THE EXPANDED VERY LARGE ARRAY OBSERVATIONAL STATUS SUMMARY

Edited by C. J. Chandler

September 14, 2009

Contents

List of Tables

List of Figures

1 INTRODUCTION

1.1 Purpose of Document

This document summarizes the current instrumental status of the Expanded Very Large Array (EVLA). It is intended as a ready reference for those contemplating use of the EVLA for their astronomical research. The information is in summary form – those requiring greater detail should consult the EVLA's staff members, listed in Section 8, or refer to the manuals and documentation listed in Section 7. Most of the information contained here, and much more, is available on the Web, and can be accessed through the EVLA home page information for astronomers, at `http://www.aoc.nrao.edu/evla/astro/`, and the VLA information for astronomers, `http://www.vla.nrao.edu/astro/`. These pages will shortly be combined into a single page for the EVLA, and the links in this document will be updated accordingly. A companion document for the VLBA is also available from `http://www.vlba.nrao.edu/astro/`.

The EVLA is a large and complex modern instrument. It cannot be treated as a "black box," and some familiarity with the principles and practices of its operation is necessary before efficient use can be made of it. Although the NRAO strives to make using the EVLA as simple as possible, users must be aware that proper selection of observing mode and calibration technique is often crucial to the success of an observing program. Inexperienced and first-time users are especially encouraged to enlist the assistance of an experienced colleague or NRAO staff member for advice on, or direct participation in, an observing program. Refer to Section 5.14 for details. The EVLA will be an extremely flexible instrument, and we are always interested in imaginative and innovative ways of using it.

1.2 What is the Expanded Very Large Array?

The EVLA is the product of a program to modernize the electronics of the Very Large Array (VLA) in order to improve several key observational parameters by an order of magnitude or more. Some of the details of the EVLA Project may be found on the web, at `http://www.aoc.nrao.edu/evla/`. The EVLA is funded jointly by the US National Science Foundation (NSF), the Canadian National Research Council, and the CONACyT funding agency in Mexico. Total funding is approximately $94 million in Year 2005 dollars, including $59 million in new NSF funding, $16 million in redistributed effort from the NRAO Operations budget, $17 million for the correlator from Canada, and $2 million from Mexico. The EVLA project will be completed on time and on budget in 2012, 11 years after it began. Its key observational goals are (1) complete frequency coverage from 1 to 50 GHz; (2) sensitivity improvement by up to an order of magnitude (nearly two orders of magnitude in speed) by increasing the bandwidth from the VLA's 100 MHz per polarization to 8 GHz per polarization; and (3) implementation of a new correlator that can process the large bandwidth with a minimum of 16,384 spectral channels per baseline. A comparison of some of the EVLA performance parameters with those of the VLA is provided in Table 1. The remaining major milestones for the EVLA are shown in Table 2.

1.3 VLA to EVLA Transition

The year 2010 will be extremely exciting for the EVLA. The correlator that has been the heart of the VLA for three decades will be turned off in January 2010. This will be followed by the shutdown of the VLA to outside users for two months, during which time hardware

Table 1: **Overall EVLA Performance Goals**

Parameter	VLA	EVLA	Factor
Continuum Sensitivity (1-σ, 9 hr)	10 μJy	1 μJy	10
Maximum BW in each polarization	0.1 GHz	8 GHz	80
Number of frequency channels at max. BW	16	16,384	1024
Maximum number of freq. channels	512	4,194,304	8192
Coarsest frequency resolution	50 MHz	2 MHz	25
Finest frequency resolution	381 Hz	0.12 Hz	3180
Number of full-polarization sub-correlators	2	64	32
Log (Frequency Coverage over 1–50 GHz)	22%	100%	5

Note: The "Factor" gives the factor by which the EVLA parameter will be an improvement over the equivalent VLA parameter.

Table 2: **EVLA Major Milestones**

Milestone	Target Date
Full EVLA correlator installation	2009 Q4
Complete testing of 10-station correlator	2010 Q1
Decommission VLA correlator	2010 Q1
Shared Risk Observing begins	2010 Q1
Last antenna retrofitted	2010 Q3
Last receiver installed	2012 Q3

will be transferred from the old correlator to the EVLA correlator and observing modes will be commissioned in preparation for EVLA early science. At the same time the direction of the configuration cycles will also change, from A→B→C→D→A to D→C→B→A→D, in order to facilitate the EVLA correlator commissioning and to limit initial EVLA data rates. When the telescope returns to general use it will be the EVLA.

2 AN OVERVIEW OF THE EVLA

The EVLA is a 27-element interferometric array, arranged along the arms of an upside-down "Y", which will produce images of the radio sky at a wide range of frequencies and resolutions. It is located at an elevation of 2100 meters on the Plains of San Agustin in southwestern New Mexico, and is managed from the Pete V. Domenici Science Operations Center (DSOC) in Socorro, New Mexico.

The basic data produced by the EVLA are the visibilities, or measures of the spatial coherence function, formed by correlation of signals from the array's elements. The most common mode of operation will use these data, suitably calibrated, to form images of the radio sky as a function of sky position and frequency. Another mode of observing (commonly called *phased array*) will allow operation of the array as a single element through coherent summation of the individual antenna signals. This mode will most commonly be used for VLBI observing and for observations of rapidly varying objects, such as pulsars. However, it will not be available initially.

The EVLA can vary its resolution over a range exceeding a factor of ~ 50 through movement of its component antennas. There are four basic arrangements, called configurations, whose scales vary by the ratios 1 : 3.2 : 10 : 32 from smallest to largest. These configurations are denoted **D**, **C**, **B**, and **A** respectively. In addition, there are 3 'hybrid' configurations labelled **DnC**, **CnB**, and **BnA**, in which the North arm antennas are deployed in the next larger configuration than the SE and SW arm antennas. These hybrid configurations are especially well suited for observations of sources south of $\delta = -15°$ or north of $\delta = +75°$, for which the foreshortening of the North arm in projection results in a more circular point spread function.

Traditionally, the VLA has completed one cycle through all four configurations in approximately a 16 month period. However, this cycle will change slightly in early 2010 to accommodate commissioning of the EVLA correlator and the onset of EVLA early science. The present best estimate for the EVLA configuration schedule in 2010 and 2011 is presented in Table 3, but prospective users should consult the web page `http://www.vla.nrao.edu/genpub/configs/` or recent NRAO and AAS newsletters for up-to-date schedules and associated proposal deadlines. Refer to Section 5.1 for information on how to submit an observing proposal.

Table 3: **Predicted EVLA Configuration Schedule for 2010–2011**

	Feb–May	Jun–Sep	Oct–Jan
2010	**D**	**C**	**B**
2010	**A**	**D**	**C**

Observing projects on the EVLA will vary in duration from as short as 1/2 hour to as long as several weeks. Most observing runs have durations of a few to 24 hours, with only one, or perhaps a few, target sources. However, since the EVLA is a two-dimensional array, images can be made with data durations of less than one minute. This mode, commonly called *snapshot* mode, is well suited to surveys of relatively strong, isolated objects. See Section 4.15 for details.

All EVLA antennas will eventually be outfitted with eight receivers providing continuous frequency coverage from 1 to 50 GHz. These receivers will cover 1–2 GHz, 2–4 GHz, 4–8 GHz, 8–12 GHz, 12–18 GHz, 18–26.5 GHz, 26.5–40 GHz, and 40–50 GHz. These bands are commonly referred to as L, S, C, X, Ku, K, Ka, and Q bands, respectively. It is also hoped that one or more receivers operating at frequencies below 1 GHz will be available by the end of the EVLA construction project, or shortly thereafter. See Section 3.2 for more details about the availability of new bands.

The 74 MHz system (also known as the '4-band' system) will be available on all antennas, but is not permanently installed. On the VLA the long dipoles needed to efficiently illuminate the antennas have been shown to reduce the gain and increase the system temperature at 20 cm by about 5%. Because of this, we expect to continue past practice of mounting the dipoles for limited periods of time in the **A**, **BnA** and **B** configurations, during which 74 MHz observing is concentrated.

The EVLA correlator will be extremely powerful and flexible. Details of the correlator configurations to be offered for EVLA early science are described in Section 4.13. It is important to realise, however, that the EVLA correlator is fundamentally a spectral line correlator. The days of separate "continuum" and "spectral line" modes of the VLA correlator are over, and all observations with the EVLA will be "spectral line." This has implications for how observations are set up, and users who may be used to continuum observing with the VLA are strongly advised to consult Section 4.13.

3 EVLA Early Science

EVLA early science will be provided by two programs for outside users and one for EVLA commissioning staff. All early science programs will be peer-reviewed. In keeping with a primary construction project goal, the EVLA will continue to be used for science throughout the commissioning of the telescope into full operations in 2013. Observing during this period will thus involve an element of risk associated with the large stepwise increases in throughput bandwidth that will be offered to the community at the start of each new array configuration cycle in 2010, 2011, and 2012.

The Open Shared Risk Observing (OSRO) program will provide early science capabilities to the general user community. These capabilities will initially include a maximum 256 MHz bandwidth that will increase to 2 GHz in mid-2011 and to 8 GHz in 2012. The Resident Shared Risk Observing (RSRO) program will provide these capabilities, and others, much sooner to community members who can reside in Socorro and help with the EVLA commissioning efforts. These same enhanced capabilities will also be made available to EVLA commissioning staff via the EVLA Commissioning Staff Observing (ECSO) program.

3.1 Expected Capabilities: Antennas

Retrofitted EVLA antennas are being returned to the array to be used as part of normal operations at the rate of approximately one antenna every two months. At the beginning of EVLA early science there will be 25 antennas in the array. The remaining three VLA antennas will be decommissioned while they await their retrofits; they will not be used in conjunction with the EVLA correlator until they have been converted to the EVLA antenna design.

3.2 Expected Capabilities: Receivers

The retrofitted EVLA antennas are outfitted with EVLA or "interim" L, EVLA or "interim" C, VLA X, EVLA K, and EVLA Q-band receivers. (Interim receivers are EVLA receivers with VLA orthomode transducers. All interim receivers will be converted to full EVLA capabilities by the end of the project. The polarization purity and sensitivity of the interim receivers typically is good only over the traditional VLA tuning range.) As of August 2009 thirteen of the EVLA antennas also have EVLA Ka-band receivers. Figure 1 shows the expected rate of antenna retrofits and installation of the final EVLA receiver systems throughout the EVLA construction project. The maximum bandwidth that can be brought back from the antennas to the correlator depends on the rate at which the antennas are outfitted with 8-bit samplers (the "2 GHz BW" line in Figure 1) and the fast 3-bit samplers (the "8 GHz BW" line in Figure 1).

Figure 1 does not tell the entire story of frequency availability for observing with the EVLA, however, since there also are some interim receivers that may be used in the absence of the final EVLA receivers. Table 4 gives a prediction of the new frequency capabilities

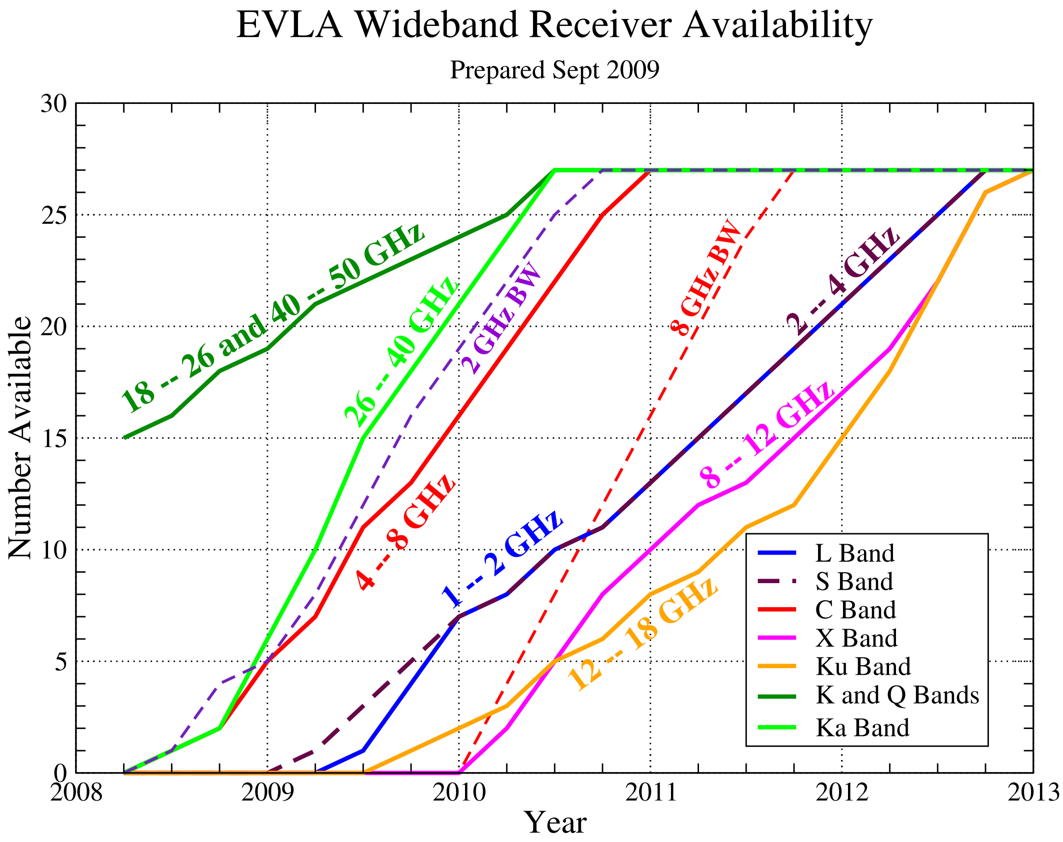

Figure 1: **EVLA Receiver Deployment Plan.** Above is a plot of the availability of the final EVLA receivers from 2008 until the end of the EVLA Construction Project in 2012. Only final EVLA receivers are shown. Interim receivers with reduced frequency coverage or polarization purity are available at some bands (see Table 4). Approximate installation dates for 2 GHz and 8 GHz bandwidths per polarization also are shown, but these will not be accessible to observers until the new correlator has been commissioned.

that we expect in March 2010, along with the expected "total" numbers of receivers for a given band, including VLA-style and/or interim receivers. New receiver bands will be offered for general use when the performance of at least five antennas has been verified by EVLA commissioning staff.

3.3 Open Shared Risk Observing

NRAO has esentially been offering shared risk access to the VLA for all users since the EVLA construction project began. The OSRO program extends this into the EVLA era by providing early access to a number of correlator capabilities and observing modes for the general user community after the VLA correlator has been turned off in January 2010. These modes represent a significant improvement over the capabilities of the VLA correlator. They are described in detail in Section 4.13.

Table 4: **Tuning Ranges of EVLA Bands**

Band	Range	Receiver availability, March 2010	
		Final EVLA systems	Total EVLA+VLA/interim
20 cm (L)	1.0 – 2.0 GHz	7	25
13 cm (S)	2.0 – 4.0 GHz	7	7
6 cm (C)	4.0 – 8.0 GHz	16	25
3 cm (X)	8.0 – 12.0 GHz	0	24
2 cm (Ku)	12.0 – 18.0 GHz	2	2
1.3 cm (K)	18.0 – 26.5 GHz	25	25
1 cm (Ka)	26.5 – 40.0 GHz	21	21
0.7 cm (Q)	40.0 – 50.0 GHz	25	25

Note: The rightmost column gives the total numbers of receivers expected to be available for a given band, including all VLA-style and/or interim receivers. Only the old narrow-band VLA receivers are available in the 8–8.8 GHz band until closer to the end of the EVLA construction project (see Figure 1).

3.4 Resident Shared Risk Observing

The WIDAR correlator and the EVLA will provide a vastly more powerful instrument than the VLA. The RSRO program offers participants early access to the growing capabilities of the EVLA as it is being commissioned, in exchange for a period of residence in Socorro to assist with the commissioning. It is intended to accelerate the development of the EVLA's full scientific capabilities by gaining enhanced resources and expertise through community participation. It will at the same time help quickly optimize the scientific productivity of the EVLA. The RSRO program will run for approximately two years (from March 2010 through the end of 2011), with up to 25% of the EVLA time available for astronomical observations allocated to the RSRO program, depending on demand and quality of science proposed. At the end of this period all access to the EVLA will be through the OSRO program, until full operations begin in 2013. This document describes only those capabilities available to the general user community through the OSRO program. Users interested in participating in the RSRO program should refer to the web page at `http://www.aoc.nrao.edu/evla/astro/rsro.shtml` for a general description of the expected capabilities available through the RSRO program, and should check with EVLA staff for further details.

4 PERFORMANCE OF THE EVLA

This section contains details of the EVLA's resolution, expected sensitivity, tuning range, dynamic range, pointing accuracy, and modes of operation. Detailed discussions of most of the observing limitations are found elsewhere. In particular, see References 1 and 2, listed in Section 7.

4.1 Resolution

The EVLA's resolution is generally diffraction-limited, and thus is set by the array configuration and frequency of observation. It is important to be aware that a synthesis array is "blind" to structures on angular scales both smaller and larger than the range of fringe spacings given by the antenna distribution. For the former limitation, the EVLA acts like any single antenna – structures smaller than the diffraction limit ($\theta \sim \lambda/D$) are broadened to the resolution of the antenna. The latter limitation is unique to interferometers; it means that structures on angular scales significantly larger than the fringe spacing formed by the shortest baseline are not measured. No subsequent processing can fully recover this missing information, which can only be obtained by observing in a smaller array configuration, using the mosaicing method, or by observing with an instrument (such as a large single antenna) which provides this information.

Table 5 summarizes the relevant information. This table shows the maximum and minimum antenna separations, the approximate synthesized beam size (full width at half-power), and the scale at which severe attenuation of large scale structure occurs.

A project with the goal of doubling the longest baseline available in the **A** configuration by establishing a real-time fiber optic link between the VLA and the VLBA antenna at Pie Town was carried out in the late 1990s, and used through 2005. This link is no longer operational; there is a goal (unfunded, at present) of implementing a new digital Pie Town link after the EVLA construction project has been completed.

4.2 Sensitivity

The theoretical thermal noise expected for an image using natural weighting of the visibility data is given by

$$\Delta I_m = \frac{SEFD}{\eta_{\mathrm{C}}\sqrt{n_{\mathrm{pol}} N(N-1) t_{\mathrm{int}} \Delta\nu)}} \tag{1}$$

where:

- $SEFD$ is the "system equivalent flux density" (Jy), a measure of the flux density of a natural radio source that would be required to double the system temperature. Thus, lower values of the $SEFD$ are better. The $SEFD$ is given by the equation $SEFD = 5.62 T_{\mathrm{sys}}/\eta_A$, where T_{sys} is the total system temperature of the receiver plus antenna plus sky, and η_A is the antenna aperture efficiency in the given band.
- η_{C} is the correlator efficiency (at least 0.92 for the EVLA).
- n_{pol} is the number of polarization products included in the image; for the correlator configurations being offered for OSRO observing (Section 4.13), $n_{\mathrm{pol}} = 2$.
- N is the number of antennas.
- t_{int} is the total on-source integration time in seconds.
- $\Delta\nu$ is the bandwidth in Hz.

Figure 2 shows the $SEFD$ as a function of frequency for those bands currently installed on EVLA antennas, and include the contribution to T_{sys} from atmospheric emission at the zenith. Table 6 gives the $SEFD$ at some fiducial EVLA frequencies. At X-band, where the VLA-style receivers are still in use, the $SEFD$ is approximately 310 Jy. It should be emphasized that until the VLA correlator is turned off in January 2010 the maximum number of antennas that can be correlated with the EVLA correlator is 12, so it has not yet been possible to test whether equation 1 holds for an image made using the full array. However, it is expected that this will be the case, and equation 1 should be used for estimating required integration times.

Table 5: **Configuration Properties**

Configuration	**A**	**B**	**C**	**D**
$B_{\max}(\text{km}^1)$	36.4	11.4	3.4	1.03
$B_{\min}(\text{km}^1)$	0.68	0.21	0.035^5	0.035
	Synthesized Beamwidth $\theta_{\text{HPBW}}(\text{arcsec})^{1,2,3}$			
1.5 GHz (L)	1.3	4.2	14	46
3.0 GHz (S)[6]	0.65	2.1	7.0	23
6.0 GHz (C)	0.33	1.0	3.5	12
8.5 GHz (X)[7]	0.23	0.73	2.5	8.1
15 GHz (Ku)[6]	0.13	0.42	1.4	4.6
22 GHz (K)	0.089	0.28	0.95	3.1
33 GHz (Ka)[6]	0.059	0.19	0.63	2.1
45 GHz (Q)	0.043	0.14	0.47	1.5
	Largest Angular Scale θ_{LAS} (arcsec)[1,4]			
1.5 GHz (L)	36	120	970	970
3.0 GHz (S)[6]	18	58	490	490
6.0 GHz (C)	8.9	29	240	240
8.5 GHz (X)[7]	6.3	20	170	170
15 GHz (Ku)[6]	3.6	12	97	97
22 GHz (K)	2.4	7.9	66	66
33 GHz (Ka)[6]	1.6	5.3	44	44
45 GHz (Q)	1.2	3.9	32	32

These estimates of the synthesized beamwidth are for a uniformly weighted, untapered map produced from a full 12 hour synthesis observation of a source which passes near the zenith.
Footnotes:

1. $B_{\max}$ is the maximum antenna separation, $B_{\min}$ is the minimum antenna separation, θ_{HPBW} is the synthesized beam width (FWHM), and θ_{LAS} is the largest scale structure "visible" to the array.
2. The listed resolutions are appropriate for sources with declinations between -15 and 75 degrees. For sources outside this range, the extended north arm hybrid configurations (**BnA**, **CnB**, **DnC**) should be used, and will provide resolutions similar to the smaller configuration of the hybrid, except for declinations south of -30. No double-extended north arm hybrid configuration (e.g., **CnA**, or **DnB**) is provided.
3. The approximate resolution for a naturally weighted map is about 1.5 times the numbers listed for θ_{HPBW}. The values for snapshots are about 1.3 times the listed values.
4. The largest angular scale structure is that which can be imaged reasonably well in full synthesis observations. For single snapshot observations the quoted numbers should be divided by two.
5. The standard **C** configuration has been replaced by a slightly modified one, formerly known as **CS**, wherein an antenna from the middle of the north arm has been moved to the central pad "N1". This results in improved imaging for extended objects, but will degrade snapshot performance. Although the minimum spacing is the same as in **D** configuration, the surface brightness sensitivity to extended structure is considerably inferior to that of the **D** configuration (but considerably better than standard **C** configuration).
6. The S, Ku, and Ka bands do not yet have a full complement of antennas, so the exact values will depend on the rate of antenna outfitting and the placement of individual antennas in the various configurations.
7. At X-band the default VLA frequency of 8.5 GHz has been assumed, since there are no EVLA 8–12 GHz receivers available yet and the VLA-style receivers will probably be used through the end of 2010.

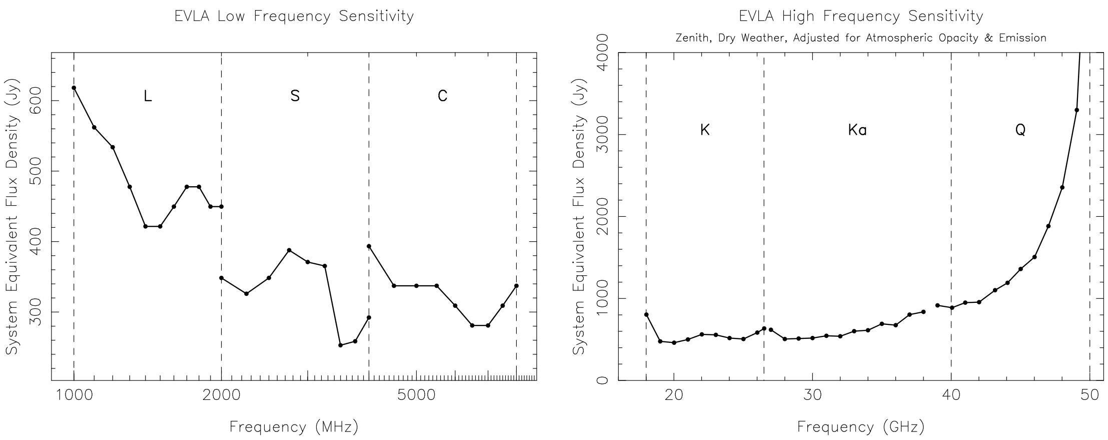

Figure 2: ***SEFD* for the EVLA.** *Left:* The system equivalent flux density as a function of frequency for the L, S, and C-band receivers; note the logarithmic frequency axis. *Right:* The system equivalent flux density as a function of frequency for the K, Ka, and Q-band receivers. The frequency axis is linear.

Table 6: $SEFD$**s and D-Configuration Confusion Limits**

Frequency	$SEFD$ (Jy)	RMS confusion level in **D** config (μJy/beam)
1.5 GHz (L)	420	89
3.0 GHz (S)	370	14
6.0 GHz (C)	310	2.3
22 GHz (K)	560	···
33 GHz (Ka)	600	···
45 GHz (Q)	1400	···

Note: $SEFD$s at K, Ka, and Q bands include contributions from Earth's atmosphere, and were determined under good conditions. At X-band, where the VLA-style receivers are still in use, the $SEFD$ is approximately 310 Jy. The confusion limits in **C** configuration are approximately a factor of 10 less than those listed above.

Note that the theoretical rms noise calculated using equation 1 is the best limit possible. There are several factors that will tend to increase the noise compared with theoretical:

- For the more commonly-used "robust" weighting scheme, intermediate between pure natural and pure uniform weightings (available in the AIPS task `IMAGR` and CASA task `clean`), typical parameters will result in the sensitivity being a factor of about 1.2 worse than the listed values.

- Confusion. There are two types of confusion: (i) that due to confusing sources within the synthesized beam, which affects low resolution observations the most. Table 6 shows the confusion noise in **D** configuration (see Condon 2002, ASP Conf. 278, 155), which should be added in quadrature to the thermal noise in estimating expected sensitivities. The confusion limits in **C** configuration are approximately a factor of 10 less than those in Table 6; (ii) confusion from objects in sidelobes of the primary beam not included in the image. This primarily affects low frequency observations.

- Weather. The sky and ground temperature contributions to the total system temperature increase with decreasing elevation. This effect is very strong at high frequencies, but is relatively unimportant at the other bands. The extra noise comes directly from atmospheric emission, primarily from water vapor at K-band, and from water vapor and the broad wings of the strong 60 GHz O_2 transitions at Q-band.

  In general, the zenith atmospheric opacity to microwave radiation is very low – typically less than 0.01 at L, C and X-bands, 0.05 to 0.2 at K-band, and 0.05 to 0.1 at the lower half of Q-band, rising to 0.3 by 49 GHz. The opacity at K-band displays strong variations with time of day and season, primarily due to the 22 GHz water vapor line. Conditions are best at night, and in the winter. Q-band opacity, caused by O_2 in the atmosphere, is considerably less variable.

  Observers should remember that clouds, especially clouds with large water droplets (read, thunderstorms!), can add appreciable noise to the system temperature. Significant increases in system temperature can, in the worst conditions, be seen at frequencies as low as 5 GHz. Tipping scans can be used for for deriving the zenith opacity during an observation.

- Antenna elevation-dependent gains. The antenna figure degrades at low elevations, leading to diminished forward gain at the shorter wavelengths. The gain-elevation effect is negligible at frequencies below 8 GHz. The antenna gains can be determined by direct measurement of the relative system gain using the AIPS task `ELINT` on data from a strong calibrator which has been observed over a wide range of elevation. If this is not possible, care should be taken to observe a primary flux calibrator at the same elevation as the target.

  The AIPS task `INDXR` applies standard gains and an estimated opacity in CL table version 1. The CASA calibration tasks (e.g. `gaincal`, `bandpass`) also use the standard gain curves. Note that currently the gain coefficients used in AIPS and CASA are for VLA antennas; the elevation-dependent gains of the EVLA antennas have yet to be fully characterized.

- Pointing. The $SEFD$ quoted assumes good pointing. Under calm nighttime conditions, the antenna blind pointing is about 10 arcsec rms. The pointing accuracy in daytime is a little worse, due to the effects of solar heating of the antenna structures. However, moderate winds have a very strong effect on both pointing and antenna figure. The maximum wind speed recommended for high frequency observing is 15 mph (7 m/s). Wind speeds near the stow limit (45 mph) will have a similar negative effect at 8 and 15 GHz.

  To achieve better pointing, "referenced pointing" is recommended, where a nearby calibrator is observed in interferometer pointing mode every hour or so. The local pointing corrections thus measured can then be applied to subsequent target observations. This reduces rms pointing errors to typically 2 – 3 arcseconds if the reference source is within about 10 degrees (in azimuth and elevation) of the target source, and the source elevation is less than 70 degrees.

  Use of referenced pointing is highly recommended for all K, Ka, and Q-band observations, and for lower frequency observations of objects whose total extent is a significant fraction of the antenna primary beam. It is usually recommended that the referenced pointing measurement be made at 8 GHz (X-band), regardless of what band your target observing is at, since X-band is the most sensitive, and the closest calibrator is likely to be weak. Proximity of the reference calibrator to the target source is of paramount importance. The calibrator should have at least 0.5 Jy flux density and be unresolved on all baselines to ensure an accurate solution.

To aid EVLA proposers there is an exposure tool calculator on-line at `http://www.aoc.nrao.edu/evla/astro/guides/exposure/evlaExpoCalc.jnlp` that provides a graphical user interface to these equations.

The beam-averaged brightness temperature measured by a given array depends on the synthesized beam, and is related to the flux density per beam by

$$T_{\mathrm{b}} = \frac{S\lambda^2}{2k\Omega} = F \cdot S \tag{2}$$

where T_{b} is the brightness temperature (Kelvins) and Ω is the beam solid angle. For natural weighting (where the angular size of the approximately Gaussian beam is $\sim 1.5\lambda/B_{\mathrm{max}}$), and S in mJy per beam, the constant F depends only upon array configuration and has the approximate value $F = 190$, 19, 1.6, 0.15 for **A**, **B**, **C**, and **D** configurations, respectively. The brightness temperature sensitivity can be obtained by substituting the rms noise, ΔI_m, for S. Note that Equation 2 is a *beam-averaged* surface brightness; if a source size can be measured the source size and integrated flux density should be used in Equation 2, and the appropriate value of F calculated. In general the surface brightness sensitivity is also a function of the source structure and how much emission may be filtered due to to the sampling of the interferometer. A more detailed description of the relation between flux density and surface brightness is given in Chapter 7 of Reference 1, listed in Section 7.

For observers interested in H I in galaxies, a number of interest is the sensitivity of the observation to the H I mass. This is given by van Gorkom et al. (1986; AJ, 91, 791):

$$M_{\mathrm{HI}} = 2.36 \times 10^5 D^2 \sum S\Delta V \ M_{\odot} \tag{3}$$

where D is the distance to the galaxy in Mpc, and $S\Delta V$ is the H I line area in units of Jy km/s.

4.3 EVLA Frequency Bands and Tunability

For OSRO observations each receiver can tune to two different frequencies from the same wavelength band. Right-hand circular (RCP) and left-hand circular (LCP) polarizations are received for both frequencies. Each of these four data streams currently follows the VLA nomenclature, and are known as IF (for "Intermediate Frequency" channel) "A", "B", "C", and "D". IFs A and B receive RCP, IFs C and D receive LCP. IFs A and C are always at the same frequency, as are IFs B and D (but the IFs A/C frequency is usually different from the B/D frequency).

The tuning ranges, along with default frequencies for continuum applications, are given in Table 7 below. As noted earlier, the S, X, and Ku bands are not yet available.

For the EVLA Ka-band receiver IFs B and D are able to tune over the full 26.5 to 40 GHz, while IFs A and C cover 32 to 40 GHz. Observations requiring 32.0 GHz should use IFs B/D. At Ka-band it is possible to tune the two IF pairs up to 10 GHz apart, while for other EVLA receivers the IFs can be separated by up to the full tuning range of the receiver. A further restriction is that if the IFs are separated by more than 2 GHz, then B/D must be the lower of the two.

Table 7: **Default frequencies for "continuum" applications**

Band	Range (GHz)	Default frequencies for continuum applications (GHz)	
		IFs A/C	IFs B/D
20 cm (L)	1.0 – 2.0	1.350	1.810
13 cm (S)	2.0 – 4.0	...	...
6 cm (C)	4.0 – 8.0	4.576	4.844
3 cm (X)	8.0 – 12.0	8.396[1]	8.524[1]
2 cm (Ku)	12.0 – 18.0	...	...
1.3 cm (K)	18.0 – 26.5	22.396	22.524
1 cm (Ka)	26.5 – 40.0	33.496	33.624
0.7 cm (Q)	40.0 – 50.0	43.216	43.344

Notes:

1. Only the old narrow-band VLA receivers are available in the 8–8.8 GHz band until closer to the end of the EVLA construction project (see Figure 1). The default frequency above is for the VLA X-band receivers; it will likely be changed for the final EVLA X-band receivers.

4.4 Field of View

At least four different effects will limit the field of view. These are: primary beam; chromatic aberration; time-averaging; and non-coplanar baselines. We discuss each briefly:

4.4.1 Primary Beam

The ultimate factor limiting the field of view is the diffraction-limited response of the individual antennas. An approximate formula for the full width at half power in arcminutes is: $\theta_{\rm PB} = 45/\nu_{\rm GHz}$. More precise measurements of the primary beam shape have been derived and are incorporated in AIPS (task `PBCOR`) and CASA (`clean` task and the imaging toolkit) to allow for correction of the primary beam attenuation in wide-field images. Objects larger than approximately half this angle cannot be directly observed by the array. However, a technique known as "mosaicing," in which many different pointings are taken, can be used to construct images of larger fields. Refer to References 1 and 2 for details.

4.4.2 Chromatic Aberration (Bandwidth Smearing)

The principles upon which synthesis imaging are based are strictly valid only for monochromatic radiation. When radiation from a finite bandwidth is accepted and gridded as if monochromatic, aberrations in the image will result. These take the form of radial smearing which worsens with increased distance from the delay-tracking center. The peak response to a point source simultaneously declines in a way that keeps the integrated flux density constant. The net effect is a radial degradation in the resolution and sensitivity of the array.

These effects can be parameterized by the product of the fractional bandwidth ($\Delta\nu/\nu_0$) with the source offset in synthesized beamwidths ($\theta_0/\theta_{\rm HPBW}$). Table 8 shows the decrease in peak response and the increase in apparent radial width as a function of this parameter. Table 8 should be used to determine how much spectral averaging can be tolerated when imaging a particular field.

Table 8: **Reduction in Peak Response Due to Bandwidth Smearing**

$\frac{\Delta\nu}{\nu_0}\frac{\theta_0}{\theta_{\rm HPBW}}$	Peak	Width
0.0	1.00	1.00
0.50	0.95	1.05
0.75	0.90	1.11
1.0	0.80	1.25
2.0	0.50	2.00

Note: The reduction in peak response and increase in width of an object due to bandwidth smearing (chromatic aberration). $\Delta\nu/\nu_0$ is the fractional bandwidth; $\theta_0/\theta_{\rm HPBW}$ is the source offset from the phase tracking center in units of the synthesized beam.

4.4.3 Time-Averaging Loss

The sampled coherence function (visibility) for objects not located at the phase-tracking center is slowly time-variable due to the changing array geometry, so that averaging the samples in time will cause a loss of amplitude. Unlike the bandwidth loss effect described above, the losses due to time averaging cannot be simply parameterized. The only simple case exists for observations at $\delta = 90°$, where the effects are identical to the bandwidth effect except they operate in the azimuthal, rather than the radial, direction. The functional dependence is the same in this case with $\Delta\nu/\nu_0$ replaced by $\omega_e \Delta t_{\rm int}$, where ω_e is the Earth's angular rotation rate, and $\Delta t_{\rm int}$ is the averaging interval.

For other declinations, the effects are more complicated and approximate methods of analysis must be employed. Chapter 13 of Reference 1 considers the average reduction in image amplitude due to finite time averaging. The results are summarized in Table 9, showing the time averaging in seconds which results in 1%, 5% and 10% loss in the amplitude of a point source located at the first null of the primary beam. These results can be extended to objects at other distances from the phase tracking center by noting that the loss in amplitude scales with $(\theta\Delta t_{\rm int})^2$, where θ is the distance from the phase center and $\Delta t_{\rm int}$ is the averaging time. We recommend that observers reduce the effect of time-average smearing by using integration times as short as 1 or 2 seconds (also see Section 4.5) in at least the **A** and **B** configurations.

Table 9: **Loss vs. Averaging Time for Time Averaging Smearing**

	Amplitude loss		
Configuration	1.0%	5.0%	10.0%
A	2.1	4.8	6.7
B	6.8	15.0	21.0
C	21.0	48.0	67.0
D	68.0	150.0	210.0

Note: The averaging time (in seconds) resulting in the listed amplitude losses for a point source at the antenna first null. Multiply the tabulated averaging times by 2.4 to get the amplitude loss at the half-power point of the primary beam. Divide the tabulated values by 4 if interested in the amplitude loss on the longest baselines.

4.4.4 Non-Coplanar Baselines

The procedures by which nearly all images are made in Fourier synthesis imaging are based on the assumption that all the coherence measurements are made in a plane. This is strictly true for E-W interferometers, but is false for the EVLA, with the single exception of snapshots. Analysis of the problem shows that the errors associated with the assumption of a planar array increase quadratically with angle from the phase-tracking center. Serious errors result if the product of the angular offset in radians times the angular offset in synthesized beams exceeds unity. This effect is noticeable at λ20 cm in certain instances, but can be safely ignored at shorter wavelengths.

Solutions to the problem of imaging wide-field data taken with non-coplanar arrays are well known, and have been implemented in AIPS (`IMAGR`) and CASA (`clean`). Refer to the package help files for these tasks, or consult with Rick Perley, Frazer Owen, or Sanjay Bhatnagar for advice. More computationally efficient imaging with non-coplanar baselines is being investigated, such as the "W-projection" method available in CASA; see EVLA Memo 67 for more details.

4.5 Time Resolution and Data Rates

The minimum integration time that will be supported for OSRO is 1 second. It is expected, however, that for normal observing in the **D** configuration integration times of up to 10 seconds will be commonly used.

The maximum recommended integration time for any EVLA observing is 60 seconds, but given current computing capabilities there is no reason to use integration times longer than 10 seconds. For high frequency observers with short scans (e.g., fast switching, as described in Section 4.11.2), shorter integration times may be preferable.

Observers should bear in mind the data rate of the EVLA when planning their observations. For the correlator configurations discussed in Section 4.13, and integration time Δt, the data rate is:

$$\begin{aligned} \text{Data rate} &= 1.7\ \text{MB/sec} \times N_{\text{ant}} \times (N_{\text{ant}} - 1) \,/\, (27 \times 26) \,/\, (\Delta t / 1\ \text{sec}) \\ &= 6.0\ \text{GB/hour} \times N_{\text{ant}} \times (N_{\text{ant}} - 1) \,/\, (27 \times 26) \,/\, (\Delta t / 1\ \text{sec}) \qquad (4) \end{aligned}$$

which corresponds to 145 GB/day when using the full 27-element array with 1 second integrations. While analyzing such data sets is not too difficult with current computers, data transfer will clearly be more of an issue than in the past. Most observers currently download their data via ftp directly from the archive. The Archive Access Tool will allow some level of frequency averaging to decrease data set sizes before ftp, for users whose science permits; note that the full spectral resolution will be retained in the NRAO archive for *all* observations. Observers may also request their data on DATs or USB drives.

4.6 Radio-Frequency Interference

The bands within the tuning range of the EVLA which are allocated exclusively to radio astronomy are 1400–1427 MHz, 1660 – 1670 MHz, 2690–2700 MHz, 4990–5000 MHz, 10.68–10.7 GHz, 15.35–15.4 GHz, 22.21–22.5 GHz, 23.6–24.0 GHz, 31.3–31.8 GHz, and 42.5–43.5 GHz. No external interference should occur within these bands. RFI is primarily a problem within the low frequency bands, and at 20 cm, interference is most serious to the **D** configuration, as the fringe rates in other configurations are often sufficient to reduce interference to tolerable levels.

Radio frequency interference (RFI) at the EVLA will be an increasing problem to astronomical observations. Table 10 lists some of the sources of external RFI at the VLA site that might be observed within the EVLA tuning range. Figure 3 shows a dynamic spectrum of the 1–2 GHz frequency range at the VLA site, illustrating the nature and origin of the interference.

Plots of all RFI observations from 1993 onwards are available online, at `http://www.vla.nrao.edu/cgi-bin/rfi.cgi`. For general information about the RFI environment, contact the head of the IPG (Interference Protection Group) by sending e-mail to nrao-rfi@nrao.edu.

The impact of RFI on astronomical observing depends on the configuration. It is worst for the **D** configuration, but RFI signal strengths can be appreciably attenuated in the extended configurations due to fringe phase winding.

The EVLA electronics have been designed to minimize gain compression in the amplifiers due to very strong RFI signals, so that in general it will be possible to observe in spectral regions containing RFI, provided the spectra are well sampled to minimize Gibbs ringing (or Hanning smoothing is applied). No astronomy is possible at frequencies coinciding with the RFI signals, but provided the interference is appropriately flagged it will probably be possible to do astronomy at frequencies in between the RFI. The flagging will be potentially be very onerous as the bandwidth of the EVLA increases, and various automated flagging algorithms are being investigated.

4.7 Subarrays

The separation of the EVLA into multiple sub-arrays will not be supported initially for OSRO.

4.8 Positional Accuracy

The accuracy with which an object's position can be determined is limited by the atmospheric phase stability, the closeness of a suitable (astrometric) calibrator, and the calibrator-source cycle time. Under good conditions, in **A** configuration, accuracies of about 0.05 arcseconds can be obtained. Under more normal conditions, accuracies of perhaps 0.1 arcseconds can be expected. Under extraordinary conditions (probably attained only a few times per year on calm winter nights in **A** configuration when using rapid phase switching on a nearby astrometric calibrator – see Section 4.11.2), accuracies of 1 milliarcsecond have been attained with the VLA.

If highly accurate positions are desired, only "A" code (astrometric) calibrators from the VLA Calibrator List should be used. The positions of these sources are taken from lists published by the USNO.

4.9 Limitations on Imaging Performance

Imaging performance can be limited in many different ways. Some of the most common are listed in the following subsections.

4.9.1 Image Fidelity

With conventional point-source calibration methods, and even under the best observing conditions, the achieved dynamic range will rarely exceed a few hundred. The limiting

Table 10: **VLA RFI Between 1 and 20 GHz**

Frequency (MHz)	Source	Comments
1000	Military	Intermittent
1030, 1090	Aerostat	
1217.6, 1237.6	GPS L2	Intermittent
1227.6	GPS-L2	Continuous
1231	Aerostat	
1233.71	FAA Radar	Continuous
1235, 1252	Aerostat	
1254.42	FAA Radar	Continuous
1291, 1295	Aerostat	
1310	FAA Radar	Continuous
1312	Aerostat	
1316.56, 1330, 1337.28	FAA Radar	Continuous
1357, 1365, 1369	Military	Intermittent
1381.05	GPS-L3	Intermittent
1385, 1393, 1432.5, 1437, 1453	Military	Intermittent
1444.5, 1453.5	High altitude balloons	Intermittent
1448.5, 1452.5, 1460.5	Military	Intermittent
1501.5	High altitude balloons	Intermittent
1504.5	Military	Intermittent
1515.5, 1525.5	High altitude balloons	Intermittent
1529.5, 1530.5	Military	Intermittent
1565.42, 1585.42	GPS-L1	Intermittent
1575.42	GPS-L1	Continuous
1606, 1616	GLONASS	Continuous
1621, 1627	IRIDIUM	Continuous
1668.4, 1680	Radiosonde weather balloons	Intermittent
1771	High altitude balloons	Intermittent
1850, 1990	Cell phones	Continuous
2106.4	High altitude balloons	Intermittent
2204.5	Military	Intermittent
2320	Satellite radio	Continuous
2227–2331	Military?	Intermittent
2332.5	Satellite radio	Continuous
2334–2341	Military?	Intermittent
2345	Satellite radio	Continuous
2387.5	High altitude balloons	Intermittent
2400, 2483.5	Microwave ovens	Continuous
2400, 2483.5	WiFi	Continuous
5648–5804	Military?	Intermittent
15200	Mini-SAR	Intermittent
18000	Military	Intermittent
18200	Mini-SAR	Intermittent

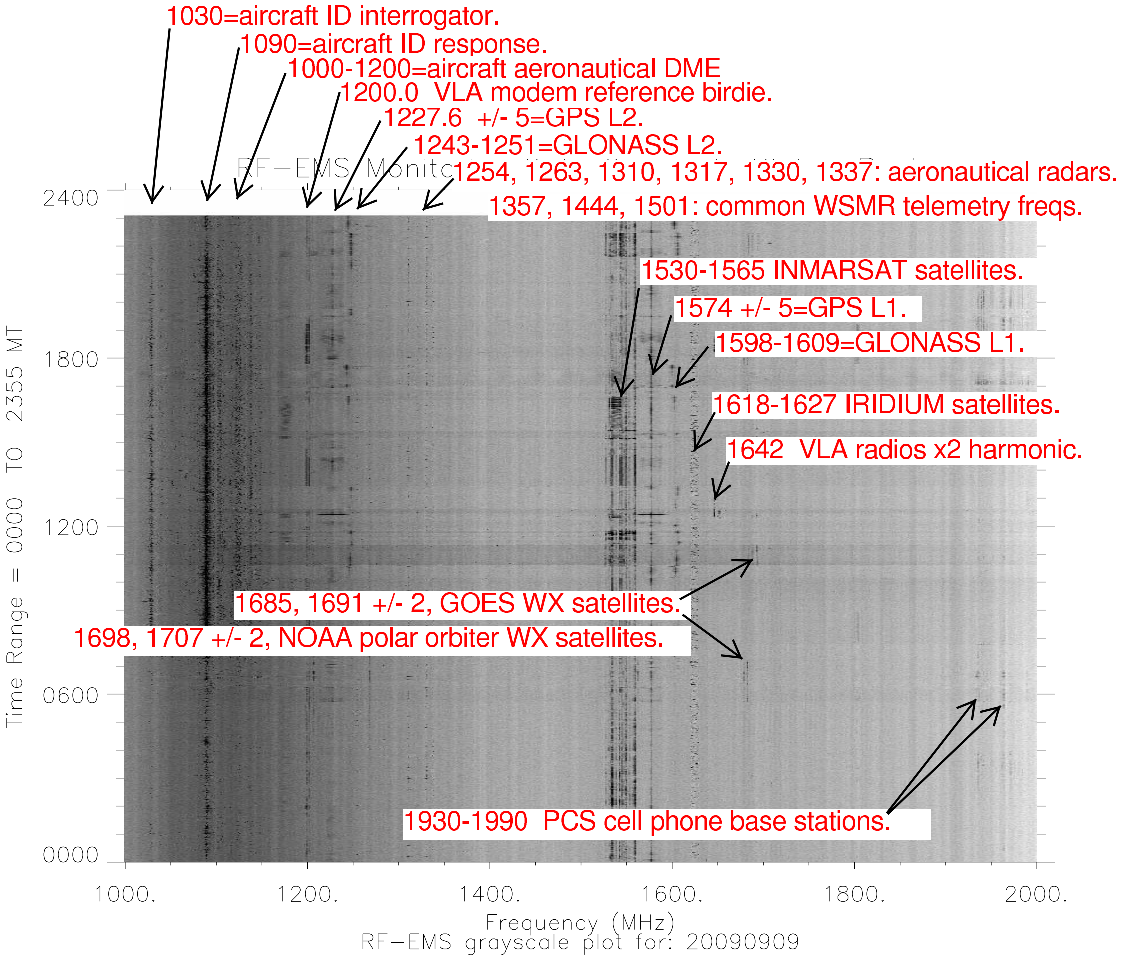

Figure 3: **Dynamic spectrum of L-band RFI.** The origin of various features is marked.

factor is the atmospheric phase stability. If the target source contains more than 50 mJy in compact structures (depending somewhat on band), self-calibration can be counted on to improve the images. If the atmospheric coherence time is several minutes or longer, weaker sources can be used for self-cal; for shorter coherence times and less sensitive bands, stronger sources will be needed. Dynamic ranges in the thousands can be achieved using these techniques.

4.9.2 Invisible Structures

An interferometric array acts as a spatial filter, so that for any given configuration, structures on a scale larger than the fringe spacing of the shortest baseline will be completely absent. Diagnostics of this effect include negative bowls around extended objects, and large-scale stripes in the image. Table 5 gives the largest scale visible to each configuration/band combination.

4.9.3 Poorly Sampled Fourier Plane

Unmeasured Fourier components are assigned values by the deconvolution algorithm. While this often works well, sometimes it fails noticeably. The symptoms depend upon the actual deconvolution algorithm used. For the CLEAN algorithm, the tell-tale sign is a fine mottling on the scale of the synthesized beam, which sometimes even organizes itself into coherent stripes. Further details are to be found in Reference 1.

4.9.4 Sidelobes from Confusing Sources

At 20 cm, large numbers of background sources are located throughout the primary antenna beam. Sidelobes from these objects will lower the image quality of the target source. Although bandwidth and time-averaging will tend to reduce the effects of these sources, the very best images will require careful imaging of all significant background sources. The deconvolution tasks in AIPS (`IMAGR`) and CASA (`clean`) are well suited to this task at 20 cm.

4.9.5 Sidelobes from Strong Sources

Another image-degrading effect is that due to strong nearby sources. Again, the 20 cm band is especially affected. The active Sun will be visible to any **D** configuration daytime observation in this band. The quiet Sun poses a lesser threat, so the general rule is to go ahead and observe, even if the target source is close to the Sun.

4.10 Calibration and the Flux Density Scale

The VLA Calibrator List contains information on 1860 sources sufficiently unresolved and bright to permit their use as calibrators. The list is available within the Observation Preparation Tool and may be accessed on the Web at `http://www.vla.nrao.edu/astro/calib/manual/`.

Accurate flux densities can be obtained by observing one of 3C286, 3C147, 3C48 or 3C138 during the observing run. Not all of these are suitable for every observing band and configuration – consult the VLA Calibrator Manual for advice. Over the last several years, we have implemented accurate source models directly in AIPS and CASA for much improved calibration of the amplitude scales. Models are available for 3C48, 3C138, 3C147, and 3C286 for L, C, X, Ku, K, and Q bands. At Ka band either of the K or Q band models works reasonably well.

Since the standard source flux densities are slowly variable, we monitor their flux densities when the array is in its **D** configuration. As the EVLA cannot measure *absolute* flux densities, the values obtained must be referenced to assumed or calculated standards, as described in the next paragraph. Table 11 shows the flux densities of these sources in November 2001 at the standard VLA bands. The accuracy of these values, relative to the assumed standards, is set by the gain stability of the instrument. The estimated 1-σ errors in the table, relative to the assumed standards, are less than 1% for frequencies up to 25 GHz, and about 2% for the 43 GHz band.

The flux densities shown in the table for frequencies below 10 GHz are based on the Baars et al. value for 3C295. For frequencies above 10 GHz, the flux densities are based on models of Mars and NGC 7027 which are themselves based on the Baars scale below 10 GHz.

Polynomial coefficients describing the derived flux densities for the standard calibrators have been determined which permit accurate interpolation of the flux density at any EVLA frequency. These coefficients are updated approximately every few years, and are used in the AIPS task `SETJY` and in the CASA task `setjy`. At present, a substantial new effort is under way to improve the long-term (past and present) accuracy of the EVLA flux density scale; contact Rick Perley or Bryan Butler for information on this work. Although final information is not yet available, it appears that the flux densities of 3C48 and 3C286 relative to 3C295 have changed by less than 1% over the last 25–30 years.

Table 11: **Flux densities (Jy) of Standard Calibrators for November 2001**

Source/Frequency (MHz)	1465	4885	8435	14965	22460	43340
3C48 = J0137+3309	15.54	5.47	3.22	1.83	1.23	0.63
3C138 = J0521+1638	8.16	3.71	2.43	1.54	1.10	0.62
3C147 = J0542+4951	21.32	7.88	4.72	2.77	1.93	1.11
3C286 = J1331+3030	14.49	7.49	5.22	3.51	2.63	1.58
3C295 = J1411+5212	21.49	6.53	3.42	1.67	0.99	0.41
NGC 7027	1.54	5.52	6.03	5.90	5.68	5.22
MARS	–	0.175	0.528	1.67	3.81	14.22

For most observing projects, the effects of atmospheric extinction will automatically be accounted for by regular calibration when using a nearby point source whose flux density has been determined by an observation of a flux density standard taken at a similar elevation. However, at high frequencies (i.e., K-band, Ka-band, and Q-band), both the antenna gain and the atmospheric absorption may be strong enough to make "simple" flux density bootstrapping unreliable. The AIPS task `ELINT` is available to permit measurement of an elevation gain curve using your own observations, and subsequent adjustment of the derived gains to remove these elevation-dependent effects. The current calibration methodology does not require knowledge of the atmospheric extinction (since the true flux densities of the standard calibrators are believed known). However, if knowledge of the actual extinction is desired, tipping scans can be included in an observation.

4.11 Complex Gain Calibration

4.11.1 General Guidelines for Gain Calibration

Adequate gain calibration is a complicated function of source-calibrator separation, frequency, array scale, and weather. And, since what defines adequate for some experiments is completely inadequate for others, it is impossible to define any simple guidelines to ensure adequate phase calibration in general. However, some general statements remain valid most of the time. These are given below.

- Tropospheric effects dominate at wavelengths shorter than 20 cm, ionospheric effects dominate at wavelengths longer than 20 cm.
- Atmospheric (troposphere and ionosphere) effects are nearly always unimportant in the **C** and **D** configurations at L band, and in the **D** configuration at X and C bands. Hence, for these cases, calibration need only be done to track instrumental changes – once per hour is generally sufficient.
- If your target object has sufficient flux density to permit phase self-calibration, there is no need to calibrate more than once hourly at low frequencies (L/S/C bands) or 15 minutes at high frequencies (K/Ka/Q bands) in order to track pointing or other effects that might influence the amplitude scale.
- The smaller the source-calibrator angular separation, the better. In deciding between a nearby "S" calibrator, and a more distant "P" calibrator, the nearby calibrator is usually the better choice.
- At high frequencies, and longer configurations, rapid switching between the source and nearby calibrator is often helpful. See the following section.

4.11.2 Rapid Phase Calibration and the Atmospheric Phase Interferometer (API)

For some objects, and under suitable weather conditions, the phase calibration can be considerably improved by rapidly switching between the source and calibrator. Source-Calibrator observing cycles as short as 40 seconds can be used. However, observing efficiency declines for very short cycle times, so it is important to balance this loss against a realistic estimate of the possible gain. Experience has shown that cycle times of 100 to 150 seconds at high frequencies have been effective for source-calibrator separations of less than 10 degrees. For the VLA this was known as "fast-switching". For the EVLA it is just a loop of source-calibrator scans with short scan length. This technique "stops" tropospheric phase variations at an effective baseline length of $\sim v_a t/2$ where v_a is the atmospheric wind velocity aloft (typically 10 to 15 m/sec), and t is the total switching time. It has been demonstrated to result in images of faint sources with diffraction-limited spatial resolution on the longest EVLA baselines. Under average weather conditions, and using a 120 second cycle time, the residual phase at 43 GHz should be reduced to ≤ 30 degrees. Further details can be found in VLA Scientific Memos # 169 and 173. These memos, and other useful information, can be obtained from Reference 12 in Section 7.

Note that the fast switching technique will not work in bad weather (such as rain showers, or when there are well-developed convection cells – most notably, thunderstorms). See the high-frequency observing guide at `http://www.vla.nrao.edu/astro/guides/highfreq/`.

An Atmospheric Phase Interferometer (API) is used to continuously measure the tropospheric contribution to the interferometric phase using an interferometer comprising two 1.5 meter antennas separated by 300 meters, observing an 11.7 GHz beacon from a geostationary satellite. The API data can be used to estimate the required calibration cycle times when using fast switching phase calibration, and in the worst case, to indicate to the observer that high frequency observing may not be possible with current weather conditions. A detailed description of the API, and instructions for accessing its data, may be found at `http://www.vla.nrao.edu/astro/guides/api/`.

4.12 Polarization

For observations requiring polarization information, the instrumental polarization should be determined through observations of a bright calibrator source spread over a range in parallactic angle. In nearly all cases, the phase calibrator chosen can double as a polarization calibrator. The minimum condition that will enable accurate polarization calibration is four observations of a bright source spanning at least 90 degrees in parallactic angle. The accuracy of polarization calibration is generally better than 0.5% for objects small compared to the antenna beam size. At least one observation of 3C286 or 3C138 is required to fix the absolute position angle of polarized emission. 3C48 also can be used to fix the position angle at wavelengths of 6 cm or shorter. The results of a careful monitoring program of these and other polarization calibrators will be found at `http://www.vla.nrao.edu/astro/calib/polar/`.

High sensitivity linear polarization imaging may be limited by time dependent instrumental polarization, which can add low levels of spurious polarization near features seen in total intensity and can scatter flux throughout the polarization image, potentially limiting the dynamic range. At the time of writing the polarization stability of the EVLA antennas has not yet been determined.

Wide field linear polarization imaging may be limited by the instrumental polarization beam. The level of possible spurious linear polarization has not yet been characterized for the EVLA.

Ionospheric Faraday rotation is always present at 20 cm. The typical daily maximum rotation measure under quiet solar conditions is 1 or 2 radians/m^2, so the ionospherically-induced rotation of the plane of polarization at these bands is not excessive – 5 degrees at 20 cm. However, under active conditions, this rotation can be many times larger, such that accurate polarimetry is impossible at 20 cm.

The AIPS program `TECOR` has been shown to be quite effective in removing large-scale ionospherically induced Faraday Rotation. It uses currently-available data in IONEX format. Please consult the `TECOR` help file for detailed information.

Circular polarization measurements will be limited by the beam squint. At the time of writing this has not yet been fully characterized for the EVLA.

Detailed polarization tests have not yet been carried out for the retrofitted EVLA antennas. In addition, the interim EVLA receivers generally have poor polarization performance outside the frequency range previously covered by the VLA (e.g., outside the 4.5–5.0 GHz frequency range for C band), and the wider frequency bands of these interim receivers may be useful only for total intensity measurements.

4.13 Correlator Configurations

The EVLA correlator is very flexible, and will be able to provide data in many ways. Initially the EVLA correlator will be configurable for Open Shared Risk Observing in the following ways:

1. A configuration for continuum applications, to comprise two independently tunable sub-bands, full polarization, each of which has 128 MHz bandwidth with 64 channels, with the possibility of smoothing in frequency to reduce dataset sizes or to improve spectral response offline. In this configuration it will also be possible to decrease the bandwidth by powers of two, keeping the same number of channels, to provide the spectro-polarimetry capabilities in Table 12. This configuration utilizes all four IFs, A, B, C, and D (see Section 4.3).

Table 12: **Correlator capabilities per sub-band for full-polarization continuum applications and spectro-polarimetry**

Sub-band BW (MHz)	Number of poln. products	Number of channels/poln. product	Channel width (kHz)	Channel width (km/s at 1 GHz)	Total velocity coverage per sub-band (km/s at 1 GHz)
128	4	64	2000	$600/\nu$(GHz)	$38{,}400/\nu$(GHz)
64	4	64	1000	300	19,200
32	4	64	500	150	9,600
16	4	64	250	75	4,800
8	4	64	125	37.5	2,400
4	4	64	62.5	19	1,200
2	4	64	31.25	9.4	600
1	4	64	15.625	4.7	300
0.5	4	64	7.813	2.3	150
0.25	4	64	3.906	1.2	75
0.125	4	64	1.953	0.59	37.5
0.0625	4	64	0.977	0.29	18.75
0.03125	4	64	0.488	0.15	9.375

2. A higher resolution configuration for spectral line applications, to comprise one tunable sub-band, dual polarization, with 128 MHz bandwidth and 256 channels, again with the possibility of smoothing in frequency to reduce dataset sizes or to improve spectral response offline. It will be possible to decrease the bandwidth by powers of two, keeping the same number of channels, to provide the capabilities in Table 13. This configuration utilizes IFs A/C or B/D (see Section 4.3).

These capabilities will be provided with integration times no shorter than 1 second, and Doppler tracking will be available with these correlator configurations. The capabilities available to the OSRO program will be expanded as soon as they can be supported for general use. It is currently hoped that 2 GHz of bandwidth will be available by the time of the D configuration beginning in Trimester 2, 2011.

Table 13: **Correlator capabilities per sub-band for spectral line applications, dual polarization**

Sub-band BW (MHz)	Number of poln. products	Number of channels/poln. product	Channel width (kHz)	Channel width (km/s at 1 GHz)	Total velocity coverage per sub-band (km/s at 1 GHz)
128	2	256	500	$150/\nu$(GHz)	38,400/ν(GHz)
64	2	256	250	75	19,200
32	2	256	125	37.5	9,600
16	2	256	62.5	19	4,800
8	2	256	31.25	9.4	2,400
4	2	256	15.625	4.7	1,200
2	2	256	7.813	2.3	600
1	2	256	3.906	1.2	300
0.5	2	256	1.953	0.59	150
0.25	2	256	0.977	0.29	75
0.125	2	256	0.488	0.15	37.5
0.0625	2	256	0.244	0.073	18.75
0.03125	2	256	0.122	0.037	9.375

If Doppler tracking is not used for an observation, or if it is likely that the data will need to be resampled spectrally in order to Doppler track to a different line rest frequency, care should be taken to make sure the spectrum is oversampled to avoid the subsequent introduction of Gibbs ringing or the need to reduce the spectral resolution by Hanning smoothing.

All observations with the EVLA correlator should be treated as traditional VLA spectral line observations, in that they will require observation of a bandpass calibrator. They may also require observation of a delay calibrator. Users should contact NRAO staff for advice on setting up observations with the EVLA correlator.

4.14 VLBI Observations

VLBI observations with the EVLA, such as phased array and single-antenna modes, will not initially be available for the the OSRO program.

4.15 Snapshots

The two-dimensional geometry of the EVLA allows a snapshot mode whereby short observations can be used to image relatively bright unconfused sources. This mode is ideal for survey work where the sensitivity requirements are modest.

Single snapshots of strong sources with good phase stability should give dynamic ranges of a few hundred. Note that because the snapshot synthesized beam contains high sidelobes, the effects of background confusing sources are much worse than for full syntheses, especially at 20 cm in the **D** configuration, for which a single snapshot will give a limiting noise of about 0.2 mJy. This level can be reduced by taking multiple snapshots separated by at least one hour. Use of the AIPS program `IMAGR` or CASA task `clean` is necessary to remove the effects of background sources. Before considering snapshot observations at 20 cm, users should first determine if the goals desired can be achieved with the existing FIRST or CORNISH (**B** configuration), or NVSS (**D** configuration, all-sky) surveys. These surveys can be accessed from the NRAO website, at: `http://www.vla.nrao.edu/astro/prop/largeprop/`.

4.16 Shadowing and Cross-Talk

Observations at low elevation in the **C** and **D** configurations will commonly be affected by shadowing. It is strongly recommended that all data from a shadowed antenna be discarded. This will automatically be done during filling (CASA task `importasdm`) when using the default inputs.

Cross-talk is an effect in which signals from one antenna are picked up by an adjacent antenna, causing an erroneous correlation. At 20 cm, this effect is important principally in the **D** configuration. Careful editing is necessary to identify and remove this form of interference.

4.17 Combining Configurations and Mosaicing

Any single EVLA configuration will allow accurate imaging up to a scale approximately 30 times the synthesized beam. Objects larger than this will require multiple configuration observations. It is advisable that the frequencies used be the same for all configurations to be combined. Objects larger than the primary antenna pattern may be mapped through the technique of interferometric mosaicing. Time-variable structures (such as the nuclei of radio galaxies and quasars) cause special, but manageable, problems. See the article by Mark Holdaway in reference 2 for more information.

4.18 Pulsar Observing

Observation of pulsars requiring modes other than those described in Section 4.13 will not initially be supported on the EVLA.

5 USING THE EVLA

5.1 Obtaining Observing Time on the EVLA

Observing time on the EVLA is available to all researchers, regardless of nationality or location of institution. There are no quotas or reserved blocks of time. The allocation of observing time on the EVLA is based upon the submission of an EVLA Observing Proposal using the on-line Proposal Submission Tool available via the NRAO Interactive Service web page, at `http://my.nrao.edu/`. The on-line tool permits the detailed construction of a cover sheet specifying the requested observations, using a set of on-line forms, and uploading of a `pdf`-format scientific and technical justification to accompany the cover information.

It is also possible to receive EVLA observing time by proposing to NASA missions, under cooperation agreements established between NRAO and those missions. Currently, such programs exist for the Chandra, Spitzer, and Fermi missions. Astronomers interested in those joint programs should consult the relevant mission proposal calls for more information.

Students planning to use the EVLA for their Ph.D. dissertation may have a problem in that such dissertations are frequently composed of pieces of several short proposals which may not be suitable for combining into a single proposal for refereeing purposes. In this case, we shall accept, one per student, a "Plan of Dissertation Research," of no more than 1000 words, at the time of the first proposal of the series, and which can be referred to in later proposals. The plan can be submitted via the NRAO Interactive Services webpage, at `http://my.nrao.edu/`. This provides some assurance against a dissertation being seriously damaged by adverse referee comments on one component proposal, when the referees may not see the whole picture. This facility is offered to students for which EVLA observations are the most important component of their planned dissertations.

The EVLA is currently scheduled on a trimester basis, with each trimester lasting four months, matching the configuration cycle. The proposal deadline for a particular configuration is 5PM (1700), Eastern Time on the 1st of February, June, or October which precedes the beginning of that configuration by three months or more. (If the first of the month falls on a Saturday or Sunday, the deadline is advanced to the next Monday.) It is not necessary to submit a proposal at the last possible deadline for a particular configuration, since all proposals will be refereed immediately following the deadline of submission, regardless of the configuration requested. Early submissions (i.e., more than one deadline in advance of the relevant configuration deadline) will benefit from referee feedback and the opportunity for revision and additional review, if warranted.

All proposals are externally refereed by several experts in relevant subdisciplines (e.g., solar system, stellar, galactic, extragalactic, etc.). The referees' comments and rating are strongly advisory to the VLA/VLBA Proposal Selection Committee, and the comments of both groups are passed on to the proposers soon after each meeting of the committee (three times yearly) and prior to the next proposal submission deadline. See `http://www.aoc.nrao.edu/epo/ad/scheduling.shtml` for a detailed description of the time allocation process.

Because of competition, even highly rated proposals are not guaranteed to receive observing time. This is particularly true for programs that concentrate on objects in the LST ranges occupied by popular targets such as the Galactic Center or the Virgo cluster. Daytime observing will also be limited by EVLA commissioning throughout 2010.

5.2 Rapid Response Science

The NRAO has established three categories of proposals for Rapid Response Science, which are described below and at `http://www.vla.nrao.edu/astro/prop/rapid/`. At present, Rapid Response Science is limited to a maximum of 5% of the total observing time on the EVLA. All proposals for Rapid Response Science must be submitted using the standard NRAO procedures, using the on-line proposal tool. Proposals submitted by any other means (e.g., phone calls, e-mails, faxes, word-of-mouth) will be rejected.

1. Known Transient Phenomena. These proposals will request time to observe phenomena that are predictable in general, but not in specific detail. For example, a proposal to observe the next flaring X-ray binary that meets certain criteria would be included in this category. Specific triggering criteria will be required. These proposals will be evaluated as part of the normal refereeing and scheduling process, and will be subject to the normal NRAO proposal deadlines. The proprietary period for observations of Known Transient Phenomena will be 12 months.

2. Exploratory Time. These proposals generally follow up on recent discoveries, with observations requested in advance of the period allocated at the most recent proposal deadline(s). Examples include **B** configuration proposals that follow up on **A** configuration discoveries made after the **B** configuration deadline, or a newly identified object that is a hot enough topic to warrant an image within a couple months. In general, there will not be a need for immediate scheduling with these proposals, but they may need to be observed in the current VLA configuration rather than waiting 16 months. Proposals for Exploratory Time will be evaluated by a subset of the VLA/VLBA Proposal Selection Committee, and may or may not be sent to external referees. The possibility that a proposer forgets about or misses a proposal deadline will not constitute sufficient justification for granting of observing time by this process. Notification of the dispensation of Exploratory Time proposals normally will be within two weeks of reception of the proposal; most of the accepted proposals are placed in the dynamic scheduling queue, and are not guaranteed to be observed. The proprietary period for Exploratory Time will be six months.

3. Target of Opportunity. These proposals are for true targets of opportunity–unexpected or unpredicted phenomena such as supernovae, novae, or extreme X-ray, optical, or radio flares in various types of objects. These proposals will be evaluated rapidly, with scheduling done as quickly as possible and as warranted by the nature of the transient phenomenon. Notification of the dispensation of Target of Opportunity proposals will always be within two weeks, and may be much faster, depending on the requirements of the proposed observation. The proprietary period for Targets of Opportunity will be decided on a case-by-case basis, and will in no instances be longer than six months.

5.3 Data Analysts and General Assistance

General assistance of all kinds is available through the data analysts, and they should be consulted first when you encounter any problem. Note that they are not available to perform remote data calibration. There are plans to provide pipeline-calibrated visibility data for the EVLA, but this will not be available initially. The e-mail address for all the data analysts is analysts@nrao.edu. An online helpdesk is in the process of being set up for assisting with EVLA observation preparation and data reduction. Specific questions about observation preparation and data reduction may also be directed to NRAO scientific staff via vlahelp@nrao.edu.

5.4 Observation Preparation

To use the EVLA, scheduling blocks must be prepared using the "Observation Preparation Tool," or `OPT`. The `OPT` is available at `http://e2e.nrao.edu/opt/`.

5.5 Fixed Date and Dynamic Scheduling

Most of the projects on the EVLA will be observed dynamically, based on a combination of scientific priority and the expected properties of the array and the weather. Some time may continue to be scheduled as "fixed-date" observing, with the observer being given a particular sidereal date and time allocation on the EVLA, depending on the needs of the project.

Please see the scheduling officers' home page for further information, at `http://www.aoc.nrao.edu/~schedsoc/`.

5.6 The Observations and Remote Observing

Since most EVLA observations will be carried out dynamically it is in general neither necessary, nor practical, for observers to be present during their observations. However, there can be considerable benefits to observers who come to Socorro to reduce and analyze their data in terms of interactions and discussions with NRAO staff. See Section 5.12 for information on coming to and staying in Socorro.

For those who choose to process their data at home, the data can be retrieved from the EVLA online archive after obtaining the project key from the data analysts, or by using the NRAO Interactive Services login from the archive web page. Alternatively, the data analysts will, upon request, mail you a tape (Exabyte or DAT) containing your uncalibrated data in its original format.

5.7 Data Access

The online archive contains all VLA data since observing started in 1976, and will also serve the user community with EVLA data. The entire archive is now on disk, and is available via the Archive Access Tool at `http://archive.nrao.edu/archive/`. This interface provides a basic data retrieval tool if you know the program code of your observations. It also provides an advanced query tool which enables searches based on a large number of user-specified criteria. Data can be downloaded via standard `ftp` protocols. With the exception of some rapid response and large proposals, (E)VLA data associated with a given proposal normally are restricted to proprietary use by the proposing team for a period of 12 months from the date of the last observation in a proposal.[1] Proprietary data may be downloaded by the observing team by making use of the project key (see Section 5.6).

Data are stored in the archive in the Science Data Model (SDM) format that will be used by both the EVLA and ALMA. They are available through the Archive Access Tool in one of several formats:

– SDM format, which must be read into CASA using the task `importasdm` for further processing.

– As a CASA Measurement Set (ms), which has already been converted from the SDM using default parameters in the CASA task `importasdm`.

– UVFITS format, which as been converted from the SDM using CASA and then written to a multi-source UVFITS file using the CASA task `exportuvfits`, using default parameters. These UVFITS files can subsequently be read by AIPS.

5.8 Data Processing

The primary data reduction package for the EVLA will be the CASA (Common Astronomy Software Applications) package, which will also be used for ALMA. CASA is still under development, although the first public release of the package is expected in early 2010, coinciding with EVLA early science. See `http://casa.nrao.edu` for more information.

NRAO will continue to support AIPS (Astronomical Image Processing System) for the foreseeable future, at least until VLBI functionality has been incorporated into CASA. See `http://www.aoc.nrao.edu/aips/` for more details.

[1]Data taken more than 12 months previously may still be proprietary, if additional data for the same proposal have been taken within the last 12 months.

It will be possible to reduce data obtained through the Open Shared Risk Observing program using either CASA or AIPS.

5.9 Travel Support for Visiting the DSOC and VLA

For each observing program scheduled on an NRAO telescope, reimbursement may be requested for one of the investigators from a U.S. institution to travel to the NRAO to observe, and for one U.S.-based investigator to travel to the NRAO to reduce data. Reimbursement may be requested for a second U.S.-based investigator to either observe or reduce data provided the second investigator is a student, graduate or undergraduate. In addition, the NRAO will, in some cases, provide travel support to the Observatory for research on archival data. The reimbursement will be for the actual cost of economy airfare, up to a limit of $1000, originating from within the U.S. including its territories and Puerto Rico. Costs of lodging in NRAO facilities can be waived on request in advance and with the approval of the relevant site director. No reimbursement will be made for ground transportation or meals.

To qualify, the U.S. investigator must not be employed at a Federally Funded Research and Development Center (FFRDC) or its sponsoring agency. The NSF maintains a master government list of some FFRDCs at `http://www.nsf.gov/statistics/nsf06316/`.

To claim this reimbursement, obtain an expense voucher from Lori Appel in the Assistant Director's office in the DSOC.

5.10 Student Assistance for Data Reduction Visits to the DSOC

Students visiting the DSOC for the purposes of working on an EVLA or VLBA observing program may be eligible to have their lodging expenses in the NRAO guest house covered by NRAO. To qualify, the student must be a graduate or undergraduate enrolled at a University in the U.S., working on an approved observing program. These are the same qualifications as required for NRAO support of air travel costs described above. In addition, the duration of the visit should be between 5 and 30 days. Requests for support should be made to Claire Chandler at least 4 weeks in advance of the proposed visit. If this is a first time visit then the student should be accompanied by a collaborator on the project, or alternatively an NRAO collaborator may be requested.

5.11 Computing at the DSOC

A primary goal of the computing environment at the DSOC is to allow every user full access to a workstation during his/her visit. There are 10 public workstations available at the DSOC for full-time data reduction by visitors. They are mostly four-processor, 2.0-GHz PCs running Linux.

For hardcopy, we have a number of high volume B&W laser printers, two color Postscript laser printers which can reproduce on both paper and transparencies, and one wide-bed color printer.

Visitors should reserve time on these workstations when they make their travel arrangements at `http://www.aoc.nrao.edu/epo/visitor/register.shtml` (see also Section 5.12). Note that users may request remote access to the visitor machines as well, without actually visiting the DSOC. Please contact the computing helpdesk (e-mail to helpdesk@aoc.nrao.edu, extension 7213, office 262) for further information about this and any other computing assistance while at the DSOC.

For a more complete description of computing facilities at the DSOC, see http://www.aoc.nrao.edu/computing/.

5.12 Reservations for the EVLA site and/or DSOC

Reservations must be made at least 1 week prior to your visit to the NRAO/NM, and 2 weeks' notice is preferred, through the online form at http://www.aoc.nrao.edu/epo/visitor/register.shtml. Computing requirements and the level of staff assistance needed must be specified through the online form.

First-time visiting students will be allowed to come to the NRAO/NM for observations or data reduction only if they are accompanied by their faculty advisor, an experienced collaborator, or if they have an NRAO staff collaborator.

5.13 Staying in Socorro

Visitors to Socorro can take advantage of the NRAO Guest House. This facility contains eight single, four double, and two two-bedroom apartments, plus a lounge/kitchen, and full laundry facilities. The Guest House is located on the New Mexico Tech (NMIMT) campus, a short walk from the DSOC. Reservations are made through the online registration form at http://www.aoc.nrao.edu/epo/visitor/register.shtml.

5.14 Help for Visitors to the EVLA and DSOC

We encourage observers to come to Socorro to calibrate and image their data. This is the best way to ensure the quickest turnaround and the best results from their observing. While in Socorro, each observer will interact with members of the DSOC staff in accordance with his/her level of experience and the complexity of the observing program. If requested through the reservation form, the visiting observer will be guided through the steps of data calibration and imaging by a pre-arranged staff friend or scientific collaborator. A list of staff scientists and their interests can be found at http://www.aoc.nrao.edu/epo/ad/aoc-research.shtml. The data analysts, computing helpdesk, and other staff are also available for consultation on AIPS and CASA procedures, and systems questions.

5.15 On-Line Information about the NRAO and the EVLA

NRAO-wide information is available on the World Wide Web through your favorite Web browser at URL http://www.nrao.edu, and information specific to astronomers using the EVLA may be found at http://www.vla.nrao.edu/astro/ and http://www.aoc.nrao.edu/evla/astro/. We strongly recommend usage of this on-line service, which is regularly updated by the NRAO staff.

6 MISCELLANEOUS

6.1 Publication Guidelines

6.1.1 Acknowledgement to NRAO

Any papers using observational material taken with NRAO instruments (EVLA 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 a facility of the National Science Foundation operated under cooperative agreement by Associated Universities, Inc.*

6.1.2 Dissertations

Students whose dissertations include observations made with NRAO instruments are expected to provide copies of, or links to, their theses for inclusion and maintenance at the NRAO library. These will be catalogued and made available via the NRAO library catalogue.

6.1.3 Preprints

NRAO requests that you submit the `astro-ph` link or an electronic copy of any accepted papers that include observations taken with any NRAO instrument or have NRAO author(s) to the Observatory Librarian. For further information, contact the Librarian in Charlottesville (library@nrao.edu).

6.1.4 Reprints

Given the prevalence of electronic access to the literature, NRAO will no longer pay for the purchase of reprints of published papers.

6.1.5 Page Charge Support

The following URL contains complete information on the observatory's policy regarding page charge support: `http://www.nrao.edu/library/pagecharges.shtml`. The following is a summary:

- When requested, NRAO will pay the larger of the following:
  - 100% of the page charge share for authors at a U.S. scientific or educational institute reporting original results made with NRAO instrument(s).
  - 100% of the page charge share for NRAO staff members.
- Page charge support is provided for publication of color figures.
- To receive page charge support, authors must comply with all of the following requirements:
  - Include the NRAO footnote in the text (see Section 6.1.1).
  - Send the `astro-ph` link or an electronic copy of the paper upon acceptance or posting on `astro-ph` to the Observatory Librarian (library@nrao.edu), with the request for page charge support. The Librarian will respond with the amount covered (based on the NRAO page charge policy) and will request the page charge form, with manuscript information completed, via fax (434-296-0278) or e-mail (library@nrao.edu). For questions, contact the Observatory Librarian at 434-296-0254.

7 DOCUMENTATION

Documentation for EVLA data reduction, image making, observing preparation, etc., can be found in various manuals. Most current manuals are available on-line (see Section 5.15). Those manuals marked by an asterisk (*) can be mailed out upon request, or are available for downloading from the NRAO website. Direct your requests for mailed hardcopy to Lori Appel. Many other documents of interest to the EVLA user, not listed here, are available from our website.

1. PROCEEDINGS FROM THE 1988 SYNTHESIS IMAGING WORKSHOP: Synthesis theory, technical information and observing strategies can be found in: "Synthesis Imaging in Radio Astronomy." This collection of lectures given in Socorro in June 1988 has been published by the Astronomical Society of the Pacific as Volume 6 of their Conference Series.

2. PROCEEDINGS FROM THE 1998 SYNTHESIS IMAGING WORKSHOP: This is an updated and expanded version of Reference 1, taken from the 1998 Synthesis Imaging Summer School, held in Socorro in June, 1998. These proceedings are published as Volume 180 of the ASP Conference Series.

3. 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, image making and display. Major sections of this 1983 manual are now out of date, but it nevertheless remains the best source of information on much of the VLA. Copies of this are found at the VLA and in the DSOC, but no new copies are available. Much of this document is available for downloading through the NRAO's website. It does not include any information about EVLA-specific hardware and software.

4. *A SHORT GUIDE FOR VLA SPECTRAL LINE OBSERVERS: This describes spectral line observations with the VLA. It may be useful for users of the VLA archive for understanding how archival observations may have been set up (local oscillator settings, etc.). It is VLA-specific, however, and much of it does not apply to the EVLA.

5. *AIPS COOKBOOK: The "Cookbook" description for calibration and imaging under the AIPS system can be found near all public workstations in the DSOC. The latest version has expanded descriptions of data calibration imaging, cleaning, self- calibration, spectral line reduction, and VLBI reductions. See `http://www.aoc.nrao.edu/aips/cook.html`.

6. *GOING AIPS: This is a two-volume programmers manual for those wishing to write programs under AIPS. It is now somewhat out of date. See `http://www.aoc.nrao.edu/aips/aipsdoc.html#GOAIPS`.

7. *VLA CALIBRATOR MANUAL: This manual contains the list of VLA Calibrators in both 1950 and J2000 epoch and a discussion of gain and phase calibration, and polarization calibration. It will remain useful for the EVLA. See `http://www.vla.nrao.edu/astro/calib/manual/`.

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

9. *HIGH FREQUENCY OBSERVING GUIDE. A web-based manual with a great deal of information for users about observing with the VLA 0.7 cm and 1.3 cm observing systems. See http://www.vla.nrao.edu/astro/guides/highfreq/.

10. *VLA MEMO SERIES. See http://www.vla.nrao.edu/memos/.

11. *EVLA MEMO SERIES. See http://www.aoc.nrao.edu/evla/memolist.shtml.

12. *The VLA Expansion Project: Construction Project Book. The EVLA Project Books contains the technical details of the EVLA construction project. It is available online at http://www.aoc.nrao.edu/evla/pbook.shtml.

13. *CASA COOKBOOK: The CASA "Cookbook" for use of the package for data reduction is available, along with other documentation, from the CASA home page (http://casa.nrao.edu). See http://casa.nrao.edu/Doc/Cookbook/casa_cookbook.pdf.

8 KEY PERSONNEL

Table 14 gives the telephone extensions and DSOC room numbers of personnel who are available to assist EVLA users. In most cases the individuals have responsibilities or special knowledge in certain areas as noted in the right hand column. You also may contact any of these people through E-mail, as noted at the end of the table.

9 Acknowledgments

This EVLA Observational Status Summary is based substantially on its predecessor, the VLA Observational Status Summary. Over the VLA history of almost 30 years, many individuals contributed to that document by writing sections, editing previous versions, commenting on draft material, and implementing the capabilities described herein. We thank all these contributors for their efforts. Please contact the listed editor of the present document with questions on the material, or suggestions that would enhance the clarify of this guide.

Table 14: **Key VLA Personnel**

Name	Phone	Room	Notes
Lori Appel	7310	340	Scheduling administrator, AD office
John Benson	7399	366	Data archive
Sanjay Bhatnagar	7376	309	CASA; Imaging algorithms
Walter Brisken	7133	373	Pulsars; EVLA calibration
Bryan Butler	7261	344	EVLA Computing Division Head; EVLA high frequencies
Claire Chandler	7365	328	Deputy AD for Science; EVLA high frequencies
Barry Clark	7268	308	EVLA/VLBA scheduling
Mark Claussen	7284	268	EVLA user support; EVLA scheduling
Vivek Dhawan	7378	310	EVLA commissioning
Bob Dickman	7300	336	EVLA/VLBA Assistant Director
Dale Frail	7338	332	Pulsars, transient sources
Miller Goss	7267	332	Spectral line
Eric Greisen	7236	318	AIPS
Helpdesk	7213	262	Computer Helpdesk
Leonid Kogan	7383	312	AIPS
Mark McKinnon	7273	326	EVLA Project Manager
Dan Mertely	7128	VLA-128	RFI monitoring and mitigation
Amy Mioduszewski	7263	208	AIPS; EVLA calibrator models; VLBI at the EVLA
George Moellenbrock	7406	368	CASA; polarimetry
Emmanuel Momjian	7452	301	EVLA commissioning
Steve Myers	7294	376	EVLA calibration; polarimetry; CASA Project Scientist
Frazer Owen	7304	320	High dynamic range; wide-field imaging
Peggy Perley	7214	282	Deputy Assistant Director for Operations
Rick Perley	7312	362	EVLA Project Scientist; flux calibration
Receptionist	7300	Front	DSOC receptionist; aocrecep@nrao.edu
Reservationist	7357	218	DSOC reservations; nmreserv@nrao.edu
James Robnett	7226	258	Computing Infrastructure Division Head
Michael Rupen	7248	206	EVLA scientific software; spectral line
Debra Shepherd	7398	266	Mosaicing
Lorant Sjouwerman	7332	367	EVLA Pipeline
Ken Sowinski	7299	375	On-line systems
Meri Stanley	7238	204	Lead data analyst
Gustaaf van Moorsel	7396	348	User support
VLA Operator	7180	VLA	On-duty EVLA Operator
VLBA Operator	7251	269	On-duty VLBA Operator
Joan Wrobel	7392	302	EVLA/VLBA scheduling
Wes Young	7337	378	CASA system administration

Note: You may e-mail any of the above individuals by addressing your message to "first initial last name"@nrao.edu. Thus, you may contact Joanne Astronomer at: "jastrono@nrao.edu". The name is truncated to eight characters. For contact with the AIPS software group, please e-mail "daip@nrao.edu". For questions about telescope time allocation, please e-mail "schedsoc@nrao.edu". The listed four-digit numbers are sufficient for calls made from within the DSOC. If you are calling from the U.S. or Canada, the 4-digit numbers must be preceded with: 1-575-835 from landlines, or 575-835 with mobile phones. If you are calling from outside the U.S. or Canada, the 4-digit numbers must be preceded with 1-575-835.