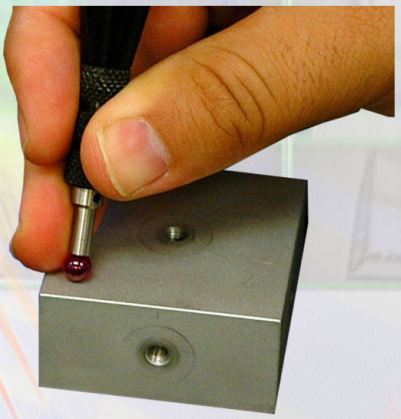
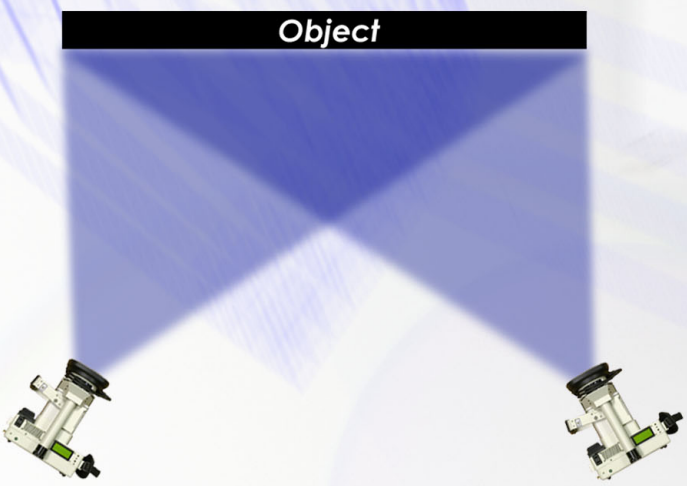
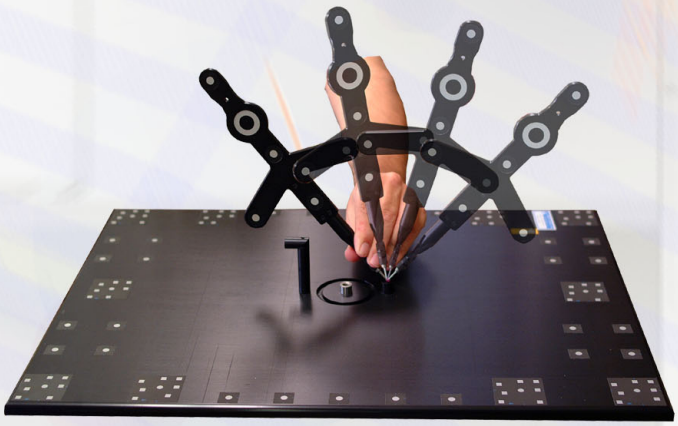
V-STARS/M User Manual

Picture Perfect Measurements™

Last Revision: February 2001







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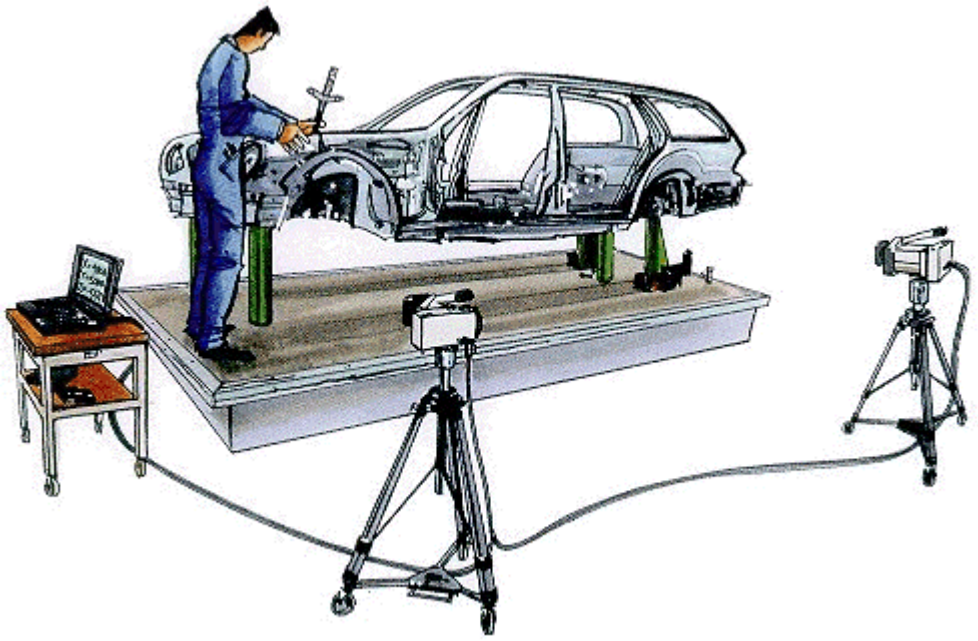
Introduction

What is V-STARS/M?

V-STARS/M is a 3-Dimensional coordinate measurement system that uses two or more high-resolution digital cameras to make fast, accurate, real-time measurement via photogrammetry. The V-STARS/M system is based on the single-camera V-STARS/S system. Additional camera(s) and software for real-time measurements have been added.



Before starting any V-STARS/M measurements, it is advisable to be fully conversant in the V-STARS/S operation. This will make the transition to V-STARS/M far easier.

Basic V-STARS/M Features

V-STARS/M has the following main features:

Probe Measurement

In addition to measuring targeted points, V-STARS/M can also measure untargeted points using a wireless, hand-held probe. The system supports 16 different probes, each of which uses standard-interchangeable CMM tips. The probes themselves are interchangeable during a measurement. If the probe is changed, V-STARS automatically recognizes the new probe. A more detailed description of the hand-held probe and its use is provided in Measuring Points with the Probe.

Immune to Vibration

One of the most powerful capabilities of V-STARS/M is its ability to make real-time measurements even in unstable or vibrating environments. This capability is achieved by measuring a stable control field of targeted points in addition to the targets on the object or the probe. These points are quickly and automatically measured each time a pair of pictures is taken. This allows the camera orientation to be automatically computed using these stable points. Any camera movement is then fully accounted for and of no consequence.

The use of a control field of stable points is a relatively easy task for many applications. On tooling, the enhanced reference system points or tooling points can be readily used. On parts and assemblies, a control field can generally be installed in a matter of minutes using V-STARS/S. The ability to perform real-time measurements in unstable environments is a major advantage over other systems. These systems must remain stable throughout the entire measurement.

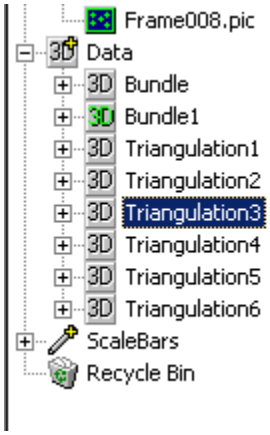
Real Time Measurement

The results of the V-STARS/M measurement are typically instantaneous. This means that coordinate data is available in real-time. If a probe is being used then the derived coordinate is displayed on screen and written to a 3D file.

```
Aero Probe with 3mm Ball Tip
PROBE26
X     234.345   0.020
Y     100.340   0.016
Z     659.956   0.021
D     156.032   0.030

PROBE27
X     894.390   0.022
Y     109.880   0.018
```

If target points are being used, the data is written to a new 3D file. This triangulation data can be written to a new file after each measurement or alternatively the data can overwritten after each epoch.



Portable

The system is portable and hence able to measure in areas that traditional CMMs cannot access. Naturally, the system is bulkier that the V-STARS/S system, but all the necessary items typically fit into three manageable cases.

Configuring V-STARS/M

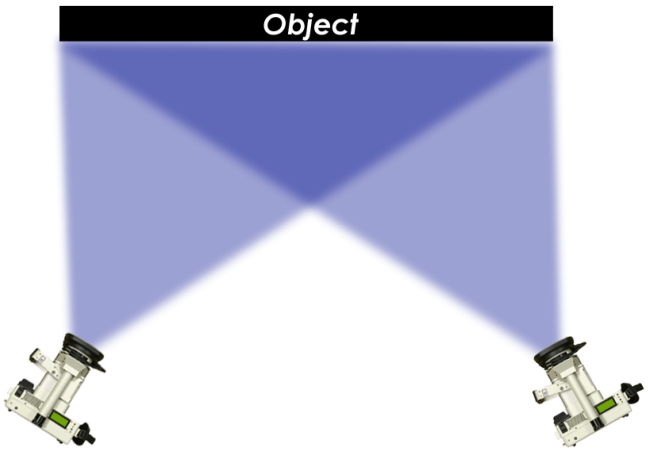
Introduction

Before measuring, it is necessary to configure the system for use in V-STARS/M. The configuration can be split into the following categories.

- Positioning the cameras.
- Using the tripods.
- Pointing the cameras.
- Camera connections.
- Setting the flash intensity.
- Cable box connections.
- Powering up.

Positioning the Cameras

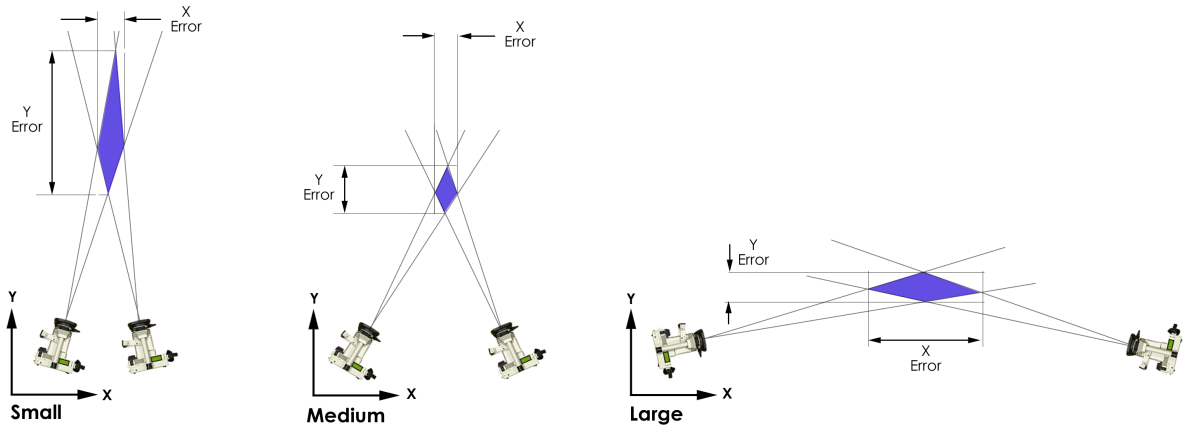
For best results, the two cameras should be placed so that one camera is just outside the left boundary of the measured area, and the other is just outside its right edge. A diagram of typical camera placement is shown in the adjacent image.



Positioning the cameras closer together makes the geometry worse and hurts accuracy, while positioning them further apart may make the far field targets or the probe targets dim and hard to measure. In general, you will find it more convenient, because of the picture window placement on the display, to put Camera 1 to the left and Camera 2 to the right but this is not necessary. The distance back from the object you must place the cameras depends on the particular accuracy requirement, but in general, it must be placed about the same distance from the object as is the size of the object.

The geometry of the camera positions will play a significant role in the accuracy potential of the M System. Much like theodolites, the camera must be carefully positioned. Angle of intersections should be as close to 90° as possible. Angles between 60° – 120° are typically acceptable.

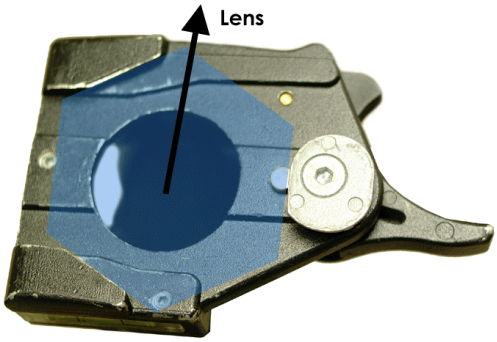
The influence of angle of intersection on accuracy is demonstrated in the diagram below.



Tripods

The INCA2 has a standard hexagonal mount that is appropriate for mounting to most standard tripod pan-heads.

1. Ensure that the tripod legs are well distributed and that all the appropriate screws are tight.
2. Ensure the tripod quick lock mechanism is in the open position.



3. Align the hexagonal base of the INCA to the tripod. Use the diagram above as a guide to the orientation of the camera.
4. Ensure the quick lock mechanism is secure before releasing the camera.

Pointing the Cameras

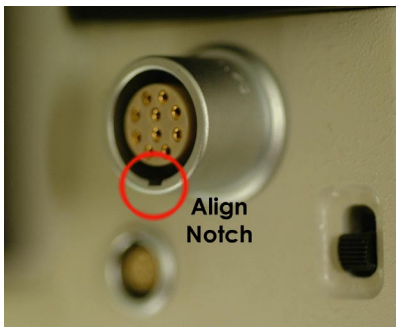
Point each of the cameras so that the area of interest is clearly visible. Keep in mind that both of the cameras will need to see the area. For larger areas, divide the workspace into smaller sections to make the measurement more manageable and to maintain accuracy.

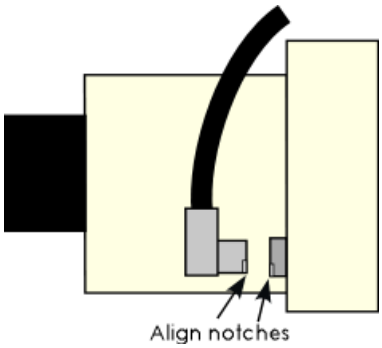
Camera Connections

It is necessary to connect each of the cameras to the cable box. The cable box supplies the camera with power and a network connection.

The INCA camera battery MUST be removed before connecting the camera to the cable box.

Start by connecting the cable to the camera. Make sure that the camera switch is in the **OFF** (down) position. The cable is connected as shown in the diagrams below. Take care to align the cable notches. **DO NOT** force the connection. Doing so may cause damage to the connector. Repeat this procedure for the second camera.





Connect the ring flash to the camera.

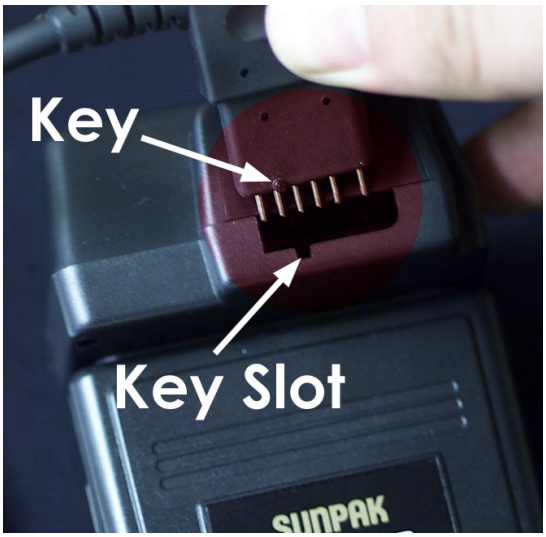
1. If the ring strobe is not attached to the ring mount on the front of the camera do the following:

a. Before attaching the ring strobe, wrap the cord around the ring mount once to make sure it does not fall in front of the lens.
b. Hold the cord in place with the cord clips provided with the system.
c. Place the ring strobe around the ring mount while pressing the two spring loaded buttons on the side of the ring strobe.
d. Release the buttons so the ring strobe catches on the lip of the lens protection mount.
e. Pull on the ring strobe to make sure it is firmly attached. If it is not, try re-mounting it until it is.
f. Leave the ring strobe attached when you re-pack the camera. The case has space for this. You will find it easier and more reliable to leave the ring strobe attached when you pack the camera.

2. Remove the strobe power pack from the camera case, and attach it to the mount on the top of the camera handle. The unit's power switch should face the back of the camera.
3. Slide the unit in until it stops, then turn the locking nut at the bottom of the unit to hold the unit firmly in place.

4. Plug the connector from the ring strobe into the power pack. The connector is keyed so you cannot insert it the wrong way. Refer to the diagram below.

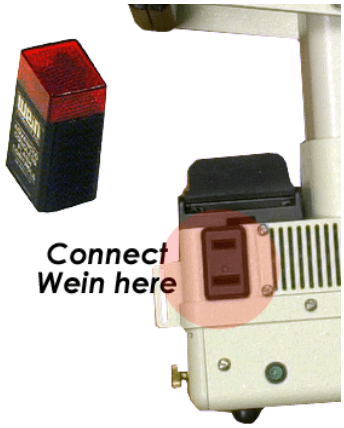
5. Slide the power switch to the BATT position. The ready light should come on in ten to twenty seconds. If the ready light takes more than twenty seconds to come on, you should replace the batteries. *See* Changing Hand-held Strobe Batteries in the INCA2 manual for how to do this. You can press the ready light to test fire the flash. Remember to turn the power switch to the OFF position when done, to keep the batteries from draining.



The Hand-held Strobe is now setup.

If an RCS unit is being used then refer to the INCA Manual for instructions on how to connect it to the camera.

In order to use the remote trigger it is necessary to plug in the IR trigger sync (Wein) into one of the cameras. Connect the Wein to the connection point on top of the camera. It can be connected to either of the cameras.



For environments that have a lot of IR noise, Radio triggers are available. Please contact GSI for more information.

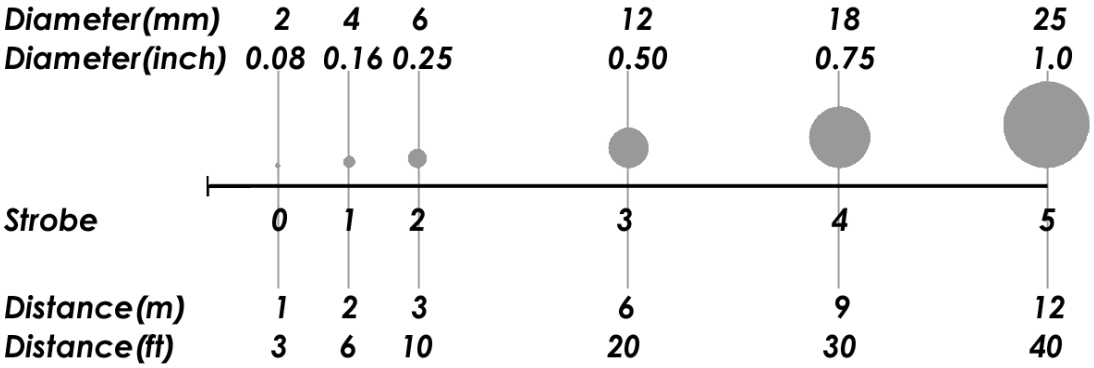
If you have one of these triggers, use the adapter cable to plug the receiver into the camera.

Setting the Flash Intensity

The flash power setting for the target exposure depends on the distance from the camera to the targets, and the target size.

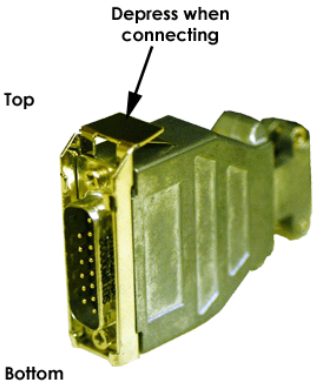
The following diagram gives recommended flash power settings at varying distances. If you are shooting the object in sections, use the size of the sections. The tables assume the recommended target size (which is also listed) is used. If the targets are smaller than this, you may want to increase the flash power setting one step to help compensate.

The tables assume the default lens f-number of F11 is used with an INCA. It is important to check the lens and make sure it is set to F11, the default setting for the lens. For more information on setting the exposure, refer to the Exposure section of this manual

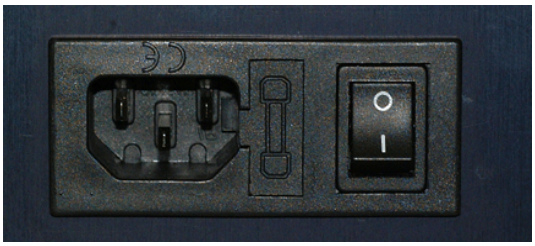


Cable Box Connections

Connect the remaining end of the cable to the system cable box. Once again, make sure you correctly align the cables before connection. Any one of the three connections can be selected. They all operate in the same manner. Connect additional cameras in the same manner.



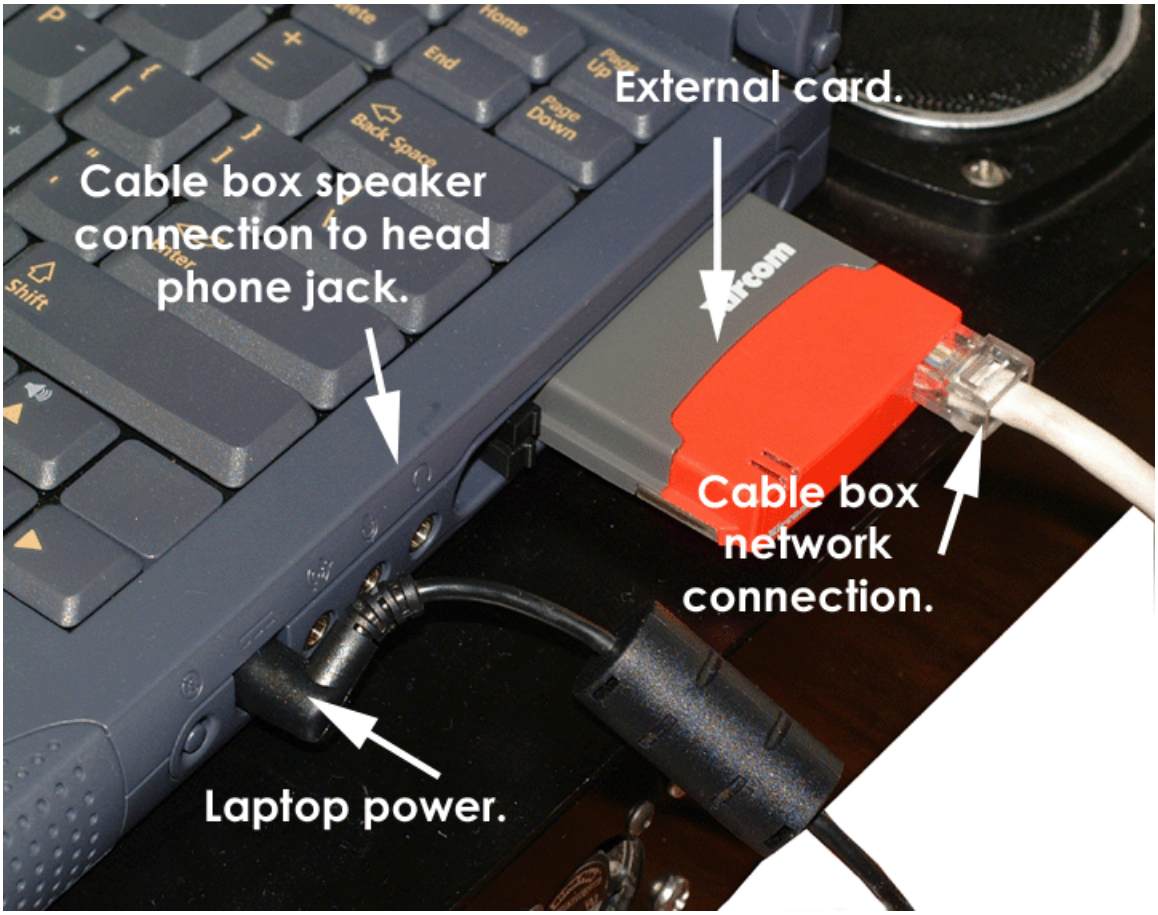
Connect the power cable to the power connector.



Connect the cable box network cable to the system laptop network card. The laptop network connection depends on whether the network is an internal connection or an external card. In both cases, the connection is the same. The external card option is shown in the connection diagram.

Connect the laptop power cable. You can use either the internal cable built into the cable box or the one supplied with the laptop. If the laptop being used is different to the one supplied with the system, then ensure the power connection is compatible before connection.

If you are working in a noisy environment, you may want to also connect the cable box speakers to the laptop. Do this by plugging the stereo jack into the headphone jack of the laptop.



Powering Up

- Switch on the power to the cable box.
- Switch on the cameras.
- Boot the system computer.
- Launch V-STARS.

Selecting a Camera Orientation Method

Introduction to Camera Orientation

Before points can be triangulated, we must accurately determine the position and aiming direction (together called the Orientation) of the cameras. V-STARS has three techniques for orienting the cameras.

1. If the cameras are not in a stable environment, Unstable Camera Orientation may be used.
2. If the cameras are stable throughout the measurement, Stable Camera Orientation may be used.
3. A variation of Unstable Camera Orientation called Quick Camera Orientation can be used in some simple setups.

In the Unstable Camera Orientation, a stable field of control points is used to orient the cameras. Orienting the camera with this technique is very similar to what is done for an S measurement. After the initial orientation, the cameras re-measure the control points every time a measurement is made, and the camera orientation is automatically computed using these stable points. Any camera movement is then fully accounted for and of no consequence.

In the Stable Camera Orientation, a targeted bar approximately one meter long is used to quickly orient the cameras. The operator moves the bar to several places in the scene and the cameras measure the bar. A quick orientation of the cameras is then performed. The cameras must be completely stable throughout the entire measurement when using this mode.

In the Quick Camera Orientation, as in Unstable Camera Orientation, a field of control points is used to orient the cameras. However, unlike Unstable Camera Orientation, control points are established by the M-Mode camera setup just before making any online measurements. This technique is effective when all of the control points can be viewed from the single two-camera setup.

Establishing Control

If the system is going to be used in the Unstable orientation mode, then it will be necessary to establish a control field. The control field is used to re-establish the location of the cameras each time a measurement is taken. In this mode of operation, the V-STARS/M system is immune to the effects of vibration.

More often than not, the V-STARS/M represents the second part of a measurement task. In the first part, the V-STARS/S system is used to collect the bulk of the required data. The multi-camera system is used to collect the data that the single camera system couldn't acquire. As a result, in most cases, the same control field can be used. If you keep this in mind when planning and executing the single camera measurement, you will simplify the control establishment procedure.

Targeting

There should be a minimum of twenty well-distributed coded targets on the object or surrounding area. By providing at least twenty points, we are ensured redundancy. Any points that may accidentally move or are damaged during the measurement can be automatically detected. More importantly, there remain enough points to continue the measurement without the affected points. The coded targets are typically affixed to magnetic sheet to simplify distribution.

Notice we always qualify the number of points with the term well distributed. The distribution of the points is much more important than the number of points. For example, it is better to have twenty points that are spread throughout the measurement volume and which fill out the field-of-view of the camera than to have thirty points clustered in one small area. If you intend to work with the control field established as part of the single camera measurement, and it contains many targets (>100), it would be prudent to reduce the number in the field of view. This will improve the data collection speed of the process.

After establishing the field, the scale bars and AutoBar can be removed. These objects are temporary and may move during the measurement.

Establishing the Driver

Once targeting has been completed carry out a single camera S network of the control area. Refer to the main manual and the Basics of Photogrammetry document for information on how to accomplish this. Process the images and verify that the results are satisfactory. Make a copy of the final bundle and delete any of the points that you intend to remove before the M Mode measurement.

Rename the final bundle to something that will help you easily identify it as the Driver file. This will make locating it, when we want to import it as the driver, a lot easier.

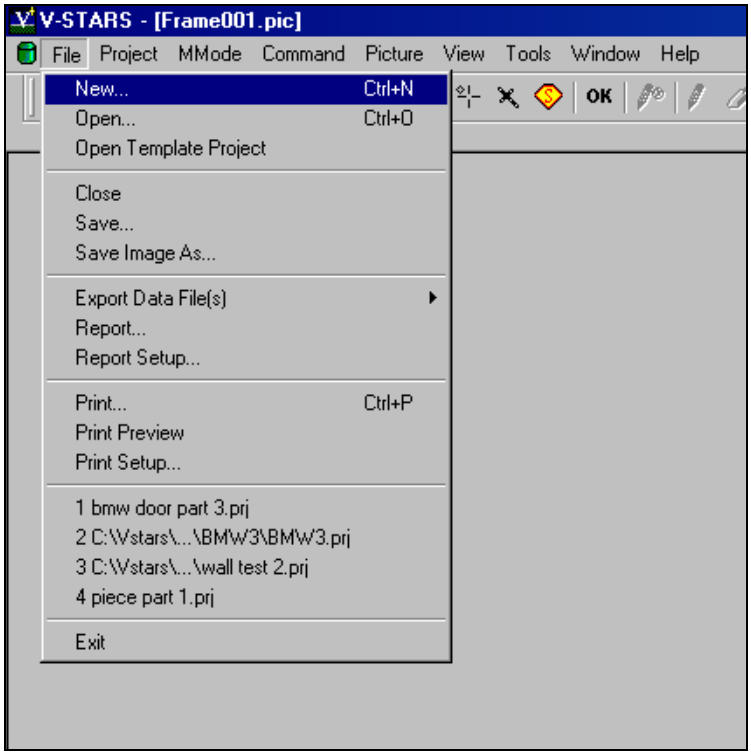
Starting an Unstable Orientation Project

In many applications, it is advantageous and sometimes necessary, that the cameras not be considered completely motionless during the measurement. This allows operation on unstable flooring, or in environments where heavy equipment is causing vibrations. By placing a stable field of control points on the object being measured, V-STARS can automatically re-orient the cameras every time a measurement is made. Therefore, unlike the stable orientation mode, you do not have to worry about camera movement during the measurement. Tripod dollies can be used, the cameras can be placed on unstable flooring, and the system can operate near heavy equipment. Unstable Orientation mode is probably the most common way you will use V-STARS/M.

Start an M project as you would start any other new single camera S project. Refer to the main manual if you are unfamiliar with how to do this.

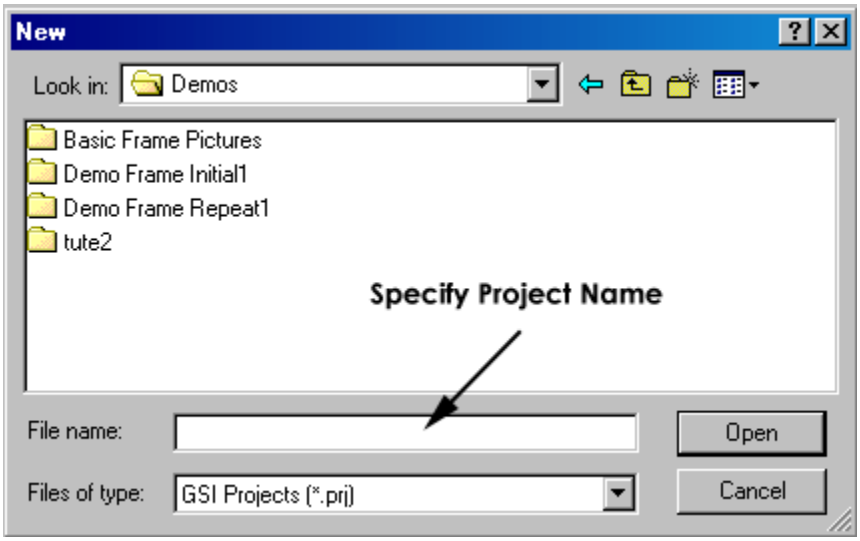
New M Project (Ctrl N)

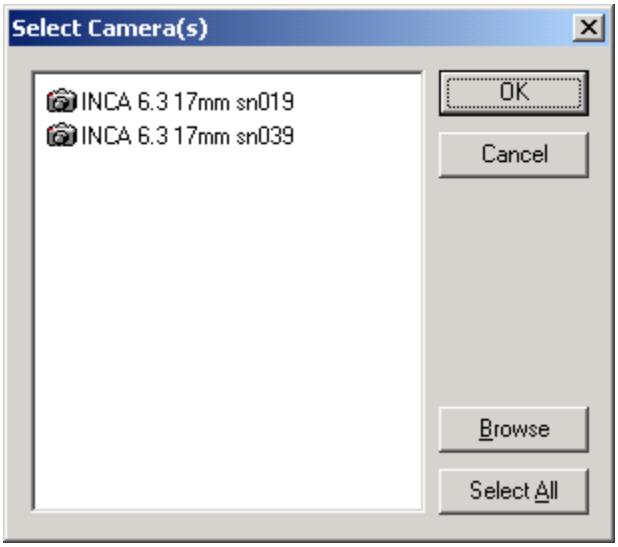
The **New** command is used to commence a new V-STARS M project. The **New** command is located under the **File** menu.



A new project will be started using the default V-STARS settings.

Once **New** is selected, the **New** Dialog box will be opened. You are required to specify a directory and project name. The default directory is typically `C:\V-STARS\Projects` and the project is normally given a meaningful name. The **Open** button will create the new project and all the necessary setup files used by V-STARS.

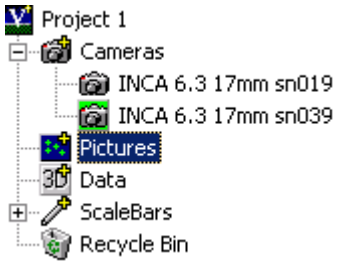




If you have an M system, there will be multiple cameras present in your GSI system directory. You will be prompted to select the cameras you wish to configure for use in M mode from the **Select Camera(s)** dialog. The cameras located in the `C:\GSI\System` directory are listed. If the cameras you wish to use are present, then select them and press the **OK** command.
If the cameras you wish to use are not present, select **Browse** to locate the cameras.

Two cameras must be present for M Mode to be active.

If two or more cameras are selected, then the last selected in the list will be the default or active camera. A green icon denotes the active camera. To change the default camera, double click on the camera you wish to make active. The active camera will be the one that fires when the button is pressed.



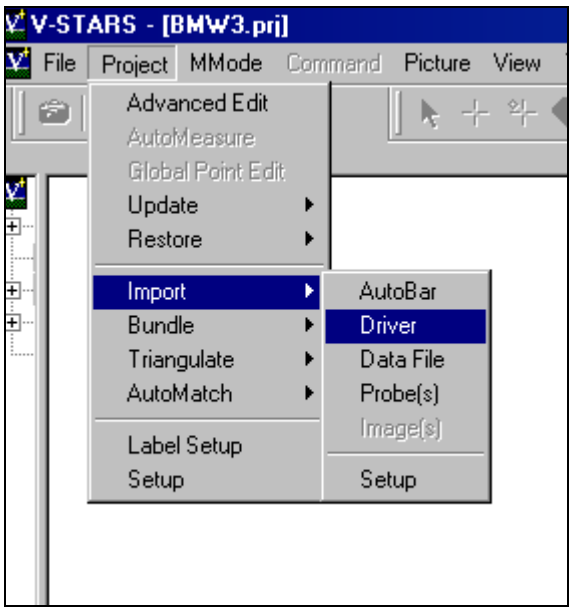
You will now need to import a driver file to the project. This file will contain the control point data that will be used to locate the camera position upon firing.

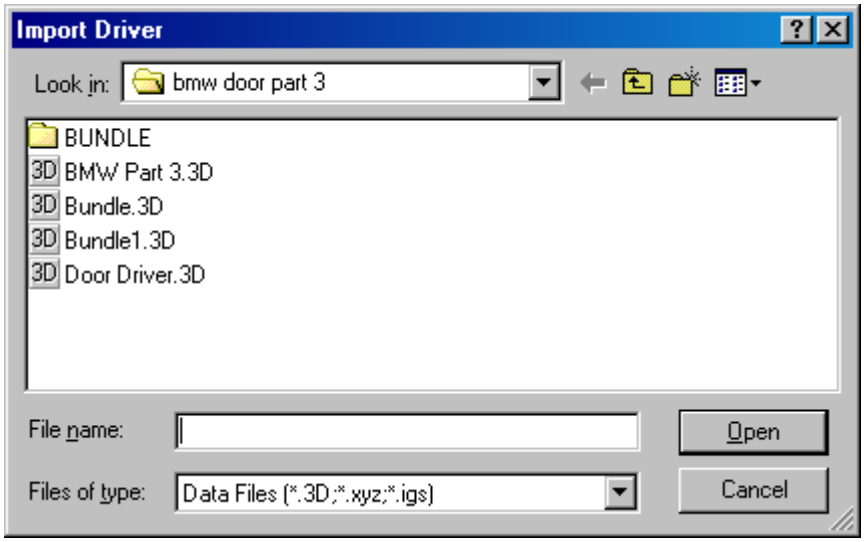
Importing Driver Files

Driver files can be imported in a number of ways. The method used will largely depend on your preference. The driver files that can be imported are **3D**, **XYZ** or **IGES** files. Refer to the V-STARS/S Manual for an explanation of how to import a driver file. For convenience, one of the more common techniques is shown below.

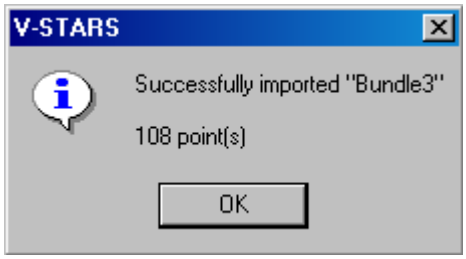
Import Driver from Project Menu

The **Import** command opens the following dialog. Select a 3D, XYZ or IGES file to import it into the project and set it as the current driver. If this file is in the "XYZ" format V-STARS will prompt you for the files units.





A summary of the imported points is shown and the file is added to the project as the driver.



Once a driver file has been selected, we are ready to enter M Mode.

Entering M Mode

Before starting M Mode let's verify that the cameras and V-STARS are communicating. If the cameras are correctly connected, the M icon, at the top of the screen in the toolbar area, will be visible. If the icon is dimmed out then there is a problem with the network or the manner in which the project has been set up. For example, verify that two cameras are present. Please refer to the Network Troubleshooting section for more information.

Also, ensure that the target exposure has been correctly set. Please refer to the section on Exposure for more information.

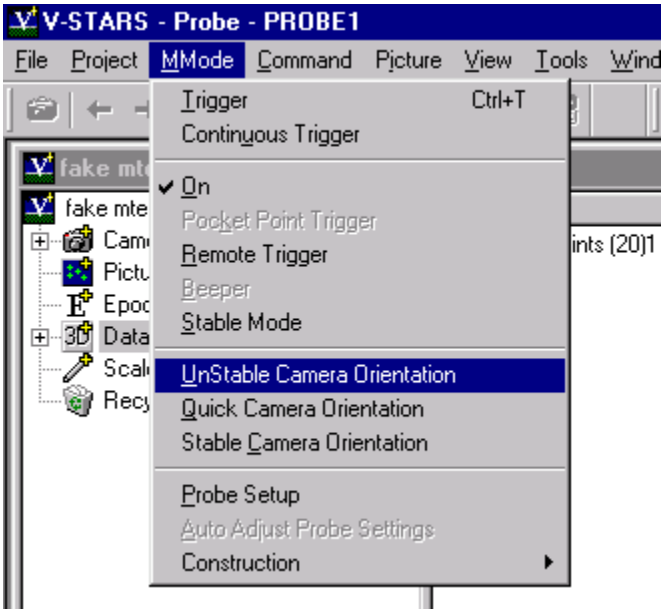
Unstable Camera Orientation

The Unstable Camera Orientation is a convenient, one-step procedure for orienting the cameras in M mode. It also incorporates a camera calibration procedure that produces significantly higher accuracies (30% better typically). **It is strongly recommended that this procedure be adopted as standard practice when working in Unstable Orientation mode.** Before the addition of Unstable camera orientation, it was commonplace to enter M Mode by clicking on the M icon and completing a number of tasks manually.

The Unstable Camera Orientation procedure is far easier to use than the old procedure. It is implemented in much the same way you enter M Mode, but most of the functions are automated for you. Follow the instructions below.

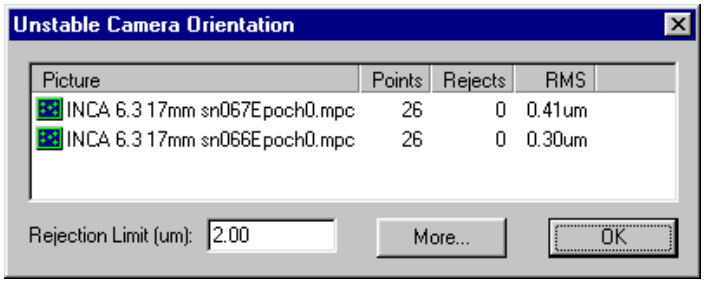
1. Go to the **MMode** menu and select **Unstable Camera Orientation**
2. The system will automatically complete the following tasks: -

a. Take a photo from each camera.
b. Complete a SuperStart for each photo.
c. Report the results to a dialog box.

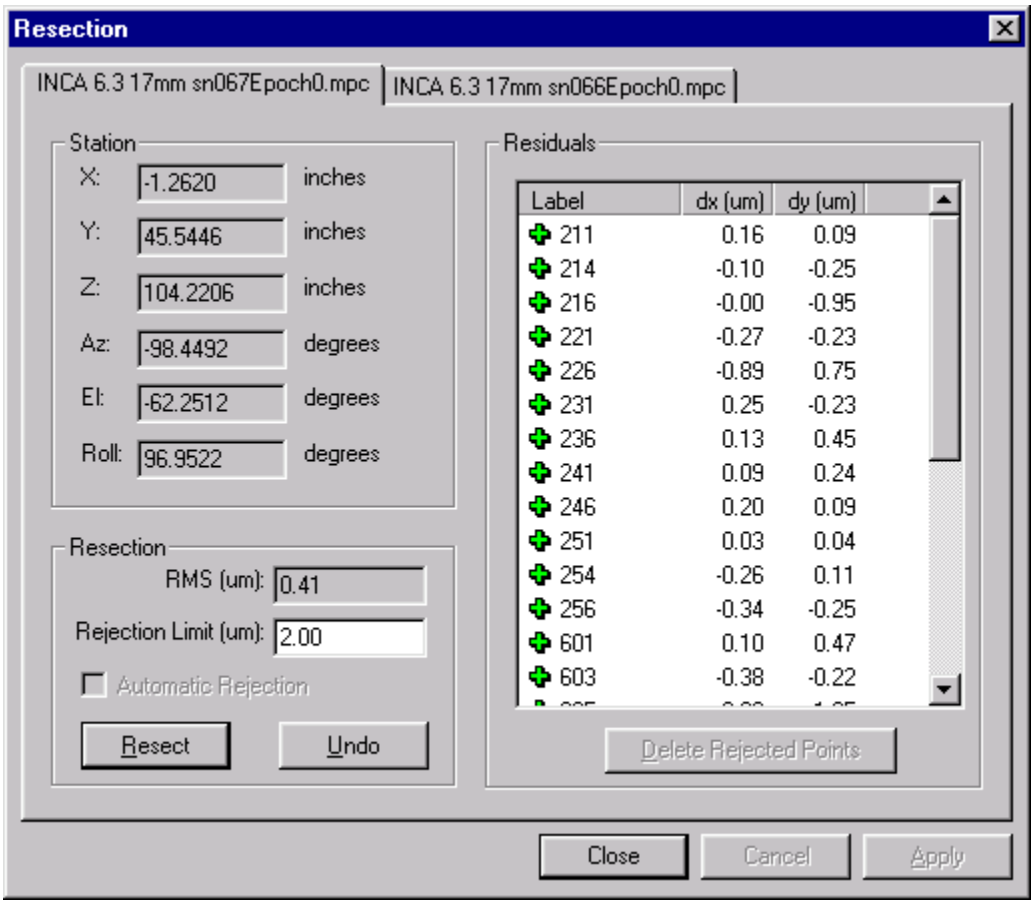


3. The results will be outputted to a window similar to the one shown below.

4. If the results are acceptable click **OK**. Typically, the RMS value for each camera should be less than 0.50µm. In addition, the number of rejected points should be low.



5. If you desire click the **More** button to view the resection results for each camera.



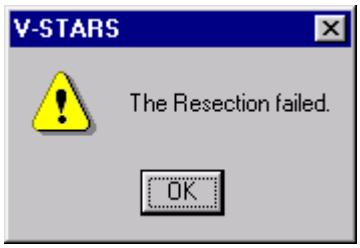
6. If they aren't acceptable, refer to the Unstable Orientation Troubleshooting section.

After you have done the orientation for the cameras, V-STARS will automatically do the orientation each time a measurement is made. This means the orientation will be recalculated each time so slight movement of the camera is fully accounted for and of no consequence.

If the camera movement is too large, the orientation will have to be repeated.

Unstable Orientation Mode Troubleshooting

Unacceptable resections are due to either poor accuracy for the control points in the driver file, or a poor starting camera calibration. Unacceptable resections are indicated by a large number of points being rejected. Alternatively, in cases where there are severe problems with the control and/or cameras, the following dialog boxes may appear.



Usually, the best way to determine which of these two situations is causing the problem is to use the table below.

CASE	Camera 1	Camera 2	Conclusion
1	RMS < 0.50µm	RMS < 0.50µm	OK to proceed
2	RMS > 0.50µm	RMS < 0.50µm	Check Calibration for Camera 1
3	RMS < 0.50µm	RMS > 0.50µm	Check Calibration for Camera 2
4	RMS > 0.50µm	RMS > 0.50µm	Check control field and both cameras
5	High point rejection	High point rejection	Check control field and both cameras
6	High point rejection.	Minimal or none	Check Calibration for Camera 1
7	Minimal or none	High point rejection	Check Calibration for Camera 2
8	Failed to Orientate	Failed to Orientate	Check camera strobes and lens caps.

CASE 1

The cameras have successfully passed the resection and orientation. This indicates that both the control field and camera calibration are acceptable.

CASE 2 & 3

If only one camera's results are unacceptable, the starting camera calibration for that camera is probably too inaccurate for the procedure to work. In this case, you should follow the procedure below.

1. Adjust the resection rejection limit. Right click on one of the image windows and select **Resection**. Change the resection value to 10μm.
2. Click the M icon M to get out of M-mode.
3. Go to the **MMode** menu and re-select **Unstable Camera Orientation**
4. Once again, check the results. Change the resection back to 2μm and repeat steps 2 and 3. If the results are now acceptable click OK.
5. If the results are not acceptable then it will be necessary to recalibrate the camera(s) failing the resection. Refer to the V-STAR/S User Manual for instruction on how to do this.

CASE 4

If both cameras have failed the resection test then it is more than likely due to the control field. In this case, you should make sure you have the correct values for the control points. If this does not rectify the problem then you will need to re-measure the control points.

CASE 5

Rejected points from both cameras is indicative of a weak control field. If the same points are rejected then this indicates that these points have moved. Remove these from the Driver file and start the Unstable procedure again.

CASE 6 & 7

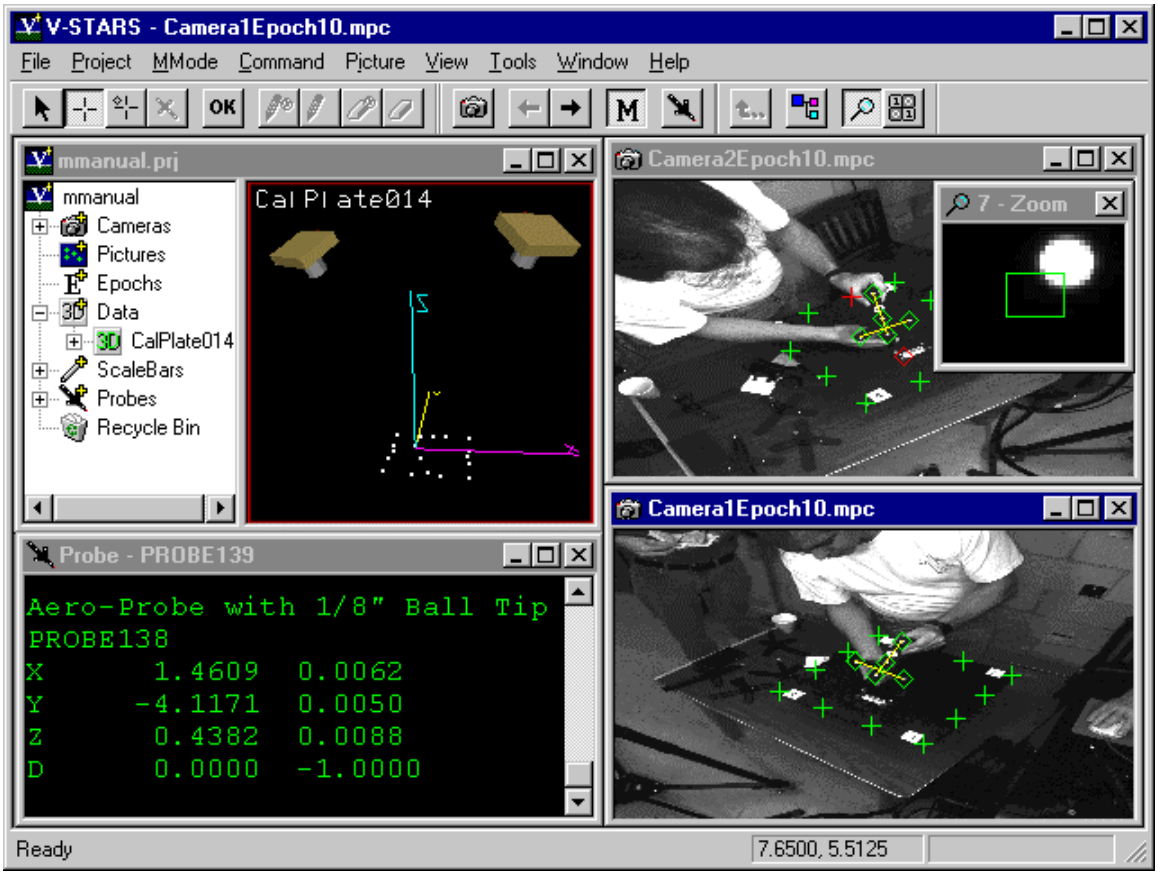
A high number of point rejects from one camera indicates a poor calibration. Follow the instructions in CASE 2 & 3

CASE 8

A Failed to Orient dialog might indicate that one or both of the camera strobes are switched off. Check both lens caps have been removed.

The V-STARS/M Windows

When a V-STARS/M project is started, the display will look similar to that shown below.



V-STARS displays a menu bar, several toolbars, and several windows that are initially blank but will eventually contain different information about the project. You can move, resize, minimize, or maximize these windows if you desire. The display can be divided into several areas. These are:

1. The Menu Bar
2. The Tool Bars
3. The Project View Window
4. The Picture Windows
5. The Zoom Window
6. The Probe Window

Most of the Toolbars and windows will be familiar to you from the single camera work you have done.

Menu Bar

The menu bar is used to select commands, and control the V-STARS measurement process. The menu bar is identical to the one used in V-STARS/S projects. However, some new features are available that apply only to V-STARS/M projects, and, conversely, there are some features used only for V-STAR/S projects that no longer apply. Most of the new menu selections specific to M projects are under the **MMode** menu. Selections that are not used in M-Mode are displayed in gray (commonly called "grayed out" selections). The use of the menu bar is described in more detail throughout the manual.

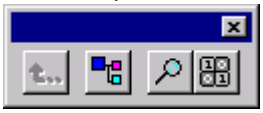
Tool Bars

V-STARS has four main toolbars.

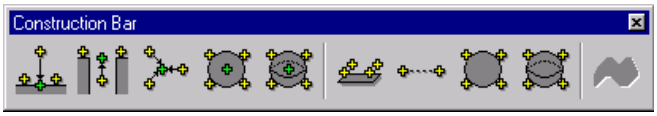
The Pictures Toolbar is used to access and take pictures.

The Cursors Toolbar selects different point selection and measuring modes. Refer to the main V-STARS/S manual for an explanation of the functions of the various icons.

The View Toolbar selects different viewing options. Refer to the main V-STARS/S manual for an explanation of the functions of the various icons.



The Construction Toolbar is used to create point entities while probing online.



The toolbars are identical to the ones used in V-STARS/S projects. The icons that do not apply in M-Mode are grayed out. Where applicable, a brief description of each toolbar is provided. Further descriptions can be found in the main V-STARS manual. The relevant M toolbars are described in more detail throughout the M Mode manual.

Picture Toolbar

The Picture Toolbar is used to take and access pictures.

To take a picture from the currently selected camera, press the Picture from Camera button. The title bar of the currently selected camera's Picture Window will be highlighted. To change the currently selected camera, click anywhere in the camera's Picture Window

The Next and Previous picture commands are not available in M Mode so these buttons are grayed out.

The M mode button is used to switch from M mode (multiple camera) to S mode (single camera).

The trigger mode button is used to trigger a measurement from the computer.

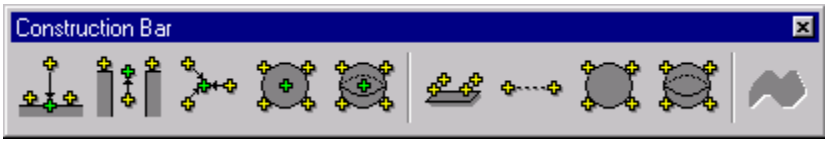
Cursors Toolbar

Refer to the main V-STARS/S manual for an explanation of the functions of the various icons.

View Toolbar

Refer to the main V-STARS/S manual for an explanation of the functions of the various icons.

Construction Toolbar



Create a point on a plane when using a ball tip probe.

Create a point on a plane that is centered in a hole.

Make a point that is the average of two or more measurements.

Make a point by measuring a circle center.

Make a point by measuring a sphere center.

Create a best-fit plane

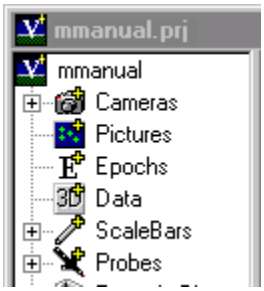
Create a best-fit line.

Create a best-fit circle

Create a best-fit sphere

Measure to a surface.

Project View Window



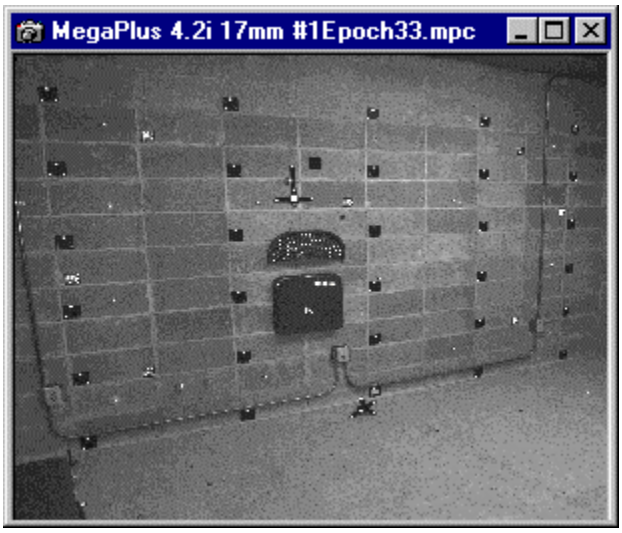
The Project View Window displays all the elements of the project in an organized hierarchical tree structure. By clicking on the nodes for each element, you can expand the node to see all the individual entities of that type. By clicking on each entity, you can see the data related to that entity. You can also right click on elements or individual entities to pop-up a menu of commands that are pertinent to that item.

Some of the more commonly used elements displayed in the project view are:

1. Cameras The cameras used in the project.
2. Data The 3D Data files used in the project.
3. Probes The Probes used in the project.

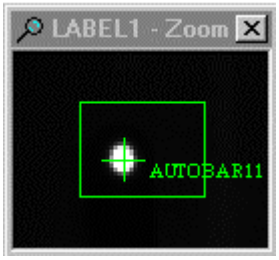
Picture Windows

The picture from each camera is displayed in a separate picture window. As with V-STARS/S projects, you can move, resize, minimize, or maximize the windows, as you like. In addition, you can change the contrast of each picture separately using the **Contrast** command. Only one picture is active at a time. To make a picture active, you merely have to click the mouse anywhere in the picture. The title bar for the active picture window will be highlighted.

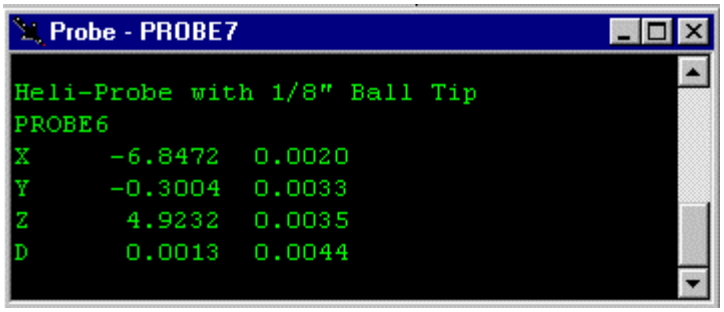


Zoom Window

The zoom window operates as in V-STARS/S projects. It is a "magnifying glass" into the active picture window. Again, as with V-STARS/S projects, you can move, re-size, minimize, or maximize the zoom window, as you like. You can change the contrast of the zoom window using the left and right arrow keys, and you can change the zoom magnification using the up and down arrow keys. The green rectangle in the zoom window is called the measuring window.



Probe Window



The results of probe measurements are displayed in the probe window. You can move, resize, maximize, or minimize this window, as you like. Probe measurements are saved into a 3D file. See Measuring Points with the Probe for a description of the contents of the window.

Triggering

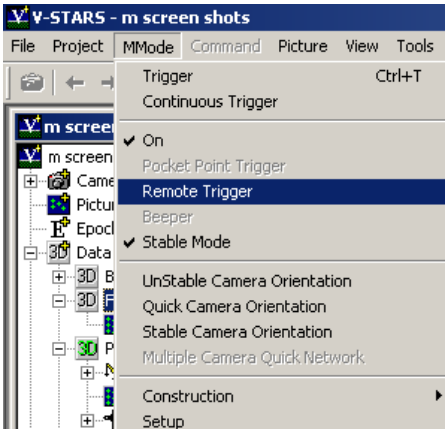
The system can be triggered using the V-STARS software trigger icon or the remote trigger supplied with the system.

If the remote trigger is going to be used, then it will be necessary to activate it. To activate the trigger go to the **MMode** menu and select the **Remote Trigger** menu item. If the optional radio triggers are being used then select the same menu item.

If the optional Pocket Point trigger is being used, then select the **Pocket Point Trigger** menu item.

If the remote trigger is not working, refer to the Troubleshooting section of the manual.

The Pocket Point and optional radio trigger are immune to false triggers caused by spurious light sources.



The system can also be placed in **Continuous Trigger** mode. In this mode, the system will trigger automatically at a defined time interval. To change the interval time, select **Advanced Edit** from the **Project** menu. The Advanced Edit dialog box will appear. Click on the **General...** button in the Parameters area of the dialog and the General Parameters dialog box will appear. Type in the desired time (in seconds) in the **Continuous Trigger Delay** field. Then, click on the **OK** button.

Moving the System

If you move the system….

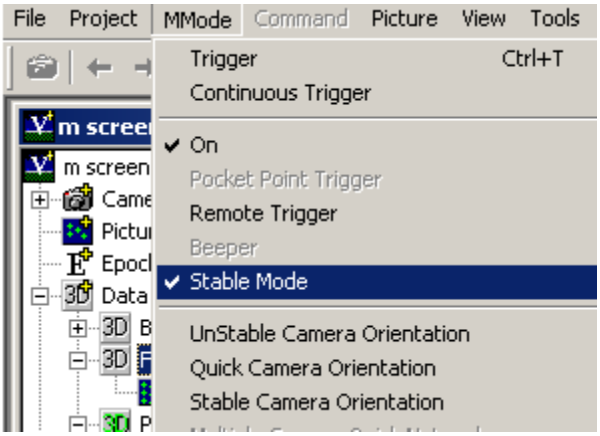
1. Click the M icon to get out of M-mode.
2. Move the cameras.
3. Point the cameras.

Go to the **MMode** menu and select **Unstable Camera Orientation** to repeat the Unstable Camera Orientation procedure.

Stable mode

It is possible to temporal place the system in **Stable Mode** (under **MMode** menu) even though you are in Unstable Orientation. Stable mode is very useful in cases where you are physically blocking too many targets to get a good resection. V-STARS will continue to use the camera orientation parameters established before entering Stable mode.

Points collected in this mode are stored in a separate folder in the probe file. The points must be **Moved to Measured** (Right click on Probe folder 3D**)** before they will be visible in the current probe folder. To enter **Stable Mode** simply activate it from the **MMode** menu. To move the points ✤ to measured, open the current probe folder 3D and right click on the 3D folder in it. Select **Move to measured**.



Naturally, in this mode, the cameras are assumed completely stable.

Exposure

Setting the Exposure

After aiming the camera, it is important to set the exposure properly. You must set the exposure for both the background and the targets. Normally, you want to underexpose the background and expose the targets so they are bright. This makes finding and measuring targets fast, easy, and reliable.

Background Exposure

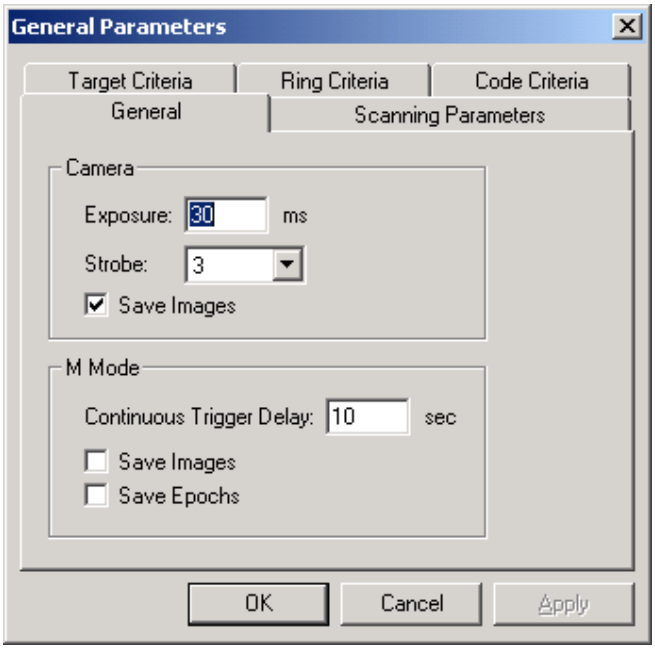
The background exposure is largely determined by the shutter time (the strobe may have some effect especially as you get closer to the object). To change the shutter time, select **Advanced Edit** from the **Project** menu. The Advanced Edit dialog box will appear. Click on the **General...** button in the Parameters area of the dialog and the General Parameters dialog box will appear. Type in the desired exposure time (in milliseconds) in the Exposure field. Then, click on the **OK** button.

The **General** command opens the following **General Parameters** dialog.

Exposure - When a camera is online the camera exposure can be set from the camera dialog.

Strobe – If the camera is online and a Remote Camera Strobe (RCS) is in use, the strobe power can be set.

Save Images – In online mode images are saved if the Save Images box is checked.



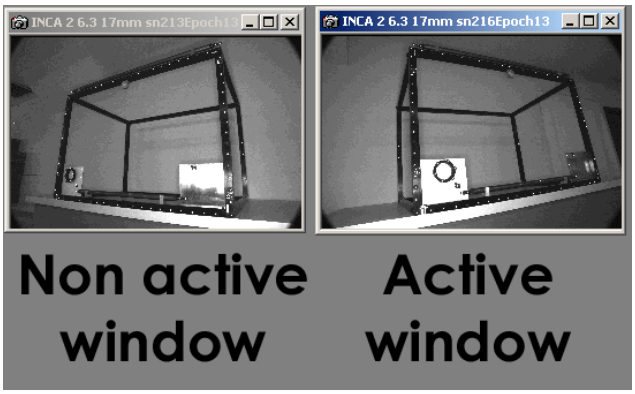
You should not set the exposure time to less than 30 milliseconds or else you may lose flash synchronization.

We recommend the smallest acceptable shutter time be used to keep the background subdued. This makes the targets easier to find and measure. You can then increase the picture contrast using the **Contrast** command.

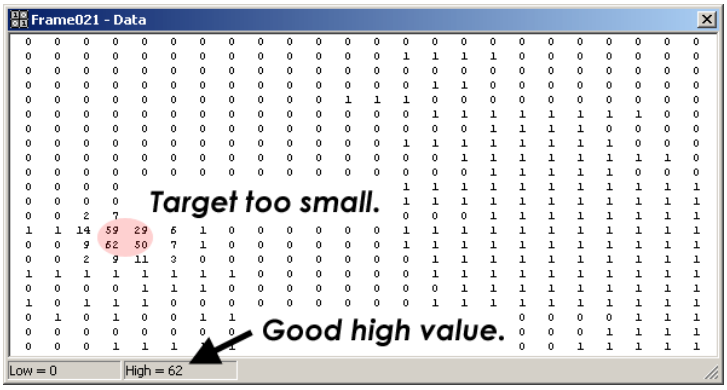
Exposing the Targets

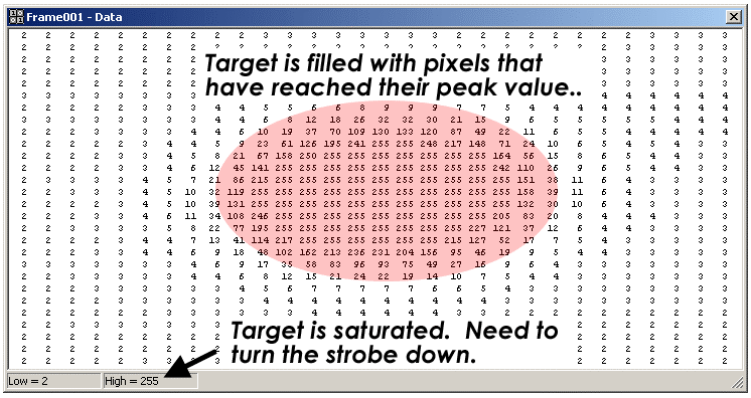
The target exposure is completely determined by the strobe setting because of the retro reflective nature of the targets. If you set the strobe power too low, the targets farthest from the camera will usually be dim and hard to measure. If you set the strobe power too high, the targets closest to the camera will usually be overexposed and the accuracy will be reduced.

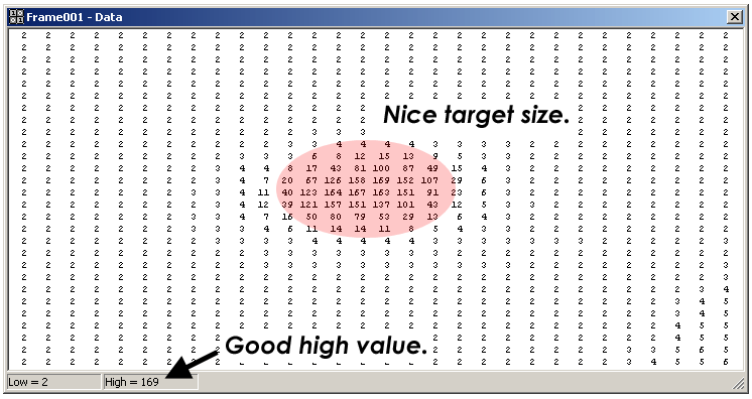
Proper target exposure always allows the dimmest targets to be measured while not overexposing the brightest targets. We recommend the following steps for setting the strobe level for each camera:

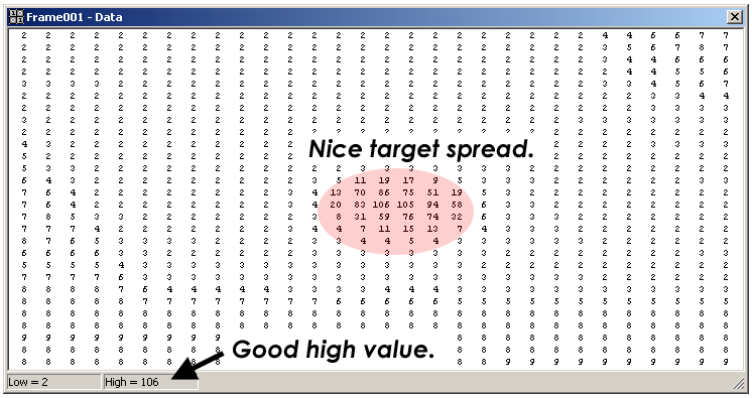


1. With the camera properly aimed, set the strobe power to 0, and take a picture. This can be done by pressing the icon. The active camera will fire. The active camera is the one that has its image window active. (Title bar will be blue). To take a picture from the other camera, click on its image window. It will then become the active camera.
2. Set the Zoom Window Contrast to 1 using the arrow keys. You may also want to enhance the picture brightness to make the targets easier to find using the Contrast command.
3. Switch on the Data window using the icon.
4. Check the dimmest target (usually the one farthest from the camera) by bringing it into the zoom window and reading the pixel values in the data window. Use the images below as a guide for what is acceptable.
5. Check the brightest target (usually the one closest to the camera) by bringing it into the zoom window and reading its pixel values.
6. If the targets were too dim, increase the strobe setting by 1 and repeat the process.
7. Stop when you have a good balance.
8. Repeat the process for the other camera.


Frame021 - Data
Target too small.
Good high value.
Low = 0
High = 62


Frame001 - Data
Target is filled with pixels that have reached their peak value..
Target is saturated. Need to turn the strobe down.
Low = 2
High = 255


Frame001 - Data
Nice target size.
Good high value.
Low = 2
High = 169

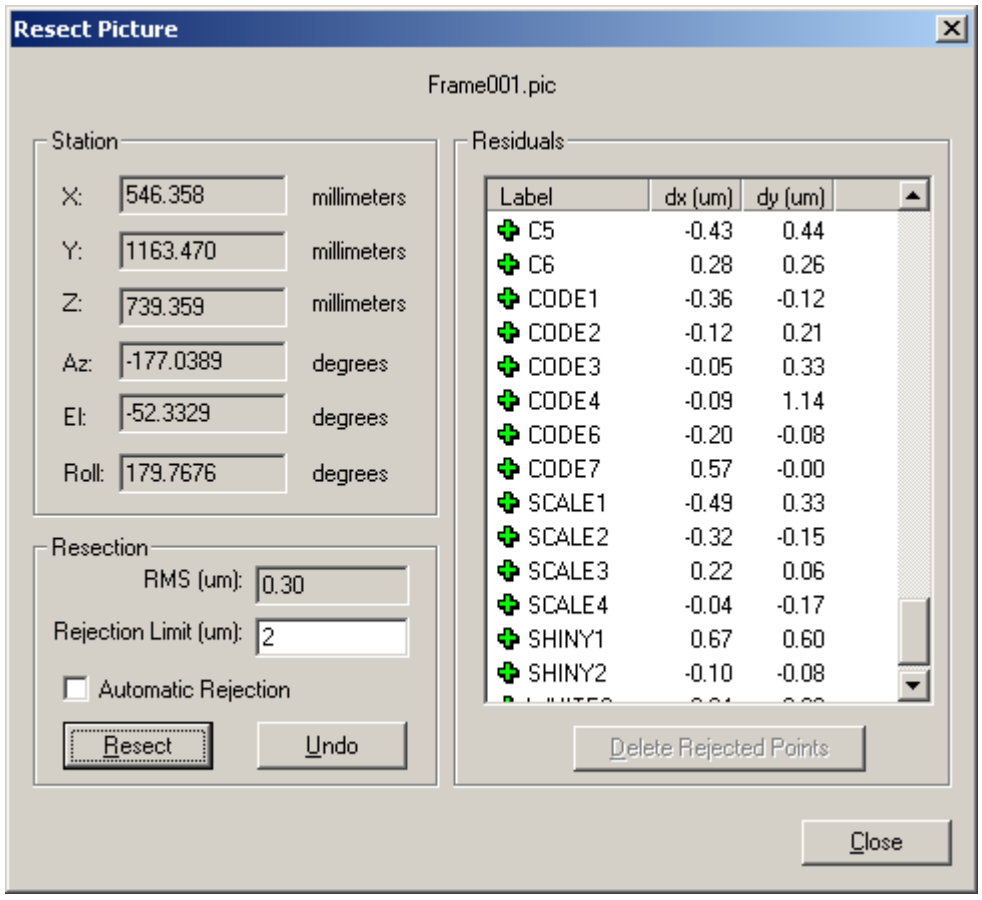

Frame001 - Data
Nice target spread.
Good high value.
Low = 2
High = 106

Checking the Camera Orientation

Camera Resection

After orienting the camera, you can check the orientation quality and filter out any poor measurements. This is especially important in M mode because points may become partially blocked as the cameras move or as the probe is positioned in the measuring area. A partially blocked target that is not filtered out can degrade the camera orientation and reduce accuracy.

To check the orientation, select **Resect** from the **Picture** menu or right click in the picture and select **Resect**. A dialog box similar to the one shown below will be displayed.



If it is not already done set the **Rejection Limit** to 2 Microns. Then, press the **Resect** button to perform a Resection using all the successfully measured control points. The Rejection Limit value is used to filter out bad measurements. Points with residuals above the rejection limit will be automatically removed from the Resection. The point residuals for the individual points are displayed in the list box. Any rejected points

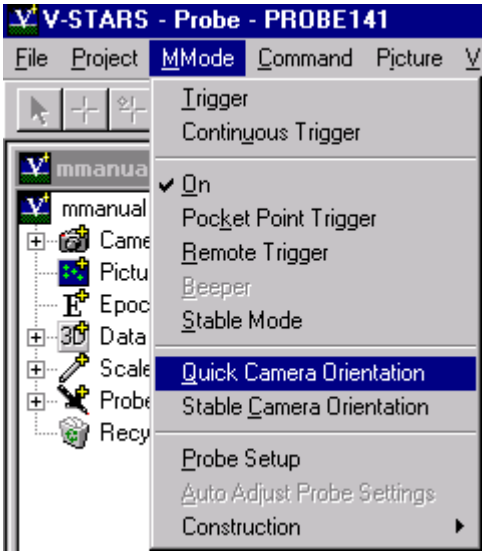
are displayed at the top of the list with a red bar . It is OK if one or two points are removed. However, if more than two points are rejected, you should consider the resection unacceptable.

The RMS of the residuals for all non-rejected points is displayed in the box. The RMS value indicates the quality of the Resection. A smaller RMS value indicates a better Resection. A typical value for the RMS is 0.5 microns or less. A value higher than this usually indicates an unacceptable resection. If you get the message "Resect error", the Resection is unacceptable.

Unacceptable resections are due to either poor accuracy for the control points, or a poor camera calibration. Usually, the best way to determine which of these two situations is causing the problem is to compare the results from both camera orientations. If both are unacceptable, the problem is probably with the control points (especially if the same points are rejected for both cameras). In this case, you should re-baseline the control points. If only one camera's results are unacceptable, the camera calibration for that camera is probably inaccurate. In this case, you should re-calibrate the camera before proceeding. See the V-STARS/S manual for information on how to recalibrate the camera.

Quick Camera Orientation

Introduction



The Quick Camera Orientation procedure is used to quickly establish a set of control points. These control points are then used to operate V-STARS in unstable mode whereby on-line measurements can be made using the probes. Using Quick Camera Orientation, just as in Unstable Orientation Mode, you do not need to worry about camera movement during the measurement. Tripod dollies and electronic pan-heads may be used.

The quick camera orientation is fast and easy to setup. However, it is not as accurate as establishing the control points through an S-Survey. In general, accuracies with the quick camera orientation are 10-30% worse than when using an S-Survey to establish the control points. This is because the coordinates of the control points are not established as accurately.

It is important to know that after the quick orientation procedure, measurements are in the local coordinate system of the AutoBar. To align to a desired coordinate system, known features must be probed that define the desired coordinate system.

The quick camera orientation procedure consists of the following steps: -

1. Attaching the targets, including the scale bar, to the object.
2. Exposing the targets.
3. Running the Quick Camera Orientation.
4. Checking the Quick Camera Orientation.

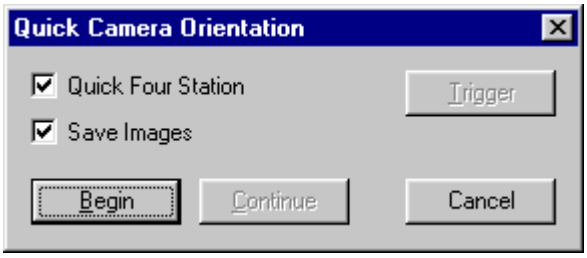
There should be a minimum of twenty well-distributed coded targets on the object (By providing at least twenty points we are ensured redundancy.) Any points that accidentally move or that are damaged during the measurement can be automatically detected. More importantly, there remain enough points to continue the measurement without the affected points.

Once again, we qualify the number of points with the term well distributed. The distribution of the points is much more important than the number of points.

After the quick orientation is completed, the AutoBar and scale bar may be removed. This is usually done, however, if they are suspected of moving during the measurement or if they are obstructing the measurement.

Running the Quick Camera Orientation

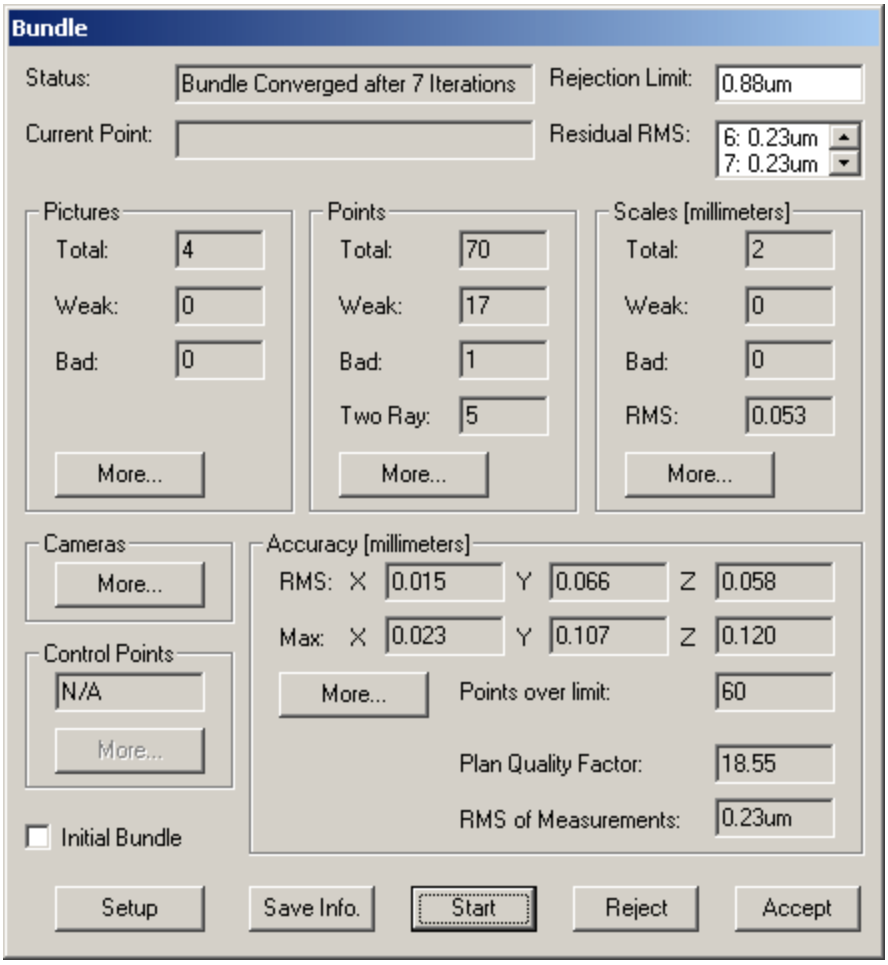
To run the Quick Orientation procedure, select **Quick Camera Orientation** from the **MMode** menu. The dialog box shown will appear.



You can select whether or not to save pictures (pictures are normally saved so you can review them if a problem is found). Then, press the **Begin** button to start the Quick Orientation. The Quick Orientation will then take a picture from each camera sequentially, and then take a second picture from each camera. After the four pictures are taken, a Bundle adjustment will be run to calculate the coordinates of all the points. You can check the results to see if they are acceptable as described in the next section.

Checking the Quick Camera Orientation

After the Quick Orienting procedure runs the Bundle Adjustment, a Bundle Summary Dialog similar to the one shown below should appear.



The units for the example measurement are in millimeters.

To check the quality of the orientation, do the following:

1. Check if any points were deleted. Points are deleted if they are not successfully measured in all four pictures. A point is usually deleted because it was not measured on one or more of the pictures. Usually this is because the target was unable to be measured satisfactorily. You can click on the **More** button in the Points area to see which points were deleted. It is generally OK to lose one or two points, but if more are lost, you should investigate. In addition, you should investigate if any of the scale bar points are lost. Finally, you should make sure you have enough total points (taking into account any

deleted points) for a good orientation. In the example above, there are 70 total accepted points. Since six of these were on the AutoBar, and four more were on the scale bar, this leaves only 60 individual and coded targets. We normally want at least 12 individual coded targets. Based on this criterion, this orientation is acceptable.

2. Check the scale points. There should be at least two total scale measurements, and none should be deleted or weak. In addition, the RMS of the scales should be less than 0.1mm. You can click on the **More** button in the scale section to get more information on the scale bar points. Usually, a scale point is deleted because it was not measured in one or more of the pictures. The point may have been blocked, or may have been too dim to be measured. If any scale measurements are lost, you should reject the quick orientation, and correct the problem before re-doing the orientation.

3. Check the RMS of Measurements (in the bottom right corner of the box) This number indicates the overall quality of the orientation. The lower the number, the better the orientation. A value of less than 0.25 is typical for a good orientation. A value of more than 0.25 indicates something is wrong with the orientation. Usually, a large RMS is caused by one or more of the cameras having a bad camera calibration, or by one or more of the targets being damaged.

4. Check the RMS Accuracy Estimates. If the RMS Accuracy estimates are greater than 0.05mm for any coordinate, something is wrong with the orientation. Usually, a large RMS is caused by one or more of the cameras having a bad camera calibration, or by one or more of the targets being damaged. You can click on the **More** button in the Accuracy section to get information on each point's accuracy.

If the orientation is unacceptable, press the **Reject** button. Then, inspect the pictures to find the source of the problem. If any targets appear damaged, you will have to replace them and re-do the orientation. If nothing is apparent, re-check the exposure of the targets, and re-do the orientation. If you still get a poor orientation, one or more of the cameras may need to be re-calibrated. Refer to the main V-STARS/S manual for information on how to calibrate a camera.

Once you have an acceptable orientation, press the **Accept** button, and V-STARS will use the camera orientations for all subsequent measurements.

Once you have done this, execute the Unstable Camera Orientation as you would normally. Refer to the Unstable Camera Orientation section for information on how to do this.

Stable Orientation

Introduction

When a stable field of control points cannot be used, the system can still be oriented. A targeted bar (Stable Orientation Bar or S.O.B) approximately one meter long is available for orienting the cameras. The operator moves the bar to several places in the scene and the bar is measured. Then, a quick orientation of the cameras is performed.

The cameras must not move during the measurement so it is important that the cameras be rigidly mounted, and be made as immune as possible to external vibration or disturbances. In this mode, we recommend placing the tripods directly on the floor; do not use the dollies. Also, use as wide a base as possible for the tripod, keep it as low as possible, and retract the tripod elevator column as much as possible. Make sure to securely tighten all the locking mechanisms on the tripod. We also recommend using the mechanical pan heads instead of the electrical ones if possible, because they are more rigid.

If the cameras do move during the measurement, you must redo this orientation procedure, however, after doing so, you can usually resume measuring where you left off. You do not usually need to re-measure points.

The procedure uses a calibrated bar approximately one-meter long that has four coded targets attached to it. The cameras are oriented by moving the Stable Orientation Bar to several locations throughout the viewing area, and measuring it.

Instead of using the Stable Orientation Bar, you can use a probe to perform this orientation procedure. However, the probe is too small to provide accurate scale for the orientation. Still, in some cases, accurate scale may not be needed, or scale may be provided by the user coordinate system.

The stable orientation procedure consists of the following steps.
1. Setting the exposure
2. Measuring the Stable Orientation Bar
3. Checking the Stable Camera Orientation

Exposing the Stable Orientation Bar

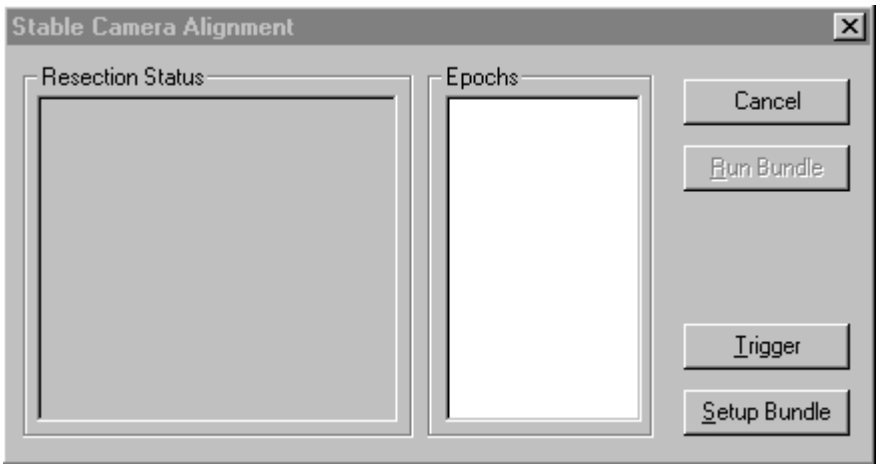
Before measuring the Stable Orientation Bar, we must first set the exposure correctly for the targets on the bar. The targets on the bar are exposed in the same manner that regular targets are exposed. Refer to the Exposure section of the manual for more information.

For most situations, a strobe setting of 1-2 is appropriate.

Measuring the Stable Orientation Bar

After properly exposing the Stable Orientation Bar, it can be measured to orient the camera. For a good orientation, the Orientation Bar should be measured at least ten times, and the bar should be placed at several locations that fill out the entire scene. If you plan to use the remote trigger, you must first enable it, by selecting **Remote Trigger** from the **MMode** menu.

To measure the bar, select **Stable Camera Alignment** from the **MMode** menu. The dialog box shown below will appear.



]

For the first measurement, we recommend you place the bar in the middle of the scene, and aim it between the cameras. Then, measure the bar by either pressing the **Trigger** button in the dialog box or by using the remote trigger. Each time the bar is measured successfully, the system beeps once and marks the bar in green in each picture as shown in the adjacent images.

If the bar was not measured, the system beeps twice. The bar will not be marked in the picture(s) where it could not be measured.

Check the picture windows to see what the problem is and correct it.

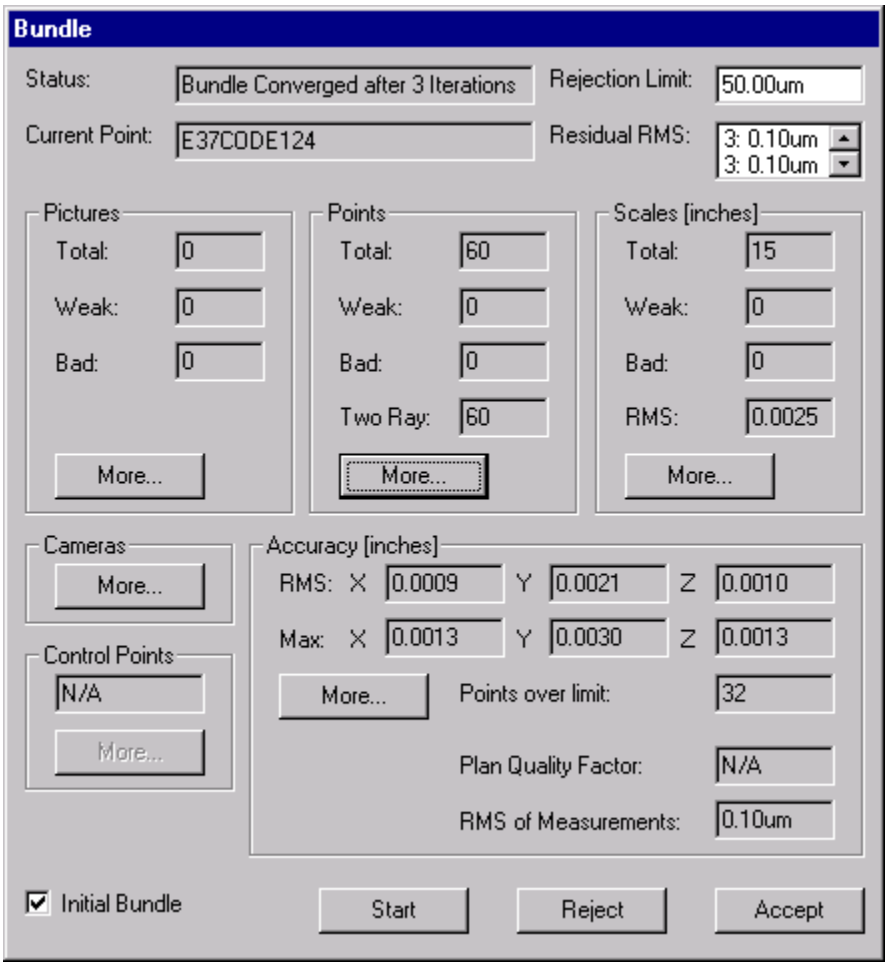
Often, the bar may not be completely in the picture, or the bar may be tilted away from one or more of the cameras so the targets cannot be seen. V-STARS provides several visual cues to indicate what may be wrong. V-STARS uses the same techniques to measure the orientation bar and the probes. (The orientation bar is actually treated just like a probe. In fact, you can even use a probe to orient the camera). Therefore, if you are having trouble measuring the Stable Orientation Bar, refer to the Troubleshooting section for instructions on how to diagnose and correct the problem.

If you need to determine why the bar is not found, you will have to exit the Stable Orientation Procedure by pressing the **Cancel** button. After you have fixed the problem, you can redo the Stable Camera Alignment.

The bar should be placed throughout the scene. Try to place the bar so it fills out the entire measuring area. After you have measured the bar, ten or more times, you can orient the cameras and check the quality of the camera orientation

Checking the Stable Camera Orientation

After measuring the orientation bar successfully at least ten times, press the **Run Bundle** button. V-STARS will run a Bundle Adjustment to produce the orientation for the cameras. When the Bundle Adjustment is done, a Bundle Summary dialog box similar to the one shown below will be displayed.



To check the quality of the orientation, do the following:

1. Check the RMS of Measurements. This number indicates the overall quality of the orientation. The lower the number, the better the

orientation. A value of less than 0.25 is typical for a good orientation. A value of more than 0.30 indicates something is wrong with the orientation. Usually, a large RMS is caused by one or more of the cameras having a bad camera calibration, or by one or more of the bar targets being damaged.

2. Check the RMS of scale measurements, and the Accuracy Estimates. The RMS should be similar to the point accuracy estimates. If the Scale RMS is more than twice the largest point accuracy estimate, something may be wrong with the camera orientation. One or more of the cameras may have a bad orientation, or one or more of the bar targets may be damaged.

If the orientation is poor, press the **Reject** button. Then, inspect the orientation bar targets for damage. If any targets appear damaged, you will have to replace them and re-calibrate the bar before you can try the orientation again. If the bar appears to be OK, we recommend repeating the orientation again. If the orientation is still poor, you should re-calibrate the cameras, and then try the orientation again.

Once you have an acceptable orientation, press the **Accept** button, and V-STARS will use the camera orientations for all subsequent measurements. You are now ready to measure points.

If any of the cameras moves during the measurements, you must repeat the stable camera orientation procedure.

Points measured in this mode are stored in a special probe folder in the Probe 3D file. When you feel comfortable that your measurements are correct, the points in this folder can be moved to the measurement folder. To do this right click on the folder and select the **Move to Measured** command. Only move the points when you are confident that the cameras did not move during the measurement.

Measuring

Measuring Points

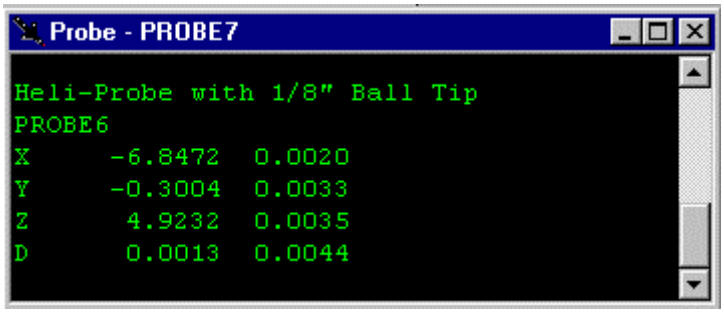
Once you have finished setting up the cameras, you can begin measuring points. You can measure individual targeted points; you can measure points with the probe (see Measuring Points with the Probe); you can even measure both triangulation points and probe points at the same time. No matter which type of point you are measuring, you must tell the system when to take a measurement. One way to do this is with the **Trigger** command under the **MMode** menu. Every time you select this command, the system will take a measurement. However, it is often more convenient to trigger the camera remotely (this is especially true when using the probe). See Remote Triggering for a description of how to do this.

Measuring Points with the Probe

Measuring with the probe is fast and easy. Simply use the probe and tip combination that is best suited for the point you want to measure. The system will automatically recognize the probe; there is no need to tell the system which probe you are using. Touch the point of interest with the probe tip (making sure that all five probe targets can be seen by both cameras), then, press the remote trigger switch to make a measurement.

Each time a probe point is successfully measured, the system beeps once and the probe window displays six lines of information in green that describe the probe measurement. The lines include:

Line 1) The type of probe measured and the probe tip used.
Line 2) The label of the probe point.
Line 3) The X coordinate of the probe tip and the X accuracy estimate.
Line 4) The Y coordinate of the probe tip and the Y accuracy estimate.
Line 5) The Z coordinate of the probe tip and the Z accuracy estimate.
Line 6) The distance from the last measured probe point and the distance accuracy estimate.



The label will automatically be incremented for the next probe measurement. To change the label, activate the probe window by clicking in it, and type in the new label.

You can scroll back through previous probe measurements using the window scroll bar.

If a measurement was unsuccessful, the window will display a message in red indicating why the measurement failed and the system will beep twice. A list of these messages and a description is provided below:

No Probe Found – The probe cannot be found; usually because all five of the probe targets cannot be measured by one or more of the cameras. Check the picture windows to see that all the probe targets are bright and completely visible. If they are, the targets will be marked with green diamonds. If the probe is not seen, move it so it can be seen and try again. If the probe appears to be visible, see Troubleshooting for other possible causes and solutions.

Resection Weak – Exterior orientation of cameras is weak. Try not to block the resection targets when probing. If the problem persists, consider going to Stable mode or moving the camera. Refer to the Stable mode section of the manual for more information.

Resection Weak (Probe Tip) – The probe accuracy estimates were large and unacceptable, usually because a false probe was found or because one or more probe targets was partly blocked. Check the picture windows to see if the true probe was found or try moving the probe a little to see if the blockage can be removed. The accuracy rejection limit can be set by the system operator.

Resection Failed – One or both camera orientations is bad. If you see many red crosses in either picture window, that camera has probably moved significantly and needs to be re-oriented. See Unstable Camera Orientation procedure for instructions on how to do this. See Troubleshooting for other possible causes and solutions.

STOPPED – V-STARS timed out waiting for response from cameras. Proceed as normal.

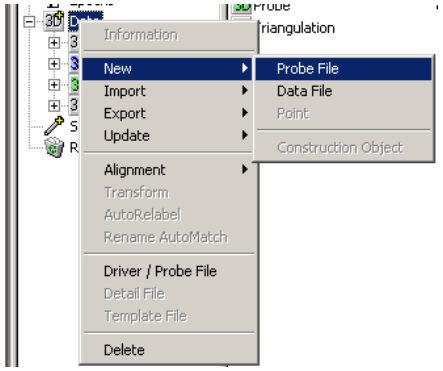
Network Error – Error in detected in INCA communication. Proceed as normal.

Probe rejected – The XYZ coordinated computed for the point exceeded tolerance limits. Retake point. If problem persists alter set up or in extreme cases, recalibration may be required.

Each probe measurement is also stored in a 3D file that you can select. You can store probe measurements in any 3D file. The icon for the active probe file is marked in yellow. Probe

To create a new file for the probe measurements, simply select **New**, and then select **Probe File**

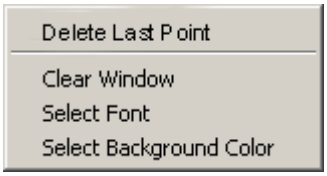
A normal 3D file can be made into the current probe file by simply selecting the **Driver/Probe File** option on the menu.



After you have setup a measurement and are measuring with the probes, you may want to re-size the probe window so you can see all the displayed information.

Right Click in the Probe Window

If you right click in the probe window you will be presented with the adjacent menu. From this menu you can clear the window, change the font, background color or Delete the last point measured.



Deleting the last point also resets the point label to the one that was just deleted.

Renaming the Probe File

V-STARS provides default names whenever a probe file is created. You may want to change the name of the file to make it more descriptive. To rename the Probe file do the following:

If the project view is not visible, select it by clicking on the Project View button.

1. Click on the 3D Data Node to see all the 3D files. Data
2. The current Probe file's 3D icon will be yellow. Probe
3. Click on the current Probe file. The file name will be highlighted. Probe
4. Click on the highlighted file name, to select it for editing Probe
5. Type in the new filename.

Making a New Probe File

By default, the probe log file is called PROBE. You can make a new Probing file anytime during a measurement. All subsequent probe measurements will be stored in the new Probe file. To make a new Probe file, do the following:

1. Right-click on the 3D Data Node.

2. Select **New Data File** from the pop-up menu.
3.

A new 3D file will be created with the default name highlighted. You can change the filename if you like by typing in the new file name.
4. Right click on the new file, and select **Probing File** from the pop-up menu.
5. The new 3D file icon will be marked in yellow to indicate this is the new Probing file. All subsequent probe measurements will be stored in this file.

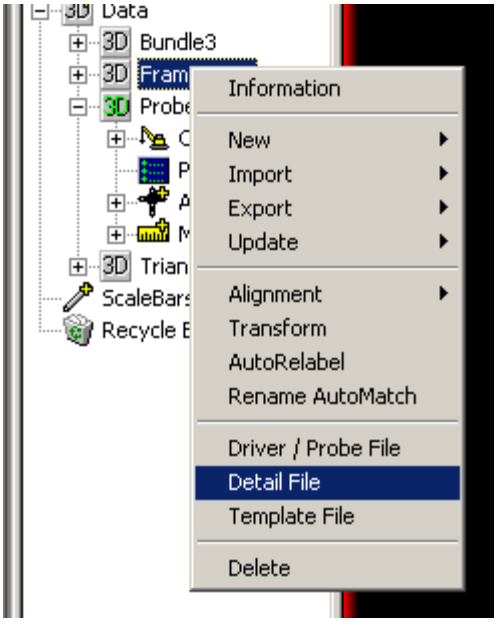
Detail Files

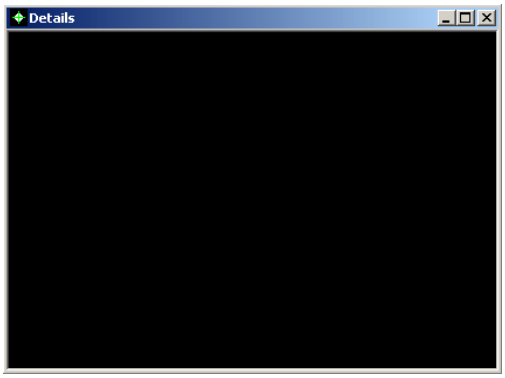
Introduction

When in V-STARS/M you have the ability to set a detail file. Put simply, a detail file is just a regular 3D file that has points you want to measure each time the cameras fire. These points could be points you wish to monitor or perhaps even build.

Setting a Detail File

To set a file as a detail file, simply hover over it with your mouse and right click. Select the Detail File option. Once selected the file will be displayed with a blue 3D icon . Once a detail file has been set, V-STARS will open a new window. This window is called the Details window. The deviations between the coordinate values in the Detail file and the actual values are reported to this window.





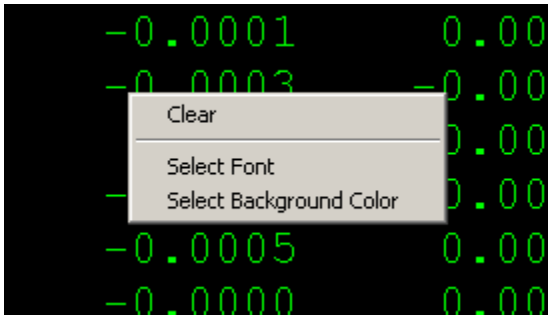
Using a detail file

Once the cameras trigger, V-STARS tries to measure all the points listed in the Detail file. If a point is successfully measured it is compared to its Detail coordinate. The difference is reported to the detail file. The measured coordinates are written to a Triangulation file.

If a point is not found then the points label is marked in red and listed as UNKNOWN. A point is considered UNKNOWN if it is physically missing or if it is beyond a certain closeness threshold. This is determined by the size of the zoom window.

If you right click in the Detail window you are presented with the following options.

You can clear the window, change the font, or select a different background color.



Construction Functions

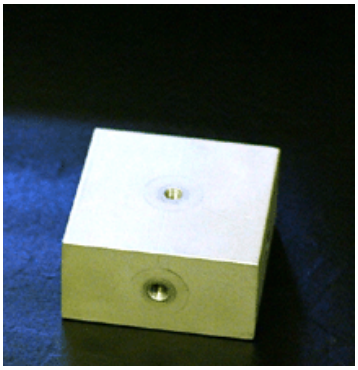
The construction functions are a handy way to create planes, circles, lines, and other features while in online mode.

The number of points to probe to define the feature is defined and can be changed at the probing stage. The RMS of the feature is displayed once the correct number of points have been probed. You can also undo the recent measurements if necessary.

Audible indications are given for various conditions such as feature created, point missed or feature rejected.

Planar Point

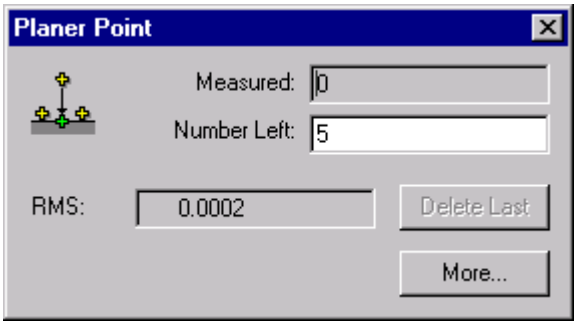
Use this feature to create a point on a plane surface. The plane that is created is used to compensate for the probe offset. The last point collected is used to define the compensation direction. It should be off the plane surface. For example in the case below, five points were collected. Four of these were on the plane surface. The fifth point was off the surface in the direction of the cameras.



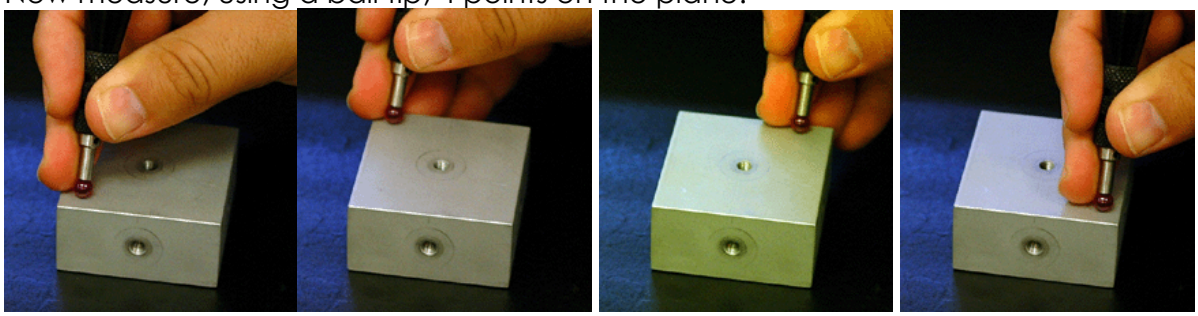
Consider the following example where we seek a coordinate of a point on the given plane.

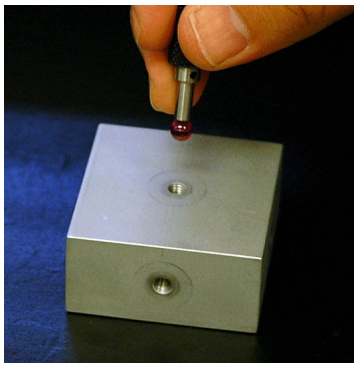
Begin by pressing the Planar Point Button

The following dialog will appear.



Now measure, using a ball tip, 4 points on the plane.

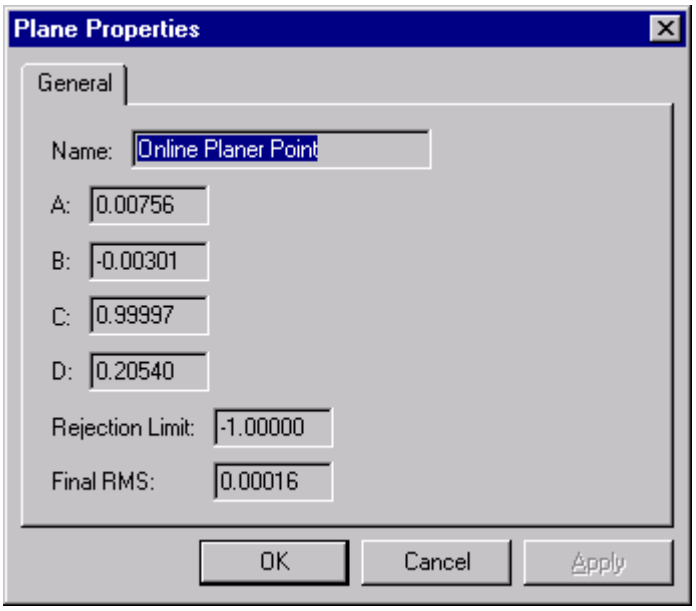




Lastly, Using the same ball tip, measure a point above the plane.

The calculated point is on the plane, directly below the last point taken

Click on the **More…** button to open a dialog that shows some of the additional parameters of the operation.

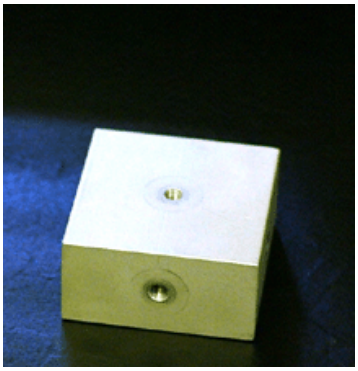


Planar Hole Point

Planar Hole Point

Use this feature to create a point in the center of a hole that is smaller than the diameter of the probe tip. Useful for measuring dimples on a surface.

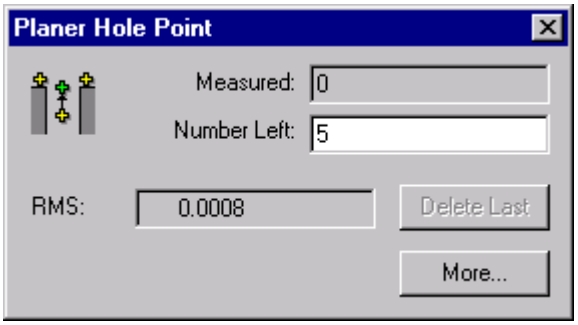
To measure the center of a hole in M-Mode, follow this procedure.

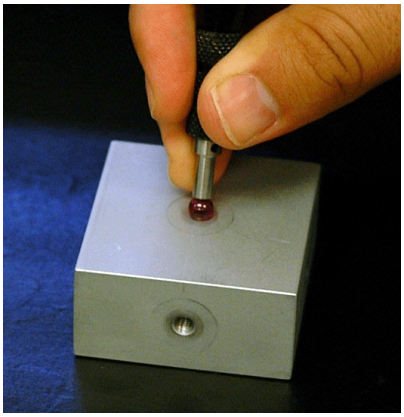


Consider the same block as the one in the first example.
However, this time we seek the XYZ location of the top-center of the hole.

Begin by pressing the Planar Hole Point Button

The following dialog will appear.



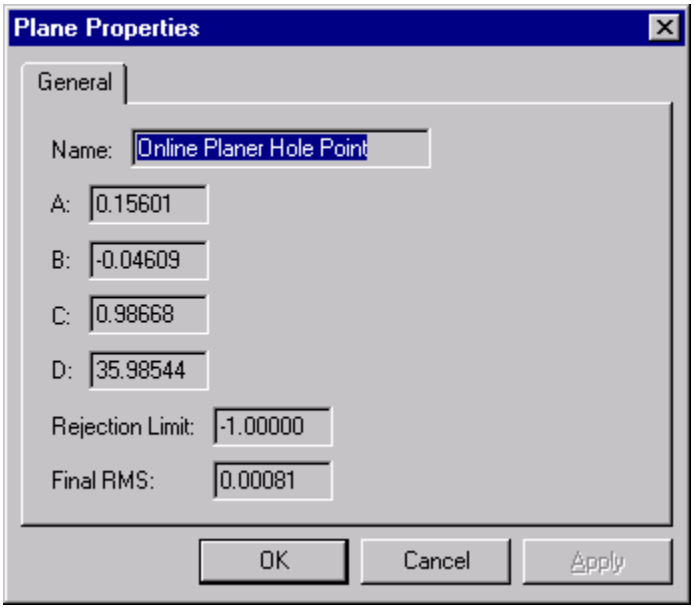


Measure the four points on the plane the same way in which we measured them in the first example.

For the last point, measure with the ball tip seated in the hole.

The calculated point is on the surface of the measured plane and in the center of the hole.

Click on the **More…** button to open a dialog that shows some of the additional parameters of the operation.



This procedure is only useful when measuring holes that are slightly smaller in diameter than the probe ball diameter. When measuring larger holes, use the circle point procedure.

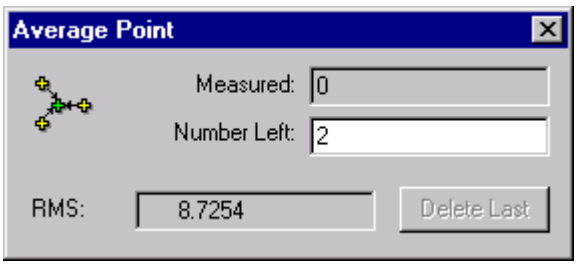
Average Point

Average Point has the following two usages:

- To find the midpoint between two points.
- To average many measurements of the same point thus improving accuracy.

In either case, the implementation is the same. Multiple points are measured and a single point is calculated from the average of the measurements.

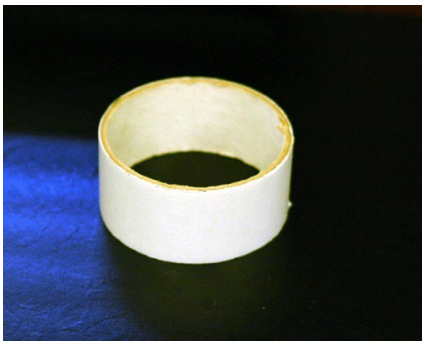
Press the Average Point button to begin taking an average point.



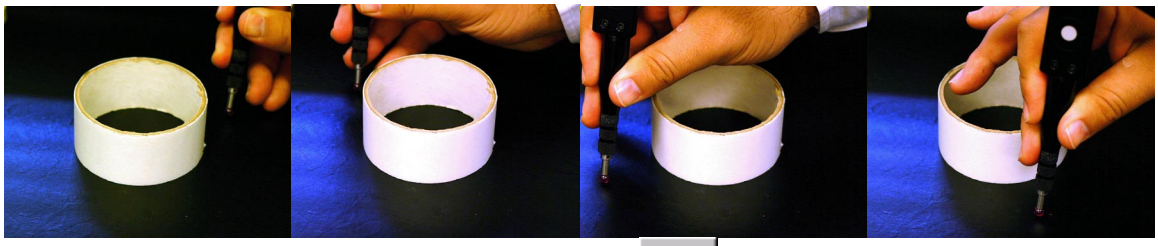
Circle Point

Use this feature to create the center of a circle. A plane parallel to the circle needs to be specified first. If the circle is not creatable then a dialog will appear to warn the user. Only the point is created. The radius and the RMS of the circle are also reported.

Consider the following example where we seek the XYZ location of the bottom-center of the hole.

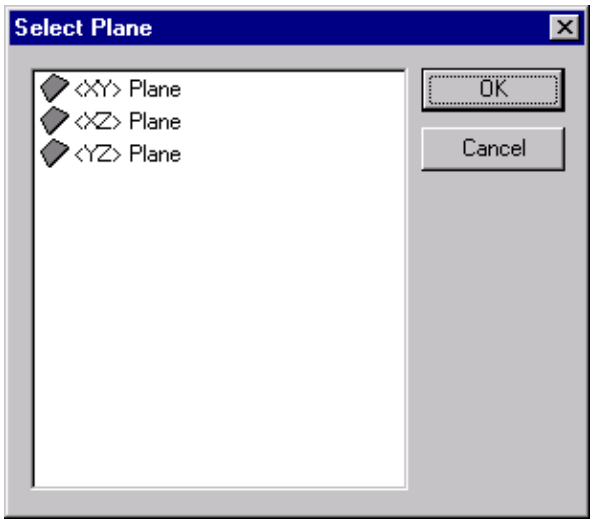


Before determining the circle, we must define the plane the circle rests on. This can be accomplished using the Plane Construction function. This is described further in the manual. The plane function works exactly like the Plane Point construction. The only difference is that a plane is created.

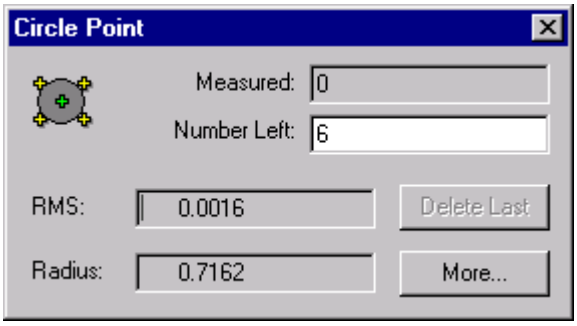


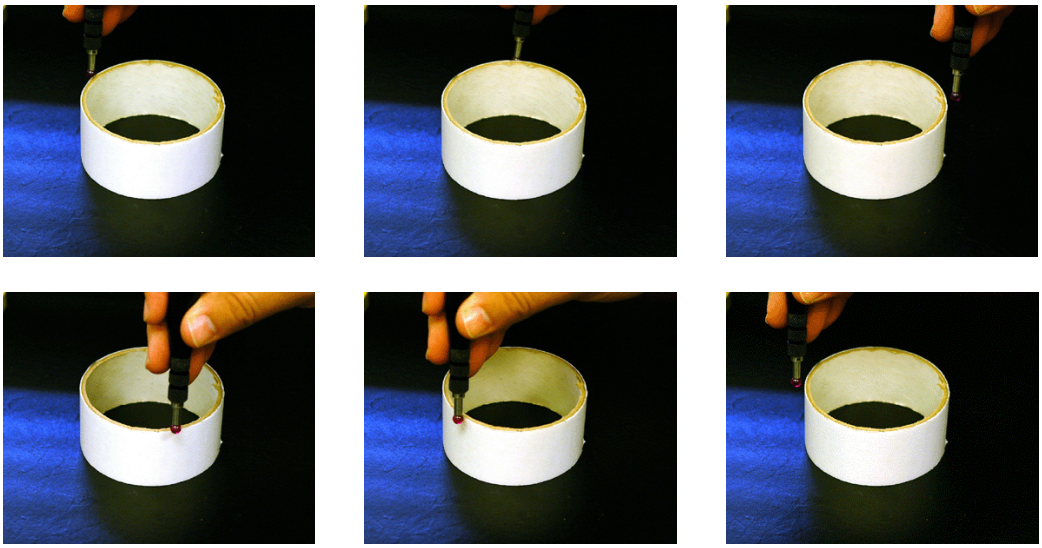
Begin by pressing the Circle Point Button

Select the plane of the circle. This will be the plane that you probed earlier.

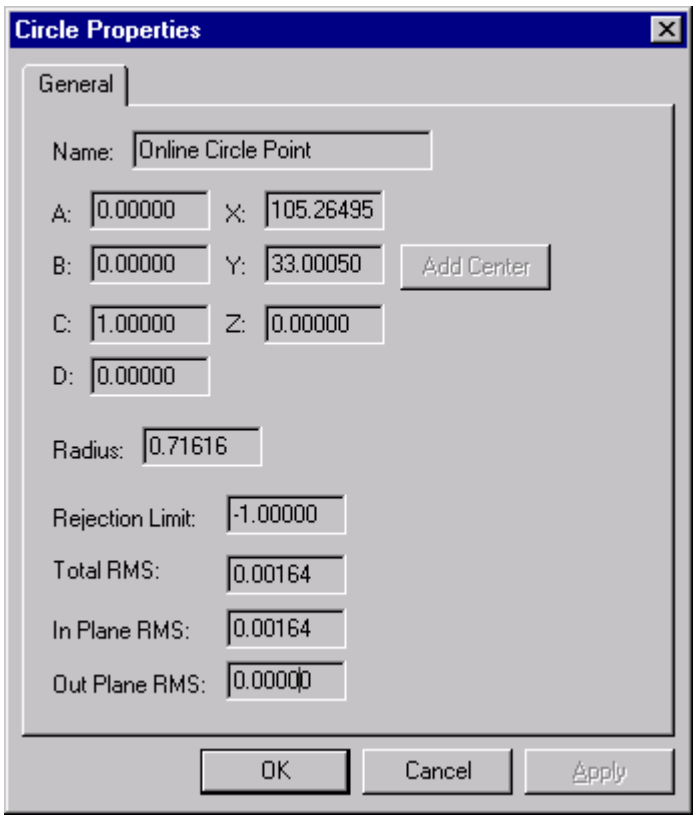


Now measure, using a ball tip, six points around the hole.



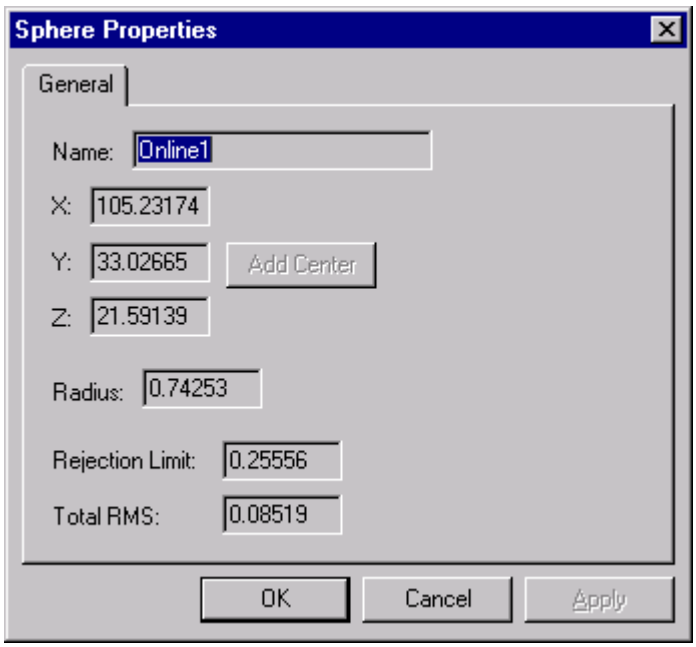


The calculated point is on the specified plane in the center of the circle.



Sphere Point

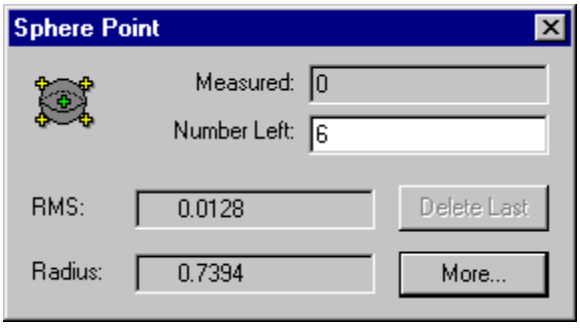
Use this feature to create the center of a sphere. Only the point is created. The radius and the RMS of the sphere are also reported.



Consider the following example where we seek the XYZ location of the center of the sphere.

Begin by pressing the Sphere Point Button

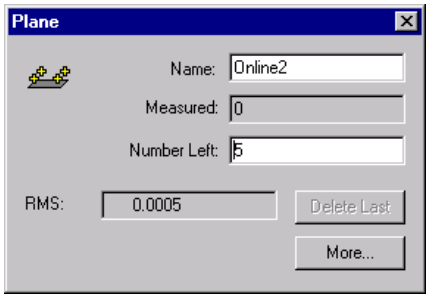
Now measure, using a ball tip, points around the sphere.

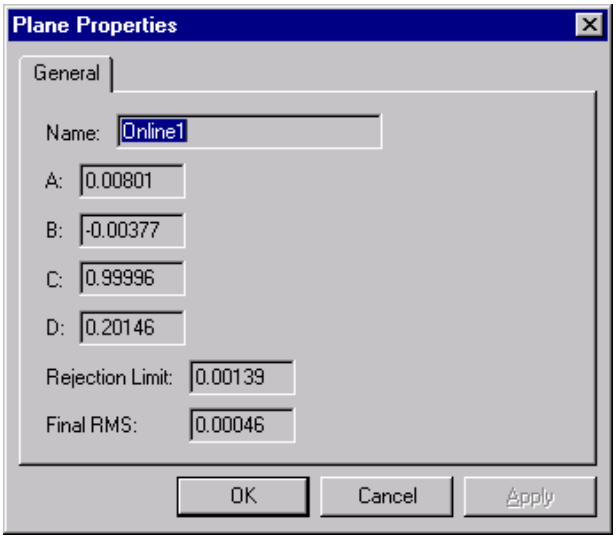


The calculated point is the center of the sphere.

Plane

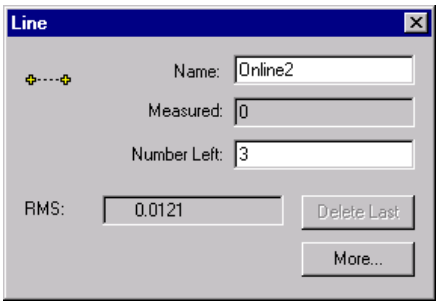
Use this feature to create a plane. The last point collected is used to define the compensation direction.

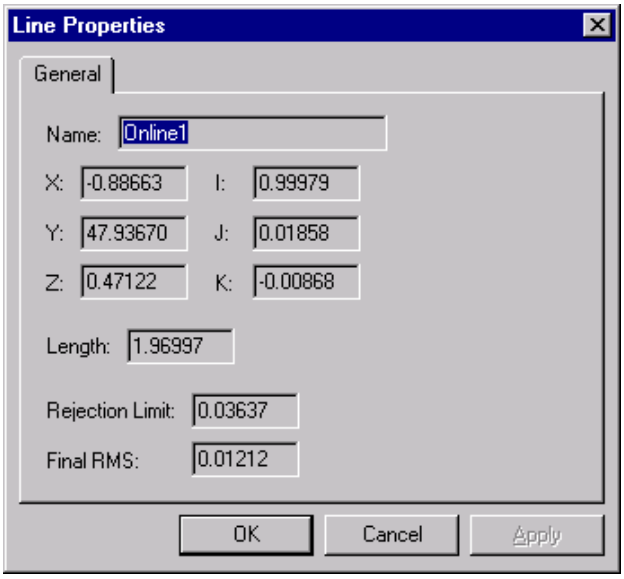




Line

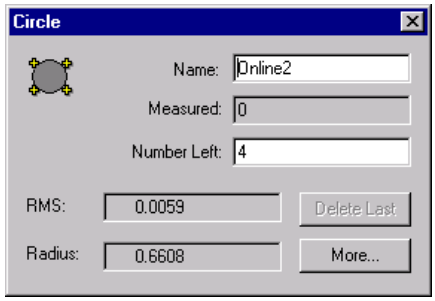
Use this feature to create a best-fit line.

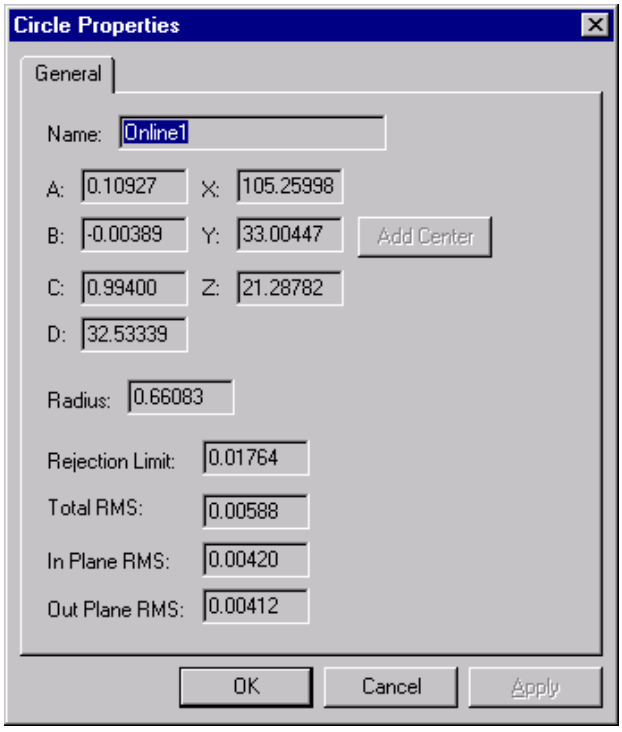




Circle

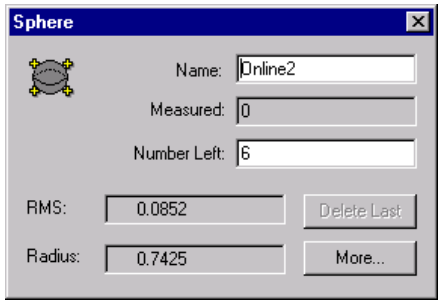
Use this feature to create a best-fit circle and center. Once again a plane needs to be defined first.

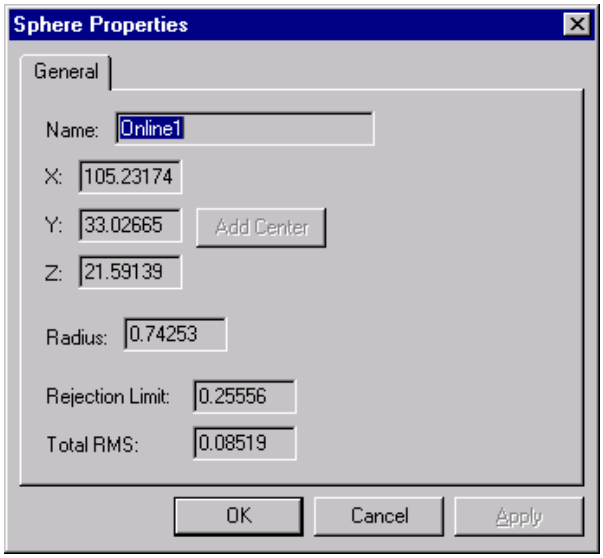




Sphere

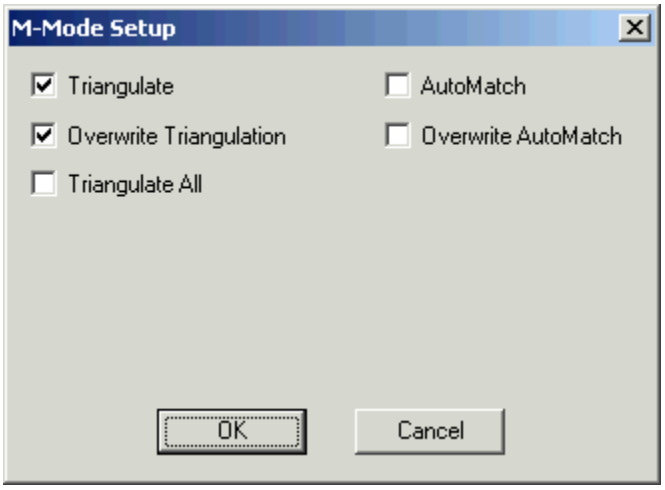
Use this feature to create a best-fit sphere and center.





M-Mode Setup

Setup Dialog



It is possible to edit the M-Mode parameters. The **Setup** dialog is located on the **MMode** menu. The following options are available.

Triangulate
Write new or detail points to a Triangulation file.

Overwrite Triangulation
Overwrite the triangulation file. If this option is not checked, a new triangulation file will be created each time.

Triangulate All
Any points in the detail file and driver file will be triangulated.

AutoMatch
A two station AutoMatch will be run. Keep in mind that this is only based on two images and therefore may not be as reliable as normal AutoMatching.

Overwrite AutoMatch
The AutoMatch file is overwritten after each epoch.

Troubleshooting

System Will Not Turn On

If the system will not turn on, check the fuse located at the rear of the cable box. If it has blown, replace it and try again. If power still does not come on, check the power source for proper power. If the power source is OK, check the power cable and try another cable if one is available.

Hand-held Strobe Doesn't Fire

If the Hand-held strobe does not flash when you take a picture, check the following:

1. Is the strobe turned on? The power switch should be set to the BATT position.

2. Is the ring strobe cable connected?

3. Is the ready/test light on? If not, the batteries may be depleted. See Changing Hand Held Strobe Batteries in the INCA2 manual.

If the strobe still does not work, press the ready/test light to fire the strobe manually. If the strobe still does not flash, the power pack or ring strobe is damaged, and must be replaced. If the ring strobe will flash by pressing the ready/test light, the strobe is ok, but the unit is not receiving the sync signal. Call GSI for assistance.

Remote Trigger Will Not Work

- Is the remote trigger activated in V-STARS?
- Is the remote trigger switched on? You should see a red flash when you press the button. The orange power light at the back should also be illuminated. If the light is off and the trigger is switch on, change the batteries.
- Is the flash sync plugged into the camera
- Is there anything preventing the signal reaching the camera? Test this by standing at the camera and pressing the trigger.
- Does the system fire when triggered manually from the computer?
- Are the flash units switched on?
- Can you hear the cameras firing?

If the remote trigger cable does not work after all these tests, the problem is probably with one of the cables or components in the remote trigger circuit. Call GSI for further instructions.

Remote Trigger Fires on Its Own

More than likely there is a spurious signal that is firing the cameras. Certain types of strobes (like the ones on fork lifts) will cause false triggering. If the problem persists call GSI to discuss some of the alternative triggering devices available.

No Pictures Appear

- Are the camera lens caps on?
- Are the strobes working?
- Do the pictures appear when triggered manually?

Call GSI for further instructions.

Resection Failed

Usually, the "Resection Failed" message is caused by a significant movement of one or both of the cameras. If you see many red crosses in either picture window, that camera has probably moved significantly and needs to be re-oriented. See Unstable Camera Orientation for instructions on how to do this. This message can also be caused by a flash failure. If the flash is not firing, refer to the Troubleshooting section on the flash.

No Probe Found

Usually, the "No Probe Found" message occurs when all or part of the probe cannot be seen from both cameras. Check the picture windows to see if both cameras found all five of the probe targets. If they are, the targets should be marked with green diamonds. If the probe is not visible, move it so it is and try again. If one camera but not the other can see the probe, try pointing the probe more towards the camera which does not see it.

If the probe is visible but still is not found, probably one or more of the probe searching criteria were not met. There are two steps involved in the probe search. In the first step, the entire picture is scanned for all candidate targets. Acceptable candidate targets must be bright enough and large enough to be considered as candidates. All acceptable candidates are marked with a red square. In the next step, all the possible combinations of candidate targets are checked to see if any of them match the five-point pattern of the current probe. If the current probe is not found, the search looks for the other probes. If none of the other probes are found, the "No Probe Found message is displayed. If a probe is found, the five red squares are replaced by green diamonds, and the probe results are displayed in the Probe Window.

Finally, check that the probes you are using are in the project.

Networking Problems

If you encounter networking problems step through the following checks.

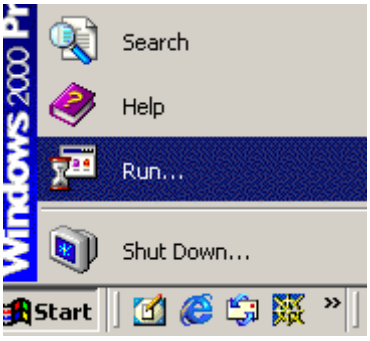
Q: Are both cameras switched on and connected to the cable box?
A: If not, connect them and try again.

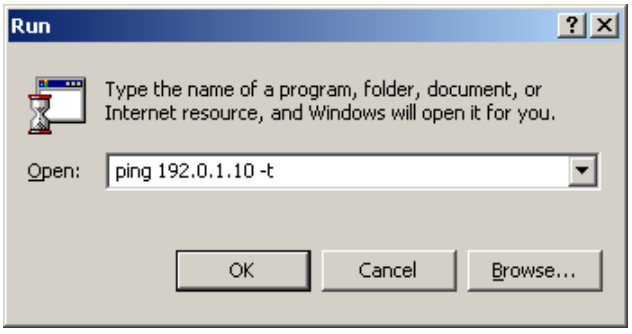
Q: Does the camera display say "Ready Net" or "Connected"?
A: If not, reboot the cameras and try again. If problem persists, continue with the troubleshooting questions.

Q: Are both cameras online?
A: The easiest way to check this is to "Ping" each of the cameras.

To ping a camera…
Select "**Run**…" from the windows **Start** Menu.
Type in "ping *ip_number* –t".
The *ip_number* is the IP number for your camera. The INCA IP numbers are listed below.

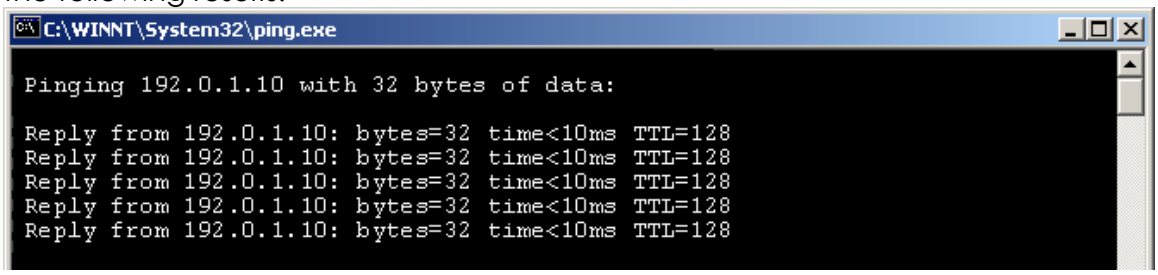
Host Computer	192.0.1.1
First INCA	192.0.1.10
Second INCA	192.0.1.11
Third INCA	192.0.1.12
Fourth INCA	192.0.1.13

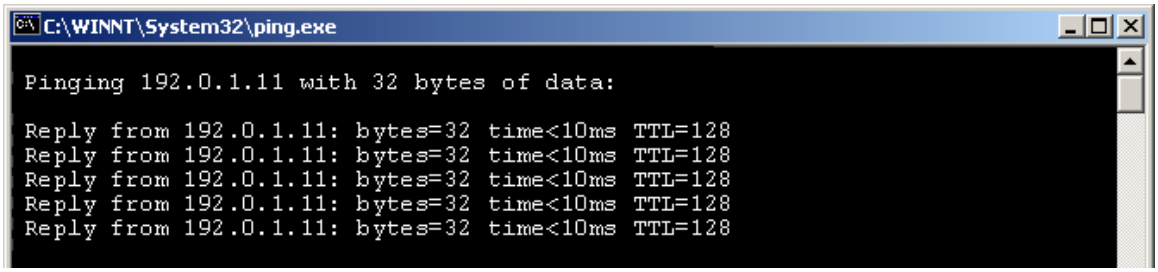




To determine the IP numbers of your cameras you may need to open the "*.dan" files in the GSI system directory. Make sure you don't change the files when you open them.

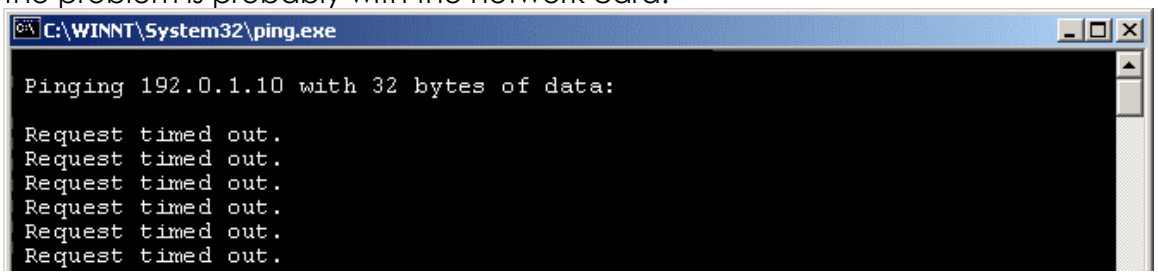
If the cameras are correctly networking with the computer, you will get the following results.





Don't be concerned if the time or TTL figures are different.

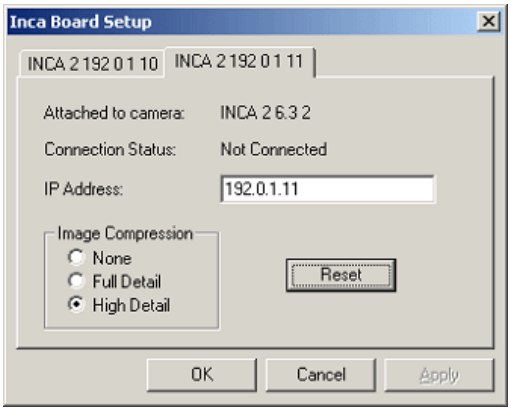
If neither Inca responds and the requests time out, (as shown below) then the problem is probably with the network card.

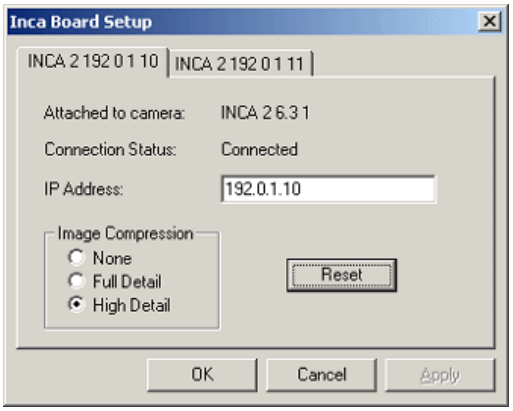


Reboot the computer and try again. Is the LED activity light near the connection point of the network cable green? If not, try rebooting the computer or if possible ejecting the network card.

If only of the two INCAs responds then there is a problem with only one of the cameras. Try rebooting the camera and repeat the ping test. If it fails again try swapping the cables with the INCA that was working. This will establish if it is a problem with the cable connection. If the camera now works contact GSI to discuss checking your cable. If the camera still doesn't work, contact GSI to discuss alternative plans of action.

If you are within V-STARS and loose the network connection to either or both of the cameras, it is possible to reconnect to the cameras from within the software. To reconnect to the software select **Advanced Edit** from the **Project** menu. Click on the **INCA Camera** button to load the **Inca Board Setup** dialog. The dialog will specify the connection status and IP Address of the camera. To reset the connection press the **Reset** button.





If you enter V-STARS and the M icon is not active, check the following…

Q: Do you have two cameras in the project?
A: Add the cameras and try again.

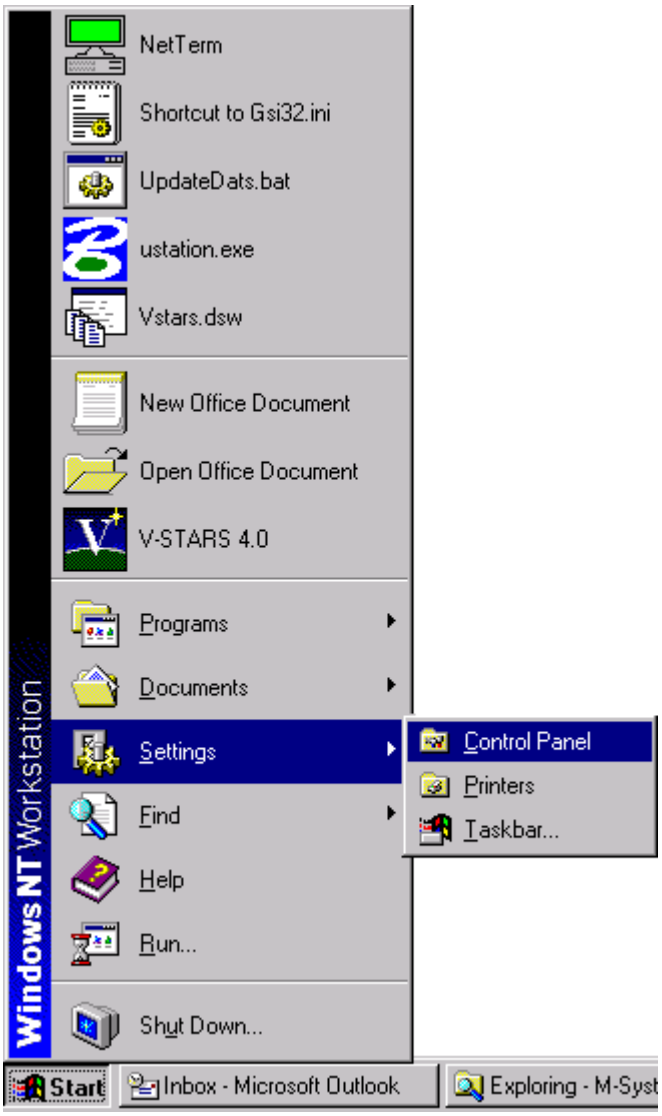
Q: Have you verified that the cameras are communicating with the computer?
A: Refer to earlier items in the network troubleshooting. If they are, verify that the camera screen on each camera reads "connected". Reboot the camera if it isn't connected.

Adjusting V-STARS Settings

Configuring the Probe Sounds

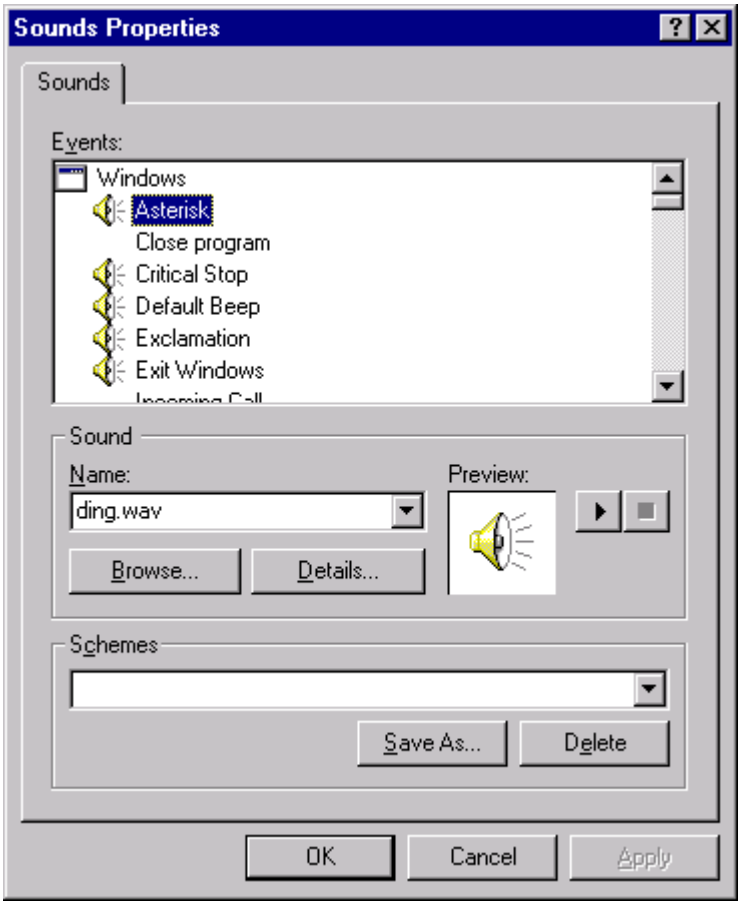
When using an INCA M-System you can configure the sounds played for a successful and a failed probe measurement.

To configure the sounds, first start the Windows Control Panel.



Then start the Sounds Applet from within the Control Panel.

Use the Sounds Properties dialog to configure the wave file for the Asterisk sound and the Exclamation sound. The Asterisk sound is played for a successful measurement, the Exclamation for a failed measurement.

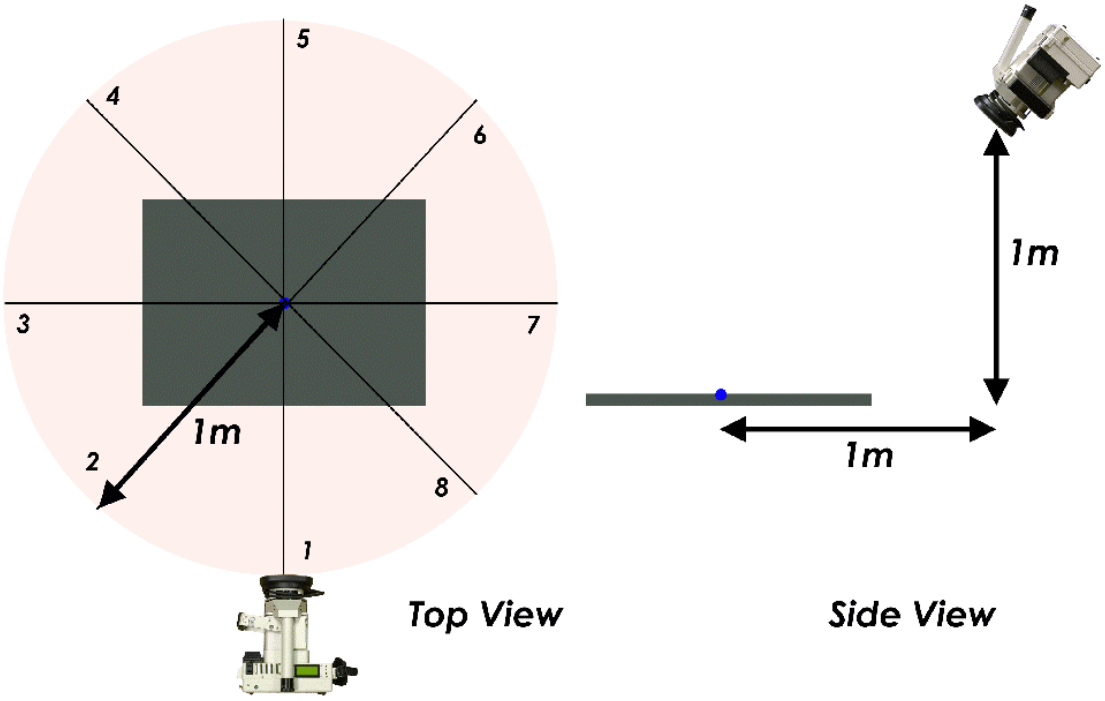


Probe Calibration

Target Calibration Procedure

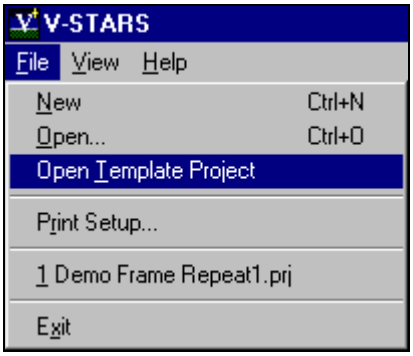
Procedure

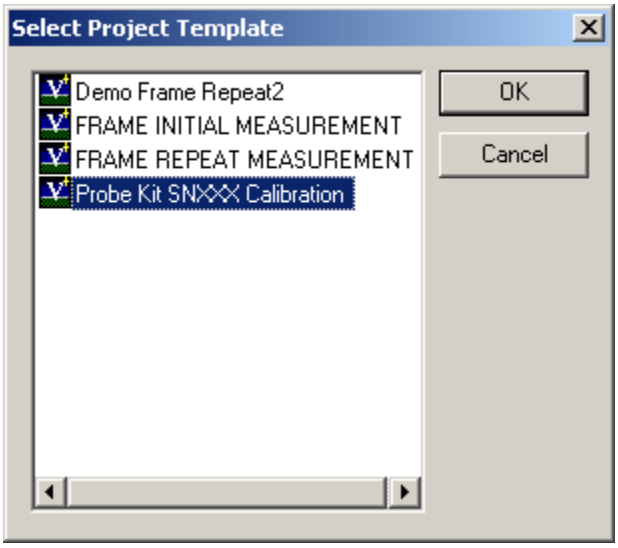
1. Place probe/s onto the calibration plate supplied with the system. More than one probe can be calibrated at the same time.
2. Make sure that the probes are securely attached to the plate so that they don't move during the photography. You can use putty or tape for this purpose. Use the tube provided with the plate to support the helo probe.
3. Set the strobe to 0 and the camera speed to 24ms.
4. When pointing the camera ensure that the center of the plate is in the center of the viewfinder circle
5. Complete a 16 picture network as shown below. Use a 0° and 90° roll at each of the eight compass points. The photos should be taken about 1m (3') out from the center of the plate and about 1m (3') above the top of the plate. You may find it more convenient to place the camera on a tripod and rotate the plate to the eight positions. If this is the case we recommend you take the first eight shots at 0° and then roll the camera 90° for the remaining eight.



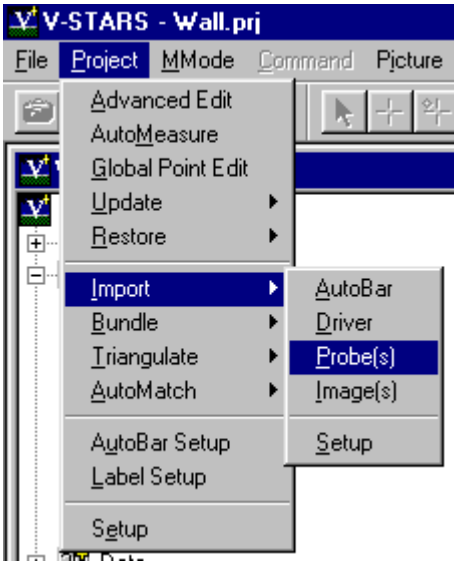
6. Use the **Open Template Project** menu item from the **File** menu and start a new template project. The Template project should be

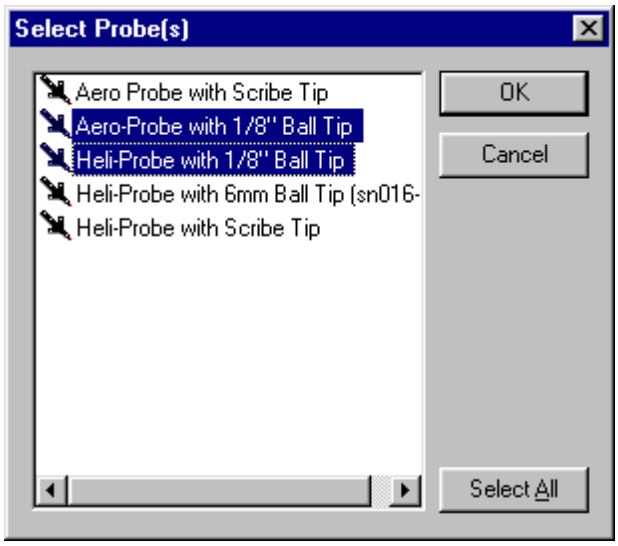
called "Probe Kit SNXXX Calibration". Refer to the section on Template projects in the main manual for more information.





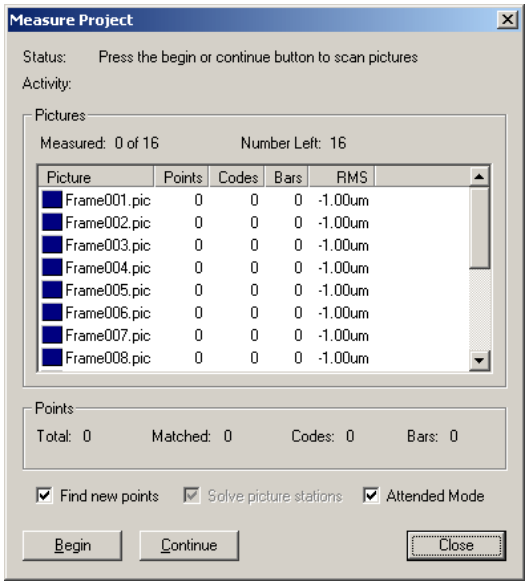
7. Add the camera used to shoot the network and import the images.
8. Import the probe you are calibrating to the project. Import the probes via the Import menu under Projects as shown below.



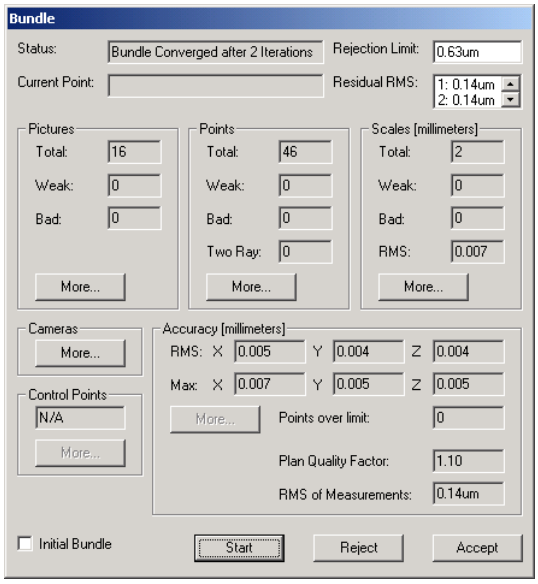


9. Run the AutoMeasure command that is located under the Project menu.

10. The AutoMeasure dialog will appear. Make sure the **Find new points** option is ticked. The settings should appear as shown in the adjacent image. The **Attended Mode** option can be checked if you wish the software to halt after each step. If not, then uncheck the box. Press **Begin** when ready



11. Once the AutoMeasure process has been completed, the Bundle Statistics Dialog will appear. A sample is shown adjacent. The number of points should correspond to 36 (10 codes + 26 individual targets) + five target points per probe. If it is different then the additional points need to be found and deleted.



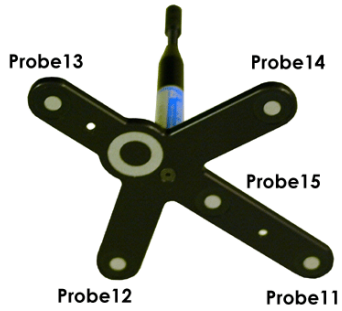
12. As part of the AutoMeasure process the targets are assigned random labels that commence with the keyword "Target". These labels must be changed to correspond to the appropriate probe label.

13. Open one of the images and select the "Global rename" Icon.

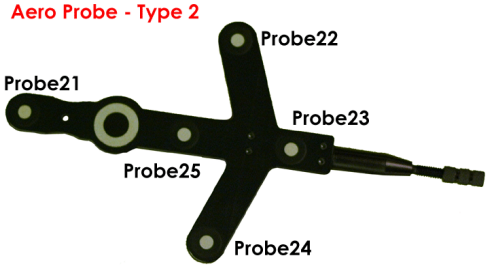
.

14. The point labels used depend on the type of probe. Below are diagrams of the four main probes. Determine the probe/s being re-calibrated and change the labels accordingly. Take care when renaming the points as the points are easily confused.

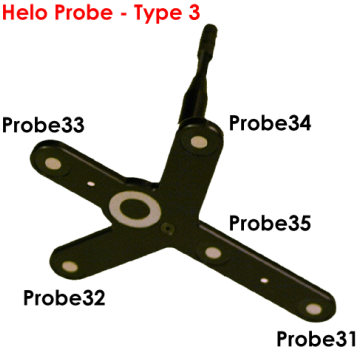
Helo Probe - Type 1



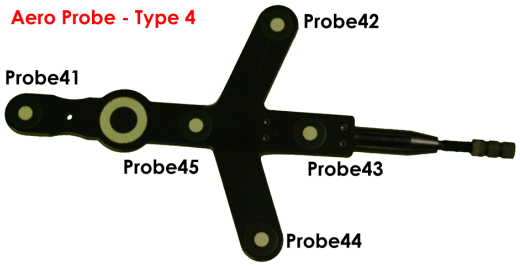
Aero Probe - Type 2



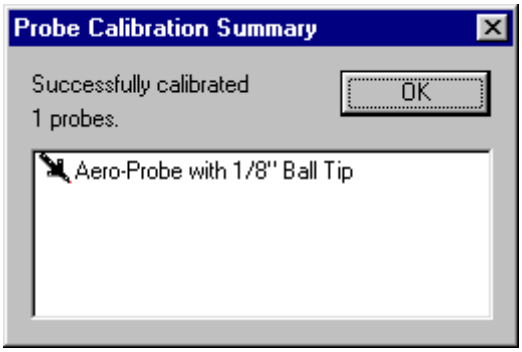
Helo Probe - Type 3



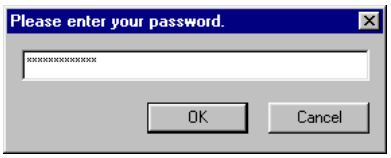
Aero Probe - Type 4

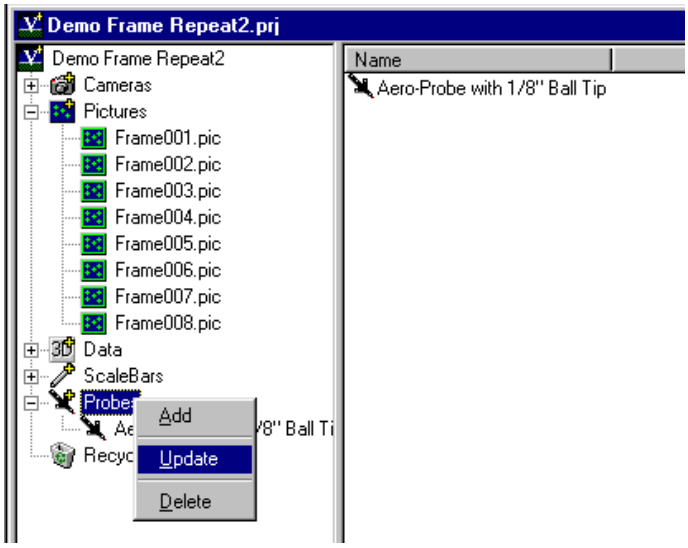


15. Once the probe/s have been re-labeled, re-run the Bundle. Verify that none of the probe points are weak or bad. At the end of the bundle, you will receive a message confirming that the probes have been recognized and updated. At this point, the probe has only been updated locally.



16. To update the probe/s in the system directory right click on the Probe node and select **Update**. Enter the system password and the probe will be updated in the system directory.





This concludes the probe target calibration. It is advisable that the probe tip calibration be carried out as soon after the probe target calibration as possible.

Aero Probe Tip Calibration Procedure

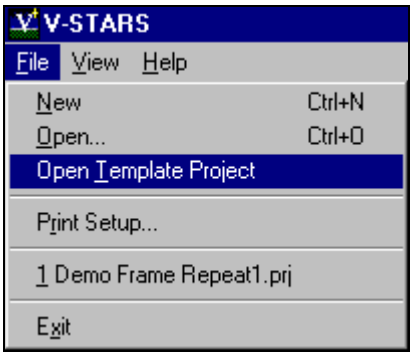
Procedure

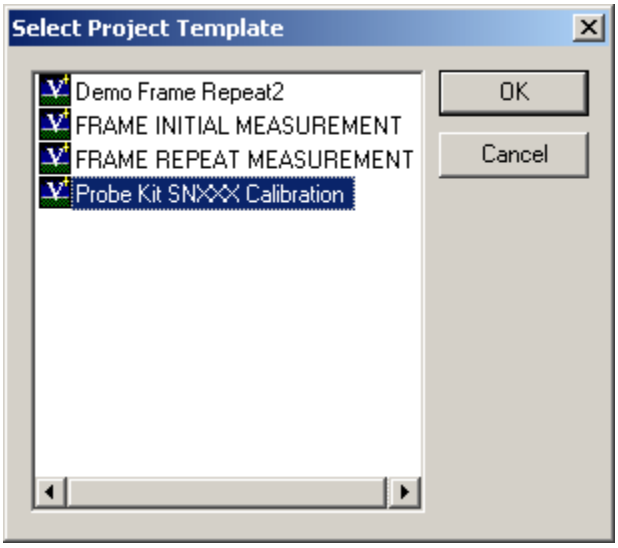
The following procedure has been prepared to help facilitate the calibration of Aero probe tips after initial probe target calibration. This procedure is applicable to both ball and scribe tips.

WARNING – The cameras used for probe calibration should themselves be freshly calibrated to ensure the best results are obtained.

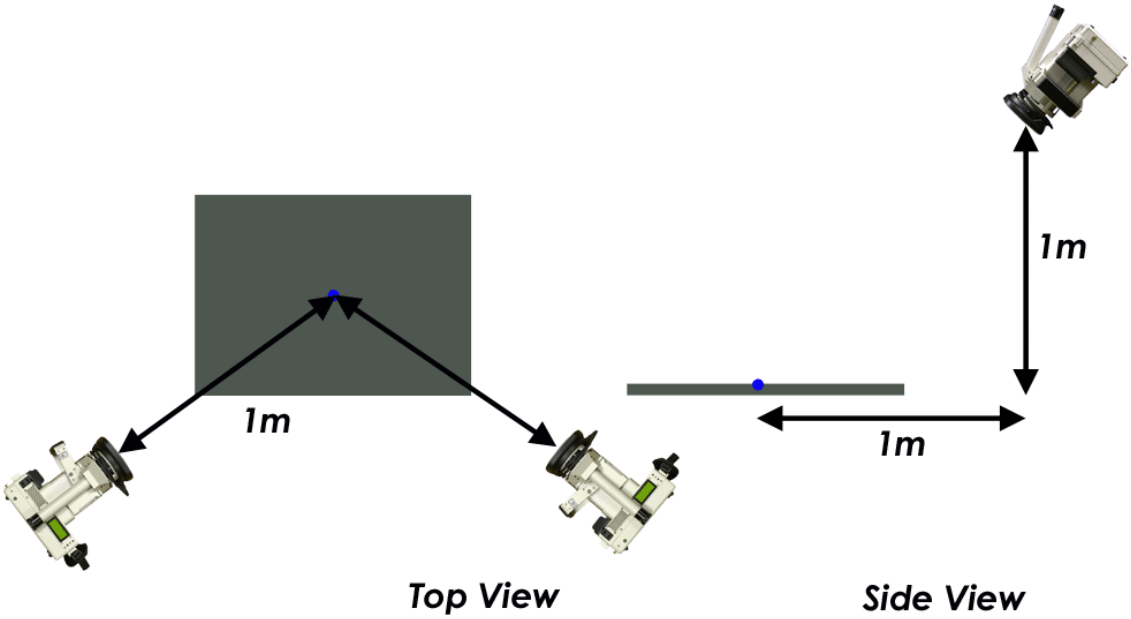
1. Configure the system for M-Mode operation.

2. Use the **Open Template Project** menu item from the **File** menu and start a new template project. The Template project should be called "Probe Kit SNXXX Calibration". Refer to the section on Template projects in the main manual for more information



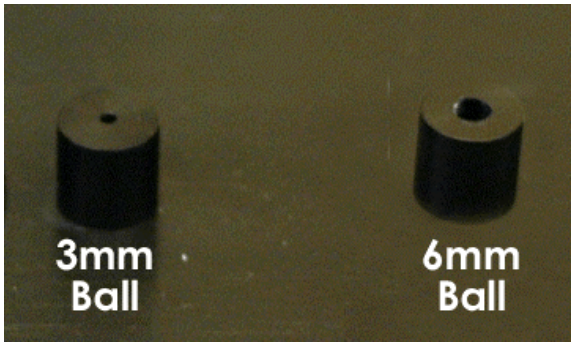


3. Position the cameras around the calibration plate. They should be placed at the corner. Ideally, they should be 1m from the center of the plate and 1m from the plate surface. Refer to the diagram below.

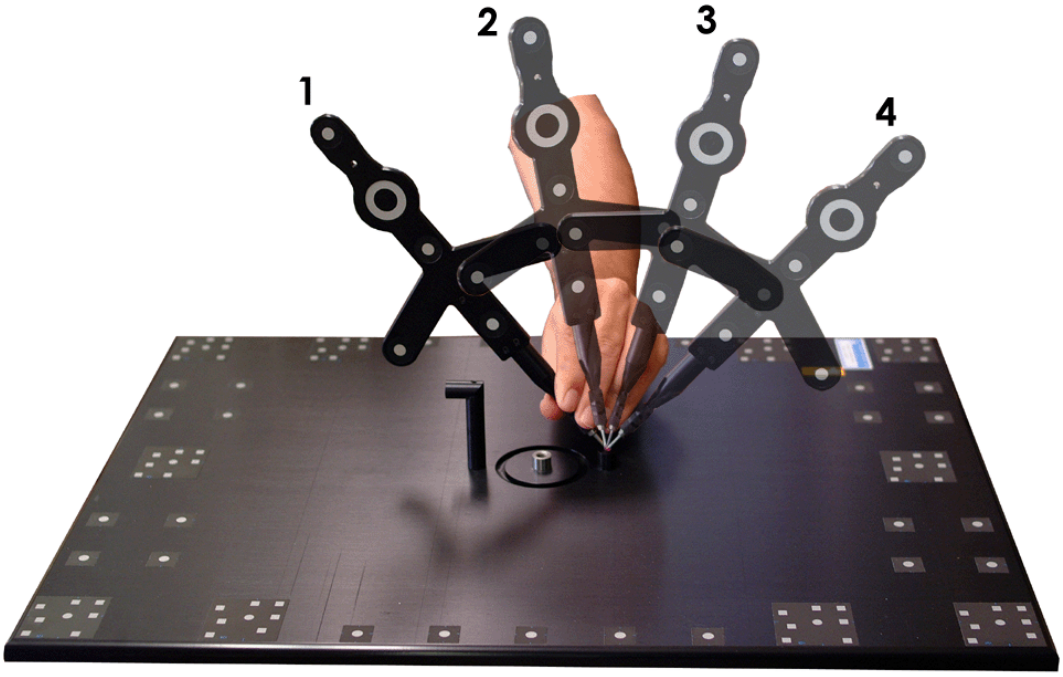


4. Use Unstable Camera Orientation to enter M Mode and verify that the resection values are less than 0.40µm. Refer to the section on Unstable Camera Orientation in this manual for more information.

5. Place the probe tip into the holder that best suits the tip. The plate comes standard with 3mm and 6mm tip holders.



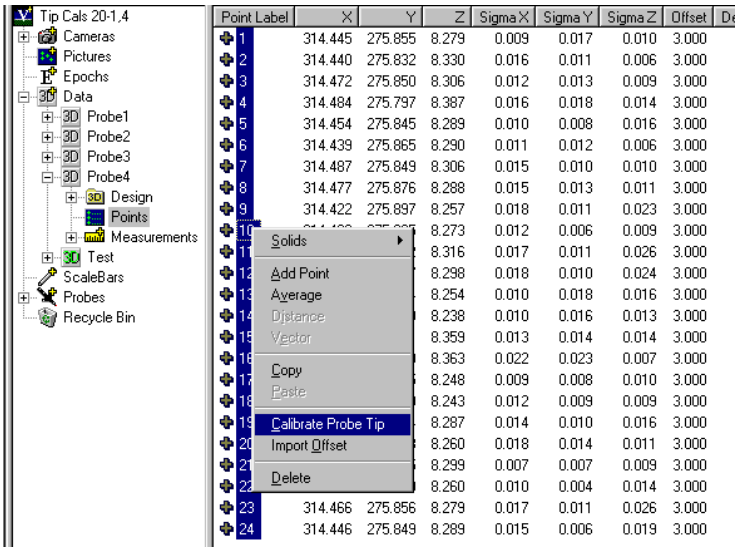
6. Using the figures below as a guide, collect 12 probe points using the probe to be calibrated. There are four positions at three orientations.



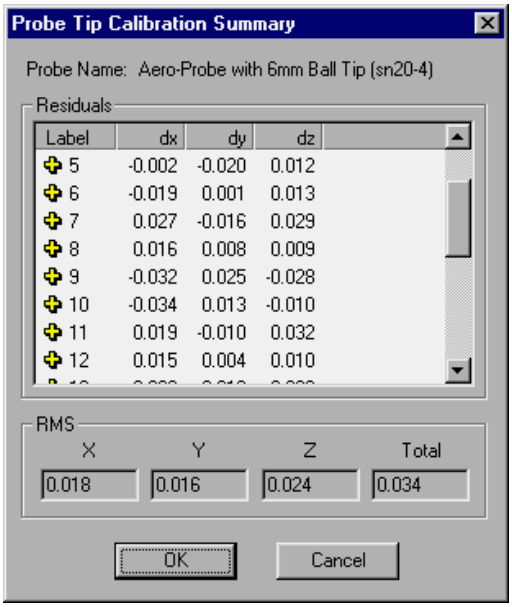
7. Rotate calibration plate 180° and collect another 12 probe points in the same configuration as described above. The plate rotation will help strengthen the calibration. Once completed there should be 24 probe points.

8. Examine the 24 points in 3D graphical view and delete any outliers. Any point that obviously lies outside the main cluster of points may be considered an outlier. These may be points where the probe slipped as the measurement was taken.

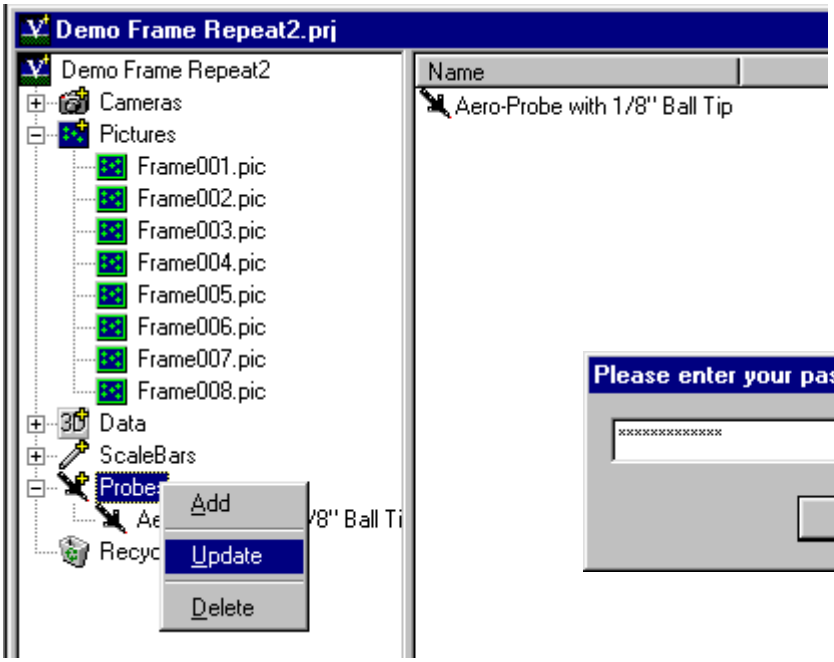
9. In the list of points select the 24 probed points. Right click and select **Calibrate Probe Tip**. This function will calibrate the probe tip using the points that have been highlighted.

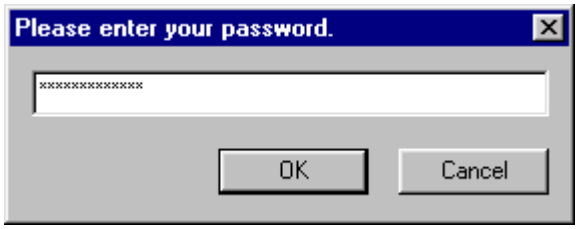


10. After the tip calibration, a dialog box will show the individual deviations from the fit. Remove any deviations that are greater than 100µm (>0.004"). If the results are acceptable, click OK and update the probe. The value in the Total RMS box should be within 30-50µm (0.001" – 0.002"). If you have deleted more than three points, the tip calibrations should be repeated.



11. To update the probe/s in the system directory right click on the Probe node and select **Update**. Enter the system password and the probe will be updated in the system directory.





Helo Probe Tip Calibration Procedure

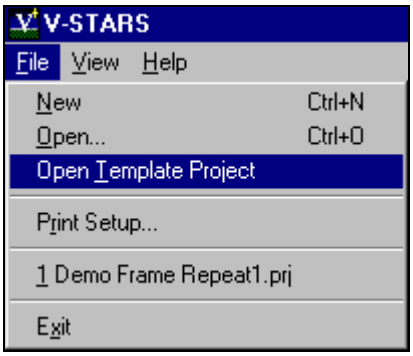
Procedure

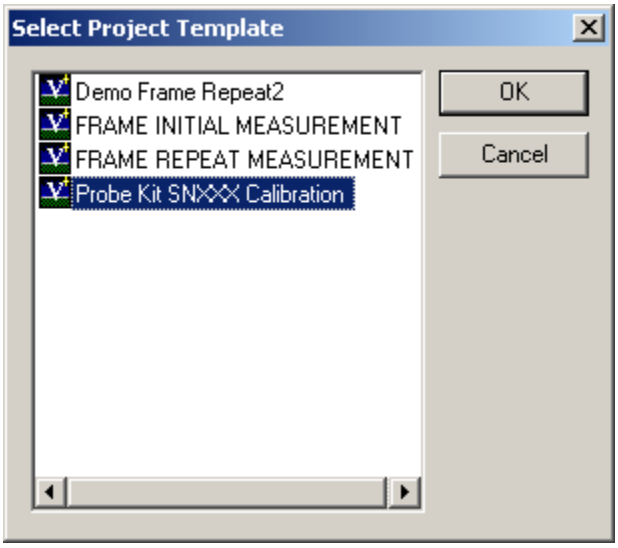
The following procedure has been prepared to help facilitate the calibration of Helo probe tips after initial probe target calibration. This procedure is applicable to both ball and scribe tips.

WARNING – The cameras used for probe calibration should themselves be freshly calibrated to ensure the best results are obtained.

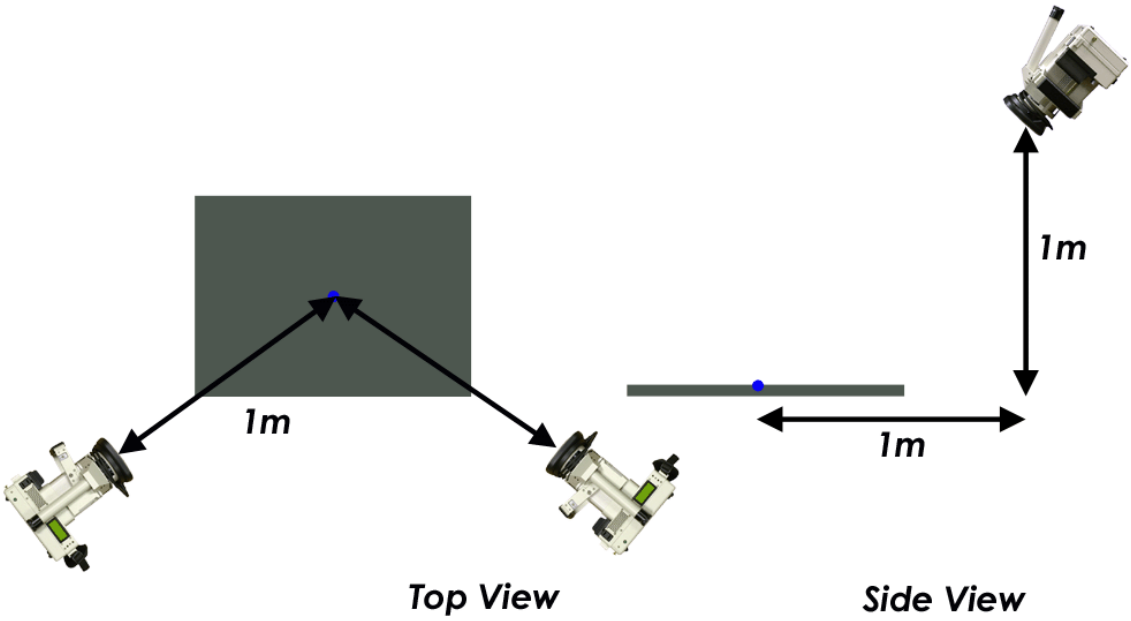
12. Configure the system for M-Mode operation.

13. Use the **Open Template Project** menu item from the **File** menu and start a new template project. The Template project should be called "Probe Kit SNXXX Calibration". Refer to the section on Template projects in the main manual for more information



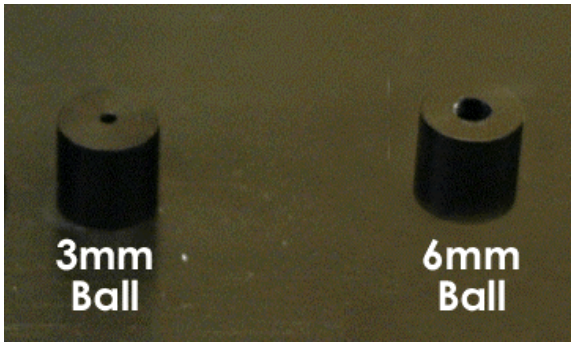


14. Position the cameras around the calibration plate. They should be placed at the corner. Ideally, they should be 1m from the center of the plate and 1m from the plate surface. Refer to the diagram below.

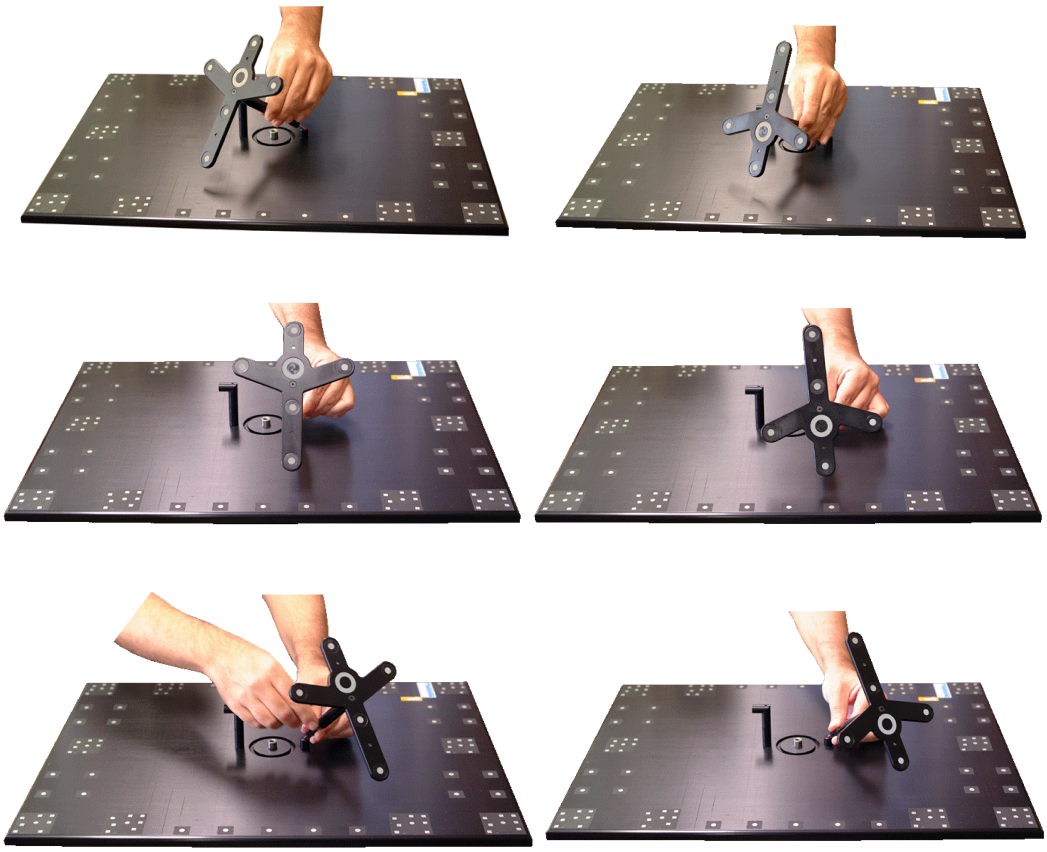


15. Use Unstable Camera Orientation to enter M Mode and verify that the resection values are less than 0.40µm. Refer to the section on Unstable Camera Orientation in this manual for more information.

16. Place the probe tip into the holder that best suits the tip. The plate comes standard with 3mm and 6mm tip holders.



17. Using the figures below as a guide, collect six probe points using the probe to be calibrated. There are three positions at two orientations.

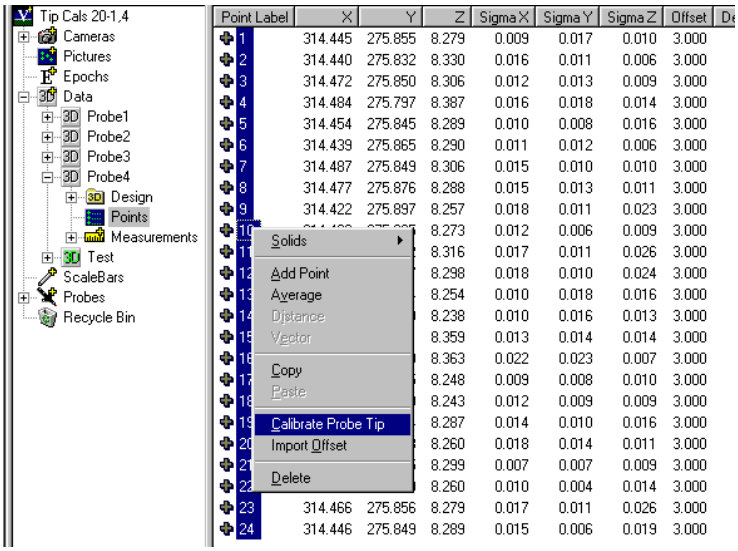


18. Rotate calibration plate 90° and collect another six probe points in the same configuration as described above. The plate rotation will help strengthen the calibration. Once completed there should be 24 probe points.

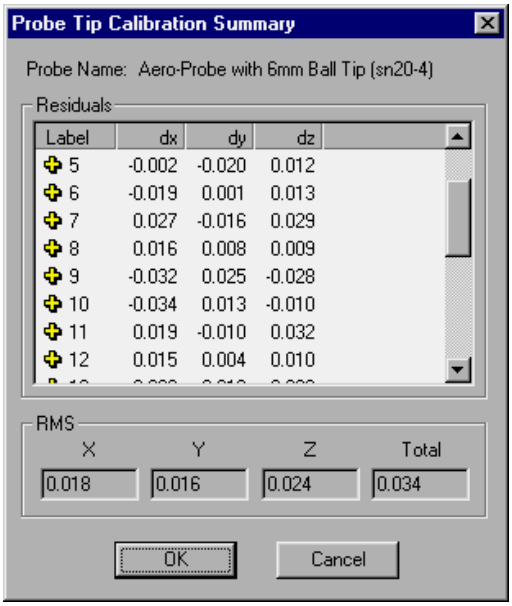
19. Examine the 24 points in 3D graphical view and delete any outliers. Any point that obviously lies outside the main cluster of points may

be considered an outlier. These may be points where the probe slipped as the measurement was taken.

20. In the list of points select the 24 probed points. Right click and select **Calibrate Probe Tip**. This function will calibrate the probe tip using the points that have been highlighted.

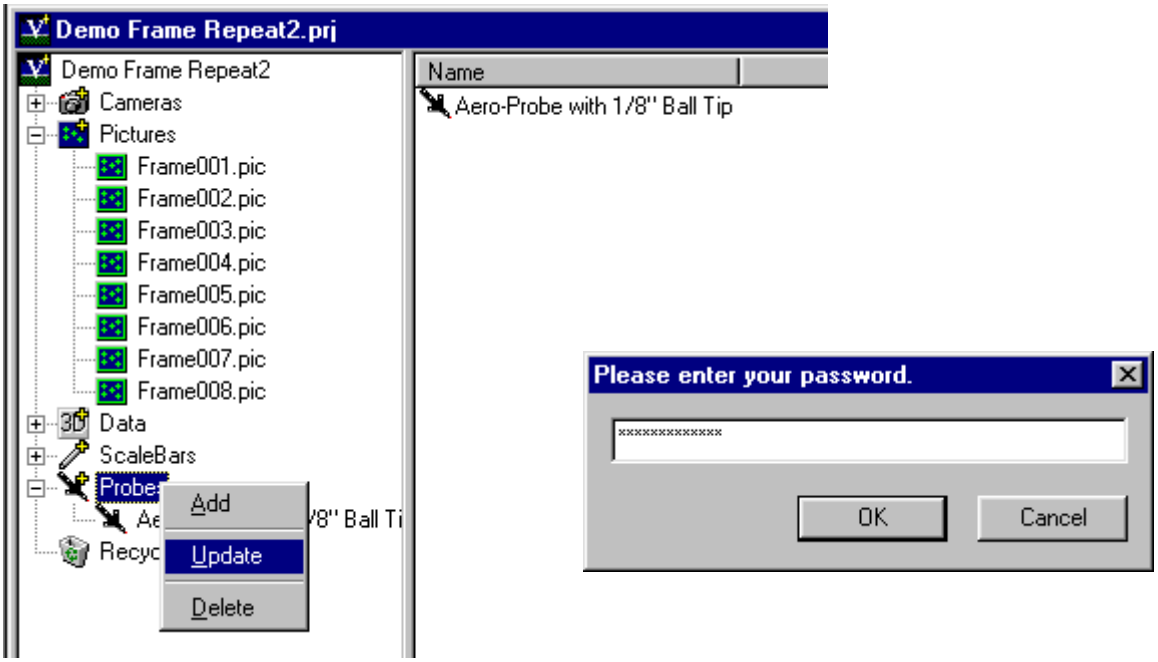


21. After the tip calibration, a dialog box will show the individual deviations from the fit. Remove any deviations that are greater than 100µm (>0.004"). If the results are acceptable, click OK and update the probe. The value in the Total RMS box should be within 30-50µm (0.001" – 0.002"). If you have deleted more than three points, the tip calibrations should be repeated.



The summary shown in this example is for an Aero probe and not a Helo probe. This has no relevance on the figures.

22. To update the probe/s in the system directory right click on the Probe node and select **Update**. Enter the system password and the probe will be updated in the system directory.


Demo Frame Repeat2.prj
Demo Frame Repeat2
Cameras
Pictures
Frame001.pic
Frame002.pic
Frame003.pic
Frame004.pic
Frame005.pic
Frame006.pic
Frame007.pic
Frame008.pic
Data
ScaleBars
Probes
Recyc
Add
Update
Delete
Name
Aero-Probe with 1/8" Ball Tip
Please enter your password.
OK
Cancel

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