FASTRAD V3.1 : Radiation shielding tool with a new Monte Carlo module.

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INTRODUCTION

We present the new version of the Radiation shielding tool : FASTRAD (http://www.fastrad.net). First, improvements performed on the interface are described showing that a radiation analysis can be easily achieved on realistic models. In the second part, the new Monte Carlo module is presented.

DESCRIPTION

FASTRAD is a software, running on Windows systems, developed by the TRAD company. The project was created in 1999 and is constantly being improved since. This tool is dedicated to the calculation of radiation effects (Dose and Displacement Damage) on electronics. The interface includes a 3D modeler with all the capabilities required for the representation of any system. For space applications, FASTRAD can consider a complete satellite model from the platform structure down to the electronic components. Radiation effects are estimated at any point of the 3D model using the following methods :

- sector analysis for a quick calculation in a first approach
- Monte Carlo algorithm for a fine calculation of energy deposition by particle-matter interaction.

A post processing feature includes a shielding assistant that helps the engineer to design the protection structure.

Hereafter we describe the main capabilities of this tool emphasizing the new features included in the 2010 version.

Radiation CAD interface.

Several interface features have been modified in order to provide the user with an intuitive and simple way to create a radiation model. The 3D solids can be defined either by using the CAD toolbar or by importing them from other CAD tools (CATIA, Pro/Engineer…) with the standard STEP or IGES format. The new advanced STEP module allows to import the hierarchy, the name and the color information. Then the full 3D designer model is managed by FASTRAD (visualization, radiation calculation, post-processing).

Another key element of the radiation tool is the management of the materials. In this new version, FASTRAD allows to use any material by determining its chemical composition through a friendly interface (see Fig. 1.).

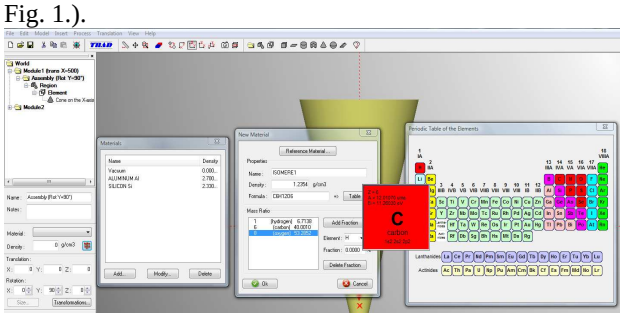

Fig. 1. Dialog boxes of the material definition module. An interactive periodic element table makes the material creation easier.

Several more helpful features (local frame display, interactive measurement tool, context menus,…) have been added to the interface. The goal is to provide a CAD software that can be used by engineers who want to minimize the modeling time in order to spend more time on radiation analysis.

Dose calculation.

The dose calculation in FASTRAD has been greatly improved with the development of the Monte-Carlo module (thanks to a partnership between TRAD and the CNES). This algorithm can be used either in a forward process or a reverse one. In the first case, FASTRAD manages the transport of electrons and photons from 1keV to 10 MeV, in the 3D model. Creation of secondary photons and electrons due to primary electrons are taken into account. Any type of energy spectrum and source geometry can be defined. Sensitive volumes (SV) are selected by the user and FASTRAD computes the deposited energy inside those SVs. The reverse Monte Carlo module is dedicated to the dose calculation due to an isotropic irradiation of electrons in a complex geometry. In this case, the forward algorithm can lead to huge computational times. The principle of the reverse method is to use (i) a forward particle tracking method in the vicinity of the SV and (ii) a backward particle tracking method from the SV to the source.

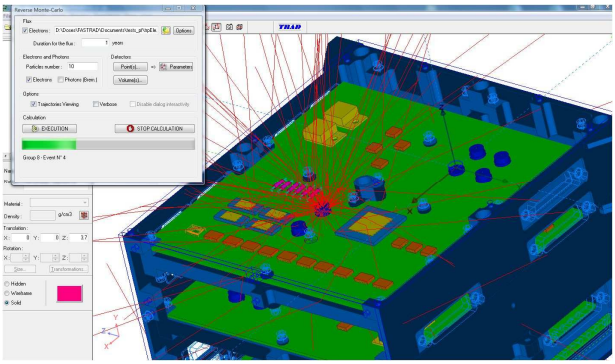

Fig. 2. Screen shot of the electron tracks during reverse Monte Carlo calculation on an electronic equipment.

The reverse Monte Carlo takes into account the energy deposition due to primary electrons and secondary photons.

The Monte Carlo module has been successfully validated with GEANT4 (www.cern.ch/geant4/) for the forward algorithm and with NOVICE (EMPC) for the reverse method. Examples of applications on electronics will be presented. Those examples cover the case of an electronic equipment in a satellite structure. The radiation environment corresponds to the electron energy spectrum of a geostationary mission (from 10 keV up to 7 MeV). The results of the deposited doses due to electrons and secondary photons show a good agreement with NOVICE results.

Other new modules include the bunker designer tool that calculates the concrete wall thickness of irradiation rooms by considering the room's geometry, the type and activity of the source and the acceptable dose rate.

This is a constantly evolving project. In the near future the Monte Carlo module will be able to manage protons and positrons.