12 METER MILLIMETER WAVE TELESCOPE

MEMO No. 212

NATIONAL RADIO ASTRONOMY OBSERVATORY
Tucson, Arizona

January 13, 1983

TO: J. Payne, J. Findlay

FROM: R. Howard

SUBJECT: Summary of 12M Radiometric Measurements for the Period November 24, 1982 thru January 4, 1983

Table I summarizes the antenna performance to date. Comparing efficiencies before and after the second panel setting, showed that there was no improvement in the 3mm aperture efficiency. The switched power efficiencies are higher than the total power efficiencies due to a problem in calibrating the load switched data and therefore, are not as accurate as the total power efficiencies. The calculated aperture efficiency using the 3.3mm prime focus feed (16 dB edge taper) is 64% (assuming no surface errors). Using the measured value of 26%, the implied RMS surface tolerance is ~250 μM. With a surface tolerance of 250 μM, the 1.3mm efficiency should only be ~.2%. The aperture efficiencies listed in Table I at 1.3mm (Dec. 17) are upper limits based on the RMS of the noise for the data taken searching for Jupiter. No point sources were detected with the 1.3mm prime focus receiver (double sideband receiver temperature was ~5000K). The 1mm pointing was determined from tracking the edge of the moon. Drift scans of the Moon were differentiated in order to get a rough idea of the beam shape and focus. The 1.3mm beam is at least as broad as at 3mm. The 3mm cassegrain efficiency is lower than prime focus by ~20%, however the cassegrain optics (main selection mirror, secondary receiver mirror and the receiver lens-feed system) were not perfectly aligned with the telescope axis.

Figure 1 shows the focus curves at 3.3mm for both prime focus and cassegrain. In both cases, the focus curve is broader than theoretical and very asymmetric. The asymmetry implies that there are large scale errors in the dish. At several focuses, the pointing and beam shape were determined. The pointing in both azimuth and elevation was basically the same for all focus values (to within 20″). For cassegrain, the narrowest beam was not at the peak of the focus curve but at ~.6 peak gain (toward dish). For the prime focus case, the narrowest beam occurs at both peak gain and ~.7 peak gain (toward dish). In both cases, the beam seems symmetric and shows no signs of astigmatism.

A map of the beam was made by combining drift scans of Jupiter (diameter ~ 30″) taken at different declination offsets (30″/STEP). Figure 2 represents the average of three drift scans thru the center of the beam (no declination offset). The sidelobes (2′ off center) are only 10 dB down. The total area mapped was ~20′ by 4′. The inner part of the map is shown in Figure 3. The map represents the beam on the sky. The two cross marks represent peaks of the sidelobes from Figure 2. The two sidelobes are symmetrically opposite and their peaks are within 2 dB of each other. This plus the fact that the beam shows no broading (HPBW is theoretical) implies that the feed is laterally focused to within ~3mm (1λ).

In summary, the low 3mm aperture efficiency can not be accounted for by a lossy feed, pointing, axial or lateral defocusing. If the efficiency is low due to random surface errors, then the focus curve should have looked symmetric. The fact that it is not symmetric points to large scale errors as being the main problem with the surface.

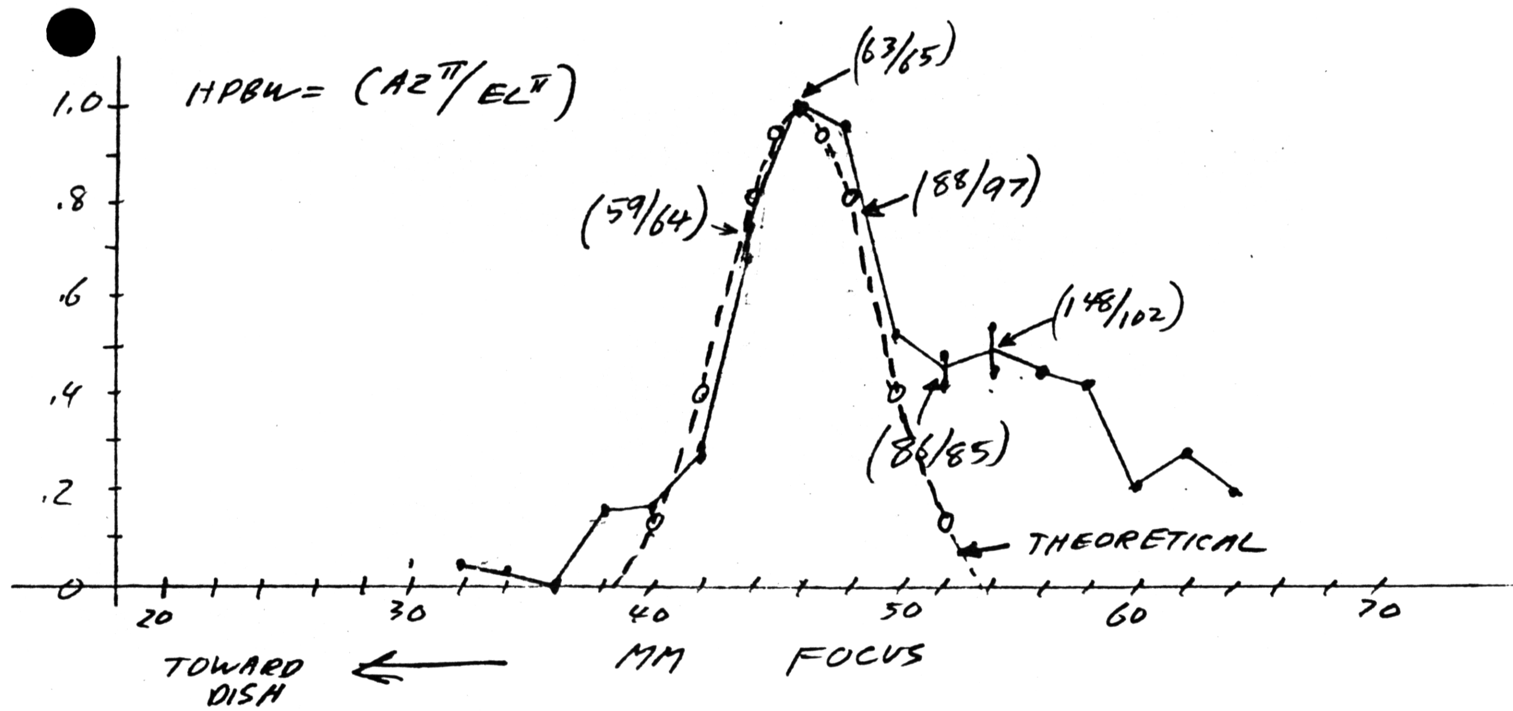
TABLE 1

12-M EFFICIENCIES (NOV. 28, 1982 - JAN. 4, 1983)

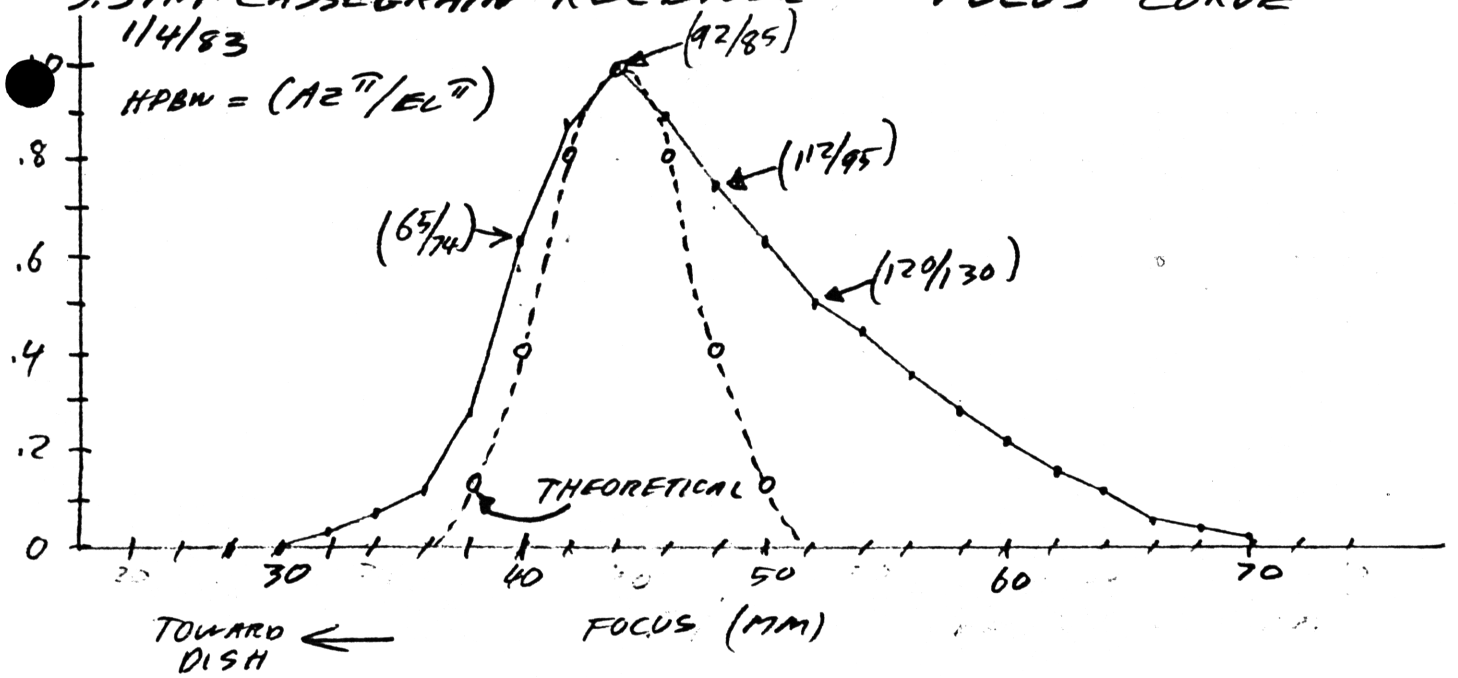
DATE	Panel Adjustment Iteration Number	Half Power Beam Width ( )	Antenna Coupling Efficiency To Sky (η_ℓ)	Aperture Efficiency Switched Power	Aperture Efficiency Total Power	Receiver
Nov. 28	1	~70	.88	.30	-	3.3 MM Prime Focus
Dec. 3	2	~70	.94	.30	.25	3.3 MM Prime Focus
Dec. 4	2	~70	.90	.30	.26	3.3 MM Prime Focus
Dec. 17	2	100-150	.81	<.006	<.006	1.3 MM Prime Focus
Dec. 21	2	~70	.90	-	.27	3.3 MM Prime Focus
Jan. 4	2	~90	.91	-	.21	3.3 MM Cassegrain

FIGURE 1

3.3MM PRIME FOCUS RECEIVER — FOCUS CURVE
12/4/82



3.3MM CASSEGRAIN RECEIVER — FOCUS CURVE
1/4/83



DRIFT SCAN THRU CENTER OF BEAM

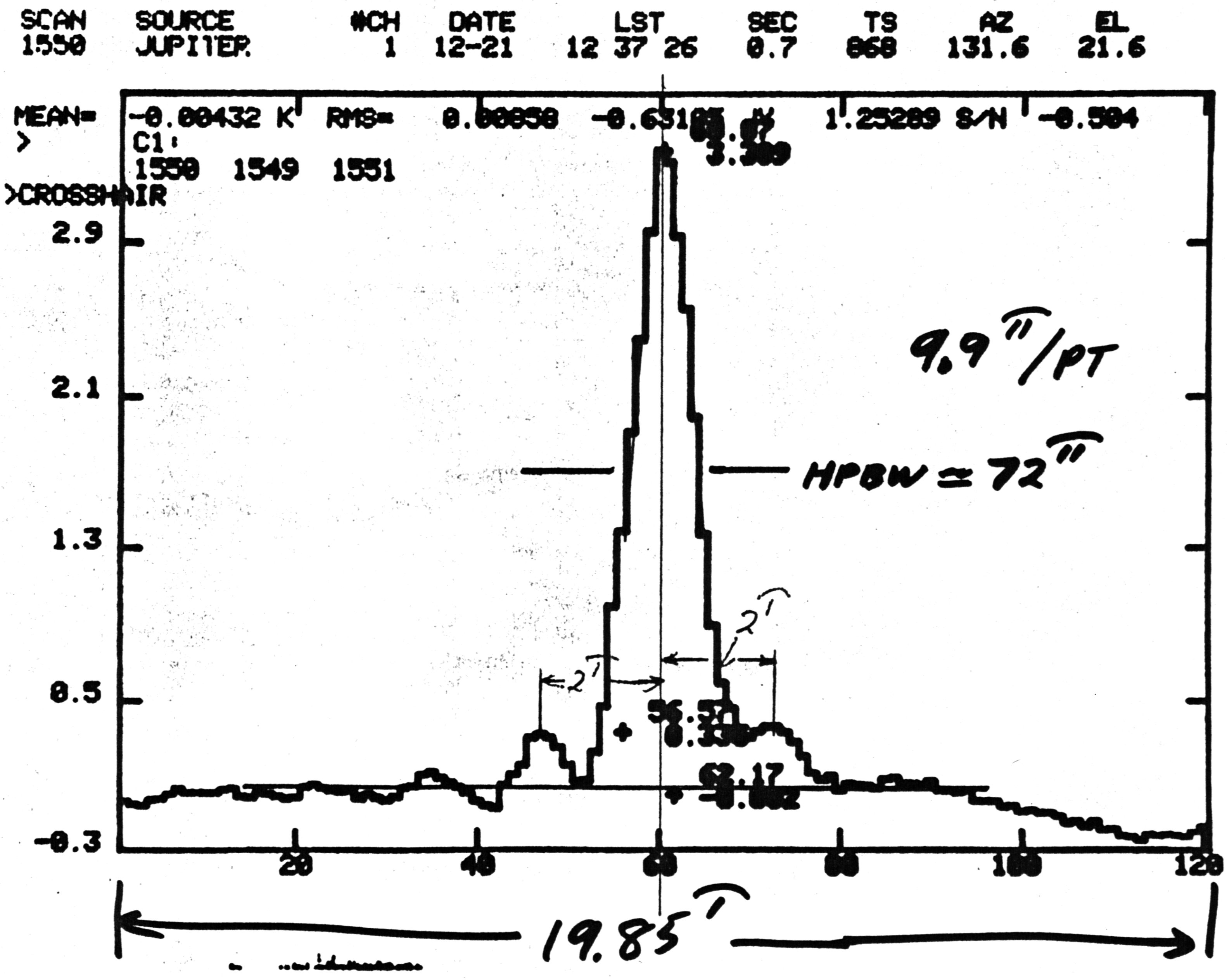


FIGURE 2

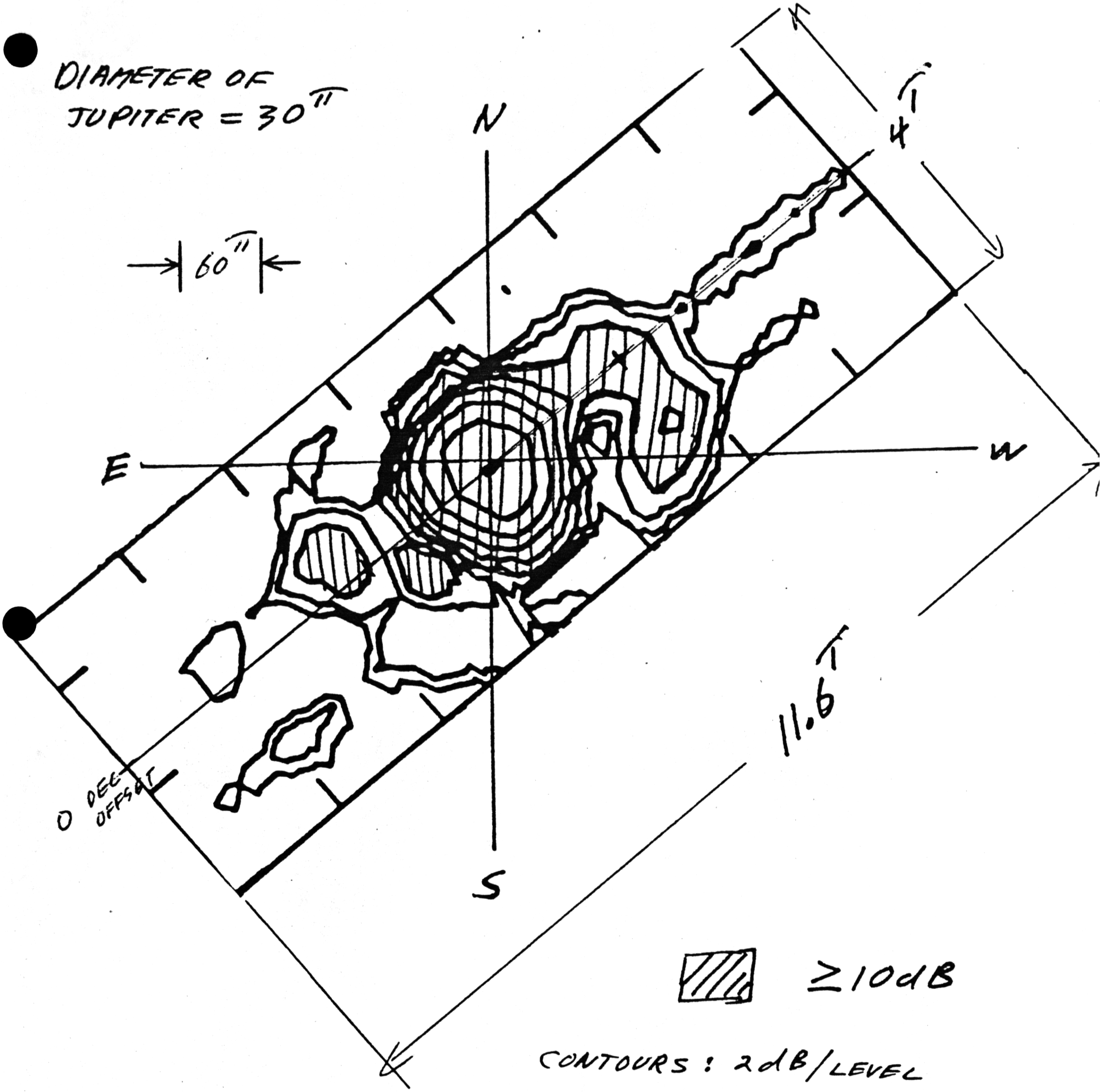
FIGURE 5

3.3MM PRIME FOCUS

12M ANTENNA

DEC. 21, 1982

JUPITER MAP



CONTOURS: 2dB/LEVEL

LOWEST LEVEL: 14dB BELOW PEAK