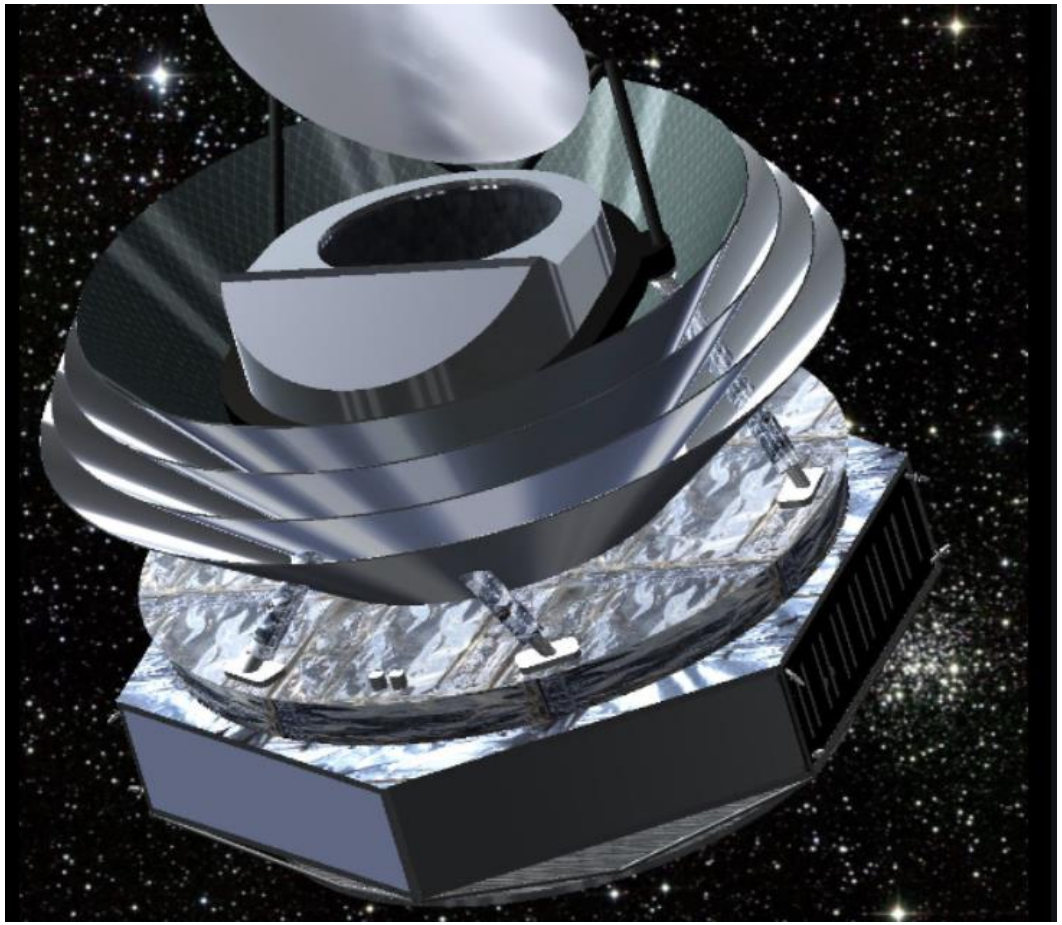
PICO
delensing status



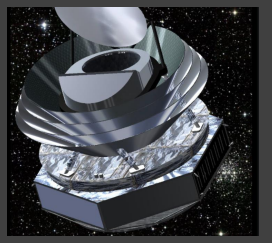
Update – 03.02.2022

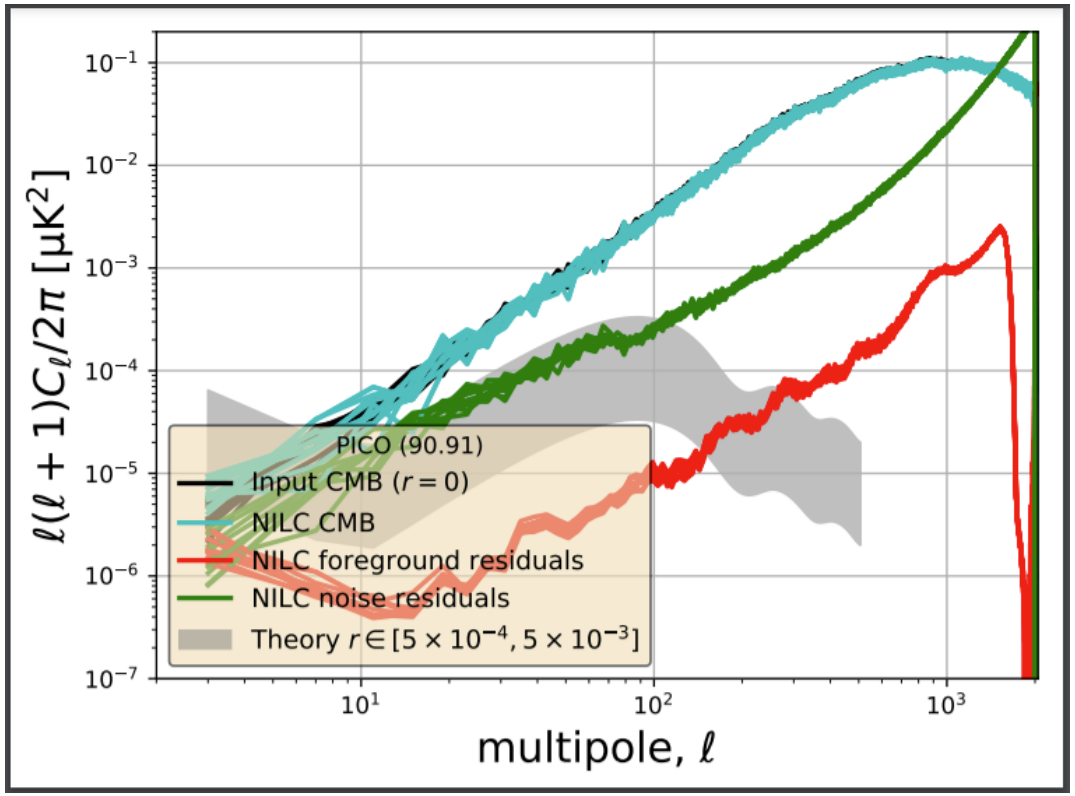
Sebastian Belkner, Julien Carron

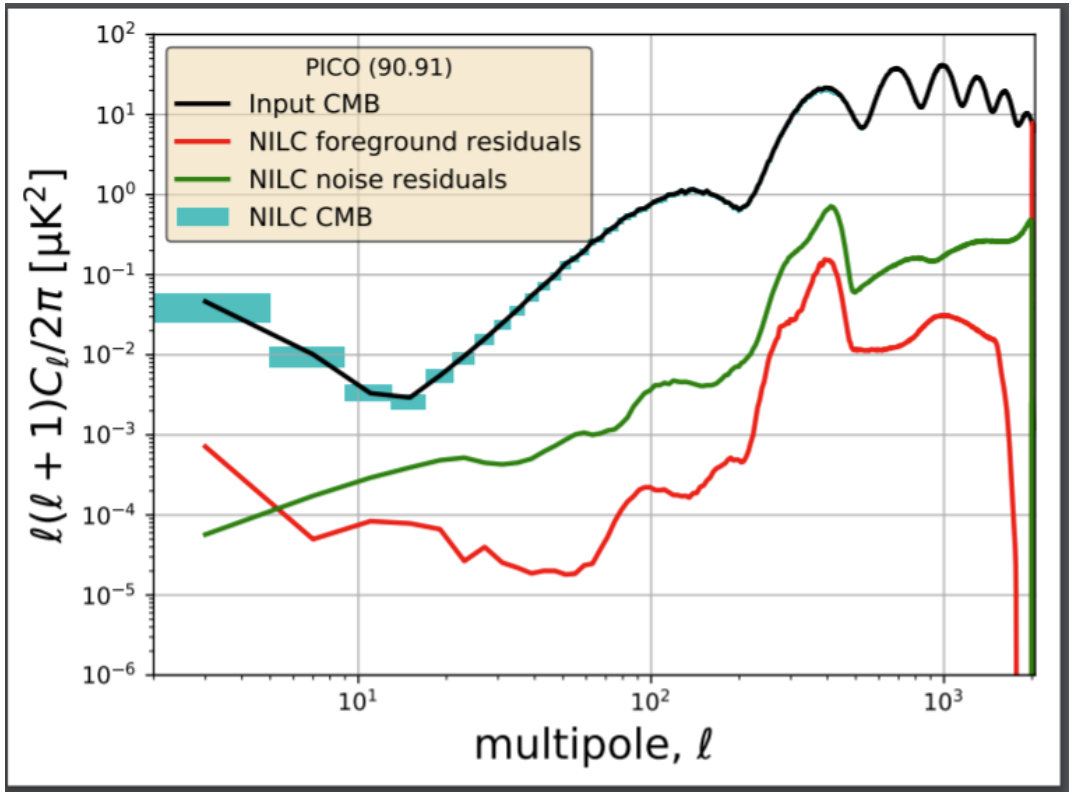
Lenscarf

Data – 90.91

- FFP10 simulations w/ foreground
- E and B GNILC fg-cleaned maps @ nside 2048

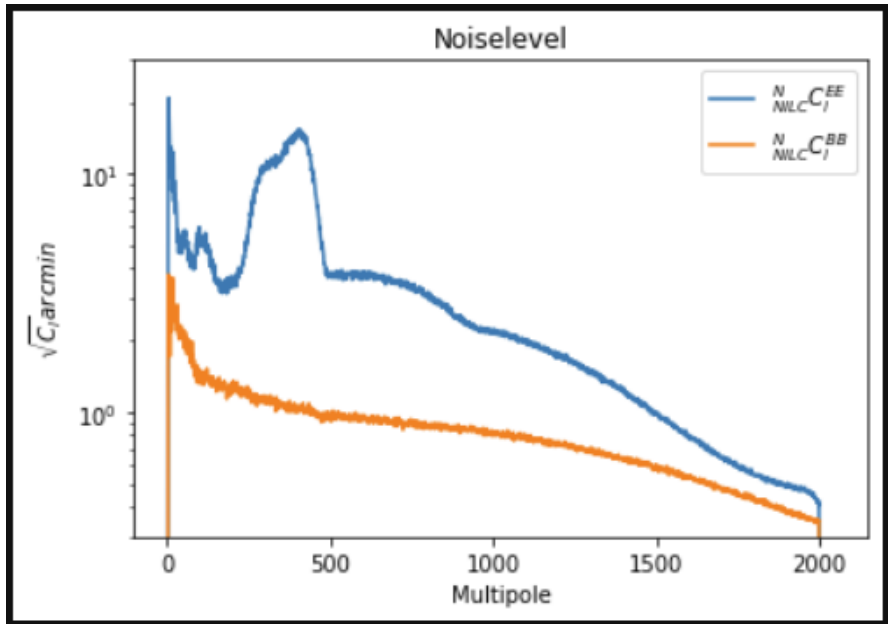


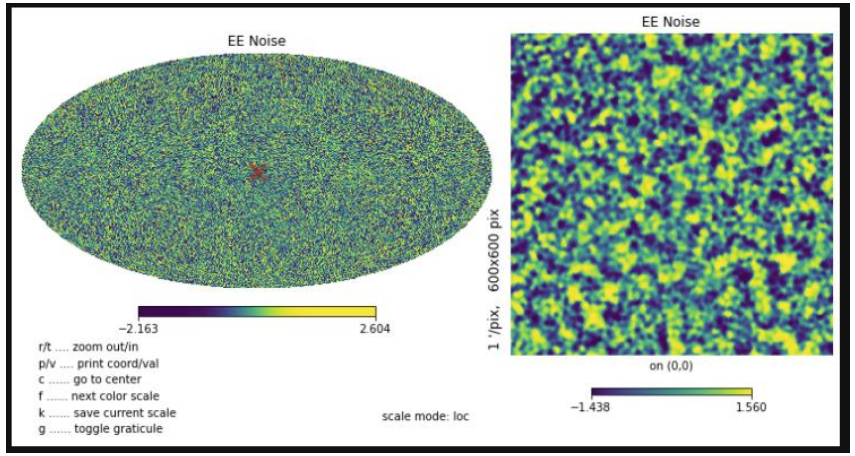


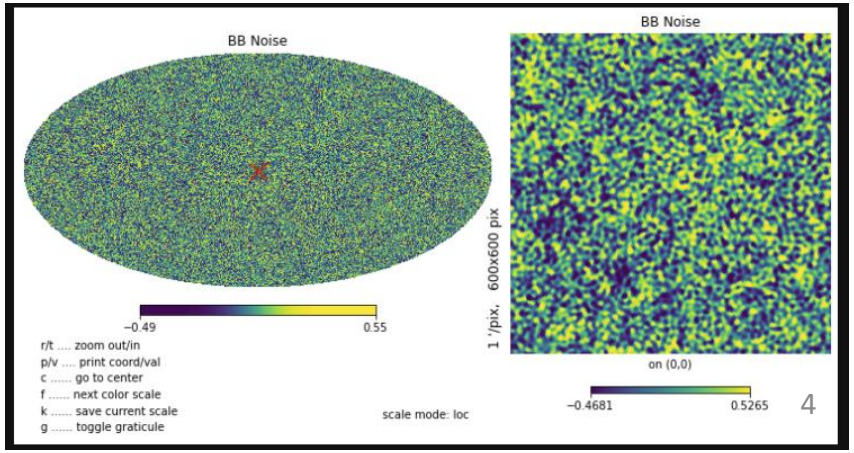


Check

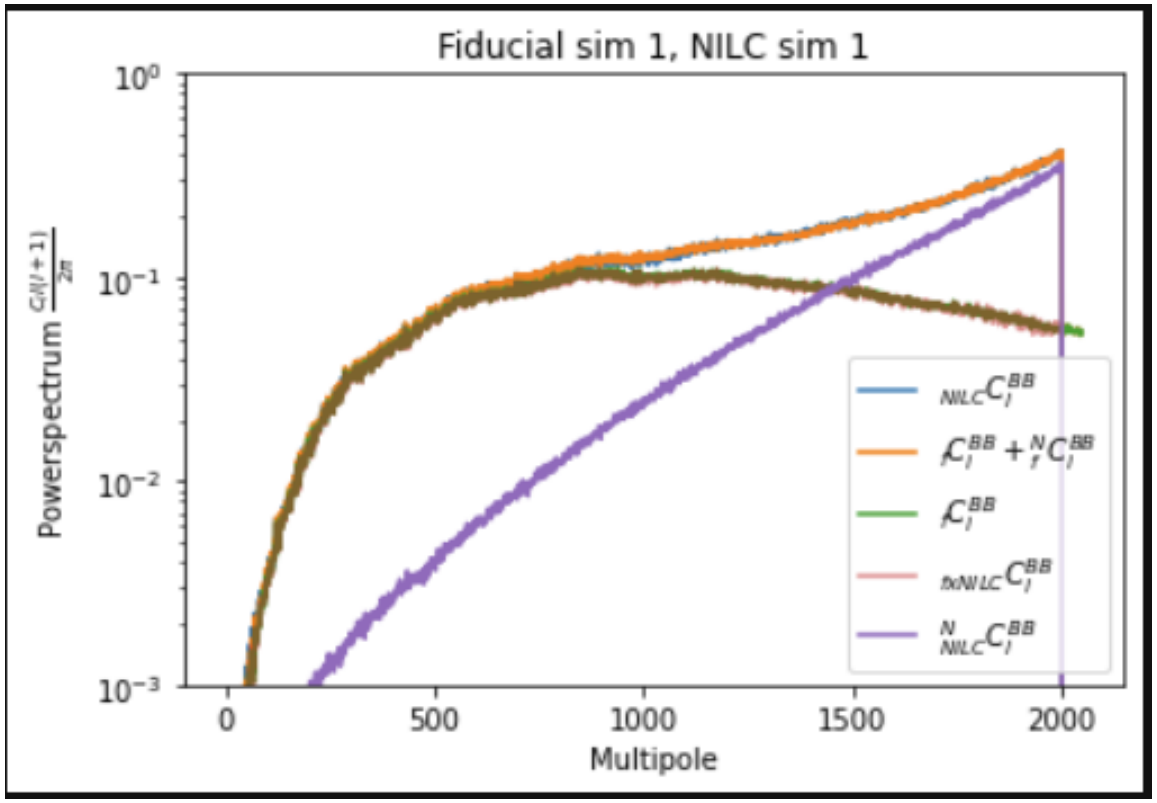
Noise

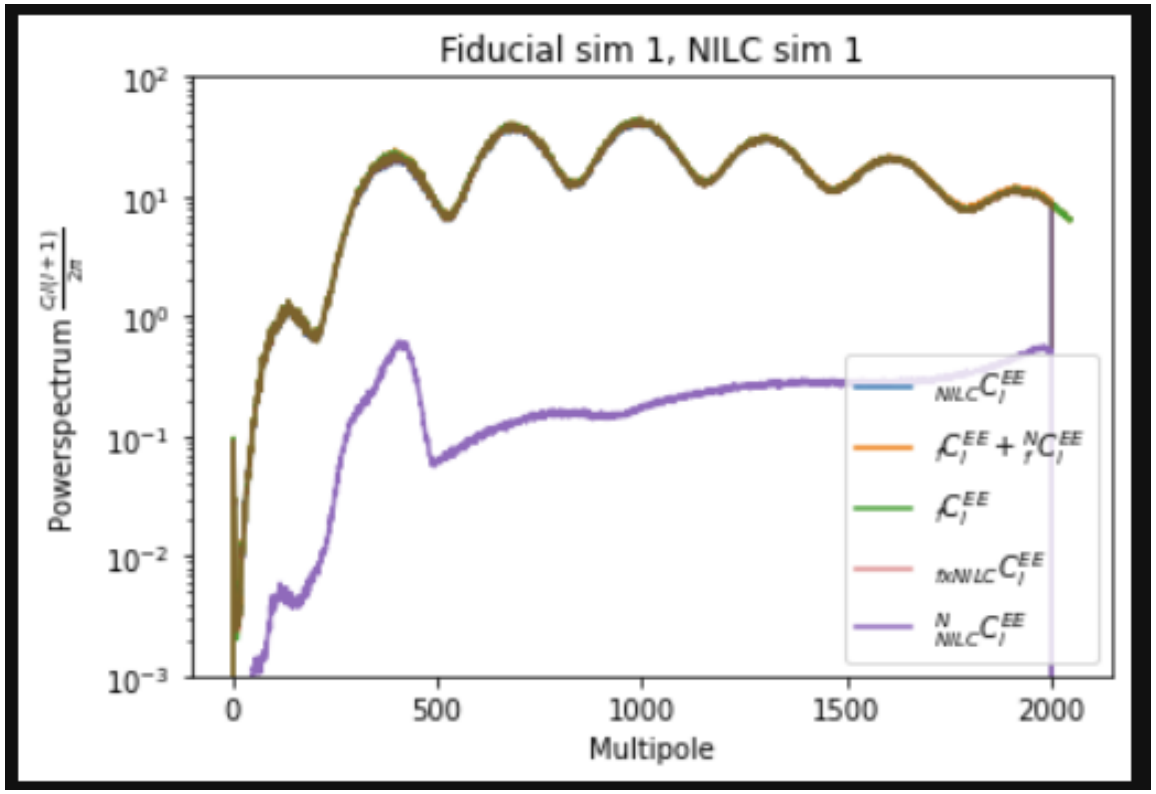

Noiselevel
$\sqrt{C_l}arcmin$
10^1
10^0
0
500
1000
1500
2000
Multipole
$N_{NILC} C_l^{EE}$
$N_{NILC} C_l^{BB}$


EE Noise
−2.163
2.604
r/t .... zoom out/in
p/v .... print coord/val
c ..... go to center
f ..... next color scale
k ..... save current scale
g ..... toggle graticule
scale mode: loc
EE Noise
1 '/pix, 600x600 pix
on (0,0)
−1.438
1.560


BB Noise
−0.49
0.55
r/t .... zoom out/in
p/v .... print coord/val
c ..... go to center
f ..... next color scale
k ..... save current scale
g ..... toggle graticule
scale mode: loc
BB Noise
1 '/pix, 600x600 pix
on (0,0)
−0.4681
0.5265

CMB


Fiducial sim 1, NILC sim 1
Powerspectrum $\frac{C_l(l+1)}{2\pi}$
Multipole
$^{NILC}C_l^{BB}$
$_fC_l^{BB} + {}^N{}_fC_l^{BB}$
$_fC_l^{BB}$
$_{fxNILC}C_l^{BB}$
$^N{}_{NILC}C_l^{BB}$


Fiducial sim 1, NILC sim 1
Powerspectrum $\frac{C_l(l+1)}{2\pi}$
Multipole
$^{NILC}C_l^{EE}$
$_fC_l^{EE} + {}^N{}_fC_l^{EE}$
$_fC_l^{EE}$
$_{fxNILC}C_l^{EE}$
$^N{}_{NILC}C_l^{EE}$

Summary

- sim index is same as ffp10 sim index
- 8 arcmin beam
- nside 2048 Pixelwindow function
- E/B maps include noise

Delens

Results I

- QE / iterative delensing
  - QE : quadratic estimator
  - Iterative: MAP
- Vary E input
  - Ideal: E from ffp10 w/o added fg + Gaussian noise
  - Mathieus E: as is
- Compare to B input
  - pure ffp10 lens-BB
  - Mathieus: lens-BB + N_res + Fg_res

Delensing algorithm

- Lenscarf – MAP with iterative approach

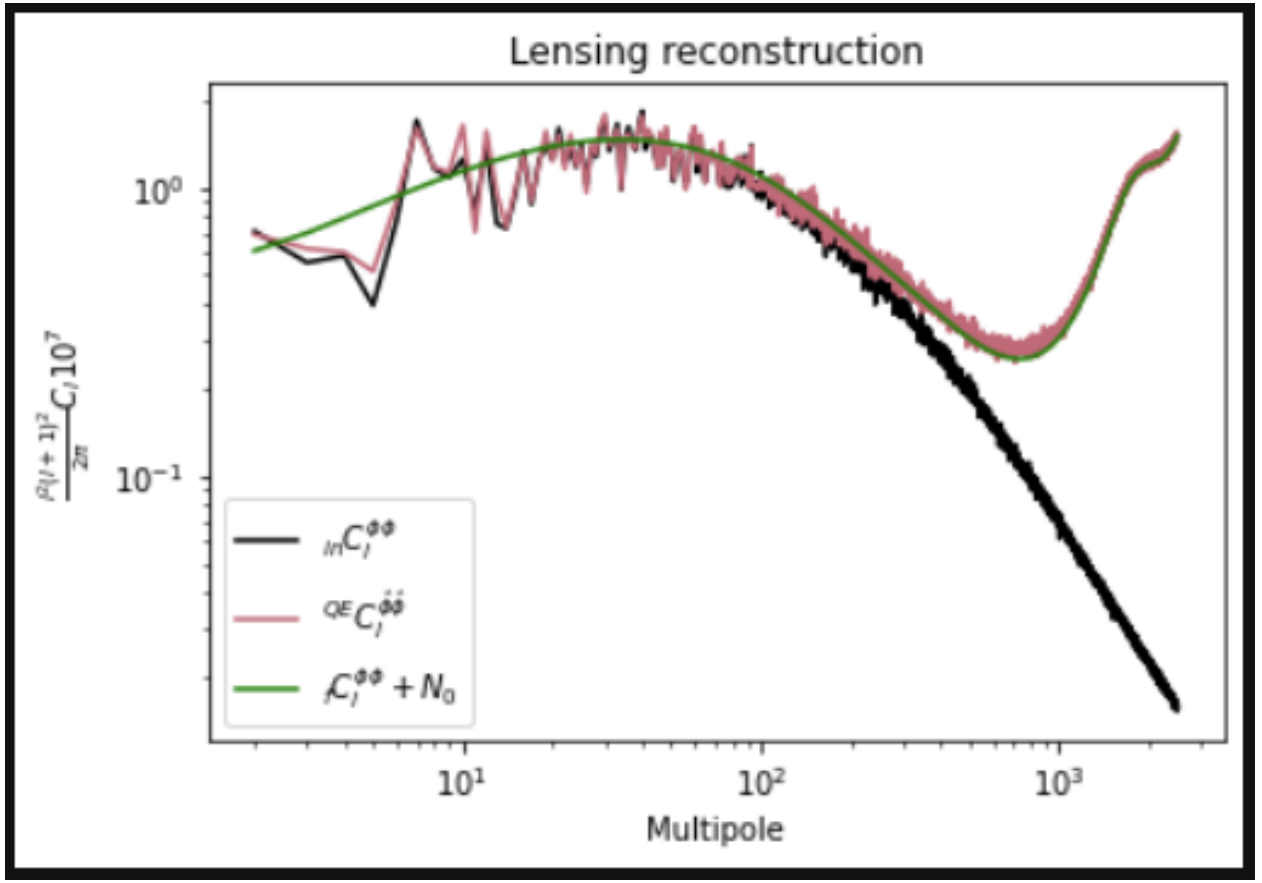
$$\ln p(\phi|X^{\rm dat}) = \ln p(X^{\rm dat}|\phi) - \frac{1}{2}\sum_{\mathbf{L}} \frac{\phi^2_{\mathbf{L}}}{C^{\phi\phi}_{\mathbf{L}}}, \qquad (2.6)$$

$$g^{\rm tot}_a \equiv \frac{\delta \ln p(\boldsymbol{\alpha}|X^{\rm dat})}{\delta \alpha_a(\boldsymbol{n})} = g^{\rm QD}_a - g^{\rm MF}_a + g^{\rm PR}_a, \qquad (2.7)$$

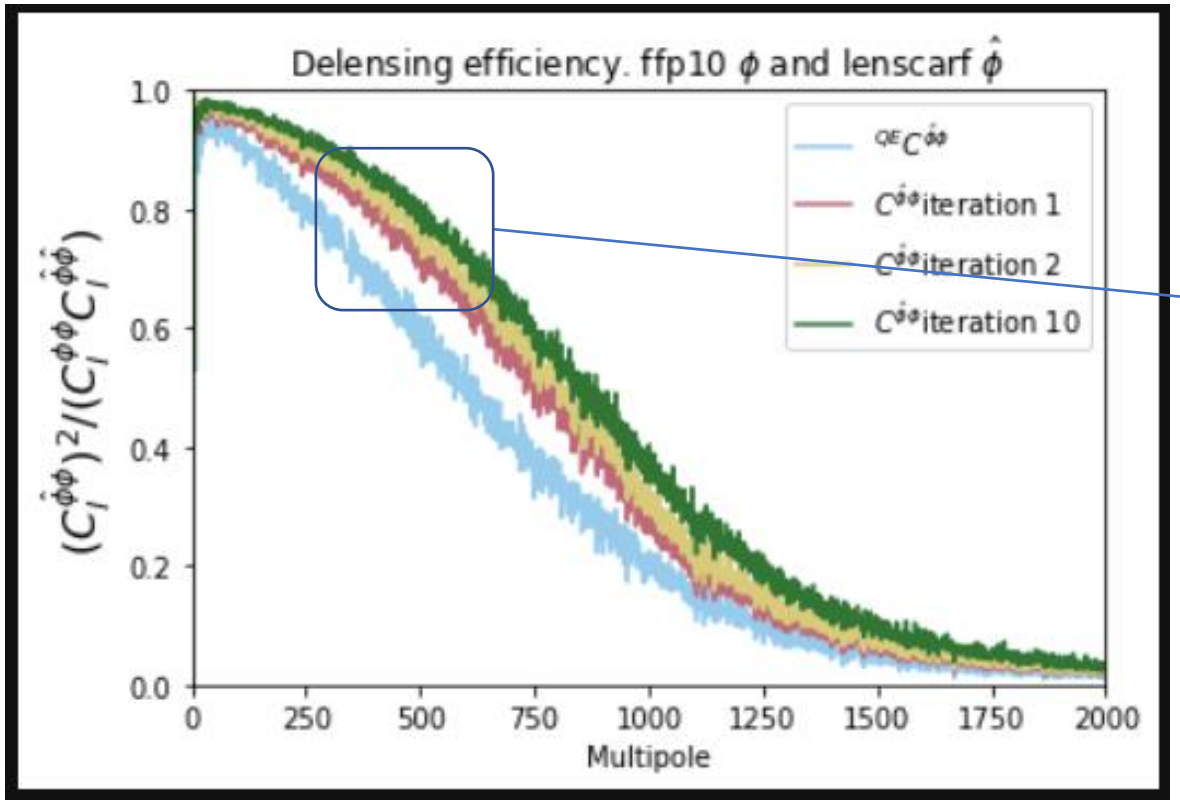
$$X^{\rm WF}_{\boldsymbol{\alpha}} \equiv C^{\rm unl} D^\dagger B^\dagger {\rm Cov}^{-1}_{\boldsymbol{\alpha}} X^{\rm dat}. \qquad (2.11)$$

- Parameter choice
  - Drop E,B modes < (30, 200)

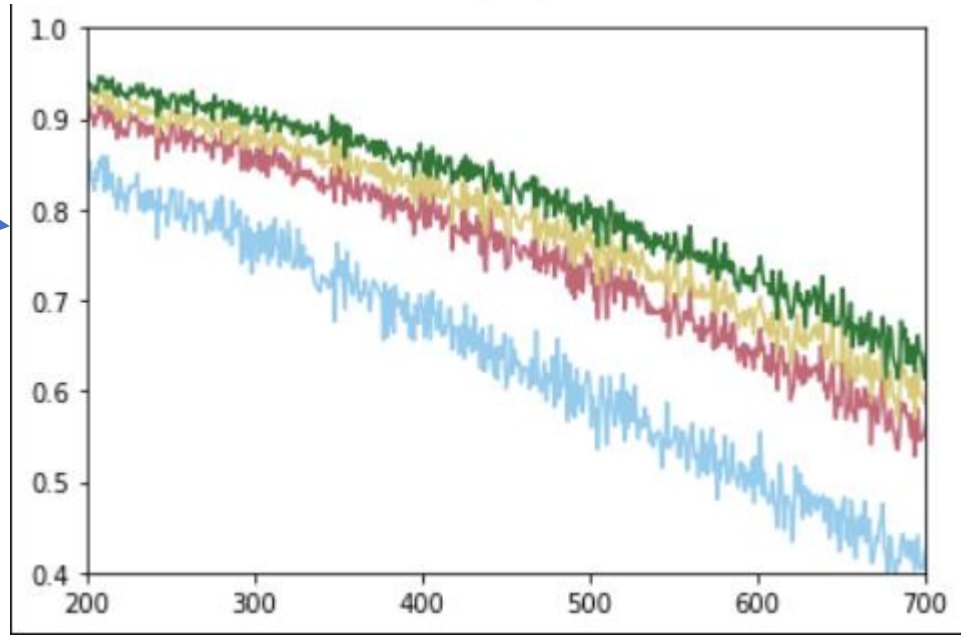
$C_l^{\phi\phi}$ - quadratic estimator



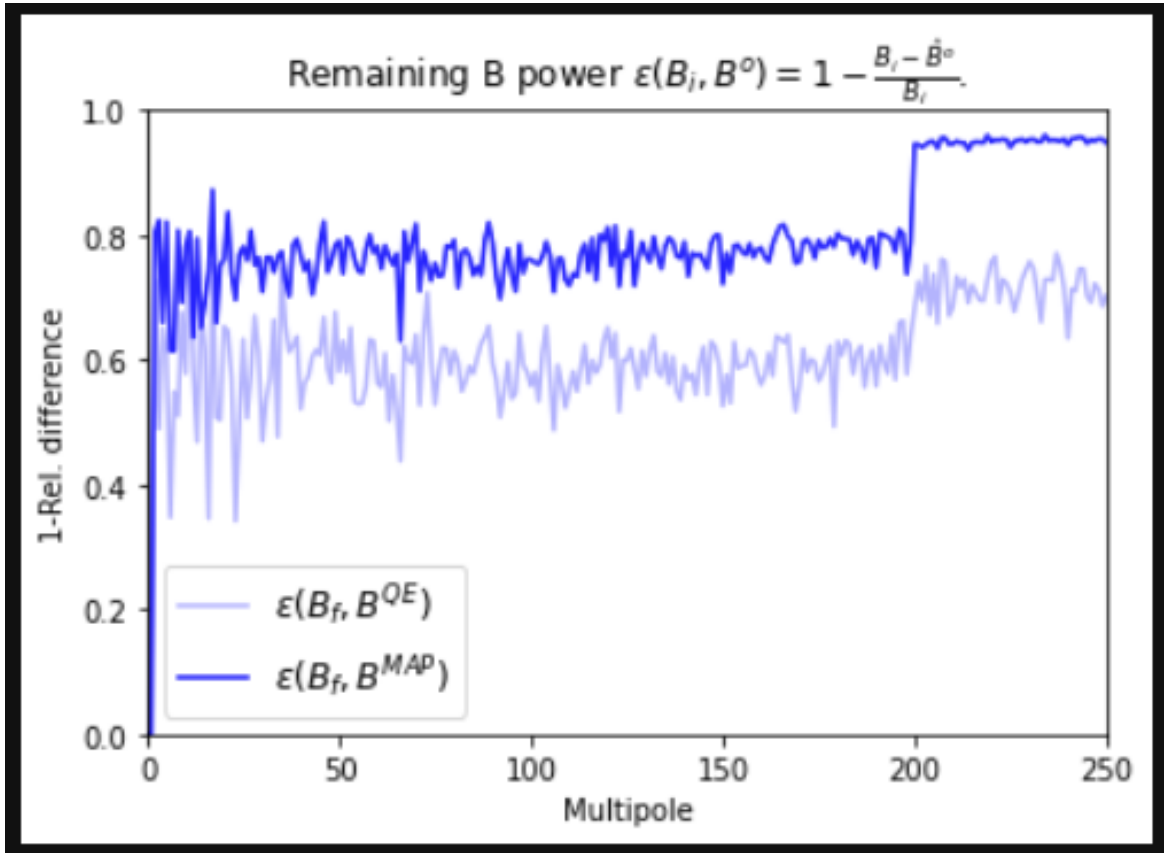
Improvement per iteration step



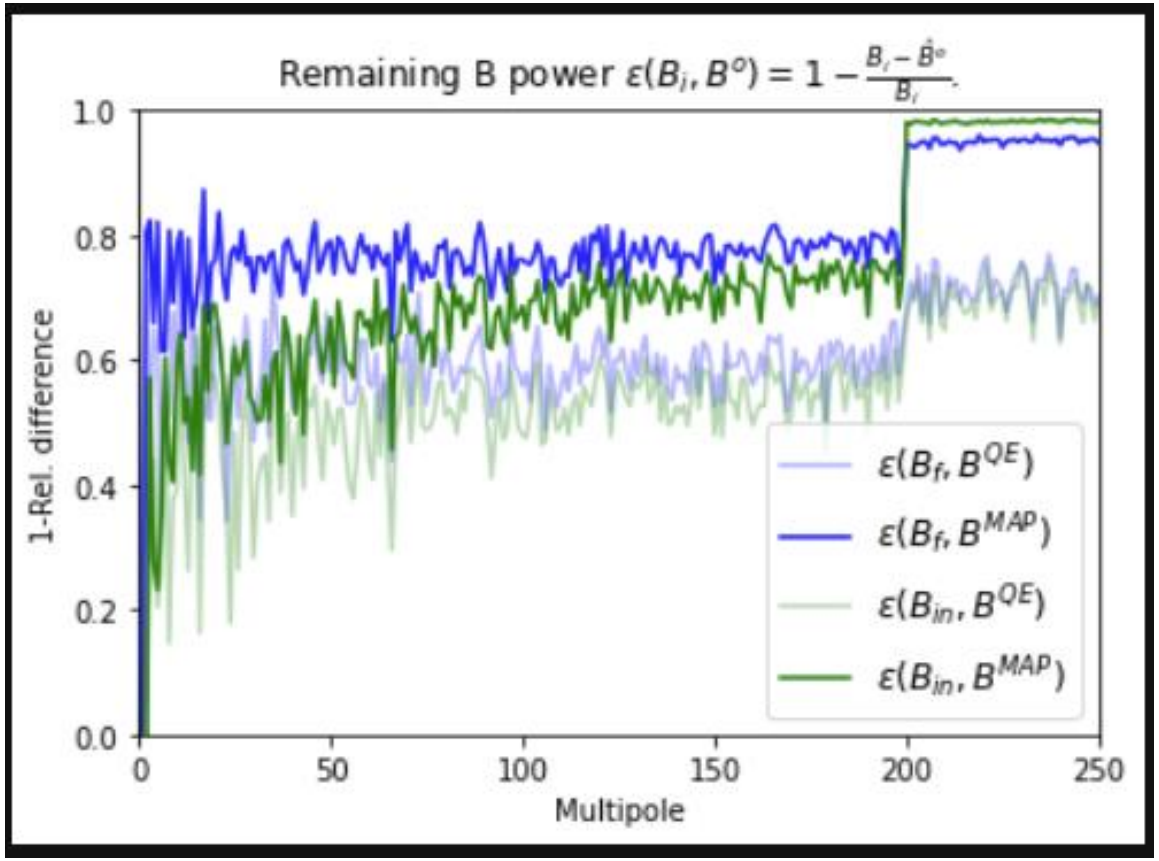
- It's converging



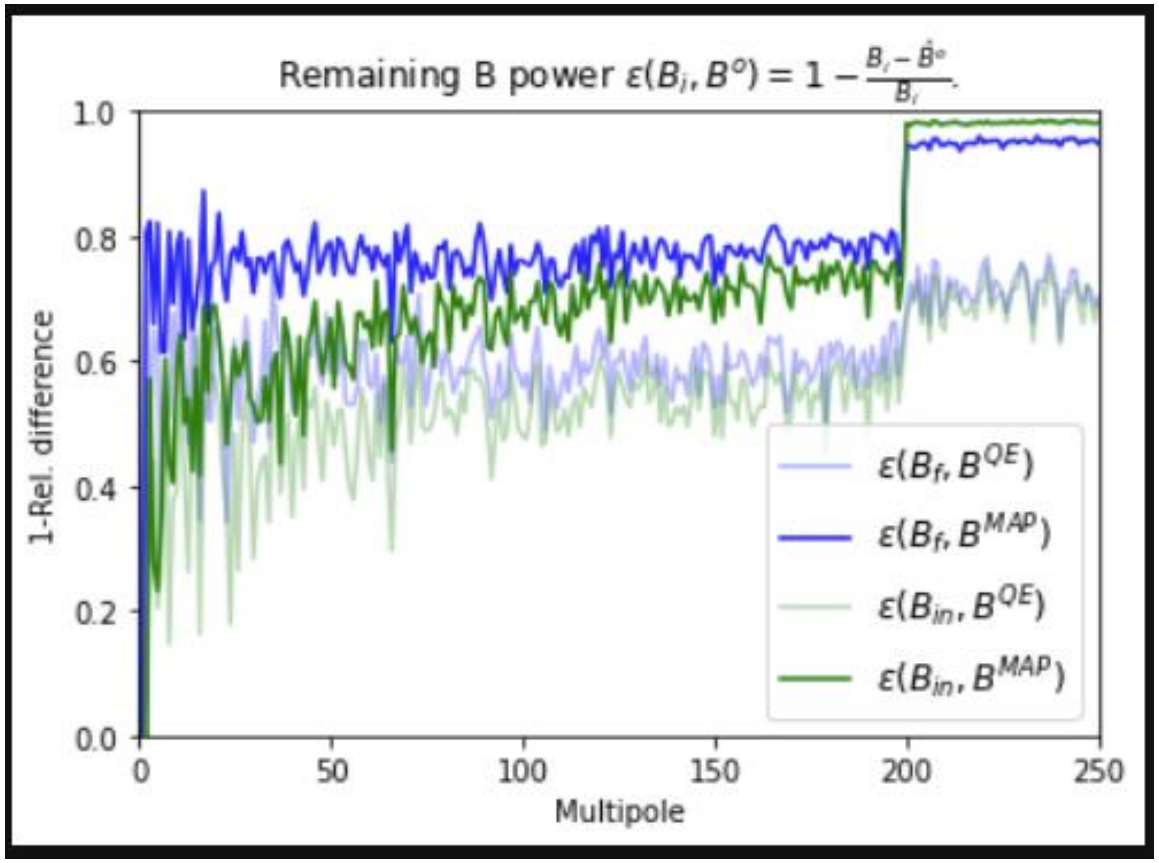
B mode after delensing

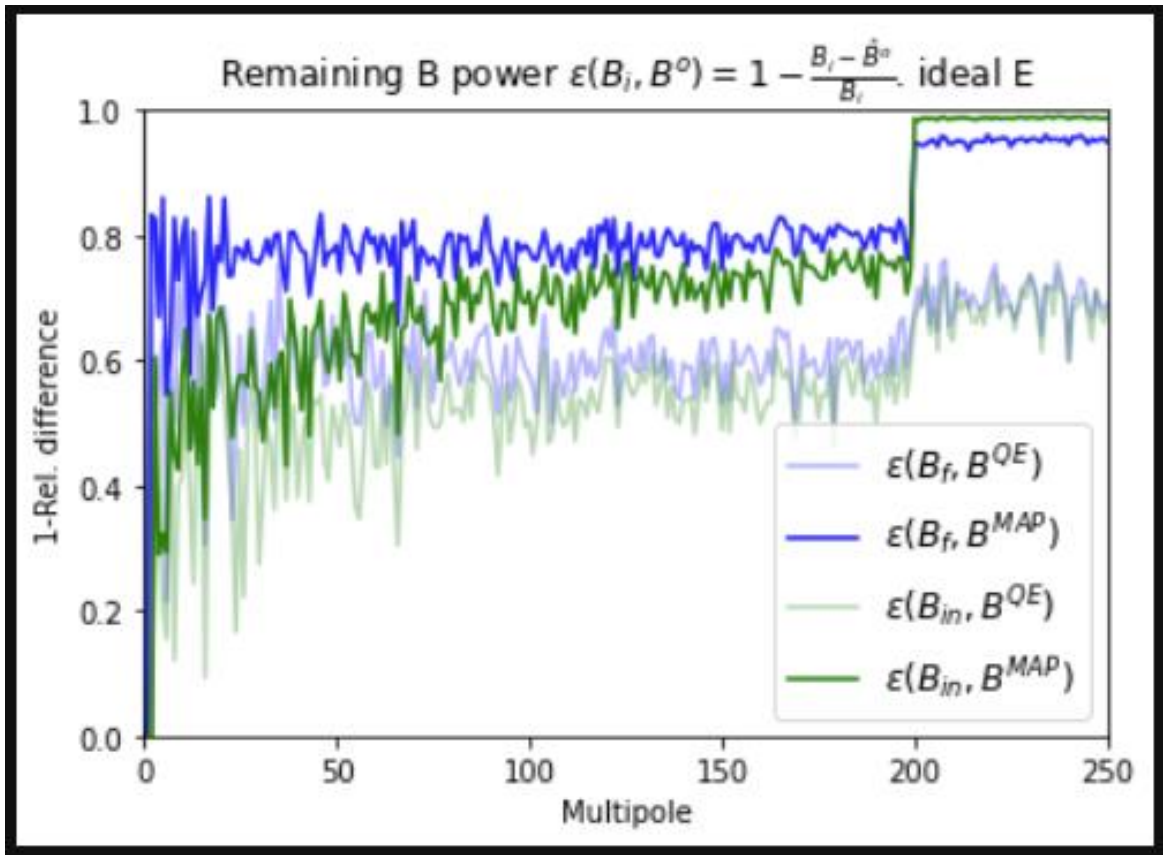


B mode after delensing

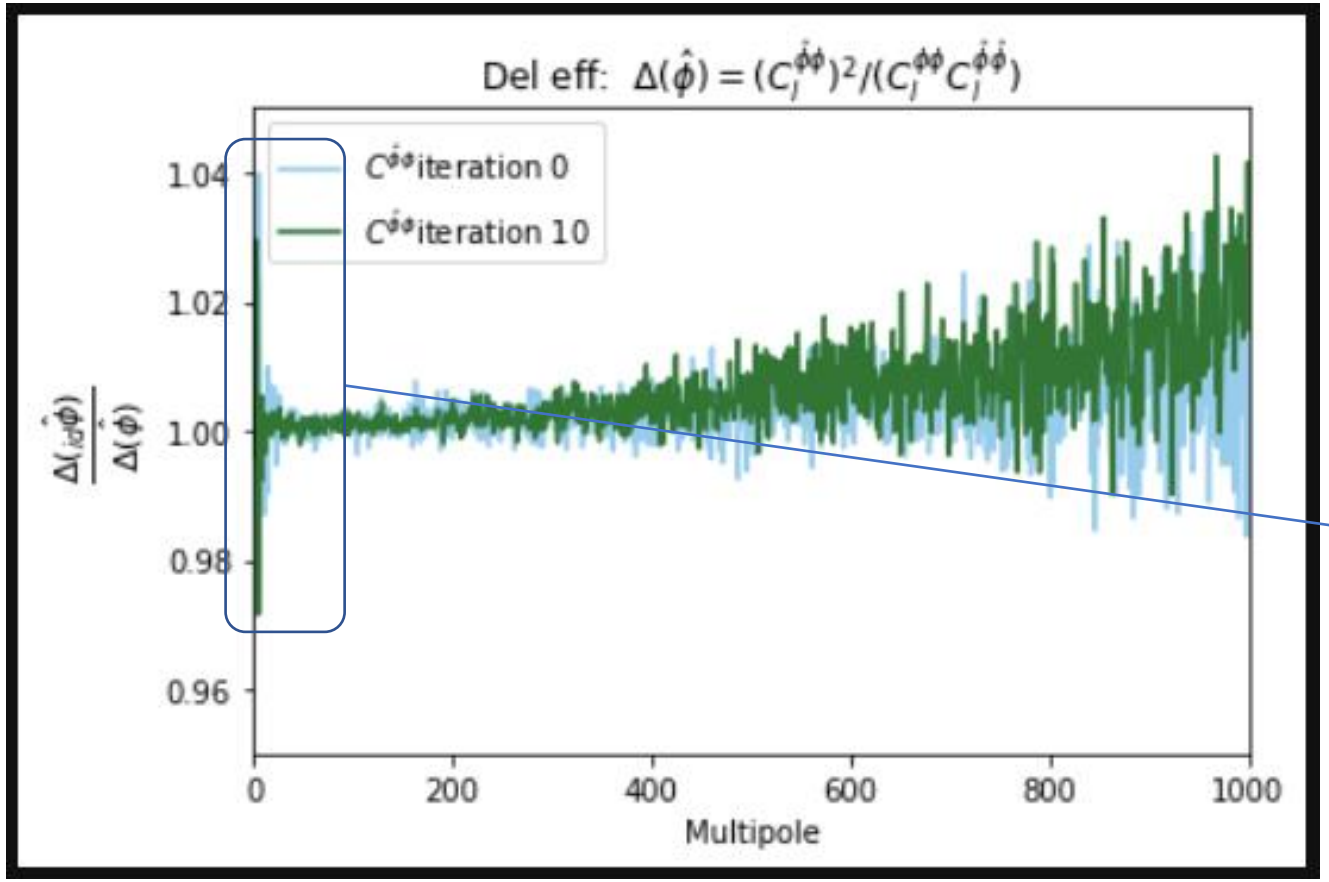


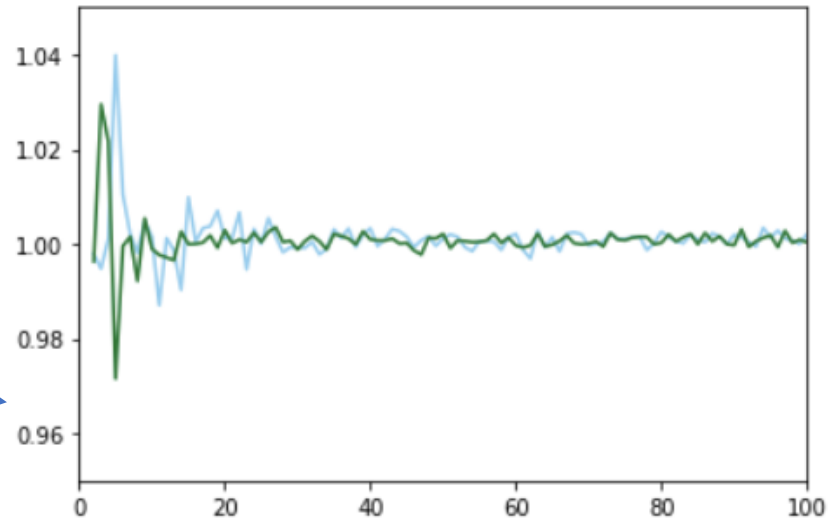
B mode after delensing



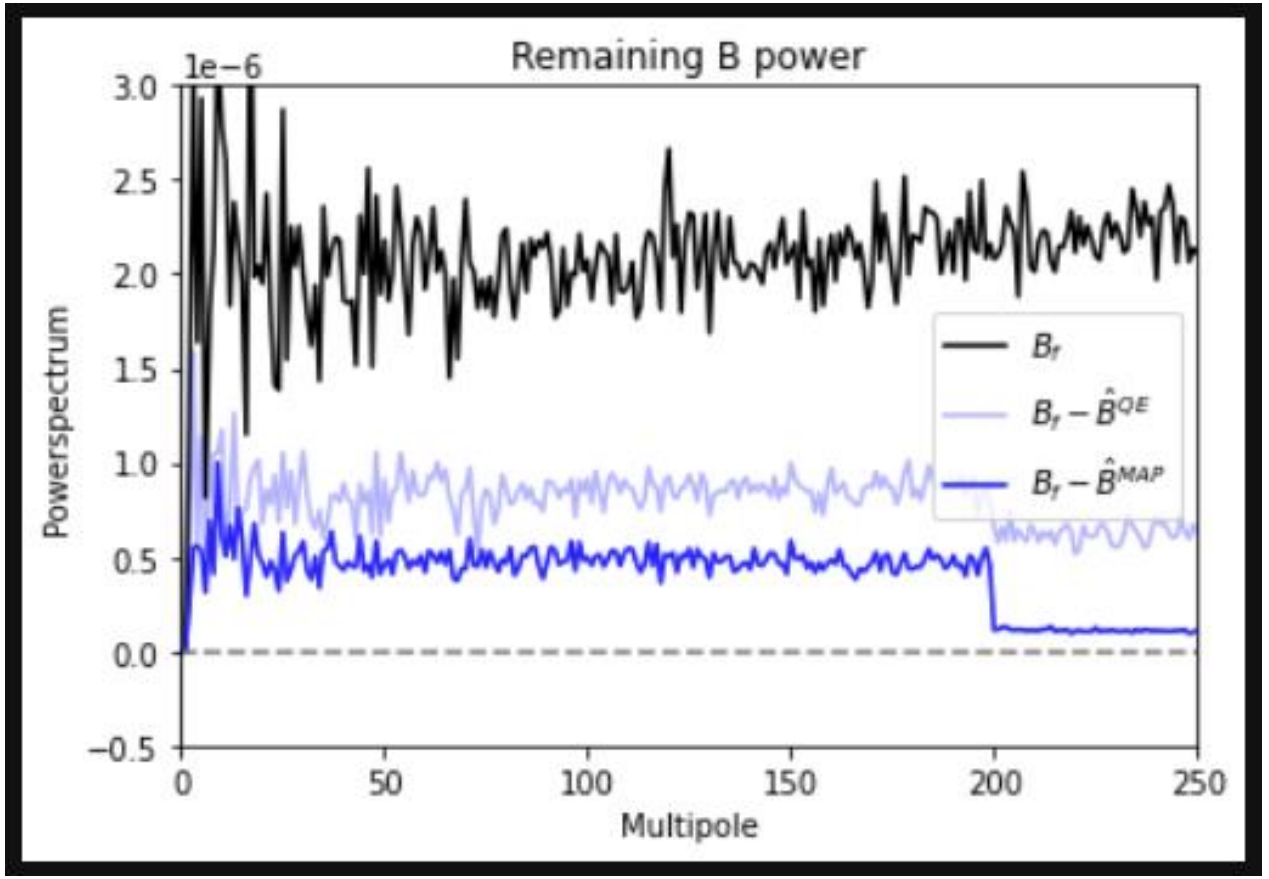


ideal E vs. sim E

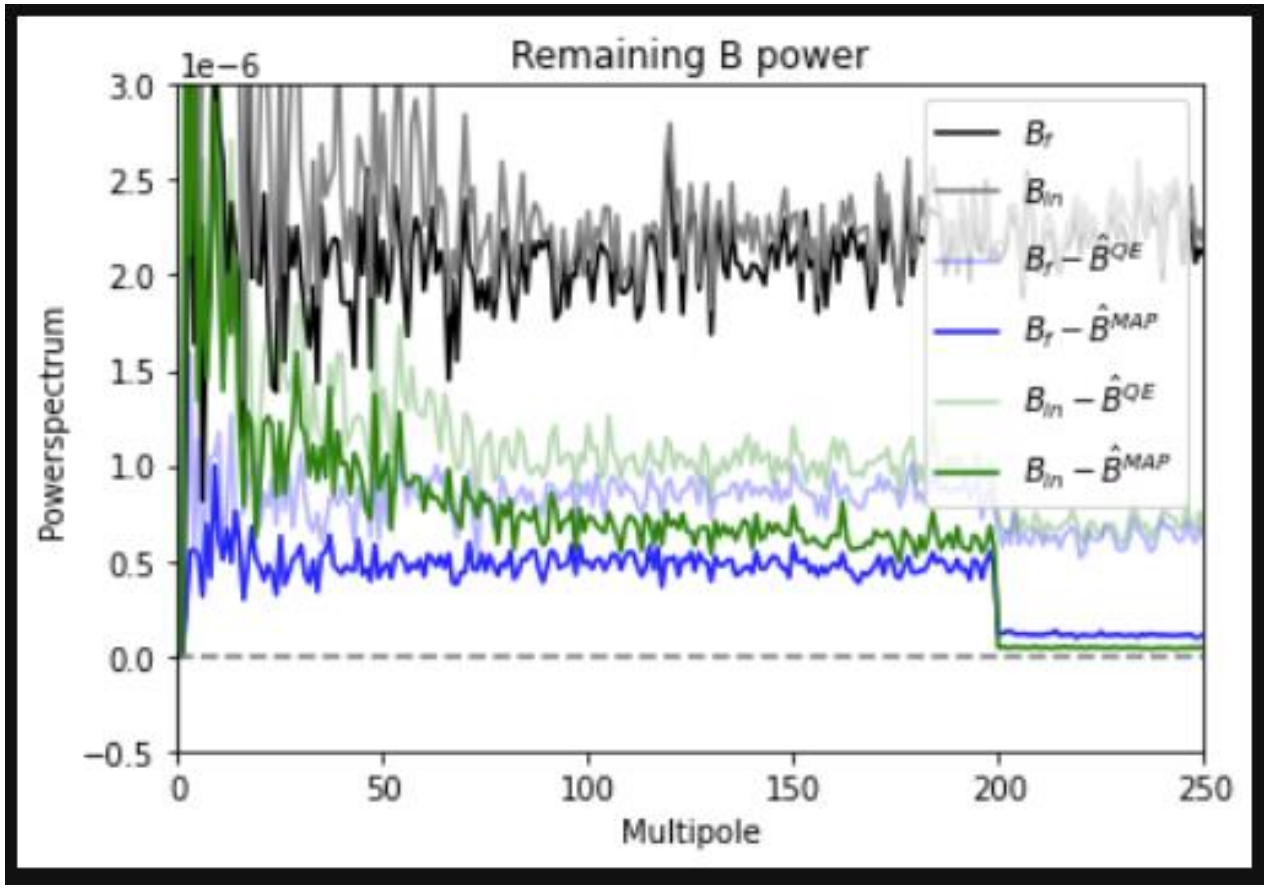




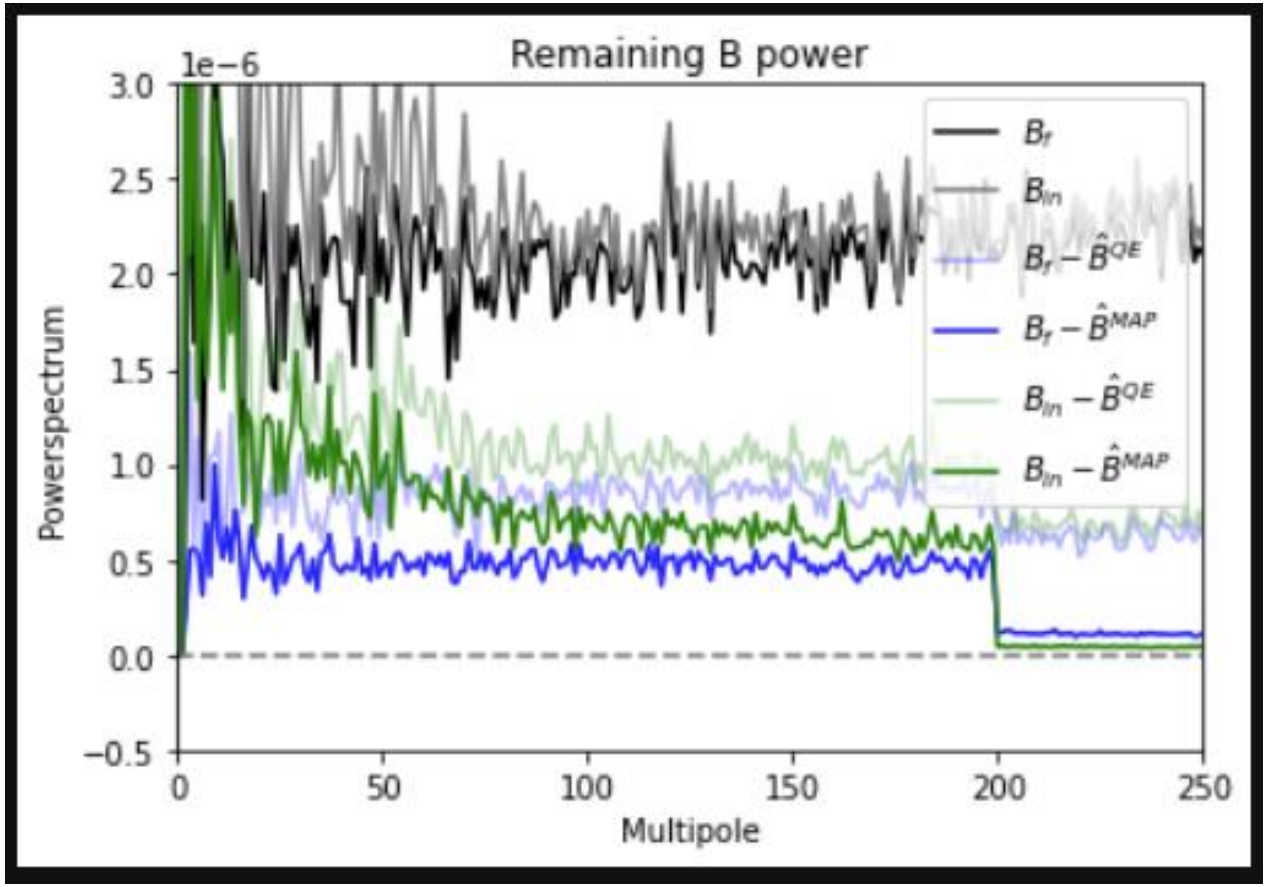
B templates

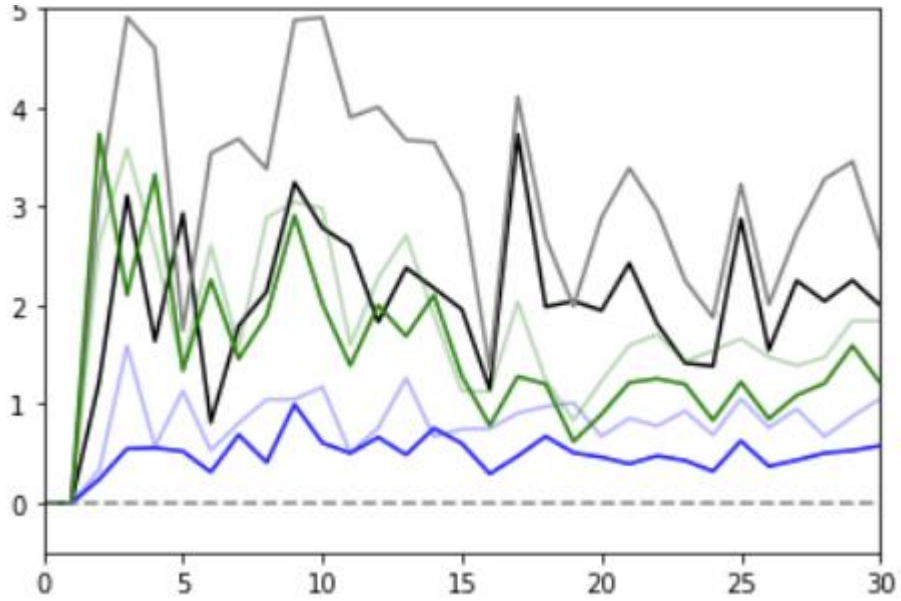

Remaining B power
1e−6
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
Powerspectrum
0
50
100
150
200
250
Multipole
B_r
$B_r - \hat{B}^{QE}$
$B_r - \hat{B}^{MAP}$

B templates

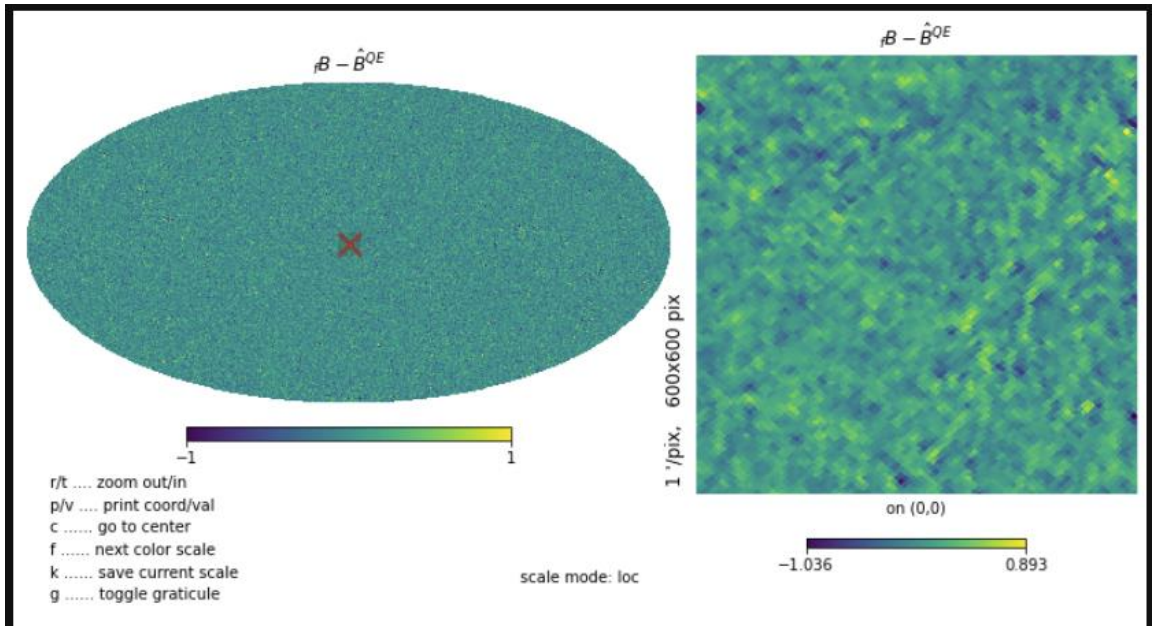

Remaining B power
1e−6
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
Powerspectrum
0
50
100
150
200
250
Multipole
B_r
B_{in}
$B_r - \hat{B}^{QE}$
$B_r - \hat{B}^{MAP}$
$B_{in} - \hat{B}^{QE}$
$B_{in} - \hat{B}^{MAP}$

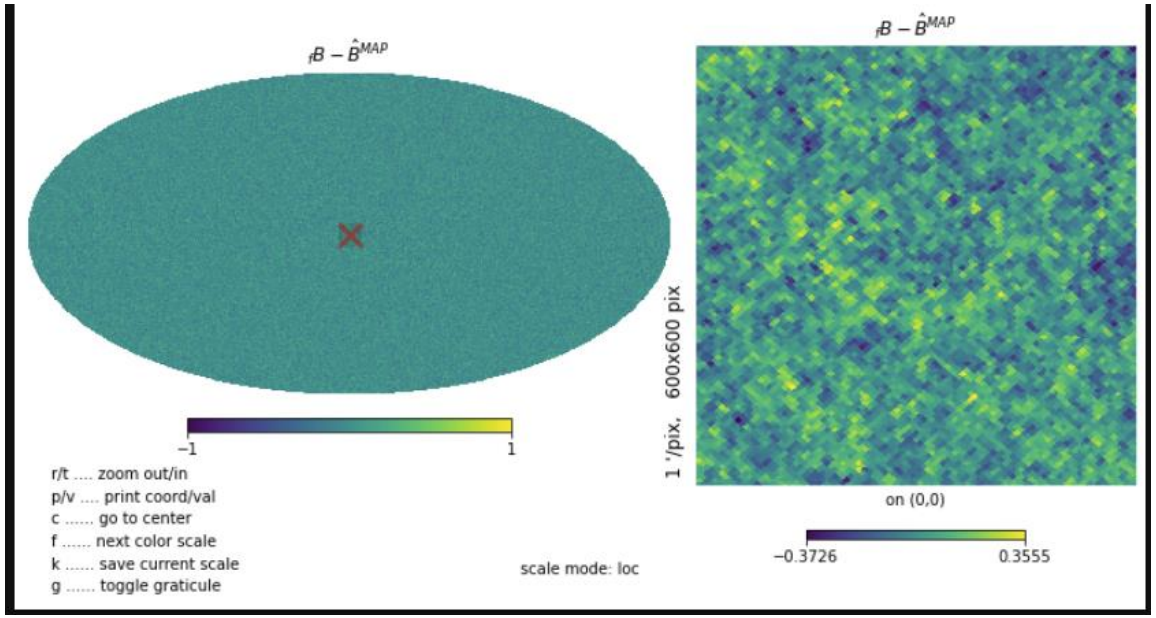
B templates


Remaining B power
1e−6
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
Powerspectrum
0
50
100
150
200
250
Multipole
B_r
B_{in}
$B_r - \hat{B}^{QE}$
$B_r - \hat{B}^{MAP}$
$B_{in} - \hat{B}^{QE}$
$B_{in} - \hat{B}^{MAP}$

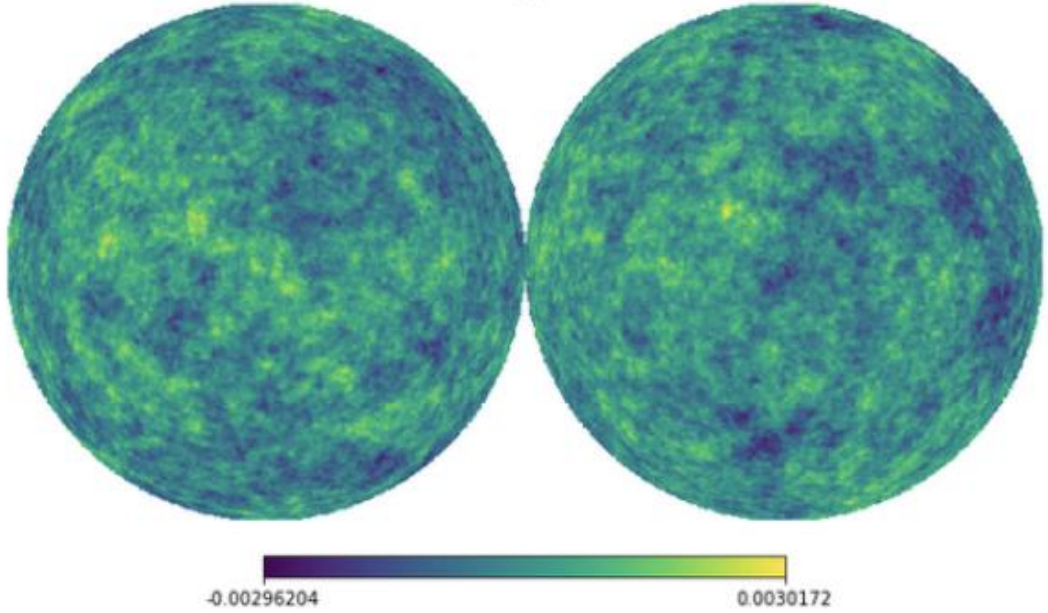

5
4
3
2
1
0
0
5
10
15
20
25
30

Remaining B, map level

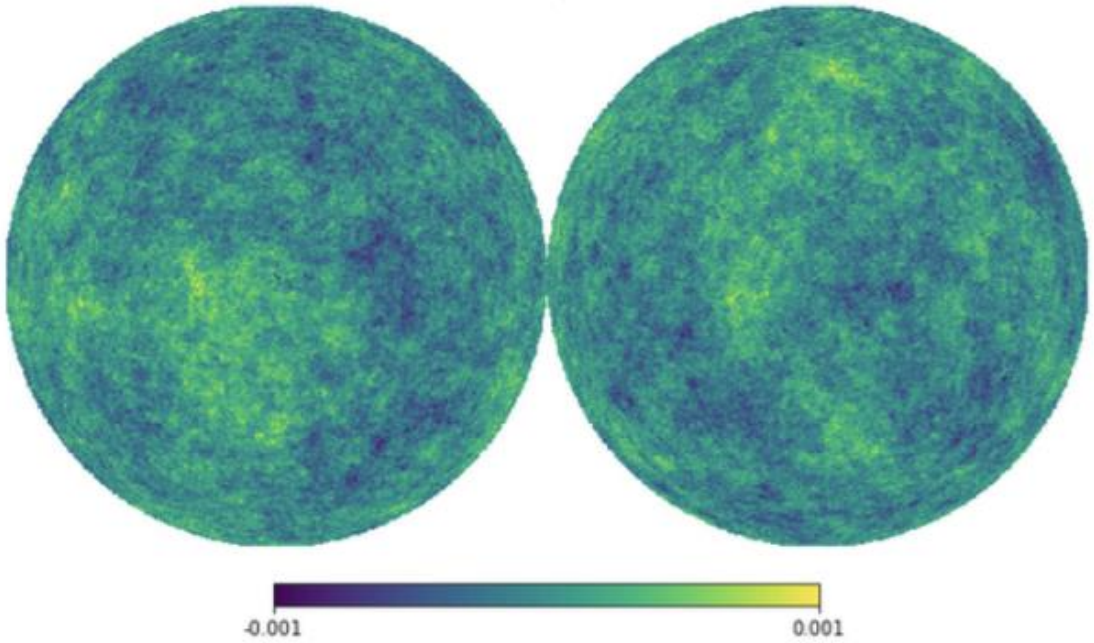




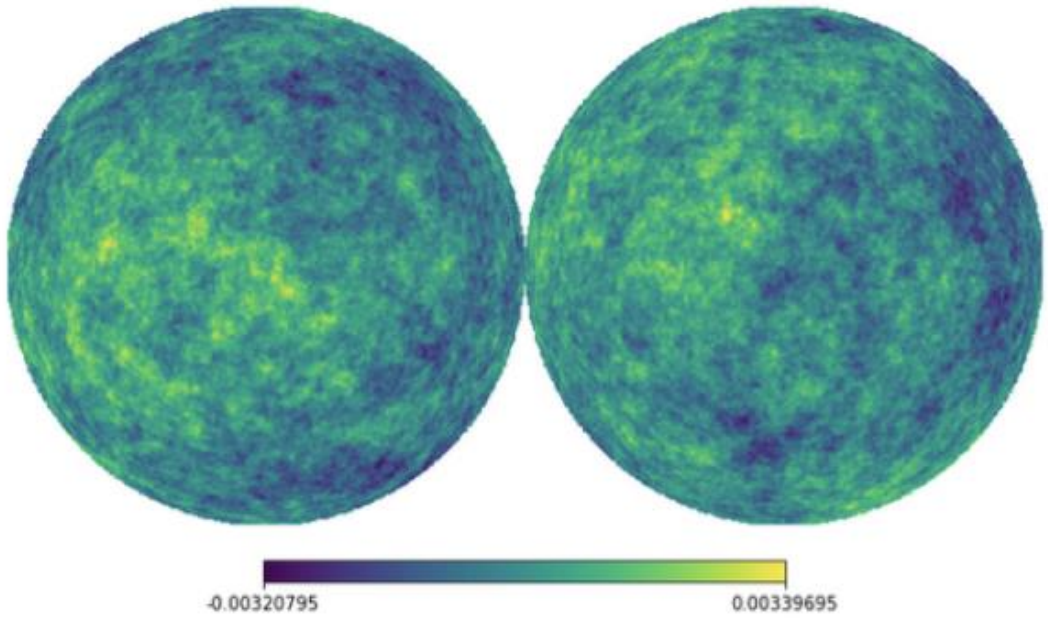
QE



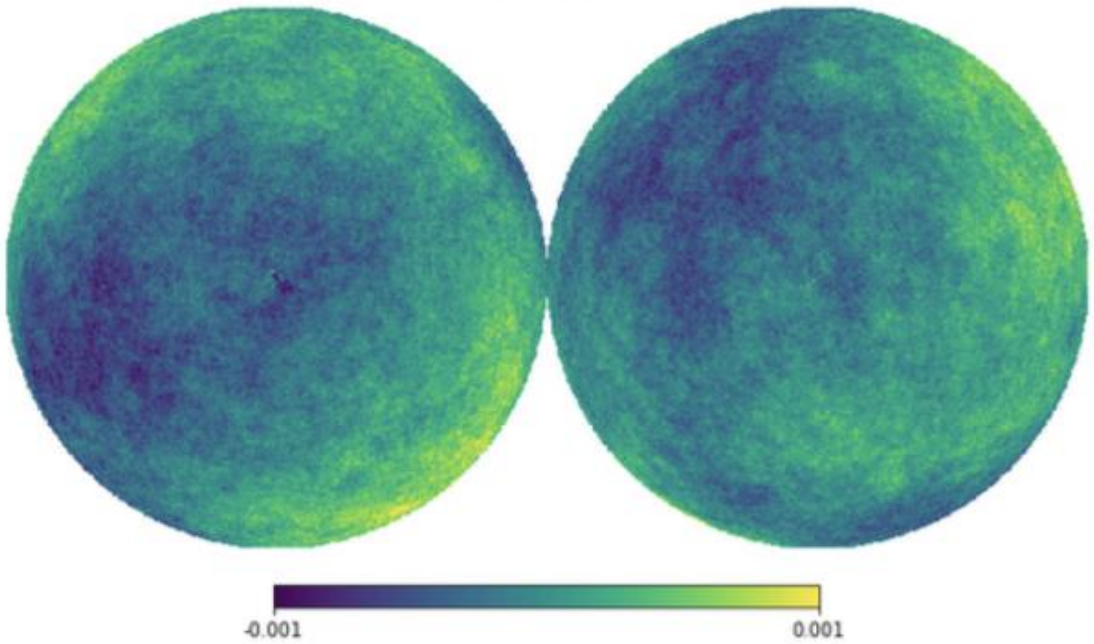
in - QE



MAP



in - MAP



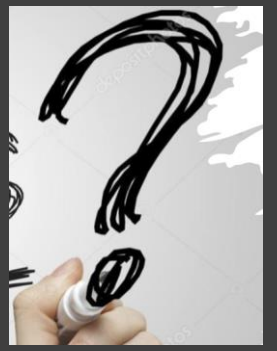
Conclusion

Conclusion

- @ ell<200
  - 60% delensing using QE
  - 80% delensing using iterative delensing
- Delensing Ideal E ~= Delensing Mathieu E

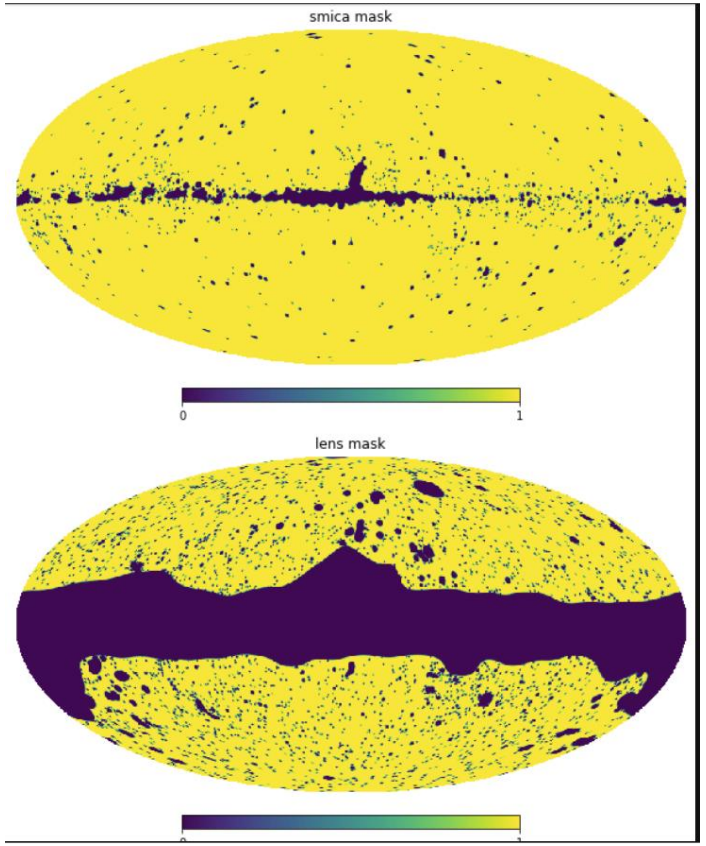

WHAT'S
NEXT?

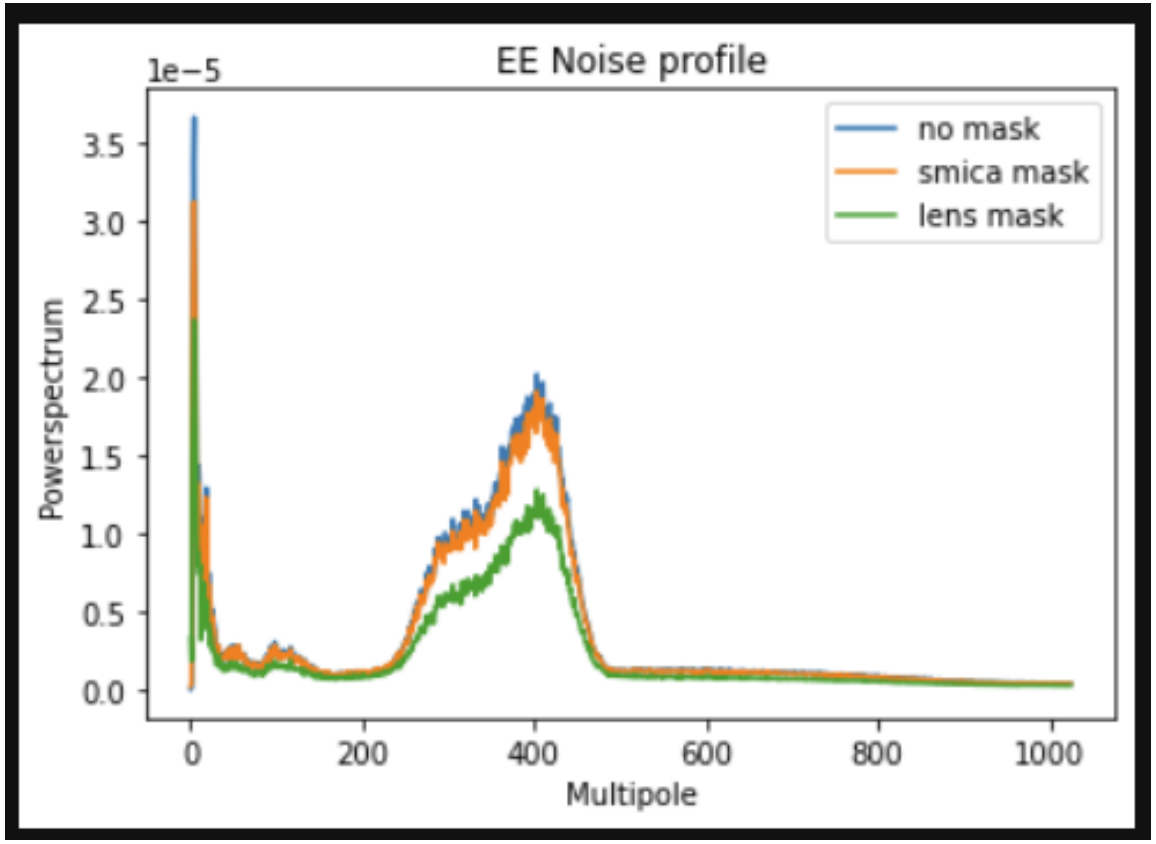
Whats next



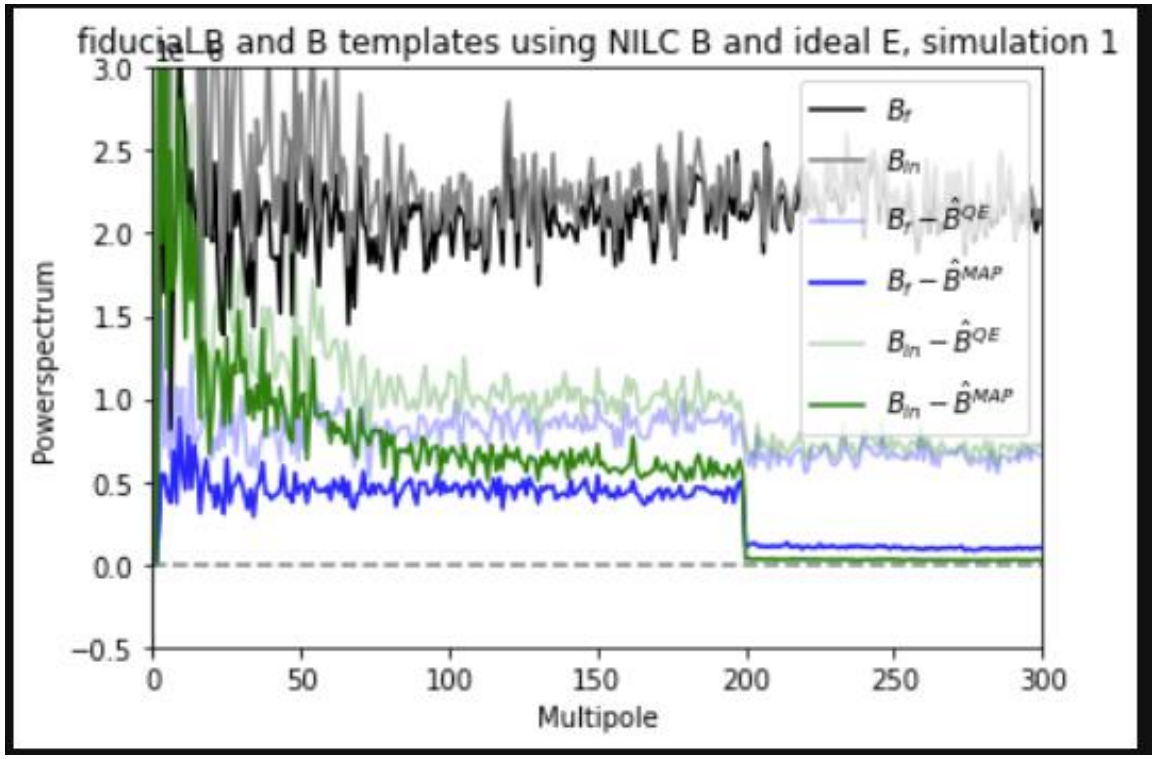
- Minor validations
- Run all simulations
- Integrate into Mathieus pipeline
- ?

Noise II

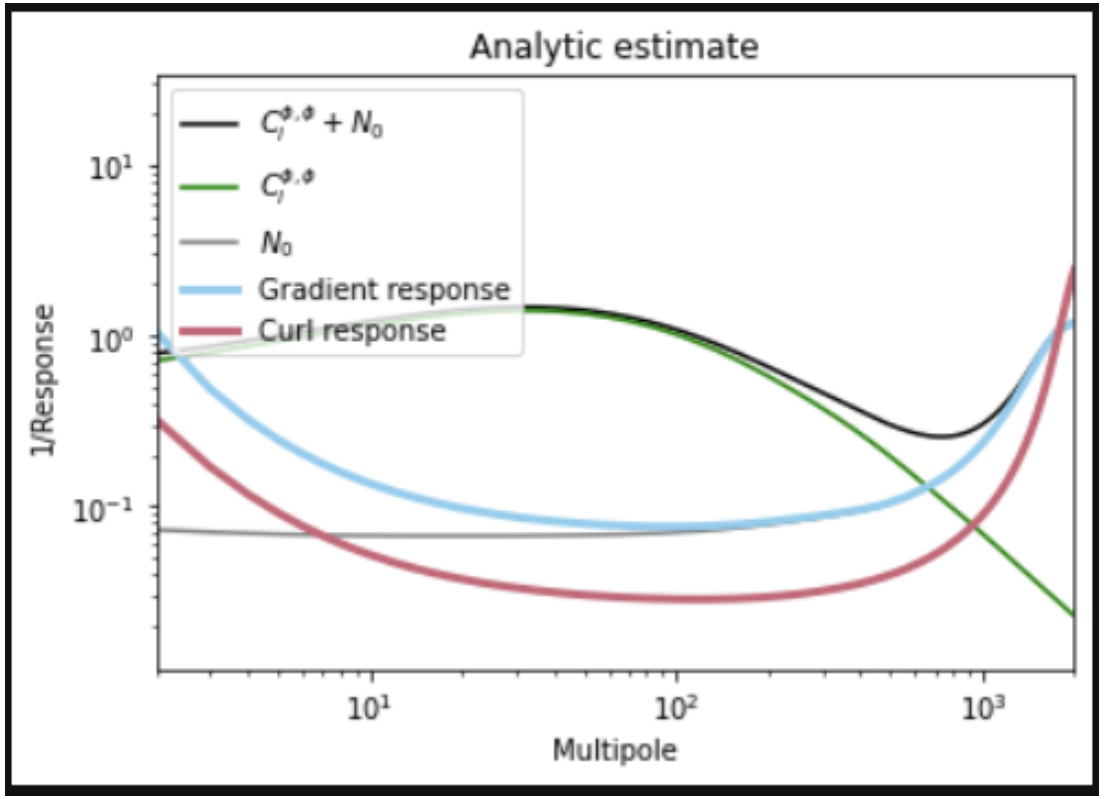

smica mask
0
1
lens mask


EE Noise profile
1e−5
no mask
smica mask
lens mask
Powerspectrum
Multipole
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
0
200
400
600
800
1000

B templates


fiducial B and B templates using NILC B and ideal E, simulation 1
1e−6
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
Powerspectrum
0
50
100
150
200
250
300
Multipole
B_f
B_{in}
$B_f - \hat{B}^{QE}$
$B_f - \hat{B}^{MAP}$
$B_{in} - \hat{B}^{QE}$
$B_{in} - \hat{B}^{MAP}$

Forecast


Analytic estimate
$C_l^{\phi,\phi} + N_0$
$C_l^{\phi,\phi}$
N_0
Gradient response
Curl response
1/Response
10^1
10^0
10^{-1}
10^1
10^2
10^3
Multipole