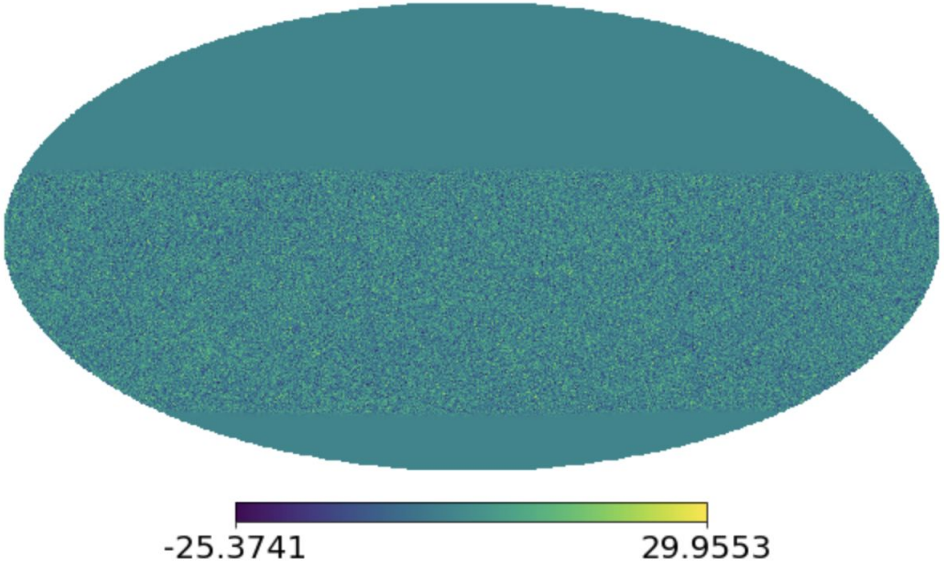
S4x Litebird

Chwide QE lensing reconstruction

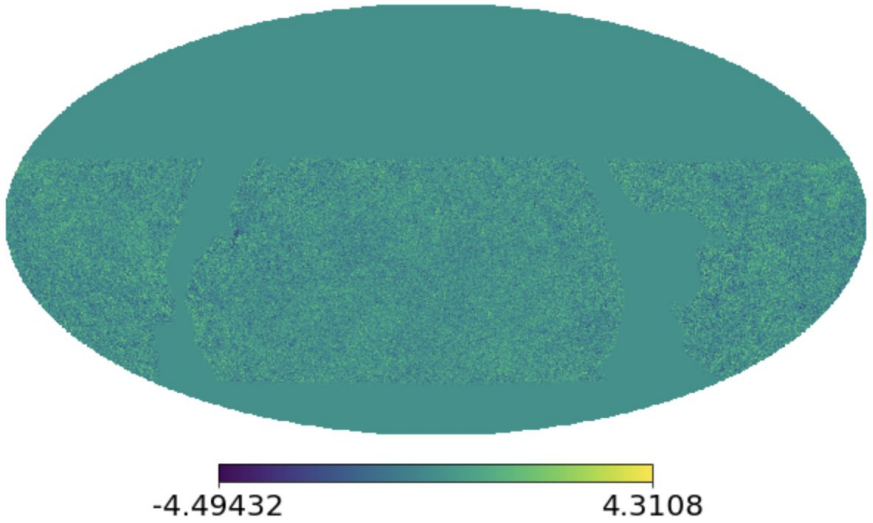
Louis Legrand 8 May 2024

Maps from Shamik

25 maps, NILC E and B maps



E map



B map

Quadratic estimator (in real space)

$$ {}_1\hat{d}(\hat{\boldsymbol{n}}) = -\sum_{s=0,\pm 2} {}_{-s}\bar{X}(\hat{\boldsymbol{n}}) \left[\eth_s X^{\rm WF}\right](\hat{\boldsymbol{n}}), $$

QE deflection field

d = $\partial\phi$

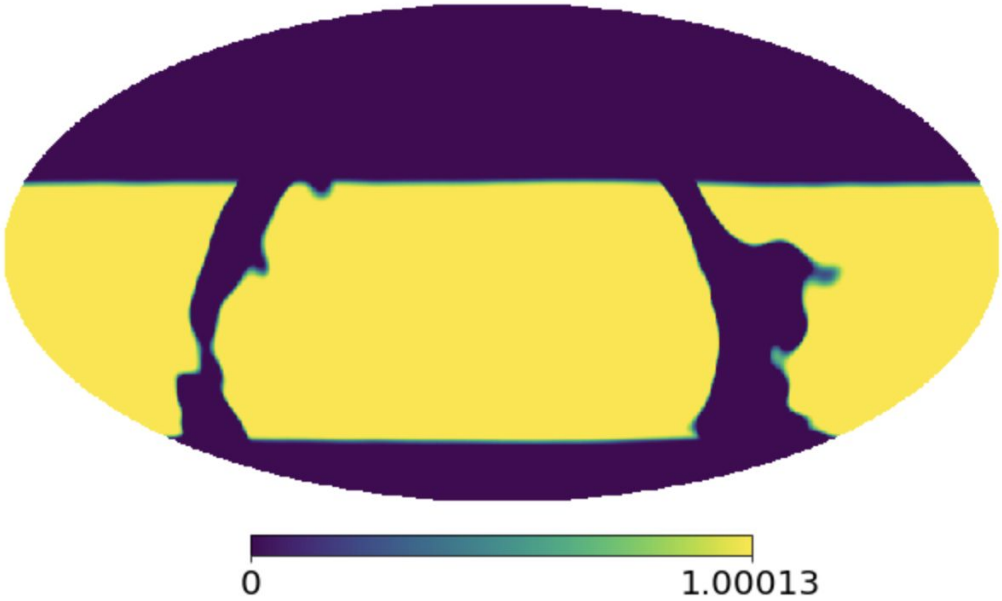
Inverse variance filtered (IVF) maps

Wiener filtered (WF) maps

- Follow Planck 2018 lensing analysis (plancklens code)
- (generalized) minimum variance estimator using E and B only
- IVF is done in pixel space, with fiducial spectra and mask
- QE weights (in the WF) use the gradCls

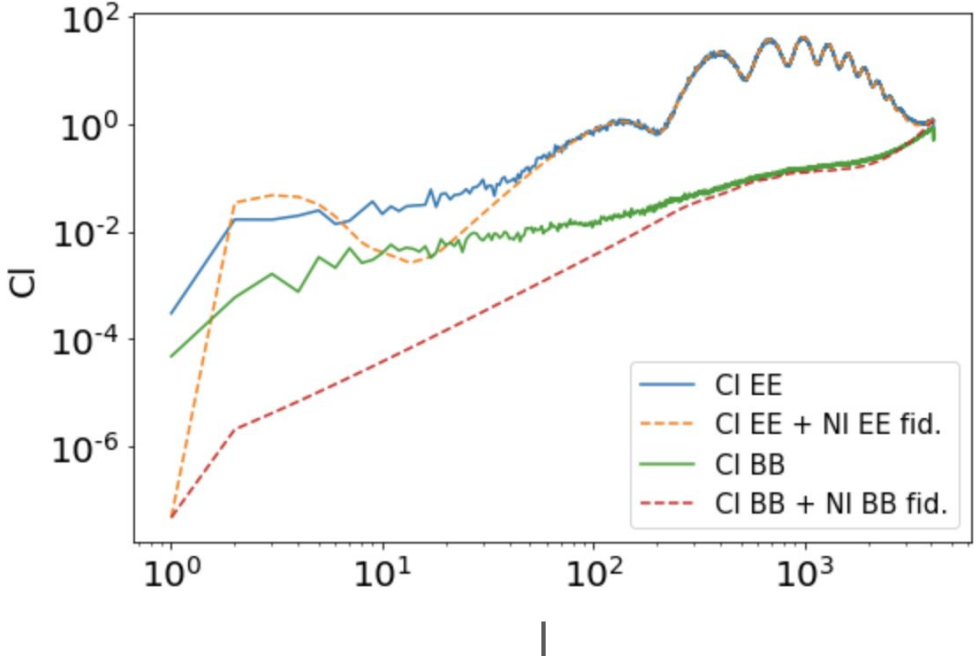
Mask

- Combination of:
  - S4 chile wide footprint with 3 degree apodization
  - Galactic dust footprint with 3 degree apodization



Filtering spectra

- Effective Gaussian beam of the NILC maps of 2.1 amin
- Polarisation noise estimated from the spectra (roughly) of 1.3 muK.arcmin
- I did not model the 1/f noise at low l
- Filtering is done between lmin=1 and lmax = 4096



Debiased and normalised QE

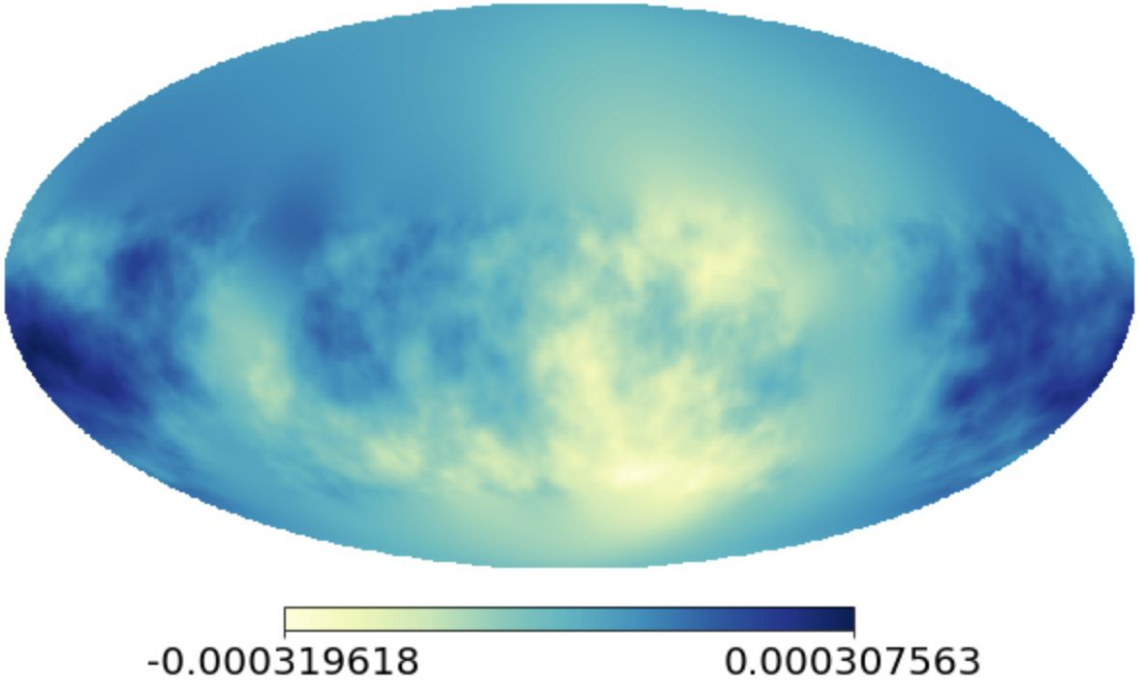
- Normalisation and mean field subtraction
- Mean field of each sim can be estimated from the other 24 simulations

$$\hat{\phi}_{LM} \equiv \frac{1}{\mathcal{R}_L^{\phi}} \left(\hat{g}_{LM} - \langle \hat{g}_{LM} \rangle_{\mathrm{MC}} \right),$$

QE response (analytical)

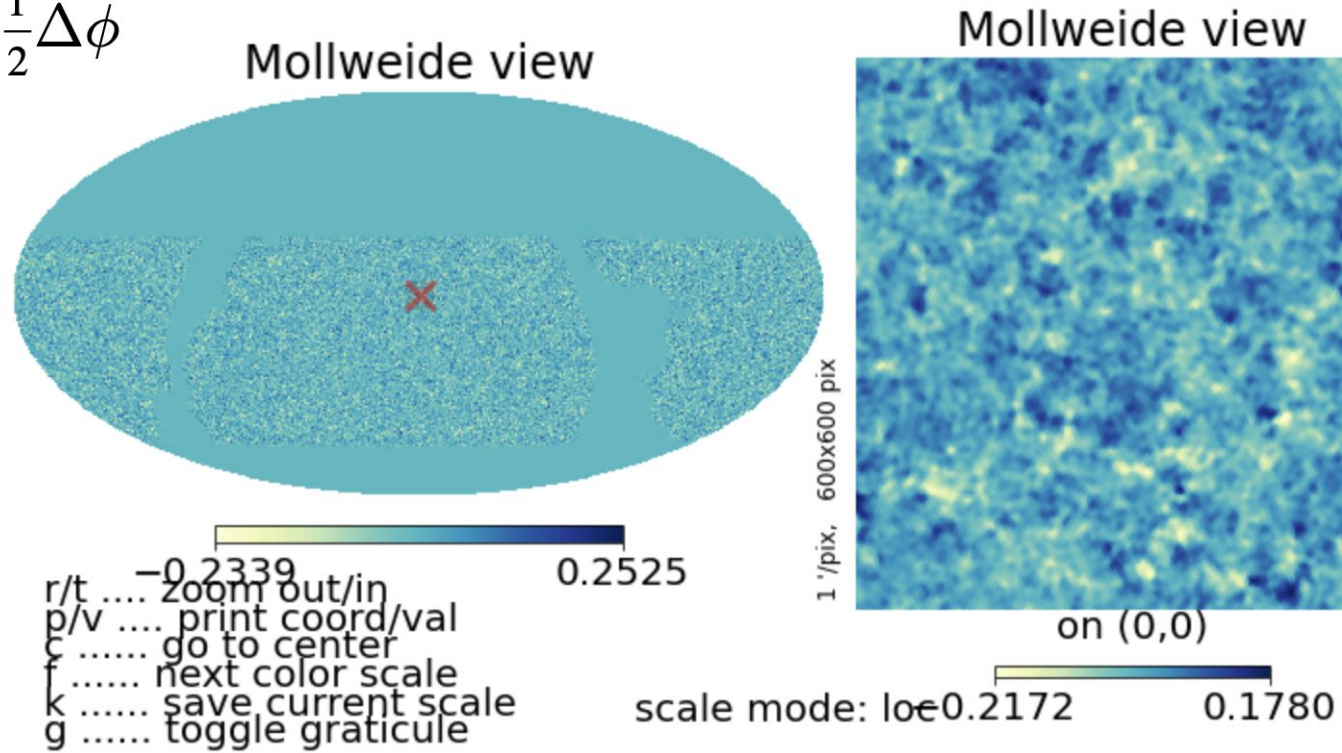
Mean field = signal from other sources of anisotropies (such as mask or foregrounds). Estimated by averaging over simulations

Reconstructed phi map

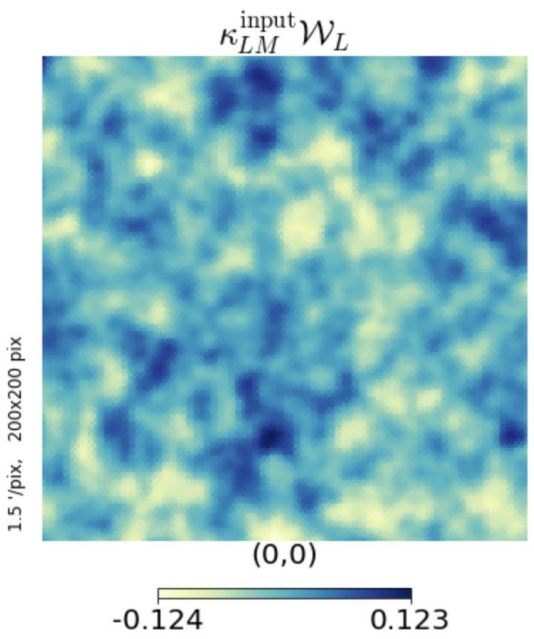


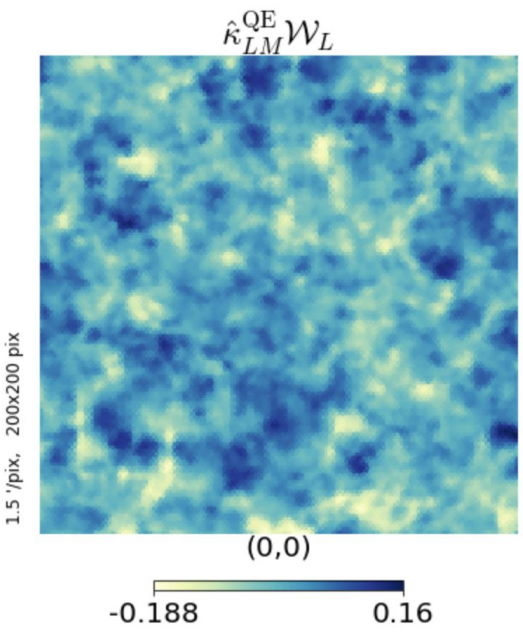
Wiener filtered convergence map

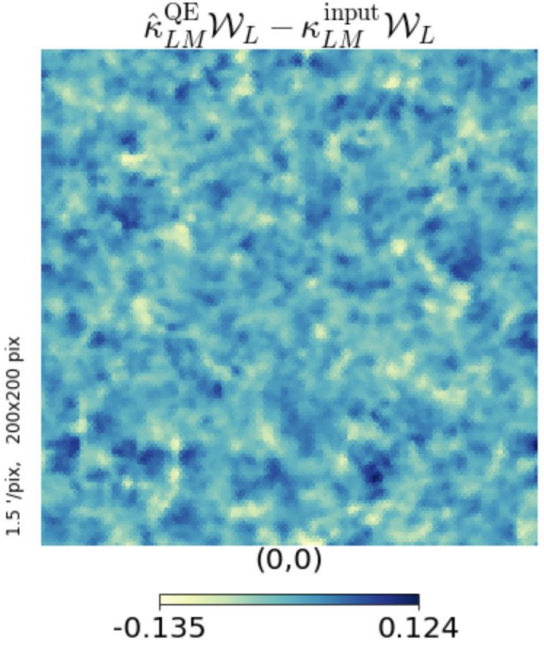
$$\kappa = -\frac{1}{2}\Delta\phi$$



Comparison with input







QE power spectrum

- Power spectrum biases

$$C_L^{\hat{\phi}^{\mathrm{QE}}\hat{\phi}^{\mathrm{QE}}} \sim C_L^{\phi\phi} + N_L^{(0)} + N_L^{(1)}$$

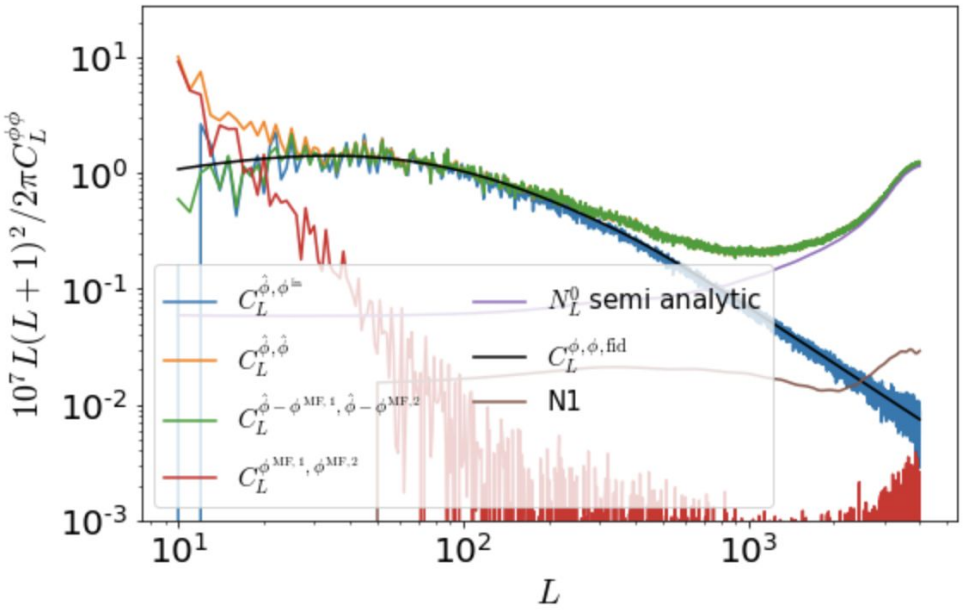
Connected contractions at first order in ϕ

4 point function of the CMB

Gaussian contractions

- N0 is estimated semi-analytically (combining fiducial spectra and spectra from the sims): unbiased at first order between the true and fiducial spectra of the maps

Mean field subtraction



Cross correlation with simulated ϕ

No mean field subtraction

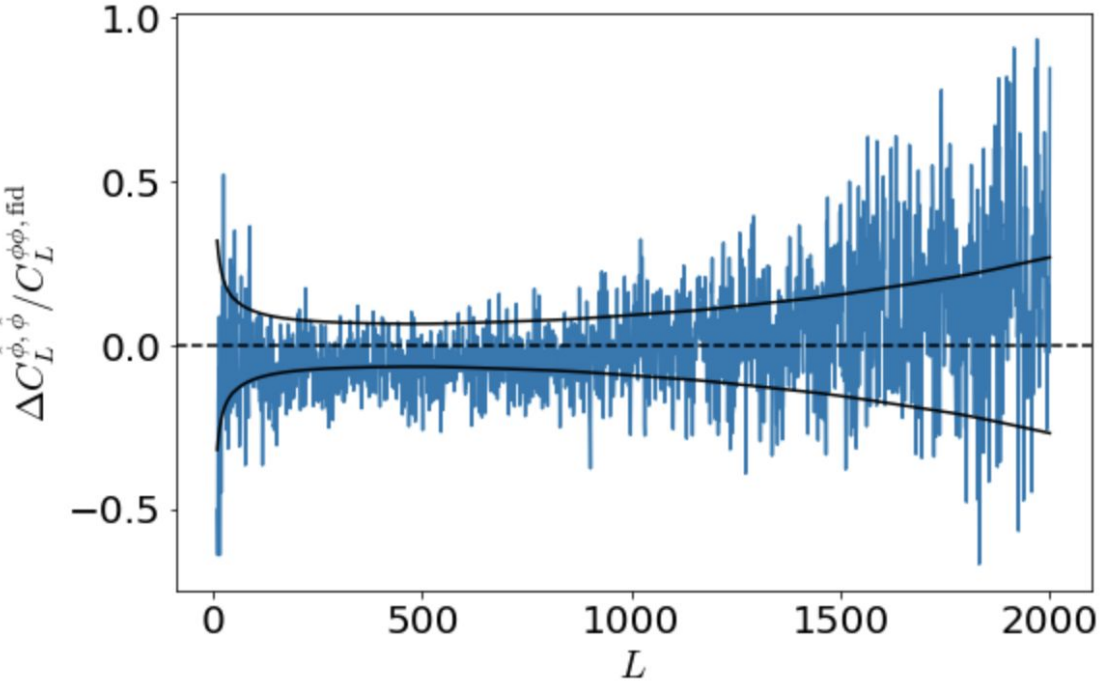
Mean field subtracted

Mean field (cross)

➢ Men field estimated from two batches of 12 simulations (subtracting a different batch from each leg of the spectrum to lower MC variance)

Relative bias

- Subtracting N0 and N1 bias
- Black lines are the expected variance



Next steps

- ➢ Should I produce B-mode template maps ?
- ➢ Use the iterative estimator to gain SNR