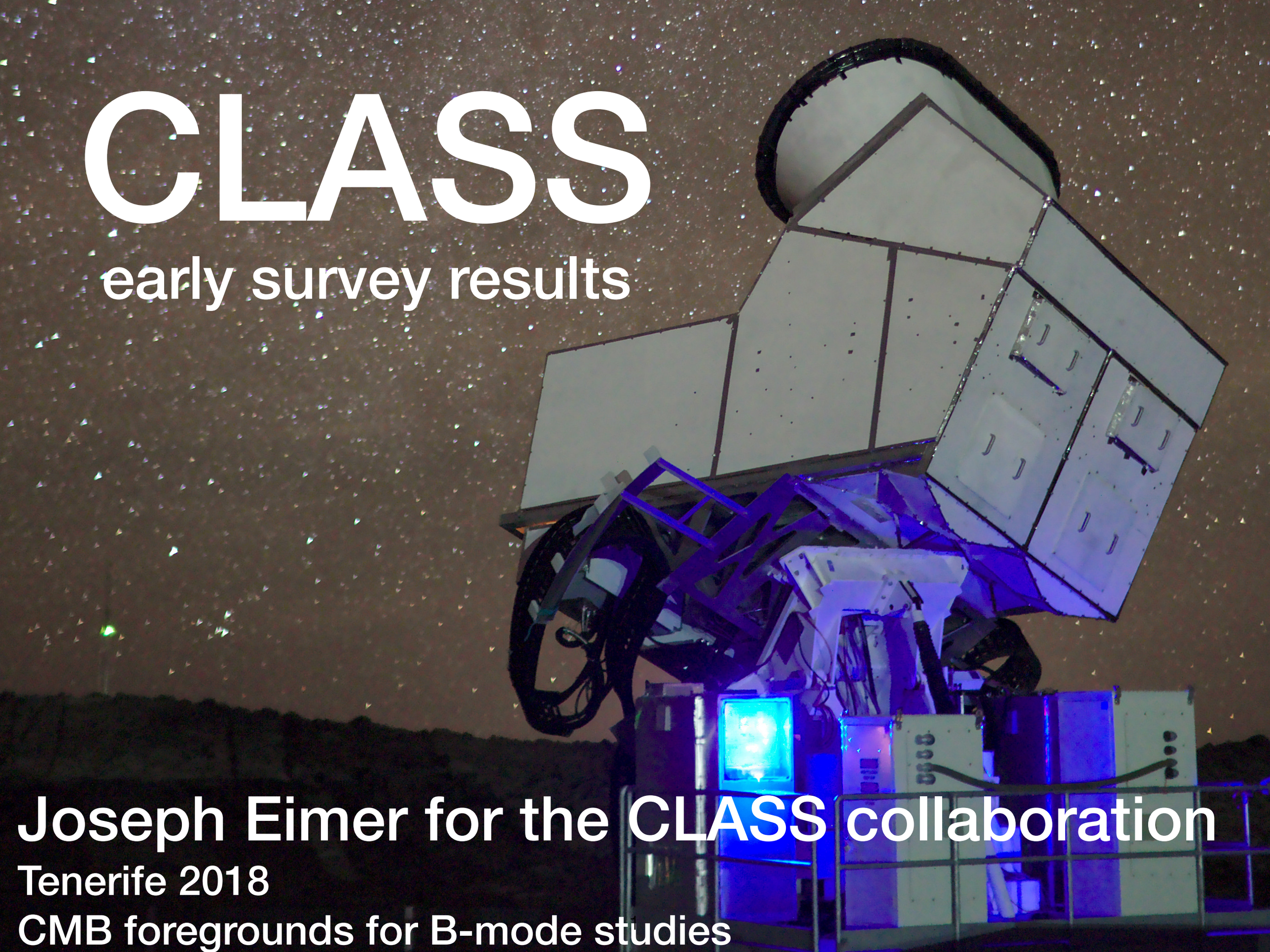
CLASS

early survey results



Joseph Eimer for the CLASS collaboration

Tenerife 2018

CMB foregrounds for B-mode studies

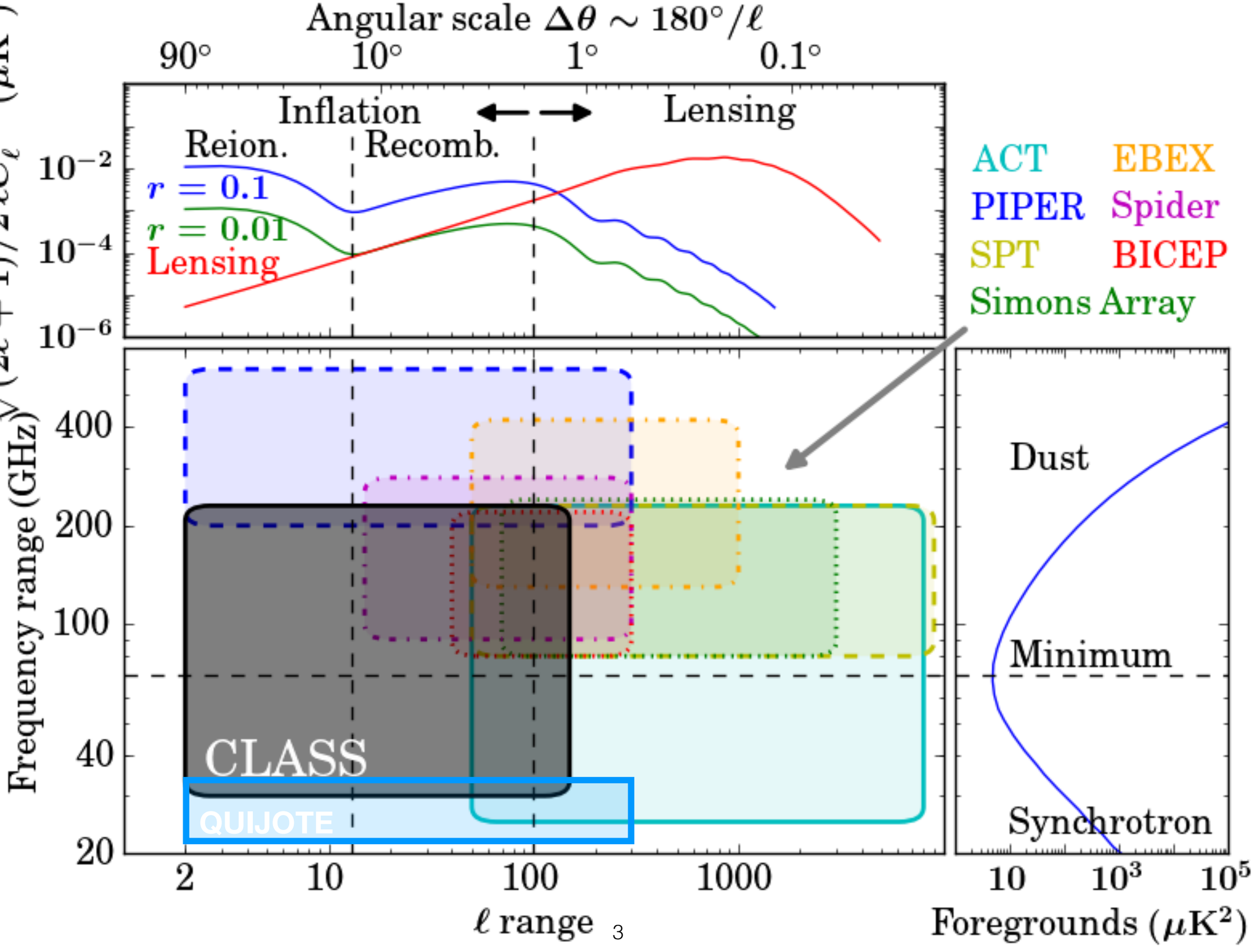
150/220 GHz

90 GHz

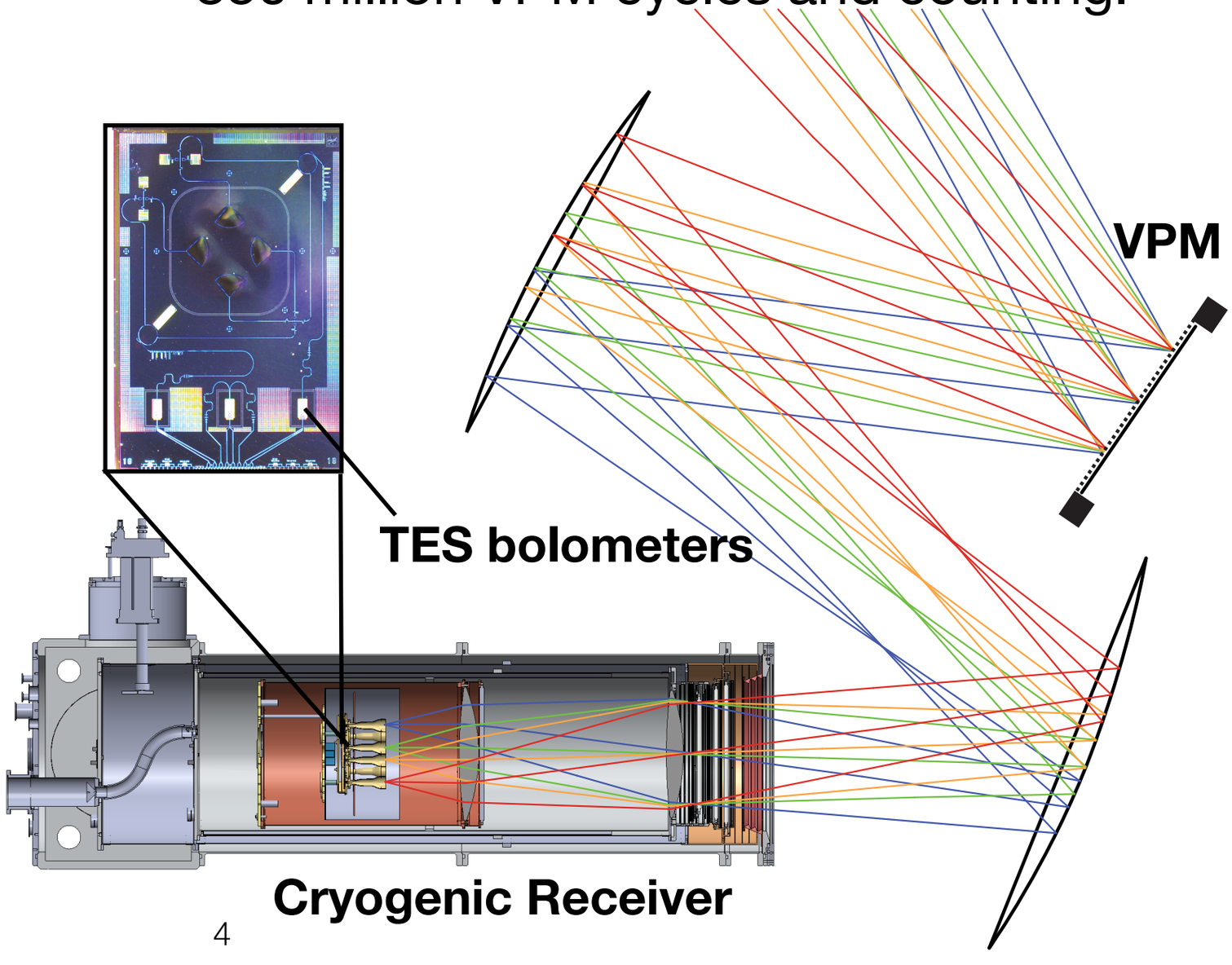
90 GHz

40 GHz

- Survey **75%** of the sky **every day.**
- Telescope is completely shrouded in **co-moving ground screen.**
- **Boresight rotation** enables polarization switching and systematic checks.
- *Fast (10 Hz) front-end polarization modulation enables* ***targeting the large-scale (l < 10)*** *modes of the CMB.*

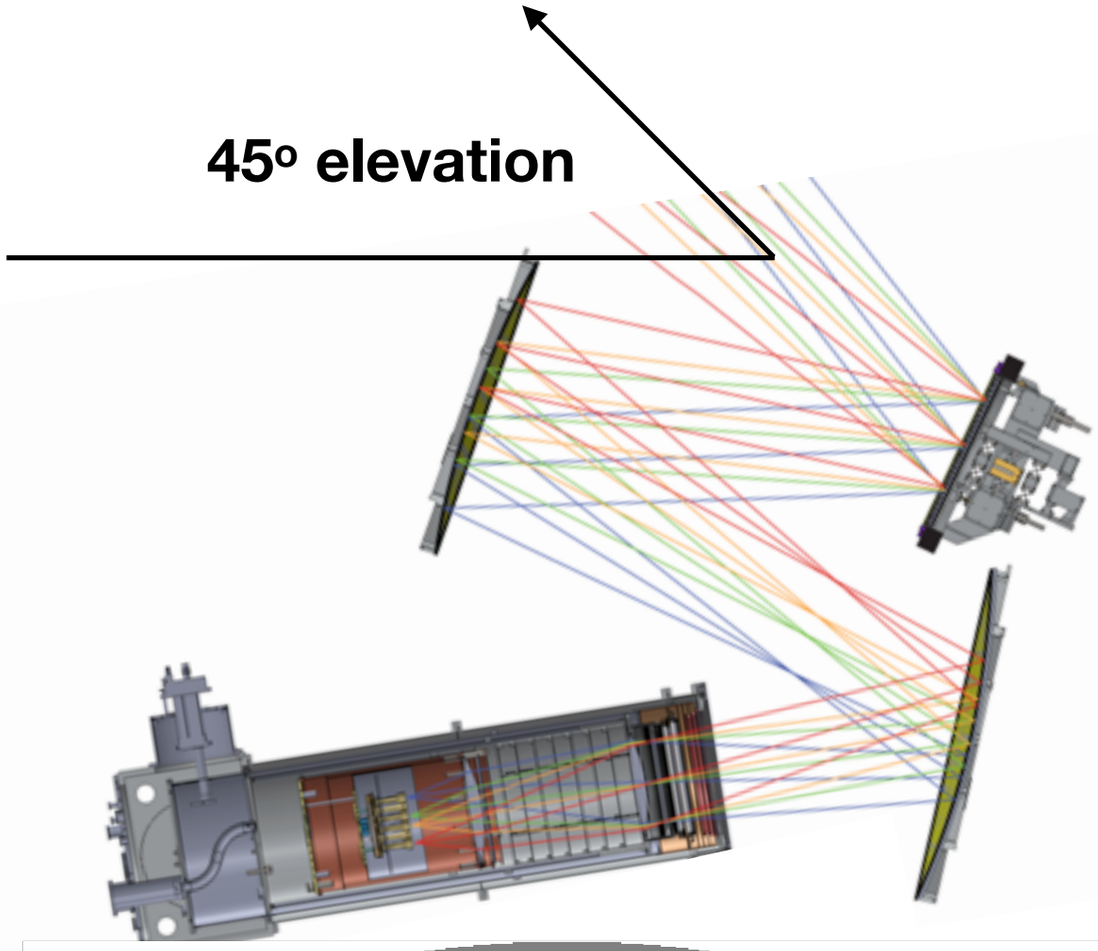

Angular scale $\Delta\theta \sim 180°/\ell$
90°
10°
1°
0.1°
$\sqrt{(2\ell+1)/2\,\ell C_\ell^{BB}}$ (μK^2)
10^{-2}
10^{-4}
10^{-6}
Inflation
Lensing
Reion.
Recomb.
$r = 0.1$
$r = 0.01$
Lensing
ACT
EBEX
PIPER
Spider
SPT
BICEP
Simons Array
Frequency range (GHz)
400
200
100
40
20
CLASS
QUIJOTE
2
10
100
1000
ℓ range
Dust
Minimum
Synchrotron
10
10^3
10^5
Foregrounds (μK^2)

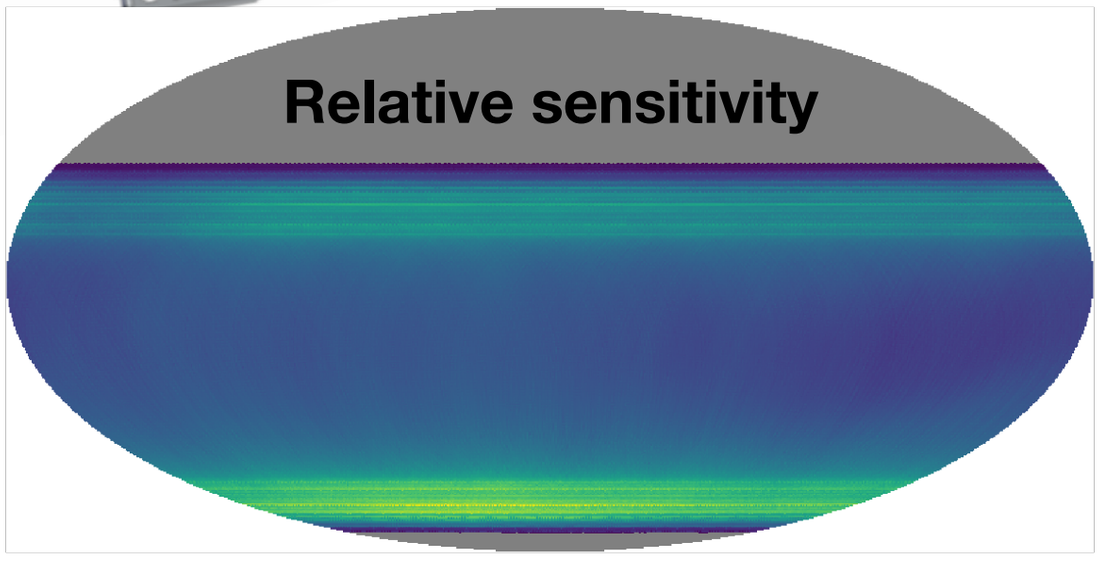
- Initial survey spanned July 2016 to March 2018.
- ~58,000 constant elevation sweeps of the telescope
- ~350 million VPM cycles and counting!



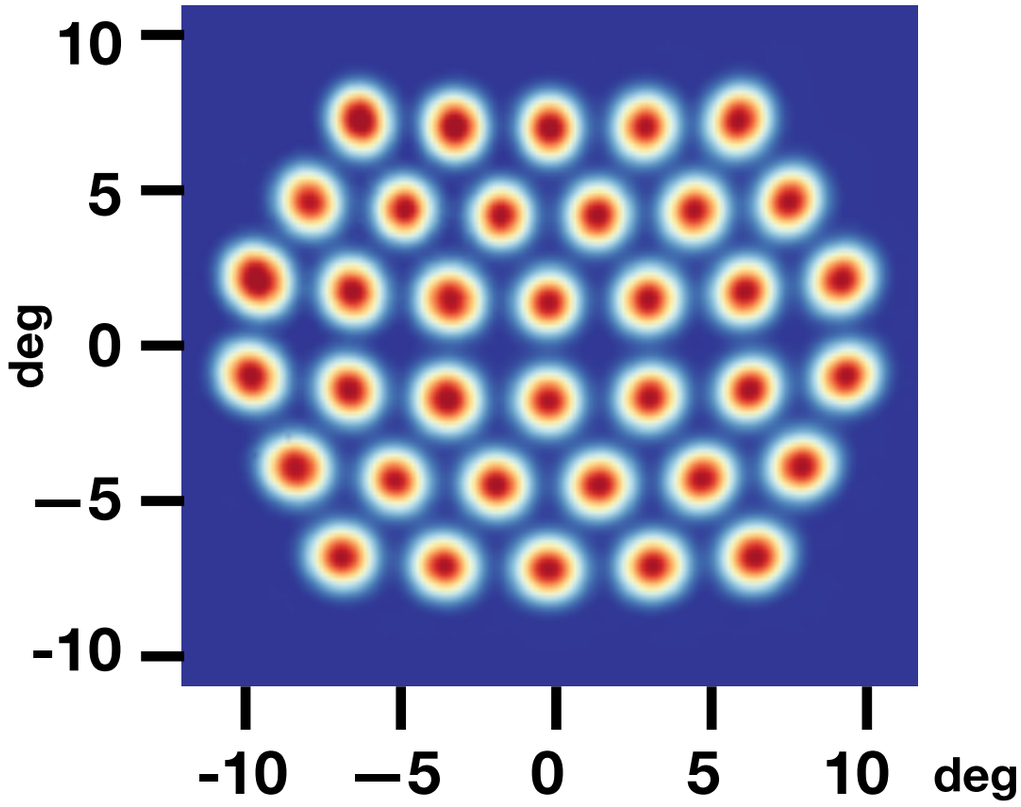
- Total optical efficiency has been measured to be 48%.

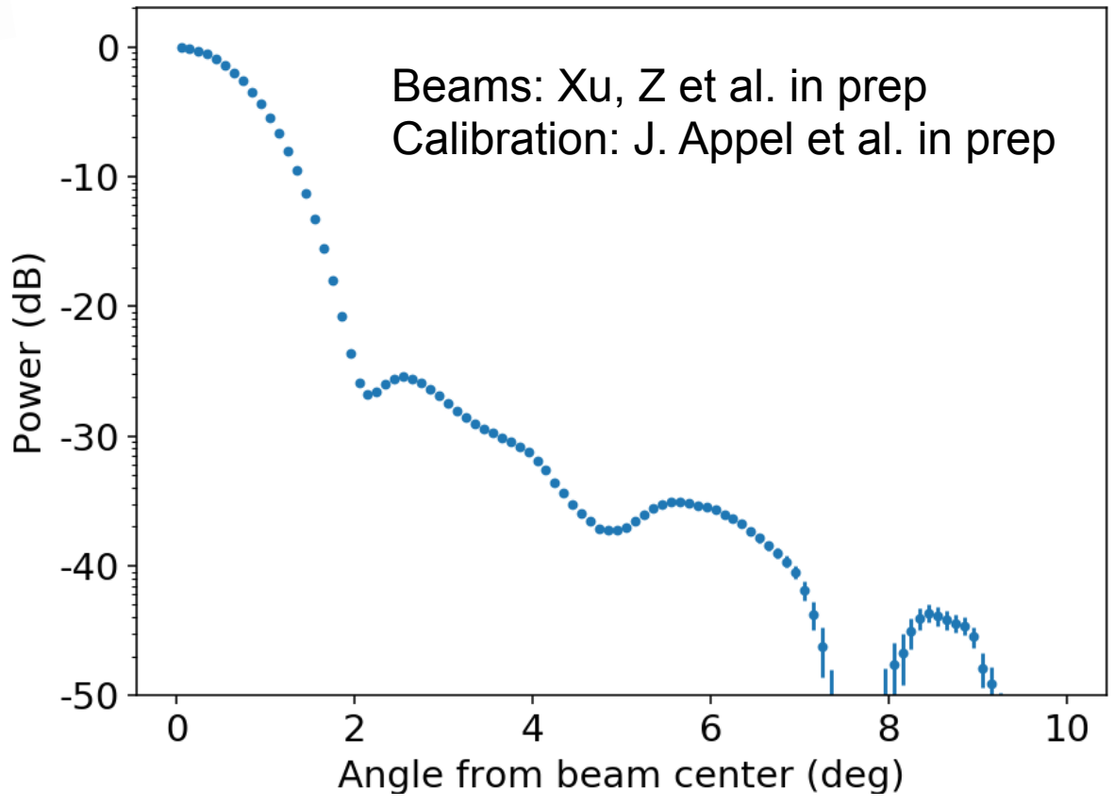
720° azimuthal sweep at 45° elevation



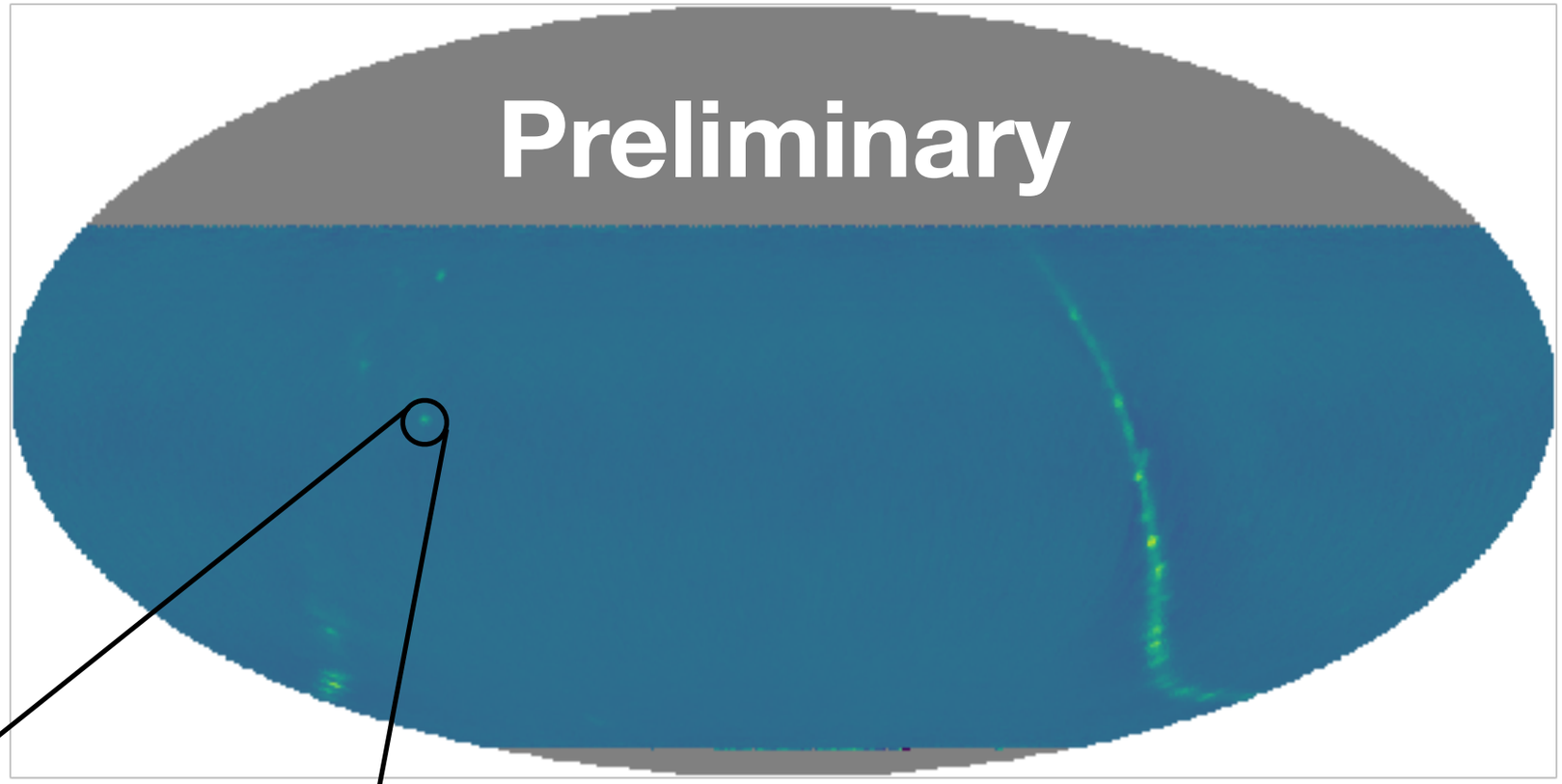


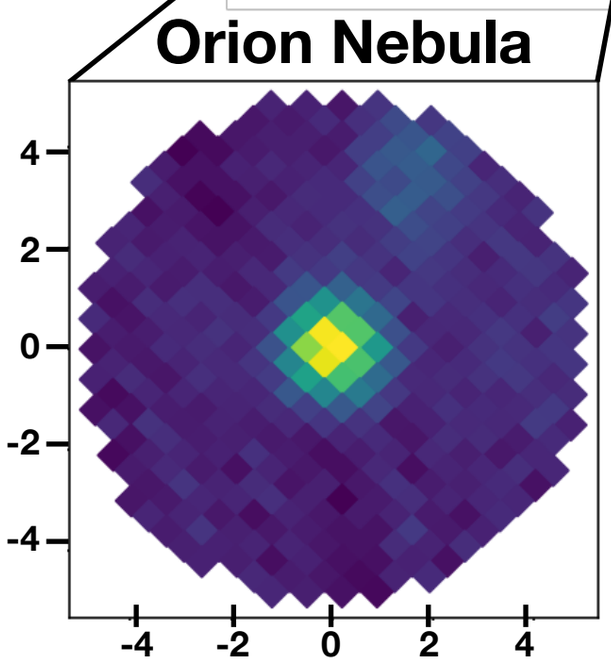
Beam map and calibrate off the moon

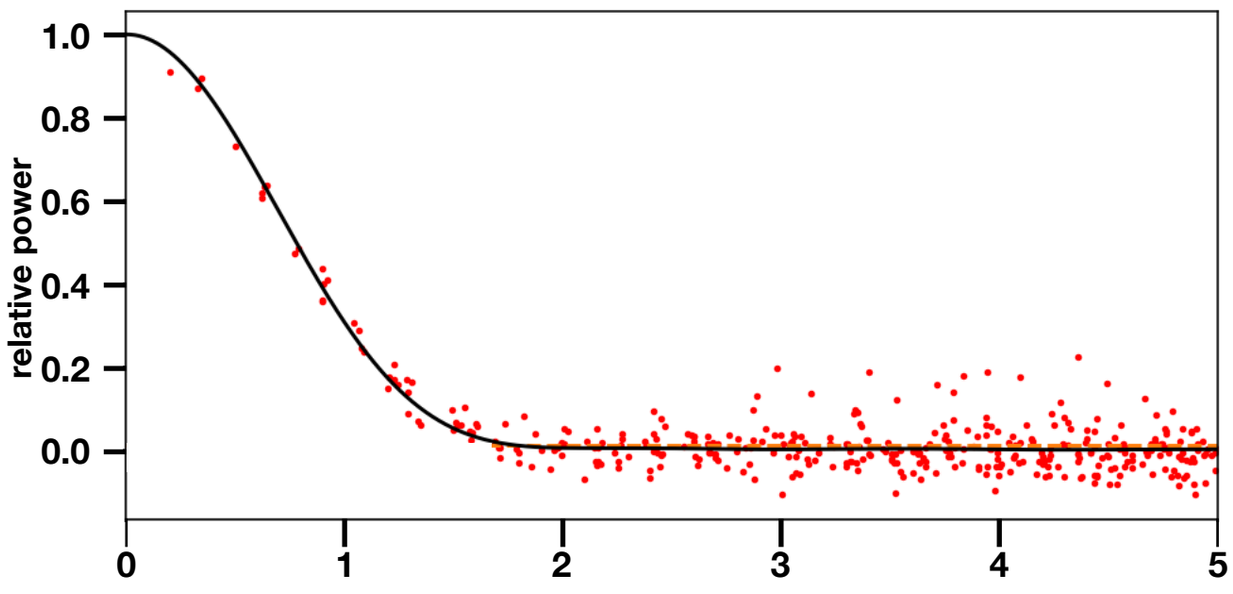




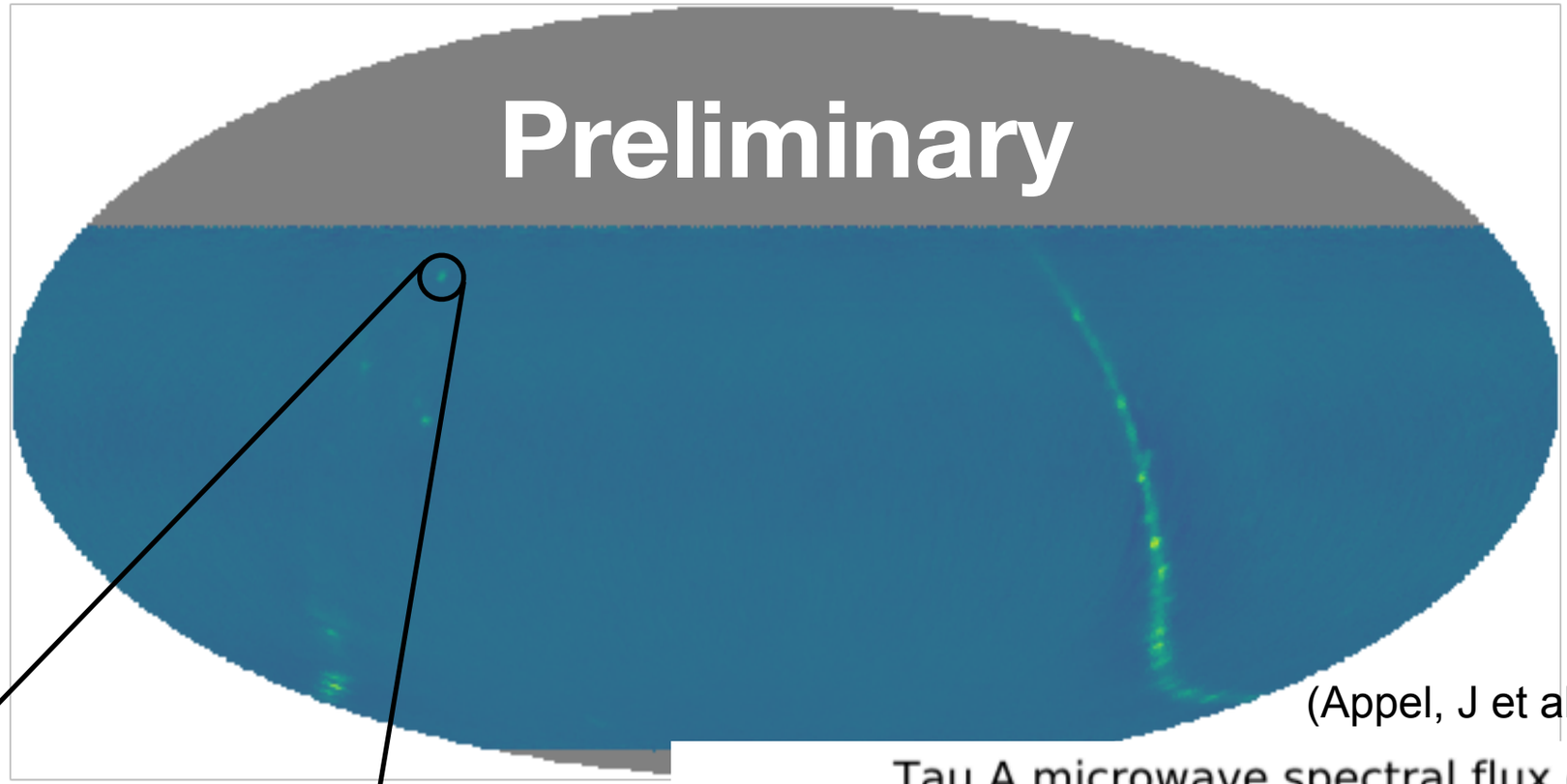
CLASS temperature survey map



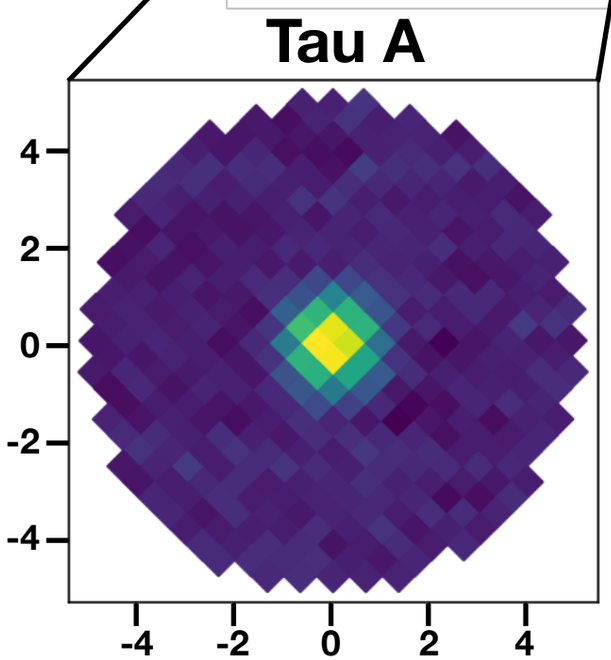


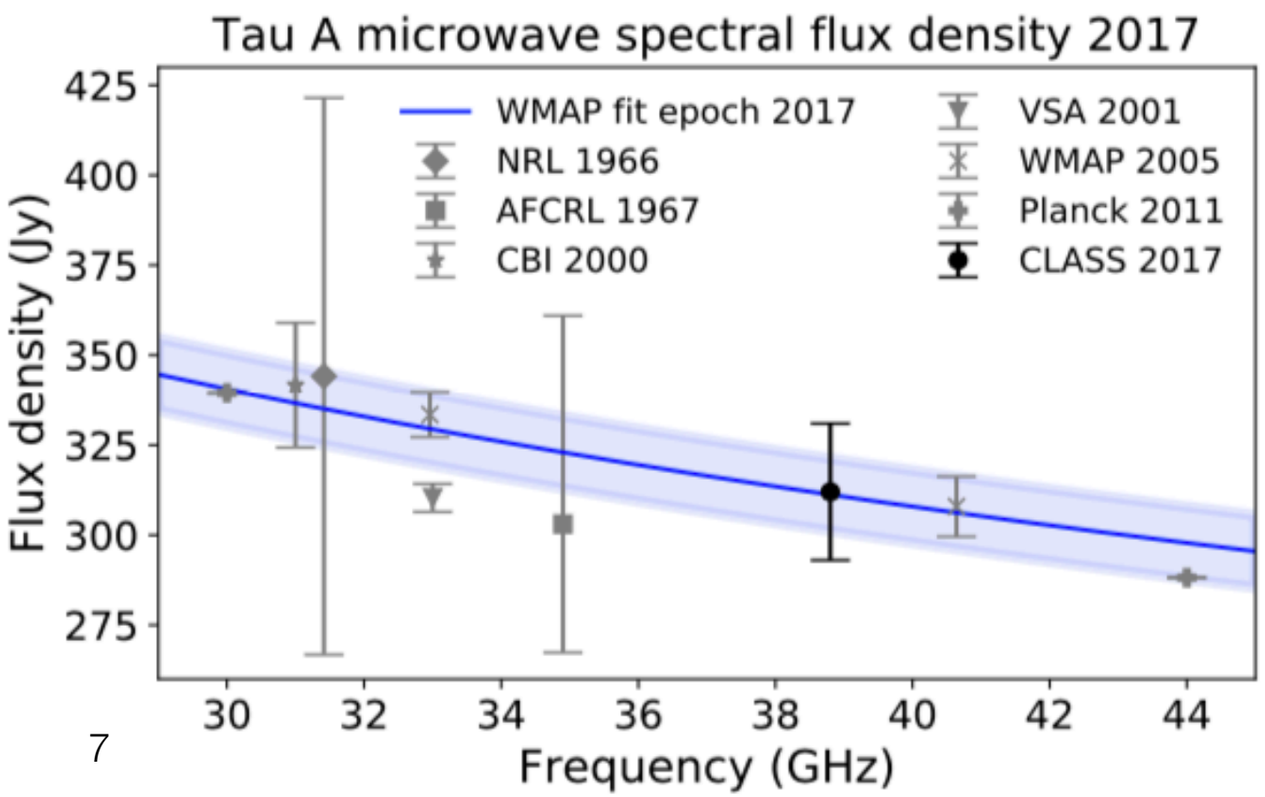


CLASS temperature survey map

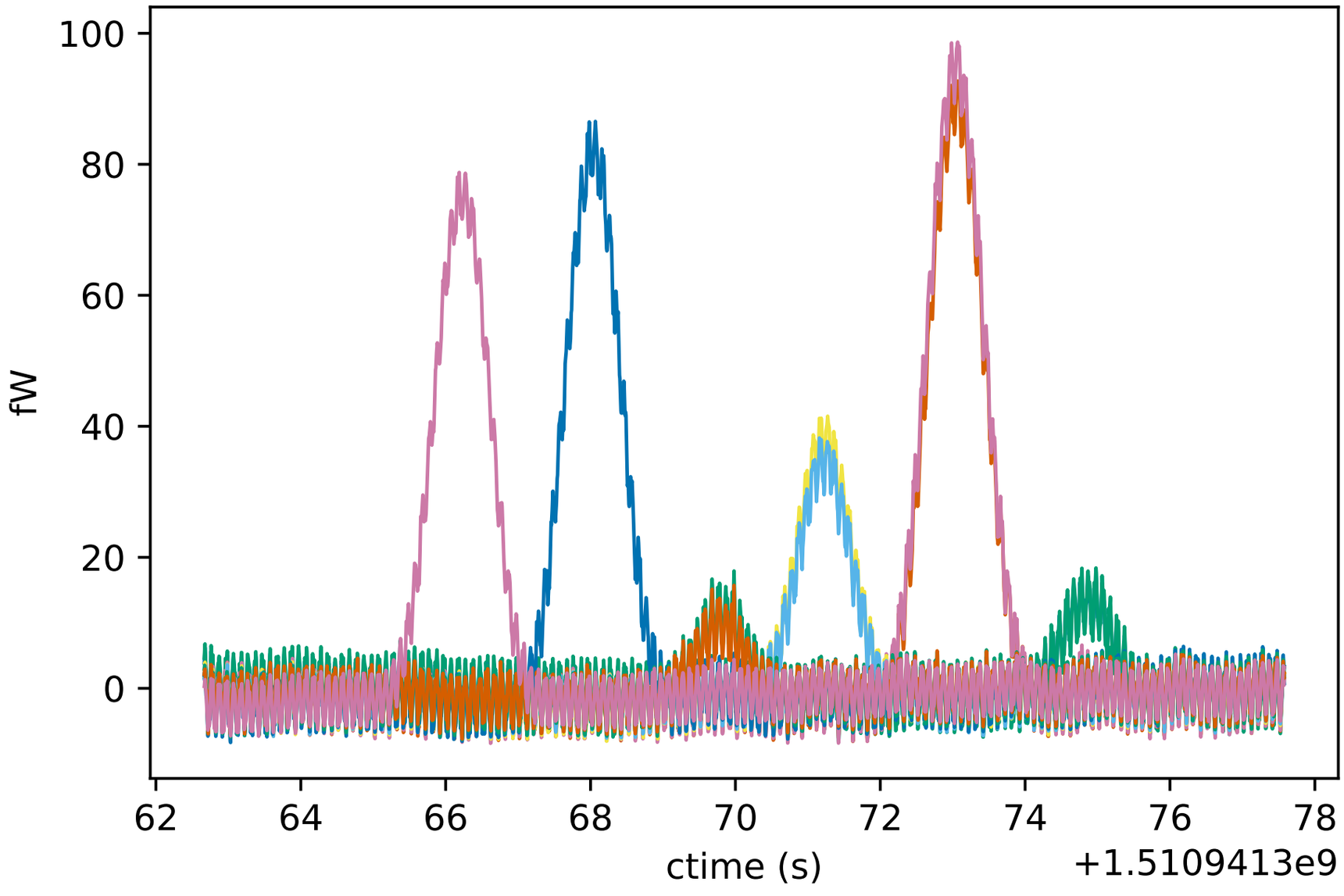


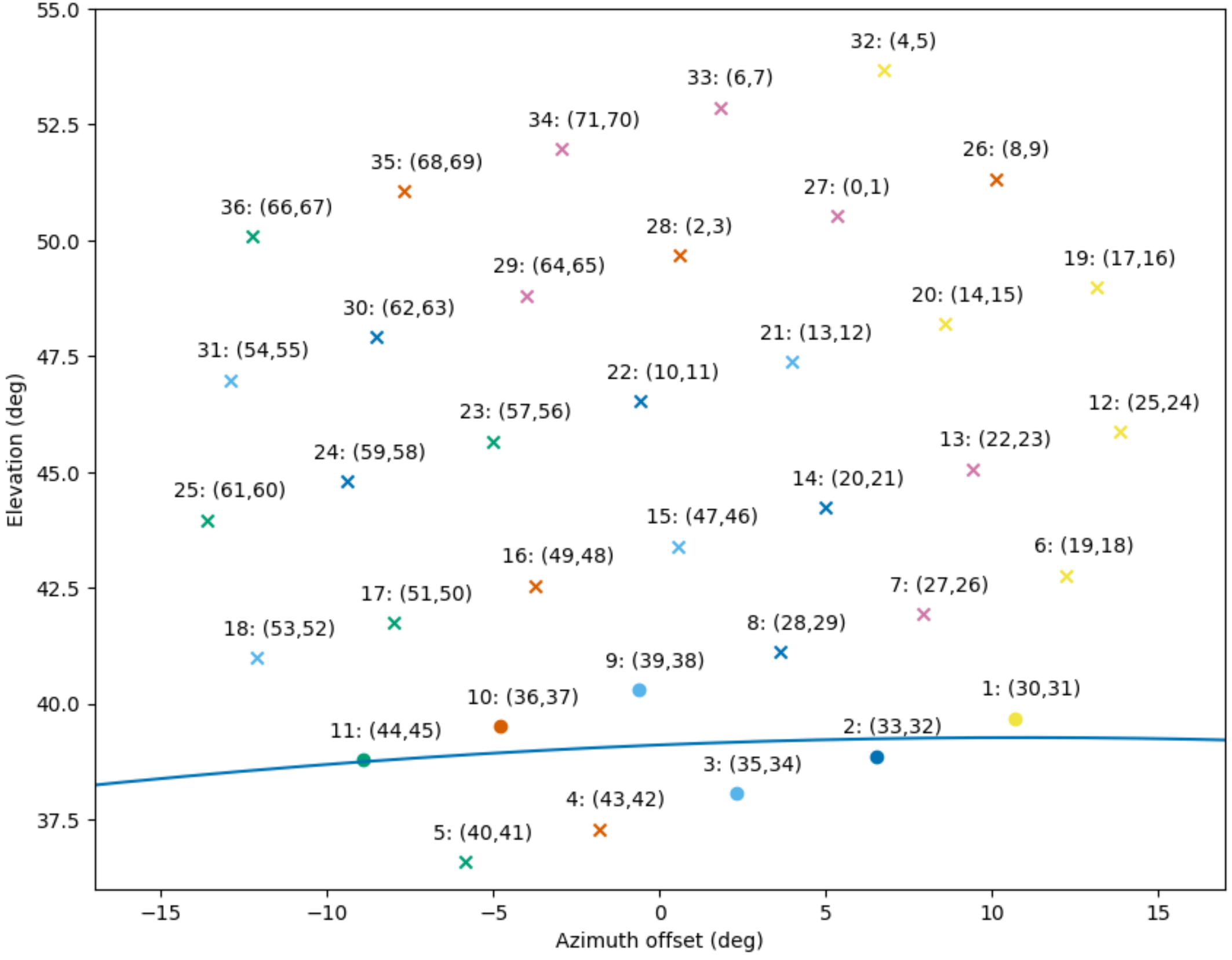
(Appel, J et al. 2018 in prep)

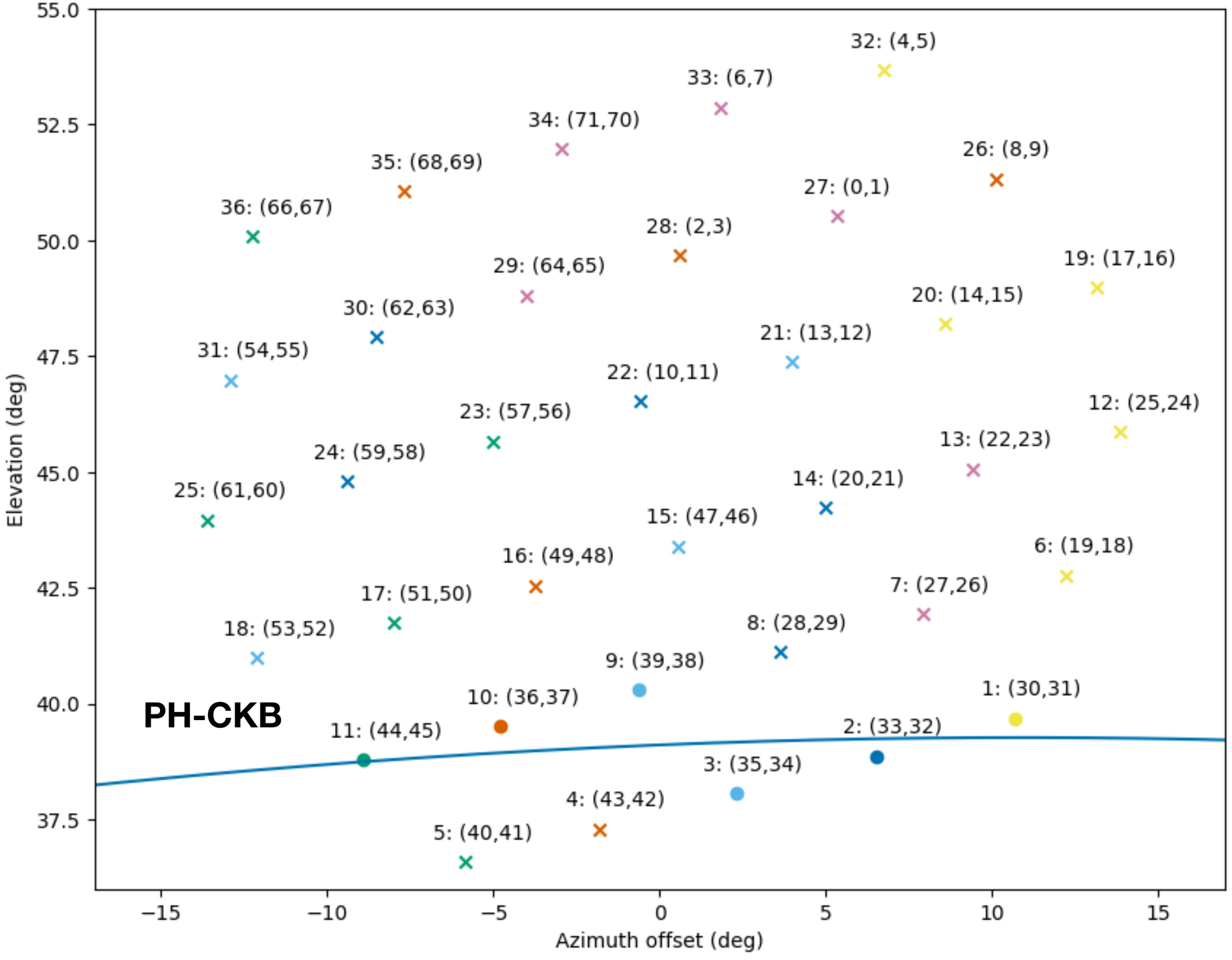




Transient events




55.0
52.5
50.0
47.5
45.0
42.5
40.0
37.5
Elevation (deg)
−15
−10
−5
0
5
10
15
Azimuth offset (deg)
32: (4,5)
33: (6,7)
34: (71,70)
35: (68,69)
36: (66,67)
26: (8,9)
27: (0,1)
28: (2,3)
29: (64,65)
19: (17,16)
20: (14,15)
30: (62,63)
31: (54,55)
21: (13,12)
22: (10,11)
12: (25,24)
23: (57,56)
13: (22,23)
24: (59,58)
14: (20,21)
25: (61,60)
15: (47,46)
6: (19,18)
16: (49,48)
7: (27,26)
17: (51,50)
18: (53,52)
8: (28,29)
9: (39,38)
1: (30,31)
10: (36,37)
2: (33,32)
11: (44,45)
3: (35,34)
4: (43,42)
5: (40,41)


PH-CKB
Elevation (deg)
Azimuth offset (deg)
55.0
52.5
50.0
47.5
45.0
42.5
40.0
37.5
−15
−10
−5
0
5
10
15
1: (30,31)
2: (33,32)
3: (35,34)
4: (43,42)
5: (40,41)
6: (19,18)
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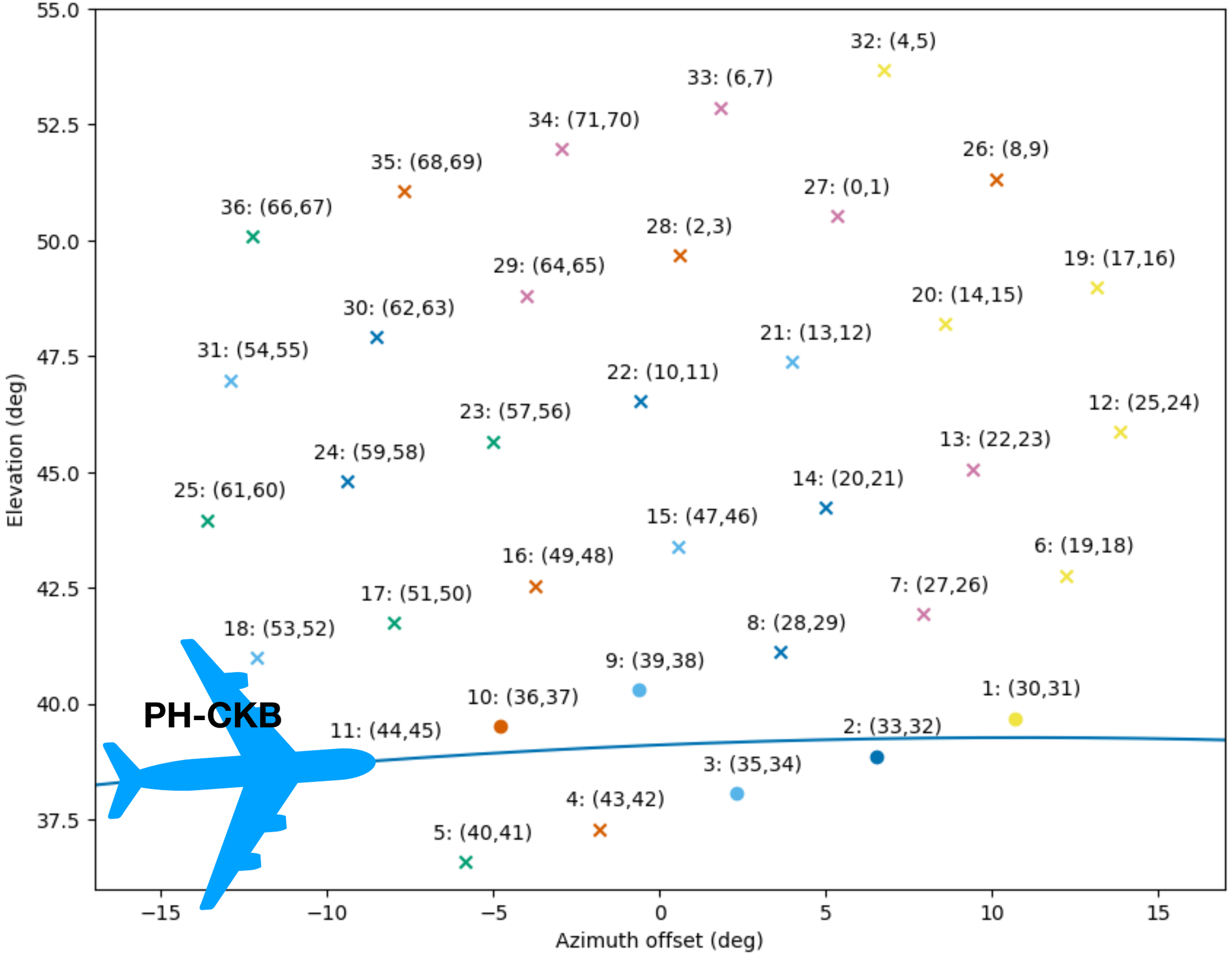
55.0
52.5
50.0
47.5
45.0
42.5
40.0
37.5
Elevation (deg)
−15
−10
−5
0
5
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Azimuth offset (deg)
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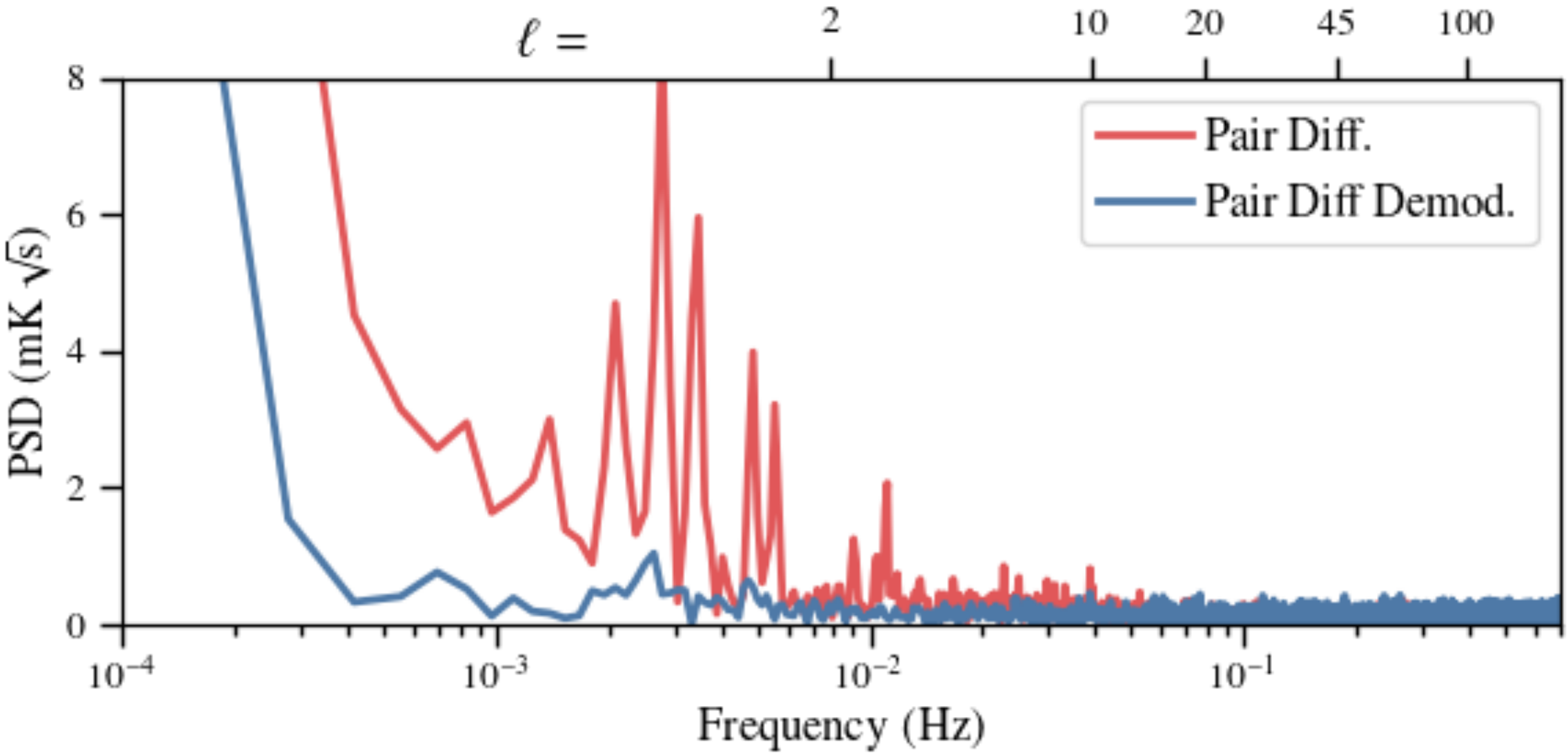
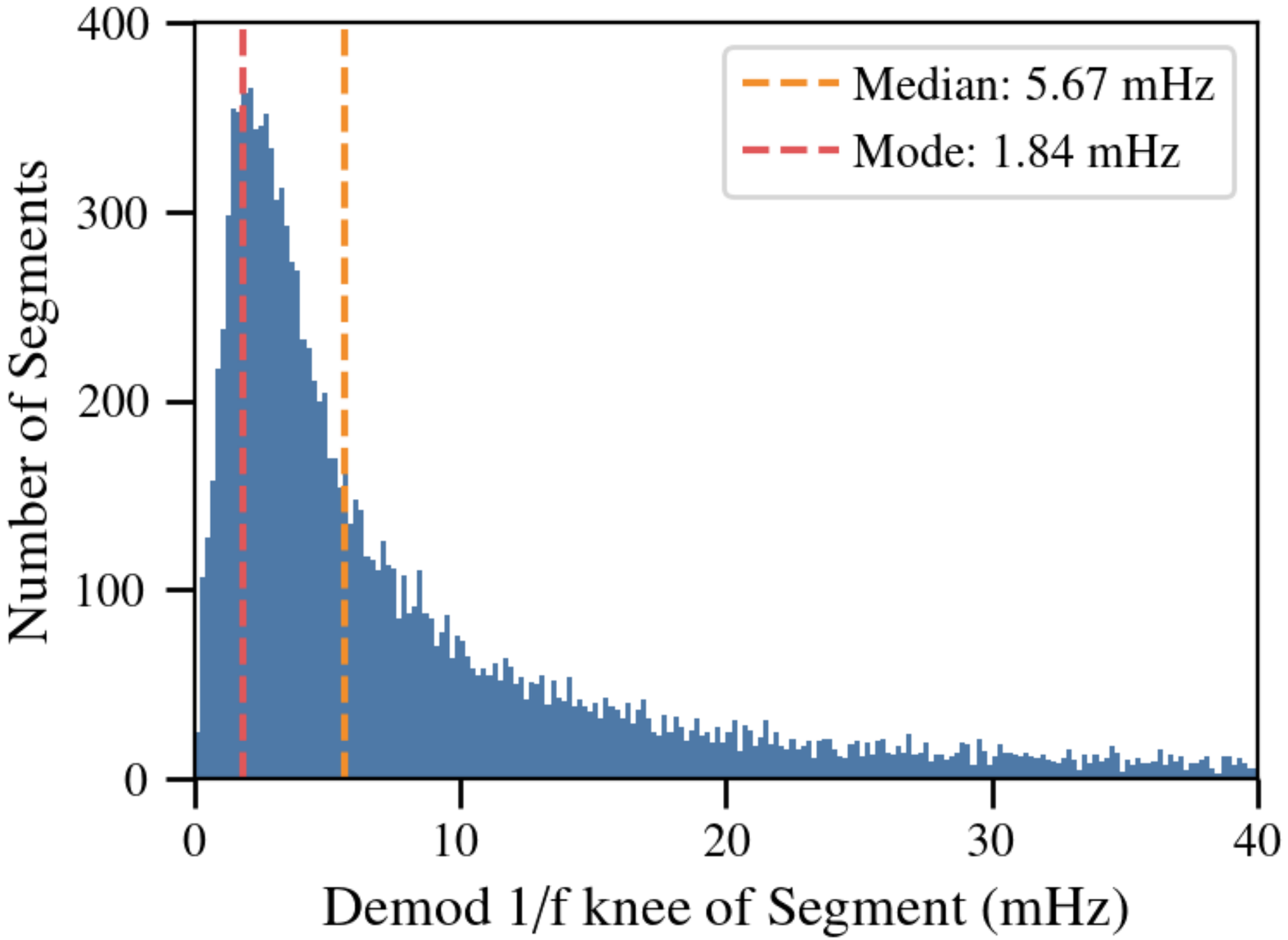
2: (33,32)
3: (35,34)
4: (43,42)
5: (40,41)

Space-like stability from the ground



(Harrington, K. et al. 2018 in prep)

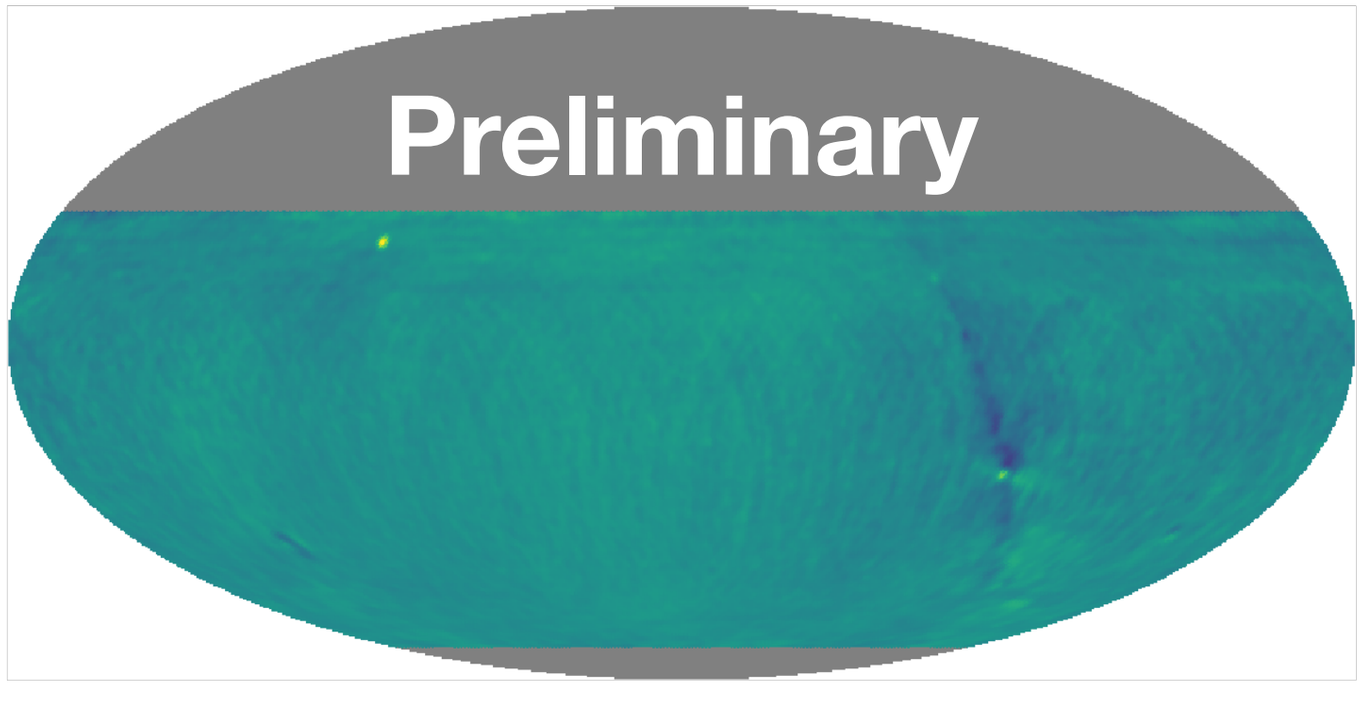
Space-like stability from the ground



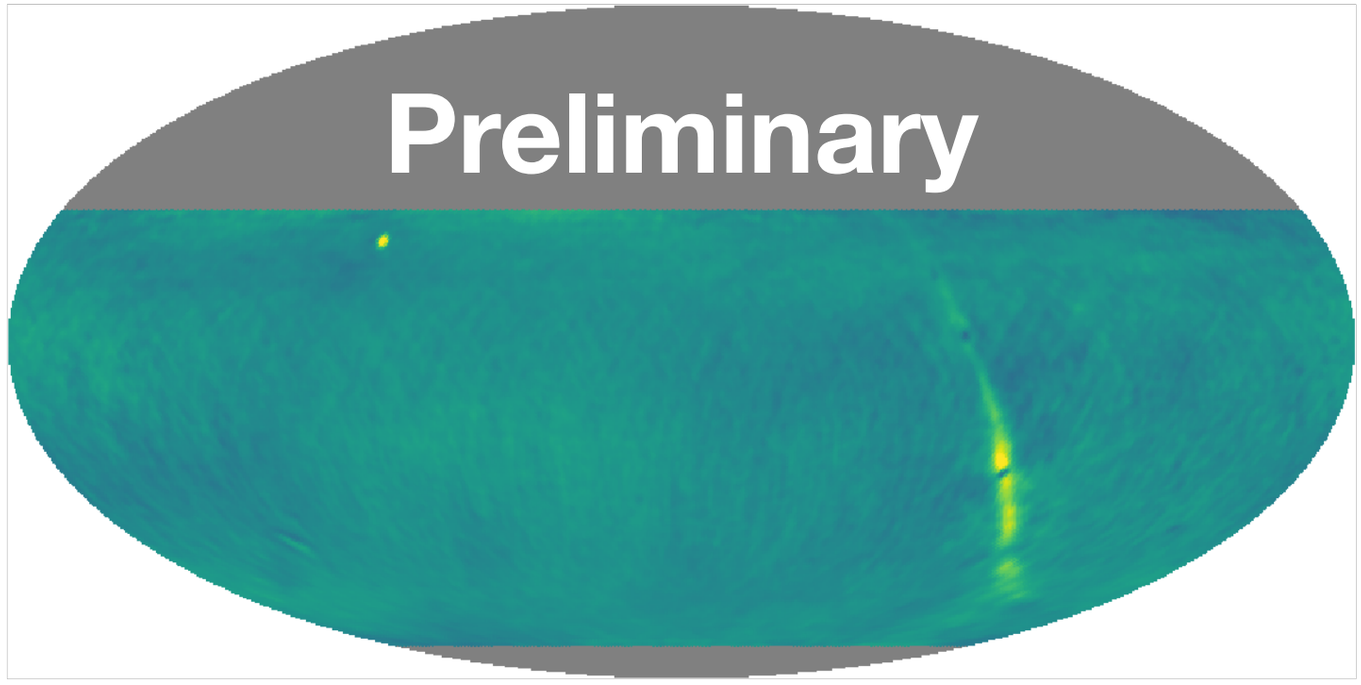
(Harrington, K. et al. 2018 in prep)

CLASS polarization survey maps

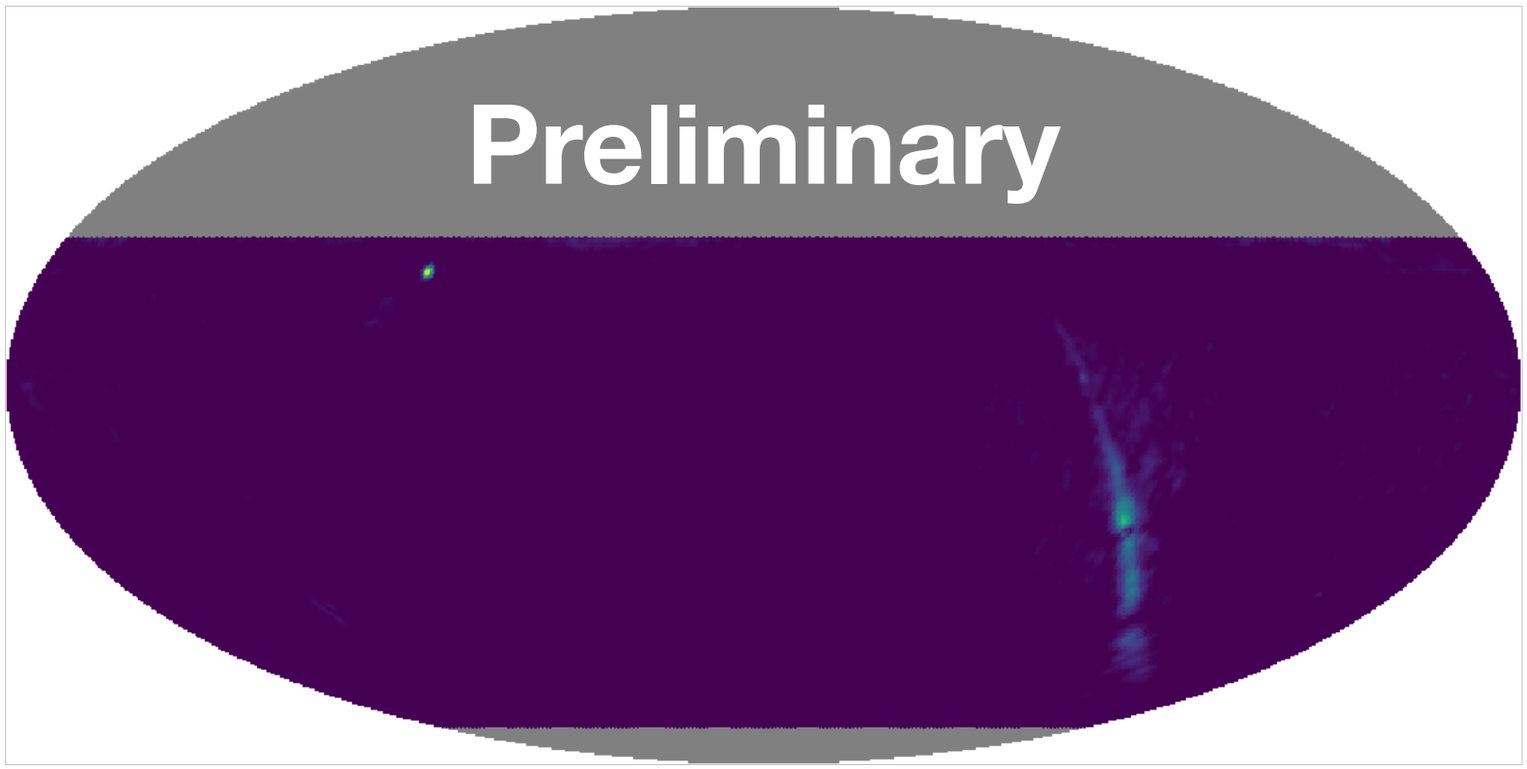
Q



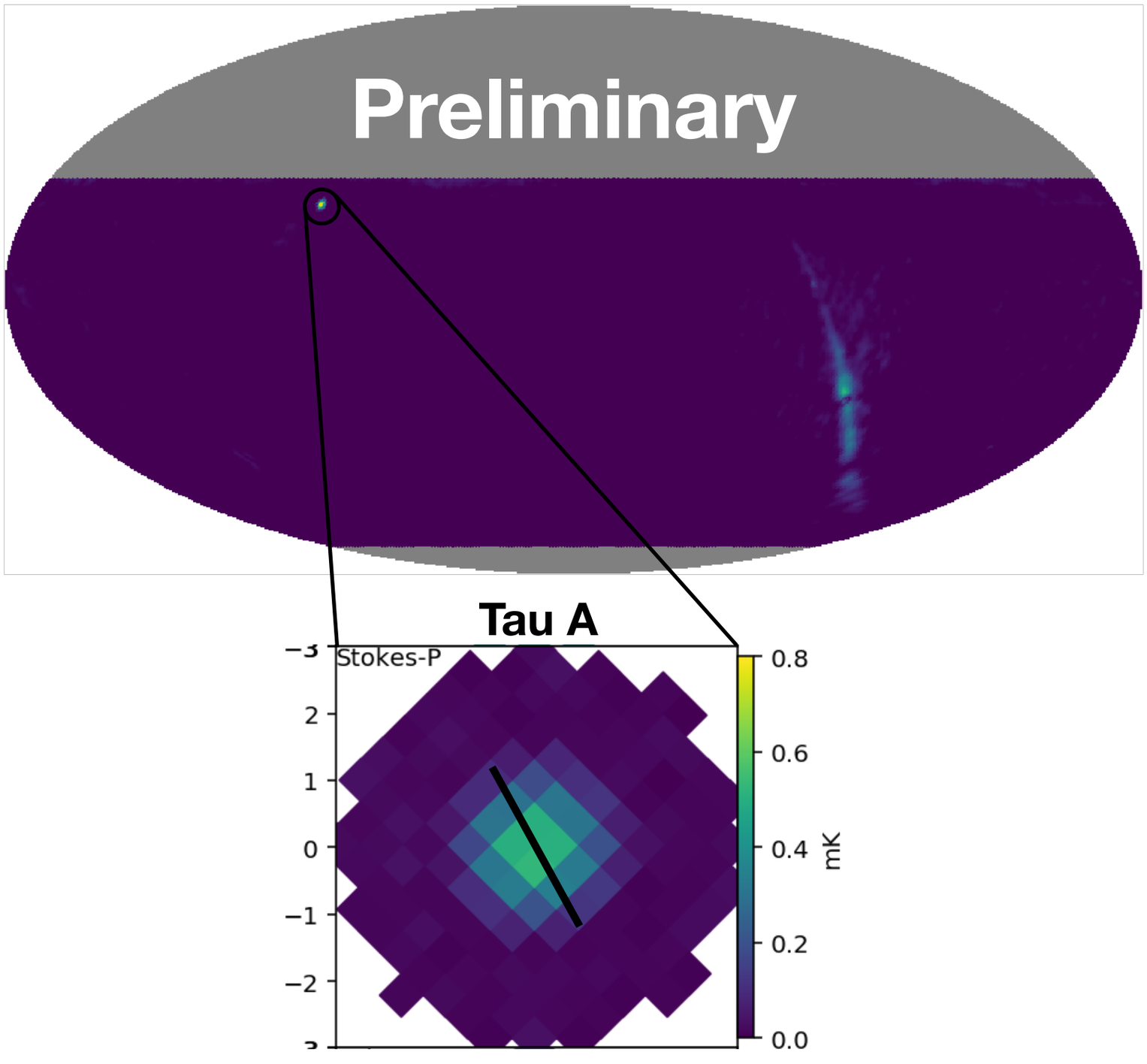
U



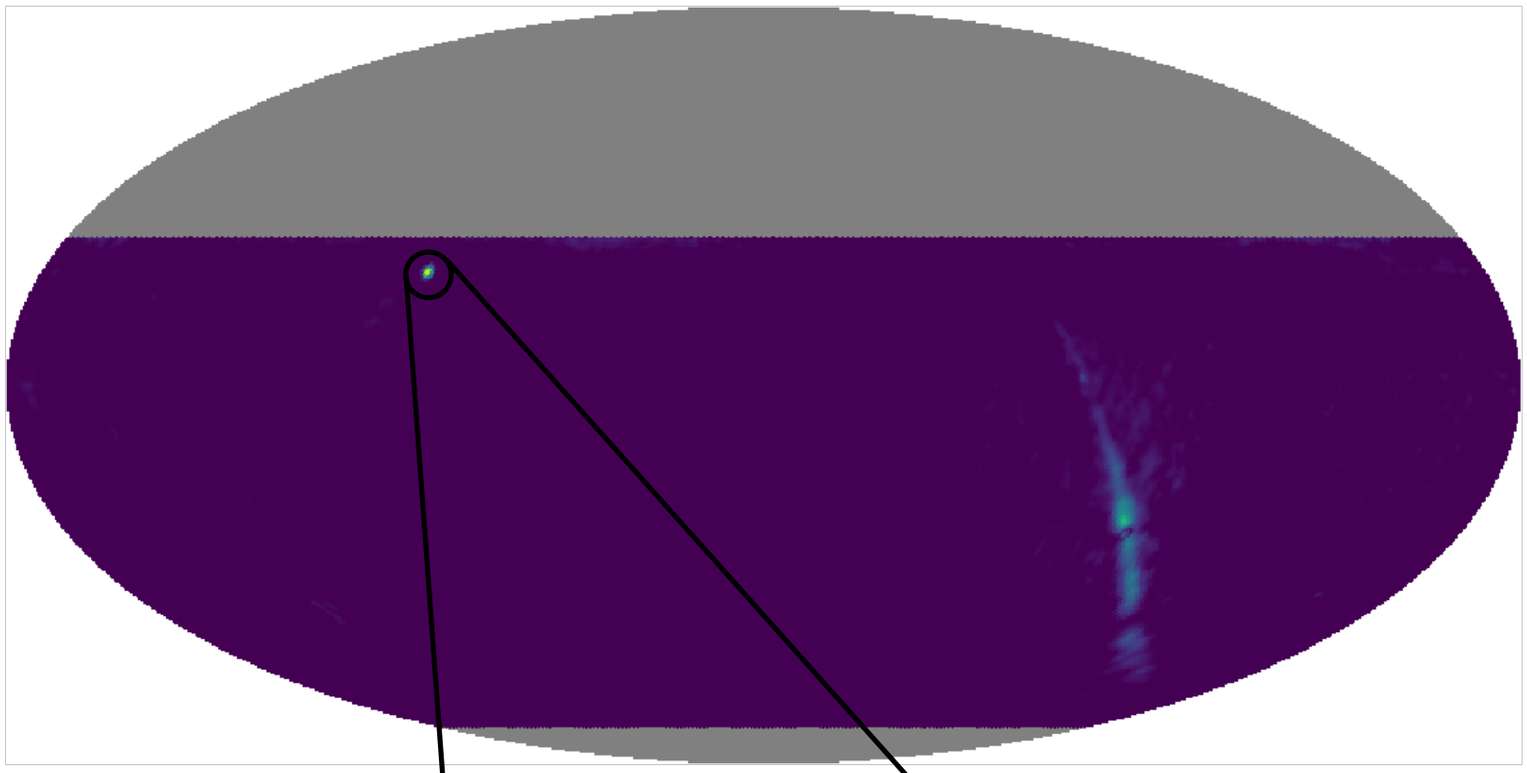
CLASS total polarization survey map



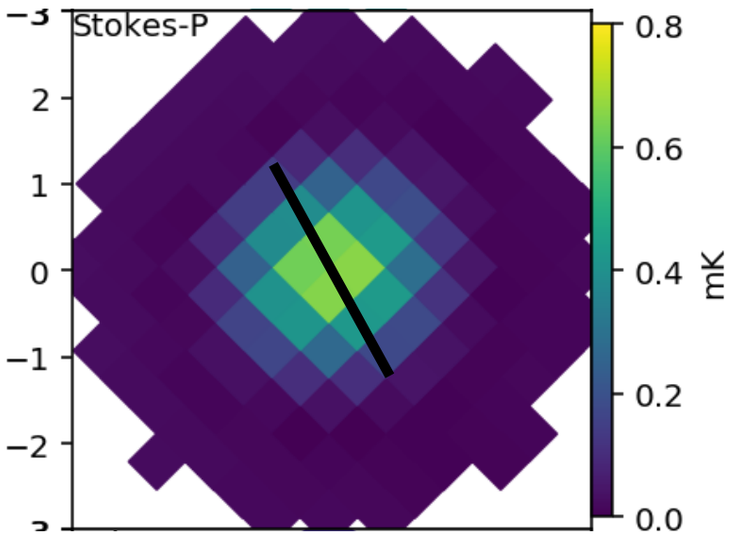
Measure polarization of Tau A



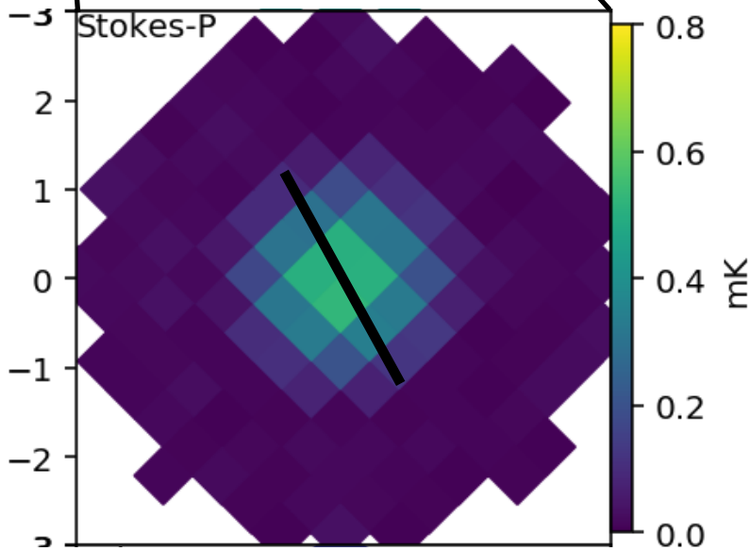
Prior to any angle calibration, differences with WMAP are less than 1º.

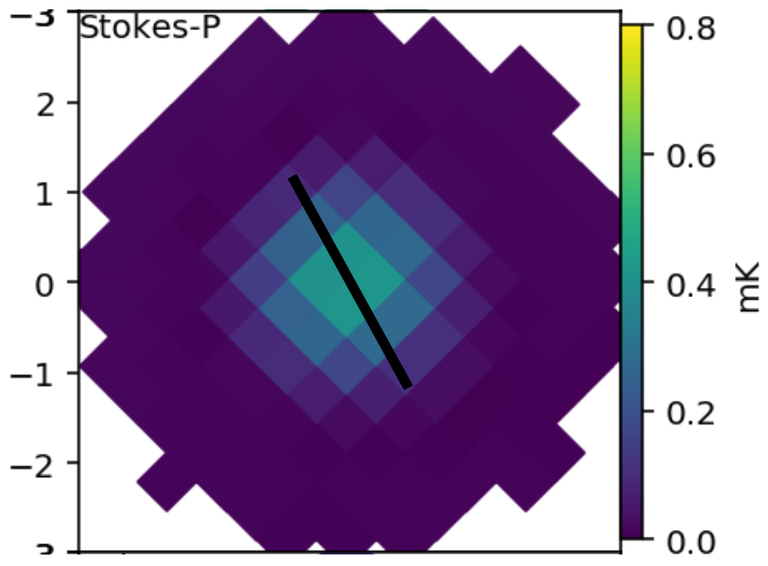


Tau A



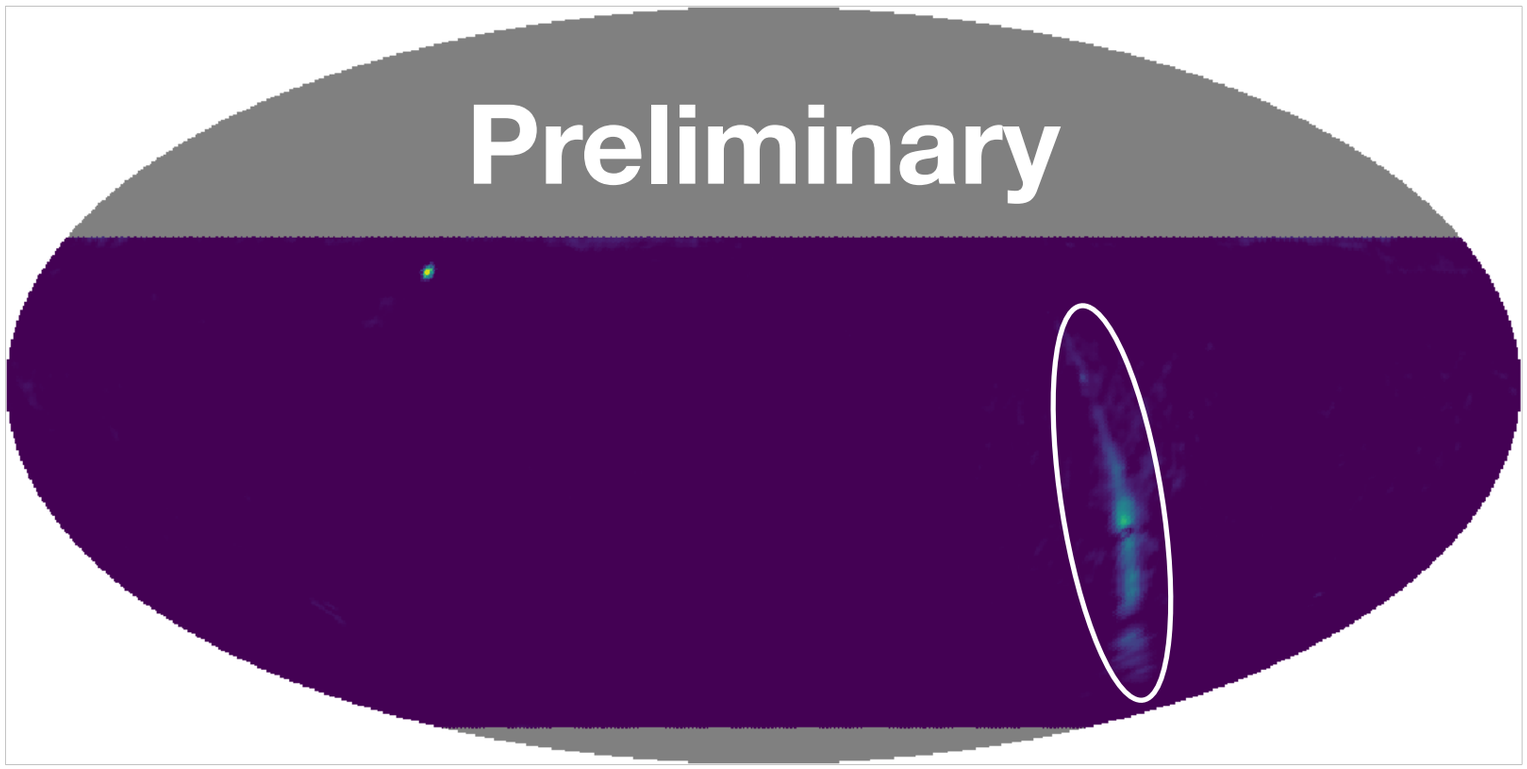
WMAP Ka



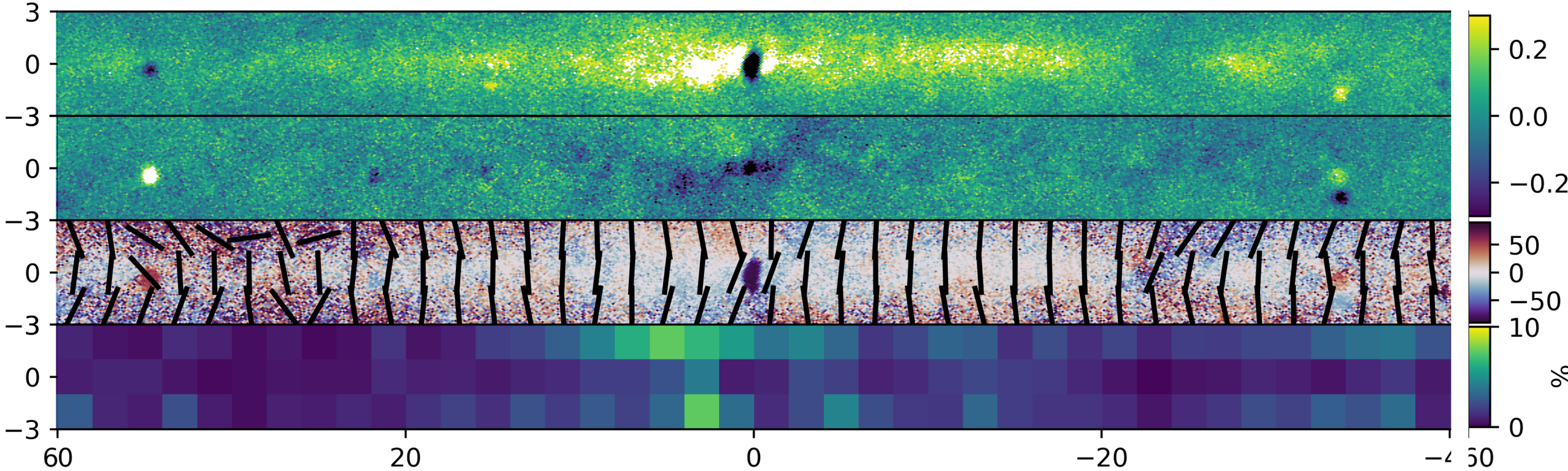


WMAP Q

Compare polarization recovery on extended sources.

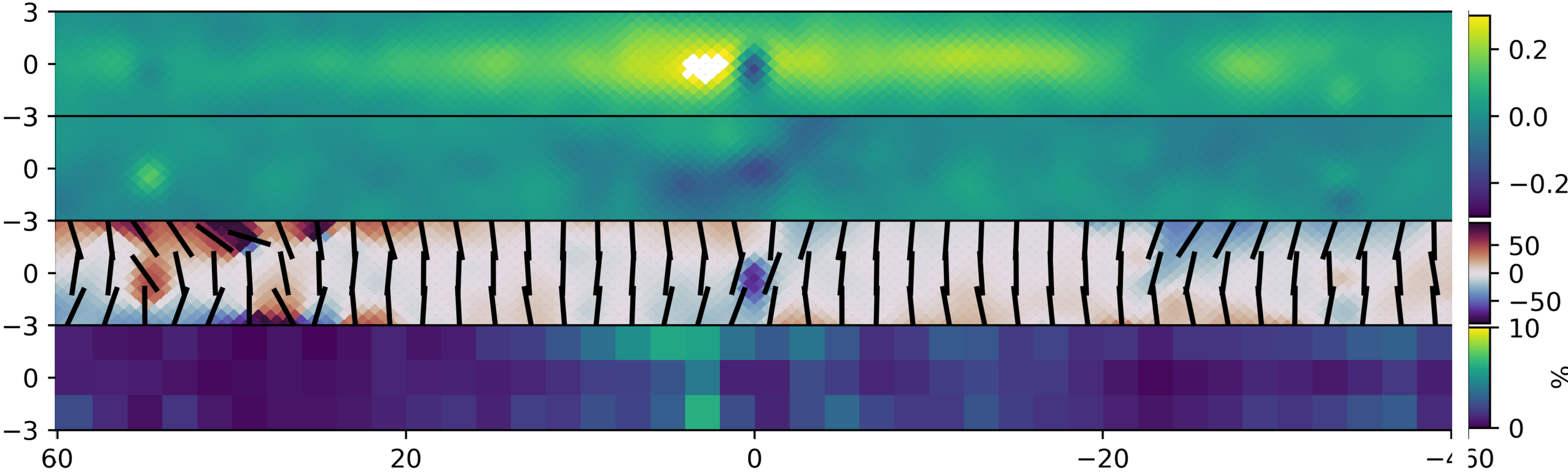


WMAP Ka-band

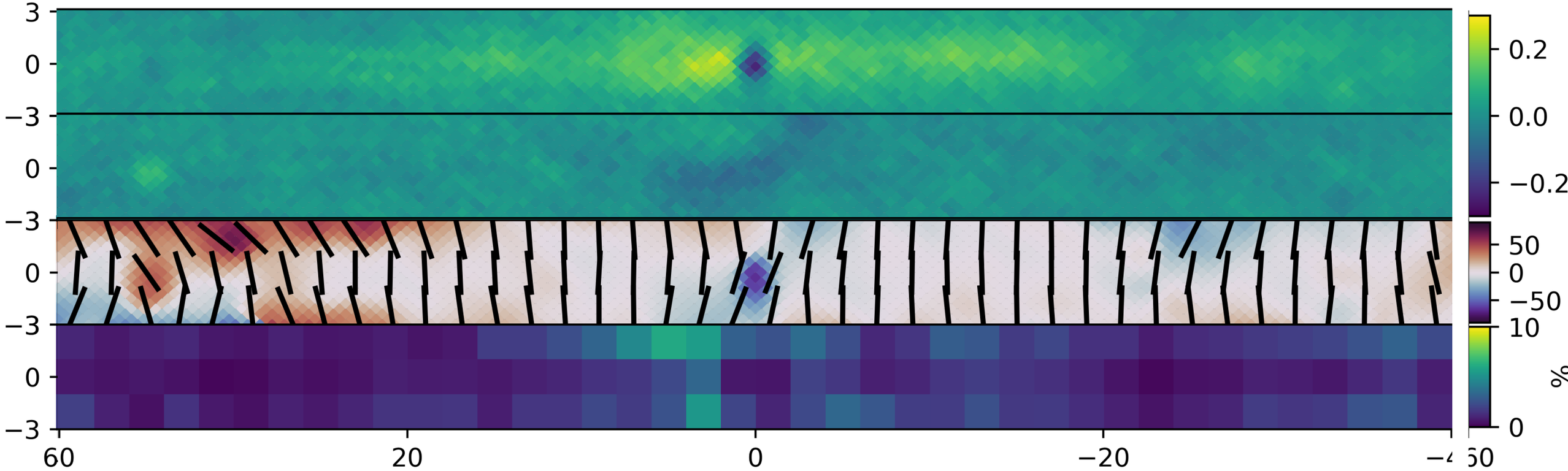


WMAP Ka-band

Smoothed with 1.5 deg Gaussian

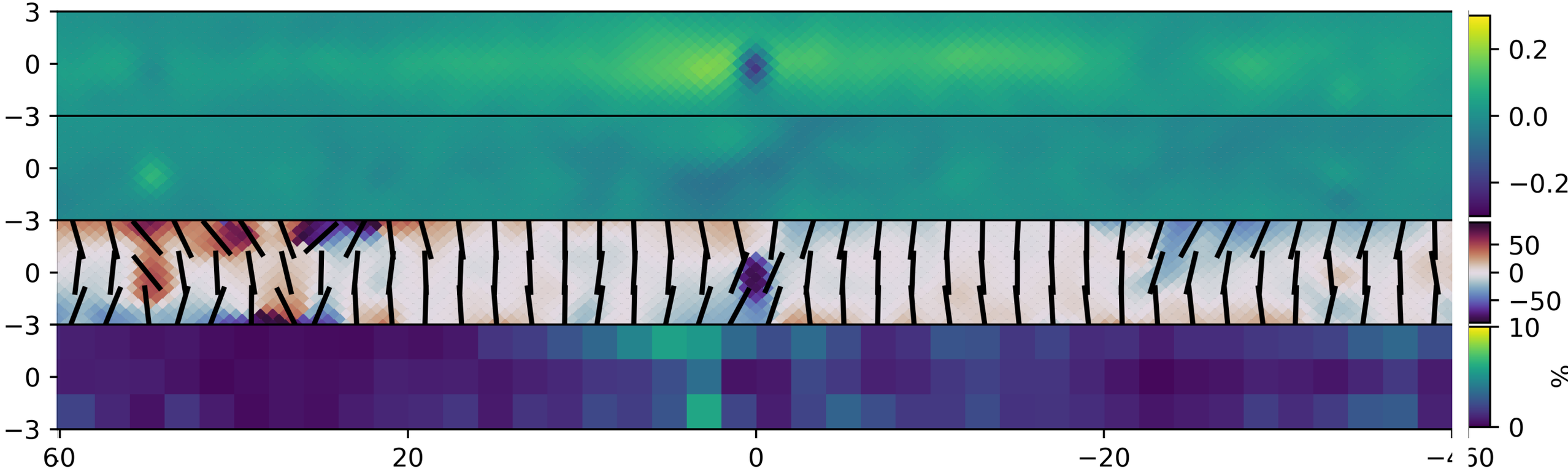


CLASS Q-band



WMAP Q-band

Smoothed with 1.5 deg Gaussian



Conclusions

- **Temperature calibration and beam measurements** have been made from mapping the moon.

- Calibration is **consistent with point sources** in the temperature map.

- Front-end polarization modulation has enabled us to make **large-scale maps** of the sky.

- The maps are **consistent with the point sources and extended sources** from previous measurements.

Thank you