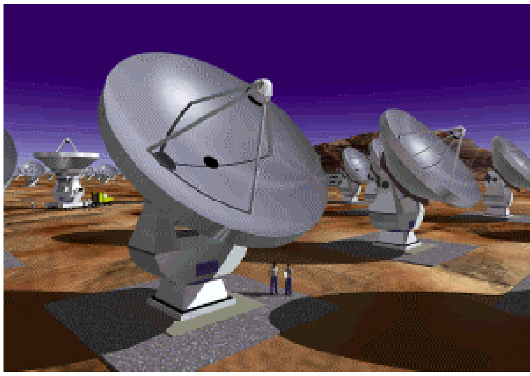

Atacama Large Millimeter Array

ALMA-SW-NNNN

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`Concept`

Steve Scott

ALMA Observing Tool: Concept and Prototype

`Concept`

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	REMARKS		

1 Introduction

These initial design concepts for the ALMA Observing Tool are intentionally limited in scope to the prototype OT while attempting to place them in context of the full OT requirements. The prototype OT only addresses input from a novice observer, and will also include many other simplifications. Most obviously, we have intentionally neglected the input of basic proposal information, and have concentrated on specification of the observing program. This function is common to both Phase I and Phase II of proposal preparation, and for the novice observer should be essentially identical.

2 Basic Observing Components

2.1 Components and Relationships

There are four basic observing components used to completely describe a set of observations: **Program, Target Field, Target Area,** and **Frequency Setup.** These components, other important system objects, and their relationships are shown in Figure 2.1. DR is the data reduction recipe, and SB represents the Scheduling Blocks. QuickLook is the QuickLook Pipeline, while Final is the final imaging pipeline.

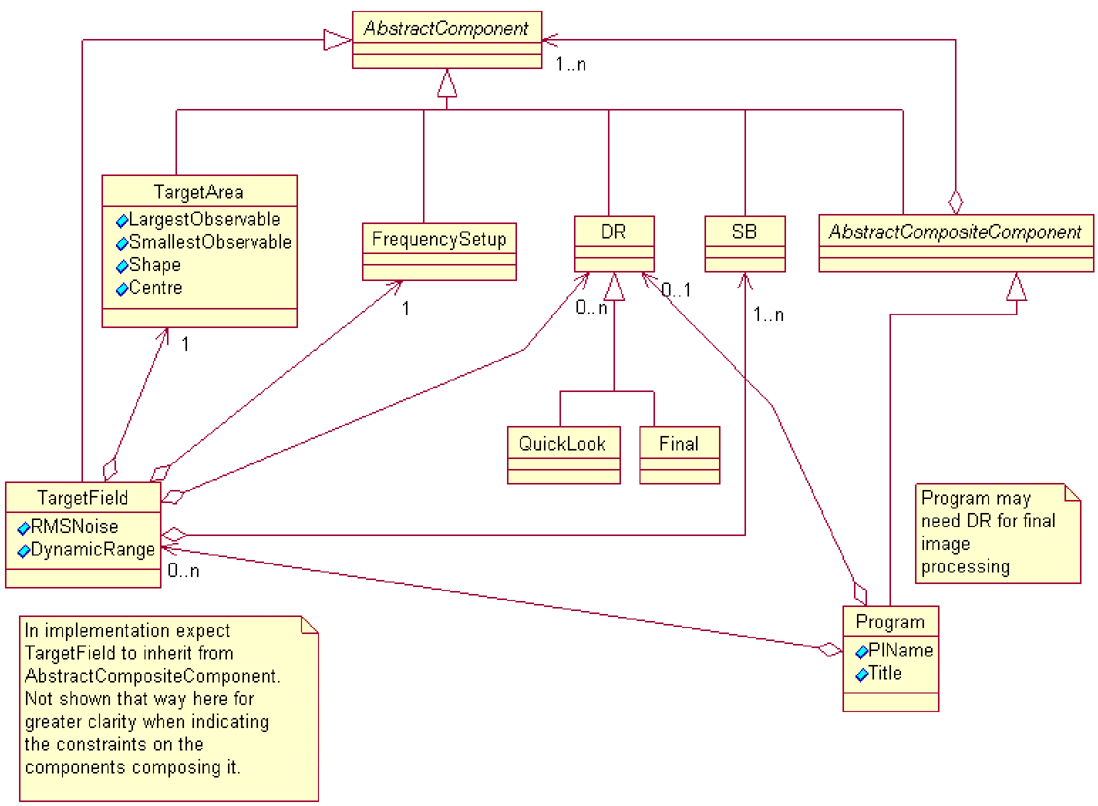

Figure 2.1 The observing components and other major classes in the OT

2.2 Program

A Program consists primarily as a set of Target Fields and is used to completely describe either the Phase I or Phase II observing program. The observer will submit the Phase I Program with the proposal to the review process. If the Program is approved without change, the Phase I Program will be used for Phase II and no further action is required. If the Program is partially approved, then the Phase I Program will form the basis for the Phase II Program. There are several ways this can be done for the novice case depending on the operational model. Here are two possibilities:

- The Program is approved on a Target Field basis and any unapproved Target Fields are removed from the Program and then the modified Program is placed directly into the ALMA Observing System as the Phase II Program.

- The Program is returned to the user with approved Target Fields marked and the user modifies the Program and submits it to the ALMA Observing System as a Phase II Program. The Program is checked to make sure all Target Fields have been approved.

2.3 Target Field

The term Target Field may be objectionable because it is composed of terms that have other meanings in our jargon, and we are open to suggestions for other nomenclature. A Target Field component consists of:

- Target Area component, including smallest and largest observable structure

- Frequency Setup component

- Dynamic range

- Image rms; the median rms in a set of channel maps. Or alternatively, an estimated flux and signal to noise ratio, again over a set of channel maps.

The Target Field components will be used to define the configurations and observing modes, and data reduction recipes used to create the image. The Target Area will be used to define the basic observing modes, such as Single Field Interferometric Mapping, or Interferometric Mosaicing, including combinations of observing modes. Many modes, such as Mosaicing, will result in observations of many different pointing centers. The largest observable structure desired will be used to help determine whether single dish or ACA observations will be used. The smallest and largest observable structures and the dynamic range will determine the configurations required. The image noise will determine integration times. The dynamic range will affect calibration strategies including accuracy of pointing, focus, and phase stability.

2.4 Target Area

A contiguous area on the sky to image with a single resolution. Defined by:

- A contiguous area on the sky

- Smallest observable structure desired in image (resolution), defined by an ellipse, and the tolerance on the size of this ellipse

- Largest observable structure desired in image, defined by an ellipse

2.5 Frequency Setup

The frequency setup component contains the definition of the set of spectral windows to be observed. Each spectral window in the set contains:

- Center frequency
- Bandwidth
- Frequency resolution
- Polarization
- Image noise channels

The spectral windows must all be in a single receiver band. The image noise channels are a set of channels within this setup that will be used for the estimate of the image noise. They need not be contiguous, and will default to all the channels. This will allow, for example, one molecular transition to define the desired science, with other spectral windows playing a secondary role in the scientific output. The Frequency Setup will affect calibration requirements.

3 Program Database

The Program Database contains saved instances of Programs, Target Fields, Target Areas, and Frequency Setups. The database is a hierarchical tree structure containing a system folder and many user folders. The normal user has read access to the system folder that will contain examples and templates, and read/write access to his/her own root folder. The user may extend the hierarchy of her/his root folder by the addition of other folders. Users may also modify the accessibility of their folders and components by other users. Note that although the database allows hierarchical labeled storage and a Program's components follow a set hierarchy, any of the four fundamental components can be stored to allow them to be reused freely in building a new Program.

The constructs of references and cloning will be supported. Any component in the hierarchy with the same name is a reference to the same object and any change to one of them changes all of them. An object is effectively cloned if it is copied and given a new name. The new component then has no connection to the old.

We propose a Program Database that is a centralized ALMA repository. This enables collaborative work by network access to the repository. Non network use is provided by synchronizing a local copy to the repository before disconnecting and uploading to the master upon reconnection. It is recognized that the centralized repository is outside of the scope of the SSR Requirements, but it is felt to be consistent with trends in collaborative work. If a central repository is not implemented, then the Program Database is implemented locally and the system portion is downloaded from ALMA on demand.

4 Major GUI components

These are the major components envisioned, but all of the subtleties of interactions of the components are not yet specified. Each component described below represents a separate window or pane.

4.1 Target position editor

- Provides a graphical way to define multiple Target Areas, each of which contains:
  - Closed area on sky
  - Smallest observable structure desired
  - Largest observable structure desired
- Allows editing of target areas, optionally on an overlay of an image
- Can overlay multiple images
- Images are FITS or other standard format files that may be local or fetched from a repository
- Area can be defined using standard shapes of polygon, ellipse, or primary beam
- Can change length/width or major/minor axes of standard shapes
- Can change length of any side of polygon or move a vertex to provide arbitrary deformation
- Can scale shapes or modified shapes (areas)
- Can rotate shapes or areas
- Can overlay outline of primary beam (primary beam will not be available until frequency has been defined)
- Can specify shape centers using
  - A name resolved by a standard catalog
  - Input in any standard astronomical coordinate and reference system (including proper motion).
  - Solar system object name
  - Arbitrary solar system object defined by an ephemeris file
  - A file containing a list of any of the above
  - As offsets from any of the above

- The smallest and largest observable structure are defined as ellipses, as well as the tolerance on the smallest observable structure
- It is possible for Target Areas to intersect. For example, a large low resolution area may surround a smaller high resolution area.
- JSky fulfills many of the above requirements

4.2 Frequency setup editor

Provides a graphical way to define multiple spectral windows in a single receiver band.

- Each spectral window is defined by:
  - Center frequency
  - Bandwidth
  - Frequency resolution
  - Image noise channels
- All known molecular transitions above a selectable threshold transition strength will be shown on the graphical display to allow transitions to be included or avoided.
- Provides a graphical way to define the channel set for determining the average noise in the image.
- All windows may be defined by molecular transition, and velocity.
- Bandwidth and frequency resolution may be defined by velocity width and velocity resolution.
- Molecular transitions may be chosen by a pulldown list of molecular transitions, ordered by frequency. An alternate method of choice is by molecule and then transition.
- Velocity reference frames of LSR, Heliocentric, Topocentric, and solar system objects shall be supported.
- Constraints of the correlator and local oscillator hardware shall be reflected in the tool.
- Polarization requirements shall be input and included in the correlator configuration. The default shall be total intensity.
- If double sideband receivers are used, the image sideband shall be shown. Image sidebands may be selected for data collection or for rejection.

- Attempts to define windows that would require more than one receiver band shall result in the user being directed that this will require another Target Field.

- Displays opacity as a function of frequency.

- Choose archiving options for atmospheric pathlength corrected data; always automatically chosen by system for novice user.

- The JCMT, BIMA or SMA correlator setup editors are good starting points.

4.3 Program editor

- Allows editing of the basic properties of the program, such as program name

- Form fill in for basic proposal Phase I information.

- Has button to allow checking of entire Program. The check will report if any Target Fields have been previously observed with ALMA.

4.4 Program tree editor

- Displays the program tree as it is being defined by actions of the target position and frequency setup editors.

- Interacts directly with the Program Database manipulator graphical component.

- Components may be dragged from the Program Database view and inserted into the program.

- Enforces rule that every target field have a single target area and frequency setup by automatically creating a new instance of this simple hierarchy whenever a new target area or frequency setup is defined. The missing component defaults to the last specified instance or will be retained as a “null reference” with visual indication that it needs completion.

- Copying of fields, areas, and frequency setups will be supported.

- Each component is named.

- Components with the same name refer to the same object. For example, the same frequency setup may be used for multiple target areas. If one of the frequency setups is edited, they all change. Conversely, it is possible to copy a component to use as a template for subsequent modification by giving it a different name.

- Double clicking on an area or frequency setup will open up the appropriate editor.

- Components may be saved in the database by dragging into the database view.

- There will be a visual indication (e.g. red background) if any of the components are not fully complete.

- An example of the hierarchy is:

```
MyProgram
    Field1
        Area1
        Freqsetup1
    Field2
        Area2
        Freqsetup2
    Field3
        Area3
        Freqsetup3
    …
```

4.5 Program Database manipulator

- Displays the contents of the program database in a tree view form, using unique icons for each of the four component types (Programs, Target Fields, Target Areas, Frequency Setups). Includes system folder where templates and examples reside.
- Allows authorized creation of new folders and movement of folders and components.
- Allows renaming of folders and components.
- Drag and drop to/from the Program tree editor.
- Button to force resynchronization with the master database when alternating between offline and online operation.

4.6 System resource estimator

- Displays estimates of target integration time and elapsed time for each field and program total.
- Displays estimates of data rates and data volumes.
- Selection of weather to use for time estimator. Choices are:
    - Weather typically assigned to this type of project by the dynamic scheduler
    - Top xx% of ALMA weather
    - Some selections of typical ALMA weather, organized by season or time of day, as appropriate
- Time estimates automatically updated when weather selection changes or observing components are changed.

4.7 Observation program description

- Gives user feedback for the completed program.

- Describes observing program in lower level terms – for the novice this may be intermediate to the low level description of the observation.

- Will help teach novice about the next level of complexity in the system and let them see consequences of their changes in specifications.

- Describes observing program in terms of basic observing objects (Scheduling Blocks and ObservingUnits). The mapping of Program input into the basic observing objects is a large parameter space (even for novice user input) that will be only partially understood when ALMA comes online. As ALMA matures, the algorithms for the mappings will be developed and it must be easy to implement new logic as the observing system evolves.

- Supplies a data reduction recipe.

- Perhaps output can be modified by expert?

- This component needs much more definition.

4.8 Simulator

- Uses an image and simulates its appearance with the proposed observing program.

- Input image may be retrieved from an image repository, may be a user supplied image, or may be derived from a theoretical model.

- In another mode, the low level observing objects are used as input and the complete observing process is simulated, providing feedback as to how the data will be obtained (including identifying any potential problems) and perhaps also generating a simulated image.

5 Implementation Decisions for the Prototype OT

We have made some tentative decisions about the implementation of the prototype tool.

- The prototype will be done using the Java programming language for the following reasons:

    - Object oriented

    - Platform independent GUI

    - Reuse of existing components (Gemini OT, JSky, UKIRT ORAC).

- The prototype will only handle the novice user.

- The goal for the prototype is to handle the case of multiple fields, all of which can be imaged with the single observing mode of Multi Field Interferometric Mapping.

- Tools and components will appear as windows within the desktop environment of the tool (these are called panes). This means that all GUI components are panes inside the basic tool desktop, not the OS desktop. These panes may be started, stopped, or iconified as desired.

- The following features/issues will not be addressed in the prototype:

  - Phase I input not directly related to the observing program

  - Polarization (all observing assumed to be in total intensity)

  - Double sideband receivers

  - Breakpoints

  - Checking Target Fields against previous observations

  - Interactive observing

  - Script generation

- It should be noted that the prototype OT will not necessarily follow all aspects of the concept outlined in this document. This is because it will re-use existing components as much as possible, for efficiency of delivery, and these do not necessarily match in functionality.

6 Scenarios

6.1 Introduction

These scenarios attempt to provide some reasonably true to life examples of how a user might try to use the ALMA Observing Tool to create their programs. The purpose of this is to attempt to capture the processes a user will go through in order to create their proposals and programs and thus to focus the minds of the Tool's designers and developers on issues that could arise when the tool is used.

This first draft of the scenarios covers two reasonably simple projects that a novice ALMA user might wish to carry out: say an astronomer who is familiar with optical and infra-red observing, but for whom this is the first venture into sub-millimetre and interferometric work. At present only the proposal stage (Phase 1) is covered. Later versions of this document will be extended to cover examples of Phase 2 and also to examine how an expert in sub-millimetre interferometry might wish to use the Tool. It may also be important to examine how a scientist from another field entirely (say Chemistry) might try to use the Tool.

The science presented in these examples is supposed to be realistic and reasonably sensible, but not necessarily actual.

6.2 Heterodyne Spectroscopy of Herbig-Haro Clumps

Goal:
To take CO spectra of several knots in HH2, to match up with the ISO mid IR image and spectra and to thus derive interesting conclusions about the chemistry of those knots.

Scenario:

1. Enter proposal "book-keeping" (PI info, collaborators, etc.)

2. Enter justification and other such "prose".

3. Should there be questions about my expertise, type of observations?

   [I'm assuming no template for this: Template case should be simpler?]

4. OK. I'd like to define what I want to look at:

   Read in my ISO image

   Select a knot: specify approximate region of interest. (small map)

   [Tool gives me some sort of feedback to let me know I am specifying my obs. and not just "browsing"]

   Repeat this for two or three other knots.

   [I'm now specifying several different target Areas, but have not yet specified frequency! - See UC for selecttargetArea]

5. Now I want to specify the spectral lines I want:

   I want $C_{13}O$(12-7) and $C_{13}O$(21-9) - line database helps me insert the correct frequencies.

   I want to correct for redshift (none!) & earth motion

6. I think the lines will be about 10km/sec wide and I want the spectrum to cover an area that is 4 times the line width and I want 40 resolution elements across the line.

7. I enter the noise level I want. Same for each preferably. Will the tool tell me what is sensible here?

   [I get the time estimate back from the tool]

   I iterate this if the answer indicates I should!

8. I now may want to change the "book-keeping" and justification.

9. I'm happy, I say so and the tool gives me complete feedback on what it has sorted out for me.

   "You will be observing with RxC, here are the details of your mapping setup...etc."

10. As a result I may want to go back to 4, 5 or 6.

11. I'm very happy and I submit it.

12. I get feedback on the submission.

6.3 Extended Map of Edge-on galaxy

Goal:
To make an extended map covering the whole of the edge-on spiral ngc891 in the CO something line

Scenario:

1. Enter proposal "book-keeping" (PI info, collaborators, etc.)

2. Enter justification and other such "prose".

3. Should there be questions about my expertise, type of observations?

   [I'm assuming no template for this: Template case should be simpler?]

4. I define the frequency of the line I wish to map. I want to enter this as CO (whatever) because I don't know its frequency.

5. I also know that I want a certain resolution or sampling. I'd liked to specify fully sampled around the nucleus and be happy with a sparser sampling at the edges. Perhaps I am also expected to enter the maximum size I wish to be able to detect?

   [As a novice I think of the resolution I want first - before defining the map]

6. Now to define the area I want to map. This is a rectangle, at an angle.

   I read in the VLA HI map;

   I ask for a rectangular map;

   With the mouse I centre it and rotate to align with the galaxy axis;

   I fix these (centre and pos. angle)

   Finally I stretch the map in both dimensions to fit the region of interest.

   [Will the tool give me feedback about sensible trade-offs between resolution, map shape and efficiency? Also should it tell me about the maximum size of object that can be detected? This will be important for me (a novice) to understand what I will get in the final image.]

   I might need to iterate at step 5 depending on this feedback.

7. I enter the noise level I want. Will the tool tell me what is sensible here?

   [I get the time estimate back from the tool]

I iterate this if the answer indicates I should!

8. I now may want to change the "book-keeping" and justification.

9. I'm happy, I say so and the tool gives me complete feedback on what it has sorted out for me.

   "You will be observing with RxC, here are the details of your mapping setup...etc."

10. As a result I may want to go back to 4, 5 or 6.

11. I'm very happy and I submit it. I get feedback on the submission.

6.4 To Do

These "to do" items are items that it would be beneficial to cover in these scenarios. However, for the purpose of this document and the prototype OT they are deemed to be lower priority. They should be developed during Phase 2 of the ALMA project.

1. Include the Phase 2 steps for both of the above scenarios. An important consideration for these cases (where Phase 2 work may be minimal for the novice) is to ensure that any limits placed on the successful proposal by the Allocation Committee are enforced.

2. Examples of collaborating with other OT users at other sites

3. Include use of the simulator(s)

4. Include data reduction specification.

5. Include scenarios that describe how an *expert* may wish to use the Tool.

6. Consider how the Allocation Committees comments and limits get into the Tool - specifically how quantitative limits are programmed in.

7 Use Cases

The Use Cases included here, and the description outlined above, should be compared with the requirements and high level Use Cases outlined in the Software Science Requirements [1]. In that document the Use Case 4.2.2, "Create Observing Proposal" is of particular interest. Also of interest are the requirements 1.0-R1, 3.0-R5, -R6, and -R11, 3.1-R1, -R2, -R4, -R6, -R7, -R10 and -R12. Many other requirements are, of course, very relevant to the Observing Tool, but for the limited scope of the prototype these seem to be the most relevant.

Also of relevance is the Initial Software Analysis [2], but for the moment the prototype Observing Tool is mainly attempting to address issues from the novice user's viewpoint. The Software Analysis provides a point of reference to ensure that the ideas here are consistent with the overall project concepts.

7.1 Use Case: NovicePhaseI/II

Novice observer uses the ObservingTool to create the observing specifications for her/his project.

Description:

The creation of the observing specification is done as part of the proposal specification during the Phase I process with the Observing Tool (OT) GUI. The Phase I observing program specification is identical to the Phase II observing program, and may be directly used if no modifications are required for Phase II. The OT may be used in “Phase 0” to investigate the scientific capabilities of ALMA. See also UC SpecifyTargetField, UseDatabase.

Role(s)/Actor(s):

Primary: The User (Observer, Staff Scientist, Array Operator), the ObservingTool

Priority: Major
Performance: Interactive
Frequency: Several per hour
Preconditions: None

Basic Course:

1. User starts the ObservingTool. If online, the local version is checked against the master version and any binaries or tables that need to be updated are downloaded. If online, the local copy of the specification database is synchronized with the master.
2. User initiates specification of a new project from scratch.
   Alternate Course: User begins with a previously existing project specification from the database. See UC UseDatabase.
3. User specifies a set of target fields (many projects will contain only a single target field). A target field includes a contiguous area on the sky to image, the frequency coverage, and an estimate of the desired noise in the image. See UC SpecifyTargetField. When specifying more than one target field, the tool will default the next target field to the values of the previous. There will be a special mode for specifying a set of target fields that only differ by the center coordinates that will be specified in a list.
4. User specifies any execution ordering requirements on the list of target fields.
5. User specifies weather for use by time estimator, choosing from:
   - Historical weather assigned by the dynamic scheduler for the resolution, sensitivity, and frequency of this project
   - User specified (e.g. top 10% of ALMA weather)
   - Average ALMA weather at various times of year or day
6. OT estimates integration time and elapsed time for the specified noise level in the specified weather.
7. OT plots estimated noise as a function of frequency across all of the specified windows.
8. OT generates observing modes, configuration requirements, local oscillator settings and correlator setup and displays to the User.
9. User optionally simulates observational results after specifying a model input image.
10. User iterates on specifications until satisfied or exhausted.
11. User saves project specification to the database with a unique name.

Postconditions:

A full specification of the project and everything necessary to execute and reduce the observations (Scheduling Blocks, data reduction recipes).

Issues to be Determined or Resolved:

- The details of specifying the model image for simulations have not been addressed.
- Polarization is not addressed.

Notes:
This use case only covers the specification for the actual observation part of the proposal; other input for a proposal is done elsewhere.

The actual mapping of user input into observing modes and eventually scheduling blocks covers a large parameter space, even for novice observers, which will only be partially covered when ALMA comes on line. As ALMA matures, more of the parameter space will be covered. It must be possible to easily implement new logic as the system evolves. <u>A goal is that the OT recognize what it does not know how to do, and not be afraid to say so</u>.

7.2 Use Case: UseDatabase

Use the Observing Tool database to store or retrieve project observing specifications or their component specifications.

Description:
The database is hierarchical to allow organization of specifications into folders and implements access control based on username/password. In many respects it resembles a modern file system. There is a system folder containing general templates that is readonly for general users. Each user has her/his own folder with read/write access and full access control lists. Users can change permissions on their folders or individual specifications to allow read and/or write access to individuals, groups, or everyone to facilitate collaboration. Examples of specifications are a target field, a frequency setup, or a project. It shall be possible to store partial specifications that can later be used as templates, with the unspecified information left for the template user.

If operating online, the full master database is available and the system folder and user specific folder are copied to the local machine. If operating offline, the local database is used and any changes made are resynchronized to the master the next time that the user is online.

Role(s)/Actor(s):
Primary: The User (Observer, Staff Scientist, Array Operator), the ObservingTool

Priority: Major
Performance: Interactive
Frequency: Many per hour
Preconditions: None

Basic Course:
1. User logs onto database if not already logged on and all operations occur on master database. If user is logging on, any changes in local database are uploaded to the master database. User is queried to resolve any conflicts in upload.
   Alternate Course: User is offline and uses local copy of database.
2. User retrieves an existing specification from the database to use as a template for a new specification (e.g. a target area or a frequency set).
3. User modifies the specification using the part of the Observing Tool for that particular specification.

4. User saves the resulting specification into the database, assigning it a unique name.
   Exception Course: Specification is not complete or does not pass validation – system rejects attempts to save.
   Alternate Course: User has incomplete specification, but saves anyway to be resumed later.
   Alternate Course: User has incomplete specification, but checks box indicating that it is to be used as a template in the future.
   Alternate Course: User copies a specification or folder.
   Alternate Course: User renames specification or folder.
   Alternate Course: User moves a specification or folder to a different folder.
   Alternate Course: User creates a new folder.
   Alternate Course: User modifies access rights for one of their folders or specifications.

Postconditions:
A new specification is stored in the database in the user's folder.

Issues to be Determined or Resolved: The use of an online collaborative database is not specified as part of the ALMA SSR Requirements. If the extension to an online collaborative database is not sanctioned, then the fallback would be to use a local database with a system section that is occasionally downloaded from a master copy.

Notes: None.

7.3 Use Case: SpecifyTargetField

Create a specification for the observation of a single "target field".

Description:
The creation of the target field is done as part of the proposal specification during the Phase I process with the Observing Tool (OT) GUI. The specification created here is also suitable for the Phase II observing program. A "target field" consists of a "target area" (a single contiguous area on the sky to be imaged), a "frequency setup" specification, a nominal noise level, and the imaging goal of the project. The imaging goal will eventually be used to determine the required beam quality and pointing accuracy. Note that the system may use a mosaic to cover the requested target area. See also SpecifyTargetArea, and SpecifyFrequencySetup.

Role(s)/Actor(s):
Primary: The User (Observer, Staff Scientist, Array Operator), the ObservingTool

Priority: Major
Performance: Interactive
Frequency: Many per hour
Preconditions: None

Basic Course:
1. User specifies the frequency setup for the observations of the field, or retrieves a previous specification from the database of specifications. This includes bandwidths, center frequencies, and resolution. See UC SpecifyFrequencySetup, UseDatabase.

2. User specifies the spatial extent of the observation. See UC SpecifyTargetArea.
   Note: Steps 1 and 2 may be done in any order.
3. User specifies nominal average noise over a range of contiguous channels

- Using the frequency setup defined in the first step, graphically select a range of contiguous channels.
  Alternate Course: Select all the channels by clicking a labeled button
- Input a noise level in Janskies
  Alternate Course: Select noise level from a slider that is labeled with both noise level and the corresponding integration time in average ALMA weather.

4. User specifies imaging goal of the program, choosing either:
   - Imaging
   - Detection
5. User saves the resulting target field specification into the database, assigning it a unique name.

Postconditions:
A full specification of the target field.

Issues to be Determined or Resolved:
There may be a better choice of nomenclature for this construct than “target field”. Any ideas?

Notes:
The User may start the procedure with a previous specification, using it as a template.

7.4 Use Case: SpecifyTargetArea

Create a specification for the observation of a single "target area".

Description:
The creation of the target area specification is done as part of the proposal specification during the Phase I process with the Observing Tool (OT) GUI. The specification created here should be adequate for the Phase II observing program as well. A “target area” is a single contiguous area on the sky, and is part of a “target field” specification. This step is similar to “Target Finder” astronomy applications that exist. See UC SpecifyTargetField.

Role(s)/Actor(s):
Primary: The User (Observer, Staff Scientist, Array Operator), the ObservingTool

Priority: Major
Performance: Interactive
Frequency: Many per hour
Preconditions: None

Basic Course:
1. User associates this target area with a target field, usually automatically as part of the target field specification.
2. User initiates specification of a new target area from scratch.
   Alternate Course: User begins with a previously existing target area specification from the database. See UC UseDatabase.
3. User specifies coordinates, reference system, and proper motion for center of area. Coordinates may be:
   - By object name from a catalog (also fetches reference system and proper motion)
   - Absolute (equatorial, galactic) field entry, reference system field entry
   - Solar system object (planets, asteroids, etc)
   - Relative to an absolute coordinate or solar system object

   - Specify an ephemeris file containing positions and times in the ALMA ephemeris format
   - From a coordinate list in a catalog
   - From a coordinate list defined by the user

   Alternate Course: User specifies center with mouse on an image overlay
4. User chooses a basic shape for the area, choosing from:
   - Polygon
   - Ellipse
   - Primary beam (not available until frequency setup is complete)

   Alternate Course: User specifies both shape and center by dragging a shape with the mouse on an image overlay
5. User modifies size of basic shape, rescaling, modifying the width/length or major/minor axis by field entry or dragging axes.
6. User optionally modifies basic shape of polygon with mouse, moving vertices to distort it into any irregular polygon.
7. User specifies desired resolution, specifying the major and minor axes of an ellipse by filling in fields or dragging the axes. The resolution ellipse will default to a size appropriate for the average ALMA configuration at the frequency specified in the frequency setup, if it has been defined.
8. User specifies largest observable object, specifying the major and minor axes of an ellipse by filling in fields or dragging the axes. The largest observable object ellipse will default to a size appropriate for the single dish beam if the frequency setup has been defined.

Postconditions:
A full specification of the target area.

Issues to be Determined or Resolved: None at this time.

Notes:
The User may start the procedure with a previous specification, using it as a template.

7.5 Use Case: SpecifyFrequencySetup

Create a specification for the "frequency setup" for an observation.

Description:

The creation of the frequency setup is done as part of the proposal specification during the Phase I process and is done with the Observing Tool (OT) GUI. The specification created here should be adequate for the Phase II observing program as well. A “frequency setup” is a full specification of all of the observing windows and includes bandwidths, center frequencies, and resolution – all the information required to setup the local oscillators and correlator. A “window” is a contiguous region in frequency. See also UC SpecifyTargetField.

Role(s)/Actor(s):

Primary: The User (Observer, Staff Scientist, Array Operator), the ObservingTool

Priority: Major
Performance: Interactive
Frequency: Many per hour
Preconditions: A database of molecule line transitions exists as part of the tool

Basic Course:

1. User initiates specification of a new frequency setup from scratch.
   Alternate Course: User begins with a previously existing frequency setup specification from the database. See UC UseDatabase.
2. User completely specifies an observing window with the following steps
3. User specifies width of window in velocity (source reference frame)
   Alternate Course: specify width of window in frequency (source reference frame)
4. Specify center frequency of window by choosing from:
   - Pulldown list of molecular line transition frequencies and field entry of velocity Lists can be ordered in several ways:
     1. Frequency ordered
     2. By molecule, then another list for transition
   - Field entry of rest frequency

   Alternate Course: User inputs a sky frequency
   Alternate Course: User graphically places window on frequency axis (with assistance of display of molecular transitions); constraints of local oscillators and correlator hardware are used to limit graphical placement.
5. User specifies spectral resolution of window in velocity (source reference frame)
   Alternate Course: specify spectral resolution of window in frequency (source reference frame)
6. User is assisted by display of selected window with respect to molecular lines, so that the window can be modified to include/exclude transitions. If a receiver is double sideband, then transitions in the image sideband are also shown. A cumulative version of the display that shows all windows will also be shown. And atmospheric opacity as a function of frequency will be shown.
7. User is advised of constraints of local oscillator and correlator hardware that limit the placement of windows.
8. User returns to step 2 until all observing windows have been specified.
9. User saves specification to the database with a unique name.

Postconditions:
A full specification of all of the desired observing windows, from which all local oscillator and correlator settings can be derived.

Issues to be Determined or Resolved: None at this time.

Notes:

- The User may start the procedure with a previous specification, using it as a template.
- The velocity may be gotten from a catalog entry for a source, but this coupling begs the question of order of specification of the target area or the frequency setup.

8 References

1. ALMA-SW-0011, revision 3, 2001-05-03, ALMA Software Science Requirements and Use Cases, Robert Lucas et al.

2. ALMA-SW-NNNN, revision 0, 2001-08-02, Initial Software Analysis, P. Grosbol, J. Schwarz et al.