

Interoffice

NATIONAL RADIO ASTRONOMY OBSERVATORY

TUCSON, ARIZONA

November 19, 1976

*25 Meter Millimeter Wave Telescope*

To: 25-M Working Group

*Memo #60*

From: B. L. Ulich

Subject: RF Specifications

Enclosed is a list of mechanical and electrical specifications which will insure good RF performance of the 25-M Telescope. Hopefully these numbers will be useful for the detailed engineering design of various telescope components. Where possible I have also computed various figures of merit against which the actual telescope performance can be judged in the initial tests.

Enclosure

c: M. Balister  
L. King  
J. Payne  
S. Von Hoerner  
W. Y. Wong

## 25-M TELESCOPE SPECIFICATIONS

### A. GENERAL

Azimuth tracking range	±270 °
Elevation tracking range	-5 ° to 125 °
Azimuth slew rate	60 °/minute
Elevation slew rate	60 °/minute
RMS pointing accuracy	1.2 "
Half-power beamwidth at wavelength $\lambda$ (mm)	10 $\lambda$ "
First sidelobe level	-20 dB
Receiver locations	4 in vertex cabin; 1 receiver or subreflector in apex cabin
Receiver box size	0.6 m x 0.6 m x 2.0 m
Maximum receiver box weight	450 kg
Maximum telescope gain ( $\lambda = 0.94$ mm)	91.9 dBi
Summary of RF performance:	

$\lambda$ (mm)	9.5	3.3	2.0	1.2	0.8
HPBW (")	95	33	20	12	8
$\eta_A$ (%)	58	55	48	32	15
Gain (dBi)	76.1	85.0	88.7	91.4	91.6
Jy/K	9.7	10.2	11.7	17.6	37

### B. PRIMARY REFLECTOR

Diameter	25 m
Geometrical area	490.87 m <sup>2</sup>
Focal length	10.5 m
Focal length/diameter ratio	0.42
Edge angle	61.525 °
Parabolic equation (x and y in m and origin at vertex)	$y = x^2/42$
Height of rim above vertex	3.7202 m
Rim space attenuation	-2.63 dB
Defocusing due to rim deflection $\Delta y$ (mm) in axial direction	2.822 $\Delta y$ mm
Telescope beam tilt due to primary reflector rotation $\Delta\alpha$ (")	1.84 $\Delta\alpha$ "
Panel gap area	0.2 %
Central blockage area	0.9 %
Feed support blockage area	6.1 %
Total RF blockage efficiency	0.85
RMS surface error	0.075 mm

C. PRIMARY FOCUS

Plate scale	16.5 "/mm
Telescope beam deviation factor	0.84
Feed aperture	0.953 $\lambda$
Axial feed defocusing for -1 dB gain reduction	0.585 $\lambda$
Ratio of peak-to-peak standing wave amplitude to total power at wavelength $\lambda$ (mm)	0.028 $\lambda$ %
Number of HPBW's scanned off-axis for:	
(a) -1 dB gain reduction	4.3
(b) 10% increase in HPBW	4.9
(c) 10 dB increase in coma lobe level	3.3
Peak cross-polarization lobe level	-22 dB
Apex cabin specifications:	
(a) maximum box weight	450 kg
(b) rotation range	$\pm 270^\circ$
(c) rotation accuracy	$\pm 0.5^\circ$
(d) axial movement range	$\pm 25$ mm
(e) axial movement accuracy	$\pm 0.05$ mm
(f) lateral (vertical) movement range	$\pm 12$ mm
(g) lateral (vertical) movement accuracy	$\pm 0.025$ mm

D. SECONDARY REFLECTOR

Diameter	1.5 m
Magnification	16.836
Eccentricity	1.12630
Focal length	176.77 m
Focal length/primary diameter ratio	7.0710
Edge angle	$4.0498^\circ$
Total subtended angle from feed	$8.0996^\circ$
Distance from secondary vertex to primary focus	0.61675 m
Hyperbolic equation (x and y in m and origin at vertex)	$y = 4.8832 \left[ \sqrt{1 + \left( \frac{x}{2.5306} \right)^2} - 1 \right]$
Height of rim above vertex	0.20995 m
Axial secondary defocusing for -1 dB gain reduction	0.582 $\lambda$
Telescope beam tilt due to secondary lateral vertex shift	15.3 "/mm
Telescope beam tilt due to secondary tilt $\Delta\beta$ ( $^\circ$ )	$-389 \Delta\beta$ "
Telescope beam tilt due to rotating secondary by $\Delta\delta$ ( $^\circ$ ) about a point R (mm) behind vertex	$\Delta\delta(0.267R-389)$ "

Secondary rotation about a point R (mm) behind vertex which aligns the offset Cassegrain feed beam with the primary axis	3505/(1456-R) °
Vertical tilt adjustment range	±5 °
Vertical tilt adjustment accuracy	±15 "
Horizontal tilt nutation range (switches the telescope beam 25' for R = 500 mm)	±6 °
Horizontal tilt nutation accuracy at 5 Hz	±15 "

E. SECONDARY FOCUS

Feed circle diameter	1.6 m
Distance behind primary reflector vertex of secondary focal plane	0.5 m
Plate scale	1.17 "/mm
Telescope beam deviation factor	1.00
Feed aperture	16.1 λ
Feed beam tilt toward secondary vertex	4.4 °
Axial feed defocusing for -1 dB gain reduction	123 λ
Ratio of peak-to-peak standing wave amplitude to total power at wavelength λ (mm)	0.24 λ %
Number of HPBW's scanned off-axis for:	
(a) -1 dB gain reduction	1100
(b) 10% increase in HPBW	1250
(c) 10 dB increase in coma lobe level	850
(d) spillover limit at wavelength λ (mm) (the corresponding coma lobe level is -18 dB)	47/λ
Vertex cabin specifications:	
(a) number of receivers	4
(b) maximum receiver weight	450 kg