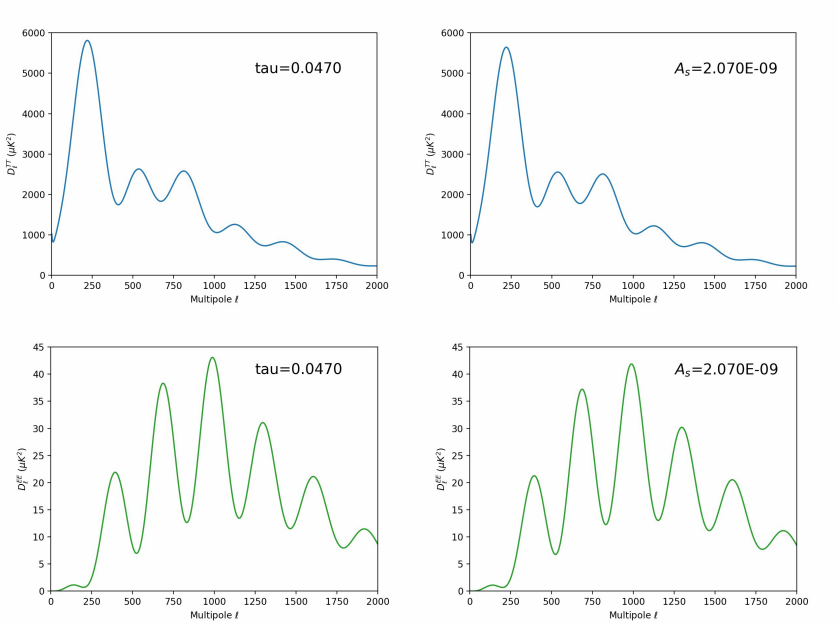
BERKELEY LAB
Bringing Science Solutions to the World

Talking Taurus

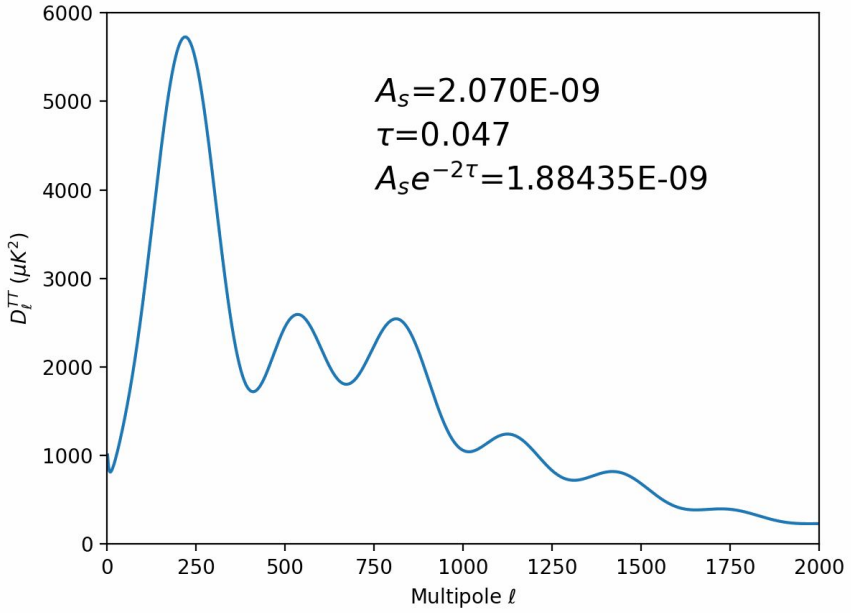
Alexandre Adler, for the Taurus Collaboration

τ Trouble

The amplitude of fluctuations scales with A_s and τ

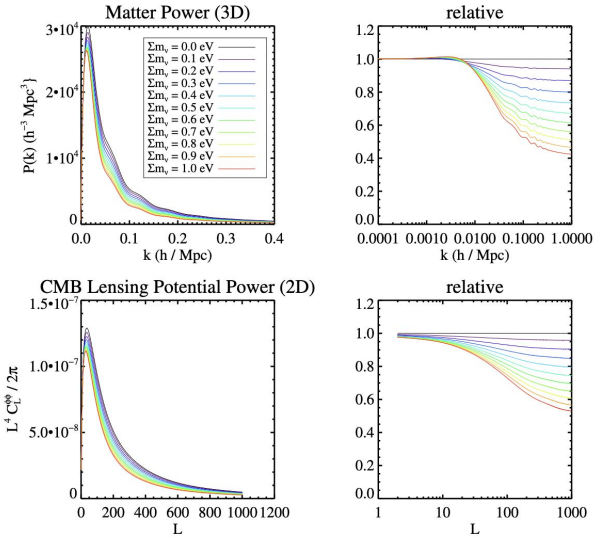


Degenerate in TT

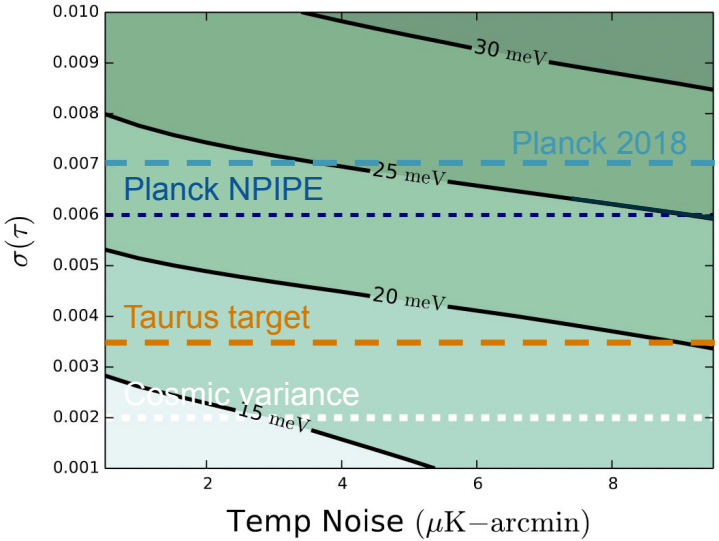


Neutrino Nuisance

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

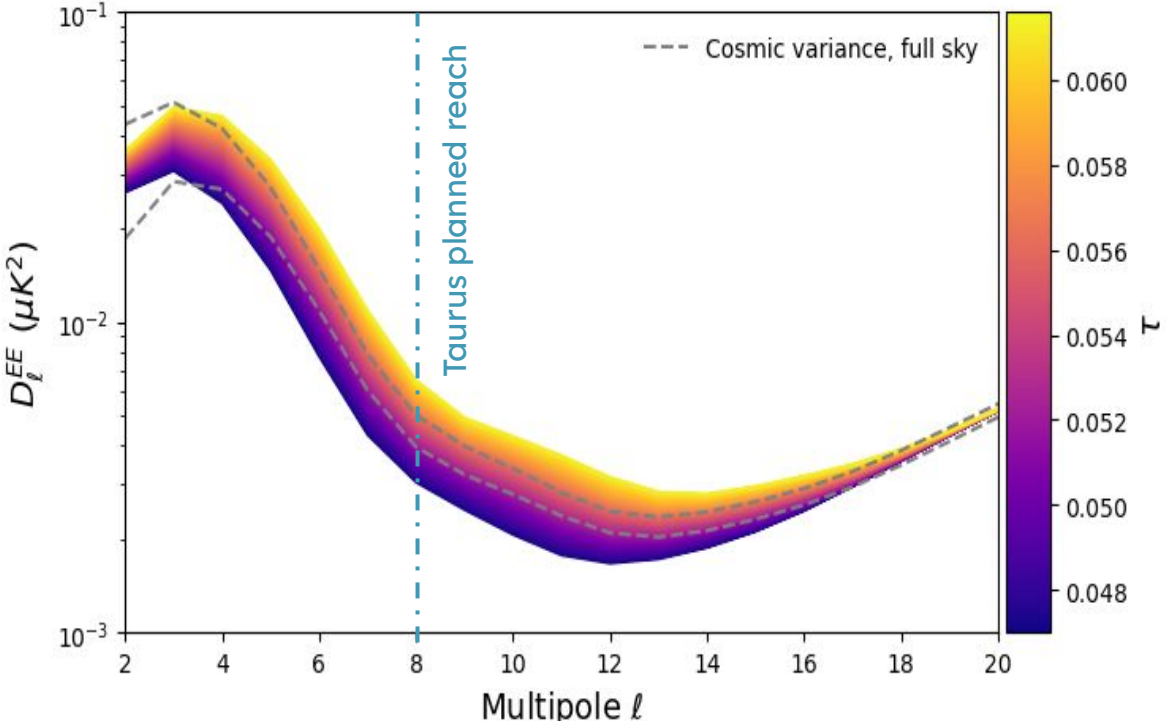


(CMB-S4 Science Book, 2016)



ibid.

EE Excitement



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

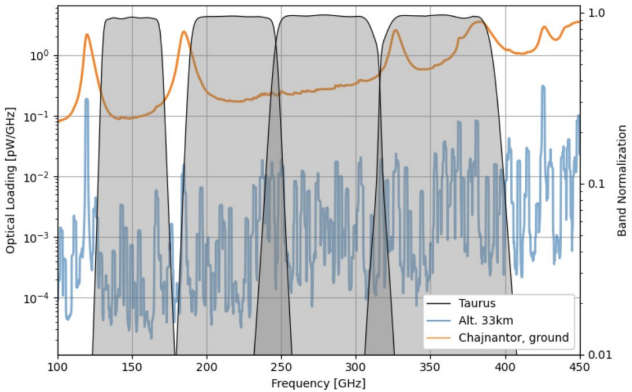
Therefore, there is a large scale E-mode, that can break the degeneracy between A_s and τ.

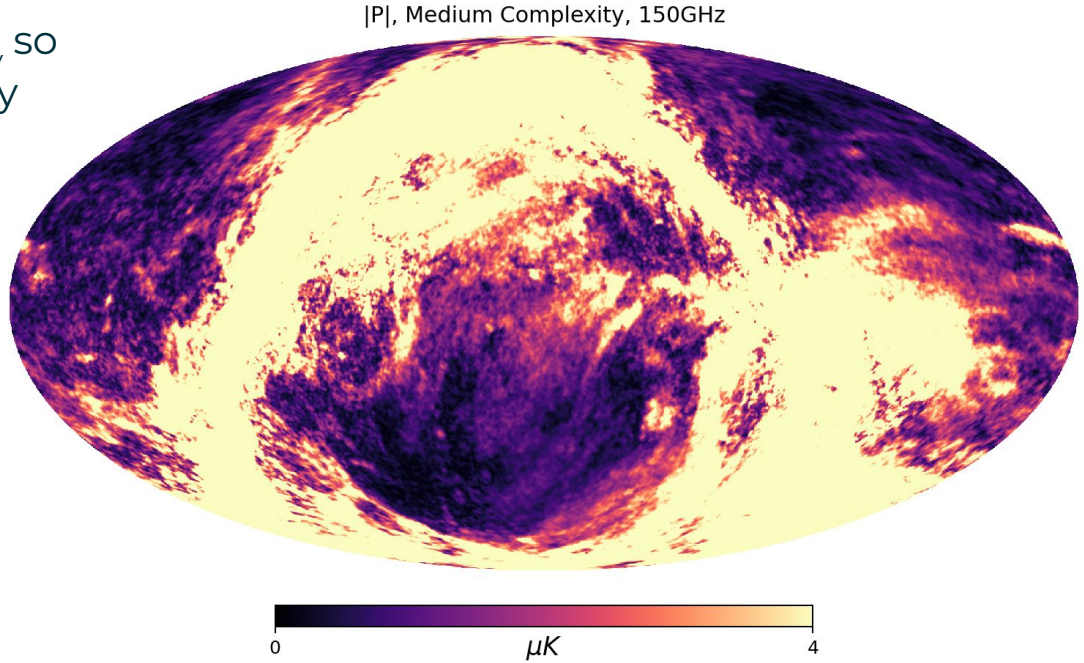
Detections by WMAP (TE at first), Planck, and CLASSxPlanck

Foreground Friction

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

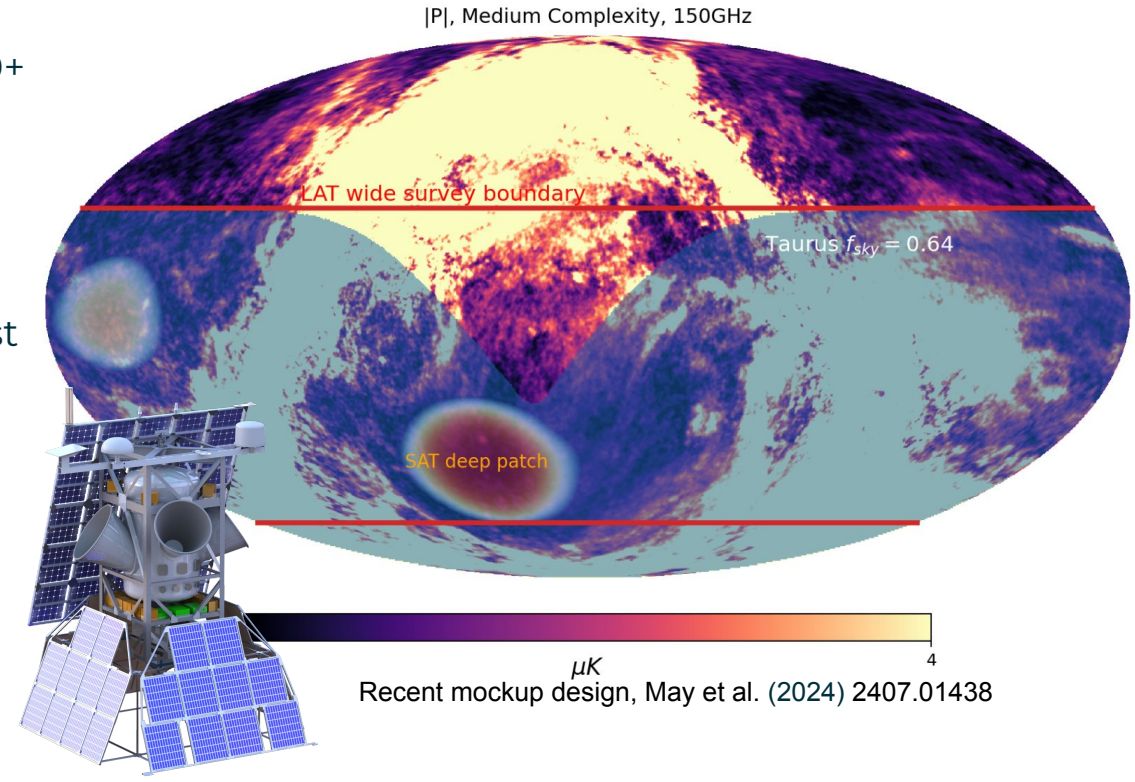
Atmosphere restricts ground sensitivity at high frequencies, and adds low-ℓ noise



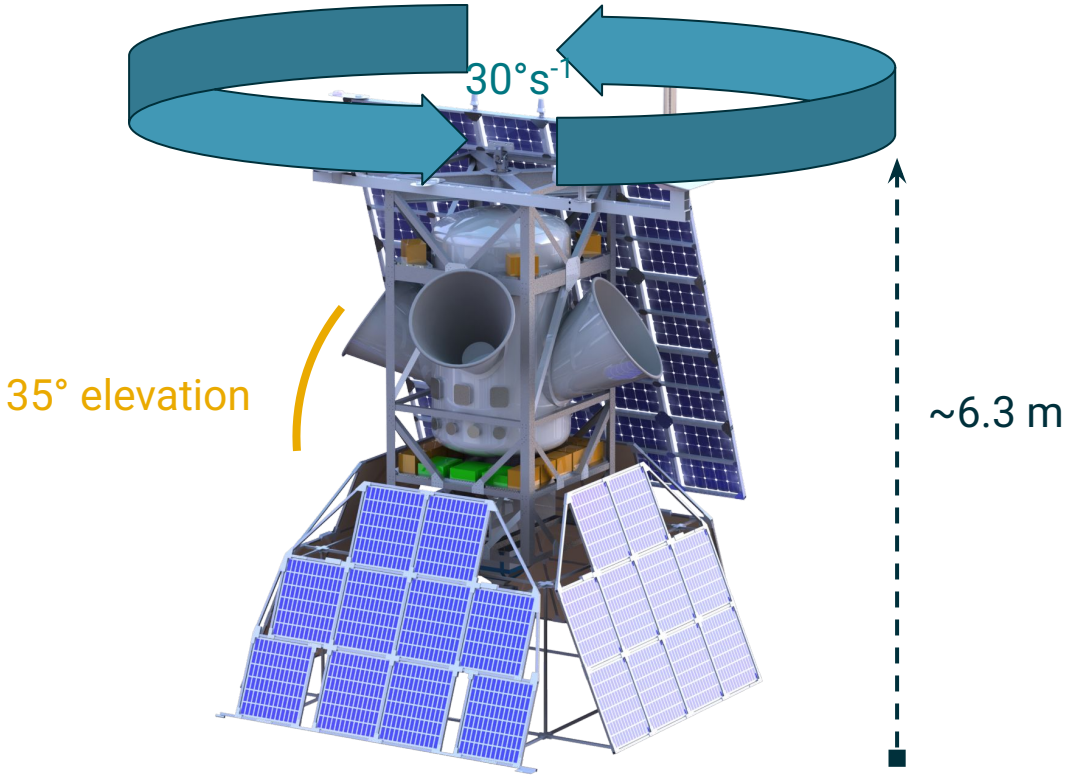


Taurus Time!

- Superpressure balloon: 30+ nights of observations at 32 km, mid-latitudes
- 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
- Ballooning is risky! But cheaper than space flight



Recent mockup design, May et al. (2024) 2407.01438



Instrument Inspection

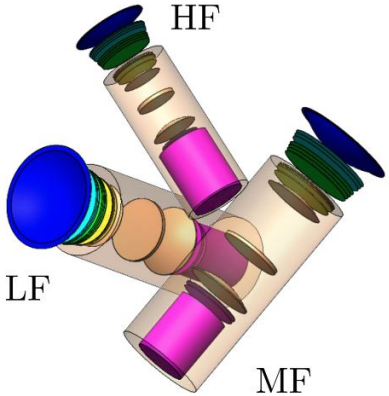
Three dichroic receivers: 150/220 GHz, 220/280, and 280/350.
Receivers depointed: larger baffles for sidelobe rejection, SSN mitigation
Band overlaps provide redundancy @ 220, 280
Stepped HWPs
Cardiff filter stack

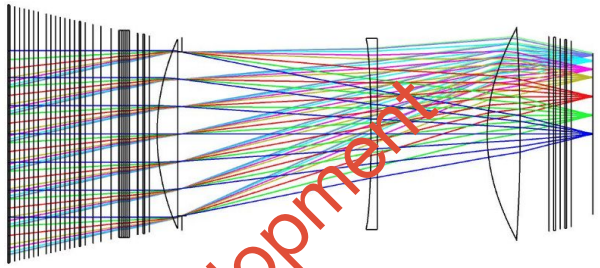
Refracting Receivers

Currently finalizing design:

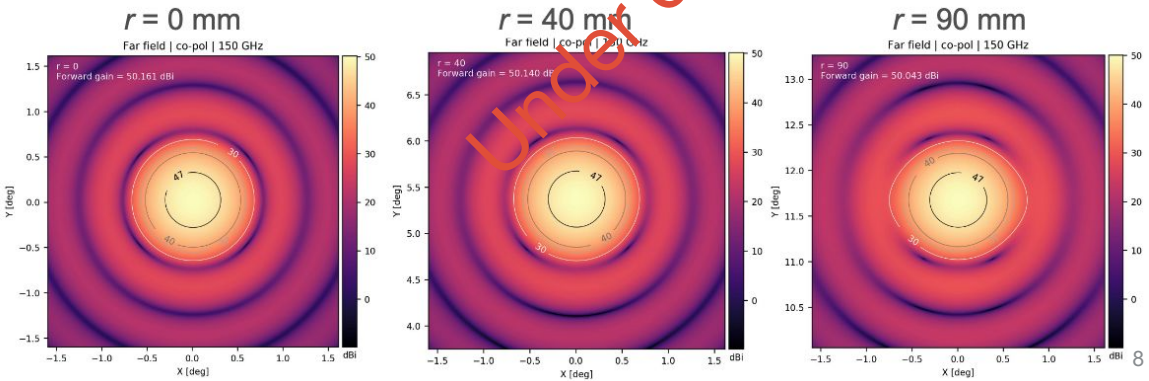
- Focal plane r~70/100mm
- FoV from 24-28°
- Strehl ratio >0.95 over focal plane
- f/1.9-f/2.4

Dr Thomas Gascard,
U of Iceland





Under development



Cool Cucumber

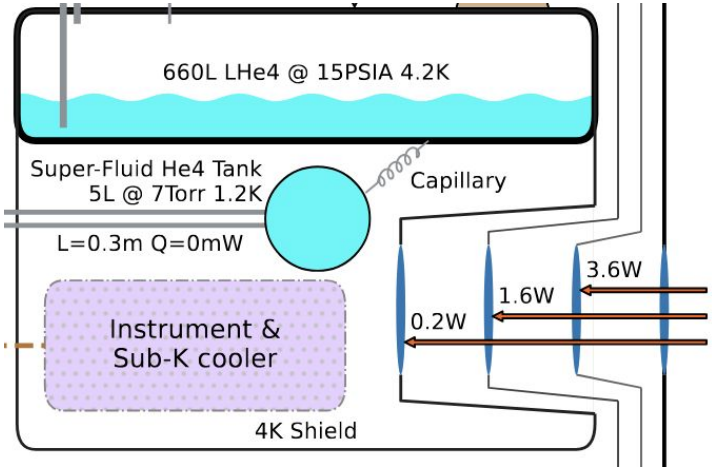
Vapour cooled shields to 70/35 K (Stirling cooler assisted)
Main He_4 tank at 4K

SPIDER He_3 fridges provide 0.3K from superfluid tank

Closed-cycle Chase DR cools down to 0.1K

Simon Tartakovsky, Princeton

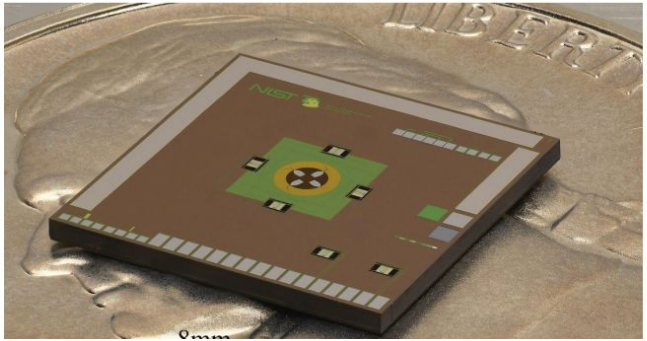
Jared L. May, CWRU



Tartakovsky et al., 2410.18150

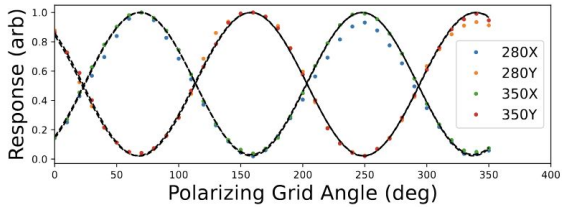
Courtesy of Prof. Johanna Nagy

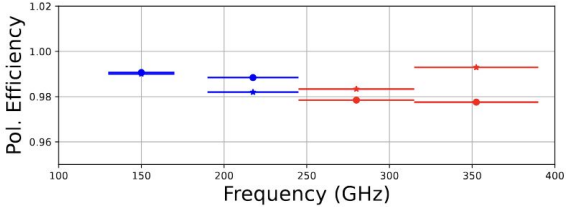
Detector Development, TES Testing



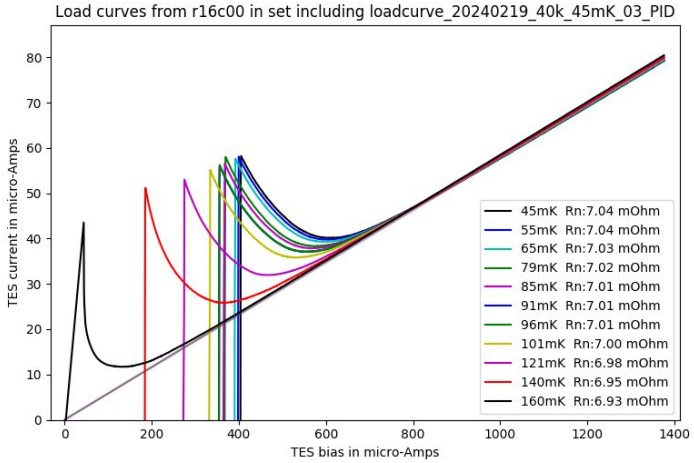
Johannes Hubmayr, NIST

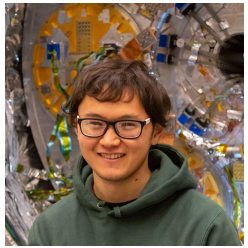
Tests of polarisation sensitivity





May et al., 2407.01438



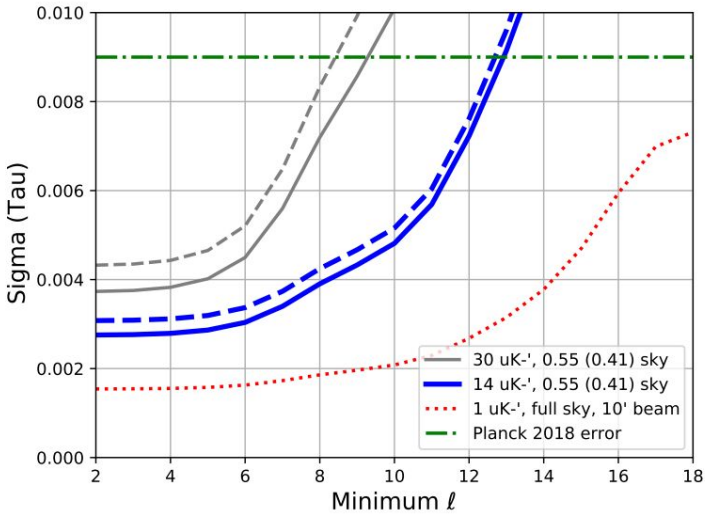


Sho Gibbs, UIUC

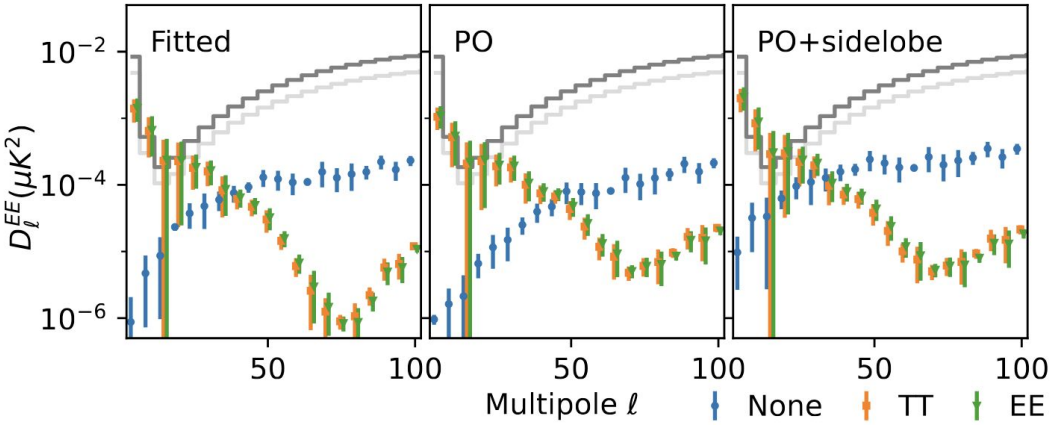
Fiducial Forecast

σ(τ) depends on:

1) ℓ_{min} we can reach
2) Flight time/detector performance/focal plane optimization
3) sky fraction usable for analysis



Fisher forecast from APRA proposal configuration

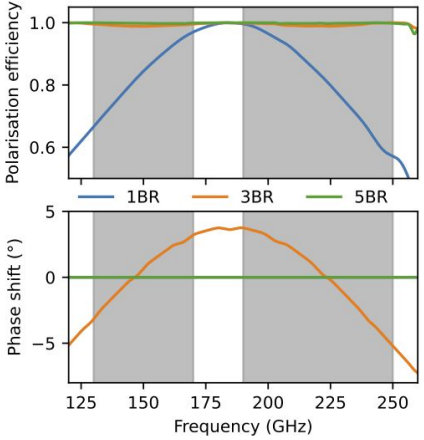


Systematics Sims

In 2406.11992, (**Adler** et al.) we examined potential HWP and beam systematics, 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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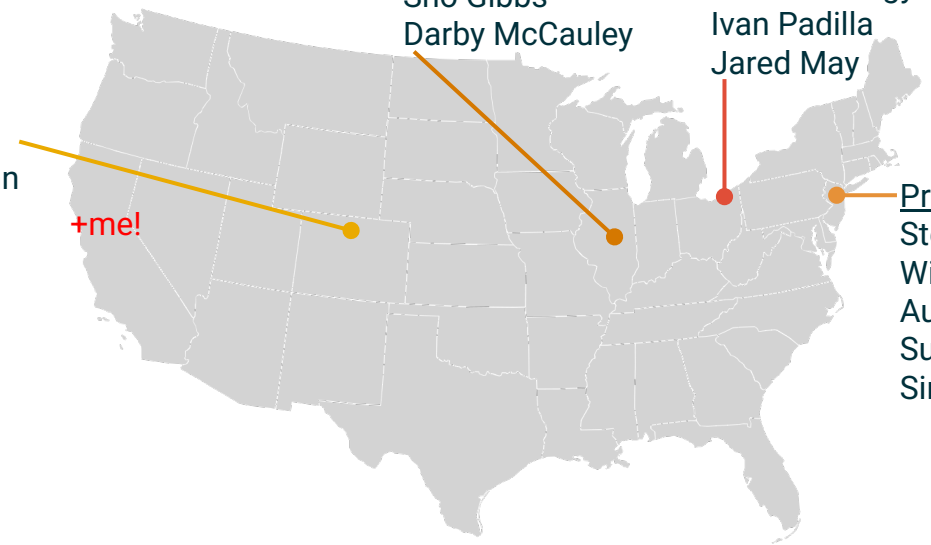
Thanks for your attention

See you all in New Zealand in a few years

Backup: Team Taurus



U of Iceland
Jon Gudmundsson
Thomas Gascard

UIUC
Jeffrey Filippini
Sho Gibbs
Darby McCauley

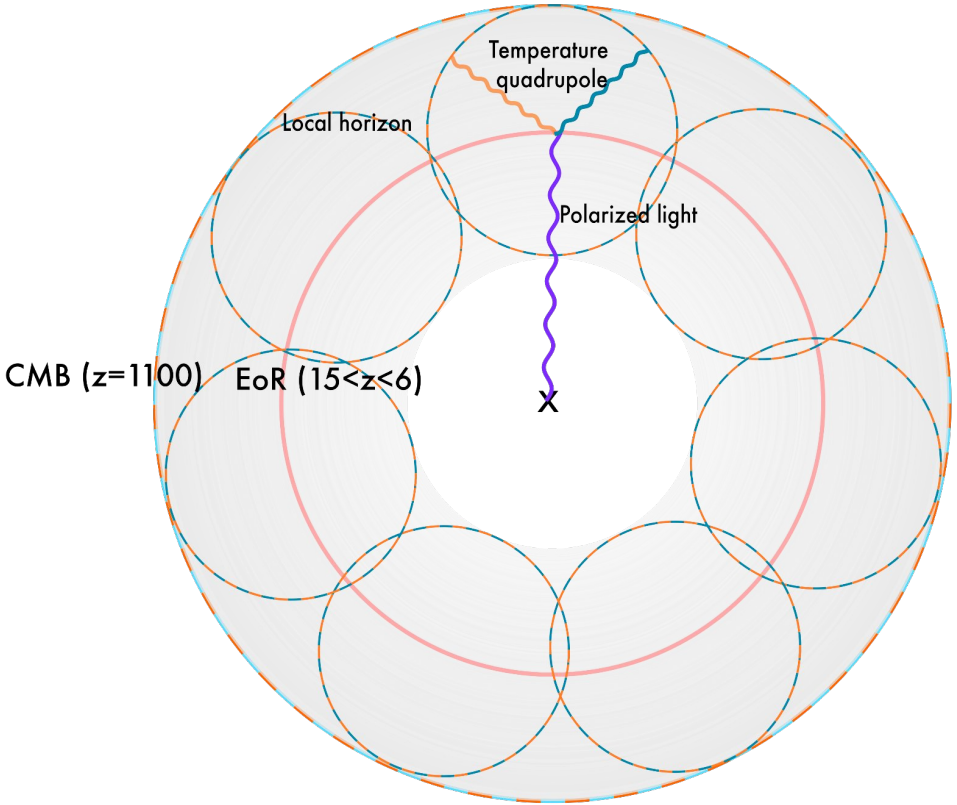
CWRU
Johanna Nagy
Ivan Padilla
Jared May

CU/NIST
Hannes Hubmayr
Jason Austermann
Shannon Duff
Malcolm Durkin
Kate Okun
Michael Vissers

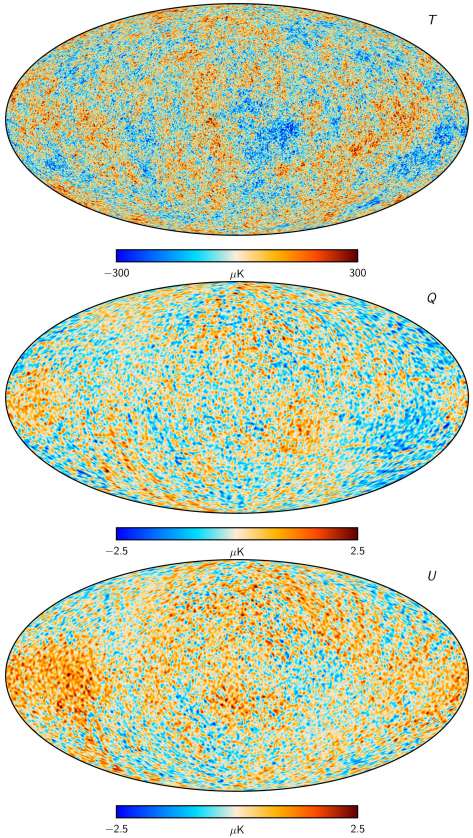
+me!

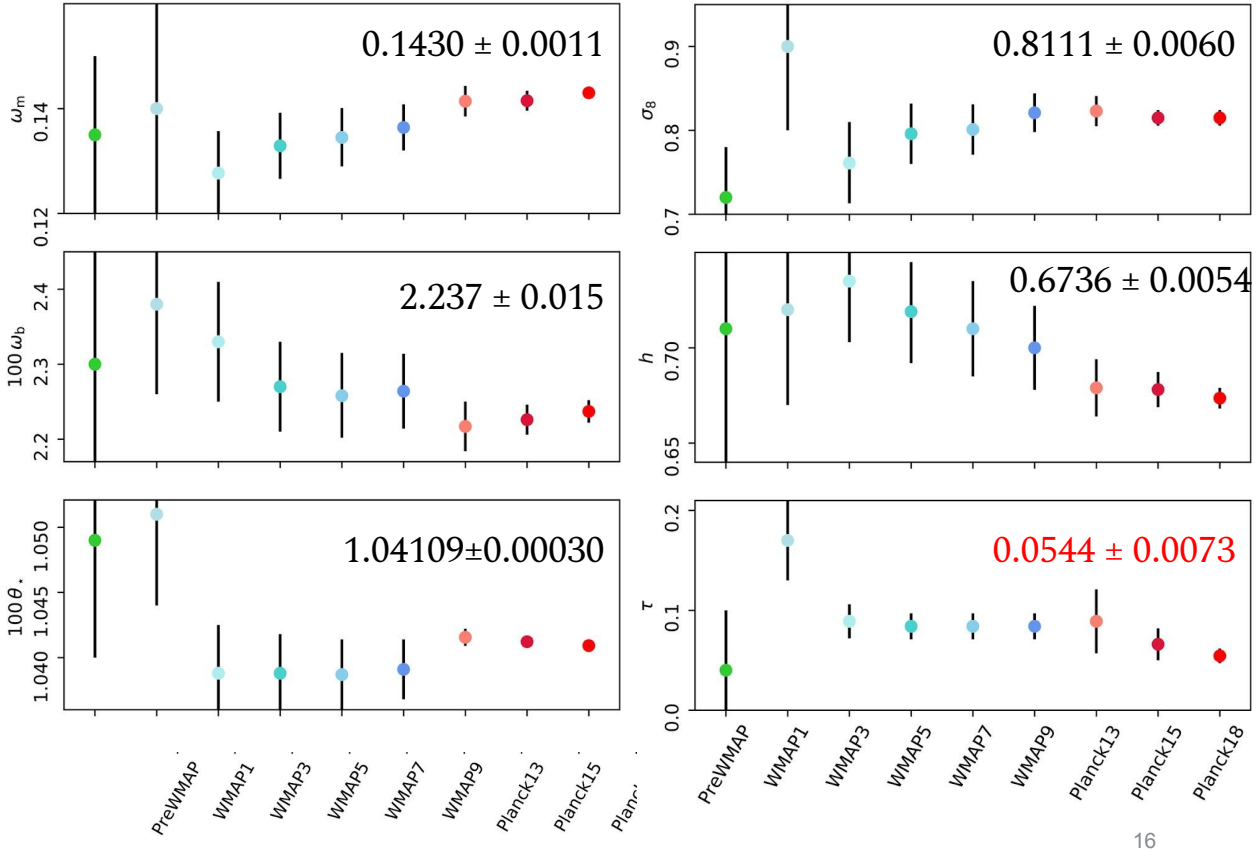
Princeton
Steven Benton (PI)
William Jones
Aurelien Fraisse
Suren Gourapura
Simon Tartakovsky

Backup: Producing Polarisation

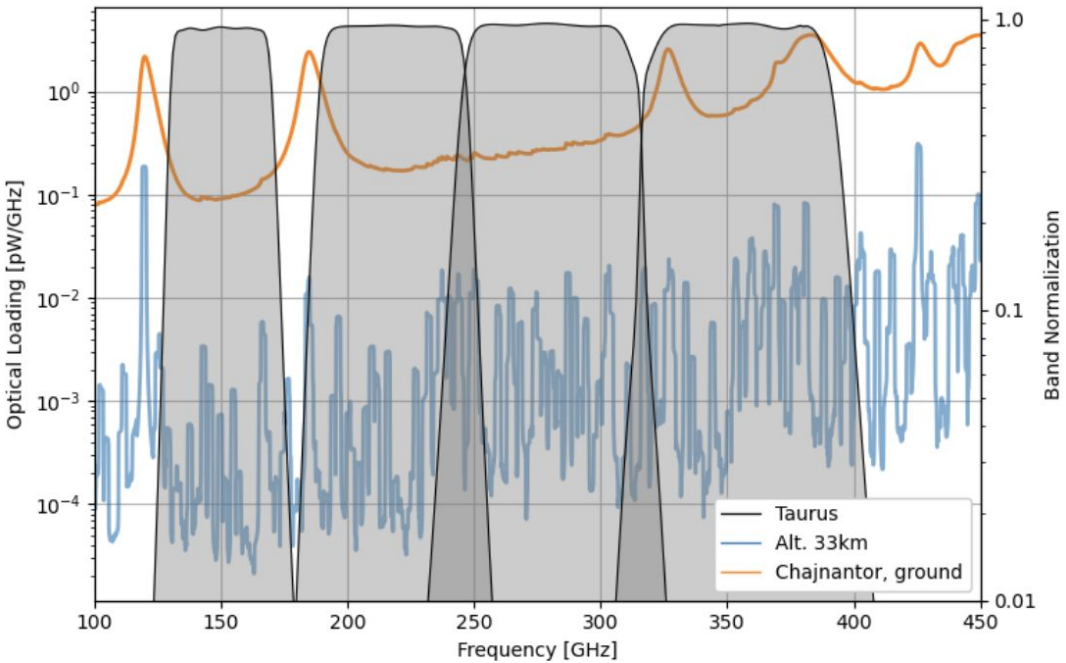


Backup: *Planck*'s Precision





Backup: Atmosphere



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

Backup: Focus Fillers

Assuming 7mm LF aperture and LF/MF/HF design

Detector Table

Center (Ghz)	Bwidth (GHz)	FWHM (')	Ndets	Power (pW)	NET (μK_{CMB} $Hz^{-1/2}$)	Inst. Sens (μK_{CMB} $Hz^{-1/2}$)
150	40	30	1096	0.9	92	2.8
220	55	22/30	2192	1.1	156	3.3
280	70	22/26	1996	1.4	290	6.5
350	85	22	900	1.6	625	20.8

Under development

Predicted sensitivity