MILLIMETER ARRAY
MEMO NO. 14

Notes on Presentations at the Meeting

I. Introduction -- Owen

The committee was asked to write two reports: one to Roberts on the general scientific merits of the project, another on technical recommendations.

II. Array Concept -- Owen

The basic instrument is an array of 15-27 10-m dishes with 1-2 km baselines operating in range of 1-10 mm, with a sensitivity of ~0.1 mJy in 8 hrs. In addition, a multielement antenna of 24 3-m dishes on a moveable plane, operated as interferometer or phased array, is planned. Its primary uses will be to map low surface brightness extended objects and to provide short spacing uv data to supplement the data from the array. frequencies: 30-50, 80-120, ~150, ~250 GHz. Need 200 receivers or 400 receivers with dual polarization.

III. Beam Patterns -- Hjellming

Y configuration likely. A layout with three curved arms (pinwheel) has been considered. The 3-m array, because it is always in a plane perpendicular to the line of sight to the source, would give uv tracks which are concentric circles.

IV. Mosaicing -- Rots

You can piece together maps made by pointing primary beams of array elements to different locations. "Cleaning" may be impossible. For mapping sources that fill the primary beams, it is important that the beams be circular so the gain wouldn't change at the field edge as the parallactic angle changes. Alternatively, equatorially mounted telescopes could be used. These are too costly, however.

V. Sites -- Owen

There was a strong feeling that if the VLA site is "adequate," it should be used. Other sites mentioned were:

a. Mt. Graham. Difficult for long baselines. Freezing mist. Environmental problems -- it may become a wilderness area.
b. White Mt.
c. Cerro Gordo near Lone Pine overlooking Owens Lake.
d. Aquarius Plateau -- 100 miles NE of Cedar City, Utah, near Capital Reef NP. 11,000 ft.
e. Ft. Apache Indian Reservation west of Springerville in Arizona. 9000 ft.

f. Grants, NM. 9000 ft.
g. Mauna Kea.
h. Chile?

It was noted that the shifting of the Bermuda high in the summertime brings moist air from the Gulf of Mexico over the Southwest. The western terminus of this flow is at the longitude of Tucson. No one knew the northern terminus.

Welch said that site testing was not very useful because the effects of long-term (~10 year) cycles in weather were larger than the instantaneous variations among good sites.

VI. Atmosphere -- Sramek

(review of MMA memo 8.)
One can observe at 90 GHz, 1 km baseline, with phase noise less than one radian about half of the time at the VLA site. The phase noise on a 1 km baseline at the VLA is very nearly the same as at Hat Creek. Phase calibration is effective only if calibrator is less than 6^{o} away and data is taken within 4 minutes.

Acoustical sounders are being used at Mt. Graham and MacDonald Observatory to measure turbulence. Moffett suggested using two spaced GPS receivers. Weinreb wanted to build 230 GHz radiometers for tipping measurements. Bobby Ulich showed data that suggested that "seeing" depends on wavelength as $\lambda^{-0.2}$ all the way from optical to radio wavelengths. Barry Clark (who speaks with great authority) said that this dependence was a coincidence and that fluctuations due to dry air were an order of magnitude less important than those due to wet air at the VLA.

VII. Numerical Techniques -- Cornwell

Hope to use self calibration.

VIII. Computers -- Owen

Processing problems probably not as severe as at VLA. Cannot project computer hardware 8 years into future.

IX. Antennas -- Horne

(review of MMA memo 5.)
10-m antenna, 80 μ rms. First one \$745K plus \$515K tooling. Fifteen would cost \$9492K. The price of carbon fiber panels is decreasing rapidly. They offer much better thermal stability than metal ones.

X. Transporters

Rail is best mode. Type depends on site (snow, etc.).

XI. Electronics -- Weinreb

Need rotatable subreflectors for access to different receivers. SIS receivers are very promising (70K, SSB). They need 4K refrigerators, which are currently much less reliable than 20K refrigerators (at GB, one failure every 3 months per 4K refrigerator). The bandwidth limitation is due to IF amplifiers. Can gang tune several FET's together.
IF distribution: no problem -- fiber optics or cables.
Spectrometer: favor hybrid correlator. Could use VLSI correlator chip being developed for VLBA (16 channels/ 16 MHz clock). Correlator could cost $10M.

XII. Competition

A. OVRO
3 10-m antennas. 83-115 GHz. Upgrade to 230 GHz in a few years. 400-m EW, NS baselines. Fourth antenna possible.

B. Hat Creek
3 6-m antennas. 70-115 GHz. 300-m EW, 200-m NS. 256-channel correlator/baseline. Proposal before NSF to add 3 more antennas.

C. Nobeyama
45-m antenna operating. 50 micron pannels, 100 micron overall accuracy. Array ready in a year (5 10-m antennas). Getting fringes on one baseline. Millitech supplying 3-mm receivers. The Observatory already invested 60 manyears in software.

D. IRAM
3 15-m antennas. First antenna in 18 months, one per year thereafter. 300-m baseline. SIS mixers. 25 micron panels. Berkeley correlator.

E. SAO -- Moran
6 6-m antennas over 200-m baseline at dry site. 230-850 GHz. $20M. Considering Mt. Graham, Mauna Kea. Could begin in 1986 if new secretary Adams likes the idea. This array is viewed as a developmental instrument in a little explored wavelength regime. Collecting area ~100m^2, much less than mm array. Could lead to National instrument ~2000.

XIII. Technical Plan -- Weinreb

(review of MMA memo 4.)
Welch suggested that OVRO and Hat Creek instruments should be considered the working prototypes and NRAO need not build another.

The committee met on the afternoon of March 2 to make recommendations and write a report.

Agenda for March 1984 Meeting of the Millimeter Array Advisory Committee
Starttime 9:30 am, March 1, 1984 in VLA cafeteria conference room

I.	Introduction - Owen	10 min
II.	Array Concept - Owen	30 min
III.	Beam Patterns - Hjellming	20 min
IV.	Mosaicing - Rots	15 min
V.	Sites - Owen, Wade	30 min
VI.	Atmosphere, Site Testing - Sramek	60 min
VII.	Numerical Methods - Cornwell	30 min
VIII.	Computers - Owen	10 min
IX.	Antennas - Horne	20 min
X.	Transporters - Temple	10 min
XI.	Electronics - Weinreb	60 min
XII.	Competition - Committee Members	30 min
XIII.	Technical Plan - Weinreb	30 min
XIV.	What Next - Proposals? - Owen,Weinreb	30 min

Questions for the Advisory Committee

II. Array Concept

1) Is it a good concept ?
2) Should we consider multi-beaming ?

III. Beam Patterns

1) What types of calculations should we make in addition to those presented ?
2) What are the important criteria ?

IV. Mosaicing

1) Is mosaicing reasonable ?
2) What tests, or calculations should be made ?

V. Sites

1) Should we even consider other sites than the VLA ?
2) New suggestions ?
3) South America ?

VI. Atmosphere, Site Testing

1) What site testing is necessary ?
   a) at the VLA ?
   b) on other sites ?

VII. Numerical Techniques

1) What tests, or calculations shuold be made in this area ?

VIII. Computers

1) We have not put alot of work into this area. What should we be most concerned about ?

IX. Antennas

1) General comments on our proposed antennas and plan of attack
2) Carbon Fibers ?
3) Does the cost estimate seem reasonable ?

X. Transporters

1) Any comments and suggestions

XI. Electronics

A) Receivers

1) Is SIS the only way to go ?
2) Do cost estimates seem reasonable ?

B) IF-LO

1) Seems clear-cut; do you agree ?

C) Correlators

1) How many channels, total bandwidth ?
2) Is the filter bank/digital scheme clearly the correct solution ?

XII. Competition

1) Do we have any ?
2) How should any competition affect our plans ?

XIII. Technical Plan

1) What changes should be made in our plan ?

XIV. What Next ?

1) When should we submit a proposal ?
2) What should people outside NRAO be doing ?
3) What, if any, meetings of other interested groups should be held ?
4) What else should we be doing ?