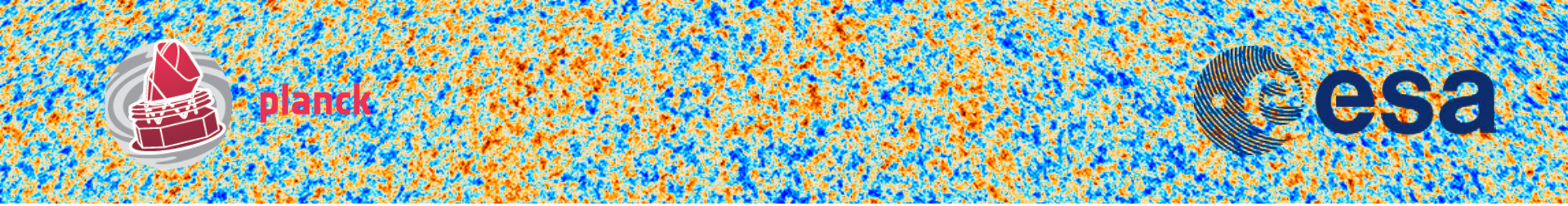
PLANCK 2014

THE MICROWAVE SKY IN TEMPERATURE AND POLARIZATION



The Planck Simulation Challenge: Full Focal Plane 8

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on behalf of the Planck Collaboration

[presented by Julian Borrill]

Purpose & Specification

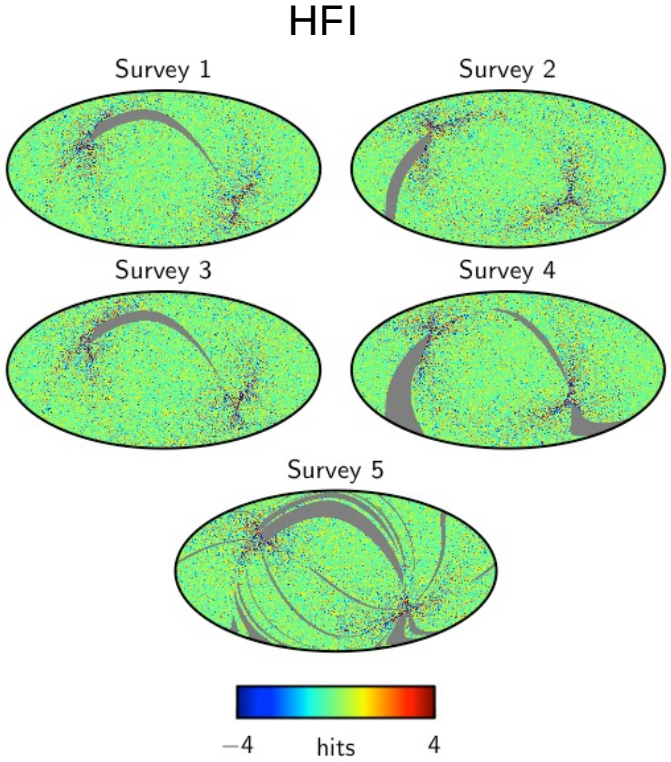
PURPOSE

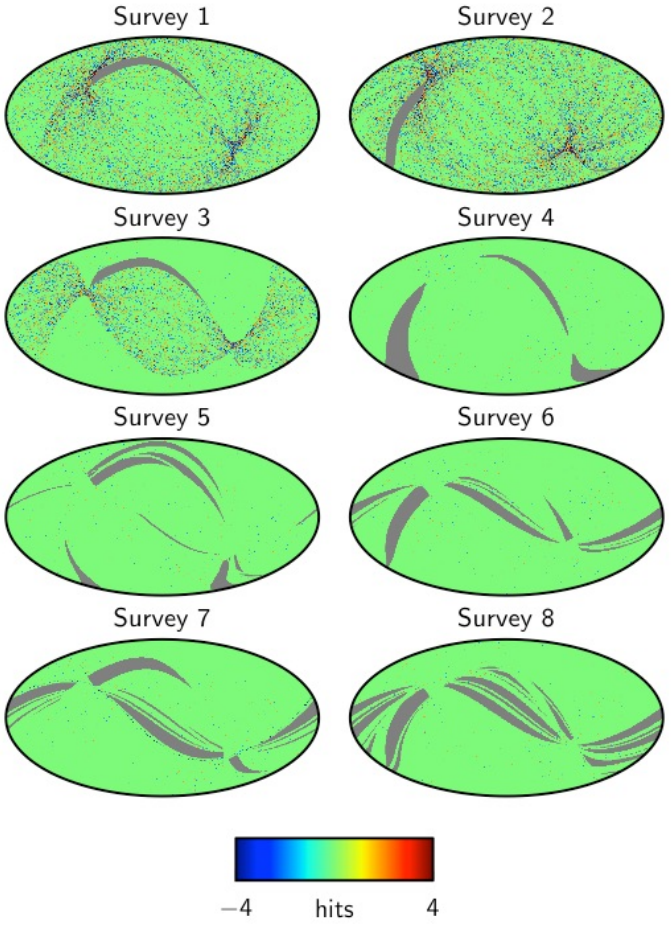
1. Validation & verification: requires accurate fiducial simulation
2. Uncertainty quantification & debiasing: requires massive Monte Carlo

SPECIFICATION

1. Instrument model:
    a. Satellite focal plane, pointing & flags
    b. Detector beams, band-passes & noise
2. Sky model:
    a. Foregrounds
    b. CMB
3. Processing:
    a. Replication of *both* DPC's map-making
    b. At massive scale

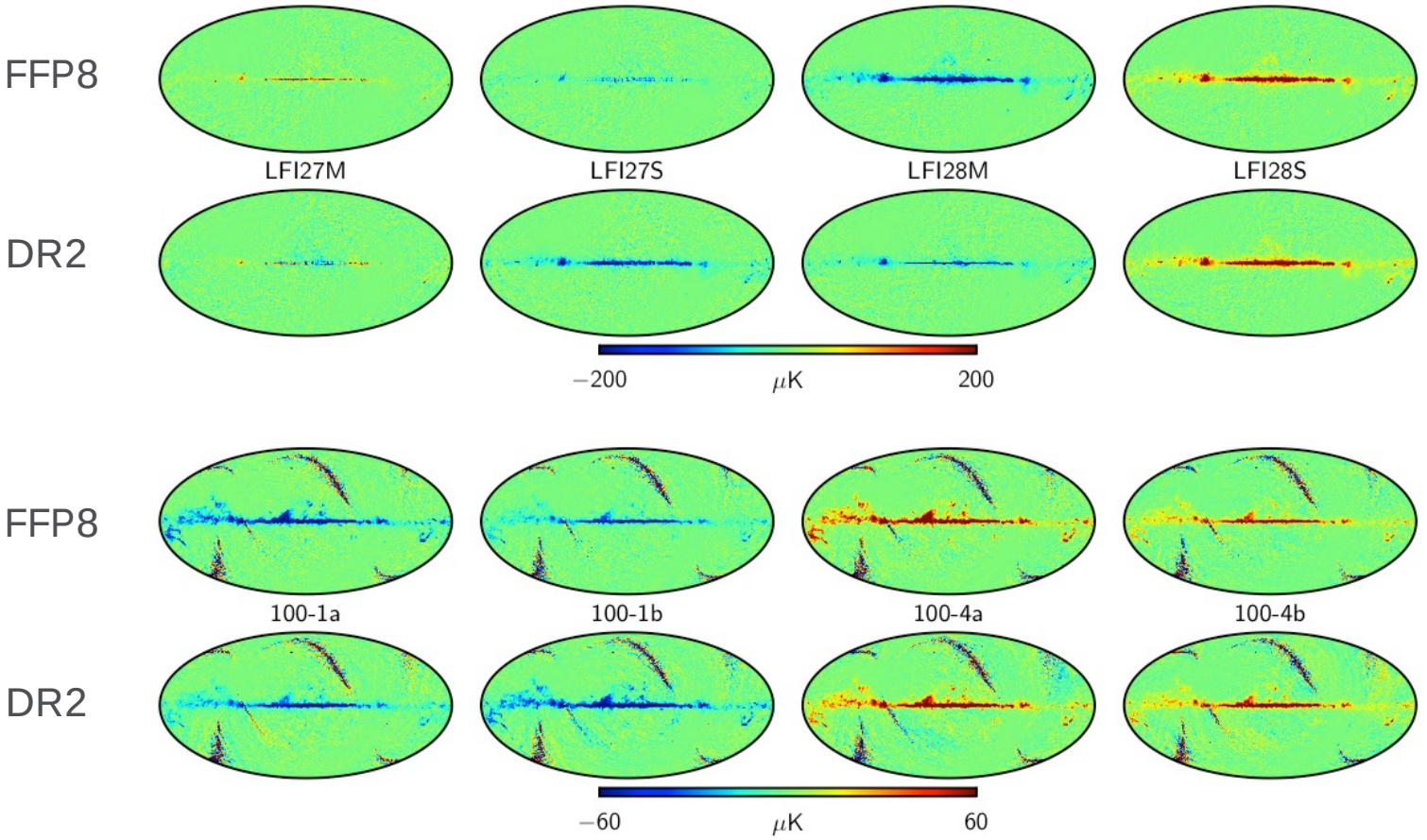
Focal Plane, Pointing & Flags: TOAST vs DPC Hit Maps





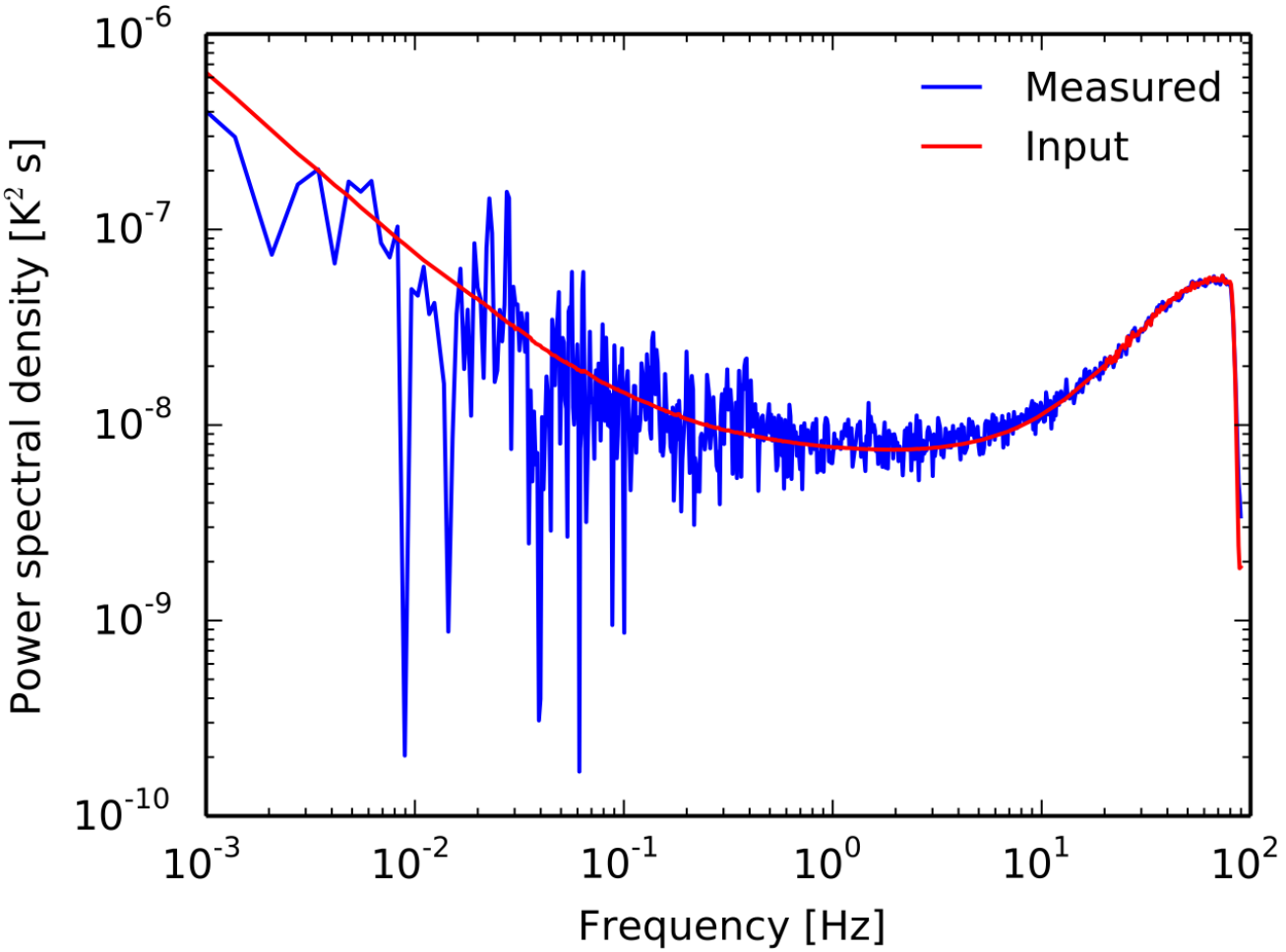
Overall discrepancy in hits: $\Delta T/T \sim 10^{-8}$

Bandpasses: Spurious Component Maps



Noise Estimation

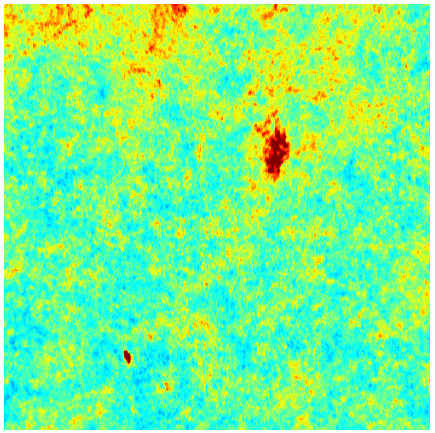
1. Subtract map from time-stream
2. Estimate noise per pointing period
3. Average noise PSD estimates per day



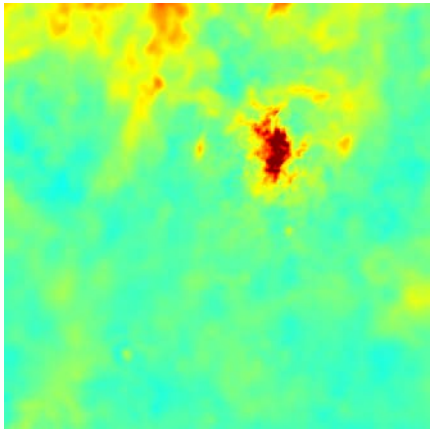
Foregrounds: Planck Sky Model

Improved 10-component model:

1. CO lines
2. Cosmic Infrared Background
3. Free-free
4. Point Sources (Infrared)
5. Point Sources (Radio)
6. Spinning dust
7. Sunyaev-Zel'dovich (Kinetic)
8. Sunyaev-Zel'dovich (Thermal)
9. Synchrotron
10. Thermal dust

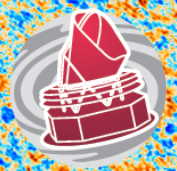


DR1



DR2

Cosmic Microwave Background: Scalar, Tensor & Non-Gaussian



- Start with the Planck 2013 cosmology
- Construct 3 components of CMB sky
    1. Scalar CMB
        a) Lensed
        b) Rayleigh-scattered
        c) Doppler-boosted

    } frequency-dependent

    2. Tensor CMB
    3. Non-Gaussian CMB
- Construct total CMB skies for various (r, f_{NL})

$$CMB = CMB_S + \sqrt{r}\, CMB_T + f_{NL}\, CMB_{NG}$$

FFP8 Fiducial Realization

Changes from DR1/FFP6:

1. Beamskyset never written to disk
2. TOD injected into flagged EF files
3. Mission-baseline destriping (HFI)

1,134 data combinations:

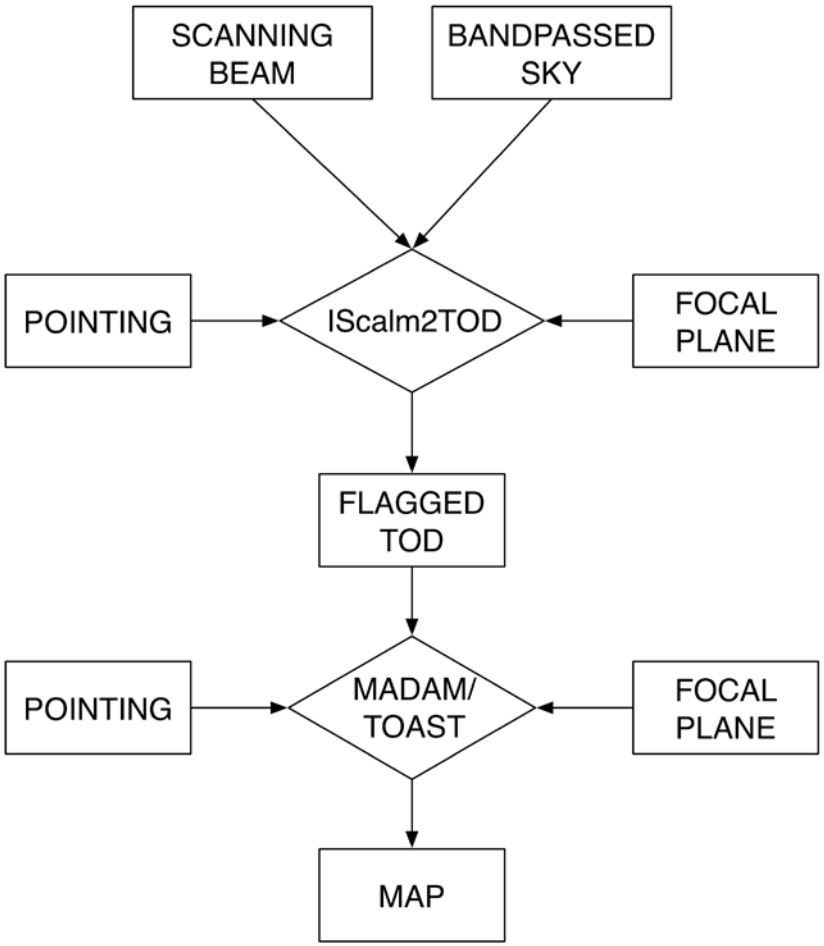
1. Frequency channel & detset
2. Mission, half-mission, year & survey
3. Full & half-ring

16 map flavours:

1. 3 x CMB + 2 x Foreground + Noise
2. 10 x total: (5 x [r, f_{NL}]) x (2 x FG)

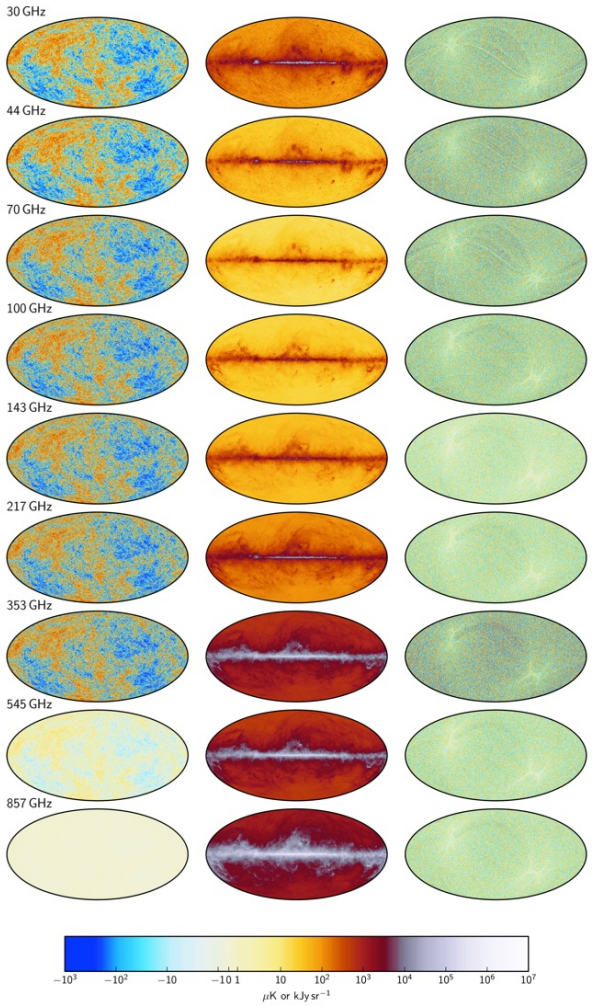
18,144 maps

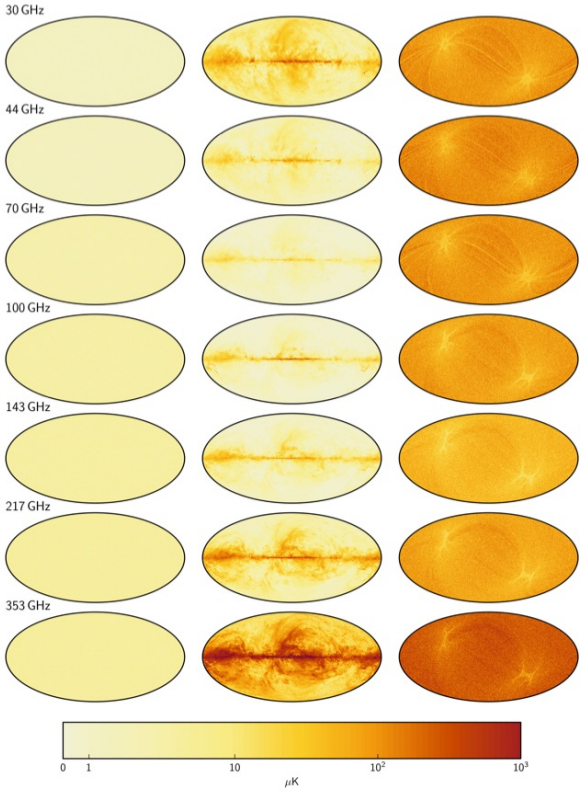
250K NERSC CPU-hours



Scalar CMB, Foreground & Noise Maps

Temperature

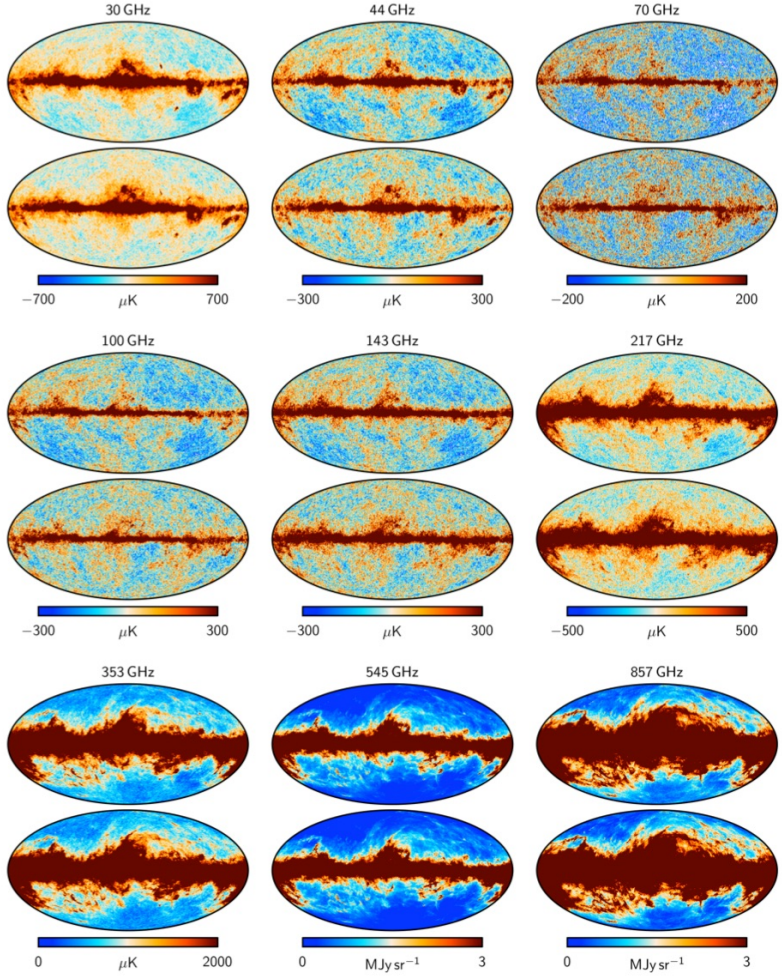




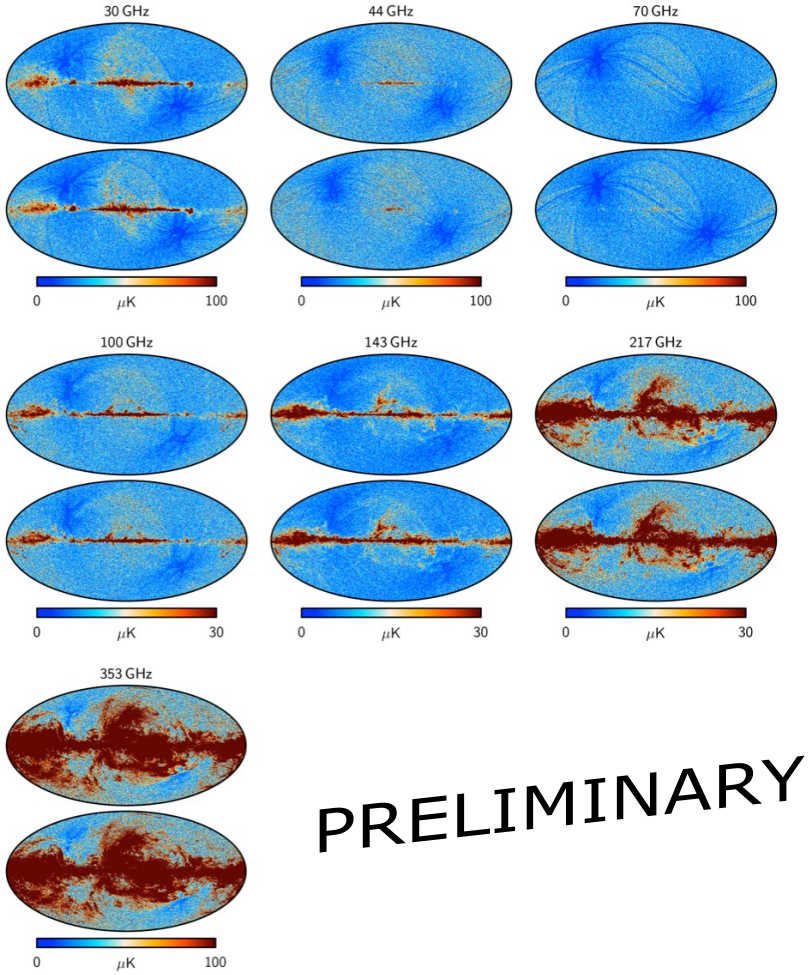
Polarization

Comparison With Real Data

Temperature



Polarization



PRELIMINARY

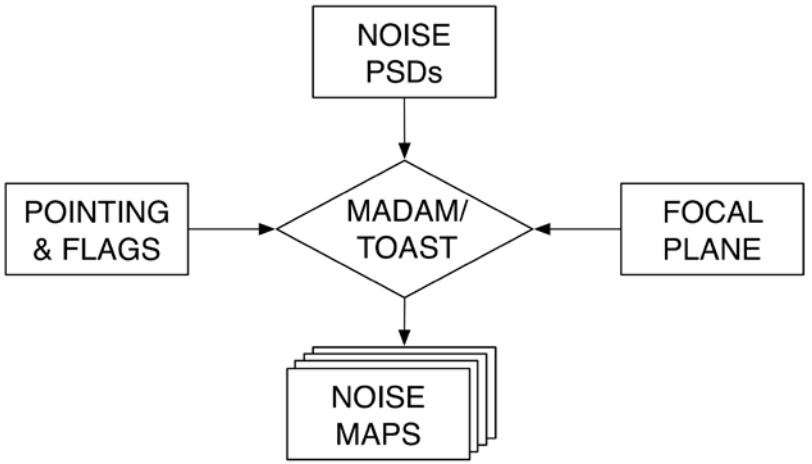
Noise Monte Carlos

Changes from FFP6/DR1:

1. 10x MC set size.
2. 10x map types.
3. Mission baseline destriping.

FFP8 contains:

1. 10^4 mission channel full maps
2. 10^3 other full maps
3. 10^2 half-ring maps.



671,400 maps

12M NERSC/CSC CPU-hours

(10K maps/hour)

CMB Monte Carlos

Changes from FFP6/DR1:

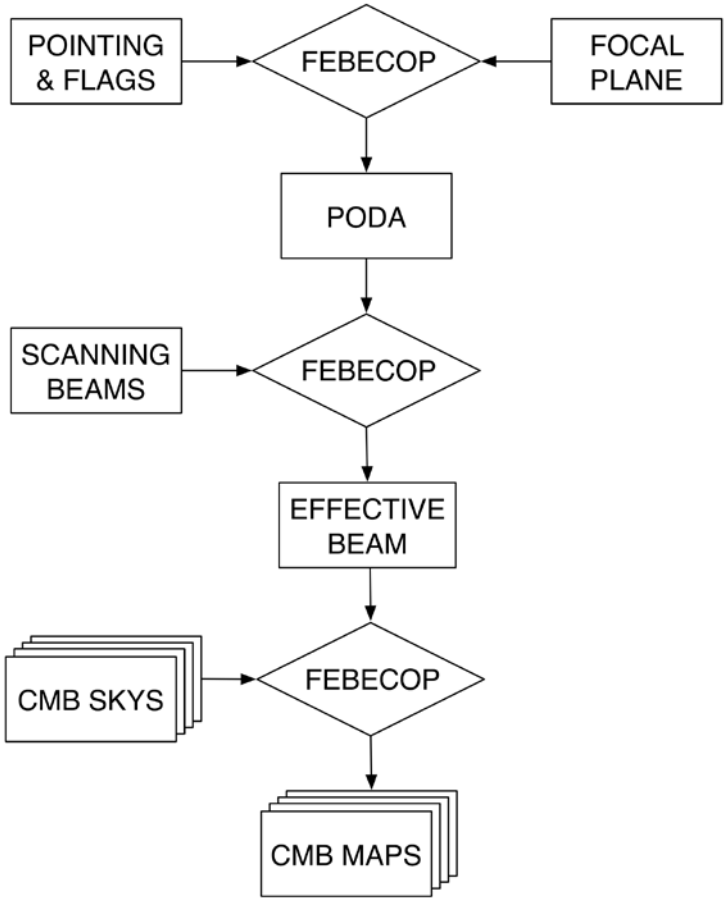
1. 10x MC set size.
2. Polarization.
3. Much larger effective beams.
4. Transition to MC-limited.

FFP8 contains:

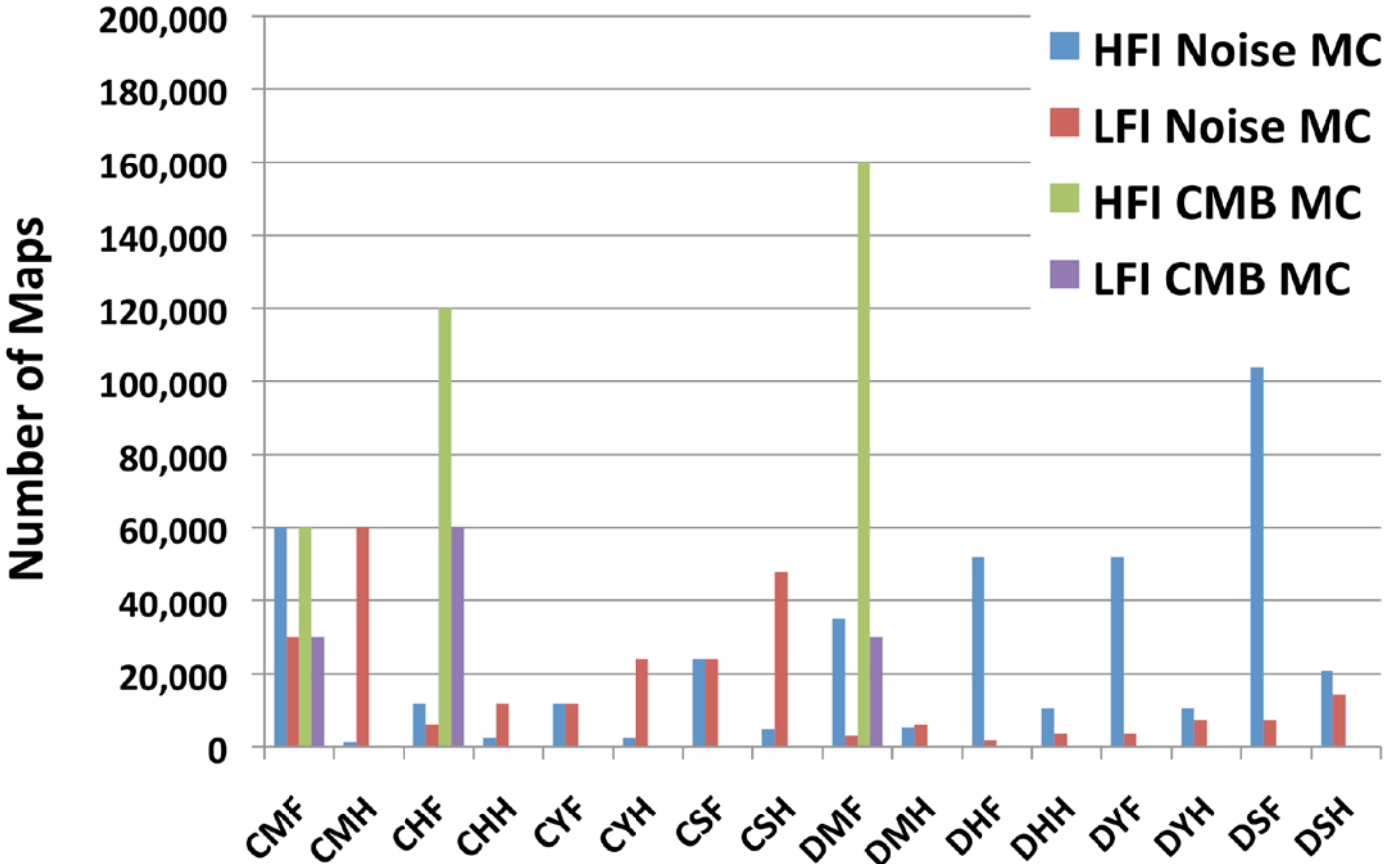
1. 10^4 mission channel full maps
2. 10^4 half-mission channel full maps
3. 10^4 mission (some) detset full maps

460,000 maps

8M NERSC CPU-hours

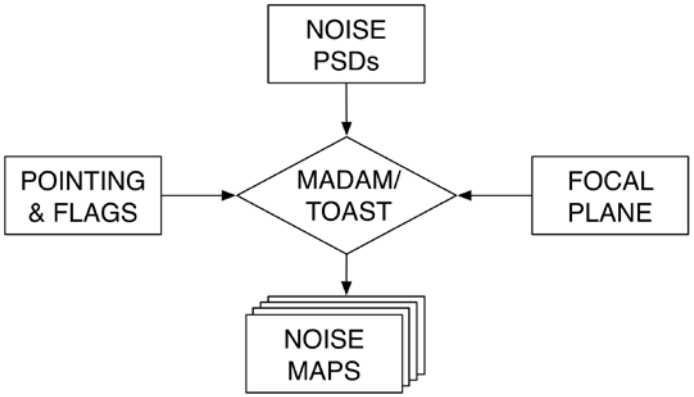


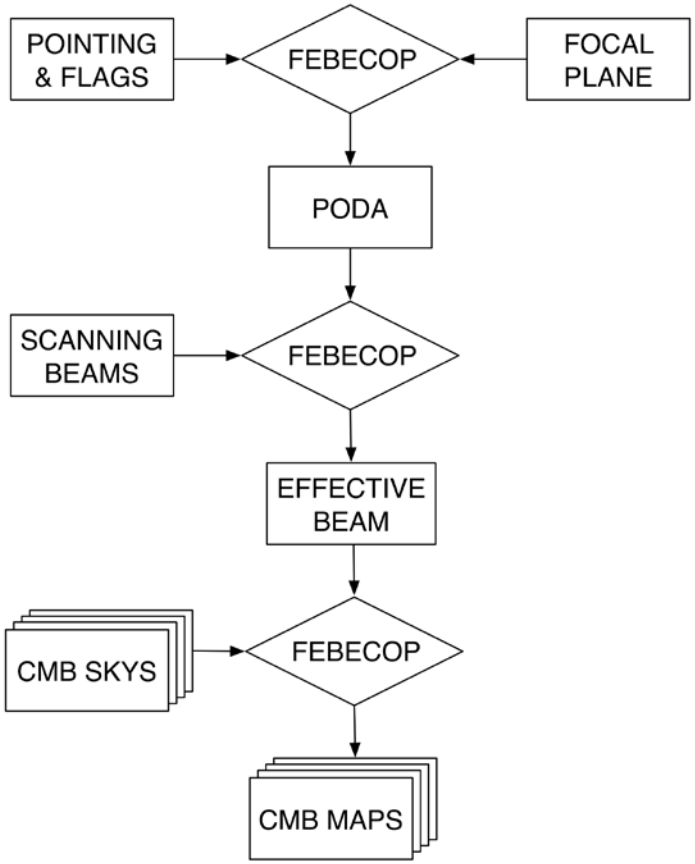
MC Map Counts



Channel/**D**etset; **M**ission/**H**alf-Mission/**Y**ear/**S**urvey; **F**ull/**H**alf-Ring

High Performance Computing Considerations



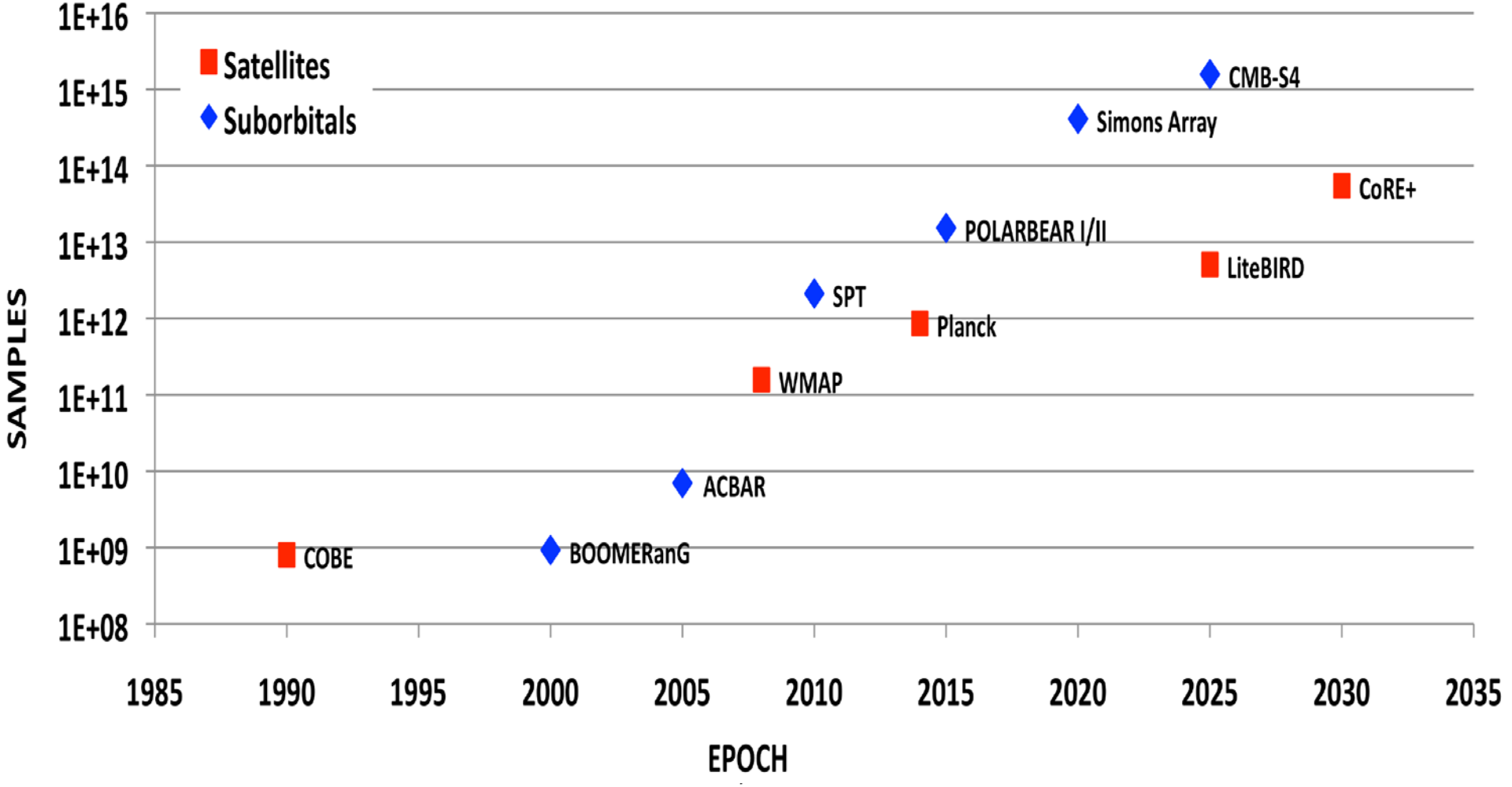


1. Minimize I/O.
2. Optimize communication.
    a. Data distribution
    b. Hybridization
3. Use an appropriate language.

Example uses Of FFP8 In DR2

1. Fiducial maps
    a. Validate & verify analysis codes
    b. Quantify uncertainties in
        – Component separation
        – Lensing reconstruction
        – Catalog construction
2. Noise MCs
    a. Validate pixel-pixel covariance matrices
3. CMB MCs
    a. Estimate TT/EE beam transfer functions
4. All MCs
    a. Combine across frequency according to component separation prescription(s) & use for statistical tests of CMB sky.

Community Access To FFP8 & Future Plans




Thank you

The scientific results that we present today are a product of the Planck Collaboration, including individuals from more than 100 scientific institutes in Europe, the USA and Canada.

Planck is a project of the European Space Agency, with instruments provided by two scientific Consortia funded by ESA member states (in particular the lead countries: France and Italy) with contributions from NASA (USA), and telescope reflectors provided in a collaboration between ESA and a scientific Consortium led and funded by Denmark.