



# Coordinated Instruments for Source Detection and Characterization

Grant Wilson  
University of Massachusetts

From Z-Machines to Alma  
1/14/06

# LMT/GTM

- 50m dia.
- 70 $\mu$ m rms surface
- 15000 ft alt
- Sierra Negra, MX

A Collaboration between

The University of  
Massachusetts at Amherst

and

Instituto Nacional de  
Astrofísica, Óptica,  
y Electrónica (INAOE)



# LMT 1<sup>st</sup> Generation Continuum Instruments

- AzTEC (imaging)
  - 144 element bolometer array
  - 1.1mm, 1.4mm, **or** 2.1mm
  - Commissioned: June 2005 at JCMT
  - 2.5 months on sky: Nov. 2005 – Feb. 2006
- SPEED (photometry)
  - 2.1mm, 1.4mm, 1.1mm, **and** 850 $\mu$ m.
  - New bolometer technology
  - Commissioning: Fall 2006 at SMT

# AzTECs



## UMass

Grant Wilson (PI)  
Min Yun

Thushara Perera

Jay Austermann  
Kim Scott  
Ilsang Yoon

Cara Battersby  
Chris Roberts

## INAOE

David Hughes  
Itziar Aretxaga

## Caltech

James Bock  
Sunil Golwala

## Cardiff

Peter Ade  
Phil Maukopf

Douglas Haig  
Simon Doyle

## Sejong University

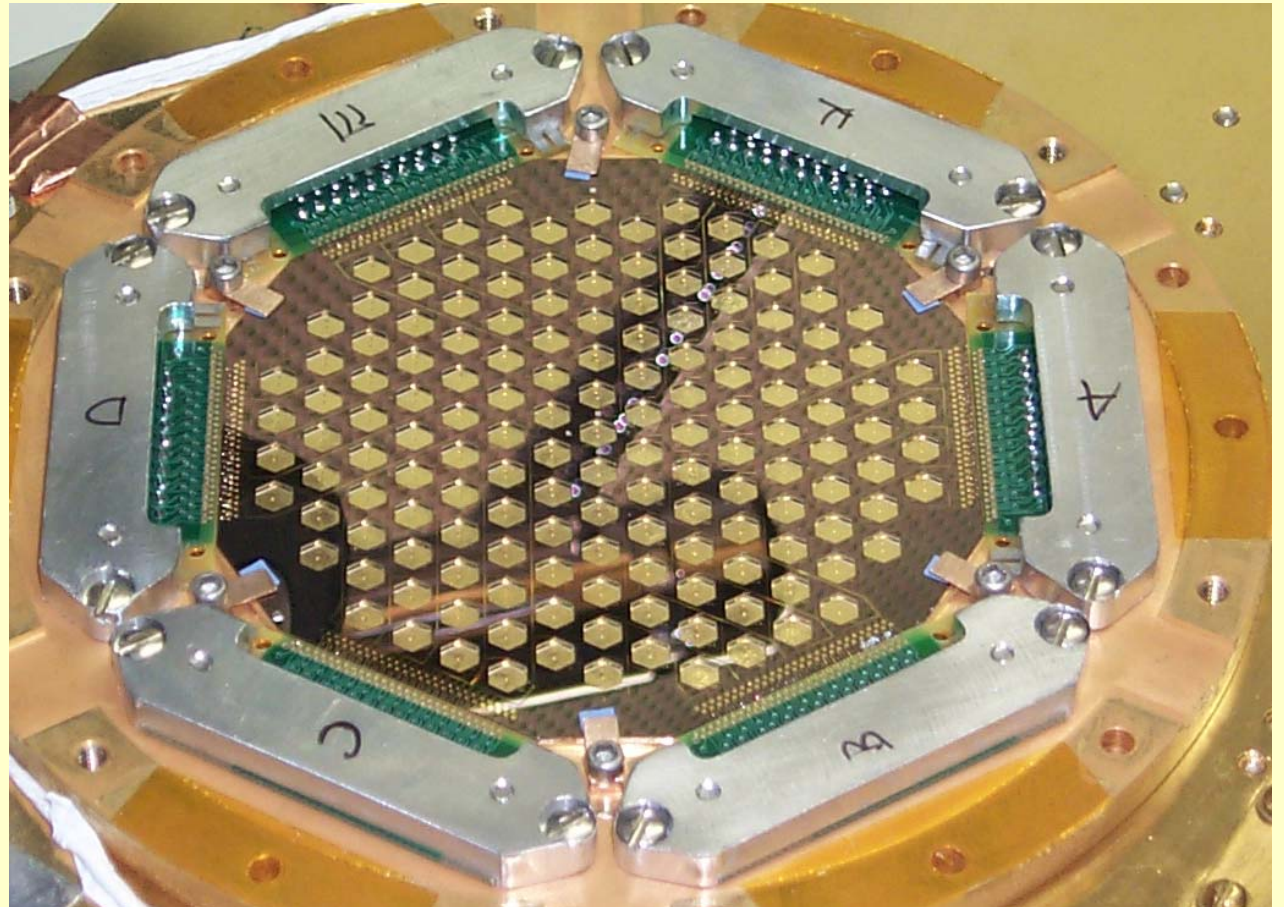
Young Woon Kang  
Sungeun Kim

## Smith College

James Lowenthal

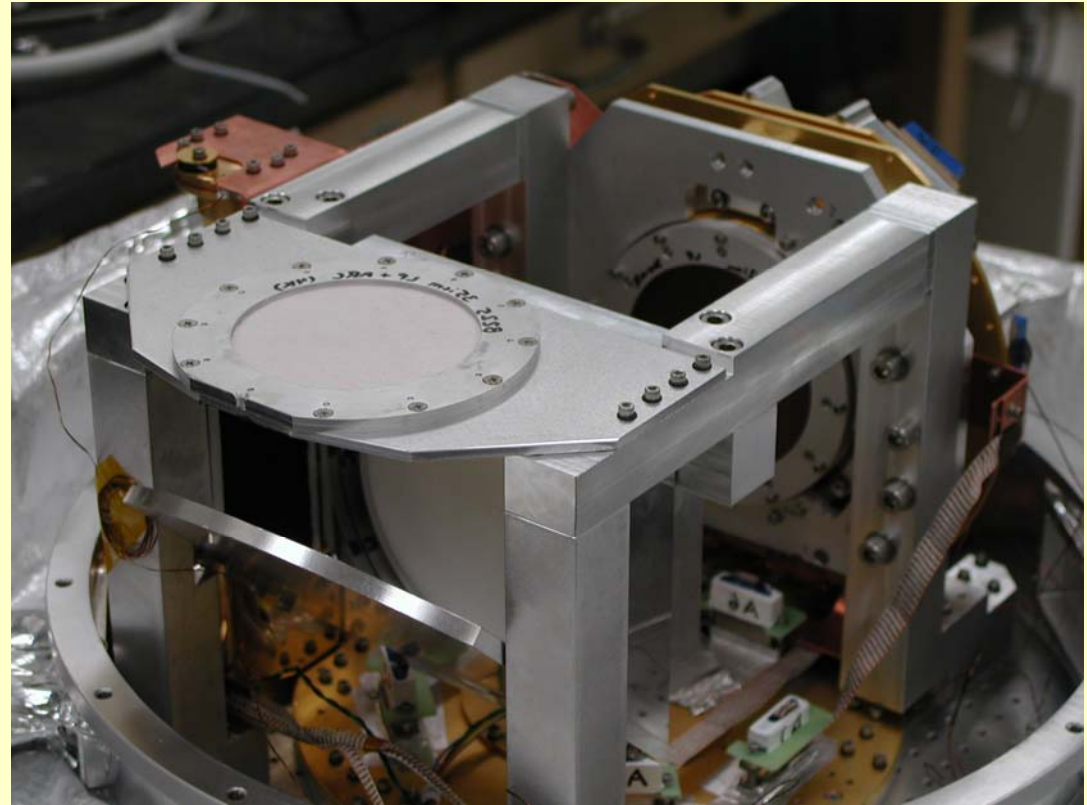
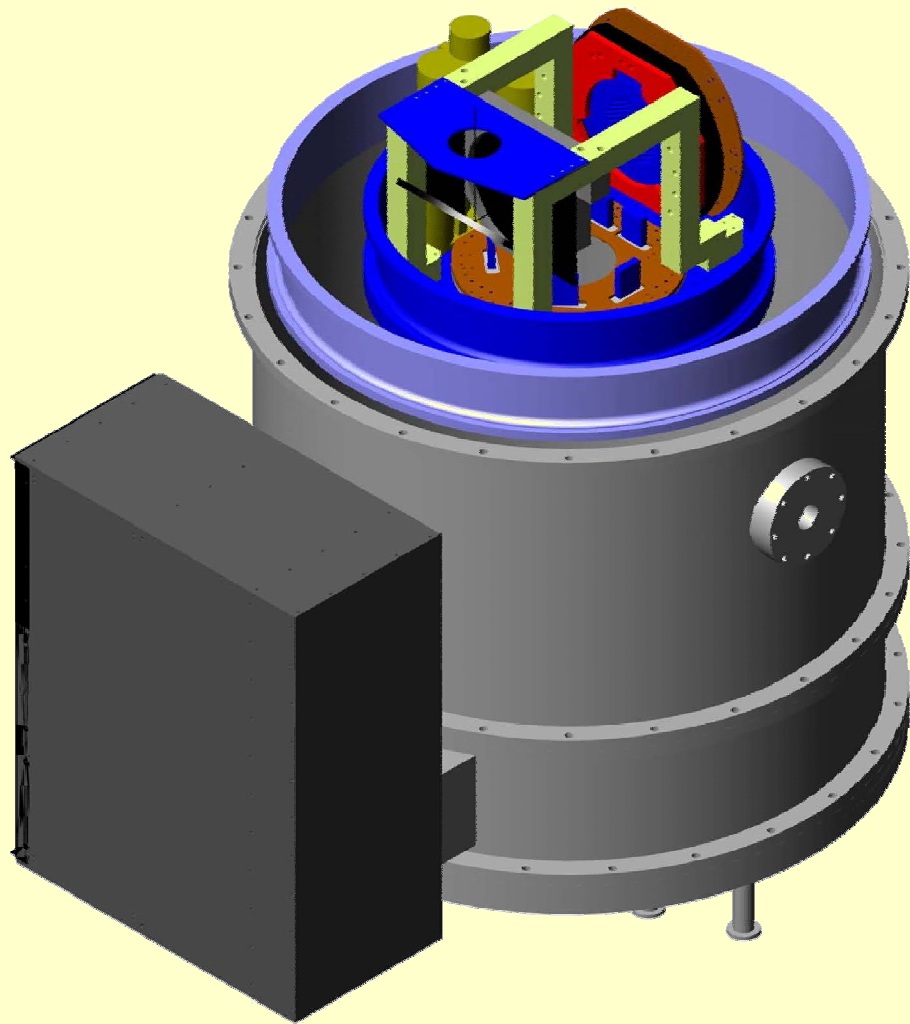
# The AzTEC Instrument

- 144 element bolometer array (designed for imaging)
- Detectors read out continuously at 64Hz.
- System designed to have good low freq. stability (AC biased)
- All commands and signals pass via fiber optics (low flux demands low systematics)



144 element spiderweb bolo array – S. Golwala

# AzTEC Internal Optics Layout



Folded optical design minimizes optical microphonic pickup and thermal gradients

# The AzTEC Instrument

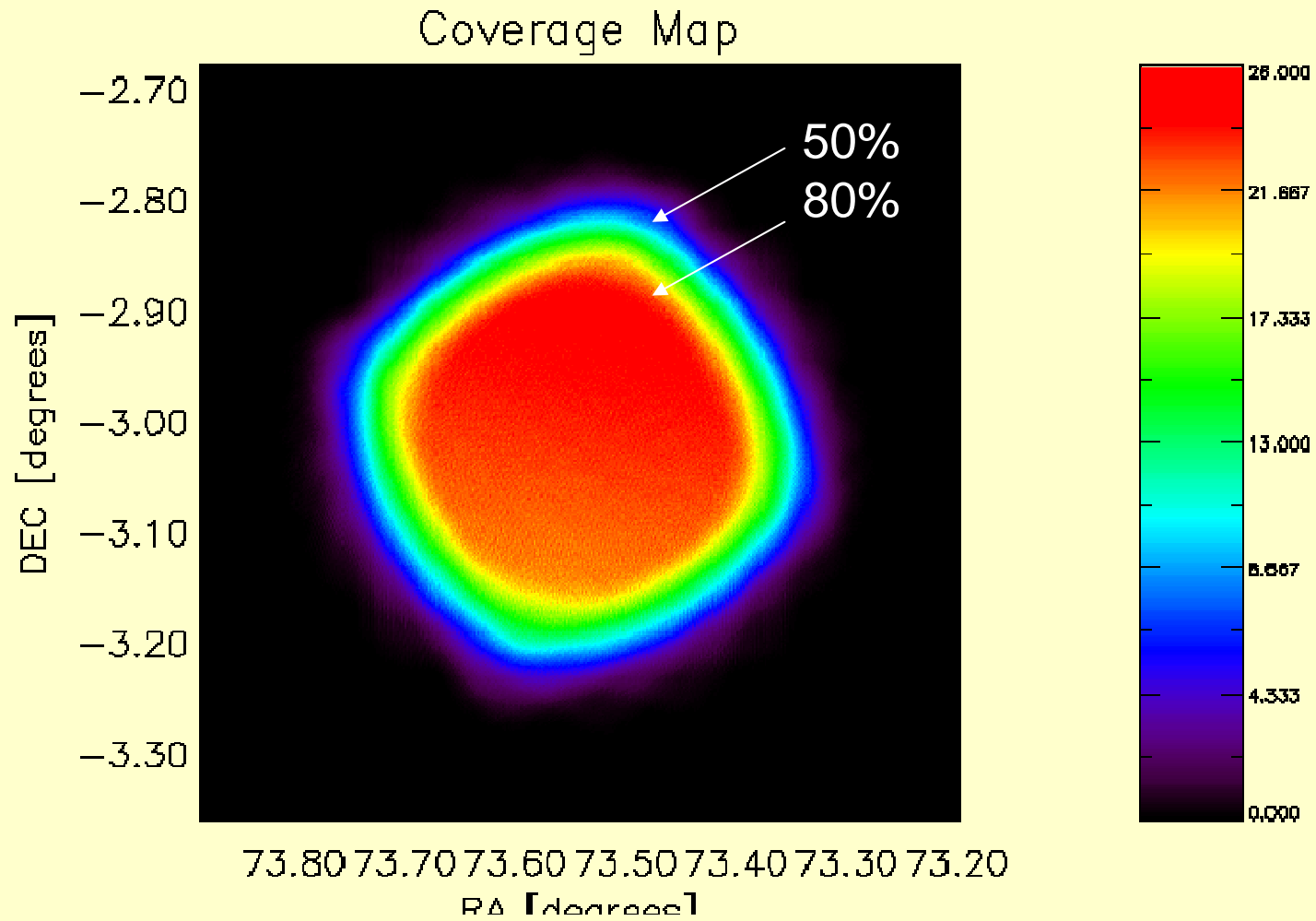
Pre-shipment checkout



Optics alignment at JCMT



# AzTEC Rastering

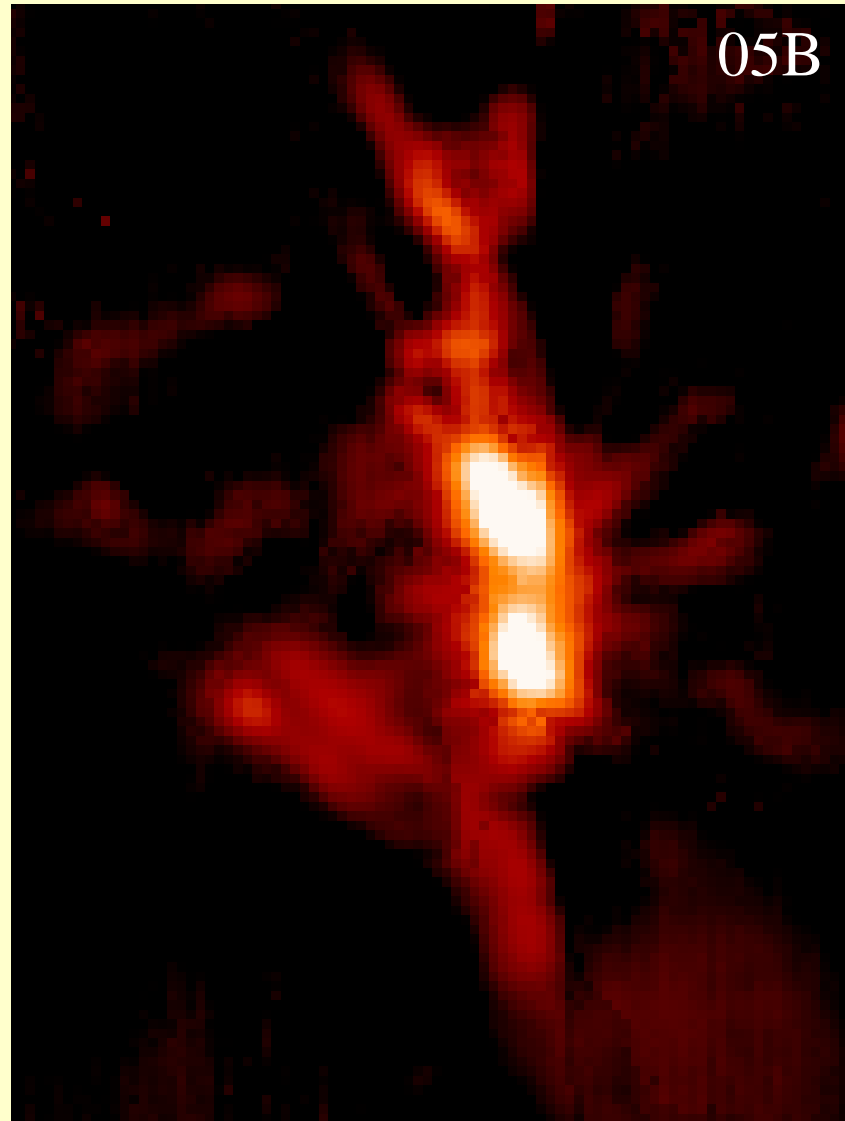




# AzTEC First Light – June 8, 2005



# Initial AzTEC Results 05B



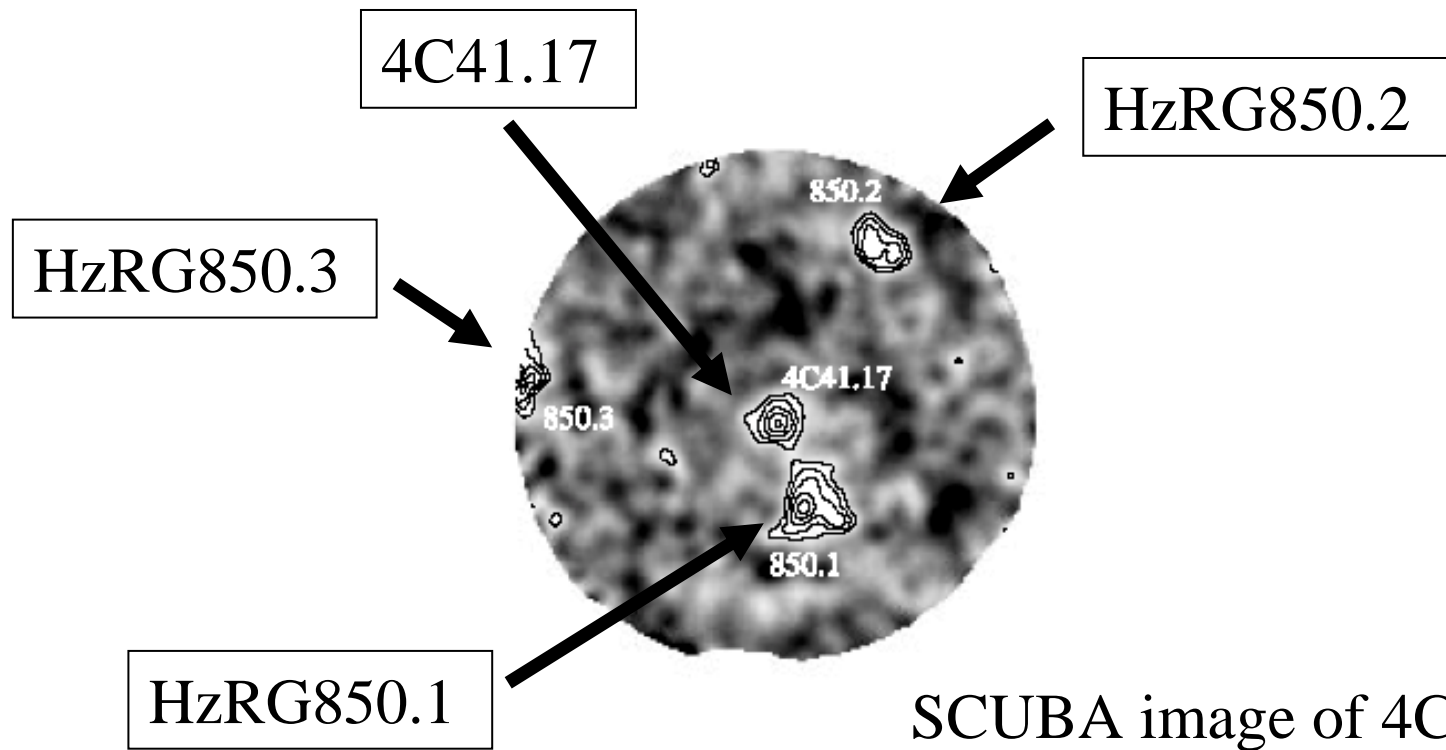
OMC1

# AzTEC/JCMT05B SMG Studies

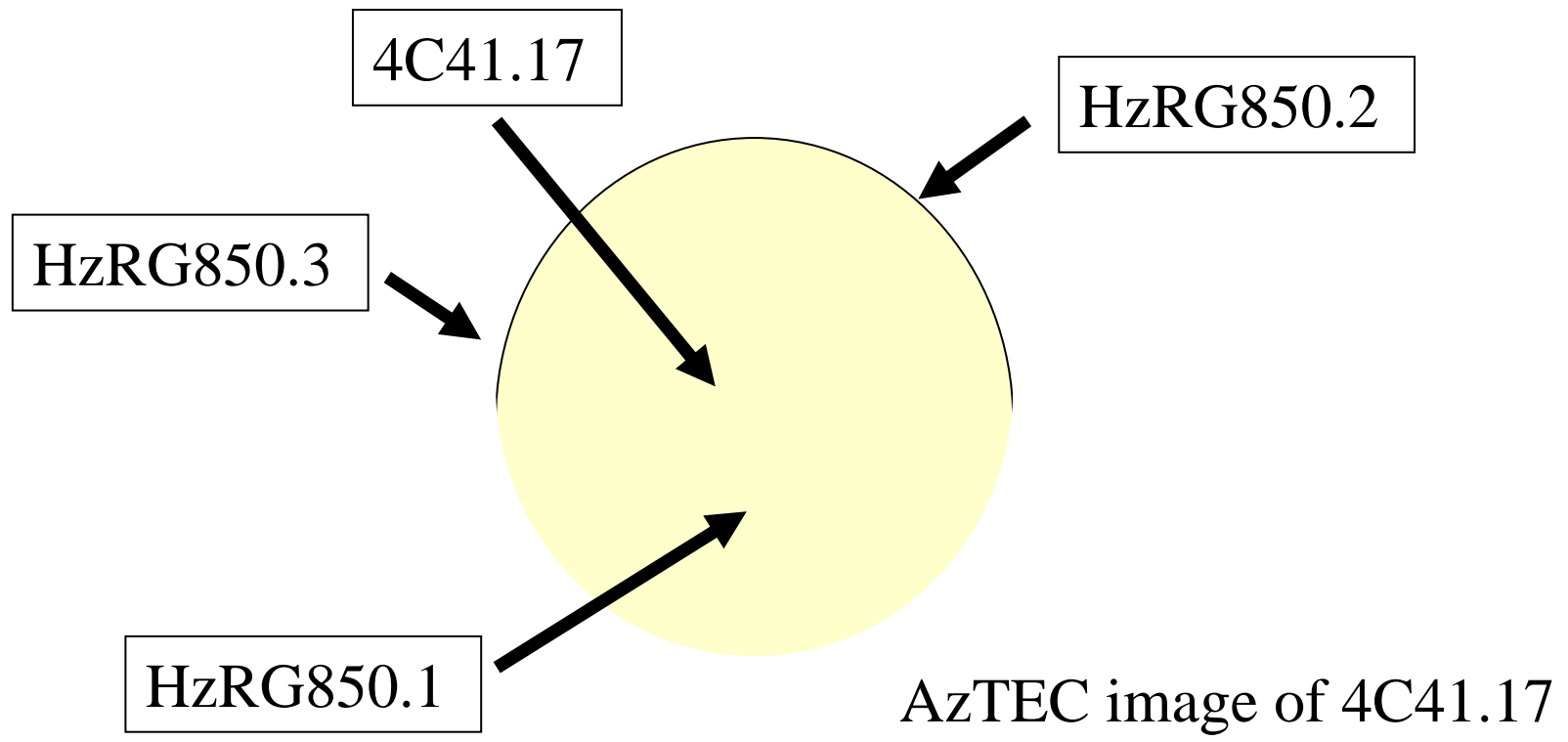
| Field    | Size<br>[arcmin <sup>2</sup> ] | Obs Time<br>[hrs] | $\sigma$<br>[mJ] | N<br>( $>4\sigma$ ) | PI           |
|----------|--------------------------------|-------------------|------------------|---------------------|--------------|
| SHADES   | 1800                           | 198.5 (225)       | 0.7              | 300                 | Dunlop       |
| COSMOS   | 900                            | 45 (45)           | 1.0              | 100                 | D.Sanders    |
| GOODS-N  | 160                            | 43 (90)           | 0.3              | 200                 | E.Chapin     |
| MS0451   | 225                            | 30 (30)           | 0.5              | 50                  | I.Smail      |
| 4C41.17  | 200                            | 48 (48)           | 0.3              | 250                 | D.Hughes     |
| 0316-257 | 50                             | 30 (30)           | 0.3              | 70                  | H.Rottgering |
| BR0952   | 21                             | 14.65 (24)        | 0.8              | 4                   | K.Knudsen    |

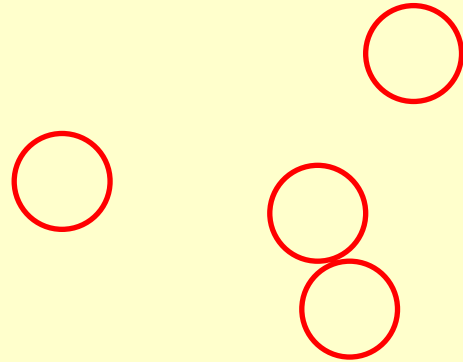
~1deg<sup>2</sup>

~900 sources



SCUBA image of 4C41.17  
(Ivison et al. 2000)





**7 of 48 hrs  
raw pointing  
PI: D. Hughes**

# AzTEC/JCMT05B SMG Studies

| Field    | Size<br>[arcmin <sup>2</sup> ] | Obs Time<br>[hrs] | $\sigma$<br>[mJ] | N<br>( $>4\sigma$ ) | PI           |
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~900 sources

# Lots of room for improvement

- Pointing is next on the list.
- Need to characterize instrument noise.
- Deep jiggle mapping needs much work.
- Still some systematics in raster and jiggle data that need exploring.
- Improved data reduction scheme in the works
  - Better atmosphere subtraction
  - Better faint/extended source reconstruction

In all, these are still the first steps towards reducing AzTEC data. Stay tuned ...



# SPEED

## UMass

Grant Wilson

Min Yun

Thushara Perera

Dan Logan

Ed Slavich

## U. Chicago

Stephan Meyer

Tom Downes

## Case Western

John Ruhl

Kecheng Xiao

## NASA/GSFC

Bob Silverberg (PI)

David Cottingham

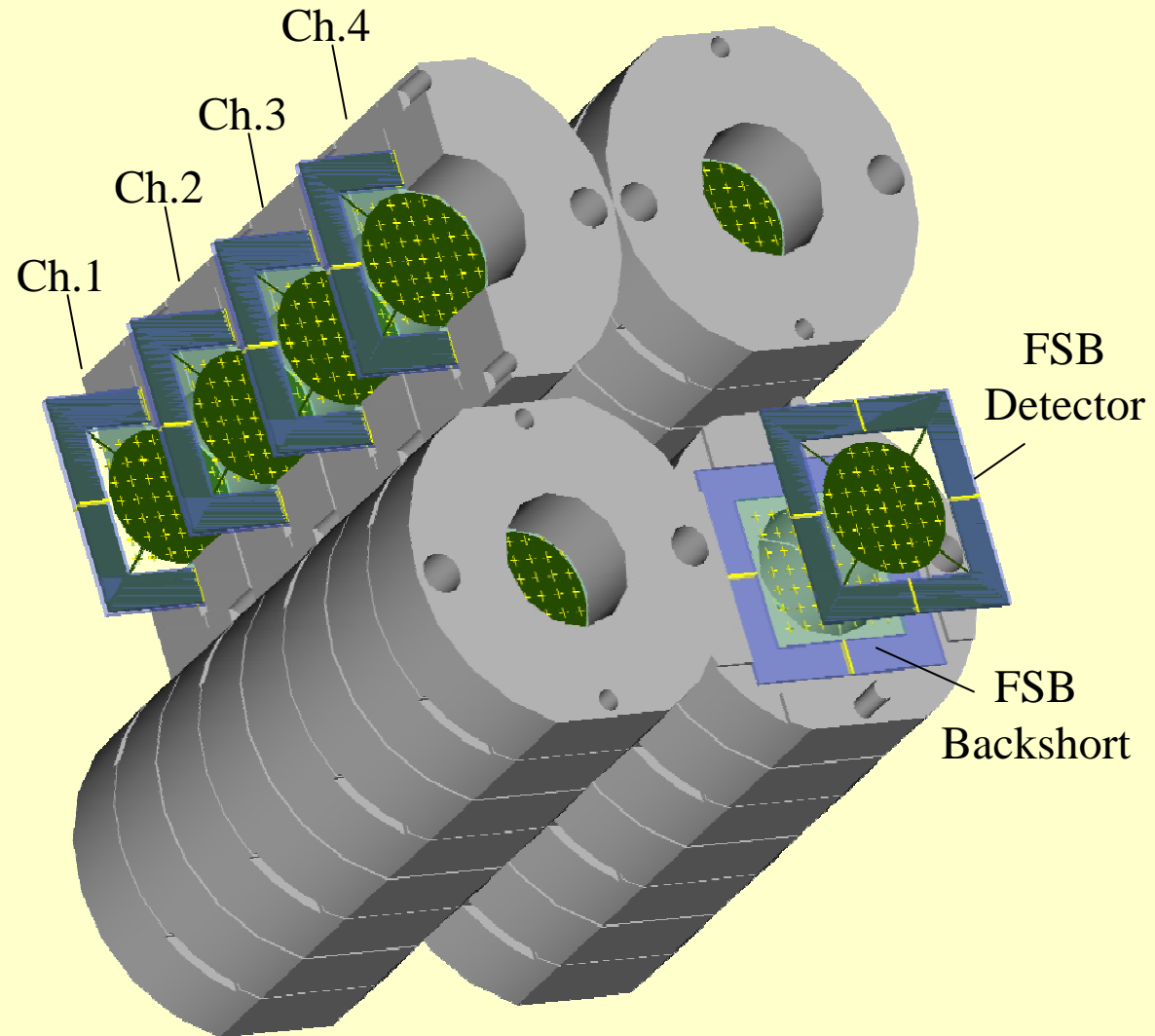
Dale Fixsen

Tina Chen

Fred Finkbeiner

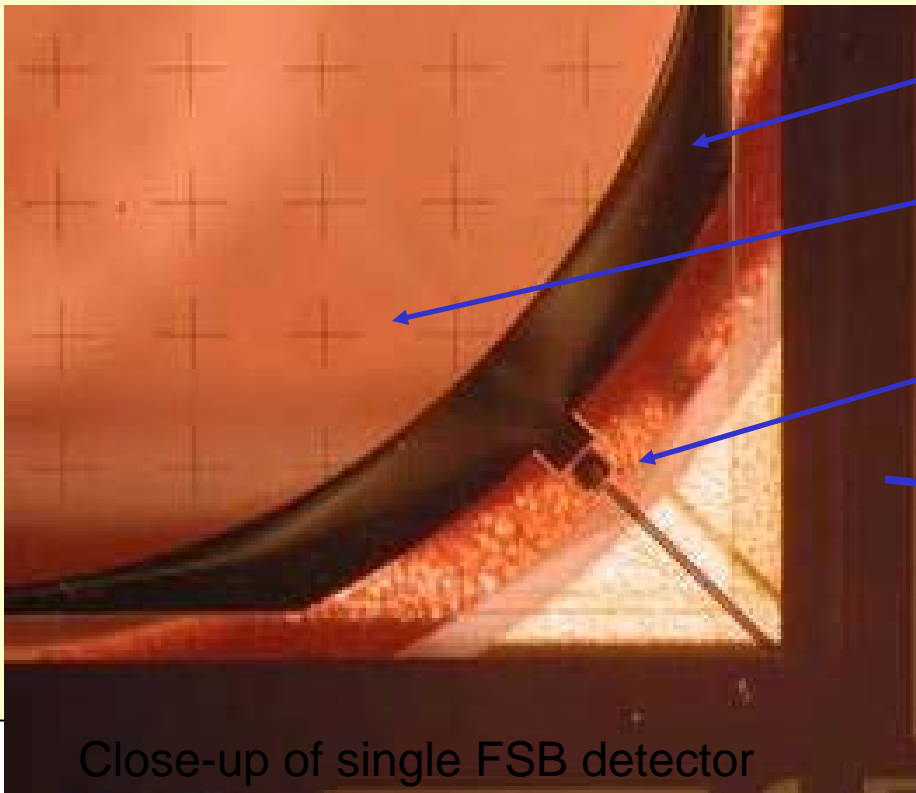
# The Speed Photometer

- Prototype 4 pixel Array of Frequency Selective Bolometers (FSB)
- Simultaneous observations at 2.1, 1.4, 1.1, and 0.85 mm in each pixel



# The Speed Photometer

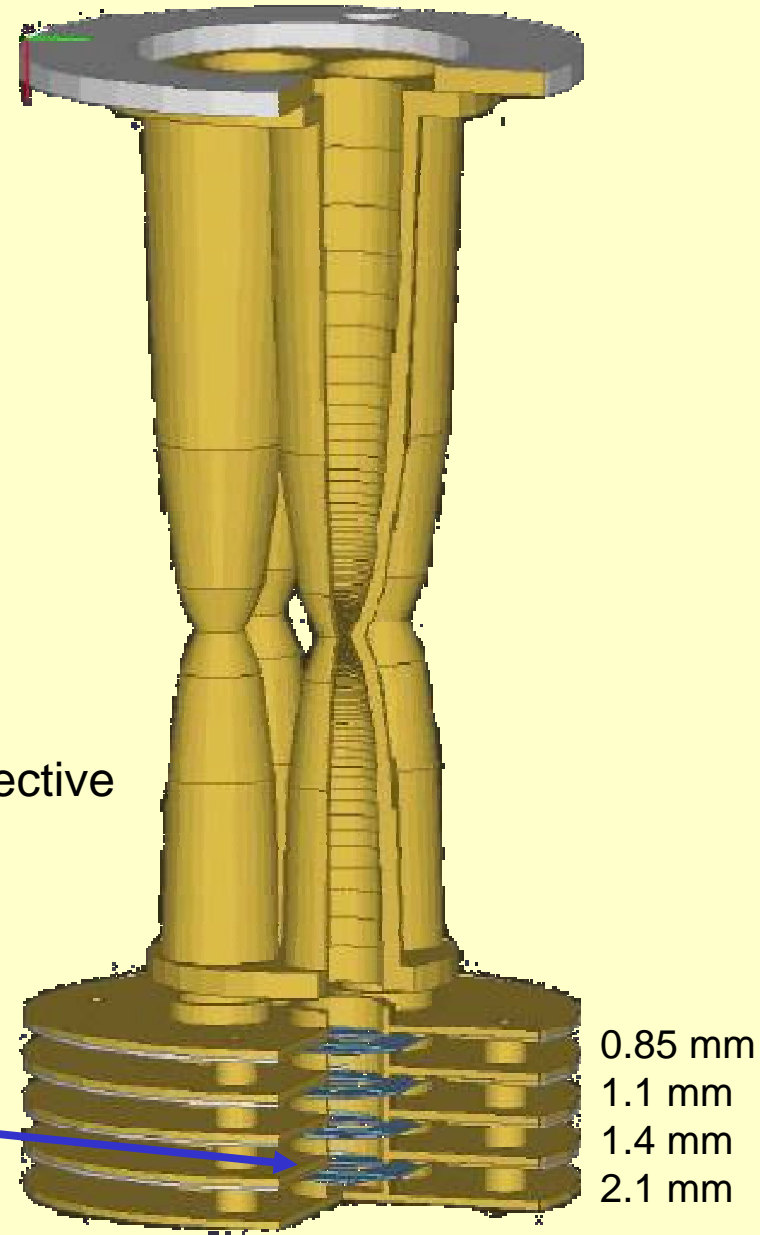
- Prototype 4 pixel Array of Frequency Selective Bolometers (FSB)
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Au ring

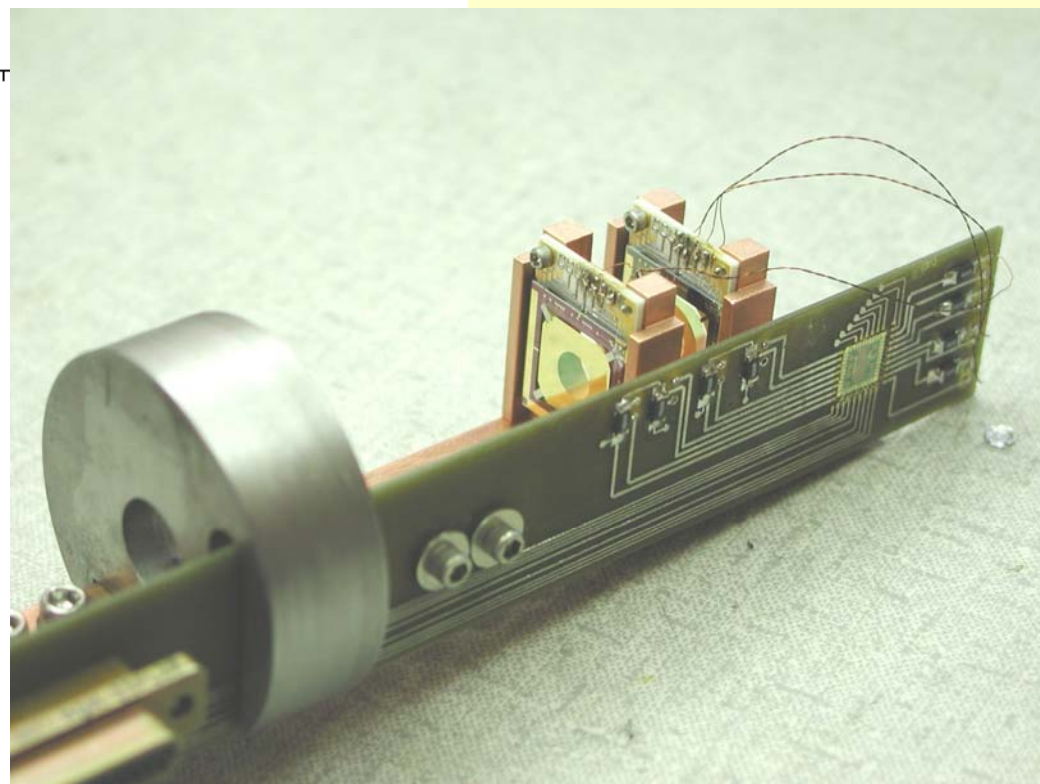
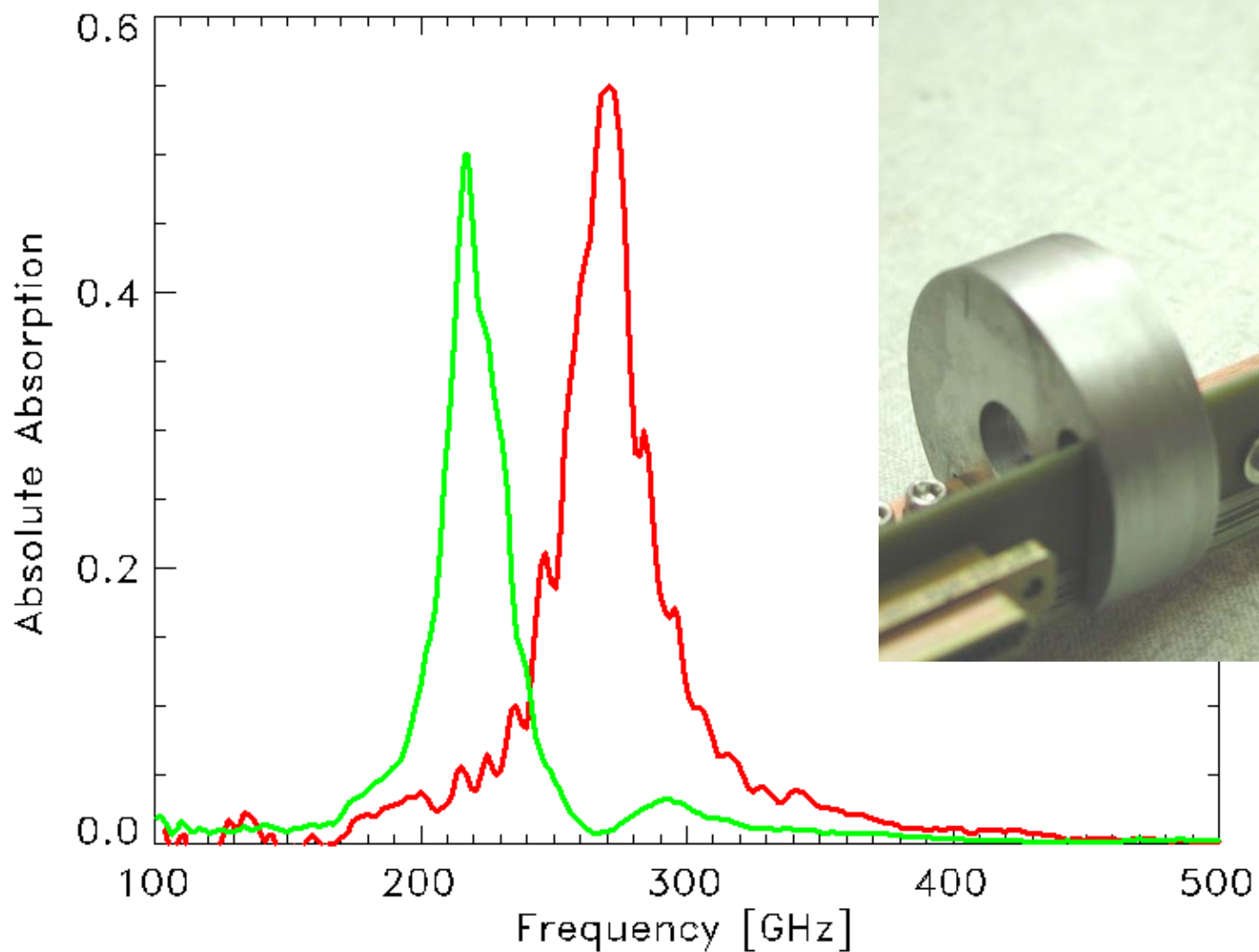
Frequency Selective Absorber

Mo/Au TES



SPEED focal plane assembly

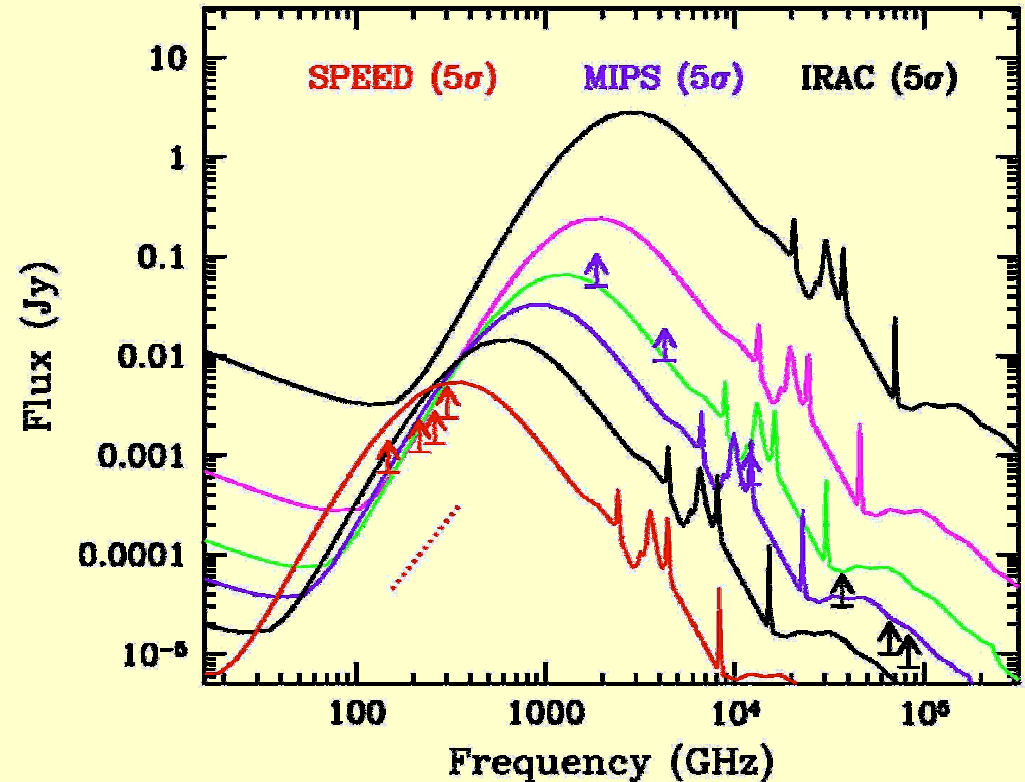
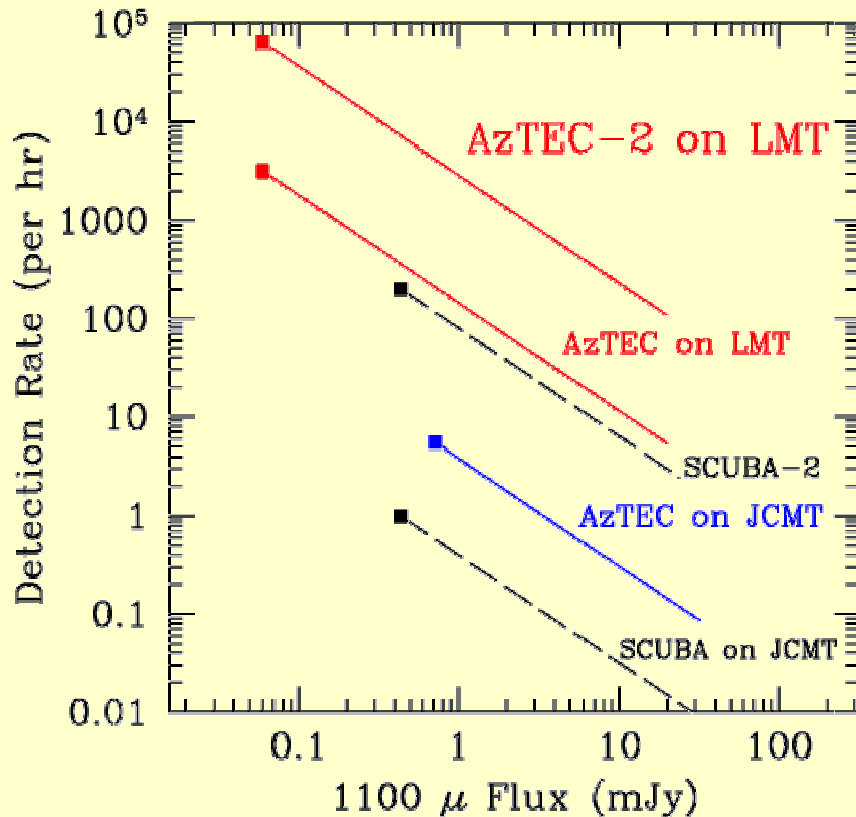
# Absorption Profile



# 1<sup>st</sup> Deployment of SPEED

- Plan to bring SPEED to SMT for commissioning in mid-late 2006.
- Focus on
  - SZE
  - follow-up of AzTEC sources
    - ~1hr to get brightest sources to  $5\sigma$  in bands 2,3,4
  - Secondary calibrators

# AzTEC/SPEED/LMT



- **Fast** High-Z galaxy photometry for
  - Photometric redshift (eg. to all Spitzer sources)
  - Spectral index of sub-mm galaxies
  - 3min to 5 $\sigma$  in photometry mode

# Summary

- AzTEC – data set in hand should expand known submm galaxy population by factor of \_\_\_\_.
  - Cosmic variance
  - Clustering
  - Biased vs. Unbiased regions
- SPEED allows rapid multi-frequency follow-up at discovery waveband.
  - Source confirmation
  - Photometric Z (given ancillary data at higher freq.)