

# Photogrammetric Measurement Report: 

## Deformation Measurements of Antenna \#2

Australia Telescope National Facility, Narrabri



| METROLOGY REPORT |  |
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| Description: | Deformation Measurement of a 22m Antenna. |
| Object Measured: | Antenna \#2, Australia Telescope National Facility, <br> Narrabri. |
| Date of Measurement: | $12^{\text {th }}$ February 2002 |
| Requested by: | Barry Parsons |
| Number of Surveys: | The Antenna was surveyed in six inclinations. |
| Requirement: | To perform a multiple measurements of the antenna <br> and to quantify the deformation resulting from its <br> various inclinations. |

## Detailed Examination:

Units $=\mathrm{mm}$ unless otherwise stated
Uncertainty of Measurement: Overall less than 0.060 mm RMS, also see 'Survey Summary' for each measurement for detailed information.

## Measurement:

The measurement was performed with the V-STARS Photogrammetry System, and is traceable to National Standards.

## Measured By:

Danny Brizzi
Harry Hanley


## Measurement Technology: V-STARS/S System

The V-STARS/S system is a camera based 3D coordinate measurement system. The technology is extremely portable and consists of a notebook computer, a single highresolution digital camera, the V-STARS software and accessories.

V-STARS is capable of measuring an objet to better then 1 part in 100,000. This equates to 0.2 mm on a 22 m antenna.

More information on the V-STARS/S system can be found on the VMS website:
http://www.sli.unimelb.edu.au/vms/vms vstars/index.html



## Survey Procedure

The antenna was surveyed from the bucket of a cherry picker.
The number of photos taken for each survey ranged between 100 and 140 images.
Figure 1. shows the positions of the camera stations (blue squares) relative to the measured points (black dots) on the main reflector.


Figure 1. Camera stations for the 90 Degree Survey


## Datum:

The antenna was aligned using the following method.
XY-Plane - Aligned through the points on 'Ring 6' (pink circle in Figure 2)
X-Axis - Aligned through the lightning rod
Z-Axis - Positive out of the antenna


Figure 2: Antenna Datum

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## Label Convention

## Main Reflector Label Convention

The main reflector labelling convention is as follows:
Ring\#_Panel\#_Point on Panel
Figure 3. contains an example of the labelling convention for the points on Ring 6 Panel 2, points 1 through to 5 . The same labelling convention was used for every point on the main reflector.


Figure 3. Labelling for Ring 6 - Panel 2

The following page contains a summary of the labelling convention for the main reflector (Figure 4).

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Figure 4. Main reflector labelling summary

## Quadrapod Label convention

The quadrapods are labelled Q1 through to Q4. Q1 is the leg closest to the north point (lightning rod) of the antenna as indicated in Figure 5.


Figure 5. Quadrapod Label Convention

The points on each leg are divided into 5 groups. Group 1 is at the base of the leg, and group 5 is at the top of the leg, as seen in Figure 6.


Figure 6. Quadrapod target label convention


## Top of Quadrapod and Sub-Reflector Label Convention

Points measured on the top of the quadrapod are labelled TOPS_1 to TOP_17.
Points measured on the sub-reflector are labels SR_1 to SR_8
Please note: due to obstructions, every point on the quadrapods and sub reflector was not visible in every survey.

## Feed Label Convention

Three points were measured on a frame attached to the feed. Their labels are F_1, F_2 and F_3.

An additional seven points were also measured on top of the fibreglass structure covering the feed. These points are labelled C_1 to C_7.

## Additional Targeting

A single strip of 99 targets was placed on the main reflector. The targets are labelled P_1 to P_99. P_1 is located at the outer edge of the reflector (Ring 6) and P_99 is the target closest to the centre of the main reflector (Ring 1).

## Survey Results

## Antenna Inclination: 90-Degrees (Z-axis to horizontal)

Survey Summary
Images Taken: 108
Survey Accuracy:

| RMS | mm |
| :--- | :--- |
| X | 0.037 |
| Y | 0.036 |
| Z | 0.038 |

The scale of the antenna was set during this survey by measuring two invar scale-bars of different lengths. The RMS of the scale bars is 0.016 mm

The antenna deformation was calculated relative to the 90 -degree survey. Each survey subsequent to the 90 -degree survey was aligned to the coordinates of the inner three rings of main-reflector points from the 90-degree survey. Since 67 points were used in each of these alignments, these alignment calculations were over-determined and were thus subjected to least-squares treatment. It is from the least-squares alignment calculation that we gain confidence that the inner three rings of points remained relatively stable as the RMS of the alignment calculation was in all cases below 0.140 mm .

The XYZ coordinates for the 90-degree survey are contained the Microsoft Excel spreadsheet: 'Antenna 2 Measurement Summary 120202.xls’


## Antenna Inclination: 75 Degrees

Survey Summary
Images Taken: 115
Survey Accuracy:

| RMS | mm |
| :--- | :--- |
| X | 0.45 |
| Y | 0.48 |
| Z | 0.49 |

The XYZ coordinates for the 75 -degree survey are contained in Appendix B
Deformation Summary
The deformation occurring in each point is contained in the Microsoft Excel spreadsheet: 'Antenna 2 Measurement Summary 120202.xls'.

A contour plot of the main reflector surface deformation at 75 degrees is shown in Figure 7.


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Figure 7. Contour plot of the main reflector surface at 75 degrees


## Antenna Inclination: 60 Degrees

Survey Summary
Images Taken: 118
Survey Accuracy:

| RMS | mm |
| :--- | :--- |
| X | 0.037 |
| Y | 0.048 |
| Z | 0.053 |

The XYZ coordinates for the 60-degree survey are contained in Appendix D
Deformation Summary
The deformation occurring in each point is contained in the Microsoft Excel spreadsheet: 'Antenna 2 Measurement Summary 120202.xls'.

A contour plot of the main reflector surface deformation at 60 degrees is shown in Figure 8.


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Figure 8. Contour plot of the main reflector surface at 60 degrees


## Antenna Inclination: 45 Degrees

Survey Summary
Images Taken: 140
Survey Accuracy:

| RMS | mm |
| :--- | :--- |
| X | 0.035 |
| Y | 0.043 |
| Z | 0.050 |

The XYZ coordinates for the 45-degree survey are contained in Appendix F
Deformation Summary
The deformation occurring in each point is contained in the Microsoft Excel spreadsheet: 'Antenna 2 Measurement Summary 120202.xls'.

A contour plot of the main reflector surface deformation at 450 degrees is shown in Figure 9.


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Figure 9. Contour plot of the main reflector surface at 45 degrees


## Antenna Inclination: 30 Degrees

Survey Summary
Images Taken: 134
Survey Accuracy:

| RMS | mm |
| :--- | :--- |
| X | 0.032 |
| Y | 0.039 |
| Z | 0.049 |

The XYZ coordinates for the 30-degree survey are contained in Appendix H
Deformation Summary
The deformation occurring in each point is contained in the Microsoft Excel spreadsheet: 'Antenna 2 Measurement Summary 120202.xls'.

A contour plot of the main reflector surface deformation at 30 degrees is shown in Figure 10.


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Figure 10. Contour plot of the main reflector surface at 30 degrees


## Antenna Inclination: 15 Degrees

Survey Summary
Images Taken: 121
Survey Accuracy:

| RMS | mm |
| :--- | :--- |
| X | 0.033 |
| Y | 0.041 |
| Z | 0.052 |

The XYZ coordinates for the 15-degree survey are contained in Appendix J
Deformation Summary
The deformation occurring in each point is contained in the Microsoft Excel spreadsheet: 'Antenna 2 Measurement Summary 120202.xls'.

A Contour plot of the main reflector surface deformation at 15 degrees is shown in Figure 11.


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Figure 11. Contour plot of the main reflector surface at 15 degrees

