The Uranus System Explorer (USE) Unveiling the evolution and formation of icy giants

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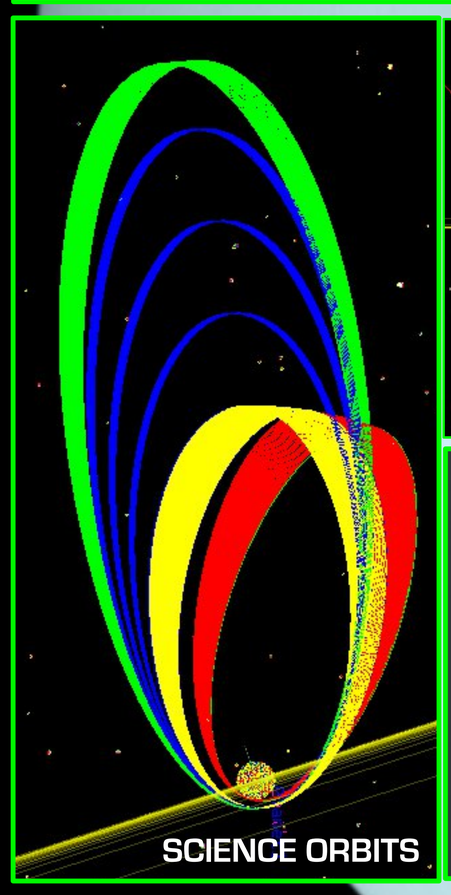
INTRODUCING USE The Uranus System Explorer

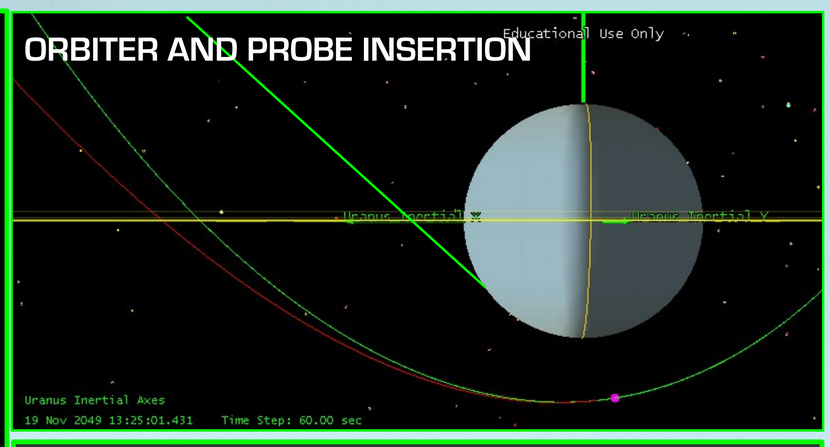
Many fundamental aspects of the Uranian system remain unknown or poorly constrained as no in-depth study of this system has been carried out thus far. Our knowledge of Uranus relies solely on the Voyager 2 flyby in 1986, as well as remote sensing from near Earth by the Hubble Space Telescope. Studying the Uranian system would allow a better understanding on how the icy giant planets formed, provide an archetype for similar exoplanets, and better constrain current solar system formation models. Uranus System Explorer (USE) will investigate the Uranian planetary system and gain new insight into the formation and evolution of icy giants. This mission will perform highly accurate measurements of the Uranian System gravity and magnetic fields as well as a number of in-situ and remote sensing investigations [1]. The mission concept presented here is the result of a student exercise during the Alpbach Summer School 2012 [2].

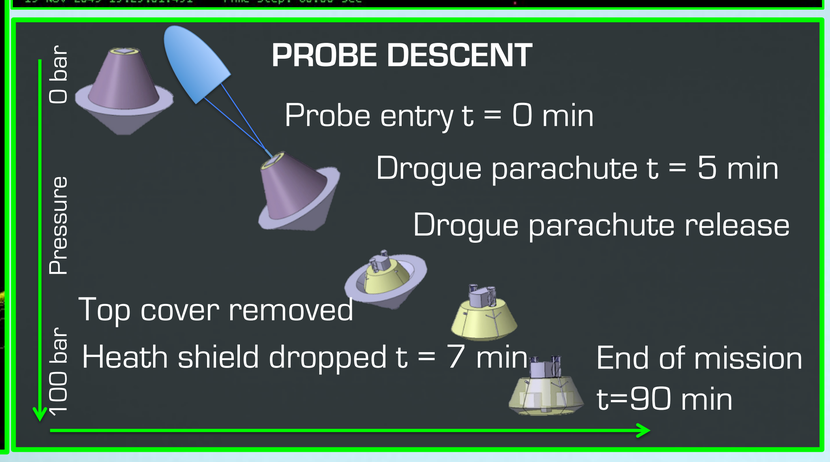
SCIENCE OBJECTIVES with an Orbiter and a Probe

Answering fundamental questions about formation and evolution of the icy giants by placing them in the planetary system formation models [3].

- **INTERIOR**: Why is the heat flux lower than expected? What are the implications for the interior and thermal evolution of the planet? Why does Uranus have such a strong intrinsic magnetic field? How do its characteristics constraint the interior? Is there a rocky silicate core?
- **ATMOSPHERE**: What is the composition of the atmosphere? Which are the drivers of atmospheric chemistry? What are the atmosphere dynamics?
- **MAGNETOSPHERE**: How is plasma transported in the magnetosphere? Is there significant plasma source in Uranus? Insight into Erath's magnetosphere during magnetic revers.







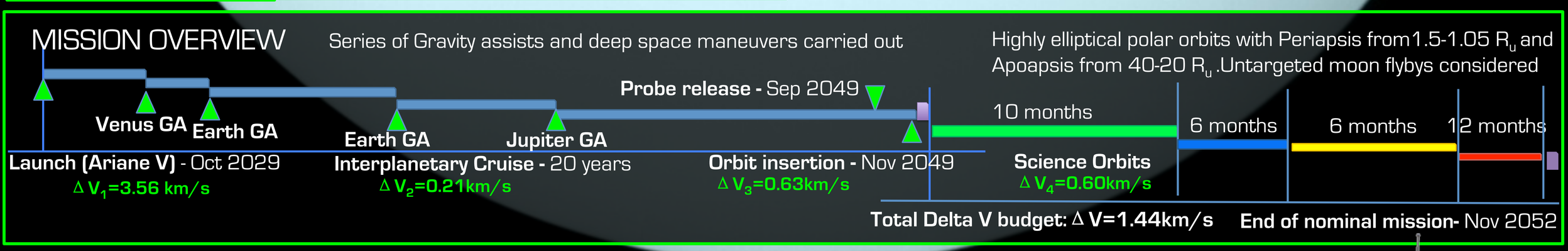
PAYLOAD

Orbiter	Imaging Camera (CAM)	Remote
	Visible and Infrared Spectrometer (VIR-V & VIR-I)	
	Thermal IR Spectrometer (TIR)	
	UV-Spectrometer (UVS)	
	Microwave Radiometer (MR)	
	Electron and ion spectrometer (EIS)	In situ
	Scalar and Vector Magnetometer (SCM & MAG)	
	Energetic Particle Detector (EPD)	
	Radio and Plasma Wave Instrument (RPWI)	
	Ion composition instrument (ICI)	
Atmospheric Probe	Mass Spectrometer (ASS & GCMS)	
	Nephelometer (NEP)	
	Doppler wind instrument (DWI)	
	Atmosphere Physical Properties Package (AP3)	

MISSION OVERVIEW

Series of Gravity assists and deep space maneuvers carried out

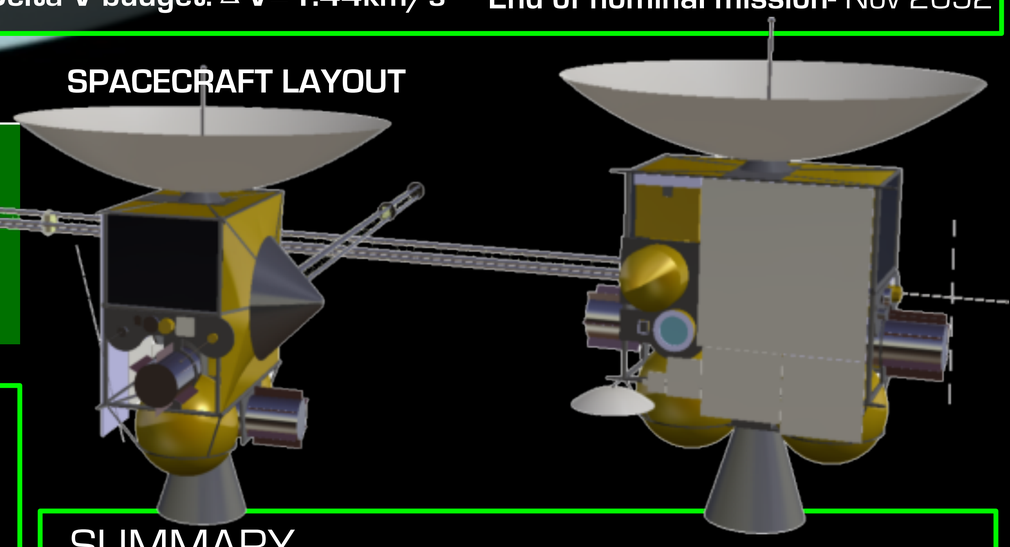
Highly elliptical polar orbits with Periapsis from1.5-1.05 R_u and Apoapsis from 40-20 R_u .Untargeted moon flybys considered



Mass Budget	Mass [kg]	
Total dry mass	2115	
Propellant before orbit insertion	935	
Propellant for in-orbit operations	949	**TOTAL**
Adaptor	186	**4185**

Communications	Frequency	Bandwith [Kbps]
Orbiter-Earth downlink	Ka-Band	6.00 at Uranus
Orbiter-Earth uplink	X-Band	0.07 at Uranus
Orbiter-Probe uplink	UHF	2.32 at 100 bar

SPACECRAFT LAYOUT



SYSTEM DESIGN

The Spacecraft design strongly driven by the unique operational profile of the mission. In order to achieve acceptable telemetry rates at Uranus, the spacecraft carries a 4m High Gain Antenna for Ka-band downlink and X-band uplink. Electrical power is provided by three Advanced Stirling Radioisotope Generators, providing 140 W of electrical power at beginning of life. The two large side panels of the spacecraft house the remote sensing instruments and the atmospheric probe, respectively, while the smaller side panels house the plasma instrument package. The magnetometer payload is housed at the end of a deployable 10m boom to minimize the influence of spacecraft fields. Primary propulsion is provided by an NTO-Hydrazine bipropellant main engine, providing a specific impulse of 318s and a nominal thrust of 645N.

SUMMARY

The USE mission represents a unique opportunity to study the Uranian system in unprecedented detail and to gain new insights into the formation and evolution of icy giant systems. The knowledge gained from this investigation would provide crucial constraints to current models for planetary formation and evolution, and would address a significant gap in current understanding of Solar System formation.

REFERENCES: [1] Arridge C., Craig B, et al.: Uranus Pathfinder: exploring the origins and evolution of Ice Giant planets, Exp Astron, September 2011, [2] http://www.summerschoolalpbach.at/ [3] Holme, R., Bloxham, J.: The magnetic fields of Uranus and Neptune: Methods and models, Journal of Geophysical Research, Vol. 101, No. E1, pp. 2177-2200, 1996.

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