

Taurus

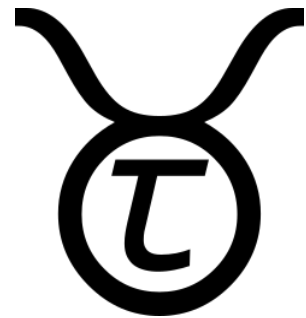
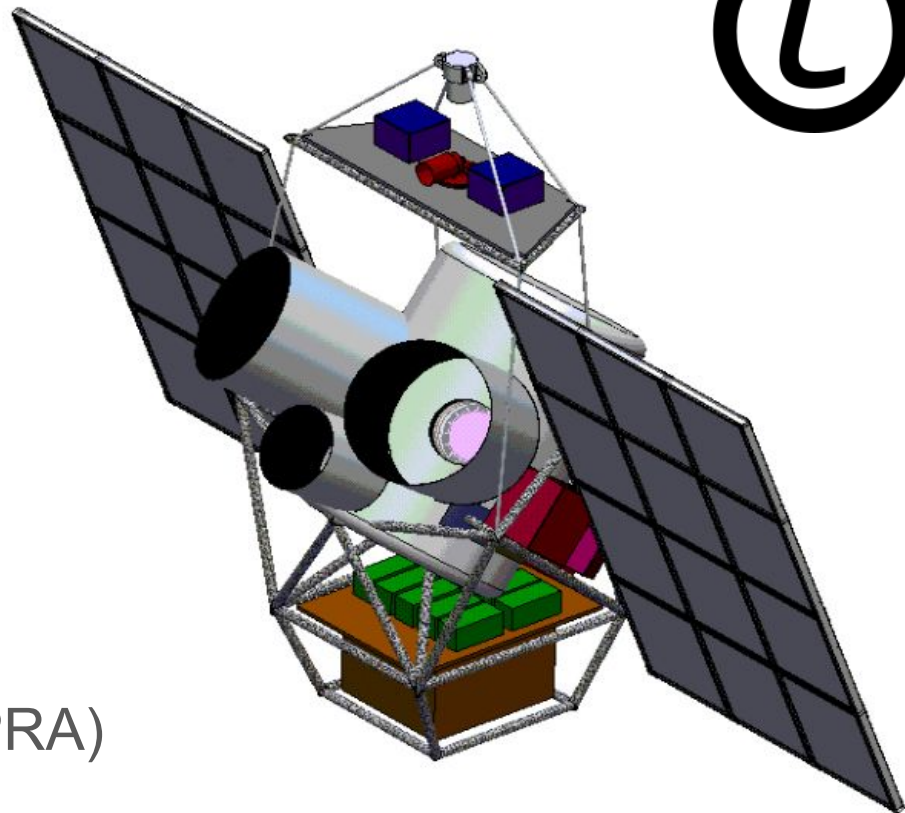
A photograph taken from space, showing the Earth's horizon and atmosphere. The sky is a deep blue, and the Earth's surface is visible as a lighter blue and white. In the foreground, a portion of a satellite instrument is visible, consisting of a dark, rectangular panel with a metallic edge and some internal components.

A Balloon-borne Polarimeter for Cosmic Reionization and Galactic Dust

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Aug 13, 2021

Taurus

- CMB E-Mode polarization
- Mid-latitude balloon (2026)
 - Up to 50 days
- **High Frequencies**
 - 4 bands: 150 – 350 GHz
- **Large Scales**
 - 70% of the sky
 - Simple Refractive Optics
 - Degree Resolution
- Recently Funded! (NASA APRA)



Reionization, Neutrinos

Big Bang
??? Inflation ???

Particles Form

Photons + matter coupled

Recombination

Dark Ages

First Stars and Galaxies

Nuclear fusion (again)

Chemistry

Geology

Biology

Anthropology, etc
Today

“Initial” fluctuations:

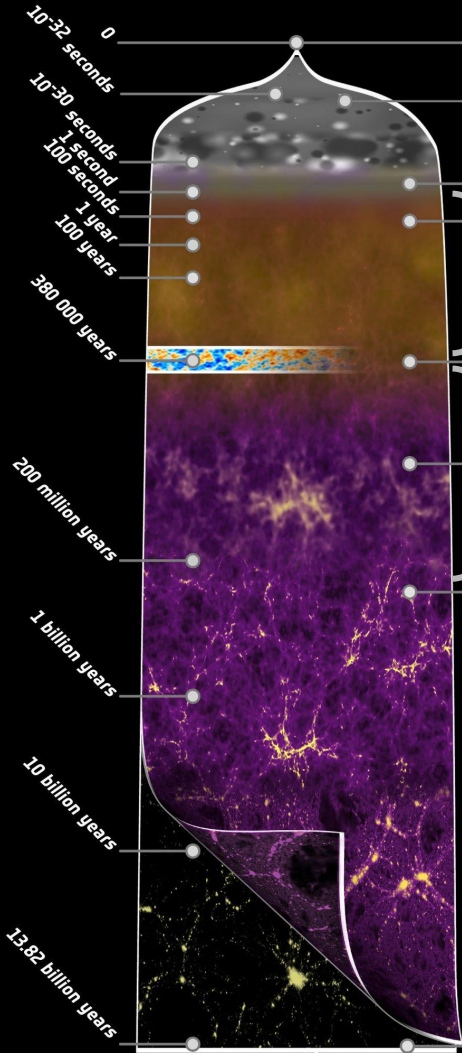
- A_s amplitude
- n_s scale-dependence

Kinds of stuff:

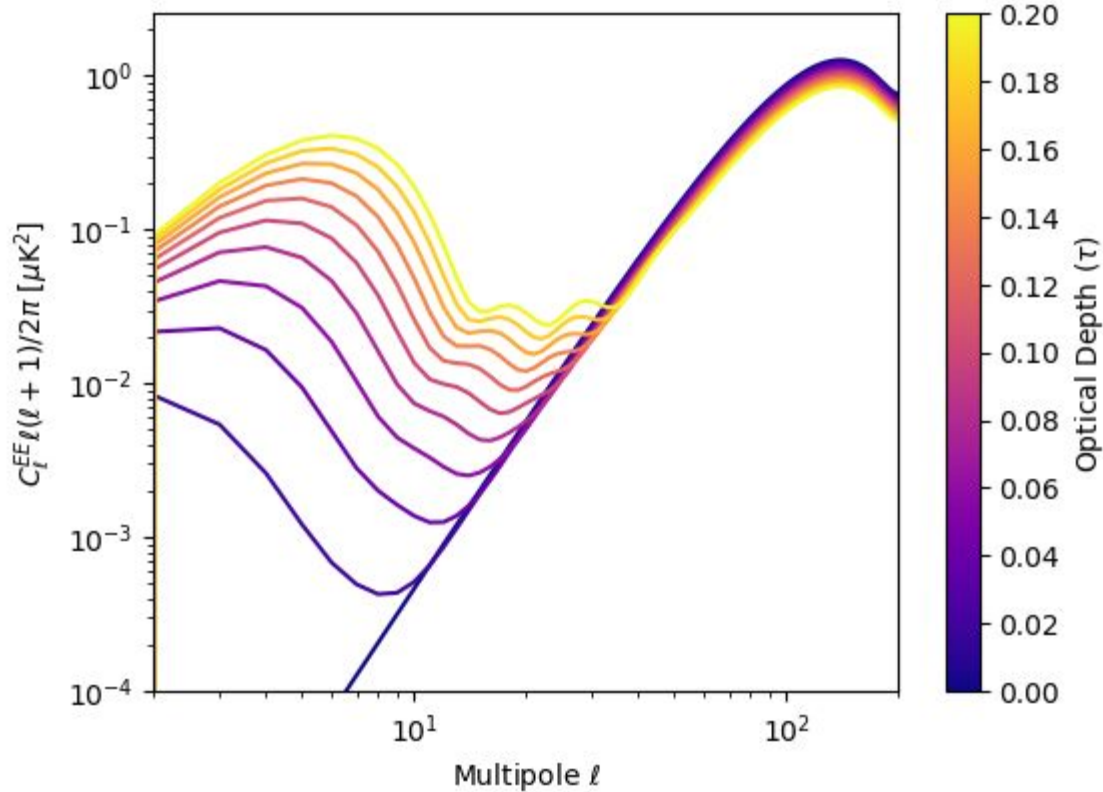
- $\Omega_b h^2$ baryons
- $\Omega_c h^2$ dark matter
- Ω_Λ dark energy
- Σm_ν **neutrino mass**

Reionization:

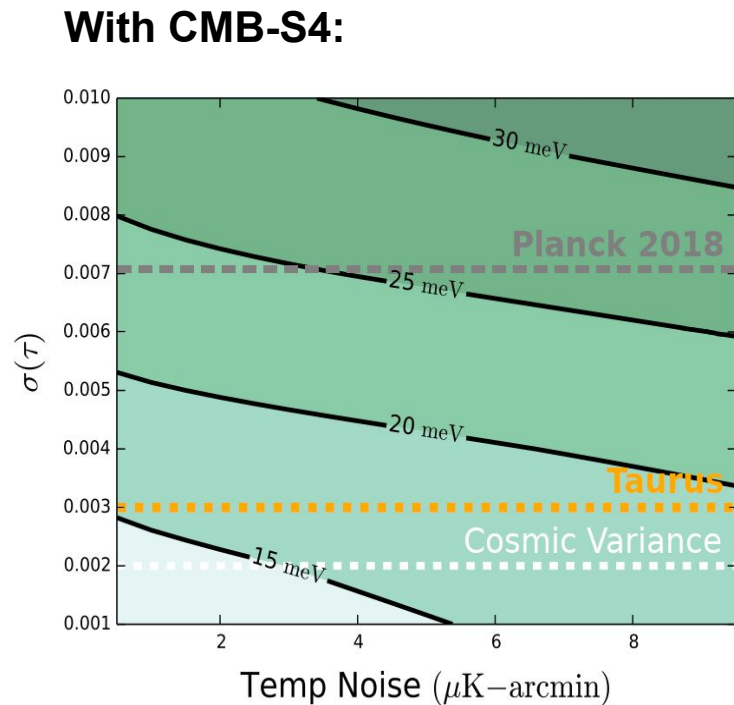
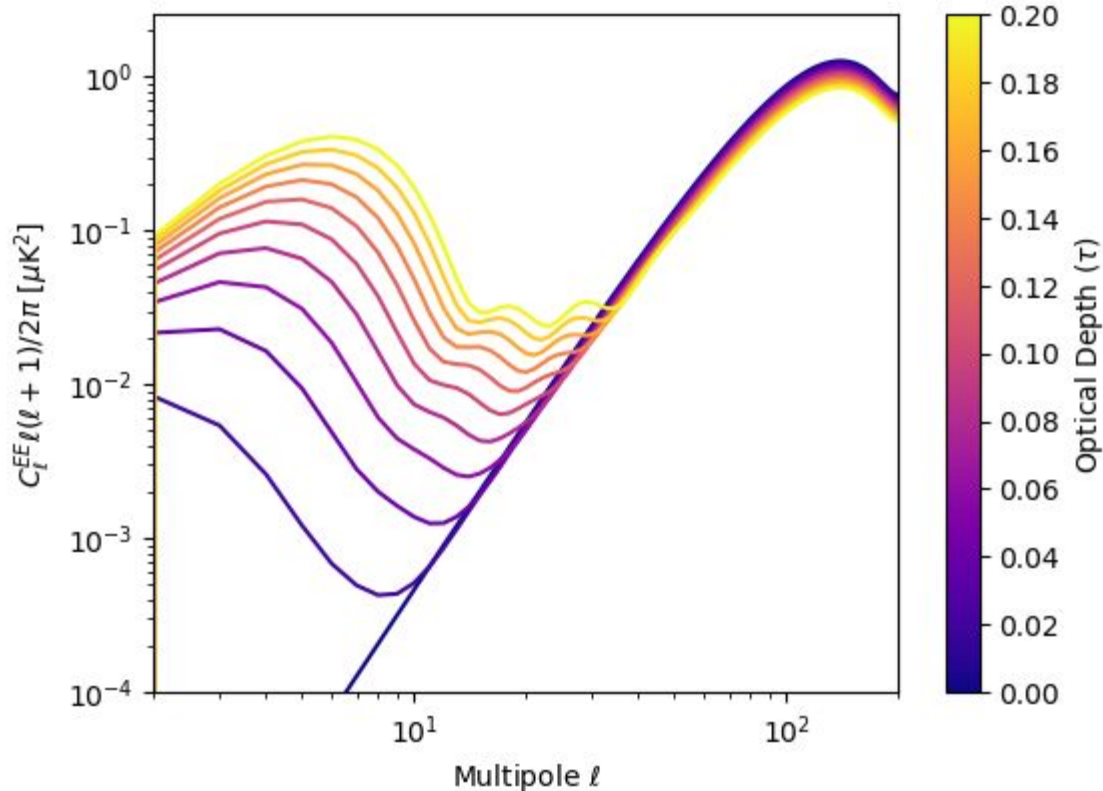
- τ optical depth



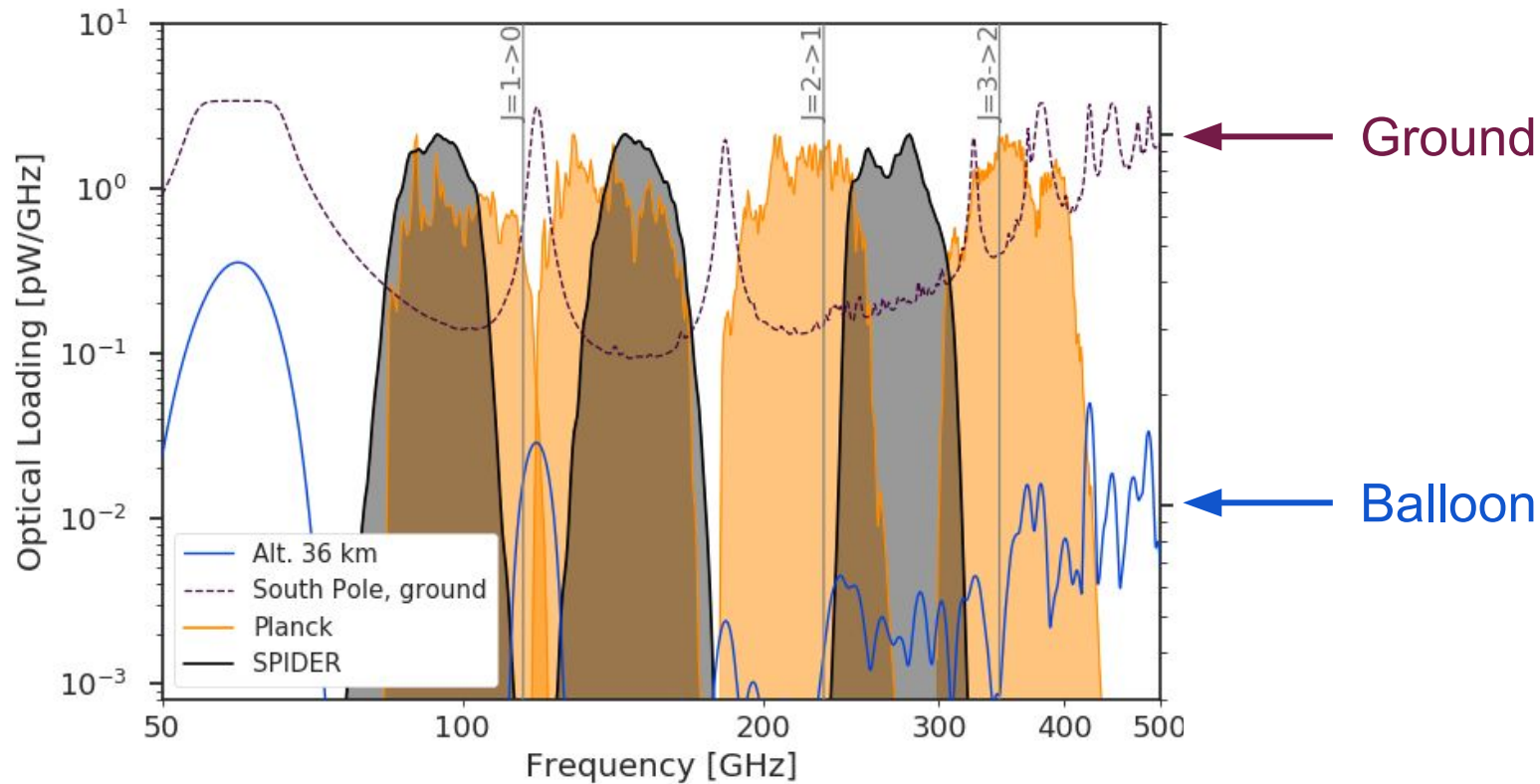
CMB E-modes and Reionization (Tau'R'Us)



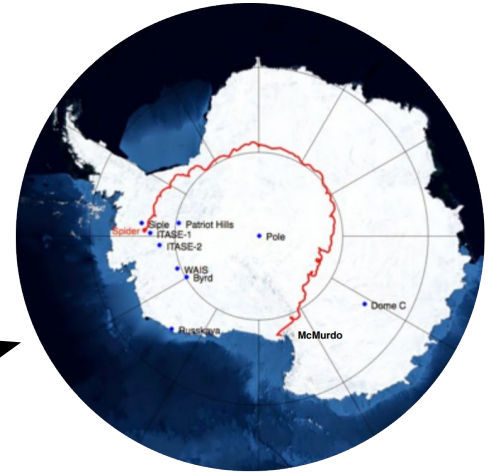
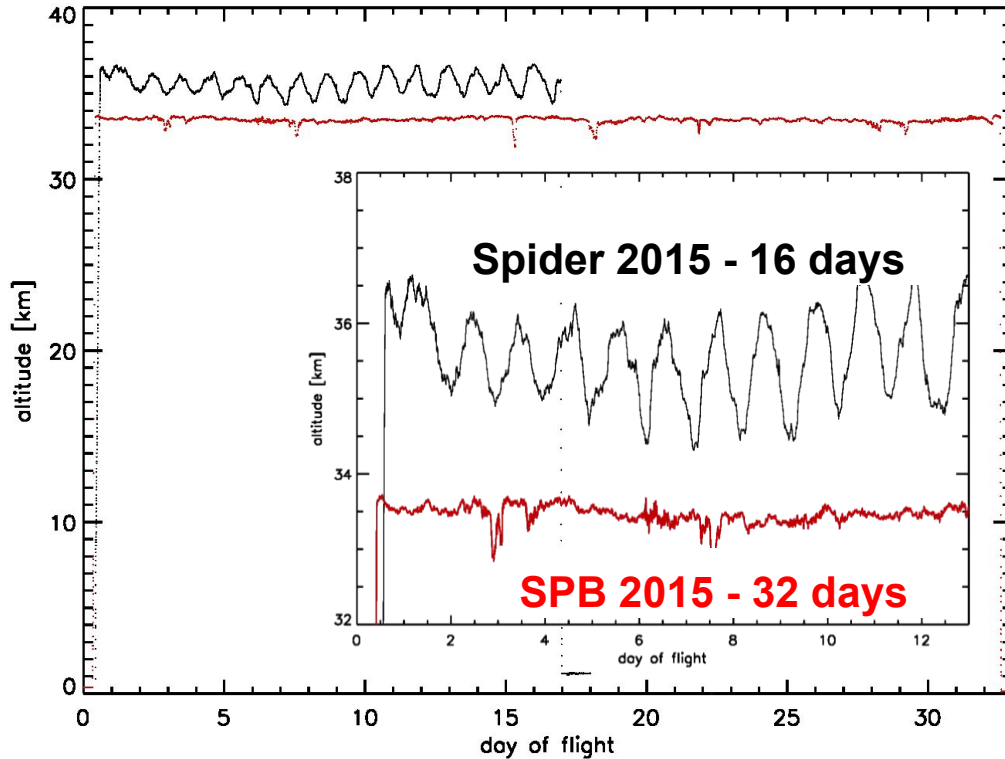
CMB E-modes and Reionization and Neutrinos



Why on a balloon? The atmosphere

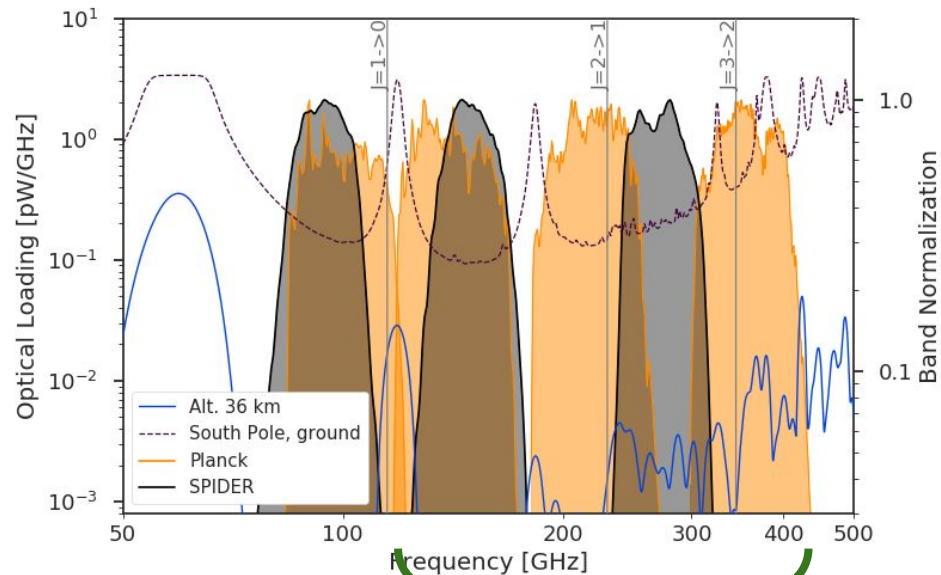


Conventional Balloon vs. Super Pressure



Conventional: zero pressure, constant daylight, diurnal He loss
Super Pressure: pressurized, day/NIGHT cycles, fixed He quantity

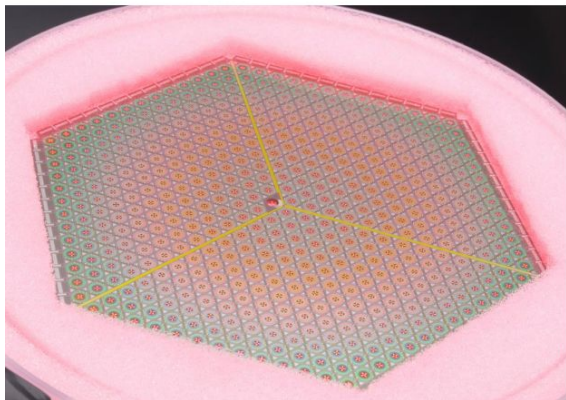
Taurus Bands



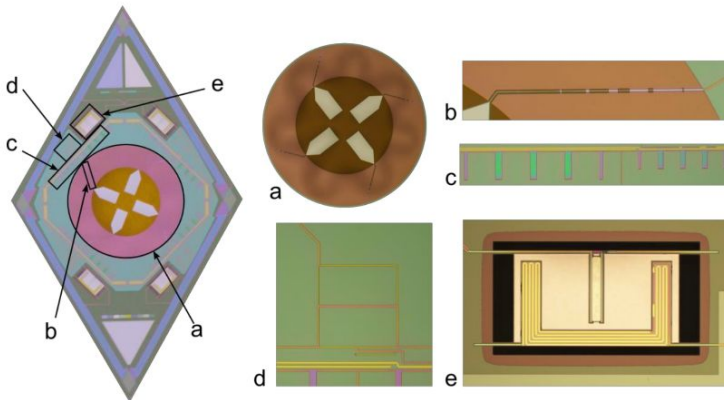
Band Center (GHz)	Bandwidth (GHz)	Beam FWHM (arcmin)	Number of Detectors	Absorbed Power (pW)	Detector Sensitivity ($\mu\text{K}_{\text{CMB}}\sqrt{\text{S}}$)	Instrument Sensitivity ($\mu\text{K}_{\text{CMB}}\sqrt{\text{S}}$)
150	40	60	3024	0.9	76	1.5
220	55	40	3024	1.1	123	2.4
280	70	60	2016	1.4	220	5.4
350	85	50	2016	1.6	550	13.4

Taurus Detectors (NIST)

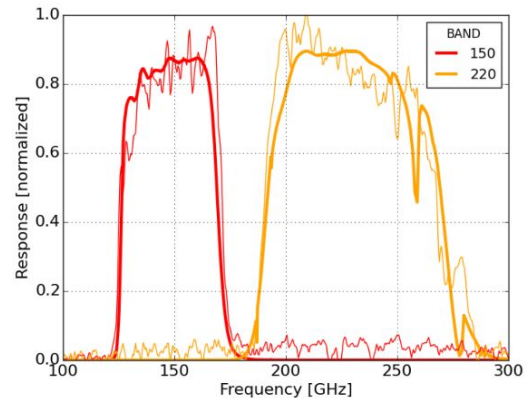
(a)



(b)

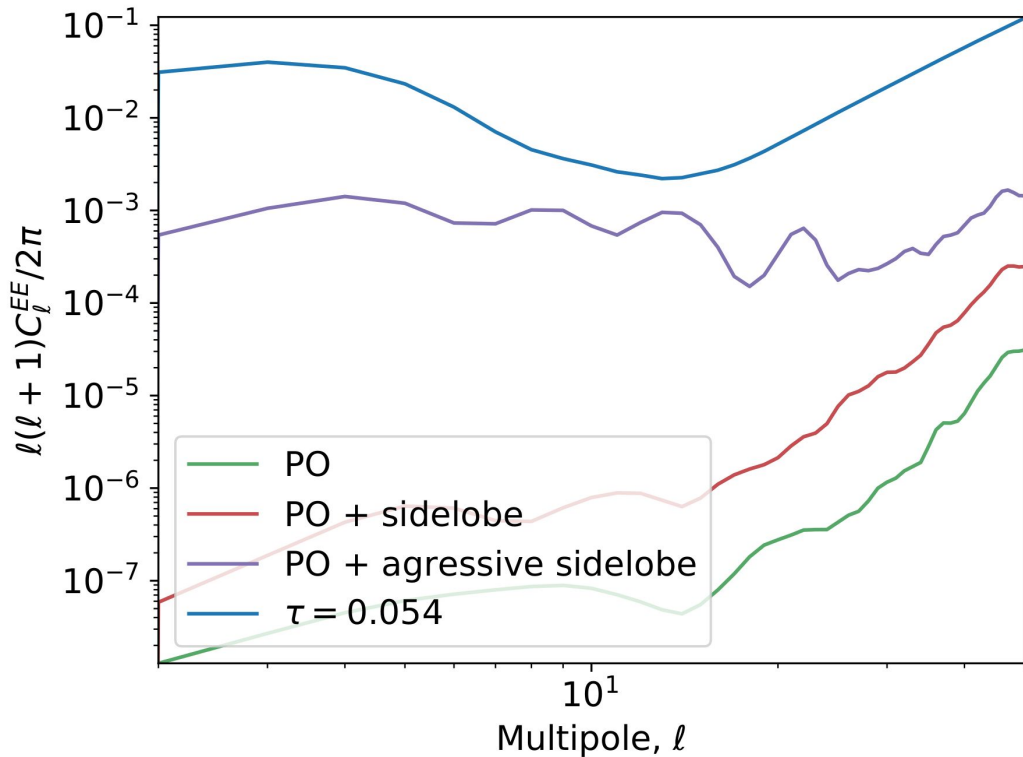
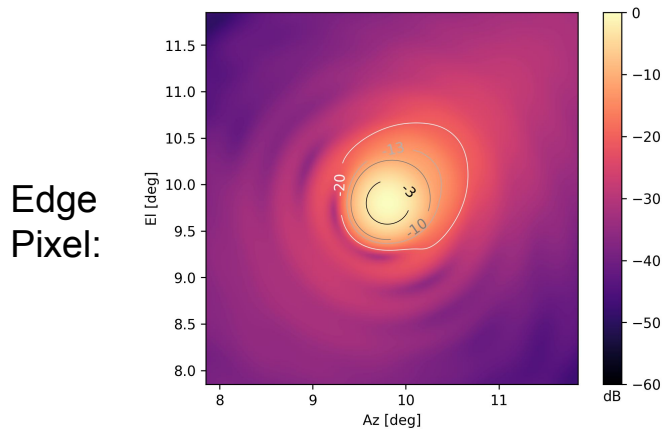
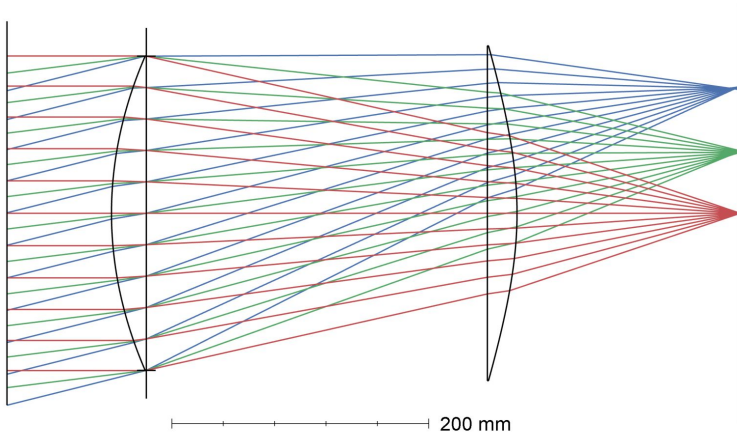


(c)

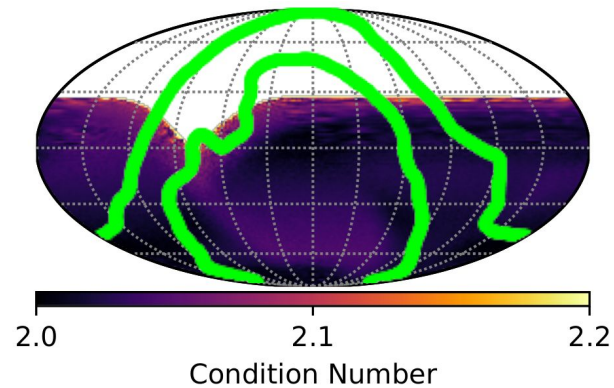
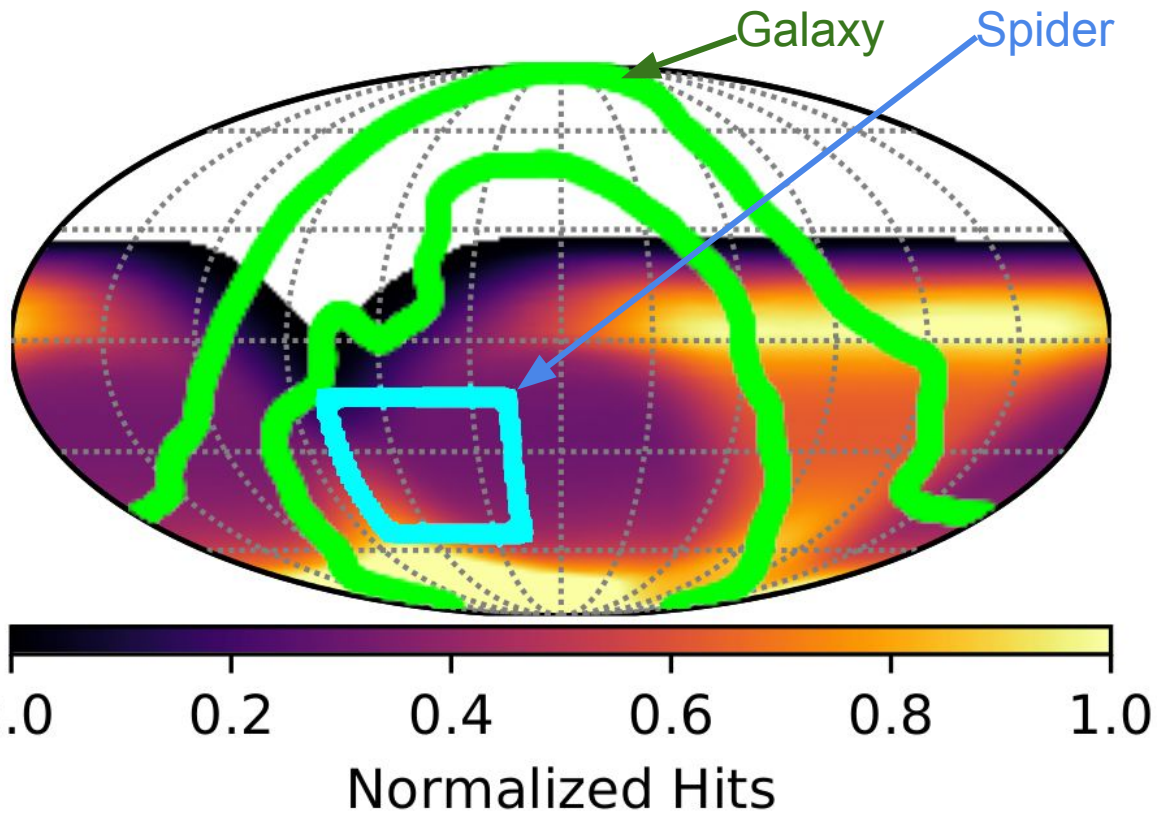


- ~10k 100 mK TESes. Dichroic 150/220 and 280/350 GHz
- Corrugated feed horns, stacked silicon wafers
- Time-domain multiplexed readout

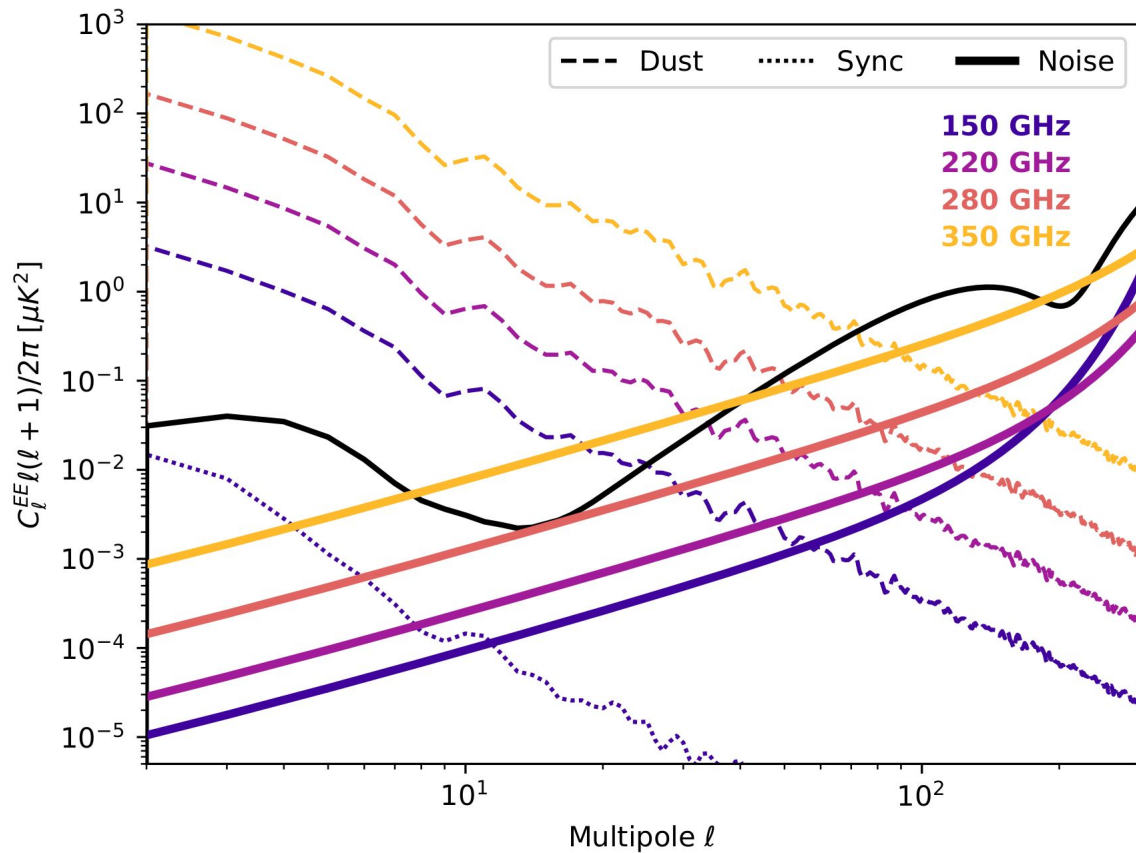
Taurus Optics



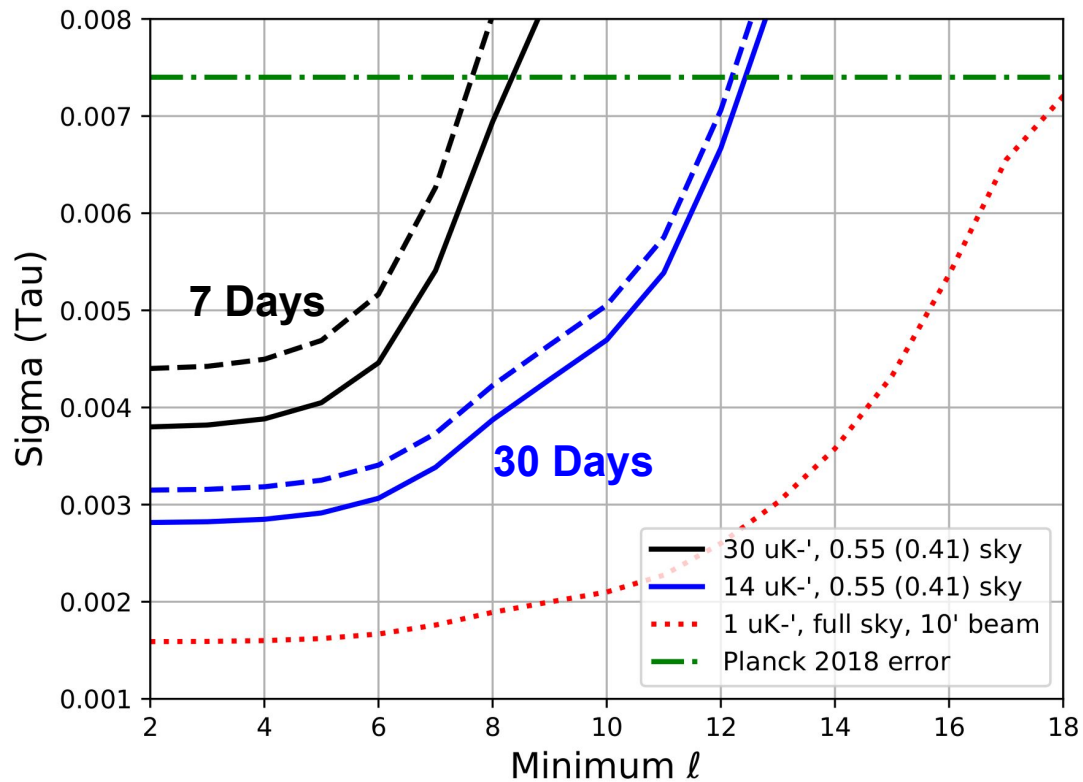
Taurus Sky Coverage: 70%



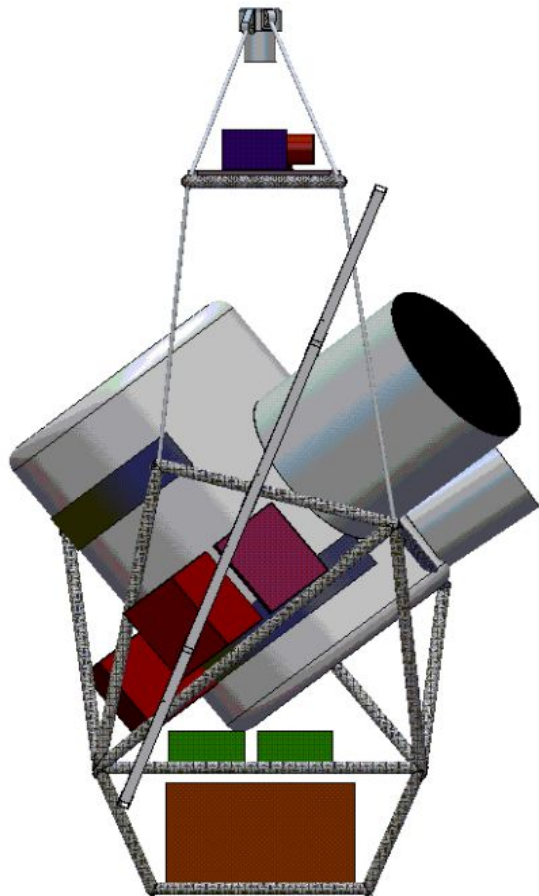
High Frequencies: Separating Dust



Projected Limits



Thank you! (and Taurus people)



Steven Benton (PI)
Bill Jones
Aurelien Fraisse

Princeton

Jeff Filippini

UIUC

Hannes Hubmayr
Jake Connors
and more

NIST

Johanna Nagy

WUSTL

Jon Gudmundsson

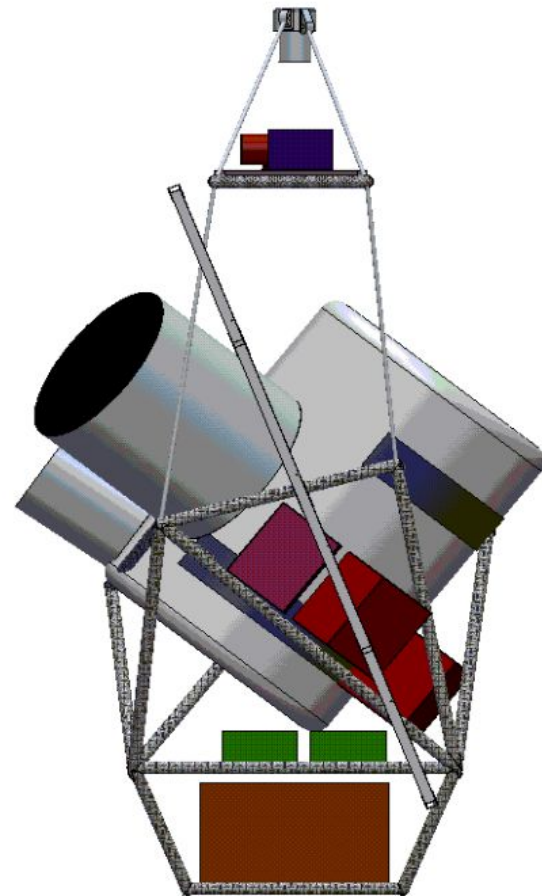
Stockholm

Barth Netterfield
StarSpec Tech.

Toronto

Sasha Rahlin

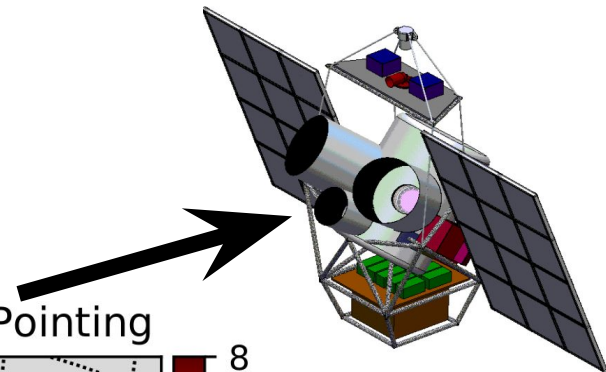
FNAL



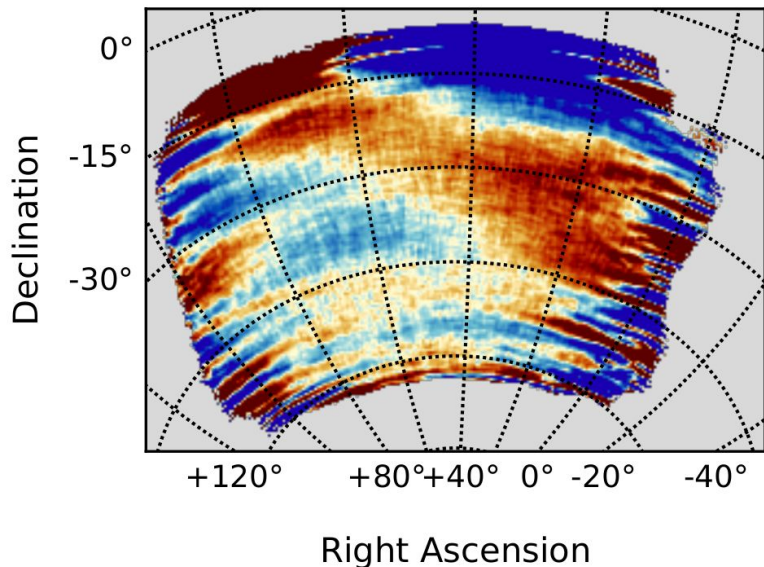
Extra Slides (hindsight)



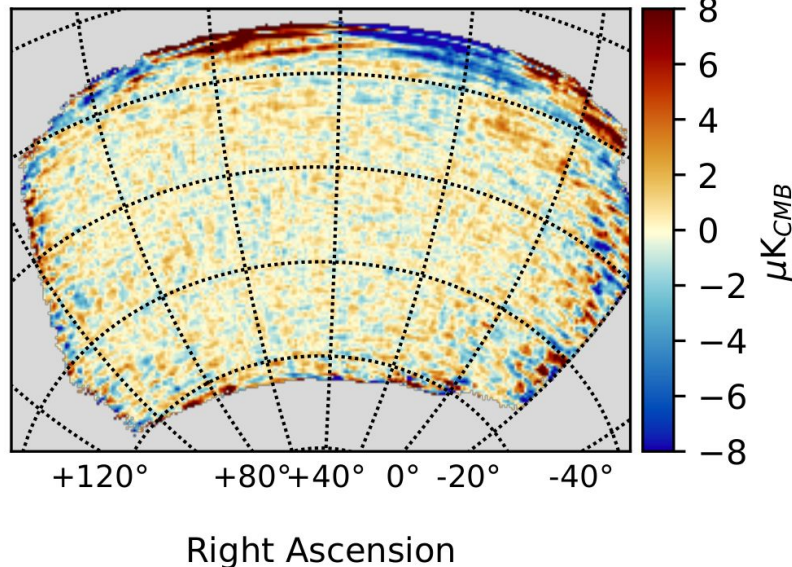
Scan-Synchronous Noise Mitigation



Q Simulation - Co-Pointed



Q Simulation - Offset Pointing



... also more sky rotation and better scan strategy

Stratospheric Balloons

