VLB ARRAY MEMO No. 430

SUMMARY OF SOCORRO WORKSHOPS

L. D'Addario
30 January 1985

This is a brief summary of conclusions reached during the meetings in Socorro, 22-24 January 1985. More detailed reports have been prepared by the various group leaders. Also included here is a list of items needing further action. It is quite possible that I have missed a few points, but I hope that nothing major has been omitted.

Conclusions Reached - by subsystem

A. Sites. Many sites are affected by interference at some level, and we do not have practical, quantitative specs on the acceptable levels. Also, the 500-1000 MHz IF band needs interference protection.

B. Station building. Normal location should be located at the azimuth of the highest natural horizon, 60 feet from the center of the antenna, with some variation allowed to accommodate individual sites. No separate tape storage or mechanics rooms will be included; a single entrance, with provision for double doors, is acceptable. Electrical loads are now specified. Probable size is 24 by 49 feet.

C. Receivers. The subreflector accuracy upgrade to .004" rms (cf. .008" spec) would improve 43 GHz efficiency from .58 to .64 and 86 GHz from .28 to .42, under the best observing conditions; implementation depends on costs, which cannot be determined now. The maser specs and a proposed scheme for cable length monitoring were discussed, with no significant comments. There was concern about whether the IF cable length variations with mechanical stress would track those of the monitored LO cable to sufficient accuracy.

D. I.F. Processing. The proposed three-place gain adjustment method (manual front end setup, 3-step programmable I.F. gain, and ALC at baseband only) seemed acceptable. The gain distribution also seems OK, unless interference pickup on the I.F. cables is a problem.

E. Microcomputer Standards. All RAM-programmable microcomputers will use CPUs from the Motorola 68000 family; will connect to the VME bus; and will use the VERSAdos operating system (if an operating system is required, and then only the needed layers of VERSAdos). This is currently seen to affect the Station Computer, the record and playback controllers, and the Fringe Processors of the correlator.

F. Digitizing. After considerable discussion, it was decided that 2-level and 4-level quantization will be generated, transmitted, and fully supported at the correlator for all sampling rates. The corresponding transmitted codes will use 1 and 2 bits/sample, respectively; the 4-level code will ensure binary symmetry; no attempt will be made to implement more efficient codes. It was also suggested, but not decided, that the correlator no longer be required to provide full spectral resolution for oversampled data.

G. Recording. (See also Digitizing and Microcomputer Standards, above.) All samples will be recorded (so-called "non-data-replacement"). Other details of the format are not yet specified; a formatter design will be pursued that allows the format to be easily changed. The error rate specs in draft specification A54001N001 are now adopted; when these specs are not met due to system degradation, the detected error rate spec shall fail first. Recording speeds of fast, medium, and slow (ratios 4:2:1), and playback speed of fast only, are the minimum requirements (design goal: additional playback speed of medium). Playback system will include removal of phase switching.

H. Correlator. (See also Digitizing and Microcomputer Standards, above.) The minimum dump period (to archive medium) shall be 0.5 sec of correlator time when all correlations are retained; and 0.1 sec with some (not yet specified) restrictions on the number of baselines and/or spectral channels. The output may be a boxcar integration over the dump period, but a design goal is to provide filtering which keeps the spectrum of the output time series flat to ± 0.9 Hz. Fringe rotation phase tracking shall be adequate at 2x speedup in the worst accessible case (precise spec still needed), and at 4x speedup if $f_0 < 43$ GHz AND $\Delta f < 8$ MHz. Expansion paths which make it easy to add stations beyond the 20th are not needed; instead, it should be easy to add lags per baseline and channels per station. The correlator chip developed for the AT may be useable for the VLBA, if it will run fast enough; but the correlator group has not yet determined exactly how they would use it and what the performance consequences would be.

I. Monitor and Control. (See also Microcomputer Standards, above.) Operator interface "screen" concepts seem OK (similar to VLA). Deeper level standardization of operator interfaces needs more study. All monitor data will be transmitted and recorded via computer links, rather than via the sample tape.

J. Post Processing. Decisions noted above will affect data rates: if 4-level is used for continuum, data rate is reduced; use of non-boxcar averaging may allow compression by factor of 4; the fact that no speedup is possible at 8 MHz

bandwidth (always true but just now realized) means more data for small fields. The archiving format cannot be decided, since it depends on the medium chosen; the decision can be postponed, although some hardware choices are needed soon; consultation with Space Telescope recommended. For geometric accountability, recording the time and total delays should be adequate.

K. Operations. Space and personnel requirements at the operations center were reviewed; the budget allows construction of only about 66% of the estimated requirement, so ways of cutting down were considered, with no definite conclusions. The building design should cover three options: combined VLA/VLBA op center; VLBA only, desired size and configuration; and VLBA only, minimum size.

L. Other issues. The playback-to-correlator interface has been determined in outline form; a formal specification will be prepared before July 1985. Support for pulsar observations appears to be rather difficult, and more study of possible modes is needed.

Action Items

Item	Date Due	Person Responsible
Calculate tolerable interference	850301	Thompson
Choose microcomp dev systems	850301	Rogers/Clark/Ewing
Write computer standards (documentation, coding, config. control)	850315	Clark
Operator interfaces: implementation stds	?	Clark
DPS-Cor interface specification	850701	Rogers
Decide on use of AT chip	?	Ewing
Decide pulsar support modes	?	?
Decide cor Mflops for calibration	?	Ewing
Where should phase cal detectors go?	?	D'Addario
How should TP/gain cal be done (analog or digital, record or PB time)?	?	D'Addario
Electronics packaging standards	?	Thompson
Decide various station locations (HI, TX, AZ, WA, NE, PR)	?	Walker

SOCORRO WORKSHOPS:
EFFECT ON SITE SELECTION AND COMPUTER COORDINATION

R. C. Walker
24 January 1985

In general, I am pleased with the results of the meeting. This is especially true of the choice of digitization levels.

There was relatively little discussion of the sites. It did become apparent that we need two things relating to RFI.

1. Dick Thompson has promised a memo giving maximum RFI levels that can be filtered in the control building. If a site has RFI above these levels, we should probably reject it.

2. The RFI surveys should include measurements in the 500-1000 MHz band that we intend to use for the IF. We also need to determine the RFI levels that can cause problems in the IF.

The computer coordination workshop produced three action items:

1. There was general agreement that the M/C, Correlator, and Recorder groups should have the same microprocessor development system. Levine will look at the details. A decision on this is expected by March 1. Call it Microprocessor dev. sys. and put Clark/Levine by it.

2. Tim Pearson's discussion of documentation and coding standards was considered to be a good start. However it needs some more details. The action item is Doc. and code std. by March 15 with Clark responsible.

3. The discussions of operator interfaces by Clark and Bignell were very similar (unexpected by some of us) and seemed good to all present. However the interface between the screen drivers and the control programs was unclear and subject to some differences of opinion. Barry promised more information. The action item is Op. interface prog. style April 1 Clark.

More details may come from other groups.

I don't think any changes to my parts of the project book are needed at this time.

Effects of the Socorro Design Review on Post Processing

W. Cotton
6 February 1985

Data Rate

The decision to support 2 and 4 level quantization and the details of the correlator design will have an impact on the amount of data which must be processed. Due to the complex nature of the VLBA and its many possible observing modes it is not possible to determine the overall impact on the system; the impact on various common observing modes will be discussed below.

For narrow bandwidth modes, use of 4 level quantization will increase the sensitivity per unit bandwidth by 7.7% (compared with 3 level) with no oversampling. For continuum modes, with the bandwidth limited by the tape capacity, the bandwidth with 4 level is half that of 2 level and 83% that of 3 level, with a 3.6% loss in sensitivity. If observers choose 4 level rather than 2 level for continuum, this will, in many cases, halve the bulk of the data.

The correlator will not be able to correlate 8 MHz bandwidth IF channels faster than real time. If the correlator is normally to be run with the factor of two speedup then this effectively limits the IF channel bandwidth to 4 MHz. Since data from different IF channels will not be combined until fairly late in the processing, the bulk of data for continuum experiments for which frequency averaging to 8 MHz bands is adequate is doubled.

Use of Finite Impluse Response (FIR) filtering was discussed at the design review. If this technique proves useable, the bulk of most data could be reduced by up to a factor of 4.

Correlator Interface

This area is currently very poorly defined. The question of separate formats for archive and distribution purposes was not settled, although at least one output device per experiment being correlated appears necessary. The format of the archive files will probably depend on the physical medium which has not yet been chosen; Space Telescope is investigating using optical disks and we should follow their development.

At present the correlator group is planning to write archive files in an as yet undefined form and the post processing group is expecting distribution tapes in FITS format. Plans for copying and sorting archive files to distribution tapes (or vice versa) are nonexistent. Neither the correlator nor post processing groups currently has the responsibility for this.

Geometric accountability

Alan Rogers suggested that the information needed was accurate time, total model group and phase delay and their time derivatives. He promised to provide some documentation on the needs of geometric observing.

Geometric software

There was some discussion of whether software for geometric solutions should be incorporated into AIPS or another, existing package should be used directly was discussed but no conclusion was reached.

EFFECTS OF SOCORRO WORKSHOPS ON SITE SELECTION AND BUILDING DESIGNS

B. Peery
5 February 1985

MY INTERPERTATIONS OF CONCLUSIONS REACHED RELATEIVE TO THE SITES, STATION CONTROL BUILDINGS AND AOC ARE AS FOLLOWS:

SITES

ONLY THREE ANTENNA LOCATIONS (PIE TOWN, KITT PEAK AND LOS ALAMOS) APPEAR DEFINITELY SET AT THIS TIME. RFI AND WIND ARE PROVING TO BE MAJOR FACTORS REQUIRING CONSIDERABLE STUDY AND TESTS AT EACH LOCATION BEFORE ACCEPTING THEM.

A REVIEW AND UPDATE OF THE RFI CRITERIA WILL BE MADE. THE 500 TO 1000 MHZ FREQUENCIES WILL BE INCLUDED AS THEY MIGHT HAVE IMPACT ON IF FREQUENCIES AND THEIR PROTECTIONS.

RFI CHECKS WILL BE MADE AT ALL SITES. FORT DAVIS, TEXAS IS THE NEXT SITE ON THE THE SCHEDULE.

STATION CONTROL BUILDING

THE BUILDING WILL BE APPROXIMATELY 24 FEET BY 49 FEET INSIDE.

THE DISTRIBUTION OF ELECTRONIC EQUIPMENT BETWEEN THE EQUIPMENT ROOM AND THE CONTROL ROOM WAS SOMEWHAT CONTROVERSIAL, BUT THE GENERAL IDEA THAT ANALOG HARDWARE WILL BE IN THE EQUIPMENT ROOM AND DIGITAL IN THE CONTROL ROOM WILL BE RETAINED AS FAR AS POSSIBLE.
THE ELECTRONIC AND TELESCOPE TECHNICIANS WILL JOINTLY USE ONE LARGE OPEN SPACE WHICH WILL BE ARRANGED, FURNISHED AND SUBDIVIDED AS NEED ARISES AFTER OPERATION HAS STARTED.

TAPE STORAGE WILL BE IN METAL CABINETS IN THE CONTROL ROOM (48 INCHES HIGH AND 19 INCHES DEEP - LENGTH AS REQUIRED).

TAPE REELS - 16 INCHES DIAMETER - TAPE 1 INCH WIDE - 18000 FEET PER REEL. APPROXIMATELY 60 REELS IN STORAGE.

ONE DOUBLE DOOR NEAR CENTER OF BUILDING ON THE SIDE AWAY FROM THE TELESCOPE WILL SERVE AS THE ENTRANCE TO THE BUILDING.

THE EMERGENCY GENERATOR WILL SERVE ONLY CRITICAL LOADS TO PROTECT THE ANTENNA DURING A COMMERCIAL POWER FAILURE.

BUILDING HEAT WILL BE ELECTRIC.

THE BUILDING WILL BE LOCATED SO AS TO CAUSE MINIMUM BLOCKAGE OF THE HORIZON WHEN THE TELESCOPE IS POINTING TO THE HORIZON. IT WILL BE APPROXIMATELY 100 FEET FROM THE CENTER AXIS OF THE TELESCOPE.

THE SCHEDULE OF ELECTRIC LOADS PRESENTED APPEARED CORRECT.

AOC

THE SPACE REQUIREMENTS AND FUNCTIONS PRESENTED (OPERATIONS GROUP MEMOS) ARE MORE THAN BUDGETED FOR. DUE TO BUDGETING CONSTRAINTS A/E ASSISTANCE IS SOME TIME OFF. WHEN THE A/E CAN BE COMMISSIONED TO DO THE WORK HE WILL BE INSTRUCTED TO DEVELOP CONCEPTUAL PLANS AND ESTIMATES FOR:

A. THE TOTAL SPACE AND FUNCTIONS PRESENTED IN THE OPERATIONS GROUP MEMO FOR VLA & VLBA COMBINED OPERATIONS.

B. THE SPACE & FUNCTIONS FOR STAND ALONE VLBA OPERATIONS.

C. A REDUCED STAND ALONE VLBA OPERATION THAT WILL MEET OUR BUDGET.

D. THESE CONCEPTUAL PLANS AND ESTIMATES WILL BE USED TO DETERMINE HOW TO PROCEED.

E. IN ALL THREE CASES CONSIDERATION WILL BE GIVEN TO EXPANSION TO THE FULL VLA-VLBA COMBINED OPERATION AND MORE.

Summary of Socorro Meetings: Monitor and Control

B. G. Clark
6 February 1985

First, and most encouraging, result is that it is agreed that all computers in the VLBA systems will use Motorola 68000 series CPUs unless there are compelling reasons to choose another. This arises in the array control computer and in the correlator control computer, where the software environment is insufficiently rich on the 68000 series, and in some very small microprocessors in the system (such as the 8 bit Intel processor on the standard interface board), where the 68000 CPU would be unnecessarily expensive and bulky.

Second, wherever it is adequate in bandwidth and acceptable in size, the VMEbus standard bus will be used throughout the system for the bus to which microprocessors are to be connected.

Third, whenever an operating sytem is required on a 68000 series cpu, VERSAdos will be used, incorporating as many layers as necessary of the system, recognizing that it can be broken down into at least the following levels: 0) No operating system needed, none provided. 1) VERSAdos realtime kernal (RMS68K). 2) Kernal plus I/O drivers. 3) Full disk operating system.

Fourth, the approach to operator interface screens as suggested (soon to be a VLBA memo) met little real opposition, and work will continue along those lines, with emphasis on compatability with the VLA control system.

The following items are ones requiring more work and decisions shortly.

First, it should be investigated whether a VME-10 based development system at all hardware development sites is necessary and desirable. Decision due by March 1.

Second, it must be investigated whether a standard programer level interface between operator interface software and hardware control software can be designed with sufficient power and flexibility to be worth implementing.

Third, project wide standards for documentation and program standards should be set. A first draft suggestion was provided by T. Pearson, a second draft, going into much more detail will be provided by B. Clark by mid March.

IMPACT OF SOCORRO WORKSHOPS ON DIGITIZATION AND RECORDING

A. E. E. Rogers
28 January 1985

This meeting confirmed many of the decisions made at MIT on 4 Jan 85. The decision to use 2 and 4-level quantization made in Socorro has no impact on the recording and playback other than a minor revision in the method of encoding 4-level data needed to make each bit have equal probability being one or zero. The following items were decided:

1) 2-level and 4-level quantization.
   1A) 4-level encoded as -W=00, -1=01, +1=10, +W=11.
2) Formatter will include non-data replacement.
3) The overall formatter concept is acceptable. Specific details of format not needed since sufficient flexibility is provided to optimize in software.
   3A) Studies of tape channel will continue with a goal of providing some specific examples of format.
   3B) Multiplexing more than one baseband channel on one track is not needed.
4) Recording specifications are acceptable after amendments made at MIT (See Memo 421). An additional statement should be added which indicates that the amount of data flagged bad should be the first specification to fail when a malfunction occurs (i.e., the passage of excessive quantities of bad data to the correlator should never occur - even when a tape channel fails).
5) Error detection is required and a detailed example of method is needed - see 3A.
6) No error correction is needed if recording specifications can be satisfied without it.
7) "Nominal" record speeds of 67, 135, 270 IPS and playback at 270 IPS is acceptable.
   7A) Option for 135 IPS playback to be studied.
8) Variable phase sampling is not needed.
9) Provision for unscrambling possible phase switching will be provided in DPS.
10) System gain specifications (see Electronics memo #30) are acceptable for prototype.

Several items need further study as follows:

1) Interference pickup on I.F. cables.
2) Coupling for phase cal injection.
3) Can I.F. distributor and baseband converters + A/Ds + formatter be packaged in one rack? Where should this rack go?
4) Should power at A/D input be measured with square law detector or by counting A/D outputs?

5) Can LSB outputs from baseband converters be eliminated, or is a reduced number of available LSB bandwidths (depending on which filters are in place) acceptable? (Either will reduce cost but might result in some compromise in certain Pulsar and high data rate modes.)

6) Clarify meaning of "(16 x 10 * * 6) K/N bits must be clocked out of DPS in parameter update period".

7) "Model switching" in DPS - study capabilities and specify details.

Action Items with specific completion dates:

1) Complete details of DPS/Processor interface and software protocol by July 1985.

Operations Notes from VLBA Design Review Workshop

Carl Bignell
January 31, 1985

The OPERATIONS workshop discussed the building space requirements for the stand alone Array Operations Center (AOC) and the monies currently allocated in the construction budget. About 34,000 sq. ft. of floor space is required and a budget of $1.5M is probably only enough to purchase about 21,500 sq. ft. (using $70 dollars per sq. ft. - best guess for building costs are $60 to $75 per sq. ft.). The discrepancy amounts to approximately 12,500 sq. ft. or $0.9M (using $70 per sq. ft.). Consideration of this problem and what could be cut from the current floor space in the AOC plan led to the following conclusions.

(a) Some small savings could be achieved by reducing office sizes however it is questionable that significant savings could be achieved without considering a significant reduction in the manpower levels. Therefore every reasonable attempt should be made to find funds to allow building the full stand alone AOC.

(b) The possibility of considering a trade off with other hardware options should be seriously pursued since it will probably be easier after construction to acquire new hardware for increasing the scientific output of the instrument than adding building space.

(c) Consideration should be given to finding ways of advancing the construction of the AOC (currently planned near end of project) so that the building becomes available at a time more appropriate for operational needs.

(d) The A & E study should be accomplished in three phases. The first phase should propose a building design which houses the combined VLA/VLBA operations. After the completion of this phase a study should be made of how one can grow over a period of time into this combined AOC and finally what could be built for the currently available funds.

Electronics Notes from the VLBA Design Review Workshop

A. R. Thompson

January 30, 1985

A VLBA design review workshop was held in Socorro on January 22-24, 1985. In the area of the receiving electronics no major design questions were identified at the workshop, and the discussion was mainly limited to a review of decisions made during the past year. The following notes summarize the points that were covered.

1. Subreflector. Quotes for both the original and the higher-accuracy specifications will be sought, and the final decision on which subreflector to procure will be made after this information is in hand. It seems tentatively agreed that the higher accuracy subreflector should be obtained providing that the additional cost is not more than about $50,000 per unit. Of the optional items in the electronics area, this is the only one on which a decision is required within the first half of 1985.

2. Feeds. The 330 MHz and 610 MHz feeds will use common dipoles with a diplexer. The 6 GHz band will use the 4.8 GHz feed and no separate feed for 6 GHz will be included.

3. Dual-Frequency Operation. It will be possible to make simultaneous observations in the 330 MHz band and any one of the bands 610 MHz, 1.5 GHz, 2.3 GHz or 4.8 GHz. Dichroic reflectors will be provided for 2.3 and 8.5 GHz and also possibly for 5 and 22 GHz and 10.7 and 43 GHz.

4. 22 and 43 GHz Front Ends. The present plan is to use HEMT amplifiers at 22 GHz and SIS-junction mixers at 43 GHz. Details of this discussion are given in VLBA Electronics Memorandum No. 32.

5. 610 MHz Front End. The double-superheterodyne filter unit for this band was described. The -3 dB bandwidth will be 4 MHz and the -50 dB bandwidth 7.2 MHz. Tests on the breadboard prototype indicate that it will allow satisfactory rejection of signals in neighboring TV channels that are as high as -40 dBm at the antenna output. R. C. Walker requested that it should be possible to switch out the unit for broadband observing at those stations where there are no signals in neighboring TV channels.

6. Receiver Noise Temperatures. Noise temperatures in the VLBA Proposal were compared with values obtained on prototype front ends constructed to date (330 MHz, 1.5 GHz, 8.4 GHz). It appears that predicted performance will be achieved or exceeded at all frequencies except 22 GHz where the decision to use a HEMT amplifier rather than a maser increases the predicted receiver temperature from 10 K to 40 K. (The resulting system temperature is increased by a factor of less than 2.) HEMT amplifiers will be used on as many frequencies as possible down to 4.8 GHz depending upon the availability of these transistors.

7. Cryogenics. The reliability of the CTI model 22 refrigerators and the importance of obtaining 10,000 hours MTBF were discussed. NRAO is working with CTI to eliminate the tolerance and assembly problems found on some of the early units. The 1.5 GHz front end will use the model 350 refrigerator since the cool-down time at this band obtained with the model 22 is too long (20-30 hours). For further details see VLBA Electronics Memoranda Nos. 29, and 31 to 34.

8. Hydrogen Maser. The preliminary maser specification given in VLBA Memorandum No. 382 will be tightened to allow a greater margin between the phase fluctuations from the maser and those induced by the atmosphere as measured by Rogers et. al. (Radio Science, 19, 1552-1560, 1984). An Allan variance of 7×10^{-14} at 1 sec is a proposed goal, and would give a margin of about 6 dB below the atmospheric effects.

9. Local Oscillator System. A breadboard prototype of the 2-16 GHz Synthesizer module is under development at Green Bank. A preliminary block diagram for the round-trip-phase measurement scheme for the L.O. cable was discussed. This cable will deliver reference frequencies of 100 MHz and 500 MHz from the maser to the antenna vertex room. A modulated reflector will be used at the vertex-room end, and it was noted that the modulation frequency should be above the loop bandwidth of any phase-lock systems that will use the reference frequencies carried by the cable. Further study of this and some other points of the cable system is required.

10. Radio Interference. A study of the effects of various interference levels is required. It is important to know the following interference thresholds for each band. (1) Signals that are weak enough to cause no problems even when within the receiving band. (2) Signals that require filtering in the IF stages of the system and can then be tolerated without degradation in the overall performance. (3) Signals that require filtering early enough in the front ends that some degradation in performance will result. I have undertaken to provide this information. Values for category (1) above are given in VLBA Memorandum No. 81.

11. Construction Details. It is planned to set up a prototype feed cone during 1986 on a structure that will simulate the floor and ceiling positions of the vertex room. This will be located at the VLA site and will be used for planning layout of feeds, front ends, helium and vacuum lines, etc. Local oscillator, IF, and monitor and control units will be mounted in modules and located in two racks in the vertex room. The modules will be of the type developed for the VLA, but some refinement of bin dimensions is required to allow full contact of the blocks of the multi-pin connectors. A trip to the VLA site was made on the afternoon of 1/24/85 to discuss modules with J. A. Campbell, and it was decided to reduce the length of the bins by an amount of order 0.05 inches, the precise value of which is to be determined by a tolerance analysis.

IMPACT OF SOCORRO WORKSHOPS ON THE CORRELATOR SUBSYSTEM

M. S. Ewing
19 February 1985
(edited by J. Romney & L. D'Addario)

The major decision of the Design Review in Socorro from the Correlator Group's viewpoint was to support only 2- and 4-level quantization without 3-level. The 4-level scheme increases hardware cost and complexity, primarily at the VLSI chip level. Our estimate of the incremental cost of 4-level against 3-level at a particular design approach and VLSI technology is $200K. The group deemed this added cost acceptable in return for simplicity in data recording and playback, for increased sensitivity in some modes, and for reduced bandwidth required at a given sensitivity (with corresponding reduction in post-correlation data volume).

The 2-/4-level spec. can be met with the same gate array approaches that were considered for 2-/3-levels, with extra overhead (and cost) due to more complicated multipliers. The Australia Telescope (AT) chip is under consideration also. It is intrinsically 2-/4-level, but its clock rate may be too low for us. As a partial compensation to the extra complexity implied by the 4-level correlation mode, correlation of oversampled data at full spectral resolution will no longer be required. The extra delay stages between multipliers and extra multiplexing will be considered an option to be implemented if possible without substantial extra cost.

The proposed "channel-by-channel" architecture was accepted; the more expensive "global bus" alternative will not be pursued further. The channel-oriented scheme requires the maximum number of station inputs to be fixed soon, but facilitates expansion along other axes -- either in the number of lags per baseline or in the number of channels. We currently plan to provide for a maximum of 20 stations; the number of lags can be increased if the current "quarter-mode" resolution of 128 frequency channels proves insufficient in operation.

A maximum speedup factor (playback speed/record speed) of 2 is supported for "normal" phase and delay tracking in extreme Array configurations (43 GHz, 10,000 km, 8 MHz bandwidth). Phase and delay updates will occur on a fixed correlator-time schedule. A speedup factor of 4 is supported if the observations permit lower effective update rates, e.g., at lower frequencies, shorter baselines, or narrower bands, or if poorer tracking is acceptable. Similarly, 86 GHz long baseline work is supported with some degradation. (Note: the phase tracking tolerance has not yet been specified, but the correlator group will make a proposal soon.)

The meeting ratified our specification of 0.5 Mbyte/sec for the maximum throughput of the fringe-processor system. This specification implies a maximum correlator dump rate of 2 Hz when all lags are active. Boxcar integration with 2 Hz all-lag dump rate was acceptable as a minimum specification. A dump rate of 10 Hz will be possible at some (as yet unspecified) reduced number of lags and/or baselines. A clear goal of the development will be to provide a digital filter that can maintain fringe amplitude and phase response up to +/-0.8 Hz. Such a fringe-rate window would allow fields up to 4 arcsec in radius to be mapped at 22 GHz.

We agreed to consider the 68000 processor family, the VME bus, and VERSADOS to be the primary choices for microprocessors in the correlator system. Fortran, Pascal, and C are still in the running as programming languages, and the VME-10 development system is suggested for our use. We have used alternative and less-costly development approaches in the past (VAX cross-compilers and 68000-conversant logic analyzers); we may still prefer this approach. In any case, some form of code sharing, at least at source level, is desirable across the VLBA Project.