The SPT-3G-Deep Cluster Catalog

Unlocking a new regime of low-mass, high-redshift clusters in the new era of SPT CMB experiments

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Arxiv: 2503.17271

Overview:

- Introduction
- The SPT-Deep Cluster Catalog
- Impact of dust emission of the high-redshift, tSZ selection function

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Introduction

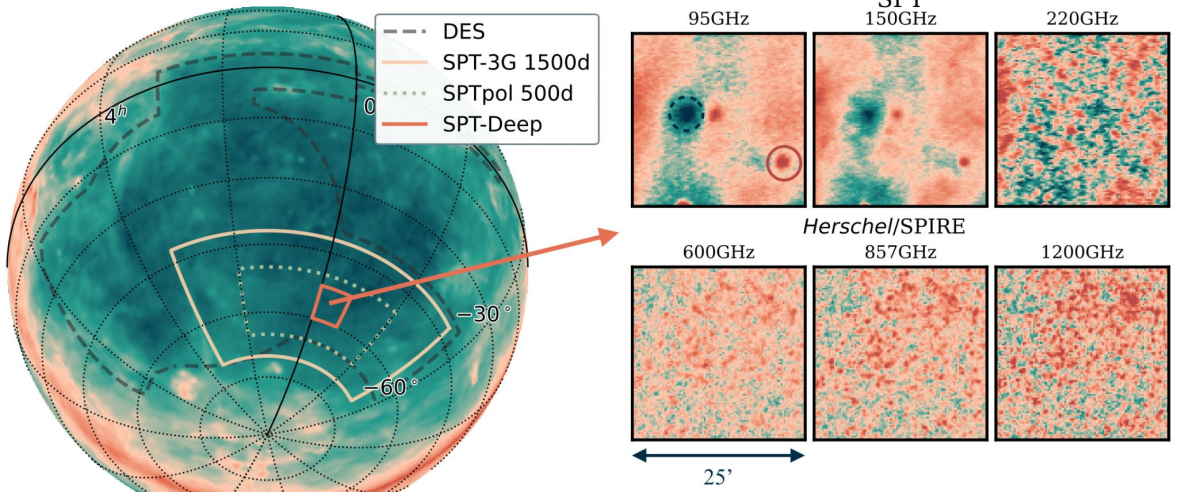
The SPT-Deep field:

- 100 deg^2 centered at RA: 352.5 and Dec: -55

- Composed of the SPT-3G main field and SPTpol 100d + 500d fields

Multi-wavelength coverage:

- Herschel SPIRE (sub-mm)
- DES (optical)
- Spitzer (infrared)



Survey	Depth (μK-arcmin) [a]	Angular Resolution
SPT-3G (2019–2023)		
95 GHz	3.2	1.6'
150 GHz	2.6	1.2'
220 GHz	9.0	1.1'
SPTpol 500d (2013–2016)		
95 GHz	11.3	1.7'
150 GHz	5.2	1.2'
SPTpol 100d (2012–2013)		
95 GHz	13.2	1.7'
150 GHz	6.2	1.2'

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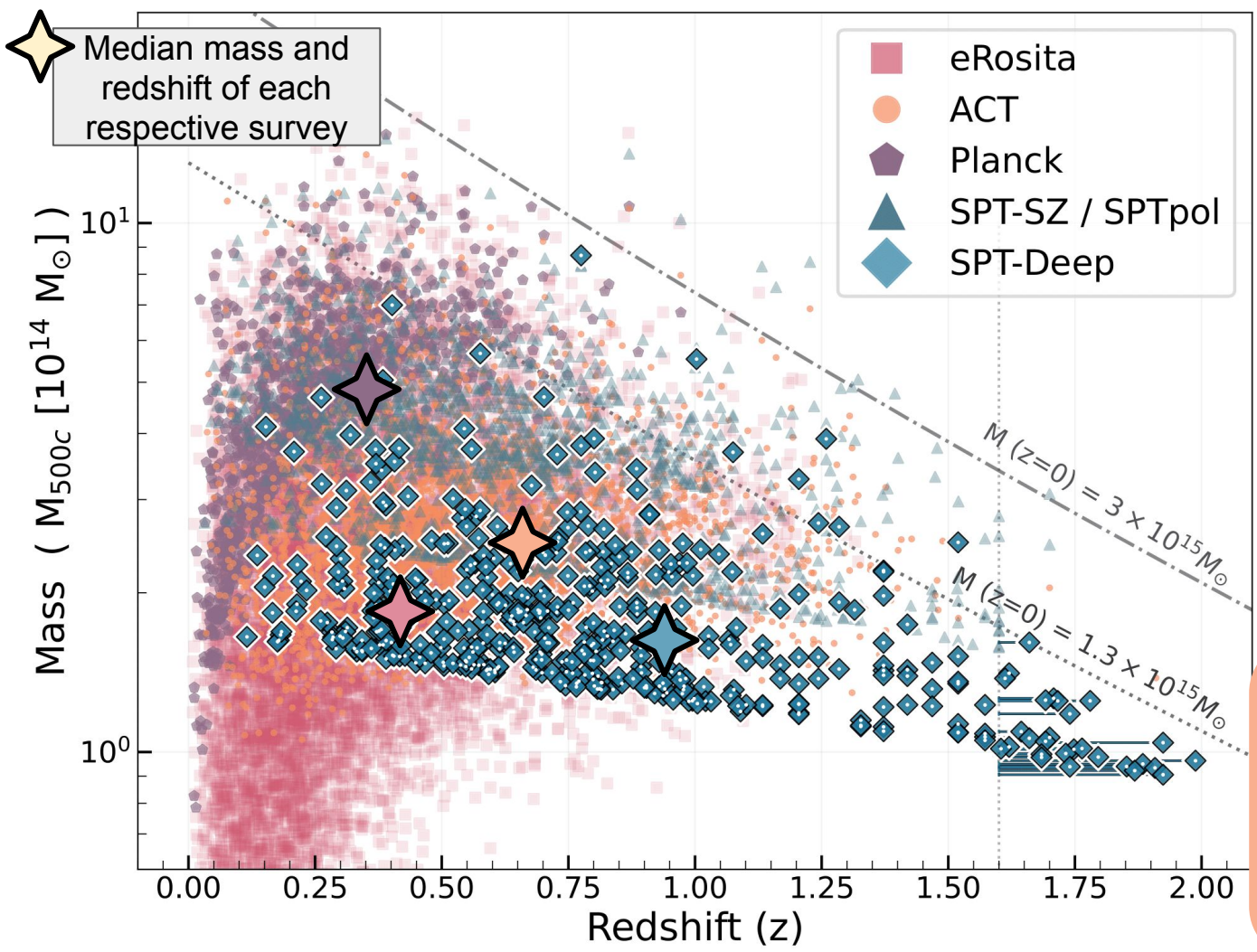
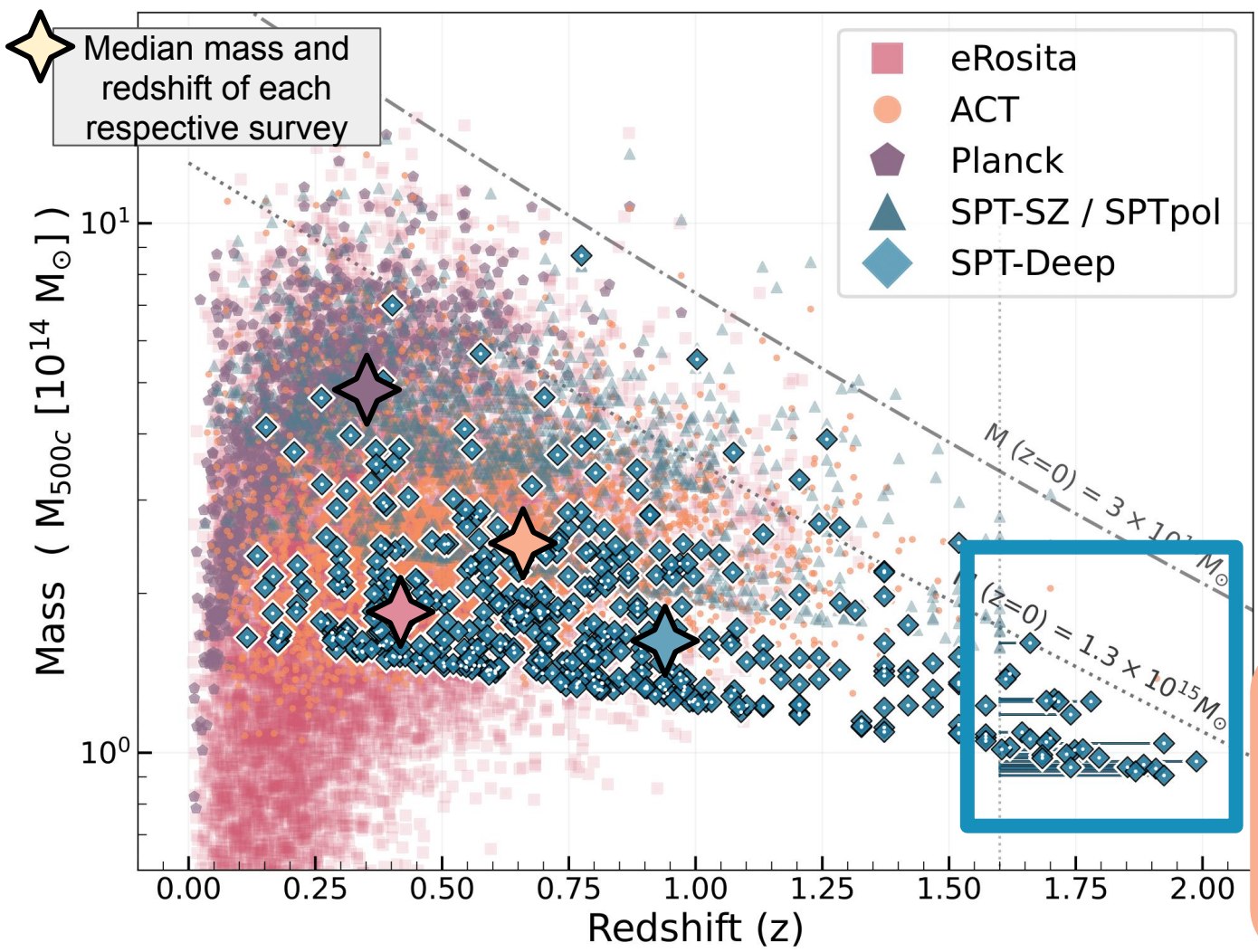


500 cluster candidates (**442** confirmed)

Redshift estimates:

- DES z < ~1.1
- Spitzer z > 1.1 - 1.6
- z > 1.6 -> perfect for further exploration with Euclid

SPT-Deep is ~2x than any previous tSZ selected cluster catalog, making it the deepest tSZ cluster catalog to date



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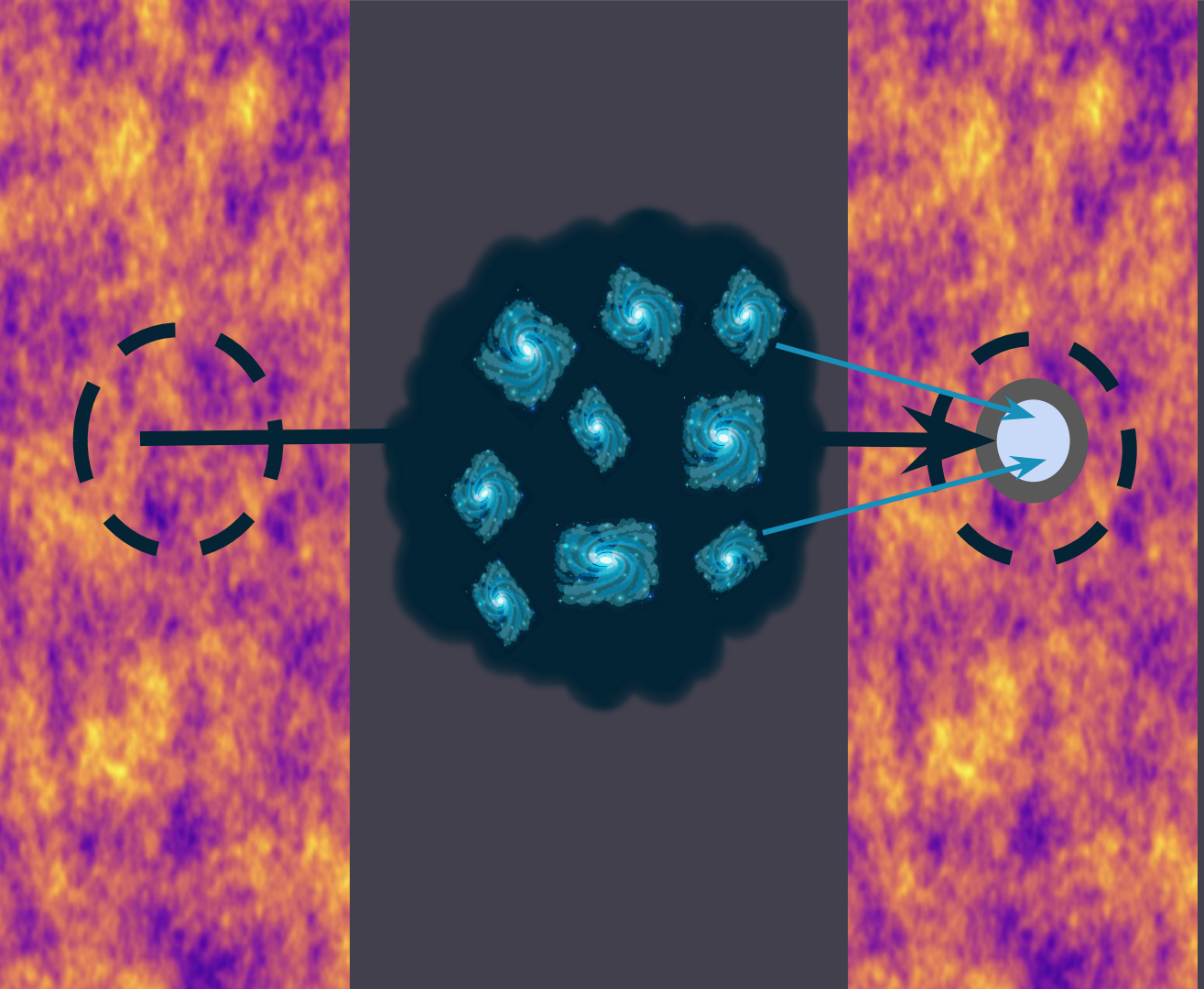
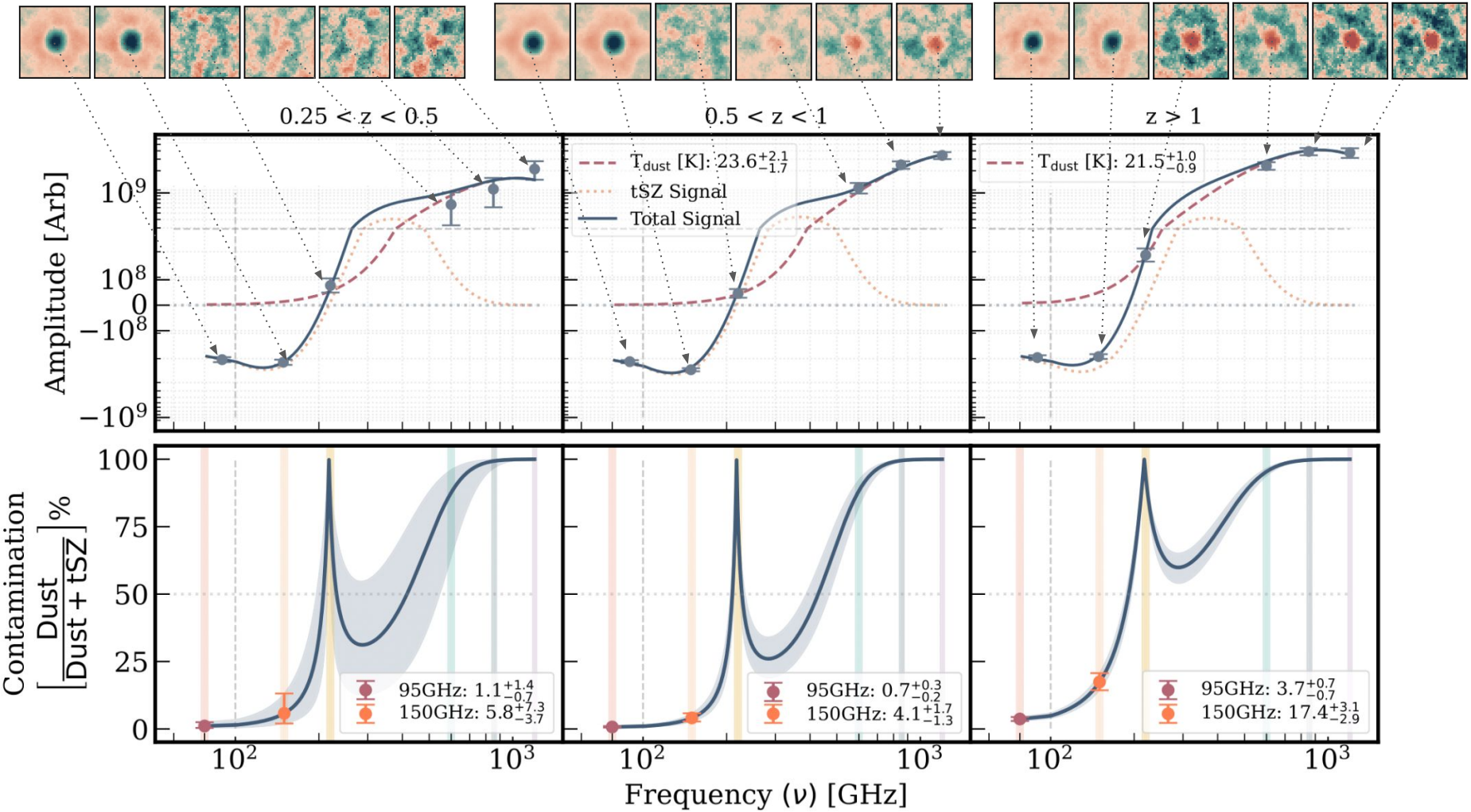
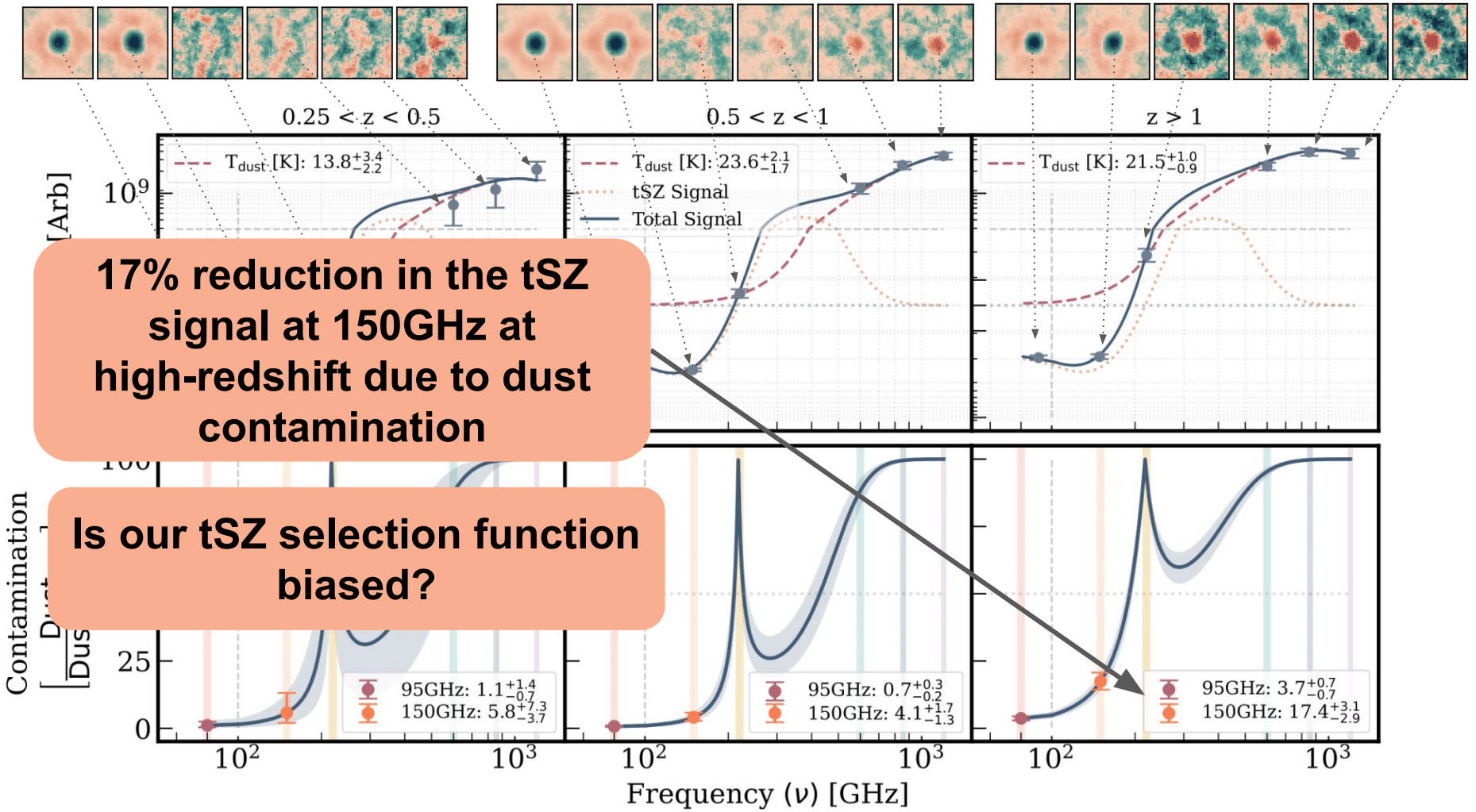


Observed tSZ decrement is mitigated due to positive emission from dusty star forming galaxies

Due to the increase in star-formation in cluster environments up to cosmic noon (z~2) this emission could bias the detection of galaxy clusters at high-z


0.25 < z < 0.5
0.5 < z < 1
z > 1
Amplitude [Arb]
10^9
10^8
0
-10^8
-10^9
T_{dust} [K]: $23.6^{+2.1}_{-1.7}$
tSZ Signal
Total Signal
T_{dust} [K]: $21.5^{+1.0}_{-0.9}$
Contamination $\left[\frac{\text{Dust}}{\text{Dust}+\text{tSZ}}\right]$ %
100
75
50
25
0
95GHz: $1.1^{+1.4}_{-0.7}$
150GHz: $5.8^{+7.3}_{-3.7}$
95GHz: $0.7^{+0.3}_{-0.2}$
150GHz: $4.1^{+1.7}_{-1.3}$
95GHz: $3.7^{+0.7}_{-0.7}$
150GHz: $17.4^{+3.1}_{-2.9}$
10^2
10^3
Frequency (ν) [GHz]



17% reduction in the tSZ signal at 150GHz at high-redshift due to dust contamination

Is our tSZ selection function biased?

Constrained Internal Linear Combination Filter

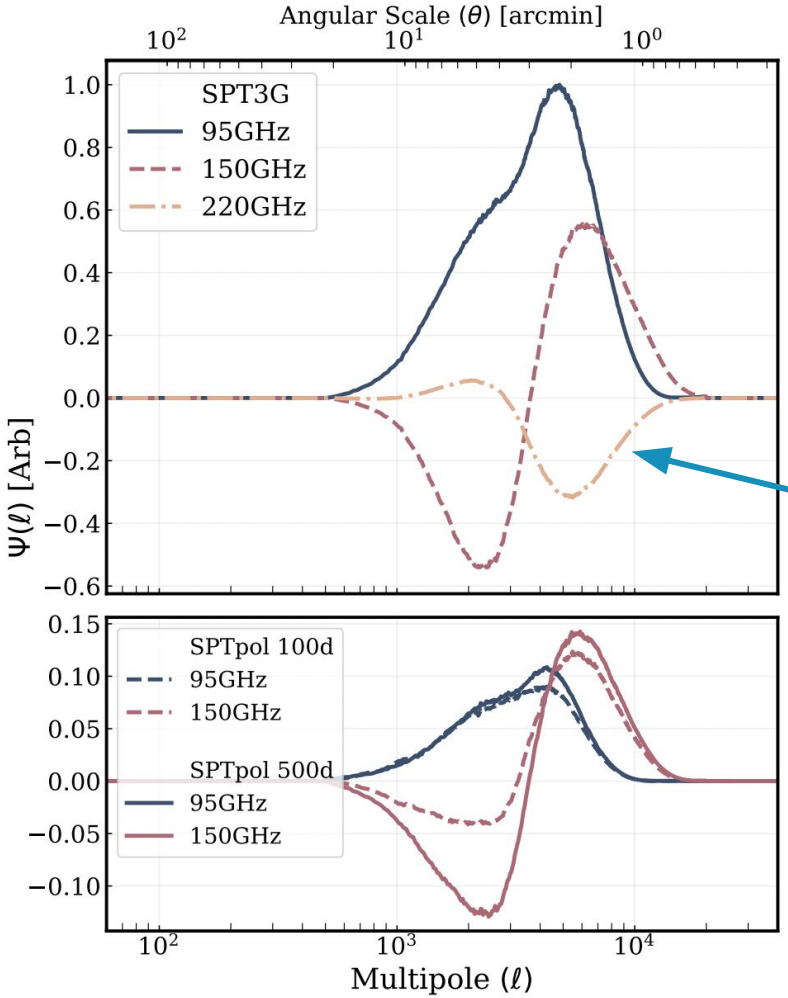
- Using the fit frequency dependence of dust emission at high-redshift, we **null the dust-signal in the combined multi-frequency CMB maps**

- Galaxy clusters obscured by dust emission should have a **higher SNR** in the **dust-nulled maps**

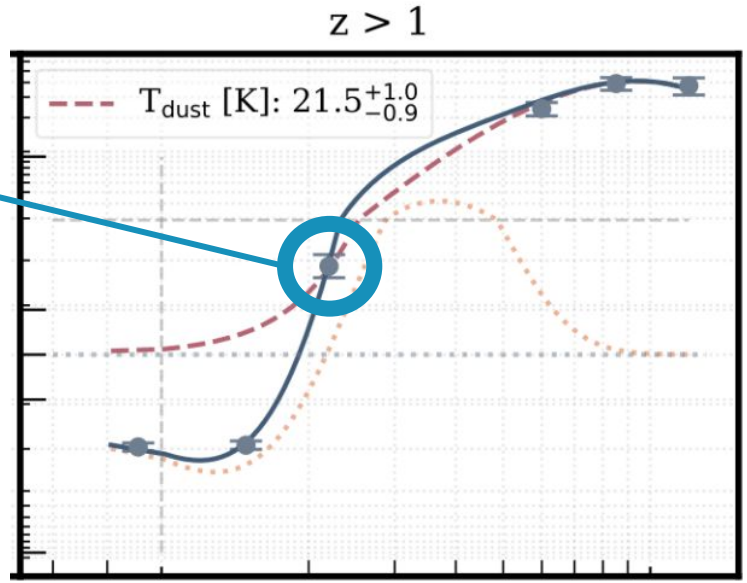
Constrained Internal Linear Combination Filter

The results demonstrate that the dust-nulled cluster catalog is consistent with the minimum-variance catalog, both in the number of recovered clusters and SNR for clusters.

We observe no increase in SNR for high-redshift clusters between the two maps.



Without the inclusion of the 220GHz band, we **do** observe a decrease in SNR for high-redshift clusters



Conclusions

- The SPT-Deep catalog is the deepest cluster catalog to date with the **lowest median mass highest median redshift** of any tSZ selected cluster sample with **multi-wavelength coverage** from the **radio to the sub-mm**

- **We do not observe a bias in the tSZ selection function at high-redshift due to dust**, which we attribute to the inclusion of the **220GHz frequency band**

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