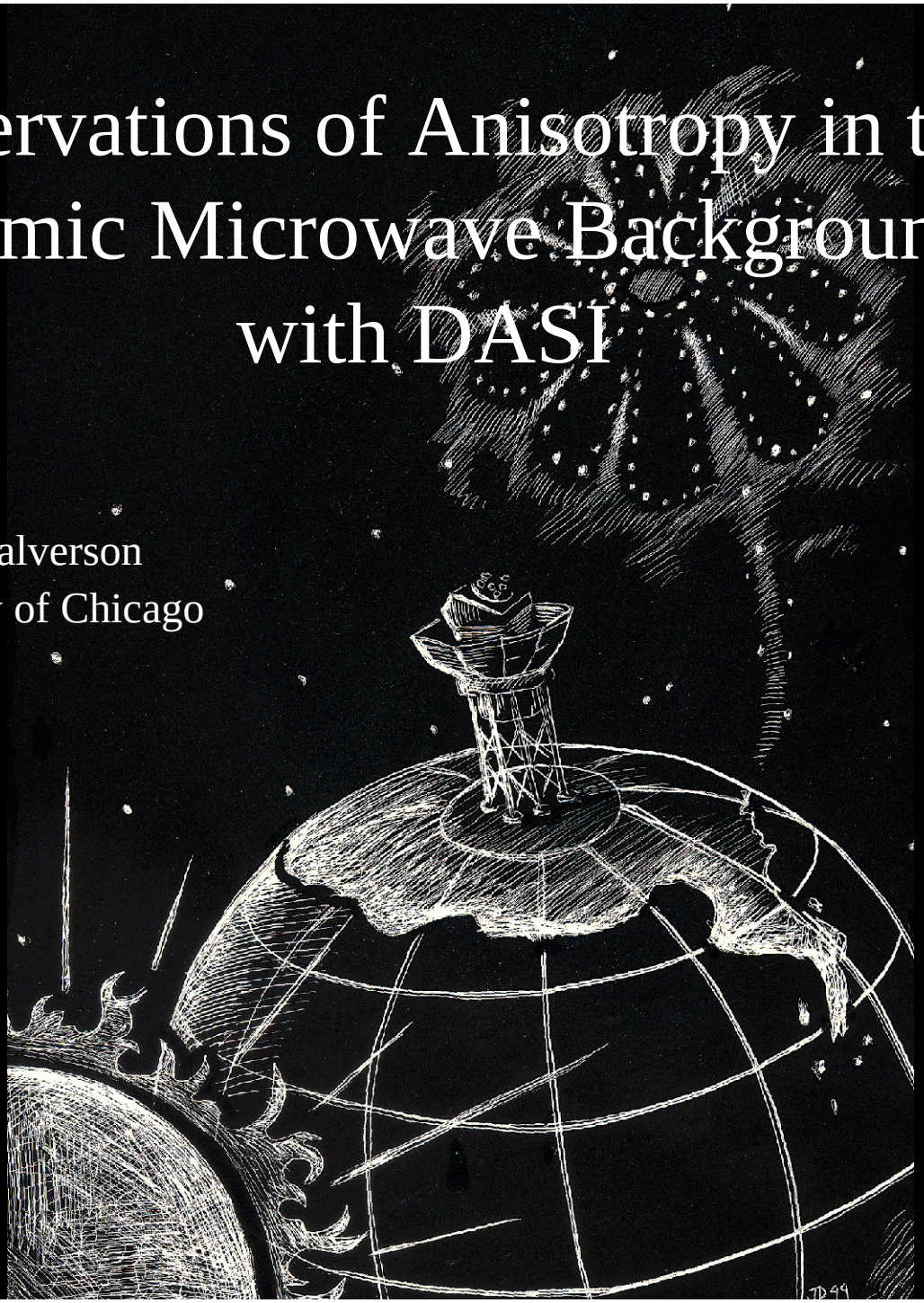
Observations of Anisotropy in the Cosmic Microwave Background with DASI

Nils Halverson
University of Chicago



Collaborators

DASI Team

University of Chicago

J. E. Carlstrom

M. Dragovan

N. W. Halverson

W. L. Holzapfel

J. Kovac

E. M. Leitch

C. Pryke

E. Schartman

S. LaRoque

G. Davidson

J. Yamasaki

CBI Team

Caltech

A. C. S. Readhead

S. Padin

J. Cartwright

T. Pearson

W. Schaal

M. Shepherd

J. Yamasaki

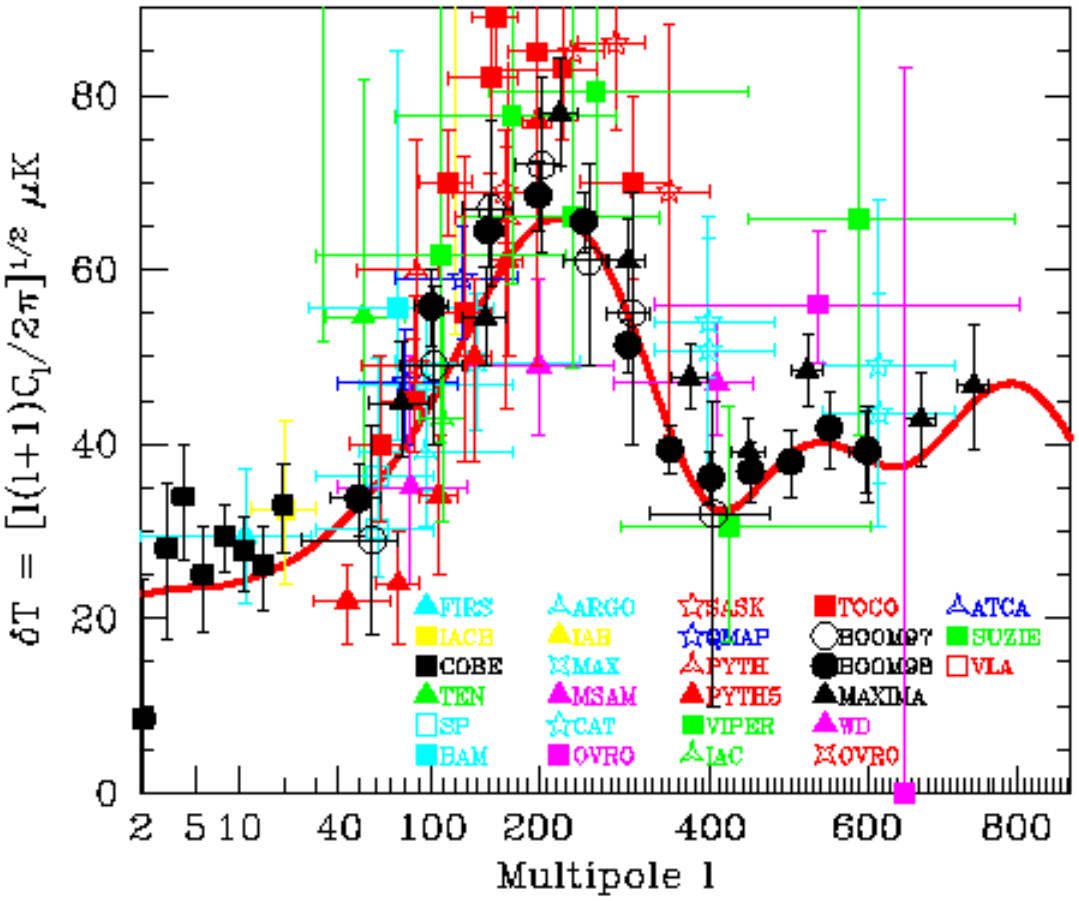
Also

M. White (UIUC)

M. Joy (MSFC)

S. Myers (NRAO)

CMB Anisotropy Measurements

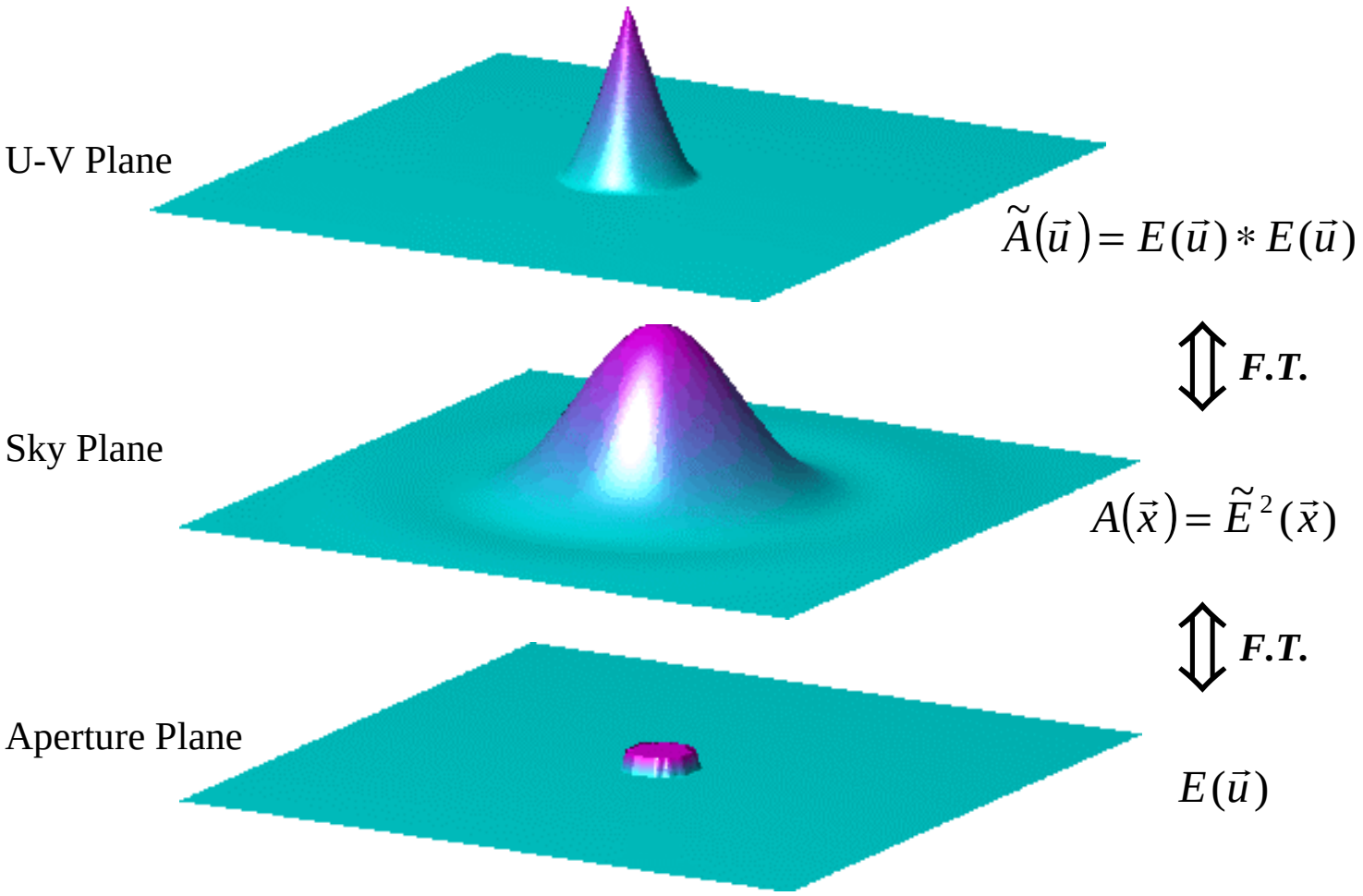


Tegmark, Nov. 2000

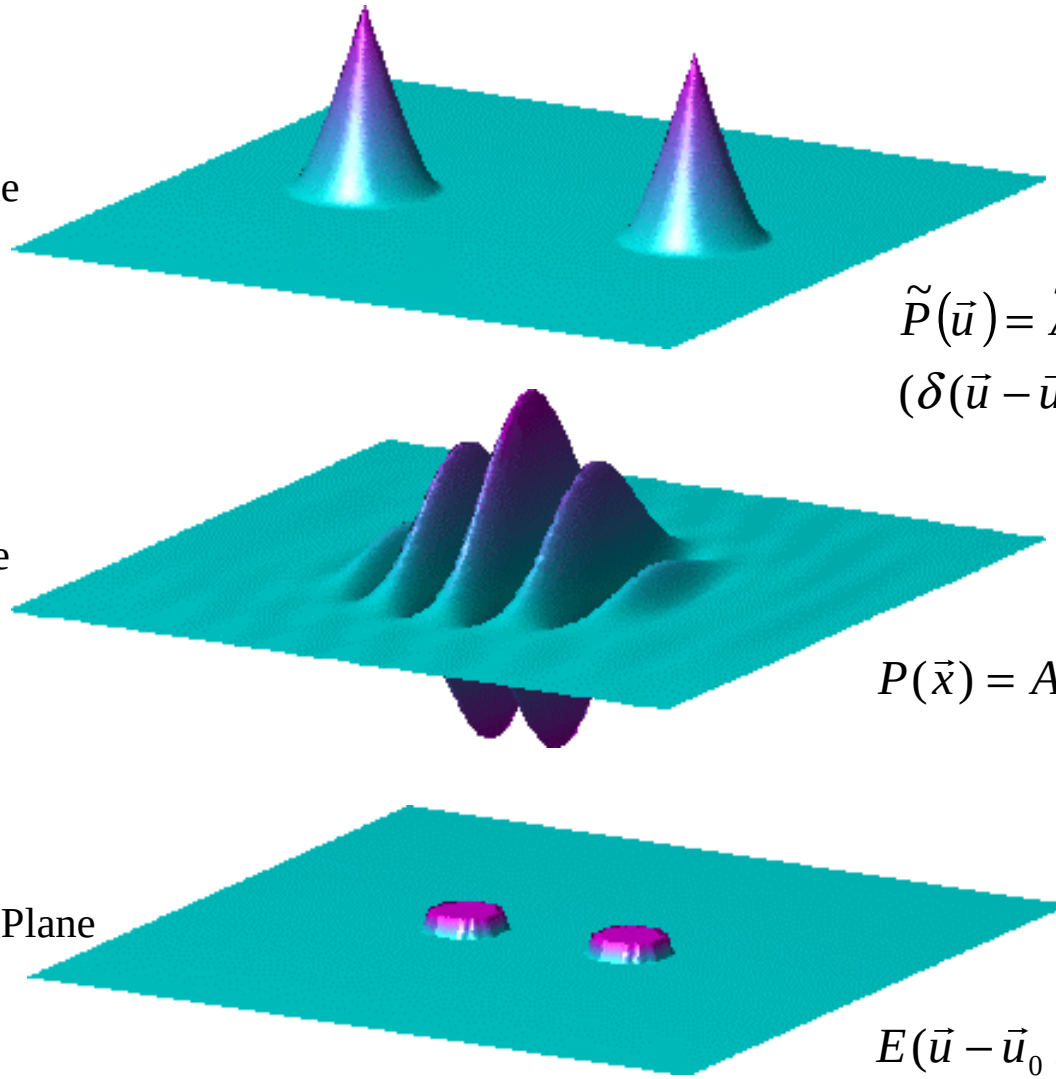
DASI Instrument

- CMB Anisotropy Experiment
  - angular scales $\theta \sim 0.2°$ to $1.3°$
  - angular wavenumbers $l \sim 140$ to 900
- 13 element compact interferometer
  - 20 cm diameter antennas
  - 120 cm maximum baseline
  - 25 cm minimum baseline
  - fixed rotatable aperture plane
- Ka band receivers
  - 26-36 GHz ($\lambda \sim 1$ cm)
  - HEMT amplifiers
- 10 GHz IF bandwidth
  - correlated in ten 1 GHz bands

Single Antenna



Interferometer



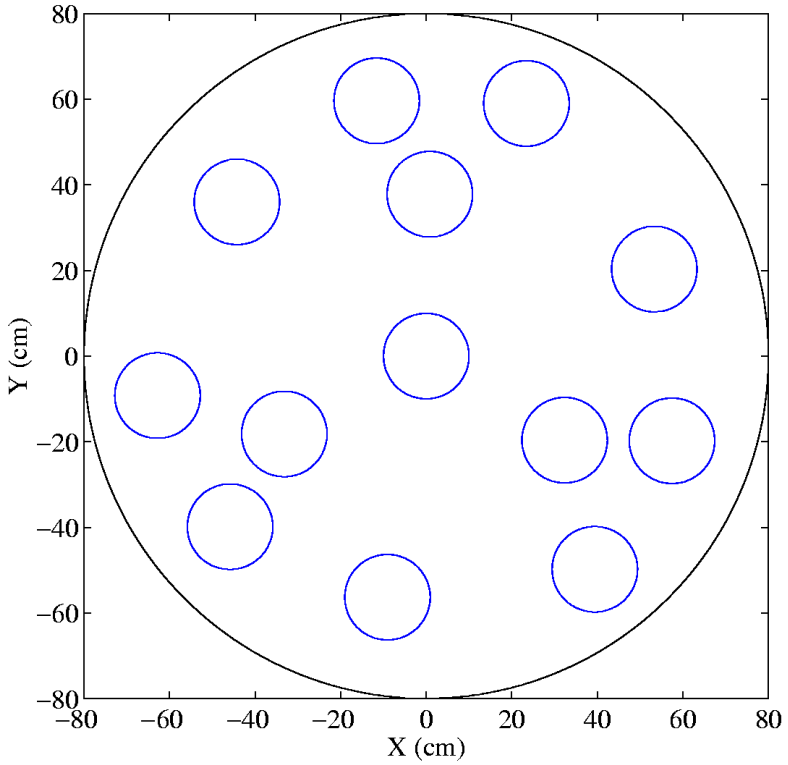
$$\tilde{P}(\vec{u}) = \tilde{A}(\vec{u}) * (\delta(\vec{u} - \vec{u}_0) + \delta(\vec{u} + \vec{u}_0))$$

F.T.

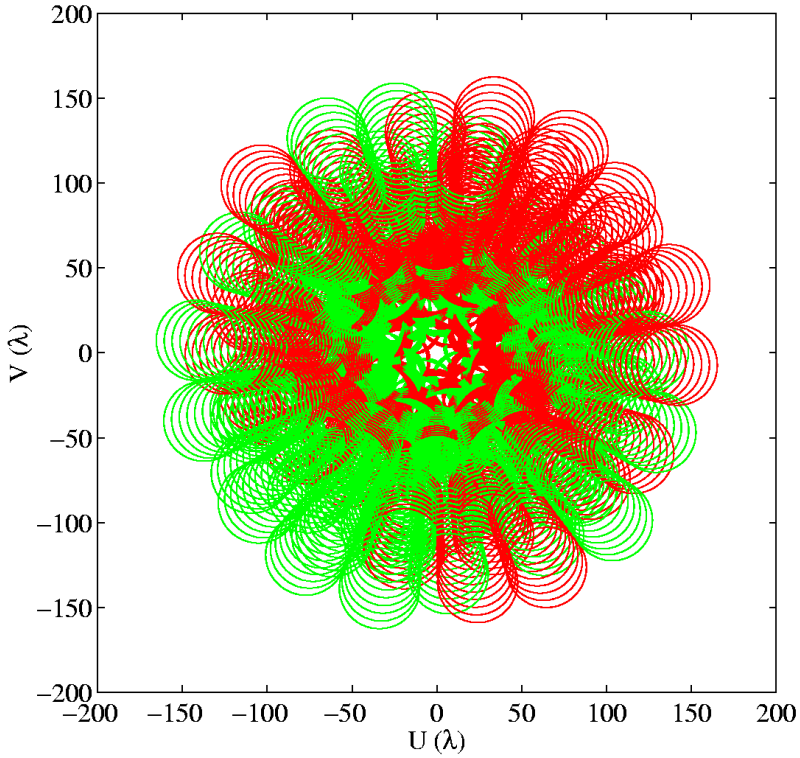
$$P(\vec{x}) = A(\vec{x}) \cos(2\pi \vec{u}_0 \cdot \vec{x})$$

$$E(\vec{u} - \vec{u}_0 / 2), E(\vec{u} + \vec{u}_0 / 2)$$

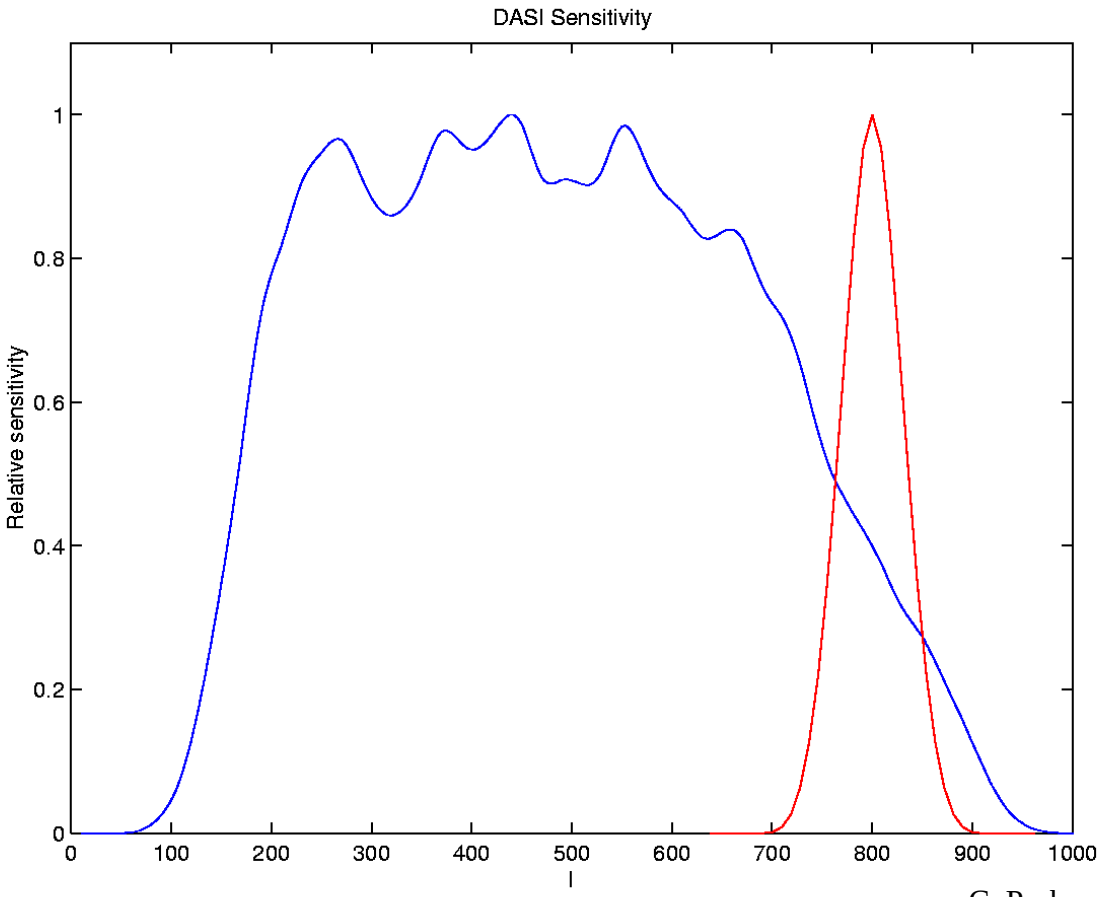
Aperture Configuration



U-V Coverage

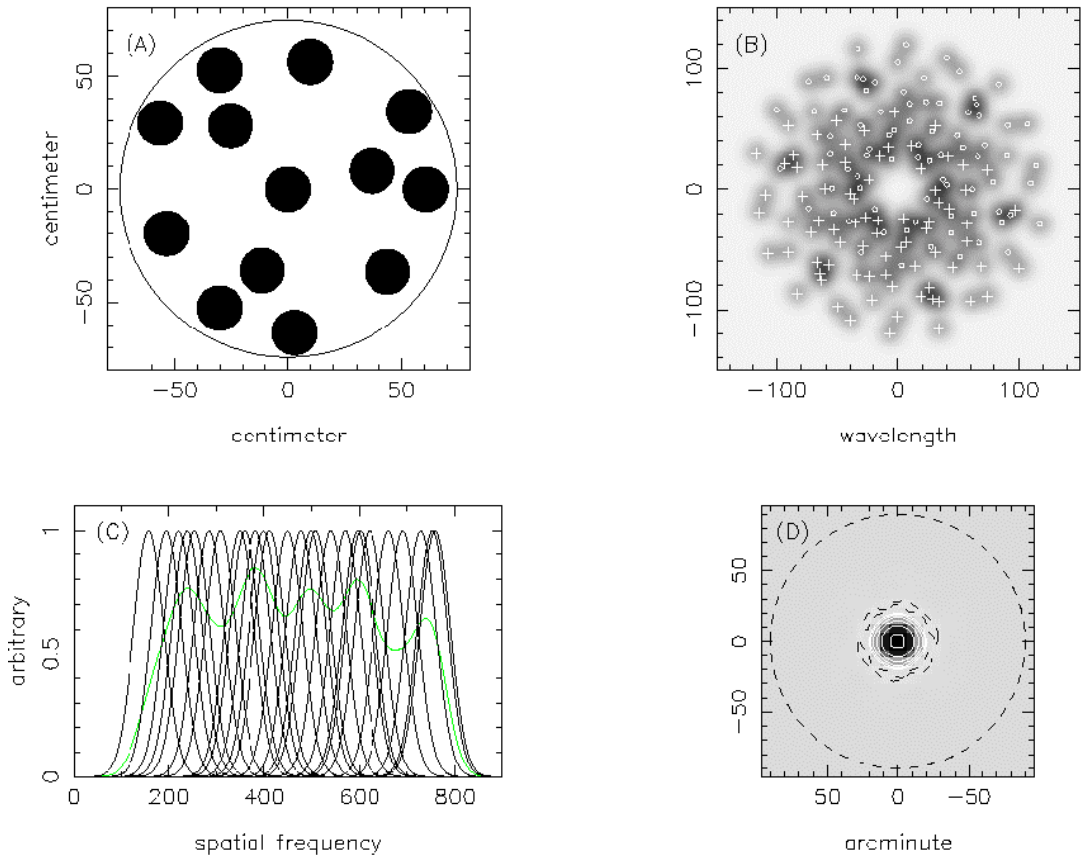


DASI L-space Sensitivity

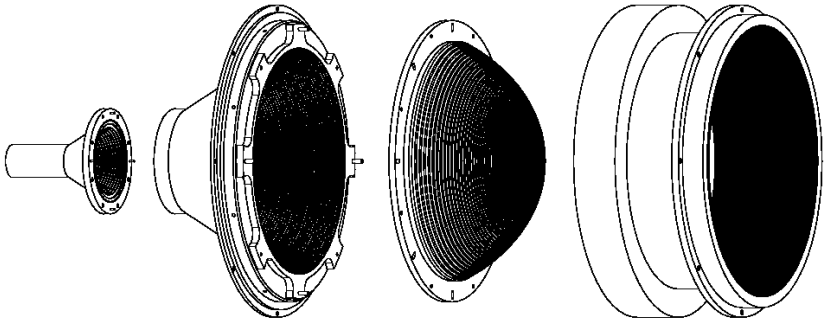


C. Pryke

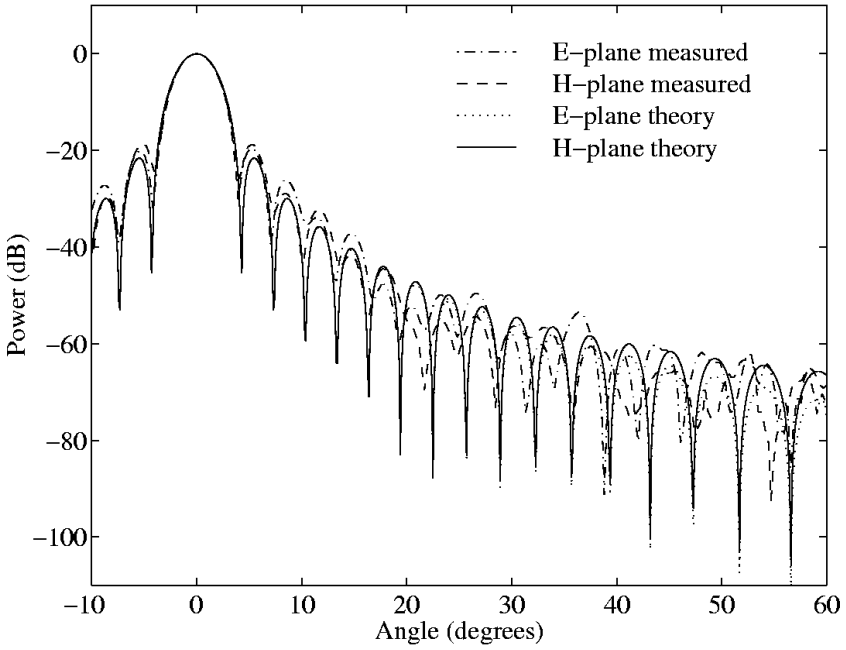
DASI Aperture Configuration



DASI Antennas

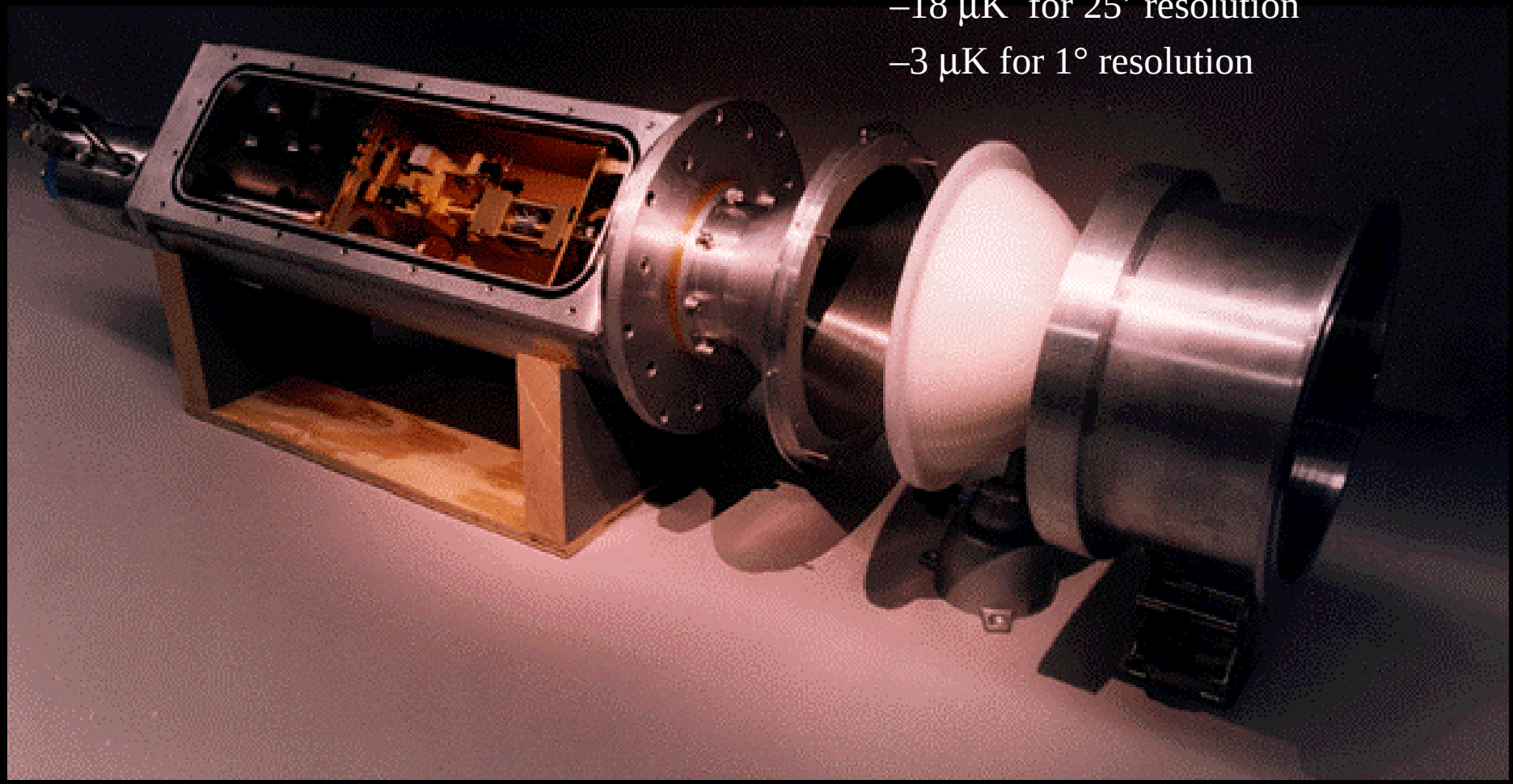


- 20 cm lensed corrugated horns
- Unobstructed apertures → low sidelobes
- Aperture efficiency 84%
- 3.4° FWHM diffraction limited beam at 30 GHz
- Crosstalk measured < -100 dB

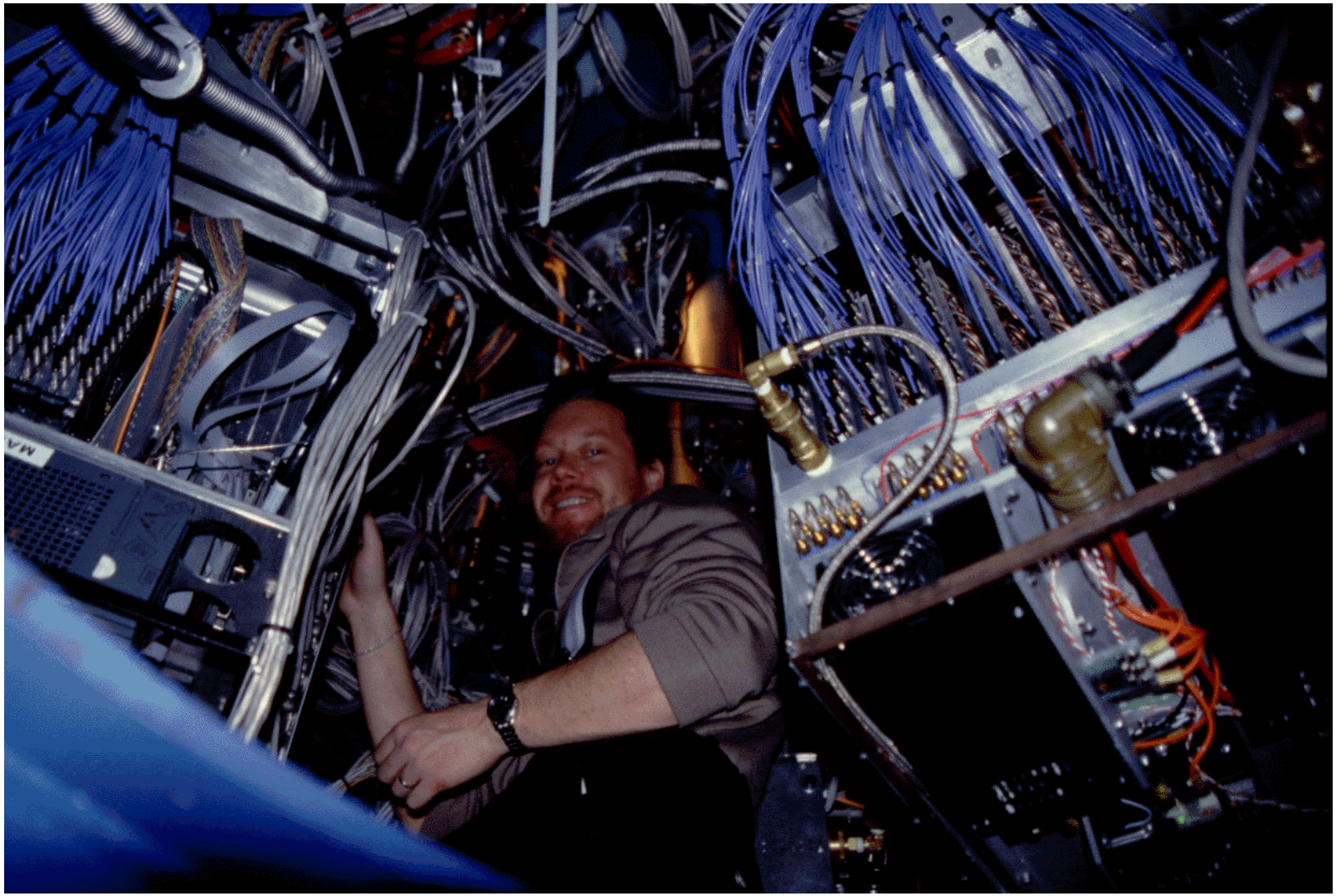


DASI Receivers

- 20 cm diameter lensed corrugated horn
- HEMT Ka band amplifier, 26-36 GHz
- T_{rx} ~ 18-25 K, T_{sys} ~ 30 K
- RMS image noise, 2 GHz band, 24 hrs:
  - –18 μK for 25’ resolution
  - –3 μK for 1° resolution

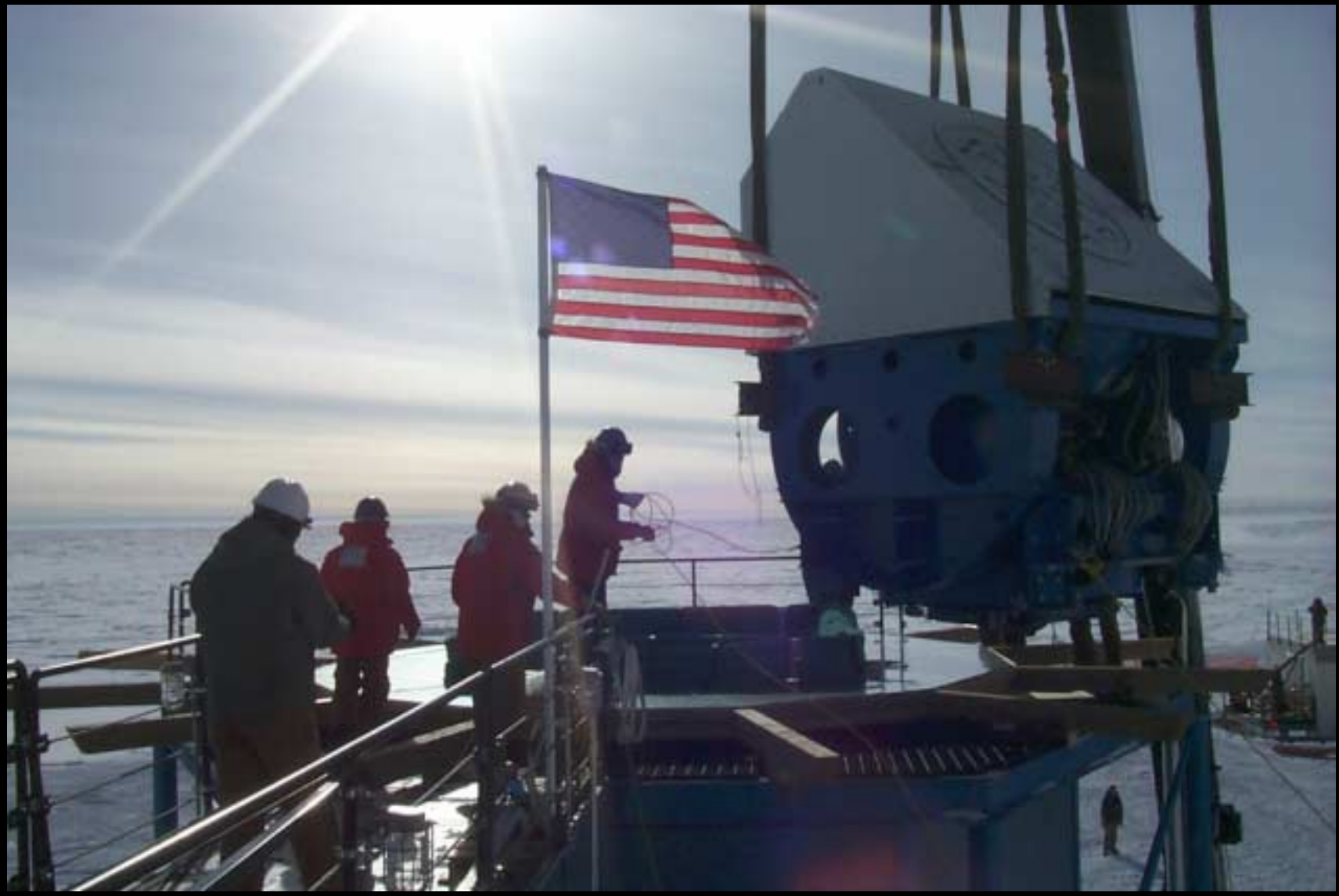


Inside DASI

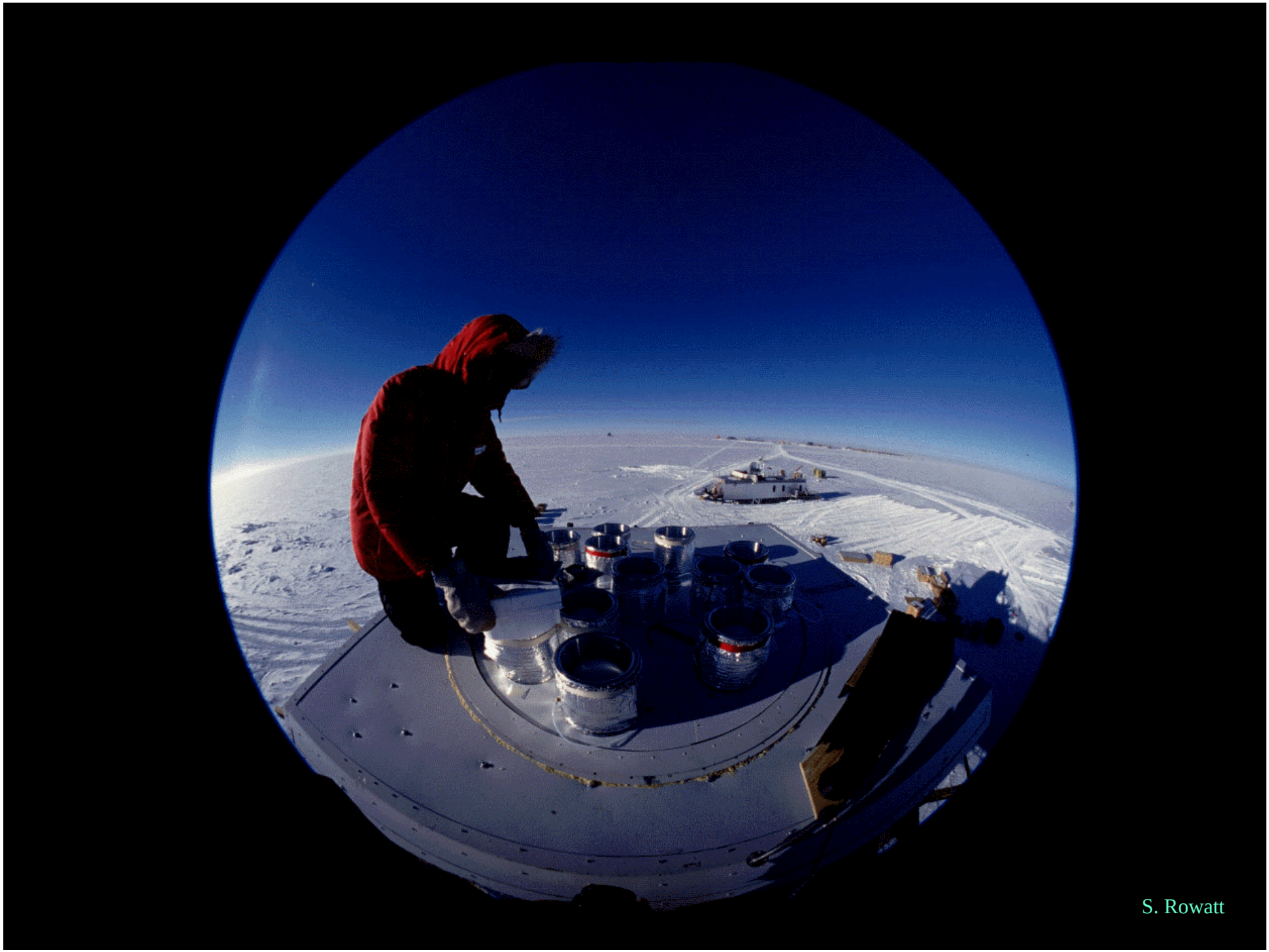



WHITING

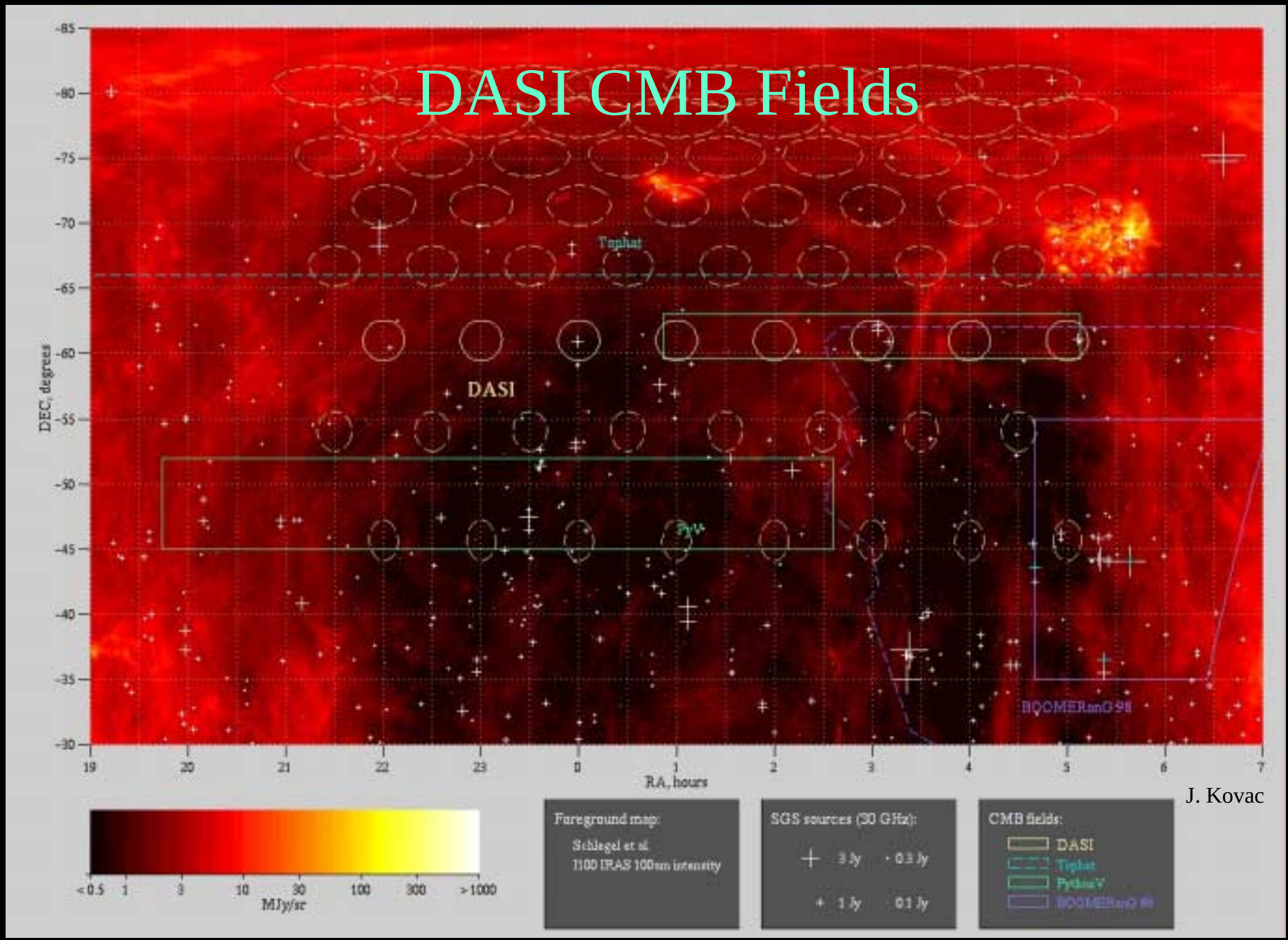
S. Rowatt



S. Rowatt

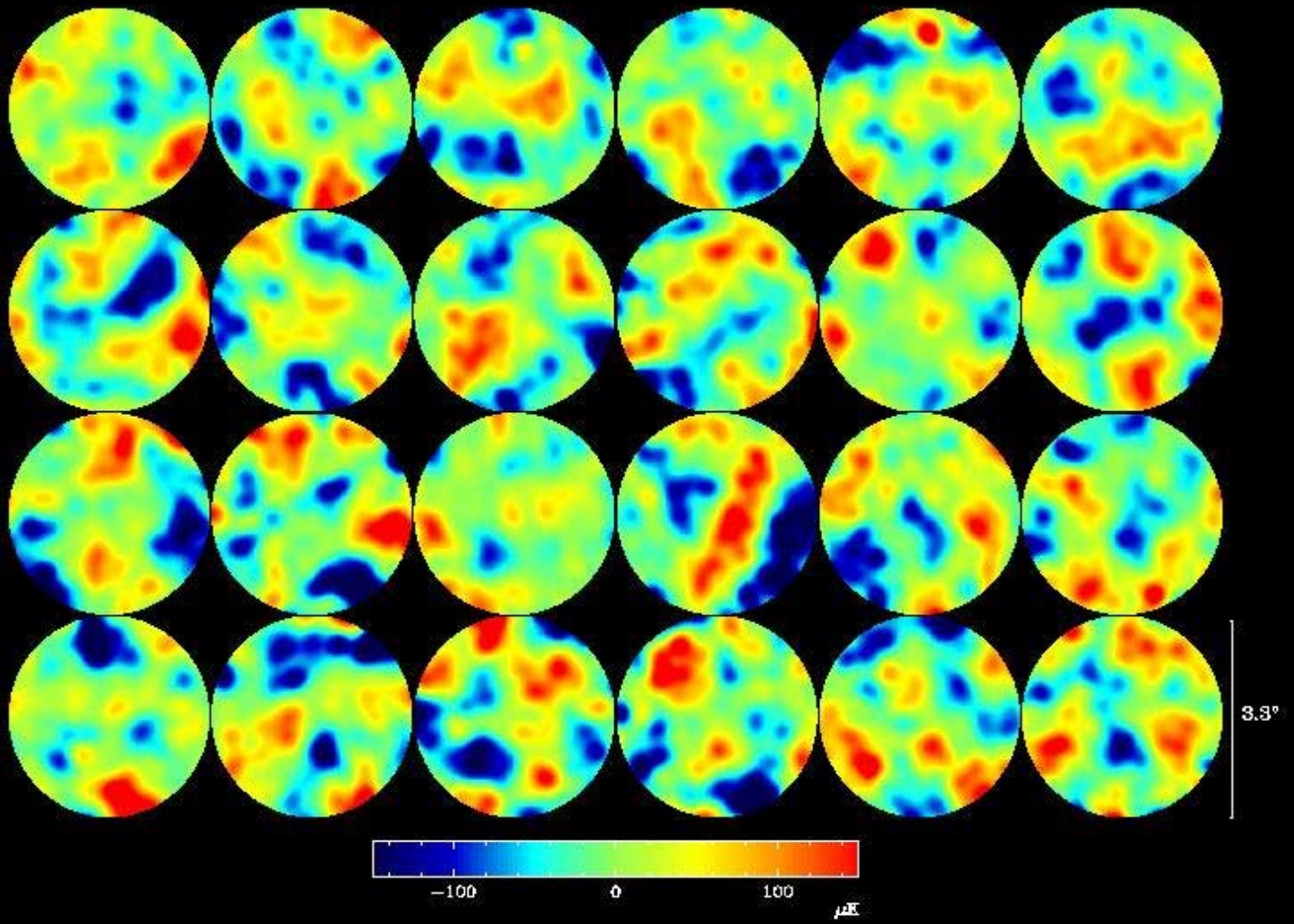

S. Rowatt

DASI CMB Fields

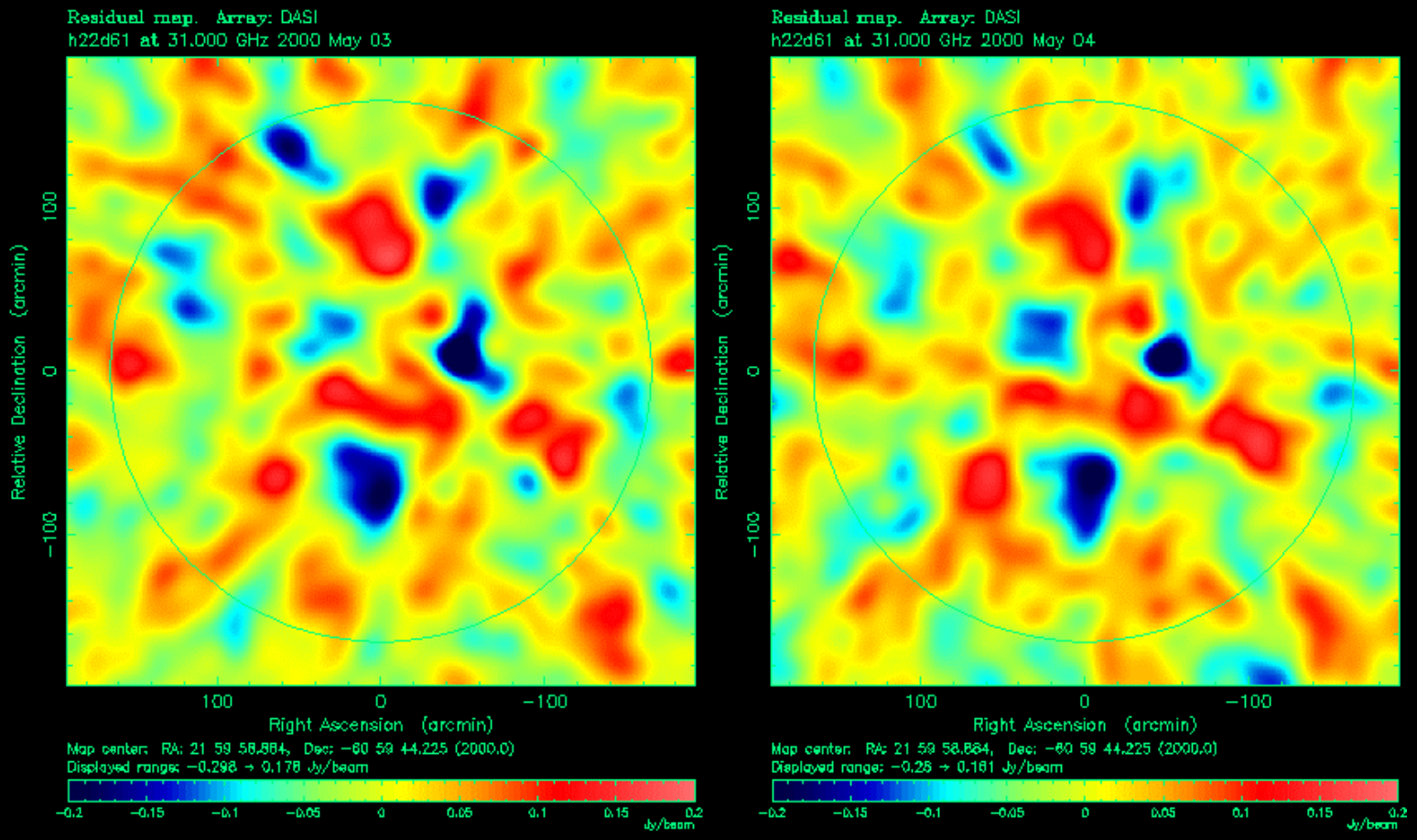


J. Kovac

CMB A, B, C Fields

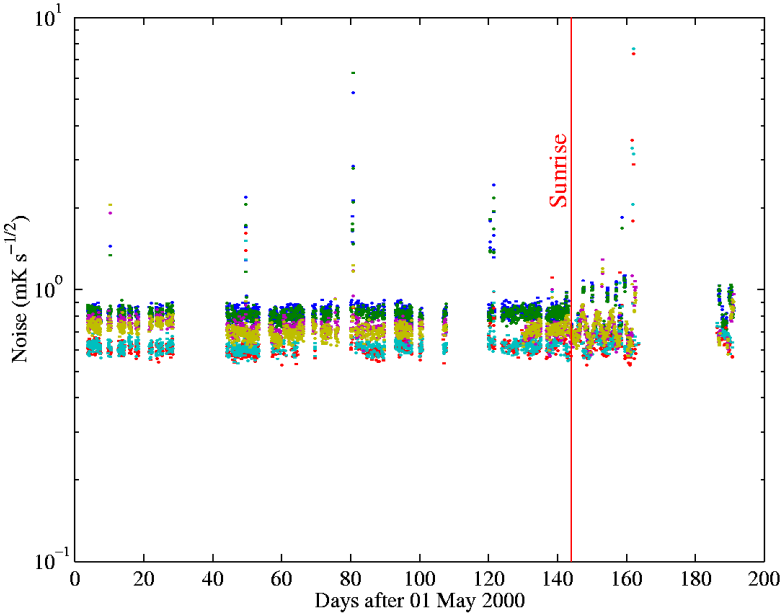


Azimuth Range Data Comparison

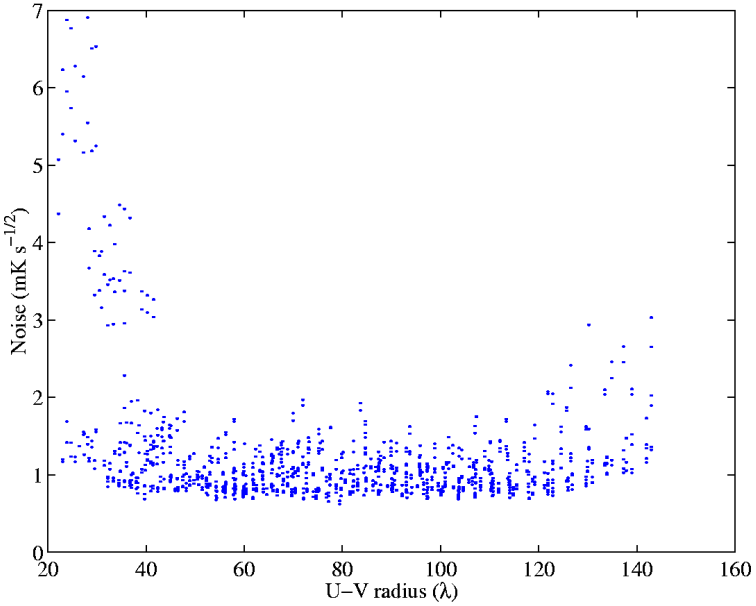


Weather Cuts

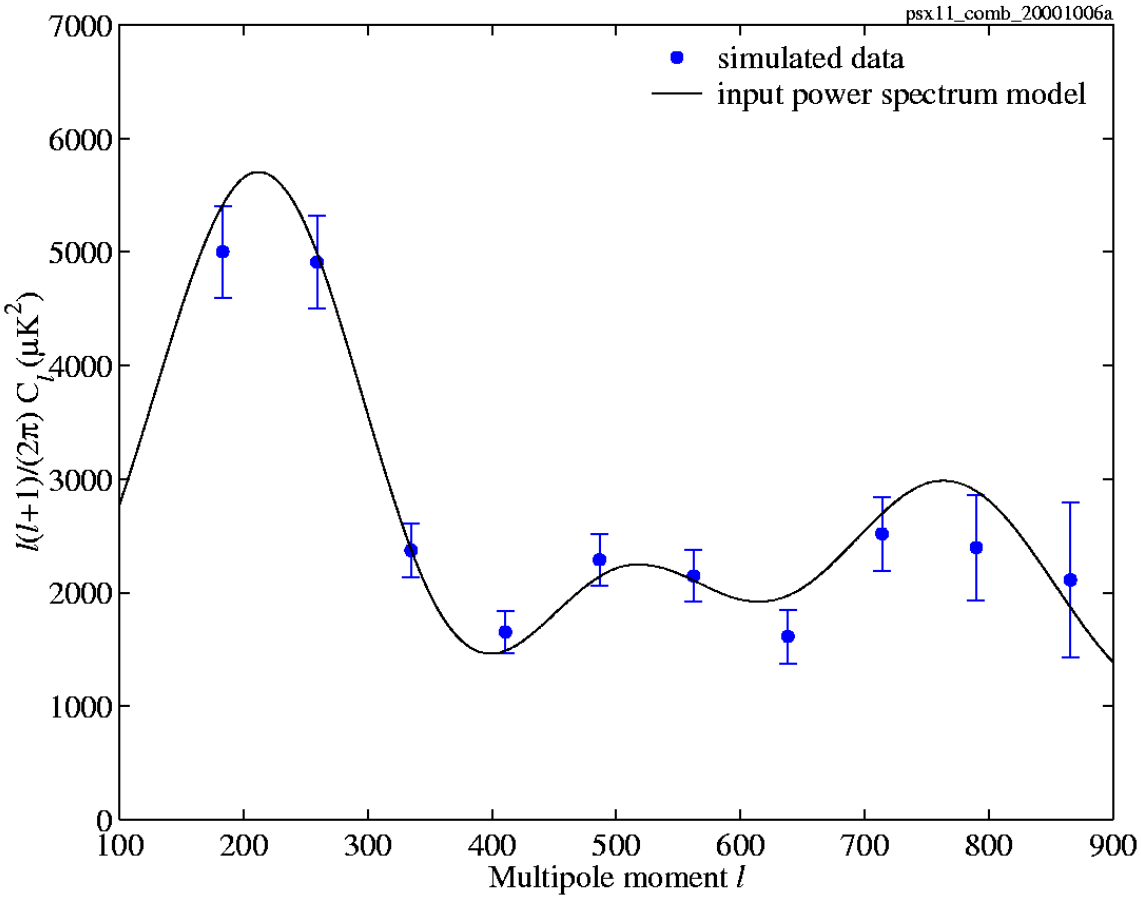
Short Baseline Timestream Noise



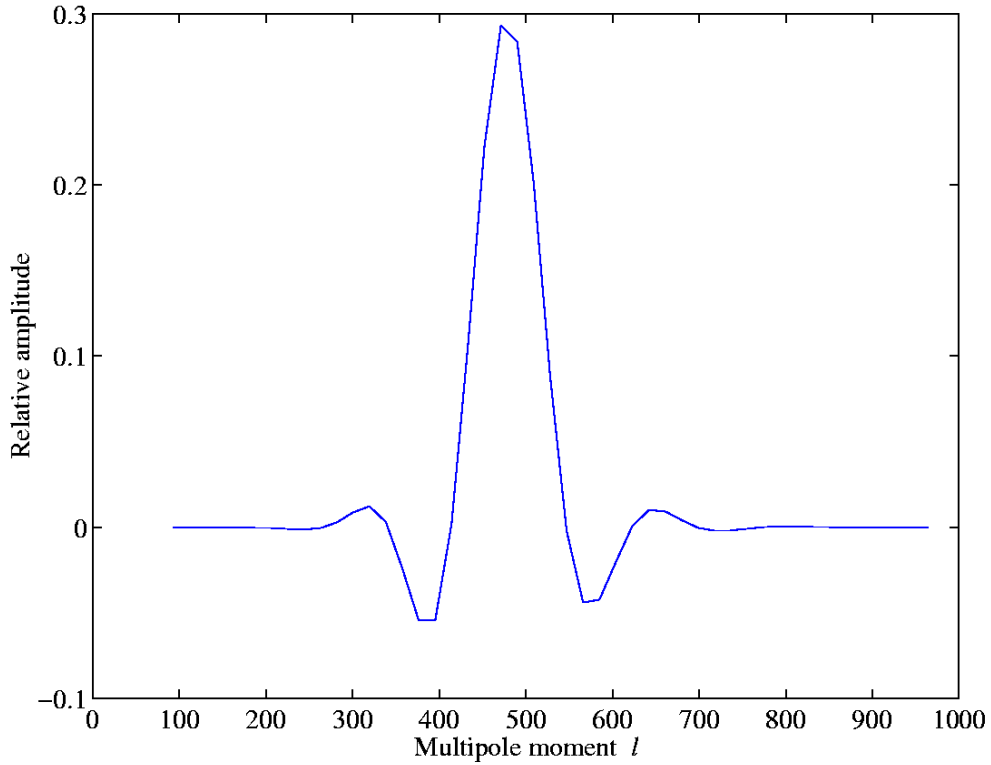
Poor Weather Noise vs. U-V Radius



Power Spectrum Sensitivity



Window Functions



$$\langle C_B \rangle = \sum_\ell C_\ell \frac{W_\ell^B}{\ell}$$