NATIONAL RADIO ASTRONOMY OBSERVATORY

MEMORANDUM

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The attached memo gives some preliminary cost and time estimates for additions to the interferometer.

An important question at the present time concerns what to do about another 85' telescope. We have the following choices:

1) Build an 85' equatorial Blaw-Knox antenna at Green Bank. This would be the quickest and least expensive way to add a fourth antenna to the interferometer (10 months and $475 K).

2) Build a VLA prototype antenna at Green Bank. I would guess that this would take 2 years and cost $1.4 million including the design study and a coordinate conversion computer. It would be convenient for the antenna to accommodate our present front-end boxes. However, more VLA design experience would be gained by building a Cassegrain feed system.

3) Build one or two VLA prototype antennas on a VLA site. If one antenna is built, the 42' could be used for interferometry. This would give us enough room to do 1" of arc interferometry and it would allow us to conclusively test the atmospheric and interference properties of the site.

I believe that this last choice would be best if there was a good chance of obtaining VLA construction funds in the next 5 years. I do not think that this is the case, so I believe we should take the first option and postpone the last option for about 5 years.

SW/cjd

Enclosure

NATIONAL RADIO ASTRONOMY OBSERVATORY

PRELIMINARY COST AND TIME ESTIMATES FOR ADDITIONS TO THE INTERFEROMETER

S. Weinreb

August 30, 1967

A. Front-End Additions

Three connected questions need to be answered in order to plan for new front-ends:

1) Do we want single switched polarization or dual polarization? The dual polarization not only allows a factor of 3 observing time reduction or sensitivity-limited sources but also allows a 10 to 30 °K decrease in system temperature since a switch is not required.

2) Do we want a second frequency simultaneously (4 IF channels for dual polarization), by switch control from the control room, by changing feeds, or by changing boxes? The first two options require a dual-frequency, dual-polarization feed; this will be difficult because of the tight circular polarization ellipticity requirements. The first option is complex if dual polarization is also desired.

3) Should we build entirely new front-end boxes or should we upgrade our present boxes? If the latter approach is taken, one new box should probably be constructed so that the new equipment can be installed one box at a time without causing interferometer down time. If new boxes are built, the present LO system must be duplicated for each box; the cost of doing this is approximately $10 K per box.

The time required for obtaining any new paramps is as follows:

Planning and Procurement --------	3 months
Quoted Vendor Delivery ----------	5 months
Vendor Delay -------------------	3 months
Test and Installation ---------- (dependent upon complexity)	3 to 6 months
	14 to 17 months

The interferometer down-time for installation of new front-ends should be about 2 weeks for final debugging of the front-ends. No new telescope cables are required.

A table showing the time required and cost for three different types of new front-ends is attached.

B. Back-End Additions

The additional IF amplifiers, delay lines, correlators, ALC, and gain monitors for a 4 antenna, 2 IF channel, and 24 correlator system could be constructed for $50 K in a 10-month period.

The computer can probably handle the additional correlators if a more optimum sampling rate is chosen and if the 4th antenna has an equatorial mount.

A small amount of down-time ($\sim$ 2 weeks) would be required for these changes provided the computer program could be debugged off-line.

C. Additional Electronics for Fourth Antenna

A fourth antenna with 3 km of new baseline would have the following electronics costs:

Baseline Cables, Connectors, Huts, and Cable Tray -----	$100 K
Scope Cables ----------	$ 30 K
Digital Equipment and Encoders ----------	$ 45 K
Polarization Mount ----------	$ 25 K
Additional LO Equipment ----------	$ 15 K
Miscellaneous ----------	$ 35 K
Total ----------	$250 K

POSSIBLE INTERFEROMETER FRONT-END ADDITIONS

Type of Operation	Item	Item Cost	Time Required and Cost
Dual-Polarization 5.5 cm New Boxes	6-5390 MHz degenerate paramps 3 Duplicate LO system Additional monitor equipment Dual circular polarization feeds	120 K 30 K 10 K 15 K	14 mo. $175 K
Single-Switched Polarization, Simultaneous 11-5.5 cm Present boxes plus one spare box	4-5390 MHz degenerate paramps 1 Duplicate LO system 1-2695 MHz paramp Additional monitor equipment 3 Dual-frequency, dual-polarization, feeds	80 K 10 K 20 K 10 K 60 K	17 mo. $180 K
Dual-Polarization, Dual-Frequency, Two Simultaneous Channels New Boxes	6-5390 MHz degenerate paramps 6-2695 MHz degenerate paramps 3 Duplicate LO system Additional monitor equipment 3 Dual-frequency, dual-polarization, feeds	120 K 120 K 30 K 20 K 60 K	17 mo. $350 K

D. Spectral Line Operation

It appears that the most flexible and feasible method of processing spectral line data would be with a one-bit digital correlator similar to the 416-channel unit presently under construction. A 600-channel unit, split into six 100-channel cross-correlators could perform spectral line processing for 4 antennas. The cost of this equipment including 4 sets of IF frequency translation equipment is approximately $130 K. Delay tracking could be performed within the digital equipment.

Non-degenerate, uncolled paramp front ends for either 1420 Mc/s or 1667 Mc/s would cost $100 K for 4 antennas.

The LO system for line work needs some careful consideration. It should be possible to use the present 1347.5 MHz, phase corrected LO as a stable "base" LO to be heterodyned with a frequency synthesizer output to give a variable LO near 1420 or 1667 MHz. I would estimate $50 K for additional LO equipment.

The computer requirements, lobe rotation use, and brightness temperature sensitivity need to be investigated. It appears, however, that a reasonable electronics system can be put together for around $300 K.