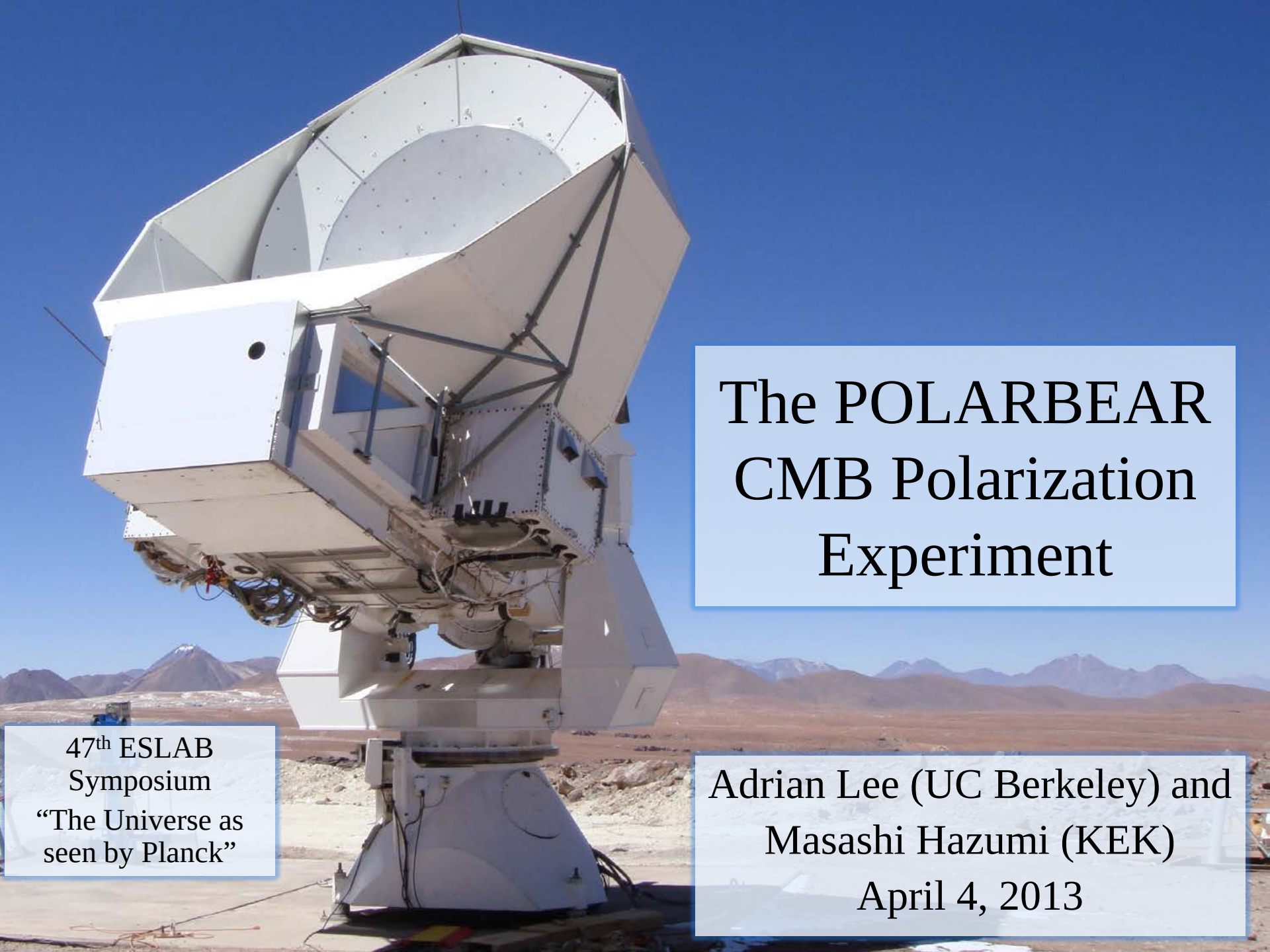


The POLARBEAR CMB Polarization Experiment

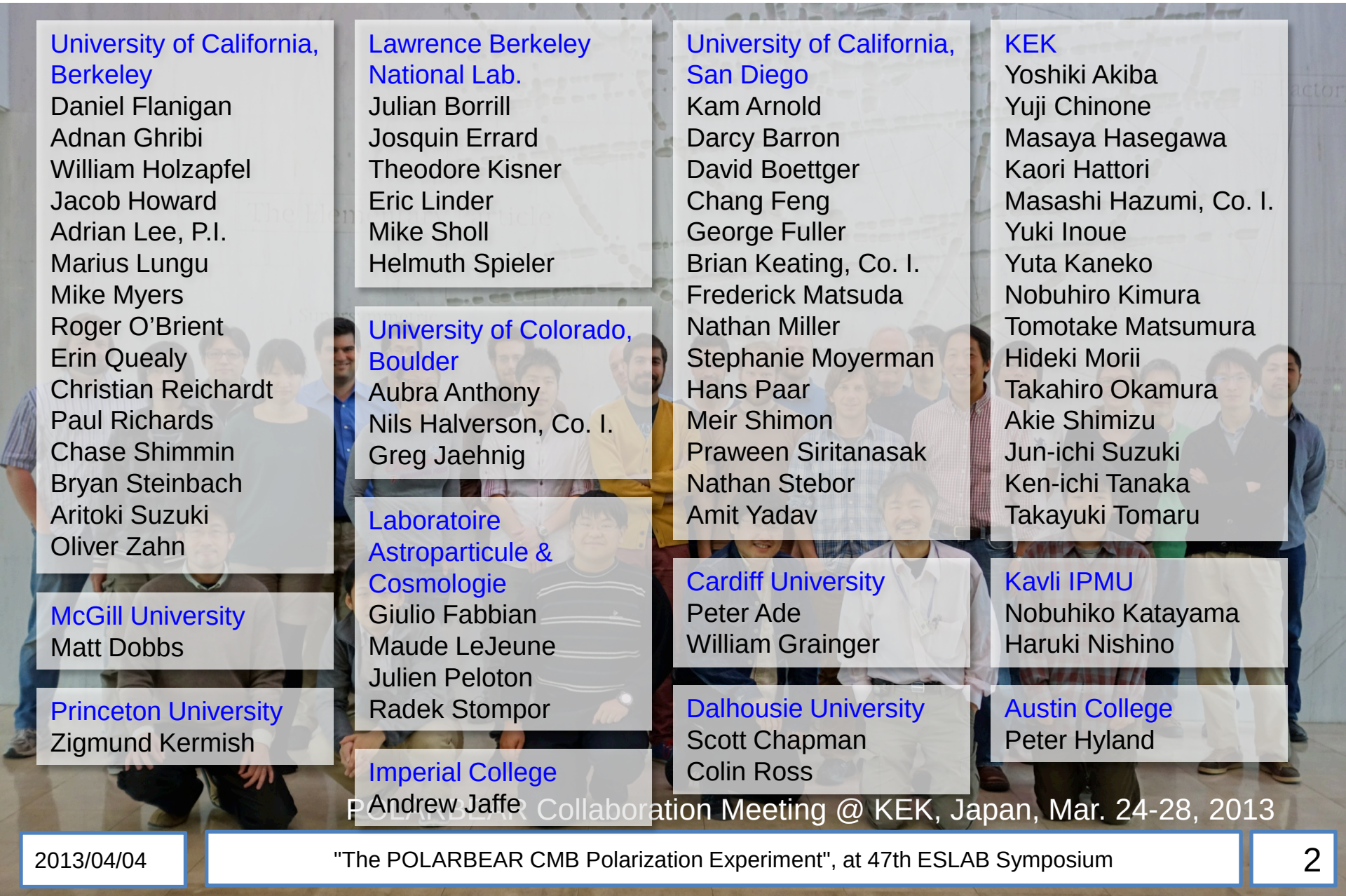
47th ESLAB Symposium

"The Universe as seen by Planck"

Adrian Lee (UC Berkeley) and
Masashi Hazumi (KEK)

April 4, 2013

POLARBEAR Collaboration



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Daniel Flanigan
Adnan Ghribi
William Holzapfel
Jacob Howard
Adrian Lee, P.I.
Marius Lungu
Mike Myers
Roger O'Brient
Erin Quealy
Christian Reichardt
Paul Richards
Chase Shimmin
Bryan Steinbach
Aritoki Suzuki
Oliver Zahn

McGill University
Matt Dobbs

Princeton University
Zigmund Kermish

Lawrence Berkeley National Lab.
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Josquin Errard
Theodore Kisner
Eric Linder
Mike Sholl
Helmuth Spieler

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Nathan Stebor
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Yuki Inoue
Yuta Kaneko
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Tomotake Matsumura
Hideki Morii
Takahiro Okamura
Akie Shimizu
Jun-ichi Suzuki
Ken-ichi Tanaka
Takayuki Tomaru

Kavli IPMU
Nobuhiko Katayama
Haruki Nishino

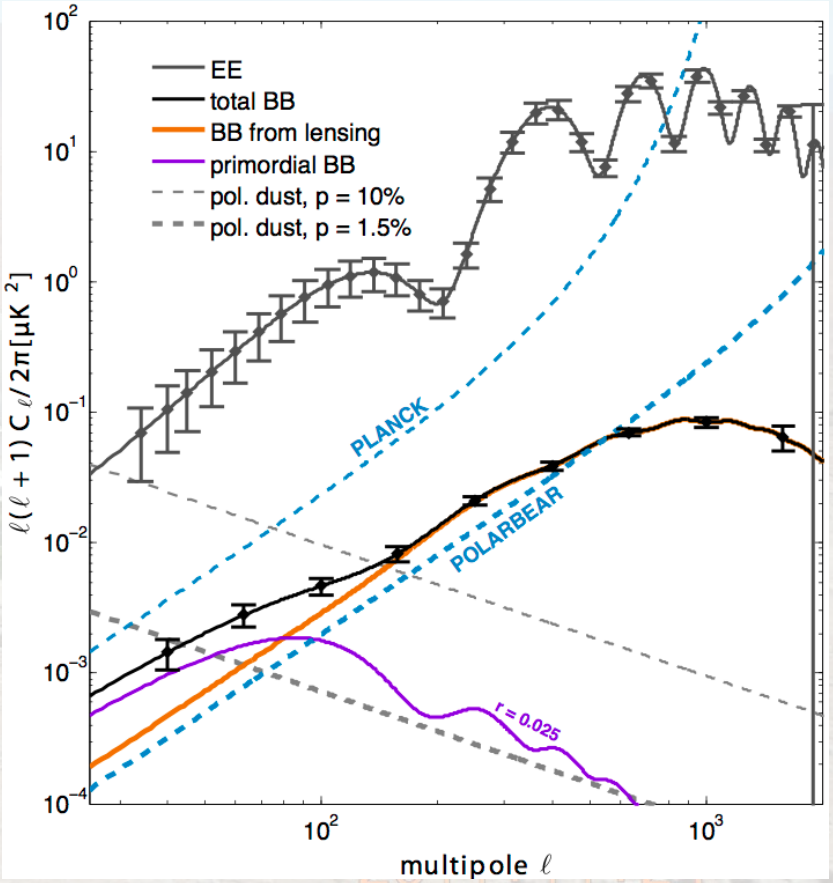
Austin College
Peter Hyland

POLARBEAR Collaboration Meeting @ KEK, Japan, Mar. 24-28, 2013

Overview

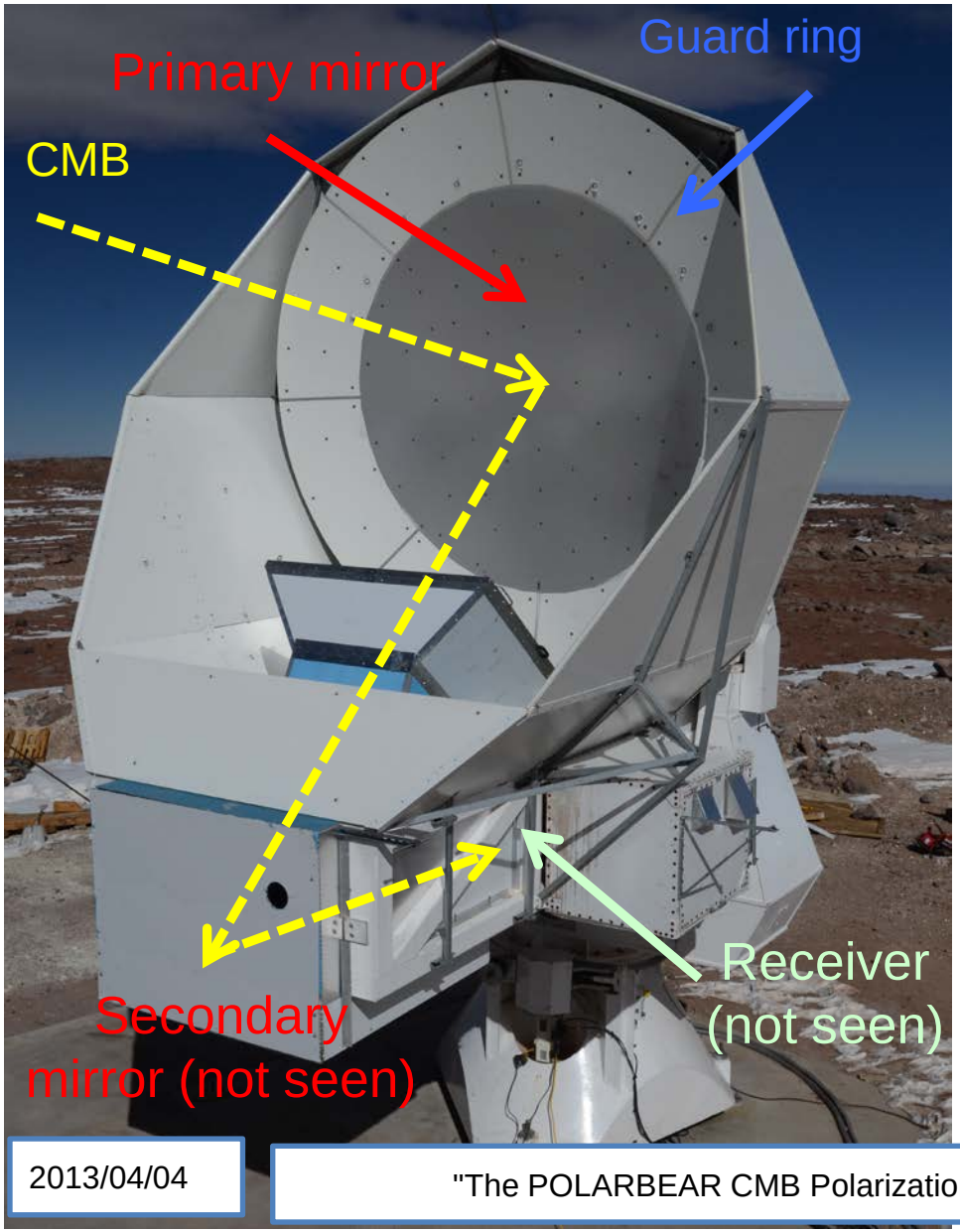
POLARBEAR Site:
Atacama, Chile
(5150m above sea level)

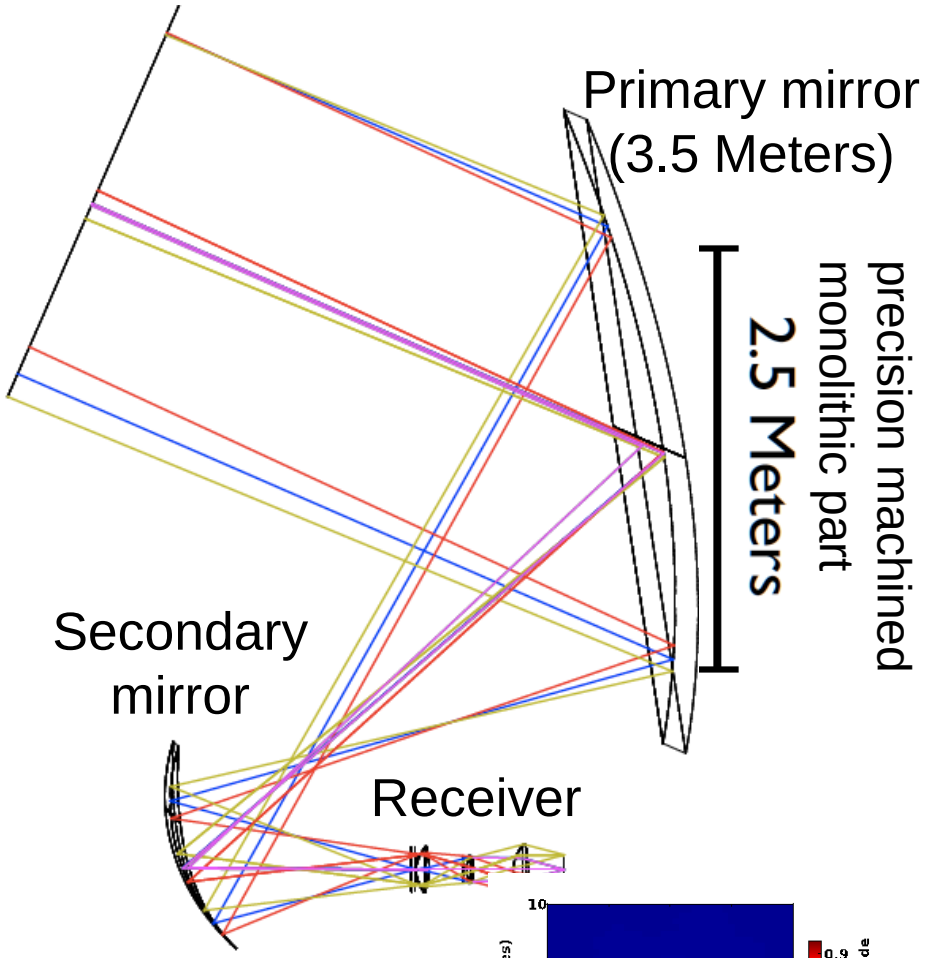
- Search for inflationary B-modes to r=0.025 (95%C.L.) *and* detect gravitational lensing B-modes
- 3.5m primary mirror and large focal plane w/ 1274 TES bolometers
- First light in Chile in Jan. 2012 and large amount of data already recorded
- Roadmap to deploy 7588 TESes in 2014 and >22000 TESes in 2016

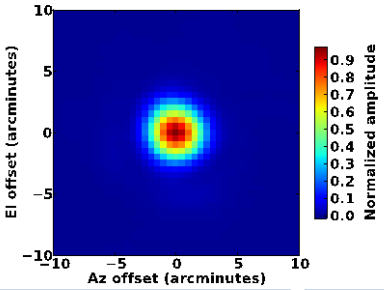


Huan Tran Telescope (HTT)

Off-axis
Gregorian-Dragone

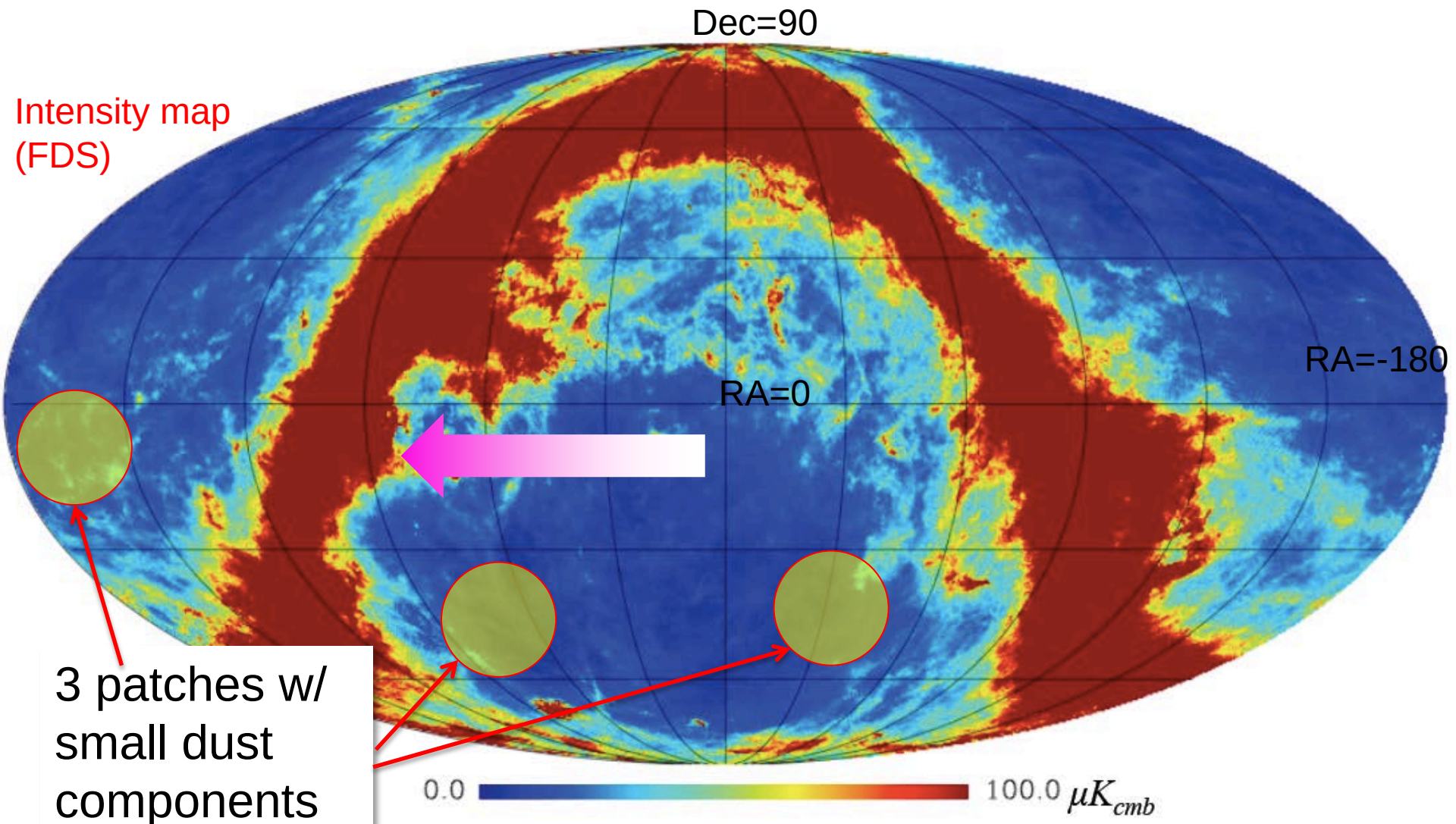




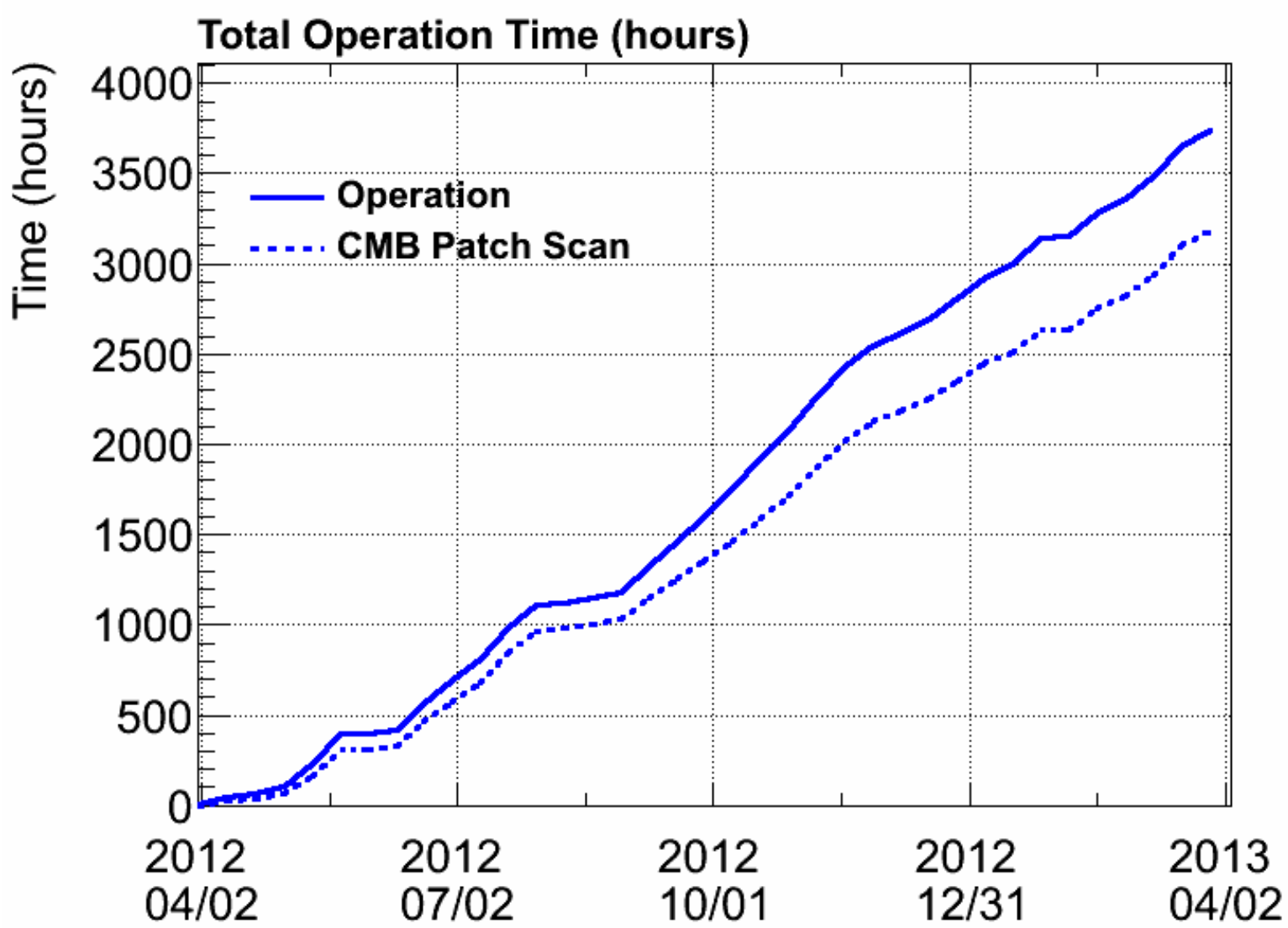


FWHM=3.5'
achieved

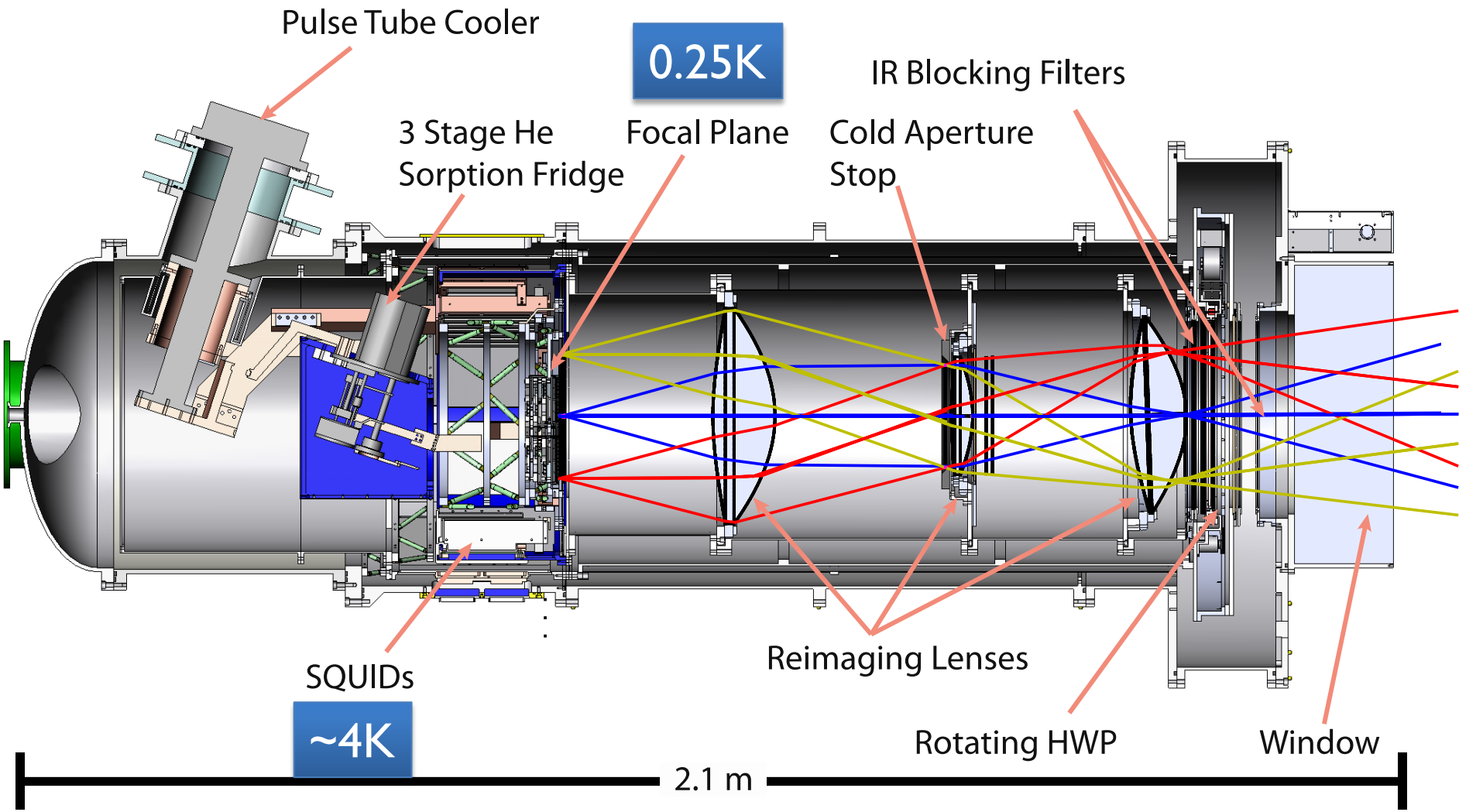
Observation (36 hour cycle)



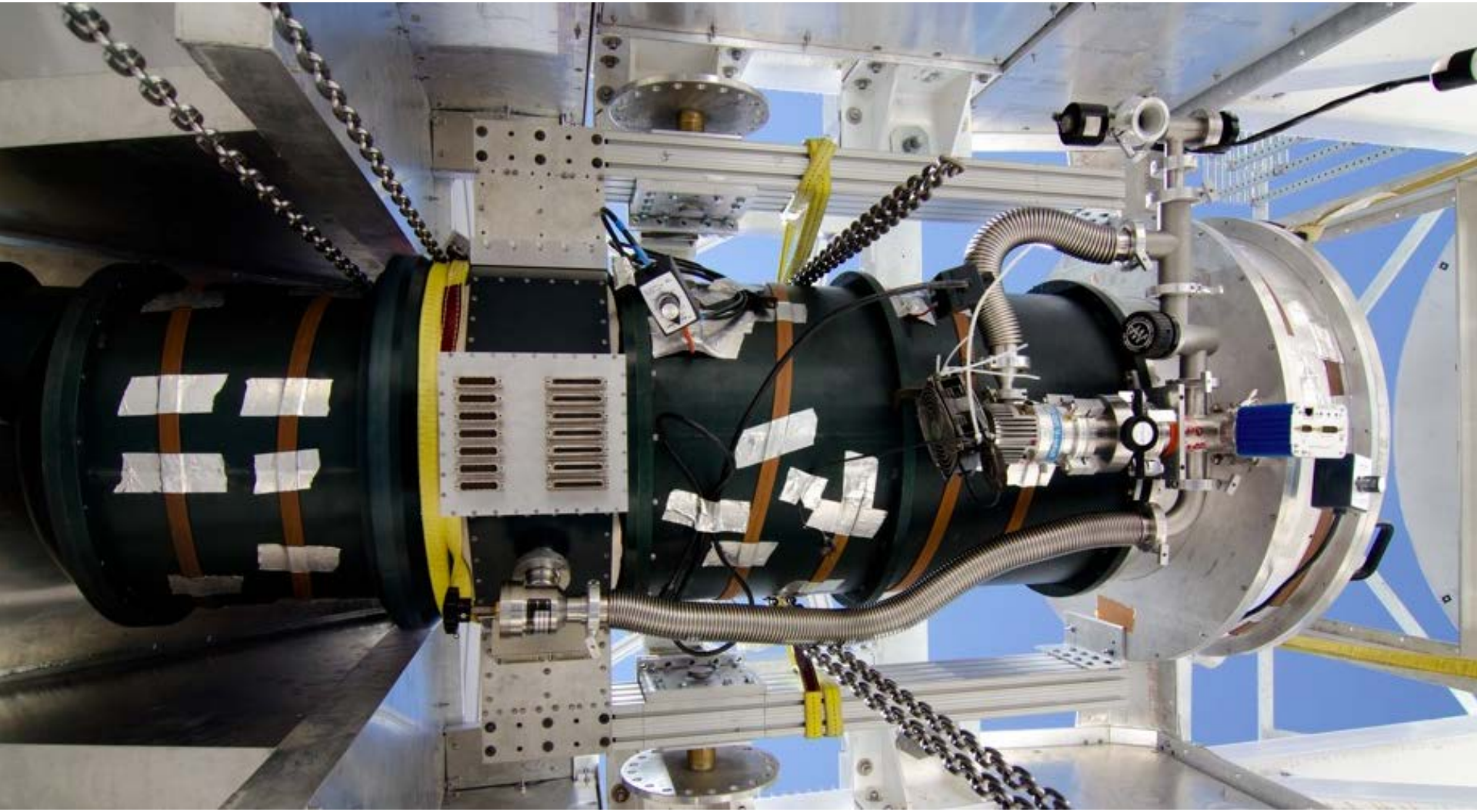
Observing Time



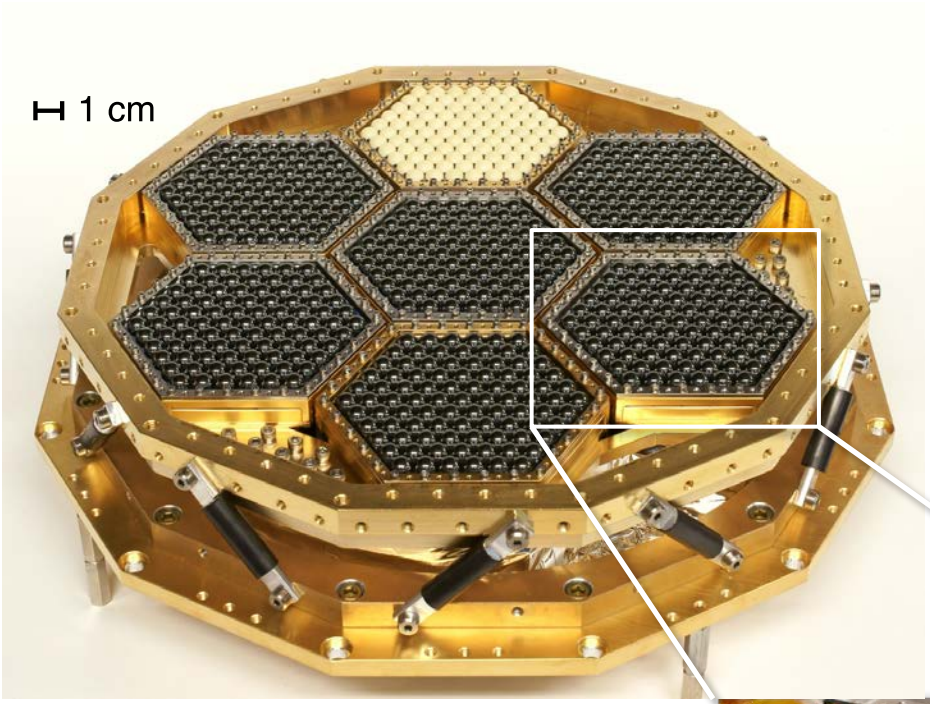
Receiver System



Receiver System

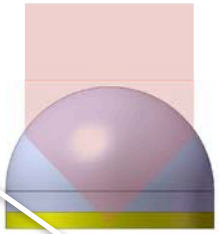


Focal Plane

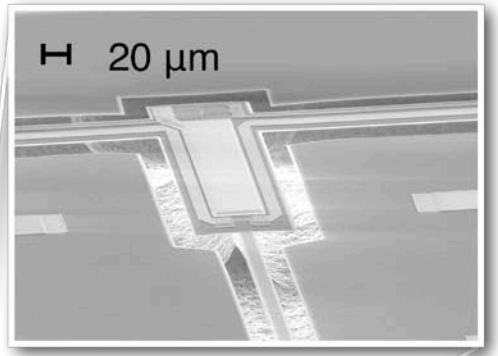


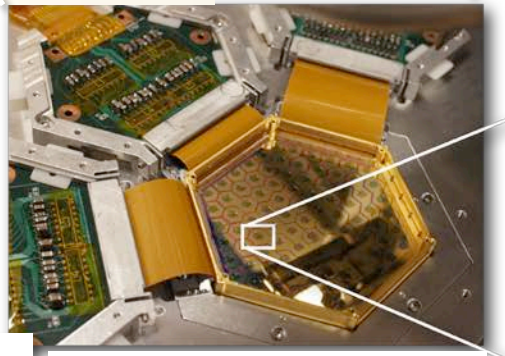
637 pixels
(91 pixels/wafer x 7 wafers)
1274 TES bolometers

Lenslet

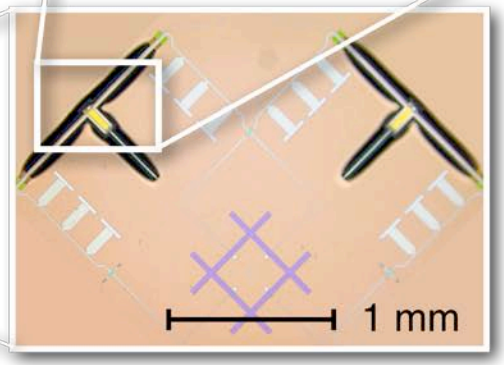


TES





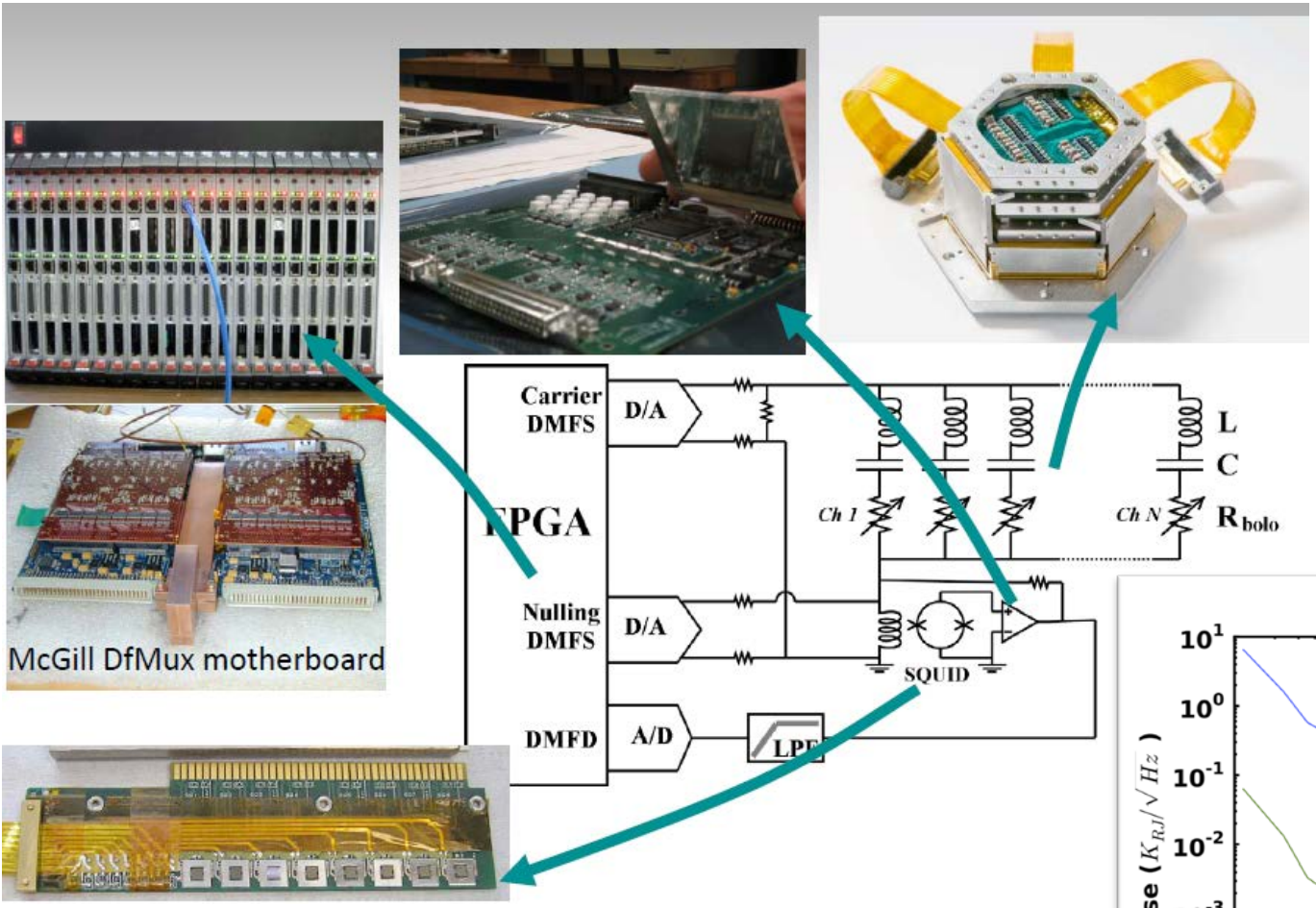
Wafer module assembly



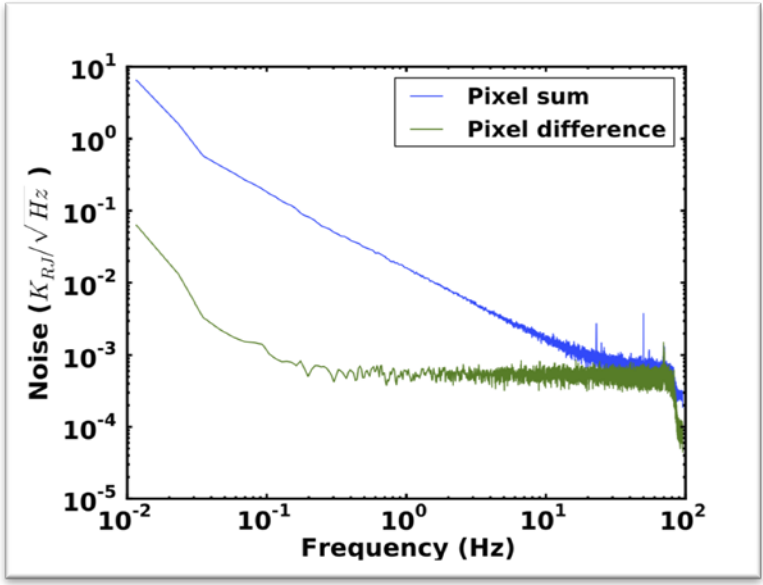
2 TES bolometers/pixel with dual-polarization double-slot dipole antenna

21 μK√s array NET
(achieved typically during observations)

Readout Electronics



Frequency-domain multiplexing (8 to 1) SQUIDs (NIST) and room-temp. electronics (McGill)



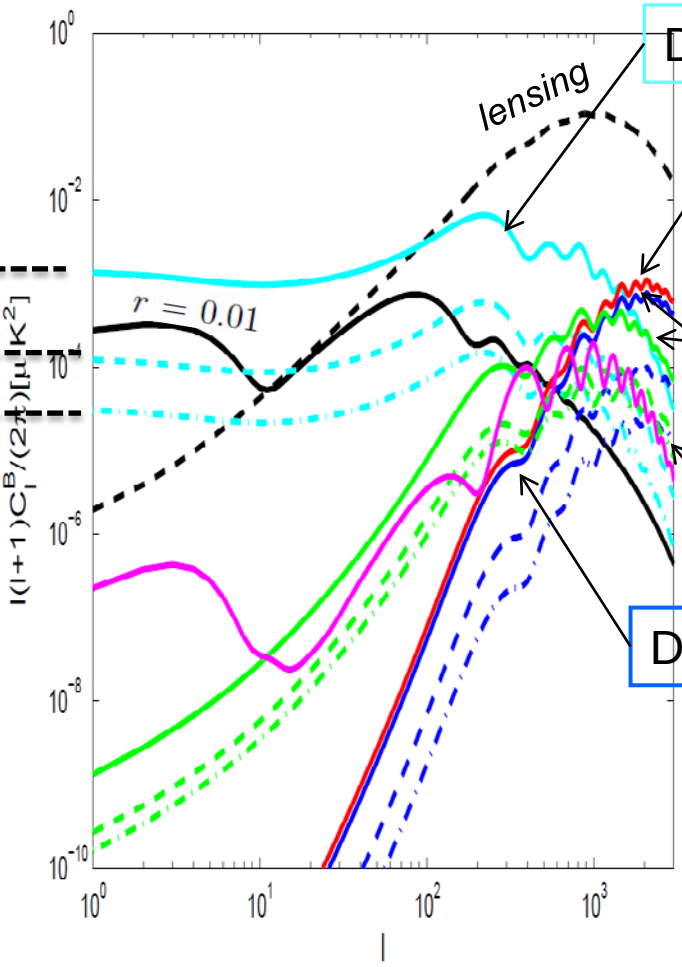
1/f knee ~ 100mHz
w/ pixel difference

Systematic Error Mitigation

Suppression with sky rotation

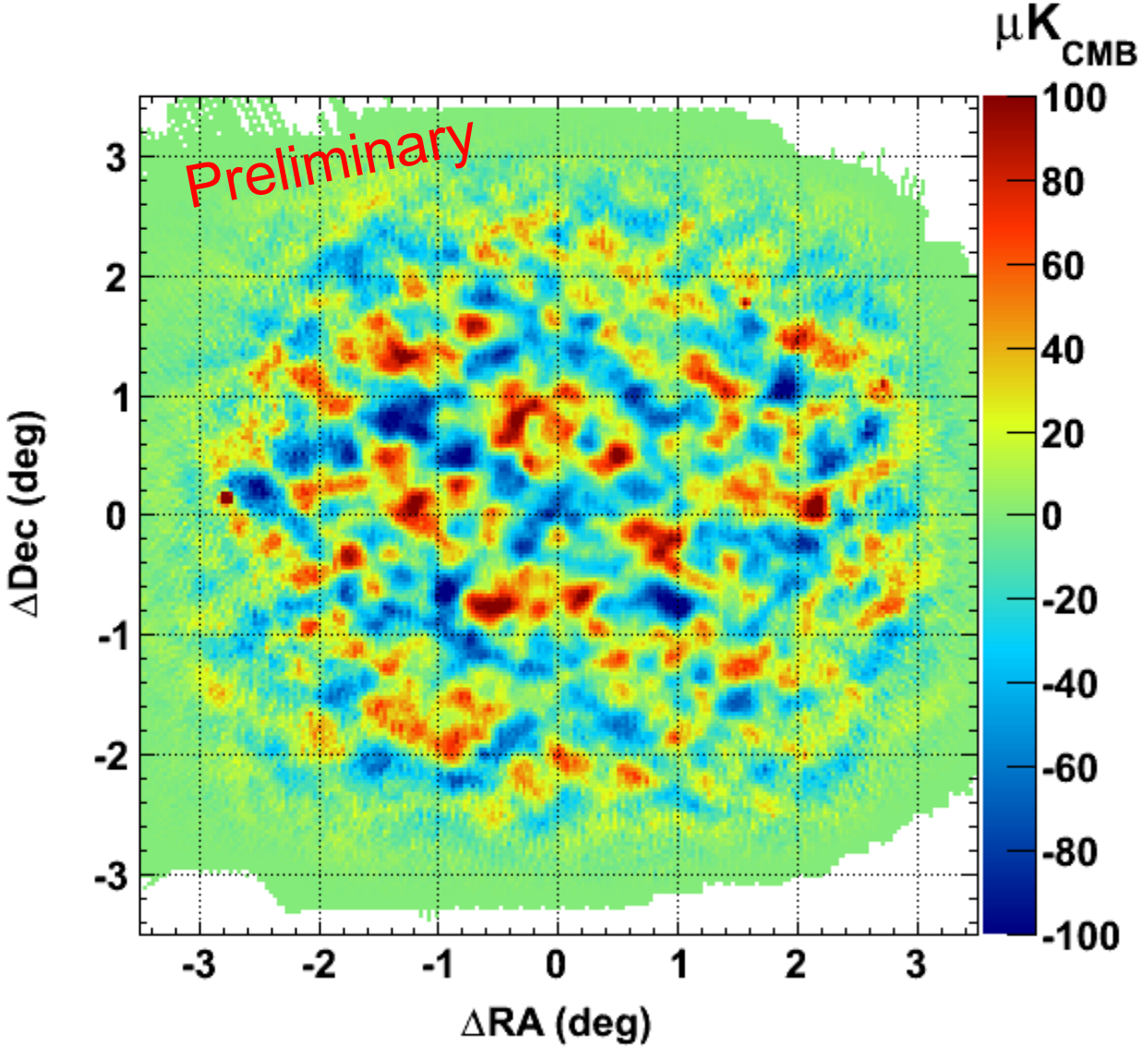
Suppression w/ stepped HWP

Beam effect forecast

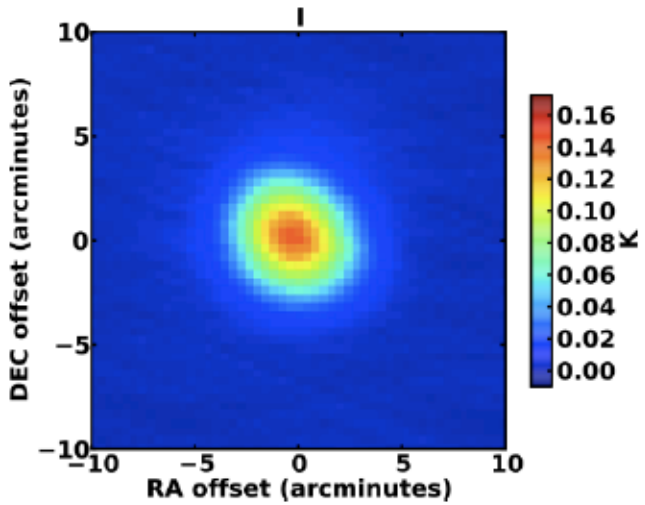


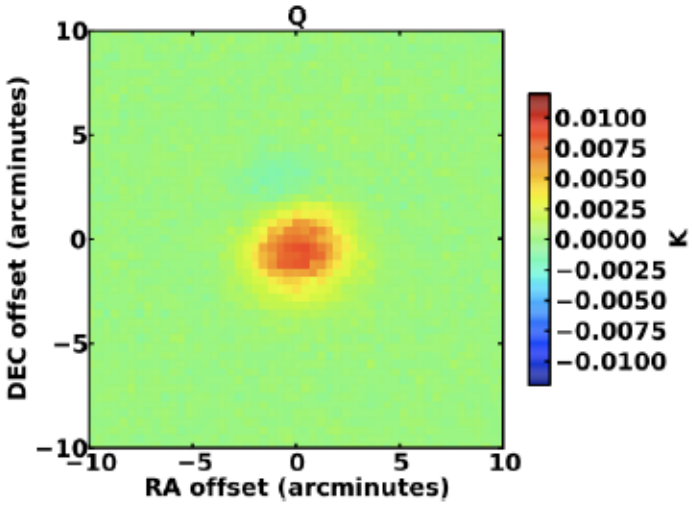
- Sky rotation in Chile is effective
- Small-enough beams
  → peak in leakage at high-l
- Comoving shields against sidelobes
- Evaluation w/ data in progress

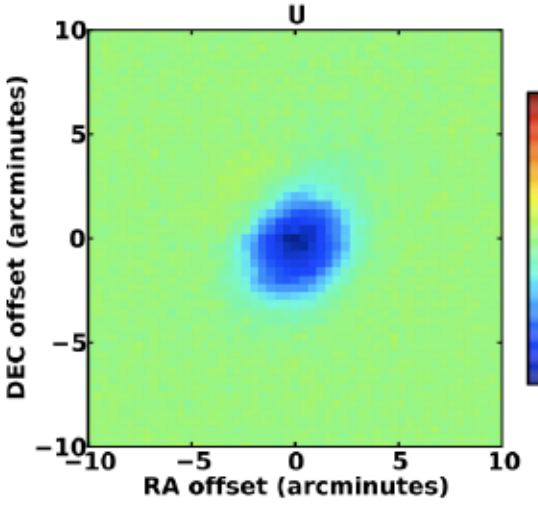
Temperature Map



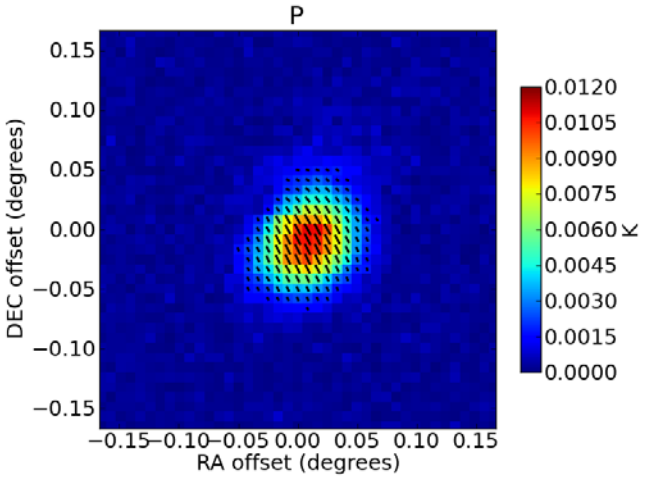
Polarized Maps of TauA





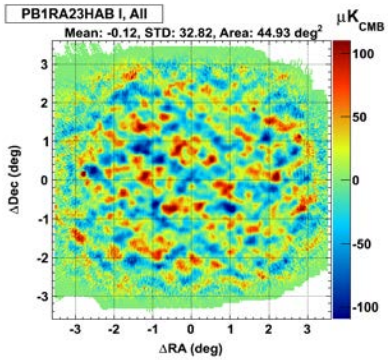


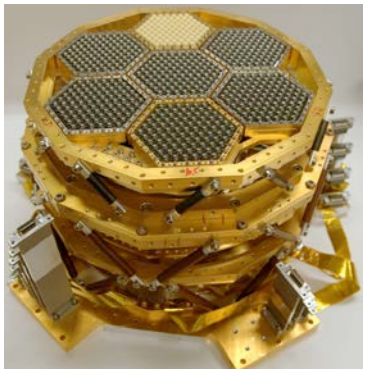
- Polarization data validation studies are in progress.
- Polarization power spectra for full data set are not known until the end of the validation studies to minimize human bias.



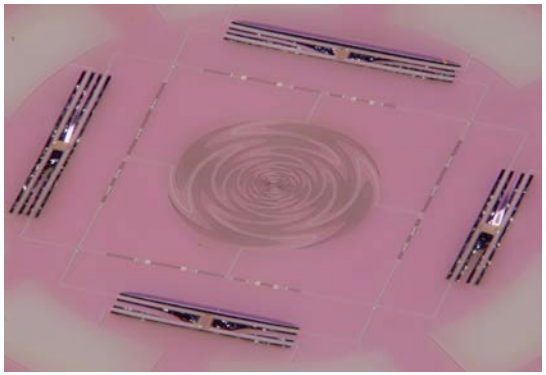
POLARBEAR Roadmap

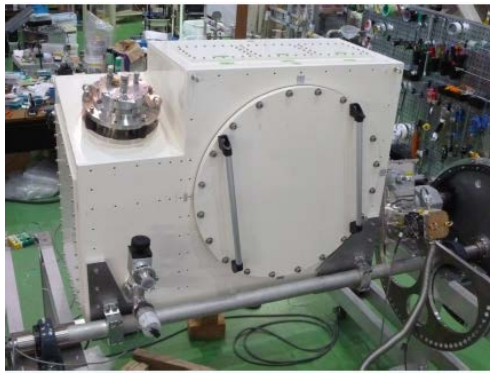
- POLARBEAR-1 (2012)
  - 1,274 Detectors
  - 1st year data taken
  - Polarized Lensing
  - Inflationary B-mode search, r ~ 0.025 (95% C.L.)





- POLARBEAR-2 (2014)
  - 7,588 Detectors
  - 90/150 GHz dual-band pixels
  - Assembly Started (led by KEK)
  - 90 meV neutrino mass (68% C.L.)
  - r ~ 0.01 (95% C.L.)





- Simons Array (2016)
  - 3 Telescopes
  - 3 x PB-2 receivers (> 22,000 detectors)
  - 90/150/220 GHz tri-band pixels
  - 50 meV neutrino mass (68% C.L.)
  - r ~ 0.007 (95% C.L.)

Summary

- Scientific objectives:
  - Search for inflationary B-modes to r=0.025 (95%C.L.) *and* detection of lensing B-modes
- Location:
  - Atacama, Chile (5150m above sea level)
- Instrument:
  - ~1000 TESes (0.25K) w/ frequency-domain multiplexing
  - 3.5arcmin beam
  - 21μK√s array NET
- Observation:
  - First light in Jan. 2012
  - More than 3000 hours of operation time as of March 31, 2013
- Roadmap:
  - 7588 TESes in 2014 and >22000 TESes in 2016

Stay tuned for initial results from POLARBEAR !

Backup Slides

Calibration Tools

- Objects on the sky
  - TauA for pol. angle
  - Point sources for beam
  - Atmosphere for relative gain
- Stimulator (IR source)
  - relative gain, relative pol. angle
- Gunn (far field)
  - absolute pol. angle
- Dielectric Sheet Calibrator
  - absolute pol. angle
- Fourier Transform Spectrometer (to be installed)
  - spectral response functions
- CMB temperature
  - absolute gain etc.

Stimulator

Gunn

DSC