Parkes Panel Upgrade - Final Report

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July 23, 2003

1 Introduction

As part of the upgrade of the Parkes 64m Radiotelescope in order to support the NASA spacecraft data acquisition during the Mars missions, 2003 to 2004, CSIRO undertook to increase the (G/T) rating of the 64m antenna. One component of this involved replacing the wire-mesh panels in the diameter range 45 to 54m.

The replacement panels would have a much better figure than the wire-mesh panels, as well as better reflectivity. There is therefore a two-fold benefit : improved efficiency of the panels (lower surface error, higher reflectivity); and reduced T (reduced transmission).

A contract for the construction and installation of the panels was awarded to SES Pty. Ltd in august 2002, and the panels were installed in march 2003.

The reflector surface was adjusted in may and june; we believe that the overall surface rms is better than 0.8mm rms.

2 The Panel Contract

The specifications for the original panels ("Specification of a Giant Radio Telescope", november, 1955), included :

2.9 "Reflector surface material - may be of open mesh or sheet. If of open mesh, minimum reflection coefficient to be 95% at 21 cm. wavelength (99% at 50 cm.)

2.10 "Reflector surface accuracy - the departure of any part of the reflector surface from a paraboloid of revolution shall not exceed $\pm$ 0.5 inch for zenith angles down to 20 degrees"

In the event, a mesh panel was selected, with a mesh grid size of 8.0 (mm), with wires of about 1mm diameter.

Previous studies had shown that these panels had approximately 20% efficiency at 8 GHz, due to the combination of 30% transparency and 2mm (rms) surface error.

The proposed upgrade would replace the wire-mesh panels in the diameter range 45 to 54m with precision panels. These panels have a reflector surface of perforated aluminium, with 2.5mm thickness; 4.75mm diameter staggered holes at 6.35mm.

The surface accuracy required was 0.25mm (rms).

Two companies were invited to tender :

Eastcoast Development Engineering (EDE)

and

Sydney Engineering and Sales. (SES)

Both companies had an established trackrecord in antenna panel manufacture.

The contract was awarded to SES in august 2002, with panel construction commencing shortly thereafter.

Every panel was carefully measured during manufacture; about 10% of the panels were remeasured by the project engineer. The panels meet the required surface accuracy, with a average rms error of 0.23 mm (rms).

The panel installation started in early march, and was completed in the last week of march.

3 Surface Adjustment

We used conventional phase-referenced holography to assess the surface shape, and to guide the adjustment process.

- We have a 4.5m reference antenna.
- The target is one the Optus B-class geostationary satellites (B1 at 49.6 degres elevation, or B3 at 50.8 degrees). The ATNF holography receiver is tuned to the 12.75 GHz uplink power control beacon.
- Each survey was made at night, taking 6 hours to provide an image with surface resolution of about 60cm*60cm, with a measurement accuracy of 0.3 mm (rms).
- The surface was adjusted during the day. The process was straightforward as the surface had (over the past years) undergone a number of adjustment refinements; in addition, the installation of the panels was done with care, so that after the installation the surface was already close to a good shape.

  It will be noticed in the surface error map (figure 1) that the new panels are in better shape than the panels interior to the 45m diameter, so that the final surface error is set by the legacy panels, rather than the new panels. This figure shows that the panels interior to 45m (dia) have "cusped" slightly at their radial edges, which we attribute to a flexing of the angle bracket which attaches the panels to the radial ribs. The new panels are distinctly stronger in this area.
- The surface rms error was 1.7mm on completion of the installation. It dropped to 1.0mm after the first round of adjustments, and to 0.7mm after the second round. It has not changed significantly since then, although we have continued some minor tidying up.
- The final surface error of the inner 54m diameter. is estimated to be better than 0.8 mm (rms).

  A contour map of the current surface (map of june 11) is shown in figure 2.

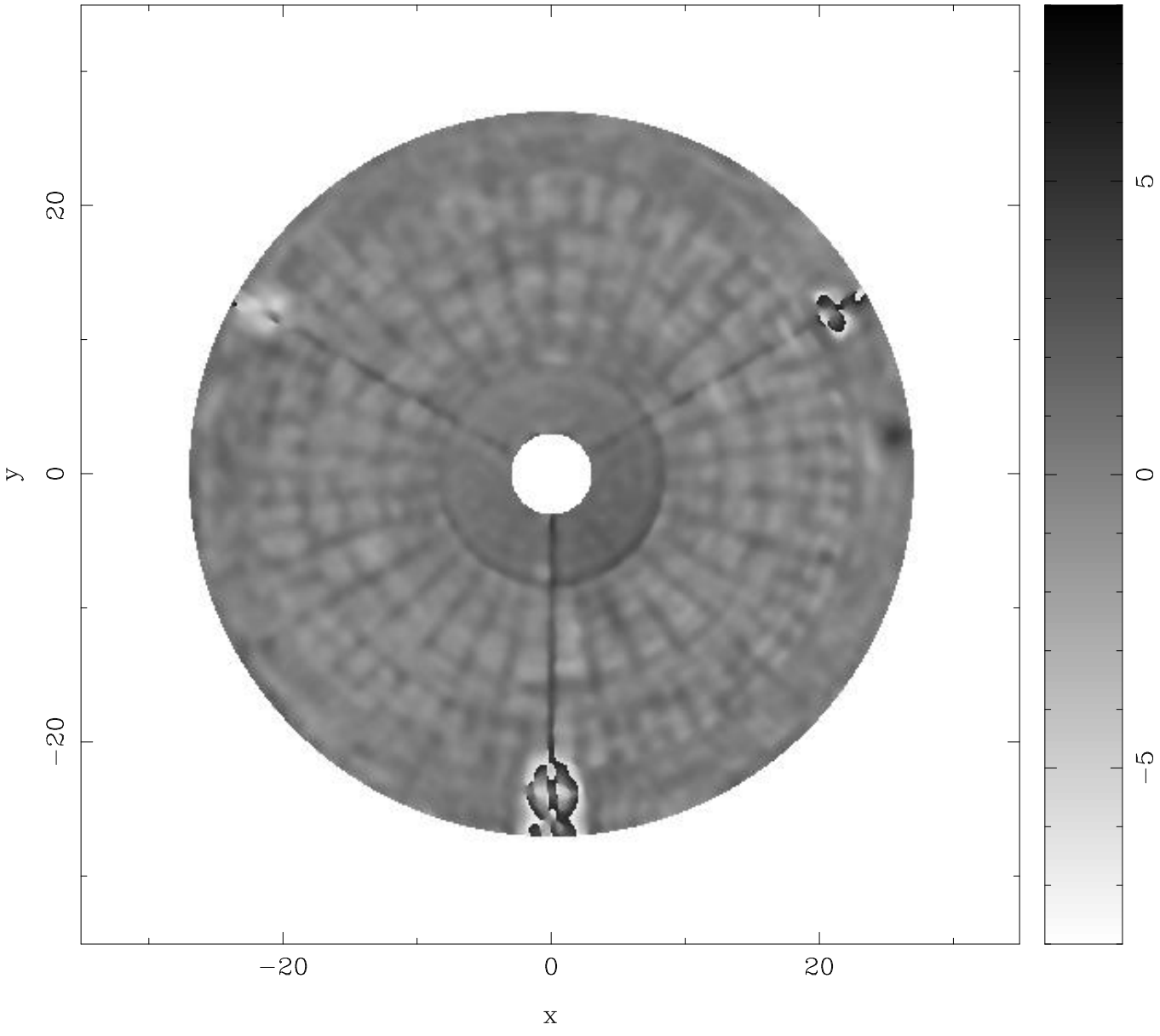

Figure 1: The surface error map made on june 11. The gray-scale range is -8mm to +8mm. The high-point on the periphery at about 75 degrees from the top is due to a "frozen" adjustment point. This has since been remedied.

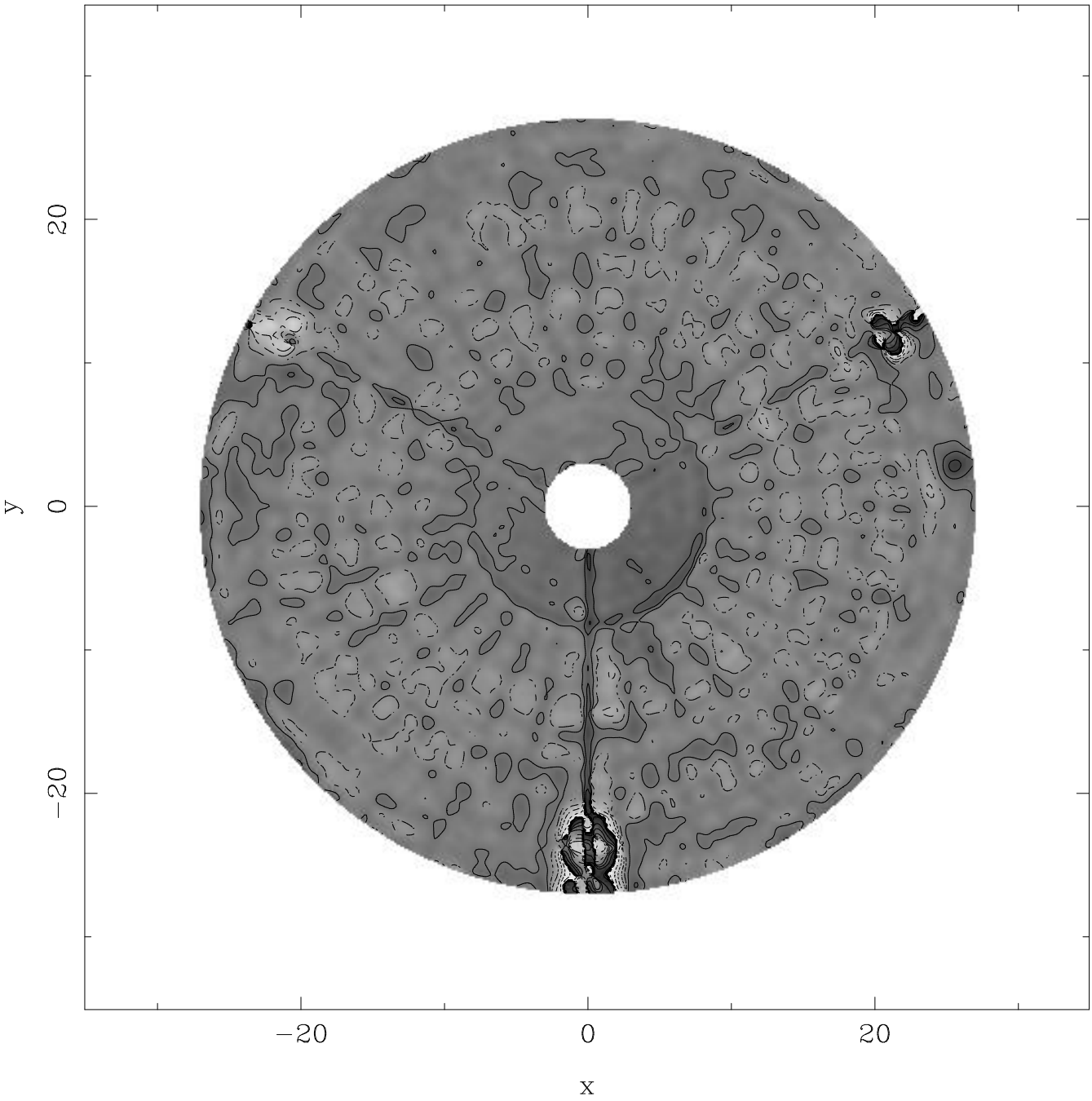

Figure 2: The surface error map made on june 11. The contours are at 0.75mm spacing, and the gray-scale range is -8mm to +8mm.