AT/40.3.1/038

The Pointing and Carriage Motion Algorithms
Preliminary Version

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1 Summary

The parkes control system will need some (minor) modifications once the new focus cabin is in place, and we have the ability to move the feed as the antenna's elevation changes. This note provides some background and describes the necessary algorithms.

2 The Basic Model

The parkes reflector distorts as the antenna's elevation changes. The distortions can be traced back to four distinct structural aspects of the antenna:

1. The central zone (17m diameter) is part of the hub, and has only minor distortions with elevation. This region has the solid, precision reflector surface.
2. The intermediate zone, between 17m and 30m (diameter). There are 30 substantial ribs extending from the hub to the rim of the antenna, and an additional set of 30 ribs (interleaved between the main ribs) which run from the 30m ring girder to the rim. The structural characteristics of the intermediate zone - at least in terms of the reflector distortions - are quite different to the outer zone. The reflector surface in this zone consists of perforated aluminium panels.
3. The outer zone, extending from 30m to 64m (diameter). Perforated panels provide the surface out to a diameter of 45m; the original wire mesh panels cover the outer region of this zone.
4. The Tripod. This supports the focus cabin; its flexure as the elevation changes allows the feed to drop below the radio axis of the reflector. The tripod also distorts the reflector shape as the antenna tips.

3 The Distortion Model

The reflector was surveyed comprehensively by Yabsley, Minnett, Puttock and Loughry in the mid-60s. A special rotating camera installed at the vertex allowed them to measure a large number of targets attached to the surface. The surveys were carried out at a number of different elevations.

Their conclusions form the basis of this note. The description below is couched in terms of the aperture plane, rather than the "Best-Fit Paraboloid", in order to bring out the role that feed illumination and observing frequency will play. The conclusions are essentially identical to D.Yabsley's.

name	meaning	plausible form/value
F	Focal length	F = 26300 mm
β	beam deviation factor	$\beta = 0.81$
ζ	raw pointing error	$\zeta = -1.96\cos(\mathrm{Elevation})$ (arcmin)
X_f	Feed droop	$X_f = -35.\cos(\mathrm{Elevation})$ (mm)
ϖ	cubic correction shift	$\varpi = +96.\cos(\mathrm{Elevation})$ (mm)
ξ	pointing compensation	$\xi = -\beta\varpi/F \sim -10.1\cos(\mathrm{Elevation})$ (arcmin)
ΔF	focus correction	$\Delta F = 36.(\sin(\mathrm{Elevation}) - 1)$ (mm)
$\Delta\theta_z$	pointing correction	
ΔX	Feed travel	

For the different operational modes we have:

1. **Basic Mode, Fully Corrected**

$$\Delta X = \varpi - X_f \tag{1}$$

$$\Delta\theta_z = \zeta + \xi \tag{2}$$

2. **Feed Locked - Quiet Mode**

The observer can choose to disable the carriage motors. Let El_0 be the elevation chosen as reference - a simple option would be 45 degrees elevation, but the observer may choose to reference to an elevation which better suits his field. The pointing and feed offsets would be defined by equations 1 and 2 for elevation El_0. Thereafter the pointing correction would be :

$$\begin{aligned}\Delta\theta_z &= (\zeta(El_0) + \xi(El_0)) \\ &+ (\zeta(El) - \beta X_f(El)/F) \\ &- (\zeta(El_0) - \beta X_f(El_0)/F) \\ \Delta X &= 0\end{aligned}$$

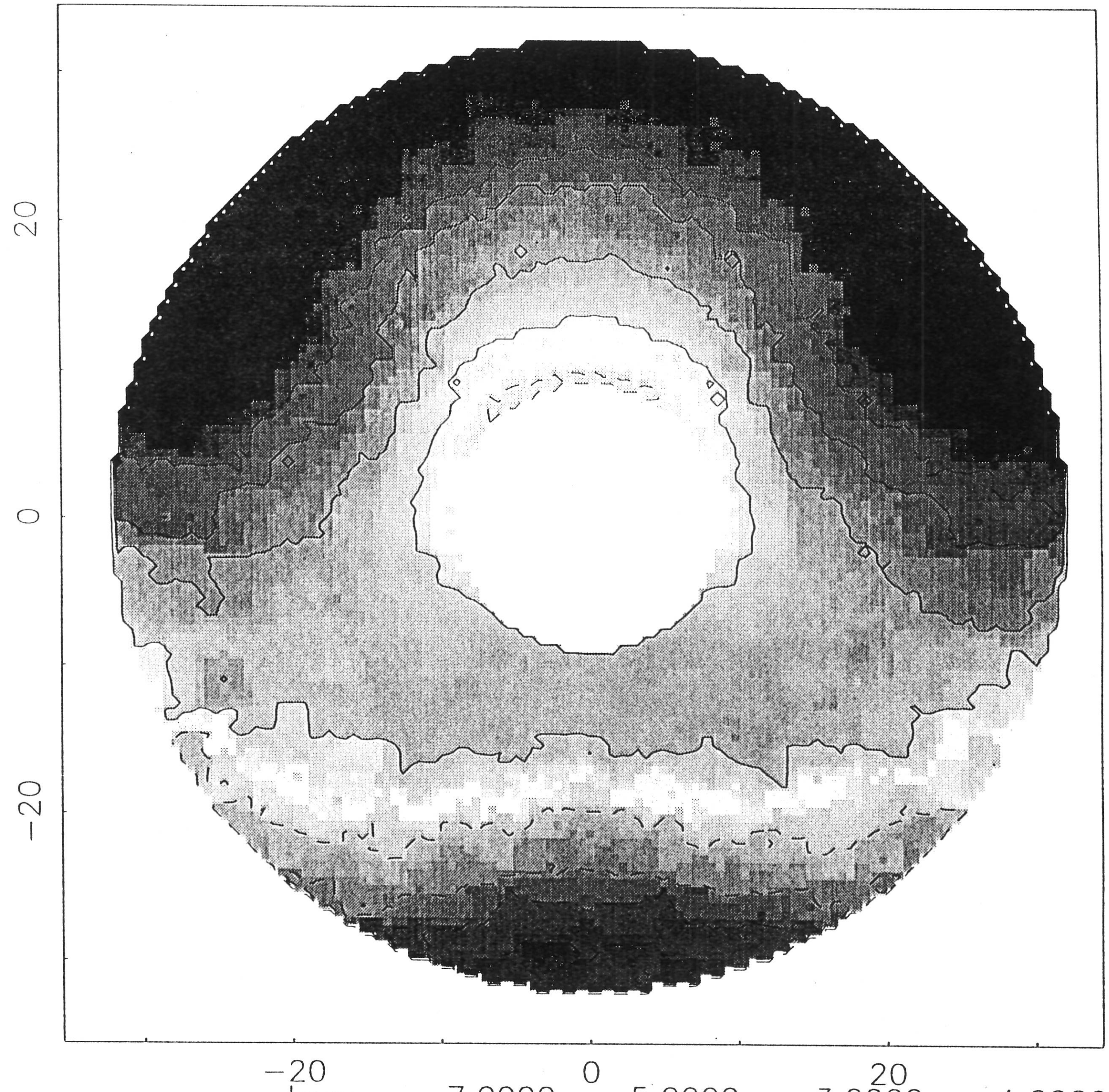
This mode corresponds to the pre-upgrade condition; we find

$$\Delta\theta_z = -1.75\cos(El) \text{ (arcmin)} \ -> \ -1.5 \text{ arcmin at 30 degreesEl}$$

The pre-upgrade algorithm is -1.4*(90 - El) (arcsec), = -1.4 arcmin at 30 El.

el30map.dat

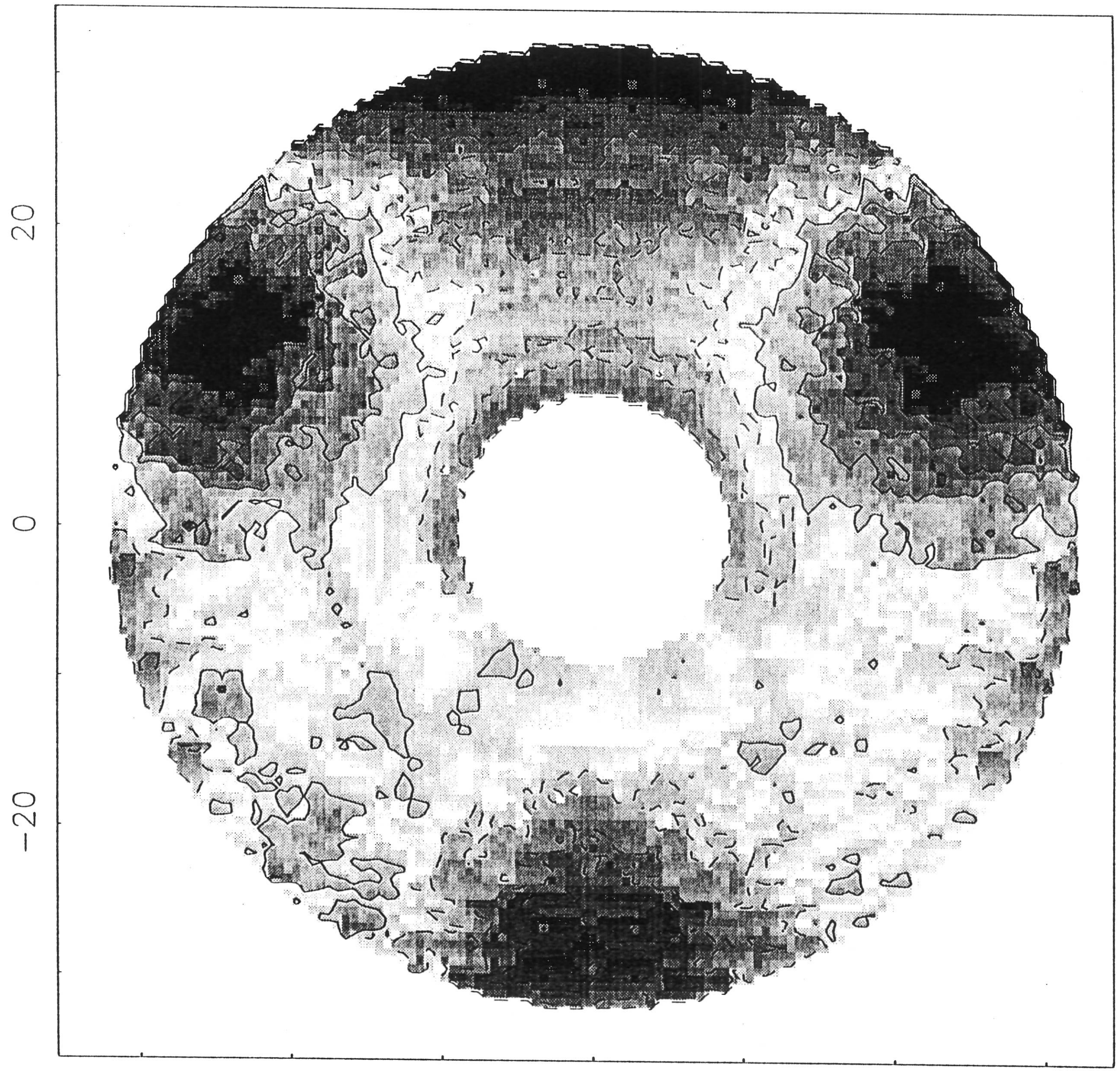
raw data.



levs: −7.0000 −5.0000 −3.0000 −1.0000 1.0000

levs: 3.0000 5.0000 7.0000

el30map.dat



levs: -3.5000 -2.5000 -1.5000 -0.5000 0.5000

levs: 1.5000 2.5000 3.5000

fully corrected

σ = 1.9 mm

pointing: x: -0'.07

y: +10'.5

feed: Δx: -1.3 mm ±1

Δy: +83.3 ±1

Δz: -18.5 ±.3