Comparison of JGO and JEO

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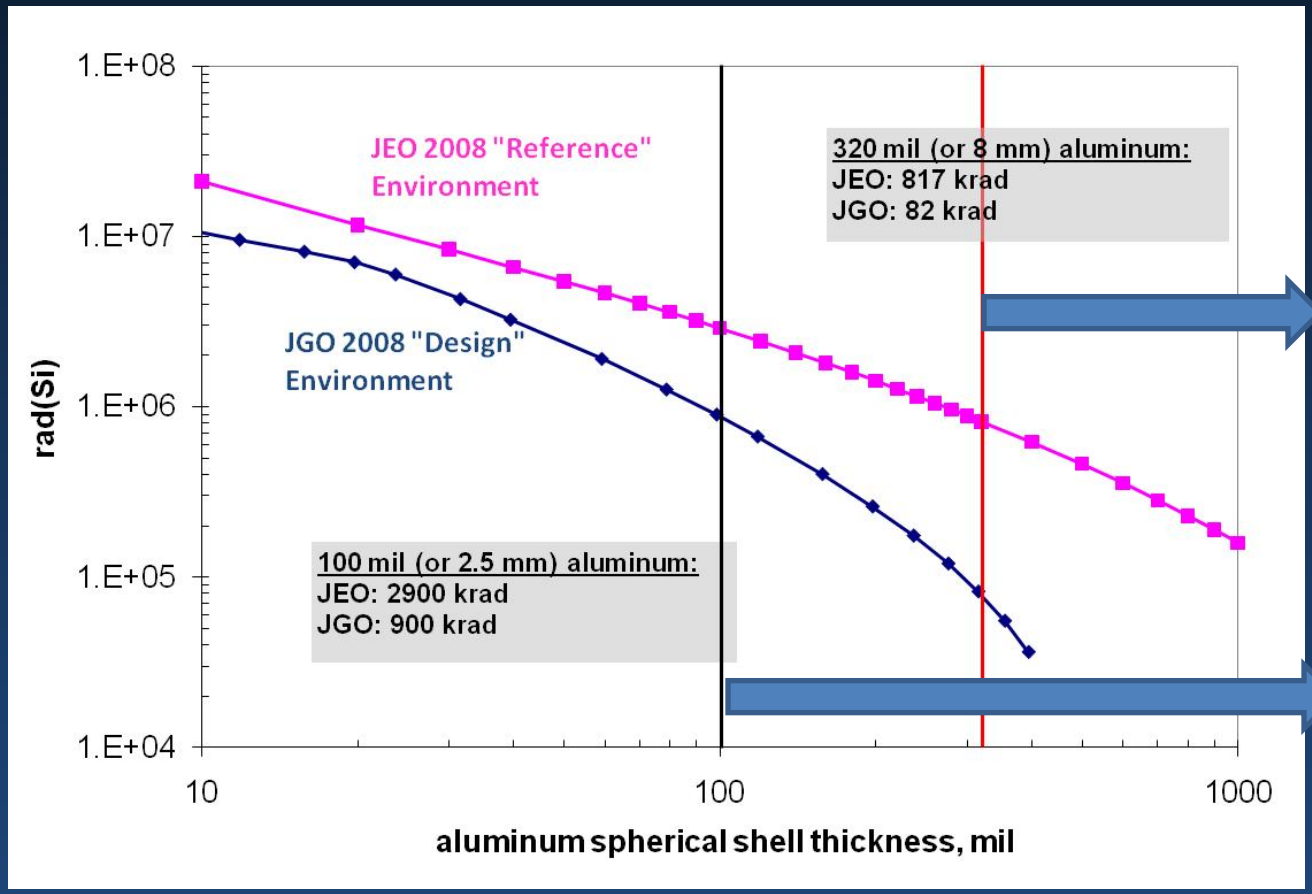
Baseline Mission Driving Requirements

	JEO	JGO
Mission Lifetime	~9 years	~9 years
Range to Sun	~ 0.7 AU to 6 AU	~ 0.7 AU to 6 AU
Parts Class	Class S, QML V	Class S, QML V
FPGAs	Not yet approved	Approved
Die Level Rad Hardness	100 krad	No requirement
APML	Required	Recommended, also suggest COTS, but with verification
Power	Constrained (5 MMRTGs)	Constrained (Solar)
Mass	Constrained (Atlas V 551)	Constrained (Ariane V)
Heritage	No direct heritage	Useful heritage from Bepi Colombo and Rosetta
Radiation	See next pages	See next pages

Requirements similar but mission designs impose unique challenges

Radiation : TID

Dose-depth curve for both JEO and JGO



Factor of ~10 difference at 10 mm (394 mils)

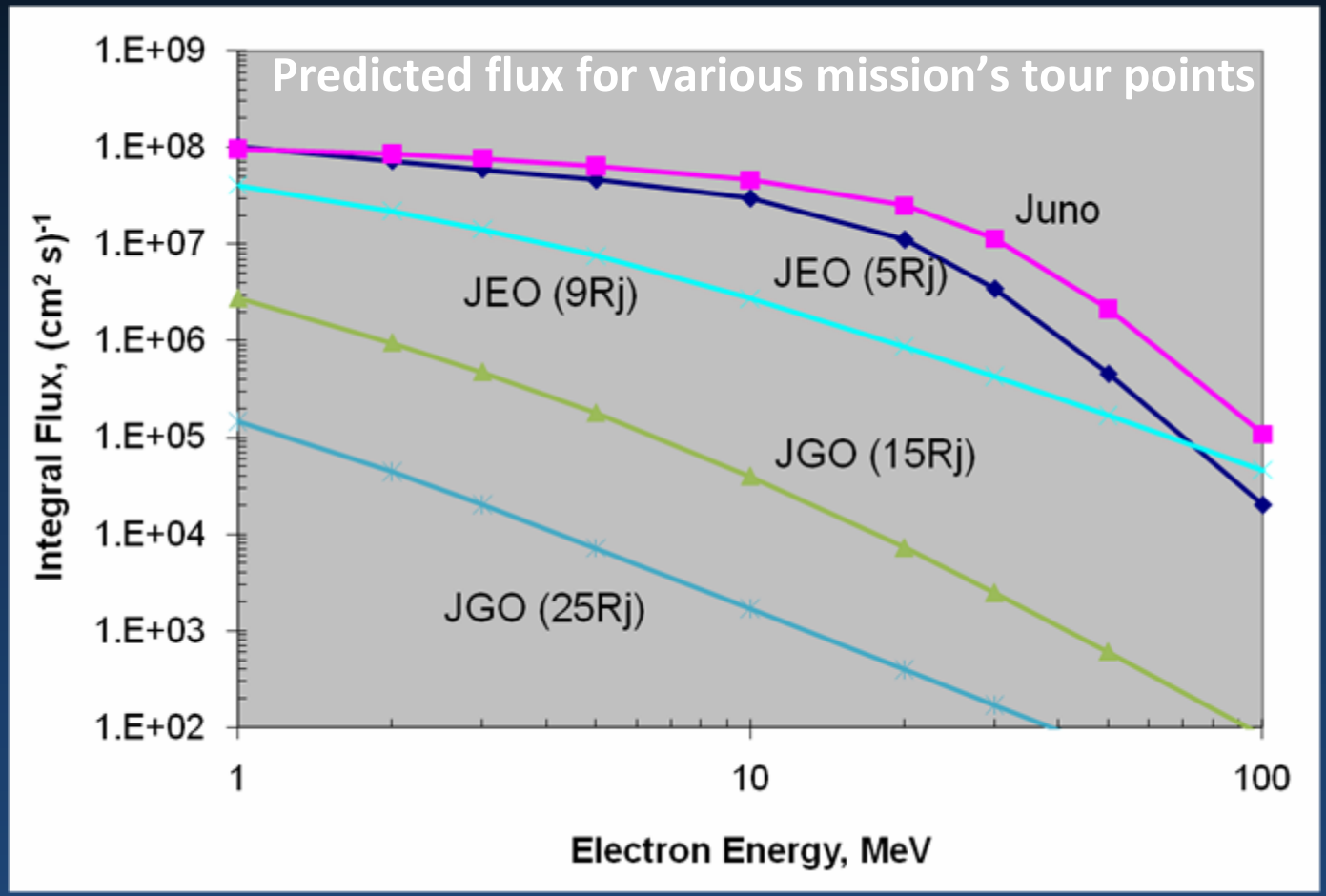
Factor of ~3 difference at 2.5 mm (100 mils)

TID Radiation can be a long term performance issue

Radiation : Flux

Unshielded Flux levels for Juno, JEO at Io and Europa and JGO at Ganymede and Callisto

JGO reduces the instantaneous flux requirement by staying away from Io and Europa's orbits



Flux-induced transient effects vary depending on point in tour

Baseline Shielding Approach

JEO

- Formal Radiation Design Factor (RDF) of 2 required
  - Part/material shielded to ½ its capability
- Distributed shielding
  - Centralized 6U chassis for instrument electronics available but not required
  - Instrument Sensors/detectors external to 6U chassis require own shielding

JGO

- Formal Radiation Design Factor (RDF) of 2 required
  - Part/material shielded to ½ its capability
- Combination of vault and spot shielding
  - Central vault for spacecraft and instruments assemblies
  - Instrument Sensors/detectors external to vault require own shielding

Levels of TID radiation influence "system" design implementation

Radiation : Other

- Charging (surface and internal) issues for JEO would be expected to be more severe than other previous NASA missions due to extended time spent in regions in high electron flux
- Displacement Dose Damage
  - JEO: 1×10^{10} MeV/g (or equivalent 2.3×10^{12} cm^{-2} of 50 MeV protons) behind 2.5 mm aluminum shielding
  - JGO: 3×10^{8} MeV/g (or equivalent 7×10^{10} cm^{-2} of 50 MeV protons) behind 10 mm aluminum shielding (preliminary estimate)
- Single Events Effects
  - SEE environment for both JEO and JGO are dominated by Galactic Cosmic Rays
    - Similar to other missions
  - Trapped protons and heavy ions are NOT significant factor except for extremely lightly shielded components

JEO instruments would need to design to more stringent radiation levels

Planetary Protection

JEO

- Provisional Category III
- $1x10^{-4}$ on contaminating Europa's (or Callisto's or Ganymede's) Ocean
- Selected approach requires all hardware to be sterile at Europa Orbit Insertion
  - Pre-launch - Dry Heat Microbial Reduction or Radiation
  - Post Launch - Radiation

JGO

- Expected Category II+
- Likely requirement: $1x10^{-4}$ on contaminating Ganymede's (or Callisto's or Europa's) Ocean
- Selected approach requires basic cleanliness during assembly but not sterilization; and set of analyses (trajectory, reliability, etc.)

Strict sterilization requirements for JEO may imply instrument redesign

Summary

- Basic requirement classes are similar
- Minimum distance of JEO is closer to Jupiter – higher radiation environment
- Requirement levels would be generally more stringent & challenging for JEO
- Instruments proposed for both spacecraft should design for each application separately
  - Specifically addressing the challenges of JEO
  - Avoid over-designing for JGO