VLB ARRAY MEMO No. 244

NATIONAL RADIO ASTRONOMY OBSERVATORY

MEMORANDUM

June 20, 1983

To: M. Balister

From: C. Moore

Subj: K and Q-Band Maser Construction for the VLBA

I have reviewed the on-hand materials for the K and Q-Band masers and make the following recommendations in regards to the construction of units for the VLBA:

1) Ruby

We have enough material on hand (bench in room 128) to make four K-band and ten Q-Band masers without any spares. I think we should have at least two spare sets of rubies (8 pieces) for each type to cover breakage. Thus, we will have to purchase a ruby boule at least 7 inches long; have it oriented and sliced; trim and orient each slab and have the slabs cut into bars, ground to size and polished. (We have one set of each type at this state now.) This process will take the better part of one year to complete.

2) Magnet Iron

We have enough Hipereo 27 on hand (GB Shop) to make one each K and Q-Band magnet. This material is only available in mill run lots of $\sim$ 1200 pounds per each dimensional thickness. Since we need three different thickneses, but 1000 pound should make all our magnets, I suggest we purchase a 4" x 7" billet and have it sawed to the dimensional thicknesses we need. An effort by JPL to have a small lot ($\sim$ 300 pounds) made and forged by a custom metallurgist has not been successful. We should stay with the original supplier, Carpenter Steel.

3) Niobium-Tin Tape

This material is needed for the K-Band magnet and our in-house supply is exhausted. Our supplier has dropped the product and the supplier to CSIRO (Airco) is no longer producing as well. The NRC purchased an equivalent material from Teledyne Wah Chang of Albany, OR but have not yet proven its suitability by demonstrating a working maser. If this material is unsatisfactory or unavailable, we could either switch to another alloy (Niobium-Titanium) or redesign the K-Band unit to use the Q-Band style box magnet that does not employ the superconducting tape.

4) Magnetic Field Sensor

The field sensitive resistor used in all NRAO masers is no longer available from any known supplier. We can try to have some made by UVA or some similar group or switch to the 4-lead Hall device mode by Siemens as did CSIRO and NRC. This will require a redesign of the monitor circuitry, which would be a good time to switch to microprocessor control of magnet tuning.

5) Waveguide Windows

The price of the WR-42 windows from Airtron has escalated recently. Since we made all the other windows used, we should either plan to make these units as well or find an outside supplier to make all our windows to our print.

In the area of design improvements, I would suggest that the following be pursued:

1) Magnets

The Q-Band magnet compensation is presently unsatisfactory. The flux distribution needs to be measured and an appropriate compensation designed and demonstrated. Once this is done a similar magnet for K-Band can be pursued; see item 3 above. The box magnet has good linearity of current versus field with low hysteresis and no flux jumps and is thus more suitable for microprocessor control.

2) Circulators

The circulators are based on materials and designs available in 1975. Eight years has brought a lot of new ideas to the field and improvements can certainly be made which will reduce the gain ripple. Some investigation of ferrite materials and designs for both Q and K-Band is warranted.

3) Pump Sources

Solid state pump sources are now a reality for moderate bandwidth ($\sim$ 100 MHz) and limited tuning range (several GHz). Continued progress in this area is expected. We should now gain experience on the lifetime of these units by implementing a solid state pump on the VLA K-Band unit and loaning our Q-Band pump with our Q-Band maser. Some work needs to be done on this Q-Band pump to improve the heat sink since this strongly influences the life time. I suggest a water cooling plate like we use for millimeter klystrons.

4) Circulator/Ruby Structure

The Q-Band unit should be modified to reduce the amount of ruby used (placing it in the center of the magnet pole pieces) since we cannot pump it all anyway. Both K and Q-Band drawings should be redrawn to accommodate fabricating on numeric controlled machines by outside vendors. Uniformity of the parts facilitates assembly and electrical adjustment with subsequent savings in man-hours.

5) Closed Cycle Refrigerators

The hydrogen-filled heat switch appears to have given us a good many problems. I think we should examine this design to make it more easily fabricated and find a way to test units to quantify their performance. I doubt if any NRAO built 4 K refrigerator has not had its heat switch changed at least once. JPL reports almost no problem in this area. A simple resistance measurement is used to quantify the room temperature thermal shunt before and after assembly.

CRM/cjd