



# Ultra High Energy Cosmology with the POLARBEAR Telescope



Stephanie Moyerman

(for Brian Keating)

UCSD

DPF 2011



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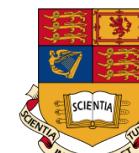


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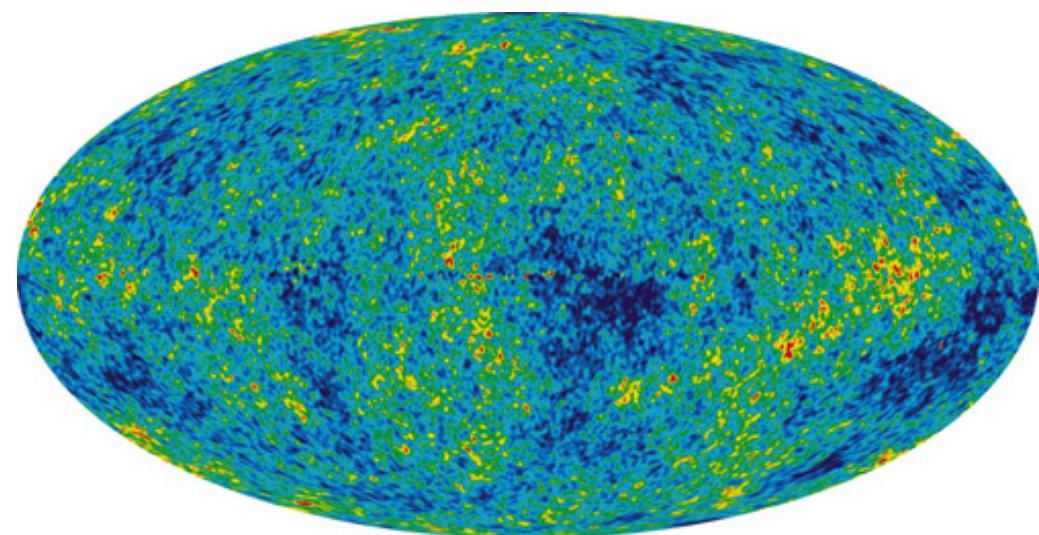
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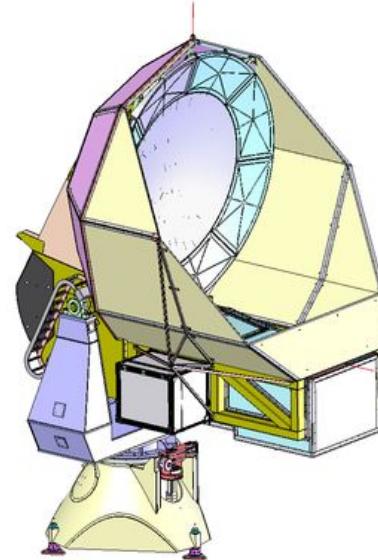
## [Cardiff University](#)

Peter Ade  
 Will Grainger  
 Carole Tucker

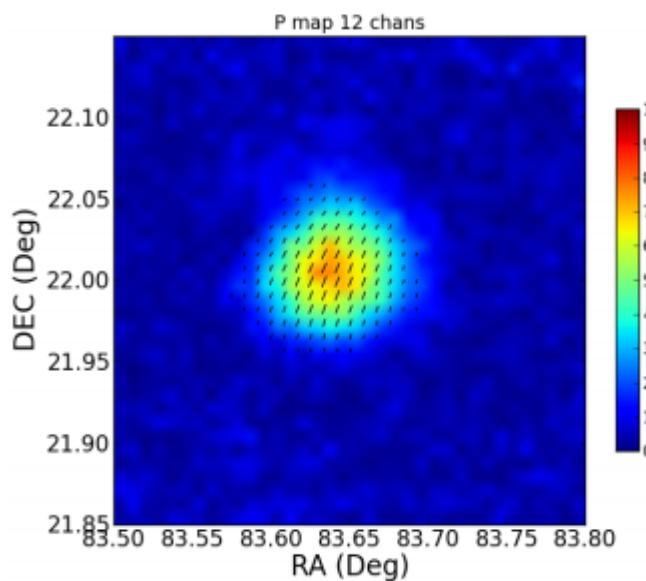




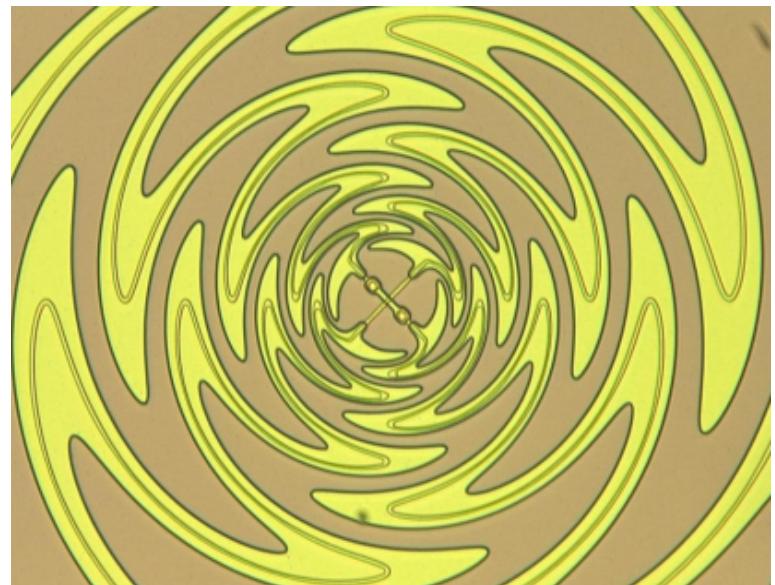
1. Background Theory



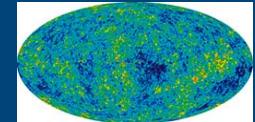
2. POLARBEAR Design



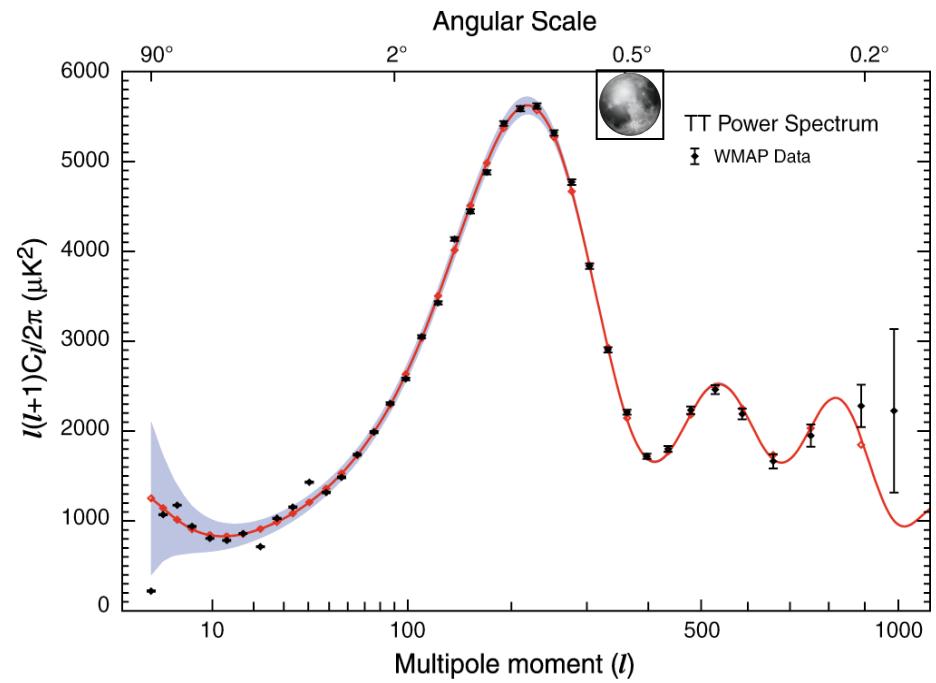
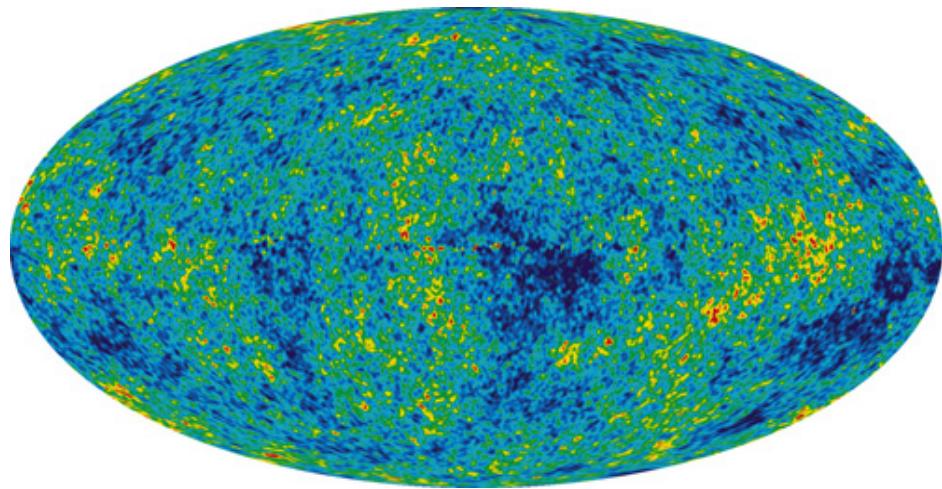
3. Recent Results and Status

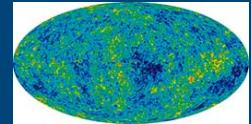


4. Future Plans



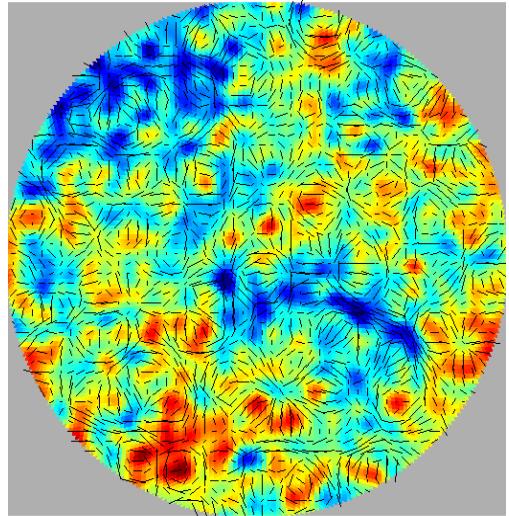
Decomposed  
Temperature Map → Angular Power Spectrum





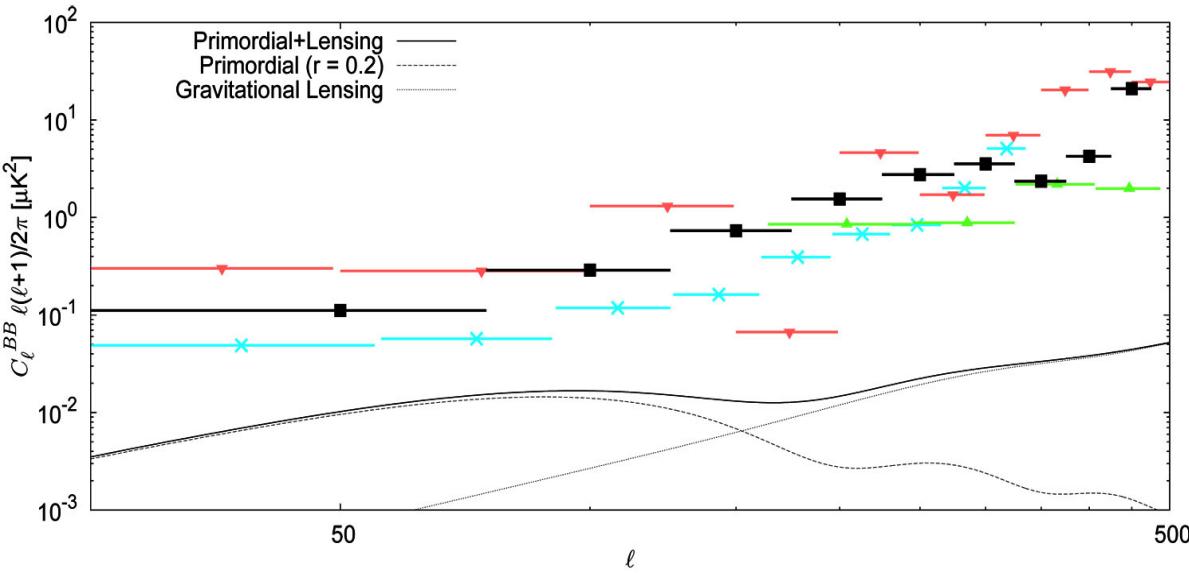
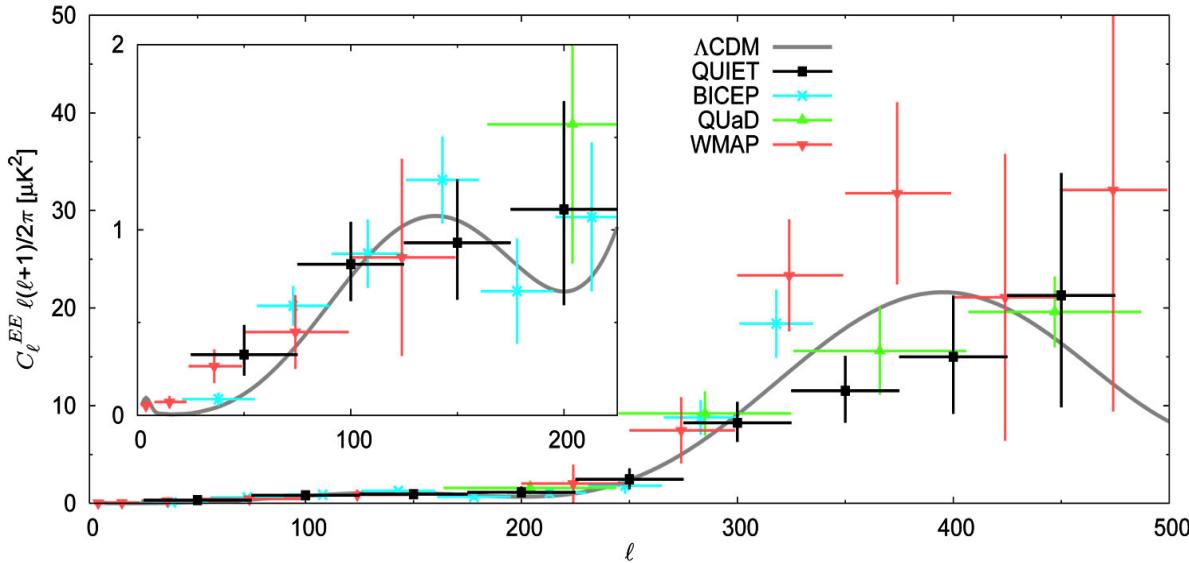
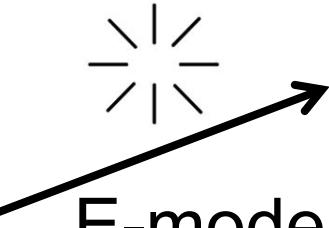
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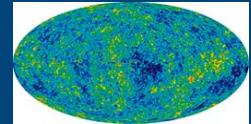
Polarization



E-mode

B-mode

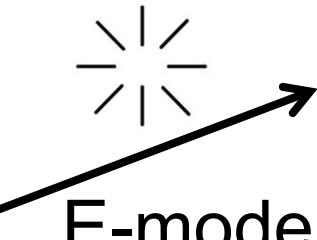
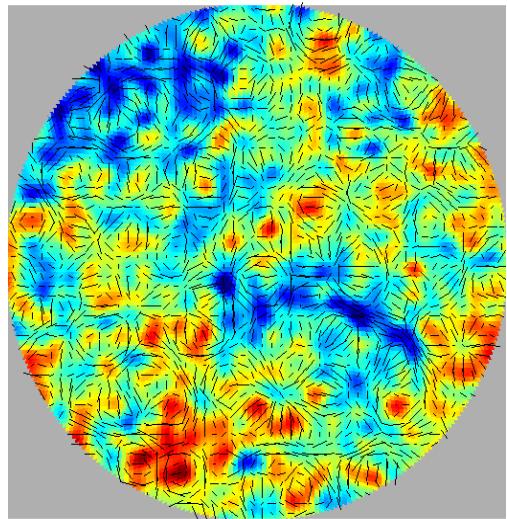




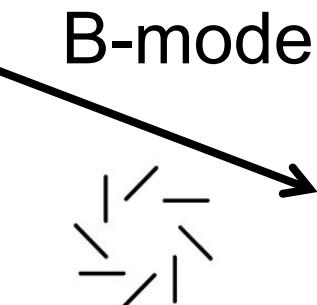
## Decomposed



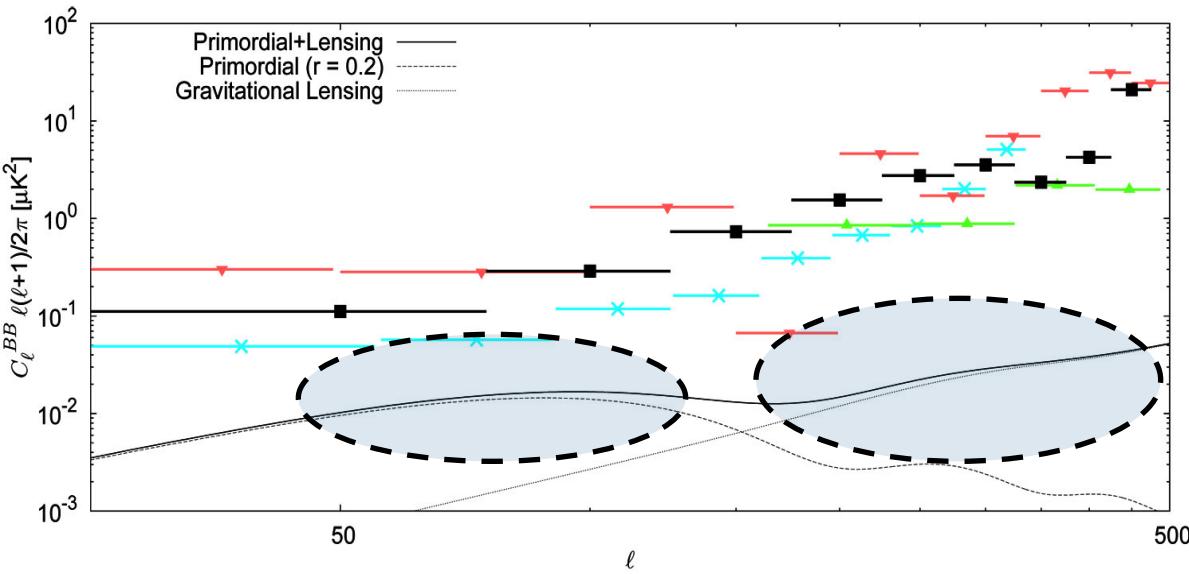
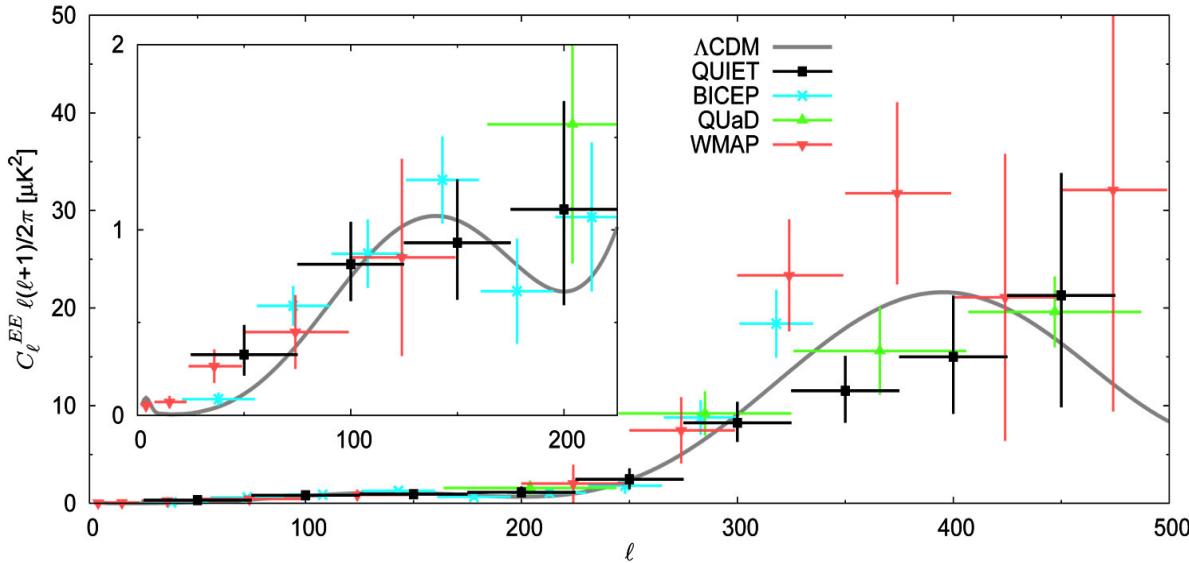
Polarization

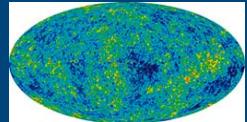


E-mode

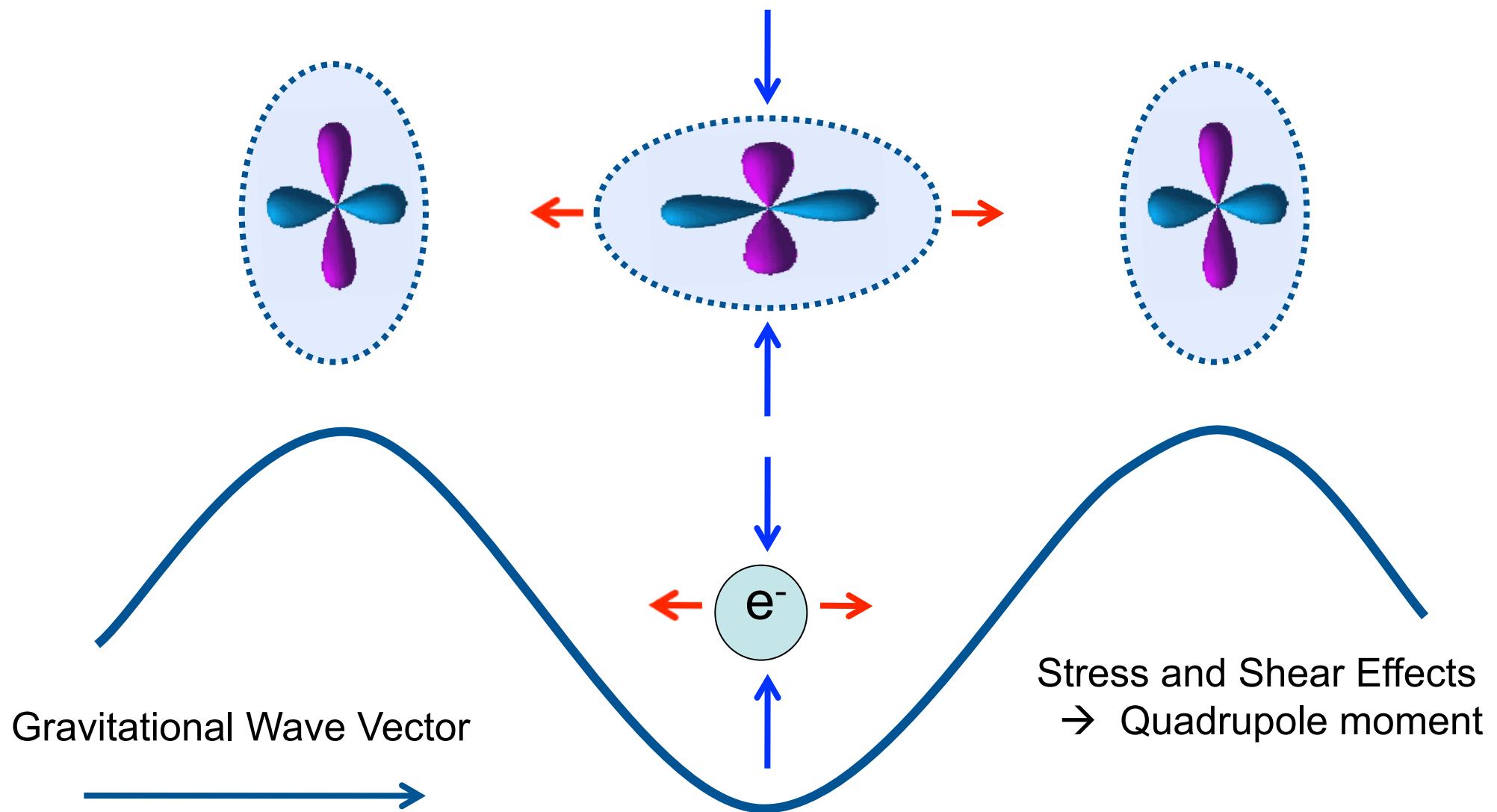


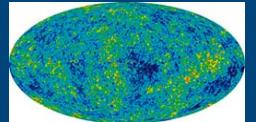
B-mode



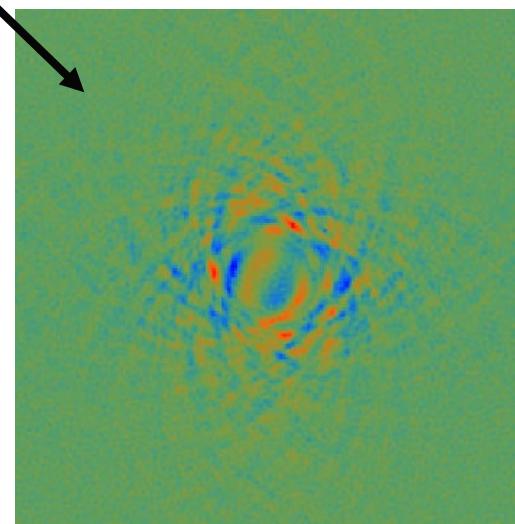
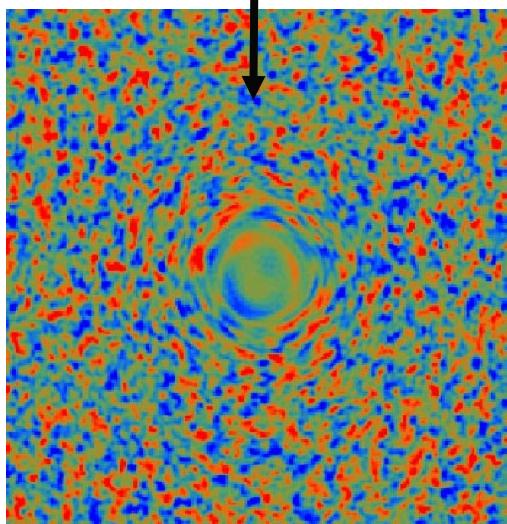
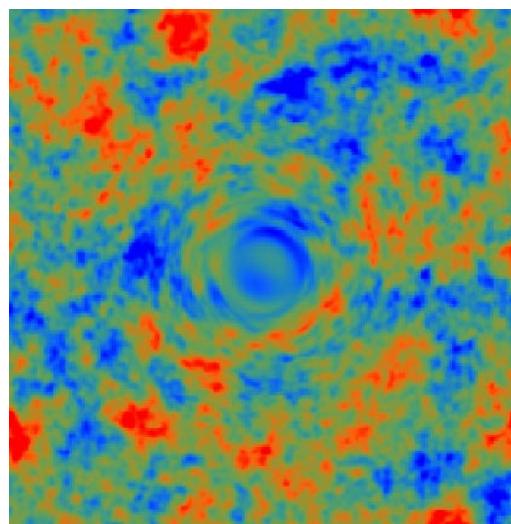
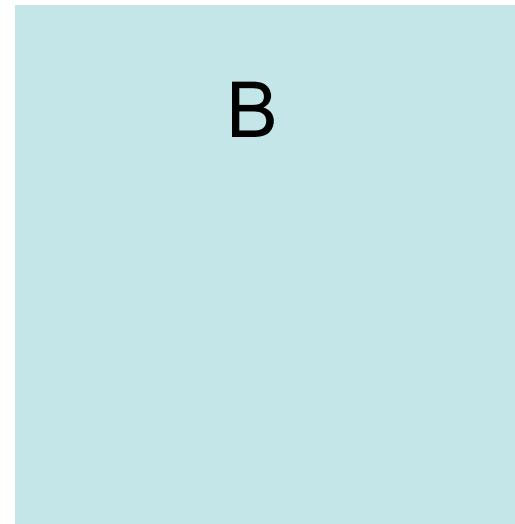
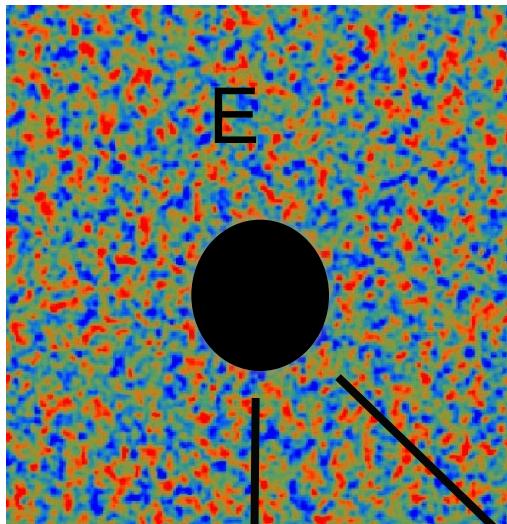
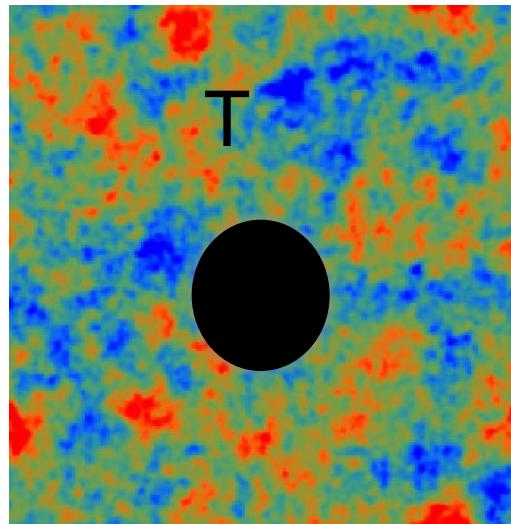


## Gravitational Waves – Large Angular Scales

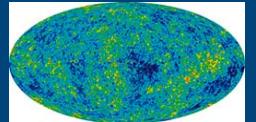




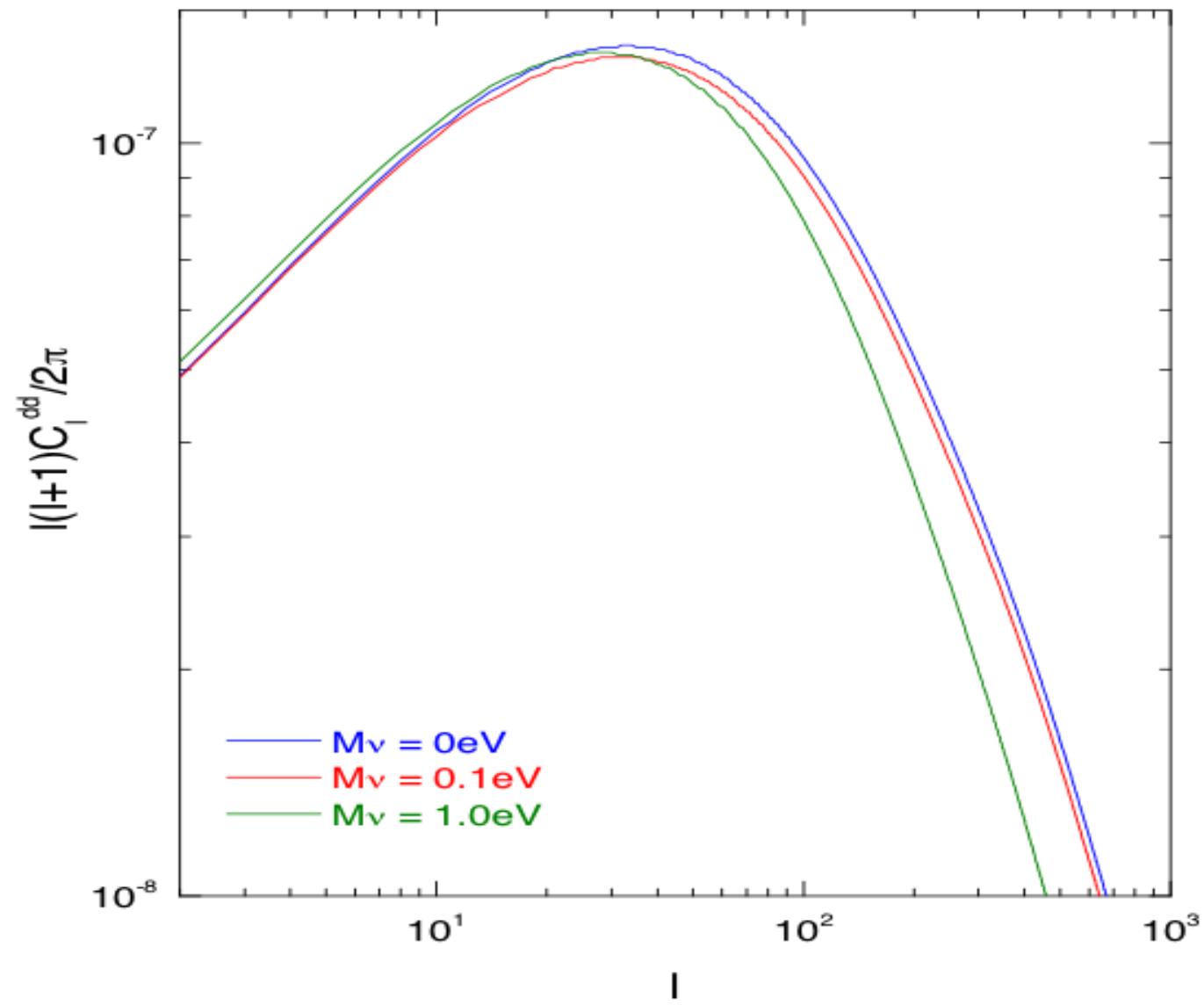
## Gravitational Lensing – Small Angular Scales

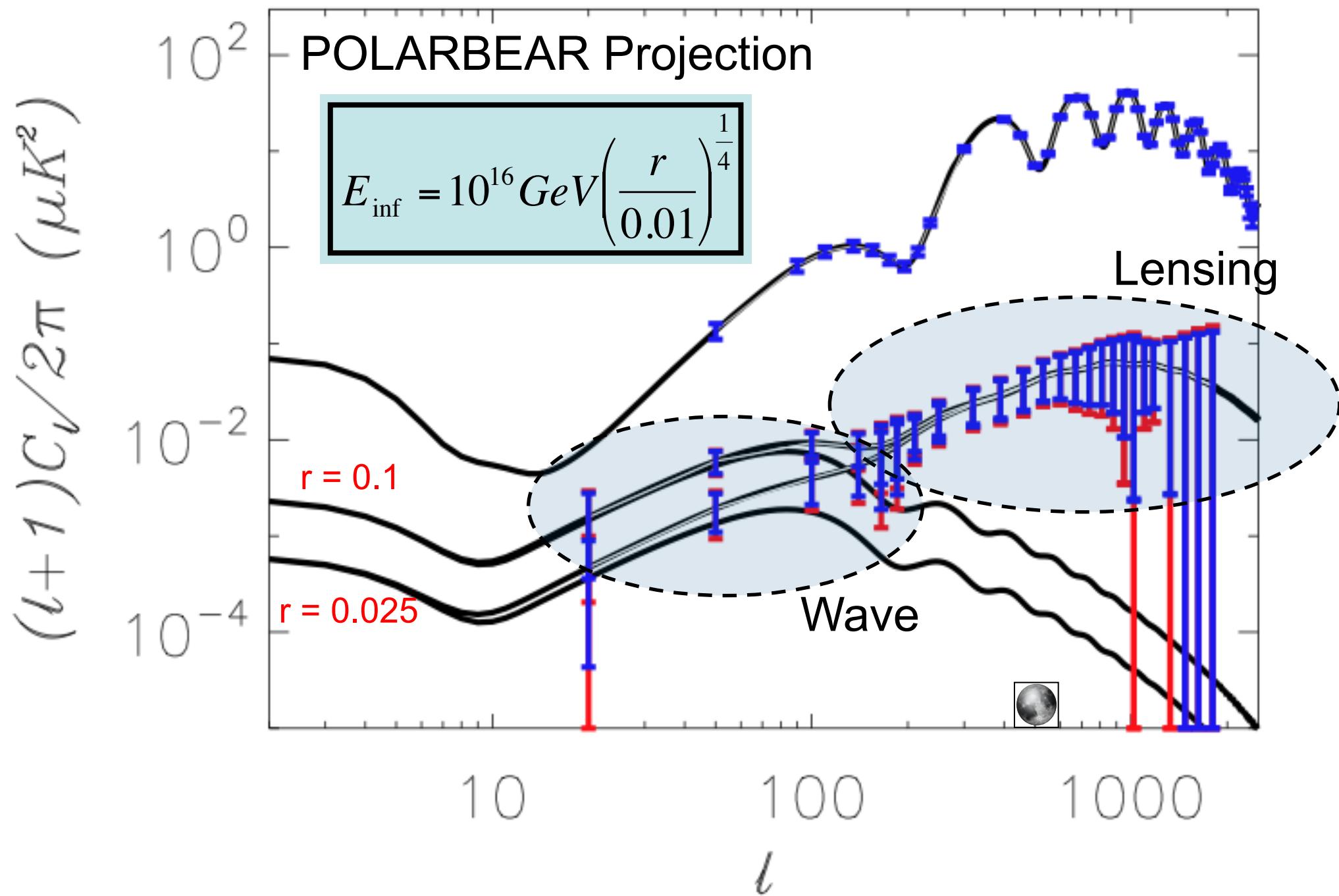
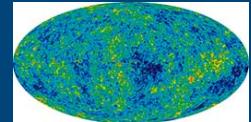


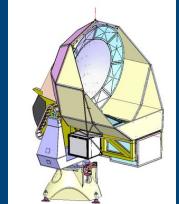
Hu & Okamoto 2002



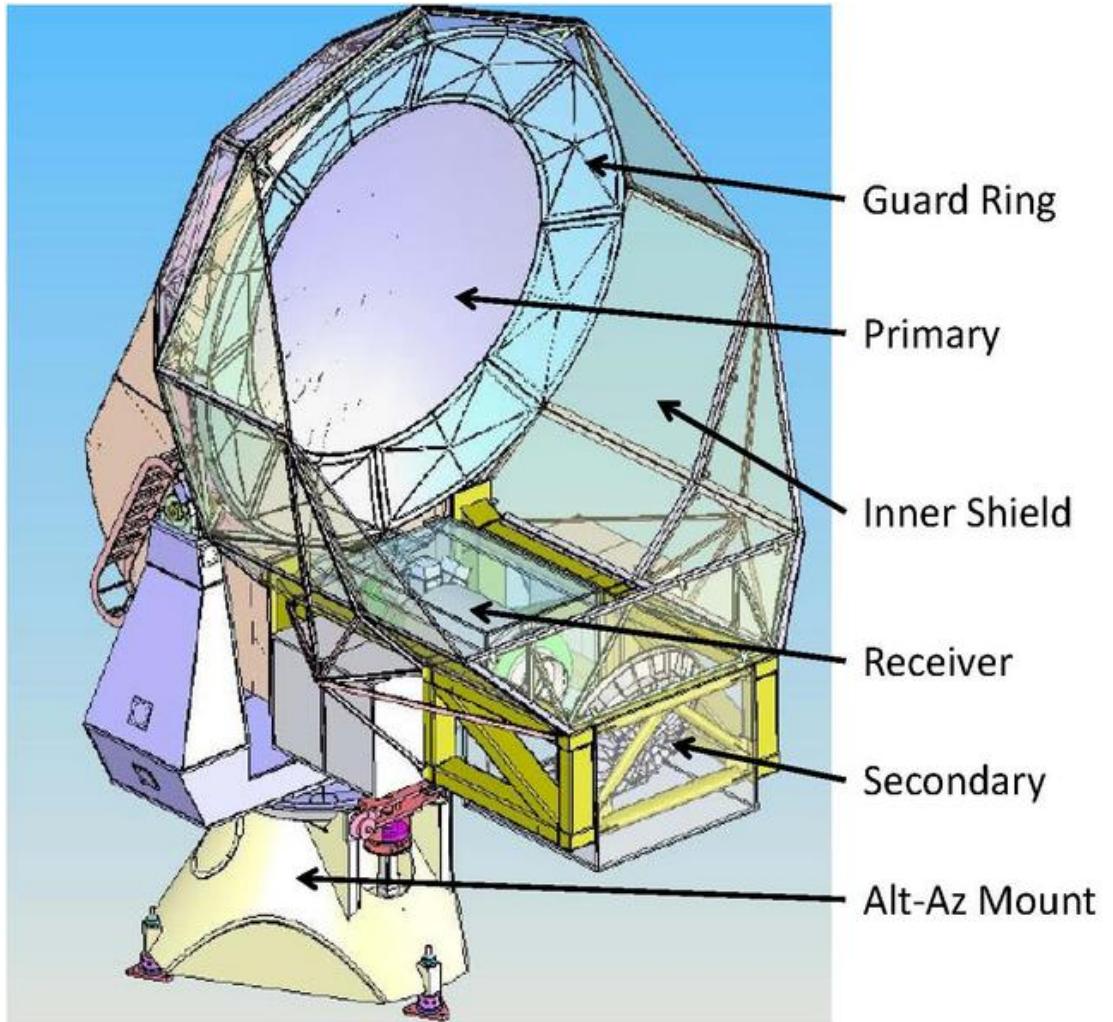
## Constraining the Neutrino Mass

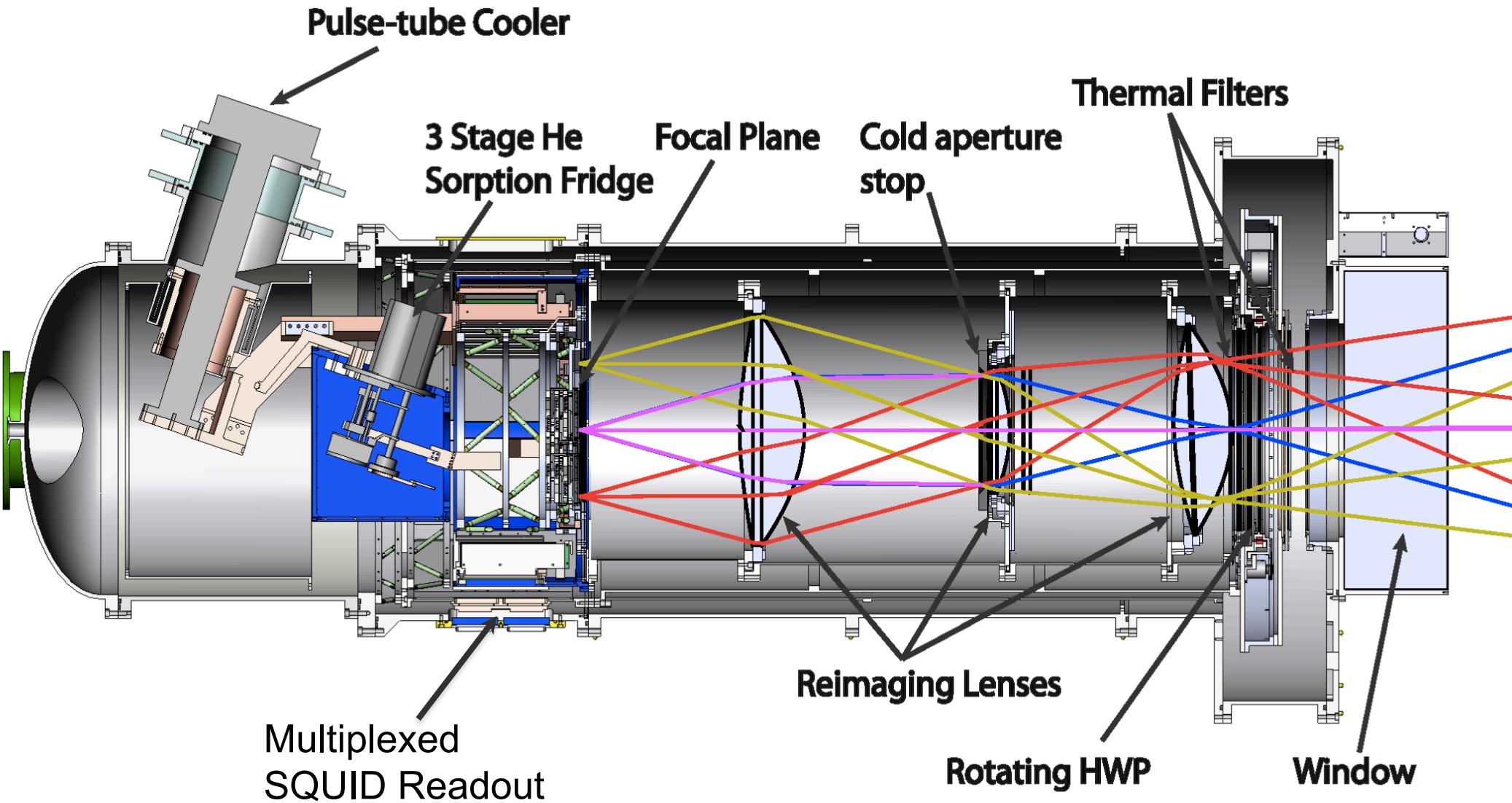
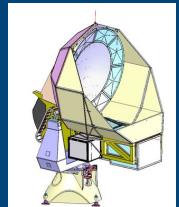


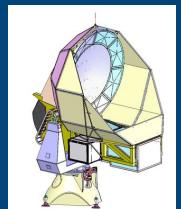




## POLARBEAR Receiver on the Huan Tran Telescope at the James Ax Observatory

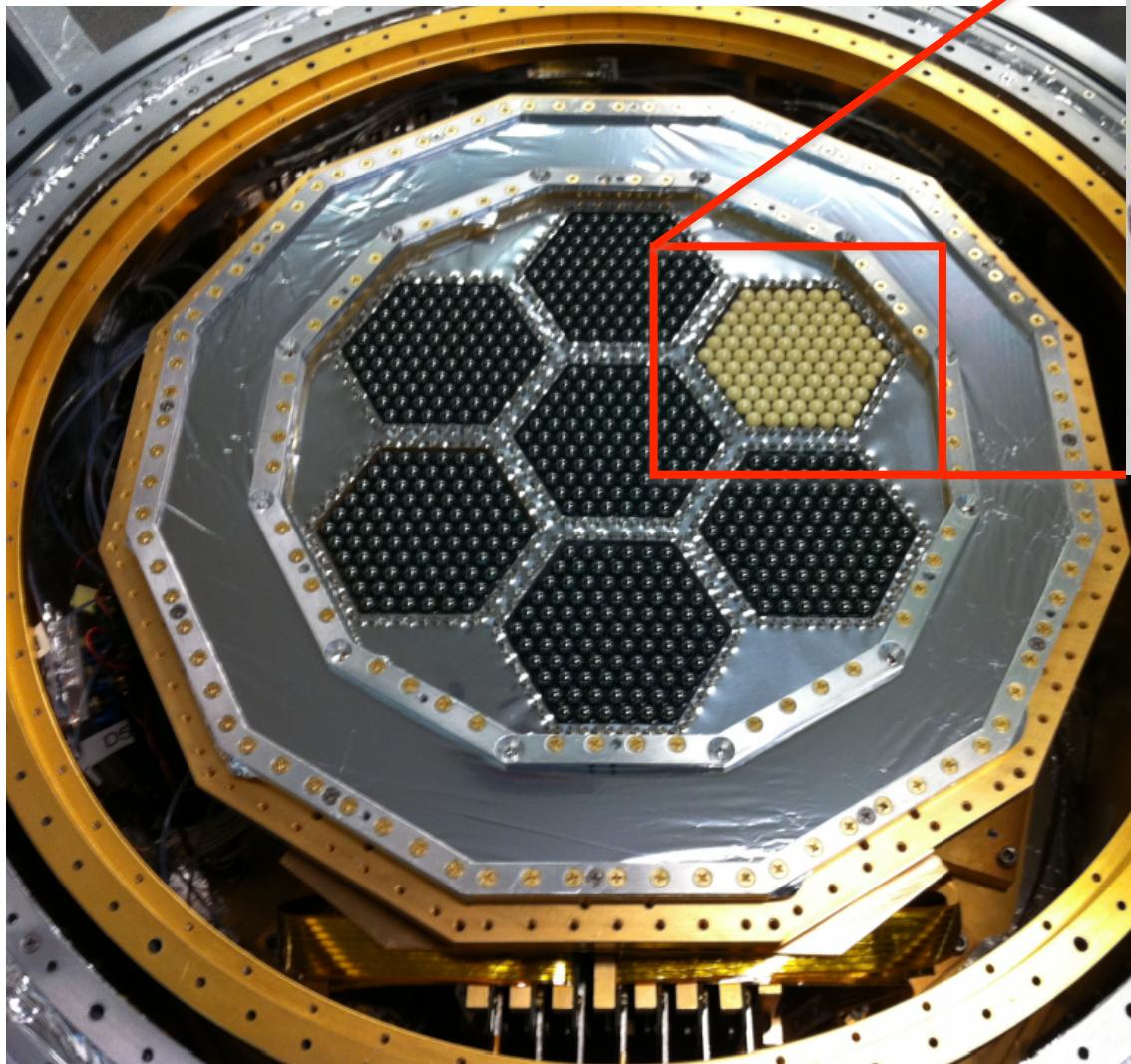




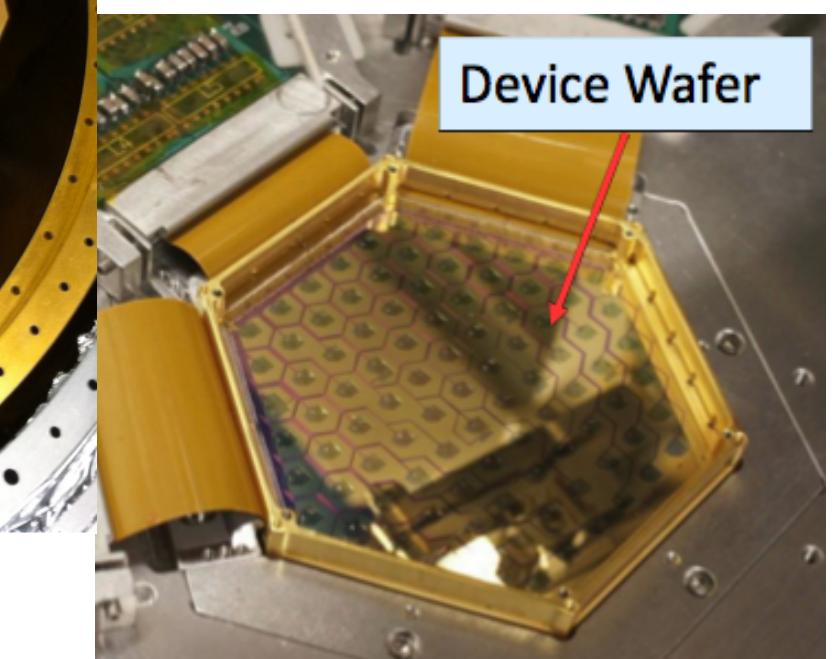
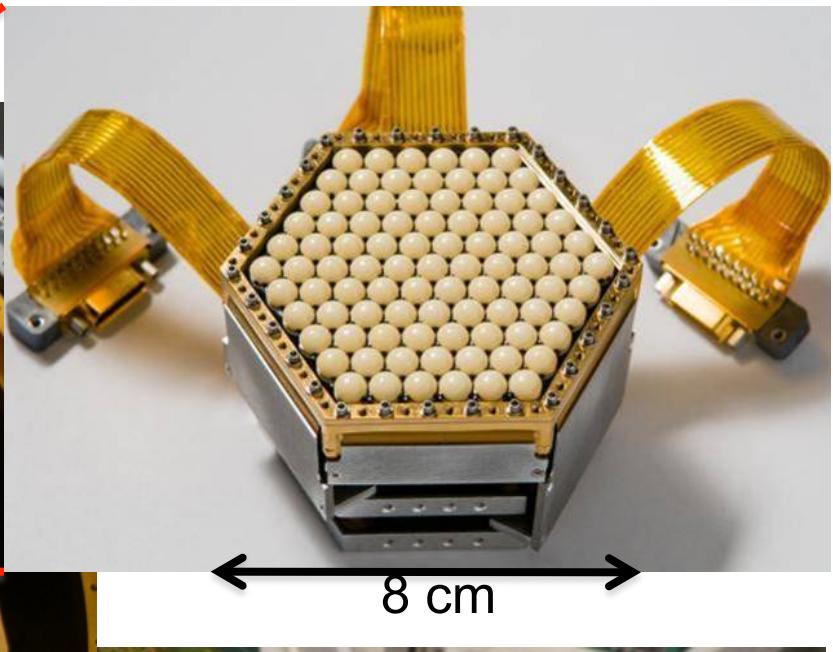


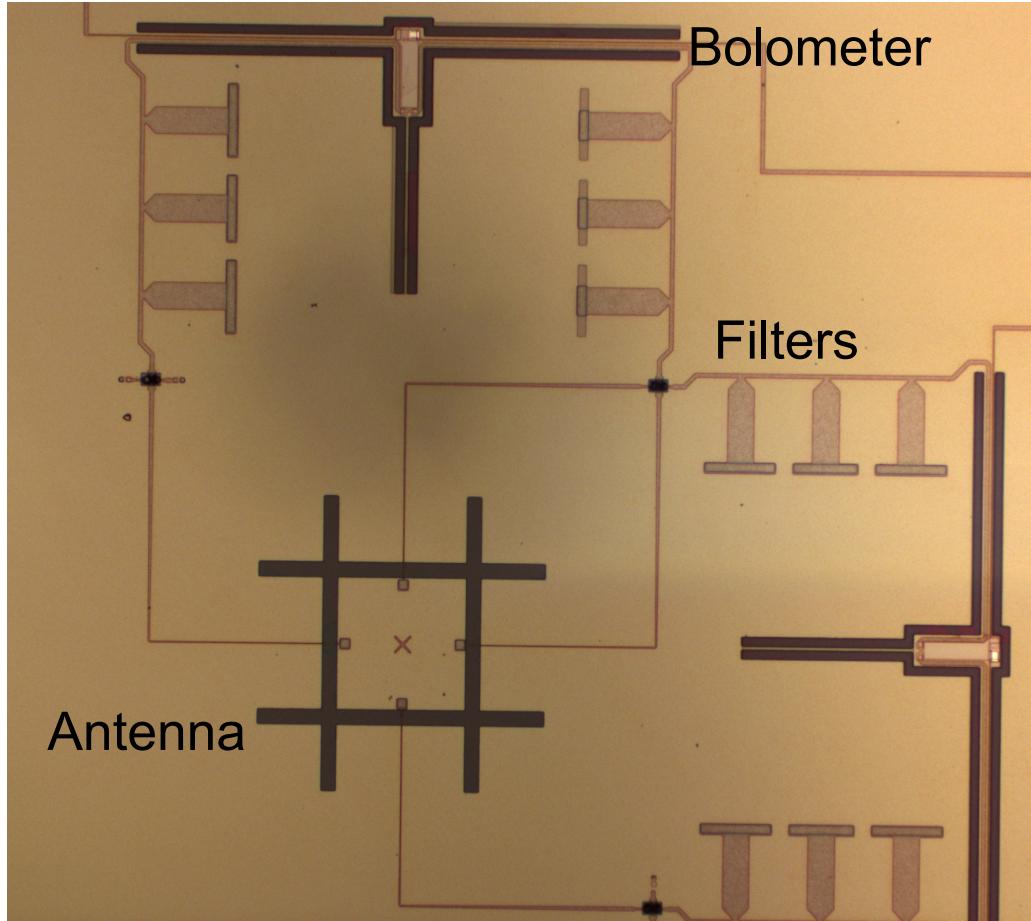
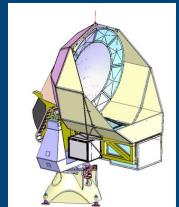
Hex Array – 91 Pixels

Entire Focal Plane – 7 Hexagonal Wafers

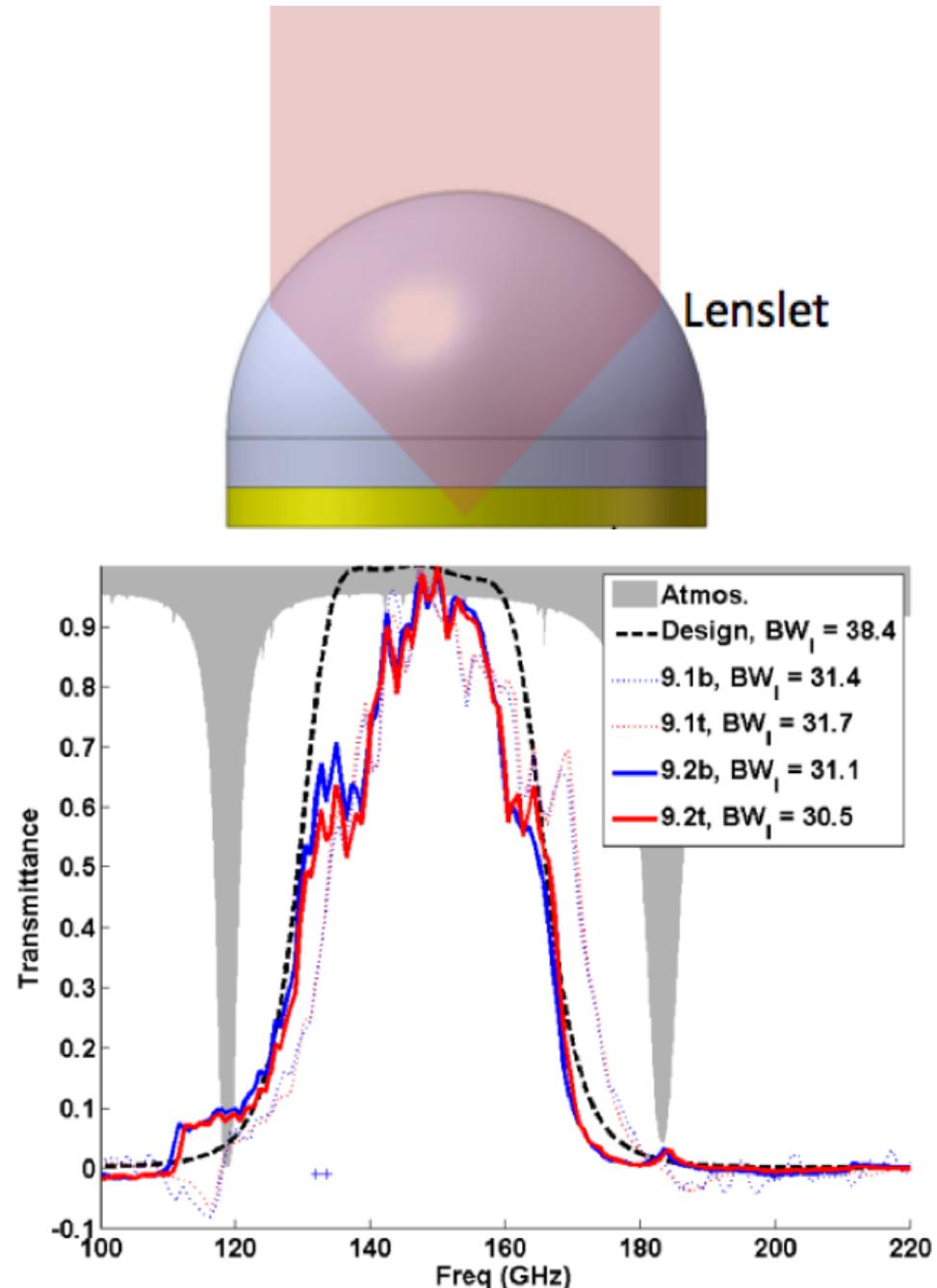


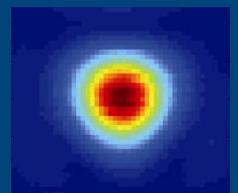
1274 Bolometers at 150 GHz





**Planarily Lithographed Antenna  
Coupled TES Bolometers**

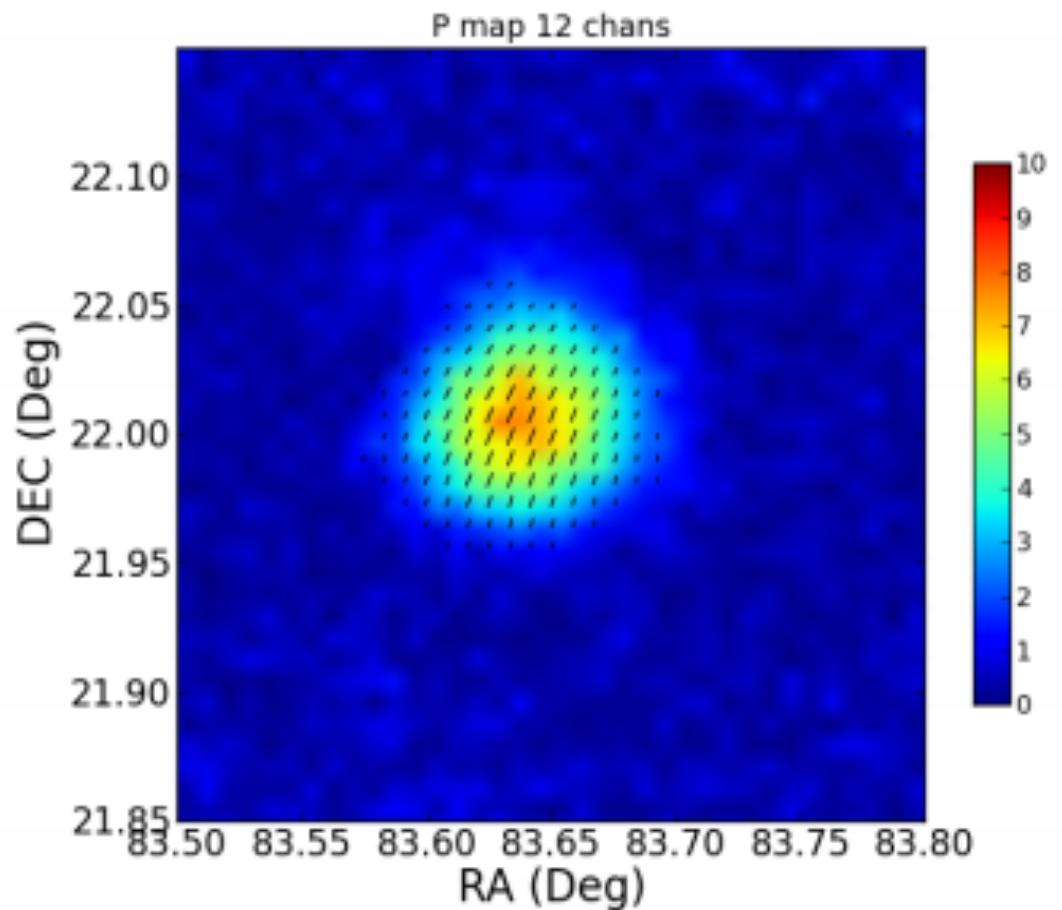




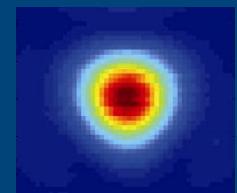
## 2010 Engineering Run in California



Modified 3 hex focal plane



Polarization map of Tau-A  
Agreement with Aumont et al., A&A 514 A70 (2010)



# Atacama Desert

## High Elevation and Low Humidity

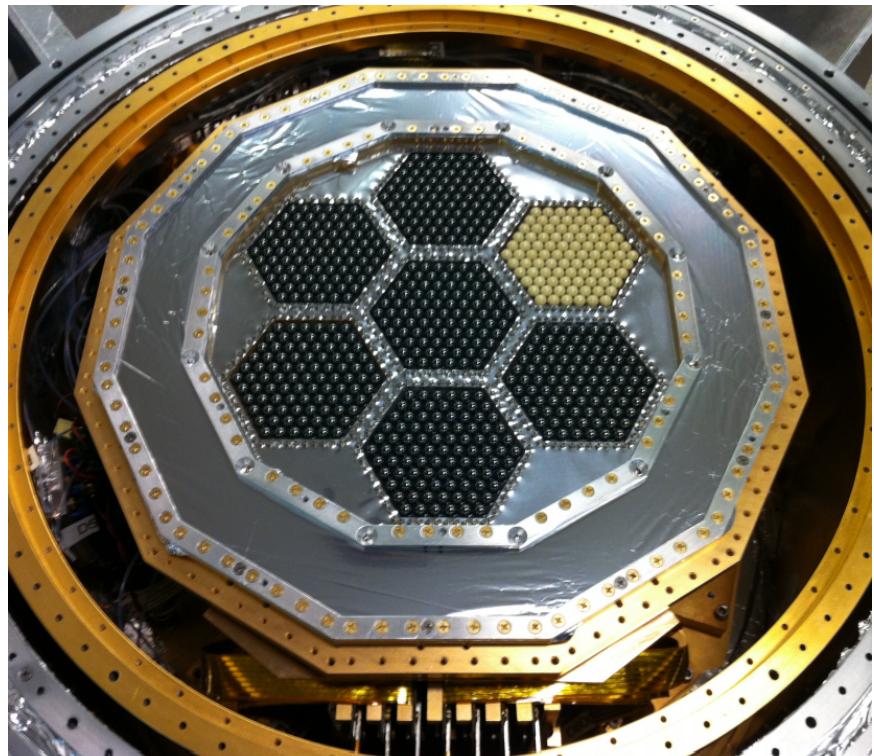
### Ideal spot for mm wave studies



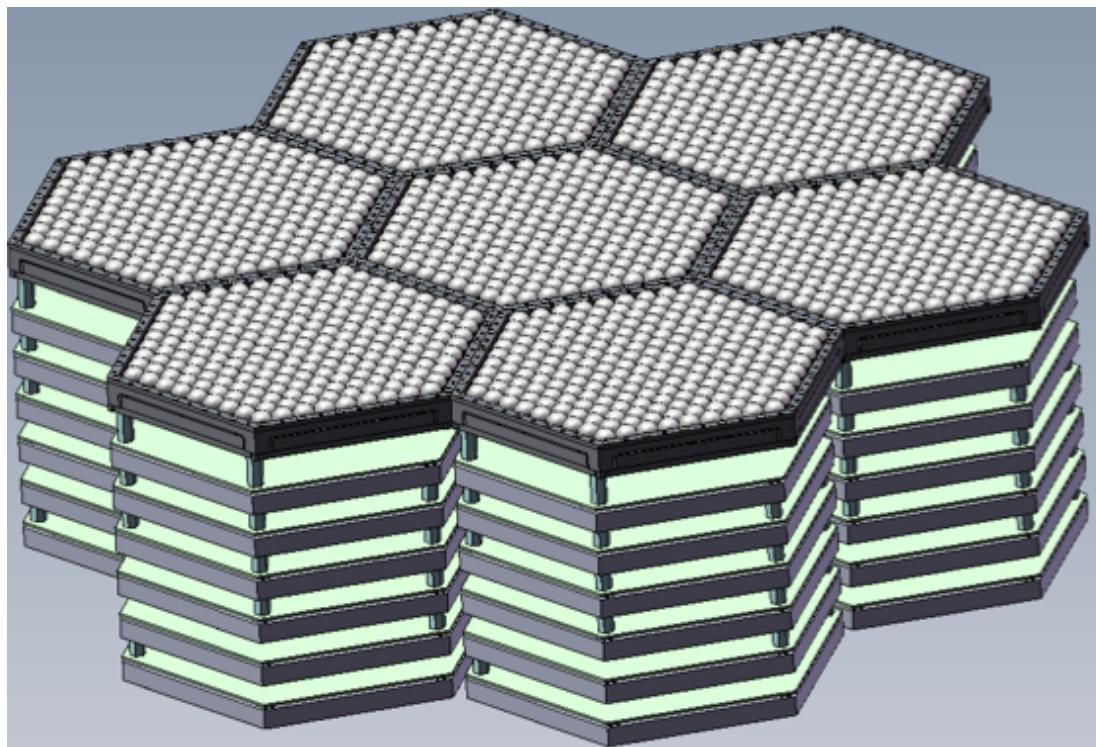


## POLARBEAR Extended

PBI – Developed and Tested.  
Deploying to Chile in 2011.



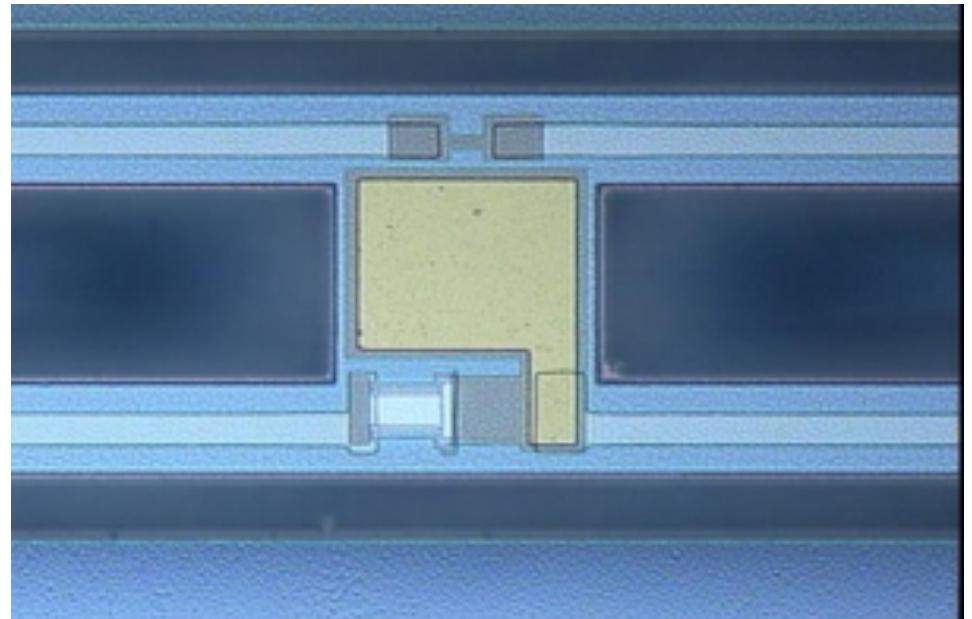
PBII – Testing, growth, and development. Expected date: 2014





## POLARBEAR II (KEK led)

- Sinuous Antennas
- Increased Bandwidth and Lower Noise
- 1500 Pixels
- 6000 Bolometers
- 90 and 150 GHz



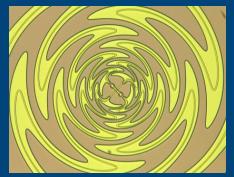


## POLARBEAR Extended

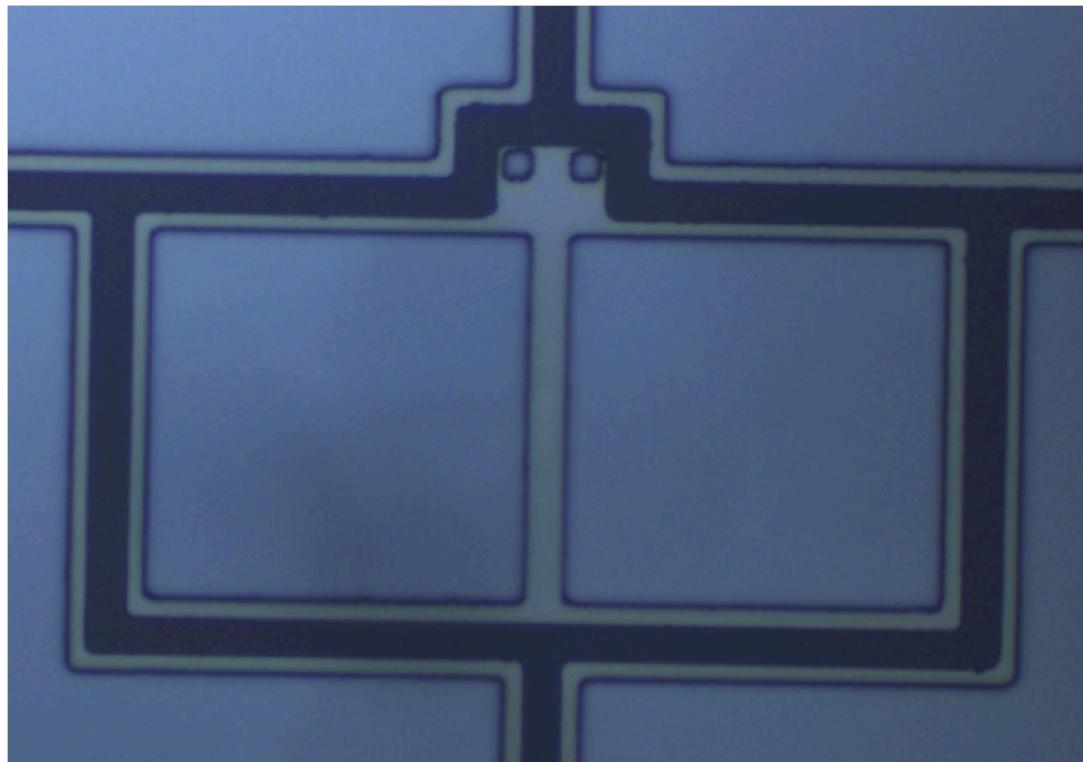


**3-6 POLARBEAR Telescopes at Atacama Site  
18,000 Total Bolometers at Multiple Frequencies  
2<sup>nd</sup> and 3<sup>rd</sup> HTT funded by James Ax Foundation to UCSD**

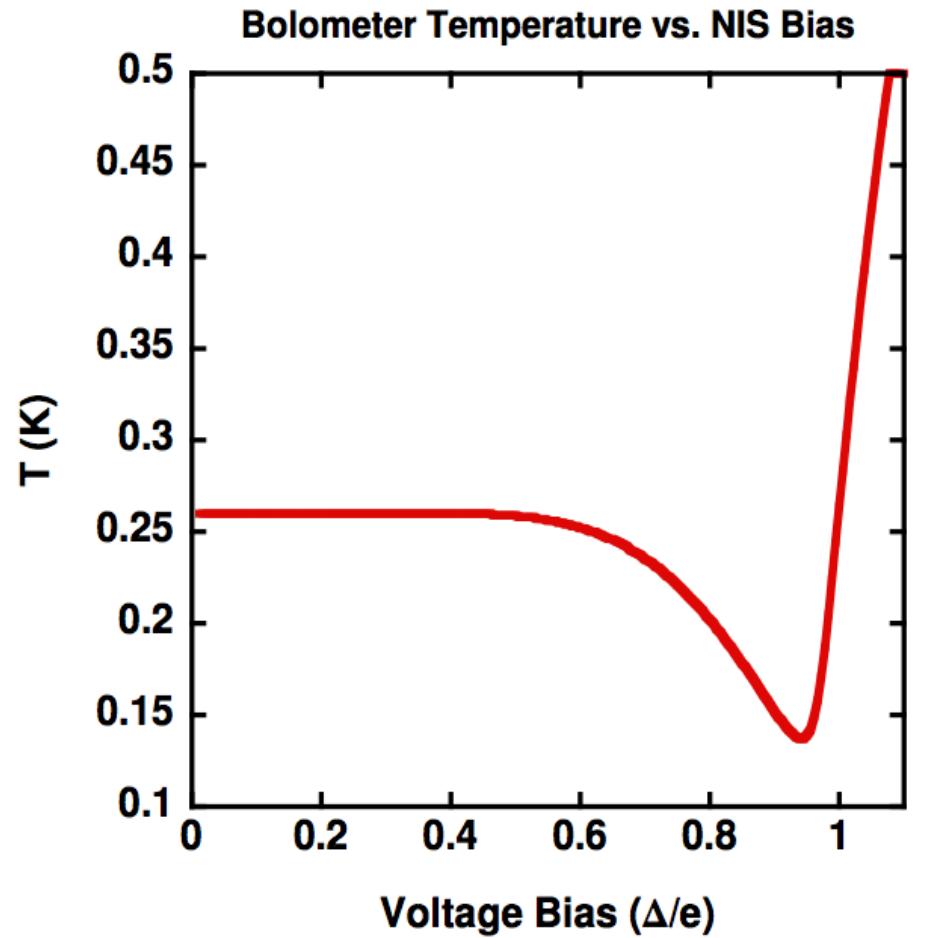
**Probe to a potentially lower value of  $r$   
Better constraint on neutrino mass (100 meV)  
High quality lensing maps over large fraction of the sky**



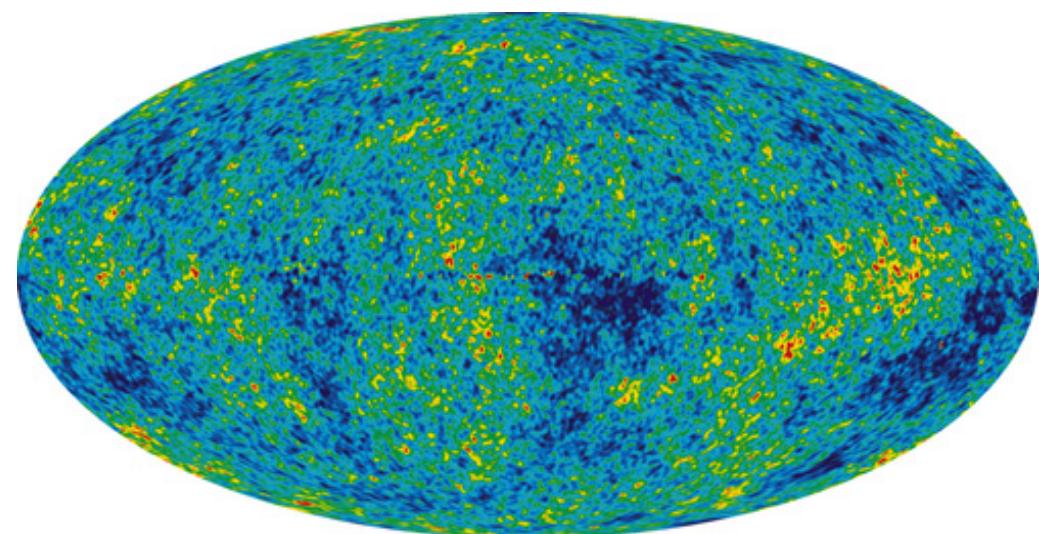
## Normal-Insulating-Superconducting (NIS) Junctions



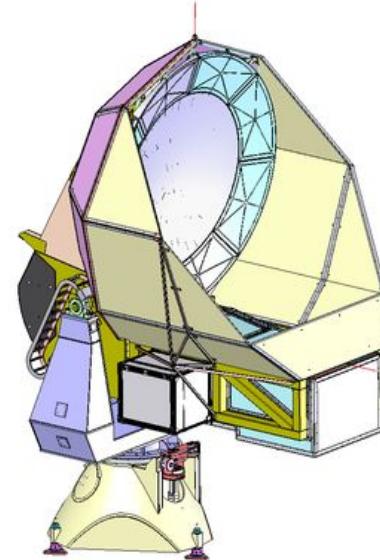
Solid State Refrigerators  
Planarly Lithographed  
Currently Explored at UCSD



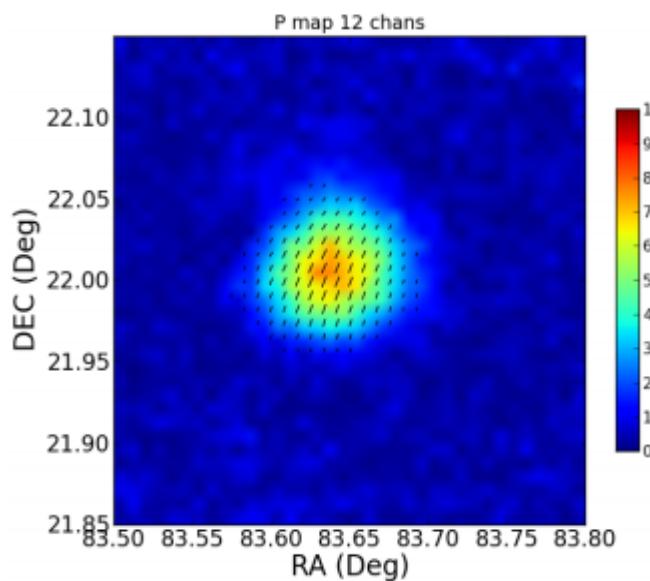
Modeled Performance



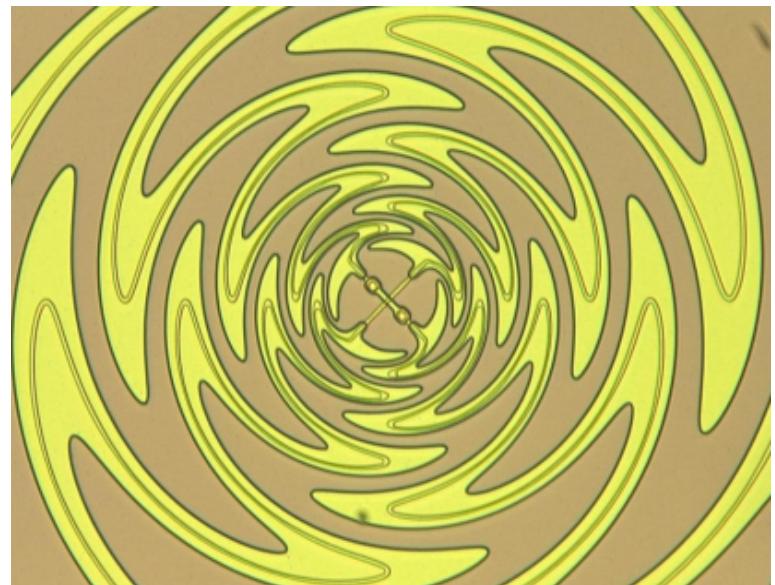
1. Background Theory



2. POLARBEAR Design



3. Recent Results and Status

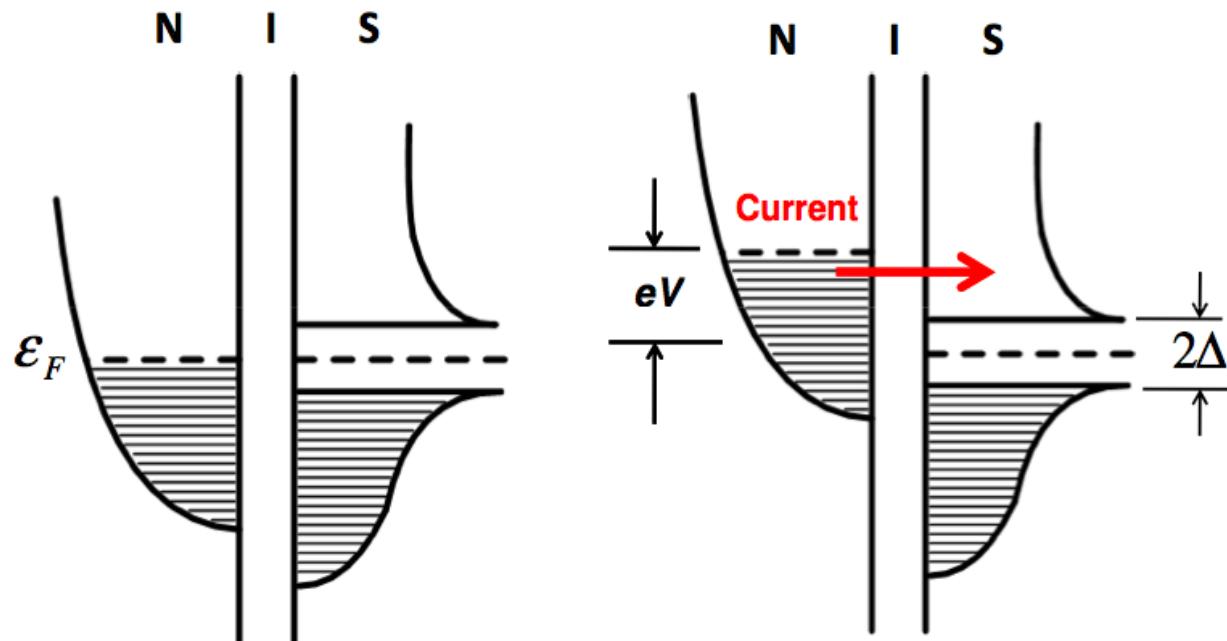


4. Future Plans

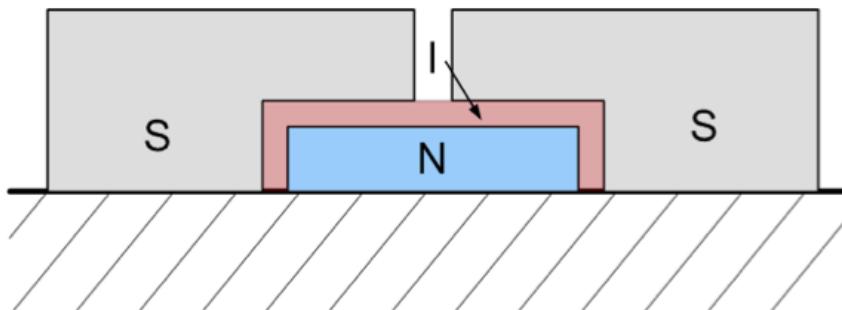
**THANK YOU**

## NIS Junctions - Solid State Refrigeration Devices

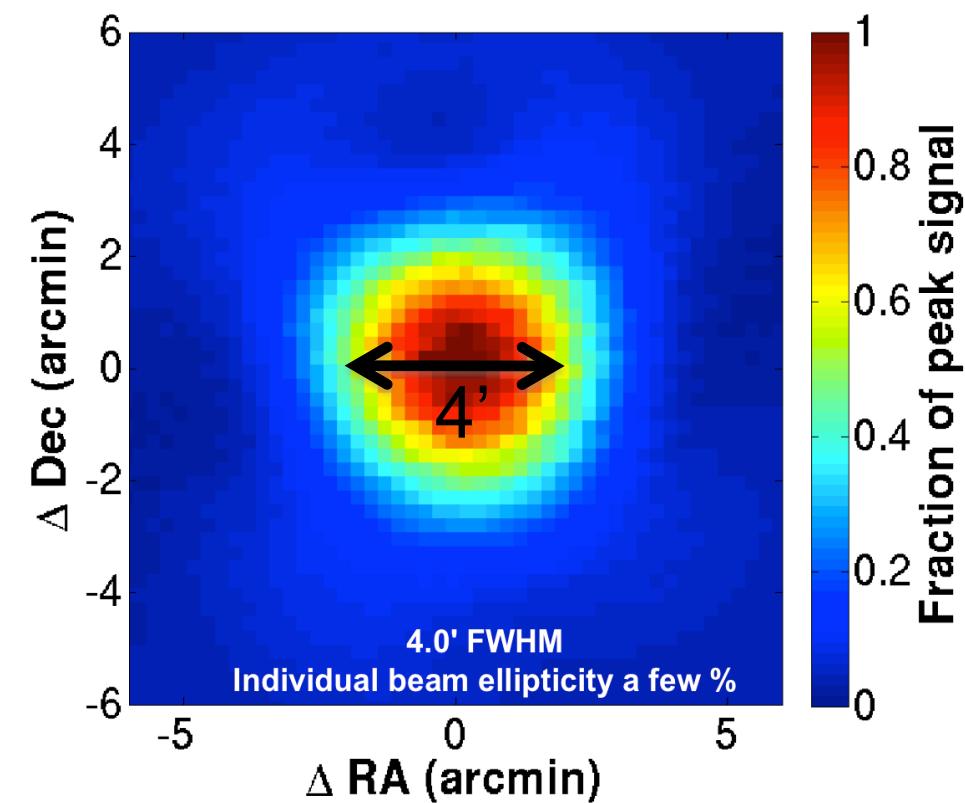
NIS Theory



Junction Schematic



## Experimental Tolerances Met During Engineering Run



Effect	Measured (Eng. run)	Required for $r = 0.025^*$
Differential Pointing	0.41"	1.1"
Differential Ellipticity	0.5%	2.9%
Differential Beam Size	0.4%	1.5%

\*Relaxed for HWP and sky rotation

Co-added map of Jupiter

