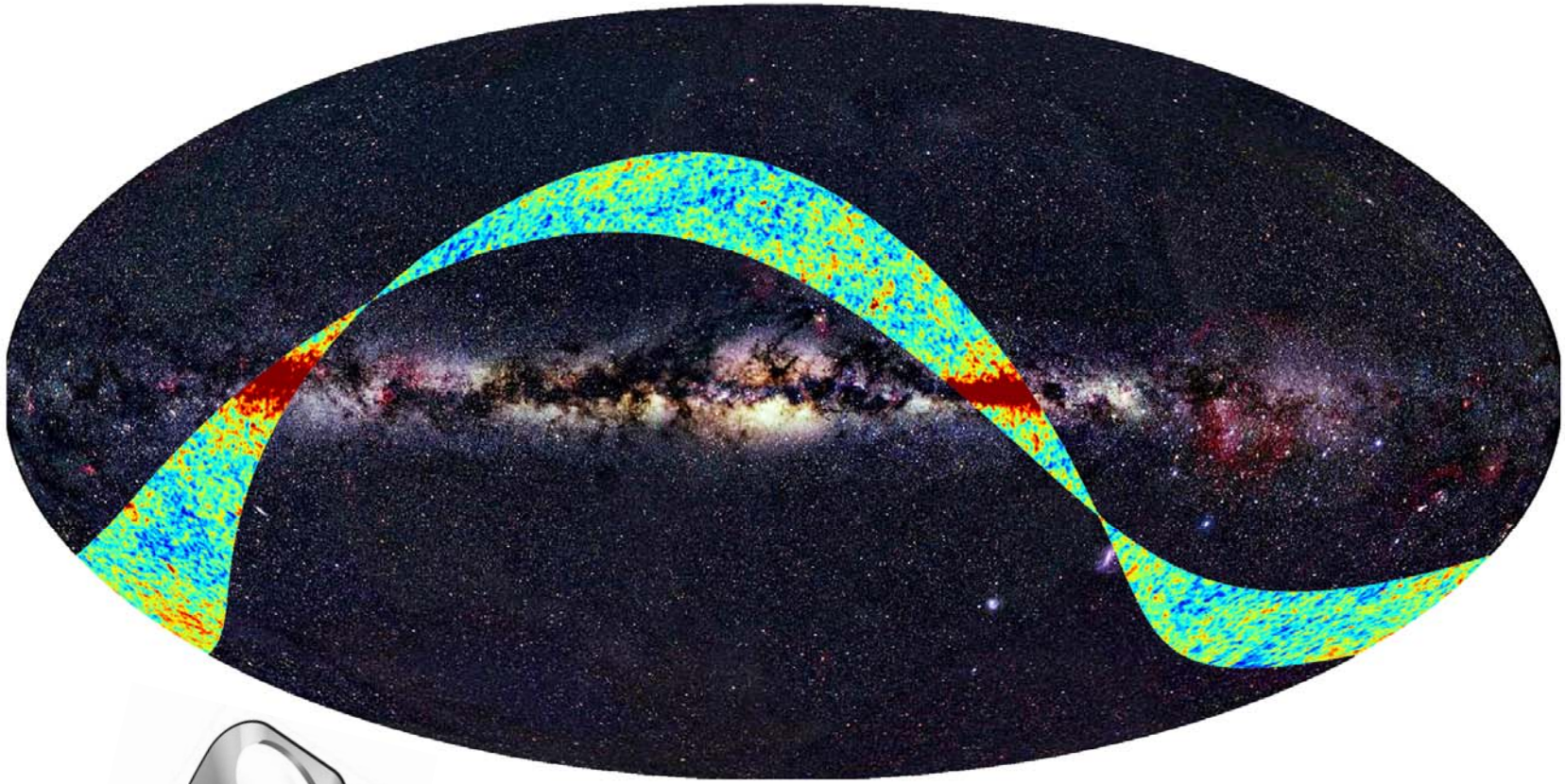


Planck Mission Status

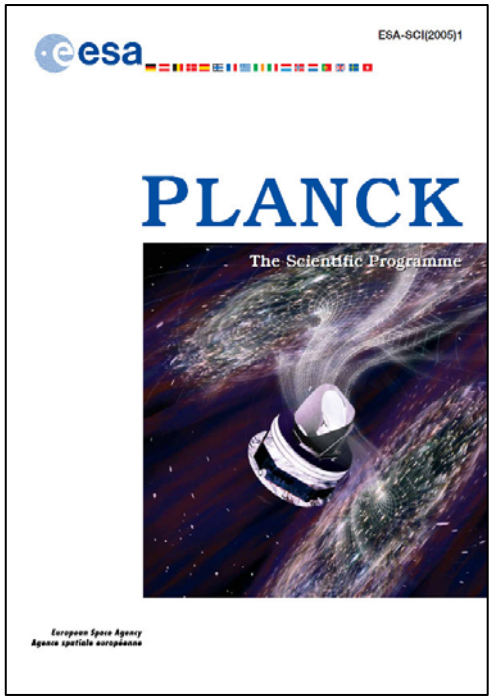
René Laureijs
ESA/ESTEC

Presentation Overview

- Scientific and Observational Objectives
- Mission Overview
- Present Status
- Prospects for Euclid

Caveat: In this presentation I give no information about the (first) observational results. Information cannot be released outside the consortium members who signed the data rights agreement

Reading: Planck blue book



Primary Scientific Objectives

- All-sky CMB anisotropy maps to an accuracy $\Delta T \sim 5 \mu K$, on angular scales larger than 5 arcminutes
- All-sky CMB polarisation maps (I, U, Q)
- Cosmological parameters, H_o, Ω_o, Ω_b, ... to a precision of a few percent
- Tests of inflationary models of the early Universe
- Search for non-gaussianity/topological defects
- Initial conditions for formation of large-scale structure
- Nature of dark matter

Power spectrum recovery by WMAP and Planck

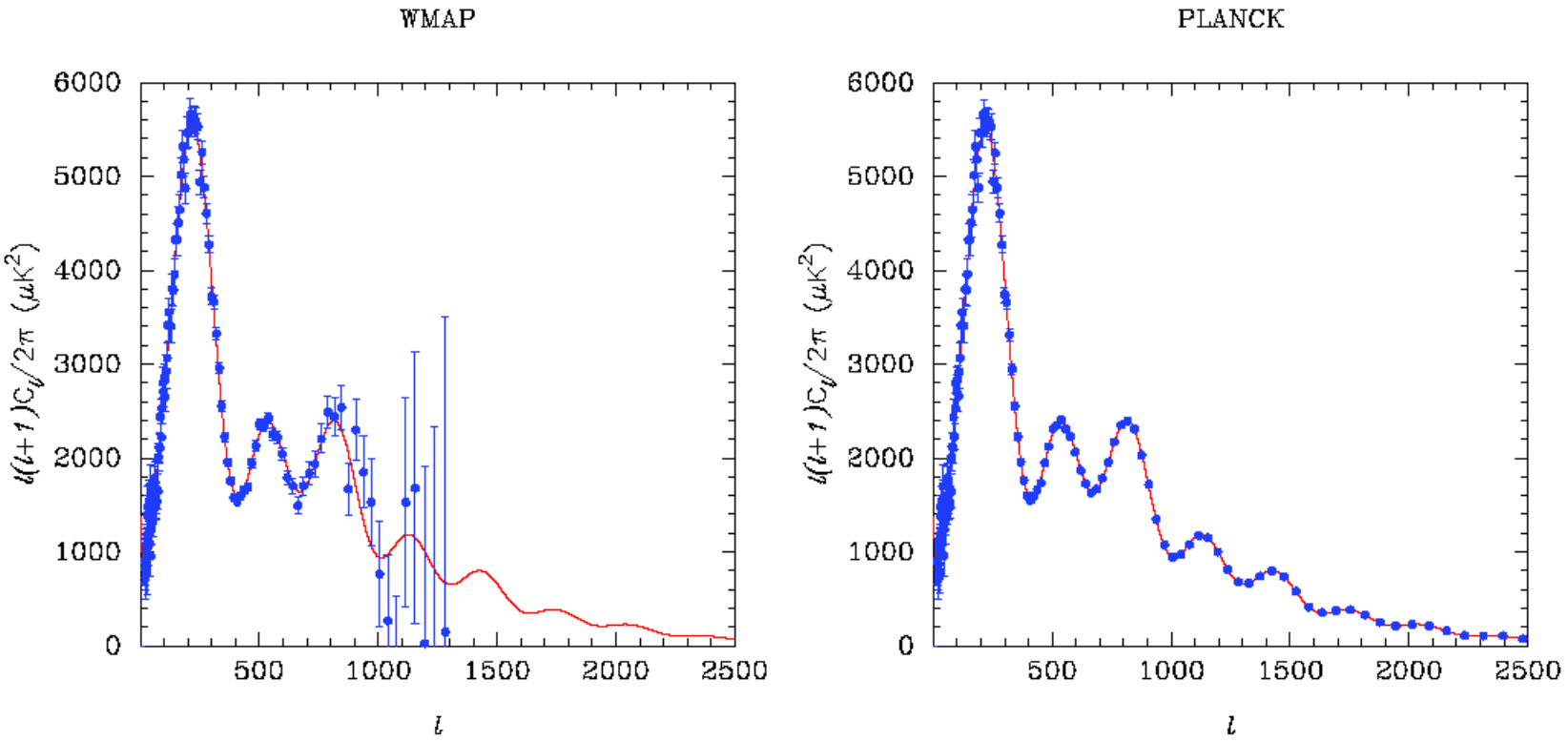
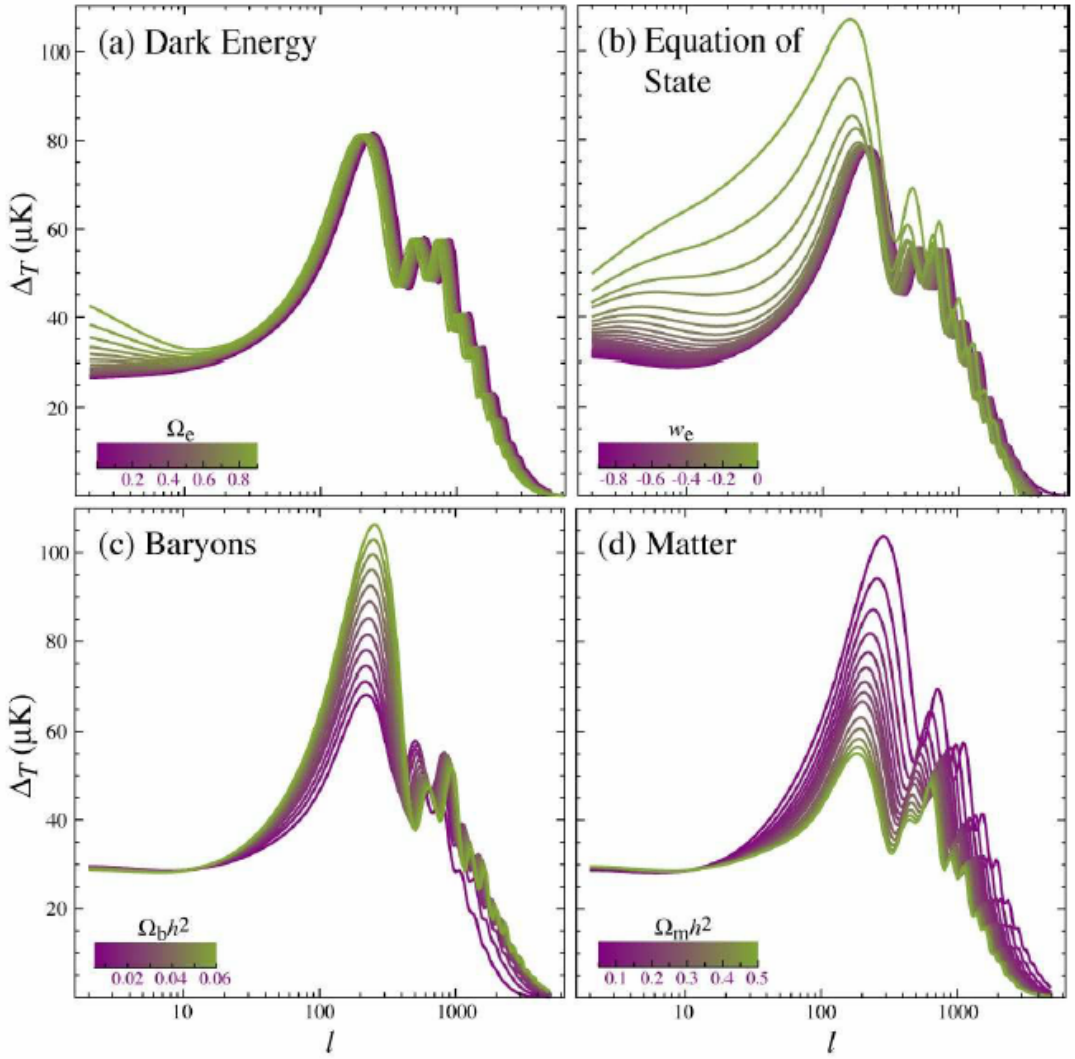


FIG 2.8.—The left panel shows a realisation of the CMB power spectrum of the concordance ΛCDM model (red line) after 4 years of *WMAP* observations. The right panel shows the same realisation observed with the sensitivity and angular resolution of *Planck*.

Power spectrum analysis



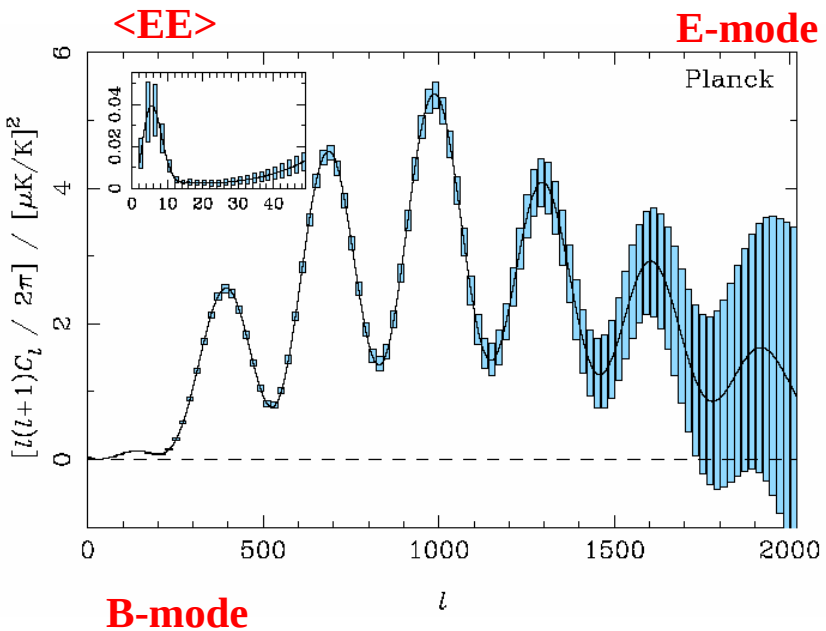
The shape of the power spectrum depends sensitively on the value of cosmological parameters

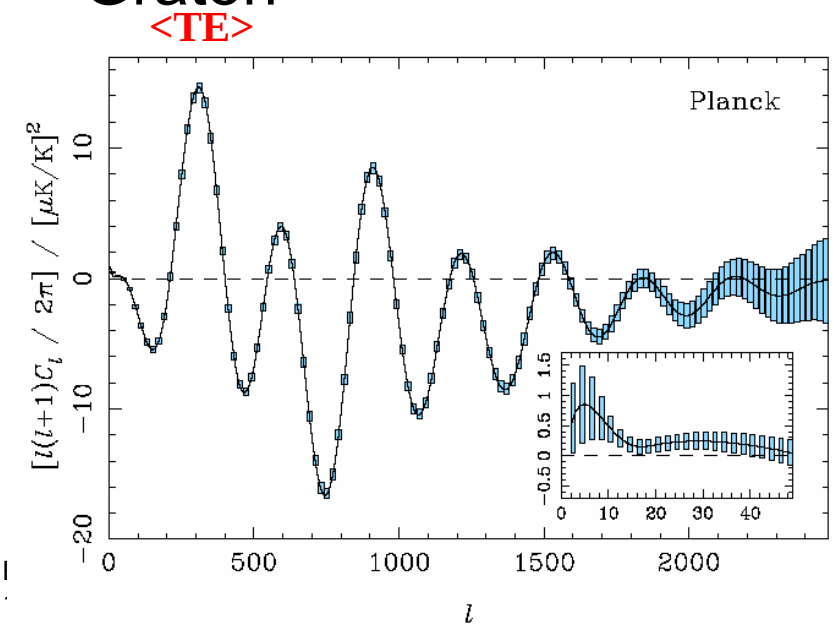
Polarisation

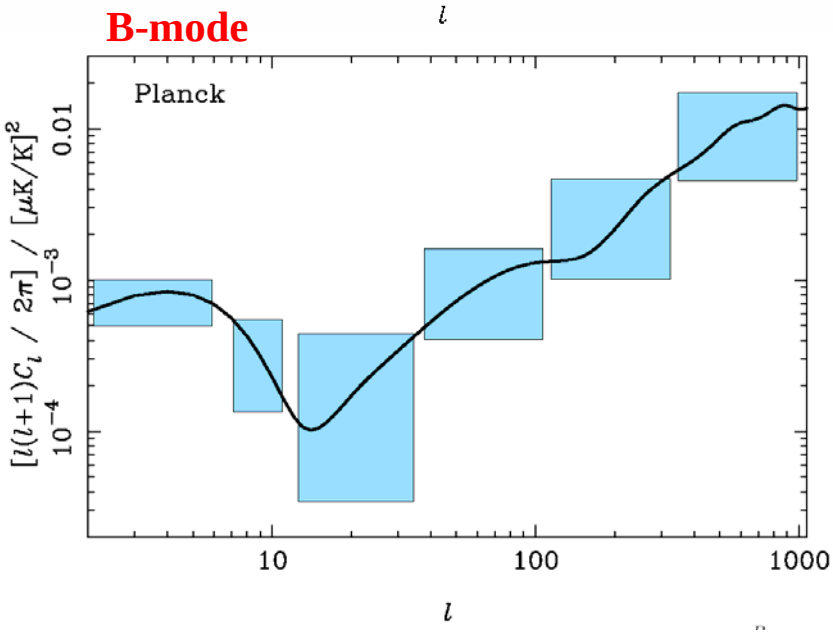
Expected power spectrum recovery involving polarisation

Model params: tau=1.7

See also Efstathiou & Graton







Non-CMB Science Objectives

- Detection of Sunyaev-Zeldovich effect in thousands of rich clusters of galaxies
  - Measurement in a few thousand clusters
  - Cosmological evolution of clusters to z ~ 1
- Extragalactic sources (>10000) and backgrounds
  - IR and radio galaxies
  - AGN's, QSO's, blazars
  - Evolution of galaxy counts to z > 1
  - Far-IR background fluctuations
- Maps of the Galaxy at frequencies 30 – 1000 GHz

Observational Objectives

- Temperature sensitivity (per pixel) of $\Delta T/T \sim 10^{-6}$ based on state-of-the-art detectors
  - Planets for beam calibration
- Ability to measure polarisation (Stokes I, Q, U) in the CMB bands, with “reasonable” cross-polar characteristics
  - Crab Nebula as prime polarisation source
- 1.5 metre aperture telescope to provide ~5’ resolution for the CMB
- Extreme attention to systematic effects:
  - wide frequency coverage (25 - 950 GHz for temperature and 25 - 400 GHz for polarisation)
  - Far-Earth orbit
  - Redundancy built in at many time-scales, from one minute to half-year

Sky emission components and Planck channels

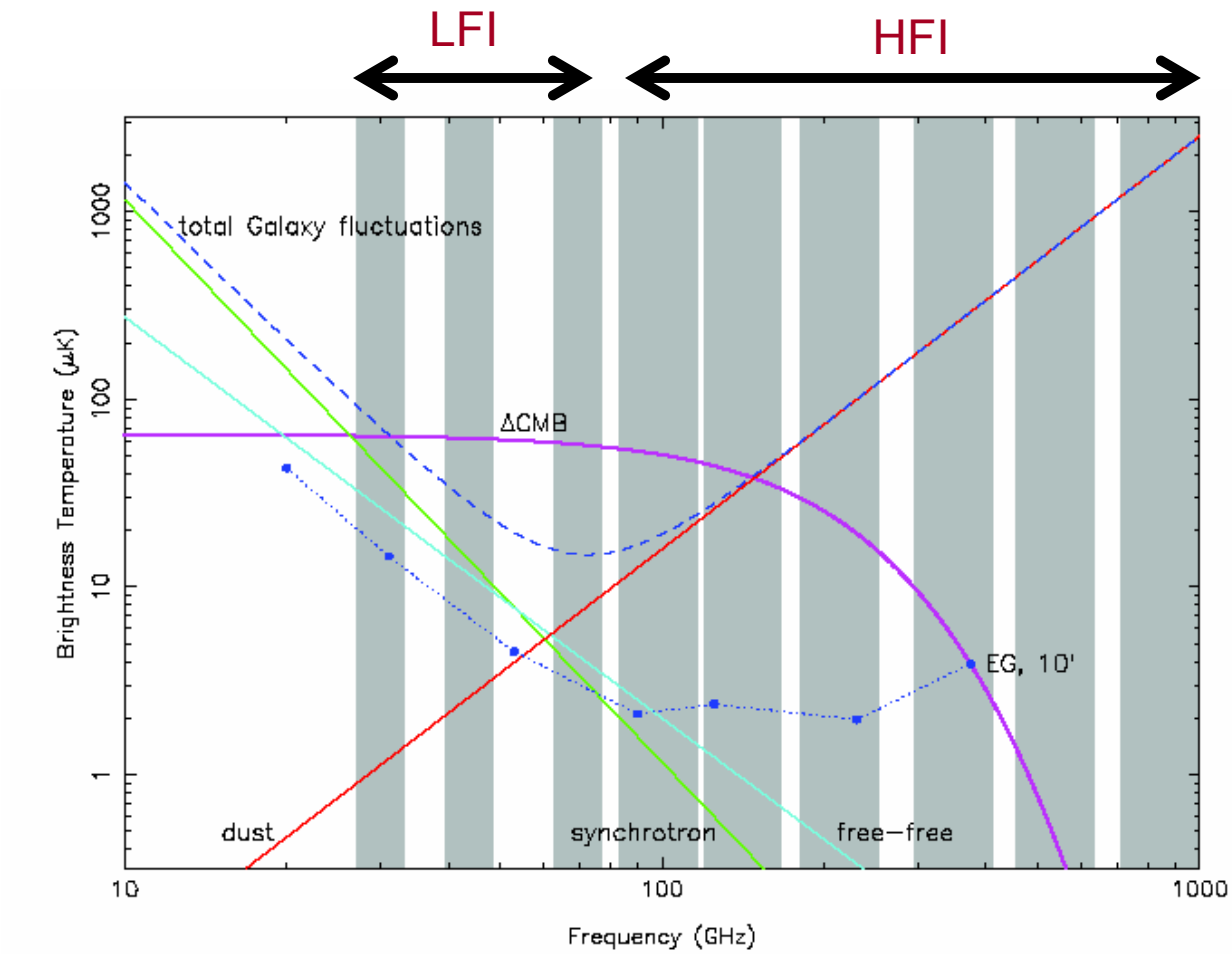
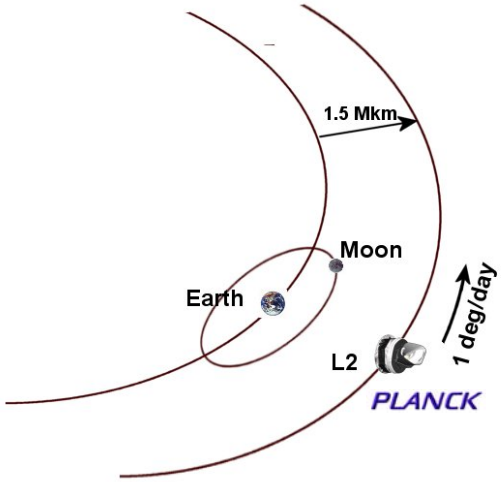
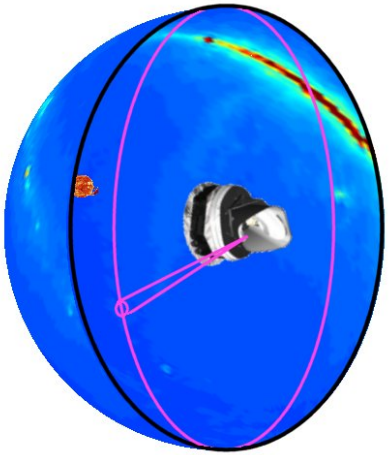


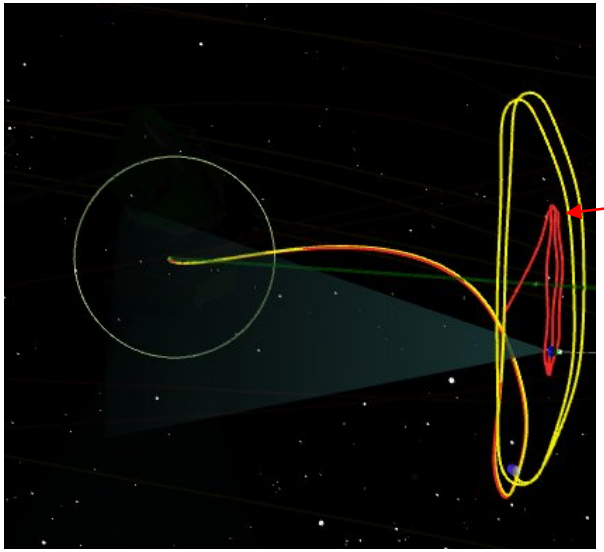
FIG 1.3.— Spectrum of the CMB, and the frequency coverage of the *Planck* channels. Also indicated are the spectra of other sources of fluctuations in the microwave sky. Dust, synchrotron, and free-free temperature fluctuation (i.e., unpolarized) levels correspond to the *WMAP* Kp2 levels (85% of the sky; Bennett et al. 2003). The CMB and Galactic fluctuation levels depend on angular scale, and are shown for ~1°. On small angular scales, extragalactic sources dominate. The minimum in diffuse foregrounds and the clearest window on CMB fluctuations occurs near 70 GHz. The highest HFI frequencies are primarily sensitive to dust.

Mission Overview

- Orbit: small lissajous in SEL2
- Planck is a spinner: 1 revolution per minute
- 1 degree scan/day – one full sky coverage in ~7 months

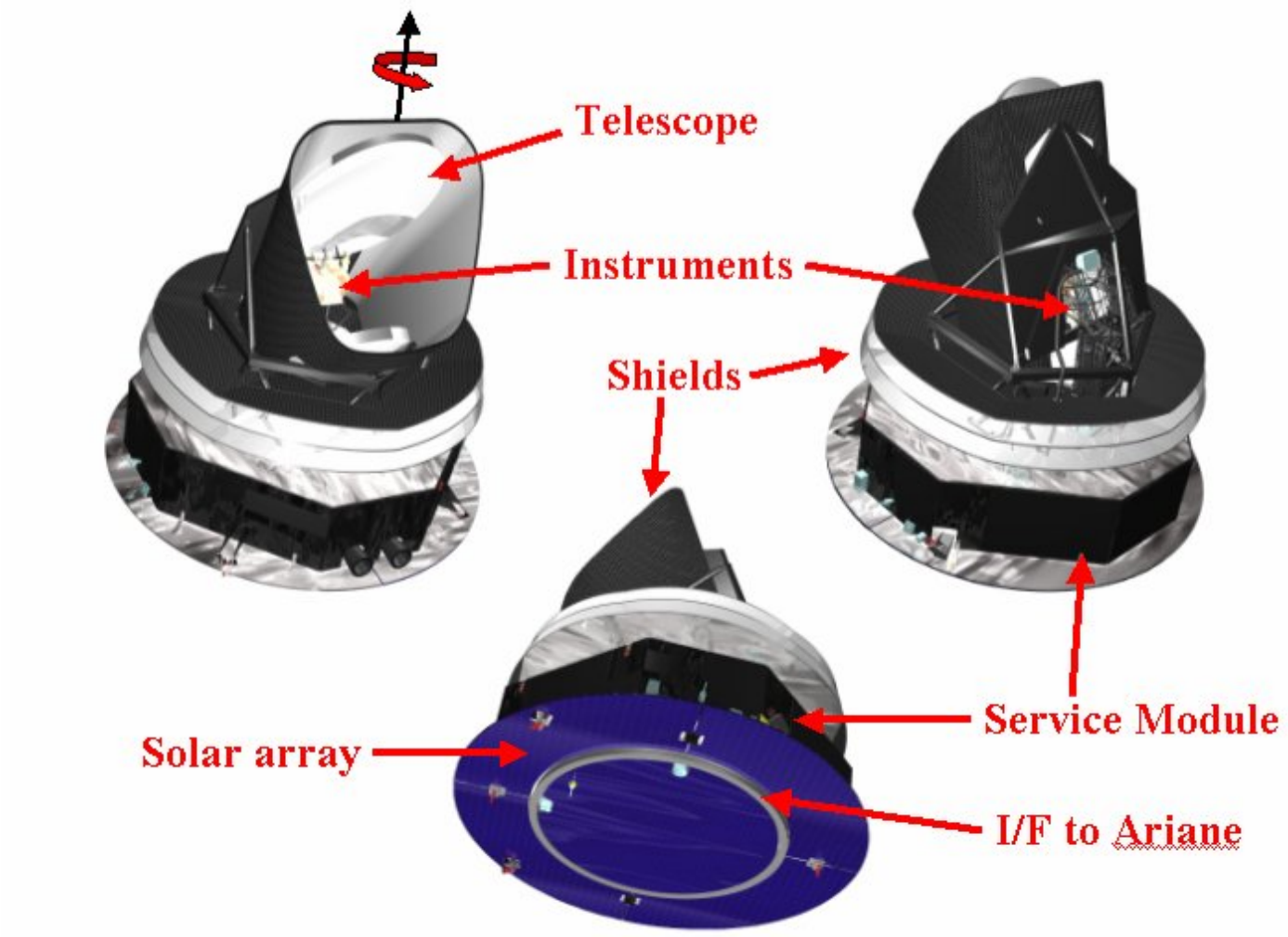




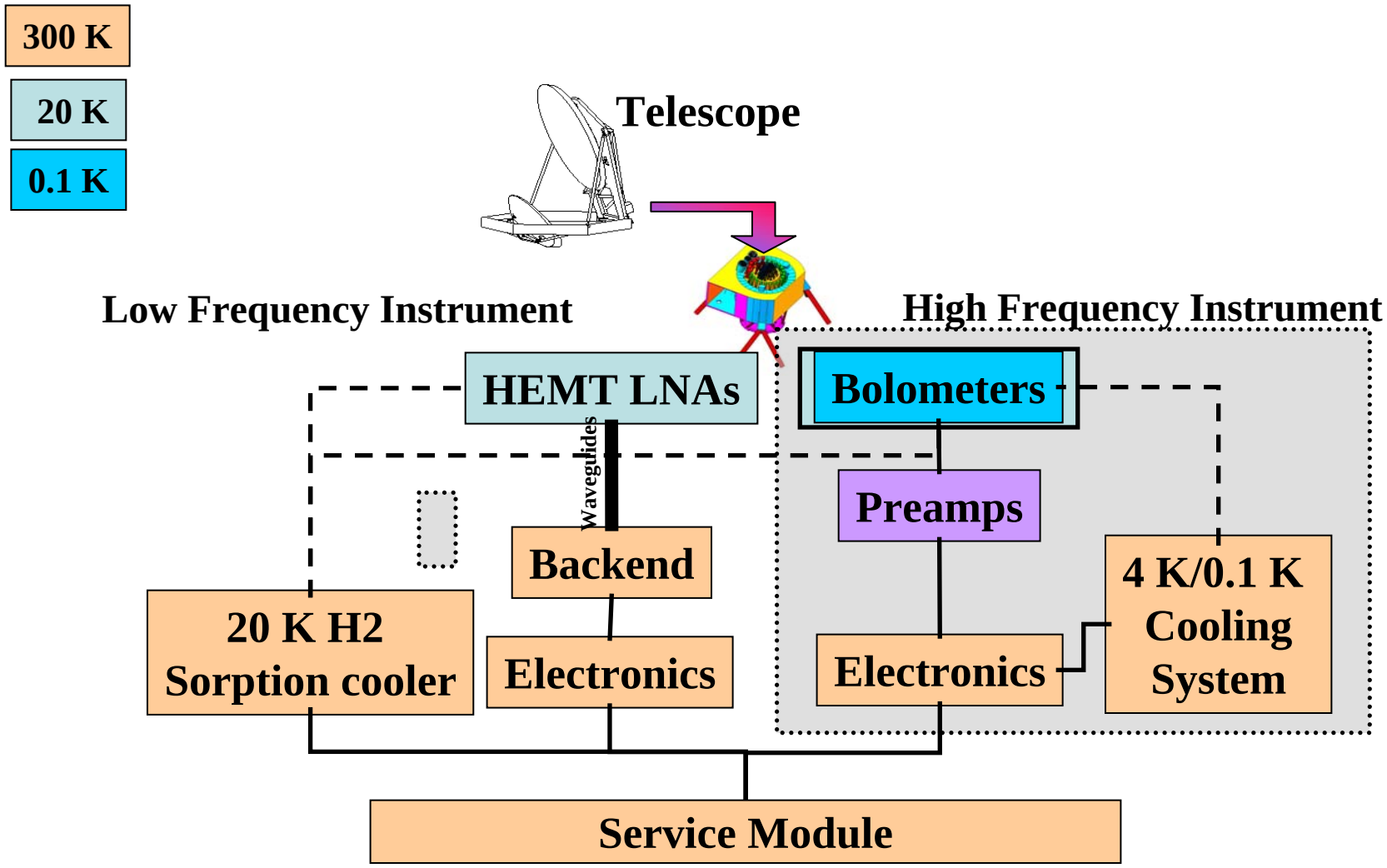


Transfer to orbit around L2

Satellite

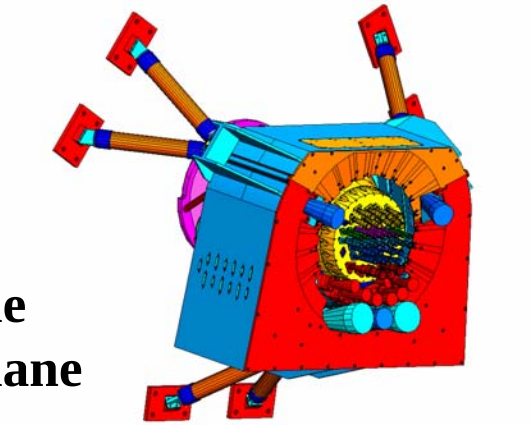

Telescope
Instruments
Shields
Service Module
Solar array
I/F to Ariane

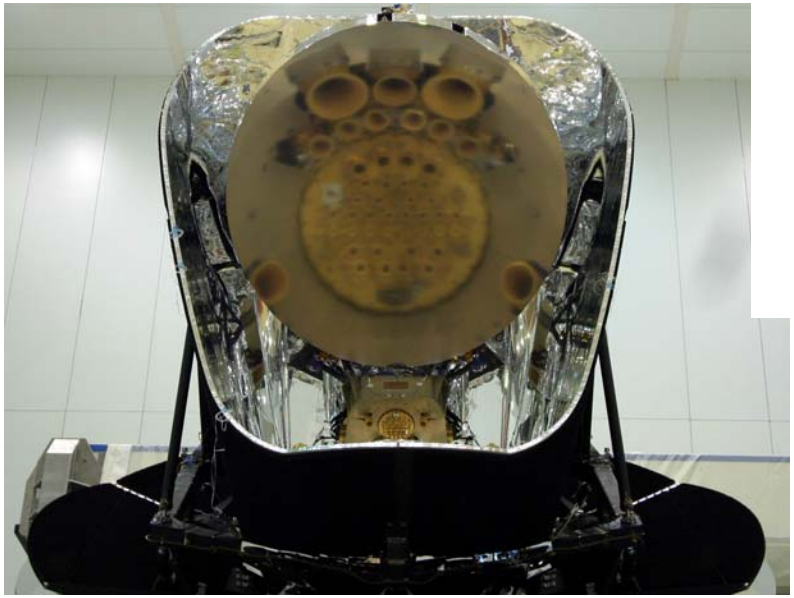
Payload: dominated by cryogenics



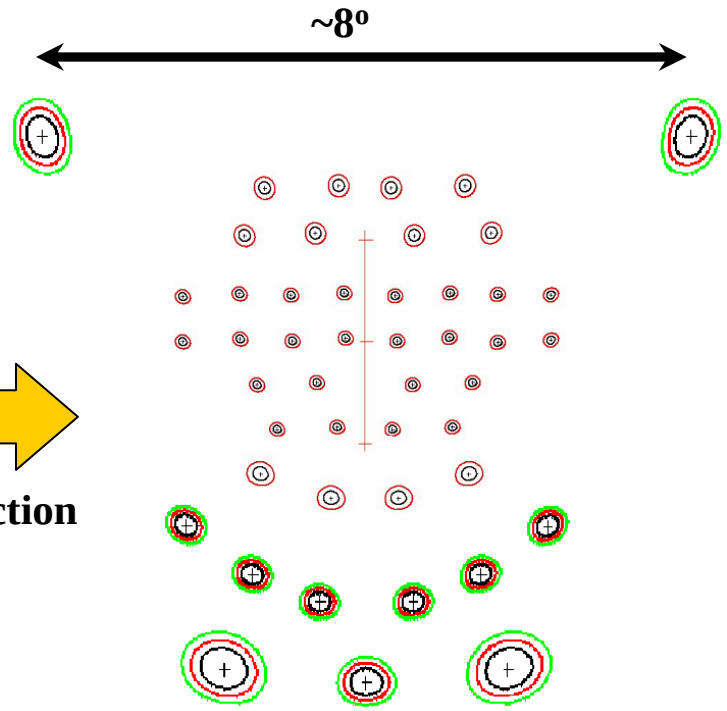
Focal plane configuration

In the focal plane





Scan direction



On the sky

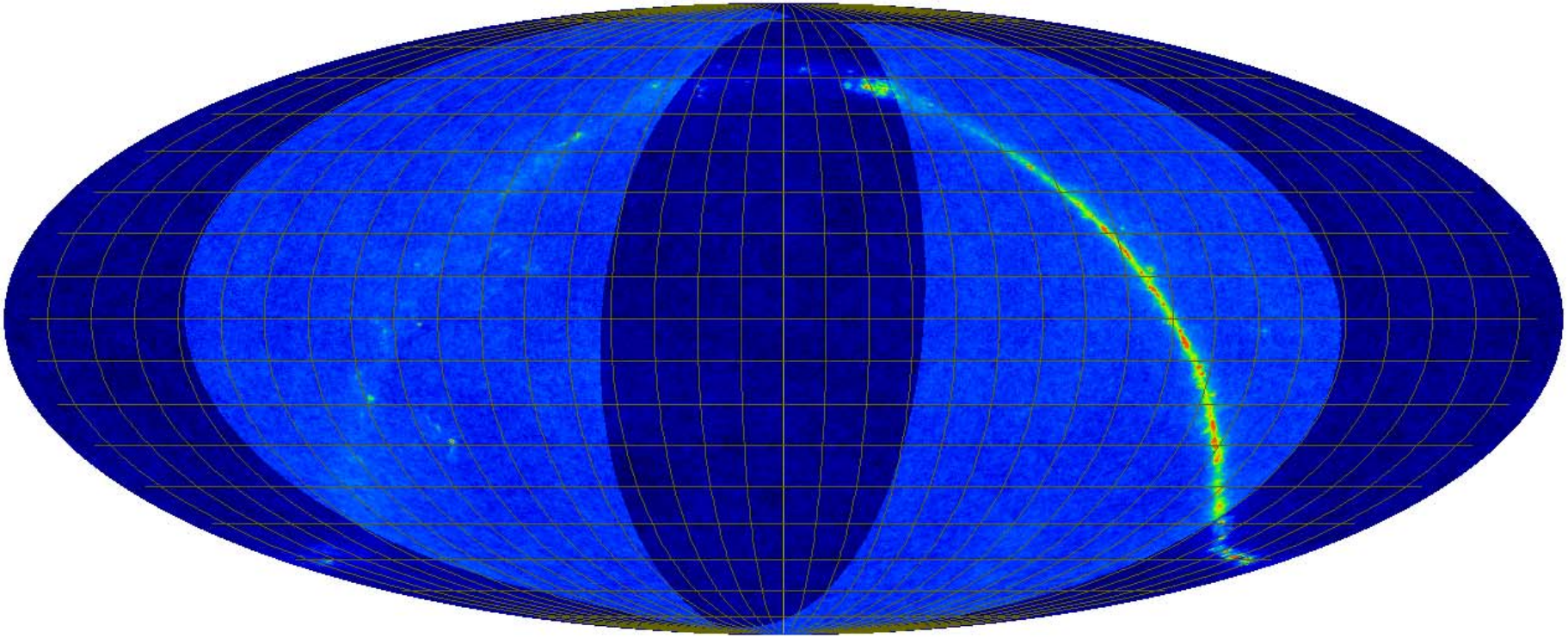
Planck is alive!

14 May 2009: Successful Launch
3 Jul 2009: 100 mK operational temperature reached
13 Aug 2009: Start first light survey
28 Aug 2009: Start routine phase

Feb 2009: completion of first survey

esa ASTROPHYSICS

Coverage as of 11 Nov
~3 months survey, ~20000 deg^2



In-Flight Performance

- The Planck sensitivity is close to the pre-flight noise figures derived from on-ground tests. HFI performs at or slightly better than goal as presented in BB.
- Excellent stability
- Survey is building up without interrupts
- Present lifetime estimate: January 2012
- Planck has requested a one year mission extension in addition to the nominal 15 months
  - 4 independent sky surveys are possible!

Prospects for Euclid

- Deeper CMB temperature maps will
  - Give better dark energy constraints from the power spectrum analysis
    - Tighter constraints on the curvature Ω_k
    - Much tighter constraint Ω_m
  - On the secondary science:
    - ISW: Excellent stability enables much better foreground subtraction which is required for the large c_l
    - Planck SZ maps can be cross-correlated with Euclid galaxy distributions providing additional information on the large scale matter distribution
- Deeper polarisation maps
  - Give better information on the foreground polarisation, which can be better modelled
  - EE, TE will be more accurate, breaking degeneracies in cosmological parameters
  - BB might/should be possible – constraining the energy scale of inflation

Other prospects for Euclid

- Planck and Euclid are both high precision cosmology missions. Planck has two PI led Consortia, like what is envisaged for Euclid.
- The Planck mission is highly complementary to Euclid with a lot of mission commonalities. Experiences from the Planck mission can be used for Euclid:
  - Operating an all sky survey in SEL2 environment
  - Large additional legacy science component
  - Organisation for data processing