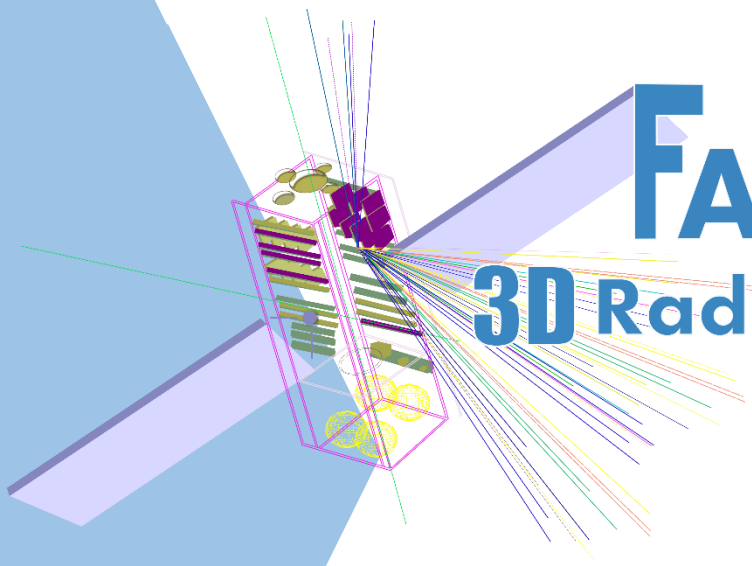

FASTRAD
3D Radiation Software

3D modelling software for
radiation shielding analyses
in **space environments**

TECHNICAL DESCRIPTION

Software developed by
TRAD Tests & radiations

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FASTRAD® SOFTWARE IS AVAILABLE ON ANNUAL SUBSCRIPTION:

FEATURES

INTERFACE & MODELLING

- Graphical User Interface
- Advanced CAD Toolkit
- Data base interface
- Exchange with other radiation codes
- Advanced STEP import

SECTOR ANALYSIS

- Extended modelling interface
- TID - by sector analysis (*ray-tracing*)
- TNID (*e.g. DDEF*) by sector analysis (*ray-tracing*)
- Six Faces Equivalent Thickness
- Ray view and shielding mapping
- Environment input portfolio

MONTE CARLO CALCULATION CAPABILITIES & SCRIPTING MODULE

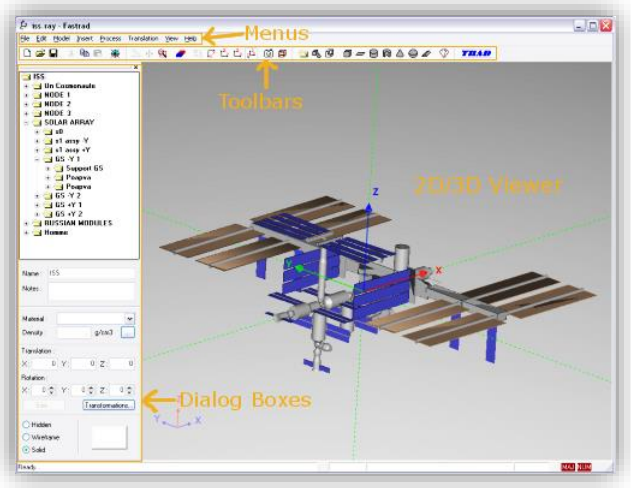
- Forward Monte Carlo calculation (*Electron, Photon & Proton transport*)
- Reverse Monte Carlo (*TID and TNID estimate for isotropic electron and proton flux*)
- 3D mapping
- Scripting module
- Internal charging

INTERFACE AND MODELLING

Thanks to a simplified configuration, you can create and handle 3D radiation models and import, export and modify entire STEP object characteristics.

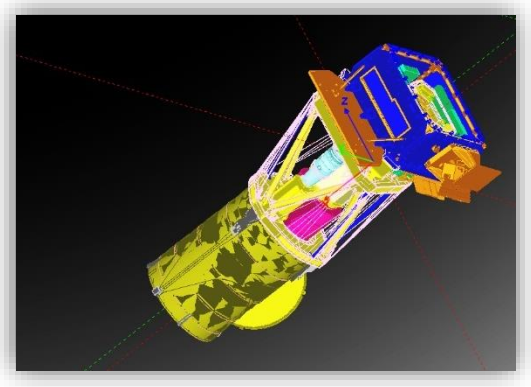
Graphical User Interface

- Framework: menus, toolbar buttons, property dialog boxes, hierarchical window.
- Viewer 2D/3D+ objects handling (*rotation, translation, etc.).*
- Insertion of simple shapes (*box, cylinder, cake, sphere, cone, triangular prism, elliptical cylinder and torus, extruded trapezoid*).
- Cut and merge operations on all shapes (*including STEP*) creating complex shapes.
- A material definition interface with a database.



CAD Toolkit

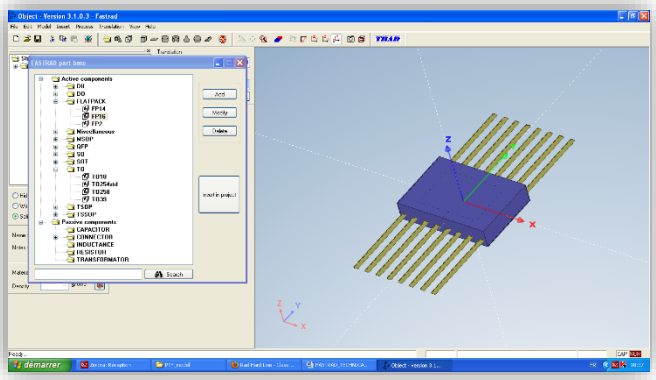
GENERAL	GEOMETRY	RADIATION ANALYSIS TOOLS
♦ Keyword search engine ♦ Print & copy view functions ♦ Clipping plane view ♦ Black & White photo view	♦ Detection of overlaps ♦ 3D measuring tool ♦ 2D grid ♦ 2D move	♦ Advanced detection of invalid shapes ♦ Mass calculation ♦ Material tool (*visualization, replacement, list cleaner*) ♦ Detector handling tool ♦ Material & Detector list exchange



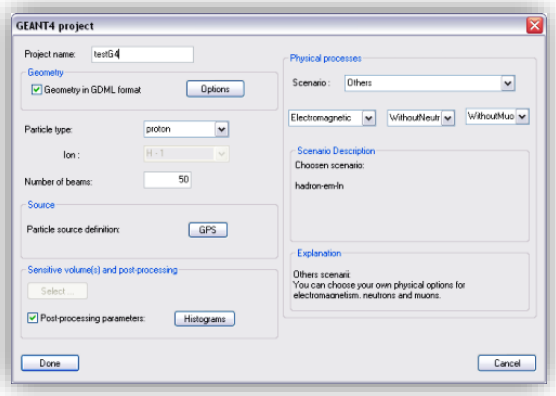
Database Interface

An interface that allows the management of the FASTRAD® model database. When using this dialog box, you can store a model in your database or you can insert any model of your database in your current FASTRAD® model.

FASTRAD® is delivered with an extensive component package model base (*flatpack, TO, etc.*). The user is invited to complement this database.



Exchange with other radiation codes



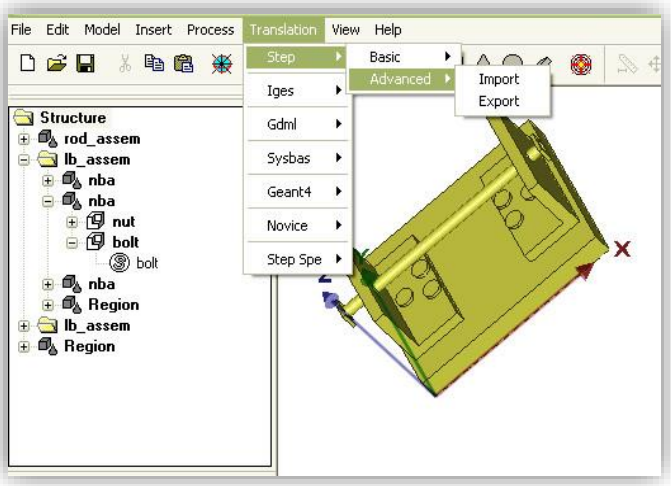
- C++ GEANT4 project export
- Export the FASTRAD® model into GDML 2.7 format
- Geometry translator
- Particle source definition
- Sensitive volume detector definition
- Result histogram (*dose, LET, etc.*)
- Selection of physical processes

Advanced STEP import

Import models written in STEP format (*AP209, AP214, partially AP203*). Compatible STEP files can be generated by CAD tools.

The reader function also allows import of:

- The hierarchy
- The name of the solids
- The colour of the solids



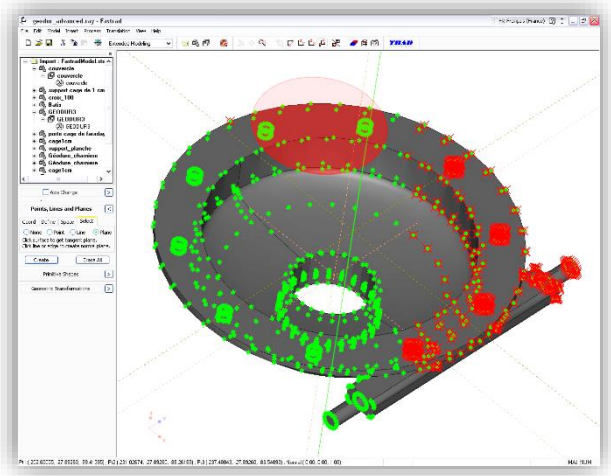
SECTOR ANALYSIS

You can create complex solids using points (*lines and planes*) in the 3D model and to perform essential calculations: TID and TNID by sector analysis (ray-tracing), six faces equivalent thickness, ray view and shielding mapping.

Extended Modelling

The user is able to create points, lines and planes using the surfaces and edges of existing solids. It is possible to apply different transformations (*projections, spaces, etc.*) on the entities to create points, lines and planes anywhere in the 3D scene.

Specific shape definition interfaces allow you to create FASTRAD® solids by directly selecting the points of the 3D graph. Transformation tools allow you to define geometrical transformations that could be repetitively applied on any part of the model in order to create geometrical patterns.



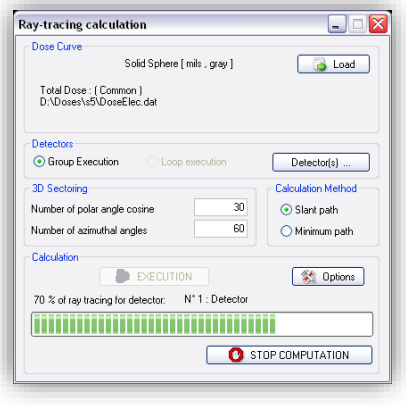
TID & TNID by sector analysis (*ray-tracing*)

Dose calculation by sector analysis on any FASTRAD® model containing simple and complex shapes and/or tessellated volumes (*coming from STEP or IGES format files*).

Two calculation methods are proposed:

- The “slant” method (*associated with solid sphere Dose Depth Curve*)
- The “minimum path” method (*with a shell sphere Dose Depth Curve*).

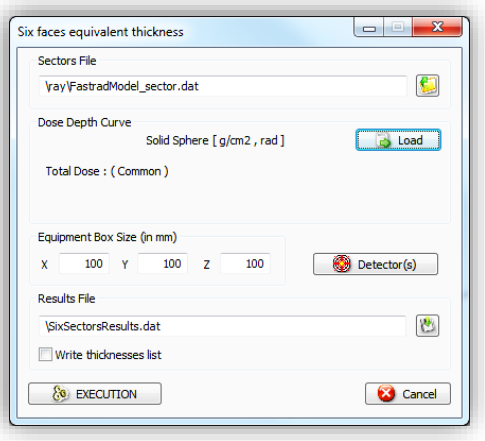
Non-Ionizing Dose (TNID)
This interface is dedicated to the calculation of TNID in sensitive areas as a Displacement Damage Equivalent Fluence (*DDEF*) or a Displacement Dose (*DD*).



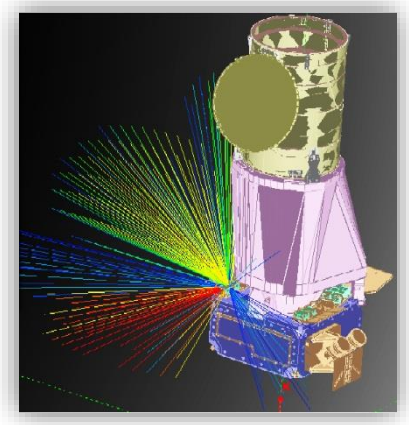
Six faces equivalent thickness

The 6 faces equivalent thickness dialog allows you to calculate the dose-equivalent thickness provided to any detector in each of the 6 directions (*+/-X, +/-Y, +/-Z*).

The user can set the size of the shielding box that simulates the equivalent shielding.



Sector analysis post-processing



The crossed thicknesses calculated by sector analysis can be visualized thanks to a color code applied for different thickness values.

This is a complimentary feature of the ray view tool. It displays a mapping of the shielding seen by the selected detector on a chosen surface.

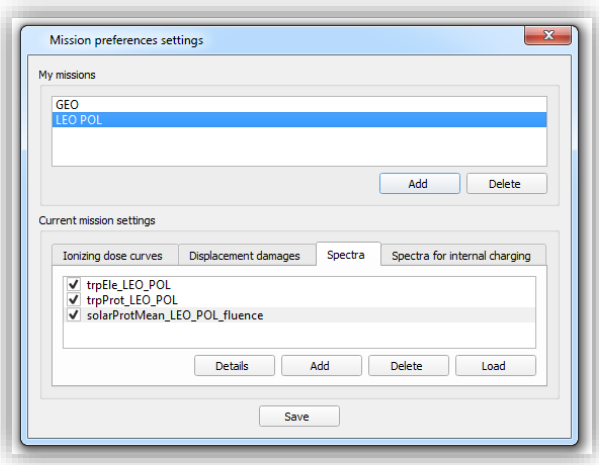
The color scale shows the most critical locations in terms of radiation shielding.

Mission Preferences (*new feature*)

A dedicated dialog box allows users to define, modify and save input environment files.

These files can then be loaded into the corresponding calculation modules:

- TID and TNID depth curves for ray-tracing,
- Spectra for Reverse Monte Carlo,
- Worst case electron spectrum for detailed Internal Charging.

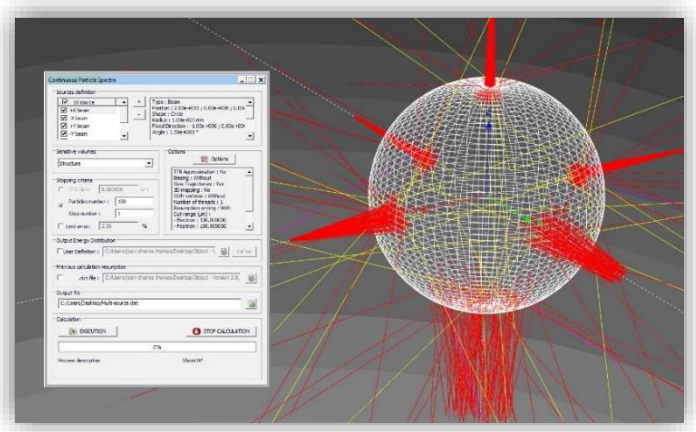


FASTRAD® gives you the keys to the most efficient Monte Carlo calculation: Both Forward and Reverse Monte Carlo calculations are available. The Monte Carlo is based on actual physical interactions of particles with matter. It considers the material composition and the particle behaviour, permitting a higher level of accuracy. The calculation can be run on several threads (*parallelization*) to decrease the computation time. Furthermore, an additional window displays up-to-date results during the calculation.

MONTE CARLO CALCULATION

The scripting module allows you to customize and accelerate your use of FASTRAD® by interacting through scripts, with the main FASTRAD® entities. For example, you can perform parameterized modelling or iterative calculations with this module, as well as customize your input/output file format. The possibilities offered by the scripts are limitless. A complete documentation (*Doxygen*) is provided to describe the scripting API and to give application samples.

3D Forward Monte Carlo transport for electrons, photons and protons



This module allows you to perform calculations using a Forward Monte Carlo algorithm. Primary electrons, protons and photons as well as secondary electrons, positrons and photons can be considered.

Several sources of particles can be defined at the same time, for electrons, protons and photons.

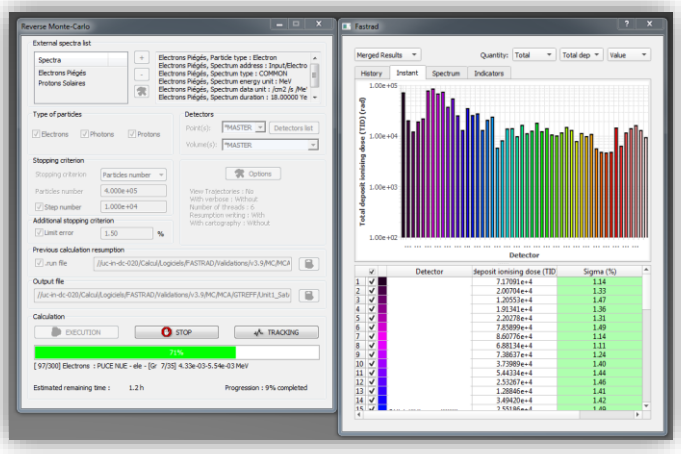
A wide range of source geometries can be defined, based on the model geometry or from virtual shapes.

Mono-energetic fluxes or continuous energy spectra can be used for the calculation. (*No limitation in the number of sources.*)

Several sensitive volumes can be selected in the 3D model. The results are:

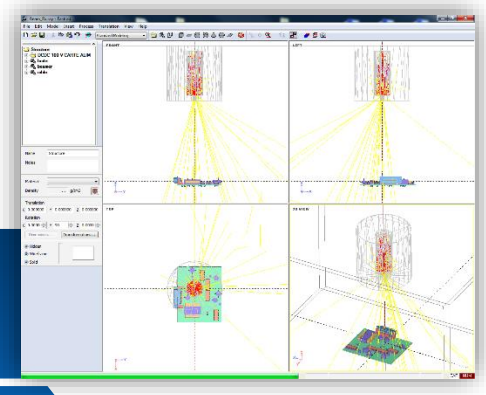
- The deposited energy
- The dose depending on the material of the target
- The particle fluence for each particle type

An interactive monitoring interface displays up-to-date results (*dose, spectra, errors*) during calculation.

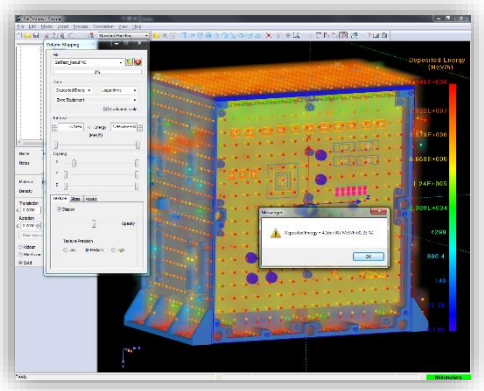


Particle trajectories can be visualized and interaction properties are displayed when a track is selected. **(*Picture 1 below*)**

The 3D mapping module allows calculation of deposited energies, transmitted integral flux and associated errors in sensitive zones previously specified. With this tool critical zones can easily be identified. **(*Picture 2 below*)**



Picture 1



Picture 2

3D Reverse Monte Carlo for incident electrons and protons

TID and TNID estimates using Reverse Monte Carlo for incident electron and proton flux.

For complex 3D models including different geometrical scales, the dose calculation becomes very time-consuming with a standard (*Forward*) Monte Carlo approach. The Reverse Monte Carlo approach gives a powerful solution for accurate TID calculation.

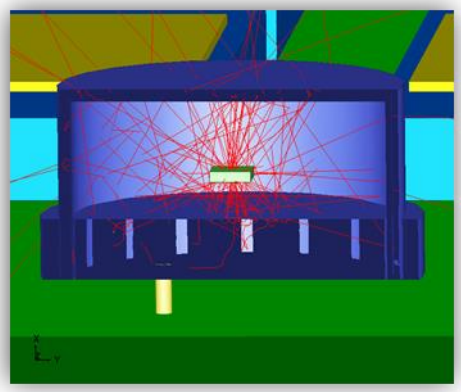
Primary and secondary electrons, primary protons and secondary photons (*Bremsstrahlung*) are taken into account. Point detectors and sensitive volumes can be considered to obtain:

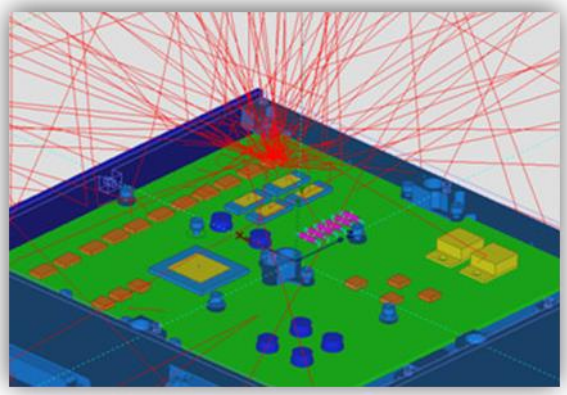
- The deposited ionizing dose: total and per particle type
- The total non-ionizing dose (*using NIEL tables*)
- The transmitted fluence per particle type

The radiation environment is defined by several spectra of electrons and protons (*no limit*).

TID and TNID calculations are performed according to the materials assigned to the punctual or volume targets. Note that the Reverse Monte Carlo method is dedicated to an isotropic environment.

An interactive monitoring interface displays up-to-date results (*dose, spectra, errors*) during calculation.





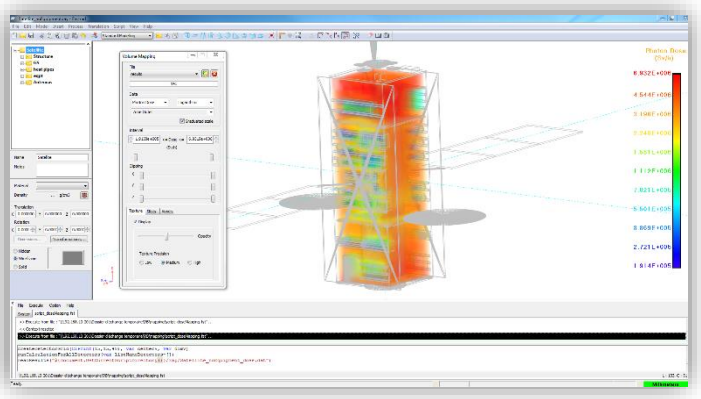
The Reverse MC module enables you to visualize the particle trajectories and to display the interaction properties when a track is selected. The 3D mapping module allows calculation of deposited energies, transmitted flux and associated errors in sensitive zones. The Reverse MC module is able to produce one mapping file for all the detectors and sensitive volumes or a merged mapping file including all the selected detectors.

Scripting module

A script language has been integrated into FASTRAD®. It allows the user to interact with the main FASTRAD® entities. It also permits the user to perform parameterized tasks, to deal with custom file formats, etc.

A Script Integrated Development Interface allows you to write your own script. Multiple features exist to help the user to quickly write a correct code.

A Script Portfolio is available to store your script files and execute them quickly.



Internal Charging (*simple and detailed*)

The simple IC module allows the calculation of the current densities (*in pA/cm²*) between two points in a dielectric volume of a 3D model.

The advanced IC module allows the calculation of the incident electron current density (*in pA/cm²*) and the trapped volumic flux in a dielectric volume of a 3D model.

These calculations are based on the electron Reverse Monte Carlo algorithm. A Monte Carlo calculation estimates the incoming and outgoing electron current for selected detectors.

The difference between the two currents gives the electric current density created in the dielectric volume.