

# The ALMA Observing Tool, experiences from Cycle 0



Science & Technology Facilities Council  
UK Astronomy Technology Centre

Alan Bridger

UK Astronomy Technology Centre

Stewart McLay, Stewart Williams (UKATC)

Hiroshi Yatagai (NAOJ)

Marcus Schilling, Rodrigo Tobar, Andy Biggs, Rein Warmels (ESO)



# Overview

1. ALMA and ALMA Observing Tool Introduction
2. Brief Cycle 0 Description
3. Cycle 0 Proposal Submission:
  - Setup
  - Deadline
  - Debrief
4. The Future



ADASS XXI, 2011-11-08



# Acknowledgements

- David Clarke, Maurizio Chavan, Liz Humphreys, Harvey Liszt, Nuria Lorente, Suzanna Randall, Mark Rawlings, Joe Schwarz, Steve Scott, Heiko Sommer, Leonardo Testi, and many more.
- All our testers over the past several years, from ALMA Regional Centres (ARCs) and elsewhere.
- Correlator subsystem for their validator module
- Control subsystem for their tuning solutions module
- Archive for...the Archive, and some utilities
- Observatory Operations for User Repository
- Joint ALMA Observatory (JAO) Software team for machines, configurations, assistance



ADASS XXI, 2011-11-08



# ALMA: What is it?

- The **Atacama Large Millimeter/submillimeter Array (ALMA)**, an international partnership of **Europe, North America and East Asia** in cooperation with the Republic of Chile. It is **the largest astronomical project** in existence.
  - *The Sun never sets on the ALMA Project!*
- At least 50 12 metre antennas at 5000m, Llano de Chajnantor, Chile, acting as an interferometer
- Plus ALMA Compact Array - 12 7m dishes, 4 more 12m *Total Power* dishes
- Largest/most sensitive instrument in World at mm and submm wavelengths (10mm-350micron, 30-950 GHz).
- Study galaxy/star/planetary system formation in un-precedented detail: Up to 15km baselines, milli-arcsec resolution



ADASS XXI, 2011-11-08



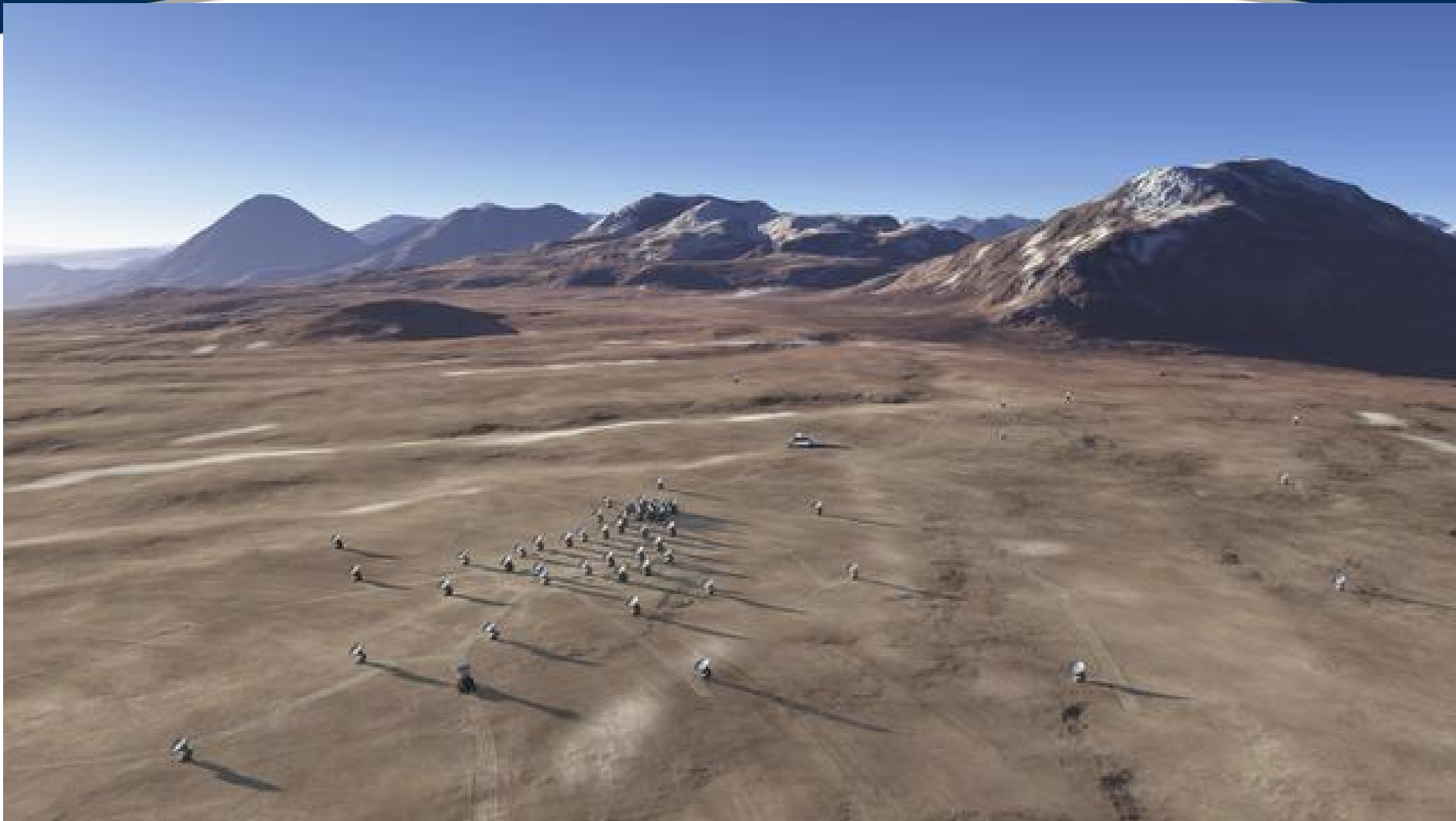
# ALMA in September 2011



ADASS XXI, 2011-11-08



# ALMA in 2013



ADASS XXI, 2011-11-08





# The Antennae: Hubble and ALMA

Hubble Image:  
Blue stuff

CO 115 & 346 GHz

12 Antennas



ADASS XXI, 2011-11-08



# The ALMA OT: multi-use

- Main Astronomer interface into ALMA
- Used for *Phase I* Proposals (Science Goals)
  - Provides validation & configured according to available capabilities
- Used for detailed *Phase II* Observing Preparation
  - Output is a series of Scheduling Blocks used to control observing (ALMA is dynamically scheduled)
- Java desktop client tool
  - Delivered to user via tarball or webstart
- Servlet (Tomcat) server front-end to the Archive
  - In Santiago (JAO)
  - Provides role-based authentication, ensures validation



ADASS XXI, 2011-11-08





# Multi-customer

- Obviously for community investigators
  - From novices to experts

But also

- In use by JAO (& ARC) staff for verification and commissioning
- Used by staff to develop observing (now, and in operations)
- Provide proposal summary information to reviewers
- And of course output used by the downstream systems



ADASS XXI, 2011-11-08



# An Intelligent Tool

The tool *knows* what ALMA can do, so the user doesn't need to (almost):

- Sensitivity calculations, observing time estimates
- Suggests defaults
- Auto-generates SBs from Science Goals
  - According to various default strategies and policies
- Derives calibration strategies
- Derives correlator setups
- Validates to ensure the project can be executed
- Constrains to current cycle capabilities
  - Configurable, so other capabilities also available for commissioning



ADASS XXI, 2011-11-08



# Server software Too

- Tomcat-based submission-service
  - Front-end to Archive subsystem and Oracle DB
  - Authenticates
  - Ensures validation
  - Initiates Project lifecycle
- Investigator searching & retrieval service
  - Using user-database



ADASS XXI, 2011-11-08



H0 to five decimal places - Observing Tool for ALMA, version Cycle0

File Edit View Tool Search Help

Perspective 1

Project Structure

Proposal

Program

Unsubmitted Proposal

H0 to five decimal places

Proposal

Planned Observing

Science Goal

General

Field Setup

Spectral Setup

Calibration Setup

Control and Performance

Unsubmitted Proposal (read-only)

Template library. Turn the keys on the JTree below & re

Proposal

Planned Observing

B3 spectral sweep CO (9-8): COSMOS SMGs

B7 continuum: COSMOS SMGs

B7 CO(9-8): Cosmic Eyelash (z=2.326)

B9 continuum: Cosmic Eyelash (z=2.326)

B3 spectral sweep: PKS1830-211 (z=0.9)

B3 continuum: GRB ToO: days 0 to 14

B6 continuum: GRB ToO: days 0 to 14

B7 continuum: GRB ToO: days 0 to 14

B6 continuum: GRB ToO: day 17

B3 continuum: GRB ToO: day 30

B6 12CO (2-1): NGC3256 mosaic

B6 13CO (2-1): NGC3256

B6 spectral line: Massive Protostellar Cluster

B9 spectral line: Massive Protostellar Cluster n

B3 continuum: Protostellar Disks

B6 continuum: Protostellar Disks

B7 continuum: Protostellar Disks

Editors

Spectral

Spatial

Proposal

Proposal Information

Proposal Title

H0 to five decimal places

Proposal Cycle

2011.0

Abstract (max. 300 words)

No, seriously!

Launch Editor

Scientific Category

Cosmology and the High Redshift Universe

Galaxies and Galactic Nuclei

ISM/Astrochemistry/Star Formation/protoplanetary disks/exoplanets

Stellar Evolution/the Sun and the Solar System

Proposal Type

Standard

Target Of Opportunity

Student Project

☐

Continuation

☐ (Not Applicable)

Related Proposals

Feedback

Problems

Information

Log

0 errors, 0 warnings

	Description	Suggestion
✓	No problems found	

Overview

Contextual Help

- Please ensure you and your co-Is are registered with the [ALMA Science Portal](#)
- Create a new proposal by either:
  - Clicking on the icon in the toolbar
  - Or clicking on this [link](#)
- Click on the tree node and complete the relevant fields.

Phase I: Science Proposal

New Science Proposal

Create Science Goals

Validate Science Proposal

Submit Science Proposal

Click on the overview steps to view the contextual help

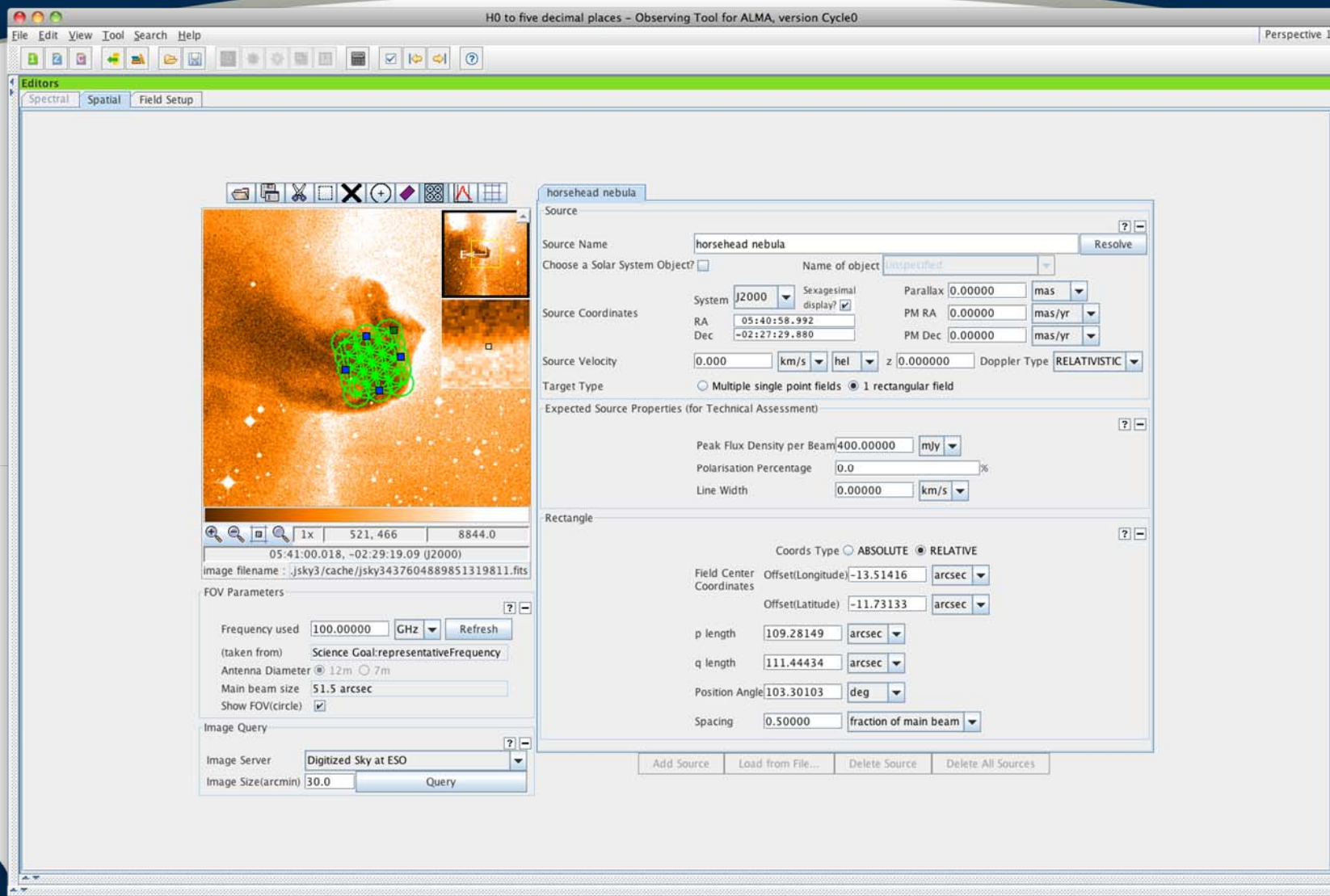
Importing And Exporting

Template Library

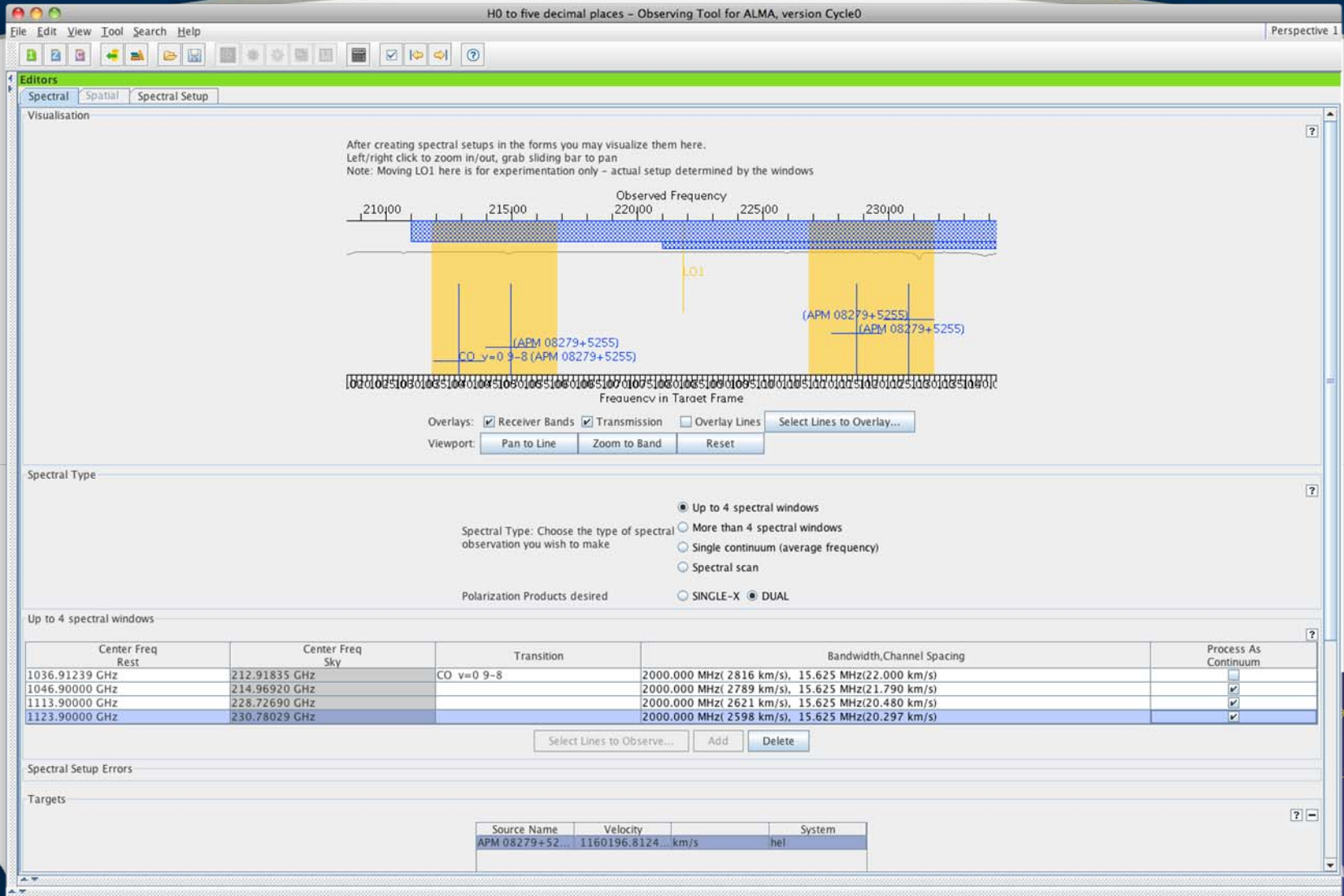
Need More Help?

View Phase 2 Steps

# Spatial Visual Editor



# Spectral Visual Editor





# Spectral Line Picker

Filter / Species

HCN

☒ Include description in search

ALMA Band

1 2 3 4 5 6 7 8 9 10

Sky Frequency (GHz)

Min 312 Max 373

Sideband Filter

☒ Enable sideband filter (recommended)

☒ Filtering lines outside sidebands

Maximum Upper-state Energy (K)

0 20 40 60 80 100 ∞

Molecule Filter / Environment

Show all atoms and molecules

Reset Filters Search Online

Notes

- The initial database is an offline database, containing selected transitions from the full spectral line catalogue.
- Additional transitions from the full catalogue can be found by clicking *Search Online*.
- Search Online* is only enabled when a species is given and one ALMA band is selected.
- Search Online* does not (yet) return all information for a transition.

Select Spectral Lines

Transitions matching your filter settings

Transition	Description	Rest Frequency	Sky Frequency	Upper-state Energy	Lovas Intensity	Sij $\mu^2$
HCNv2=1 J=4-3, l=1e	Hydrogen Cyanide	354.46 GHz	354.46 GHz	1066.9 K	62.5	32.46 D <sup>2</sup>
HCN v=0 J=4-3	Hydrogen Cyanide	354.505 GHz	354.505...	42.53 K	17.4	35.65 D <sup>2</sup>
HCNv2=2 J=4-3, l=2f	Hydrogen Cyanide	356.135 GHz	356.135...	2095.18 K	5.2	25.21 D <sup>2</sup>
HCNv2=2 J=4-3, l=2e	Hydrogen Cyanide	356.163 GHz	356.163...	2095.18 K	6.3	25.21 D <sup>2</sup>
HCNv2=1 J=4-3, l=1f	Hydrogen Cyanide	356.256 GHz	356.256...	1067.12 K	72	32.46 D <sup>2</sup>
HCNv2=2 J=4-3, l=0	Hydrogen Cyanide	356.301 GHz	356.301...	2073.45 K	9.4	33.61 D <sup>2</sup>

Add to Selected Transitions

Selected transitions

Transition	Description	Rest Frequency	Sky Frequency	Upper-state Energy	Lovas Intensity	Sij $\mu^2$
CO v=0 3-2	Carbon Monoxide	345.796 GHz	345.796 GHz	33.192 K	70	0.036 D <sup>2</sup>

Remove from Selected Transitions

Close Dialog and Apply Selection



# Cycle 0

ALMA Officially opened its doors to the community during 2011 with its Cycle 0:

- 16 12m antennas
- 4 receiver bands
- Limited correlator modes
- Limited observing modes
- To be executed in parallel with continuing construction, verification and commissioning
- Approximately 500-700 hours of observing allotted over 9 months
- About 100 proposals expected to be executed
- “Best Efforts” basis, commissioning prioritized



ADASS XXI, 2011-11-08



# Cycle 0 Proposal System Setup

- Build OT deployments, tarball and webstart
  - Good configuration management required
  - Good communications with ARCs to establish deployment process
  - OT Deployed (29<sup>th</sup> March) at each of the 3 ARCs (Also Chile and a backup for EA as the earthquake and related problems were still causing power disruption)
- 30<sup>th</sup> March Call for Proposals announced
- April-May configure and deploy server in Santiago
  - Joint Obsprep/ObOps/Archive/JAO Computing effort
- 1<sup>st</sup> June Archive opened for submissions...



ADASS XXI, 2011-11-08



## A world map with a dark blue background and white city lights. The map highlights several locations with colored circles and labels. In North America, there are three red circles in the western and central US. In South America, there is a green circle in Chile with a white radio telescope icon. In Europe, there is a green circle labeled 'OT hub' and a red circle. In East Asia, there is a yellow circle. In the bottom left corner, there is a logo for ALMA, featuring a stylized radio telescope dish and the text 'ALMA' below it.

- 

# Cycle 0 Deadline

- 1<sup>st</sup> June Archive opened for submissions...
  - 3 received by 15<sup>th</sup> June.
- 30<sup>th</sup> June, 15:00 UT, deadline.
- Over 900 unique proposals received, plus several thousand *resubmissions* (allowed by observatory policy)
- Last two hours ~1350 submission attempts
  - ~ 240 new submissions, rest were resubmissions
- Server seized up with about 45 minutes left
  - So deadline extended by 1.25 hours
- More than 9:1 over-subscription rate
- A great success!



ADASS XXI, 2011-11-08



# Cycle 0 Debrief

- Why did the server fail?
  - Number of submissions / minute well within limits established by stress testing
  - But level of queries was unexpected and not well tested
- Answer *slightly* surprising:
  - Oracle DB collapsed under weight of queries from users
  - Response time falls, connections left open, propagates, exceed allowed simultaneous connections -> errors to users
  - Xpath, so not tremendously efficient. But still why? Oracle *can* handle this
  - Hardware not the final system, and in retrospect under-powered for this level of querying
- More power in place for Cycle 1
- And of course we are looking to improve system response to this and the user's experience



ADASS XXI, 2011-11-08





# Cycle 0 Debrief: Other lessons

## Few surprises:

- Last minute changes undesirable, but they happen
- Communication is hard in a project this size
- Few big OT issues – confusion over resolution/largest structures
- Never under-estimate the imagination of users
  - OT Constrains to capabilities available in Cycle 0
  - (although fully powered “under the hood”)
  - But still users found ways to express their science goals that are ... challenging



# And what's next?

## The fun never stops:

- In September Cycle 0 Observing Preparation (Phase II) began, using the OT
- Auto-generation of SBs, in particular default calibration setups
- Still much manual work – that's another story
- 30<sup>th</sup> September Observing began



ADASS XXI, 2011-11-08



# Cycle 1 and beyond

- February 2012, Cycle 1 Call for Proposals
  - More antennas, more observing modes,...
- Cycle N
  - ACA Integration
  - All correlator modes
  - More spectral modes
  - Double sideband receivers...
  - Simultaneous arrays, subarrays
  - We must keep them all simple



ADASS XXI, 2011-11-08



# ALMA Papers in this Conference

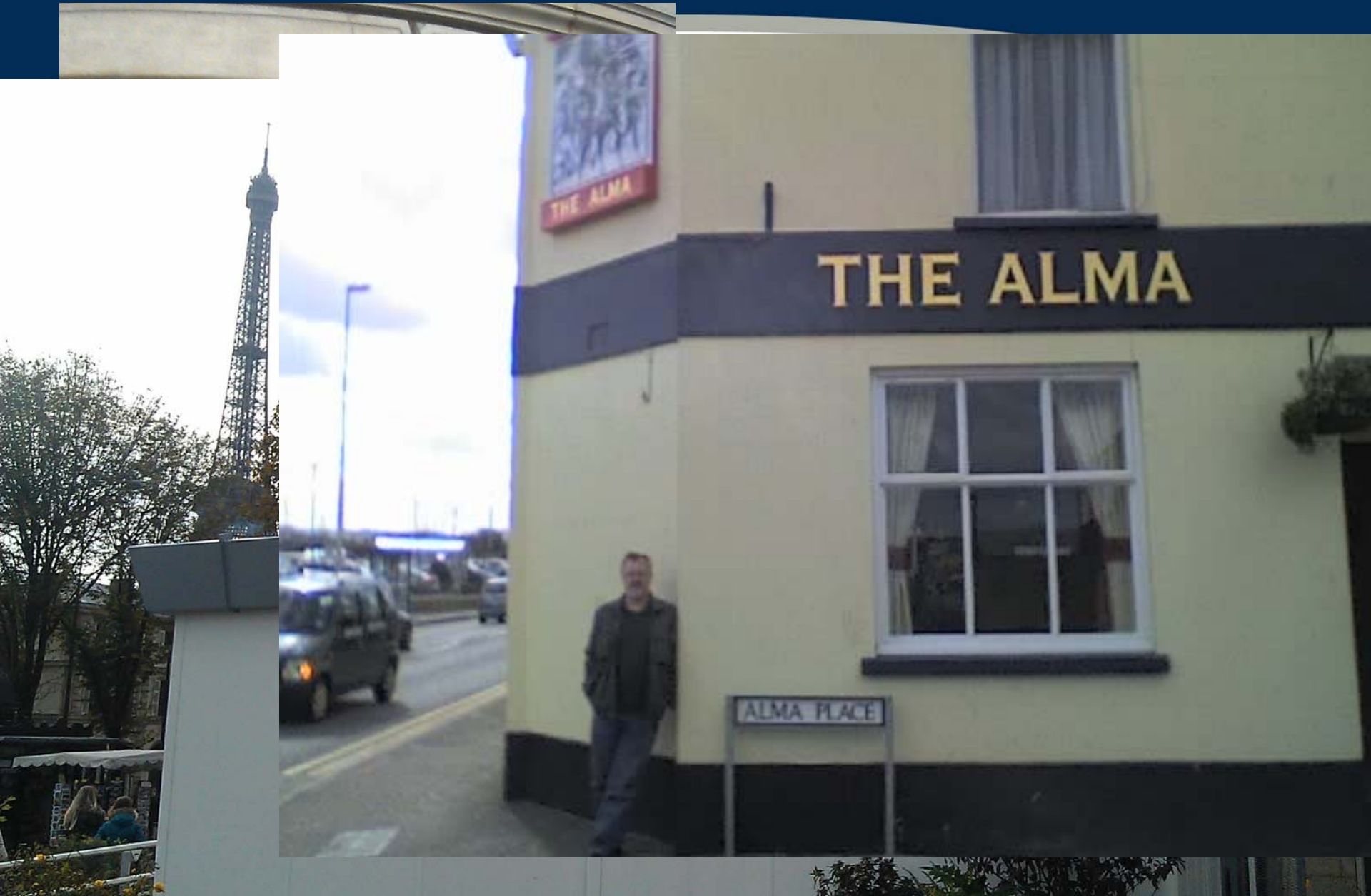
- O21 Nuria Lorente: [Visibility Isn't Everything: Managing Meta and Auxiliary Data in ALMA Observations.](#)
- P024 David Clarke: [ALMA Scheduling - It's Dynamic!](#)
- P029 Lindsey Davis: [Translating ALMA User Science Goals into Pipeline Processing Requests](#)
- P089 Alisdair Manning: [The ALMA Science Archive: Data Flow](#)
- P104 Fernando Morales: [Entity-relationship Model for ALMA.](#)
- P114 Dirk Petry: [Analysing ALMA data with CASA](#)
- P130 Nemesio Rodriguez-Fernandez: [Imaging On-the-fly ALMA observations](#)
- P133 Juan de Dios Santander Vela: [The ALMA Science Archive: Implementation](#)
- P137 Marcus Schilling: [Human Computer Interaction in the ALMA Control Room](#)
- P147 Felix Stoehr: [The ALMA Science Archive: Design](#)
- P152 Alexis Tejeda: [ALMA Telescope Calibration Subsystem computing performance](#)
- P165 Mauricio Zambrano: [Business Intelligence applied to the ALMA Software Integration process](#)



ADASS XXI, 2011-11-08



# British-French Alma Connection



# Questions?



[www.almaobservatory.org](http://www.almaobservatory.org)

*The Atacama Large Millimeter/submillimeter Array (ALMA), an international astronomy facility, is a partnership of Europe, North America and East Asia in 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.*



ADASS XXI, 2011-11-08

