

NATIONAL RADIO ASTRONOMY OBSERVATORY

Charlottesville, Virginia

November 17, 1983

MEMO TO: H. Hvatum
FROM: K. Kellermann
SUBJECT: VLBA Volume III

I have read through Chapters I, II, III, IV, V, VI, VII, VIII and list my comments below. I note the rather uneven treatment due to the multiple authorship, i.e. figure numbering, acknowledgements, cost tables, etc. I suggest you issue guide lines for these things. Perhaps budget estimates should be put in a separate chapter. Do we need an introduction explaining what Vol. III is and that costs were done independently of Vol. I, and are in \$1983?

More important, some parts of the report are already obsolete, and do not reflect current thinking. I comment on specific examples below, but it is not clear to me how to treat this without continually rewriting things. Perhaps the report should be backdated to August, but then it will realistically represent our plans.

Chapter I, Configuration

Section II. The most important thing here will be to at least mention Pietown under 10. Perhaps more emphasis on Los Alamos vs. Bernal.

It might be appropriate in Chapter I or II to give the tentative order of construction that we now more or less agree on.

Chapter II, Sites

Note that all costs and planning have always assumed the AOC is at a current NRAO facility (Section II and Red Book). I don't think this is generally appreciated by those giving us advice.

Section III.B. Give humidity range i.e. $40 \pm 10\%$

Section III.E. Should the leased telephone lines be included here? Why is the parking area so big? Do we want to reduce the size of the antenna control building? Do we need the separate computer room? Main Operating Building - I hope we can get

something other than the Green Bank-Charlottesville "Box" design. Cost estimate: the caveat about contingency, management, etc. should either be removed or included everywhere, or discussed in an introduction.

Chapter III. Antenna Elements

I would like to see more emphasis on the "Advanced Design." Bill Horne is too busy with the RFP to waste time writing and we have agreed that I will try to do this.

Chapter IV. Electronics

Section II.A. It is my understanding that we will not initially implement the 5/22, 10/43, and 22/43 GHz dichroic options. Only that the feeds will be positioned to allow this later. This is not clear from the text.

Section II.B. I am concerned that we may not meet our specifications for 22 and 43 GHz performance. Masers are in common use for 1.3 cm VLBI now, with 40-60 K system temperatures being routinely achieved in good weather. We can not accept a 1989 goal of 130 K. I fear that in two years, the HEMT and SIS systems will not offer the required performance, the maser will be felt unreliable and we may be forced to a disappointing performance.

It seems to me not unlikely that the 2 K refrigerator will also have reliability problems and so the SIS solution may not be realistic.

Should we not work on the maser reliability problem now, (if there is such a problem) and try to make this very attractive and demonstrated low noise device, with which we have considerable experience meet our reliability requirements.

The VLBA 15 GHz receiver specification is 40 K, not 55 K. 55 K is given in Volume I as the current performance. 40 K was predicted by 1986. Predicted noise temperatures always seem to increase as the target date approaches.

Section D. It may be appropriate to modify the link discussion in view of the Pietown site.

Section E. Is the VLA water vapor radiometer program a high priority one? While it is certainly appropriate to defer production of the 10 radiometers, we still need a lot of work to develop a stable radiometer, and to understand how to relate the radiometer measurements to path length fluctuations.

IV. Construction Plan. Napier has suggested that the VLA 8 GHz systems be built first so that where possible they can be installed during the normal overhaul. If they can be built at a faster rate then some can be put on VLBA antennas.

Chapter V. Data Acquisition

This chapter goes into more detail than others. I still have trouble with this chapter, as I would not be prepared to defend some of the discussion, particularly relating to VCR/Instr costs, operations, and feasibility. I suggest changing all reference to "red-cover" report to Volume I. All figures can be reduced to 1/2 page or less and should go in place in the text.

Section C. Subchannel Format. I do not understand what is meant by "nondata replacement" format.

Section F, line 2. VLBI array should read VLB Array.

Section G. The second sentence strains the credibility of the whole project. "It is hoped that both systems will be ready for some operational tests starting 1 September." Changing the date will easily fix up the report, (too easily) but that does not change the fact that we are way behind in the critical area.

At this point we are probably not considering reel-to-reel VCRs realistically. Volume III is supposed to be a project plan not a design study, and I suggest deleting this discussion.

We may need to fall back to the system with a "large number" of manually changed VCRs, (particularly if we keep putting off starting development of an automatic changer); but the impact to operations is significant!

Change 311284 to end of 1984 (last line of Section G).

Table G-1. How about including 4 head VCR system.

Design Costs. I don't understand the 100k for MKIIIA development and 35k for M&S if NASA supports this for the CDP. On the other hand I don't see any VCR development. This chapter should reflect cost to the VLBA Project, I think, without distinction as to what is done at NRAO or Haystack.

Section called Comments (MKIIIA vs. VCR). VCR numbers taken from "red book" are 1982\$ whereas new numbers are 1983. About half of the difference is due to escalation.

Section J. Third line states "typically" the units are separated by 100-300 m. Why include the word "typically?" Everything is identical.

Item B suggests that we could have super HDR mode (1.5 Gbps) for 180k. This is misleading!

The Video Converter Parts List is unnecessary, but if included, items 31, 32, and 33 are missing.

If I understand correctly Chapter VI allows for only 16 input channels per station whereas Chapter V gives 32. Either we should delete 1/2 of the video converters or add input channels to correlator.

Chapter VI. Monitor and Control

Section B. Fringe Verification Buffer: Should this be bigger than 2 Mbits?

Section D. Hardware: Comment about redundancy is very important - Underline.

Chapter VII. Correlator

Section C. It is stated that the choice between custom n-MOS VLSI chip and other alternatives does not make a large impact on cost or correlator design. Why then incur the risk of the VLSI development? What is cost and time schedule if VLSI development is unsuccessful and we have to retreat to PAL or gate array design. Or worse, and perhaps more probable, will VLSI question remain unresolved after say 1 year, with a solution looking good after a further 6 months work. There is a tendency for that sort of thing to go on and on.

Does the Correlator system provide for the autocorrelations for each station required for spectroscopy. Is this included in cost? If not, what is cost increase?

Will it be feasible to play back multiple narrow band recordings simultaneously. Can we either recirculate data to make better use of the "fast" correlators, or buffer each "slow" data stream, and multiplex several "packets" through the fast correlator. Note the Volume I design easily allowed for this mode with the recirculating system. It is not clear how important this multiple playback will be to make up for otherwise lost correlator time and/or implementing more than 512 spectral channels.

The cost of the correlator less computer (420k) and playback units (660k) is \$2.66M. This may be compared with \$898k estimated about 18 months ago (pg. VII of Vol. 1). I (and perhaps the NSF if they read this) would like to understand the reason for this large discrepancy. The two designs are comparable in performance specs, although the Volume I design has several advantages (allows multiple VCR playback, gives autocorrelations, no risky VLSI development).

Chapter VIII, Data Processing

What is the impact on computing requirements if we allow for 16 or 32 separate frequency channels. Note in the middle of page 3, 4 to 6 frequency channels are indicated.

Section III.A.2. Last sentence has the word "despite" twice. This section might be interpreted to claim that the VLBA needs the same amount of computer power as the VLA. This has not been demonstrated and we are not asking for it.

Section III.C.1. In addition to the common use of phase closure by the VLA and VLBA, the VLBA will also make use of phase referencing, as done normally for the VLA. Also the inner VLBA baselines only exceed the longer VLA baselines by a factor of 2, so there is a real continuity in baseline length and thus post-processing techniques.

Section III.C.3. Paragraph 3. I would prefer to delete the first 2 sentences. Geodetic as well as astronomy data will be analyzed in and out of house. Outside astronomers may also want to develop their own software and we may have an in-house geodeticist. Let's treat astronomers and geodeticists in the same way.

Section IV. AIPS. It is suggested that the correlator put out a FITS Tape. Good! Why doesn't the VLA DEC 10?

Section V. I would have thought that the VLA experience is directly relevant to the question of separating development from operations. Of course, there is no agreement on the VLA experience!

cc: M. Roberts

KIK/cw