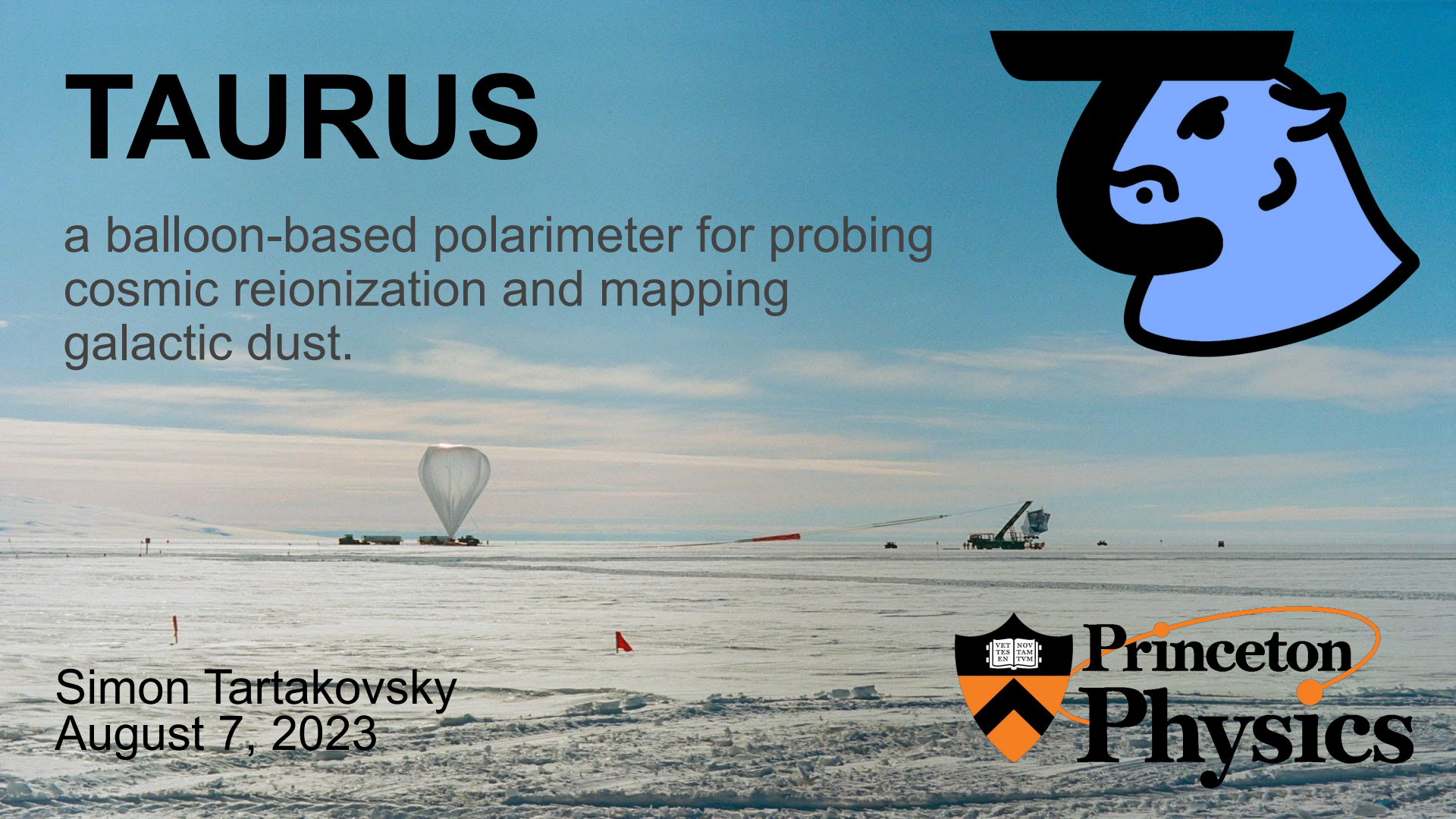
TAURUS

a balloon-based polarimeter for probing cosmic reionization and mapping galactic dust.

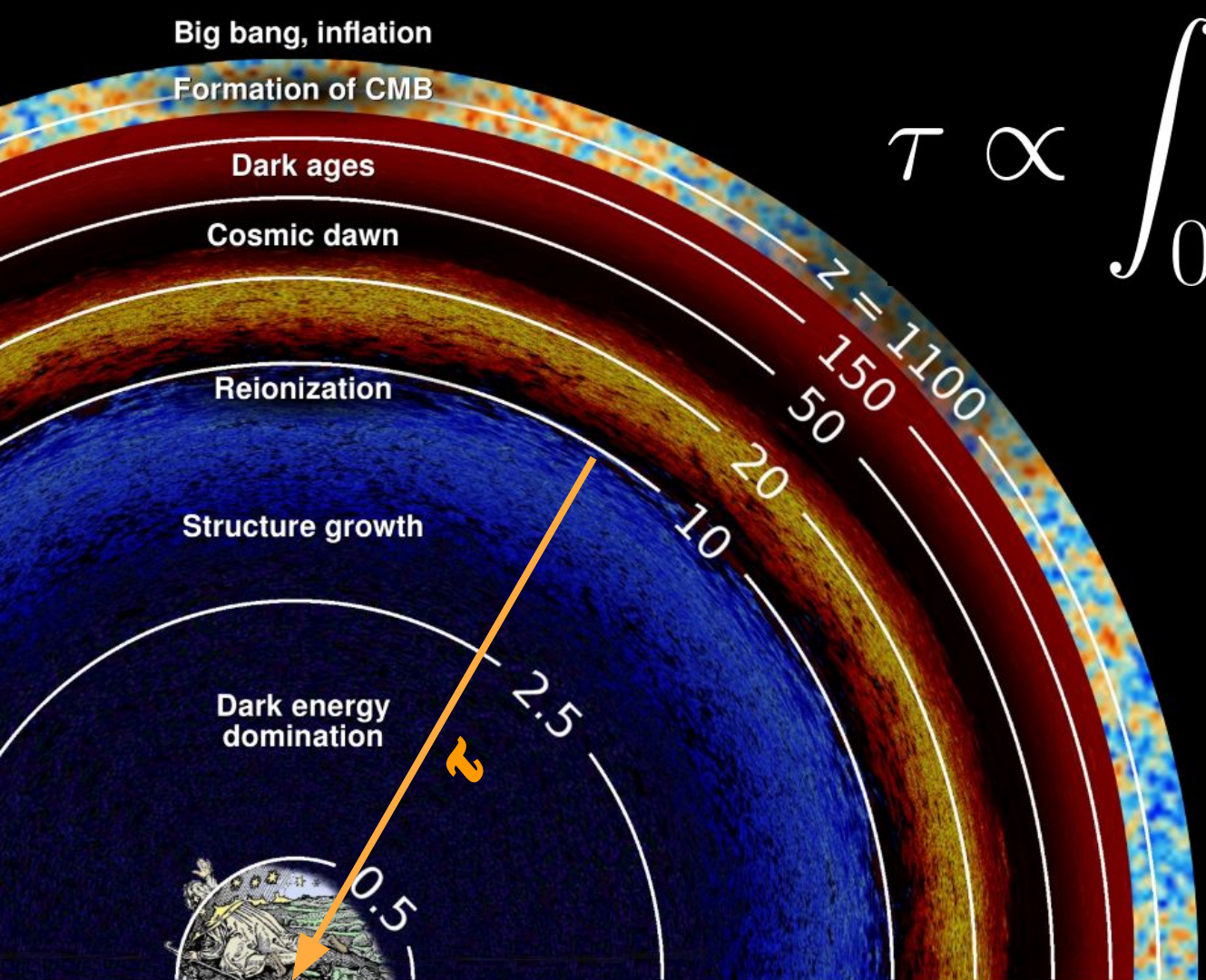


Simon Tartakovsky
August 7, 2023

Princeton Physics

Outline

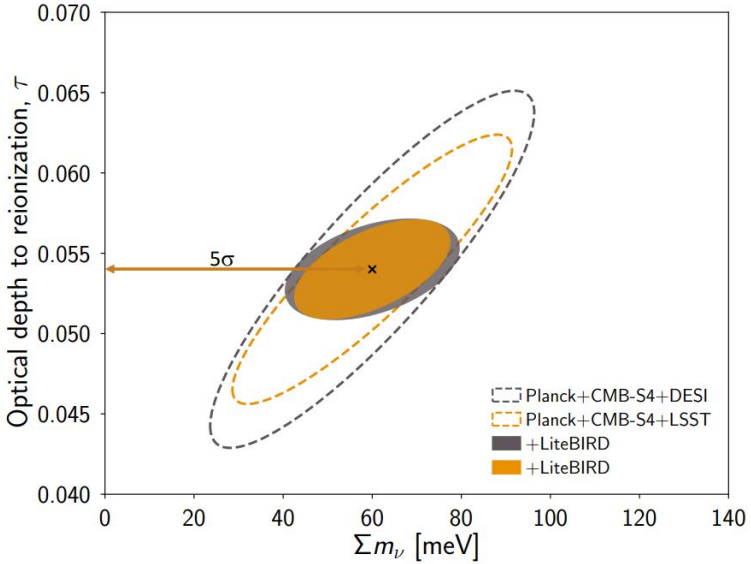
- What is Tau
- Expected Impacts
- How to measure Tau - Polarization at large angular scales
  - Large angular scales
  - Dust maps
  - High frequency receivers
- Introducing Taurus
  - Super pressure balloons
  - Scan Strategy
  - Detectors
- Forecast

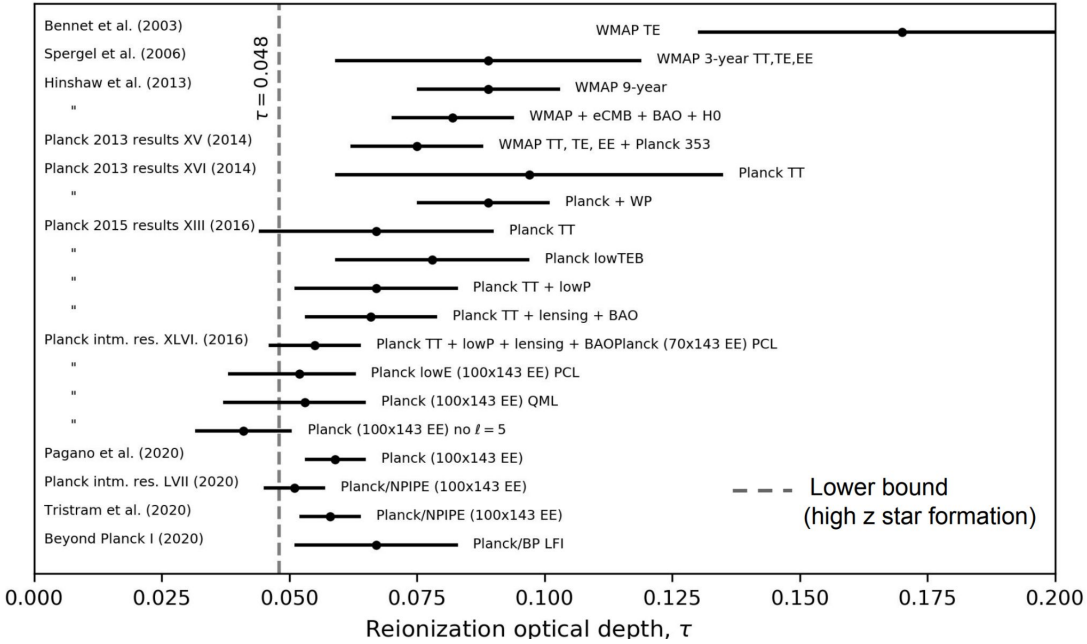


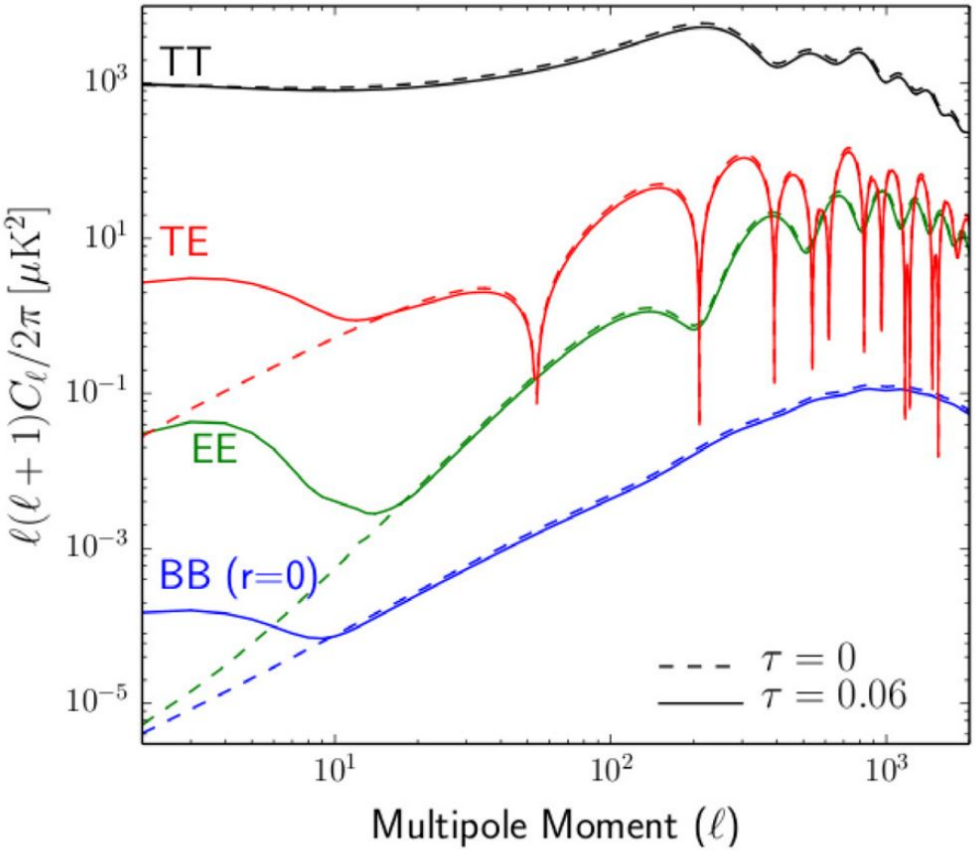
$$\tau \propto \int_0^z n_e(z')dz'$$

H.C. Chiang

Expected Impact

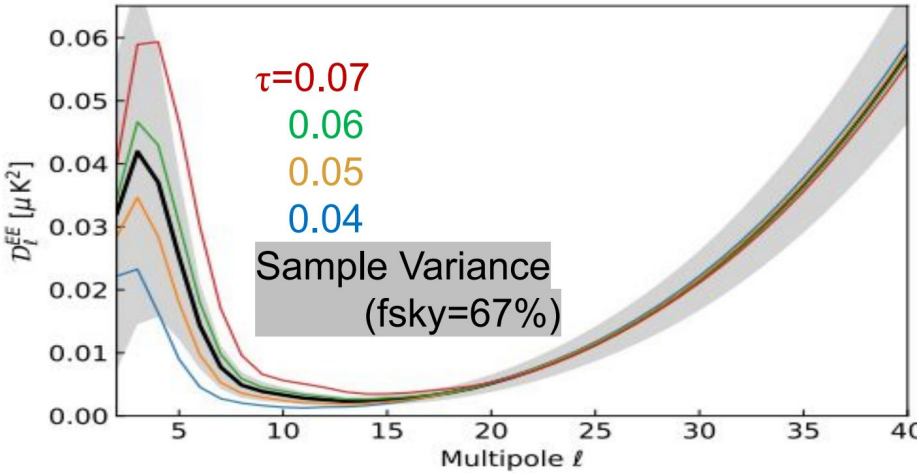






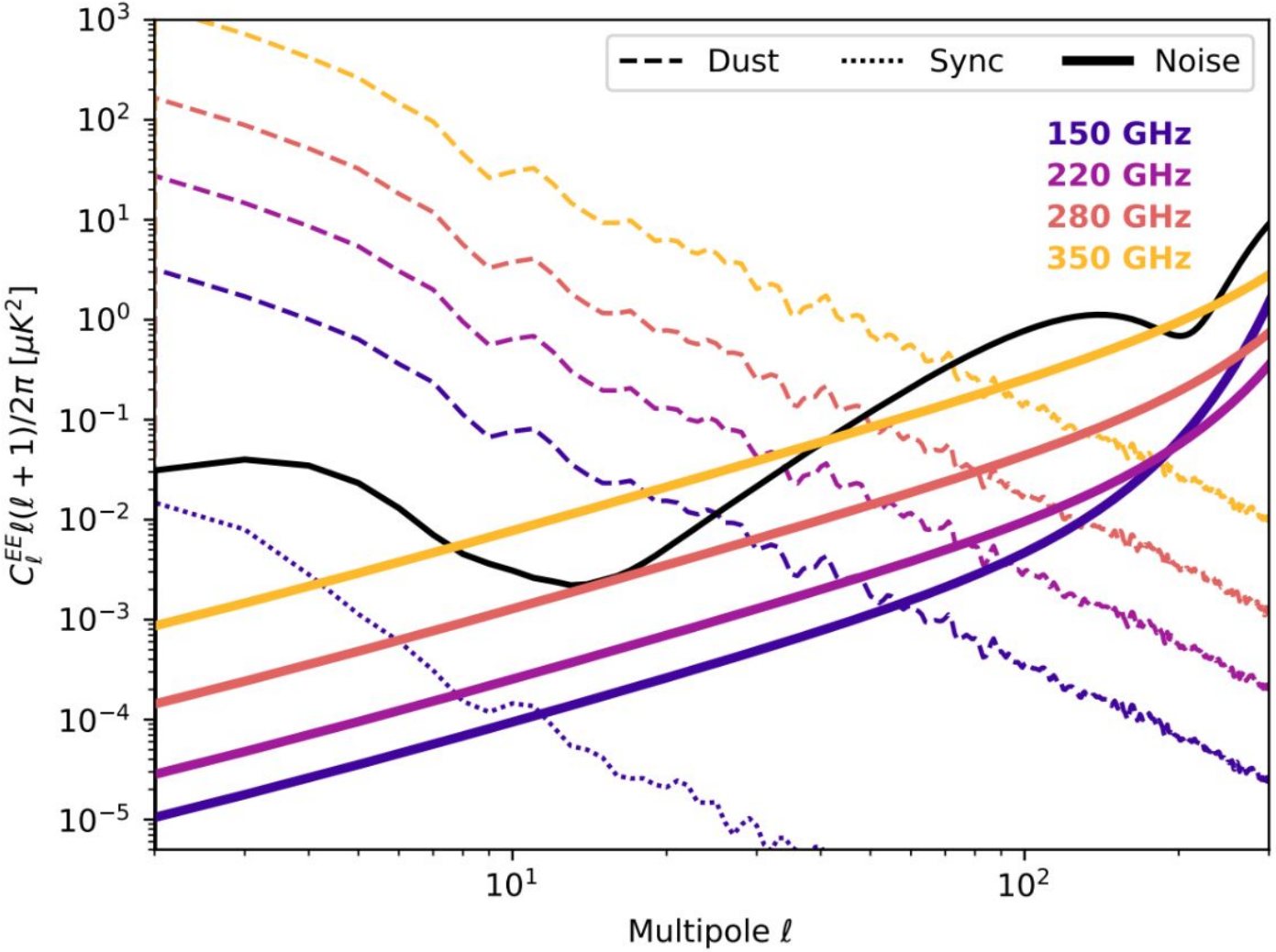
Tau most noticeable at large angular scales in polarization maps.

Key to good measurement is large sky coverage and systematic mitigation.



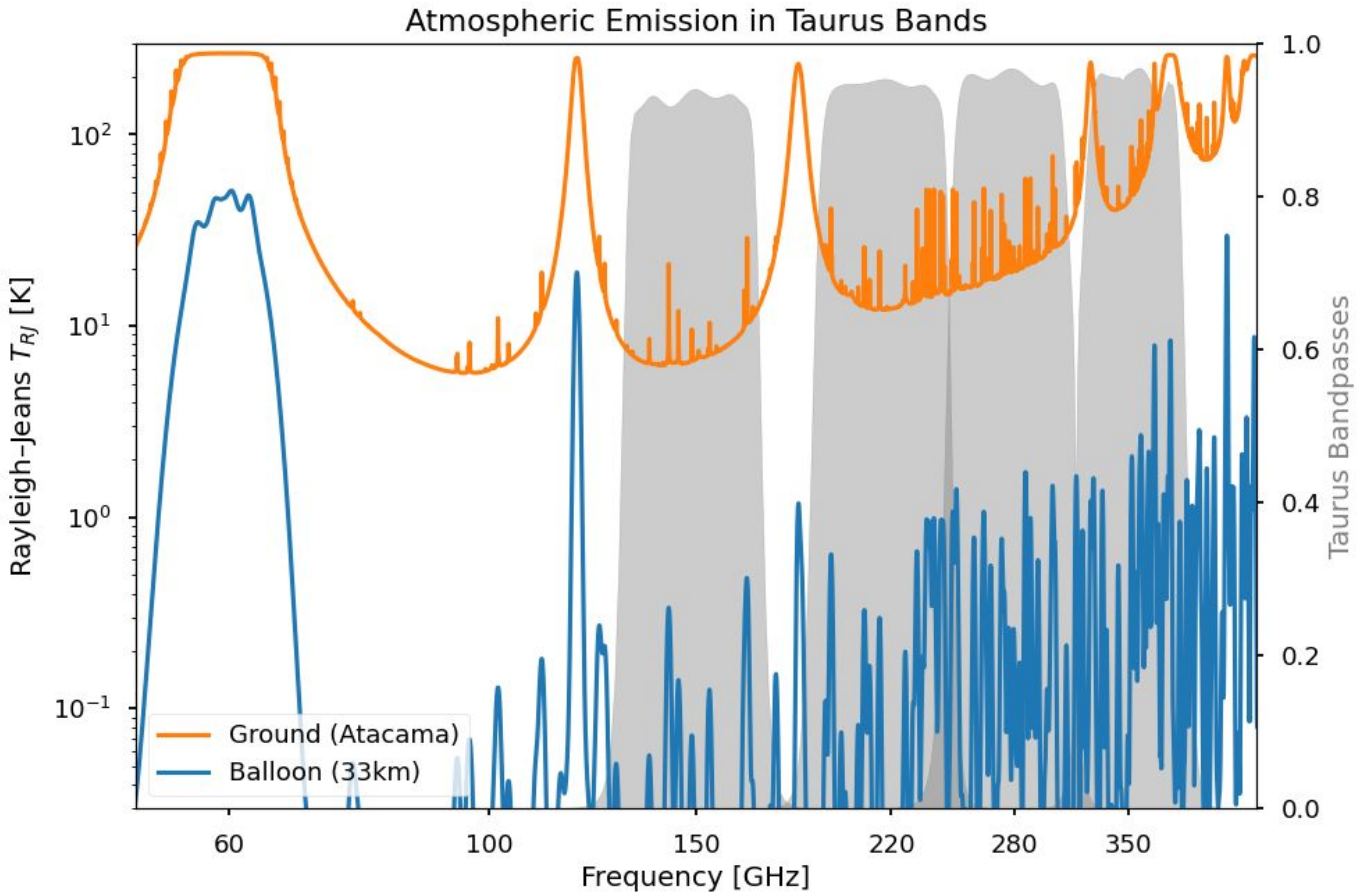
Staggs et al.

Planck Collab



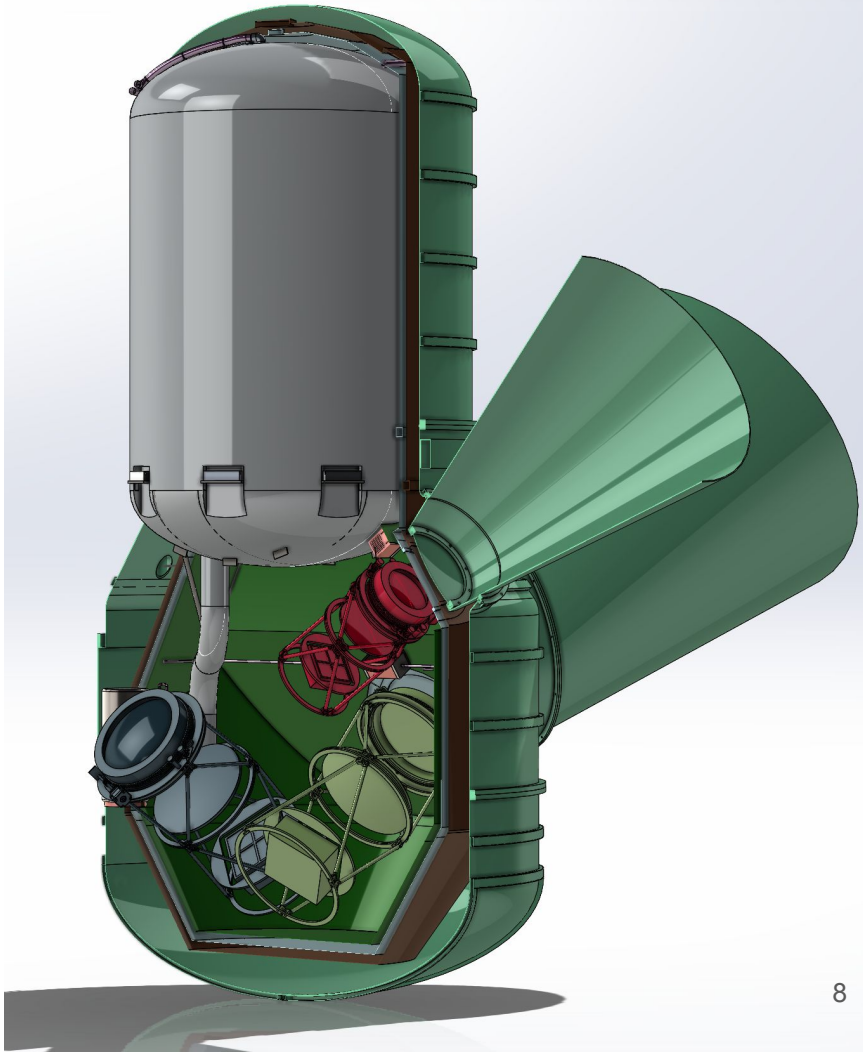
Galactic Dust dominates signal at large angular scale.

Mapping dust is critical, best done at high frequency.


Atmospheric Emission in Taurus Bands
Rayleigh-Jeans T_{RJ} [K]
10^2
10^1
10^0
10^{-1}
Taurus Bandpasses
1.0
0.8
0.6
0.4
0.2
0.0
Ground (Atacama)
Balloon (33km)
60
100
150
220
280
350
Frequency [GHz]

Tau“R”Us

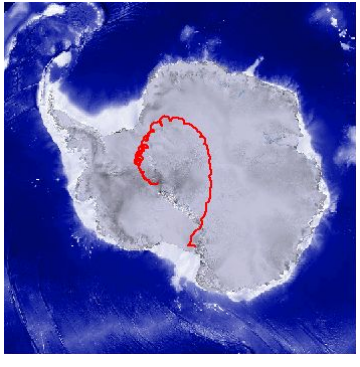
- Cryogenic balloon payload
  - Liquid He cryostat
  - Transition Edge Sensors (TES) cooled to 100mK with dilution fridge
- Low ℓ
  - Systematic mitigation scan strategy
  - 70% sky coverage
- Dust mapping
  - 4 bands: (150-220) and (280-350)GHz
- 3 telescopes: 2 LF and 1 HF
- 50 day flight (2026-7)



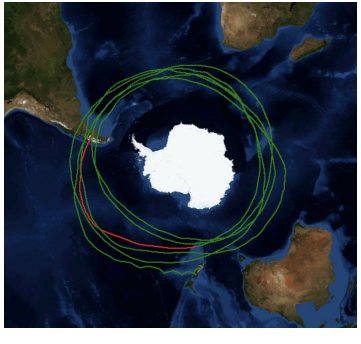
NASA Super Pressure Balloon

Mid-latitude flight with day-night cycle. Balloon is sealed so it does not deflate with temperature cycles

ULDB ~ 30 days

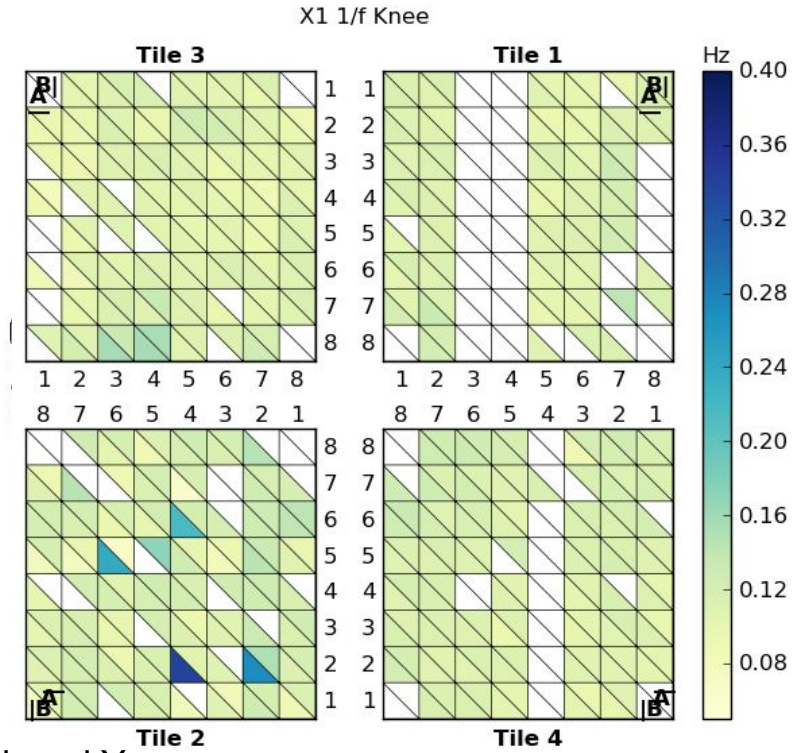


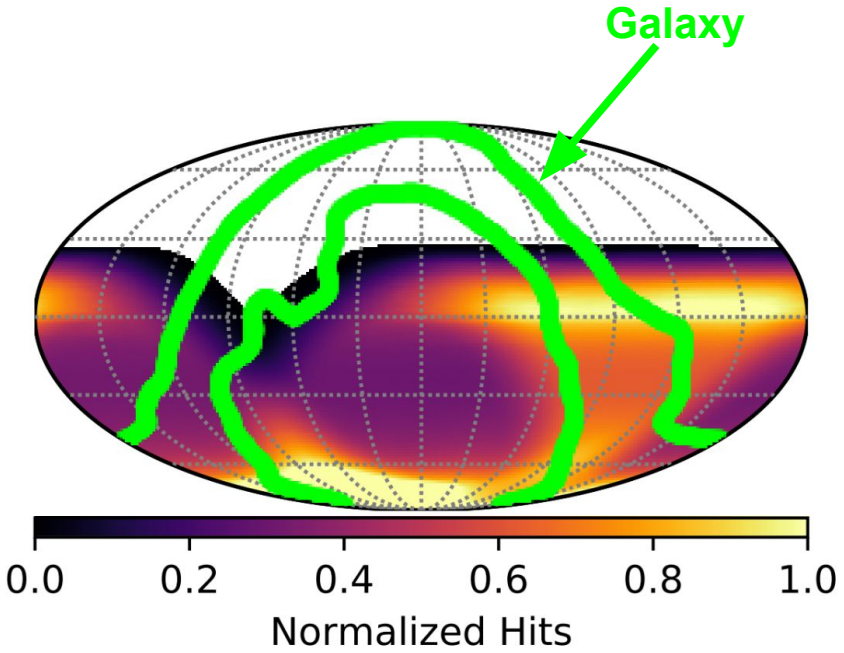
SPB ~ 50 days



Scan Strategy

Sky modulation - 70% sky coverage

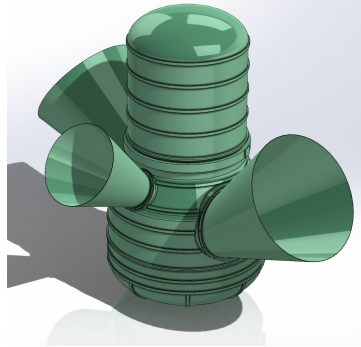


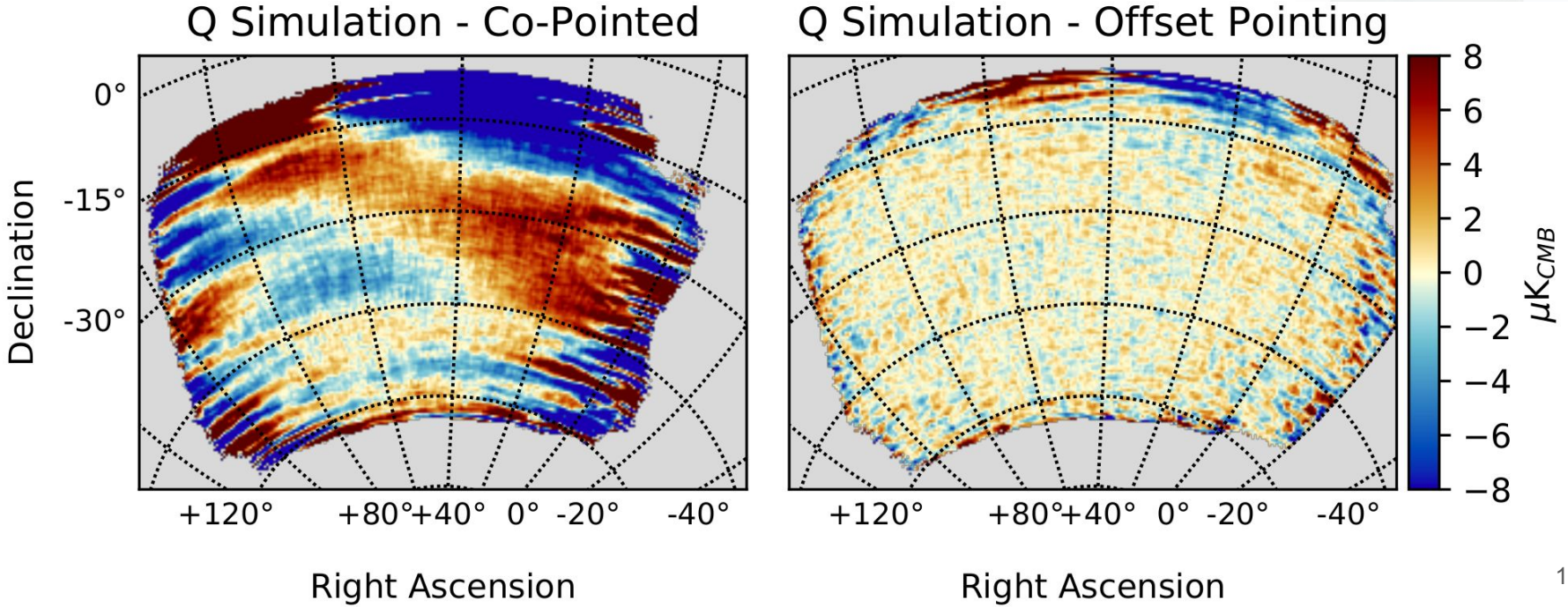


Edward Young

Scan Strategy

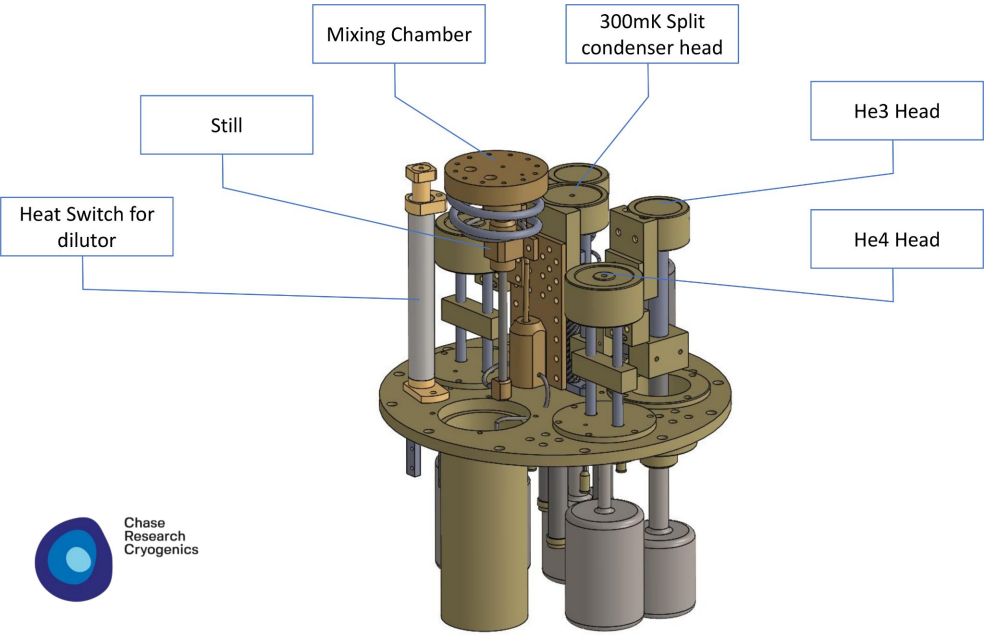
Depointed receivers



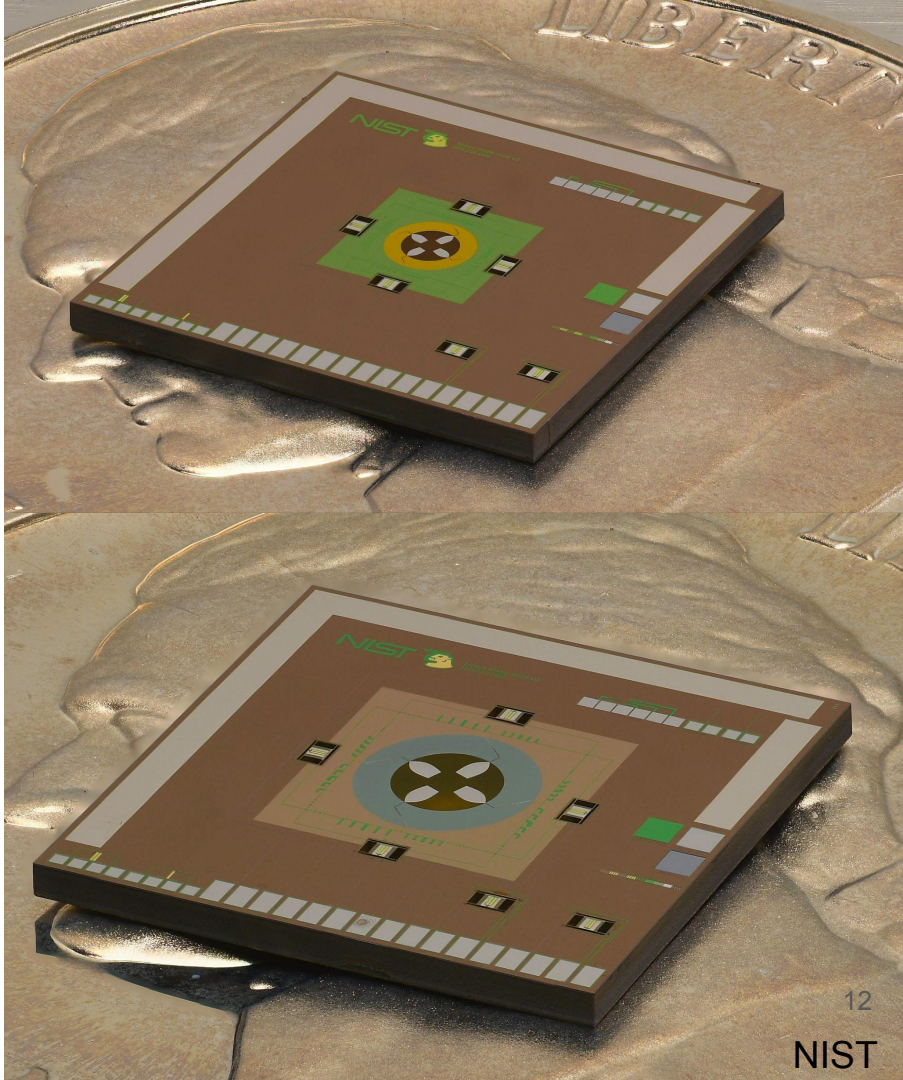


Detectors + DR

- 10k TESes. Dichroic 150/220 and 280/350 GHz
- Cooled to 100mK by dilution refrigerator

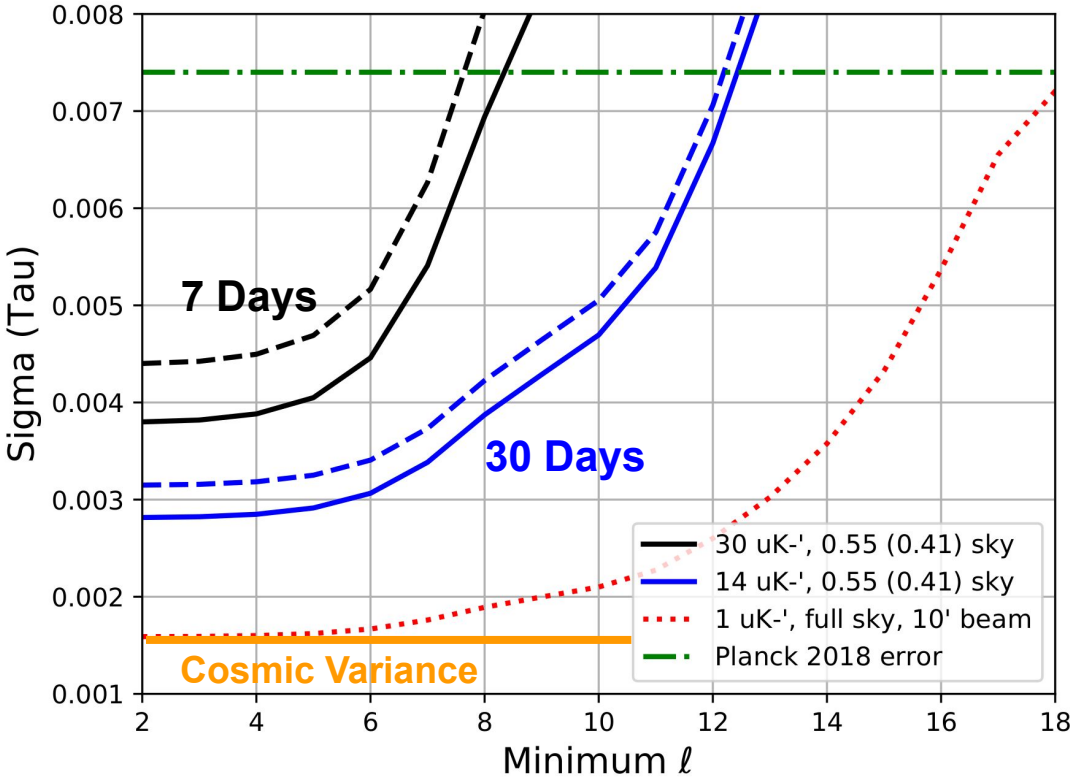


Chase Research Cryogenics



NIST

Forecasts



- **Large scales**
  - 70% sky coverage
  - Low ℓ systematics mitigation
  - Long observation time
- **Dust mapping**
  - High fidelity dust maps - 350 GHz detectors

Thank you