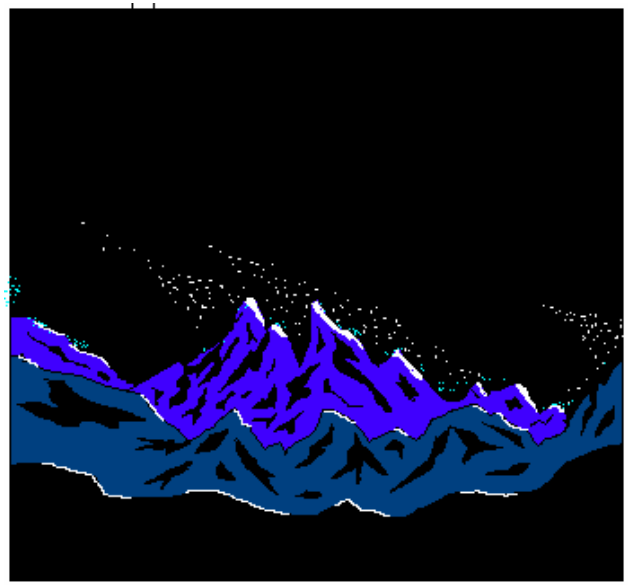
Europa Geophysical Explorer Mission Concept



The Next Step in

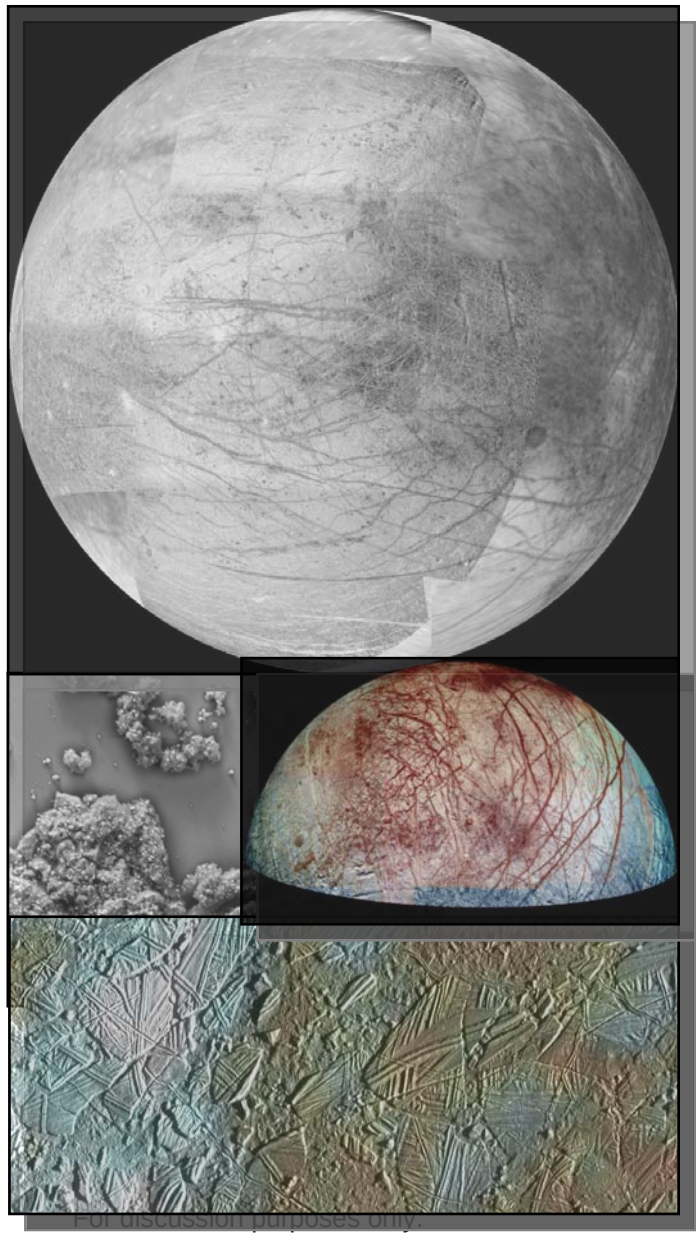
Europa Exploration

Jackie Green, Study Lead

Introduction to EGE 2005

➢ **The Strategic Road Map for Solar System Exploration recommended in May 2005 that NASA implement the Europa Geophysical Explorer mission as a Flagship mission early in the next decade**

- **The Europa Geophysical Explorer will**
  - Characterize **tidal deformations** of the surface of Europa and **surface geology** to confirm the presence of a subsurface ocean
  - Measure the **3 dimensional structure** and **distribution** of subsurface water.
  - Determine **surface composition from orbit**, and, potentially, **pre-biotic chemistry,** *in situ*
- **Mission Concept**
  - **Orbiter** equipped with ice penetrating radar and a suite of remote sensing and other instruments.
  - **Lander** designed to land safely on the rugged, icy surface of Europa (**optional**)



Objectives of this Study

- **NASA Headquarters Solar System Exploration initiated a 45 day study of the mission in early May 2005 in order to**
  - Understand new mission possibilities that have emerged since the Europa Orbiter mission was cancelled
  - Define technology and advanced development needs to support a launch early in the next decade

- **The Study is sponsored through technology programs:**
  - Science – Curt Niebur
  - SS Chief Technologist – Jim Robinson
  - Radioisotope Power System Program – Ajay Misra

The Next Step in Europa Exploration

Why can we do this mission now? What has changed?

- **The Europa Geophysical Explorer conceived in 2005 can be a much more capable mission than the Europa Orbiter cancelled in 2001:**

✓ **Earth Gravity Assists (EGAs) are on the table (direction from NASA)**
  - Dramatic increase in delivered mass
  - Somewhat longer flight time is acceptable

✓ Advances in Radiation Hard components and sub-systems
  - Results from considerable investments from X-2000 and JIMO

✓ Developments in RPS Systems
  - Technology development for the MMRTG, SRG, and upgraded MMRTG

However,

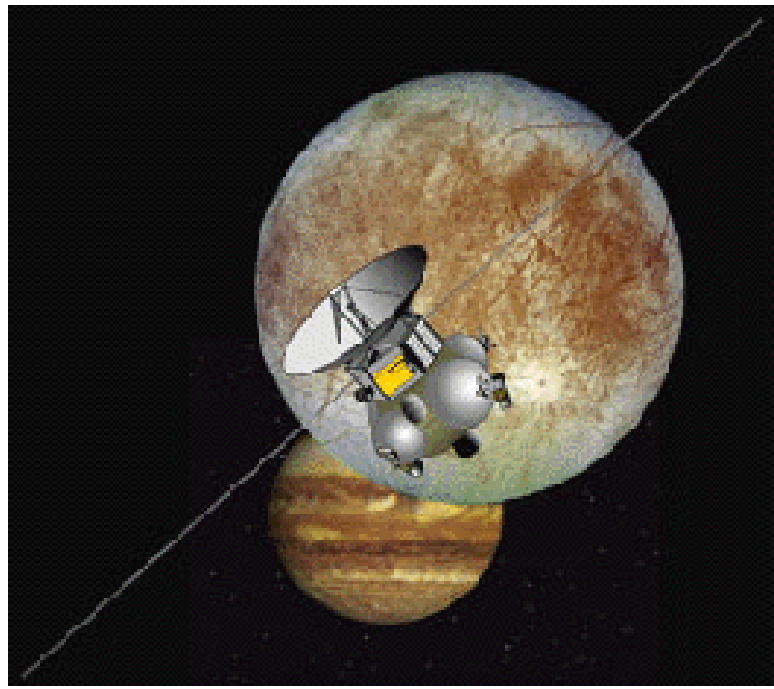
- **Additional mass capability must be applied judiciously, without driving costs into an unaffordable range**

Options for Additional Available Mass

- **The Additional Available mass may be used for:**
  - Additional spacecraft growth margin needed due to challenges of a Europa mission
  - Additional instruments for enhanced orbital science
  - Extra radiation shielding that could result in a longer mission duration
  - A capable lander for surface operations (ref., Tibor Balint, Europa Surface Science Package Report, 09/2004)
  - Other purposes, still to be defined

Draft Level One Requirements

- **Draft Level One Requirements**
  (from NASA HQ, Curt Niebur)
  - **Earliest Launch:** 2012
  - **L/V:** Delta IV- Heavy
  - **Primary Propulsion:** Chemical
  - **Power:** RPS Power Systems
  - **Orbital Mission:** 30 days minimum to meet orbital science objectives
  - **Earth gravity assists:** Allowed



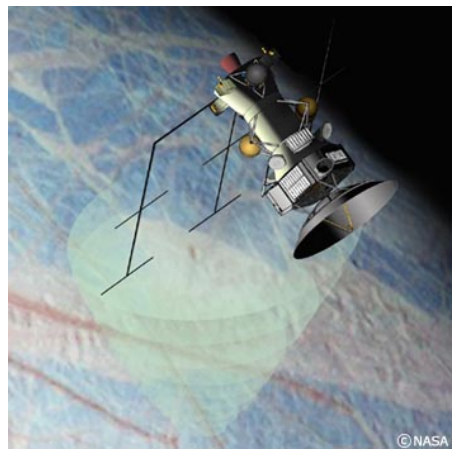
EGE Reference Mission Definition

- **Several potential mission options were explored within the EGE study.**
  - This trade space explored the system impacts of selecting different payloads, power systems, DSN architectures, trajectories, and launch vehicles.

- **Of these options, one option was selected as the <u>Reference Mission</u> because it:**
  - 1) Meets the requirements provided by Headquarters and the OPAG Europa Sub-Group
  - 2) Is the more conservative case, relying least upon advanced technology and infrastructure development.

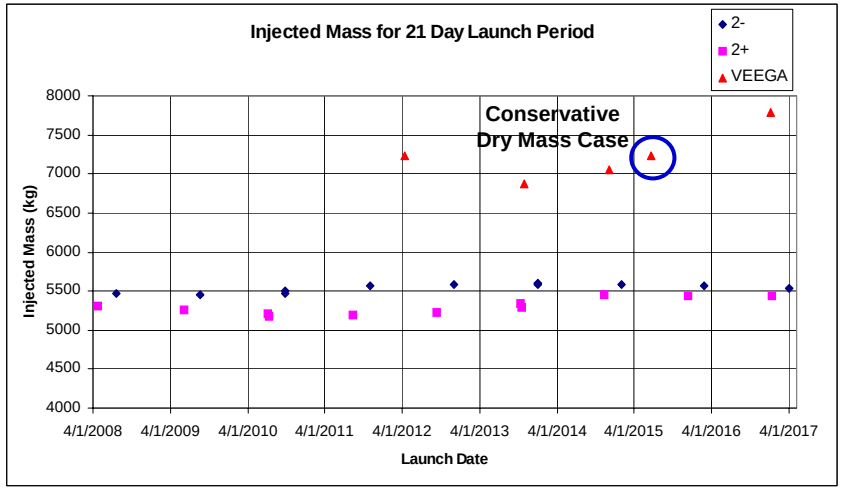
- **The Reference Mission option has the following mission parameters:**
  - Payload allocation: 150 kg / 150 W*
  - Lander Feasibility: TBD
  - RPS type, or design: MMRTGs
  - Trajectory: VEEGA
  - Launch Vehicle: Delta 4050H
  - DSN: Existing Architecture

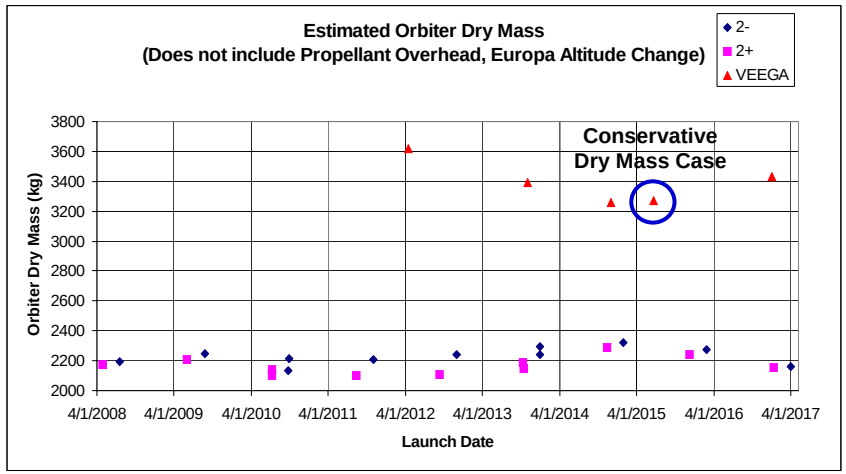
*(already includes 43% margin)



EGE Reference Mission Parameters

- **Launch Date: April 15, 2012**
  - However, assume most conservative S/C dry mass value between 2012 and 2017.
- **Trajectory: VEEGA**
- **Launch Vehicle: Delta IV-Heavy**
- **Launch Mass Capability: ~7230 kg (C3=~14)**
  - Corresponds to most conservative S/C dry mass.
- **Estimated Available Dry Mass: ~3250 kg**
  - Is the most conservative mass value between 2012 and 2017 – (corresponds to 2015 value)
- **Total time to Europa: ~8 years.**
  - Trip to Jupiter: 6.4 years
  - Jovian System Tour: ~1.5 years
- **Note on use of conservative mass estimate:**
  - There are mass benefits for launching in 2012 and 2013. For example, if the 2012 launch date occurs, it would permit ~300kg additional spacecraft dry mass (i.e., ~3600 kg)

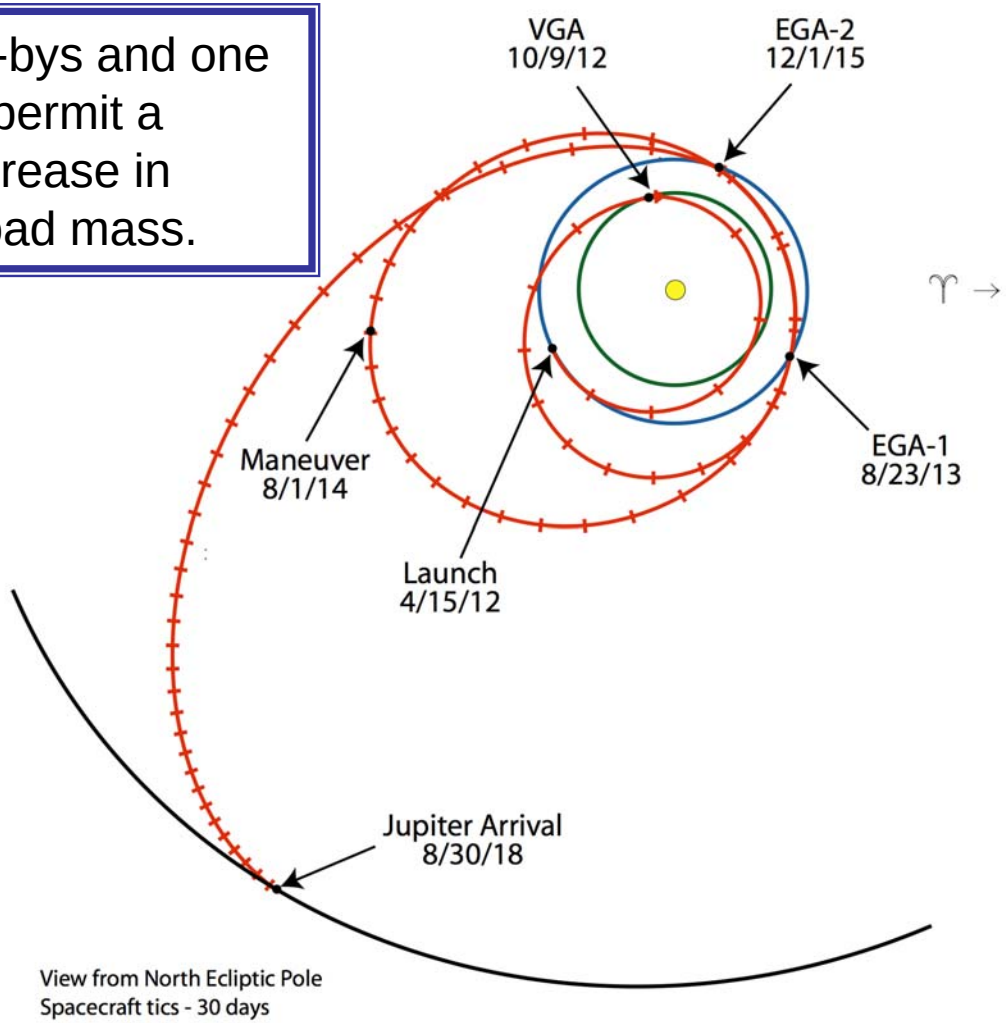




EGE Mission Design

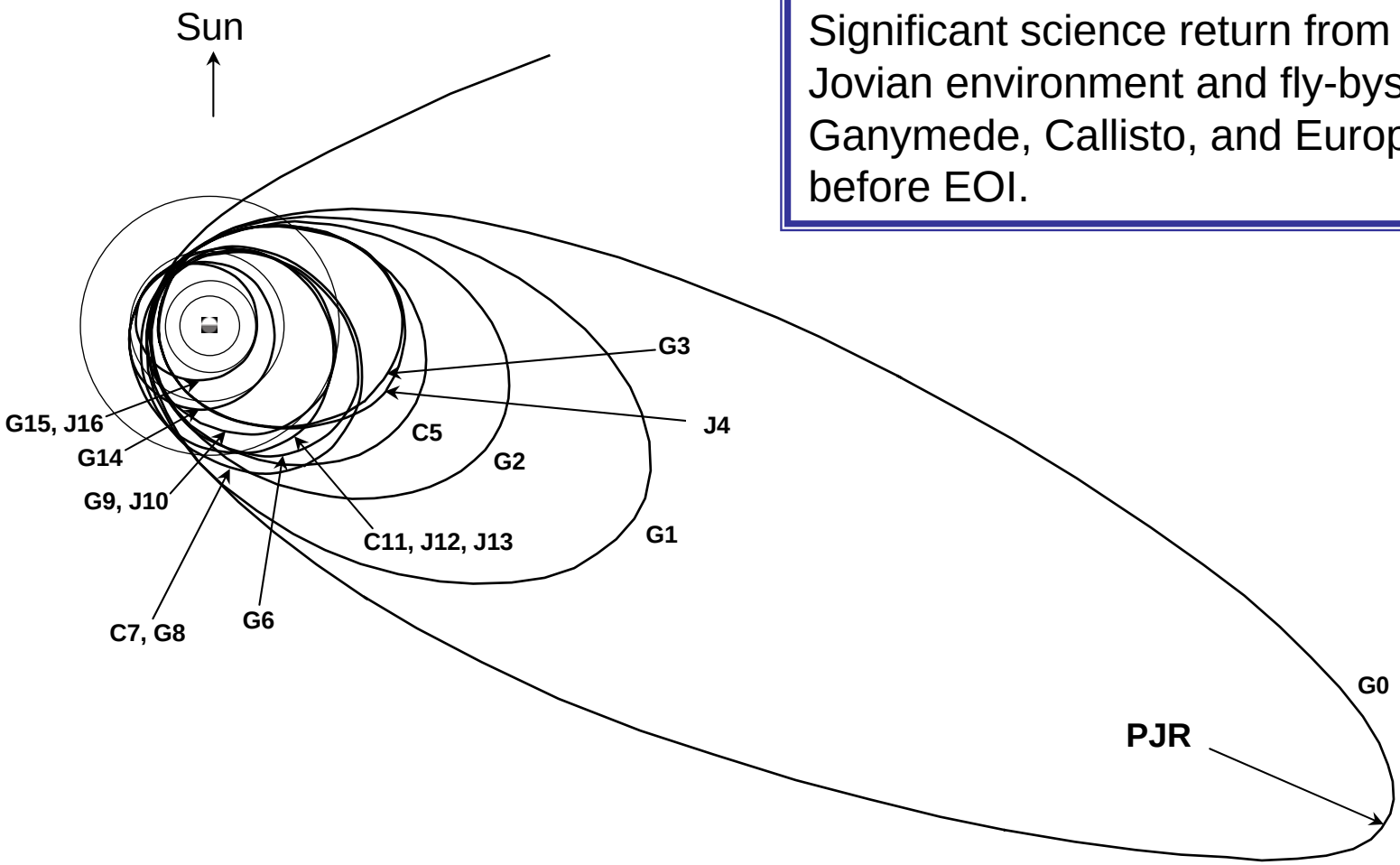
2012 VEEGA Trajectory

Two Earth fly-bys and one Venus fly-by permit a significant increase in science payload mass.



EGE Mission Design

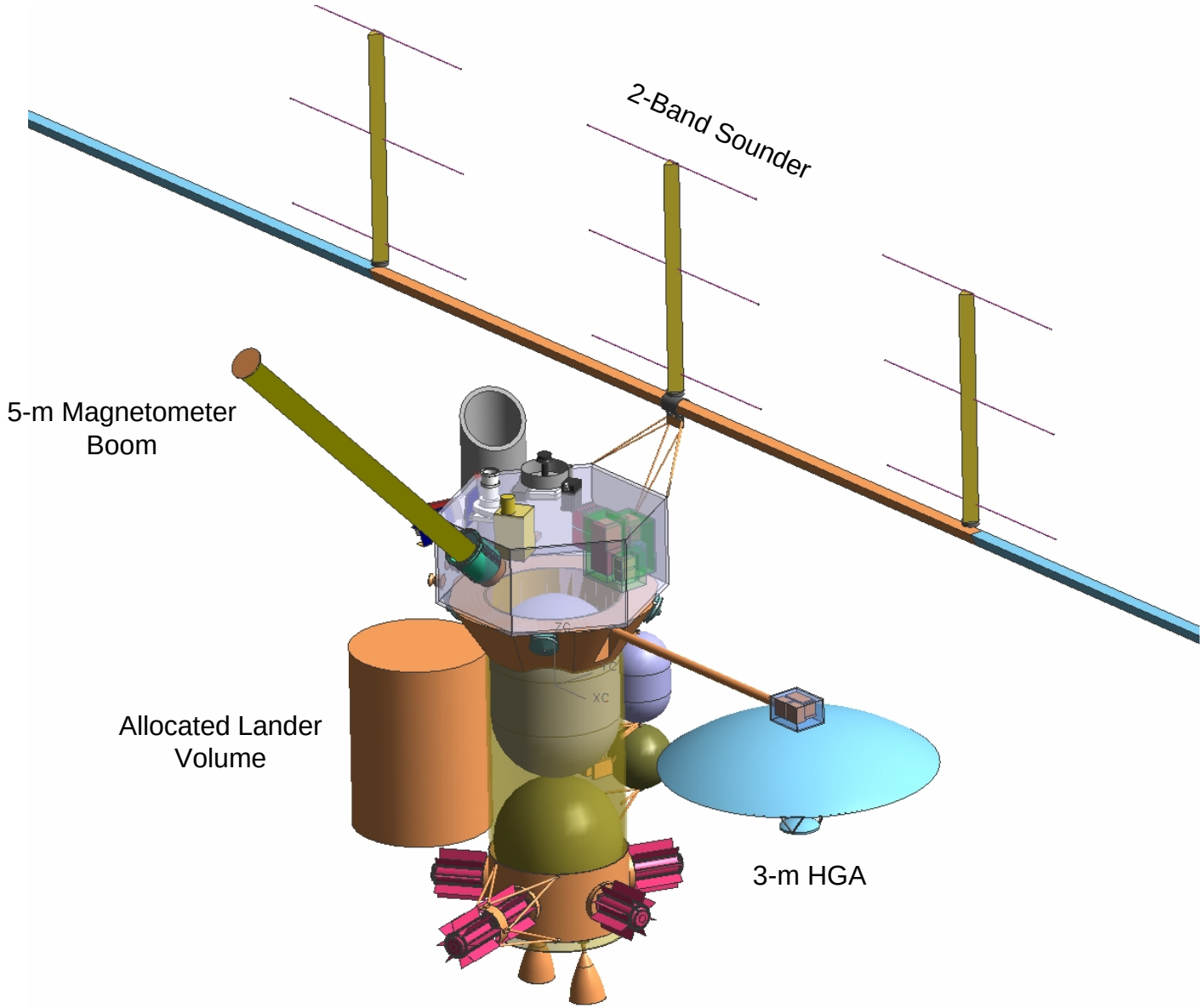
Representative Jovian Tour



Significant science return from the Jovian environment and fly-bys of Ganymede, Callisto, and Europa before EOI.

Sun-Jupiter Fixed View

EGE Spacecraft – Deployed Configuration



Conclusions

- **In this quick study, we have explored some of the trade space options for the Europa Geophysical Explorer mission. At least one concept has demonstrated that it can meet the science objectives with significant margins.**

- **Next steps:**
  - Investigate the trade space more broadly.
  - Work with OPAG for guidance on trade study priorities that could enhance science.
  - Investigate detailed technical issues, not addressed in this preliminary study, including determining investment requirements for needed technologies.

Back Up Slides

Back up charts – Decadal Survey

- **Decadal Survey of 2002**
- **Science Goals for Europa Geophysical Explorer according to Decadal Survey**
- **Strategic Road Map for Solar System Exploration (2005)**

Origins of the Europa Geophysical Explorer

- **In 2001, a representative subset of the Planetary Science Community developed a Decadal Survey, a plan for Solar System Exploration between 2003-2013.**

- **This team developed 12 Key Questions about the Solar System and defined spaceflight missions to address these scientific questions.**

- **Among 12 Key Questions, one group voiced the desire to explore and understand *the origin and evolution of habitable worlds.* Specifically,**

  - **What planetary processes are responsible for generating and sustaining habitable worlds, and where are the habitable zones in our Solar System?**
  - **How do the processes that shape the contemporary character of planetary bodies operate and interact?**

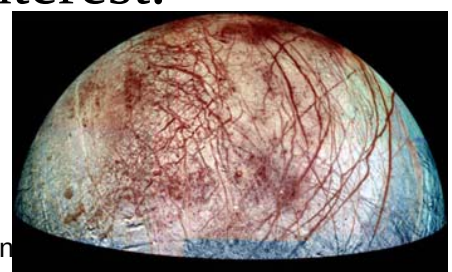
  - **In answer to these questions, the Decadal Survey outlined a mission to Jupiter's moon, Europa. This mission, the subject of this study, is the Europa Geophysical Explorer.**

Europa Geophysical Explorer

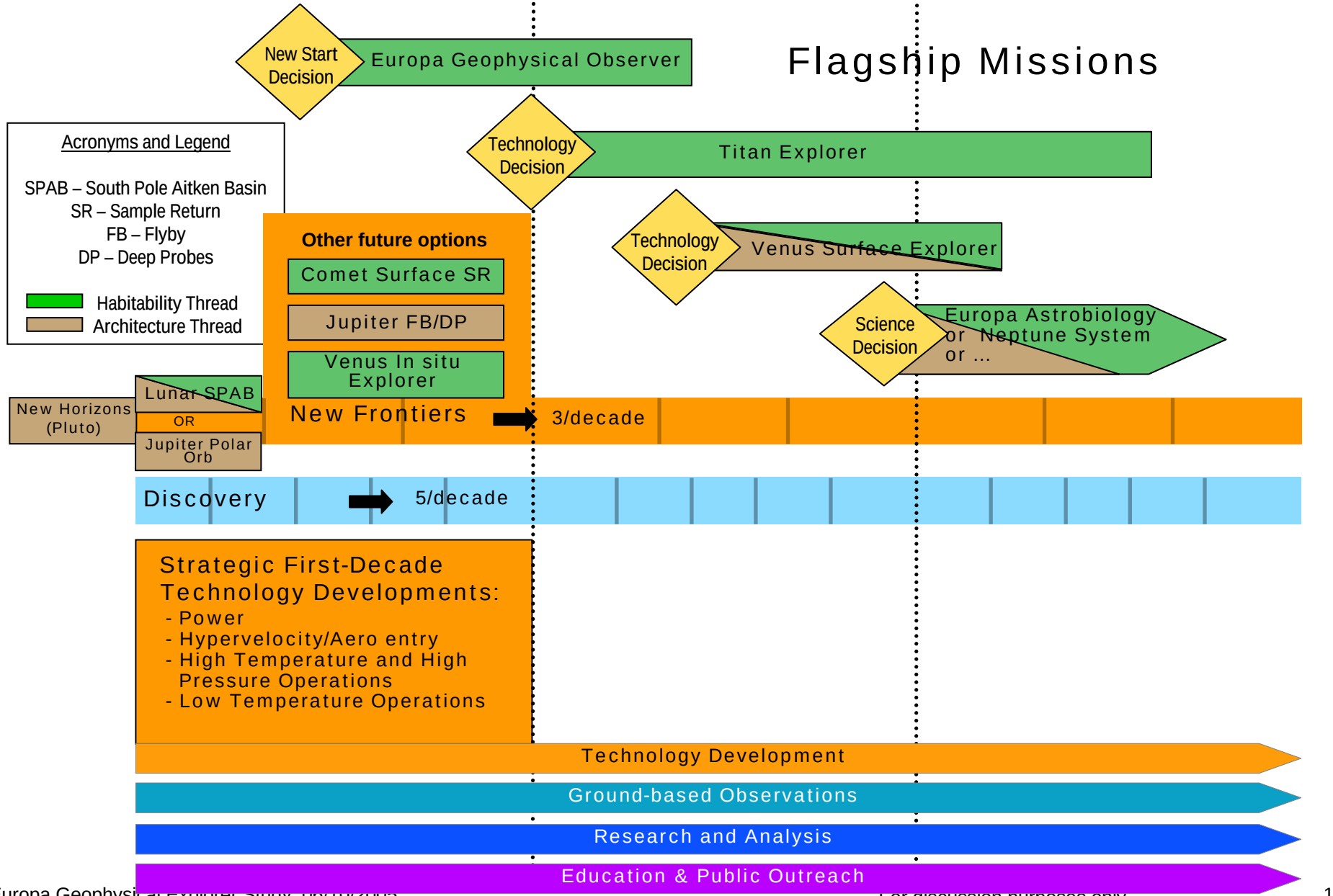
Europa Geophysical Explorer: An orbiter of Jupiter's ice-encrusted satellite will seek the nature and depth of its ice shell and ocean.

Decadal Survey Defined Goals:

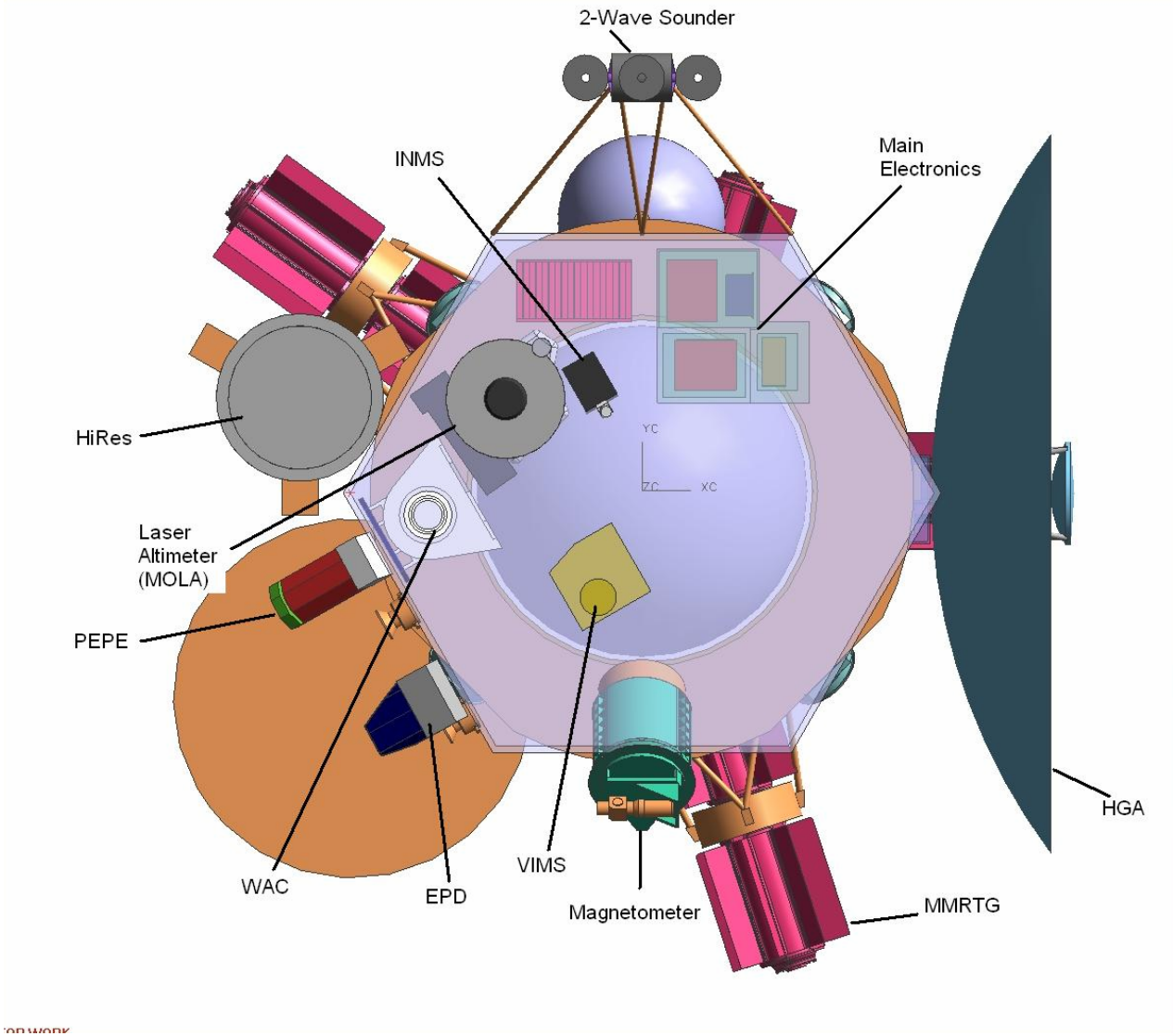
- Assess the effects of tides on the satellite's ice shell to confirm the presence of a current global subsurface ocean.
- Characterize the properties of the ice shell and describe the three-dimensional distribution of subsurface liquid water.
- Elucidate the formation of surface features and seek sites of current or recent activity.
- Identify and map surface compositional materials with emphasis on compounds of astrobiological interest.
- Prepare for a future lander mission.



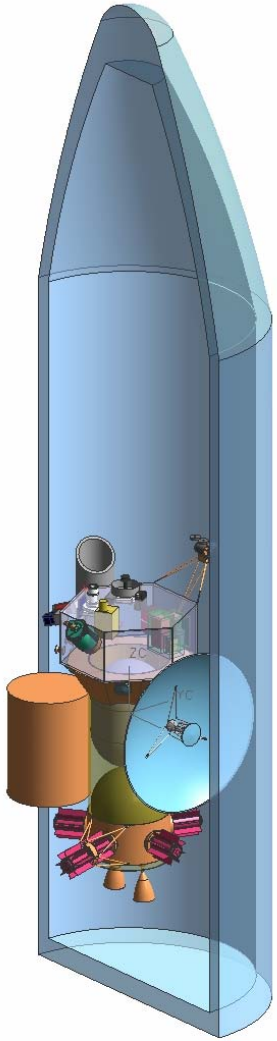
Solar System Exploration Roadmap (May 2005)



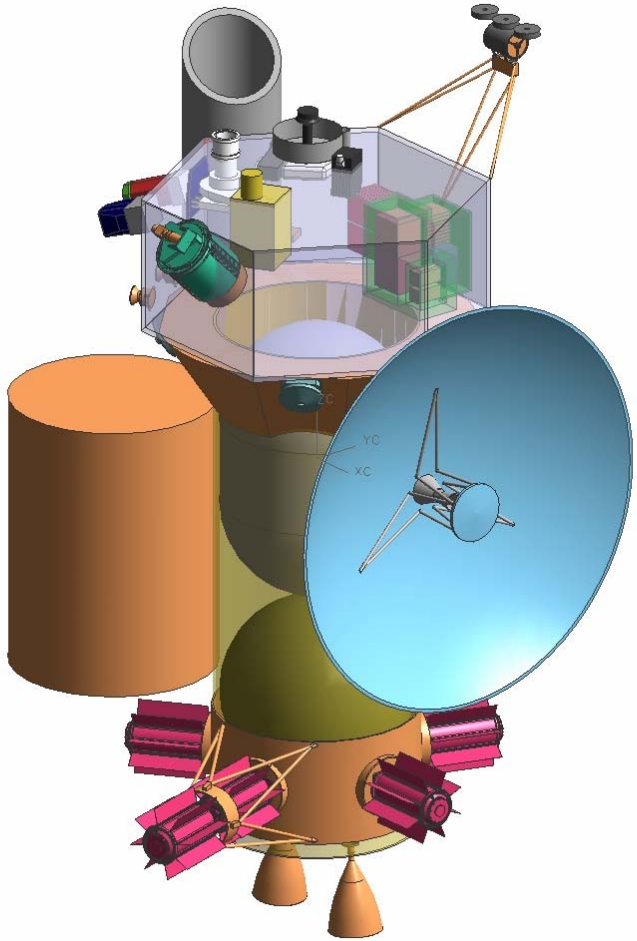
EGE Spacecraft – Instrument Configuration



EGE Spacecraft – Stowed Configuration



EGE Spacecraft within Delta IV-H Launch Vehicle Fairing



EGE Spacecraft in Stowed Configuration

Science Objectives

- **The newly-formed Outer Planets Assessment Group convened a special Europa Sub-Group in May 2005 to redefine the Science Objectives for the Europa Geophysical Explorer:**
  1. Confirm the presence of a subsurface ocean
  2. Characterize the 3-dimensional configuration of the icy crust, including possible zones of liquid
  3. Map organic and inorganic surface compositions, especially as related to astrobiology
  4. Characterize surface features and identify candidate sites for future exploration
  5. Characterize the magnetic field and radiation environment
  6. Understand the environment of Europa in the context of the Jovian system

The Science Objectives are essentially the same as those of the original Europa Orbiter Level 1 (Floor) and 2 (highly desired) Requirements

Core Team Members

- **Jackie Green, Study Lead**
- **Rob Abelson, Lead Systems Engineer**
- **Bill Smythe, Instrument Lead Scientist/Engineer**
  - Tom Spilker, Science Advisor
  - Jim Shirley, Science Advisor
- **Jan Ludwinski, Trajectory Development**
- **Elizabeth Kolawa, Technologist and radiation lead**
- **Peter Illsley, Configuration**
- **Pam Chadbourne, Program Systems Engineer**