Atacama Submillimeter Telescope

Cameras: 200-1000 μm

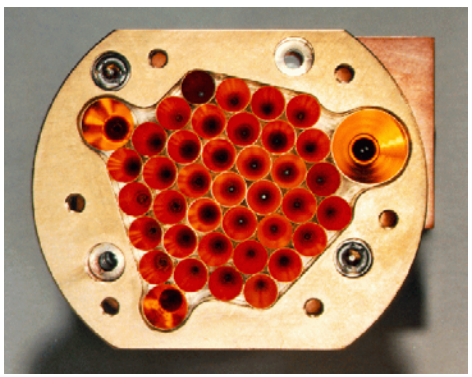
C. Darren Dowell (JPL/Caltech)

2003 October 11

Outline

- Detectors:
  - feedhorn arrays
  - filled pop-up arrays
  - filled ‘waffle’ arrays
  - photoconductors
- System design
  - optics – what temperature?
  - coolers – what temperature?
  - telescope surface
  - pointing and calibration

Feedhorn-Coupled Arrays



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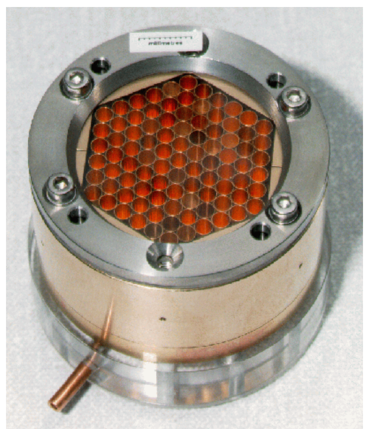
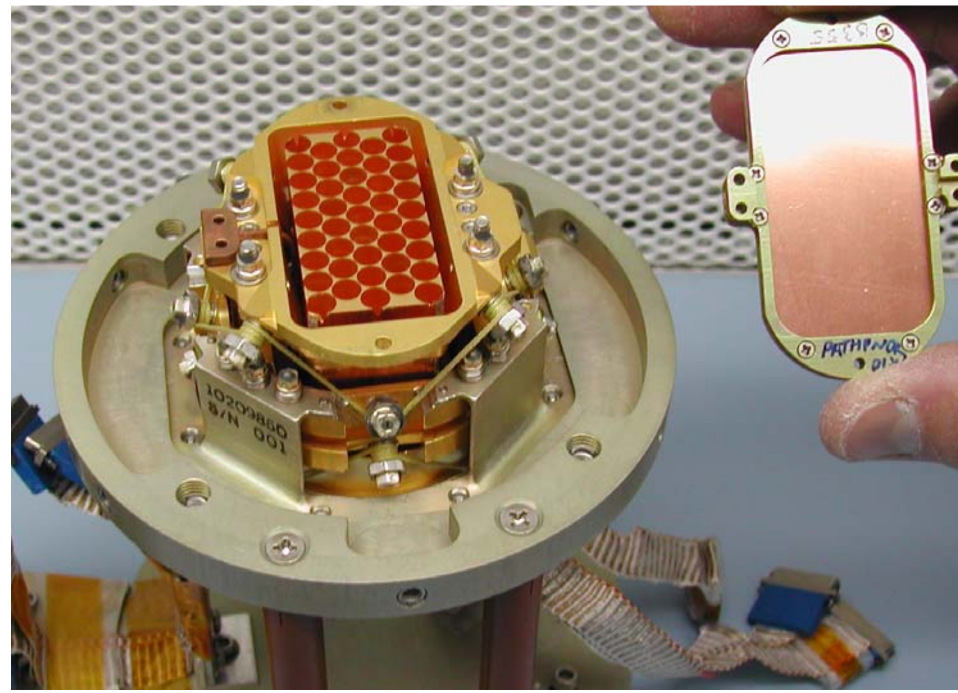


91

SCUBA



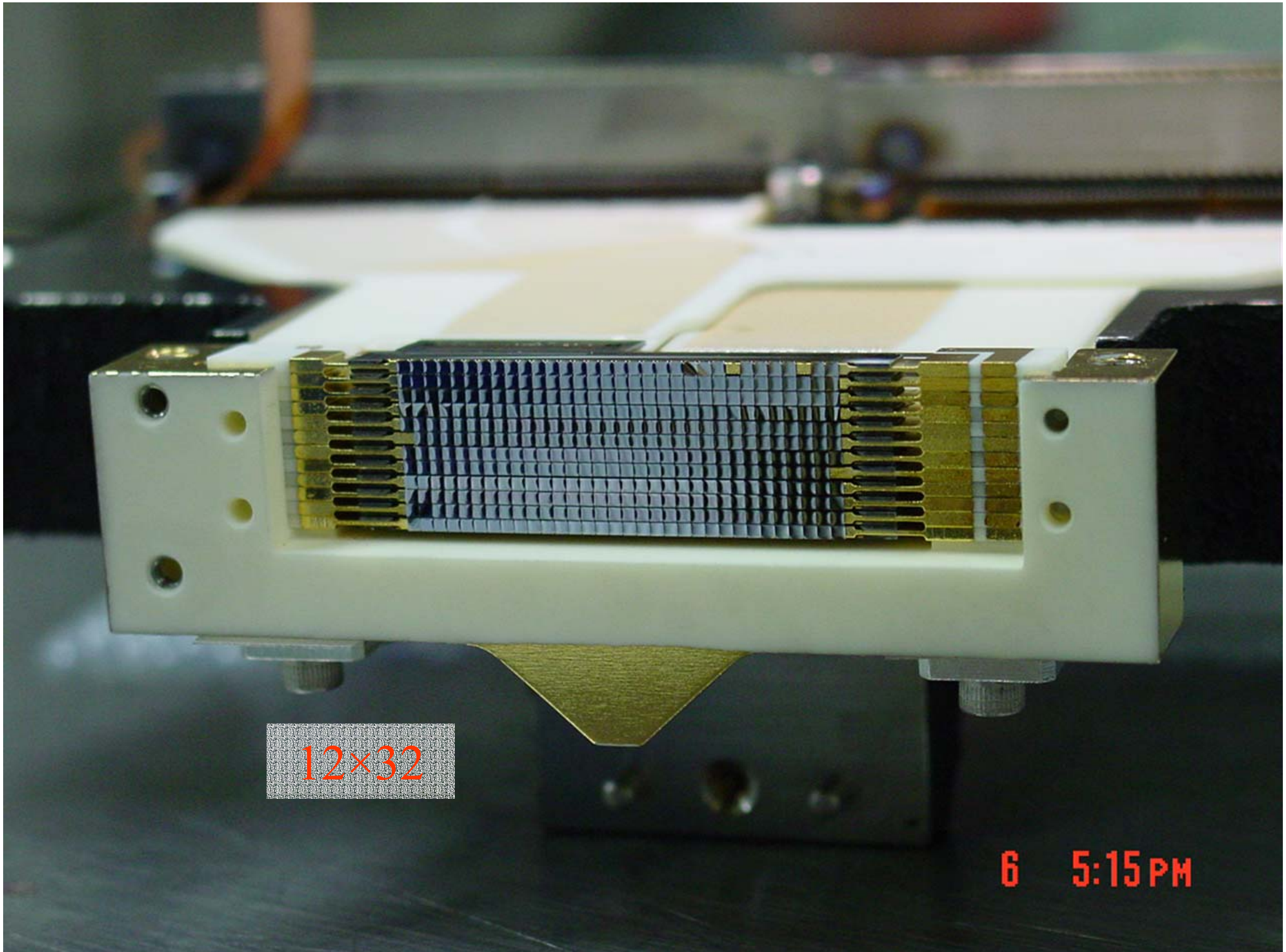
43 (+ 88 + 139 = 270)

SPIRE/Herschel

Feed-Coupled and Filled Arrays

- For fixed field of view, 0.5 fλ filled arrays have 3.5 times greater mapping speed than 2 fλ feedhorns. (Griffin, Bock, Gear 2002)
- For fixed number of pixels, 2 fλ feedhorns are 1.5 times faster than 0.5 fλ filled arrays.

SHARC II "Pop-Up" Bolometer Array (GSFC)

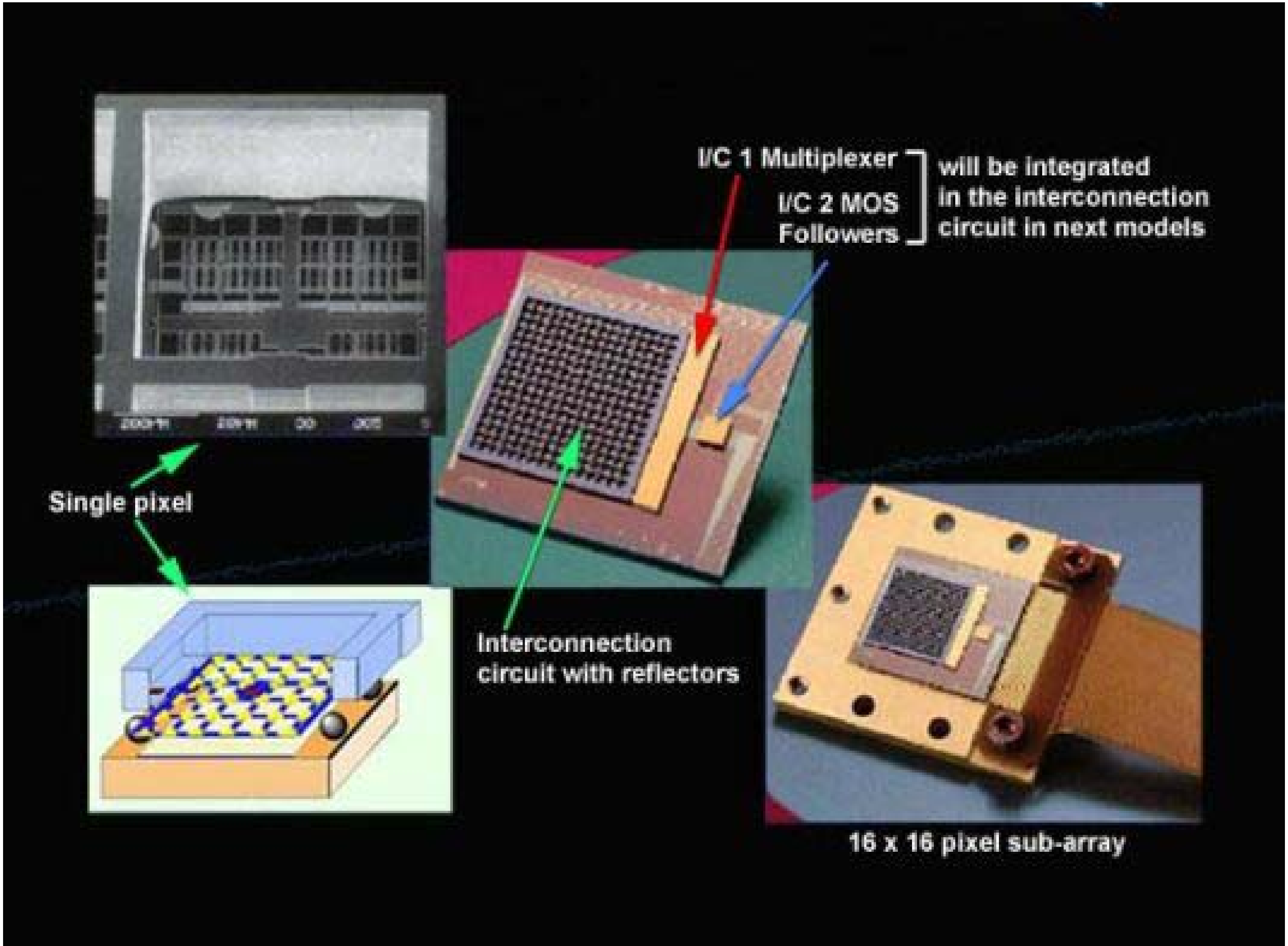


G. Voellmer

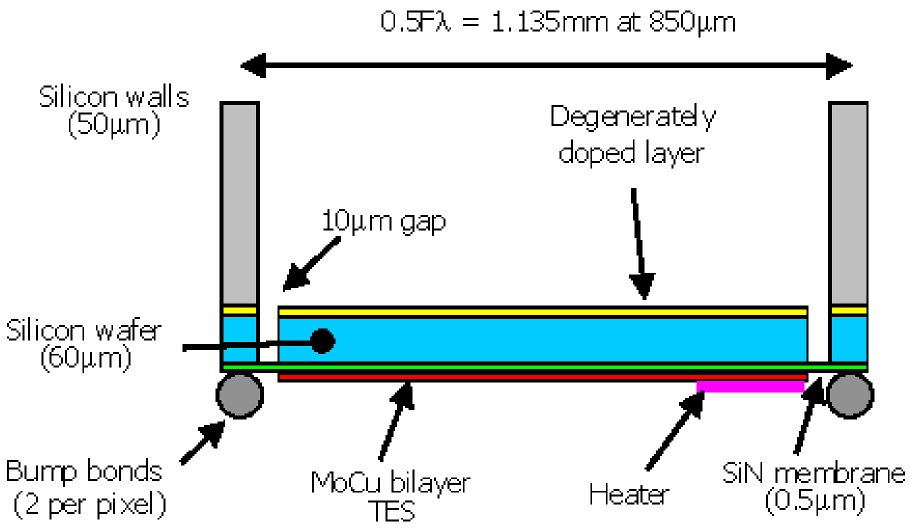
‘Waffle’ Bolometer Arrays

- CEA: arrays up to 64×32 for PACS/Herschel photometer
  - Designed for λ = 60-210 μm
  - High resistance; MOSFET multiplexer
  - 10^{-16} W $Hz^{-1/2}$
- ROE/NIST: SCUBA-2 80×80 arrays
  - 450 μm and 850 μm
  - TES; SQUID time-domain multiplexer
  - 10^{-17} W $Hz^{-1/2}$ at 0.1 K
- Berkeley (+ frequency-domain SQUID MUX)
- JPL

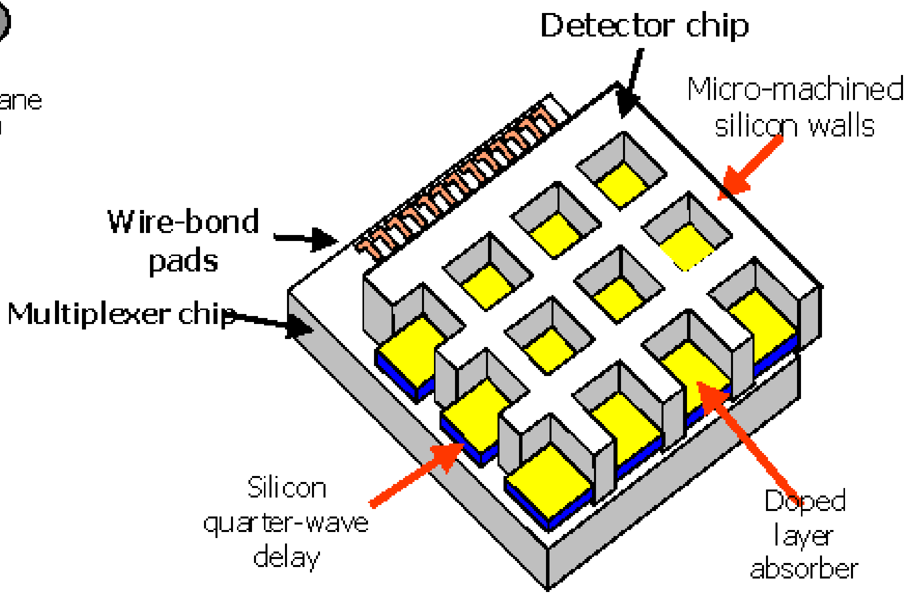
CEA/PACS Bolometer Arrays



SCUBA-2 Arrays



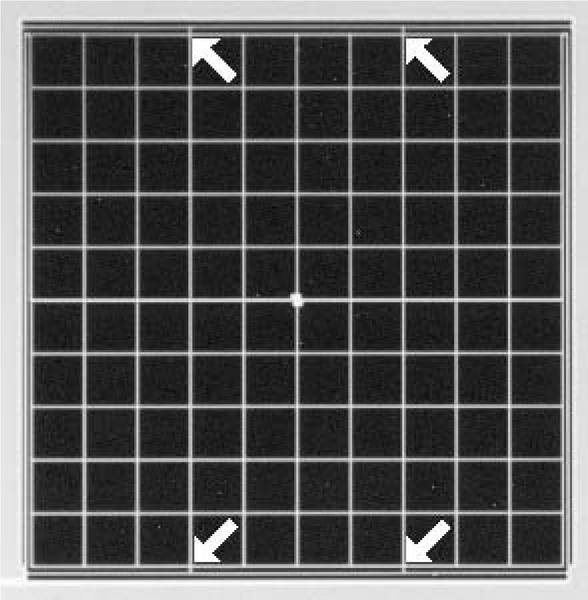
A single pixel design

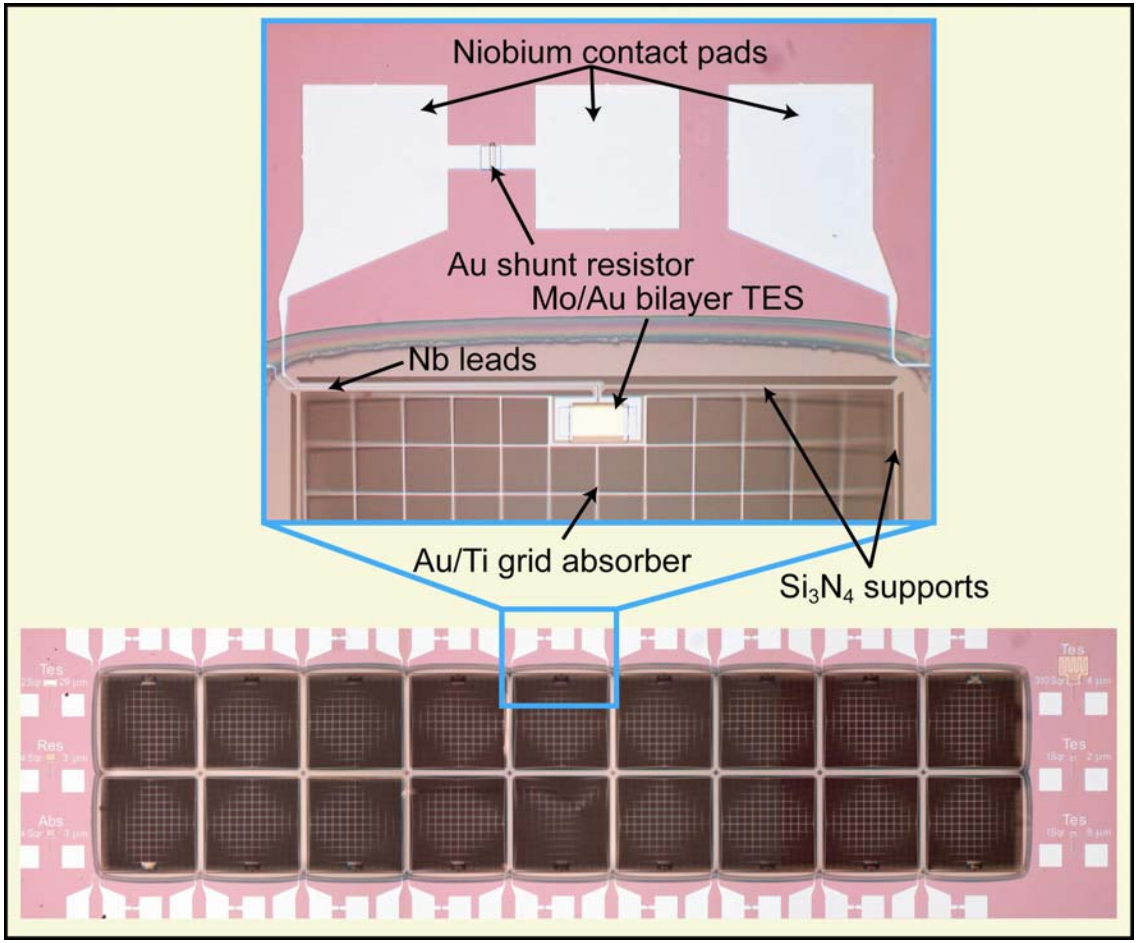


A concept of the array design

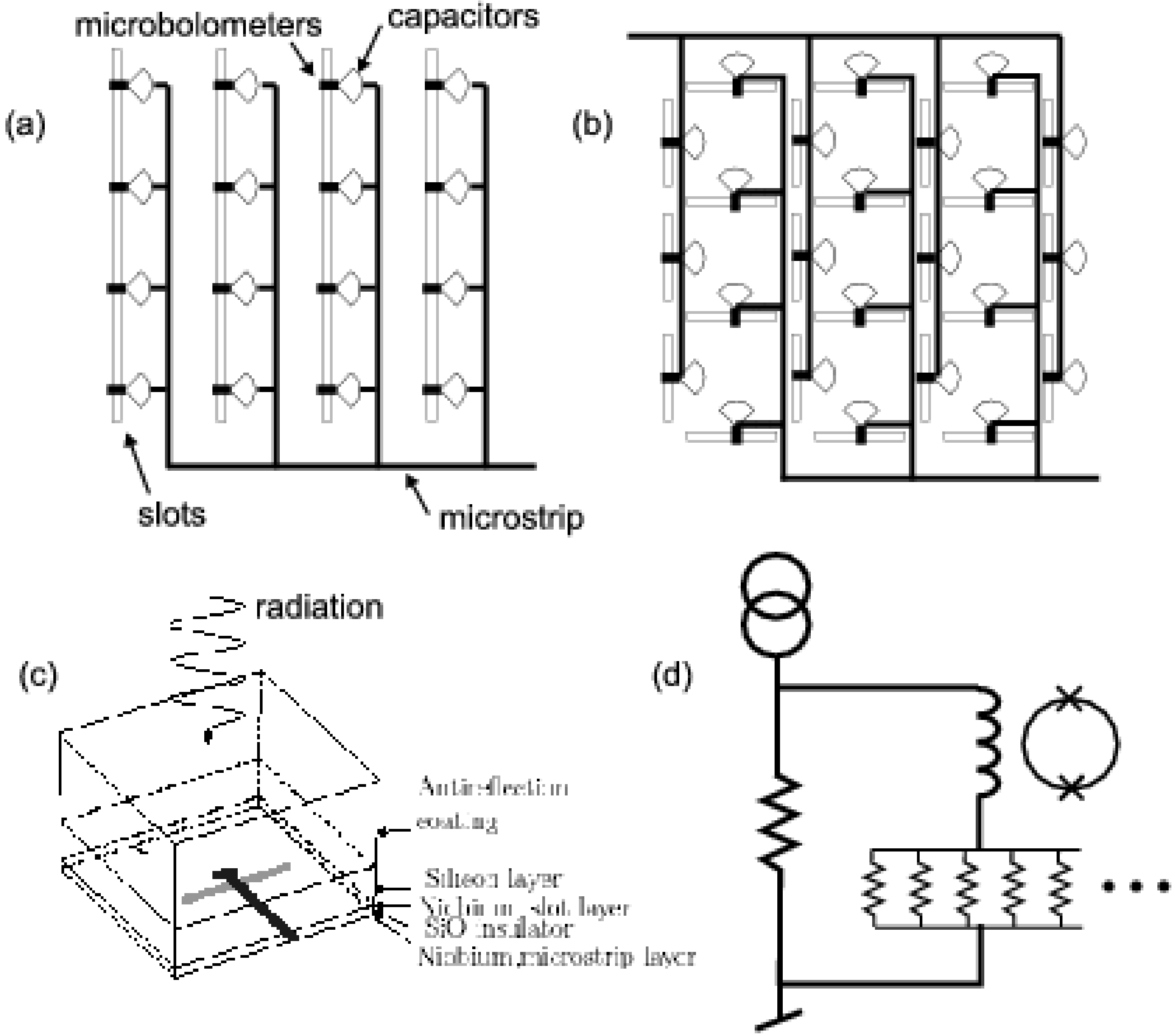
Berkeley

JPL





Antenna-Coupled TES Array

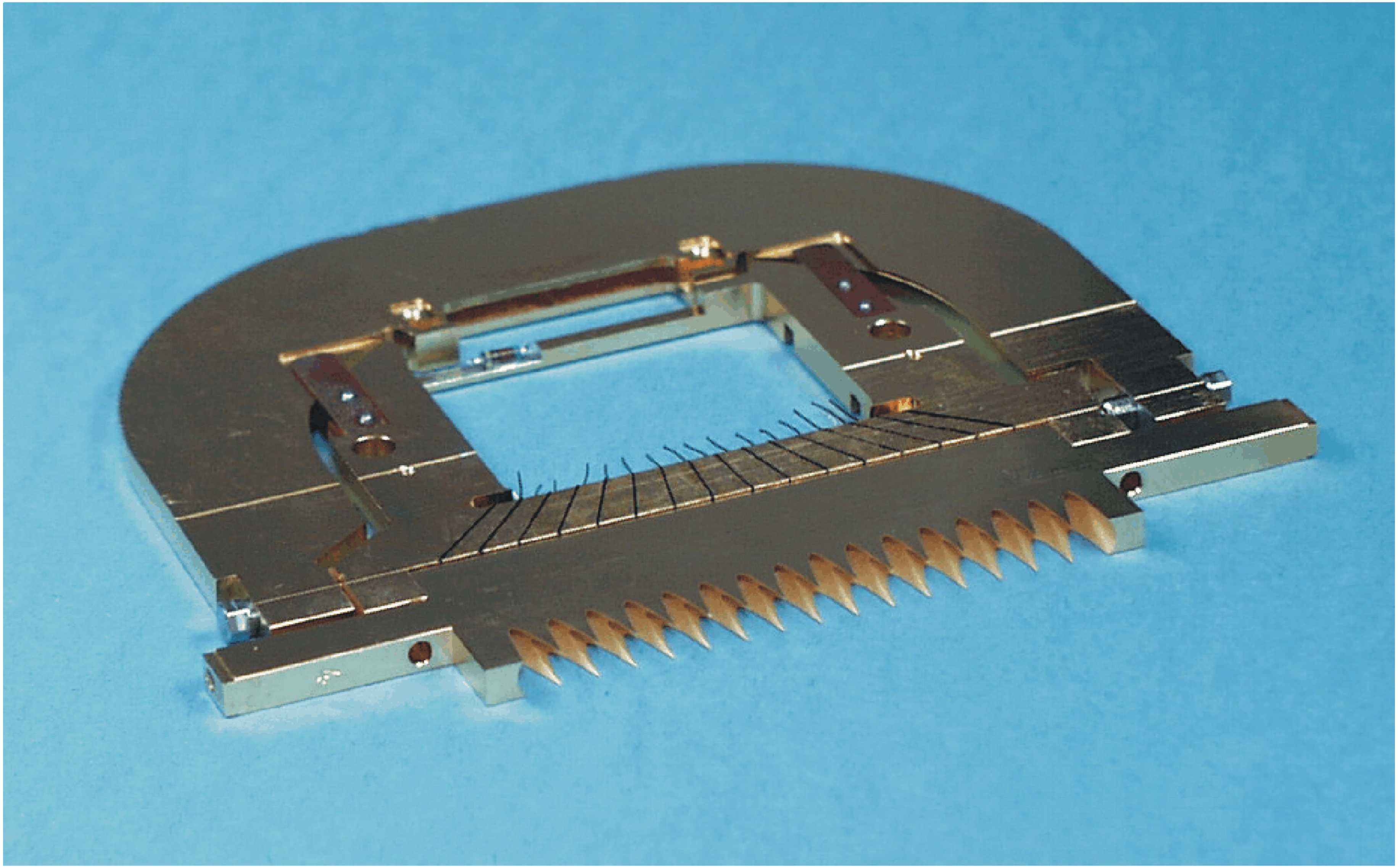


P. Day (JPL)

Photoconductors

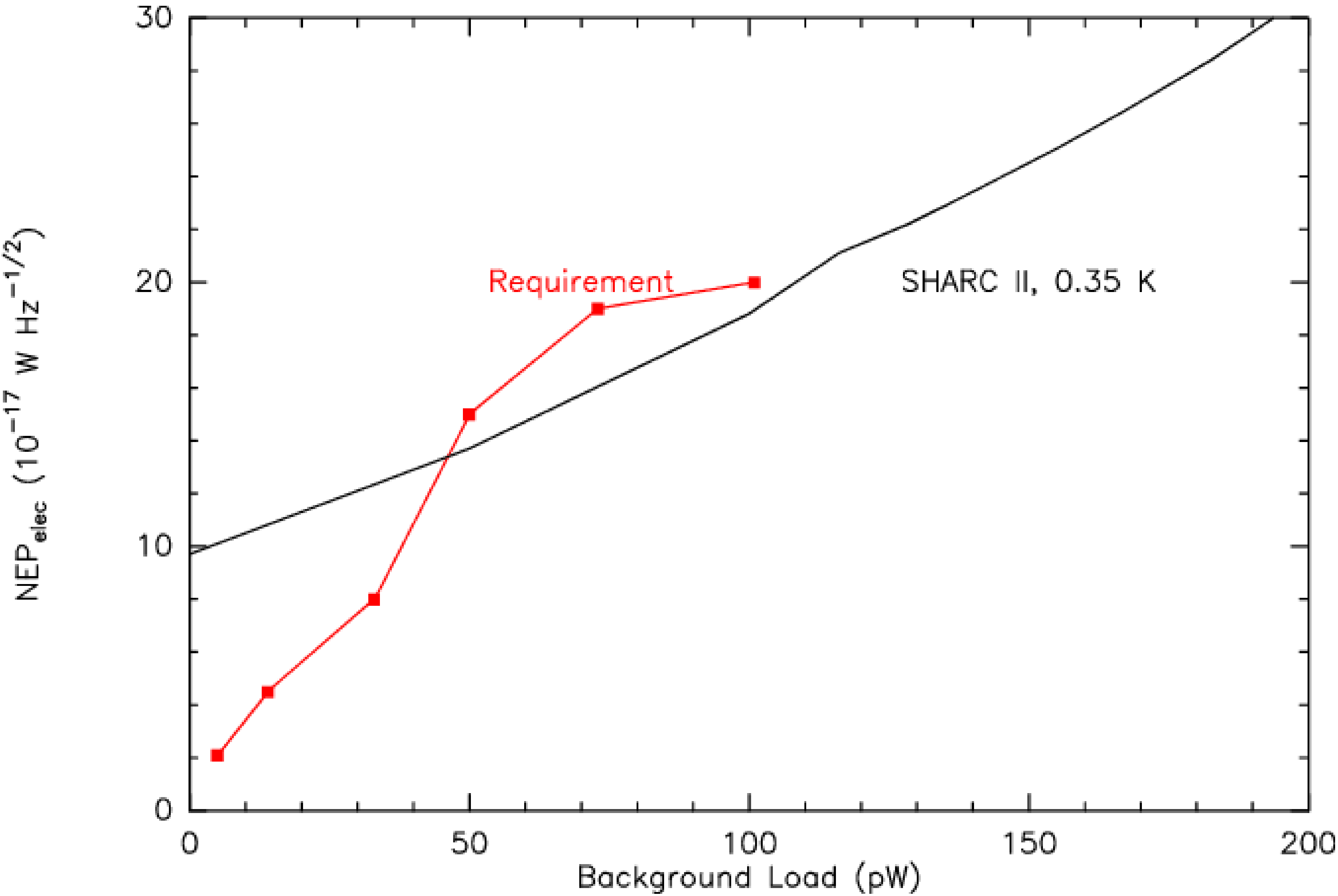
- Multiplexed large arrays
- Plenty of margin in NEP despite relatively high operating temp (few K)
- Can they handle the count rates for broadband applications?
- Wavelength coverage:
  - Unstressed Ge:Ga – $\lambda < 100$ μm
  - Stressed Ge:Ga – $\lambda < 200$ μm
  - Future: GaAs to $\lambda = 300$ μm?
- Stressed detector arrays have significant mechanical complexity.

PACS/Herschel, FIFI LS/SOFIA Stressed Photoconductors



Sensitivity and Loading Requirements

	circular	1.32 fλ	square	0.5 fλ
λ / PWV / airmass μm / μm /	Q pW	NEP_{ph}/3 W $Hz^{-1/2}$	Q pW	NEP_{ph}/3 W $Hz^{-1/2}$
200 / 200 / 1.0	136	2.4×10^{-16}	50	1.5×10^{-16}
200 / 800 / 2.0	200	3.2×10^{-16}	73	1.9×10^{-16}
350 / 200 / 1.0	90	1.4×10^{-16}	33	0.8×10^{-16}
350 / 800 / 2.0	276	3.3×10^{-16}	101	2.0×10^{-16}
870 / 200 / 1.0	14	3.5×10^{-17}	5	2.1×10^{-17}
870 / 800 / 2.0	37	7.5×10^{-17}	14	4.5×10^{-17}


30
20
10
0
0
50
100
150
200
Background Load (pW)
NEP$_{elec}$ (10^{-17} W Hz$^{-1/2}$)
Requirement
SHARC II, 0.35 K

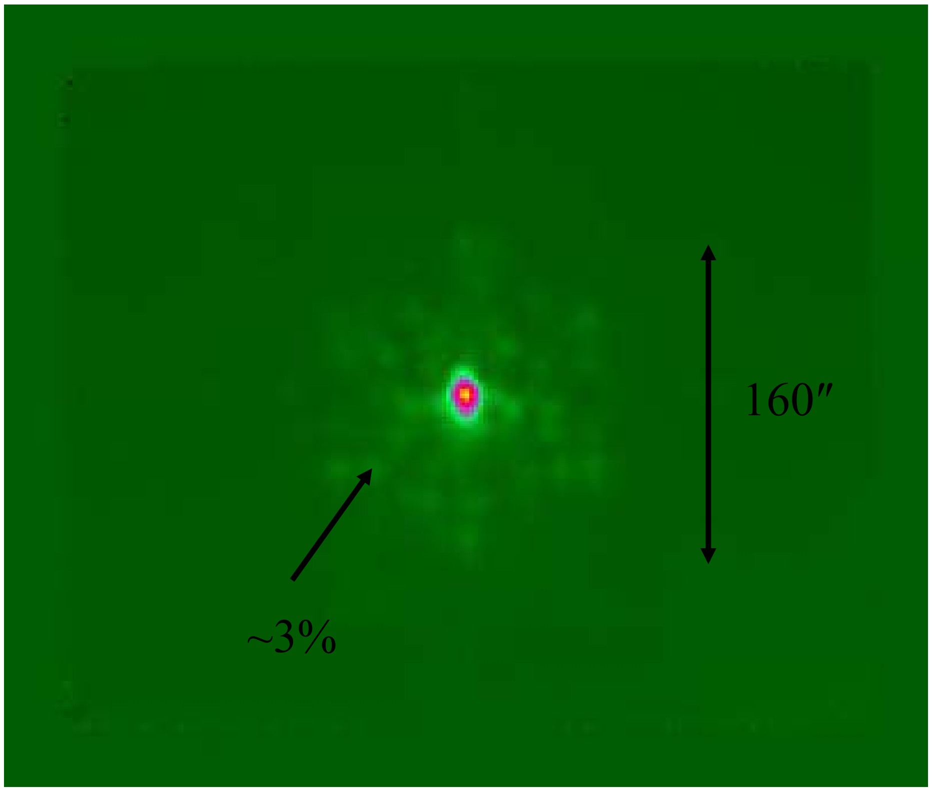
System Requirements

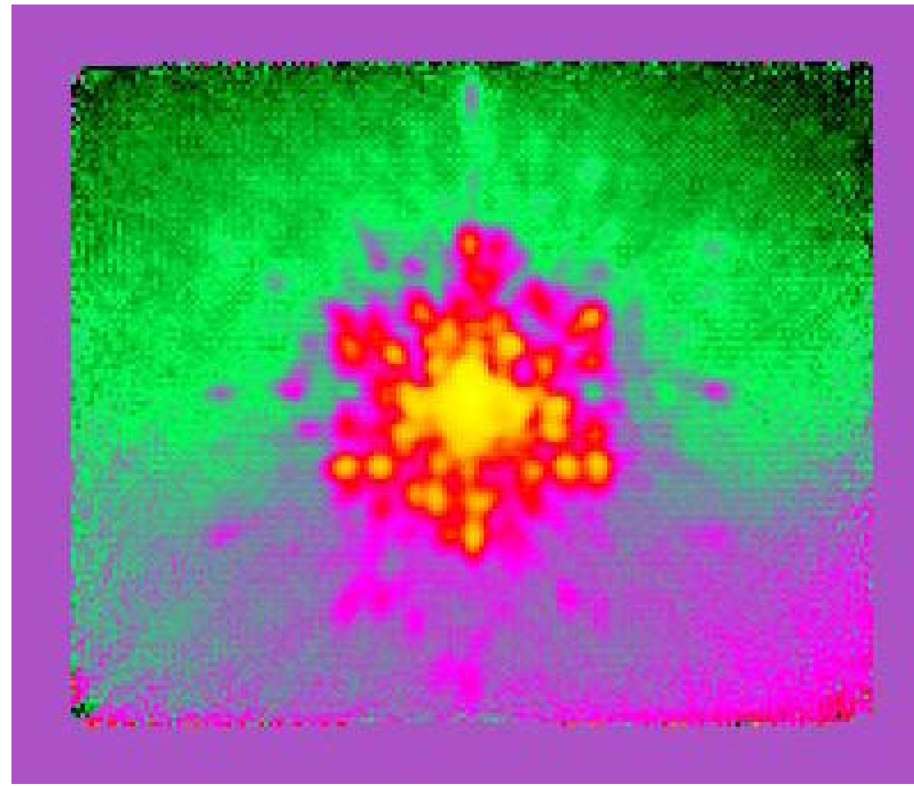
- Optics:
  - 4 K is fine for bare arrays at $\lambda < 700$ µm.
  - Need to check situation for $\lambda = 850$ µm; SCUBA-2 planning on 1 K focal plane box.
- Refrigerator:
  - 0.3 K is fine for $\lambda < 700$ µm.
  - Need to check situation for $\lambda = 850$ µm; SCUBA-2 planning on 0.1 K.

Bolometers and Coolers

- I know of no instrument in the field with bolometers and a mechanical ~4 K cooler.
- Let’s hope this works with TES’s.

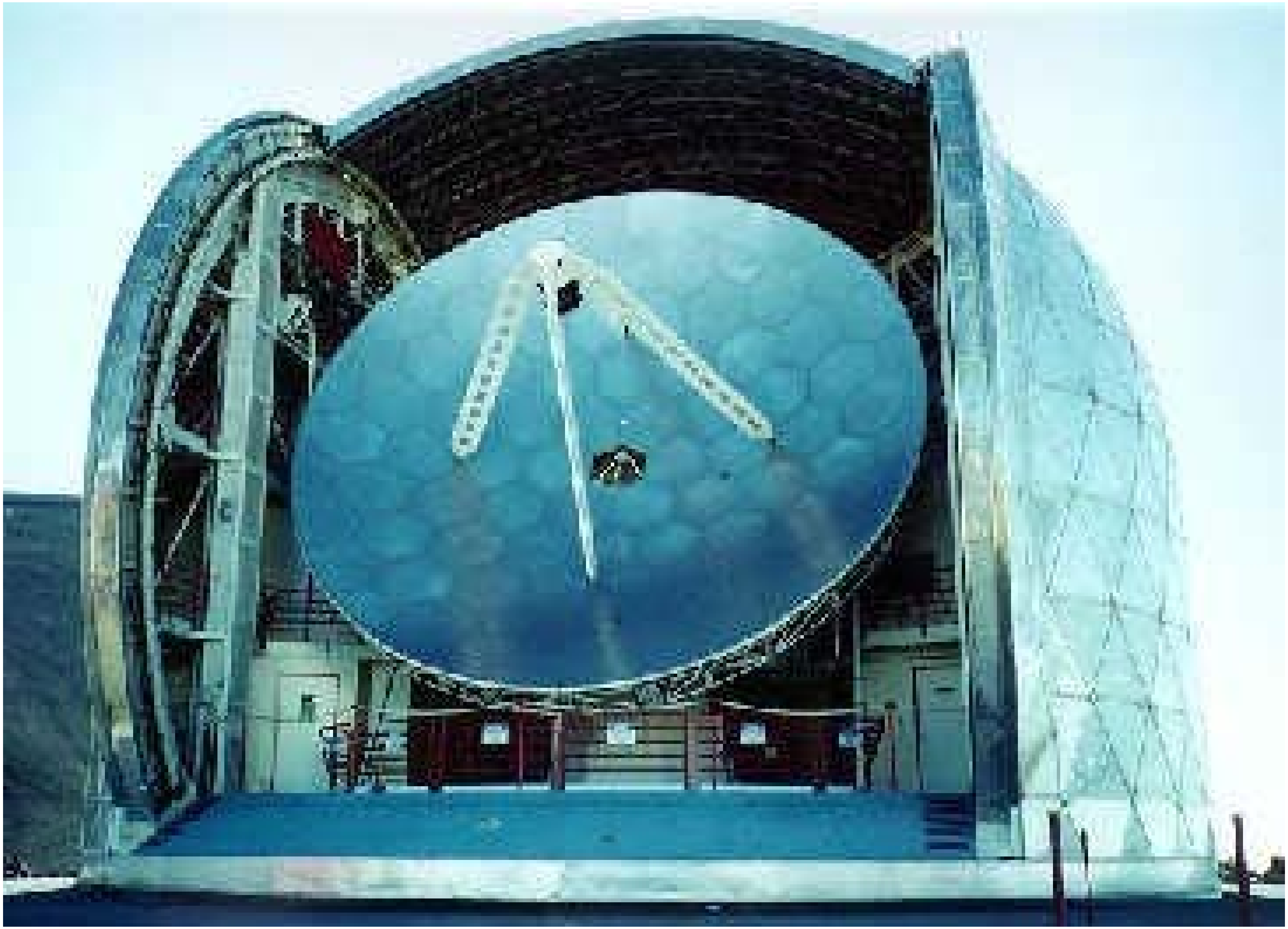
SHARC II 350 μm Sidelobes



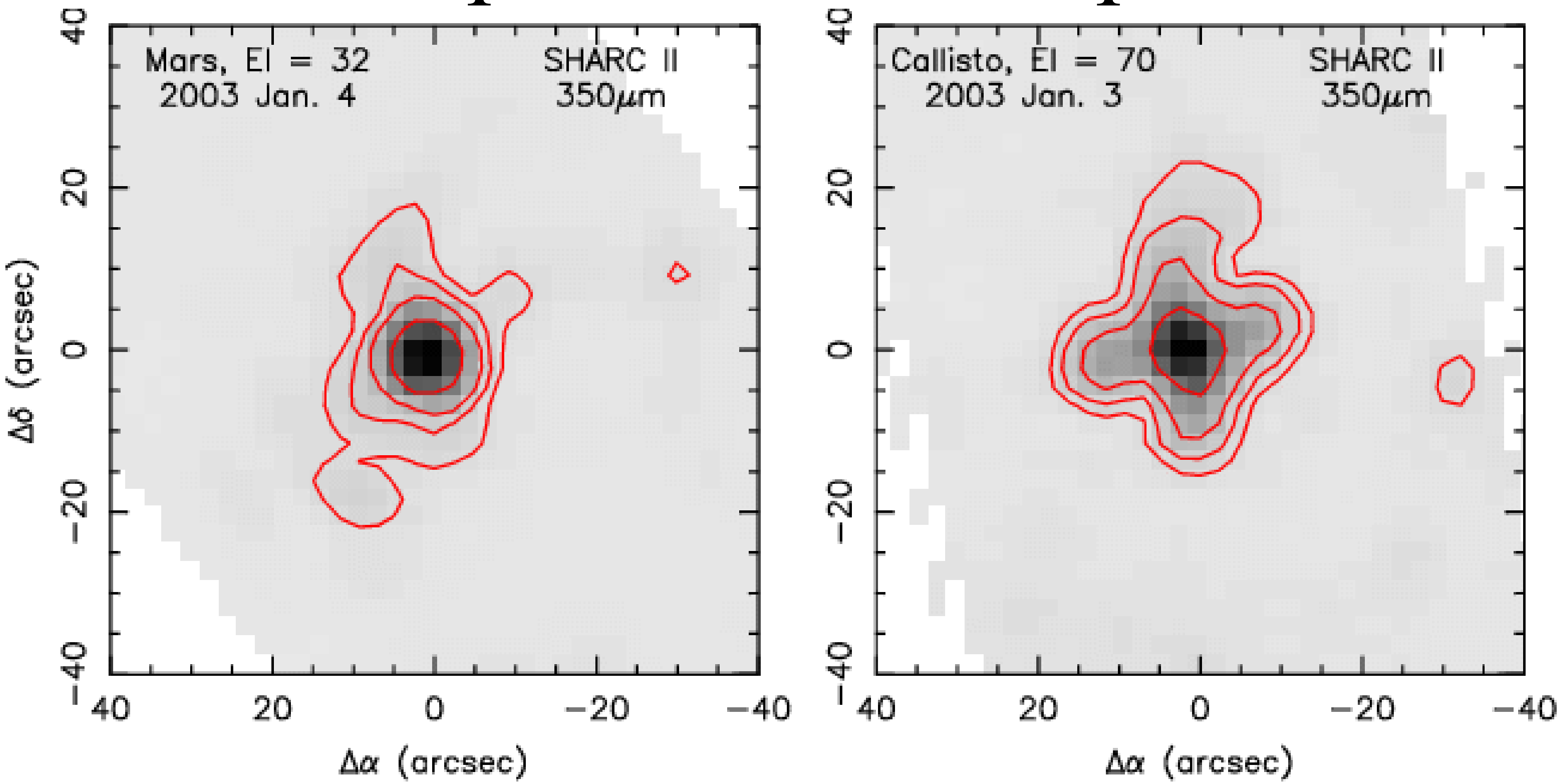


CSO: $\eta \sim 0.3$

Caltech Submillimeter Observatory



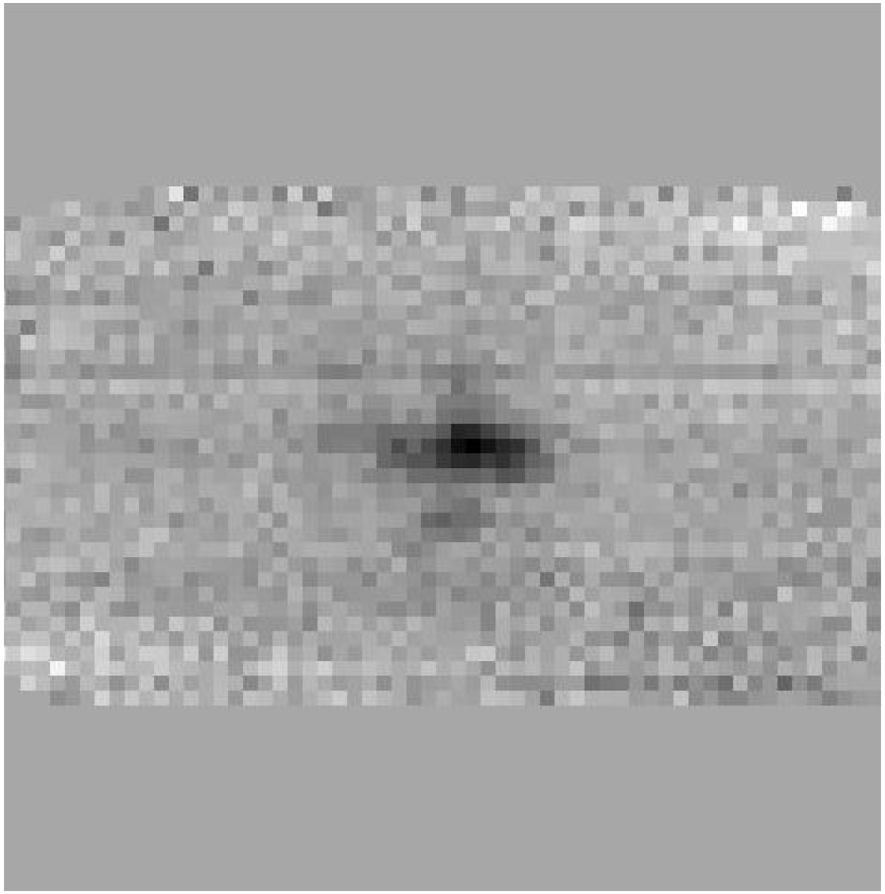
Beam Shape/Elevation Dependence



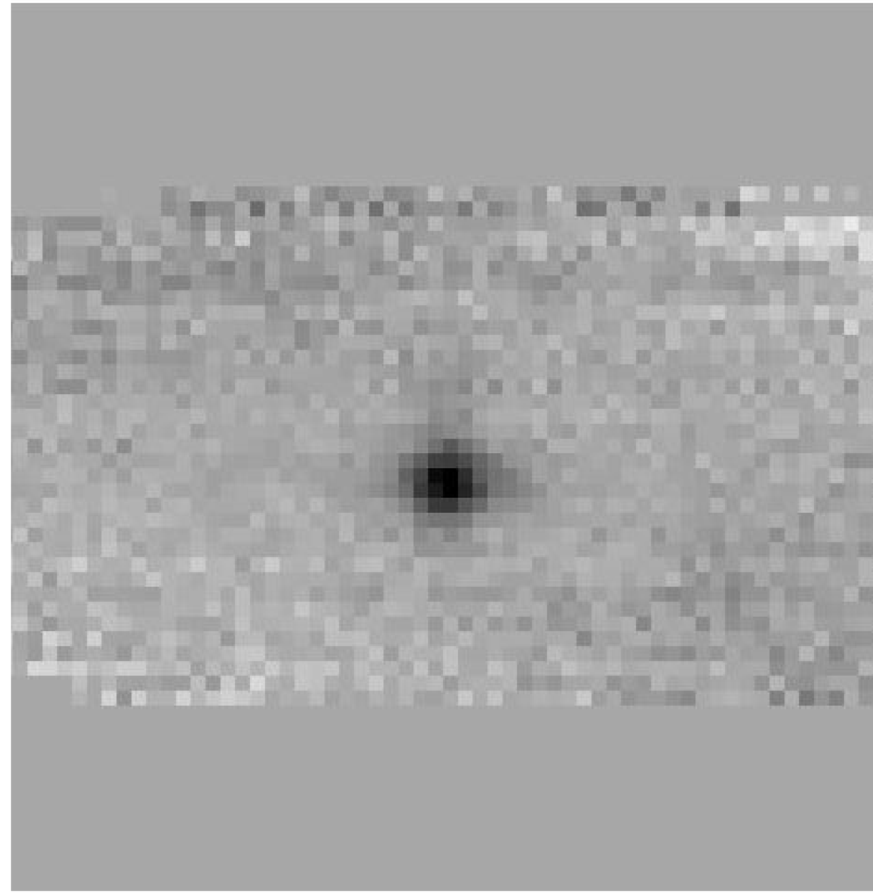
contours: 5%, 10%, 20%, 50%

- Remedy: Use new surface correction system at CSO.

CSO Surface Correction System in Action



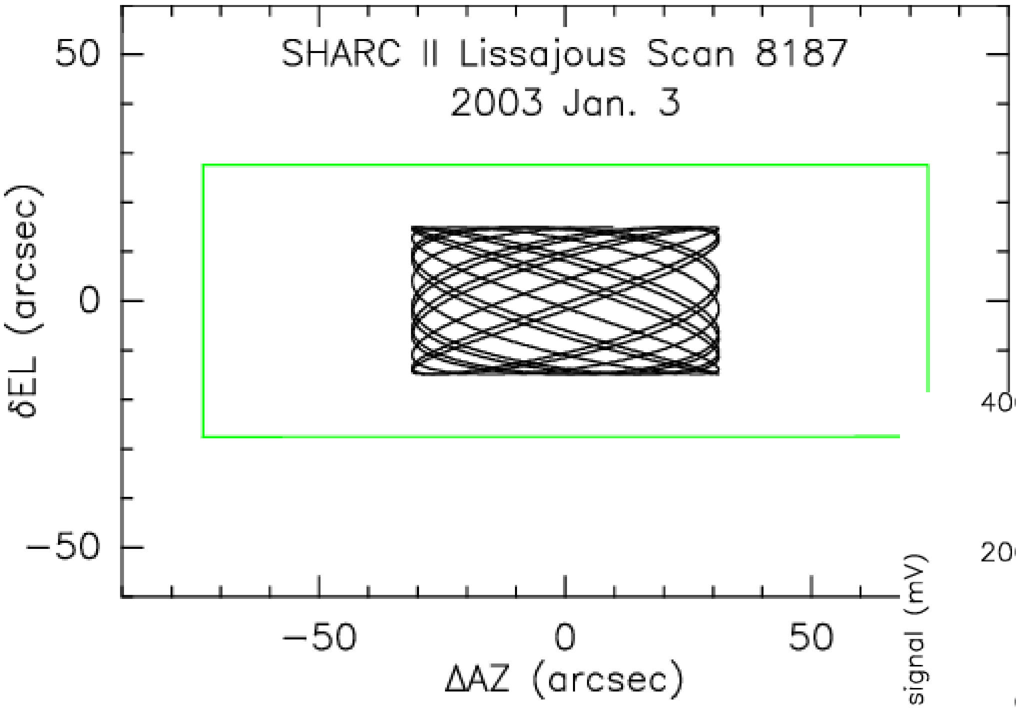
before

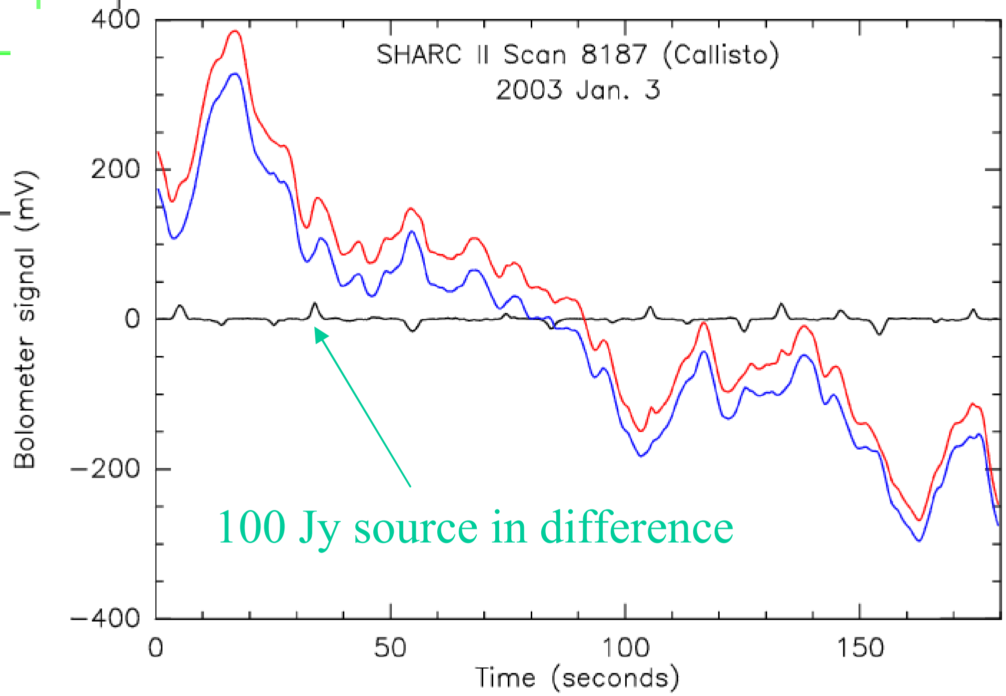


after

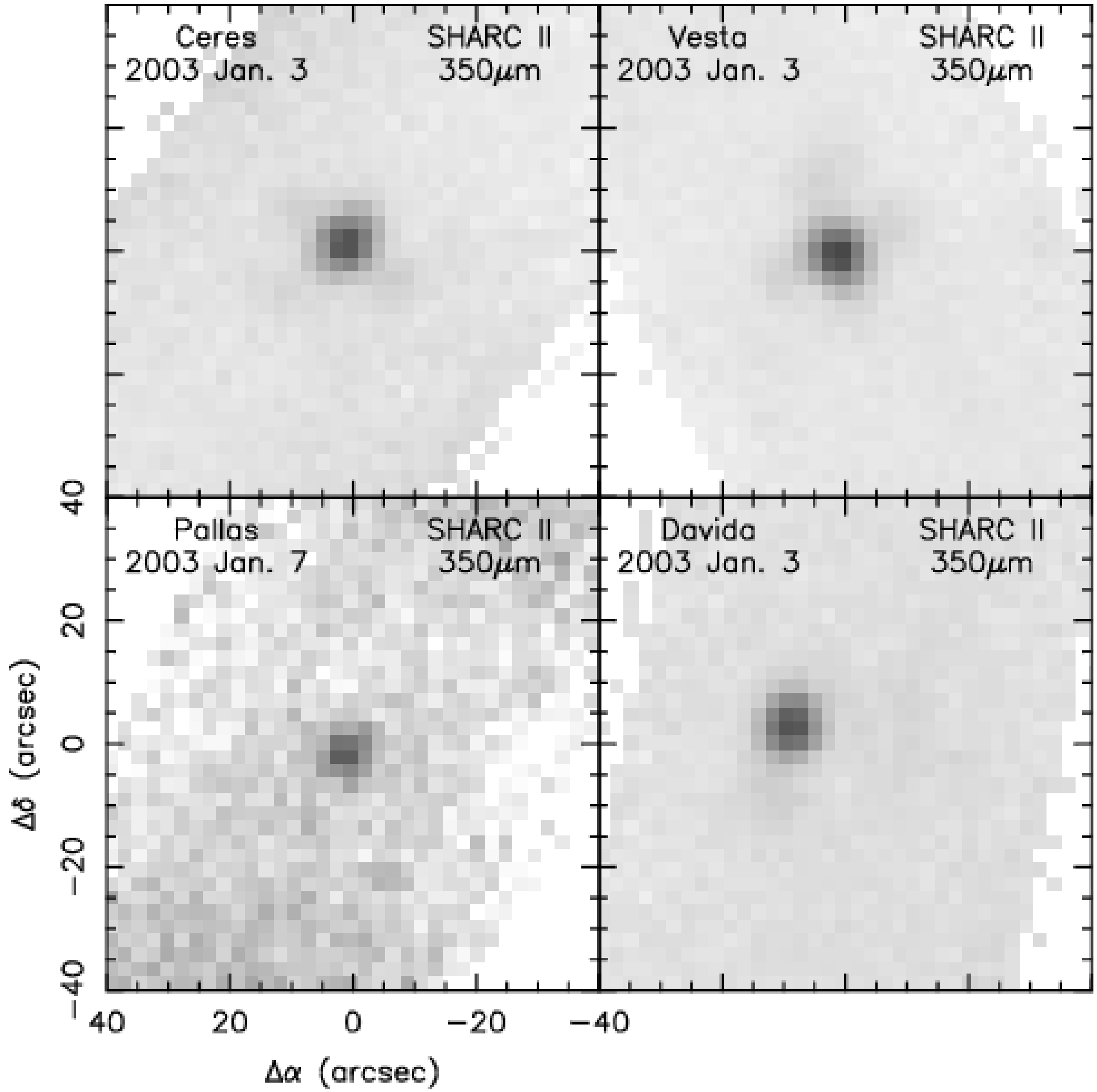
- April 2003; elevation ≈ 80°

SHARC II Observing Mode: Scanning without Chopping Secondary Mirror





Asteroids as Flux Calibrators



Blazars as Pointing References