Hera Saturn Probe Net Flux Radiometer

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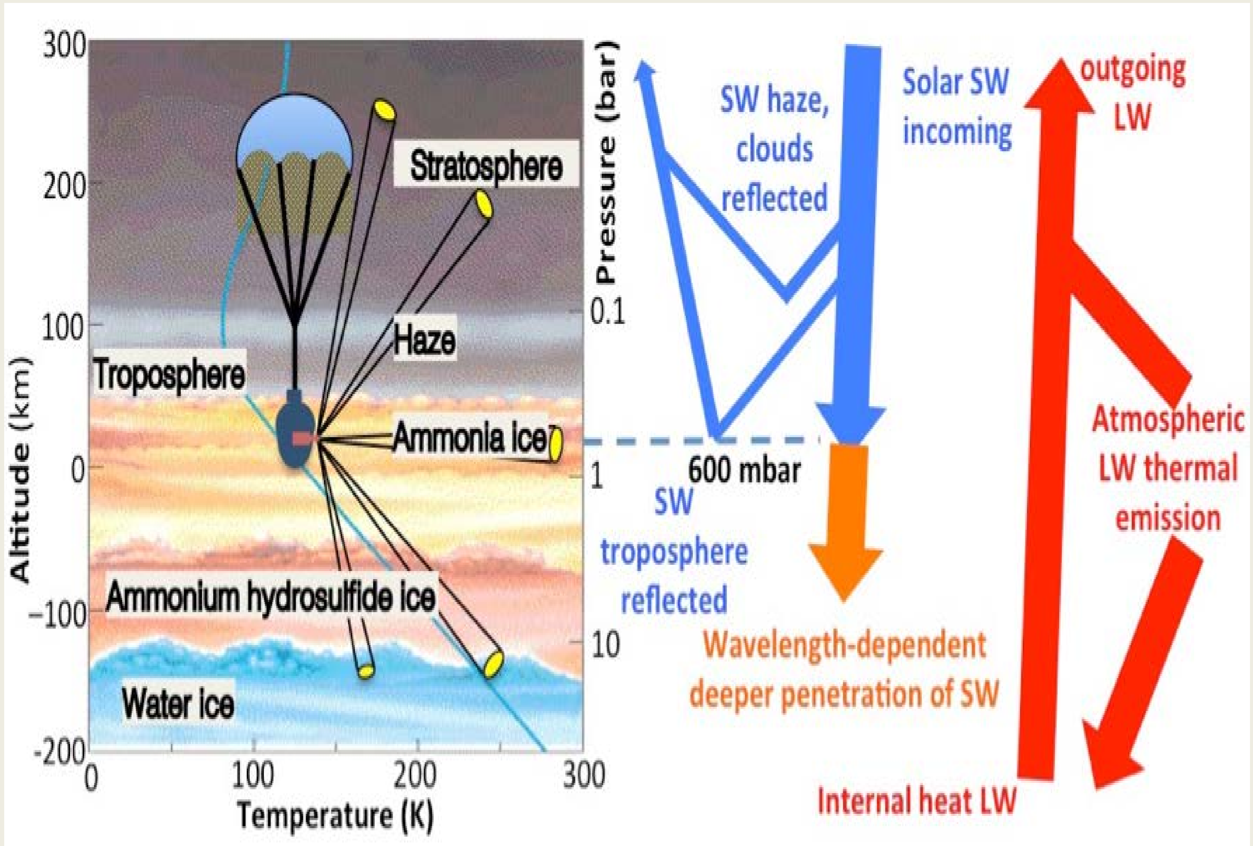
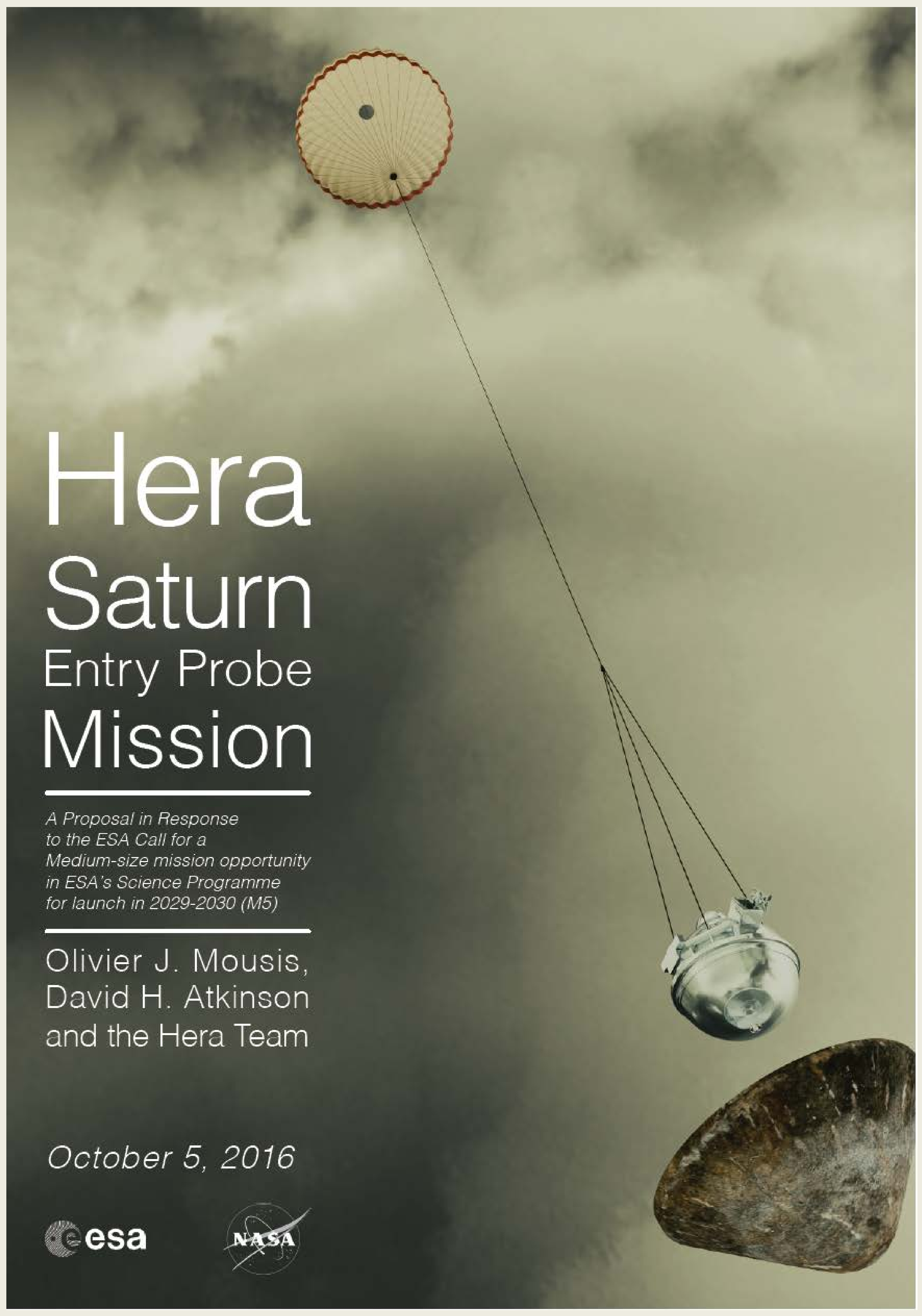
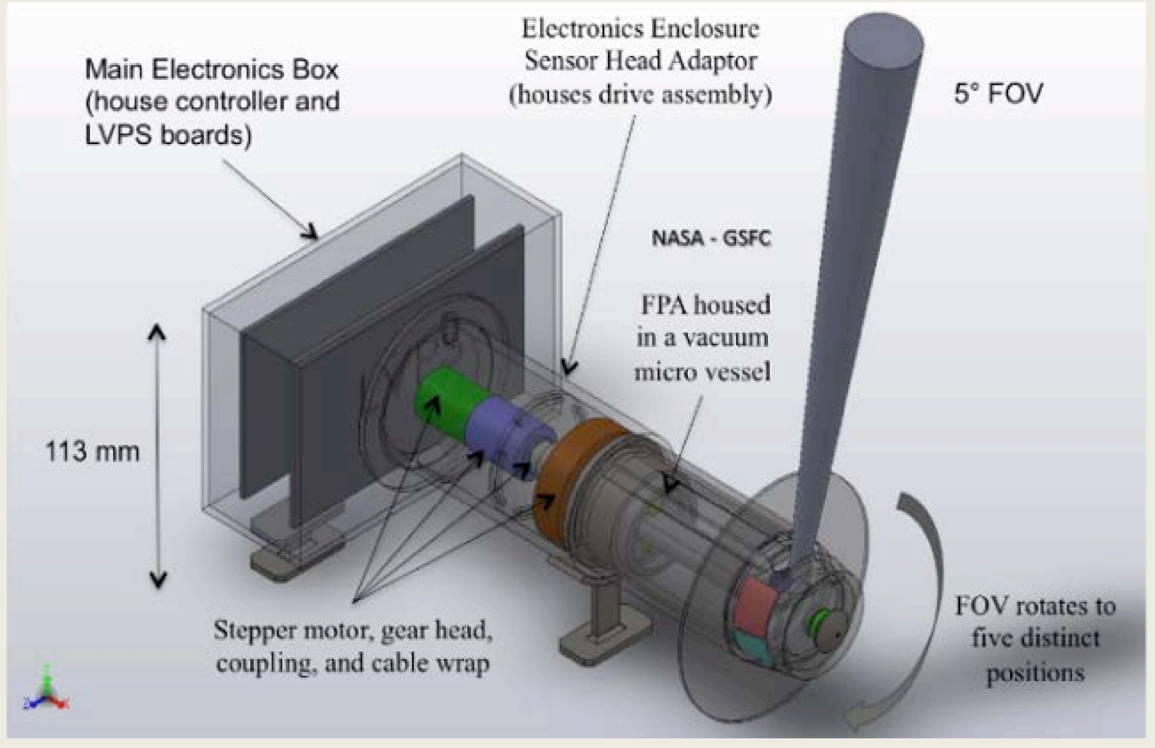
The atmospheric structure of the outer planets remains a key topic in planetary science, with many questions remaining in the wake of the 1995 Galileo Probe that entered Jupiter's atmosphere. While Saturn's atmosphere is expected to resemble Jupiter's in the broad sense, there are likely to be many differences in detail, e.g. due to differences in composition and distance from the Sun. Key questions include:

- What are the altitudes/pressures and compositions of the cloud layers?
- How do the cloud layers interact with solar visible, and planetary thermal radiation to influence the atmospheric energy balance?
- How does the energy balance contribute to atmospheric dynamics?

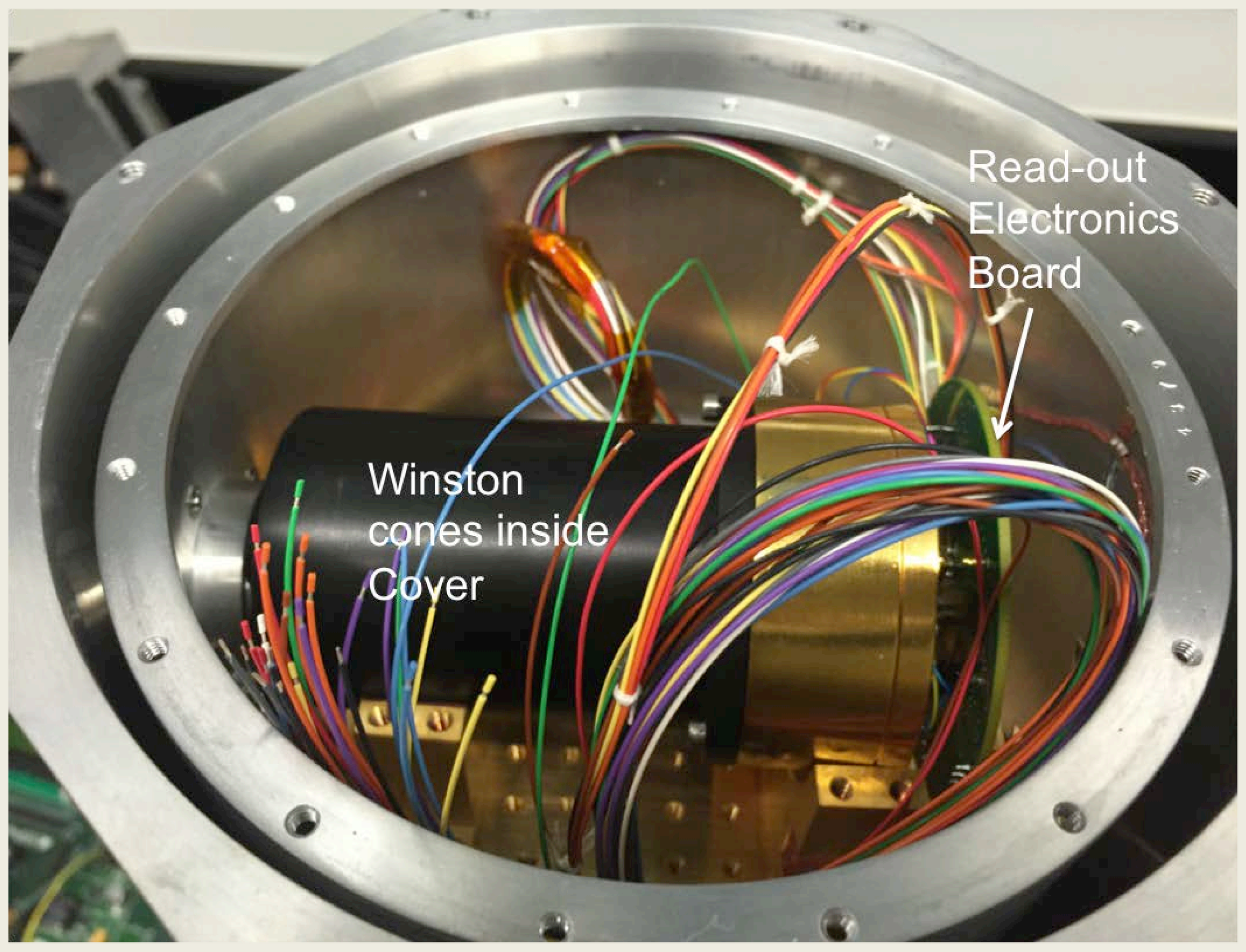


Saturn thermal structure, opacity sources, and global radiative balance (the transition altitudes are similar for other gas and icy giants). At various altitudes, viewing angles sample different processes. *In situ* measurements by a Net Flux Radiometer are critical for understanding the balance between the down- and up-welling radiation streams (Short Wave - SW; Long Wave - LW), to evaluate effects due to primary opacity sources, and to establish the extent of solar heating *e.g.*, at pressures deeper than 600 mbar for Saturn.

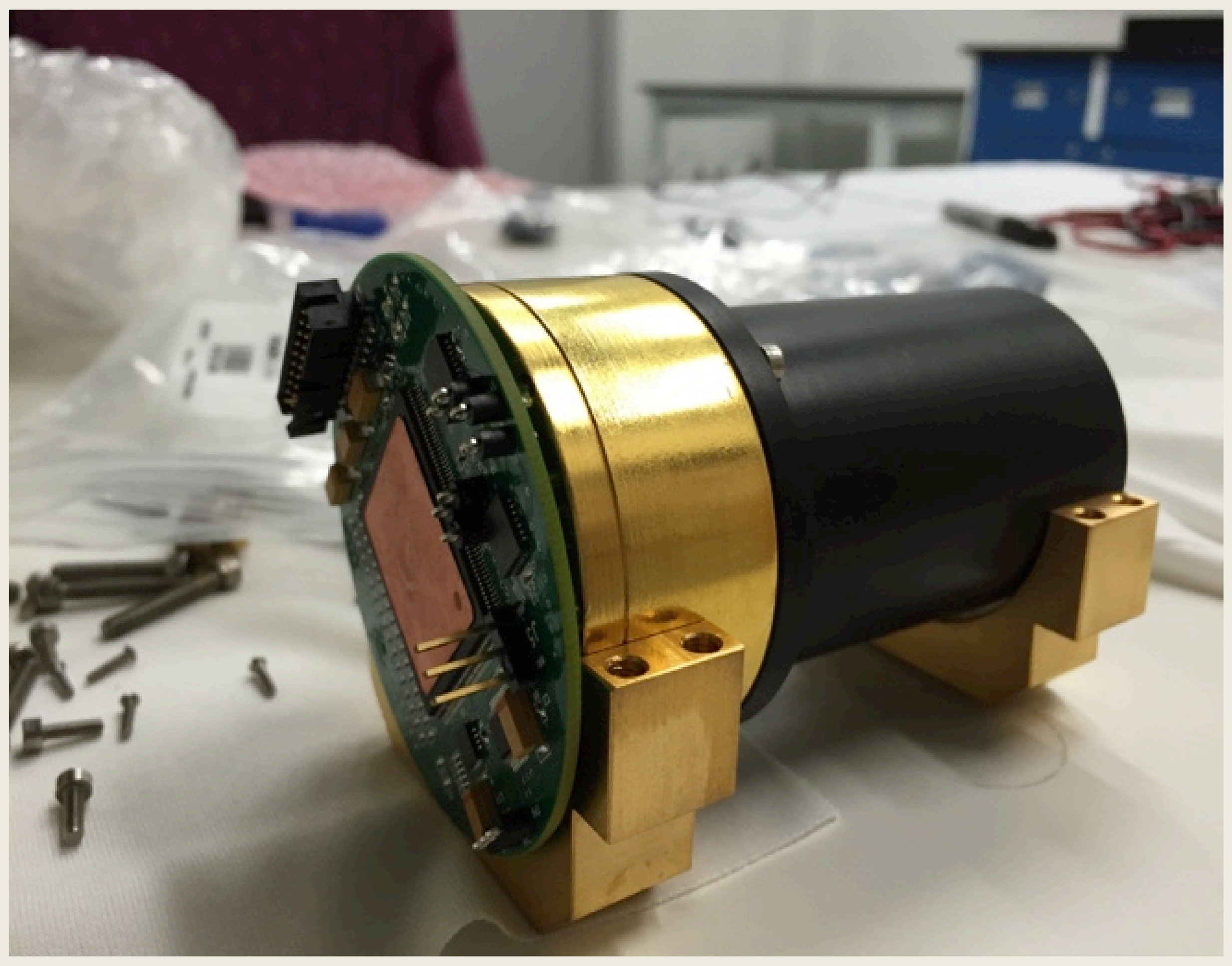




Goddard Space Flight Center (GSFC) Saturn Net Flux Radiometer (SNFR) instrument concept responds to the science goals of the ESA Cosmic Vision M5 Hera Saturn Probe Mission. The baseline design has two spectral channels i.e., a solar channel (0.4-to-5 µm) and a thermal channel (4-to-50 µm). The SNFR is capable of viewing five distinct viewing angles during the descent. Non-imaging Winston cones with band pass filters define each spectral channel with a 5° Field-Of-View (FOV). Uncooled thermopile detectors are used in each spectral channel and are read out using a first generation Multi-Channel Digitizer (MCD) radiation hard Application Specific Integrated Circuit (ASIC), developed at GSFC.



SNFR detector Focal Plane Assembly (FPA) being fit checked inside a liquid N_2 dewar for cold testing. The FPA MCD ASIC read-out electronics is controlled by a "flight like" Pro-ASIC Field Programmable Gate Array (FPGA) board. This sub-system will reach TRL6 after cold testing



Prototype FPA for testing detectors, Winston cones, filters, windows and readout electronics

Parameter	Property	
Instrument type	Filter Radiometer	
Spectral range	0.4 to 50 µm in two to four distinct spectral channels	
Non-Imaging Optics	Winston cones	
Field-Of-View; Eténdue	5°; 1.543×10^{-7} m².sr	
Detectors (uncooled)	Thermopiles	
Pixel size	250 µm × 250µm	
Signal-to-Noise Ratio	Solar	Thermal
100 K	299	106
300 K	468	12,719
Mass	~ 2.4 kg (including harness)	
Basic Power	~ 5 W	
Envelope	(113 × 144 × 279) mm³	
Mission data volume	297 kbits (90-minutes)	
Operating modes	100 ms integrating mode	
Observation strategy	Sequential rotation into 5 sky view angles.	

Technical specifications of GSFC SNFR concept designed to meet Saturn net flux measurement scientific goals.

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