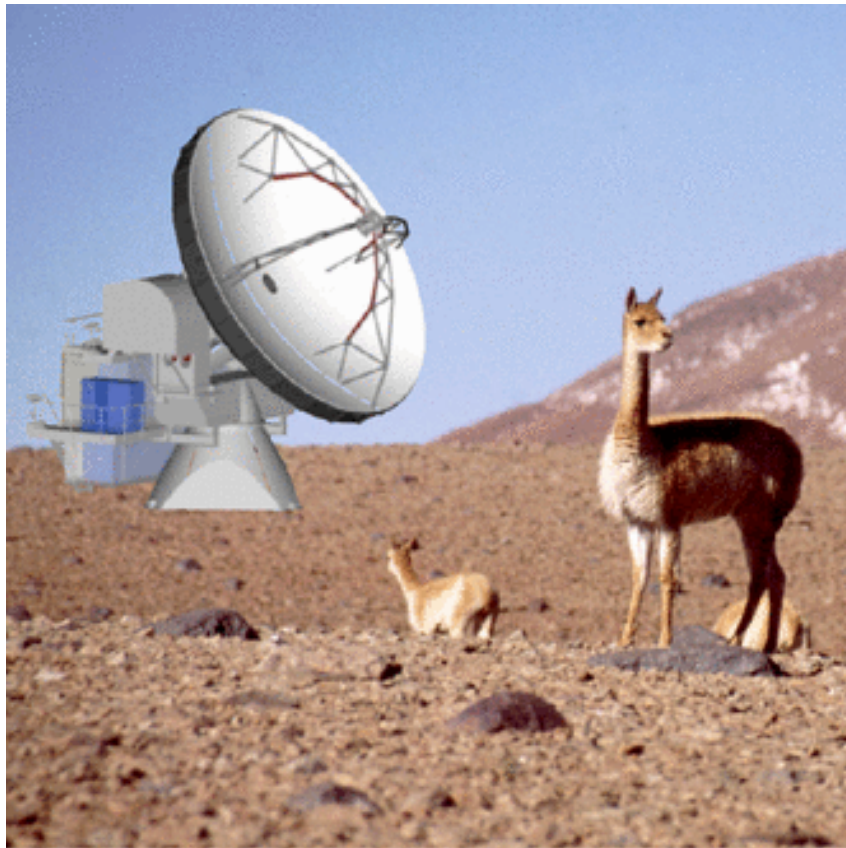


APEX-SZ



Daniel Schwan
U. C. Berkeley

What is APEX-SZ?

- Search for distant galaxy clusters via Sunyaev-Zel'dovich (SZ) effect
 - Unique redshift independent probe
- Survey 250 sq. degrees to $10 \mu\text{K}/\text{pixel}$
 - 1000's of clusters
- Using Atacama Pathfinder Experiment (APEX) Telescope in Chile
- Large-scale monolithic TES bolometer array with SQUID readout
- Online in 2004
 - Stepping stone for SPT (2006)

Collaborators

UC Berkeley/LBNL

Sherry Cho

Matt Dobbs

Nils Halverson

Bill Holzapfel

Trevor Lanting

Adrian Lee

Jared Mehl

Paul Richards

Daniel Schwan

Helmuth Spieler

Martin White

MPIfR

Frank Bertoldi

Rolf Guesten

Ernst Kreysa

Karl Menten

Dirk Muders

Andrea Raccanelli

Peter Schilke

MPIfR



APEX Telescope

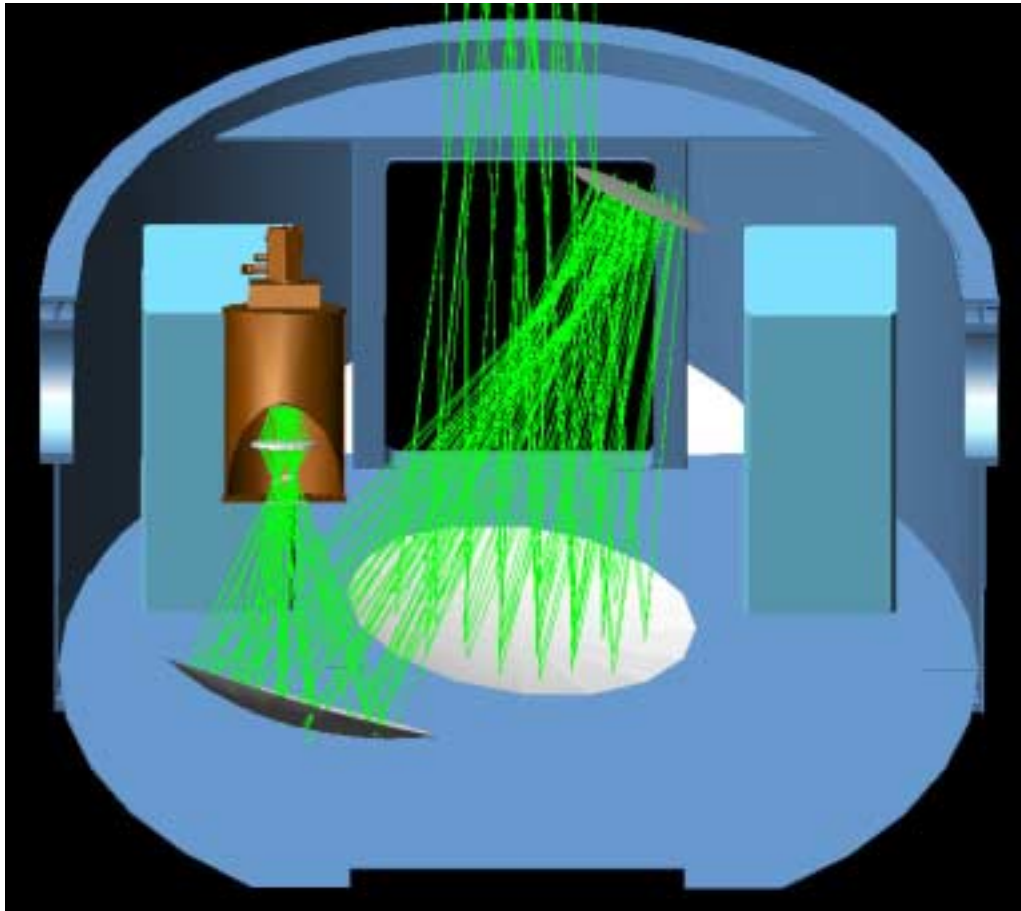


ALMA prototype

- Fabrication complete, parts en route to Atacama plateau
- 12 meter on-axis Cassegrain at 16,500 ft
- 0.4° maximum field of view
- 45'' resolution at $\lambda = 2$ mm
- $18 \mu\text{m}$ surface accuracy goal

- APEX-SZ has 25% time over two years

APEX-SZ Optics



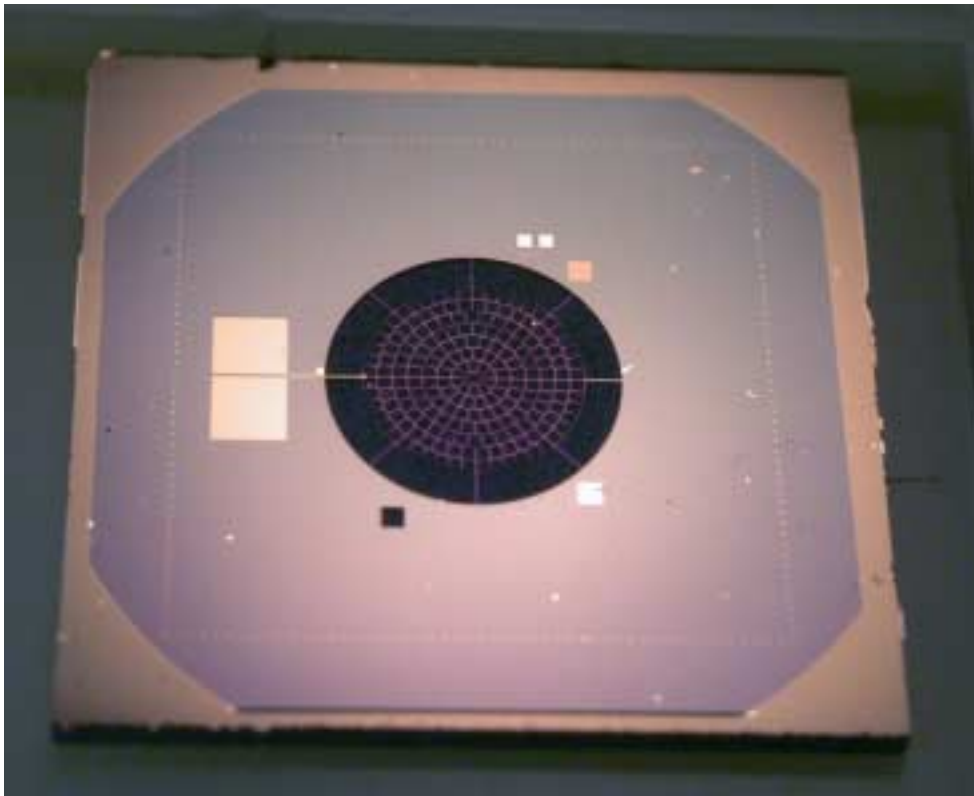
- 0.4 degree field of view
- $f / 1.6$
- 1.5 m tertiary
- Cold Lyot stop
- Cold lens
- $2f\lambda$ horn diameter, optimized for mapping speed

N. Halverson

APEX-SZ Receiver

- Single color observations at 2mm & 1.4 mm
 - Swap horns and filters for frequency change
- TES spider-web bolometers
- 324 element array fabricated at UC Berkeley
- Individual SQUID readouts
- Pulse-tube cooler

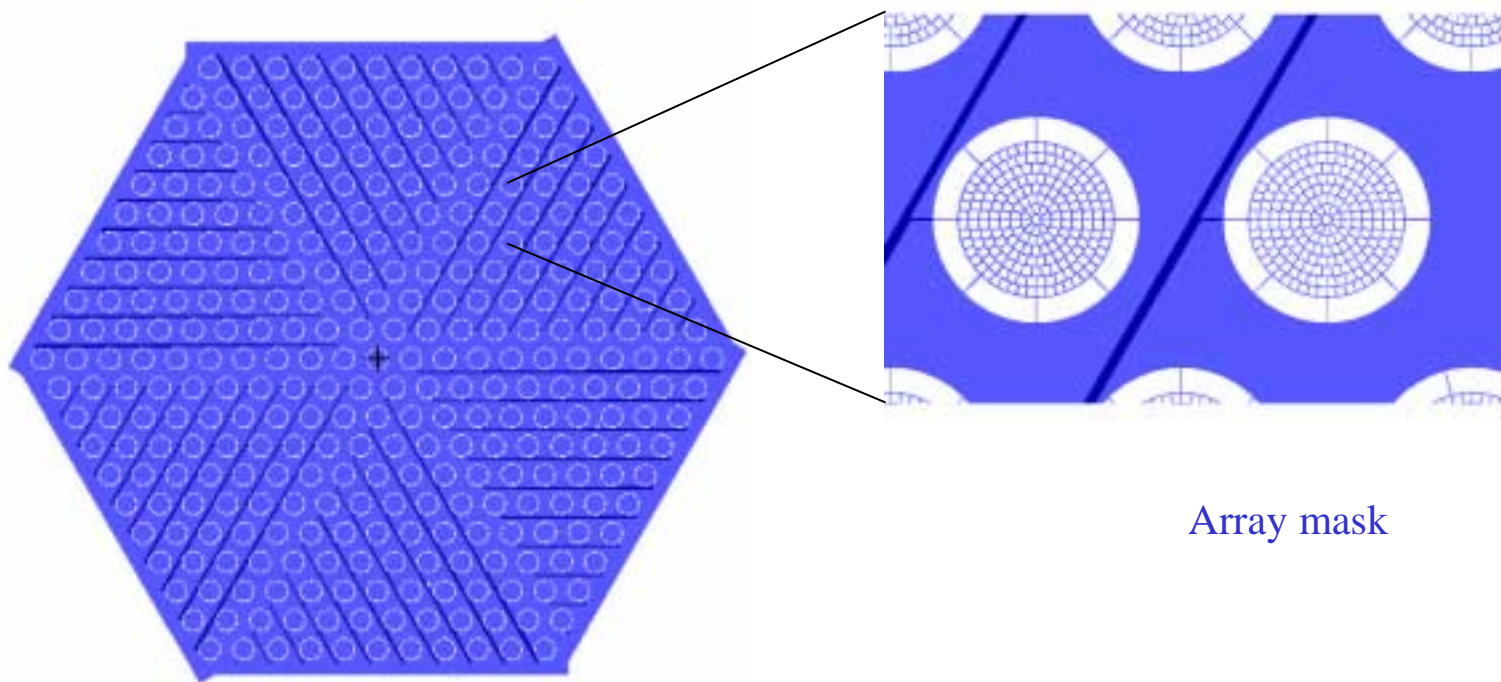
SZ-specific TES Bolometers



Bolometer prototype for APEX-SZ, SPT

- Geometry optimized for SZ observation
- Predicted $280\mu\text{K}\cdot\text{s}^{1/2}$
- Single bolometers fabricated and tested
- Array fabrication underway

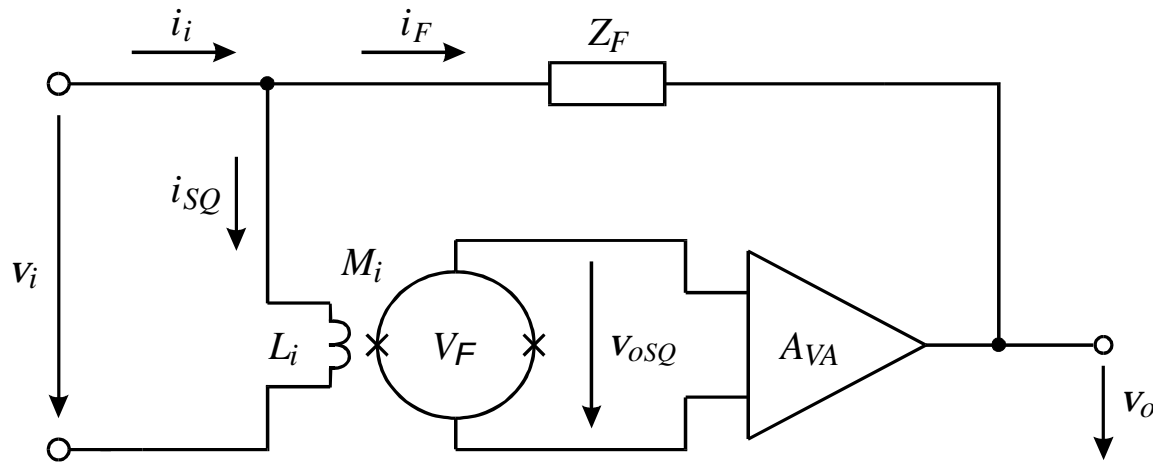
TES Bolometer Array



Array mask

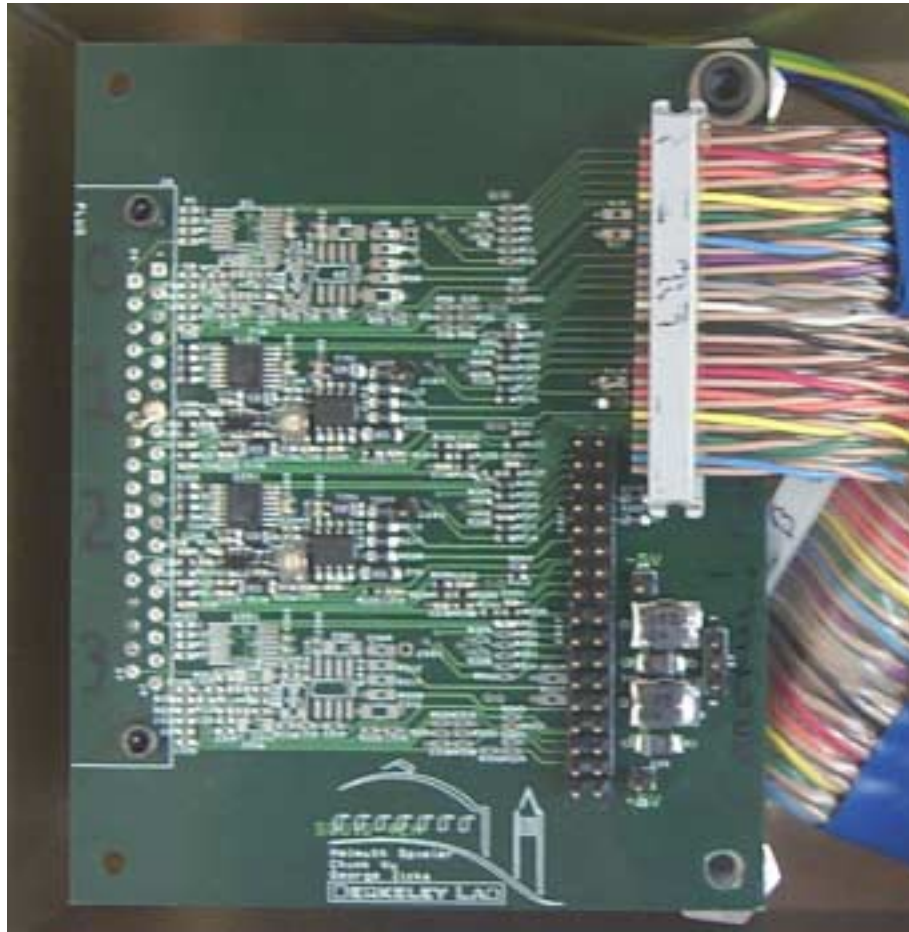
- 6 identical wedges

SQUID Readout Electronics



Shunt feedback SQUID amplifier

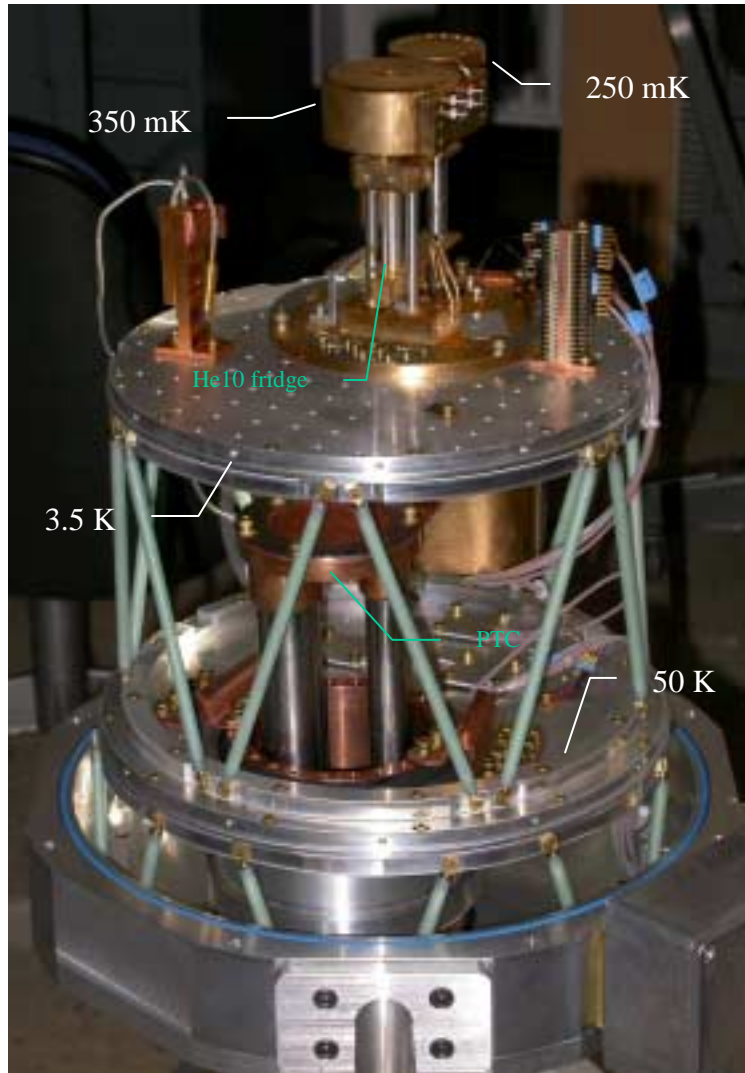
- Low input impedance to maintain constant voltage bias of bolometers
- Large dynamic range to accommodate AC bias up to 1 MHz
 - Compatible with multiplexing
- Successfully demonstrated concept, have moved on to next stage of development



Four channel shunt-feedback controller board

- On board DAC for autotuning
- Testing in progress

Pulse-Tube Cooler Testing

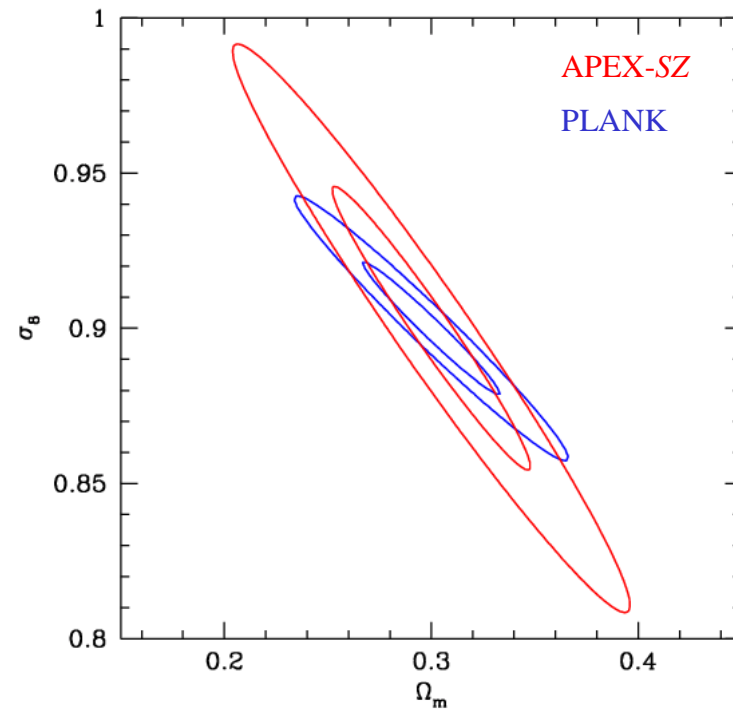
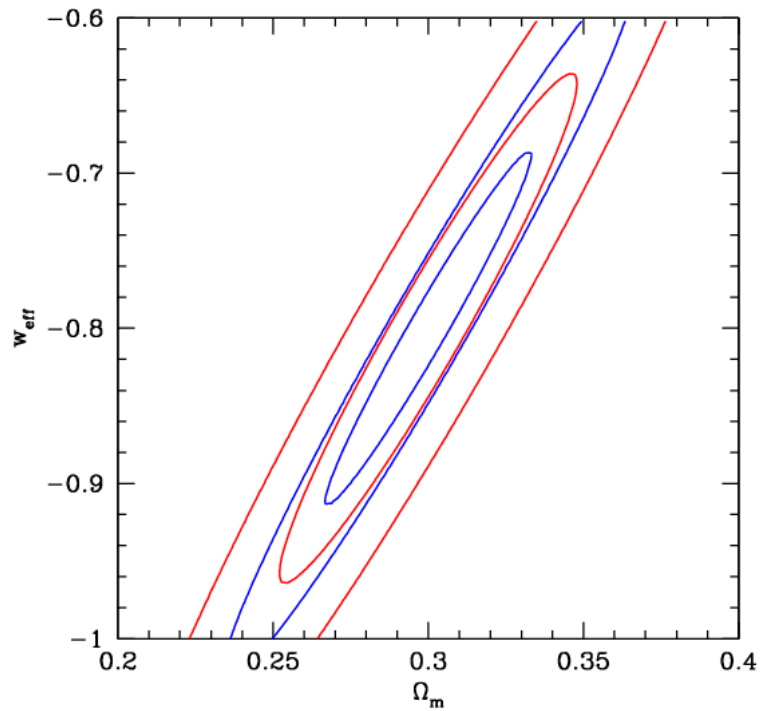


- Closed He gas cycle
 - No cryogenics
 - Reduces logistical and personnel demands
- 300mK for 50 hours
- Microphonics tests underway
- Dewar will be test bed for APEX-SZ, SPT and PolarBearR technologies

Science Goals

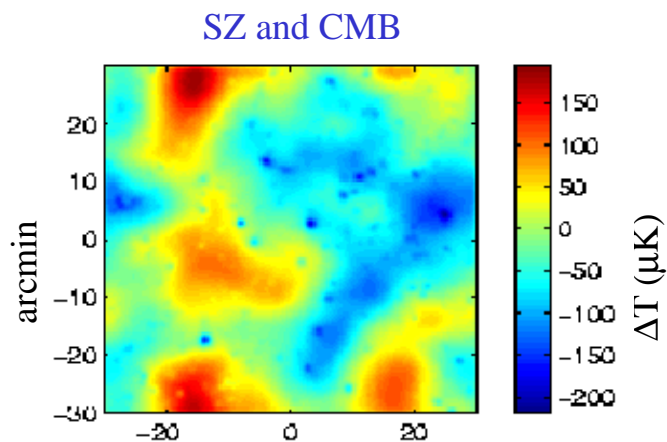
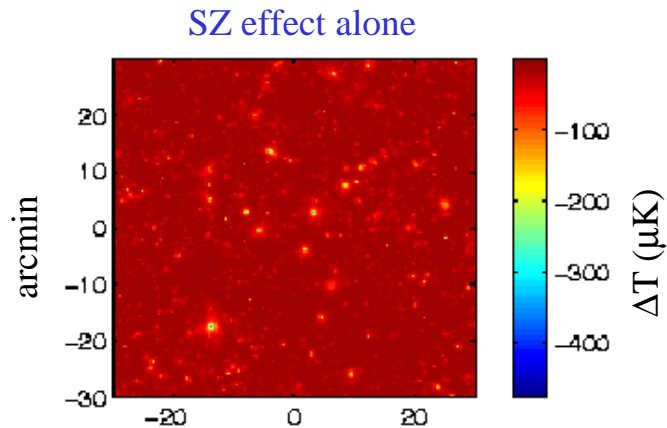
- Survey 250 sq. degrees to $10 \mu\text{K}$ per $0.8'$ pixel in two seasons
- Catalog 1000's of previously unknown galaxy clusters
- Observe evolution of structure and test theories of structure formation
 - Independently constrain Ω_m , w and σ_8
- Independent measurement of Hubble constant H_0 and acceleration parameter q_0
- Possibly study other CMB secondary anisotropies – weak lensing, Ostriker-Vishniac effect

Cosmology with SZ



courtesy M. White

Data Analysis Challenges



- Source confusion
 - CMB
 - Filamentary SZ
 - Point sources
 - Other foregrounds
- Y-distortion – mass relation
- Completeness
- Redshift information
- Etc ...

M. White

Project Status

- APEX-SZ receiver funded
- Telescope being shipped to Chile
- Diffraction limited tertiary optics designs achieved
- Single TES bolometer demonstrated, array fabrication in progress
- SQUID readout prototype fabricated and testing in progress
- Cryogenic testing of pulse-tube cooler in progress
- Investigating scan and analysis strategies
- First observations, early 2004

END TALK



<http://www.bolo.berkeley.edu/apexsz/>