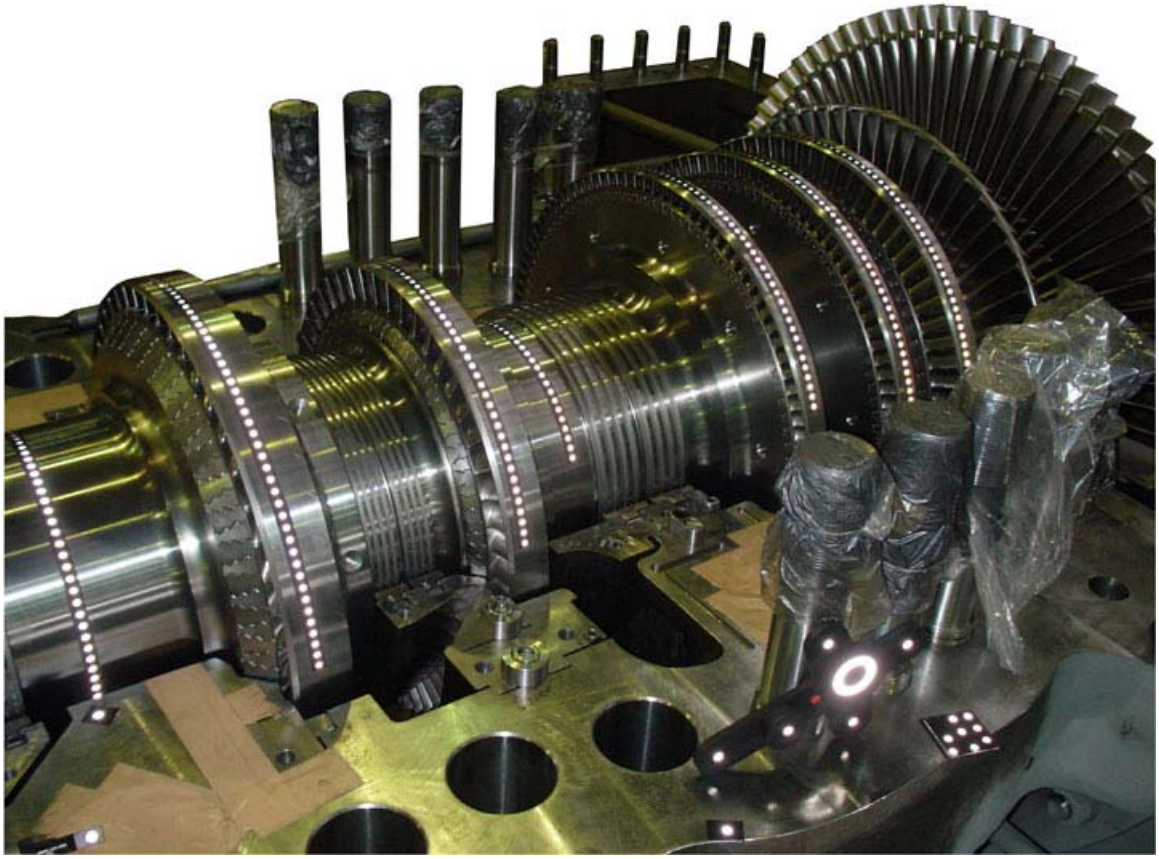
Geodetic Systems

V-STARS S6 Demonstration
Measurement Report



May 2004

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Object Measured

One object was measured as part of the V-STARS demonstration. The object was a large turbine (3.0L x 2.5W x 0.5H). The turbine is shown on the cover of this report.

The primary objective of this measurement was to determine some of the key dimensional information relating to the location of the shaft relative to the casing.

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

Equipment Used

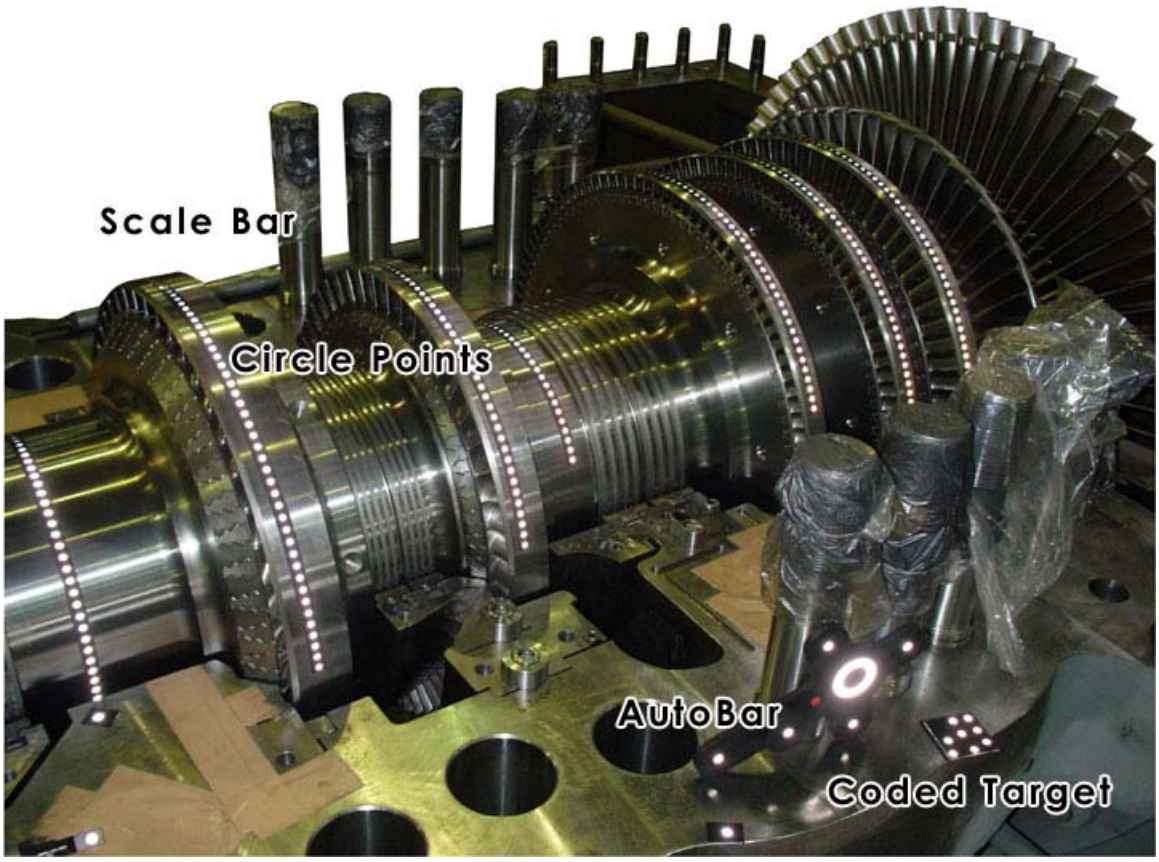
1. V-STARS S6 Camera System (INCA3 S8 system shown)
2. Scale Bars
3. AutoBar.
4. Various Targets

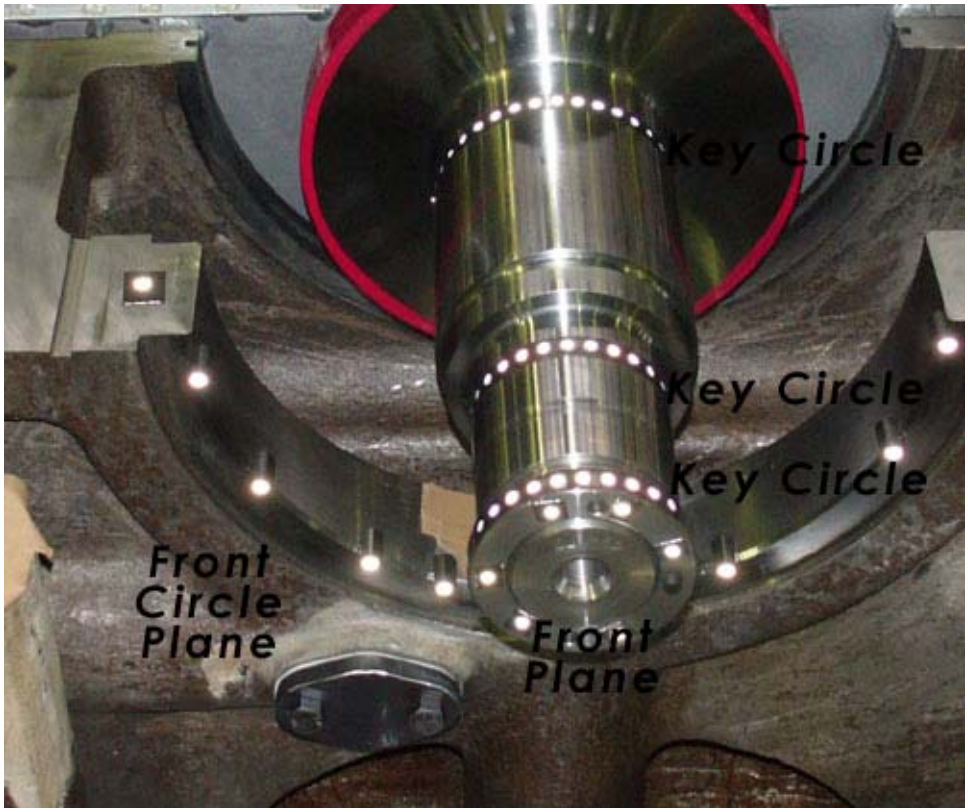
Turbine Measurement Objectives

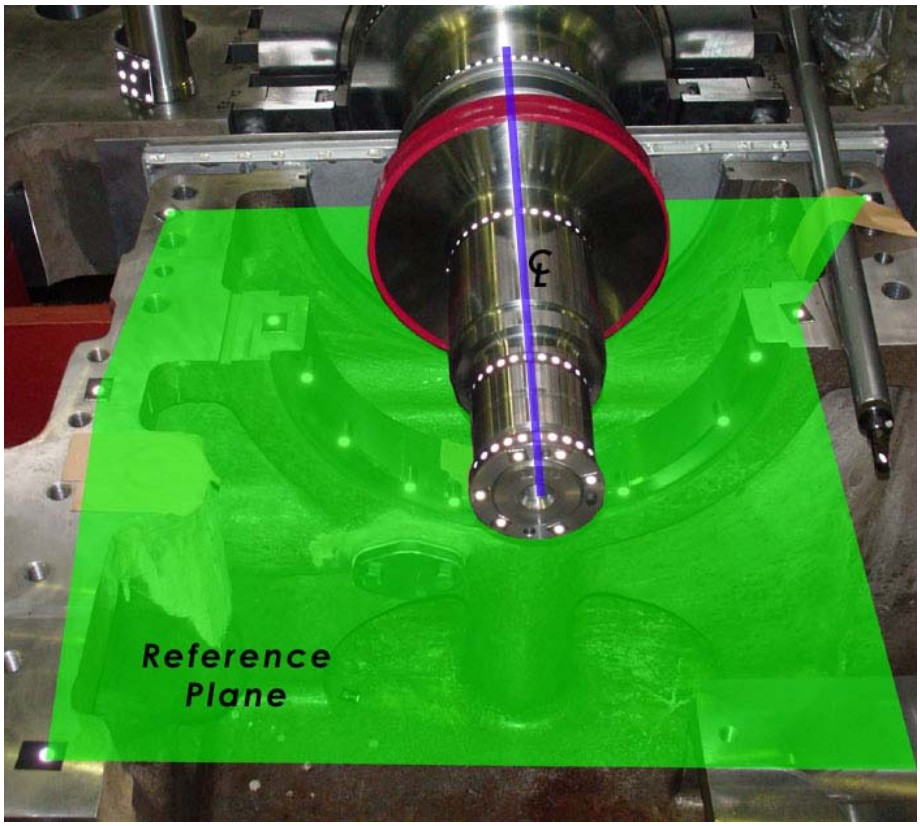
1. Demonstrate camera use and object targeting
2. Determine location of key circles along turbine
3. Compute best-fit planes for turbine casing
4. Determine relationship between circle centers and case plane

Turbine Targeting

1. AutoBar for initial coordinate system
2. Reference coded targets to tie photography together
3. Edge targets for end circle planes
4. Single dot targets for key circles
5. Single dot targets for key planes
6. Two scale bars

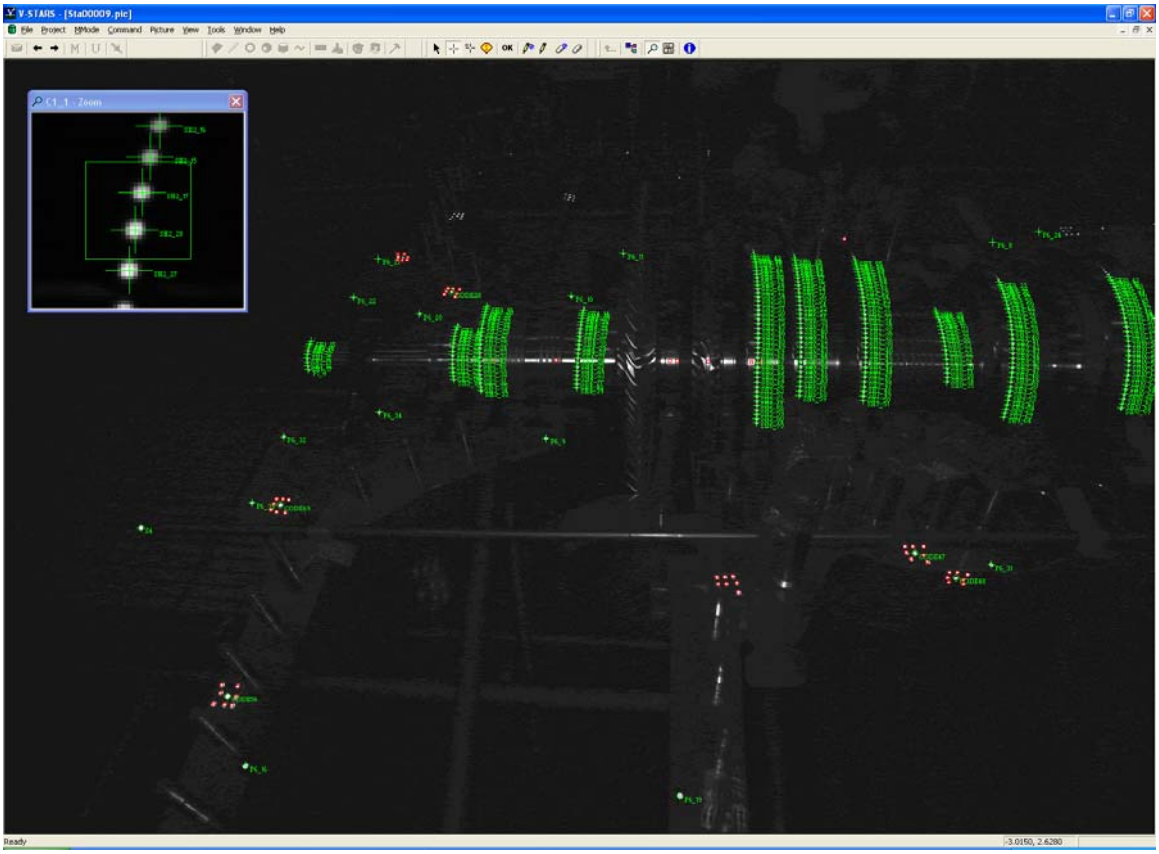



Key Circle
Key Circle
Key Circle
Front
Circle
Plane
Front
Plane


℄
Reference
Plane

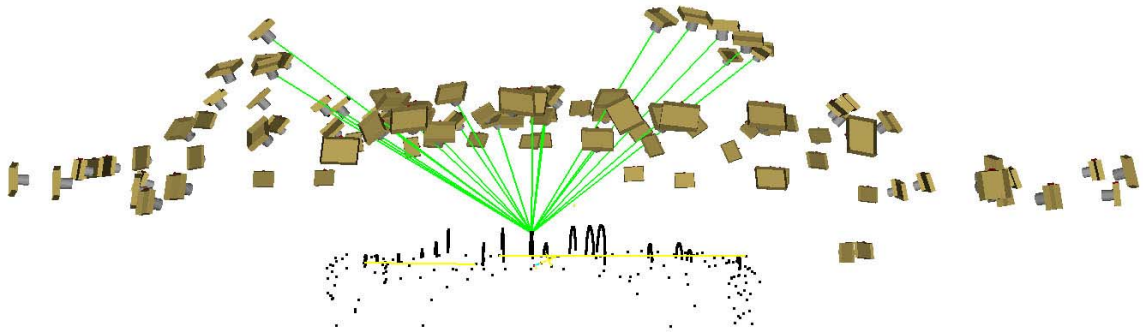
Measurement Statistics

No. of photos	104	
No. of points	883	
Accuracy RMS X,Y,Z	X	0.010
	Y	0.009
	Z	0.008

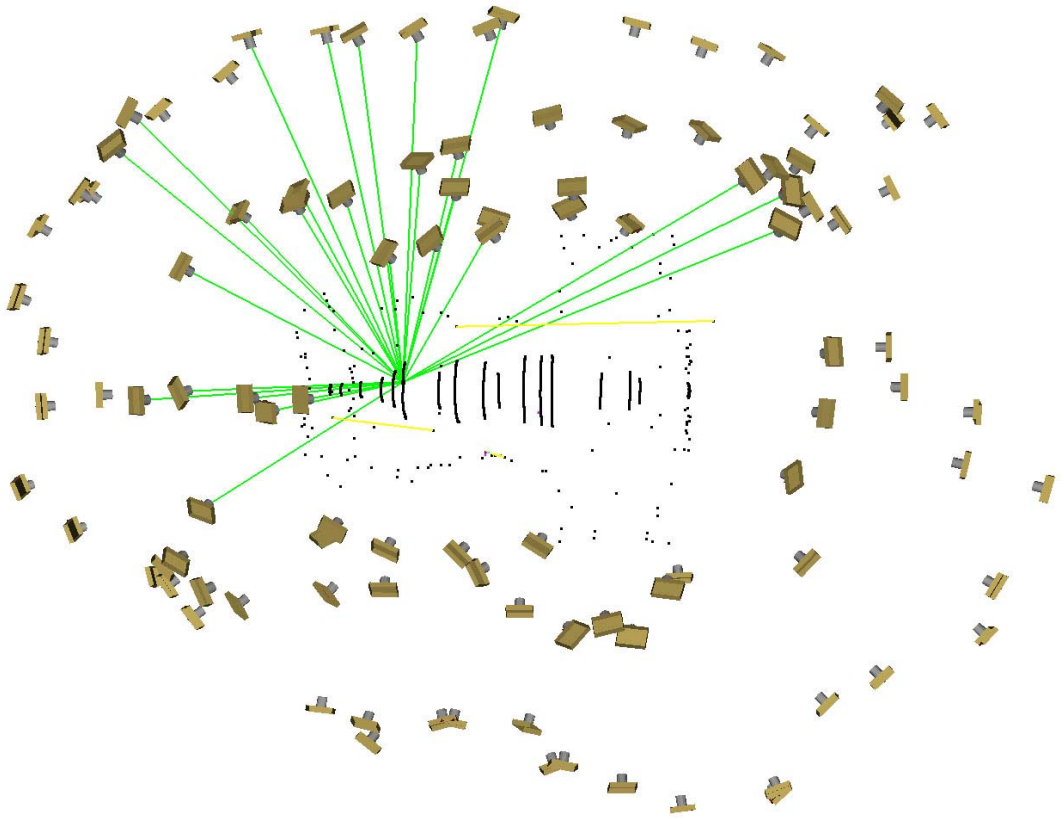


Typical V-STARS measurement image

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



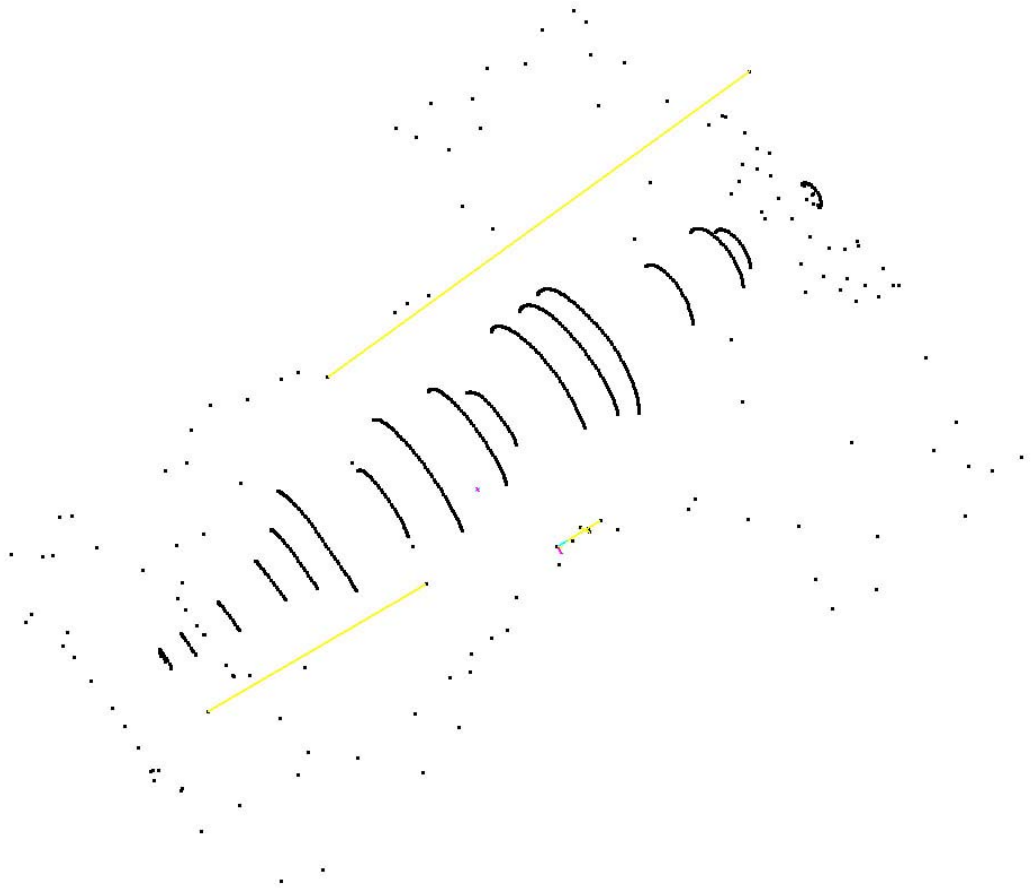
Front View



Top View

Point Cloud

The final point cloud from the network is shown below.

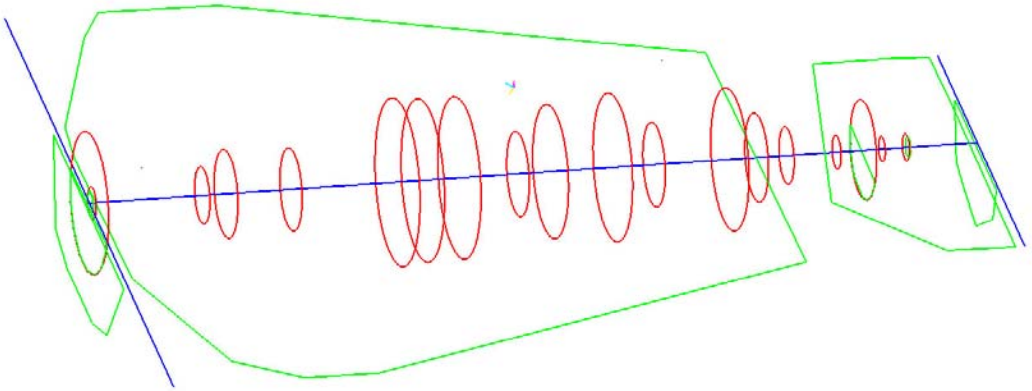


Alignment

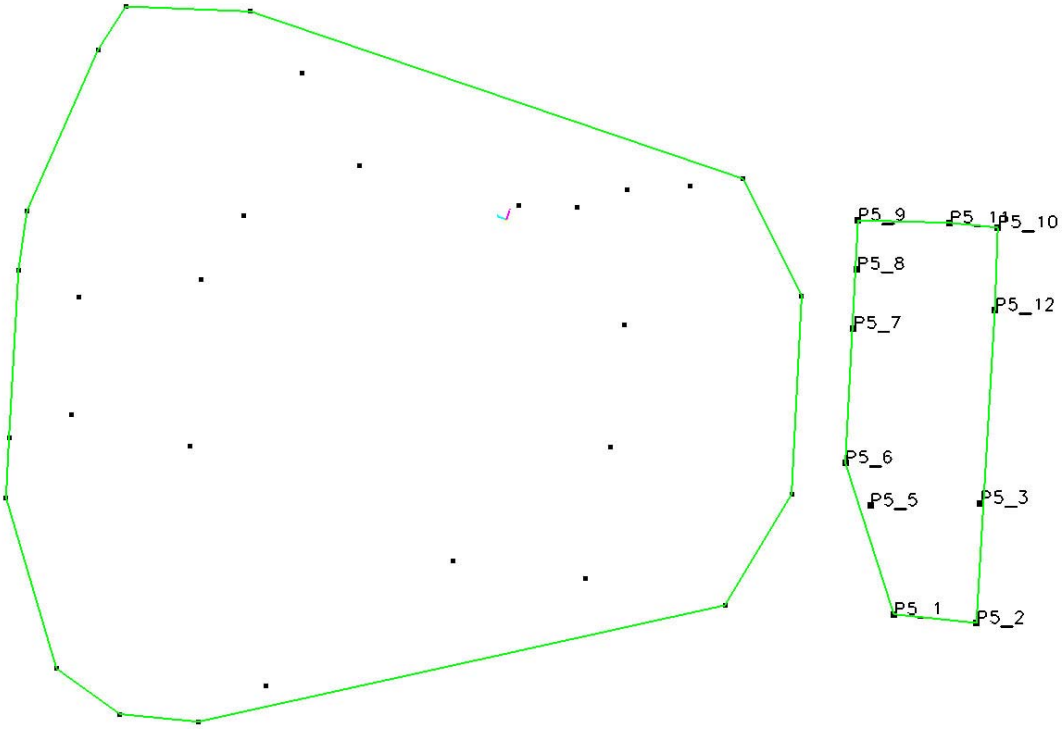
No Alignment was necessary for this measurement.

Analysis

The data collected was used to compute the some of the key geometric characteristics of the turbine. The key planes, circles and lines computed are shown in the image below.



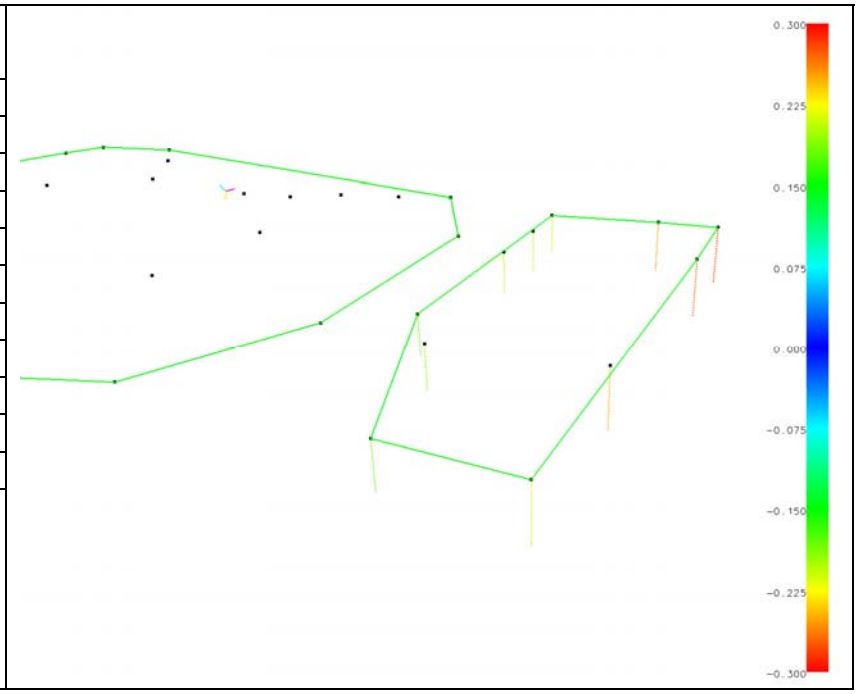
Initially the two planes that define the turbine casing were computed. These are shown in the image below. The points on the smaller plane (P5_1 to P5_12) were measured against the larger plane to determine the misalignment of the two.



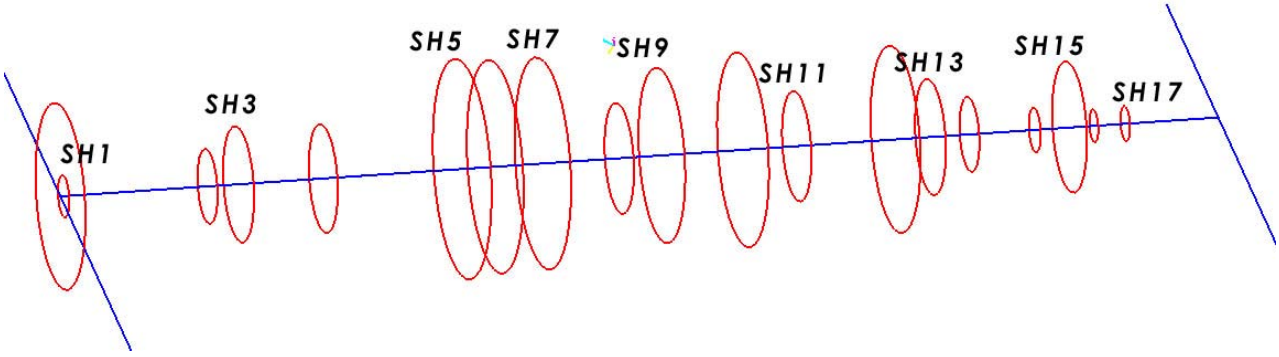
Large Plane RMS = 0.035mm
Small Plane RMS = 0.007mm

The values are shown in the image below and displayed graphically in the image.

Point	Deviation (mm)
P5_1	-0.144
P5_2	-0.173
P5_3	-0212
P5_4	-0.088
P5_5	-0.150
P5_6	-0.142
P5_7	-0.161
P5_8	-0.161
P5_9	-0.245
P5_10	-0.214
P5_11	-0.236
P5_12	-0.117



Each of the key circle data was used to compute a center point. This point was then measured against the center plane.



The results of the circle measurements are shown below:

Name	X	Y	Z	Radius	RMS
C1_CENT	-875.622	626.248	1367.633	249.864	0.033
C2_CENT	-230.559	-478.388	-1121.744	174.838	0.033
SH1	-873.556	623.022	1359.505	56.557	0.033
SH10	-441.022	-120.936	-316.024	260.094	0.025
SH11	-406.825	-179.727	-448.595	147.559	0.019
SH12	-344.006	-288.182	-692.249	250.082	0.020
SH13	-321.604	-326.194	-778.635	155.168	0.057
SH14	-296.804	-368.930	-874.669	100.096	0.018
SH15	-255.262	-440.404	-1035.686	59.983	0.049
SH16	-217.615	-505.202	-1181.563	44.339	0.018
SH17	-197.443	-539.542	-1258.912	47.544	0.019
SH2	-781.958	465.394	1004.590	100.102	0.023
SH3	-762.173	431.485	928.074	155.147	0.042
SH4	-708.234	338.655	719.033	145.121	0.034
SH5	-619.822	186.632	376.546	294.661	0.036
SH6	-598.787	150.423	295.077	285.116	0.018
SH7	-568.477	98.287	177.658	283.517	0.019
SH8	-519.805	14.558	-10.928	148.095	0.024
SH9	-492.703	-32.044	-115.893	234.523	0.018

Based on the center points the following deviations to the large plane were calculated.

Point Label	Delta X	Delta Y	Delta Z	Total
SH1	0.023	0.004	0.004	0.024
SH2	-0.007	-0.038	0.015	0.041
SH3	0.029	0.019	-0.001	0.035
SH4	0.002	0.003	-0.001	0.003
SH5	0.002	0.036	-0.015	0.039
SH6	0.001	0.005	-0.002	0.005
SH7	-0.002	0.002	-0.002	0.003
SH8	-0.014	0.003	-0.005	0.015
SH9	-0.010	0.005	-0.005	0.012
SH10	0.001	-0.022	0.010	0.025
SH11	-0.018	0.034	-0.020	0.044
SH12	-0.121	-0.204	0.059	0.245
SH13	0.005	0.095	-0.041	0.103
SH14	0.004	0.013	-0.005	0.014
SH15	-0.020	0.025	-0.016	0.036
SH16	-0.034	-0.001	-0.008	0.035
SH17	0.159	0.020	0.032	0.164

Time Summary

Initial Investigation	10 minutes
Targeting	20 minutes
Photography	10 minutes
Processing	20 minutes
Analysis	30 minutes
Total	**90 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 very accurate and more importantly were produced quickly.