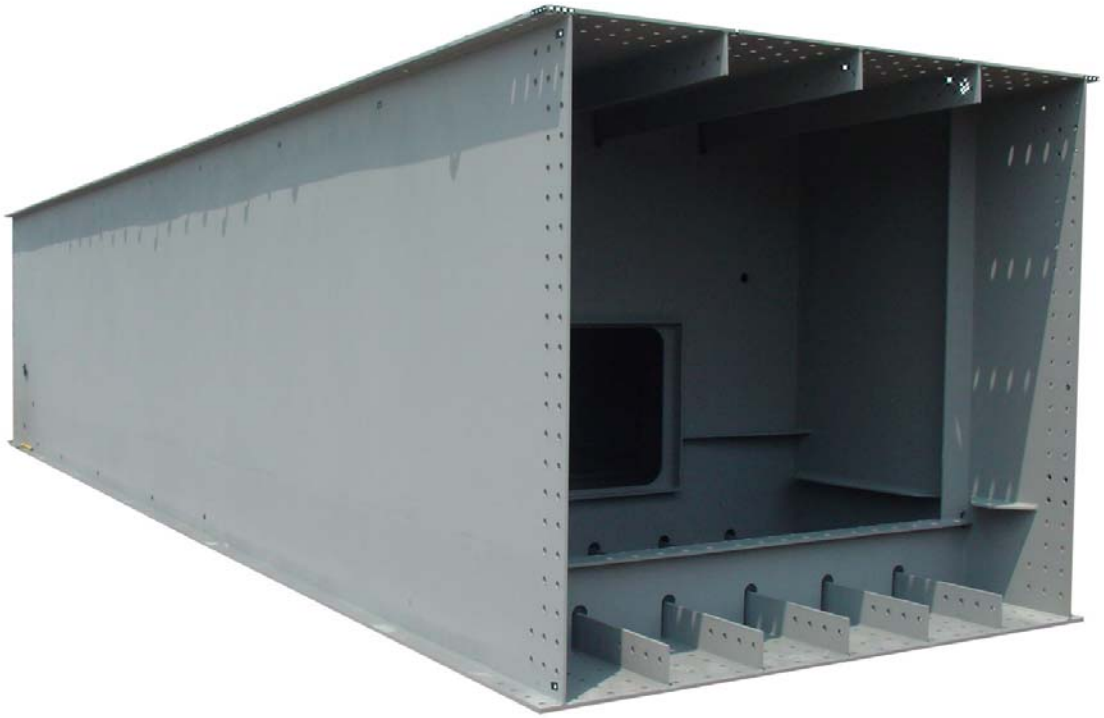
Geodetic Systems

V-STARS S6 Demonstration
Measurement Report for

Samsung Heavy Industries
South Korea



June 2004

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Object Measured

One object was measured as part of the V-STARS demonstration. The object was a large bridge block (11.3L x 2.7W x 2.3H). The block is shown on the cover of this report.

The primary objective of this measurement was to determine some of the key dimensional information of the block.

Of key importance in this measurement was the time to complete the measurement and the accuracy.

The block was measured with the INCA2 S6 system.

Equipment Used

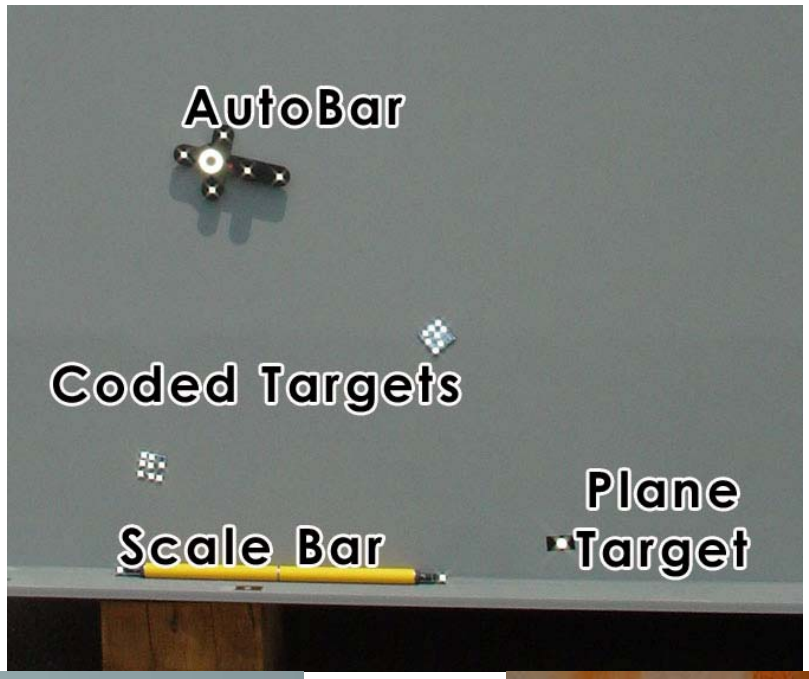
1. V-STARS S6 Camera System (INCA3 S8 system shown in image below)
2. Scale Bars
3. AutoBar.
4. Various Targets

Block Measurement Objectives

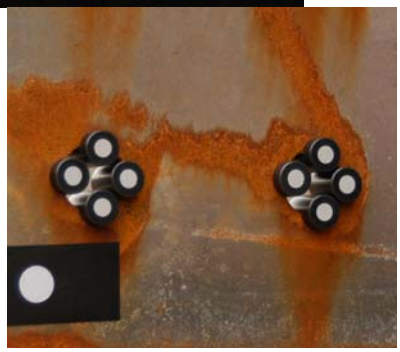
1. Demonstrate camera use and object targeting
2. Determine location of key corners
3. Determine the location of key bolt holes
4. Compute best-fit planes for block sides
5. Compute key distances
6. Complete various analysis tasks

Block Targeting

1. AutoBar for initial coordinate system
2. Reference coded targets to tie photography together
3. Edge targets for bolt holes
4. Adapters for bolt holes (not used due to incorrect hole size)
5. Edge targets for key planes
6. Single dot targets for key planes
7. Three scale bars



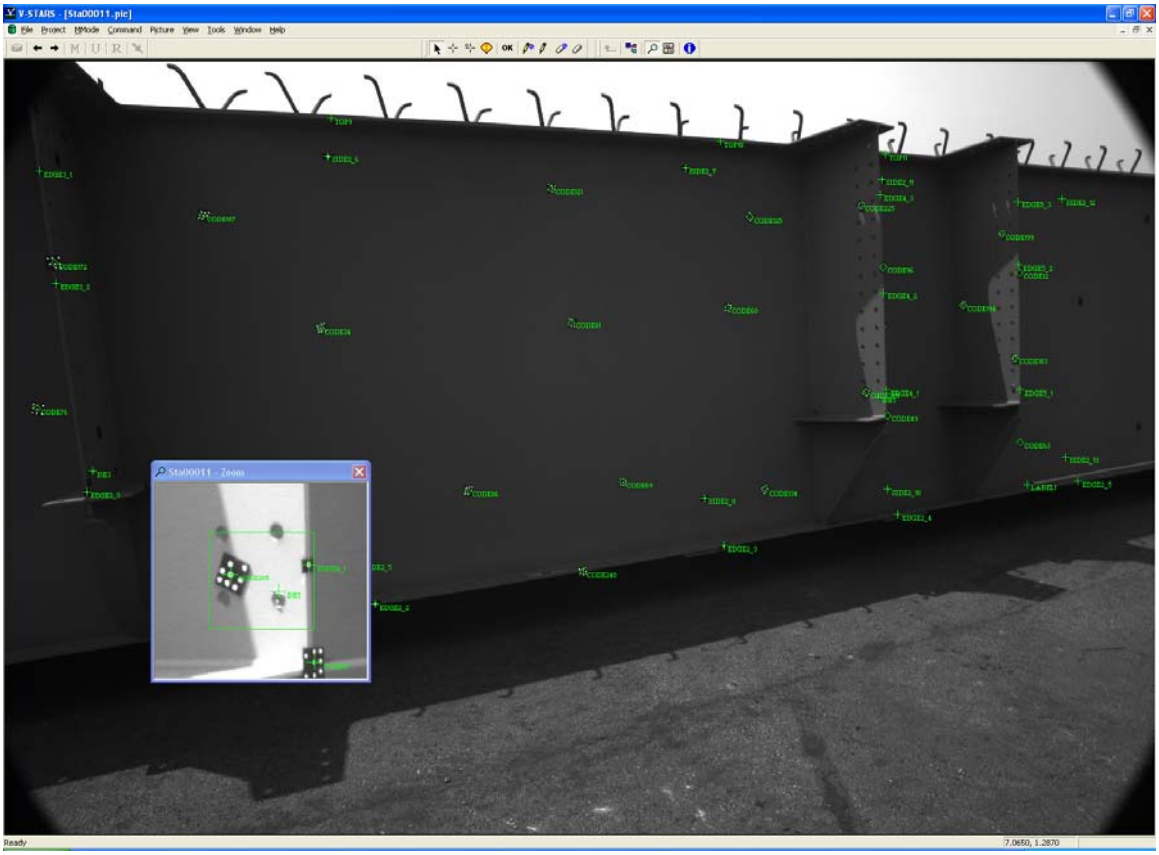
Bolt hole adapter



Bolt hole edge targets

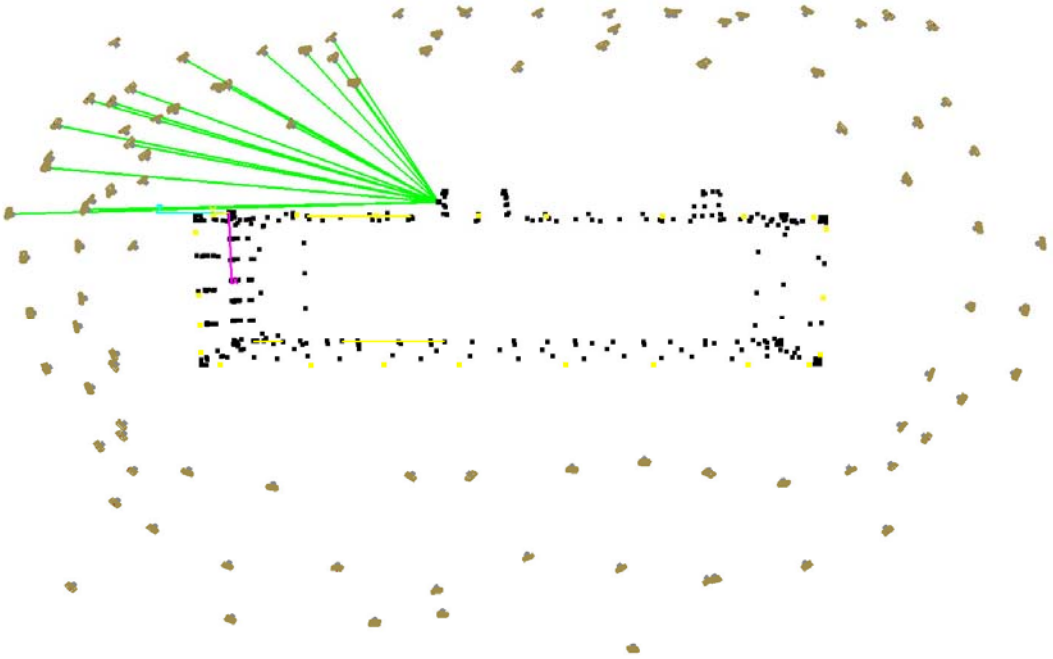
Measurement Statistics

INCA2	
No. of photos	102
No. of points	456
Accuracy RMS X,Y,Z X 0.07mm Y 0.04mm Z 0.07mm	
Scale Agreement = 0.08mm	



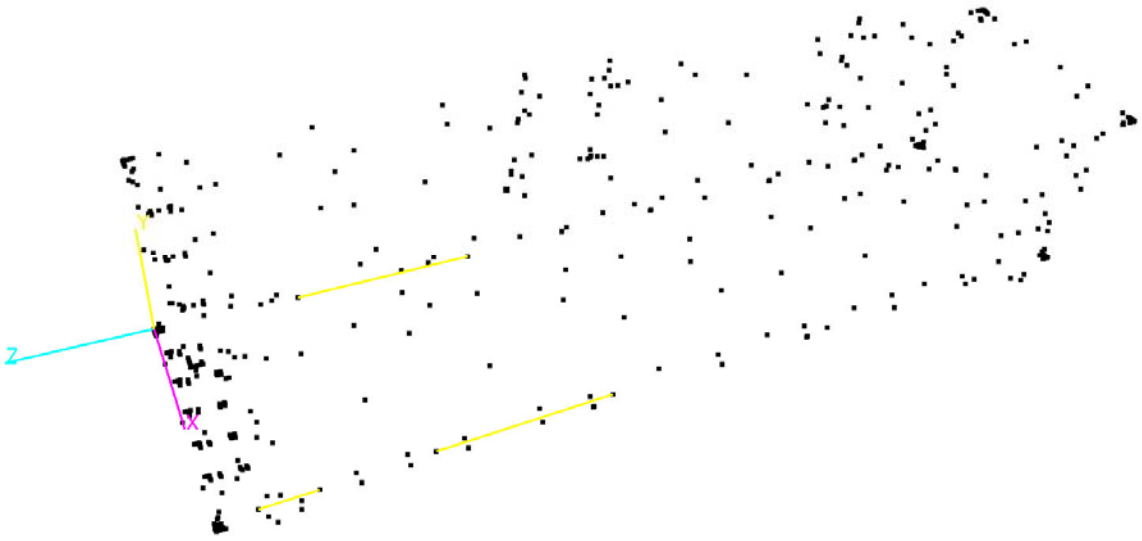
Typical V-STARS measurement image

The diagram below illustrates the geometry used to create the point cloud.



Point Cloud

The final point cloud from the network is shown below.

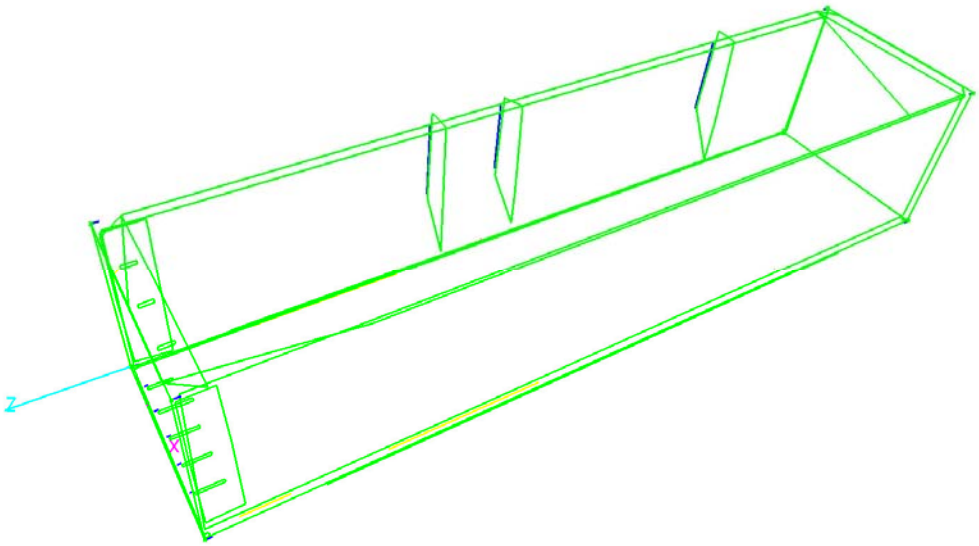


Alignment

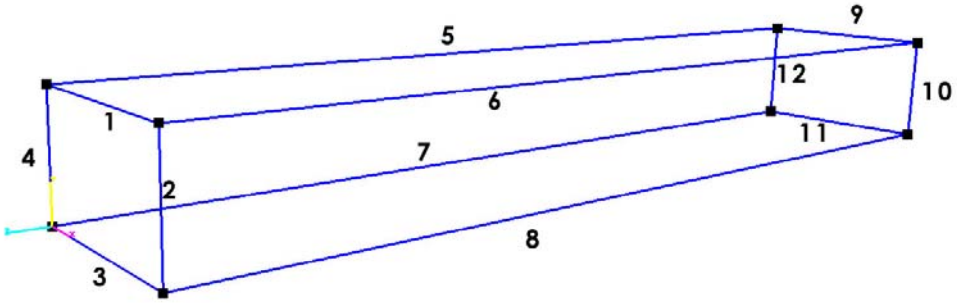
No Alignment was necessary for this measurement. Typically the block would be aligned into the relevant design coordinate system.

Analysis

The data collected was used to compute the some of the key geometric characteristics of the block. Some of the key planes and lines computed are shown in the images below.

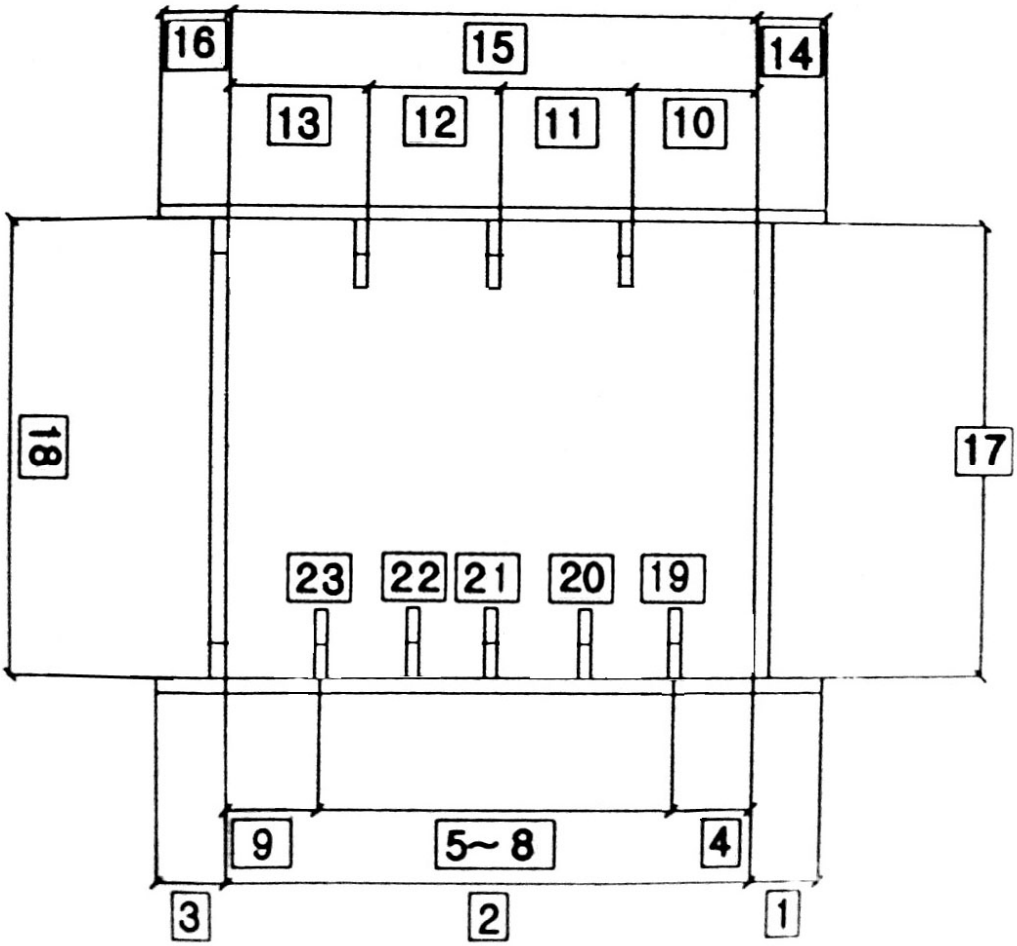


The corner distances are shown in the table below.



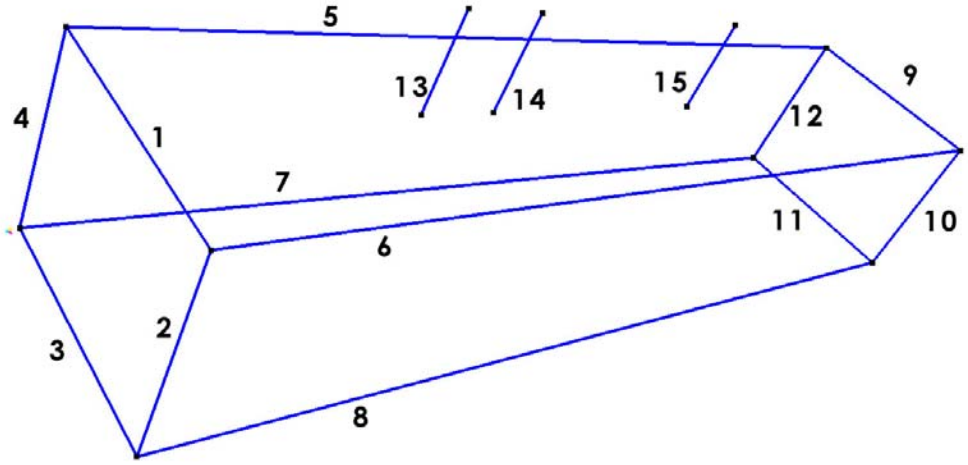
Dist(mm)	V-STARS
1	2701.63
2	2299.08
3	2700.80
4	2299.23
5	11252.45
6	11255.09
7	11251.18
8	11252.81
9	2701.14
10	2300.66
11	2700.25
12	2300.30

The distances were calculated for the front portion of the bridge block. The diagram below summarizes the key distances computed.



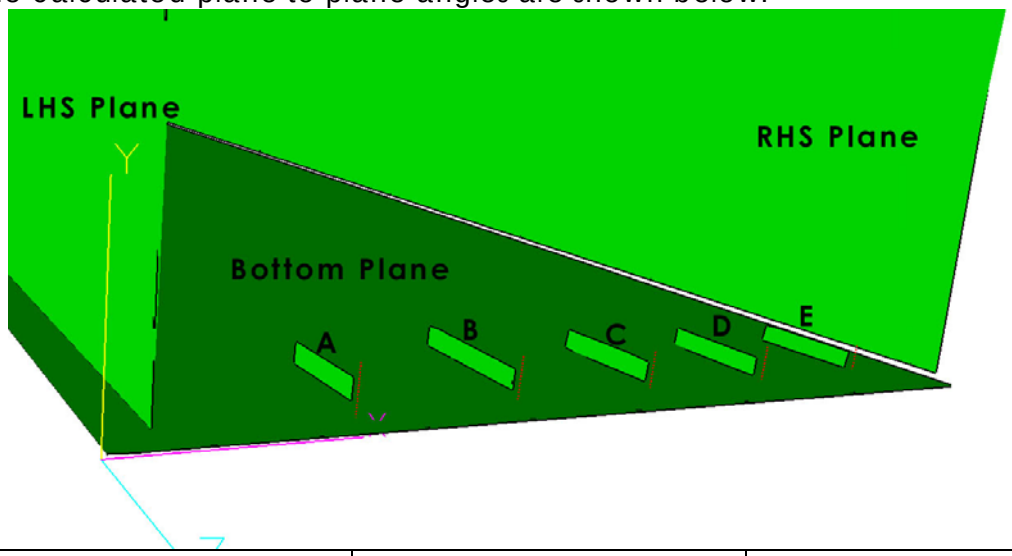
	DIST(mm)		DIST(mm)
1	101.95	**13**	617.55
2	2498.64	**14**	100.25
3	100.23	**15**	2500.94
4	421.56	**16**	100.60
5	415.06	**17**	2299.08
6	419.71	**18**	299.23
7	416.86	**19**	150.30
8	415.90	**20**	151.00
9	409.55	**21**	151.36
10	633.80	**22**	150.28
11	625.24	**23**	151.07
12	624.36		

The bolt holes measured were used to compute the following distances.

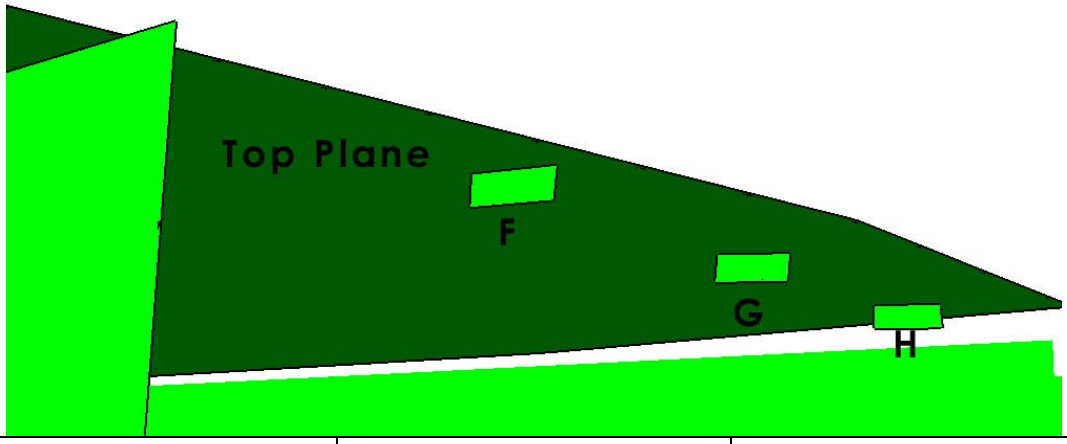


Dist(mm)	V-STARS
1	2553.89
2	2100.99
3	2549.83
4	2098.33
5	11162.20
6	11163.92
7	11163.36
8	11164.79
9	2552.47
10	2100.12
11	2549.29
12	2099.97
13	1400.20
14	1400.37
15	1400.67

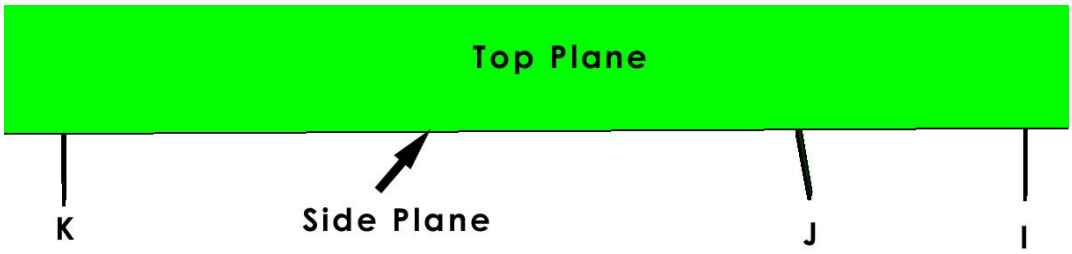
The calculated plane to plane angles are shown below.



Plane 1	Plane 2	Angle ˚
LHS Plane	Bottom Plane	89.9770
RHS Plane	Bottom Plane	89.9602
A	Bottom Plane	89.4286
B	Bottom Plane	89.3219
C	Bottom Plane	89.0344
D	Bottom Plane	88.7863
E	Bottom Plane	89.5657
LHS Plane	RHS Plane	0.0527
Top Plane	Bottom Plane	0.0606



Plane 1	Plane 2	Angle ˚
LHS Plane	Top Plane	89.9697
RHS Plane	Top Plane	89.8999
F	Top Plane	89.2103
G	Top Plane	89.0438
H	Top Plane	89.5448



Plane 1	Plane 2	Angle ˚
I	LHS Plane	89.6671
J	LHS Plane	79.9666
K	LHS Plane	89.8084
Edge	**Plane 2**	**Distance (mm)**
Edge I	LHS Plane	536.65
Edge J	LHS Plane	537.89
Edge K	LHS Plane	538.54

Time

Initial Investigation	10 minutes
Targeting	30 minutes
Photography	20 minutes
Processing	15 minutes
Analysis	15 minutes
Total	**90 minutes**

Future Measurements

With careful planning the time taken for future or ongoing measurements can be greatly reduced. It is envisaged that the measurement time can even be reduced to less than 60 minutes in most cases. The following are just a few examples of how the measurement time could be reduced.

Item	Effect	Estimated time saving
Neutral density filters	These filters cut out a great deal of ambient light and result in a much smaller image file size. This makes image file scanning and processing significantly faster.	Scanning will be 5-10 times faster
Dedicated measurement area.	The creation of a dedicated measurement area with permanent coded targets has a significant effect on targeting time and photography.	Approx. 15-30 minutes saved for targeting, more for processing.
Photographic procedure	The introduction of a photographic plan or procedure ensures that the time photographing the object is minimized, while maximizing the point accuracy.	Approx. 10 minutes.
Bolt hole adapters	Bolt hole adapters will allow rapid targeting of the bolt hole positions.	Adapter targeting in < 5 minutes
Special corner targets	Feature targets are special targets that allow features such as corners to be rapidly measured. They are processed automatically by V-STARS software. A time saving benefit is achieved both during the targeting and analysis stage.	Corner targeting in < 5 minutes. Analysis reduced to no time.
Macro analysis functions	V-STARS incorporates "construction" objects which are powerful analysis macros. Construction objects allow repeated analysis tasks to be completed automatically.	Analysis tasks can be completed in minutes rather than hours
Template projects	Template project allow key project parameters to be set up the same way for each block measured.	Potential saving of 30-60 minutes

Concluding Remarks

The measurement undertaken has shown that V-STARS can be a very powerful measurement tool. The results of the measurement undertaken were both fast accurate.

GSI would like to thank Samsung Heavy Industries 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.