Early Science with ALMA

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Milestones

- [Prototype interferometer]
- [OSF tests (Q4 2005)]
- Single antenna (Q2 2006)
- Single-baseline interferometer (Q3 2006)
- Short baselines with 3 antennas (Q3 2006)
- Baselines up to ~4km with up to 8 antennas

Early Science (Q4 2007; T = 0)

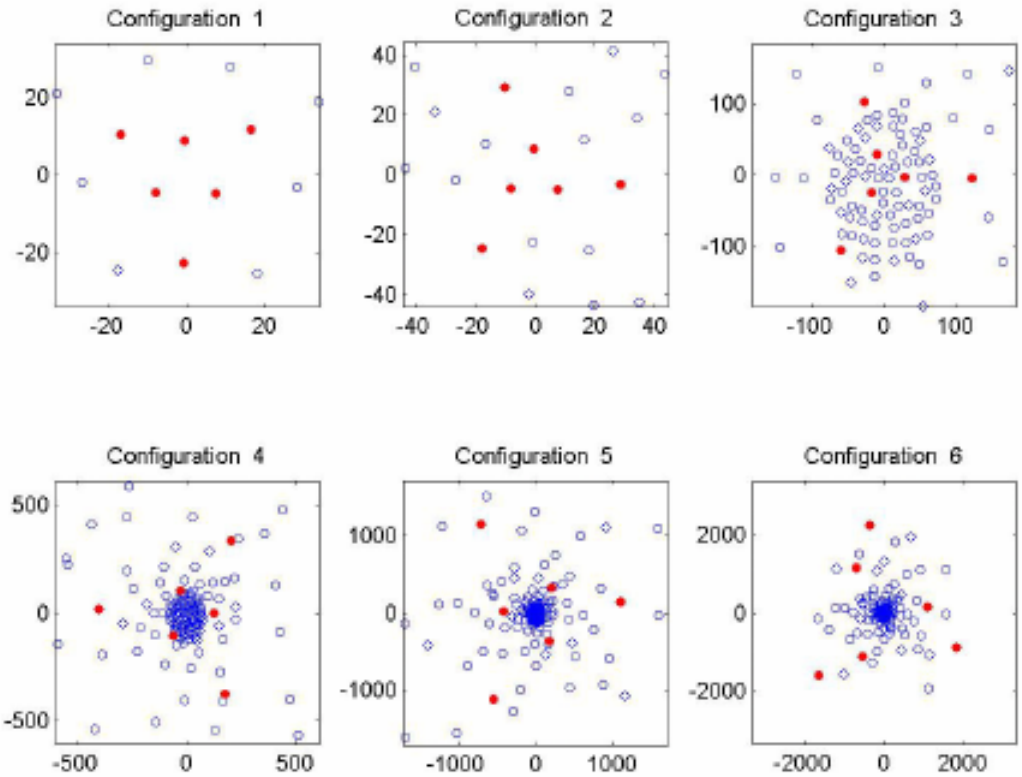
- Continuing commissioning

Full operation (Q1 2012)

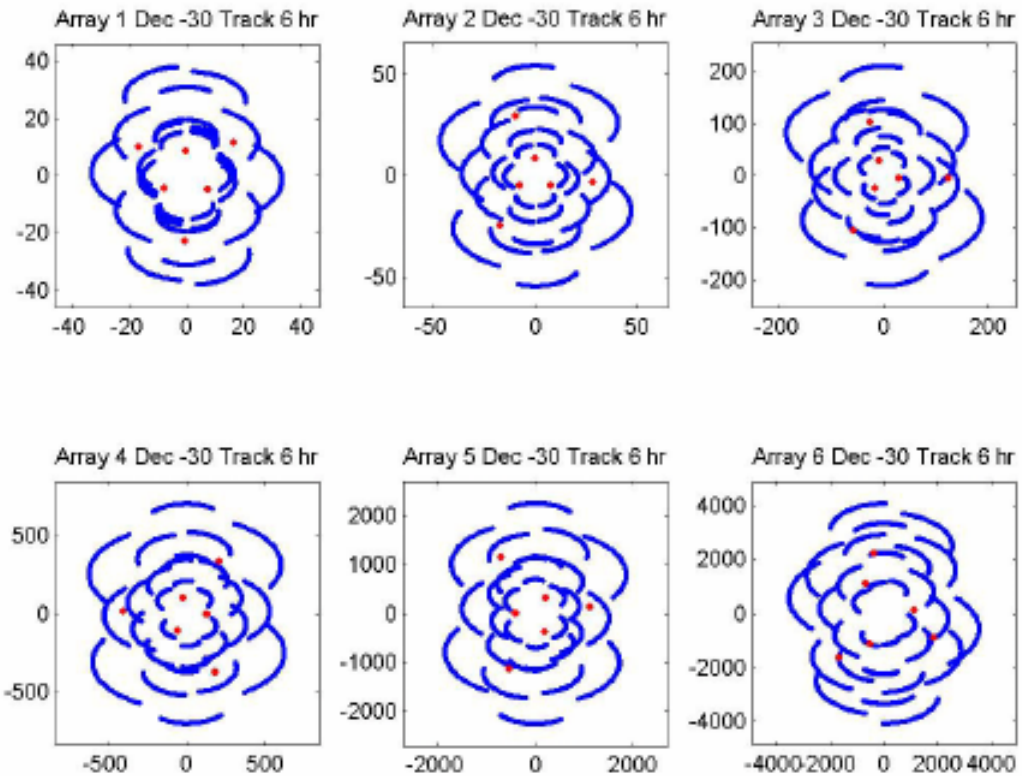
Early Science

- 6 antennas available for science
- Limited number of modes
- Not continuous science operations
- Limited array configurations
- No breakpoints, limited eavesdropping
- No imaging pipeline
- Central archive at OSF

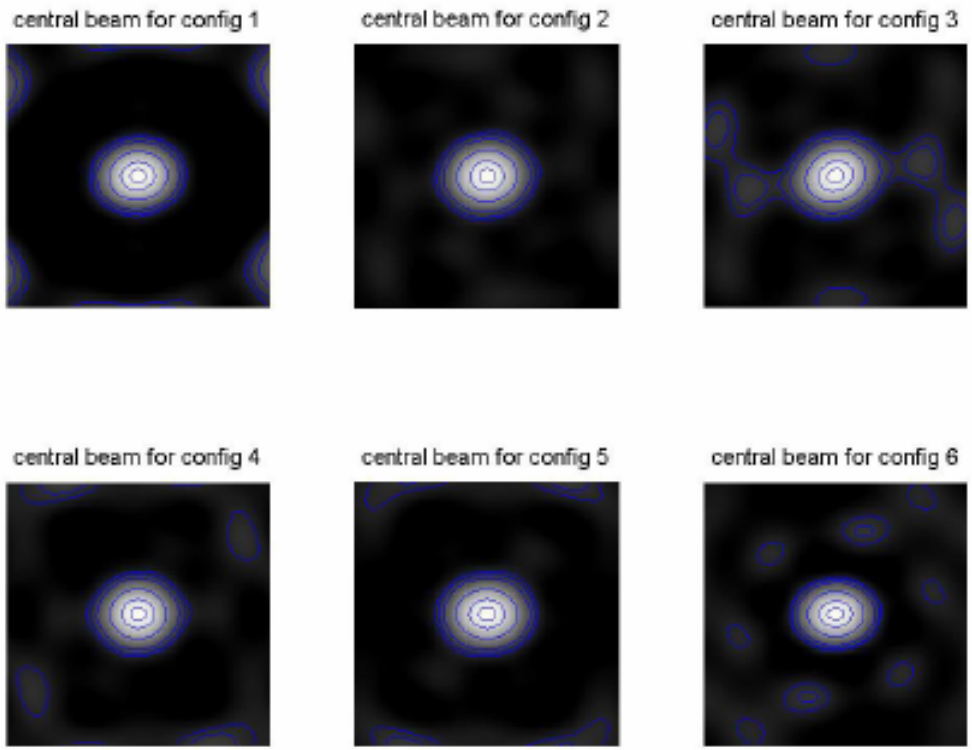
Early science configurations



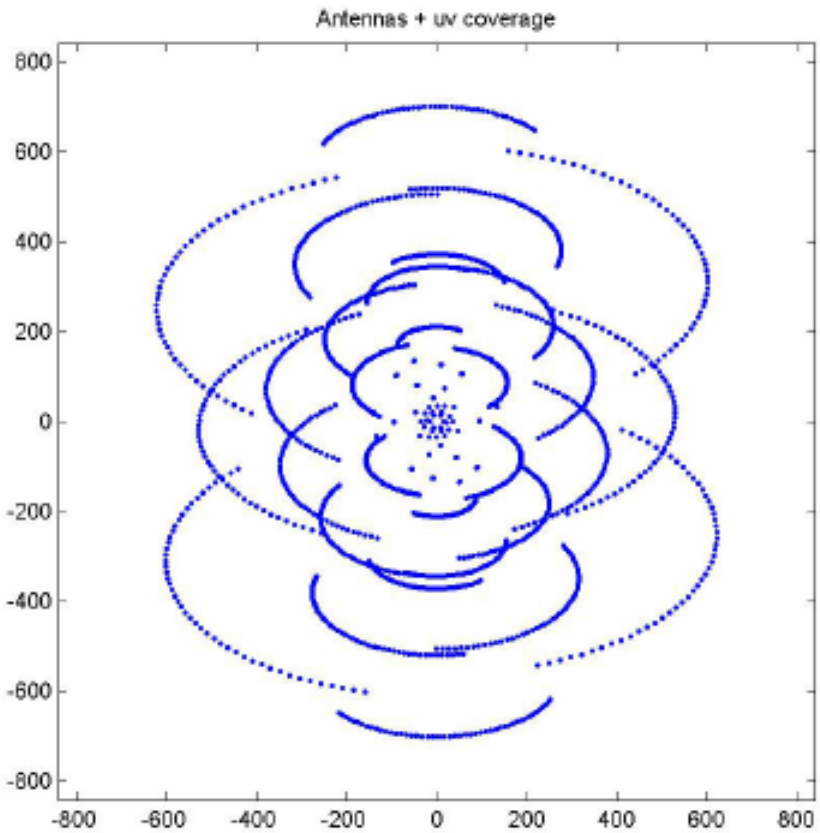
Early science u-v coverage



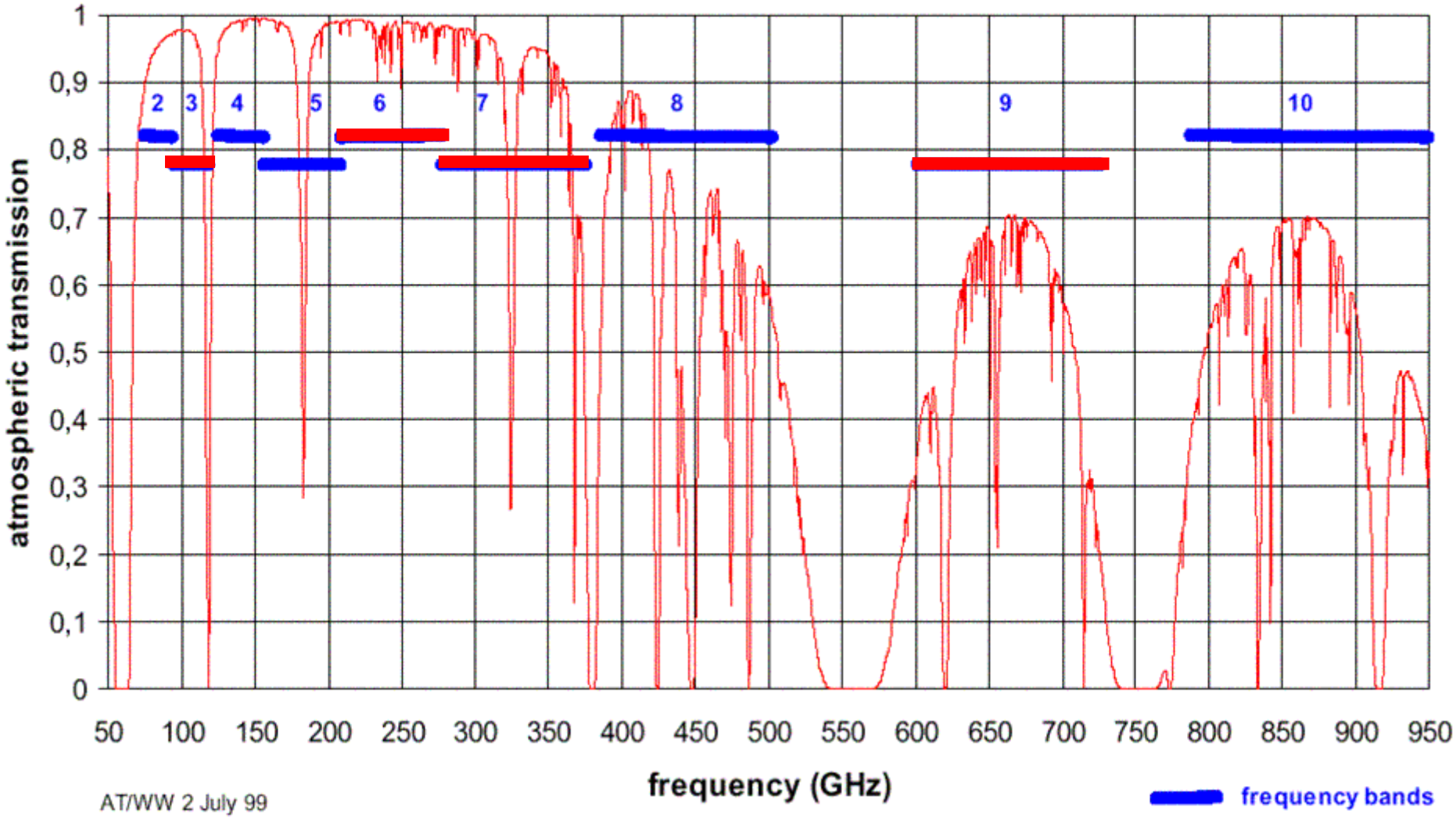
Early science beams



Early science combined configurations



Atmospheric transmission at Chajnantor, pwv = 0.5 mm



ALMA bands

1	31.3 – 45 GHz
2	67 - 90 GHz
3	84 - 116 GHz NRAO
4	125 – 163 GHz
5	163 – 211 GHz
6	211 – 275 GHz HIA
7	275 – 373 GHz IRAM
8	385 – 500 GHz
9	602 – 702 GHz SRON
10	787 – 950 GHz

Under construction

Proposed Japanese bands

EU FP6 proposal

What is a “mode”?

A mode is an element of an observational setup, including

- Configurations
- Receivers
- Correlator setups
- Calibration strategy
- Reduction strategy

Only a limited number of modes will be supported initially

- Those tested at ATF
- High scientific priority

Correlator – initial modes

- Start with ATF prototype one baseline correlator modes.
- 4 basebands
- No tunable filter

Bandwidth	Single Polzn	Dual Polzn	Full Polzn
2GHz	256	128	64
128MHz	2048	1024	512
31.25MHz	8192	4096	2048

Useful numbers

- 1 km baseline → 0.6 arcsec λ/D at 100 GHz
- Point-source sensitivity for 6-antenna array (1 hour, 100 GHz, full bandwidth, dual polarization):
  - 100 GHz (Band 3) 60 μJy
  - 250 GHz (Band 6) 170 μJy
  - 350 GHz (Band 7) 300 μJy
  - 650 GHz (Band 9) 1.5 mJy
- Sensitivity calculator available on the Web

Calibration strategy for Early Science

- Baselines up to 4km
- Phase fluctuations corrected by a combination of:
  - Fast switching
  - WVR phase correction
- Instrumental phase transfer between frequencies
- Need calibrator surveys

Imaging

- Pipeline unavailable, or with restricted functionality (need to accumulate data to define heuristics)
- Conventional off-line reduction (AIPS++)
- Mosaics supported
- Combination of total power plus interferometric data
- Data rate limited, brought on line to scale with number of available baselines

Before Early Science

For continuum and the subset of spectral-line modes selected for early science, confirm:

- Single-field image sensitivity and fidelity
  - Noise
  - Dynamic range
  - Reproducibility
- Combination of single-dish and interferometric data
- Mosaic image sensitivity and fidelity

Proposals

- Two calls for proposals in the first 24 months
- Phase 1 Observing Tool
- Regional Time Allocation Panels
- International Review
- Phase 2 Observing Tool → scheduling blocks

First proposal call: time-line

Relative Date (months)	Nominal Date	Actor	Task
T-10	2006 Dec1	JAO	Start Call for Proposals preparation
T-8	2007 Feb 1	ARC	Call for Proposals 01 (CfP01) released: some modes guaranteed to work at T=0 some modes are possible but not guaranteed for T=0
T-6	2007 Apr 1	ARC	Observing proposal submission deadline
T-4	2007 Jun 1	ARC	Regional program review work complete
T-3	2007 Jul 1	ARC/JAO	International program review work complete, LTQ ready, Phase 2 begins
T-1	2007 Sep 1	ARC	Phase 2 complete, all SBs certified correct by ARCs
T = 0	2007 Oct 1	JAO	Early Science Operations start
T+2	2007 Dec 1	ARC	Data delivery & data analysis support begins

Note the compressed timeframe, which calls for a simple set of modes for Early Science

Commissioning and Science Verification (CSV)

- Test and optimize elements of the ALMA system (e.g. antenna, correlator mode, pipeline release).
- Demonstrate scientific capability to user community.
- Starts on handover from Systems Integration.
- Ends with acceptance on behalf of ALMA Operations.
- Outputs are documented operational procedures, manuals, reports and public datasets.

Commissioning

- Overall aim is to show that the technical specification is met.
- Initial testing
- Interaction with systems integration team and other construction groups in order to fix problems
- Optimization
- Documentation
- Training of operations staff
- Includes end-to-end test from proposal preparation to data distribution

Commissioning Team

- Small, multidisciplinary core team
- Led by Project Scientist
- Operations provides a major element of the team
- Includes:
  - Technically qualified astronomers
  - System engineer(s) – to identify problem areas and liase with technical support
  - Dedicated software support
- Supported by:
  - Array operators, technical, IT
  - Systems integration
  - Construction IPTs

Science Verification

- Demonstrate scientific performance of a mode
- Science Verification team; consult with community
- Open call for ideas rather than specific proposals
- Requires:
  - Mode is fully commissioned
  - Documentation available
- Outputs:
  - Reduction scripts
  - Reduced dataset (immediate public release)
  - Report

Demonstration Science

- Public relations (pretty pictures), but also of scientific value
- Requires multi-configuration observations.
- Data public

Opportunities for involvement

- Commissioning team
  - Essential to exploit expertise in European community
  - Substantial commitment required (but not necessarily at OSF)
  - Managed
  - Anticipate call for statements of interest
- Science Verification/Demonstration Science
  - Ideas
  - Be ready for public data release
- Early Science