

OLTARIS: Enhancements Supporting the Europa Mission

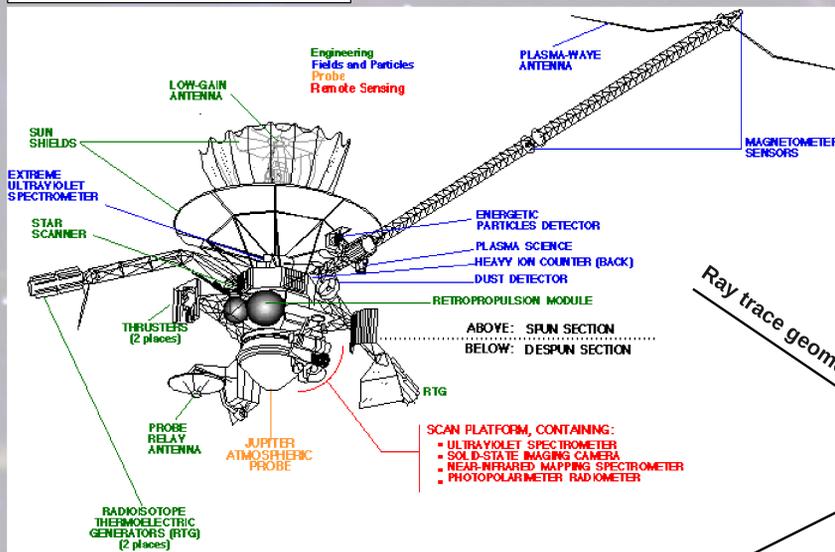
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 Francis F. Badavi, Christopher Newport University, Newport News, Virginia
 Tony C. Slaba, Old Dominion University, Norfolk, Virginia
 Ryan B. Norman, NASA Postdoctoral Program, Hampton, Virginia
 Jan L. Spangler, Lockheed Martin Operations Support, Hampton, Virginia



Abstract

The On-Line Tool for the Assessment of Radiation in Space (OLTARIS) is a web-based set of tools and models that allow engineers and scientists to assess the effects of space radiation on spacecraft, habitats, rovers, and spacesuits. The site is intended to be a design tool for those studying the effects of space radiation for current and future missions as well as a research tool for those developing advanced material and shielding concepts. The tools and models are built around the HZETRN radiation transport code and are currently focused on human-related responses. The site, along with the analysis tools and models within, have been developed using strict software practices to ensure reliable and reproducible results in a production environment. They have also been developed as a modular system so that models and algorithms can be easily added or updated. The focus of this poster is to highlight new capabilities that have been added to support outer planet missions. Specifically, the electron, proton, and heavy ion design environments for the Europa mission have been incorporated along with an efficient coupled electron-photon transport capability to enable the analysis of complicated geometries and slabs exposed to these environments.

Galileo Probe Example



XML Thickness File Uploaded to OLTARIS

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<creator creator_name="Chris Sandridge" creator_organization="NASA"
creator_email="c.a.sandridge@nasa.gov" creator_date="July 13 2010"/>
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target_z="90.0" order="outside_in">
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</ray>
<ray number="2" thk_count="1" xdir="0.208328E+00" ydir="0.453191E-01" zdir="0.977008E+00">
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</ray>
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Capabilities

- User Selected Environment(s)
 - Free-space Galactic Cosmic Ray (GCR)
 - Free-space Solar Particle Event (SPE)
 - Earth orbit (Circular)
 - Europa Design Environments (electrons and protons - 105 days at Europa, Jovian Tour, Peak flux at 5R_J and 9R_J) plus electron transport – **NEW to support Europa mission**
- Evaluation of User-Defined Thickness Distributions
 - Upload thickness distributions
 - Aluminum, polyethylene, tissue
- Evaluation of User-Defined Materials for Multi-Material Slab Calculations
 - Materials defined by chemical formula, elemental mass percentage, or molecular mass percentage
 - Arbitrary slabs created with user-defined materials
- User-Selected Response Functions
 - Differential flux/fluence
 - Dose in tissue or silicon
 - Dose equivalent based on ICRP60 standard
 - Whole-body effective dose equivalent using standard body models
 - TLD-100 (Thermo-Luminescent Dosimeter)
 - Differential/Integral LET (Linear Energy Transfer)

Project Summary

Project Name: Europa_105
 Project Description: 105-day Europa mission
 Environment Type: Europa
 Thickness Distribution Name: Galileo_SSI_968.xml (968 rays)

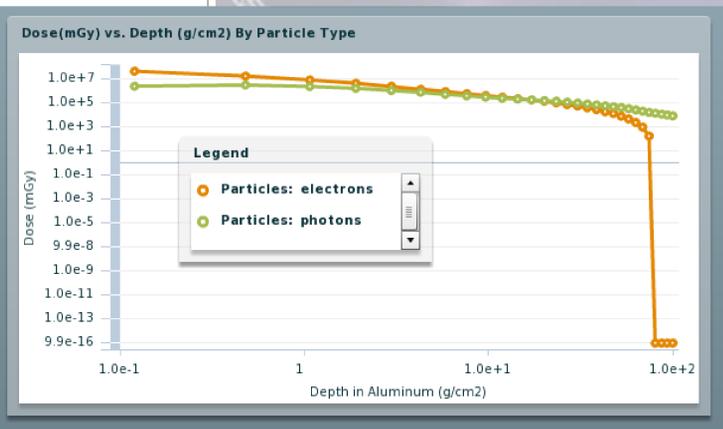
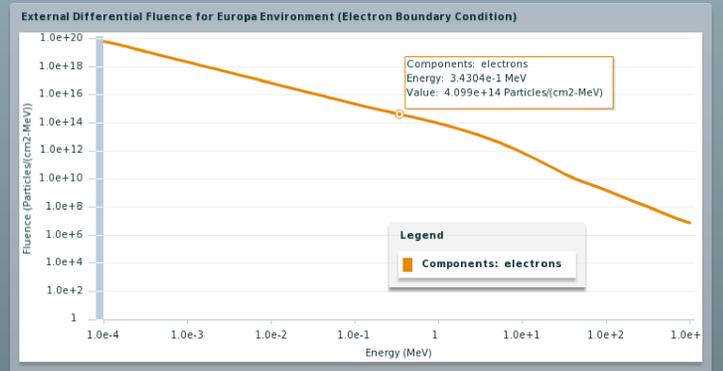
Data	Value	
Dose	4.759E+05 mGy	+ Sphere Viewer
Dose (electron)	2.666E+05 mGy	+ Sphere Viewer
Dose (photon)	2.056E+05 mGy	+ Sphere Viewer
Dose (positron)	9.643E+03 mGy	+ Sphere Viewer

Table Data

Usage hints:
 * To copy data to your system's clipboard, select the Plot/copy data link. The Copy Data button the data used for the current plot to your system's clipboard. Then you can paste it into Excel.
 * Use the button below to download a zip archive of all table data. Downloads may take a few especially when there are Differential Flux, TEPC or LET data sets.

Data	
Total Dose (mGy) vs. Depth (g/cm2)	+ Plot/copy
Total Dose (mGy) vs. Depth (g/cm2) by Particle Type	+ Plot/copy
Boundary Condition Fluence (electrons/(MeV-cm2)) vs. Energy (MeV) by Particle Type	+ Plot/copy data + Download
Fluence (electrons/(MeV-cm2)) vs. Energy (MeV) at Point 1 by Particle Type	+ Plot/copy data + Download
Fluence (electrons/(MeV-cm2)) vs. Energy (MeV) vs. Depth (g/cm2) by Particle Type	+ Plot/copy data + Download

Europa Design Environment Electrons for 105-Day Mission



Dose vs. Depth in Aluminum from Electron Environment

Software

- Requirements derived from use cases – give the user what they want
- Modular architecture for easy maintenance and rapid insertion of new models, methods, and algorithms
- Meets NASA STD-7009 models and simulation standard
- All software version controlled and regression tested to ensure reliability
- Validation benchmarks used to test and evaluate the accuracy of the physics and transport models.

<https://oltaris.nasa.gov>



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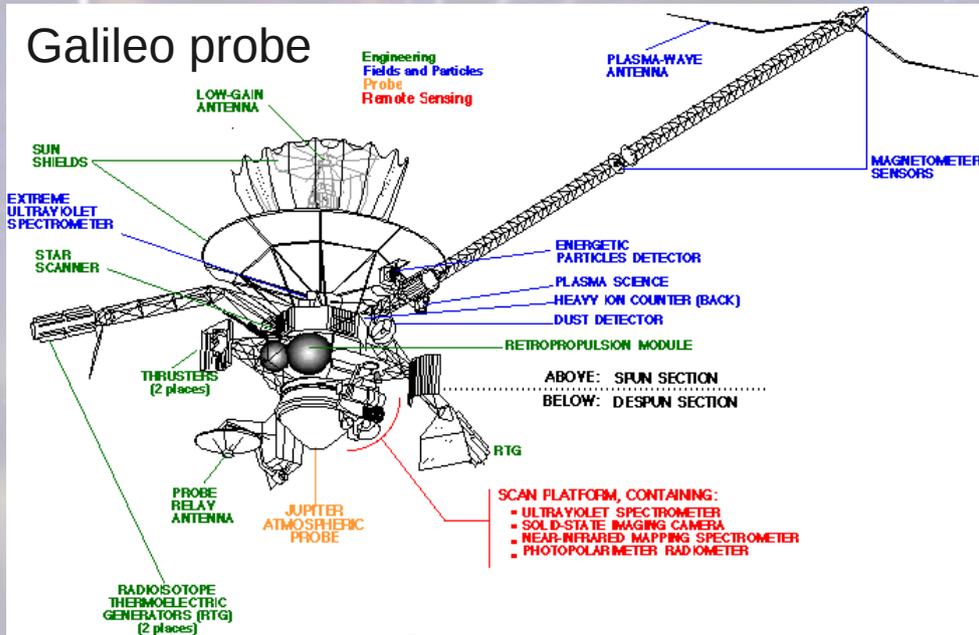
Europa Jupiter System Mission - 4th Instrument Workshop
Universal City, California
July 26-29, 2010

OLTARIS – On-Line Tool for the Assessment of Radiation in Space

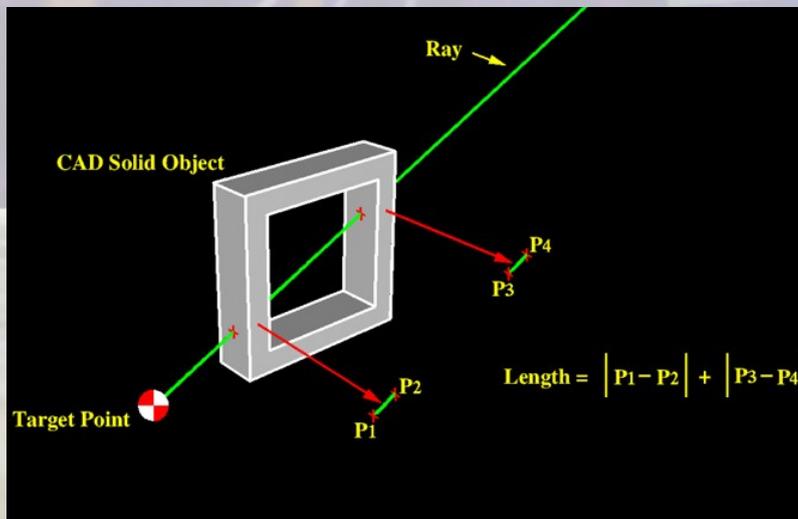


- Web-based tool for engineers and researchers interested in radiation shielding design and analysis
- Radiation transport based on HZETRN – fast and accurate
- Rapid analysis of complex geometries
- Recently integrated Europa design environments and electron transport
- Current Capabilities
 - GCR, SPE, LEO, and Europa reference design environments
 - User-defined materials, slab geometries, upload thickness distributions
 - Responses: flux/fluence, dose in tissue or silicon, dose equivalent, whole-body effective dose, TLD, LET, TEPC
- Maintained and updated by Radiation Shielding Team at NASA Langley Research Center

Spacecraft Example



Ray trace geometry



XML thickness distribution for upload to OLTARIS

```
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<creator creator_name="Chris Sandridge" creator_organization="NASA"
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.
.
.
</thickness_set>
</analysis_description>
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```

Typical Analysis Through OLTARIS



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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OLTARIS

On-Line Tool for the Assessment of Radiation In Space

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Project Summary

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 Project Description: 105-day Europa mission
 Environment Type: Europa
 Thickness Distribution Name: Galileo_SSI_968.xml (968 rays)

Event Totals

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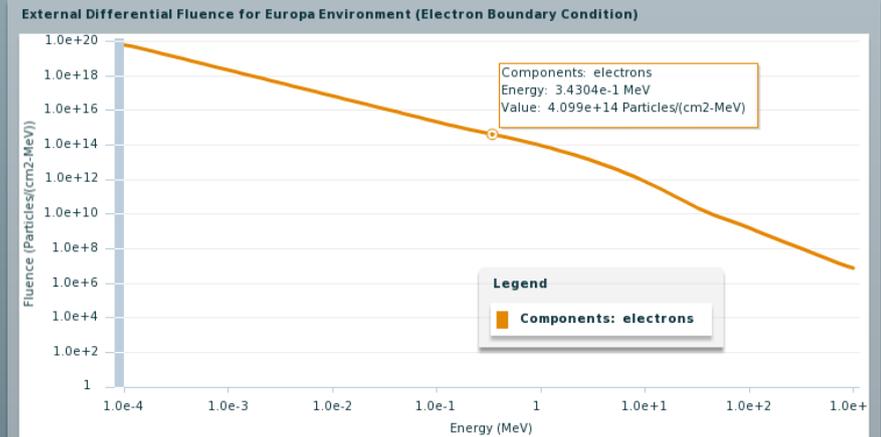
Table Data

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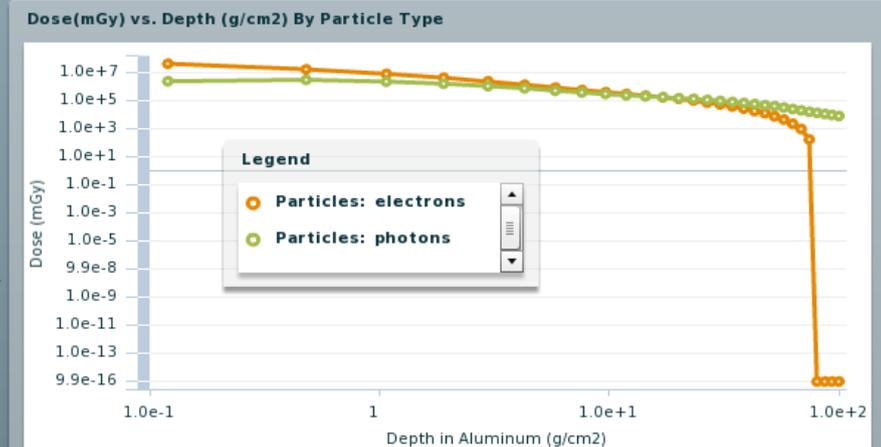
[Download All Tables](#)

Data		
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Fluence (electrons/(MeV-cm2)) vs. Energy (MeV) at Point 1 by Particle Type	+ Plot/copy data	+ Download
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Europa Electron Design Environment



Dose vs. Depth due to Electrons



<https://oltaris.nasa.gov>