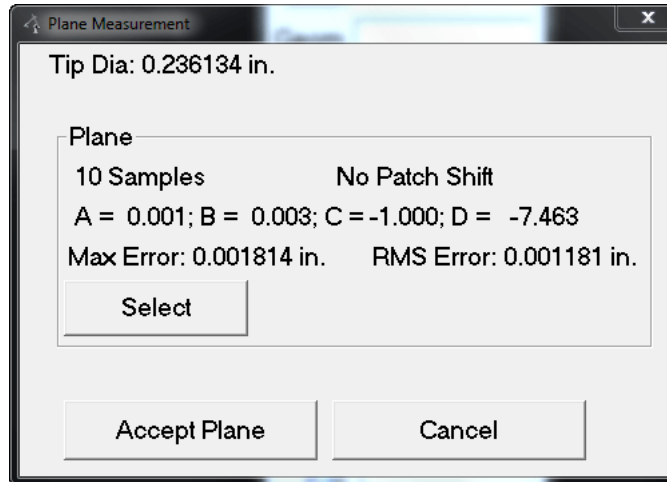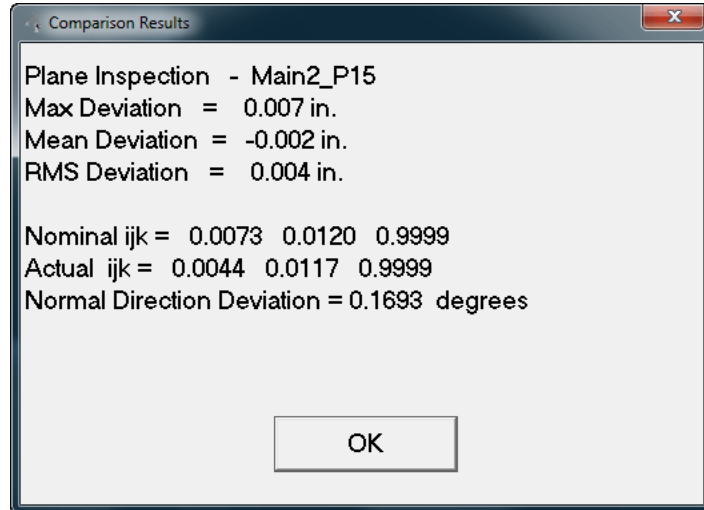

Figure 4-13. Plane measurement mode.

When finished measuring points, press and hold the assigned Accept button or click the Accept Plane button. To cancel geometry creation, press the assigned Cancel button or click the Cancel button.

You can right-click this measurement mode button in order to inspect a plane that already exists in your file. The inspect mode will compare your measured feature to the geometry selected as the reference. To inspect a plane, first right-click on the Plane button. When prompted, choose the plane to inspect. You'll then be prompted to measure plane points. After measuring and accepting the plane points, you'll get a comparison of feature characteristics (Figure 4-14).
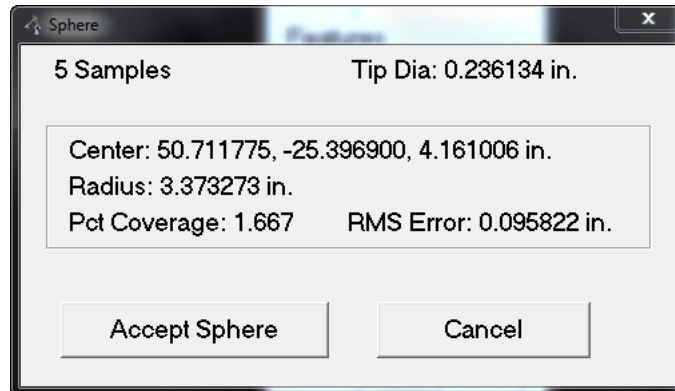
Figure 4-14. Comparison results.

Comparison Results

Plane Inspection - Main2_P15
Max Deviation   =   0.007 in.
Mean Deviation =   -0.002 in.
RMS Deviation   =   0.004 in.

Nominal ijk = 0.0073   0.0120   0.9999
Actual ijk = 0.0044   0.0117   0.9999
Normal Direction Deviation = 0.1693 degrees

OK

● Sphere

Sphere mode (Figure 4-15) creates a best-fit sphere to a series of measured points. Once 4 points are measured, the Sphere window displays statistics for the fit and the resulting sphere. You can remove the previously-measured point from the fit by pressing the assigned Delete Last button.

Figure 4-15. Sphere measurement.

Sphere

5 Samples   Tip Dia: 0.236134 in.

Center: 50.711775, -25.396900, 4.161006 in.
Radius: 3.373273 in.
Pct Coverage: 1.667   RMS Error: 0.095822 in.

Accept Sphere   Cancel

When finished measuring points, press the assigned Accept button or click the Accept Sphere button. This will create a sphere and a point representing the center of that sphere. To cancel geometry creation, press the assigned Cancel button or click Cancel.

➤ Cross Section

Cross Section mode (Figure 4-16) will automatically trigger measurements when the probe crosses a specified coordinate frame axis value (plane). This is useful, for example, when creating measured cross-sections of complex geometry. After initiating this mode, the Section Specification dialog will appear, in which you specify the axis (X, Y, or Z) and plane on that axis that you would like to use to trigger measurements:

Figure 4-16. Cross section mode.
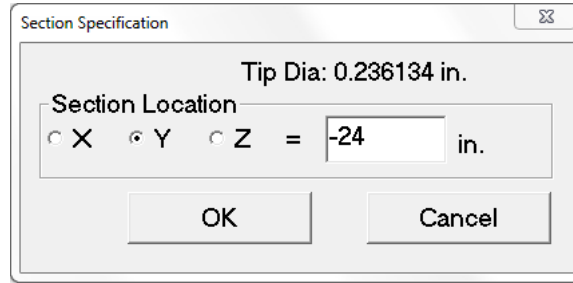
Once the plane is defined, click the OK button or the assigned Accept button. This will bring up the Section Measurement dialog (Figure 4-17).

Figure 4-17. The section measurement dialog.
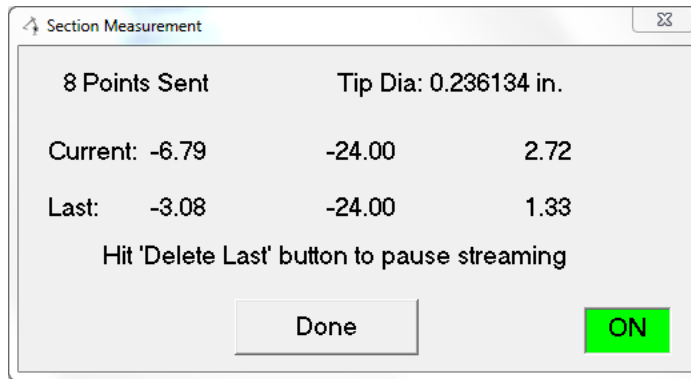
When ready to begin measurement, press the assigned Record button . The arm will begin streaming data to SA (Figure 4-18). When the probe crosses the specified plane, a measurement will be fired. Notice that the result of this measurement will be an interpolated point that lies directly on the specified plane. (Due to limits of hardware sampling frequency, network speed, computer speed, and other restrictions, it is highly unlikely that the instrument's measurement will lie perfectly on the specified plane).

Figure 4-18. Measuring at a specific cross-sectional value.
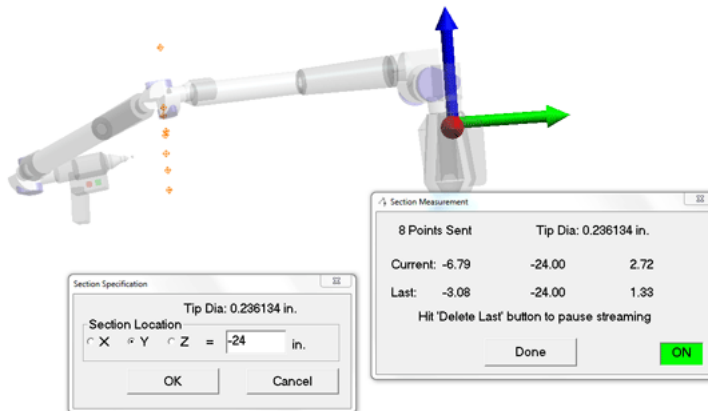
To pause measurement, press the assigned Delete Last button, which will put the arm back into a mode in which the graphical view will be continuously updated with the arm's position, but no measurements will be taken. When finished measuring, press the assigned Accept or

Cancel button, which will return you to the interface.

⊥ Frame

Frame mode (Figure 4-19) constructs a frame based on the probing direction (final joint position) of the arm. The origin is placed at the probe position, and the constructed frame's Z-axis is along the direction of the probe.


Figure 4-19. Measuring a frame with the arm.
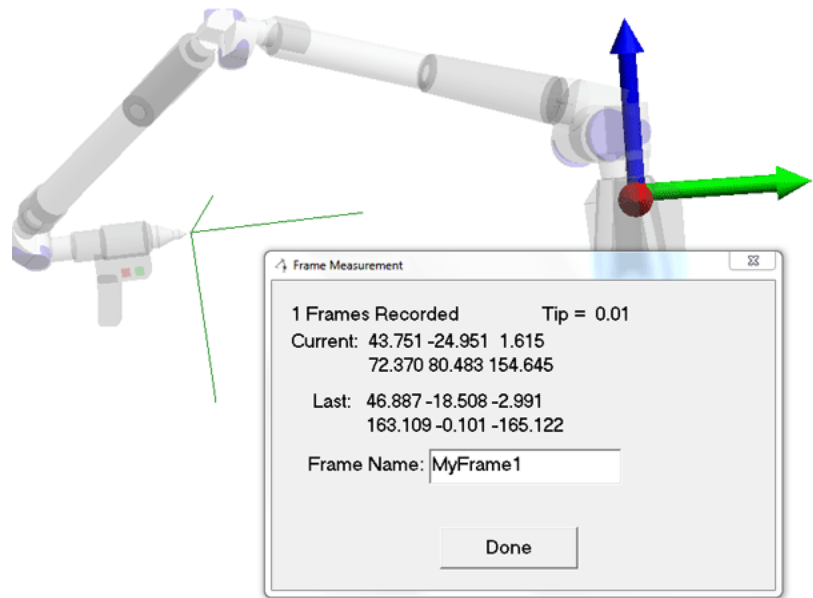
To specify a name for the constructed frame, fill in the Frame Name field. To measure a frame, press the assigned Record button. When finished measuring, press the assigned Accept or Cancel button.

✥ Batch (Guided Points)

Batch, or Guided Points mode, guides the user to a series of selected points using dynamic zooming and audio cues. When entering this mode, you are first prompted to select the points to guide to (usually nominal points). Select these points in the order in which you'd like to measure them, then press **Enter**. Next, you will be presented with the Measure a Batch of Points dialog (Figure 4-20).

Figure 4-20. Settings for measuring a batch of points.
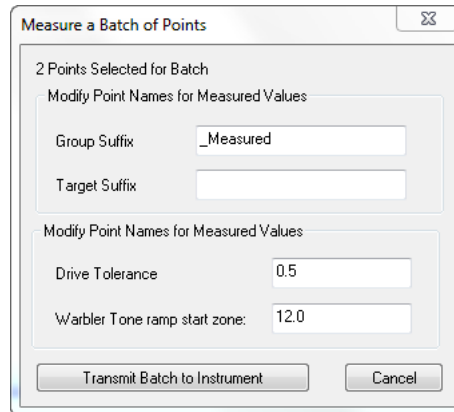
- **Group Suffix.** Attaches the specified suffix to the group of measured points.

- **Target Suffix.** Attaches the specified suffix to each measured target.

- **Drive Tolerance.** Specifies the radius around the current point that is considered to be "good" or "in-tolerance". When the probe is within this radius, it turns green and the tone reflects an in-tolerance position (see below image).

- **Warbler Tone ramp start zone.** Specifies the radius at which the audio tone begins to ramp up in pitch to signify that the probe is approaching the desired position.

When the desired parameters are entered, click Transmit Batch to Instrument to begin measurement. While in the actual measurement mode (Figure 4-21), press the assigned Record button to measure the point and the assigned Delete Last button to delete the previous point. Note that as the probe is moved closer to the desired position, the tone increases in pitch and the view zooms in closer to the reference point.
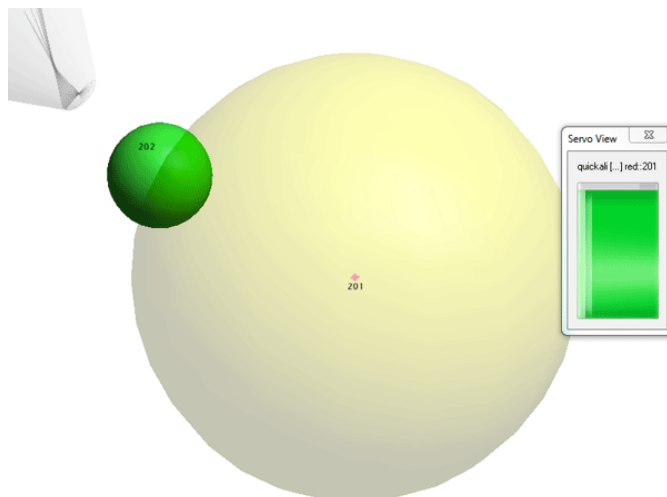
Figure 4-21. Measuring a batch of points.

When all of the batch points have been measured, this mode exits

automatically. You can also exit the mode prematurely by pressing the assigned Accept or Cancel button.

📕 Scanner

Scanner mode activates the laser line scanner on the arm, if equipped. Typically, the assigned Record button starts and stops scanning, while pressing the assigned Accept or Cancel button will end scanning mode. The specific display for this mode is dependent on the hardware being used to execute the scan.

Σ Average Discrete Points

Average Discrete Points (Figure 4-22) mode creates an averaged point from a number of measured points. This mode is useful when you want to average out a series of potentially noisy measurements (perhaps from vibration or other issues).

When in this mode, press the assigned Record button to begin taking samples. The number of samples that are averaged to determine the ultimate measurement position is determined in the Edit Arm Settings window.
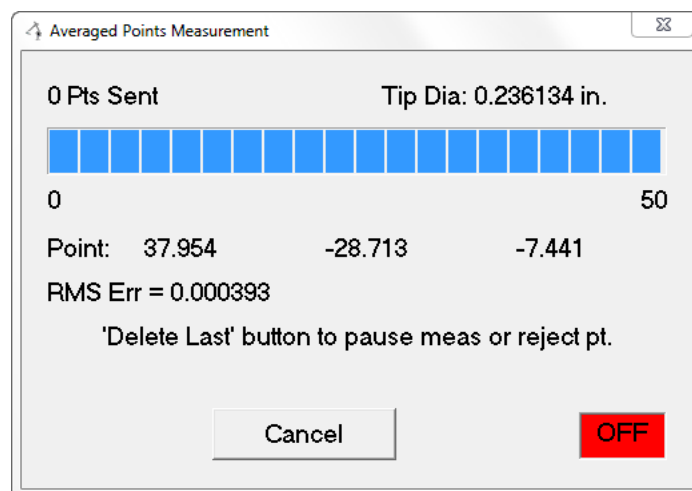
Figure 4-22. Measuring averaged points.

While taking samples, the assigned Delete Last button will pause sampling. Press the assigned Record button to resume. At the completion of the desired number of samples, the resulting point (and RMS error) will be displayed. Press the assigned Delete Last button to reject the point, the assigned Record button to take another measurement, and the assigned Accept button to complete the measurement mode.

🌐 Geometry Trigger

Geometry Trigger mode allows you to define planar, cylindrical, or spherical cross sections that, when crossed by the probe, trigger measurement. By default, these geometric triggers are not defined. You first need to define them by right-clicking on the Geometry Trigger button, which will take you to the Make Geometry Crossing Triggers

dialog (Figure 4-23). The top of this dialog (separated into Add Planes, Add Cylinders, and Add Spheres sections) is where the geometry triggers are defined. The active geometry triggers are displayed in the list in the center of this dialog.
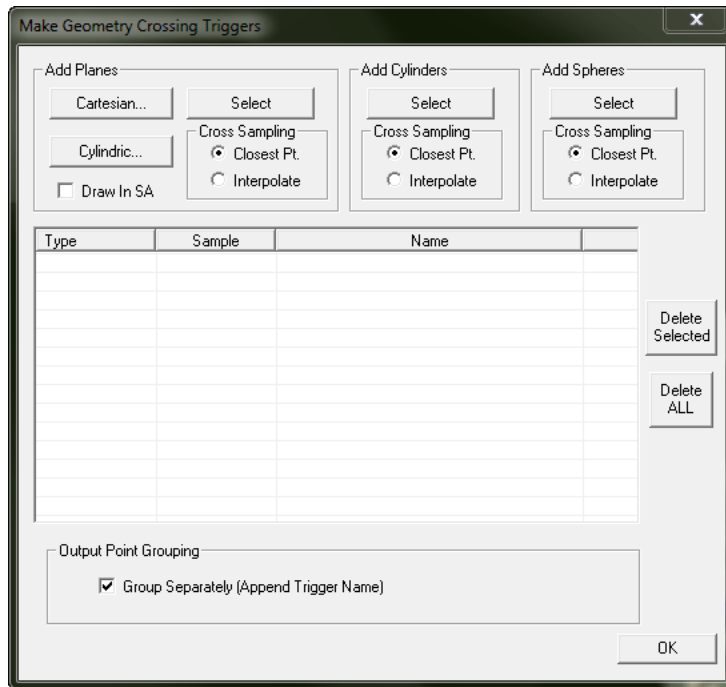

Figure 4-23. Defining geometry triggers.

Add Planes:

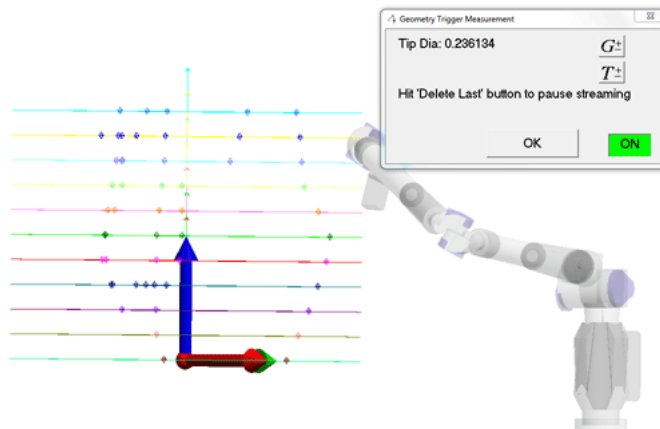- **Cartesian.** Creates planar triggers (Figure 4-24) along the X, Y, and/or Z axes:

Figure 4-24. Planar geometry triggers.

After clicking this button, you are presented with the Cartesian Along Working Axes dialog (Figure 4-25).

Figure 4-25. Defining the extent of planar geometry triggers.

In this dialog, check the axes along which you'd like to create planes, and also specify their start and stop position (in active units), as well as their spacing. In this example, planes will be placed along the active Z axis, from Z=0" to Z=20", spaced by 2" (see image above).

It is important to realize that, due to a number of limiting factors such as hardware sampling speed and computer speed, the sampled data will almost never be taken exactly on the geometry's boundary. In the Cross Sampling section, choose Interpolate to have SA interpolate between two sampled points on each side of the geometry trigger, and Closest Pt. to have SA use the closest sampled point to the trigger. The Interpolate option will result in a point lying directly on the geometry trigger (although it will not have been an actual sampled point), whereas Closest Pt. will be a true sampled point, but will likely not lie directly on the defined trigger.

You can also specify the width and height of the planes (for drawing purposes only) if they are going to be drawn in the graphical view.

- ▪ **Cylindric.** Creates planar triggers that pivot about the working frame's Z axis. Clicking this option brings up the Cylindric About Z in Working dialog (Figure 4-26). Here, you can define the start angle, stop angle, and angular spacing of the planes. Note that the X-axis defines the 0-degree plane for these values.

Figure 4-26. Defining cylindric geometry triggers.
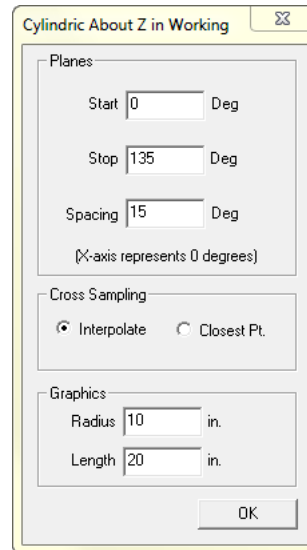
It is important to realize that, due to a number of limiting factors such as hardware sampling speed and computer speed, the sampled data will almost never be taken exactly on the geometry's boundary. In the Cross-Sampling section, choose Interpolate to have SA interpolate between two sampled points on each side of the geometry trigger, and Closest Pt. to have SA use the closest sampled point to the trigger. The Interpolate option will result in a point lying directly on the geometry trigger (although it will not have been an actual sampled point), whereas Closest Pt. will be a true sampled point, but will likely not lie directly on the defined trigger.

Figure 4-27. Cylindrically oriented planar triggers.
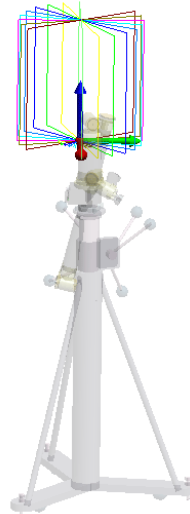
You can also specify the radius (width) and length of the planes (for drawing purposes only) if they are going to be drawn in the graphical view. The settings in Figure 4-26 were used to create the trigger planes in Figure 4-27.

- **Select.** Allows you to add an existing plane to the list of trig-

gers by clicking in the treebar or the graphical view.

- **Cross-Sampling.** This applies to triggers added via the Select method (see previous). It is important to realize that, due to a number of limiting factors such as hardware sampling speed and computer speed, the sampled data will almost never be taken exactly on the geometry's boundary. Choose Interpolate to have SA interpolate between two sampled points on each side of the geometry trigger, and Closest Pt. to have SA use the closest sampled point to the trigger. The Interpolate option will result in a point lying directly on the geometry trigger (although it will not be an actual sampled point), whereas Closest Pt. will be a true sampled point, but will likely not lie directly on the defined trigger. Note that the desired option must be chosen prior to selecting the plane.

- **Draw In SA.** This option will physically create the trigger planes in the job upon clicking the OK button for the Make Geometry Crossing Triggers dialog.

Add Cylinders

This section is used to add cylindrical geometry triggers.

- **Select.** Allows you to add an existing cylinder to the list of triggers by clicking in the treebar or the graphical view.

- **Cross-Sampling.** It is important to realize that, due to a number of limiting factors such as hardware sampling speed and computer speed, the sampled data will almost never be taken exactly on the geometry's boundary. Choose Interpolate to have SA interpolate between two sampled points on each side of the geometry trigger, and Closest Pt. to have SA use the closest sampled point to the trigger. The Interpolate option will result in a point lying directly on the geometry trigger (although it will not be an actual sampled point), whereas Closest Pt. will be a true sampled point, but will likely not lie directly on the defined trigger. Note that the desired option must be chosen prior to selecting the cylinder.

Add Spheres

This section is used to add spherical geometry triggers.

- **Select.** Allows you to add an existing sphere to the list of triggers by clicking in the treebar or the graphical view.

- **Cross-Sampling.** It is important to realize that, due to a number of limiting factors such as hardware sampling speed and computer speed, the sampled data will almost never be taken exactly on the geometry's boundary. Choose Interpolate to have SA interpolate between two sampled points on each side

179

of the geometry trigger, and Closest Pt. to have SA use the closest sampled point to the trigger. The Interpolate option will result in a point lying directly on the geometry trigger (although it will not be an actual sampled point), whereas Closest Pt. will be a true sampled point, but will likely not lie directly on the defined trigger. Note that the desired option must be chosen prior to selecting the sphere.

Trigger List

The Make Geometry Crossing Triggers dialog displays a list of the currently active triggers (Figure 4-28). You can single or multi-select active triggers, then remove them from the trigger list using the Delete Selected button. Or, you can delete all active triggers using the Delete ALL button.

Figure 4-28. A list of the defined geometry triggers.

- **Group Separately (Append Trigger Name).** When this option is checked, measured points will be separated into point groups based on their respective triggers (Figure 4-29). The trigger name will be appended to the end of the group name as appropriate. Once the geometry triggers have been defined, click OK to return to the interface. At this point, left-clicking the Geometry Trigger button will take you into the measurement mode. Pressing the assigned Record button will begin (or continue) streaming points, and only those triggered by the geometry triggers will be recorded. To pause streaming, press the assigned Delete Last button. To exit measurement mode, press the assigned Accept or Cancel button.

Figure 4-29. Separately grouped measurements on different geometry triggers.
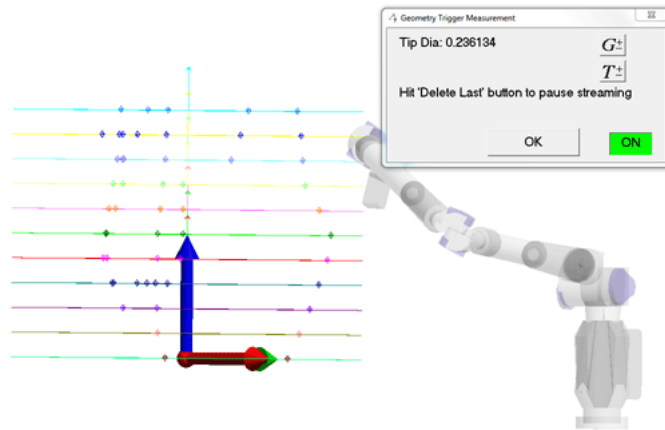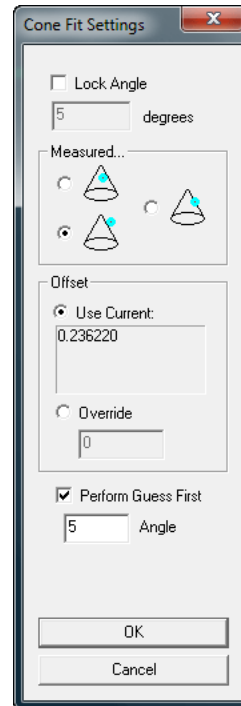
◢ Cone

Cone mode (Figure 4-30) creates a best-fit cone to a series of measured points. Once at least 12 points are measured, the Cone window displays statistics for the fit and the resulting cone. You can remove the previously-measured point from the fit by pressing the assigned Delete Last button.

Figure 4-30. Cone measurement mode.
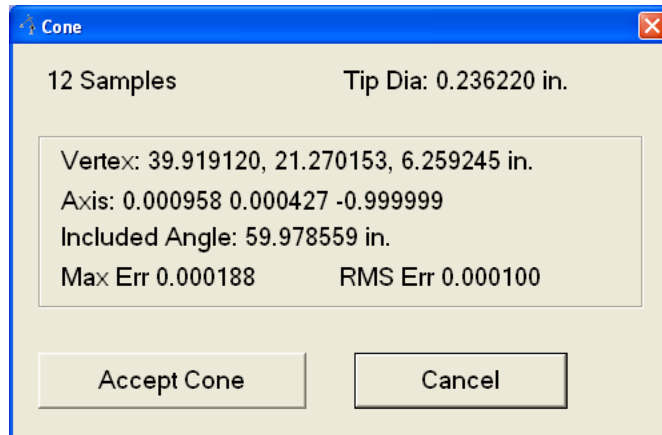
Fit parameters (Figure 4-31) can be accessed by right-clicking on the Cone icon.

Figure 4-31. Fit settings for a cone.

- **Lock Angle.** Allows you to specify the apex angle and lock it, so that the resulting cone matches the specified angle.

- **Measured.** Indicate whether you measured the outside of the cone, inside of the cone, or have zero offset.

- **Offset.** Use the current probe offset, or override it with a custom value.

- **Perform Guess First.** When checked, as each additional point is measured the fitting algorithm will re-evaluate all of the measured points. If unchecked, the initial guess parameters will not necessarily be re-evaluated as additional points are measured. In general, leave this option checked, unless computation times become unreasonable.

- **Angle.** Define the apex angle used for the initial cone fit guess.

When finished measuring points, press the assigned Accept button or click the Accept Cone button. To exit the dialog, press the assigned Cancel button.

SA ArmPad

The SA ArmPad (Figure 4-32) is a patent-pending input method that takes advantage of a calibrated pad (like a mousepad) that can be placed on any work surface. Once calibrated, you can tap any function on the pad with a probing device, instantly performing an action or entering the selected measurement mode. You can then perform various interactive actions with SA without using the computer or setting down the arm/probe.

By measuring three calibration points (A, B, & C below), SA will recognize the position and orientation of the pad, as well as which pad is being used. (Multiple variations of ArmPads, each with different functionality, are possible). As long as the pad is not moved relative to the instrument, its functions can be activated.

Figure 4-32. The SA ArmPad.

Calibrating the ArmPad is a straightforward process. It only needs to be performed once for a given instrument/pad orientation. That is, as long as the relative position between the instrument and the pad remain fixed, there is no need to recalibrate. Calibration results are stored with the instrument interface persistence files, so if an interface is shut down and restarted, the calibration is stored and recalled.

To Calibrate the ArmPad:

1. In the instrument interface (but without any measurement modes active), click the SA ArmPad button ▦ , or hold button 2 on the arm for a brief moment.

Figure 4-33. The ArmPad calibration dialog.

2. The ArmPad Calibration dialog will appear (Figure 4-33). Follow the prompts and touch the probe to each calibration point on the pad, measuring a single point at each.

Contact NRK Support to request a free pad. Or, click the Print Pad button to bring up a PDF of the pad which you can print out yourself on a letter-sized sheet of paper to use. (Note that the PDF should be printed at full scale, ensuring Page Scaling is set to NONE.

The Cancel and Done buttons have various uses (which are intuitive) based on context--they are equivalent to the Cancel or Accept buttons on the arm itself. The Prev and Next buttons have several meanings depending on context as well. For example, they switch to the previous or next feature when performing a GD&T Inspection, and they move

to the previous or next relationship when trapping measurements.

To Select a Measurement Mode Using the ArmPad:

- With the arm interface running, tap the probe onto the desired measurment mode on the pad. (Note: you do not need to press a button to select the mode).

To Change Views Using the ArmPad:

- With the arm interface running, tap the probe to the Top, Front, Side, or Oblique boxes on the pad.

To Autoscale the View Using the ArmPad:

- With the arm interface running, tap the probe to the Autoscale button (similar to the ✛ button) on the pad.

To Delete the Last Measured Point Using the ArmPad:

- With the arm interface running, tap the probe to the Delete Last Point button on the pad.

Edit Arm Settings

To access the SA Arm interface options, press the Edit Arm Settings button ✔ in the bottom left-hand corner of the interface. This takes you to the Options dialog (Figure 4-34).
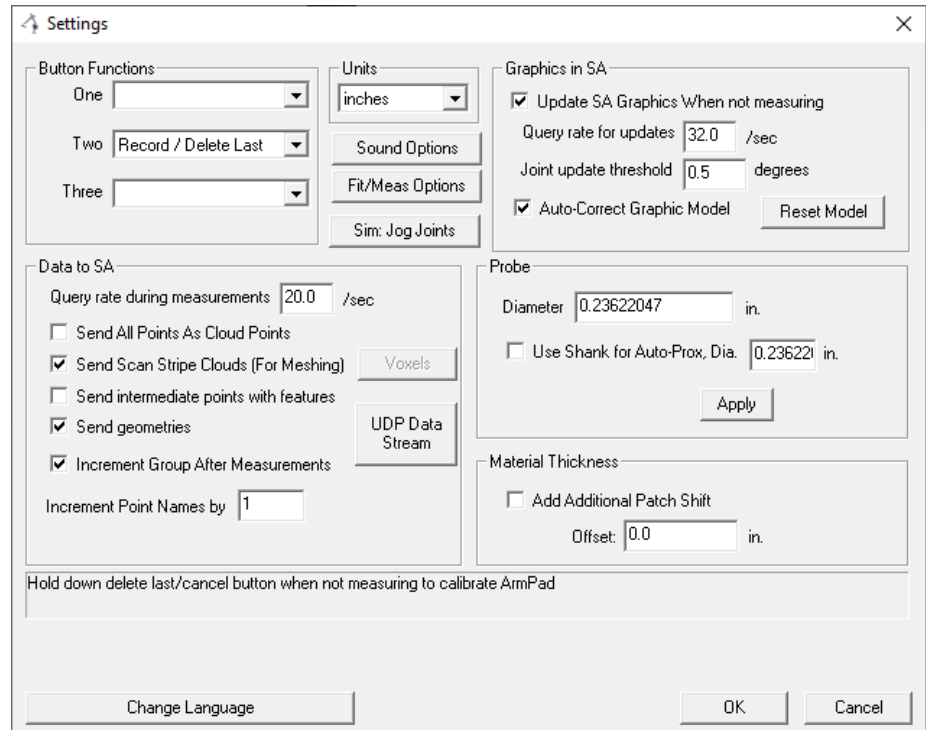
Figure 4-34. The Arm interface options dialog.

Button Functions

Arm buttons 1, 2, and 3 (if available) can be set to perform a series of functions:

- **None.** Disables the associated button so it performs no action.

- **Record/Accept.** The associated button will record a point or begin streaming points if pressed momentarily, and accept a dialog, accept geometry creation, or close a measurement mode if held for a few seconds.

- **Delete Last/Mouse Toggle.** The associated button will delete the last point or pause streaming if pressed momentarily, and if held for a few seconds, will toggle the use of the arm to control the mouse cursor.

- **Delete Last/Cancel.** The associated button will delete the last point or pause streaming if pressed momentarily, and cancel a dialog, cancel geometry creation, or close a measurement

mode if held for a few seconds.

- **Record / Delete Last.** The associated button will record a point or begin streaming points if pressed momentarily, and delete the last point if held for a few seconds.

- **Accept / Cancel.** The associated button will accept the mode if pressed momentarily, and cancel if held for a few seconds.

- **Next / Previous.** These controls can be used directly with Feature Inspection by progressing to the next feature if pressed momentarily, and returning to the prior feature if help for a few seconds.

Button Operations Summary

Button Operations Summary				
Button Setting Name	Short	Long	Active Meas - Short	Active Meas - Long
Record/Accept	Next	Accept Mode	Record	Accept
Delete Last/Cancel	Prior	Mouse Pad	Delete Last	Cancel
Delete Last/Mouse Toggle	Prior	Mouse Toggle	Delete Last	
Record/Delete Last	Next	Prior	Record	Delete Last

The button functions can also be triggered even without the arm buttons by using the number keys on the keyboard. Press 1,2, or 3 to trigger the function of the corresponding button on the arm. You can also use Ctr+1, Ctr+2,Ctr+3 to trigger the corresponding long hold function.

Toolbar button operations are hard coded. For details refer to the "Instrument Toolbar" on page 194.

Units

Instrument interfaces have unit settings in addition to SA itself. Choose the active units (inches, meters, millimeters, centimeters, or feet) in this drop-down.

Sound Options

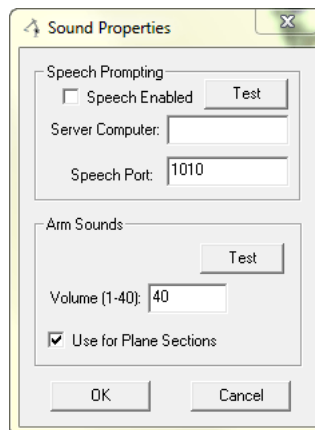Clicking the Sound Options button will bring up the Sound Properties dialog (Figure 4-35).

Figure 4-35. The Sound Properties dialog.

Speech Prompting

- **Speech Enabled.** If the SA Speech Server is running, this option will add speech prompting to the arm interface.

- **Test.** This button can be used to verify that the speech feature is operating correctly.

- **Server Computer.** The IP address of the computer running the speech server (leave blank if running on the current computer).

- **Speech Port.** The network port used by the speech server (set in the Speech Server's settings).

Arm Sounds

- **Test.** Play a series of arm sounds to check the volume setting and verify that arm sounds are audible.

- **Volume (1-40).** Sets the volume of the arm's speaker (if applicable). If the arm is not equipped with an internal speaker, the computer's speaker will be used instead, and this setting will have no effect.

- **Use for Plane Sections.** When enabled, the arm will sound when the probe crosses a plane section or geometry trigger that results in a measurement.

Fit/Meas Options

The Fit/Meas Options button brings up a dialog (Figure 4-36) where you can specify a series of options related to arm measurement and geometry fitting.
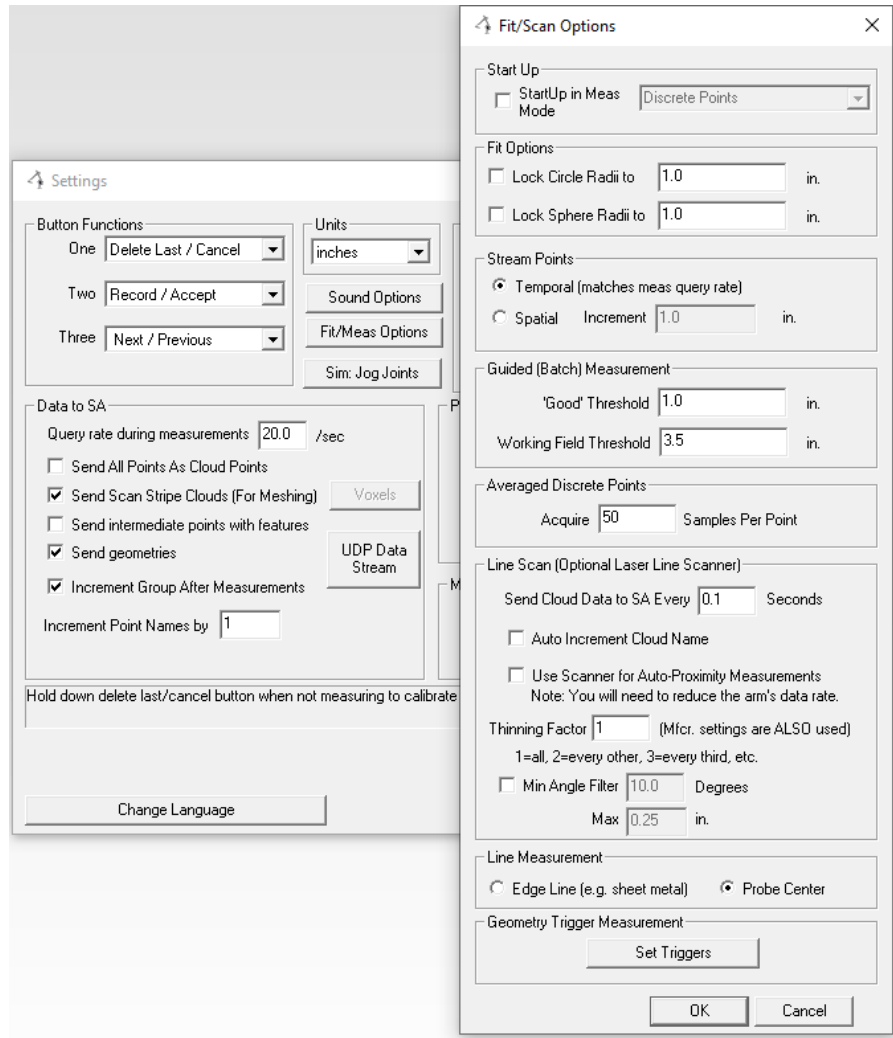
Figure 4-36. The Fit/Scan options dialog.

Start Up

- **Startup In Meas Mode.** Check this option and choose a measurement mode to have the interface automatically enter a specific measurement mode after being started.

Fit Options

- **Lock Circle Radii to.** Check this option and enter a radius to lock the resulting circle from a circle fit to a specific radius.

- **Lock Sphere Radii to.** Check this option and enter a radius to lock the resulting sphere from a sphere fit to a specific radius.

Stream Points

- **Temporal.** When in Stream Points mode, points will be recorded at the rate specified under the Arm Settings in the Query Rate During Measurements field. Note that due to hardware, network, and other limitations, the rate will not match the requested rate exactly.

- **Spatial.** When in Stream Points mode, points will be recorded spaced by the specified increment. Note that due to hardware, network, and other limitations, the spacing will not match the requested increment exactly.

Guided (Batch) Measurement

- **'Good' Threshold.** Set the default radius for measurements to be considered "good" (in the "green zone").

- **Working Field Threshold.** Set the default radius in which the mode begins zooming and emitting an audio cue.

Averaged Discrete Points

- **Acquire X Samples per Point.** Specify the number of samples that will be averaged to produce the resulting measured point while in Average Discrete Points mode.

Line Scan (Optional Laser Line Scanner)

This section of the Fit/Scan Options dialog is important for controlling line scanner data .
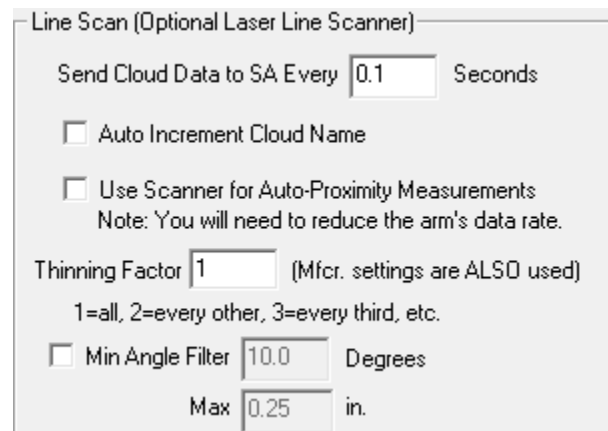
Figure 4-37. Line Scan Controls within the Fit/Scan Options

- **Send Cloud Data to SA Every [X] Seconds.** Point cloud data acquired from scanners is sent to SA in batches. This option allows you to control how frequently those cloud point batches are sent to SA.

- **Auto Increment Cloud Name.** When selected, upon completion of a scan, the point cloud name will automatically be incremented for the next set of scan data.

- **Use Scanner for Auto-Proximity Measurements.** This check mark can be enabled in order to use the scanner for proximity triggered measurements. This can be a very fast way to measure points in specific locations.

- **Thinning Factor.** This setting is applied in addition to the manufacturer's thinning settings in order to determine what por-

tion of the scanned points are actually sent to SA. For example, if the manufacturer's settings are set to send every 2nd point, and the setting here is to send every 2nd point, then SA will receive every 4th point.

- **Min Angle Filter.** This is a more advance filter option that considers the curvature of a scan line. This provide a means to keep data on transition and edges while filtering out excess data on flat, featureless regions. It offers two controls a *Minimum Angle* in degrees to define the flat regions and a *Max* distance value which ensures that points are returned within this maximum threshold. This ensures some data is returned on wide flat expanses.

Line Measurement

- **Edge Line (eg sheet metal).** This option is used for measuring an edge, typically of a thin plate (such as sheet metal) when in Line measurement mode. For this mode, you first define the plane of the flat surface whose edge you'd like to measure. Then, start measuring and slowly drag the probe tip along the surface until it begins to fall off the edge. This will define one end of the line. Repeat on the other end of the edge, and a line will be created. It is important to move the probe tip very slowly (depending on the measurement query rate) and to ensure that the probe remains in contact with the surface at all times.

- **Probe Center.** When in Line measurement mode, the line is fit to the probe center points.

Geometry Trigger Measurement

- **Set Triggers.** This is equivalent to right-clicking on the Geometry Trigger measurement mode button, and allows you to define geometry triggers.

Data to SA

- **Query Rate During Measurements.** Specify the rate at which the instrument is polled for data while measuring. This controls, for example, the rate at which measurements are recorded during the temporal Stream Points measurement mode, and the rate at which data is transmitted for UDP Broadcasts. Keep in mind that the requested data rate is limited by hardware, network, and other restrictions.

- **Send All Points as Cloud Points.** All measured points will be sent to SA as cloud points instead of measured targets.

- **Send Scan Stripe Clouds (For Meshing).** Enabling this option will change the cloud format sent to SA to a Scan Stripe Cloud. This format included a probing transform per scan line used

in meshing. For high speed scanners Voxels can be used to reduce the data density as you scan.

Figure 4-38. The Voxels button offers controls to both thin the incoming data and improve its quality.
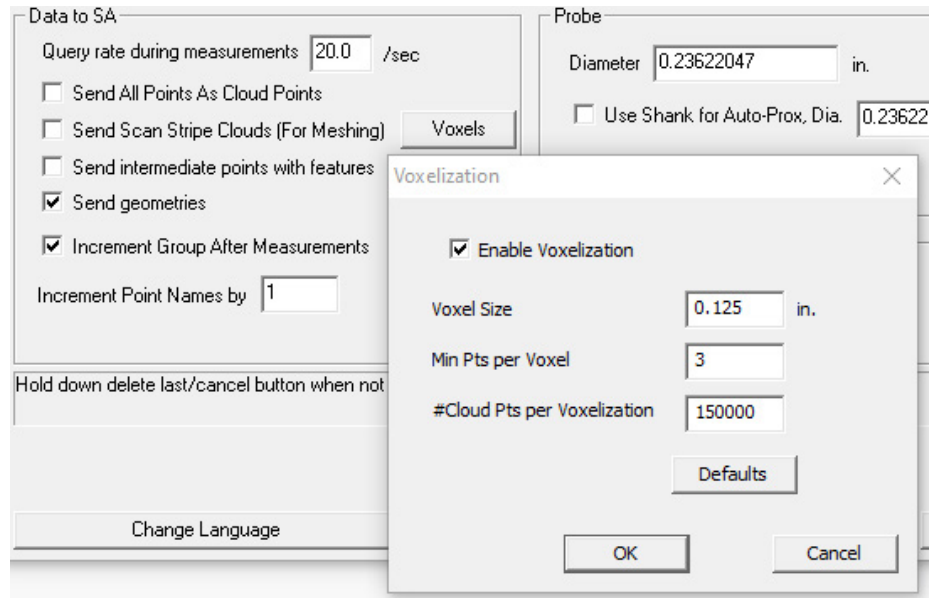
The *Voxel Size* control and *Min Points per Voxel* should be familiar from SA's Voxel controls. The *#Cloud Pts per Voxelization* option controls how many points are processed in a batch before they are sent to SA. This means a larger number will slow the rate data appears in the graphics.

- **Send Intermediate Points with Features.** For measurement modes that create geometry, if checked this option will also send the measured points that created the geometry. By default, these points are not sent.

- **Send Geometries.** If disabled, geometries resulting from measurement modes that create geometry will not be sent to SA.

- **Increment Group After Measurements.** When selected, the group name will increment upon the completion of a measurement mode.

- **Increment Point Names By X.** Each subsequent measured point will be incremented by the specified amount.

UDP Data Stream

The UDP Data Stream feature (Figure 4-39) enables the instrument interface to broadcast real-time probe position and orientation over the User Datagram Protocol (UDP). This allows the interface to send this data over a network without requiring a specific data connection to be established beforehand. This means that other clients on the network can be set up to receive this data and, perhaps, do something useful with it.

Figure 4-39. The arm interface's UDP data stream properties dialog.
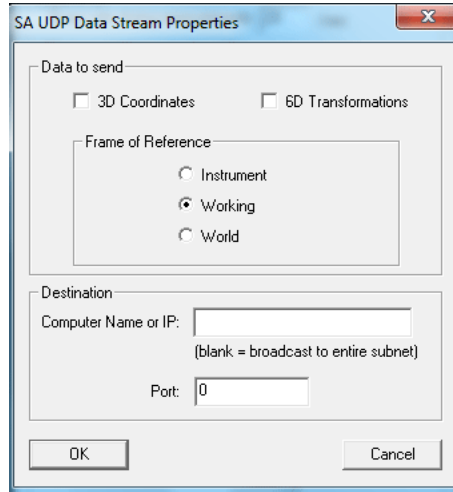
For example, you might set up UDP data streaming to broadcast real-time 6D probe information to a custom client application that is listening on the proper port for UDP data packets. This client application could take this 6D information and process it, performing a useful task (such as using the 6D information to control a motorized pan/tilt head camera mount).

- **Data to Send.** Choose whether to send 3D coordinates (X, Y, and Z probe position) or 6D Transformations (X, Y, Z, and probing vector). You must also choose whether to send this data relative to the instrument, working, or world coordinate frame.

- **Destination.** Enter the network computer name or IP address to target for the UDP broadcast, or leave it blank to broadcast to the entire local network. You must also specify a port number to target.

To test the data being transmitted via UDP packets, use the SpatialAnalyzer UDP Monitor (available in the SA Install directory as `Spatial-alAnalyzer UDPMonitor.exe`. Set it up with the appropriate port, then click the Start button to view the data as it arrives over the network port, as seen in Figure 4-40.

Figure 4-40. The SpatialAnalyzer UDP Monitor.
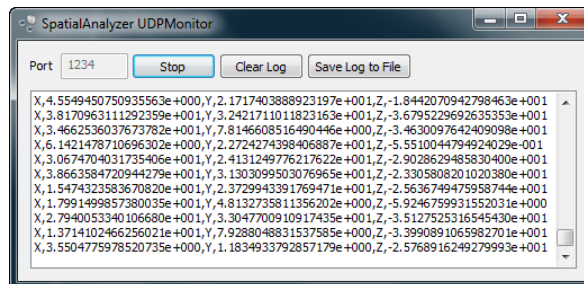
Graphics in SA

- **Update SA Graphics When Not Measuring.** When enabled,

the depiction of the arm in the graphical view will update, even when a measurement mode is not active.

- **Query Rate for Updates.** The rate at which graphical updates will occur when not measuring. While the interface will ask the instrument for this rate, the actual update rate is limited by hardware, network, and other restrictions.

- **Joint Update Threshold.** If a joint encoder has not rotated by the angle specified in this field, the joint's graphical view will not update. Larger values will result in less frequent updates.

- **Auto-Correct Graphic Model.** Due to the kinematics involved, and that fact that some manufacturers do not have fixed encoder orientations (or they do not expose this information), sometimes the model of the arm in the graphical view may appear to be oriented incorrectly. When this option is enabled, the interface will attempt to automatically correct the kinematics of the model of the arm in the graphical view. This option is exclusively for graphical purposes, and has no effect on the accuracy of the actual measurement data coming from the instrument.

- **Reset Model.** If the model continues to be incorrect, click this button to attempt to reset the graphical representation.

Probe

- **Diameter.** You can override the arm's probe diameter by entering a different value in this field (generally NOT recommended). Click the Apply button to apply the changes.

- **Use Shank for Auto-Prox.** When enabled the shank axis of the probe can be used with a calibrated shank probe to take proximity measurements.

Material Thickness

- **Add Additional Patch Shift.** Select this option to add an additional thickness for the Patch (Projected Pt.) measurement mode. This can be used, for example, to account for extra material thickness on a measured surface.

- **Offset.** Enter the desired patch shift offset amount in this field. A positive offset implies that there is extra material on the measured part.

Choose Language

This button is used to load or create a translation file for the arm interface.

Arm Calibration

This will display hardware-specific calibration routines and set-

tings. The options provided by this button are strictly controlled by the instrument manufacturer.

Toggle Arm Buttons

Press this button to toggle the arm buttons on and off. Toggling the arm buttons off will render them inoperable until toggled back on again. The number keys on the keyboard can also be used as an alternative to the buttons on the arm. Refer to "Button Control" on page 162 for more information.

Blue Question Mark

This button will display the MP string commands that can be used to set the arm measurement modes or apply additional settings via Measurement Plans.

Instrument Simulation

In simulation mode, you can simulate the different measurement modes, as well as record points to simulate a measurement process. When simulating, you will come across a series of buttons in various parts of the interface (Figure 4-41).

Figure 4-41. The simulation buttons.

1S | 1L | 2S | 2L

These buttons refer to "First button, short", "First button, long", "Second button, short" and "Second button, long" and refer to simulating pressing the arm buttons momentarily or pressing and holding them.

Instrument Index Number

At the very bottom of the interface is the collection, instrument index number, and name of the active instrument. This index number (which for a given collection begins counting from zero) is used in several places in SA--one of which is Measurement Plans.

Instrument Toolbar

The instrument toolbar is a simpler, easier to learn and use interface for arm measurement than the full arm interface. It is well suited for performing simple point measurement and scanning tasks, for new users, and when performing inspection routines using the SA Toolkit. It does not have any of the geometry measuring routines that are found in the traditional arm interface.

The instrument toolbar is displayed in Figure 4-42. It is accessible from the main arm interface by clicking the icon. (Similarly, the icon switches back to the standard interface).

Figure 4-42. The arm instrument toolbar.

Setting the Point Name

To explicitly set the point name for the next measured point, click the text field above the probe diameter listing. This will call up the Instrument Interface Point Naming dialog (Figure 4-43), which allows you to specify the collection, group, and target names. If performing an inspection routine, the SA toolkit will name your data for you.
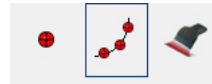

Figure 4-43. Naming a point in the arm toolbar.
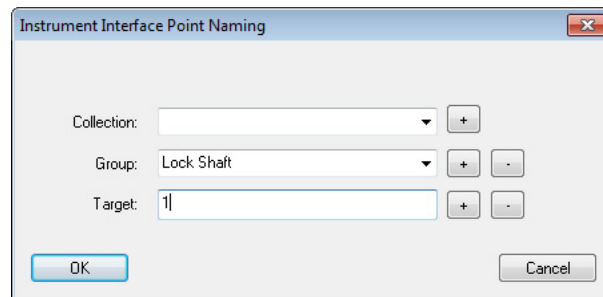
Measurement Modes

There are three measurement modes available to you in the toolbar: single point measurement, stream measurement, and scanning mode (Figure 4-44).

Figure 4-44. (Left to right) Single point mode, stream mode, and scanning mode.

Click the single point or streaming measurement mode to activate it. For arms that have a scanner device with a switch attached, flip the switch to activate scanning mode. Some instruments may require you to click the scanning measurement mode button.

Measuring In The Toolbar

The following buttons control measurement using the arm toolbar.

- **Button 1.** A short press moves to the next feature in the SA Toolkit, whereas a long press iterates the measurement mode.

- **Button 2.** A short press records a measurement, whereas a long press deletes the last measurement.

- **Button 3.** A short press advances to the next feature in the SA Toolkit, whereas a long press iterates the measurement mode.

Checks/Utilities

By clicking the ⬙ icon, you can access calibration, scanner, and arm settings (these are the same destinations as found in the traditional arm interface).

Portable CMM Quick-Start Guides

API and Kreon Arms:

- ▪ "API Axxis / Kreon Arm (7 DOF)" on page 197

Faro Arms:

- ▪ "Faro Arms" on page 202

Hexagon and Romer Arms:

- ▪ "Hexagon Absolute Arm" on page 207
- ▪ "Romer/Cimcore Arms" on page 213

API Axxis / Kreon Arm (7 DOF)

Prerequisites

> **Note:** You must have the proper calibration file for the arm (manufacturer-supplied). The file name will contain the arm serial number and will end with ...Arm.tab. You will be prompted to browse for the path to this file when the interface starts.

1. Copy Calibration files (calibration files are supplied with arm and scanner and are place in the **C:\ProgramData\Kreon Technologies\Calibration** by default but you can browse to any location).

2. Download `Plugin_SpatialAnalyzerXXXX.zip` from ftp://ftp.kinematics.com/pub/SA/Install/Driver%20Downloads/Scanners/Kreon%20Scanner%20Plugin/. Check the SA Readme file for the appropriate version.

As an example, SA version 2019.04.09 requires Plugin 3.3.2.3.

Starting in SA version 2020.12.01 you need Plugin v.20.0.0.0

3. Unzip the file to your hard drive, and run `Setup.exe`. The installer will guide you through the process of installing the scanner and the HASP dongle driver.

> **Note:** You must have the proper calibration file for the scanner. The Kreon install will prompt you for the file. It will be named [scanner serial number].cal.

Part of the installation process copies necessary files into the SA install directory. For that reason the Kreon plugin will need to be run again with each new SA installation.

4. Configure your network connection as needed for your scanner. The **SkylineConfig.exe** utility is part of the current (Plugin-SpatialAnalyzerXXX install and will be placed in your SA install directory). Run this utility from the SA install directory to verify and configure your network.

5. Once configuration is complete a reboot may be necessary.

Finally, the Kreon arm uses an additional external USB License dongle. This dongle must be in place on the machine for the arm to be used in SA.

Running the Instrument in SA

1. Add an instrument using the menu item Instrument>Add Instrument or use the 🏃 icon.

2. Select the API Axxis or Kreon 7DOF arm (Figure 4-45).
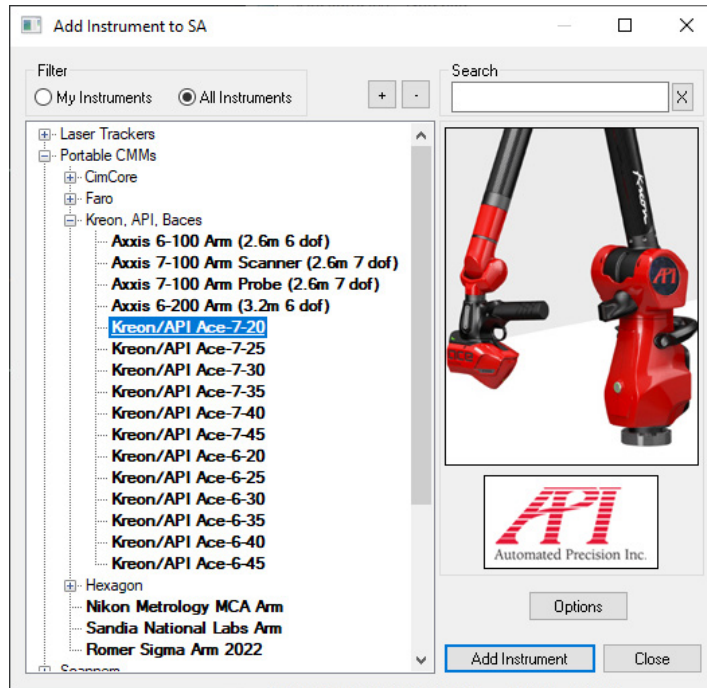
Figure 4-45. Adding a 7-DOF Kreon arm.

3. With the new instrument added run the arm interface module. Simply click the 🏃 icon.

4. You will be asked to choose a communication method and a parameter file. This parameter file should be supplied with the arm (Figure 4-46).
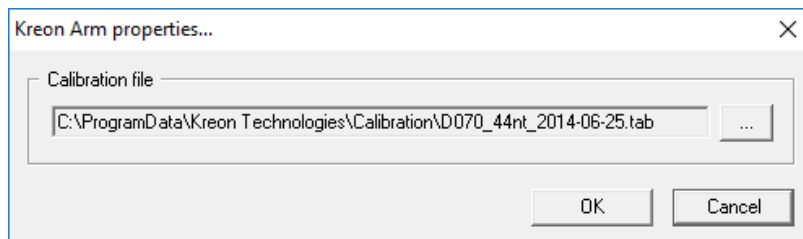
Figure 4-46. The Axxis connection settings dialog.

Once the connection is established the arm must be initialized. This includes first selecting a profile from the drop down list and then initializing the encoders. To do so, simply exercise the arm until all encoders have a green status (Figure 4-47). Once complete , SA arm interface will then appear.

Figure 4-47. Exercising the encoders on the arm.
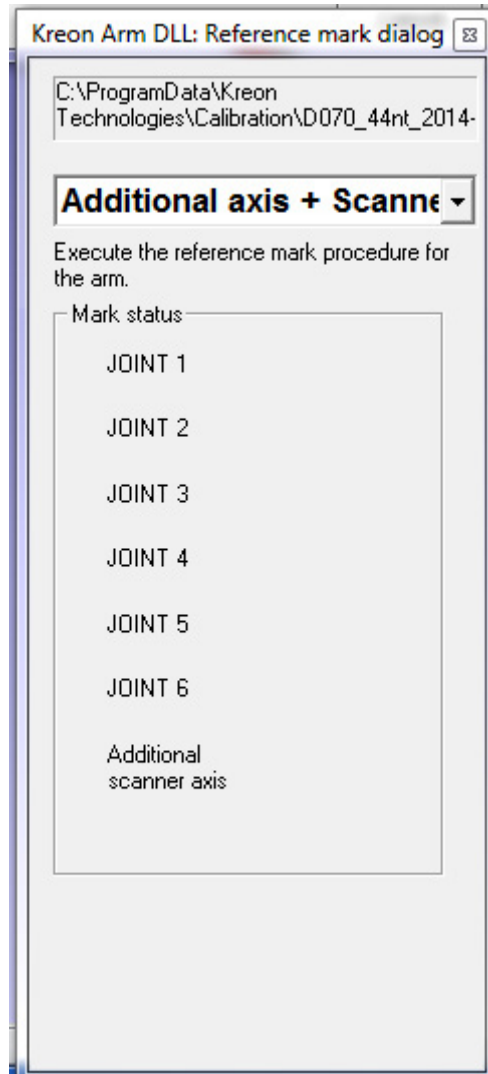
Scanner Calibration and Controls:

In order to scan be sure to set a scanning profile in the Kreon Arm Probe Management utility (see "Kreon Arm Specific Settings" on page 201). To access the Scanner calibration routine press the Calibration button in the arm interface. Perform a scanner calibration with a certified Sphere and accept the results or repeat as needed following the direction in the dialog (Figure 4-48).

Figure 4-48. Calibrating the arm.
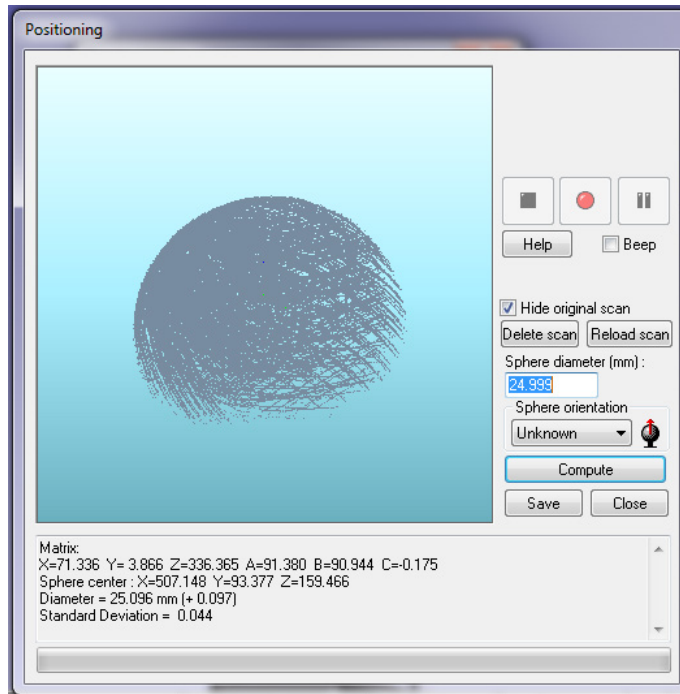
Right-clicking on the scanner button in the instrument interface will provide direct access to the scanner settings controls (Figure 4-49).

Figure 4-49. Scanner settings through Right-Click
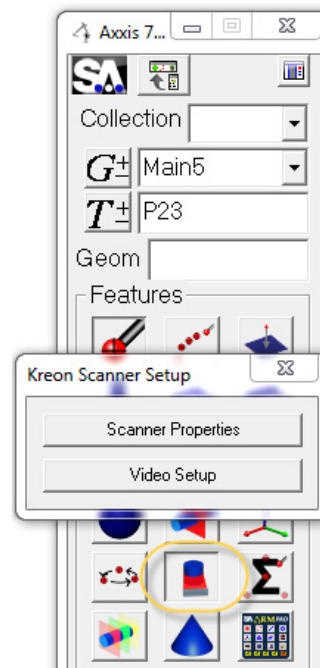
The Scanner Properties button the Video Setup button provide access to information about the scanner, its firmware and calibration date as well as access to the exposure and Quality control settings (Figure 4-50).
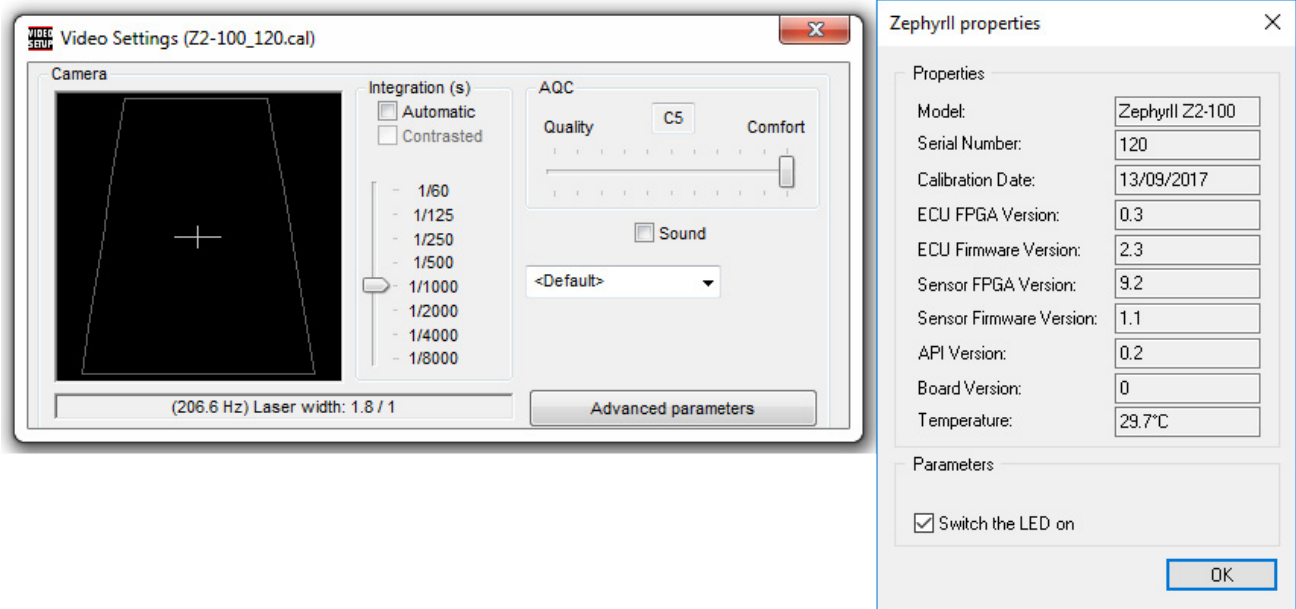
Figure 4-50. Scanner Properties and Video Setup

Kreon Arm Specific Settings

The Arm configuration profiles is first selected when you connect to SA through the Encoder Initialization dialog. However, the Arm configuration can be changed during operation through the Kreon Arm Probes Management tool located in the task bar (Figure 4-51).

Its important to note that the profile must be changed from a probing configuration to a scanning profile in order to change modes of operation.

The probes Management tool also provides calibration access.

Figure 4-51. Calibrating the touch probe.
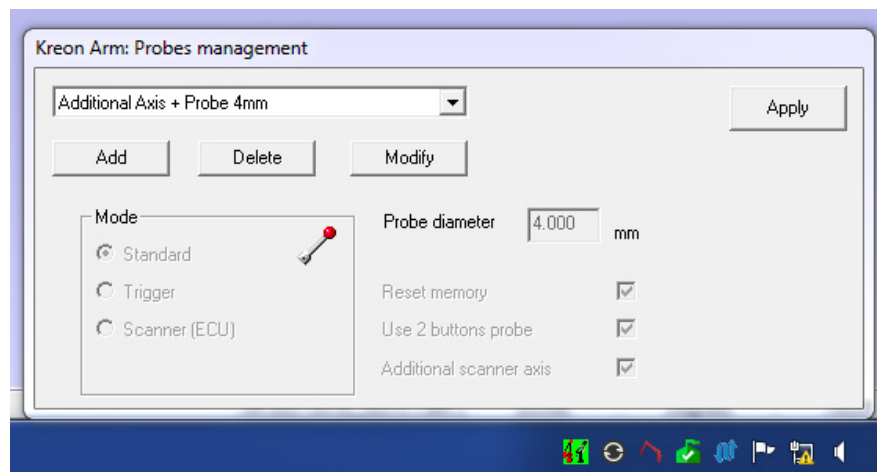
With a satisfactory calibration the arm is ready to measure. Simply use the buttons on the arm to trigger measurements, change measurements, etc.

Faro Arms

This Quick-start guide applies to the setup of the Faro Platinum, Quantum and Edge.

Hardware Setup:

Faro Arm is a USB connected device. Install the drivers before connecting the USB cable. Once installation is complete connect the cable and ensure that the power switch located on the arm is turned on.

Software Setup:

Download and install the appropriate 32 or 64 bit version of 'FaroArmUSBdriver' from the Driver Downloads section of the NRK FTP site at:

http://www.kinematics.com/ftp/SA/Install/Driver%20Downloads/PCMM%20Arms/FARO/USB%20Arms/

The driver from our webpage is a 3rd party driver and is the last version fully tested in SA.

Faro Driver version 6.6.0.15 or later does not include all the common files SA uses to switch between probing and scanning. If you are in a version prior to 2020.12.01 and use a newer Faro driver you will also want to download the common files here:

ftp://ftp.kinematics.com/pub/SA/Install/Driver%20Downloads/PCMM%20Arms/Faro/

Unzip the files and copy the dll files to `C:\Program Files (x86)\Common Files\FARO Shared\Devices.`

Connection Setup:

Most arm models can connect in either of 3 ways. Using USB, bluetooth, or wireless connections. *To use the default USB connection no additional set up is necessary.*

Bluetooth Connections:

1. *Open the front panel of the arm, go to connections and then enable bluetooth.*

2. *Go to the bluetooth connection on the computer and add a device.*

3. *Once the device is found (the name of which should match the arm serial number) click on it and select Pair device. The pairing code is "faro".*

4. *Once connected to windows go to hardware and find the com port used for the connection.*

5. *Open the Faro Bluetooth Connection Utility in the start menu and enter the Com Port set from the bluetooth connection*
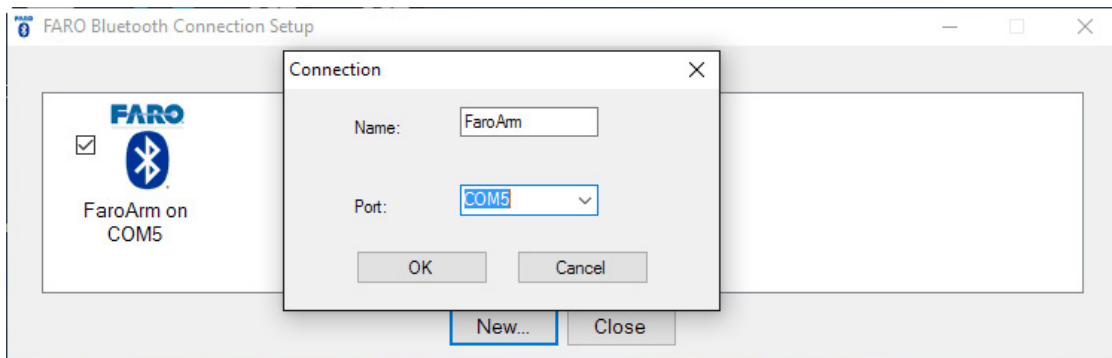
6. *Once connected close the connection dialog. You should get a windows prompt telling you that there is a connection.*

An example video can be found here:

> *https://www.youtube.com/watch?v=hUoUKYKSCvk*

Wireless Connection

1. *Open the front panel of the arm, go to Settings>Connection and select WiFi*

2. *Select WiFi to PC/Laptop (to connect to an existing network use Wifi to network, connect to that network)*

3. *Once enabled. open the computers wifi connections and connect to the Faro Wifi signal (named according to the arms serial number).*

4. *Open the Faro Ethernet Setup utility from the start menu and select the wifi card for the host adapter. The arm connection should appear after you press "refresh".*

5. *Choose this connection by checking the check box and press OK.*

An example video can be found here:

https://www.youtube.com/watch?v=3gh2cJE7Pf0

Running the Instrument in SA:

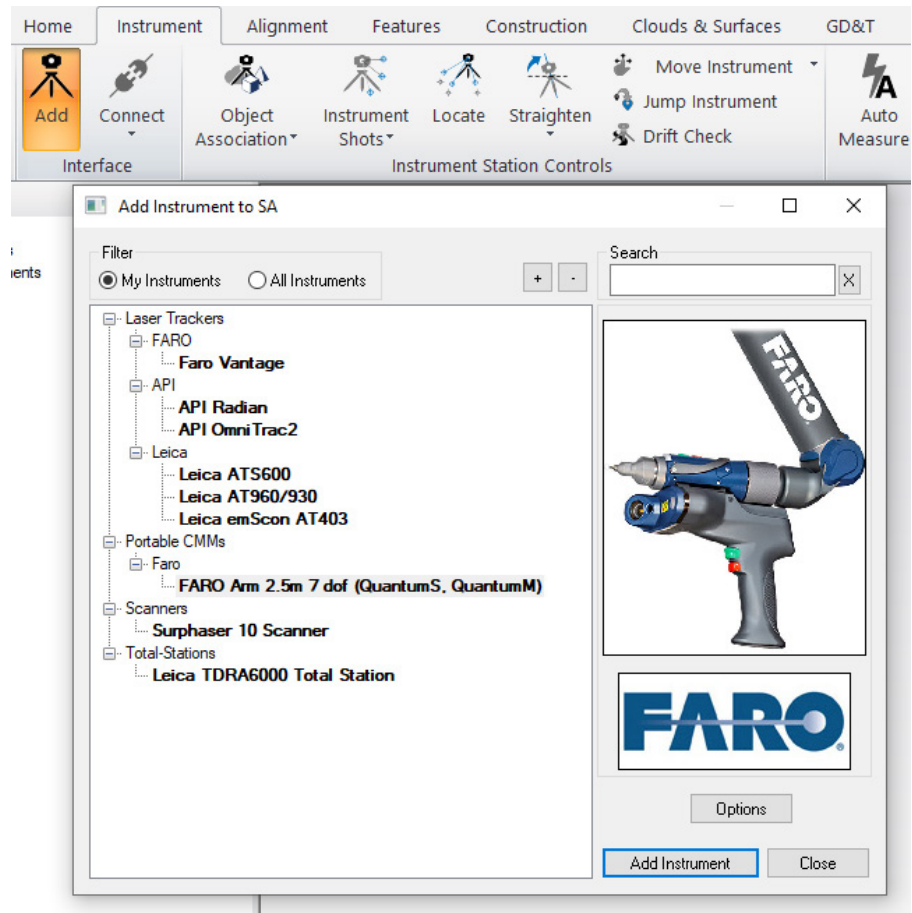**1.** Add an instrument using the menu item Instrument>Add Instrument and select the appropriate FaroArm from the list.

Figure 4-52. Adding a Faro Arm to SA

2. With the new instrument added run the arm interface module. Simply press the Connect icon or go to Instrument>Run Interface Module and Connect. SA should automatically detect the arm and start the Instrument Interface.

Instrument Graphics

The first time you connect to a new arm in SA the arm graphics may not be correct and the arm graphics and the measured points may not line up. This is because SA doesn't know the default starting encoder locations. This not a problem because the graphics are fit to the

measurements, not the other way around. It will not affect the measurements and can easily be corrected as follows (see Figure 4-53).

Figure 4-53. Correcting the arm graphic model with measured points
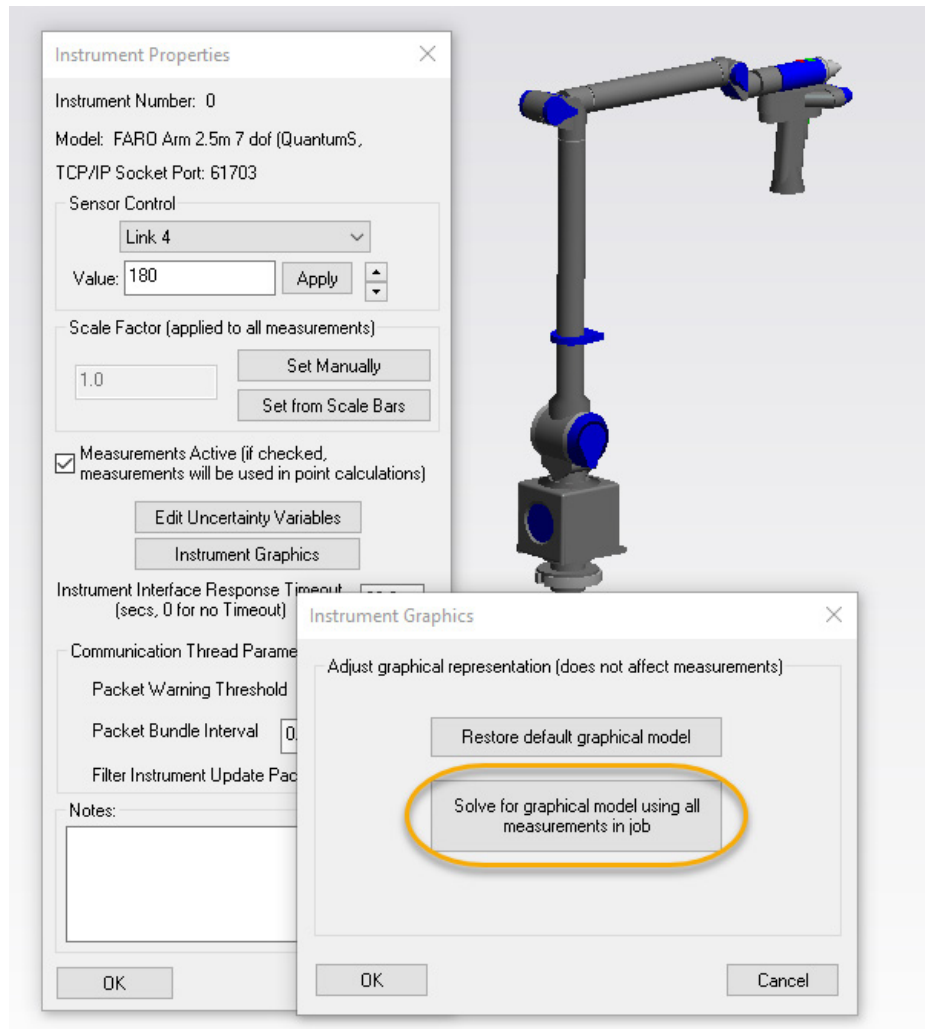
To correct the arm model graphics follow these steps:

1. Measure a bunch of points in the graphics around the arm in different joint orientations.

2. Open the arm's properties by right-clicking on it and select *Instrument Graphics* then select *Solve for graphical model using all measurements in the job.*

When you do this SA will compute the encoder angles necessary to fit the measurements and correct the arm graphics for you. This will be saved in the persistence file for the instrument and will need to be done performed once.

Instrument Controls

Most users will be happy using the instrument toolbar. It offers basic controls over the measurement naming, measure acquisition modes. The wrench and screwdriver icon provides direct access to the arm

configuration as well
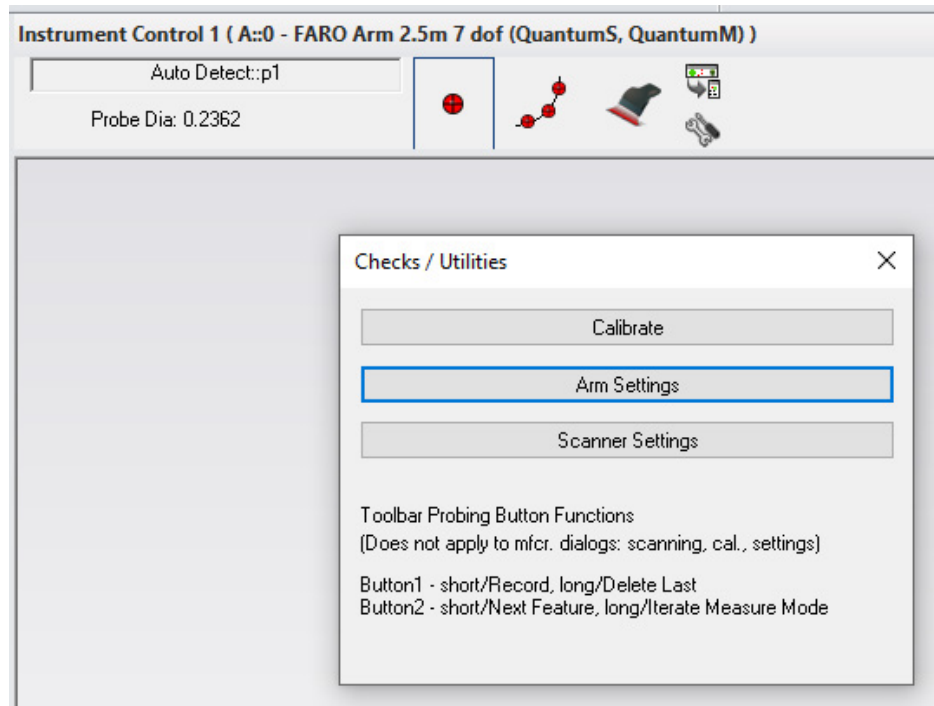
Figure 4-54. Instrument Controls in the Toolbar

More detains on the full interface can be found at the beginning of the chapter. You might want to see the fill set of arm settings available here (see "Edit Arm Settings" on page 185).

Hexagon Absolute Arm

This Quick-start guide applies to the setup of the Hexagon and Romer Absolute Arms including external and integrated scanners.

RDS Installation and Configuration:

Download and install the correct version of RDS for your SA version.

- SA version 2023.2 version requires RDS 6.3 or later.

Run the RDS Installer and follow the prompts. Once installed, plug in the arm via the USB cable and verify Windows has properly recognized the device and installed the drivers properly.

RDS will always be active in the system tray (Figure 4-55) and will show the current connection status of your arm. It is your primary tool for calibration and arm configuration.
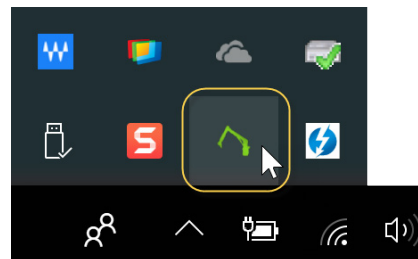
Figure 4-55. RDS in the System Tray.

In order to perform a calibration you will need to be an "Advanced" user which requires a password. "Advanced" is also the default password (Figure 4-56):

Figure 4-56. The RDS status window.
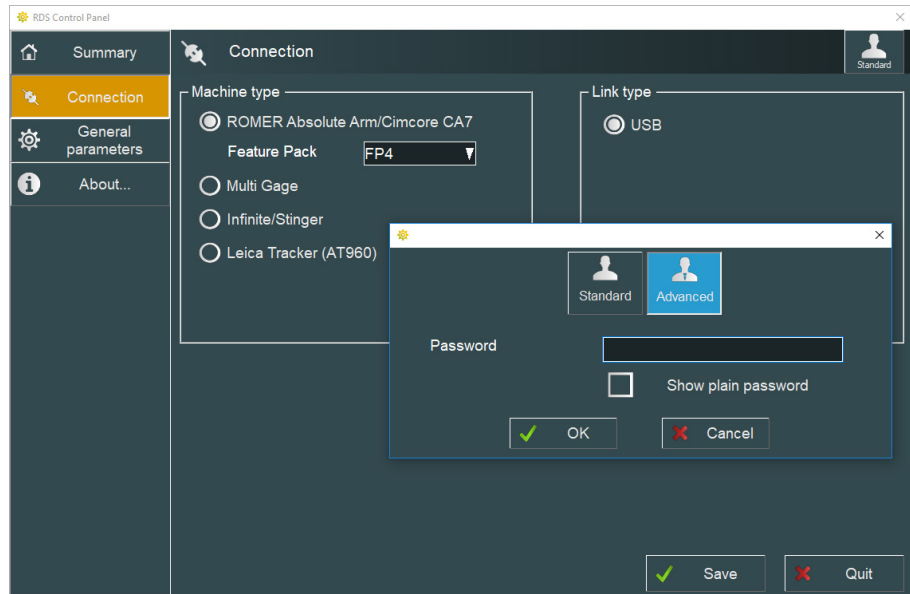
Genera Scanner Configuration

If your arm comes with a scanner you will need to configure RDS and the system use it. Steps include the following:

1. Ensure that the Ethernet cable is connected to your PC.

2. Set the Computers network card to an appropriate IP address.

The default scanner IP address of *192.168.178.200.*

Make sure the computer IP address is 192.168.178.XXX with the last digits being between 0-255 but not 200. Example, 192.168.178.100 for the computer. For more information on changing IP addresses please consult the IP Address Basic section.

3. Calibrate the Scanner using the utilities provided as part of RDS.

Adjust the default settings as needed. The Scanning page in RDS becomes available when the scanner is engaged (Figure 4-57).

Figure 4-57. RDS Scanner Settings page
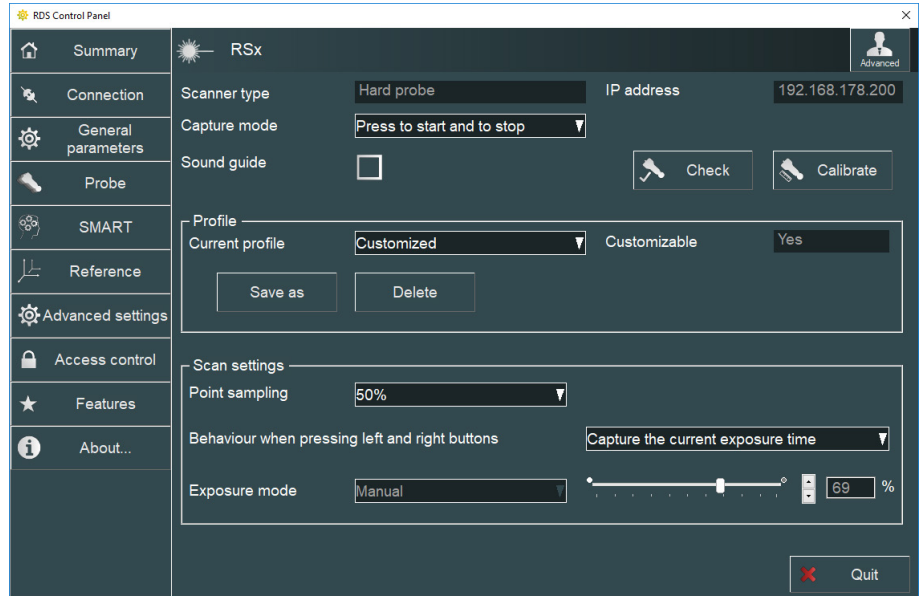
Running the Absolute Arm

1. Add an Absolute Arm to SA using the Add button on the Instrument tab. Select the correct Absolute Arm model and click Add Instrument (Figure 4-58).

Figure 4-58. Adding the Absolute arm to SA.
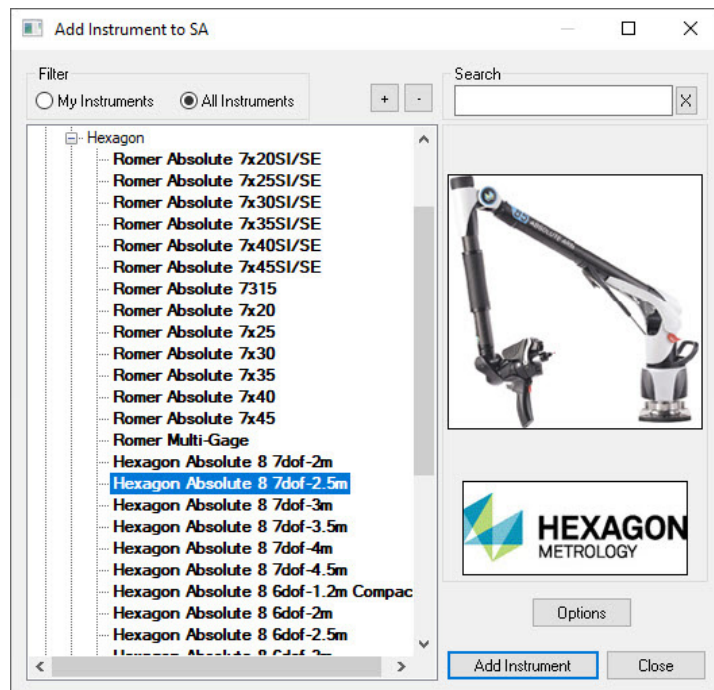
2. Run the instrument interface using the Connect button.

Most basic arm measurement operations are available through the instrument toolbar including point naming, single point and point scanning. It even includes right-click configuration (Figure 4-59).

Figure 4-59. Instrument Toolbar Controls

Multiple Arm Connections.

Beginning with RDS 6.4 there is now the ability to connect to multiple arms on the same computer through RDS. This is accomplished by selecting the Configure Instrument option in the SA CMM Log On dialog(Figure 4-60).

Figure 4-60. Configure Instrument control used to connect to different arms from within SA.
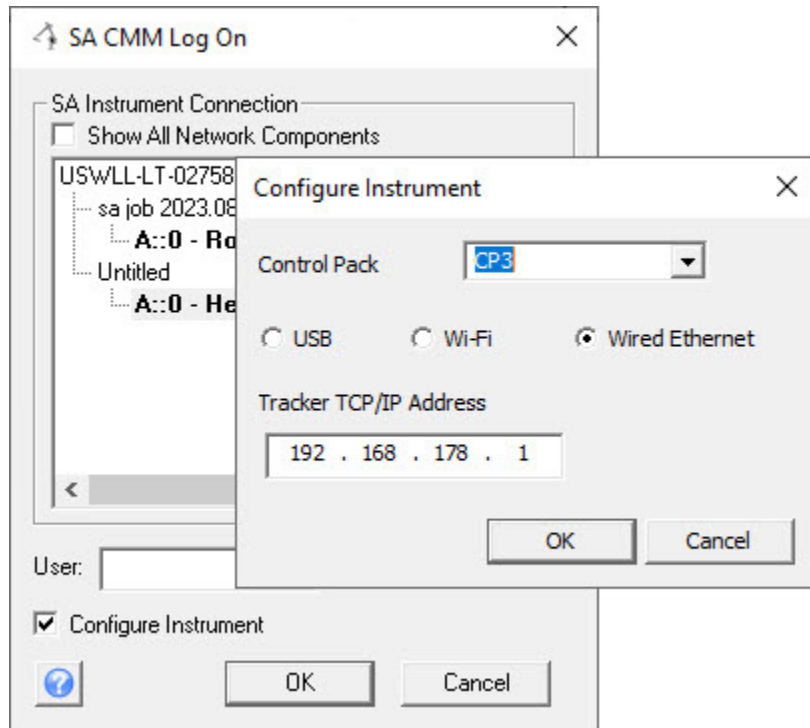
Note that if two or more arms are to be used for scanning they need to be on separate networks.

Scanning with the Absolute Arm (SI)

Scanning is as simple as sliding the switch on the back of the grip. As soon as the scanner is engaged the RDS Scanning control interface will appear (Figure 4-61). The "Previewing" window will be displayed as network communication with the scanner is established.

Figure 4-61. The RDS Scanning interface.
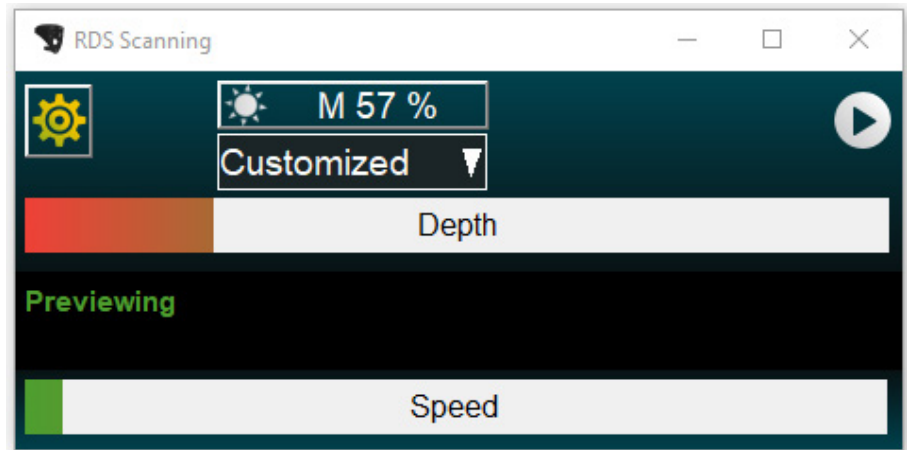
Additional Notes on Scanning:

There are a number of very important optional controls available within the arm interface's settings "Edit Arm Settings" on page 185.

- **Auto-Increment Names.** Cloud names can be automatically incremented by checking the option in the **Arm Settings> Fit/Meas Options.**

- **Auto-exposure.** An auto-exposure routine can initialized by pressing both buttons at the same time.

- **Proximity Triggers.** The scanner can be used to collect measurements in a particular location using **Instrument>Automatic Measurement>Auto Correspond with Proximity trigger>.** The choice of which mode to use is controlled in the **Arm Settings> Fit/Meas Option.**

Data thinning for RS6 and AS1 scanners

These newer scanners also require a newer arm firmware and RDS update. Check with the manufacturer on the correct firmware and feature pack for your system.

These scanners can send a lot of Data to SA very quickly which can lead to graphic performance problems. Generally the *Point Sample* within RDS can be turned down to its lowest setting. This reduces the number of points along a scan line which is often excessive unless trying to detect edges. The *Scan Speed* should remain as fast as possible (300Hz) in order to allow a user to move the scanner quick.

If you still have performance issues with these settings, further reductions in data density can be made within the Arm Settings in the SA interface.

- **Thinning Factor.** This provides a means to decrease the density of the scans sent to SA as needed.

- **Min Angle Filter.** This is a more advance filter option that con-

siders the curvature of a scan line. It offers a *Minimum Angle* threshold to thin data in flat regions, and a *Max* distance value which ensures some data is returned on wide flat expanses.

- **Voxelization.** Data can also be voxelized before sending it to SA which can greatly reduce noise.

Romer/Cimcore Arms

This Quick-start guide applies to all Romer/CimCore 6 and 7DOF arms.

Hardware Setup:

This arm is a USB connected device. Install the drivers before connecting the USB cable. Once installation is complete connect the cable and ensure that the power switch located on the arm is turned on.

Software Setup:

Download and install WinRDS (check the readme in your version of SA for the correct WinRDS version) which can be found here:

ftp://ftp.kinematics.com/pub/SA/Install/Driver%20Downloads/PCMM%20Arms/Cimcore/

Once downloaded, with the instrument disconnected, install the instrument driver, and reboot the PC.

Now connect the arm and turn the power on. When connecting via USB for the first time Windows will display the dialog in Figure 4-62.

Figure 4-62. The Hardware Update wizard.

Select Yes, this time only and press Next. Follow the prompts until the Hardware Update is complete.

If this dialog did not appear and the drivers have not been associated to the hardware, navigate to the windows "Device Manager".

Under "Device Manager" (Figure 4-63) locate the Cimcore USB Arm, then right click and select "Update Drivers". This will display the "Hardware Update Wizard" as discussed above. Follow the same directions as above.
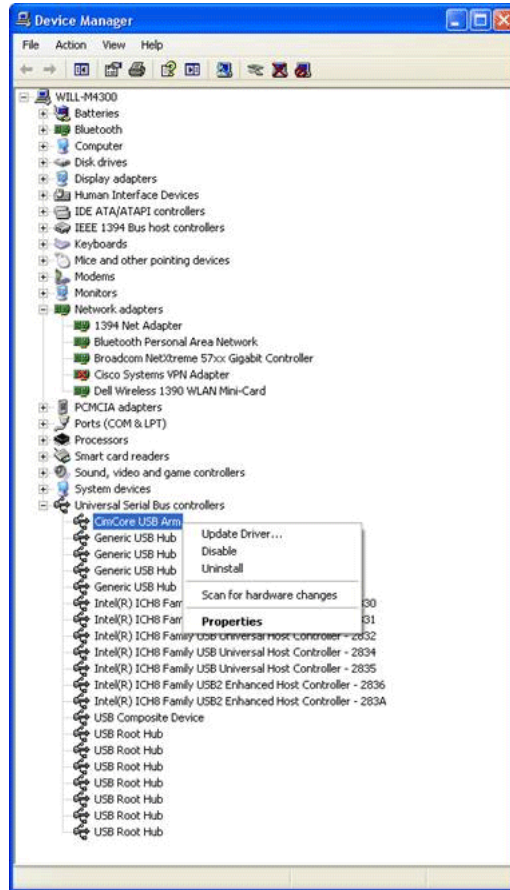
Figure 4-63. Device Manager.

Now that drivers are installed and the hardware is updated, test the connection by running WinRDS. Start>Programs>Cimcore>WinRDS >Cimcore Arm Utilities.

If the connection is working correctly, WinRDS will initialize the arm. Move the arm to until the below dialog is satisfied. Now that the connection has been tested close WinRDS.
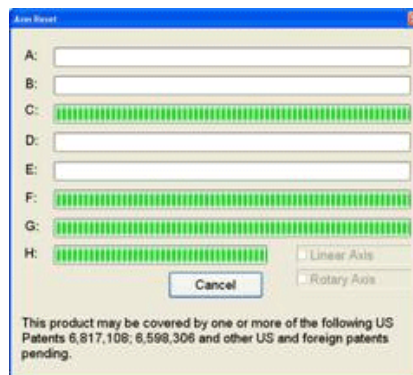

Figure 4-64. Exercising the encoders on the arm.

Running the Cimcore Arm in SpatialAnalyzer

Run the 'RomerPathSet.exe' utility located in the SA install folder. (e.g. C:\Program Files (x86)\New River Kinematics\SpatialAnalyzer xxx) This utility tells the interface where to look for the RDS dll's (If the path is not set, you may need to right-click and select *Run As Administrator*).

Connecting the arm for the first time in SA requires one extra step than usual. First add the desired Cimcore Arm by selecting Instrument>Add. Then select Instrument>Run Interface Module. Select the Portable CMM interface (Figure 4-65).

Figure 4-65. Starting the interface.
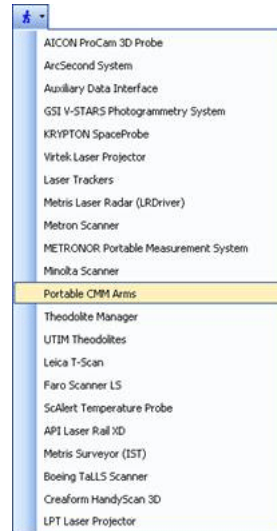
Select the instrument (Figure 4-66).

Figure 4-66. Connecting to the instrument.
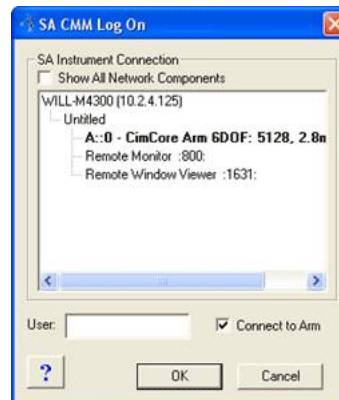
Once selected, a prompt will display asking for communication method (Figure 4-67). This step will persist the next time the interface is connected.

Figure 4-67. Choosing the communication method.
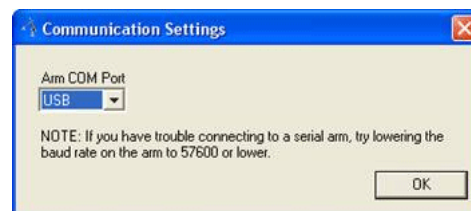
The next time connection is required, simply use the 🏃 icon to run and connect the interface module. The arm interface will display once connection is complete.

This Page Intentionally Left Blank.

Measuring With Total Stations

Theodolites and Total Stations connect to SA through the Theodolite Manager. This utility adds additional multi-unit controls necessary for theodolite use. It also provides direct access to the control pad for each instrument which provides the individual scope controls.

This chapter also covers the new Total Station interface built to streamline use of Leica robotic total stations.

Choosing an Interface

Spatial Analyzer 2022 introduced a new interface for Total Stations (Figure 5-1).

Figure 5-1. Choosing An Interface for Connection
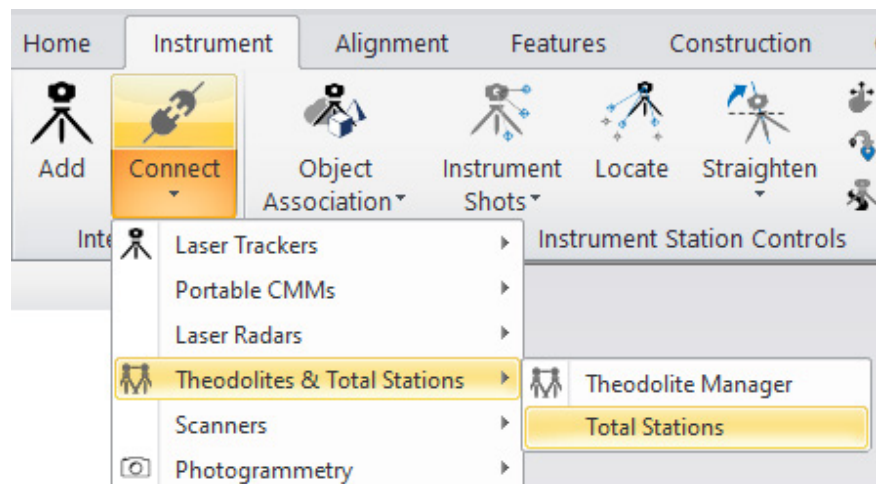
This interface is designed to simplify the connection and measurement process for a robotic total station applications. It much more like the controls a laser tracker user would be familiar with. It currently only supports Leica total stations that use GeoCOM communication protocol.

The Theodolite Manager was built with theodolite users in mind and offers specific capabilities needed for that application. Sokkia total stations are also supported through the theodolite manager.

- "Theodolite Manager" on page 218
- "Total Stations Interface" on page 280

Theodolite Manager

Theodolite manager provides a solution for interfacing a wide range modern digital theodolites and total stations to SpatialAnalyzer. This chapter covers both an overview of general operation and a selection of Quick-Start guides for instrument specific details and connection requirements (see "Theodolite and Total Station Quick-Start Guides" on page 234).

Figure 5-2. A job containing theodolites.
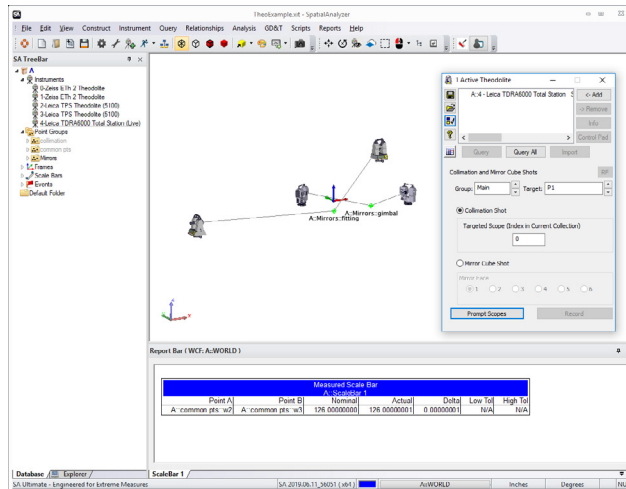
An image of an example SpatialAnalyzer job with Theodolites is shown in Figure 5-2. The instruments are shown with measurements and a scale bar. The actual distance between the scale bar points is shown with a Point Comparison callout view.

Cabling and Power Options

Fundamentally, communication to all current digital theodolites is done through a serial link. However, over time, different instrument manufacturers have selected slightly different flavors of serial communication to talk to their instruments. Some units use TTL (Transistor-Transistor Logic) level signals, but otherwise essentially follow RS-232 protocols. Additionally, some instruments require 6 volts for power, others 12 volts and still others 4 volts. Because of this non-uniformity among manufacturers some special cabling is usually required for a specific instrument.

Direct to the Instrument

This way of cabling an instrument is really most useful for applications where a single Total Station is to be used or where a limited network is configured. In this case, the instruments may be plugged directly into the computer or to a power augmenting device supplied by the instrument manufacturer. Most manufacturers supply cables and power units for this purpose.

Using a Serial Distribution Interface (SDI)

In instances where a user wishes to use a network of theodolites cabling issues for power and signals can become a major annoyance. The SDI unit manufactured by Brunson Instrument Company addresses these issues, by providing a simple USB device that provides all instruments with power and digital signals while still maintaining common cabling for each instrument. This is accomplished by using a signal conditioning device embedded in the Theodolite Junction Box in the last few feet of the cabling. The Theodolite Junction box performs three primary tasks:

- It alters the signal to levels suitable for each instrument.

- It provides a convenient "trigger" button remote from the instrument itself.

- It provides a junction point to which a short, theodolite-specific cable can be attached. This cable is necessary since there is no standard connector for all makes and models of theodolites.

Adding a Theodolite to an SA Job

Just as with other instrumentation in SA, the first step is to add the desired instrument to the SA job. This is done by selecting **Instrument>Add** from the main menu. Now you need to start the corresponding instrument interface. This can be done from the Operating System Start-Bar, or by selecting **Instrument>Run Instrument Module** from the main menu. After selecting the appropriate instrument, you will see the initialization dialog pictured in Figure 5-3.

Figure 5-3. The Theodolite manager setup buttons.

These three buttons allow you to either make a new configuration of instruments, recall the last configuration, or recall a stored configuration by name. The first time you run the software you must make a new configuration.

You will then see the main *Theodolite Manager* dialog (Figure 5-3).

Figure 5-4. The Theodolite Manager.

The following sections will describe each component of the interface by section.

The area appearing as a large blank region is a listing of all active instruments being managed by this instance of the theodolite manager. It is possible to have multiple versions of theodolite manager tied into the same SA job at once.

Figure 5-5. The control buttons.

The control buttons (Figure 5-5) allow the operator to perform global tasks related to Theodolite Manager. In order from top to bottom these buttons provide the capability to save a Theodolite Manager configuration, recall a configuration, set user options for a configuration, and view information about Theodolite Manager.

Figure 5-6. Buttons for managing the instrument list.
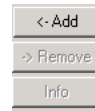
The buttons to the right of the instrument list are used to manage the instrument list (Figure 5-6). Here the user may add, delete, or display information about a specified theodolite connection.

The buttons at the bottom of the dialog allow a user to poll the instruments connected to Theodolite Manager (Figure 5-7). The top two only poll specifically highlighted instruments in the instrument list. If none are highlighted the buttons are deactivated.

Figure 5-7. Instrument polling buttons.

To add an instrument, click the Add button. A progress bar will display briefly while Theodolite Manager scans for available communication ports. The **Add Instrument** dialog will then appear (Figure 5-8).

Figure 5-8. The Add Instrument dialog.
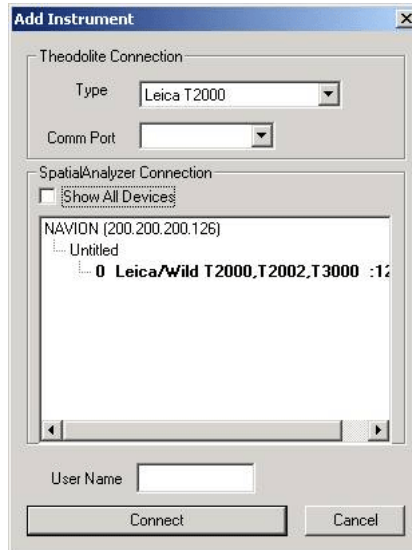
In the Theodolite connection area of the dialog users select the desired theodolite and its corresponding communications port.

The operator must then identify which SpatialAnalyzer job and which instrument within that job it corresponds to. By default the dialog limits its display to compatible and available instruments in all jobs on the network. If the show all devices checkbox is checked all instruments and SA jobs on the local network are displayed. The operator must simply highlight the desired instrument.

The operator also has the opportunity to optionally enter the user name for the operator of this instrument. If no name is given the instruments will be referred to as Station1, Station2, etc.

Once all selections are made the operator may click the Connect button. At this time the instrument is initialized and an item is added to the instrument list.

In this case it identifies that SpatialAnalyzer Instrument 0 (SP0) is a Leica T2000 connected to serial port Com4. After adding a second instrument the display might appear something like Figure 5-9.

Figure 5-9. This theodolite manager setup has two instruments added.
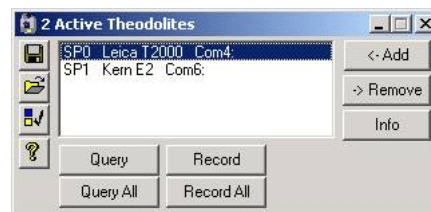
Notice that in this case we have highlighted one of the instruments and the other buttons in the interface have therefore been activated. Multiple highlights are possible and are accomplished using the standard windows selection methods of holding down either **Ctrl** to add select, or **Shift** to region select multiple instruments.

To demonstrate that the instruments are now connected, move the instruments to a new position and click the Query All button. You should see all the instrument move to their actual azimuth and elevation in SA.

Measurement Modes

Theodolite Manager allows operators to use theodolites in one of three primary measurement modes. These modes have been established based on a survey of common methods for applying theodolites. Some industries or applications may exclusively use one method while still others will vary their selection with each task at hand.

To change Measurement modes, click the User Options ![icon] button. The dialog in Figure 5-10 will be displayed.
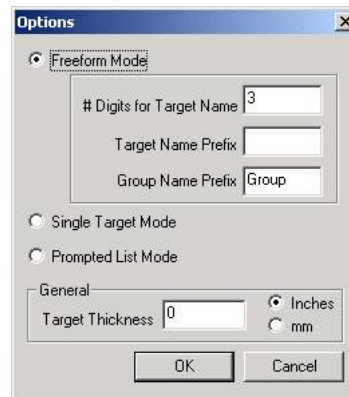
Figure 5-10. The Theodolite Manager's User Options.

The **Target Thickness** section will apply to all measurement modes. This is simply the target thickness (probe offset) used in SA for various analysis tasks such as point to surface queries.

Freeform Mode

The Freeform measurement mode is really designed for experienced crews who want and have the ability to enter target numbers at the theodolite. By far the biggest collection of these users are experienced operators of Leica T2000, T2002, and T3000 series theodolites. However, this methodology applies to other instruments as well. Newer Leica instruments and Zeiss Eth-2's for example, can use this method.

In freeform mode it is always necessary that the operator set the target number on the scope before recording. Recording may be accomplished at the instrument or the interface as desired.

Since SA uses both Target Names and Group Names the strategy employed is to arbitrarily divide the number into a group component and a target component. Several examples will be presented below to further illustrate the concept.

With the following settings (Figure 5-11):

Figure 5-11.

the target numbers would convert to:

Target Number	Group Name	Target Name
1000	Group10	Tar00
2505	Group25	Tar05
2833	Group28	Tar33

With the following settings (Figure 5-12):

Figure 5-12.

The target numbers would convert to:

Target Number	Group Name	Target Name
1000	Fender1	T000
2505	Fender2	T505
2833	Fender2	T833

Single Target Mode

This mode is often used when building operations need to be performed or when a novice crew needs to be guided through the measurement process. The basic premise is that all theodolites will typically shoot the same target at the same time. This is particularly helpful for inexperienced users since sighting errors can be immediately identified and corrected.

After enabling the Single Target Mode in the user options dialog, the interface will appear as pictured in Figure 5-13.

Figure 5-13. Single Target mode.

Note the extra section added to the bottom of the standard dialog. This enables users to enter alphanumeric group and target names. When the Prompt Scopes button is hit, the theodolites will display the desired target to prompt the scope operators to point at it. Any incrementing or decrementing of the group or target name will auto-

matically update the instrument prompts. Recording may be accomplished through the standard user interface or by hitting the record button on the theodolite or its corresponding Theodolite Junction Box.

Prompted List Mode

This measurement mode is designed for tasks where the desired survey points are known right from the start. These names may either come from a CAD file, an ASCII file or may be entered at survey time by the operators.

When the Prompted list interface is initiated, the user interface appears as in Figure 5-14.
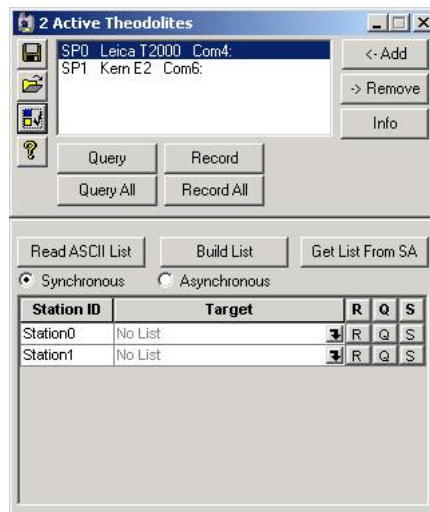
Figure 5-14. Prompted list mode.

Alternatively, if user names were entered as the instruments were added, this dialog might appear as in Figure 5-15.
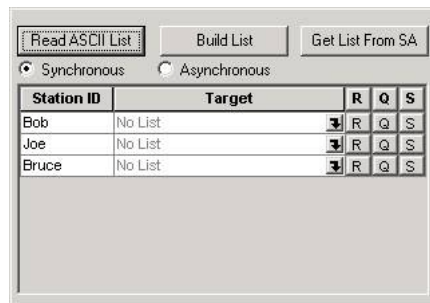
Figure 5-15. User names in the dialog.

In this mode, each instrument has it's own list of targets to be surveyed. This list may be created on the spot using an ascii editor such as notepad, or by using the Build List option. Or it may be read from an existing file with the Read ASCII List option. Alternatively the user may hit the Get List From SA button and they will then be prompted in SA to select points. All points are identified by both group and target names with the following format (group::target).

When the Build List button is hit, the operator sees the Construct Target

List dialog (Figure 5-16).

Figure 5-16. The Construct Target List dialog.
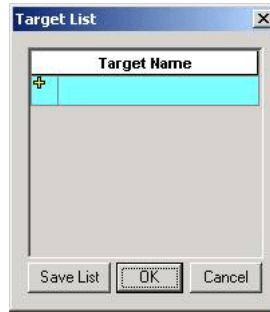
By typing a "group::target" name in the green field and hitting enter a new target is added to the list.

After several are entered our list might appear as follows (Figure 5-17).


Figure 5-17. Targets have been added to the list.
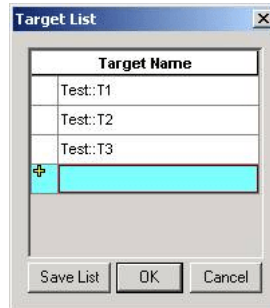
Clicking OK will retain the list for this job. Clicking Save List will allow the operator to specify a filename so that this may be recalled later (always a good idea).

Returning to the main dialog, we see that the instrument list now has two lines. One line corresponding to each instrument station (or user).

Figure 5-18. Record, Query and Skip controls.
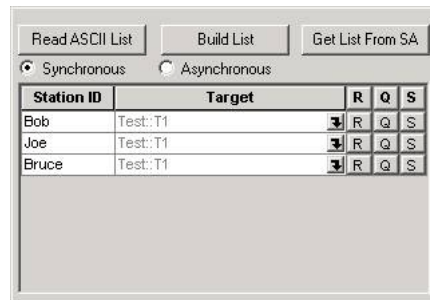
The buttons to the far right hand side in each row allow the operator to Record-R, Query–Q, or Skip–S a specific instrument (Figure 5-18).

The second column is the current target for a given user. When the dialog is first presented this column displays "No List" since a target list has yet to be loaded. After the target list is loaded, this column will display the current target for each instrument.

In Synchronous mode all instruments will be prompted to shoot a specific target. If an operator cannot see the target, plunging (pointing the scope downward) causes the shot to be skipped when the re-

cord all button is pressed. As each operator acquires data, they will be prompted to "Wait". When the last theodolite acquires data, all scopes will be prompted with the next target name. In Asynchronous mode all operators may proceed through the list at their own rate.

A target hot-spot box to choose the current target for that scope (more about that later). To the right are buttons for Record, Query, and Skip.

The down arrow in the second column is called the Target Hot Spot Control. The target hot spot pops up the target list for each instrument. When you hit the hotspot you get the list at right.

This is similar to the building list except the user cannot add new targets and the left column displays target status for that particular instrument.

The left column presents icons to indicate state of the target (Shot, Skipped, UnShot). The bold item is the current target for that user. You can click select what target you want to shoot next, and then either continue from there or (optionally) only prompt skipped or undone targets. When you shoot or skip the scope will proceed to the next target in the list. In Asynchronous mode all scopes use the same list but can progress through them at their own pace, skipping as required, and going back as required. Note that the operator will not normally view the list in this way, normally they would view all this information in the main dialog. The list is just a control to allow the user to move around the job freely.

Theodolite Data Observer

Theodolite Data Observer is activated from SA's Instrument menu. This dialog makes it easier to drive Theodolite systems from the graphic view in SA. The interface is shown in Figure 5-19.
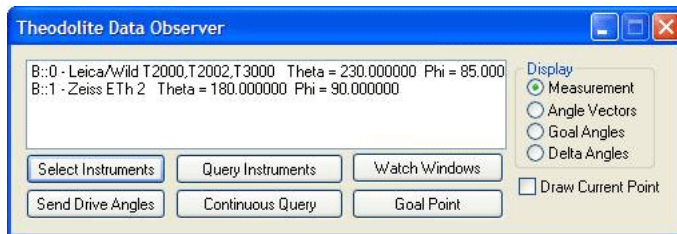
Figure 5-19. Theodolite Data observer.

This interface allows the display of Measurements, Angle Vectors, Goal Angle, and Delta Angles. Each view of the data is applicable for different applications. Use the Select Instrument button to choose the instruments to control from this control. Select the desired Goal Point then Send Drive Angles and Watch Window options to setup a real-time graphical build mode for the currently selected instruments. Continuously Query will repeatedly record angle measurements from the instruments. This mode is important for tracking the

theodolites movements through a measurement process.

Using Theodolites in SA

Survey Preparation:

Considerations for proper theodolite station setup include:

- Set up the theodolites ensuring they have an unobstructed line of sight to the point of interest.

- Try not to have extreme acute or obtuse apex angles between the two instruments. Two rays to a single point that are approximately 90° will solve for a much more accurate point.

- Since the bundle adjustment algorithms use the current locations of the instruments as a starting guess, it is best to "rough" position the instruments. To do this, either enter the instrument transformations manually, or use the Drag Instruments function from the Instruments menu. It is best to place the instruments near their final location, as this will speed the bundle solution. (See "Local Minima" in the Additional Info section)

- If using theodolites with level compensators, you will use the option to force instrument vertical during the bundle adjustment. If this is the case, the virtual instrument models should be perfectly parallel to each other before initiating the bundle adjustment.

- Setup the instrument following the manufacturer's directions.

- Be sure the device power is on.

Figure 5-20. Theodolite Network
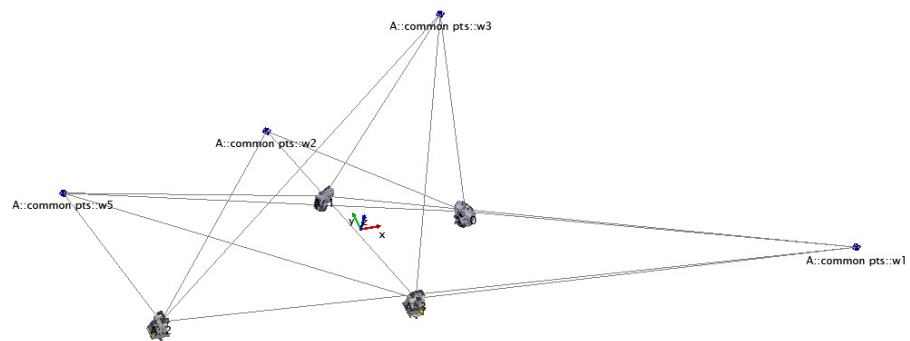
Measuring Points

Now, with the theodolites set up properly, have each instrument record each point. The key here is to have multiple instruments record an observation with the same point name in the same point group. After all common points are shot, each point should have at least 2 measurement details in its point properties. Note: If a point has two

measurement details from two different instruments and one instruments line of sight intersects with the other, SA will solve for a point. This point may or may not be close to where the actual point should be depending on the orientation of each instrument.

Collimation

Collimation is the process consists of making rays from two instruments accurately parallel to each other. Using SA, this is done by having two theodolites measure the face of the other. Collimation can be useful when needing to align multiple theodolites to each other without having a common reference system. This application is more suitable for evaluating angles, due to the fact that he distance is unknown until its input manually by the user. Preparation for the collimation of theodolites is not as involved as bundle adjust, but can be just as useful.

- So after having each theodolite measure the others face, ensure that those points were named the same so that there are two measurement details for that observation.

- Now open the measurement details and double-click one of the point observations.

- In the "Spherical Measurement" dialog box select Advanced Options.

- There select Collimation Shot and pick and instrument. (Choose the instrument that was measured in that observation NOT the instrument that did the measuring)

- Click OK and then repeat for the second observation.

- See visual aid below (Figure 5-21).
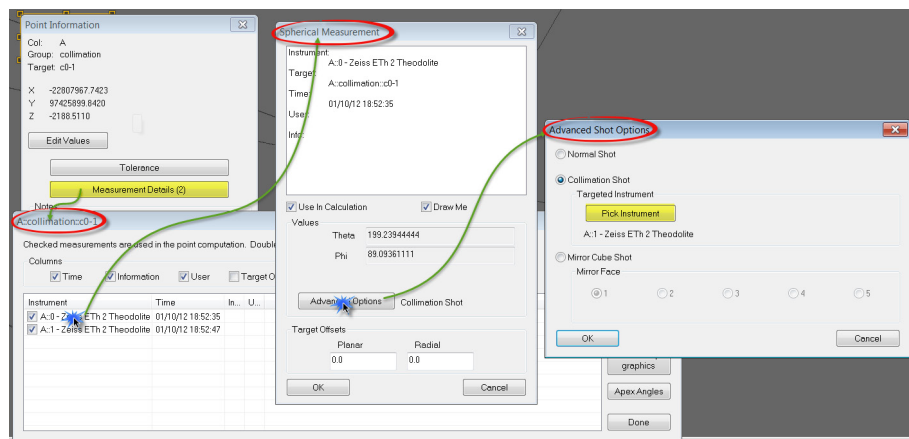
Figure 5-21. Measurement Details

Now that the collimation points have been established you are now ready to collimate the instruments. To do this select **Instrument>Collimation**. The dialog box shown below will be displayed.

To collimate the instruments to each other, a distance is needed.

There are a few options, but in its most basic form you know the approximate distance between the instruments and it can be input here manually (Figure 5-22).

Figure 5-22. Instrument Collimation Options
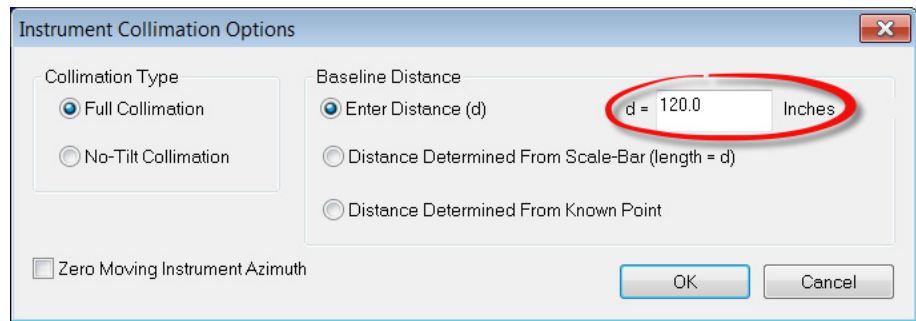
Selecting OK will prompt SA to align the instruments based on the collimation shots and the distance between the two instruments.

A line for each line of sight will be created which should be 180° from each other. If there are more than two instruments you can repeat these steps making. (Follow Inst0 to Inst1, then Inst1 to Inst2, then Inst2 to inst3, so on and so forth for additional instruments).

The collimation Type select offers two options for greater control:

- **Full Collimation.** This option will perfectly align the collimation shots.

- **No-Tilt Collimation.** Collimation can be performed while holding gravity. This option will align the shots as well as is possible while holding the instrument Rx and Ry orientations.

There are 3 baseline methods available for collimation:

- **Enter Distance (d).** Provides a means to enter a know distance between the instruments. The selected instruments are aligned using the collimation shots and this entered value.

- **Distance Determined From Scale-Bar (length=d).** This method assumes that the distance (d) is the length of a measured scale bar. Collimation is computed based upon a common collimation shot and two measured points that define the scale-bar location and distance based on the given length.

- **Distance Determined From Known Point.** The 3rd method still used the collimation point for alignment but establishes distance and orientation based upon a know point in space with respect to the non-moving instrument. The measurement of this known point from the moving instrument along with the collimation shot is used for alignment.

The Instrument Collimation dialog also offers an option to **Zero the Moving Instrument Azimuth**. This option requires a live instrument connection, and when selected, will zero the instrument's Azimuth value

based upon the collimation shot-line.

Mirror Cubes

Definition

When using a mirror cube to aid in a bundle adjustment one must know the face definitions (Figure 5-23).
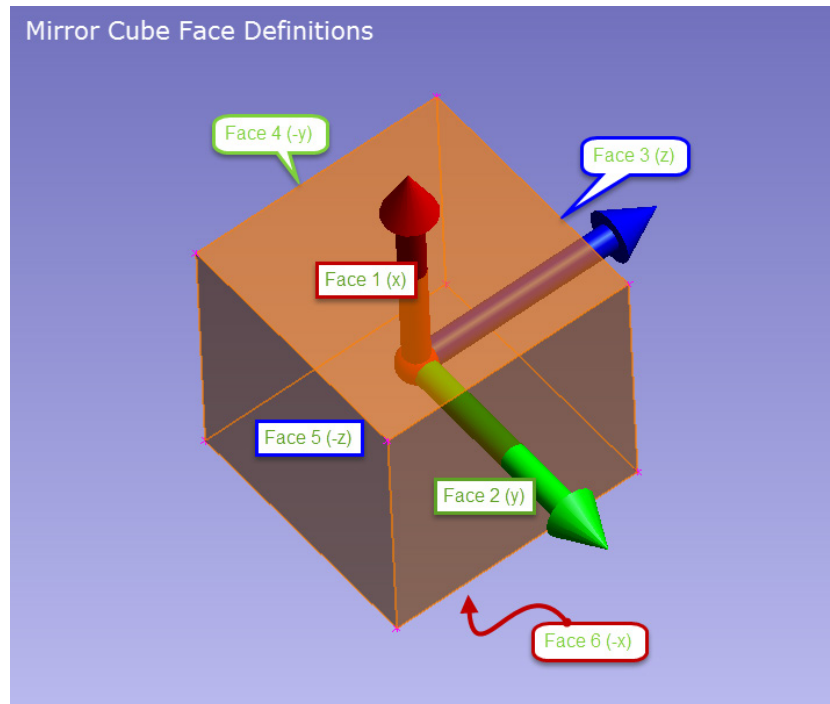

Figure 5-23. Mirror Cube Face Definitions

- **Mirror face 1.** Is the top of the cube, opposite the bonded surface (Face 6) and defines the positive X direction of the mirror cube frame.

- **Mirror face 2.** Is 90° to face 1, and defines the positive Y direction.

Once face 2 is defined the numbering of the rest of the faces moves counterclockwise around the cube, when looking at face 1.

- **Mirror face 3.** Defines the positive Z direction.

- **Mirror face 4.** Is opposite face 2 and defines (-Y).

- **Mirror face 5.** is opposite face 3 and defines (-Z).

- **Mirror face 6.** Typically glued to a surface, is opposite face 1 and defines (-X).

Using Mirror Cubes

Though it can be a bit tricky aligning the theodolites to the faces of the mirror cube, the idea is to align a theodolite normal to one face of the mirror cube. Then set up another theodolite normal to a face that

is 90° from the face the previous instrument aligned to. In addition to each theodolite measuring the mirror cube and naming those shots the same in the same point group, you will also need to change the point properties from normal shots to mirror cube shots (Figure 5-21).

To change the point properties, double-click the point in question in the tree. Then click on "Measurement Details". There should be two measurement details, one from each instrument that measured the mirror cube.

Then single-click the first point in the list and click properties. The window below will then be displayed (Figure 5-24). In this window you want to click "Advanced Options", where you will be able to select mirror cube shot and what face of the mirror cube was measured using the aforementioned face definitions (Figure 5-23). Repeat these steps for the other mirror cube shot.

Figure 5-24. Defining Observations as Mirror Cube Shots
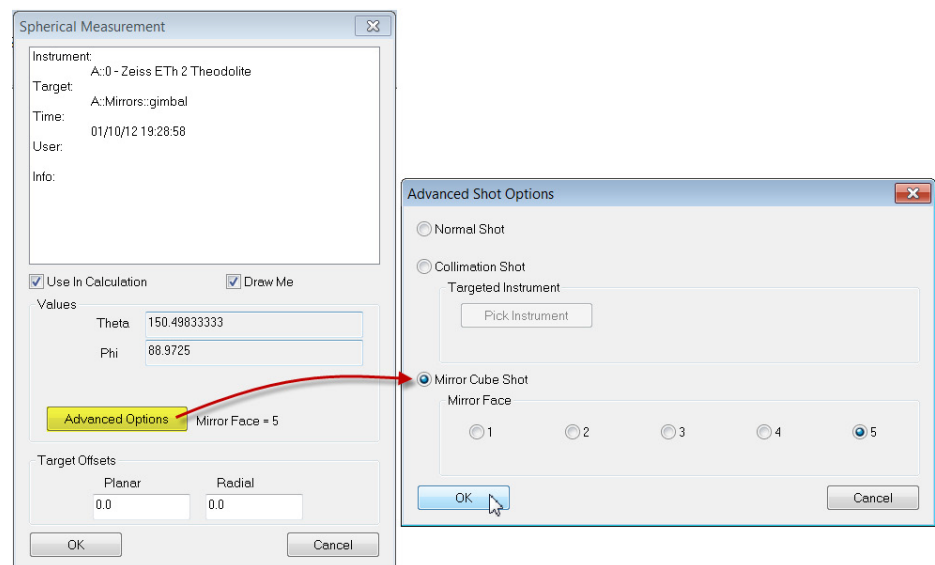
Scale Bars

Adding a Scale Bar

After measuring the necessary points, the user should create a scale bar. For instruments that measure angles and distances, it is not necessary to use scale-bars in the bundle process but they are required for theodolite networks. Without them, the instruments will scale freely. To do this you will need to utilize two points that have a known distance from each other. They can be two points designated only for the scale or common points, but either way they need to be recorded from the theodolite before the scale bar is created. Once you have the actual distance select **Construct > Scale Bar > Pick 2 Points**. At this point, select the two points that you just measured the distance between. The window below will appear (Figure 5-25). Select edit to change the length to the actual measured amount. After hitting ok

the new length should populate. You should also notice that a scale bar is now listed in the tree bar.
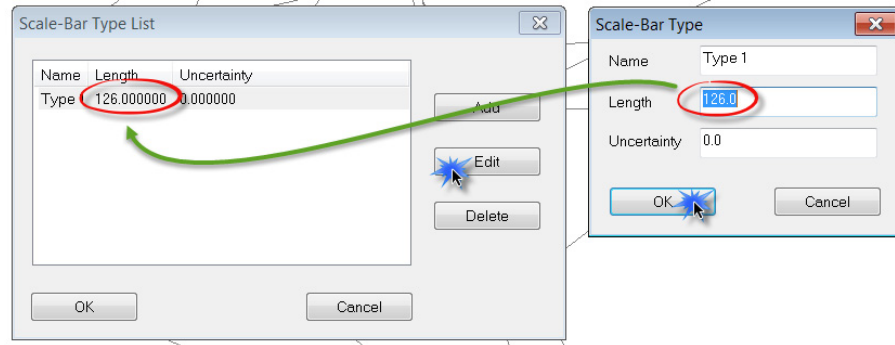
Figure 5-25. Scale-Bar Type List

Bundle Adjustment

Now with the common points observed and the scale bar created, a bundle adjust can be performed.

Mirror Cube Frame Construction

At this point, you can now begin to create the mirror cube frame. Go to **Construct > Frames > Mirror Cube**. You will be prompted to select the mirror cube point. After making that selection, the window below will be displayed (Figure 5-26).
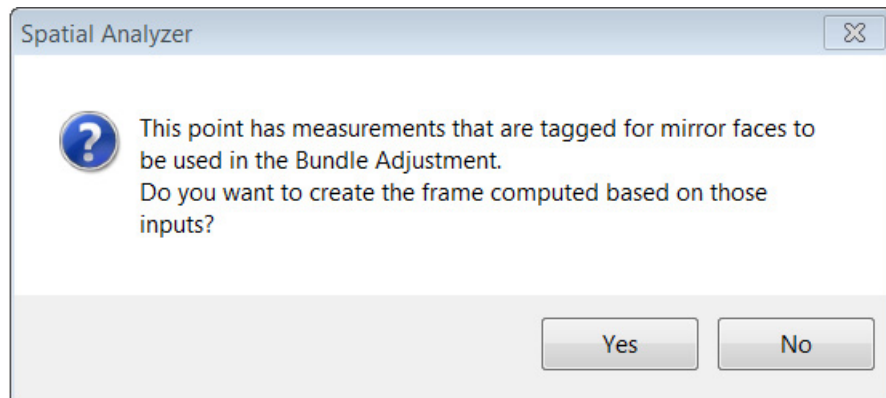
Figure 5-26. Frame Creation Prompt

Choosing "Yes" will prompt SA to create a frame based on the current alignment of the two instruments to the mirror cube. Choosing "NO" will allow you to change the properties of the frame which can be done in the window below (Figure 5-27).

Figure 5-27. Mirror Cube Frame Dialog
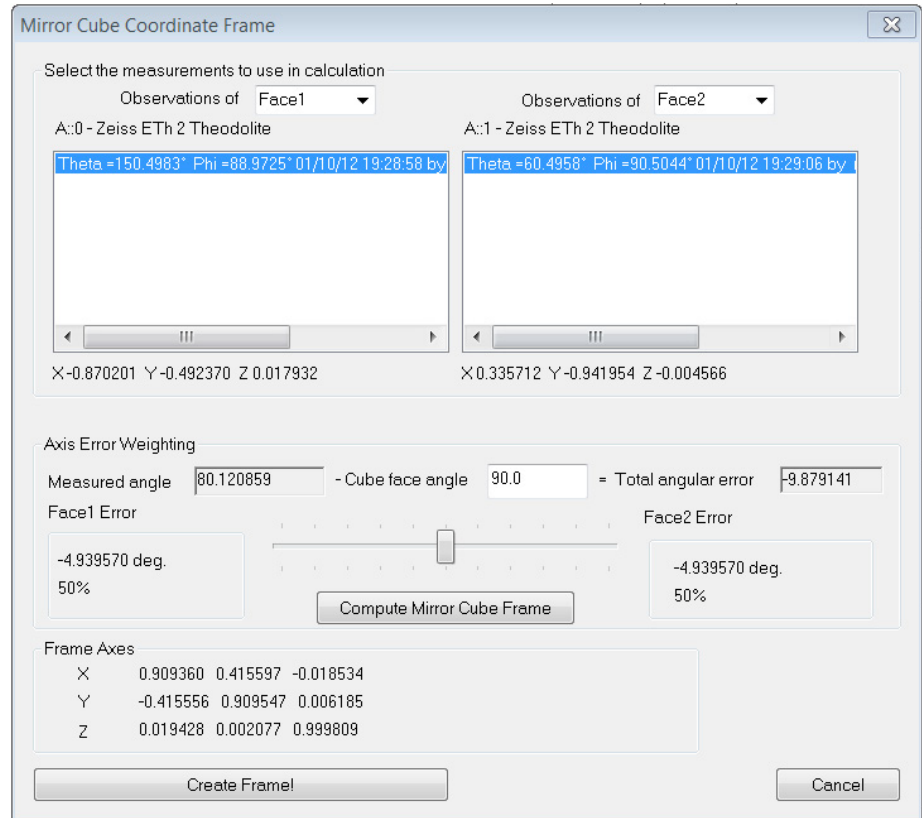
In this dialog the user is presented with some possible options.

- You may select which instrument represents the X-axis of the coordinate frame.

- You may select or deselect specific shots from each instrument. When there are multiple shots, their vector directions are averaged to calculate the vector displayed below the measurement box.

- The check box for coordinate axes determines whether the axes of the frame are outward along the theodolite vectors or inward toward the theodolites.

- The axis weighting box allows you to control the distribution of the errors between the two axes.

- Set the cube face angle (normally 90 degrees). Press "Compute Mirror Cube Frame" after doing this update.

- The difference between the cube "ideal" angle and the theodolite vector angle will be displayed.

- Use the slider bar to control how far the frame axes are away from the theodolite axes. Sliding the bar to the left places more of the error on the "right-side" instrument.

- Choose carefully when distributing the error. In some cases, it may be better to have no error on one axis since it is difficult to

> tell if the "error" is coming from the theodolite measurements or the mirror cube itself.

Once you are satisfied with the frame information, you can select "Create Frame!". This will construct a frame on the mirror cube measured point utilizing the parameters that were set.

Total Station Prism Constants

Prism constants are defined differently by Leica than for all other manufacturers. They use a default reference prism with an absolute correction of -34.4mm as the reference. This means that:

Leica Constant = Absolute Constant +34.4mm

If you are using prisms from different manufacturers you will need to be careful to identify if the reported constant is a Leica or Non-Leica constant and adjust the definition accordingly.

SA's Sokkia interfaces expect you to enter the Absolute Constant while within the Leica Interface we expect the Leica Constant. This means that an open air corner cube will have a zero constant in the Sokkia interface and a 34.4mm offset in the Leica interface.

Theodolite and Total Station Quick-Start Guides

Leica Total Stations:

- "Leica TCRP and TS-Series" on page 235
- "Leica TDRA6000 and TS30 Total Station" on page 244
- "Leica Nova (MS60, TM60, TS60) and Leica Viva (TS16)" on page 254

Sokkia Total Stations:

- "Sokkia Net1" on page 270

Leica TCRP and TS-Series

Establishing Bluetooth Connection on PC

Use the Bluetooth wizard installed on the PC to create a new connection (Figure 5-28). Be sure the Leica 1203+ is powered on.

Figure 5-28. The Bluetooth Settings window.
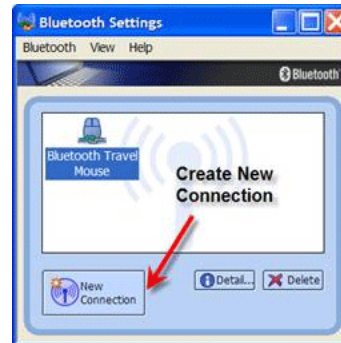
The Bluetooth wizard will search for the device (Figure 5-29).

Figure 5-29. Adding the new connection.
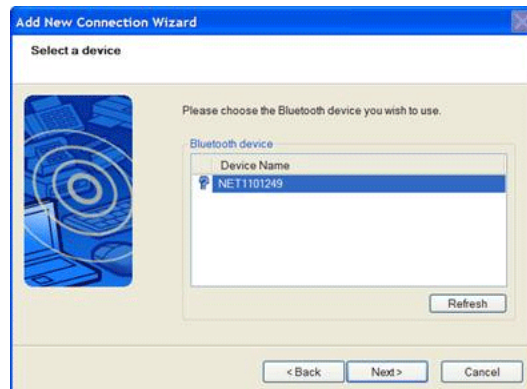
The Bluetooth manager will complete the connection and display the COM number being used. Remember this number as it is needed inside of SA to establish connection. If prompted for a password just use "0000".

Figure 5-30. This instrument is set up on COM4.
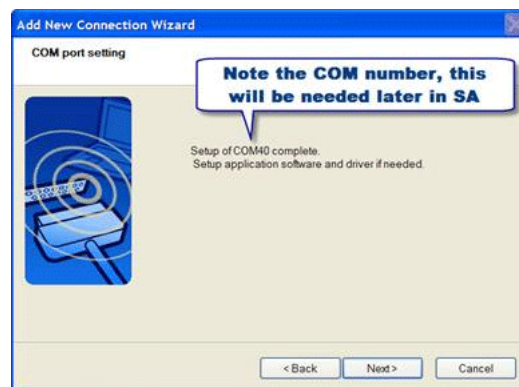
Now the Leica 1203+ is a recognizable connection for Bluetooth. Each time the Leica 1203+ is powered the user must enter the Bluetooth manager and activate the connection (Figure 5-31).

Figure 5-31. Activating the connection.

Starting the Interface

1. Select **Instrument>Add** and choose the Leica Total Station (TS3X, T120x) from the Instrument List.

2. Now run the instrument interface module under **Instrument>Run Interface Module** and choose **Theodolite Manager**.

3. Select New Setup and then Add (Figure 5-32).

Figure 5-32. Creating a new setup.
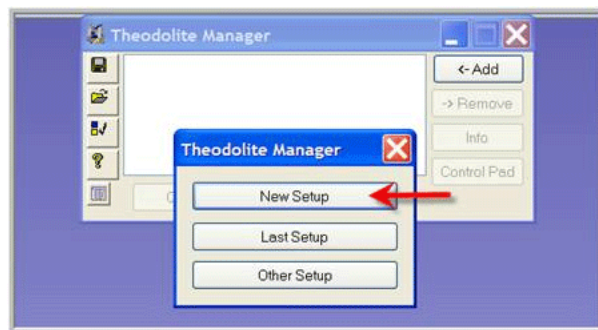
4. Select the instrument type and the COM Port. Then select the instrument in the available SpatialAnalyzer list and click Connect.

Figure 5-33. Connecting to the instrument.
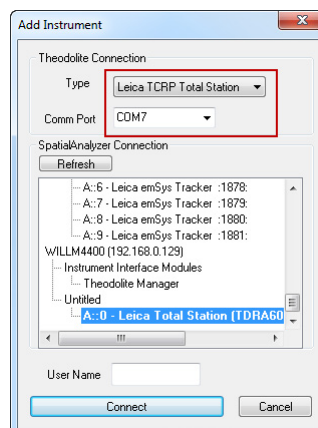
The Interface

Figure 5-34. The total station interface.
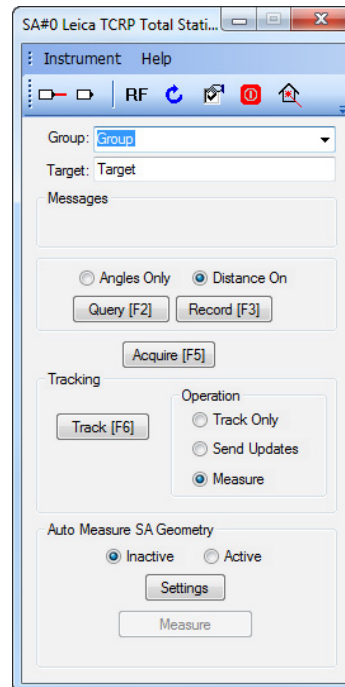
Toolbar

- Laser beam on
- Laser beam off
- RF Reverses the face of the instrument
- ↻ Displays rotation dialog for manual entry of rotation values
- Displays the user options
- Shuts down the instrument
- Opens the reflector database

Group and Target

Defines the Group name and target name for the measured point. If the measured point is recorded from the instrument it will do one of two things:

- If in Freeform Mode it will decode the instrument target based on the parameters in the Theodolite Manager Options (Figure 5-35). For example, if the Target name is 32 on the instrument, when recorded in SA it will be Group3::2 per the below settings.

237

Figure 5-35. Freeform mode.
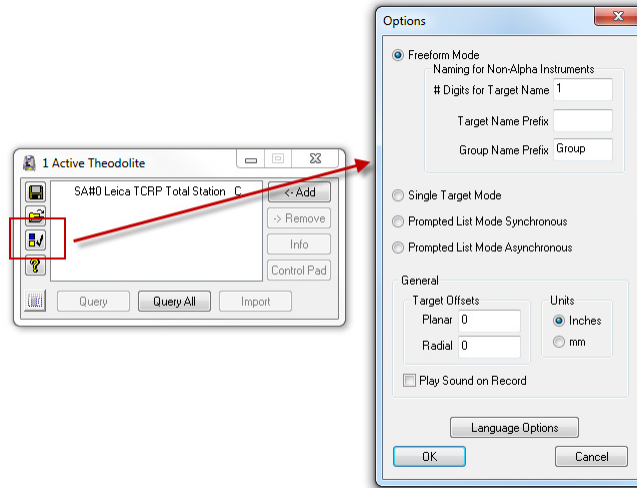
- If the Theodolite Manger options are set to Single Target Mode, the prescribed point name in the SA interface will be used.

Messages

The message dialog will notify the user if a measurement or process encounters an issue. The message will clear automatically or right-click the message.

Figure 5-36. An error message.
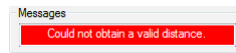
Query and Record

Query will send updates only to SA. If you wanted to update a watch window, you use Query. Record will send a measured point to SA (Figure 5-37). See above section regarding point naming if recorded from the instrument.

Figure 5-37. Query vs. Record.

Acquire

Acquire [Acquire [F5]] will use the Leica ATR functionality to lock onto a target. This is especially useful for Prisms and Tape targets. Point the instrument close to the target and press acquire. ATR will find the best center for the target.

Tracking

With the instrument locked onto a prism, tracking can be used. Select the desired options and press Track (Figure 5-38).
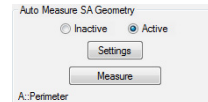
Figure 5-38. Tracking.
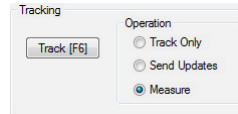
Track only will do exactly what it says, it will only track the prism and not send updates or measurements. Send updates is like query, but used for sending updates to SA while tracking. Measure will send measurements to SA while tracking.

Auto Measure SA Geometry

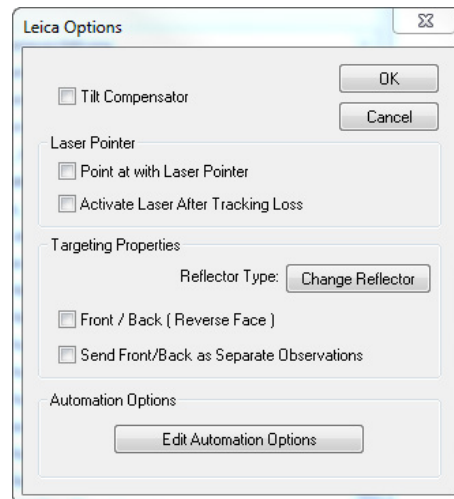**Figure 5-39.** Auto-Measure settings.

User Options

The user options (Figure 5-40) can be accessed by using or by **Instrument>Options**.

Figure 5-40. The instrument options.

- **Tilt Compensator.** Turns the tilt compensator on and off. If on, the instrument must be level in order to measure.

Laser Pointer

- **Point at with laser pointer.** When the SA command "point at" is executed the laser will turn on.

- **Activate Laser After Tracking Loss.** When the tracking stops because the line of sight as been broken the laser beam will turn on.

Targeting Properties

- **Change Reflector.** Choose the desired reflector type. For prism, the user has the option of adding Planar and Radial offsets in addition to the Prism Constant. For prism and tape targets, the ATR can be used if desired when a point is recorded.

- **Front/Back (Reverse Face).** When checked, a back sight measurement will be taken with each front sight measurement

- **Send Front/Back as Separate Observations.** When a front/back sight measurement is taken, if checked, they will be stored as separate observations.

Perimeter Scanning

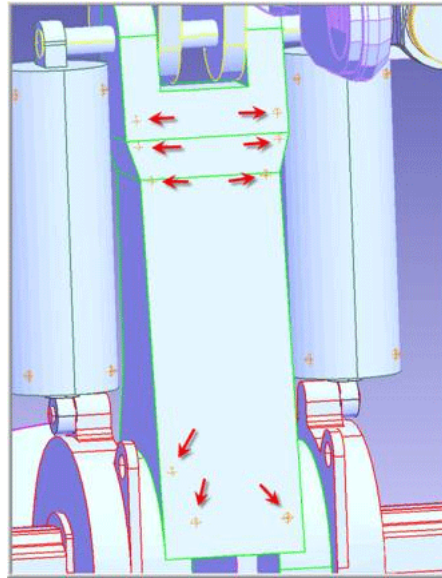1. Measure points defining the area to scan (Figure 5-41).

Figure 5-41. Perimeter points.

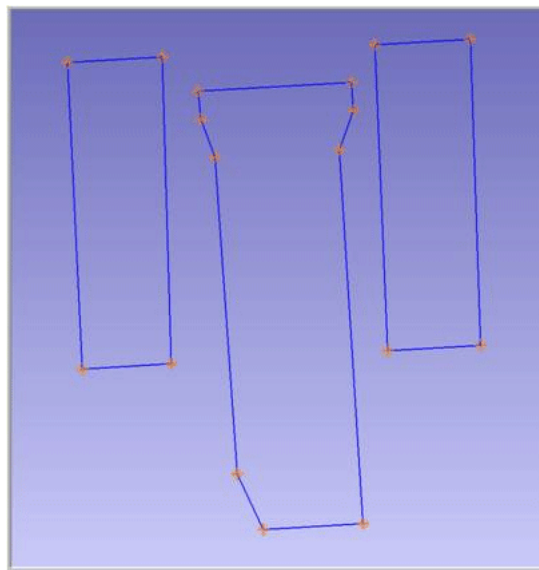2. Construct a perimeter from the measured point in SA under **Construct>Perimeter** (Figure 5-42).
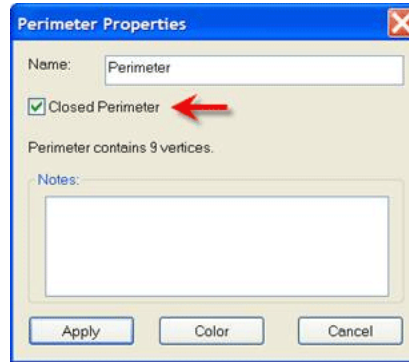

Figure 5-42. Defined perimeters.

3. Two types of perimeters exist in SA, open and closed (Figure 5-43). A single perimeter can be changed from open to closed in the perimeter properties dialog.

Figure 5-43. Marking a perimeter as closed.

4. Set the scan properties for the appropriate perimeter. If the perimeter is closed the scan will be bounded by the perimeter. If it is open, the scan lines will be perpendicular to the perimeter.

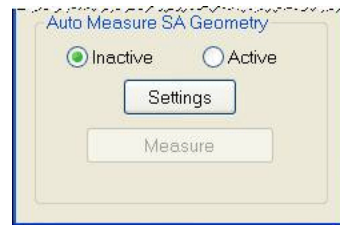
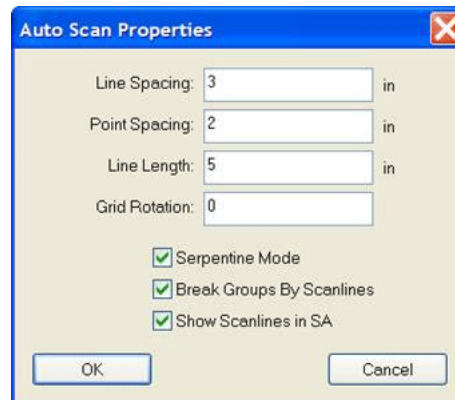**Figure 5-44.** Auto Measure SA Geometry settings.

Figure 5-45. Auto Scan properties.

The user can specify the distance between scan lines and points per scan line (Figure 5-45). In addition the user can also specify line length for open perimeters. The orientation of the lines to the perimeter can be controlled by the Grid Rotation field.

To measure a Perimeter, first select Active in the user interface (Figure 5-46) and then select a perimeter from the Treeview in SA. Once the perimeter is selected, select the measure button.

Figure 5-46. Selecting *Active* in the interface.
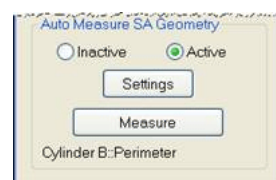
The scan will start (Figure 5-47) and lines will be constructed (if option

was checked). Points will be spaced per user setting. A point will always be measured at the beginning and end of each line.
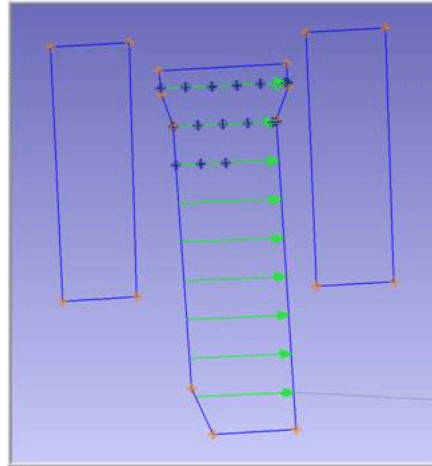

Figure 5-47. Scanning.

To stop a scan, press the Cancel button in the progress dialog.

Auto Measure

The Leica 1203+ can also be used in the SA command Auto Measure. This command will drive the instrument to points in a group and allow a measurement to be recorded.

To perform the Auto Measure, select **Instrument>Automatic Measurement>Auto Measure**.

Select the group to measure and the dialog in Figure 5-48 will appear.
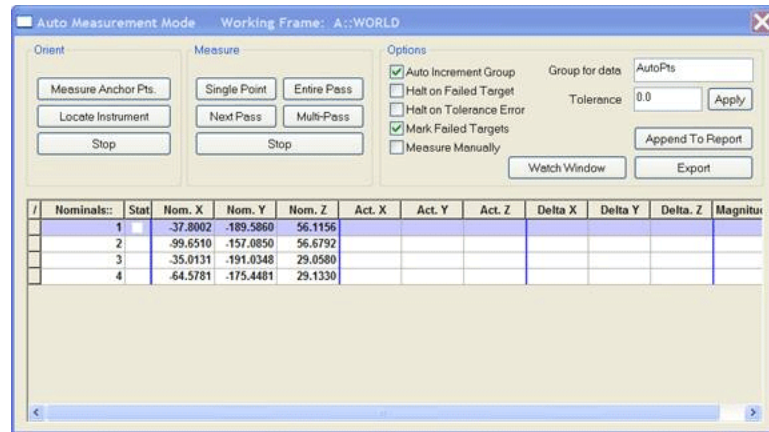

Figure 5-48. The Auto Measure dialog.

This will allow for a single point to be measured or an entire pass be performed. Choose Entire Pass and the instrument will drive to the first point.

Sight the target and press Record (**F3**) in the instrument interface. Once the measurement is recorded the instrument will drive to the next point.

Figure 5-49. Completion of the Auto Measure procedure.
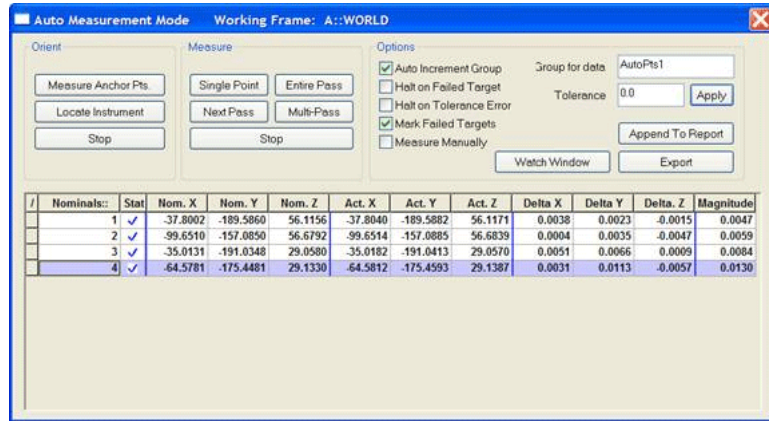
Leica TDRA6000 and TS30 Total Station

This Quick-start guide can be used for initial configuration, connection and basic operation of the Leica TDRA6000 and TS30 Total Stations within SA. For more details on instrument operation and configuration contact Leica directly.

Hardware Setup

Set up the unit following the manufacturer's directions. Leica total stations may be connected either with a USB cable, wireless network adapter or Bluetooth connection. Ensure that you have the necessary cables, router or a Bluetooth adapter. Be sure the power is turned on and the battery is charged.

Software Setup

It is recommended that initial connection and testing be performed using a cable connection to your computer. To connect directly to the PC, you will need to install the instrument drivers. The current drivers SA supports can be downloaded from http://www.kinematics.com/ftp/SA/Install/Driver%20Downloads/TotalStations_Theodolites/Leica/.

Direct Cable Connection:

1. On the scope, select **Instrument > Interfaces**

2. Set the GeoCom connection to Port 1 (RS232, RS232 GeoCOM).

3. Set the GSI connection to Port 1   (RS232 GeoCOM, None, GSI GSI Polar2).

4. Connect the USB cable and continue to the *Starting the Inter-*

face section…

Connecting to Bluetooth

1. On the scope, select **Instrument > Interfaces.** The device used needs to be configured as shown (Figure 5-50).
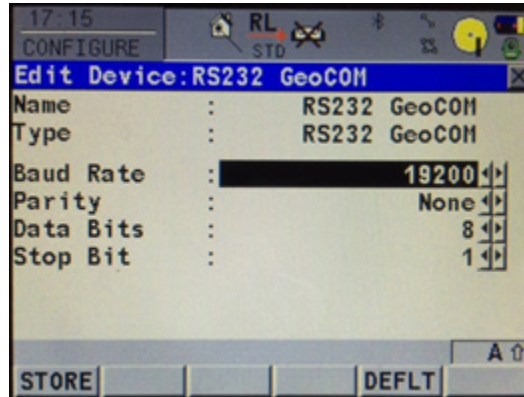

Figure 5-50. RS232 Device Configuration

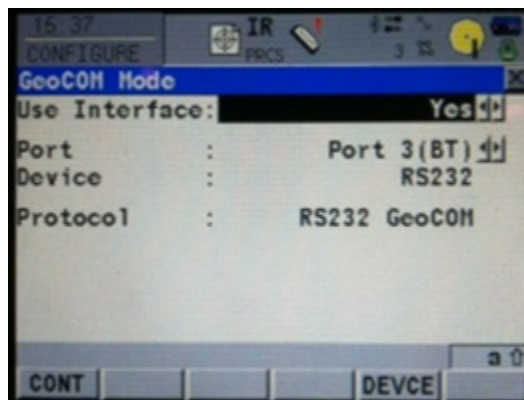2. Set the GeoCom connection to Port3 (BT) (RS232, RS232 GeoCOM) (Figure 5-51).

Figure 5-51. GeoCOM Mode

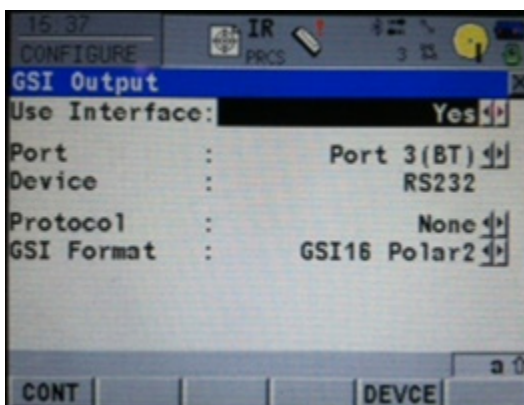3. Set the GSI connection to Port3 (BT) (RS232 GeoCOM, None, GSI GSI Polar2) (Figure 5-52).

Figure 5-52. GSI Mode

4. On your PC, go to your Bluetooth adapter and select Add a Device.

5. Select the device from the available Bluetooth connections

and select next.

6. When prompted, enter the pairing code: **0000**. Once con-
nected, a COM port number will be assigned. If you navigate
to **More Bluetooth Options** and look for the **Outgoing** COM port this
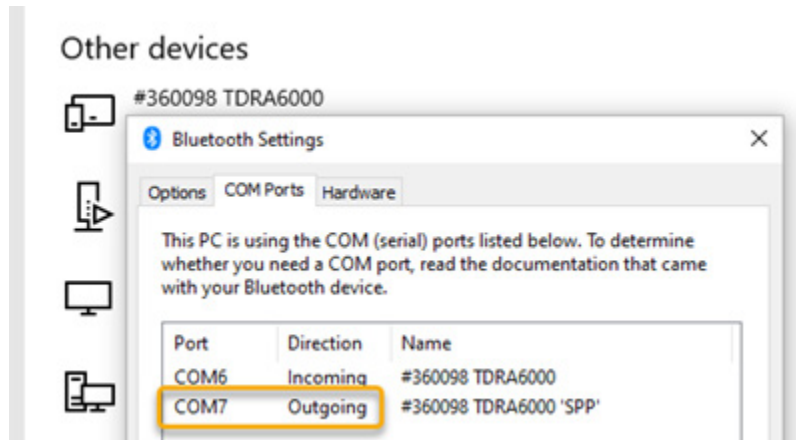is the port number that SA needs in order to connect (Figure
5-53).

Figure 5-53. Com Port

It is also possible to transfer files saved on the scope's internal memo-
ry or CF card to a computer over a bluetooth connection. This can be
done with the: LEICA Geo Office – Tools – [Data Exchange Manager].
This tool functions much like an FTP connection over a COM port and
is available from Leica Geosystems.

Starting the Interface

1. Select **Instrument > Add** and choose the Leica TDRA6000 (or
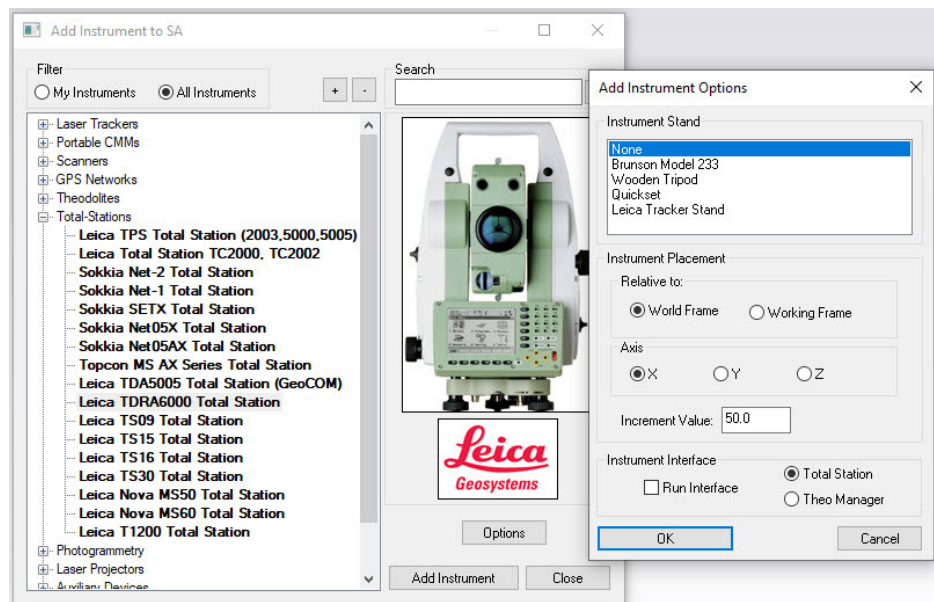TS30) Total Station from the *Add Instrument to SA* dialog (Fig-
ure 5-54).

Figure 5-54. Adding the
TDRA to the Job. The default
interface to use when connect-
ing can be set under Options.

**2.** Now run the instrument interface module under **Instrument >**

Run Interface Module and choose either the traditional **Theodolite Manager** or the new **Total Stations** interface. The Total Stations interface is designed for single station use and will be familiar for laser tracker users (see "Total Stations Interface" on page 280).

Figure 5-55. Choose the interface you would like to use.
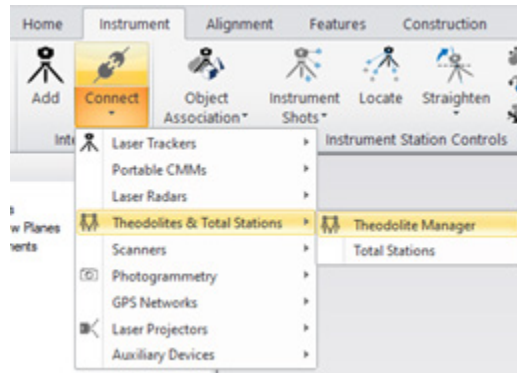
3. Select New Setup and then Add (Figure 5-56).

Figure 5-56. The Theodolite Manager dialog.
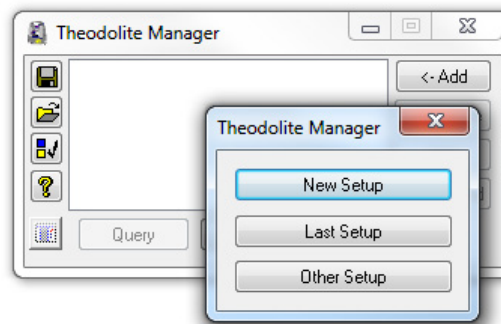
4. Select the instrument by name in the *Type* drop down menu.

5. Select the Com Port. The port number was displayed in the Bluetooth manager during the creation and can be found by going to the properties of the device in the Bluetooth manager.

6. Select the instrument station to connect to by clicking in the available Spatial Analyzer Connections job list and press Connect.
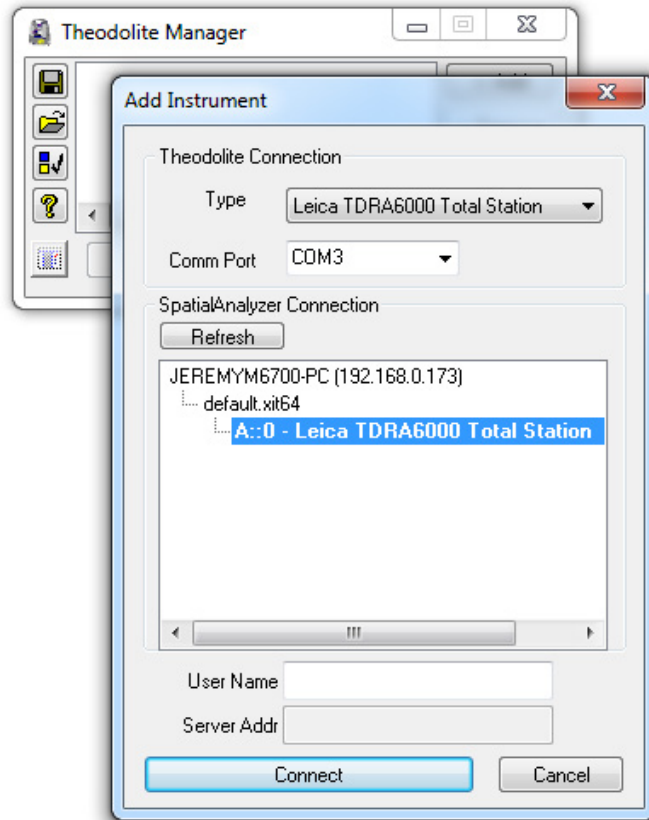
Figure 5-57. Connecting to the added instrument model

Once connected the Leica TDRA6000 /TS30 interface will display and you will be ready to begin using the instrument (Figure 5-58).
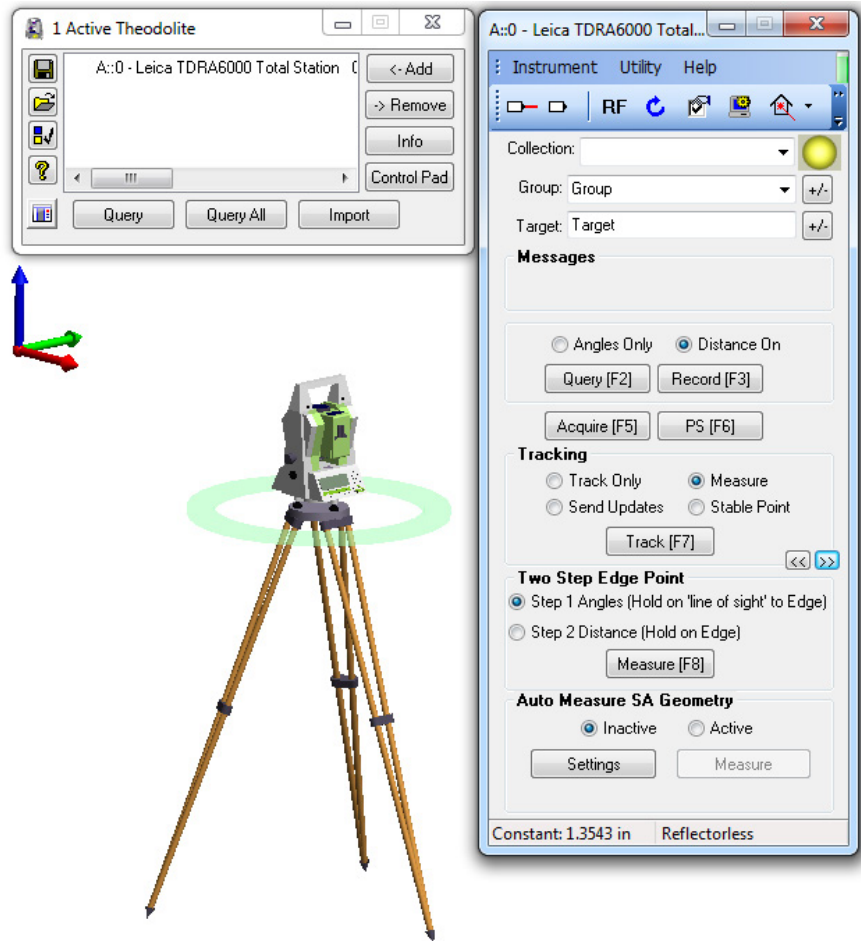
Figure 5-58. TDRA Interface

Instrument Specific Operations

Tracking with the Leica TDRA6000 /TS30

The TDRA6000 can track a reflector much like a Laser Tracker.

1. In the Tracking section, Choose a reflector target from the Targets and Reflectors database (ensure that ATR is turned on for that target)

2. Choose the tracking type (Track only, Send Updates, Measure, Stable Point)

3. Press the Track (F7) button to begin tracking the target

Edge Point Measurement

The Leica TDRA6000 /TS30 has a built in Edge Point Measure Mode designed to allow precise measurements to be made on the edge of parts.

1. Precisely sight on the edge you wish to measure, then in the Two Step Edge Point section, Press Measure. This will take an angles only measurement of the edge

2. Using an edge nest or other reference target measure the pre-

cise distance to that edge point. The true edge point will then be calculated automatically from these shots and the resulting point passed to SA.

Precise Point Scan within a Perimeter

The Leica TDRA6000 /TS30 has the ability to scan a predefined region, do to so, start by building a perimeter within SA to define the region within which to perform the scan.

1. Measure Points to define the perimeter of your scan (Perimeters are constructed as a 3D polygons, or a closed region built from straight lines connecting individual point locations).

2. Select *Construct> Perimeter*. You will be prompted to select the points to define the polygon. Choose each point in order to define a closed polygon, the first and last points will be connected automatically to construct the closed perimeter.
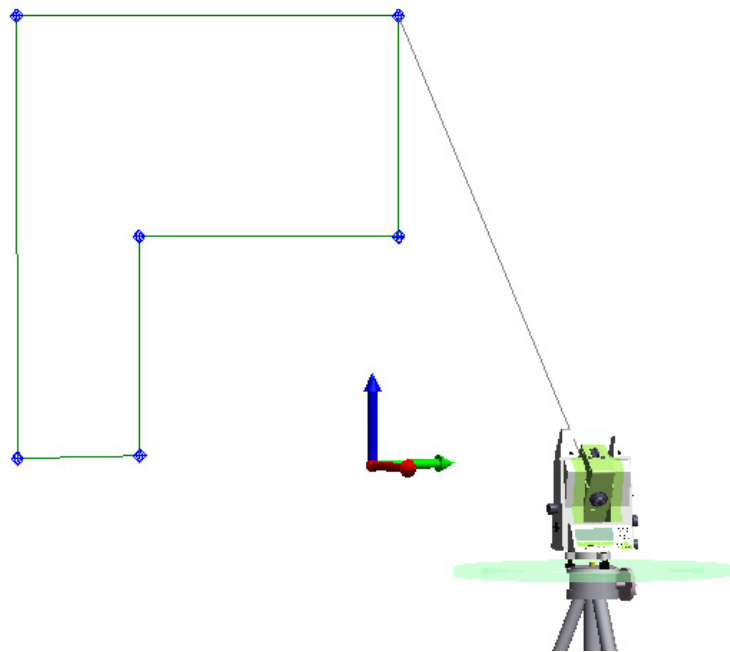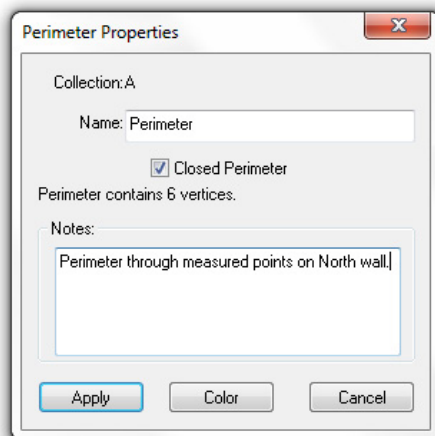
3. Click the Settings button to change the parameters of the scan based on the line and point spacing in the *Auto Scan Properties* dialog (Figure 5-77).

Figure 5-60. Auto Scan Properties dialog.
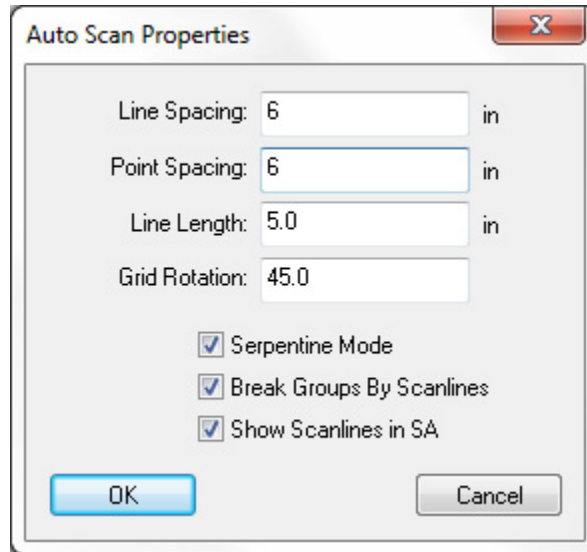
4. Change the *Auto Measure SA Geometry* to *Active* by selecting the radio button. When you do so, a note will be shown at the bottom of the interface that states: *"Awaiting SA Perimeter Selection"* (Figure 5-61).

Figure 5-61. Auto Measure SA Geometry
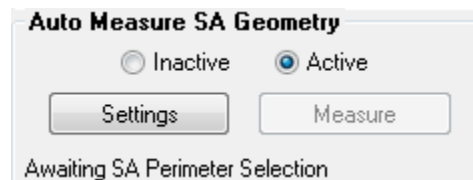
5. Click on the desired perimeter by clicking on double-clicking on it in the tree. When selected, the perimeter *Collection::Name* will be displayed.

6. To begin the scan, click Measure. An example of this type of perimeter scan is pictured in Figure 5-78.

Figure 5-62. A point to point auto measure scan.
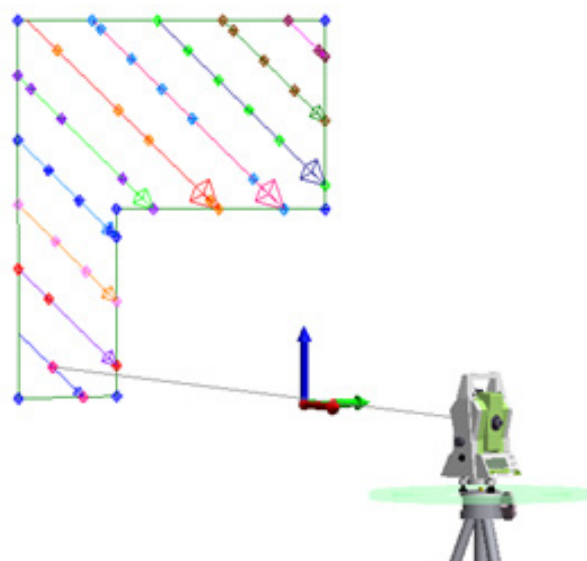
Measuring Directly from the Scope

Measurements can be taken on the TDRA directly, while SA is used to passively record the measurements. To do so go into a survey mode and start a job. When the record buttons (All, DIST, REC) are visible you should be able to trigger the measurements from the scope and record them within SA automatically.

- Recorded points will use the point name specified on the scope.

- The group name is composed of the Group Name Prefix specified in the Theodolite Manager Freeform Mode plus any additional numbers or letters from the point name beyond 3 characters.

- As an example, if you have a group prefix set as "Group" and for the point name type "12345" SA should build a new point group named "Group12" with point "345".

Point Import Options and Formats

SA provides a number of import options to order to import points measured without SA and then use those points for analysis. There are two ways to import points:

1. Importing points directly through Theodolite Manager. This option provides the ability to link points directly to an instrument model and can be done by connecting in simulation as well as with live instruments (Figure 5-63).
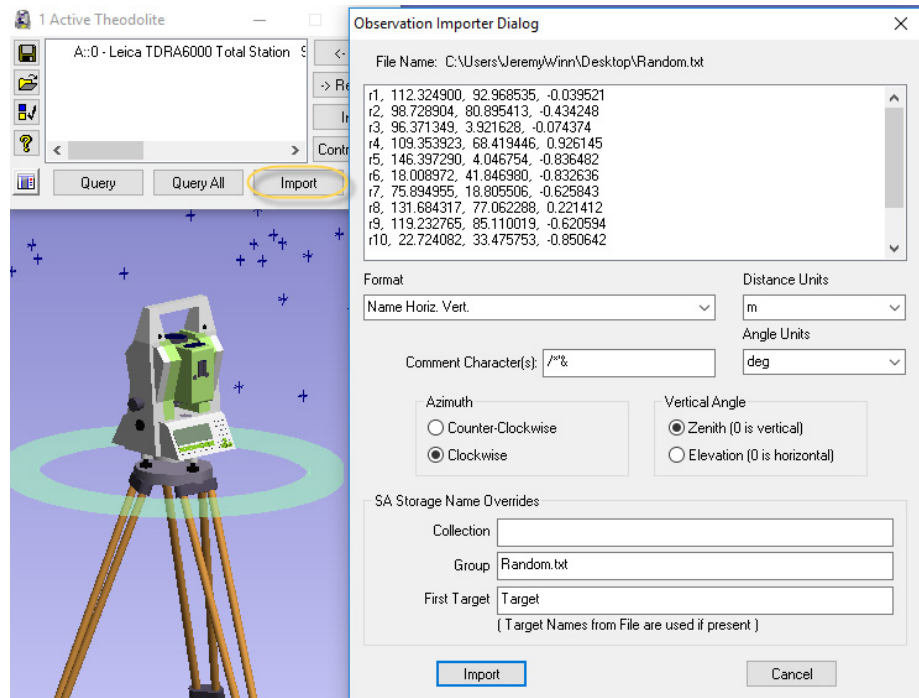
Figure 5-63. Import ascii files through theodolite manager

2. Importing through the **File > Import** options. In addition to ascii files there are a number of useful formats available through

File > Import > Custom Formats including:

- **Leica GSI8 / GSI16 File.** Which provides import of GSI data containing Name, Hz Angle, Vert Angle, Distance OR Name, Easting, Northing, Elevation.

- **Leica ADF (.adf).** Which provide the ability to import nominal and measured points as separate point groups

Leica Nova (MS60, TM60, TS60) and Leica Viva (TS16)

This guide may be used for initial configuration, connection and basic operation of the Leica Nova and Viva Total Station within SA. For more details on instrument operation and configuration, please contact Leica Geosystems directly.

License Requirements

In order to gain full total station integration with SA additional licenses must be purchased from Leica Geosystems and loaded on the instrument. Optional licenses include:

- **Virtual GeoCOM.** Used for wireless communication and control.

- **GeoCOM robotic.** Which enables remote pointing and robotic control of the total station from SA.

- **GeoCOM imaging.** Which enables image capture and display within SA.

- **GeoCOM video.** Which enables live video display within SA.

- **Scanning.** Which enables the MS60's scanning functionality

Hardware Setup

Leica total stations may be connected either with a USB cable, wireless network adapter or Bluetooth connection. Ensure that you have the necessary cables, router or a Bluetooth adapter. Be sure the power is turned on and the battery is charged.

Configuring the Instrument for Optimal Use with SA

1. Navigate to **Users > System Settings > Regional Settings**.

2. Check that the Hz angle display is set to *North anti-clockwise* and the V angle display is set to *Zenith angle*. This will ensure that the angles displayed on the instrument match those of the recorded points in SA.

Software Setup

To use the live remote video function available on this instrument, you will also need to install the VLC player application. Once installed, a Video button will appear on the **Camera Interface** dialog. In the 2020.12.01 version a 64-bit version of the T-Manager was introduced which also requires a 64-bit version of the VLC player (all prior versions used a 32-bit VLC player). The tested VLC install can be downloaded from our webpage here: https://www.kinematics.com/ftp/SA/Install/Driver%20Downloads/TotalStations_Theodolites/Leica/Leica%20Nova%20MS60%20Drivers/

Troubleshooting. If the video button does not appear in the camera window, make sure that you connection is either using a TCP/IP cable connection or a WLAN connection. Bluetooth does not support video.

To verify that your VLC is installed correctly you can open a command prompt window and type the word "Set" and press enter. The string "VLC_PLUGIN_PATH=C:\Program Files\VideoLAN\VLC\" should appear in the list.

Direct Cable Connection

Install the correct driver for your cable:

- **GEV234.** This cable is a USB to USB cable. It establishes the connection through a TCP/IP connection and should be used for scanning and video applications. It will establish a new network connection on your computer and you should be able to find the IP Address on the scope and connect using that IP address.

- **GEV218.** This cable is a USB to Serial converter cable. So that applications that require a serial connection are able to be used.

On the instrument select **Settings > Connections > All Other Connections**. Set the GeoCom connection to USB (to obtain the current IP address and port, press Cntrl..).

Connect the USB cable and continue to the section *Running the Instrument*.

Within the Theodolite Manager Select TCP for the port and enter the scopes IP address and then connect (see Figure 5-72 on page 262).

Wireless Connection

A connection can be established to the Nova by adding the device to a preexisting network or by building an Ad-hoc connection with your PC. For more detailed instructions, refer to the document "Connecting a Nova total station with a PC using a WLAN" on our download page. For a quick synopsis on a Windows 7 machine, follow these steps:

Building an Ad-hoc Connection on a Win7 PC (Win10 does not directly support Ad-hoc).

1. Turn on the wireless adapter on your PC and go to **Control Panel > Network and Sharing Center**.

2. Select **Setup a new connection or network > Set up a wireless ad hoc (computer to computer) network**.

3. When prompted, enter a network name (e.g. "Ad-hoc MS60) and a security type, if desired (no authentication, WEP and WPA-2 are supported).

4. Select Save this network then Next to create the network.

5. Set the IP address to be compatible with the instrument.

Setting the IP Address in the Adapter Properties for the Instrument

1. Turn on the wireless adapter on your PC and go to **Control Panel > Network and Sharing Center**.

2. Select **Manage wireless networks > Adapter properties** for the network you wish to connect to and for editing the properties of your ad-hoc network.

3. In the *Wireless Network Connection Properties* dialog, select Internet Protocol Version 4 (TCP/IPv4).

4. Select Properties and enter the IP address rather than obtaining one automatically. This address determines the computer's IP address on the network.

5. On the instrument select **Settings > Connections > All Other Connections**. Set the GeoCom connection to WLAN (to obtain the current IP address and port, press Cntrl..).

6. Continue to the section *Running the Instrument*.

Connecting to an Existing Wireless Network

You can connect the Total Station directly to an existing wireless network using the following Steps.

1. Select Settings > Connections > Internet wizard

2. Select **WLAN** and connect to an available network.

3. On the instrument select **Settings > Connections >**

All other connections. Set the GeoCom connection to *Port WLAN* (to obtain the current IP address and port, press Control).

4. Open the GSI output settings and make sure that the *Output GSI data to device* option is checked.

5. Continue to the section *Running the Instrument*.

In some cases, you may need to set the IP address manually. You can also manually control the internet connection and check the adapter status as follows:

1. Open the Windows CE control panel by selecting **Fn + Windows Key.**

2. Click on WLAN Settings in the taskbar and select the network you wish to connect to from the network list and click Connect.
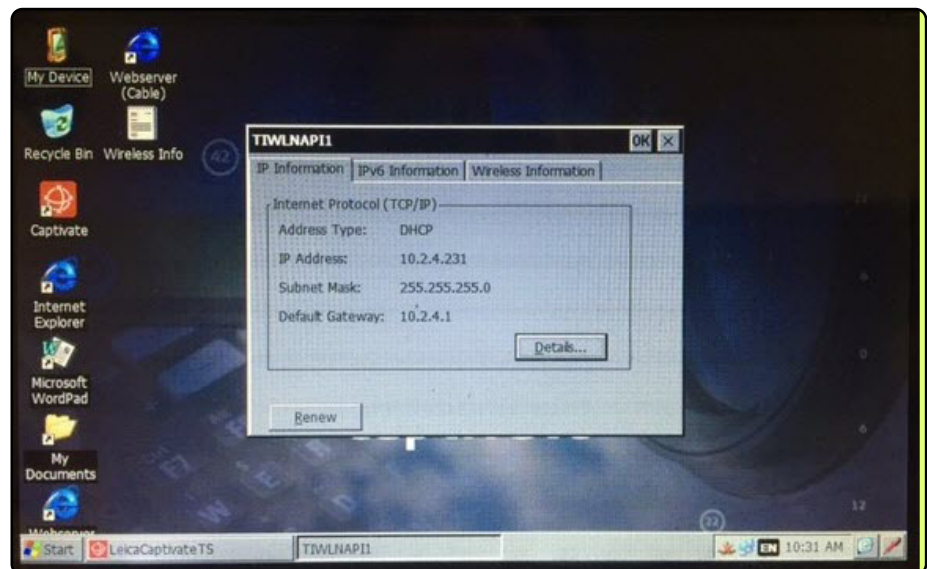
Figure 5-64. Wireless Connection through TIWLNAPI1

3. Once connected restart the LeicaCaptivate application.

▪ Select **Start > Settings > Network and Dial-Up Connections** TIWLNAPI1 (or OWL221A1).

▪ Select Enable, and then Properties.

▪ Choose Specify an IP address, and enter the IP address for the total station on the network. The first three numbers of the IP address need to match the first three numbers entered for the PC. The last number must be unique from the PC.

- ▪ Return to the Windows CE desktop, click on WLAN settings in the taskbar. In the **Wireless Information** tab, select the ad-hoc network that you created and select Connect.

4. On the instrument select **Settings > Connections > All Other Connections**. Set the GeoCom connection to WLAN (to obtain the current IP address and port, press Cntrl..).

5. Open the GSI output settings and make sure that the *Output GSI data to device* option is checked.

6. Continue to the section *Running the Instrument*.

A youtube video demonstration can be found here:

https://youtu.be/pl_6_p8mqG0

Connecting to Bluetooth

A Bluetooth connection is fast an convenient but will limit scan and video operations available for the MS60 that need a faster TCP/IP connection.

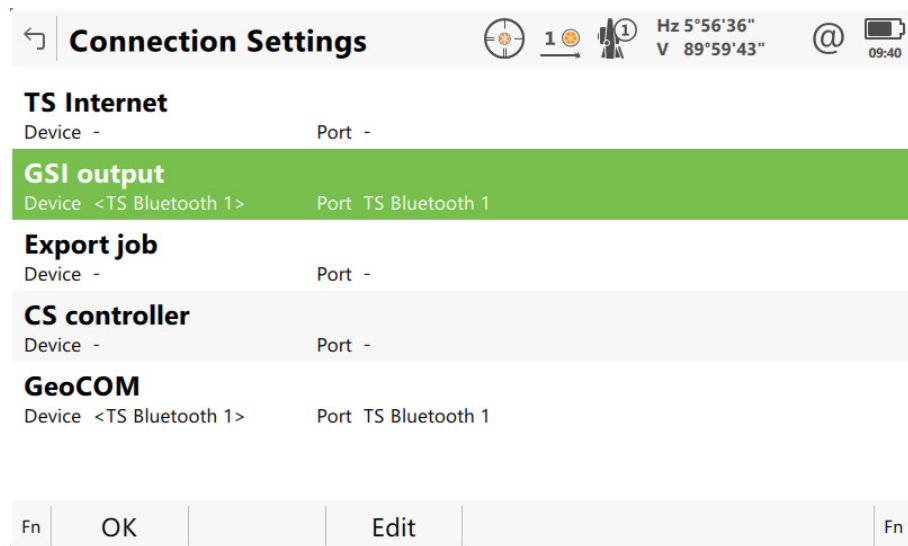1. Select Settings > Connections > All other connections to get to the **Connection Settings**(Figure 5-65).


Figure 5-65. GeoCOM Connections Dialog

2. Set the GeoCom connection to TS Bluetooth 1 and also enable GSI output to allow operation of the scope to trigger measurements . You will also want to verify that the GSI Format is GSI16 Polar 2 (Figure 5-66).

Figure 5-66. GSI Configuration
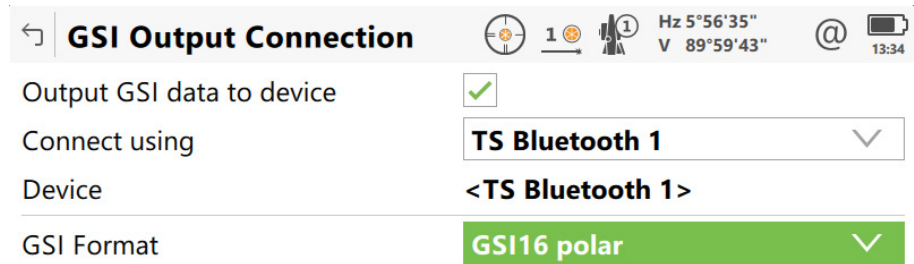
3. On your PC, go to your Bluetooth adapter and select Add a Device. Select the device from the available Bluetooth connections and select next.

4. When prompted, enter the pairing code: **0000**. Once connected, a pair of COM ports number will be assigned. You can use the More Bluetooth Options option to see which COM ports were assigned for the connection. You will enter the "Outgoing" port number in SA to connect(Figure 5-67).

Figure 5-67. COM Port Designations in the Bluetooth Settings
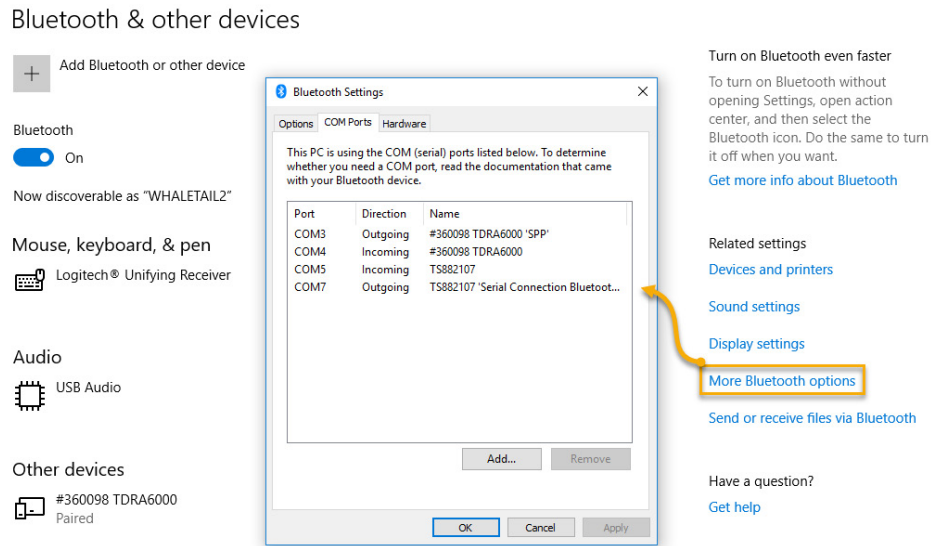
5. Continue on to the section *Running the Instrument*.

No additional configuration of the Baud rate should be necessary for a bluetooth connection, but if you cannot connect you might check the settings. To do so, go to the GeoCOM Connection panel and press Device. The defaults are 115200, None, 8, 1, None (Figure 5-68). Older scopes with eariler versions of GeoCOM will suggest a slower rate of 19200.
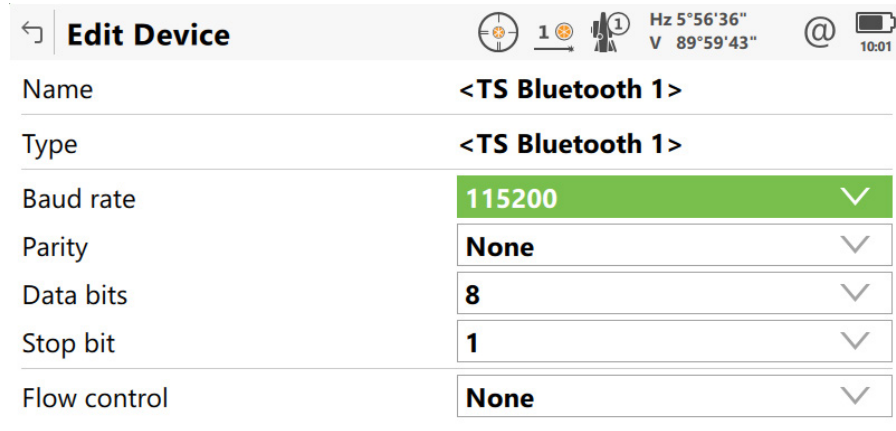
Figure 5-68. Default Blue-
tooth communication settings

Triggering Measurements from the Instrument

Also be sure to enable GSI Output from the scope in order to get the red trigger button on the scope to send measurements to SA. Measurements from the scope will use the Collection and Group name set within the Theodolite Manager not the instrument Control Pad. For more information see "Measurement Modes" on page 222.

Adding an Instrument to SA

1. Select **Instrument > Add** and choose your Leica Total Station from the **Add Instrument to SA** dialog (Figure 5-69).
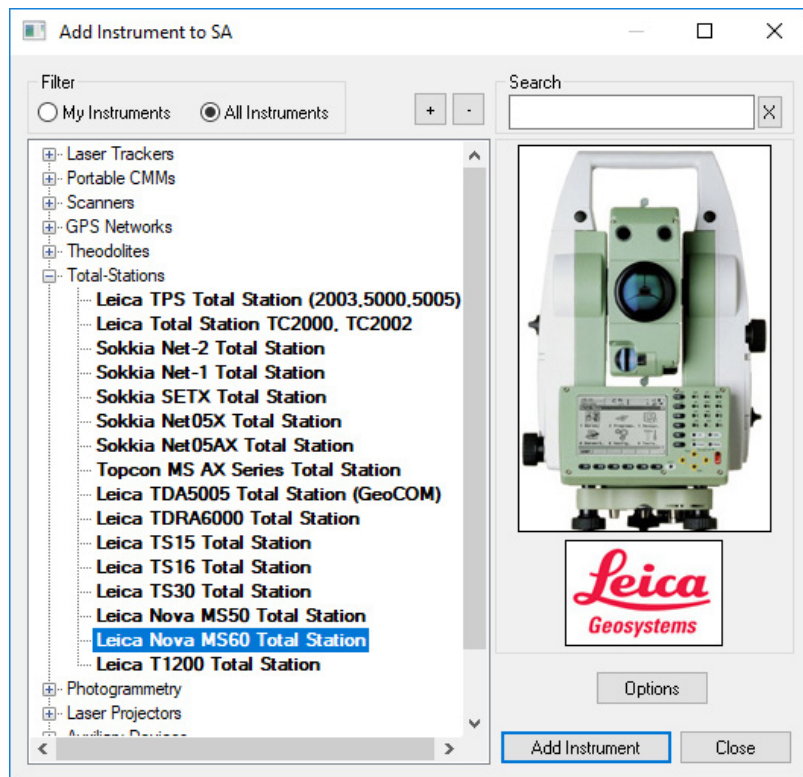
Figure 5-69. Adding the Leica Nova MS60 Total Station to a job.

The instrument model you add defines the instrument plant in your

job file. Add additional instrument models each time you perform an instrument move. You can also use the right-click open **Jump Instrument to New Location** option for this purpose.

There are now two separate ways to run a Leica Total Station in SA. You can use our classic **Theodolite Manager** or our newer **Leica Total Station Interface** which is recommended for single instrument operations and current instruments.

Connecting Using the Leica Total Station Interface

1. Now run the instrument interface module under **Instrument > Connect>** and choose **Lieca Total Station**.

2. Select the instrument model you want to connect to in your SA job from the network list and press OK to move to the connection dialog (Figure 5-70).
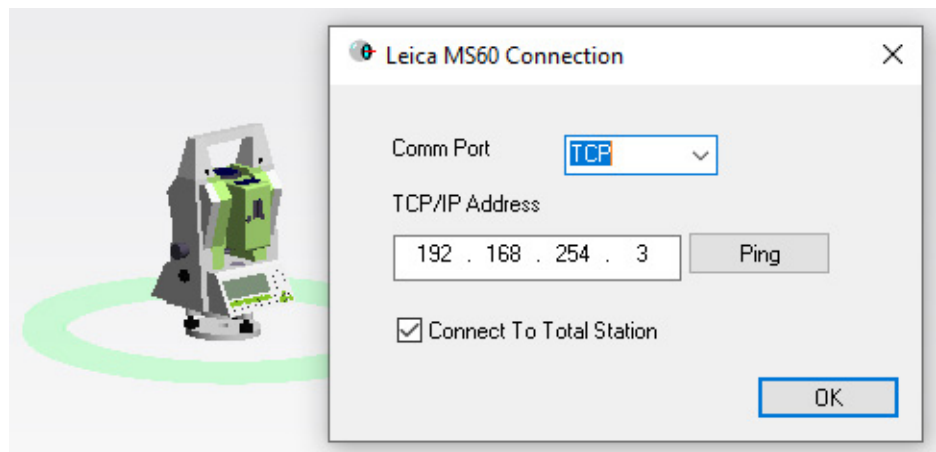


Figure 5-70. Leica Total Station Connection Dialog.

Instrument Specific Operations

For more information on instrument controls in the Leica Theodolite Manager, refer to "Total Stations Interface" on page 280.

Connecting Using the Theodolite Manager

1. Now run the instrument interface module under **Instrument > Run Interface Module** and choose **Theodolite Manager**.

2. Select New Setup and then Add (Figure 5-71).

Figure 5-71. The Theodolite Manager dialog.
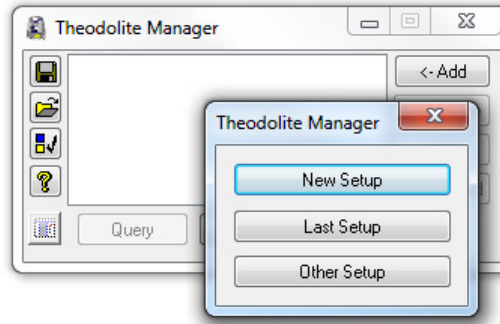
3.   Select the instrument type and the COM Port. Set the COM Port to TCP if you are connecting with either a cable or wireless; or enter the port number for Bluetooth. Then select the instrument in the available SpatialAnalyzer list and click Connect (Figure 5-72).

Figure 5-72. Adding a new setup using an IP address.

To obtain the current Instrument IP navigate to Settings>
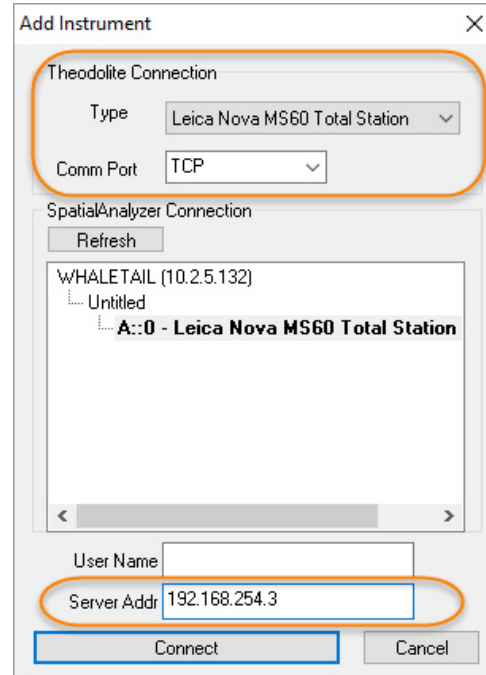
Note: If connecting with a cable or wireless, enter the instrument's IP address in the Server Address box.

Click on the GeoCOM connection and then press Control. This will display the current IP address settings for the Instrument. Be sure to close the GeoCom Dialog before trying to connect with SA.

4.   Select the instrument in the available SpatialAnalyzer list and click Connect.

A youtube video demonstration can be found here:

https://youtu.be/W4O61akKCo4

Instrument Specific Operations

Tracking with the Leica Nova and Viva

Total stations can track a reflector much like a Laser Tracker.

1. In the Tracking section, Choose a reflector target from the Targets and Reflectors database (ensure that ATR is turned on for that target)

2. Choose the tracking type (Track only, Send Updates, Measure, Stable Point)

3. Press the Track (F7) button to begin tracking the target

Edge Point Measurement

The Leica scopes has a built in Edge Point Measure Mode designed to allow precise measurements to be made on the edge of parts.

1. Precisely sight on the edge you wish to measure, then in the Two Step Edge Point section, Press Measure. This will take an angles only measurement of the edge

2. Using an edge nest or other reference target measure the precise distance to that edge point. The true edge point will then be calculated automatically from these shots and the resulting point passed to SA.
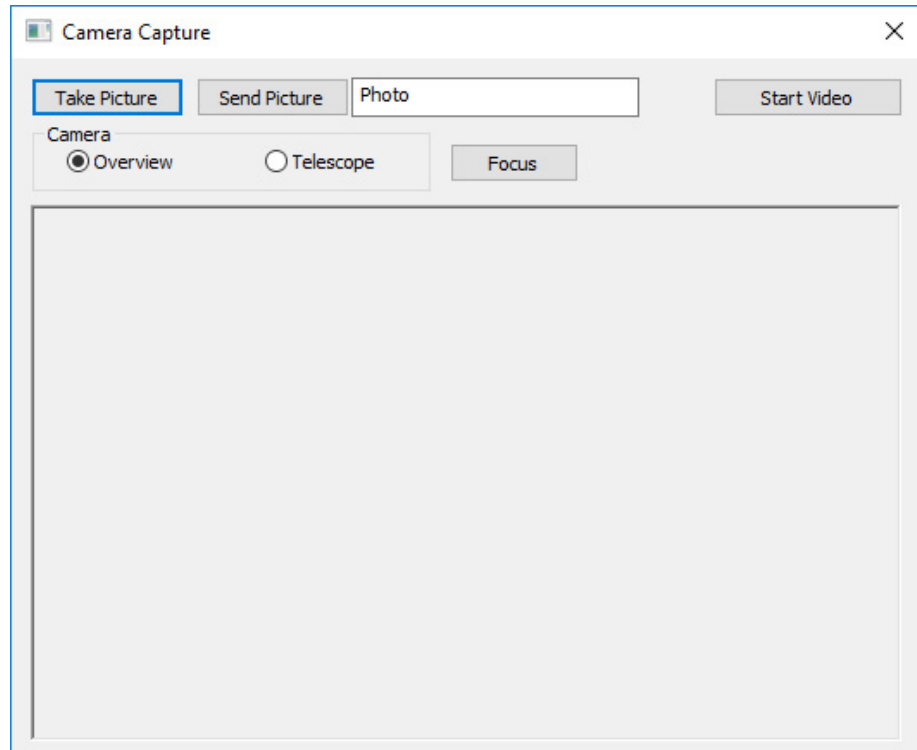
Imaging and Video Control

Both the Leica Nova and Viva total stations provide image capture and live video display options. To access the image control press the Camera button 📷 in the Auto Measure SA Geometry section of the interface. This icon will bring up a Camera Capture window like this(Figure 5-73):

Figure 5-73. Camera Capture window Controls

- **Take Picture.** This button will request a new image from the scope and refresh the current image displayed.

- **Send Picture.** This button will capture the current image and send it as a picture to SA for use in reporting, using the name entered in the filed next to the button.

> 💡 **Tip:** To Display video the VLC media play must be installed. Be sure to install the 32bit version of VLC play. This is required for both 32bit and 64bit SA versions.

- **Overview and Telescope.** These two controls provide the ability to toggle between the two cameras, zooming in and out as needed.

- **Start Video.** This button starts live streaming of video within the camera capture window. This requires a 32bit version of the VLC media player to be installed. While live video is active an operator can click in the view to point the instrument at that location. This provides the means to actively drive the instrument by using the video screen.

Room or Perimeter Scanning

The MS60 can quickly scan a perimeter and generate a point cloud within SA. This is ideal for quick large volume measurement.

1. In the *Auto Measure SA Geometry* section of the instrument interface, ensure that the Revert ⓡ button is *not* depressed. This button changes between scanning modes (Figure 5-74). This Revert button switches the scan operation and Settings function from a scan to a precise point scan grid scan (see "Precise Point Scan within a Perimeter (both Nova and Viva Total Sta-
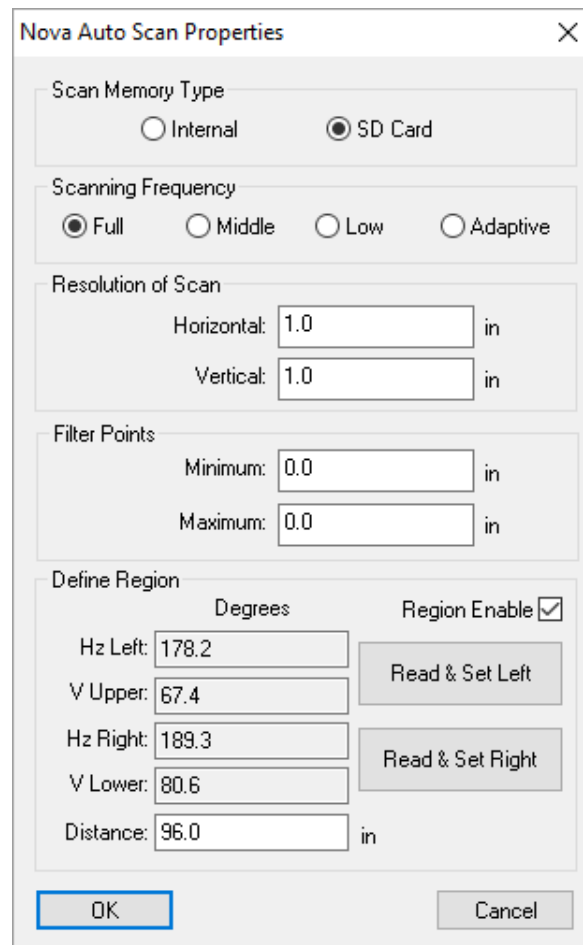
Figure 5-74. Auto measure SA Geometry section of the Interface.
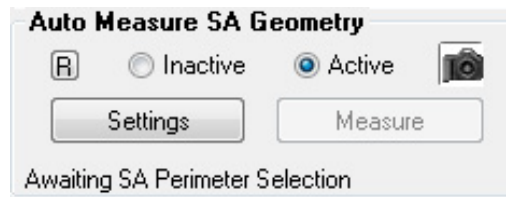
2. Click Settings to change the parameters of the scan. The density of the scan is defined as the **Horizontal** and **Vertical** resolution of the grid at the specified **Distance**. Once satisfied with the settings click OK (Figure 5-75).

**Figure 5-75.** Auto measure SA geometry profile parameters.

The Scan settings now provides the ability to greatly refine your scan. It provides the following options:

- **Resolution of Scan.** This section allows you to define the density of the scan data returned with the scan by identifying the distance between returned scan points.

- **Filter Points.** This **Minimum** and **Maximum** defines distance exclusion thresholds allowing to you to set up a distance filter so that you only record points at a particular distance from the

instrument.

- **Define Region.** This section allows you to define a square perimeter based upon angle shots only without defining a perimeter in SA. You can point the instrument to the upper left corner of what you want to measure and then press the *Read & Set* buttons to record the angles and then do the same at the lower right to define a box. The distance value is then used to determine the resolution of the scan within that perimeter. As long as the *Region Enabled* check box is checked this perimeter will be used. When enabled the measure button will be available without perimeter selection.

3. If not measuring a region defined in the settings, change the *Auto Measure SA Geometry* to *Active* by selecting the radio button. When you do so, a note will be shown at the bottom of the interface that states: *"Awaiting SA Perimeter Selection."*

4. Click on the desired perimeter by clicking on double-clicking on it in the tree. When selected, the perimeter *Collection::Name* will be displayed.

5. To begin the scan, click Measure. An example of this type of perimeter scan is pictured in Figure 5-76.

Figure 5-76. Perimeter scan using the Auto Measure SA Geometry measurement mode.
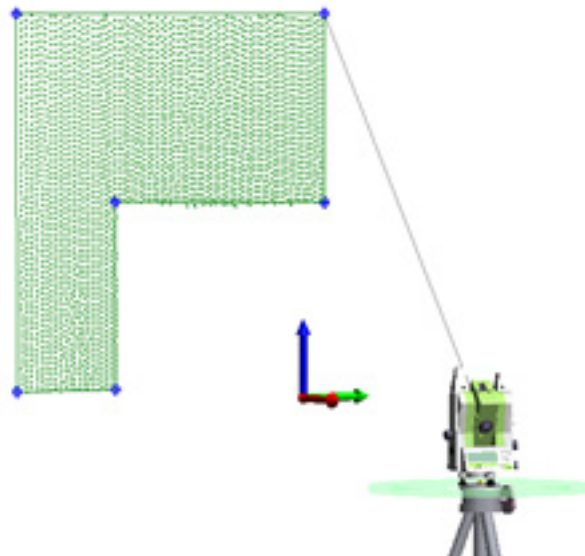
If a scan fails to transfer to SA for any reason it is not lost. The scan is saved internally either to memory or on the SD card and will only be clear if the scan transfer to SA is completed successfully. If this process fails the scan can be imported afterword.

Importing Nova Scan Files into SA

If you choose to scan while not connected to a computer, you may

import these files into SA at a later time. The Nova Scans are saved as `*.SDB` files on the SD Card or the internal memory. To do so, follow these steps:

1. Add an instrument to your SA job file to which you wish to import the scan data. Data will be imported into SA relative to this instrument.

2. Either connect to the live instrument using a cable or connect using the simulation mode.

3. Locate and move the `*.SDB` files to your local machine. If you are connected using the cable, you can use Windows Mobile Device Center to navigate to the SD card directly.

4. In Theodolite Manager, select your instrument and click Import.

5. Select the `*.SDB` data type, navigate to your data, and click Import.

Precise Point Scan within a Perimeter (both Nova and Viva Total Stations):

While the scanning function is ideal for covering a large region quickly it can be helpful to do a more precise grid measurement using reflectorless measurements. There is still an option to do so:

1. In the *Auto Measure SA Geometry* section of the instrument interface, ensure that the Revert Ⓡ button *is* depressed. This button changed between scanning modes.

2. Click the Settings button to change the parameters of the scan based on the line and point spacing in the **Auto Scan Properties** dialog (Figure 5-77).
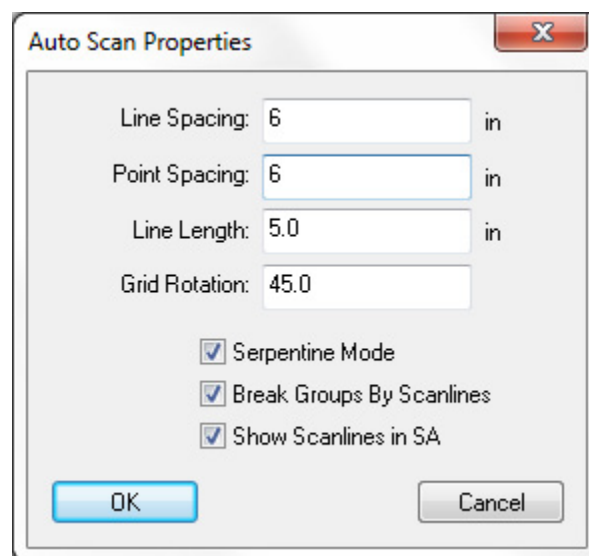

Figure 5-77. Auto Scan Properties dialog.

3. Change the *Auto Measure SA Geometry* to *Active* by selecting the ra-

dio button. When you do so, a note will be shown at the bottom of the interface that states: *"Awaiting SA Perimeter Selection."*

4. Click on the desired perimeter by clicking on double-clicking on it in the tree. When selected, the perimeter *Collection::Name* will be displayed.

5. To begin the scan, click Measure. An example of this type of perimeter scan is pictured in Figure 5-78.
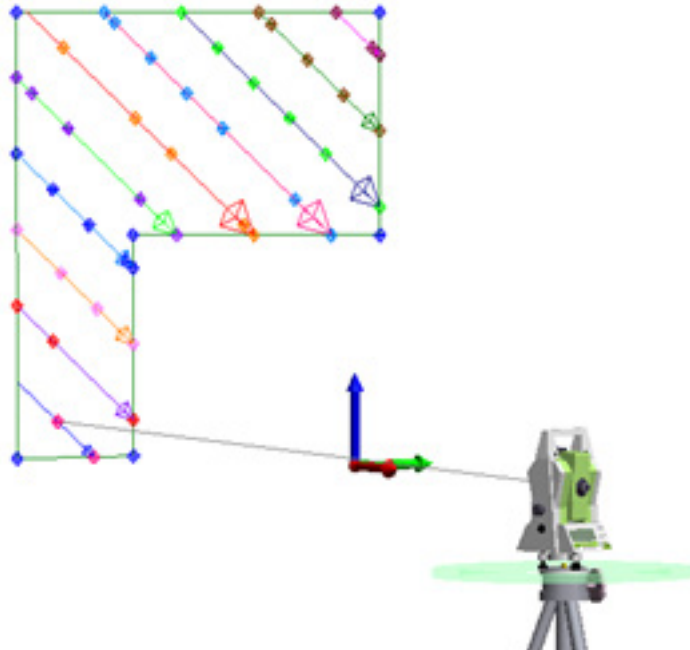

Figure 5-78. A point to point auto measure scan.

Point Import Options and Formats

SA provides a number of import options to order to import points measured without SA and then use those points for analysis. There are two ways to import points:

1. Importing points directly through Theodolite Manager. This option provides the ability to link points directly to an instrument model and can be done by connecting in simulation as well as with live instruments (Figure 5-63).

Figure 5-79. Import ascii files through theodolite manager
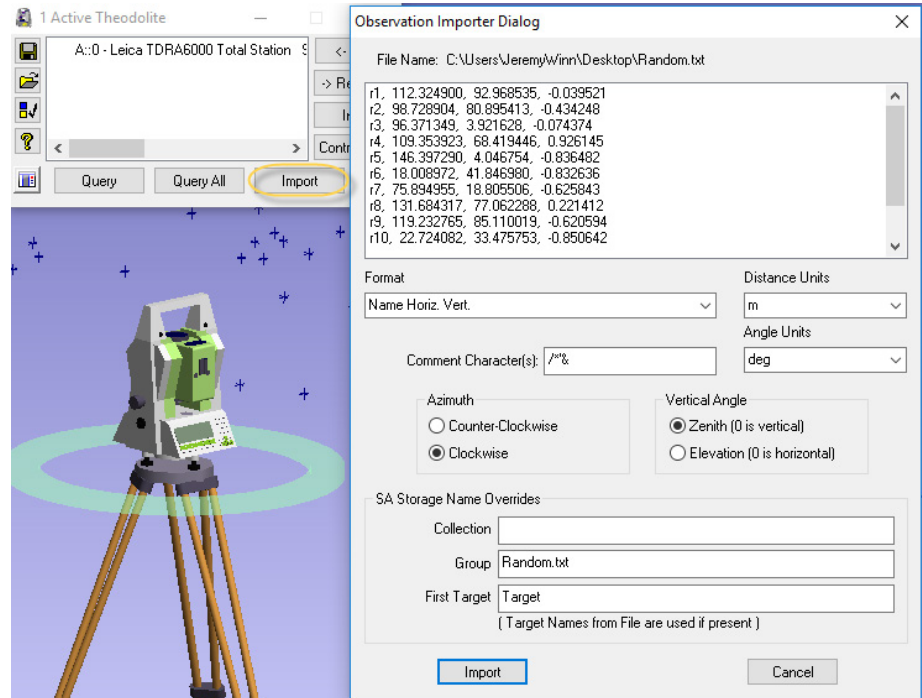
2. Importing through the **File > Import** options. In addition to ascii files there are a number of useful formats available through **File > Import > Custom Formats** including:

- **Leica GSI8 / GSI16 File.** Which provides import of GSI data containing Name, Hz Angle, Vert Angle, Distance OR Name, Easting, Northing, Elevation.

- **Leica ADF (.adf).** Which provide the ability to import nominal and measured points as separate point groups.

Sokkia Net1

SpatialAnalyzer interfaces with the Sokkia Net1 using the Theodolite Manager via a Bluetooth or RS232C (Serial Port) connection. This quick start guide will cover required Sokkia Net1 settings along with step by step instruction for using the Sokkia Net1 in SA.

Connections

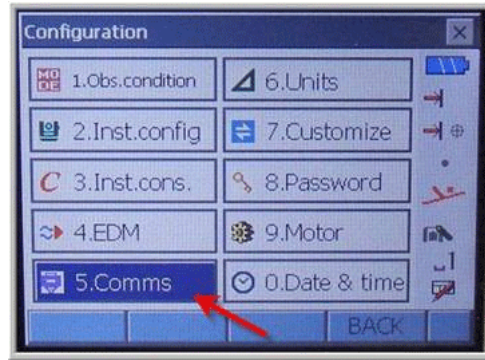Before attempting to connect to SA, first choose your preferred connection on the Net1.

1. Enter the configuration menu (Figure 5-80).
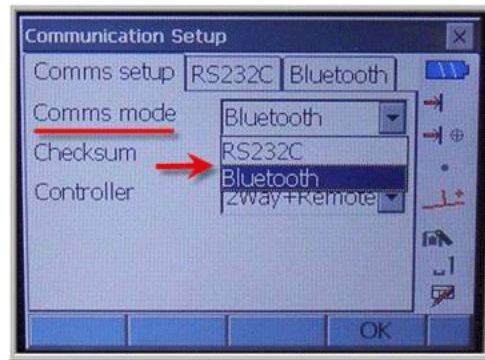

Figure 5-80. The configuration menu.

2. Select Communications (Figure 5-81).

Figure 5-81. Selecting Comms.

3. Set the communication mode (Figure 5-82).

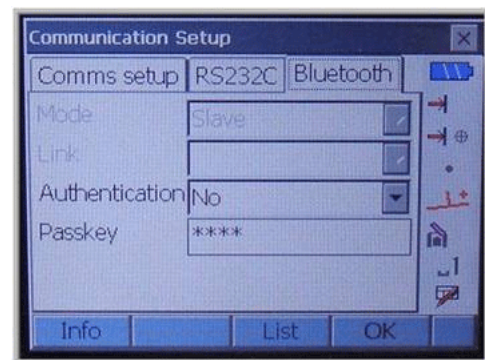**Figure 5-82.** Choosing the Comm mode.

4. RS232C Settings (Figure 5-83).

Figure 5-83. The correct RS232 settings for connection.
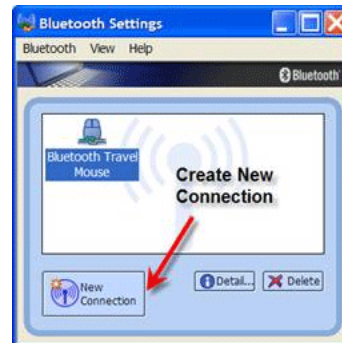
5. Bluetooth Settings (Figure 5-84).

Figure 5-84. The proper Bluetooth settings.

Establishing Bluetooth Connection on PC

1. Use Bluetooth wizard installed on PC to create a new connection (Figure 5-85). Be sure the Sokkia Net1 power is on.

Figure 5-85. Creating a new connection.

2. The Bluetooth wizard will search for the device (Figure 5-86).

Figure 5-86. The Add New Connection Wizard.
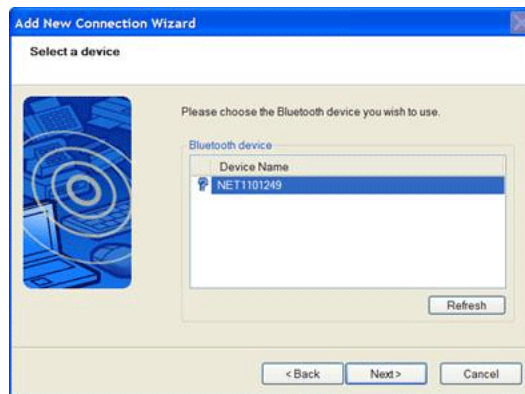
3. The Bluetooth manager will complete the connection and display the COM number being used (Figure 5-87). Remember this number as it is needed inside of SA to establish connection.

Figure 5-87. The assigned COM port.

4. Now the Sokkia Net1 is a recognizable connection for Bluetooth. Each time the Sokkia Net1 is powered the user must enter the Bluetooth manager and activate the connection (Figure 5-88).

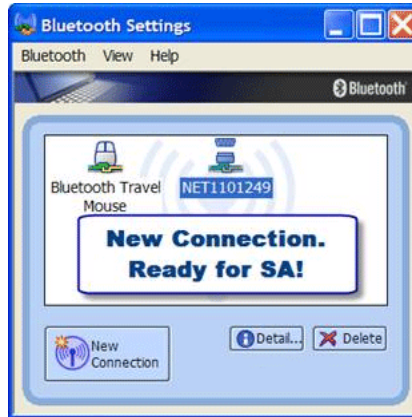**Figure 5-88.** The connection has been established.

5. Add the Sokkia Net1--select the Sokkia Net1 and pick instrument options (Figure 5-89).

Figure 5-89. Adding the total station to the job.
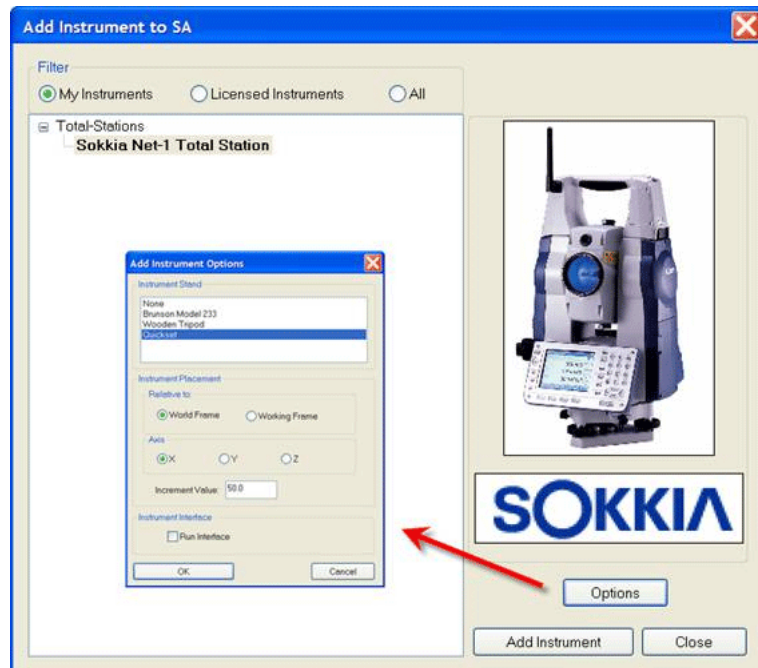
6. Run the Theodolite Manager and select New Setup, then Add (Figure 5-90).

Figure 5-90. Creating a New Setup.
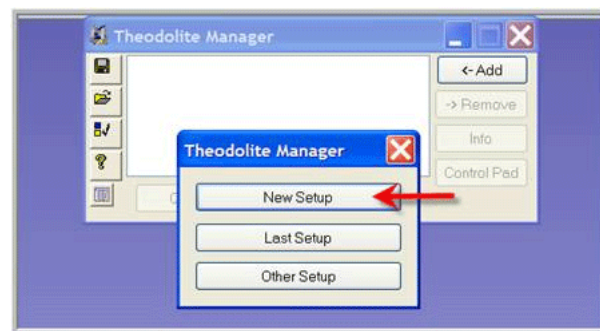
7. Select the instrument type and the Comm Port. This port was displayed in the Bluetooth manager during the creation of

the connection. Then select the instrument in the available Spatial Analyzer list. Once connected the Sokkia Net1 interface will display (Figure 5-91).

Figure 5-91. The Sokkia interface.
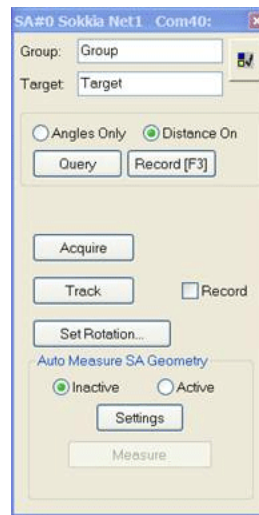
The following topics will be covered:

- Selecting a Reflector
- Single Point Measurement
- Perimeter Scanning
- Target Tracking
- Auto Measure Points

Selecting Target Reflector

1. Select the options button in the interface (Figure 5-2).

Figure 5-92. The options button.
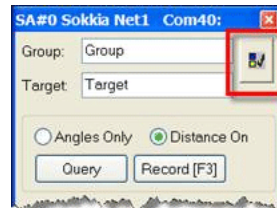
2. Select the Change Reflector button (Figure 5-3).

Figure 5-93. The Sokkia options window.
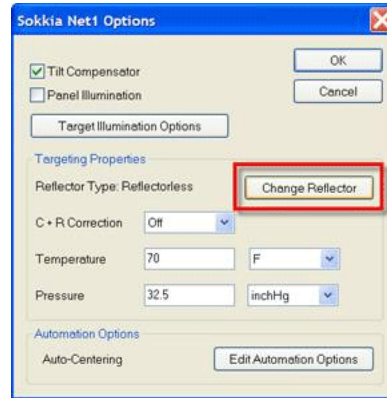
3. Select desired reflector type (Figure 5-4) .

Figure 5-94. Selecting the desired reflector.

Single Point Measurement

1. Specify Group and Target Name.

2. Sight Target.

3. Select Query or Record (**F3**) in the interface. Query will force the instrument to calculate a measurement. Record (F3) will send the measurement to SA (Figure 5-5).

Figure 5-95. Recording a measurement.
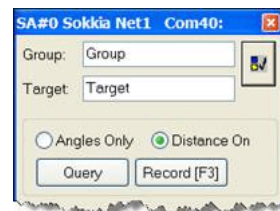
Perimeter Scanning

1. Measure points defining the area to scan (Figure 5-6).

Figure 5-96. Measurements
of the area to scan.
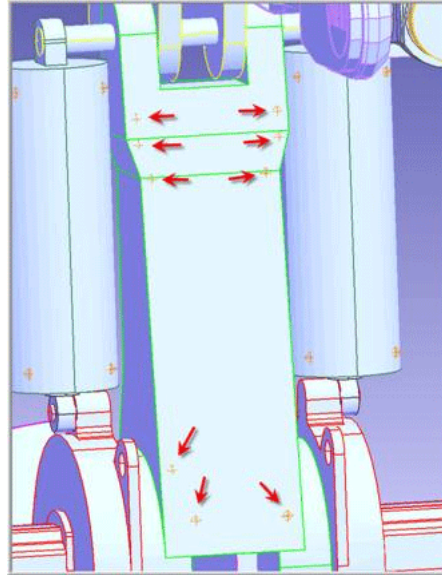
2. Construct a perimeter from the measured point in SA under
    Construct>Perimeter (Figure 5-7).

Figure 5-97. The defined
perimeters.
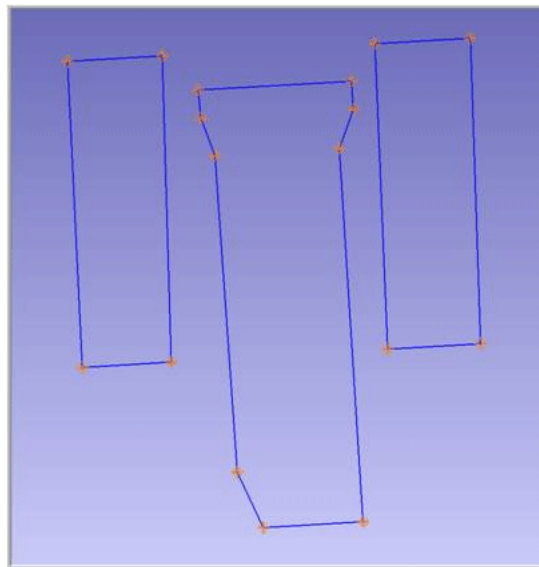
3. Two types of perimeters exist in SA, open and closed. A single
    perimeter can be changed from open to closed in the perim-
    eter properties dialog (Figure 5-8).

Figure 5-98. The Perimeter Properties window.
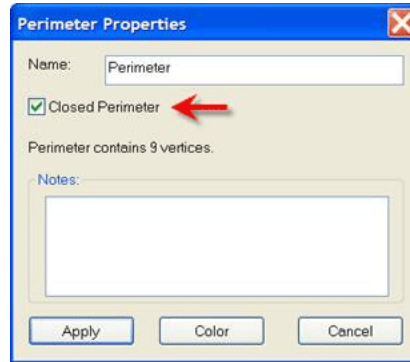
4. Set the scan properties for the appropriate perimeter. If the perimeter is closed the scan will be bounded by the perimeter. If it is open, the scan lines will be perpendicular to the perimeter.

Figure 5-99. Auto Scan properties.
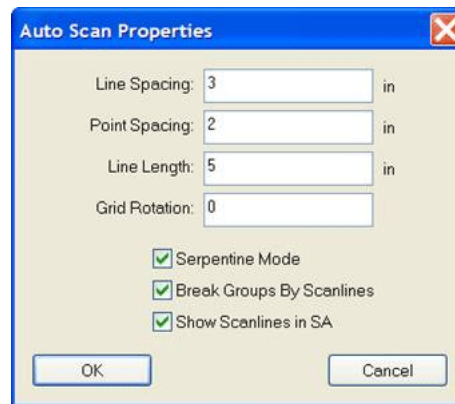
5. The user can specify the distance between scan lines and points per scan line (Figure 5-9). In addition the user can also specify line length for open perimeters. The orientation of the lines to the perimeter can be controlled by the Grid Rotation field.

To measure a Perimeter, first select Active in the user interface (Figure 5-10) and then select a perimeter from the Treeview in SA. Once the perimeter is selected, select the measure button.

Figure 5-100. The Active setting.
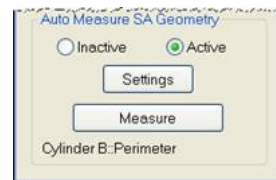
The scan will start and lines will be constructed (if option was checked). Points will be spaced per user setting. A point will always be measured at the beginning and end of each line.

To stop a scan, press the cancel button in the progress dialog.

Target Tracking

The Sokkia Net1 is capable of tracking a prism target.

Figure 5-101. The track setting to track a prism target.
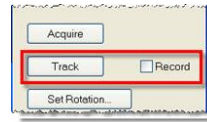
Simply select track and start moving the prism (Figure 5-11). The Net1 will track the prism. If the record option is check, measurements will be sent to SA while the prism is being moved.

Auto Measure

The Sokkia Net1 can also be used in the SA command Auto Measure. This command will drive the instrument to points in a group and allow a measurement to be recorded.

To perform the Auto Measure, select **Instrument>Automatic Measurement>Auto Measure**.

Select the group to measure and the dialog in Figure 5-12 will appear.

Figure 5-102. Auto Measure mode.
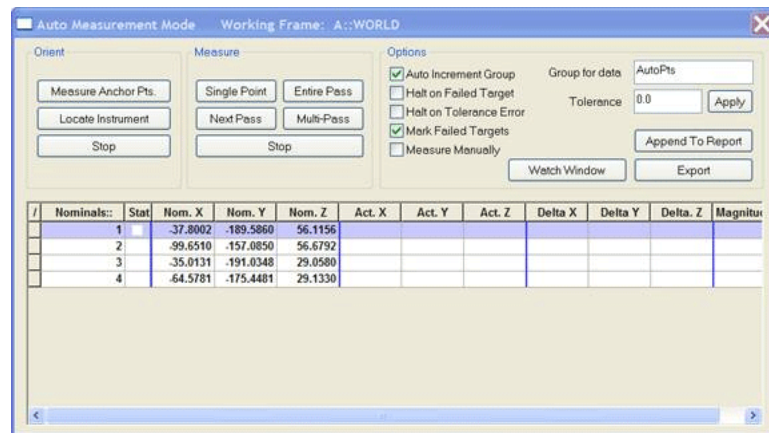
This will allow for a single point to be measured or an entire pass be performed. Choose Entire Pass and the instrument will drive to the first point.

Sight the target and press Record (**F3**) in the instrument interface. Once the measurement is recorded the instrument will drive to the next point.

Figure 5-103. A completed auto measurement.
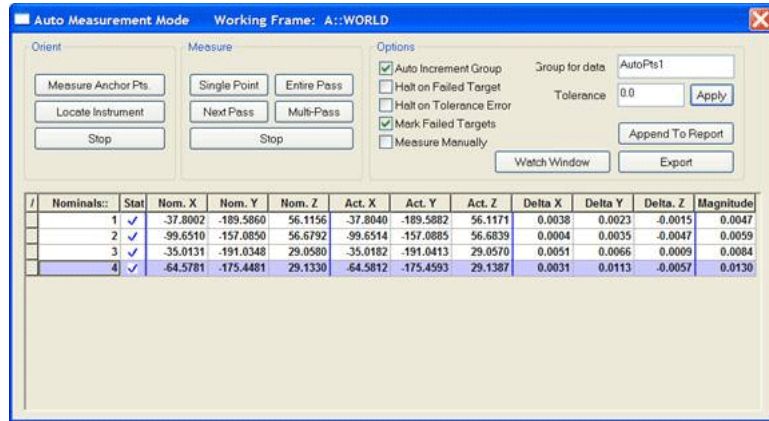
Total Stations Interface

The Total Station Interface is designed for single station use and is modeled after the laser tracker interface, as many of the measurements and operations overlap. The following guide describes its use and capabilities.

To use the Total Station interface, you must first configure your instrument settings based on the instrument QuickStart guide:

- "Leica TDRA6000 and TS30 Total Station" on page 244
- "Leica Nova (MS60, TM60, TS60) and Leica Viva (TS16)" on page 254

Connection process

1. Add an instrument model to SA (Figure 5-104) and then select **Connect>Theodolites & Total Stations> Total Stations.** The Theodolite Manager remains the generic default for all Theodolites and Total Stations.
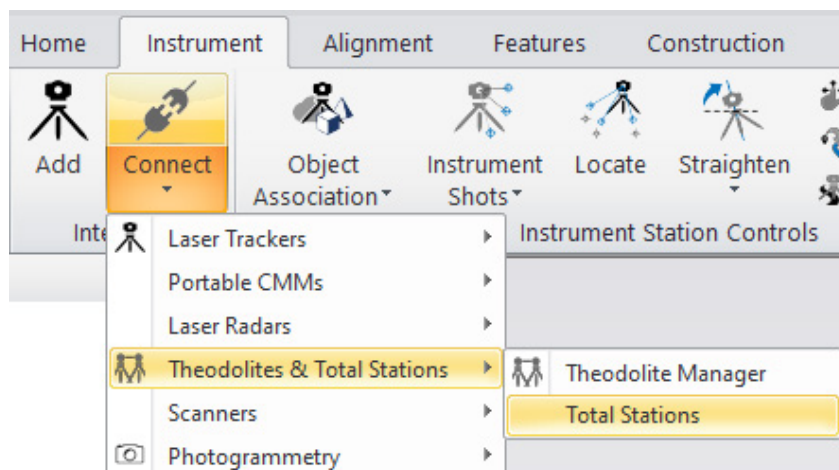
Figure 5-104. Selecting the Leica Total Station Interface

2. Enter the instruments COM Port or IP address (Figure 5-105). You will need to pre-configure the instrument's settings and connection which is details in the Quickstart Guide.

Figure 5-105. Enter the Instruments COM port or IP address
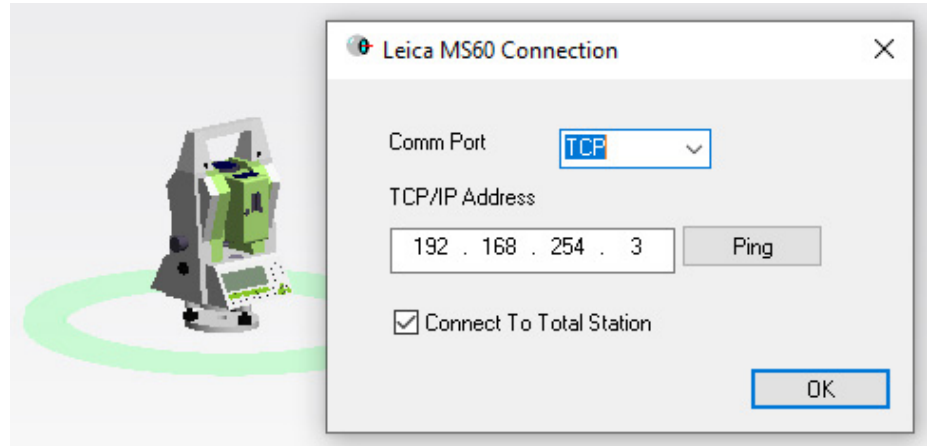
Total Station Interface

The Total Station interface should appear very familiar to SA Laser tracker users because much of the capabilities and functionality was pulled directly from it.

Target Management

Target definitions are managed through the Reflector Icon which opens the Reflectors and Targets database (Figure 5-106).
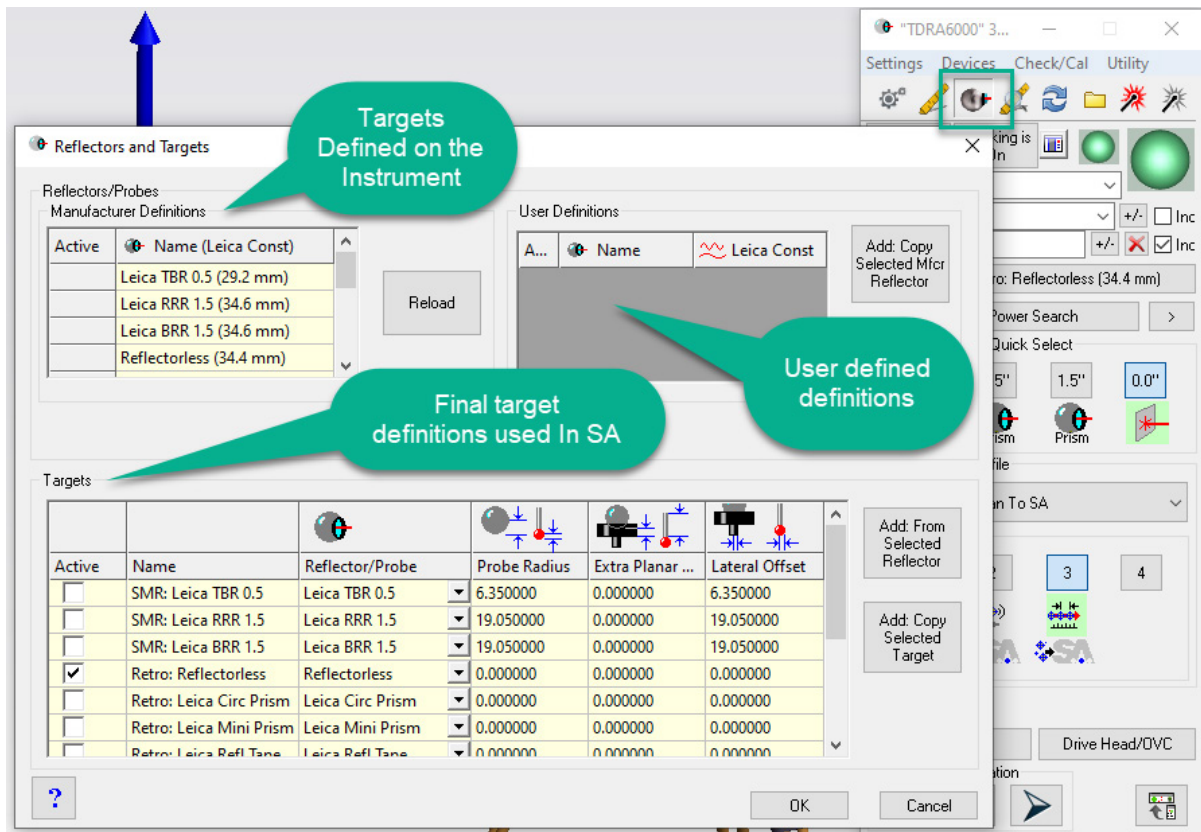
Figure 5-106. Reflectors and Target management

- **Manufacturer Definitions.** These are the target definitions defined on the scope and are the foundation for the target definitions used within SA. The Leica constant saved with the target will be reported. Use the Reload button to refresh the target list if changes have been made on the scope that are not reflected here.

- **User Definitions.** Custom target definitions can be built within the SA interface by adding a reflector definition and the reflector's constant.

- **Targets.** Targets are built from the manufacturer definition or User Definition and provide an option to edit the offsets saved with the points.

Atmospheric Corrections and Weather

The Weather Status Icon is the small traffic light next to the beam status icon. It also allows direct access to the weather settings if you double-left click on it (these can also be accessed through **Devices>Weather>Setup**) (Figure 5-107).
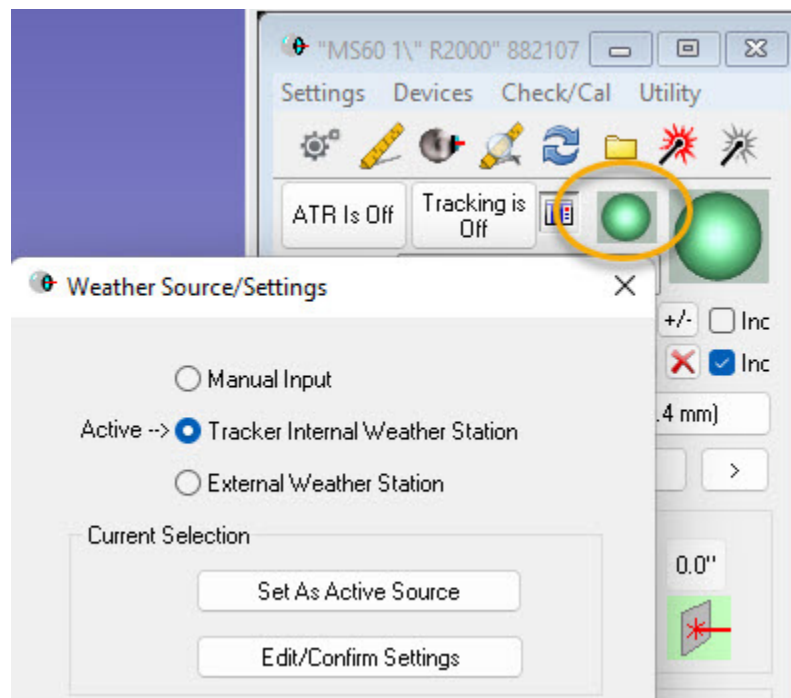
Figure 5-107. Weather or Atmospheric Correction settings

- **Manual Input.** When selected the Weather status icon will turn yellow as a reminder to check the settings on a regular basis. Editing the values manually will push the new settings to the scope for Atmospheric correction.

- **Tracker Internal Weather Station.** This will record the current settings from the instrument with each shot. It is up to the user to adjset these values on the instrument.

- **External Weather Station.** Alternatively a external weather station can be plugged into the computer and used to set the weather readings on the scope. SA will pull the readings from the weather station and push them to the instrument in this mode. This works well for example if you have an AT MeteoStation.

If there is a problem reading from the selected weather source the weather status icon will turn red.

To add a new target:

1. Select a Manufacturer Definition or User Definition to use for the target by clicking on the definition and highlighting it.

2. Press the Add: From Selected Reflector button to select a tooling offset to include with the point. More than one definition can be built at one time (you can build a 1.5" red ring reflector and a Pin nest definition at one time).

3. Press OK to build the new target definition. Measurements will use the selected reflector displayed in the measure button and can be assigned to one of the 4 quick selects by right clicking on the target definition (Figure 5-108).
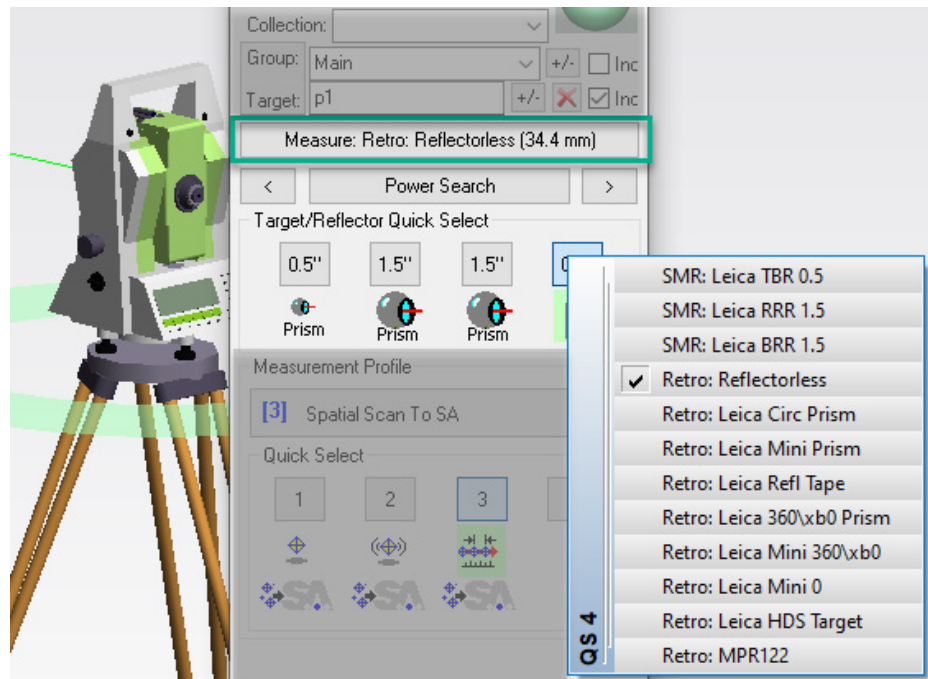
Figure 5-108. Active Target and Target Quick Select Options

ATR / Tracking and Search

ATR Control

Unlike the Theodolite Manager which had an On/Off switch for each specific target, the Total Stations Interface has a single On/Off control. When ATR is enabled it will be used to center on all reflectors.

Tracking Control

Tracking is used to send updates to SA and monitor the current beam location. Unlike the Theodolite Manager, tracking only needs to be turned off to conserve battery life.

Target Search Options

- **Power Search.** The Power Search controls are available directly under the Measurement button. The Left and Right buttons can be used to perform a full 360 scan in either direction, while the Power Search button will trigger a region scan (when enabled) and can be used with a right-click to access the Power Search configuration dialog.
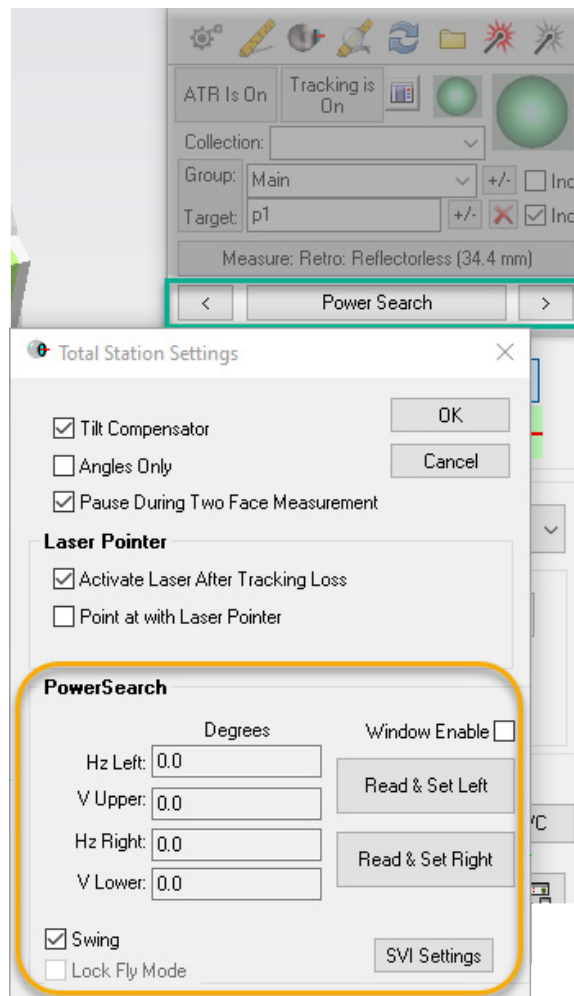
Figure 5-109. Power Search Controls and General Instrument Settings.

- **Find Target.** The find target option can be used as an alternative to Power Search and performs a spiral search for a reflector.

- **Dive Head/OVC.** This button provides access to both the manual drive controls to point the instrument in a desired direction, and access to the Overview Camera for instruments that provide that option.

Target search settings are drawn from and pushed directly to the instrument. Therefore they are not saved

Camera Operations

The Drive Head/OVC button provides access to the camera and real-time video display (Figure 5-110).

Figure 5-110. Example Video window displaying the current view through the instruments camera.
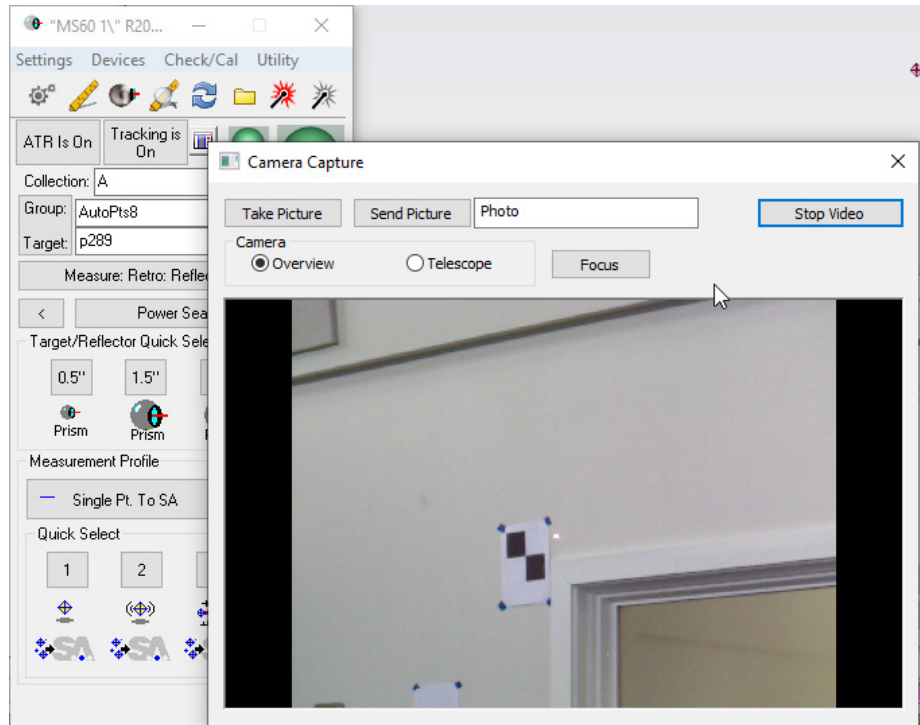
The button functions are as follows:

- **Take Picture.** This button refreshes the current image from the selected *Overview* or *Telescope* lens. The Focus button triggers the selected lens to refocus.

- **Send Picture.** This button takes the specified name from the entry field and saved the current image in the SA tree using the specified name.

- **Start/Stop Video.** This button enabled the real-time VLC embedded video display. The video will appear within the same window and clicking on the video can be used to drive the instrument to the selected point.

The current version of SA requires a special 32bit version of the VLC player to be installed. This version is available here:

http://www.kinematics.com/ftp/SA/Install/Driver%20Downloads/TotalStations_Theodolites/Leica/Leica%20Nova%20MS60%20Drivers/vlc-3.0.1-win32.exe

The VLC player will need to be run once independently of SA prior to its use within SA in order to register its path with windows.

Measurement Profiles

A measurement is defined by a measurement rate, duration and the data that is returned to SA. This measurement definition is called a **Measurement Profile** and can be selected from the drop down list or the measurement profile Quick Select list (Figure 5-111).
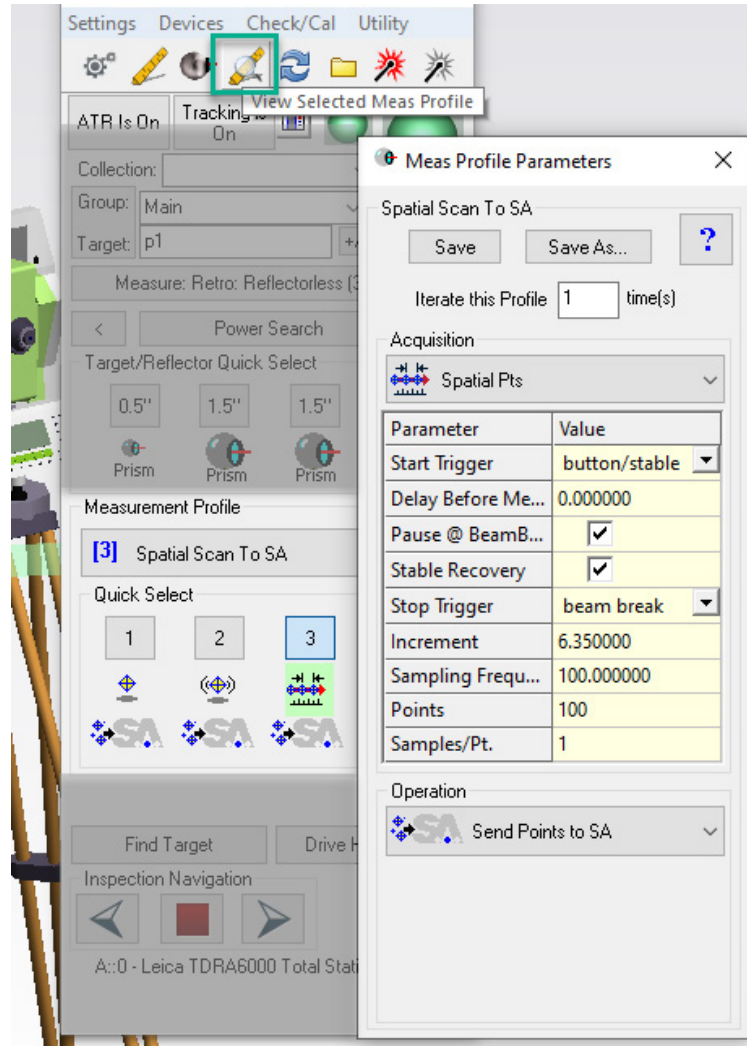
Figure 5-111. Measurement Profiles

Each measurement profile is composed of two sections:

- **Acquisition.** Defines how a measurement is taken. For example in the **Spatial Pts** profile above the "**Increment**" filed defines the spacing in the scan. Each profile has a list of fields that can be edited providing full control over the measurement process.

- **Operation.** Defines what data format to send to SA. This can include points, clouds, geometry or a combination of such.

Stationary Measurements

Total Stations Interface provide 3 levels of accuracy. The difference between these modes is the measure time:

- **Fast Point.** Performs a 1/2 second measurement

- **Standard Point.** Performs a 2 Second Measurement
- **Precise Point.** Performs a 5 second measurement, not available in all scopes.

Any measurement profile can be set to use these modes but basic controls are easily apparent when using the instrument toolbar (Figure 5-112).
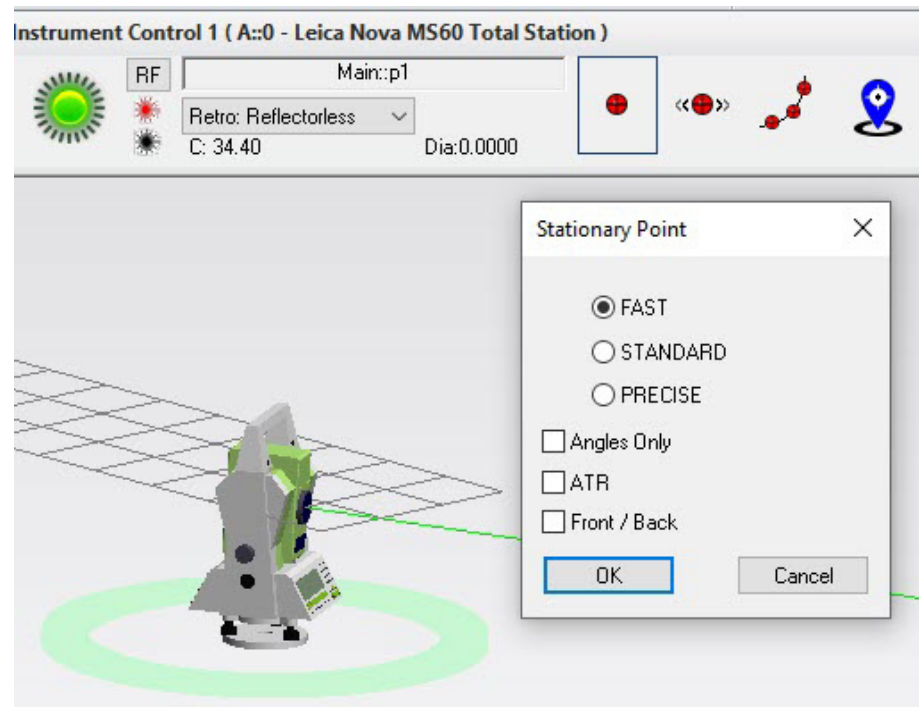
Figure 5-112. Stationary Measurement Modes

Additional controls include:

- **Angles Only.** These measurements
- **ATR.** The ability to turn ATR on or off is available for applicable targets.
- **Front/Back.** Offers the ability to automatically perform a front/back face measurement. The Instrument Settings also offer an option to enable or disable prompting for back face measurements (see Figure 5-109).

Stable Point Measurements

Stable point measurements use a scan operation. The move distance and duration threshold can be adjusted in the Settings. Stable point measurements can also be used with either Fast, Standard or Precise measurement modes.

Perimeter Scan

This profile provides the ability to perform a grid scan within a defined perimeter. Use the **Line Spacing** and **Point Spacing** to define a grid of evenly spaced lines and equally spaced points along the lines. To use

the profile it must be opened and a perimeter selected from within SA or a set of points that are used to define a perimeter.

Nova Scan Profile (MS60 Only)

Scanning with the MS60 is accomplished using the **Nova Scan** Measurement profile (Figure 5-113).
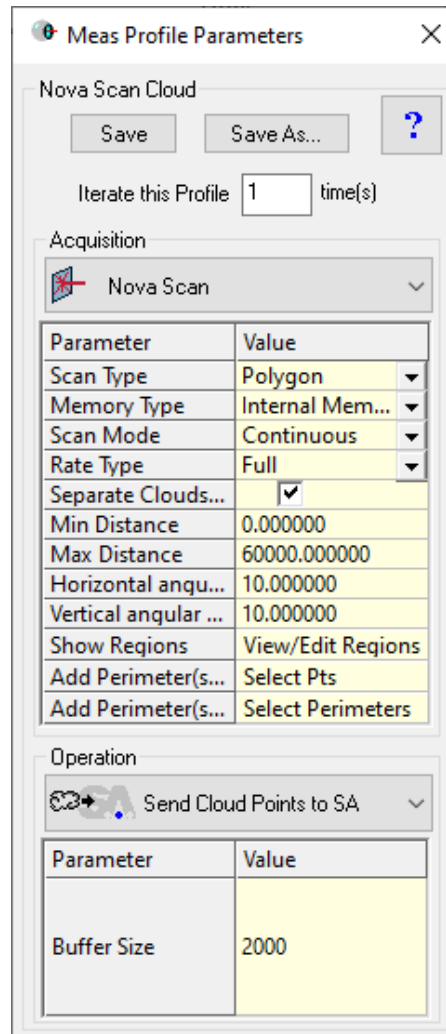
Figure 5-113. Nova Scan Measurement Profile

- **Scan Type.** Choose the scanning Method. The polygon is the most common scan, using the selected perimeter or points defining a perimeter. Rectangle is a simple version of this, using only 2 points to define a rectangular area. Dome scans are also available for newer MS60 models and can be used with 2 points to define a band (where the 2 points define the upper and lower limits of the band). A Dome scan without any points selected will perform a full 360 room scan.

- **Memory Type.** The scan data is first saved locally either on the scope or the SD card in the instrument.

- **Scan Mode.** Continuous is the typical method and performs

a continuous scan. Point to Point can also be used for greater accuracy and uses a stope and go progression from point to point.

- **Rate Type.** The resolution settings for the scan can be adjusted here. The MS60+ can now accept specific rates up to 30KHz.

- **Separate Clouds Option.** When enabled this option saves scans of separate polygons as separate clouds in SA.

- **Min & Max Distance.** The Min and Max distance settings are used as filters to limit data collection beyond these values. *The Min Distance and Max Distance headers can be used as buttons to measure the current beam distance.*

- **Horizontal & Vertical Angles.** The Vertical and Horizontal angles options are also filters that limit the extents of the scan. *These headers can also be used as buttons to measure the beams current orientation.*

- **Show Regions.** Opens a dialog displaying the currently defined regions saved in the measurement profile.

- **Add Perimeters.** These options are used to select perimeters or points defining perimeters from within SA and will initiate a selection mode.

Instrument Toolbar

The Total Stations interface also supports its own instrument toolbar. This streamlined interface provides direct access to the most common functions (Figure 5-114).

Figure 5-114. Total Stations Toolbar.

Available operations include:

- **Beam Status.** As well as showing the current status of the beam you can double click on it to issue a Find Target command.

- **RF.** The RF button is short for Reverse Face and can be used for that application.

- **Laser Controls.** The Red and Black icons control the On and Off switch for the instruments laser respectively.

- **Point Name Control.** The point name control is used to define the starting name for the next measured Collection Group and Target. When scanning the group name will be used for the point cloud.

- **Reflector Selection.** At the bottom of the reflector selection drop-down list is an option to "*Define Target*" which will open the reflectors and targets database. The Constant and probe diameter of the selected reflector are shown.

- **Query.** The query button offers a means to trigger a position update from the current beam location. If locked onto a reflect it will take a fast measurement.

- **Single Point.** Right-click on any of the single point measurement modes to access point measurement settings (see Figure 5-112). The same options are also available for Stable point measurements.

- **Spatial Scans.** Spatial scans can be performed by many total stations. Right-click to access the spatial increment, stable start, and Loop & Iterate trapping controls.

- **Tracking.** When tracking is On the instrument will constantly send position updates to SA for watch window applications and dynamic monitoring.

- **Power search.** Powersearch Left and Right icons. The power search region can be enabled within the settings.

- **Level Compensator Status.** The level compensator status icon can be used to turn on and off the level compensator.

- **Alarm Icon.** The alarms icon provides access to the current instrument settings for weather, level, battery, and RMS. Warning thresholds can be set for these values.

- **Settings.** Provides direct access to instrument specific settings including target measurement and powersearch options.

- **Battery Icon.** Displays the current battery status.

- **Joystick/Camera Control.** Offers access to the direct instrument drive controls and the instrument camera when available.

- **Switch Interfaces Icon.** This button provides the ability to switch to the full interface.

Additional Utilities

Additional instrument specific settings and utilities can be found in the instrument settings and under the Utilities menu. The following notes may be helpful:

- **Battery Status.** The battery Status can be found by double clicking on the Beam state display or by going to **Utilities>Tkr Status.**

- **UDP Data Stream and SA Remote.** The Total Station interface offers the ability to connect and drive the instrument using the SA Remote app which can be downloaded from you're Apple App Store. Refer to the Users Manual for more information. An Android app is also available for download from the Kinematics web page.

AutoMeasure Operations

The total station interface offers the ability to use manu of the auto measure operations from within SA including:

- **Auto Measure Points.** Provides a means to measure a group of points automatically in any way needed.

- **Auto Measure a Vector Group.** Is similar to measuring points, offers full control and uses a vector group as a reference.

- **Measure Batch of Vectors.** This automated option also measures a set of vectors but does so using a Surface Vector Intersection algorithm such that it searches along a nominal vector to find the point at which this vector intersects the actual surface. The tolerances can be adjusted within the total Station Properties using the SVI Settings button.

Total Stations Interface MP Commands

Total Stations	
Basic Operations	
Start Instrument Interface	Starts the Total Station Interface. Use interface Type 0 in Argument 3 for the Leica Total Station and 1 for the Theodolite Manager
Set Instrument Measurement Mode/Profile	Offers an option to set the active Measurement Profile.
Set Instrument Group and Target	Offers a means to set the Group and Target Names for the next measurement.
Measurement Controls	
Auto Measure Points	Performs a points based automatic measurement
Auto-Measure Vectors	Performs a vector group based automatic measurement
Auto-Measure Surface Vector Intersections	Performs a surface vector intersection measurement at each point location.
Configure and Measure	Measures a point using the specified name and meas profile
Point At Target	Points at a selected point
Scan within Perimeter **	Scan within perimeter is supported but does not offer any resolution control.

Total Stations	
Instrument Operational Checks	
Set Laser On	Turns on the red laser pointer
Set Laser Off	Turns off the red laser pointer
PowerSearch	PowerSearch performs an automatic and rapid search for a prism.
Set Tracking On	Enables Tracking, an already targeted prism is followed automatically.
Set Tracking Off	Disables Tracking
Set ATR On	Enables ATR (Automatic Target Aiming) for precision target centering
Set ATR Off	Disables ATR centering

Measuring With Photogrammetry

Photogrammetry systems use either photo or video capture to triangulate the position of many target locations all at one time. The can be done with a great deal of accuracy. For this reason Photogrammetry has become an integral part of metrology. Photogrammetry system vary greatly in their capability. Refer to the specific manufacture for greater detail.

Photogrammetry Quick-Start Guides

Aicon DPA

This quick-start guide can be used for initial configuration, connection and basic operation of the AICON Move Inspect DPA Photogrammetry system within SA. For more details on instrument operation and configuration, please contact AICON directly.

Hardware Setup

Set up the AICON MoveInspect system following the Manufacturer's directions.

Software Setup

SA uses a built in SDK to work with the DPA system but the AICON DPA Pilot needs to also be installed on your machine. It would be best to contract the manufacturer directly for the recommend version for your system, but a version of the Pilot software can be access on our webpage here:

https://www.kinematics.com/ftp/SA/Install/Driver%20Downloads/Photogrammetry/AICON/

The DPA system require a separate AICON license dongle for operation.

Starting the SA Interface

1. Within SA select **Instrument > Add** and choose the AICON DPA System from the Instrument List (Figure 6-1). Press the Options button and ensure that the Increment Value is set to 0 (Figure 6-2). You may also want to inclue a tripod in the model because a graphical instrument currently is not available. This only needs to be done the first time you connect. Press the Add Instrument button to add the instrument to SA.

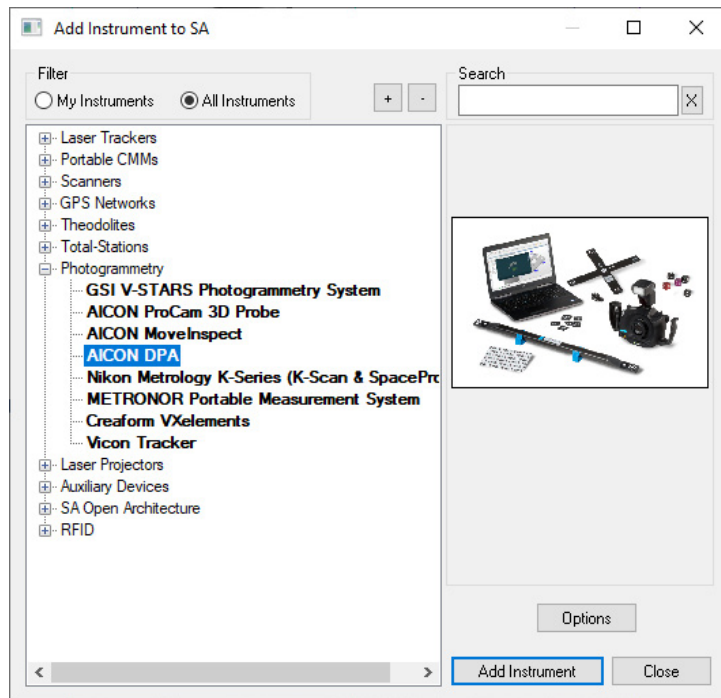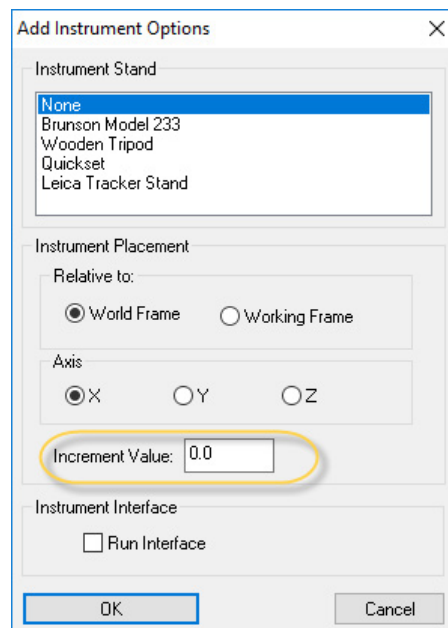**Figure 6-1.** Adding the Aicon DPA system to a new SA Job file

Figure 6-2. Instrument Placement Control

2.   Start the instrument interface using **Instrument > Run Interface Module and Connect** or 🏃 . The Aicon DPA system will open (Figure 6-3). If you see a "Wrong or missing license!" error check that the Aicon DPA dongle is plugged into the computer.

Instrument Interface Specifics
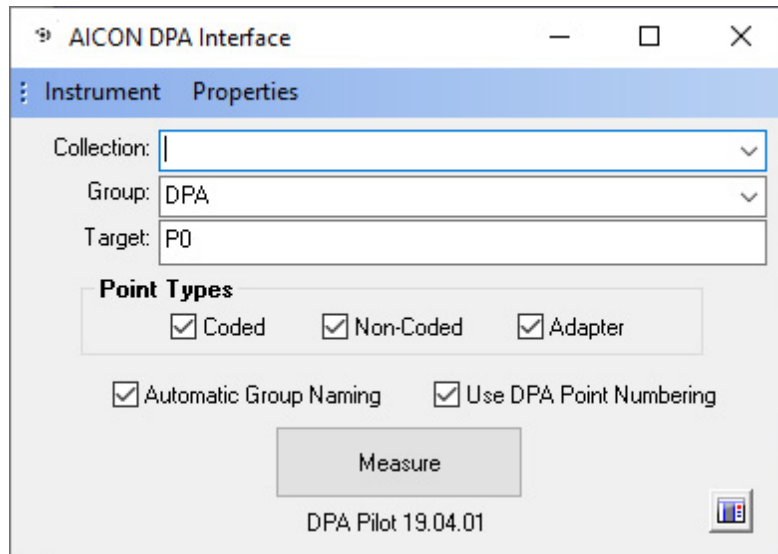
Figure 6-3. The Aicon DPA Interface

The **Instrument** menu provides project management controls including the following:

- **Load Project.** Which will open a selection utility to select an available project. Once loaded the Measure button will become a Continue button that can be used to directly access the project.

- **Import Project.** This option imports the points from the selected project so that the data can be used within SA, but does not load the project.

- **Close Project.** This option exits the currently open project.

The **Properties** menu provides configuration tools for DPA including the following:

- **GUI.** Within the GUI selection is a set of display configurations including (Advanced, Shop Floor, Reduced, and Minimal). These settings change the display configuration of a project when it is opened providing successively reduced complexity an user options.

- **Component Gallery.** The component gallery can be accesssed directly through this option. This provides easy of access for editing templates and components used within projects.

Point Naming and Import Controls

An SA standard Collect, Group, and Target point name control is avail-

able as part of the DPA interface but is not needed most of the time with the default two options enabled:

- **Use DPA Point Naming.** Ensures the imported points will have the target index numbers as their names.

- **Automatic Group Naming.** This option with build separate groups for Coded, Uncoded, and/or Adpater points.

The Group and Target names entered will only be used if these options are disabled.

The Point Types control allow you to import only those point types of interest from the selected project. Only the checked options will be imported.

- **Coded.** These targets will be named in the range of 1-516.

- **Non-Coded.** These targets will be named in the range of 1,000 to 5,000

- **Adapter.** These targets are returned with numbers >10,000.

Press the Measure button in the SA interface to begin the DPA configuration and measurement process. If you have loaded a project the text will change to Continue.

Project Management Basics

Template Configuration:

The first step is to either select an existing template, import one or build a new one. **Templates** are used to manage settings and components used in a project. Components include:

- **Cameras.** Camera type, settings and calibration information

- **References.** Points and know geometry used as a reference in a measurement (typically a reference cross).

- **Scales.** Like a scale bar scales are composed of 2 well known targets with a calibrated distance.

- **Adapters.** Adapters are defined constellations of points that are used to compute the position and orientation of reference points or frames.

Figure 6-4. Templates
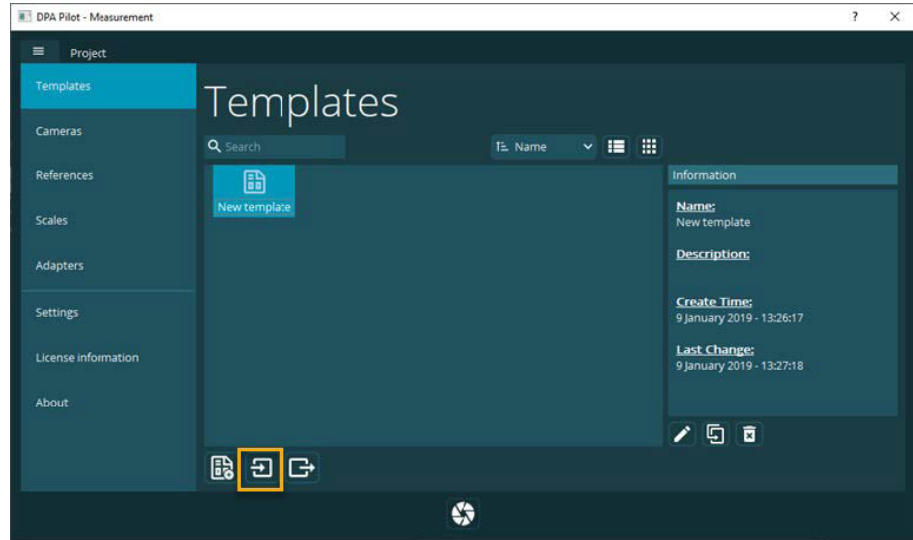
Templates can be imported using the import button highlighted in (Figure 6-4).

Each project has a defined template which includes the camera and accessories used. This template configuration can also be accessed from the **Properties>Component Gallery** menu.

Image Import or Capture:

The Camera referenced in a project defines the way in which images are imported. Image **Transfer Mode** can be set to the following opions:

- Memory Card. Which allows for a system wide file browse and selection. Make sure the resolution of the camera that took the photos match that of the images or they will not import.

- WiFi Transfer directly. Which allows direct transfer and processing of images captured with a DPA Professional system + WiFi module.

- WiFi: C1. Which allows direct transfer and processing of images captured with a C1 camera.

Camera configuration and connection

The camera wireless connection should be setup as follows:

- The drivers for the camera are included in the DPA Pilot software which should have been installed initially.

- Turn on the camera and its WiFi connection and you should see the network available in your compute network control. Note that the default password to connect to a C1 camera is "HMI-Aicon".
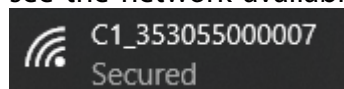
- ▪ Once connected a new Camera device should appear in your list of Devices and Drives.
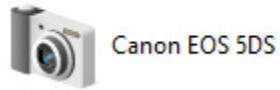
Basic example of importing data to SA

To work with an existing set of images, set your camer to Memory Card Transfer Mode, and begin a new *Measurement Project.* You will see the option to import images (Figure 6-5).
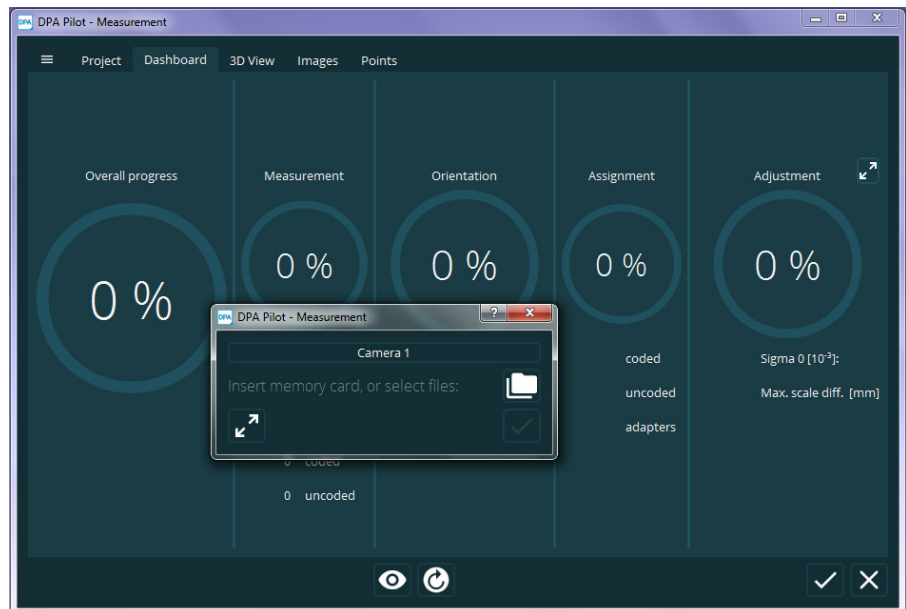
Figure 6-5. DPA Image Import

As soon as images are loaded the computation process should begin and the progress of this process is displayed on the dashboard(Figure 6-6).

Figure 6-6. Dashboard progress display.
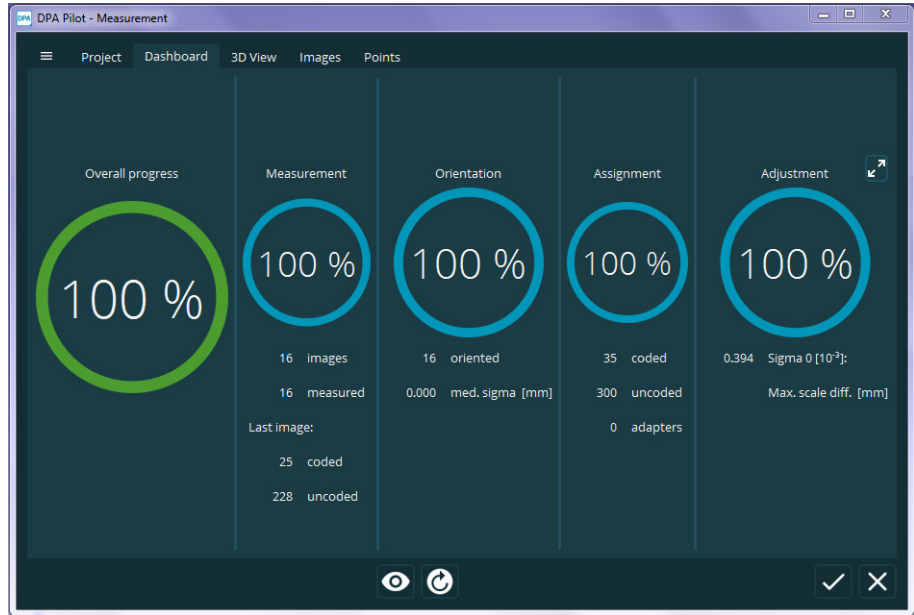
Once the computation process is complete the images and points can be viewed within the PDA Measurement window on their respective tabs.

Pressing the accept check mark ✓ at the bottom right side of the screen will pass the computed points to SA.

Below is an example set of points imported from the Car Door Tutorial file available from Aicon (Figure 6-7).

Figure 6-7. Automatic Group Naming as a result of importing points from an example DPA project.

Aicon Move Inspect

This quick-start guide can be used for initial configuration, connection and basic operation of the AICON Move Inspect Photogrammetry system within SA. For more details on instrument operation and configuration, please contact AICON directly.

Hardware Setup

Set up the AICON MoveInspect system following the Manufacturer's directions. This will depend on the camera configuration and system type. Ensure you have the appropriate camera mounts, tripods, and cabling to power the unit.

- Communication with SA is done through TCP/IP Ethernet connection so an appropriate network connection is necessary. Use the IP Configuration program within the MoveInspect directory to configure the IP's of the cameras which are typically on the 192.168.0.x network.
- Control over the dynamic reference system from SA was added in 2017 and requires MoveInspect v7.01.06 or later.

Software Setup

SA does not interface with the cameras directly but rather with the host application, AICON MoveInspect. Therefore, MoveInspect must be installed, calibrated, and running on the local machine prior to any attempt to connect to SA.

- Please contact AICON directly to obtain the correct version of MoveInspect for your camera system and install it following the manufacturer recommendations. (http://aicon3d.com)
- You can verify SA's current version compatibility by looking in

the SA readme file available under the Help menu within SA.

Probe, Adapter and panel setup and calibration must also be performed within MoveInspect. Target recognition and interpretation is also performed within MoveInspect. Once correctly configured SA can acquire any of 3 data types from AICON these include:

- Point measurements from coded / noncoded targets, probes and adapters.
- A constellation of points from coded targets and panels
- 6D Frames from adapters

Basic MoveInspect Connection

Start MoveInspect software before attempting to connect to the instrument in SA.

3. Select a "Configuration" from the "Administration" Menu (Figure 6-8). A configuration defines the measurement environment and the configuration of the camera system. This includes both the probe definition and any adapters. These must be configured in order to be used within SA.
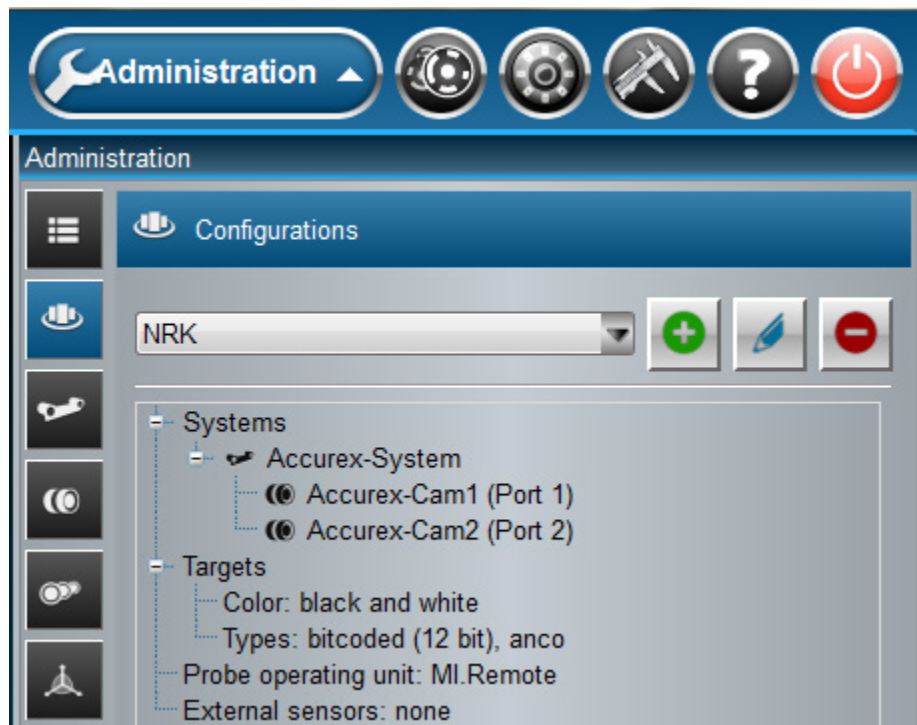
Figure 6-8. Configuration Selection from the Administration page.

4. To begin measuring, go to the Measurement menu and from the Connection page select Connect (Figure 6-9), this may be done automatically in newer versions of MoveInspect.

Figure 6-9. Connecting within MoveInspect.
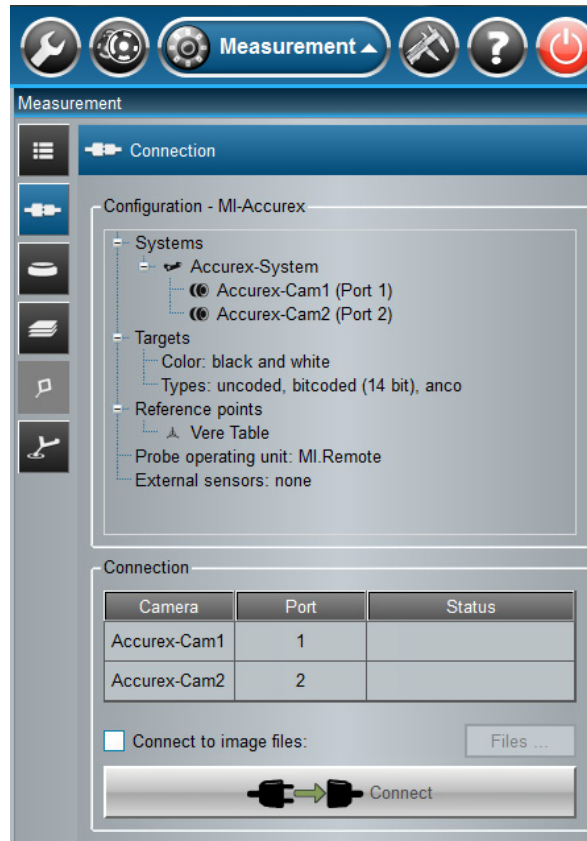
5. Once connected you can switch to the Measurements page in MoveInspect. All subsequent measurement control can be performed within SA.

Starting the SA Interface

1. Within SA select **Instrument > Add** and choose the AICON MoveInspect System from the Instrument List (Figure 6-10). Press the Options button and ensure that the Increment Value is set to 0 (Figure 6-11). This only needs to be done the first time you connect. Press the Add Instrument button to add the instrument to SA.

Figure 6-10. Adding the Icon move Inspect System
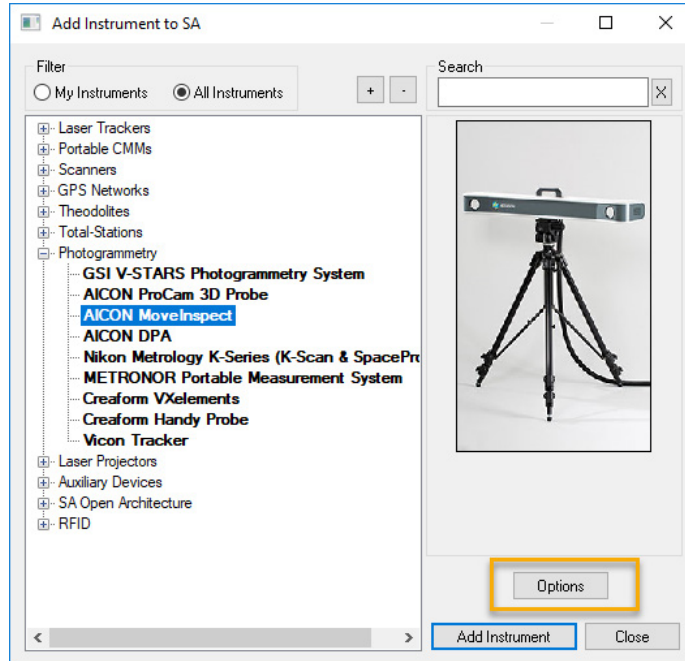
Figure 6-11. Add Instrument Placement Control
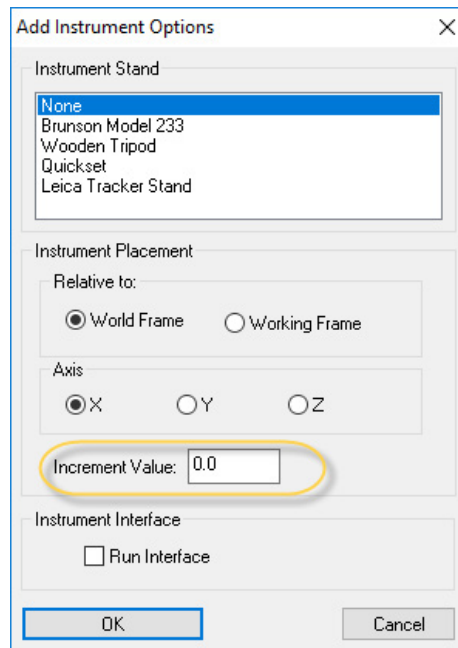
2. Start the instrument interface using **Instrument > Run Interface Module and Connect** or 🏃 .

3. When the interface opens, press the Connect [F9] button to establish a connection with Aicon MoveInspect (Figure 6-12).

Figure 6-12. Starting the Server
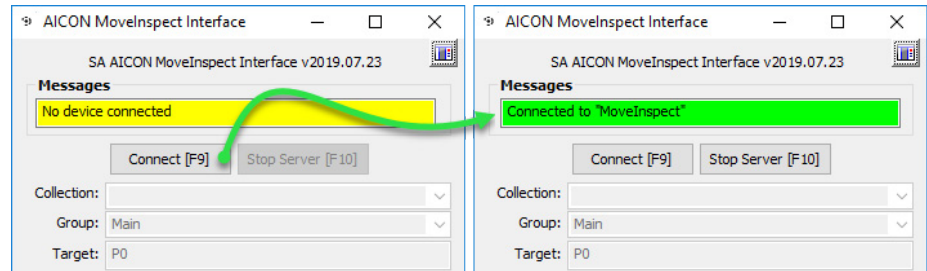
Instrument Specific Operations

The primary controls within the AICON MoveInspect Instrument Interface are as follows (Figure 6-13):

- **Measurement Mode.** User to switch between Probing and Tracking. Probing uses the MI probe and defined tips, while Tracking mode is needed for coded/uncoded target measurement as well as all adapter operations.

- **Reference.** The dynamic reference set within MoveInspect can be both controlled from within SA by name and new references can be defined and enabled.
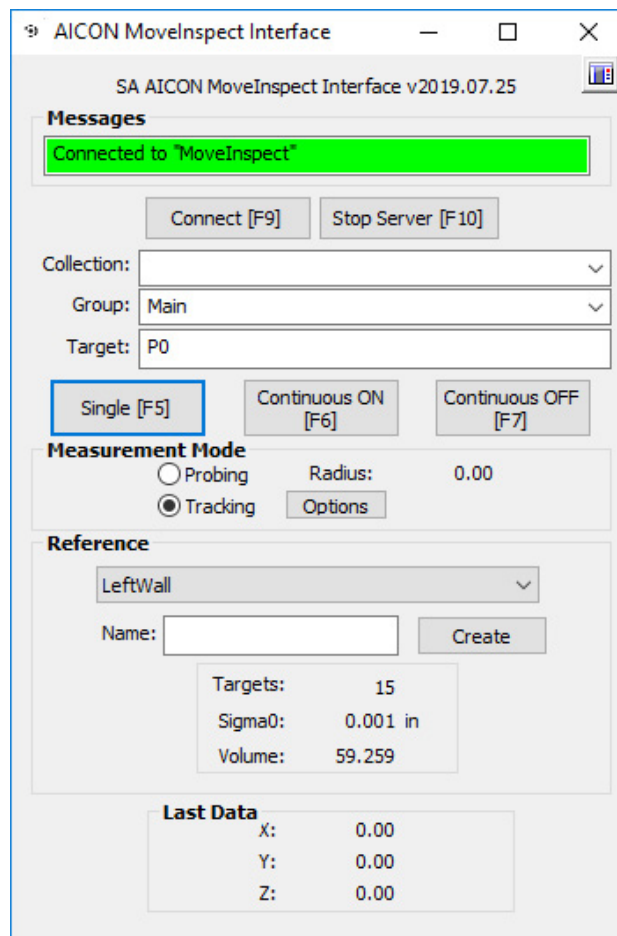
Figure 6-13. Aicon Measurement Control and the SA Interface

Probing

In **Probing** mode, full control over Collection, Group, and Target designations are set from the designated fields and the displayed probe radius will be saved with each point taken.

Tracking

In **Tracking** mode the Options button should be used to ensure that the desired measurements filters are in place (Figure 6-14).
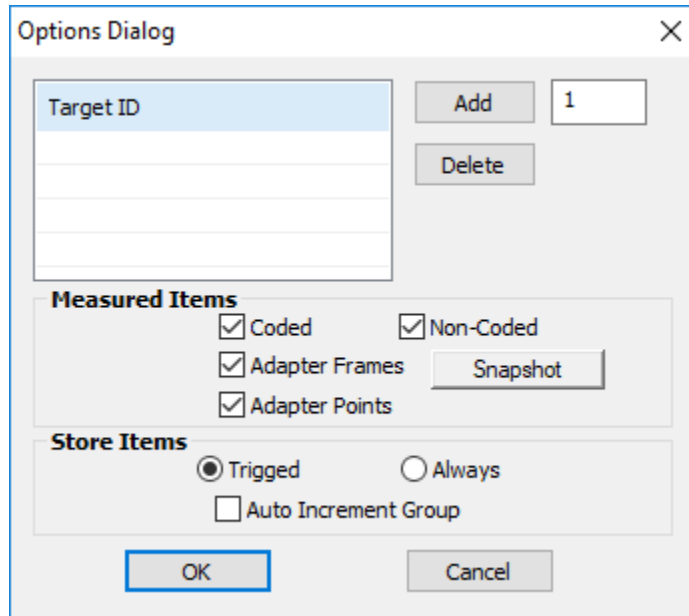
Figure 6-14. Options controls for tracking mode acquisition

The **Target ID** list can be used to identify and measure only specific named targets (coded or non-coded) by number. It operates in either of two modes. If the list is empty then all visible targets will be measured. Alternatively, if specific numbers are added then only those specific targets will be recorded.

The **Measured Items** selection presets master controls to turn on or off targets of different types. When a measurement is taken the targets that are enabled in this section will be recorded within SA.

Adapters. All of the visible adapters in the current MoveInspect configuration will be recorded to SA when in Tracking mode and the adapter options are enabled in the **Measured Items** section. A single adapter can be defined such that it returns a frame or set of frames as well as a set of return points. Point naming is based upon the designated adapter naming, not the dialog target name.

- **Probing Frames.** Frame measurements recorded from an adapter will use the Frame names defined within the adapter. This means that if a measurement has already been taken in SA and the adapter frames already exist, then no additional frames will be created. Instead, each measurement will update the transform of the existing frames within SA. This can be very

helpful in updating a frame to frame relationship and can directly be used in trans-track operations. In order to record static 6D measurements and record these frame measurements as separate frames, the Snapshot button must be enabled. The adapter frame name and a timestamp will be then returned with each measurement.

- **Adapter points.** Adapter point measurements will also use the point names designated in the adapter definition along with the Group name specified in the Aicon Interface. Each measurement will be recorded as a separate observation on the existing points unless the **Auto Increment Group** option is enabled in the **Store Items** section.

Store Items. The Store Items section controls how and when measurements are stored in Tracking mode.

- **Triggered.** With triggered enabled measurements will be taken when the MI probe button is triggered only.

- **Always.** With this option enabled all the visible items will be recorded when the **Single** measurement button is pressed or sequentially as long as a **Continuous** measurement is active.

- **Auto Increment Group.** Is used to separate each sequential measurement in separate groups as apposed to recording additional observations on existing points.

Dynamic Reference. This section is used to set and define the dynamic reference within MoveInspect. The drop down list will be populated with the reference systems currently defined within MoveInspect automatically when you connect.

To define a new Dynamic Reference do the following:

1. Take a single Measurement of all visible reference points. Optionally, construct a frame relevant to these points (by probing features or fitting CAD to the points, etc.) and make this the working frame.

2. In the SA Interface for MoveInspect, type in a name for the Dynamic Reference and select Create (Figure 6-15). Once active, the MoveInspect software should reflect the new Dynamic Reference in the "Measurement" menu.

Figure 6-15. Defining a new Dynamic Reference
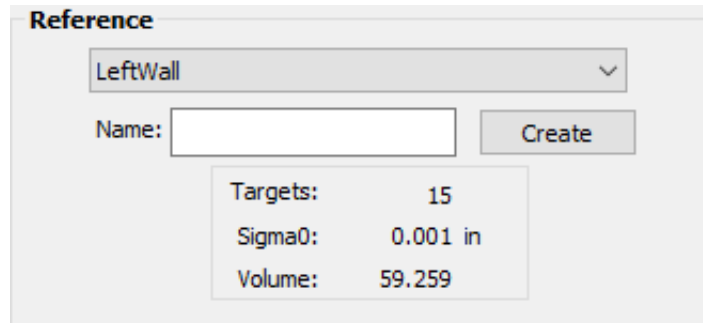
Once the reference is active, the points involved in the reference are no longer measured into the SA file, but they are being used to update the instrument position relative to the points (Figure 6-16).

Figure 6-16. Activated Dynamic Reference in MoveInspect
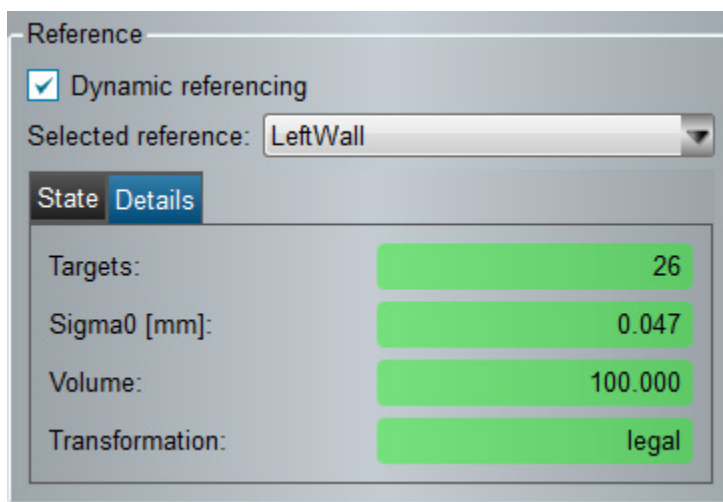
- To disable the active dynamic reference system select the "*None*" field from the first row from the drop down list.

The status of the Dynamic Reference is determined by the thresholds set for the reference. This is done as part of Administration in MoveInspect and include the following parameters:

- **Min Target Count.** How many reference points must be visible.

- **Max Sigma.** The upper uncertainty threshold for the transform.

- **Min Volume (%).** The minimum volume covered by the visible points as a percentage of the full volume if all points were visible.

Notes on the Probe:

The MI Probe interacts through a Bluetooth connection directly with the AICON MoveInspect software (Figure 6-17). Connection and prove definition control is available in the Administration tab:

Figure 6-17. Probe Button Functions
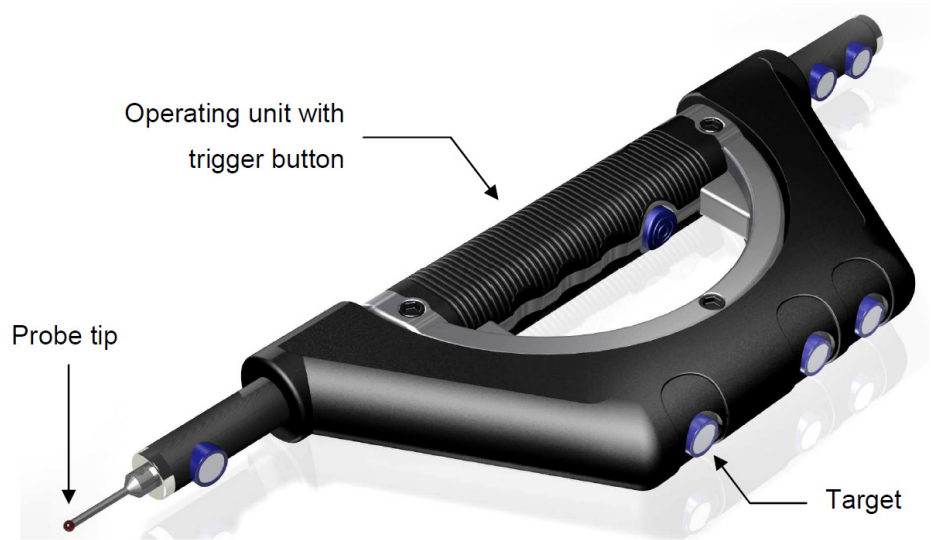
In probing mode the probe tip and probing vector is saved in SA. The probe measurement button can also be used to trigger measurements in Tracking mode and can be set as the trigger for measurements of the selected targets, through the *Store Items* radio buttons.

Notes on MP Script Controls:

In additional to general instrument operations there are a set of specific *Instrument Operational Check* commands available as part of a Measurement Plan (MP) script for AICON:

AICON MoveInspect	
Connect	Connects to the server and connects SA to MoveInspect.
Stop Server	Disconnects the communication between the interface and the MoveInspect software
Set Measure Mode []	Set the mode to: "Probing" or "Tracking" in place of [].
Set Filter []	Sets the measurement action to: "Coded", "NonCoded", "AdapterFrames", "AdapterPoints" followed by "True" or "False" in place of []. For example: "Set Filter AdapterFrames True".
Snapshot	Toggles the current Adapter frame setting from updating an existing frames transform to recording separate frames with each measurement.
Set StoreMode []	Controls the Store Items radio button selection. Use "Set StoreMode Triggered" or "Set StoreMode Always".
Measure	Initiates a Single Measurement.
Measure Continuous	Initiates a Continuous Measurement.
Stop	Stops the current measurement.
Set Reference []	Where [] is the Name of the desired existing dynamic reference system. No name specified deactivates reference.

Creating an Adapter

Adapters are a rigid constellation of target points that are used to define or represent an object. From this set of targets a set of return targets or frames can be defined such that a measurement of the coded targets returns a set of helpful and often hidden reference points. 6D frames can also be defined in relationship to this target constellation such that a single measurement of this constellation will compute

and return a set of adapter return point or 6D frames.

Adapters are defined in the MoveInspect software under Administration, much like a probe, and are added as part of a Configuration.

To define a new adapter the point name and position of the set of target points needs to be collected either from within MoveInspect or within SA and used to define a new adapter. An example of this process is as follows:

Within SA capture the point names and coordinates that define the new adapter's position in space:

1. Activate a DR (optional to hide any target points that would otherwise be recorded), set the Measure Mode to Tracking and open the Options dialog making sure that the coded or noncoded targets you want to use for the adapter will be recorded.

2. Place the adapter in the view of the camera's and take a Single (tracking) measurement to create a new point group from the adapter targets.

3. Construct a frame that is relevant to the points that compose the adapter. Construct additional frames or location points as desired in relationship to the target points.

Next, within MoveInspect do the following:

4. Create a new Adapter from the "Administration" menu in MoveInspect and select the appropriate target type(s) (Figure 6-18)

Figure 6-18. Adapter Configuration
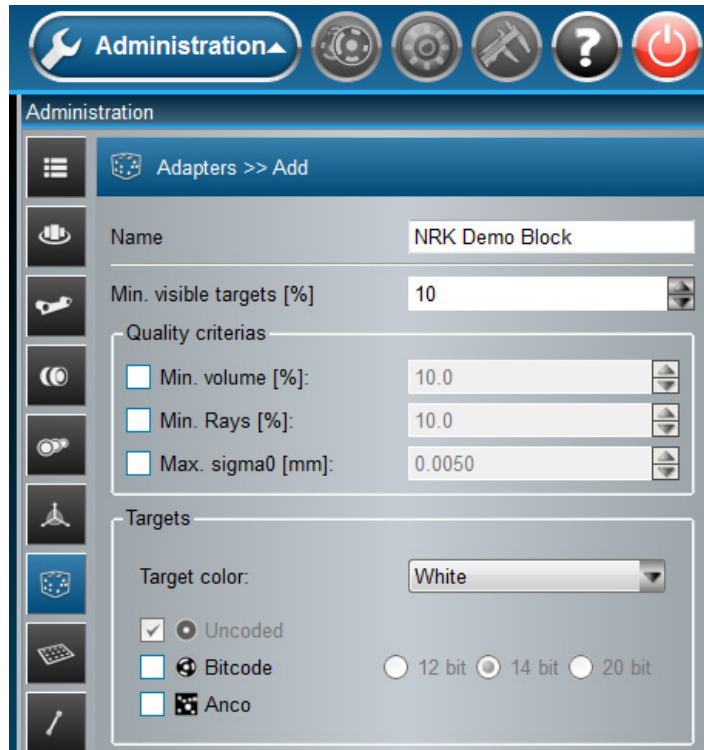
5. Copy both the Point Names and point coordinates of the measured adapter points from SA (Figure 6-19) and paste them into MoveInspect "Targets" (Figure 6-20). Leave "No." column 0 unless it's a coded target.

Figure 6-19. Copy Adapter Points from SA

Figure 6-20. Pasting Adapter Points into MoveInspect

6. Copy the transform of the adapter frame into the "6dof" tab. Don't change working frames between copying the Targets and 6dof!

The names can be pasted into their column from SA or the Targets can be given new names. An Adapter is defined by 3 tabs...

- **Targets.** are the measured targets used to define the adapter

- **Points.** are the computed adapter points that can be returned as part of a measurement.,

- **6Dof.** are the names and transforms of computed frames that also can be returned as a measurement.

A resulting adapter frame or set of return points should be defined. This makes it possible that when the adapter points are measured the resulting frame(s) transform is returned.

Figure 6-21. Adapter points and related frame built on an NRK part
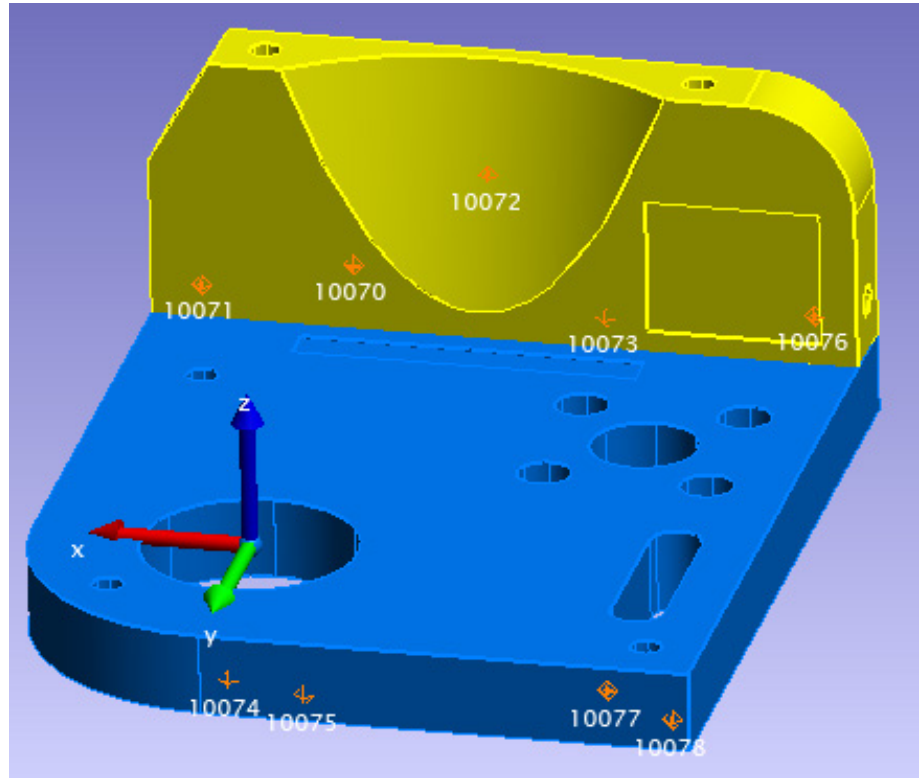
The coordinate and name of each return frame needs to be pasted or type into the 6DOF tab of the adapter definition. This frame could be defined anywhere but should be meaningful relative to the adapter targets, such as is shown in (Figure 6-21). In this example the NRK part has been defined as an adapter and the center of the large hole has been defined as a return frame. When a measurement is taken the targets are recorded in MoveInspect, the frames transform computed, and passed on as the frame measurement.

Figure 6-22. Applying Adapter base frame transform

The working frame should not change between copying the target coordinates and the adapter frame transform.

7. Save the adapter changes ![checkmark icon], then return to the Configurations tab ![adapter icon] of the "Administration" menu and edit the configuration to include the new adapter and save the configuration(Figure 6-23).
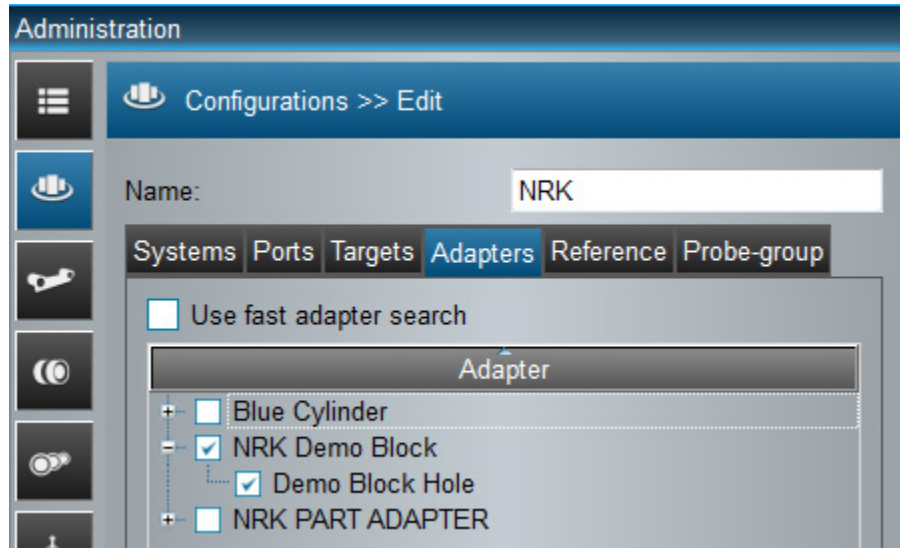
Now measuring Targeting/ Continuous/ Frames to SA will constantly update the position of a frame matching the adapter's 6DOF name (i.e. "Demo Block Hole") in the active collection.

Using an Adapter for Alignment

Once a dynamic reference and at least one adapter are defined, SA can be used to do some alignment or layout work. If the adapter is set up to come in as a frame, then a goal frame can be constructed in SA with respect to the points used as a dynamic reference. The frame representing the adapter comes from measuring the pattern of points on an object. A single measurement or snapshot with Frames to SA as the action will populate the SA TreeBar with the adapter frame(s). For real-time 6 degree of freedom feedback during the alignment process, first create a frame to frame relationship between the goal frame and the adapter. With a watch window on the relationship, the user can see the current position of the part with respect to the goal position.

For some added clarity to the user, CAD or SA Objects can be moved with the adapter frame in real time using the trans-track feature of SpatialAnalyzer. If this is desired, first move the objects to the adapter frame in its starting position. The starting position can be measured with a snapshot. Generally this can be accomplished with

a frame to frame transform (since the adapter frame is likely known with respect to the CAD), but it can also be accomplished with points to objects relationship fitting, for example. Once the objects are in the appropriate starting position, trans track can begin. **Edit > Move Objects > Transform in 6D using Instrument Updates**. With the measurement set as Targeting/Continuous/Frames to SA, the watch window on the Frame to Frame relationship will show the current 6dof deviation from the goal frame, and the trans-track will update the location of the CAD or SA Objects to match the current position of the adapter frame (Figure 6-24).
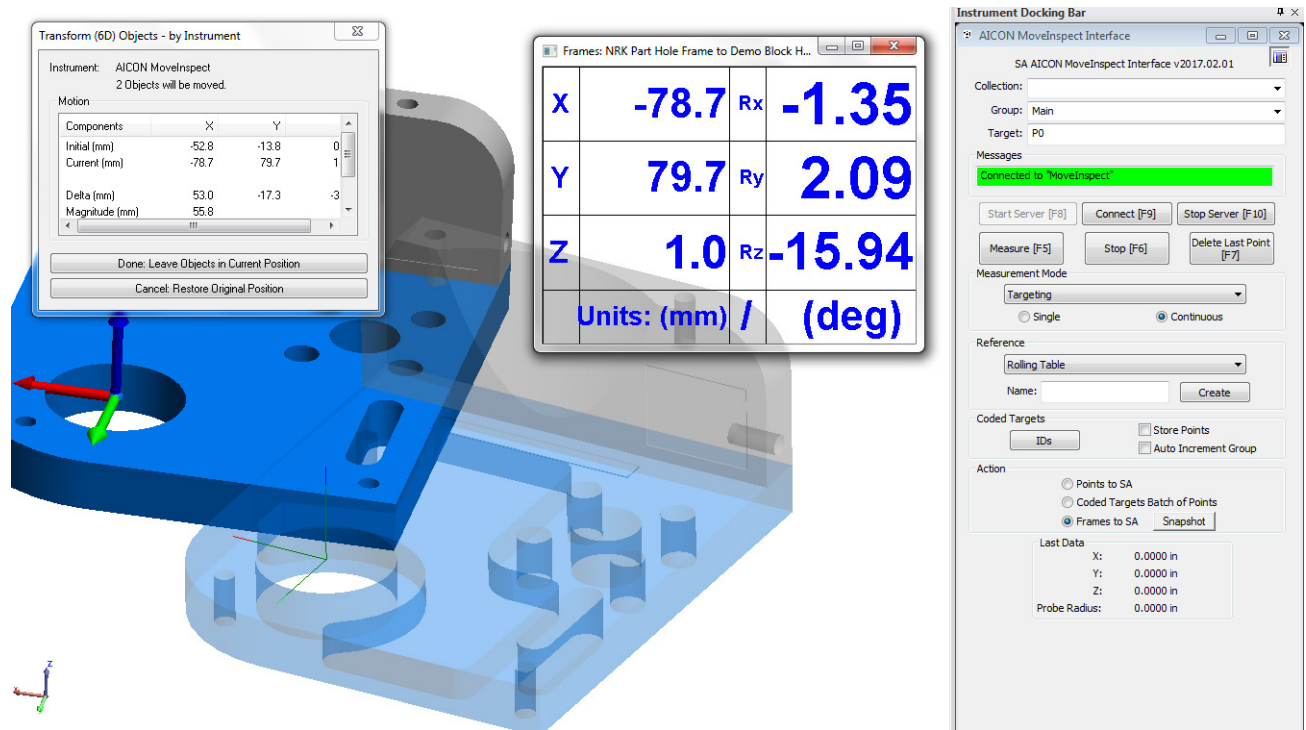
Figure 6-24. Using an Adapter with live updates in SA

Creaform VXelements

This quick-start guide can be used as an introduction to basic operation of the Creaform system within SA. SA communicates directly with VXelements which is used in the background for data capture, so for initial setup and calibration of the Creaform system contact Creaform directly.

Starting the Interface

1. Select **Instrument > Add** and choose the Creaform VXelements Photogrammetry System from the Instrument List (Figure 6-25).

Figure 6-25. Adding a the Creaform VXelements System to SA
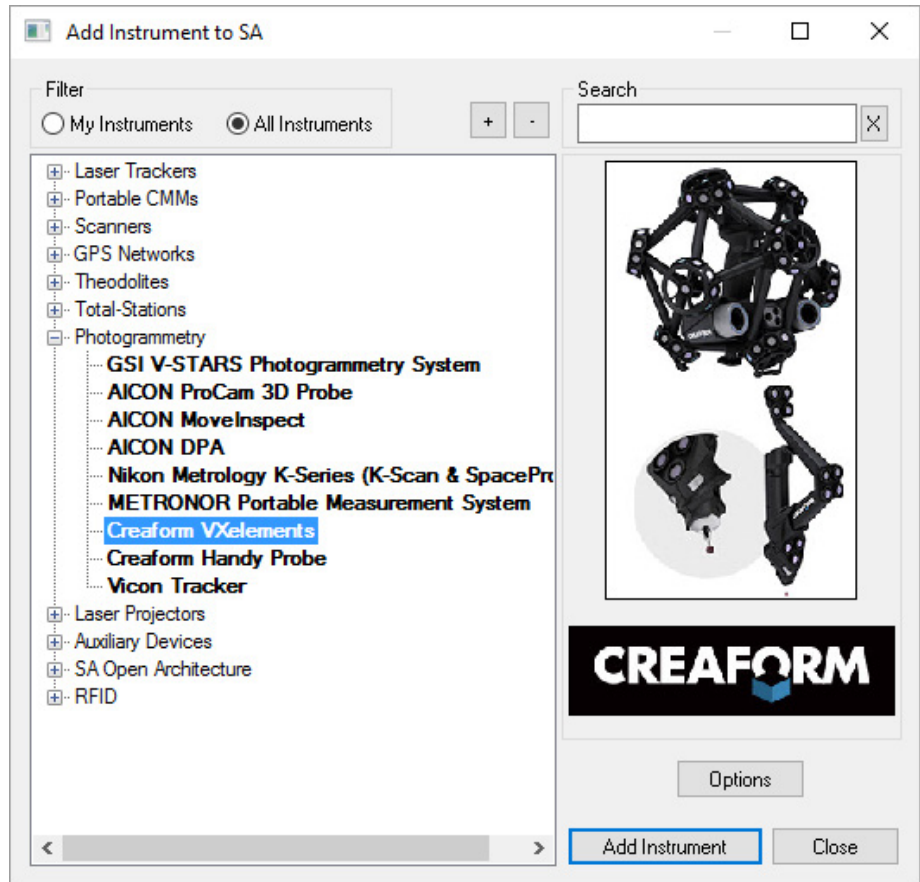
2. Start the instrument interface using **Instrument > Run Interface Module and Connect** or 🏃 . You can also pick the Creaform VXelements interface from the list of interfaces.

Starting the interface within SA will automatically start VXelements for you so it should not be running prior to connecting in SA (Figure 6-26).

Figure 6-26. Starting VXelements

VXelements Interface

The Creaform VXelements interface is composed of two separate dialog controls. The first is SA's Creaform VXelements Interface which is used to transfer data to SA and controls naming for points and clouds

measured by the system. The second dialog is the VXelements control panel which should be familiar to Creaform users. This panel is used to display the system status and allows you to edit specific functions for the measurement process (Figure 6-27).
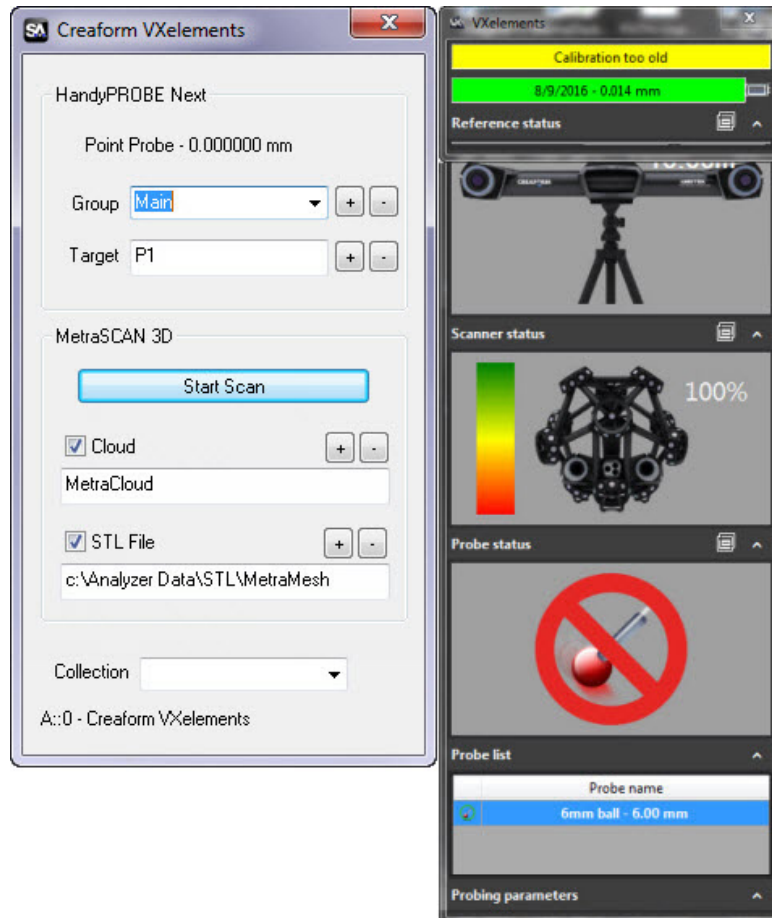
Figure 6-27. Creaform VXelements SA Interface.

Probing with the Handyprobe Next

Probing mode is started automatically and points can be triggered immediately from the system using the button controls on the Handyprobe Next. Before measuring check the following:

1. Check the Probe List to be sure the correct probe is defined. The probe name and diameter is shown in both dialogs. Verify that the Automatic Probe Detection Check Box is checked within VXelements. This setting can be found here (Figure 6-28):
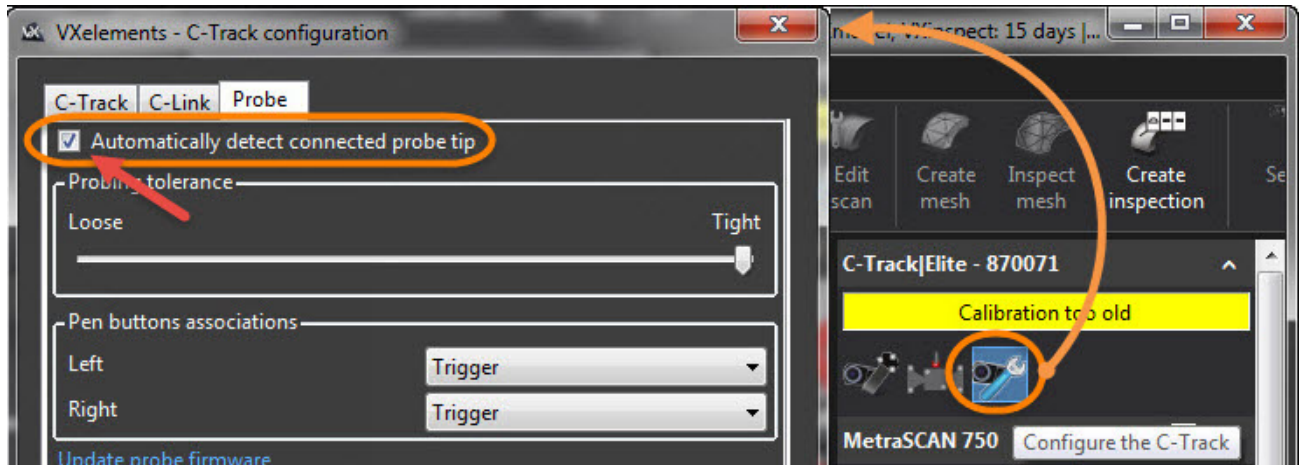
Figure 6-28. Automatic Probe Detection

2. Check the probing parameters within the VXelements control to be sure the measurement mode is set correctly. Single point measurements as well as spatial or temporal scans can be performed with the probe and the settings for those measurements are defined here (Figure 6-29).
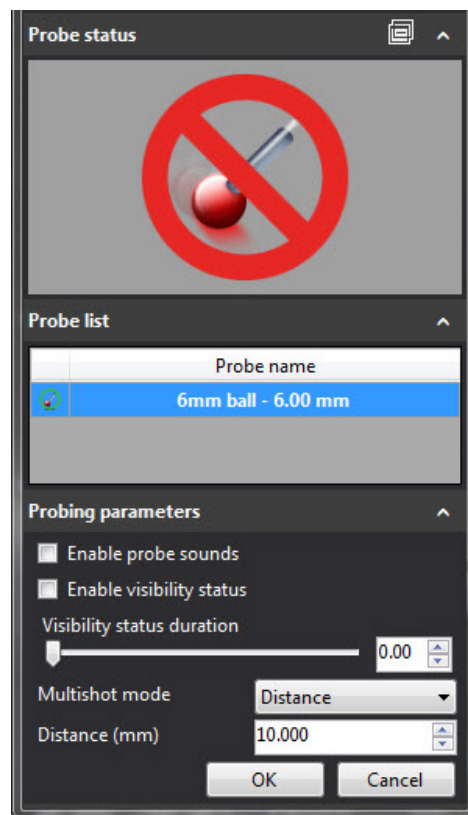
Figure 6-29. HandyProbe Next Probing Controls

3. Check the collection, group and target names set within the SA interface

4. Start measuring.

The Handyprobe provides a set of convenient buttons that can be used for measurement control and toolkit navigation. Buttons work as follows:

- **Measure button.** This button is used to trigger a measurement. Long press will start a scan.

- **Check (Validate) button.** Short press = Navigate to Next Task in SA Toolkit (If you are in the Last Task, this will Stop Trapping.   Another hit will go back to the First Task.) Long press = Navigate to Previous Task in SA Toolkit.

- **'X' (Cancel) button.** Short press = Remove last measured point in SA. Long press = Stop Task (trapping measurements) in SA Toolkit

Scanning with the Metra Scan 3D

The live scanning process is performed within a separate VXelements window that is started by pressing the Start Scan button within the SA interface. The scanning operational sequence would go as follows:

1. Set the desired cloud name within the SA interface and press the Start Scan button (Figure 6-27).
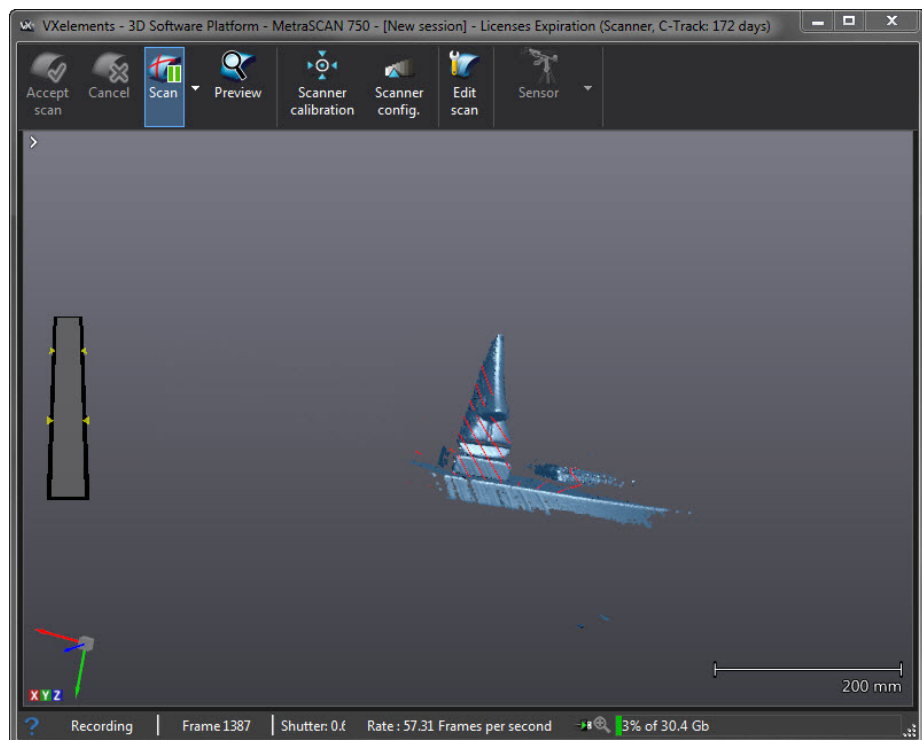
Figure 6-30. VXelements scanning window

2. Scan the part

3. Press the Scan Pause Button (Figure 6-30) and then, if you are finished press the Accept scan button send the scan to SA (Figure 6-31).

Figure 6-31. Accepting the Scan
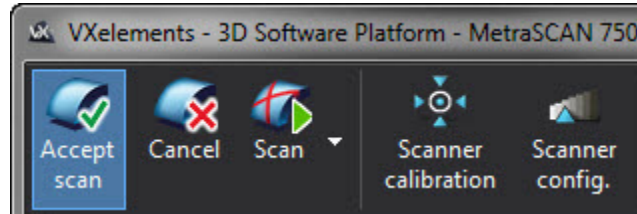
Scans are saved in VXelements while a session is in progress, which allows a scan to be accepted and then restarted. When you restart a scan you will be prompted to continue or start fresh (Figure 6-32). If you continue the new data is added to the prior scan and the full data set is then again sent to SA when you accept the scan.

Figure 6-32. Resuming a Scan
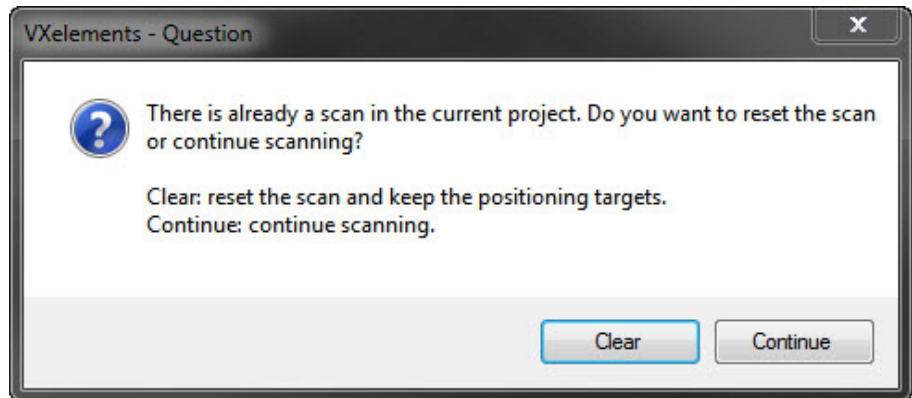
Accepting the scan does not send SA the raw cloud but instead triggers VXelements to process the scan data, creating a mesh. This mesh can then be transferred to SA in either of two ways.

- **Cloud.** When the cloud check box is checked in the interface and the scan is accepted, a cloud is sent directly to SA which defines the vertex points of that mesh.

- **STL File.** The interfaces also provides an option to save the mesh as an STL file. This STL file can then be imported into SA as a graphical mesh for greater visual clarity and rough query purposes. To import the STL, first build a frame on the instruments base and make it the working frame. Then use File>Import>STL file.

GSI V-STARS Photogrammetry System

Software Installed and Setup:

SA does not interface with the cameras directly but rather with the host application V-Stars. V-Stars must be installed and running on the machine prior to using the interface with it in SA. Follow the manufacturer directions for this process. The following are a set of suggestions to help a beginner get started.

- The Computers Network communication needs custom setup. Suggestions include enabling Jumbo at the highest rate with both Rx &Tx enabled. Also disable the Vision filter Driver.

- Control between single point and continuous measurement is selected within the MMode menu within V-Stars and will need to be toggled for correct operation within SA.

- To use traditional probes the definition files need to be placed in the probe folder (C:\ProgramData\Geodetic Systems\Probes) and the probe button needs to be enabled in the main toolbar.

- Dream target support was added in 2017 and requires V-stars v.4.9.1.0 or later. The Dream Probe is not a traditional probe. You don't have to put it in the Probes folder. Just import it into your project as a normal 3D file, right click on it and make it a template and then make it active(Figure 6-33). Also be sure that the Dream Target is enabled within the MMode menu.
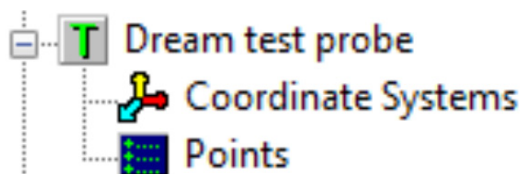
Figure 6-33. Active Dream Target

- An initial V-Stars bundle should be performed in single camera mode prior to connecting in SA.

Starting the SA Interface

1. Select **Instrument > Add** and choose the GSI V-Stars Photogrammetry System from the Instrument List (Figure 6-34).
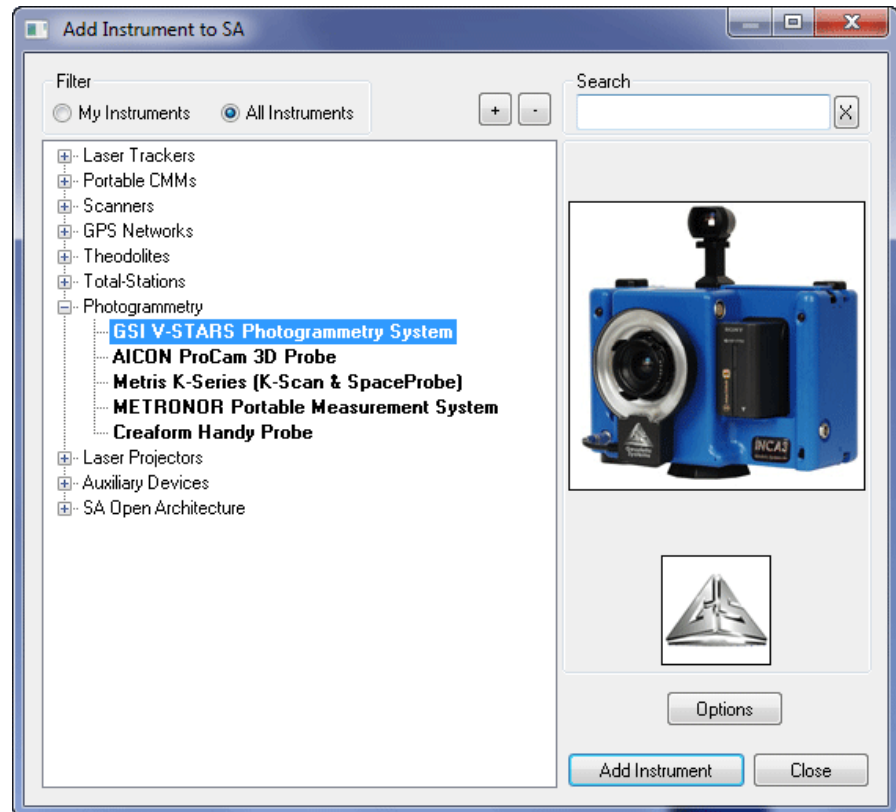
Figure 6-34. Adding the V-Stars Instrument to the job

2. Start the instrument interface using **Instrument > Run Interface Module and Connect** or 🏃 .

GSI V-Stars Interface Overview

The GSI V-Stars Interface can be divided into 4 sections (Figure 6-35):

- Section 1 - Provides data naming controls
- Section 2 - Provides trigger functions to record data
- Section 3 - Provides data type selection
- Section 4 - Controls SA's processing of that data
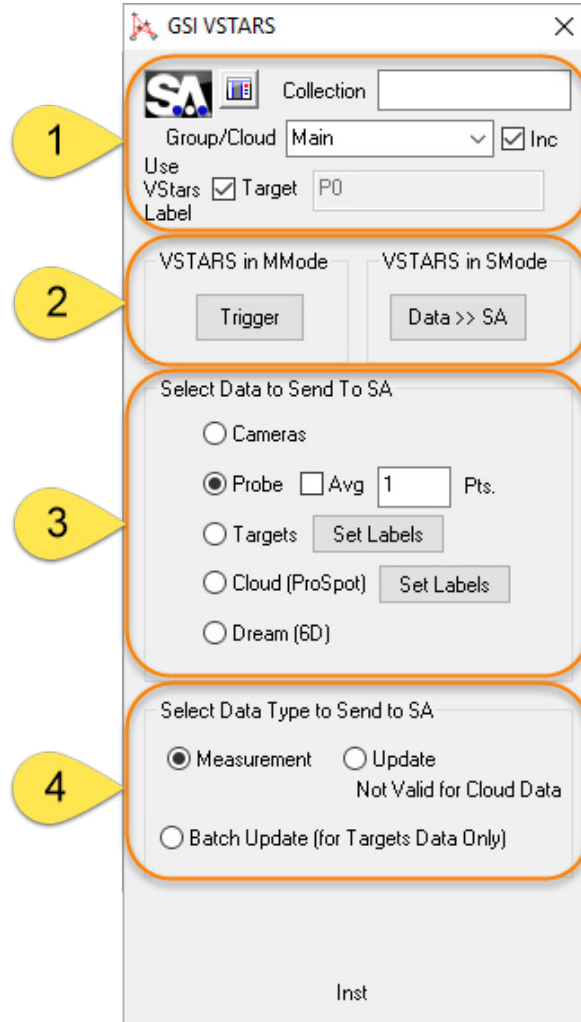
Figure 6-35. The V-STARS interface.

Section 1: Target Label Definition

This section designates the Collection Group/Cloud and Target sent to SA for a particular target. Typically the target names sent to SA should match those used by V-Stars. To ensure this Check the *Use VStars Label* Check box. Checking the *Inc* checkbox will auto-increment Group/Cloud names. When checked, the group or cloud name will automatically increment after each time data is sent to SA. In probing applications this should be turned off so that you can get multiple points in the same group(Figure 6-36).
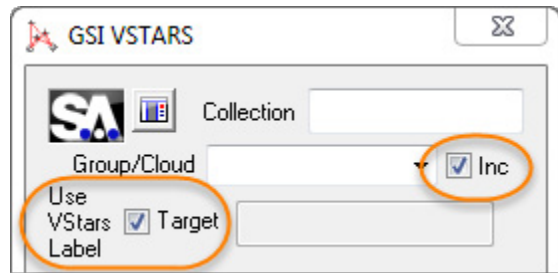
Figure 6-36. Section 1 - Point naming controls

Section 2: Trigger Functions

Data triggering needs to be defined and set up within V-Stars. When in M-Mode either a single trigger can be sent or V-Stars can be set to a continuous mode. The buttons in section 2 then act as a start stop function for either M-Mode or S-Mode. (Figure 6-37):

- **Trigger (M-Mode).** The Trigger Button will initiate data transfer to SA in multi-camera mode. The data type sent is defined in the following section (Camera, Probe, Targets, Clouds (ProSpot), or Dream (6D)). This will either be a single event or a continuous transfer depending on the setting defined in V-Stars.

- **Data>>SA.** Using the Data >> SA button will initiate an immediate project import from V-STARS. This is a great way to start and to get a constellation of points in SA to use as a frame of reference.
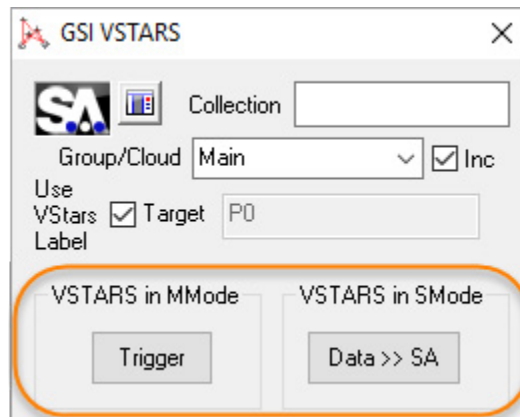
Figure 6-37. Section 2 - Trigger Functions

Section 3: Data To Send to SA

When a Trigger event is recorded data is sent from the interface to SA. The type of data sent is controlled by a set of radio buttons.
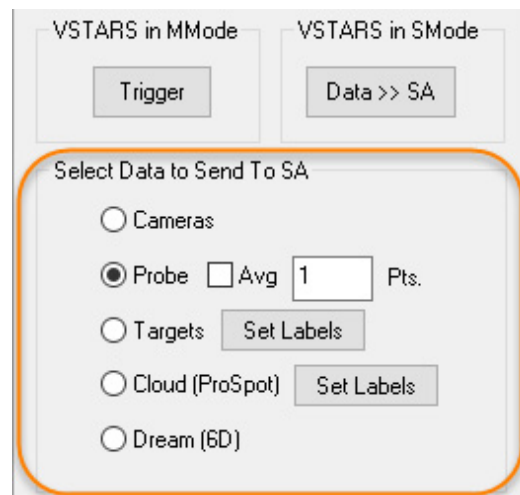
Figure 6-38. Section 3 -Data To Send to SA

Data Source controls work as follows:

- **Camera.** The camera transforms are sent to SA updating the camera positions shown in the graphics.

- **Probe.** The most recent PROBE point is sent to SA. Checking the *Avg* chekbox will send a single averaged point when the point count has been reached. Typically used in continuous mode.

- **Targets and Cloud (ProSpot).** A filtered selection of particular target types can be sent based upon user selection (Figure 6-39). Selecting Cloud (ProSpot) will send data to SA in the form of a point cloud once a trigger event occurs. Note that the cloud sent will carry then name shown in the 'Group/Cloud' edit box.
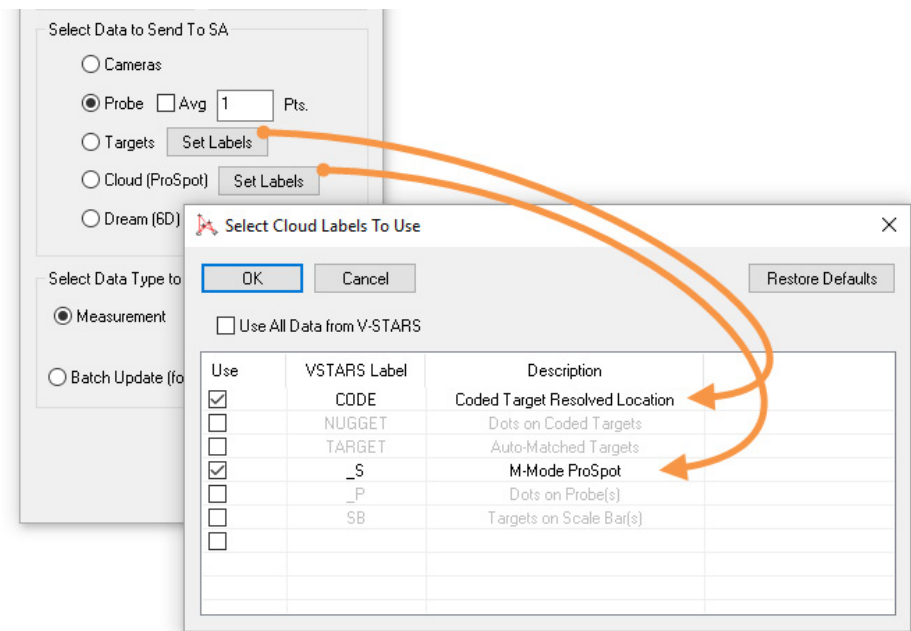
Figure 6-39. Data Type Selection and Target Labels

The Set Labels buttons provide access to a filters control. They are used to set the V-Stars data types (labels) which will be sent when measuring either 'Targets' or 'Cloud (ProSpot)'. The Targets data selection defaults to "CODE", and the Cloud (ProSpot) data selection defaults to "S". The selections denote strings. When any of the selected strings are found in the V-Stars label of a point, that point will be sent to SA in the selected data form ('Targets' means points, and 'Cloud (ProSpot)' means a point cloud). To include additional data types simply check the use check box next to the data type.

- **Dream (6D).** With this selected, under "Select Data Type to Send to SA", if you select: *Measurement*, you will get point data with 6D data embedded. You can construct frames on these points using the embedded 6D data if desired. When set to *Update*, you will get 6D updates. With V-Stars M-Mode in "Continuous Trigger", these updates can be used for 6D tracking

("TransTrack") in SA. - Support for 6D tracking requires V-Stars v.4.9.1-dev360 (from 11/28/2016) or later.

Section 4: Data Type to Send to SA

- **Measurements.** By default, the interface sends measurements to SA as points or clouds which are stored as such. This setting preserves this default behavior.

- **Update.** Updates are not added to the SA Tree Database like Measurements. Rather, are used as updates for monitoring processes such as Watch Windows. Updates are meant to be used with Probe data (see section 3), but can be used with all but the Cloud data.

Figure 6-40. Section 4 - Data Type to Send to SA
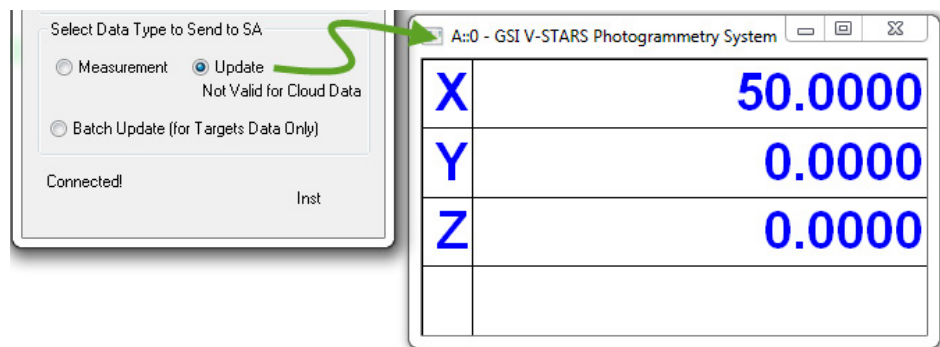
- **Batch Update.** Originally intended for use with SA's Instrument >> Automatic Measurement >> Measure Batch of Points, this command lets you transmit a batch of pts to the instrument, set tolerances, and update that set of points once the instrument sends the batch back to SA. Being photogrammetry, the V-Stars system sends them all back at once (those it can see at least).

MP Command List:

V-Star specific MP control can be obtained using the following commands:

- **Set Instrument Group and Target.** Used to set the name controls in the interface for measurements.

- **Instrument Operational Check.** This command includes a list of string based commands to set interface settings and perform basic operations. Refer to the MP Command Reference for a full listing of string commands.

GSI V-Stars Photogrammetry Simulation

The V-Stars simulation utility provides the user with the ability to lay out a network of cameras and points, establish which of the points are within the camera's field of view, bundle the cameras together and determine the network uncertainty for each point. This a very powerful tool for pre-designing a measurement process.

Requirements

- V-stars v.4.9.7 or later must be installed and running on the local machine
- SA version 2023.1 is required for this process. Prior support was only available in 32bit SA which was discontinued in 2019.

Simulation Overview

The simulation process is conducted from the properties of the V-Stars instrument added to the SA tree. The basic concept is that a set of camera positions can be established in SA, and a set of reference points defined. Along with these you can establish a set of reference vectors relative to the surfaces and objects that are being measured.

You can then fabricate measurements to these points and take advantage of the position and orientation of the surface to determine which points are visible and fabricate measurements to those.

Once the fabrication process is complete a V-Stars bundle can be run and the resulting uncertainty for each point established.

Simulation Setup and Controls

To begin, setup your camera network for the simulation process. This includes both the camera parameters and locations.

1. Set the Camera Parameters to match those of your camera and the incident angle threshold.

The **Camera Parameters** dialog allows the user to establish the field of view of each camera, which establishes the points/vectors visible. This field of view is established using the parameters of the camera to be used. The size of the CCD and the focal length of the lens establish the angle of visible area while the range parameters establish the distance parameters in clear focus or within range. The *Incident Angle* is used only with vectors and further limits the number of points considered. If the incident angle is larger than the tolerance you set it will be excluded from the calculation (Figure 6-41).

- **Focal Length.** Distance from the focal point to the CCD
- **CCD Height.** Height of the CCD
- **CCD Width.** Width of the CCD

- **Range Min.** Minimum range from the focal point to the near ned of the field of view.

- **Range Max.** Maximum range from the focal point to the far end of the field of view

- **Incident Angle.** The angle between the camera shot line and the normal of the surface.
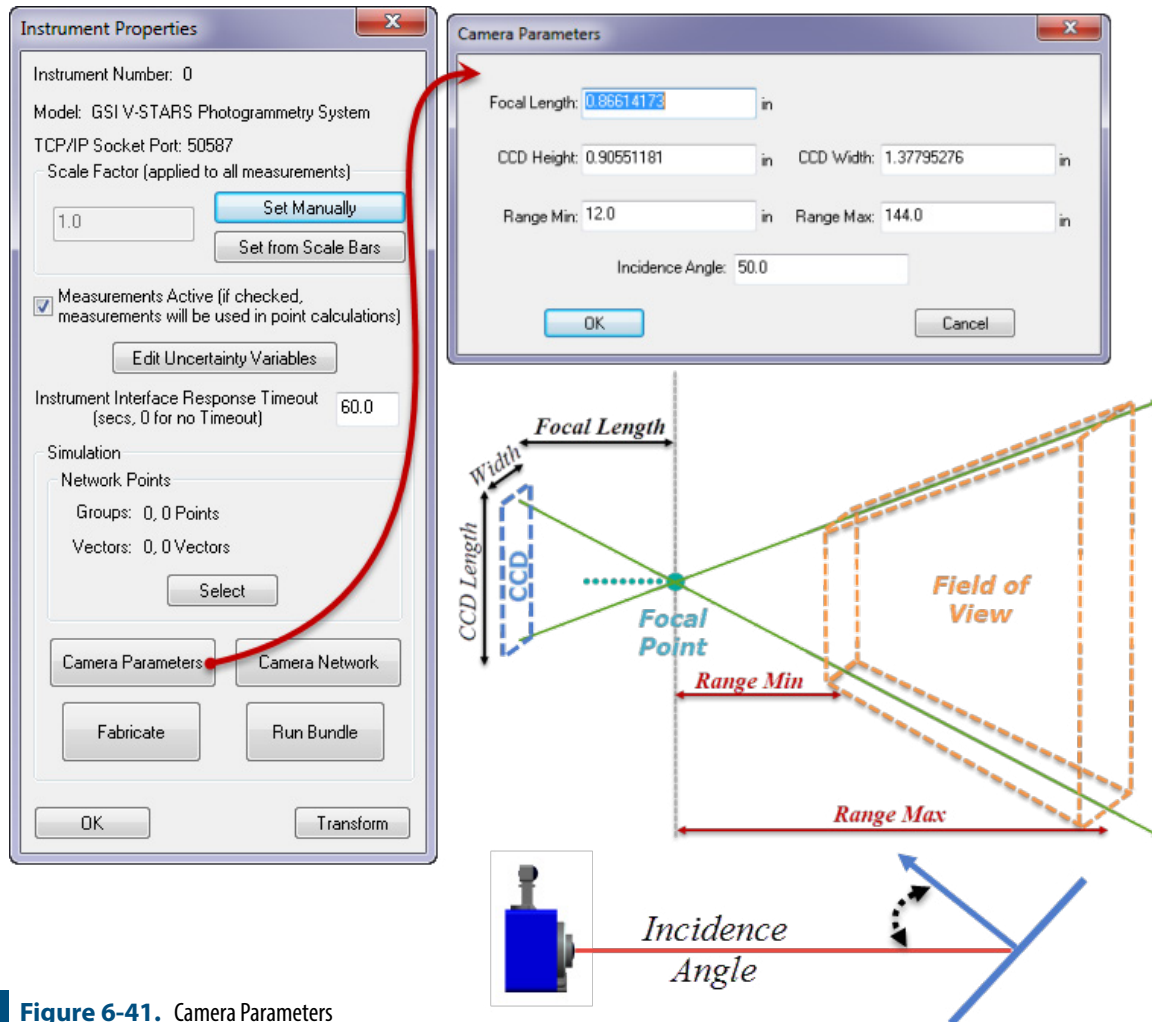
Figure 6-41. Camera Parameters

2. Establish and editing the *Camera Network Configuration*

The Camera Network button provides full control over the cameras within a V-Stars network and their display within SA. Remember that a single instrument added to the SA tree represents a network of camera locations and each camera location relative to the network frame is controlled from this dialog. Here you can add or import cameras to the network, edit there position and orientation and change their display attributes.

This dialog can be used before, during and after shots are fabricated and the bundle is run. It is a very useful tool for analysis in that it allows individual shots from particular cameras to be turned on or off

and the field of view analyzed. Parameters of a particular camera can be accessed by right-clicking on the camera in the network list and multi-camera control is provided through the buttons in the right panel (Figure 6-42).

- **Load Cameras.** Load a predefined camera network.

- **Save Cameras.** Save an existing camera network.

- **Add Camera.** Places a new camera at the current working frame and display the transform dialog for the newly added camera.

- **Field of View ON.** Turn on field of view display for the selected cameras from the list.

- **Field of View OFF.** Turn off field of view display for the selected cameras from the list.

- **Show.** Cause the selected cameras to be displayed within the graphics view window.

- **Hide.** Cause the selected cameras to be removed from the graphics view display window.

- **Highlight ON.** Cause the selected cameras to become highlighted within the graphics view display window.

- **Highlight OFF.** Cause the selected cameras to become de-highlighted within the graphics view display window.

- **Shot Rays ON.** Cause the selected cameras to display shot rays to their visible measurements.

- **Shot Rays OFF.** Disable shot ray display for the selected cameras.

- **Move.** Move the selected cameras about the current working frame.

- **Delete.** Delete the selected cameras.

- **Un-Check.** Un-check ALL items within the list.

- **Check.** Check ALL items within the list.
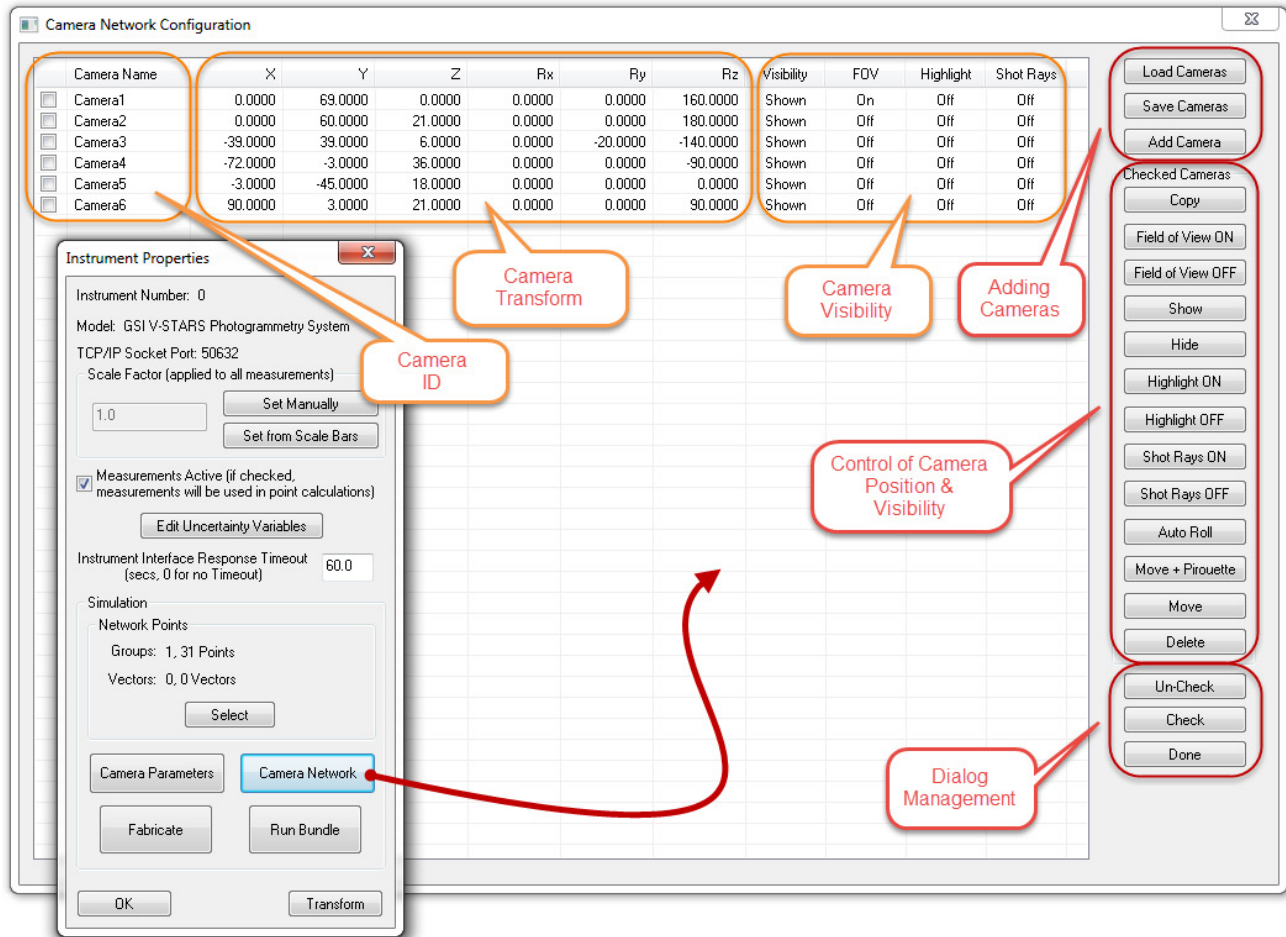
Figure 6-42. Camera Network

Performing the Simulation

1. Graphically select the points and/or vectors to consider in the simulation.

Points and/or vectors can be selected graphically. If you have a CAD model vectors can provide additional information

2. Fabricating Measurements

Pressing the Fabricate button causes SA to evaluate which of the selected points/vectors should be included in the analysis for a particular camera and builds measurements to them if they fit the criteria. Points must be within the established field of view and not obscured by any surface in the job file. Vectors must also fit the criteria of points and have an incidence angle less than the established limit. Shots will be fabricated and shot lines will become visible for points or vectors that fit the criteria. These parameters can then be viewed individually or as a group using the camera network controls (Figure 6-43).
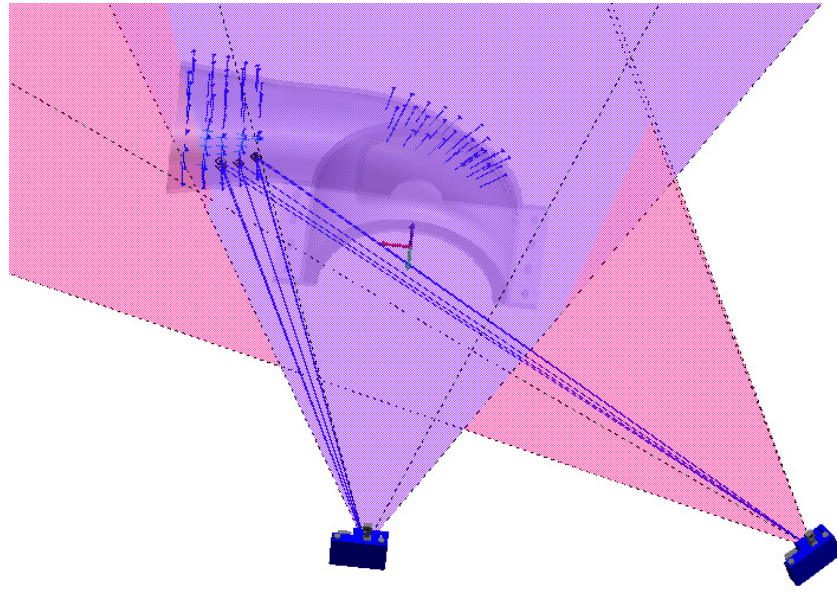
Figure 6-43. Fabrication.

3. Running the Bundle and uncertainty analysis

Once measurements have been fabricated, the camera network and point locations are passed to V-Stars for analysis and to perform the full bundle. The V-Stars application must be running for this to happen.

When complete, the uncertainty covariances are then returned to SA and saved within each point's properties. This provides the uncertainties reported in the point properties and includes the full CoVariance matrix returned from V-Stars which can be accessed as part of the observation properties saved within the point (Figure 6-44).
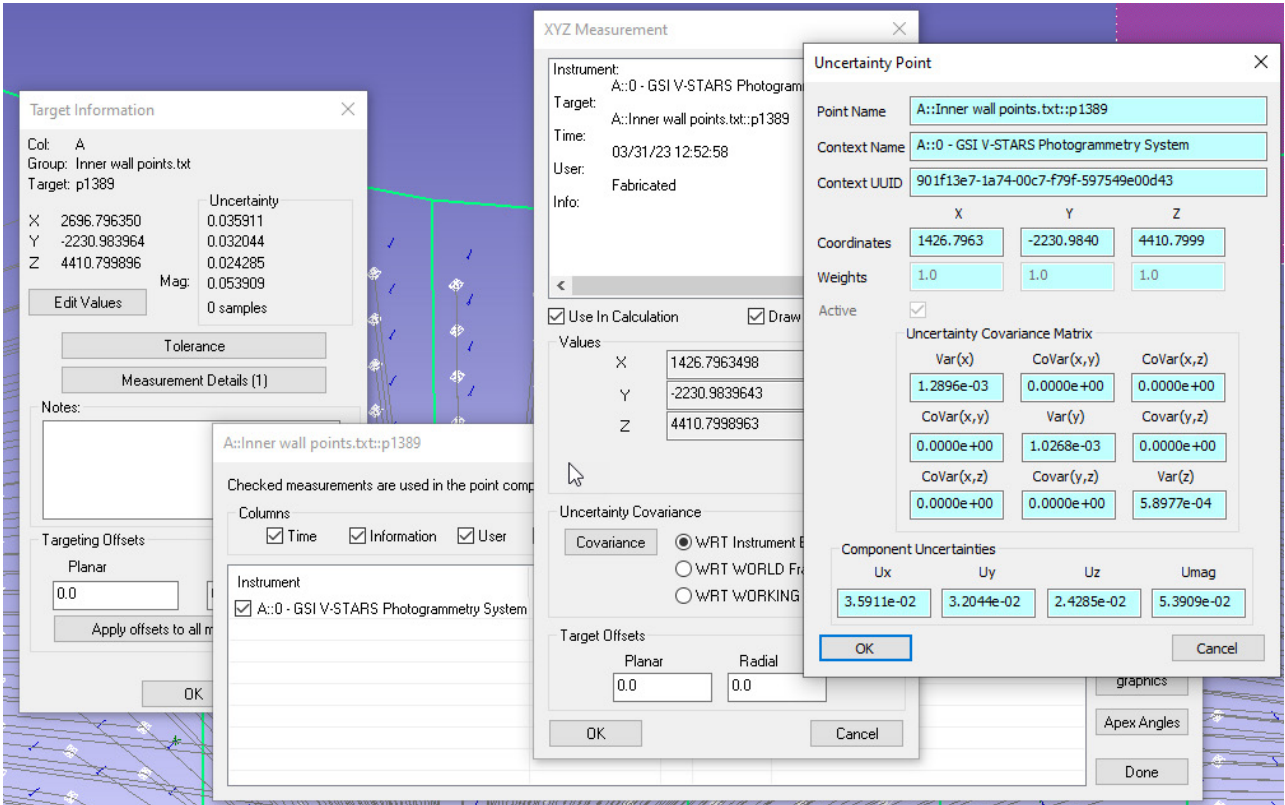
Figure 6-44. Accessing the covariance matrix within the observation properties saved for a point.

For clarity these covariance values are maintained with the point and should directly match those reported by v-stars. This bypasses the Monte Carlo simulation process performed by other instruments in SA and no uncertainty point cloud is produced.

The errors can be visualized using the ellipsoid display enabled on the Analysis tab of the User Options (Figure 6-45).
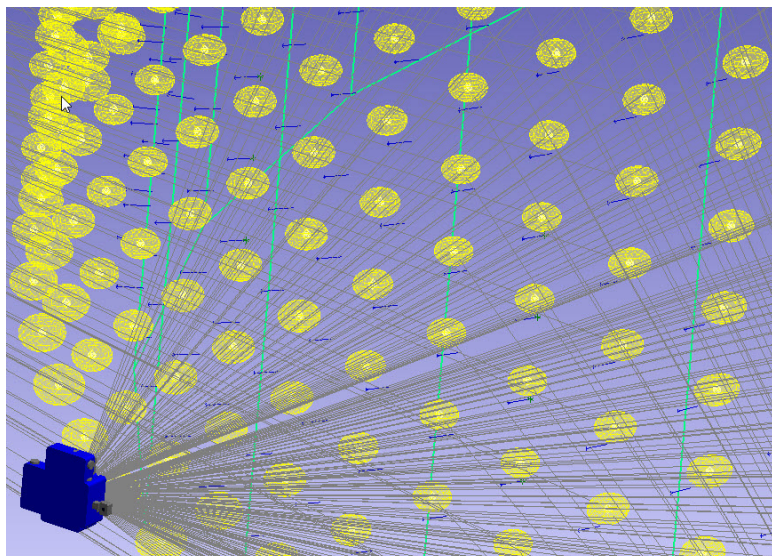
Figure 6-45. Photogrammetry uncertainties.

Troubleshooting

There are a couple of parameters to verify is the simulation does not run correctly. These currently include the following:

1. The camera focal length cannot be entered as ZERO. Doing so will cause the simulation to generate an error from the V-Stars application when it is run.

2. Verify that the points included in the simulation process have unique names.

Saving and Loading Camera files.

- Camera files can be exported to an ascii or csv file and re-imported. What actually gets stored are i,j,k vectors and upon retrieval, these get converted to appropriate angles which are not always what you started with, but are equivalent.

- If a camera file does not load, double check that the format has both a "Carriage Return" and a "Line Feed" by opening the file in notepad++.

Metronor Solo and Duo Systems

This Quick-Start guide can be used for initial configuration, connection and basic operation of the Metronor Solo and Duo Photogrammetry system within SA. For more details on instrument operation and configuration contact Metronor directly.

Prerequisites

Set up the Metronor system following the Manufacturer's directions. This will depend on the camera configuration and system type. Ensure you have the appropriate camera mounts, tripods, and cabling to power the unit.

SA does not interface with the cameras directly but rather with the host application Metronor Server. Therefore, Metronor must be installed, calibrated, and running on the local machine prior to any attempt to connect to SA.

- Please contact Metronor directly to obtain the correct version of the Metronor Server for your camera system and install it following the manufacturer recommendations.

  (http://www.metronor.com/)

- You can verify SA's current version compatibility by looking in the SA readme file available under the Help menu within SA.

Duo system alignment, and light-pen tip calibration must be performed within the Metronor Server. Target recognition and interpretation is also performed within Metronor. Once correctly configured SA can acquire any of 3 data types from Metronor these include:

- Point measurements from targets and probes
- A constellation of points from LEDs
- 6D Frames measurements

Starting the Interface

1. Start Metronor Server (Figure 6-46).

2. Run Metronor Server and perform setup and field checks per OEM guidelines.
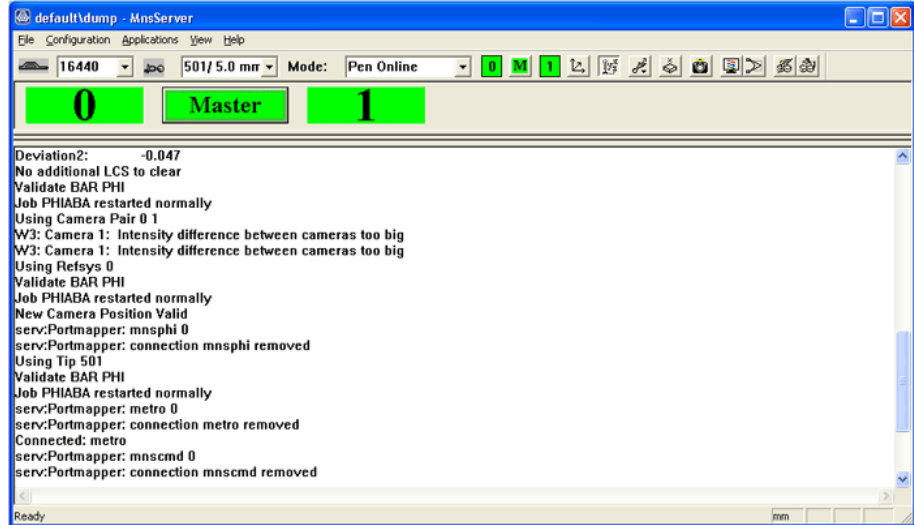
Figure 6-46. The startup process.
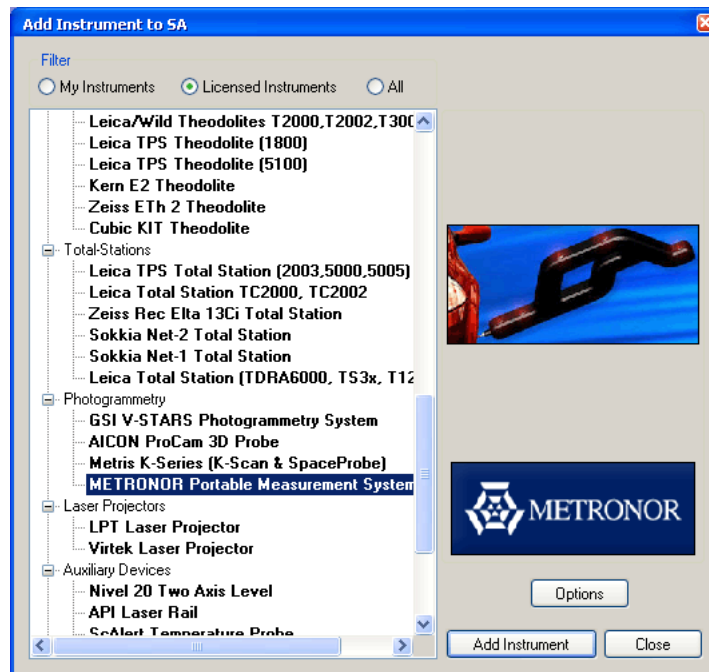
Figure 6-47. Adding the Metronor to SA.

3. Select **Instrument > Add** and choose the Metronor Portable Measurement System from the Instrument List (Figure 6-47).

4. Run the Metronor interface from the **Start > Programs > SpatialAnalyzer 20##.##.## > Interfaces** menu.

5. The Spatial Analyzer Metronor Logon dialog box will open and will ask what device you want to connect to (Figure 6-48). Select the instrument and type the server name (which will be either the computer name or the computer's IP address). Ac-

cept the default Server Port.

Figure 6-48. The logon dialog.
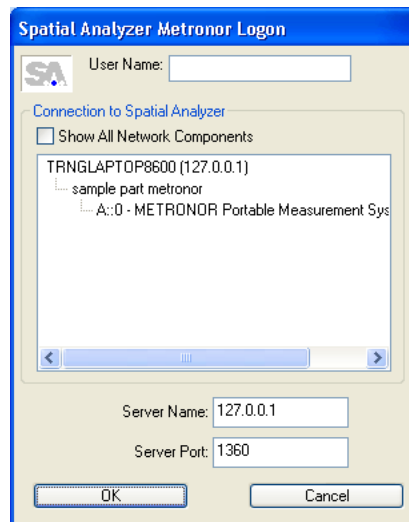
6. This will start the Metronor Interface.

Figure 6-49. Metronor Interface
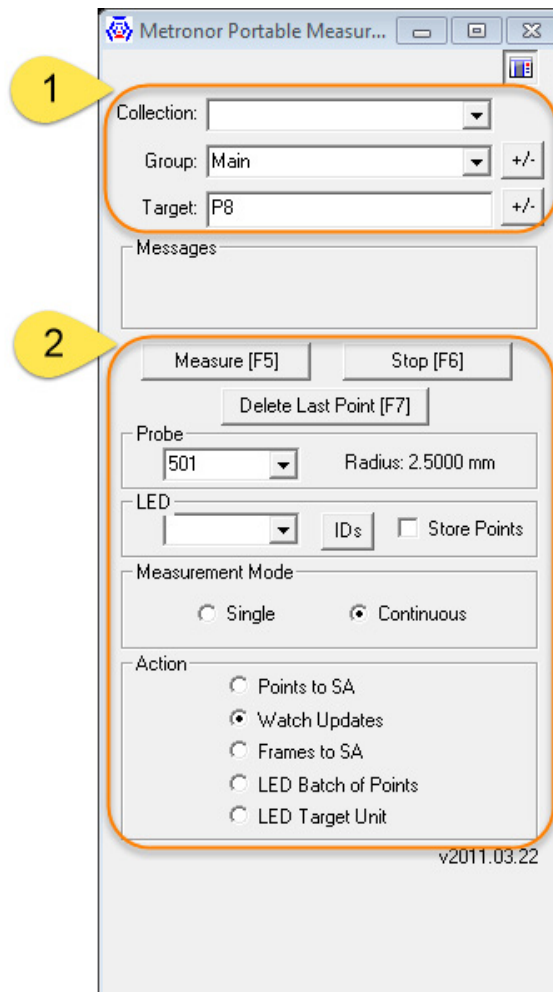
The Primary Metronor Interface Controls:

Target Naming Control (section 1):

 The Upper section of the Metronor Interface provides full control over Collection, Group, and Target designations for all points acquired by the system.

- Single point measurements will use the full designation
- When measuring frames the Group Name will be used

Measurement process Control (section 2):

Metronor will recognize the Probe, Adapter, or Panel within the field of view and utilize it during the measurement process:

- **Probe.** Selection is based upon probe name. The properties of the probe and its calibrated position and probe radius will be utilized based upon the name selected in this dropdown dialog.

- **LED.** Section can be used for selective filtering of LED point measurements

- **IDs.** Opening the IDs dialog and specifying target names provides a means to only record the specified targets.

- **Store Points.** check box allows you to either send points to SA or just send updates.
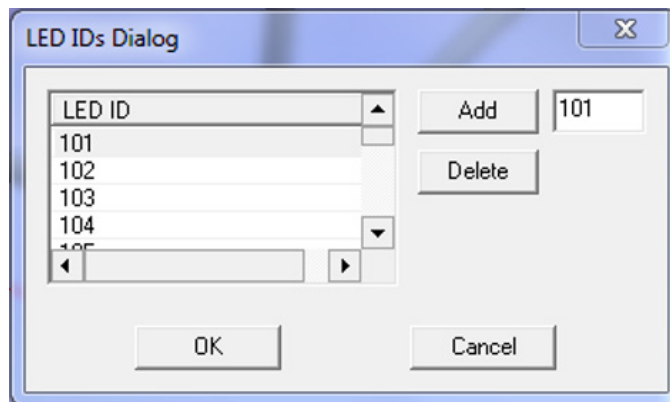
Figure 6-50. IDs Dialog

Measurement Mode selection presets the target type SA is looking to receive

- **Single.** designation only recognizes a single event at a time.

- **Continuous.** is used to send updates to SA for moving targets and to stream measurements.

Action settings are used to determine the format of the measurements the Instrument Interface records and sends to SA (points, frames, or updates)

- **Points to SA.** Sends triggered probe points over to SA.

- **Watch Updates.** Send updates to SA which can be used for

monitoring or watch windows. No points or frame positions are save within SA when this option is checked.

- **Frames.** Sends received 6DoF measurements over to SA. These 6D measurements are recorded as frames within the specified collection.

- **LED Batch of Points.** Sends points for each measured LED

- **LED Target Unit.** Sends a single target by name.

Measurement Plan Control

The Metronor will respond to basic instrument MP commands such as the following:

- Start Instrument Interface

- Set Instrument Group and Target

- Instrument Operational Check

Metronor Portable Measurement System	
Set MeasureMode Single	Set the measurement mode to discrete point measurement.
Set MeasureMode Continuous	Set the measurement mode to continuous point measurement.
Set Action Points	Sets the measurement action to send points to SA.
Set Action Updates	Sets the measurement action to send updates to SA.
Set Action Frames	Sets the measurement action to send frames to SA.
Set Action Batch	Sets the measurement action to send an LED batch of points to SA.
Set Action Unit	Sets the measurement action to send an LED target unit to SA.
Set Tip []	Sets the probe tip to [], where [] must match one of the names in the probe dropdown ID list.

Vicon Tracker

Prerequisites

Vicon Tracker must be installed and running before SpatialAnalyzer will connect to the instrument. SpatialAnalyzer and Vicon Tracker must be installed on the same computer.

Starting the Interface

1. Ensure Vicon Tracker is running and instrument is operating correctly per OEM guidelines.

2. Select **Instrument > Add** and choose the Vicon Tracker from the Instrument List.

3. Run the instrument interface using **Instrument > Run Interface Module and Connect** or 🏃

Instrument Interface Overview
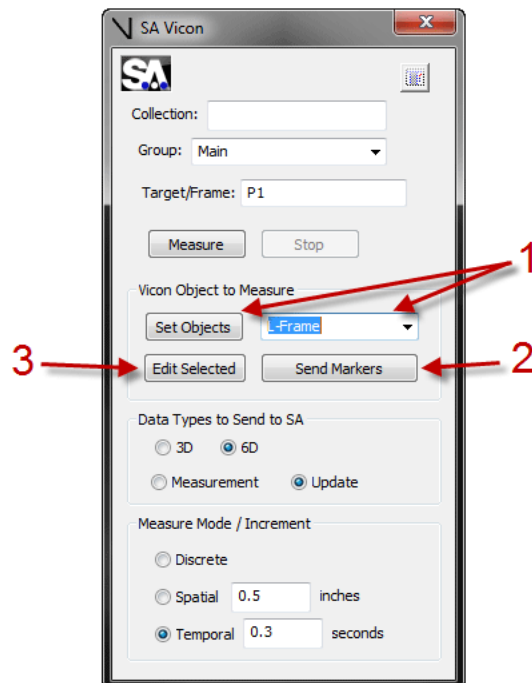
Figure 6-52. The Vicon interface.

Press Set Objects to populate the drop down combo box with all objects currently in view of the cameras in Vicon Tracker. For this, you must be sure all defined objects are in the view of the cameras. Here, an Object called 'L-Frame' is selected in the drop down.

Press Send Markers to send the sphere centers of all the Vicon markers in the selected object. This is for co-locating with other instruments in SA.

Press Edit Selected to add an offset frame/probe to the selected object (Figure 6-52).

Figure 6-53. Defining an offset.

Just follow the steps in the dialog to create an offset frame or probe for the selected object.

1. Create a frame in SA on the object (or e.g. a probe which you have rigidly attached to the object) by measuring with an instrument, or creating by some other means.

2. Click 1) Select Offset Frame From SA. You'll be prompted to select the frame you have created, and the *Name* field will be populated with the name of the frame from SA.

3. Click 2) Measure Reference Frame to Offset to take a fresh 6-DOF measurement of the object you've selected. You'll see a suggested name appear.

4. In the *3) Enter name for this new Offset Object/Probe* field, type in a name if you'd like to use your own name.

5. In the *4) (Optional)* field, enter the probe radius for the offset probe.

6. Press OK to add this new offset frame/probe definition to the drop down combo box.

When your new offset object is selected, the offset frame will be sent to SA whenever you have "6D" Data Type selected, or the origin of the offset frame will be sent if you have "3D" Data Type selected. The probe radius will be added to all data sent from your offset object definition.

This Page Intentionally Left Blank.

Measuring With Precision Scanners

Precision Scanners such as the Nikon Laser Radar and API Ladar are specialized for high-accuracy surface measurements within predefined regions or at specific point locations. This chapter discusses how to properly and effectively measure with these instrument within Spatial Analyzer.

It also includes a set of specific guides for the use of specific models.

Precision Scanner

The advantages to precision scanners are that they allow very detailed surface measurements to be made at predefined locations without user interaction or surface contact. They also lend themselves very well to automation cells as specific feature measurements can easily be collected in an automatic fashion.

This chapter covers the operation of precision scanners such as the Nikon Laser Radar and API Ladar. While the capabilities of these instruments are similar, the interfaces differ to a great extent so each will need to be considered individually.

Many of the specific application that will be covered are auto-meaure functions for feature measurement within SA. For more details on these functions refer to the Instruments Chapter within the Users Manual.

Precision Scanner Quick-Start Guides

Automated Precision (API)

API Scanners

- "API Dynamic 9D Ladar" on page 345.

Hexagon

Hexagon Scanners

- "Leica ATS600" on page 92. The Leica Absolute Tracker ATS600 is also a laser tracker and is listed in the laser trackers chapter.

- "Total Stations Interface" on page 280. The Leica Nova MS60 total Station can also be considered a precision scanner as it can perform many of the same functions at a lower accuracy. For more details refer to the Total Stations chapter.

Nikon

Nikon Laser Radar

- "Nikon APDIS - MV400 Series" on page 355.
- "Nikon Laser Radar (MV200/300)" on page 375.

API Dynamic 9D Ladar

Prerequisites and Connection

- SA version 2023.1 or newer
- Follow API's recommendations for the instrument mounting, set up and cabling.
- The default connection uses an ethernet connection and a 192.168.0.168 IP address.

Starting the Interface

1. Select **Instrument > Add** and choose the API Ladar from the ***Add Instrument to SA*** dialog (Figure 7-1).
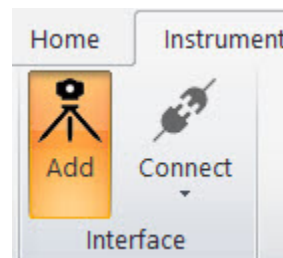
Figure 7-1. Add and Connect Button In SA on the Instrument Tab.

Under the Options button is the ability to control the default instrument placement and the ability to add a stand, if desired. You can also choose to auto Run the instrument when it is added (Figure 7-2).
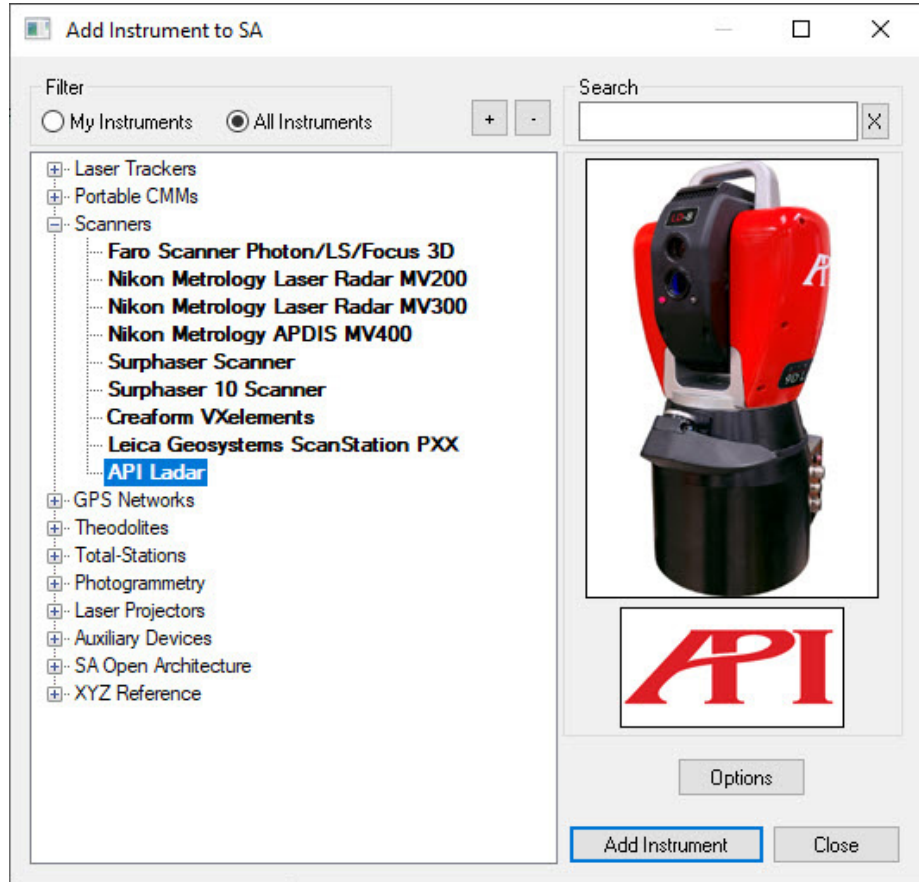
Figure 7-2. Add New Instrument Selection Dialog

2. Now run the instrument interface module using the Connect button. The interface will then open (Figure 7-3).
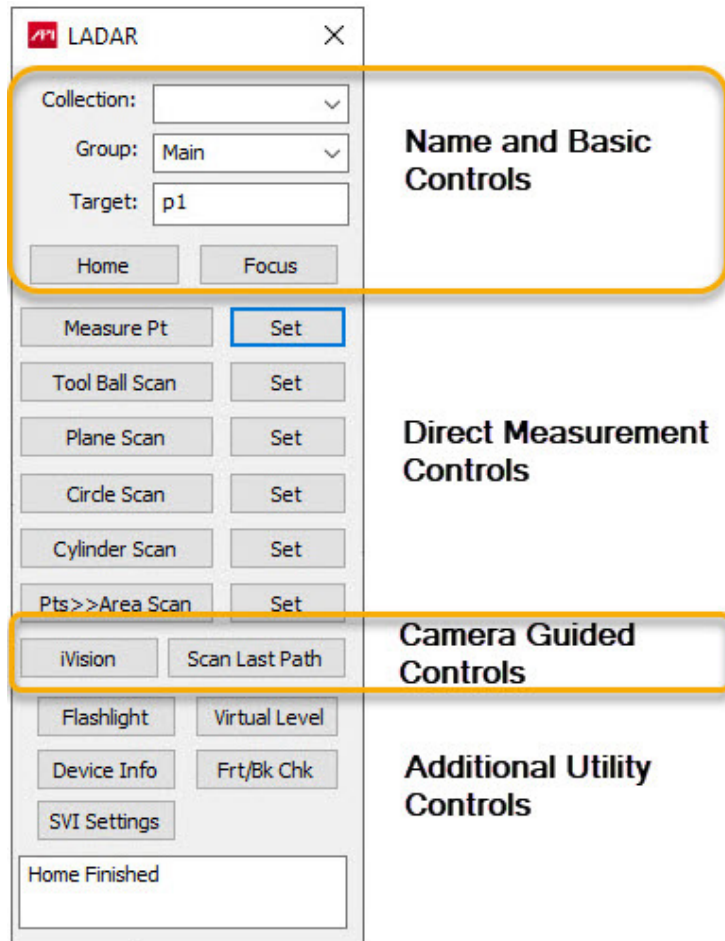
Figure 7-3. API Ladar Interface

Naming and Basic Controls

At the top of the API Ladar interface is a set of utility controls.

- **Collection:: Group:: Target.** The name control identifies the name of the next acquired point taken from the instrument.

- **Home.** Return home to the LADAR mounted nest and return to original position.

- **Focus.** Performs a beam focus operation at the current location.

Direct Measurement Controls

Point Measurements

Basic measurements at the current beam location can be accomplished by pressing the Measure Pt. button.

- **Measure Pt.** This Option offers two options using the [Set] button: Send **Point to SA** and **Measure Sphere**. Point to SA Measures a point at current location and sends to SA. Selecting Measure

Sphere will perform of a scan of a sphere of a given size and the desired data will be returned (Figure 7-4).
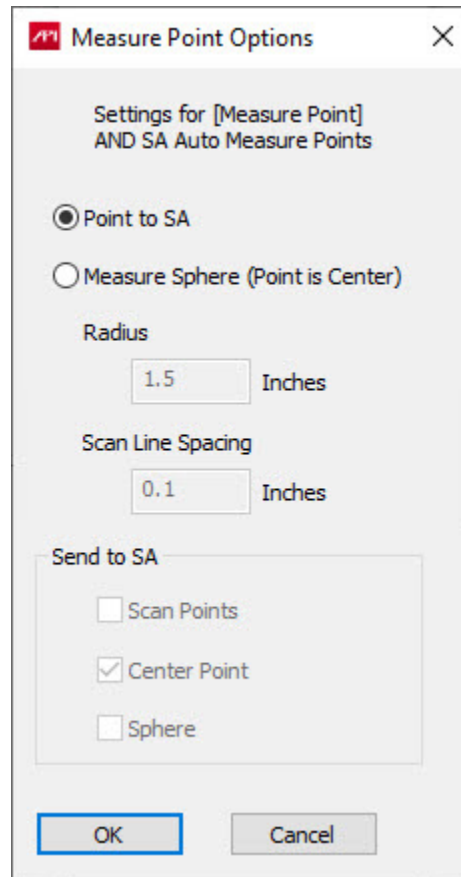
Measuring SA Objects

Direct measurement of selected objects can be performed with the Tooling Ball, Plane, Circle, and Cylinder Scan buttons. In each case the scan will use the settings saved for the feature type (Figure 7-5).

- **Tool Ball Scan.** Select sphere(s) from SA to measure. The [Set] button offers control over the scan parameters to use (Scan Line Spacing and data format to send).

- **Plane Scan.** Select plane(s) from SA to measure- The [Set] button offers control over the scan parameters to use (Scan Line Spacing and Width of Extra Area Around Scan).

- **Circle Scan.** Select circle(s) from SA to measure - The [Set] button offers control over the scan parameters to use (Scan Line Spacing and Width of Extra Area Around Scan, and what return data to record in SA).

- **Cylinder Scan.** Select cylinder(s) from SAto measure- The [Set] button offers control over the scan parameters to use (Scan Line Spacing and Width of Extra Area Around Scan).

Figure 7-5. Setting Controls for object measurement operations
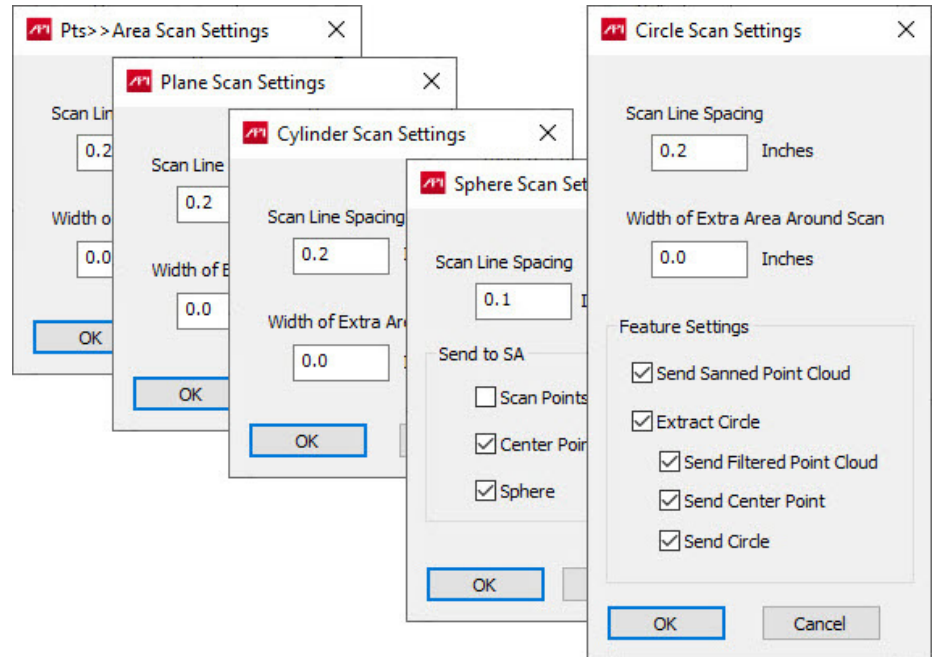
Camera Guided Controls

Measuring with the Camera

- **iVision.** This button will open video window which also offers near complete measured control (Figure 7-6).
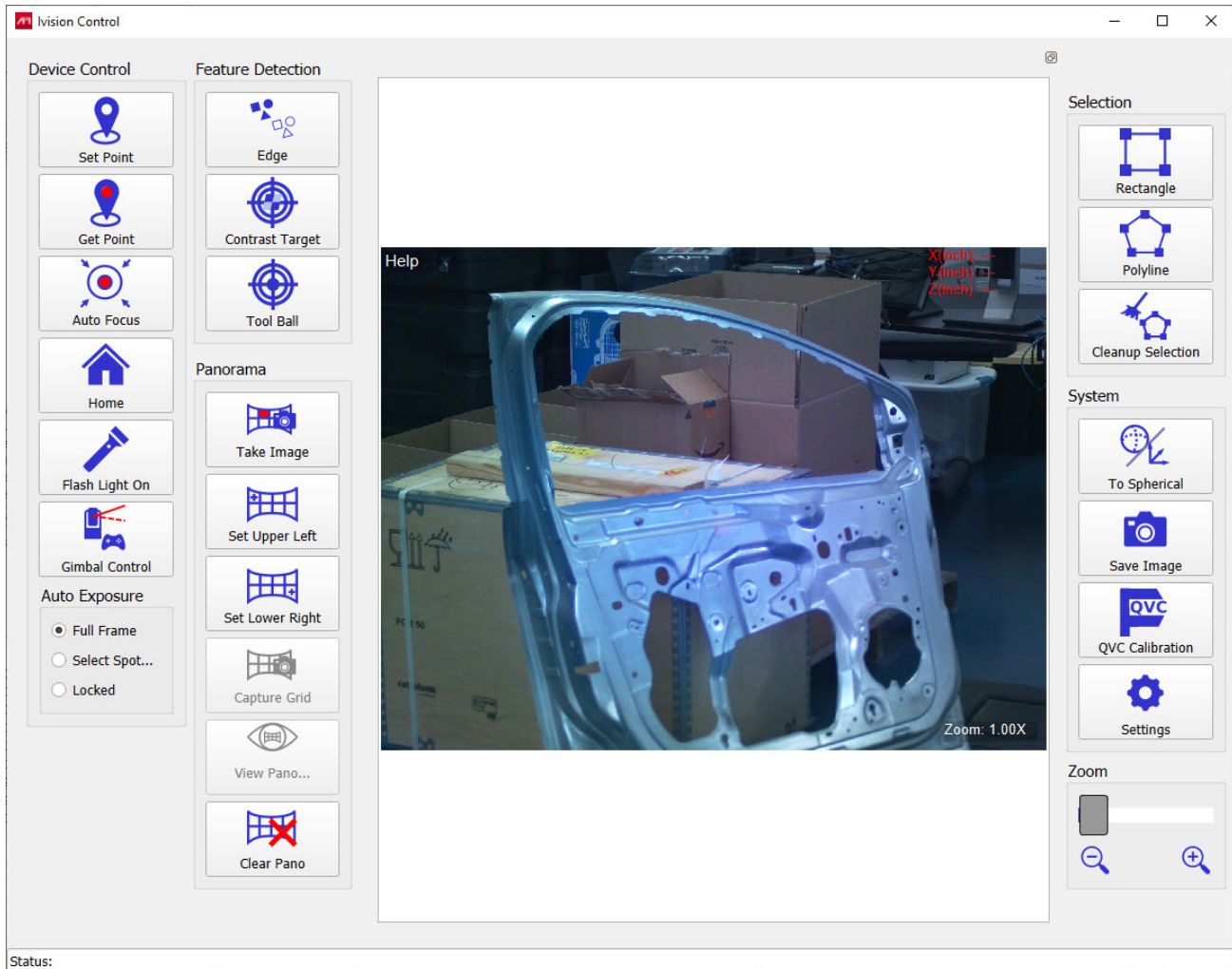
Figure 7-6. API iVision Screen

Refer to the API Ladar documentation for details on the use of the iVision Camera and its capabilities.

Common operations include:

Point Measurement:

1. Drive the beam by clicking in the view. You can do this by clicking or by enabling the Gimbal Control which allows you
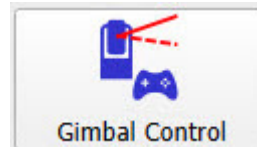
    to click and hold to drive.

2. Under Device Control press the Get Point button.
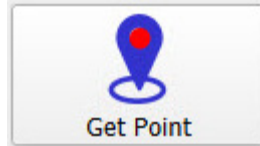
Get Point A point will be created in SA using the name currently entered in the interface. It will also be marked in the camera view.

3. Repeat as needed.

Feature Detection:

To measure a contrast target for example you have a couple of options.

1. Within the camera view you can press the Contrast Target button.
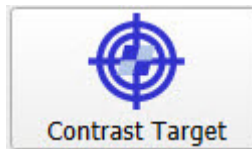
Contrast Target

2. The ivision control will search the camera view and identify targets in the view. You can then click on one to center on that target (Figure 7-7).
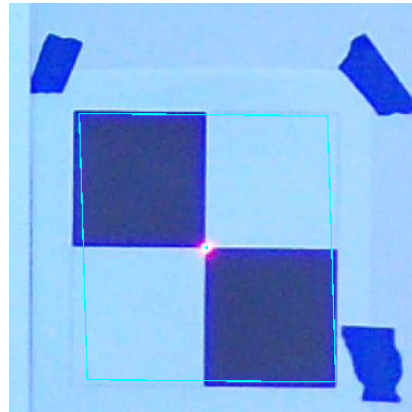
Figure 7-7. Centered on a Contrast Target in the camera view

3. You can the use the Get Point button to trigger a measurement centered on the target.

Alternatively you can scan a contrast target and then extract the center point from within SA using the point extraction tool on the Instrument tab of the ribbon.

Region Measurement:

1. Select Rectangle or Polyline from the Selection section.

2. Define region to scan. In rectangle mode you click and drag to draw a rectangular region. In Polyline mode you click to define a perimeter in the camera view.

3. Right click on the region in the view and select Define Region. This is where you control the resolution of the scan (Figure

7-8).
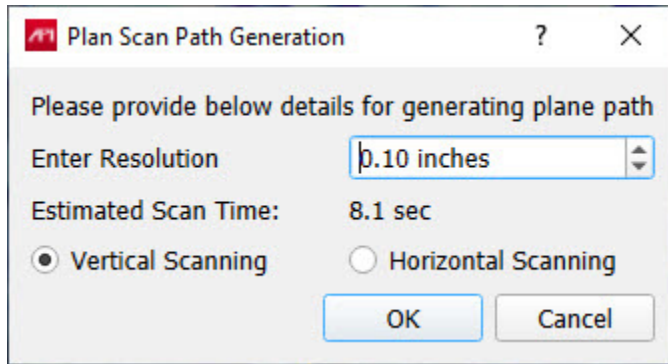
4. To begin the measurement, close the iVision window or bring up the interface control and press the San Last Path button within the instrument interface.

Image Capture:

The Ladar offers both individual image capture and the ability to define panoramic image.
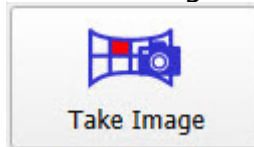
In either case the image will first need to be saved (using the Image Save button) to disk and can then be transferred to SA by simply drag-drop in the SA graphics, or directly into an SA report, to add it as an embedded file for use in a report.

Auto-Measure Operations

Supports the following in the SA >> Instrument >> Automatic Measurement menu(Figure 7-9):
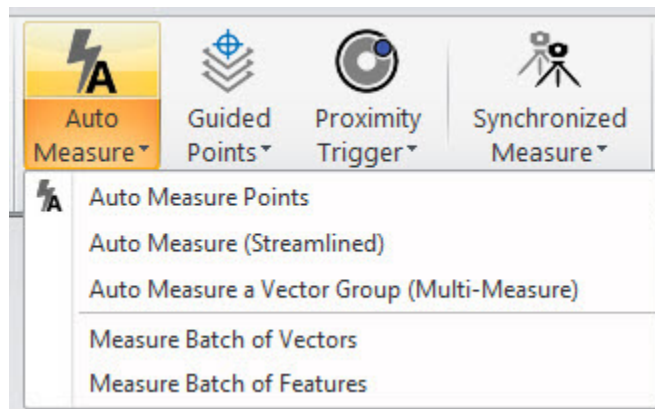
Figure 7-9. Auto Measure Controls Within SA

- **Auto Measure Points.** Measures a point group and offers full control over the measurement process including repeat options.

- **Auto Measure Points (Streamlined).** Offers a quick means of

measuring a point group.

▪ **Auto Measure Vector Group (Multi-Measure).** Offers a full control dialog for measuring selected vectors within a vector group. The [SVI Settings] button can be used to control the resolution and tolerance of the scan process.

▪ **Measure Batch of Vectors.** Offers a quick way to meausure all the vectors in a selected vector group. The SVI Settings button can be used to set the Surface Vector Intersection (SVI) resolution settings used by the Auto Measure Batch of Vectors function.

▪ **Measure Batch of Features.** Measures a series of GR-Features using the nominal object as the reference. It uses the individual [Set] button settings per feature type to control the resolution of the scan and the saved data.

▪ **Pts >> Area Scan.** This button will prompt the user to select points from SA to form a scan area (rectangle). It will then immediately can and return a cloud using the saved settings within the corresponding [Set] button.

Additional Utilities

▪ **Flashlight.** Toggles flashlight on/off

▪ **Virtual Level.** Performs virtual level operation and saves the results to SA Instrument History.

▪ **Device Info.** This operation will retrieve device information from the ladar and save this to the SA Instrument History. The instrument history can be accessed by right-clicking on the instrument in the tree.

▪ **Frt/Bk Chk.** Perform a Front/Back check on the current location, and send results to SA Instrument History.

Status Box at Bottom of Interface Window - reports current status/ pending action

* Note: the unit takes several seconds to shut down and disconnect when the interface is closed "Disconnecting..." will show in status box.

MP/SDK Integration

The following MP commands are supported for the Ladar:

- **Point At Target.**

- **Auto Measure Points.**

- **Auto-Measure Vectors.**

- **Auto-Measure Surface Vector Intersections.**

- **Auto-Measure Batch of Vectors**

With the 2024.1 version the following were also added:

- **Scan within perimeter.** This command also offers the ability to scan a list of perimeters. The resolution of the scan is controlled from the [Pts..Area Scan] [Set] button.

Nikon APDIS - MV400 Series

Prerequisites and Connection

- SA version 2022.2 or later is requires along with the Nikon SDK v10.05.06.06174 or later.

- Follow Nikon's recommendations for the instrument mounting, set up and cabling.

SA/Nikon SDK Installation

The Nikon SDK 64-bit file set (SDKx64_v10.05.07.6425) needs to be downloaded from:

https://www.kinematics.com/ftp/SA/Install/Driver%20Downloads/Laser%20Radar/Nikon%20Metrology/APDIS_MV400_x64/

Once downloaded, this zip file should be extracted into SA Install x64 directory:

C:\Program Files (x86)\New River Kinematics\SpatialAnalyzer xxxx.xx.xx.0\x64

Starting the Interface

1. Select **Instrument > Add** and choose the Nikon APDIS MV400 from the **Add Instrument to SA** dialog (Figure 7-10).

Under the Options button is the ability to control the default instrument placement and the ability to add a stand, if desired. You can also choose to auto Run the instrument when it is added.

Figure 7-10. Adding the Nikon APDIS Model to SA
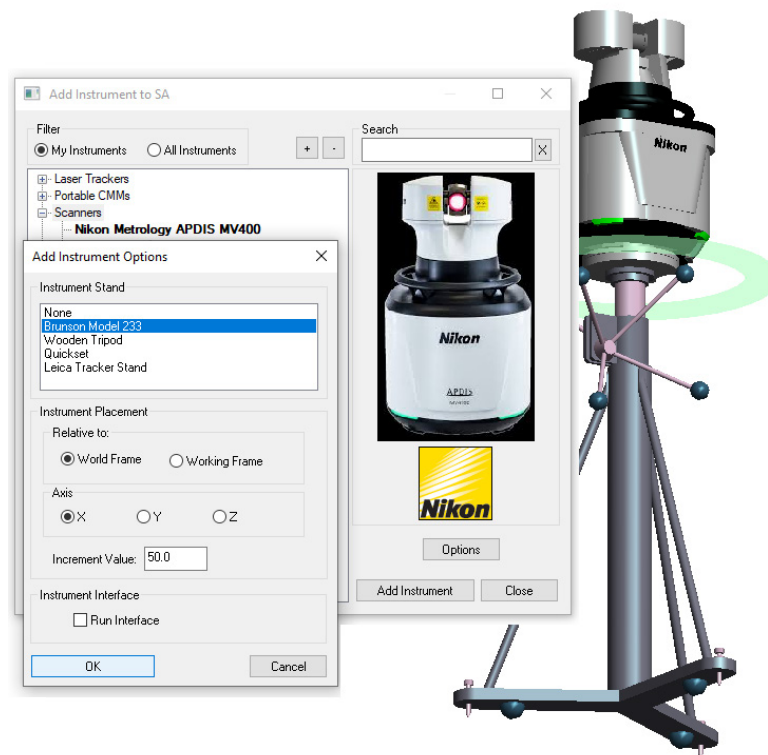
2. Now run the instrument interface module using the Connect button. This is done first, and the interface will open and be accessible and then the connection is made to the instrument from the interface (Figure 7-11).

Figure 7-11. Connect Button In SA
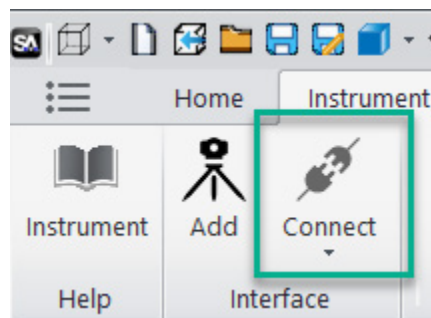
Connecting to the Device

3. Press Connect/Disconnect button in the SA LR interface and select the instrument from the Select CLR dialog. The available LR's on the network should be listed in the selection dialog or an IP address can be entered manually (Figure 7-12).

Figure 7-12. Connect Button
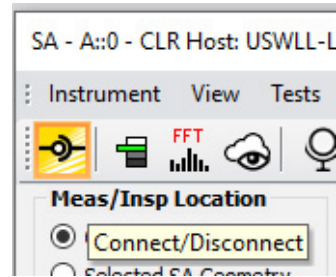
The Nikon **HostSim.exe** can also be used to run the instrument in simulation. Once the LR Toolkit is installed, this application can be found in the Nikon folder here (Figure 7-13):

C:\Program Files\Nikon Metrology\LRToolkit-10.05.01.5866. (Or later)

Figure 7-13. Select CLR dialog used to connect to the instrument.
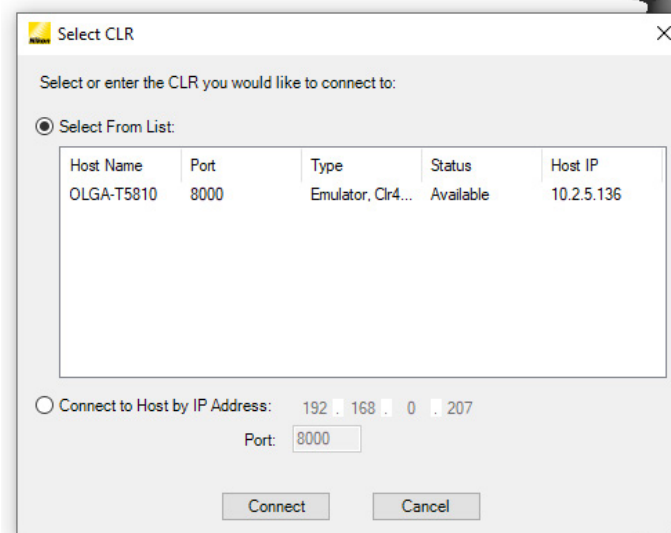
APDIS Interface Controls and Operation

LR Operational Tests

Access the LR Operational Tests are available under the *Tests* menu. Consult the Nikon documentation for operational check procedures (Figure 7-14).

- **Linearization.** Linearize the LR before each measurement session.

- **Self Test.** Conduct Self Test to confirm that range measurement and signal processing are performing within specifications.

- **Flip Test.** The Flip Test provides quick feedback on system calibration parameters through range and angle readings.

- **Stare Test.** Shows the Stare Test dialog.

- **Vibration Analysis.** Certain specially equipped MV4x0 Laser

Radars will support the ability to measure the vibration frequency (up to 2 kHz) of the part being measured.

- **Angle Calibration.** Shows Angle Calibration dialog.

- **MCM Calibration.** Shows the MCM Calibration dialog. Calibrations can be created and saved in any position or orientation. This is essential when mounted on a robot and can be controlled through MP automation .
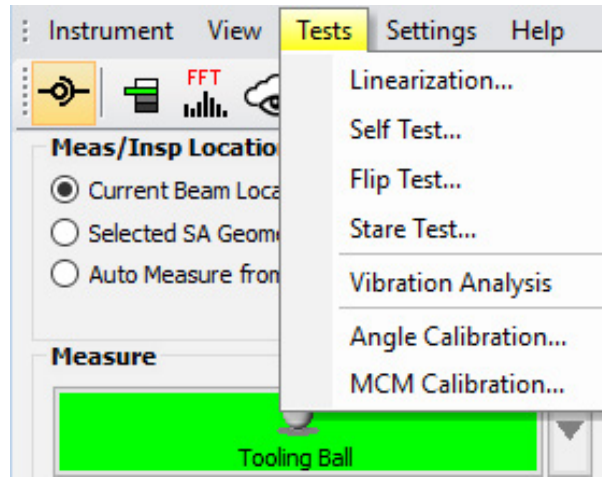
Figure 7-14. Selection of LR Self Test available through the menu.

Current Beam Location, SNR and Auto-Focus Limits

The upper half of the APDIS LR Interface offer the necessary basic controls for beam and focus operations (Figure 7-15).
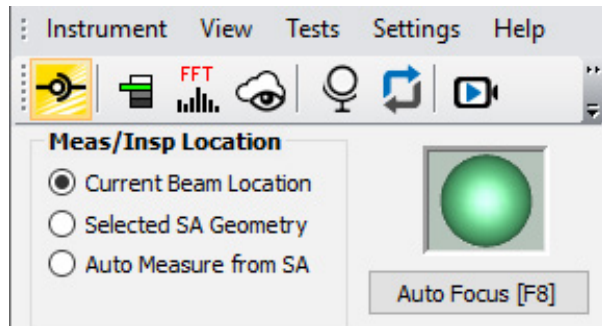
Figure 7-15. Upper APDIS Interface Controls

- **Show/Hide FFT Window.** Toggles the FFT window visibility (Figure 7-16).
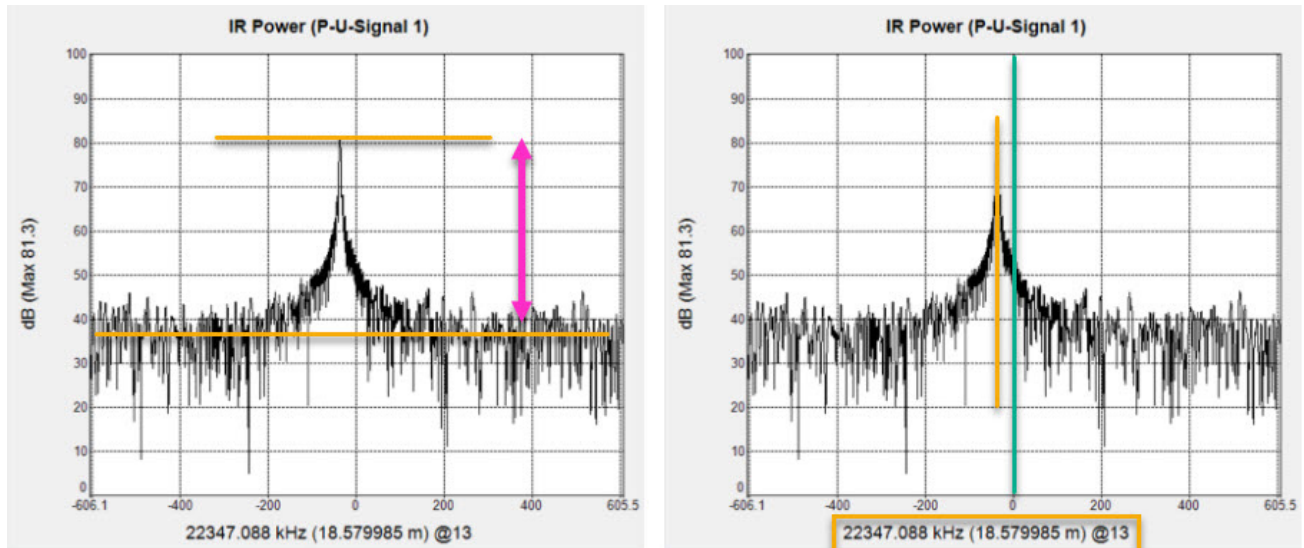
Figure 7-16. The IR Power window can be used to inspect the Signal to noise ratio and peak shift.

This allows the user to view the IR Power and SNR (signal to noise ratio) of the return (shown in pink). The relative shift from the focus zero point is also helpful in understanding the quality of the return(Figure 7-16).

- ■ 📺 **Video Window.** Toggles the video output window (Figure 7-17). Using **Ctrl** + **Shift** + **+** or **Ctrl** + **Shift** + "**-**" will increase or decrease the steering speed (Figure 7-17).
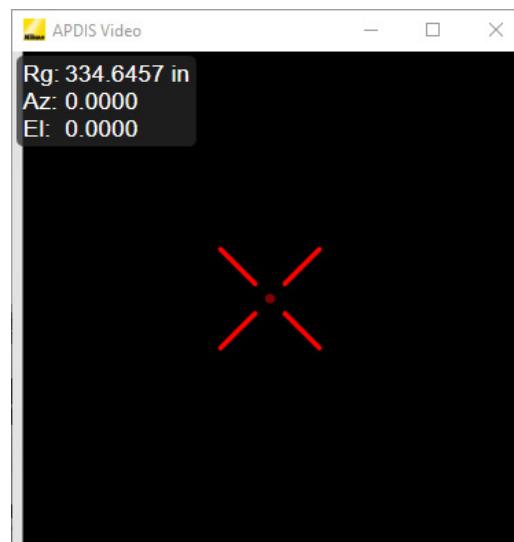
Figure 7-17. Video Window with position values.

Auto Focus

An Auto Focus operation can be triggered using the Auto Focus [F8] button or the F8 key. The Set Focus Limits dialog can be accessed through *Instrument>Beam Location>Set Focus Limits* and provides a means to limit the extent of the autofocus search and speed the operation (Figure 7-18).
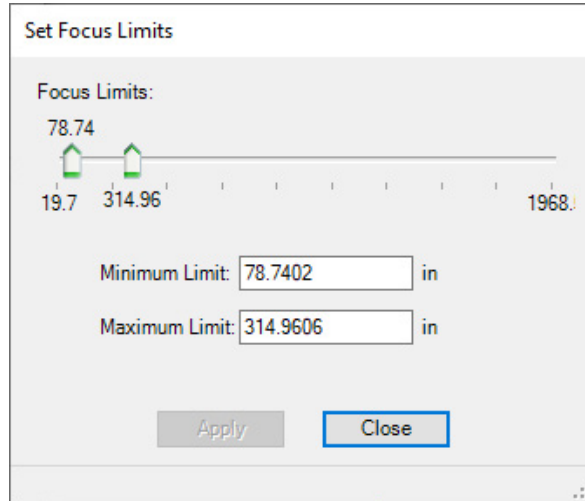
Beam Location

The Beam Position is displayed both in the video window and can be accessed in the Beam Position control dialog (Figure 7-19) available under *Instrument>Beam Location>Beam Position*.

Figure 7-19. Beam Location
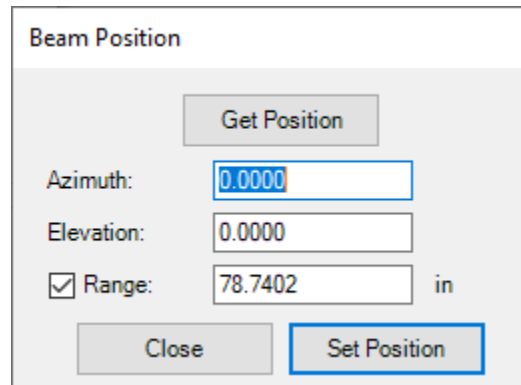
Meas/Insp Location Controls

The APDIS LR interface supports three measure locations (Figure 7-15).

- **Current Beam Location.** Used to measure the current location of the beam.

- **Selected SA Geometry.** Used when a supported geometry is to be measure. An example would be a perimeter or a vector group.

- **Auto Measure from SA.** Used when SA sends an auto-measure request to the LR interface.

Measure and Target Manager

A measurement taken from the LR interface, when you press the Measure [F3] button, uses the parameters defined in the selected measurement target.

There are many targets and you can build your own. The interface offers 4 quick select buttons that can be programmed with your most commonly used operations. In addition, the selected **Meas/Insp Location** controls the corresponding target and measurement quick select options, so you can have 4 presets per operation.

To select a target for a particular quick select button, press the arrow button the right of the desired button. A list of targets will appear for selection categorized by type (Figure 7-20).
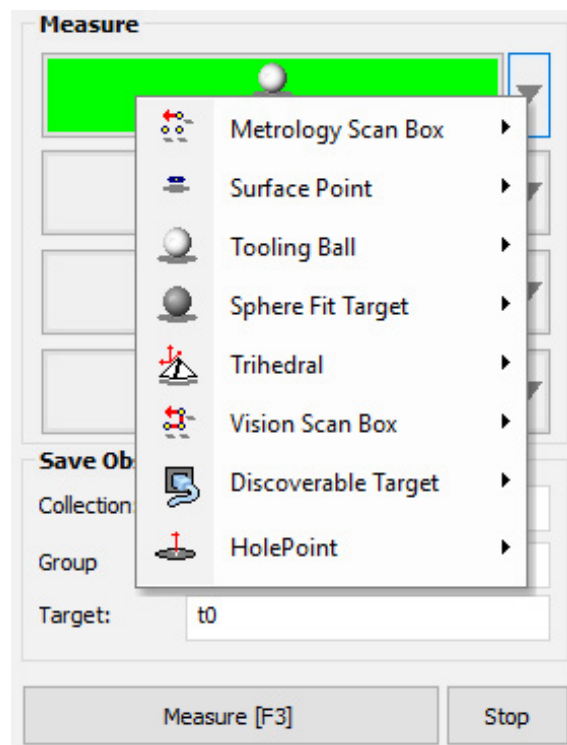
Figure 7-20. Measure section of the APDIS LR Interface

To access the parameters defined for the measure modes, double-left click on a quick select button and the ***Advanced Target Manager*** will appear (Figure 7-22). Here a user has both full access to all the measurement modes available, can tweak a particular profile to suit the measurement task at hand, and designate the quick access button associated with it.

Measurement Targets

Measurement Targets are defined using reference geometry which define where a measurement is to take place and the area to cover. Examples of measurement targets include:

- **Circles**

- **Closed Perimeters**
- **Open Perimeters**
- **Point Groups**
- **Vector Groups**

Measurement Methods

The way in which targets are measured include mothods such as:

- **Surface Point.** Which is a direct surface measurement

- **Reflector.** Which finds the center of a reflector.

- **Tooling Ball.** Which is a spiral search to find the center of a reflective tooling ball.

- **Sphere Fit Target.** Which is a scan of a non-reflective spherical target to which sphere fit is then performed.

- **HoleCircle.** Which defines a number of passes across a circle's edges and a coverage threshold.

- **Metrology Scan.** This measurement process scans along a line segment (or sequence of line segments) much line a Vision Scan, but to do so it defines a set of measurement points along each segment. It then moves from point to point performing an SVI measurement at each location. It produces a scan of lower density but higher accuracy than a vision scan.

- **Vision Scan.** This measurement scans along a line segment (or sequence of line segments). It is a continuous scan where the laser doesn't stop during the scan progression, performing a much faster region scan than is performed by the metrology scan process but at lower resolution.

- **Edge Search.** Which searches for an edge.

- **Surf-Vector Intersection (SVI).** Which searches along a nominal vector to where it intersects with an actual surface.

There are two different quality thresholds that can be set for different targets. As an example the thresholds from a metrology scan are shown here (Figure 7-21):

Figure 7-21. Quality Thresholds for a Metrology Scan

Quality Filter	
ScanPowerThreshold	45.0000
QualityThreshold	80.0000

- **ScanPowerThreshold.** This establishes the a baseline power return (dB, see FFT window) necessary for data to be send to SA.

- **QualityThreshold.** Is a standardized threshold to filter out

poorly resolved points. It establishes a Pass/Fail criteria in a range from 0-100 and is used when processing a region, much like an RMS result. A similar quality setting is used for geometry fit results.

For additional details refer to the UserGuide_MV330-350_v1.5.pdf available from Nikon.
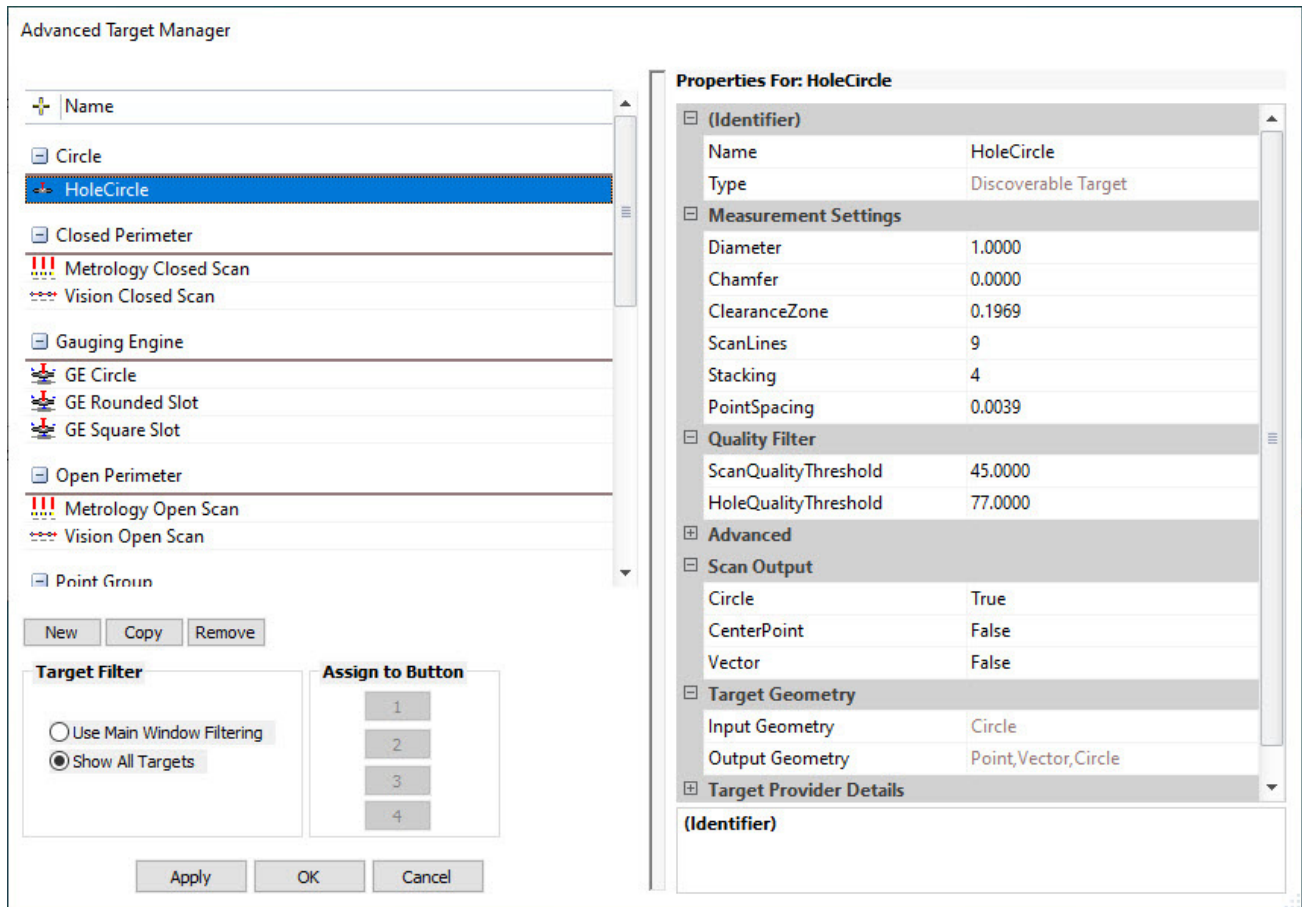
Figure 7-22. Target Manager

Special Operations

Cloud Viewer

The Cloud Viewer button opens an advanced cloud processing utility which can be used for both viewing data that has been measured, processing that data, and defining regions to rescan (Figure 7-23).
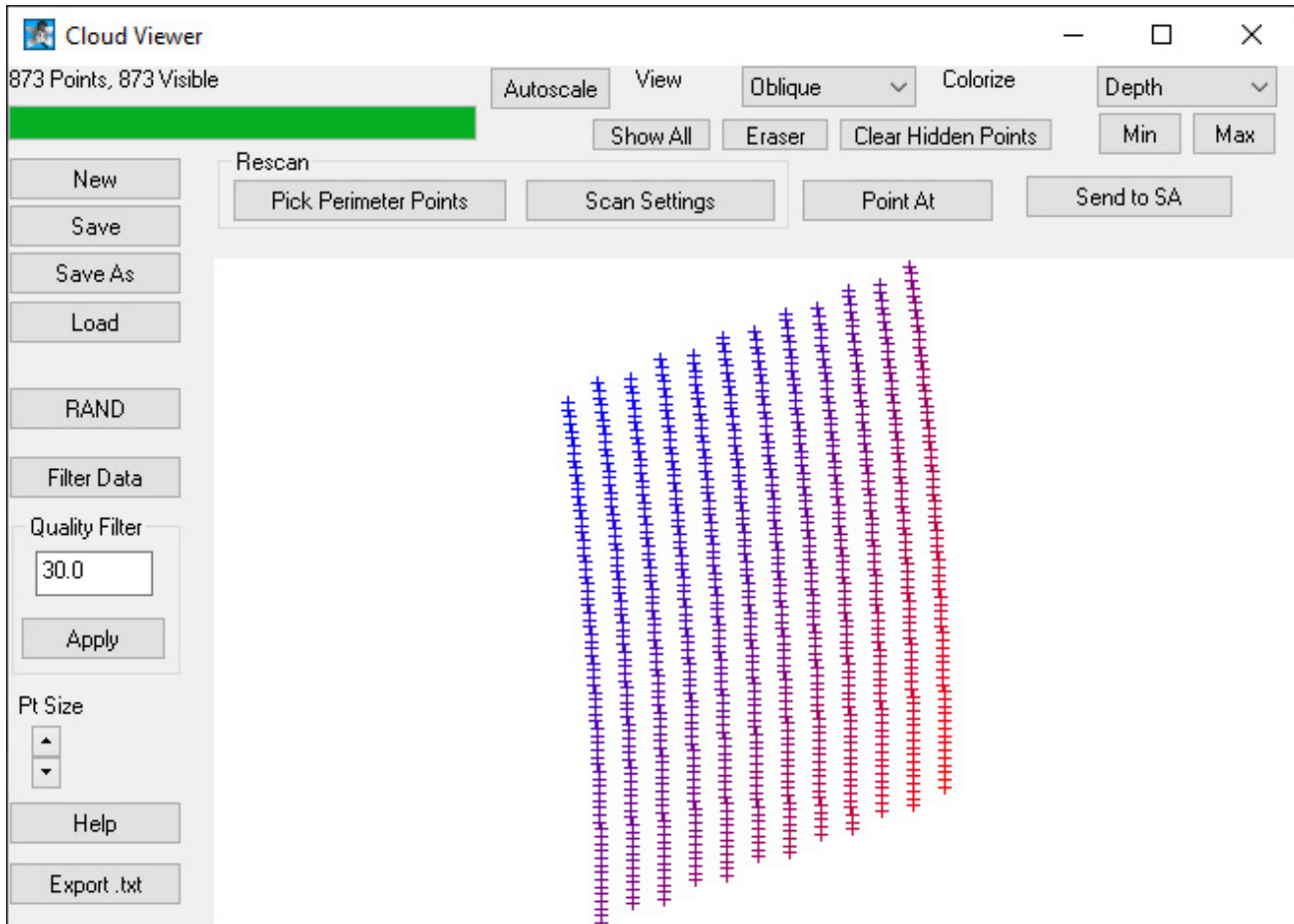
Figure 7-23. Cloud Viewer control panel and display.

Mirror Measurements

The Mirror button opens the mirror target control dialog which can be used for advanced applications where a mirror or set of mirrors are used as part of the measurement process. Mirror measurements expand the visibility of the LR such that it can measure through a first surface mirror and measure features on a part that could not be measured from the instruments location. Mirrors can even be chained together allowing full part visualization from a single instrument plant.

The position and normal of the mirror can be measured and returned to SA. This requires measurement of 2 points. The first point of a tooling ball directly and the second measuring the same tooling ball through the mirror (Figure 7-24).

Figure 7-24. Mirror Measurement Control Dialog after measuring 2 points to define a mirror.
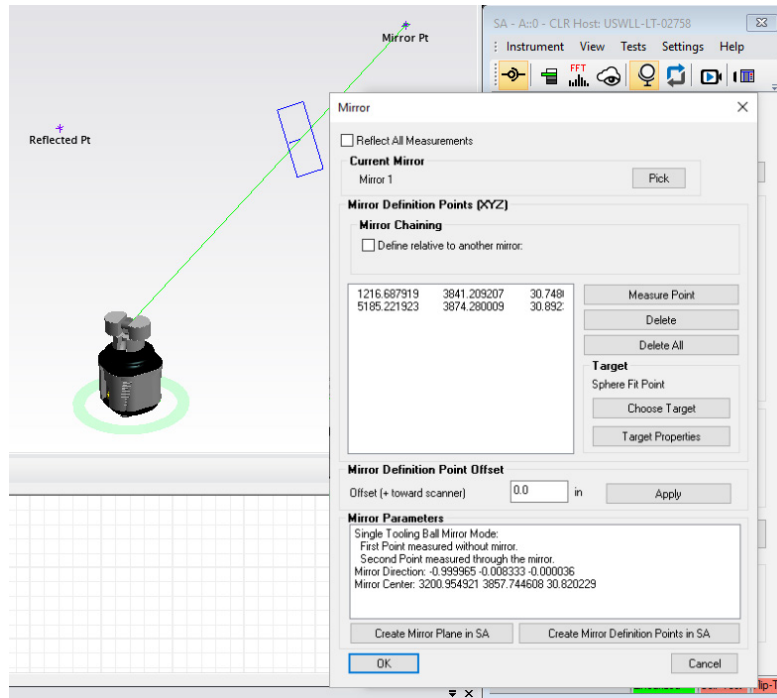
If more than 2 points are measure, a plane is directly fit to the measurements and a mirror is defined from this plane fit.

This mirror definition can then be activated using the R*eflect All Measurements* check box. When active, the mirror icon will start flashing in the interface and additional measurement will be automatically reflected.

The *Create Mirror Plane* in SA option is helpful in that if you don't automatically mirror measurements you can also directly mirror objects using the commands within SA.

Continuous Repeat

The Continuously Repeat button initiated a continuous data stream to SA which sends updates by repeating the current measurement mode. This can be very helpful when using watch windows and performing layout operations.

Saved Observations and Output

Target Naming Controls

These controls are used to define the way measurements are saved within the SA Tree (Figure 7-25).

365

Figure 7-25. Saved Data and Output controls
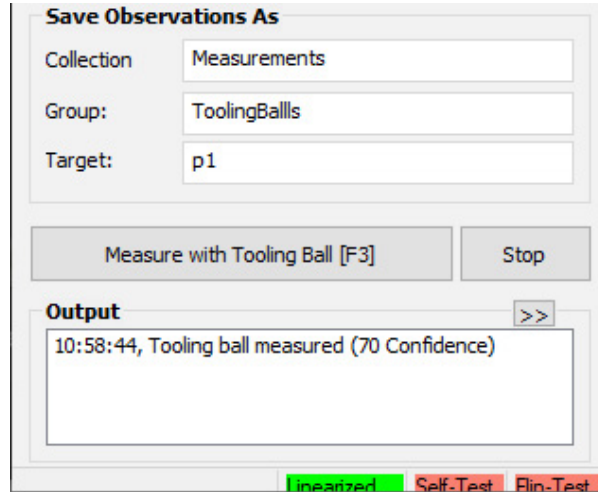
Point measurements are saved using the specified point name:

- **Collection Name.** Specify the collection name for the group and target to be stored. If left blank, the group and target will be stored in the active collection.

- **Group Name.** Specify group name for target to be stored.

- **Target Naming.** Specify name for target, target name will automatically increment after each measurement.

In the case where a target definition returns an object, be that a circle or a point cloud for example, the collection name still applies and the Group name is used for the object.

Output

Displays information specific to the laser radar measurement process and can be viewed as a log of operations. The ellipsis arrows provide a means to open a larger record of the events and save them as a text file.

Example Single Point Measurements

This section will briefly cover some basic single point measurement types. For further information please consult Nikon Metrology.

Tooling Ball

1. Select the desired tooling ball measurement mode for selected quick select. Use the drop-down arrow to pick the desired measurement mode. If the needed measurement does not exist, create a new one in the target manager .

2. Steer the laser to the tooling ball of choice. Point the laser to a surface near the tooling ball and press **F8** to perform an auto-

focus. Once complete aim the laser to the center of the tooling ball.

3.   Press the Measure button [Measure with Tooling Ball [F3]] or **F3**.

4.   The point will be sent to SA, if not check the output box to check measurement failure details.

Surface Point

1.   Select the desired surface point measurement mode for selected quick select. Use the drop down arrow to pick the desired measurement mode. If the needed measurement does not exist, create a new one in the target manager.

2.   Steer the laser to the surface point of interest. Press **F8** to perform an auto-focus.

3.   Press the Measure button [Measure with Surface Point [F3]] or **F3**.

Example Scanning Measurements

This section will briefly cover some basic scanning measurement types. For further information please consult Nikon Metrology.

Box Scanning

Box scanning allows the scanner to perform a scan bounded by a box with prescribe dimensions.

1.   Point the laser at the center of the area of interest.

2.   Select the appropriate scan mode. Double click the measurement mode to access scan parameters. Enter the scan box dimensions.

3.   Press Measure or **F3**.

4.   A scan will be performed inside the bounding box.

Perimeter Scanning

Perimeter scanning allows the scanning region of the LR to be constrained by a 3D perimeter.

1.   In SA, select **Construct>Perimeter**. Select the measured or nominal points which describe the bounding region to be scanned. Two types of perimeters exist in SA, open and closed. A single perimeter can be changed from open to closed in the perimeter properties dialog.

2.   In the LR Interface, change the *Meas/Inspec Location* to **Selected SA Geometry**.

3.   In SA, select the desired perimeter. Once selected, the quick

selects will populate with measurement modes applicable to perimeters.

4. Double-click the measurement mode to access scan parameters.. Often times a user will change the output format, grid rotation and point spacing.

5. Press Measure or **F3**.

MCM Calibrations

When measuring with the LR in different orientations, such that it is not oriented vertically with respect to gravity, additional compensations should be considered for optimal accuracy. Monument Compensation Model (MCM) calibrations can be used for this purpose. *Settings>MCM Database* opens a dialog (Figure 7-26) which provides both a list of existing calibrations and offers the ability to record an additional one.
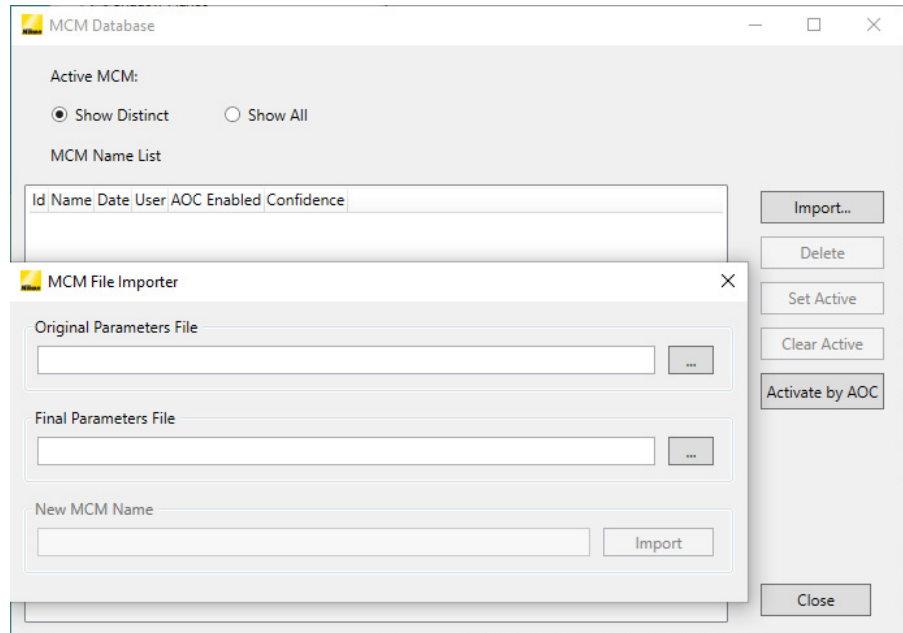
Figure 7-26. Import control from the MCM Calibration Dialog

MP/SDK script control is also essential for the MCM process. The following commands are available:

- **LR APDIS Perform MCM Calibration.** Allows a point group to be selected and measured to build a new calibration

- **LR APDIS Activate MCM Calibration.** Provides the ability to set the active calibration when desired.

- **LR APDIS Get Active MCM Calibration.** Provides the ability to check the current MCM calibration in use.

APDIS Models and Licensing

Different LR models come with both different capabilities and licensing restrictions. The current capability of your model can be checked under *Instrument>Hardware Capabilities (*Figure 7-27*).*

Figure 7-27. Example list of Hardware Capabilities and licenses
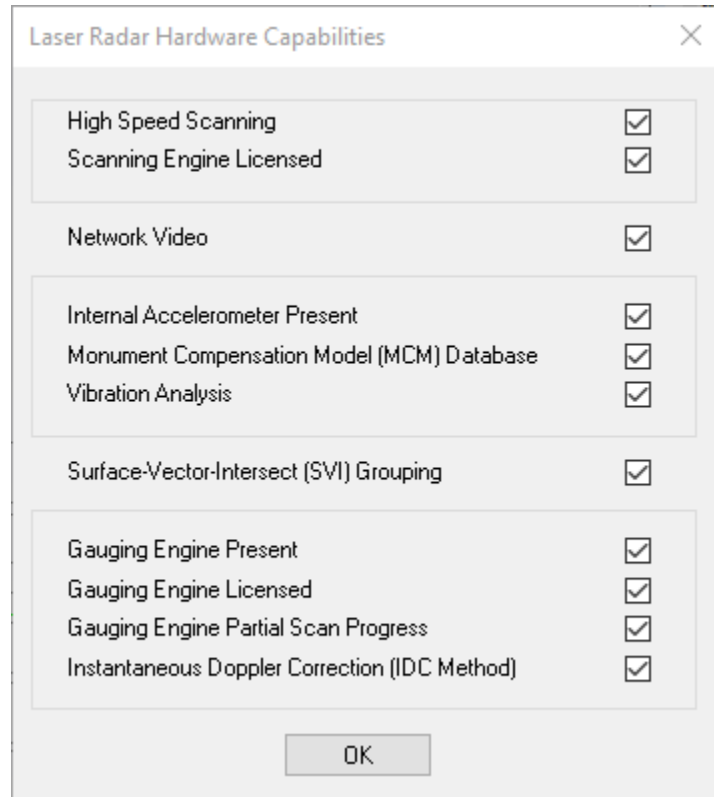
Auto Measure from SA

There are several automatic measure functions that can be triggered from the Instrument menu within SA. *Auto Measure* opens a dialog that allows selection, drive and automatic measurement options. *Batch* commands are much simpler and run through a list of targets in one pass only. These commands exist for both points and vectors. Vectors offer the added benefit of allowing the LR to search the nominal vector for the actual surface intersection point. For more information take a look at the instruments chapter of the users manual.

Using the LR Gauging Engine from SA

Starting with SA version 2022.2 there is now an Auto-Measure option to process a list of GR-Features. This is currently supported through the MV430/MV450 Gauging Engine (GE). Currently supported geometry types include:

- circles
- rounded slots

- rectangular slots

If the user's job has a list of GR-Features with pre-defined nominals, SA can measure this list using the LR's Gauging Engine capability.

Nikon Interface Controls

There are GE specific target profiles that can be linked to individual Features in the tree. These profiles can be edited and saved for specific features.   For example (Figure 7-28):
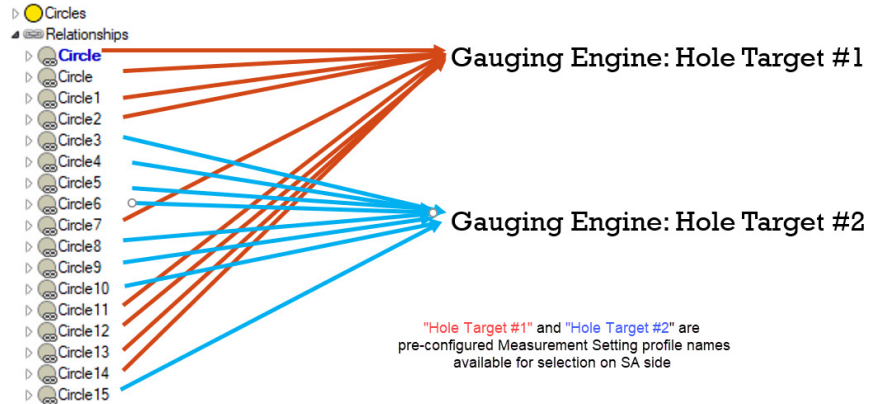
Figure 7-28. Example GE target profile assignment to different features in the SA Tree.

To configure GE target profile / measurement settings on Nikon AP-DIS LR application, use the *Gauging Engine* section in the Target Manager dialog (Figure 7-29).
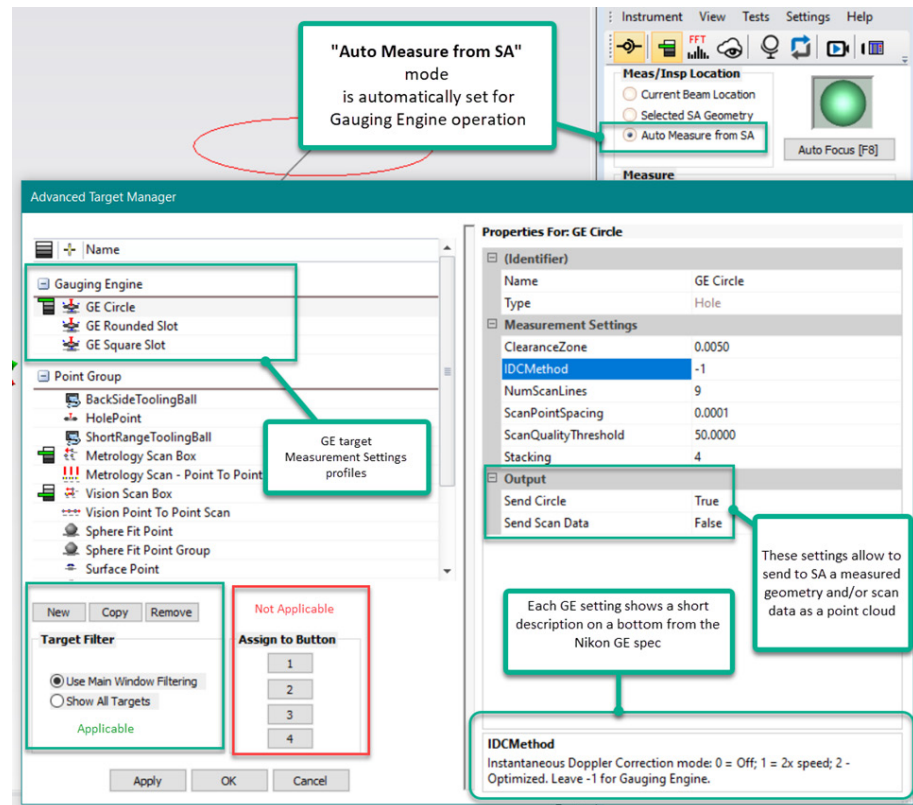
Figure 7-29. Gauging Engine specific target management controls.

The selected GE Target definition setting show a short description on the bottom from the Nikon GE specifications.

Users can define whether to send to SA a measured geometry and/or scan data in form of a cloud. By default, a measured geometry will be sent automatically to SA.

SA Feature Configuration

You can optionally assign a predefined measurement profile to a feature. If this step is skipped, measurement defaults will be used.

To assign a specific measurement profile to a feature, R-click in SA tree on geometry relationship and select the *Inspection >> Configure Instrument* menu option (Figure 7-30).
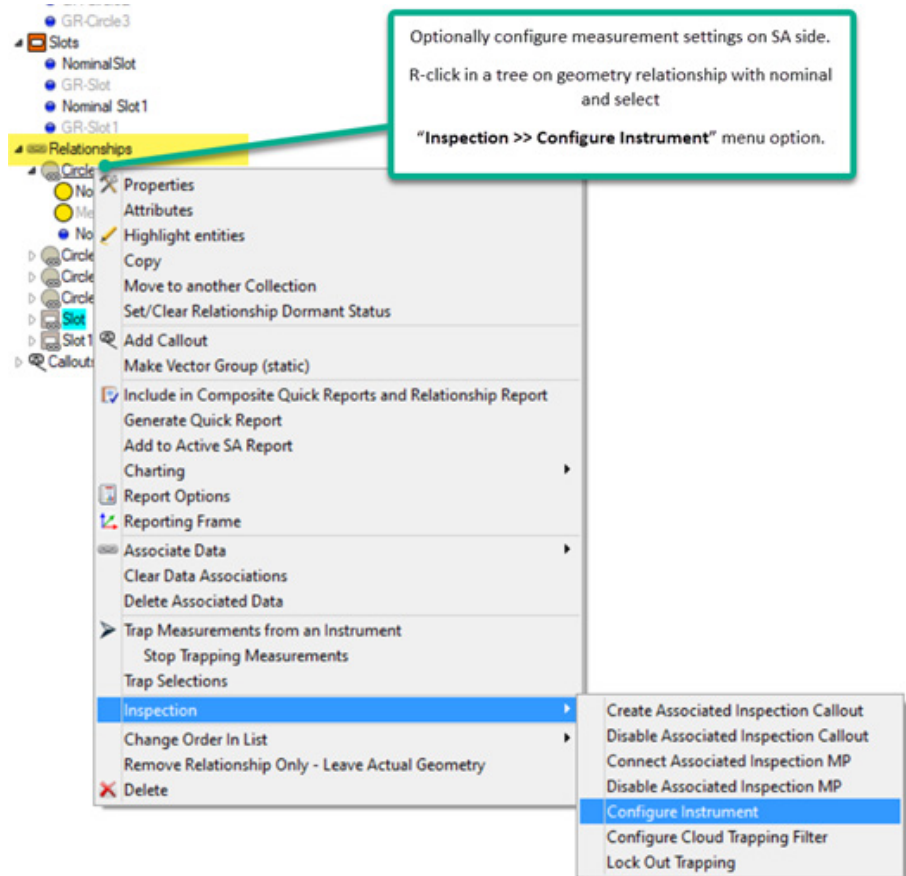
Figure 7-30. Configuring a particular GR-Circle for GE measurement.

You can select a measurement profile for a feature from a list of available GE settings received from LR interface Target Manager (Figure 7-31):
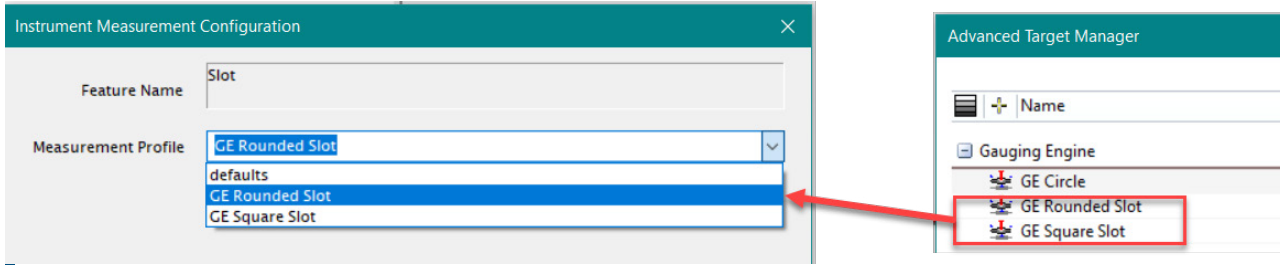
Figure 7-31. Selecting an existing Gauging Engine Definition.

The same dialog allows you to apply the same settings to selected features or reset to defaults.

Triggering the Measurement Process

To start the measurement process, navigate to the Instrument tab of the SA ribbon and select *Instrument >> Taking Measurements >> Auto Measure >> Measure Batch of Features* (Figure 7-32).
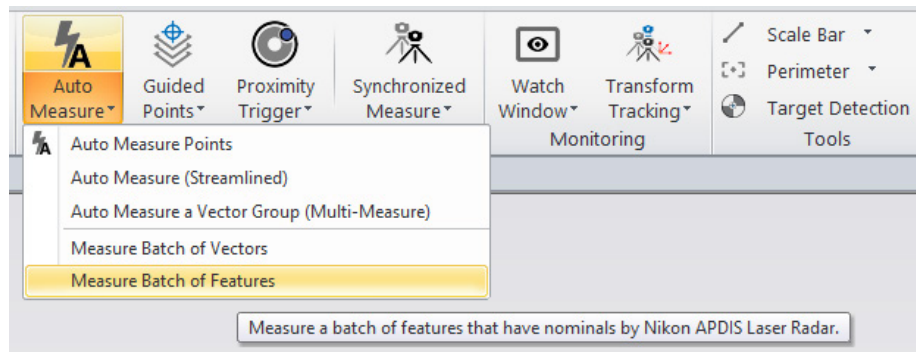
Figure 7-32. Measure Batch of Features Option.

SA application prompts you to select a list of GR-Features to measure and then sends this list to the LR for measurement using Gauging Engine.

On completion of each measurement, SA receives a measurement result (geometry or/and scan data) and immediately associates it with the geometry relationship.

Each measured object (geometry and/or cloud) lists the measurement settings details in the job units (Figure 7-33).
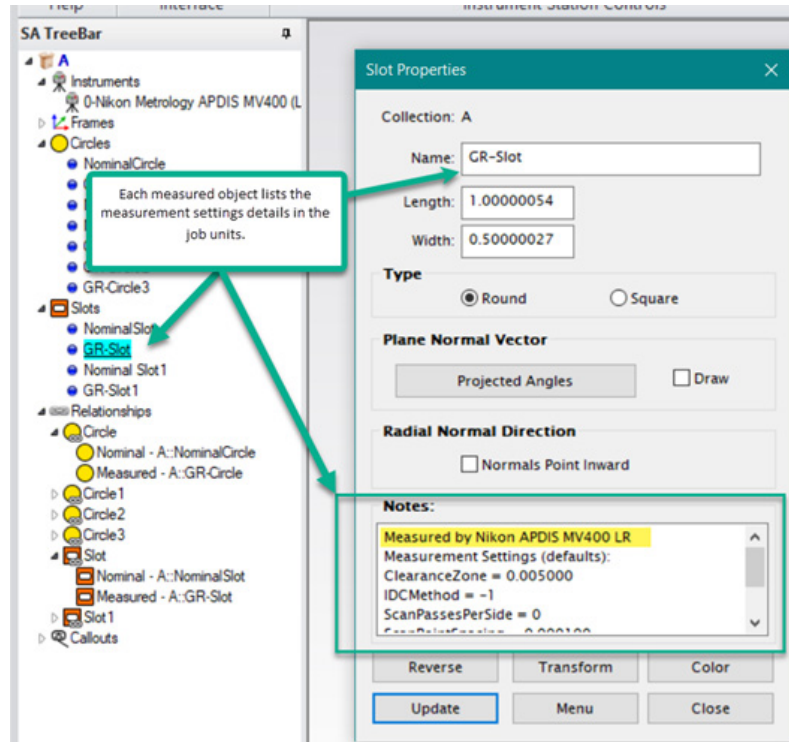
Figure 7-33. Resulting measured feature and saved settings in the object notes.

Laser Radar Automation (MP/SDK) Commands

A list of MP command strings can be found in the interface under *Help>Help Topics>Measurement Plans (MP)*. This dialog offers a full list of strings that can be used with the **Set Instrument Measurement Mode/Profile** and **Instrument Operational Check** commands.

Nikon Laser Radar	
Basic Operations	
Start Instrument Interface	Starts the LR Interface
LR Hardware Connect	Connects to the LR interface to the instrument
LR Hardware Disconnect	Disconnects the LR interface from the instrument
LR Verify Hardware Connection	checks the connection between the interface and the instrument
LR Set Red Laser Intensity	Sets the red laser intensity level for the LR
LR Get Most Recent SNR Info	Return signal-to-noise-ratio information about the IR FFT
LR Self Test	Performs a Self Test and returns the results
LR Self Test - Linearization	Performs a Linearization test and returns the results
LR Self Test - Flip Test	Performs a Flip Test and returns the results
LR APDIS Perform MCM Calibration	Provides a means to perform an MCM calibration
LR APDIS Activate MCM Calibration	Set's the active MCM calibration on the instrument
LR APDIS Get Active MCM Calibration	Returns the name of the currently active MCM Calibration
Measurement Controls	
Auto-Measure Surface Vector Intersections	Performs an auto measure using a reference vector group to find the intersection with a measured surface
Auto-Measure Points	Performs a points based automatic measurement
Auto-Measure Vectors	Performs a Vector based automatic measurement
Auto-Measure Specified Geometry	Performs an automatic measurement using the selected geometry
Auto-Measure Batch of Features	Auto measure of SA Geometry Relationships (Features) by MV430E/MV450E Gauging Engine (GE)
Configure and Measure	Measures a point using the specified name and measurement profile/target
Scan within Perimeter	Scans within the specified perimeter

Nikon Laser Radar	
Point At Target	Points at a selected point
"Set Instrument Measurement Mode/Profile" - Input Strings	
<Target type name>	Sets the specified target type as the measurement profile
mirroron <mirror name>	Enables the selected mirror measurement
mirroroff	Disables the active mirror measurement mod
"Instrument Operational Check" - Input Strings	
Linearization	
FlipTest	Perform a flip test
SelfTest	Perform a self test
StareTest	Perform a stare test
FullComp	Performs a full compensation
QuickComp	Performs a quick compensation (currently functions the same as a full compensation)
MCMCalibration <ptgroup>	Performs an MCM calibration using a point group. (Point group syntax is Collection::PtGroupName)
MCMCalibration <ptgroup1>, <ptgroup2>, ..., <ptgroupN>	Performs a relative MCM calibration using several point groups
MCMCalibration <ptgroup1>, ..., <ptgroupN> TRUE	Validate a relative MCM calibration using several point groups
AutoFocus	Initiates an autofocus operation
SetFocusLimits <min> <max>	Sets the focus limits using the specified min and max distances
IRPowerWindow <ON/OFF>	Open/Close IR Power Spectrum FFT Window
Start Video	Starts the video display
IsVideoOn?	Verify status of the video streaming
Stop Video	Stops the video display
SaveVideoFrame <path and filename>	Save video frame as an image file (BMP, JPG, PNG, GIF, or TIFF)
HWCapability <capability>	Offers the ability to check if the LR supports hardware capabilities (SVIGrouping, ScanEngineLicense, HighSpeedScan, GaugingEngine, GaugingEngineLicensed, MCMDatabase, NetworkVideo, InternalAccelerometer, VibrationAnalysis, InstDopplerCorrection, GEPartialScanProgress)
SetScanPowerThreshold [ ]	Provides a means to set the can power threshold for the active target.
SetConfi denceThreshold [ ]	Provides a means to set the quality (confidence) threshold for the active target.

Nikon Laser Radar (MV200/300)

SA/Nikon SDK Installation

To support MV200/MV300 the SDKx86_v08.02.05.3840.zip should be downloaded from:

https://www.kinematics.com/ftp/SA/Install/Driver%20Downloads/Laser%20Radar/Nikon%20Metrology/MV200_MV300_x86/

Once downloaded, this zip file should be extracted into SA root install directory:

C:\Program Files (x86)\New River Kinematics\SpatialAnalyzer xxxx.xx.xx.0

Starting the Interface

Add the Laser Radar Instrument by using 🖼️ or the menu item **Instrument>Add** (Figure 7-34).
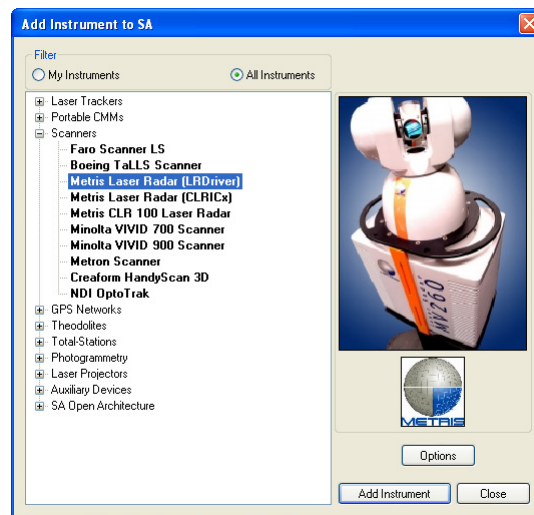
Figure 7-34. Adding the Laser Radar to the job.

Start the instrument interface using 🏃 or the menu item **Instrument>Run Interface Module and Connect** (Figure 7-35).

Figure 7-35. The Laser Radar interface.
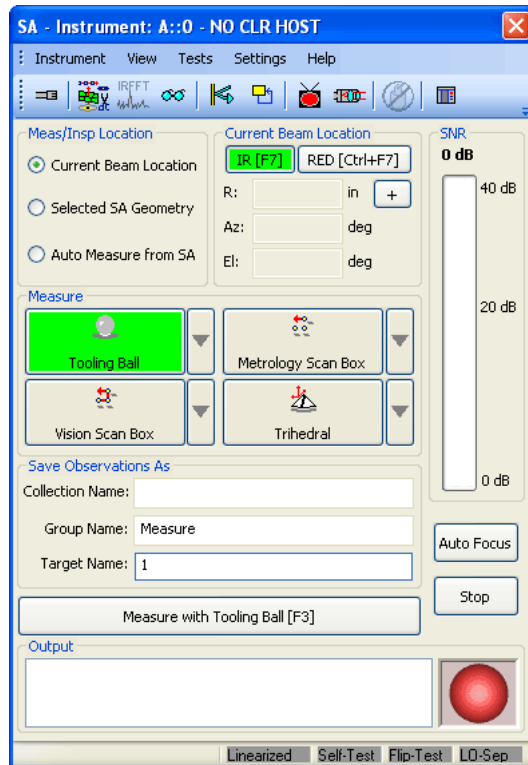
Use the Connect button ⊒ to display the Select CLR dialog. Select the respective instrument and press Connect (Figure 7-36).

Figure 7-36. Selecting the instrument to connect.
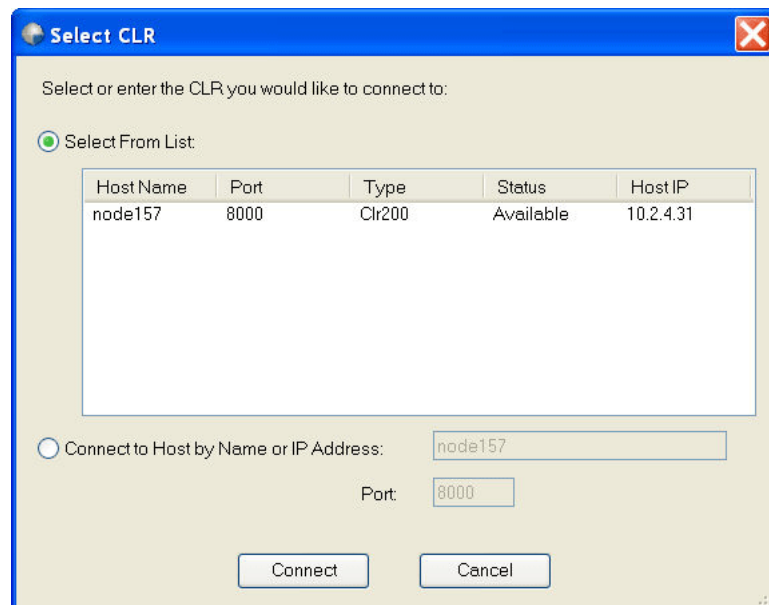
Instrument Interface Controls

Figure 7-37. The toolbar in the laser radar interface.

- ⊒ **Connect/Disconnect.** Opens the LR Connection dialog (see

above).

▪   **Target Manager - Advanced.** Displays the target manager interface (Figure 7-38).
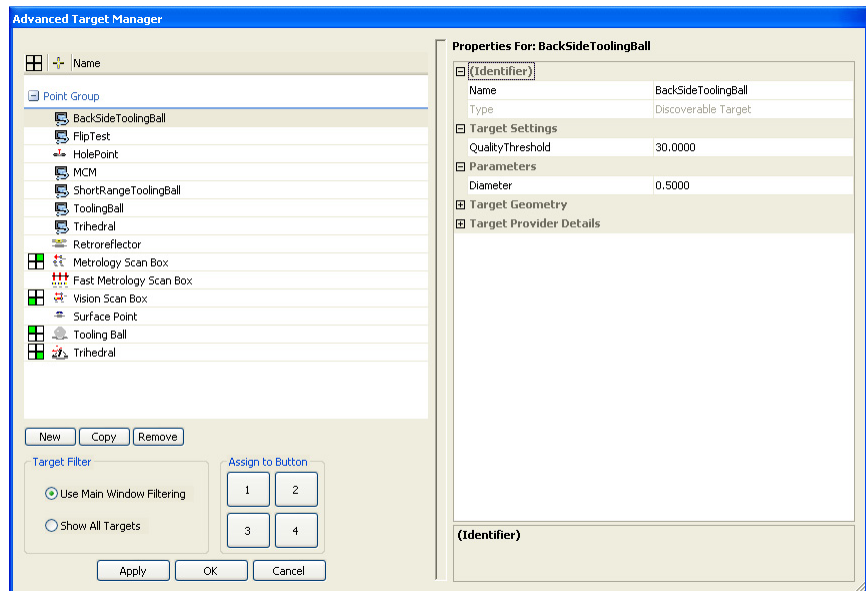
Figure 7-38. The Advanced Target Manager.

▪   **Show/Hide FFT Window.** Toggles the FFT window visibility (Figure 7-39).
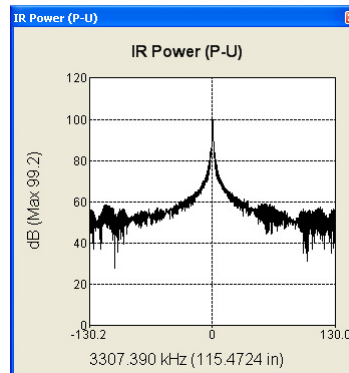
Figure 7-39. The FFT window.

▪   **Cloud Viewer.** Opens the cloud viewer interface (Figure 7-40).
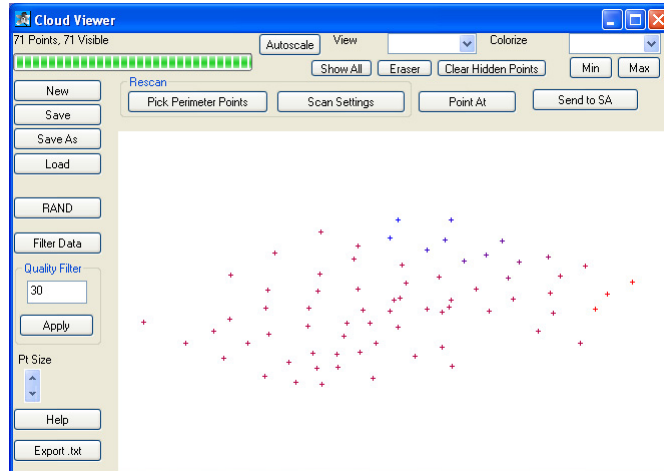
Figure 7-40. The Cloud Viewer.

- ▪ **◁ Mirror.** Displays the mirror target dialog (Figure 7-41).

Figure 7-41. The mirror target dialog.

- ▪ **🗗 Continuously Repeat Command.** Sends updates by repeating the current measurement mode.

- ▪ **◼ Video Window.** Toggles the video output window (Figure 7-42). Using **Ctrl** + **Shift** + **+** or **Ctrl** + **Shift** + "**-**" will increase or decrease the steering speed.
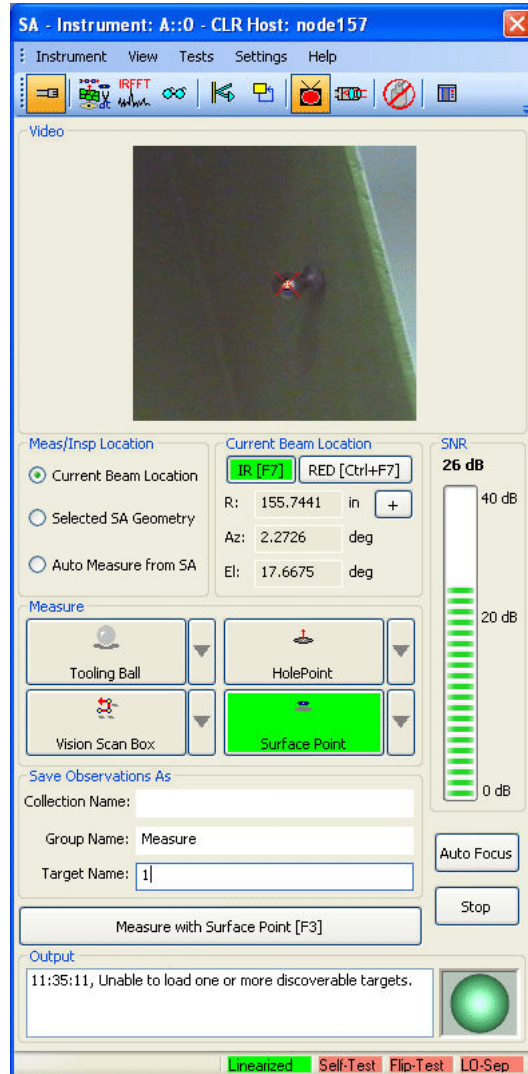
Figure 7-42. The video window.

- ▪ 🎞 **Video Focus.** Displays slider for manual focusing of video camera.

- ▪ ⊘ **Shutdown.** Disconnect and shutdown scanner.

- ▪ ▤ **Dock/Undock.** Docks or Undocks the instrument interface in SA.

Target Naming

Figure 7-43. Specifying a target name to measure.

- ▪ **Collection Name.** Specify the collection name for the group and target to be stored. If left blank, the group and target will be stored in the active collection.

- **Group Name.** Specify group name for target to be stored.

- **Target Naming.** Specify name for target, target name will automatically increment after each measurement.

Measure/Inspection Location

The LR interface supports three measure locations (Figure 7-44). When selected the user can configure the "measure" quick selects. When the measure operation is changed the "measure" quick selects will change.
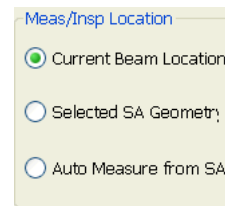
- **Current Beam Location.** Used to measure the current location of the beam.

- **Selected SA Geometry.** Used when a supported geometry is to be measure. An example would be a perimeter or a vector group.

- **Auto Measure from SA.** Used when SA sends an auto-measure request to the LR interface.

Current Beam Location, SNR and Auto-Focus Limits

This allows the user to view the IR SNR (signal to noise ratio) or the Red (pointing laser) focus limits (Figure 7-45). When selected the display to the right will change. When "Red" is selected the user will have quick access to the focus limits. **F7** can be used to toggle between the two displays. Auto-focus can be accessed via the interface button or use **F8**.
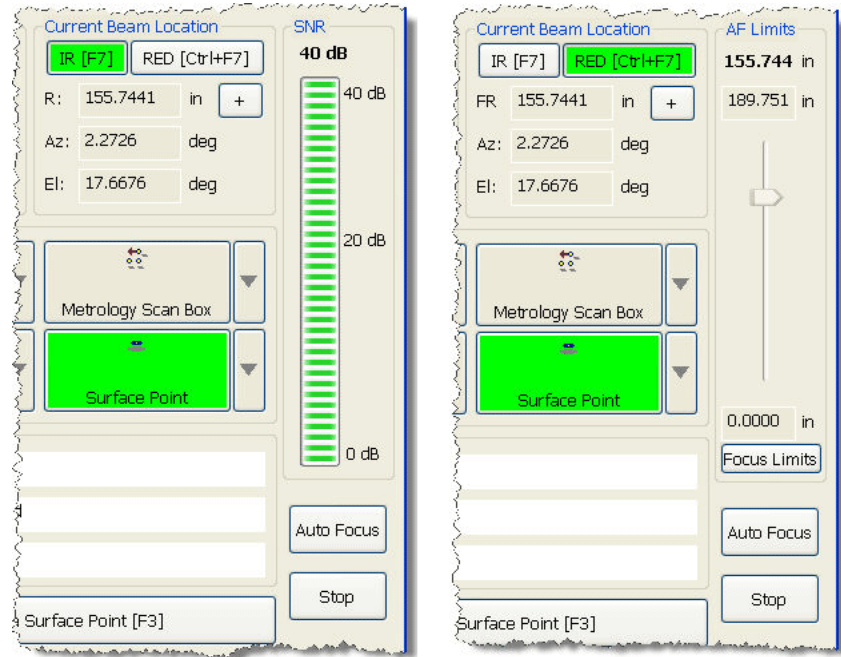
Figure 7-45. SNR/AF Limits.

Measure and Advanced Target Manager

To select a Measure mode for a particular quick select, press the arrow button the right of the desired button. A list of measure types will appear for selection (Figure 7-46).
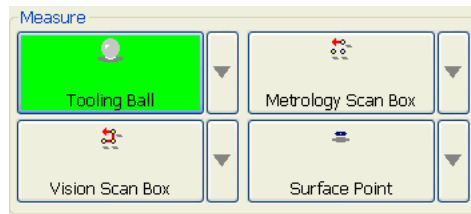
Figure 7-46. Measurement modes.

To access the parameters for the measure mode, double-left click and the **Advanced Target Manager** will appear (Figure 7-47). Here a user can tweak a particular profile to suit the measurement task at hand.

Figure 7-47. Specifying measurement details in the target manager.
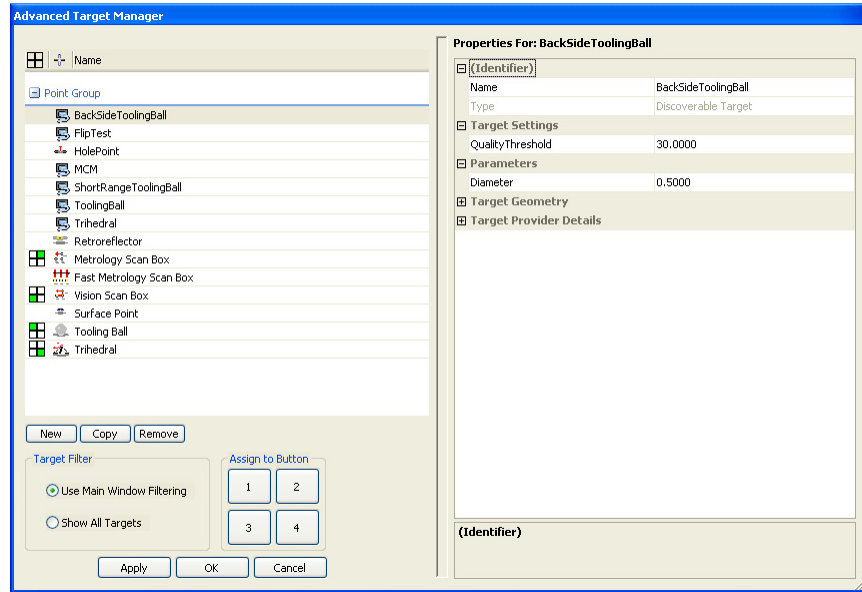
Output

Displays information regarding the current measurement process (Figure 7-48).

Figure 7-48. The output window.
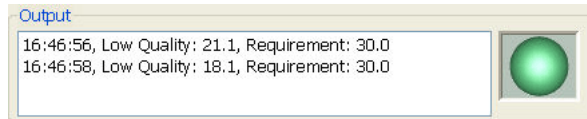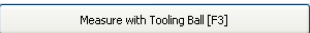
LR Operational Tests

Access the Nikon LR Operational checks under the menu item Tests. Consult the Nikon documentation for operational check procedures.

Single Point Measurements

This section will briefly cover some basic single point measurement types. For further information please consult Nikon Metrology.

Tooling Ball

1. Select the desired tooling ball measurement mode for selected quick select. Use the drop-down arrow to pick the desired measurement mode. If the needed measurement does not exist, create a new one in the target manager ![icon] .

2. Steer the laser to the tooling ball of choice. Point the laser to a surface near the tooling ball and press **F8** to perform an auto-focus. Once complete aim the laser to the center of the tooling ball.

3. Press the measure button ![Measure with Tooling Ball [F3]] or **F3**.

4. The point will be sent to SA, if not check the output box to check measurement failure details.

Surface Point

1. Select the desired surface point measurement mode for selected quick select. Use the drop down arrow to pick the desired measurement mode. If the needed measurement does not exist, create a new one in the target manager 🖼 .

2. Steer the laser to the surface point of interest. Press **F8** to perform an auto-focus.

3. Press the measure button ⌴ Measure with Surface Point [F3] ⌴ or **F3**.

Scanning Measurements

This section will briefly cover some basic scanning measurement types. For further information please consult Nikon Metrology.

Box Scanning

Box scanning allows the scanner to perform a scan bounded by a box with prescribe dimensions.

1. Point the laser at the center of the area of interest.

2. Select the appropriate scan mode. Double click the measurement mode to access scan parameters. Enter the scan box dimensions.

3. Press Measure or **F3**.

4. A scan will be performed inside the bounding box (Figure 7-49).
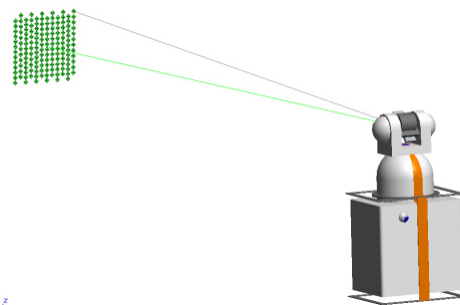
Figure 7-49. Scanning a box.

Perimeter Scanning

Perimeter scanning allows the scanning region of the LR to be constrained by a 3D perimeter.

1. In SA, select **Construct>Perimeter**. Select the measured or nominal points which describe the bounding region to be scanned. Two types of perimeters exist in SA, open and closed. A single perimeter can be changed from open to closed in the perimeter properties dialog.

2. In the LR Interface, change the *Meas/Inspec Location* to **Selected SA Geometry** (Figure 7-50).
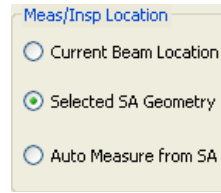
Figure 7-50. Choosing *Selected SA Geometry*.

3. In SA, select the desired perimeter. Once selected, the quick selects will populate with measurement modes applicable to perimeters.

4. Double-click the measurement mode to access scan parameters (Figure 7-51). Often times a user will change the output format, grid rotation and point spacing.

Figure 7-51. Scan parameters.

Output	
TracePerim	False
NewGroupForEachScanLine	False
SendToCloud	False
SendToCloudViewer	False
SendToPtGrp	True
Scan	
GridRotation	0.0000
LineSpacing	1.0000
PointSpacing	1.0000

5. Press Measure or **F3**.

<table>
<tr><td>

Measuring With
Room Scanners

</td><td>

CHAPTER

</td><td>

8

</td></tr>
</table>

Room scanners loosely include instruments designated for large volume scanning. These devices typically rotate and pivot to provide up to a full 360 degree scan of a volume. Refer to the specific system for greater detail.

Room Scanner Quick-Start Guides

Operationally room scanner interfaces range greatly in complexity and capability. Refer to the specific manufacture type for greater detail.

"Faro LS/Focus3D" on page 385

"Surphaser" on page 388

"Leica Geosystems ScanStation PXX" on page 401

Faro LS/Focus3D

Prerequisites

Before connecting to a Faro LS/Focus 3D Scanner in SA, the appropriate drivers must first be installed. Navigate to our website and download the latest drivers from here:

http://www.kinematics.com/ftp/SA/Install/Driver%20Downloads/Scanners/Faro%20LS%20Photon%20Scanner/

1. Unzip the dll's into the current SA install folder. Place the `.bat` files in the current SA install folder. The SA install will be within

C:\Program Files (x86)\New River Kinematics...

2. From within the install directory, run `Unregister iQpen.bat` by right-clicking and selecting Run as Administrator.

3. Then run `Register iQOpen.bat` again by right-clicking and selecting Run as Administrator.

Running the Faro Scanner

1. Add a Faro Scanner Phton/LS/Focus 3D to SA via **Instrument>Add**. Select the Faro Scanner and press Add Instrument (Figure 8-1).
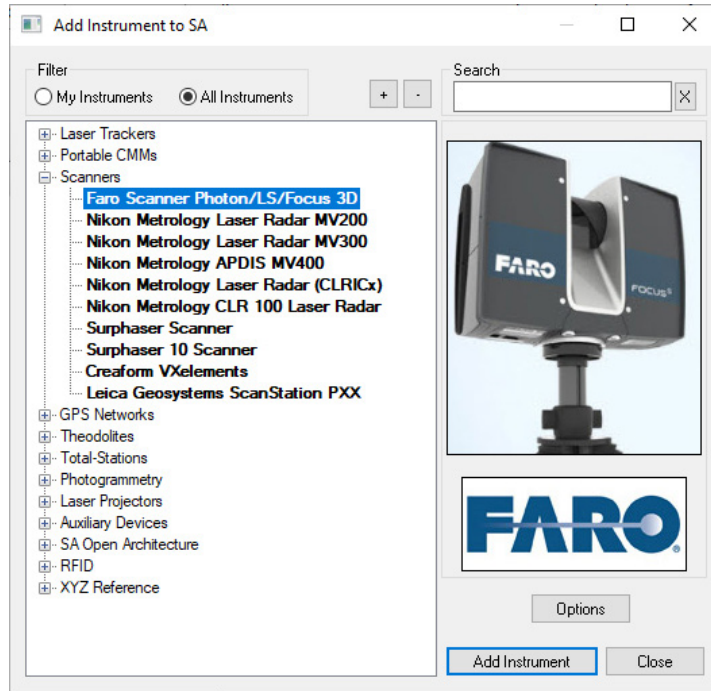
Figure 8-1. Adding a Faro scanner to the job.

2. Run the instrument interface module under **Instrument>Connect**.

3. The Faro Scanner Interface will now appear and be ready for use (Figure 8-2).
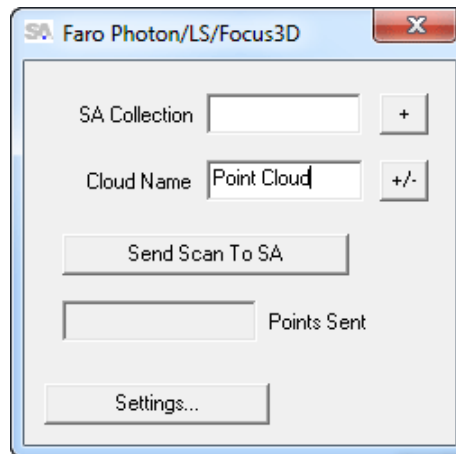
Figure 8-2. The Faro scanner interface.

To import a scan file:

1. Enter the Collection and Cloud Name to use for the newly imported cloud

2. Edit the Settings if desired. The settings provide a means to thin the data and edit the packet size used to send the data to SA (Figure 8-3).
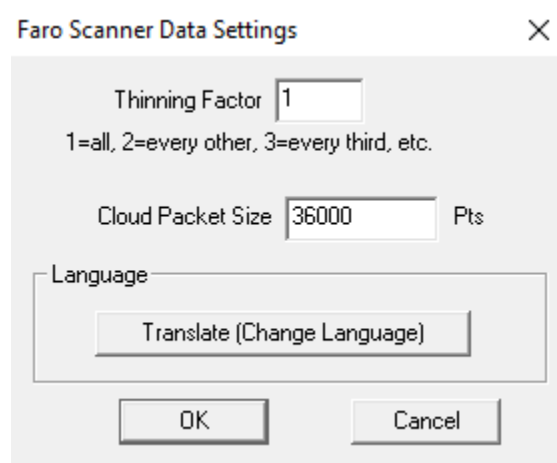
Figure 8-3. Settings for the Faro Scanner Import

3. Navigate to the scan file you wish to import.

The Faro Photon/LS/Focus3D interface offers the ability to import LS WorkSpace Files (*.fws), LS Scan Files (*.fls), and iQ Scan Files (*.iQScan).

(under Human Interface Devices) and right-click on it. Select Update Driver and direct the search to the folder in which you placed the USB drivers.

You will also need to locate the Rpr file for your particular scanner which is the parameter file and should be supplied with the instrument.

Running the Surphaser

1. Add a Surphaser to SA via **Instrument>Add** or using the 🖥 icon. Select the Surphaser Scanner or Surphaser 10 Scanner and press Add Instrument (Figure 8-5).
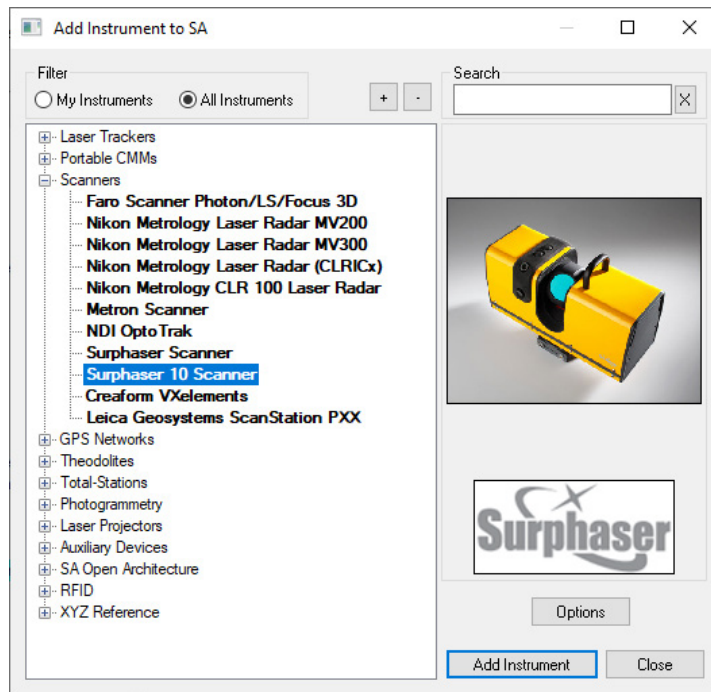
Figure 8-5. Adding the Surphaser to SA.

2. Run the instrument interface module under **Instrument>Run Interface Module** and choose *Surphaser.*

3. When the instrument interface opens for the first time you will need to browse to the Options tab and update the path to the Rpr file (Figure 8-6).

Figure 8-6. Options Tab of the Surphaser Interface
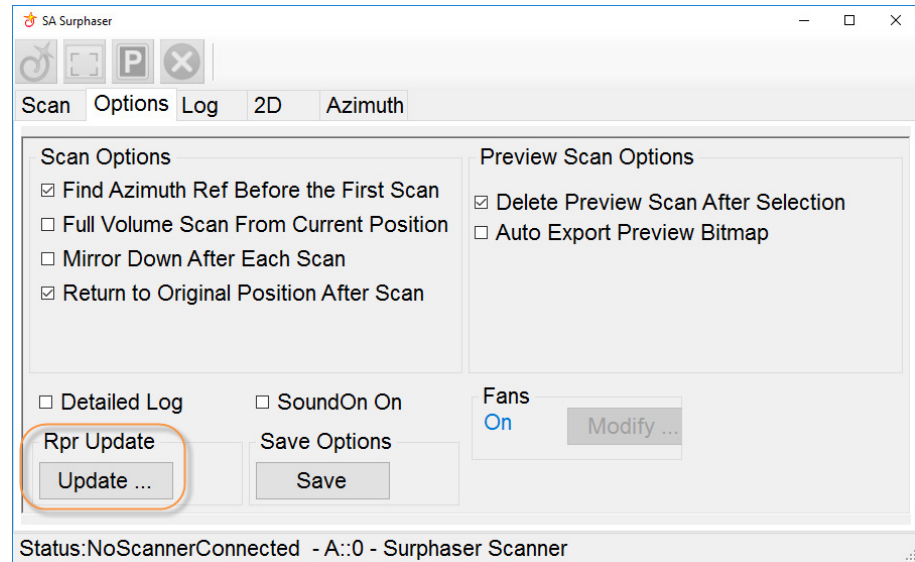
The Rpr file needs to be in the following directory: C:\Users\[user]\ AppData\Roaming\NRK\SA Surphaser 3.12. Each scanner has it's own Rpr file so it is possible to have multiple files in this same directory. You will need to set this path by selecting Open once for each file. This will register the Rpr file with the Scanner's internal list (in an XML file also in this directory). From then on any of the registered scanners can be plugged in and used and the correct Rpr file will be found for it automatically.

After the first connection a user should be able to simply plug in the scanner, add a new instrument model and press the Running Man icon to connect.

Scanning with the Surphaser

The SA Surphaser Interface provides a lot of options but a basic scan can be performed as follows:

1. Verify the Scan Density and Processing Option settings are set at reasonable levels.

2. Check the ouput file name (Collection & Cloud Name) for the cloud is set how you would like it to appear in SA and check that the *Send to SA When Done Scanning* check box is enabled.

3. Adjust your scan region as desired or set it to a *Full Volume* scan

4. When satisfied press the scan button

Instrument Specifics

The instrument interface provides a detailed panel style control for driving the scanner. It is composed of a set of master control buttons and 5 tabs to easily set up and process a scan (Figure 8-7).
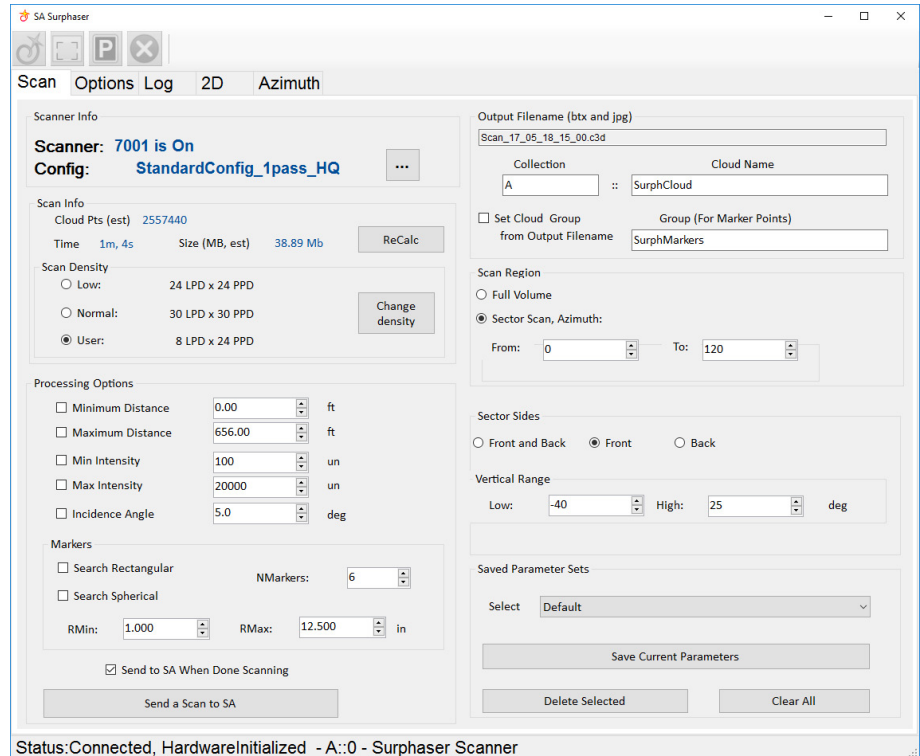
Figure 8-7. SA Surphaser Interface

- **Scan Tab.** Which provides direct configuration of the scan to be performed.

- **Options Tab.** Which provide a set of controls and preferences for scanning and scan previews that shouldn't need to be edited on a regular basis (Figure 8-6).

- **Log Tab.** This page provides a running record of the scanner activity and the associated file names and directories used

- **2D Tab.** This page provides a preview image of the scan and allows for region selection and re-scan control.

- **Azimuth Tab.** Provides move control and Azimuth zero point rest control.

Scan Controls

The *Scan* tab provides the primary scan controls:

Scanner & Scan Info

The scanner section provides identification information and configuration control (Figure 8-8).

This section provides a preview of the scan that would be generated with the current settings. This can be very helpful because it provides advance knowledge of the number of points being requested, the time required to generate the scan and the resulting file size that would be generated.

Scan Density

The scan density can be defined either using **Low** or **Normal** density as well as using a **Custom** value set through the Change density button. The **Lines Per Degree (LPD)** and **Points Per Degree (PPD)** defines a grid density that can be set at a prescribed distance, and doing so will present an estimate for the Scan Time and Scan File Size.

To set the density at a given range, enter the **Point Spacing** you would like to have at a give distance and press the Set button. This will re-compute the user defined density setting for you (Figure 8-9).

Figure 8-9. Change density controls dialog.

Voxelization

Scans can be sent to SA at full resolution and/or using a voxelized sub-sampling approach. Simply check the options as to which data foramt to import into SA. Much like voxelizing a cloud directly within SA, the **Voxel Size** determines the volume of data processed to produce a single point, the **Min Pts/Voxel** determines the required number of points per voxel for a point to retained, providing an outlier rejection option. The **# Pts to Voxelize** determines the batch processing size.

Cloud Name Controls

The cloud name control section is used to define the base name of the point cloud saved within the SA job file (Figure 8-10). It will also be used to name the voxel cloud, by appending "_vox" to the entered cloud and using it for the target point group if needed.

Figure 8-10. Cloud Name Control

The collection and cloud name can be entered here as well as the group name for the target markers. The *Set Cloud Group from Output Filename* checkbox can be used to ensure that the saved scan files or imported scan file names are used and synchronized with the cloud names within SA.

Processing Options

Processing filters are applied as a post processing operation following the scan and prior to passing the scan data to SA (Figure 8-11).

Figure 8-11. Scan Processing Options

- **Distance filter.** Minimum and Maximum Distance setting can be enabled to remove points from the scan that are beyond these thresholds.

- **Intensity filter.** Minimum and Maximum Intensity setting can be enabled to remove points from the scan that are beyond these thresholds.

- **Incidence Angle.** Defines an acceptance threshold for scan angle which describes the minimum incidence angle accepted.

- **Markers.** Both rectangular (checkerboard), circular and spherical markers can be detected from the scan automatically as part of the post scan processing. The NMarkers numeric field provides a convenient way to identify how many markers should exist in and be extracted from the scan. Only the best specified

number of targets in the data set will then be returned. The RMin and RMax controls can be used to restrict target detection to with a size range (for both target types).

Figure 8-12. Example Scanner Targets
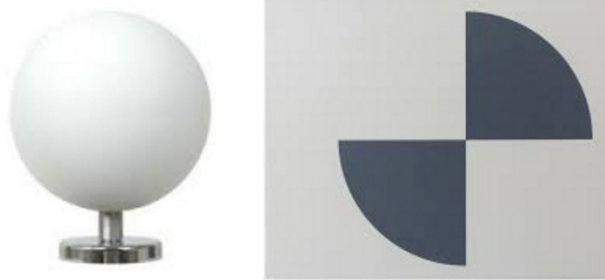
As of 2023.1, found Marker points will now have a subscript stating their type: _Rectangular, _Circlular, or _Spherical.

Output Filename

When a scan is generated it is generated both as a btx file and jpg in the Surphaser Directory and passed to SA using a Collection::Object Name. The files are saved in the same directory as the Rpr file (C:/Users/[User]/AppData/Roaming/NRK/Surphaser3.12/Scan). The Set from FileName button makes it easy to set the correct collection object name in SA to match the Scanner output file name.

Scan Region

Scanning can be restricted both in Azimuth and Vertical Range. To perform a full 360 degree scan use the *Full Volume* setting (Figure 8-13).

Figure 8-13. Scan Region Controls

- **Sector Scan, Azimuth.** This control defines the horizontal rotation of the scanner from start to finish in degrees from the currently set zero point. Scans are performed from right to left, counterclockwise as viewed from the top of the scanner.

- **Sector Sides.** The scan can be restricted to only use the front

or back face of the scanner as well as both. With Front and Back checked the scan includes a full path from low over the vertical to the back low point in a full arc.

- **Vertical Range.** When either front or Back are set the vertical range controls become enabled and set the upper and lower limits of the scan.

These values can also be easily populated by doing a quick overview scan and then selecting the region you would like to scan graphically from the image on the *2D* Tab (Figure 8-14). A prompt will provide an easy way to update the existing Azimuth and Vertical Range settings from the selected region. This region can then be save as part of a Parameter Set. More than one region will remain selected for reference but only a single scan region can be used at one time.
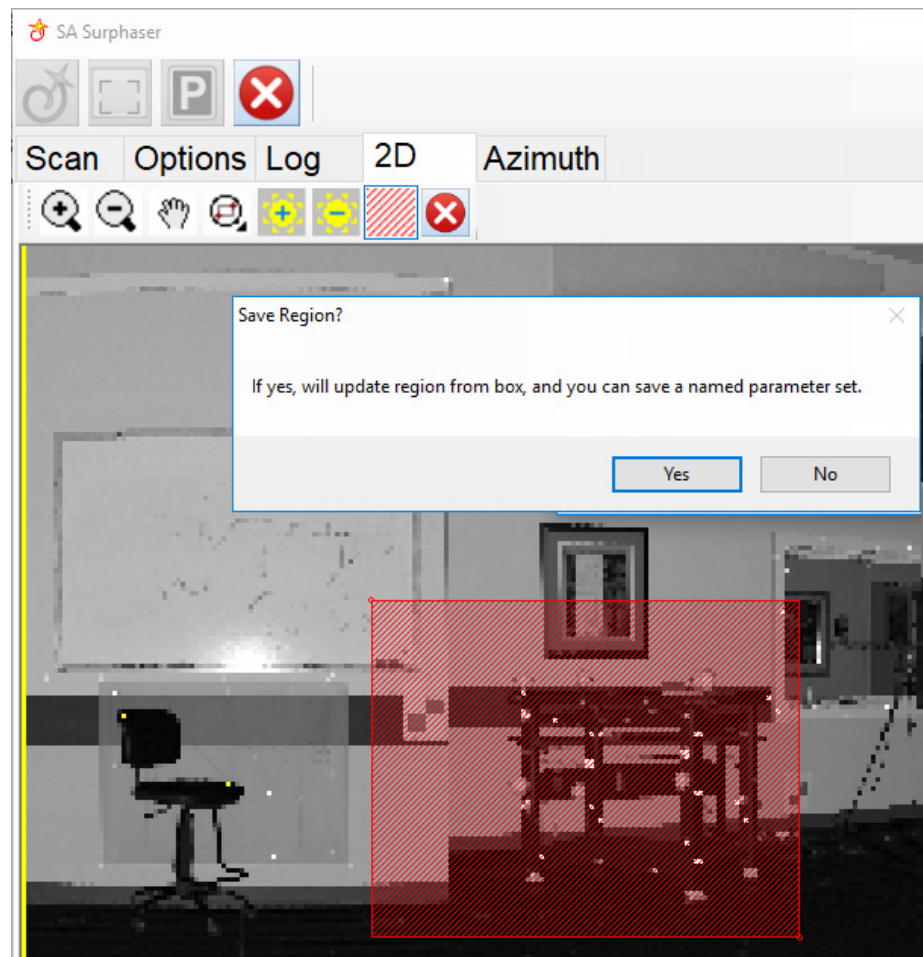
Figure 8-14. Region selection from the 2D Tab.

Parameter Sets

Configuration settings for a scan can be named and saved as part of a *Parameter Set*. These include the following parameters:

- Name
- Scan Density, LPD (Lines per Degree), and PPD (Points per De-

gree)

- Distance, Intensity and Incidence Angle Filters with options to turn either on or off.

- Markers, Search Rectangular (true or false), Search Spherical (true or false), *NMarkers* (number of markers), *RMin* (minimum marker size), *RMax* (max marker size)

- Full Volume or Sector Scan. Sector Scan is the same as before, with settings for the vertical and horizontal ranges. Full Volume is a full 360 deg. scan.

- Sector Scan Range, Azimuth From, To (degrees), and Elevation Low, High (degrees).

- Front, Back, Front and Back. Previous versions of the Surphaser interface only allowed either the front face or both. Now, a Sector Scan can include only the back face as well.

Parameter sets are saved in the persistence file. To update a saved parameter set (rather than create a new one with a small change), press Save Current Parameters and give it the same name as the existing parameter set you wish to update. This will overwrite the existing parameter set and update it.

Camera Tab

A Camera tab has been added in 2023.1. When you use the [Regions] button in the 2D tab to select a region(s) of the scan, the interface offers the chance to Save the Region.

- If you respond "Yes", the interface will set the scan sector angles (azimuth and elevation) to match the selection and open the Scan tab.

This allows you to save the selected region as part of a new Parameter Set, and shows the sector angles from the selection. If you select multiple regions, the prompt to save will apply to the last selected region. But the Scan Selected button will scan all that are selected.

- If you respond "No", you'll see that the Scan Selected Area button in the main window will be enabled, and the interface will stay in the 2D tab.

This way, you can easily scan the selected region if desired without being required to save the region. If you do use the Scan Selected Area button, the text "_SelectedArea" will be appended to the cloud name if sent to SA.

Importing Saved Scan Files

At the bottom of the Scan tab is a Send a Scan to SA button. This button provides direct access to importing pre-existing scan files of *.btx,

and *.ptx formats (Figure 8-15).

Figure 8-15. Controls for Importing Scans
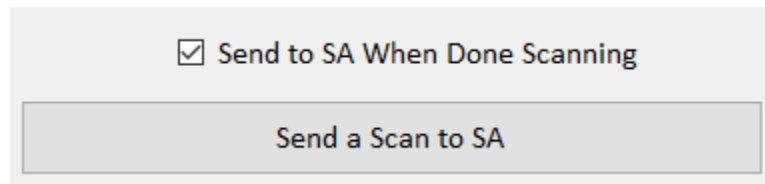
The *Send to SA When Done Scanning* option is used to trigger an import as soon as a scan completes. Scan files (.c3d, .btx) as well as preview images (.jpg) and text files of the marker coordinates (.txt) are saved in the **C:\Users\[User]\AppData\Roaming\NRK\SA Surphaser 3.12\Scan** directory as part of the scanning process. These file may need to be periodically purged to keep the size down.

Working Offline

In addition to importing existing saved san files using the Send a Scan to SA button, **Parameter Sets** can be created offline through the simulation interface. To start the Surphaser interface in simulation (without hardware) do the following:

1. Select **Instrument>Run Interface Module**

2. Then select the **Surphaser** interface from the list of interfaces

3. In the Surphaser Connection dialog first pick the instrument model then un-check the Connect Scanner check box, and press OK.

Parameter sets are saved in the persistence file located in **C:\Analyzer Data\Persistence**. The *SASurphaserSettings.bin* file contains the saved Parameter Sets and can be distributed to different machines.

Azimuth Designation

The Surphaser currently does not have an absolute zero location for the Azimuth (horizontal angle). This means that starting a scan from a designated azimuth value will not necessarily return the same results if you turn off the scanner and then reconnect later. It can also drift or be rest during a connection. For this reason, the Azimuth tab offers the users the ability to reset the zero location or move the instrument to a preset value (Figure 8-16).

Figure 8-16. Azimuth Tab of the Surphaser Interface
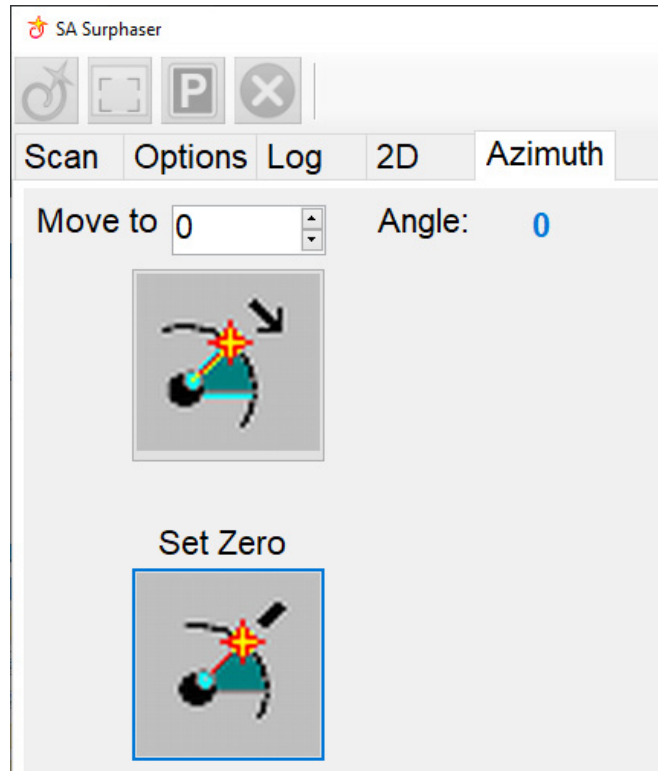
If the azimuth changes for any reason it is advisable to add an additional instrument station to SA. This can be done by right-clicking on the instrument and selecting **Jump Instrument to New Location**. This will make it easier to align the scans.

At this point, the best practice is to scan common markers in order to precisely locate the new station to the old. If the Azimuth control is used, then a test scan will reveal how well the reset azimuth matches the old. Be sure the newly added station is in the same position as the old in this case.

Measurement Plan (MP) support

SA provides comprehensive support for automation purposes. You can define regions from measurements within SA, designation perimeters and scan them as needed using predefined Parameter Sets called by name. However, the azimuth zero position can and will change so that needs to be accounted for.

- **Set Instrument Group and Target.** The "Point Name" argument will set the Collection and Cloud names, as well as the group name for found targets, and the voxel cloud name (if set to send).

- **Configure and Measure.** The "Point Name" argument will set the Collection and Cloud names, as well as the group name for found targets, and the voxel cloud name (if set to send). The "Measurement Mode" argument specifies the Saved Parameter

Set (measurement profile). If the profile is not found, the command will fail if the User Interaction Mode is set to Silent. Otherwise, you'll be asked if you want to use the current settings. If "Measure Immediately" is false, the command will simply set the profile selected if it is found. The "Timeout in Seconds" is ignored, since scan time can vary quite a lot, depending on scan paramters.

- **Scan within perimeter.** Ensure that the azimuth has not drifted on the scanner since the definition of the "Scan perimeter name". You can use the [Azimuth] tab in the interface to control the zero location, or simply use scanned [Markers] to locate the instrument. The "Parameter set name" specifies the Saved Parameter Set (measurement profile). If the profile is not found, this command will proceed with current settings if the User Interaction Mode is set to Silent. Otherwise, you'll be asked if you want to use the current settings.

- **Instrument Operational Check.** Instrument Operational Check "*Send Scan to SA [path]*". Supports importing of both *.ptx and binary *.btx files. Also the command "*Find Zero*" is available to return as closely as possible to the Azimuth zero point.

Leica Geosystems ScanStation PXX

This guide may be used for initial configuration, connection and basic operation of the Leica ScanStation PXX within SA. This includes the P30/ P40, and P50 scanners. For more details on instrument operation and configuration, please contact Leica directly.

Hardware Setup

Setup the unit following the manufacturer's directions. The ScanStation requires an Ethernet connection to the machine running SA 2016.09.01 or later (The interface was updated to PxxScannerAPI v.3.0.184 in SA v2023.1). Be sure the Leica device power is on and that the batteries are charged.

License Requirement

No additional software installation is required on the computer. However, *you must have a license installed on the Pxx to connect in SA*.

- Under **Status>System Information>Options** is a setting *API Data Access* which must be activated (it is deactivated by default). Contact your Leica Geosystems representative for more information.

- To add a License. Plug a USB key into the scope with a license file in root directory and select tools>>license>>upload.

Starting the Interface

1. Select **Instrument>Add** and choose the Leica Geosystems ScanStation Pxx from the ***Add Instrument to SA*** dialog (Figure 8-17).
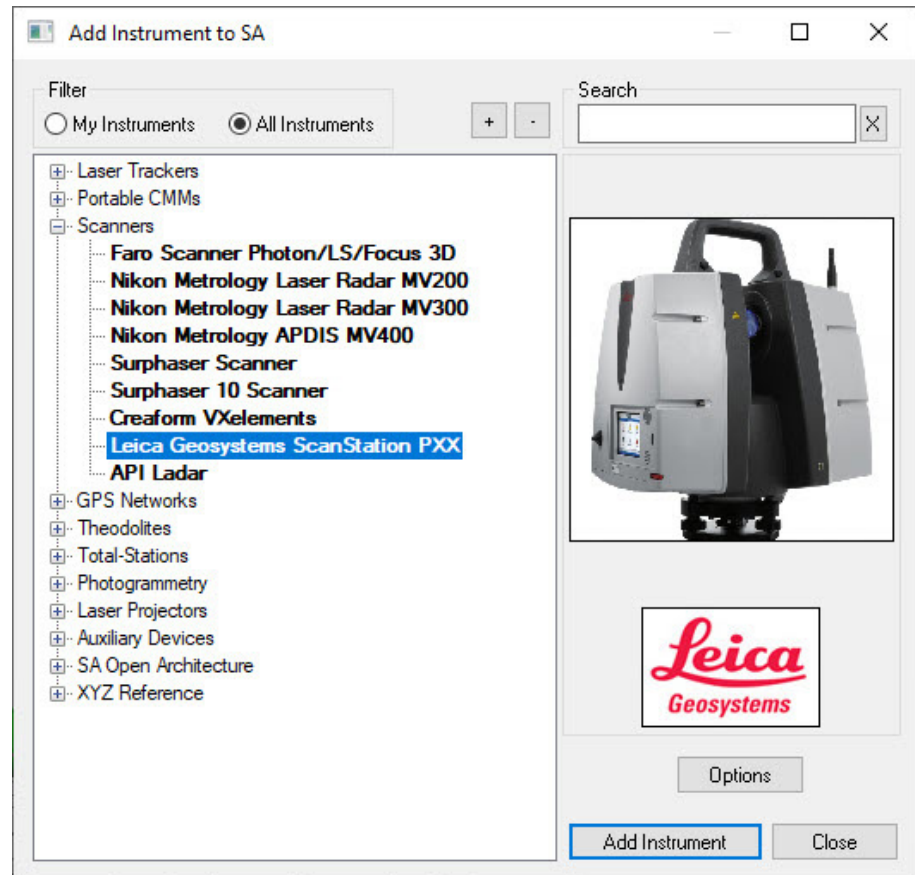
Figure 8-17. Adding the Leica ScanStation PXX to a job.

2. Now run the instrument interface module and connect using the Connect button. This will open the SA interface utility. Prior to 2023.2 an additional connect dialog was presented but now the interface will open directly (Figure 8-18).
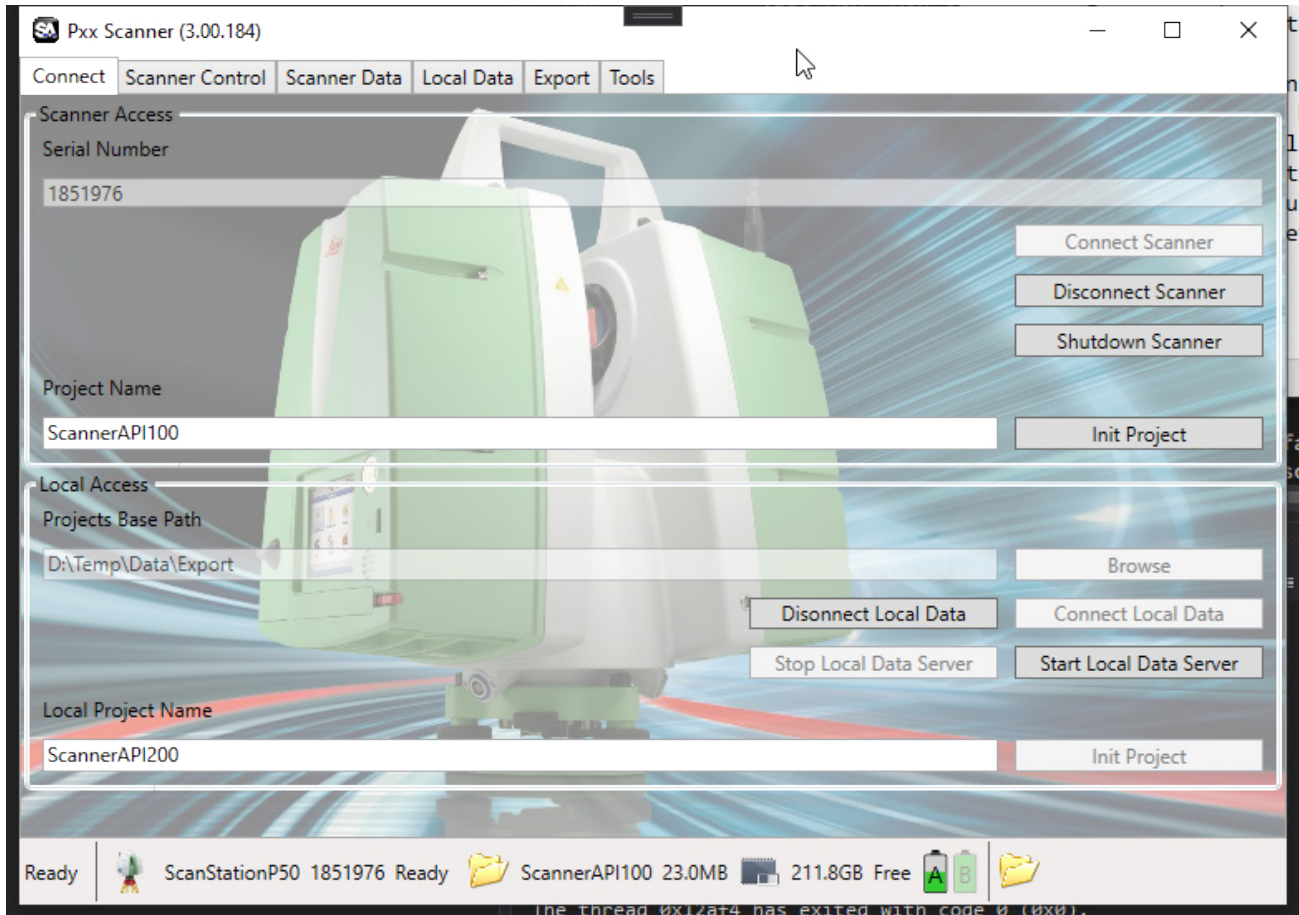
Figure 8-18. PXX Scanner control dialog showing the Connect Tab.

Initial Connection and Configuration

When the **PXX Scanner Control** dialog appears the connection to the scanner still needs to be established and the project initiated. To do so:

1. Enter the instrument's serial number and click Connect Scanner. The scanner uses a DHCP connection so an IP address identification is not necessary.

2. Enter the *Project Name* and press Init Project (Figure 8-18). This will specify the directory for the scan data on the scope. When set this Project will be listed on the status bar at the bottom of the Control Dialog.

3. Specify a *Projects Base Path*. This directory is used for direct file transfer as well as temporary file transfer of scan data while importing into SA.

Export Settings

The *Export Settings* tab (see Figure 8-19) in the **PXX Scanner Control** dialog defines the scan filter definitions and the scan transfer location on

the local machine. The *Export Path* defines the location on the local machine where scan files will be transferred.

The advanced settings are master controls for filter options not typically changed for scans unless needed for a particular application.

- *Remove Intensity Overload Pixels*. This option is checked by default and removes any pixels that have an overload intensity such as pixels taken from a mirror or reflector. The location of the pixels are typically incorrect.

- *Remove Mixed Pixels*. This option is checked by default. It removes pixels that have a mix of return intensities indicating that the target is not reliable, typically occurring on edges of surfaces.

- *Remove Low Quality Pixels*. This option is unchecked by default but allows you to receive pixels with a low quality return.

- *Mixed Pixel Filter*. This is considered Leica's "Intelligent Area Filter". It will smooth out the data based upon the relative position of adjacent points in the scan. The degree that this is done is based upon the slider setting. To turn it off, slide the Area Filter slider to *Min*.
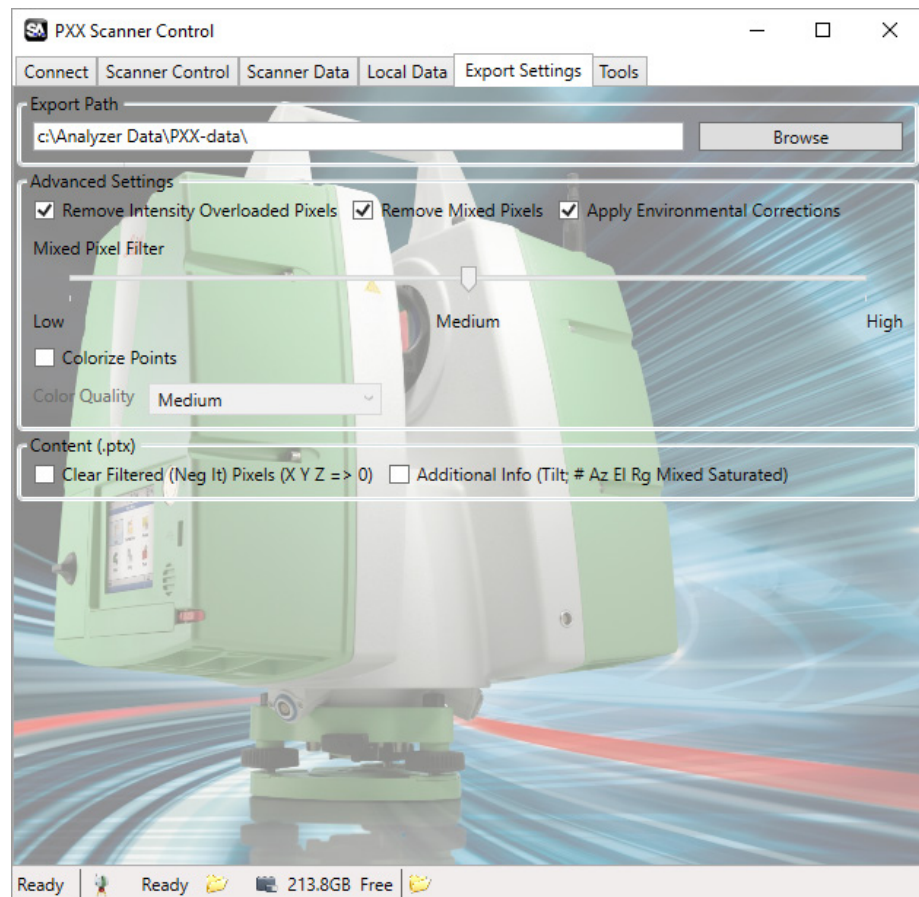
Figure 8-19. Export Settings tab.

Scanner Control

The *Scanner Control* tab defines the scan and controls (start/stop/pause/resume) (Figure 8-20). There are 3 horizontal tabs on the left. Start with the Range Scan tab to create an initial scan and preview.
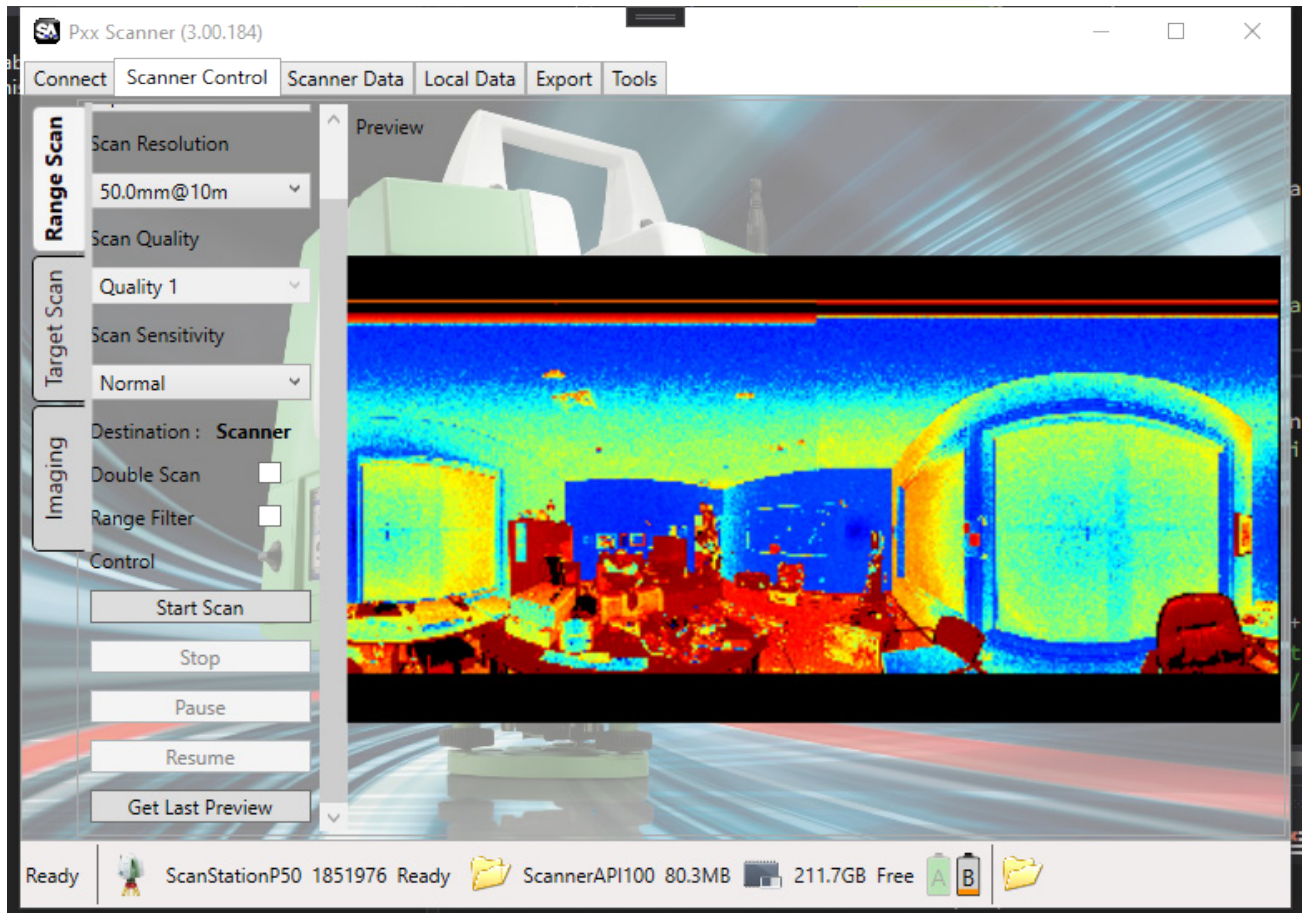
Figure 8-20. Scanner Control tab is used to initiate scans and will show a preview of the recorded data.

- **Scan Resolution.** This setting defines the density of the cloud. You can chose from 7 preset scan resolution settings defined as the distance between adjacent scan points at the distance specified. This represents the angular spacing of individual points. The points will be closer together at a closer distance and wider at a great distance based on this angular setting. The default setting when connecting to SA is the lowest resolution.

- **Scan Quality.** This setting defines accuracy for a particular point. Higher accuracy results in an increase in the overall measurement time.

- **Scan Sensitivity.**

- **Double Scan.** This option enables scanning with both front and back sight.

- **Range Filter.** Enables a range limit.

- **Start Scan.** Initiates a new Scan.
- **Get Last Preview.** Will retrieve a preview of the last scan.

Target Scans Data

After performing a Range Scan and the Preview is visible, switch to the Target Scan (horizontal tab).

Set the Name, Target Type, Diameter, etc. and then press [Pick Target] to click on the target location in the scan (Figure 8-21).
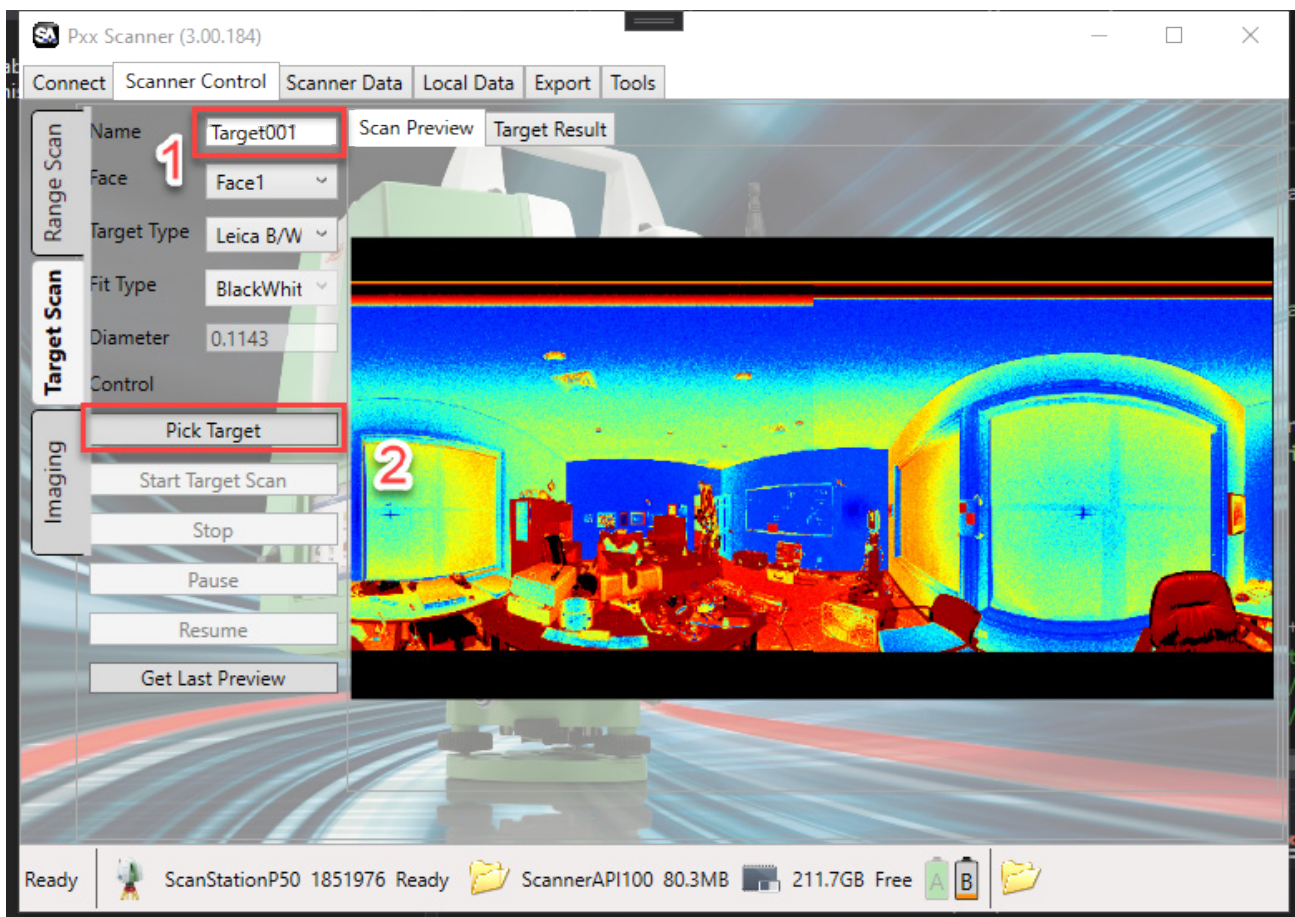
Figure 8-21. Target Scanning

Be sure to set the target's Name. This name will be shown in the Scanner Data under your Project, and the name that will appear in SA for the Target Center Point.

Repeat for all desired Targets in the scan (Set the Name, then Pick the target location in the preview).

Scanner Data

The *Scanner Data* tab provides a view of scan data on the instrument. It

offers a tree view on the left and details on the selected item on the right as well as a preview of that scan (see Figure 8-22).

In order to send data to SA:

1. Ensure that the Collection name and Cloud/Group name are set as desired on the Export tab.

2. Select the item you would like to import from the tree on the left here in the Scanner Data tab. This will display a preview and update the summary information.

3. Right-click again on the item of interest in the tree and select the desired option such as "Send Scan to SA as pt cloud".
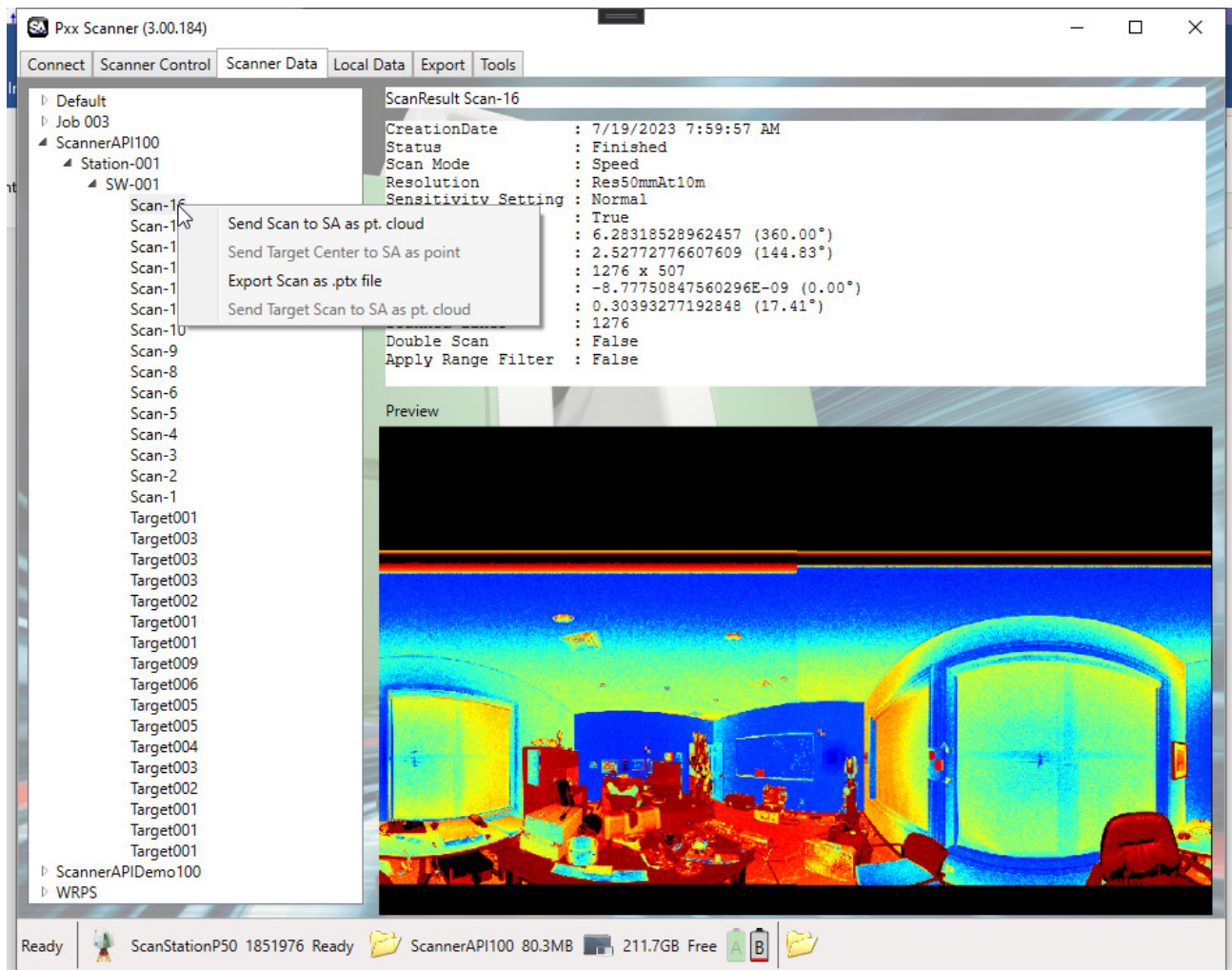
Figure 8-22. Scanner data tab.

This Page Intentionally Left Blank.

Operating Laser Projectors

Laser projectors combine measurement capacity with precision projection capability. For part layout aplications the can be very useful devices. SA supports several Laser Projectors interfaces.

Laser Projector Overview

Laser projector operation can be broken down into 3 categories:

1. Alignment
2. Part or Ply Construction
3. Projection and Instrument Controls

Alignment

Alignment of the laser projector within the SA job files provides the ability to accurately project objects. The Alignment process starts within SA. Choose **Instrument>Laser Projector>Align** this will prompt for selection of the alignment points. Just like a best fit operations these points are used to align the projector in the job file. You will then be asked to guild the projectors beam to the corresponding reflector to be measured.

An initial alignment must be performed in this way prior to starting to work with a laser projector. After an initial alignment has been made the projectors offer a quick auto-align function to refine the alignment much like a drift check operation.

Part or Ply Construction

Parts within the SA job must be converted to projection files to be able to define the mirror angles necessary to correctly project them. This process starts on the SA side. Select **Instrument>Laser Projector>Project** to choose an object to project. The controls within the projector interface will then control the way in which that part or ply is saved and projected.

Projection and Instrument Controls

Each interface offers a slightly different set of controls but each offers the ability to start and stop projection as well as iterate between parts. Refer to the individual Quick-Start guides for specifics.

Laser Projector Quick-Start Guides

SA supports the following Laser Projectors:

LPT (see "LPT" on page 410)

Assembly Guidance (see "Assembly Guidance" on page 416)

LAP (see "LAP CAD-Pro Laser Projector" on page 422)

LPT

Setup the projector following the manufacturer's directions. The LPT functions as a separate computer with a separate IP address and must be connected through a network connection using an Ethernet cable. Ensure that the unit is powered on.

1. Make sure the projector and the PC have compatible IP addresses. This can be done by attaching a monitor, keyboard, and mouse to the projector and verifying the Projector's IP address.

2. Open Windows Explorer on the PC. In the *Address* field, type the computer name of the projector. For example, **\\LPT10587**.

3. You will see a dialog box entitled **Connect to LPT10587** (for example). Enter your username and password. The default username and password are both **Admin**.

4. Once you are logged onto the projector, Windows Explorer will show the hard drives on the projector.

5. Run *RayTracer Operator* on the PC. (*RayTracer Operator* can be run on the projector but it is recommended to run it on the PC.)

6. On the *RayTracer Operator* Login screen, type **Admin** for the User ID, and **Admin** for the password.

7. You should have a database set up on the PC already, but if not, contact LPT for assistance. (To get started, you can run *RayTracer Administrator* to create a new database or to incorporate tools and parts created 'offline' (see "Using SA to Create Offline Tools and Parts" on page 412). Or, just copy a database from the projector to the PC, and use *RayTracer Administrator* to set it active.)

8. Be sure the database you wish to use is indicated in the *RayTracer Operator* login, and press OK.

9. Once *Operator* is running, check the 'Laser Name' list in the application's main window. Ensure that the projector you are connecting to is in the list, and that it is checked. If not, you must check it and 'take ownership' of the projector. Otherwise, commands will appear to succeed, but none will be carried out.

Running the Projector

1. Select **Instrument>Add...** and choose the LPT Laser Projector from the Instrument List (Figure 9-1).
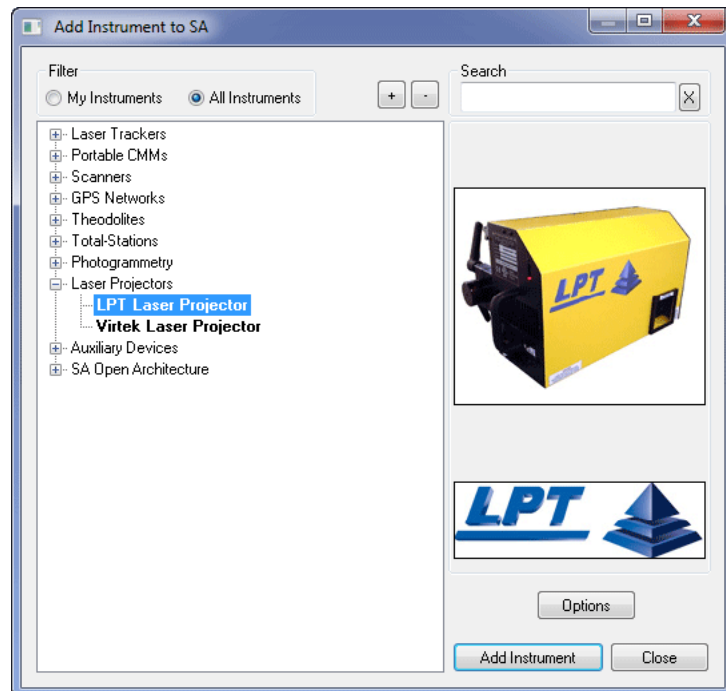
Figure 9-1. Adding an LPT to the SA job.

2. Select **Instrument>Run Interface Module**. Select **LPT Laser Projector** from the list.

3. In this dialog (Figure 9-2) two options appear: you can connect to a computer running *RayTracer Operator* or work Offline. Be sure to select **Connect to Operator**, and indicate the name of the computer running Operator. (The 'This Computer' button will fill in your pc's name in case you are running *Operator* on the PC as recommended.)

Figure 9-2. The Connect to SpatialAnalyzer dialog.
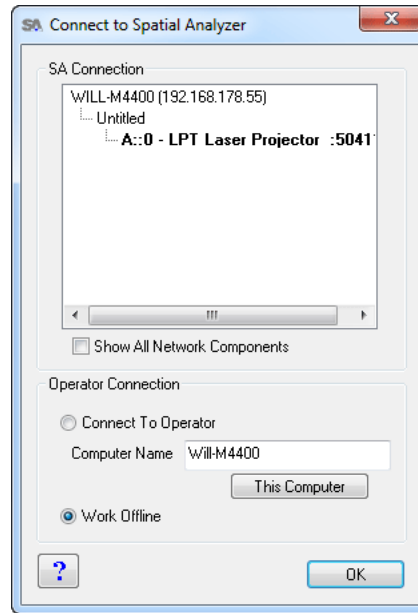
4. The progress report at the bottom of the interface window will indicate actions as they take place.

Using SA to Create Offline Tools and Parts

1. Run SA and add an LPT projector. Then run the LPT Laser Projector Interface, and select *Work Offline* in the interface's **Connect to SA** dialog (see "Running the Projector" on page 411).

2. The interface will then run in *OFFLINE Mode*. You will select the path for the 'Offline Tool' and 'Offline Part' xml files in the interface. You can create as many tools and parts as you wish. It is highly recommended that tool and part 'sets' be created. In other words, for any set of parts, create a corresponding tool which represents the projector's location while projecting those parts. These tool and part sets can be organized in folders.

To Create a tool

- Set the path and file name for the tool in the 'Offline Tool' area of the interface. In SA, select **Instrument>Laser Projector>Alignment**. You'll be prompted to select the instrument (projector) and the Group (set of alignment points). The points will be written to the file indicated by the path in the 'Offline Tool' area of the interface.

To Create a Part

1. Set the path and file name for the part in the 'Add to Offline Part' area of the interface. If you are creating a part from anything other than points, be sure to set the Ply Filter in the interface (see section below for use of the Ply Filter). In SA, select **Instrument>Laser Projector>Project Objects**. You'll be prompted

to select the instrument (projector), and the Objects to project (geometric entities, points, etc.). You will be prompted for a Ply Name for the object in the Part file. The objects will be written to the ply in the file indicated by the path in the 'Add to Offline Part' area of the interface, and codes to ensure uniqueness in the part file will be added to the ply name. You can continue to add objects (plies) to the same part file, and/or create new part files as desired.

2. Once desired set(s) of tools and parts have been created, use *RayTracer Administrator* to add these sets to a projector database.

3. During the creation of tools, you may wish to start up the projector (described below) and ensure the validity of the tool by actually aligning the projector to the tool. Then the parts corresponding to that tool location can be projected to ensure their validity. All this is described below.

Projecting within SA

Alignment

There are several possible ways to perform this action:

1. If you have been working with a projector in SA, and you are continuing work on a file, the projector's location/orientation will be persisted by SA and the interface. If this is the case, hit the 'Auto Align' button in the 'Align' section of the interface. Operator will pop to the forefront, and an Auto-alignment will take place. Operator's view area will go green upon a successful alignment. NOTE: For the following methods, be sure to use the 'Toggle FOV' (field of view), and 'Toggle +' (center cross) buttons in the interface to aid in the initial location of the projector.

2. If you are starting a new job, you can create alignment points (a tool) in SA, and align the projector to that tool. In the interface, be sure that 'Add to Projector Part' is selected in the 'Projections from SA' area (in 'Online' mode, if 'Add to Offline Part' is selected, Tools will be created in the last used offline tool.) Create a group of points in SA which you wish to use as the alignment tool. In the SA Instrument menu, select Laser Projector >> Alignment. You'll be prompted to select the instrument (projector), and the Group (set of alignment points). Once the group is selected, you will be prompted for the Tool Name. A tool by this name, containing the points from the selected Group, will be added to Operator's database. You will see the tool name and point appear in Operator if it is visible. Finally, the interface will instruct you to manually align the projector in Operator.... just maximize operator, and hit

the 'Manual Alignment' button. Guide the projector to each indicated point, and left click when near the point. After 4 such points are Accepted, Operator will take over and finish the alignment. (If the alignment fails, Operator will give you an oportunity to override the alignment and continue, but you should check for the source of the failure - it is generally an rms error exceeded in the alignment calculation.) Once you have performed this manual alignment procedure, you should be able to Auto-align (as described above) so long as the projector is not moved, and the Tool in Operator is not changed.

3. If you have previously created Tools offline (as described above), you can use LPT RayTracer Administrator to add the tool(s) to your database, and they can then be used by selecting them from the 'Tool:' list in Operator. As always, a one time manual alignment will have to be performed in Operator, and then Auto-align from the interface can be used until the projector is moved, or the Tool is changed.

Projecting

1. For projecting within the current Part, simply use the 'Next', 'Current', and 'Previous' buttons in the interface to toggle through plies. The 'Pause' and 'Resume' buttons also apply to the current Part.

2. Use LPT RayTracer Administrator to add any offline parts you have created (as described above) to the current database.

3. To add a part to the current database, and project it immediately: Be sure the projector has a valid alignment (Operator's view screen is green.) Be sure 'Add to Projector Part' is selected in the interface. Edit the name of the part if desired. (As with offline parts, you are free to continue to add projection objects (plies) to the part as many times as you wish.) If you are creating a part from anything other than points, be sure to set the Ply Filter in the interface (see section below for use of the Ply Filter). In SA, go to the 'Instrument' menu, and select **Laser Projector>Project Objects**. You'll be prompted to select the instrument (projector), and the Objects to project (geometric entities, points, etc.).   If this is a new part, the part will be added to the current Database. The selected projection object(s) (i.e. the ply) will be added to the part and projected immediately. The ply name in the part will be "CommandedProjection_X", where X is a code to ensure uniqueness.

Using the Ply Filter

In the interface's 'Projections from SA' area is a 'Ply Filter' button. The button shows information about the current active filter option.

Filter Options Are:

- **None.** Just project everything as is

- **Minimum Angle.** Starting with the first point, look at all consecutive sets of 3 points in the ply, e.g. 1, 2, and 3. Make vectors 1to2 and 2to3. If the angle between 1to2 and 2to3 is less than the selected minimum angle, point 2 is eliminated, and the evaluation continues.

- **Number of Points.** Numerically spaced points are eliminated until the desired maximum number of points is reached.

- **Minimum Distance.** Starting with the first point, look at all consecutive sets of 2 points in the ply, e.g. 1 and 2. If the distance between 1 and 2 is less than the selected minimum distance, point 2 is eliminated, and the evaluation continues.

The ply filter is applied to any entity which comprises a continuous projection along some curve. (Anything except points.)

The current active filter (indicated on the filter button) is applied to all plies coming into the interface, whether they are to be projected immediately, added to the current database part, or added to an offline part.

Assembly Guidance

Hardware Setup

Setup the unit following the manufacturer's directions with an unrestricted view of the work area.

Software Setup

You can download and install the latest drivers from http://www.kinematics.com/ftp/SA/Install/Driver%20Downloads/Projectors/AssemblyGuidance%20LaserProjector/ . You will need the following files:

- `LASERGUIDESDK_3_04_18.`exe or later
- `Register LaserGuide dll.bat`
- `Unregister LaserGuide dll.bat`

Installation

1. Run the file LASERGUIDESDK_3_04_18.exe or later on your machine. This will walk you through the installation process of the LaserGuideSDK used by SA to communicate with the device and will install some ocx files that LaserGuide's main dll needs in order to work properly.

2. Restart your computer.

3. Move the Register `LaserGuide dll.bat` into the SA install folder typically located here: C:\Program Files (x86)\New River Kinematics\SpatialAnalyzer XXXX

4. Double click "Register LaserGuide dll" to run the file from this directory. If you have previously registered from a different di- rectory or run an older version, you will need to run the "Unregister LaserGuilde dll.bat" utility first.

NOTE: On Win10 pc's, you will likely have to right-click on the *.bat file, and select "Run as Administrator". If this does not work, you'll have to consult your IT Department for help.

Figure 9-3. Windows registration.
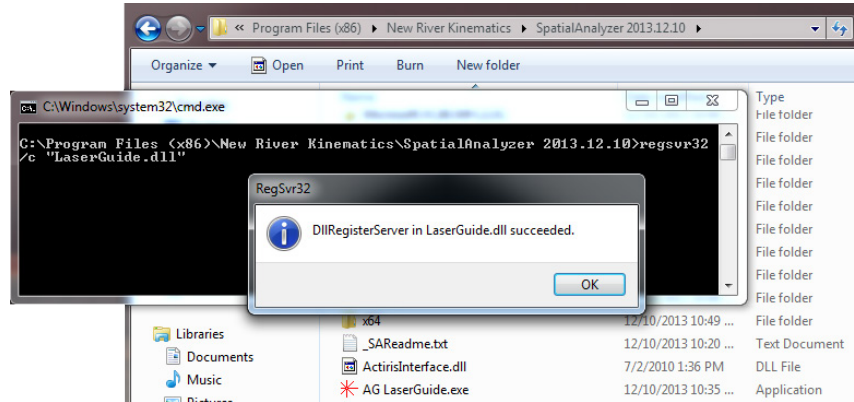
Network Configuration

Be sure to create a fixed IP address on your computer that will be compatible with the IP address of your projector(s). The default address should be stamped on the front of your projector. For example, if your projector's IP address is 10.1.1.1, then you need to change your computer's IP address to 10.1.1.X; where X is between 1 and 255.

Starting the Interface

1. Select **Instrument>Add** and choose the Assembly Guidance Laser Projector.

Figure 9-4. Adding an Assembly Guidance Projector to SA.
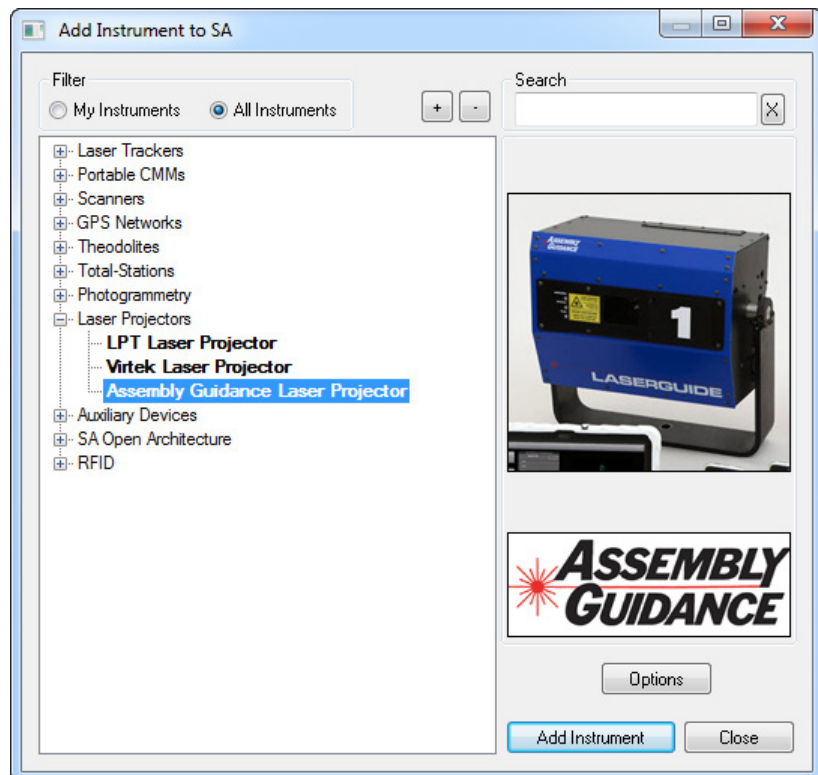
2. Now run the instrument interface module under **Instrument>Run Interface Module and Connect**.

3. Enter the projector's IP address and click the Connect ⟩⟩ but-

ton on the **AG LaserGuide** (see Figure 9-5) dialog. For more detailed connection information, you click on the Show Projector Window (see Figure 9-6) button to bring up the Assembly Guidance Contol Utilities.

Figure 9-5. AG LaserGuide dialog.
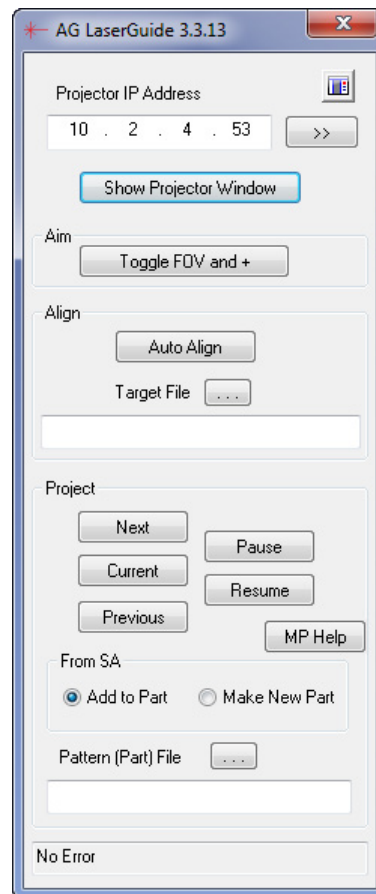
Figure 9-6. Projector window.
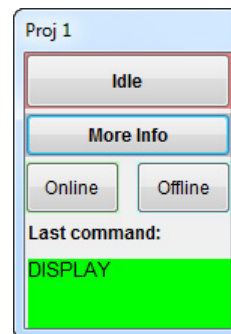
Aligning the Projector

There are two methods of aligning the projector in SA.: automatic and manual. To perform an auto alignment, use the browse button in the **AG LaserGuide** dialog (see Figure 9-7) to find a preexisting registra-

tion file to use. Click the Auto Align button, and the projector will auto measure the alignment points and the transformation from the measured points to the current point locations will be used to align the projector within SA.

To Perform a Manual Alignment

1. Measure six reflector positions with a separate instrument within the field of view of the projector. Located in the *Aim* section of the instrument interface is the Toggle FOV and + button. This can be used to display the projector region and also to import a set of known location points.

2. Select **Instrument>Laser Projector>Alignment**.

3. Select the instrument to align and then the measured point group for alignment.

4. Browse to a location to save a Registration data file in .txt format.

5. Use the manual alignment utility pictured in (Figure 9-7) to point the laser at each registration point in order by name. To do so, click and hold while dragging the mouse. This drives the laser pointer relative to the cross hairs in the dialog and, in turn, drives the projector beam to the reflector point. Once aimed correctly, right-click to scan the target.
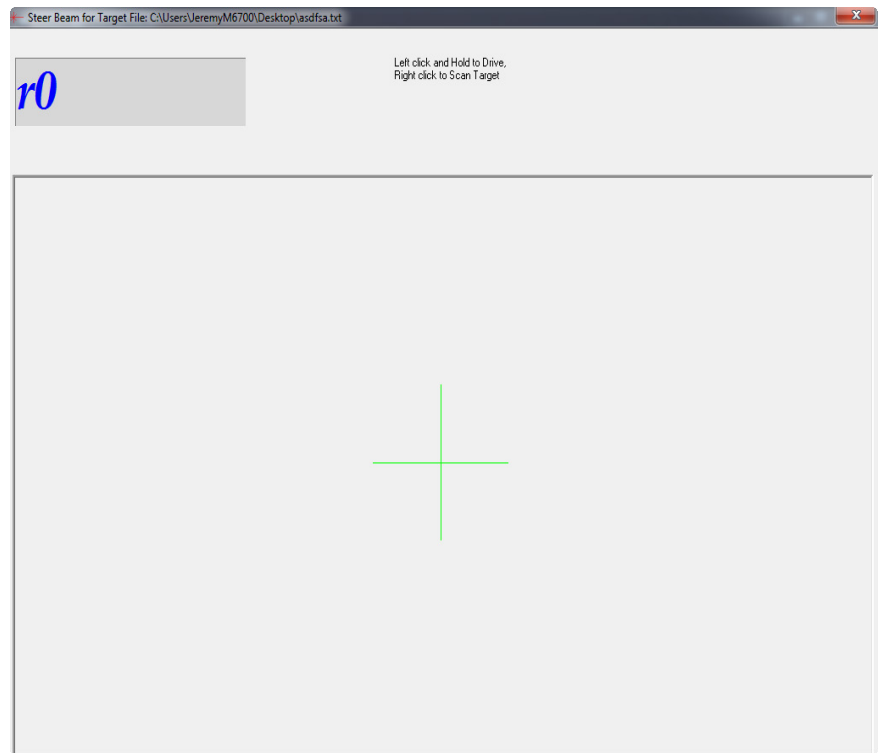
Figure 9-7. Steer Beam for Target dialog.

6. After each of the individual target locations have been identified in this fashion, these points will automatically measured

and the alignment will be performed.

Point and Object Projection

The Assembly Guidance Interface provides the tools to project points as well as objects in SA. To project an object it must be added to a part file. These part files are then used to build the laser path definition for the projector. A single part may contain several patterns and additional patterns can be added to an existing part file.

Projecting Part Files

1. In order to project patterns from a previously created part file, simply browse to the file using the Pattern (Part) File button ⬚ in the interface.

2. Click Current to project the part shown in the selection path. You can utilize the Pause and Resume buttons to control projection of the current part file and the patterns it contains.

3. Select Next and Previous to toggle through part files in the same folder as the current part shown in the *Part File Edit* box.

Building/Editing Part Files and Projecting Objects

1. In the *From SA* section of the interface , select Add to Part or Make New Part.

2. Select **Instrument>Laser Projector>Project Objects**. You will then be prompted to select the instrument (if you have more than one in the job).

3. Now select the objects you wish to project. Doing so will create a file using the name of the first object selected for projection if you have Make New Part selected. If you chose Add to Part, it will add the selected objects to the current part file.

> 💡 **Tip:** Objects cannot be removed from a part file through SA.

MP/SDK Control Options

Aligned Vision LaserGuide Projector	
Instrument Operational Checks	
Pause	Pause the current projection.
Resume	Resume the current projection.
Current	Project the current pattern (part) file.
Next	Project the next pattern file in the current file's folder.
Previous	Project the previous pattern file in the current file's folder.
Cross	Project the field of view and center crosshair for location.
Field Of View	Project the field of view and center crosshair for location.
Set Part Name []	Set active part PATH to that designated by [] ([] not part of string).
Add Patterns to Existing Part	Tell the interface to add projections from SA to the current selected part file.
Make New Part	Tell the interface to make a new part file, located in the current part file's directory, but carrying the name of the first projection object in the projection from SA.
Set Auto Align File []	Set the path to an alignment file, designated by [] ([] not part of string). This path will be updated in the UI, and will be used for the next Auto Alignment, whether commanded from MP, or from the Auto Align control in the UI. NOTE: The file must have the usual Aligned Vision Target File format: name, x, y, z, phi, theta, and the usual padding of 0's at the end. This is not the same as an ascii file exported from SA, as described in the "Manual Align…" command.
Auto Align	Perform and Auto Alignment using the file shown in the "Align" section of the UI.

Aligned Vision LaserGuide Projector	
Manual Align from Exported File []	Start the Manual (mouse drive) Alignment with an ASCII file exported from SA. The existing MP command, "Export ASCII Points", can be used with all default settings, but populate ASCII File Path with the desired file path and name, the Group Name to Export, Data Delimiter of Space, Target Name Format of Target, and Desired Coordinate System of Cartesian. Then, for this command, the [] is the ASCII File Path argument from above ([] not part of string). NOTE: This command expects an ascii file of format "name x y z", NOT a projector Target File as described in the "Set Auto Align File…" command. When this command is processed, the interface will create the AV Target File corresponding to the coordinates in the exported ascii file. The Target File will go to the same directory as the exported file, and will have the same name, but prepended with "AV_".
Basic Operations	
Project Objects	This is NOT a string command, but a standard MP command. Note that the arguments are "Instrument ID" as with any other command, and "Objects To Project". This second argument can be selected from the SA job, or for a projection object (perimeter, b-spline, etc.) that has been created within the MP, this can be a reference to that object or objects.
Stop Projection	This stand alone command cancels any projection from the selected instrument.

LAP CAD-Pro Laser Projector

Hardware Setup

Setup the unit following the manufacturer's directions with an unrestricted view of the work area.

Software Setup

No additional software or driver installation is required to run the LAP projection in SA.

Network Configuration

Set a fixed IP address on your computer which is compatible with the address of your projector(s) gateway. The default address of the gateway should be 192.168.100.112, therefore your computer needs an IP address added of 192.168.100.X, where 0 < X < 255 but is NOT 112.

Note that SA's interface is designed to only connect to a single projector at one time and it will automatically connect to the first projector on the network.

Starting the Interface

1. Select **Instrument>Add** and choose the LAP CAD-Pro Laser Projector(Figure 9-8).

Figure 9-8. Adding an LAP Projector to SA.
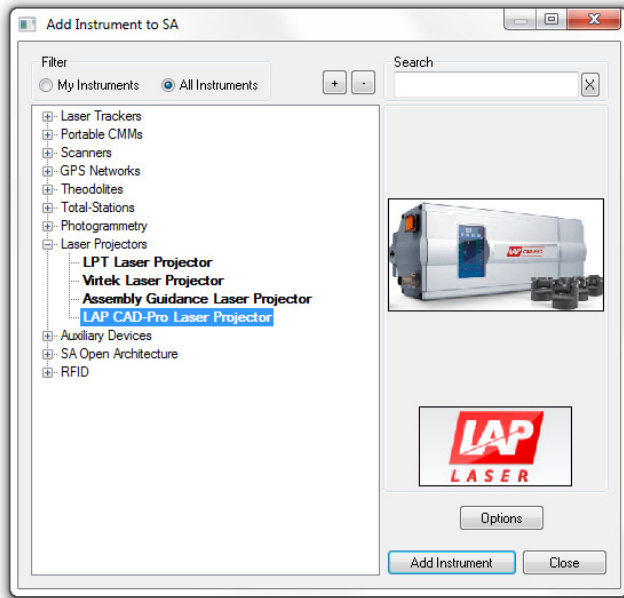
2. Now run the instrument interface module by pressing **Connect**. Or in the classic menus select: **Instrument>Run Interface Module and Connect**.

SA will try to detect if you have the default network address set and will warn you if you do not as follows(Figure 9-9):

Figure 9-9. LAP Network Configuration
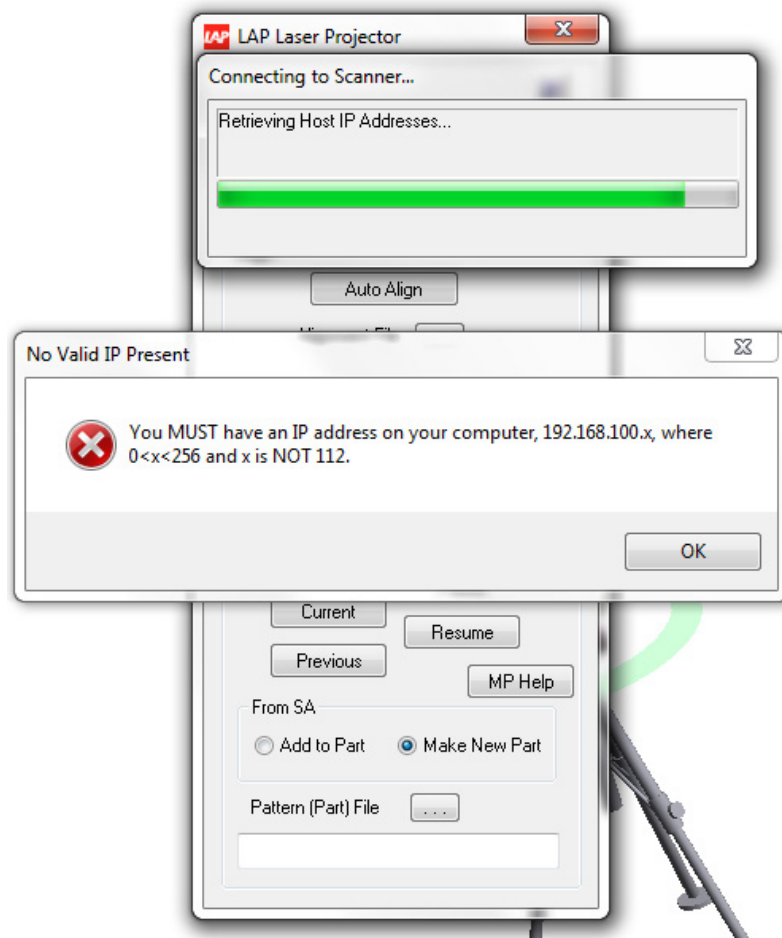
If you see an error such as "No Projector Found at Connector -XS1, Try connecting to -XS2", open a web browser and log onto the controller gateway by entering the projector's IP address in the address bar (192.168.100.112) and log in with user name "admin" and password "LAPLASER". Under "Control" you can check whether the expected "SynchroNet16" protocol is active (Figure 9-10).

Figure 9-10. LAP Control configuration needs to be set to SynchroNet16 to facilitate SA communication.
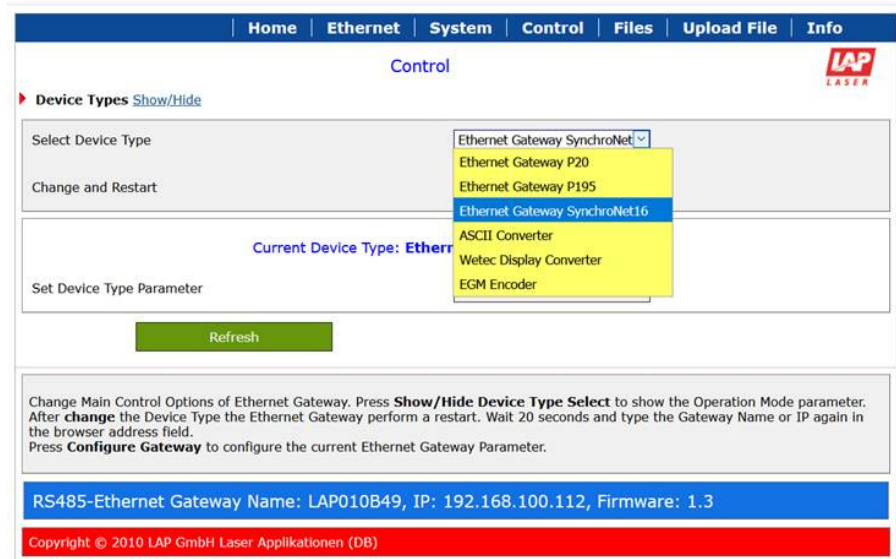
3. Use the Toggle FoV and + button to visualize the field of view and the center cross of the instrument and to ensure that the alignment targets are completely within the view of the projector.

Focusing the Beam

The laser beam must be focussed to optimally project contours onto a surface. Focussing is possible only for laser projectors with a green laser source. Laser projectors with red or multi-colour laser sources are focussed at a fixed customer-specific distance at the factory.

To focus a green laser do the following, using the remote:

1. On the remote press the <Focus> button twice and select the laser projector to be focussed via the <F1> ... <F9>, assuming you have more than one projector on the network. At this point the yellow LED will flash indicating that it is in focusing mode and can be focused.

2. Focus the sight cross-hair with the ">" and "<" buttons at the remote control to make it thin and sharp on the surface.

3. When done pres the <focus> button again.

Aligning the Projector

There are two methods of aligning the projector in SA: *Automatic* and *Manual*.

- A manual alignment must be performed first to initially locate the instrument in the job file.

- Automatic alignments can then be used to quickly align using an existing saved alignment and to refine an existing align-

425

ment during operation.

To perform an auto alignment, use the Alignment File [...] button in the **LAP Laser Projector** dialog (Figure 9-11) to find a preexisting registration file to use. Once selected, Click the Auto Align button, and the projector will auto measure the alignment points and the transformation from the measured points to the current point locations will be used to align the projector within SA.
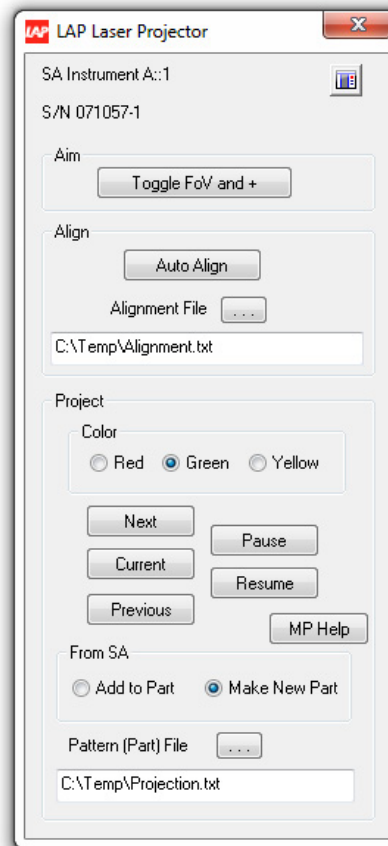
Figure 9-11. LAP Interface dialog.

To Perform a Manual Alignment

In order to perform an initial manual alignment perform the following steps.

1. Measure at least six reflector positions with a separate instrument or import the target locations. Point can be imported using **File Menu>Import>ASCII Text File Formats>Import Text File (**e.g. with the PointNameXYZ filter as points in millimeters).

2. Double check that the alignment points are in the projectors field of view. Located in the *Aim* section of the instrument interface is the Toggle FOV and + button. Also check that a location to save a Registration data file (in .txt format) has been selected in the dialog.

3. Select **Instrument>Laser Projector>Align Laser Projector** (Figure

9-12).
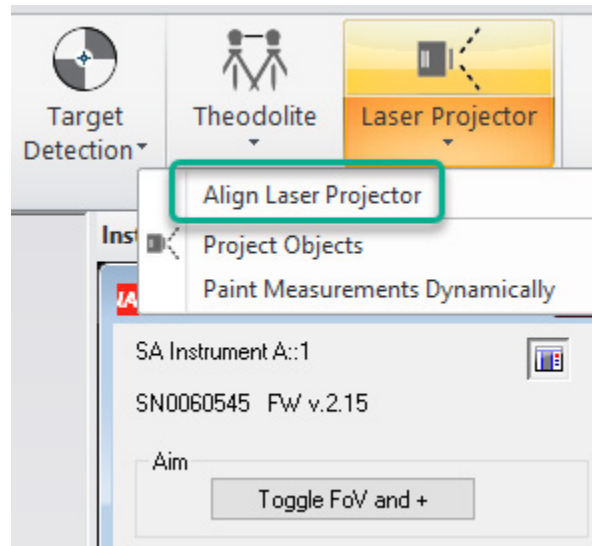
4. Select the instrument to align and then the measured point group for alignment.

5. Use the manual alignment utility pictured in (Figure 9-13) to point the laser at each registration point in order by name. To do so, click and hold while dragging the mouse. This drives the laser pointer relative to the cross hairs in the dialog and, in turn, drives the projector beam to the reflector point. Once aimed correctly, right-click to scan the target. You can adapt the projected search frame size by editing the field "Search Rad".
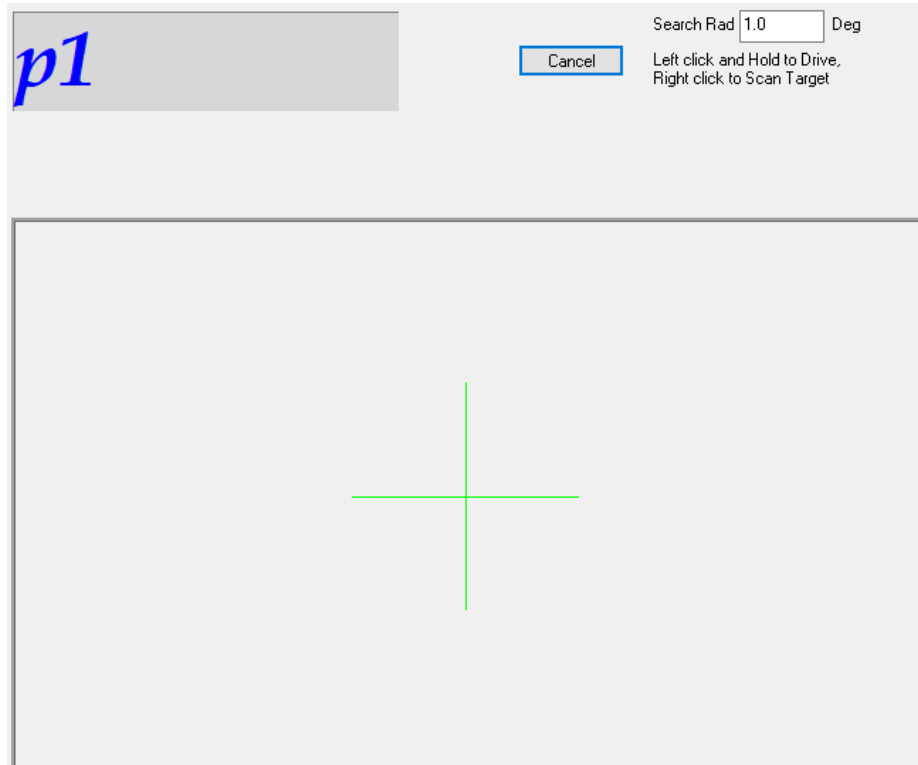
Figure 9-13. Steer Beam for Target dialog.

6. After each of the individual target locations have been identified in this fashion, these points will automatically be re-measured and the alignment will be performed.

Alignment results are recorded within the Instrument History (right-click menu) and include the raw values currently available (Figure 9-14).
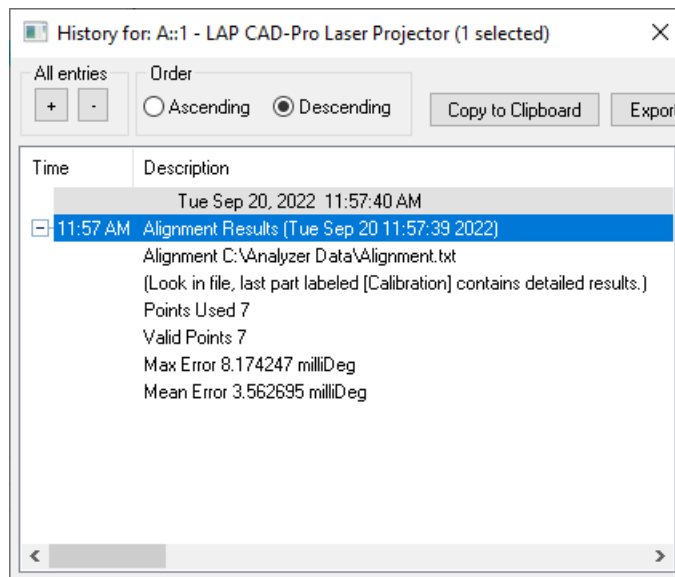
Figure 9-14. Alignment Results available in the instrument history.

An additional copy of the Alignment File is made automatically. The copy will be in the same directory as the alignment file, with "_copy" appended to the name. If the Manual Alignment is canceled, the con-

tents of the "_copy" file will be written back to the original file so that the original alignment is rest.

Point and Object Projection

The LAP Interface provides the tools to project points as well as objects in SA. To project an object it must be added to a part file. These part files are then used to build the laser path definition for the projector. A single part may contain several patterns and additional patterns can be added to an existing part file. Take note of the part selection mode, "**From SA**" radio button options, prior to projecting a new object (Figure 9-15).
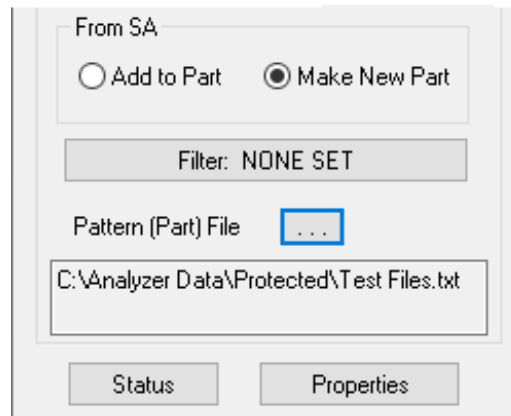
Figure 9-15. Projection Settings

Projection Filter

Below the part selection is a button that by default states "*Filter: NONE SET*". This button offers the ability to apply filter projects to reduce the number of via points and increase the speed of projection.

Optional filters are:

- **Minimum Angle.** When a given triplet of projection via points forms an angle less than this value, the central via point is removed. This ensures that 'flat' sections of the projected shape will contain fewer points, and areas with curvature greater than or equal to the minimum angle contain more.

- **Number of Points.** So long as the number of via points is greater than this value, the total number of via points is forced down to this value. Ideally, the specified Number of Points should be close to an integer factor of the total number of via pts. If, for example, the Number of Points specified is 30, and the initial number of via points is 60, then every other via point is skipped by this filter.

- **Minimum Distance.** Via point pairs are evaluated, and the first is removed if the pair is closer than this value. The remaining point is then evaluated with the next one.

Colors can be set in the interface for projectors that support the green, red, yellow options. If you are projecting, you can even set the "Add to Part" option, and set the color to create multi-colored projections (Figure 9-16).

Figure 9-16. Color Selection

Color (if available, check model)

○ Red ● Green ○ Yellow

Projecting Part Files

1. In order to project patterns from a previously created part file, simply browse to the file using the Pattern (Part) File button [...] in the interface.

2. Click Current to project the part shown in the selection path. You can utilize the Pause and Resume buttons to control projection of the current part file and the patterns it contains.

3. Select Next and Previous to toggle through part files in the same folder as the current part shown in the *Part File Edit* box.

Building/Editing Part Files and Projecting Objects

1. In the *From SA* section of the interface , select Add to Part or Make New Part.

2. Select **Instrument>Laser Projector>Project Objects**. You will then be prompted to select the instrument (if you have more than one in the job).

💡 **Tip:** Objects cannot be removed from a part file through SA.

3. Set the color to use for the projection, LAP supports Red, Yellow and Green.

4. Now select the objects you wish to project. Doing so will create a file using the name of the first object selected for projection if you have Make New Part selected. If you chose Add to Part, it will add the selected objects to the current part file.

Projecting objects with the same name and make new part selected will replace the existing part.

MP/SDK Control Options

LAP Laser Projector	
Instrument Operational Checks	
Pause	Pauses the current projection.
Resume	Resumes the current projection.
Current	Projects the current pattern (part) file.
Next	Projects the next pattern file in the current file's folder.
Previous	Projects the previous pattern file in the current file's folder.
Cross	Toggles the center cross (+) for aiming the projector.
Set Part Name []	Sets the active part PATH to that designated by [].
Add Patterns to Existing Part	Adds projections from SA to the current selected part file.
Make New Part	Makes a new part file, located in the current part file's directory, but carrying the name of the first projection object in the projection from SA.

LAP Laser Projector	
Set Filter None	With no filter set, there is of course no difference in projection behavior.
Set Filter Angle []	Minimum Angle - When a given triplet of projection via points forms an angle less than this value, the central via point is removed.
Set Filter Points []	Number of Points - So long as the number of via points is greater than this value, the total number of via points is forced down to this value.
Set Filter Distance []	Minimum Distance - Via point pairs are evaluated, and the first is removed if the pair is closer than this value. The remaining point is then evaluated with the next one.
Set Auto Align File []	Set the path to an alignment file, designated by [] ([] not part of string). This path will be updated in the UI, and will be used for the next Auto Alignment, whether commanded from MP, or from the Auto Align control in the UI. The file must have the usual alignment file format: name, x, y, z, phi, theta, search radius.
Set Search Radius Degrees []	For alignment target search bloom size. [] is not part of the string, but represents a number between 0.1 and 2 for the search bloom size in degrees.
Set Search Time Out Seconds []	For the new Cal point search timeout. [] is not part of the string, but represents a number between 0.25 and 10 for the target search timeout in seconds.
Auto Align	Perform and Auto Alignment using the file shown in the "Align" section of the UI.
Set Color Red	Sets the current projection color to red.
Set Color Green	Sets the current projection color to green.
Set Color Yellow	Sets the current projection color to Yellow.
Basic Operations	
Project Objects	This is NOT a string command, but a standard MP command. Note that the arguments are "Instrument ID" as with any other command, and "Objects To Project". This second argument can be selected from the SA job, or for a projection object (perimeter, b-spline, etc.) that has been created within the MP, this can be a reference to that object or objects.
Stop Projection	This stand alone command cancels any projection from the selected instrument.
Align Laser Projector	This command will initiate the manual "mouse drive" alignment procedure, referencing the Point Group's points by name

Virtek Iris Projectors

Hardware Setup

Setup the unit following the manufacturer's directions with an unrestricted view of the work area.

Software Setup

You can download and install the latest supported drivers from our webpage here:

http://www.kinematics.com/ftp/SA/Install/Driver%20Downloads/Projectors/Virtek/

You will need the following files:

- `Support_ Virtek Iris 3D Software.zip`
- `VirtekProjectorDLLs.zip`

Installation

Contact Virtek for additional information on initial setup of your system with the Virtek software, but in general you will need to:

1. Unzip and install the `_Support_ Virtek Iris 3D Software.zip`. Follow the manufacturer directions for all Virtek software installation.

2. Restart your computer.

You will also need to add the dll files to your SA installation:

3. Unzip and copy the VirtekProjectorDLLs into the x64 folder of the installation directory for you SA version.

The installation directory can be found here:

C:\Program Files (x86)\New River Kinematics\SpatialAnalyzer XXX.X\x64

Projector Licensing

Contact Virtek to ensure you have the necessary licence to run the projector on the designated computer. This may require running a license request utility on the machine and sending the resulting re-

quest file to Virtek to get a license.

Network Configuration

Be sure to create a fixed IP address on your computer that will be compatible with the IP address of your projector(s) or use a direct connection and a DHCP setting. The default IP address should be stamped on the front of your projector. For example, if your projector's IP address is 192.168.3.2, then you need to change your computer's IP address to 192.168.3.X; where X is between 1 and 255 (and use a subnet mask of 255.255.255.0).

Work Order and Directory Configuration

Virtek projectors use a layered structure:

- **Work Cells.** Highest level set directly within the Virtek Server Manager. A work cell manages a connection to one or more projectors.

- **Work Order.** Designates a projector alignment for display.

- **Projection Objects.** These are the files that contain the drive coordinates for a particular projection. Typically a Work Order will consist of many projections.

To get started, the following must be set:

1. At least one Work Order must be defined. This will include a *.cal file, a *.xgal file and a *.xtar file which should not be edited.

2. At least one *.ply file must exist in that Work Order. This is a projection file and is used each time you add a projection from SA.

Work Orders are found in the following directly by default:
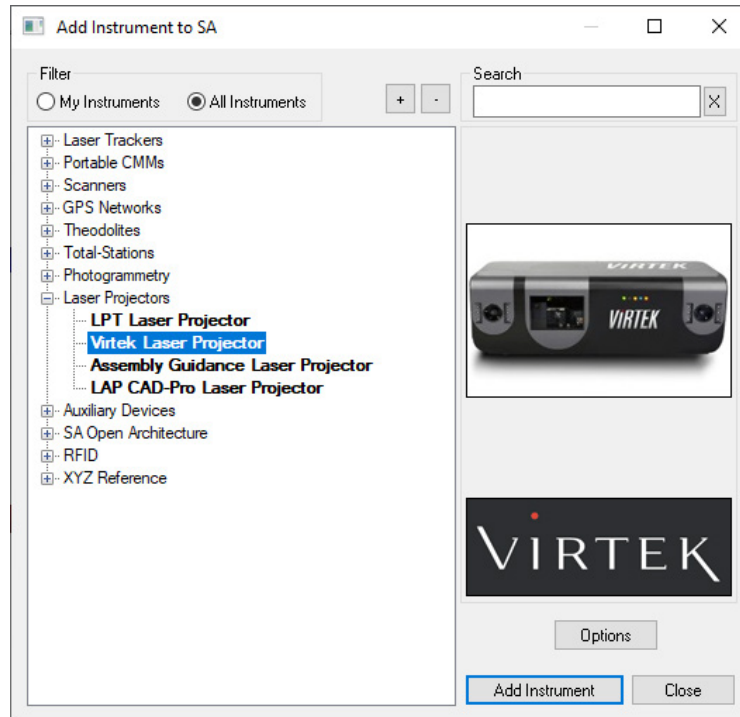
C:\Program Files (x86)\Virtek\Vertek Server\Work Orders

The easiest way to add a new Work Order, particularly if you do not have one yet is to use an MP command. Refer to the MP Command list.

SA Interface to the Virtek Projector

1. Select **Instrument>Add** and choose the Virtek Laser Projector. This will add a projector station to the SA job file.

433

Figure 9-17. Adding a Virtek Laser Projector model to SA.

2. Press *Connect* to run the instrument interface module or select **Instrument>Run Interface Module and Connect**.

3. Select the projector model you added to the job file and press OK. This will open the Virtek Projection interface (see Figure 9-5) dialog.

4. Within the *Client ID* field enter the name of the Work Cell to connect to. This tells SA what projector to connect to and where to look for Work Orders.

Figure 9-18. Virtek Iris Interface dialog. This is the basic control module used to control the projector from SA.
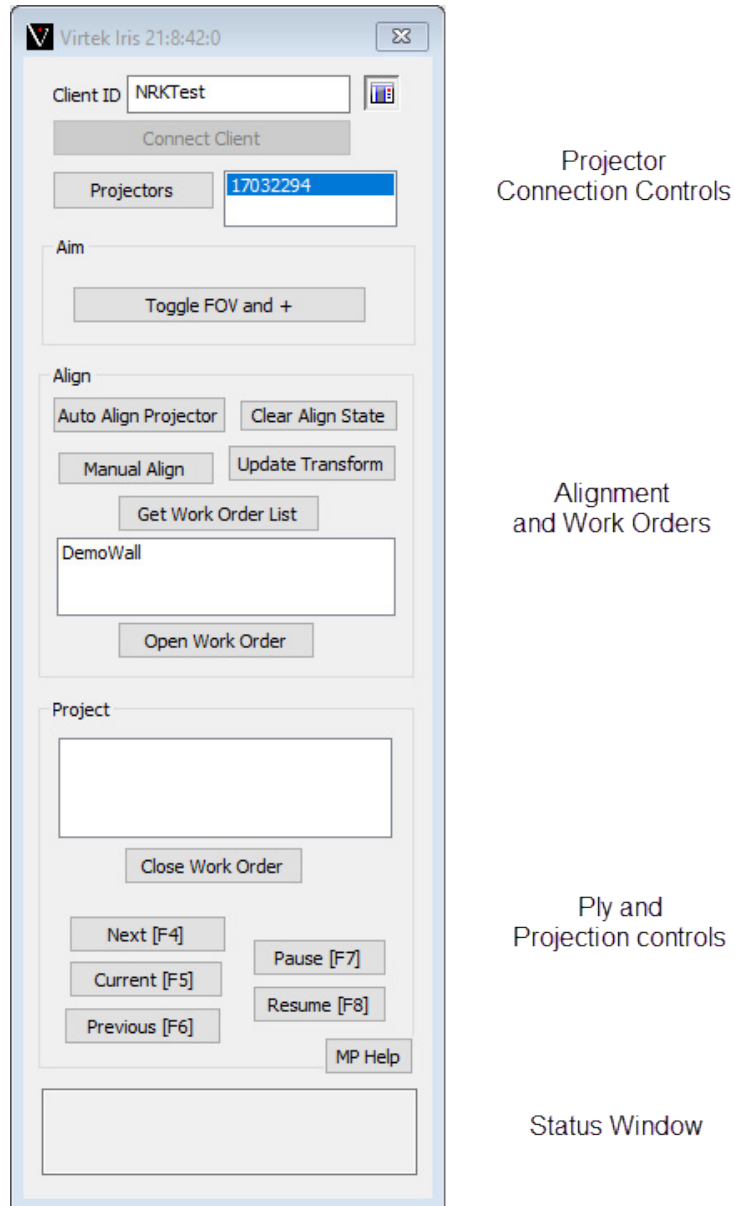
Aligning the Projector

There are two methods of aligning the projector in SA: *Auto Align* and *Manual Align*. A manual alignment must be performed once in order to orient the instrument in the Work cell. This alignment is then saved with the Work Order and auto align can be then performed to update the instruments transform in the job and can be used as a drift check.

Clear Alignment and *Update Transform* are options that should not be needed unless something goes wrong in the normal sequence of automatic communications with the projector.

To Perform a Manual Alignment

Each Work Order has one and only one alignment saved with it.

1. *Import or Measure Alignment Points.* Import points from a file

or just measure at least six reflector positions with a separate instrument within the field of view of the projector. The Toggle FOV and + button can be used to display the projector visible region and the center point in that view.

2. Select the Manual Align button. The option **Instrument>Laser Projector>Alignment** is not used with a Virtek projector.

3. Select the instrument to align and then the reference point group for alignment.

4. Use the manual alignment utility pictured in (Figure 9-7) to point the laser at each registration point in order by name. To do so, Left-Click and hold while dragging the mouse. This drives the laser pointer relative to the cross hairs in the dialog and, in turn, drives the projector beam to the reflector point. Once aimed correctly, right-click to scan the target. Perform these steps for each point in the reference group.
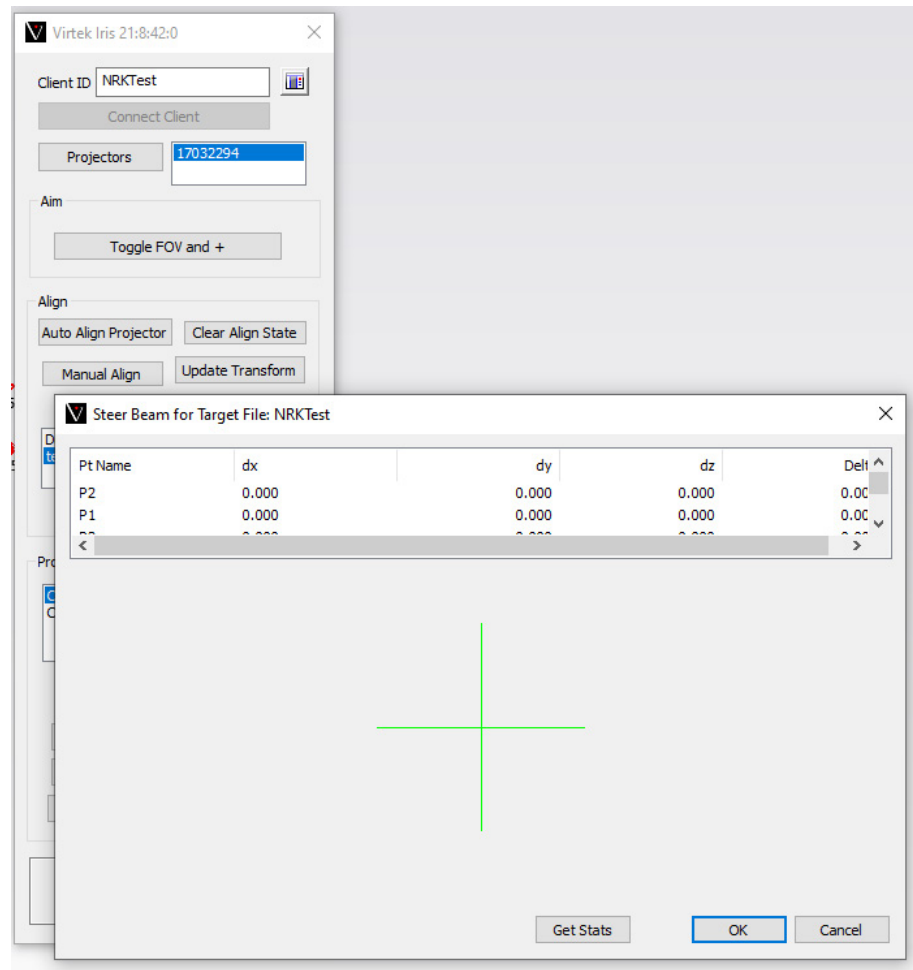

Figure 9-19. Steer Beam for Target dialog.

After each of the individual target locations have been identified in this fashion, these points will be automatically re-measured and the alignment will be performed. Alignment results are saved within the instrument history.

Projection Shapes from SA

The Virtek Interface provides the tools to project points and objects selected within SA. To project an object it must first be translated into guide points and saved into a projection file within a Work Order.

Creating Projecting Files

In order to add a new projection to a work order. Perform the following Steps:

1. Ensure that the desired Work Order is Open by selecting it in the list. The projections in this work order will then be shown within the projections list.

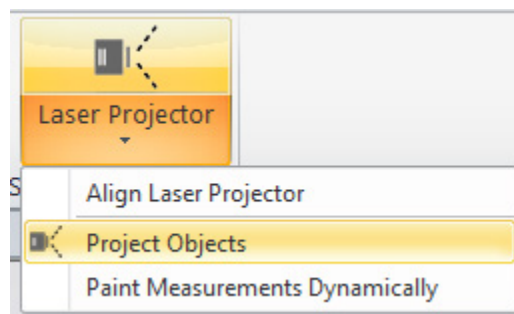2. From SA select *Instrument>Laser Projector>Project Objects*

Figure 9-20. Creating new objects to project from within SA is performed from the SA menu: Project Objects

If this command is issued when you have a valid Work Order opened and aligned, it will add the selected object(s) to the Work Order. The name of the first object selected will be added to that open Work Order's Project (plies) list in the UI. It will be automatically selected, and projected. So the .ply file in this open Work Order will have been edited to include the selected object(s).

If this command is issued when you have just created a new Work Order (see "Select or Create Work Order []" command above) then that Work Order cannot yet be opened, but the command will create or edit the Work Order's .ply file to include the selected object(s). The name of the first object selected will appear in that Work Order's Project (plies) list in the UI once the Work Order can be opened and has been aligned.

If this command is issued when you have a valid Work Order selected, but not opened, the command will first attempt to open the Work Order, and then add the projection to it, and attempt projection.

If this command is issued when you have no valid work order selected at all, you'll get a notification at the bottom of the interface, saying "No Work Order selected in WO List."

Navigating Between Projection Files

In order to project patterns from a previously created work order file, simply select the work order and then select the desired object to

project from the list.

Click Current to project the part shown. You can utilize the Pause and Resume buttons to control projection of the current part file and the patterns it contains.

Select Next and Previous to toggle through part files in the currently selected work order.

MP/SDK Control Options

A number of options exist for dynamically controlling your projector. The following MP commands are currently available:

Virtek Iris Projector	
Instrument Operational Checks	
Pause	Pause the current projection.
Resume	Resume the current projection.
Current	Project the selected ply in the current part.
Next	Project the next ply in the current part.
Previous	Project the previous ply in the current part.
Cross	Project the center cross hair for location.
Field Of View	Project the projector's field of view for location.
Select or Create Work Order []	Select Work Order if a folder is found which matches the name designated by [] ([] not part of string). Otherwise, create a new Work Order folder in the active Work Orders. The new Work Order will be highlighted in the interface's Work Orders list, ready for a subsequent "Add Cal File from Exported File []" command. Also, that new Work Order will not be valid (and cannot be opened) until it contains a valid .cal file and a valid .ply file. These are requirements of Virtek's Server Manager. NOTE: This command will fail if you have not set up a valid Work Cell in Iris. See your Virtek representative for more info regarding initial setup.
Add Cal File from Exported File []	Add the .cal file to the existing selected Work Order with the points from an ASCII file exported from SA. The existing MP command, "Export ASCII Points", can be used with all default settings, but populate ASCII File Path with the desired file path and name, the Group Name to Export, Data Delimiter of Space, Target Name Format of Target, and Desired Coordinate System of Cartesian. Then, for this command, the [] is the ASCII File Path argument from above ([] not part of string). NOTE: This command expects an ascii file of format "name x y z", NOT a projector .cal file defined in a Work Order.When this command is processed, the interface will create a .cal file corresponding to the coordinates in the exported ascii file. The .cal file will go to the current selected Work Order, and will have the same name, but will have the extension ".cal". This commad will fail if there is no current active Work Order. See your Virtek representative for more info regarding initial setup. Also note that until there is also a valid .ply file in the Work Order, Virtek will not allow the Work Order to be Opened. So you will need to add a .ply BEFORE you will be able to run the initial Manual Align on the .cal file in a new Work Order.
Auto Align	Perform and Auto Alignment. NOTE: This requires that you have defined and selected a valid Work Order, and that the work order has a valid .cal file in it. This alignment will be performed using the targets defined in that file.
Basic Operations	
Project Objects	This is NOT a string command, but a standard MP command. Note that the arguments are "Instrument ID" as with any other command, and "Objects To Project". This second argument can be selected from the SA job, or for a projection object (perimeter, b-spline, etc.) that has been created within the MP, this can be a reference to that object or objects.
Stop Projection	This stand alone command cancels any projection from the selected instrument.