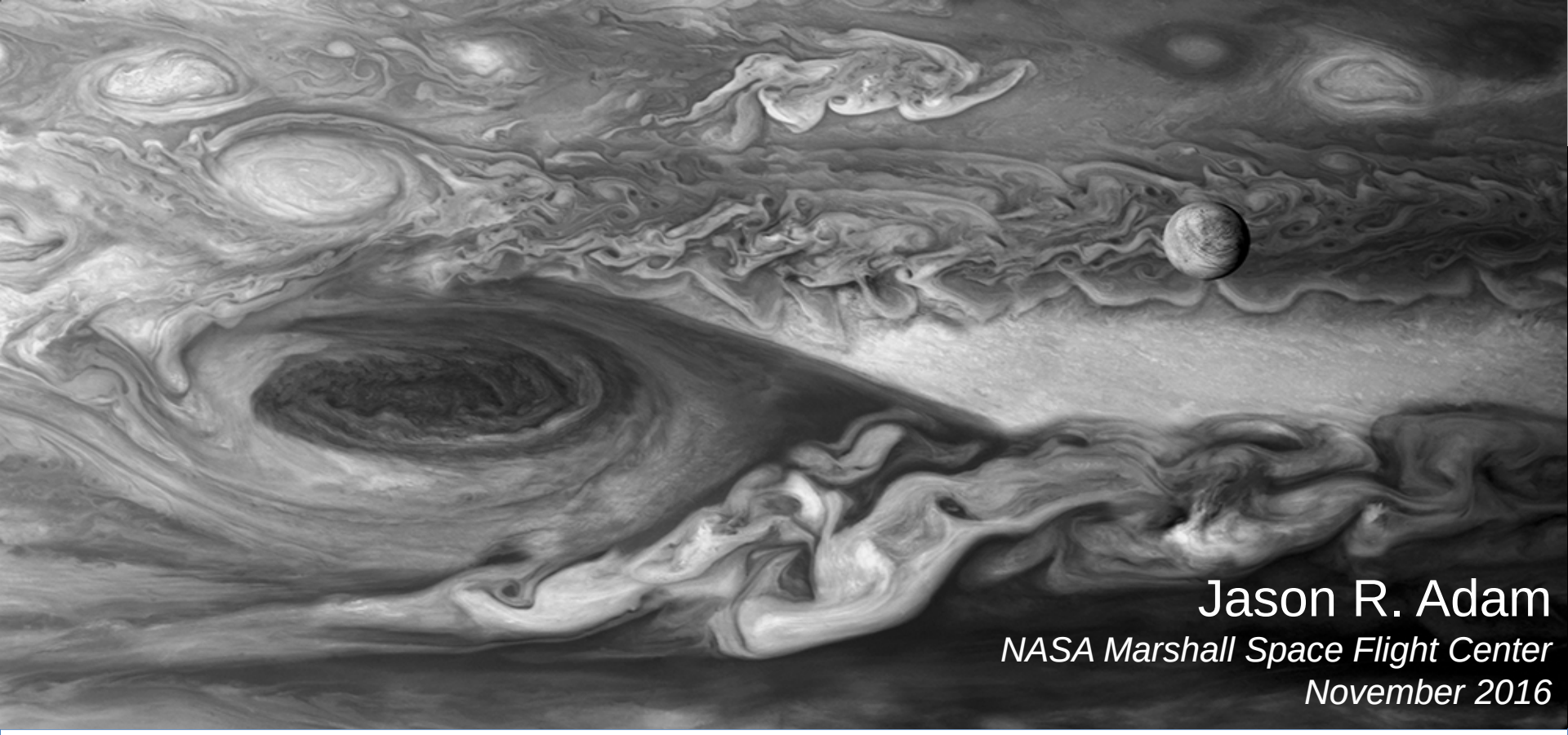


Jason R. Adam
NASA Marshall Space Flight Center
November 2016

Europa Mission Overview

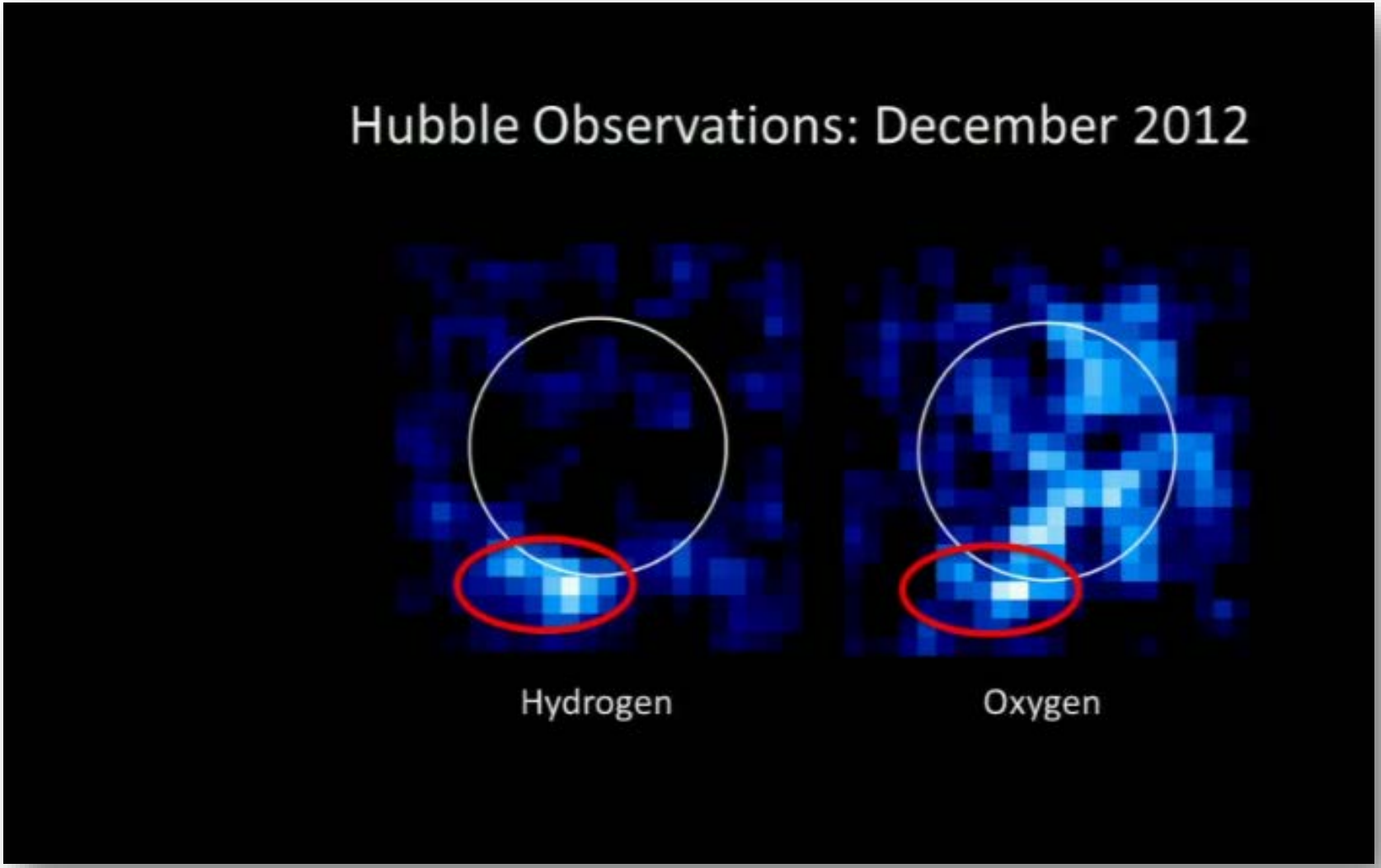
A Little About Me…

- Project Manager from NASA Marshall Spaceflight Center
  - Manage Europa Activities at MSFC
- NASA Civil Servant for ~14 years
- Started at Stennis Space Center, MS
  - Engine Test Operations
  - Worked Variety of Missions: Constellation/Ares I, Commercial Crew Program, Lunar Landers….Now Europa
- North Dakota Native
  - Grew Up In Williston, ND
- Graduated from North Dakota State University; Fargo, ND
  - BS Industrial & Manufacturing Engineering

- Love My Wife & 3 Kids & my North Dakota State Bison!!

- …we also say Roll Tide!

Europan Geysers?



Credit: NASA
http://solarsystem.nasa.gov/europa/docs/hstuvauroras_full.jpg

Key Science Questions

- How did the giant planets and their satellite systems accrete, and is there evidence that they migrated to new orbital positions?
- What were the primordial sources of organic matter, and where does organic synthesis continue today?
- Beyond Earth, are there contemporary habitats elsewhere in the solar system with necessary conditions, organic matter, water, energy, and nutrients to sustain life, and do organisms live there now?

TABLE S.1 Crosscutting Science Themes, Key Questions, and the Missions in the Recommended Plan That Address Them

Crosscutting Science Theme	Priority Questions	Missions
Building new worlds	1. What were the initial stages, conditions, and processes of solar system formation and the nature of the interstellar matter that was incorporated?	Comet Surface Sample Return, Trojan Tour and Rendezvous, Discovery missions
	2. How did the giant planets and their satellite systems accrete, and is there evidence that they migrated to new orbital positions?	Jupiter Europa Orbiter, Uranus Orbiter and Probe, Trojan Tour and Rendezvous, Io Observer, Saturn Probe, Enceladus Orbiter
	3. What governed the accretion, supply of water, chemistry, and internal differentiation of the inner planets and the evolution of their atmospheres, and what roles did bombardment by large projectiles play?	Mars Sample Return, Venus In Situ Explorer, Lunar Geophysical Network, Lunar South Pole-Aitken Basin Sample Return, Trojan Tour and Rendezvous, Comet Surface Sample Return, Venus Climate Mission, Discovery missions
Planetary habitats	4. What were the primordial sources of organic matter, and where does organic synthesis continue today?	Mars Sample Return, Jupiter Europa Orbiter, Uranus Orbiter and Probe, Trojan Tour and Rendezvous, Comet Surface Sample Return, Enceladus Orbiter, Discovery missions
	5. Did Mars or Venus host ancient aqueous environments conducive to early life, and is there evidence that life emerged?	Mars Sample Return, Venus In Situ Explorer, Venus Climate Mission, Discovery missions
	6. Beyond Earth, are there contemporary habitats elsewhere in the solar system with necessary conditions, organic matter, water, energy, and nutrients to sustain life, and do organisms live there now?	Mars Sample Return, Jupiter Europa Orbiter, Enceladus Orbiter, Discovery missions
Workings of solar systems	7. How do the giant planets serve as laboratories to understand Earth, the solar system, and extrasolar planetary systems?	Jupiter Europa Orbiter, Uranus Orbiter and Probe, Saturn Probe
	8. What solar system bodies endanger Earth's biosphere, and what mechanisms shield it?	Comet Surface Sample Return, Discovery missions
	9. Can understanding the roles of physics, chemistry, geology, and dynamics in driving planetary atmospheres and climates lead to a better understanding of climate change on Earth?	Mars Sample Return, Jupiter Europa Orbiter, Uranus Orbiter and Probe, Venus In Situ Explorer, Saturn Probe, Venus Climate Mission, Discovery missions
	10. How have the myriad chemical and physical processes that shaped the solar system operated, interacted, and evolved over time?	All recommended missions

Europa Mission Listed In Top Tier By NASA Decadal Survey

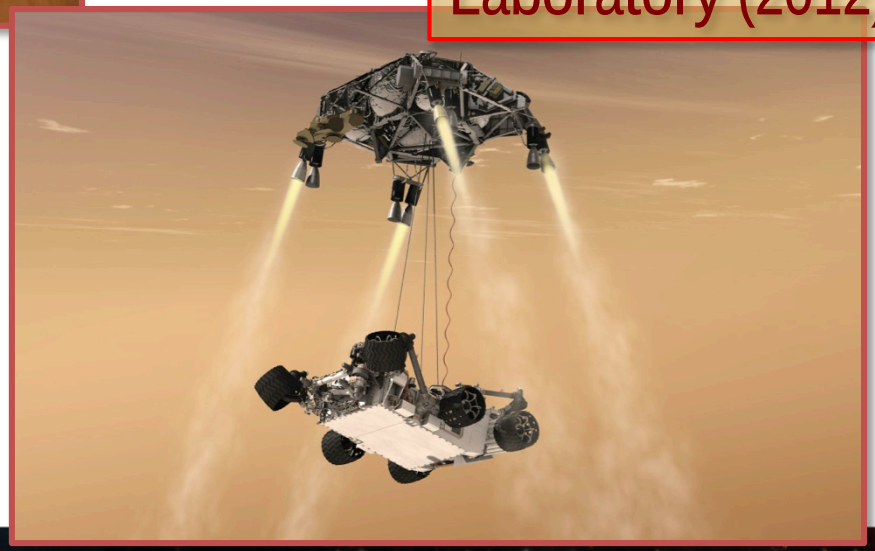
https://solarsystem.nasa.gov/docs/131171.pdf

Europa Lander Architecture Leverages The Past

Mars Pathfinder (1997), Mars Exploration Rover (2004)

Viking Mission (1975)

Mars Science Laboratory (2012)



Europa Mission

Science Mission Directorate

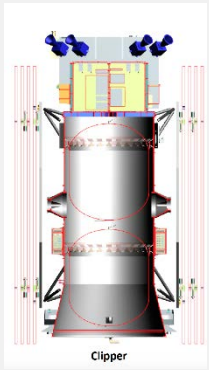
Planetary Science Division

Decadal Survey

Top Tier Interplanetary Priority: Europa

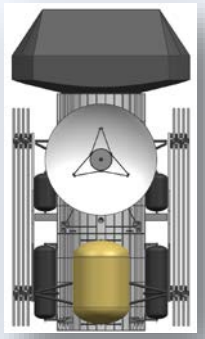
Europa Project

Clipper

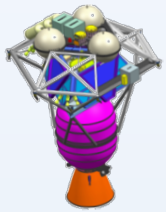


Lander

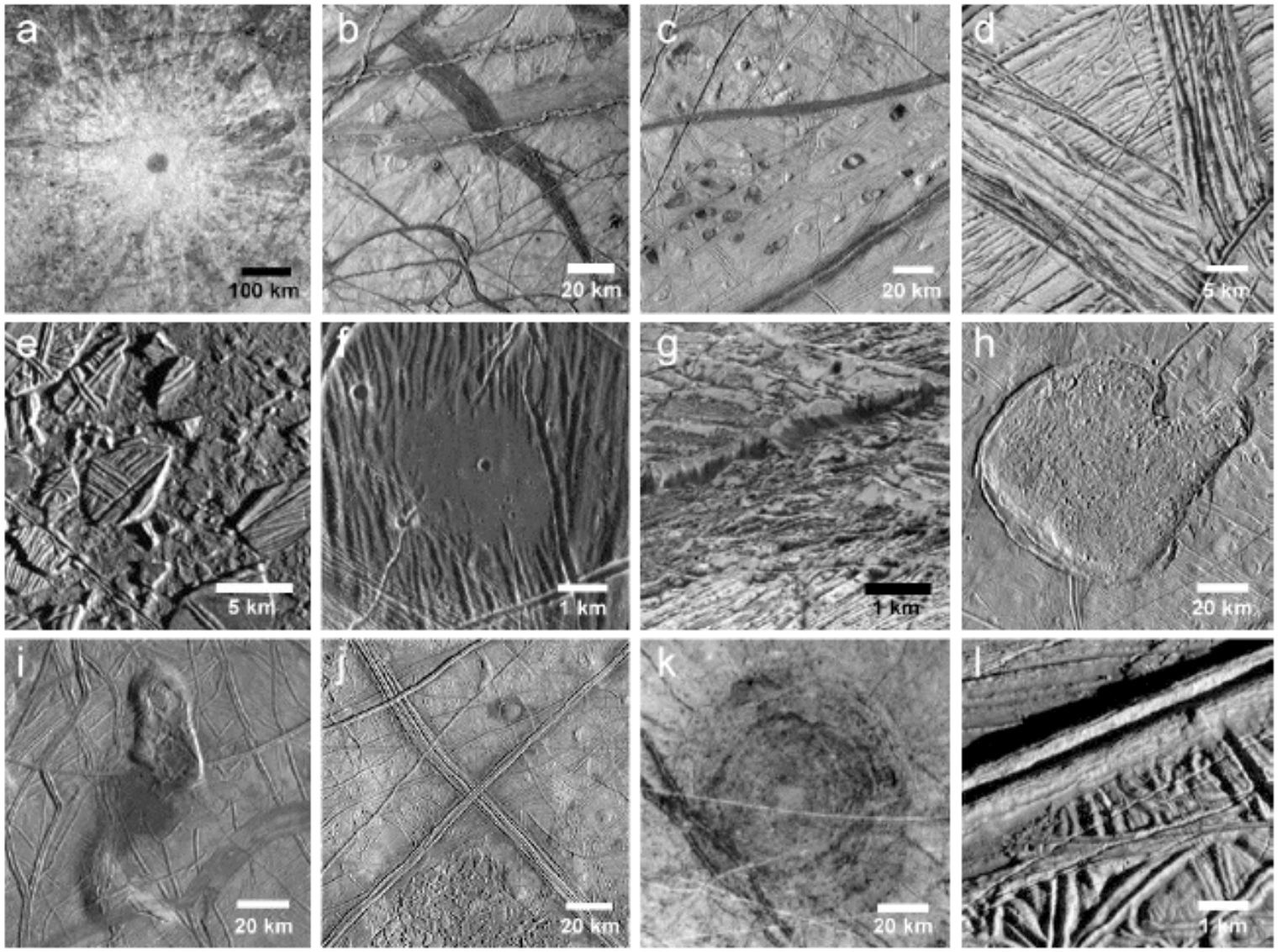
Carrier Stage



Descent, Lander & De-Orbit Stage



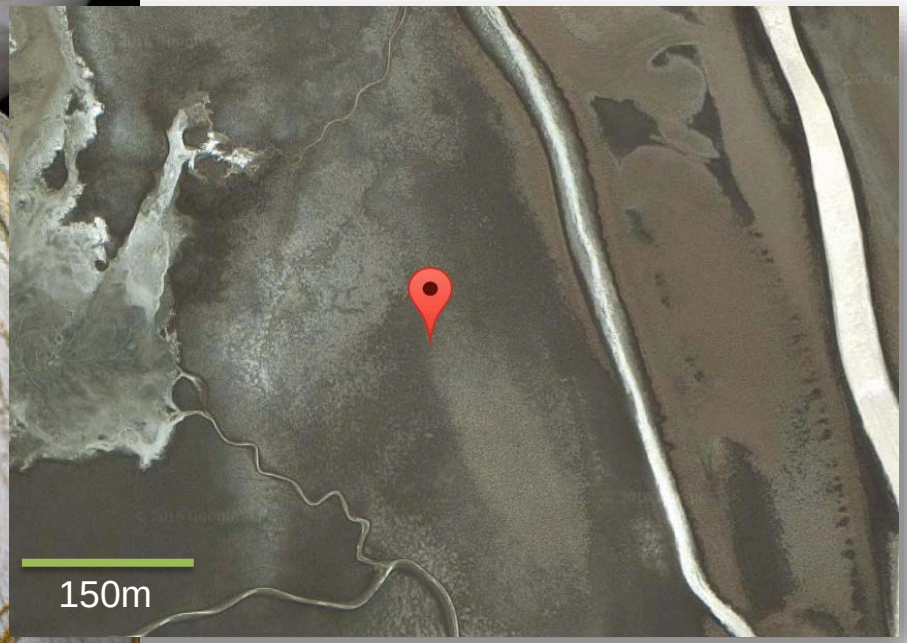
Galileo Images Show Europa Having Rugged, Unusual Terrain



https://solarsystem.nasa.gov/galileo/gallery/europa.cfm

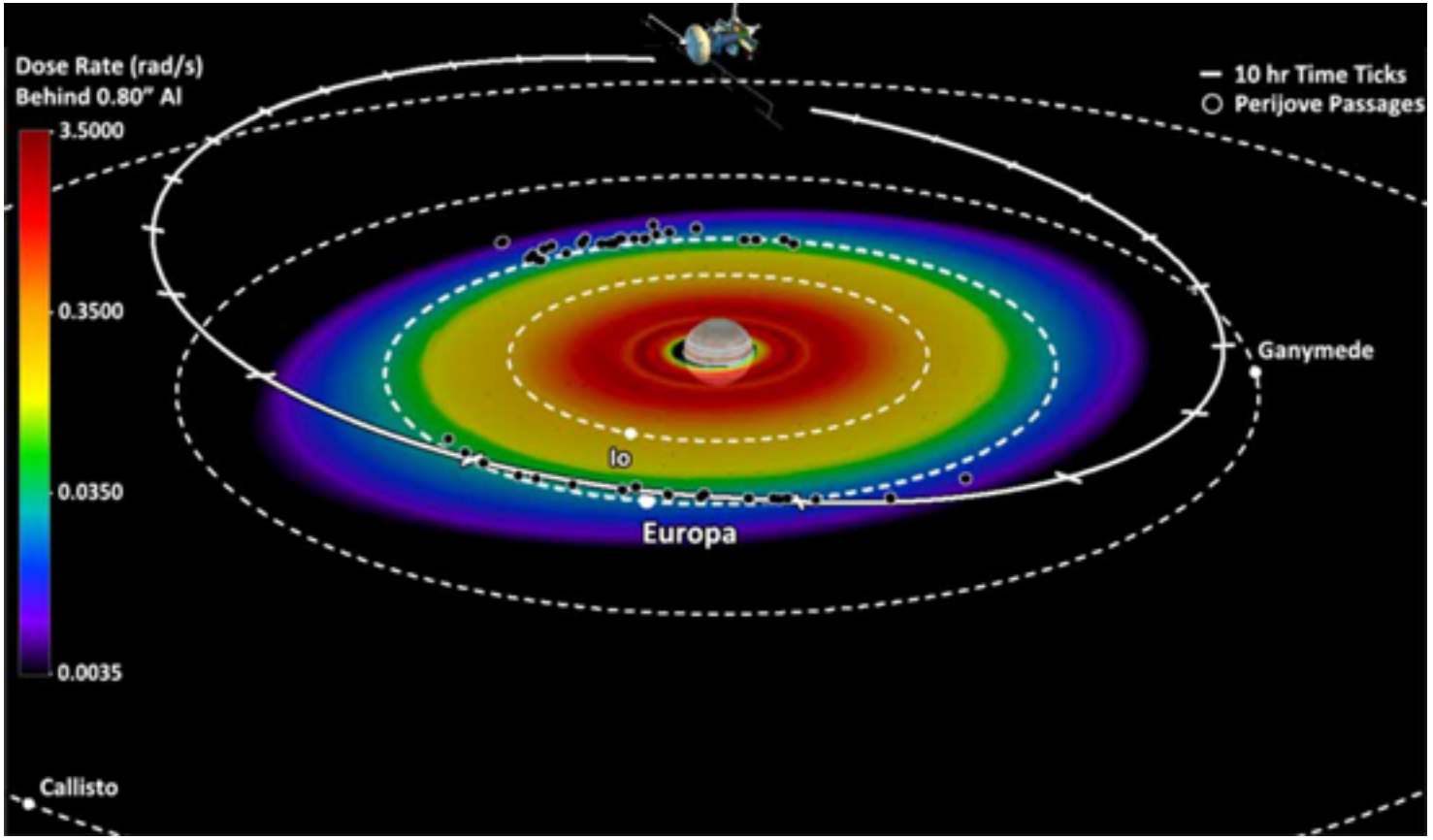
The Importance of High Resolution Imagery

Devil's Golf Course – Death Valley



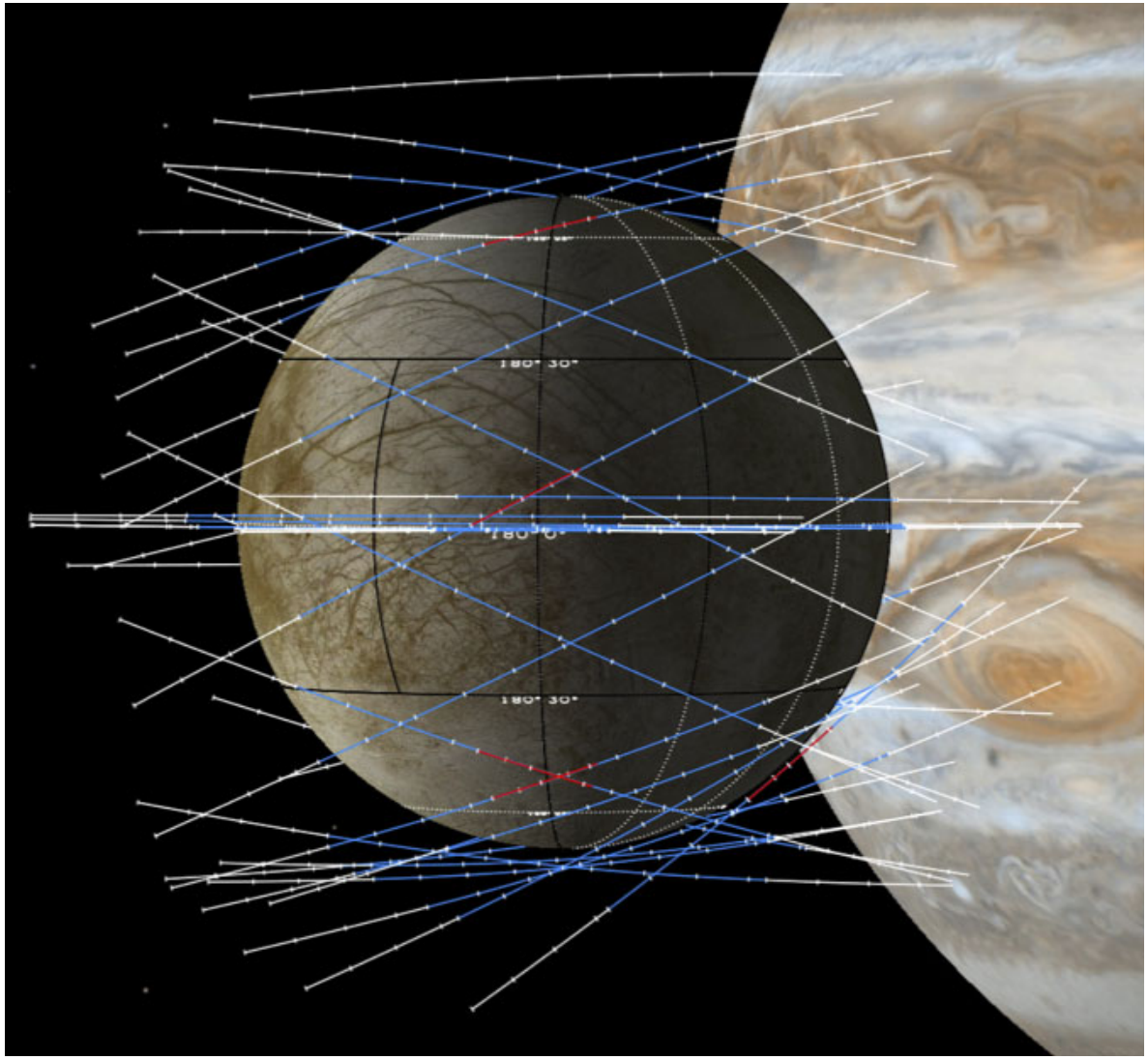
Current Knowledge Cannot Exclude Possibility of Ubiquitous Landing Hazards

Radiation Example (Individual Mileage May Vary)



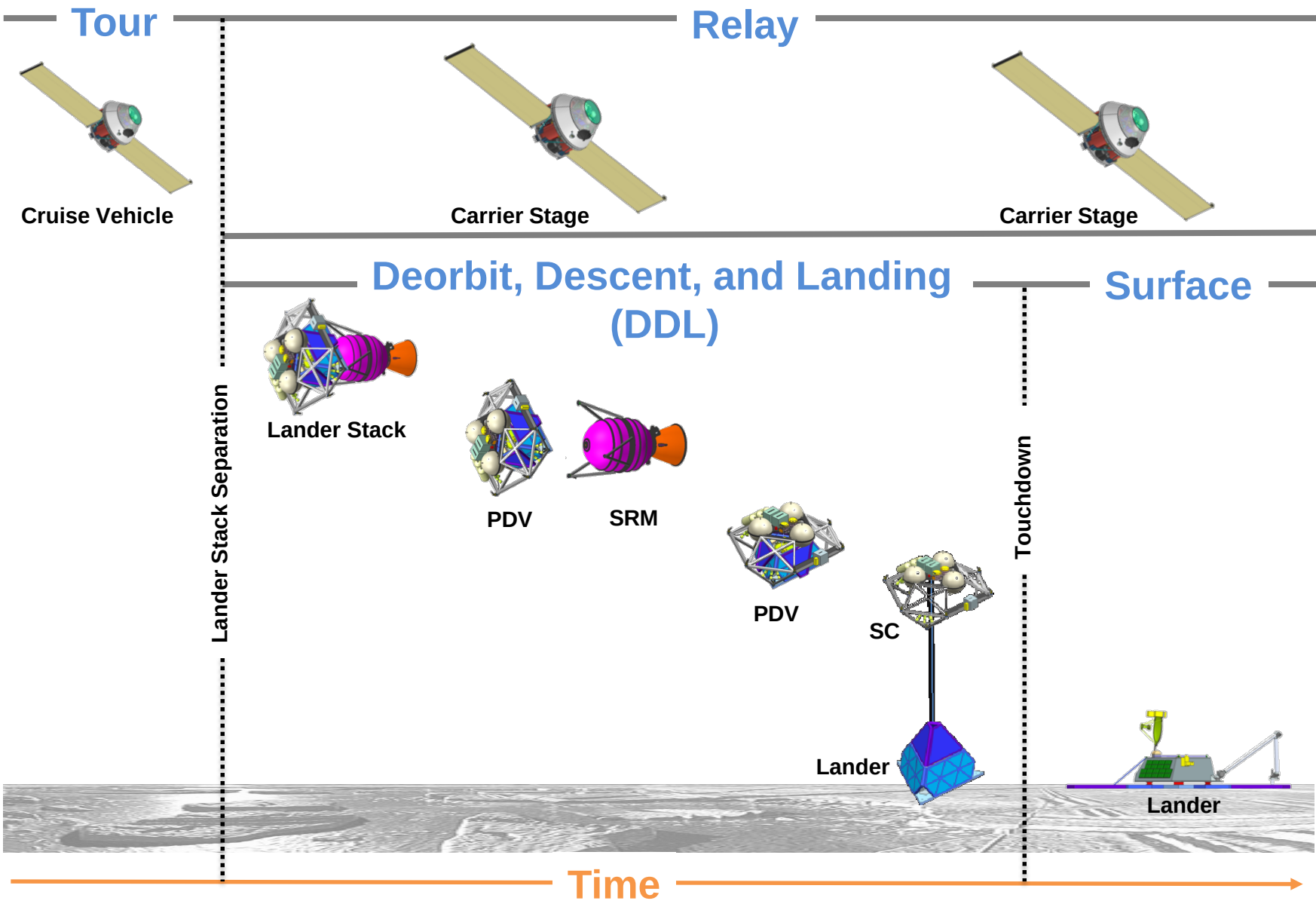
https://en.wikipedia.org/wiki/Europa_Multiple-Flyby_Mission

Clipper Fly-Bys (Notional)



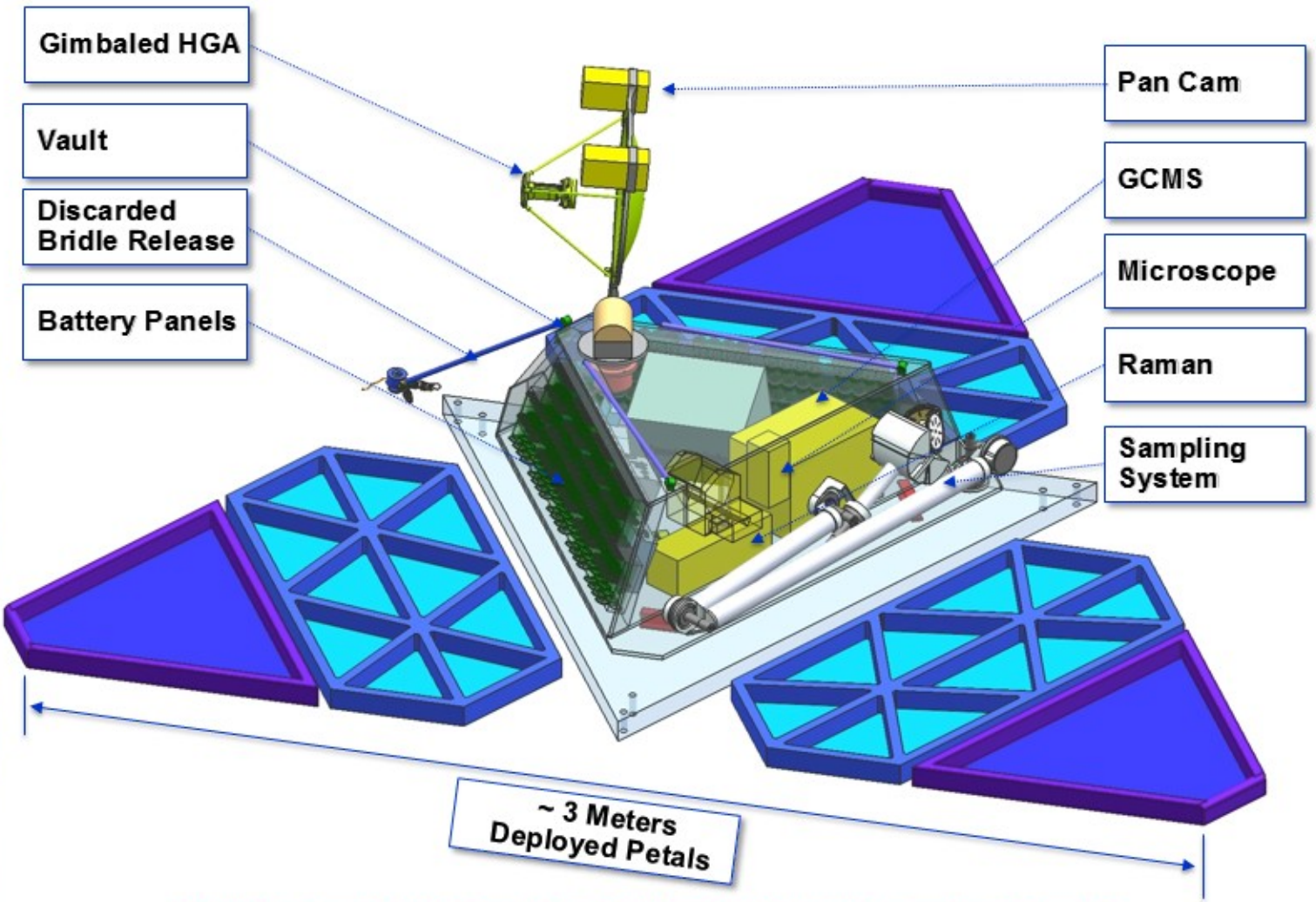
https://en.wikipedia.org/wiki/Europa_Multiple-Flyby_Mission#/media/File:EuropaClipper.jpg

Recap: Top-Level Event Sequence



http://futureplanets.blogspot.com/2016_04_01_archive.html

Lander Surface Concept



http://futureplanets.blogspot.com/2016_04_01_archive.html

Top Technical Challenges

- Planetary Protection
  - Low Probability of 'Reverse Contaminating Europa'
  - Cannot Depend On Propellant Burn For Sterilization
  - May Mean Motor Bake-Out
  - Impacts To Propellant Performance? Repeatable?
  - Bio-Barrier To Maintain Sterility
- Radiation Tolerance
  - Radiation Dose Is Significant
  - All On-Board Components Need To Be Rad Tolerant
- Thermal Management
  - Temp Control Impacts Time & Total Impulse Uncertainty
- Long Term Space Storage
  - 3-7 Year Transit Time

Risk Mitigation Plans Developed To Address Each Risk Area

Summary

- Europa Is A High Priority For NASA
  - Findings *could* lead to new understandings
    - Could conditions exist elsewhere in our Solar Systems that could be conducive to life?
    - Perhaps help us understand the biological building blocks of our own world
- NASA/Marshall is very excited to lead a significant element of the Europa Mission.

Potential Geysers on Europa *(100-200 miles in height)*