Status of ALMA Software

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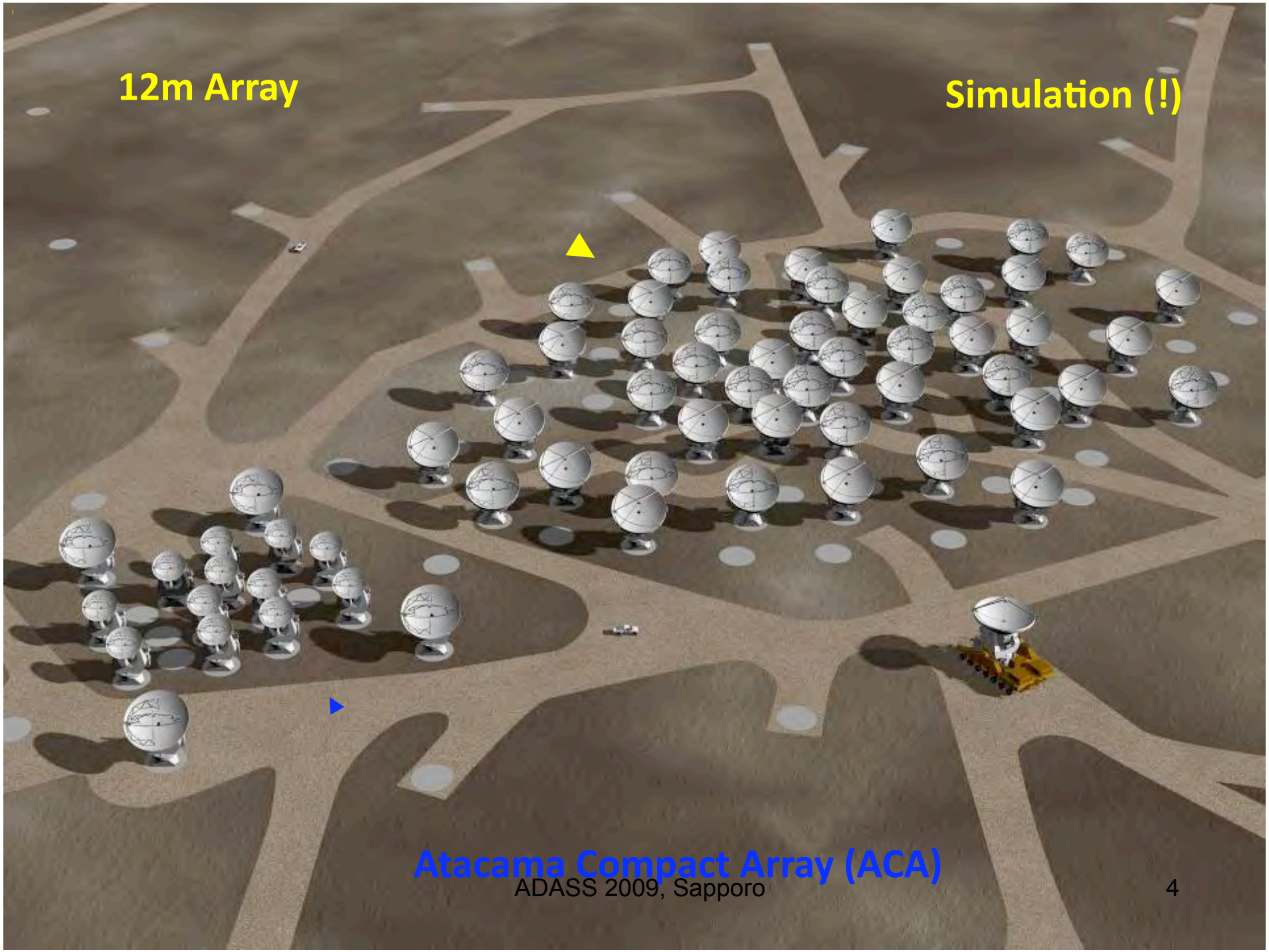
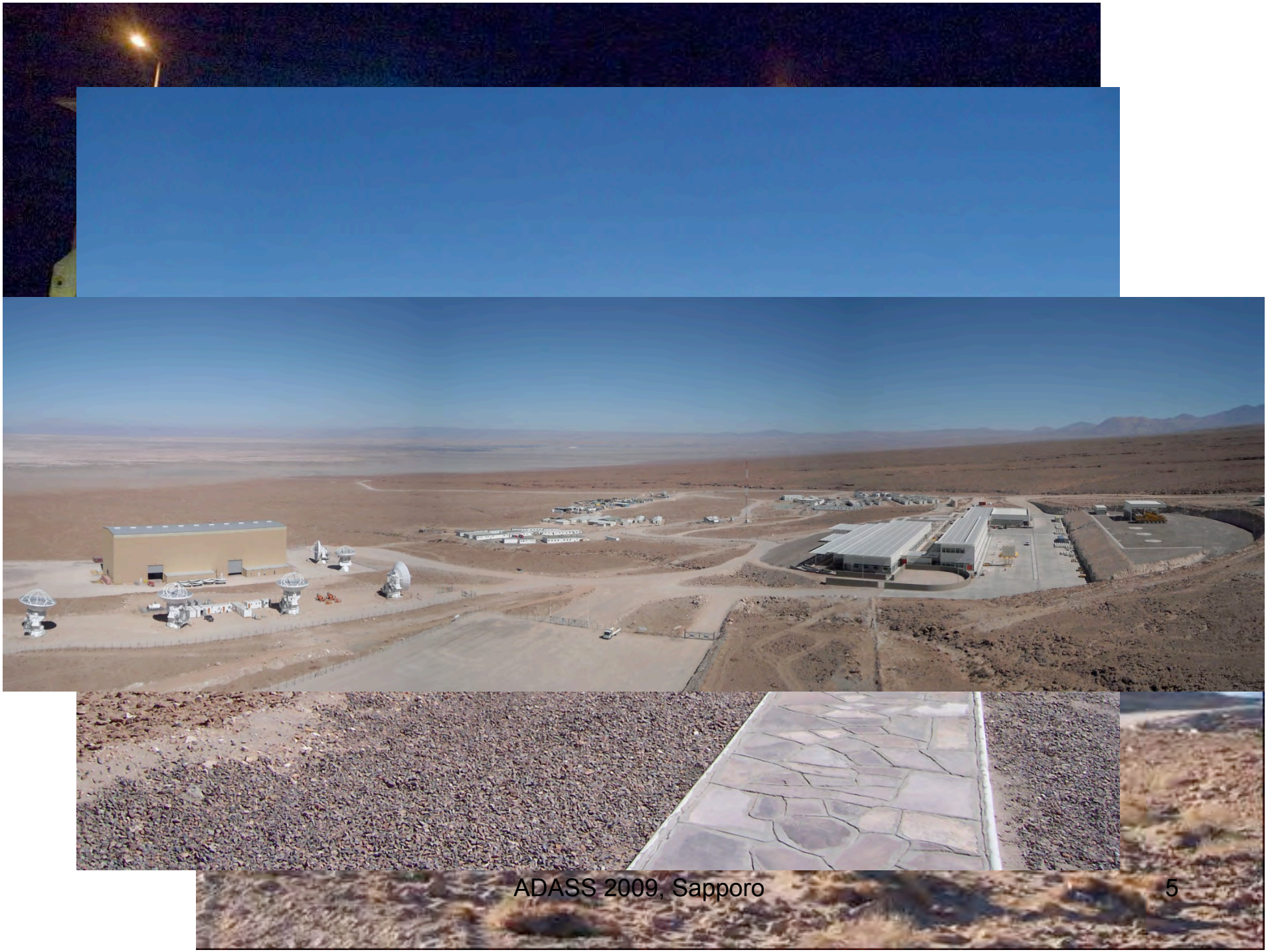
ALMA at ADASS

- Lorente – Science Data Model for ALMA/EVLA (Before me)
- Nakazato – Single Dish Analysis software for ALMA (After me)
- Davis – ALMA Pipeline Heuristics(P#12)
- Hoffstadt – Reusable state machine (P#28)
- Morita – Spatial Frequency Weights (P#48)
- Reveco – Device code generation framework (P#63)
- Sugimoto – Single dish simulator (P#71)
- Tobar – ACS and POSIX compliant RTOS (P#77)
- Wicenec – ALMA Front-end Archive (P#83)
- Ye – 3D Data Cube viewer (P#88)

ALMA

- 66 transportable antennas
  - 54 12m antennas
  - 12 7m antennas
  - 14km largest antenna separation (~milli-arcsecond)
- 100 – 1000 GHz
- Interferometer (all antenna pairs) plus single-dish measurements
- Very dry site @ 5000m in Northern Chile
- Worldwide collaboration: East Asia (NAOJ), Europe (ESO), North America (NRAO)
- $1.3B – most expensive ground-based telescope (so far)
  - ~$50M software development (450 FTE-y) & computers


12m Array
Simulation (!)
Atacama Compact Array (ACA)



Major Scientific Milestones

1. Start of Scientific Commissioning (2010 Q1)
   - Currently in "Assembly, Integration, Verification" (AIV) stage
   - Emphasis on control software, data processing software
2. Start of Early Science (2011 Q3)
   - Requires most software, including user software (e.g., phase 1 & 2)
   - Automatic pipelining not reliable
3. Inauguration (2012 Q4)
4. Completion of Construction (2013)

ALMA Computing Integrated Product Team (IPT)

- Software system designed and built as an ambitious, demanding, end-to-end software system
  - Up-front design and implementation
  - Result will be a ~3M line of code "end to end" software system running on over 200 computers on 4 continents.
    - (figure does not include comments, documentation, or adopted/ modified products like CASA, NGAS, ATM, etc).
- Work areas
  - Functional: Proposal preparation, monitoring, dynamic scheduling, equipment control and calibration, correlator control and processing, archiving, automated pipeline processing, offline processing, operational software, data acquisition
    - Not: embedded software (hardware groups), algorithm development

ALMA Computing IPT (2)

  - Support Activities: management, requirements, analysis, common software, software engineering, integration and test, commissioning support
  - Necessary operational computer equipment
- Personnel distribution (70+ FTE)
  - Multi-site (15), multi-continent (4) software development organization
  - Complete technical authority in IPT management
  - Subsystem development sometimes split between organizations, but with a dominant partner

Commissioning Software

Key deliverables:

- Control & ACA Software (including all hardware at antennas and AOS)
- Correlator Software (control and raw data acquisition)
- Common Software (common framework and libraries for all ALMA software)
- Executive Software (operator user interfaces, procedures)
- Front-End Archive (basic archiving and queries, at OSF)

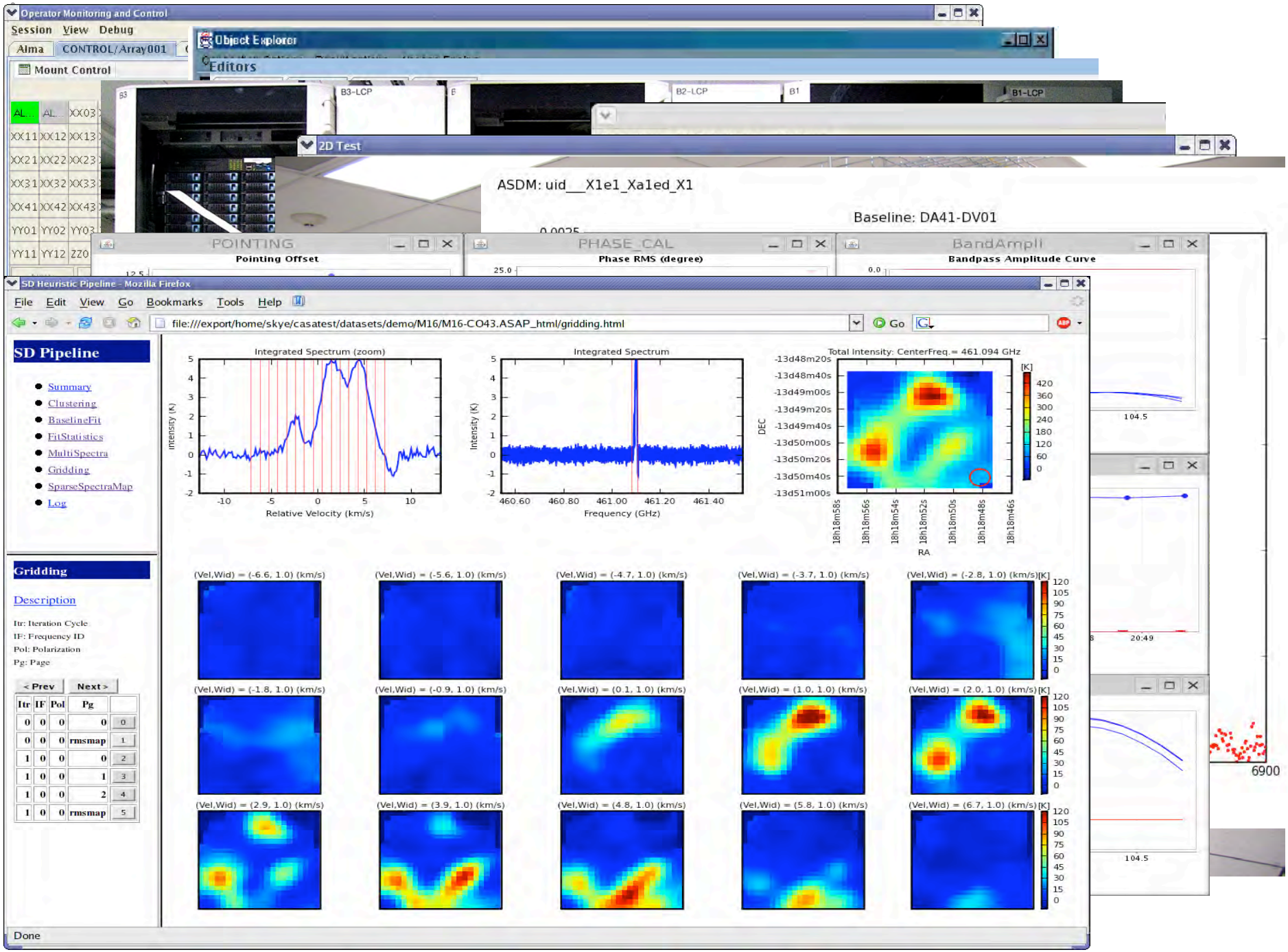
+ Some items from later-stage subsystems

- Quicklook display (subset of Pipeline, needed by operator)
- Scheduling Block (SB) queue handling (subset of Scheduling, no dynamic sched.)
- Data reduction Commissioning features (subset of CASA, CLIC/Gildas)
- SB creation (subset of Observation Preparation)
- Online calculation of telescope calibration parameters.

Observatory Software

Key deliverables:

- Data driven Pipeline: automated flagging, calibration and imaging with associated quality information for common ALMA observing modes.
- Operations Support for science ops.: proposal review support, data products management, support monitor and quality checking of data …
- Dynamic scheduling (weather optimized choice of SBs)
- Offline data reduction: extensive support for multi-channel, multi-polarization, multi-spectral window, multi-pointing flagging, calibration, imaging, and analysis for interferometric, single dish, and combined data.
- Fully distributed Archive operation (storage of SBs, raw data, Pipeline images and logs, monitor data, calibr. data, site data), VO support.
- Telescope Calibration pipeline, providing real-time calibration data
- Observation Preparation for all ALMA observing modes and suitable also for novice users (automated generation of SBs), widely portable.


Operator Monitoring and Control
Session View Debug
Alma CONTROL/Array001
Mount Control
Object Explorer
Editors
B3-LCP
B2-LCP
B1-LCP
2D Test
ASDM: uid__X1e1_Xa1ed_X1
Baseline: DA41-DV01
POINTING
Pointing Offset
PHASE_CAL
Phase RMS (degree)
BandAmpli
Bandpass Amplitude Curve
SD Heuristic Pipeline - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
file:///export/home/skye/casatest/datasets/demo/M16/M16-CO43.ASAP_html/gridding.html
SD Pipeline
Summary
Clustering
BaselineFit
FitStatistics
MultiSpectra
Gridding
SparseSpectraMap
Log
Integrated Spectrum (zoom)
Integrated Spectrum
Total Intensity: CenterFreq.= 461.094 GHz
Intensity (K)
Relative Velocity (km/s)
Frequency (GHz)
DEC
RA
Gridding
Description
Itr: Iteration Cycle
IF: Frequency ID
Pol: Polarization
Pg: Page
< Prev
Next >
Itr IF Pol Pg
rmsmap
(Vel,Wid) = (-6.6, 1.0) (km/s)
(Vel,Wid) = (-5.6, 1.0) (km/s)
(Vel,Wid) = (-4.7, 1.0) (km/s)
(Vel,Wid) = (-3.7, 1.0) (km/s)
(Vel,Wid) = (-2.8, 1.0) (km/s)
(Vel,Wid) = (-1.8, 1.0) (km/s)
(Vel,Wid) = (-0.9, 1.0) (km/s)
(Vel,Wid) = (0.1, 1.0) (km/s)
(Vel,Wid) = (1.0, 1.0) (km/s)
(Vel,Wid) = (2.0, 1.0) (km/s)
(Vel,Wid) = (2.9, 1.0) (km/s)
(Vel,Wid) = (3.9, 1.0) (km/s)
(Vel,Wid) = (4.8, 1.0) (km/s)
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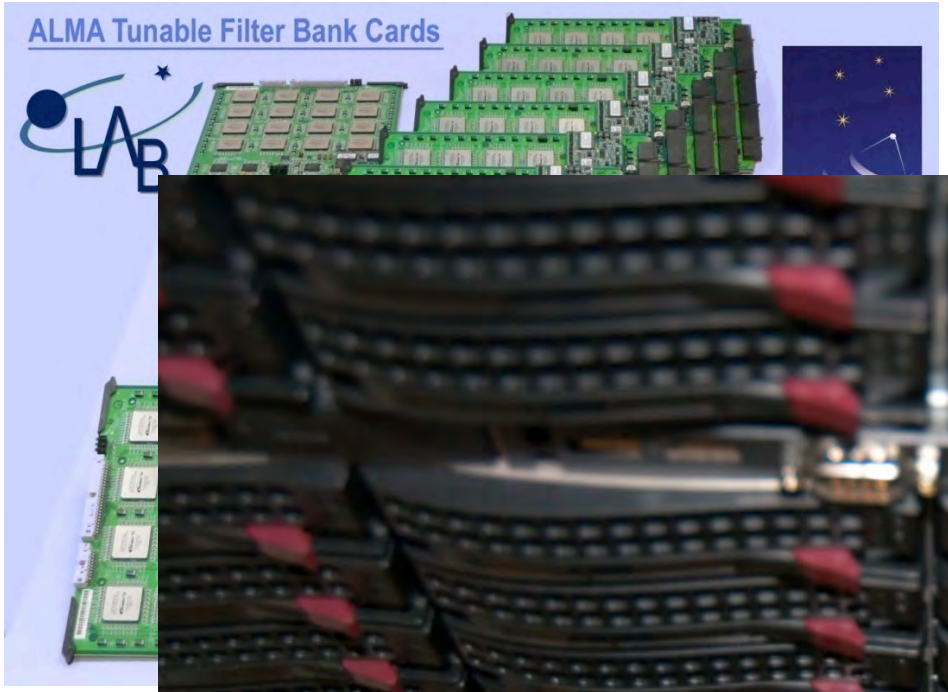
[K]
Done
6900



- (large datasets

Underlying Technologies

- Programming Languages: Java, C++, Python
- Source file management: CVS, make, eclipse
- Communications: CORBA
  - Direct binary arguments & large structures in XML
  - Services: Notification channel (events), A/V streaming (bulk data)
- Object runtime & distribution: Container/Component
  - Homegrown (part of ALMA Common Software (ACS))
- Persistence (All persistence through ALMA Archive interfaces)
  - File storage & replication: NGAS (ESO)
  - Meta/Auxillary data: XML + RDBMS
    - Raw data is *not* FITS
  - RDBMS (& XML): Oracle

Underlying Technologies (2)

- Adopted software: Lots
  - ATM, SLALIB, CALC, MATPLOTLIB, …
- User Portal: Plone, CAS
- Code generation
  - Fundamental data structures (science and project data models) represented in UML, language bindings generated from this.
  - ICD ➔Spreadsheet ➔Device Drivers
- OS: Linux & Real-Time Linux (Operational), Linux/MacOS (CASA)
- Real-Time I/O: CAN bus, simple master/slave protocol

Process

- Several groups involved in process areas:
  - High Level Analysis: Conformance to architecture, interfaces. (No longer active)
  - Software Engineering: Largely tool (e.g., version control), and infrastructure support.
  - Science Software Requirements: Requirements management, user tests, domain knowledge (now lead by commissioning/operations staff)
  - Integration, Test, Support: Standard test environment, integration tests.
  - Common Software: Provide frameworks for a common technical approach.

- Some less
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    & testing
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development

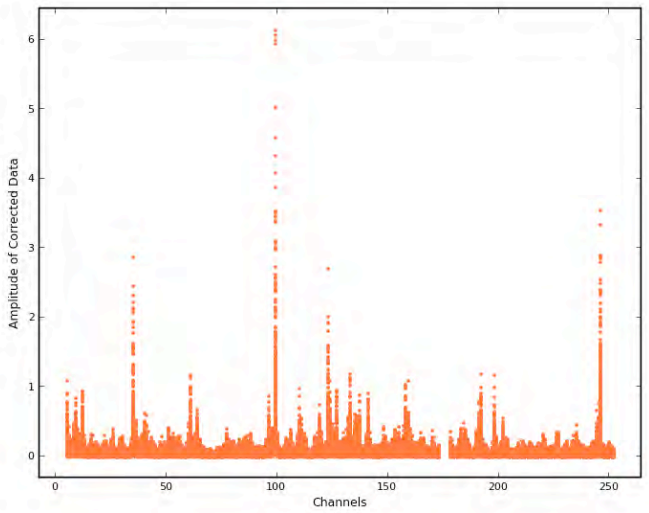
Organizational Principles

- Trilateral IPT
- Broken into 16 subsystems (= functional/support areas)
  - 2 – 11 people per subsystem
- Cross-subsystem developments (e.g., observing modes) take place in temporary Function Based Teams (FBTs)
  - ~5 per 6 month cycle
  - Started FBTs in 2006 to overcome problem with developments being too independent
- Fixed 6 month release dates; detailed planning discussed at annual CDR#n review (2009 = CDR7)
  - Progress checked via requirements tracking, testing

Overall Status

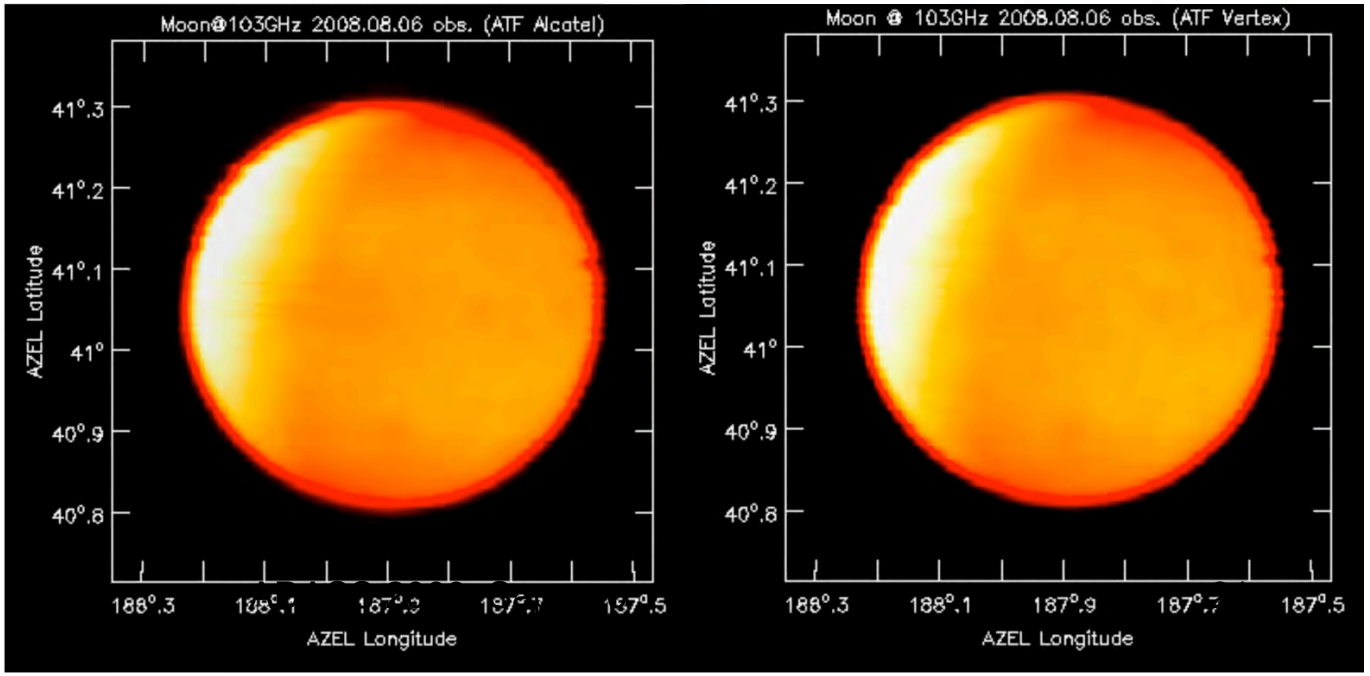
- We have been running an end-to-end system since 2005
- The software is in use 24x7 in Chile (in 4 independent installations)
  - "Commissioning" level use
- Software areas not yet in use at the observatory: science pipeline, science archive/VO, Phase I proposal, dynamic scheduling, "observatory operations" (e.g., observing tracking)
- CASA – was AIPS++
  - Data processing package for ALMA & EVLA
  - In beta release, will be fully released in December
  - Generally well received, but with a lot of skepticism to overcome

Sgr B2 Spectrum
97.9 GHz

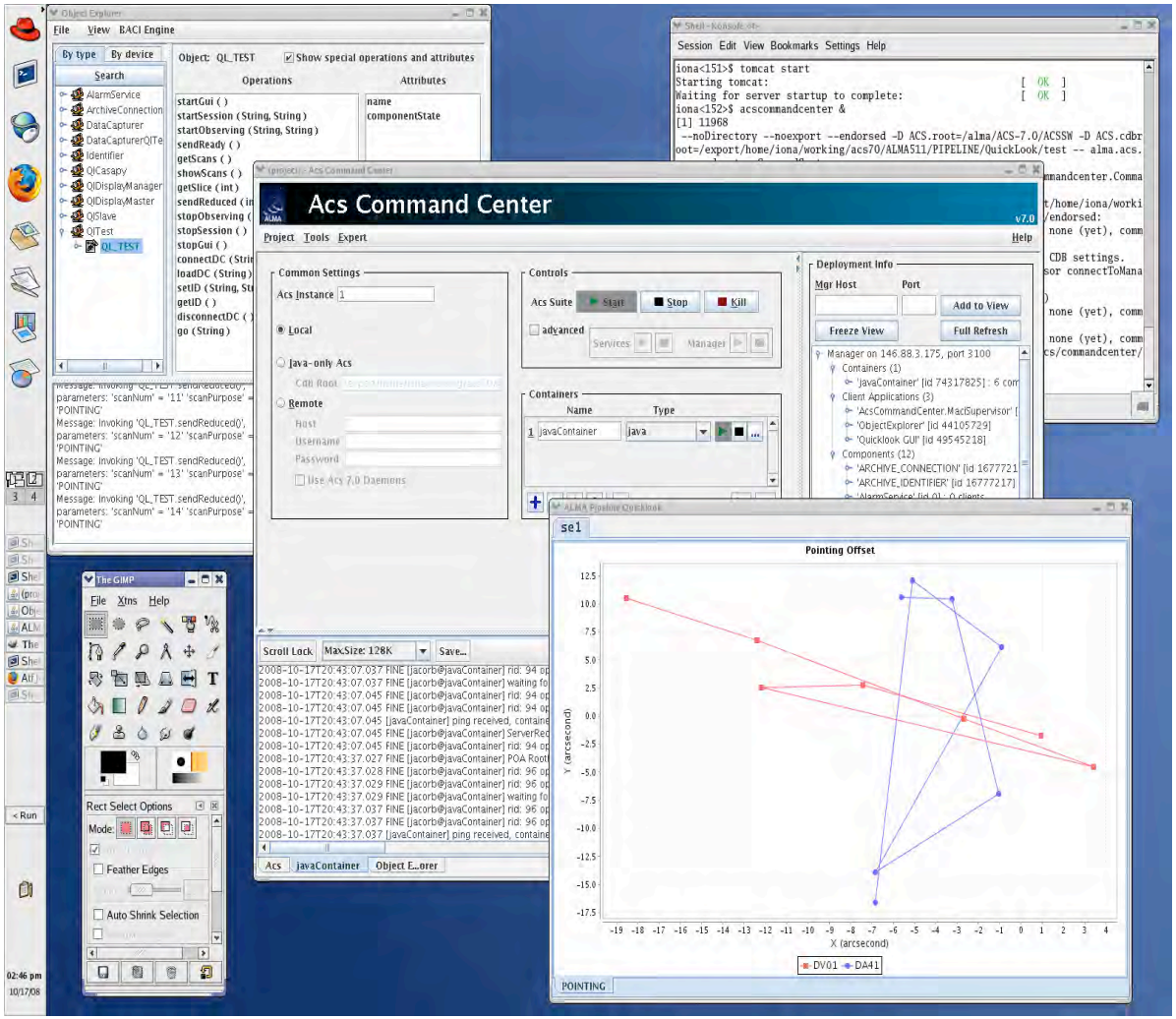


Raster on Moon with Total Power detectors simultaneously on 2 antennas

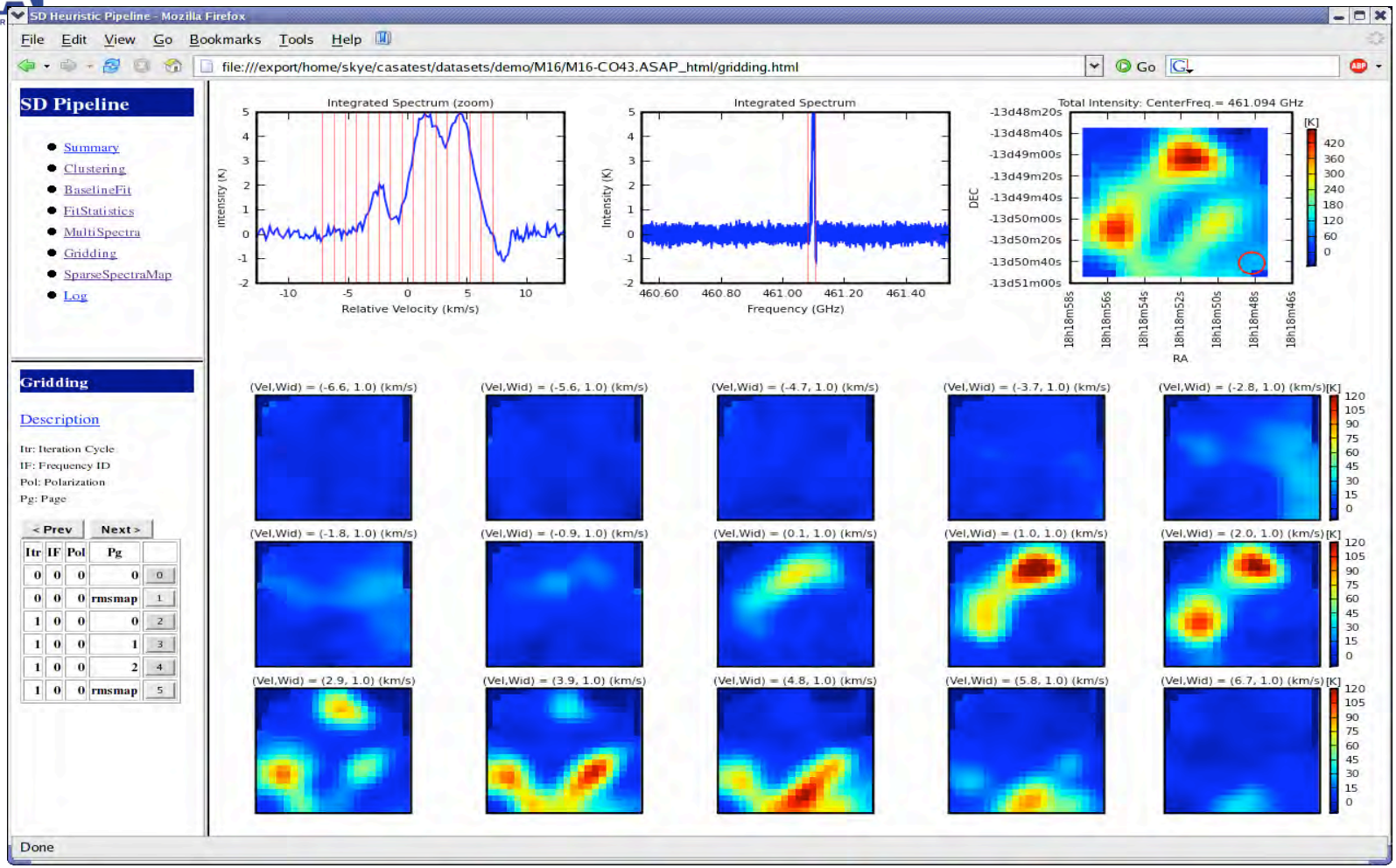
Taken at ATF, not using production receivers, but verifying software for control, tuning, correlator and data reduction



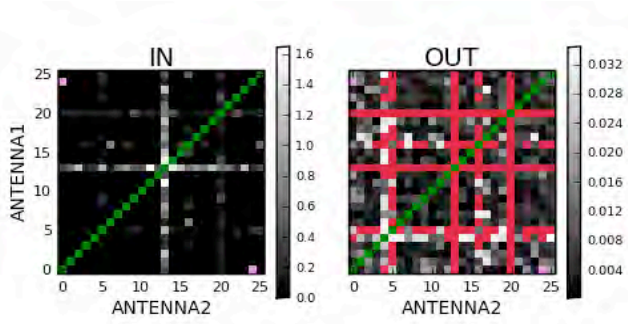
The Quicklook Display System in Playback Mode



The Single Dish Pipeline: M16 CO Gridding and Imaging Stage



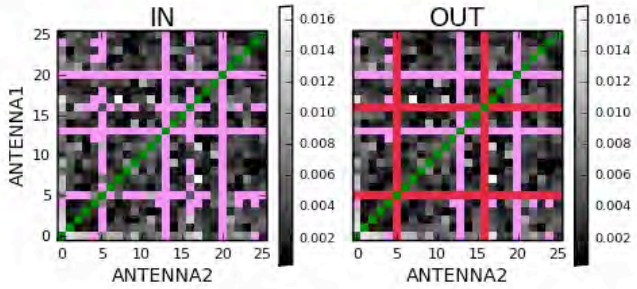
Standard Interferometry Pipeline: NGC2146A HI Calibrator Flagging Stage



STAGE: GAIN baseline phase MAD flagging
dataType:MAD over TIME of raw phase deviation FIELD_ID: 1 POLARIZATION_ID:LL DATA_DESC_ID: 0

Calculation History:
Origin:GAIN baseline phase MAD flagging

Flagged at previous stages:
original flags
flagged before this stage
Flagged here:
rules:
outlier

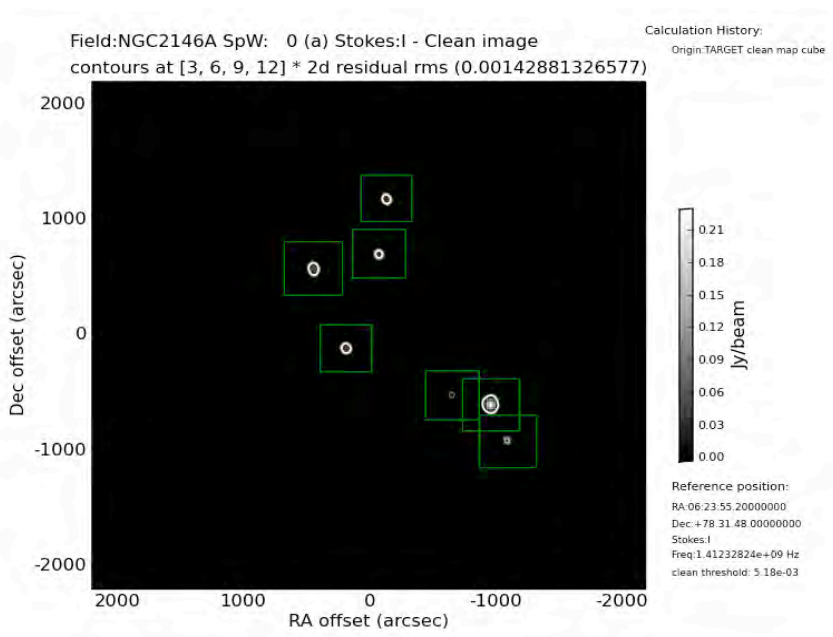


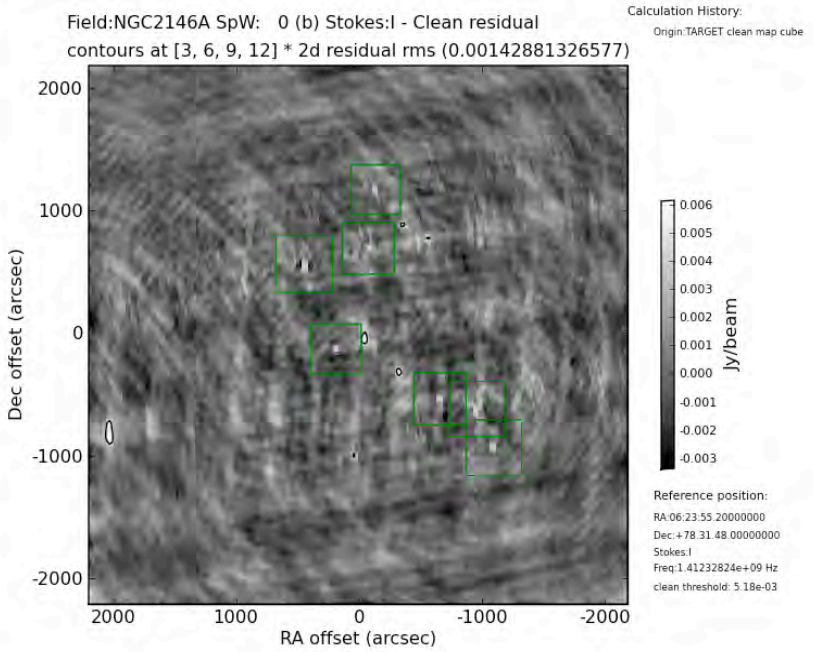
STAGE: GAIN baseline bad antenna flagging
dataType:MAD over TIME of raw amp deviation FIELD_ID: 1 POLARIZATION_ID:LL DATA_DESC_ID: 0

Calculation History:
Origin:GAIN baseline bad antenna flagging

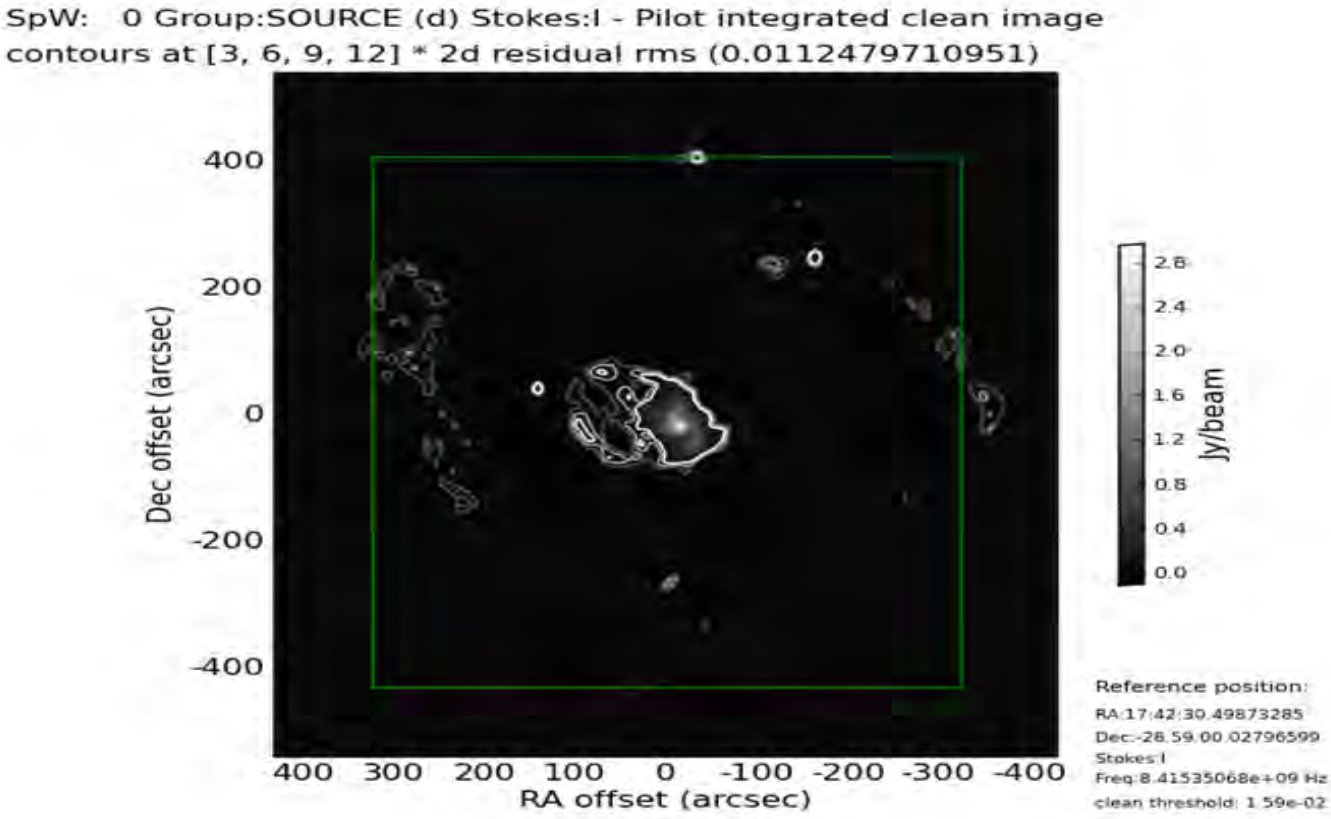
Flagged at previous stages:
original flags
flagged before this stage
Flagged here:
rules:
ANTENNA2 axis - too many flags

Standard Interferometry Pipeline: NGC2146A HI Final Imaging Stage

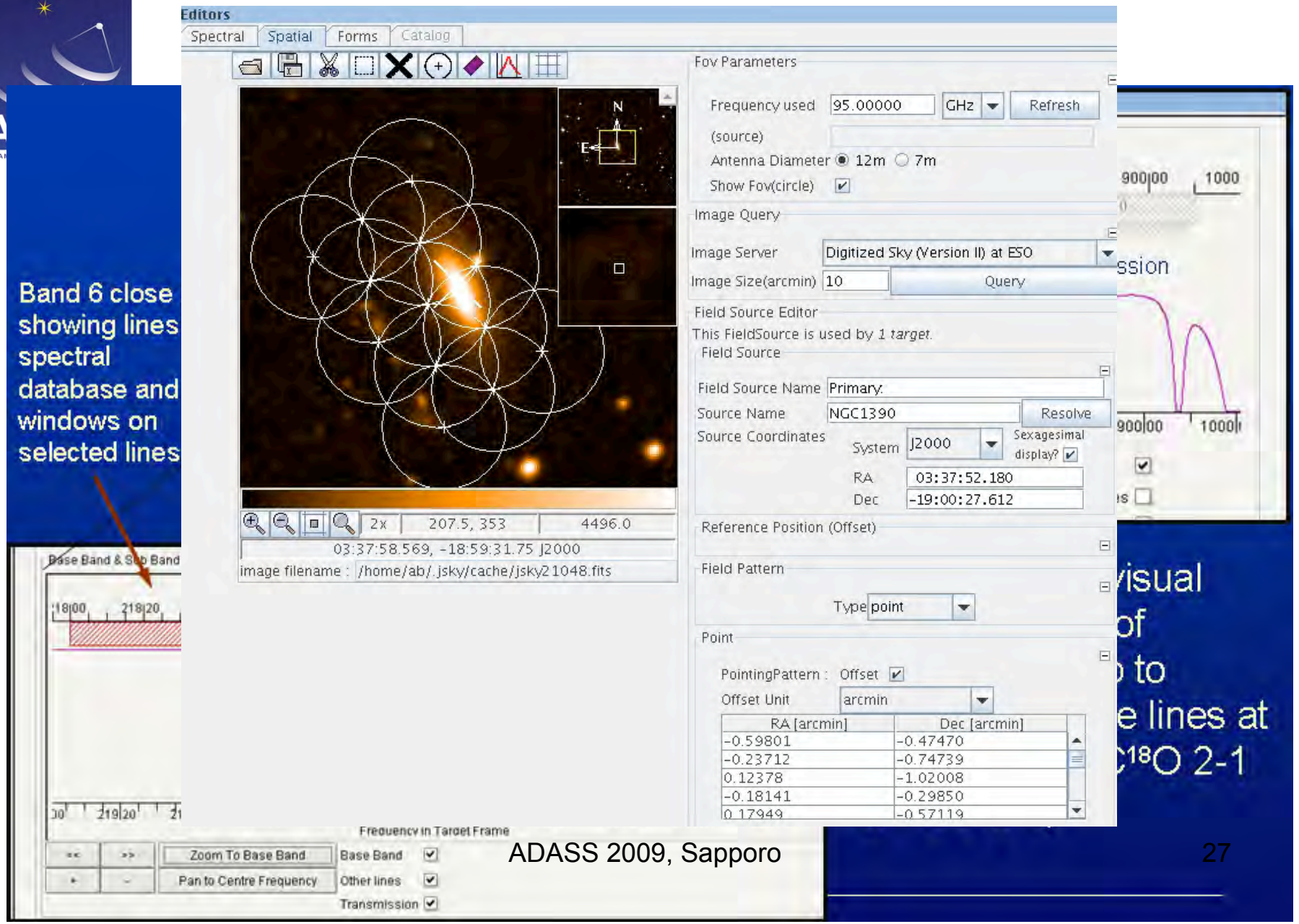


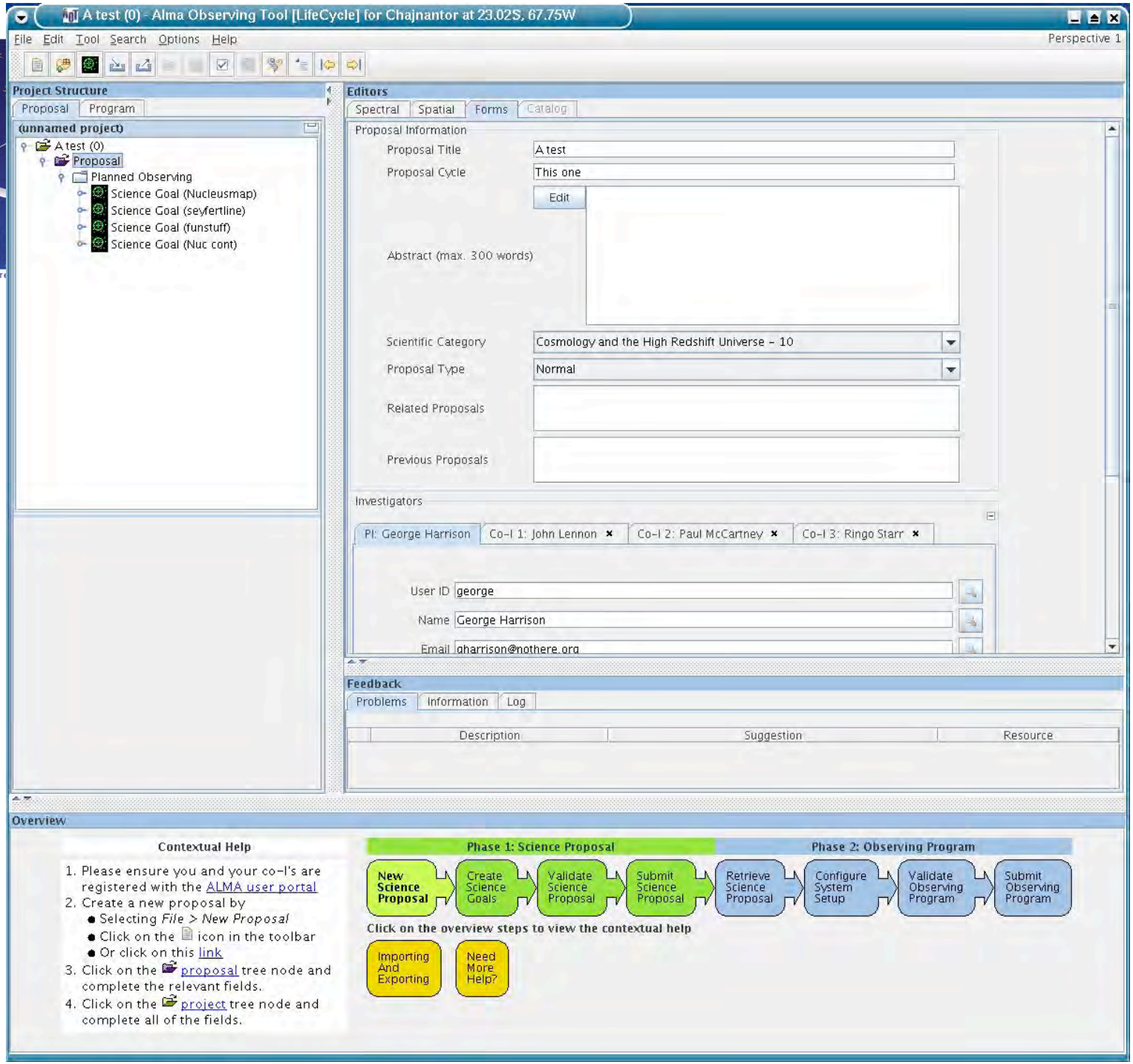


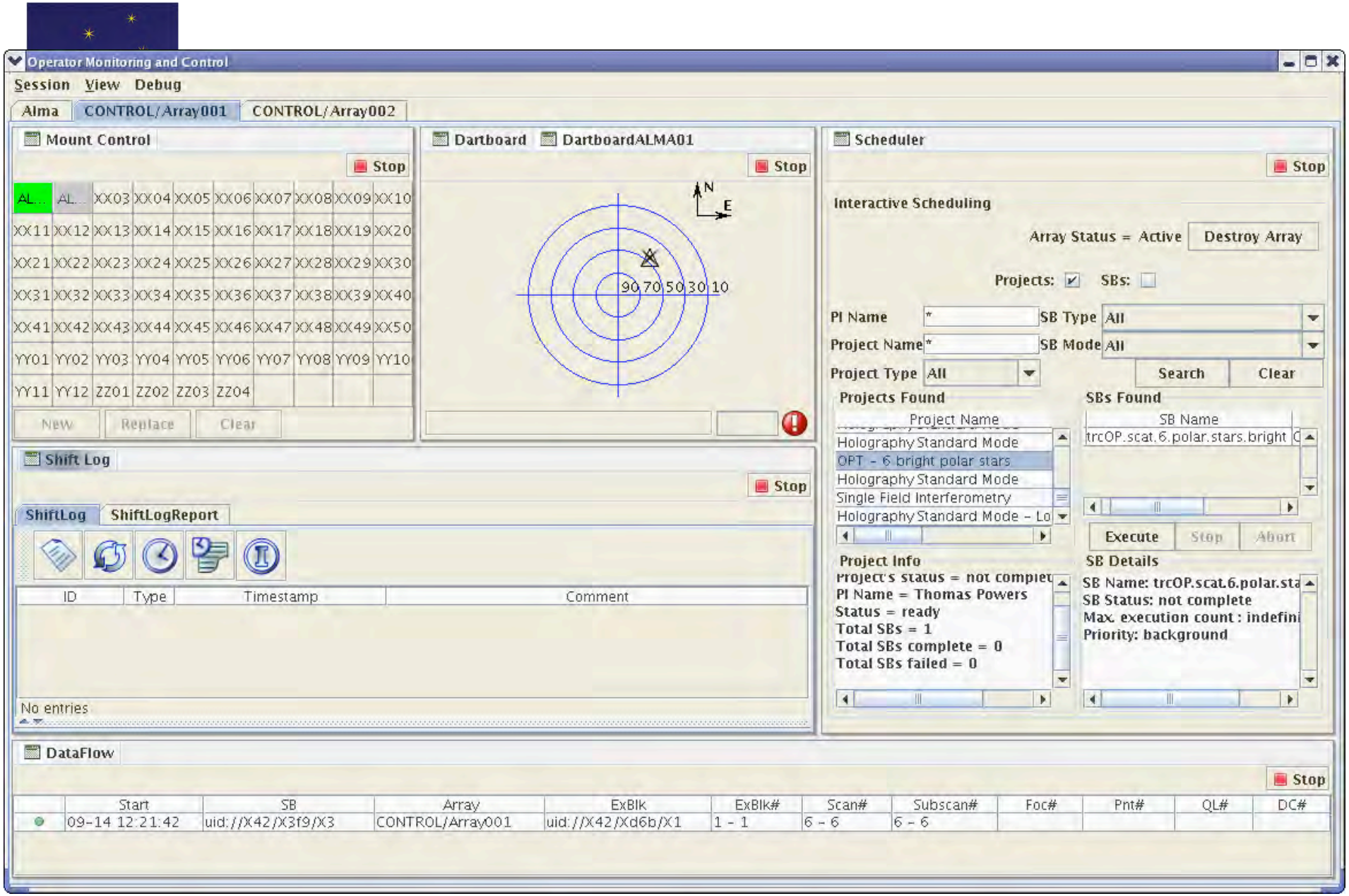
Pointed Mosaic Pipeline: Sagittarius A X Band Final Imaging Stage

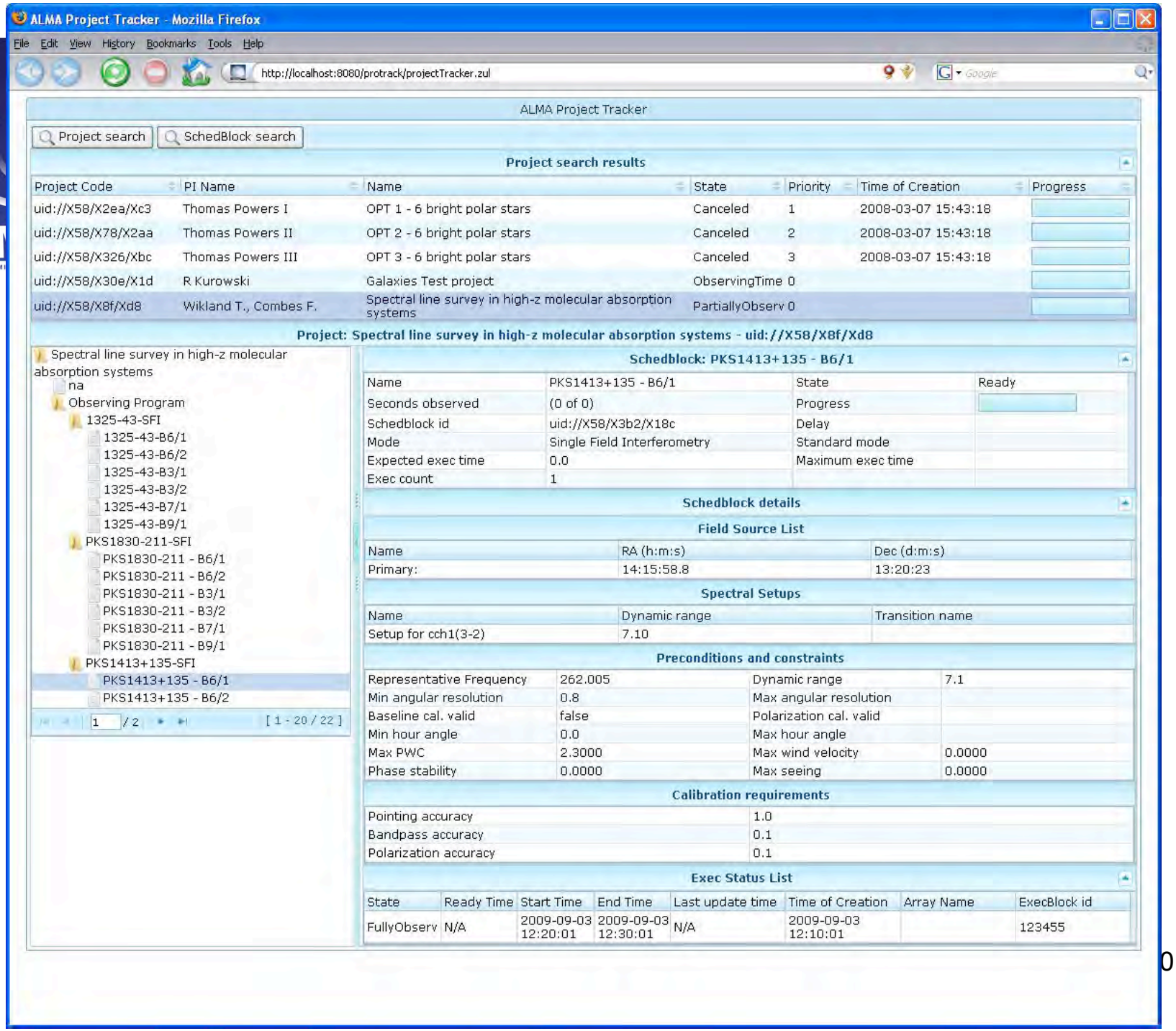


Final pointed mosaic continuum image of the target source. All calibrator and target flags have been applied.


Band 6 close showing lines spectral database and windows on selected lines
Editors
Spectral
Spatial
Forms
Catalog
Fov Parameters
Frequency used
95.00000
GHz
Refresh
(source)
Antenna Diameter
12m
7m
Show Fov(circle)
Image Query
Image Server
Digitized Sky (Version II) at ESO
Image Size(arcmin)
10
Query
Field Source Editor
This FieldSource is used by 1 target.
Field Source
Field Source Name
Primary
Source Name
NGC1390
Resolve
Source Coordinates
System
J2000
Sexagesimal display?
RA
03:37:52.180
Dec
-19:00:27.612
Reference Position (Offset)
Field Pattern
Type
point
Point
PointingPattern :
Offset
Offset Unit
arcmin
RA [arcmin]
Dec [arcmin]
-0.59801
-0.47470
-0.23712
-0.74739
0.12378
-1.02008
-0.18141
-0.29850
0.17949
-0.57119
2x
207.5, 353
4496.0
03:37:58.569, -18:59:31.75 J2000
image filename :
/home/ab/.jsky/cache/jsky21048.fits
Base Band & Sub Band
Frequency in Target Frame
Zoom To Base Band
Pan to Centre Frequency
Base Band
Other lines
Transmission
visual
of
to
e lines at
C18O 2-1

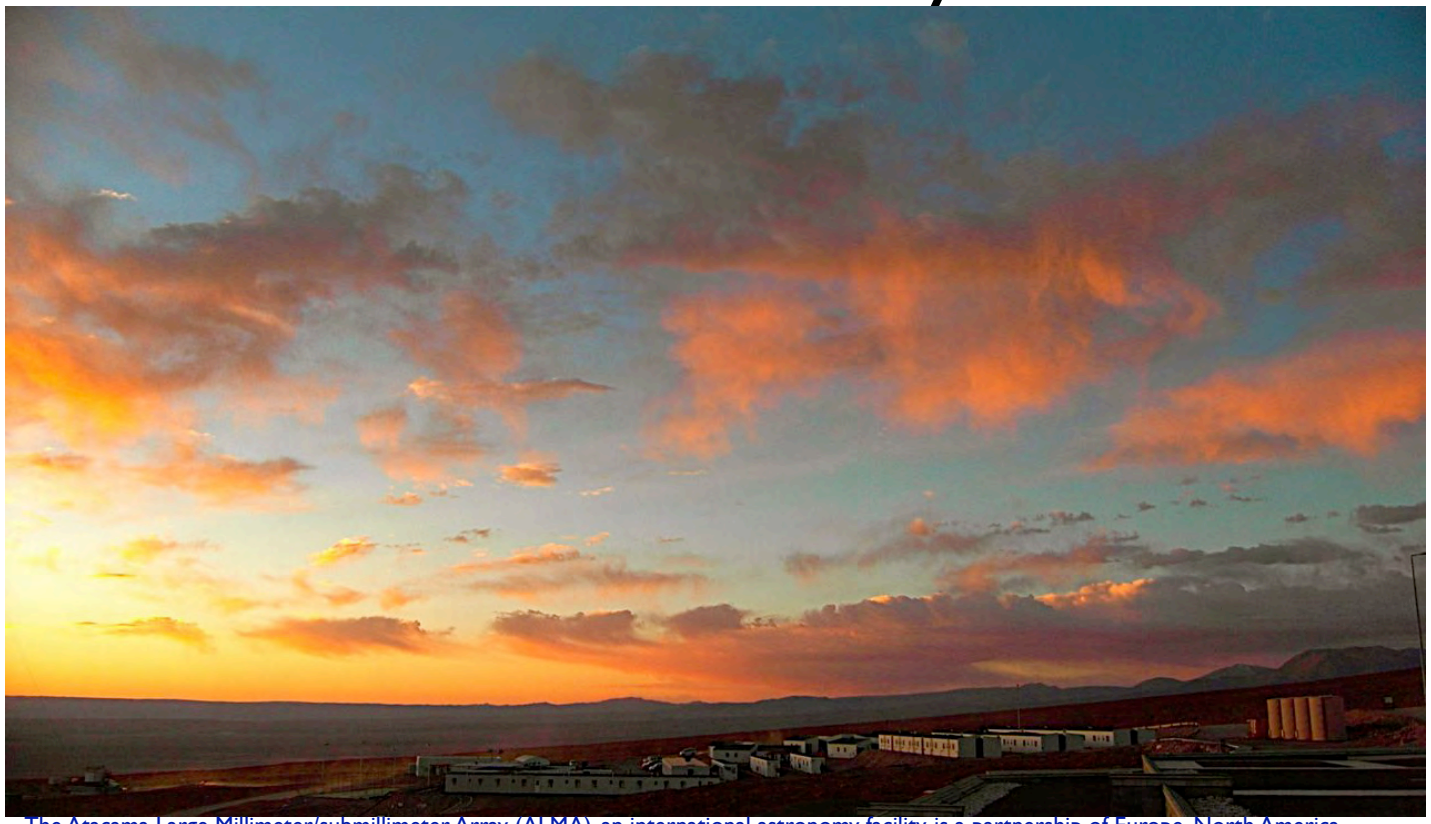

A test (0) - Alma Observing Tool [LifeCycle] for Chajnantor at 23.02S, 67.75W
File Edit Tool Search Options Help
Perspective 1
Project Structure
Proposal Program
(unnamed project)
A test (0)
Proposal
Planned Observing
Science Goal (Nucleusmap)
Science Goal (seyfertline)
Science Goal (funstuff)
Science Goal (Nuc cont)
Editors
Spectral Spatial Forms Catalog
Proposal Information
Proposal Title
A test
Proposal Cycle
This one
Edit
Abstract (max. 300 words)
Scientific Category
Cosmology and the High Redshift Universe - 10
Proposal Type
Normal
Related Proposals
Previous Proposals
Investigators
PI: George Harrison
Co-I 1: John Lennon
Co-I 2: Paul McCartney
Co-I 3: Ringo Starr
User ID
george
Name
George Harrison
Email
gharrison@nothere.org
Feedback
Problems Information Log
Description
Suggestion
Resource
Overview
Contextual Help
1. Please ensure you and your co-I's are registered with the ALMA user portal
2. Create a new proposal by
Selecting File > New Proposal
Click on the icon in the toolbar
Or click on this link
3. Click on the proposal tree node and complete the relevant fields.
4. Click on the project tree node and complete all of the fields.
Phase 1: Science Proposal
Phase 2: Observing Program
New Science Proposal
Create Science Goals
Validate Science Proposal
Submit Science Proposal
Retrieve Science Proposal
Configure System Setup
Validate Observing Program
Submit Observing Program
Click on the overview steps to view the contextual help
Importing And Exporting
Need More Help?


Operator Monitoring and Control
Session View Debug
Alma CONTROL/Array001 CONTROL/Array002
Mount Control
Stop
AL... AL... XX03 XX04 XX05 XX06 XX07 XX08 XX09 XX10
XX11 XX12 XX13 XX14 XX15 XX16 XX17 XX18 XX19 XX20
XX21 XX22 XX23 XX24 XX25 XX26 XX27 XX28 XX29 XX30
XX31 XX32 XX33 XX34 XX35 XX36 XX37 XX38 XX39 XX40
XX41 XX42 XX43 XX44 XX45 XX46 XX47 XX48 XX49 XX50
YY01 YY02 YY03 YY04 YY05 YY06 YY07 YY08 YY09 YY10
YY11 YY12 ZZ01 ZZ02 ZZ03 ZZ04
New Replace Clear
Dartboard DartboardALMA01
Stop
N
E
90 70 50 30 10
Scheduler
Stop
Interactive Scheduling
Array Status = Active
Destroy Array
Projects:
SBs:
PI Name *
SB Type All
Project Name *
SB Mode All
Project Type All
Search
Clear
Projects Found
Project Name
Holography Standard Mode
OPT - 6 bright polar stars
Holography Standard Mode
Single Field Interferometry
Holography Standard Mode - Lo
SBs Found
SB Name
trcOP.scat.6.polar.stars.bright
Execute
Stop
Abort
Project Info
PI Name = Thomas Powers
Status = ready
Total SBs = 1
Total SBs complete = 0
Total SBs failed = 0
SB Details
SB Status: not complete
Priority: background
Shift Log
Stop
ShiftLog
ShiftLogReport
ID
Type
Timestamp
Comment
No entries
DataFlow
Stop
Start
SB
Array
ExBlk
ExBlk#
Scan#
Subscan#
Foc#
Pnt#
QL#
DC#
09-14 12:21:42
uid://X42/X3f9/X3
CONTROL/Array001
uid://X42/Xd6b/X1
1 - 1
6 - 6
6 - 6


ALMA Project Tracker - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost:8080/protrack/projectTracker.zul
ALMA Project Tracker
Project search
SchedBlock search
Project search results
Project Code | PI Name | Name | State | Priority | Time of Creation | Progress
uid://X58/X2ea/Xc3 | Thomas Powers I | OPT 1 - 6 bright polar stars | Canceled | 1 | 2008-03-07 15:43:18
uid://X58/X78/X2aa | Thomas Powers II | OPT 2 - 6 bright polar stars | Canceled | 2 | 2008-03-07 15:43:18
uid://X58/X326/Xbc | Thomas Powers III | OPT 3 - 6 bright polar stars | Canceled | 3 | 2008-03-07 15:43:18
uid://X58/X30e/X1d | R Kurowski | Galaxies Test project | ObservingTime | 0
uid://X58/X8f/Xd8 | Wikland T., Combes F. | Spectral line survey in high-z molecular absorption systems | PartiallyObserv | 0
Project: Spectral line survey in high-z molecular absorption systems - uid://X58/X8f/Xd8
Spectral line survey in high-z molecular absorption systems
na
Observing Program
1325-43-SFI
1325-43-B6/1
1325-43-B6/2
1325-43-B3/1
1325-43-B3/2
1325-43-B7/1
1325-43-B9/1
PKS1830-211-SFI
PKS1830-211 - B6/1
PKS1830-211 - B6/2
PKS1830-211 - B3/1
PKS1830-211 - B3/2
PKS1830-211 - B7/1
PKS1830-211 - B9/1
PKS1413+135-SFI
PKS1413+135 - B6/1
PKS1413+135 - B6/2
1 / 2 [1 - 20 / 22]
Schedblock: PKS1413+135 - B6/1
Name | PKS1413+135 - B6/1 | State | Ready
Seconds observed | (0 of 0) | Progress
Schedblock id | uid://X58/X3b2/X18c | Delay
Mode | Single Field Interferometry | Standard mode
Expected exec time | 0.0 | Maximum exec time
Exec count | 1
Schedblock details
Field Source List
Name | RA (h:m:s) | Dec (d:m:s)
Primary: | 14:15:58.8 | 13:20:23
Spectral Setups
Name | Dynamic range | Transition name
Setup for cch1(3-2) | 7.10
Preconditions and constraints
Representative Frequency | 262.005 | Dynamic range | 7.1
Min angular resolution | 0.8 | Max angular resolution
Baseline cal. valid | false | Polarization cal. valid
Min hour angle | 0.0 | Max hour angle
Max PWC | 2.3000 | Max wind velocity | 0.0000
Phase stability | 0.0000 | Max seeing | 0.0000
Calibration requirements
Pointing accuracy | 1.0
Bandpass accuracy | 0.1
Polarization accuracy | 0.1
Exec Status List
State | Ready Time | Start Time | End Time | Last update time | Time of Creation | Array Name | ExecBlock id
FullyObserv | N/A | 2009-09-03 12:20:01 | 2009-09-03 12:30:01 | N/A | 2009-09-03 12:10:01 | | 123455

ALMA is nearly here!

D. Barkats



The Atacama Large Millimeter/submillimeter Array (ALMA), an international astronomy facility, is a partnership of Europe, North America and Eas cooperation with the Republic of Chile. ALMA is funded in Europe by the European Organization for Astronomical Research in the Southern Hemisphere (ESO), in North America by the U.S. National Science Foundation (NSF) in cooperation with the National Research Council of Canada (NRC) and the National Science Council of Taiwan (NSC) and in East Asia by the National Institutes of Natural Sciences (NINS) of Japan in cooperation with the Academia Sinica (AS) in Taiwan. ALMA construction and operations are led on behalf of Europe by ESO, on behalf of North America by the National Radio Astronomy Observatory (NRAO), which is managed by Associated Universities, Inc. (AUI) and on behalf of East Asia by the National Astronomical Observatory of Japan (NAOJ). The Joint ALMA Observatory (JAO) provides the unified leadership and management of the construction, commissioning and operation of ALMA.