# Low-ell BB AWG update

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CMB-S4 Collaboration Meeting
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CMB-S4

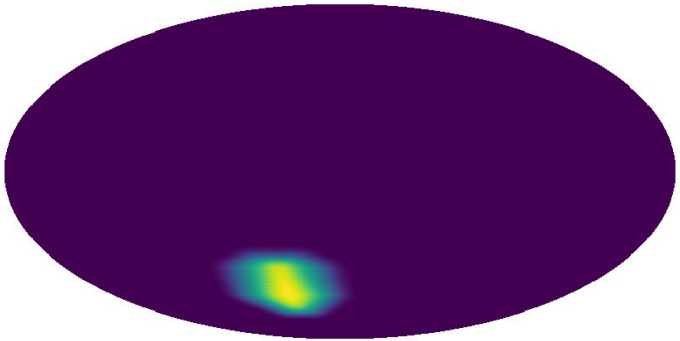
# Outline

- PBDR / low-ell BB data challenge 08
- On-going work
  - Component separation
  - Interface with DM on noise levels and observing matrices
  - Analysis of alternatives support
- Summary

# PBDR / DC08

Work led by Caterina Umilta, Clem Pryke

- Goal: verify that given input noise levels per band of SATs and SPLAT, the experiment meets the *r* science goal with real delensing.
- Simulations:
  - Noise realizations reweighted by hit map such that resultant N_\ell match the PBDR Tables 2-1 / 2-2.
  - Signal (CMB)
    - *r* = 0
    - *r* = 0.003
  - Signal (polarized Galactic foregrounds)
    - Gaussian dust and sync
    - Amplitude modulated Gaussian dust and sync
    - Vansyngel model
- 500 realizations of each component.

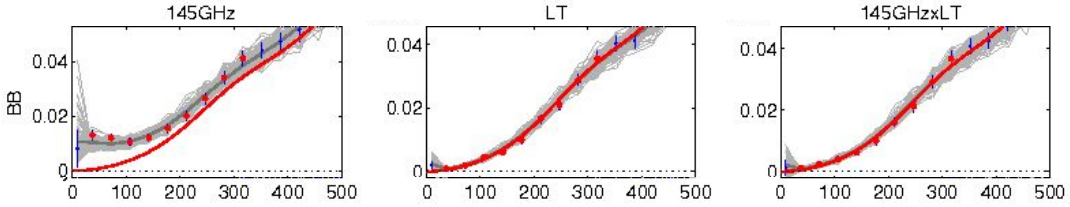


95GHz SAT relative hits on the ultra-deep patch

Background postings (for DC06, and DC08 based on identical machinery):
http://bicep.rc.fas.harvard.edu/CMB-S4/analysis_logbook/20191016_dc06_dsr/
http://bicep.rc.fas.harvard.edu/CMB-S4/analysis_logbook/20200208_06_sims_details/

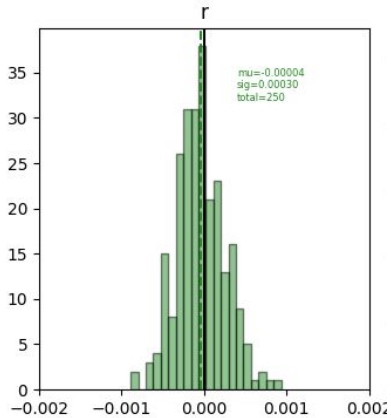
# Analysis approach

Work led by Caterina Umilta, Clem Pryke




Example auto/cross-spectra between 145GHz and LT bands

- Parametric foreground model, power-spectrum based likelihood.
- Data vector: auto- and cross-spectra among all SAT bands and a pseudo-band, which is the lensing template constructed from maps of the LAT bands.
- Construct bandpower covariance matrix from simulations, with conditioning given known zero expectation values.
- 9 parameter model (*r* and Galactic foreground parameters)

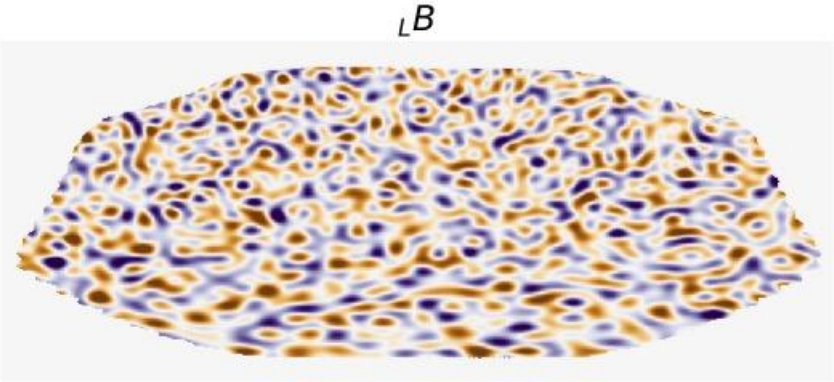



Example distribution of best-fit *r* values from 250 *r*=0 realizations

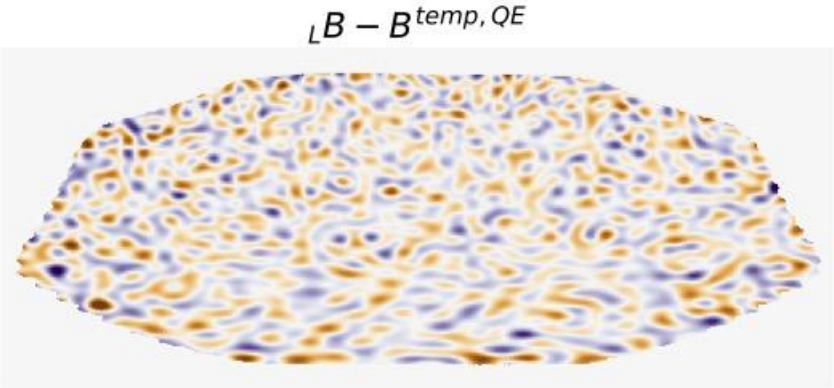
Posting: http://bicep.rc.fas.harvard.edu/CMB-S4/analysis_logbook/20211114_dc08b_MLsearch_500sims/
Figures from:
http://bicep.rc.fas.harvard.edu/CMB-S4/analysis_logbook/20210623_bkfinal_08blt000709/
https://stanford.edu/~wlwu/cmbs4_posts/20211118_dc08_ilc_lt_bpcorr/

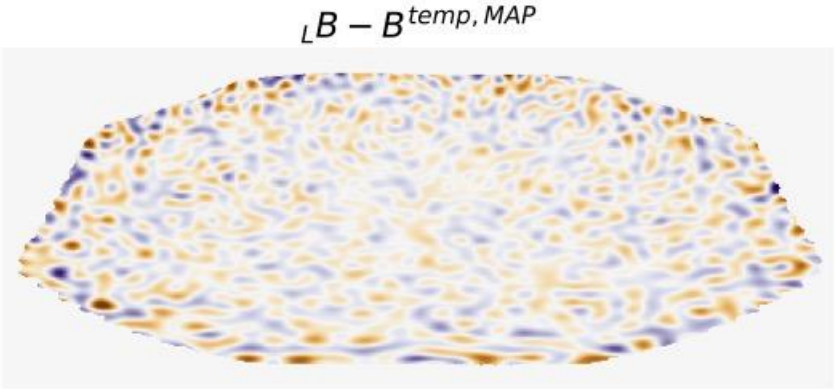
# Lensing template

Work led by Sebasian Belkner, Julien Carron




- Generate ILC map from LAT maps as inputs to MAP $\phi$ generation (by Caterina).
- Generate lensing B templates from MAP $\phi$ and WF E map.



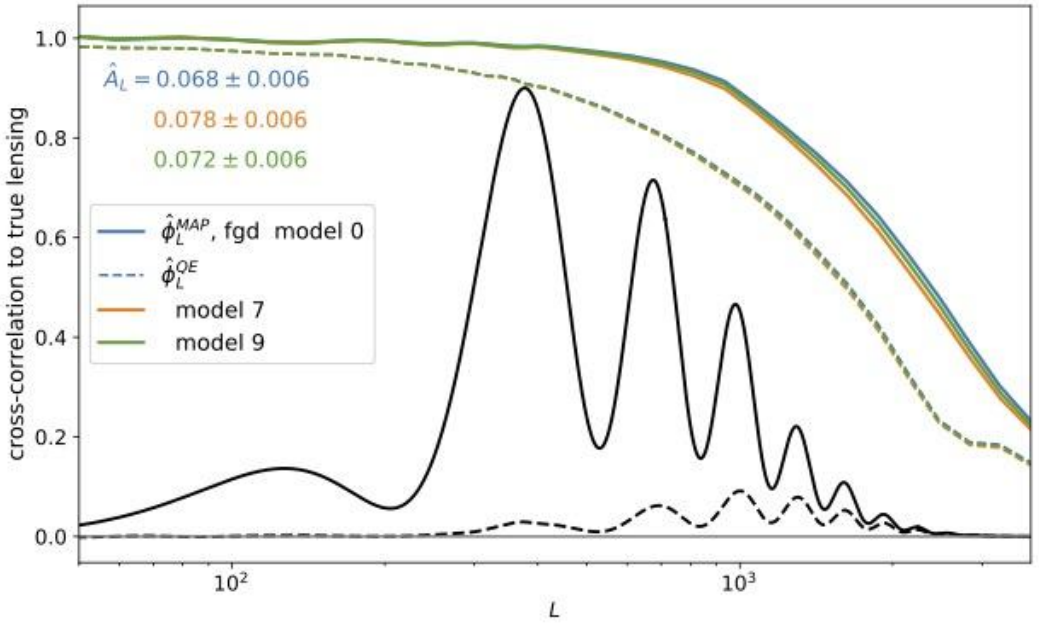




Figures from:
https://github.com/CMB-S4/delensing

# Lensing template

Work led by Sebasian Belkner, Julien Carron

- Demonstrate on simulations that the residual AL is as expected in analytic forecasts.
- Current Galactic fg models do not have large impact in terms of residual AL and bias (though also do not have small-scale non-Gaussianity).

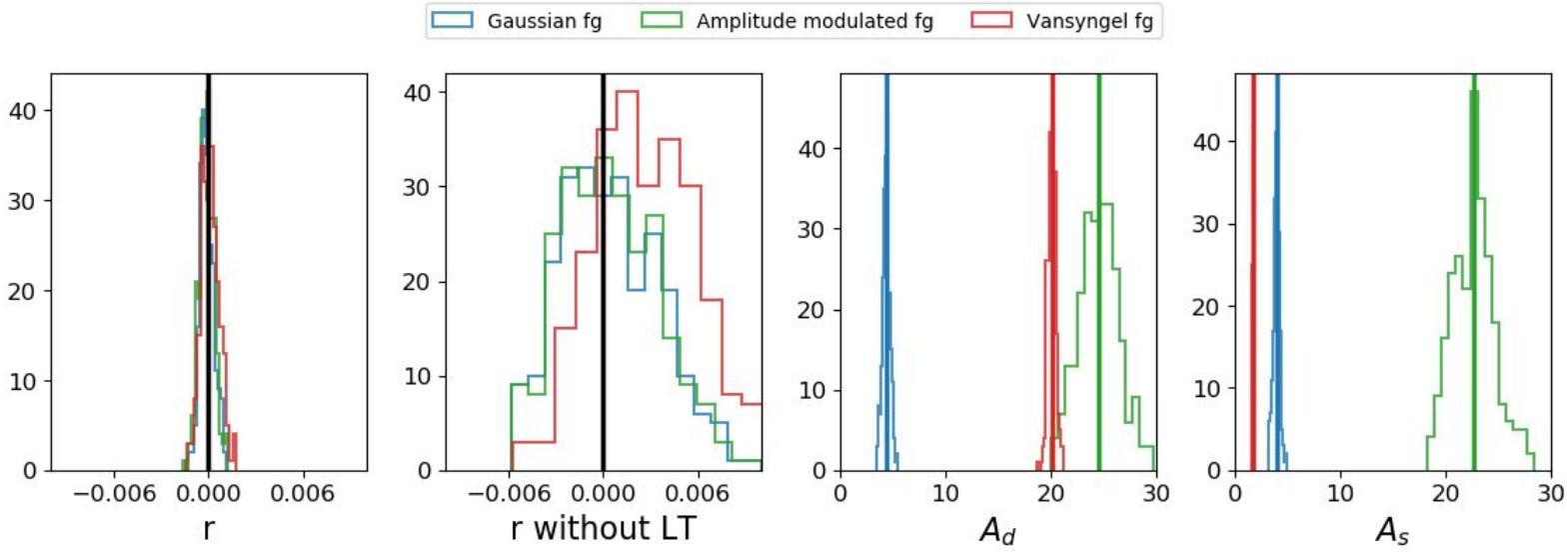



Paper in prep to detail new development in curved-sky estimators propelled by needs in low-ell BB!

Figure from PBDR Appendix A.2.1

# σ(r) and detection significance

Work led by Caterina Umilta




We find that with the configurations listed in the measurement requirements achieve the science requirement: we achieve $\sigma(r) \lesssim 5 \times 10^{-4}$ if $r = 0$ and a $5.3\sigma$ detection significance for a median realization of the simulated bandpowers if $r = 0.003$.

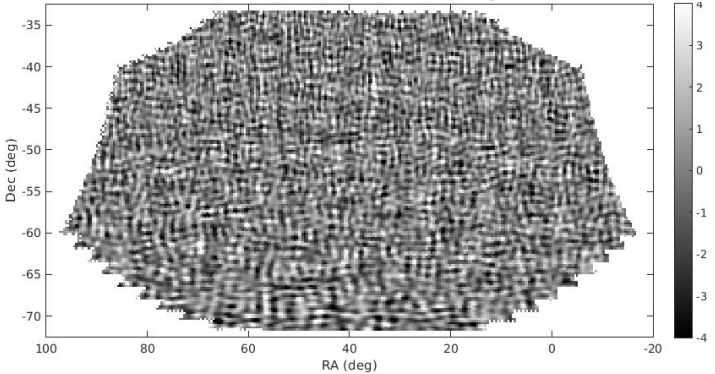
Figure from PBDR Appendix A.2.1
Postings: http://bicep.rc.fas.harvard.edu/CMB-S4/analysis_logbook/20211114_dc08b_MLsearch_500sims/
http://bicep.rc.fas.harvard.edu/CMB-S4/analysis_logbook/20220107_cosmomc_dc08_results/

# Component separation (pixel-space likelihood)

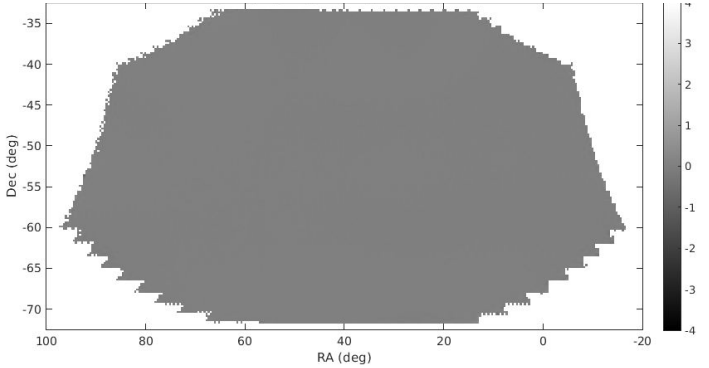
Work led by Dominic Beck

- For our local low-ell BB DC08, we would like to apply alternative foreground cleaning/component separation approaches (as done for the DSR).
- More agnostic foreground model (assumes only dust / sync SED β parameter) than PBDR analysis.
- Component-separated CMB map could be more immune to foreground non-isotropy.
- For Gaussian foregrounds (fg00), recover similar σ(r) pre-delensing.
- To be explored: delensing and including more complex foregrounds.

CMB Q map from CMB+fg+noise input



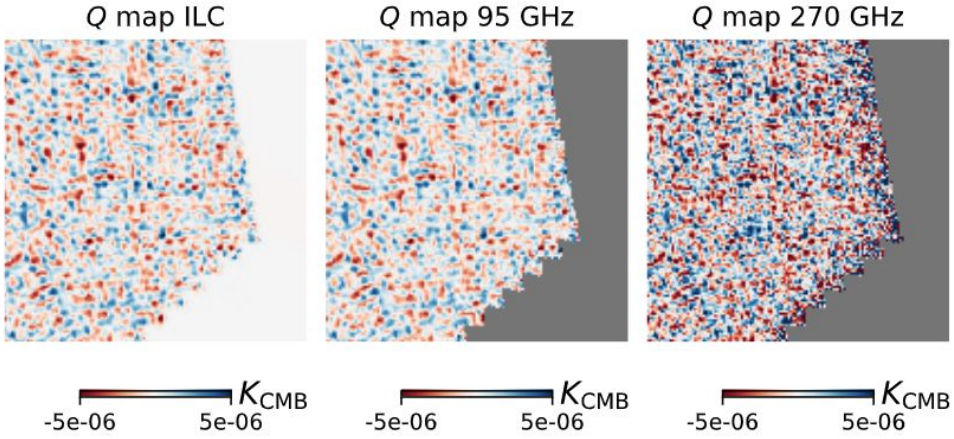

CMB Q map from fg-only input

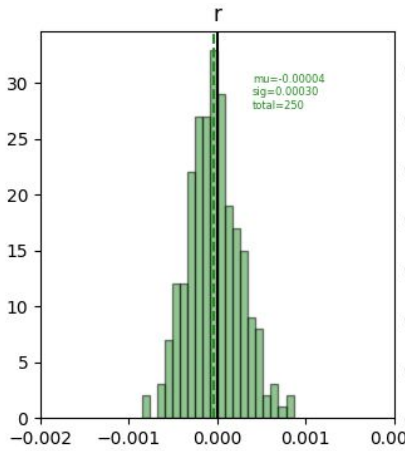



Postings: http://bicep.rc.fas.harvard.edu/CMB-S4/analysis_logbook/20211003_pixellike_s4_dc08_sats/

# Component separation (ILC-like)

Work led by
Federico Bianchini,
Kimmy Wu



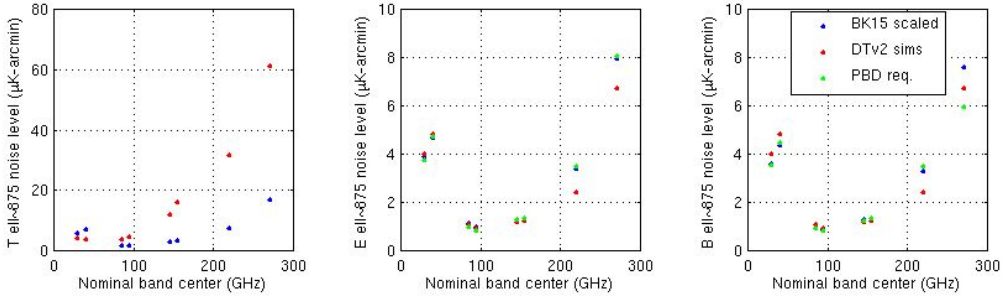



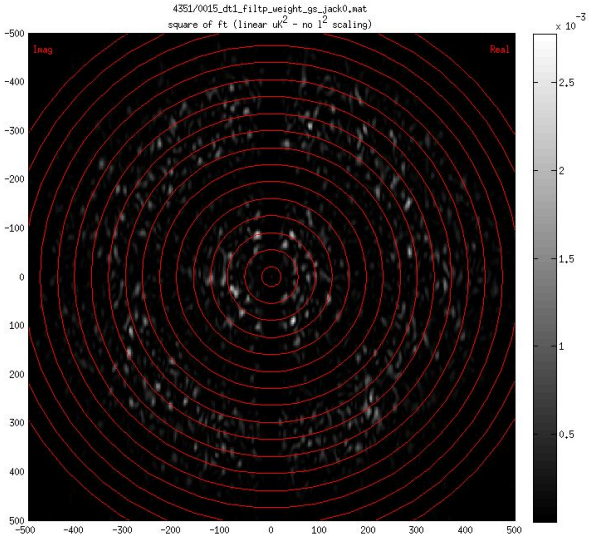

- Testing both a “parametric” LC approach and a true (blind) ILC.
- Developed likelihood framework for both ILC x lensing template (LT) case, and ILC-LT case.
- For Vansyngel fg model (09), σ(r) larger than requirement. For the simple Gaussian foreground model (fg00) and amplitude-modulated fg (07), recover similar σ(r) as PBDR analysis.

Postings: https://fbianc.notion.site/ILC-on-SAT-DC08b00-sims-performance-and-foreground-dependency-125aac8799944419bc4036acbfbd2610
https://stanford.edu/~wlwu/cmbs4_posts/20211122_dc08_ilcmlt/ https://stanford.edu/~wlwu/cmbs4_posts/20211118_dc08_ilc_lt_bpcorr/
https://stanford.edu/~wlwu/cmbs4_posts/20220226_ilclt_margfg/

# Interfacing with DM simulations/activities

- Check noise levels of DM simulations (design tool → DC1) against scaled performance from experiments.
- Take observing matrix generated by DM group and applying to no-filtering simulations to generate multiple realizations.

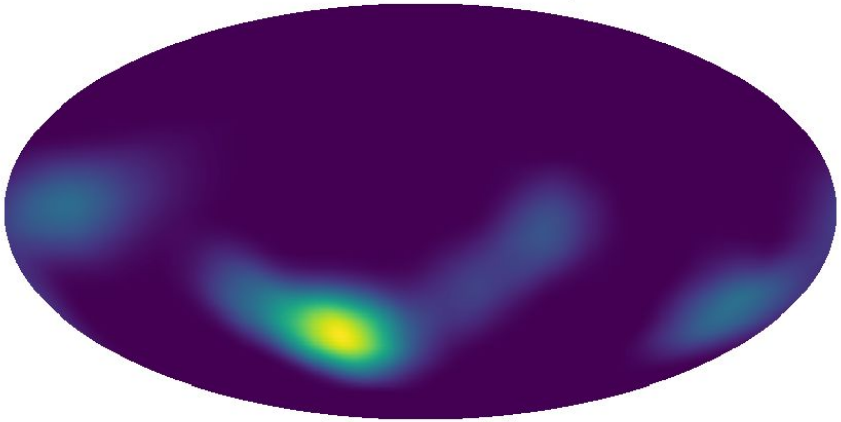



Postings:
http://bicep.rc.fas.harvard.edu/CMB-S4/analysis_logbook/20210208_DMsim/,
http://bicep.rc.fas.harvard.edu/CMB-S4/analysis_logbook/20210506_dt1_vs_bk15_3/
https://cmb-s4.atlassian.net/wiki/spaces/XC/pages/825065473/PBD+design+tool+sims+SP+LAT+noise+check+update+common-mode+filter
http://bicep.rc.fas.harvard.edu/CMB-S4/analysis_logbook/20210917_09_mapspager/

# Supporting AoA activities

- Generated PBD configuration SAT and LAT maps on the Chile deep patch.
- Generated LAT ILC maps for computing the lensing templates.
- Analysis to be compared with Fisher forecasts produced by Chile AoA team.
- Representatives on Chile AoA and SP AoA *r* forecasting.



95GHz SAT relative hits on the Chile deep patch

Postings: http://bicep.rc.fas.harvard.edu/CMB-S4/analysis_logbook/20220510_dc08d_chile_ilc_maps/

# Summary

- For the Pole deep patch, generated simulation-based σ(r) and detection significances given noise levels set by measurement requirements. Results show that measurement requirement noise levels meet *r* science requirement.
- Curved-sky MAP lensing estimate further matured prompted by needs in low-ell BB AGW.
- On-going activity to develop component separation methods with various foreground model assumptions to counter potential biases or misestimations in real data.
- On-going coordination with DM on Data Challenge simulations.
- Supporting analysis of alternatives activities.

- Coordinates:
  - meeting every two Mondays 9:30-10:30am (pacific),
  - lowellbb@cmb-s4.org
  - Telecon notes google doc
  - Analysis logbook