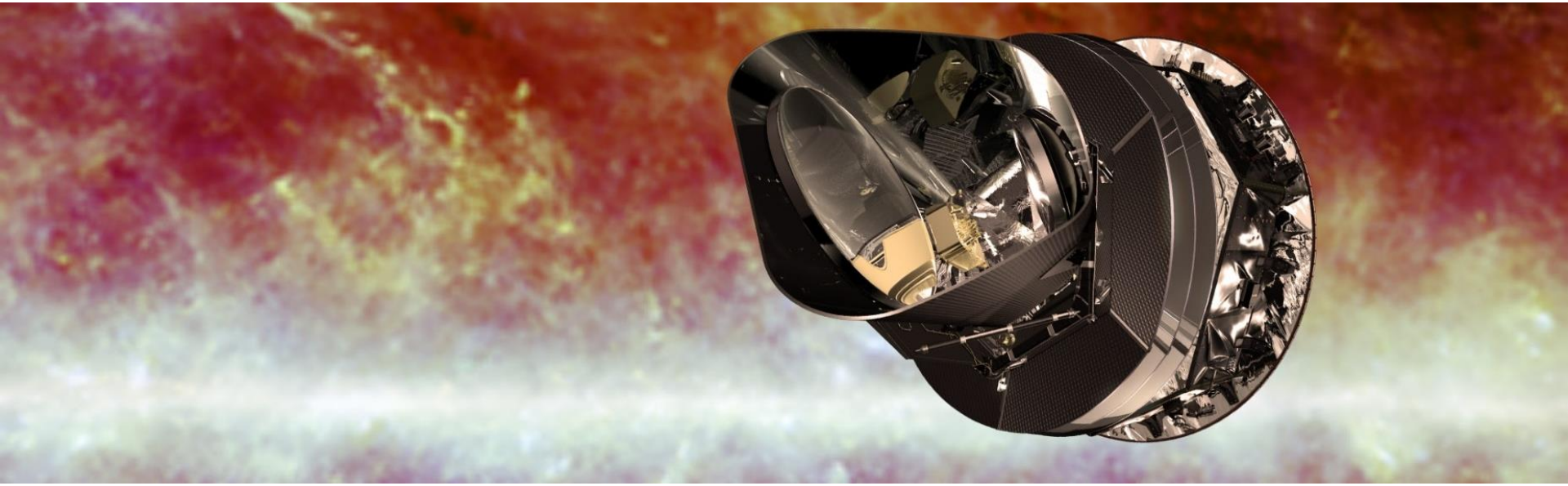
RF Optical expertise @ OAS BO

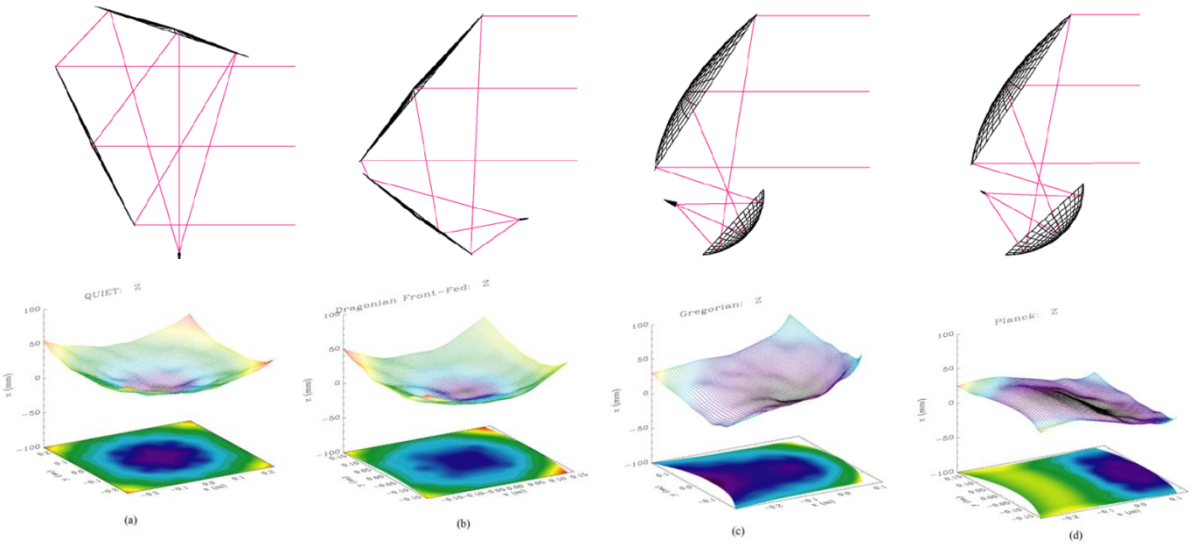
- **People**: Francesco Cuttaia, Maura Sandri, Fabrizio Villa
- **Projects**: Planck, LSPE/STRIP, CORE, ALMA, SRT, LiteBird
- **Software**: GRASP, HFSS, CST, SRSR
- Microwave and Radio



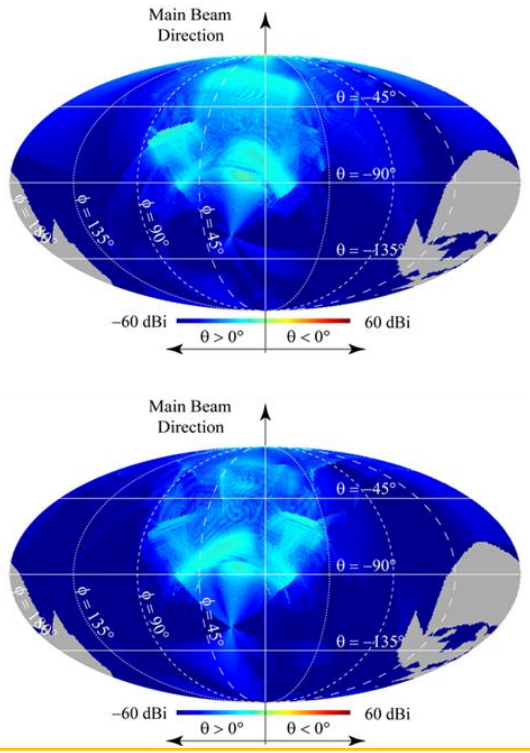
RF Optical expertise @ OAS BO

- Focal surface evaluation
- Main beams and sidelobe simulations (20 years of expertise with GRASP)
- Straylight evaluation (Planck case)
- Optical tuning (in-flight tuning of the Planck LFI main beams)
- In-flight measurements of the telescope emissivity
- Near field evaluation
- Calibration targets design

Focal Surface Evaluation

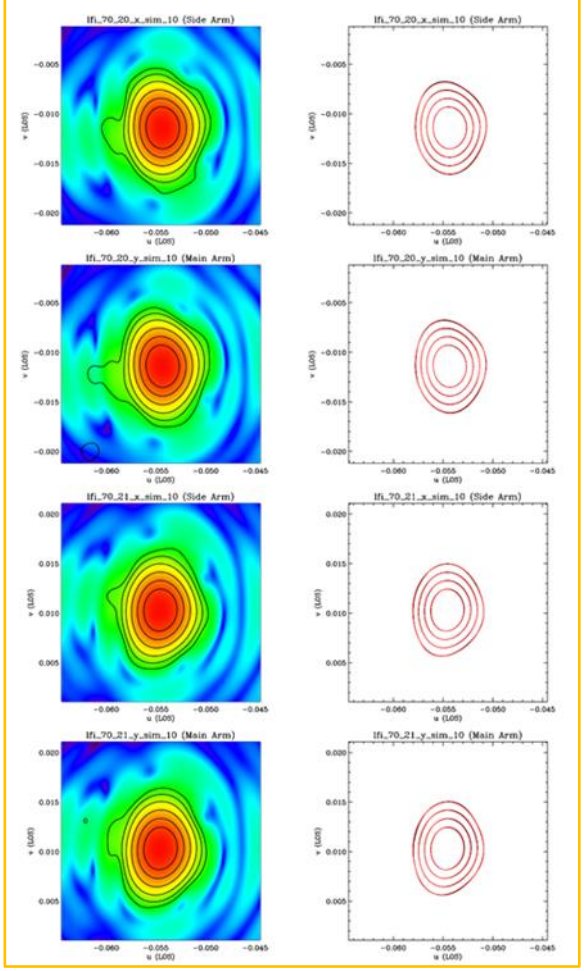


Sidelobe Simulations

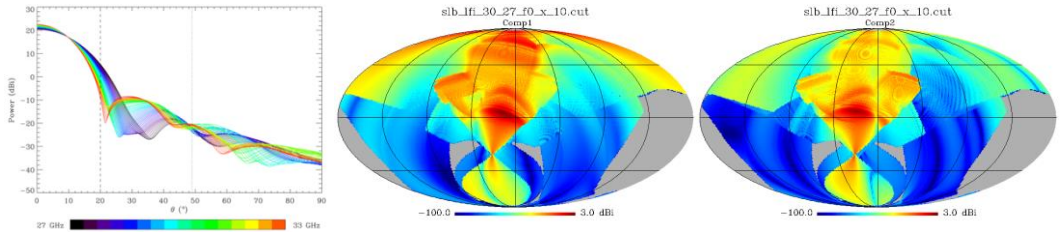


RF Optical expertise @ OAS BO

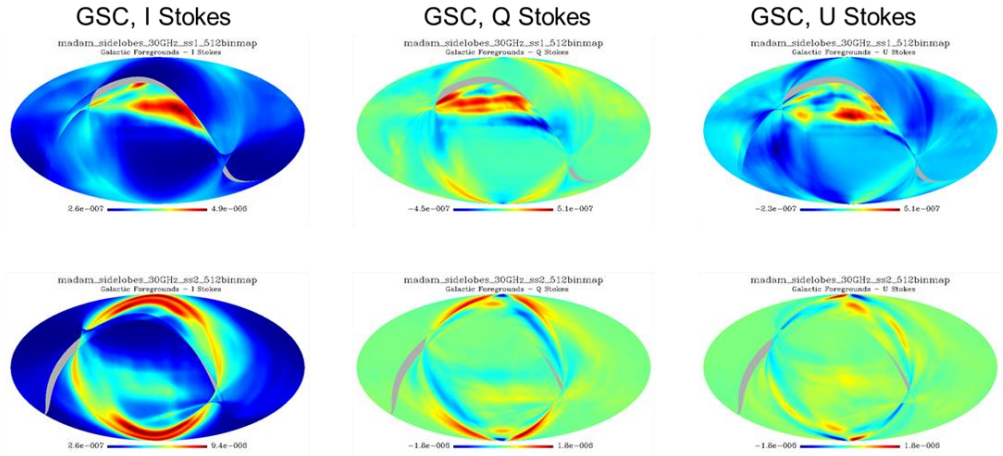
MB Simulations and Measurements with Planets



Beams Across the Band



Galactic Straylight Evaluation



RF OPTICAL EXPERTISE @ OAS BO

Astronomy & Astrophysics manuscript no. "Planck Telescope 2017"
December 7, 2018

Characterization of the in-flight properties of the *Planck* telescope

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(Affiliations can be found after the references)

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ABSTRACT

The European Space Agency's *Planck* satellite was launched on 14 May 2009, and surveyed the sky stably and continuously between August 2009 and October 2013. The scientific analysis of the *Planck* data requires understanding the optical response of its detectors, which originates partly from a physical model of the optical system. In this paper, we use in-flight measurements of planets within ~1°of boresight to estimate the geometrical properties of the telescope and focal plane. First, we use observed grating lobes to measure the amplitude of mechanical dimpling of the reflectors, which is caused by the hexagonal honeycomb structure of the carbon fibre reflectors. We find that the dimpling amplitude on the two reflectors is larger than expected from the ground, by 20% on the secondary and at least a factor of 2 on the primary. Second, we use the main beam shapes of 26 detectors to investigate the alignment of the various elements of the optical system, as well as the large-scale deformations of the reflectors. We develop a metric to guide an iterative fitting scheme, and are able to determine a new geometric model that fits the in-flight measurements better than the pre-flight prediction according to this metric. The new alignment model is within the mechanical tolerances expected from the ground, with some specific but minor exceptions. We find that the reflectors contain large-scale sinusoidal deformations most probably related to the mechanical supports. In spite of the better overall fit, the new model still does not fit the beam measurements at a level compatible with the needs of cosmological analysis. Nonetheless, future analysis of the *Planck* data would benefit from taking into account some of the features of the new model. The analysis described here exemplifies some of the limitations of in-flight retrieval of the geometry of an optical system similar to that of *Planck*, and provides useful information for similar efforts in future experiments.

Key words. Cosmology: observations – Cosmic background radiation – Surveys – Space vehicles: instruments – Instrumentation: detectors

RF OPTICAL EXPERTISE @ OAS BO

Experimental Astronomy
https://doi.org/10.1007/s10686-018-9616-z
ORIGINAL ARTICLE

In-flight measurement of Planck telescope emissivity

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Abstract

The Planck satellite in orbit mission ended in October 2013. Between the end of Low Frequency Instrument (LFI) routine mission operations and the satellite decommissioning, a dedicated test was also performed to measure the Planck telescope emissivity. The scope of the test was twofold: i) to provide, for the first time in flight, a direct measure of the telescope emissivity; and ii) to evaluate the possible degradation of the emissivity by comparing data taken in flight at the end of mission with those taken during the ground telescope characterization. The emissivity was determined by heating the Planck telescope and disentangling the system temperature excess measured by the LFI radiometers. Results show End of Life (EOL) performance in good agreement with the results from the ground optical tests and from *in-flight* indirect estimations measured during the Commissioning and Performance Verification (CPV) phase. Methods and results are presented and discussed.