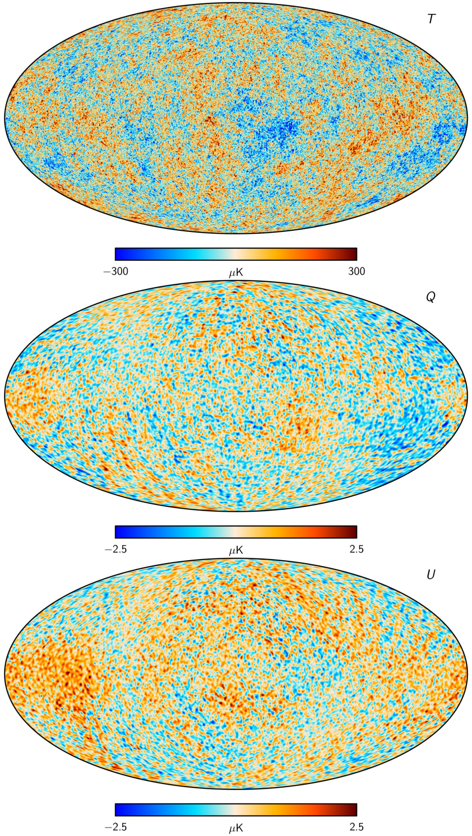
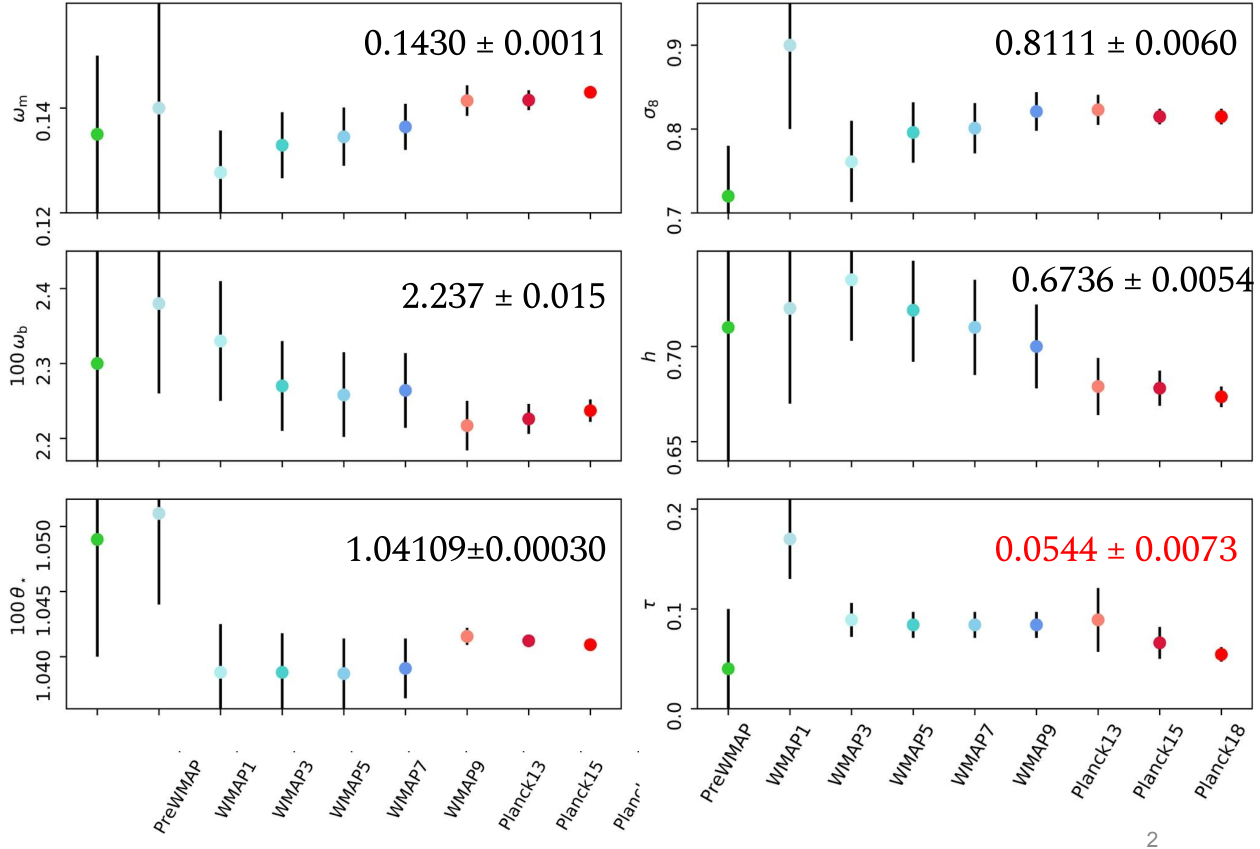
BERKELEY LAB
Bringing Science Solutions to the World

Talking Taurus

Alexandre Adler

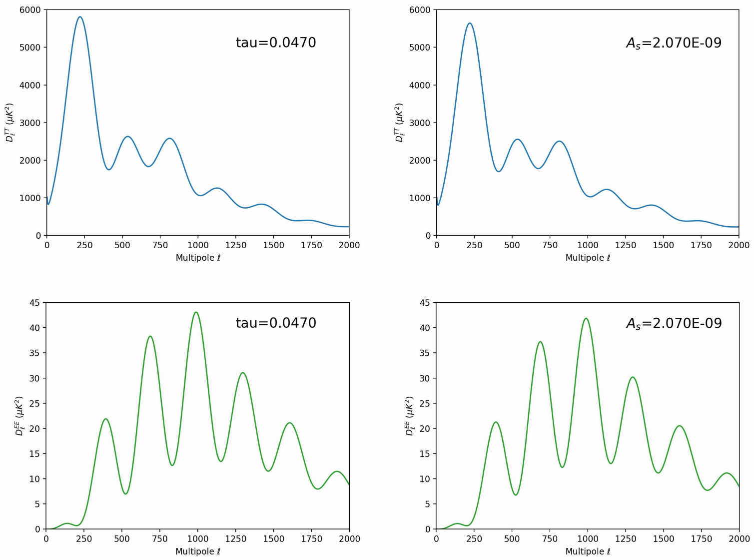
Planck's Precision



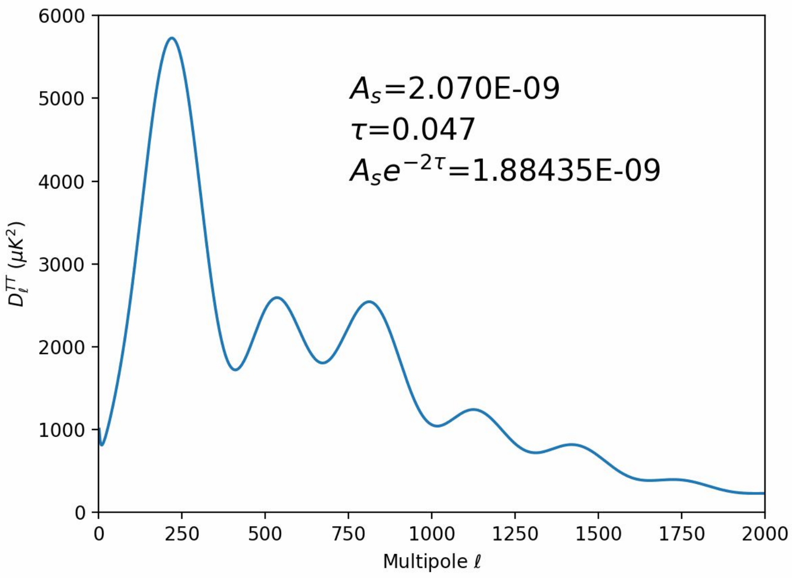


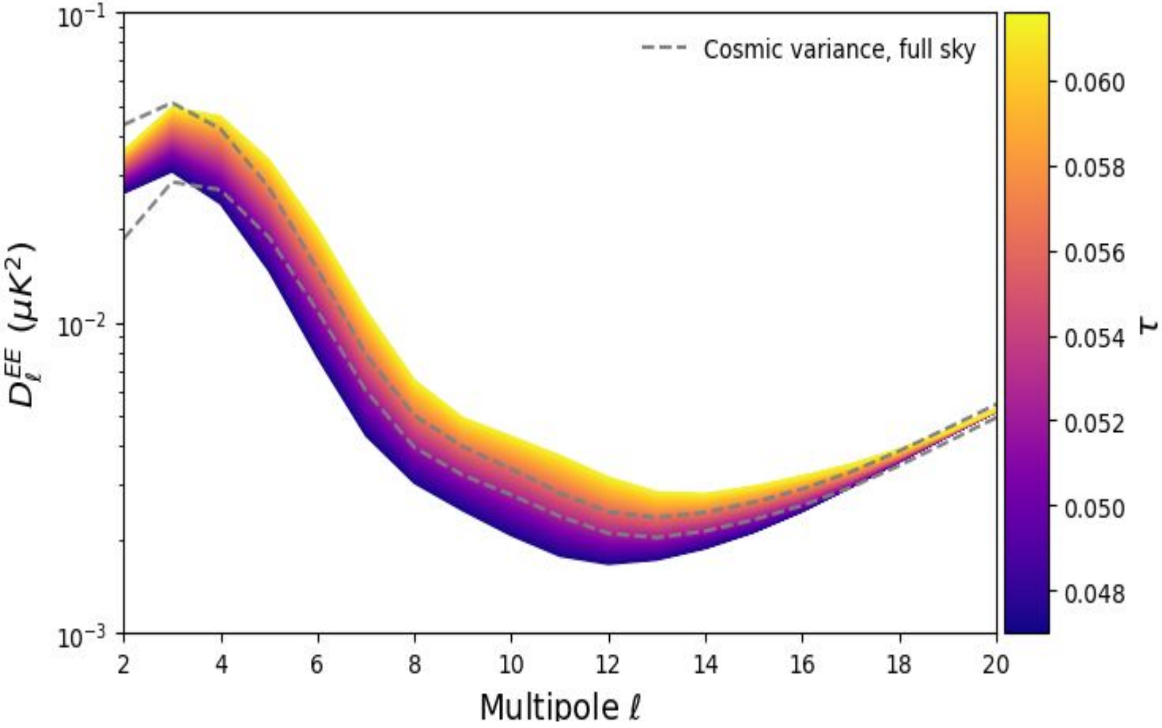
τ Trouble

The amplitude of fluctuations scales with A_s and τ



How can we disentangle them?





EE Excitement

During reionisation, Thomson scattering of CMB photons by electrons causes a net polarisation.

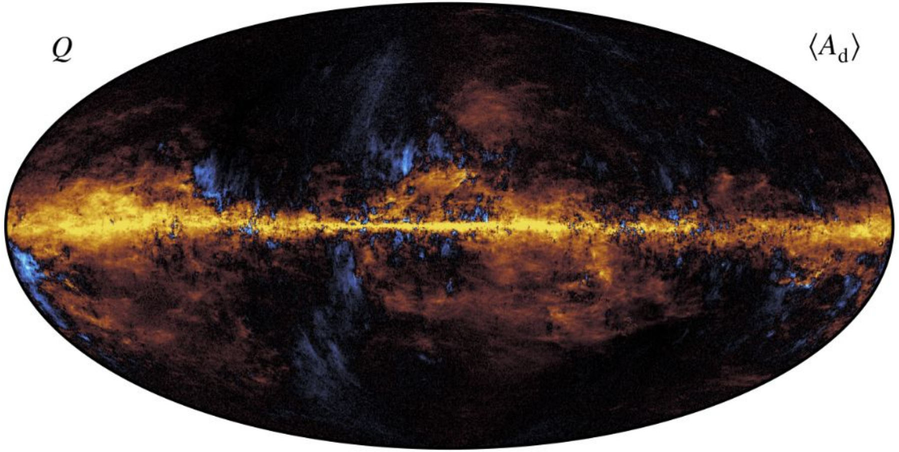
Therefore, there is a large scale E-mode, that can break the degeneracy between A_s and τ.

First detection in WMAP's TE correlation in 2003 (0.117 ±0.055)

Dust Disruption

Foregrounds are very bright, polarized, and have structure on large scales.

Sample variance scales as $1/f_{sky}$ so we can't just mask all the dusty areas.

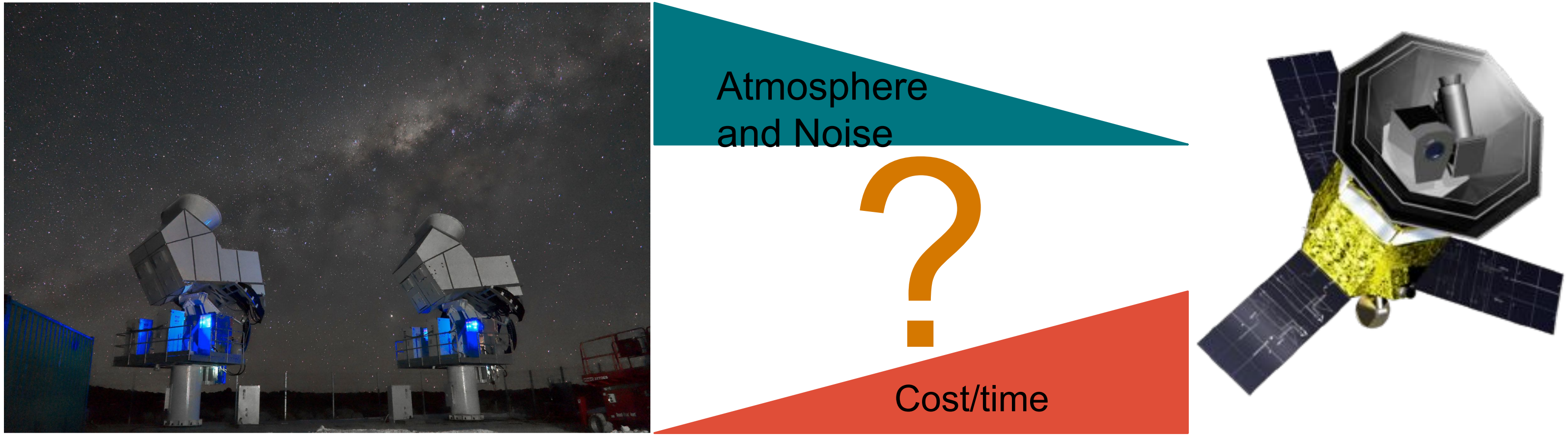


Map of polarized thermal dust emission,
Beyond Planck XV, T. L. Svalheim et al. (2022)

Nominal Needs

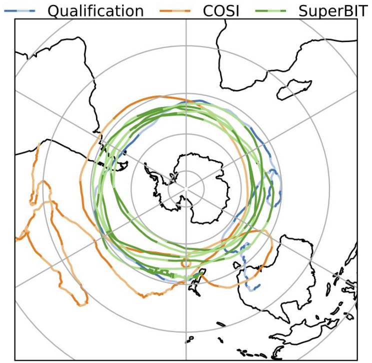
An experiment with:

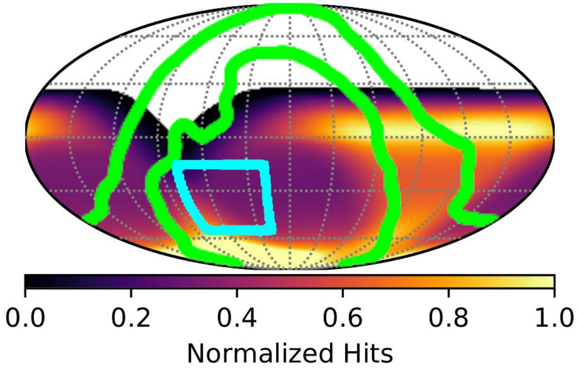
- Excellent sensitivity: many detectors that integrate for a long time
- Multiple frequency channels to disentangle foreground emission
- As large a sky coverage as possible to beat sample variance



Taurus Time!

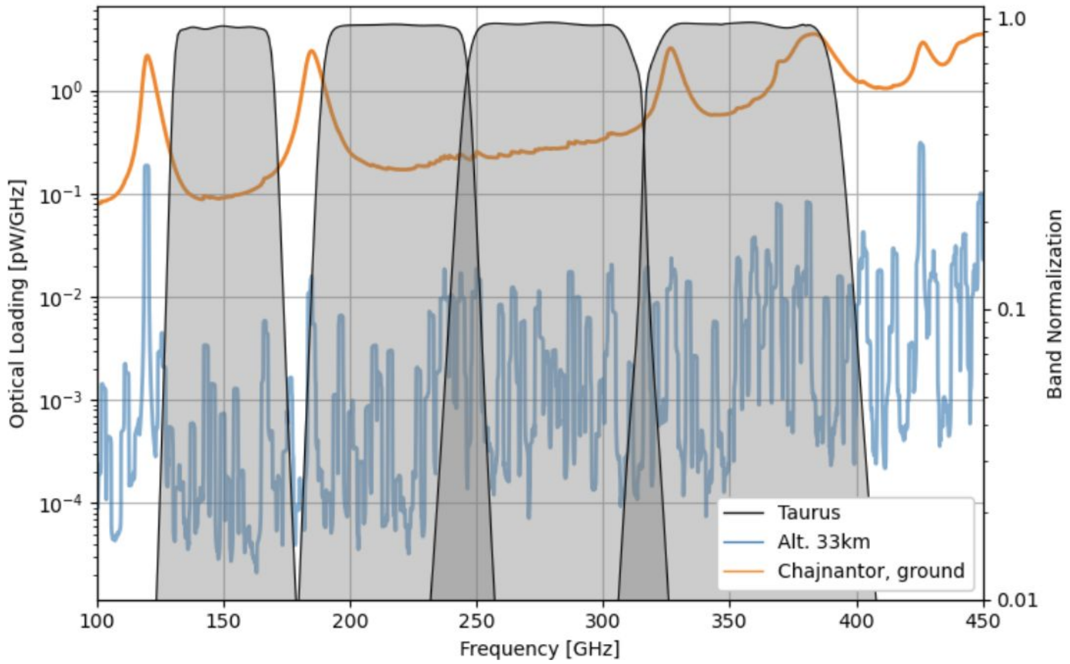
- Superpressure balloon: 30 days of observations at 32 km
- Four frequency bands centred on 150, 220, 280 and 350 GHz to probe dust
- ~10000 TES detectors at 100 mK, each sensitive to two frequency bands
- Split between three refractors
- Scan at night, recharge during the day
- Ballooning is risky! But cheaper than space flight





Up-to-date mockup design, May et al. (2024)
2407.01438

Atmospheric avoidance



The atmosphere is far more opaque at the frequencies of the dust emission: water vapor adds optical loading.

One detector/day at 350 GHz in the stratosphere is as sensitive as ~200 days on the ground

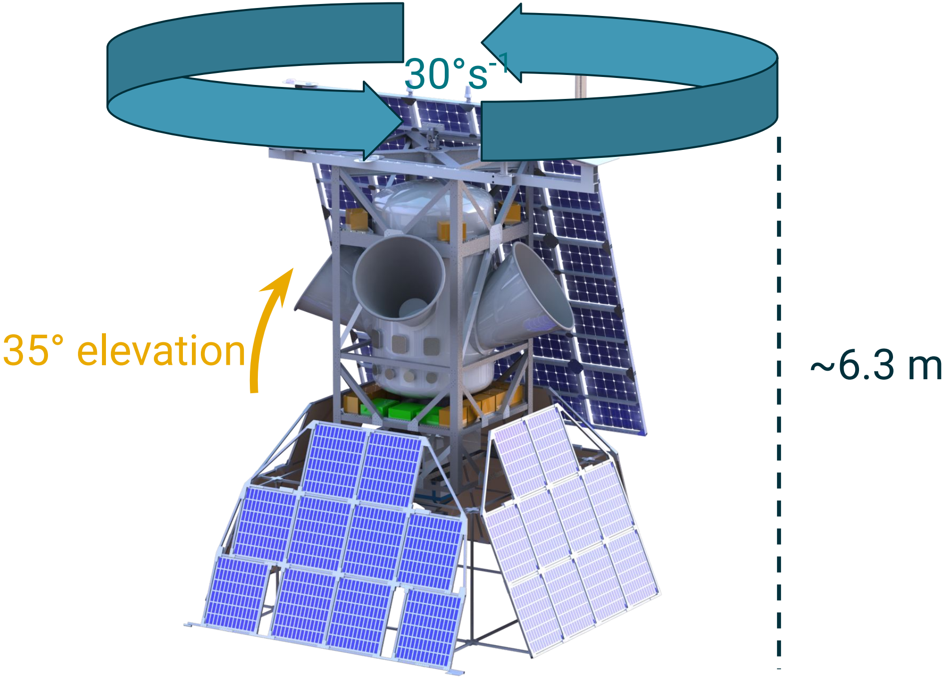
Turbulence further increases the advantage

Instrument Inspection

Three receivers: one at 150/220GHz, one at 280/350GHz, third TBD (150/220 or 220/280)

Refractor optics, depointed receivers to deal with SSN

Stepped HWPs, filters, baffles for sidelobe rejection

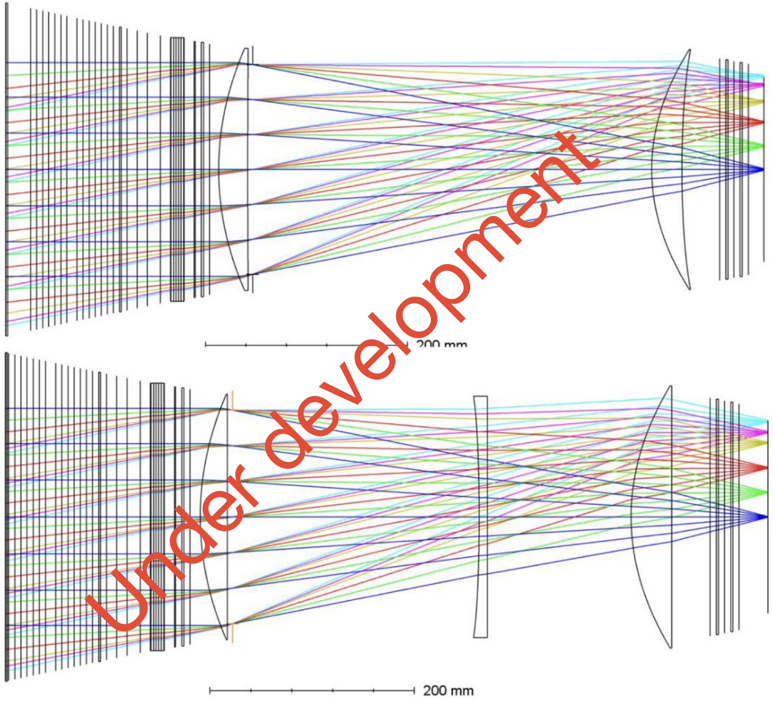


Refracting Receivers

Currently finalizing design:

- Two or three-lens model
- FoV from 24-28°
- Strehl ratio >0.95 over focal plane
- f/2.1-f/2.4

Dr Thomas Gascard,
U of Iceland



Focus Fillers

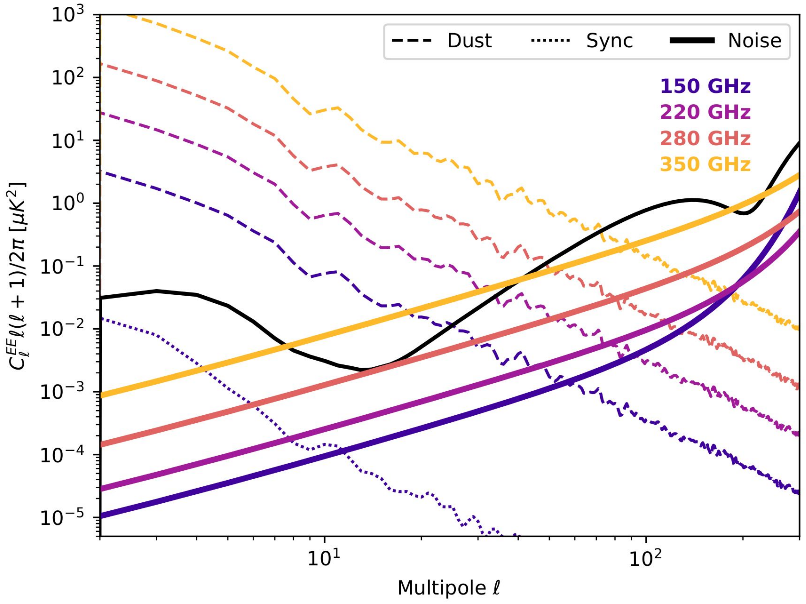
Assuming two 150/220 refractors and one 280/350

Detector Table

Center (Ghz)	Bwidth (GHz)	FWHM (‘)	Ndets	Power (pW)	Det. Sens (μK_{CMB} $Hz^{-1/2}$)	Inst. Sens (μK_{CMB} $Hz^{-1/2}$)
150	40	30	3024	0.9	76	1.5
220	55	22	3024	1.1	123	2.4
280	70	26	2016	1.4	220	5.4
350	85	22	2016	1.6	550	13.4

Under development

Predicted sensitivity



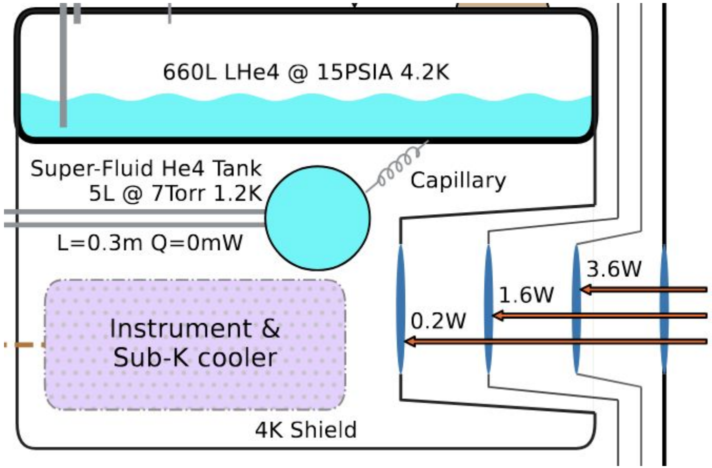
Cool Cucumber

Cryocooler down to 70K
Main He_4 tank at 4K

SPIDER He_3 fridges provide 0.3K from superfluid tank

Closed-cycle Chase DR cools down to 0.1K

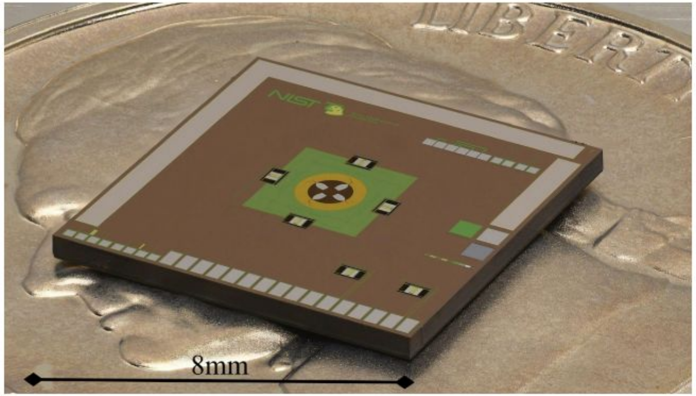
Simon Tartakovsky, Princeton



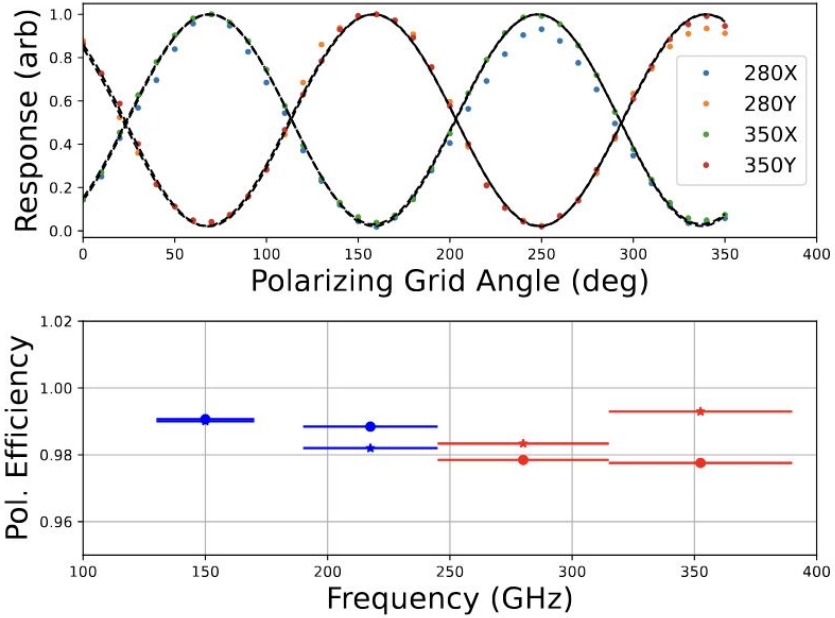
Tartakovsky et al., 2410.18150

Courtesy of Prof. Johanna Nagy

Detector Development



280 GHz NIST pixel prototype

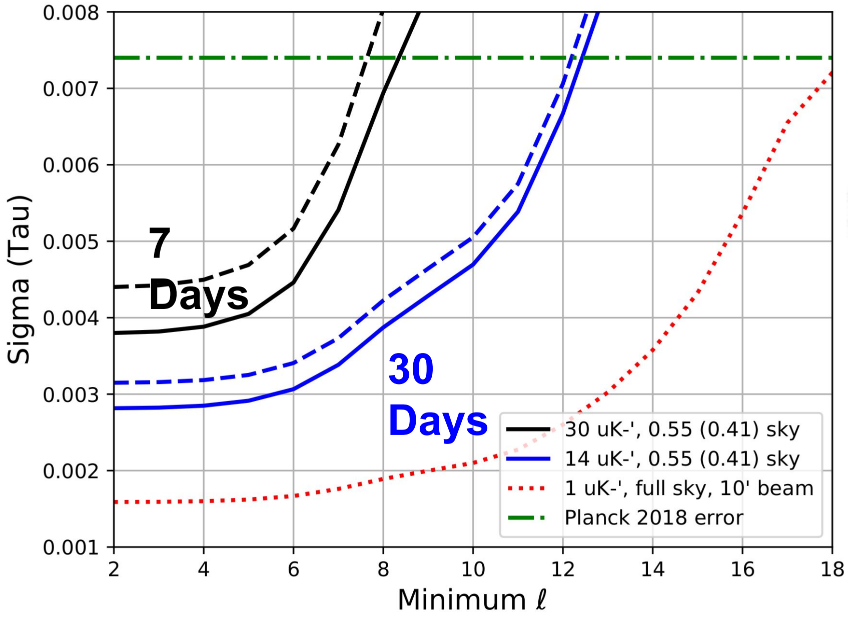


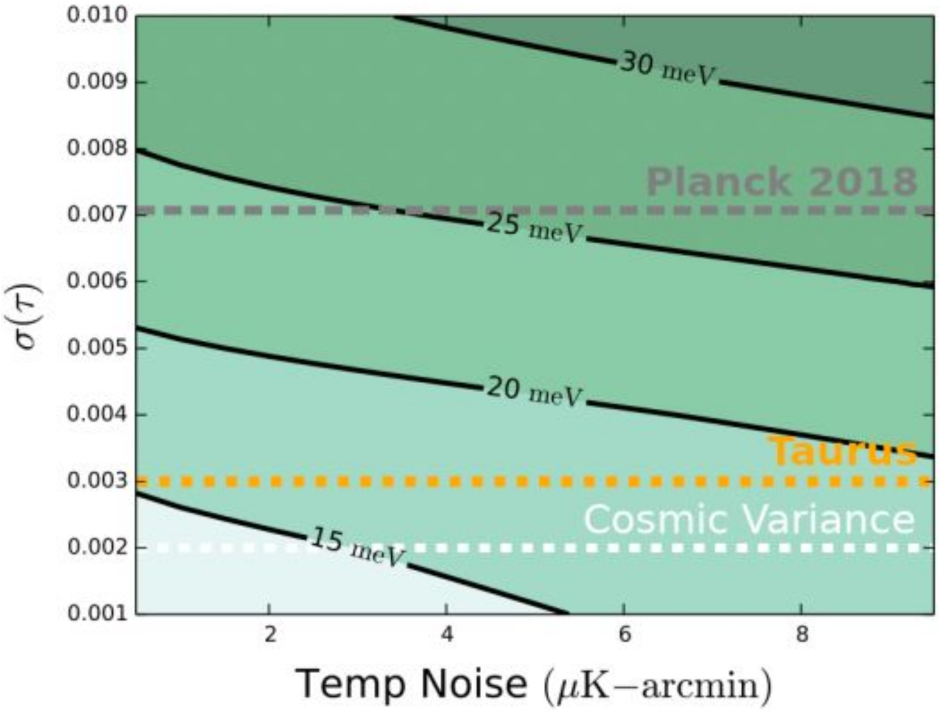
Tests of polarisation sensitivity

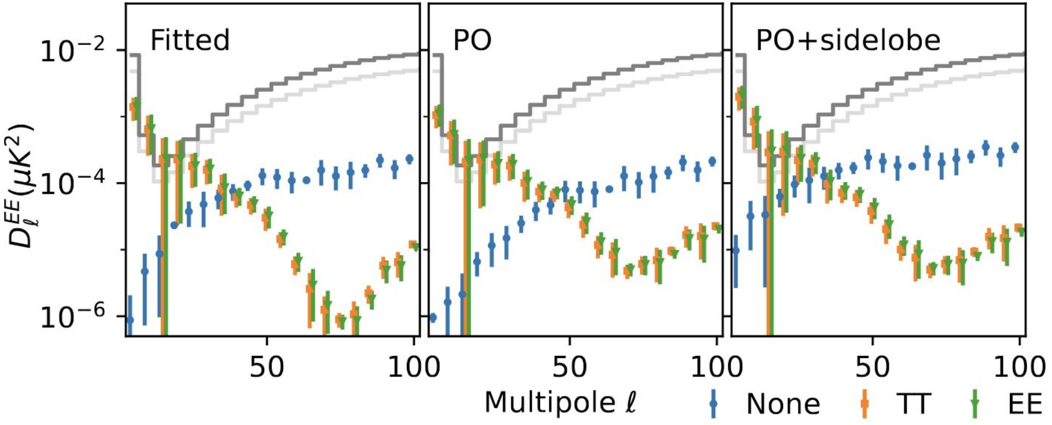
May et al., 2407.01438

Fiducial Forecast

Sensitivity depends on the l we can reach and the usable sky fraction

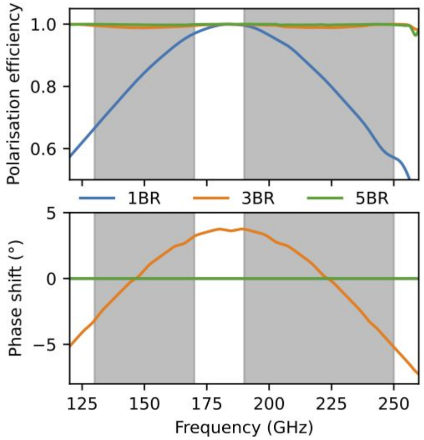






Simulating Systematics

In 2406.11992, we examined potential systematics related to HWP and beam, finding that some measure of calibration would enable us to reach our targets.



Top: Residuals at power spectrum level due to improper beam assumption, compared to sample variance for various sky fractions.

Right: Non-idealities in HWP Mueller matrices for the 150/220 telescope.

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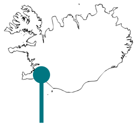
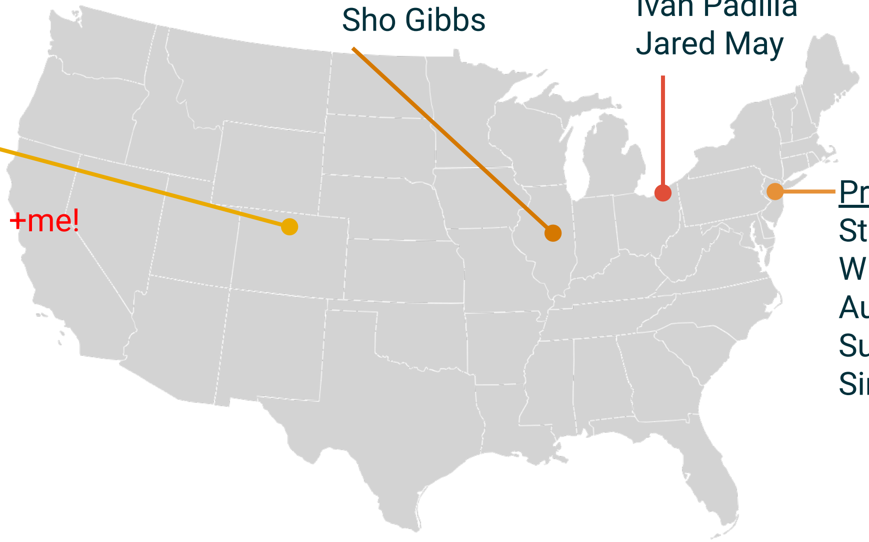
Thanks for your attention

No animals were harmed in the making of this presentation

Backup: Team Taurus





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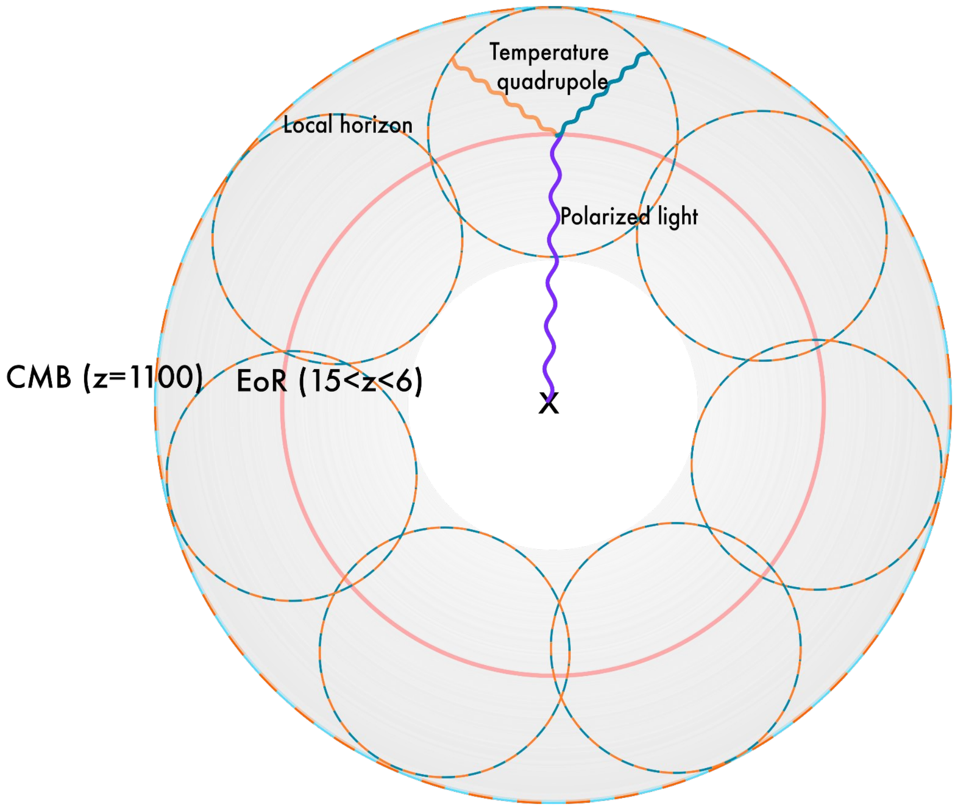
Jared May

U of Iceland
Jon Gudmundsson
Thomas Gascard

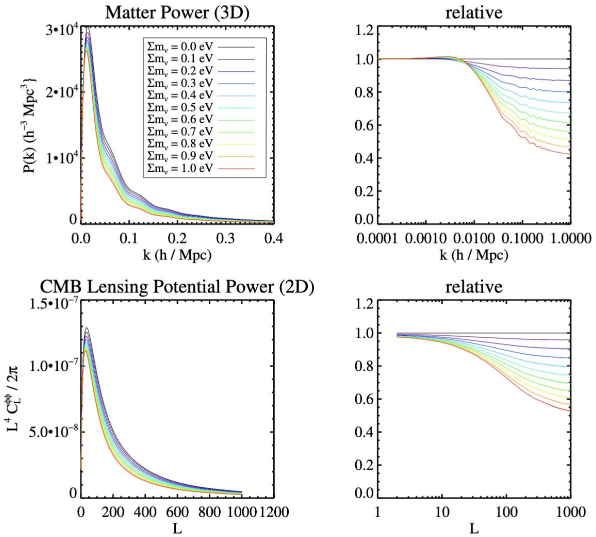
Princeton
Steven Benton (PI)
William Jones
Aurelien Fraisse
Suren Gourapura
Simon Tartakovsky

Backup: Producing Polarisation

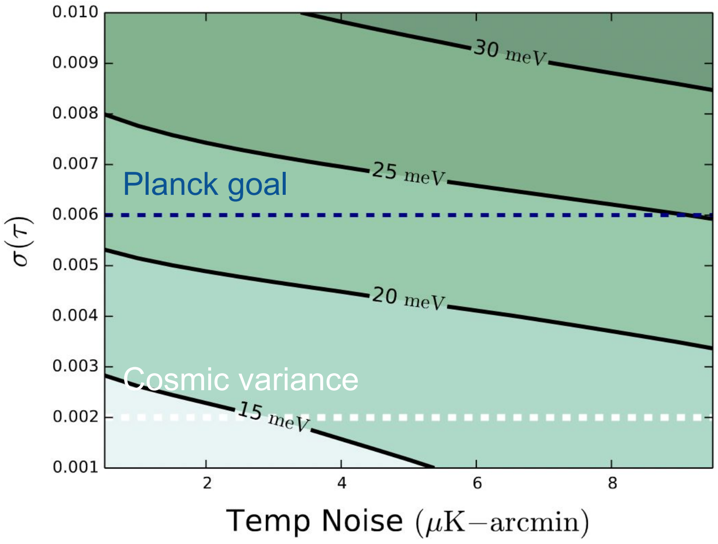


Backup: Neutrino Nuisance

Main obstacle to measuring sum of neutrino masses through their suppression of structure growth!



(CMB-S4 Science Book, 2016)



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