Telescope Time Allocation (TTA): Concept

Dana S. Balser, Mark J. Claussen, Anand Crossley, Jeffrey S. Kern, Ryan, S. Lynch, Anthony H. Minter, Amy J. Mioduszewski, Loránt O. Sjouwerman, & Stephan Witz

02 July 2019

Abstract

We discuss high level (level 0) software requirements for a new set of telescope time allocation tools for the proposing process. The following facilities are included: VLA, VLBA, HSA, GMVA, and GBT. Here we only provide a description of the basic concepts.

History

0.1 Original draft—08 Jun 2018 (dsb).

0.2 Updates based on committee work—18 Jan 2019 (dsb).

1.0 Updates based on feedback from scientific staff—02 Jul 2019 (dsb).

Contents

1 Background

On 25 September 2014, a small group of National Radio Astronomy Observatory (NRAO) managers, scientist, and developers met in Socorro, NM to discuss at a high level the software tools that provide the functionality from proposing to scheduling for the VLA, GBT, and VLBA.[1] During this meeting we reviewed the process for the VLA, GBT, and VLBA with detailed discussion of the various tools. The ALMA observing tool (OT) and the Phase I/Phase II approach was explored along with the strategy used by other observatories (e.g., HST). Here Phase I and II correspond to the proposal and observing process, respectively. Barry Clark proposed a way to remove Sessions in the proposal submission tool (PST) to "a more primitive version of how to specify observing time requests".[2] The main results of the meeting follow.

- *Web-based Tools:* There was no compelling reason to change from using web-based tools, unless it is decided to adopt the ALMA tools which use a downloadable tool.
- *Databases:* We should refactor the databases.[3]. That is, we need a more sensible database structure.
- *Phase I:* We should implement a Phase I tool (à la ALMA) for the VLA, GBT, and VLBA. This would include a rationalized PST, source catalog tool (SCT), telescope specific resource catalog tool (RCT), and exposure/sensitivity calculators.[4]
- *PST without Sessions:* We should adopt Barry Clark's proposal to remove Sessions from the PST after developing Use Cases.
- *GOST:* the general observing setup tool (GOST) should be replaced by the VLA RCT (VLA only).
- *Metrics:* Metrics should be supported via documentation and new database structures.

In Fall 2015, a series of informal discussions were held with small groups of stakeholders to flesh out some of the details. After these discussions and feedback from the Users Committee, it was generally agreed that we should replace or significantly modify the Telescope Time Allocation (TTA) tool suite. It was decided to proceed in a Phased approach where first we would make improvements to the VLA Prioritizer and remove Sessions in the PST, and then on a later timescale develop a new tool suite. The VLA Prioritizer has already been modified and released in semester 17A. We wrote software requirements to remove Sessions from the PST[5], developed a prototype, and implemented a test version in 2017. Feedback from internal testing, however, indicated that the Session-less PST was confusing since there were some aspects (e.g., overhead) that still made the user think about Sessions but now the details were hidden. It was therefore deemed not to be a step forward and was abandoned.

Since these initial discussions the Green Bank Observatory (GBO) and Long Baseline Observatory (LBO) were created to operate the GBT and VLBA, respectively, and the VLBA was brought back into the NRAO. Nevertheless, we continue to have a common TTA process that is run by the NRAO and use the same scientific reviewers. The TTA process also includes proposals to the global mm VLBI array (GMVA).

2 Charge to the Committee

The SSR Assistant Director, Lewis Ball, charged the committee with the following tasks:

> *"Refine the draft document 'TTA Software Requirements' to capture all essential high level (Level 0) stakeholder requirements for a new suite of software tools to support the submission, scientific and*

[1] See https://staff.nrao.edu/wiki/bin/view/OSO/ProposingToScheddulingBrainstorm2014.
[2] See https://staff.nrao.edu/wiki/pub/OSO/ProposingToScheddulingBrainstorm2014/sessions_BarryClark.txt.
[3] See https://staff.nrao.edu/wiki/pub/OSO/ProposingToScheddulingBrainstorm2014/VLA-PHT-PBT-OPT.pdf
[4] See https://staff.nrao.edu/wiki/pub/OSO/ProposingToScheddulingBrainstorm2014/IMG_0887.JPG.
[5] See https://safe.nrao.edu/wiki/pub/Software/TTAProjects/pstRequirements.pdf.

technical review, time allocation, and scheduling of proposals for the NRAO telescopes, consistent with the requirements for observing preparation given NRAO's commitment to SRDP.

Key communications from the Committee (updated drafts, minutes of meetings etc) will be distributed to the broader TTA email list to help ensure appropriate wider input from all the key internal stakeholders."

The NRAO Director and the SSR Assistant Director provided the following high level guidelines to the committee:

- The software needs to support the VLA, VLBA and GMVA. Support for the GBT is an option, but is not a core requirement. NRAO welcomes input from the GBO on the level of interest in participating in NRAO's development of the new tools versus the option of developing its own tools.
- The look and feel of NRAO software should be similar across the different facilities if at all possible. The new TTA software should therefore be as close to ALMA as is reasonable. The intent is that the user interface will essentially follow the design and functionality of the ALMA OT. Thus "took and feel" refers to the experience of a user submitting a proposal to NRAO. To the extent that it is efficient to do so, the implementation is expected to draw from the ALMA tools as well. If there are needs specific to the North American NRAO telescopes that require a departure from the ALMA design, and there are clear arguments for taking a different approach, then we will do so. Another way of putting this is that we expect the NA NRAO tools to be "only as different from the ALMA tools as they need to be."
- A major NRAO initiative is to produce science ready data products (SRDPs). We therefore need to include any information necessary to generating SRDPs in the software requirements for the VLA. Since the VLBA is expected to be reintegrated into NRAO, it is expected to be in scope for the SRDP project.
- It is not a requirement that the proposal handling elements of the tools follow the ALMA model, since these are not exposed to the users. If such elements can be efficiently reused it makes sense to do so. However, given differences in the ALMA and NRAO process this may not be sensible or possible.
- Given the age and inefficiencies of the observing preparations software, and the coupling between it and the proposal submission and assessment tools, the OPT and similar tools will need to be renewed as soon as possible. However, it will be competing for limited DMS resources together with SRDP and PST/PHT priorities. This Committee is not charged with defining the formal requirements for the observing preparation tools. However, it is expected to identify the requirements for the interface between the PST/PHT suite of tools and the proposal preparation tools, in anticipation of the timely development of new proposal preparation tool.
- Time should be allocated as total telescope time (no change from the current approach). This is in contrast to ALMA where a sensitivity level is allocated by the TAC.
- The software does not have to support the TAC setting priorities at the source level (with the exception of conflicts). The allocation level may be the correct place.

3 Overview

Figure 1 compares the project hierarchies of ALMA, VLA, GBT, and VLBA.[6] In detail they are different, but at the lowest level they are similar. Each telescope has sources, resources, and timing. The scheduling and observing are handled differently, but this is not surprising since they are different instruments.

Figure 2 summarizes the main activities from proposing to data delivery. We divide these into two main components: proposing and observing. Telescope time is requested on the VLA, VLBA, GBT, HSA, and GMVA by

[6]See: https://staff.nrao.edu/wiki/pub/OSO/ProposingToScheddulingBrainstorm2014/VLA-PHT-PBT-OPT.pdf (taken from Bryan Butler). The VLBA terminology is that the equivalent of a scheduling block is called a program. There is also an informal equivalent of a program block, implemented by convention on program names.

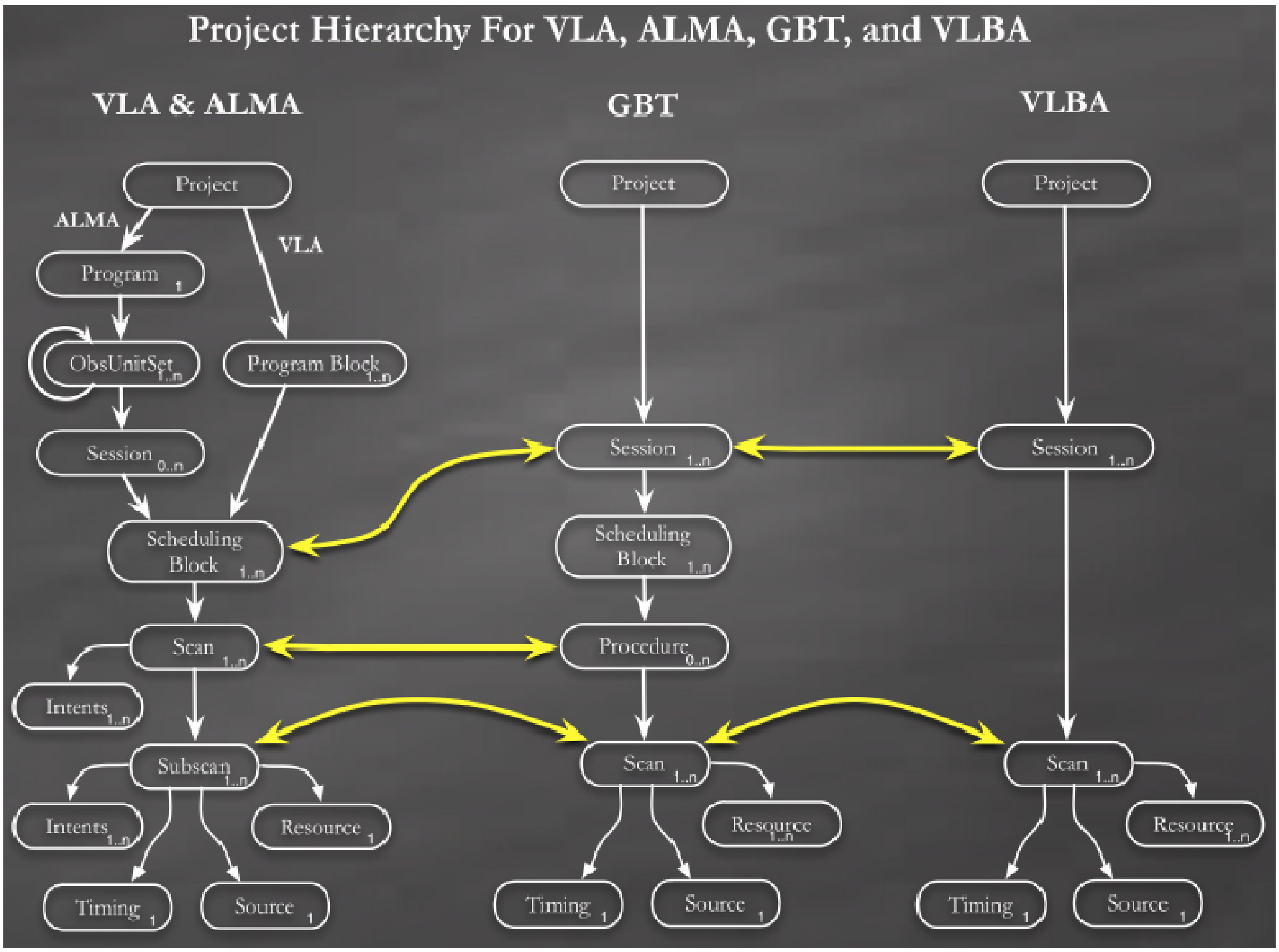

Figure 1: Project hierarchies for ALMA, VLA, GBT, and VLBA.

creating, editing, validating, and submitting a proposal. Exceptions are joint external proposals that do not go through the NRAO review process (e.g., global cm VLBI).

For these external proposals basic information is captured to derive metrics, and if accepted any information necessary to perform the observations. All proposals submitted through the NRAO TTA process are evaluated during the review process, except "Sponsored" proposals where time has already been granted via a contract. First, reviewers anonymously evaluate both the technical and scientific merit of each proposal, including a data management (DM) review for Large proposals. A telcon is then held by each science review panel (SRP) to discuss the results of the individual reviews and form a consensus review. The SRP chairs meet face-to-face with observatory staff at the telescope allocation committee (TAC) meeting to assign priorities based on the linear-rank score and scheduling/resource constraints. These TAC recommendations are reviewed by the Director and finalized at the Directors' Review. Since HSA and GMVA proposals use other facilities these proposal require consensus with external TACs. Once finalized the results are communicated to the public (e.g., disposition letters).

The observing process is telescope dependent. For the VLA a project is created for proposals that have been approved for observing. Scheduling blocks are then generated. For projects that include SRDPs there is an added requirement that SBs can be generated automatically. Once the observations are completed SRDPs are generated and the data are delivered. Since the VLBA is in scope for SRDPs a similar process is necessary. For the VLBA, VLBI schedule files will need to be generated. Similarly, if SRDPs are requested then these VLBI schedule files will need to be automatically generated. SRDPs are not in scope for the GBT, but they should *not* be designed out of the software. For the GBT projects are created and then scheduling sessions are generated. A scheduling session consists of the information required to schedule the GBT using the Dynamic Scheduling System (DSS), but unlike SBs they do not include the information for observing. In most cases the observations are performed remotely by the project team. Raw data are archived but no SRDPs are delivered.

Here we only consider software requirements for the proposing process. Nevertheless, to work through the various Use Cases it is useful to discuss how a project is processed from proposing to data delivery. Also included, however, are software requirements for metrics that are related to proposing (e.g., the proposal oversubscription rate). Here we focus on high level software requirements (Level 0) and do not discuss system design.

4 Software Requirements: Proposal Submission

The ALMA project data model is summarized in §A. Included are details of the ALMA OT Phase I process. For ALMA a project is at the top level and contains one proposal, review information, and scheduling/execution blocks. ALMA proposals consist of one or more science goals. Each science goal consists of a field setup, spectral setup, calibration setup, control and performance, and a technical justification.

The ALMA project data model does not fully support the requirements of the AUI North American facilities lacking support for multiple telescopes, joint external proposals, and differentiation between sponsored and open-skies observing. Here we develop a variant of the ALMA structure which addresses these requirements as well as some of the shortcomings of the ALMA model (see Figure 3). A proposal is at the top level and includes basic *proposal information*: identifying information, title, abstract, overall science objective, etc. Each proposal consists of one or more *allocation requests*. *Allocation requests* specify and justify the user's request for observatory resources. Each request will be for one telescope, and should constitute the necessary resources to produce a scientifically viable data set. The *allocation request* is similar is some respects to the ALMA science goal concept, but provides the additional flexibility and structures required to support joint proposals, both among the AUI telescopes and external to AUI. Because there are differences in usage a new name was chosen to avoid confusion with the term science goal. Justification for the allocation of resources is provided in the *allocation request* and, usually, the science products that will be derived from the observations. **We need to provide users with some guidance on when to have one or more allocation requests. A general rule of thumb is that if you have a multi-frequency project, for example, then if you need both frequencies to do the science then both frequencies should go into a single allocation request; otherwise you should create two allocation requests.**

The review process assigns priorities to each *allocation request* and creates an *allocation award*. This contains all of the details of the *allocation request* plus any review information. For proposals with approved *allocation awards*, a *project* is created for each award, which are by construction per telescope.

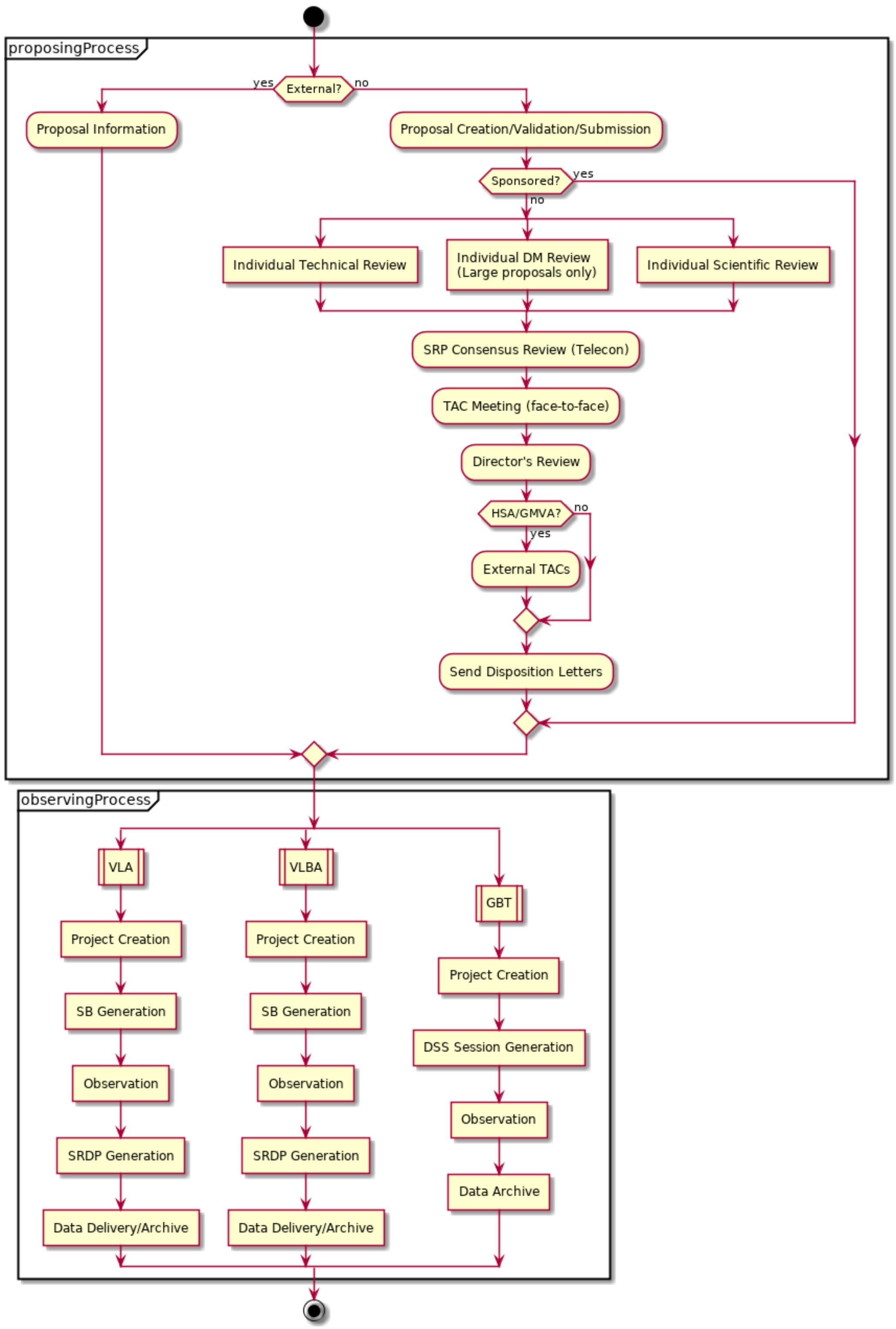

Figure 2: Activity diagram from proposing to data delivery for the VLA, VLBA, and GBT.

Projects are primarily for observatory tracking purposes and should be transparent to the user. One or more *scheduling blocks* (SBs) would be generated for each project, based on the information contained in the *allocation award*. So *Projects* contain the information for performing the observation, whereas *Programs* link each observation (scheduling and execution blocks) to an anticipated SRDP. *Programs* play a similar role to the ALMA observing unit set (OUS) structure in that they are used to organize the execution of the pipeline for SRDP generation. Unlike the ALMA OUS, however, *programs* do not contain *scheduling blocks* but rather organize the execution blocks (and other *programs*) for the purposes of processing. An execution block is an instance of an observation of a *scheduling block*.

Below we discuss each component separately.

4.1 Proposal Information

Proposal Information includes identifying information, title, abstract, and the scientific justification. This section is independent of which telescopes are included in the proposal. Author affiliation information needs to be stored in a way that persists so that the information at the time the proposal was submitted can be captured. *Proposal information* consists of the following:

1. PROPOSAL ID: yys-xxx where yy is the year (e.g., 2019 →19), s is the semester (either A or B), and xxx is a unique identifier. For example, 21A-123. Currently, the VLBA monitor and control system is limited to only 5 characters, and therefore if this is not updated an additional legacy ID must continue to be created for VLBA *projects*.
2. PRINCIPAL INVESTIGATOR: should include the global ID.
3. CONTACT PERSON: should include the global ID.
4. CO-INVESTIGATORS: should include the global IDs.
5. AUTHOR PRIMARY AFFILIATIONS: need to accommodate null values.
6. AUTHOR PROFESSIONAL STATUS: for example, are they students?
7. AUTHOR GENDER: for metrics.
8. TITLE:
9. ABSTRACT:
10. SCIENTIFIC JUSTIFICATION:
11. PROPOSAL REVIEW CATEGORY: semester, director's discretionary time (DDT), or external. Authors of external proposals will be required to include basic proposal information.
12. SCIENCE CATEGORY:
13. THESIS PROJECT: logical yes/no if the current proposal is a thesis project. If so, the student name and expected year of graduation should be shown. Also, the dissertation plan should be available. The essential *allocation requests* should be indicated.
14. RELATED PROPOSALS: proposal ID of previous proposals that are related to the current proposal in scientific scope.
15. RE-SUBMISSION: proposal ID of a previous proposal that is being submitted again.

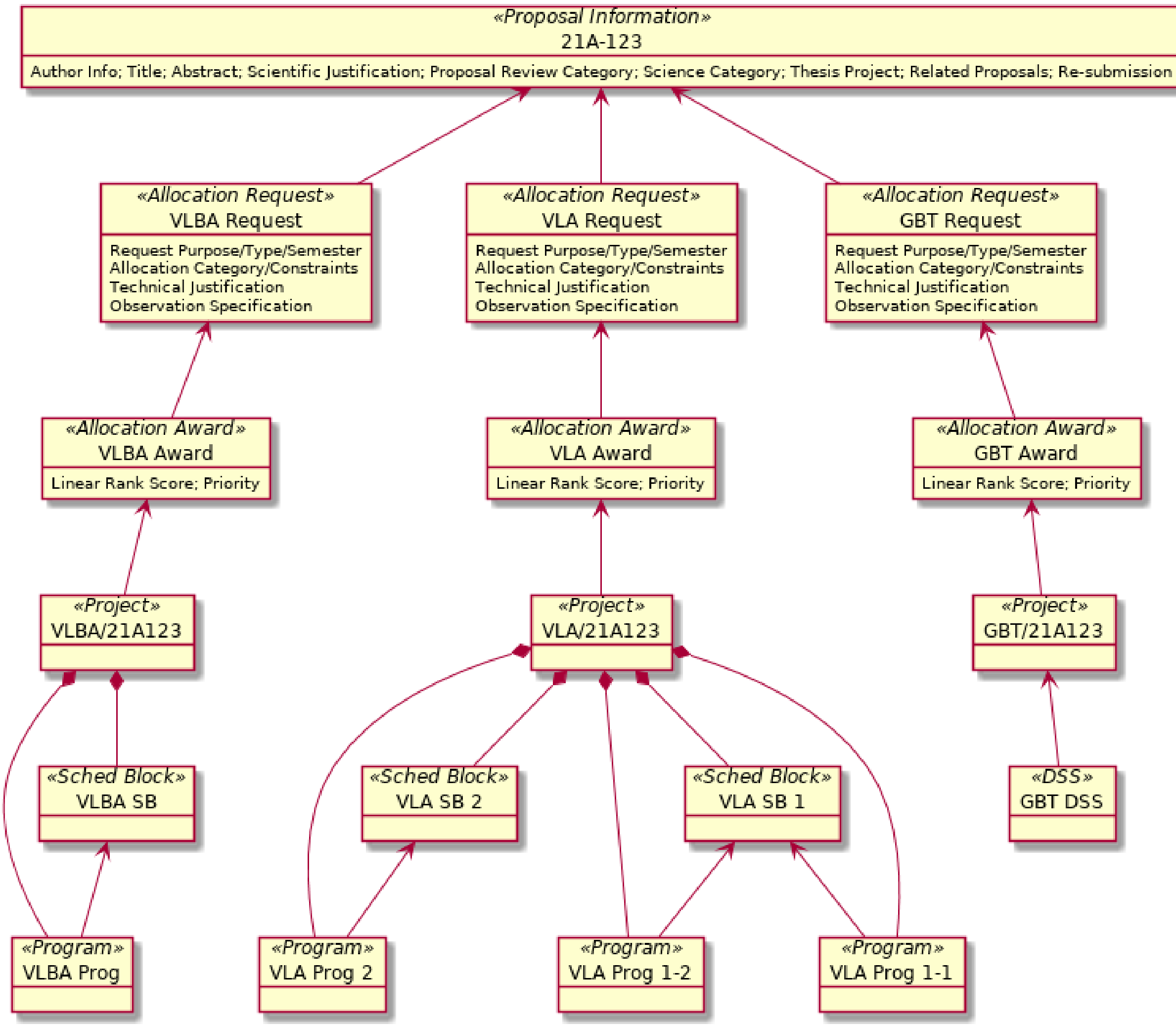

Figure 3: Proposal structure. The top level includes the basic proposal information (e.g., P.I., abstract, etc.). The *allocation request* contains many of the details: positional information and the associated telescope resources. *Allocation awards* are generated after the review process and contain the TAC results. If time is approved by the TAC, *Projects* are produced and include the information necessary to generate *scheduling blocks* (VLA/VLBA only). *Programs* provide the information to initiate SRDP generation where one ore more SB executions may be required.

4.2 Allocation Request

The *allocation request* primarily provides the detailed resources required for the observations. Currently this process is focused on telescope time, but future *allocation requests* could be other resources such as network bandwidth, storage, or processing. As a general concept during the allocation process enough information should be captured to allow the observation or processing to be executed. Some users may opt to make changes prior to observations but this is not in general required. For *allocation requests* that request time at external facilities (e.g., HST), only the telescope, total time, and technical justification are required. An *allocation request* consists of the following:

1. ALLOCATION REQUEST ID: an ID that combines the proposal ID with the telescope or resource being requested. For example, if proposal 21A-123 was an AUI joint proposal requesting both the VLA and VLBA then the allocation request ID would be VLA/21A-123 and VLBA/21A-123, respectively.

2. REQUEST PURPOSE: specifies the goal and data products that are needed. For example, astrometry (position and image); detection (flux density, signal-to-noise ratio, image); monitoring (flux density, time); and polarimetry imaging (image, polarization angle, image, rotation measure).

3. REQUEST TYPE: the instrument or resources being requested. This is typically the telescope being requested. Here the HSA and GMVA are considered as separate telescopes. Joint proposals (e.g., HST) would be different *allocation requests*. We might also consider correlator resources (e.g., to run data through the correlator again).

4. REQUEST SEMESTER: The user should specify the semesters for which the proposed observations are expected to be executed. The default should be the current semester when the proposal review category is "DDT" and the call for proposals semester if the proposal review category is "semester".

5. ALLOCATION CATEGORY: open-sky, sponsored, or RSRO. If sponsored then the user should specify if the proposal is public or closed. If public, then the name of the sponsor should be specified.

6. TECHNICAL JUSTIFICATION: a technical justification for the resources specified in the request type.

7. ALLOCATION TYPE: regular, large, or DDT. If the proposal review category was DDT then only DDT should be allowed here. The user needs to specify one of the following DDT types: exploratory, target of opportunity, or EPO. For large proposals there should be a separate section made visible to the user to include the data management plan. The software should display a table that includes the raw and, if selected, SRDP estimated data size. There should be an option for the user to input the data size for data products produced by the authors. Lastly, there should be an option for the user to indicate that this *allocation request* is for filler time.

8. TRIGGERED: an option to specify if the *allocation request* is triggered. If so the user needs to specify: target type, origin of trigger, trigger event description. The semester(s) and number of events plus required response window (with units) would go into the allocation constraints (see below).

9. CALIBRATION METHOD: an option to either use the standard observatory calibration strategy or a user specified strategy. If the latter is chosen the user needs to provide a detailed explanation.

10. OBSERVATION SPECIFICATION: defines the scientific observations (and products for SRDP telescopes) the proposer is requesting. Ideally much of the hardware specific configuration will be automatically populated based on the scientific information provided by the proposer, although the ability for technical experts to optimize the hardware will be retained. Conceptually for each observation specification the following categories of information need to be captured: the field, the front-end, the back-end, the total on source time, and the desired SRDP. Of course these types of information are not independent and changes to one aspect will affect others. The detailed design of this portion of the system will need to allow intuitive navigation of these interactions. Interfaces should be similar to ALMA with visual displays of the field and spectral setup, and efficient methods to use configuration information in multiple fields.

Field: composed of a coordinate system, position, position range, field of view, velocity/redshift, velocity definition, and velocity reference frame. For Solar System objects an ephemeris file should be uploaded. The software should include the ephemerides of standard Solar System objects and therefore allow the user to select from a list of such sources. There needs to be a way to update the ephemeris at a later time before the observations are executed. For some kinds of observations the ephemerides may not be available until a couple days before the observing. Further, for VLBI observing, improved ephemerides to be used for correlation may only be available after observing has completed. There must be a way to handle flexible delivery times of these files.

Front-End: consists of the array configuration (for the interferometers) and the receiver. In some cases the front-end and back-end are the same (e.g., GBT MUSTANG). Specifying the array configuration is relatively straight forward for the VLBA, HSA, and GMVA where the stations are fixed. The user needs to specify the stations requested/required given the constraints. This is more complicated for the VLA, however, and the basic logic is described in §B. The detailed algorithm is specified in the VLA Configuration Algorithm system document (No. 6. in §D).

Back-End: provides information on the detectors which consist of correlators, FX spectrometers, V/F converters, etc. A similar logic should be used to configure the VLA WIDAR, VLBA DiFX, and GBT VEGAS back-ends. An example for the VLA WIDAR correlator is given in §C. The detailed algorithms are given in the VLA, VLBA, HSA, GMVA, and GBT Resource Specification system documents (No. 1.-5. in §D).

Total On Source Time: the total on source time. This may be determined by many different considerations (sensitivity, event occurrence rate, uv-coverage for an interferometer, etc). The software should assist the proposer in determining this value (e.g, a built in sensitivity calculator). The total time request should be based on the field integration times, calibration overhead, and a global project overhead rate. The total *allocation request* time should be based on this number, with an option for the user to provide a different number, with appropriate justification. Regardless of the calculations or considerations involved in deriving the *allocation request*, an *allocation award* is solely an award of observing time to the PI. Both the user specified and the observatory calculated values should be provided in the review process. Detailed requirements are given in the VLA, VLBA/HSA/GMVA, and GBT Exposure Calculator system documents (No. 7.-9. in §D).

SRDPs: an option to specify if SRDPs should be generated (only for the VLA and VLBA). If the user specified that the calibration method is "standard observatory calibration" then the default here is that SRDPs be generated. If the user overrides the default then they must justify why and this information should be made available to the scientific and technical reviewers. If SRDPs are generated then the following additional information should be requested to provide the intent: a list of spectral lines with associated rest frequency and line width plus for each image the expected peak flux density (continuum and line), the polarization products (currently only XX, YY, LL, RR, or I), whether to perform a continuum subtraction, and if the line is in absorption or emission. The rest frequencies should have the corresponding velocity/redshift, velocity definition, and velocity reference frame. Since this additional information may not be readily available this request should be optional.

11. ALLOCATION CONSTRAINTS: should include the following categories.

    - *Strong/Weak Fixed Observations.* The date/time is fixed but there may be some flexibility (e.g., only a sub-set need to be executed). A list of (UT start, UT end, duration) should be specified. This allows for a delta; that is, the duration does not have to equal (UT end - UT start). The software should allow the list to be grouped with a number n that needs to be observed where n is greater than or equal to one. Irregular integration times should be accommodated.
    - *Regularly/Irregularly Spaced Windowed Observations.* The observations can start in different ways: a UT time can be specified, a trigger (both internal or external), a date range (e.g., sometime in August), etc. A cadence is then specified which is a list of numbers and associated deltas. We may want to assume some grouping to allow for more complexity. Irregular integration times should be accommodated.
    - *Night Time Only.* There are three choices: thermal stability (GBT only); RFI night; and Solar avoidance. Given the distributed nature of VLBI this option should not be allowed for the VLBA, HSA, or

GMVA.

- *Other.* There should be an option to allow the user to enter text that describes their non-standard allocation constraints.

12. *External Dependencies:* Information that will be provided from an external source. For example, target of opportunity proposals where the target will not be know until later. There should be a way to indicate if there are external dependencies and if so a way to enter details (e.g., text-box).

4.3 Allocation Award

Each proposal will consist of one or more *allocation requests*. The proposal review process described in §5 will assign a linear-rank score for each proposal and a scheduling priority to each *allocation request*, or in some cases to a specific *scheduling block*. There may also be scheduling constraints that are included in the disposition. The *allocation award* therefore consists of all of the detailed information contained in the *allocation request* plus the linear-rank score (used in the scheduling algorithm for some telescopes), the priority, and any scheduling constraints. In some cases the proposer or the TAC may recommend a proprietary period that is different than the default. Therefore, there should be a field that captures the proprietary field in the *allocation award*.

4.4 Project

One *project* is created for each *allocation award* that has been approved time. They are telescope dependent but in general they should contain all of the information in the *allocation award*. *Projects* are formed after the proposal process and therefore software requirements are not included in this document.

4.5 Scheduling Block

The information necessary to generate *scheduling blocks* should be contained in each *project*. Their detailed structure will be telescope dependent. *Scheduling blocks* are formed after the proposal process and therefore software requirements are not included in this document.

4.6 Program

Programs are tied to the execution blocks. They include user intent on the desired data products and therefore knowledge on the execution blocks to combine and when to execute the pipeline. *Programs* are formed after the proposal process and therefore software requirements are not included in this document.

5 Software Requirements: Proposal Review

The reviewing software should enable the NRAO to manage the proposal review process and provide interfaces for both internal and external users. Figure 2 summaries the different review components. Each open-skies proposal receives an individual scientific review and one or more technical reviews (optional) at the *allocation request* level. Large proposals also may receive a data management review at the *allocation request* level. Each SRP has a teleconference where they discuss the proposals in their panel. They produce a consensus review (text plus score). Once complete a normalized linear-rank is generated by SRP for the telescope allocation committee (TAC), which is comprised of the SRP chairs. The TAC assigns a scheduling priority taking into account the technical and science review, resources, and any scheduling constraints. The scheduling priority that is assigned by the TAC is done for each *allocation request*. There may be different scheduling priorities for each scheduling block (VLA/VLBA) or DSS session (GBT) within a given *allocation request*. Individual sources may be removed due to conflicts. The TAC results are discussed at a Directors' review where modifications may be made. The results are then made public by: disposition letters, TAC report, and science program. **Here we assume that the proposal authors, including the PI, are made visible to the reviewers. In the future we may use a double blind approach where the reviewers and authors are both anonymous.**

Once approved for any telescope time the following information becomes public in the proposal finder tool (PFT): proposal ID, author names, title, abstract, science category, and approved hours per *allocation award*.

5.1 Individual Review

Each proposal receives an individual review. The reviewer of each individual review is not made visible to the panel, but usually becomes obvious during the panel review telecon (see below). Three types of individual review are considered: science reviews (required), one or more technical reviews for each *allocation request* (optional), and one or more data management reviews for each *allocation request* for Large proposals (optional). An interface is required that allows NRAO administrators to assign reviewers. There should be a mechanism that allows individual reviewers access to previous reviews; care must be taken of any conflicts of interest.

For all reviewers the first step after logging in using their NRAO user account is to declare conflicts. There should be an interface that lists:

- PROPOSAL ID:
- TITLE:
- AUTHORS: full list of author with the PI labeled.
- CONFLICT: status of yes or no.
- CONFLICT REASON: text-box for reviewer to describe why they are conflicted.

The software should automatically mark the reviewer as conflicted if they are an author on the proposal with a reason: "Reviewer is an author of the proposal.". The reviewer should be allowed to self declare any additional conflicts and supply a reason. Once complete there should be a way for the reviewer to accept these conflicts and move to the next stage.

Once conflicts have been declared there should be a summary view of all the proposals where the following is listed:

1. PROPOSAL ID:
2. TITLE:
3. PI:
4. REVIEW TYPE: Primary, Secondary, Tertiary, None, or Conflict.
5. STATUS: Enter Review, Conflict, In Progress, or Complete.

The reviewer should be able to filter on telescope and joint proposals. The reviewer should be able to generate a PDF of a single proposal, all proposals in a single PDF file, or all proposals in individual PDF files. There should be an option to limit the components of the proposal generated (e.g., do not include source list since this may be thousands of sources). The reviewer should not be able to view or review any proposal for which they are conflicted.

5.1.1 Science Review

We currently use a panel-based system to perform the science reviews (Schwab, Balser, and Hunt, 2015). There are 9 science review panels (SRPs): AGN, GWT, PCO, EGS, HIZ, ISM, NGA, SSP, and SFM. These may evolve with time and therefore the software should be flexible. Each SRP consist of $5 + r$ reviewers plus one chair, where r is the number of supplemental reviewers given by $r = 4.0\,n/30.0 - (N + 0.5)$. Here n is the number of proposals in a given SRP and N is the usual number of SRP members (5). We therefore consider adding supplemental reviewers when $n > 50$.

Individual science reviews are performed anonymously for each proposal that consist of text plus a score (between 0.1 and 9.9). There should be a mechanism to remind the reviewer that smaller numbers are better scores. These scores are normalized to have a mean of 5 and a standard deviation of 2. The software should allow the user to enter a review for all proposals for which they are not conflicted. The review consists of

1. COMMENTS FOR THE SRP: these are intended to be rough working notes for the SRP teleconference and to be used to form the consensus comments.
2. INDIVIDUAL SCORE: a number between 0.1 and 9.9. These should be labeled as 0.1 (best) and 9.9 (worst). The default score should be zero and therefore if a reviewer does not input a score (e.g., conflicted) then the score should be zero. Reviews with a score of zero should not be used to derive the normalized score (see below).

The following information from the proposal should be easily accessible: proposal code, PI, title, SRP. That is, while entering a review the reviewer should not have to view the proposal PDF to find this information. There should be a mechanism for the reviewer to complete the review which will be locked after a certain date/time. The reviewer should be able to enter reviews either manually or by file import. There should be a way for the reviewer to complete all reviews with a single action.

The SRP chair should also have an interface that summarizes the review status and allows them to assign reviewers to specific proposals. There should be a matrix: reviewer by proposal ID. Each cell should contain information about the review type and status. The review type should be indicated by text (primary, secondary, tertiary, none, conflict), whereas the review status should be represented by color (none→white, saved→gray, complete→green, closed→blue, conflict→red). The SRP chair should be able to export a csv-formatted file that lists:

1. PROPOSAL ID:
2. TITLE:
3. PI:
4. TOTAL TIME: the total proposed time in hours.
5. THESIS: if a thesis proposal then “y”; otherwise blank.
6. EXTERNAL: if an external joint proposal then “y”; otherwise blank.
7. MULTI-SEMESTER: if proposing to use multiple configurations that span multiple semesters “y”; otherwise blank (VLA only).
8. REVIEW TYPE: Primary, Secondary, Tertiary, None, or Conflict for each SRP member.

The SRP chair should be able to assign reviews either manually or by file import (same format as export).

5.1.2 Technical Review

The individual technical review is telescope dependent and therefore performed at the *allocation request* level. For example, a proposal with two *allocation requests* that includes the VLA and GBT will require two technical reviews, one for each telescope. In some cases a single *allocation request* may require up to two technical reviews. For example, an HSA proposal that includes the GBT as a station will require VLBA and GBT technical reviews. The technical reviews are performed by observatory staff and are not panel-based like the science reviews.

The software should allow the reviewer to enter a review for all proposals for which they are not conflicted. The review consists of:

1. COMMENTS FOR THE PI: these comments should be made available to the PI (but also visible to the SRP/TAC).
2. COMMENTS ONLY FOR THE TAC: these comments should not be made available to the PI.

The following information from the proposal should be easily accessible: proposal code, PI, title, technical justification. That is, while entering a review the reviewer should not have to view the proposal PDF to find this information. There should be a mechanism for the reviewer to complete the review which will be locked after a certain date/time. The reviewer should be able to enter reviews either manually or by file import. There should be a way for the reviewer to complete all reviews with a single action.

5.1.3 Data Management Review

The data management review is only done for Large proposals. The user interface should be similar to the technical review. These should be performed by observatory staff who have knowledge of data management resources and constraints.

5.2 SRP Consensus Review

After the individual reviews are complete there should be a mechanism for the NRAO administrator to normalize the score and move to the next phase, the SRP review. For each reviewer derive the mean ($\bar{s}$) and standard deviation ($\sigma_{\rm s}$) of the (non-zero) raw scores (s). The normalized scores for each proposal are then: $\hat{s} = a * s + b$, where $a = 2/\sigma_{\rm s}$ and $b = 5 - a * \bar{s}$. If the parent distribution is Gaussian, this will transform it so that it has a standard deviation of 2 with a mean of 5. Only the non-zero raw individual scores should be used to derive the normalized score.

Once the scores are normalized a new interface should be available for the SRP review. Here each SRP will discuss the proposals in their panel during a teleconference and produce a consensus SRP review and SRP score. The interface should list:

1. PROPOSAL ID:
2. TITLE:
3. PI:
4. ALLOCATION TYPE: regular, large, DDT.
5. TRIGGERED: if the proposal is triggered.
6. TOTAL TIME: the total proposed time in hours.
7. THESIS: if a thesis proposal then “y”; otherwise blank.

8. JOINT: if an external joint proposal then list the telescope and time.
9. NORMALIZED SCORE: includes the "mean" and "standard deviation" of the normalized scores for the given proposal.
10. SRP SCORE: defaulted as the mean normalized score. Only the SRP chair should be able to modify this value.
11. SRP CONSENSUS COMMENTS: includes the "PI and TAC comments" and "TAC only comments". Any SRP member should be able to edit this field unless they are conflicted.
12. STATUS: Enter Review, Conflict, In Progress, or Complete.

The reviewer should be able to filter on telescope, SRP, allocation type, semester, and joint. There should be a way for the SRP chair to complete all SRP reviews. The SRP should be able to view the individual science, technical, and DM reviews. For the science reviews this should include the SRP comments and the "normalized" scores. These should both be anonymous; that is, do not list the reviewer name. The SRP member should be able to export the individual science, technical, and DM reviews with a single action.

The SRP chair should be able to export a csv-formatted file that lists:

1. RANK: the rank of the proposal (e.g., 1, 2, 3) in ascending order using the mean normalized score.
2. PROPOSAL ID:
3. MEAN NORMALIZED SCORE:
4. STANDARD DEVIATION OF THE NORMALIZED SCORE:
5. NUMBER OF REVIEWS:
6. TITLE:
7. PI:
8. TOTAL TIME: the total proposed time in hours.
9. THESIS: if a thesis proposal then "y"; otherwise blank.
10. JOINT: if an external joint proposal then "y"; otherwise blank.
11. MULTI-SEMESTER: if proposing to use multiple configurations that span multiple semesters "y"; otherwise blank (VLA only).
12. REVIEW TYPE: Primary, Secondary, Tertiary, None, or Conflict for each SRP member.

This is similar to the file exported in the previous stage with the addition of the rank, mean normalized score, and standard deviation of the normalized score. The file should be ordered by the mean normalized score (ascending).

5.3 TAC Meeting

Once the SRP consensus review is complete there should be a mechanism for NRAO administrators to generate the normalized linear-rank score. First the proposals are ranked within each panel using the SRP score (R=1,2,3, etc.) and then normalized by $10\,R/n$, where n is the number of proposals within the SRP. The software should generate preliminary priorities (A, B, C, N, F, or H) for observations in the current semester for each *allocation request*. This is telescope dependent and described in the VLA, VLBA/HSA/GMVA, and GBT Preliminary Priority system documents (No. 10.-12. in §D).

The software should generate PDFs that summarize all Large proposals, all Triggered proposals, all RSRO proposals, and all proposals for each telescope. These summaries should list the following for each proposal: proposal ID, normalized linear-rank score, SRP, allocation type, PI, CO-I's, title, abstract, joint info, preliminary priorities, and SRP comments. The software should also generate pressure plots for each telescope: histogram of the number of hours per LST. These should be broken down by priority and frequency range. The compute and space usage of each proposal (and the total) should be generated. Detailed requirements are given in the VLA, VLBA/HSA/GMVA, and GBT LST Pressure Plot Specification document (No. 13.-15. in §D).

The TAC weighs the scientific and technical merit of each *allocation request* and assigns updated priorities and approved time with any constraints, TAC comments to the PI, and TAC comments to NRAO. An NRAO administrator should be able to input this information into the system either manually or with file import.

5.4 Directors' Review

To prepare for the Directors' review the software should generate the following csv-formatted files.

- For all *allocation requests* by telescope: proposal ID, PI, allocation type, title, linear-rank score, requested time, and approved time (by priority).
- For joint external proposals by telescope: proposal ID, external facility, PI, title, requested NRAO time, requested external time, approved external time, priority, and normalized linear-rank score.

The software should produce the following statistics for each telescope by proposal count: the number of proposals submitted, approved (priority A, B), filler (C), rejected (N), and oversubscription (submitted/approved) by telescope; and by proposal hours: the requested time, the available time, the approved time (priority A, B), filler time (C), rejected time (N), and the pressure (requested hours/available hours).

5.4.1 Reports

There should be a mechanism to generate and email disposition letters. The proposal finder tool (PFT) database should be updated soon after the disposition letters are sent.

The software should generate a csv-formatted file for the science program for each telescope that includes: PI, proposal ID, title, approved hours, allocation type.

6 Software Requirements: Metrics

Here we list metrics that are related to the software within the proposal process (see Figure 2). Each metric begins with the cadence (e.g., every month) and the type of report in square brackets. A description of the metric is given together with a discussion. The metrics are detailed in the Metrics Definitions system document (No. 16. in §D).

1. [MONTH] [FLASH REPORT] Metric: Sponsored observing: hours per month on open skies and sponsored observing over past 13 months. Pie, bar, and line charts. Discussion: The observed hours resides in software downstream, but we can use the proposal and allocation request IDs to connect the observed hours with the sponsor information. We also need to know if the allocation request is public or closed.
2. [QUARTER] [PEMR] Metric: Proposals with NRAO PIs: number of proposals per cycle with NRAO PIs, for deadline and DDT proposals. Discussion: The author affiliation and type of proposal is included in the proposal information. The primary institute should be used from the account database when more than one affiliation is included.

3. [QUARTER] [PEMR] Metric: Proposals submitted per observing period, for deadline and DDT proposals. Discussion: This is specified in each allocation request via the allocation type. We need to use different nomenclature since cycle has different meanings for ALMA and VLA.

4. [QUARTER] [PEMR] Metric: Oversubscription rate (proposals received / proposals approved), for deadline and DDT proposals. Discussion: This information is available in the allocation award.

5. [QUARTER] [PEMR] Metric: Number of proposals in support of theses submitted and accepted. Discussion: This information is available in the proposal ID and the allocation award; we need to tie the project to the allocation request ID.

6. [QUARTER] [ODSM WIKI] Metric: Observing hours by PI: US, foreign, unspecified. Observing hours by PI: Graduate student, AUI Staff, Other Observing hours by PI: Country Observing hours by US PI: US State Discussion: The observed hours resides in software downstream, but we can use the proposal and allocation request ID to connect the observed hours with the affiliation and professional status information in the allocation award. For the affiliation we need to accommodate null values.

7. [QUARTER] [ODSM WIKI] Metric: Observed hours by SRP. Discussion: The observed hours resides in software downstream, but we can use the allocation request ID to connect the observed hours with the science category. For the VLBA we will have to use the legacy ID unless the VLBA is upgraded to include larger strings.

8. [QUARTER] [ODSM WIKI] Metric: Deadline proposals by SRP. Deadline proposals by type: Regular, Large, Sponsored, Dissertation (with disertation proposals broken down by allocation type and telescope). Discussion: We need to better define the metric and have continuity over time (out of scope here). Our current proposal structure contains all of the necessary information.

9. [SEMESTER] [DIRECTORS' REVIEW] Metric: Number of proposals and number of proposers per semester. Discussion: We need to make sure the global ID is included since there are duplicate names.

10. [SEMESTER] [DIRECTORS' REVIEW] Metric: Fraction of deadline proposals with US PIs (US authors) per SRP. Fraction of deadline observing time by proposals with US PIs (US authors) per SRP. Discussion: We need to better define the metric and have continuity over time (out of scope here). Otherwise the information is available in the current proposal structure.

11. [SEMESTER] [SOS LETTERS] Metric: For VLA and VLBA proposals, provide: proposal ID, PI last name, PI first name, PI email, grade(s), telescope(s). Discussion: Our current proposal structure contains all of the necessary information. We use the global ID to get the email in the profile; we want the current email for the contact person.

12. [ANNUAL] [DDT REPORT] Metric: Table of DDT proposals: proposal info + observing time Discussion: Our current proposal structure contains all of the necessary information. There was some discussion about observing time. For example, does this include lost time. For the GBT the answer is no. This issue is out of scope here but we should better define this metric in general.

13. [ANNUAL] [EXTERNAL PROPOSALS] Metric: Time requested (and approved) on non-NRAO telescopes. Discussion: This requires different options under the allocation request. For external telescope requests (e.g., HST) that go through our TAC we need to specify telescope, technical justification, and the time (e.g., orbits).

Since many metrics are given as a function of time, there is a requirement that historical data be available. Databases developed for the new software suite should be well documented and the documentation should be maintained throughout development and operation. This will allow for generating novel metrics reports without the need for UI modifications.

All observing projects executed on the VLA, VLBA, or GBT should have an entry in the new database, including projects approved by external TACs and sponsored projects. Projects that are not public should be identified as "closed" and should not require any other meta-data.

Data collected to generate various metrics should be static. For example, the time available on the VLA for a given configuration should not change with time. Similar data may be required for scheduling/observing and by necessity evolve with time. If so, then these should be different fields in the database so that the metrics do not change with time.

7 Use Cases

Here we specify use cases that should capture most types of observing projects.

7.1 VLA

7.1.1 Survey of 100+ Sources (see VLA/15B-178)

Proposal: Determine the metallicity structure in the Galaxy using HII regions. The goal is to observe the radio recombination line and free-free continuum emission toward 120 Galactic HII regions. The exact sources are not known since this will depend on the success of the selection strategy. That is, they will iterate on the source list based on the results of each execution block. Discussion: The telescope resources would be the same for all fields. All potential sources would need to be included to handle source conflicts, but the user would have to opt out of the total time calculated by the software since only a sub-set of sources will be observed. They could use this information, however, to estimate the total time and include this in the justification.

7.1.2 Mosaic (see VLA/15B-013)

Proposal: VLA mosaic of the end of the northern and southern Galactic bars. The goal is to mosaic the radio recombination line and free-free continuum emission over a one square degree region at the end of the northern and southern bars. There will be 634 pointing per mosaic. Discussion: The telescope resources would be the same for each source. The software should be able to determine if this project should be a pointed mosaic or OTF based on the integration time per field. Given the larger integration time a pointed mosaic is best.

7.1.3 Multi-frequency Project

Proposal: Requires observations of 2 sources for 20 min at C-band, X-band, and Ka-band with the constraint that the C-band and Ka-band observations have to be observed in the same scheduling block. Discussion: There would be three unique telescope resources, one for each frequency band, that are applied to the two sources. The constraint that the C and Ka-band be observed in the same *scheduling block* needs to be included in the scheduling constraints.

7.1.4 Sub-array Project

Proposal: The VLA can be split into multiple sub-arrays using different resources and/or sources. In this example, we want to observe one source for 5 hours using two sub-arrays using L-band and S-band. Discussion: We need to capture the number of sub-arrays, the number of antennas in each sub-array, and the configuration. The configuration should include two observatory specific cases: long/short baselines and uniform. We will need the ability to specify this at the pad level. We require that each sub-array has independent parameters for the observation specification. The *allocation request* time is the maximum value of the observation specification (not the sum).

7.1.5 Triggered Project (see VLA/18A-123)

Proposal: Radio observation of rapid, luminous and blue stellar explosions. Optical surveys will trigger the radio observations. The first epoch is scheduled in less than 1 week. Then four follow-up epochs to be observed approximately (within 1-2 weeks of) 20, 40, 80, and 160 days after discovery. Discussion: The current PST seems to capture the appropriate information. The proposal should be specified as Triggered with the following information: (1) target type; (2) origin of Trigger; and (3) Trigger event description. The information for scheduling should be put in the allocation constraints: (4) Semester(s) and number of events; and (5) Required response windows, with units. That is, we put the constraints for all proposals in one place. This information should be captured in a way that can easily be searched and compiled.

7.1.6 Moving Source Project (see VLA/17A-387)

Proposal: Measuring lunar heat flow. The issue is that the Moon moves so rapidly in the sky that it can be observed at nearly any right ascension so the LST range cannot be calculated a priori. Discussion: The user can upload an ephemeris file to capture the scheduling information.

7.1.7 Pulsar Imaging

Proposal: May use pulsar gating or may not. May want fast dump data to search for short transients (e.g. the localization observations of the repeating FRB). All the standard calibration. May require some windowed scheduling (e.g. astrometric VLBI observations for pulsar parallaxes/velocities). Discussion: The scheduling constraints should be captured in the allocation constraints. The software should provide these types of measurements as an option in the observation specification.

7.2 VLBA

7.2.1 Astrometry Project

Proposal: Measure the parallax of water masers in 10 sources to derive the distance. Discussion: The allocation constraint formalism should work here: a list of times with deltas for each source. There would only need to be one *allocation request* with potentially multiple SBs. In the past, astrometry projects have often been observed with fixed time depending on the priority. But since the constraints may be different for each source it is not clear how this fits into our current structure: for each *allocation request* there are one or more observation specifications and allocation constraints. We agreed to keep this simple and require different *allocation requests* for sources with different constraints.

7.2.2 VLBA Pulsar with a VLA Trigger

Proposal: The VLBA is dynamically scheduled to observe a pulsar. When this is observed the VLA is triggered within a week. Discussion: This would be two *allocation requests*: one for the VLBA observations and one for the VLA. The VLA would be Triggered.

7.2.3 VLBA with Multiple Fields

Proposal: Observations that request 10 fields in the primary bean. Discussion: This requires multiple passes with the correlator. Here we want to capture the number of fields, phase centers, etc.

7.2.4 VLBA Polarization with VLA Calibrator

Proposal: A VLBA polarization observation that makes use of nearly simultaneous VLA observations of a calibrator source. Discussion: This is similar to §7.2.2 except here there is no user involvement between observing and VLBI correlation. This will be handled differently by the system.

7.2.5 VLBA with Multiple Fields with Special Calibration

Proposal: Observations that request the correlation of multiple fields within the same pointing field of view. The strategy is to determine the calibration from one of these targets and apply that calibration to one or more of the targets. Discussion: This is a special case of §7.2.3 but will be handled differently by the system.

7.3 HSA

7.3.1 HSA plus the VLA

Proposal: HSA observations using Y1 plus simultaneous observations with the VLA. Discussion: This requires two *allocation requests*. One for the HSA component (VLBA and Y1) and one for the VLA. We must include a time constraint that these two *allocation requests* are connected.

7.3.2 HSA with Additional Resources

Proposal: An HSA observation with Y27 (phased array), but simultaneously use the full bandwidth of the VLA correlator; that is, use DiFX and WIDAR. Discussion: This is not expected to be an edge case as these requests are common. One option is to have one *allocation request* where the multiple backends would be specified within a given observation specification. This is in contrast to use case §7.3.1 where we have HSA using Y1 and the VLA is used simultaneous.

7.4 GBT

7.4.1 Wide Area Pulsar Survey (e.g., GBNCC)

Proposal: Essentially a point map to discover pulsars. The survey could cover a large area of the sky and therefore it might be useful to break the survey up into sensible LST ranges to facilitate scheduling. Discussion: There could be one field with a large RA/Dec range or multiple fields. For the latter, the software should group the sources into sensible DSS sessions.

7.4.2 Single Pointed Observations Pulsars

Proposal: Observe one or more pulsars at one or more frequencies. Discussion: There would be different observation specifications for the combinations of pulsars and frequencies (e.g., if there were 10 targets all with 3 frequencies then we would need 30). The user should not need to enter all of these details so the software provide a mechanism to create these options. That is, there are 3 unique set of resources.

7.4.3 Single Pointed Observations of Pulsars with Constraints

Proposal: Similar to §7.4.2 except with scheduling constraints. Discussion: We discussed several different types of constraints: (i) observe a source with a regular cadence with some error (pulsar monitoring); (ii) a trigger with an irregular cadence (e.g., SN goes off and they want to observer 1 day, 10 days, 1 month, etc.); and (iii) observe at different points in the phase of some orbit (e.g., binary star). We should capture these constraints automatically if possible.

7.4.4 Pulsar Gridding Observations

Proposal: Similar to §7.4.2 except with multiple short sub-scans to make a small point-map. The purpose is to refine positions of new pulsars at higher frequencies. Discussion: Similar setup as §7.4.2 except that the field of view equal to the point map size is specified indicating that mapping is required.

7.4.5 Multi-telescope Pulsar Observations

Proposal: Same as §7.4.2 except there are simultaneous observations with another telescope which could be different AUI telescopes (e.g. GBT/VLA) or external telescopes (e.g. GBT/Arecibo or GBT/Chandra). Discussion: This would be handled by the schedulers and therefore external to the software here.

7.4.6 Pulsar HSA Observations

Proposal: HSA observations in which the GBT also records pulsar data products. We had one project like this so far, where the users ran GUPPI alongside the VLBI recorder. This is not a standard observing mode and rare enough that we may simply want to handle this on a case-by-case basis. But more generally, we should think about how users would specify and justify non-standard setups like this. Discussion: For HSA *allocation requests* the user should select the stations to be used. Instead of capturing and attempting to validate detailed tuning specifications only the receiver bands should be captured during the proposal stage. The administrative overhead in maintaining the information for external stations was felt to outweigh the advantages of being able to validate this. For the case of additional resources (e.g., GUPPI, simultaneous use of the VLA, etc.), the additional resources should be attached to the HSA *allocation request* and are not an additional *allocation request*.

7.4.7 Standard Spectral Line (see GBT/14B-431)

Proposal: Detect radio recombination line emission from several normal galaxies. The goal is to use RRLs as an unobscured tracer of star formation. Discussion: Should be straight forward with a similar observation specification for each source.

7.4.8 ARGUS Mapping (see GBT/16A-235)

Proposal: The goal is to map a region $6' \times 4'$ in HCN across the entire disk of a normal galaxy. The total time on source is estimated to be 32 hr. Discussion: The user would specify the field of view required which would yield the information necessary to specify the map, assuming standard procedures for this type of observing. The user could override these defaults if necessary.

7.4.9 High Redshift CO (see GBT/16B-210)

Proposal: The goal is to observe two high z sources in different CO lines. For one source we observe CO(1-0), CO(2-1), and CO(3-2), whereas for the other we only observe in CO(1-0) and CO(3-2). Discussion: There would need to be 5 observation specifications; otherwise this is straight forward.

7.4.10 Bistatic Radar (see GBT/15B-368)

Proposal: The goal is to perform bistatic radio observation on a near-Earth asteroid. Discussion: The setup should be straight forward in terms of observation specification. Given the typical coordination of such observations these would probably need to be fixed observations in the allocation constraints.

7.4.11 Polarization Project (see GBT/13B-306)

Proposal: The goal is to confirm the variable polarization-dependent HI absorption in quasars. They need two 8 hr long tracks on two sources and then a calibration run on 3C286 across transit. Discussion: The difficulty is to capture the calibration method which impacts scheduling. Probably best to capture this as text in the allocation constraints.

7.4.12 Comet Project

Proposal: The goal is to observe OH in a specified comet as it approaches as part of a multi-wavelength effort. They request 5 observing sessions across any of 5 date ranges. Discussion: The scheduling details should be able to be accommodated in the allocation constraints with irregularly spaced windows.

7.4.13 ARGUS OTF Map

Proposal: The goal is to map a region using the on-the-fly mode but with different types of switching: (1) using the ends of the rows as OFFs; (2) using frequency switching; and (3) using a reference OFF position. The overhead and sensitivity will vary depending on the type of switching.

7.4.14 ARGUS Point Map

Proposal: The goal is to map a region by moving the antenna to a specified position and integrating (a point map). There are three different types of switching: (1) using the ends of the rows as OFFs; (2) using frequency switching; and (3) using a reference OFF position. The overhead and sensitivity will vary depending on the type of switching.

7.4.15 ARGUS Single Position

Proposal: The goal is to observe a single position with the ARGUS array. There are different types of possible switching modes: (1) On/Off position using the antenna main drives; (2) On/Off position using the sub-reflector (nodding); and (3) frequency switching. The overhead and sensitivity will vary depending on the type of switching.

A ALMA Project Data Model

The ALMA project data model (APDM) which, by design, is similar to that used at the VLA and consists of three main structures: proposing, reviewing, and observing information (Bridger and Butler, 2008). The top level structure is shown in Figure 4. In this document we only provide requirements for proposing and reviewing.

ALMA projects are divided into one or more science goals (see Figure 5). The observations are executed using scheduling blocks (SB) which are continuous blocks of time that are scheduled on the telescope. ALMA/VLA scheduling blocks correspond to observing sessions for the GBT and VLBA (see Figure 1). Scheduling blocks are organized into observing unit sets (OUS). There is a hierarchy of OUSs that consist of group observing units sets (GOUS) and member observing unit sets (MOUS). The intention is that data from different GOUSs will not be combined, whereas each MOUS corresponds to a different array configurations (e.g., 12-m, TP array, etc.), and therefore data from different MOUSs can be combined.

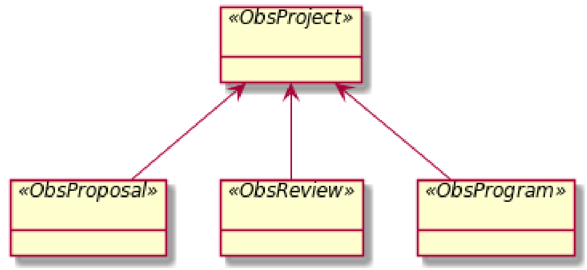

Figure 4: A schematic of the top level structure of the ALMA project data model (APDM) taken from Bridger and Butler, 2008. The APDM describes how the information is organized for an observing project.

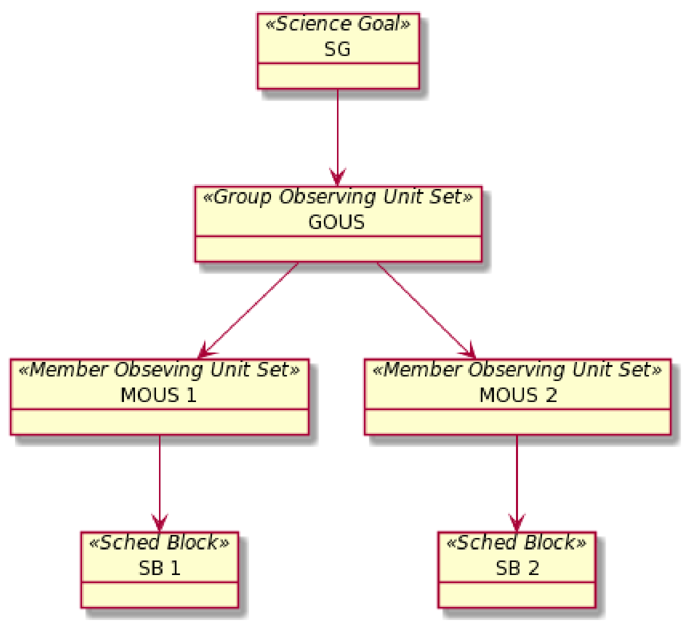

Figure 5: The program structure for ALMA. Scheduling blocks (SBs) are organized into observing unit sets (OUS) with a hierarchy of group and member OUSs.

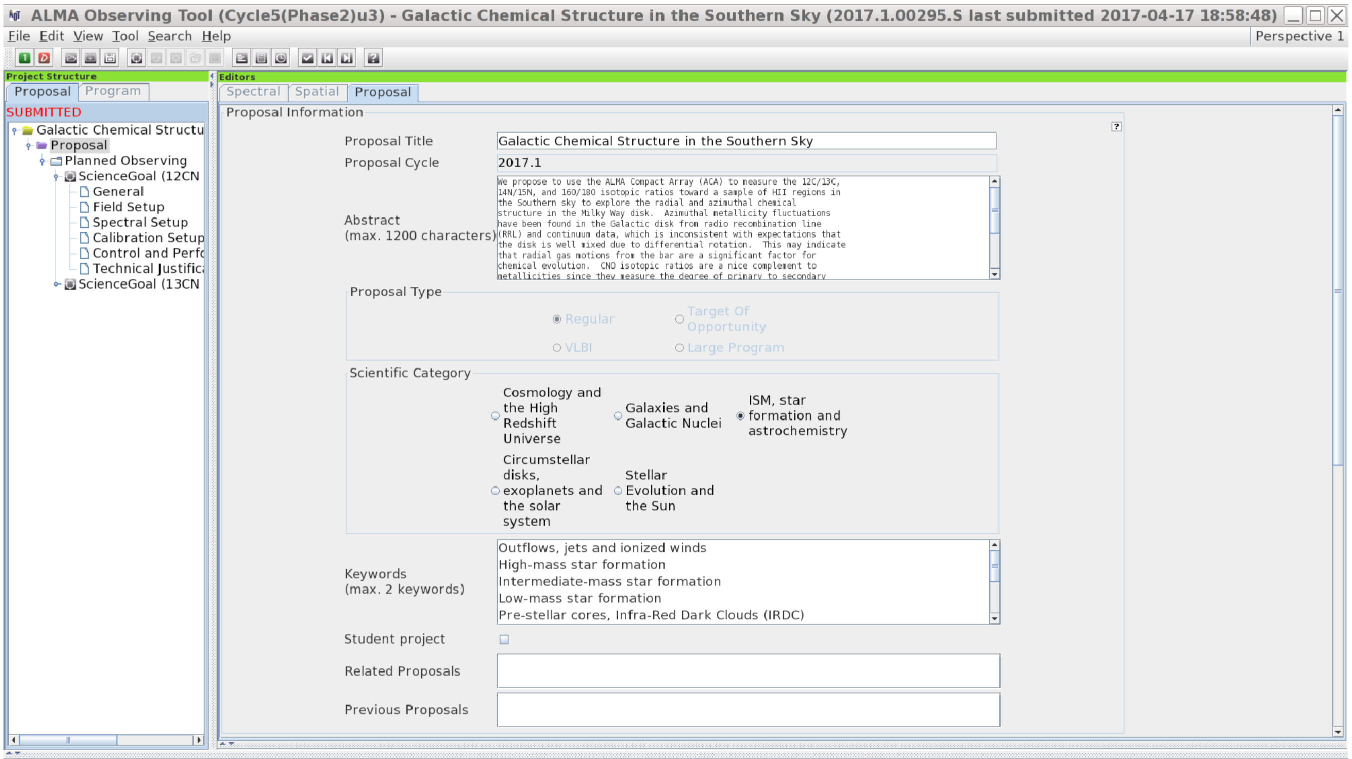

Figure 6: A screen shot of the ALMA OT cover sheet.

A.1 ALMA Phase I (Proposing)

A.1.1 General Information

Figure 6 shows a screen shot of the ALMA OT proposing information section. The following general information is required:

1. PROPOSAL TITLE:
2. ABSTRACT: maximum length of 1200 characters.
3. PROPOSAL TYPE: regular, target of opportunity, large program, or VLBI.
4. SCIENCE CATEGORY: (1) cosmology and high redshift universe; (2) galaxies and galactic nuclei; (3) ISM, star formation and astrochemistry; (4) circumstellar disks, expoplanets, and the solar system; and (5) stellar evolution and the Sun.
5. KEYWORDS:
6. STUDENT PROJECT: check box.
7. RELATED PROPOSALS:
8. PREVIOUS PROPOSALS:
9. INVESTIGATORS: selected from a user database.
10. SCIENTIFIC JUSTIFICATION: import a PDF file.
11. DUPLICATE OBSERVATIONS: justify any new observations of duplicate archival data or accepted programs.

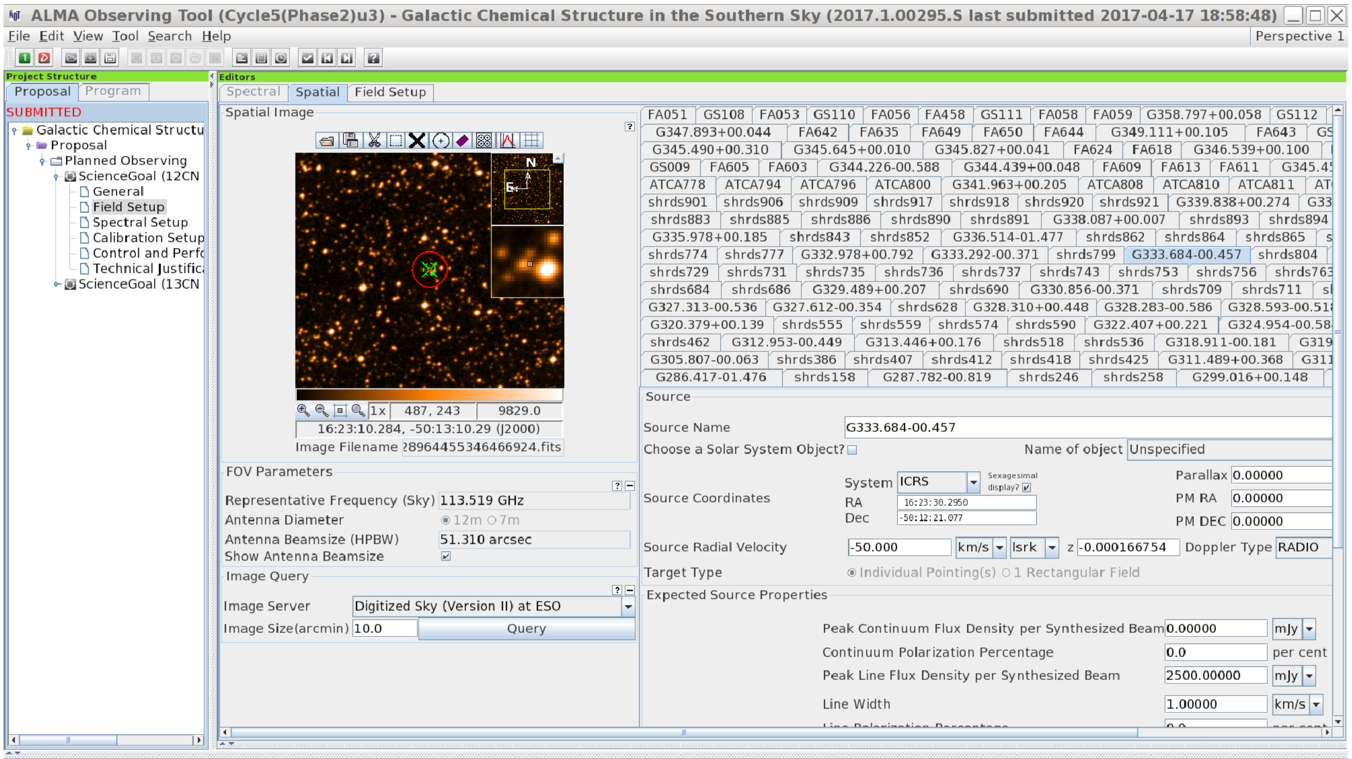

Figure 7: A screen shot of the ALMA OT field setup.

A.1.2 Science Goals

ALMA proposals consist of one or more science goals. Each science goal consists of a field setup, spectral setup, calibration setup, control and performance, and a technical justification.

Field setup

Figure 7 is a screen shot of the field setup. A spatial image may be displayed in the left frame with different backgrounds (e.g., SDSS, NVSS, etc.). Each field contains the following parameters.

1. NAME:
2. POSITION: coordinate system, RA, Dec, parallax, proper motion RA, and proper motion Dec. Offsets can also be specified.
3. VELOCITY: the value, units, reference frame, and Doppler type. A redshift may be specified instead.
4. TARGET TYPE: individual pointing or rectangular field.

More than one source may be included. The expected source properties must also be specified and include: peak continuum flux density per synthesized beam, continuum linear polarization, continuum circular polarization, peak line flux density per synthesized beam, line width, line linear polarization, and line circular polarization.

Spectral Setup

Figure 8 is a screen shot of the spectral setup. A interactive graphical display shows the different ALMA bands and frequencies. There are four basebands and it is possible to define 4 spectral windows per baseband for a total of 16 spectral windows. The user can select frequencies based on spectral lines listed in Splatalogue.

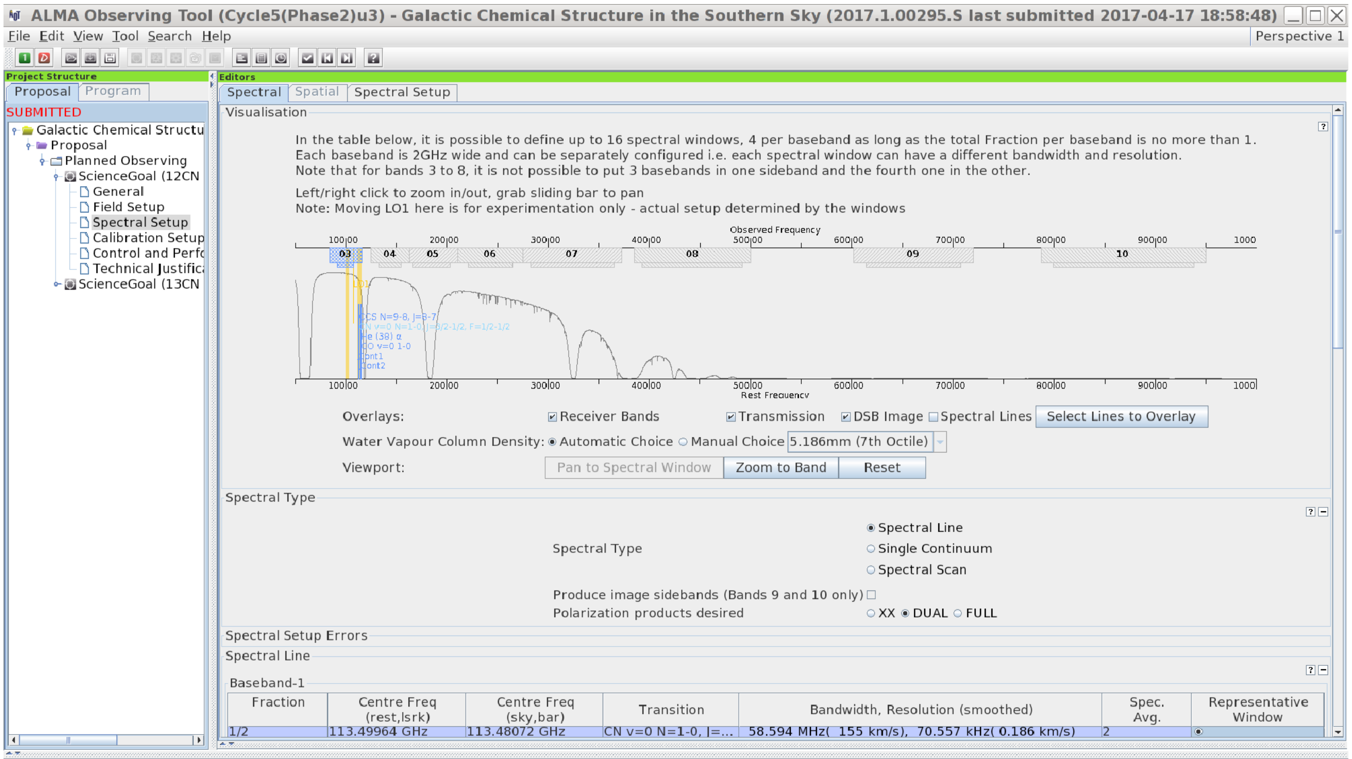

Figure 8: A screen shot of the ALMA OT spectral setup.

Calibration Setup

Here the user specifies the calibration strategy. There are three choices: (1) system-defined calibration (recommended); (2) system-defined calibration with separate amplitude calibration using solar system object; and (3) user-defined calibration.

Control and Performance

Figure 9 is a screen shot of the control and performance section. The user selects a desired angular resolution (the ACA alone may be specified), the largest angular structure in the source, and the desired sensitivity per pointing.

Technical Justification

The technical justification is specified for the sensitivity, imaging, and correlator configuration.

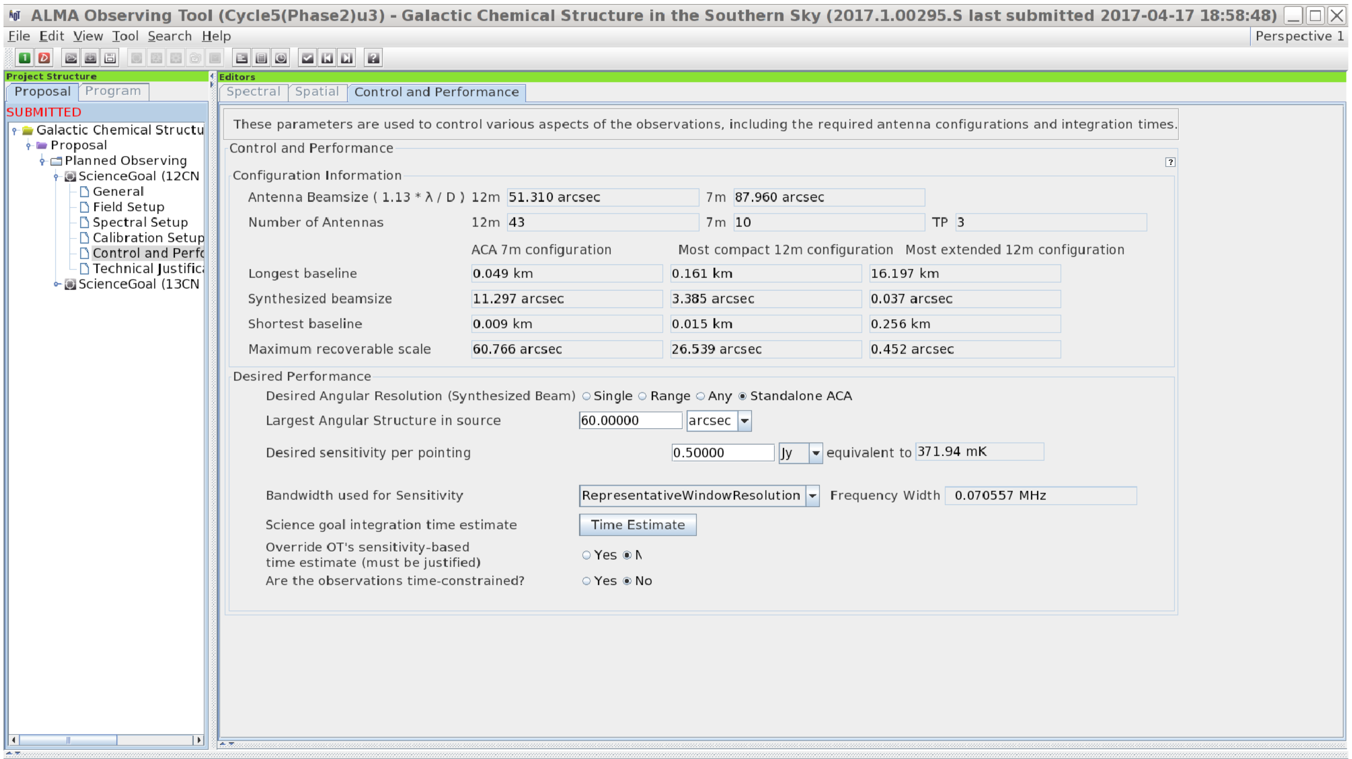

Figure 9: A screen shot of the ALMA OT control and performance section.

B VLA Configuration Specification

Here we summarize the logic to allow the user to specify the VLA configuration(s) that are required to achieve their science goals. First the user specifies the following information:

- *Request Purpose:* a finite list that includes detection, astrometry, flux monitor, pulsar timing, polarization (structure imaging), spectral index, spectral feature. This should already have been specified above.
- *Source Type:* a finite list that includes point-like (single component), multi-component compact, diffuse (extended), complex structure, and non-imaging.
- *Frequency:* a default value is shown based on the spectral configuration above if available (e.g., line/velocity info).
- *Sensitivity:* in flux density, brightness temperature, or fractional polarized emission.
- *Bandwidth:* either the channel width for lines or full bandwidth for continuum.

Once specified a list of the different array configurations, together with the spatial resolution, largest angular scale (LAS), is shown. The starting array configuration is highlighted. For example, astrometry or multi-component compact would be A configuration; diffuse (extended) or complex structure would be D configuration; and detection, flux monitoring, pulsar timing, or non-imaging would be ANY configuration. The user can select one or more configurations from the list. The nominal field of view (FOV) is also displayed and the user is allowed to increase this value if necessary and within the allowable limits. *We plan to revisit this strategy and to discuss the experience of ALMA OT users.*

C VLA WIDAR Configuration

Here we provide an example of the logic used to configure the VLA WIDAR correlator.

- Lines: specify rest frequencies with corresponding velocity/redshift, velocity coverage/range, velocity definition, and velocity reference frame.
- Line Placement: create Barycentric line subbands. Software will determine the observing band, suggest the samplers (e.g., 3-bit or 8-bit for VLA WIDAR), and place the sub-bands. The user can override these values.
- Sub-bands: modify sub-bands and add continuum if possible.
- Doppler: specify Doppler position.
- Doppler: Doppler switch.
- Basics: choose visibility integration time (guess from configuration/band and requested FOV) while keeping the data rate within the allowable limits.
- Validation

D System Documents

Here we list system documents (Level 1) that will provide more detail to the software requirements.

1. VLA Resource Specification. This includes the details on how to specify the front-end/back-end resources and any configuration.
2. VLBA Resource Specification. This includes the details on how to specify the front-end/back-end resources and any configuration.
3. HSA Resource Specification. This includes the details on how to specify the front-end/back-end resources and any configuration.
4. GMVA Resource Specification. This includes the details on how to specify the front-end/back-end resources and any configuration.
5. GBT Resource Specification. This includes the details on how to specify the front-end/back-end resources and any configuration.
6. VLA Array Configuration Algorithm. Includes the detailed algorithm on how to take the user input and select the VLA configuration(s).
7. VLA Exposure Calculator. Includes the detailed algorithm for determined the integration time given an rms sensitivity.
8. VLBA/HSA/GMVA Exposure Calculator. Includes the detailed algorithm for determined the integration time given an rms sensitivity.
9. GBT Exposure Calculator. Includes the detailed algorithm for determined the integration time given an rms sensitivity.
10. VLA Preliminary Priorities. Includes the algorithm to determine the preliminary priority.
11. VLBA/HSA/GMVA Preliminary Priorities. Includes the algorithm to determine the preliminary priority.
12. GBT Preliminary Priorities. Includes the algorithm to determine the preliminary priority.

13. VLA Pressure Plot Specification. Includes the algorithm to determine the preliminary priority.
14. VLBA/HSA/GMVA Pressure Plot Specification. Includes the algorithm to determine the preliminary priority.
15. GBT Pressure Plot Specification. Includes the algorithm to determine the preliminary priority.
16. Metrics Definitions.

E Acronyms

ALMA: Atacama Large Millimeter/submillimeter Array

AUI: Associated Universities Inc.

DDT: Director's Discretionary Time

DMS: Data Management and Software

EPO: Education and Public Outreach

GBO: Green Bank Observatory

GBT: Green Bank Telescope

GMVA: Global mm VLBI Array

GOUS: Group Observing Unit Set

GOST: General Observing Setup Tool

HSA: High Sensitivity Array

LBO: Long Baseline Observatory

MOUS: Member Observing Unit Set

NA: North America

NRAO: National Radio Astronomy Observatory

PEMR: Performance Evaluation and Management Report

PFT: Proposal Finder Tool

PHT: Proposal Handling Tool

PST: Proposal Submission Tool

ODSM: Observing and Data Service Metric

OPT: Observing Preparation Tool

OT: Observing Tool

OUS: Observing Unit Set

RCT: Resource Catalog Tool

RFI: Radio Frequency Interference

RSRO: Resident Shared Risk Observing

SB: Scheduling Block

SCT: Source Catalog Tool

SRDP: Science Ready Data Product

SRP: Science Review Panel

SSR: Science Support and Research

TAC: Telescope Allocation Committee

TTA: Telescope Time Allocation

UT: Universal Time

VLA: Very Large Array

VLBA: Very Long Baseline Array

VLBI: Very Long Baseline Interferometry

References

Bridger, A. and B. Butler (2008). "The ALMA/EVLA project data model: steps toward a common project description for astronomy". In: *SPIE* 7019.

Schwab, F. R., D. S. Balser, and G. C. Hunt (2015). *Comments On Peer Review and Rating of NRAO Observing Proposals*. TTAR 01. National Radio Astronomy Observatory.