CSIRO - Australia Telescope National Facility

The Tidbinbilla 34 m Beam Waveguide Antenna: Use of the 2.86 to 5.35 GHz horn for 4.8 GHz operation.

1. Introduction

This report follows on from the initial consideration of the Tidbinbilla 34 m antenna for radio astronomy given in Ref.1, and the subsequent availability of a special wideband horn which can operate over the frequency range 2.86 to 5.35 GHz. This horn was optimised to feed a 34 m diameter beam-wave-guide antenna and the use of this horn at 4.8 GHz with the Tidbinbilla antenna is the subject of this investigation. For operation at 2.86 GHz, the original optics design called for the flat mirror M6 to be 1854 mm diameter, and the horn/receiver assembly to be mounted horizontally. This report shows that a mirror of diameter 1550 mm can be used for operation at 4.8 GHz, so that the horn can be mounted vertically.

2. The wideband horn

The horn to be provided has the following key parameters (see also Ref. 2):

Aperture diameter:	627 mm
Conical semi-angle:	11°
Aperture size (d/λ):	10.0
Horn phase error (Δ):	0.48

Note that the 8.4 GHz narrow-band horn also has an aperture diameter of 10λ, but the conical semi-angle is 6.254° giving $\Delta = 0.274$ compared to 0.48 for the wideband horn. Consequently, the phase centre of the wideband horn will be closer to the apex, particularly for frequencies near the upper edge of the band. This in turn forces the horn to be situated higher in the assembly, causing some blockage of the reflected signal from M6. Also, near the upper part of the band, the radiation pattern will be more narrow than at the lower part of the band, thus tending to under-illuminate the reflectors M6 and hence M5, etc. Ideally, to obtain an optimum solution at 4.8 GHz, the aperture of the horn should be reduced to say A-A^{1} as shown in the attached figure. The phase centre would rise towards the aperture, and hence the horn lowered to reduce the blockage still further.

Finally, the attached figure shows that the mirror M5 will be under-illuminated compared to say 8.4 GHz, although this is based on ray-optics. A more optimum horn with the aperture AA^{1} at 4.8 GHz would avoid this. Detailed computer studies would be required to establish the current loss at 4.8 GHz compared to a more optimum horn.

3. Conclusion

The wideband horn designed to cover the frequency range 2.86 to 5.35 GHz can be used at 4.8 GHz with a flat reflector, M6, having a size 1550 mm. See attached drawing.

4. References

[1] Thomas, B. MacA.: "The Tidbinbilla 34 m Beam Waveguide Antenna: Feeding arrangements, and operations at 4.8 to 6.8 GHz", ATNF Technical Document 39.3/074

[2] Stanton, P.H., Lee, P.R., and Reilly, H.F.: "HRMS Sky Survey Wideband Feed System Design for DSS-24 Beam Waveguide Antenna." JPL TDA Progress Report 42-114, 15 August, 1993, pp 316-326.

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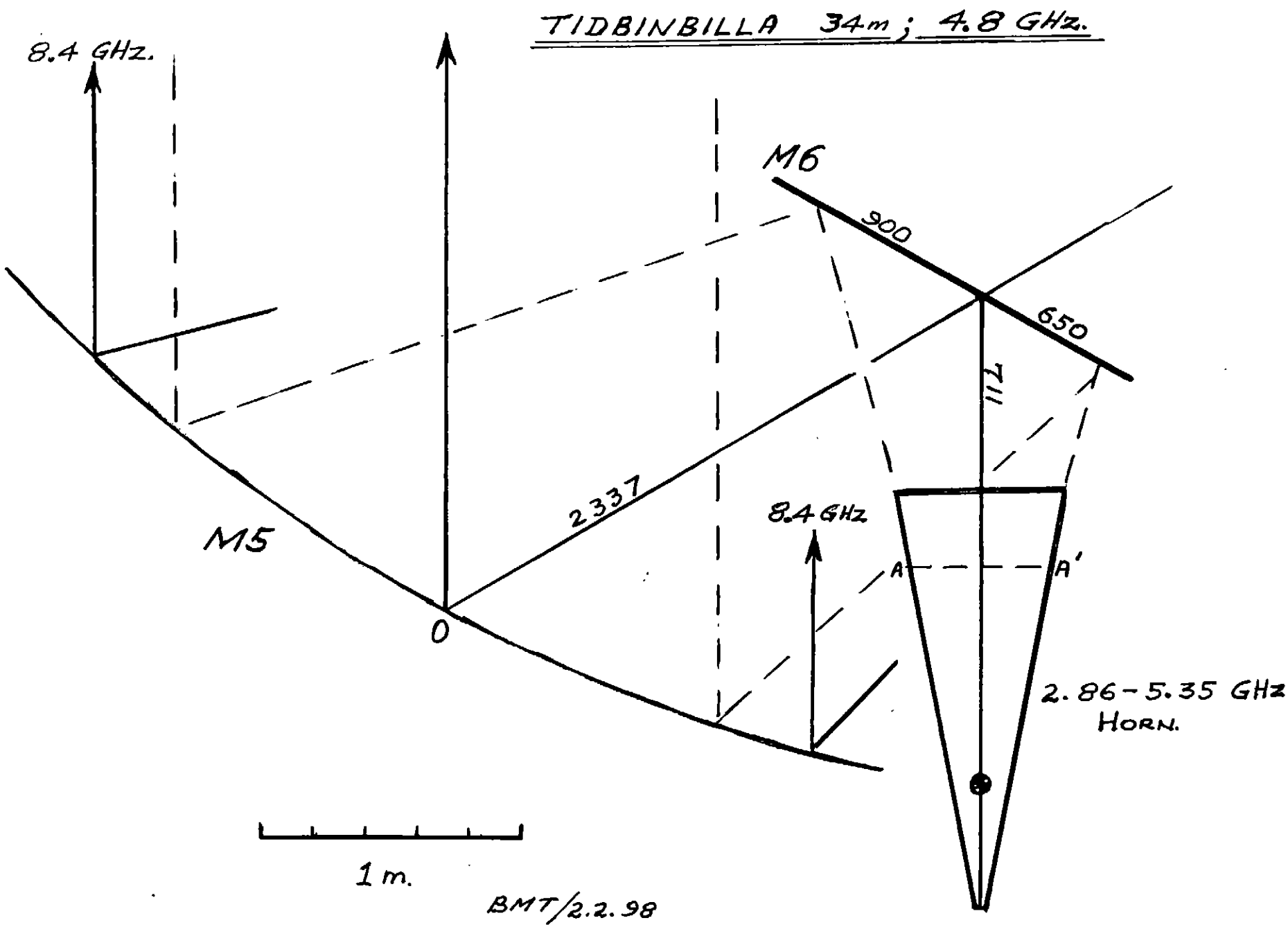
TIDBINBILLA 34m; 4.8 GHz.
8.4 GHz.
M6
900
650
711
2337
M5
0
8.4 GHz
A
A'
2.86 - 5.35 GHz
HORN.
1 m.
BMT/2.2.98