A Concept for a Joint NASA/ESA Mission for In Situ Exploration of an Ice Giant Planet

D.H. Atkinson (David.H.Atkinson@jpl.nasa.gov), O. Mousis,
T.R. Spilker, A. Coustenis, M. Hofstadter, J.-P. Lebreton, K. Reh, A.A. Simon

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Boulder, Colorado
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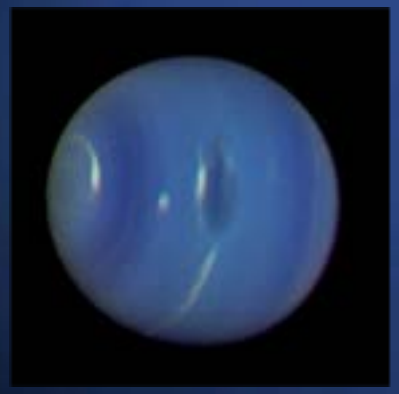
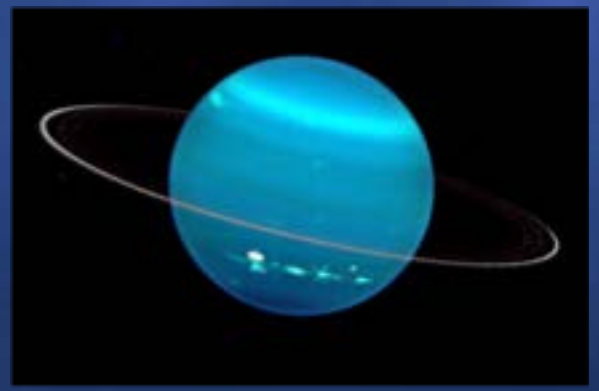
Jet Propulsion Laboratory
California Institute of Technology

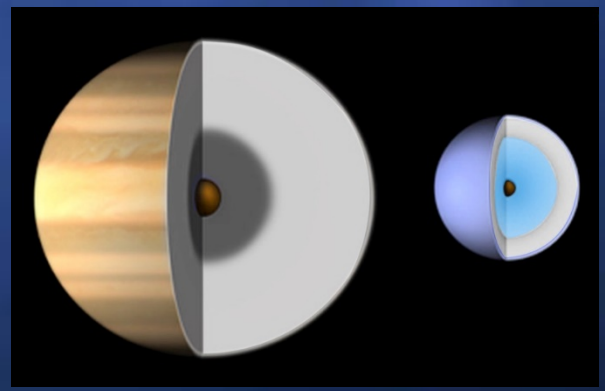
Science Justification for Outer Planet Entry Probes

> ***Comparative planetology*** *of well-mixed atmospheres of the outer planets is key to the origin and evolution of the Solar System, and, by extension, extrasolar systems.*
>
> *Atreya, S. K. et al., "Multiprobe exploration of the giant planets – Shallow probes," Proceedings of the 3rd International Planetary Probes Workshop, Anavyssos, Greece, 2005.*

For all the capabilities of remote sensing, only *in situ* exploration by descent probe(s) can completely reveal the secrets of the deep, well-mixed atmosphere containing pristine materials from the epoch and location of giant planet formation.







Heritage: Previous Studies and Previous Missions

Galileo Probe


NASA TECHNICAL MEMORANDUM

N73-30403
NASA TM X-2824

NASA TM X-2824

CASE FILE COPY

MISSION PLANNING FOR PIONEER SATURN/URANUS ATMOSPHERIC PROBE MISSIONS

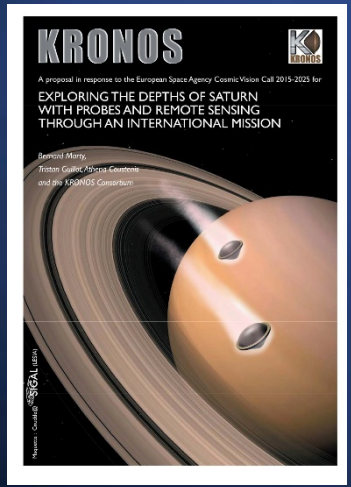
by Byron L. Swenson, Edward L. Tindle, and Larry A. Manning

Ames Research Center
Moffett Field, Calif. 94035

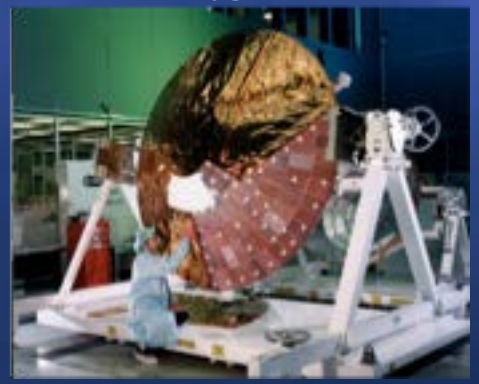
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • SEPTEMBER 1973

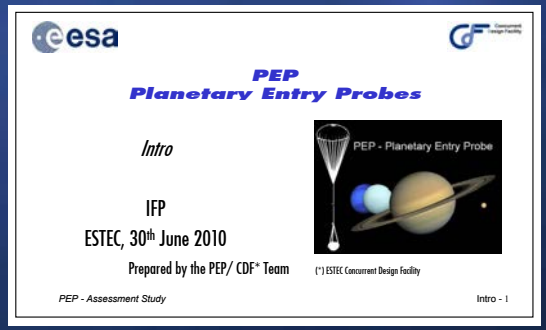
NASA 1973

ESA KRONOS Proposal



ESA Huygens Probe




esa

PEP
Planetary Entry Probes

Intro

IFP
ESTEC, 30th June 2010

Prepared by the PEP/ CDF* Team

(*) ESTEC Concurrent Design Facility

PEP - Planetary Entry Probe

PEP - Assessment Study

Intro - 1

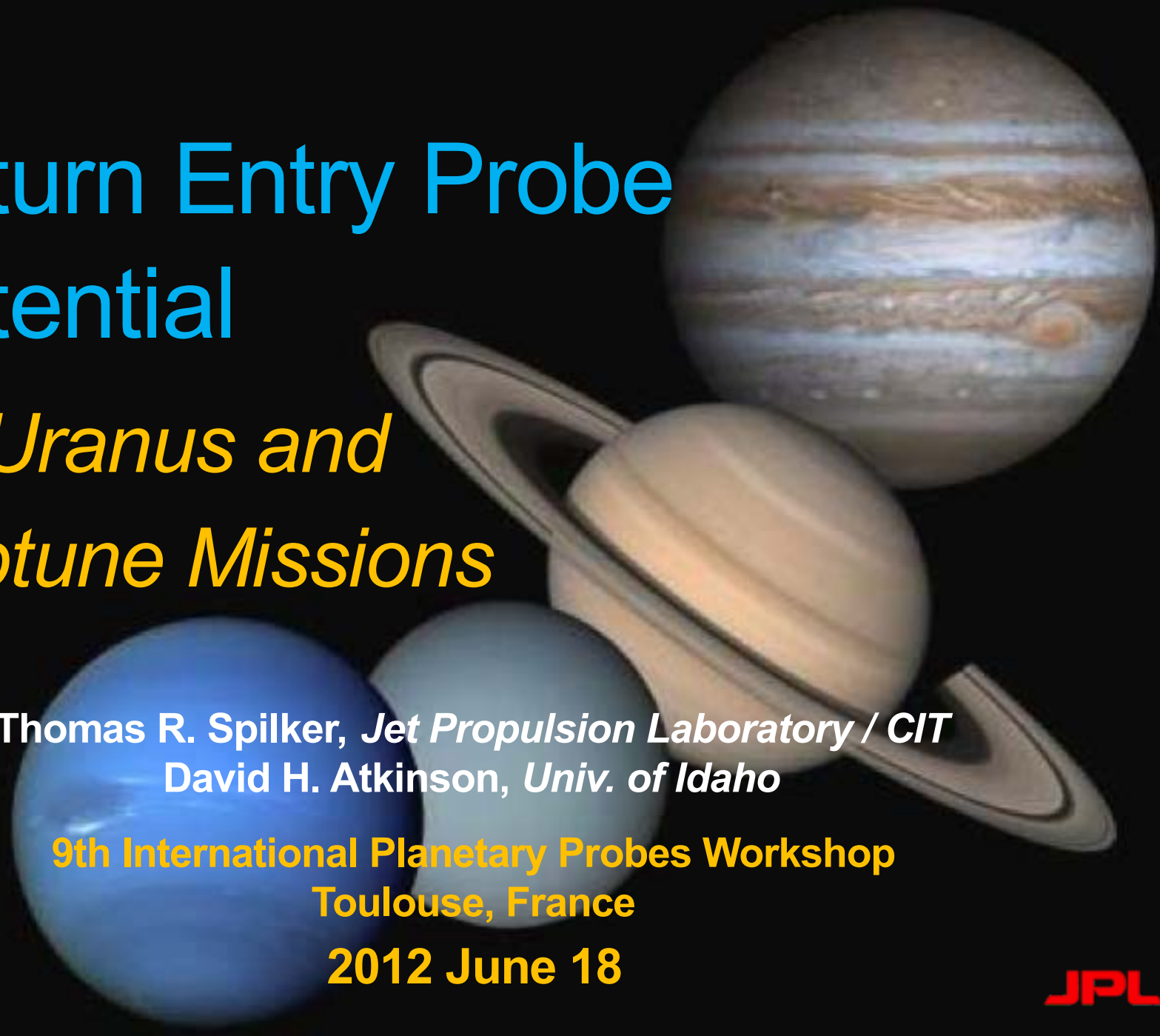
ESA PEP Study


SPRITE
Saturn Probe Interior and Atmosphere Explorer
NASA New Frontiers 4
Amy Simon, PI


Hera
Saturn
Entry Probe
Mission
A Proposal in Response
to the ESA Call for a
Medium-size mission opportunity
in ESA's Science Programme
for launch in 2029-2030 (M5)
Olivier J. Mousis,
David H. Atkinson
and the Hera Team
October 5, 2016
esa
NASA

Saturn Entry Probe Potential

for Uranus and Neptune Missions



Thomas R. Spilker, ***Jet Propulsion Laboratory / CIT***
David H. Atkinson, ***Univ. of Idaho***

9th International Planetary Probes Workshop
Toulouse, France
2012 June 18

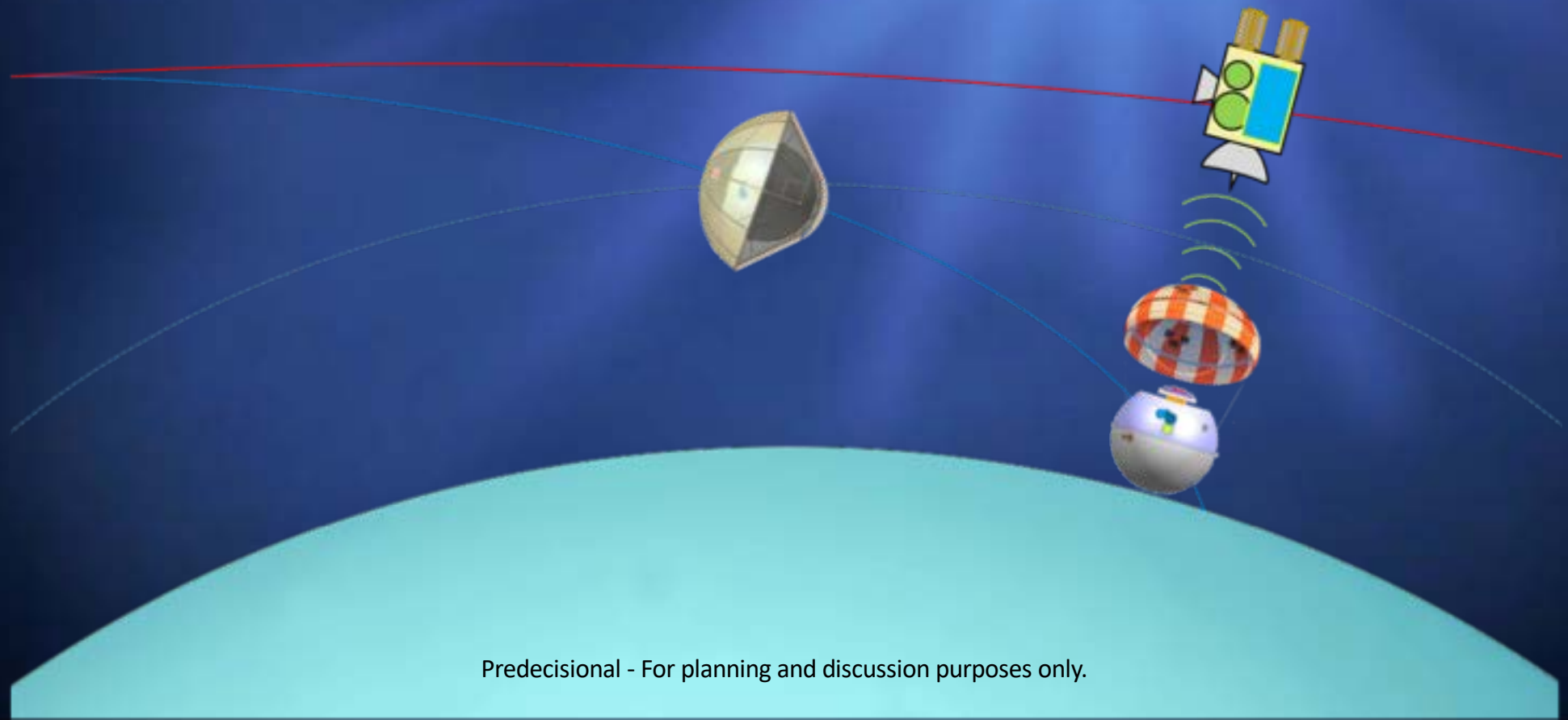
Ice Giant Probe Mission Concept

From Reh, et al. Return to the Ice Giants Pre-Decadal study summary, IPPW-14, 12-16 June, 2017

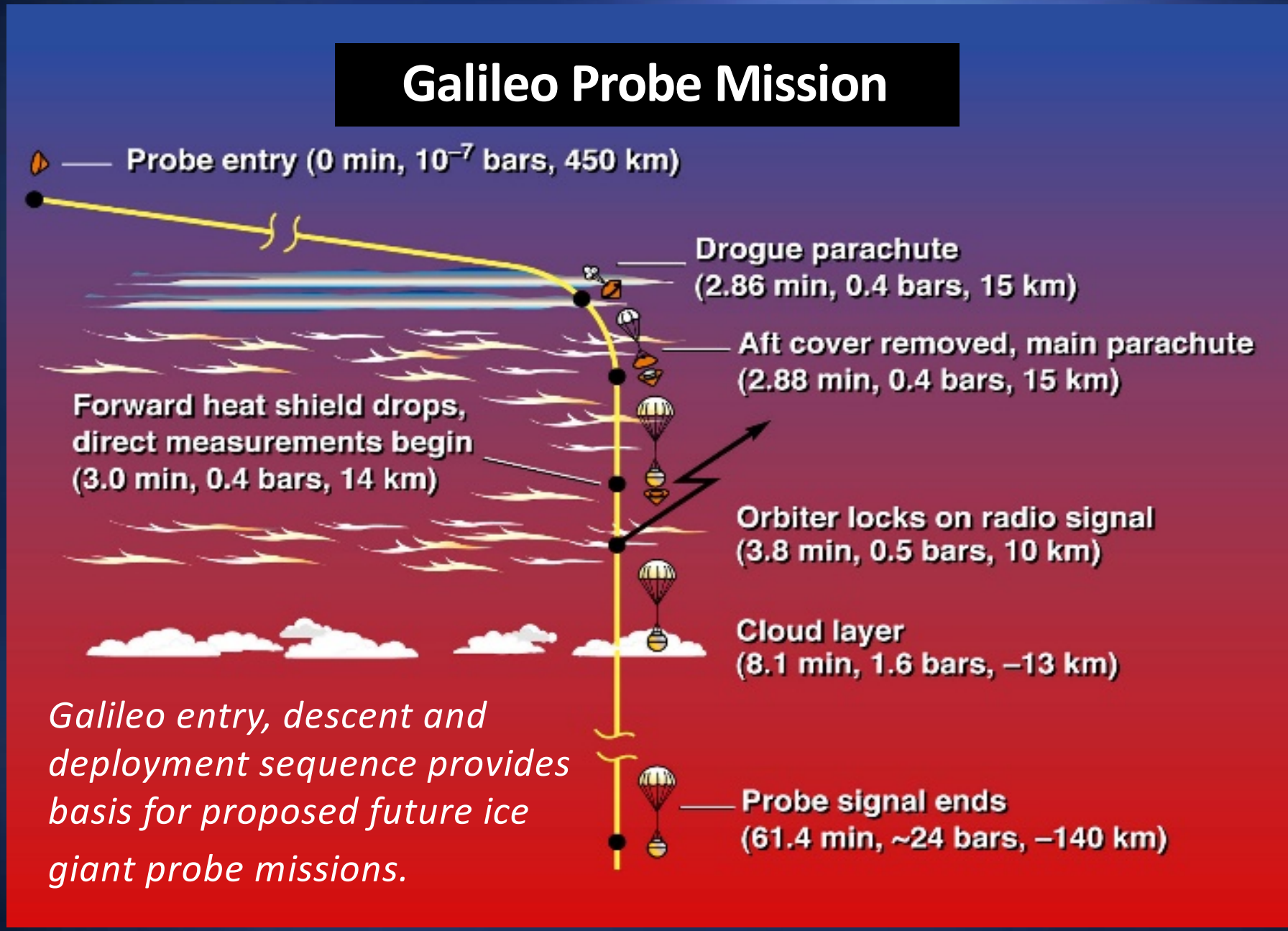
Release:
- ~60 days prior to entry
- Spin stabilized
- RHUs for coast heating

Uranus/Neptune Entry:
Entry V = 23.5/24.1 km/s

Telecomm to Carrier Relay Spacecraft:
Duration: >1 hr
Max Range: <100,000 km



Galileo Probe Mission



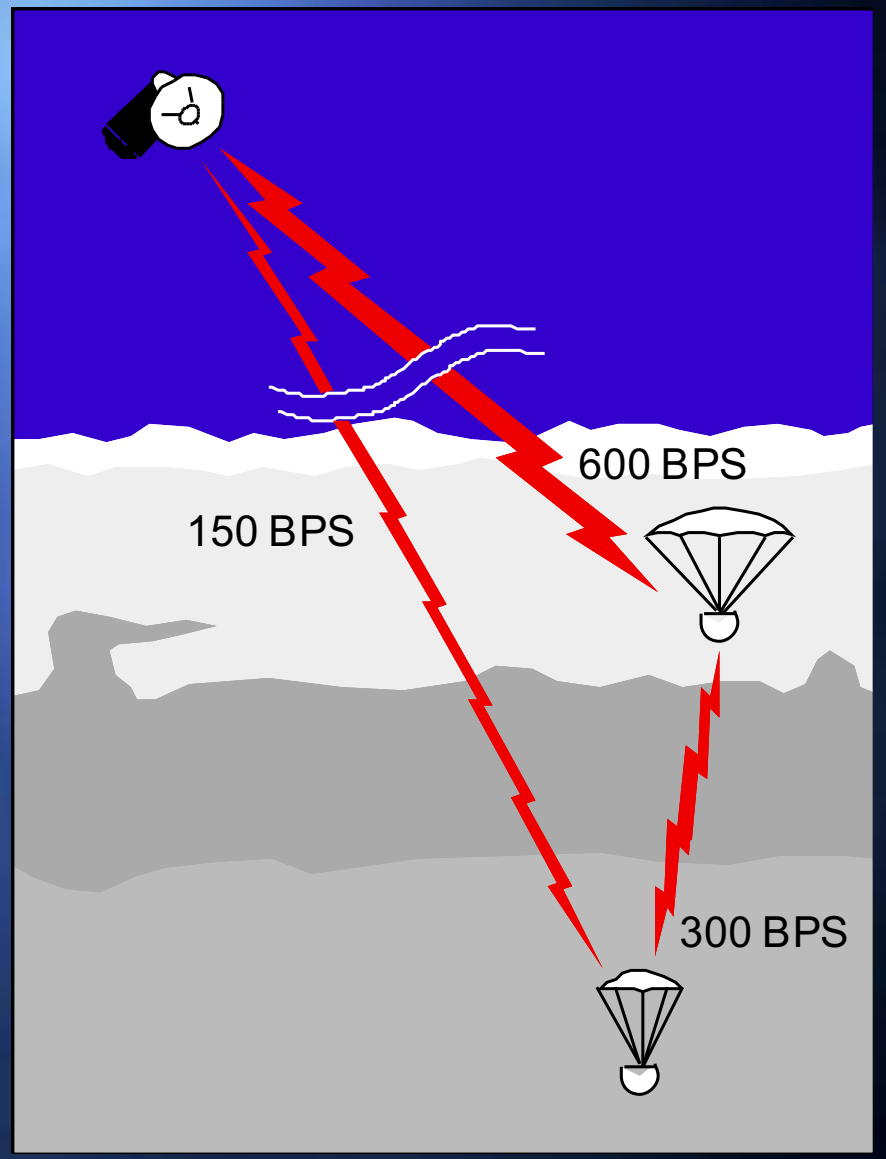
Galileo entry, descent and deployment sequence provides basis for proposed future ice giant probe missions.

Probe Science Payload

Instrument	Measurement
Mass Spectrometer (MS)	Elemental and chemical composition including noble gases and key isotopes
Atmospheric Structure Instrument (ASI)	Pressure and Temperature, Entry and Descent Accelerations → Density
Radio Science Experiment	Atmospheric dynamics: winds and waves; atmospheric absorption → composition
Nephelometer	Cloud structure, aerosol number densities and characteristics
Net Flux Radiometer	Net radiative fluxes: upwelling thermal IR, solar energy
Helium Abundance Detector	Helium Abundance

Deep Probe Telecommunications: Staged Probes

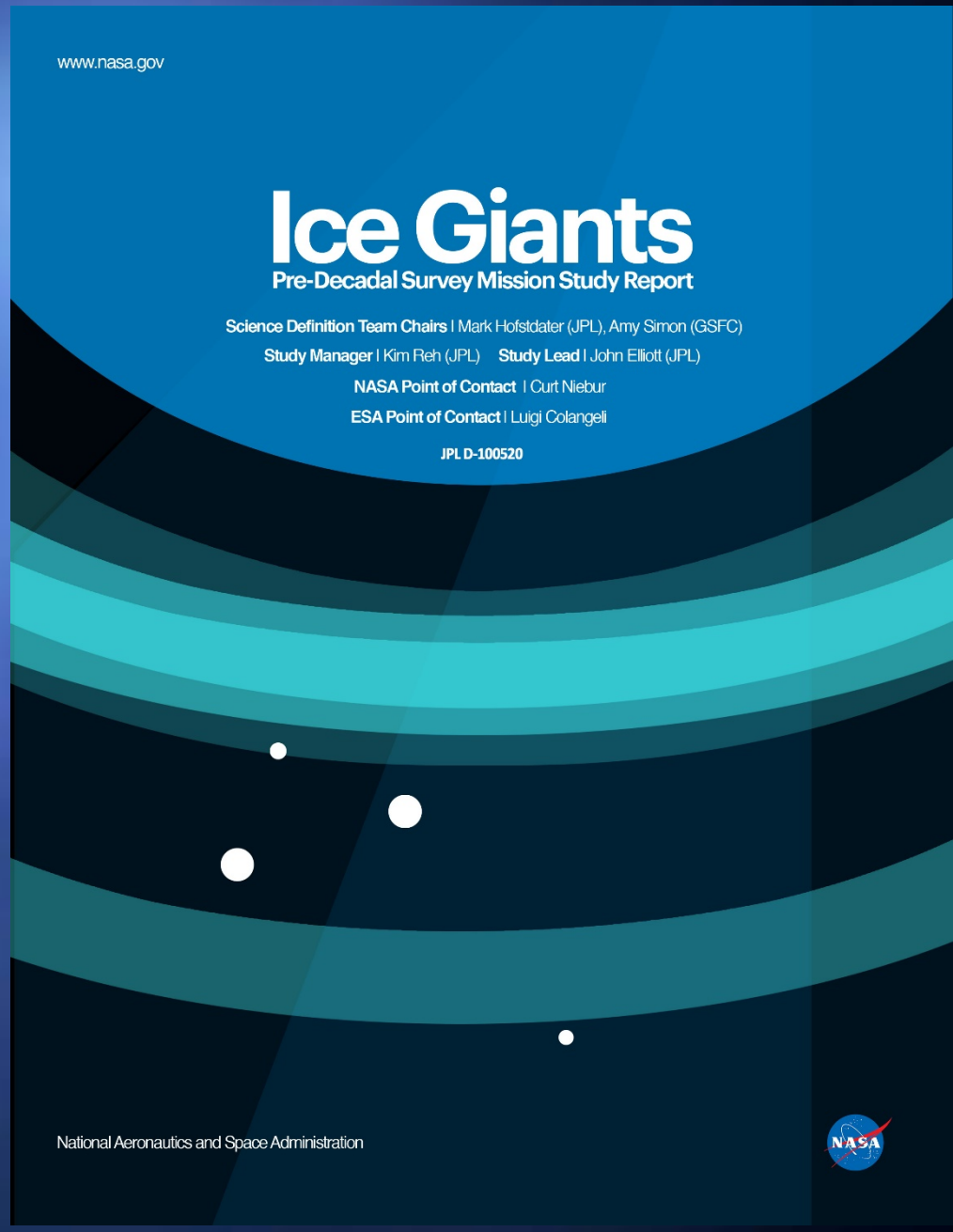
- Outer planet atmospheres primarily H_2/He but with significant radio-absorbing species: NH_3, H_2O.
- At UHF, shallow probes (10-20 bars) remain within relatively “clear” atmosphere → low absorption.
- Communication from deep atmosphere requires transmission through absorbing atmosphere → greatly reduced data throughput.
- Architecture Option: Shallow probe descending slowly releases deep probe for rapid descent → Offers potential to overcome RF opacity that limits deep probe telecomm data rates.



Summary

- The Giant Planets played a significant role in shaping the solar system including the formation and evolution of the terrestrial planets.
- With the exception of in situ measurements of Saturn's atmospheric composition, the Jupiter and Saturn systems have been explored in detail. The last largely unexplored class of planets is the Ice Giants.
- Remote Sensing is a very powerful technique, but is unable to measure essential components of the atmosphere, noble gases and key isotopes in particular.
- The legacy of the Galileo probe mission directly translates to concepts for future planet entry probe missions to Saturn and the ice giants.

Future ice giant explorations require an in situ element that will draw heavily on the experience of the Galileo probe, and outer planet probe mission concept studies.



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