Results from Low-ell BB Data Challenge 06

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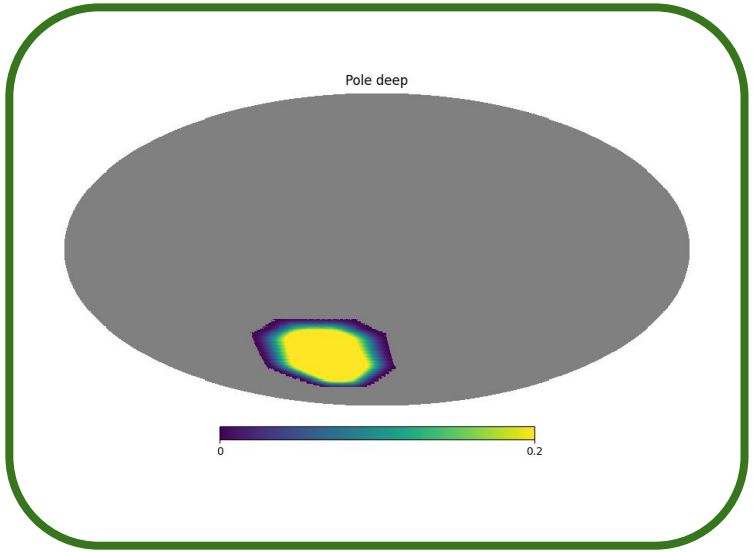
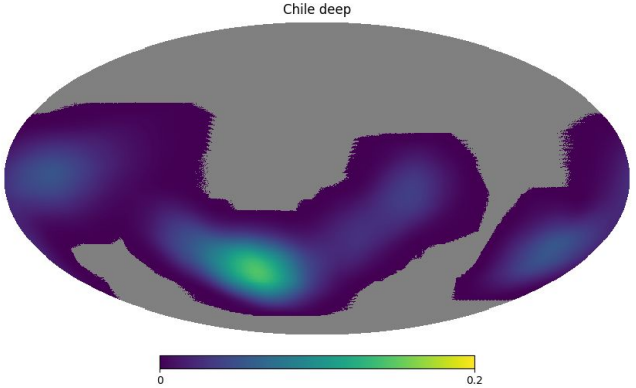
DC06 ingredients

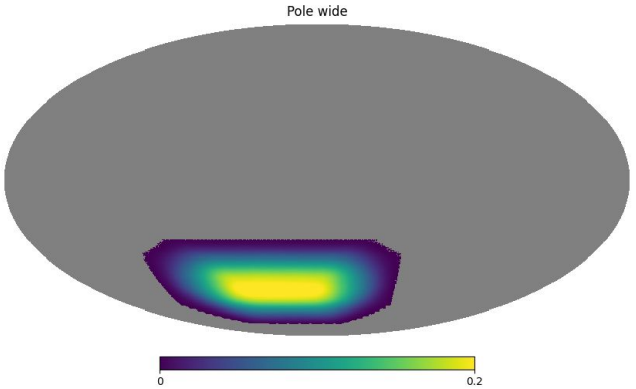
- Map-based sims following the DSR instrument configuration (06)
  - 8 SAT frequency bands + 20 GHz on LAT (nside=512)
  - Additional 6 LAT frequency bands (nside=2048) for delensing
- 50 simulations each for r=0 and r=0.003
- three masks
- three foreground models

Three masks available



This analysis was done
on Pole deep only





Three foreground models

- Gaussian foregrounds (model 00)
  - Dust, with A_d=4.25 μK^2 , β_d=1.6, α_d=−0.4
  - Synchrotron, with A_s=3.8 μK^2, β_s=−3.1, α_s=−0.6

- Amplitude modulated Gaussian foregrounds (model 07)
  - same as the Gaussian foregrounds, but multiplied by a template that scales the amplitude in different parts of the sky

- Vansyngel model (model 09)
  - sophisticated model including non-Gaussian structure extending to high ell, and decorrelation, one realization for dust and synchrotron each

Multicomponent likelihood analysis

We run maximum likelihood searches on a 9+ parameter model

r		tensor to scalar ratio
A_{dust}	A_{synch}	amplitudes at ell=80
β_{dust}	β_{synch}	frequency spectral indices

α_{dust}	α_{synch}	spatial spectral indices
ε		dust/synch spatial correlation
Δ_{dust}		dust decorrelation

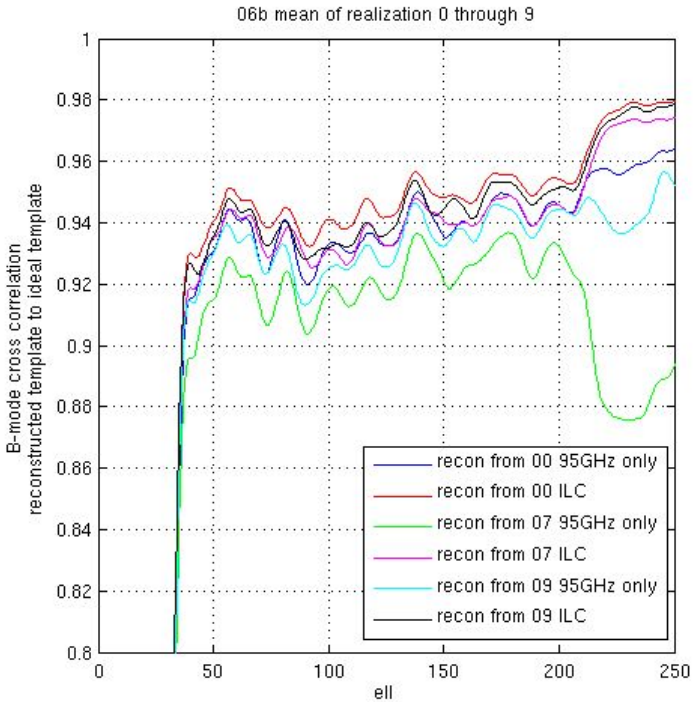
+ Lensing Template

Lensing templates

We test several lensing templates (see Julien Carron's talk):

- ideal, i.e., difference between lensed and unlensed input sims
- CMB + noise only, reconstructed on 95GHz
- CMB + noise + fg (three fg models), reconstructed on 95 GHz
- CMB + noise + fg (three fg maps), fed through ILC, and through reconstruction

Clem's plot shows the correlation of the templates with fg with the ideal one



ILC

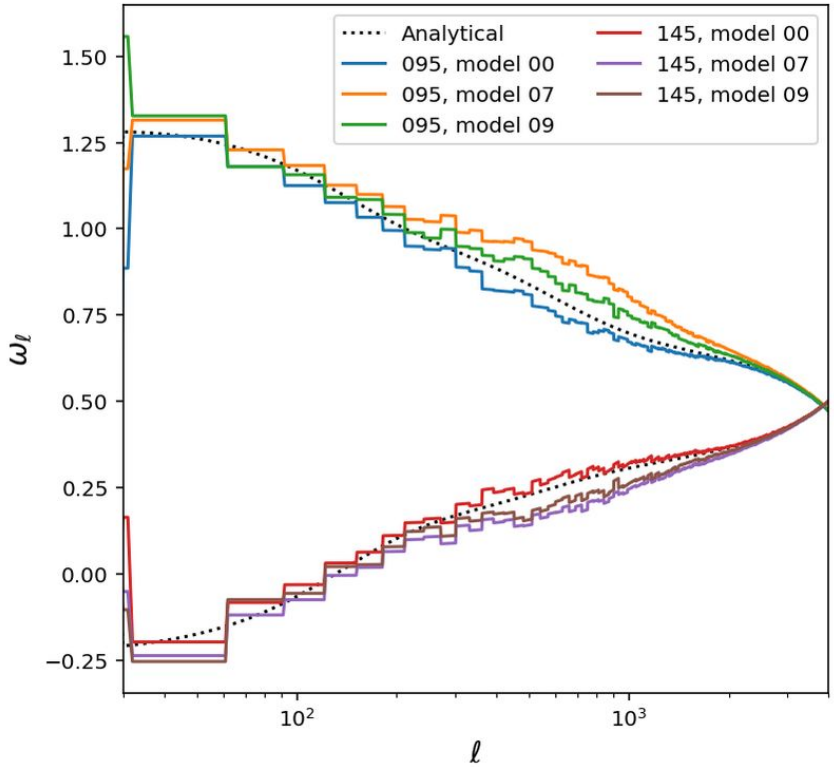
We do a spectral ILC

$$\omega_\ell = \frac{a^T R_\ell^{-1}}{a^T R_\ell^{-1} a}$$

where R_ℓ is the matrix of all auto- and cross-spectra and a is the CMB emission law

Weights are dominated by the two central frequencies, i.e., 95 and 145 GHz, even for more complex foreground models

ILC weights



We use analytical weights as they are very close to empirical ones, but much smoother

All maps have the same weights, independently of the foreground model

ILC maps and spectra - E/B maps

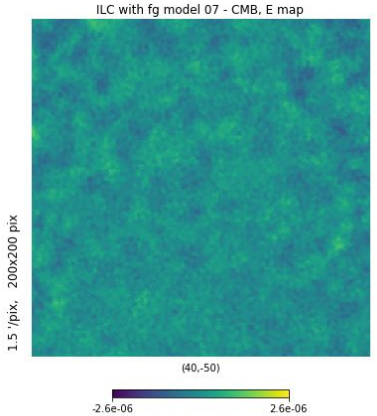
ILC - CMB

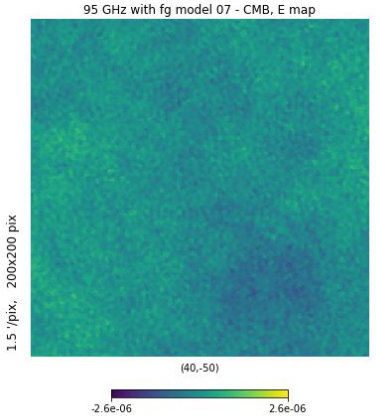
95 GHz - CMB

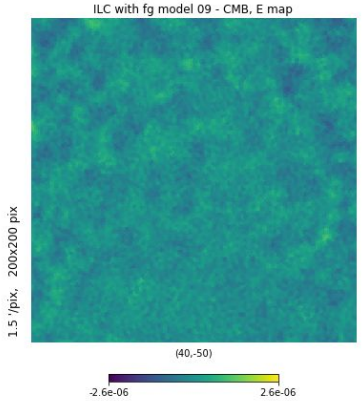
ILC - CMB

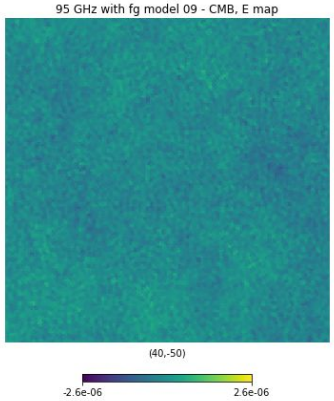
95 GHz - CMB

E

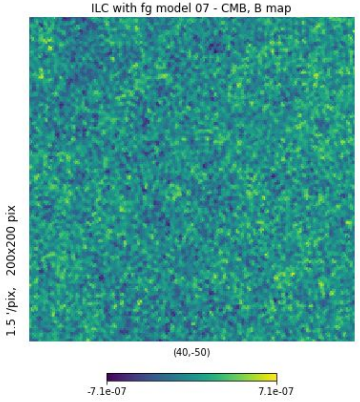


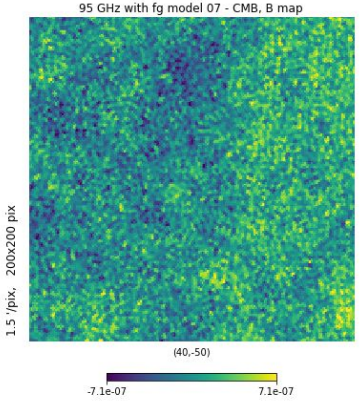


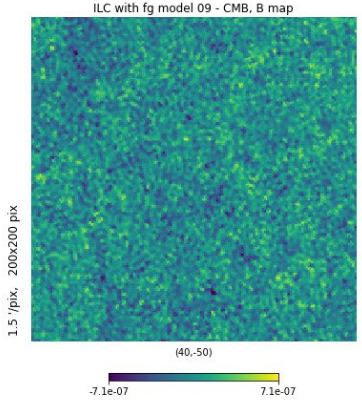


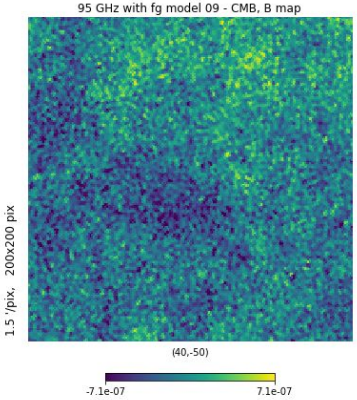


B









ILC maps and spectra - E/B maps

ILC - CMB

CMB

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CMB

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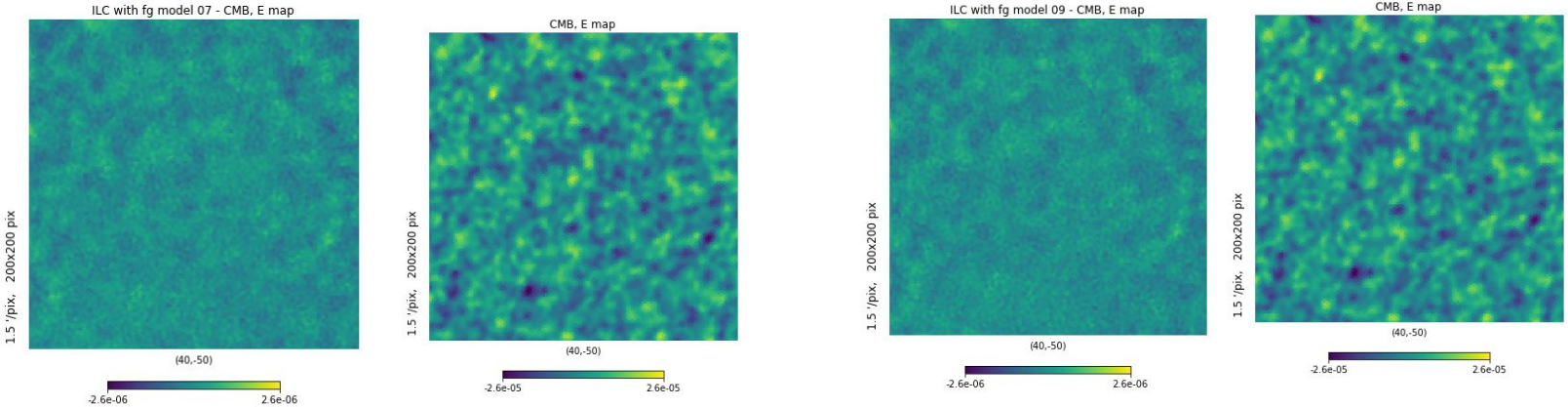

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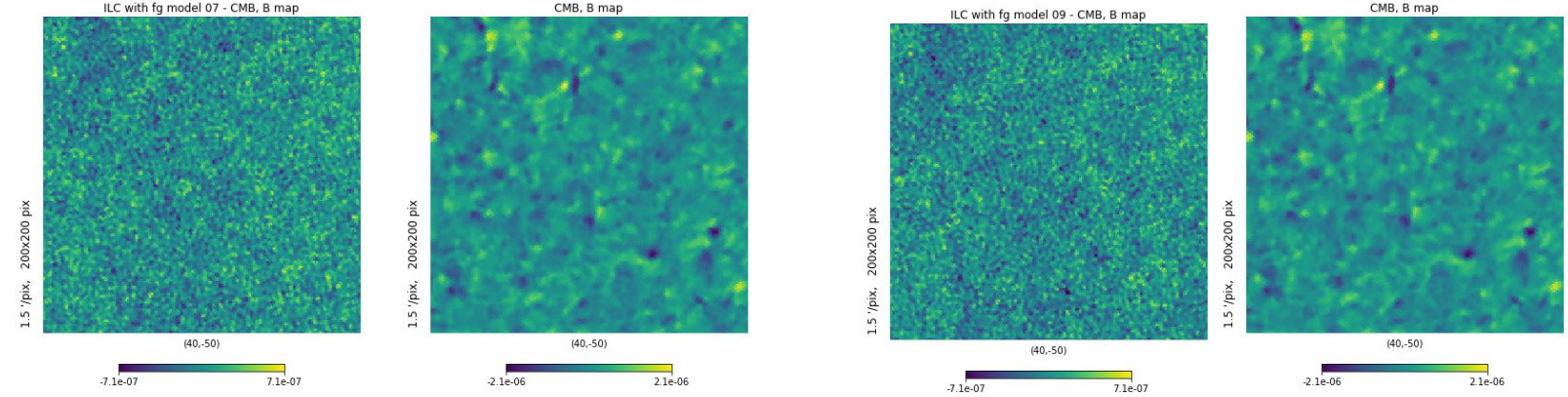
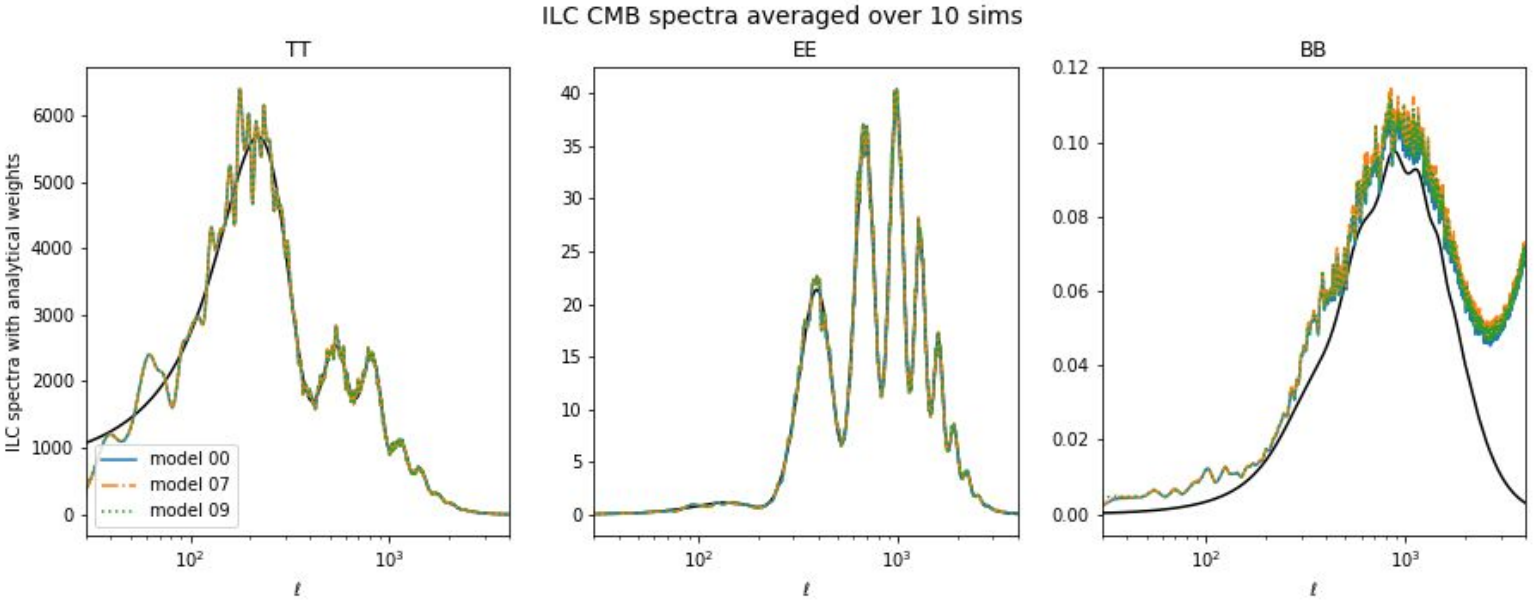
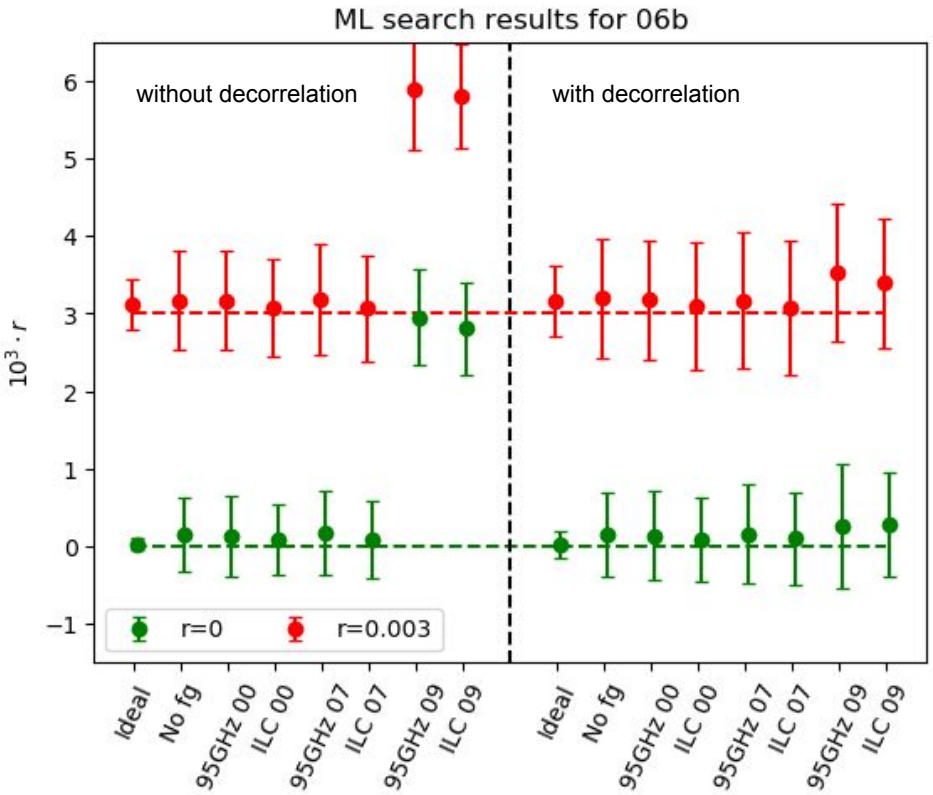


ILC maps and spectra - spectra



ML search results

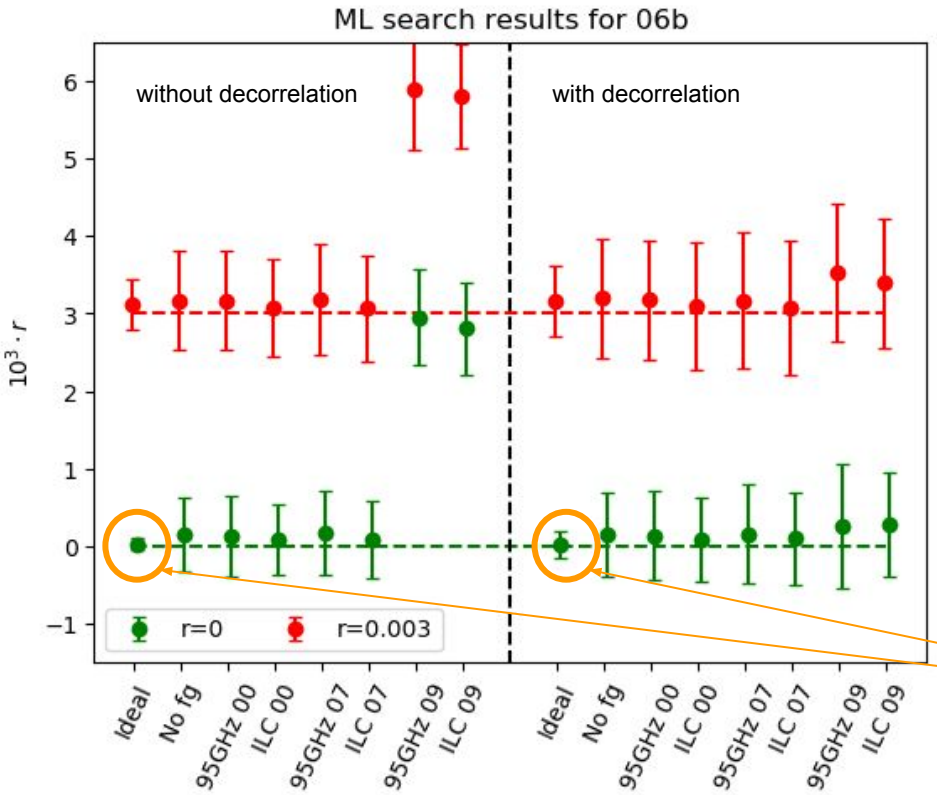


Overall we recover unbiased results for all modes - adding decorrelation removes the bias for Vansyngel model (09)

The different types of LT yield similar results

The ILC LT seems to drive a small improvement over the 95 GHz only LT

ML search results



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currently not clear why sigma_r is so low here, more tests are needed

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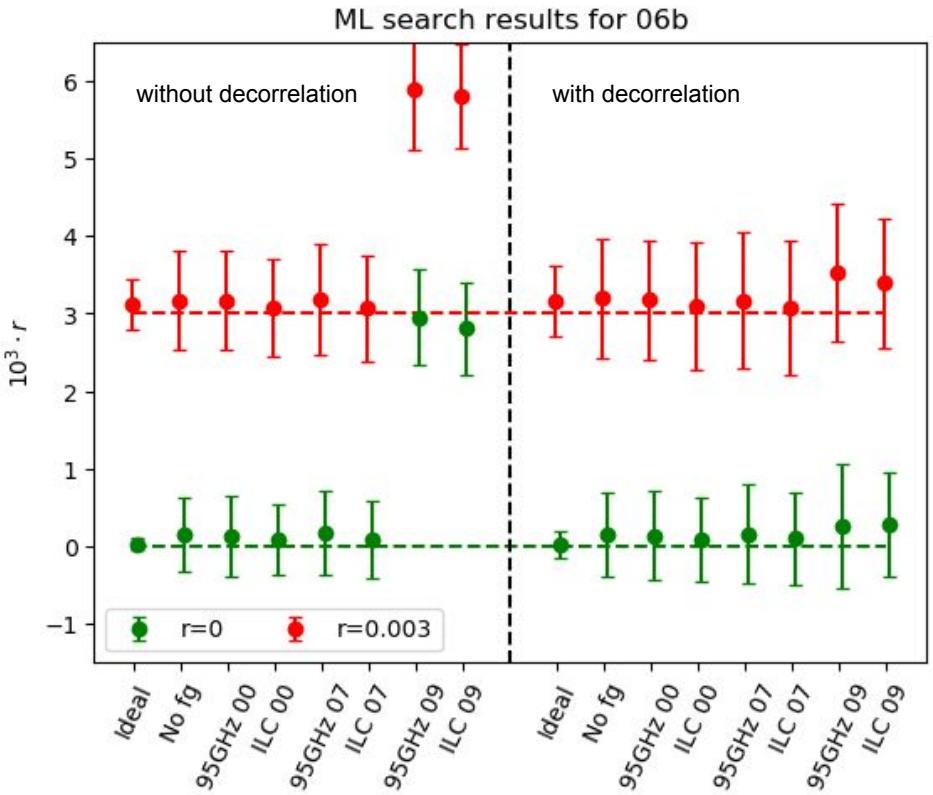

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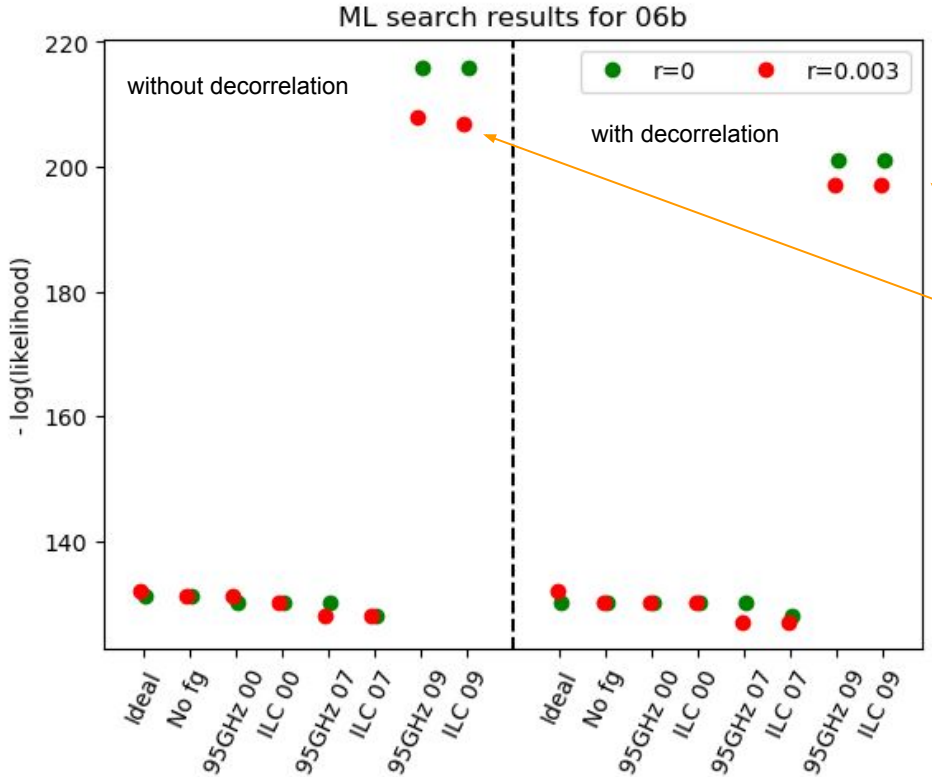
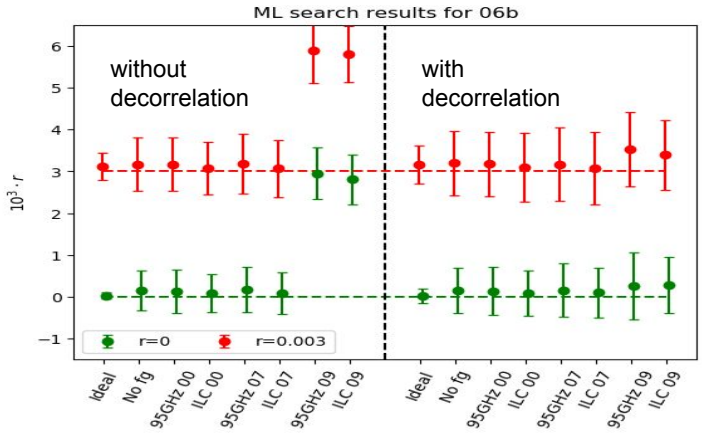


Adding decorrelation improves the log(lkl)

ML search results



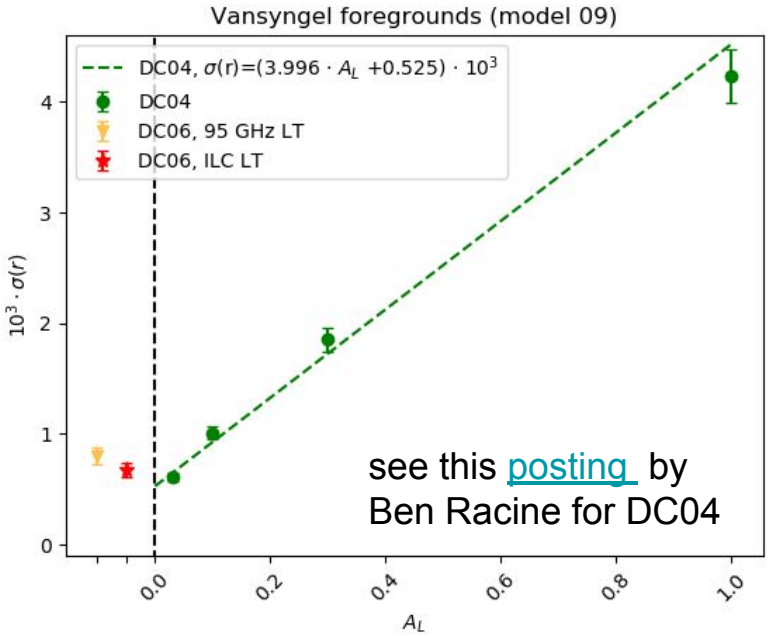
(values multiplied by 1000)	r=0		r=0.003	
	without decorr	with decorr	without decorr	with decorr
95 GHz Gauss fg	0.14 ± 0.52	0.14 ± 0.58	3.17 ± 0.64	3.18 ± 0.77
ILC Gauss fg	0.08 ± 0.45	0.09 ± 0.53	3.07 ± 0.63	3.09 ± 0.82
ILC Vansyngel fg	2.8 ± 0.6	0.28 ± 0.67	5.6 ± 0.7	3.39 ± 0.84

ML search results - comparison with DC04

For DC04 we do not have ML runs with lensing templates. Instead we artificially tuned down the value of A_L.

Here we show a comparison between DC04 and DC06 for the Vansingel fg model, which has non-Gaussian, decorrelated foregrounds.

For DC06 we expect $A_L \sim 0.1$



[Note: 04 is CDT era map depths, 06 is DSR/PBD - so not apples-apples]

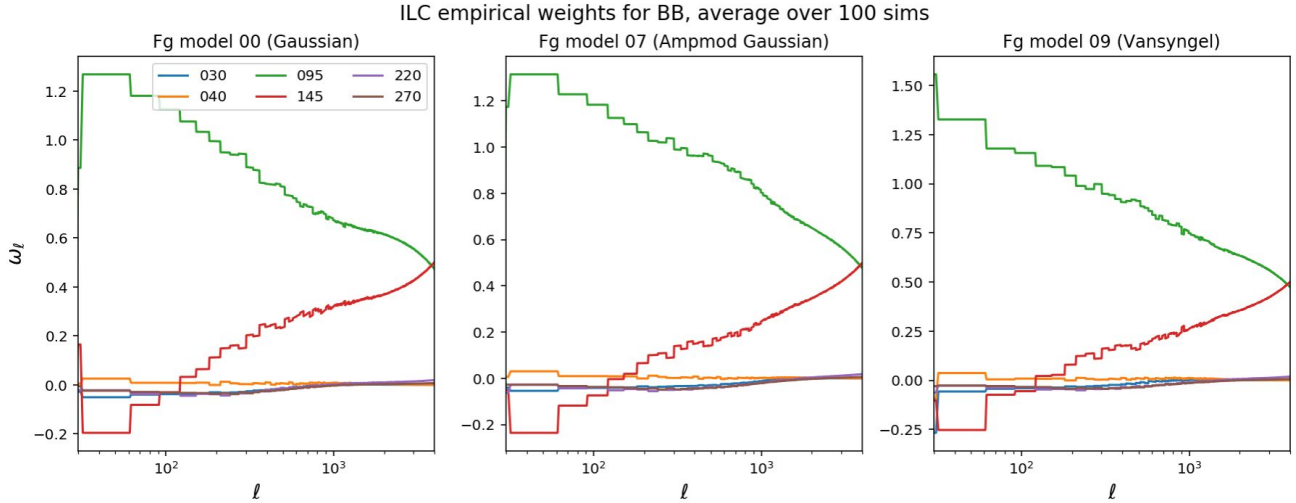
Conclusions

- Analysis on DC06 completed
  - For the first time we have a full simulation of S4 including “real delensing” doing iterated reconstruction on a foreground cleaned high resolution map!
- Overall good results independent of the foreground model used or lensing template
- Need for other foreground model to test
- Moving towards the next generation of sims

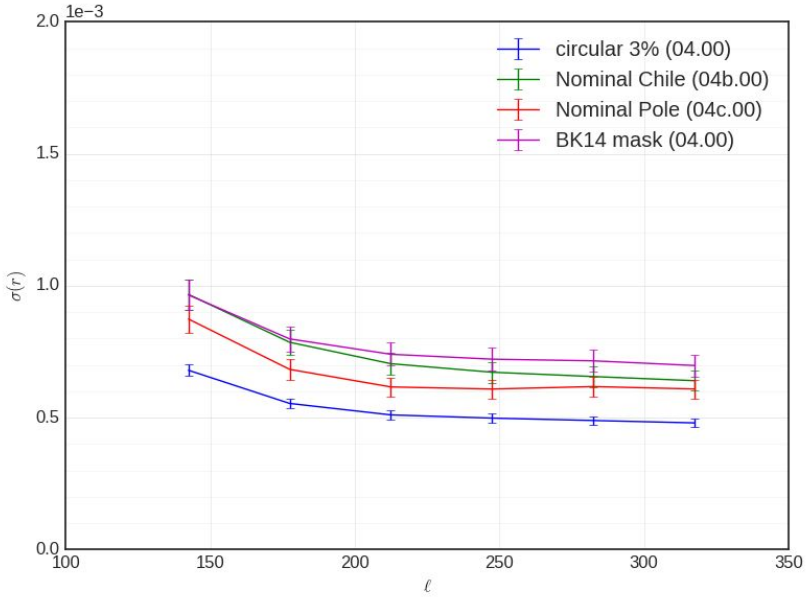
Backup slides

ILC weights

1. Averaging over 100 sims does not reduce scatter for TT and EE weights, that's why we use analytical
2. Frequencies other than 95 GHz and 145 GHz do not seem to matter much even for the Vansyngel or amplitude modulated models



Evolution of sigma(r) with multipole



Ben had shown in this posting that sigma(r) has little improvement when the lmax used in the ML search is above ell ~ 230. Here is a plot for AL =0.1 and r=0

As using multipoles beyond ell ~ 230 seems to bias other parameters such as beta_d, results presented here only show ML searches with 5 bins (instead of usual 9 bins)