ALMA Memo No. 358 - OBSERVING

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Abstract

This memo proposes an entity which provides an integrated description for dynamically scheduled observations. The **observing object** is created from the observing proposal and used throughout the observing and data reduction process. It is archived and provides a self contained and complete record of the data.

1 Introduction

An observing proposal usually consists of one or more connected sets of observations to realize certain science goals. These observations must be broken down into scheduling blocks to facilitate dynamic scheduling of observing proposals from many users. This presents a number of logistic problems, not only for the proposers who think of observing programs in larger logical units, but also for the dynamic scheduler which must keep track of the interdependencies between the scheduling blocks as well as scheduling the most suitable observations according to the science rating, LST, UT, weather, status of the instrument etc.

This memo proposes an entity which we will call the **observing object**, which provides an integrated description of a connected set of observations. The observing object contains the observing requirements, the observing methods, the scheduling blocks and their interdependencies. It provides an easy way for the proposer, and other users of the data, to track the progress of the observations through the entire system from proposal to archive and final images. For the dynamic scheduler, the observing object provides an interface which describes the requirements and status of the observations, which the scheduler uses whilst the observations are in progress. When the observations are complete, the observing object provides an overall record of the observations and the quality of the data.

The **observing object**, with its connected set of observations and calibrations, is also the logical entity to be used in data reduction. A simple observing proposal may be represented by only one observing object which also describes the imaging methods. More complex observing proposals may comprise of several sets of observations represented by different observing objects, perhaps with different priorities. Each is self contained, with its requirements, observing methods, scheduling blocks, and data reduction. Complex images may require several sets of data (from different configurations, arrays, epochs, or frequencies etc.). The observing objects provide a description and pointer to these data. The imaging methods and pointers to the observing objects should be kept as an object which is associated with the composite image.

2 Requirements

. An observing proposal is represented by one or more **observing objects**

- . Provides an integrated description of a connected set of observations.
- . Created from the observing proposal.
- . Carries the observing methods and scheduling blocks.
- . Used by the dynamic scheduler.
- . Modified by the observing process.
- . Keeps the status of the observations.
- . Is archived.
- . Used in Data Reduction.
- . User friendly, self contained, and complete
- . Used by proposers, or others, to understand and re-process the data.

3 Bookeeping

Project description: mostly public, part privilaged access. E.g.

- . Project name
- . Date
- . Title
- . PI Name, email and contact address.
- . Proposal Abstract
- . Implementation notes.

4 Observing Requirements

The requirements are derived from the observing proposal, probably best translated from scientific requirements into instrumental parameters. The **Requirements** are used by the dynamic scheduler.

E.g.

. Array configuration - the range of suitable antenna spacings
. Time requested and allocated to this set of observations.
. Dependencies on other sets of observations.
. LST range acceptable.
. UT range - for time critical observations
. Receivers
. Frequency - or range acceptable. e.g. for continuum observations
. Bandwidth - or range of acceptable bandwidth settings
. Polarization and accuracy required.
. Source position - or range of positions for multi-target observations.
. Opacity
. Seeing
. uv-coverage
. Pointing accuracy
. RMS Flux sensitivity

5 Status

Status of observations described in this observing object. The **Status** is used by the dynamic scheduler. The status should contain information that the scheduler needs without looking into the observing methods and scheduling blocks whilst the observations are in progress. When the observations are complete, the status provides an overall record of the quality of the data.

E.g.

. Priority of this set of observations
. Percentage complete
. uv-coverage acquired - e.g. LST ranges already observed
. Current RMS flux sensitivity
. Pointing RMS - used to access data quality.
. Passband accuracy
. Polarization - instrumental calibration accuracy

6 Observing Methods.

Methods describe how to make and sequence the observations. E.g. an observing script, describing one or more scheduling blocks.

The observing sequence may contain PREOB - scheduling blocks required in advance to calibrate other observations, MIDOB - one of more scheduling blocks, including sequencies, loops, and other interdependency relations, and POSTOB - final calibration scheduling blocks. E.g.

PREOB - if needed do:
. Setup Frequency
. Setup Correlator
. Passband calibration
. Polarization calibration
. Flux density calibration
. Phase calibration
. Pointing calibration
. Test source calibration

MIDOB:
. Do THIS or THAT
. Loop WHATEVER until SOMESUCH
. Then do THESE
. Else SOMETHING

POSTOB:
. Final calibration if needed for whole set of SBs

7 Data Reduction

Requirements and Methods used to reduce the data. Pointers to the visibility and image data. The Science Requirements are converted into data processing requirements, and used to calculate the Resource Requirements for the Pipeline and Archive. E.g.

Requirements:
. Images or whatever
. Field of view
. Angular resolution
. Velocity resolution
. Bandwidth
. Number of channels

Methods:
. Identify calibrators
. Calibration methods (phase, amplitude, passband, polarization etc.)
. Imaging method
. Deconvolution methods
. Analysis
. Results extraction: feedback to observer, scheduler, etc.

8 Conclusion

The **observing object** provides a logical unit for observing, scheduling and data processing. The Observing Methods might have quite complex dependences, but must be broken into **scheduling blocks**. The Requirements and Status provide a more uniform interface for the dynamic scheduler and insulate it from the complexities of the observing methods. The users can have their own hierarcies and priorities inside the methods; the scheduler does not have to know about all this. Instead, the Status is updated with the types of things that the scheduler should be concerned with.

An observing proposal may comprise of several observing objects, e.g. different sources, or receivers, or single dish, compact array and extended array observations of the same source. Observations from several observing objects may be combined, e.g. in mosaic observations, and an imaging method, or data analysis may use the data described in several observing objects. In these cases the observing object provides an interface between the imaging methods and the data described in the individual observing objects.

The observing object serves to reconcile the needs of the astronomer, and the scheduling of many proposals in an efficient and comfortable way.