TEXAS A&M UNIVERSITY
Physics & Astronomy

SIMONS OBSERVATORY

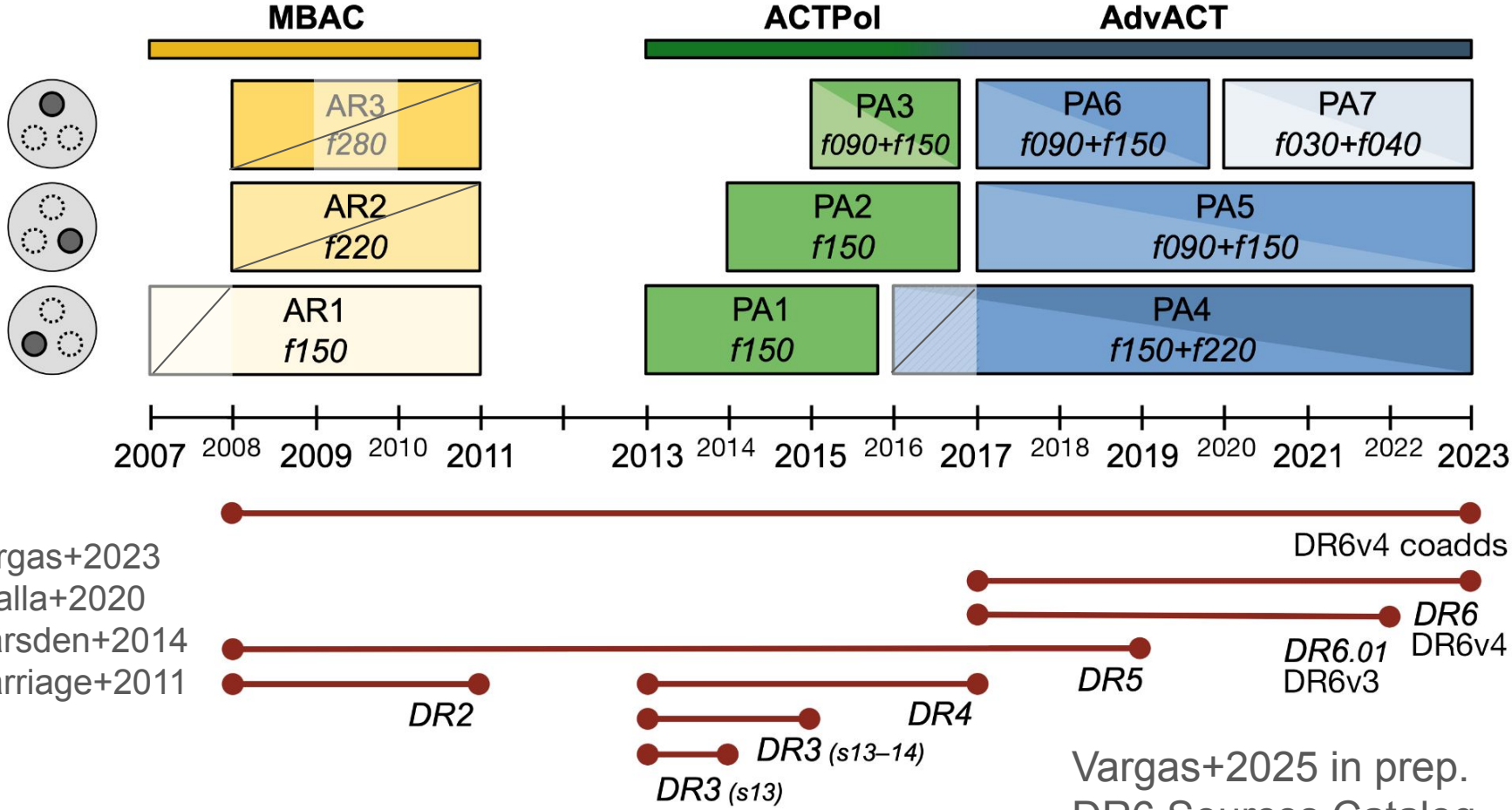
CMB S4

Extragalactic Millimeter Sources from Atacama Cosmology Telescope Observations

Cristian Vargas

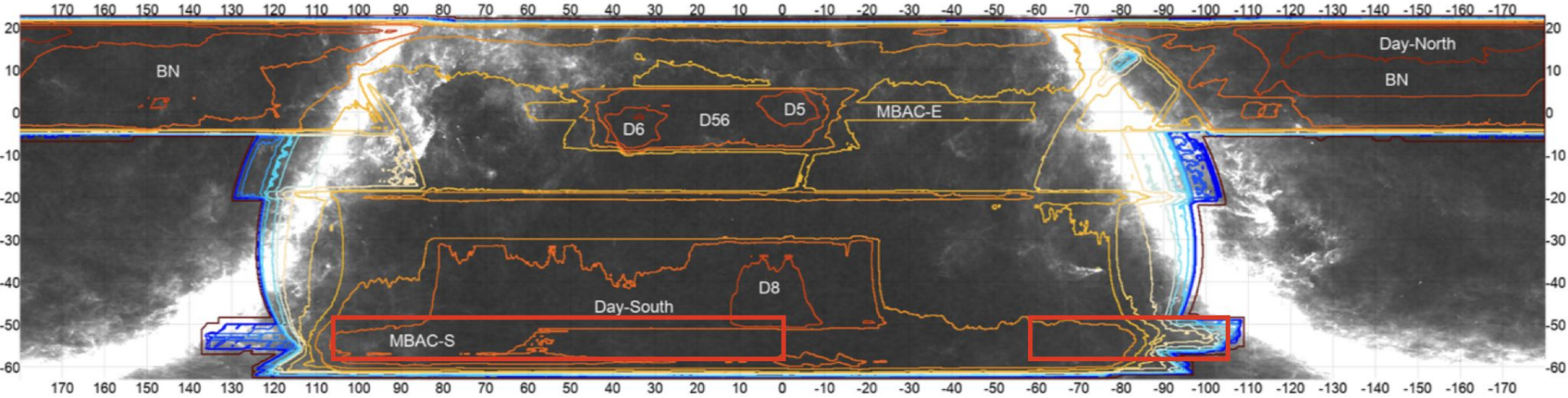
mm-Universe Conference **25/06/2025**

ACT Arrays and Timeline



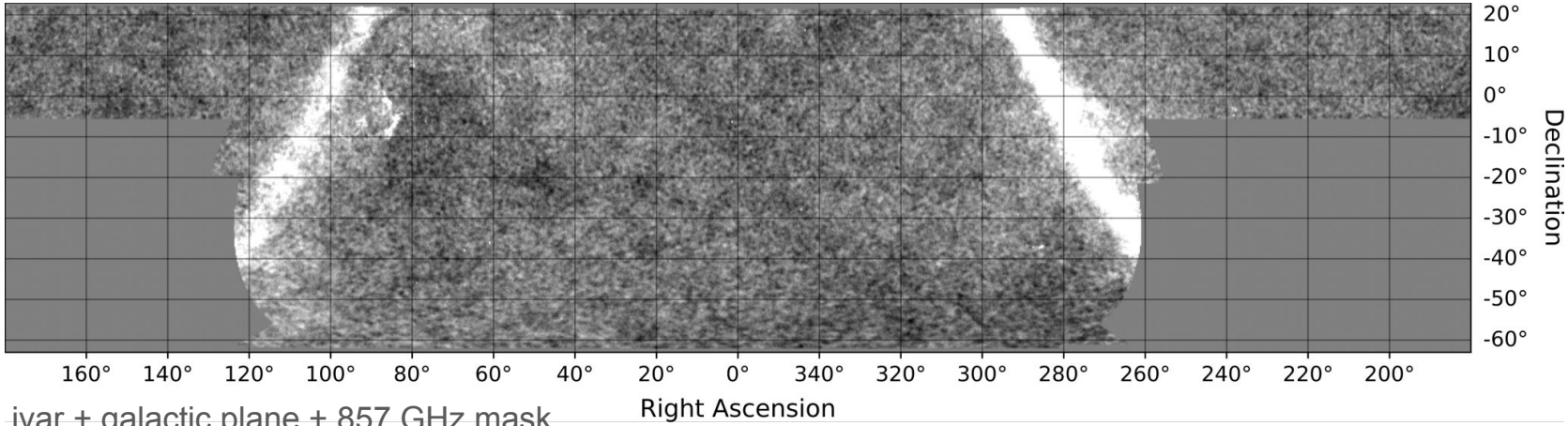
Vargas+2025 in prep.
DR6 Sources Catalog

Example f150 ACT-only daynight DR6+ coadd depth (Planck 353 GHz in the background)

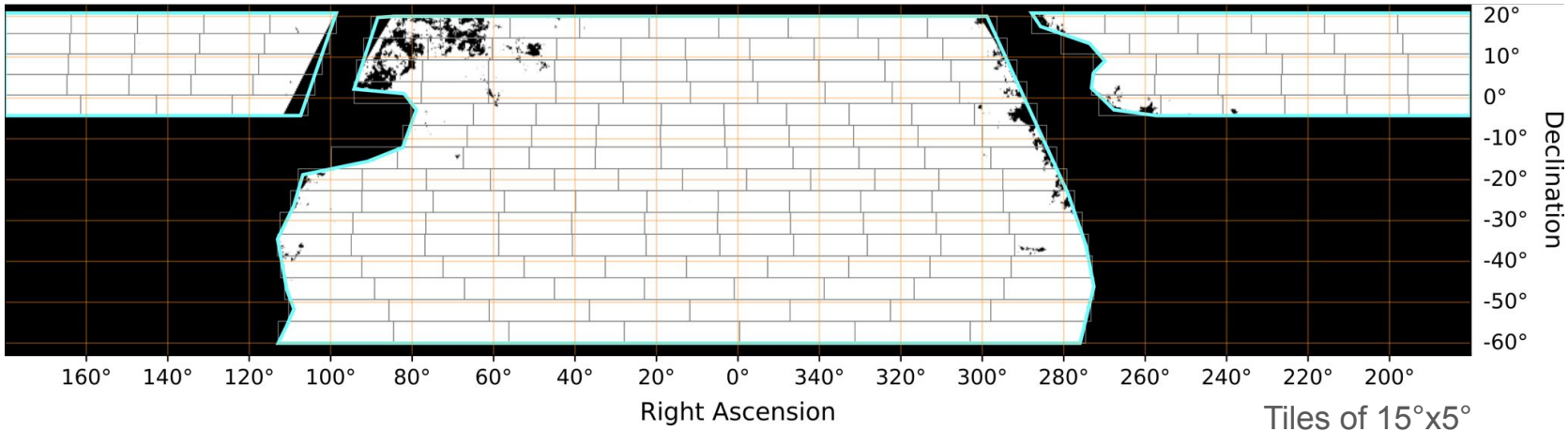


Maps, masking, tiling

Example f150 ACT+Planck daynight DR6+ coadd
From the maps paper Naess et al. 2025 arXiv:2503.14451

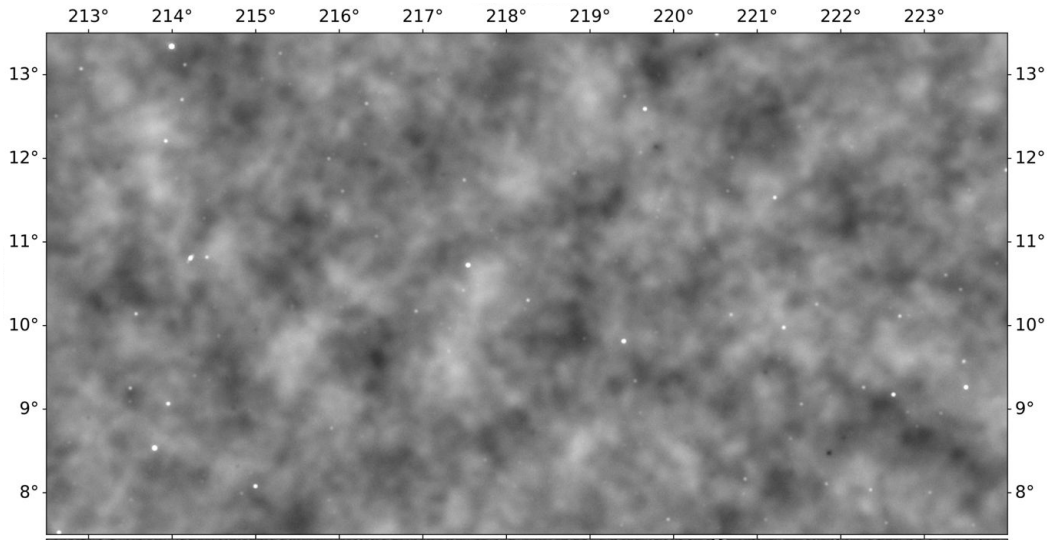


ivar + galactic plane + 857 GHz mask



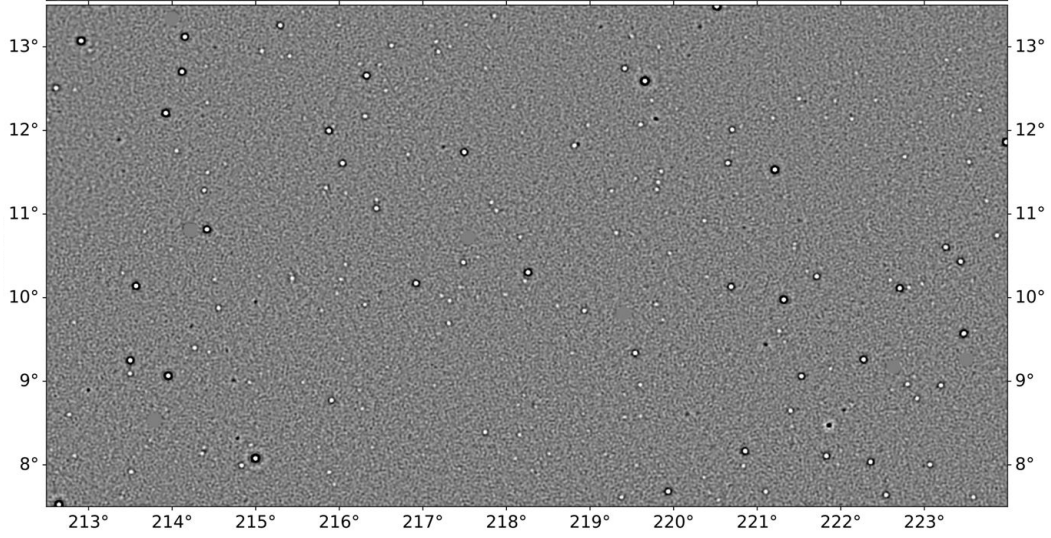
Tiles of 15°x5°

Original ACT-only
f090 day-night map



Iteration thresholds 50,
20 and 5 signal-to-noise

Second iteration
stitched filtered map



scripting + nemo

https://github.com
/simonsobs/nemo

inputs are: map,
ivar, beam, freq,
mask

subset of Dusty

Number of sources	
Synchrotron	28092
Dusty	2399
Dusty high-z	1695
Unclassified	282
Stars/Planetary nebula	85
Number of detections (5-sigma)	
Three band	3490
Two band f090 f150	18069
Two band f150 f220	3954
Two band f090 f220	3499
One band f090	28017
One band f150	20169
One band f220	4704
3-sigma measurements	
Two band f090 f150	24174
Two band f150 f220	6834
Two band f090 f220	6051

AdvACT (5-sigma)
30858 sources
15950 sq. deg.
1.935 src / sq.deg.

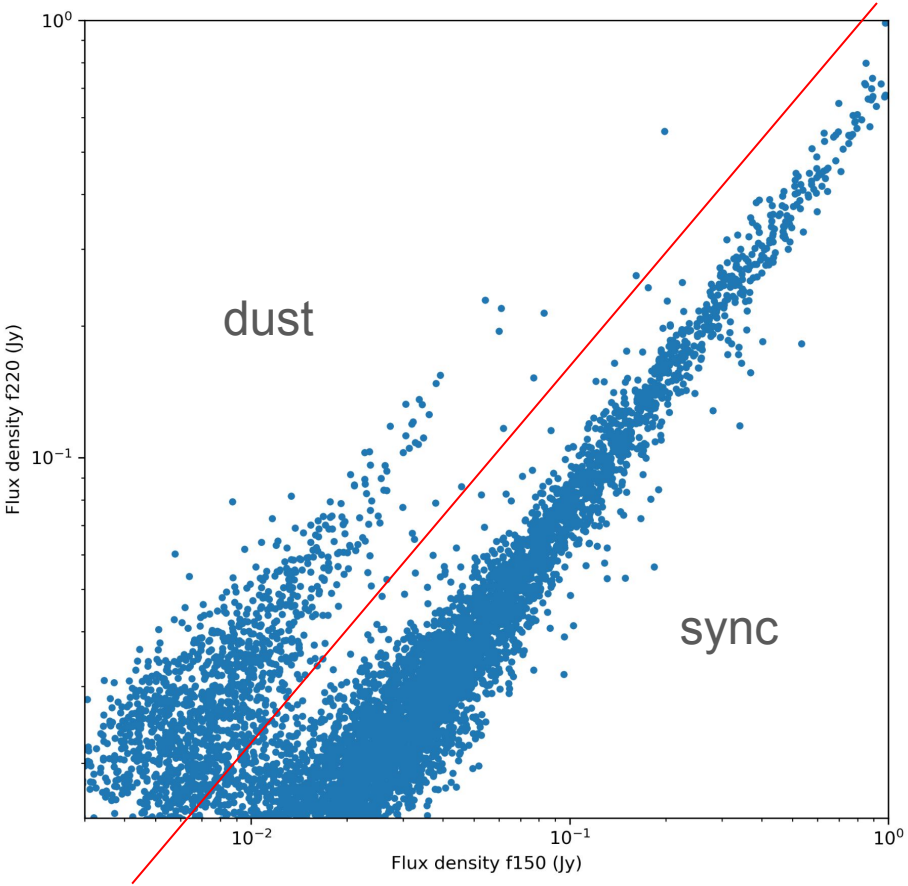
SPT (4.5-sigma)
4845 sources
2530 sq. deg.
1.915 src /sq.deg.

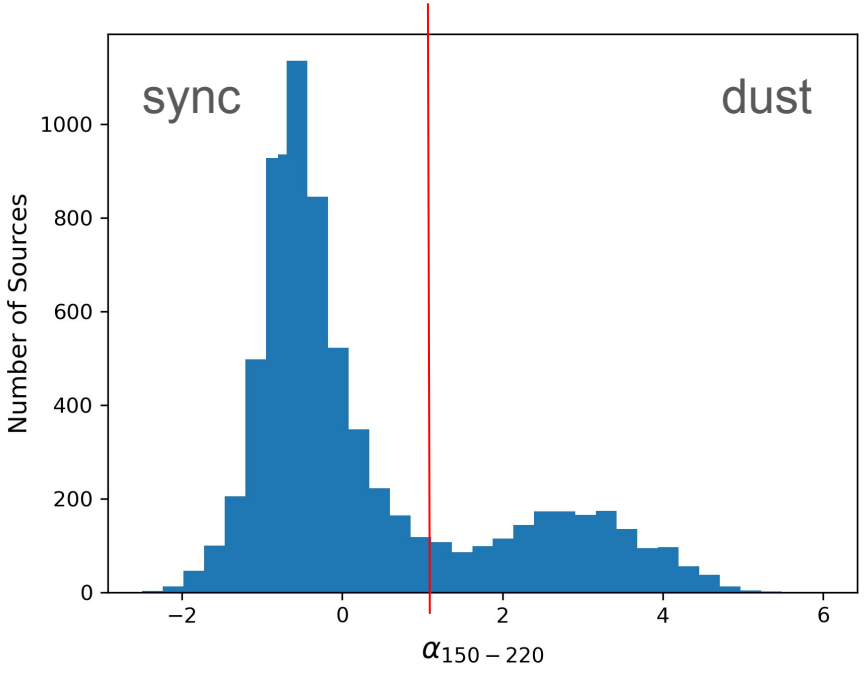
SPT 3G
~28000 sources
~1500 sq. deg.

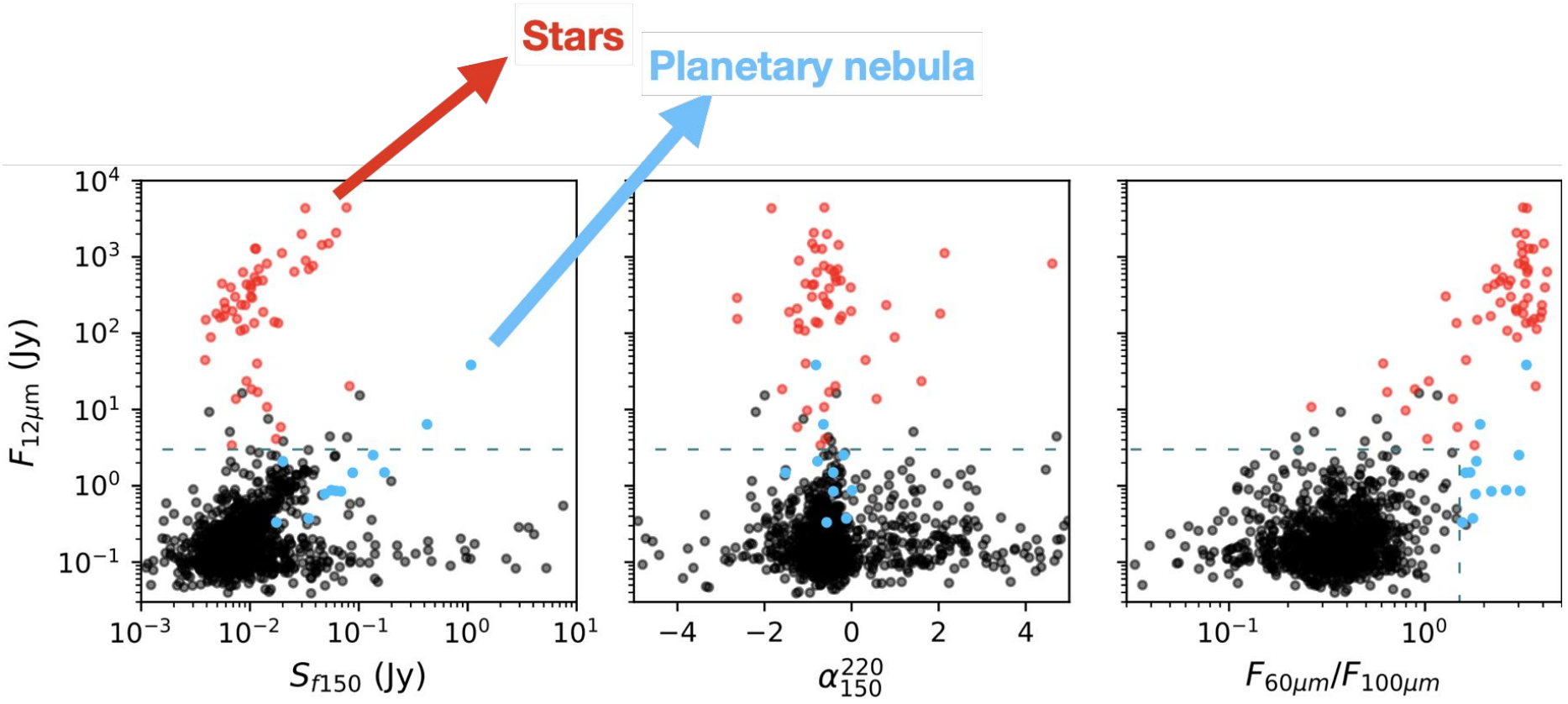
Separation of populations

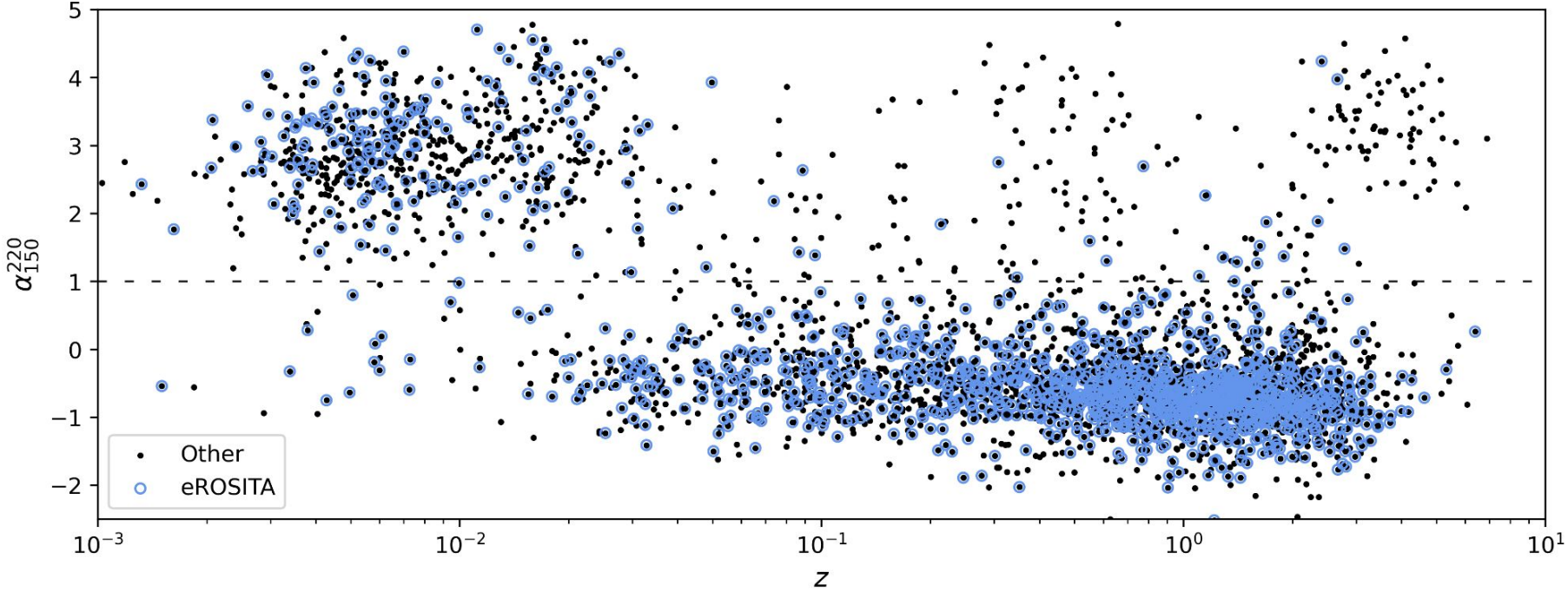
$$S_\nu \propto \nu^\alpha$$

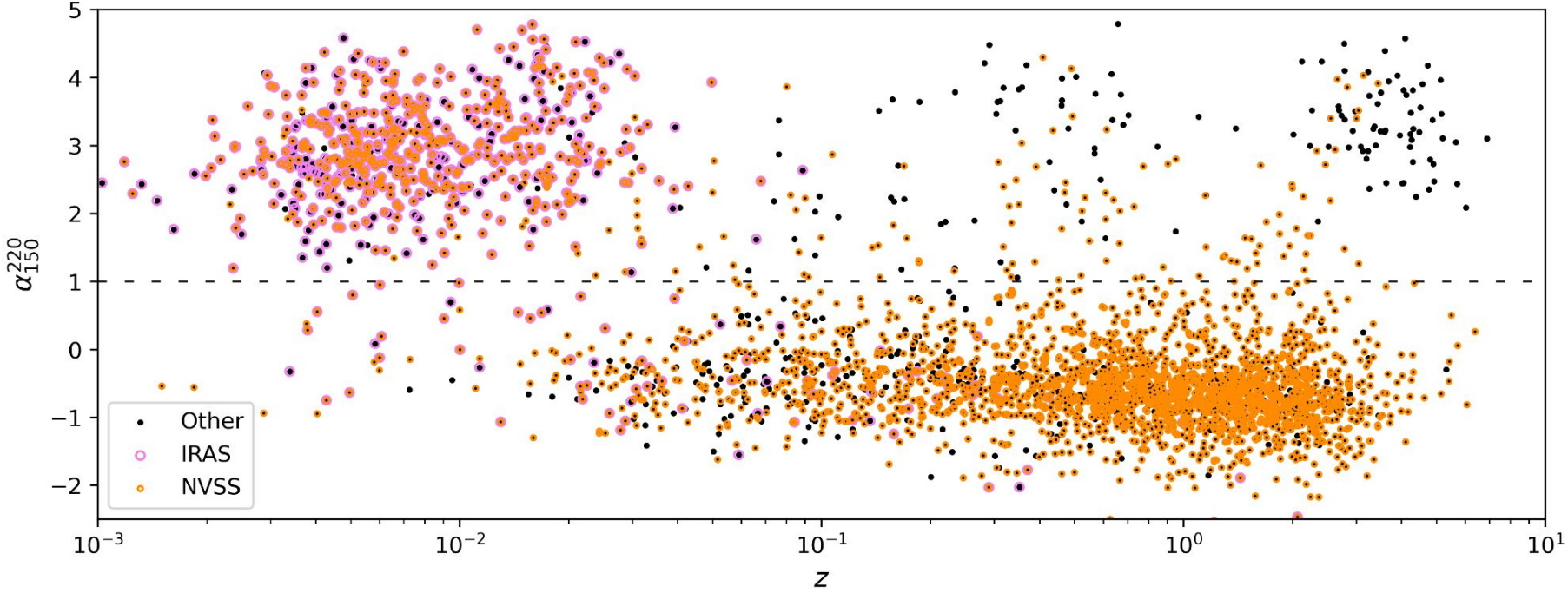
$$\alpha_{\nu_a - \nu_b} = \frac{\log(S_{\nu_a}) - \log(S_{\nu_b})}{\log(\nu_a) - \log(\nu_b)}$$



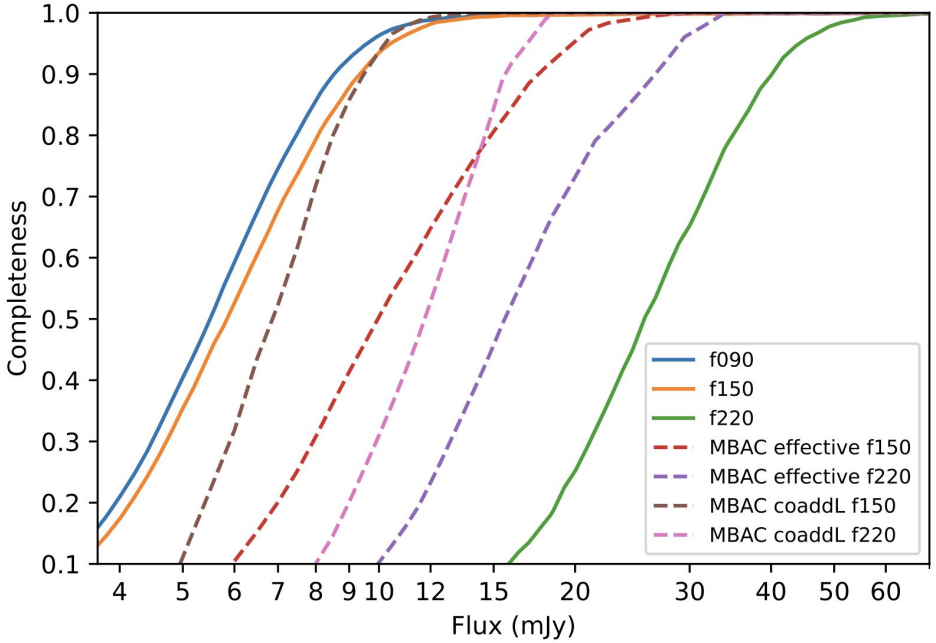


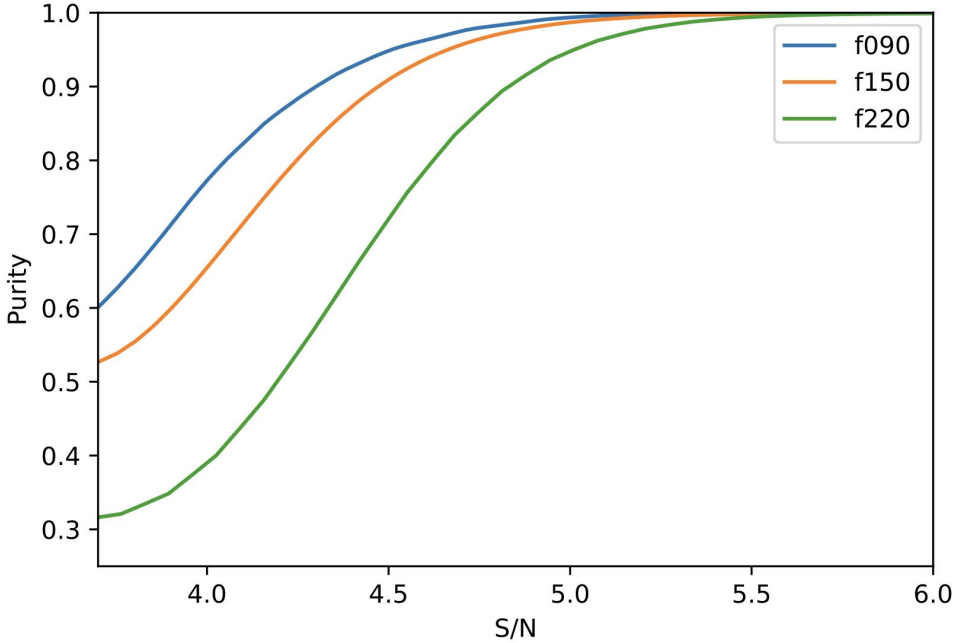

Stars
Planetary nebula
$F_{12\mu m}$ (Jy)
S_{f150} (Jy)
α_{150}^{220}
$F_{60\mu m}/F_{100\mu m}$


5
4
3
2
1
0
−1
−2
α_{150}^{220}
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
z
Other
eROSITA


5
4
3
2
1
0
−1
−2
α_{150}^{220}
Other
IRAS
NVSS
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
z

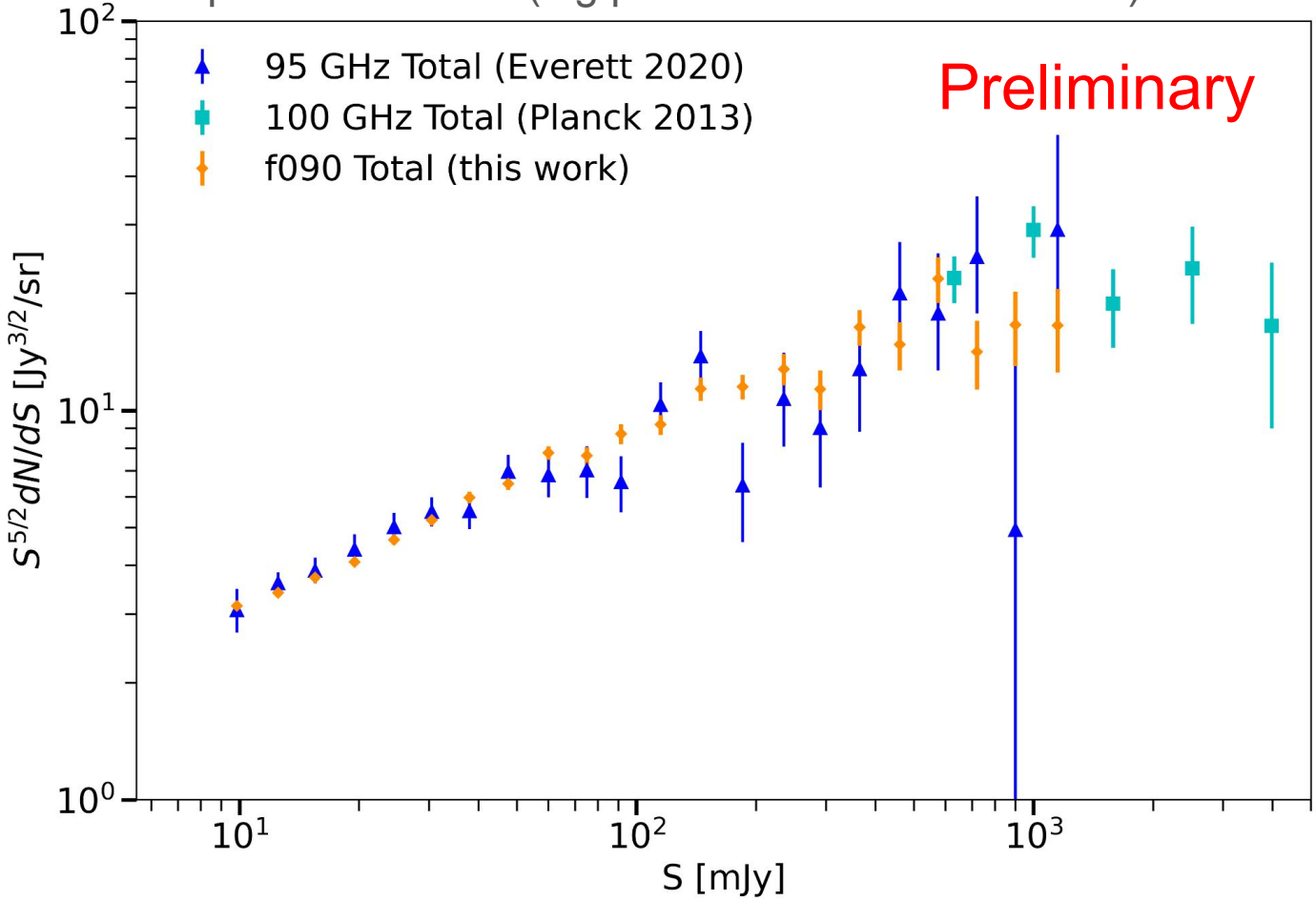
From suite of simulations (using nemo-sim-kit)

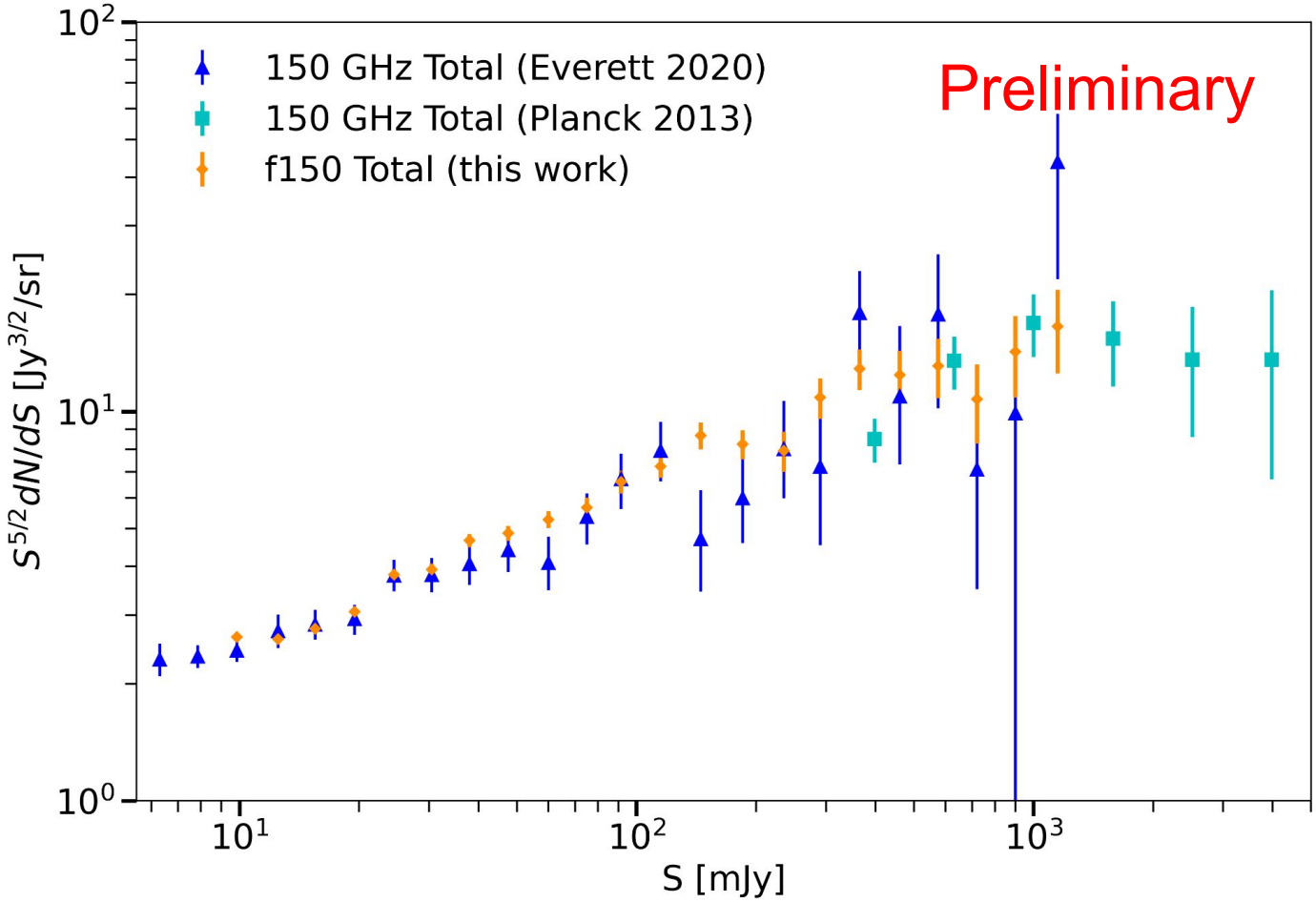


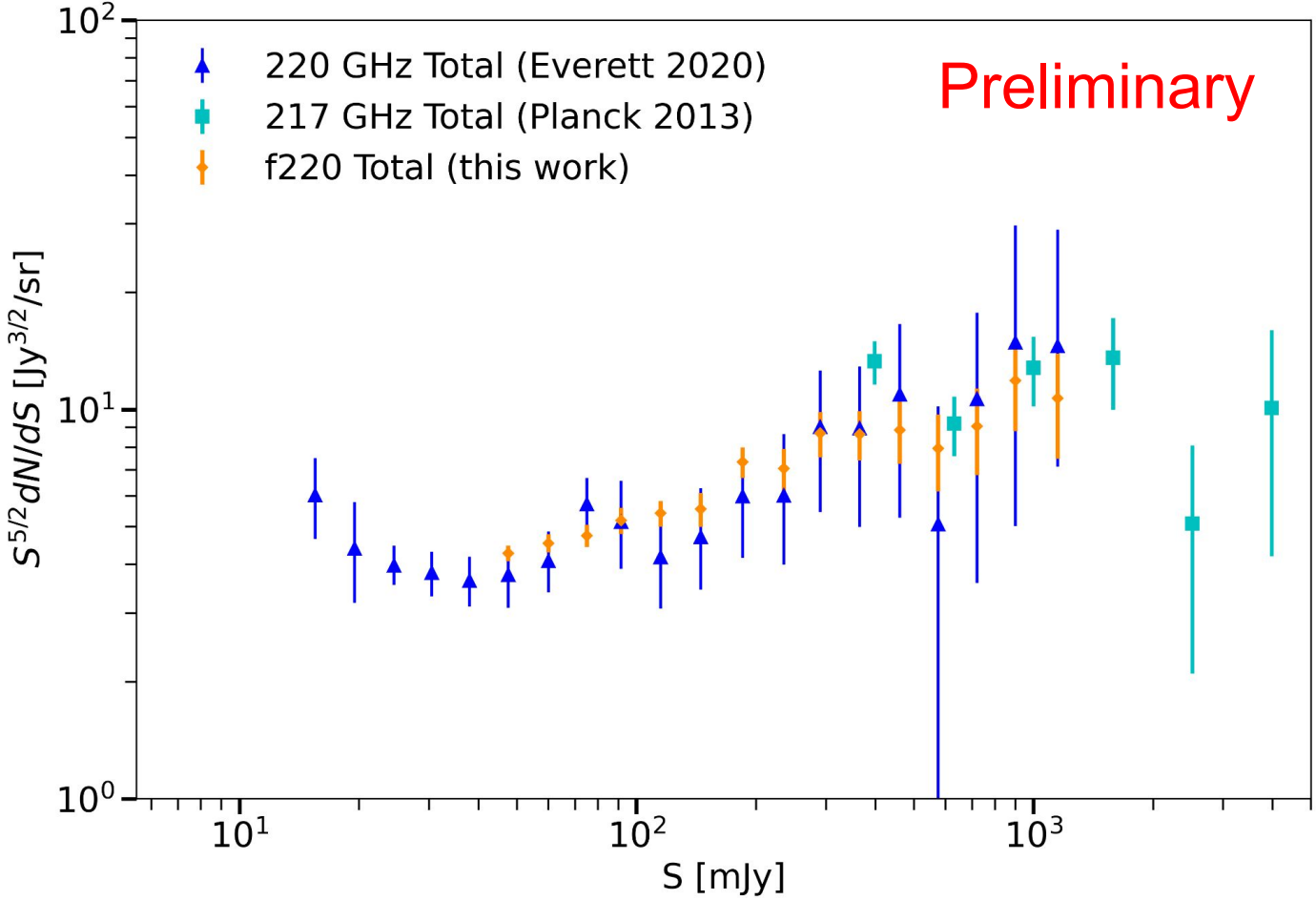


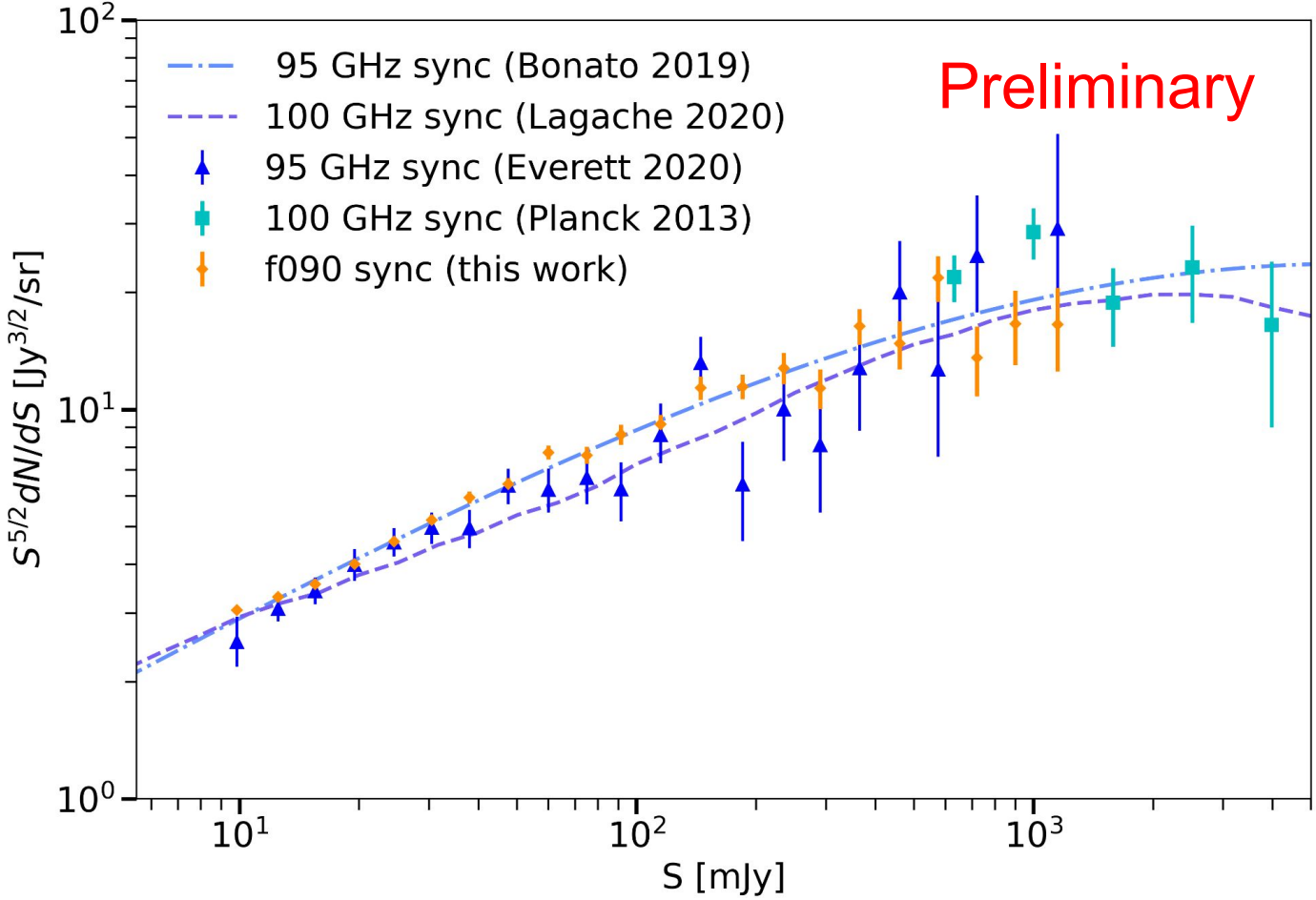
For comparison, the SPT median 95% is 12.89, 7.60, and 26.83 mJy at 95, 150, 220

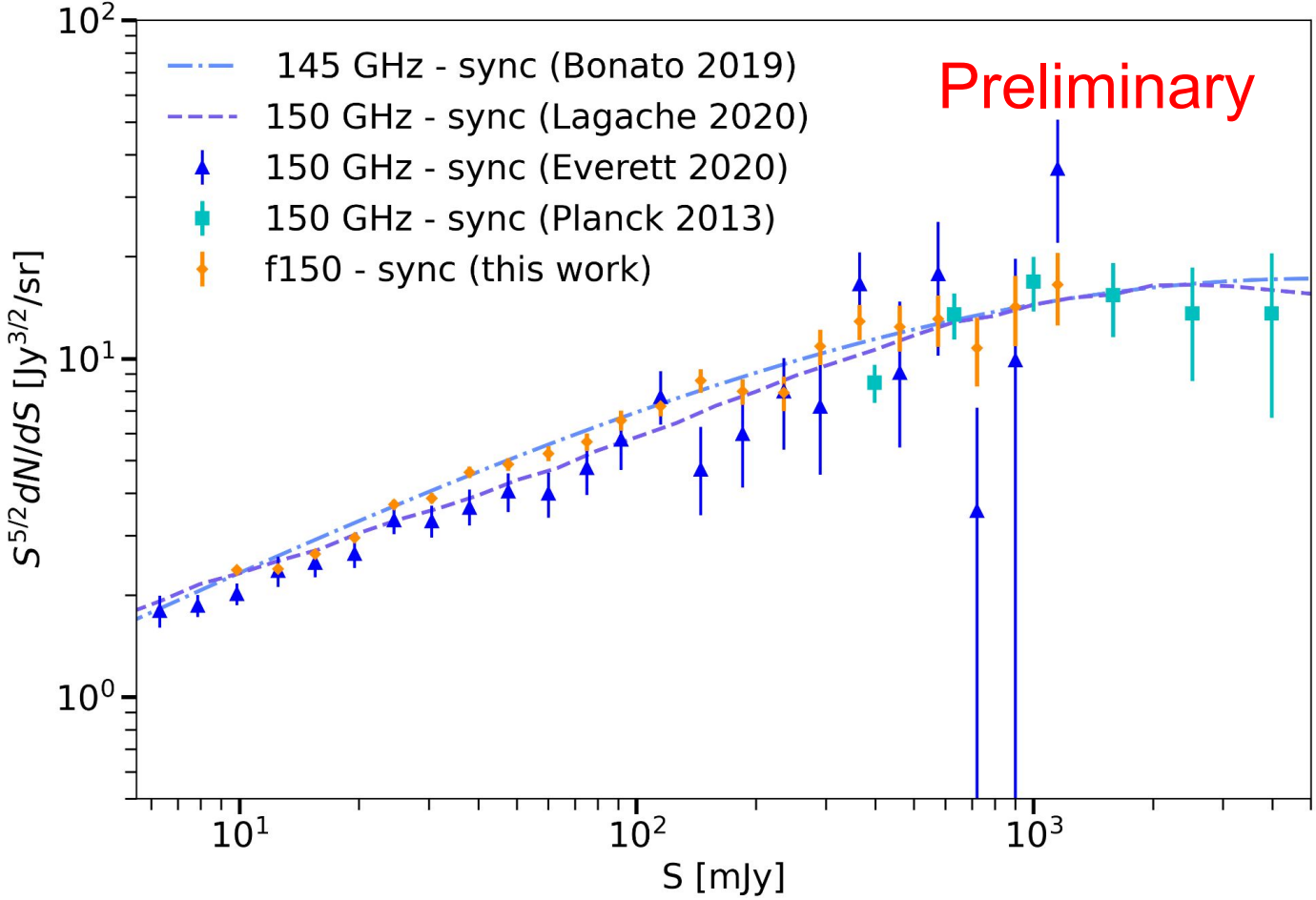
Excellent purity S/N>5.0

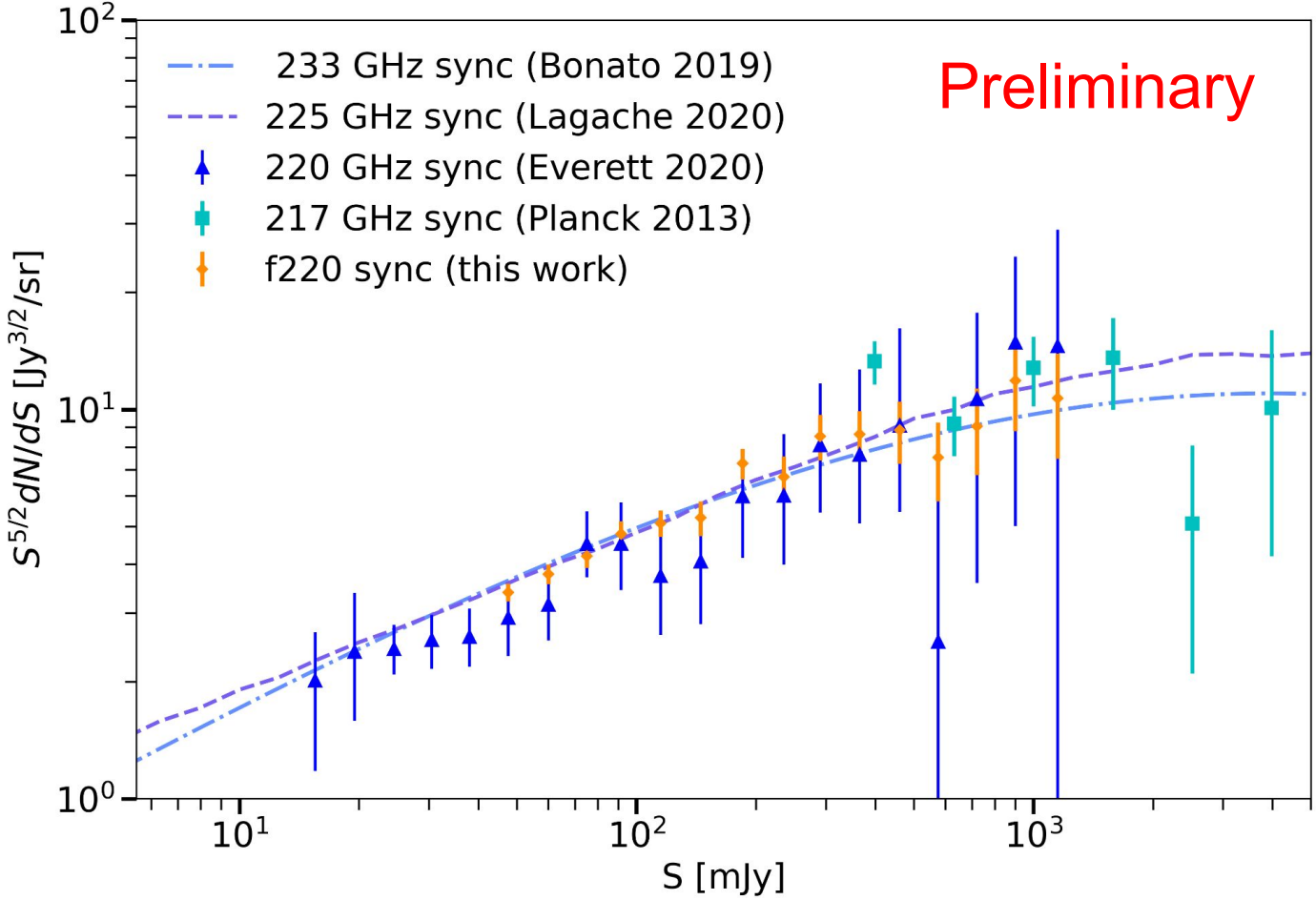

Population statistic (big plots to visualize error bars)
95 GHz Total (Everett 2020)
100 GHz Total (Planck 2013)
f090 Total (this work)
Preliminary
$S^{5/2}dN/dS$ [Jy$^{3/2}$/sr]
S [mJy]
10^0
10^1
10^2
10^3

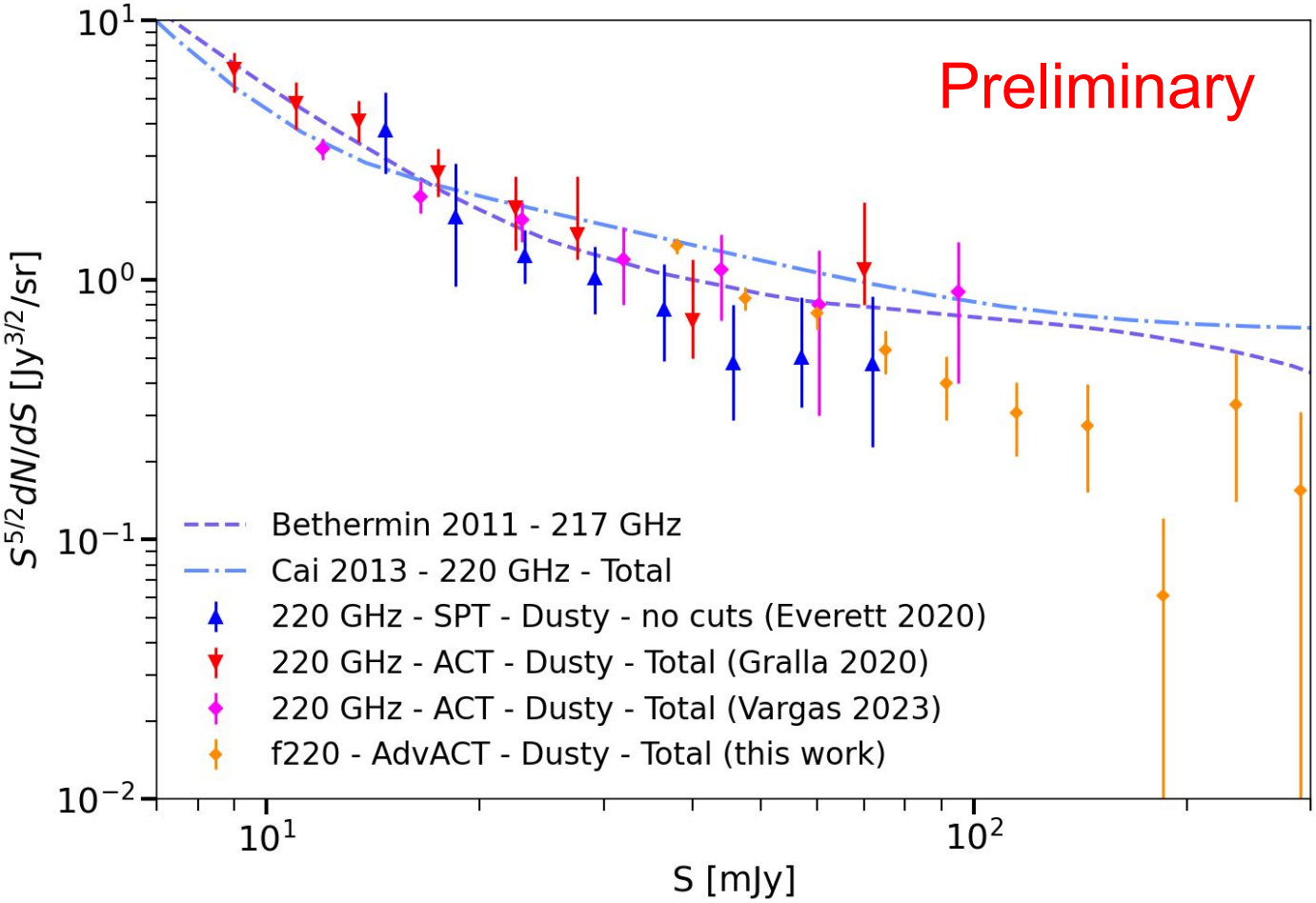

150 GHz Total (Everett 2020)
150 GHz Total (Planck 2013)
f150 Total (this work)
Preliminary
10^2
10^1
10^0
$S^{5/2}dN/dS$ [Jy$^{3/2}$/sr]
10^1
10^2
10^3
S [mJy]

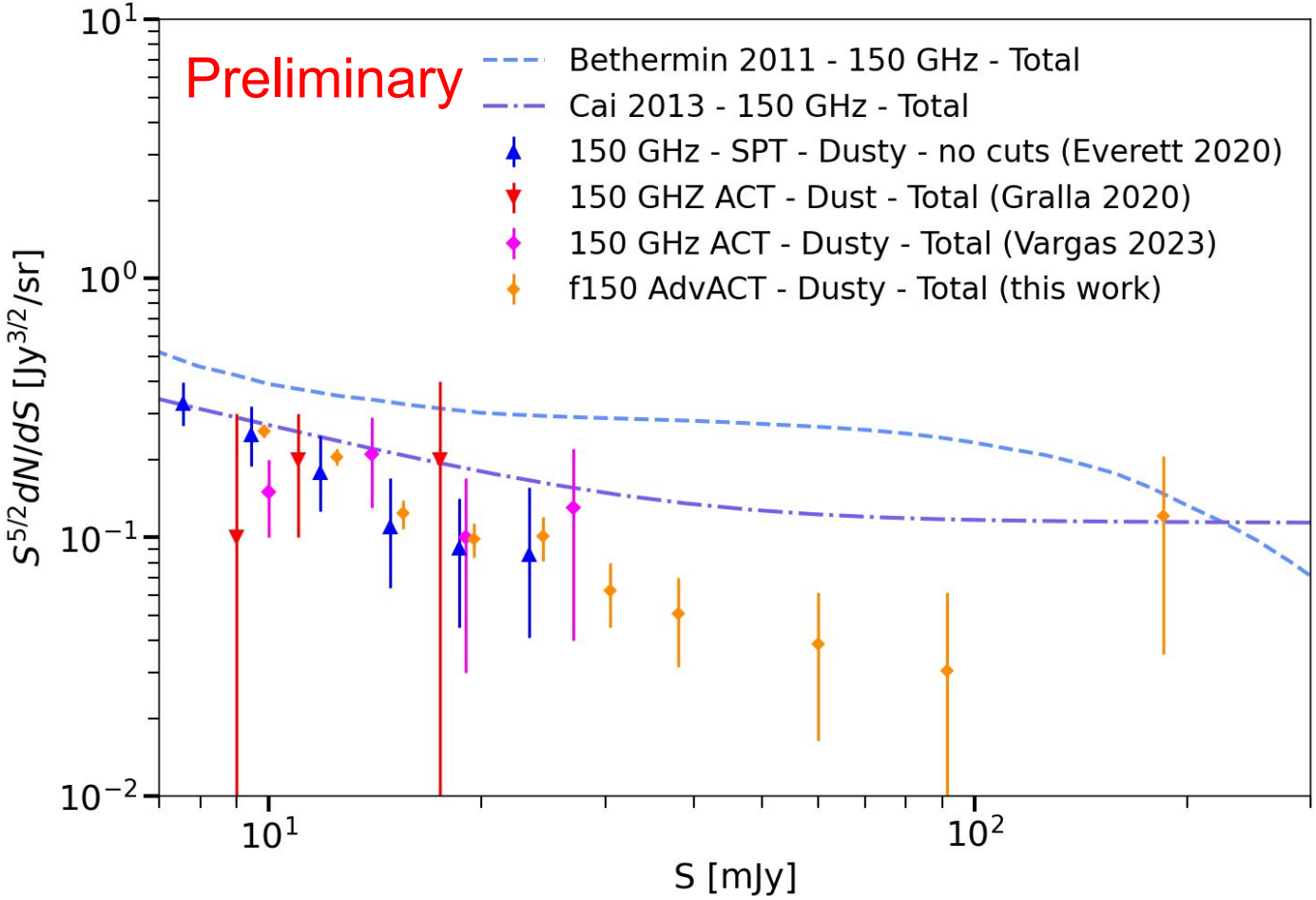

220 GHz Total (Everett 2020)
217 GHz Total (Planck 2013)
f220 Total (this work)
Preliminary
$S^{5/2}dN/dS$ [Jy$^{3/2}$/sr]
S [mJy]
10^0
10^1
10^2
10^1
10^2
10^3

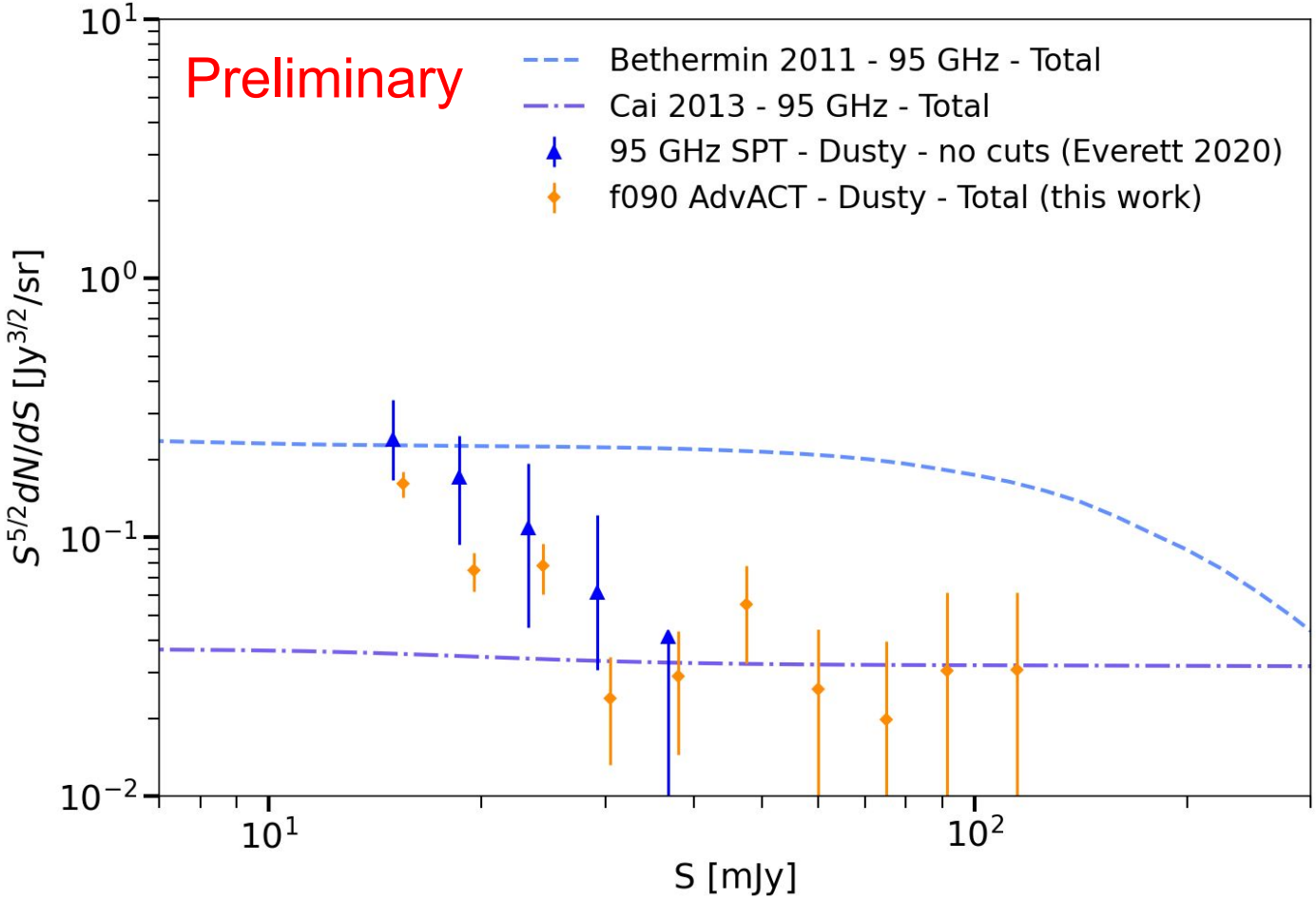

95 GHz sync (Bonato 2019)
100 GHz sync (Lagache 2020)
95 GHz sync (Everett 2020)
100 GHz sync (Planck 2013)
f090 sync (this work)
Preliminary
$S^{5/2}dN/dS$ [Jy$^{3/2}$/sr]
S [mJy]
10^0
10^1
10^2
10^1
10^2
10^3

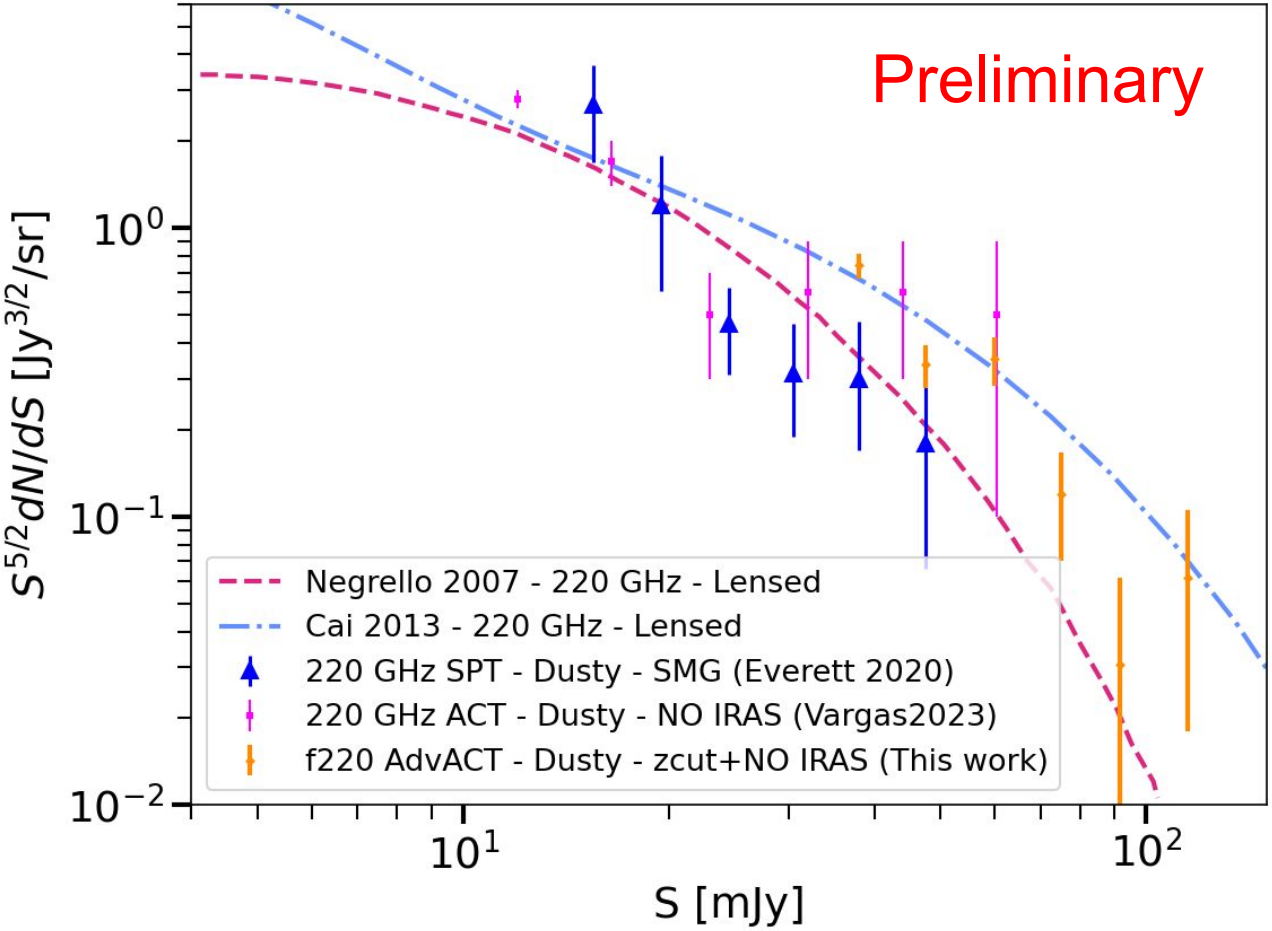

145 GHz - sync (Bonato 2019)
150 GHz - sync (Lagache 2020)
150 GHz - sync (Everett 2020)
150 GHz - sync (Planck 2013)
f150 - sync (this work)
Preliminary
$S^{5/2}dN/dS$ [Jy$^{3/2}$/sr]
S [mJy]
10^0
10^1
10^2
10^1
10^2
10^3

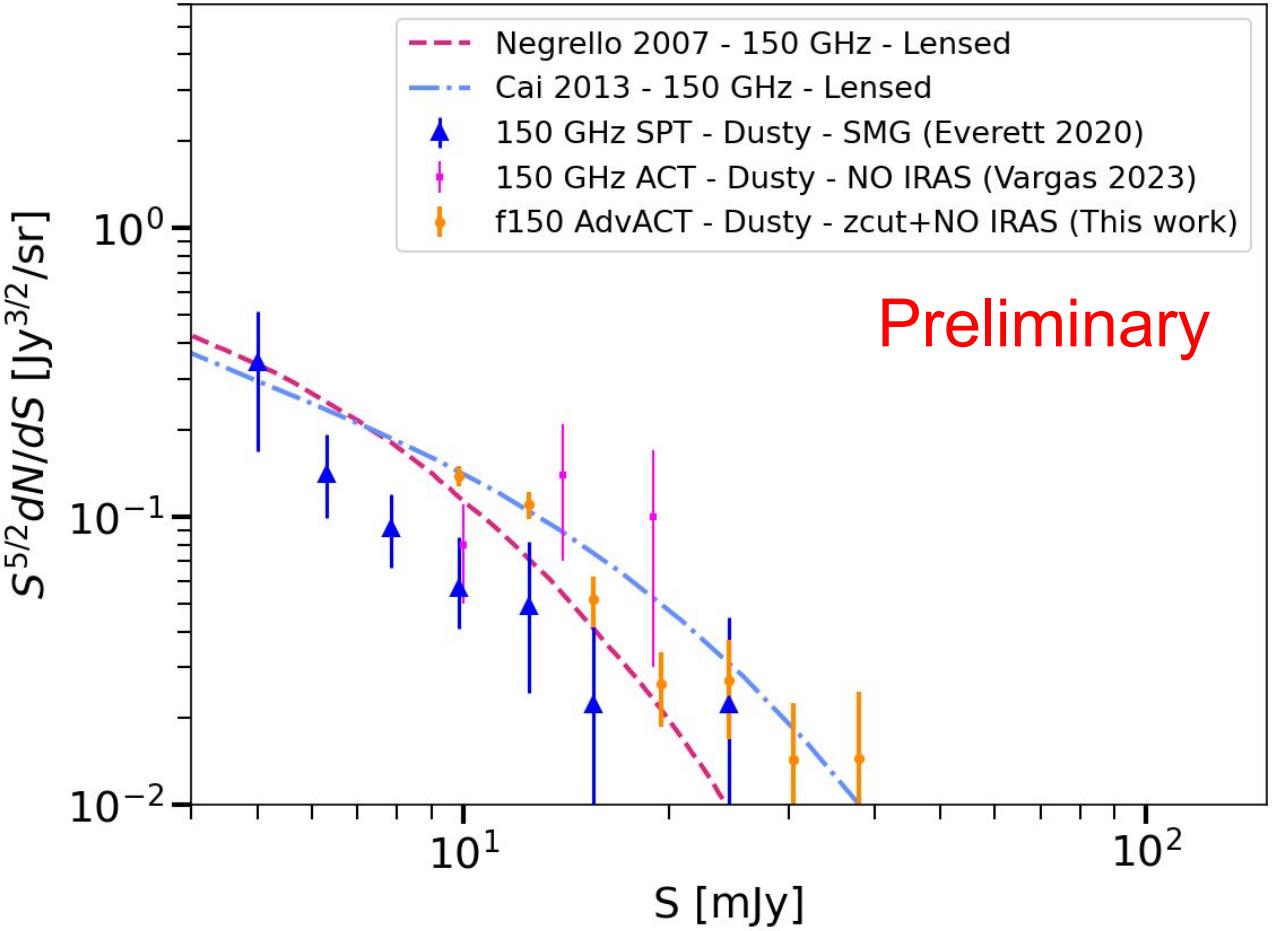

233 GHz sync (Bonato 2019)
225 GHz sync (Lagache 2020)
220 GHz sync (Everett 2020)
217 GHz sync (Planck 2013)
f220 sync (this work)
Preliminary
10^2
10^1
10^0
$S^{5/2}dN/dS$ [Jy$^{3/2}$/sr]
10^1
10^2
10^3
S [mJy]


Preliminary
10^1
10^0
10^{-1}
10^{-2}
$S^{5/2}dN/dS$ [Jy$^{3/2}$/sr]
10^1
10^2
S [mJy]
Bethermin 2011 - 217 GHz
Cai 2013 - 220 GHz - Total
220 GHz - SPT - Dusty - no cuts (Everett 2020)
220 GHz - ACT - Dusty - Total (Gralla 2020)
220 GHz - ACT - Dusty - Total (Vargas 2023)
f220 - AdvACT - Dusty - Total (this work)


Preliminary
Bethermin 2011 - 150 GHz - Total
Cai 2013 - 150 GHz - Total
150 GHz - SPT - Dusty - no cuts (Everett 2020)
150 GHZ ACT - Dust - Total (Gralla 2020)
150 GHz ACT - Dusty - Total (Vargas 2023)
f150 AdvACT - Dusty - Total (this work)
$S^{5/2}dN/dS$ [Jy$^{3/2}$/sr]
S [mJy]
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{1}
10^{2}


Preliminary
Bethermin 2011 - 95 GHz - Total
Cai 2013 - 95 GHz - Total
95 GHz SPT - Dusty - no cuts (Everett 2020)
f090 AdvACT - Dusty - Total (this work)
$S^{5/2}dN/dS$ [Jy$^{3/2}$/sr]
S [mJy]
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{1}
10^{2}


Preliminary
$S^{5/2}dN/dS$ [Jy$^{3/2}$/sr]
10^0
10^{-1}
10^{-2}
10^1
10^2
S [mJy]
Negrello 2007 - 220 GHz - Lensed
Cai 2013 - 220 GHz - Lensed
220 GHz SPT - Dusty - SMG (Everett 2020)
220 GHz ACT - Dusty - NO IRAS (Vargas2023)
f220 AdvACT - Dusty - zcut+NO IRAS (This work)


Negrello 2007 - 150 GHz - Lensed
Cai 2013 - 150 GHz - Lensed
150 GHz SPT - Dusty - SMG (Everett 2020)
150 GHz ACT - Dusty - NO IRAS (Vargas 2023)
f150 AdvACT - Dusty - zcut+NO IRAS (This work)
Preliminary
$S^{5/2}dN/dS$ [Jy$^{3/2}$/sr]
10^0
10^{-1}
10^{-2}
10^1
10^2
S [mJy]

Summary and Expected Data Products:

- Multi frequency source catalogs of 30,000+ sources
- Number counts for total and different populations
- Filtered maps, useful for forced photometry
- Products will be hosted on NASA LAMBDA.

https://lambda.gsfc.nasa.gov/product/act/act_dr6.02/