APPLICATION OF THE GEANT TOOLS FOR SPACECRAFT INTERNAL CHARGING SIMULATION

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Abstract

In report the application of the GEANT Monte-Carlo tools for a calculation of deposition of the electrical charge in dielectric materials of spacecraft are considered. The contribution of processes of energy loss and stopping of primary and secondary cascade particles, formation of holes is analyzed. At calculation of trajectories of movement of all charged particles. The influence an internal electrical field on tracing charge particles is taken into account. The results of calculation of distribution of the internal charge in dielectric material and for some electron energies and space radiation spectra for typical spacecraft orbit are presented.

Introduction

By consideration of spacecraft (SC) internal charging processes under impact of relativistic trapped electrons is need detailed description of particle transport in dielectric materials.

Now for this goal 3D Monte-Carlo particle tools are using wide. In this paper we consider the simulation of transport of electron monoenergetic beam and space radiation through glass target using GEANT tools/1/.

The influence of internal electric field of preliminary volume-charged glasses/2/ is taken into account.

Calculation results

In fig. 1,2,3 the results of modeling of passage of a electron beam through glass target are shown, at normal incident angle with initial energy 1.5 MeV for 10^5 events. The thickness of a target is 0.5 g/cm^2. In fig. 1 the distribution of number stopped electrons on depth of target is given. As we can see from figure a maximum of stopped electron distribution to have on depth 0.375 g/cm^2.The depth mean width is ~ 0.25 g/cm^2.

In figure 2 the spectrum backscattering electrons is shown. A maximum of a spectrum is on energy 0.6 MeV.

In figure 3 the spectrum of outgoing electrons is shown. A maximum of this spectrum to have on energy 0.6 MeV, and on energy 0.8 Mev the spectrum sharply falls.

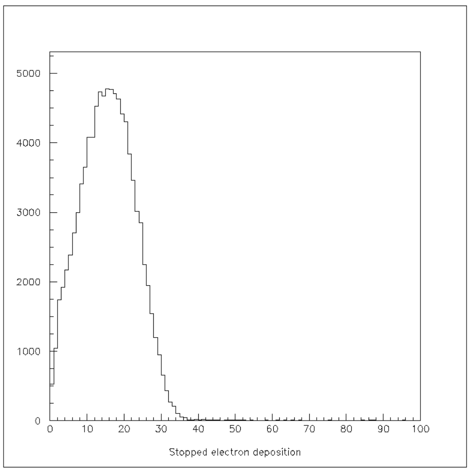


Fig. 1. Stopped electron distribution.
T= 1.5 Mev, normal incident angle.

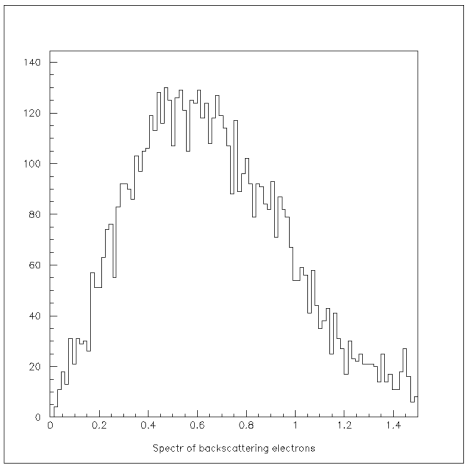
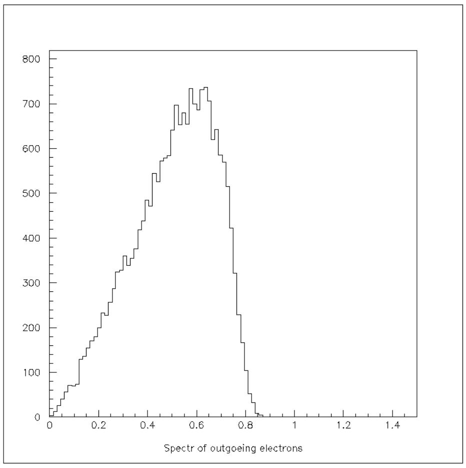


Fig. 2.Backscattering electron spectrum,
T= 1.5 Mev, normal incident angle.

In fig. 4 and 5 the distribution stopped electros on depth for the same conditions, but with the internal electrical field E is given. The electrical field linearly depends on depth.



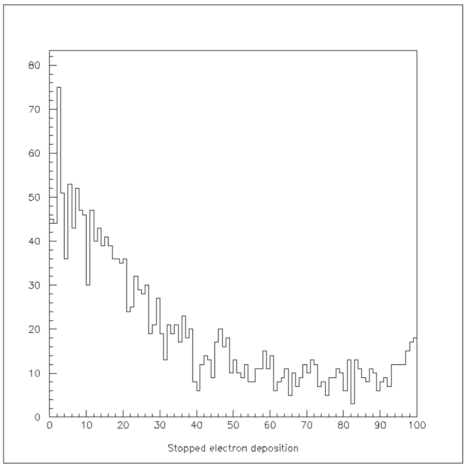


Fig. 3.Outgoing electron spectrum. T= 1.5 Mev, normal incident angle.

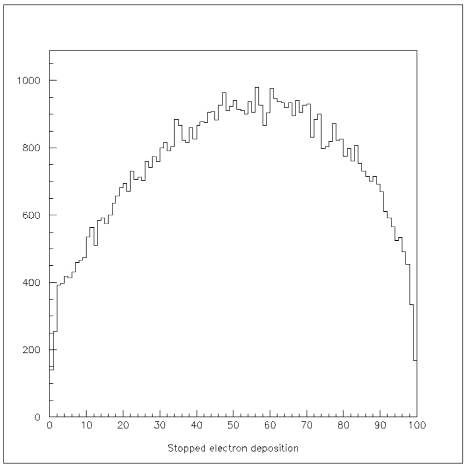
Fig. 4. Stopped electron distribution. T= 1.5 Mev, normal incident angle. E= 1.0 MeV/cm.

In fig. 4 and fig. 5 the distribution stopped electros on depth for the same conditions, but with the internal electrical field E is given. The electrical field linearly depends on depth.

In fig. 4 the case of normal incident electrons is considered, and in fig. 5 isotropic incident electron cases.

Comparing fig. 4,5 with fig. 1, we can notice, that the electrical field brings in significant changes on electron distribution. Sharply changes both number stopped electrons, and kind of their distribution on depth.

In fig. 6 the stopped electron distribution on depth of dielectric is shown, in case of normal incident electrons with energy 0.5 MeV. The electrical field is absent. A maximum of distribution is on depth 0.1 g/cm^2.



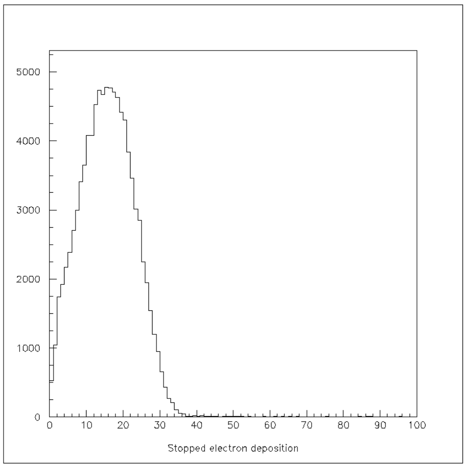


Fig. 5.Stopped electron distribution. T= 1.5 Mev, isotropic incident electron distribution, E= 1.0 Mev/cm.

Fig. 6.Stopped electron distribution. T= 0.5 Mev, normal incident angle.

In fig. 7 the stopped electron distribution on depth of substance is given, in case of normal with energy 5 MeV for 10^5 events with the internal electrical field. The electric field again linearly depends on depth. A kind of the stooped electron distribution essentially differs from all previous cases. The number stopped electron in a maximum is small.

In fig. 8 and 9 the stopped electron distribution on depth for exponential incident electron spectra is shown. Average energy is 0.5 MeV, isotropic incident electron distribution. In fig. 8 the case is considered, when the internal electrical field is absent.

In fig. 9 the case is considered, when at substance there is an electrical field linearly dependent on depth.

As we can see, by comparing these two figures, the electrical field strongly influences a kind of the given distribution, compressing it in the party of reduction of depth. Comparing these results with previous, it is possible to notice, and that fig. 8 has similarity to fig. 4 and fig.5.

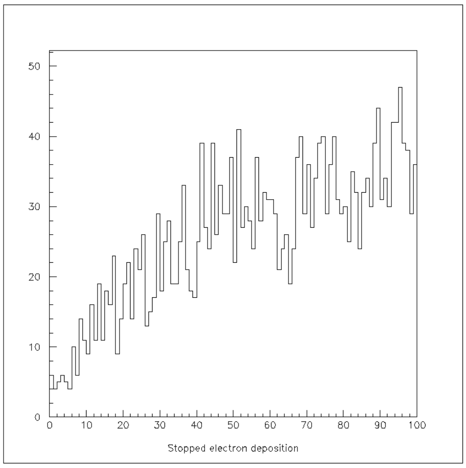


Fig. 7. Stopped electron distribution.
T= 5 Mev, normal incident angle.
E= 1.0 Mev/cm.

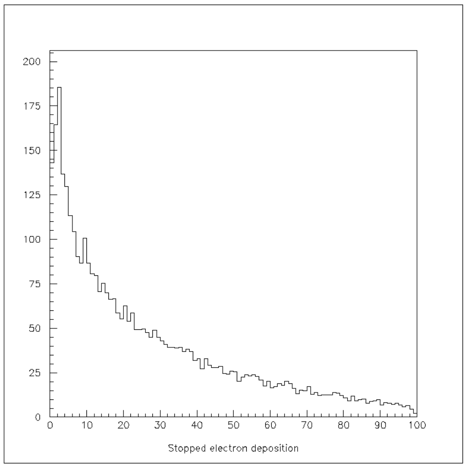


Fig. 8. Stopped electron distribution.
Exponential spectrum, <T>= 0.5 Mev,
isotropic incident electron distribution,
E= 0.0 Mev/cm.

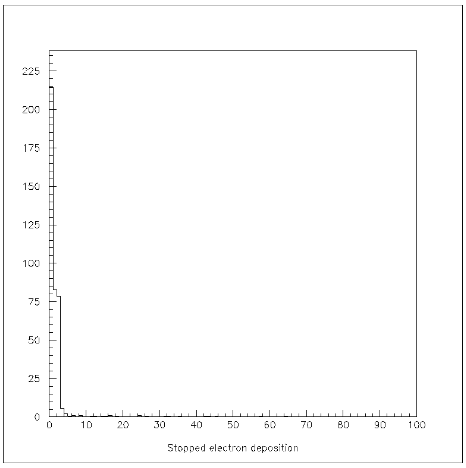


Fig. 9. Stopped electron distribution.
Exponential spectrum, <T>= 0.5 Mev,
isotropic incident electron distribution,
E= 0.0 Mev/cm

References

1. CERN User's Guide
2. Gross B., Nablo S.V., High-potential in electron-irradiated dielectrics, J. Appl. Phys. 1965. v. 36, N 6 pp. 2064-2065.