22-26 JULY 2019 MILANO LTD 18 LOW TEMPERATURE DETECTORS
SIMONS FOUNDATION Advancing Research in Basic Science and Mathematics
MEXT
Core-to-Core Program
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Deployment of POLARBEAR-2A

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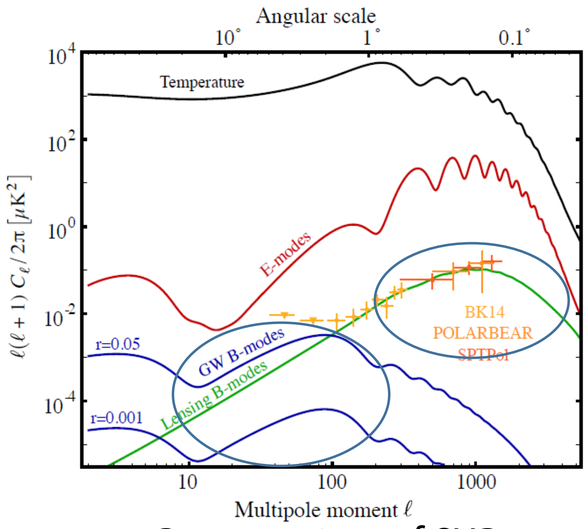
on behalf of POLARBEAR collaboration

CMB anisotropy and physics

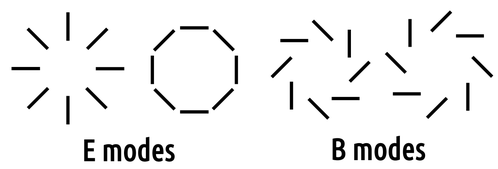
The polarization fluctuations of the Cosmic Microwave Background have the potential to provide new information about physics and cosmology.



Power spectrum of CMB
CMB-S4 Science Book, arXiv:1610.02743 [astro-ph.CO]

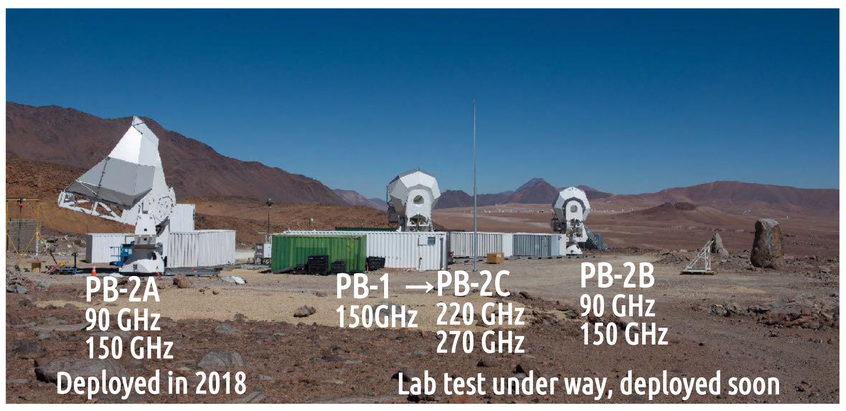
low-ℓ region
Primordial Gravitational Wave by inflation in early universe

High-ℓ region
Gravitational Lensing by large scale structure (neutrino mass)



POLARBEAR and Simons Array

☆ Chile, Atacama desert, altitude 5,200m, suitable place for mm-wave observation. (typical precipitable water vapor ~1mm)
☆ 2.5m primary mirror off-axis Gregorian telescope
☆ Continuous rotating Half-wave plate to mitigate 1/f noise
☆ PB-1 started in 2012, PB-2 receivers are being deployed



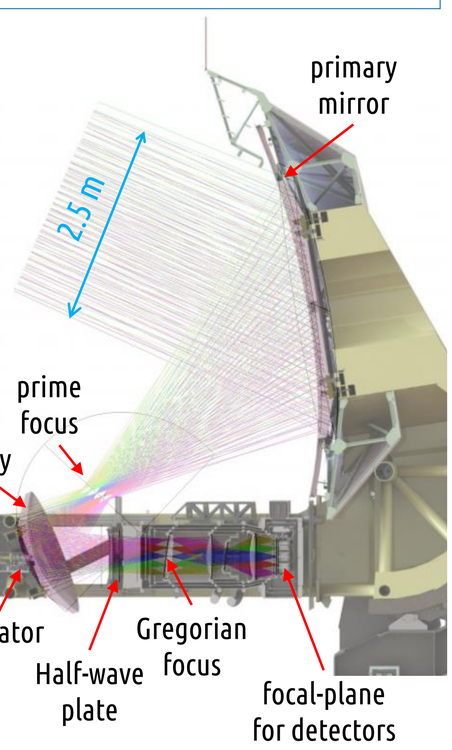
3 telescope for Simons Array experiment

Expected performance by Simons Array

Sensitivity after 3 years observation with 3 telescopes of expected performance

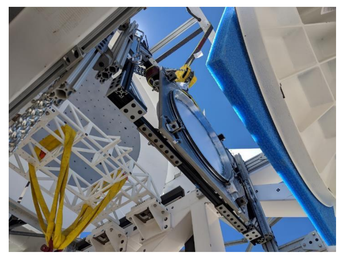
Inflation, tensor to scalar ratio: r
$\sigma(r)|_{r=0.1} \sim 0.006$

Sum of the neutrino masses
$\sigma(\Sigma m_\nu) \sim 40$ meV
combined with DESI BAO results

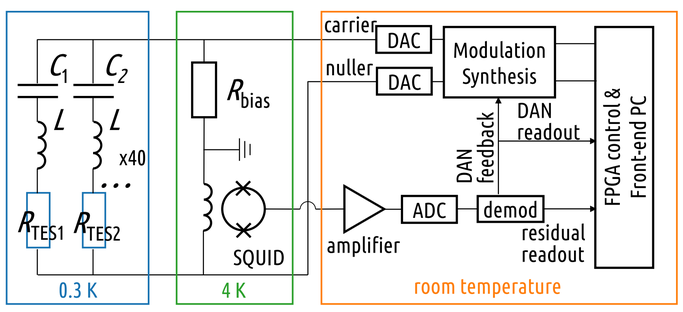


Design of POLARBEAR-2A receiver

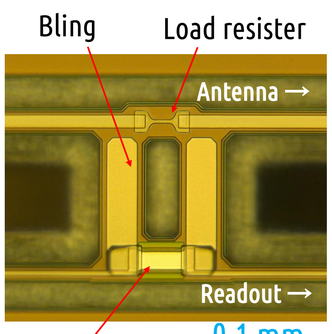
☆ Transition Edge Sensor (TES) bolometers which operate at 0.3 K cooled by He sorption cooler
☆ 2 spectral bands (90 and 150 GHz) in each detector
☆ ~40 cm detector plane, 7588 sensors mounted (~6 times more than PB-1)
☆ 40 channels are multiplexed in 1 readout channel of SQUID.



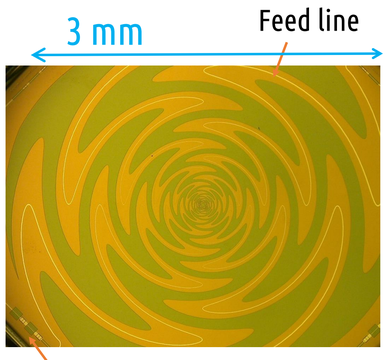
Half-wave plate with rotator attached on telescope



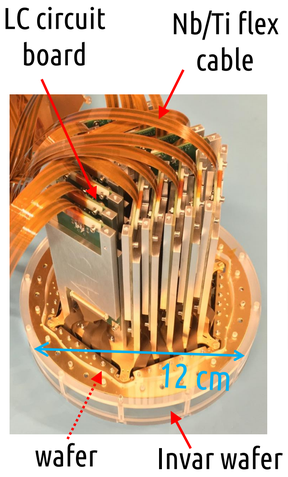
TES readout scheme



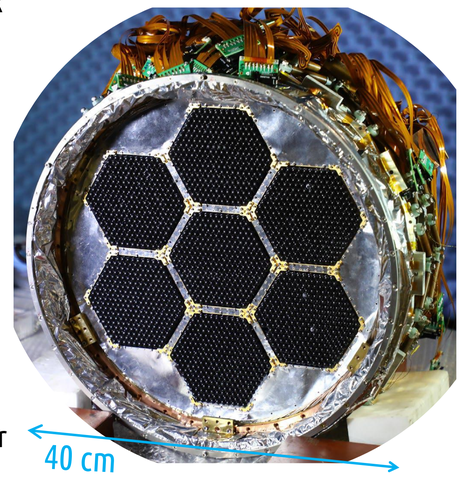
Microscope image of TES bolometer



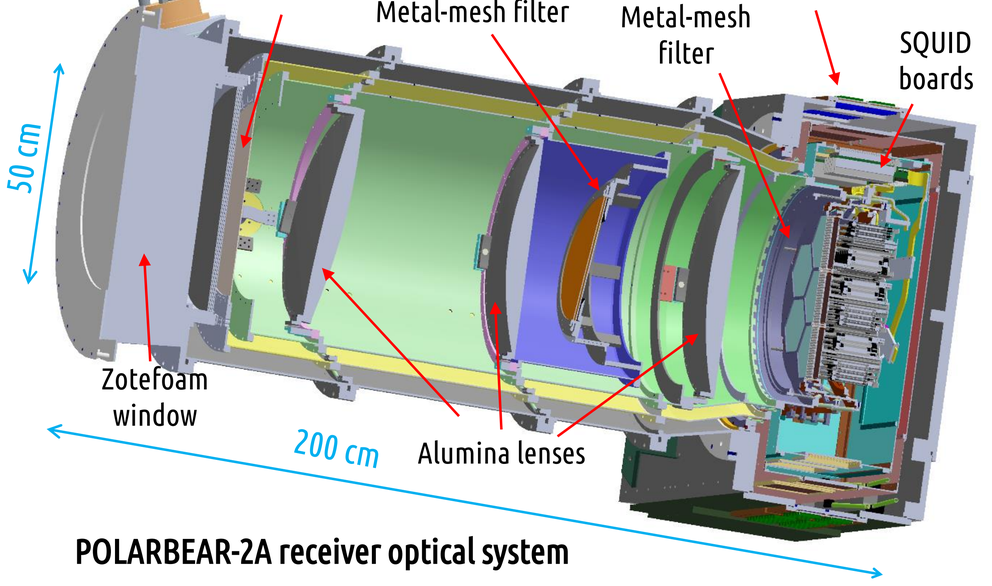
Microscope image of sinuous antenna



Detector module



Assembled focal-plane structure



POLARBEAR-2A receiver optical system

PB-2A site installation 2018

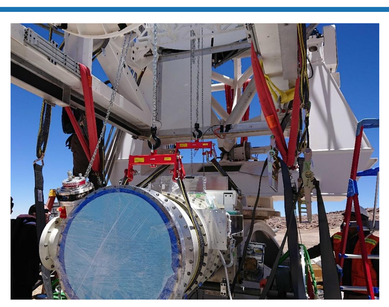
time →

Packages arrived to Atacama site.

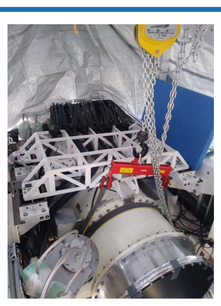
Assembly work in high-bay.

Receiver assembly completed.

Transport to the telescope.



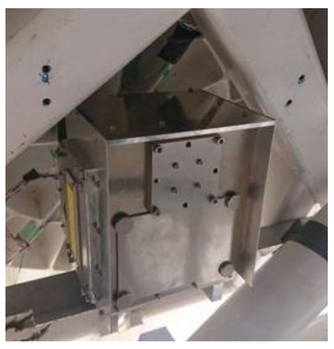
Hoisting work by hand.



Receiver attached.

Ready to start scan!

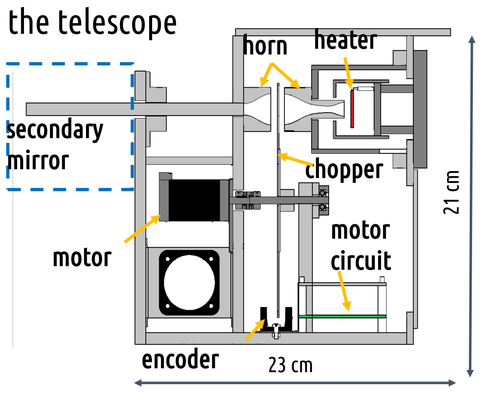
Calibrator tests



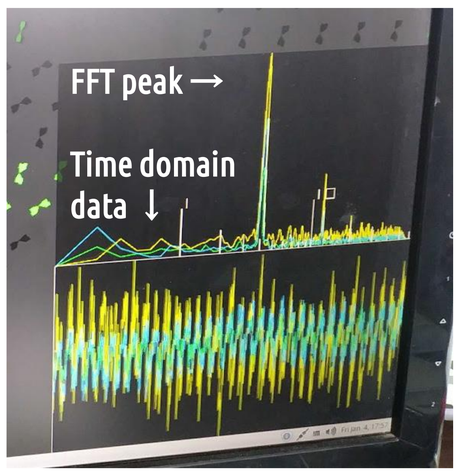
Stimulator mounted on the telescope

Stimulator

Stimulator is an artificial reference source which uses radiation from ceramic heater which put behind secondary mirror.
It is used for good channel selection, relative gain adjustment and time constant measurement.
Currently stimulator is in test operation.



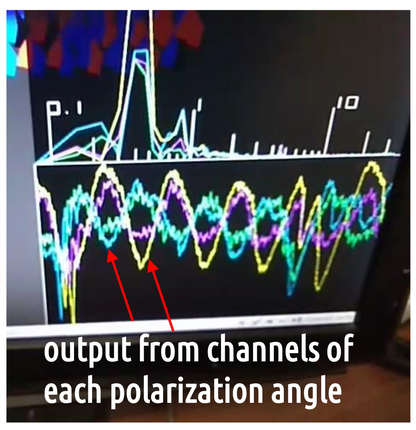
Design of PB-2A stimulator



Detector response to stimulator

Wire-grid calibrator

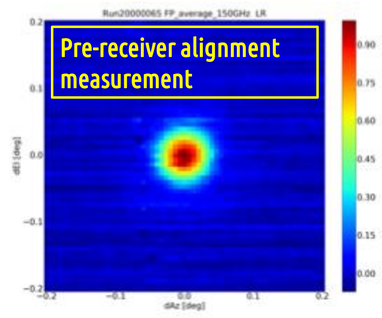
Polarization angle is needed to be calibrated in order to control fake B-mode signal made by contamination of E-mode.
Wire-grid is one of polarization angle calibrators, and a trial run was performed.
Calibration with improved instrument and half-wave plate is planned.



First wire-grid test and it's quick result.

Planet observations

Beam shape can be checked by the data from planet scan, since planets are well smaller than expected beam size.



Circular Venus images were seen in many channels, although this is a preliminary result. The beam shape will be improved after optical alignment.

We have achieved the first light