VLB ARRAY MEMO No. 537

(860314)

Systems Engineering

Dick Thompson

The following notes result from a systems group meeting held on March 4, 1986. Those attending were Durga Bagri, Mike Balister, Barry Clark, John Granlund, Hein Hvatum, Peter Napier, Alan Rogers, Jon Romney, Dick Thompson, Craig Walker and Sandy Weinreb. The purpose of the meeting was mainly to define tasks and areas of study to be covered by the systems group, and in some cases to indicate time scales and people involved. Each of the subheadings below indicate an area or task for which the systems engineer or systems group takes some responsibility. The systems group will formally consist of Dick Thompson, Jon Romney and Craig Walker. Other people will be involved in specific areas as mentioned below.

Fringe Rotation. As proposed by the project manager at the coordination meeting of February 10, 1986, the fringe rotation will be included in the correlator, unless ongoing studies reveal any reason why this is not practicable. This proposal, on which there is general agreement, rests to some extent on the assumption that the correlator will be of the FX type (i.e. Fourier transformation before cross correlation), which is quite likely but not yet certain. At the present time fringe rotation is being included in preliminary design studies of the correlator. Also, as a rather small project, a breadboard system for fringe rotation by offsetting the 100 MHz maser reference has been designed by Joe Greenberg and Sandy Weinreb. Note that it is not clear that offsetting the maser is the best way to perform fringe rotation at the antennas: this point is discussed in a report of the Australia Telescope meeting of May 24, 1984. However, a prototype offset unit could be useful for testing, and provides a possible backup scheme if problems arise in rotation in the correlator.

The fringe rotation question is an important system consideration and systems engineering should be involved in studies or tests which may confirm or modify the present plan. However, the question of the type and architecture of the correlator is the responsibility of the correlator group led by Jon Romney. The systems group should follow the correlator design at least to the extent that it affects details of the design of other parts of the overall system.

Calibration System. The present plan is to put both the high- and low-level noise sources on the front ends for Pie Town. The high-level sources add the order of 10^3K and are largely for solar observations. The low-level sources add about 10% of the system noise temperature and are used for the general gain calibration. Barry Clark pointed out that calibration of the high-level noise sources at the VLA has never been very

satisfactory, and probably will be no better on the VLBA, considering that it is very uncertain whether the latter will prove to be an important instrument for solar observation. Alan Rogers plans to supply a pulsed calibration system for testing on the Pie Town antenna. A spare coaxial cable in the LO/IF run from the equipment room to the vertex room will be available for this system. Tests with the pulsed calibration system should be aimed at answering two questions. First, does the pulsed calibration system improve the phase measurement accuracy over that obtained with the round-trip-phase scheme incorporated in the VLBA local oscillator system? Second, does a pulsed calibration system offer an alternative to the noise sources for amplitude calibration, as suggested by Larry D'Addario (VLBA Memoranda Nos. 471 and 472). Organizing these tests and making any resulting changes in the system design is a responsibility of the systems group.

Phase Switching. Phase switching will not be included in the installation at Pie Town, but can be added to the system rather simply. It's usefulness will depend largely upon how serious is the problem of offsets due to quantization threshold errors. VLBA Memorandum No. 470 by Craig Walker discusses closure errors and is relevant to the question. A decision on the desirability of phase switching and any subsequent implementation is a systems group responsibility.

Cables and Interconnections. Systems engineering is responsible for specification of interfaces between racks and other major instrumental units, and making sure that connection of signals are of the right form and power level. Dick Thompson is currently working on a recommended plan for RF, IF, LO, and M/C bus cabling.

Testing of Equipment. The planning and implementation of the systems integration tests in Aug-Oct 1986 will be the responsibility of Dick Thompson with help from Jim Oty (Installation Supervisor) and Durga Bagri. They will also oversee any necessary modifications to the electronics resulting from these tests. A similar pattern of responsibility will apply to the checkout of the equipment after installation on the Pie Town antenna. This does not include acceptance tests of the antenna involving a total power receiver (see VLBA Memoranda Nos. 489 and 511).

Maser Contract-Monitoring and Testing. Larry Beno and Dick Thompson will monitor the maser procurement from Sigma Tau Standards Corporation. This task will include participation in the testing at the Sigma Tau facility, and repeating some of the tests after the masers have been delivered. Alan Rogers points out that there could be serious degradation of stability of the 5 MHz output resulting from the derivation of this signal by a digital divider from the 10 MHz crystal oscillator. He has

offered to help with testing the 5 MHz stability. Systems engineering must be responsible for ensuring that this problem is not overlooked, and for producing an alternative derivation of the 5 MHz signal if the tests indicate that this is necessary.

Contract with Haystack. Jon Romney has volunteered to take the prime responsibility in monitoring this contract.

Station Timekeeping. Final specification of the station timekeeping system is required. Preliminary plans which do not agree on some details, can be found in VLBA Memoranda Nos. 504 and 510.

Electronics Packaging. Larry D'Addario is completing specifications on this subject.

Temperature Control. The systems group should work with the antennas and site groups to advise on the requirements for temperature control of the electronic equipment on the antenna and in the site building. Some investigation of the stability required should also be made to see if the high stability originally specified is really necessary.

Documentation. Guidelines are required for documentation of the hardware designed and constructed within NRAO. Such documentation should be similar to that for the VLA, i.e. reports on individual types of modules and modular subsystems.

Record Keeping. A system for record keeping on individual modules and subsystems will be required at the time that equipment goes to the VLA for the system tests. The records should indicate all retrofits, modifications, failures and repairs of each unit. A satisfactory system of this type is now in use at the VLA.

Spares. Planning of spares for the VLBA system is the joint responsibility of the systems group and the project manager: see VLBA CC Memorandum No. 56. This mainly concerns spares of modules, etc. required to maintain the array in operation without extensive down time for repair. Acquisition of such spares will mainly occur during the late part of the construction period.

Action Items.

Memoranda or specifications on the following subjects are required by the approximate dates given:

Cable Plan	April 1, 1986	Dick Thompson
Systems Integration Tests	July 1, 1986	Dick Thompson
Station Timekeeping	May 1, 1986	Dick Thompson /Jon Romney
Electronics Packaging		Larry D'Addario