National Radio Astronomy Observatory
Tucson, Arizona

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MEMORANDUM

TO: 12-M Memo Series

FROM: John Payne, Chris Salter

SUBJECT: Status of 12-m system

1) Aperture Efficiency, Beamwidths and Axial Focus

Following final adjustment of the telescope optics and refiguring of the secondary reflector, we have remeasured the aperture efficiencies of the 12-m telescope in the Cassegrain configuration. The following efficiencies were obtained using Venus as calibrator; the efficiencies measured on Saturn were consistent with these values. We also present half-power beamwidths (HPBW).

WAVELENGTH	RECEIVER	APERTURE EFFICIENCY	HPBW	
			AZ	EL
3.33 mm	70-115 GHz Cooled Mixer	0.40 ± 0.03	77"	76"
3.33 mm	90 GHz Room Temp RX With improved Feed	0.45 ± 0.03	73"	71"
1.34 mm	200 - 240 GHz Cooled Mixer Receiver	0.14 ± 0.02	34"	34"
800μ, 1.1 mm 1.4 mm, 2.0 mm	Bolometer Rx	-	51" ± 5"	43" ± 5"

These measured efficiencies and HPBWs are to be compared with the following prime focus results,

WAVELENGTH	RECEIVER	APERTURE EFFICIENCY	HPBW	
			AZ	EL
3.33 mm	90 GHz Room Temp Receiver	0.48 ± 0.03	72"	72"
1.34 mm	223 GHz Room Temp Receiver	0.19 ± 0.03	28"	28"

The telescope beam patterns were clean at all wavelengths greater than 1 mm. Sidelobe levels appear to be very low. At the shorter wavelengths ($\lambda \leq 1.4$ mm) the main beam patterns measured with the bolometer were somewhat assymetric at the lower levels. This was not the case for the 1.3 mm mixer receiver. The half-power beamwidths with the bolometer are almost independent of wavelength.

The axial focus curves of the telescope were clean and agreed with theoretical predictions for their half widths down to a wavelength of 1.3 mm. At shorter wavelengths (1.1 mm, 800μ) the width of the focus curve becomes broader than theoretical. Measurement at 3.3 mm and 1.3 mm showed identical focus curves in orthogonal polarizations; astigmatism does not appear to be a significant problem at these wavelengths.

Even with the improved feed at 3.33 mm, the Cassegrain efficiency is probably slightly less than at prime focus. The following factors affecting Cassegrain efficiency will be investigated in the near future

1) The Cassegrain geometry has turned out to be slightly different from the original design. This could be contributing to loss in efficiency.

2) The lens-corrected feed horn used at the Cassegrain focus is almost certainly less efficient than the feeds used at prime focus.

3) There will be a slight loss in the two flat mirrors used to direct the beam from the subreflector to the receiver, and in the subreflector itself.

At λ 1.34 mm, the Cassegrain performance is significantly lower than at prime focus. The aperture efficiency is lower and the beamwidths greater. We believe that, in addition to the factors detailed above, large scale errors in the subreflector may be a major culprit. A more precise subreflector is on order and this will be installed and tested when time and the observing schedule permit.

2) Receivers

We now have three receivers mounted on the telescope.

1) The old 70-115 GHz dual-channel cooled mixer receiver (T_R(DSB) ~200K per channel). The receiver noise temperature (DSB) varies from 180K to 300K per channel over its frequency range. It will be phased out in mid-1984 and replaced with a new cooled mixer receiver having a noise temperature (DSB) ~100K per channel at 115 GHz.

2) The new 200-240 GHz dual-channel mixer receiver (T_R(DSB) ~300K per channel). The noise temperatures are higher than those obtained in the laboratory. We are currently investigating this.

3) The 0.3K bolometer receiver equipped with filters for λ 2 mm, 1.4 mm, 1.1 mm and 800μ. The sensitivity seems to be in the range 2-3 Jy/sec at 1.4 mm. However, the sensitivity is currently being marred by microphonics induced by the cryogenic refrigerators of the other receivers. This problem will be fixed during the next month.

3) Receiver Changing

During the test period we routinely changed receivers by rotating the central flat mirror. We could change from one receiver to another in less than 15 minutes. The pointing differences between all receivers were less than 20" and the repeatability of pointing on reselecting a given receiver was better than this.

Selecting receivers by this method is a simple operator function and we now are ideally situated to change observing frequency to suit prevailing atmospheric conditions.

4) General Comments

While making the observations in the test period, we were impressed by the speed with which the transparency of the atmosphere could change at 230 GHz. In future the 12-m telescope could be scheduled in such a way as to take full advantage of the occasions when conditions are suited to 1 mm observations. Continuous monitoring of the 1 mm optical depth at the telescope site seems to be a priority and equipment is under development to perform this.