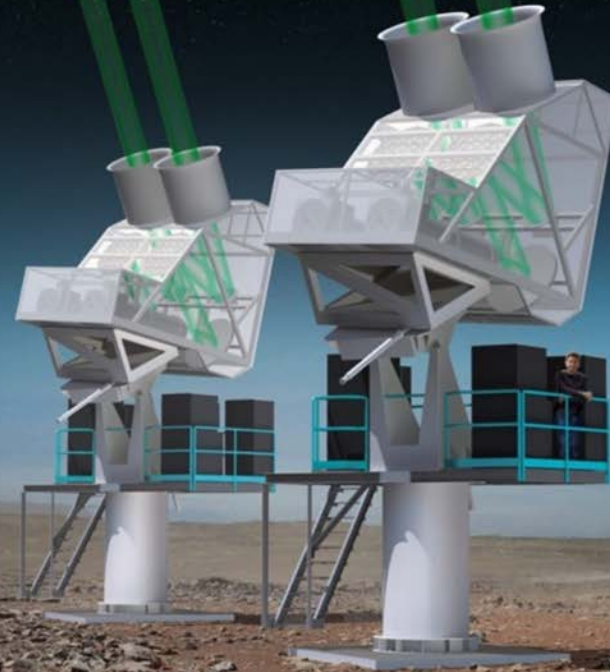


Cosmology Large Angular Scale Surveyor

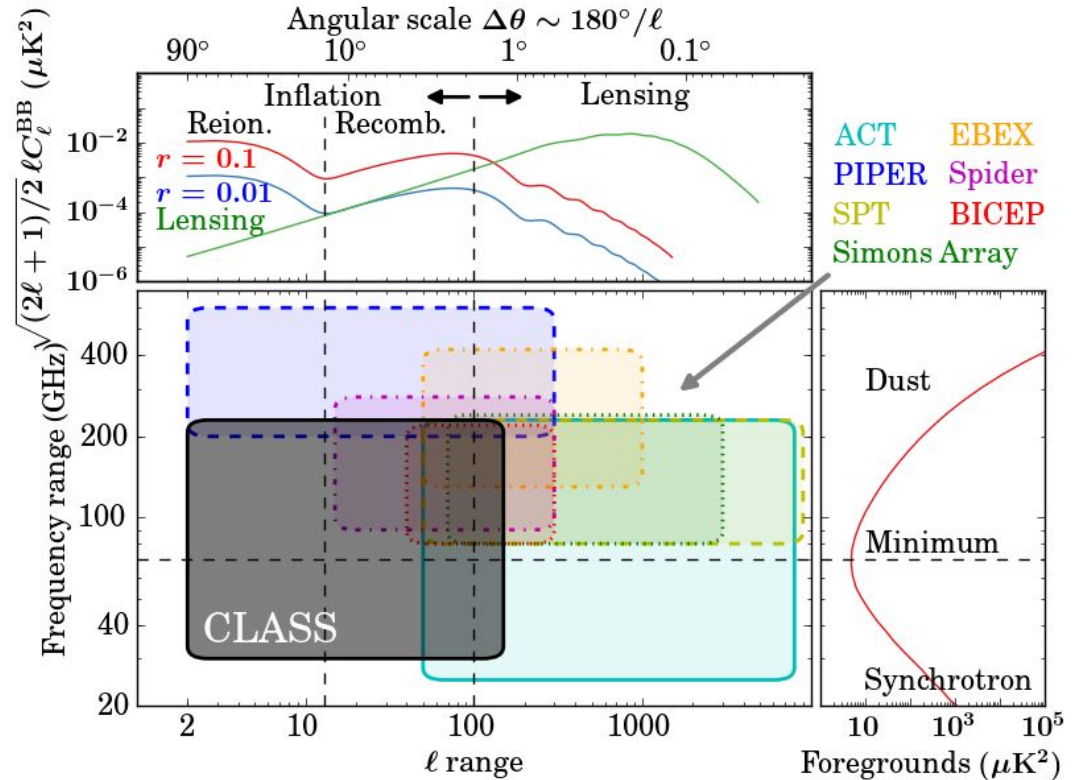


NLST

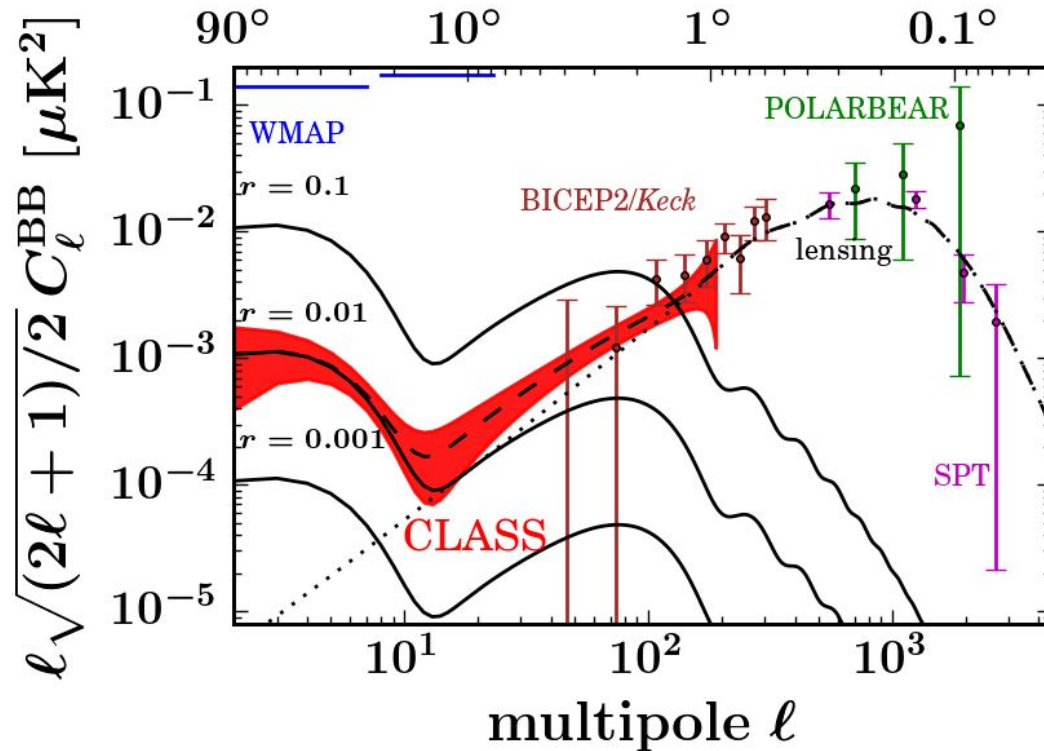


CLASS Experiment Design

- Sensitive to polarization signal from recombination *and* reionization.
- Frequency coverage straddles the foreground minimum and enables foreground subtraction.

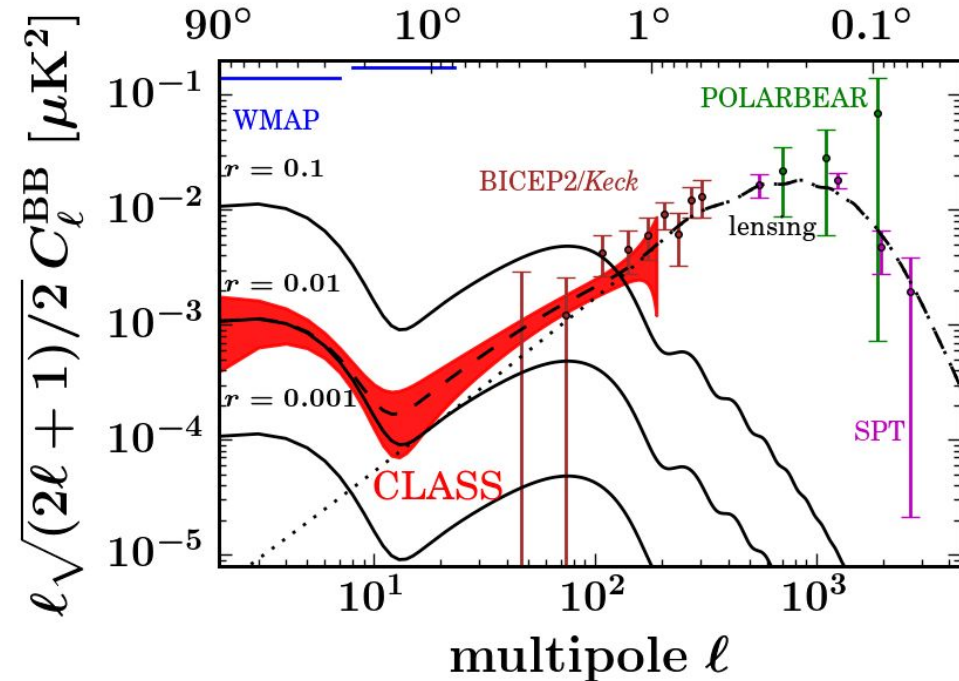


CLASS Experiment Design



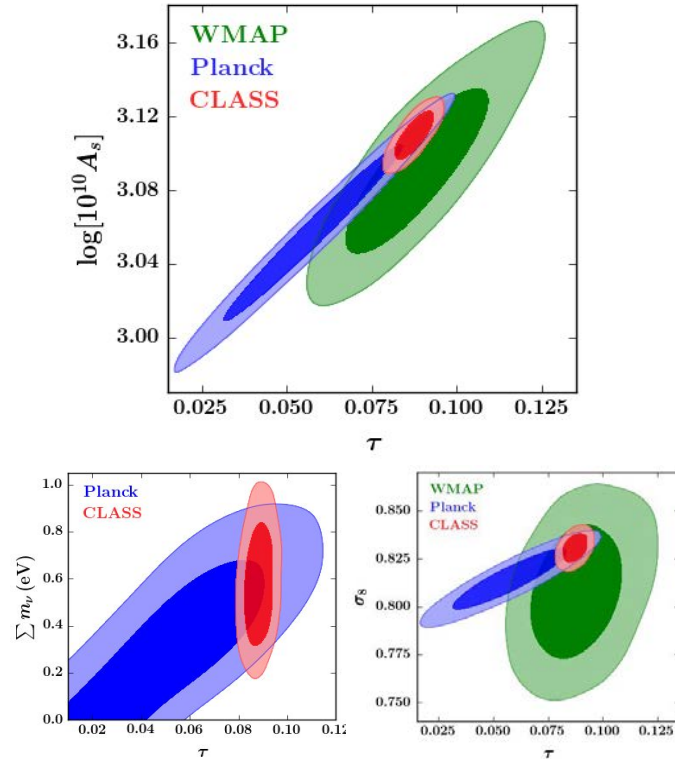
Why go after reionization?

- For $r \lesssim 0.01$, lensing B-modes dominate primordial B-modes from recombination.

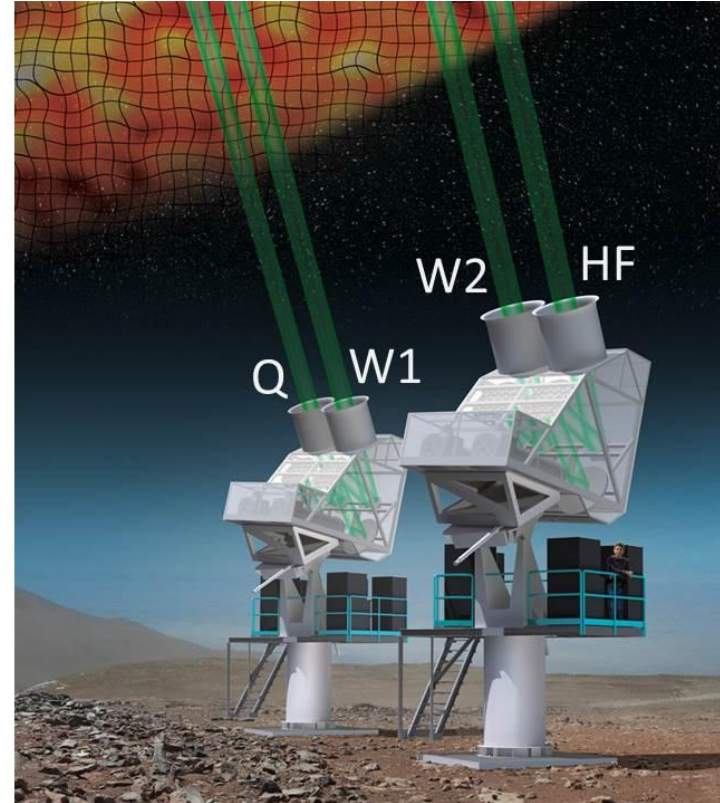
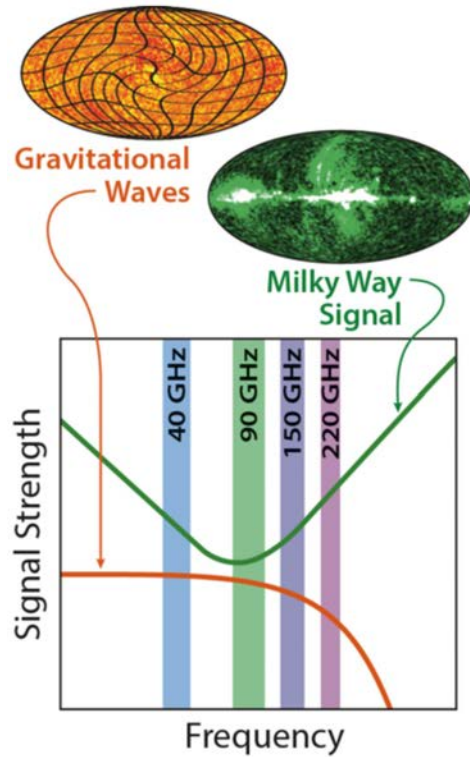


Why go after reionization?

- For $r \lesssim 0.01$, lensing B-modes dominate primordial B-modes from recombination.
- Low ℓ E-mode spectrum measures optical depth to reionization.

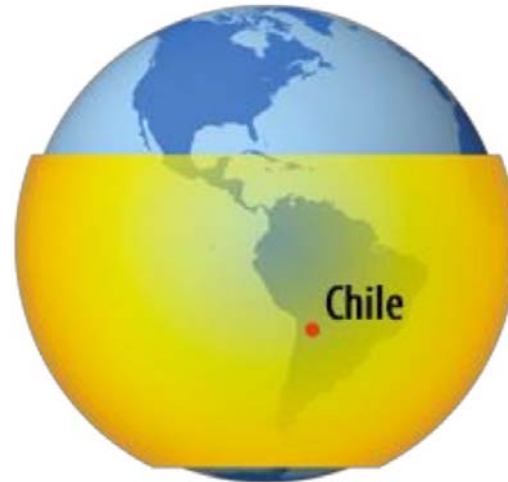


CLASS Experiment Design



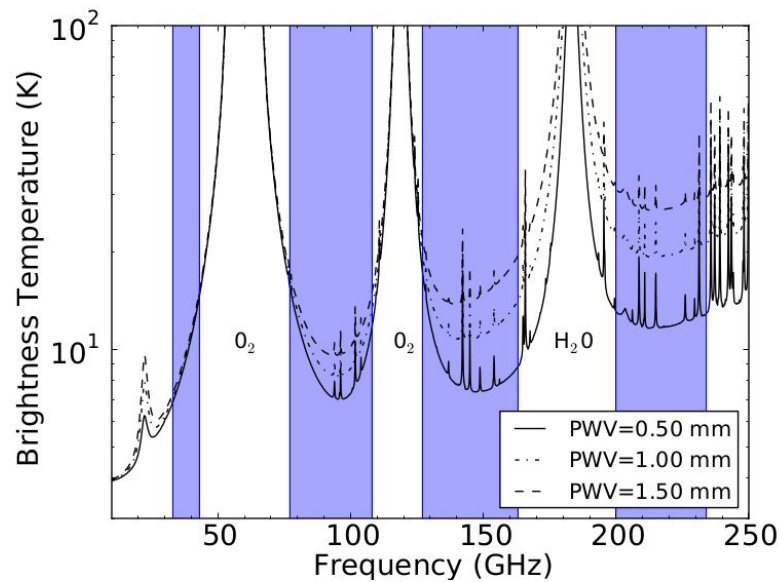
Measuring Large Angular Scales From the Ground

- Survey large fraction of sky



Measuring Large Angular Scales From the Ground

- Survey large fraction of sky
- Minimize loading from the atmosphere

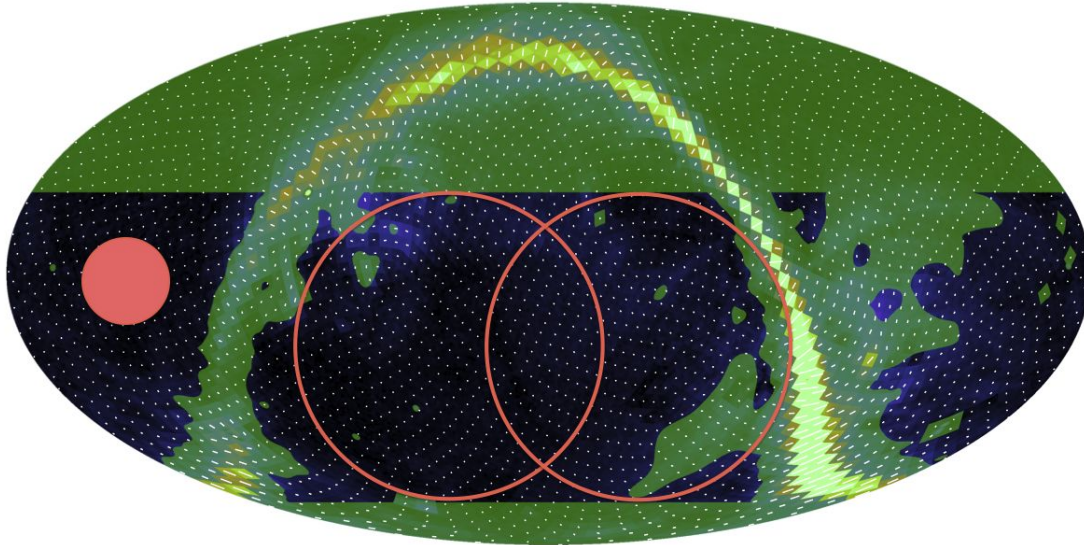


Measuring Large Angular Scales From the Ground

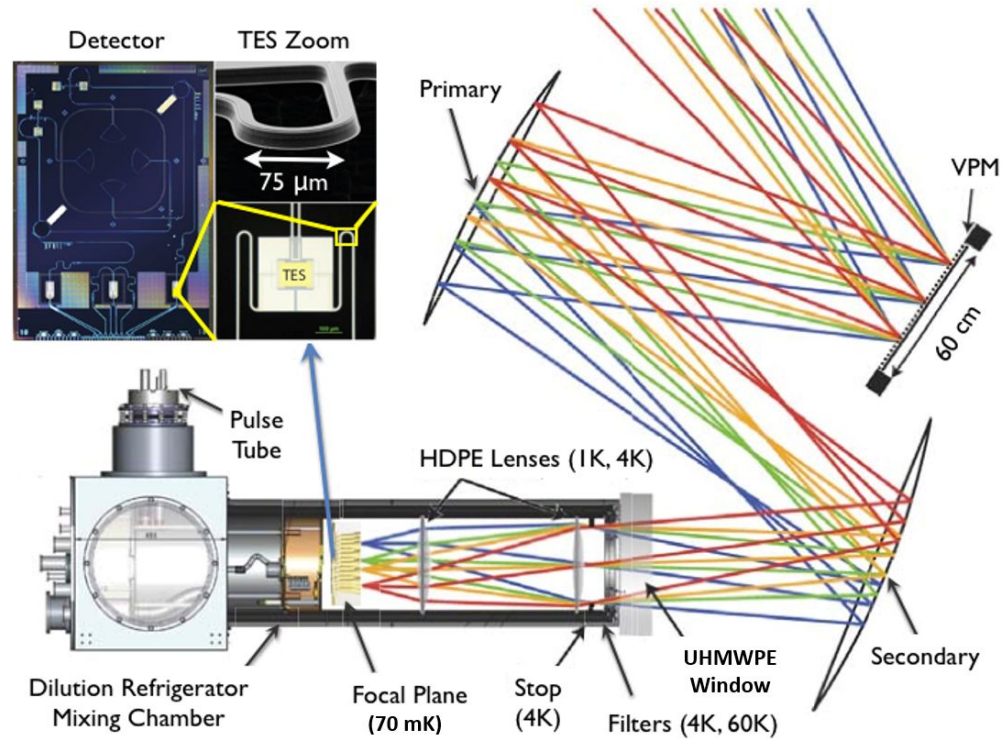
- Survey large fraction of sky
- Minimize loading from the atmosphere
- Stability!

Observing Strategy

- 70% of sky covered every day
- Azimuth scans 720°
- Elevation remains constant
- Boresight stepped 15° each day, from -45° to 45° degrees



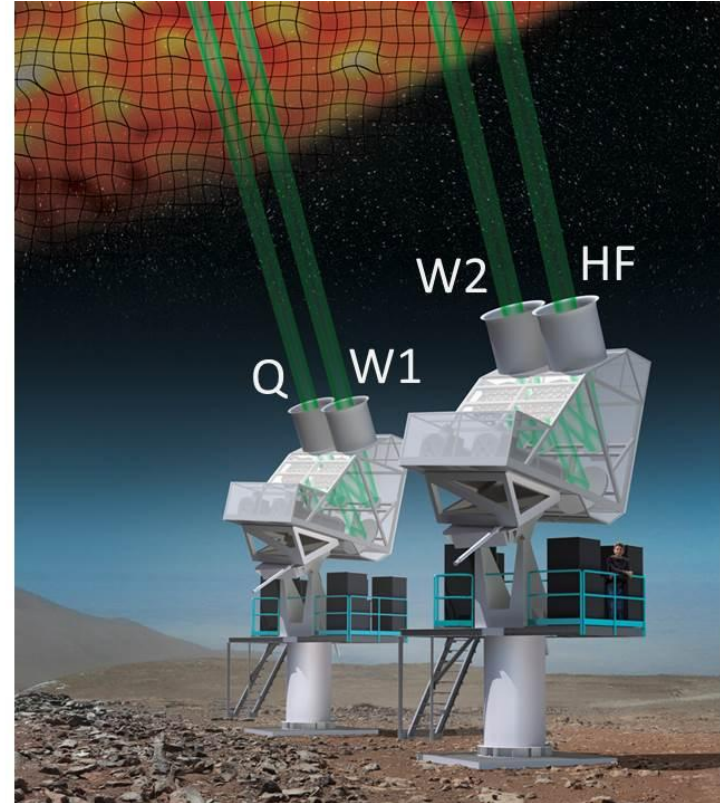
The CLASS Receivers



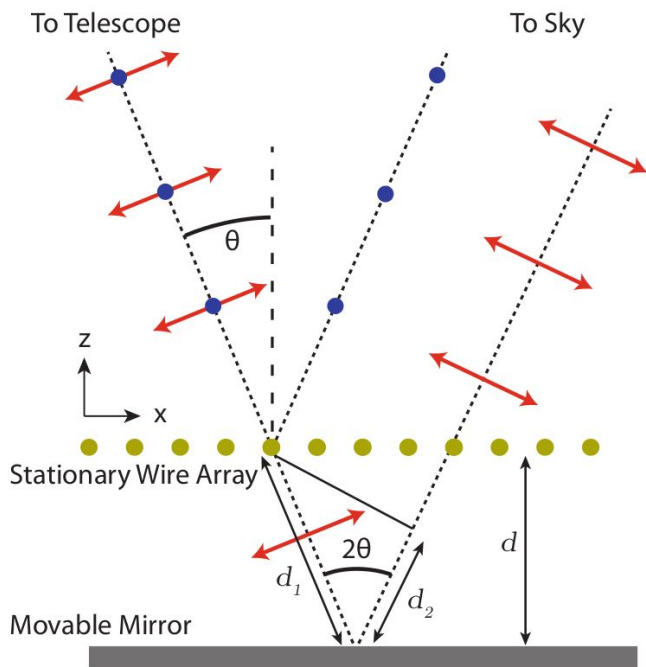
The CLASS Receivers

Telescope	Beam Size	N_{TES}	Survey NEQ ($\mu K \text{ arcmin}$)
40 GHz	90'	72	39
90 GHz	40'	518	13
90 GHz	40'	518	16
150 GHz	24'	2000	15
220 GHz	18'	2000	43

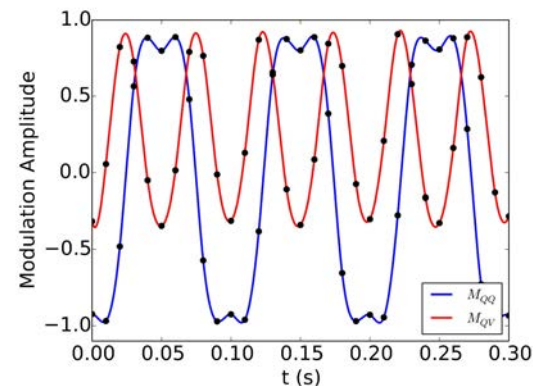
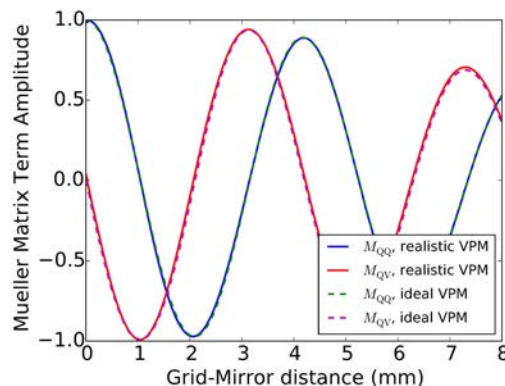
Total survey time: 5 years



Variable-delay Polarization Modulator

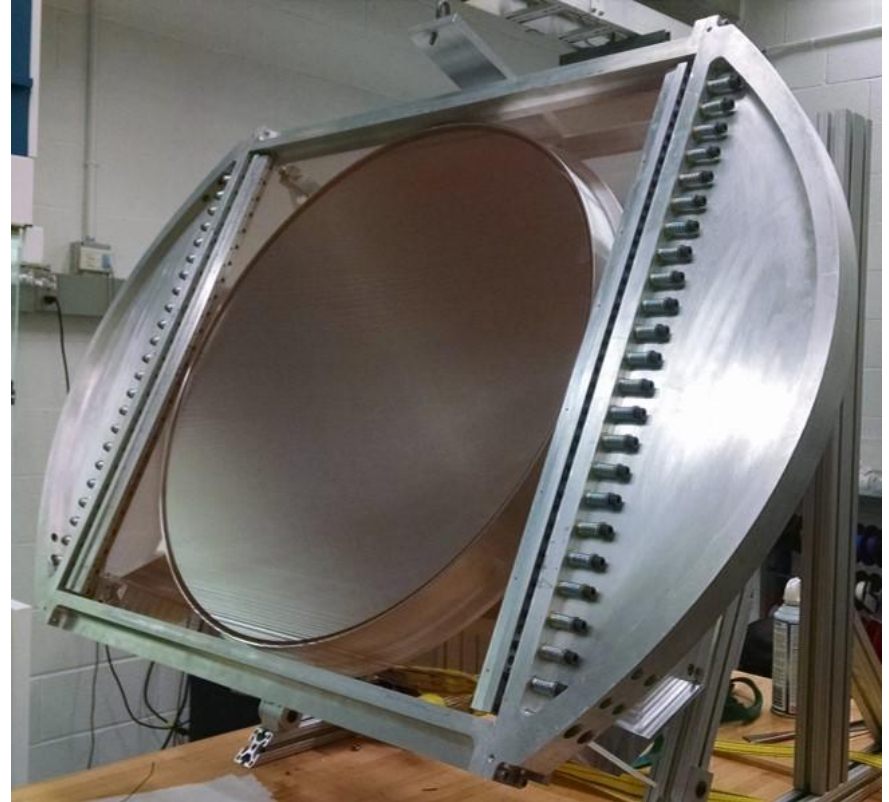
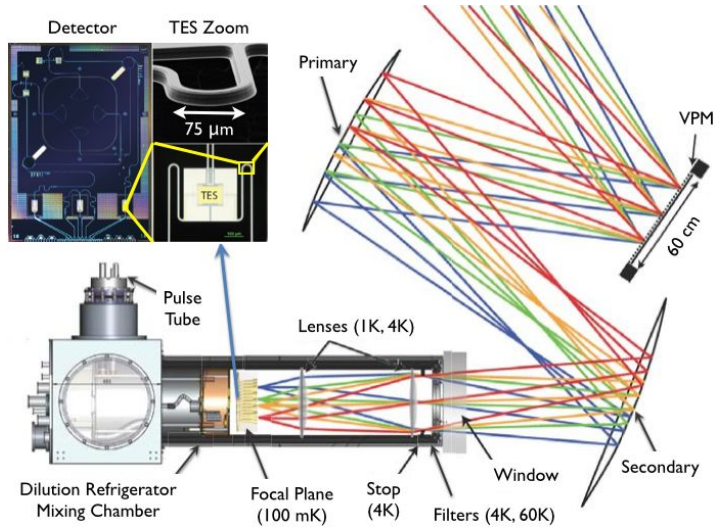


$$s \sim \frac{1}{2}(I - U \cos(2dk \cos \theta) + V \sin(2dk \cos \theta))$$

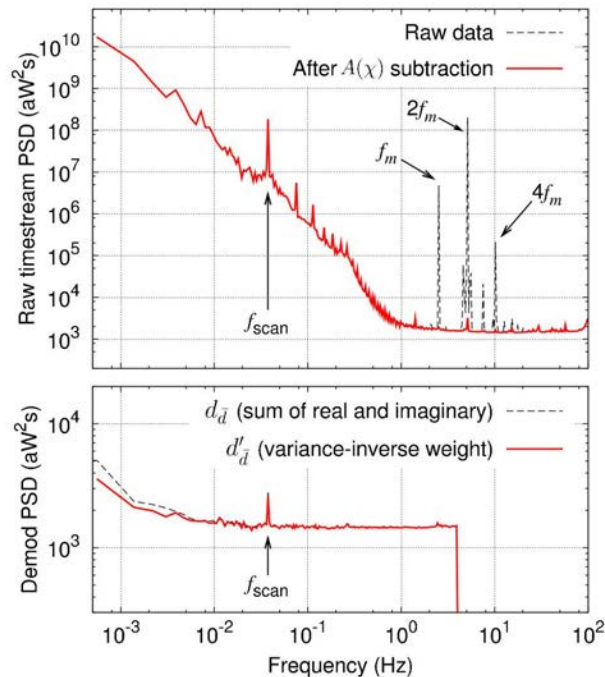


N.J. Miller *et al*, "Recovery of Large Angular Scale CMB Polarization for Instruments Employing Variable-delay Polarization Modulators", 2015

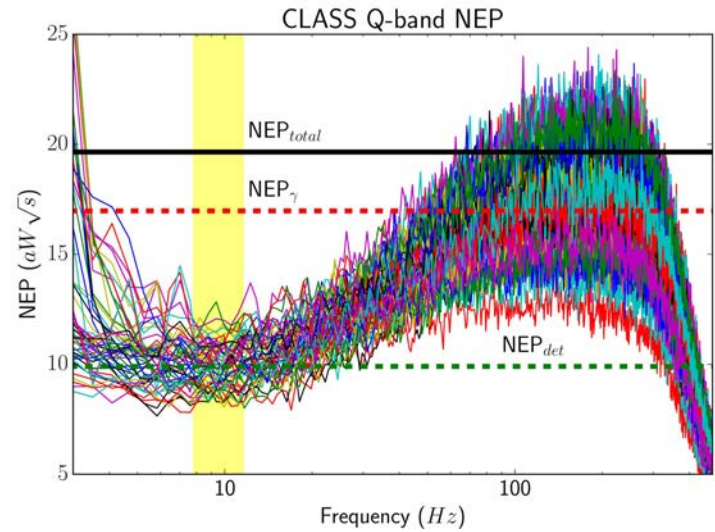
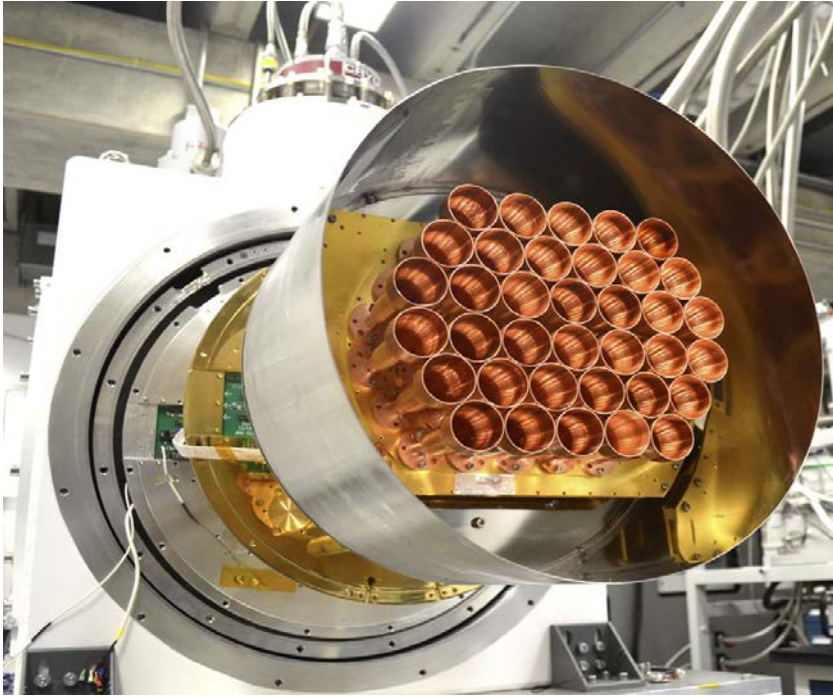
Variable-delay Polarization Modulator



Polarization modulation has been demonstrated:



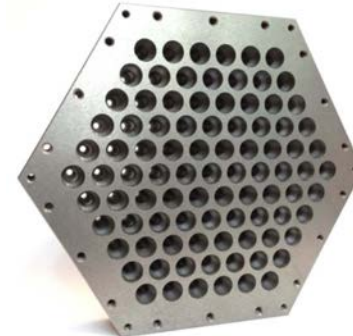
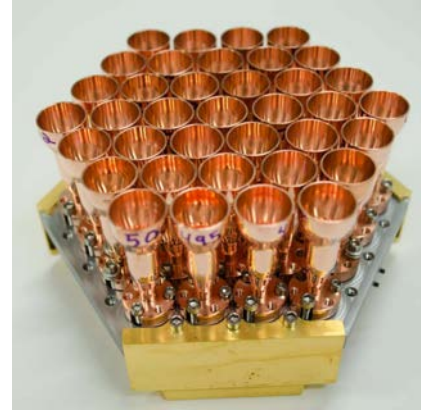
Q-Band Receiver



Deployed early 2016

Upcoming Receivers

- W-Band Receiver
 - First to be deployed Summer 2017
 - Second W-band receiver 2018
- HF Instrument
 - Dichroic: 150/220 GHz channels.
 - Chip designs complete
 - Test parts in fabrication

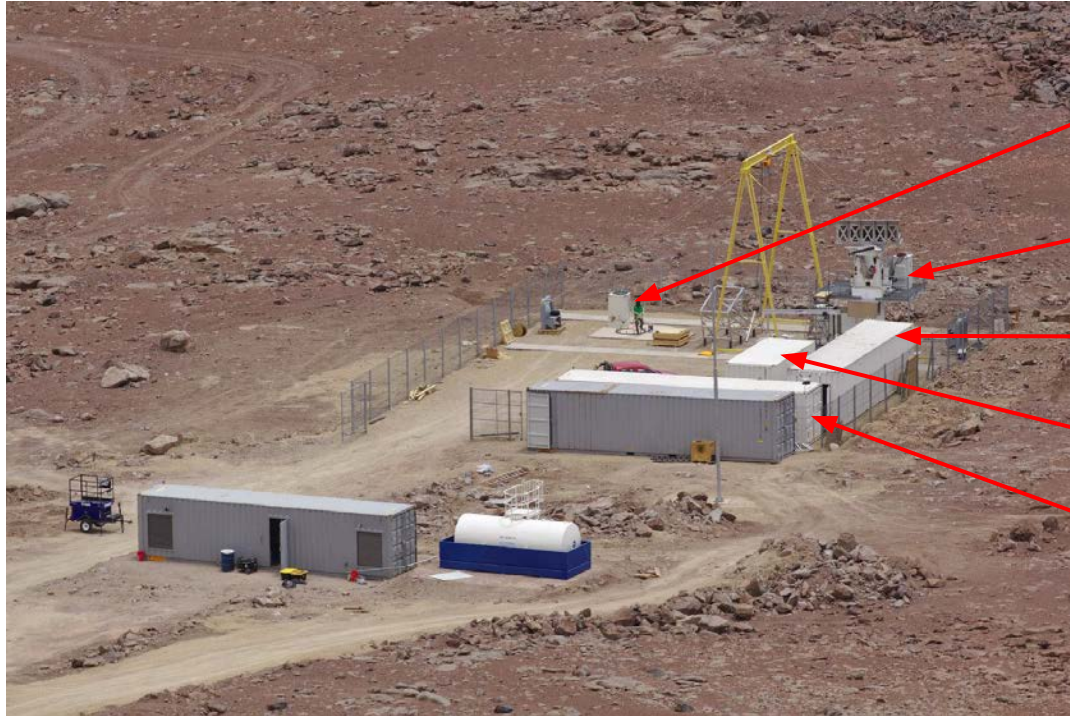


CLASS Observing Site



CLASS Observing Site

To Radio Downlink



Mount 2

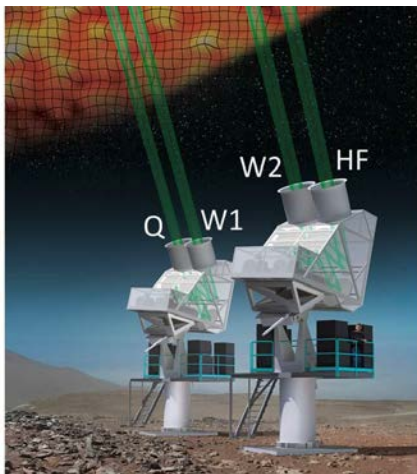
Mount 1

Receiver Lab

Machine Shop

Control Room

(Circa January 21, 2016)



February 28, 2016



Current State of the Survey

- Q-Band first light:
5/8/2016
- Observations have
achieved >50%
observing efficiency
since June.
- W1 Receiver
integration underway



Summary

- CLASS targets large angular scale CMB polarization
- CLASS is unique as a ground-based experiment in having sensitivity to the polarization signal from reionization
- CLASS frequency coverage enables removal of dominant foregrounds
- The CLASS Q-band instrument has been on the sky for most of 2016.
- First W-band instrument to be deployed Summer 2017