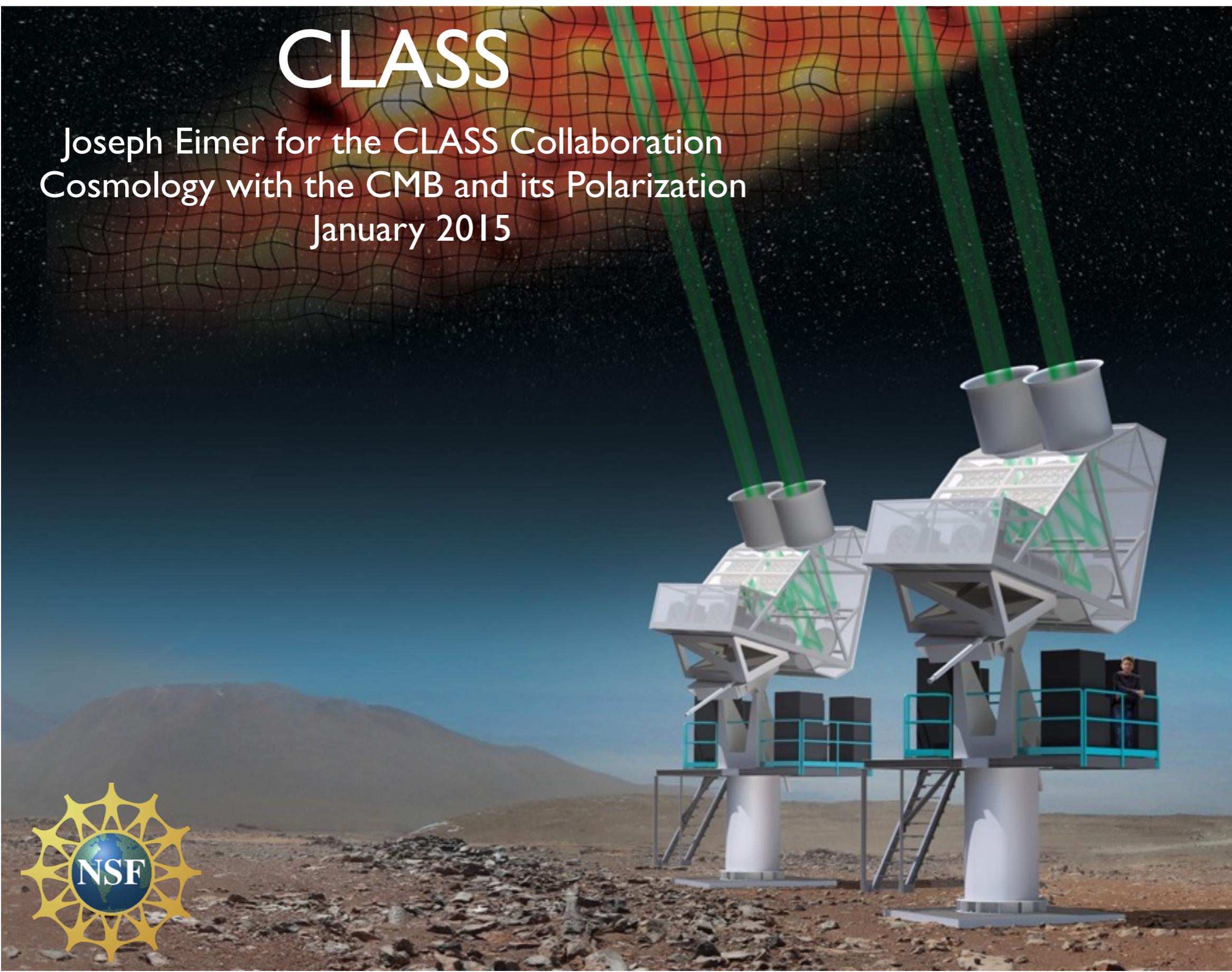
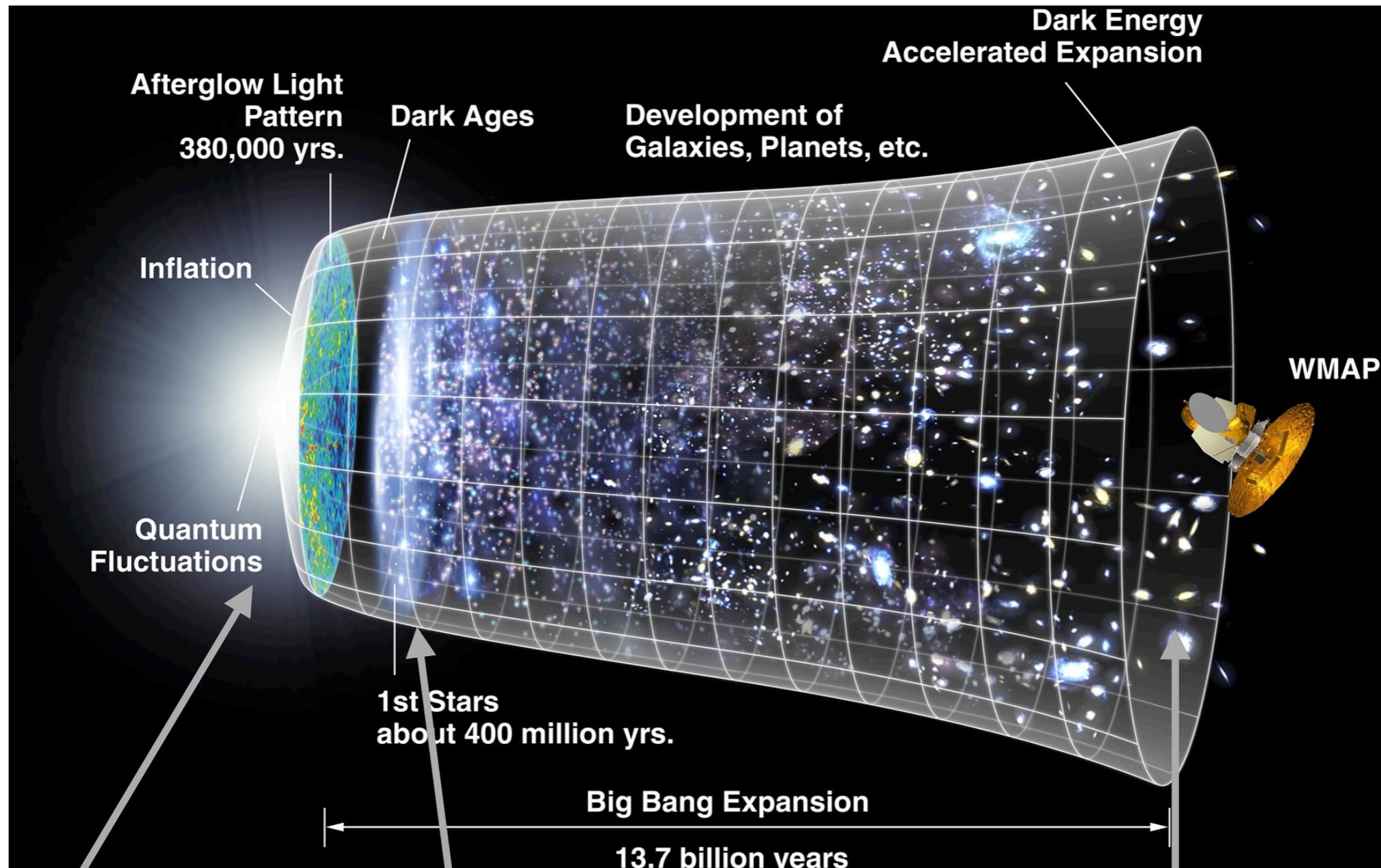


## CLASS

Joseph Eimer for the CLASS Collaboration  
Cosmology with the CMB and its Polarization  
January 2015



# Scientific objectives

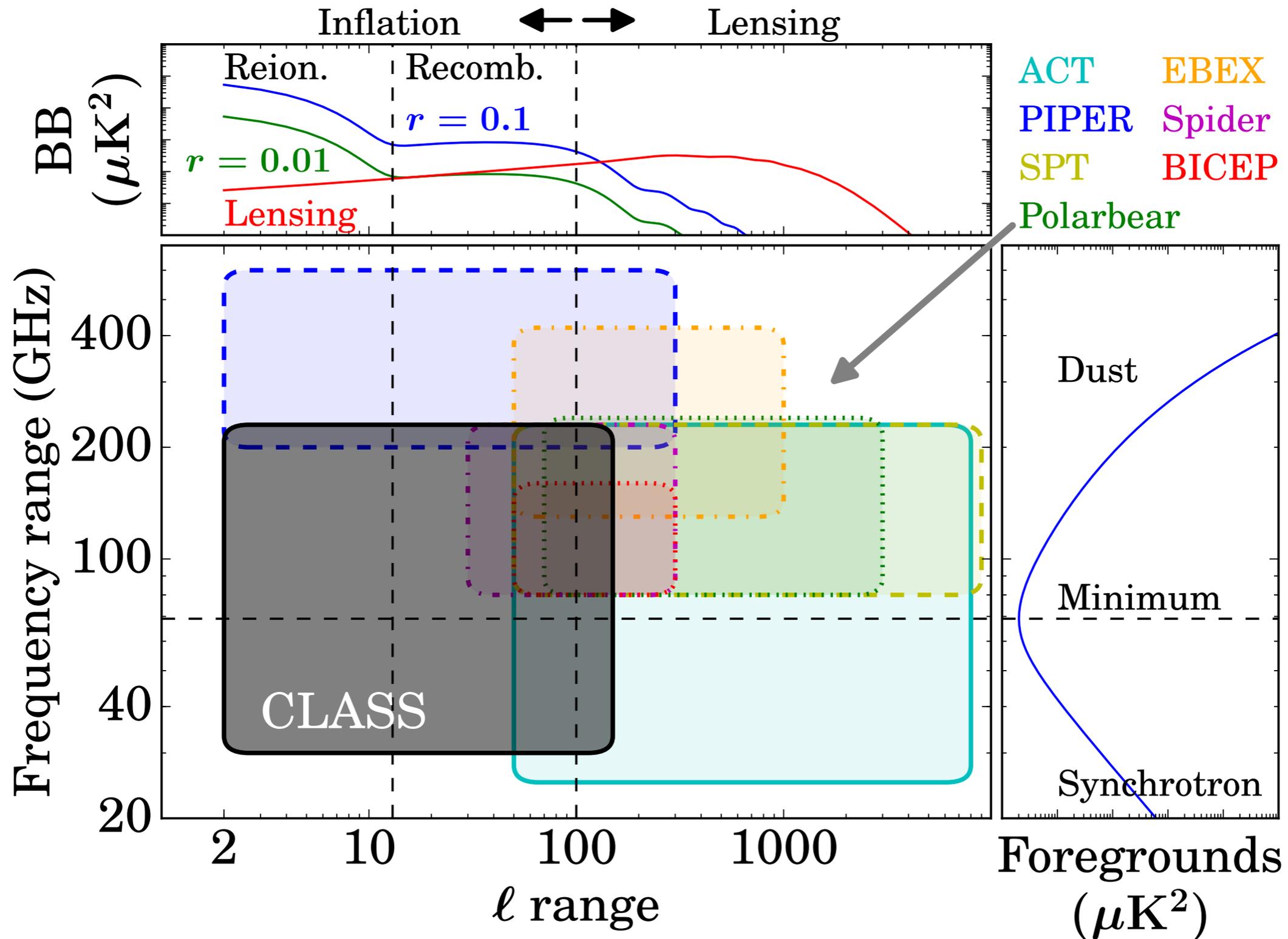


Inflation

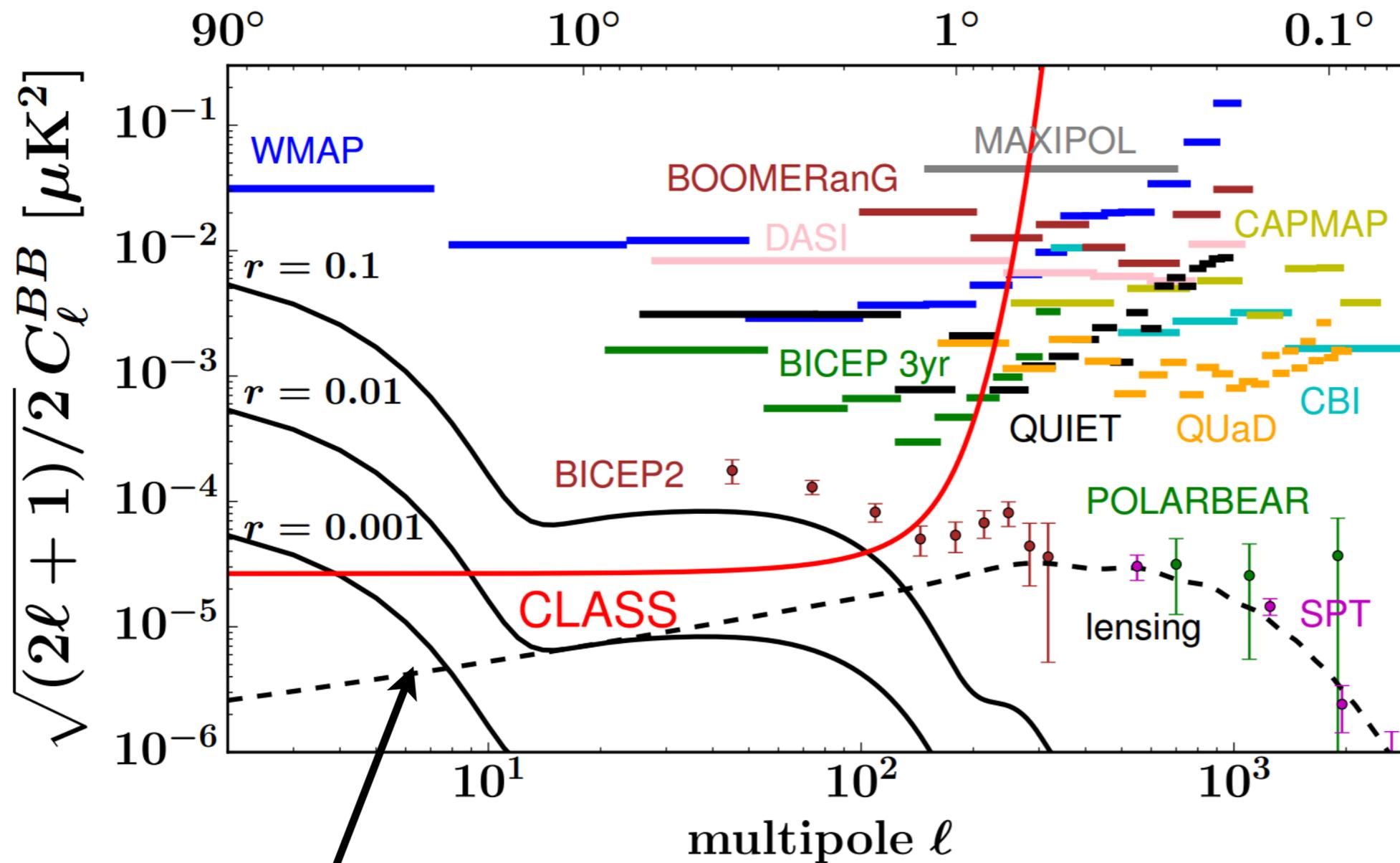
Reionization

Galactic science

CLASS targets **reionization and recombination peaks** on **both** sides of the foreground minimum.



# CLASS: target the largest scales.

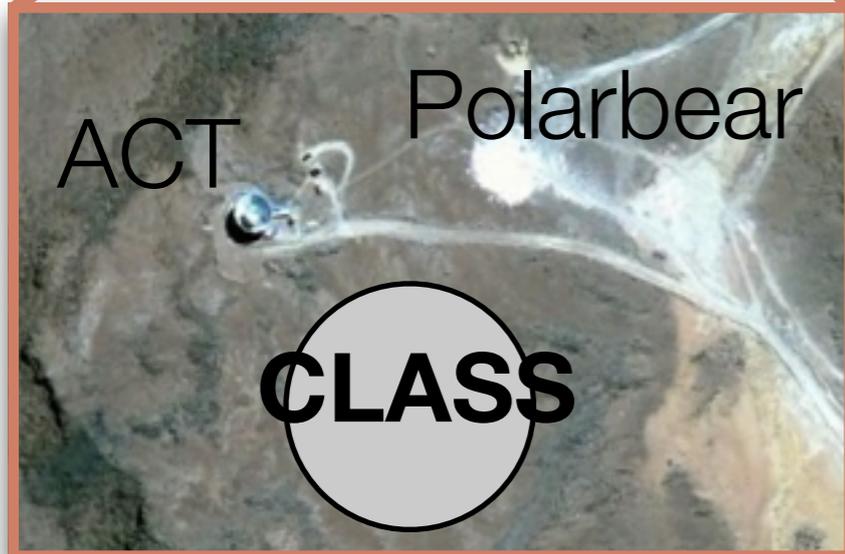
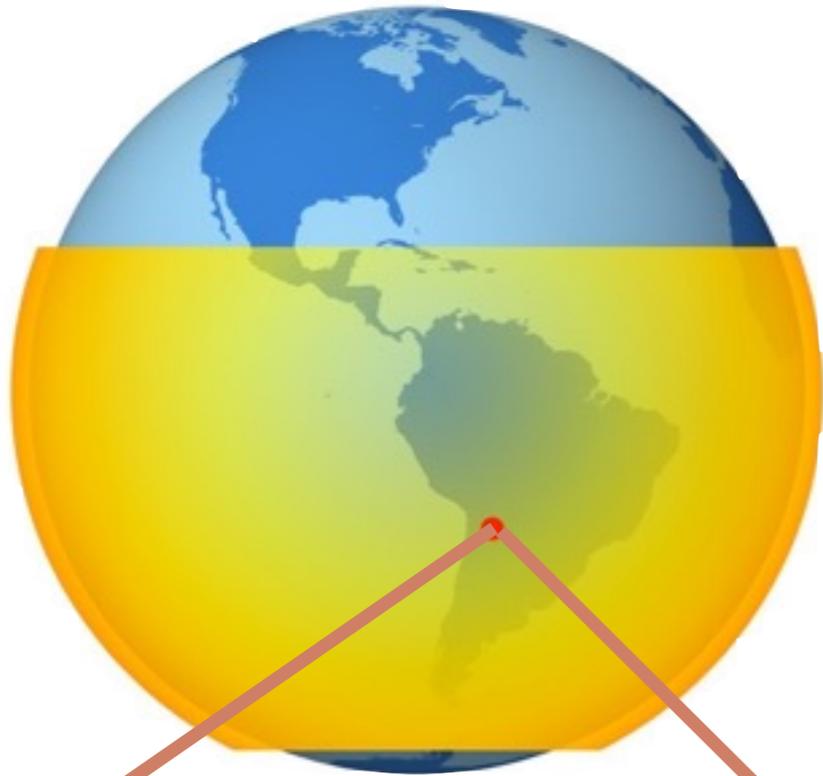


Sensitivity per  $\ell$  after foreground cleaning

Based on simulations, CLASS can detect  $r=0.01$

# CLASS: survey strategy

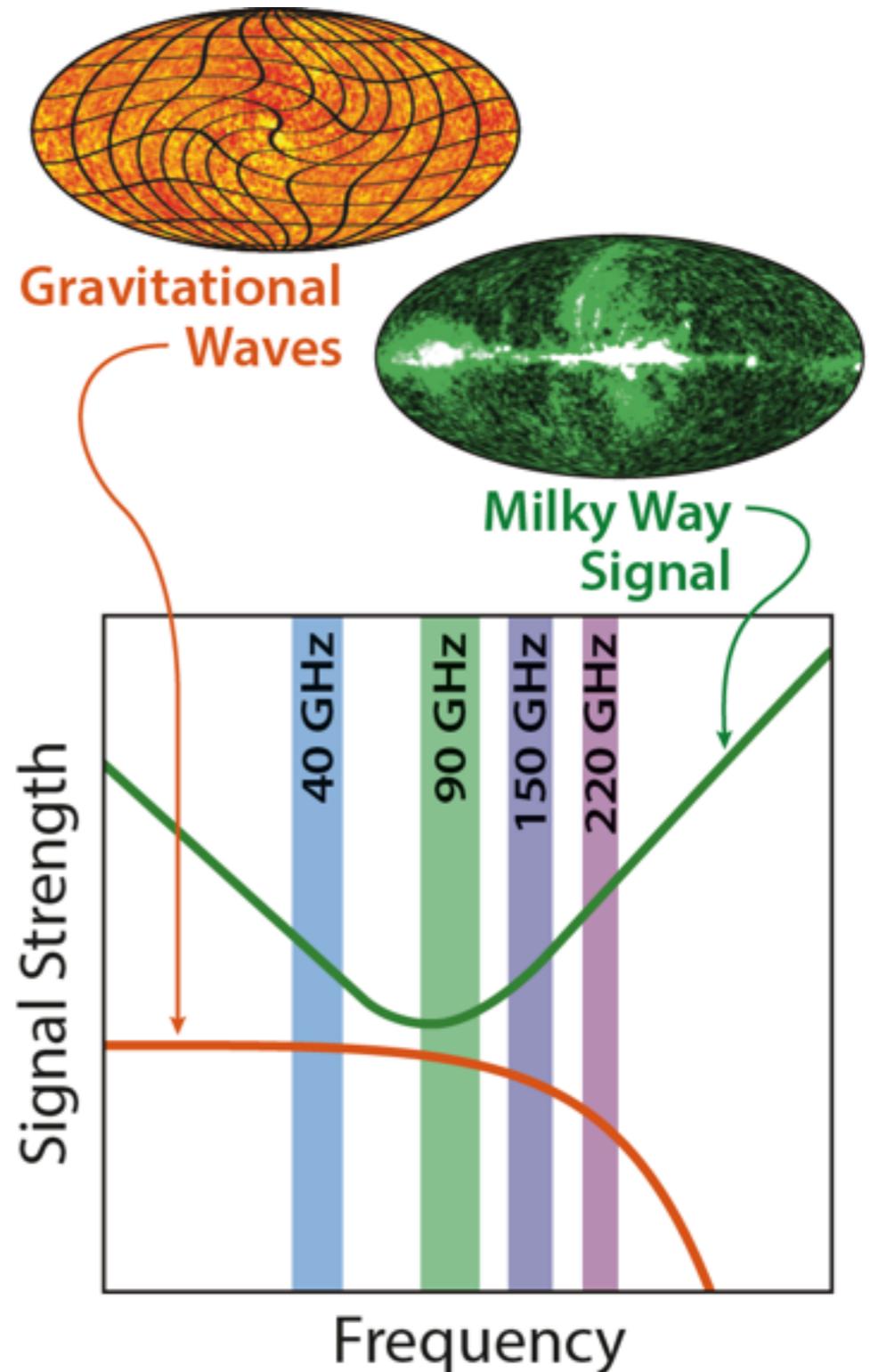
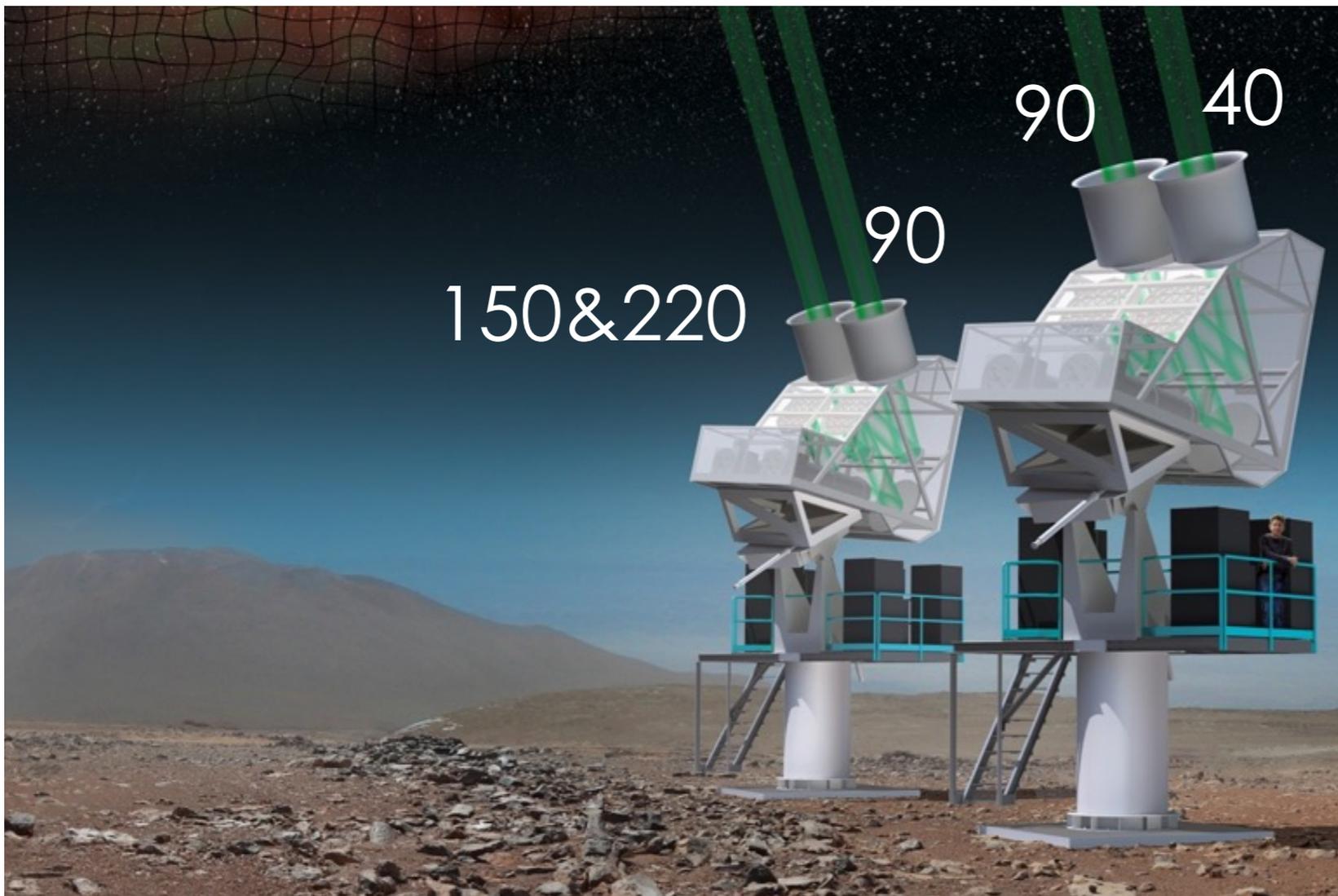
---



- Constant elevation scans will cover declination  $-78^\circ < \delta < +32^\circ$  every day.
- Cross-linked scans ensure every point in the survey is observed with the telescope oriented and scanning at different angles.
- Boresight bearing will be stepped  $\sim 15^\circ$  per day through a range of  $\pm 45^\circ$ .
- Identical 90 GHz telescopes will be placed on different mounts to enable an entire suite of new cross-linking maps and systematics checks.

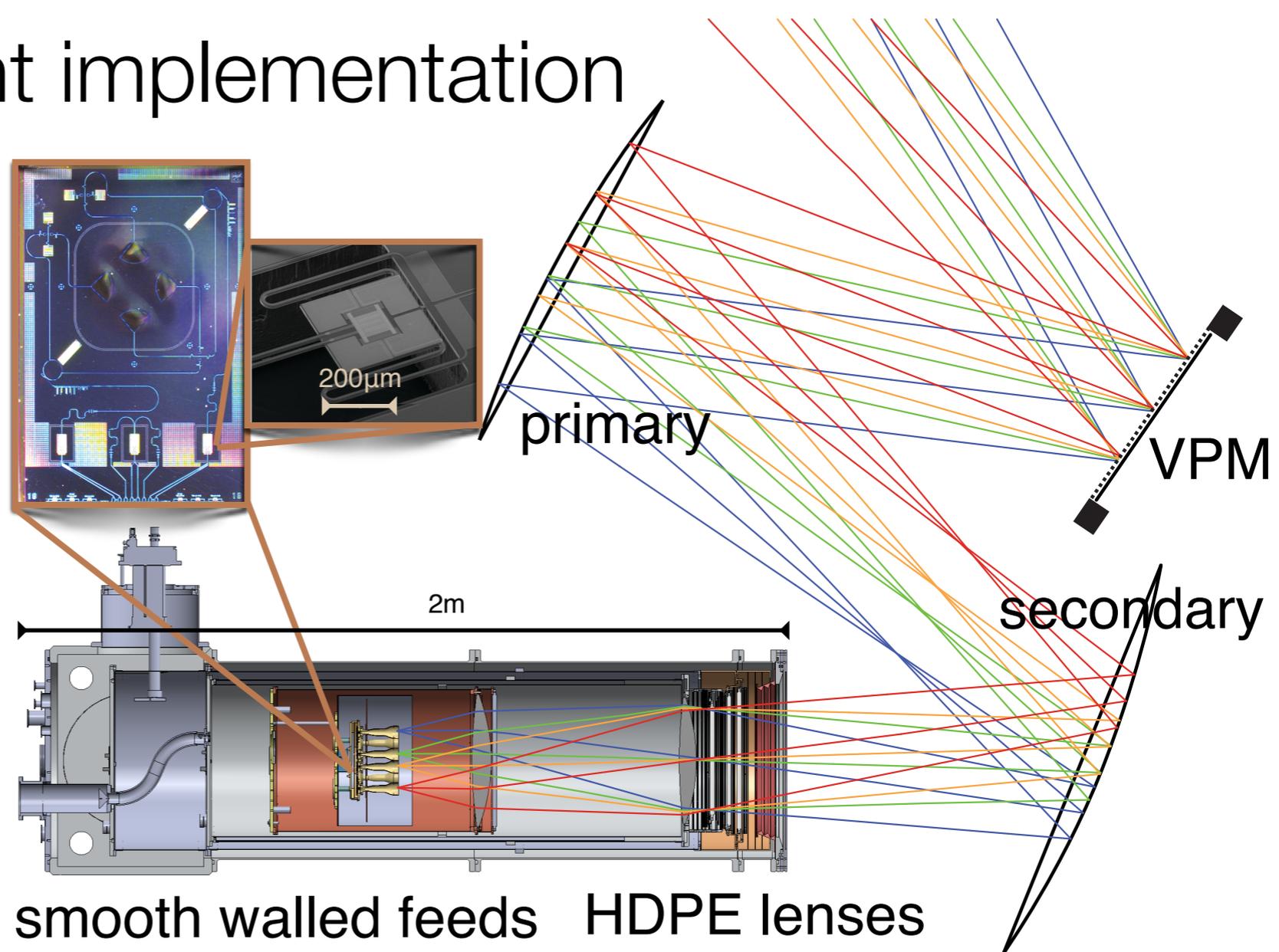
# CLASS: frequency coverage

- Four bands straddle galactic foreground minimum
- Each band optimized within an atmospheric window



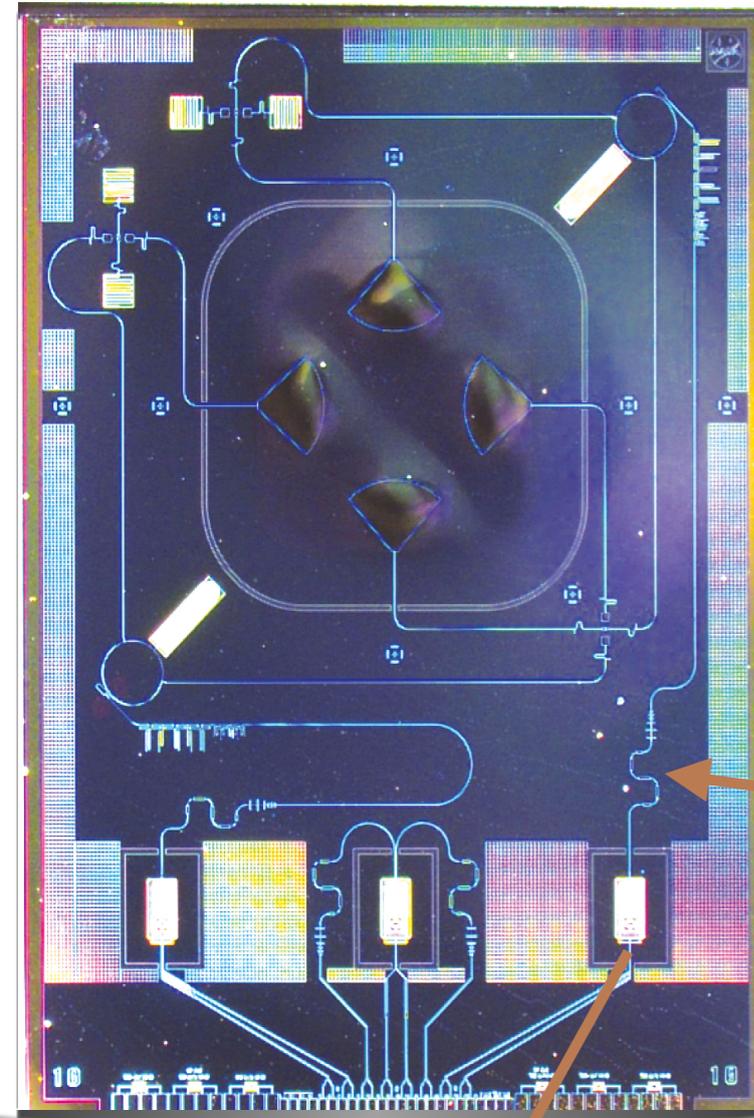
# CLASS: instrument implementation

- Front-end polarization modulation - Variable-delay Polarization Modulator
- High efficiency optics and detectors.
- Continuous operating dilution fridge with 70 mK base temp.

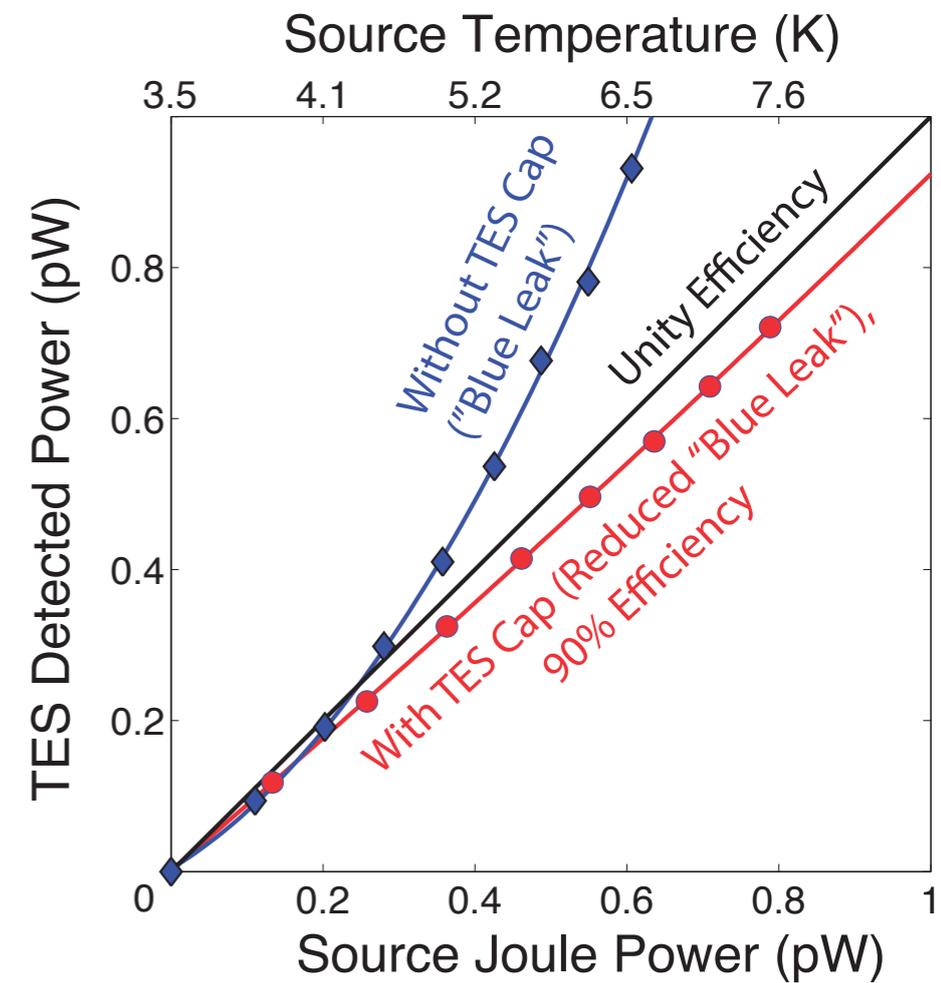
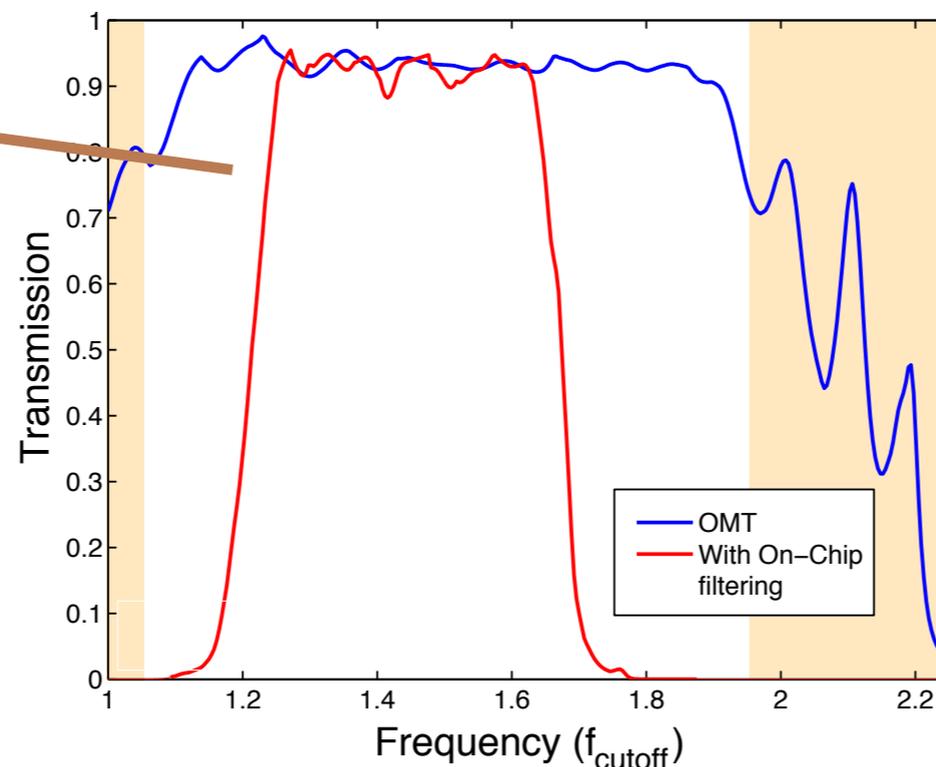


Telescope	$N_{\text{TES}}$	FWHM	TES NEQ ( $\mu\text{K} \sqrt{\text{s}}$ )	Obs. Time (years)	Survey NEQ ( $\mu\text{K} \text{ arcmin}$ )
40 GHz	72	1.5°	214	5.0	39
90 GHz	518	40'	171	5.0	13
90 GHz	518	40'	171	3.5	16
150 GHz	2000	24'	278	3.0	15
220 GHz	2000	12'	820	3.0	43
Total	5108				10

High sensitivity achieved by 1000s of high efficiency, low-noise detectors operating continuously at 70 mK.

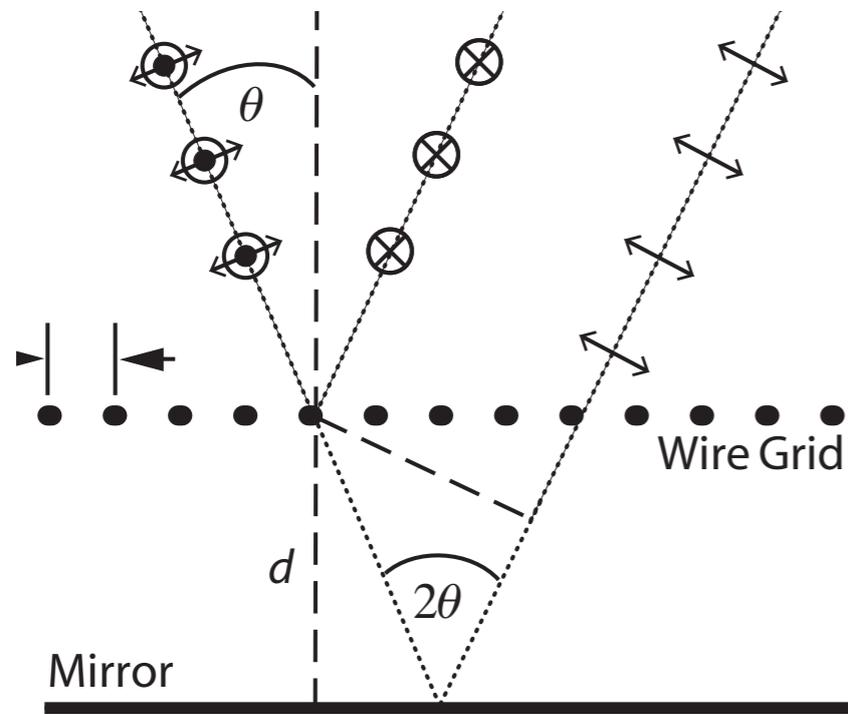


Measured ~90% efficiency and linear response up to source temperatures of 7.6 K

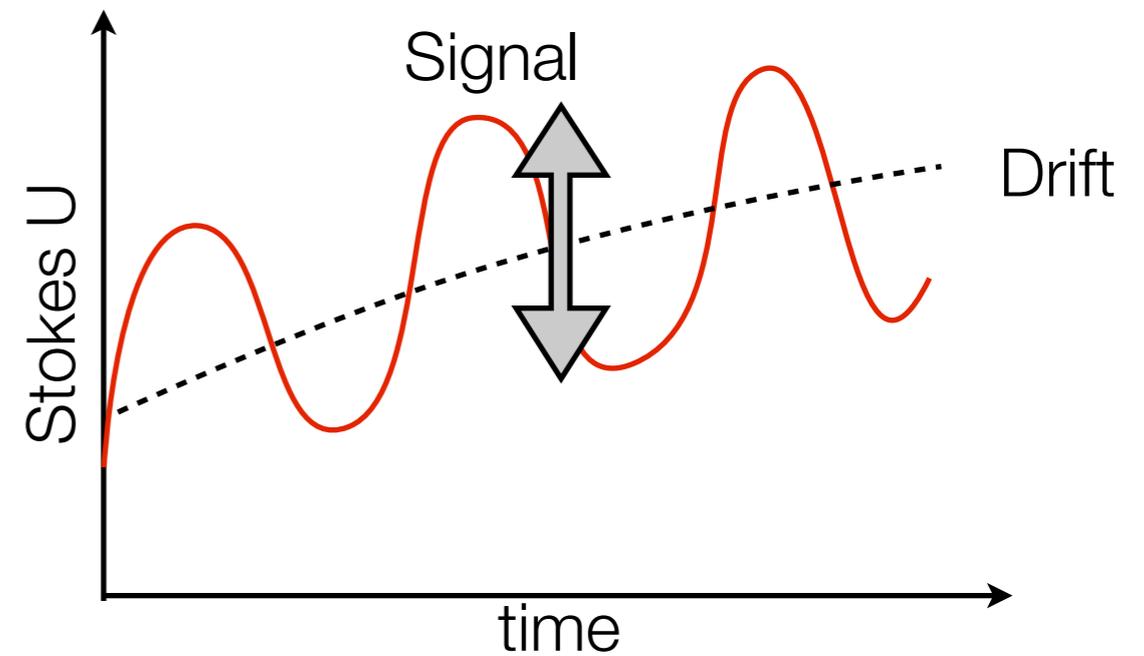


Wollack et al. (in prep)

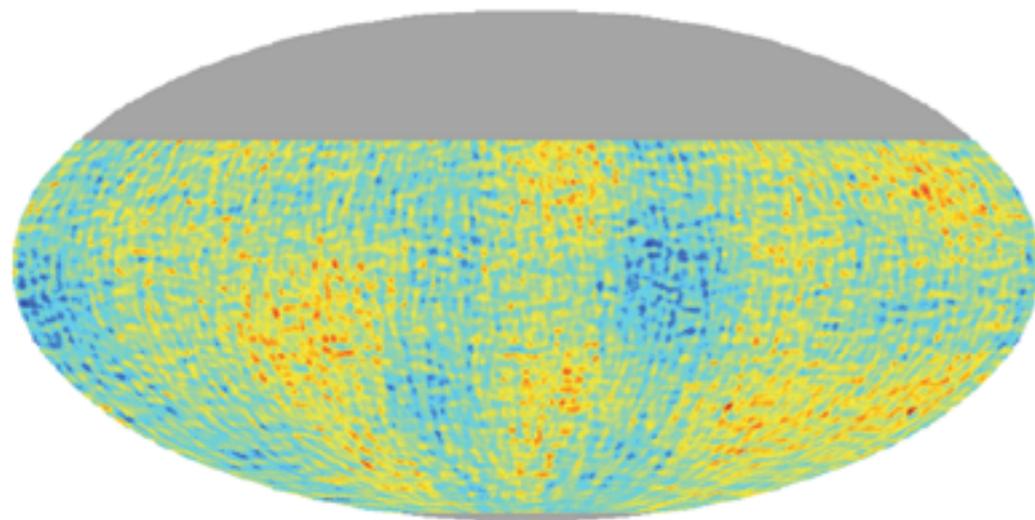
# Front-end 8 Hz polarization modulation enables large-scale observation.



CMB Simulation

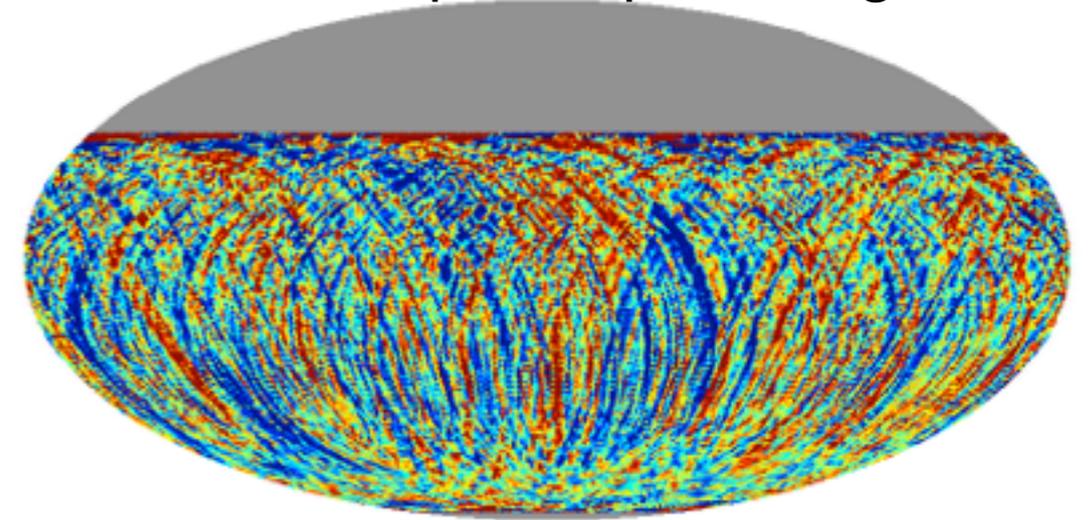


Recovery WITHOUT modulation and simple map-making



-1.5e-06 1.5e-06

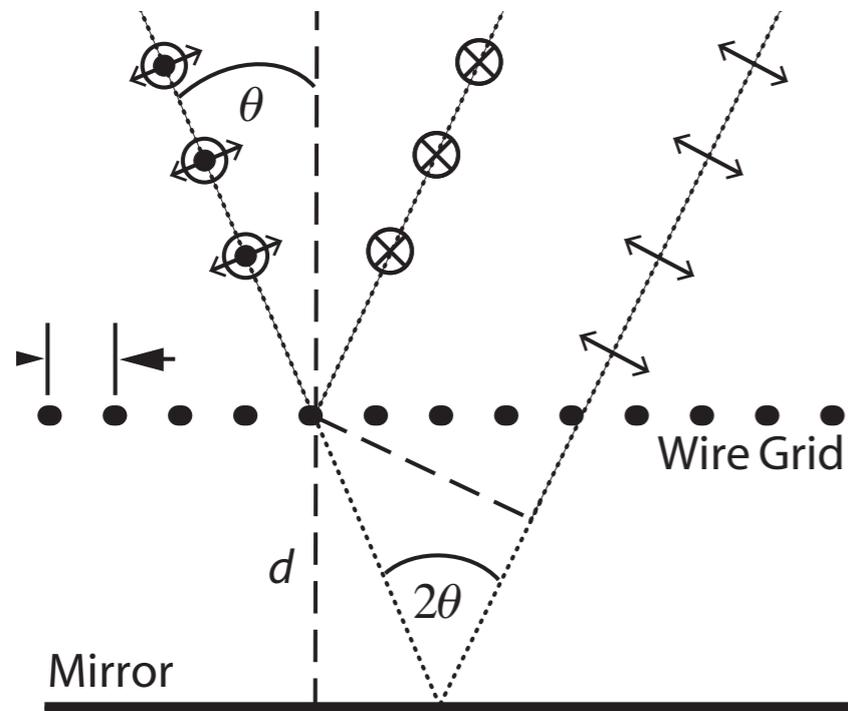
Miller et al. (in prep)



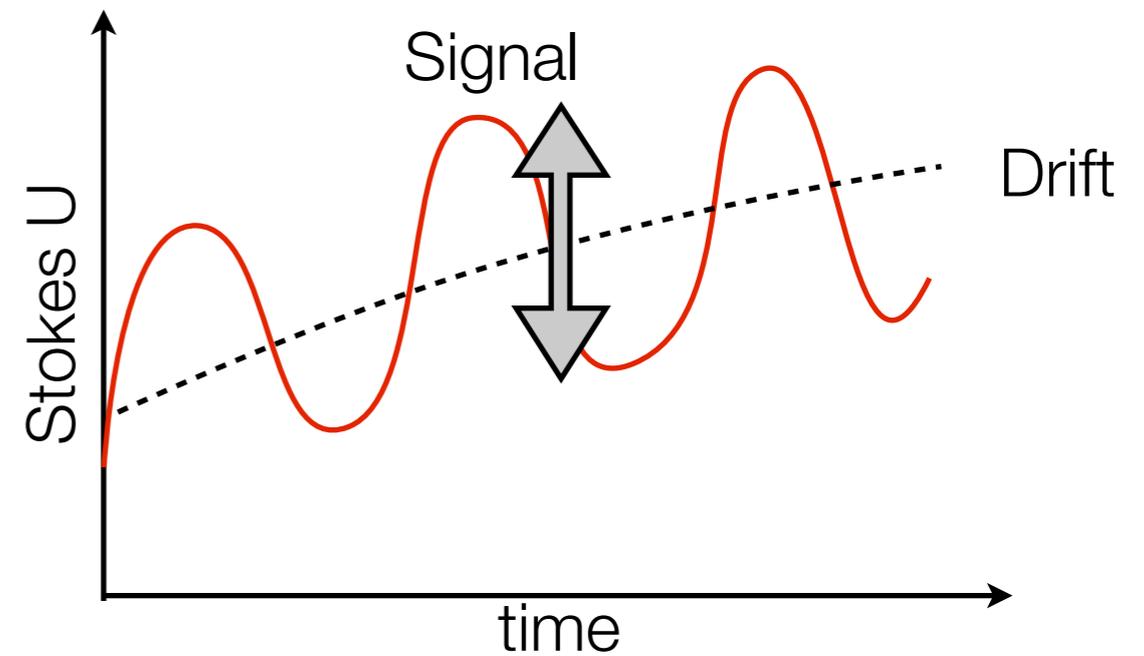
-1.5e-06 1.5e-06  $\kappa$

Alignment errors, differential emissivity, Atmosphere + Differential Gain

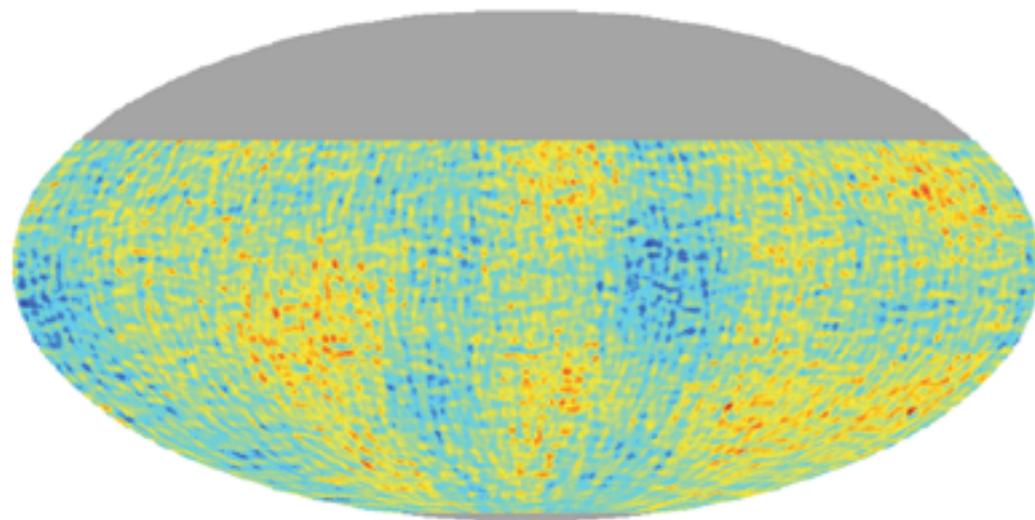
# Front-end 8 Hz polarization modulation enables large-scale observation.



CMB Simulation

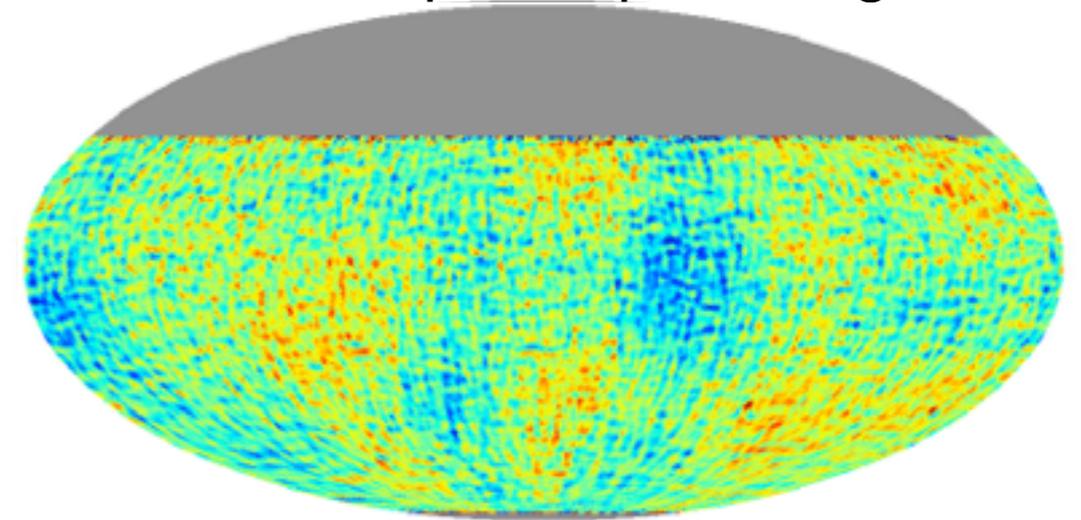


Recovery WITH modulation and simple map-making



-1.5e-06 1.5e-06

Miller et al. (in prep)

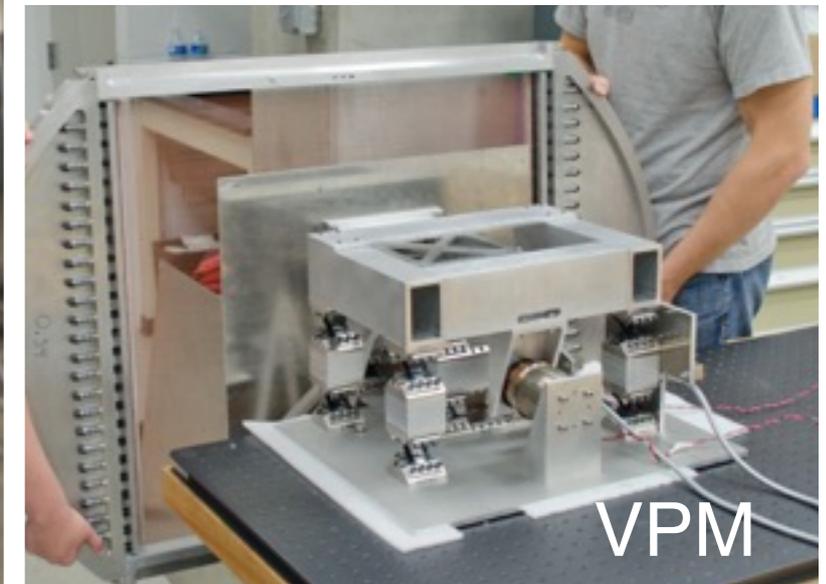
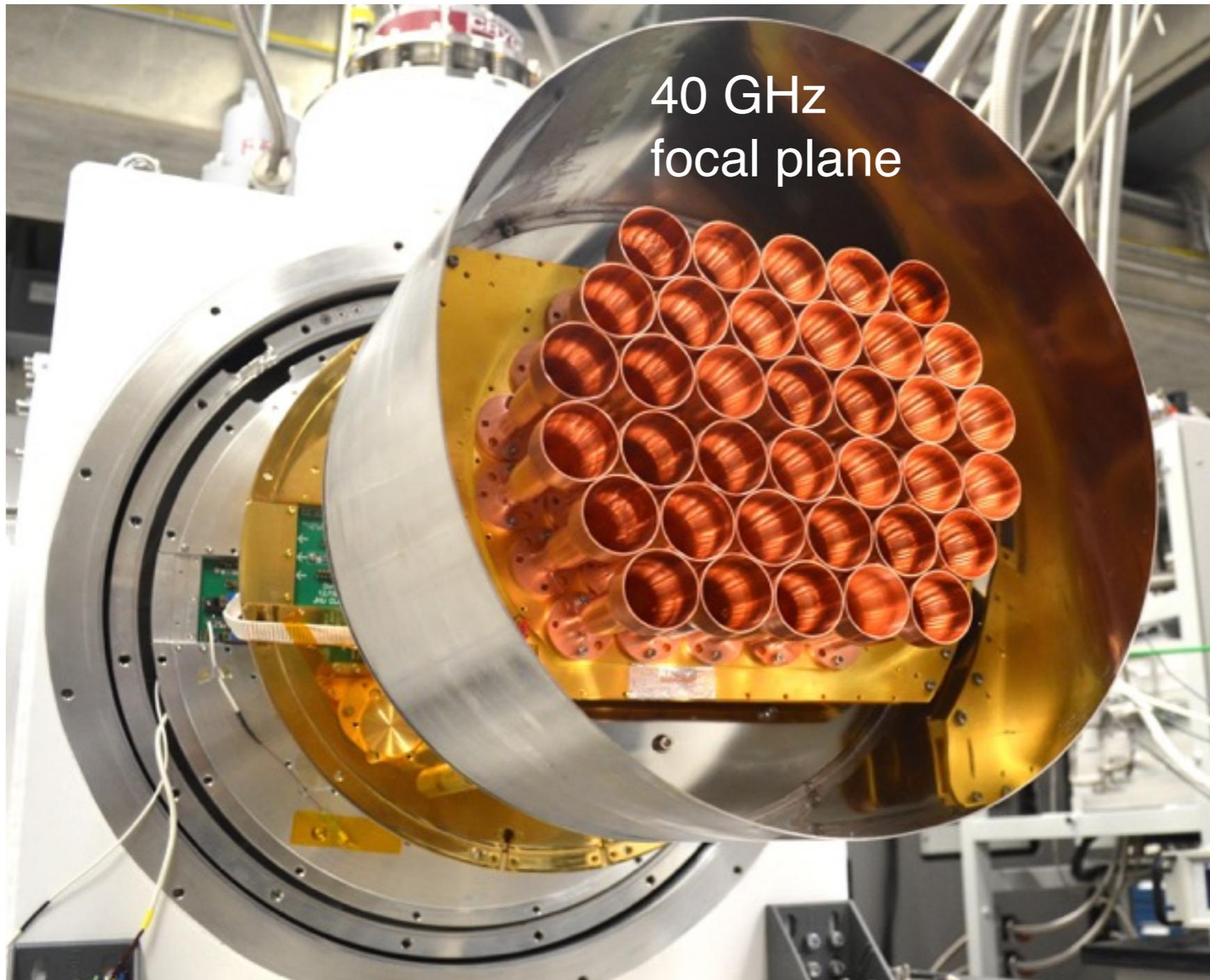


-1.5e-06  $\kappa$  1.5e-06

Alignment errors, differential emissivity, Atmosphere + Differential Gain

# 40 GHz telescope headed to the Atacama!

---



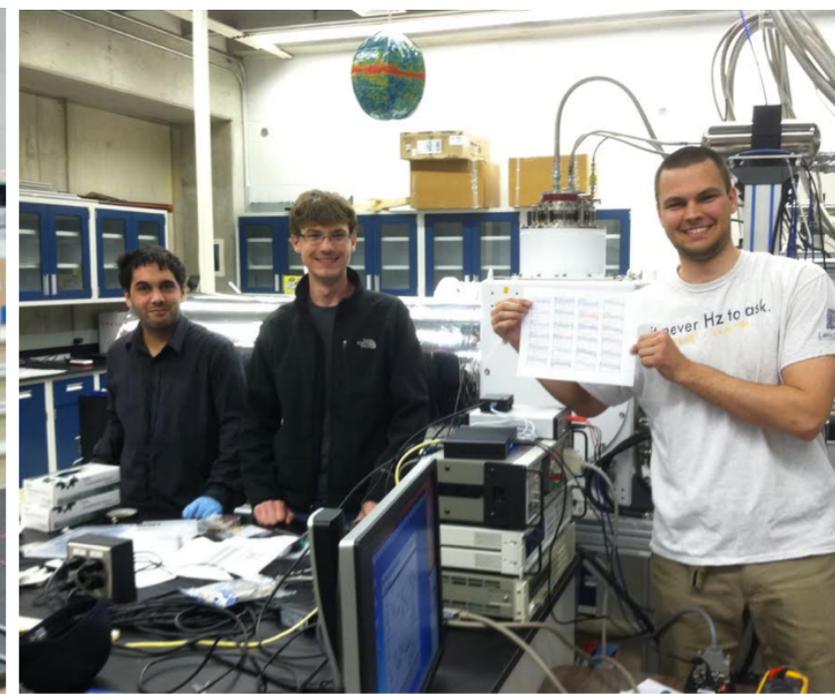
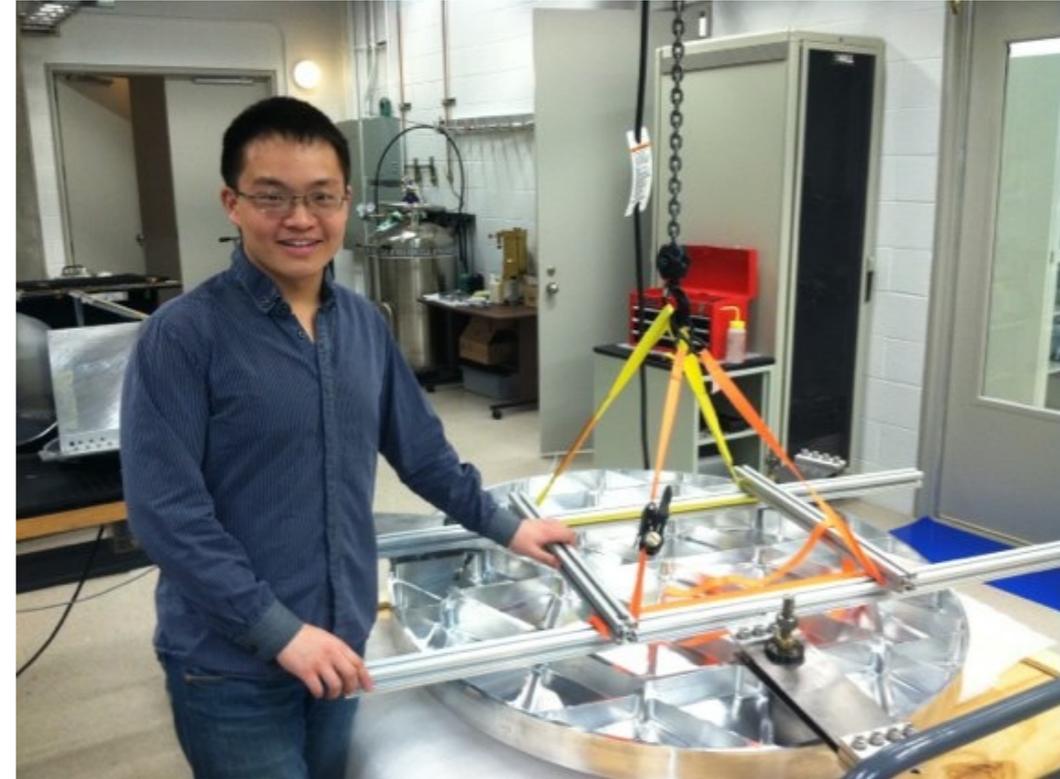
See Katie Harrington's poster for many instrument details.

# Summary

---

- CLASS surveys CMB polarization in the full range of multipoles where primordial B-modes might dominate over gravitational lensing.
- The survey is made possible through the utilization of front-end polarization modulation and high-efficiency optics and detectors.
- The CLASS strategy of large survey area and multi-frequency coverage will enable a detection of  $r$  down to  $r = 0.01$  - even in the presence of galactic foregrounds.
- In addition to Inflation science, CLASS will make a cosmic variance limited measurement of the E-mode spectrum on the largest scales and therefore improve constraints on the optical depth to reionization.
- Site construction underway now — to be immediately followed by telescope deployment!

# Site construction underway!



Thank you.