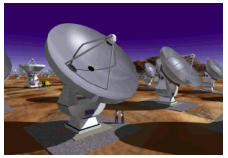
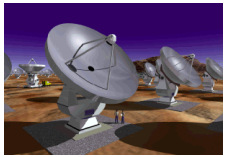


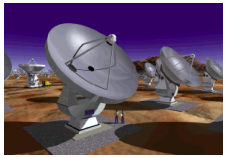
ALMA Software: Observing and Data Reduction Tools

Robert Lucas (IRAM)



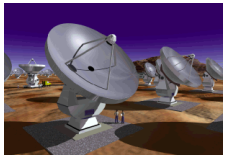
Outline

- General Science Software Requirements
- Observing Tool
- Pipeline Data Processing
- Off-line Data Processing
- Status information



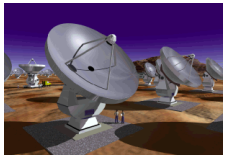
General Science Software Requirements

- See ALMA Software memo 11:
  http://www.alma.nrao.edu/development/computing/docs/joint/0011/ssranduc.pdf
- Elaborated by the Science Software Requirements Committee
- Deal with a large variety of projects:
  - observing well understood at 3mm, as site is very good;
  - much more difficult at 300μm, where development is expected to occur in the observing modes/strategy (e.g. atmospheric radiometric correction is needed)
- A high degree of automation is needed to guarantee observing efficiency with the high data rate; but development has to be possible.
- ALMA should be easy to be used in an efficient way by the non specialist as it will be a unique instrument; but experts should be able to use the instrument in modes we do not yet foresee.



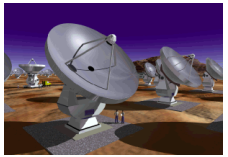
Instrument Control

- Control command language
  - simple, easily editable, programmable
  - control all basic hardware components
  - provides a way to develop the basic observing modes
- Graphical User Interfaces, e.g.
  - Observing Tool, used both at proposal submission and occasionally for interactive mode
  - Operator Interface
  - Data Reduction User Interface



Proposal Preparation

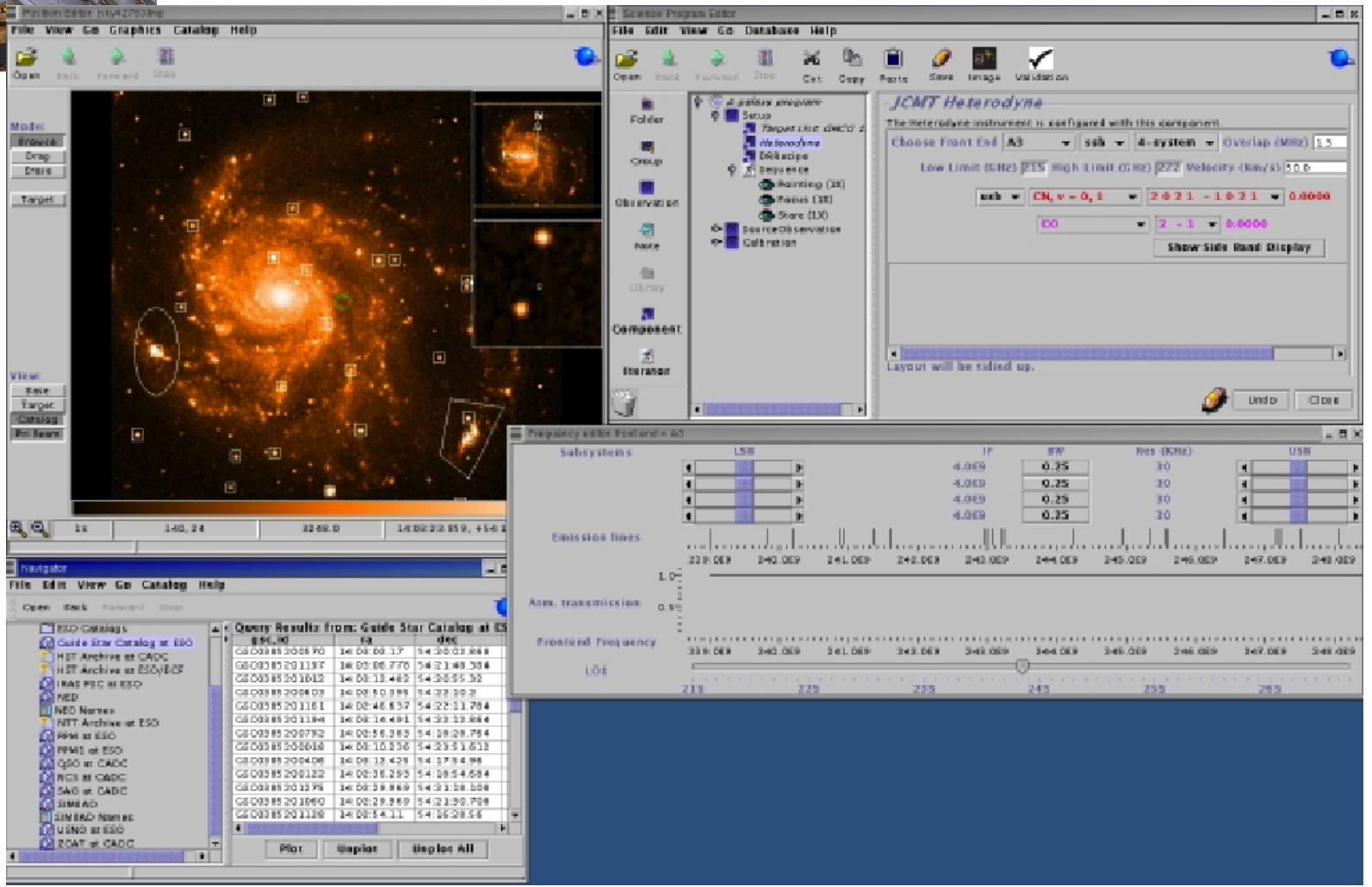
- In two phases (before and after reviewing).
- Uses the Observing Tool:
  - Knows the standard observing modes
  - Novice and Expert modes
  - Translates astronomical information into observing parameters
  - Provides reasonable defaults for observer's input
  - Enables detailed input using components: observation setup, correlator setup, s[dflensitivity calculation, interface to data simulation.
  - Prepares the scheduling (Scheduling Blocks)
  - Informs the user (and the reviewers) on data rate and data processing needs.

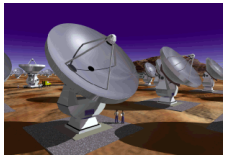


Proposal Preparation: Observing Tool

- Also used in cases of interactive observing.
- Concept based on existing similar tools, e.g. Gemini and ORAC OTs (Gemini and UKIRT/JCMT).
- Prototype in development
- Feedback from users to developers is very important (subsystem scientist, SSR, ...)

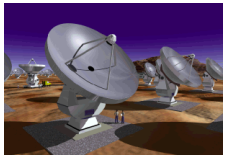
Proposal Preparation: Observing Tool





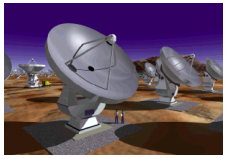
Dynamic Scheduling

- Essential feature of the instrument
- Allows to optimize use of the variable site conditions (sub-millimeter / millimeter weather)
- Uses both project stringency and scientific rating
  (stringency = ratio of total available time to time during which a given programme could be scheduled)
- For this projects are split into Scheduling Blocks which are the basic scheduled observing units.
- Scheduling Blocks can be logically linked for complex projects
- Break Points available to enable user decision taking.



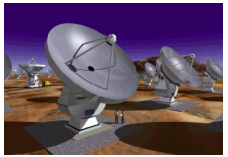
Pipeline Data Processing

- Blind data taking and need for large time investment from the user to produce images has in the past limited the efficiency of aperture synthesis imaging at radio wavelengths
- In the mm range the atmospheric conditions vary hence the need for real time information on the quality of the data taking
- For most projects the data reduction can be made automatic, e.g. thanks to the abundant coverage of the uv plane.
- Advantages: more uniformity in the calibration, hence in quality evaluation, and in imaging options.
- We need fully developed software with carefully tested procedures, that fulfill the needs of ALMA widely used standard modes of observation.



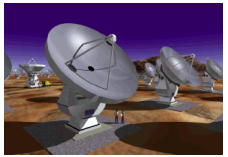
On-Line calibration

- Reduces pointing scans, focus scans, delay measurements, antenna position measurements ...
- Performs atmospheric calibration using state-of-the art model of atmosphere transmission; including radiometric phase correction.
- Check atmospheric phase quality on phase calibrators as well as signal amplitude from each antenna.
- Provides feedback to the observing process (to optimize observational parameters) and to the dynamic scheduler (to inform it of the actual observing conditions).



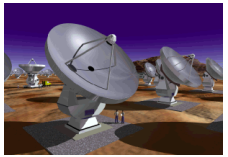
Quick Look

- Display observing parameters and results from on-line calibration
- At short intervals provide raw science images (calibrated data, but not deconvolved; gridded for single dish)
- Provides feedback to humans (operators, staff astronomers) on site on the actual quality of the data acquired
- Perform quality tests on test source
- Results available to the observer (PI) through a regularly updated web page.



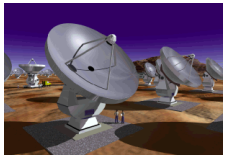
Science Data Processing

- When requested by the PI (at break points, and at least at the end of the observations)
- Check and correct the flux scale
- Perform a final calibration (using all available calibration data)
- Include data obtained during previous observing sessions
- Build, deconvolve, and archive the final image
- Process single-dish as well as interferometric data.



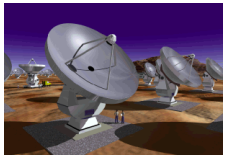
Archiving

- We expect, from the needs of typical science projects, an average data rate of 6Mb/s and thus about 180 Tb a year.
- A peak data rate of 60Mb/s is required for some projects.
- Archive visibility data, calibration data, images produced by the pipeline.
- Archive complete information on the conditions under which the data were observed and reduced (quality information).
- The archive should include efficient search capabilities to select and retrieve science data, to enable archival research when proprietary periods are expired.
- The archive will be designed to be Virtual Observatory compliant.



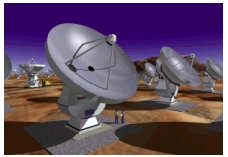
Off-line Data Processing

- This is less specific to ALMA, as many components are common to all radioastronomy synthesis and single-dish instruments.
- The intent is to make use of existing software tools and packages.
- All observing modes should be well covered (single dish and interferometer, mosaics, ...)
- User friendly interfaces for the standard modes (no detailed knowledge of aperture synthesis should be required).
- Allow development of new data reduction algorithms
- Quite detailed requirements in ALMA Sw Memo 18
  http://www.alma.nrao.edu/development/computing/docs/joint/0018/ALMAoffline-sw-18.pdf

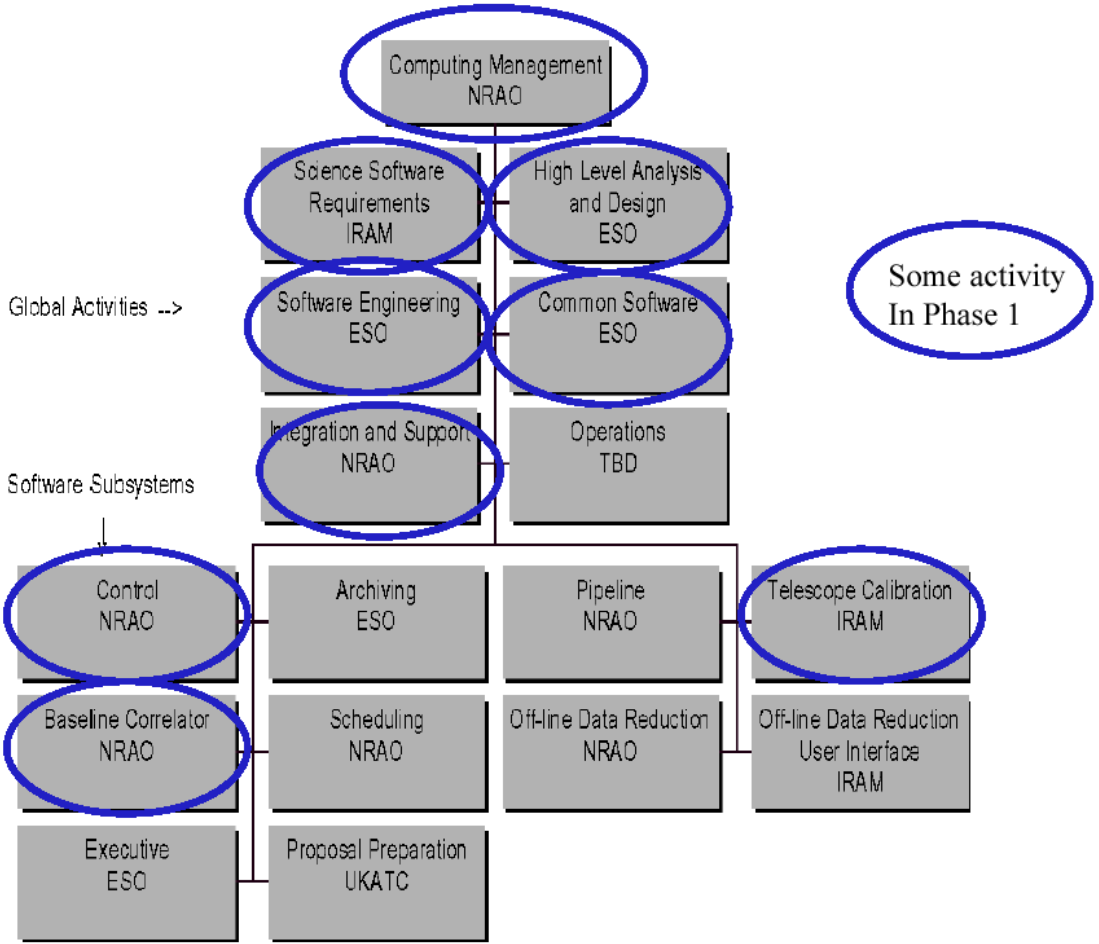


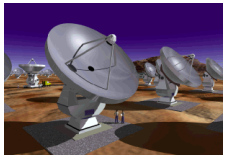
General Status

- We formally entered Construction Phase (phase 2) in June 2002
- Prototype Control Software getting ready to allow testing the first prototype antenna in a few weeks at VLA site
- All parts of the system will use common software components (ALMA Common Software), well developed too.
- Other parts are in the design stages; a software architecture has been defined for the whole project
- ALMA software work split in subsystems (10 Software Subsystems, 7 Global Activities)
- Each Subsystem is closely followed by a member of the SSR Committee as a 'Subsystem Scientist'
- Internal Review is scheduled in December 2002, in which the SSR Committee will actively participate.
- Official PDR is planned for Spring 2003.



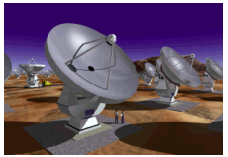
ALMA Software





Data Processing Status

- Data reduction subsystems (both pipeline and off-line) are foreseen to make a large use of the AIPS++ imaging package.
- In order to assess to which degree AIPS++ is meeting ALMA needs:
  - A simple test is being performed on an existing instrument (IRAM Plateau de Bure), as a collaboration between ALMA and AIPS++: perform end-to-end data processing of standard Plateau de Bure projects
  - An audit is performed on how well AIPS++ satisfies Memo 18 requirements; this should be kept up-to-date as development in AIPS++ progresses.
  - Benchmarks will be defined and attached to the requirements, to assess the performance levels.

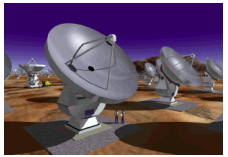


The IRAM/AIPS++ test

- Phase I: Reduce a sample Plateau de Bure Project in AIPS++, using the same methods that are used at this site:
  - Use of radiometric phase correction
  - Calibrate with low signal-to-noise
  - Transfer phase from 3mm to 1mm

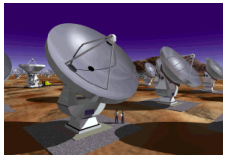
  Status:
  - Phase transfer not satisfactory yet (simplified method available)
  - Detailed comparison of results is not yet available
  - Some difficulties with software stability
- Phase II: Reduce other data sets to gain experience.
  Status: not yet really started.

A preliminary report was made available early September and presented to ASAC.



The AIPS++ audit

- Purpose:
  - measure compliance to requirements
  - check the rate of improvements (repeat)
  - provide inputfor development planning
  - relatively objective information
- SSR activity (Steve Myers, and other auditors)
- Evaluation is mainly based on availability and documentation of features.
- Feedback solicited from AIPS++ project.
- Final report available soon.



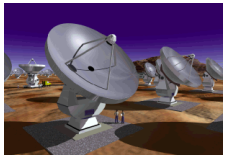
The AIPS++ audit, preliminary results

	Acceptable	Inadequate	Unavailable	TBD
All	58%	16%	16%	10%
Critical	66%	14% (0%)	12% (0%)	8%
Important	52%	19% (<10%)	19% (<10%)	10%
Desirable	35%	17%	33%	15%

TBD = needs ALMA development or too hard to determine

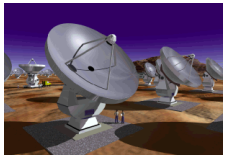
red = required state in 2007

- Different grades from different auditors 14%
- Finalization of document in progress

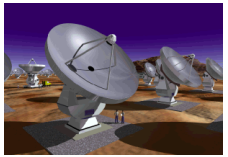


Benchmarking

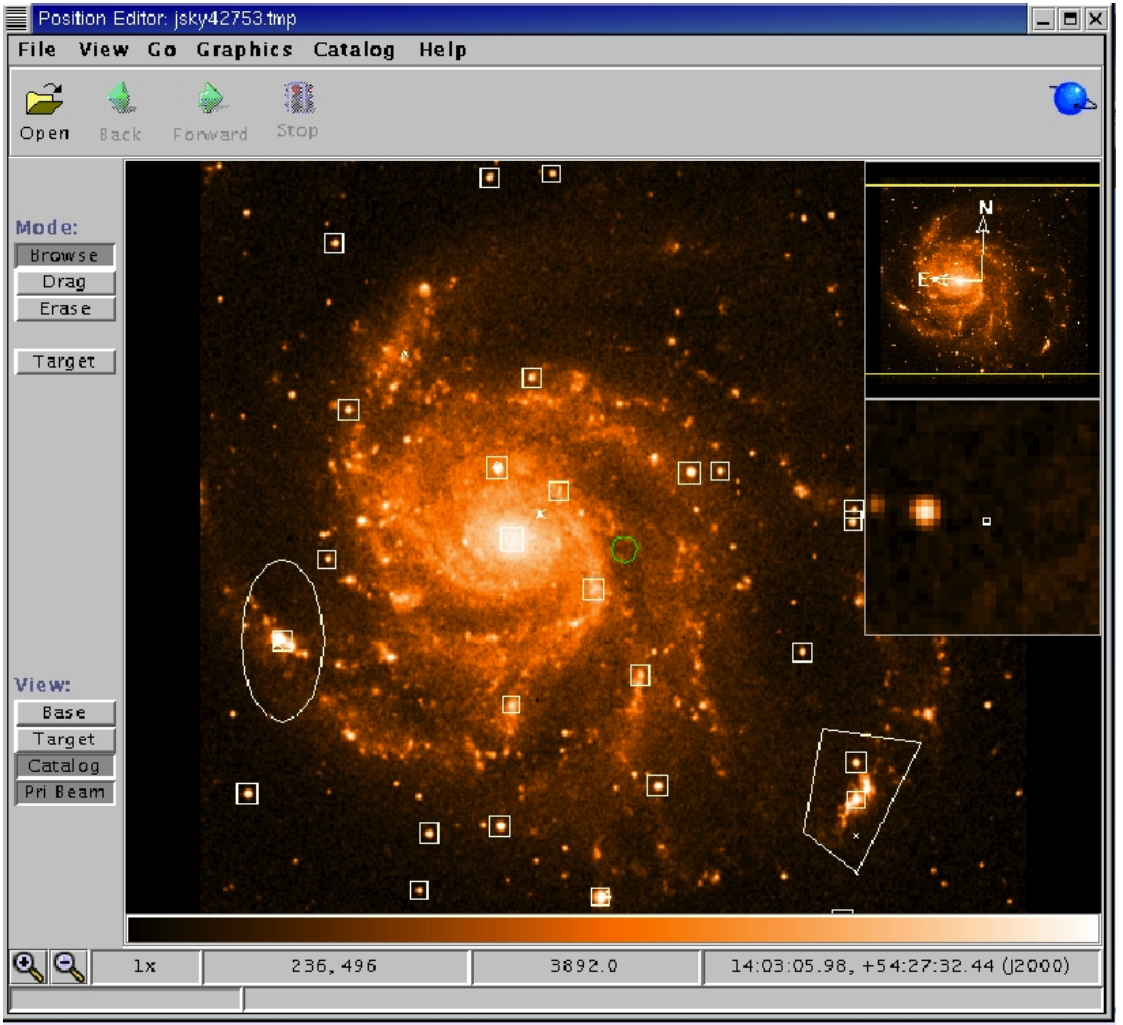
- The requirements state that representative data sets should be provided to enable benchmarking of Off-Line package performance.
- The AIPS++/IRAM test is foreseen to be extended by a Phase III in order to evaluate the performance of the functionalities within the scope of the test, but on data sets of size relevant to ALMA.
- The current plan is to proceed with this in the next few months.

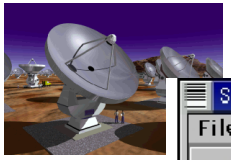


A suivre ...

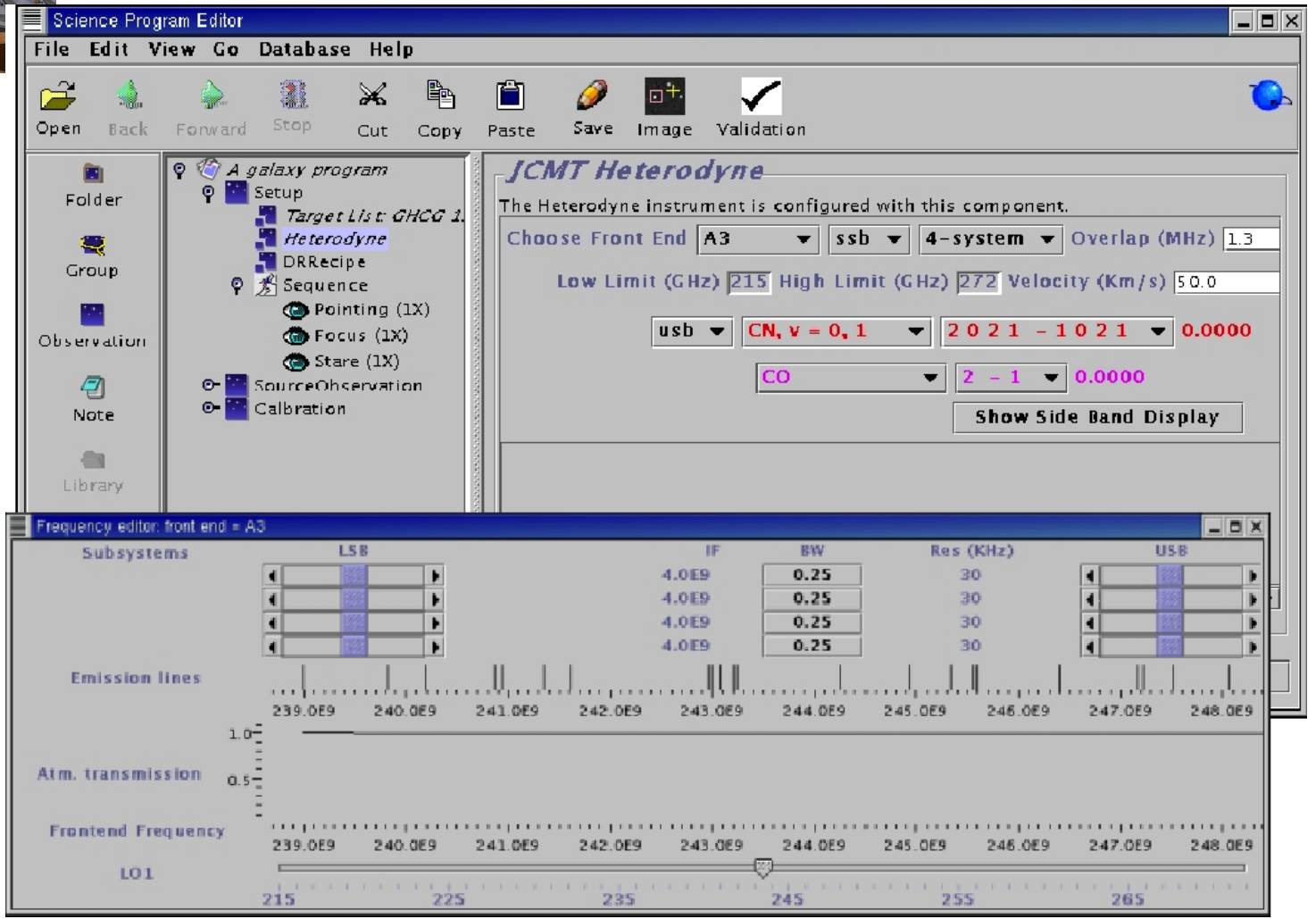


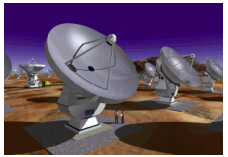
Observing Tool: TargetEditor



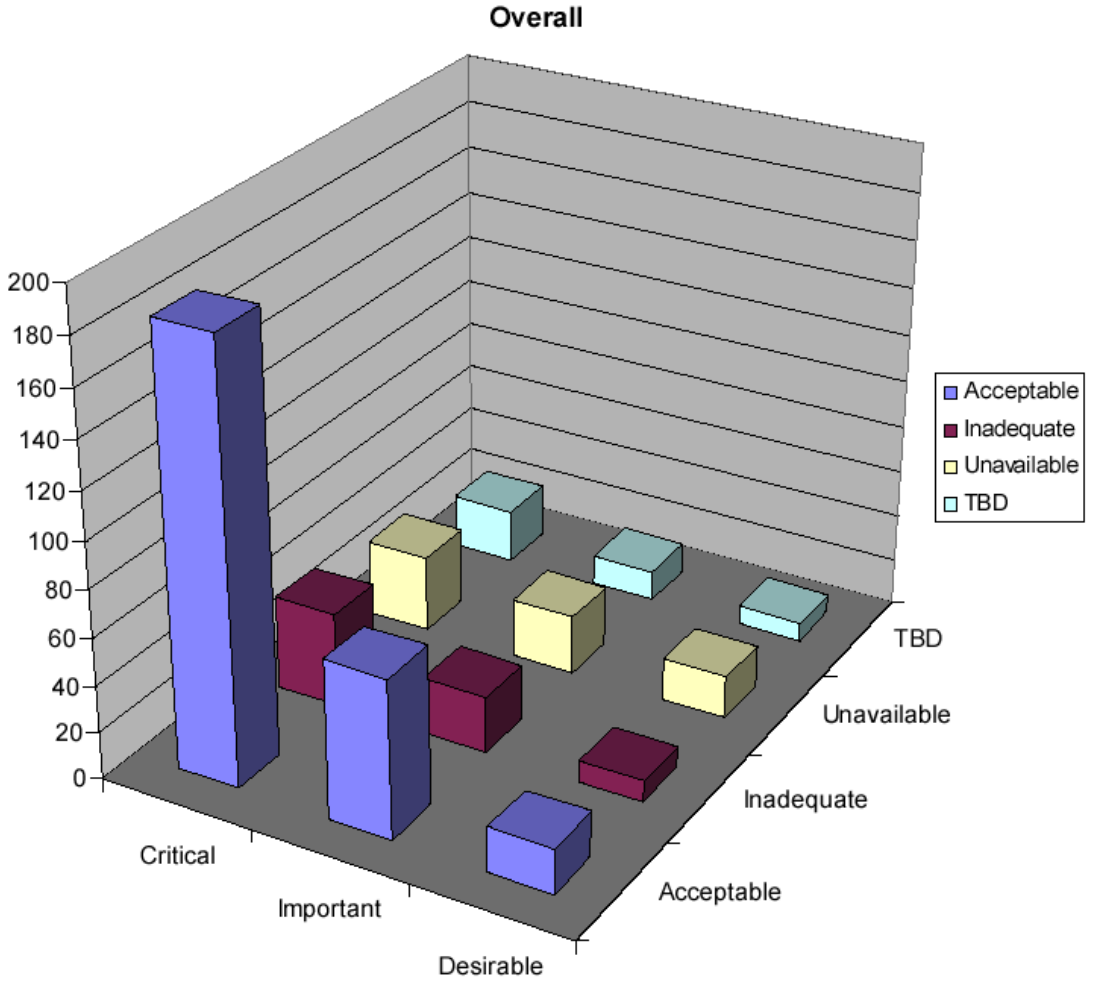


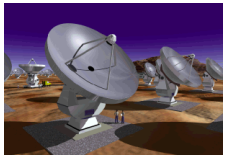
Proposal Preparation: Science Program Editor





The AIPS++ audit, preliminary results





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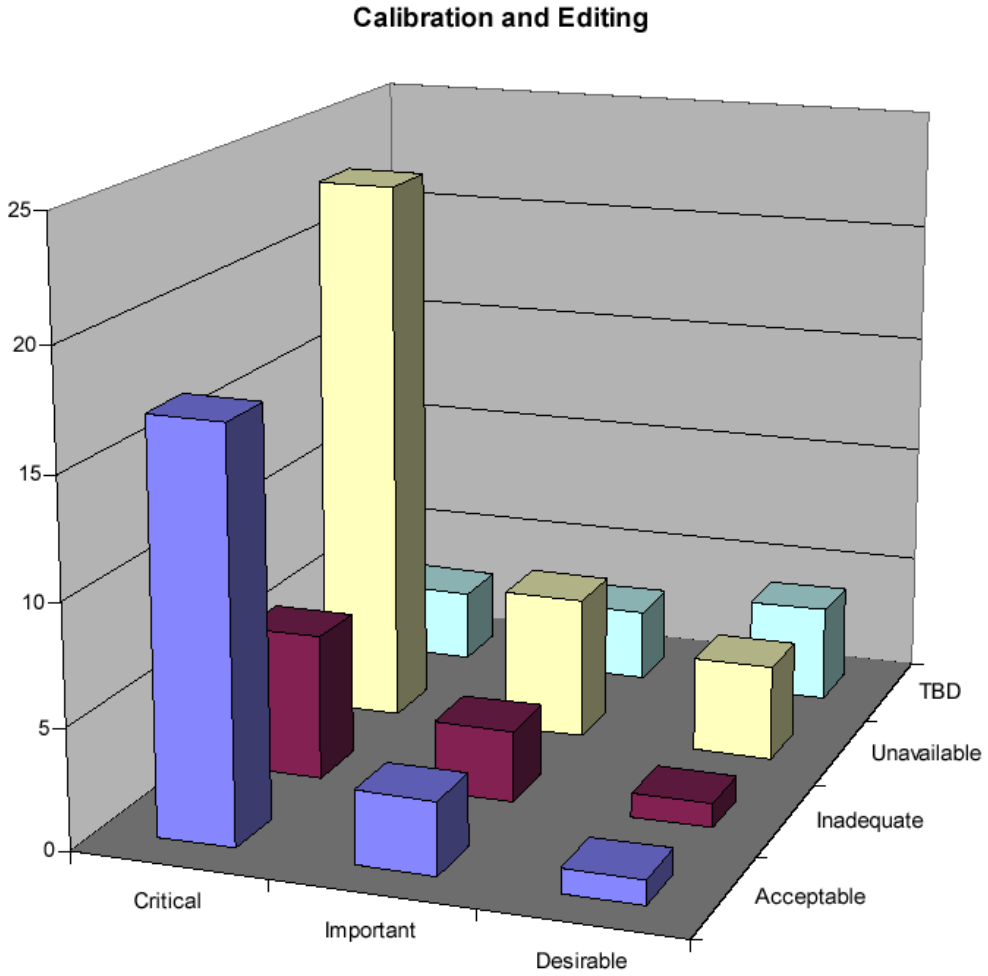

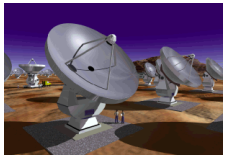

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