ALMA: Atacama Large MM/Submm Array

Early Science is Almost Here!

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(NRAO/North American ALMA Science Center)

Atacama Large Millimeter/submillimeter Array

Expanded Very Large Array

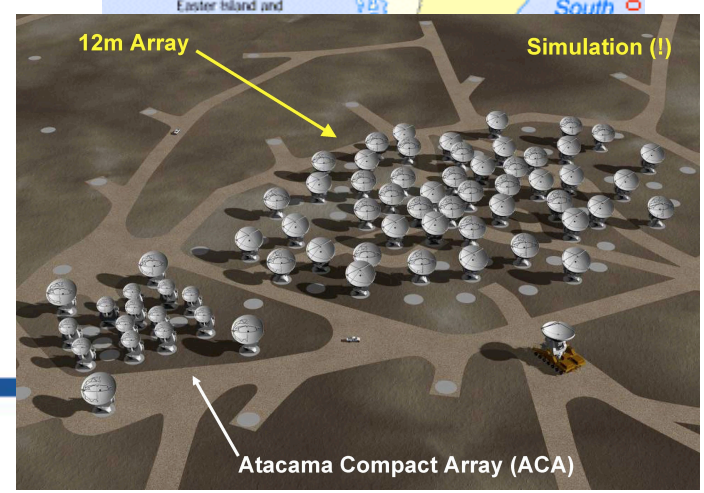
Robert C. Byrd Green Bank Telescope

Very Long Baseline Array

AAS Seattle, WA, Jan. 11, 2011

The Atacama Large MM/Submm Array : ALMA

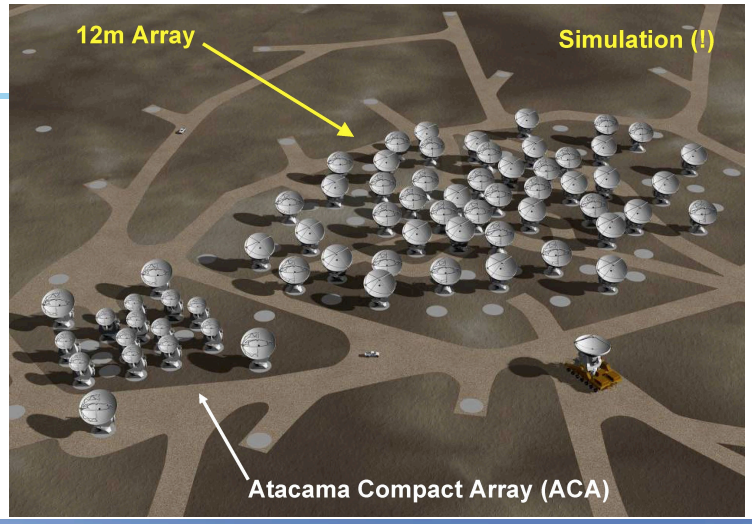
- A global partnership to deliver a transformational millimeter/submillimeter interferometer
  - North America (US, Canada, Taiwan)
  - Europe (ESO)
  - East Asia (Japan, Taiwan)
- 5000m (16,500 Ft) site in Chilean Atacama desert
- Main Array: 50 x 12m antennas
  - + Total Power Array 4 x 12m
  - + Atacama Compact Array (ACA): smaller array of 12 x 7m antennas
- Total shared cost ~1.3 Billion ($US2006)



ALMA in a Nutshell

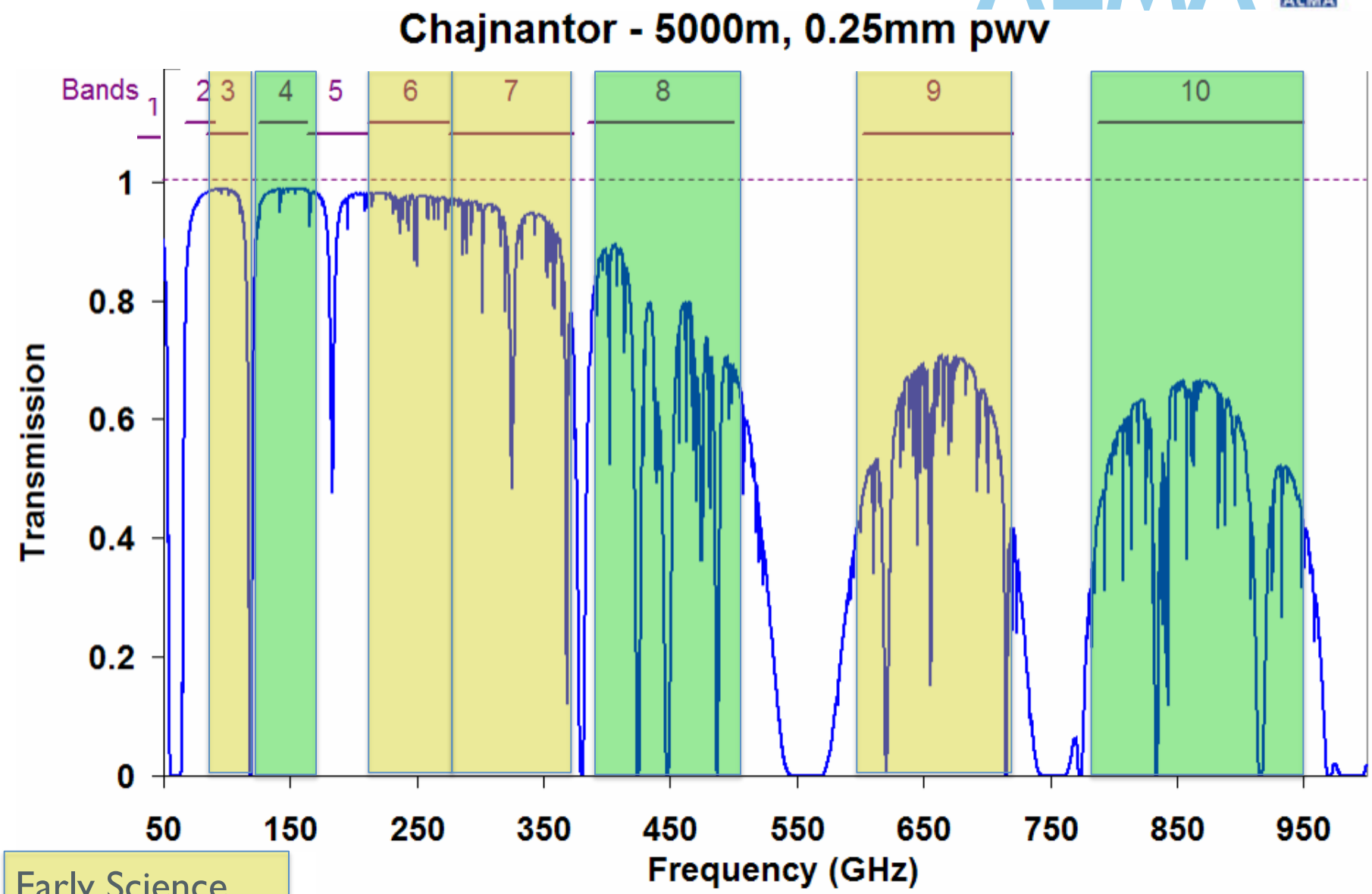
- Baselines up to ~15 km (0.015" at 300 GHz) in "zoom lens" configurations
- Sensitive, precision imaging 84 to 950 GHz (3 mm to 315 μm)
- State of the Art low-noise, wide-band receivers (8 GHz bandwidth)
- Flexible correlator with high spectral resolution at wide bandwidth
- Full polarization capabilities
- Estimate 1 TB/day to be 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

Receiver Bands

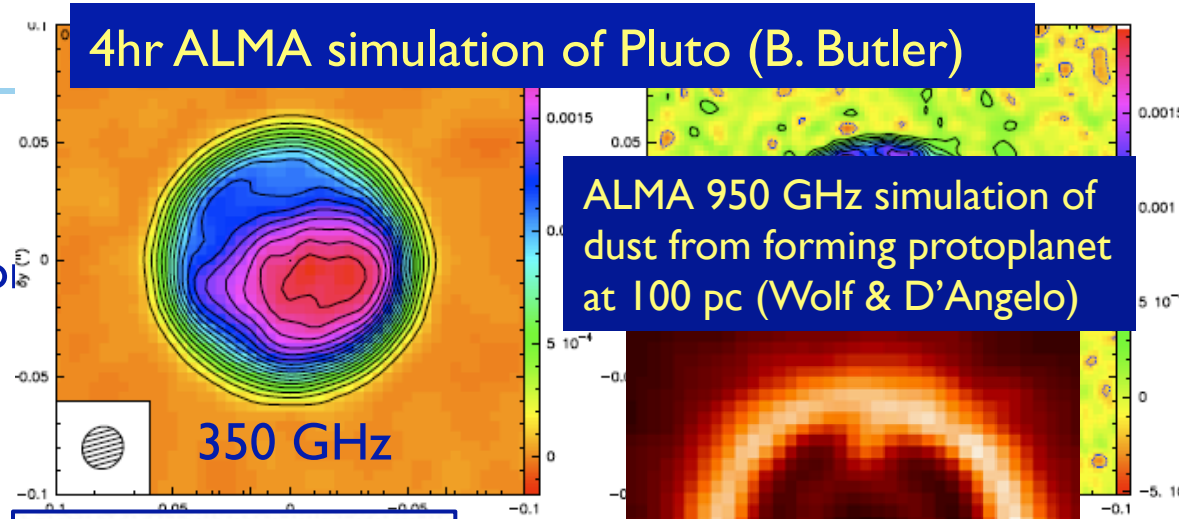


Early Science

Full Operations

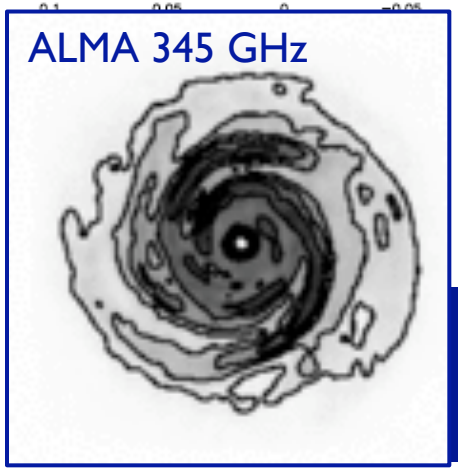
Breadth of Full Science: Galactic

- Exploring the Solar System from the sun to minor planets and moons
- Revealing disks and forming protoplanets around nearby stars
- Resolving the accretion process(es) of massive protostellar and cluster formation

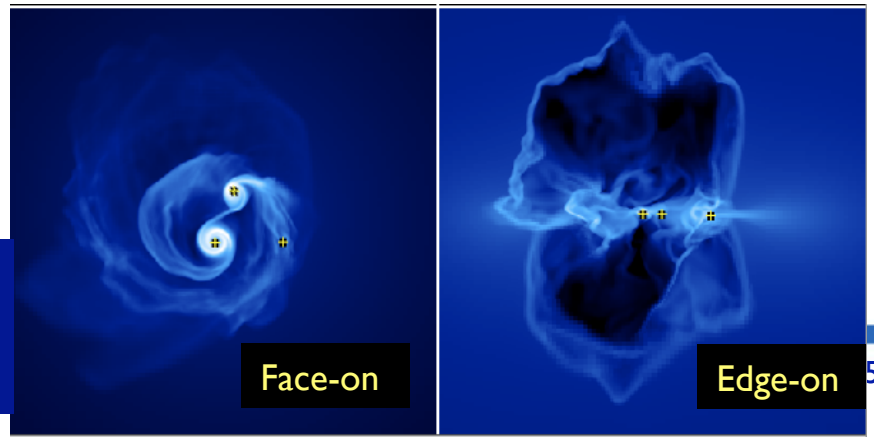


4hr ALMA simulation of Pluto (B. Butler)

ALMA 950 GHz simulation of dust from forming protoplanet at 100 pc (Wolf & D'Angelo)



Simulation of dust opacity in a face-on circumstellar disk at 50 pc (Cossins et al. 2010)



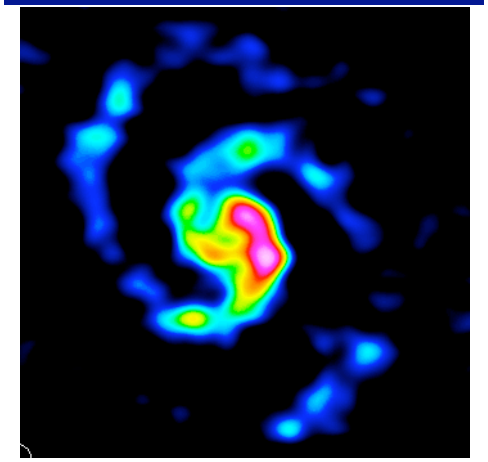
Theoretical simulation of massive star formation with 10 AU resolution (Krumholz et al. 2009)

Breadth of Full Science: Extragalactic

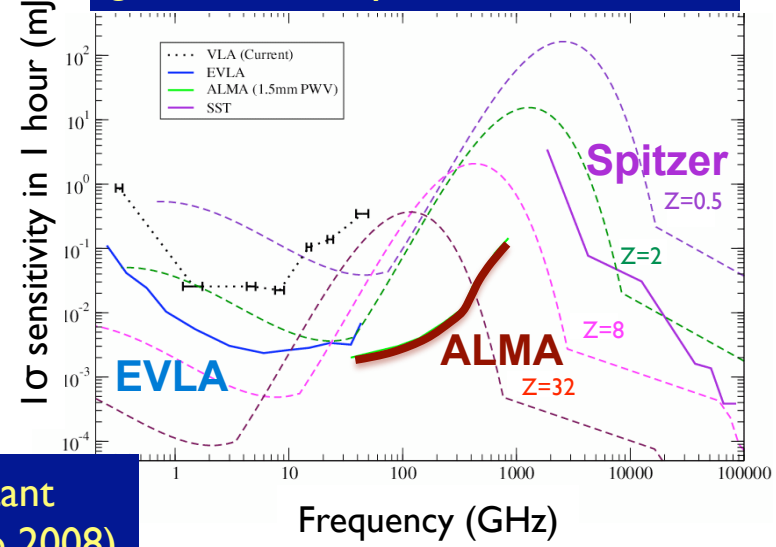
ALMA

- Detailed imaging of dust and gas in nearby galaxies
- Probing the nature of AGN, black holes, GRBs and other transient phenomena
- Imaging dust and gas from high redshift galaxies

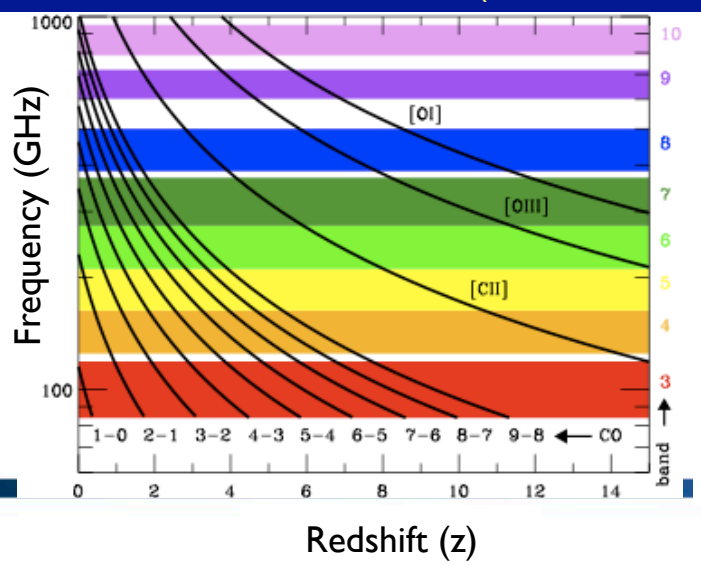
4 hr CASA Simulation of M51 at z=0.1 in CO(1-0)



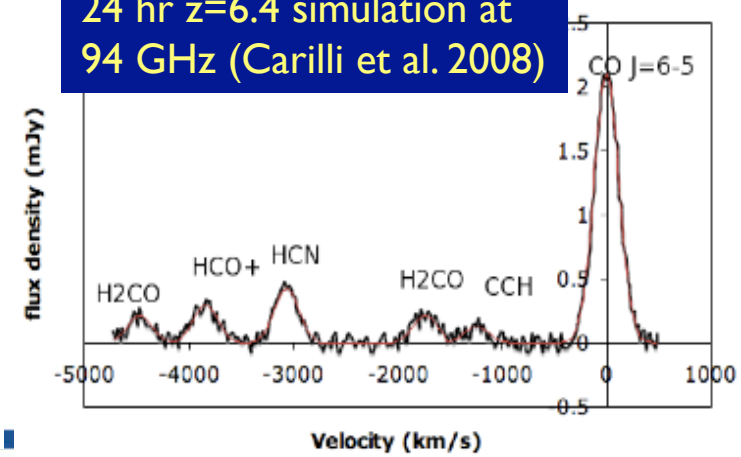
Detect dust continuum from high-z galaxies as easily as those at z~0.5



Nearly continuous coverage of important lines as a function of redshift (Maiolino 2008)

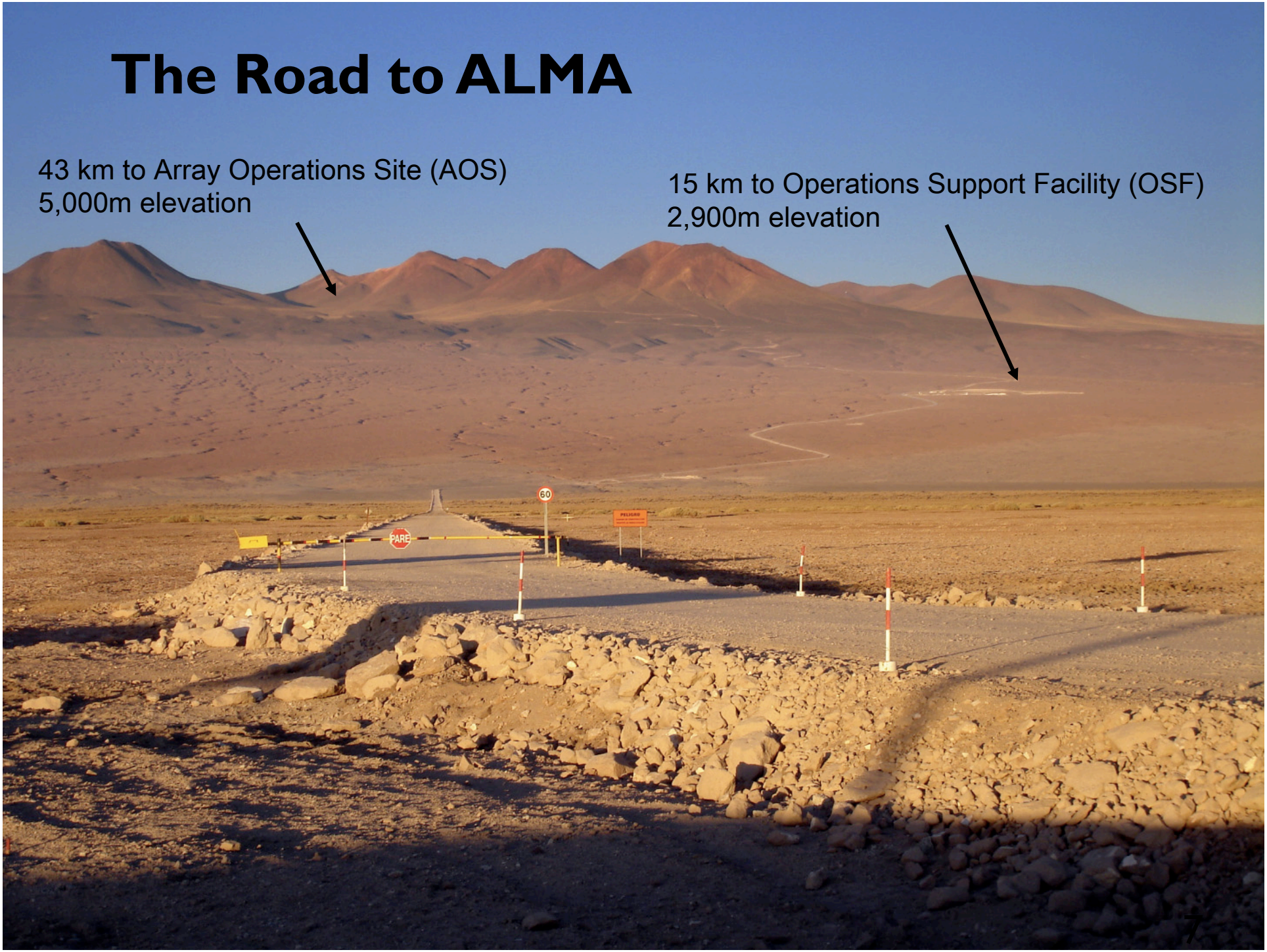


24 hr z=6.4 simulation at 94 GHz (Carilli et al. 2008)



NRAO

The Road to ALMA



Operations Support Facilty (2900m level)

Melco, Vertex, and AEM, (EA), (NA), (EU) antenna assembly

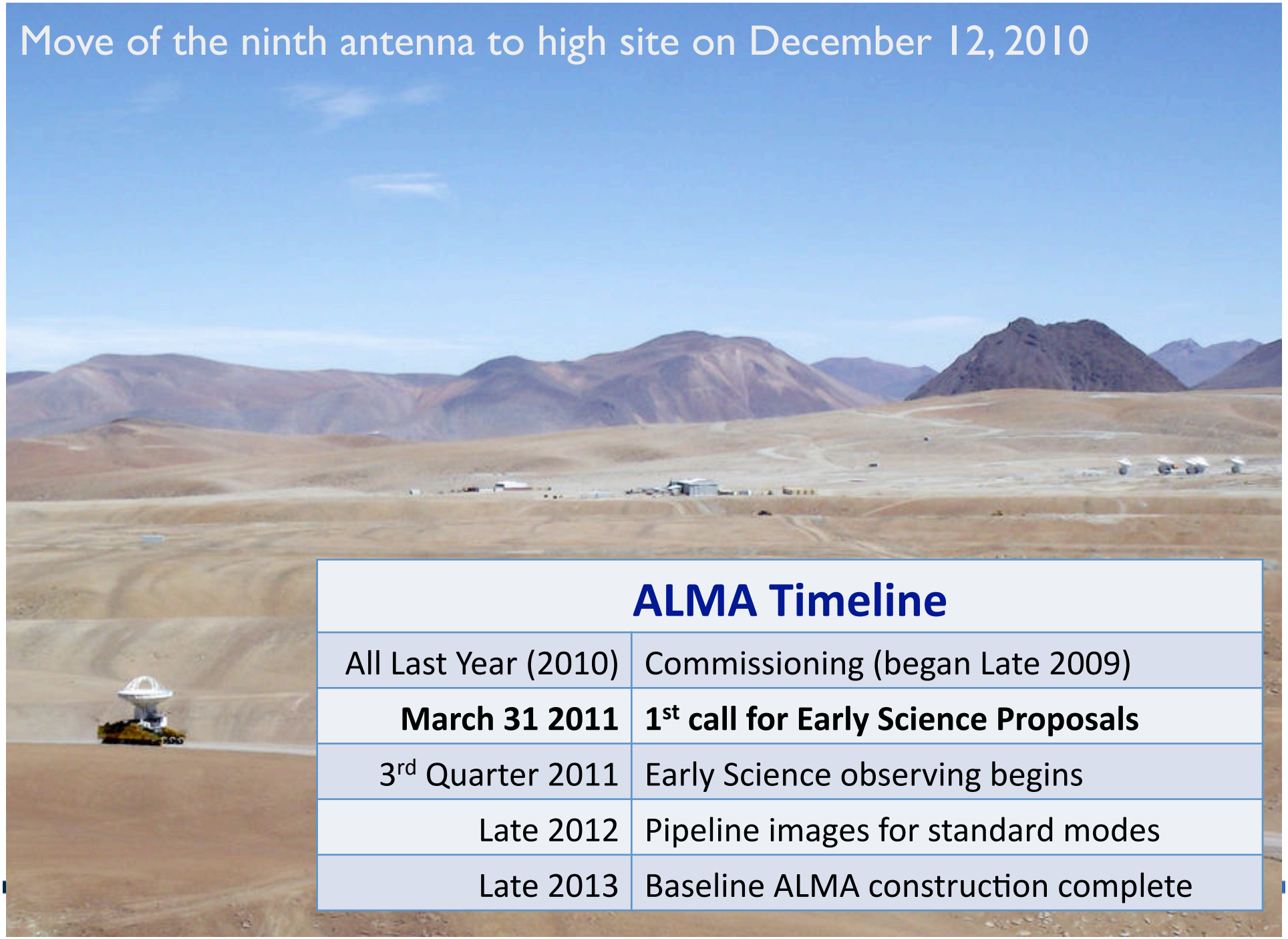
Contractors camp

There are now >23 antennas in various stages of completion

Progress at the Array Operations Site at 5000m → the "high site"

AOS Technical Building - completed 2008

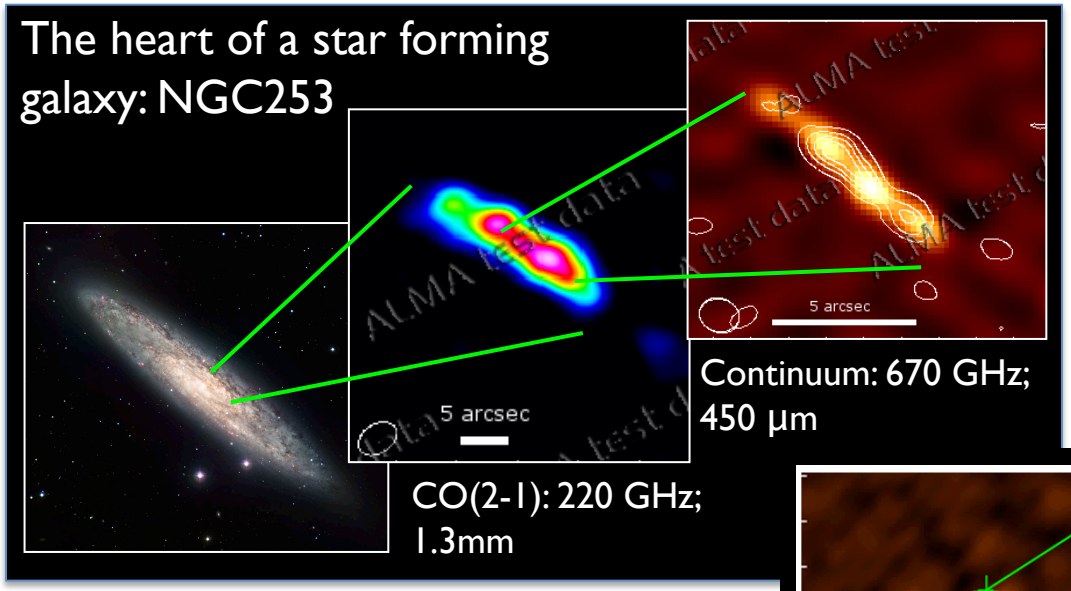
Home of the ALMA 12-m and ACA correlators

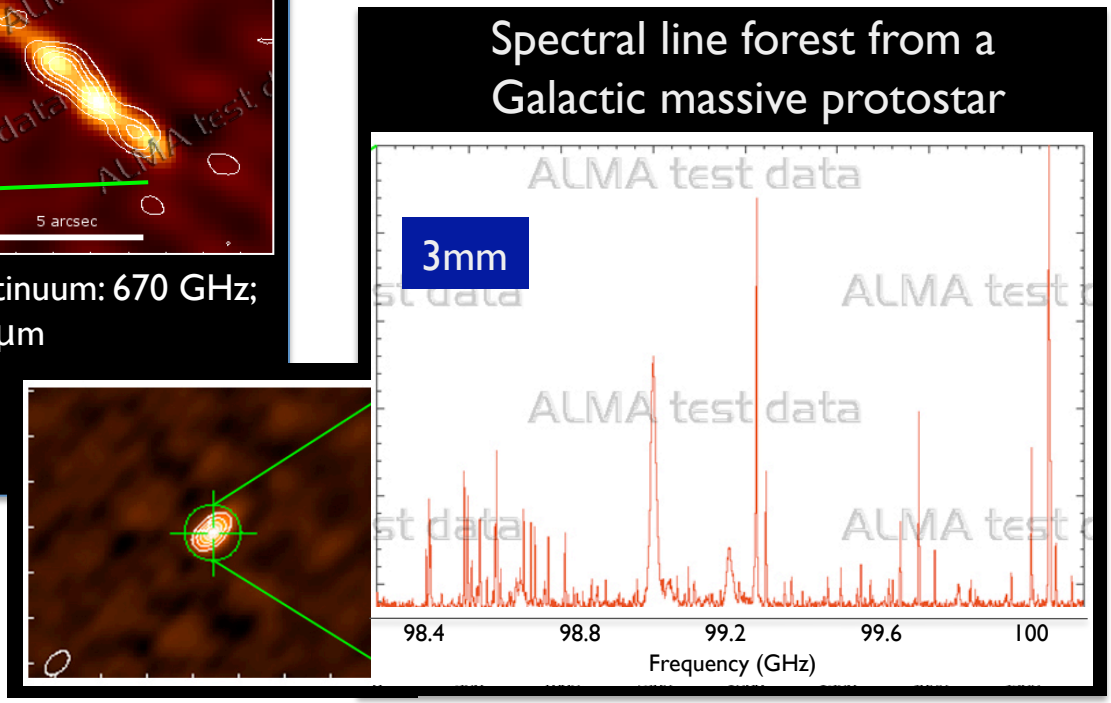


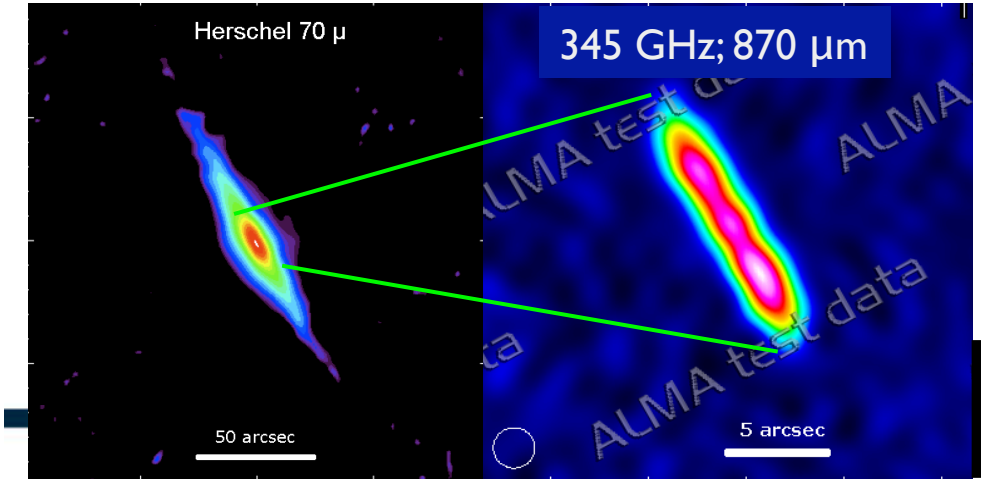
ALMA Timeline	
All Last Year (2010)	Commissioning (began Late 2009)
March 31 2011	**1st call for Early Science Proposals**
3rd Quarter 2011	Early Science observing begins
Late 2012	Pipeline images for standard modes
Late 2013	Baseline ALMA construction complete

Commissioning: Stunning Test Images

ALMA







- See ALMA solicitation for Science Verification (SV) ideas http://science.nrao.edu/alma/
- SV data will be released near the call

Dust continuum of the potentially planet forming debris disk: Beta Pictoris

ALMA 1st Call March 31

At least:

- 16 antennas
- 4 Receiver bands 3, 6, 7, 9 ➔ 100, 230, 345, 670 GHz ➔ 3, 1.3, 0.8, 0.45 mm
- Baselines up to 250m (0.4" at 670 GHz)
- Range of correlator modes: up to 4 spectral windows and 8 GHz bandwidth
  - @345 GHz 0.007 to 27 km/s channels with bandwidths 200 to 7500 km/s

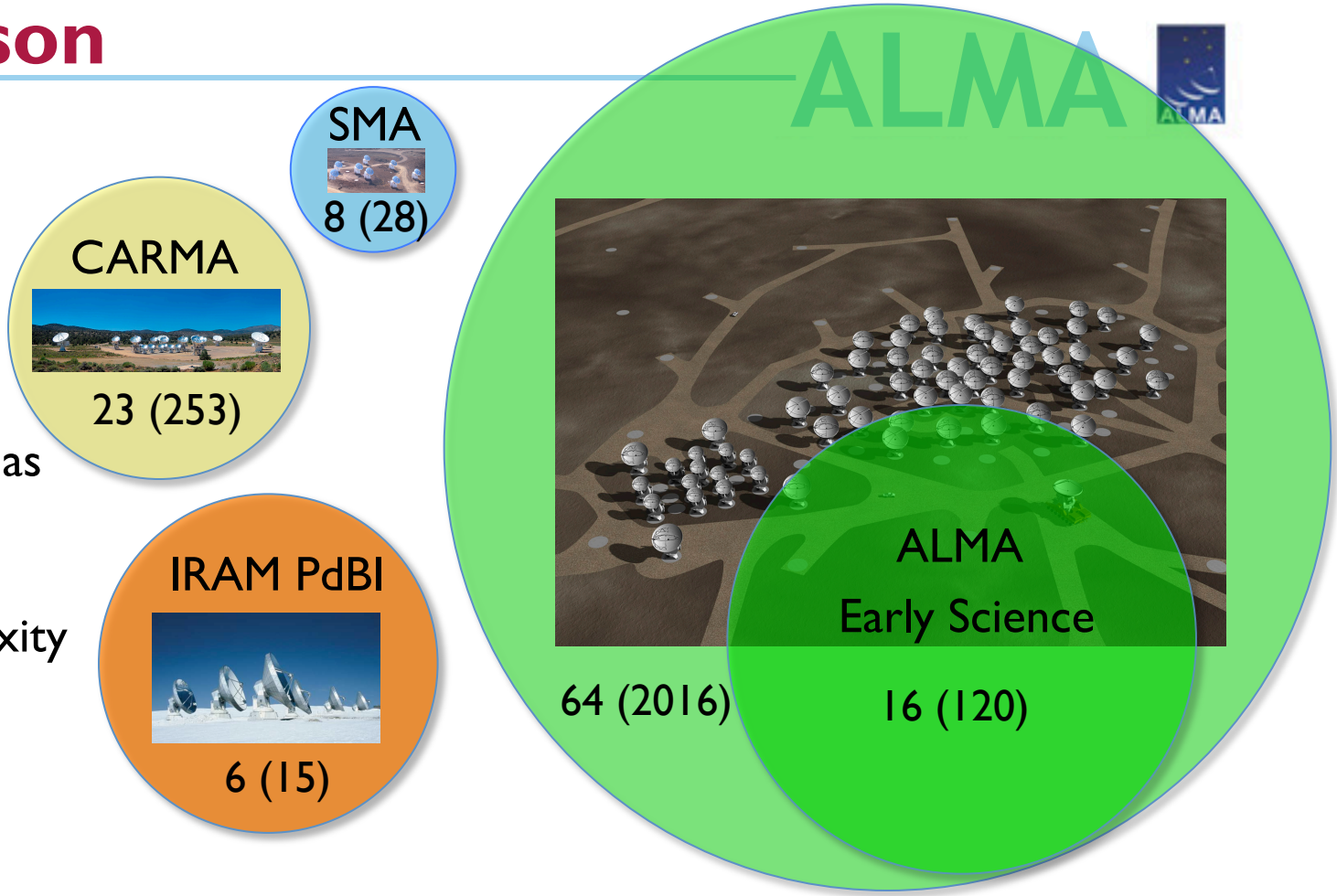
➢ Additional capabilities **may** be announced with the call (limited mosaicing and polarization, somewhat longer baselines)

Process:

- Due date June 30, observing begins Fall 2011
- Observing will span 9 months, with ~600 hours available
- A single international Proposal Review Committee, chaired by Neal Evans
- Off-line data reduction necessary
- User support from ALMA Regional Centers ARCs

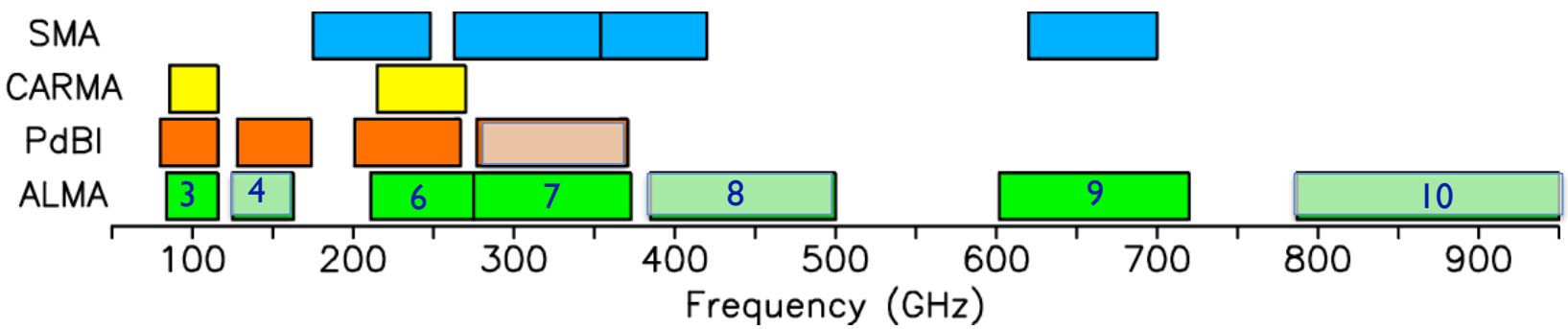
Comparison

Collecting Area



- Sensitivity goes as collecting area
- Imaging complexity goes as # of baselines

Spectral Coverage

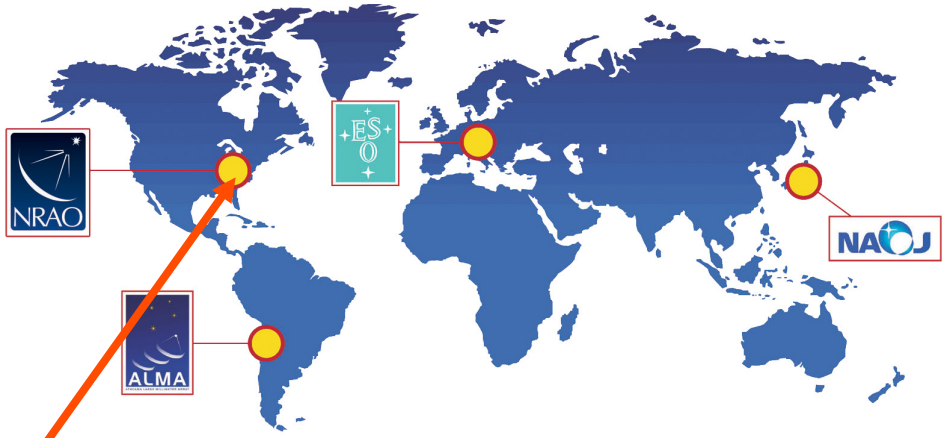


Science Support

- Three ALMA Regional Centers: ARCs
  - NA: Charlottesville, VA, USA
  - EU: Garching, Germany
  - EA: Mitaka, Japan

- North American ARC: US - Canada (7.25%) partnership for core support

- North American ALMA Science Center (NAASC) encompasses NA ARC and includes partnership with Taiwan



NAASC: One-stop shopping for:

- Proposal Help and Submission
- Observation preparation
- Data archive
- Data processing
- Community outreach

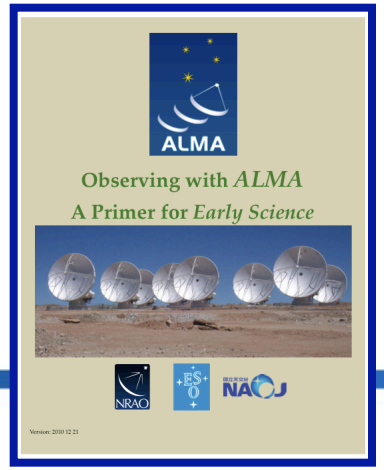
http://science.nrao.edu/alma/

NAASC User Support

ALMA

- Modern Helpdesk with self-help capability (also used by NRAO, Spitzer, and Herschel)
- Comprehensive User Tools
  - OT (Observing Tool) for proposal and observation preparation
  - Project Tracker for tracking the status of your project
  - ALMA Science Archive for public and proprietary data retrieval
  - CASA for data reduction and eventually pipeline products

- Additional NAASC community support programs
  - Science workshops and tutorials
  - Face-2-Face visitor support
  - Publication page charge support
  - Post-docs and students



Upcoming NAASC Supported Workshops & Tutorials

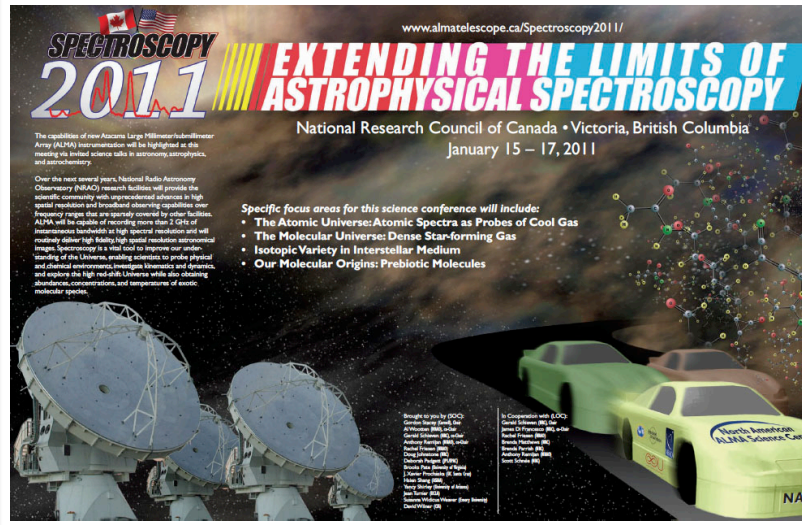
Training Tutorials

- Jan. 18: Victoria, BC (following "Extending the Limits of Astrophysical Spectroscopy")
- Feb. 24-25: Hands-on Tutorials (NRAO-CV)
- March 11: Santa Fe, NM (following "Building on New Worlds, New Horizons")
- April 26-27: Hands-on Tutorials (NRAO-CV)
- May 9-10: Hands-on Tutorials (NRAO-CV)
- May 22-26: Boston, MA (218th AAS Meeting)

➔http://science.nrao.edu/alma/training.php

Science Workshops

- 5th annual meeting next week



- Announcement soon for next year's meeting

ALMA Community Days

- Regionally located/organized and NAASC supported ALMA training workshops
- One or more per month leading up to the proposal deadline
- Proposal deadline Feb. 1; see announcement: http://science.nrao.edu/alma/
  - Proposals received from Hawaii, CfA-SMA, and Caltech -- interest by several others including Tucson – looking forward to more proposals!

Summary

ALMA

- Amazing scientific promise
- Tremendous progress in construction: 9 antennas at high site
- 1st Call for Early Science at the end of March,
  - already more collecting area and spectral coverage than current arrays
- Many training events coming up and proposals for ALMA community days being accepted
- One-Stop for community support at NAASC

http://science.nrao.edu/alma/

Tomorrow at AAS

- 2PM Ballroom 6A Special session: "Observing with ALMA"
  - More details on NAASC, ES capabilities, and User Tools
  - Dave Wilner: "ALMA does Disks: A Users Perspective"
  - Jean Turner: "ALMA does Galaxies: A Users Perspective"
- 4:00PM Observing Tool demos at NRAO booth
- 5:30PM RM304 Splinter Session: "Early Science Proposal Preparation Tutorial"

Thursday: 11am-1pm Observing Tool demos at NRAO booth

NRAO

ALMA
ATACAMA LARGE MILLIMETER ARRAY

www.almaobservatory.org

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