Measuring With Laser Radar

This chapter covers connection and basic operation of the Nikon Laser Radar in SA.

Nikon APDIS - MV400 Series

Prerequisites and Connection

- SA version 2022.2 requires Nikon SDK v10.05.06.06174
- Follow Nikon's recommendations for the instrument mounting, set up and cabling.

SA/Nikon SDK Installation

The Nikon SDK 64-bit file set (SDKx64_v10.06.06174.zip) 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.

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 8-1. Adding the Nikon APDIS Model to SA
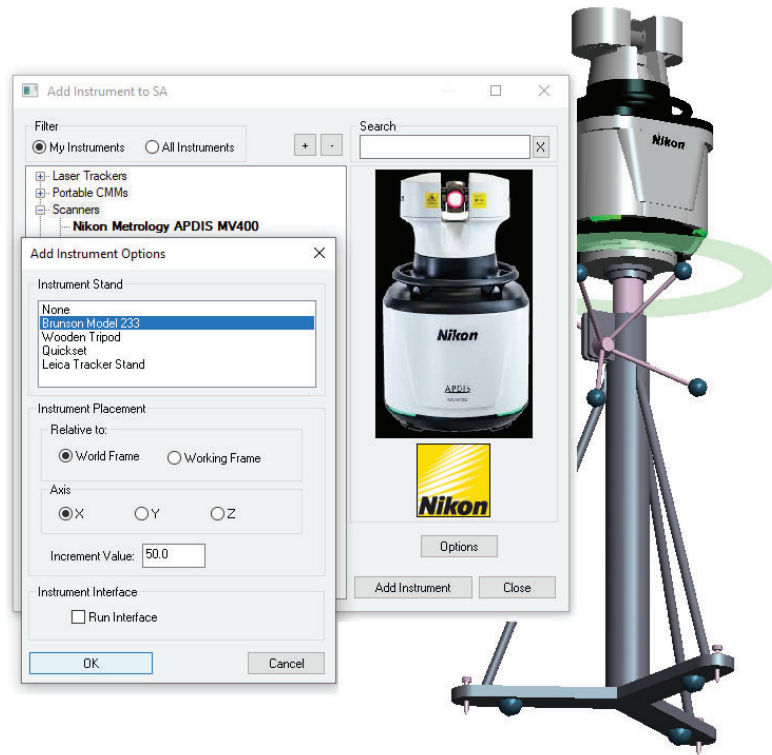
2. Now run the instrument interface module using the Connect button. This is done first, and the interface will open and be accessible and then the connection is made to the instrument from the interface.

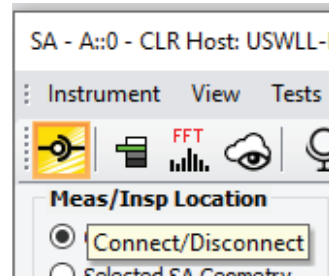**Figure 8-2.** Connect Button In SA
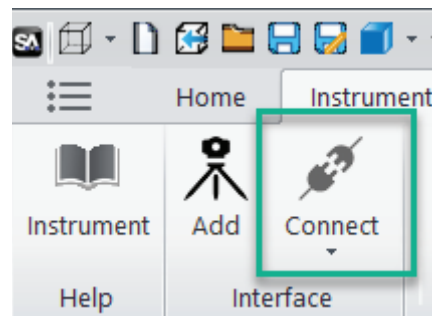
Connecting to the Device

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.
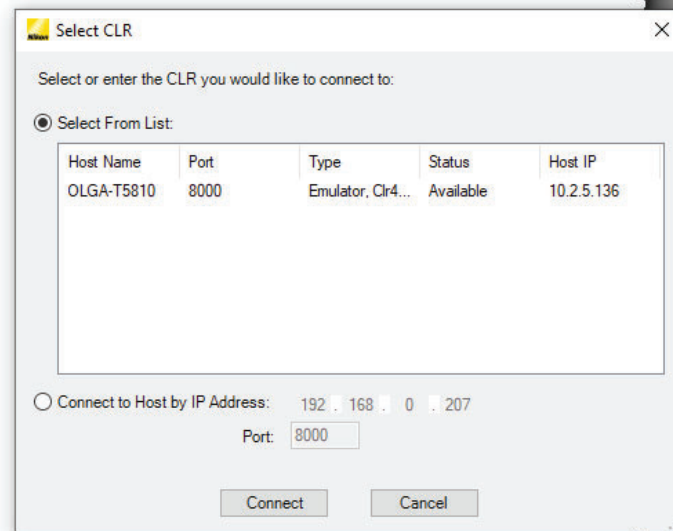

Figure 8-3. Connect Button

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:

C:\Program Files\Nikon Metrology\LRToolkit-10.05.01.5866. (Or later)

**Figure 8-4.** 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.

- **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.
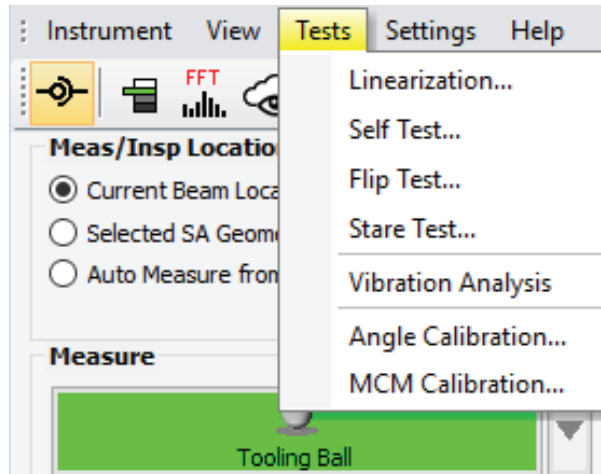
Figure 8-5. Selection of LR Self Test available through the menu.

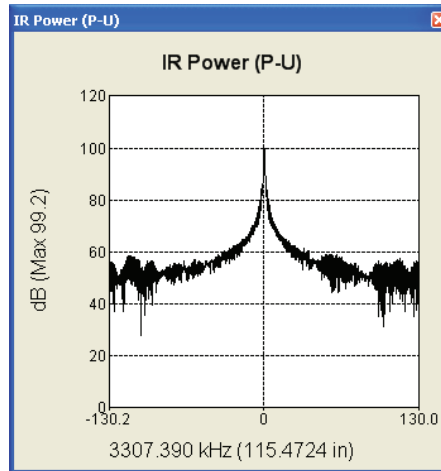## Current Beam Location, SNR and Auto-Focus Limits

The upper half of the APDIS LR Interface offer the necessary basic controls for beam and focus operations (Figure 8-6).
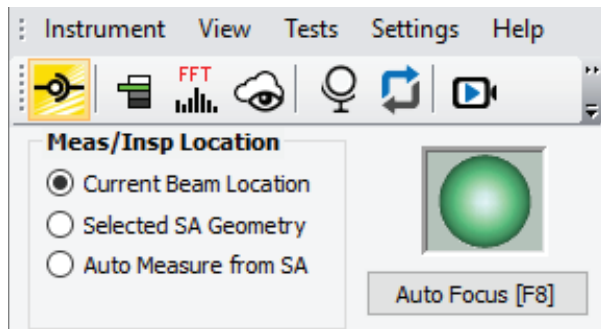
Figure 8-6. Upper APDIS Interface Controls

- **Show/Hide FFT Window.** Toggles the FFT window visibility (Figure 8-7).

Figure 8-7. The IR Power window.

This allows the user to view the IR SNR (signal to noise ratio) or the Red (pointing laser) focus limits (Figure 8-35). 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**.

- ▪ 📺 **Video Window.** Toggles the video output window (Figure 8-8). Using **Ctrl** + **Shift** + **+** or **Ctrl** + **Shift** + "**-**" will increase or decrease the steering speed (Figure 8-8).

Figure 8-8. Video Window with position values.
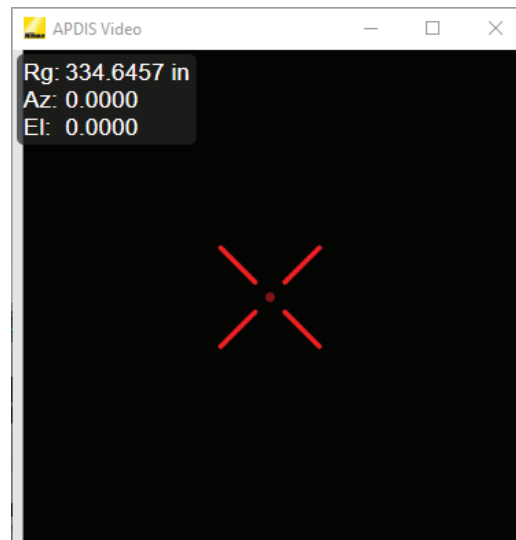
Auto Focus

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 8-9).
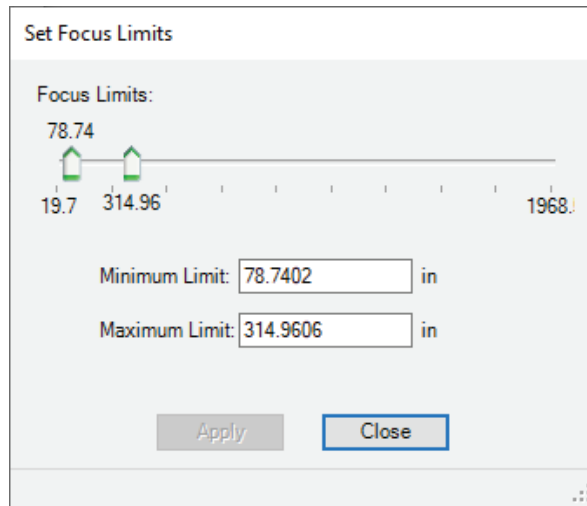
Figure 8-9. Focus Limits

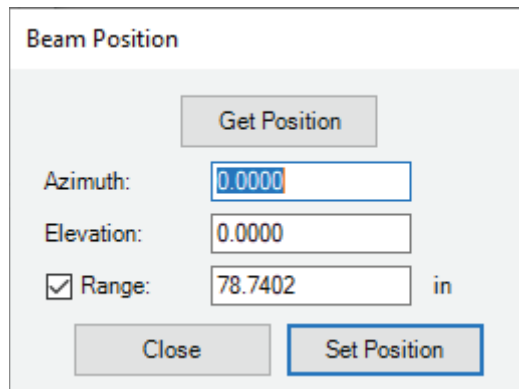## Beam Location

The Beam Position is displayed both in the video window and can be accessed in the Beam Position control dialog (Figure 8-10) available under *Instrument>Beam Location>Beam Position*.

Figure 8-10. Beam Location

Meas/Insp Location Controls

The APDIS LR interface supports three measure locations (Figure 8-6).

- **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 mea-

surement 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 8-11).
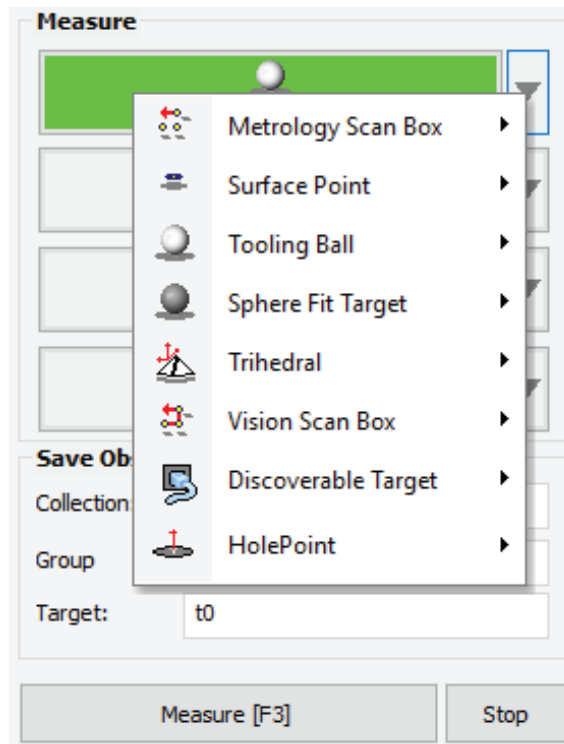
Figure 8-11. Measure section of the APDIS LR Interface

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 8-12). 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**

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- **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.** Which is a scan that moves through a grip of fixed point measurements.

- **Vision Scan.** Which is a continuous scan where the laser doesn't stop during the scan.

- **Edge Search.** Which searches for an edge.

- **Surf-Vector Intersection.** Which searches along a nominal vector to where it intersects with an actual surface.
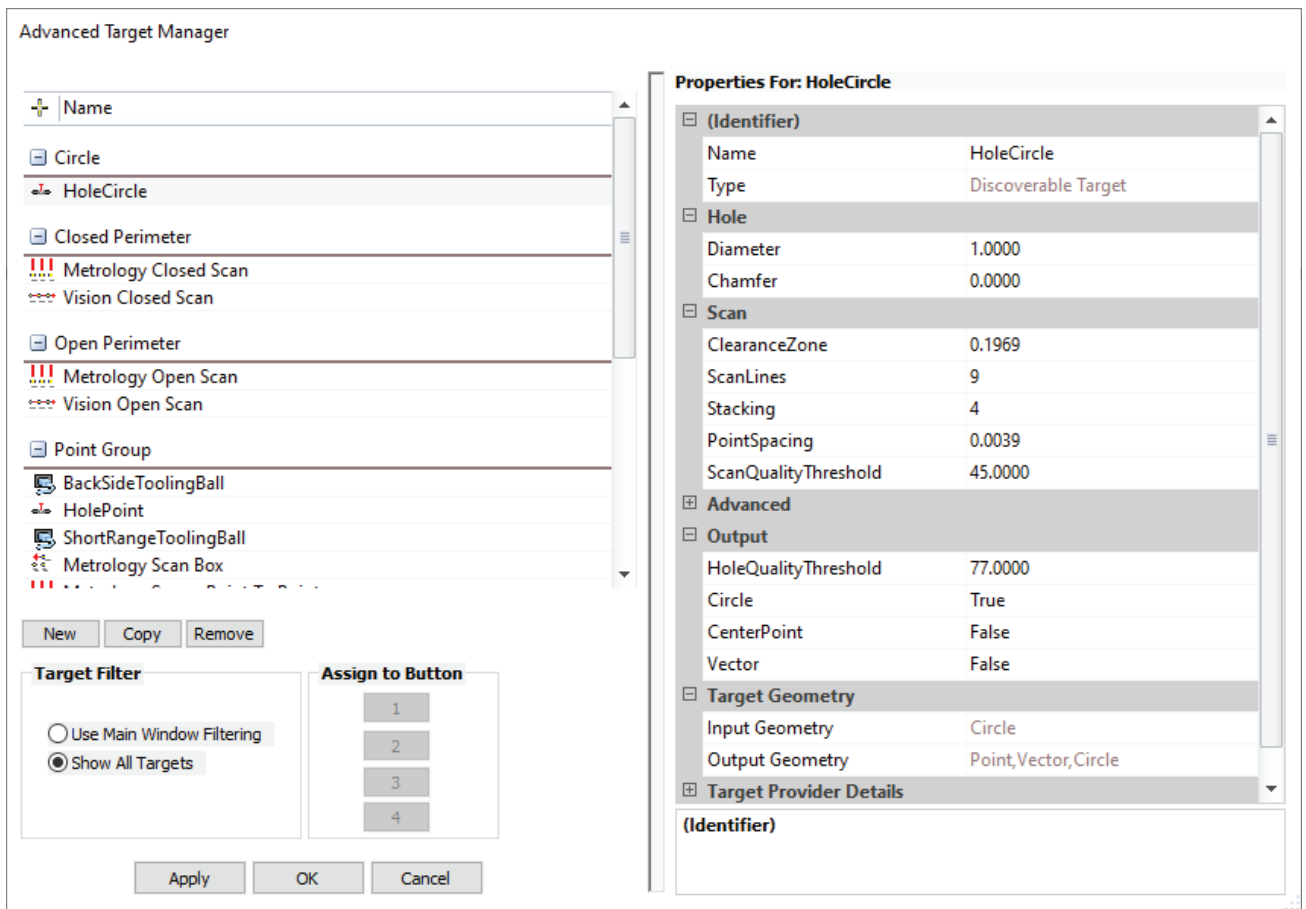
Figure 8-12. Target Manager

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 8-13).
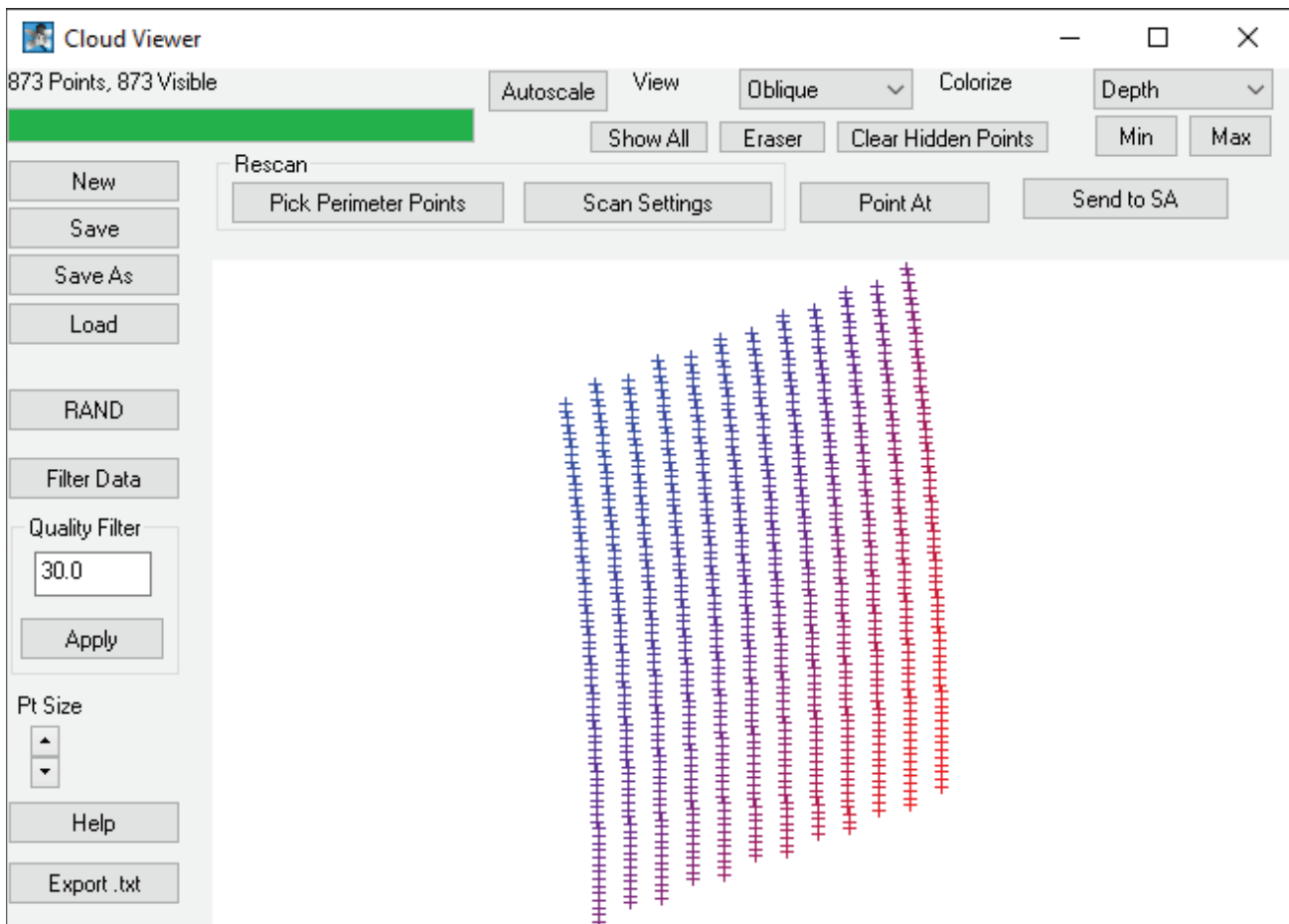
Figure 8-13. Cloud Viewer control panel and display.

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 8-14).

Figure 8-14. Mirror Measurement Control Dialog after measuring 2 points to define a mirror.
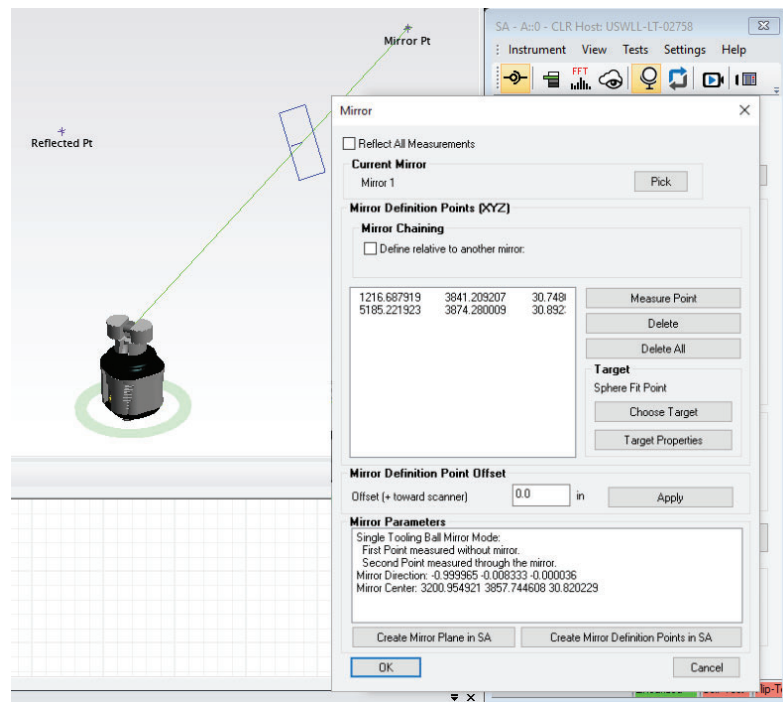
If more than 2 points are measure, a plane is directly fit to the measurements and a mirror is defined from this plane fit.

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 8-15).

Figure 8-15. Saved Data and Output controls
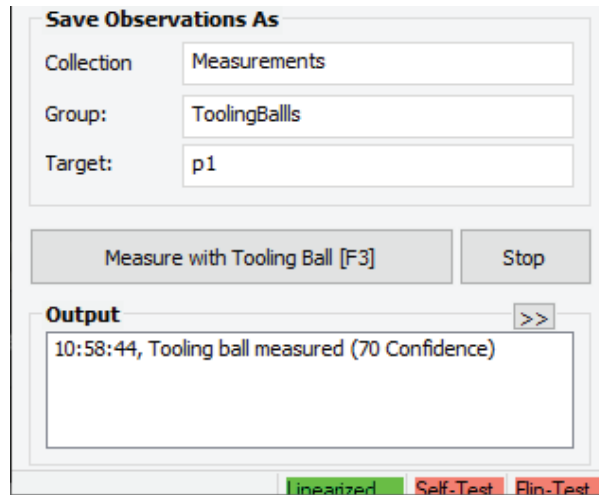
Point measurements are saved using the specified point name:

- **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.

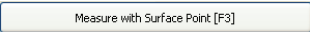3. Press the Measure button [Measure with Surface Point [F3]] or **F3**.

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 (Figure 8-39).

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 8-40).

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 8-41). 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 8-16) which provides both a list of existing calibrations and offers the ability to record an additional one.
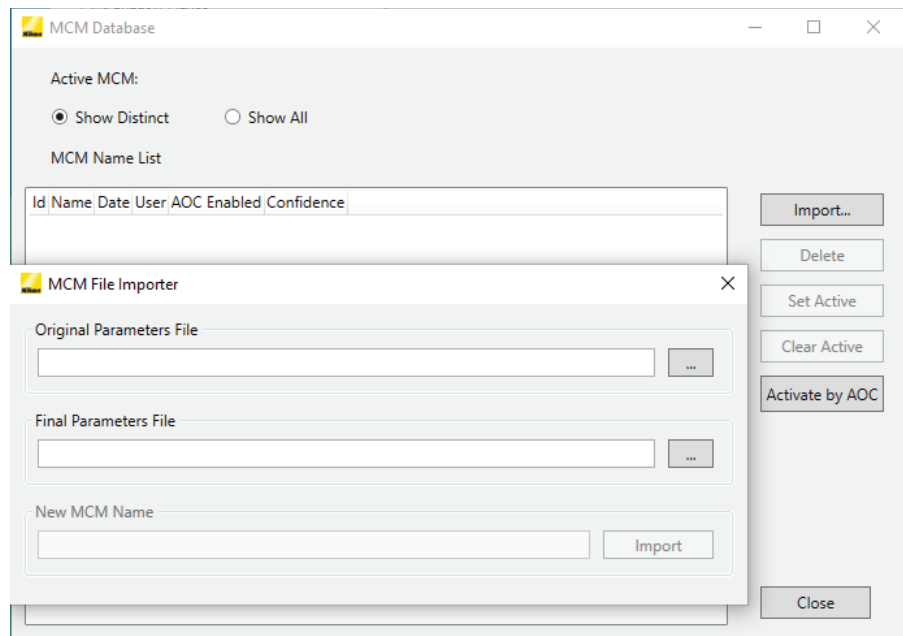
Figure 8-16. Import control from the MCM Calibration Dialog

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 8-17*)*.

Figure 8-17. Example list of Hardware Capabilities and licenses
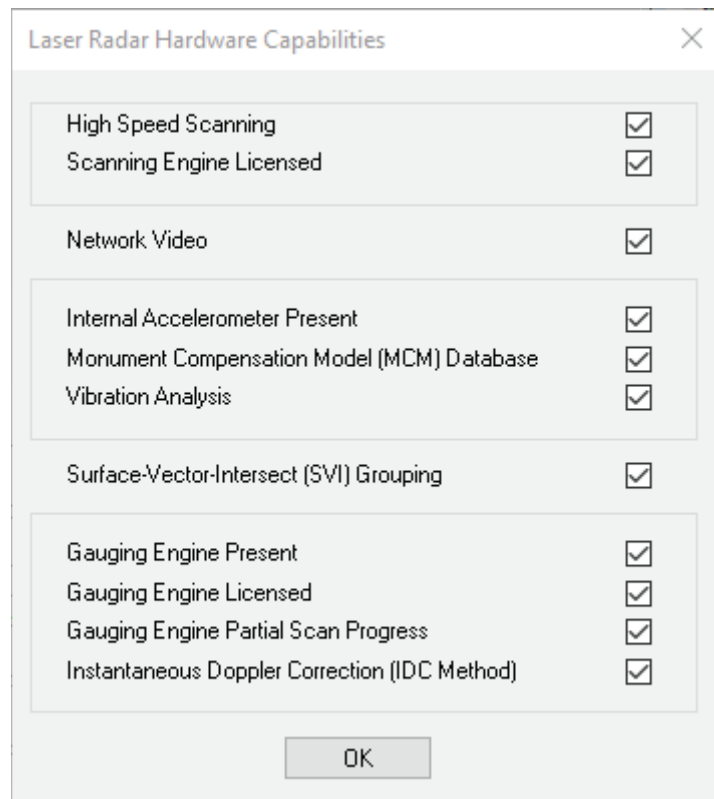
Auto Measure from SA

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 8-18):

Figure 8-18. Example GE target profile assignment to different features in the SA Tree.
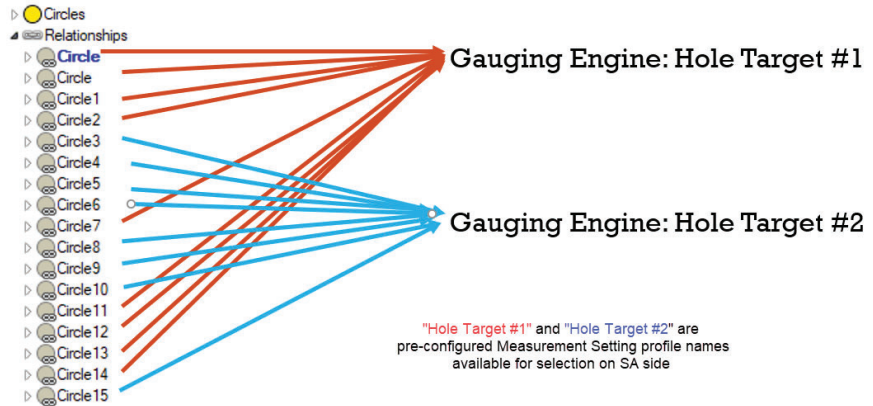
To configure GE target profile / measurement settings on Nikon AP-DIS LR application, use the *Gauging Engine* section in the Target Manager dialog (Figure 8-19).

**Figure 8-19.** Gauging Engine specific target management controls.
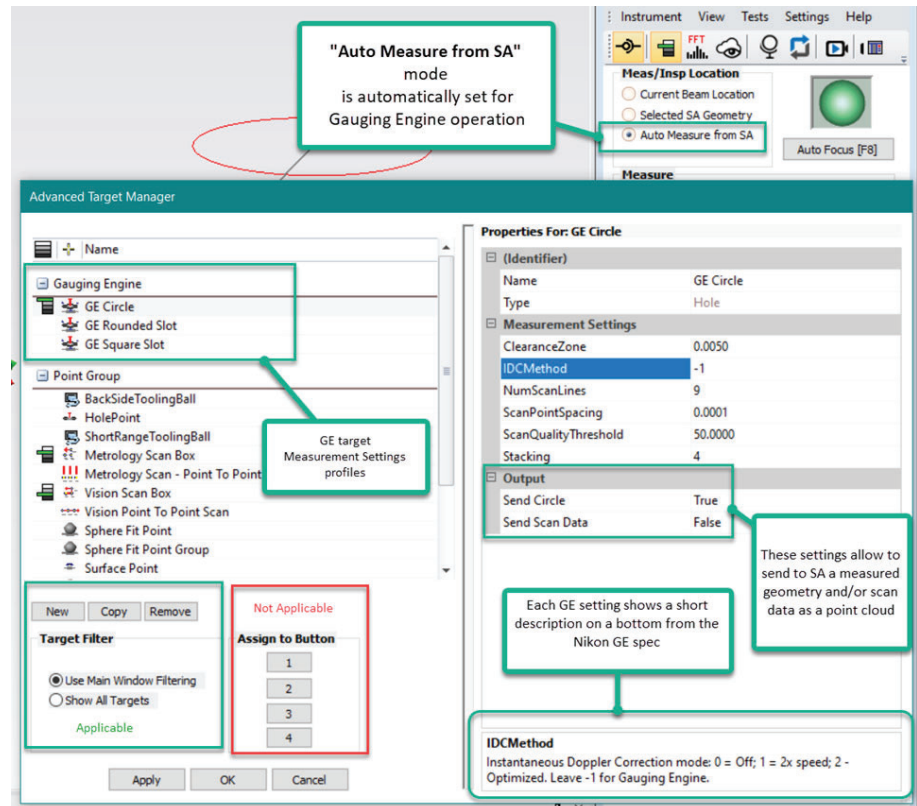
The selected GE Target definition setting show a short description on the bottom from the Nikon GE specifications.

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 8-20).
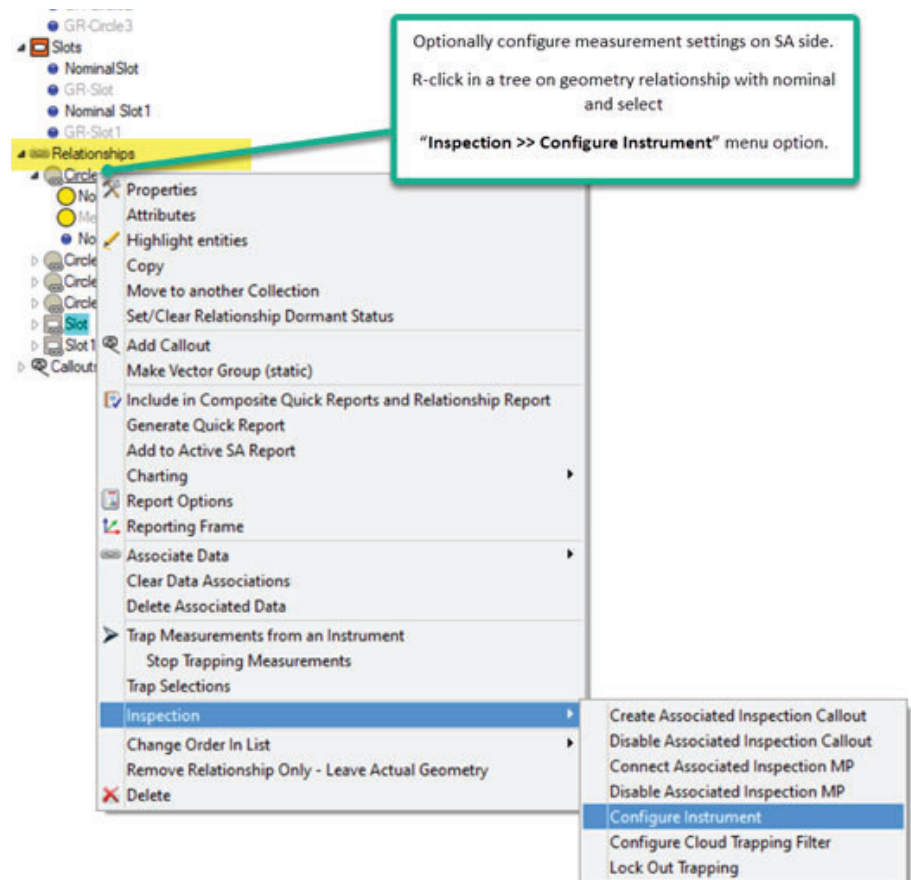
Figure 8-20. Configuring a particular GR-Circle for GE measurement.

You can select a measurement profile for a feature from a list of available GE settings received from LR interface Target Manager (Figure 8-21):
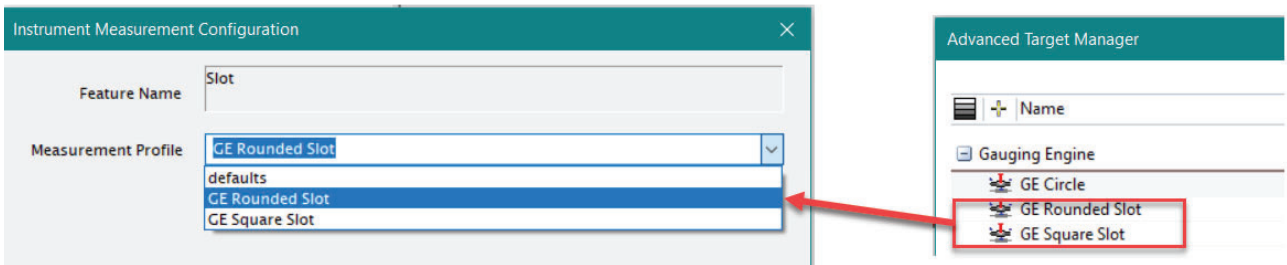
Figure 8-21. Selecting an existing Gauging Engine Definition.

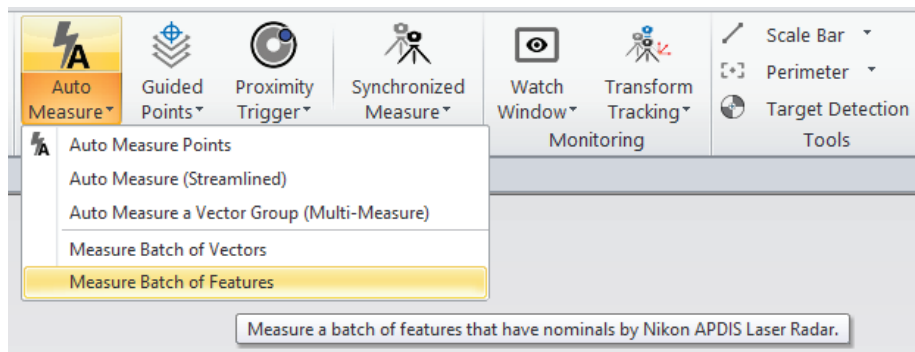The same dialog allows you to apply the same settings to selected features or reset to defaults.

Trigging 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 8-22).

Figure 8-22. 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 8-23).
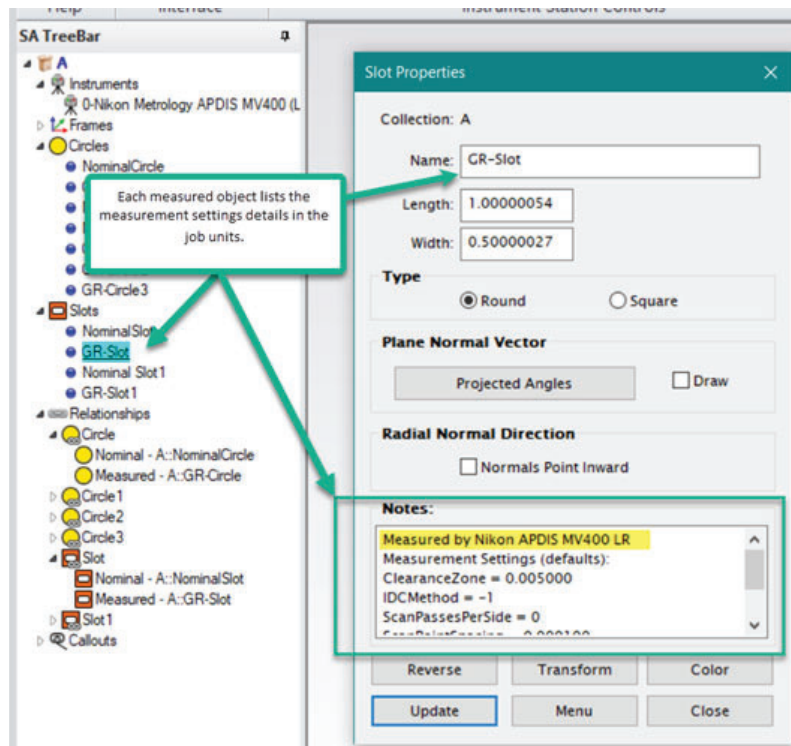
Figure 8-23. Resulting measured feature and saved settings in the object notes.

Laser Radar Automation (MP/SDK) Commands

A full list of MP commands can also be found in the interface under *Help>Help Topics>Measurement Plans (MP)*

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 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
Configure and Measure	Measures a point using the specified name and meas profile
Scan within Perimeter	Scans within the specified perimeter
Point At Target	Points at a selected point
Measure 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

Nikon Laser Radar	
Instrument Operational Checks	
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
Start Video	Starts the video display
Stop Video	Stops the video display
HWCapability <capability>	Offers the ability to check if the LR supports hardware capabilities (SVIGrouping, ScanEngineLicense, HighSpeedScan, GaugingEngine, GaugingEngineLicensed, MCMDatabase, NetworkVideo, InternalAccelerometer, VibrationAnalysis, InstDopplerCorrection, GEPartialScanProgress)