VLB ARRAY MEMO No. 550

(860528)

National Radio Astronomy Observatory

Socorro, New Mexico

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To: VLBA Project
From: Craig Walker
Subject: Pie Town test plan.

This memo is a further refinement of the test plan ideas presented by Ken Kellermann in VLBA Memo 489 and by Barry Clark in an unpublished, preliminary test schedule. The tests included are only those that will require astronomical observations of some sort. It is assumed that all of the equipment used will have been checked out during the system tests at the VLA and during installation. The most important aspects of this plan probably are thost that concern the equipment needed for the tests and the activities that need to occur before the tests. The plan can give a sequence and approximate time scale for the tests, but the uncertainties in time that each activity will take are large. The schedule serves mostly to show when certain special equipment, such as the 3 mm system, are likely to be needed.

I. Project Schedule: This sets the time frame of the tests.

Delivery of Pie Town antenna to NRAO: Mar. 1, 1987
Electronics installed and working: July 1, 1987

Therefore observational tests should start on July 1.

II. VLBA Equipment expected to be ready at start of tests:

Antenna
Building
Site computer, M/C system.
Receivers: 1.5, 4.8, 10.7, and 15 GHz
L.O. system
I.F. system (4 baseband converters)
Partial data aquisition system.
Partial recording system (at least 1 tape recorder).
Phase cal system.

III. VLBA Equipment expected to be delayed.

VLBA maser.	July 15, 1987
Remote computer control.	?
VLBA correlator.	>1989
22 GHz receiver.	May be ready in time.

IV. Special equipment and capabilities needed for tests.

Frequency standard options:
Wait for VLBA maser.
Borrow Rubidium from Green Bank.

Use VLA maser if VLBI tests can be done to somewhere else.
Time transfer (Borrowed Loran?)
Local, real time control for crude tests.
Automated raster pointing proceedures - general patterns.
Pointing.
Holography.
It should be possible to schedule many hours of pointing at a time.
Broad band total power detectors (500 MHz).
Baseband total power detectors (eg. for maser observations).
Strip chart for first crude measurements.
Ability to record the following information for transfer to some machine (VAX or PC) that will analyze data.
Start and stop times of integration (or valid data).
Commanded pointing position (RA, Dec, Alt. Az)
Offsets required by current pointing equation.
Offsets in use. Includes offsets for raster.
500 MHz total power for each IF
Baseband total power for each converter
All L.O. settings
Temperature (perhaps of several parts of structure or at least sun and shade - ie. are there likely to be large differentials.)
Dew Point
Wind Speed and Direction
? Cloud cover
Receiver in use
Location in feed ring (we may vary this)

Software to analyze pointing data (VAX or PC)
Solve for pointing offsets from total power data.
Plot pointing data vs. various parameters (Lotus 123 ?)
Do parameter solutions.

86 GHz receiver (borrowed from Tucson?)
Total power backend for 86 GHz (same as for others?)
Beam switch or somesuch?

Mark II VLBI system (borrowed)

VLBA interface to Haystack correlator.

Holography system (Mark II VLBI if 22 GHz is available and masers are sufficiently strong).
Holography software
If 22 GHz, will use NRAO spectral line VLBI software and AIPS. Will need a program that creates the dummy u-v information given the above data base. Is all else ready?

V. Classes of tests (includes lists special needs).

Crude operation of telescope - focus, tracking, rough pointing
Needs: Strip chart.
Real time control.

Pointing.
Needs: Total power detectors.
Automated data collection.

Efficiency at high frequency
Needs: Well calibrated cals.

VLBI tests of function, telescope position, and L.O.

VLBI astrometric tests (accurate position, axis offsets, band-to-band phase connection etc.)
Needs: Astrometric software.

Calibration quality tests.
Phase cal vs. astronomical calibration.
Amplitude calibration.
Solar cals.

Polarization tests (VLBI ?)
Needs: A VLBI partner that won't cause most of problems.

Holography and beam measurements
Needs: Mark II system.

VI. Tasks to do before tests begin:

1. Set up pointing data handling. Be sure everything needed is present. (Walker, Crane, and Clark?)

2. Determine if a switched system is needed for pointing. If so, obtain it. Water masers may be strong enough that total power or comparison of on and off frequency bands is sufficient. Are there enough masers and will the method work in poor weather? What if we need to use another frequency? Pointing methods should be tested on existing telescopes.

3. Decide whether the 3mm observations will be done at Pie Town or Kitt Peak. How will the receiver be obtained? Peter Napier and Ken Kellermann will look into this.

4. Try Mark II / water maser holography.
First observations were done for March 17, 1986 on the VLA. (Walker and Benson).

VII. Manpower:

Craig Walker - Pointing, Misc. 1/2 time
John Benson - VLBI processing and reduction (scheduling?)
Would like to spend 4-6 weeks in New Mexico.
Ken Kellermann - Will try to organize 3mm tests.
Bill Cotton - Could help with initial pointing tests.
Pat Crane - ?
Others?

VIII. Possible sources of Mark II systems:

From comments at the March 3, 1986 Science meeting.
JPL has 3 complete sets although they use IVC recorders.
A fourth set will be available eventually.
Renzetti is the contact.
SAO has a floater.
Illinois may still have a system (NRL's??)
Iowa, Fort Davis, and OVRO already have them and may not need them after our antennas are there.

Ray Escoffier is investigating modifications of current model VCR's.

IX. The following is a proposed sequence of tests. Each numbered item could be a week, although the time scale is very uncertain. It is assumed that all hardware is working as far as can be told without astronomical observations before the tests start. It is also assumed that 1.5 scientists are available for the tests. This includes one full time equivalent scientist in New Mexico for pointing, efficiency and other single dish tests plus a part time scientist elsewhere (Charlottesville) to plan and reduce the VLBI observations. The VLBI tests should take fairly short periods of observing time and, because different people are involved, their reduction should not slow down the single dish tests.

1-3 Begin tests with the 6 cm system. Do crude focus and pointing. Install preliminary pointing curves. Test pointing under a variety of conditions (night, day, calm, wind etc.)
Make 6 cm efficiency measurements.

4 First VLBI; 6 cm. To VLA. Perhaps Mk II and VLBA systems. Do enough sources and HA's to get a rough position solution. This should only take a day (2-4 hours of data taken) if the equipment has been checked out before the tests start.
Continue taking pointing data.

5. Reduce VLBI. First fringes. Solve for station position.
Install improved pointing equation.
Begin tests at 1.3 cm. Crude focus, pointing. Use masers.

6. More pointing tests at 1.3 cm.

7. Make efficiency and beam shape measurements at 1.3 cm.
Take VLBI data at 1.3 cm. Schedule scans to test phase stability, frequency switching, band to band phases etc.

8. Analyze VLBI results.
More pointing tests. By this time, the pointing should be under reasonable control at 1.3 cm.

9. Fix any troubles revealed by the VLBI.
Pointing, efficiency, beam shape at 18 cm.

10. Pointing, efficiency, beam shape at 2.8 cm.
Take first Mk II / maser holography data.

11. Pointing, efficiency, beam shape at 2 cm.
Reduce holography data.

12. Write up results to date.
First NUG observations. Date will depend on NUG schedule.

The next 5 items will only be done if it is decided to do the 3 mm tests at Pie Town

13. Mount 3 mm receiver.

14. Do 3 mm pointing tests. Measure efficiency.

15. Move 3 mm to another feed ring position.

16. Finish 3 mm observations.

17. Write up 3 mm observations.

Back to tests at standard frequencies.

18. Second holography run.
Do more VLBI tests on areas shown earlier to need tests.
VLBI tests of calibration methods.
The holography and VLBI runs can be scheduled together and take about a day.

19. Reduce VLBI tests and holography.
Compare holographic results with 3 mm results.
More pointing tests.

20. Determine gain curves (we may get this from the pointing observations).

21. More tests of calibration methods (VLBI mostly)
Phase cal tones vs. stable system
Amplitude calibration.

22-26. Test polarization characteristics. The sequence for each frequency is:
Solve for polarization instrumentals.
Evaluate stability of polarization instrumentals.
Investigate right/left relative phase stability.
Instrumentals as a function of position within the beam.

At about this time, Kitt Peak will demand attention. By the 23-Apr-86 draft schedule, Kitt Peak will be ready for tests about 6 months after Pie Town.

Later. Test new frequencies as they become available. These include 0.3, 0.6, 2.3, 8.4, 43, and 86 GHz.