

# JUICE Radiation Environment

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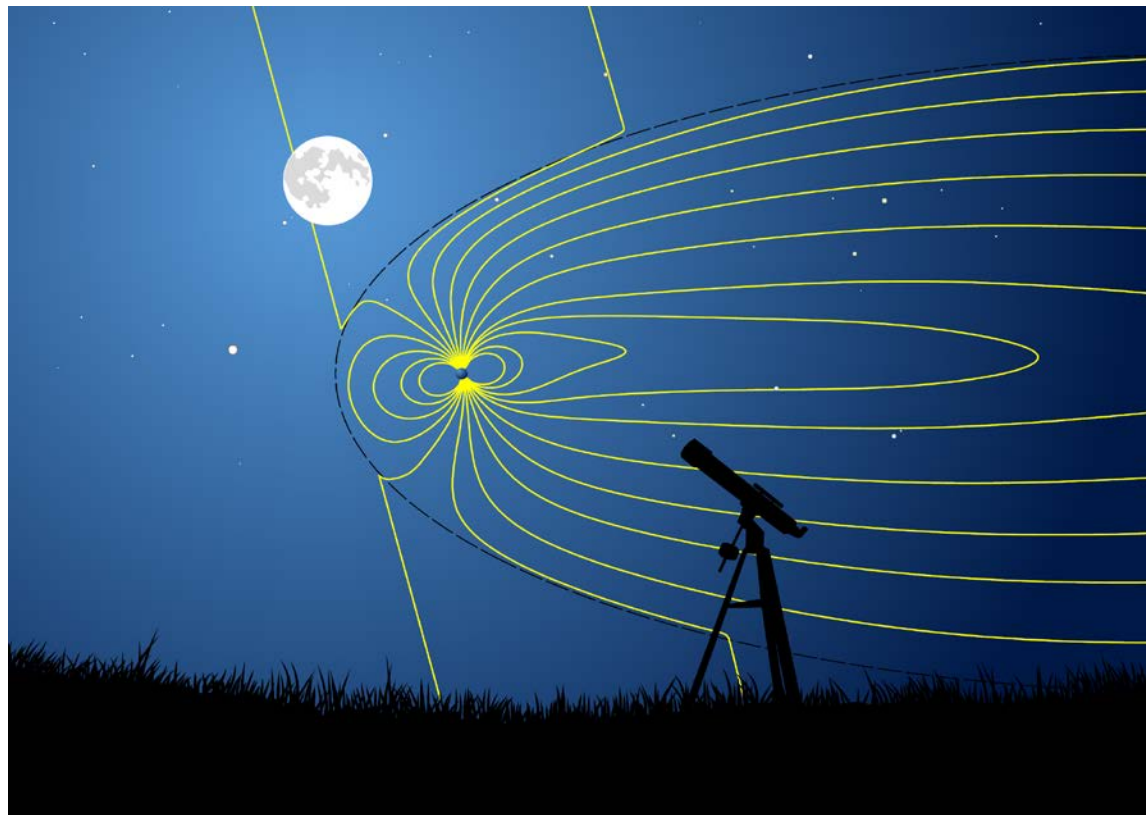


# Outline



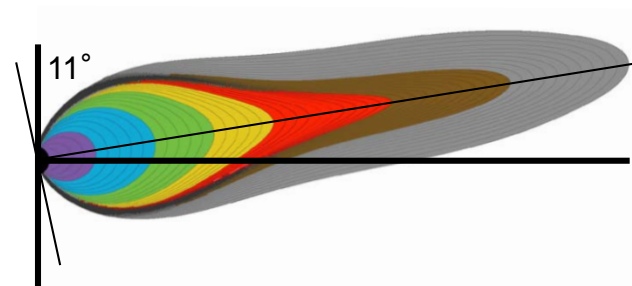
- Jupiter's magnetic field
- Jupiter's radiation environment properties
- Radiation exposure of JUICE
- Radiation simulation and verification





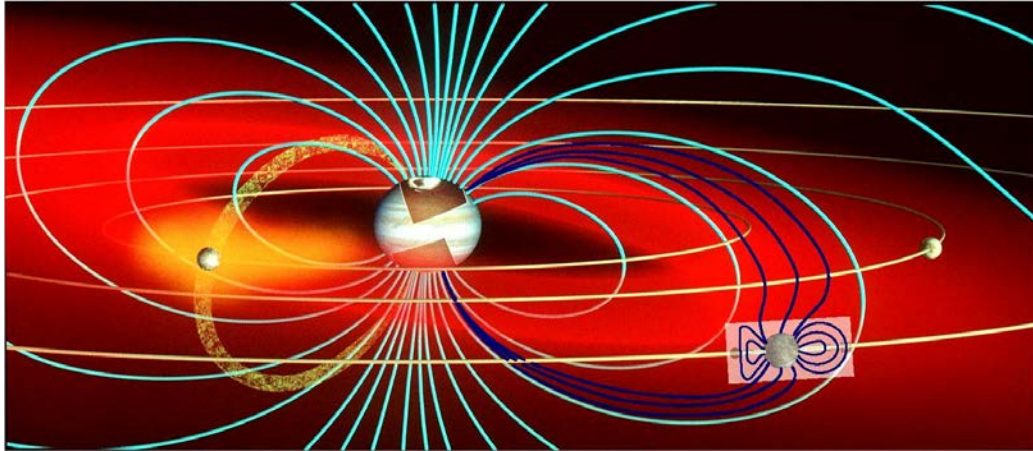
<i>Characteristics</i>	<i>Earth</i>	<i>Jupiter</i>	<i>Ratio</i>
Equatorial radius (km)	$6.38 \times 10^3$	$7.14 \times 10^4$	~10x
Magnetic moment (G-cm <sup>3</sup> )	$8.1 \times 10^{25}$	$1.59 \times 10^{30}$	$2 \times 10^4$
Rotation period (hr)	24.0	10.0	2.4x
Aphelion/perihelion (AU)	1.01/0.98	5.45/4.95	

- As the magnetic field at the equator is proportional to  $B/R^3$ , the Jovian magnetic field is proportionally **20 times** larger than the Earth's
- Much higher energy and flux levels of trapped particles than at the Earth or in the interplanetary space.



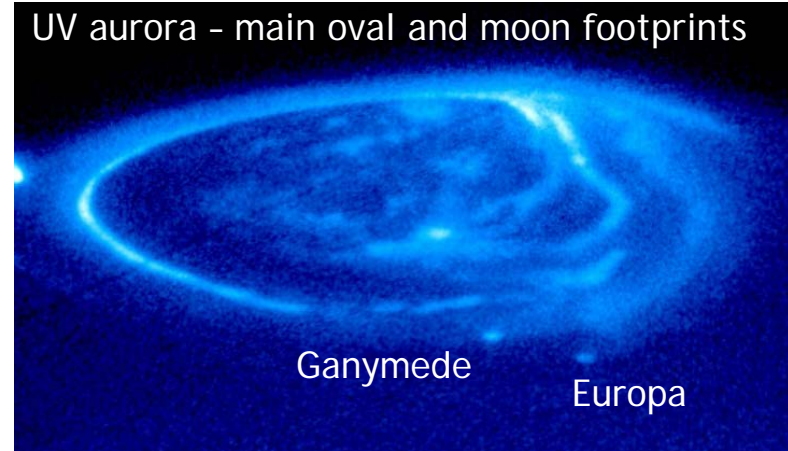
H. Garrett, JPL, 2015

## Properties

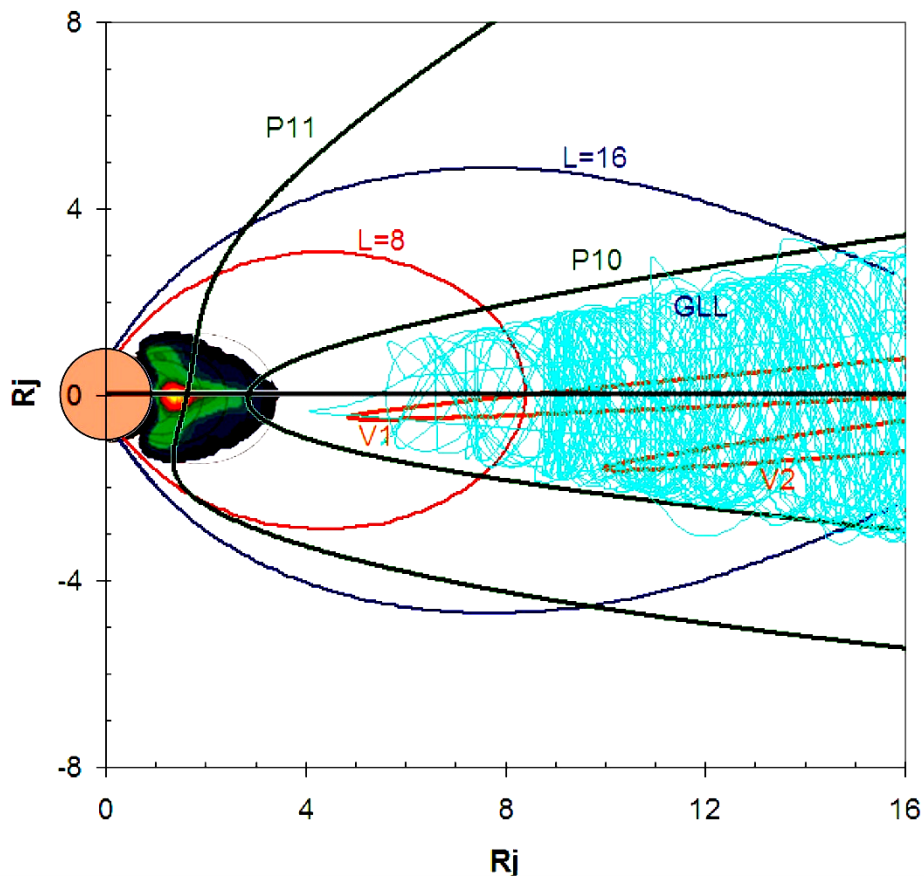


## Energy transfer in the coupled system

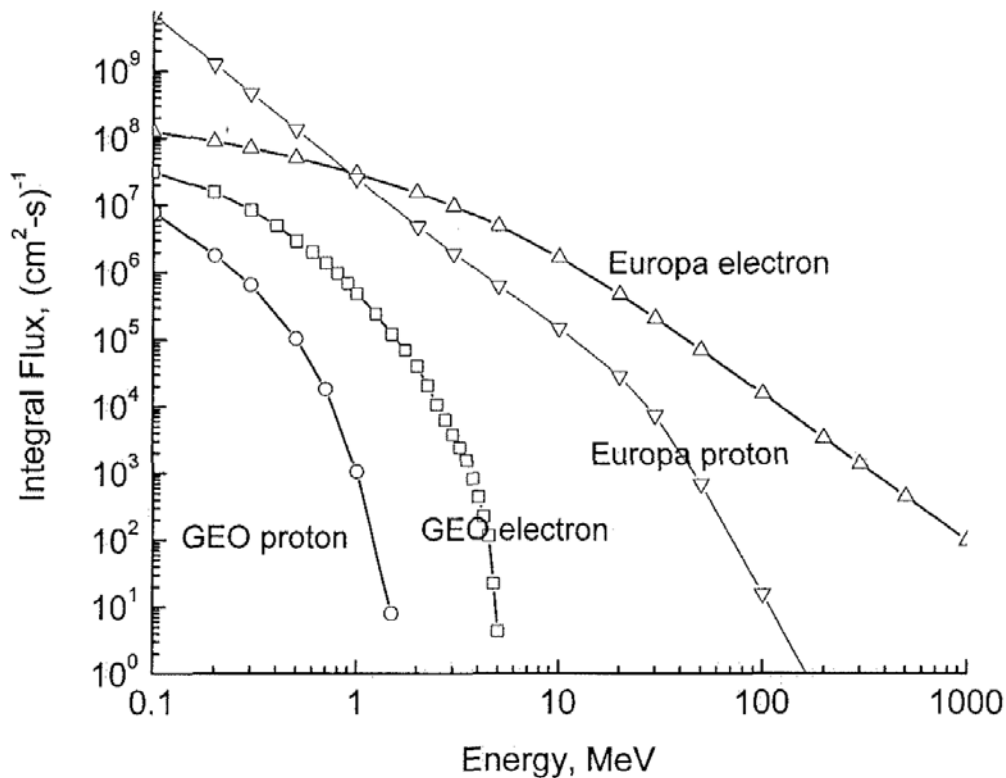
### UV aurora - main oval and moon footprints



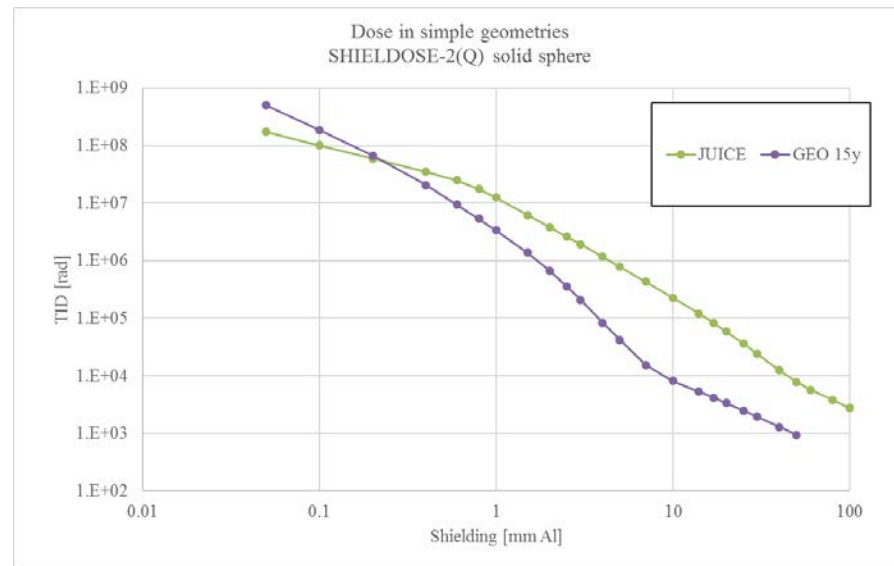
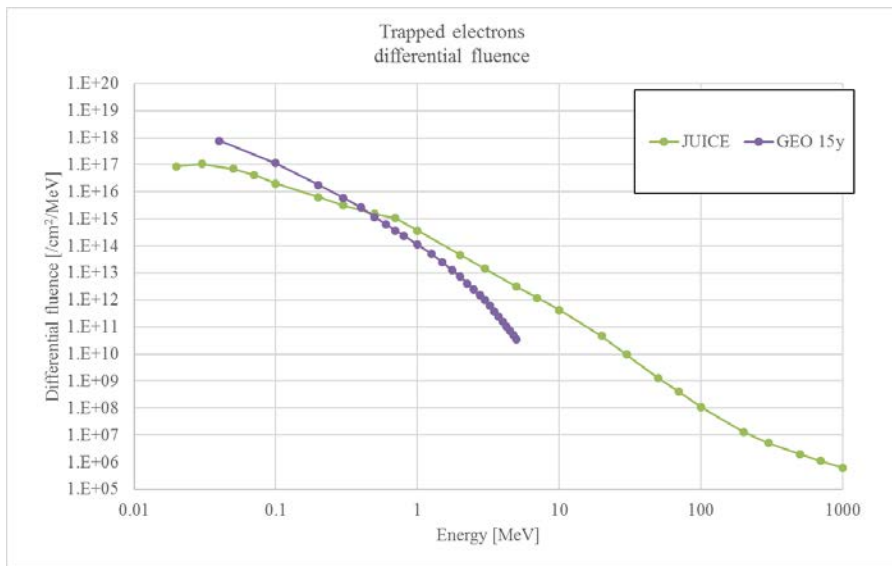
Pioneer 10, 11  
 Voyager 1, 2  
 Galileo



H. Garrett, JPL, 2015



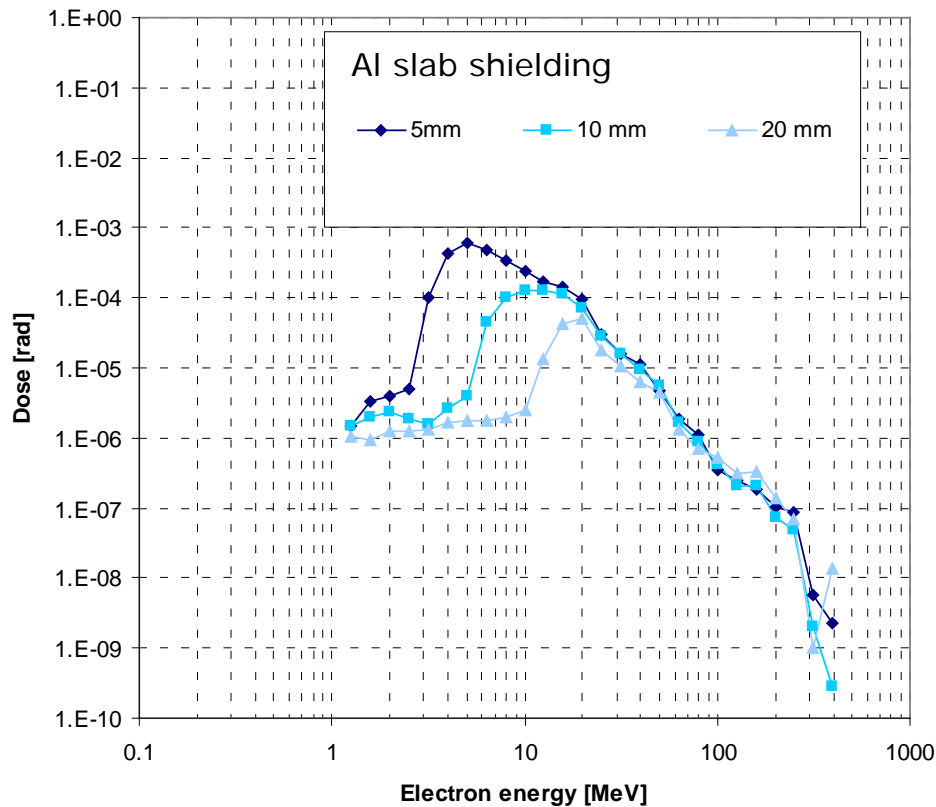
I. Jun, H. Garrett, JPL



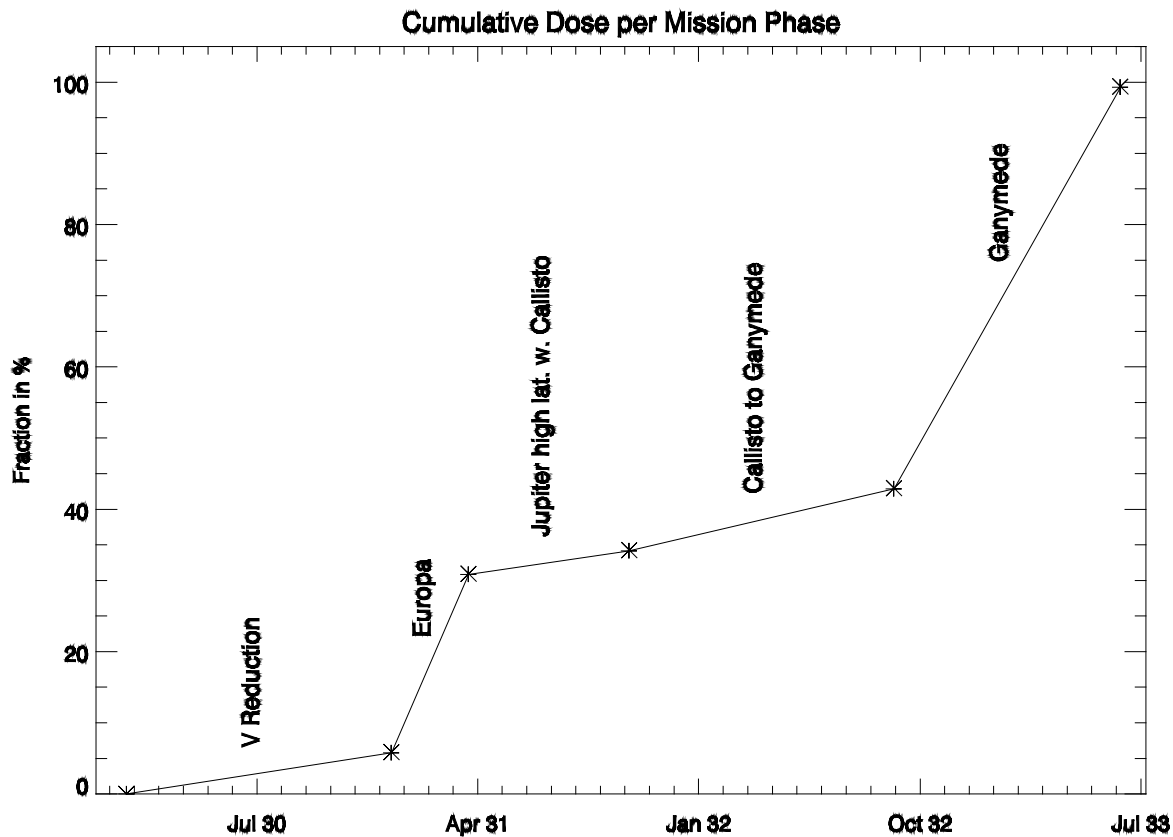
G. Santin et al, RADECS 2017

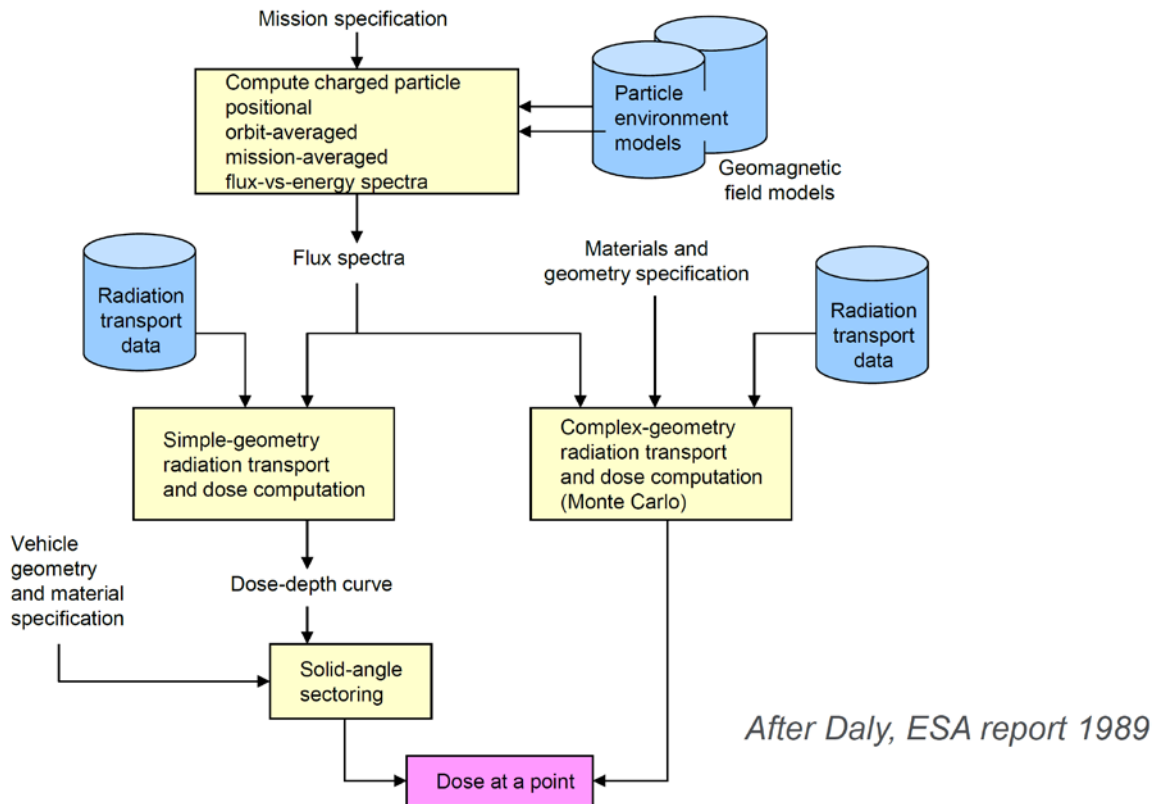


### Dose at 5, 10, 20 mm (binned) VS primary energy JOSE model >1MeV

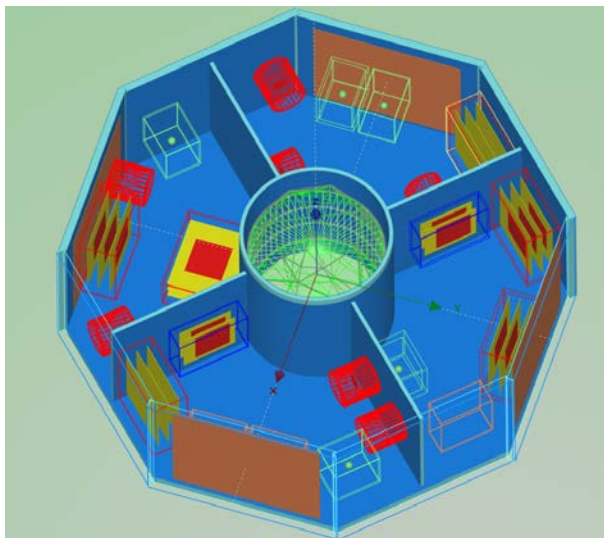


G. Santin, ESTEC

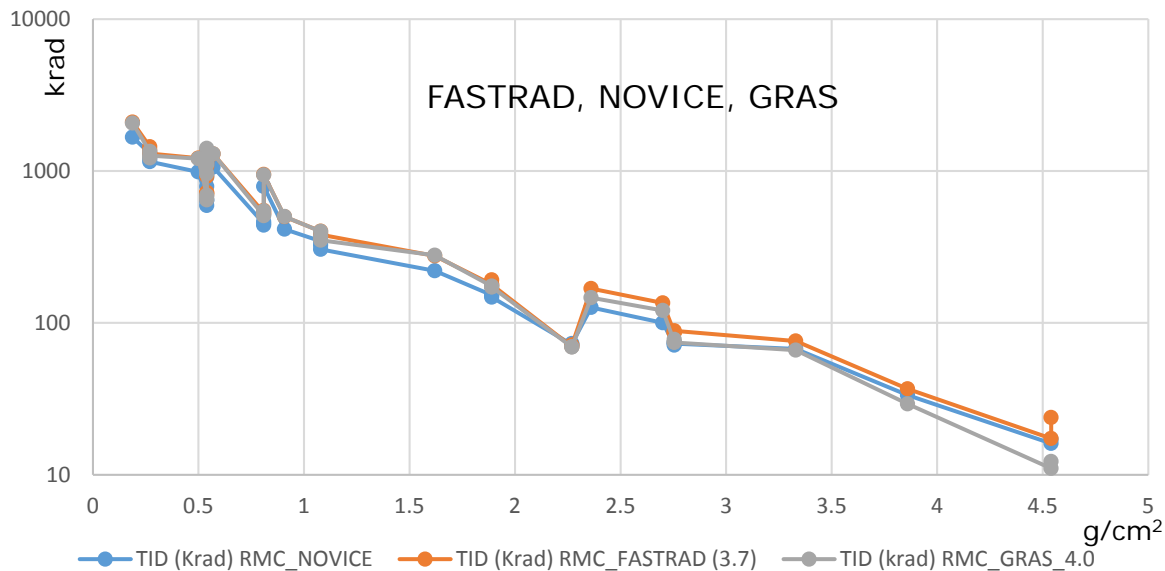




*After Daly, ESA report 1989*

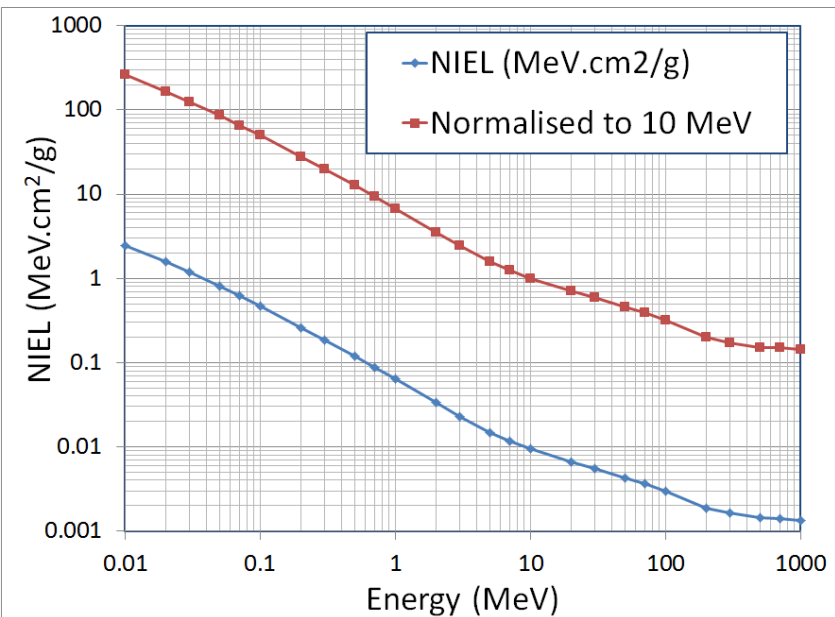


Generic Spacecraft Model

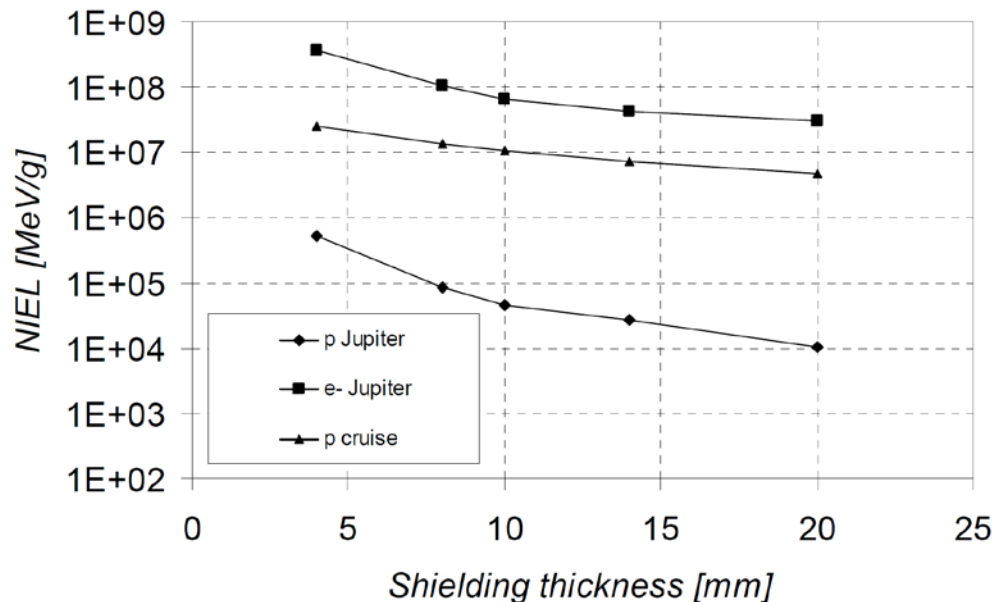


M. Vuolo, ESTEC

## Protons



NIEL electrons and protons  
mission total with cruise  
(planar slab, semi infinite)



JUICE Spectrum, 2010

- ❑ Jupiter has a very severe radiation environment
  - Dominated by electrons
  - Limited knowledge on shape & variability – magnetic field model
  
- ❑ Large effort deployed on simulations of radiation exposure and shielding optimisation
  - Simulation effort new to industry and instrument teams
  - Comparison of tools developed – relatively good level of similarity
  - Radiation exposure is dependent on geometry
  
- ❑ Currently obtained an optimised spacecraft with full spacecraft simulations