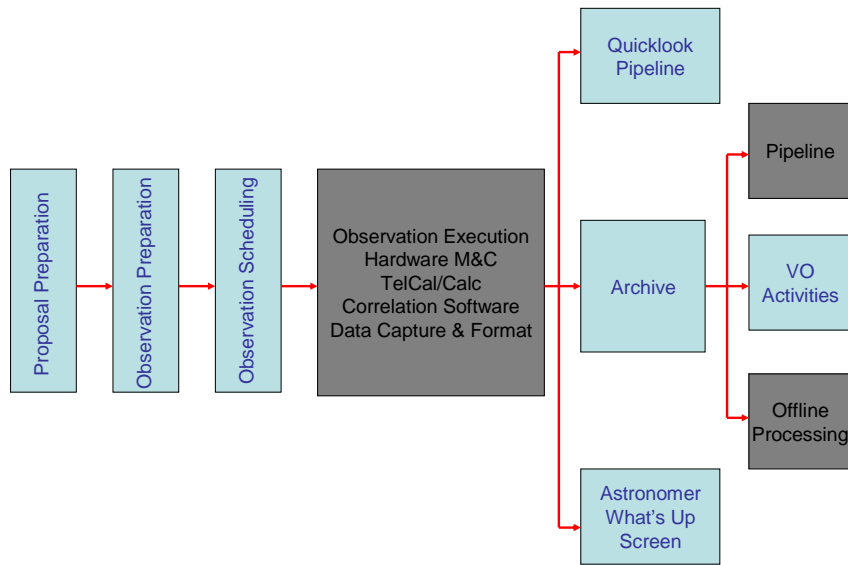


# Timescales and Deliverables for the EVLA e2e Project

## *Introduction:*

This document is intended as a companion for the "EVLA e2e Science Software Requirements" document in which the requirements, timescales and priorities are given for each of the e2e subsystem. For the purposes of designing and costing the EVLA e2e software, it is necessary to re-order this information so that the major milestones for the software deliverables are more transparent. In astronomy vernacular, we are transposing the SSR "cube" of sub-systems:timescales:priorities to one of timescales:priorities:sub-systems.

The timescales, requirements and priorities are fully defined in the "EVLA e2e Science Software Requirements" document. In brief, timescales are defined by five distinct phases ordered chronologically A through E, while priorities are listed as 1 (essential), 2 (important) and 3 (desirable). Each requirement within a subsystem described and is designated by a numerical code which has a timescale and priority attached to it. Figure 1 is a basic diagram showing the different e2e sub-systems (light blue boxes) and their interaction with the on-line Monitor and Control system, and the off-line processing. Requirements and design documents for these other components of the EVLA software system are also available.



**Figure 1.** A simple block diagram of the e2e subsystems (light blue boxes). For historical reasons, TelCal (also called Real-time Calibrator Analysis) is included in the "EVLA e2e Science Software Requirements" document but is shown here (correctly) as part of the Monitor and Control system. VO activities are defined in this document only in relation to their interaction with the Archive and Quicklook pipeline.

The timescales that have been assigned to each requirement are the **final** dates when the software will be released to Operations. It is expected, therefore, that alpha and beta releases

will precede these dates, along with full testing by staff and outside astronomers. For this reason, the timescales are tied to specific project milestones. In an effort of this size it is expected that these timescales are subject to change. However, the relative ordering of the phases (A-E) and the deliverables within those phases should not change.

In the next several sections we will describe what the e2e system will look like as a function of time. Two assumptions govern these deliverables. The first is that software development shall take place from the inside out. In other words, e2e should support the core capabilities of the EVLA on-line system before adding enhancements. Early (Phase A and B) priorities include archive support for both Monitor and Control data, and raw data from the correlator controller, and basic observing scheduling of the telescope. A second, and related assumption is that the capabilities of individual sub-systems will undergo a staged development. Under this model, the highest priority and earliest timescales are assigned to those capabilities that are needed for expert astronomers to bring the system into operation. System enhancements, such as those that make the telescope more accessible to novice users, will be added at later times.

## **Release A**

The prototype correlator has arrived and there are enough EVLA antennas to carry out simple interferometry experiments. After the on-the-sky tests are finished, it is expected that staff scientists will use the correlator to gain familiarity with the hardware capabilities and to test out different components of the software system.

The detailed deliverable for each subsystem on this timescale are listed below. They are taken from Excel files and linked (via OLE) to this document. Changes made to the Excel files will propagate to this document. The first column is the requirement number. The second and third columns are the Priority and Timescale, respectively. The final column is a short description of the requirement.

**Archive (SSR Chapter 4):** The archive begins as basic storage for monitor and control data and for storing raw visibilities. Some simple data retrieval mechanism is also required at this stage.

4.1-R1.1	1	A	There shall be an EVLA archive which stores all data obtained with the EVLA. This archive shall include interferometer data taken for any reason (science, testing, calibration);
4.1-R1.3	1	A	There shall be an EVLA archive which stores all data obtained with the EVLA. This archive shall include: monitor and control data;
4.2-R1.1	1	A	The raw data in the archive shall include: raw interferometer data;
4.2-R1.2	1	A	The raw data in the archive shall include: header information;
4.2-R2	1	A	All information describing the observation shall be accessible through the header (or an equivalent object).
4.8-R1	1	A	There shall be an Archive Retrieval Tool to access the archive.

4.8-R2.5	1	A	The Archive Retrieval Tool shall return the requested information such as: monitor and control data;
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**TelCal (SSR Chapter 5):** A large part of the TelCal system is expected to be in place at this time. Using the EVLA antennas it should be possible to derive complex gains from the observed visibilities. As noted earlier, TelCal is not actually part of e2e but belongs to the monitor and control system.

5.1-R1	1	A	The Real-time Calibrator Analysis Tool shall be activated after each calibration scan, except during autophasing, where it must be able to run during scans.
5.1-R2	1	A	The Real-time Calibrator Analysis Tool shall determine the autophasing phase for each antenna, IF, and sub-band, and make it available to the real-time observing system.
5.1-R2.1	1	A	When autophasing, some measure of quality should be recorded and made available to operators and observers (an example might be the rms phase across the array).
5.1-R2.2	1	A	It shall be possible to select either on-the-fly autophasing (with appropriate simple source model input), which is done on each integration, or to specify that phases determined during calibrator scans are to be used to phase the array during scans on the astronomical source.
5.1-R3	1	A	The Real-time Calibrator Analysis Tool shall have the capability of taking visibility data along with a source model for a calibrator and deriving antenna-based complex gains therefrom.
5.1-R3.1	1	A	There should be a capability of specifying simple u-v restrictions on the input visibilities (e.g., boxes or circles in the u-v plane).
5.1-R3.2.1	1	A	There should be a capability of specifying the following simple parametric source models: point source (flux density, position, polarization, and the variation of these with frequency).
5.1-R7.1	1	A	The Real-time Calibrator Analysis Tool should support the following higher level functions: antenna location determination.
5.1-R7.2	1	A	The Real-time Calibrator Analysis Tool should support the following higher level functions: global pointing model determination, per antenna;
5.1-R7.3	1	A	The Real-time Calibrator Analysis Tool should support the following higher level functions: pointing offset determination, per antenna and frequency band
5.1-R7.4	1	A	The Real-time Calibrator Analysis Tool should support the following higher level functions: complex bandpass, per antenna, given frequency band, correlator and backend setup;
5.1-R7.5	1	A	The Real-time Calibrator Analysis Tool should support the following higher level functions: focus, per antenna and frequency band;
5.1-R7.6	1	A	The Real-time Calibrator Analysis Tool should support: delays (including the crossed-hands), per antenna, frequency band, IF, and sub-band;
5.1-R7.7	1	A	The Real-time Calibrator Analysis Tool should support: polarization calibration terms, per antenna and frequency band;
5.1-	1	A	The Real-time Calibrator Analysis Tool should support: flux density scale

R7.8		determination (i.e., the conversion factor from correlation coefficient to Janskys).
5.1-R8	1 A	The outputs from the Real-time Calibrator Analysis Tool should be archived (probably by passing them to the Archive Tool).
5.1-R1.1	2 A	It should be possible to also specify shorter or longer intervals between activations, e.g., execute at the end of every integration, rather than just at the scan end, or, do not execute at the end of every scan, but rather only at the end of some number or grouping of scans.
5.1-R7.1.1	2 A	The Real-time Calibrator Analysis Tool should support the following higher level functions: residuals from the solutions shall be examined, and poor solutions reported to operations staff.
5.1-R7.2.1	2 A	The Real-time Calibrator Analysis Tool should support the following higher level functions: residuals from the solutions shall be examined, and poor solutions reported to operations staff.
5.1-R7.3.1	2 A	The Real-time Calibrator Analysis Tool should support the following higher level functions: arbitrary 'pointing patterns' (e.g., 5-point, triangles, the 'Craig cross', etc...) shall be allowable;
5.1-R7.3.2	2 A	The Real-time Calibrator Analysis Tool should support the following higher level functions: residuals from the solutions shall be examined, and poor solutions reported to operations staff.
5.1-R7.9	2 A	The Real-time Calibrator Analysis Tool should support: TIP analysis to derive antenna parameters (Tcal) and atmospheric opacity at the observed frequency;

## **Release B**

The limited production correlator arrives for use by staff scientists.

**Scheduling Tool (SSR Chapter 3):** A very basic scheduling tool is introduced to support the scheduling/program block concept.

3.1-R1	1	B	There shall be a Scheduling Tool whose function is to pass a Control Script to the EVLA real-time system to control the telescope.
3.1-R2.1	1	B	The execution of an SB shall not be interrupted by the scheduling process (except possibly through an error condition or manual intervention).
3.1-R2.2	1	B	An SB can be executed again (in order to reach the required sensitivity level, or if it had failed for hardware reasons), but cannot be restarted in the middle of its execution.
3.1-R3.1	1	B	The Scheduling Tool shall handle the observing for the EVLA in the main modes: Manual mode: a facility shall be provided for direct submission of Control Scripts to the real-time system, either from a file, or directly from keyboard input.
3.1-R6	1	B	The Scheduling Tool shall have a facility enabling the operator or NRAO staff to abort the current SB and interrupt the normal operation of the queue. Any aborted SB is automatically reinserted into the queue.
3.1-R7	1	B	The Scheduling Tool shall have a facility enabling the operator or NRAO staff to modify the priorities of SBs in the queue. Such priority modifications shall always have an associated length of time, which shall be specified at the time of the change (e.g., for the next hour, for the next day, forever).
3.1-R8	1	B	The Scheduling Tool shall be able to run off-line using recorded historical inputs or simulated inputs, to facilitate debugging and tuning of parameters.
3.1-R10	1	B	The Scheduling Tool shall check submitted Scheduling Blocks for correctness, to prevent malformed SBs from being executed.
3.2-R2.1	1	B	The dynamic priority of a given SBs shall be calculated at the decision time based upon the criteria: Availability of the SB for scheduling. An SB will not be scheduled (dynamic priority set to zero) if its principal direction is below the horizon (or if some other staff-entered LST constraint is not met), if the required observing conditions (e.g., number of functioning antennas, phase rms, wind speed, opacity, RFI, solar interference, etc...) are not met or would compromise the observations with the specified observing parameters (including a consideration of whether self-cal will help or not).

**Archive (SSR Chapter 4):** Basic program data (control scripts, program blocks, etc) start to show up in the archive at this stage and some environmental data are stored as well.

4.4-R1.1	1	B	Monitor and control data stored in the archive shall include: instrumental parameters (pointing model parameters, referenced pointing offsets, antenna locations, transmission delays, subreflector rotation, focus curve parameters, etc...).
4.4-R2	1	B	The archive shall include all technical/environmental data measured by the EVLA system including times when the array was not observing.
4.4-R3	1	B	Each item shall contain a time-stamp that is referenced to the data time stamps (i.e., not off by some large arbitrary offset due to internal clock slews within modules).
4.6-R1.3	1	B	Project data stored in the archive shall include: the Program Block as submitted to the Scheduling Tool;
4.6-R1.4	1	B	Project data stored in the archive shall include: all Control Scripts actually executed by the real-time system;
4.8-R2.1	1	B	The Archive Retrieval Tool shall return the requested information such as: a raw uv data file;
4.8-R2.2	1	B	The Archive Retrieval Tool shall return the requested information such as: header information;
4.10-R1.1	1	B	Technical data and header information shall be freely available;
4.10-R1.2	1	B	Calibration observations and staff test observations shall be public;
4.4-R1.2	2	B	Monitor and control data stored in the archive shall include: status of instrumentation (e.g., error flags);
4.6-R1.5	2	B	Project data stored in the archive shall include: all Program Blocks, Scheduling Blocks, Control Scripts, or any other command submitted to the system (via GUI or directly typed in) during interactive or manual observing mode.
4.4-R1.3	3	B	Monitor and control data stored in the archive shall include: monitor point information (e.g., module temperatures, voltages).

**TelCal (SSR Chapter 5):** The remaining higher order functions are added at this stage, including more complex source models and auto-flagging.

5.1-R3.3	2 B	There should be a capability of specifying more complex source models, via input as a FITS image cube or set of CLEAN components as a function of polarization and frequency (or any other, relatively simple and easily manipulated, image-plane description).
5.1-R4	2 B	The Real-time Calibrator Analysis Tool should have the capability of determining the current phase stability of the instrument + atmosphere, given the visibilities and complex gain solutions. This quantity should be accessible by the Scheduling Tool.
5.1-R5	2 B	The Real-time Calibrator Analysis Tool should have the ability to recognize bad data (via some auto-flagging procedure, or by analyzing residuals from its own gain solutions) and reject them. This includes RFI recognition. Such data and flagging must be reported to operations.
5.1-R6	2 B	The Real-time Calibrator Analysis Tool should have the capability to recognize misbehaving antennas based on its results, and should be able to report this information to the real-time system and to operations.
5.1-R7.5.1	2 B	The Real-time Calibrator Analysis Tool should support arbitrary 'focus patterns' shall be allowable;
5.1-R7.5.2	2 B	The Real-time Calibrator Analysis Tool should support: residuals from the solutions shall be examined, and poor solutions reported to operations staff.
5.1-R2.2.1	3 B	For phases determined on the calibrator and applied to the astronomical source, simple extrapolation schemes should be available, including but not limited to: last sampled value, or mean of last N sampled values.
5.1-R3.2.2	3 B	There should be a capability of specifying the following simple parametric source models: elliptical gaussian (flux density, position, major and minor axis width and position angle, polarization, and the variation of these with frequency).
5.1-R3.2.3	3 B	There should be a capability of specifying the following simple parametric source models: elliptical limb-darkened disk (flux density, position, major and minor axis width and position angle, limb-darkening parameter, polarization, and the variation of these with frequency).
5.1-R3.2.4	3 B	There should be a capability of specifying the following simple parametric source models: combinations of the above simple single sources.
5.1-R7.3.3	3 B	The Real-time Calibrator Analysis Tool should support the following higher level functions: single-dish pointing determination should also be supported;
5.1-R7.5.3	3 B	The Real-time Calibrator Analysis Tool should support: single-dish focus determination should also be supported.



## Release C

This release starts the development of more astronomer-friendly tools such as the Proposal Submission Tool and the Observing Tool. Capabilities developed at this time must primarily serve the commissioning and testing activities of staff scientists.

**Proposal Tool (SSR Chapter 1):** The proposal tool needed at this stage is very basic - even the current Latex cover pages would suffice

1-R1	1	C	There shall be a Proposal Tool for the preparation and submission of proposals for the EVLA.
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**Observing tool (SSR Chapter 2):** There needs to be a capability to generate schedule and program blocks from scratch. During this time an expert should be able to provide the necessary hardware and correlator set-up along with an ASCII source list.

2.1-R1	1	C	There shall be an Observing Tool for the generation of Program Blocks as input to the Scheduling Tool.
2.1-R3	1	C	The output of the Observing Tool shall be a Program Block, which is a set of Scheduling Blocks that are to be considered as an ensemble by the Scheduling Tool.
2.1-R5	1	C	Program Blocks output from the tool shall be readable by the tool.
2.1-R7.1	1	C	The Observing Tool shall include as components tools for: Observation setup.
2.1-R7.2	1	C	The Observing Tool shall include as components tools for: Hardware setup (including a Correlator setup subcomponent).
2.1-R8.1	1	C	The Observation setup component shall: Allow the user to specify which configuration is desired (in the case where a Project is observing in multiple configurations).
2.1-R8.2.1	1	C	The Observation setup component shall: Allow the user to create and manipulate (add to and delete from) a source catalog derived from: direct entry into the tool.
2.1-R8.2.3	1	C	The Observation setup component shall: Allow the user to create and manipulate (add to and delete from) a source catalog derived from: user-supplied source lists in ASCII format.
2.1-R8.3.1	1	C	Allow the user to easily construct a Source List from the source catalog which contains all of the sources to be observed. Sources in the Source List should be selectable via: interactive selection from the source catalog.
2.1-R8.4.1	1	C	Allow the user to specify, for each source in the Source List: valid time ranges or extents, which can include: valid specific date ranges. valid specific time ranges. valid relative time ranges (relative to the rest of the



		sources in the Source List).
2.1-R8.4.2	1 C	Allow the user to specify, for each source in the Source List: other constraints on when the source may be observed, including: valid hour-angle ranges. valid elevation angle ranges. valid current observing conditions, including opacity, phase rms, RFI, wind speed, etc....
2.1-R8.4.3	1 C	Allow the user to specify, for each source in the Source List: a hardware setup (via the Hardware setup component)
2.1-R8.4.6	1 C	Allow the user to specify, a list of antennas which are to be used, to facilitate subarrays:
2.1-R8.4.6.1	1 C	Allow the user to specify, as a list of antenna numbers or pad locations.
2.1-R9.1	1 C	The Hardware setup component shall provide: The ability to specify the integration time for written data.
2.1-R9.3	1 C	The Hardware setup component shall provide: The ability to specify whether autophasing is desired.
2.1-R9.4	1 C	The Hardware setup component shall provide: The ability to specify the receiver band(s).
2.1-R9.5	1 C	The Hardware setup component shall provide: The ability to specify the central observing frequencies or velocities (in any of geocentric, LSR, or heliocentric velocity frames), or choose from a number of defaults based on band (for continuum) or known line transition, for each correlator baseband (or subband).
2.1-R9.6	1 C	The Hardware setup component shall provide: The ability to specify how the velocity (doppler) tracking is to be done (e.g., continuous, per scan, per session, etc...).
2.1-R9.9	1 C	The Hardware setup component shall provide: Output which can be fed automatically into the Observation setup component (to be attached to sources in the Source List).
2.1-R9.10.2	1 C	A Correlator setup subcomponent, which shall provide: The ability to specify desired total bandwidth or velocity width and channel width in frequency or velocity units (the tool should then display close available matches in correlator setup parameter space, and make them available for selection), for all of the central velocities specified (for each baseband/subband so that, e.g., simultaneous wide- and narrow-band observations can be done, or multiple transitions may be observed at once).
2.1-R9.10.3	1 C	A Correlator setup subcomponent, which shall provide: The ability to specify the required polarization products, for each baseband (and subband).
2.1-R10.6	1 C	Output which can be fed automatically into the Observation setup component source catalog.
2.2-R1.1	1 C	The Observing Tool shall divide a Program Block into Scheduling Blocks based upon parameters chosen: by observer input, e.g., by specification of cycle times and counts.
2.2-R2	1 C	The Program Block shall have a timestamp and revision number assigned to it upon submission.

2.2-R3	1	C	The observer shall be able to assign the Scheduling Blocks within a particular Program Block a mandatory relative priority amongst themselves, to ensure the proper order of execution.
2.1-R3.1	2	C	The Program Blocks produced by the Observing Tool shall be human-readable (i.e., not binary).

**Archive (SSR Chapter 4):** More environmental data and project data are added at this stage. The search and retrieve facilities need to be improved. There should be a mechanism for designating data as either proprietary or public.

4.1-R1.2	1	C	There shall be an EVLA archive which stores all data obtained with the EVLA. This archive shall include: environmental data (e.g., weather data, WVR, APM, GPS);
4.1-R2	1	C	There shall be an Archive Tool capable of accessing (including searching and retrieving) the information in the archive.
4.1-R3	1	C	There shall be a backup for the archive to protect the data from catastrophic failure and loss.
4.2-R1.3	1	C	The raw data in the archive shall include: calibration data, including WVR data (at ~1s intervals).
4.3-R1.1	1	C	The environmental data in the archive shall include: all measured weather data (e.g., temperature, relative humidity, wind speed and direction, barometric pressure);
4.3-R2	1	C	Each item shall contain a time-stamp that is referenced to the data time stamps (i.e., not off by some large arbitrary offset due to internal clock slews within modules).
4.6-R1.2	1	C	Project data stored in the archive shall include: operators log (electronic version);
4.8-R2.3	1	C	The Archive Retrieval Tool shall return the requested information such as: environmental data;
4.10-R1.3	1	C	Access to proprietary data shall be restricted to authorized users;
4.10-R2	1	C	The enforcement of access control to proprietary data will be consistent with EVLA policy.
4.10-R2.1	1	C	Proprietary data will considered to be owned by the associated proposal. A mechanism shall be provided to designate the authors of that proposal as authorized users of that data.
4.10-R2.2	1	C	The EVLA staff shall have the capability of marking data associated with any given proposal or project as public.
4.3-R1.2	2	C	The environmental data in the archive shall include: any available atmospheric electron content data (from GPS, e.g.);
4.3-R1.3	2	C	The environmental data in the archive shall include: any available RFI monitoring data;
4.4-R4	2	C	All archived technical data shall be indexed by time, to facilitate the linking of this data with appropriate observation periods.
4.7-R4.1	2	C	The Archive Search Tool interfaces shall present a look-and-feel suitable for the differing needs of types of archive users. These should include: a

		technical interface aimed at EVLA staff users of the archive, and for Archive Tool development and debugging;
4.10-R2.3	2 C	The EVLA staff shall have the capability of making proprietary data accessible to a designated user other than the owner.

**Whats Up Screen (SSR Chapter 5):** The emphasis at this stage is to return information that will be useful for the early commissioning of the EVLA.

5.5-R1	1 C	There shall be made available over the internet an astronomer's ``what's up" screen, giving current observational and instrumental information for the EVLA.
5.5-R2.1	1 C	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: current date and time.
5.5-R2.10.1	1 C	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: the (uncalibrated) spectrum observed on an astronomical source (amplitude/phase or real/imaginary) with various options such as: time integration;
5.5-R2.10.2	1 C	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: the (uncalibrated) spectrum observed on an astronomical source (amplitude/phase or real/imaginary) with various options such as: choice of a single baseline (antennas selectable) or all baselines;
5.5-R2.10.3	1 C	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: the (uncalibrated) spectrum observed on an astronomical source (amplitude/phase or real/imaginary) with various options such as: vector or scalar averaging.
5.5-R2.2	1 C	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: begin and end time of current scan.
5.5-R2.3	1 C	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: source being observed, with frequency or velocity (selectable), and position (selectable as sky or azimuth/elevation).
5.5-R2.4	1 C	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: correlator setup.
5.5-R2.7	1 C	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: visibility amplitude and phase, on a specified baseline, over a specified frequency or velocity range, for all polarization products (u, v, and w should also be displayed).
5.5-R2.8.1	1 C	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: array properties, such as: array status (e.g., number of functioning antennas, error flags);
5.5-R2.8.2	1 C	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: array properties, such as: current system temperature on each antenna at the observing frequency;

5.5-R3	1 C	The time-lag between when data is collected by the real-time system or produced from the quick-look Pipeline Tool and when it is available to the ``what's up" screen should be less than 10 seconds. This may guide a decision on whether data is all archived first, and then retrieved from the archive into the ``what's up" screen, or fed directly from the real-time system into it (the fear is that the time lag between when data is collected and when it is actually available in the archive could be as long as minutes).
5.1-R7.10	3 C	The Real-time Calibrator Analysis Tool should support: antenna aperture efficiency determination, per frequency, given knowledge of source flux density, atmospheric opacity, and other system quantities.

## ***Release D***

By this time all of the station and baseline correlator boards will be installed, tested and handed over to NRAO. The main modes of the correlator will be available and users may begin to use the correlator on a shared-risk basis.

**Proposal Tool (SSR Chapter 1):** The capabilities at this stage resemble those of the PST written for the VLA and GBT. The major difference is the addition of simple calculators for estimating integration times and sensitivities.

1-R2	1 D	The proposals shall be submitted electronically and all observer input shall be in digital form.
1-R3	1 D	The Proposal Tool shall allow storing of intermediate stages to local disks.
1-R4	1 D	If the Proposal Tool stores input information on NRAO computers for later modification (intermediate stages), then access to that information should be restricted via a password generated uniquely for that proposal, emailed only to the author of that proposal.
1-R5	1 D	Proposals output from the tool shall be readable by the tool.
1-R6.1	1 D	The Proposal Tool should require input of the proposal title
1-R6.2.1	1 D	The Proposal Tool should require: Proposal author information, including name, institution, presence at EVLA for observations, whether the observations are for a Ph.D. thesis, and if so, anticipated graduation year. It should be possible to enter this information: via direct input into the tool;
1-R6.3.1	1 D	An indication of which author is the contact author, and contact information for that author, including address, phone number, and email address. It should be possible to enter this information: via direct input into the tool (in this case, such information may be ``normalized" by NRAO at the proposal handling stage, i.e., made consistent with previous or other entries or observatory standards);

1-R6.4	1 D	References to previous proposals related to this one (these may also be added at the proposal handling sby the observatory);
1-R6.5	1 D	The category of observation, selectable from a list of, e.g., solar system, galactic, extragalactic, other;
1-R6.6	1 D	The type of observation, selectable from a list of, e.g., continuum, spectroscopy, polarimetry, solar, pulsar, mosaicing, other, etc...;
1-R6.7	1 D	Keywords which apply to the proposal (from a list provided by the observatory - example lists are those used by astronomical journals [AJ or ApJ]);
1-R6.8	1 D	An indication of whether observations from other telescopes will also be necessary (e.g., for combining GBT data with mosaiced EVLA data, o for planetary radar), which telescopes are required, whether observing time has already been obtained on them, if so, what are the dates/times, if not, when will it be known;
1-R6.9	1 D	A short summary (abstract) of the proposed observations and scientific justification, length to be set by NRAO management, and enforced by the tool if possible;
1-R6.10	1 D	An indication of the level of staff help required (e.g., none, light consultation, heavy consultation, staff collaborator);
1-R6.11	1 D	An indication of whether the data will be reduced at the observers home institution or at the AOC;
1-R6.12	1 D	An indication of preferred dates, or dates that should not be allowed (i.e., prioritization as a function of date).
1-R7.1	1 D	The Proposal Tool should support source lists. The tool should require entry, for all sources, of all fields useful to decide scientific priority and technical feasibility.
1-R7.2	1 D	The submission tool shall supply a flexible interface for importing the source information from another medium, e.g., as an imported file listing the above information.
1-R8	1 D	The Proposal Tool should require the input of the scientific justification, which should be a single file prepared by the observer in one of a small number of preferred formats (ASCII, PostScript, or PDF). The allowable size of the scientific justification is to be set by NRAO management (preferably in number of pages), and enforced if possible by the Tool.%
1-R9	1 D	The Proposal Tool shall allow for the input of requirements on observing conditions. These can be in the form of crude indicators ("any", "average", "good", "exceptional", etc...), a requirement on the specific rms phase of the atmospheric phase monitor, a requirement on the wind speed, a requirement on the opacity, or a specification of "stringency" (see Appendix A for a definition of stringency), or combinations thereof.
1-R10	1 D	The Proposal Tool should allow for an indication that a proposal is for Target-of-Opportunity Observations (TOO).
1-R10.1	1 D	The Proposal Tool should allow for an indication of whether this is a Type 1 or Type 2 TOO (Type 1 are relatively common but, in detail, unpredictable phenomena, Type 2 are newly discovered bodies or phenomena and truly exotic events).

1-R14	1 D	There shall be the facility to search a database of previous observations of objects for a proposal, with the results returned to the proposer, as well as being made accessible to the scheduling committee. This might be effected by calling the Archive Search Tool (but this is an implementation question).
1-R15	1 D	The basic input parameters shall be translated by the tool into control parameters (e.g., observing mode, configurations, observing time, correlator setup) which the expert shall be able to check. These can be overridden manually (e.g., by EVLA staff).
1-R16	1 D	There shall be a facility to take all of the information contained in the proposal and turn it into a printable electronic document (a PostScript or PDF file), which can be easily accessed by the user (either by being stored on a local disk, or easily downloaded from an NRAO computer). If NRAO operations has a requirement on the particular layout and format of such hard copy, it shall be recognized.
1-R17	1 D	There shall be a facility to formally submit the proposal for consideration by the scheduling committee, i.e., to bundle up all information and make it available to NRAO (e.g., via emailing the information directly, or by placing it in a location where it can be easily accessed by NRAO operations staff on an internal computer, and emailing a pointer to its location). Additional information shall be calculated at the time of submission, and included as part of the Proposal.
1-R3.1	2 D	This stored version shall be easily transferred (across platforms) between co-authors and collaborators.
1-R6.2.2	2 D	It should be possible to enter this information: by selection from a database of such information (at least for name and institution);
1-R6.3.2	2 D	or by selection from a database of such information;
1-R6.3.2.1	2 D	the proposer should be able to indicate that the information in the database is out-of-date and provide new information for the database (this information may be ``normalized" by NRAO after reception before entry into the database).
1-R7.3	2 D	There shall be a mechanism for specification of source selection parameters in lieu of an enumerated source list, in order to facilitate the target definition for large surveys.
1-R7.8	2 D	A connection to commonly available astronomical databases (e.g., the CDS and NED databases) shall be available.
1-R10.2	2 D	For Type 1 TOO proposals, the Proposal Tool should allow for an indication of what should trigger the observation.
1-R-11.1.1	2 D	The Proposal Tool shall perform certain simple calculations, including: the integration time required: for a given bandwidth and channel (e.g., velocity) width;
1-R-11.1.2	2 D	The Proposal Tool shall perform certain simple calculations, including: the integration time required: under poor, average and good observing conditions;
1-	2 D	The calculation of integration time should incorporate simple calibration



R11.2		overhead heuristics (TBD).
1-R11.3	2 D	The Proposal Tool shall perform certain simple calculations, including: the appropriate configurations needed given desired brightness sensitivity, resolution, and source angular size.
1-R11.4	2 D	The Proposal Tool shall perform certain simple calculations, including: the amount of time required to achieve a specified rms level, given the specification of required observing conditions (e.g., required phase stability at the specified frequency).
1-R12	2 D	The tool shall calculate the data rate and the total data volume for the project.

**Observing Tool (SSR Chapter 2):** During this stage a proper GUI is needed, along with an improved source list and calibrator selection for novice users.

2.1-R2	1 D	The Observing Tool shall be able to read in the output from the Proposal Tool, and use the information therein to initialize parameters.
2.1-R4	1 D	Since the Observing Tool is the primary interface of the observer to the EVLA, it should be easy-to-use and robust:
2.1-R4.1	1 D	This tool shall operate using a GUI.
2.1-R4.2	1 D	There shall be built-in help capability.
2.1-R6	1 D	The Observing Tool shall allow its state and intermediate output to be saved and restored at any time.
2.1-R7.3	1 D	The Observing Tool shall include as components tools for: Calibrator selection.
2.1-R8.2.2	1 D	The Observation setup component shall: Allow the user to create and manipulate (add to and delete from) a source catalog derived from: output from the Calibrator selection component.
2.1-R8.2.4	1 D	The Observation setup component shall: Allow the user to create and manipulate (add to and delete from) a source catalog derived from: the source list from the proposal.
2.1-R8.4.5	1 D	Allow the user to specify, for target sources and their associated phase calibrators, a cycle time, and how much time is spent on each source in each cycle (if more than one phase calibrator is associated with the source, then the ordering of observing must also be specified).
2.1-R8.4.7	1 D	Allow the user to specify an associated position and velocity. Note that the coordinates and velocities must be allowed to be functions of time, either as parameterized trajectories, or as tabulated values (to allow for moving sources). It should be possible to specify that the position and velocity are unknown (e.g., for some types of TOO observations).
2.1-R8.4.7.1	1 D	For moving sources, the tool shall be able to calculate positions and velocities via: a built-in ephemeris calculator, for all solar system bodies ~200 km in diameter (note that at this point, extremely accurate positions are not needed - they are merely a guide to choosing calibrators and for the Scheduling Tool).



2.1-R8.5	1	D	Check for and report hardware setup conflicts between subarrays, for multiple subarray observing.
2.1-R8.7	1	D	Provide to the user a list of standard observing modes that may be used to achieve the science goals, from which they could choose defaults.
2.1-R7.7.1	1	D	Allow for user-input standard observing modes to be read from an input file.
2.1-R8.10	1	D	Provide the capability for the user to specify a minimum allowable length of an SB within the PB.
2.1-R8.10.1	1	D	Allow for an additional constraint on uv coverage in the case that short SBs are allowed (e.g., ``uv coverage must be complete except for an allowance for the existence of small gaps of T duration", or ``uv coverage is completely unimportant").
2.1-R9.2	1	D	The Hardware setup component shall provide: The ability to specify solar observing (e.g., if certain filters or other special hardware is required).
2.1-R9.10.1	1	D	A Correlator setup subcomponent, which shall provide: The ability to choose a correlator setup from a menu based on actual hardware setup (e.g., number of channels, width in Hz), for each central frequency or velocity.
2.1-R9.10.4	1	D	A Correlator setup subcomponent, which shall provide: Pre-configured setups (templates) shall be available for frequently observed transitions and standard continuum frequencies for each band.
2.1-R10.1	1	D	The Calibrator selection component shall provide: A built-in calibrator catalog.
2.1-R10.2	1	D	The Calibrator selection component shall provide: The ability to import calibrators from a user-supplied source list in ASCII format.
2.1-R10.3	1	D	The Calibrator selection component shall provide: The ability to directly input calibrators.
2.1-R10.4.1	1	D	The Calibrator selection component shall provide: The ability to select the following types of calibrators, based on source location, frequency, and array configuration: primary and secondary flux density scale calibrator(s).
2.1-R10.4.2	1	D	The Calibrator selection component shall provide: The ability to select the following types of calibrators, based on source location, frequency, and array configuration: calibrators for tracking time variable complex gain as a function of time (``phase" calibrators).
2.1-R10.4.3	1	D	The Calibrator selection component shall provide: The ability to select the following types of calibrators, based on source location, frequency, and array configuration: reference pointing calibrator(s).
2.1-R10.4.4	1	D	The Calibrator selection component shall provide: The ability to select the following types of calibrators, based on source location, frequency, and array configuration: bandpass calibrator(s).
2.1-R10.4.5	1	D	The Calibrator selection component shall provide: The ability to select the following types of calibrators, based on source location, frequency, and array configuration: polarization calibrator(s).

2.1-R10.7.1.1	1	D	The ability to input a description of the sky brightness distribution for any chosen calibrator, via: parametric models of the following types: point source (flux density, position, polarization, and the variation of these with frequency).
2.1-R13	1	D	The Observing Tool shall have a ``check" function, in which it presents expected sensitivities on all target sources, as well as verifying correlator modes, LO setups, etc.
2.1-R6.1	2	D	Saved outputs shall (by default) be distinguished by name.
2.1-R6.2	2	D	It shall be possible to save outputs locally (on the user's home computer).
2.1-R8.2.5	2	D	The Observation setup component shall: Allow the user to create and manipulate (add to and delete from) a source catalog derived from: a list of solar system bodies.
2.1-R8.2.6	2	D	The Observation setup component shall: Allow the user to create and manipulate (add to and delete from) a source catalog derived from: access to standard astronomical catalogs (e.g., CDS, NED).
2.1-R8.3.2	2	D	Sources in the Source List should be selectable via: sequential extraction of targets from a list of sources (e.g., to conveniently schedule survey programs).
2.1-R8.3.3	2	D	Sources in the Source List should be selectable via: user input of selection parameters (e.g., area of sky, flux density, source size, depending on what is available in the catalog).
2.1-R8.4.4.1	2	D	Allow the user to specify, for target sources, associated ``phase" calibrators: by denoting calibrator(s) from the Source List, along with applicable date ranges (in most cases, a single calibrator will be chosen over the entire range, but for moving sources, there will need to be different calibrators on different dates, and in some cases [notably astrometry], multiple calibrators may be desired).
2.1-R8.4.4.3	2	D	Allow the user to specify, for target sources, associated ``phase" calibrators: by denoting a list of possible phase calibrators, {it which are to be observed at the beginning of the execution of the SB}, and the ``best" picked, based on some heuristics TBD.
2.1-R8.4.5.1	2	D	Allow the user the ability to indicate that the cycle time should be chosen by the Scheduler at the time of execution of the SB should be provided.
2.1-R8.4.6.2	2	D	Allow the user to specify via clicking on desired antennas in a display showing the pad locations of the antennas, given the configuration.
2.1-R8.6	2	D	Produce target source lists which are exportable, editable (easily with text editors, i.e., it is normal printable ASCII), and re-usable for further sessions.
2.1-R8.9	2	D	Allow integration times and cycle repeats to be set based upon a desired level of sensitivity under the requested stringency (e.g., atmospheric, ionospheric, RFI) conditions.
2.1-8.9.1	2	D	Limits imposed by the scheduling committee, such as hard limit on the total project integration time, shall also be factored in.

2.1-R9.7	2	D	The Hardware setup component shall provide: The ability to specify multiple central observing frequencies in different receiver bands, as allowed by the correlator and hardware (e.g., observing simultaneously in C- and Q-bands).
2.1-R9.8	2	D	The Hardware setup component shall provide: Links to a standard provided line catalog (e.g., based on the JPL or Lovas line catalogs), in order to facilitate selection of less common line transition frequencies.
2.1-R9.10.5	2	D	A Correlator setup subcomponent, which shall provide: The ability to choose a correlator setup from a menu based on observational parameters (e.g., based on molecular transitions and velocity widths).
2.1-R9.11	2	D	A Correlator setup subcomponent, which shall provide: A warning if the combination of center frequency plus correlator setup causes known RFI to be observed.
2.1-R10.4.2.1	2	D	The Calibrator selection component shall provide: a display to show the distribution of these sources relative to target source location, with associated properties (flux density, position accuracy, flux density vs. frequency, etc...), and to allow for interactive selection of the calibrators to be used.
2.1-R10.8	2	D	The ability to do any of the above as a function of date, attaching the appropriate date range to the calibrator (for moving target sources).
2.2-R3.1	2	D	There shall be the facility to support contingent priority (see below), such that the priorities of subsequently queued blocks are adjusted based upon the results of execution of previous blocks, e.g., the time since execution of a previous block to ensure the desired time spacing of monitoring observations.
2.1-R5.1	3	D	Program Blocks output from the tool shall contain all of the information needed by the Scheduling Tool (i.e., you can use a Program Block as a template for creation of a new Program Block, with minimal modification).
2.2-R4.1	3	D	The proposer shall be able to specify what is needed for real-time checking of data quality, including: choosing a standard calibrator as a test source to be observed to assess the conditions for stringency.

**Scheduling Tool (SSR Chapter 3):** The next level of improvement is to operate the scheduler in "Normal mode", a quasi real-time dynamic scheduling of the telescope. Some simple criteria for evaluating the priority of a SB is required. Observers will be given only simple feedback about their programs.

3.1-R3.2	1	D	The Scheduling Tool shall handle the observing for the EVLA in the main modes: Normal mode: normal EVLA observing shall be dynamically scheduled in quasi-real time based upon the queue of SBs.
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3.1-R3.3	1	D	The Scheduling Tool shall handle the observing for the EVLA in the main modes: Interactive mode: a facility shall be provided for the normal dynamic queue to be suspended, and control passed over to an observer (e.g., overriding priorities in the main queue, or through use of an auxiliary queue) so that the observer can submit a PB or SBs for immediate observing.
3.1-R5	1	D	The Scheduling Tool should display in a window the current status of the queue, including the SB currently being observed, the next few scheduled SBs, and SBs currently under consideration with high priority.
3.1-R9.1	1	D	The objective of dynamic scheduling shall be to produce the highest scientific output per unit time. Because of uncertainties in future weather and the possibility of transient phenomena that might occur, an absolute solution for this is not possible. A heuristic approach is required. Algorithms and heuristics shall be clearly documented.
3.1-R13	1	D	For SBs that indicate so, source positions must be able to be inserted after the SB is in the queue.
3.1-R15.1	1	D	As SBs are scheduled, feedback to the observers (PIs) shall be the following: A Scheduler web page is maintained which lists priority ranked programs.
3.1-R15.2	1	D	As SBs are scheduled, feedback to the observers (PIs) shall be the following: An email is sent to the PI when the first of his/her SBs is executed for the first time.
3.1-R15.3	1	D	As SBs are scheduled, feedback to the observers (PIs) shall be the following: A final email is sent at the end of the program (when all the data are archived and available).
3.2-R1	1	D	The order of execution of Scheduling Blocks from the queue shall be on the basis of an assigned dynamic priority.
3.2-R1.1	1	D	The decision for the next SB to execute shall be made shortly before the end of the scheduling block currently in execution.
3.2-R2.2	1	D	The dynamic priority of a given SBs shall be calculated at the decision time based upon the criteria: Scientific Value (see below).
3.2-R2.3	1	D	The dynamic priority of a given SBs shall be calculated at the decision time based upon the criteria: Relative Priorities assigned by the observer using the Observing Tool.
3.2-R2.4	1	D	The dynamic priority of a given SBs shall be calculated at the decision time based upon the criteria: Environmental Priority Modifiers based upon current conditions.
3.2-R3.1	1	D	The following criteria will be used in evaluating the Scientific Value of an SB: Science rating as determined by the scheduling committee and the referees.
3.2-R3.2	1	D	The following criteria will be used in evaluating the Scientific Value of an SB: Proximity to a preferred date or LST (e.g., for emulation of fixed-time scheduling for placing observations near observations made with another instrument, or hitting a particular phase of a variable object).
3.2-R5.1	1	D	Environmental Priority Modifiers include: Current local weather conditions (temperature, dew point, wind speed).
3.2-R5.2	1	D	Environmental Priority Modifiers include: Current atmospheric conditions (opacity and phase rms at the observing frequencies used in the SB - note that this assumes the availability of this information in the Scheduling Tool, which may require auxiliary instruments such as an atmospheric phase

		monitor or a tipper meter, the data from which must be treated appropriately.
3.2-R5.3	1 D	Environmental Priority Modifiers include: Current ionospheric conditions (phase rms at the observing frequencies used in the SB - this may require processing of raw data from GPS receivers or other auxiliary devices to derive the phase rms).
3.2-R5.4	1 D	Environmental Priority Modifiers include: Current RFI conditions at the observing frequency (or frequencies), if known.
3.2-R2.5	2 D	The dynamic priority of a given SBs shall be calculated at the decision time based upon the criteria: Contingent Priorities.
3.2-R2.6	2 D	The dynamic priority of a given SBs shall be calculated at the decision time based upon the criteria: Operational Priorities.
3.2-R3.3	2 D	The following criteria will be used in evaluating the Scientific Value of an SB: Suitability of the phase of a periodic phenomenon (for instance the phase of a close binary star, or the orbital phase of a planetary satellite).
3.2-R7	2 D	Special calibration observations may be required at the beginning and/or end of execution of one or more SBs, which we denote as preamble and postamble blocks. These are particular versions of Control Scripts. The Scheduling Tool must account for these when determining priority, e.g., if a particular SB requires long preamble and postamble blocks, that should be factored into the required time to complete the SB, modifying its priority.

**Archive (SSR Chapter 4):** Improvements to the archive required at this stage include, storage of full project data, web-based GUIs, improved search capabilities for non-experts, documentation, and mirror facilities.

4.1-R1.4.1	1 D	There shall be an EVLA archive which stores all data obtained with the EVLA. This archive shall include: proposal, PBs, operator logs;
4.1-R4	1 D	The archive shall enable astronomers and engineers to access and use data which have been obtained with EVLA, regardless of where the information physically resides.
4.2-R3	1 D	In the presence of irreversible data corrections, flagging, or modifications, such as RFI excision on time scales shorter than the integration time, the archive must be able to store and recognize both the corrected (modified) and uncorrected (original) data.
4.2-R4	1 D	Each scan within the data shall be identified by its type ("phase" calibrator, target observation, pointing scan, etc...).
4.6-R1.1	1 D	Project data stored in the archive shall include: all user (observer) input including the project proposal;
4.7-R1	1 D	There shall be an Archive Search Tool to access the archive.
4.7.R1.1	1 D	The Archive Search Tool shall be operated through a web-based GUI.
4.7-	1 D	The Archive Search Tool shall have a CLI to interrogate the archive from

R1.2		scripts or other Tools.
4.7-R5	1 D	The search criteria shall include all the information in the observation headers, including any information pointed to in sub-headers.
4.8-R1.1	1 D	The Archive Retrieval Tool shall have a CLI to access the archive from scripts or other Tools.
4.8-R1.2	1 D	The Archive Retrieval Tool shall be operated through a web-based GUI (possibly the same one as the Archive Search Tool).
4.8-R2.4	1 D	The Archive Retrieval Tool shall return the requested information such as: calibration data;
4.1-R5	2 D	The data shall be archived and made accessible (with access control) as soon as practical after they are taken or produced.
4.1-R6	2 D	The principal archive(s) should be easily accessed by users from all EVLA partners and major collaborators.
4.3-R3	2 D	All archived environmental data shall be indexed by time, to facilitate the linking of these data with appropriate observation periods.
4.6-R2.1	2 D	Submission of Project data to the archive shall be controlled. an EVLA staff member may submit data to the archive as needed;
4.6-R3	2 D	The submission process shall provide a link between the submitted data and the original raw data.
4.6-R4	2 D	It should be possible for the observer to insert notes into the archive related to the project, including observing notes, descriptions of why it was set up as it was, etc... (an ``electronic logbook".
4.6-R5	2 D	The archive shall include any relevant maintenance forms, e.g., detailing problems with receivers during observation.
4.7-R1.3	2 D	The Archive Search Tool shall serve as a front end to the Archive Retrieval Tool, which manages the data extraction and delivery.
4.7-R2	2 D	The Archive Search Tool shall operate on supported platforms as designated by the project.
4.7-R3.1	2 D	There shall be a variety of help and documentation facilities available from the UI and on the Internet for the Archive Search Tool. These shall include: An up-to-date and complete Reference Manual for the Archive Search Tool functions, operation, and installation.
4.7-R10	2 D	An archive user shall be able to browse all of the header information for requested data.
4.8-R1.3	2 D	The Archive Retrieval Tool shall be accessible from the Archive Search Tool.
4.8-R1.4	2 D	The Archive Retrieval Tool shall be able to accept (properly verified) web-based search and extraction requests.
4.8-R2.9	2 D	The Archive Retrieval Tool shall return the requested information such as: project data;
4.8-R3	2 D	For retrieval of raw or calibrated uv data files, optional averaging over time or frequency must be available.
4.8-R5	2 D	If an archive user requests a disk file transfer operation, then the Archive Retrieval Tool shall put data in a user-accessible directory. The user will be informed about the estimated transfer time. An email message can be requested at the end of the transfer.



4.8-R6	2	D	In any EVLA supported data transfer method, the data shall be delivered to a user within the EVLA project defined maximum time.
4.10-R2.4	2	D	The data associated with a given proposal will (usually) be made public on the basis of the expiration of a proprietary interval after the latest observation done on the basis of the proposal. The archive software must recognize and enforce this interval.
4.3-R1.4	3	D	The environmental data in the archive shall include: other atmospheric sounding data, if available (e.g., atmospheric phase monitor, tipping radiometer, FTS);
4.6-R2.2	3	D	Submission of Project data to the archive shall be controlled. an observer or archive user, who has been granted authorization, may submit data for inclusion in the archive;

**What's Up Screen and Atmospheric models (SSR Chapter 5):** The higher level capabilities for the What's up Screen are added here. These may be useful for real-time science observing. Monitors of the atmosphere and the ionosphere will return data sufficient of correct pipeline processed data and to help with making real time scheduling decisions.

5.5-R2.5	1	D	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: surface meteorological parameters (temperature, dew point temperature [or humidity], wind speed and direction, pressure);
5.5-R2.6.1	1	D	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: auxiliary monitoring device output: Atmospheric Phase Monitor - raw data and related derived quantities (structure function, rms phase, corner time, exponent);
5.5-R2.9	1	D	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: results of real-time calibrator analysis output for the current session, including any focus, delay, reference pointing, complex gain, etc..., data.
5.4-R1	2	D	Atmospheric modelling shall be available in the Pipeline and to the Scheduling Tool. The model shall be able to predict the absorption, emission and pathlength on the line of sight through the atmosphere at all EVLA bands. The prediction will be based on measured data, including, but not limited to: measured atmospheric parameters at the site: temperature, pressure, humidity; measured atmospheric emission in the observed EVLA bands; measured WVR data; measured atmospheric profiles of temperature and water content if available from atmospheric sounders; measured optical depths from tipper meters and/or FTSs, if available; measured electron content from GPS or other techniques.
5.4-R2	2	D	Atmospheric modelling shall be used to derive the opacities in all astronomical bands in use, in order to correct the observed amplitudes at various elevations.
5.4-R3	2	D	Atmospheric modelling shall be able to provide the conversion factors between WVR data and the water contribution to the astronomical phase in all EVLA bands.



5.5-R2.6.2	2 D	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: auxiliary monitoring device output: current opacity estimate for all observing bands, from either surface data, seasonal estimate, TIPS of the array itself, separate tipping radiometers, separate FTS devices, etc...
5.5-R2.6.5	2 D	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: auxiliary monitoring device output: Atmospheric electron content information (if available, via GPS);
5.5-R2.8.3	2 D	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: array properties, such as: the \$uv\$ coverage and dirty beam, integrated over the current session, for a chosen target source;
5.5-R2.8.4	2 D	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: array properties, such as: the thermal noise rms reached since the beginning of the observing session (from theory, using actual system temperatures);

## Release E

**Proposal Tool (SSR Chapter 1):** The PST should operate in a "wizard mode" for novice users, and be capable of generating SB's for the simplest observing configurations.

1-R1.1	1	E	The Proposal Tool, Observing Tool, Scheduling Tool, Pipeline Tool, and Archive Tool shall be integrated into a common software package, or at least be able to be invoked from each other and pass data back and forth, and have a common look-and-feel for any interactive access.
1-R13.1	1	E	The tool shall react to user input by providing warnings based on the situation and selected observing mode, including: hardware limitations, including feasibility of using the correlator at the requested spectral resolution and total bandwidth;
1-R13.2	1	E	The tool shall react to user input by providing warnings based on the situation and selected observing mode, including: data rate/volume;
1-R7.4	2	E	The submission tool shall provide access to catalogs such that sources can be imported by common name, including at least 3C, 4C, NGC, Markarian, and UGC. Consistency between positions and names of type Bnnnn+nnn, Jnnnn+nnn, and Gnnn.n+n.n shall be enforced. Consistency between entered names, positions, and the above catalogs shall be enforced.
1-R7.5	2	E	The submission tool shall allow access to a pulsar catalog, whose format shall be XML, with a well-defined schema, provided by the observatory.
1-R7.6	2	E	The submission tool shall be able to calculate the position, distance, size, and flux density as a function of frequency of the Sun, Moon, major planets, satellites, and asteroids (all bodies ~200 km diameter), and be able to insert them into the source list. Note that at this point, extremely accurate positions are not needed - they are merely a guide to the scheduling committee.
1-R-11.1.3	2	E	The Proposal Tool shall perform certain simple calculations, including: the integration time required: using real observing statistics;
1-R-11.1.4	2	E	The Proposal Tool shall perform certain simple calculations, including: the integration time required: for the measured RFI environment;
1-R12.1	2	E	The tool shall calculate the data processing load as per EVLA memo 24.
1-R13.3	2	E	The tool shall react to user input by providing warnings based on the situation and selected observing mode, including: expected data quality;
1-R13.4	2	E	The tool shall react to user input by providing warnings based on the situation and selected observing mode, including: expected stringency limitations (e.g., weather, RFI, ionospheric conditions).
1-R14.1	2	E	The search results should be ordered by relevance, with relevance weighted (in this order) by selected: (1) source name or coordinate; (2) observing frequency; (3) resolution or configuration; (4) required or achieved rms; (5) date (closest to specified date, with default being the current date).
1-	3	E	This stored version shall be easily editable with normal text editors (i.e.,

R3.2			should be normal printable ASCII text).
1-R7.7	3	E	The submission tool should allow for entry of orbital elements (as a 6 element vector) for other solar system bodies, and from those orbital elements, calculate coordinates.
1-R-11.1.5	3	E	The Proposal Tool shall perform certain simple calculations, including: the integration time required: given sky coordinates, for low frequency (the Tool should know about the distribution of background temperature and confusing sources).

**Observing Tool (SSR Chapter 2):** More ease-of-use improvements are needed at this stage such as wizards for selecting standard observing setups, pipeline reduction setups, and some observation prediction capabilities.

2.1-R1.1	1	E	The Proposal Tool, Observing Tool, Scheduling Tool, Pipeline Tool, and Archive Tool shall be integrated into a common software package, or at least be able to be invoked from each other and pass data back and forth, and have a common look-and-feel for any interactive access.
2.1-R4.3	1	E	There shall be a batch or script mode for automated generation of Program Blocks.
2.1-R4.4	1	E	The use of the Observing Tool shall not entail an excessive learning curve. Average users, with some knowledge of radio astronomy (as obtained by attending the NRAO Summer School) shall be able to become proficient in using the tool on a timescale of roughly 1 working day of dedicated use, and truly neophyte users (e.g., graduate students in other areas of astronomy) should reach proficiency with an investment not exceeding a few working days of dedicated use.
2.1-R8.8	1	E	Offer, for the selected standard observing mode, sensible defaults for all parameters deduced from the science goals, making these parameters unnecessary to manipulate for the general user.
2.1-R10.7.1.2	1	E	The ability to input a description of the sky brightness distribution for any chosen calibrator, via: parametric models of the following types: elliptical gaussian (flux density, position, major and minor axis width and position angle, polarization, and the variation of these with frequency).
2.1-R11.1	1	E	The Pipeline data reduction setup component shall provide: The ability to specify the desired spatial and spectral extent of the final image cubes.
2.1-R11.2	1	E	The Pipeline data reduction setup component shall provide: The ability to specify the desired u-v tapering and weighting (e.g., robustness parameter) for creation of the final image cubes.
2.1-R11.3	1	E	The Pipeline data reduction setup component shall provide: The ability to specify the desired frequency or velocity selection, averaging, smoothing, etc..., of the final image cubes.
2.1-R11.6	1	E	The Pipeline data reduction setup component shall provide: A mechanism for the software to impose constraints (e.g., allowable ranges of input parameters) on the observer's specification of all of the above items, so that the pipeline is not asked to do more than is realistic.
2.1-R2.1	2	E	In many cases, this should be all that is required for creation of a simple Program Block.

2.1-R4.5	2	E	It shall be easy to extend the capability of the Tool, for instance by adding more available methods of setting up the correlator or by adding further specifications for the pipeline reduction.
2.1-R7.4	2	E	The Observing Tool shall include as components tools for: Pipeline data reduction setup.
2.1-R7.5	2	E	The Observing Tool shall include as components tools for: Observation prediction.
2.1-R8.4.4.2	2	E	Allow the user to specify, for target sources, associated "phase" calibrators: by denoting a list of possible phase calibrators, the "best" of which is to be picked automatically by the Scheduling Tool, based on some heuristics TBD (these heuristics will likely be a combination of: source flux density, distance/direction to target source, and source structure, e.g., "pick the brightest compact one within 5 deg") - this is useful for moving sources.
2.1-R8.4.6.3	2	E	Allow the user to specify via more complicated heuristics, e.g., "all antennas with a functioning Ka-band receiver", or, "the 13 antennas with the best pointing", or, "the 9 antennas with the best combined $T_{\text{sys}}/\eta_a$ at Q-band".
2.1-R8.8.1	2	E	Should this be supported by the Scheduling Tool, the Observing Tool shall support the facility for some parameters (e.g., calibrators, loop cycle times, integration times) to be selected automatically at run-time by the Scheduling Tool depending on actual weather, phase fluctuations, and pipeline results.
2.1-R8.11	2	E	Provide a warning if "interfering sources" are near any target source over the date/time range of interest. Such sources are defined as: Sun, Moon, planets, strong sources at low frequency (Cas A, Cyg A, galactic plane, etc...), or others TBD. If desired, such warnings should be allowed to be turned into date/time constraints attached to the SBs in the PB.
2.1-R10.4.2.2	2	E	The Calibrator selection component shall provide: The ability to select the following types of calibrators, based on source location, frequency, and array configuration: astrometric phase calibrators.
2.1-R10.4.3.1	2	E	it shall be possible to select different reference pointing patterns, either from a menu (showing, e.g., classical 5-point, triangles, shifted triangles, the 'Craig cross', etc...) or via input as an ordered table of offsets and dwell times.
2.1-R10.4.6	2	E	The Calibrator selection component shall provide: The ability to select the following types of calibrators, based on source location, frequency, and array configuration: focus calibrator(s).
2.1-R10.4.6.1	2	E	it shall be possible to select different focus patterns, either by specifying number of points, focus distance between points, center focus, and dwell time per point, or via input as an ordered table of focus positions and dwell times.
2.1-R10.4.7	2	E	The Calibrator selection component shall provide: The ability to select the following types of calibrators, based on source location, frequency, and array configuration: delay calibrator(s).

2.1-R10.5	2 E	The ability to have the tool pick all the appropriate calibrators from the above list automatically, given the type of observation (e.g., flux density and phase calibrators are needed for all, bandpass only for spectroscopy, polarization only as needed), the observing band and configuration, and the target source location (selection heuristics to be provided by NRAO scientific staff).
2.1-R10.7.2	2 E	The ability to input a description of the sky brightness distribution for any chosen calibrator, via: parametric models of the following types: a set of CLEAN components, with polarization and frequency variation information.
2.1-R10.7.3	2 E	The ability to input a description of the sky brightness distribution for any chosen calibrator, via: parametric models of the following types: a FITS image, with polarization and frequency variation information.
2.1-R11.4	2 E	The Pipeline data reduction setup component shall provide: A mechanism for the observer to convey intent to the pipeline, including at least the following information: How calibrators are to be used, Level of flagging (e.g., light, medium, heavy). Preferred deconvolution algorithm and associated parameters. Preferred mosaicing algorithm and associated parameters. Any other necessary pipeline control parameters.
2.1-R11.5	2 E	The Pipeline data reduction setup component shall provide: A mechanism for the observer to select from a number of pre-defined heuristics for pipeline data reduction, for common observing modes (e.g., flag. set flux density scale. compute time variable complex gain from calibrator. compute bandpass calibration from calibrator. apply calibrations to target source. decimate in frequency. loop: image, deconvolve, self-calibrate). The specific heuristics are TBD.
2.1-R11.7.1	2 E	The Pipeline data reduction setup component shall provide: Estimates for the Pipeline to evaluate the data processing resources needed for science data processing. If the resources needed for image deconvolution are significant, the proposer shall be asked when image deconvolution needs to be executed, for instance: after observing session.
2.1-R11.7.2	2 E	The Pipeline data reduction setup component shall provide: Estimates for the Pipeline to evaluate the data processing resources needed for science data processing. If the resources needed for image deconvolution are significant, the proposer shall be asked when image deconvolution needs to be executed, for instance: at the end of program execution.
2.1-R11.8	2 E	The Pipeline data reduction setup component shall provide: The ability to specify all of the above quantities separately for both the default archive image pipeline, and the quick-look pipeline.
2.1-R11.9	2 E	The Pipeline data reduction setup component shall provide: The ability to specify times at which the quick-look Pipeline Tool should be run during execution, e.g., at the end of each SB.
2.1-R11.10	2 E	The Pipeline data reduction setup component shall provide: An estimate of how long it will take the quick-look Pipeline Tool to complete for each requested execution.
2.1-R11.11	2 E	The Pipeline data reduction setup component shall provide: The ability to specify pulsar dispersion measure.
2.1-	2 E	The Observation prediction component shall be able to: estimate S/N.

R12.1			
2.1-R12.2	2	E	The Observation prediction component shall be able to: estimate synthesized beam size.
2.1-R12.3	2	E	The Observation prediction component shall be able to: estimate primary beam size.
2.1-R12.4	2	E	The Observation prediction component shall be able to: estimate surface brightness sensitivity.
2.1-R12.5	2	E	The Observation prediction component shall be able to: estimate range of angular scales well sampled.
2.1-R14	2	E	The Observing Tool will support specification of science goals (e.g., in the form of source lists from the proposal) in lieu of detailed specification of total time, integration times, configurations, etc...
2.2-R1.2	2	E	The Observing Tool shall divide a Program Block into Scheduling Blocks based upon parameters chosen: automatically, for standard observing modes with ``science oriented" input (e.g., sensitivity).
2.1-R6.3	3	E	Saved outputs shall be easily editable with normal text editors (i.e., should be normal printable ASCII text).
2.1-R8.3.4	3	E	Sources in the Source List should be selectable via: on the basis of an image (e.g., from survey databases, or from the EVLA archive) one shall be able to define the area to be mapped interactively (e.g., with a mouse).
2.1-R8.4.4.4	3	E	Allow the user to specify, for target sources, associated ``phase" calibrators: by indicating that at the beginning of the execution of the SB, the sky should be searched in the area around the source of interest for the ``best" calibrator, based on some heuristics TBD
2.1-R8.4.7.2	3	E	For moving sources, the tool shall be able to calculate positions and velocities via: user input orbital elements (6 element vector) for other solar system bodies.
2.1-R8.4.7.3	3	E	For moving sources, the tool shall be able to calculate positions and velocities via: user input solar longitude and latitude.
2.1-R10.7.1.3	3	E	The ability to input a description of the sky brightness distribution for any chosen calibrator, via: parametric models of the following types: elliptical limb-darkened disk (flux density, position, major and minor axis width and position angle, limb-darkening parameter, polarization, and the variation of these with frequency).
2.1-R10.7.1.4	3	E	The ability to input a description of the sky brightness distribution for any chosen calibrator, via: parametric models of the following types: combinations of the above simple single sources.
2.1-R11.7.3	3	E	The Pipeline data reduction setup component shall provide: Estimates for the Pipeline to evaluate the data processing resources needed for science data processing. If the resources needed for image deconvolution are significant, the proposer shall be asked when image deconvolution needs to be executed, for instance: when certain sensitivity levels are reached.
2.1-R12.6	3	E	The Observation prediction component shall be able to: produce dirty beams.
2.1-R12.7	3	E	The Observation prediction component shall be able to: effect its calculations on execution timescales on the order of 10 seconds or less, and should not require significant computational resources.



2.1-R12.8	3	E	The Observation prediction component shall be able to: for suitable source models, simulate maps with the desired array configurations.
2.1-R12.9	3	E	The Observation prediction component shall be able to: provide simulated spectra based on physical models and given observing parameters.
2.1-R15	3	E	The Observing Tool shall be cognizant of the Project and Program parameters as allocated by the scheduling committee, and will, unless requested otherwise, apply those limits to the time being scheduled.
2.2-R4.2	3	E	The proposer shall be able to specify what is needed for real-time checking of data quality, including: option for the system to automatically choose the test source at execution time.

**Scheduling Tool (SSR Chapter 3):** Full-up dynamic scheduling is required at this stage, along with scheduling heuristics to deal with operational priorities. Observers need tools so that they can be fully informed about the status of their project.

3.1-R1.1	1	E	The Proposal Tool, Observing Tool, Scheduling Tool, Pipeline Tool, and Archive Tool shall be integrated into a common software package, or at least be able to be invoked from each other and pass data back and forth, and have a common look-and-feel for any interactive access. Note that it is not required that observers be given access to the Scheduling Tool, but operators and NRAO staff must have access to it.
3.1-R4	1	E	The Scheduling Tool shall support observing in multiple subarrays;
3.1-R9.2	1	E	The objective of dynamic scheduling shall be to produce the highest scientific output per unit time. Because of uncertainties in future weather and the possibility of transient phenomena that might occur, an absolute solution for this is not possible. A heuristic approach is required. Parameters and weights involved in the heuristics shall be documented, and easily adjustable.
3.1-R14.1	1	E	For observations of moving sources, the Scheduling Tool must insert appropriate calibrators into the Control Script (lists with dates are provided in the SB), and must calculate accurate target source position and velocity trajectories based on: an internal ephemeris calculator (for all solar system bodies ~200 km diameter - note that this must be a very accurate ephemeris).
3.1-R14.2	1	E	For observations of moving sources, the Scheduling Tool must insert appropriate calibrators into the Control Script (lists with dates are provided in the SB), and must calculate accurate target source position and velocity trajectories based on: provided orbital elements.
3.1-R14.3	1	E	For observations of moving sources, the Scheduling Tool must insert appropriate calibrators into the Control Script (lists with dates are provided in the SB), and must calculate accurate target source position and velocity trajectories based on: provided tabulated positions and velocities as a function of time (e.g., output from the JPL horizons system).



3.1-R11.1	2	E	For SBs that indicate so, the Scheduling Tool should be able to choose an appropriate calibrator: When the SB is being considered for scheduling, in the case that a list of possible calibrators with associated dates, or a list of possible calibrators associated with a moving source, is provided in the SB.
3.1-R11.2	2	E	For SBs that indicate so, the Scheduling Tool should be able to choose an appropriate calibrator: After being chosen for scheduling, if there is an indication that the ``best" calibrator (either from a provided list, or from an indication that an area of sky is to be searched) should be found at the time of observing, then the Scheduling Tool should submit a short Control Script to the real-time system to initiate this, and use the output from the Real-time Calibrator Analysis Tool to make the decision of which calibrator to use, based on a set of provided heuristics (TBD).
3.1-R12	2	E	For SBs that indicate so, the source-calibrator cycle time, and amount of time spent on each, should be calculated by the Scheduling Tool, based on current observing conditions (opacity, phase stability, etc...).
3.1-R15.4	2	E	As SBs are scheduled, feedback to the observers (PIs) shall be the following: A Project Web page is created (with password or other access protection) which gives the current status of the Project.
3.1-R15.5	2	E	As SBs are scheduled, feedback to the observers (PIs) shall be the following: An email is sent to the PI when the first of his/her SBs gets for the first time into the top ~10 ranked ones, as an announcement of approaching execution (but not a guarantee, the weather being not easily predicted).
3.2-R4.1	2	E	There can also be Contingent Priorities, which are modifiers arising at decision time based upon the results of the execution of other SBs from the same Program Block. These might include: Elapsed time since previous execution (for monitoring variable objects at a regular rate).
3.2-R4.2	2	E	There can also be Contingent Priorities, which are modifiers arising at decision time based upon the results of the execution of other SBs from the same Program Block. These might include: Hour Angle or Parallax Angle spacing since previous execution (for improving uv or parallax angle coverage).
3.2-R5.5	2	E	Environmental Priority Modifiers include: Stringency factor: SBs requiring rare conditions may be preferred when those conditions occur.
3.2-R5.6	2	E	Environmental Priority Modifiers include: Predictions of future observing conditions (far enough into the future to complete the SB), including possibly detailed weather predictions from mesoscale models or as provided by the National Weather Service, if possible.
3.2-R6.1	2	E	Depending upon the algorithm chosen for implementation of the system, the following heuristics may also be appropriate to consider for Operational Priorities: The status of the Program as a whole (preference should be given to finishing a Program Block once it is started).
3.2-R6.2	2	E	Depending upon the algorithm chosen for implementation of the system, the following heuristics may also be appropriate to consider for Operational Priorities: The status of the Project as a whole (preference should be given, for example, to getting a small amount of D configuration time to provide short spacings for a project that already has a large amount of B configuration time).

3.1-R14.4	3	E	For observations of moving sources, the Scheduling Tool must insert appropriate calibrators into the Control Script (lists with dates are provided in the SB), and must calculate accurate target source position and velocity trajectories based on: provided solar longitude and latitude.
3.1-R15.6	3	E	As SBs are scheduled, feedback to the observers (PIs) shall be the following: The Project web page is updated at regular intervals (e.g., each SB, or $\sim 10$ min whichever is longest). This includes the quick look image, quality check information from the quick look pipeline, and general execution status of the program.
3.2-R3.4	3	E	The following criteria will be used in evaluating the Scientific Value of an SB: The contribution of the execution of the scheduling block to the program. (That is, the contribution to the sensitivity, taking into account the system temperature at the current elevation, atmospheric opacity and/or ionospheric conditions, current or past RFI environment, and the number of available antennas, is to be considered, not just the time.).
3.2-R8	3	E	Pipeline results from the astronomical targets themselves (for instance, test point sources) can be used in computing scheduling block priorities.

**Archive (SSR Chapter 4):** The archive must be capable of supporting full VO and pipeline functions at this stage.

4.1-R1.5	1	E	There shall be an EVLA archive which stores all data obtained with the EVLA. This archive shall include: data products (e.g., calibrated data and images from the pipeline).
4.1-R2.1	1	E	The Proposal Tool, Observing Tool, Scheduling Tool, Pipeline Tool, and Archive Tool shall be integrated into a common software package, or at least be able to be invoked from each other and pass data back and forth, and have a common look-and-feel for any interactive access.
4.5-R1.1	1	E	Data products stored in the archive shall include: calibrated data (or the ability to generate on-the-fly), with the most up-to-date calibration;
4.5-R1.2	1	E	Data products stored in the archive shall include: images/image cubes (or the ability to generate on-the-fly);
4.5-R2.1	1	E	The Pipeline and Calibrator Analysis Tools shall have access to the archive to deposit resulting calibration information (possibly the fully calibrated data, or information on how to obtain it) and images;
4.5-R3	1	E	The submission process shall provide a link between the submitted data and the original raw data.
4.5-R4.1	1	E	For long integrations or large numbers of channels, the images are stored in the archive.
4.5-R5.1	1	E	The archive should contain all calibrations which are applicable.
4.8-R2.6	1	E	The Archive Retrieval Tool shall return the requested information such as: a calibrated uv data file;
4.8-R2.7	1	E	The Archive Retrieval Tool shall return the requested information such as: an image cube;
4.10-R1.4	1	E	Image data, and other data products, will be proprietary if the data from which the image is made is proprietary.

4.2-R5	2	E	There shall be a mechanism to identify whether the observational data is scientifically meaningful or not (this is to allow a user to eliminate test observations for technical purpose, e.g., out-of-focus astronomical observation, etc.);
4.5-R1.3	2	E	Data products stored in the archive shall include: the pipeline or post-processing software versions and data reduction scripts;
4.5-R1.4	2	E	Data products stored in the archive shall include: data quality information (e.g., noise level and dynamic range, based on pipeline results);
4.5-R1.5	2	E	Data products stored in the archive shall include: history of flux density determinations of calibration sources;
4.5-R2.2	2	E	an EVLA staff member may submit the results of off-line reduction and imaging for inclusion in the archive (e.g., in cases where there was fault in the pipeline reduction);
4.5-R4.2	2	E	For short integrations or small datasets, images shall be generated on-the-fly from the visibilities upon extraction from the archive.
4.5-R5.2	2	E	The archive should support different versions of the same image, made with differing calibrations, imaging parameters, deconvolutions, or software.
4.5-R5.3	2	E	If recalibration by using better calibration algorithm and/or better calibration data is recommended by the EVLA, then the stored image will be recomputed based on the new calibration.
4.7-R3.2	2	E	There shall be a variety of help and documentation facilities available from the UI and on the Internet for the Archive Search Tool. These shall include: An introductory cookbook, including examples, designed to let a novice user, possibly without extensive knowledge of radio astronomy, know how to utilize the database efficiently and how to do data mining by using the archive.
4.7-R4.2	2	E	The Archive Search Tool interfaces shall present a look-and-feel suitable for the differing needs of types of archive users. These should include: a user-friendly but comprehensive interface aimed at EVLA observers and archive users with knowledge of radio astronomy;
4.7-R6	2	E	The Archive Search Tool shall allow searching the observation database to see if observations for particular targets have been previously done.
4.7-R7	2	E	Regular expressions including wild card and ranges shall be available in search (although we do not envision full support of regexp type expressions, but rather simple * and ? type wild card specification).
4.7-R8	2	E	The search criteria used for database search shall be shown with search results and shall be able to be modified.
4.8-R2.8	2	E	The Archive Retrieval Tool shall return the requested information such as: other data products;
4.8-R4	2	E	The archive user can select network transfer or physical data delivery (disk/tape) for data retrieval. The Archive Retrieval Tool shall have upper limits in total data size for each of them, which shall be determined by the EVLA project by taking into account the network bandwidth and the I/O speed.
4.8-R7	2	E	At user request, a preview image (e.g., a small image cube) of the data found in the search shall be made available before actual data transfer.
4.8-	2	E	The preview image cube of the images and dirty beams shall be made either

R7.1		on-the-fly upon request or produced by the pipeline in advance (using the same criteria as for full images).
4.8-R7.2	2 E	If a user requests a preview image without specifying the frequency/velocity information in the line data search, the Archive Retrieval Tool shall provide a sensible default velocity integrated intensity image (e.g., 10 km/s for Galactic, 300 km/s for extragalactic, centered on the observer-specified rest frequency and tracking velocity).
4.8-R7.3	2 E	A simple image viewer for the preview image shall be also provided.
4.9-R1	2 E	The archive shall be designed to meet the requirements, if practical, for on-going virtual observatory projects so that the EVLA data can be used more efficiently.
4.9-R2.1	2 E	Whatever the final shapes of virtual observatories become, the EVLA archive system shall be able to provide the following basic elements: the archived image
4.9-R2.2	2 E	Whatever the final shapes of virtual observatories become, the EVLA archive system shall be able to provide the following basic elements: image quality information for archived images
4.9-R2.3	2 E	Whatever the final shapes of virtual observatories become, the EVLA archive system shall be able to provide the following basic elements: data quality information for selected observations
4.9-R3	2 E	The interface shall be designed to meet the requirements for virtual observatories. This assumes that the EVLA project receives the requirement information early enough to meet the project's development plan.
4.10-R1.5	2 E	Astronomical calibration observations, as well as the calibration pipeline output, can be extracted from the midst of otherwise proprietary data.
4.1-R1.4.2	3 E	There shall be an EVLA archive which stores all data obtained with the EVLA. This archive shall include: links to papers, related data, etc...
4.1-R7	3 E	There may be several ``shadow" archives which hold all or subsets of data, which shall enable users over the world to access the observational data efficiently.
4.5-R1.6	3 E	Data products stored in the archive shall include: catalog information (e.g., flux density, spectral index, source size) extracted from images or data;
4.5-R2.3	3 E	an observer or archive user, who has been granted authorization, may submit the results of off-line reduction and imaging for inclusion in the archive;
4.5-R2.4	3 E	the pipeline, staff, or authorized users shall be able to deposit catalog information extracted from data into the archive.
4.5-R4.3	3 E	The decision between image storage and on-the-fly extraction shall be determined by the computing capability of the archive extraction pipeline, and may evolve with time.
4.5-R6	3 E	Quick-look data products are not stored in the final archive by default (see pipeline requirements).
4.6-R6	3 E	The archive shall have the ability to attach a persistent link to external archives and catalogs (e.g., DSS image) of the corresponding sky area.
4.6-	3 E	The archive shall have the ability to attach references and/or links to

R7		published papers (e.g., via ADS) that used the data.
4.7-R2.1	3 E	The appearance and operation of the Archive Search Tool shall be platform independent.
4.7-R3.3	3 E	There shall be a variety of help and documentation facilities available from the UI and on the Internet for the Archive Search Tool. These shall include: Interactive context-based help provided in the GUI.
4.7-R4.3	3 E	The Archive Search Tool interfaces shall present a look-and-feel suitable for the differing needs of types of archive users. These should include: a user-friendly interface aimed at novice users or astronomers outside the expert radio astronomy community (e.g., casual browsers, NVO users).
4.7-R9	3 E	The Archive Search Tool shall allow search criteria based on a combination of search fields (e.g., the product of time and bandwidth).
4.8-R1.5	3 E	The Archive Retrieval Tool shall be accessible from the Data Post-processing Package.
4.8-R2.10	3 E	The Archive Retrieval Tool shall return the requested information such as: Run the pipeline on raw data with optional input parameters.
4.9-R2.4	3 E	Whatever the final shapes of virtual observatories become, the EVLA archive system shall be able to provide the following basic elements: catalogues derived from the archive, if available
4.10-R3	3 E	The Archive Retrieval Tool will maintain a record of data extracted.
4.10-R4	3 E	For data younger than a "data notification age", the Archive Retrieval Tool will send an email to the last known address of the contact person of the associated proposal, informing them of the data being extracted and including the comment solicited above.

**Quicklook pipeline (SSR Chapter 5):** This is likely a version of the off-line pipeline but used prior to the end of the project so that an astronomer can access the quality of the data at intermediate stages.

5.1-R9	1 E	The outputs from the Real-time Calibrator Analysis Tool should be available to the quick-look Pipeline Tool.
5.2-R1	1 E	The quick-look Pipeline Tool shall be activated automatically under given conditions (e.g., after a certain time interval, after each scheduling block, etc...). These intervals should be specified in the Observing Tool. The output from the Tool shall be accessible to operators and observers.
5.2-R10.1	1 E	The quick-look Pipeline Tool shall always compute the dirty image of astronomical sources when directed to do so (the operator or astronomer should be able to select spectra only), using the fastest algorithm possible. The supported observing modes should include: normal single-field synthesis;
5.2-R10.2	1 E	The quick-look Pipeline Tool shall always compute the dirty image of astronomical sources when directed to do so (the operator or astronomer should be able to select spectra only), using the fastest algorithm possible. The supported observing modes should include: multiple source



		observations ("snapshots");
5.2-R11	1 E	The quick-look Pipeline Tool should deconvolve the dirty images, if possible in the short time allowed, using a fast deconvolution algorithm, with minimal controlling inputs.
5.2-R12	1 E	The processing described in the previous requirement shall be done for: the continuum data; the line-averaged spectra, over a pre-defined velocity or frequency range (defined either by the astronomer or by the staff astronomer or operator).
5.2-R2	1 E	It should also be possible to run the quick-look Pipeline Tool whenever requested by the staff astronomer, operator, or observer (assuming a reasonable request). Inputs will be requested (the Pipeline data reduction setup component of the Observing Tool or its equivalent will be executed), and an estimate of the time to complete the requested operations will be given.
5.2-R3	1 E	It should be possible to abort execution of the quick-look Pipeline Tool gracefully, including cleaning up of files, killing all spawned processes, etc...
5.2-R4	1 E	The time-lag between when data is collected by the real-time system and when it is available to the quick-look Pipeline Tool should be less than 30 seconds. This may guide a decision on whether data is all archived first, and then retrieved from the archive into the Tool, or fed directly from the real-time system into it (the fear is that the time lag between when data is collected and when it is actually available in the archive could be as long as minutes).
5.2-R5	1 E	The quick-look Pipeline Tool should use the pipeline data reduction parameters as specified in the Observing Tool, including the heuristic for data reduction.
5.2-R6	1 E	The quick-look Pipeline Tool shall be able to process data in multiple subarrays.
5.2-R7	1 E	The quick-look Pipeline Tool should apply all flags generated by the real-time system, and should include facilities for generating flags based on the data itself, either of calibrators or of data taken on the target object. This includes recognition of RFI. Flags generated from data taken on the target object must be reported to operations. The setup parameters of the pipeline shall include a list of such facilities to be used, and a selectable level of flagging, e.g., light, nominal, heavy.
5.2-R8	1 E	The quick-look Pipeline Tool should create calibrated image cubes and/or spectra, with the best calibration information currently available, including: conversion of correlation coefficients into flux density, including any of the following corrections not already made to the data: Tsys, gain, opacity, Van-Vleck, flux density scale; bandpass calibration; polarization calibration; transfer of amplitude and phase correction from calibrator(s) (using the scaling factor between the calibration and observing frequencies if necessary); WVR phase correction, if desired and available.
5.2-R9.1	1 E	The following calibration modes shall be supported: calibration transfer (including fast switching);
5.2-	1 E	The following calibration modes shall be supported: self-calibration.

R9.2			
5.5-R2.11	1	E	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: the (uncalibrated) spectrum observed on an astronomical source (amplitude/phase or real/imaginary) with various options such as: the resultant image cube and/or spectrum from all quick-look pipeline executions related to the current observing session.
5.2-R10.3	2	E	The quick-look Pipeline Tool shall always compute the dirty image of astronomical sources when directed to do so (the operator or astronomer should be able to select spectra only), using the fastest algorithm possible. The supported observing modes should include: mosaicing;
5.2-R13	2	E	The quick-look Pipeline Tool should allow for a modest number of self-calibration + imaging/deconvolution iterations, if time allows.
5.2-R14	2	E	The quick-look Pipeline Tool should complete its execution on a time scale which is reasonable for astronomy decision making (current thinking is a few minutes at most).
5.2-R15	2	E	It should be possible to reproduce any function of the quick-look Pipeline Tool in the off-line data reduction package.
5.2-R5.1	2	E	If the quick-look Pipeline Tool is being run on request by a person, then that person should be able to modify the pipeline data reduction parameters for that particular run of the Tool, i.e., that person should have access to the Pipeline data reduction setup component of the Observing Tool.
5.3-R1	2	E	The default image pipeline needs to be triggerable from the on-line system (i.e., the on-line system recognizes that a Program has been completed, and sends a signal to the default image pipeline that it should commence with its processing. The default image pipeline may have to delay execution until all necessary calibration quantities are obtained, but it should have the capability of receiving the indication from the on-line system that all of the visibility data has been collected for that program).
5.5-R2.12.1	2	E	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: pulsar information, including: Pulsar name and its current period (calculated for ongoing observation);
5.5-R2.12.2	2	E	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: pulsar information, including: Dispersion measure (provided by astronomer) and derived quantities (dispersion smearing time at observed frequency/bandwidth);
5.5-R2.12.3	2	E	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: pulsar information, including: Time bin configuration, as required by hardware;
5.5-R2.12.4	2	E	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: pulsar information, including: A time averaged pulse profile made using time bins.
5.5-R2.6.3	2	E	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: auxiliary monitoring device output: Water Vapor Monitor byproduct data (e.g., derived precipitable water vapor from WVM data);

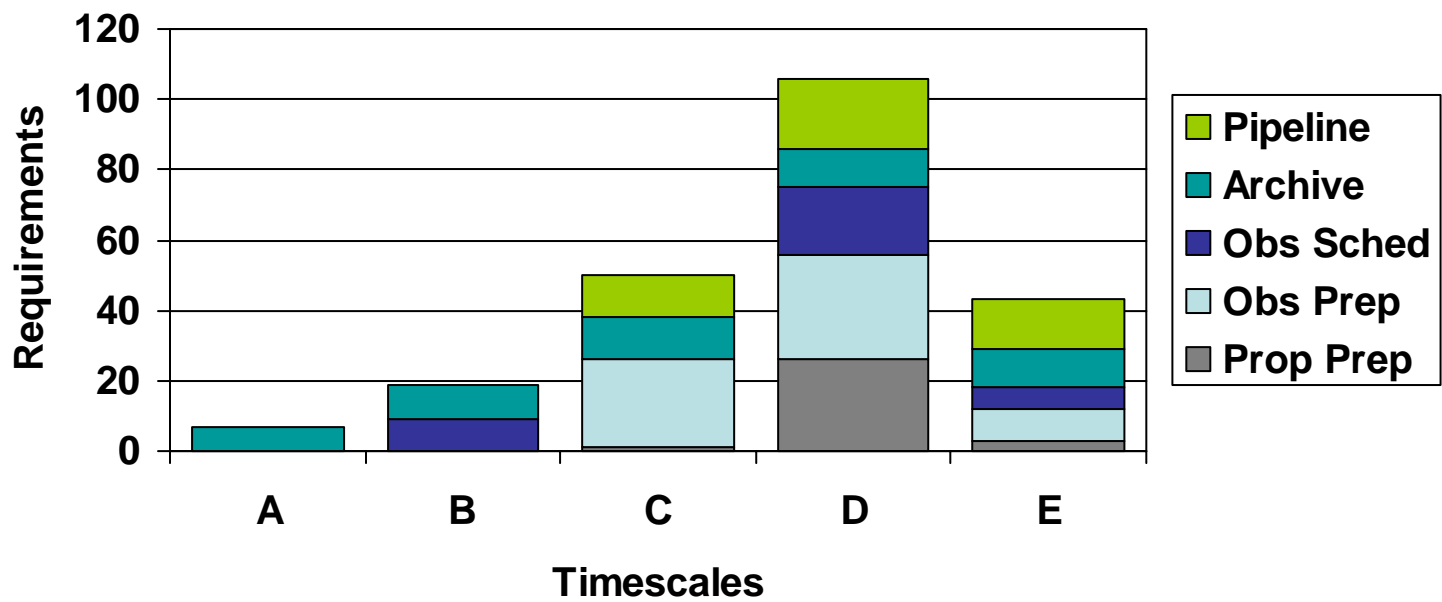


5.5-R4	2 E	It should also be possible for the staff astronomer, operator, or observer to initiate execution of the quick-look pipeline from the ``what's up" screen (assuming a reasonable request).
5.5-R4.1	2 E	The person initiating the execution of the quick-look pipeline should be able to modify the pipeline data reduction parameters associated with the Program Block, i.e., should have access to the Pipeline data reduction setup component of the Observing Tool.
5.5-R5	2 E	There should be a link to the Scheduling Tool web page from the ``what's up" screen.
5.5-R6	2 E	There should be a link to the Project web page from the ``what's up" screen
5.5-R2.6.4	3 E	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: auxiliary monitoring device output: RFI monitor (if available);
5.5-R2.8.5	3 E	The following quantities and their time histories (where appropriate) shall be able to be displayed via the ``what's up" screen: array properties, such as: for mosaic observations: the above quantities for each pointing center.

## Timeline and Deliverables

The preceding sections describe in some detail the timeline of requirements for each subsystem of e2e that need to be delivered to the EVLA project. The degree of effort is not uniform across the project. This is illustrated in Figure 2.

### Priority 1 Requirements



**Figure 2.** *Priority 1 science requirements for different e2e subsystems as a function of the release date (A-E). Some sub-systems (Archive) require on-going development throughout the EVLA project, while others (Proposal prep) are only required at later times in the project.*