VLBA MEMO NO. 35

NATIONAL RADIO ASTRONOMY OBSERVATORY
Green Bank, west Virginia

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MEMO TO: Addressee

FROM: K. I. Kellermann

SUBJECT: Questions to be considered for the VLBA

Scientific Goals

Can we better relate the scientific goals to the system requirements?

Configuration

This is an open-ended question. We should discuss the current "best" configurations, but it is realized that these are only models. A more important question is whether we can clearly justify 10 antennas vs 9, etc. In addition to the more quantitative demonstration of Dynamic Range, we probably want to show pictures of real (scaled down) radio sources, as observed with various hypothetical Arrays. The Canadian group has raised the question of whether an Array "optimized" using ordinary Fourier inversions of calibrated data is also optimized if it is "self-calibrated"? How does the (u,v) coverage (i.e. Dynamic range) of full tracks with the VLBA compare with the VLA in various snapshot modes.

Control System

If we use a satellite l.o. link, should this also be used for control and monitoring? What are current and projected costs of satellite communication link? Is it realistic to expect direct access to the satellite from our own ground terminal?

Antenna Elements

We have a good conceptual design that has been favorably received in the community, but no one has made serious evaluation of the cost of this antenna. Our cost estimates are based on improved VLA antennas, assuming a quantity discount.

Independent input comes from the TIW estimate of antennas for the Canadian Array and from studies commissioned by JPL to E-Systems, Harris, and Ford Aerospace for addition to the DSN. These are summarized below.

Manufacturer	Diameter	Number	Surface (inches rms)	Cost (10^6)
T.I.W.	32-m	8	0.032	$2.13 (1981)
E-Systems	32-m	10	0.035	1.65 (1978)
	25-m	17	(VLA)	1.47 (1978)
Ford	30-m	13	0.058	2.1 (1978)
	34-m	9	"	2.5 (1978)
Harris	32-m	11	0.047	1.25 (1978?)
	38-m	7	"	2.20 (1978?)

For many reasons these costs are not directly applicable to our situation, but the costs do provide some indication of the market. Also of interest is the VLB antenna currently being built by TIW in Italy, and I shall try to learn what I can from the Italians.

At a very minimum we need to reappraise the cost (1982) of a modified VLA antenna. How does the uncertain economic situation affect the quantity discounts? What have we learned from the VLA about the performance of these antennas, in particular the pointing. What needs to be shielded or insulated? Can or should the design be modified to circulate water?

Can we make a useful cost estimate of the W-Y-W antenna? There are some who argue that we should have bigger antennas (32-m?). The strongest argument is that one can always improve the receivers, etc., but not increase the size of the antennas. What do we trade off for increased size in surface accuracy and pointing? Do we want to reopen these questions? If not, how do we justify the choice of 25 m?

What can we learn from more recent JPL studies or from our own work on the new Green Bank antenna? Can we be more detailed about construction of surface panels? Have we learned anything from the two test panels? What tests are planned on the test panels? What will it cost to have an outside evaluation and costing of the W-Y-W antenna? Do we want to request funds to do this. What will the detailed engineering design cost? When should we request funds for this?

Feed System

Some questions have arisen with regard to the polarization capability of these dual-frequency feeds. What is the best way to get the H and all 4 OH lines from the L-Band -- broad bandwidth at L-Band (1.4-1.72 GHz) or three frequencies 1.4, 1.62-1.72, 5 GHz? Should we consider an IF Polarimeter? Are dual frequency feeds necessary or desirable for the short wavelengths? Will it be cheaper to have separate feeds at 10.7, 15, 22 and 43 GHz? What changes are necessary if we opt for a 15-21 GHz maser?

Are the cost estimates realistic?

Front End Systems

Are the advantages of the maser-upconverter system (VLBAM No. 26) worth the extra cost and complexity? Can we cover 15-22 GHz with one maser? How important is dual polarization at 43 GHz? Is it better to have a high gain (lower second stage noise) single channel system at 43 GHz?

Local Oscillator System

The price of Hydrogen masers continues to increase rapidly. The current SAO price is about 25% higher than the number we used. Oscilloquartz has raised their estimate by a factor of two, so that it is now comparable to the SAO price we used in our design study. It is still not clear, however, whether Oscilloquartz will be a real source of masers.

In view of the increasing maser cost, sattelite links appear more attractive. But both the Dutch and Canadians have not been encouraged by their experiments, and have shifted their emphasis toward masers. Do we want to experiment with satellite links? If so, what should we do? We need to get Knowles to CV to discuss his experiments with the Canadians.

Record System

The MKIII system is uncomfortably expensive and complex. The commercial cost is close to $400K (with computer). Should we get a cost estimate from Phoenix Corporation? Is that consistent with the cost estimates in the Design Study? Do we need the flexibility of MKIII or is there a cheaper way to implement a fully compatible record system? How many independent channels do we really need? What progress has been made at Haystack and JPL to improve the bit density?

Are multiple cassette recorders a viable alternative? What progress has been made to increase the bandwidth? What has Allen Yen accomplished?

Processor

What are the alternatives in implementing a Processor? How much should be done in hardware? software?

Post-Processing

What have we learned from the VLA (or elsewhere) about the feasibility of using H_2O vapor measurements to calibrate the atmospheric phase fluctuations? What are the relative merits of the various self-calibration schemes now in use? How effective are self-calibration methods in the weak signal case, or in the special case where the SNR is poor on some baselines, but good on others.

Based on VLA experience, what are the Post-Processing needs? Have we realistically allowed for making multiple maps from the same data?

Operation and Management

Is the number of people right? This is probably the most important and most difficult question we must address. We have allowed for an adequate

(generous) OOE budget, but have we included enough personnel for new development? What insight do we have from VLA experience on the system reliability?

Development and Funding Plan

What work should be done by NRAO following the submission of the proposal? The following might be considered:

(1) Outside evaluation of Antenna Design
(2) Detailed Engineering Design of Antenna
(3) Experiment with satellite l.o. link and/or real time fringe verifier and system monitor.
(4) Develop 15-23 GHz maser
(5) Develop front end prototypes
(6) Experiment with enhanced tape density and/or increased bandwidth.
(7) Design and develop Prototype Processor
(8) Design and develop feed systems.

Should we push for the early construction and operation of a prototype antenna? To be useful, how long in advance of other antennas must the prototype be finished?

Can we obtain funding to support any of this prior to authorization. With the exception of (1), these are interesting and important problems even without the VLBA, and have potential application to improve current VLBI systems.

Interaction with Others

Canada. How does the final Canadian configuration affect our selection of configuration or even the number of antennas? How much coordination is feasible? How can we help each other? i.e., should we help them build maser amplifiers, they help us build broadband VCR's, etc.?

What level of formality is desirable to insure the availability of a European (Italy) antenna?

Cost Estimates

I am aware of four internal inconsistencies in the Design Study which result in Table VI-7 (pg. VI-13) being low by a net 46K per antenna. A free beer to the first person who correctly identifies these errors. Additional free beers to anyone who finds other internal inconsistencies.