OLTARIS: Overview and Update on New Capabilities

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Sponsor
Space Radiation Program Element

Outline

- Introduction and history
- Overview of OLTARIS
- Focus on recent enhancements
  - User-uploaded trajectories for Earth orbit environments
  - Ray-by-ray transport
- Future work
- Summary

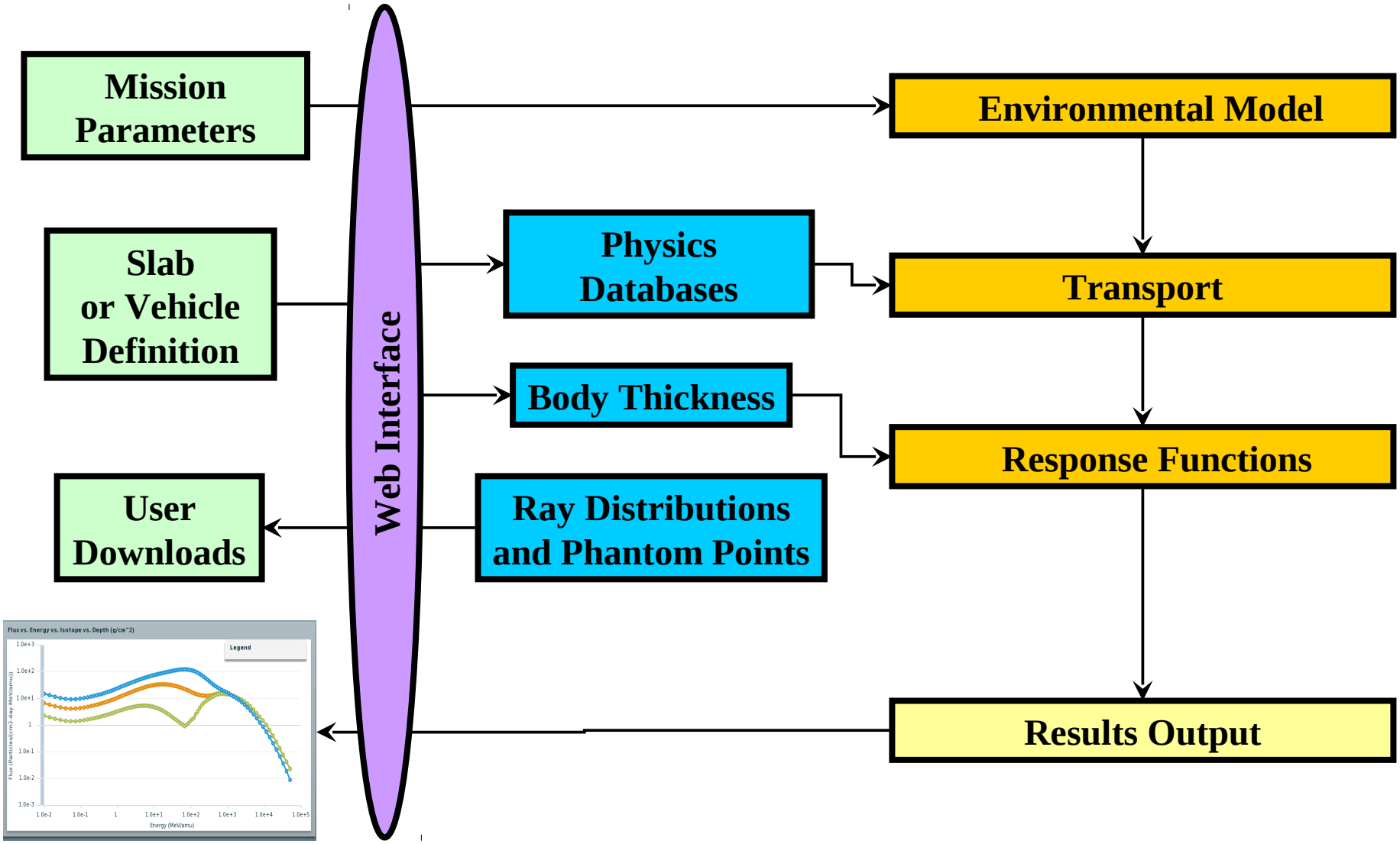
Introduction

- Radiation models and methods (software) have been developed by researchers for 35+ years
- Few had access to the software and it was very difficult to combine, maintain, and update
- **OLTARIS** – **O**n-**L**ine **T**ool for the **A**ssessment of **R**adiation **i**n **S**pace
  - Web portal created to supply the “best practices” in radiation shielding models, methods, and algorithms to the community
  - Rigorously developed in a modular framework that is easily maintained and updated
  - Easily accessible by NASA’s customers and collaborators

History and Statistics

- Originally deployed in early 2008
- Number of users – 144
  - 63 government
  - 46 academia
  - 35 industry
- Number of job runs – 5,600 since Nov. 2009
  - Doesn't include test site
- Number of updates – 46 worthy of change-log entries
  - Version control physics code: Rev. 3152
  - Version control web code: Rev. 2169

Modular Program Flow



Environmental Models

Solar Particle Events (SPE)

- Select from historic events or combinations
- User defined parameters to several fitting functions (Exponential in Energy or Range, Weibull, Band)

Galactic Cosmic Rays (GCR)

- Select from historical solar min/max
- Enter mission dates
- Enter solar modulation parameter (φ)

Environmental Models (cont.)

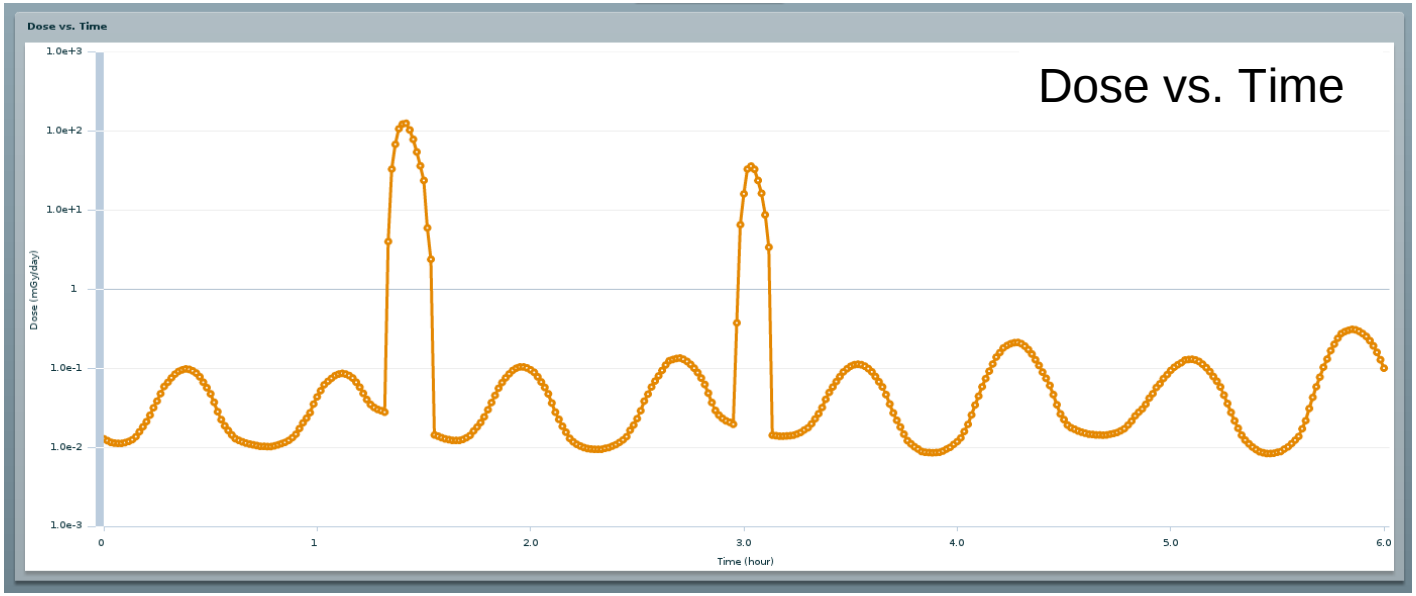
Earth Orbit

- Circular, day-averaged by selecting altitude, inclination, and date
- User can select the components to include
  - GCR attenuated by Earth's magnetic field
  - Trapped protons
  - Neutron albedo

- User-uploaded trajectories (NEW)
  - User can compute results averaged over entire trajectory or at every point along the trajectory
  - GCR and trapped protons only

Environmental Models (cont.)

Earth Orbit



- User-uploaded trajectories (NEW)
  - User can compute results averaged over entire trajectory or at every point along the trajectory
  - GCR and trapped protons only

Environmental Models (cont.)

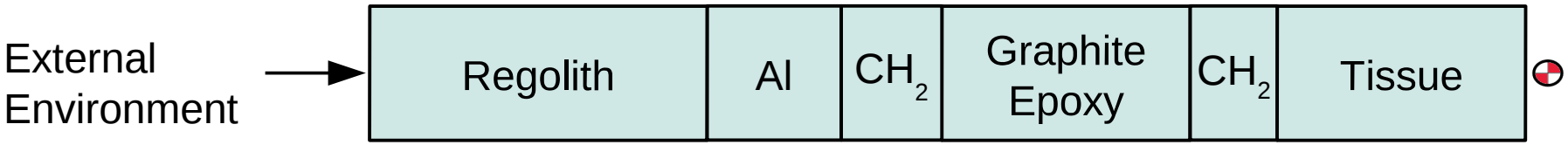
Lunar Surface

- GCR or SPE
- Contribution from surface is neglected

Europa (moon of Jupiter) Missions

- Intense electron environment
- Four mission design environments
- Integrated electron transport

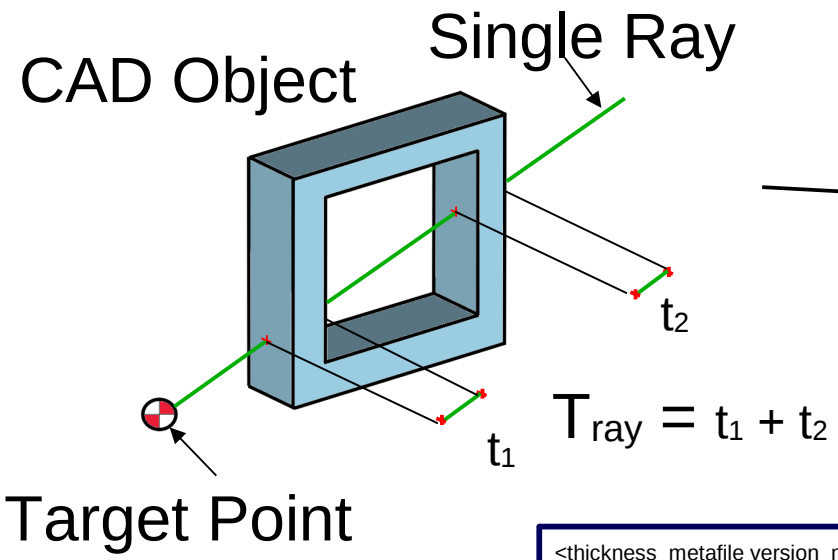
Multi-layer Slab



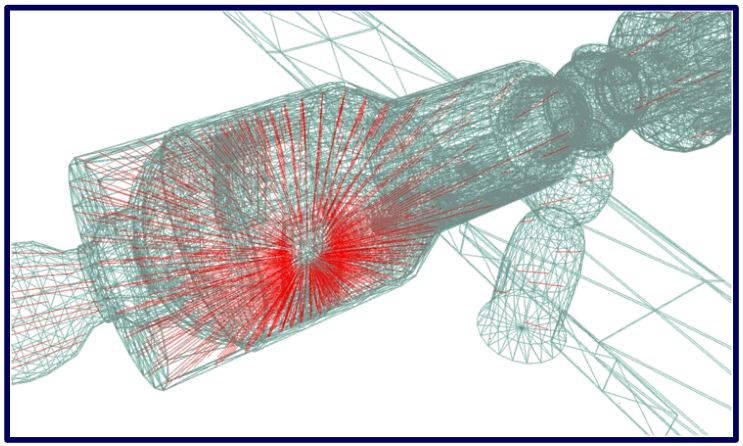
- Any number of materials in any order
  - Materials defined by chemical formula, molecular mass percentage, or elemental mass percentage
  - Cross-section database must be computed before the material is used in a slab or thickness distribution
- Responses returned at interfaces
- Bi-directional transport includes back-scattered neutrons

Thickness Distributions

Raytrace Concept



ISS Raytrace



XML Thickness File

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<creator name="Chris Sandridge" organization="NASA" email="c.a.sandridge@nasa.gov" />
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<analysis_description number_of_zones="1">
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<material material_id="1" type_id="1" name="Aluminum"/>
</material_table>
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</ray>
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</ray>
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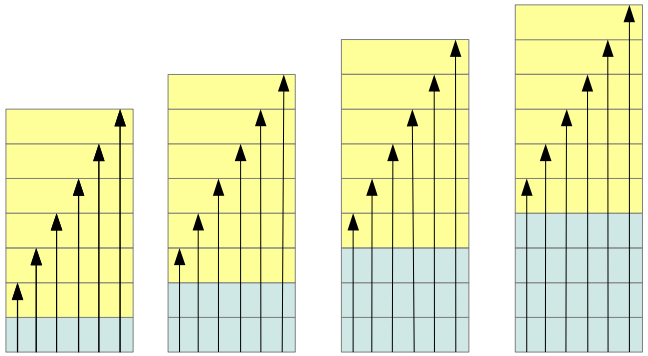
Solution Methods for Thickness Distributions



Interpolation-based

- Three materials or less
- Like materials are collocated
- Forward-only transport using HZETRN
- Creates response database vs. depth in each material
- Response at target point computed by interpolating each ray thickness then integrating over all rays

Ray-by-ray (NEW)

- Any number of materials in any order
- Bi-directional transport along each ray then integrate over all rays to get total response
- Enables much higher fidelity but may take much longer to run

Response Functions

- Converts output from transport into useful quantities
  - Differential flux/fluence (output from Transport module)
  - Dose (computed in silicon or tissue)
  - Dose equivalent (uses ICRP 60 quality factor)
  - Whole body effective dose equivalent
    - Uses ICRP 60 tissue weights
    - User can select human phantom model (CAM, CAF, MAX, FAX)
    - Phantom can be oriented
  - LET spectrum (Linear Energy Transfer)
  - TLD-100 (Thermo-Luminescent Dosimeter)
  - TEPC (Tissue Equivalent Proportional Counter)
- Availability of responses depends on geometry and environment

Typical Analysis through OLTARIS

National Aeronautics & Space Administration

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+ Send a Comment | + Report a Bug | + View Change Log

Projects | Uploads | Slabs | Materials | Documentation | Log Out

OLTARIS
On-Line Tool for the Assessment of Radiation In Space

Use form below to define a new project.

Edit Project

Project Name: SPE_sample

Comments: [No Comment]

Environment Definition + Reference + Help

Type:	Free Space
Comments:	*No Comments*
Solar Particle Event	August 1972 (King) multiplier=1.0

Edit Environment | Change Environment Type

Geometry + Help

Slab | Thickness Distribution: STS_dloc2

Response Functions + Reference + Help

- Differential Fluence: Differential Fluence after Transport (Function of Depth, Energy and Isotope)
- Dose: Dose in Tissue
- Dose Equivalent: Uses ICRP 60 quality factor
- Effective Dose Equivalent: Whole body quantity, uses anatomical model and ICRP 60 quality factor, also computes Avg. Dose Equivalent to BFO, skin, and lens. Use the drop down list below to select the anatomical model: Female Adult voXel 2005 (FAX) + Reference
- TLD-100: TLD = Thermo-Luminescent Dosimeter
- TEPC: TEPC = Tissue Equivalent Proportional Counter
- LET: LET in Tissue

Update project | Cancel | Reset form

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NASA Official: Chris Sandridge
Project Manager: Lisa Simonsen
Website Manager: Jan Spangler

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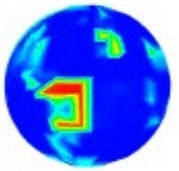
Return to Project List | Return to Job List

Project Summary

Project Name:	SPE_sample
Project Description:	[No Comment]
SPE defined by Historic Event:	August 1972 (King) multiplier=1.0
Thickness Distribution Name:	STS_dloc2 (968 rays)
Grid Engine Id:	2089108

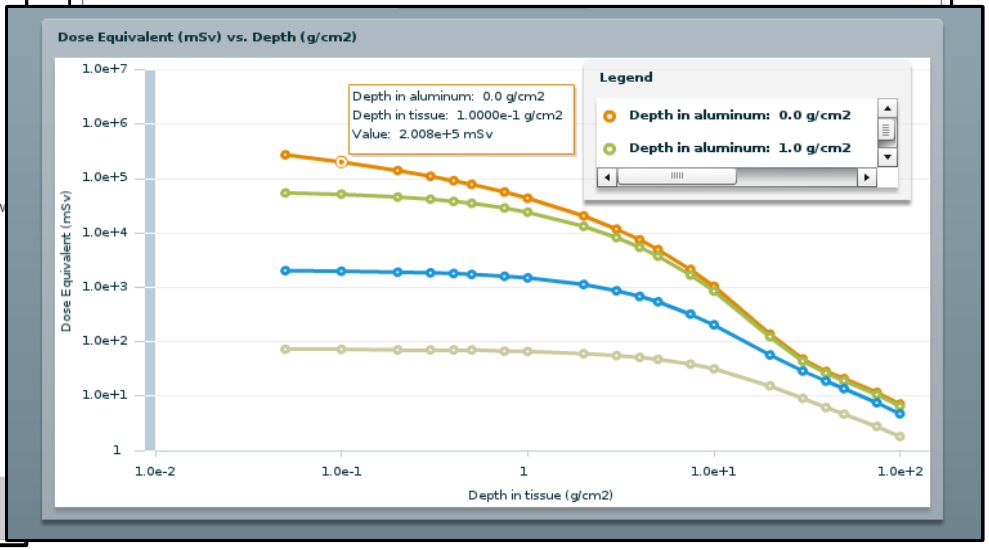


Event Totals + Help

Data	Value	
Dose at point 1	8.690E+03 mGy	+ Sphere Viewer
Dose Equivalent at point 1	1.561E+04 mSv	+ Sphere Viewer

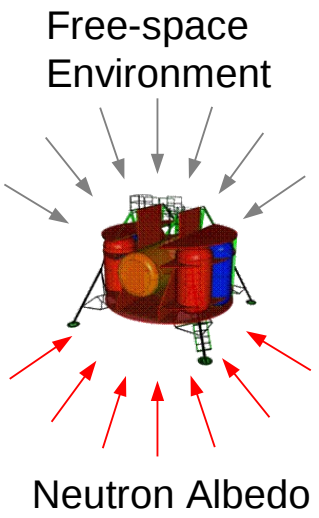
Whole Body Effective Dose Equivalent & Average Organ Dose Equivalent Values

For this calculation **only**, the selected body model is added to the vehicle thicknesses.



Some Future Updates

- Lunar Surface Environment
  - Ray-by-ray including albedo neutrons
  - Interpolation w/albedo neutrons
- Badhwar-O'Neill 2010 GCR Model
- Multi-layer spheres
- Earth Orbit Electrons
- Effective Dose vs. Depth



- Let us know what you want!

Summary

- Introduction and History
  - OLTARIS created to give the radiation shielding community access to reliable, well tested tools and models
- Overview of capabilities that benefit the radiation shielding community
- Emphasized new ray-by-ray and point-by-point trajectory analysis that adds accuracy and fidelity
- Briefed upcoming additions – lunar albedo, BO-10, ...

- Check us out at https://oltaris.nasa.gov

Home Page at https://oltaris.nasa.gov