



Isotropy & Statistics

Status of the post-PTEP paper

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Isotropy and Statistics



- Various **anomalies** have been found in both the WMAP and Planck temperature CMB data with a statistical significance around $2-3\sigma$ C.L.
 - Even if not impossible, it is difficult to think that these anomalies are due to residual of systematic effects (two independent experiments have observed the same features).
 - Hints of new physics
 - They might simply be flukes due to a statistically unusual configuration of temperature anisotropies on the sky, cannot be addressed further without new information.
- **Goal:** consider the E-mode CMB polarisation to study these anomalies. In particular the idea is to **focus on testing/ruling out the fluke hypothesis.**
- **Project paper group:** Coordinated by T.Banday. Around 20 people signed in the group. Regular telecons on Monday afternoon every two weeks. Minutes of the calls are gathered in a wiki page.

<https://wiki.kek.jp/x/YZHpbw>

Isotropy and Statistics: anomalies



List of anomalies considered in the paper

- Dipole modulation (variance asymmetry)
- Low-ell alignments
- Even-odd asymmetry (harmonic based)
- Variance (harmonic based)
- Lack of correlation (harmonic based)
- Cold spot
- Test of non-Gaussianity (1-dim moments, variance, skewness, kurtosis)

Isotropy and Statistics: pipeline



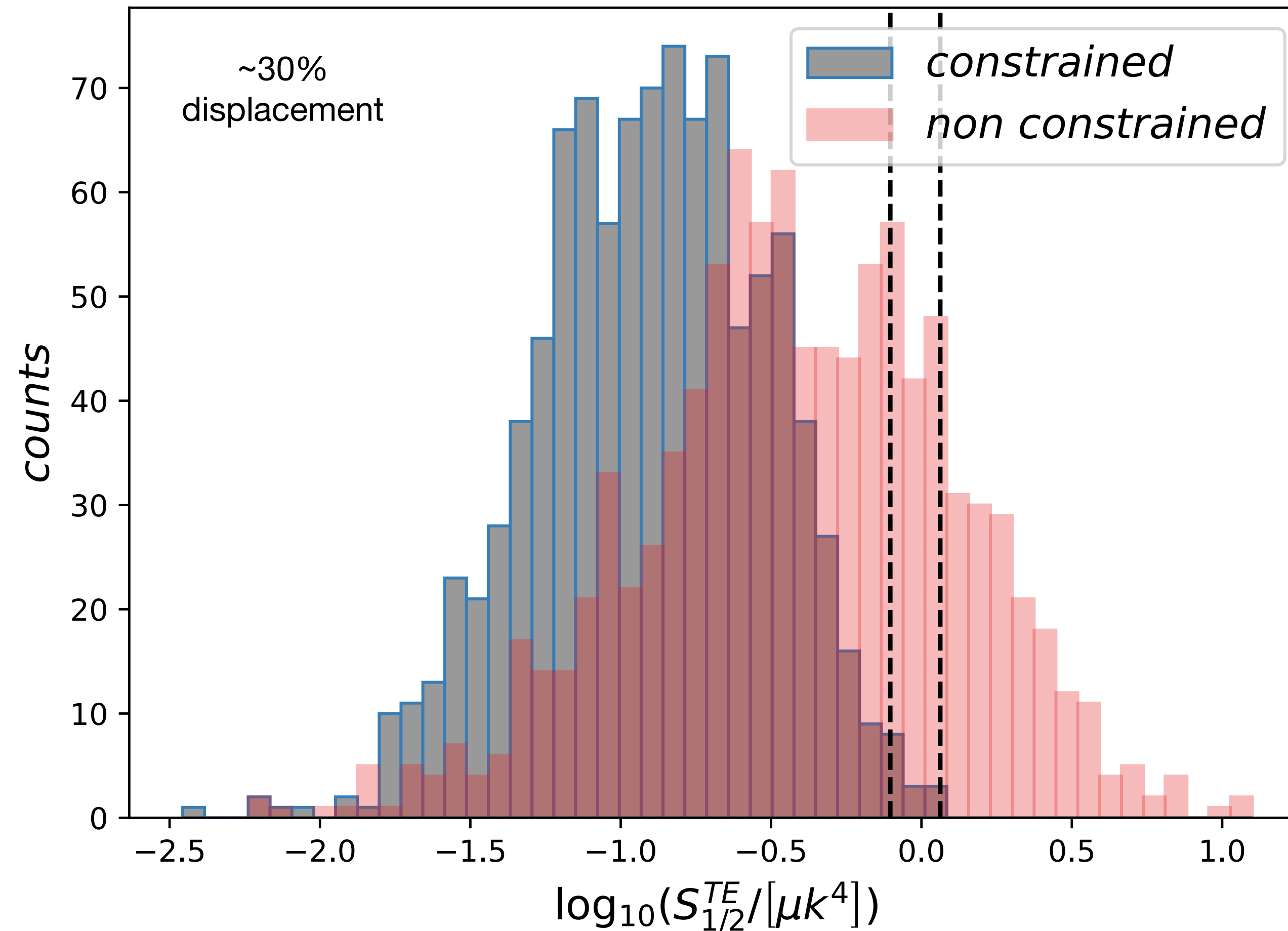
- The paper has to present a set of estimators that, considering the information present in the CMB pol (E-mode), are able **to rule out the fluke hypothesis**. This is an R&D work. A lot of estimators are considered and tested. Some of those are not working, others instead are promising.
- The recipe to check whether an estimator is good or not in ruling out the fluke hypothesis is following:
 - build the pdf built with unconstrained sims (LCDM sims)
 - build the pdf built considering E modes constrained to what observed in T
 - Larger is the shift between the two pdfs and larger **IS THE PROBABILITY TO RULE OUT THE FLUKE HYPOTHESIS**

Isotropy and Statistics: example



Lack of correlation anomaly

$$S_{1/2}^{TE} \equiv \int_{-1}^{1/2} d(\cos \theta) [C^{TE}(\theta)]^2$$

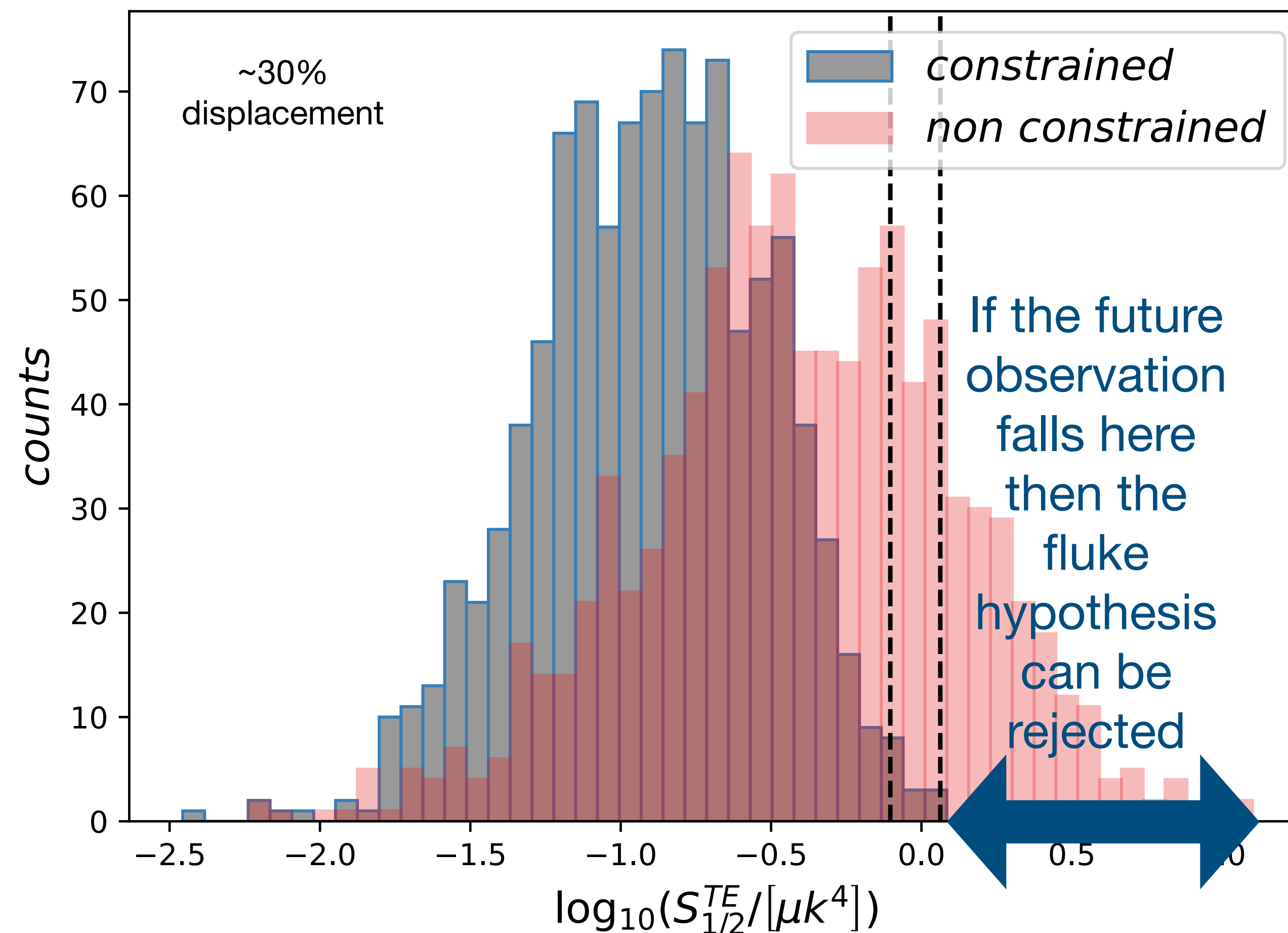




Isotropy and Statistics: example

Lack of correlation anomaly

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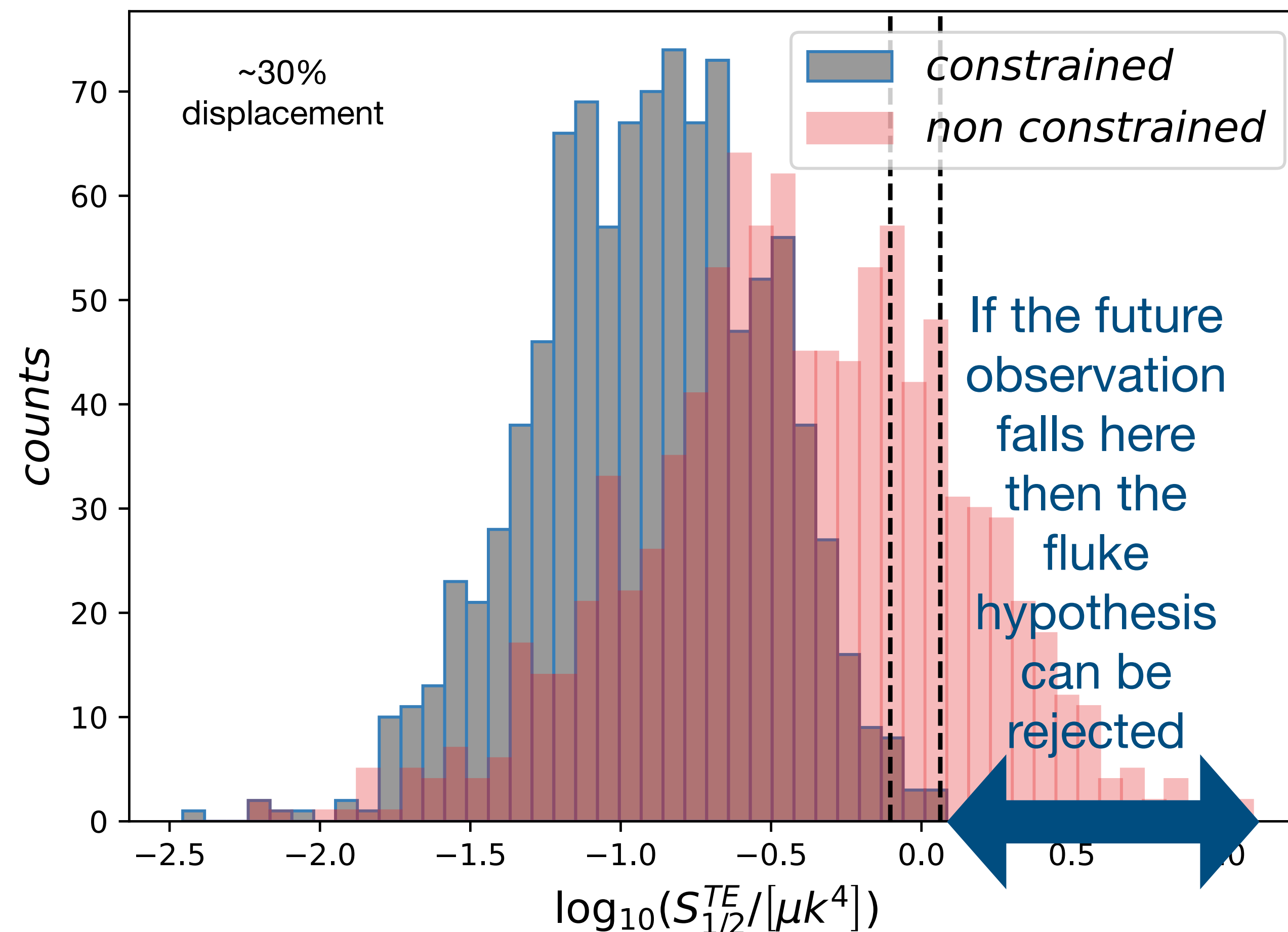


Isotropy and Statistics: example

Lack of correlation anomaly

$$S_{1/2}^{TE} \equiv \int_{-1}^{1/2} d(\cos \theta) [C^{TE}(\theta)]^2$$

As a general behaviour (and as expected!), we find that estimators that depend on the cross-correlation between T and E modes are the most useful for this kind of analysis.



Isotropy and Statistics: sims & status



- Data and sims:
 - Unconstrained T- and E-mode sims from the fiducial Planck best fit
 - Constrained E-mode sims to the observed temperature Planck SMICA map
- We consider a full-sky cosmic variance limited sims at a nominal LiteBIRD resolution
- All the anomalies listed before have been considered with these set of sims.

Isotropy and Statistics: comments



- Currently the main activity is related to the building of the estimators with constrained sims which do include in the pipeline the impact of the in-painted technique (this is essential to generate the constrained realisations).
- **The idea is to complete the draft by the summer.** There is an in-person meeting in Santander in June to speed up the completion of the analysis.
- Additional complications (e.g. due to foreground residuals) will be considered only for those estimators which are found to be promising in the idealised case