ALEXANDRA RAHLIN

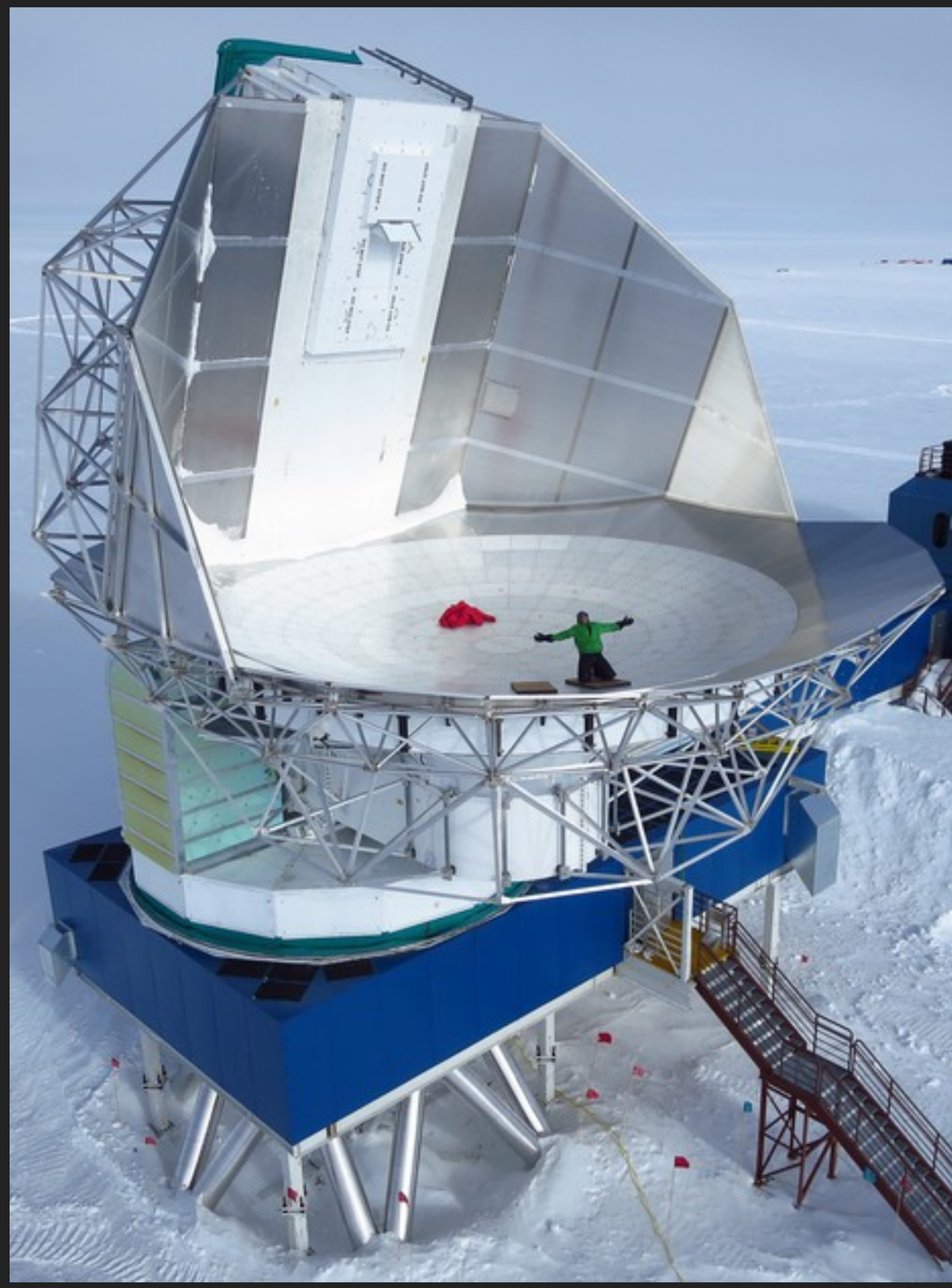
Fermilab

SPT3G: THE 3RD GENERATION RECEIVER FOR THE SOUTH POLE TELESCOPE

NORDITA | 2017 July 20

THE SOUTH POLE TELESCOPE

- 10-m sub-mm quality wavelength telescope
  - 100, 150, 220 GHz
  - 1.6, 1.2, 1.0 arcmin resolution



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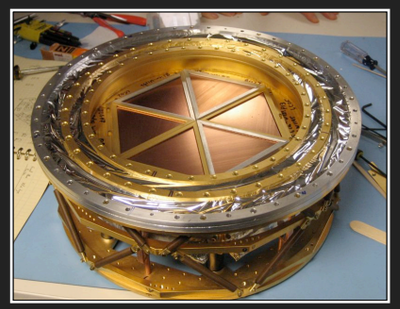

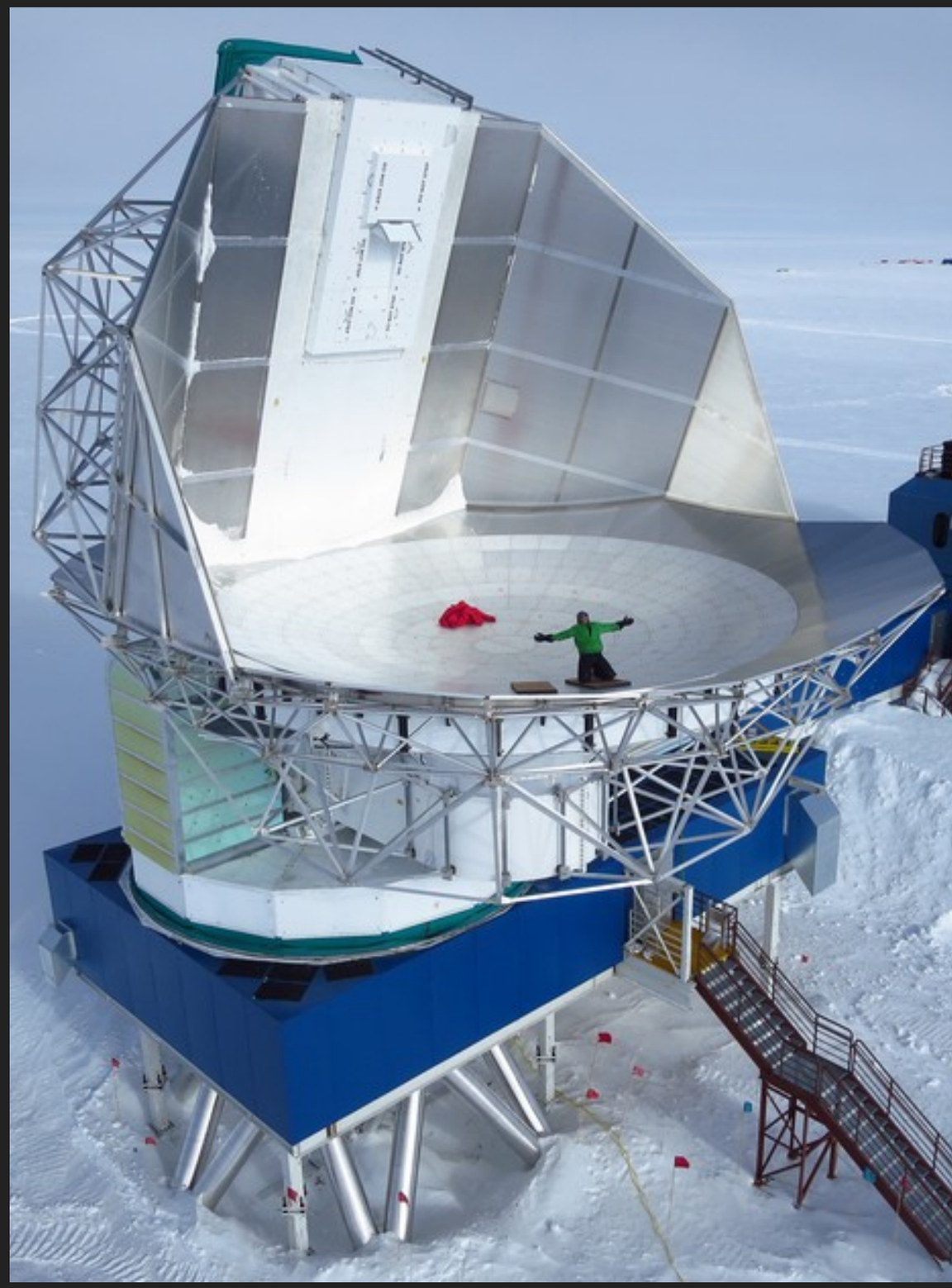

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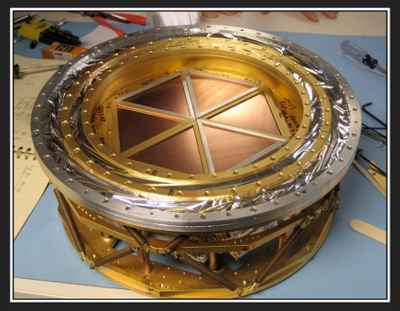
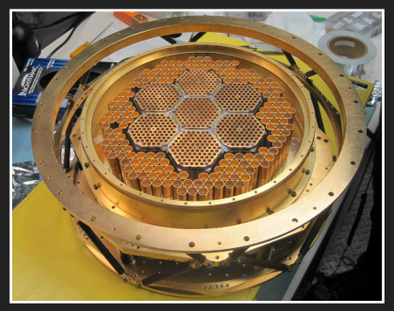
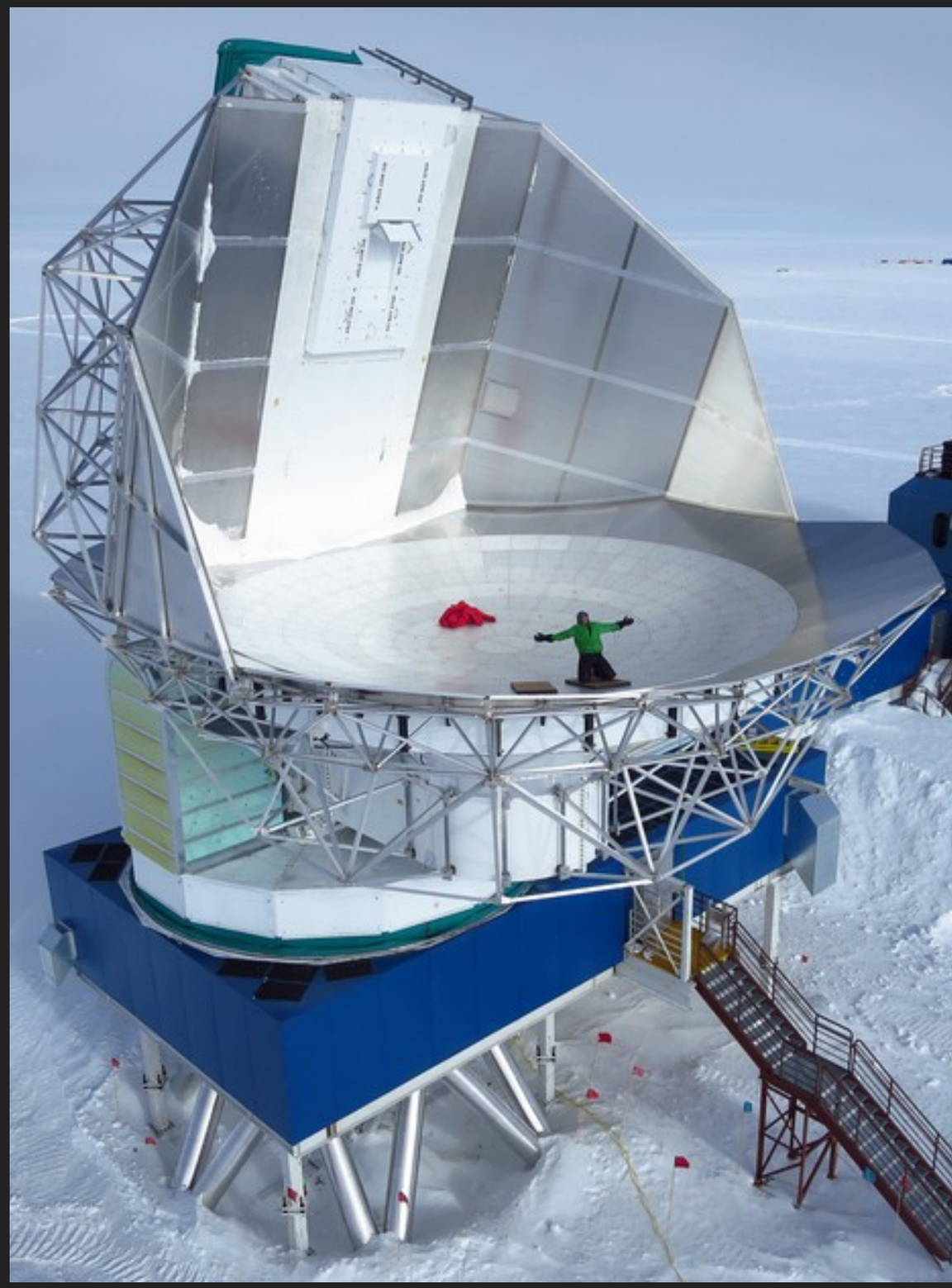
- 2012: SPTpol
  - 1600 detectors
  - 100, 150 GHz
  - +polarization







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- 2017: SPT-3G
  - ~16,200 detectors
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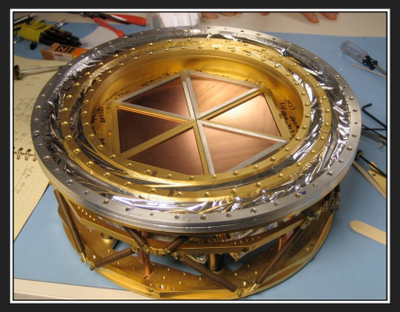
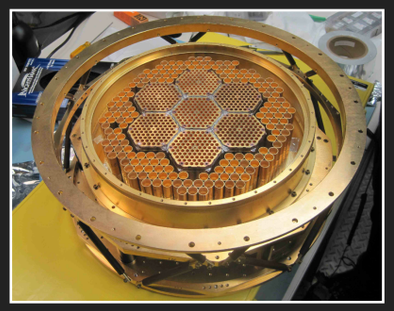
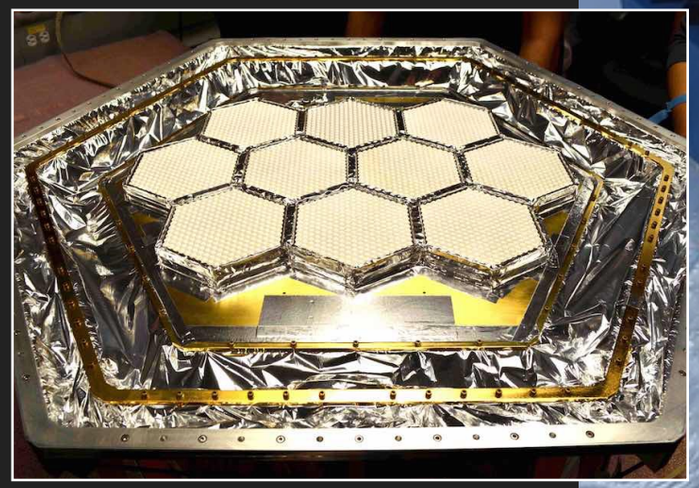
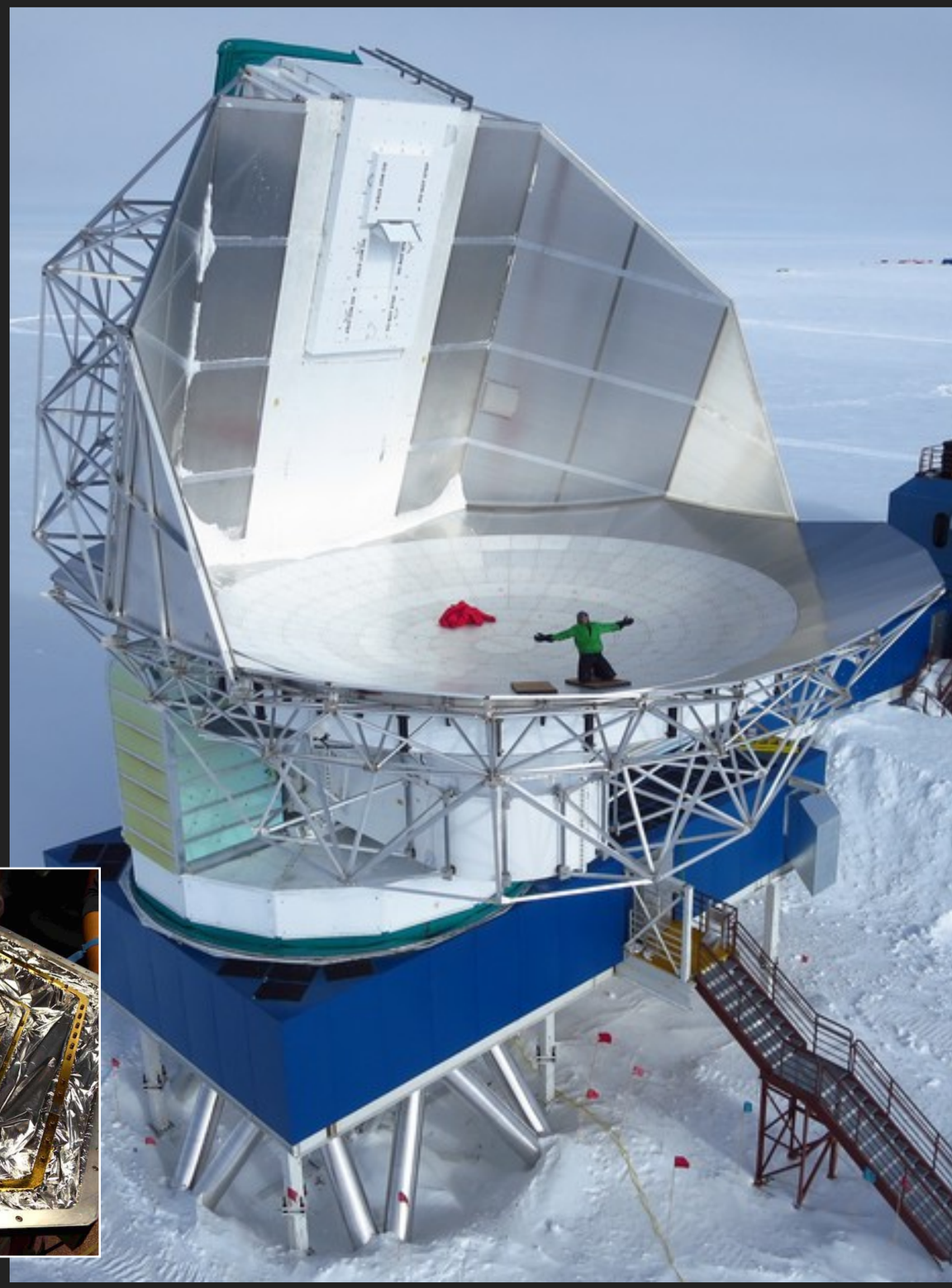








SPT/PLANCK TT COMPARISON

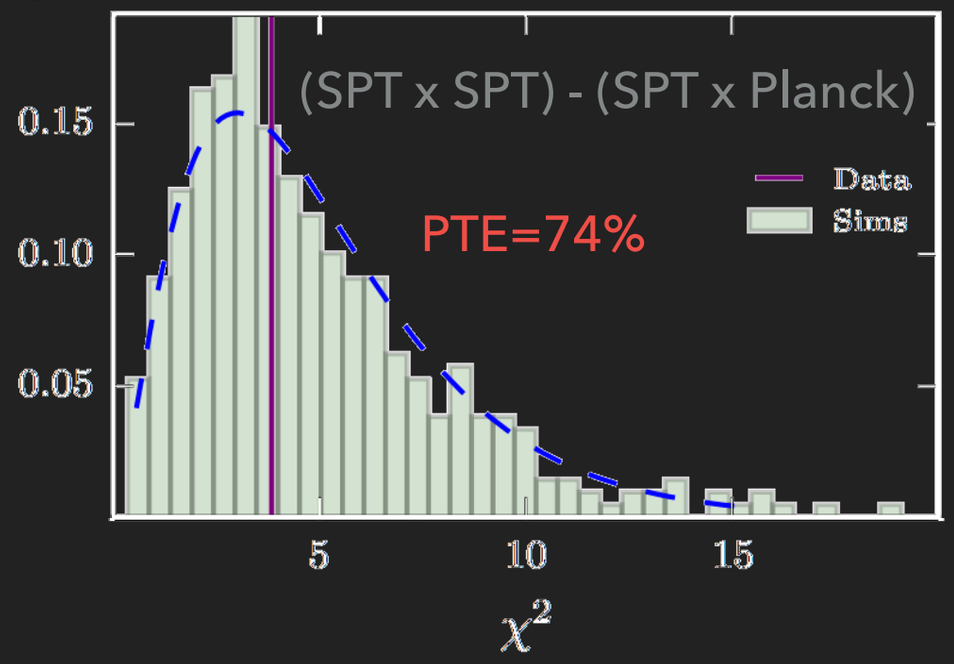
Aylor, Hou, Knox, Story, et. al (arXv:1706.10286)
Hou, Aylor, et. al (arXv:1704.00884)

1. When Planck and SPT are restricted to measure the same modes on the sky (SPT-SZ patch between 650 < ell < 2000), the resulting cosmological parameters are fully consistent.

2. The observed tension between Planck on the full sky and SPT arise from both sky area and from the data above ell > 2000 measured by SPT.

3. The high-ell SPT data (between 2000 < ell < 3000) drive shifts away from Planck full sky in the two density parameters $\Omega_m h^2$ and $\Omega_b h^2$ - and therefore H_0.

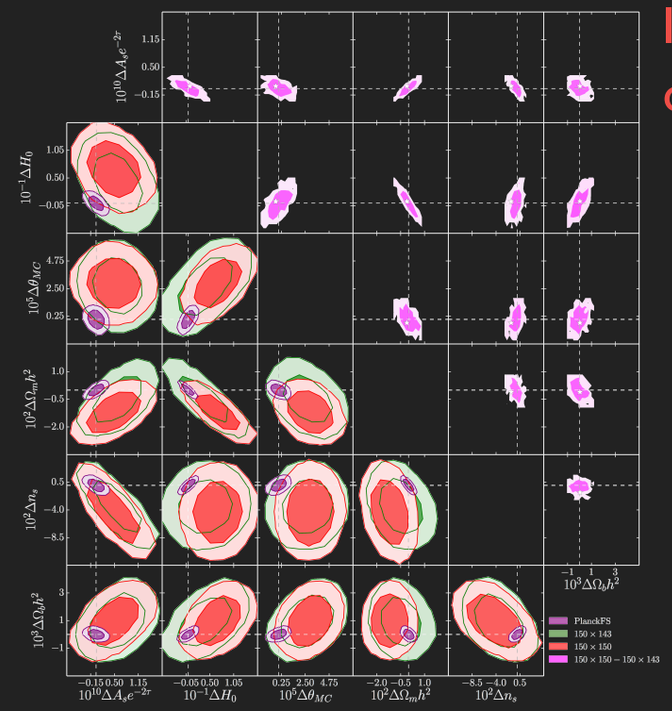
χ^2 for differences in ΛCDM parameters



Parameter differences

In-patch comparison

Planck FS vs SPT



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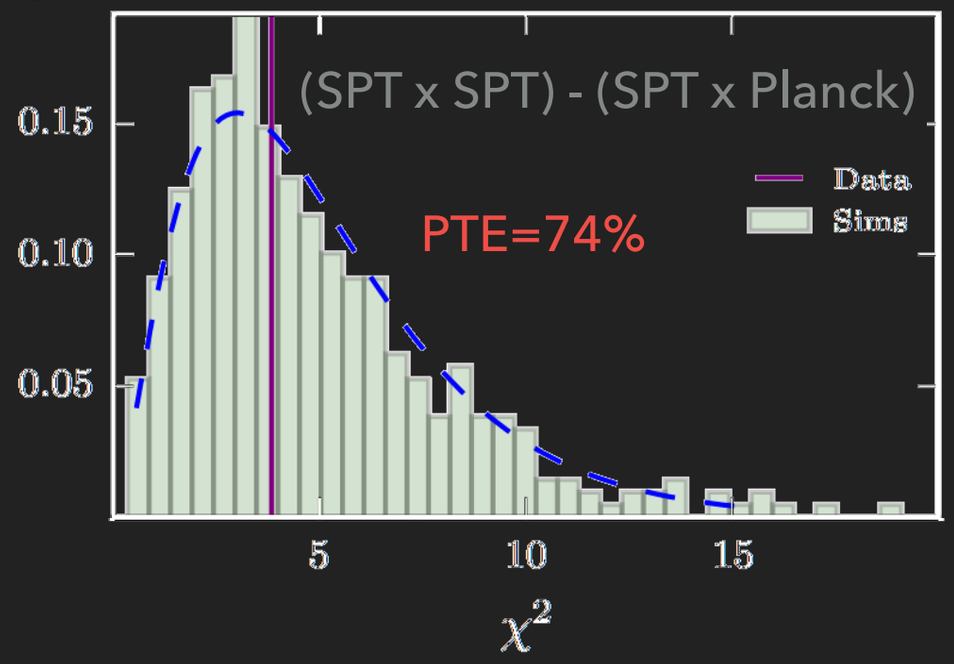

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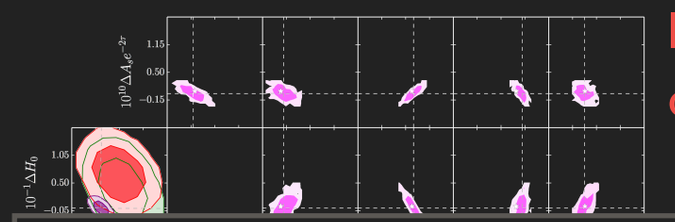
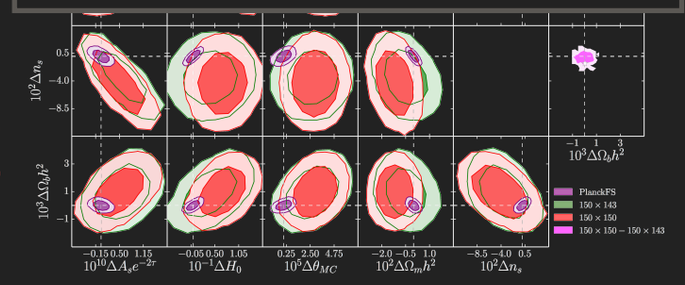
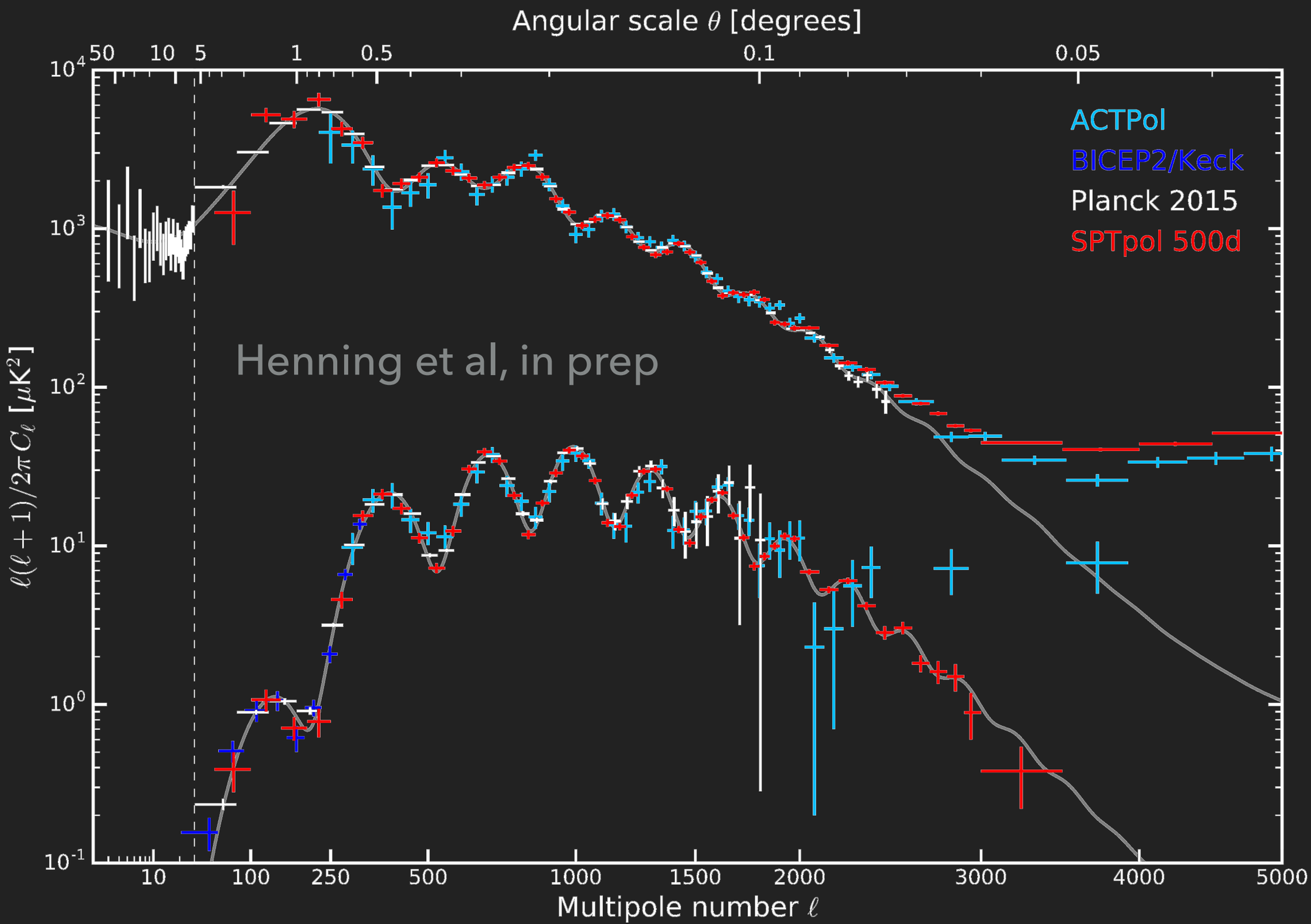


This test is 300 times more precise than comparing to full-sky.

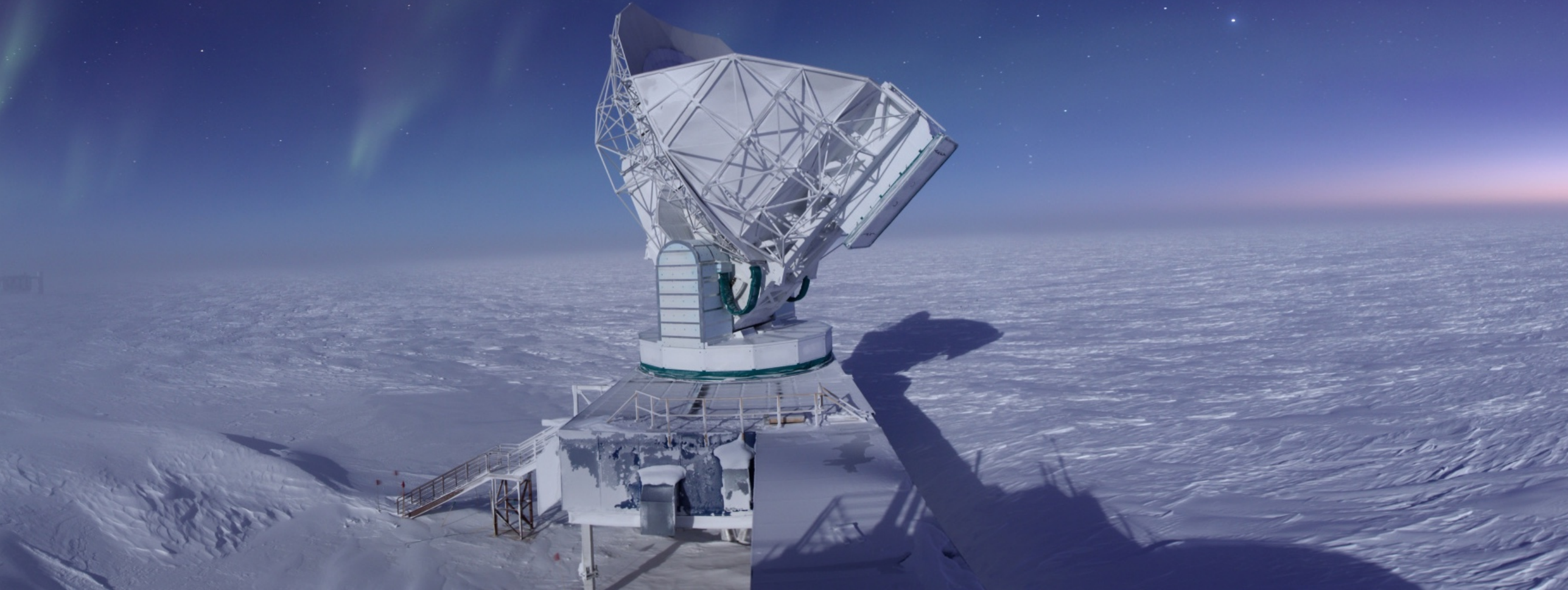
Planck FS vs SPT



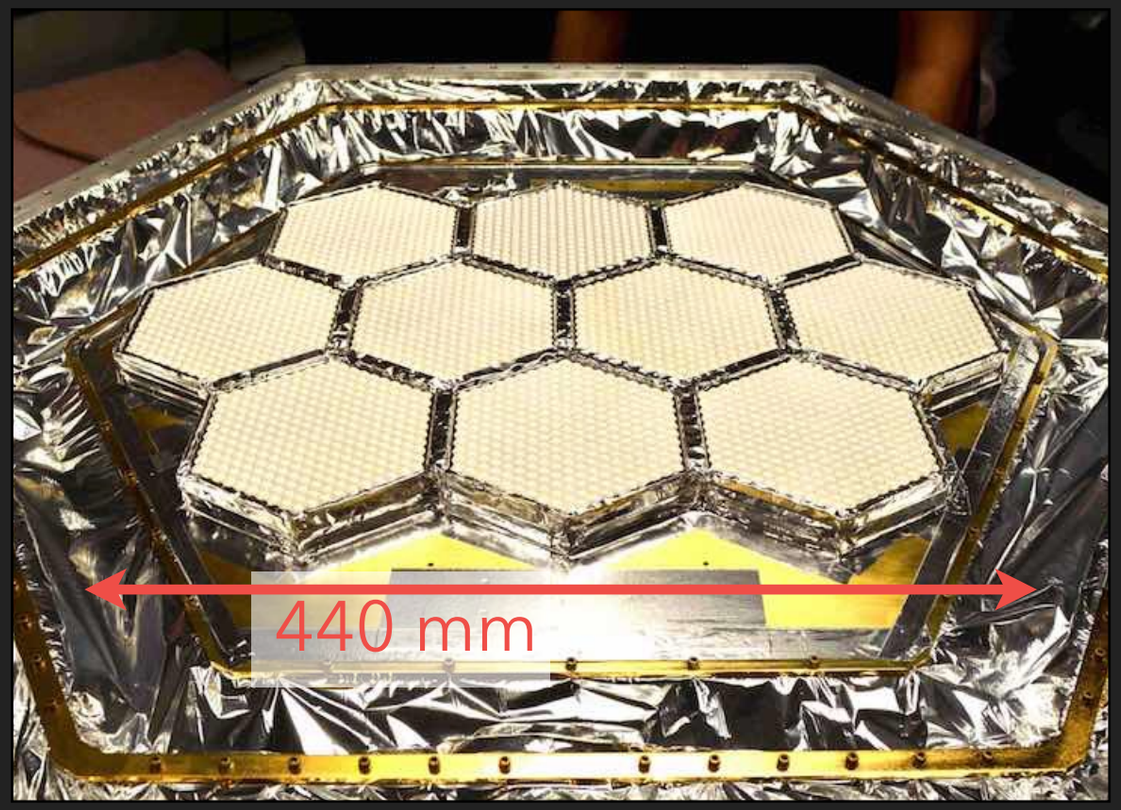
SPTPOL 500D SURVEY



SPT3G

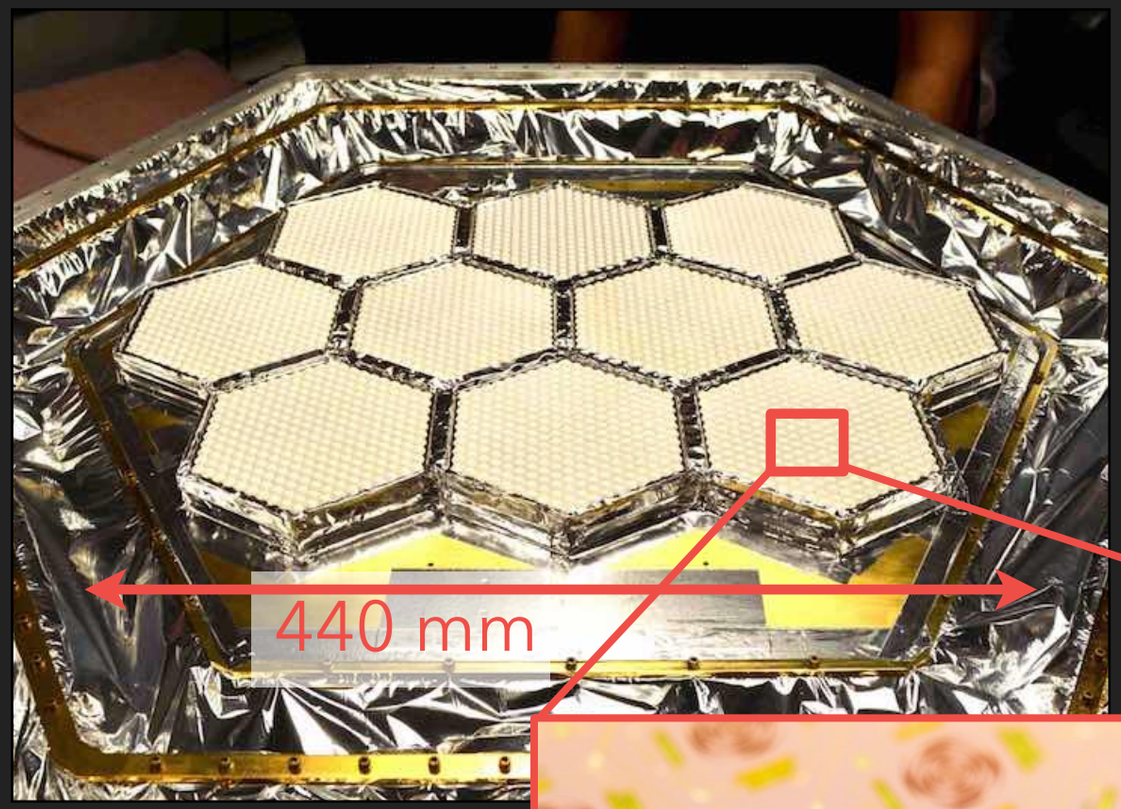


SPT3G DETECTORS



10 wafers

SPT3G DETECTORS



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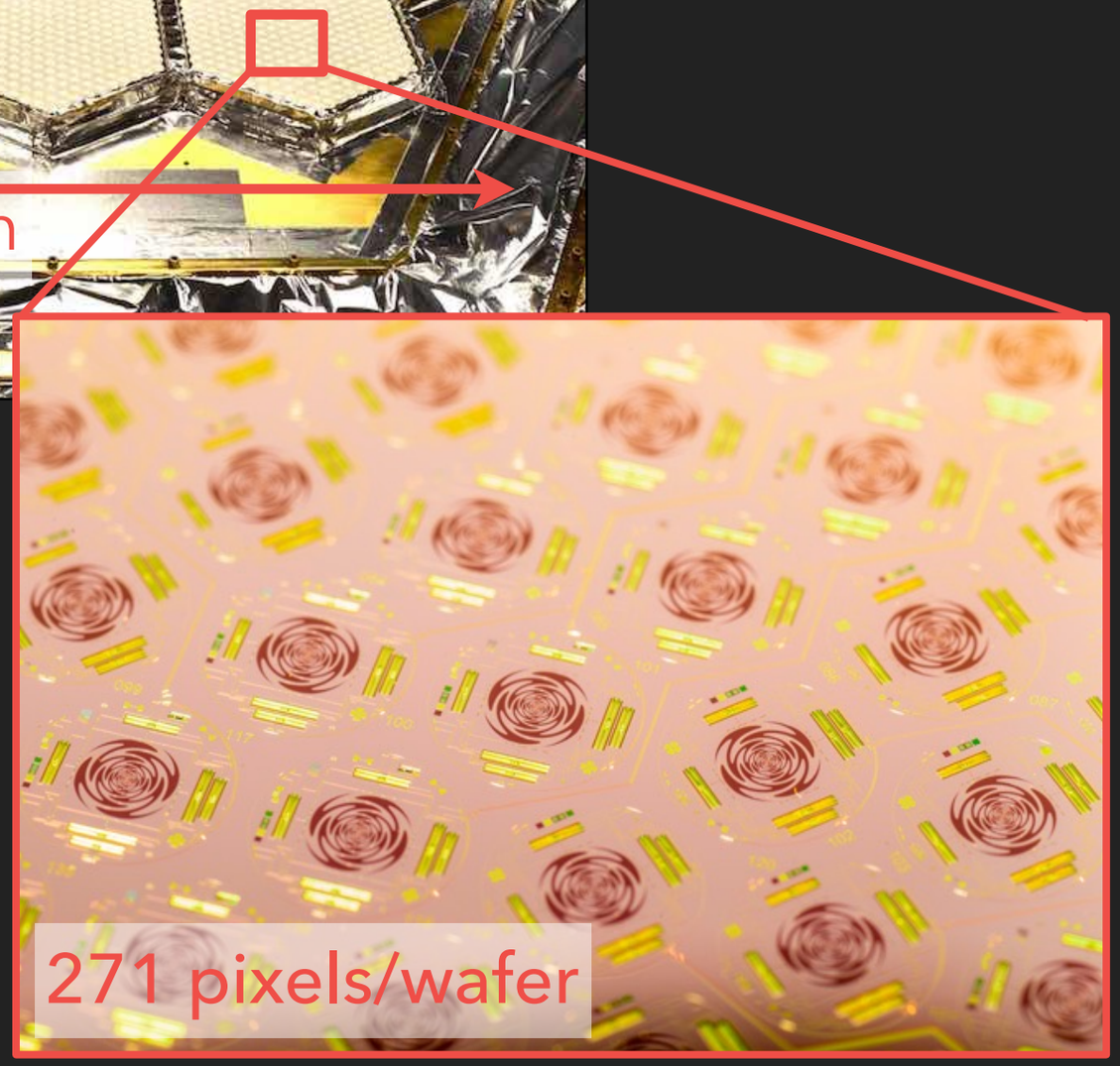

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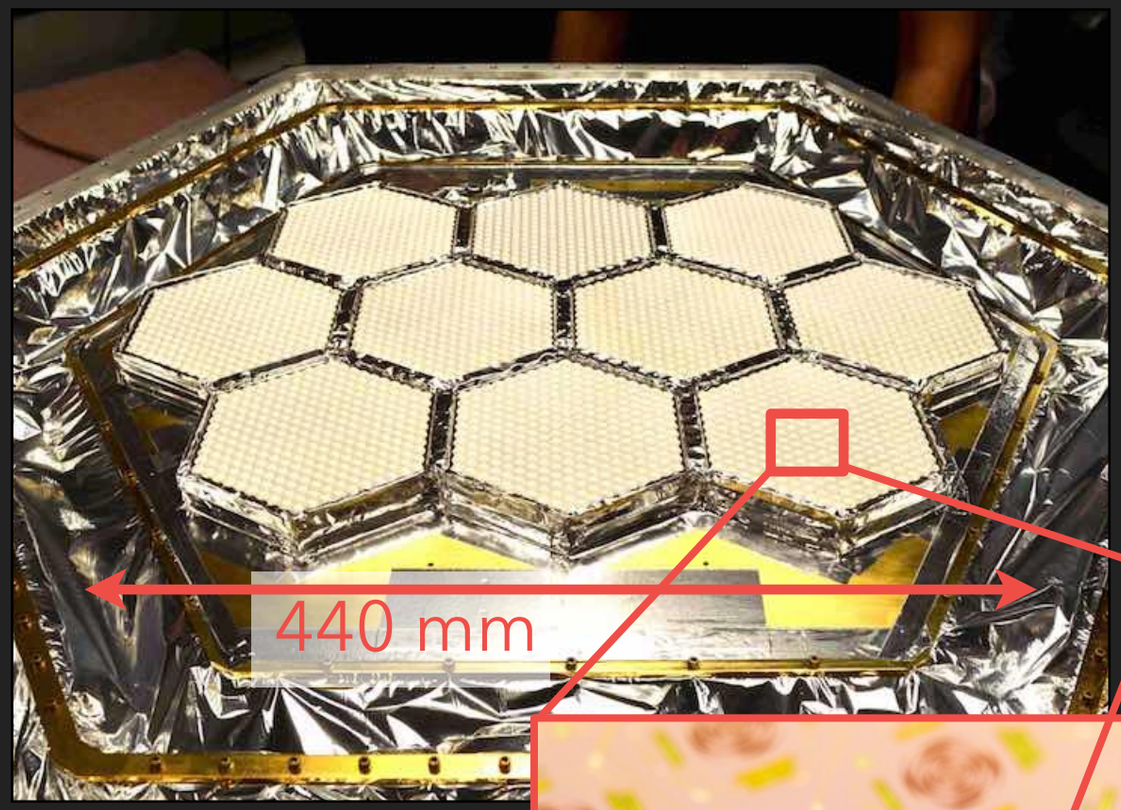

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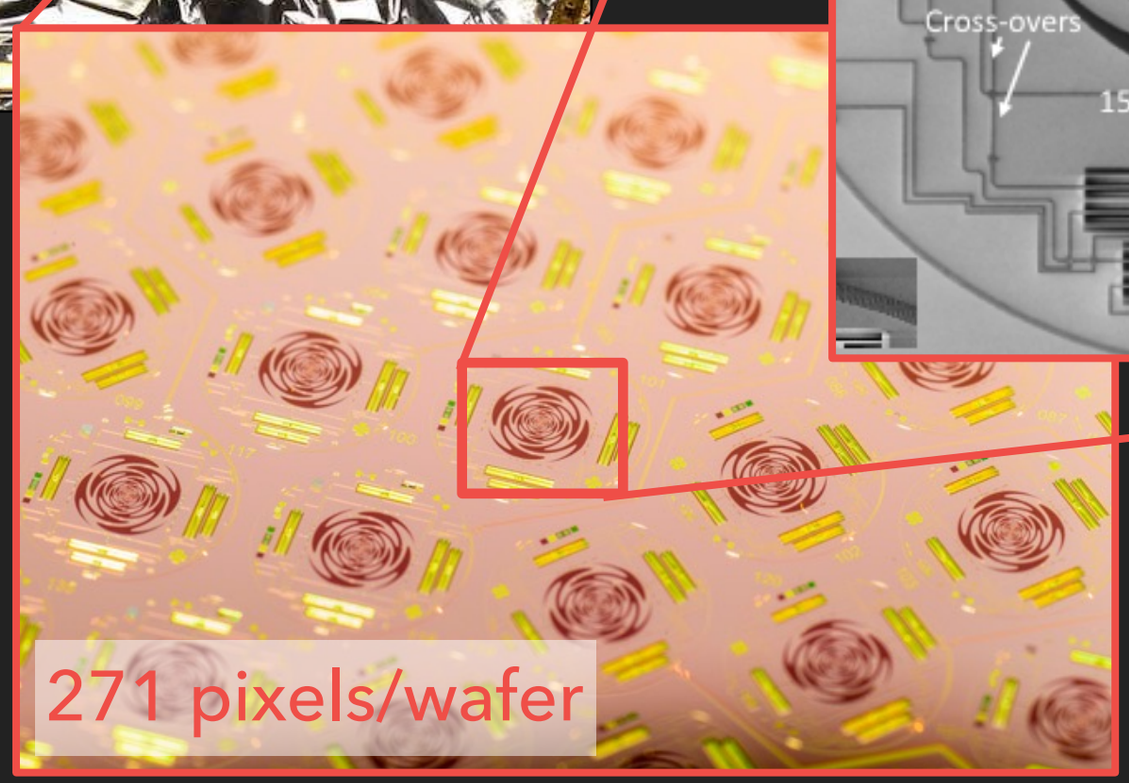
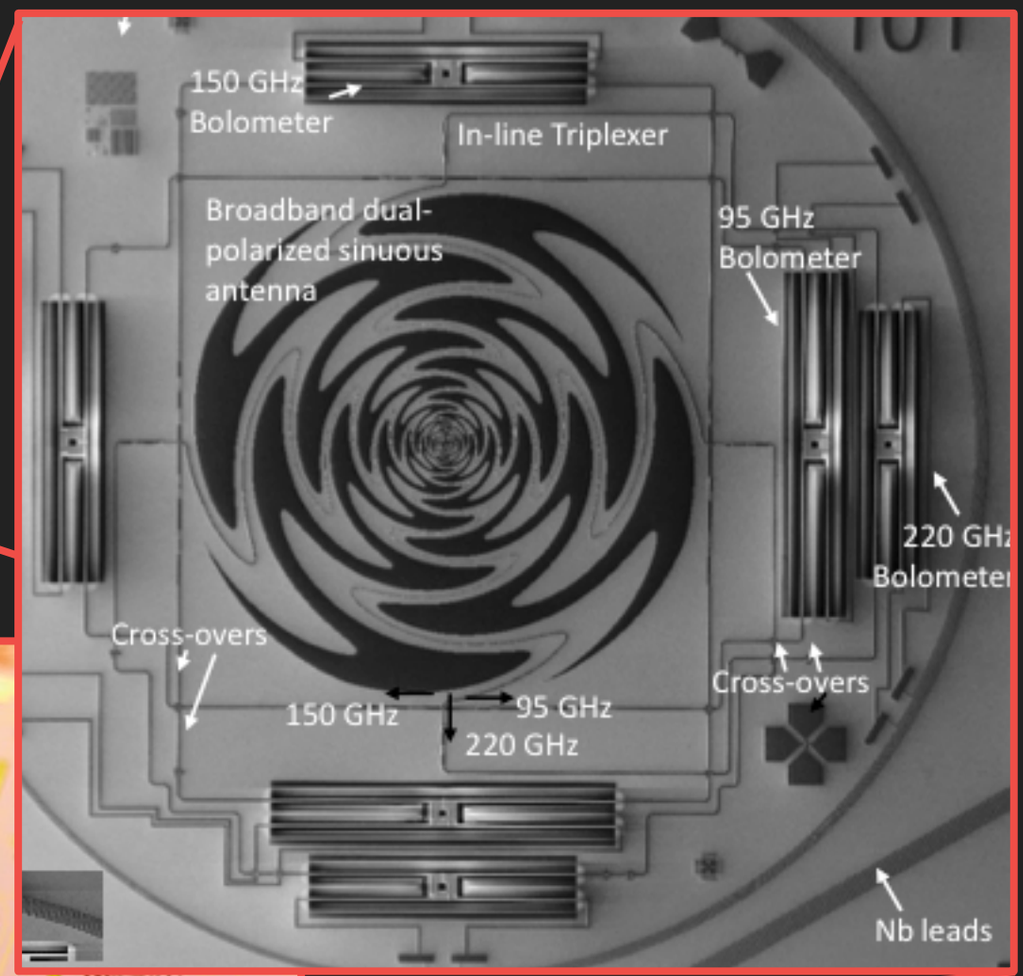


6 bolometers/pixel



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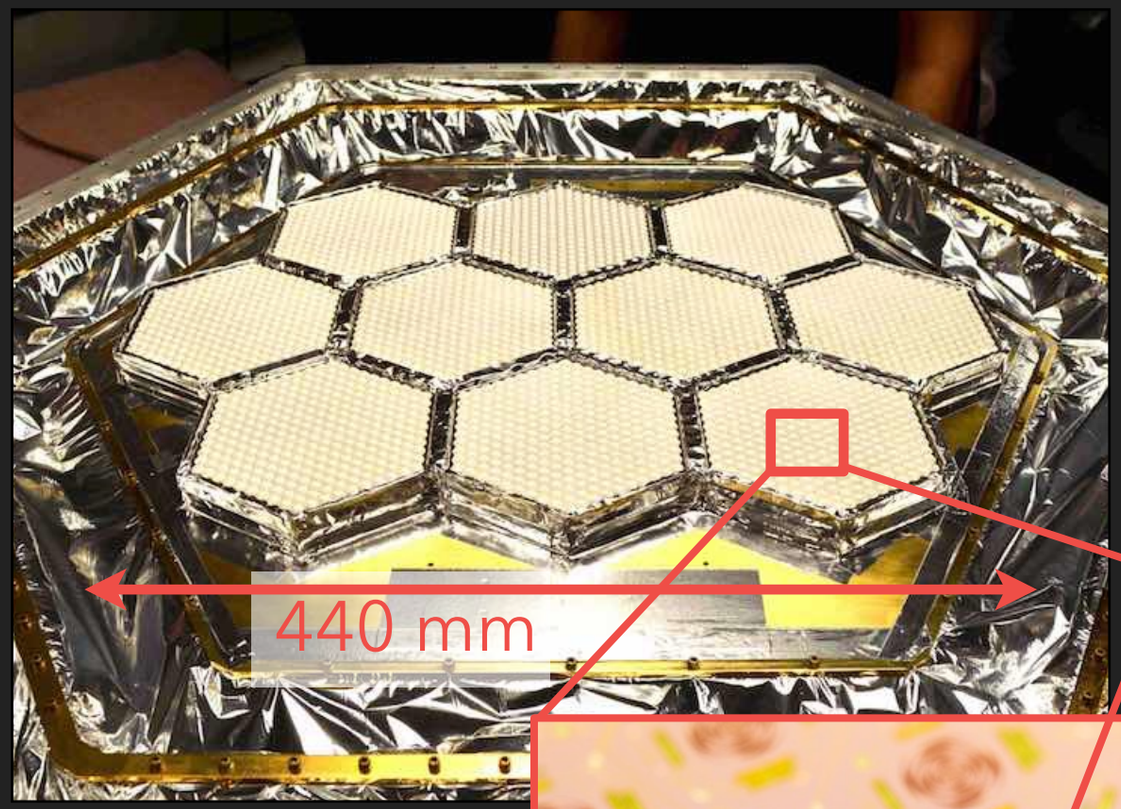

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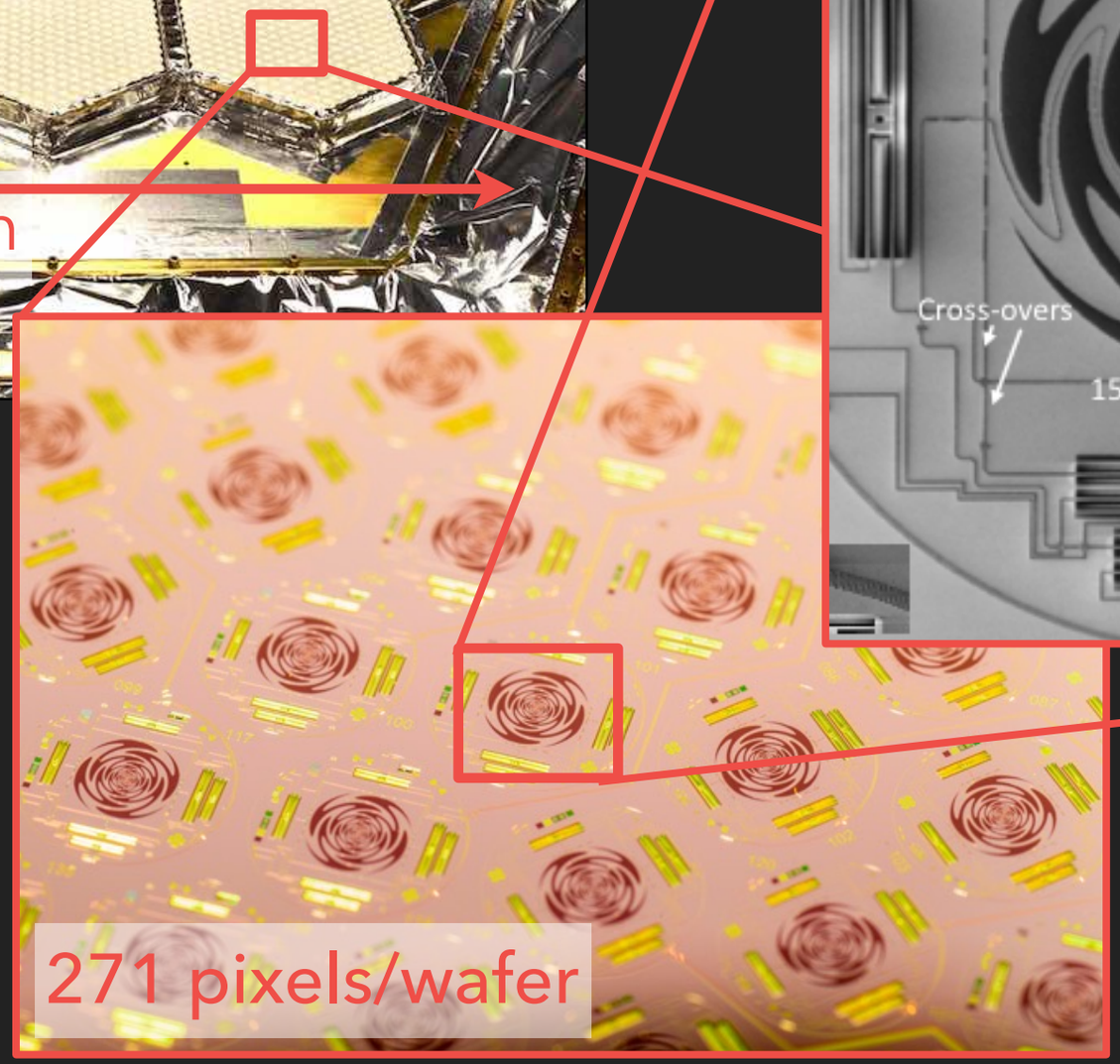

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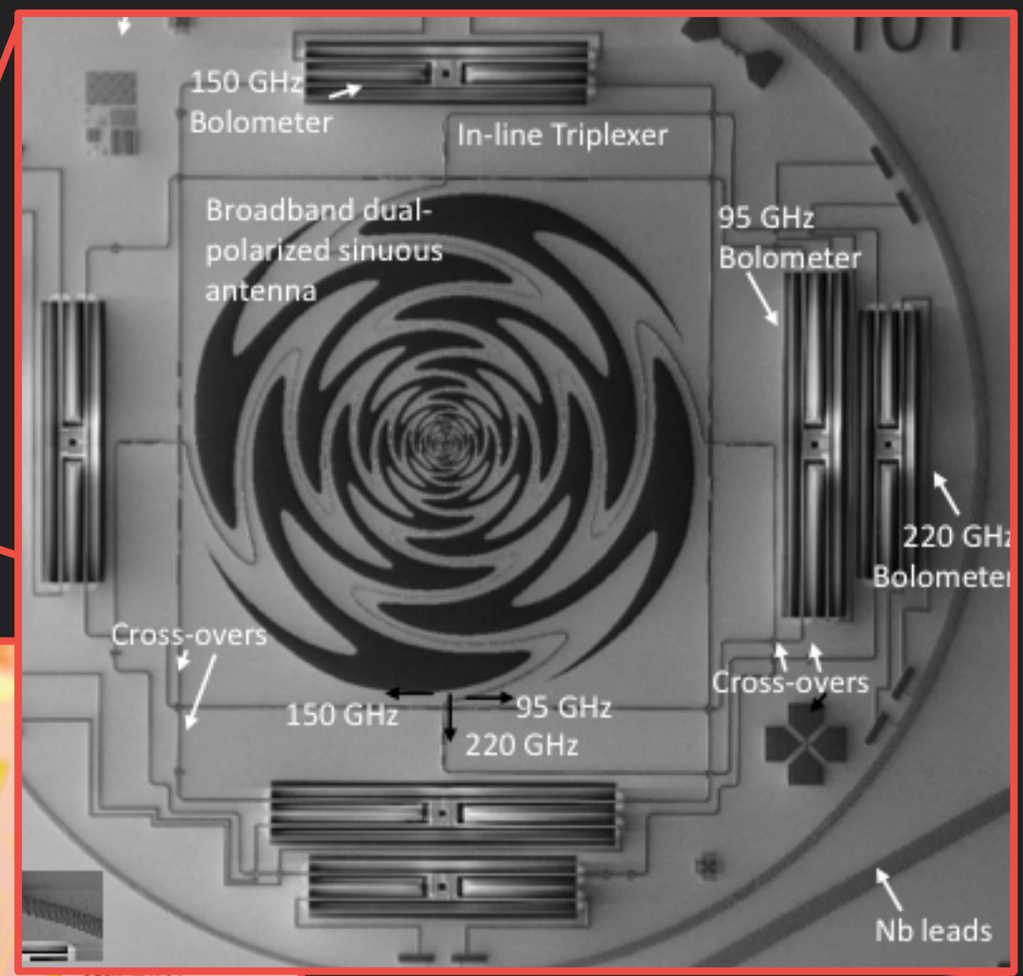
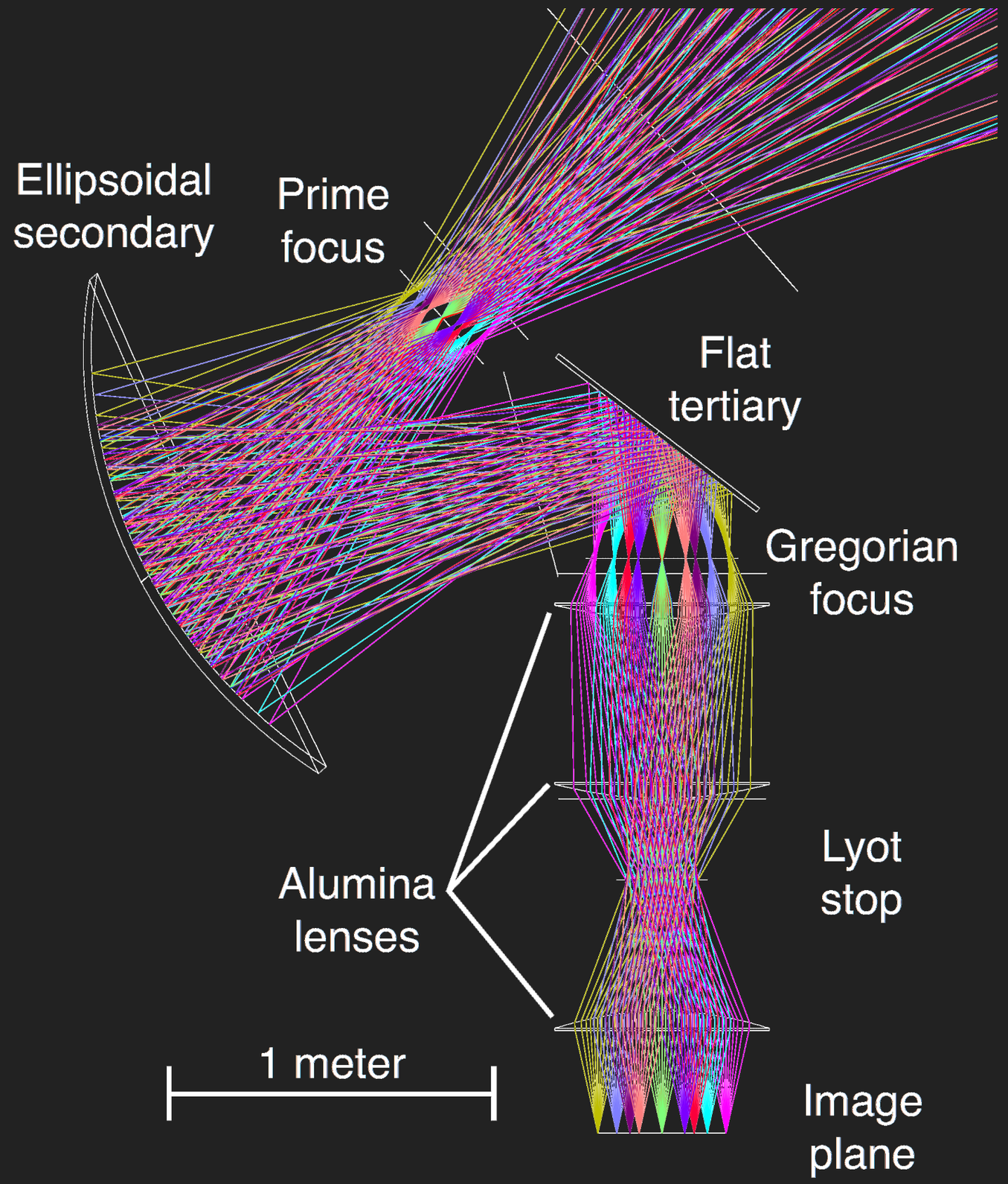


64x frequency domain multiplexed readout

OPTICS

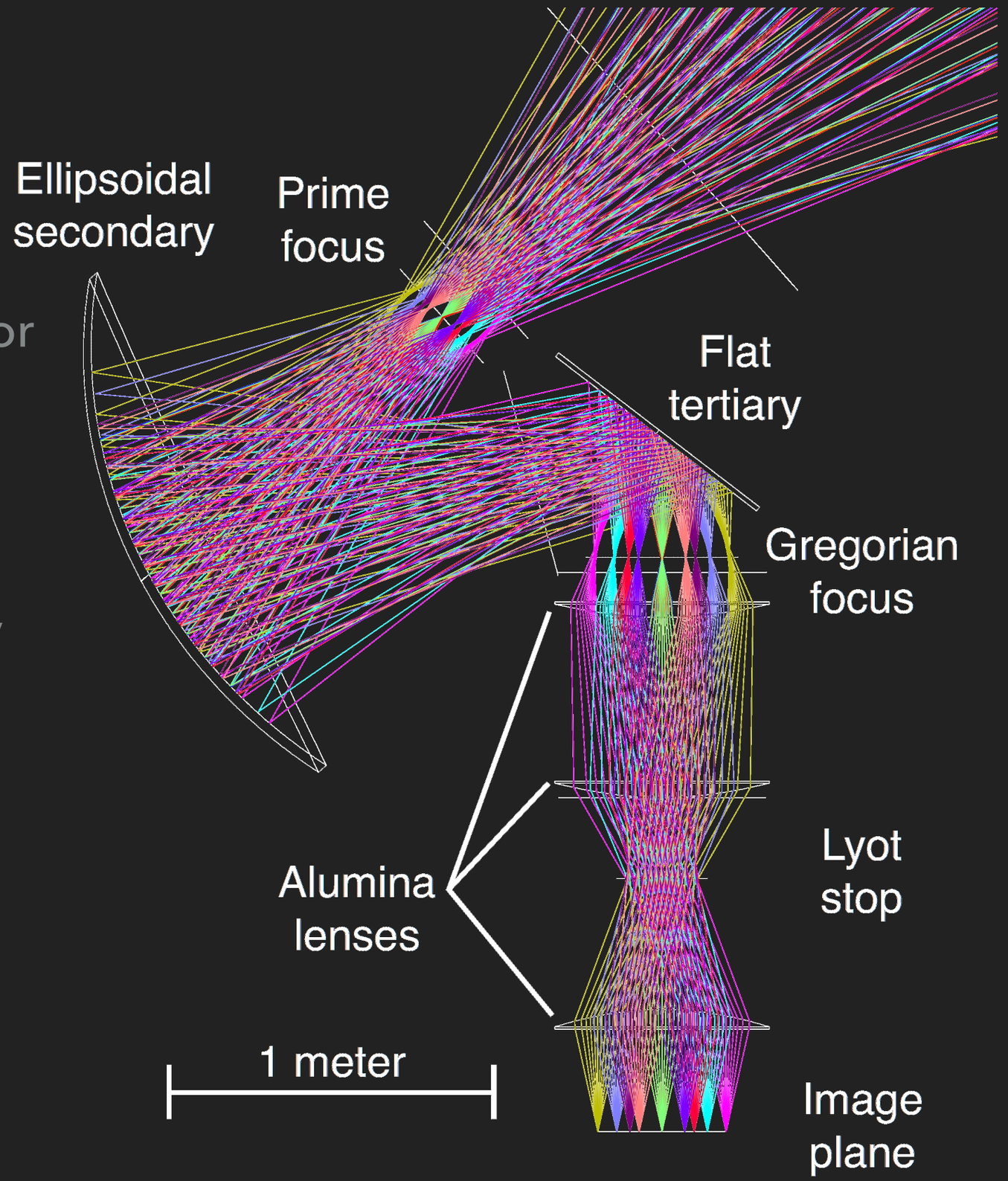
- 8m primary illumination
- 1.9° field of view



OPTICS

- 8m primary illumination
- 1.9° field of view
- Alumina lenses
  - wide transmission bandwidth for trichroic detectors
  - 3-layer plastic AR coating baselined
  - deployed 2-layer thermal spray coating
- Eight lossy surfaces

Frequency	95	150	220
Deployed	0.946	0.941	0.879
Baseline	0.980	0.987	0.921



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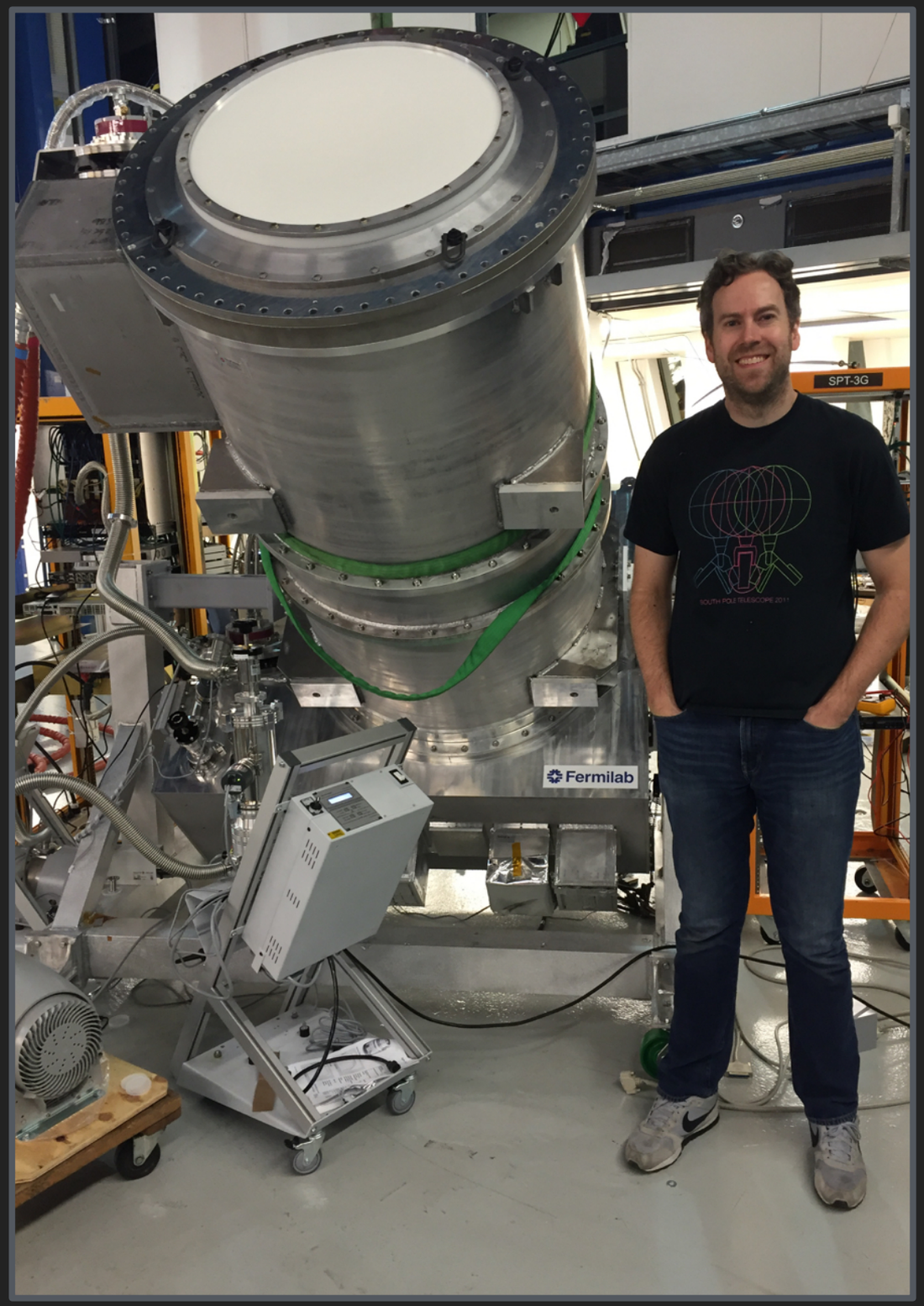
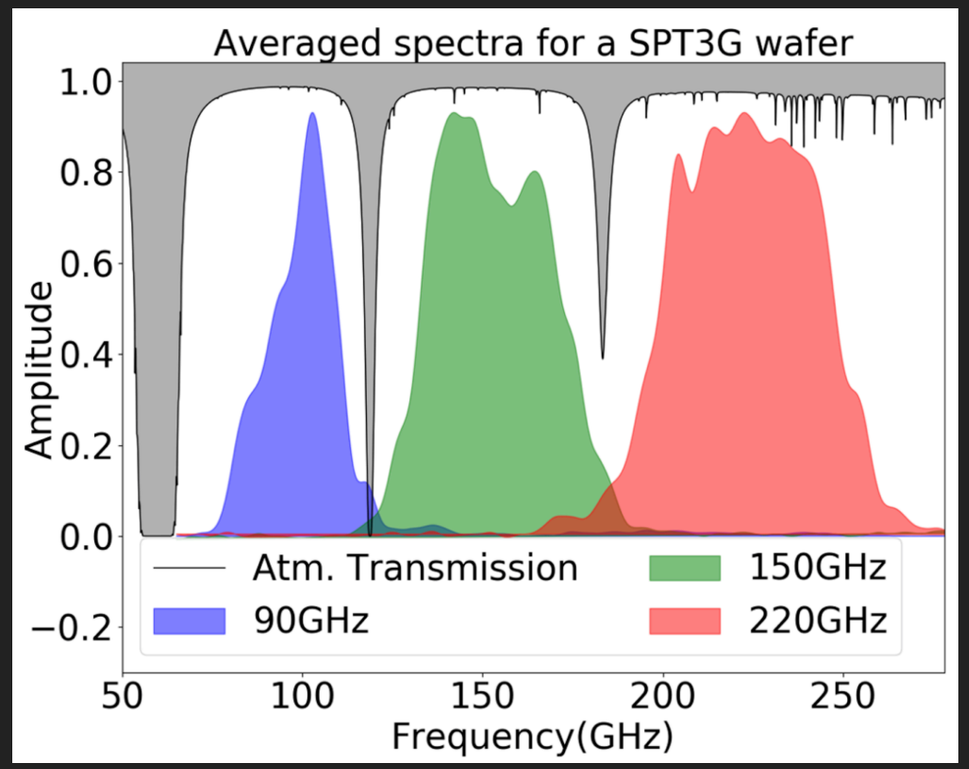
- 1.9° field of view
- Alumina lenses
  - wide transmission bandwidth for trichroic detectors
  - 3-layer plastic AR coating baselined
    - deployed 2-layer thermal spray coating
    - Eight lossy surfaces
- Cryogenically cooled
  - 4K lenses
  - 300mK focal plane



DETECTOR PERFORMANCE

- TES bolometers:
  - R_{normal} ~ 1.3-2.5 Ω
  - T_c 480-540 mK
  - P_{sat} ~ 15/20/25 pW (95/150/220 GHz)
- 60-90% detector optical efficiency
- Uniform optical bands
- ~10,000 usable channels (73% yield)



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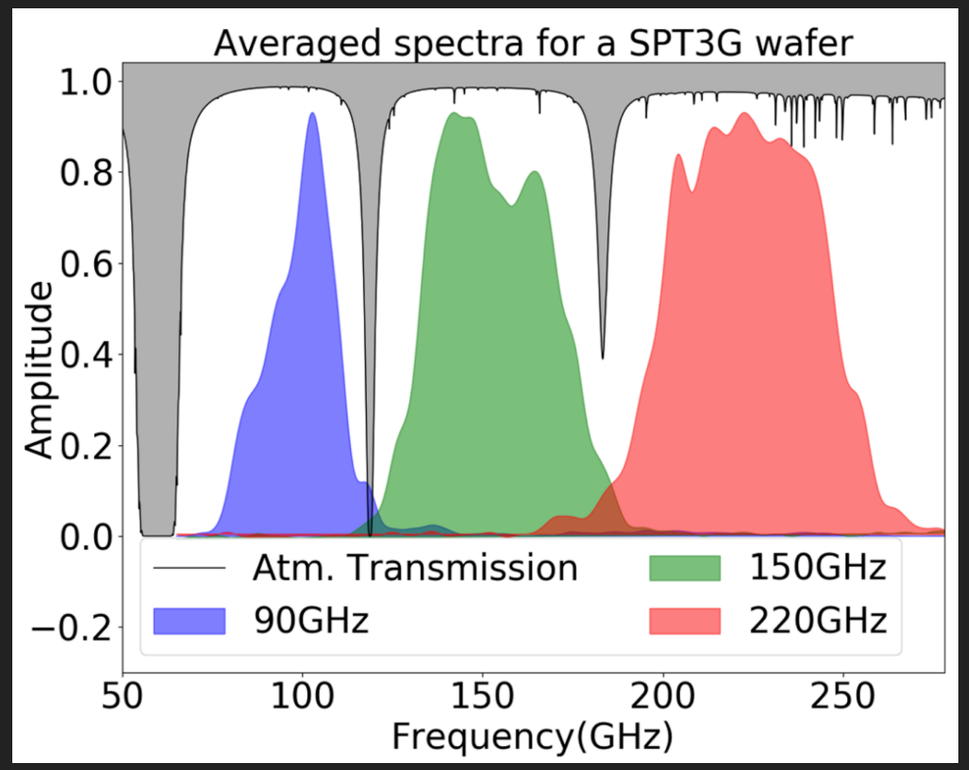
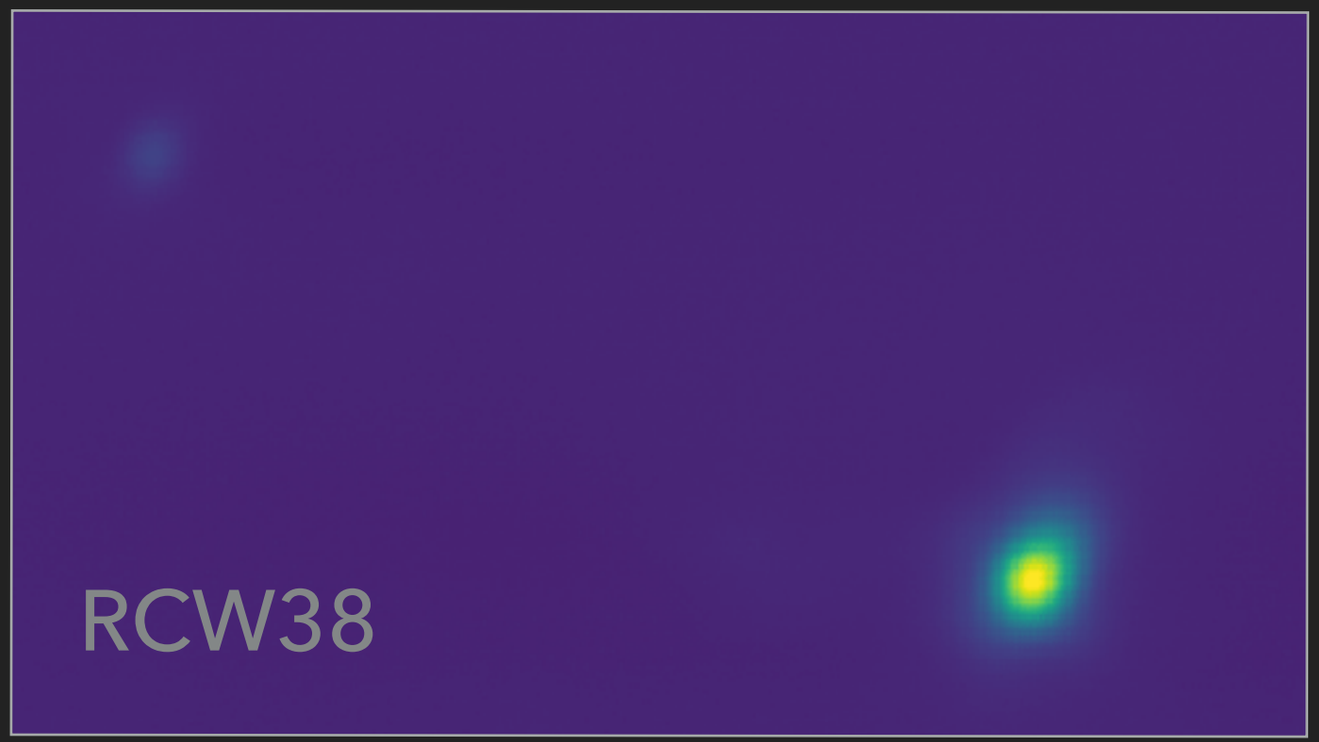
- Projected sensitivities:

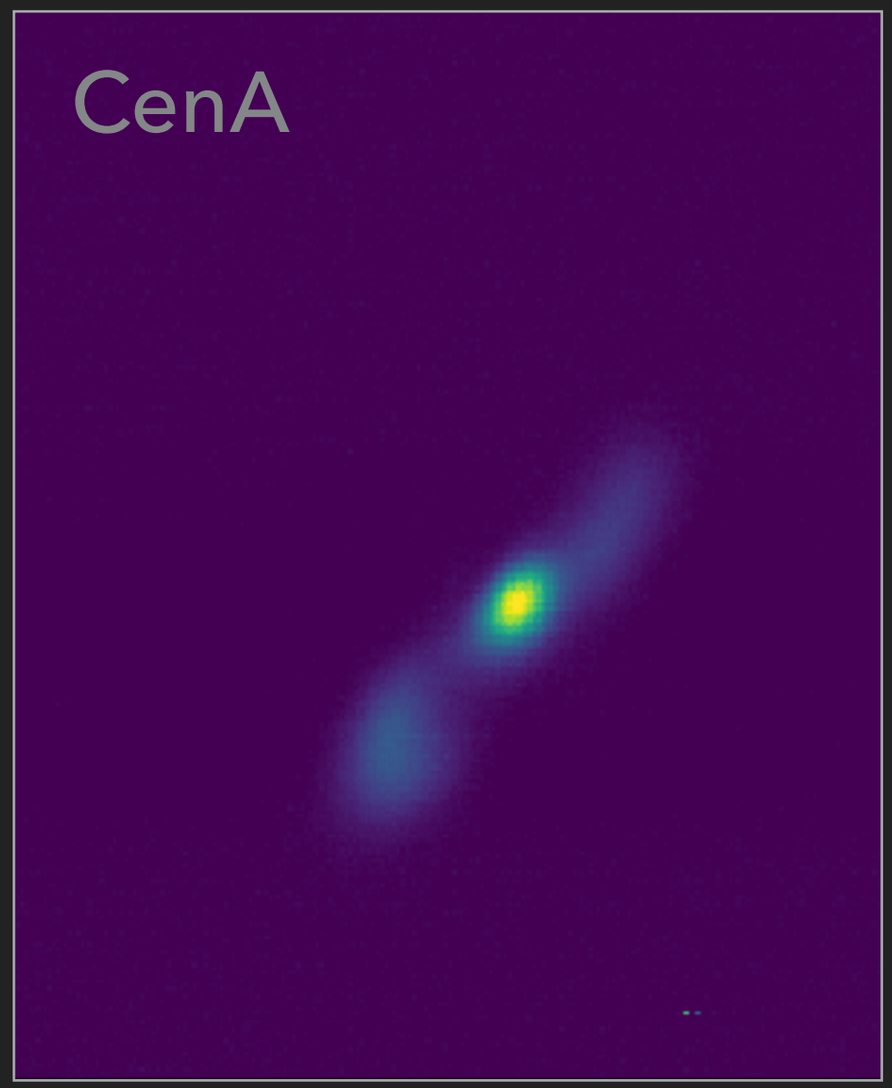


Band	NET (bolo) [uK-rts]	NET (array) [uK-rts]	mapping speed (x SPTpol)
95 GHz	509	7.4	16.4
150 GHz	460	6.5	5.3
220 GHz	1188	17	inf

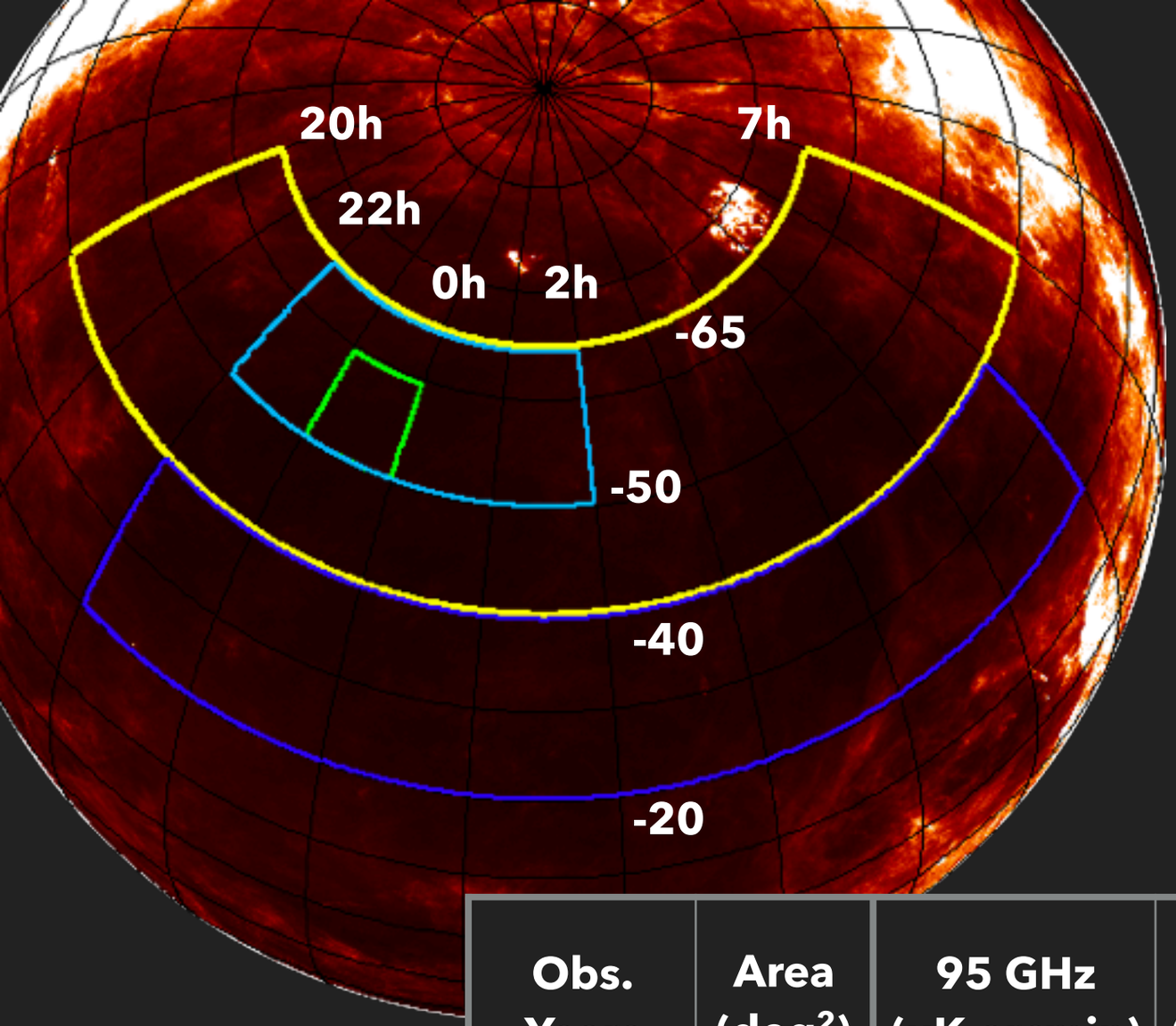
SOURCE OBSERVATIONS FOR CALIBRATION



Pointing offsets,
flux calibration



Polarization
from side lobes

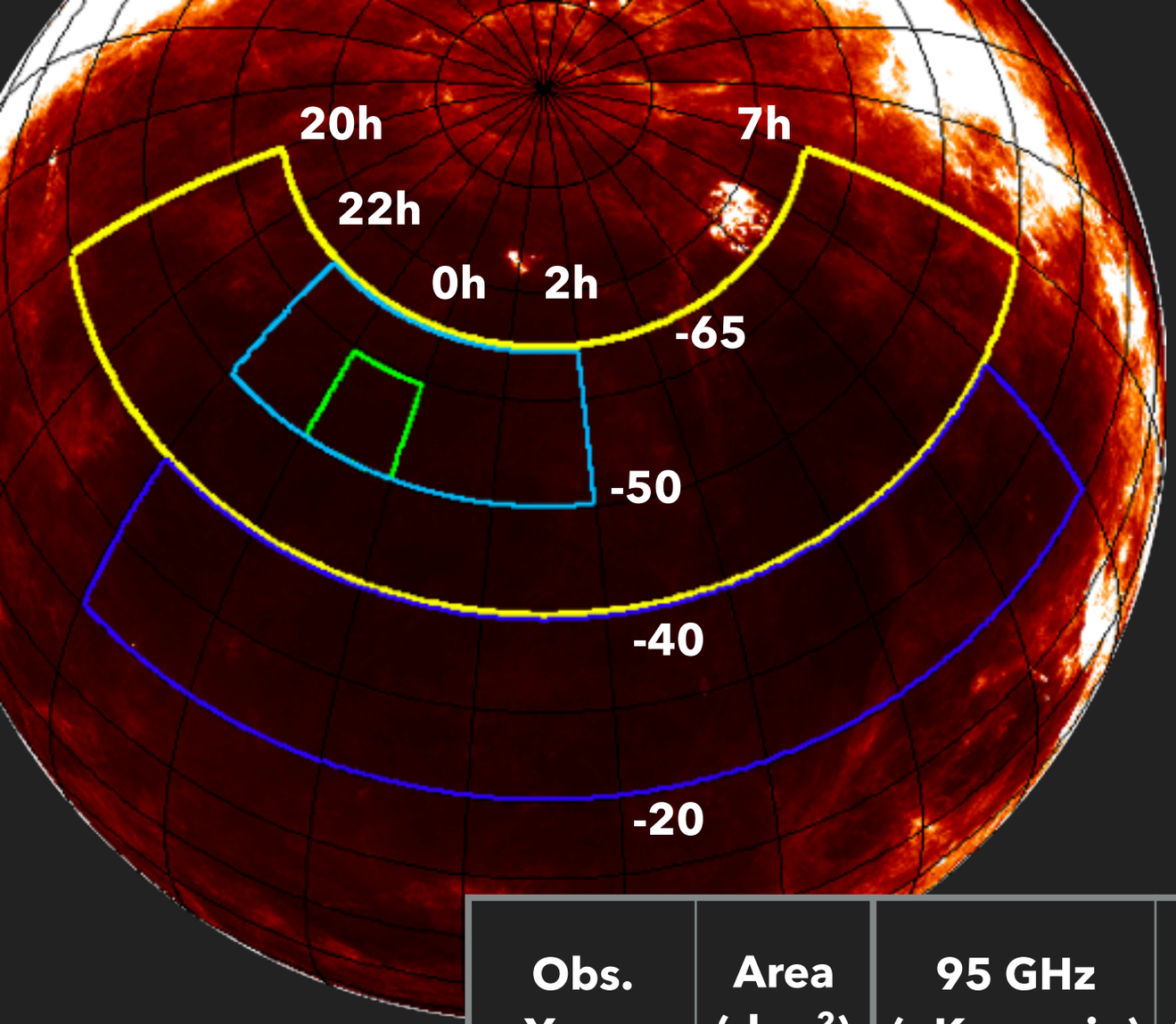


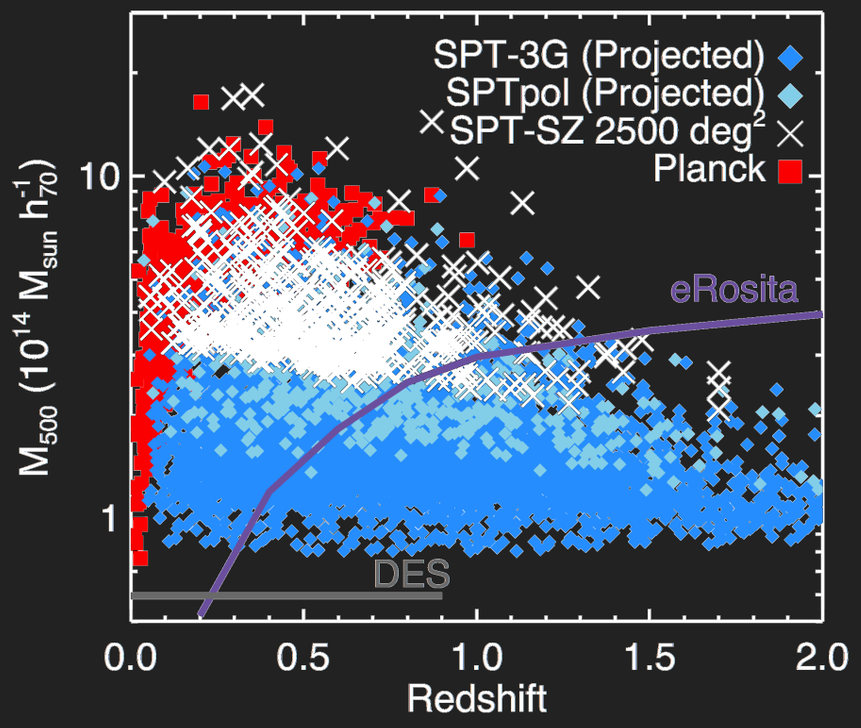
SPT SURVEYS

- Next season:
  - Replace lenses with improved transmission properties
  - Install low-impedance SQUIDs (target readout noise 12 pA/rtHz)
  - Replace wafers (target 90% yield, P_{sat}/P_{opt} ~ 2)

	Obs. Years	Area (deg^2)	95 GHz (uK-arcmin)	150 GHz (uK-arcmin)	220 GHz (uK-arcmin)
SPT-SZ	2007-11	2500	40	17	80
SPTpol-Main	2012-16	500	13	5	-
SPTpol-Deep	2012-16	100	10	3.5	-
SPTpol-Summer	2012-16	2500	47	28	-
SPT-3G (proj)	***2017-21***	***2500***	***3.6***	***3.3***	***8.5***

SPT SURVEYS





	Obs. Years	Area (deg^2)	95 GHz (uK-arcmin)	150 GHz (uK-arcmin)	220 GHz (uK-arcmin)	M_{500} Lim.(z=0.7) (1e14 M_{sun})	$N_{clusters}$
SPT-SZ	2007-11	2500	40	17	80	3.0	~500
SPTpol-Main	2012-16	500	13	5	-	2.0	~500
SPTpol-Deep	2012-16	100	10	3.5	-	-	-
SPTpol-Summer	2012-16	2500	47	28	-	4.5	~200
SPT-3G (proj)	***2017-21***	***2500***	***3.6***	***3.3***	***8.5***	***1.3***	***~7000***

FUTURE RESULTS FROM SPT

- SPT-SZ
  - 2500d point source catalog (Everett++)
  - 2500d multi-frequency TT consistency (Mocanu++)
  - SPT+DES cluster lensing (Baxter++)
  - SPT+DES shear, density, CMB lensing joint analysis
- SPTpol
  - BB spectrum (Sayer++)
  - lensing (Mocanu++)
  - Fast radio bursts (Harrington++)
  - BICEP/Keck/SPT delensing
  - SZ cluster finding and cosmology
  - Transients (Natoli, Whitehorn ++)
- SPT-3G
  - Stay tuned!

Thank you!