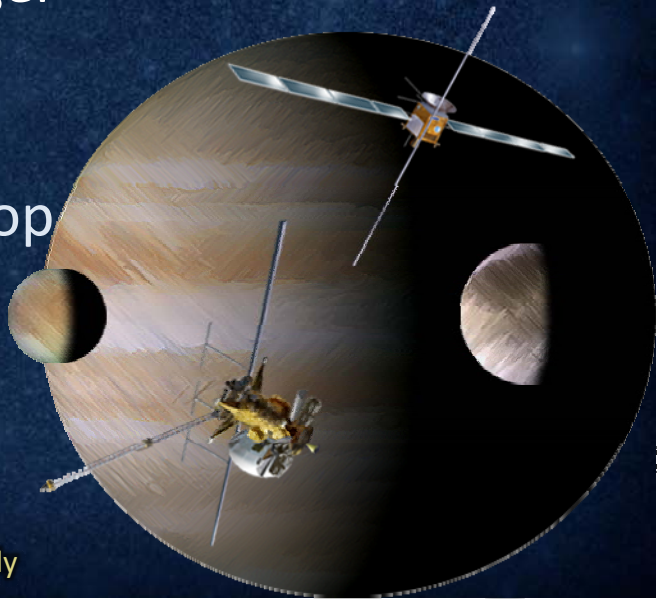
JGO
Technical Requirements

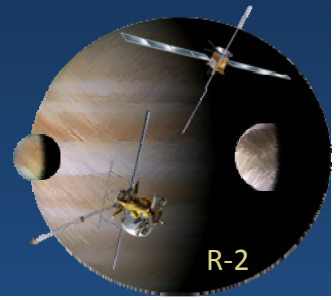
Arno Wielders
JGO study payload manager

EJSM Instrument Workshop
July 27-29, 2010



Content

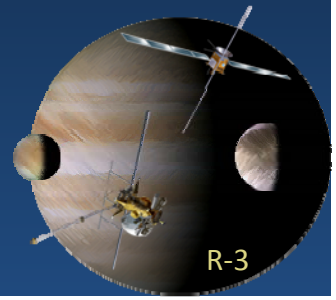
- Engineering standards at ESA
- Environmental requirements
- Radiation
- Thermal
- Yaw rotation
- Telemetry
- Limited resources
- Booms
- Planetary protection



Engineering documentation

European Cooperation for Space Standardisation:

- initiative established to develop a coherent, single set of user-friendly standards for use in all European space activities
- Space standards on three branches: Project Management, Product Assurance and Engineering
- Documents are applicable in all European Space Agency projects
- All documents can be found at: www.ecss.nl
- Website also features;
  - Helpdesk
  - Discussion forum



Environmental specification

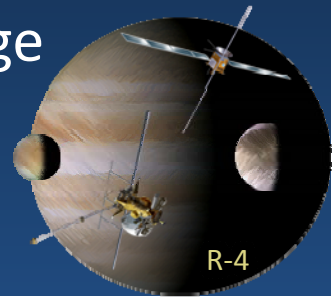
Documents available now:

- Laplace Environmental specification; Issue 3
- Jupiter Environmental Document: Part 1

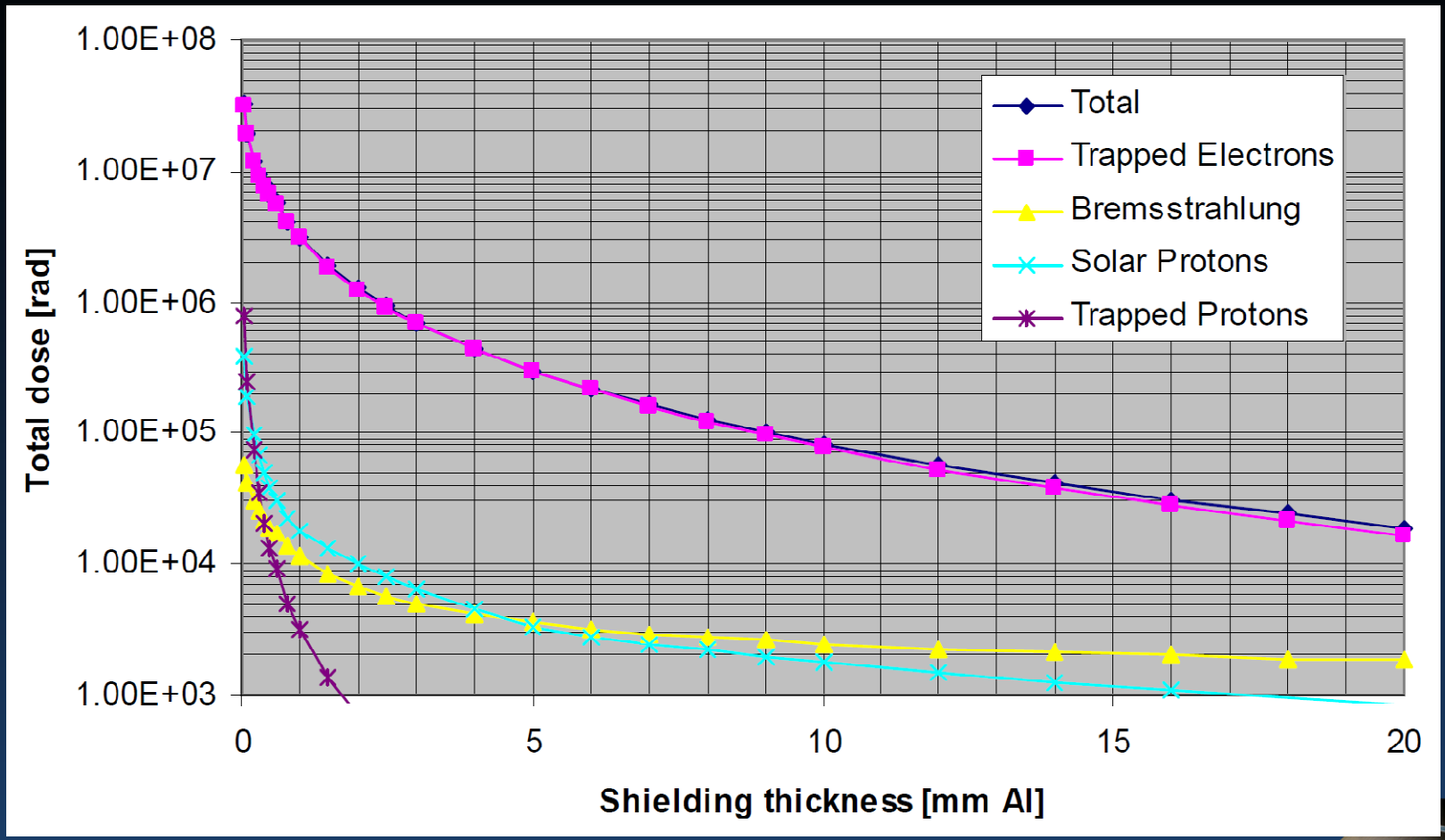
Environmental Documents for AO

- JGO Environmental specification Part 1 and 2
  - Particle radiation specification
  - Jovian system characteristics
  - Describes the environment through all phases of the mission

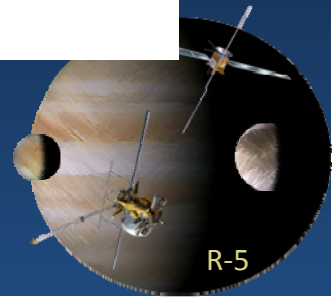
- All documents will be available as part of the AO package



Radiation Environment



Environment is dominated by electrons



Radiation Environment

Key items:

- Radiation design margin is 2 (for spot shielding a larger margin should be considered)

- The dose-depth curve determines which part needs to be shielded by what thickness, there is no standard spacecraft shielding thickness provided yet

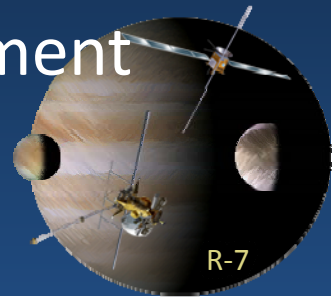
- Early delivery of instrument model for integrated radiation modelling by prime contractor expected to minimise the overalll required shielding (~ 1 year after confirmation of AO selection)

- Testing of instrument components/subsystem required with relevant particles (electrons and protons)

- Heavy ions impact currently being studied in Radiation working group and ESA experts and will be part of the updated environmental specification

Charging

- Surface and deep-electric charging
  - Surface charging
    - Optical surfaces, in-situ instruments, etc.
    - Proper grounding needed
  - Deep-electric charging
    - Internal grounding strategy
    - Adequate connector design needed
  - Scientific requirement to have a few Volts difference over spacecraft surface will require intense collaboration between S/C prime and instrument teams

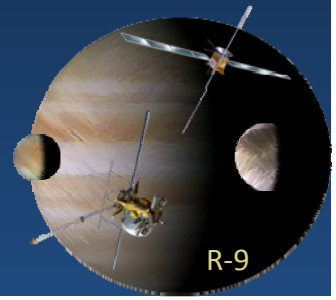


EMC requirements

- Electromagnetic Compatibility:
  - Electric charging few Volt over spacecraft
  - 2 nT DC magnetic field and 0.1 nT between 0-64 Hz.
  - < 50 dBµV/m below 45 MHz
- Potential distortions of antenna beam patterns and effects on scientific measurements
- Careful selection of components and EMC characteristics to be determined by analysis and tests

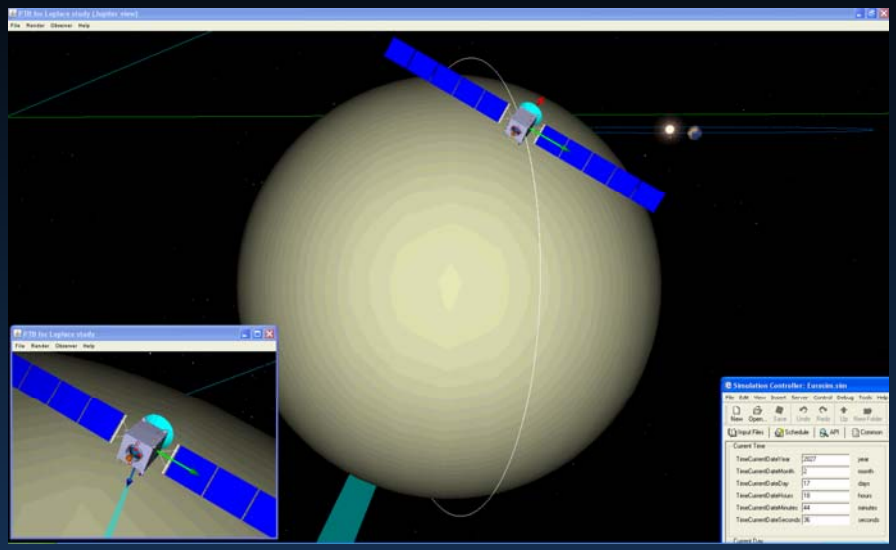
Thermal

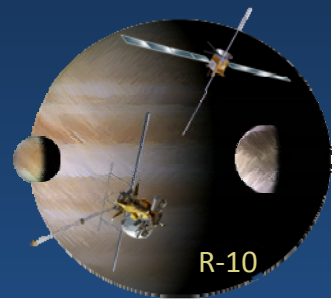
- Hot case (Venus flyby) and cold case (Jupiter science phase)
  - HGA will be used as shield during Venus phase
- Spacecraft designed with one cold face (for most amount of time) with radiators
- Instruments shall be designed however to survive some short duration of thermal load on radiators
- Inside S/C temperature range from 0-30 degrees C
- Outside S/C instrument components will experience cold space temperatures
- Instruments need to define what kind of cooling it needs (cold finger) and the associated thermal load
- Spacecraft equipped with radiators only, no active cooling foreseen



Yaw rotation

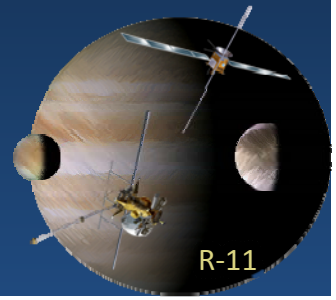
- During flybys unconstrained pointing capability
- During Ganymede orbit phases
  - Baseline is continuous rotation of s/c around yaw
  - Exceptionally stable pointing will be performed, with recovery period
- Stable Earth pointing will be performed (TM download)





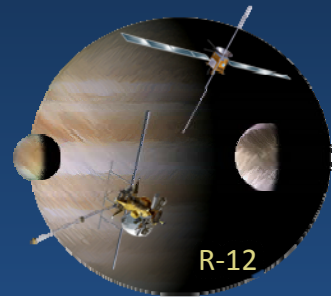
Yaw rotation

- Instrument required to:
  - Analyse effect of yaw rotation on science observations
  - Allowable yaw rotation during observations
  - Yaw rotation can be stopped, but for short amount of time and not often.
  - Instruments most likely to be affected:
    - Cameras
    - Spectrometers
- Instruments teams to define when, for how long, at which frequency a stable pointing is required
  - Be conscious about consuming system resources!



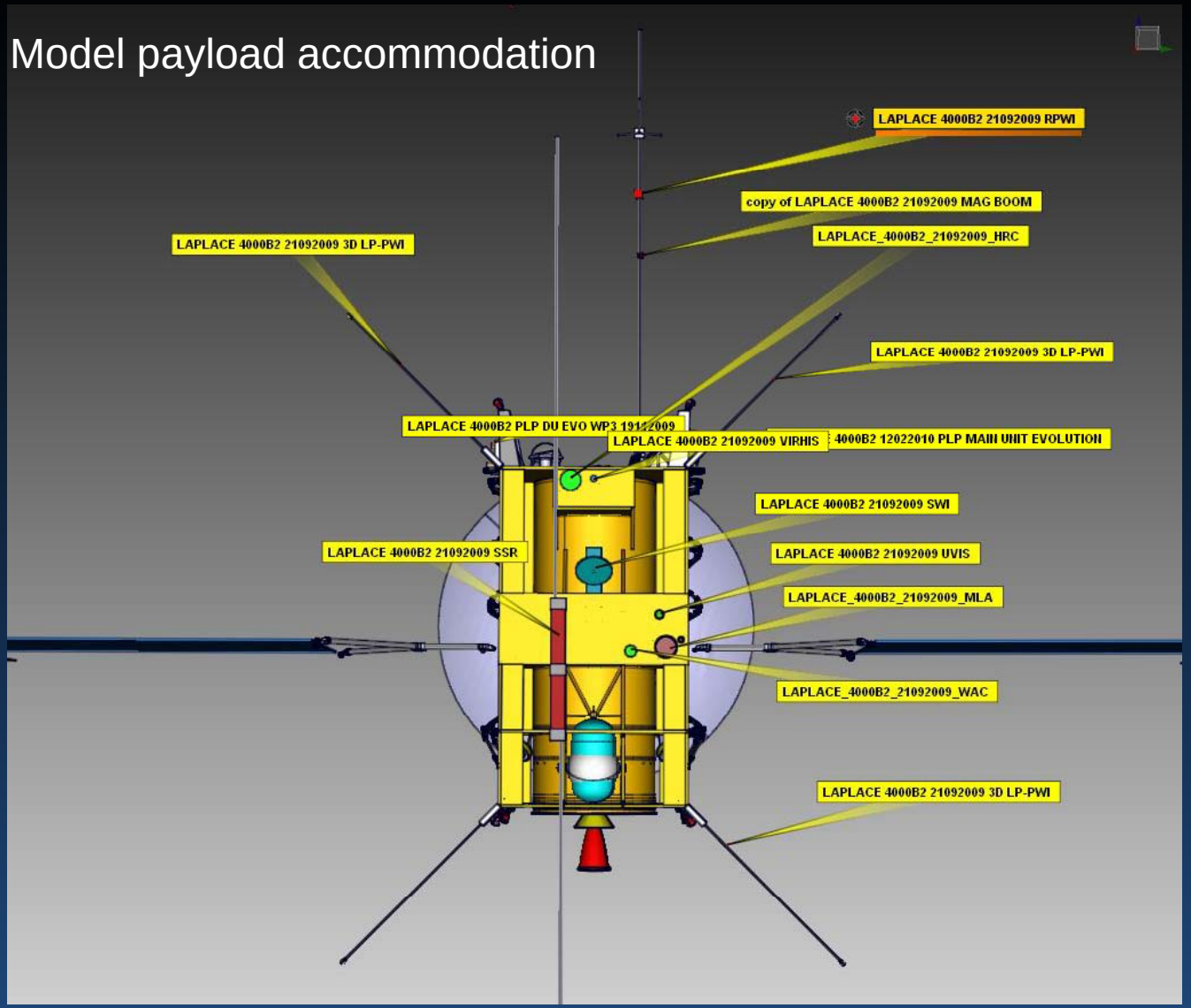
Booms

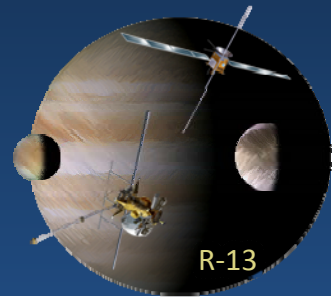
- Field of View accommodation & large amount of appendages
- Large number of booms – it is recommended to consider combined sensor accommodations
  - Accommodation of booms on s/c body is the baseline
  - Accommodation of part of RPWI on SA is under study



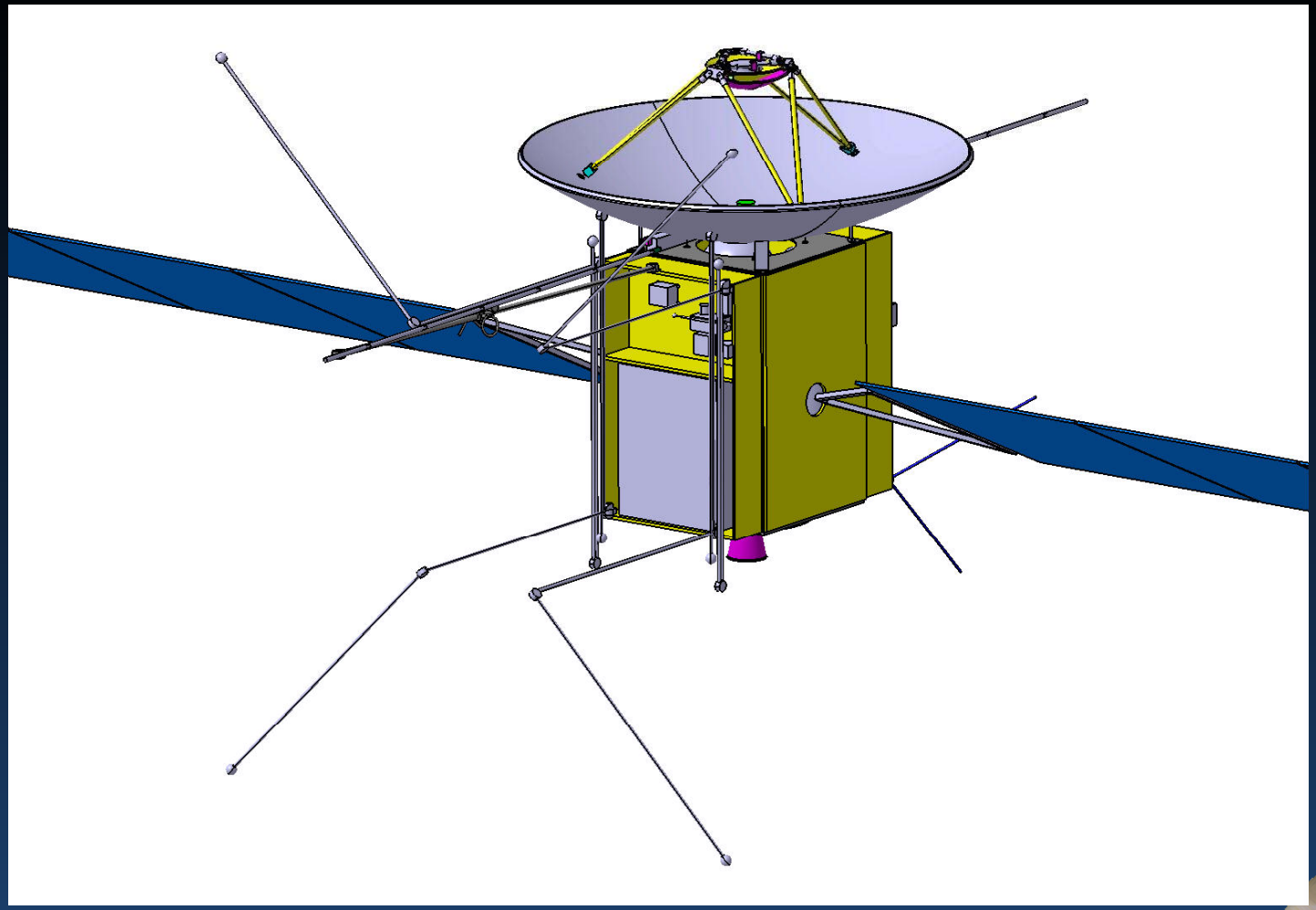
Booms

Model payload accommodation

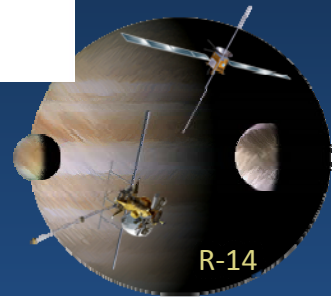




Booms

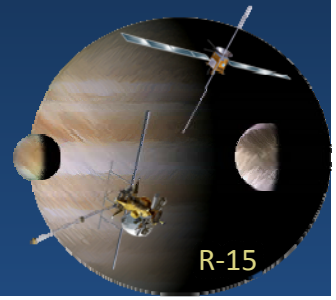


Model payload accommodation



Telemetry

- Limited science data telemetry available (1 Gbit per day)
  - Optimize overall data volume required
  - Investigate on-board data analysis to reduce downlink to Earth
  - Study during which phase of the mission your instruments will need to operate to fulfil science requirements (Ganymede Elliptical Orbit or Ganymede Circular Orbit)



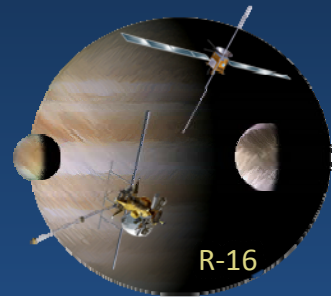
Spacecraft Resources

Limitations:

- Standby & average power
- Due to the large impact on mass of solar array power is a scarce commodity. Low-power elements and units are preferred.

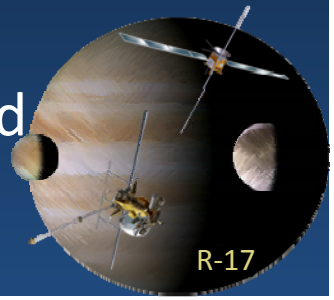
Sharing resources:

- Combining instrument functions
  - Sharing of
    - DPU, PCDU, etc



Planetary Protection Requirements

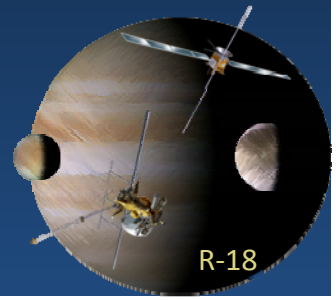
- Category II + additional requirements
  - Significant interest in processes of chemical evolution
  - Remote probability of contaminating future exploration
- Demonstrate probability of contaminating the Ganymede subsurface ocean ≤ 10^{-4}
  - Investigating timescales and transport properties of surface processes
- Contamination of Europa ocean ≤ 10^{-4}
  - Probability of accidental impact on Europa (reliability)
- Probability of impact launch vehicle on Mars ≤ 10^{-4} for 50 years after launch
  - Probability of accidental impact as a consequence of failure
- Planetary protection plan will be compiled and reviewed



Introducing One Microbe into Ganymede Ocean or Other Habitable Environment $<10^{-4}$

- In principle, analysis has to include:
  - Bioburden at launch
  - Cruise survival
  - Survival in the Jovian radiation environment
  - Probability of impact on Ganymede
  - Mechanism(s) and timescale for transport to the ocean

- Measures: Considering that the S/C disposition is de-orbiting to Ganymede:
  - Describe mechanism(s) and timescales for transport to the ocean
    (more or less done, tune in after July 2010 for COSPAR response)
  - Consider bioburden control for H/W

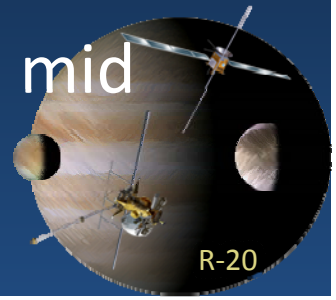


Introducing One Microbe into Ganymede Ocean or Other Habitable Environment $<10^{-4}$

- Recommended scope for bioburden control until further notice:
  - Assembly, testing and launch in ISO 8 clean room condition
  - Perform biological assays during the course of the H/W final assembly
  - Assess temperature/time profiles of manufacturing processes, especially for items behind radiation shielding
  - Estimate reduction based on agreed bioburden levels, inactivation rate and S/C radiation dose mapping

PP – Summary and Next Steps

- Early delivery of instrument parts list might be required to be reviewed by ESA planetary protection officer (TBD)
- Analysis to be performed for JGO until SRR:
  - Probability of impact analysis for Europa (FS)
  - Take into account passive bioburden control pre-launch (FS+PL)
  - Provide S/C radiation dose levels (internal and external) and fold in expected bioburden density and inactivation parameter for microbes (FS+PL)
- Final decision on Ganymede PP status expected mid 2011



Announcement of Opportunity

Proposal information package
- Description of the AO process
  - Process, evaluations, responsibilities, contents, etc.
- Science Management Plan (SMP)
  - Development and Implementation, contributions and responsibilities (ESA & member states), science management (operations and data)
- Science Requirements Document (Sci-RD)
- Experiment Interface Document A (EID-A)
  - Provisions by the spacecraft
- Science Ground Segment Interface Document

- Templates for assisting response
  - Proposal Template
  - Experiment Interface Document B (EID-B)
    - the description of the instrument needs
- Additional technical reference information
  - Environment specifications, etc

- Response shall also include a Letter of Endorsement by the respective national funding agencies