NATIONAL RADIO ASTRONOMY OBSERVATORY
SOCORRO, NEW MEXICO
VERY LARGE ARRAY

VLA OBSERVATIONAL STATUS REPORT
June 15, 1984

This report communicates the current observational limitations of the VLA to both users and potential users. It contains the essential information needed to prepare an observing program with the VLA. The hardware configuration as well as the current sensitivity of the VLA are briefly outlined.

More technical information is also available from the following books:

a) Synthesis Mapping - Proceedings of the NRAO-VLA Workshop held at Socorro, NM (June 21-25, 1982) (available from B. O'Brien, Green Bank and E. J. Fomalont at the VLA).
b) An Introduction to the NRAO, Very Large Array (available from A. Patrick, VLA).
c) The Very Large Array: Design and Performance of a Modern Synthesis Radio Telescope, Napier, P.J., Thompson, A.R., and Ekers, R.D., Proc. IEEE, 71, 1295, 1983 (available from E. J. Fomalont, VLA).
d) Various manuals available at the VLA (see Section 7.0).

1.0 HARDWARE CONFIGURATIONS

Continuum, polarization and spectral line observations at the five separate wavelengths 1.3 cm, 2 cm, 6 cm, 18-20 cm and 90 cm (90 cm is currently for use in VLBI experiments only) are supported. 8.0-8.8 MHz should become available for VLBI on a single antenna by the end of 1984. Observations at seven different bandwidths (50 MHz/2^n where n = 0,1,2...6) are possible in each of the two separate IF pairs A,C and B,D. It is possible to have separate bandwidths on the different IFs. These pairs are separately tuneable within a 500 MHz band. A pair of orthogonal circularly polarized feeds are used at all bands.

The array is cycled through its four main configurations during a 15 month period. The reconfiguration schedule for the next year and the approximate long term schedule is outlined in Table IV. Updates to this table are published in the NRAO and AAS Newsletters.

2.0 OBSERVATIONAL LIMITATIONS

Tables I and V summarize the sensitivity and resolution of the VLA. Note that the sensitivities in Table I and Section 2.1 refer to the naturally weighted data whereas the resolutions quoted in Table V refer to uniformally weighted data.

2.1 Sensitivities

The sensitivity parameters listed in Table I are based on theoretical estimates using the quoted system temperature and comfirmed from observations. The numbers refer to a single

50 MHz continuum observation using two IF correlators (RCP+LCP) for naturally weighted u,v data. The rms receiver noise can be calculated using the formulae (for natural weighting):

in brightness temperature:

$$\frac{1.1a}{\sqrt{n(n-1)h\ df}}\ t^2 \quad \text{Kelvins}$$

or:

$$\frac{1.5a}{b_1 b_2\ \sqrt{n(n-1)h\ df}}\ \lambda^2 \quad \text{Kelvins}$$

or in flux density per beam area:

$$\frac{a}{\sqrt{n(n-1)h\ df}} \quad \text{mJy}$$

where:

- n = number of antennas involved
- h = integration time on source, in hours
- df = channel bandwidth, in KHz
- t = taper, in km
- λ = observing wavelength, in cm
- b_1, b_2 = FWHP's of the synthesized beam, in arcsec

	L-band	C-band	U-band	K-band
and a =	620	420	1100	4500?

Use of uniform weighting will decrease the sensitivity by a factor of 1.5 - 2.5 depending on the taper and map size.

A more detailed description of noise formulae including uniform weighting and tapering is given in the "Synthesis Mapping - Proceedings of the NRAO-VLA Workshop held at Socorro, NM".

The sensitivity degrades near the band edges. Dynamic range, interference and/or confusion (particularly at 20 cm) may prevent one from reaching the sensitivity limits quoted in Table I.

All antennas have now been outfitted with new 2 cm FETs. The sensitivity at 2 cm is now about 3 times better ($T_{sys} \simeq 110°$) than the old receivers.

One antenna has a 1.3 cm maser receiver. The sensitivity of this antenna is about four times better than the average.

2.2 Large Scale Structures

Mapping of large sources is restricted by the smallest spacings of the array. Table V indicates approximately the largest-scale structure "visible" to the VLA at the four standard bands and configurations. Sources with extended regions larger than these limits will be missing major fractions of flux density and maps may seriously misrepresent the large-scale structures. See the "Synthesis Mapping - Proceedings of the NRAO-VLA Workshop held at Socorro, NM" for more details.

2.3 Dynamic Range

The dynamic range, loosely defined to be the ratio of the maximum map brightness to the minimum believable map brightness, is limited mainly by phase stability. Many of the synthesized maps generated from VLA observations are limited by dynamic range and not by noise (Table I). Self-calibration can improve the dynamic ranges up to 5000:1 depending strongly upon source structure, u,v coverage, signal-to-noise levels and data quality (general guidelines for self calibration are available from the VLA COOKBOOK). See the "Synthesis Mapping - Proceedings of the NRAO-VLA Workshop held at Socorro, NM" for more details.

2.4 Pointing

Occasional large daytime antenna pointing errors of 1 arcminute or more occur when the sun shines upon the yoke and pedestal under calm conditions (dawn to dusk period). At 2 cm this could affect the sensitivity by as much as 30 percent.

Installation of antenna thermal insulation is in progress but will not be complete until the end of 1985 or early 1986. This will significantly reduce the large pointing errors on calm days. The rms pointing error is 15 arc seconds for all antennas during the night and for all insulated antennas during the day. Consult the on-duty operator for a list of insulated antennas. Pointing errors due to wind continue to be a problem. Noticeable degradation at high frequencies occurs at wind velocities above three meters per second (7 mph).

Observations within 1.5 degrees of field center should be avoided due to both pointing errors and hardware limits.

2.5 Interference

The bands within the frequency range of the VLA that are allocated exclusively to radio astronomy are the following: 1400-1427 MHz, 4990-5000 MHz, 15.35-15.4 GHz, and 23.6-24.0 GHz. There should be no interference within these bands. Some interference (White Sands radar, meterological balloons, airborne drones, etc) can be expected outside of these bands, particularly at 20 cm (1340-1730 MHz). The results of an interference study in the 20 cm band (from 1350 to 1730 MHz) are available in VLA Test Memorandum No. 139. In summary:

(1) There are birdies every 50 MHz at frequencies of 1300 +n50 (n=1,...) MHz over the whole tunable range. These are of moderate strength, could interfere with narrow band continuum observations, and they should be avoided. It is most important to avoid the 1600 MHz birdie as it is exceptionally strong.

(2) Strong signals which are always present are listed in VLA Test Memorandum No. 139.

(3) Located within the range 1670 to 1700 MHz are the frequencies used by meteorologists to receive weather data from balloons. These are released from nearby Mt. Baldy during thunderstorm season. Thus, one is 'probably' safe during the winter and spring in this frequency range - but summer observations, especially in the daytime, are likely to be affected.

Two bands have been set up at 20 cm to help avoid interference. The HH code places the observing frequency within the protected band and should be used with observing bandwidths of 25 MHz or less. The LL code should be used with 50 MHz bandwidths.

2.6 Bandwidth and Time Averaging Smearing

A. Effects Due to Bandwidth

Observing with a finite bandwidth causes a radial smearing of the map which increases with separation from the phase center. There is a corresponding reduction in the peak response and hence point source sensitivity.

The distance dependence of the effect scales inversely with bandwidth. The loss in gain is tabulated in Table II(a) for an untapered observation at 50 MHz. $\frac{\Delta\nu}{\nu}$ is the ratio of the bandwidth to the observing frequency and $\frac{X}{X_{1/2}}$ is the ratio of the radial distance from the phase center to the FWHP of the synthesized beam.

The increase in the beamwidth in the radial direction is proportional to the loss in peak intensity (i.e. radial beamwidth is approximately equal to FWHP [Table V] divided by the loss in sensitivity [Table II(a)]). The integrated flux density remains constant with a modest amount of smearing.

A more detailed discussion of this effect is found in the Green Book (An Introduction to the NRAO Very Large Array) and in Chapter 3 of "Synthesis Mapping - Proceedings of the NRAO-VLA Workshop held at Socorro, NM".

B. Effects Due to Time Averaging

Time averaging over intervals for which the visibility changes significantly causes loss of amplitude similar to that due to the bandwidth effect. However, the analysis of the time effects is more complicated. A simple case exists only for the north pole, where the losses are equivalent to bandwidth losses except that the smearing is in the azimuthal, rather than the radial direction. A simple guideline for keeping time averaging losses small is to keep them less than the corresponding bandwidth losses. Table II(b) gives the averaging times for which, at $\delta = 90°$, time averaging losses equal bandwidth losses.

2.7 Confusion

As indicated in Table I, the presence of sources in the primary antenna beam but outside the useful or practical mapping area can limit map quality. These sources can lead to aliasing problems and produce unwanted sidelobes in the maps. Although bandwidth and time smearing in the larger configurations will suppress some of the effects from confusing sources in the primary beam, they are a major concern especially at 20 cm. The brightest source expected in the primary antenna beam is listed in Table I for each of the observing bands.

2.8 Strong Source Interference

The presence of very strong sources in the sky may lead to interference problems. For example, the Sun is such a strong source that the far sidelobes of the antenna are not able to suppress its signal entirely. For broad continuum bandwidths the correlated signal from the sun is bandwidth smeared down to negligibly low levels. However, this is not true for the narrow bandwidth spectral line observations of weak sources in the more compact configuration during the daytime which may be degraded even when the sun is far away from the source.

2.9 Positions

The absolute positional accuracy obtained is generally about 0.1 arcsec in the A array (in C array accuracy is about 0.3 arc seconds). The main limitations are the phase errors caused by the ionosphere and the troposphere. Positional accuracy of 0.03 arcsec can be obtained by using only the class B calibrators, checking antenna baseline parameters and praying for stable weather. Position errors in declination are about a factor of 2 worse for sources at -20 degrees declination and will deteriorate at more southern declinations.

The VLA now supports the J2000 epoch ephemeris as well as the 1950.0 epoch.

2.10 Polarization

Circular polarization measurements are limited by large circularly polarized sidelobes and are restricted to sources with very large degrees (>10%) of circular polarization or to point sources located at the center of the primary beam. This limitation is due to the offset of the two oppositely polarized beams.

Linear polarization observations are possible at all bands. The on-axis instrumental polarization can usually be determined to an accuracy of much better than 0.5 percent at 6 and 20 cm. At 2 and 1.3 cm the accuracies are usually about a factor of 2 worse. The limit of this accuracy is partly a result of pointing errors. Mapping the polarization of sources more than 10 percent of the half power beam width away from the beam center at 6 cm may be subject to uncertainties greater than one percent because of the large linearly polarized sidelobes. This limitation is also present at the other bands; the location of the polarized sidelobes scales with wavelength.

Polarization observations in the 20-cm band are sometimes hampered by ionospheric Faraday rotation. The amount of Faraday rotation has been occasionally larger than 35 degrees and will probably continue to be a factor in observations at 20 cm even during the minimum of the solar cycle. Observations at the short wavelengths, particularly 1.3 cm, are hampered by pointing problems. More information can be obtained from the Linear Polarization Measurements document in the COOKBOOK and a general discussion is available in the "Synthesis Mapping - Proceedings of the NRAO-VLA Workshop held at Socorro, NM".

In general the instrumental polarization can be calculated from observations of the calibrator normally used to obtain the amplitude and phase of the instrument, provided that there are enough observations to ensure both a high signal-to-noise ratio in the cross hands and reasonable change in parallactic angle ($\geq 90°$). Absolute position angles are determined by observing a strongly linearily polarized source whose polarization is known (i.e. 3C286, 3C138).

2.11 Spectral Line Capabilities

Spectral line observations are currently supported in only a single polarization mode (right or left circular polarization). The permitted number of baseline-channels is currently 10240. Software for the spectral line calibration is a bit more cumbersome than that for continuum processing. The system temperature is now applied on-line.

In general, a channel-to-channel stability of about 30:1 can be achieved easily but achieving 100:1 at wide bandwidths is very hard. Stabilities better than 100:1 require special treatment and cannot be guaranteed.

The basic combination of bandwidth channels and antennas are listed in Table III. Further tradeoffs between the number of channels and antennas by bandwidth are possible. See "A Short Guide for VLA Spectral Line Observers" or the "Synthesis Mapping - Proceedings of the NRAO-VLA Workshop held at Socorro, NM" or the Green Book for more information.

UVFITS tapes may now be written on the pipeline. These make it possible to use the full 3-D structure in AIPS.

2.12 VLBI Observations

VLBI observations using the VLA and the Mark II or Mark III backend are possible either using phased array mode or a single antenna. There is one antenna (9) which has a maser at 22 GHz (system temperature = 95 K, $\Delta\nu$ = 200 MHz, Frequency = 22-24 GHz). Three other antennas are equipped with 90 cm receivers (system temperature = 120° K, efficiency = 30%). One of these may be used for 90 cm VLB experiments. There is now a VLBI cookbook available (in COOKBOOK manual). See comments under 3.0 (VLA REMOTE OBSERVING PROGRAM) for the support available for in-absentia VLBI observing.

2.13 Snap Shot Mode

When signal to noise is not critical, and a source is not very extended adequate observations of small sources can be made in short periods of time.

Single snap shots with good phase stability should give dynamic ranges of about 50 to 1 for sources whose angular size does not exceed the numbers listed in Table V for "Largest Scale Structure Visible". Snapshots do not give as good protection against the sidelobes of distant confusing sources as full mapping. This is especially true at 20 cm in the C and D arrays. A single snap shot at 20 cm will give an rms noise of ~1 mJy due to confusing sidelobes. This level can be reduced either by making multiple snap shots, with at least 1 hour separating the observations or by mapping and cleaning the entire beam with the AIPS program MX.

2.14 Shadowing

Observations at low elevations taken in the C and D arrays may be affected by antenna shadowing (see VLA Scientific Memoranda No. 134). The OBSERV program has an option which will indicate when shadowing will occur and on what antennas. After the observations the program SHADOW can be used to find out what antennas have been shadowed and to flag shadowed antennas. There are no automatic on-line shadowing corrections applied to the data. Observations using a hybrid array with a longer north arm (see Section 8.0) may be preferable for sources with declinations $<-15°$.

2.15 Combining Configurations

It is sometimes useful to combine data from different configurations when there is a large range of scale structures in the source. This can be done by using software in AIPS.

2.16 Weak Source Detections

DC offsets in the correlators may sometimes lead to artifacts in the center of the field. It is advisable to offset the source positions from the field center in weak source detection experiments.

3.0 VLA REMOTE OBSERVING

3.1 Observing File Preparation

The observing file can be prepared for standard VLA observing programs. The observer is required to specify the detailed source list, sequences and observing options at least two weeks in advance. The observing files for any complicated programs or spectral line programs generally must be completed by the observer himself. In particular the observer must take responsibility for setting frequencies for line programs. The preparation of VLBI observing files is the responsibility of the observer. In those circumstances where it is not possible for the VLBI observer to prepare his source file, NRAO will do it if P. Crane receives the schedule at least two weeks before the start of the Network run.

3.2 Absentee Observing

Observers may be absent during the observations. For standard VLA continuum or spectral line programs and all standard Mark II VLBI programs which need very little operator interaction, the observer is generally not required to be present at the VLA site. However, for all Mark III VLBI programs longer than 3 hours or for observing programs which require the attention of the operator beyond his normal duties, an on-site observer is required and the observer will have to carry out most of the extra tasks related to his programs. The VLA will supply help to relieve the observer in long (>12 hours continuous) programs of this type; however the observer MUST request this service WELL (>2 weeks) in advance of the observing run.

3.3 Editing and Calibration of VLA Data and Related Tasks

(a) Any standard VLA continuum observing program can be edited and calibrated. Complicated calibration of continuum data or calibration of spectral line data may be possible but must be checked out well in advance.

(b) Calibrated visibility tapes (Export tapes), backup tapes and copies of archive tapes can be prepared.

(c) In general, maps will not be produced.

3.4 DEC-10 Dial-Up Line

The DEC-10 has two dial-up lines which may be used for preparing observing files or monitoring progress of an observing run from the database on the DEC-10. Currently these lines may not be used to reduce observing data. One telephone number (505) 772-4346, will access either line. Modem protocols allowed include Bell 103j (300 baud), Bell 212A (1200 baud) and Racal-Vadic. Eight bits and no parity are the usual settings.

NRAO will pay for the call. Dial (505) 772-4011 and request to be called back on FTS and transferred to the computer (DEC-10).

3.5 On-Site Help

The data analyst who normally carries out the tasks listed under 3.1 and 3.2 will be available on week days to on-site observers for direct assistance in matters related to the remote observing program.

3.6 How To Make Use of Remote Observing Services

(a) Check the appropriate box on the observing cover sheet for your proposal.

(b) Contact either Dave Wunker (505-772-4359) or Peggy Perley (505-772-4239) and pass on the details well in advance (>2 weeks). The advance notice is required to enable us to schedule all the requests efficiently.

(c) For VLBI observations contact P. Crane at least two weeks before the start of the VLBI Network session. For MK III assistance call P. Hicks at least two weeks before the start of the VLBI Network session. Complicated observing files must be prepared by the observer.

4.0 VLA CALIBRATORS

The VLA staff has completed a list of sources which are sufficiently unresolved and unconfused to permit calibration at all bands to a few percent. This list currently contains about four hundred sources and it is readily available at the VLA site. Although the primary flux density calibrator is 3C286, there are two circumpolar sources (0212+734, 1803+784) whose fluxes are monitored frequently for use as flux density calibrators. 1328+307 (3C286) and 0518+165 (3C138) are currently used to establish the absolute position angle of the linear polarization. More information is available in the VLA Calibrator books located at the VLA site.

5.0 PLOTS OF U,V COVERAGE

The u,v coverage of the full 27-antenna VLA for the A, B, C, and D configurations is shown in Figure 1 for 7 different declinations. These displays refer to continuous observations tracking the source from rising to setting for sources at declinations less than 64° and tracking the sources for 12 hours for sources at declinations greater than 64°. Figure 2 displays the u,v coverage of a snap shot observation at 50 degrees declination for a duration of 15 minutes at zero hour angle. More detailed plots are available in the u,v coverage manual at the VLA site. Custom plots may also be made using the Zeta pen plotter from the VAX. A summary of the standard configurations is displayed in Table V.

6.0 SOFTWARE

The current on-site VLA software capabilities for converting raw visibility data into well-calibrated maps are best summarized by briefly listing the various tasks presently implemented at the different stages of data processing. No attempt is made to list the complete set of either the software options or its limitations.

The on-line computers, the Modcomps, automatically (a) change the LO phase to compensate for differential atmospheric refraction; and (b) correct the visibility phases for variations in the effective electrical length of the waveguide and some of the antenna LO paths (this latter correction is often termed the "round-trip phase correction"). In addition, gain variations caused by changes in the system temperature are corrected by using real time measured system temperatures (this correction is applied to both continuum and spectral line data). The latter correction may be turned on or off at the astronomer's option and by default is turned on at all bands.

Processing required to take the initially corrected visibility data from the Modcomps through calibration to the final maps is accomplished using the DEC-10 general purpose computer. The software is quite extensive and employs an antenna-based calibration technique. For the calibration of data there exist programs to (a) flag data good or bad, (b) correct phases for known source position errors, antenna position errors and time errors, and (c) correct amplitudes for general zenith angle dependent effects such as atmospheric absorption. The antenna gain, phase and polarization characteristics are calculated from calibrator source observations, interpolated in time and stored with the visibility data.

Conversion of calibrated u,v data to maps can be done using either the DEC-10 and the pipeline or the VAX based post-processing system (AIPS). On both systems the tasks for conversion of calibrated data to maps include sorting, gridding, fast Fourier transform, source subtraction in the u,v plane, and the clean algorithm. Both u,v plane convolution (to aid in reducing the aliasing problems) and tapering are supported. Self-calibration is only available on the VAX.

The Pipeline System is available for use. It handles a large volume of data efficiently and in particular, accommodates a substantial increase in spectral line processing. The system can write UVFITS tapes that can be read on the VAX for transfer of visibility data (continuum or spectral line). Maps made in the Pipeline can be displayed directly on DISPLAY (PDP-11/44).

Map display formats include: character display on computer terminals, line printer output (DEC-10) and Versatec (VAX); contours with or without polarization on the Tektronix storage tube terminal (DEC-10), ZETA pen plotter (DISPLAY and VAX) and the Versatec dot matrix plotter (DEC-10, DISPLAY and VAX); gray scale and color images in 2 and 3 dimensions (2-D, 3-D) on the IIS video terminal (VAX and DISPLAY); and Dicomed film recorder from VAX and PDP-11s.

The AIPS post-processing system includes options to edit and display u,v data, to make and deconvolve maps using a variety of algorithms including CLEAN and MEM, self calibrate, display 2-D and 3-D maps on a TV monitor, contour maps on the VERSATEC printer, source fitting, polarization, optical depth, etc. Input is maps (FITS) or u,v data (EXPVIS or UVFITS). Modest spectral line capabilities are available. This system is currently running on the two VAX 11/780 computers at the VLA and on a VAX 11/780 and a Modcomp in Charlottesville. The AIPS system at the VLA has dismountable disk packs for temporary use by observers who have very large storage requirements. These packs are available from Ina Cole.

All computers support map data exchange using the FITS format.

One return visit to Charlottesville or the VLA for further VLA reduction is supported by NRAO (contact Ed Fomalont at the VLA (505) 772-4247).

7.0 DOCUMENTATION

Documentation for VLA data reduction, map making, observing preparation, etc. is found in five main manuals:

INTRODUCTION TO THE NRAO VERY LARGE ARRAY (Green Book): This manual has general introductory information on the VLA. Topics include theory of interferometry, hardware descriptions, observing preparation, data reduction, map making and display. The 1983 manual is available.

NRAO-VLA WORKSHOP: Synthesis theory and technical information and observing strategies can be found in: Synthesis Mapping - Proceedings of the NRAO-VLA Workshop held at Socorro, NM (June 21-25, 1982) copies are available from B. O'Brien, Green Bank or Eva Fomalont at the VLA.

THE OBSERVERS REFERENCE MANUAL: This is a reference manual which contains all the information on individual computer programs and utilities run from the DEC-10. There is a separate volume for the PIPELINE.

VLA COOKBOOK: The Cookbook contains some observing strategies and recipes on the initial data reduction of continuum, polarization, spectral line, solar observations, guides to self-calibration.

AIPS COOKBOOK: The "Cookbook" description for the AIPS system is located in the VAX terminal rooms and the Cookbook. (See Ina Cole or Sandy Treppa-Richards for copies).

VLA CALIBRATOR BOOK: This manual contains the list of VLA Calibrators in both 1950 and 2000 epoch and a discussion of gain and phase calibration.

VLBI COOKBOOK: This manual describes VLBI observing procedures and requirements when the VLA is one of the NUG stations.

PIPELINE REFERENCE AND USER'S MANUAL: The technical description of and "how to use" the pipeline are described in these manuals.

The Very Large Array: Design and Performance of a Modern Synthesis Radio Telescope, Napier, Thompson, and Ekers, Proc. of IEEE, 71, 295, 1983.

Requests for documentation should be made to Alison Patrick at the VLA.

8.0 VLA OBSERVING REQUESTS

Observing requests should be sent to the NRAO Director:

Dr. Morton S. Roberts
Director
NRAO
Edgemont Road
Charlottesville VA 22901

Requests should be concise (less than 1000 words) and emphasize the scientific justification. Sufficient thought should be given to instrumental capabilities to enable filling out the attached observing application form, which should be submitted with the proposal.

Closing dates for receipt of observing requests are listed in Table IV. Prospective users are advised to submit their proposals well in advance of the change to the required configuration and certainly no later than the appropriate deadlines listed in the Table. Proposals submitted requiring a specific configuration other than the one for the next quarter will be referreed but final evaluation and scheduling will not occur until the appropriate quarter.

The basic reconfiguration cycle is spread over one and a quarter years in order to slide the sidereal times available at night through each configuration. The proposed long term schedule is given in Table IV(b) but it may be subject to changes.

The duration of each configuration will be varied in response to proposal pressure. We will support observations during the reconfiguration. Suitable observations are point source monitoring and detection programs for which the configuration is not critical. During reconfiguration we will pause in the hybrid configuration with the North arm in the next larger configuration. For declinations $<-15^\circ$ the longer North arm hybrid gives a more circular beam and reduces shadowing.

Configurations and proposal deadlines for 1984 are listed in Table IV.

VLA observers are also urged to arrange their travel as soon as possible after scheduling and no later than two weeks before you are scheduled to arrive at the site. Both room and vehicle reservations (Albuquerque to VLA site) can be made by dialing (505) 772-4357, or FTS 476-8357.

9.0 VLA ARCHIVE DATA

The directory of the VLA archive data back to September, 1981 is available in four reports, covering the four years 1981, 1982, 1983, and 1984 (1982.SRT, etc.) to date. There is also available a cumulative report, covering all years, but only containing observations longer than one hour on source (ACCUM.SRT). Users with access to the VLA DEC-10 can find computer readable versions of these reports in user area [13,542]. Hardcopy versions are available from Alison Patrick and in all NRAO libraries.

NRAO has the following policy on the extent to which an observing team has exclusive use of the raw data obtained as part of their VLA observations. This policy is:

> Eighteen months after the end of a VLA observation the raw (uncalibrated visibility) data will be made available to other users on request. The end of an observation is defined to be after the last VLA configuration requested, either in the original proposal or in a direct extension of the proposal. Data taken for VLBI observations are immediately available.

10.0 PUBLICATION GUIDELINES

Any papers using observational material taken with NRAO instruments (VLA or otherwise) or papers where a significant portion of the work was done at NRAO, should include the following acknowledgement to NRAO and NSF:

> "The National Radio Astronomy Observatory is operated by Associated Universities, Inc., under contract with the National Science Foundation."

Preprints

NRAO requests that you submit three copies of all papers which include observations taken with any NRAO instrument or have NRAO authors(s) to Ellen Bouton in the CV Library. NRAO authors may request that their papers be included in the official NRAO preprint series. Multiple author papers will not be included in the series if they are being distributed by another institution. All preprints for distribution should have a title page that conforms to the window format of the NRAO red preprint covers. Note that preprints will be distributed ONLY when the NRAO author so requests; inclusion in the series is not automatic. This action will also cause the paper to be included in NRAO's publication lists.

Reprints

NRAO no longer purchases reprints from the major astronomical journals for distribution. However, NRAO will purchase and distribute reprints in the following cases:

1. The paper is in a publication less likely to be readily available to other astronomers (i.e., IAU symposia/colloquia, IEEE and SPIE proceedings, commercial journals).
2. The paper is likely to be in great demand (i.e. comprehensive catalogs, detection of ETI, etc.).

In such cases, please send copies of the order forms supplied by the publisher to Ellen Bouten in the CV Library.

NRAO will also order 50 reprints for the personal use of the NRAO author(s) if reprints are requested at the time of submission of page charge information. Orders at a later date should be avoided in order to minimize administrative hassle. Normally, the first author should be responsible for reprint orders and share reprints as appropriate with collaborators. Do not ask NRAO to order reprints in those cases where reprints will be received from a non-NRAO first author.

TABLE I

VLA SENSITIVITY AND RESOLUTION*

Frequency (GHz)	1.34 - 1.73	4.5 - 5.0	14.4 - 15.4	22.0 - 24.0
Wavelength (cm)	22 - 18	6	2	1.3
Band Name	20cm (L)	6cm (C)	2cm (U)	1.3cm (K)
System Temperature (°K)	60	50	110	400[†]
Antenna Effeciency (%)	51	65	52	43
RMS Sensitivity (mJy) in 10 minutes (50-MHz bandwidth - 27 antennas)	.18	.12	.35	1.3[†]
RMS Sensitivity (mJy) in 12 hours (50-MHz bandwidth - 27 antennas)	.021	.014	.04	.16[†]
**Untapered brightness (mK) temperature (D configuration)	7.4	4.9	15	55[†]
***Dynamic Range without Self-Calibration	50	70	10 - 20?	10?
Antenna Primary Beam Size (FWHP)	30'	9'	4'	2'
Brightest Source (mJy) Expected in Antenna Primary Beam after correction for beam.	100	2.3	<.1	<.01

* Table entries are sensitivities for a point source using one IF pair (RCP+LCP). Sensitivities will be a factor of $\sqrt{2}$ better when B and D IFs are used.

** See text for discussion of formula used. Calculations based on natural weighting.

*** Extremely dependent on weather and frequency of calibration.

† The ammonia lines are located near the band edge where sensitivities are about a factor of 2 worse.
The 1.3 cm receivers will be retrofited with new FET amplifiers beginning in December 1984 (and lasting about two years). The sensitivity of the new receivers should be 2 to 4 times better than the present ones.

TABLE II(a)

LOSS OF PEAK INTENSITY DUE TO BANDWIDTH SMEARING

Peak Intensity	1.0	0.95	0.90	0.80	0.50
Distance from the phase center for configuration A *	0	13"	20"	25"	50"
B	0	40"	60"	80"	3'
C	0	2'	3'	4'	9'
D	0	8'	11'	15'	30'
$\frac{\Delta\nu}{\nu}\frac{\chi}{\chi_{\frac{1}{2}}}$ **	0	.52	.74	1.0	2.0

* For an average untapered observation with 50 MHz bandwidth.

** See Section 2.6 A for discussion of parameters or the GREEN BOOK or Chapter 3 of the "Synthesis Mapping - Proceedings of the NRAO-VLA Workshop held at Socorro, NM" for more details.
$\Delta\nu$ = bandwidth, $\chi_{\frac{1}{2}}$ = FWHP
ν = observing frequency, χ = displacement from beam center.

TABLE II(b)

AVERAGING TIMES AT WHICH TIME LOSSES EQUAL BANDWIDTH LOSSES, FOR $\delta = 90°$

Bandwidth (MHz)		50	25	12.5	6.25	3.125
Observing Frequency (MHz)	1460	415	210	105	55	25
	4885	140	70	35	18	9*
	15000	45	22	10	5*	3*
	23000	30	15	7*	3*	2*

* Default minimum integration time is 10^s. It is possible to obtain integration times as low as 3 1/3 seconds (DEC-10 FILLER will not currently handle this rate on-line; data must be filled from tape).

TABLE III

NUMBER OF ANTENNAS AND MAXIMUM CHANNEL SEPARATION WHICH CAN BE USED FOR SPECTRAL LINE OBSERVING*

# Channels	# Antennas	Maximum Channel Separation Achievable for This # Channels (kHz)
8	All	6250
16	All	3125
32	25	781
64	18	195
128	3	49
256	9	12

* Channel separations from 380 Hz to 6.25 MHz are available in steps of factors of 2.

NOTE: Channel-baselines are currently limited to 10240.

TABLE IV(a)

VLA CONFIGURATIONS FOR 1984/5

Quarter	Configuration	Proposal Deadline
1984 Q3	C/D, D	April 01, 1984
1984 Q4	D, D/A, A	June 15, 1984
1985 Q1	A, A/B, B	September 15, 1984
1985 Q2	B, B/C	December 15, 1984
1985 Q3	C, C/D	March 15, 1985
1985 Q4	D, D/A	June 15, 1985

Mixed configurations will be available during each configuration change. These will normally consist of a longer North arm.

TABLE IV(b)

APPROXIMATE LONG TERM VLA CONFIGURATION SCHEDULE

	Q1	Q2	Q3	Q4
1984	B	C	D	A
1985	A	B	C	D
1986	D	A	B	C
1987	C	D	A?	B

TABLE V

CONFIGURATION SUMMARY

CONFIGURATION	MAXIMUM ANTENNA PAIR SEPARATION		MINIMUM ANTENNA PAIR SEPARATION		APPROXIMATE SYNTHESIZED* HALF-POWER BEAMWIDTH FOR HIGH DECLINATION SOURCES (arcseconds)				APPROXIMATE LARGEST SCALE STRUCTURE "VISIBLE" TO VLA** (arcseconds)			
	km	ns	km	ns	20 cm	6 cm	2 cm	1.3 cm	20 cm	6 cm	2 cm	1.3 cm
A	36.4	121,250	.68	2,267	1.4	.4	.14	.08	25	7	2	2
B	11.4	36,740	.21	700	3.9	1.2	.4	.3	80	25	7	5
C	3.4	11,431	.063	210	12.5	3.9	1.2	.9	240	80	25	15
D	1.03	3,429	.040	133	44	14	3.9	2.8	900	240	80	50

* These numbers are estimates for a uniformly weighted and untapered map produced from full synthesis observations of a source which passes near the zenith.
Resolution degrades for southern sources.
Sources below -15 degrees declination observed with the long north arm configuration will have resolutions similar to those of the smaller configurations.
The approximate resolution of snapshots is about 1.3 times the above values.

**These numbers do not represent the maximum field of view but are the largest source size which can be reasonably well mapped in full synthesis observations. For single snap shot observations these numbers should be divided by 2.

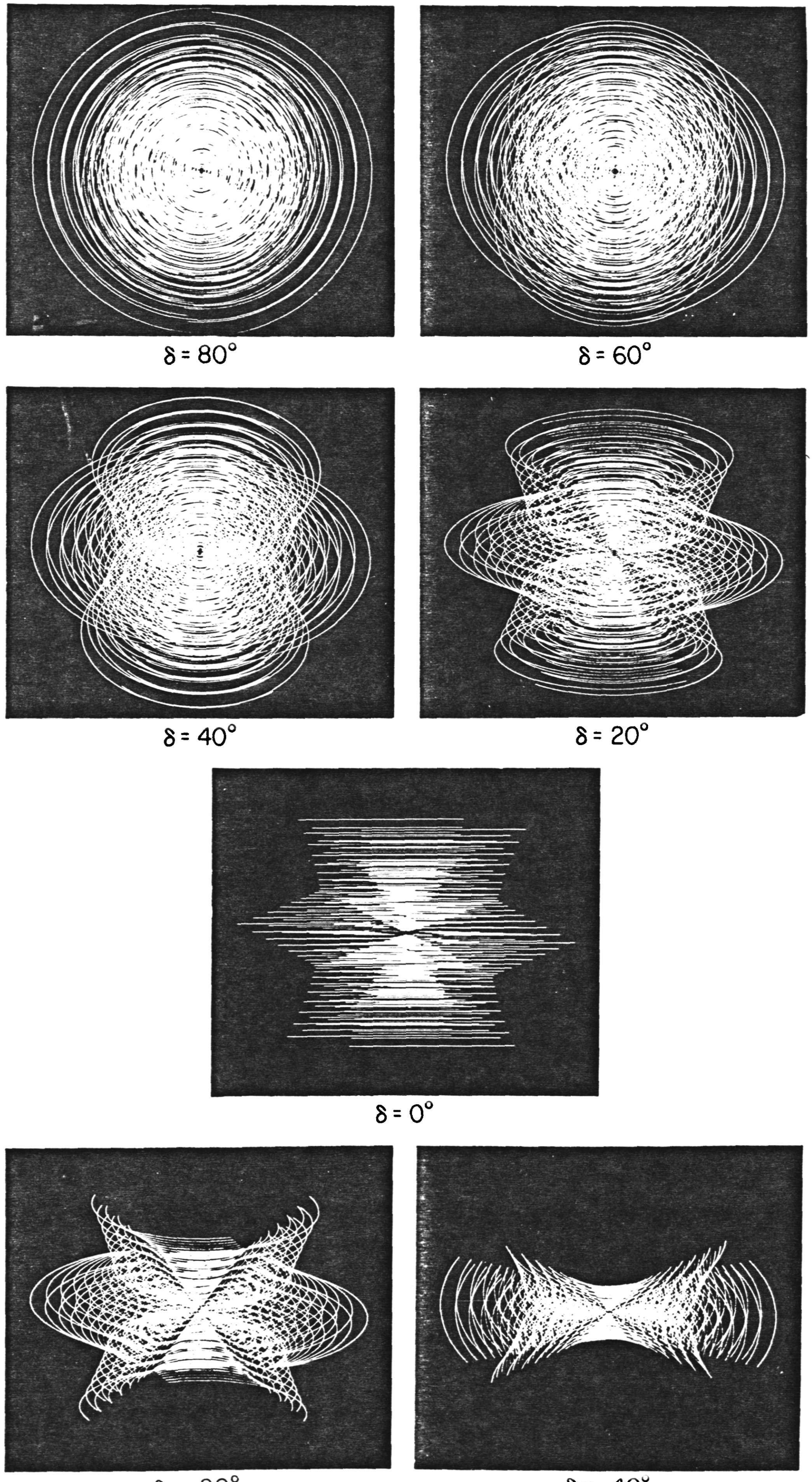

Figure 1

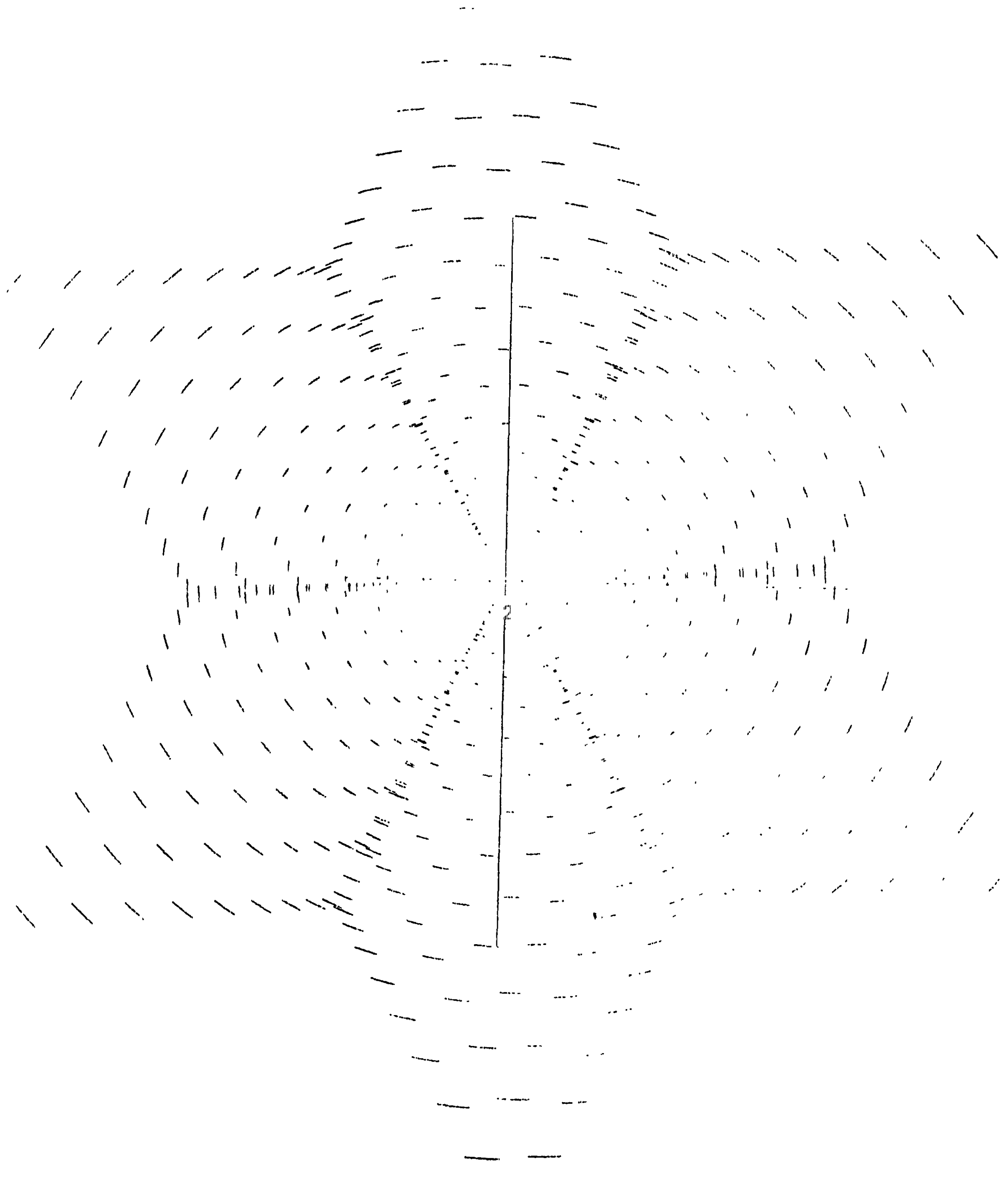

Figure 2

DEC=50^{d}
HA =$0^{h}, 0^{m}$ to $0^{h}, 20^{m}$

A

received:

VLA OBSERVING APPLICATION

SEND TO: Director NRAO Edgemont Rd. Charlottesville, Va. 22901

DEADLINES: 15th of Mar., June, Sept., Dec. for Q 3, 4, 1, 2 respectively

1 Date:

2 Title of Proposal:

3 Authors	Institution	Who will observe?	For Grad Students Only: Observations for PhD Thesis?	For Grad Students Only: Anticipated PhD Year

4 Related previous VLA proposal number:

5 Contact author for scheduling:

Address:

6 Telephone:

TWX:

7 Scientific category: ☐ planetary, ☐ solar, ☐ stellar, ☐ galactic, ☐ extragalactic

8 Configuration(s) (A, B, C, D, A/B, B/C, C/D, Any)					
9 Wavelength (90 20 18 6 2 1.3 cm)					
10 Time requested (hours or days)					

11 Type of observation: ☐ mapping, ☐ point source, ☐ monitoring, ☐ continuum, ☐ lin poln, ☐ circ poln, ☐ spectral line, ☐ solar, ☐ VLBI, ☐ phased array, ☐ other ______________

12 ABSTRACT (do not write outside this space):

NRAO use only

(13) Observing style: ☐ Will be present ☐ Will prepare files & return to reduce ☐ Will use modem ☐ Absentee (NRAO prepares OBSERV file & sends calibrated data)

(14) Reduction: Number of maps ________ Maximum size of maps ______________ Self-cal maps ________ Private disk pack _____

(15) Off-site reduction: ☐ none, ☐ post map, ☐ post calibration, ☐ everything.

(16) Help required: ☐ none, ☐ consultation, ☐ friend (extensive help), ☐ staff collaborator.

(17) Spectral line only:

	line 1	line 2	line 3		line 1	line 2	line 3
transitions to be observed				number of channels (N)			
channel bandwidth (KHz) (Δ)				number of antennas			
observing frequency (±NΔ/2)				rms noise after 1 hour (mJy)			

(18) Number of sources _____ (If more than 10 sources please attach list. If more than 30 give only selection criteria and LST range(s).)

Name	Epoch 1950☐ 2000☐ RA hh mm	Dec ±xx°.x	Config.	Band (cm)	Band width (MHz)	Total Flux line (Jy)	Total Flux cont. (Jy)	Largest ang. size	Weakest signal (mJy/beam)	Required dynamic range	Possible LST range hh - hh	Time requested

(19) Special hardware, software, or operating requirements:

(20) Preferred range of dates for scheduling:

(21) Dates which are not acceptable:

(22) Please attach a self-contained Scientific Justification not in excess of 1000 words.

When your proposal is scheduled, the contents of this cover sheet become public information. (Any supporting documents are for refereeing only)