Engineering Module Measurement Using PRO-SPOT

Introduction:

The following report is a summary of the PRO-SPOT work carried out at the NASDA facility in Japan. One measurement on the outside of the Space Station Engineering Module was undertaken using the new target projection system.

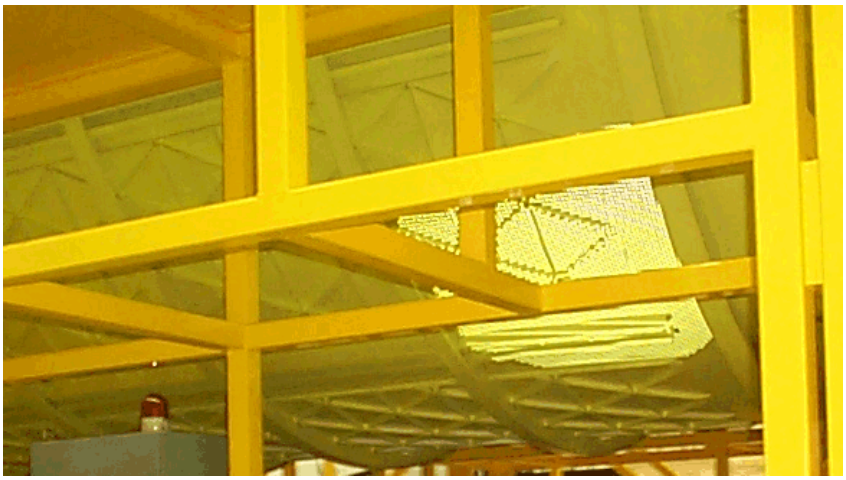
A small 1.5m circular patch was measured on the outer skin. During the demonstration the V-STARS Multiple (M) camera system was also demonstrated.

This report explains the procedure used to complete the measurement. It also includes a description of the V-STARS/M system.

PRO-SPOT Measurement.

Primary Measurement Requirement:

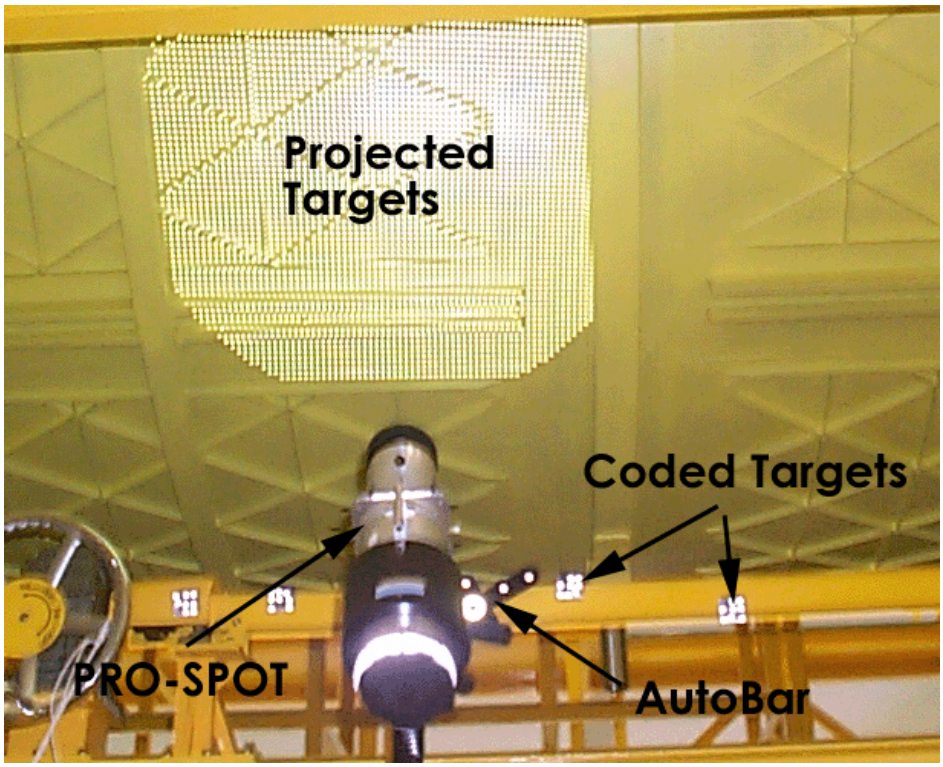
- Determine location of multiple surface points



Targeting.

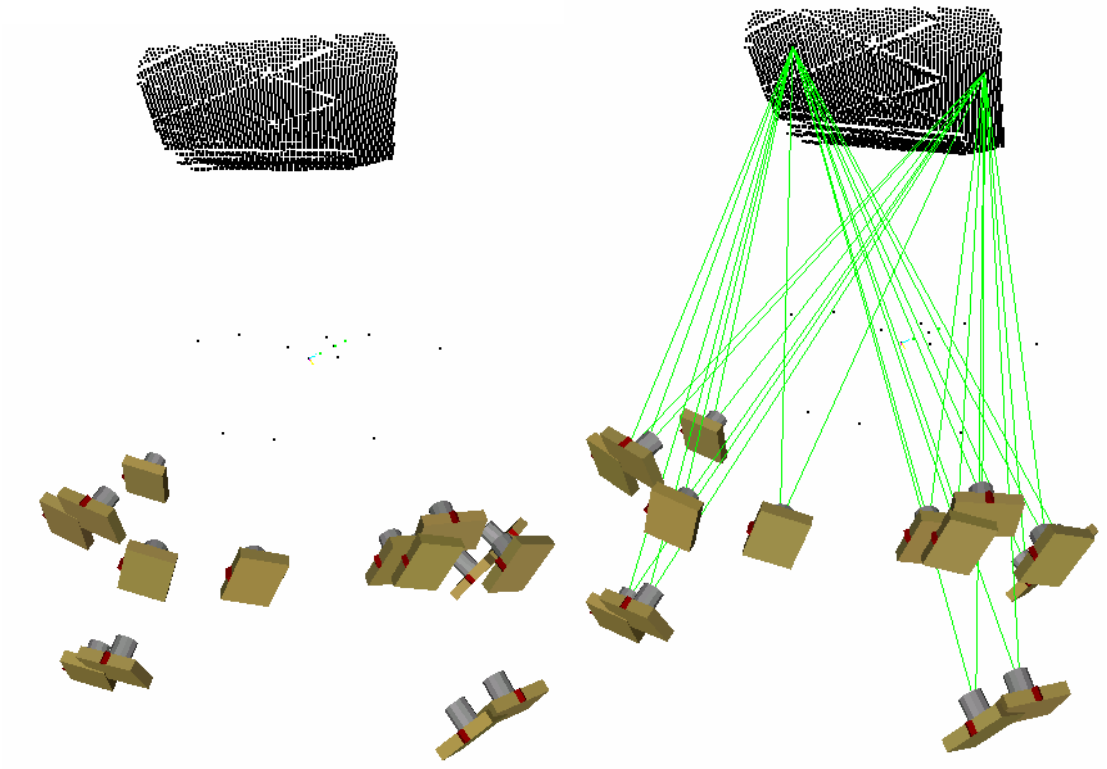
Targeting for this measurement was very simple. Coded targets, and an AutoBar were added to the area surrounding the area of interest for the measurement.

The surface targets were generated using the PRO-SPOT projector. A modeling light was used to focus and position the array of targets. The adjacent image shows some of the key targeting and the position of the projector.



Photography

A total of 15 photographs were taken for the skin measurement. The network configuration is shown in the image below.

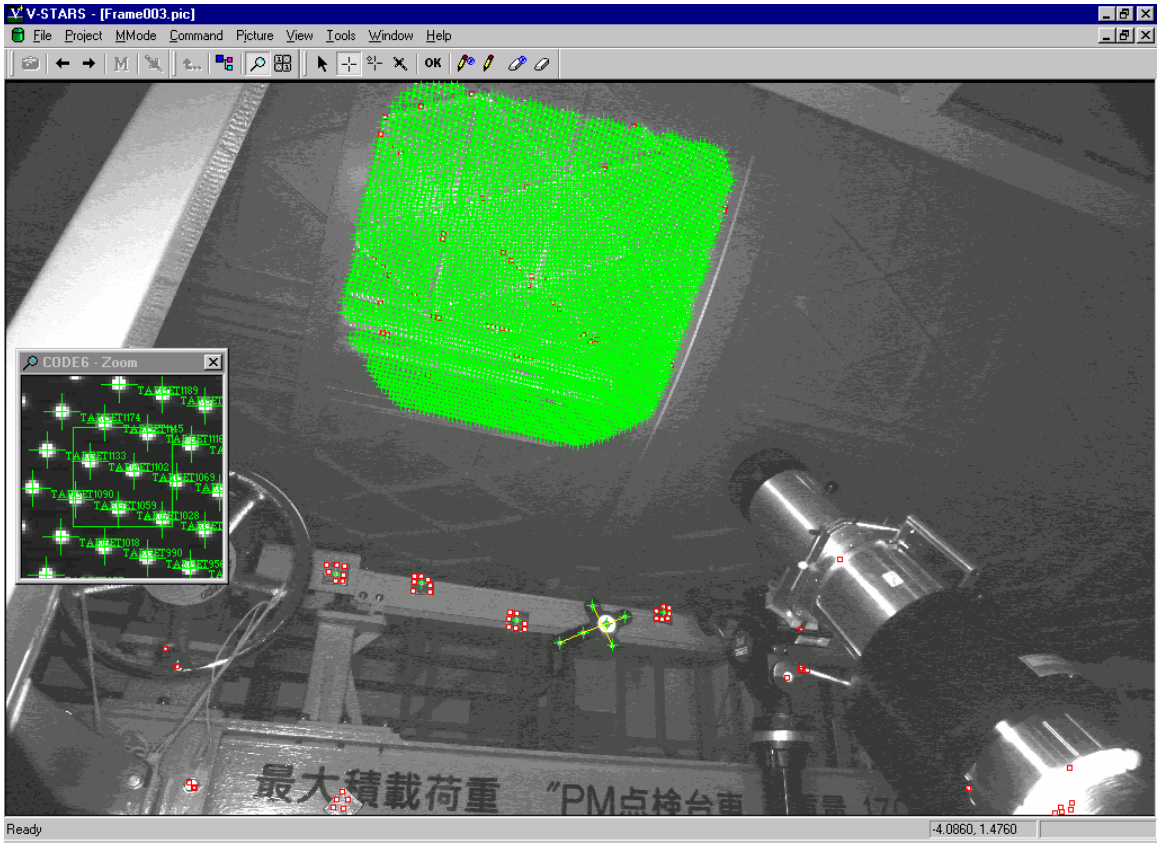


Front View

A sample point intersection for the measurement is shown in the image below. The photography for the measurement was completed in approximately three minutes.

Processing

Seen below is an image taken as part of the measurement.

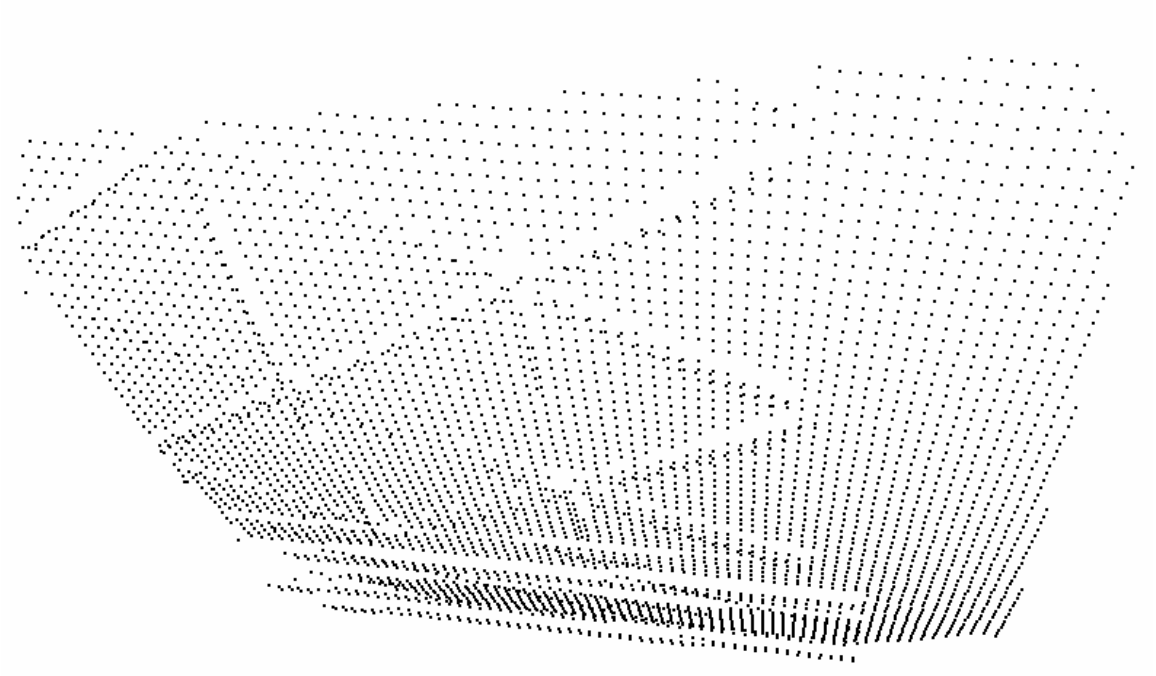


The following is a summary of the measurement statistics from the measurement.

No of photos	15		
No of points	4546		
RMS(mm) X,Y,Z		X	0.015
		Y	0.014
		Z	0.009

The processing was completed in less than five minutes.

The point cloud for the part is shown below:



Alignment

No alignment was completed for the skin measurement. An alignment for the part could have been implemented using the edge of part and other features such as the pocket holes.

Analysis

No analysis was completed on the part. If the part had been aligned and an IGES file was available it would be possible to compare the point data to the design surface. Deviations from the surface would then appear as a color map. Alternatively the point data can be exported from V-STARS and then imported to almost any CAD package.

Time Summary

The following is an estimate of the time taken to complete the measurement.

Targeting	1 minute
Photography	3 minutes
Processing	5 minutes
Total	**10 minutes**

Discussion

The PRO-SPOT projector system has demonstrated how large volumes of high accuracy surface data can be collected very quickly. Once again the results of the measurement are very accurate and more importantly were produced quickly.

Advantages of this technology over other measurement technologies include: -

1. *Non-contact*

The measurement technique is completely non-contact. There is no surface deviation due to measurement contact with the surface.

2. *Variable data collection rates*

The number of points collected on the surface can vary from as few as 600 to as many as 6,000. The time needed to collect the point data is the same regardless of the different point densities.

3. *Fast Data Acquisition*

The information necessary to create the point data is collected in a matter of minutes. This makes the system ideal for a production environment where time constraints are critical.

4. *Flexibility*

The PRO-SPOT system is flexible enough to handle a wide variety of surface measurement tasks. For a large component, the projector can be moved to a new set up and the data incorporated together. Alternatively a second projector could be added.

5. *Portability*

The system can easily be packed up and carried to a supplier or customer for on site measurement tasks.

V-STARS/M Measurement.

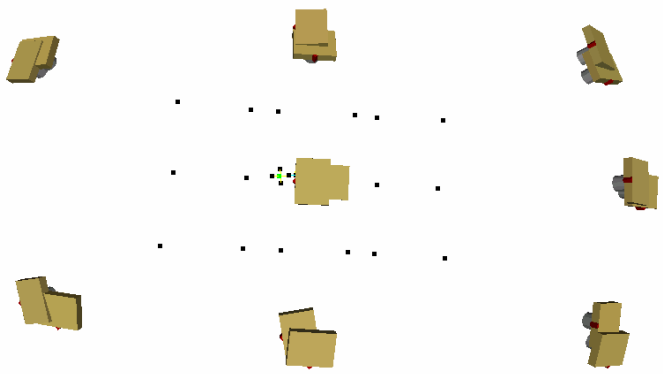
Object:
A bank of metal cabinets was used to demonstrate the system

Primary Measurement Requirement:

1. To demonstrate point collection using the V-STARS/M System
2. To demonstrate some of the geometric analysis capabilities of the V-STARS Solids module.

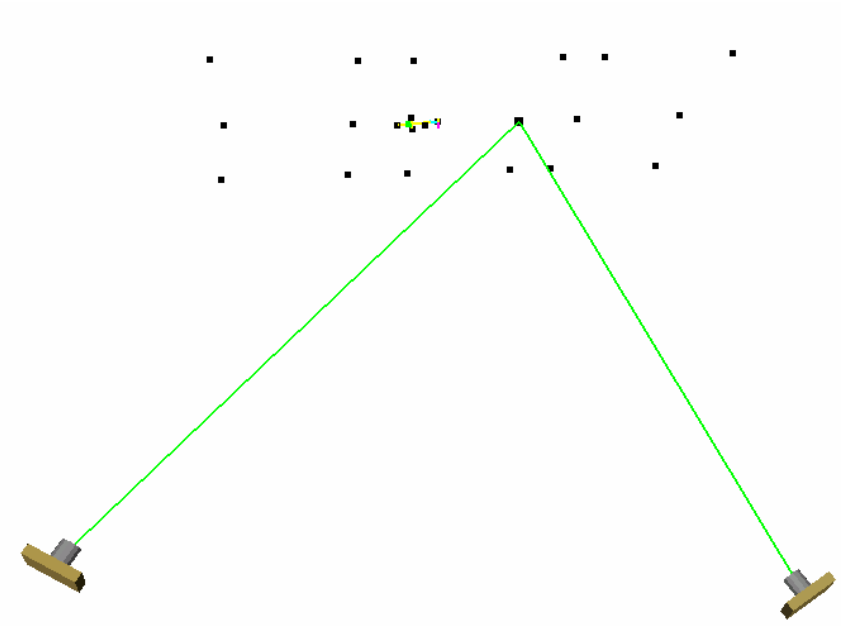
Targeting.
Targeting for this measurement was again very simple. Six coded targets were placed on each of the three panels. An AutoBar was also added to the object.

Photography
Initially it is necessary to determine the coordinates of the targets in order to establish a "coordinated" reference field. A total of 16 photographs were taken for the establishment measurement. The network configuration is shown in the adjacent image.



Data Collection

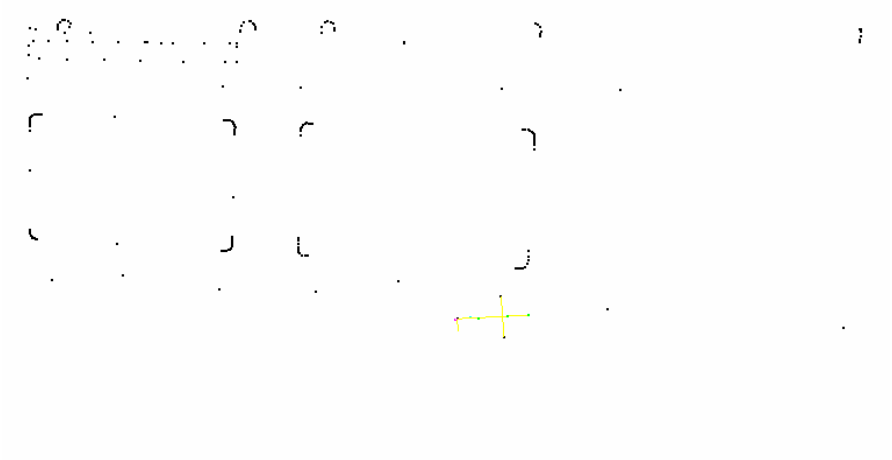
Once the coordinated field has been established it is possible to commence the data collection phase. The cameras are located so they face the area of interest. They are shown in the image below:



Wireless probes are used to collect the required data. Up to 16 different probes are available. Each of these has a unique pattern of dots and is automatically identified by the system. The probes also have a variety of tips available. The probes typically come with a 3mm or 6mm ball tip. Scribe tips are also available.

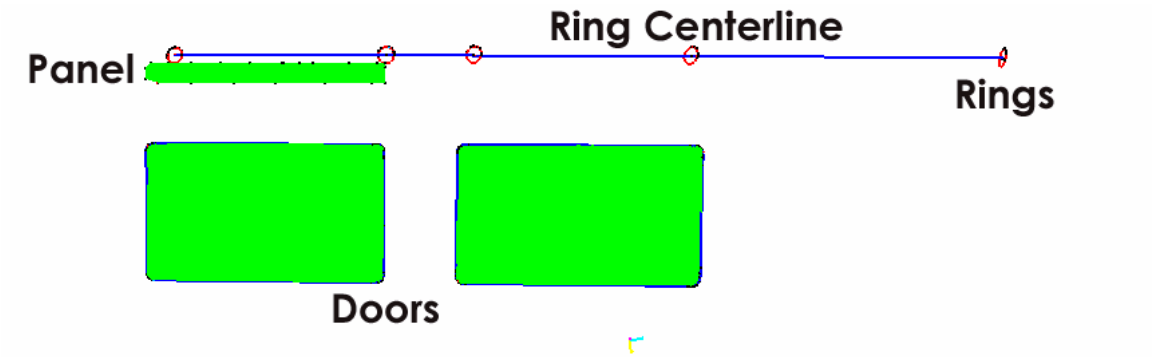
The cameras are triggered using a remote triggering device. Once triggered the probe tip position is determined.

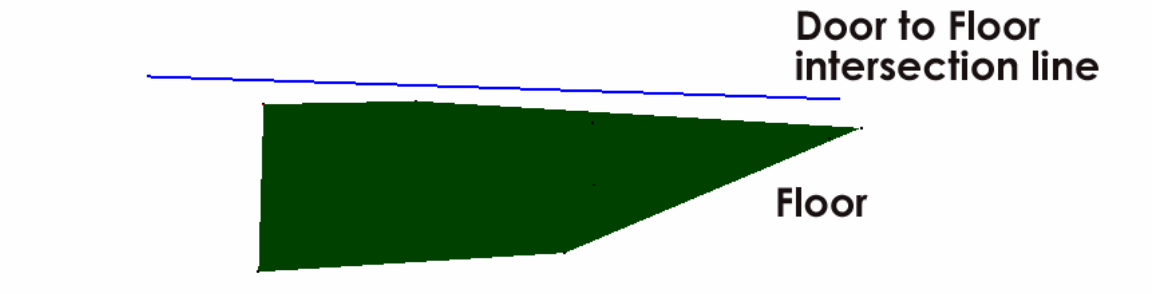
The data collected is shown in the image below:



Data Analysis

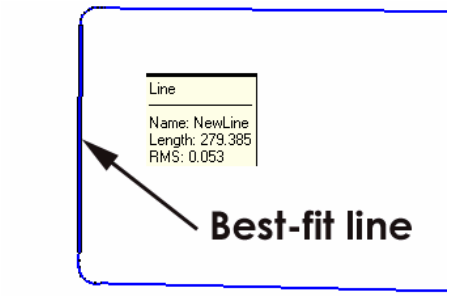
The data collected was used to determine some of the geometric features of the object. These features were determined using the Solids module of V-STARS. These are shown below:

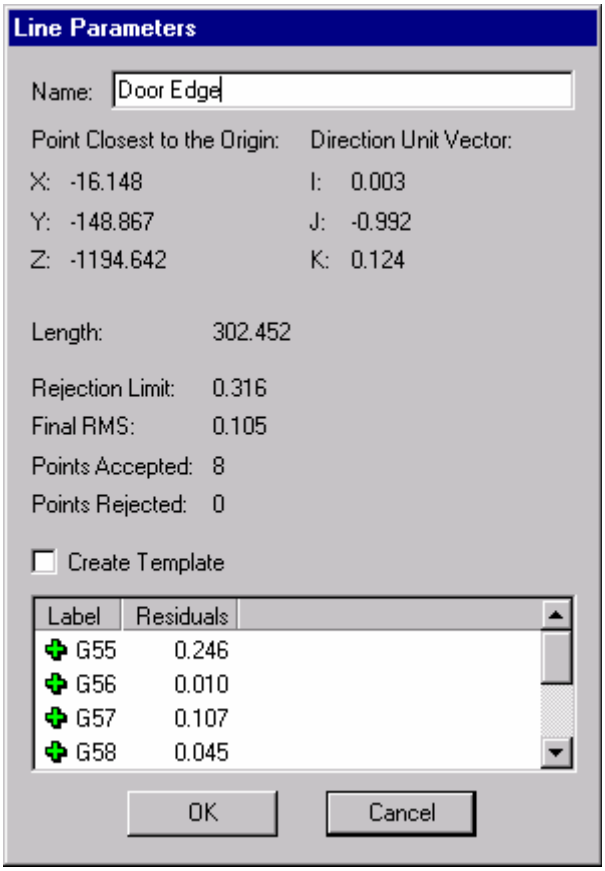




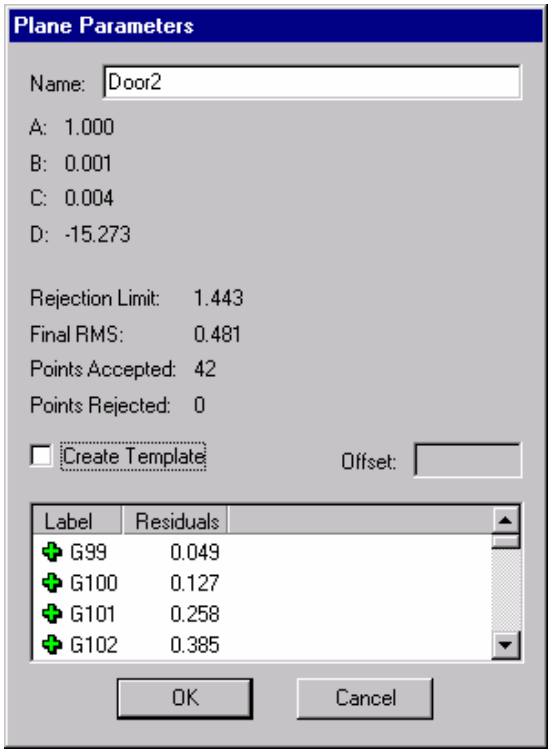
The diagrams below show some of the outputs of the best-fit operations.

Best-fit line

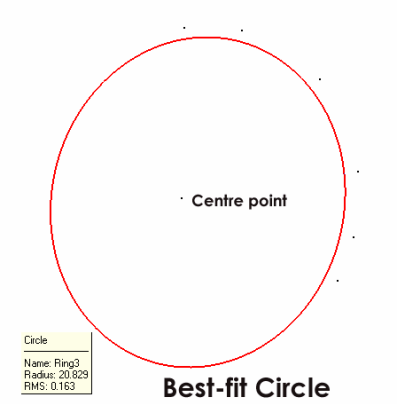




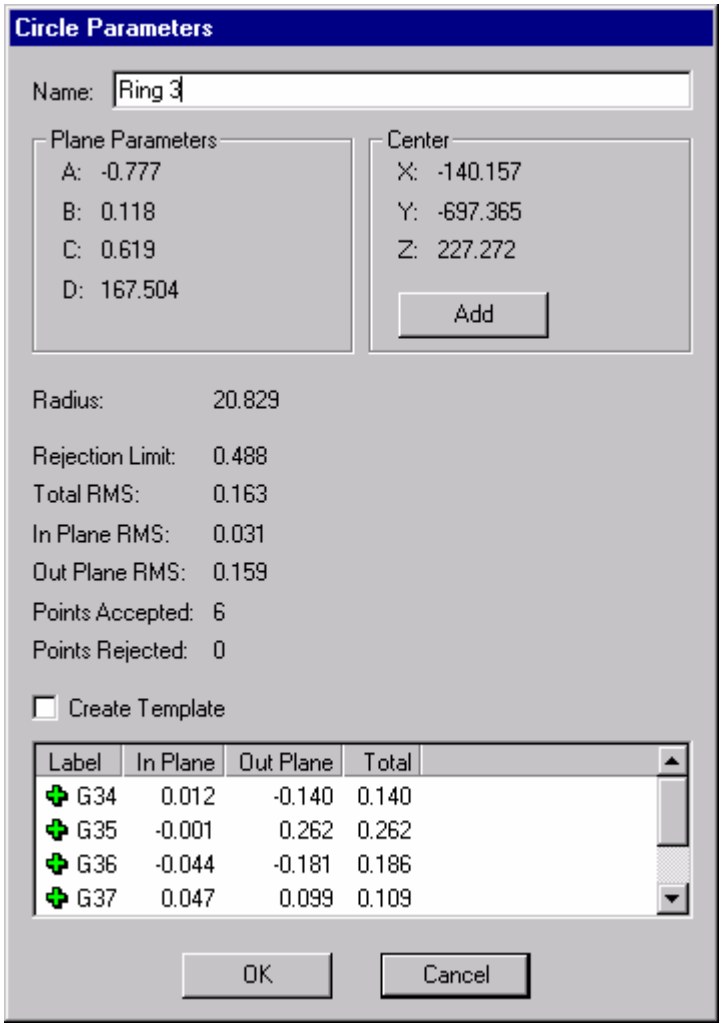
Best-fit Plane



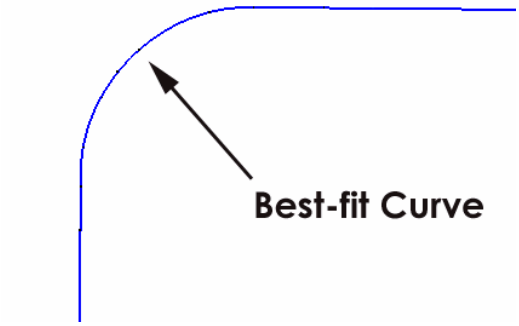
Best-fit Circle

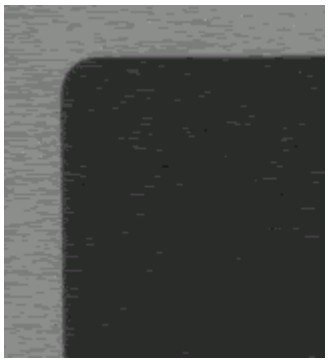


Best-fit Circle

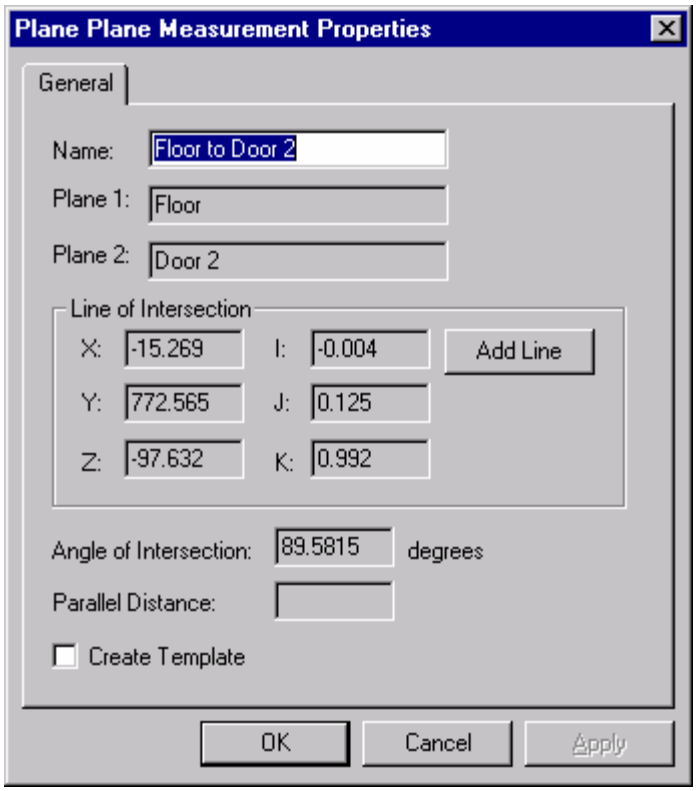


Best-fit Curve





Plane to plane intersection



Concluding Remarks:

The measurements undertaken have shown that V-STARS and the PRO-SPOT target projector can be a very powerful inspection tool. The results of the measurement are very accurate and more importantly were produced quickly. With correct planning and targeting this data acquisition time could even be reduced further. There is also great scope use this technology to complete part inspections.

GSI would like to thank NASDA for welcoming us into their facility. We will be happy to discuss the results of this report or any other aspect of the technology presented.