National Aeronautics and Space Administration

Europa Mission Status

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Presentation to the Planetary Protection Subcommittee

November 17, 2014

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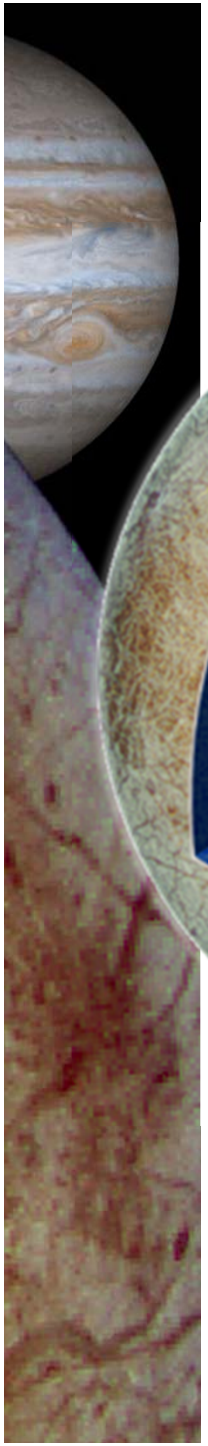
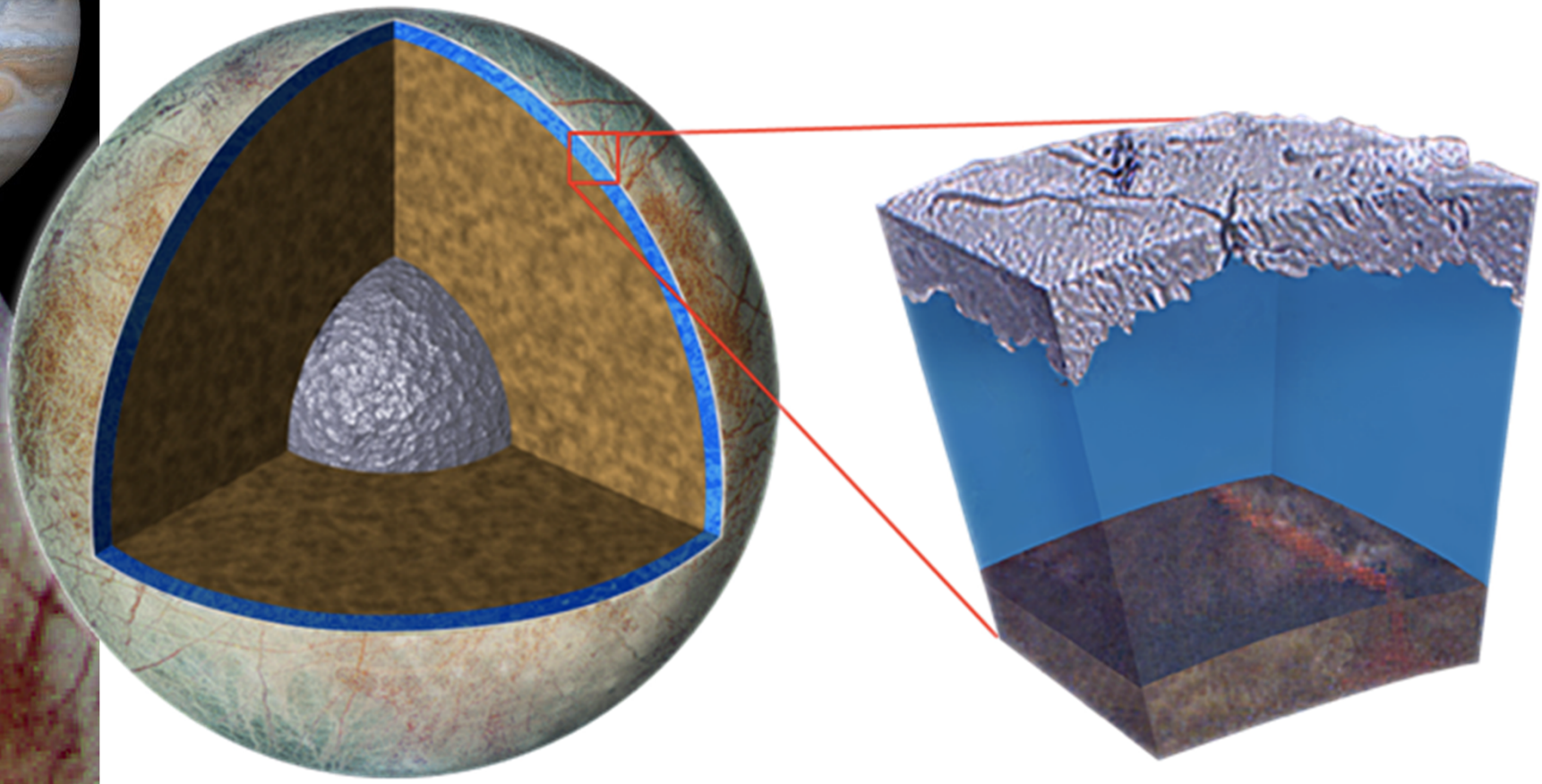
Caveat

- The mission concepts presented in this briefing are notional. They have not yet been reviewed through the Agency approval process, any cost estimates are rough at best, and instruments are still notional.

Why Europa?

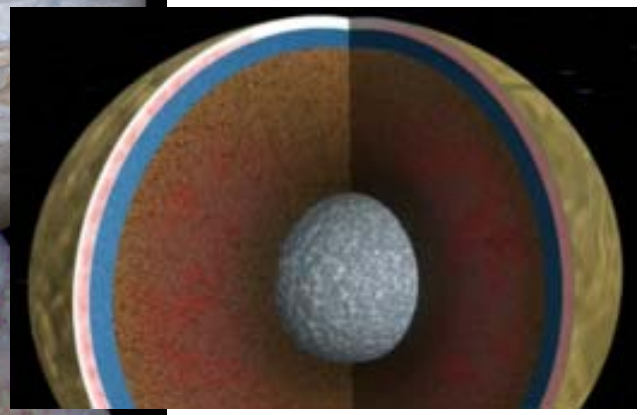




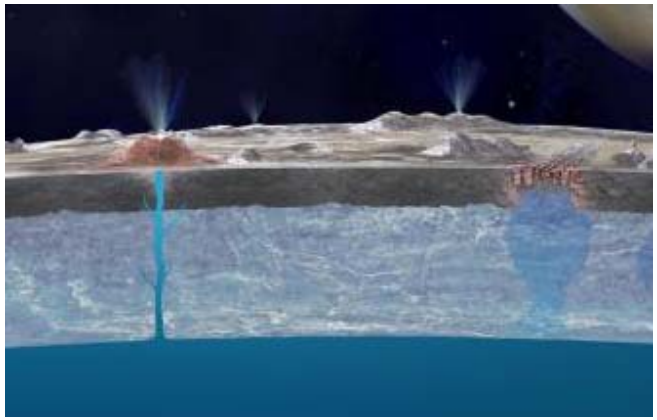
"Europa, with its probable vast subsurface ocean sandwiched between a potentially active silicate interior and a highly dynamic surface ice shell, offers one of the most promising extraterrestrial habitable environments, and a plausible model for habitable environments beyond our solar system"

- The Decadal Survey

The Big Question: Is Europa Habitable?



How deep and salty is the ocean?
Gravity, Magnetometer
(GRAIL, GRACE)

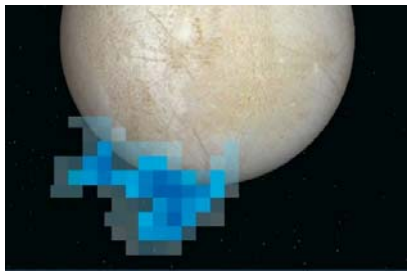


How active is the ice shell?
Camera, Thermal Imager
(MRO, ICESat)

How thick is the ice shell?
Radar, Gravity
(MRO, Cassini)

What's in the plumes?
Mass Spectrometer
(Cassini)

What's the brown stuff?
IR & Mass Spectrometers
(Landsat, MRO)



The drive to answer these questions has guided mission concepts for 15 years, drawing on our experience at Mars, Saturn and Earth

Evolution of Mission Concept

- Since 1999 NASA has studied over 18 mission concepts that would answer those important questions

  Europa Orbiter (2001): small $1B orbiter mission with ~20 kg payload
  - Lesson: the radiation was worse and custom rad-hard parts more expensive than anticipated; cost increased

  Jupiter Icy Moons orbiter (JIMO) (2004): large orbiter mission with >200 kg payload
  - Lesson: increased science scope massively impacts mission design

  Europa Explorer & Jupiter Europa Orbiter (JEO) (2007-2011): $4-$5B orbiter mission with ~100 kg payload
  - Lesson: orbiting Europa strains mission and spacecraft design

  Orbiter (2013): <$2B orbiter mission with ~90 kg payload
  - Lesson: trade science return and payload against need to orbit Europa

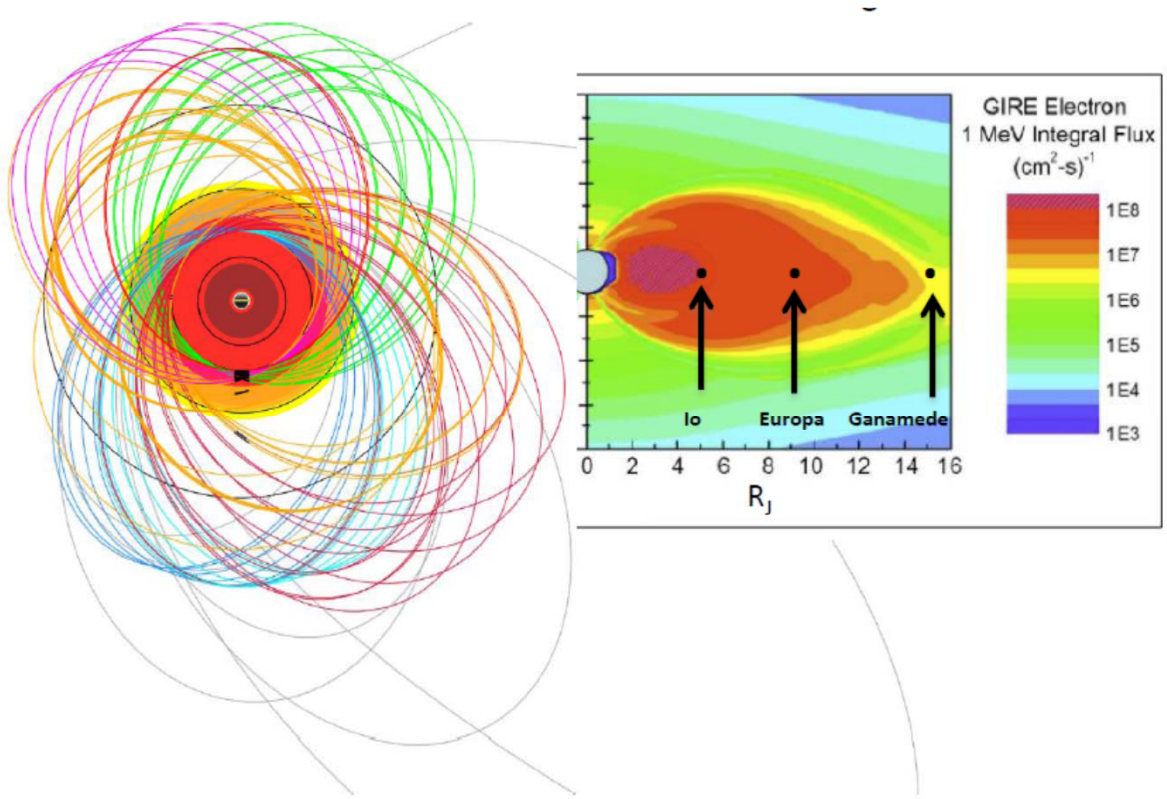
  Lander (2013): $4B soft lander lasting one month
  - Lesson: sample acquisition necessary, landing blind

Mission Architecture

- Scientific desire for global coverage has invariably led to Europa orbiter mission architectures in the past
- Europa orbiter mission:
  - Very expensive in propellant (ΔV) due to large orbit insertion maneuver
  - This maneuver takes away from mass that could be used for scientific instrumentation and radiation shielding
  - Limited lifetime due to continual immersion in harsh radiation (less data return, data return more susceptible to s/c or DSN anomalies)
- Experience at Saturn with Cassini provides an alternative approach:
  - With Europa mission investments and leveraging off previous research/experience on Cassini, the team has developed strategies to gain near global coverage via multiple flybys from a Jupiter orbit.

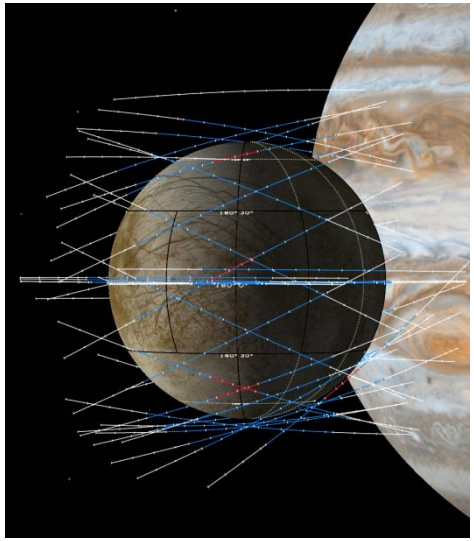
Potential Multiple Flyby Mission Concept

- Systematic build up of Europa flybys to obtain global-regional coverage of Europa
- Key mission strategy: While in orbit around Jupiter,
    1. Dip into the harsh radiation environment to collect a high volume of Europa data
    2. Get out of intense radiation environment and downlink high volume of data with large downlink margins



JPL Clipper concept

- Successful concept design allowed a paradigm shift from Orbiter ($4.7 B Decadal CATE JEO estimate, excluding launch vehicle) to Multiple Flyby concept (≈ $2B FY 15$, excluding launch vehicle).
- Achieves >80% of science for <50% of cost (SDT & Independent Board):
  - Limit science scope (focus on Europa, not Jovian System)
  - Builds on multiple Juno and Cassini developments
  - Achieve near global coverage without sustained very high radiation environment at Europa
    - Fly by close, collect science data, leave
    - Standard hi-rad parts replace custom hi-rad parts
  - Less propellant needed to enter Jupiter orbit, mass goes to shielding
  - Simplified Operational concept; same concept for each flyby
- Fly-by & collect science data, remaining Jupiter orbit used to recharge batteries & downlink data (capable of 5 times more data downlink)



Regional-Global coverage of Europa achieved through 45 flybys

Europa Clipper Mission Concept Review Charter and Purpose

- Director for Solar Systems Exploration at the Jet Propulsion Laboratory, requested an independent review of the Europa Clipper mission
- The independent review team was asked to critically review the end-to-end mission concept, organization, technical, and management plans, consistent with a Mission Concept Review (MCR) level of maturity
- The review was conducted at the Jet Propulsion Laboratory September 16-18, 2014
- A team of subject matter experts with decades of relevant hands on experience was assembled for the purpose of the review. The chair and membership was coordinated closely between JPL, APL, and HQ

Brief summary of MCR findings

- The review and material presented and discussed exceeded all expectations for an MCR.
- The design has benefited greatly from the substantial early funding, and the Project has applied the resources smartly towards engineering (22 risk retirement activities) and science (11 risk reduction studies) risk areas
- The mission concept and design is sound, enabled by an in-depth knowledge and close collaboration between science and engineering

Additional upcoming efforts

- 57 Dedicated Hubble Observations with optimal lighting conditions planned for Oct. 2014 – March 2015, to attempt to verify existence of Europa plumes
  - Not confirming their existence does not mean they don't exist. Variability factors are currently not understood.
- Host a workshop with leading astrobiologists and Europa scientists to understand how to possibly interrogate the plumes if they exist.
  - Previous 'plume' workshop fully endorsed mission concept and strawman payload
  - Identify 'best' instruments and mission concepts to maximize likelihood of detecting current life if it exists
- Released SALMON 2 PEA in July 2015 to solicit instrument investigations for an unspecified Europa mission
  - Selections are expected in April 2015