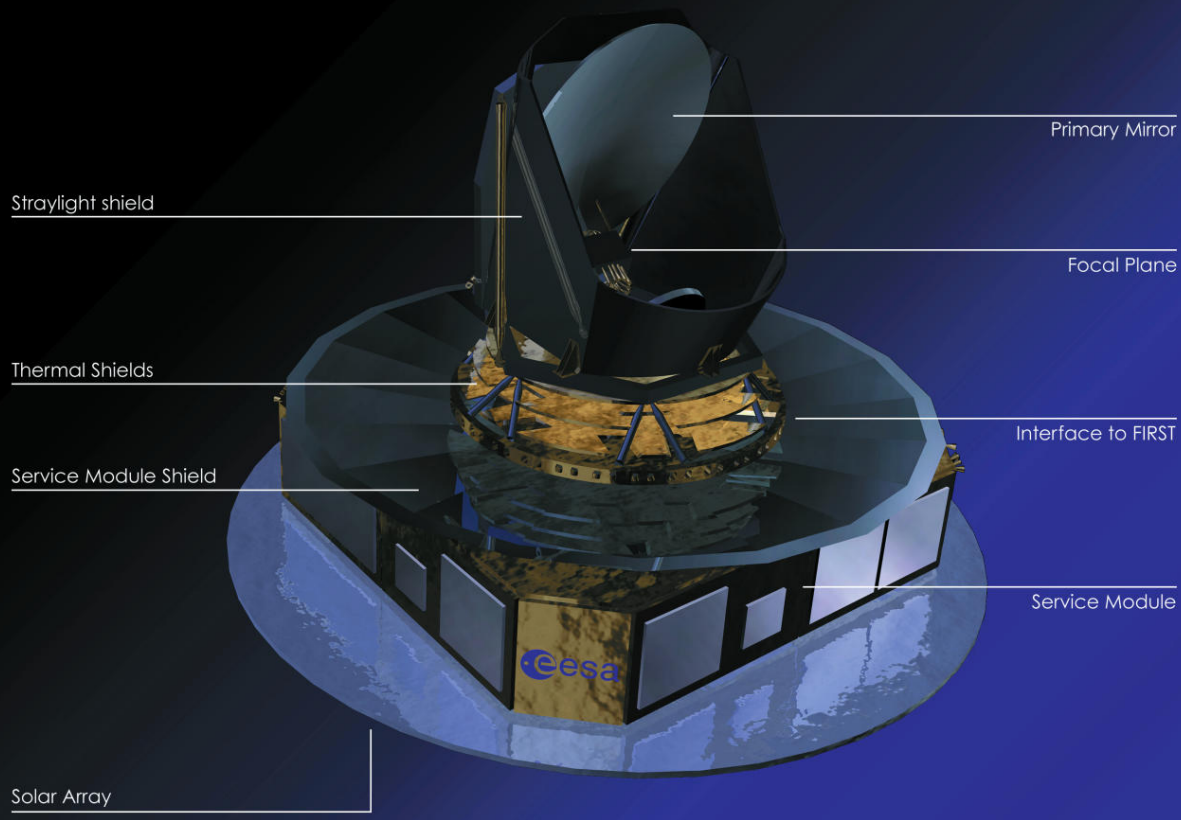
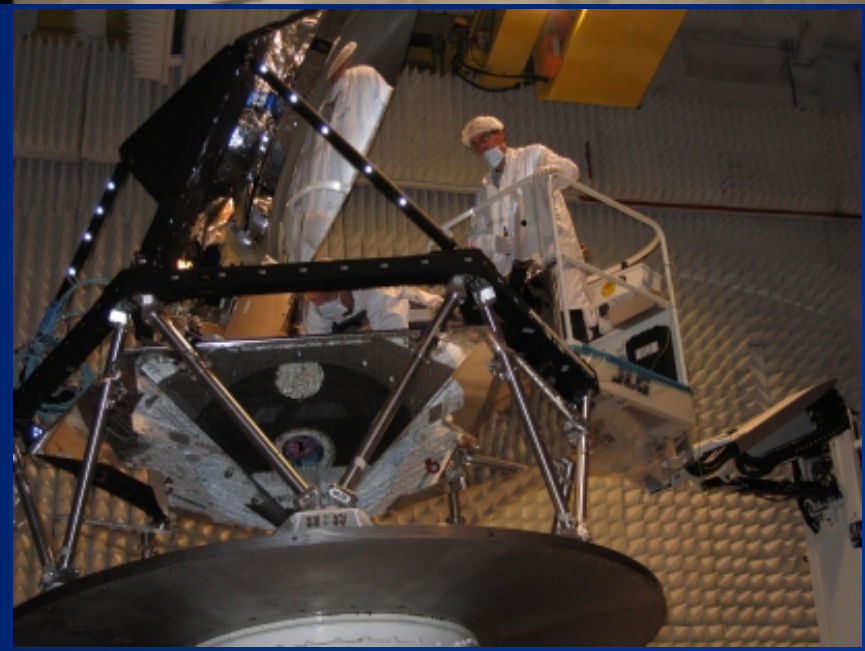
2. Instrumentation and Orbital Parameters:

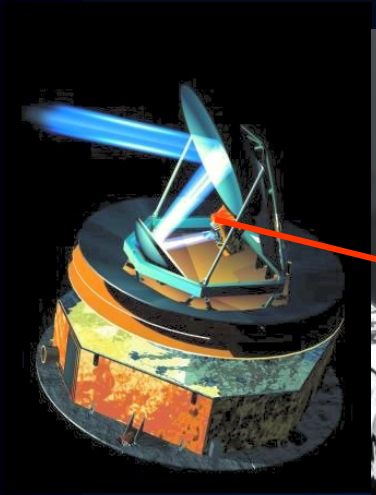


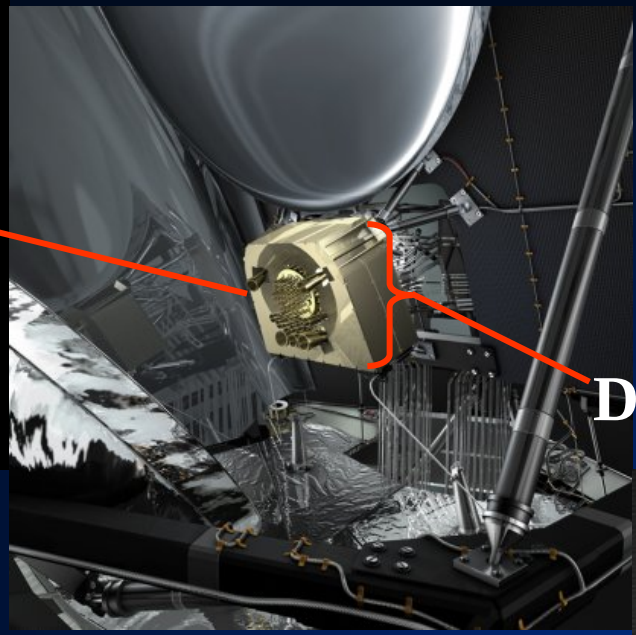
The Planck instrument is an amazing piece of modern technology! In the next section we present pictures of Planck as it is being built. It MUST work, because once it is inserted into its orbit, it will be even beyond the Moon, and well beyond the reach of Shuttle Missions which could repair it, such as the repair missions to the Hubble Space Telescope.

The Planck spacecraft is 4.2 m high and has a maximum diameter of 4.2 m, with a launch mass of around 1.8 tons. The spacecraft comprises a service module, which houses systems for power generation and conditioning, attitude control, data handling and communications, together with the warm parts of the scientific instruments, and a payload module. The payload module consists of the telescope, the optical bench, with the parts of the instruments that need to be cooled - the sensitive detector units - and the cooling systems.



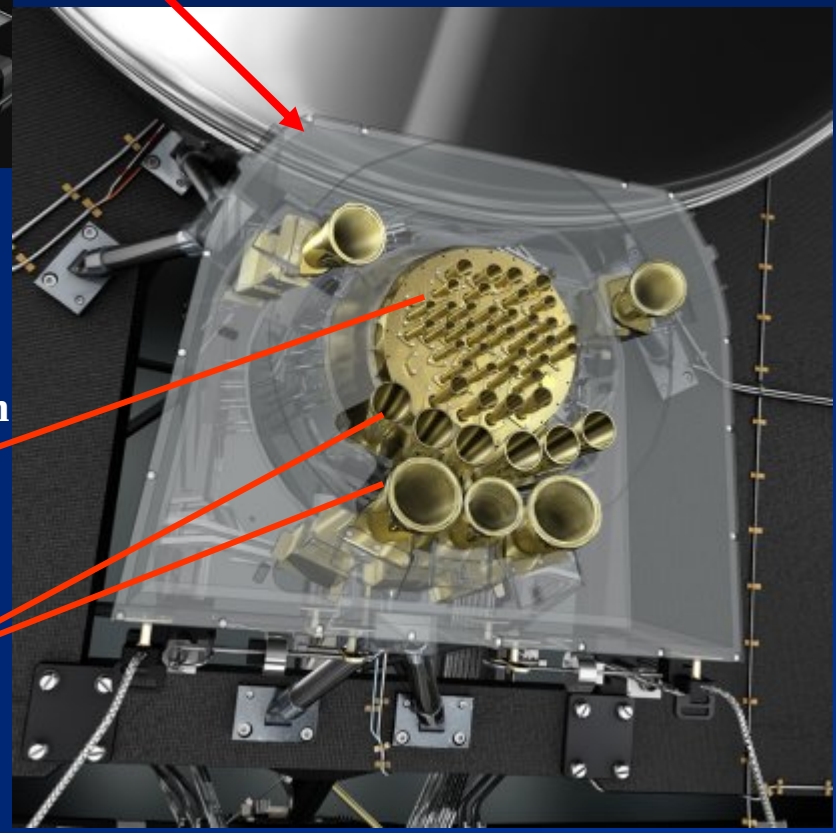
The Planck telescope is an off-axis tilted Gregorian design with a primary mirror 1.75 x 1.5 meters in size.





To measure the CMB in the 8 frequency bands described earlier, Planck has two separate arrays of detectors, the High Frequency and Low Frequency Instruments, which must be kept VERY cold.

Detectors



HFI feed horn array

LFI feed horn array

HFI (High frequency Instrument): an array of microwave detectors using spider bolometers, cooled to 0.1 K

LFI (Low frequency Instrument): an array of radio receivers using high electron mobility transistor mixers, cooled to 20 K

High Frequency Instrument (HFI) schematic

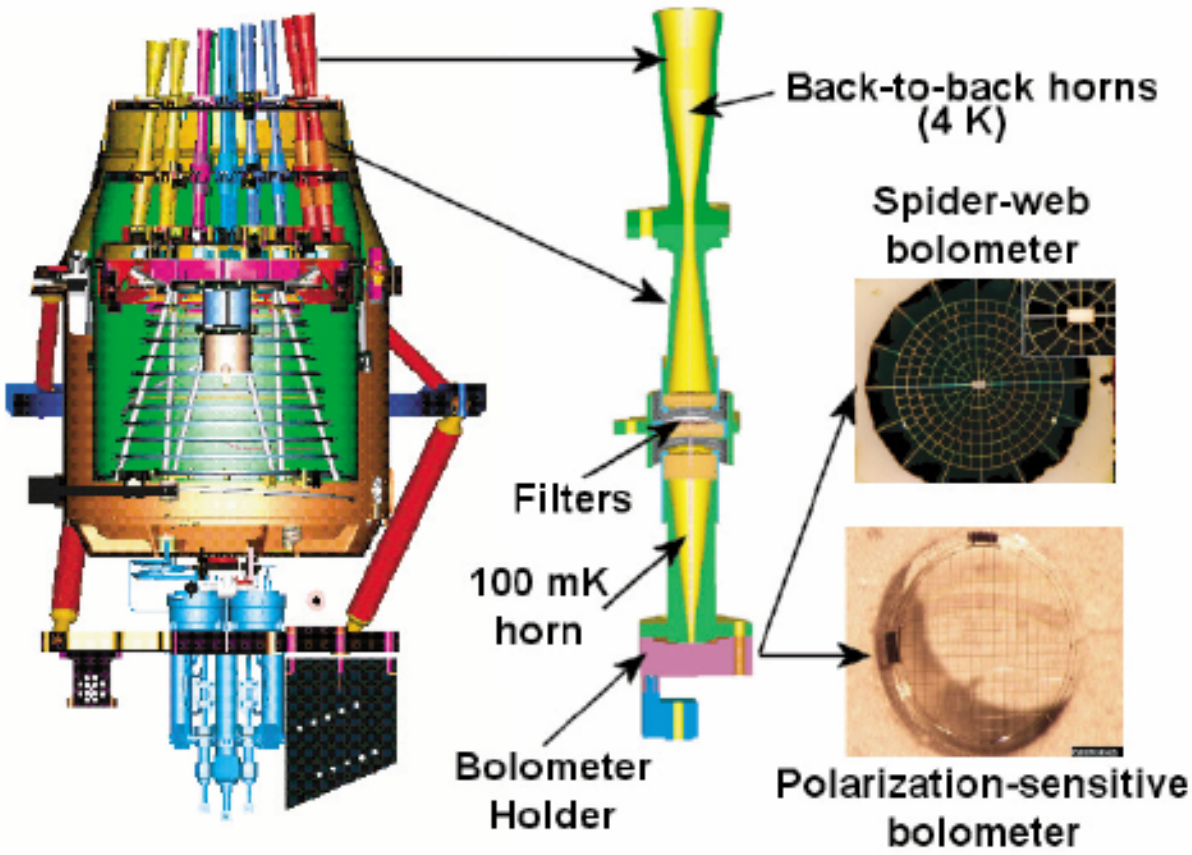
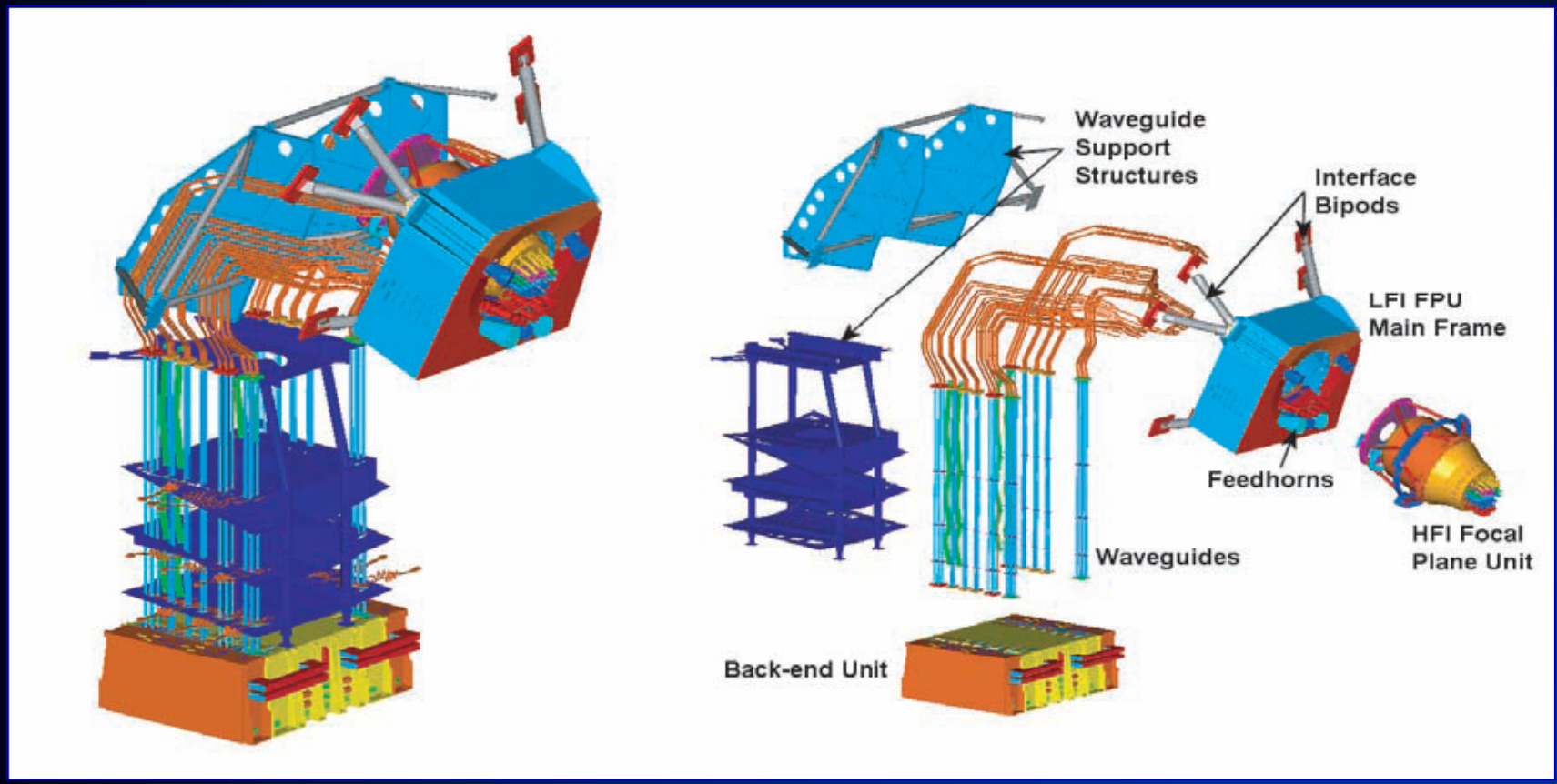


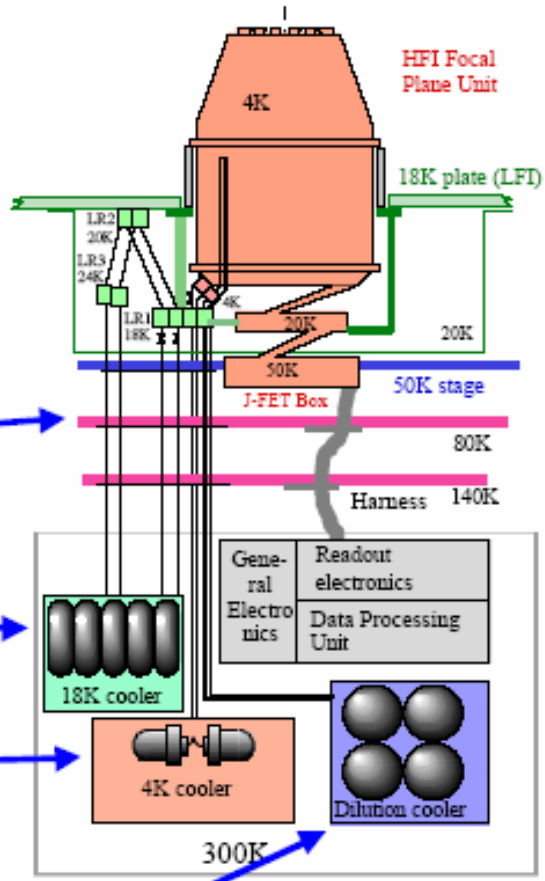
FIG 1.8.—Cutaway view of the HFI focal plane unit. Corrugated back-to-back feedhorns collect the radiation from the telescope and deliver it to the bolometer cavity through filters which determine the bandpass. The bolometers are of two kinds: (a) "spider-web" bolometers, which absorb radiation via a spider-web-like antenna; and (b) "polarisation-sensitive" bolometers, which absorb radiation in a pair of linear grids at right angles to each other. Each grid absorbs one linear polarization only. The absorbed radiant energy raises the temperature of a thermometer located either in the center of the spider-web, or at the edge of each linear grid.

Low Frequency Instrument (LFI) schematic



Array of differential microwave radiometers (DMRs) designed to measure the CMB at 30, 44, and 70 GHz using High Electron Mobility Transfer (HEMT) technology, cooled to 20K using hydrogen sorption coolers

Cooling system



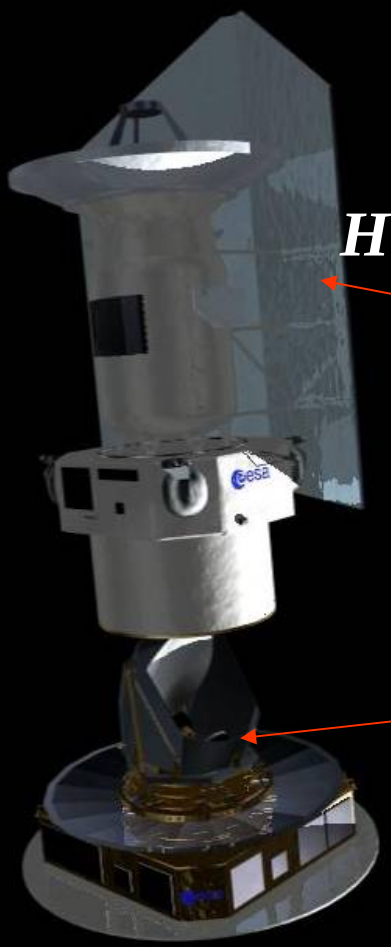
V-groove radiators (to 60 K)

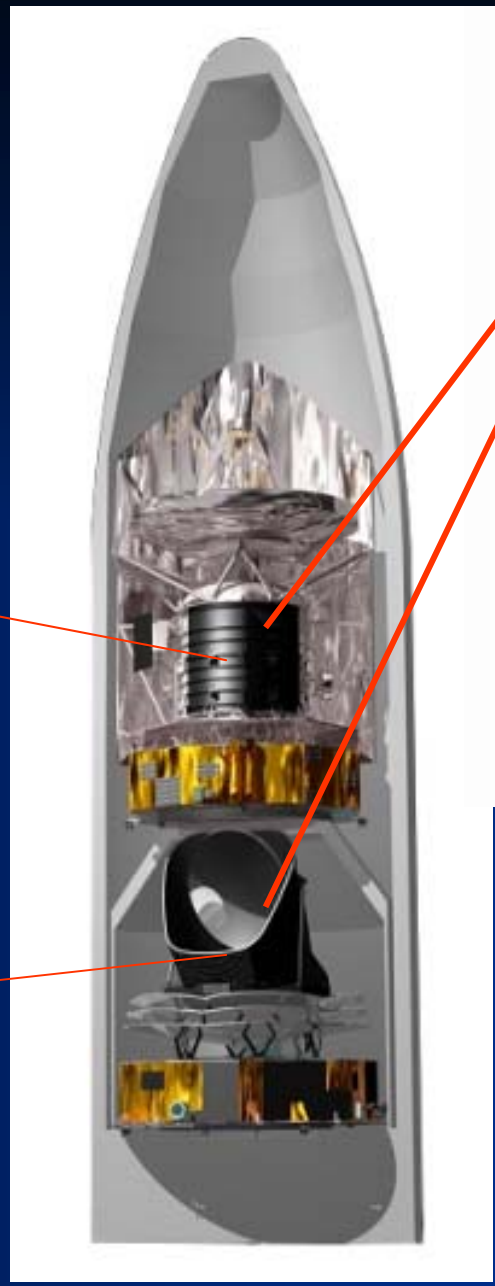
20 K H_2 sorption coolers (JPL)

4 K Stirling cooler (RAL/MMS)

0.1 K $^3He/^4He$ dilution cooler (CRTBT)

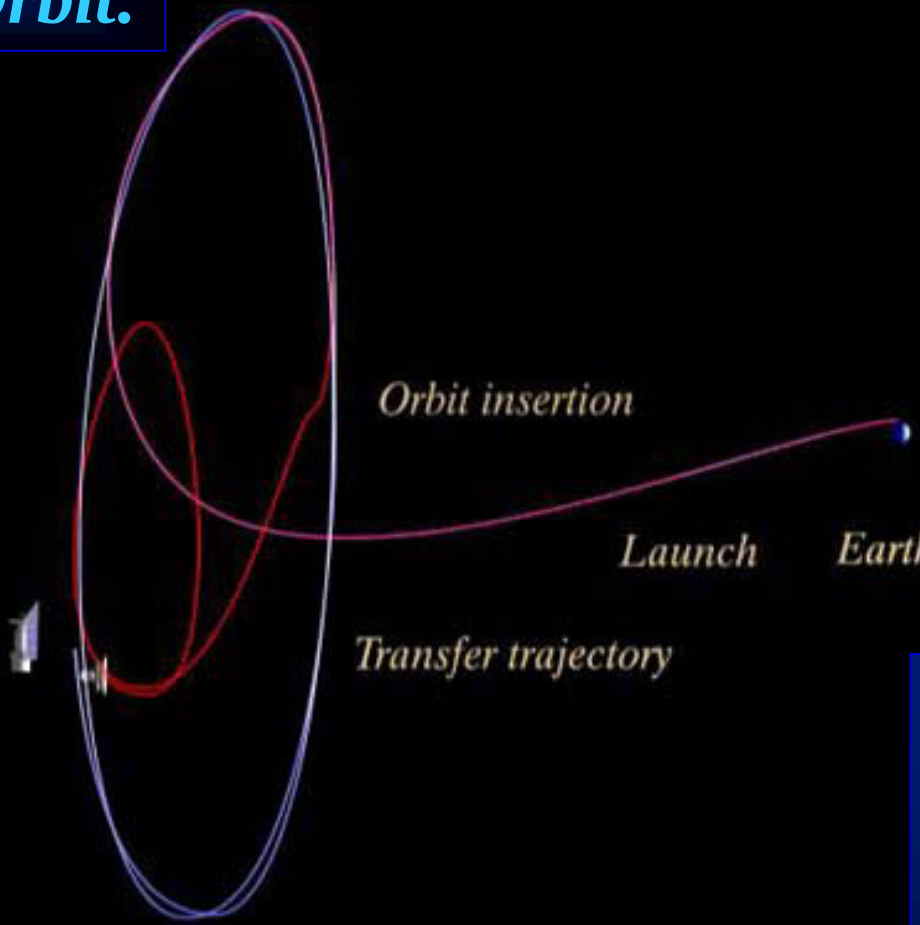
The Rocket:





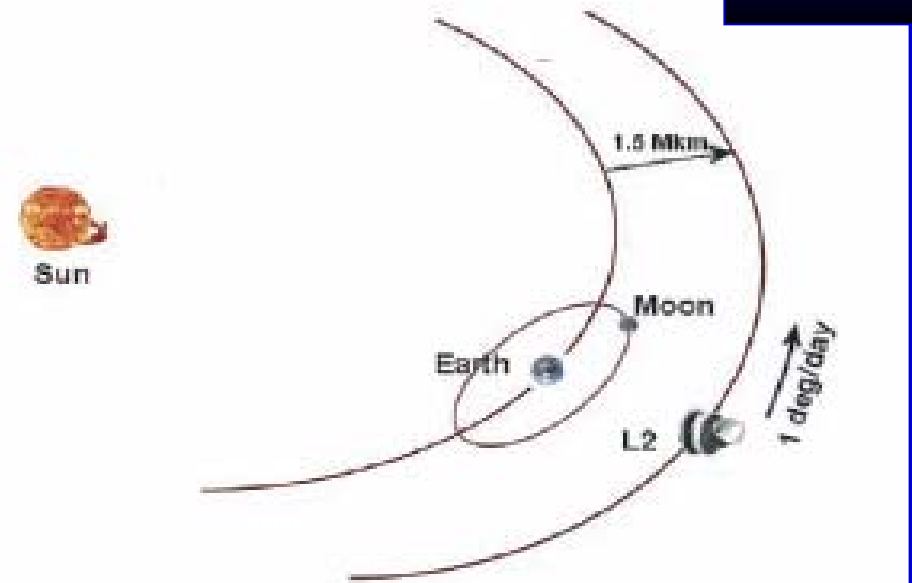
ESA's Arianne 5 Rocket will launch both Planck and Herschel from ESA's launch base in French Guiana, near the equator. The launch is currently set for the end of October, 2008.

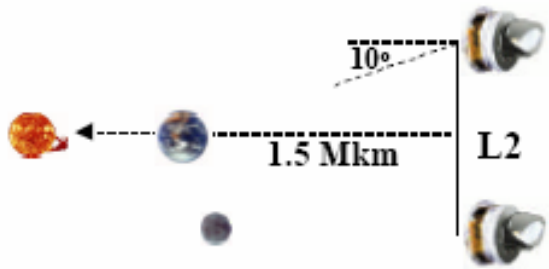
The Orbit:

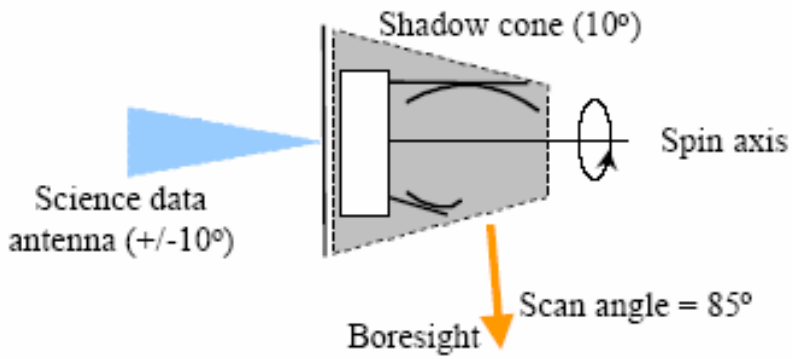


Planck will be inserted into an L2 orbit, about 4 times farther from the Earth than the Moon, and on the opposite side from the Sun, so that it will not have to deal with the constant effects of going into and out of the Sun's heat. Herschel will be inserted into a separate L2 orbit.

The telescope will spin at ~ 1rpm, constantly pointed away from the Sun, moving with the Earth at 1^0/day.







The teams of scientists in Europe and the United States who will work with the data have been working for more than a decade to plan how they will download, store, and analyze the data, and what products the public can expect.