The Millimeter-wave Bolometric Interferometer (MBI)

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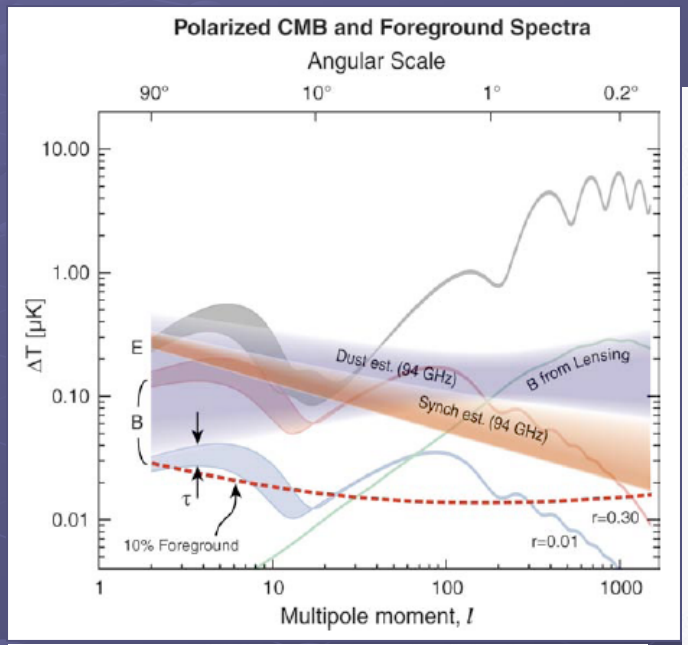
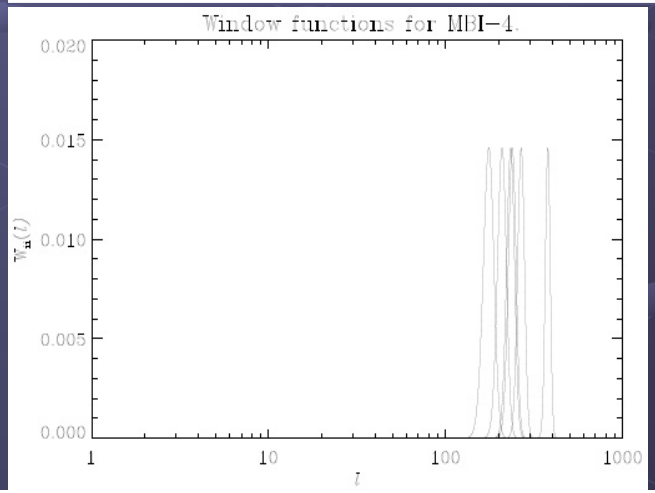
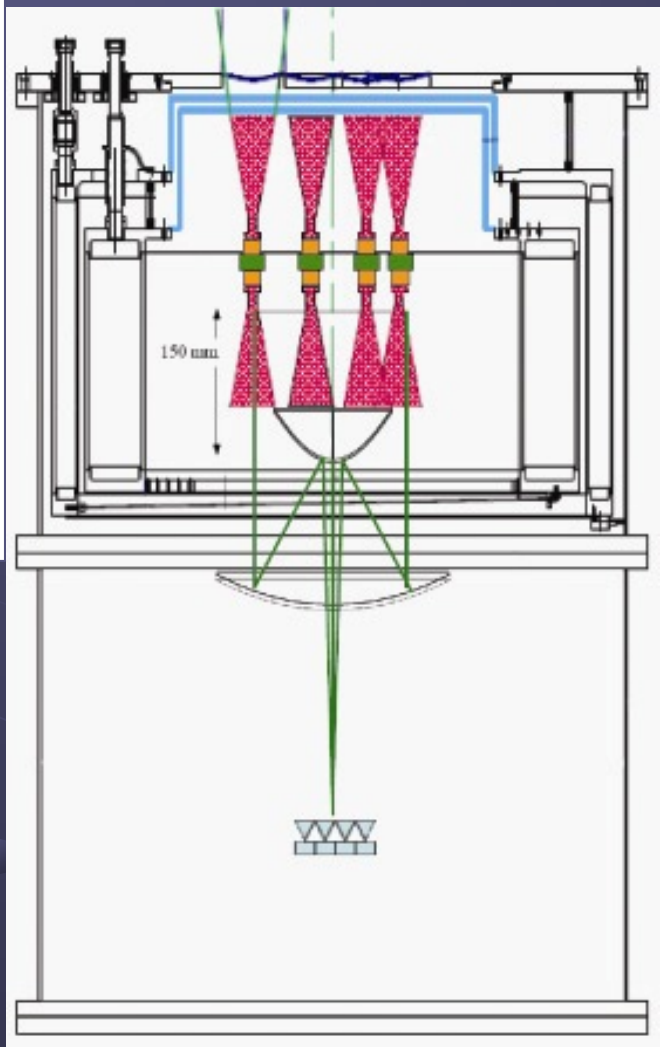
MBI

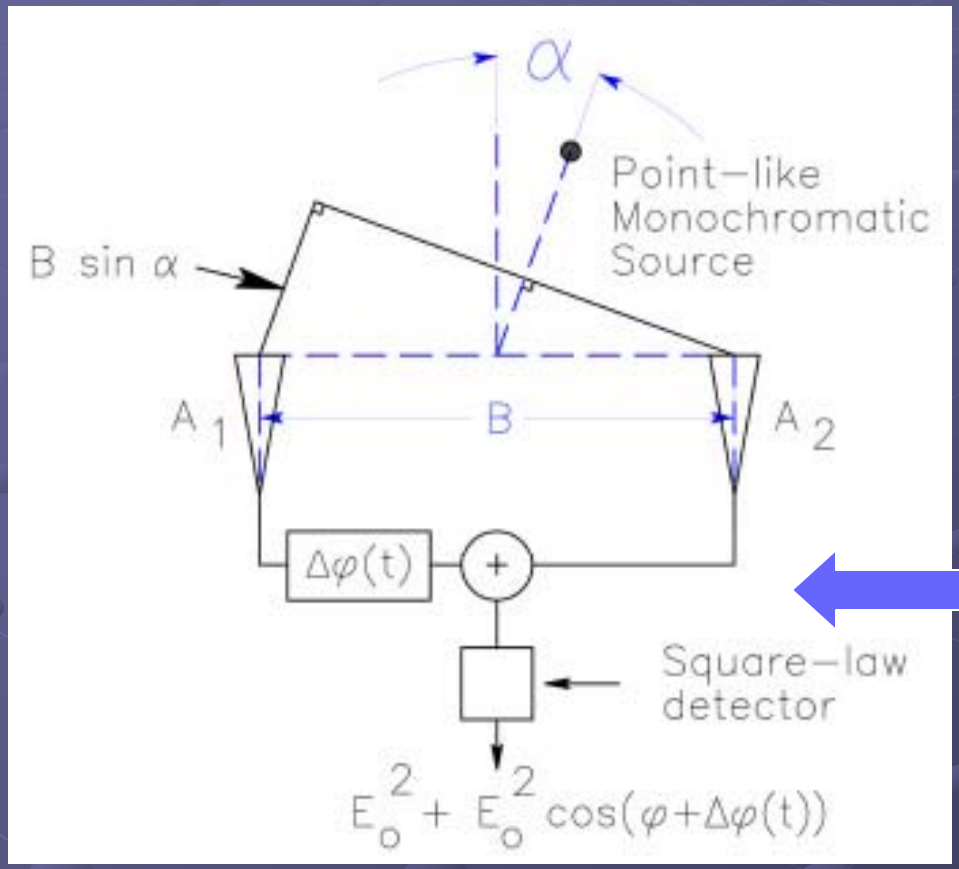
- Uses interferometry & bolometers to search for B-Mode Polarization.
- Interferometry used to control systematic effects.
- MBI-4, at 90 GHz, is the first step in this process.
- Interference from quasi-optical beam combination.
- Observes the sky directly with four corrugated horn antennas.







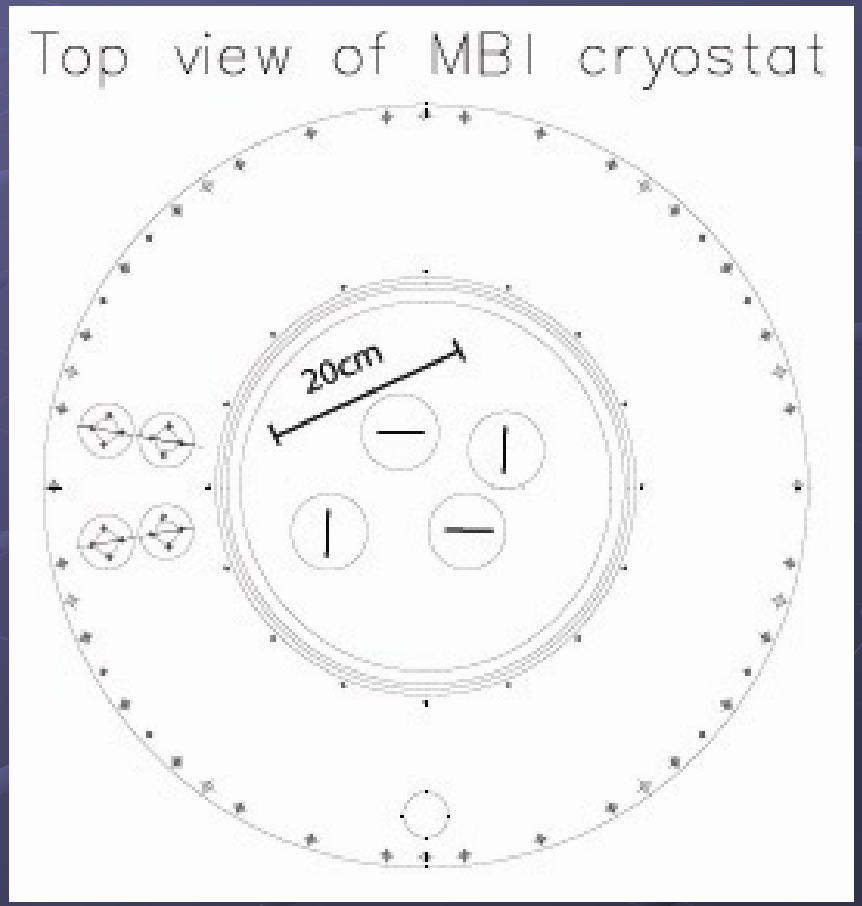
Interferometers



- Give instantaneous differencing measurement, no chopping needed.
- Directly measure Fourier modes (ℓ modes).
- Possible to observe without reflective optics. (horns only)
- Can be very stable. (e.g. DASI & CBI)
- MBI is an adding interferometer.
- DASI, CBI use coherent receivers to form multiplying interferometers.

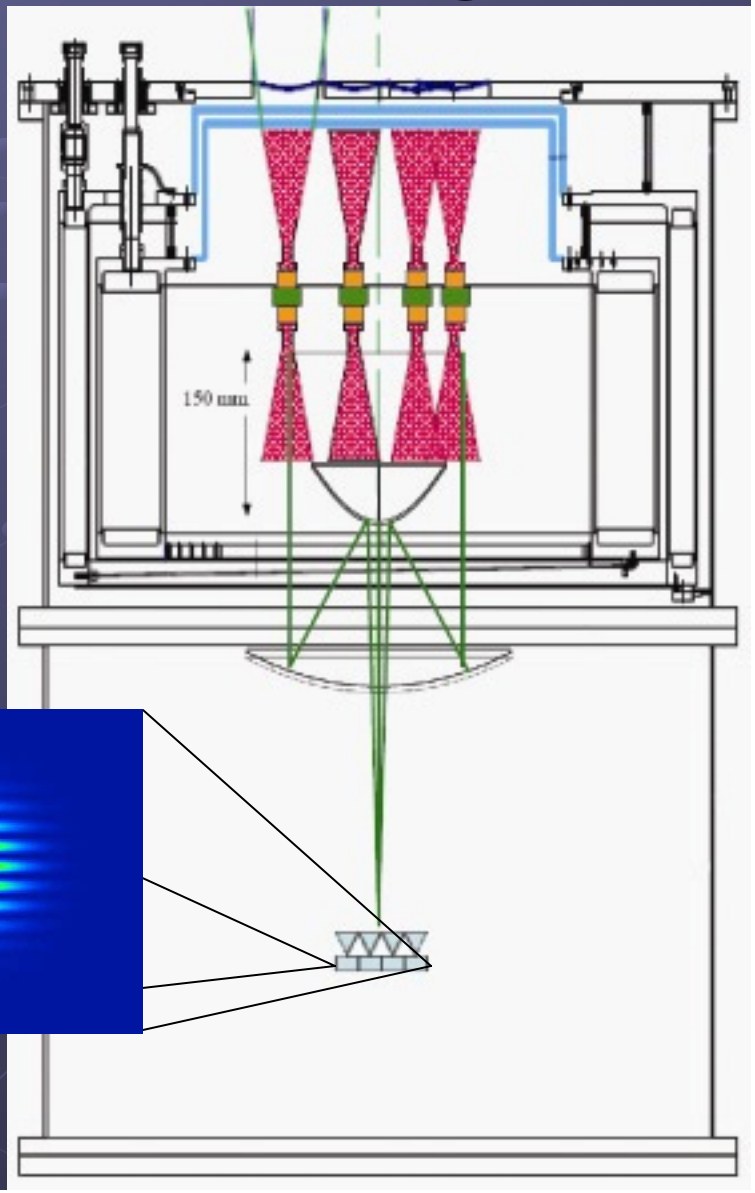
MBI-4

- MBI-4 horns have Gaussian 8° FWHM FOV.
- Four low side-lobe corrugated horn antennas.
- Our baseline lengths produce sensitivity to Fourier ℓ values from 150 to 270 with a $\Delta\ell/\ell$ = 0.3.
- ℓ range optimized for B-mode sensitivity and u-v coverage.
- Alternating a phase shift of ±90° allows for the recovery of differences at all points in the focal plane.

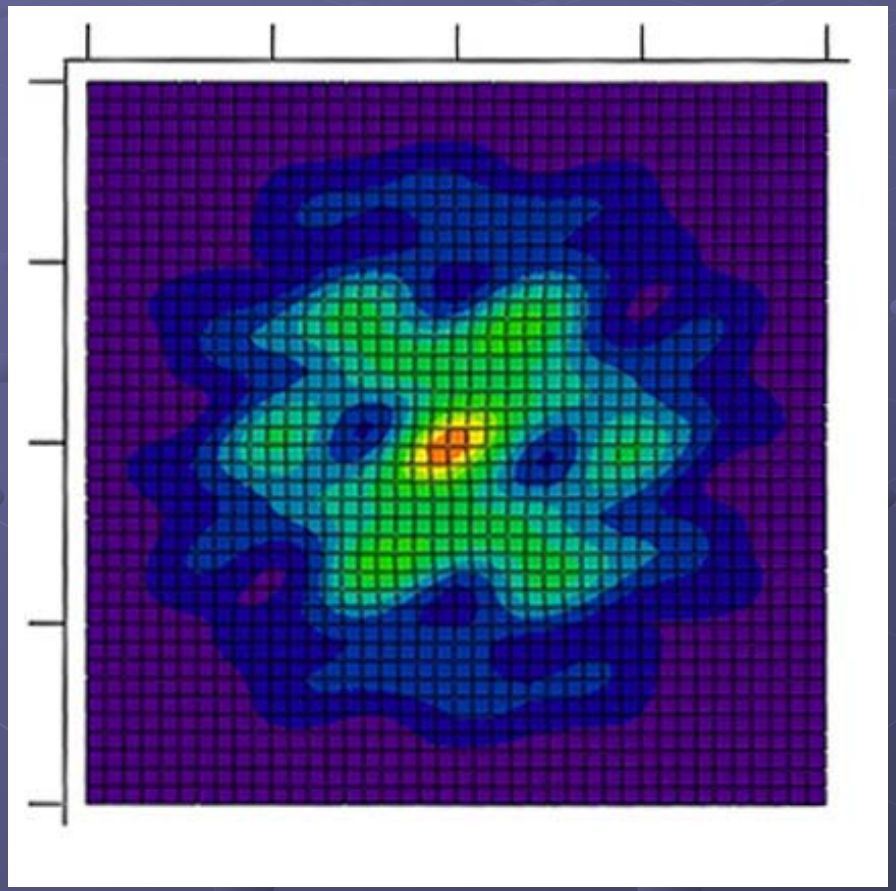


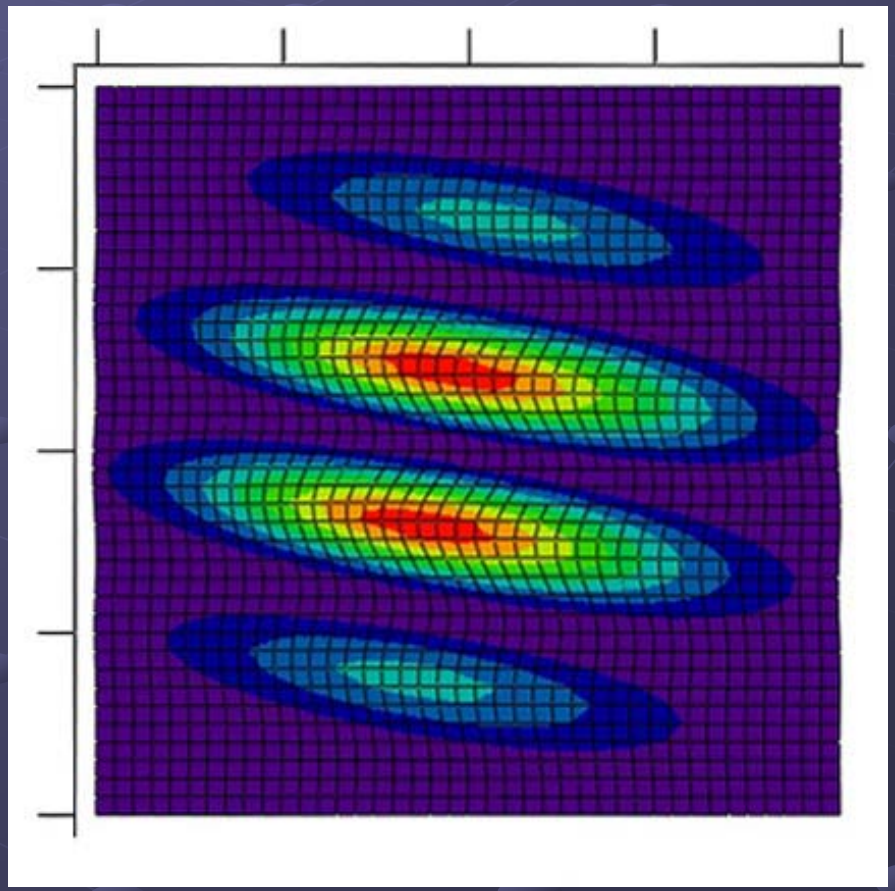
Fringes and Phase Shifting

- We use the fringe pattern in the focal plane to recover full visibilities for Stokes' parameters T, Q and U.
- These are used to compute power spectra for TT, TE, EE and BB.
- Phase switching with waveguide Faraday rotators occurs after the sky horns.
- Phases of horns are modulated by ±90º sequentially.
- We recover the fringe signal for each baseline by using lock-in detection.



Effect of Phase Shifting





Bolometers

- More sensitive above 90 GHz than HEMT amplifiers
- Spiderweb bolometers (JPL)
- Polarizations selected by single mode wave guides. (not PSBs)
- Array of 16 (4x4) bolometers in the focal plane.
- Bolometers cooled to 340 mK using ^{3}He refrigerator.

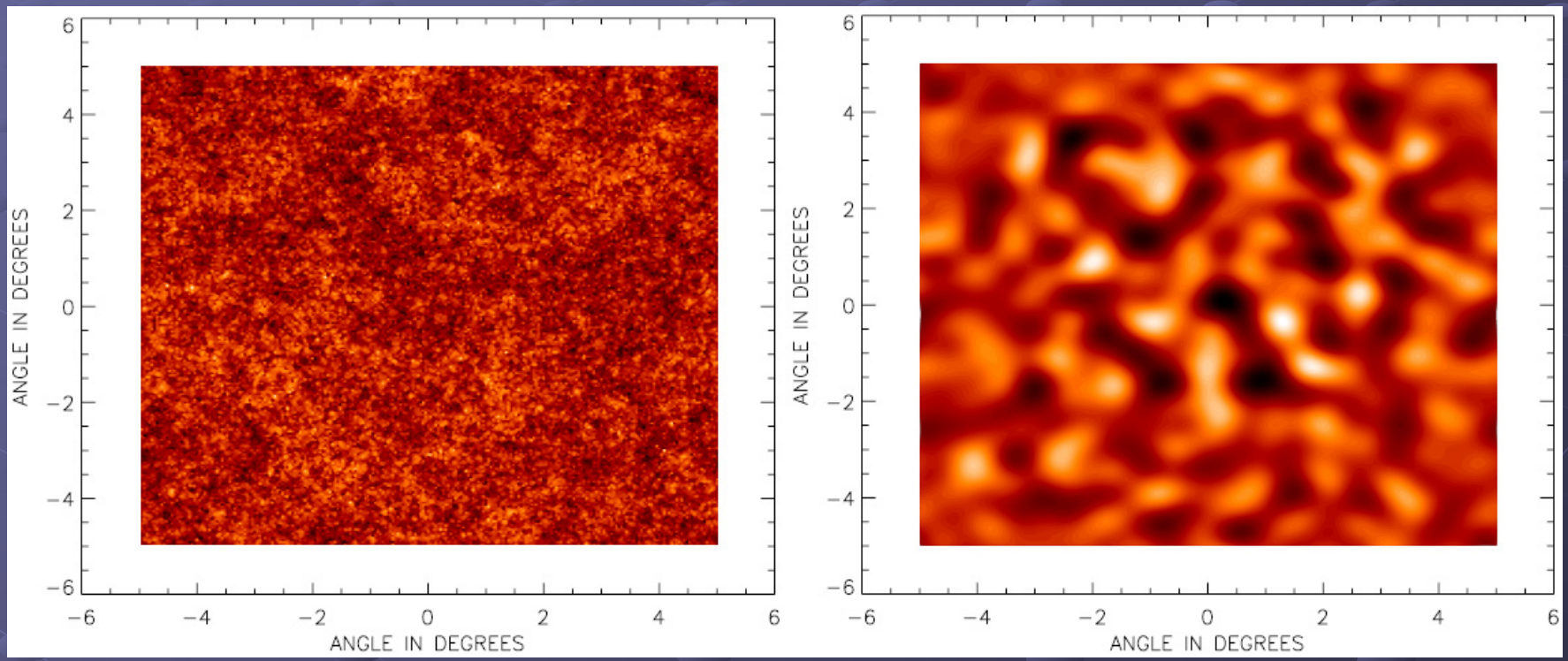
Sensitivity & Observations

- Observations of the North Celestial Pole will be made this winter from Pine Bluff, WI.
- Multiple signal modulations: instrument rotation, sky rotation
- Rotations provide dense, uniform coverage in the u-v plane
- Sky temperature of ~50K, optical efficiency ~50% yield expected sensitivity per visibility of ~250 $\mu K\sqrt{s}$
- Reach μK sensitivity with ~20 hrs observing (E-Mode level)

Simulated Analysis

Simulated CMB temperature on sky.

Recovered from MBI-4



Status

- First light expected late winter ’06.

Future Steps

- Close packed horn array
- More frequencies
- Move to White Mt., CA

MBI collaboration

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