NATIONAL RADIO ASTRONOMY OBSERVATORY

ELECTRONICS DIVISION TECHNICAL NOTE NO. 99

TITLE: Q-BAND MASER STATUS

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NATIONAL RADIO ASTRONOMY OBSERVATORY

MEMORANDUM

February 23, 1981

To: M. Balister
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From: R. Norrod

Subj: Q-Band Maser Status

1.0 Introduction

Recent tests at Green Bank on the Q-band prototype maser has provided some information on the maser noise performance. An OKI klystron that delivers approximately 100 mW to the dewar input was used to pump the maser. This pump power level is not sufficient to fully saturate the rubies but has allowed some tests to be made.

2.0 Gain Response

Because of the low pump power, it was necessary to reduce the magnetic field taper, resulting in a narrow gain response. Figure 1 illustrates the response at a center frequency selected for maximum pump power. Measurements of gain variation vs. pump power (6 dB/dB measured at 100 mW pump power) showed that the pump transitions are not saturated. As to tunability, the klystron has reasonable output power (greater than 80 mW) from about 87 GHz to 92 GHz, transforming to signal frequencies of 42 GHz to 45 GHz. The maser tuned over this range with no extreme gain variations. At certain frequencies, the maser tends to break into oscillations. This could be due to poor circulator isolation and should be investigated further.

3.0 Noise Performance

Calculations in Figure 2 show that the maser noise temperature referred to the dewar input is approximately 35°K. The method used in Figure 2 to calculate the second stage contribution is taken from NRAO Electronics Division Internal Report No. 179 by Craig Moore. Uncertainty in the cold load temperature results in an uncertainty in the maser temperature of about $\pm$ 3°K. Contribution of a short length of coin silver waveguide between the horn and dewar input was subtracted but contributions from waveguides within the dewar were not. Loss of coin silver waveguide was measured for a 12-inch length and scaled for the 1.6 inch section.

4.0 Recommendations

Damage to certain refrigerator parts incurred due to a faulty heater thermostat will require stripping the maser for repairs. This will begin immediately. Some tests on the circulator should be done to check the isolation. Little else can be accomplished until the high power klystron is returned from Varian. The last indication from Varian was that we could expect the repaired unit in mid-April.

RDN/cjd

Enclosures

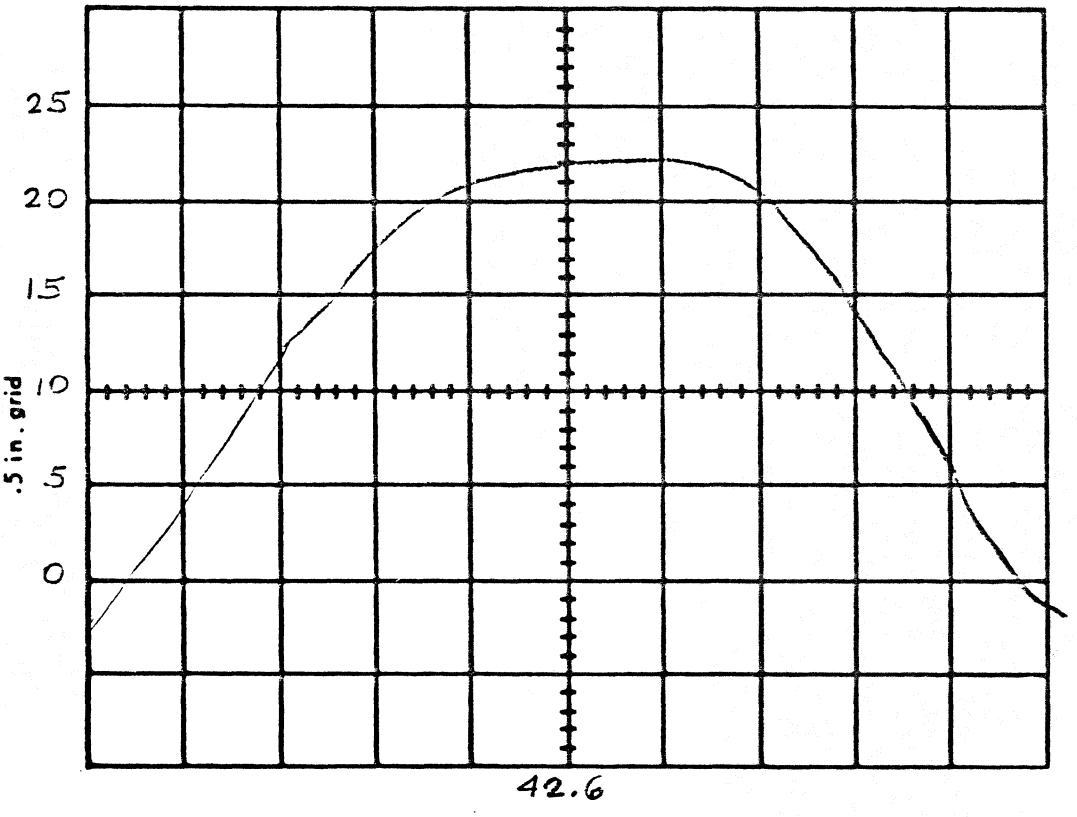

Figure 1
Q Band Maser Gain

$Y_{H/C}$ = 3.95 dB $\qquad$ T_H = 297°K

$Y_{ON/OFF}$ = 11.60 dB $\qquad$ T_C = 80°K

$$T_{RX} = \frac{T_H - Y_{H/C}\, T_C}{Y_{H/C} - 1} \quad ; \quad T_{2nd} = \frac{T_H + T_{MASER}}{Y_{ON/OFF} - 1}$$

$$T_{MASER} = T_{RX} - T_{2ND}$$

Calculations:

T_{Rx} = 66.3°K

Trial T_{maser}	Calculated T_{2nd}	Calculated T_{maser}
30°	24.3°	42.0°
42°	25.2°	41.1°

L_I = Waveguide Input Line Loss = 0.08 dB (1.6 inches):

$$T_{maser} = 297\ (L_I - 1) + T_{eq}\, L_I$$

$$T_{eq} = [T_{maser} - 297\ (L_I - 1)]/L_I$$

$$T_{eq} = \underline{\underline{34.9°K}}$$

Figure 2

Noise Temperature Calculations