ALMA: Atacama Large Mm/submm Array
Current Status and Overview For Cycle 1

Kim Scott
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Atacama Large Millimeter/submillimeter Array
Expanded Very Large Array
Robert C. Byrd Green Bank Telescope
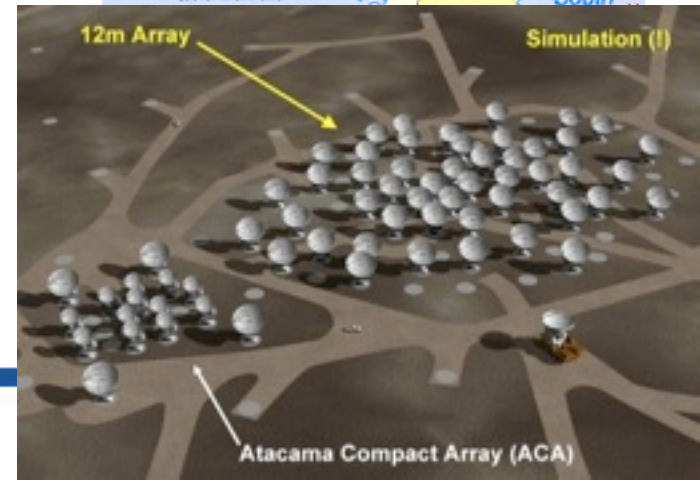Very Long Baseline Array

The take-away message in one slide

- ALMA is operating now!
- Accepted proposals for ALMA Cycle 0 began observations 30 Sept
- Proposals for ALMA Cycle I: due sometime in 1st half of 2012
  - ALMA Science Portal at
    https://almascience.nrao.edu
- Cycle 0 observing ends late 2012
- Cycle I observing begins afterwards

Talk Outline

- **ALMA Overview**
- ALMA Status & Test Data
- Cycle I Capabilities under Discussion
- Proposal Logistics, Support from the NAASC
- Future Capabilities of ALMA

ALMA Overview

- A global partnership to deliver a transformational millimeter/submillimeter interferometer
  North America (US, Canada, Taiwan)
  Europe (ESO)
  East Asia (Japan, Taiwan)
  In collaboration with Chile

- 5000m (16,500 Ft) site in Chilean Atacama desert

- Main Array: 50 x 12m antennas
  + Total Power Array 4 x 12m
  + Atacama Compact Array (ACA): smaller array of 12 x 7m antennas

- Total shared cost ~1.3 Billion ($US2006)
- On budget for completion on time

12m Array

Simulation (!)

Atacama Compact Array (ACA)

ALMA Overview

- Baselines up to 15 km (0.015" at 300 GHz) in "zoom lens" configurations

- Sensitive, precision imaging 84 to 950 GHz (3 mm to 315 μm)

- State-of-the-art low-noise, wide-band SIS receivers (8 GHz bandwidth)

- Flexible correlator with high spectral resolution at wide bandwidth

- Full polarization capabilities

- Estimate 0.5 TB/day archived

12m Array   Simulation (!)

Atacama Compact Array (ACA)

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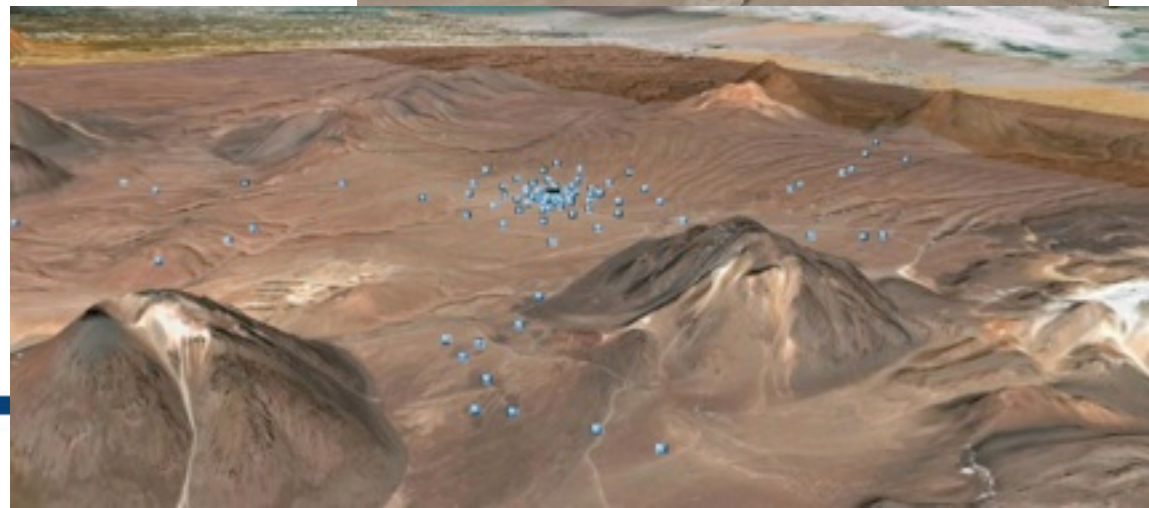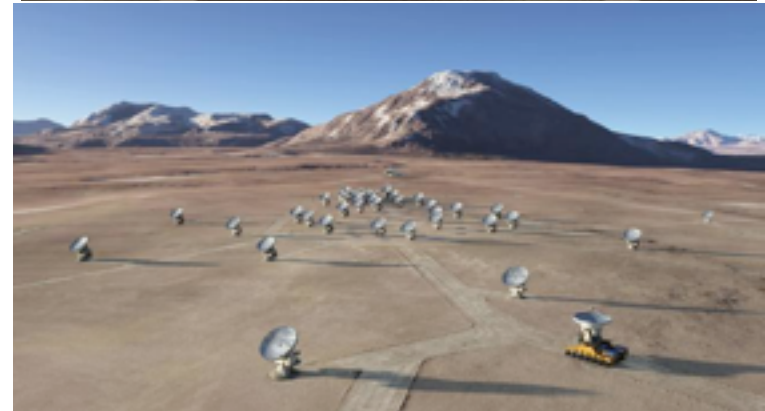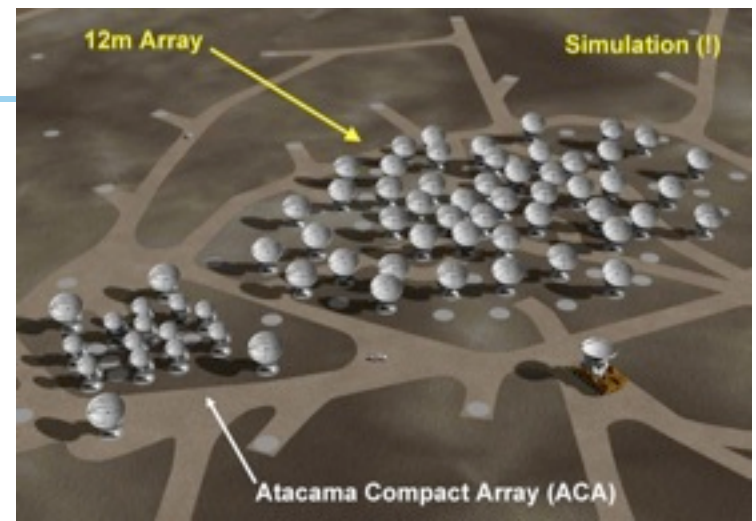
- Estimate 0.5 TB/day archived

  - A resource for ALL astronomers
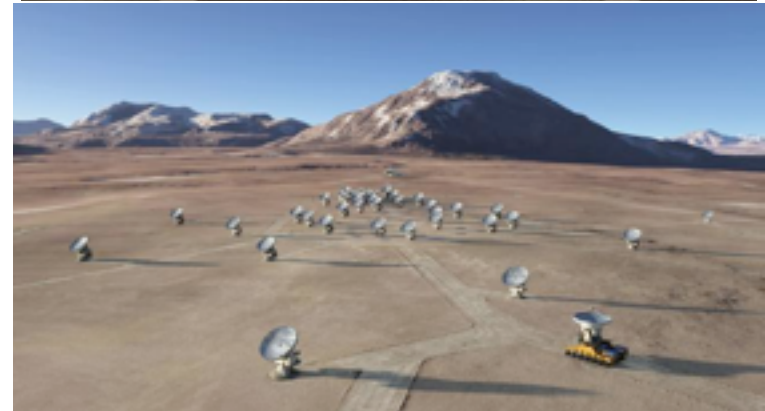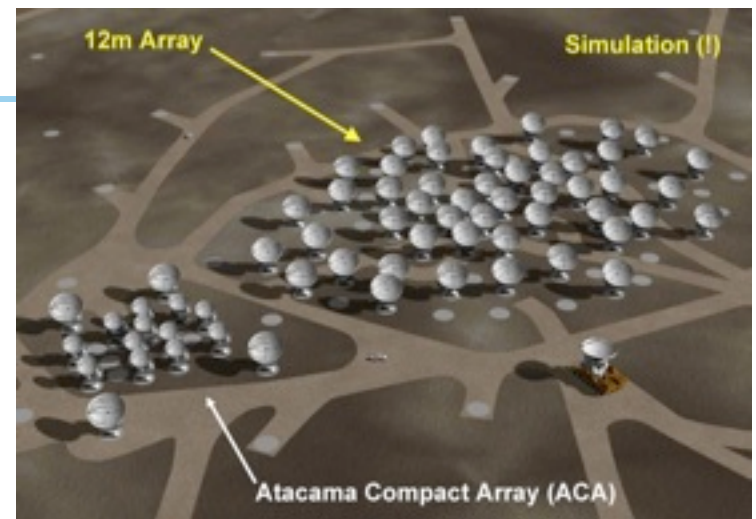
ALMA will be 10-100 times more sensitive and have 10-100 times better angular resolution compared to current millimeter interferometers

ALMA Receiver Bands
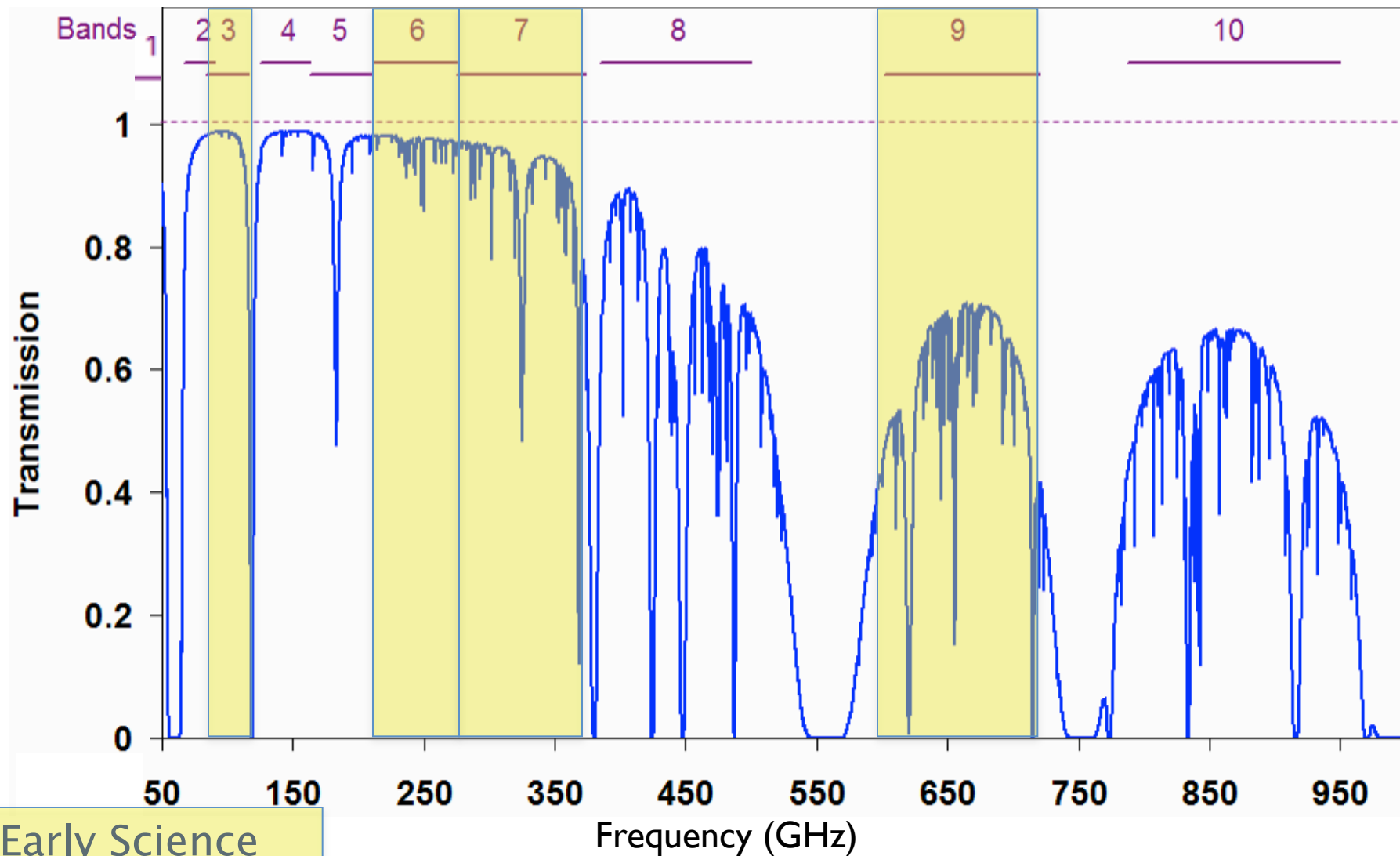
Early Science

ALMA Receiver Bands
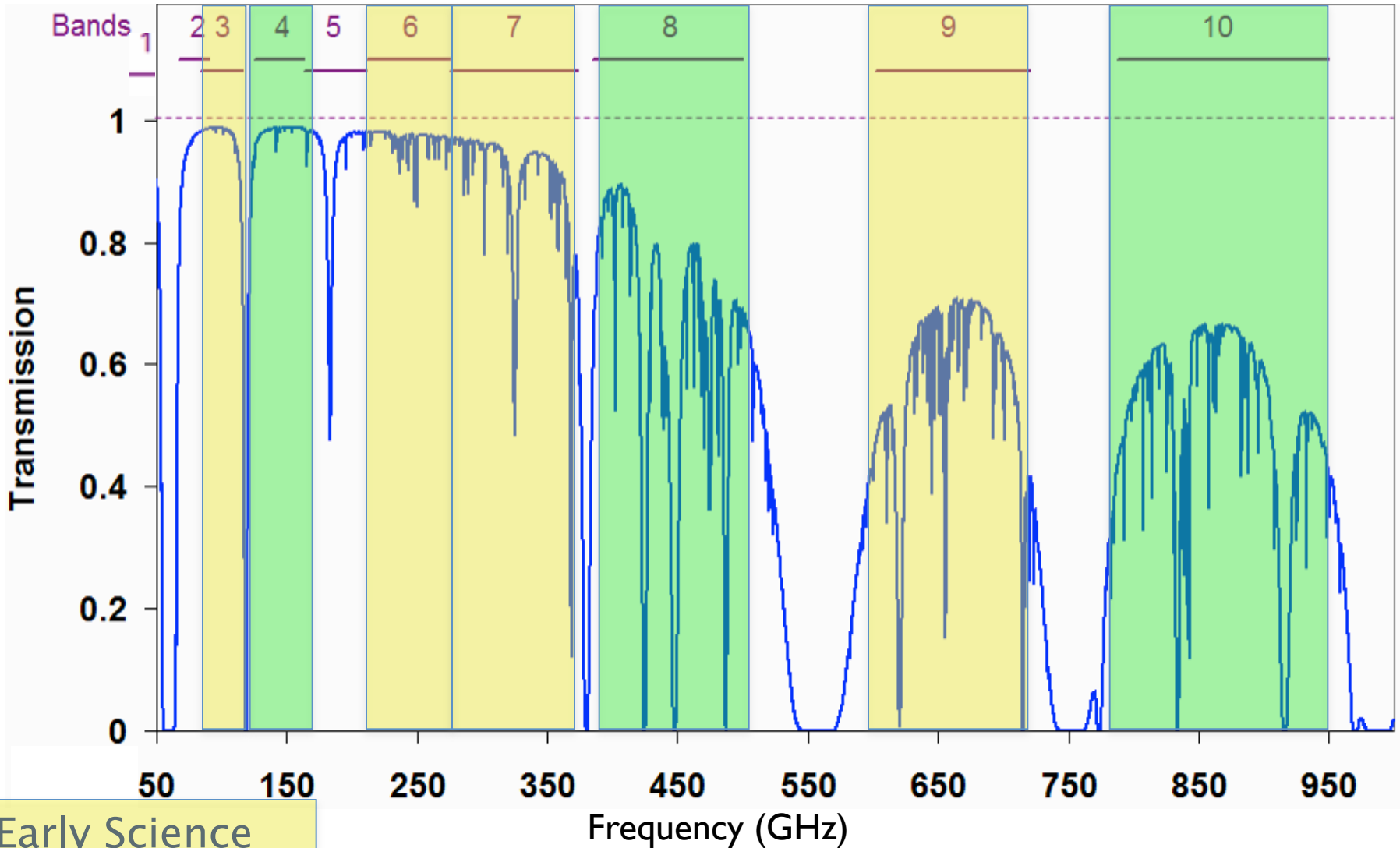
Early Science

Full Operations

ALMA in Context

Collecting Area

of antennas
(# of baselines)

➢ Sensitivity goes as collecting area

➢ Image fidelity goes as # of baselines

SMA
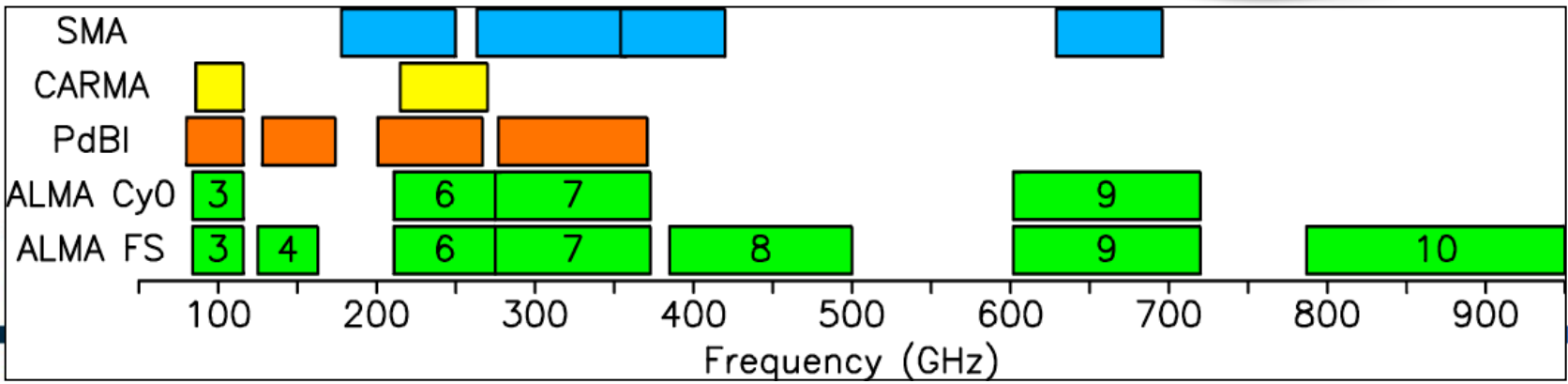8 (28)
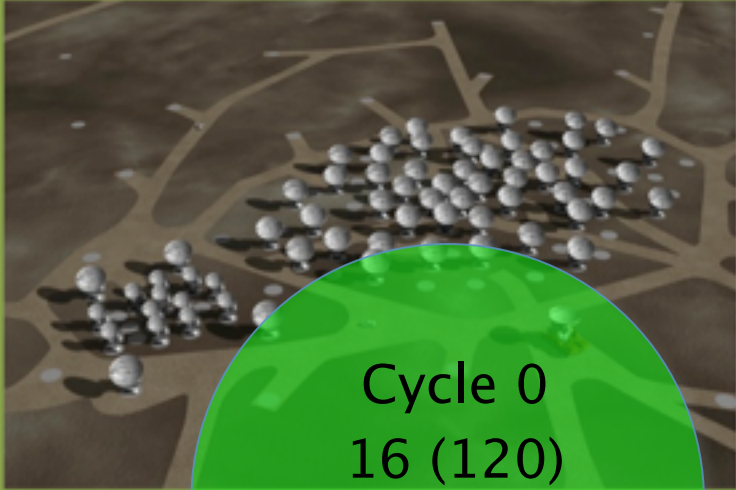
CARMA
23 (253)

IRAM PdBI
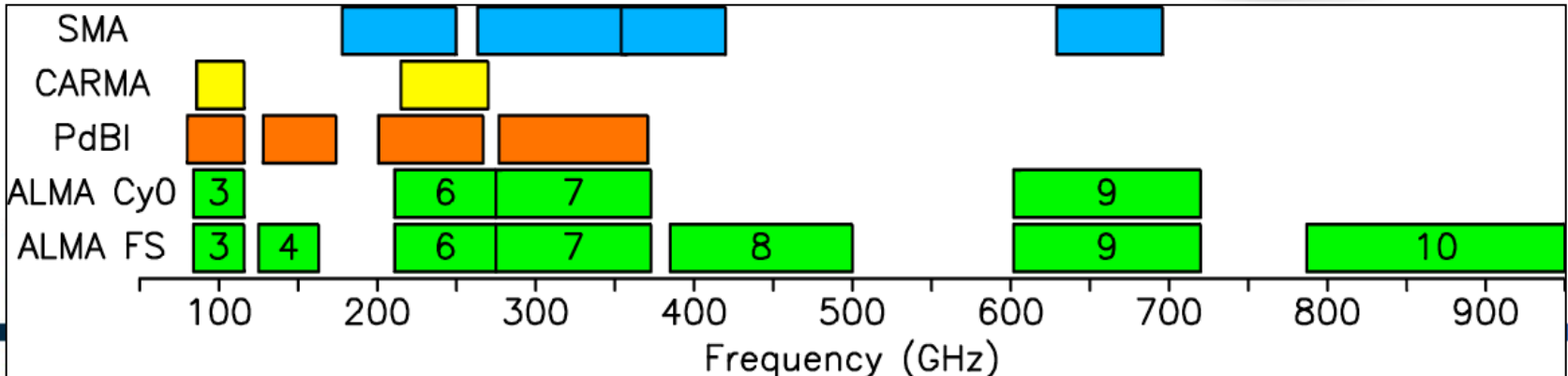6 (15)

ALMA Full Science
64 (2016)

Cycle 0
16 (120)

Spectral Coverage

ALMA in Context

Collecting Area

of antennas
(# of baselines)

➤ Sensitivity goes as collecting area

➤ Image fidelity goes as # of baselines

SMA
8 (28)

CARMA
23 (253)

IRAM PdBI
6 (15)

ALMA Full Science
64 (2016)

Cycle 1
32 (496)

Cycle 0
16 (120)

Spectral Coverage

	100	200	300	400	500	600	700	800	900
SMA									
CARMA									
PdBI									
ALMA Cy0	3	6	7		9				
ALMA FS	3 4	6	7	8	9		10		

Frequency (GHz)

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- **ALMA Status & Test Data**
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Current Status

- ALMA Cycle 0 observations began 30 Sept 2011

- Commissioning and science verification ongoing

20 September 2011

Image Credit: ALMA (ESO/NAOJ/NRAO), W. Garnier (ALMA)
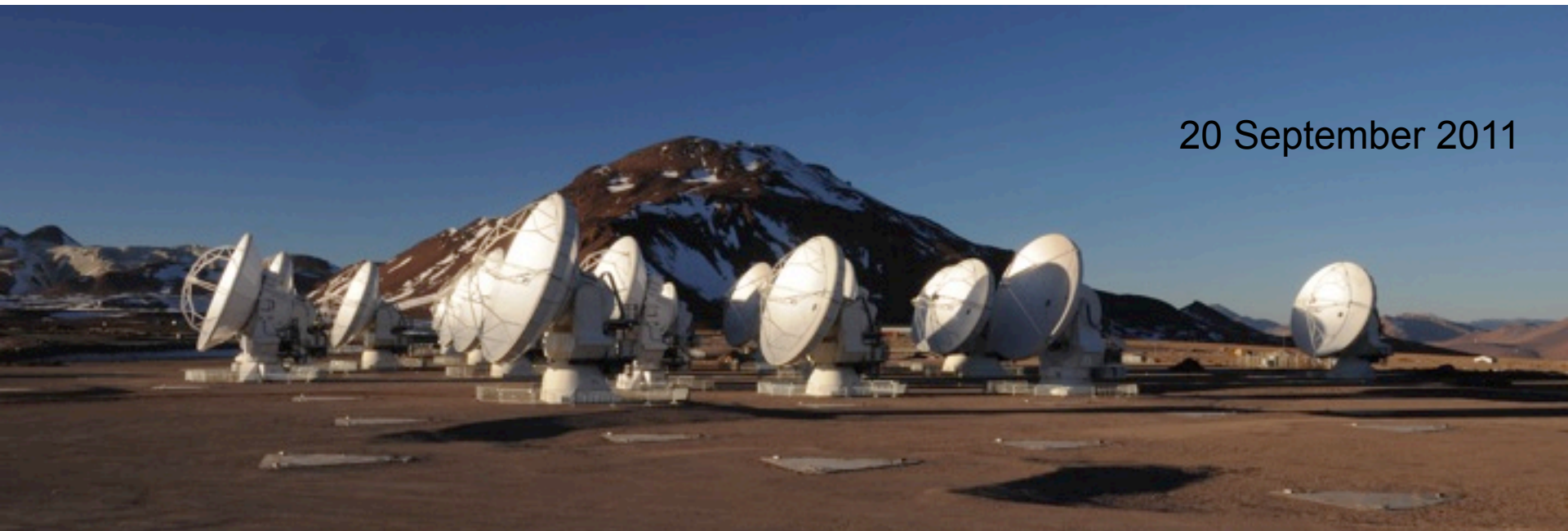
Current Status

- 26 antennas at the Array Operations Site (AOS)
  - 21 x 12m antennas in ES compact configuration
  - 5 x 7m antennas of ACA
- > 51 antennas in various stages of completion
- Correlator/spectral modes
  - Both ACA and 64 element correlators functioning
  - All antennas equipped with B3, B6, B7, and B9 receivers
- Data products for first Cycle 0 projects delivered to PI's

Science Verification Data

- Five datasets released
  - 1: **TW Hya: Band 7, high spectral resolution (casaguide).** Meredith Hughes, Stuartt Corder, Chunhua Qi, Karin Oberg, Michiel Hogerheide, Andrea Isella, Dmitry Semenov.
    - Additional data on TW Hya is available (without a separate CASA guide) here: Band 3, Band 6.
  - 2: **NGC3256: Band 3, low spectral resolution (casaguide).** Kazushi Sakamoto, Alison Peck, Satoki Matsushita, Martin Zwaan.
  - 3: **Antennae galaxies: Band 7, high spectral resolution (casaguide).** Christine Wilson, Junko Ueda, Francois Boulanger, Nicole Nesvadba, Cinthya Herrera.
- Look for updates on Science Portal:
  - https://almascience.nrao.edu/alma-data/science-verification

TW Hya 350 GHz SV Data

ALMA
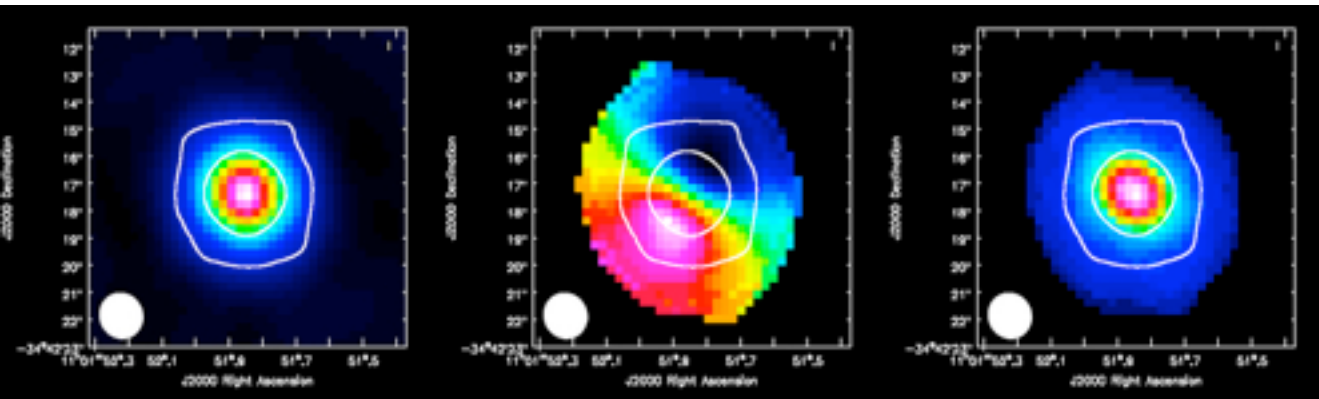
CO J=3-2 in TW Hya: **left** – integrated intensity; **center** – intensity-weighted velocity field; **right** – intensity-weighted velocity dispersion. Continuum is superposed as contours.

HCO+ J=4-3 in TW Hya: **left** – integrated intensity; **center** – intensity-weighted velocity field; **right** – intensity-weighted velocity dispersion. Continuum is superposed as contours.

NRAO
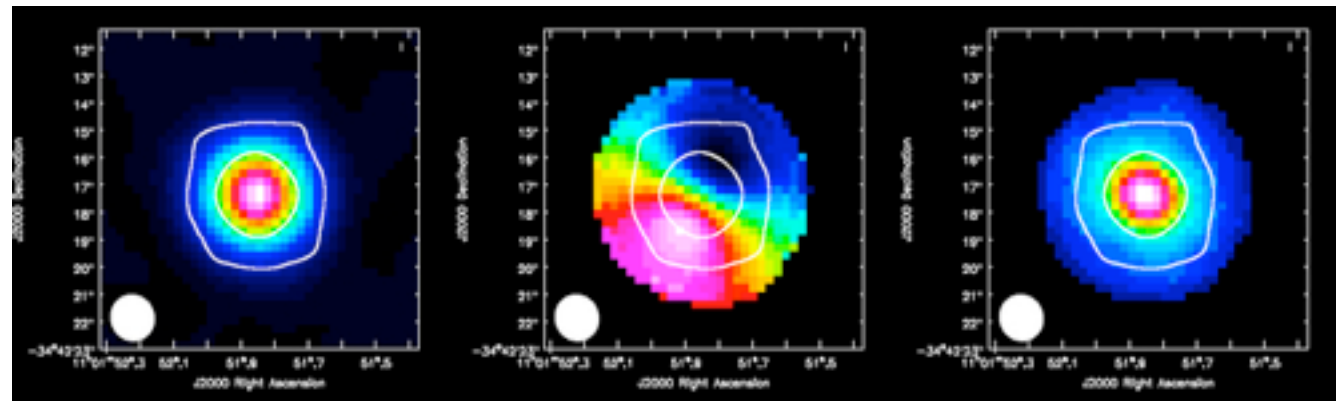
The 'Antennae': SV Data

The CO(3–2) total intensity map (moment 0) comparison with SMA data. Color image is ALMA data, combining southern and northern mosaics. Contours show SMA data (Ueda, Iono, Petitpas et al., submitted to ApJ, arXiv1110.2496).
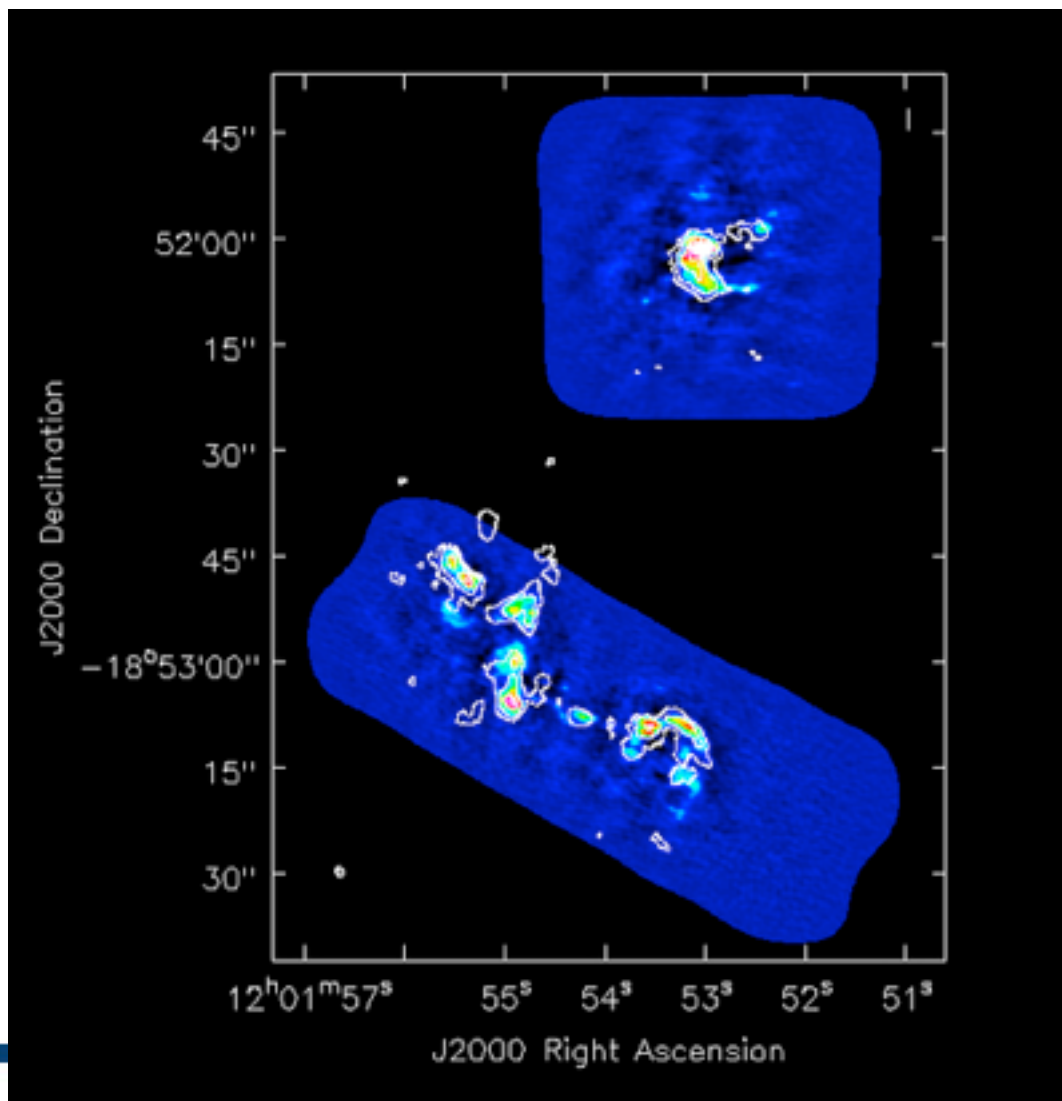
The 'Antennae': SV Data

- Press Release – See
NSF link for science
discussion

CREDIT: NRAO/AUI/NSF; ALMA (ESO/NAOJ/
NRAO); HST (NASA, ESA, and B. Whitmore
(STScI)); J. Hibbard, (NRAO/AUI/NSF); NOAO.

- Radio (VLA)
- Optical (HST)
- Submm/mm (ALMA)
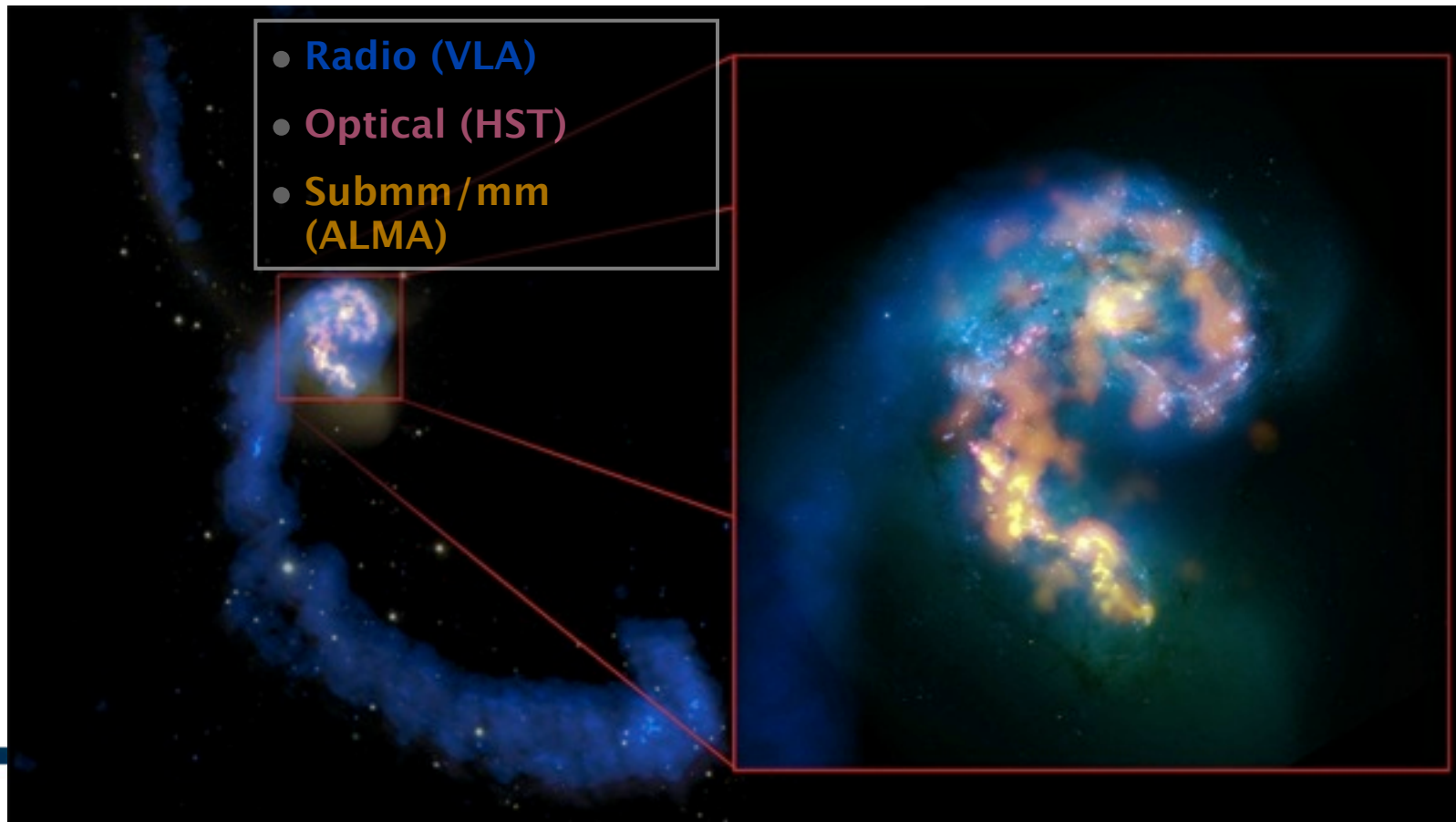
BR1202: [CII] at z = 4.7 (not released)

- Matches SMA results (Iono et al. 2006), and is of higher quality

- However, some data taken at elevation 10º – does not meet Quality Assurance requirements necessary for User data
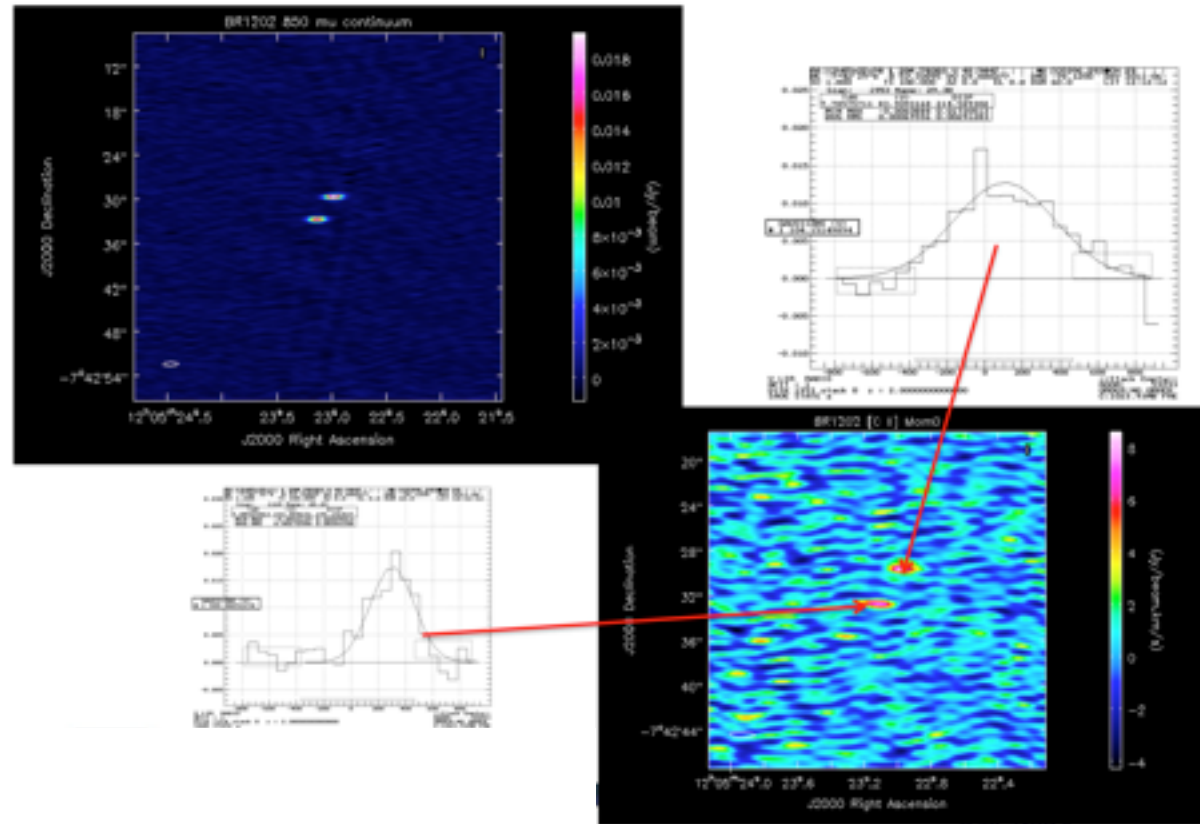
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Cycle 1: Plans (Proposed)

- Proposal deadline: **sometime in 1st half of 2012**
- Starts **after Cycle 0 ends**
- Duration: **~10 months**
- Total time for science observations: **~1500 hrs**
- Programs supported
  - Standard Proposals
  - Target of Opportunity (ToO)
  - Director's Discretionary Time (DDT)
  - Time critical observations, with scheduling sharpness of 1–2 weeks
- Programs not supported
  - Large programs (>100 hrs)
  - Highly rated Cycle 0 proposals will not be carried over to Cycle 1
  - Highly rated Cycle 1 proposals will not be carried over to Cycle 2

Cycle 1: Antennas and Array Configurations (Proposed)

- Number of antennas
  - 32 x 12m antennas for main array
  - At least 6 x 7m antennas for ACA
  - 1 x 12m ACA antenna for zero-spacing observations (single-dish)
- 12m array configurations
  - Maximum baseline lengths: 150m – 1km
  - Configurations: TBD; expect ~4–9 configurations
  - PIs will apply for required angular resolution and largest angular scale, not specific configuration
- ACA capabilities
  - Single configuration, designed to fill in short-spacings not covered in the compact configuration of 12m array
  - Single-dish observations: for spectral-line data only
  - Only used in combination with 12m array

Cycle 1: Receiver and Correlator Capabilities (Proposed)

- Bands 3, 6, 7, and 9 (same as Cycle 0)
- Correlator
  - Add capability to do spectral averaging
  - Independent bandwidth/resolution in four basebands
  - Independent baseband tuning, sideband separation

Band	Frequency (GHz)	Primary beam (arcsec)	Angular Resolution (arcsec)	Continuum Sensitivity (mJy min$^{1/2}$)
3	84 - 116	62	0.6 - 4.1	0.09
6	211 - 275	25	0.3 - 1.7	0.14
7	275 - 373	19	0.2 - 1.2	0.25
9	602 - 720	9	0.1 - 0.6	2.5

Cycle 1: Observing Modes (Proposed)

1. **Single-field interferometry**
   - Sources separated by <15° – maximum of 15 sources per Science Goal
   - Sources separated by >15° – 1 source per Science Goal
2. **Mosaics**
   - Maximum of 150 pointings per Science Goal

- Maximum of 5 Science Goals per proposal

Cycle 1: Observing Modes NOT Supported

- Spectral sweep mode
- Polarization
- Solar observations

While these modes will not be offered in Cycle 1, dedicated campaigns to test these capabilities will be carried out during this period.

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ALMA Cycle 0/1 Timeline

Date	Milestone
30 September 2011	Start of ALMA Cycle 0 observing (compact configuration)
February 2012	Engineering shutdown
March 2012	Recommence Cycle 0 observing (extended configuration)
1st half of 2012	Cycle 1 CfP; release of new OT and proposers guide
	Cycle 1 proposal deadline; technical assessment and proposal review process
Late 2012	End of ALMA Cycle 0; start of Cycle 1

Proposal Checklist

□ Read Primer and Proposers Guide

□ Create ALMA account by registering at the Science Portal

□ Download Observing Tool (OT), try Sensitivity Calculator

□ Download CASA 3.3 (current release), try simdata

□ Prepare the Science & Technical Justifications (one PDF file)

□ Prepare Science Goals (sources, frequency & correlator setup, integration times) within the OT

□ Make use of the Helpdesk & the Knowledgebase

□ Submit to Archive!

Science Portal (https://almascience.nrao.edu)

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Register –
▸ to submit proposals as PI
▸ to be Co-I on proposals
▸ to submit Helpdesk tickets

Science Portal

Documents & Tools

Science Portal

Documents & Tools

Sensitivity Calculator

Proposers Guide,
Technical Handbook

Observing Tool
"Quickstart" guide
& videos

CASA and CASA-
based observing
simulators

Science Support

- Three ALMA Regional Centers: ARCs
  - NA: Charlottesville, VA, USA
  - EU: Garching, Germany
  - EA: Mitaka, Japan
- North American ARC: US - Canada
- North American ALMA Science Center (NAASC) encompasses NA ARC and includes partnership with Taiwan
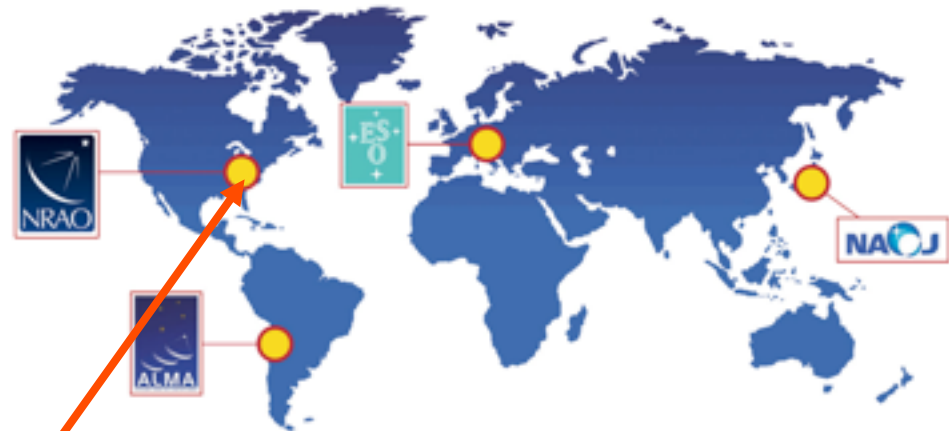
NAASC in Charlottesville, VA

NAASC: One-stop shopping for:
- Proposal help and submission
- Observation preparation (Phase 2)
- Data archive
- Data processing
- Face-to-face visitor support
- Workshops and tutorials
- Community outreach

NRAO User Support
https://almascience.nrao.edu

ALMA

NRAO User Support
https://almascience.nrao.edu

ALMA

ALMA Helpdesk –
‣ Includes self–help capability
‣ Staffed world–wide

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Future Capabilities of ALMA

- >3x (>1.5x) better sensitivity with 50 x 12m antennas in main array compared to Cycle 0 (Cycle 1)
  - Fantastic "snapshot" uv-coverage (1225 baselines)
  - Imaging fidelity ~10x better!
- Higher angular resolution: baselines ~15km, matched beams in all bands
- Better imaging of resolved objects and mosaics
  - TPA: 4 x 12m antennas with subreflector nutators
  - ACA: Compact configuration 12 x 7m antennas
  - "On-the-Fly" mosaics: quickly cover larger areas of sky

Future Capabilities of ALMA

- More receiver bands: 4, 8, 10 (2mm, 0.7mm, 0.35mm)
- Polarization: magnetic fields and very high dynamical range imaging
- ALMA Development Program
  - mm VLBI
  - More receiver bands
  - Higher data rates

Summary

- Amazing scientific promise of ALMA
- Steady progress in construction: 26 antennas now at high site
  - Already more collecting area and spectral coverage than current arrays
- Proposal submission for Cycle 1 in 1st half of 2012
- NAASC is your One-Stop shop for community support

Info common across project { https://almascience.nrao.edu/

NAASC specific programs { https://science.nrao.edu/facilities/alma