HFI data processing: calibration and maps

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Odd even rings null test 2015

- null test showing noise and systematics residual (dominant)
- $+ - 2 \, \mu K$ range for CMB channels
- $+ - 10 \, \mu K$ for 353 GHz
Odd even rings null test 2017

• much lower level of systematics residuals
The 2013 data had strong noise/syste excesses at low $\ell$ in Polarization

- noise limited sensitivity of Planck channels maps limited at 100, 143 and 217 GHz
- Gaussian 1/f noise mostly associated with glitches tails not removed
- strong low $\ell$ excess due to leakages T into E and B
- the problem was more severe in relative terms for HFI than for LFI

December 2012 situation (2013 release)
• EE and BB cross and difference spectra for three different null tests:
  – det set
  – half mission
  – odd-even rings
• 2015 and 2017
Solar system motion w.r.t the CMB induces a strong dipole common to all frequencies when main foregrounds are remove
- direction and amplitude should coincide
- this constrain the SED of the dust foregrounds dipole ad quadrupole
Dipole from Solar system motion

amplitude = 3362.71 ± 0.09 µK (stat. fg.) ± 0.35 µK (gain var.),
GLON = 264°021 ± 0°003,
GLAT = 48°253 ± 0°001.

V_{Sol} = 370.14 ± 0.04 Km/sec

LFI
- 44 GHz  δ A = 0.09 µK
  δ l = 0.003°   δ b = 0.000°
- 70 GHz: δ A = 1.65 µK
  δ l = 0.023°   δ b = 0.012°

\[ V_{Sol} = 370.14 \pm 0.04 \text{ Km/sec} \]
very good agreement between dust bandpass mismatch coefficients from ground measurements and Sroll extraction using a dust spatial template (2015 dust map)
Simulations of accuracy of leakage recovery

- E2E simulation of the leakage recovery for dust and CO at 353 GHz
- Dust show recovery with errors rms $3 \times 10^{-3}$ TBC
- CO show $510^{-3}$
• use of Planck 2015 dust template
• do a component separation → dust template
• then 2nd iteration
Recovery of polarization efficiency

- The recovery is very good for PSBs.
- It is of course much worse for SWBs, which have a small polarization sensitivity.

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Summary of systematic effects

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New paradigm for CMB data processing

• initially destripers remove 1/f noise in intensity from redundant observations of the same pixel by a single detector
• Planck HFI Sroll is a « generalized destriper » which uses redundancy of several polarized detectors at the same frequency (intercalibration of CMB response, bandpass mismatch coefficients using foreground templates, relative polarization efficiency,...)
• we have also tested the extraction from the sky data of foreground templates (CO) and the iterative improvement in a single open loop (dust)
• we are developing the Sroll map maker integrating
  – multi frequency to do the component separation simultaneously
  – multi instruments which will use different technologies to remove systematic effects
Improving Planck HFI 353 GHz

- The Planck 353 GHz is the best all sky dust foreground tracer today
- we improve it by correcting systematic effects at very low \( \ell \)
- for B-modes detection: limitation introduced the dust correction using 353 GHz assumed to be white noise limited