

# Cosmology and Particle Physics with POLARBEAR

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For the POLARBEAR Collaboration



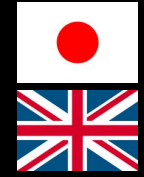
ICHEP2012

Melbourne

7 July 2012



# POLARBEAR Collaboration



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## Dalhousie University

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## Cardiff University

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5 countries, 11 institutes

# POLARBEAR Science goals

- POLARBEAR will measure CMB polarization with unprecedented high precision on large and small angular scales.

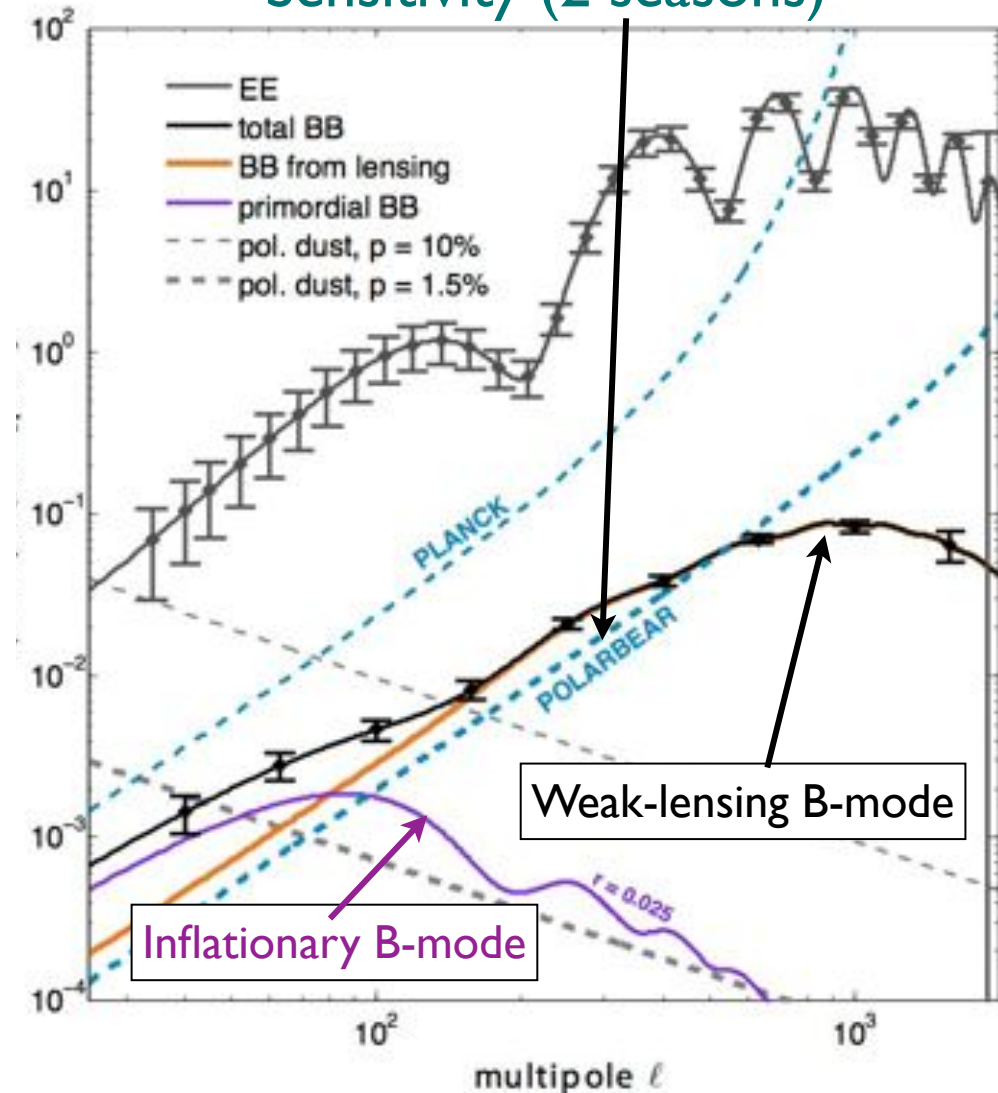
## • Inflationary B-mode ( $l \sim 100$ )

- sensitivity for scalar to tensor ratio  $r = 0.025$  (95%CL)

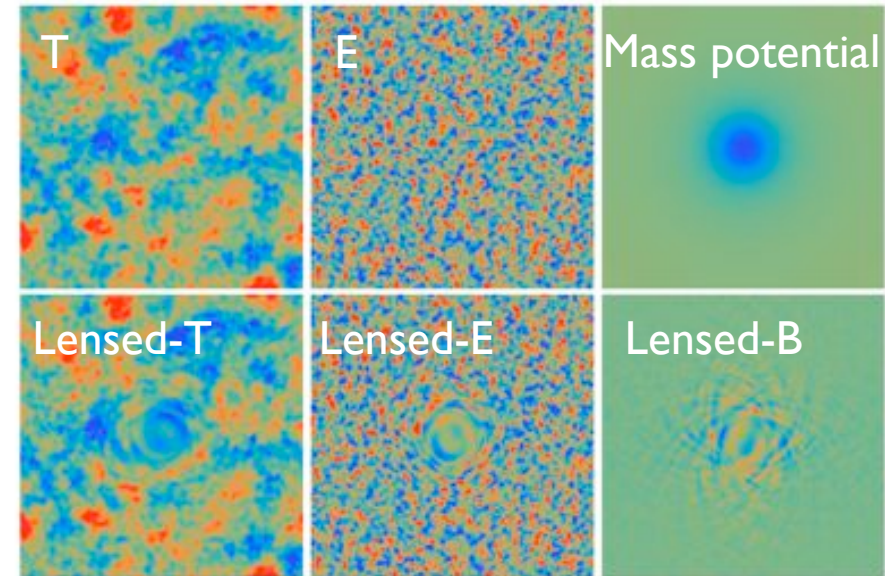
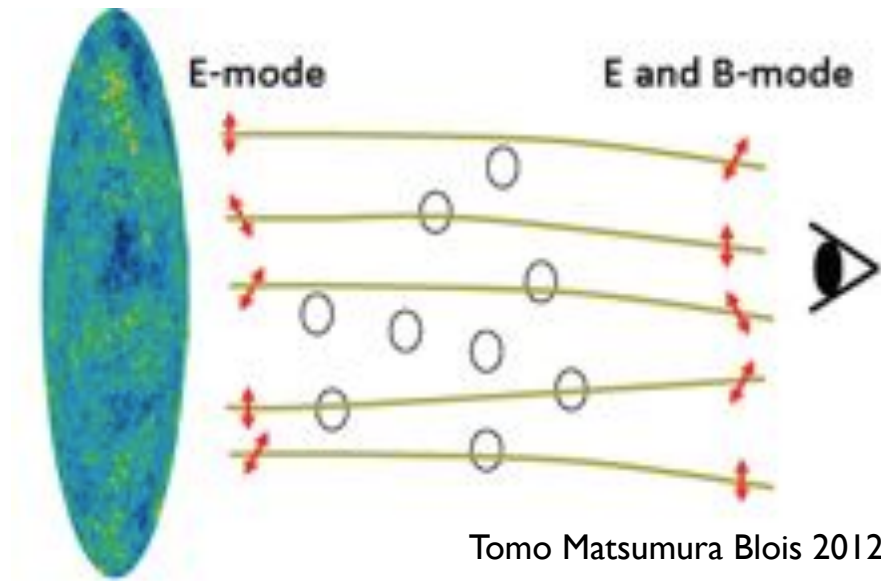
## • Weak Lensing B-mode ( $l \sim 1000$ )

- $> 10\sigma$  detection
- sensitive to sum of neutrino mass --> Next page

## POLARBEAR expected Sensitivity (2 seasons)



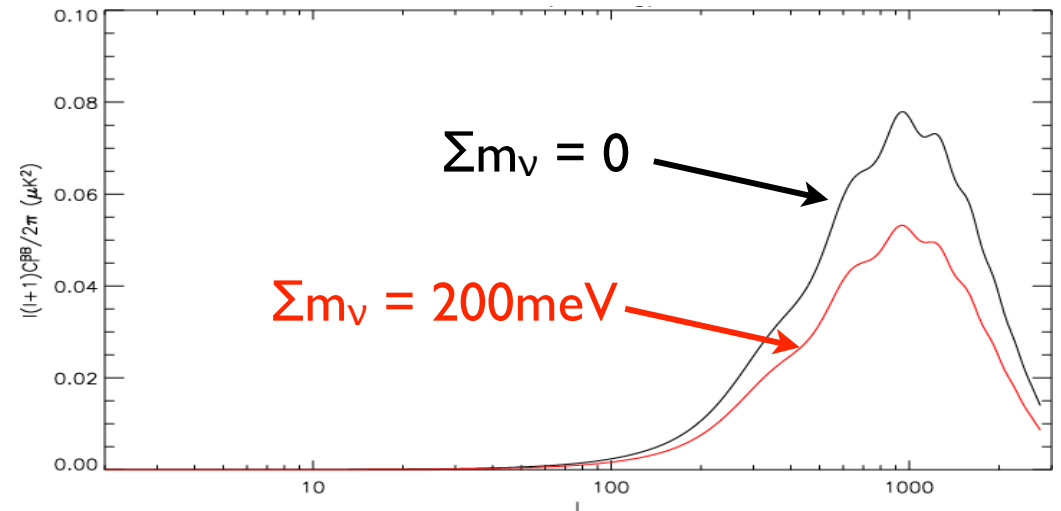
# Lensing B-mode



Lensing field smears the power at scale below the free streaming length.

-> This generate 'B-mode' from E-mode pattern, which contains rich physics e.g. neutrino mass .

## Expected lensing B-mode power

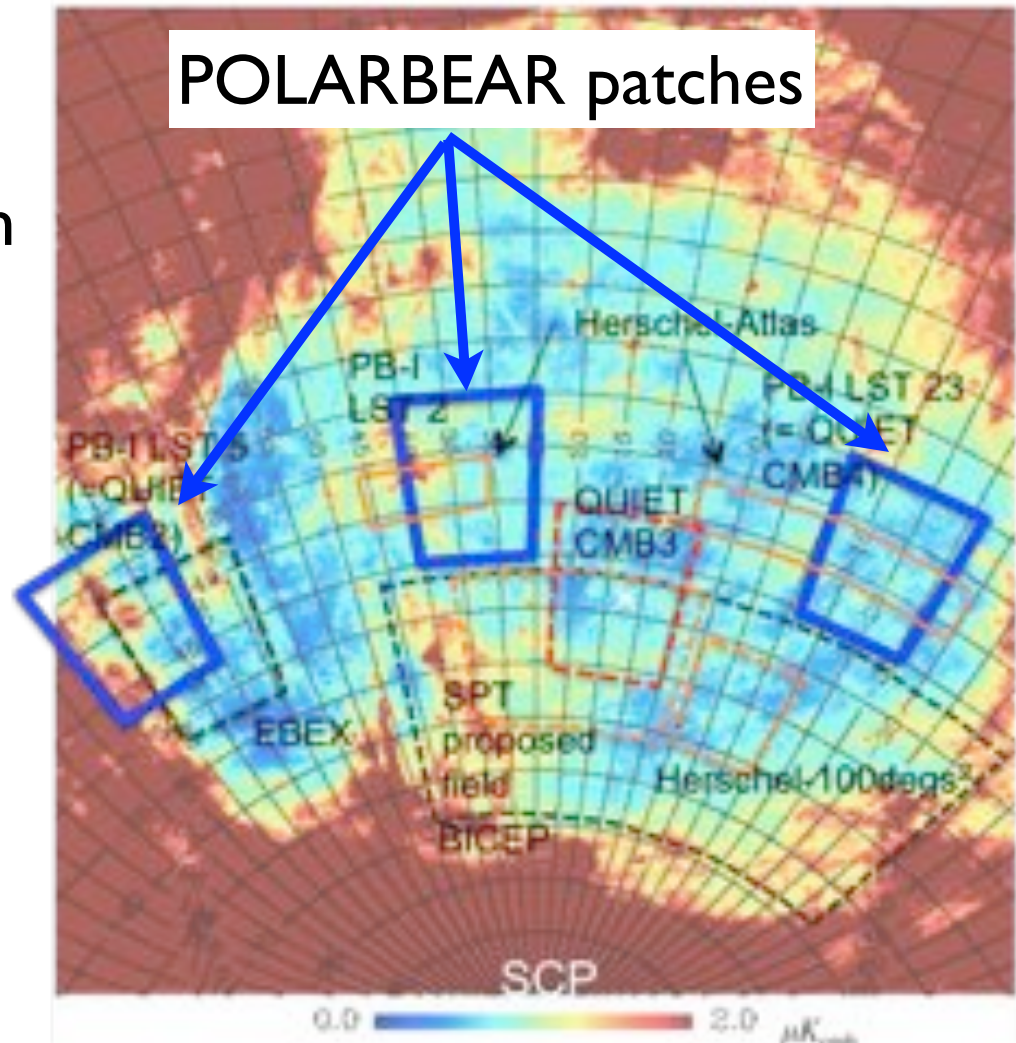


# Observed Patches

- Three 15x15deg patches
  - 700 deg<sup>2</sup>
  - Selected lowest dust region

\* Exploring possibility of initial deep lensing observations smaller patches.

- Overlapping with QUIET, EBEX, Herschel, Planck
  - Foreground can be constrained by
    - QUIET (40+90GHz) for synchrotron
    - Planck (217+353GHz) for dust



# POLARBEAR Design

## Huan Tran Telescope

2.5m monolithic primary

Co-moving shield

Secondary baffle

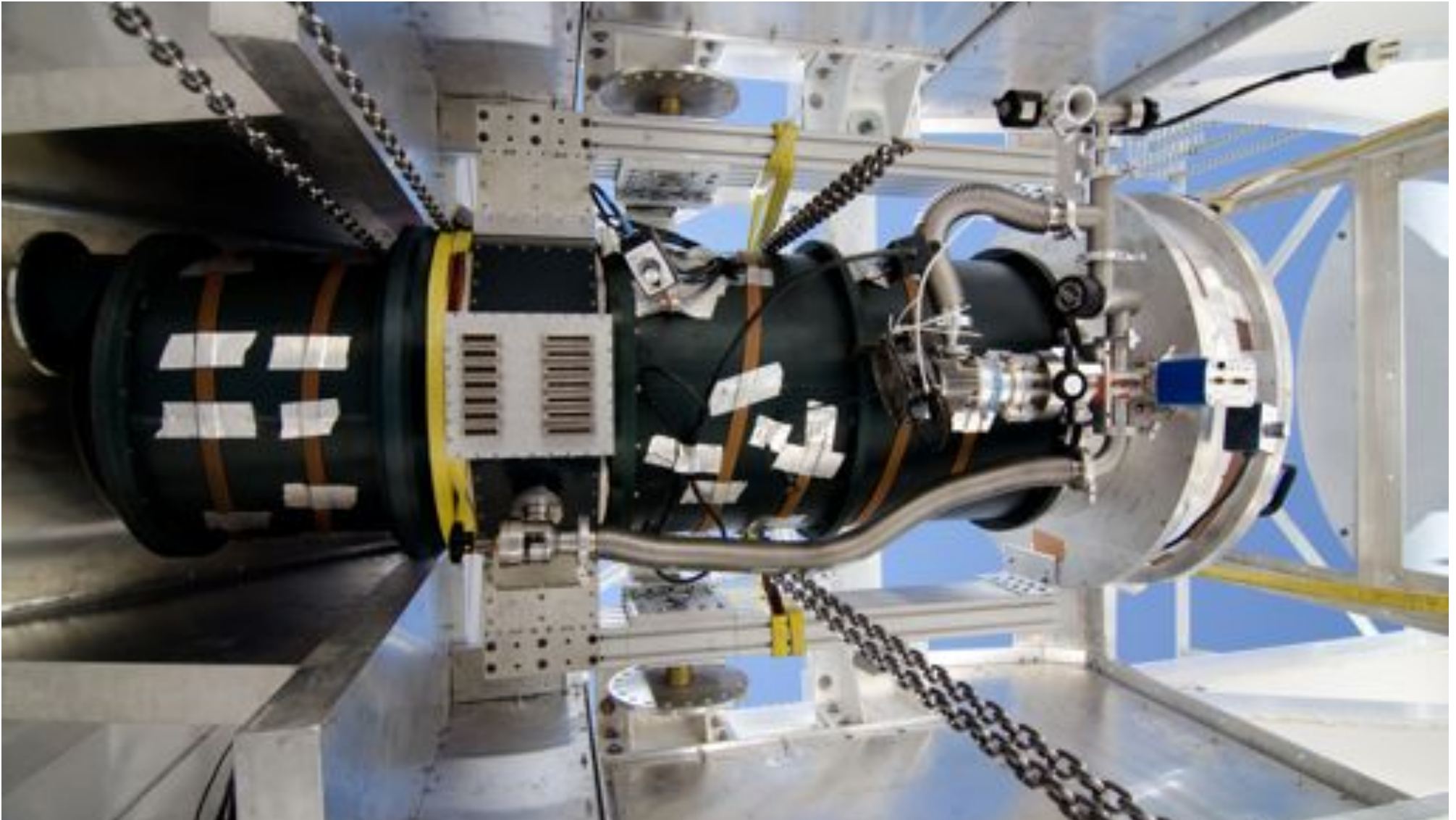
Secondary enclosure

- Off-axis Gregorian-Dragone design
- 2.5m primary
  - 3.5' beam at 150GHz
- Co-moving shield to mitigate sidelobes
- 19cm focal plane,  $2.3^\circ$  diffraction-limited field-of-view

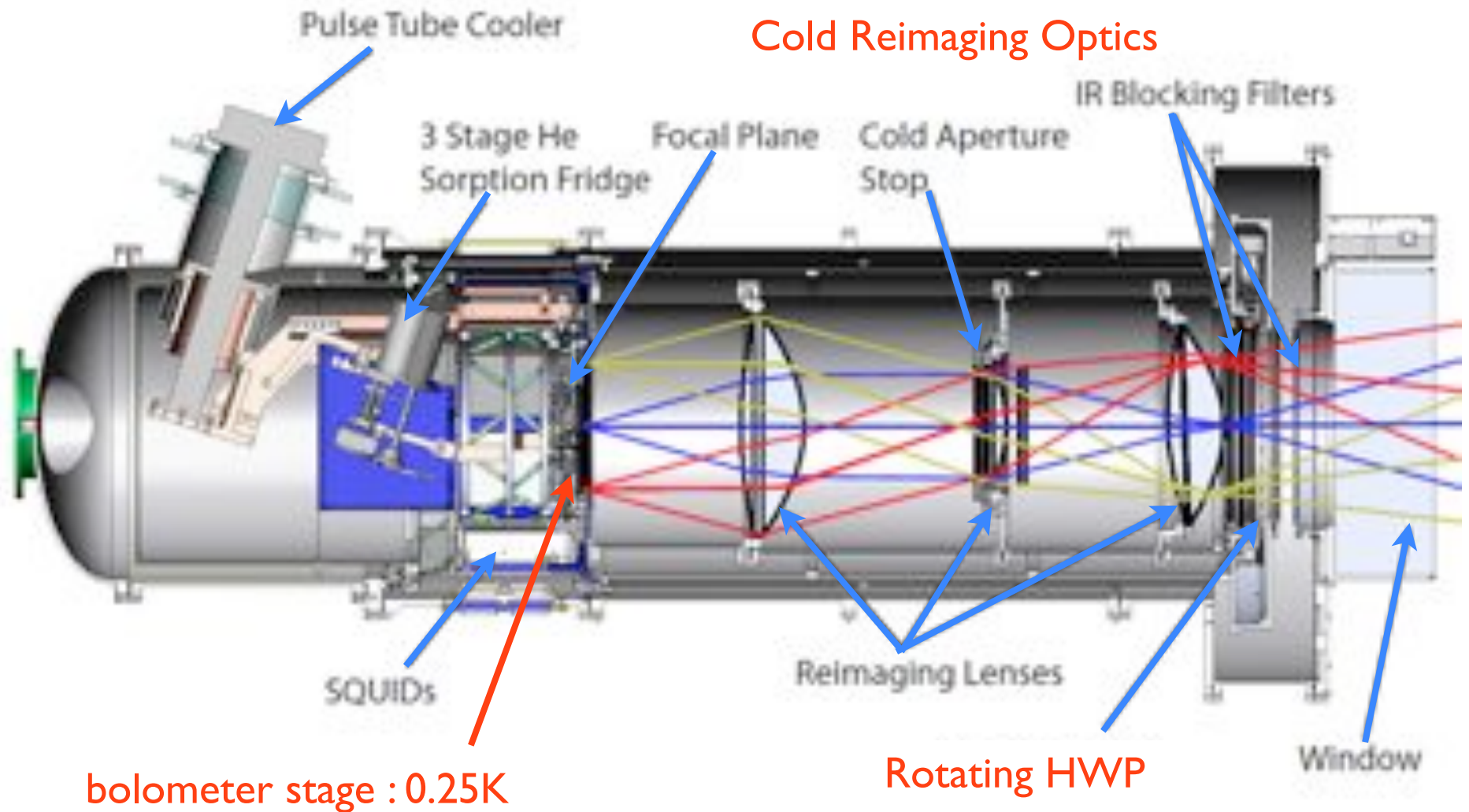


sited at 5000m elevation  
above the Atacama desert

# Receiver overview



# POLARBEAR Receiver



bolometer stage : 0.25K

Rotating HWP

2.1m





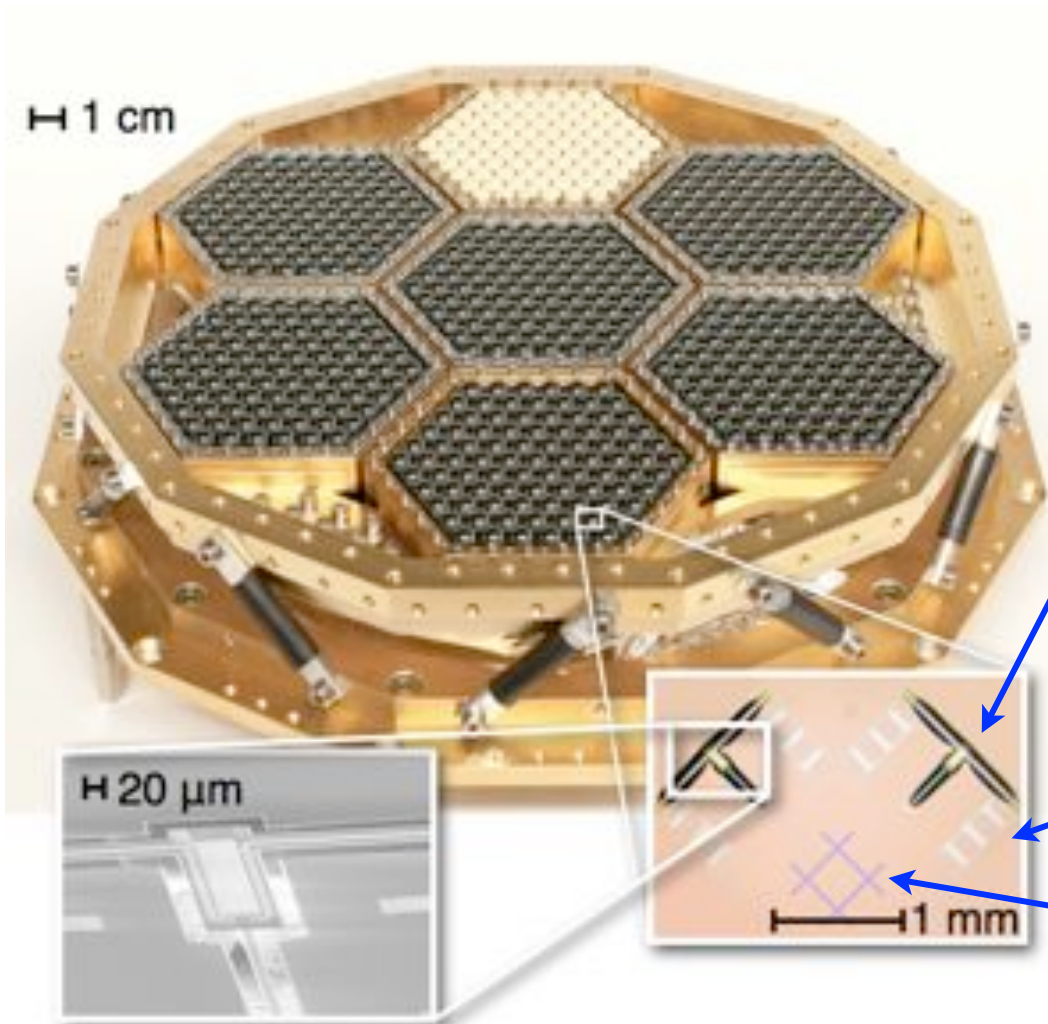
# Antenna-coupled TES Bolometer

91 pixels (182 bolometers) per wafer under AR-coated lenslet

TES bolometer

Microstrip Filter (150GHz)

Dual-polarization Slot Antenna



Total: 7 wafers = 637 pixels (1274 bolometers)

Array sensitivity :  $\sim 21 \mu\text{K} \sqrt{\text{s}}$  (with current operation yield as of July.7)

# Deployment in Chile



- Site deployment was started in mid-september 2011.

Telescope assembly

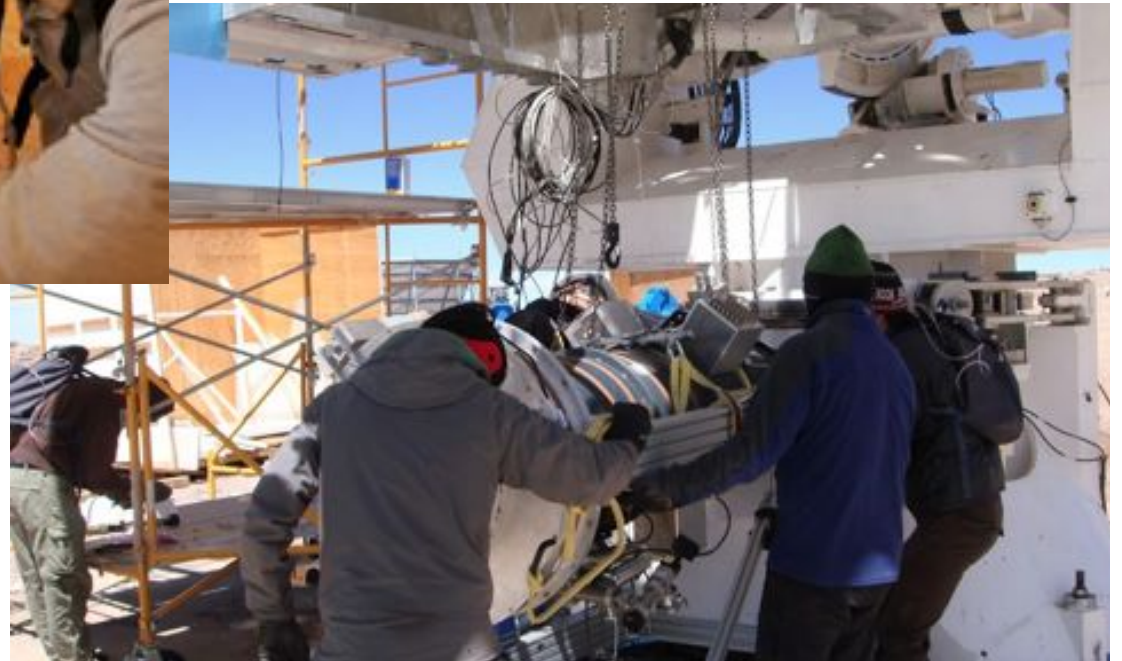


# Installing Focal Plane/Receiver



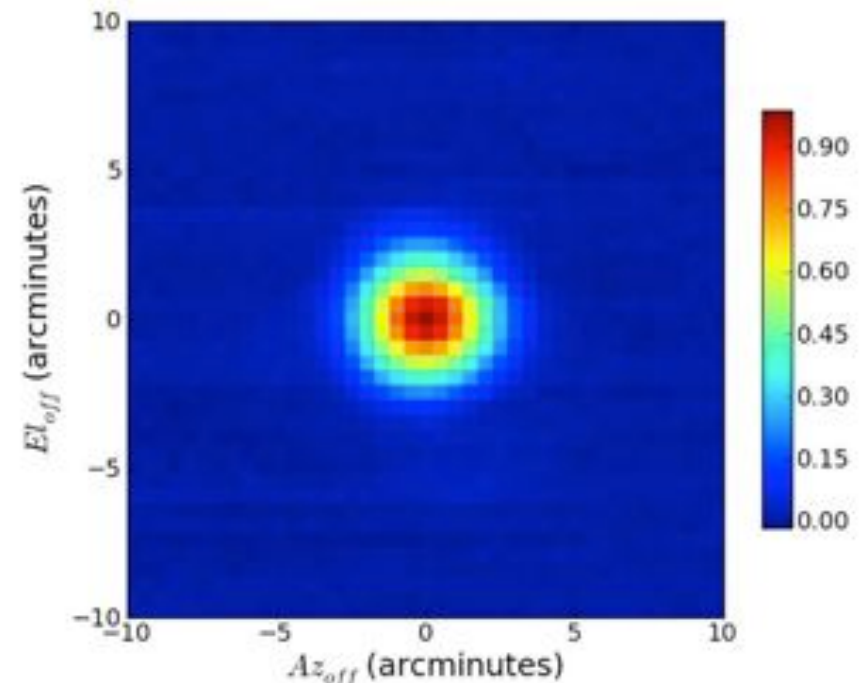
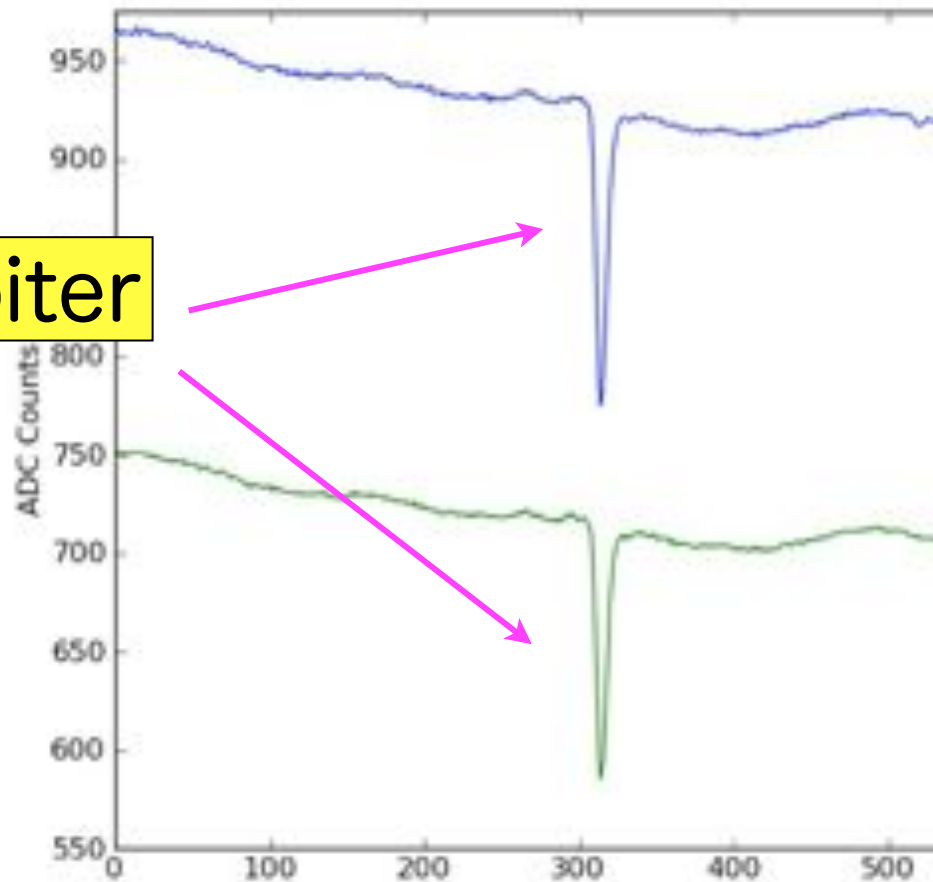
Focal Plane assembly  
at the site

Hoisting Receiver  
up on Telescope



# First Light (2012.01.10)

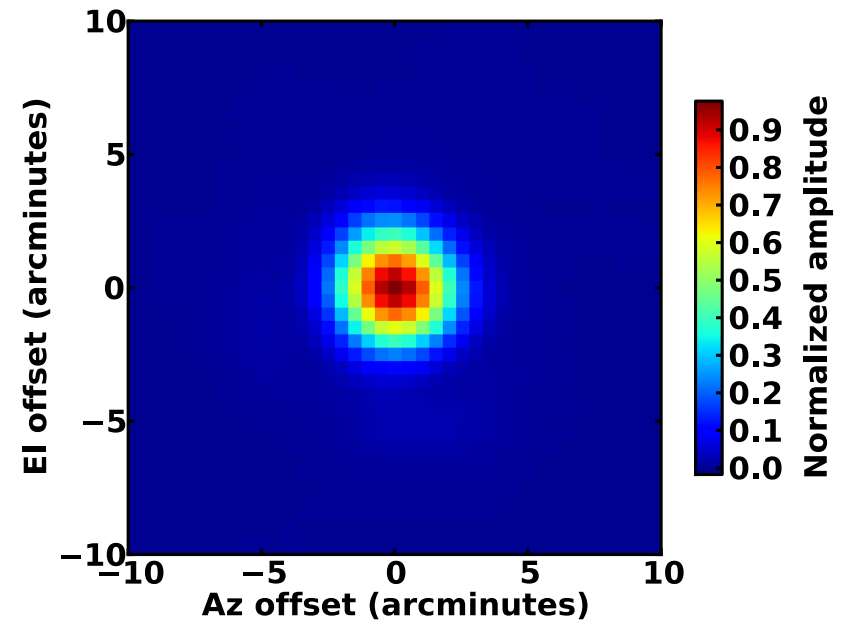
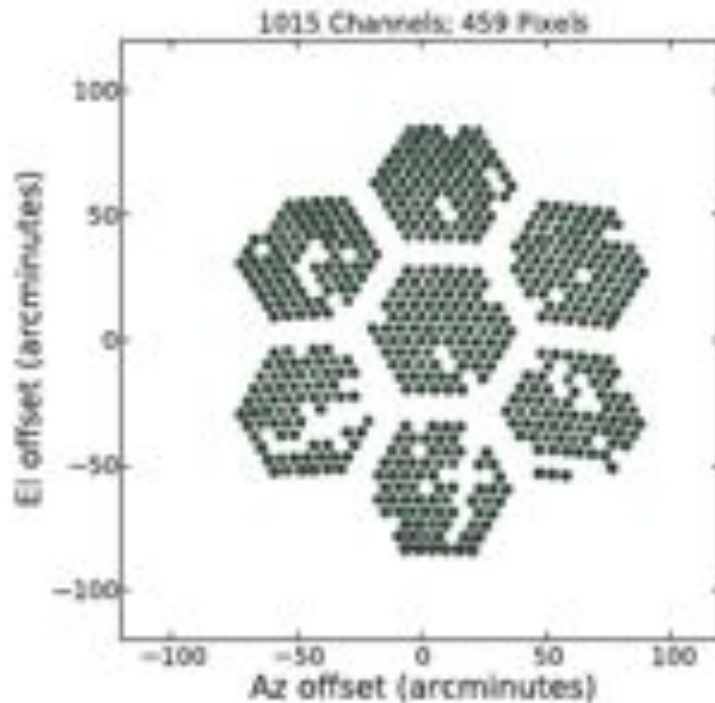
Jupiter



Routine observations  
have started since ~April 2012

# Receiver System Characteristics

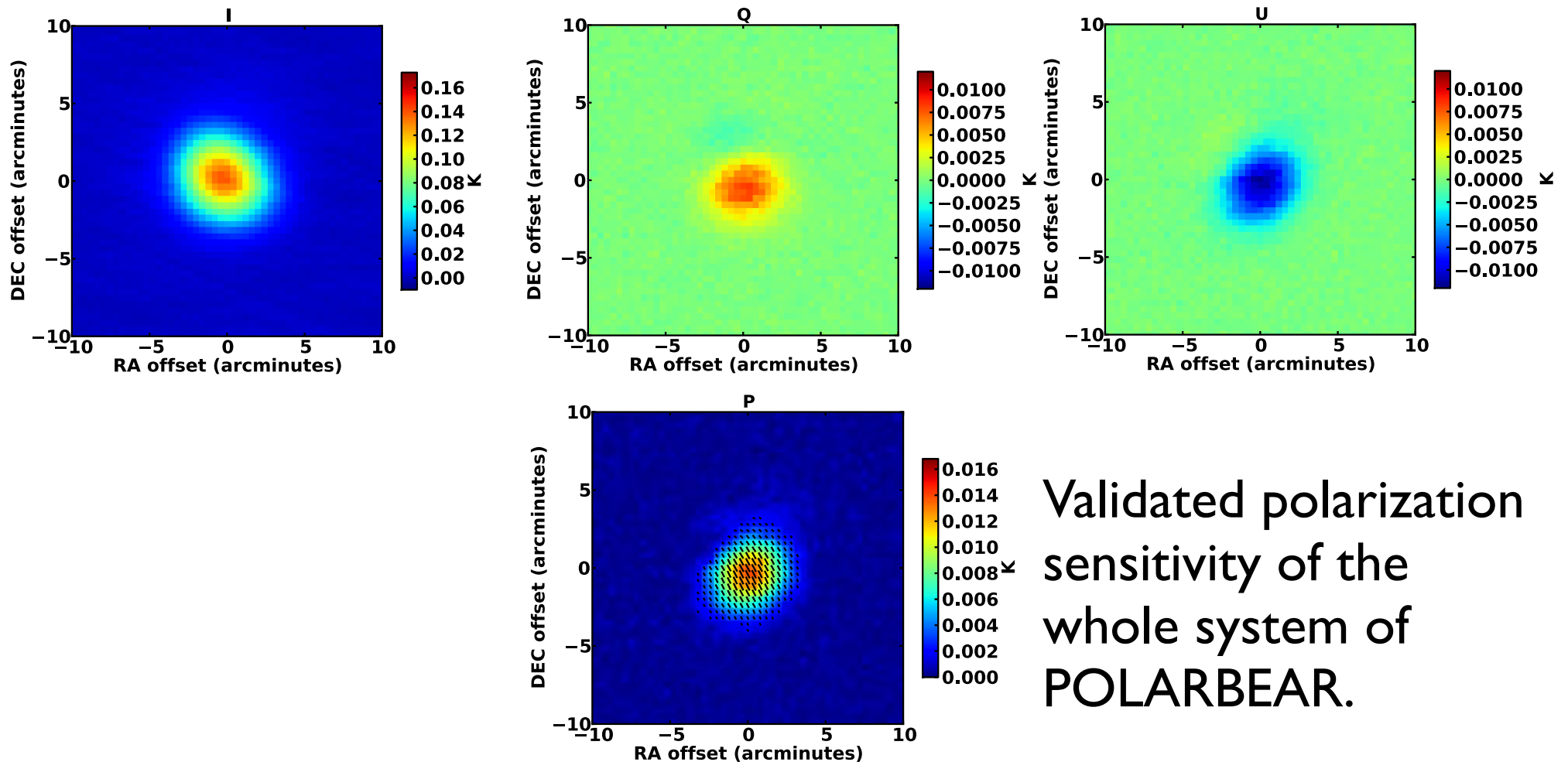
## Beam



- ~3.5' FWHM
- ~5% ellipticity consistent with optics simulation.  
(Beam systematics are under evaluated.)

# Preliminary Data

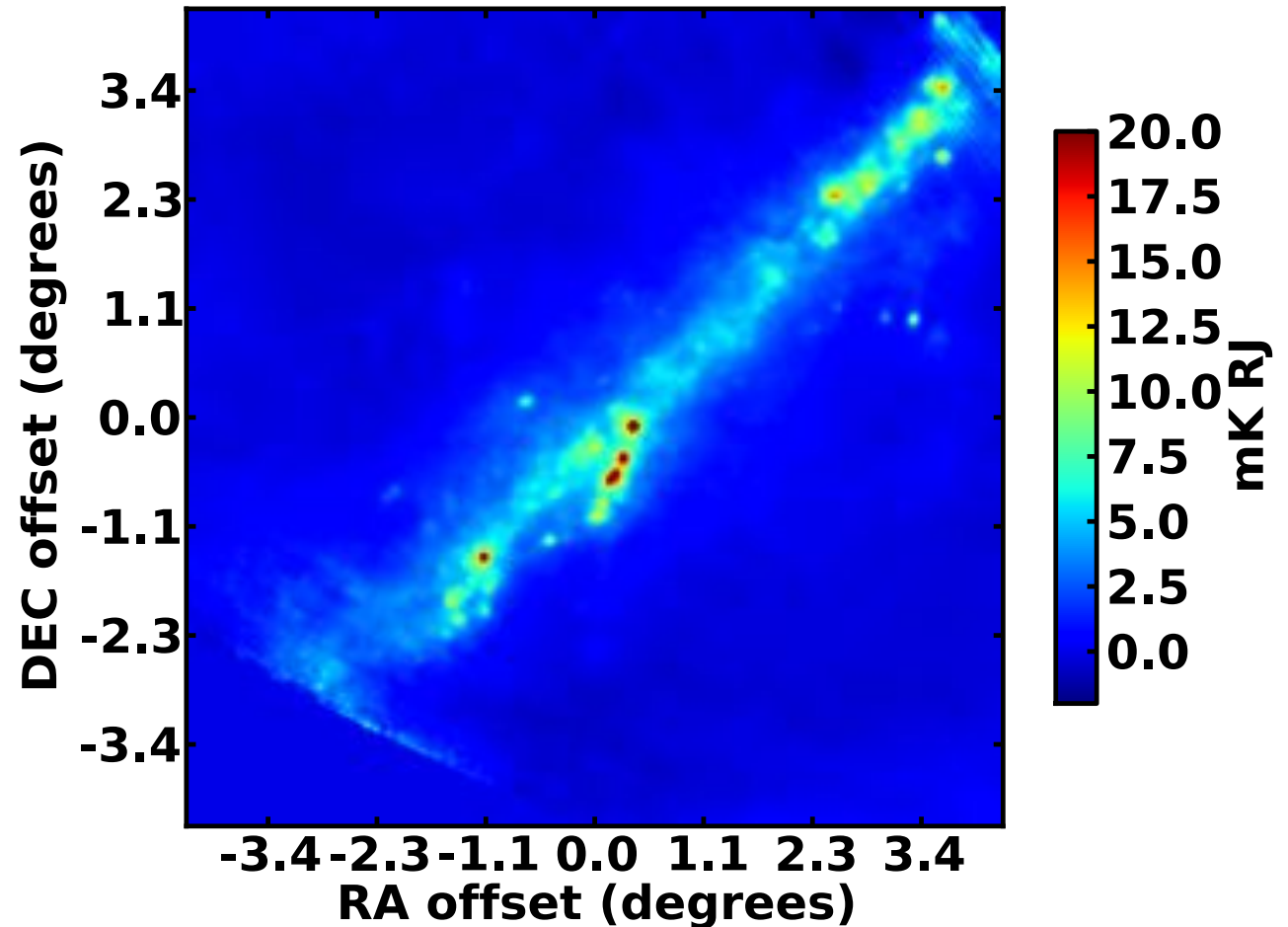
## Polarized maps of TauA Data



# Preliminary Data

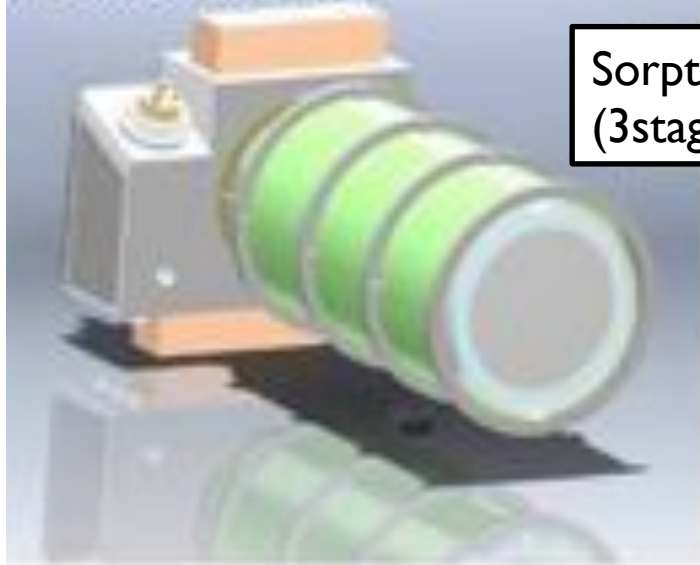
## Preliminary Galaxy Map

- 1 hr of data



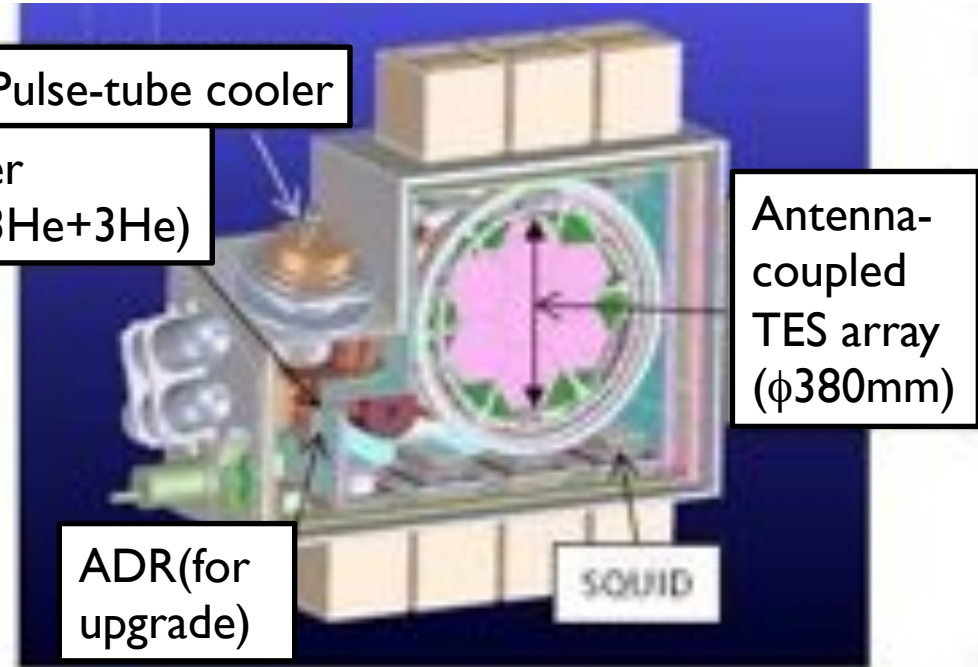
# Coming next: POLARBEAR-2

Overview(Focal plane cryostat  
+Optical cryostat)



Pulse-tube cooler

Sorption cooler  
(3stage: 4He+3He+3He)

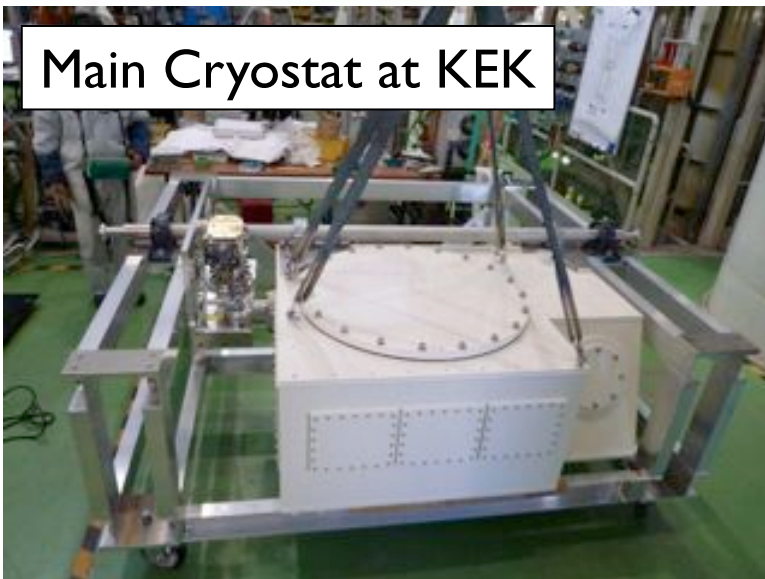


Antenna-  
coupled  
TES array  
( $\phi 380\text{mm}$ )

ADR(for  
upgrade)

SQUID

Main Cryostat at KEK



- Upgrade of POLARBEAR
  - dichroic detector (90 + 150GHz)
  - Larger focal plane with 7588 bolometersKEK leads the receiver construction.
- Better sensitivity for  $r$  and neutrino mass
- Deployment schedule : 2014 spring



# Summary

- POLARBEAR is a ground-based experiment in the high Atacama desert in Chile, and is designed to detect CMB B-mode polarization with a 1,274-TES bolometer array.
- Science Goals:
  - Search for inflationary B-mode  $r \sim 0.025$
  - Constrain (absolute) neutrino mass scale
- Deployment was successfully done, and routine CMB observation has been started.