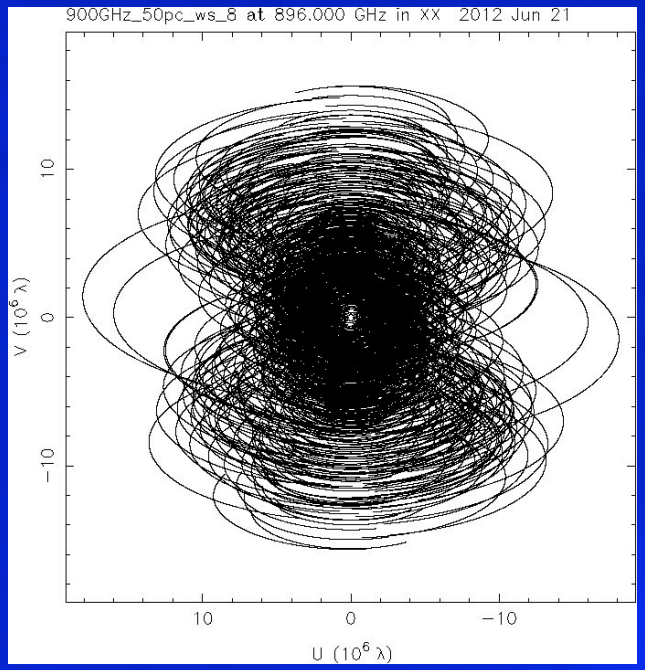
Toward ALMA Science

Alison Peck
Deputy Project Scientist
Joint ALMA Office

ALMA Science Requirements

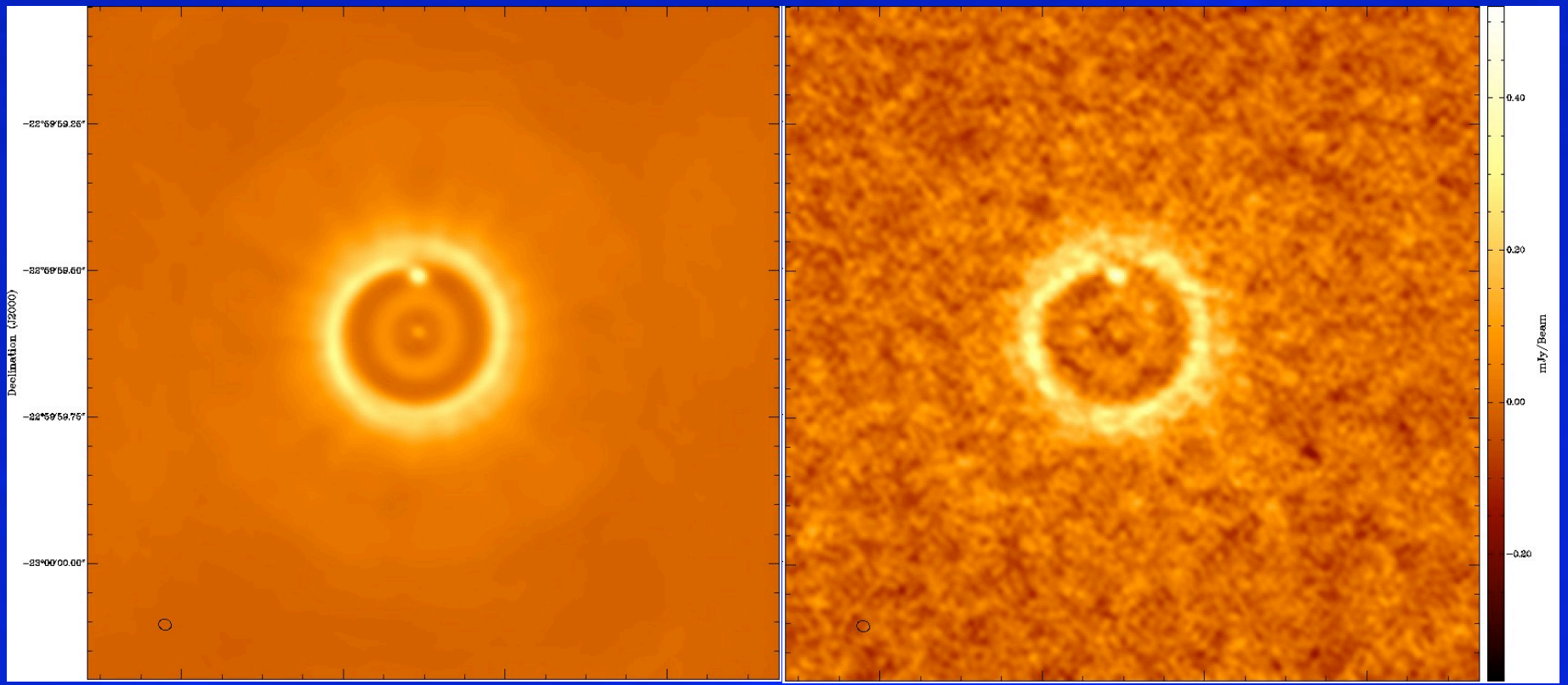


CASA simulations soon to be online

- High Fidelity Imaging
- Precise Imaging at 0.1″ Resolution
- Routine Sub-mJy Continuum Sensitivity
- Routine mK Spectral Sensitivity
- Wideband Frequency Coverage
- Wide Field Imaging Mosaicing
- Submillimeter Receiver System
- Full Polarization Capability
- System Flexibility

Imaging Performance

CASA simulations by R. Reid



Noiseless

Thermal noise (672GHz, O21)

ALMA Median Sensitivity

(1 minute; 75% Quartile opacities λ>1mm, 25% λ <1mm)

Frequency (GHz)	Continuum (mJy)	Line 1 km s^{-1} (mJy)	Line 25 km s^{-1} (mJy)
35	0.02	5.1	1.03
110	0.027	4.4	0.89
140	0.039	5.1	1.01
230	0.071	7.2	1.44
345	0.12	10	1.99
675	0.85	51	10.2
850	1.26	66	13.3

Commissioning

Commissioning commences with arrival of the third antenna to the high site, when phase closure is expected to be achieved, and continues until handover to Operations at the end of 2012.

Current activities:

–Revising Commissioning Plan (esp schedule and staffing)

–assisting with Antenna Integration at the Operations Support Facility

–involved with development of the Operations Plan, with Ops Working Group

–Working at ALMA Test Facility with Computing, System Engineering, Antenna, Front End and other teams on adding functionality to software

Resources will be needed from AIV, Operations, Science IPT and ARCs

Approximate Schedule

- First fringes: ATF Q2 2007 ✓ (static fringes w/ new BE - Friday)
- AOS, OSF: Complete early 2008.
- Antennas: #1 2007 ✓, #2 2007 ✓ … #66 2011.
- Front Ends: #1, #2 2007, → production.
- BE/DTS: → production.
- Correlator: Q1 complete… Q4 2008; ACA 2008.
- Software: R4… AIVC 2007, Ops 2008.

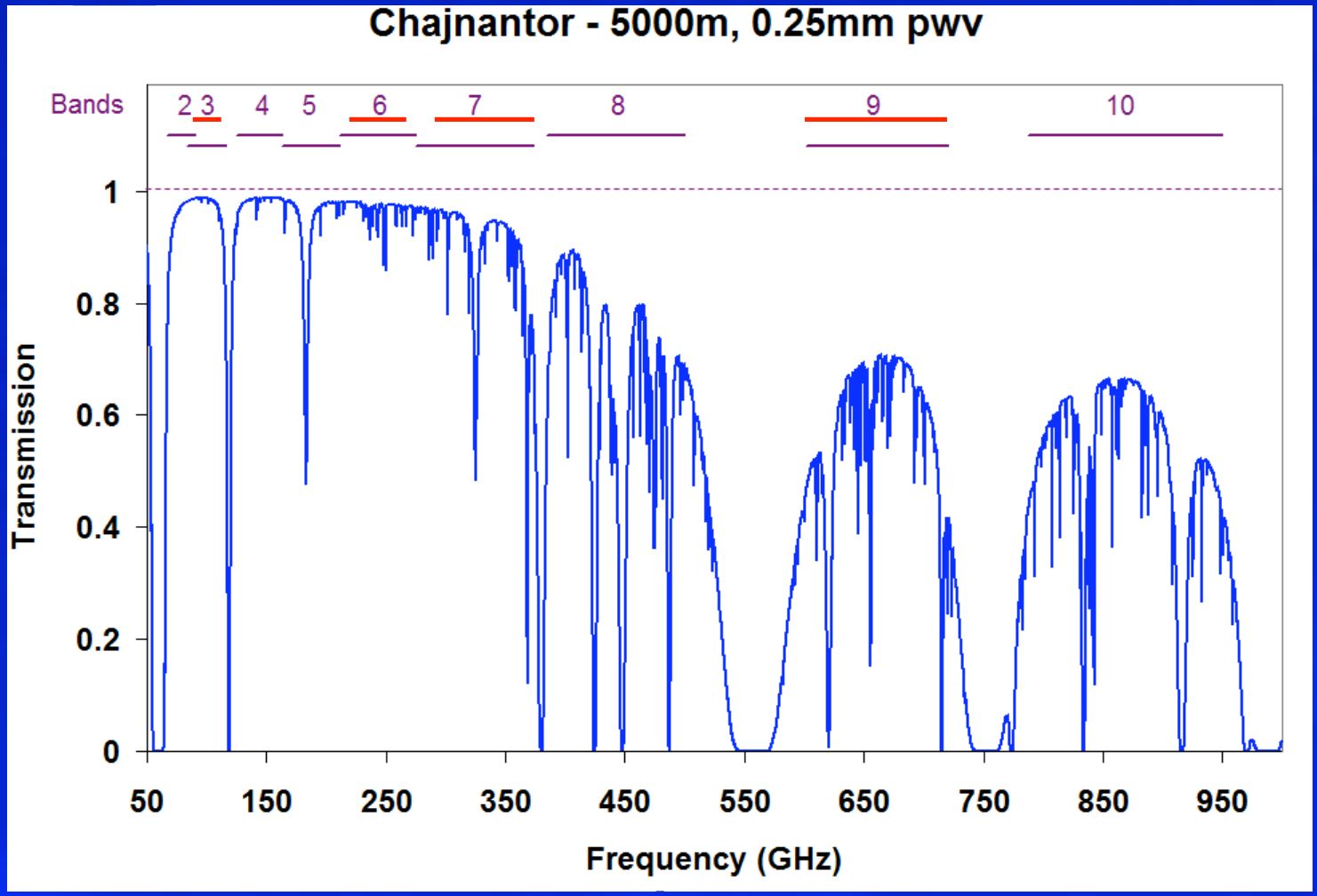
- **CSV: handover of verified 3-element interferometer at AOS (currently 2009Q1)**

- Call for Early Science: Q1 2010
- Early Science: 2010
- Full Operations: 04 Sep 2012

Receivers / Front Ends

ALMA Band	Frequency Range	Receiver noise temperature		Mixing scheme	Receiver technology
		T_{Rx} over 80% of the RF band	T_{Rx} at any RF frequency		
1	31.3 – 45 GHz	17 K	28 K	USB	HEMT
2	67 – 90 GHz	30 K	50 K	LSB	HEMT
3	84 – 116 GHz	37 K	62 K	2SB	SIS
4	125 – 169 GHz	51 K	85 K	2SB	SIS
5	163 - 211 GHz	65 K	108 K	2SB	SIS
6	211 – 275 GHz	83 K	138 K	2SB	SIS
7	275 – 373 GHz	147 K	221 K	2SB	SIS
8	385 – 500 GHz	98 K	147 K	DSB	SIS
9	602 – 720 GHz	175 K	263 K	DSB	SIS
10	787 – 950 GHz	230 K	345 K	DSB	SIS

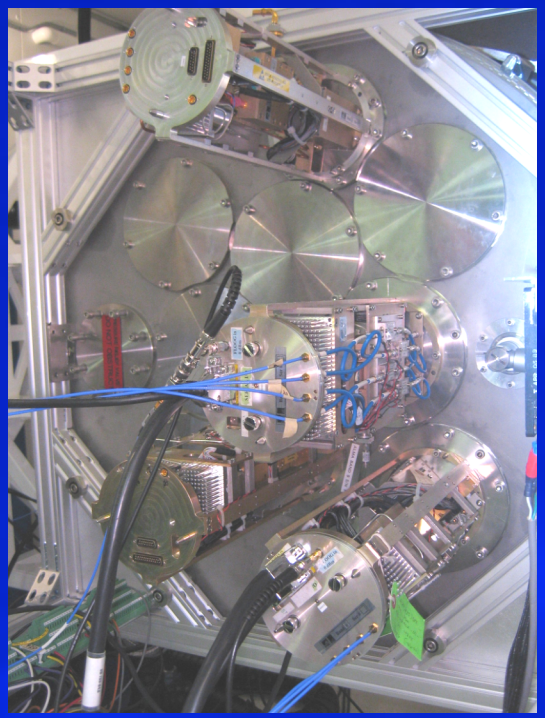
Atmospheric Opacity



Equipment available

FE #1 (4 cartridges) – Mar07

Band 3



Band 7

Band 6

Band 9

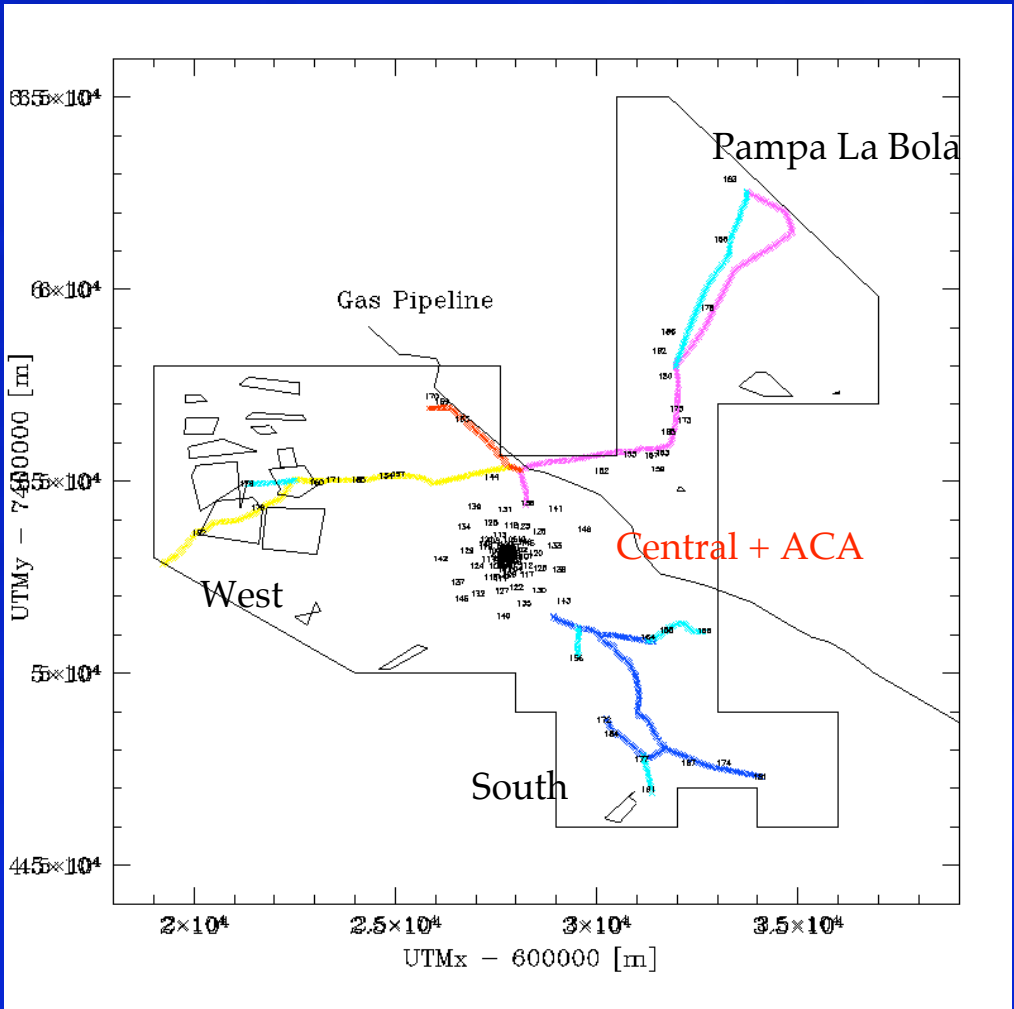
⇒Bands 3, 6, 7, 9 available (4 and 8 may be added soon after)

⇒All types of 12m antenna used for interferometric commissioning

⇒2 subarrays; can test single-dish and interferometric observing in parallel;

⇒Initial configurations compact; thereafter First Science Configurations as already defined

Initially Only Compact Configurations



Commissioning activities

- Antenna and array calibrations
  - –Pointing and focus software

    (initial SD pointing and focus done by AIV, we optimize)
  - –Primary beam and surface measurement (likewise)
  - –Antenna location (baseline)
  - –Delay

- Observing calibration tasks
  - –Phase calibration, fast switching and WVR development
  - –Calibrator surveys (need dense grid for fast switching)
  - –Temperature and flux scale
  - –Bandpass
  - –Instrumental polarization

More Commissioning activities

- Single-dish modes
  - –Mosaic with beam and position switching
  - –On-the-fly mapping
  - –Autocorrelation and continuum total power
  - –[Frequency switching]
  - –Total power calibration

- ACA 7m array (from CSV + 12 months, roughly)

Expected Task Durations

- Current numbers:
  - –Array/antenna calibration -- 95 days
  - –Testing calibration strategies -- 150 days
  - –Commissioning observing modes -- 230 days
  - –Single dish observing modes -- 60 days (in parallel)
  - –ACA 7m array (in parallel)
- Assume 20% downtime from outside factors
- Delaying factors include inclement weather, hardware/software problems, staffing shortfalls…
- Additional downtime from failures during CSV tests are included in the estimates (may expect 40-50% downtime in total based on experience at other telescopes)
- <10% SV fraction
- Consistent with a ~20-month program

One Month Outline of Commissioning Staff in Chile

Location	Week 1	Week 2	Week 3	Week 4	Total
OSF	2-3 day shift 2 night shift	2-3 day shift 2 night shift	2-3 day shift 2 night shift	2-3 day shift 2 night shift	18 people
SCO	6	6	6	6	
Off duty	4	4	4	4	
Research, travel or leave	2-3	2-3	2-3	2-3	
Total	18 people				

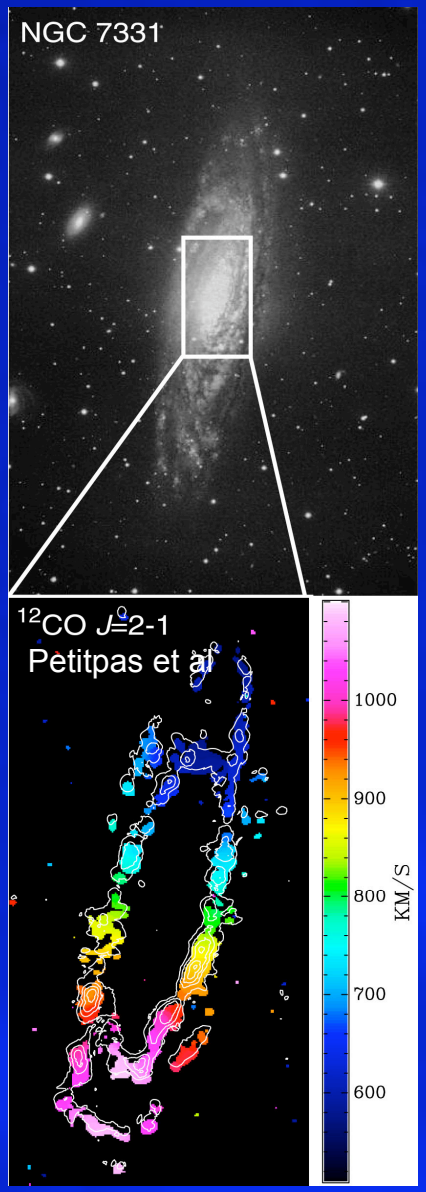
Modified turno system (8/28)

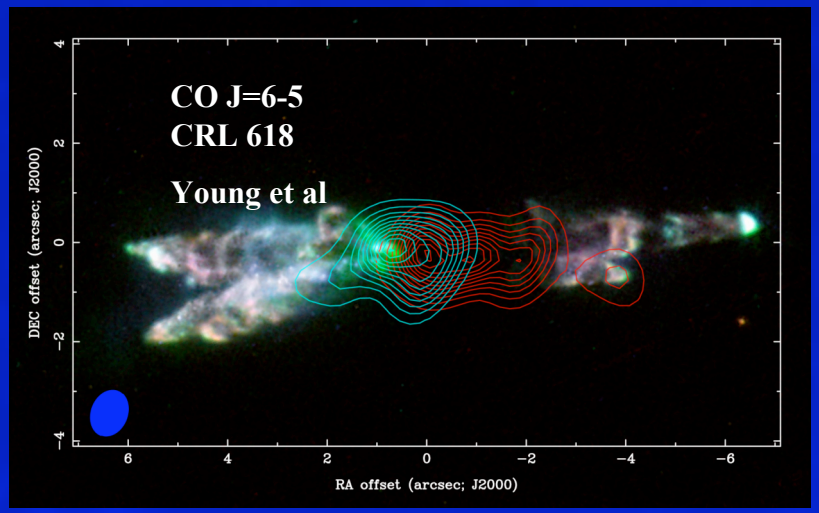
Staffing available

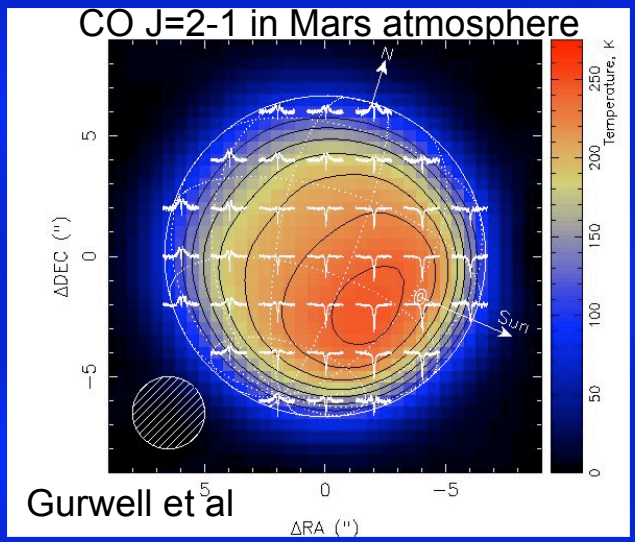
- Project Scientist + Deputy (R Hills and A Peck)
- 3 commissioning scientists (apply now!)
- Science IPT staff on rotation
- Operations astronomers (apply soon!)
- Ad hoc specialists
- ARC (and ARClet) staff on rotation (come visit!)

The new Operations staff being hired will form an integral part of the Commissioning team, and the AIV scientists will move to Commissioning as well; there is no “handover” point

ALMA Science Precursors

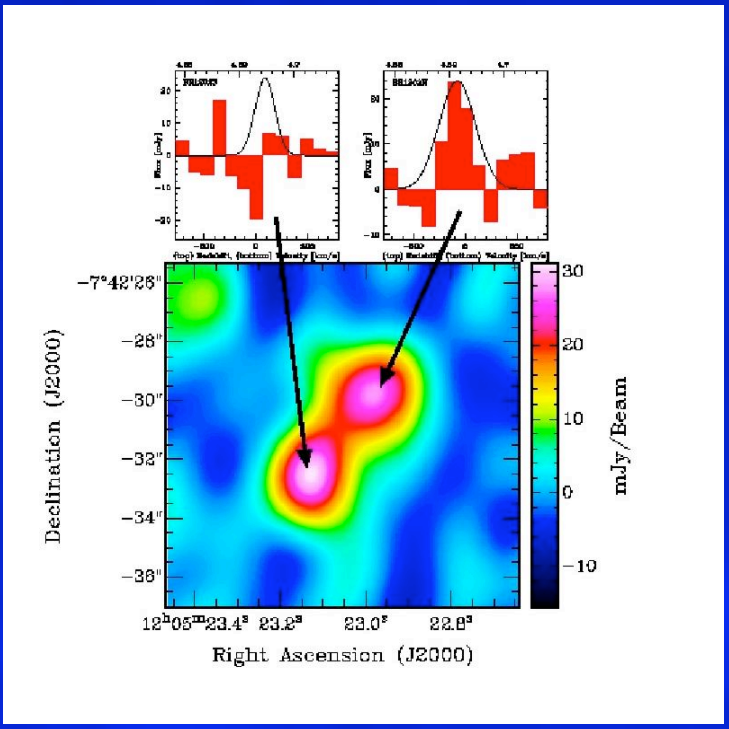


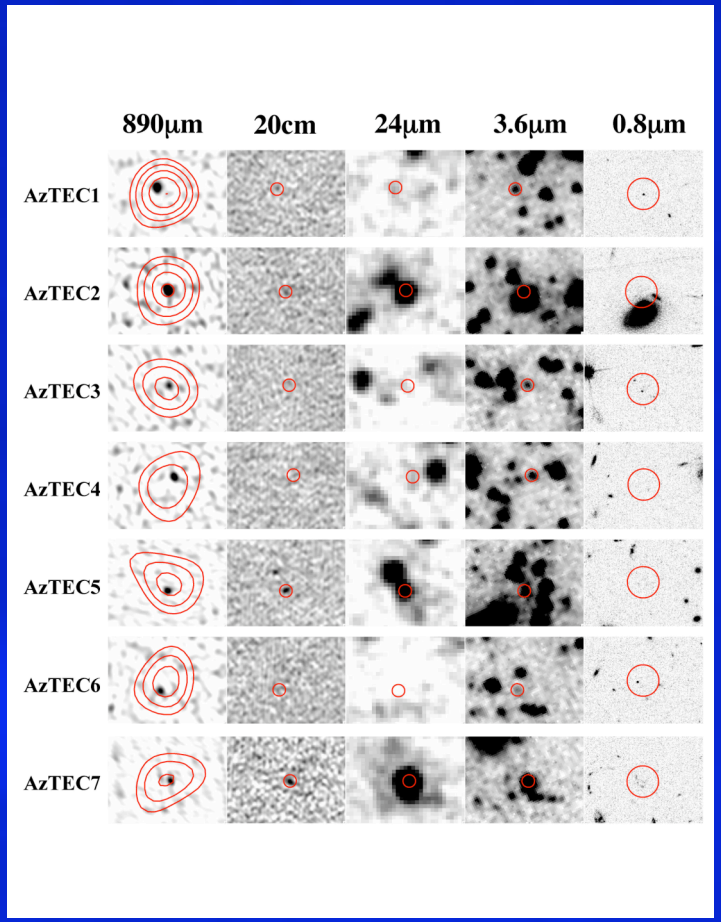




Astrometry and High Redshift Galaxies

BR1202-0725 CII at z=4.7
Iono et al 2006





7 srcs at 345 GHz
Younger et al, 2007

Proto-ALMA Science Teasers Tomorrow

Observing rotation of molecular outflows	Ralf Launhardt
Molecular gas in the nuclei of radio galaxies	Daniel Espada
A survey for water maser toward Bok Globules	Itziar de Gregorio-Monsalvo
Ubiquitous Uniqueness: The hot core of I17233	Silvia Leurini
L1641-N: feedback in cluster formation and a large Class 0 protostar disk	Thomas Stanke
Observing Planetary systems with ALMA	Antonio Hales