# CCAT

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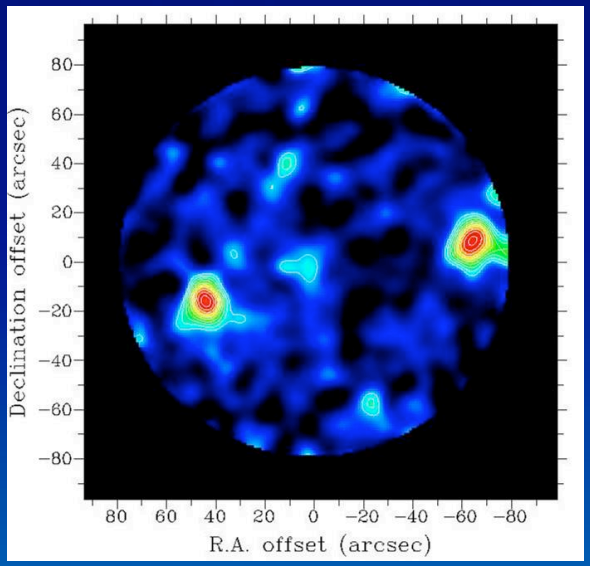
CCAT Project

Presented by Ian Robson
UK ATC

# Why CCAT ?

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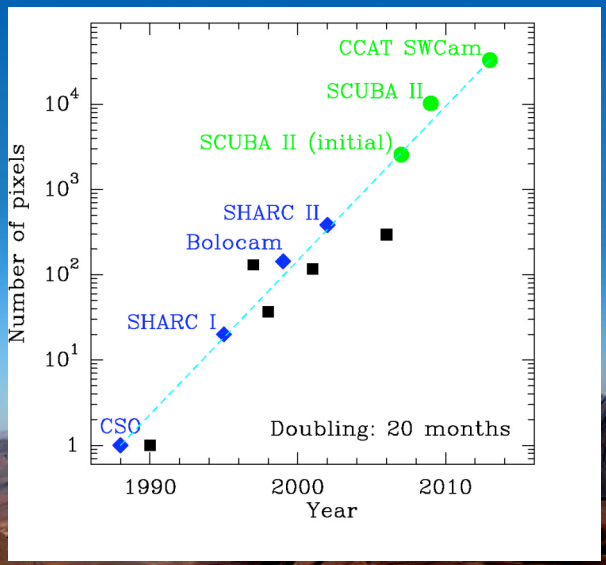


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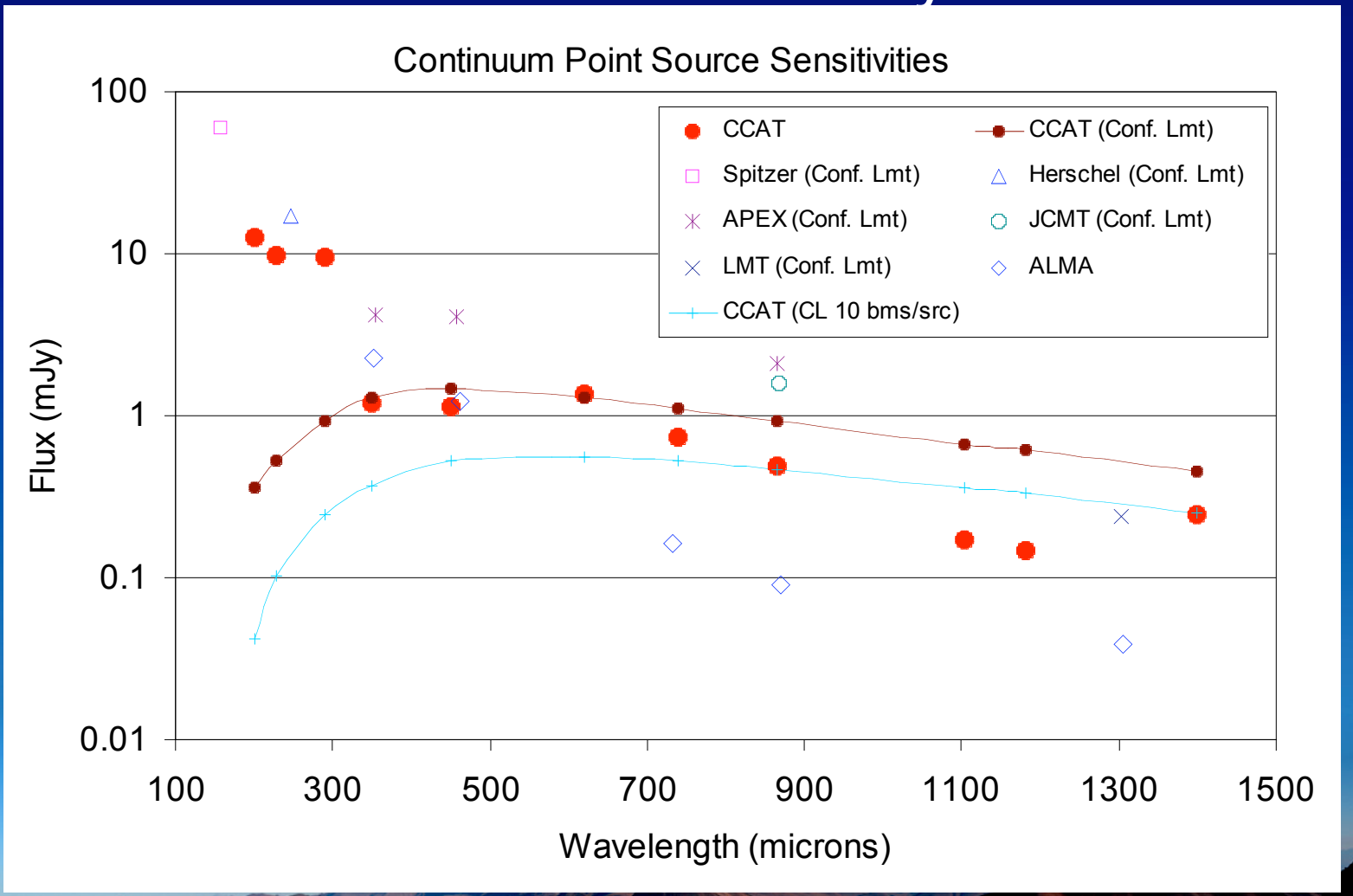
CCAT
25 m, 10 μm rms
Cerro Chajnantor

# CCAT Overview

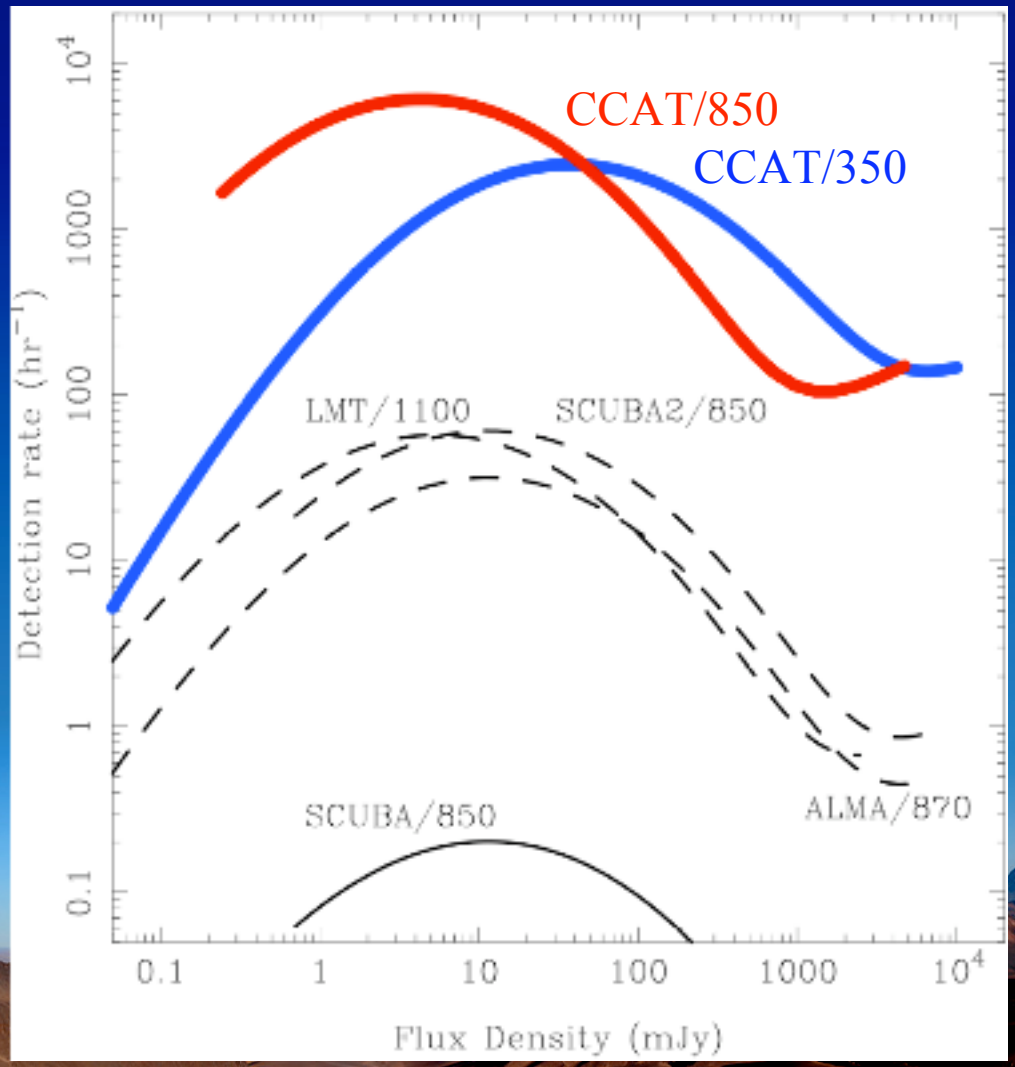
- Big: 25 m diameter submm telescope
  - high aperture efficiency at 200 μm
  - 3.5″ at 350 μm
- Wide Field-of-View > 15′
  - large format bolometer array cameras
- High, very dry, low latitude, mountain site
  - 5600 m, median PVW < 1 mm
  - wide sky coverage
- Complement ALMA
  - Fast continuum multicolour mapping

# CCAT Sensitivity




Continuum sensitivities of CCAT and other instruments (5 $\sigma$ in 1 hour) with confusion limits (30 beams source$^{-1}$). CCAT sensitivities computed for precipitable water vapor appropriate to that band.

# Submm Galaxy Detection Rate

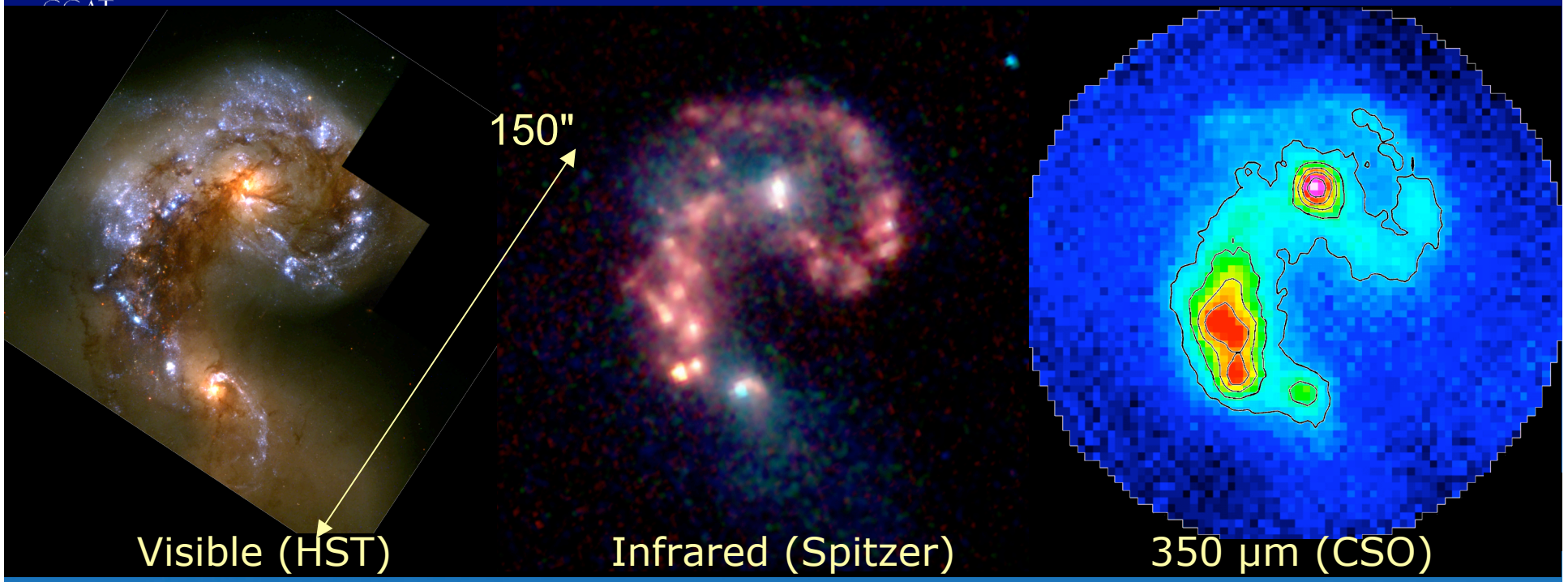



- CCAT is an ultrafast mapper
- Assumptions
  - 32 x 32 (1024) pixel detector, Nyquist sampled, 350 μm & 850 μm
  - Observationally verified counts (good to factor 2)
  - Confusion and all sky limits
- 350 μm & 850 μm detection rates are compatible,
- Detection rates:
  - ~150 × SCUBA2; ~300 × ALMA
  - About 100-6000 per hour
  - Lifetime detection of order $10^{7\text{-}8}$ galaxies: ~1% of ALL galaxies!
- '1/3 sky survey': ~1000 deg$^2$ at 3 deg$^2$ hr$^{-1}$ in 5000 hr

# Distant Submm Galaxy Surveys

- CCAT Detection Rate Will Provide Huge Samples
  - Find rare distant red objects; i. e., opt/IR (or 350 μm) dropouts
  - Address clustering properties of submm galaxies
  - Map large-scale structure, high density regions
  - Measure submm galaxy luminosity function
- CCAT Confusion Limit Fainter than Other Large Surveys
  - Higher precision number counts
  - Are faint submm galaxies more quiescent ?
- Surveys Guide Detailed Follow-on Studies with ALMA
  - CCAT will provide accurate positions

# Nearby Interacting Galaxies




Images of the Antennae show the submillimeter reveals active star formation regions hidden at shorter wavelengths. The bulk of the luminosity emerges in the submillimeter. CCAT will provide a submillimeter image with a spatial resolution similar to the infrared image. Mapping this galaxy would require hundreds of pointings with ALMA. With CCAT's high mapping speed and sensitivity, a complete survey of all galaxies in the local volume would be practical.

# CCAT Galactic Plane Survey

- Measure the Galaxy-wide star formation rate and history
- Obtain the complete inventory of cold dust in the Galactic Plane
- Determine the relative importance of global and local triggers for star formation
- Provide templates, recipes and prescriptions for Xgal science

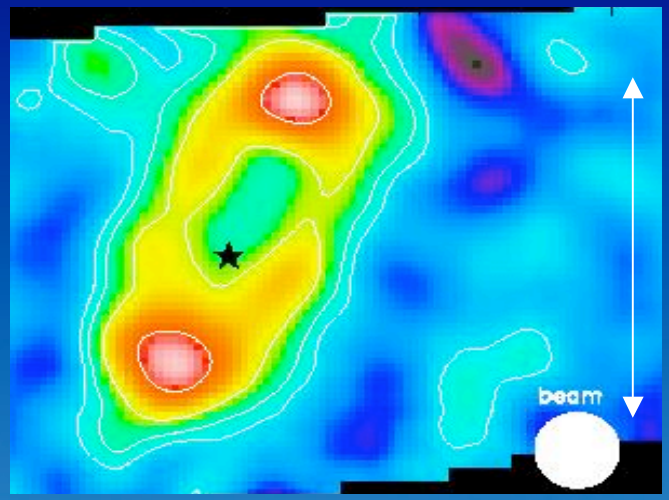
- CCAT mapping speed (0.9 deg$^2$ hr$^{-1}$) and sensitivity (8.5 mJy) enable:
  - a complete survey of the “inner” Galactic Plane
  - detect *all* star forming regions (i. e., cool dust - 1 $M_o$ at 20 kpc )
  - not just massive star regions (i. e., warm or hot dust)

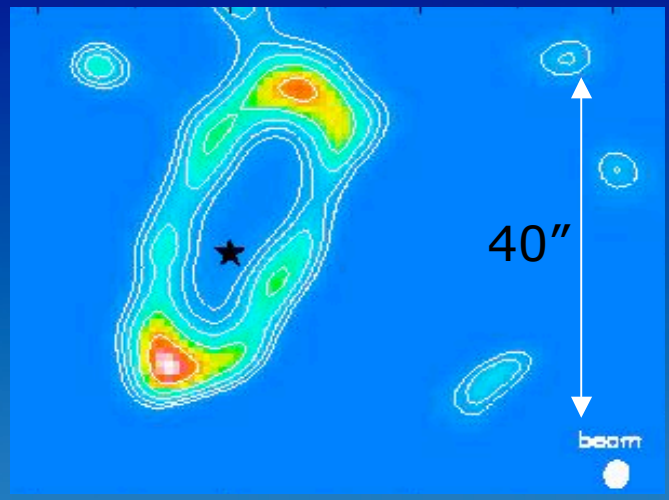
# Debris Disks

CCAT objective: high-quality images of statistical sample of nearby disk systems

- surveys for undiscovered cold disks (T < 40 K) around nearby stars
- important data points on spectral energy distribution
- unbiased surveys for disks in stellar clusters

CSO/SHARC II Marsh et al. 2005




Images of Fomalhaut debris disk at 350 μm. The observed image (*left*), with 10″ resolution, shows a complete debris ring encircling the star. With enhanced (3″) resolution (*right*), we can infer the presence of a planet due to the asymmetry of the ring. CCAT will achieve this resolution intrinsically and be capable of 1″ resolution with image enhancement techniques. CCAT imaging will measure the entire flux and should show substructure pinpointing the location of the planet. Imaging this system would require dozens of ACA pointings. Ability to do dynamics of the 'blobs' as they rotate around the star.

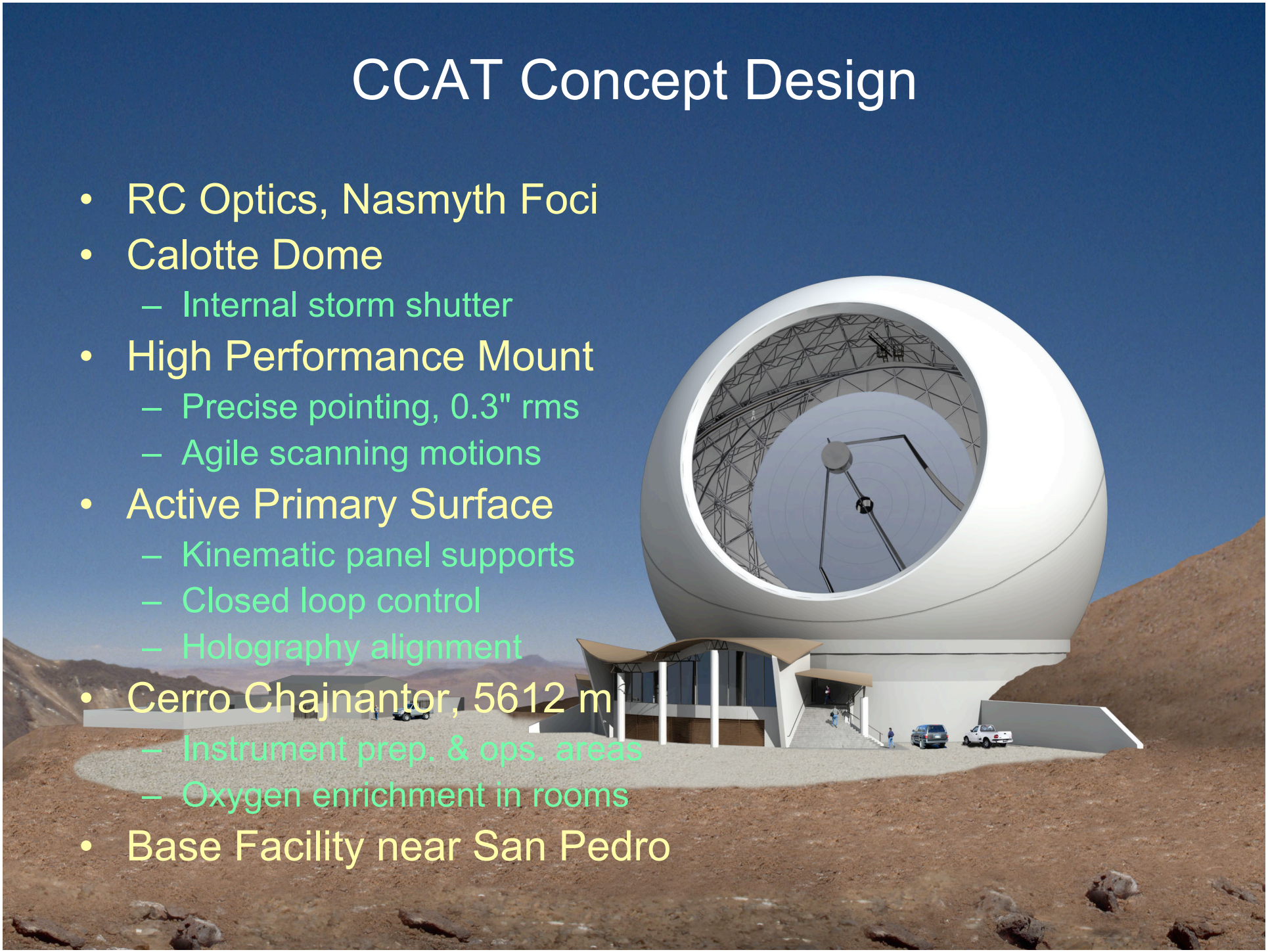
# CCAT Technical Goals

| | Requirement | Goal | remark |
|---|---|---|---|
| Wavelength | 350–1400μm | 200–2500μm | |
| Aperture | 25 m | | |
| Field of view | 10' | 20' | |
| Half WFE | < 12.5 μm | < 9.5 μm | rms |
| Site condns. | < 1.0 mm | < 0.7 mm | median pwv |

These Goals and Advanced Bolometer Arrays Will Make CCAT a Revolutionary New Observatory

# CCAT Concept Design

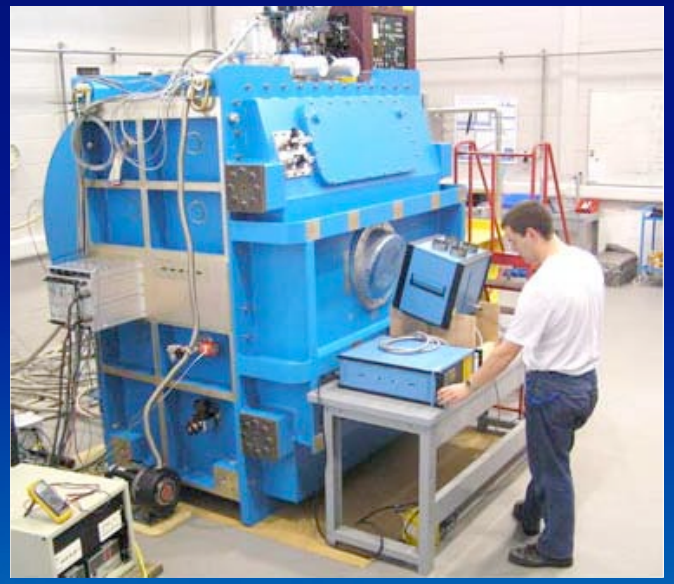
- RC Optics, Nasmyth Foci
- Calotte Dome
  - Internal storm shutter
- High Performance Mount
  - Precise pointing, 0.3" rms
  - Agile scanning motions
- Active Primary Surface
  - Kinematic panel supports
  - Closed loop control
  - Holography alignment
- Cerro Chajnantor, 5612 m
  - Instrument prep. & ops. areas
  - Oxygen enrichment in rooms
- Base Facility near San Pedro



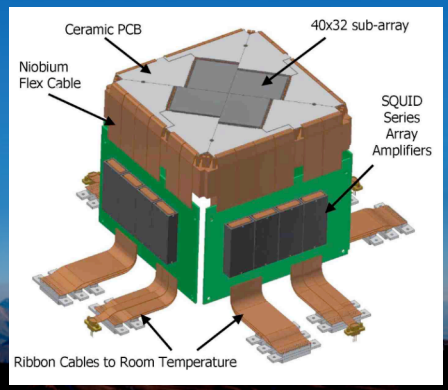
# CCAT Instruments

- Direct Illumination Cameras
  - SCUBA-2: 450 & 850 μm
  - SWCam: 200–620 μm
- Antenna Coupled Camera
  - LWCam: 700–2000 μm
- Spectrometers
  - Multiobject gratings
- Heterodyne Receivers
  - Array cameras
  - ALMA receiver, connect to ALMA, VLBI
- Legacy Instrumentation

# Direct Illumination Cameras



- SCUBA-2 (UK)
  - To JCMT next month
  - On CCAT, would be:
    - Proven first light instrument
    - 5' FoV
- CCAT SW Camera (concept)
  - 200 μm, 350 μm, 450 μm, 620 μm
  - Single color with filter wheel
  - NIST TES silicon bolometers
  - Total: 32 000 pixels
  - 5' field of view @ 350 μm



# Consortium

- Caltech
  - Includes JPL involvement
- Cornell University
- University of Colorado Boulder
- UK (STFC)
- Canada (Univs. of BC & Waterloo)
- Other Institutions Interested

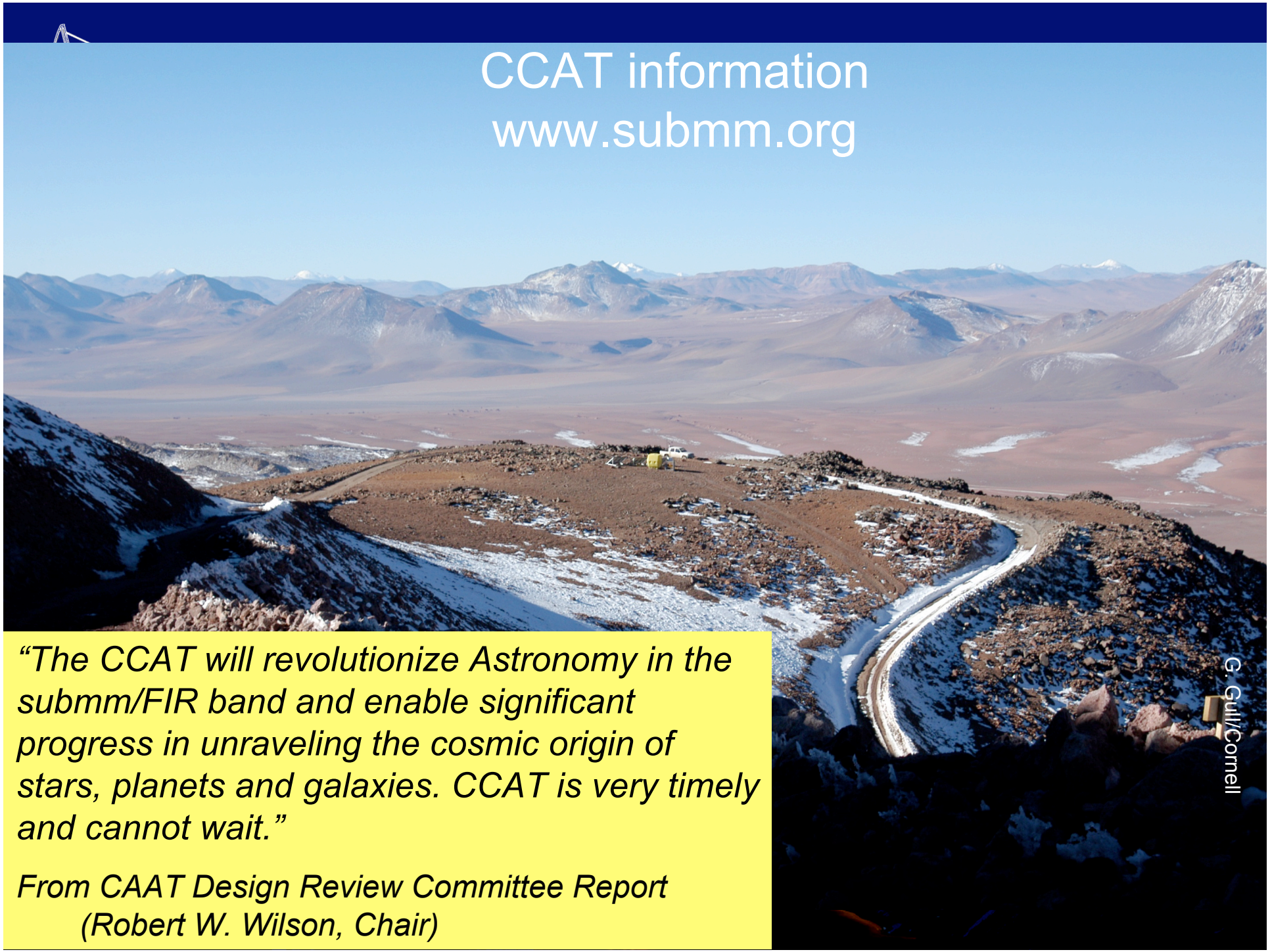
Interim Consortium Agreement Signed in 2007

Full Project Agreement planned in 2008

# Project Phases and Schedule

- Feasibility/Concept Design Study
  - 2004 – 2006
  - Cornell, Caltech, & JPL: Develop Baseline Concept, Assess Feasibility, Initial Cost Estimate
- Consortium Development Phase
  - 2006 – 2008
  - Complete Consortium, Identify & Secure Funding
  - Address Key Technical Issues
- Technical Development Phase
  - 2008 – 2011
  - Detailed Design, Manufacture, Integration
- Commissioning Phase
  - 2012 - 2013
  - Optimize Performance & Handover to Operations

# CCAT information
# www.submm.org




*"The CCAT will revolutionize Astronomy in the submm/FIR band and enable significant progress in unraveling the cosmic origin of stars, planets and galaxies. CCAT is very timely and cannot wait."*

*From CAAT Design Review Committee Report*
*(Robert W. Wilson, Chair)*