NILC results for PICO

Mathieu Remazeilles

3 June 2021

To-do list

- **Model 90.91**
  - **Baseline (21-800 GHz):**
    - $r = 0$ (10 realizations of CMB and noise)
    - $r = 0.003$ (10 realizations of CMB and noise)
  - **w/o LF (43-800 GHz):**
    - $r = 0$ (10 realizations of CMB and noise)
  - **w/o HF (21-462 GHz):**
    - $r = 0$ (10 realizations of CMB and noise)

- **Model 90.92**
  - **Baseline (21-800 GHz):**
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    - $r = 0.003$ (10 realizations of CMB and noise)
  - **w/o LF (43-800 GHz):**
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- **Model MKD**

To-do list

- **Model 90.91**
  - **Baseline (21-800 GHz):**
    - $r = 0$ (10 realizations of CMB and noise) ✓ done!
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- **Model MKD**

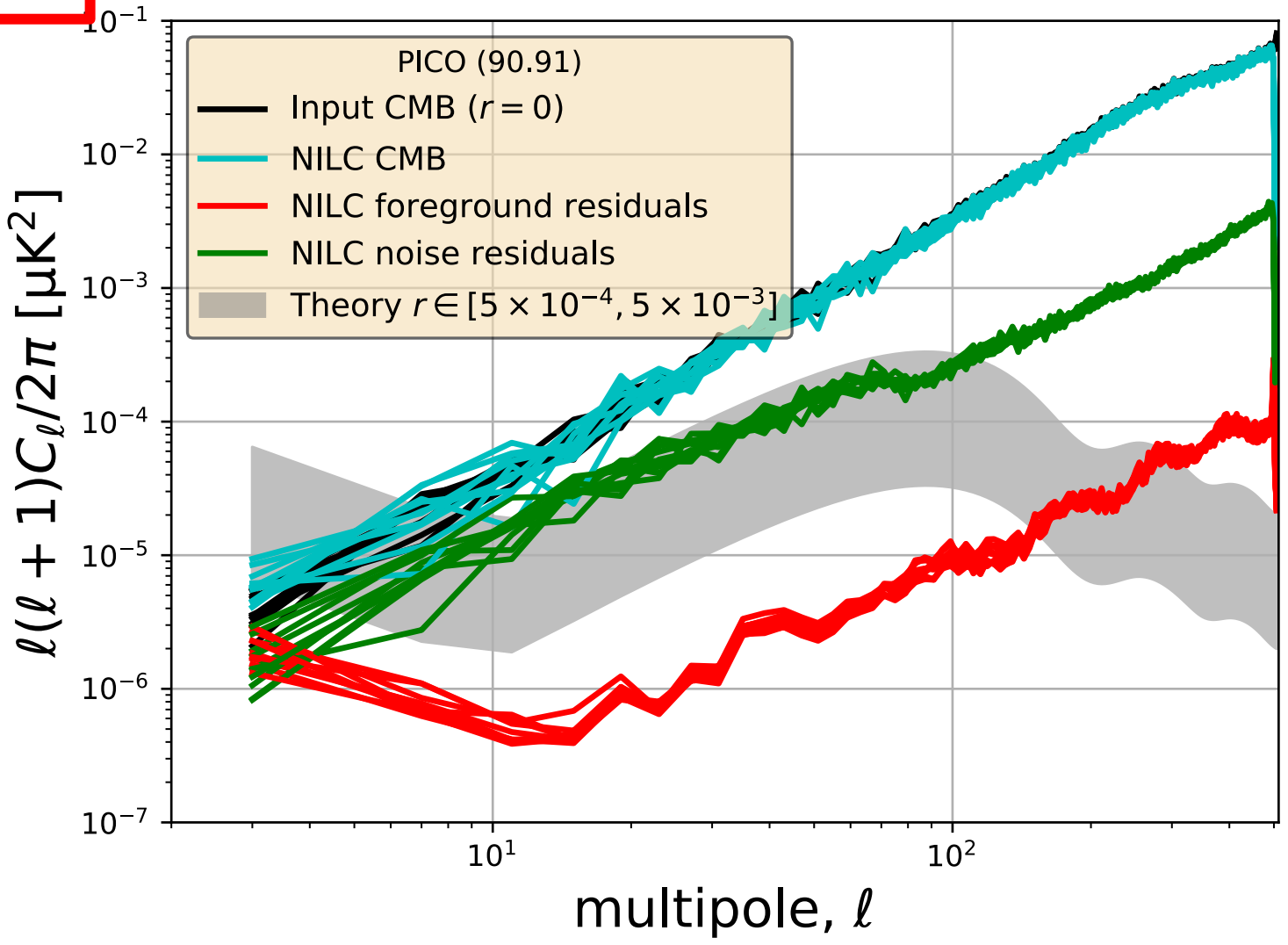
$$r = 0$$

90.91 & 90.92

Baseline
21-800 GHz

90.91, $r = 0$

NILC



10 realizations

MASTER

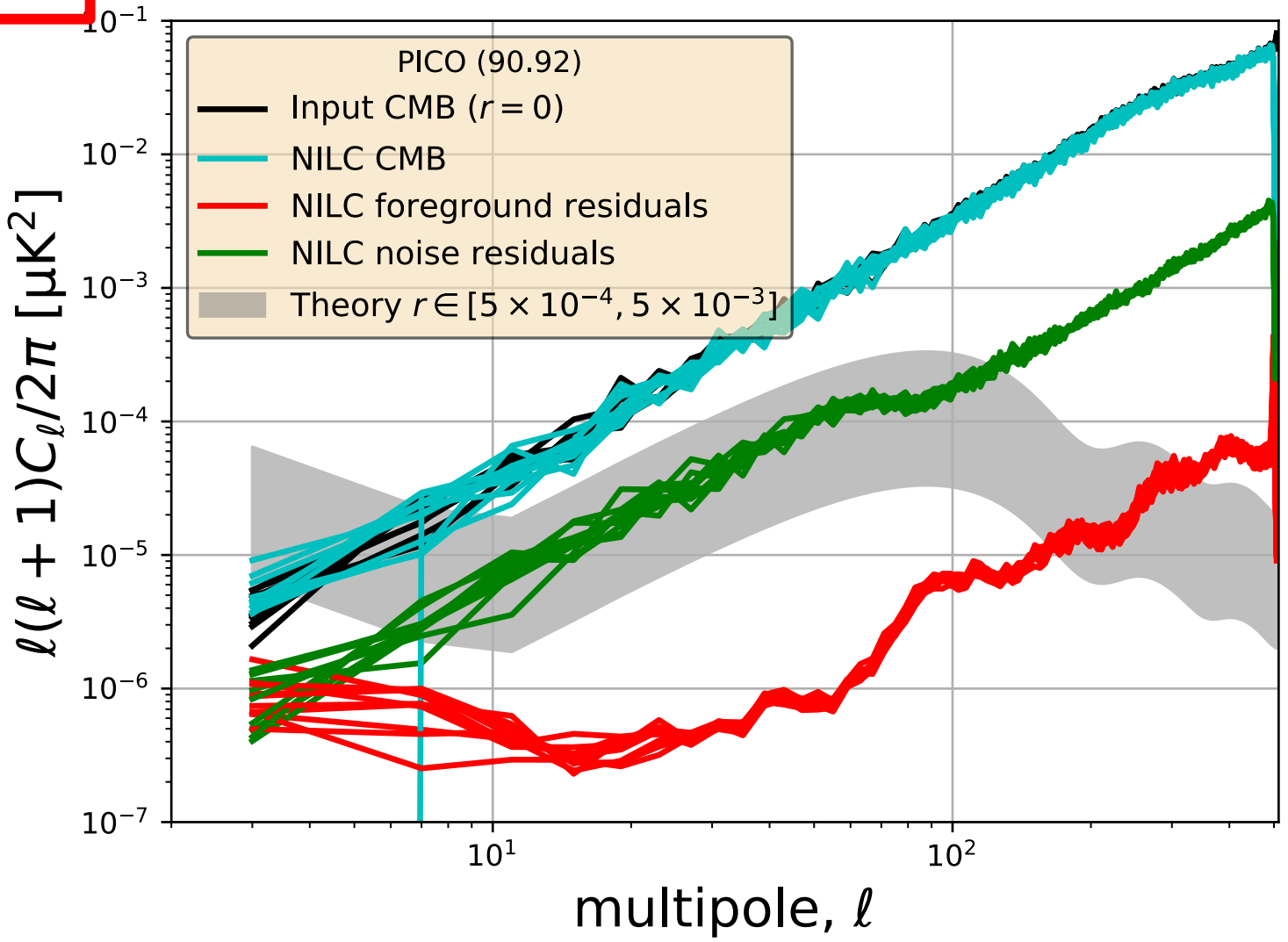
$f_{\rm sky} = 50\%$

Binning: $\Delta\ell = 4$

Baseline
21-800 GHz

90.92, $r = 0$

NILC



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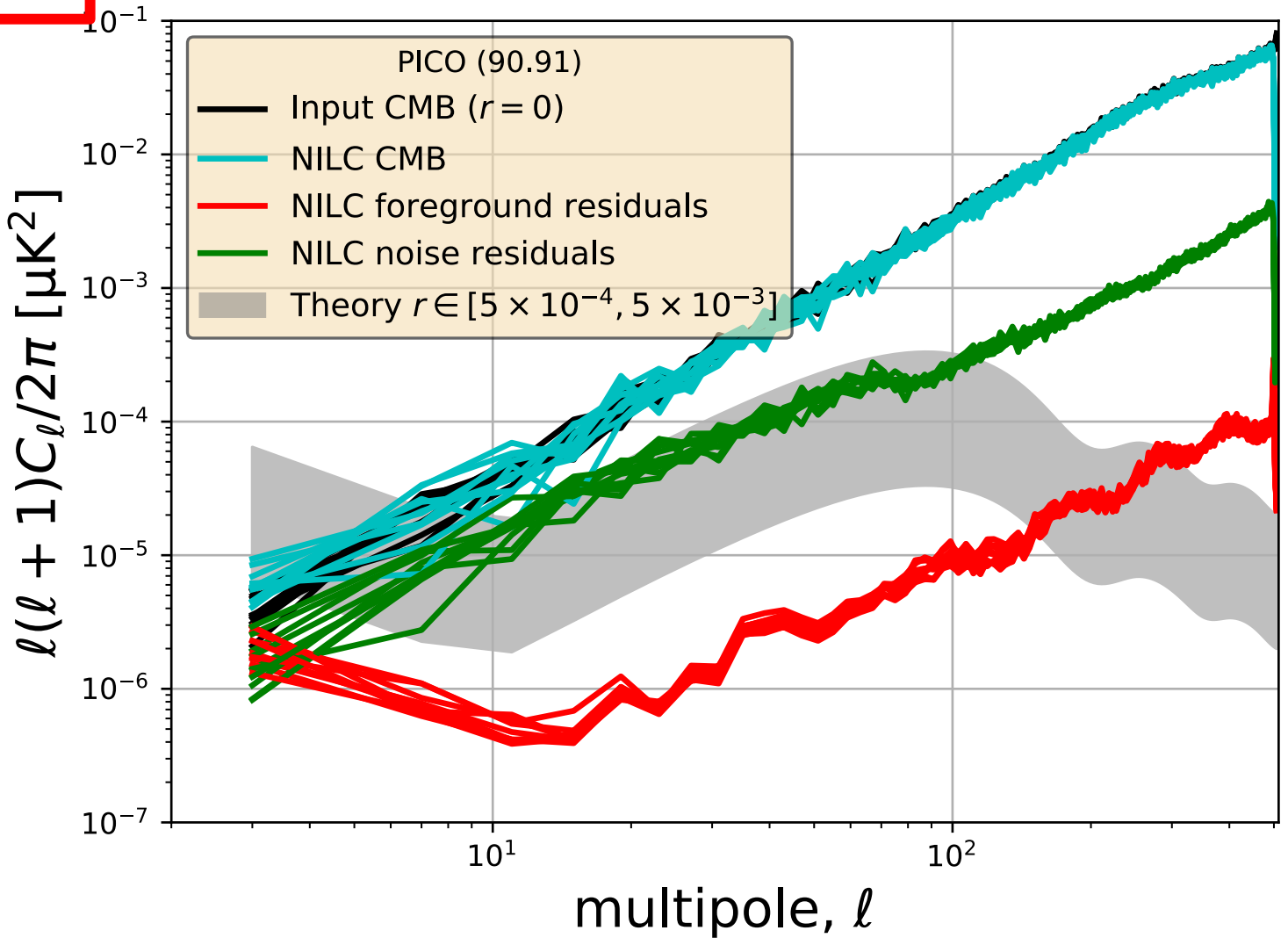

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w/o LF
43-800 GHz

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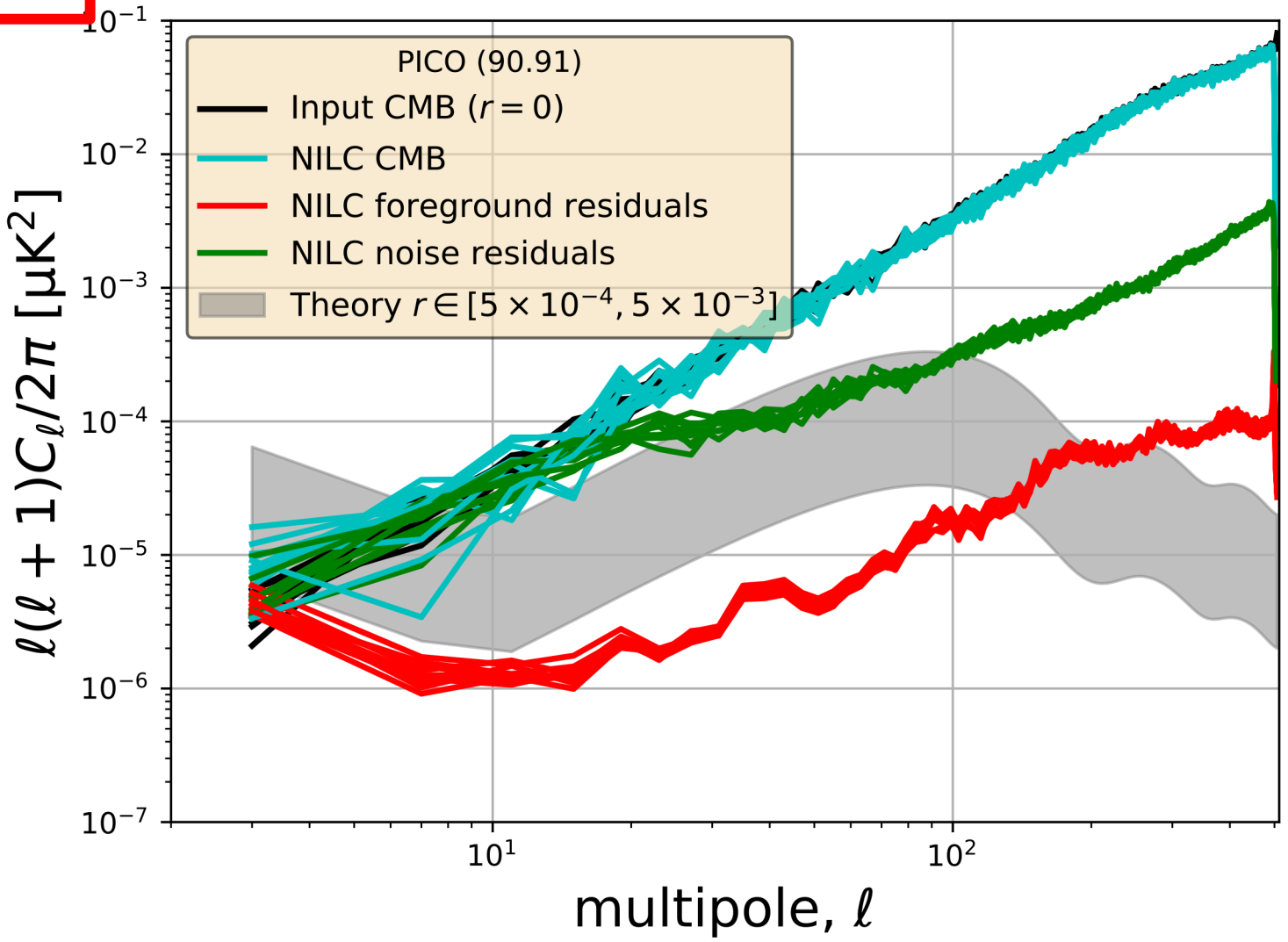

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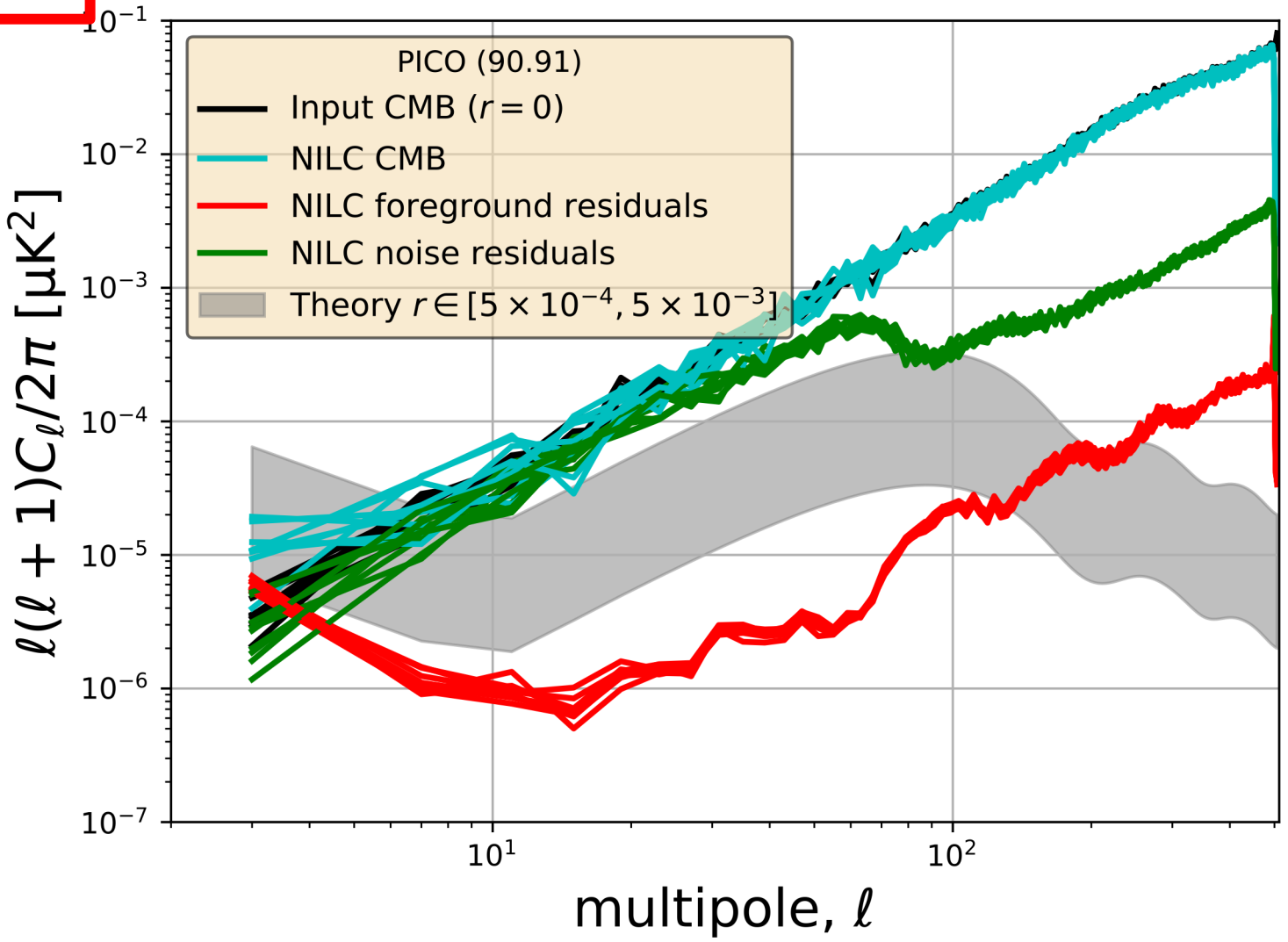

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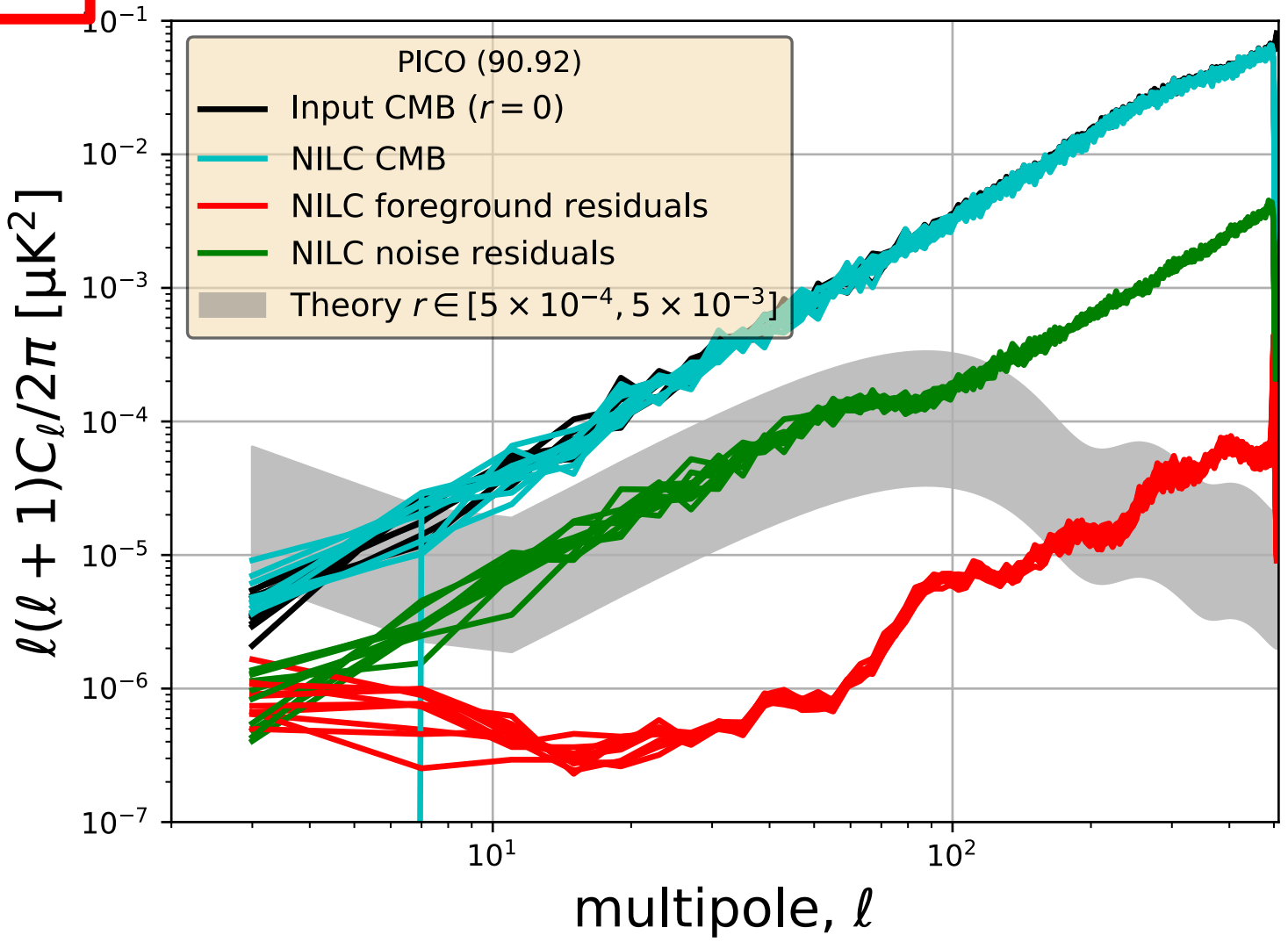

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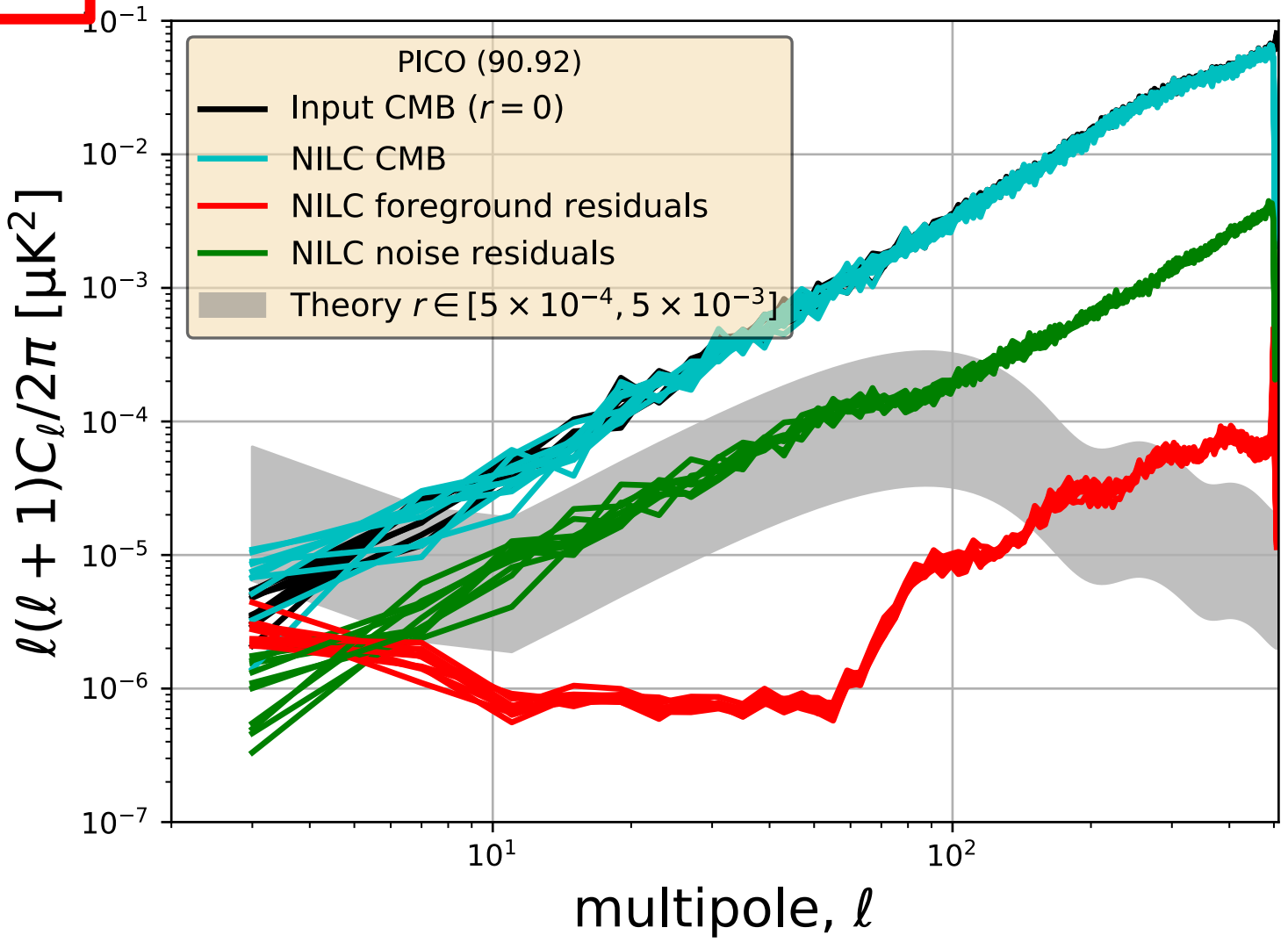

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21-462 GHz

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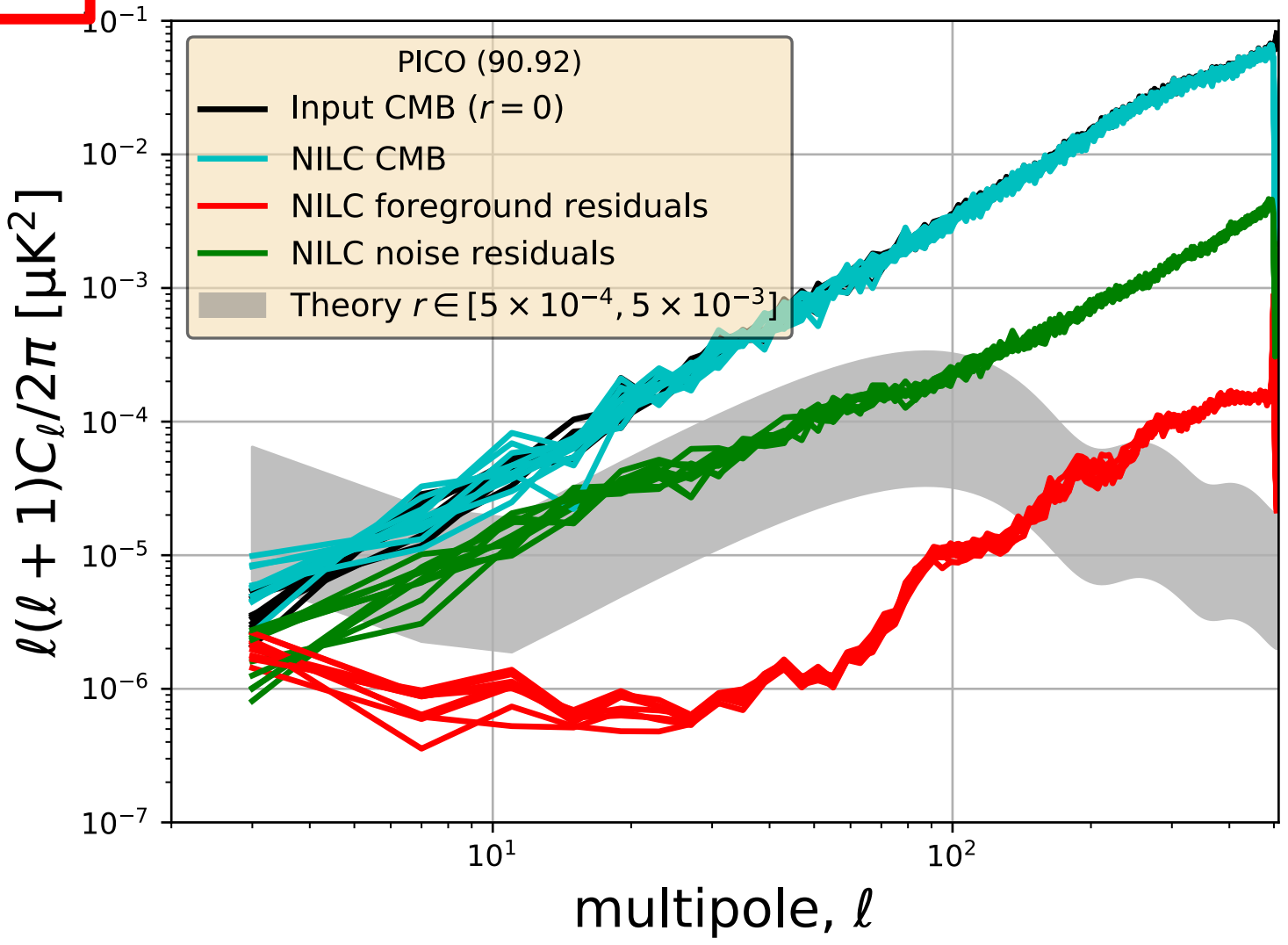

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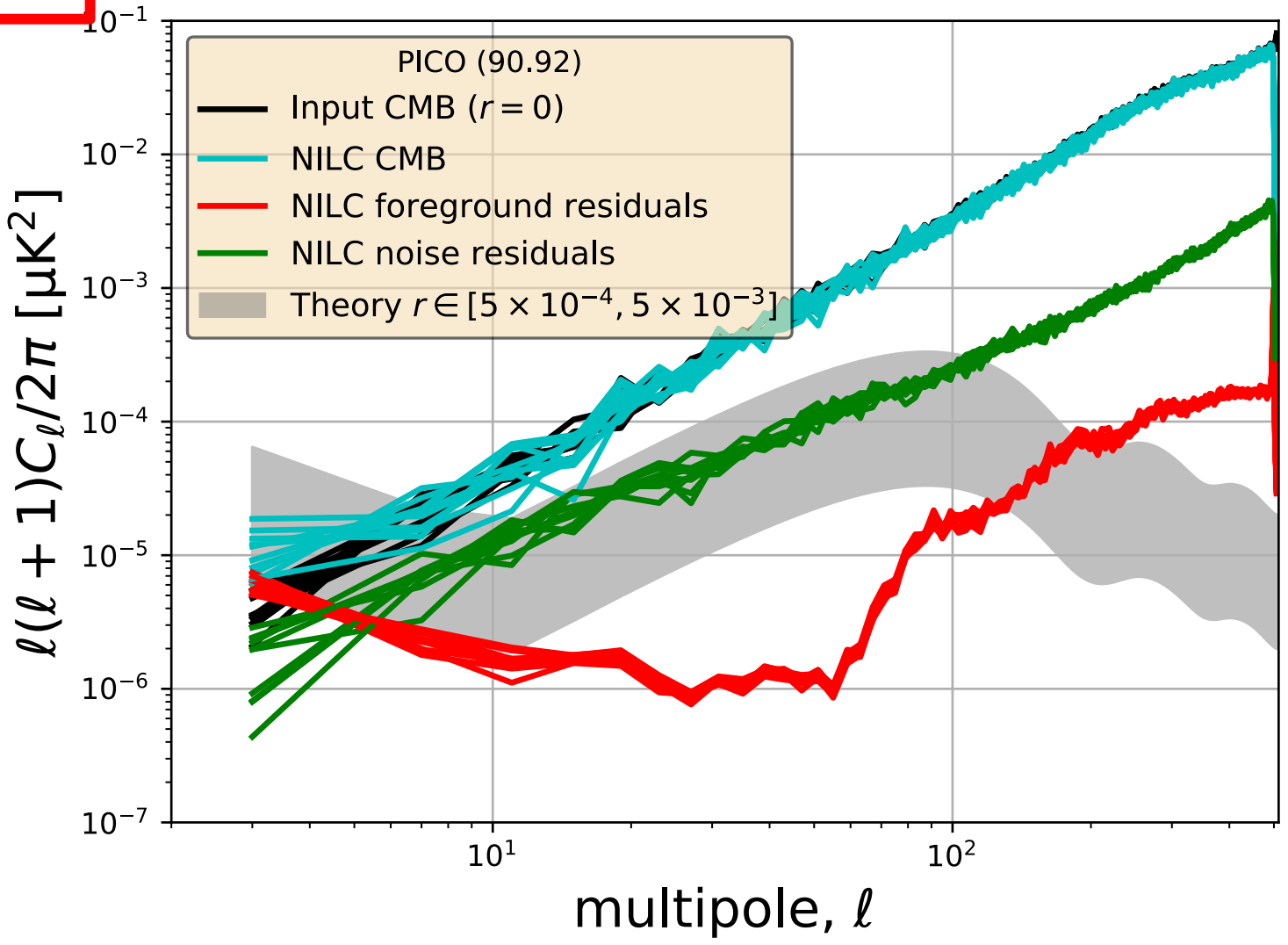
Descope
43-462 GHz

90.92, $r = 0$

NILC



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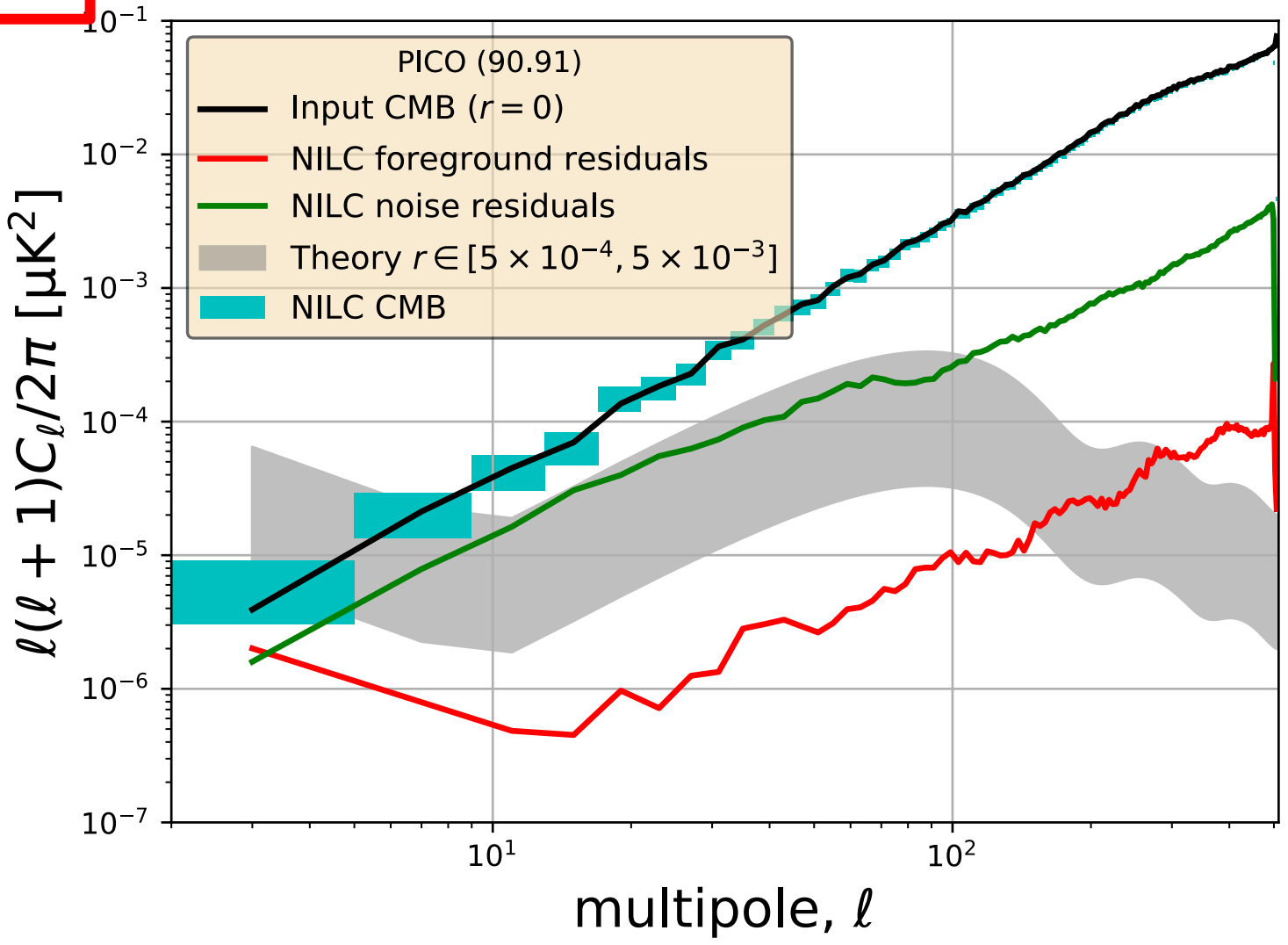
90.91, $r = 0$

NILC



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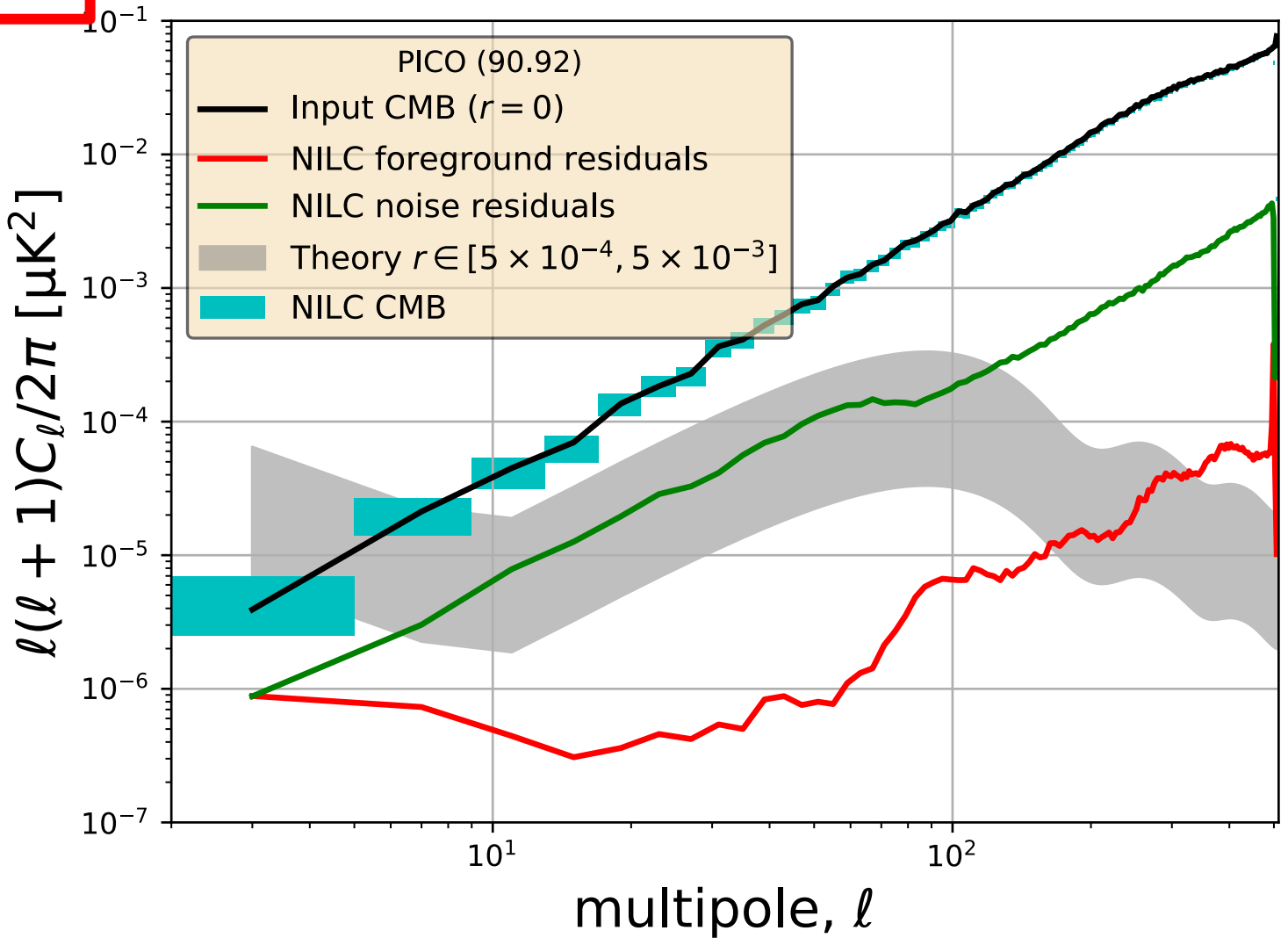

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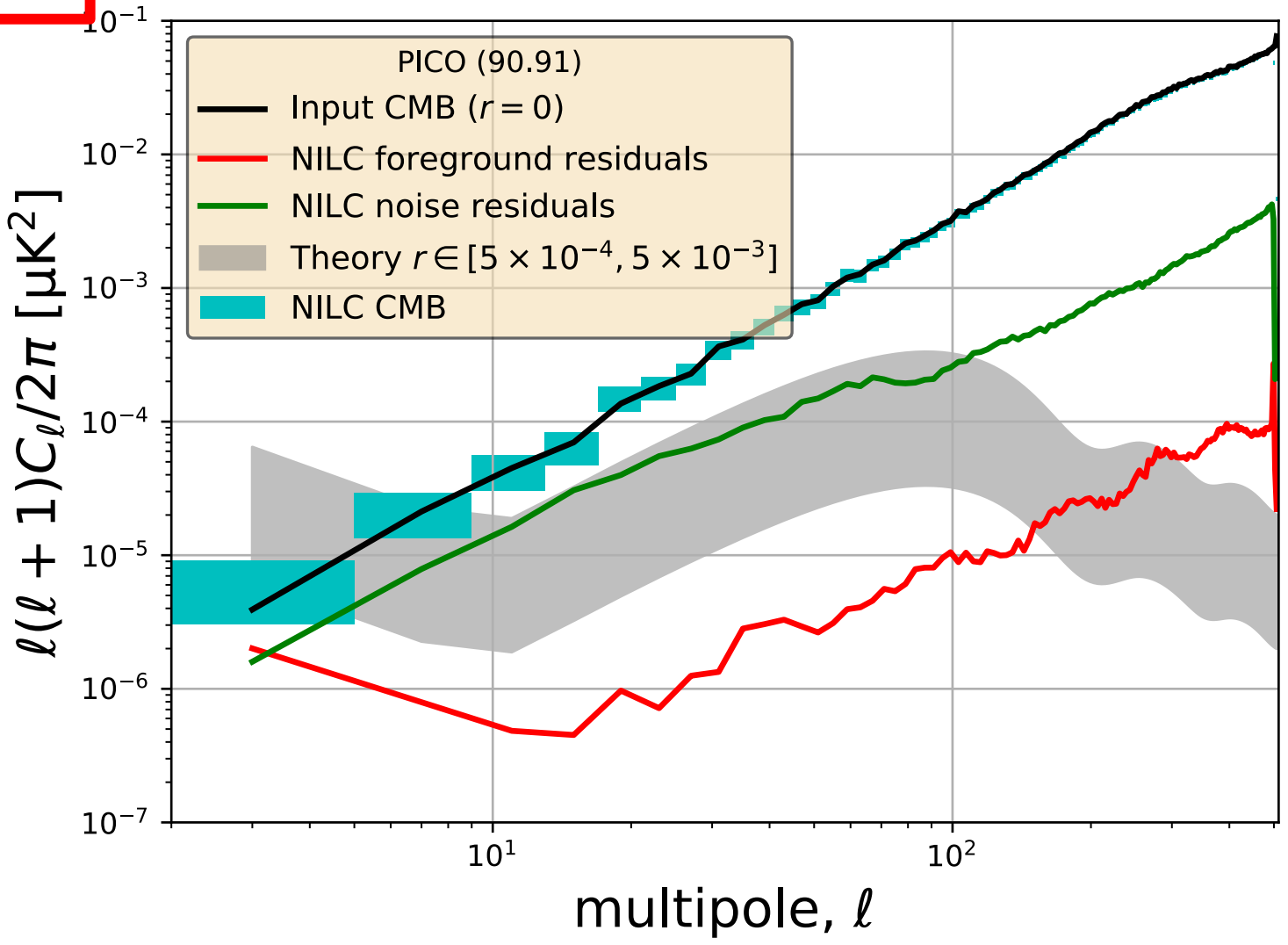

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w/o LF
43-800 GHz

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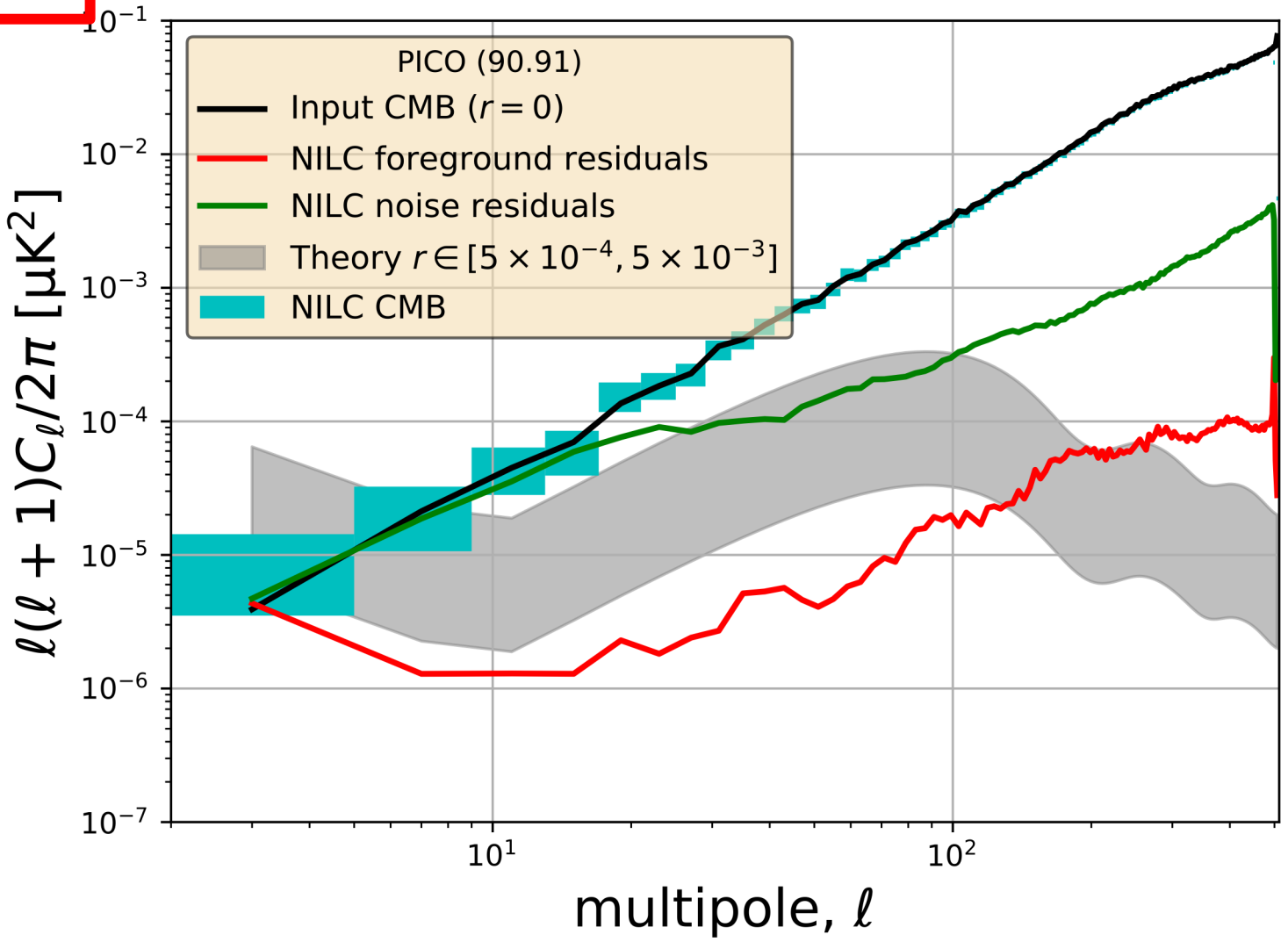

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21-462 GHz

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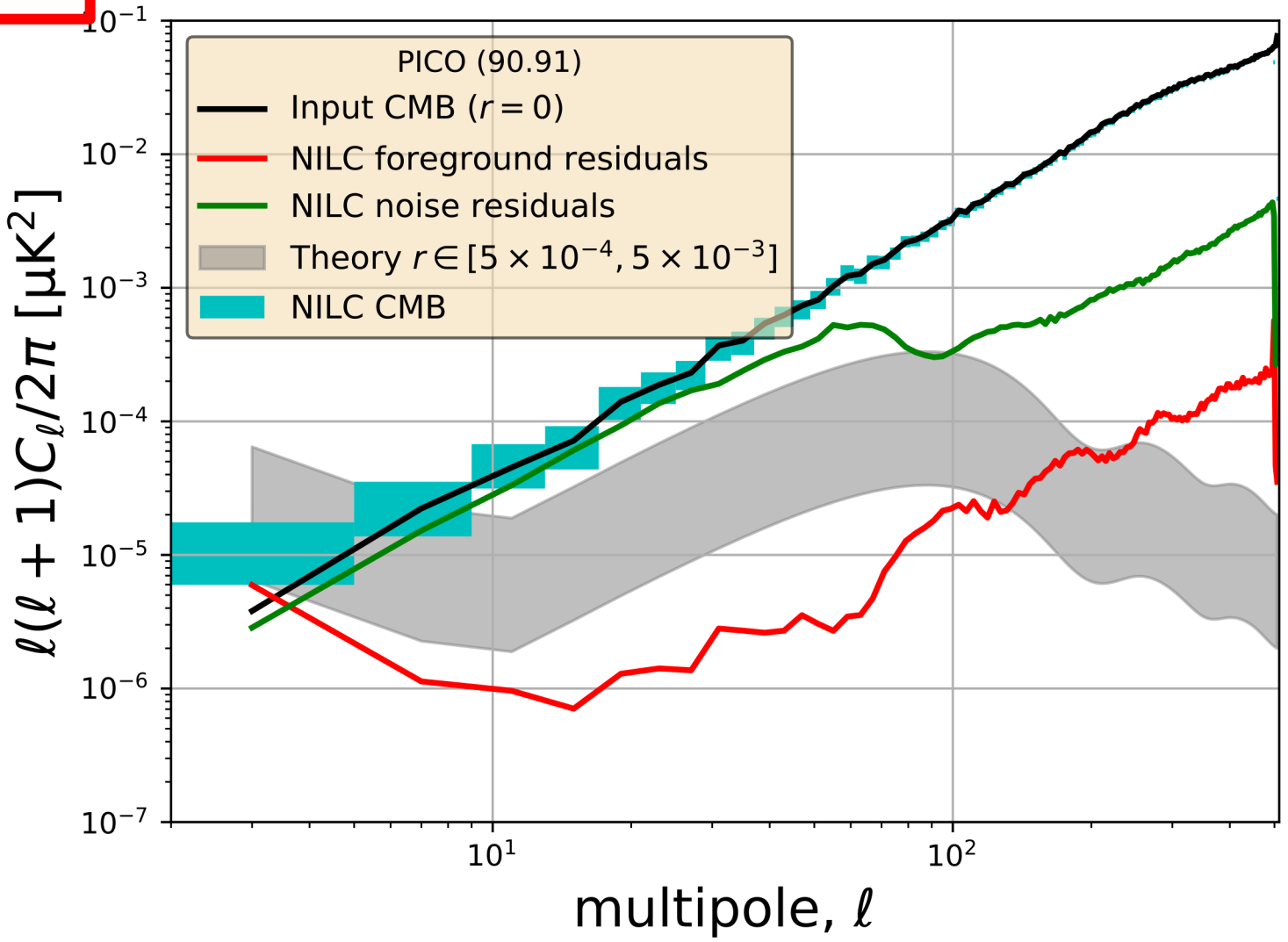

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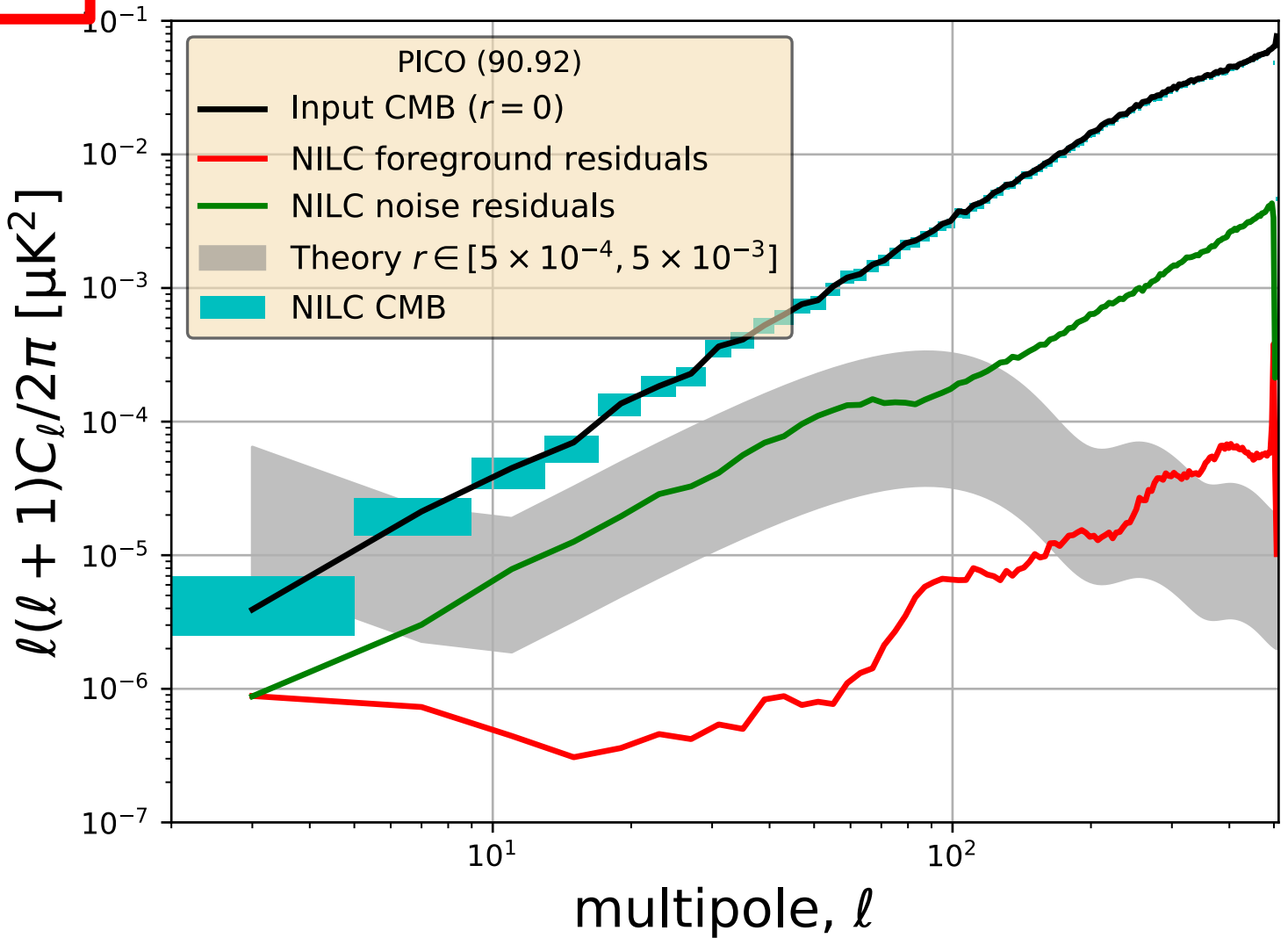

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43-800 GHz

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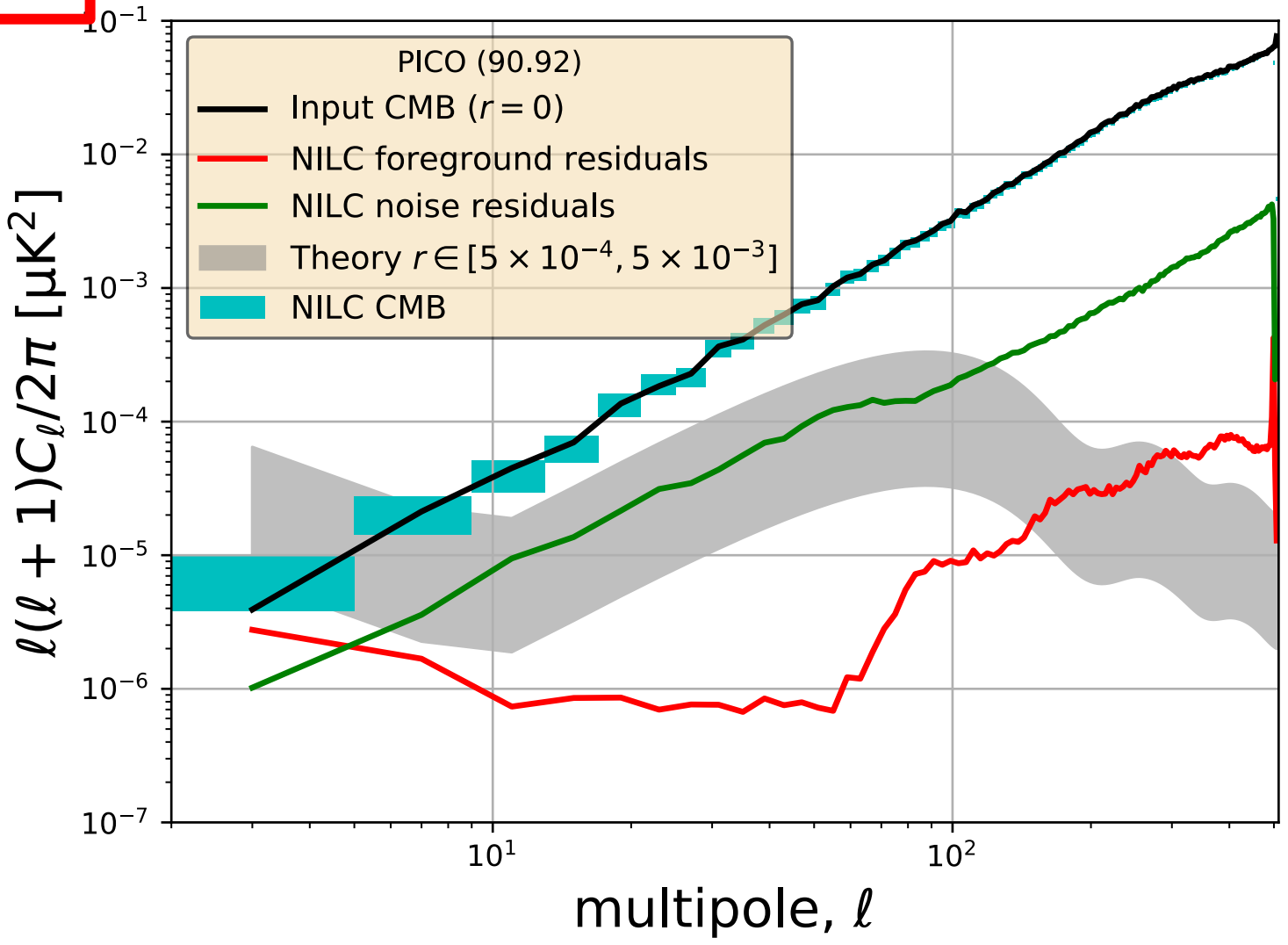

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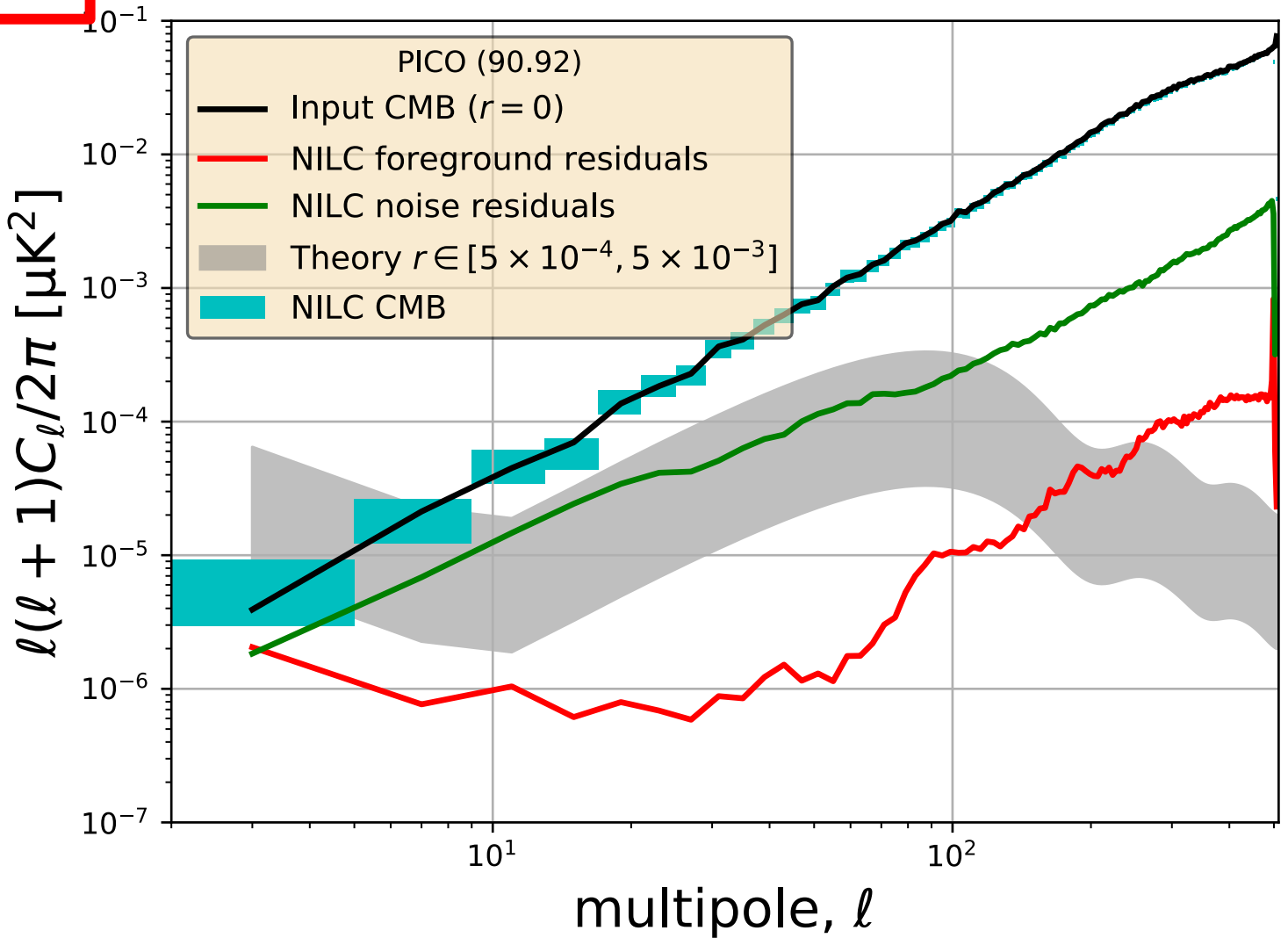
Binning: $\Delta\ell = 4$

w/o HF
21-462 GHz

90.92, $r = 0$

NILC



10 realizations

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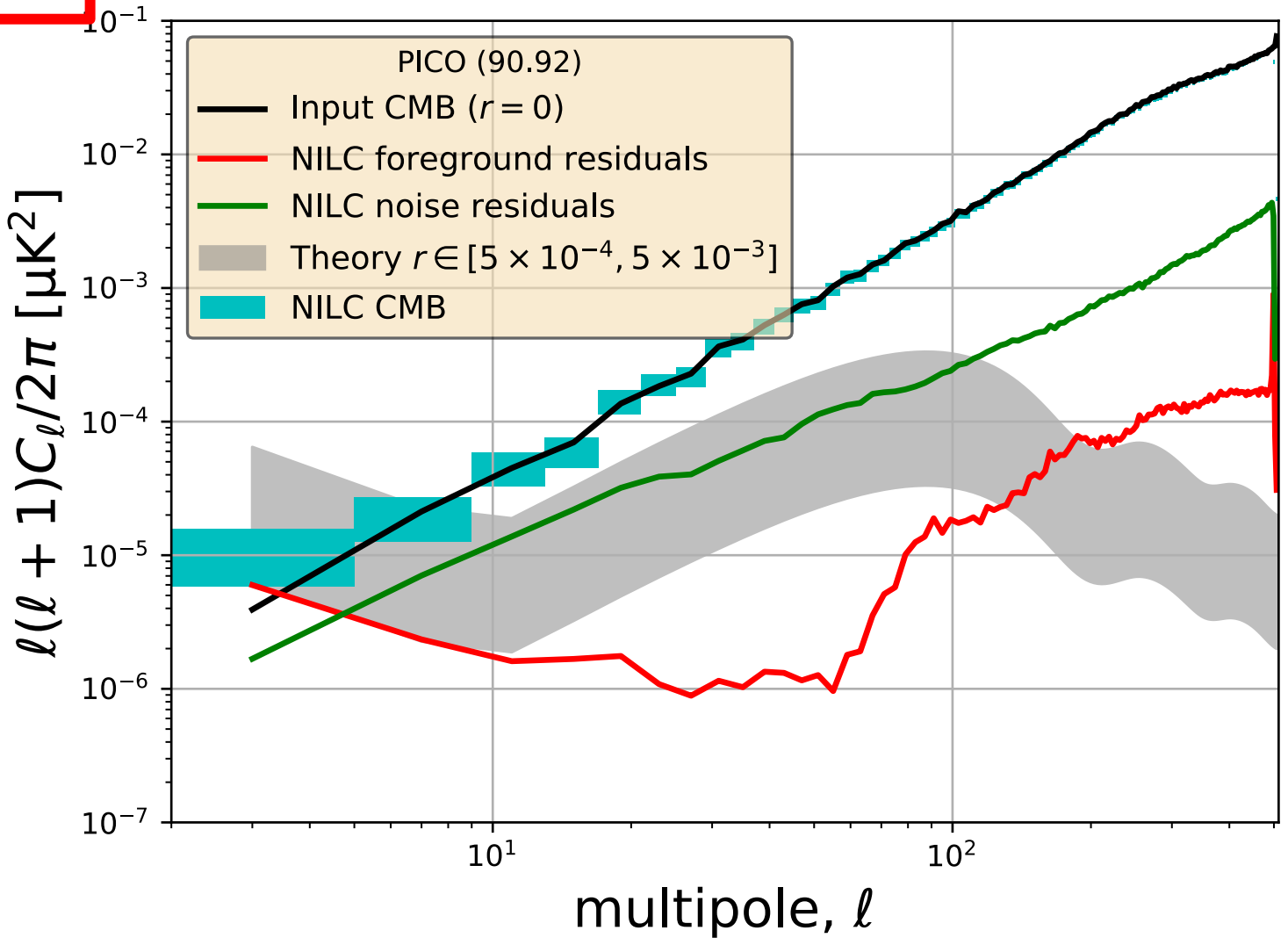
Descope
43-462 GHz

90.92, $r = 0$

NILC



10 realizations

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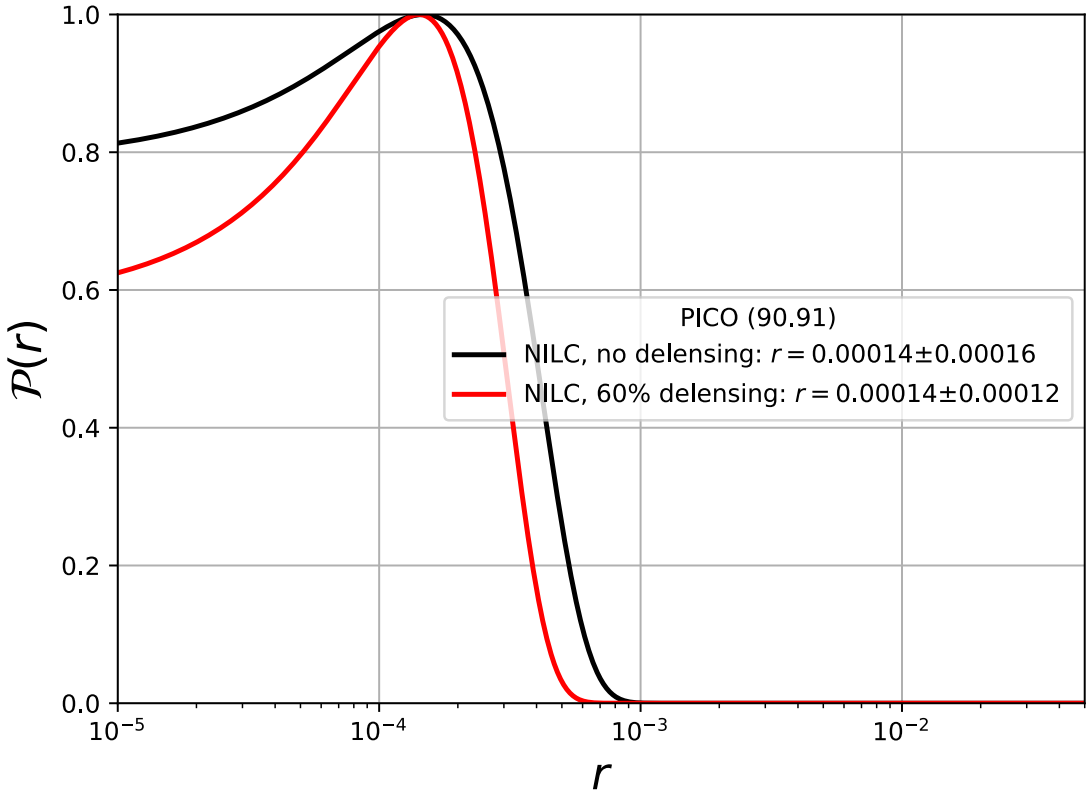
Binning: $\Delta\ell = 4$

Baseline
21-800 GHz

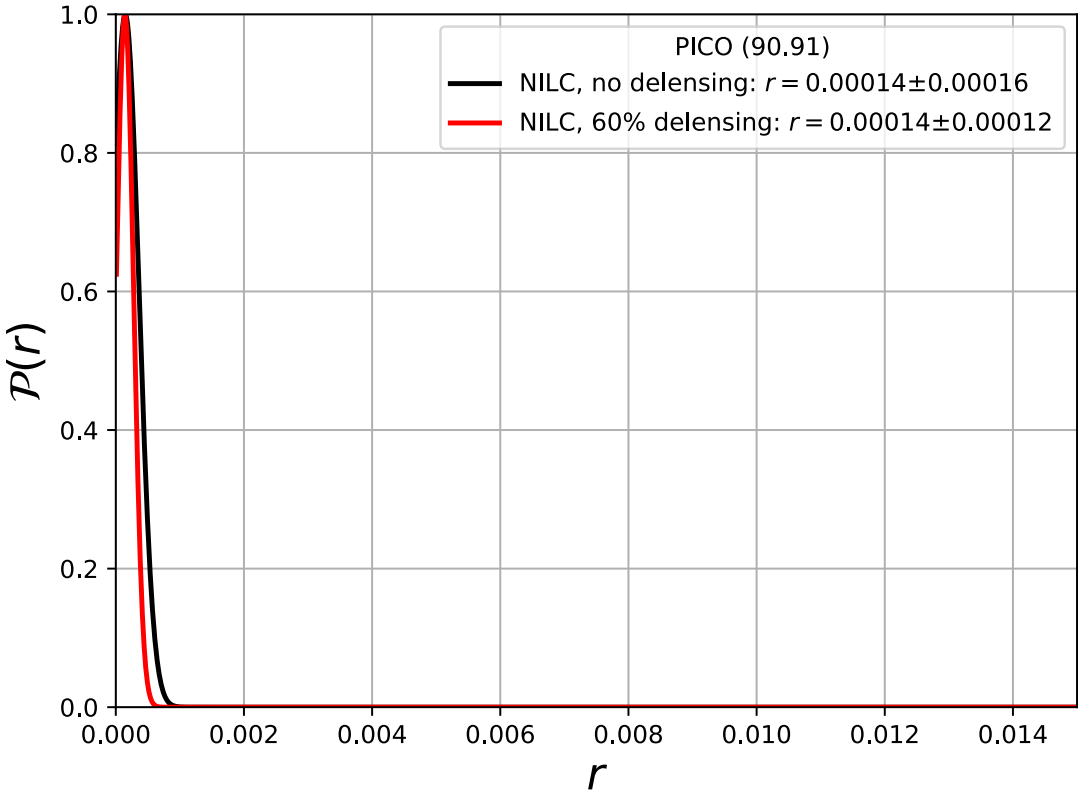
90.91, $r = 0$

NILC

Logarithmic scale



Linear scale

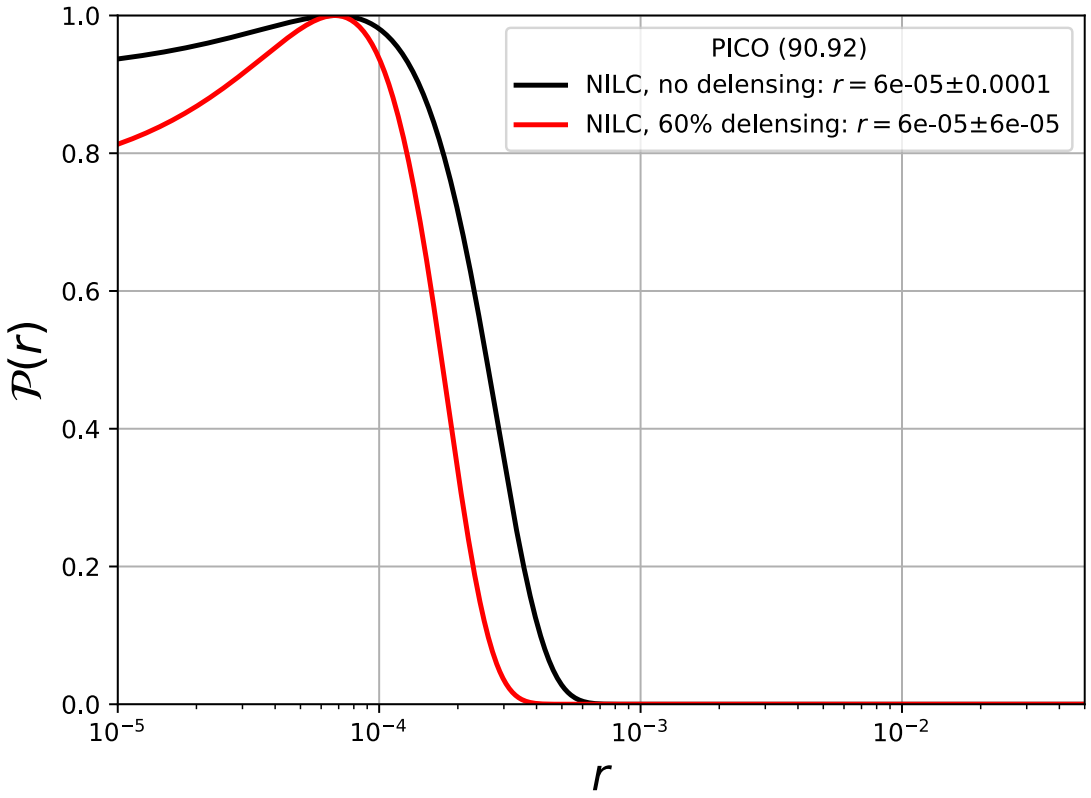


Baseline
21-800 GHz

90.92, $r = 0$

NILC

Logarithmic scale



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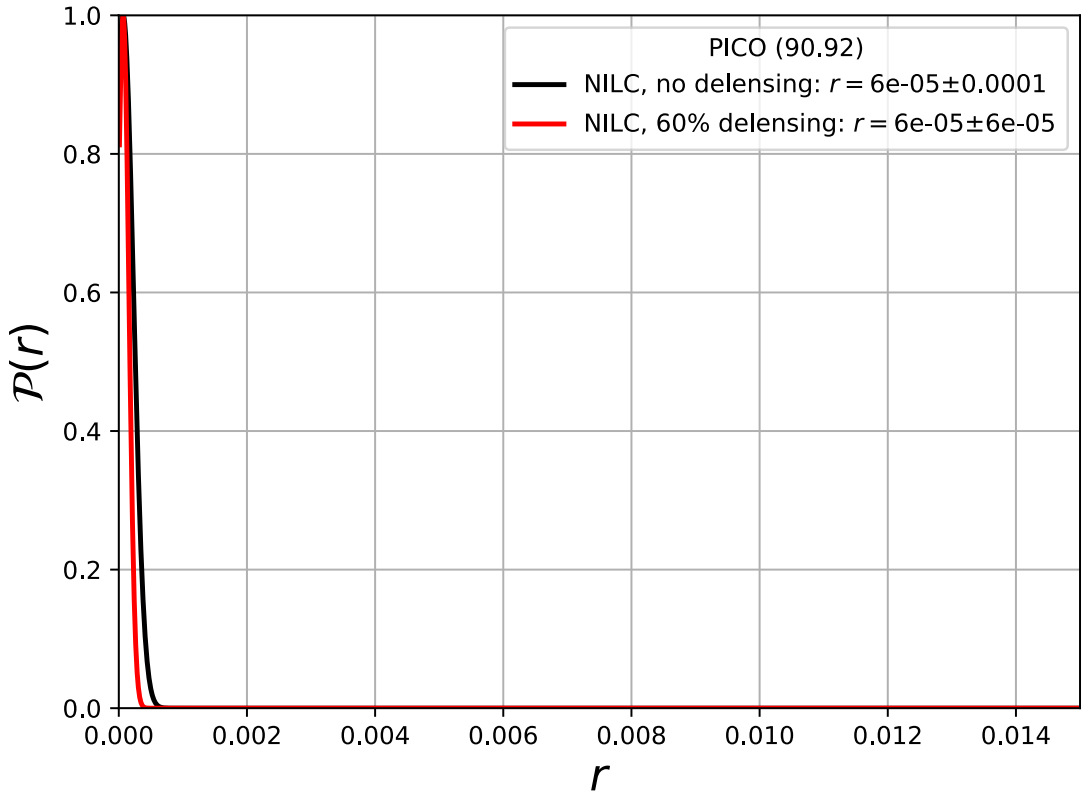

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21-800 GHz

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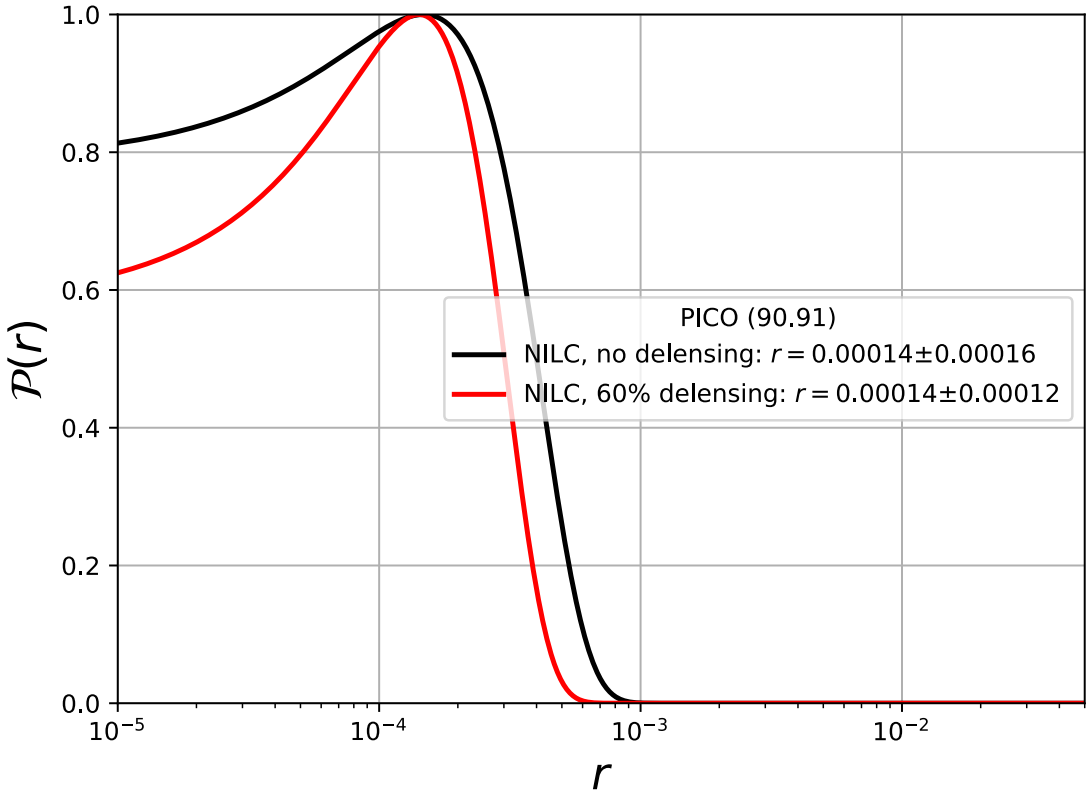

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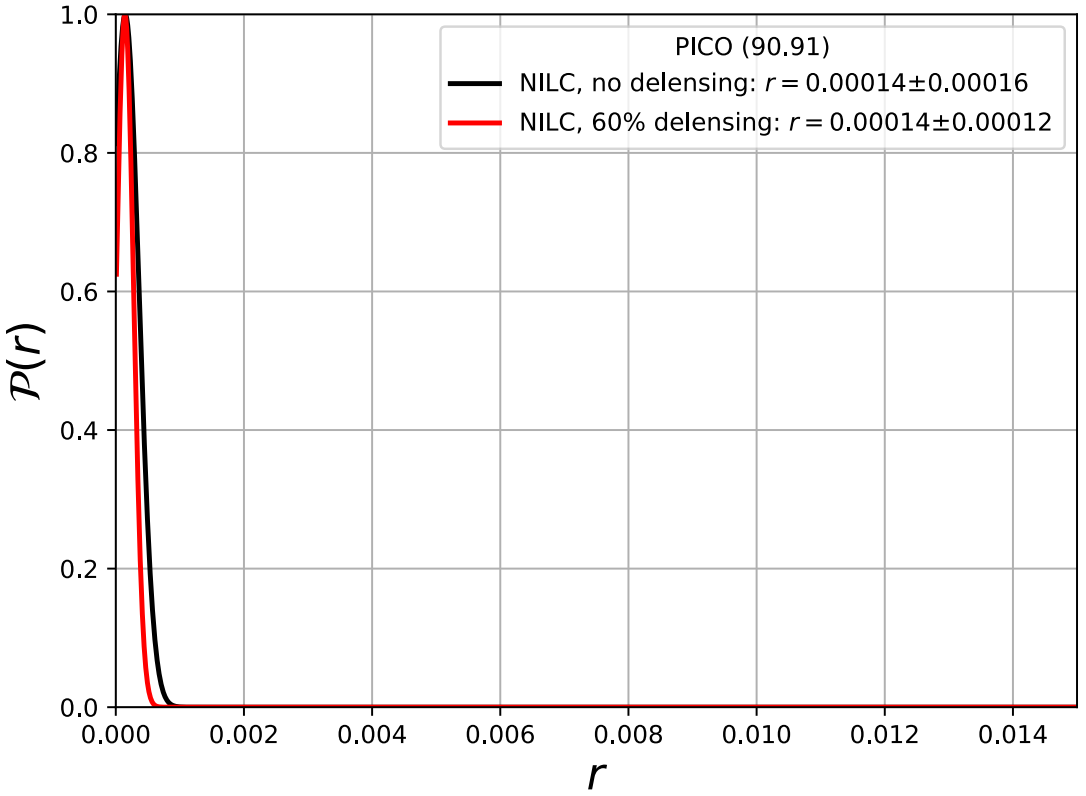

w/o LF
43-800 GHz

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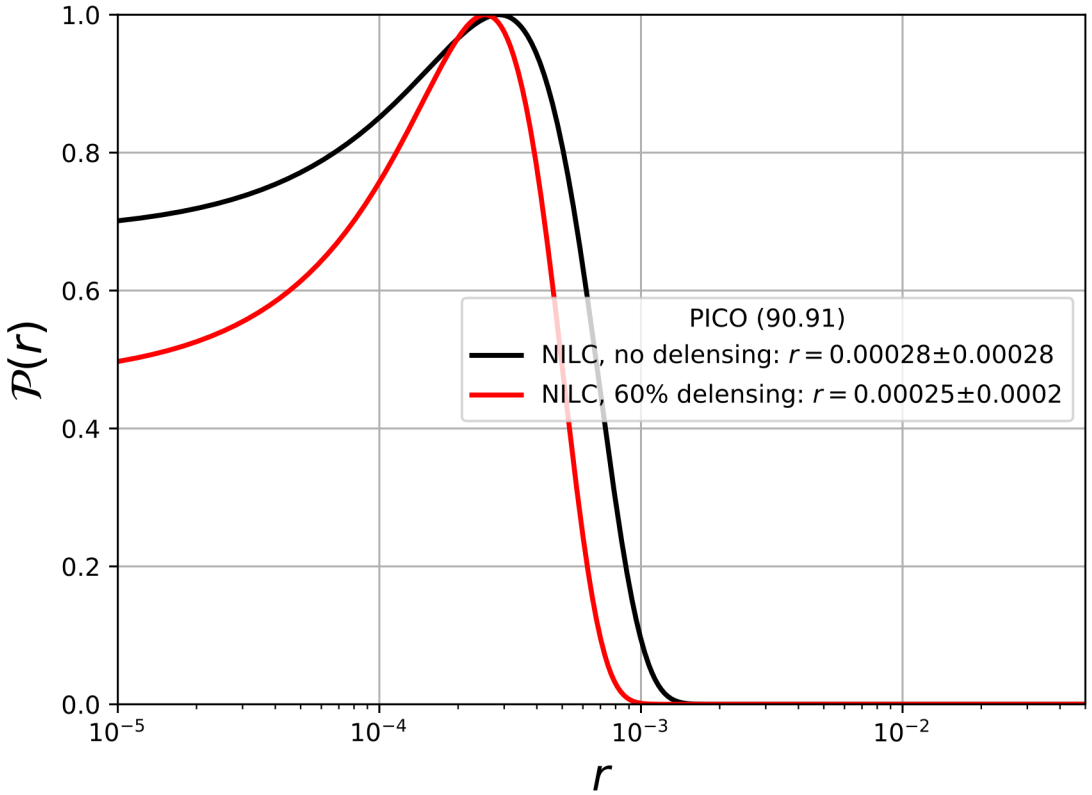
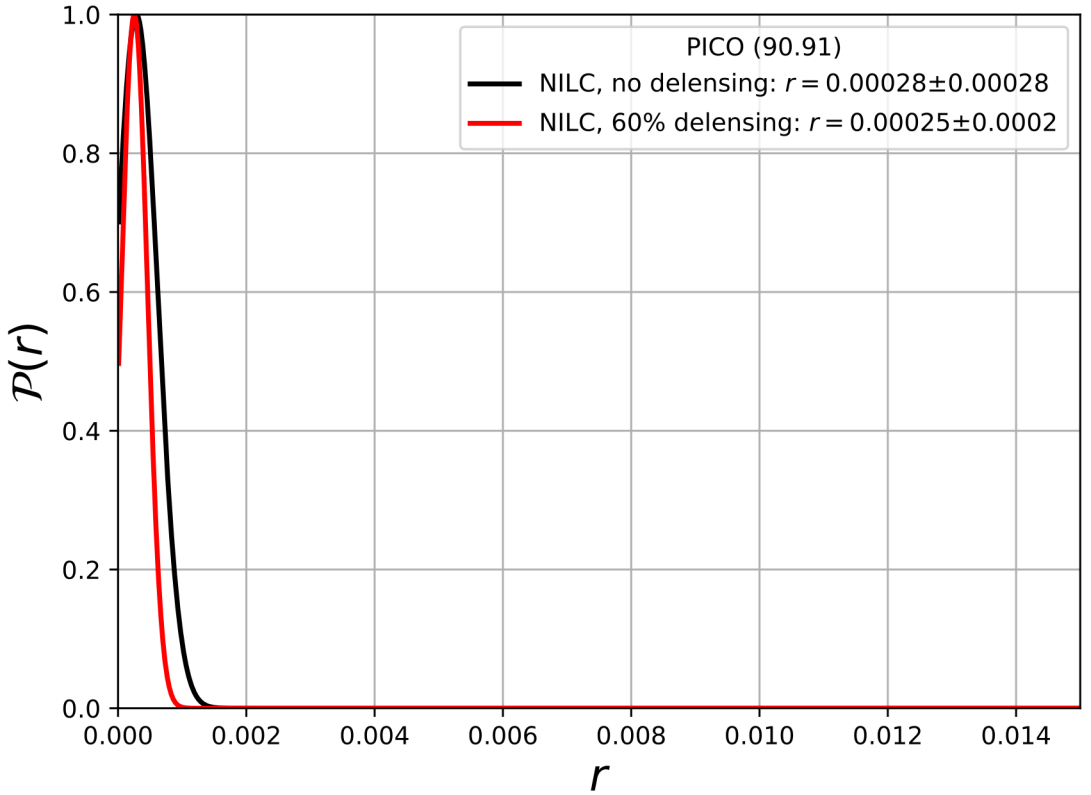


Linear scale

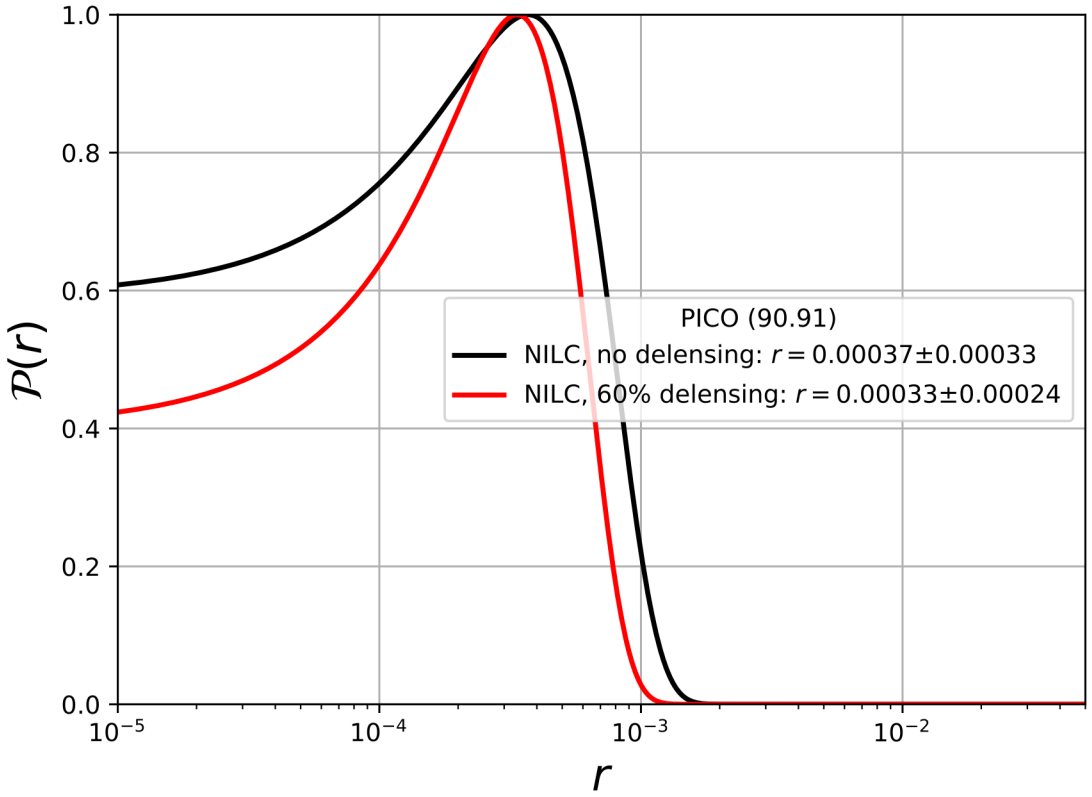


w/o HF
21-462 GHz

90.91, $r = 0$

NILC

Logarithmic scale



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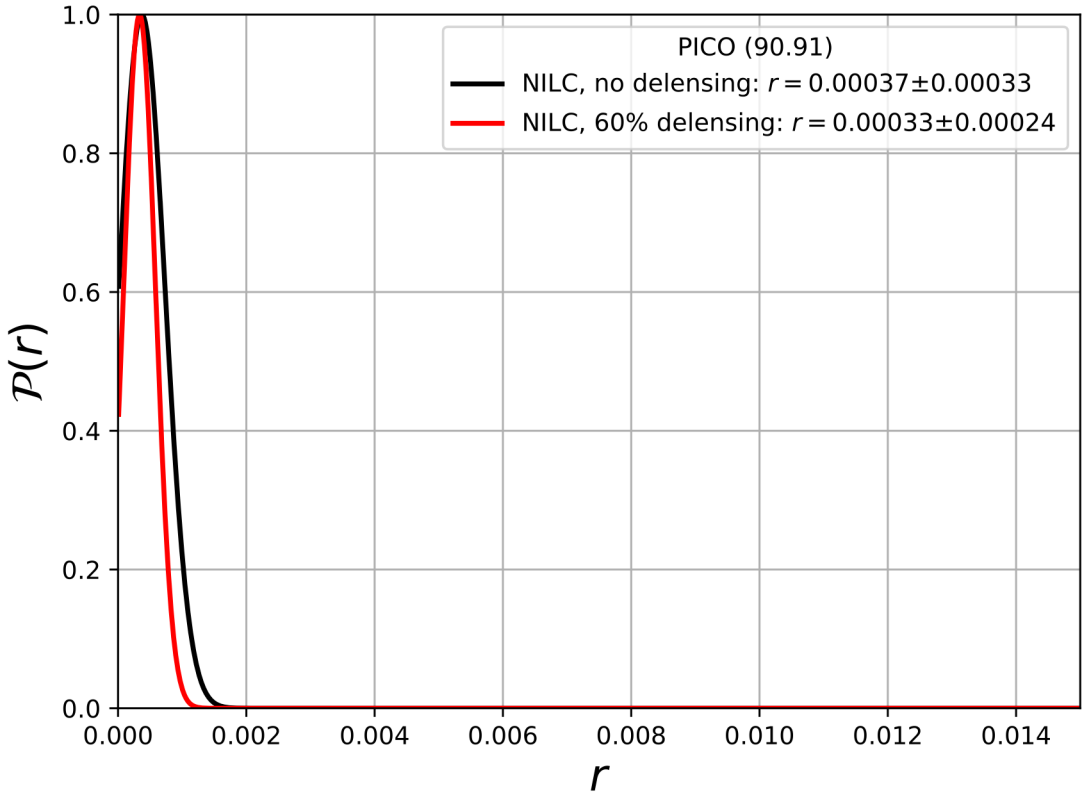

Baseline
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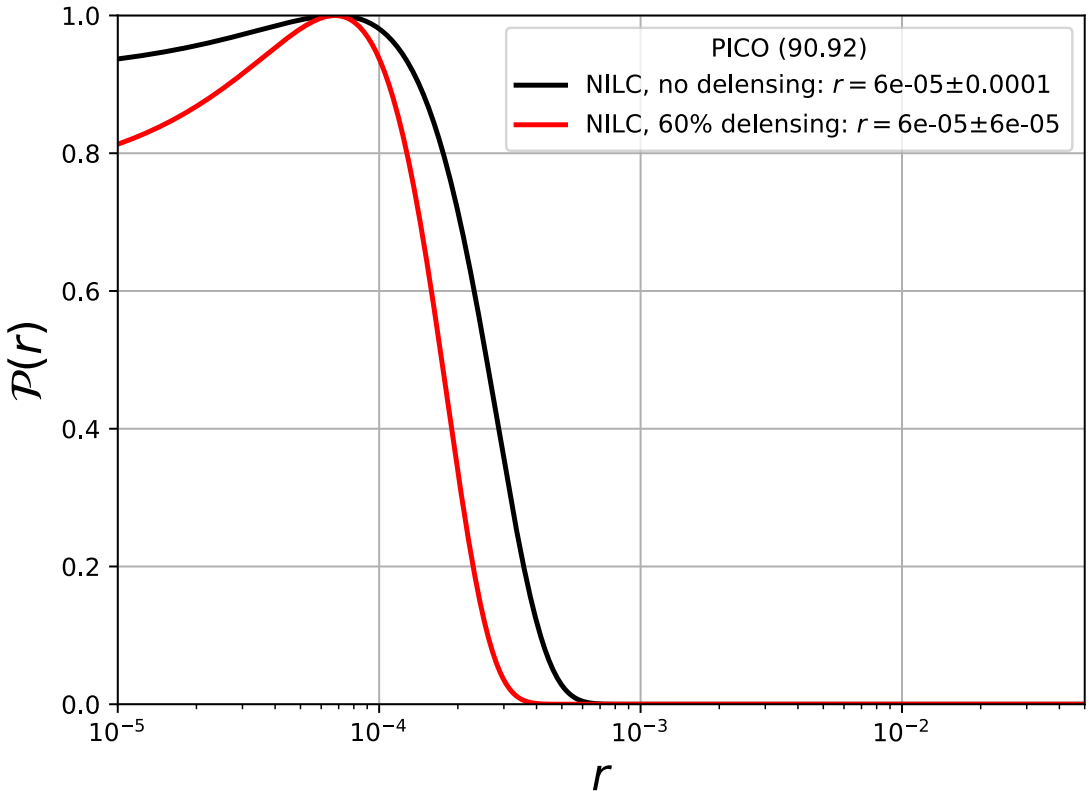
Logarithmic scale



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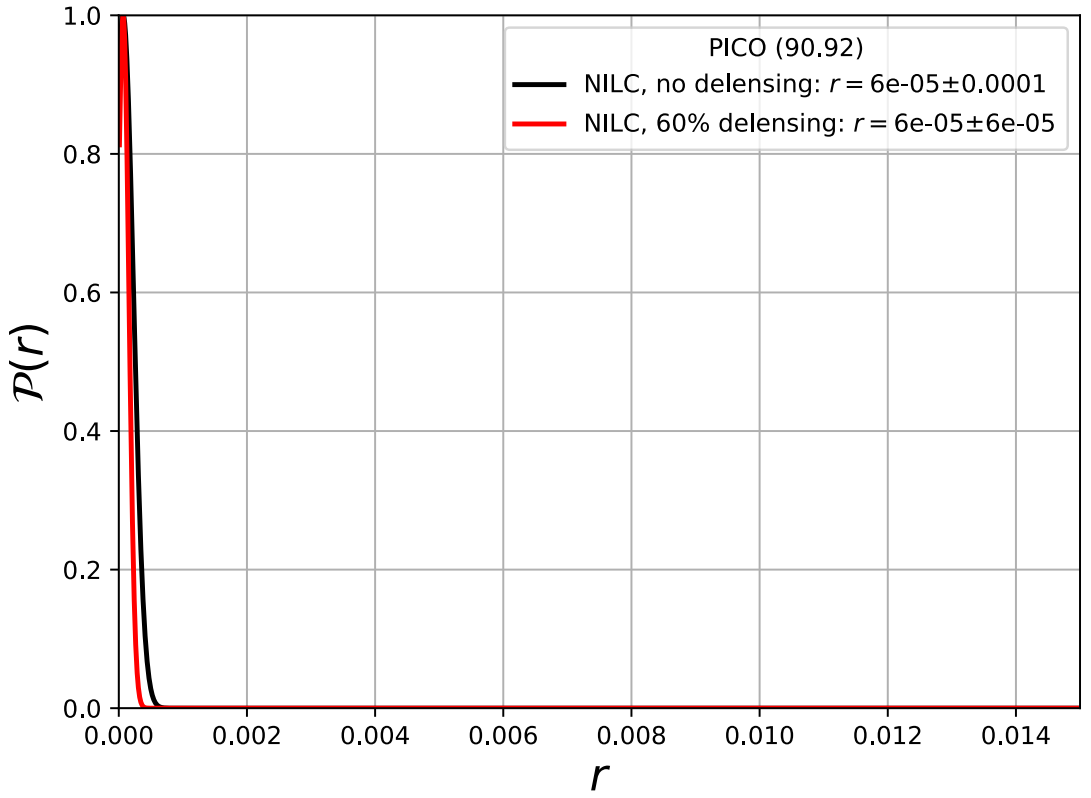

w/o LF
43-800 GHz

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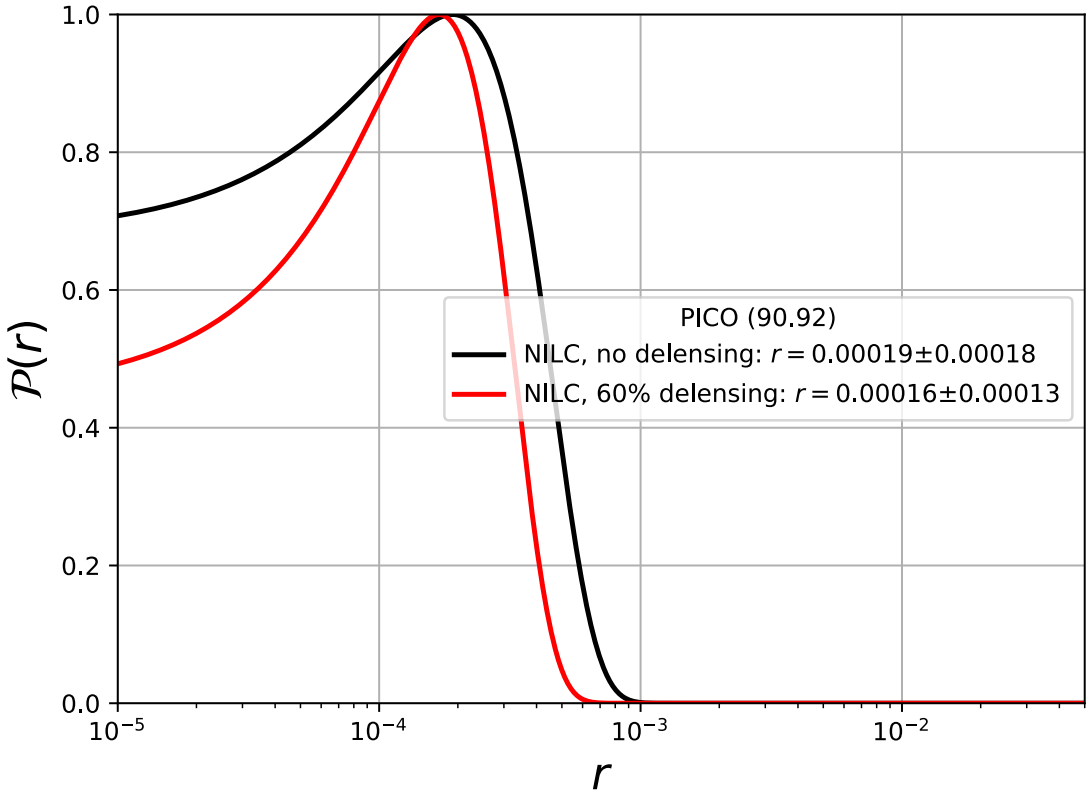
Logarithmic scale



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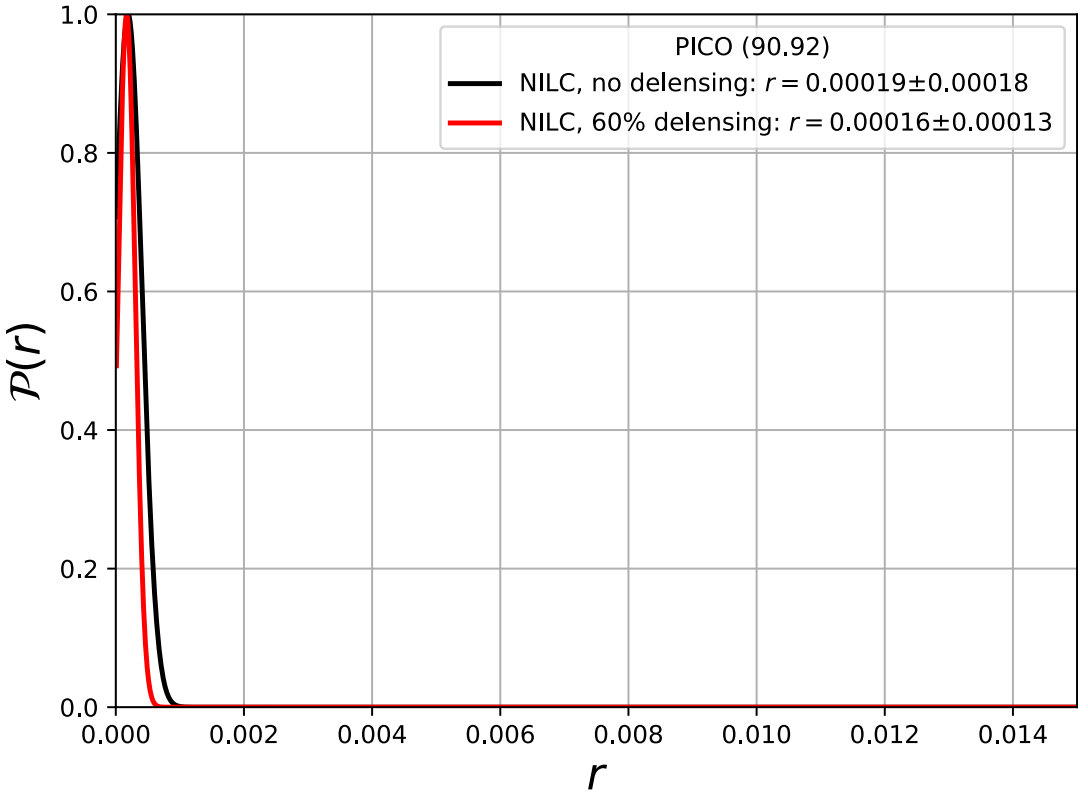
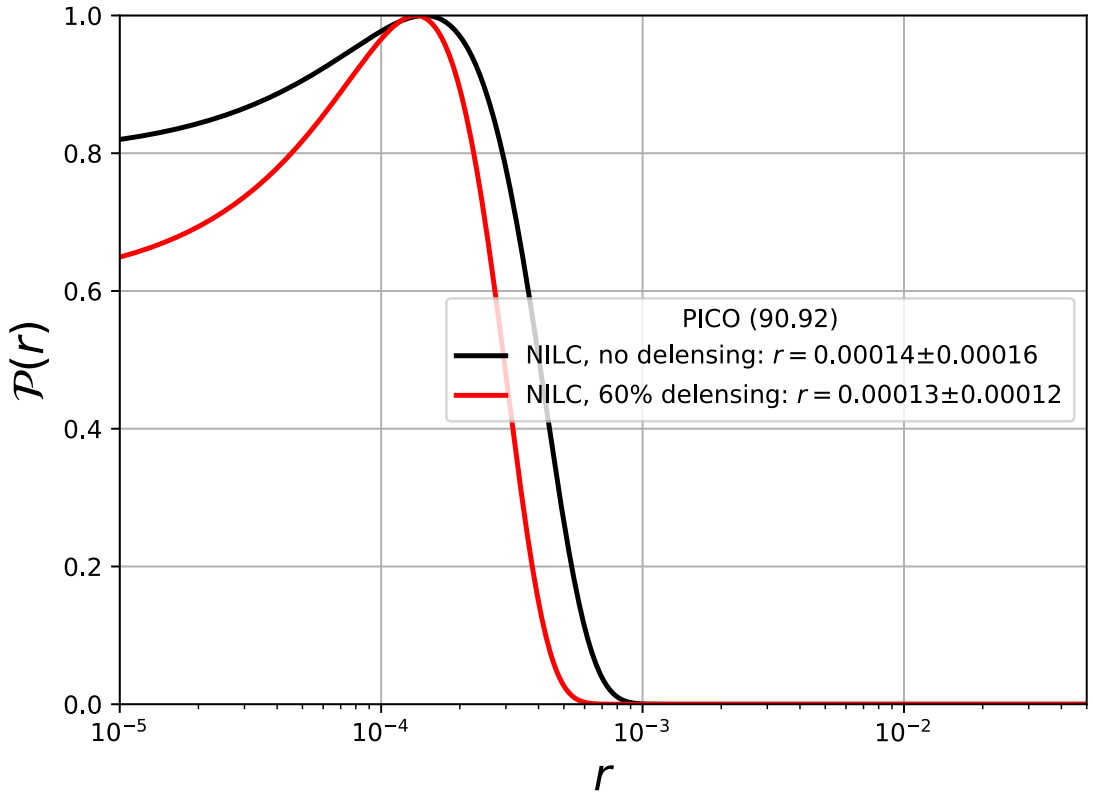


w/o HF
21-462 GHz

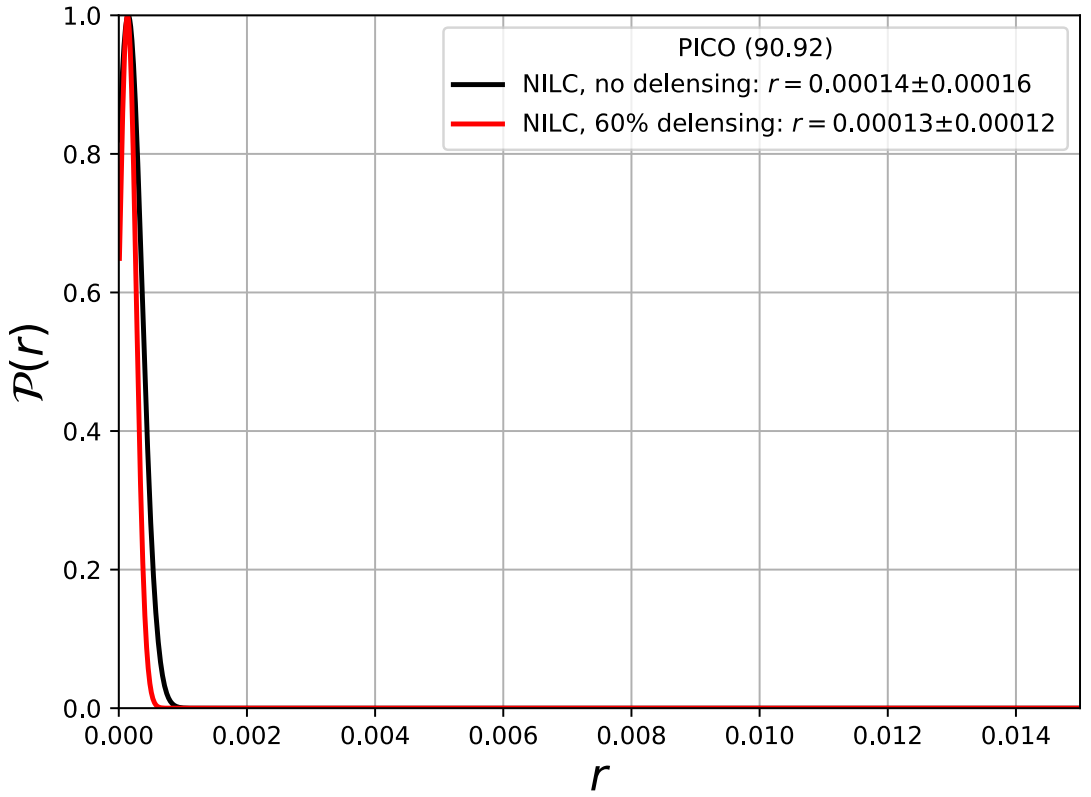
90.92, $r = 0$

NILC

Logarithmic scale



Linear scale



Descope
43-462 GHz

90.92, $r = 0$

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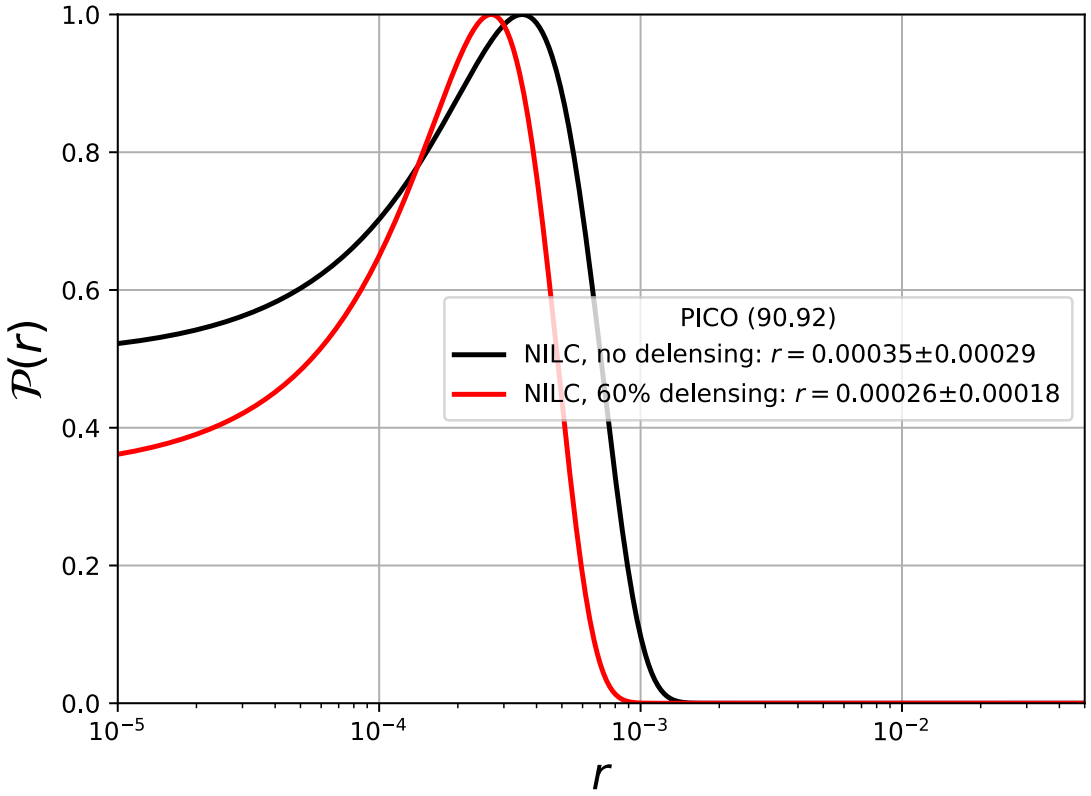

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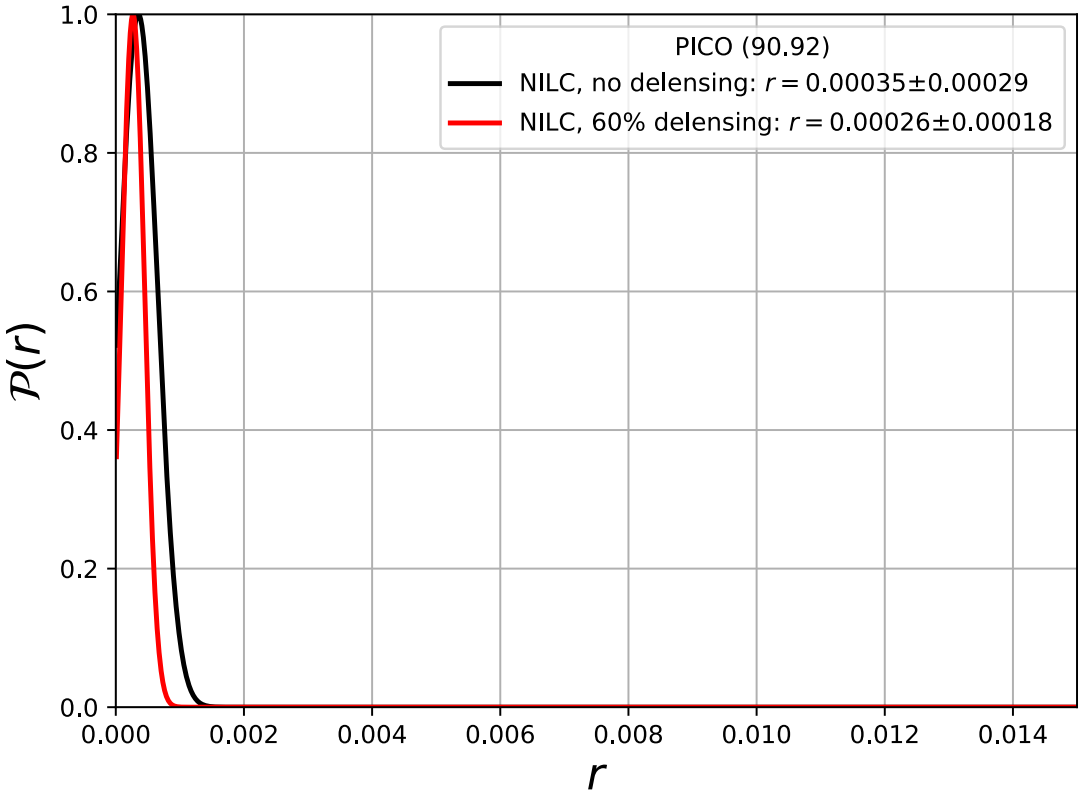


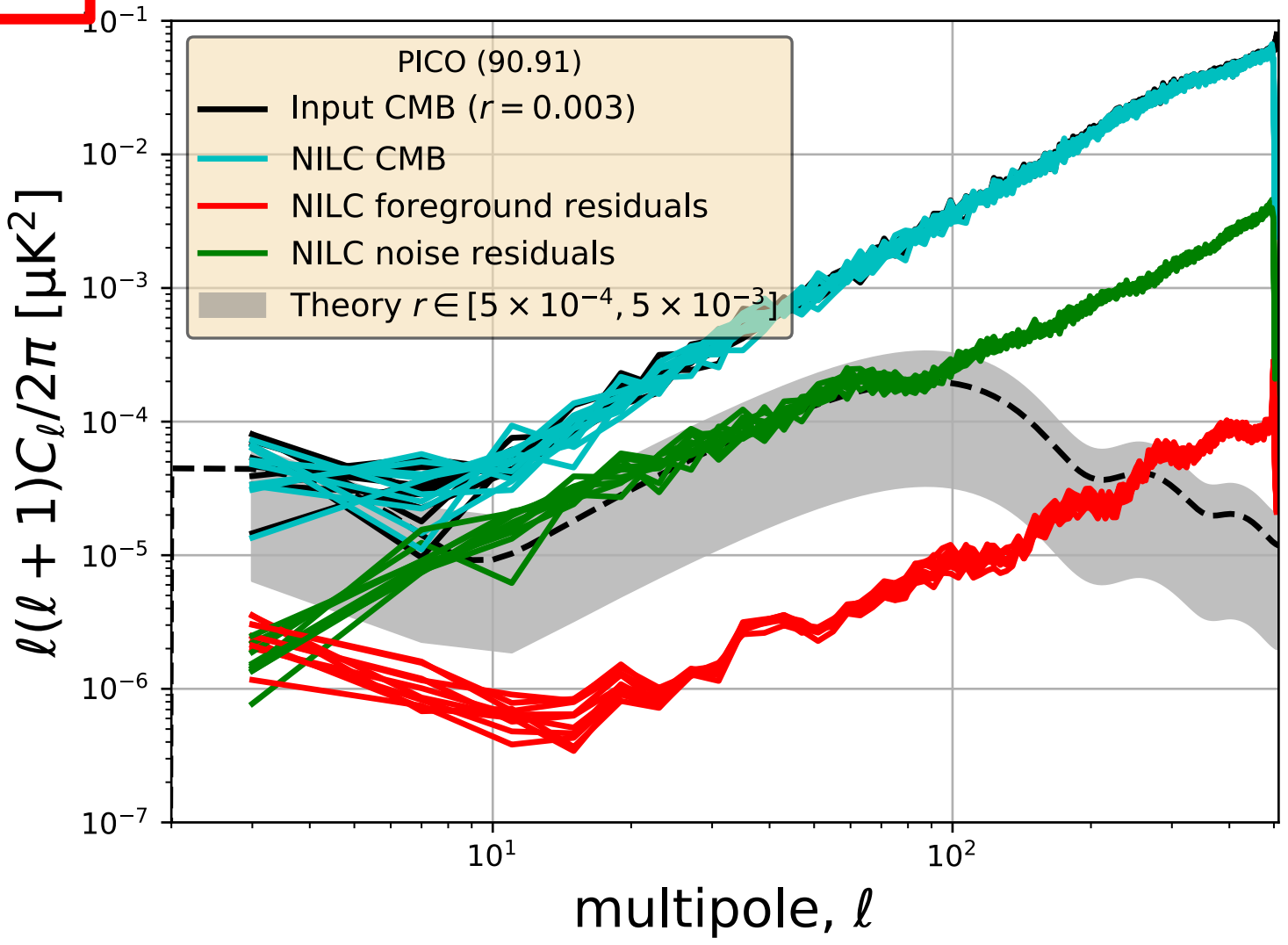
$$r = 0.003$$

90.91 & 90.92

Baseline
21-800 GHz

90.91, $r = 0.003$

NILC



10 realizations

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Baseline
21-800 GHz

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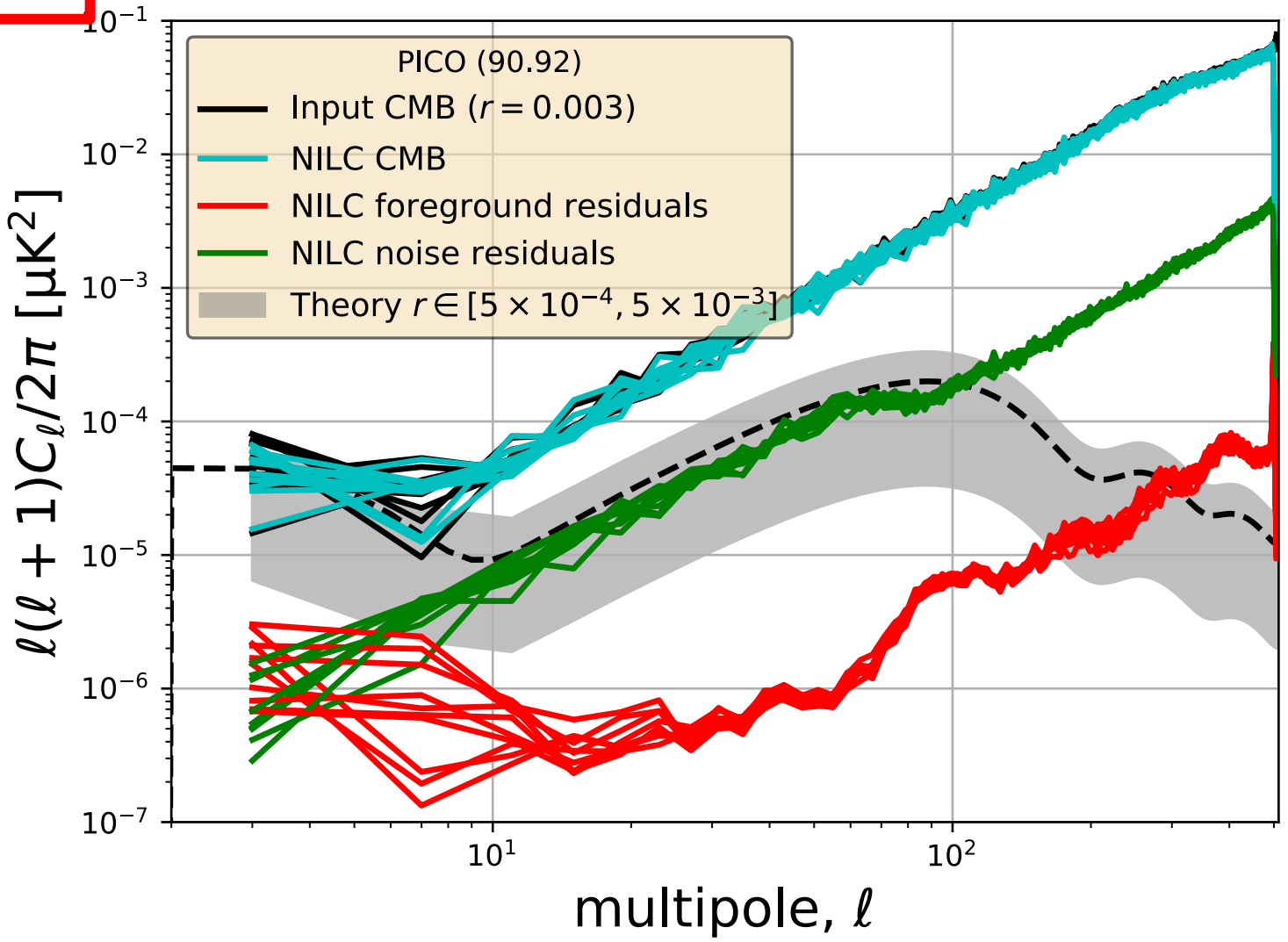

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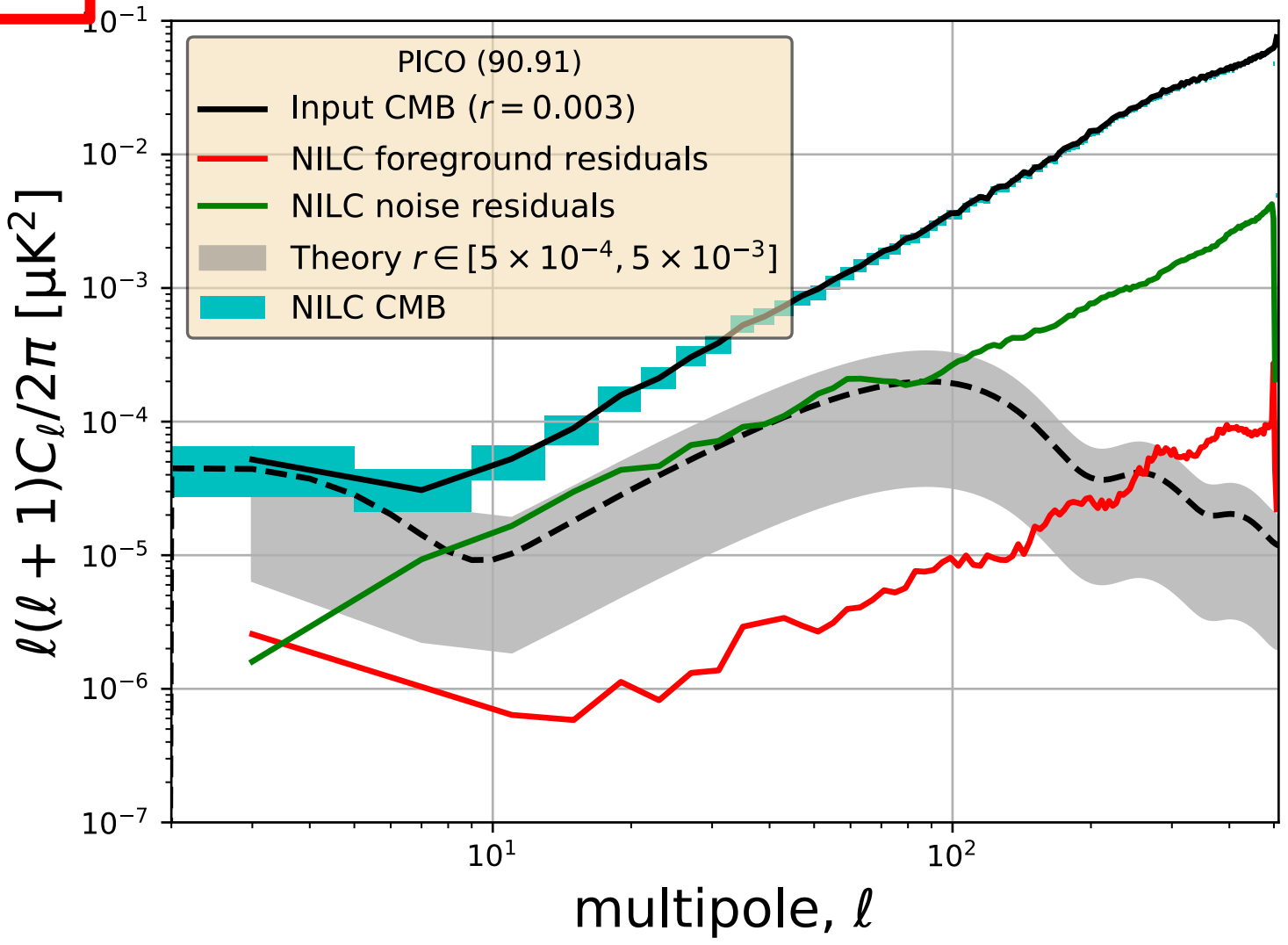

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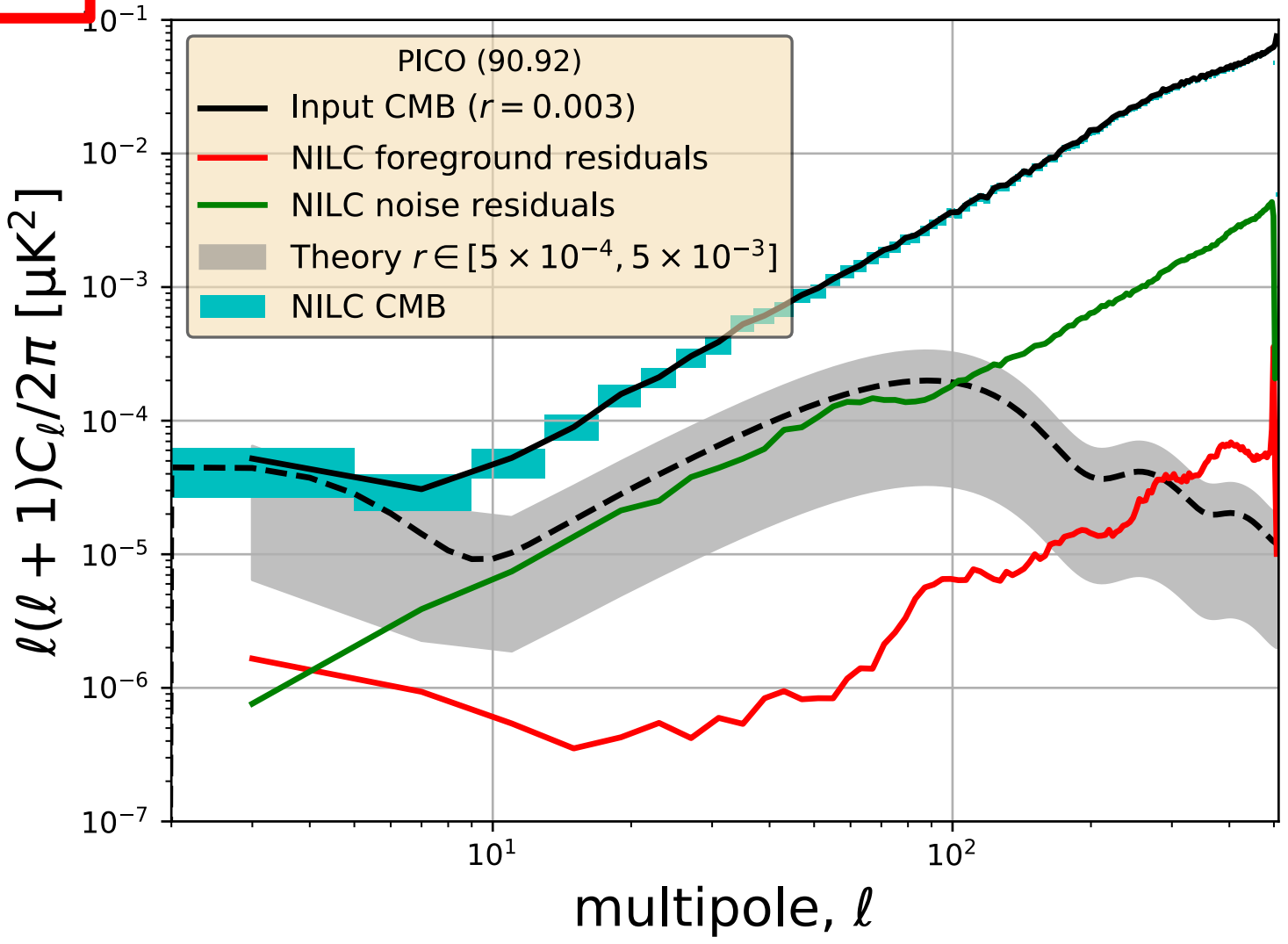

10 realizations

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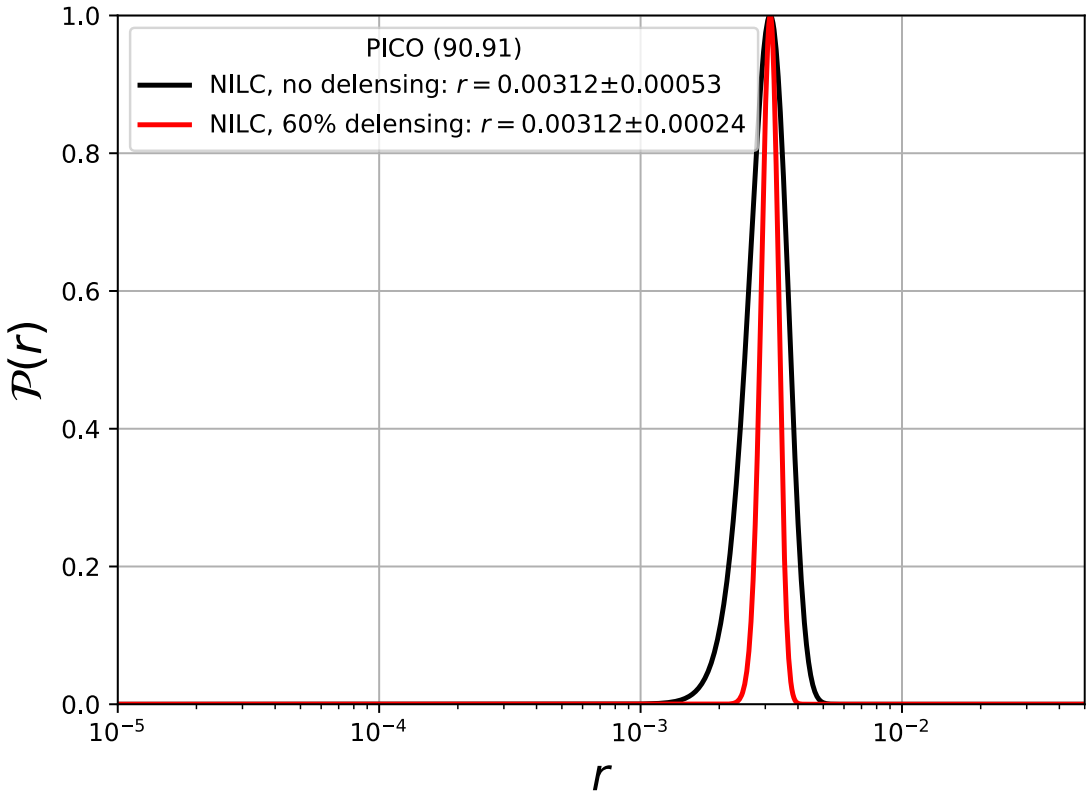
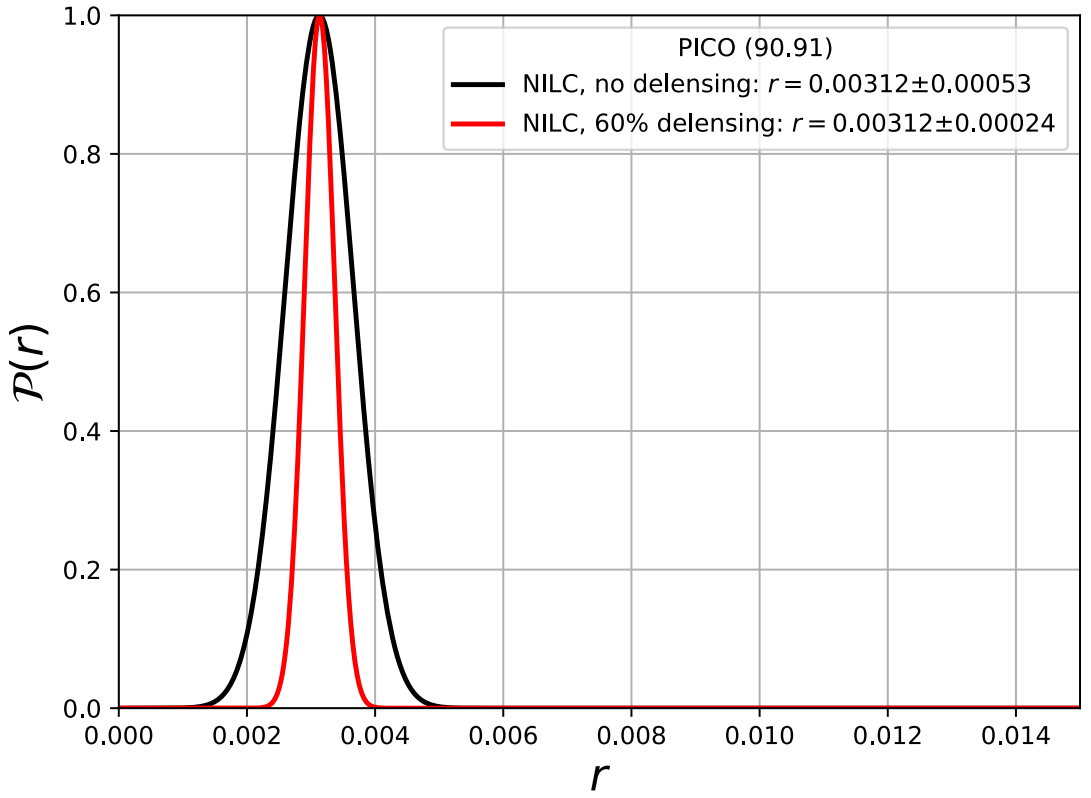
NILC

Logarithmic scale



Linear scale



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21-800 GHz

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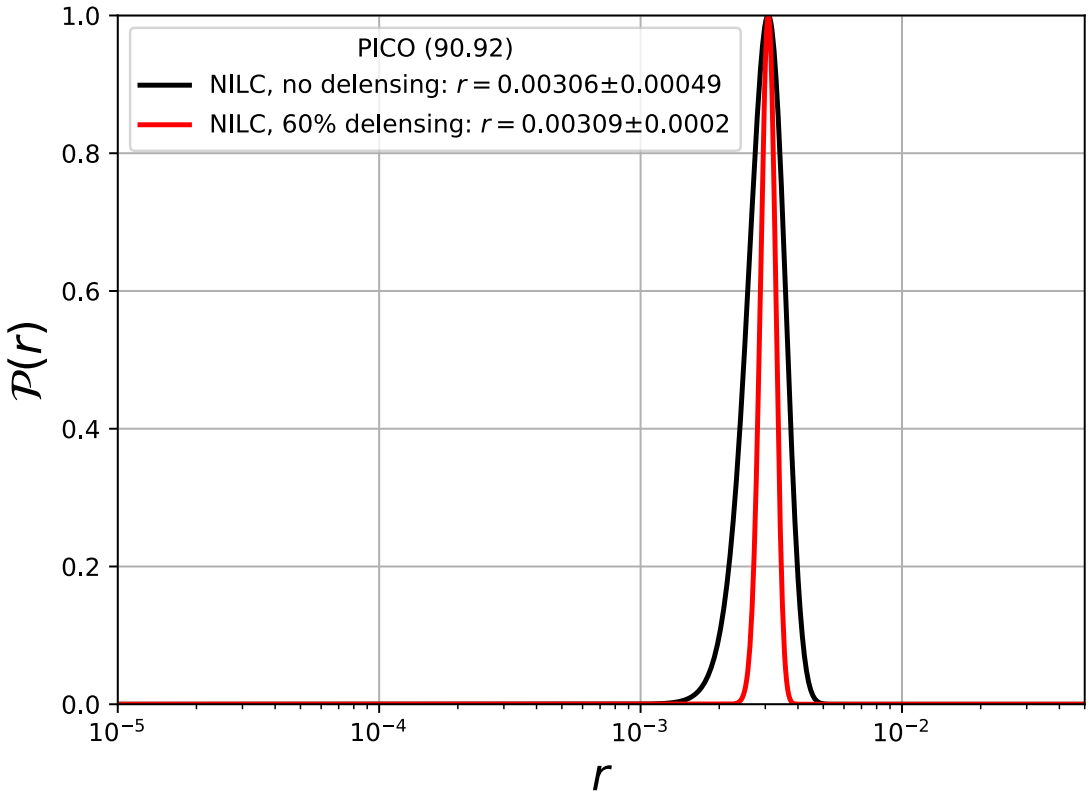

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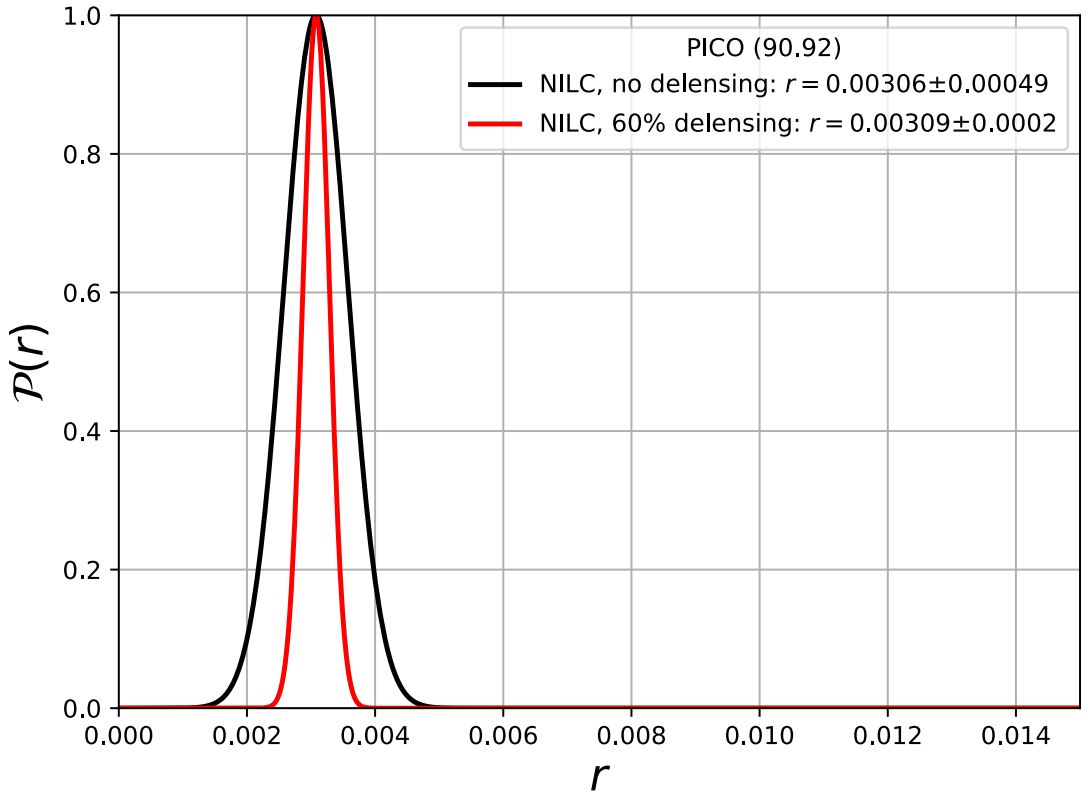


Note on the likelihood

The component separation exercise has been performed on sky maps with full lensing contamination.

Suppose that PICO can perform e.g. 60% delensing, then the fraction of residual lensing power will be $A_L = 0.4$ after delensing.

Now for the r forecasts, we do the following shortcut to account for "delensing":

- $C_\ell^{BB,\mathrm{NILC}}$ is corrected for the residual noise bias and the residual lensing bias:

$$C_\ell^{\mathrm{CMB}} + C_\ell^{\mathrm{fgds}} = C_\ell^{BB,\mathrm{NILC}} - C_\ell^{\mathrm{noise}} - A_L C_\ell^{\mathrm{lens}}$$

- Build a simple Gaussian likelihood to fit r only:

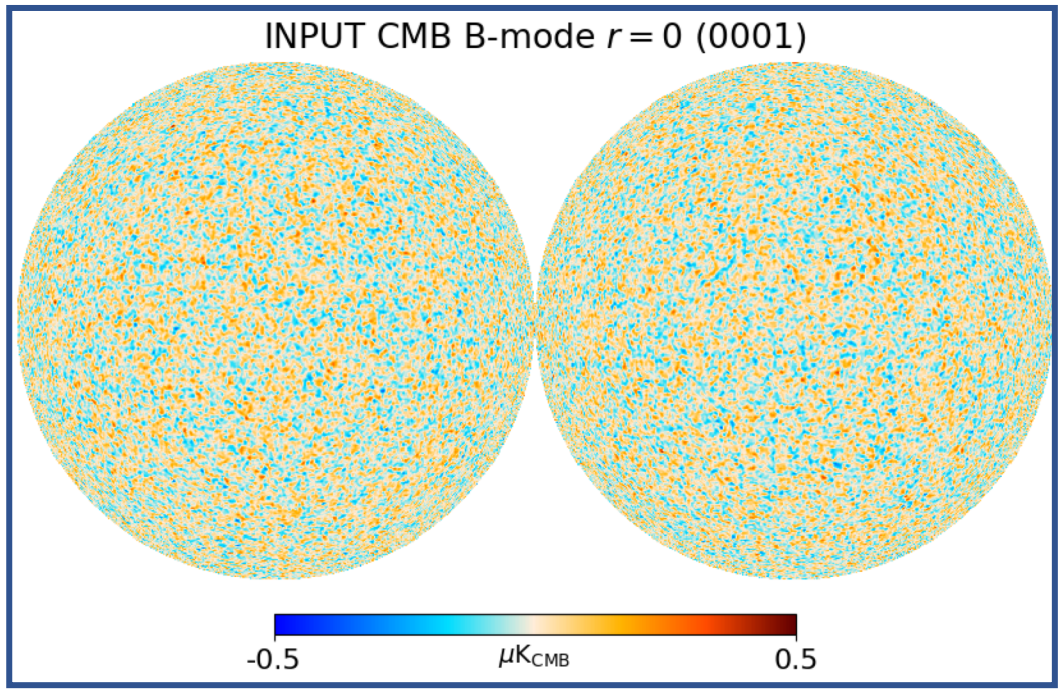
$$-2\ln\mathcal{L}(r) = \sum_{\ell=2}^{\ell_{\mathrm{max}}} \left(C_\ell^{\mathrm{CMB}} + C_\ell^{\mathrm{fgds}} - r\,C_\ell^{prim}(r=1)\right) \mathrm{M}_{\ell\ell'}^{-1} \left(C_\ell^{\mathrm{CMB}} + C_\ell^{\mathrm{fgds}} - r\,C_\ell^{prim}(r=1)\right)$$

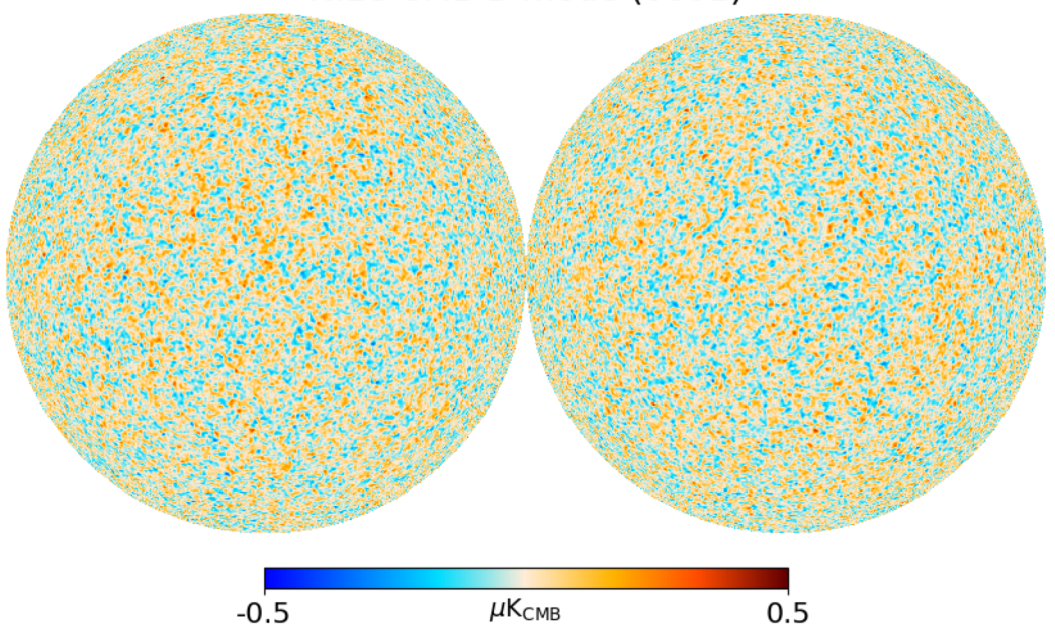
- The covariance matrix includes cosmic/sample variance of residual lensing signal, residual foregrounds and residual noise (and cross-terms):

$$\mathrm{M}_{\ell\ell} = \frac{2}{(2\ell+1)f_{\mathrm{sky}}}\left(C_\ell^{BB,\mathrm{NILC}} - (1-A_L)C_\ell^{\mathrm{lens}}\right)^2 = \frac{2}{(2\ell+1)f_{\mathrm{sky}}}\left(C_\ell^{\mathrm{CMB}} + A_L C_\ell^{\mathrm{lens}} + C_\ell^{\mathrm{fgds}} + C_\ell^{\mathrm{noise}}\right)^2$$

Expected residual lensing cosmic variance

Backup

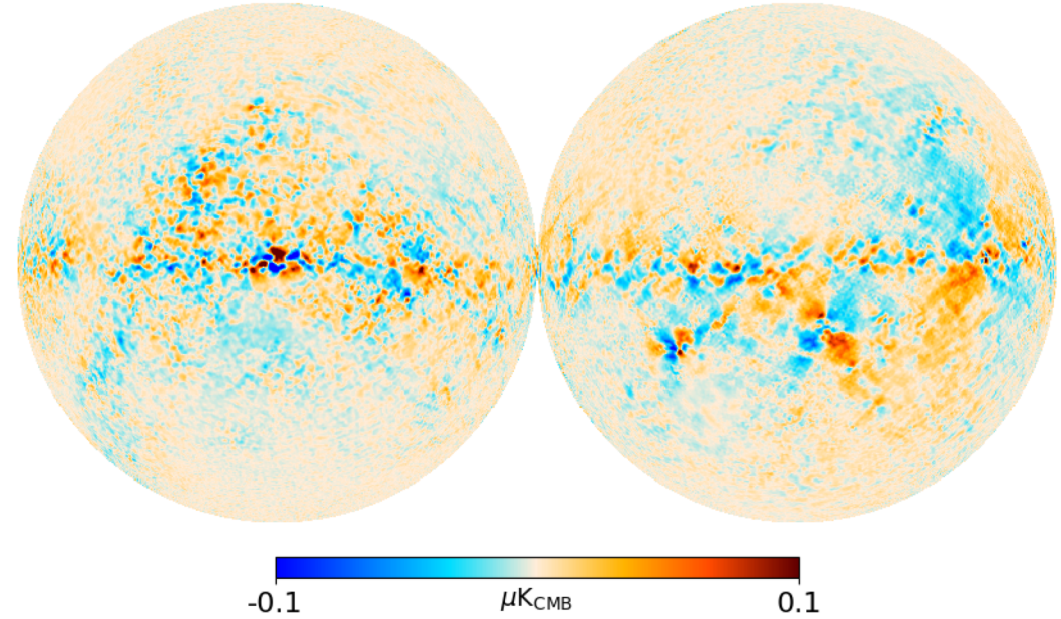

INPUT CMB B-mode $r = 0$ (0001)
-0.5
μK_{CMB}
0.5

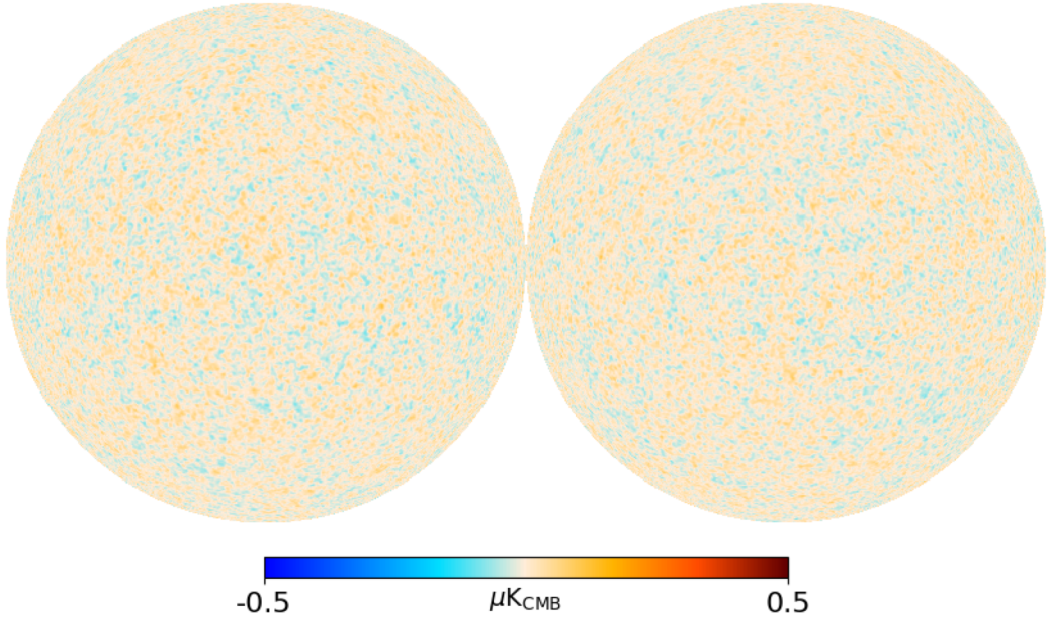

NILC CMB B-mode (0001)
-0.5
μK_{CMB}
0.5

90.91

$r = 0$

NILC


NILC foreground residuals B-mode (0001)
-0.1
μK_{CMB}
0.1


NILC noise residuals B-mode (0001)
-0.5
μK_{CMB}
0.5