Planck-HFI legacy for the future CMB polarisation experiments

Corrections of foregrounds and instrumental systematic effects

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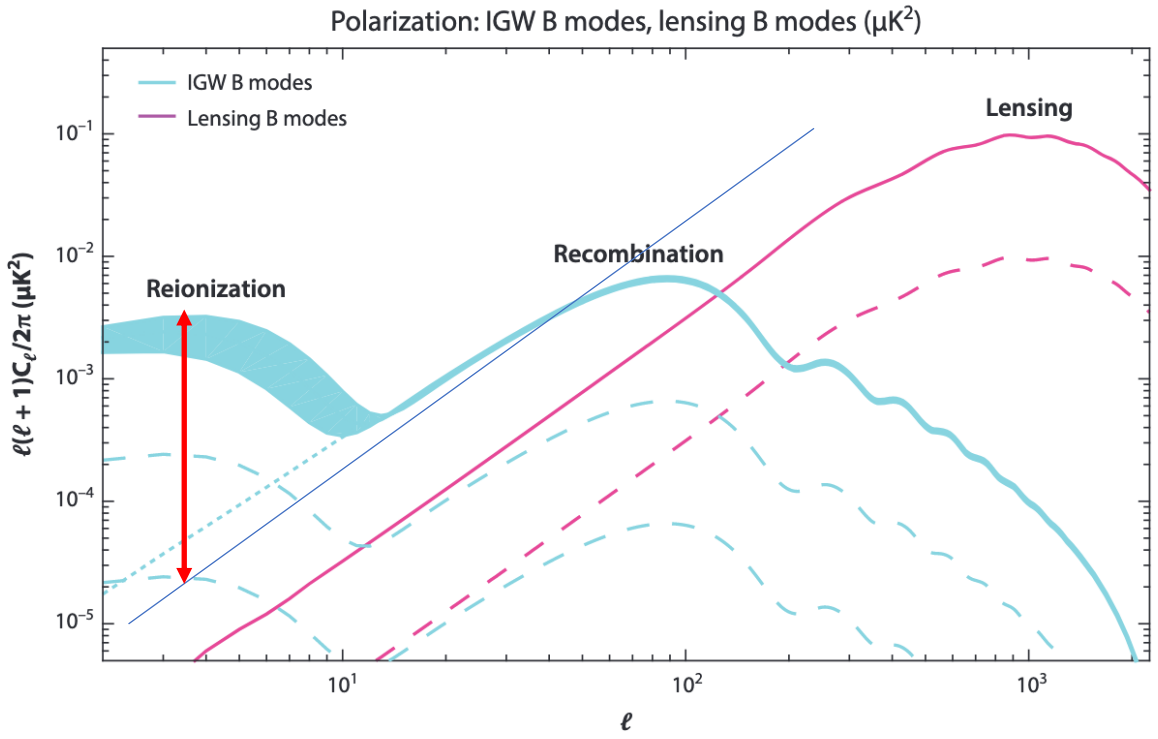
- For a white noise and systematics
  - using the reionization peak ($\ell \sim 3$) gives a gain of two orders of magnitude on the r parameter w.r.t. the recombination peak ($\ell \sim 80$)
  - Getting the instrumental and foreground removal systematics below the detector white noise has taken 10 years to get close this situation
- We need to bring the instrumental and foregrounds systematics as close as possible to a white spectrum 2< l <100

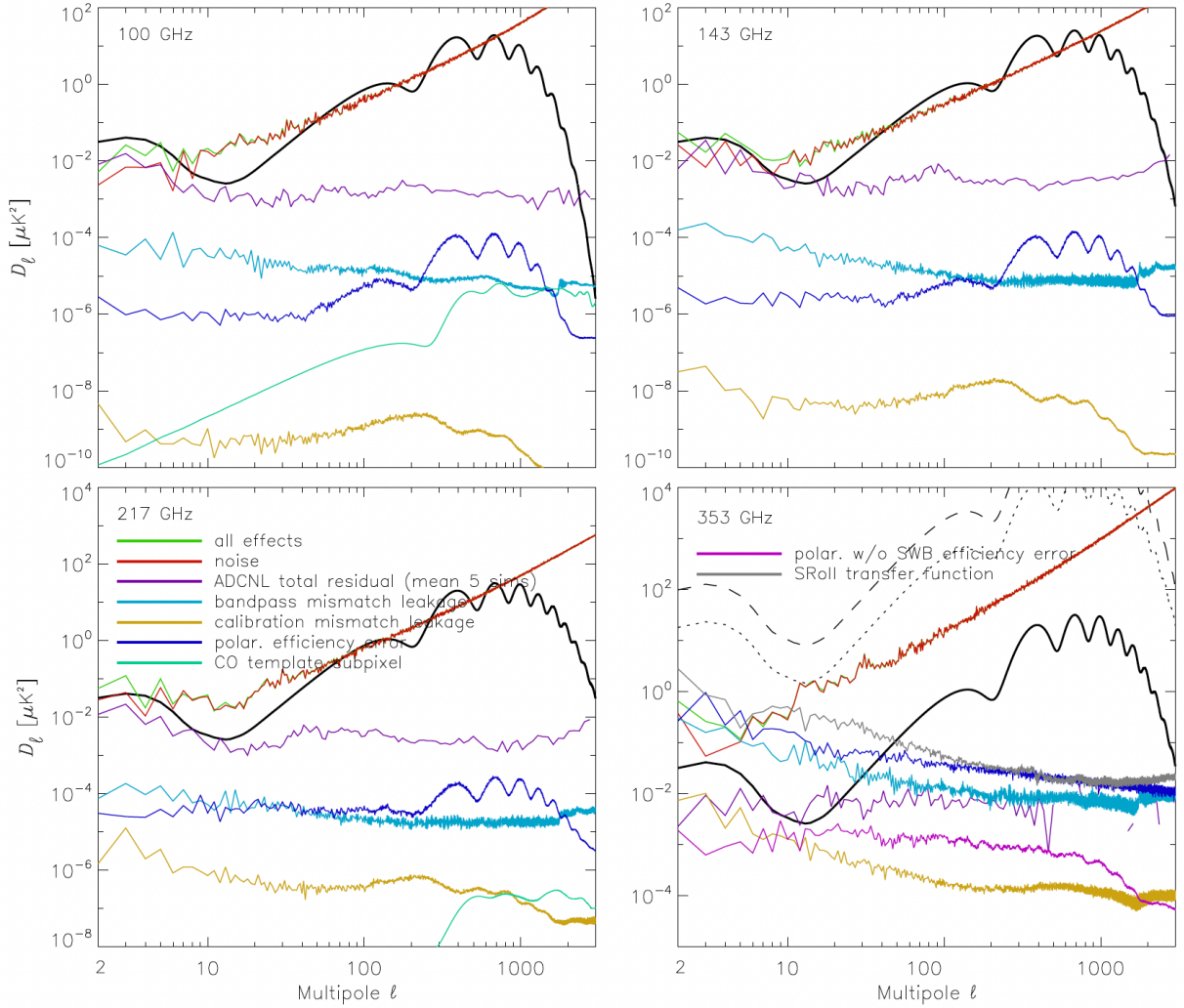


HFI polarisation data progress in 10 years after launch

- Planck HFI polarisation data were not used until the 2015 Results (PR2)
  - Using only data ell > 30 for determination cosmology parameters except τ (reionization parameter) and r (polar to scalar ratio)
  - The main result using intensity or adding polarization was to show that the parameters were fully compatible
- The Planck intermediate paper XVI (2016) reduced the large scale systematic effects in polarization to use the EE reio. peak to measure τ with $6\,\sigma\ (0.055 \pm 0.009)\ 2 < \ell < 10$
  - The Planck 2018 Results (PR3) used the full HFI polarization capability
  - The dust foreground has a steep power spectrum and when removing it at $\ell < 10$
    - systematics at 353 GHz leak into CMB
    - Dust SED errors and/or spatial variations can also leak systematics on CMB spectra at lower freq (see Talk by A. Ritacco)

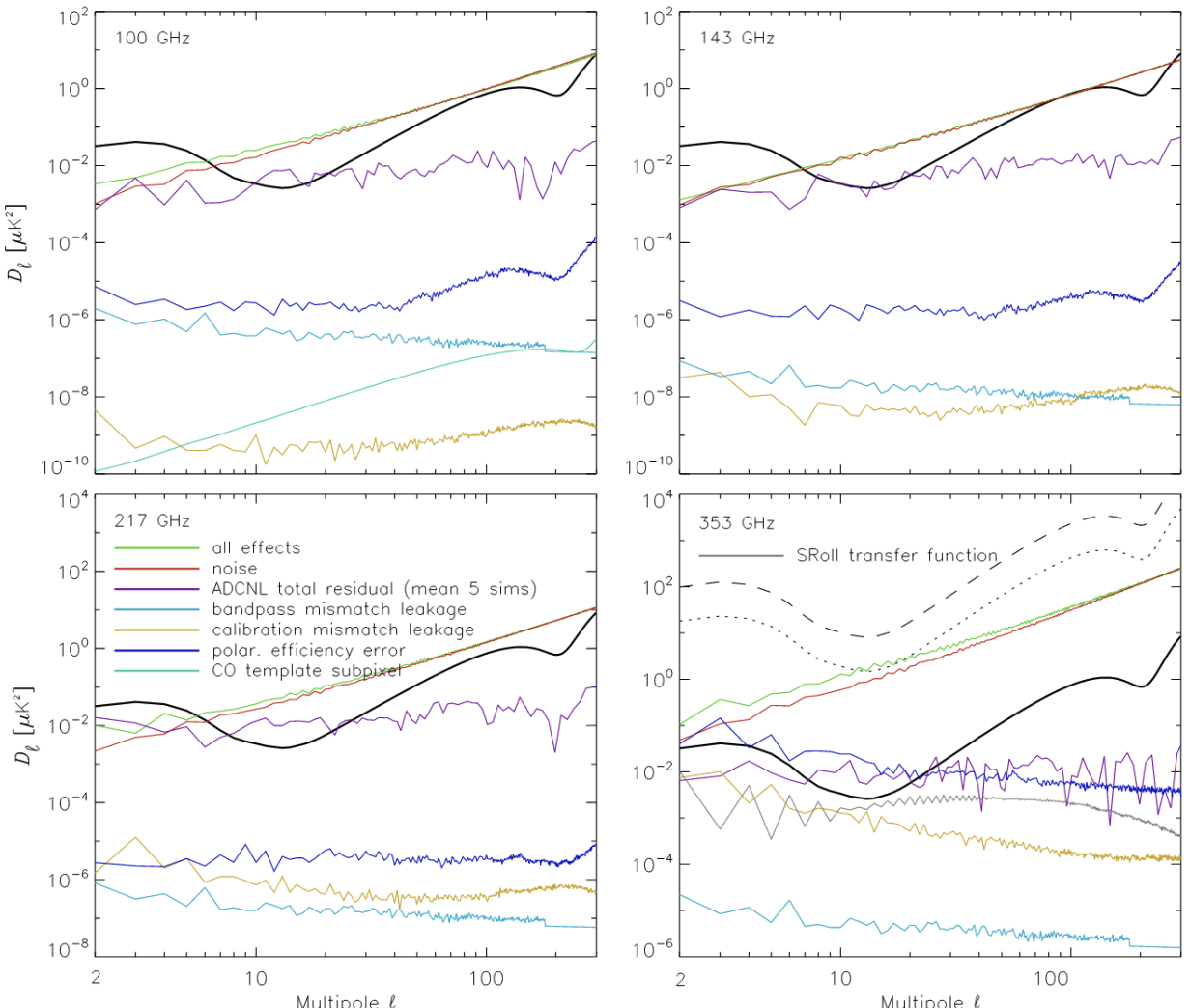
Syste compare PR3 SRoll2

Sroll1 (PR3)



Sroll2 (2019-2020)

J.-M. Delouis et al.: SRoll2: an solution to reduce large scale systematics in the HFI maps



EE Power Spec. ell<30 : τ is cosmic-variance limited sigma (Pagano et al 2020)

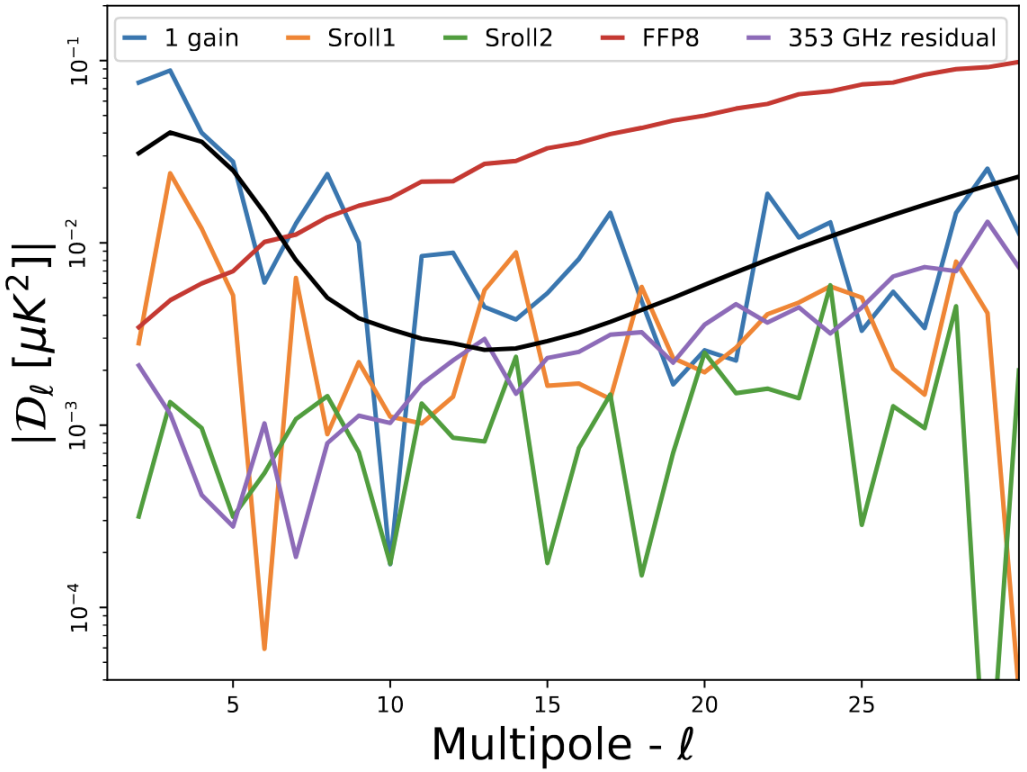


Fig. 3. As Fig. 2 but for the pseudo 100 × 143 cross-spectra. In purple, we plot the auto-spectrum of 353 GHz residual systematic effects rescaled to 100 × 143 (~8×10^{-4} factor applied, ~0.02 from 100 GHz and ~0.04 from 143 GHz). The red line is the square root of the product of 100 and 143 GHz noise spectra that is proportional to the variance associated with the noise in the cross-spectrum. In the SRoll2 maps, the large scale is dominated by signal and $1/f$ noise rather than residual systematic effects.

$\tau = 0.0566\ ^{+0.0053}_{-0.0062}$ (10 % uncertainty)

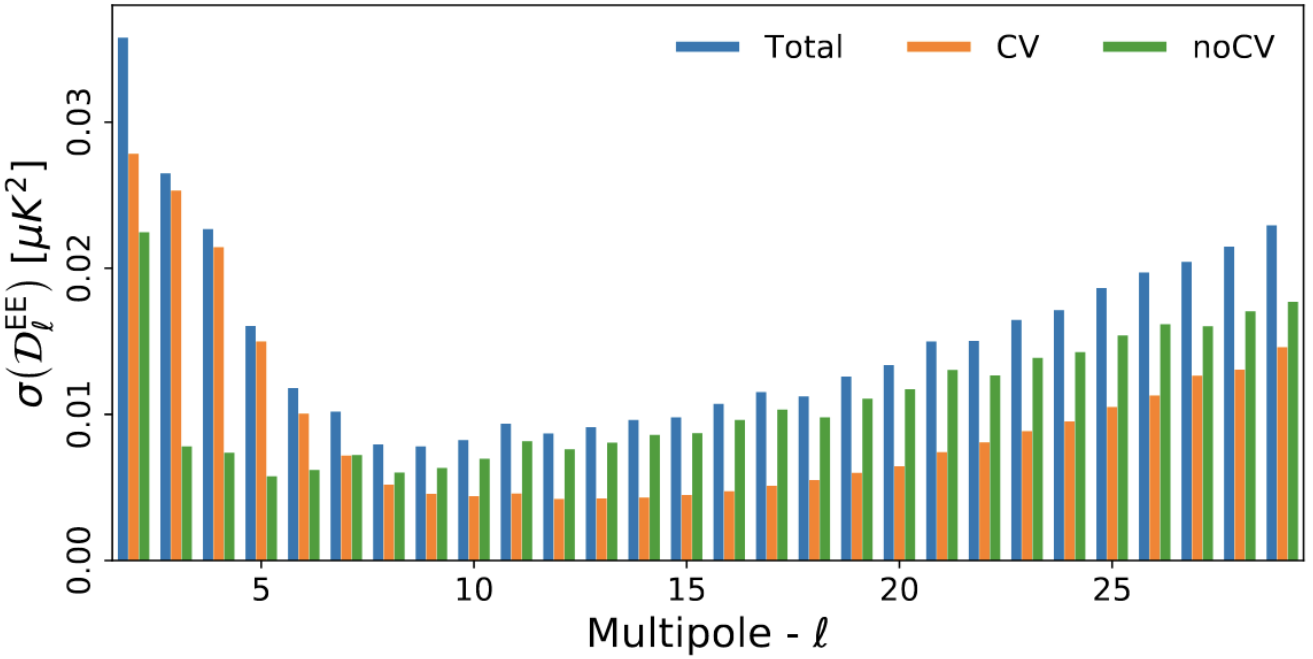


Fig. 10. Error comparison for 100×143 spectrum on 60% of the sky. We show the total error (blue bar), the amount solely due to cosmic variance (orange), and that only due to noise and systematic effects (green). The cosmic variance shown corresponds to $\tau = 0.055$.