

# Astronomy at Submillimeter Wavelengths with the Cornell Caltech Atacama Telescope

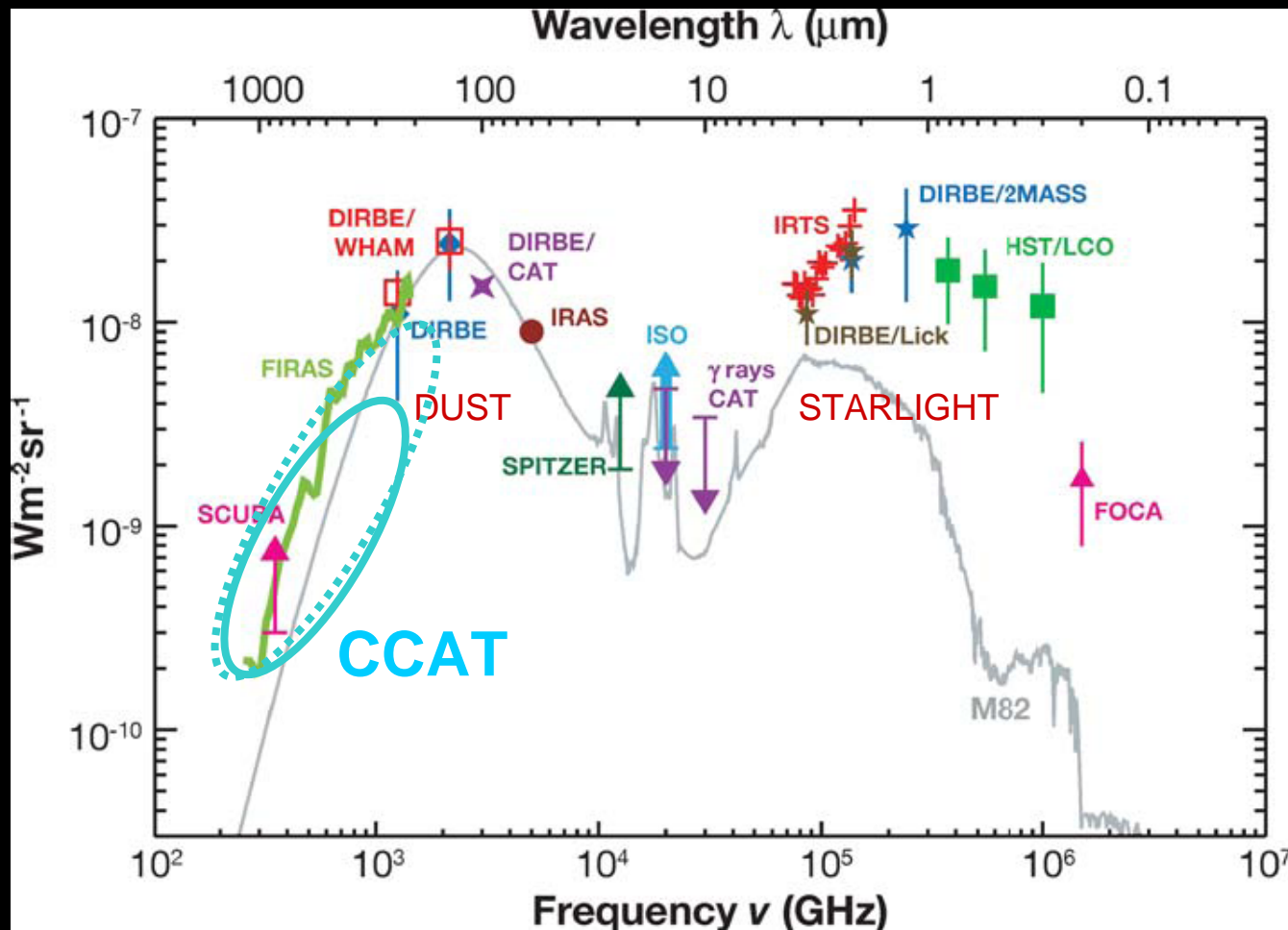
Jason Glenn  
The University of  
Colorado

1. Science drivers for  
CCAT
2. Summary of CCAT  
Telescope and Project

Cornell Caltech Atacama Telescope

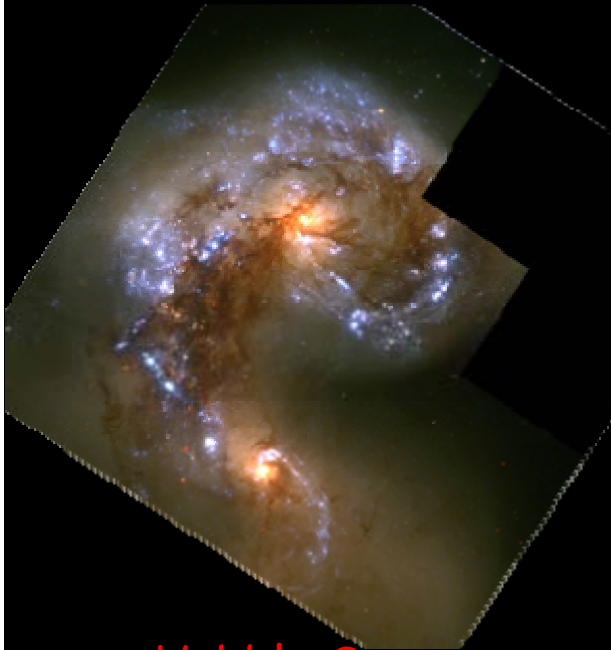
# Cosmic Far-Infrared Background Radiation

COBE (1996): The Cosmic FIR background nearly equals the extragalactic optical/UV background  $\rightarrow$  dust-obscured galaxy formation (stars & AGN)



Lagache,  
Puget, &  
Dole 2005

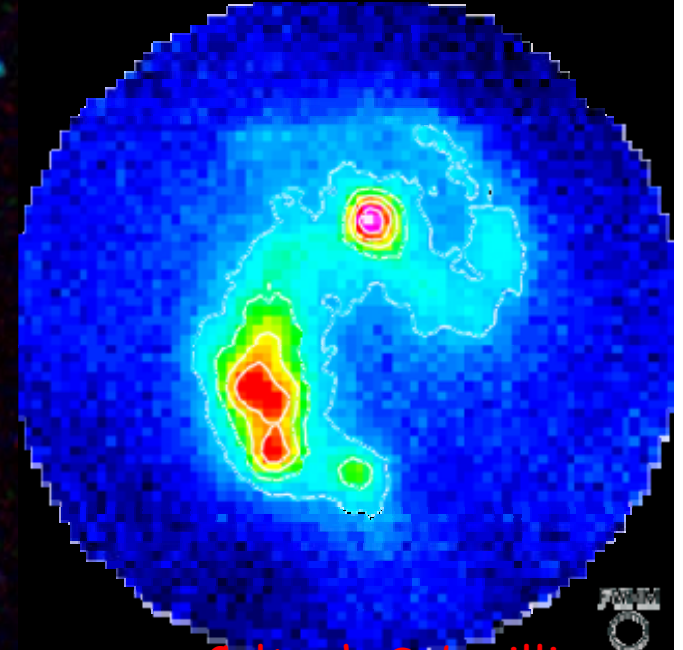
# Submillimeter Emission from Starbursts



Hubble Space  
Telescope:  
Visible



Spitzer Space  
Telescope: Mid-  
Infrared



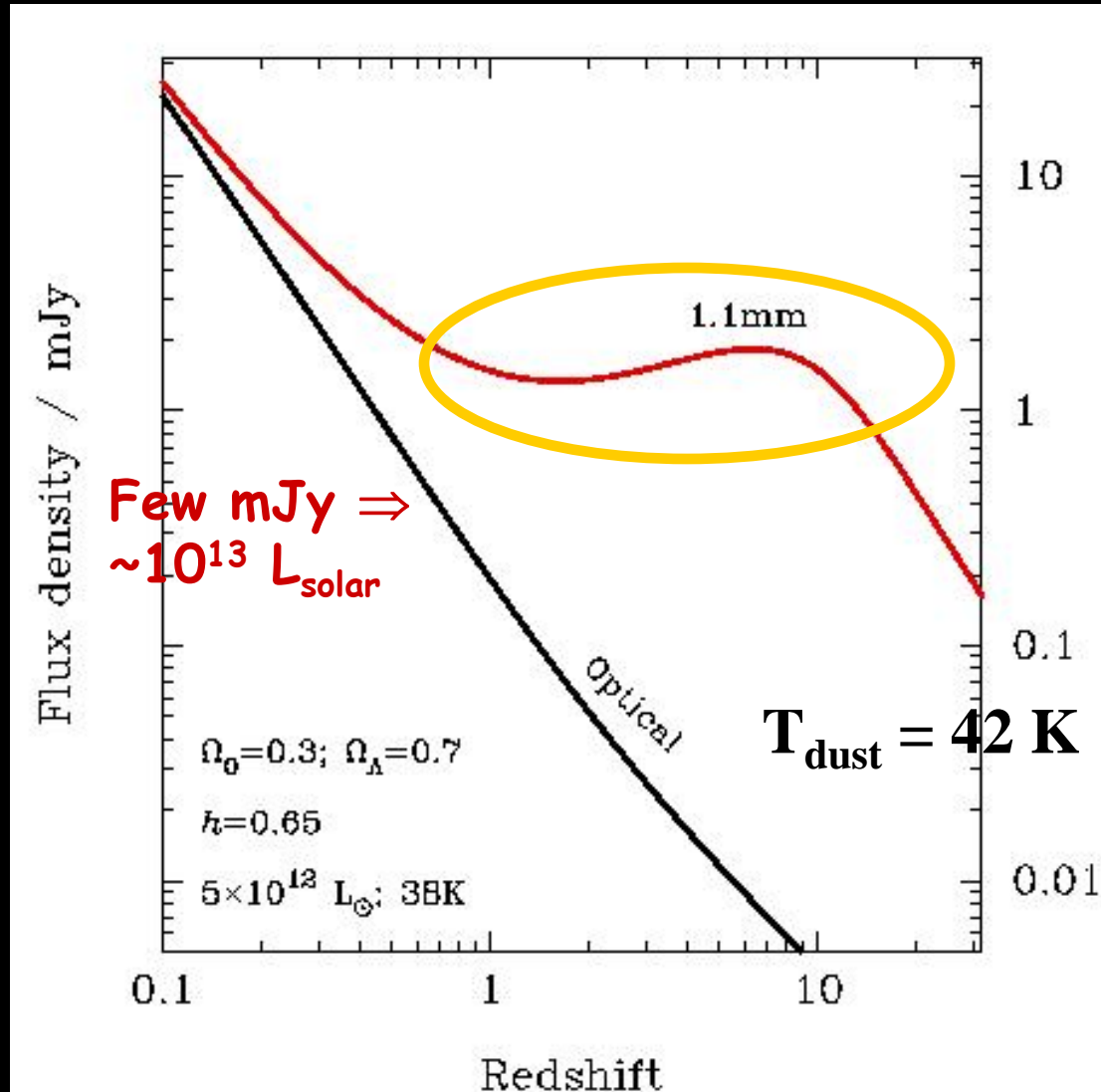
Caltech Submilli-  
meter Observatory:  
350  $\mu\text{m}$

NGC 4038/4039

- Starburst triggered as galaxies collide
- Star formation obscured in the visible, brighter in the mid-infrared, completely revealed in the submillimeter

# Submillimeter Galaxies as High-z Probes

For  $I_{\nu} \propto \nu^{3.5}$ , flux density is (nearly) independent of redshift

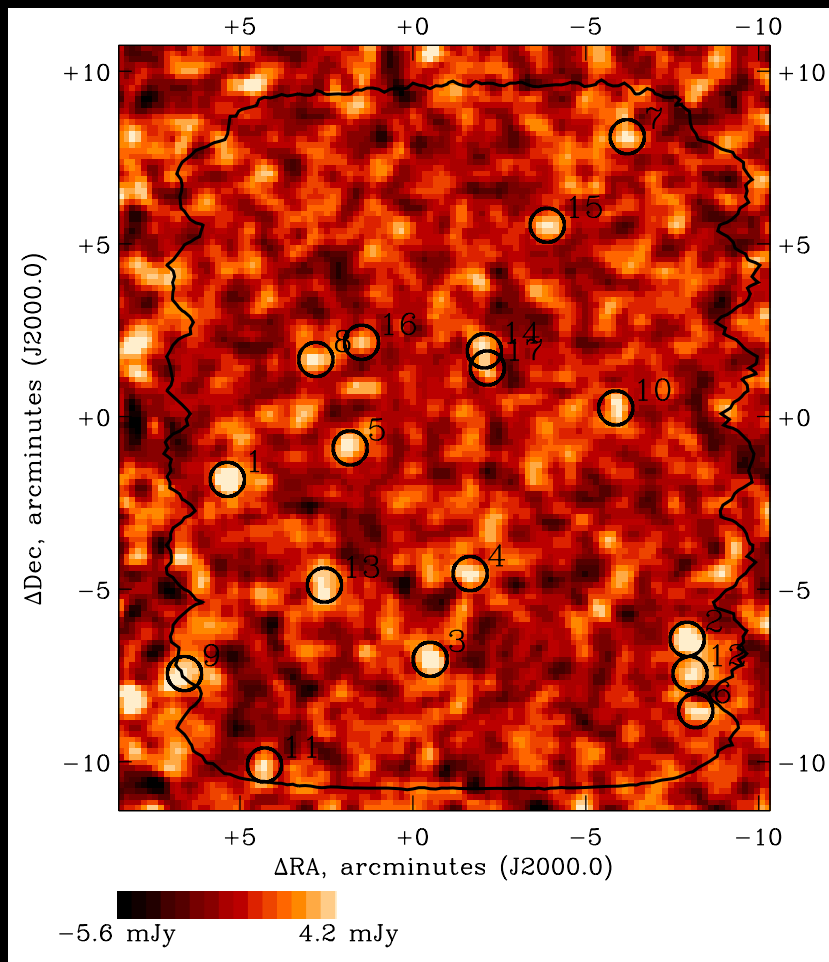


## CCAT

- Catalog of 100,000s of galaxies
- Sensitivity to the highest redshifts
- Resolve the bulk of the CFIRB into galaxies
- Complete FIR SEDs
- *Excellent source catalogs for ALMA*

Adapted from  
A. Blain

# Bolocam 1.1 mm Observations of the Lockman Hole



## Results

- $N(S) \propto S^{-\delta}$ ;  $\delta = 2.7 + 0.18 / -0.15$
- SHADES:  $\delta = 2.7 \pm 0.2$  mJy @ 850  $\mu\text{m}$
- Resolved  $\sim 10\%$  of background
- Need
  - Large surveys
  - Better angular resolution
  - Deeper surveys
  - **CCAT + ALMA**

Laurent et al. (2005)  
Maloney et al. (2005)

University of Colorado, Caltech, JPL, Cardiff

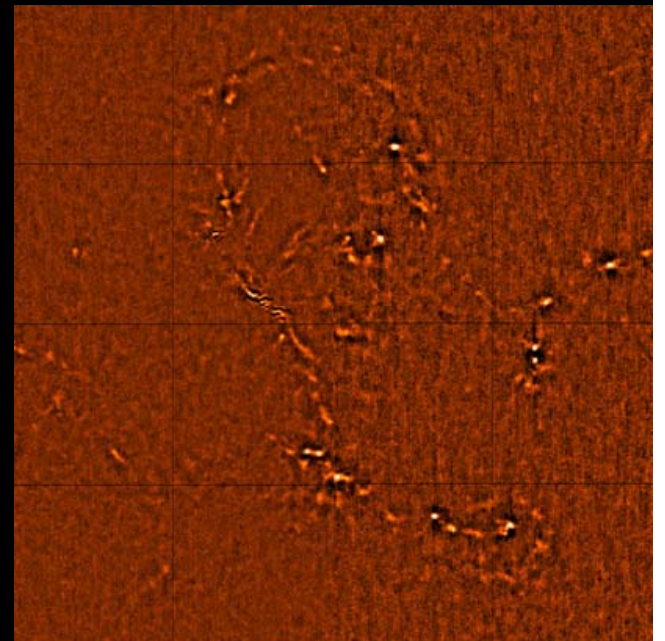
# *A Taste of CCAT: Bolocam CSO Galactic Plane Survey*



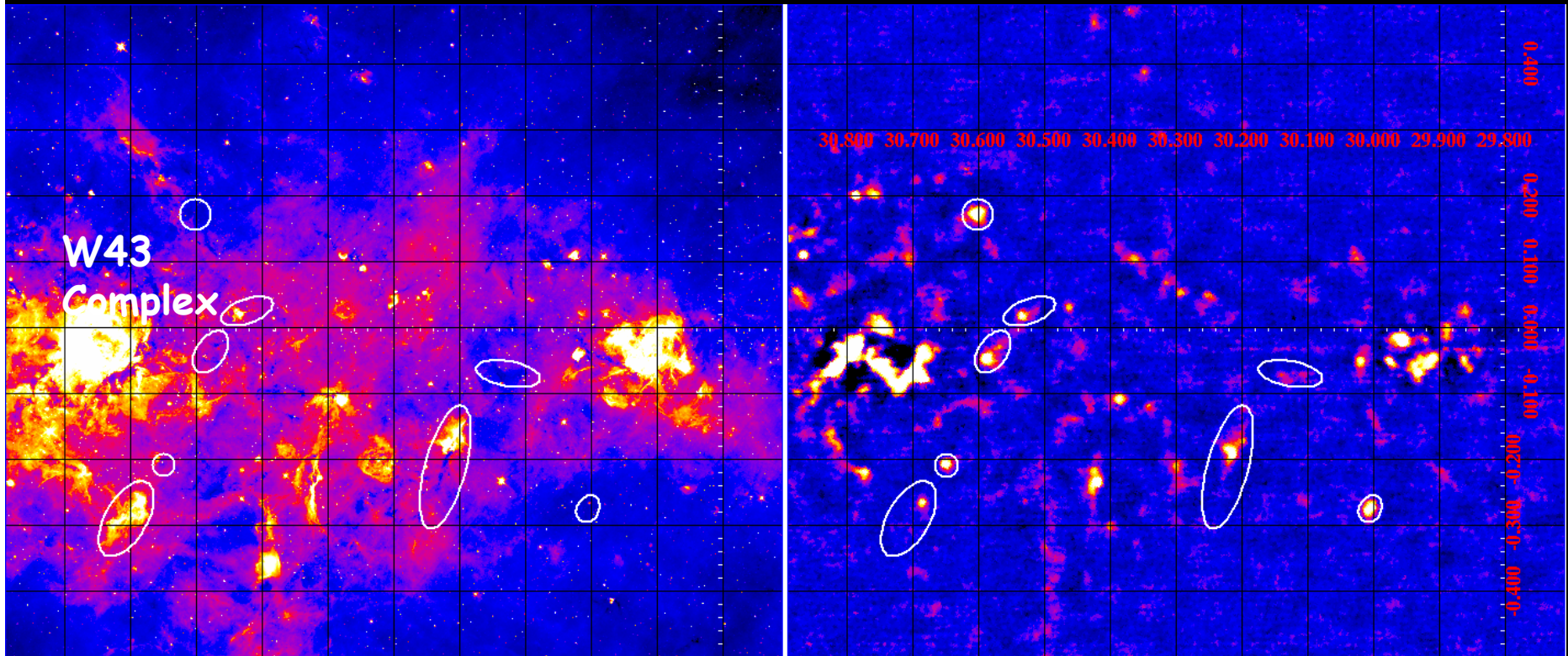
Structures  
coherent over  $2^\circ$ !!

To understand star formation on Galactic scales (e.g., cloud collapse and triggering) will require large maps and cross correlation across wavebands

Colorado, Caltech, Texas, Hawaii



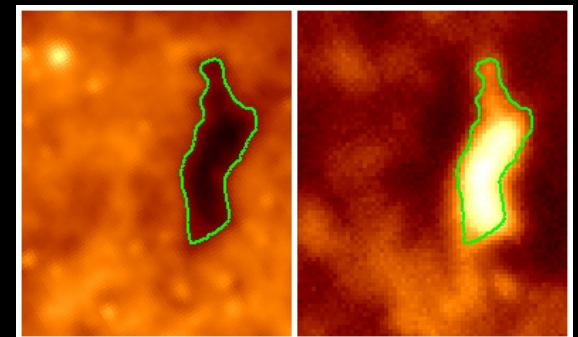
# Multiwavelength Comparison



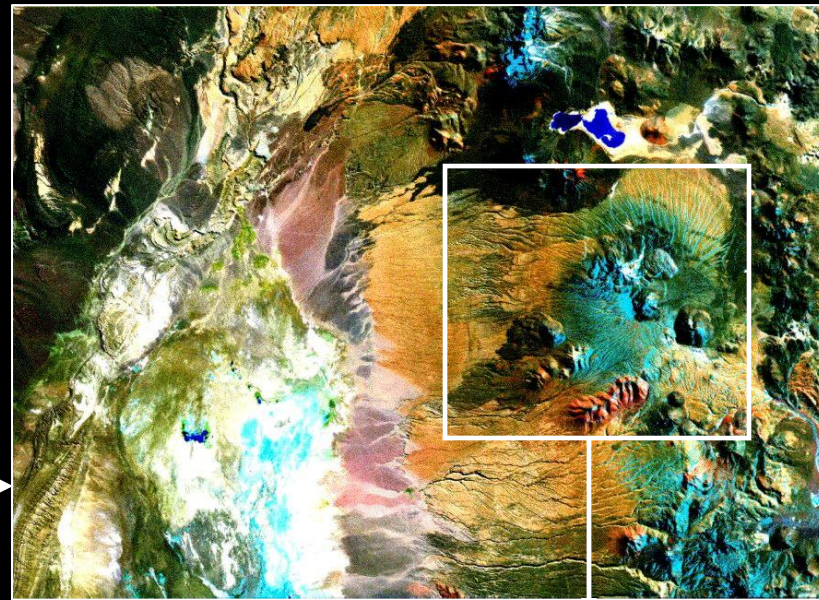
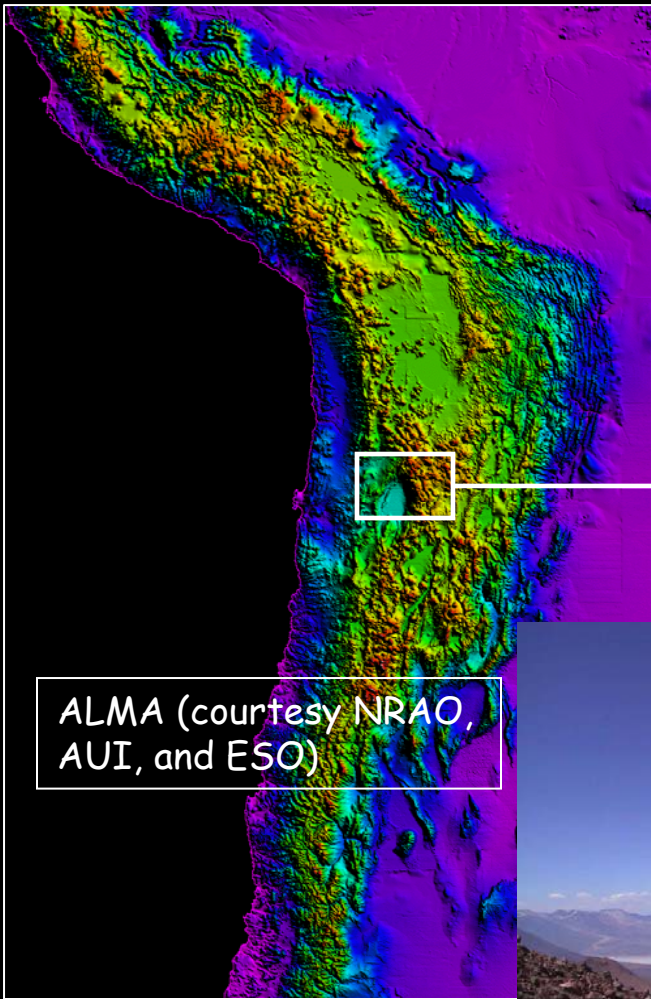
**Above:** Bolocam map (right) of the l=30 region with the 8  $\mu$ m Spitzer-GLIMPSE map (left).

**Right:** InfraRed Dark Cloud (IRDC) in the Galactic center region; MSX Band A image (Left) and Bolocam 1.1 mm image. (Right)

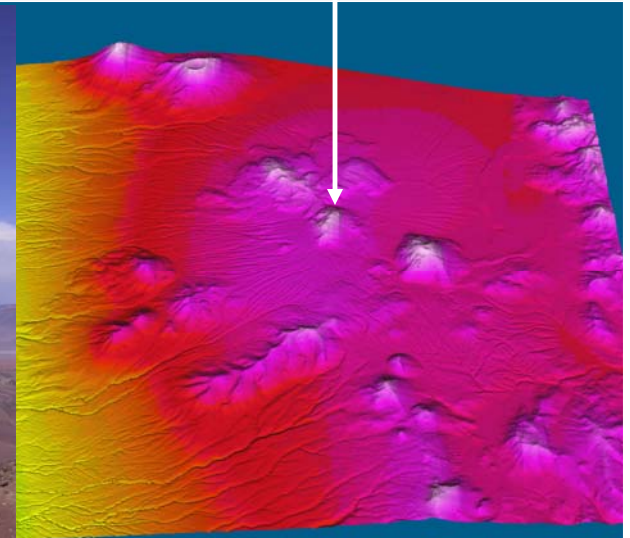
**CCAT: Deeper flux-limited surveys**  
**Break up cores**



# *CCAT Site: In the Atacama Desert, 500 meters above the ALMA Plateau*



Cerro Chajnantor  
(18,400 ft)

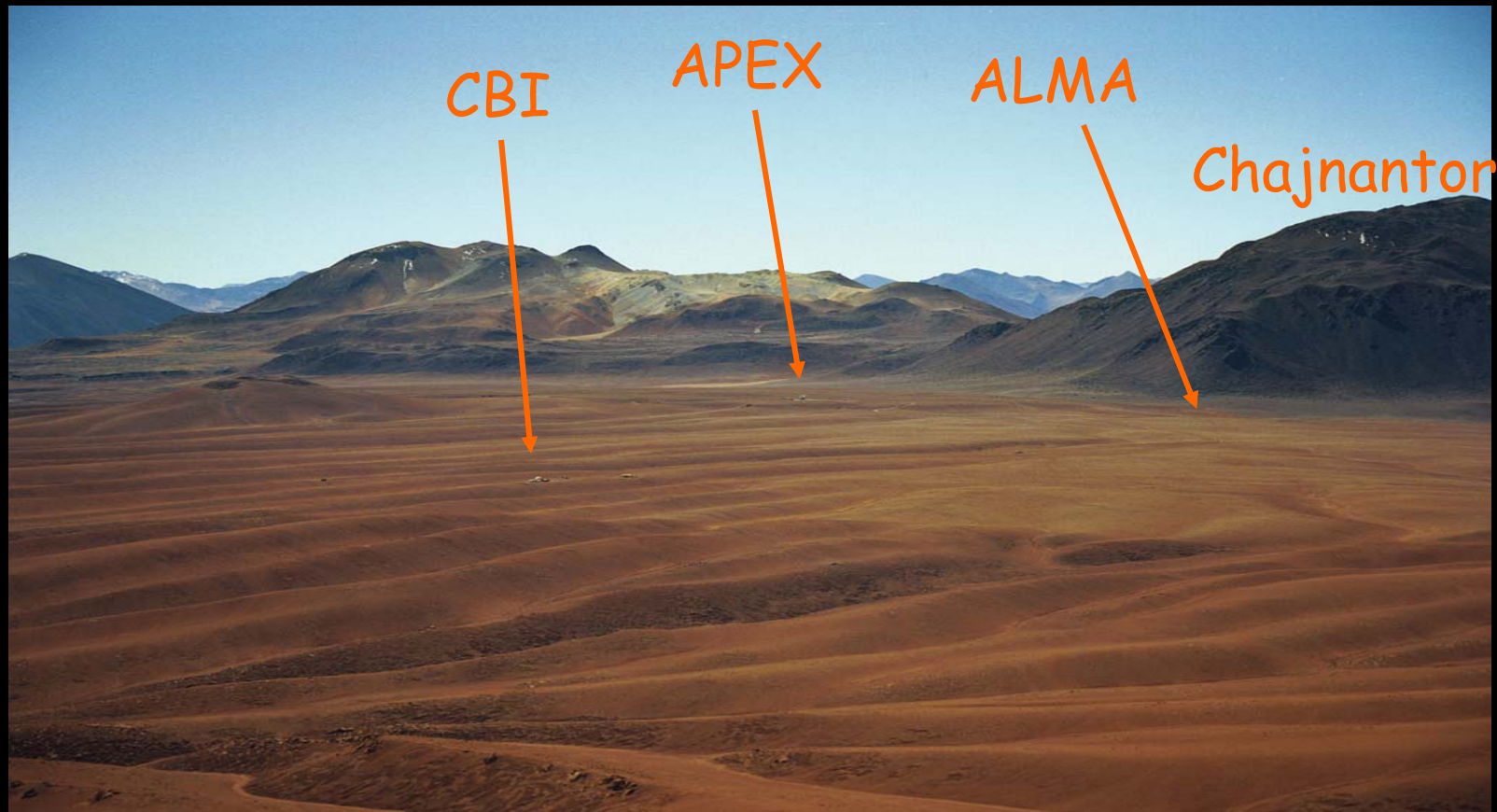




# Site: Chile, Above Chajnantor Plateau

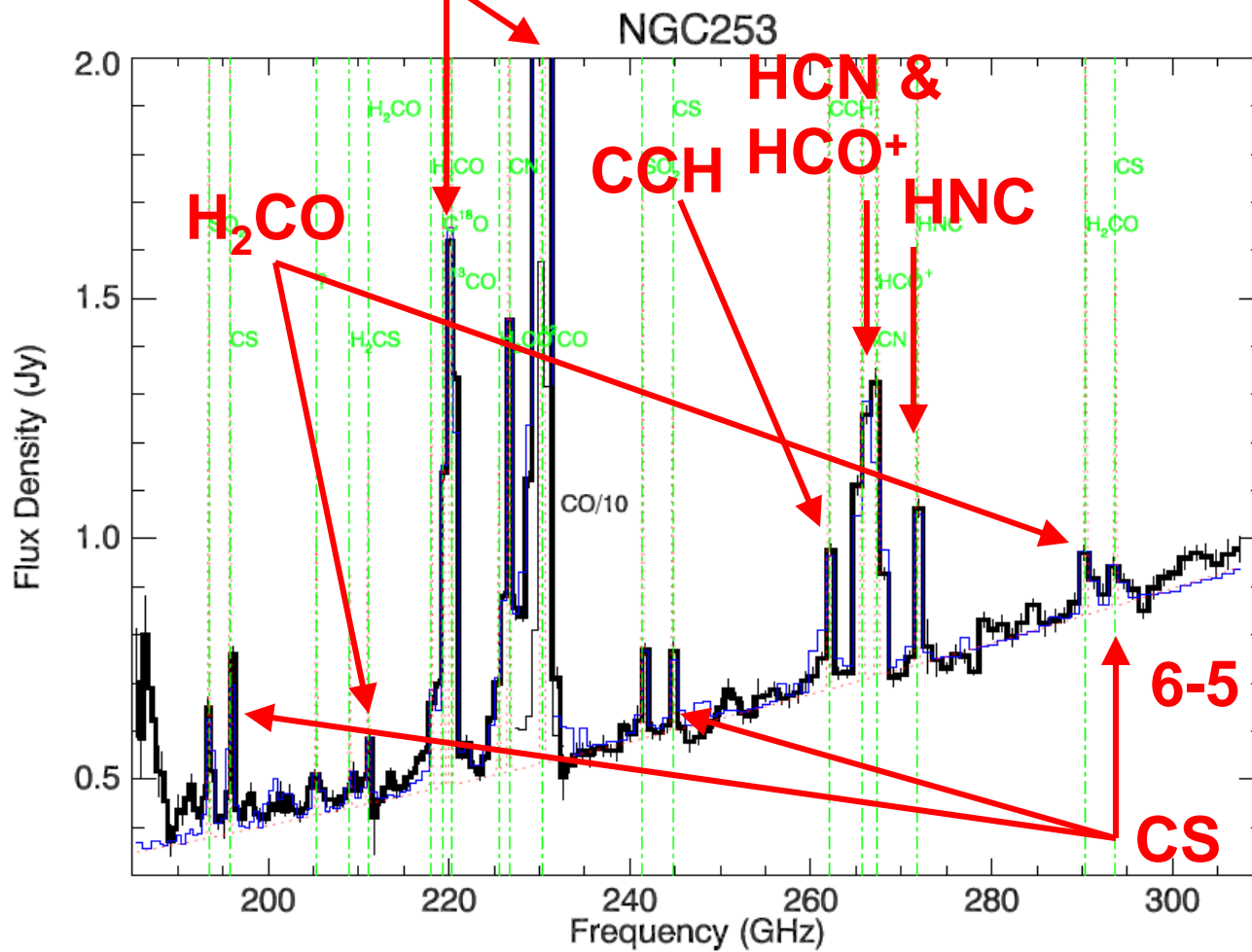
5,600 m: Superb atmospheric transmission

Proximity to facilities - notably ALMA



# Z-Spec NGC 253

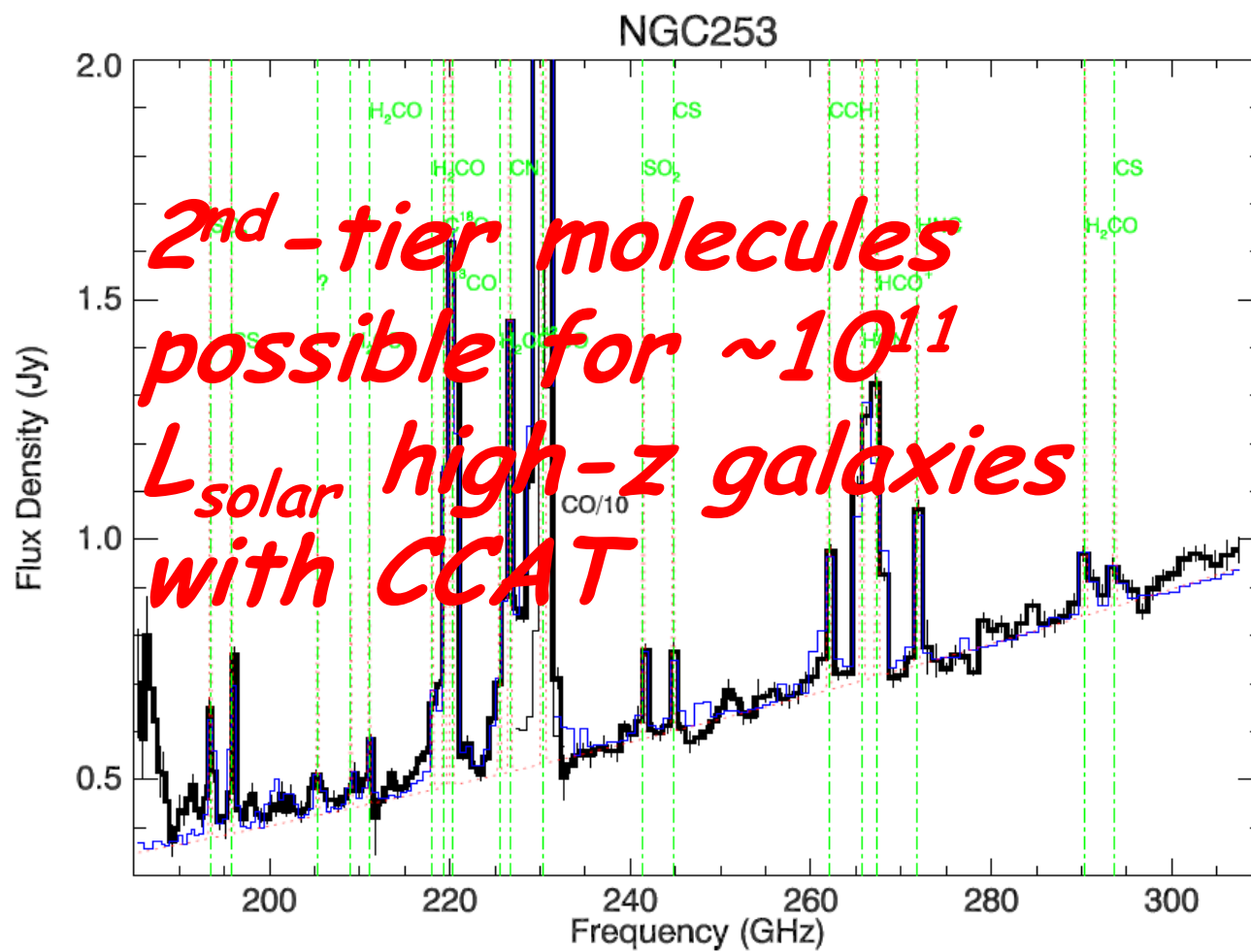
CO



- Cryogenic waveguide-coupled grating
- Bolometer array
- Next: Flexible waveguides  $\Rightarrow$  reconfigurable MOS

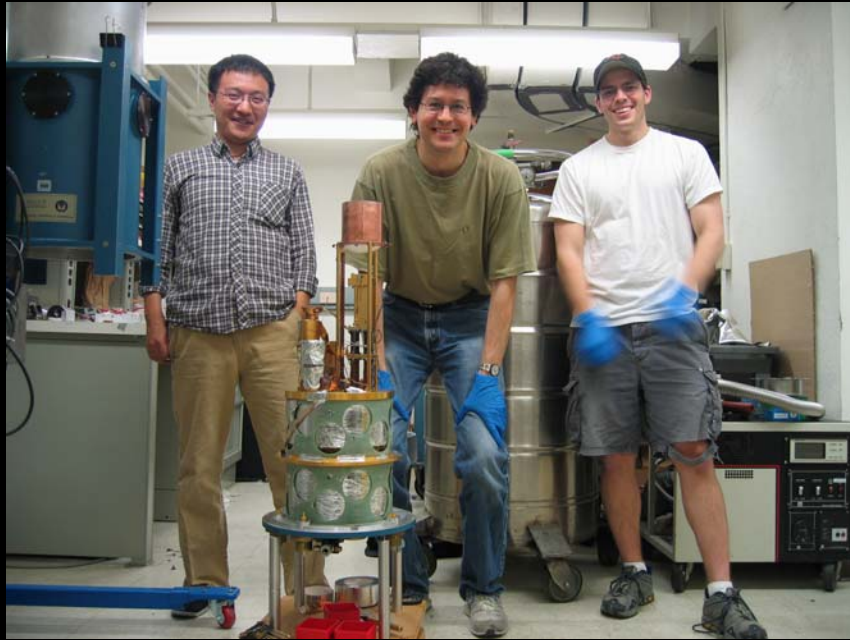
Colorado, Caltech, JPL, Cardiff

# Z-Spec NGC 253



Colorado, Caltech, JPL, Cardiff

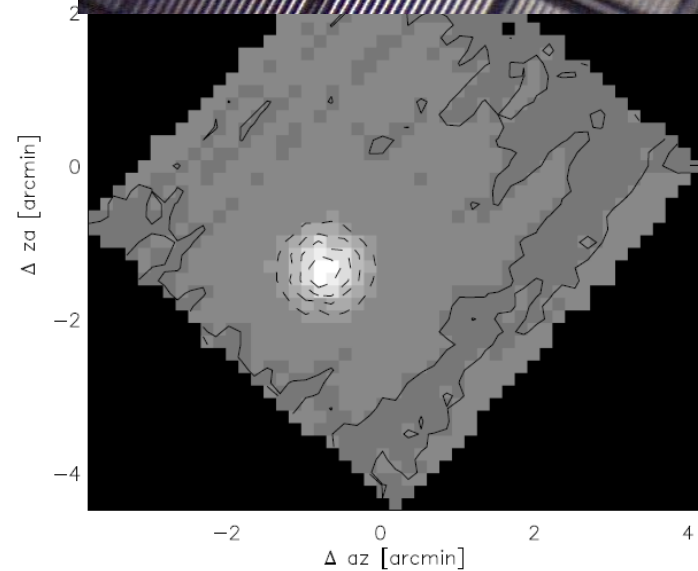
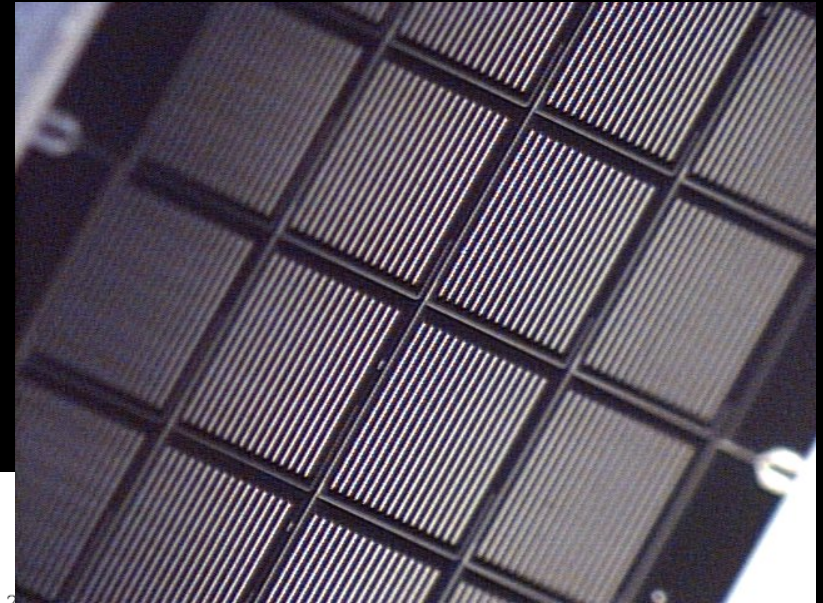
# Detector Technology: Multicolor "MKID" Camera Microwave Kinetic Inductance Detectors



Prototype camera (Caltech  
Submillimeter Observatory)

- 592 pixels
- Each 4 colors (750  $\mu\text{m}$ , 850  $\mu\text{m}$ , 1.1 mm, 1.3 mm)

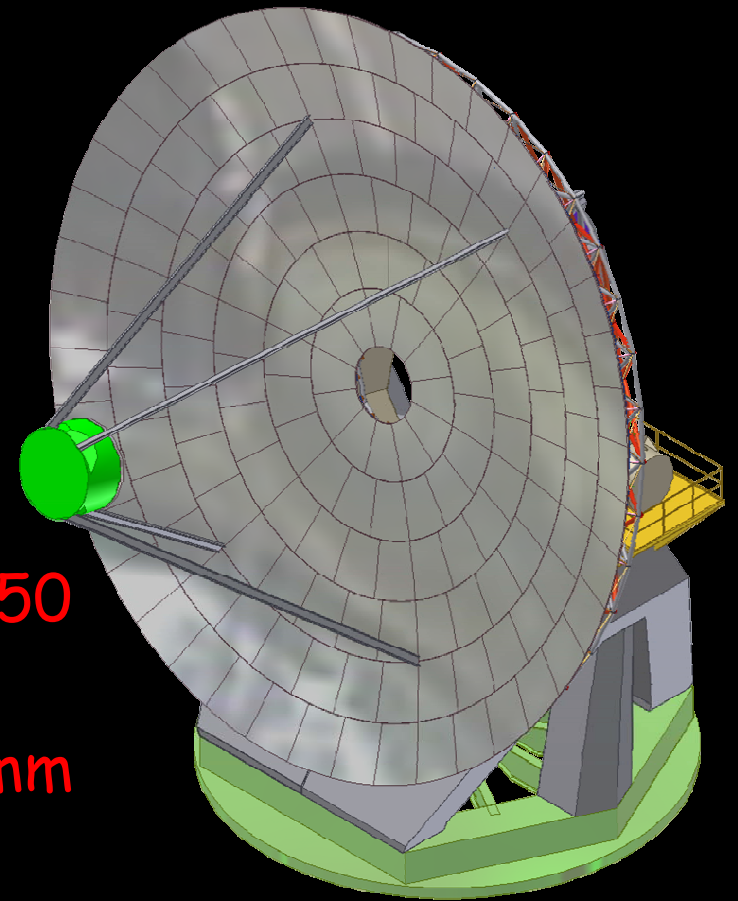
Colorado, Caltech, JPL



Jupiter!

# CCAT Specifications

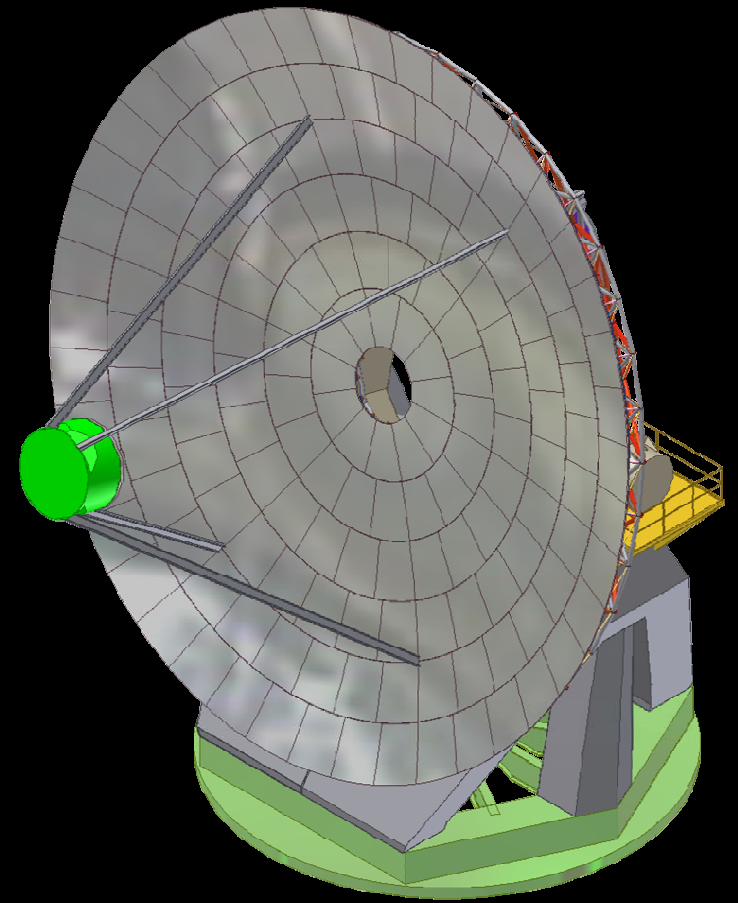
- 25-m diameter
  - ⇒ 3" beams @ 300  $\mu\text{m}$
- 20' FOV
- Active open-loop surface
- Instrumentation
  - Short-wave camera: 200  $\mu\text{m}$  - 750  $\mu\text{m}$
  - Long-wave camera: 850  $\mu\text{m}$  - 2 mm
  - Heterodyne receivers
  - Multiobject spectrograph
- Schedule
  - Detailed engineering design commencing
  - Construction begins 2009
  - Commissioning 2013



Vertex Antenna Design

# CCAT Partnership

- Still forming
- Initial partners
  - U.S.: Cornell University, Caltech, University of Colorado
  - UK: Astronomy Technology Centre
  - Canada: University of Waterloo, University of British Columbia
  - Potentially Germany: University of Cologne
- Interested in discussions with more potential partners
- Fundraising still underway:
  - Expected cost \$100M (700 million 元 )



# Student Training and Exchange



## CCAT Spectroscopy Workshop

May 13-14,  
Boulder

University of Colorado at Boulder

