SYSTEM ON MODULE TOTAL IONIZING DOSE DISTRIBUTION MODELING

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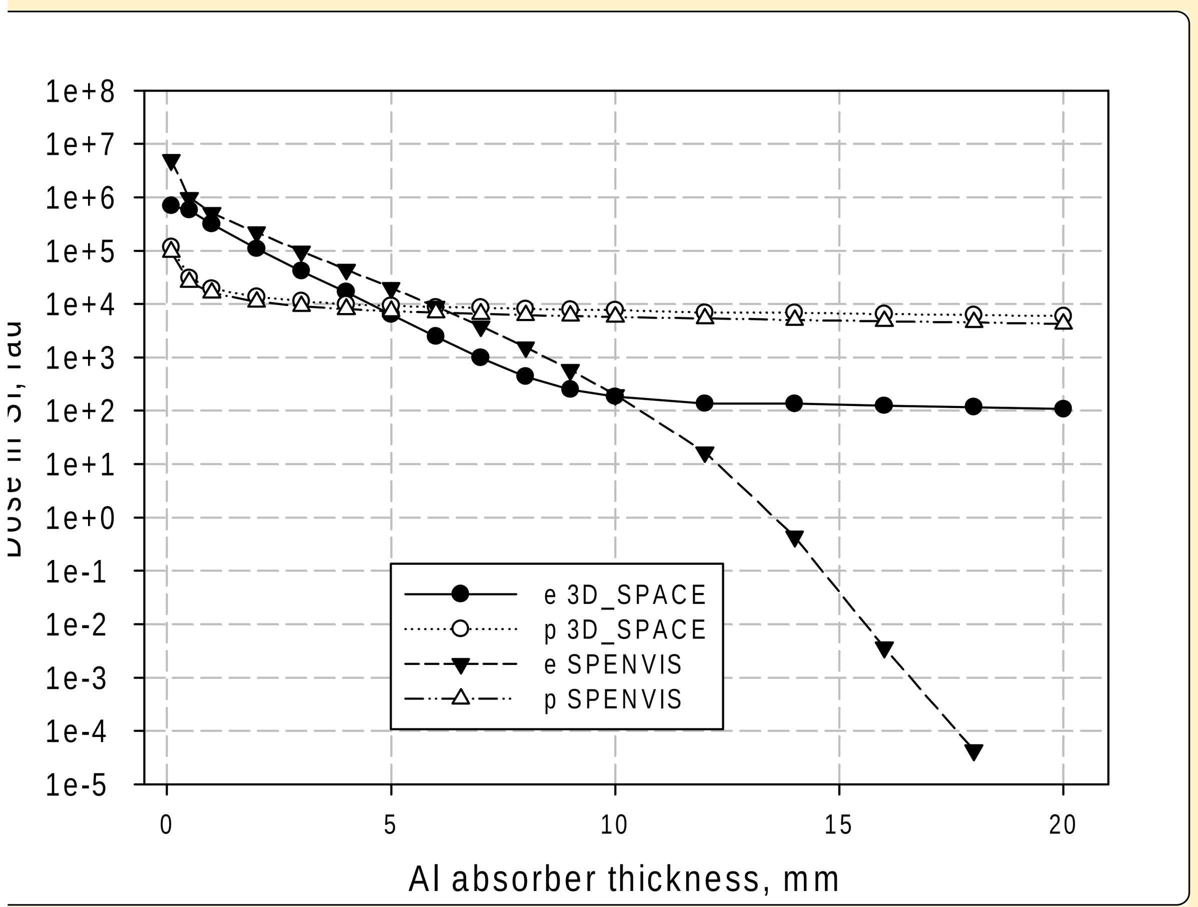
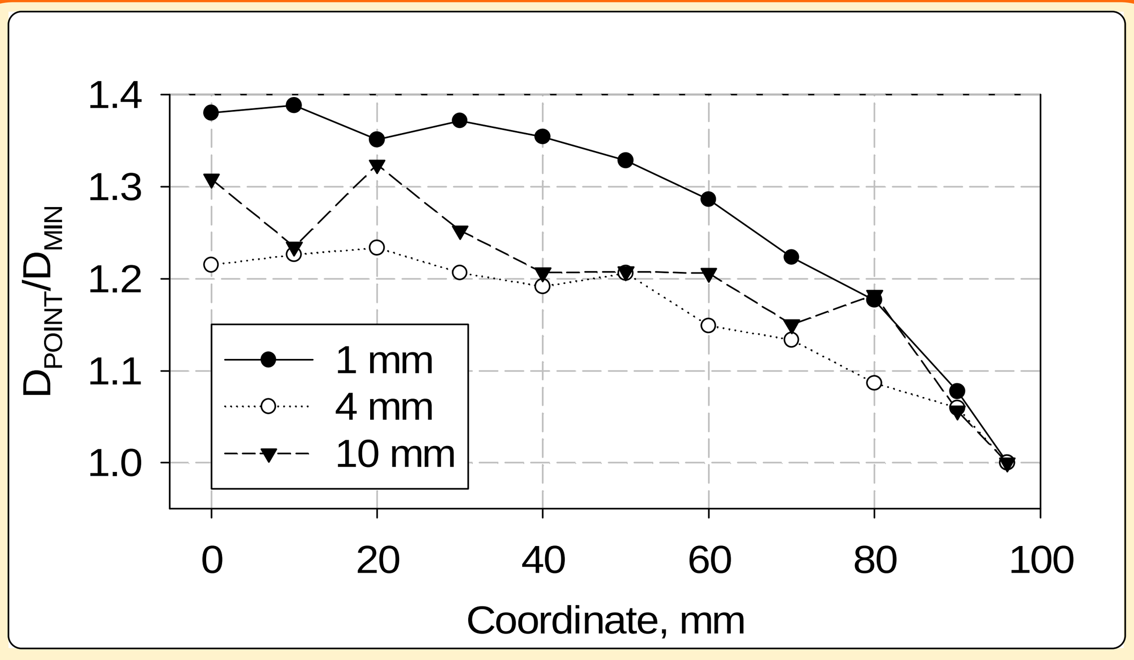
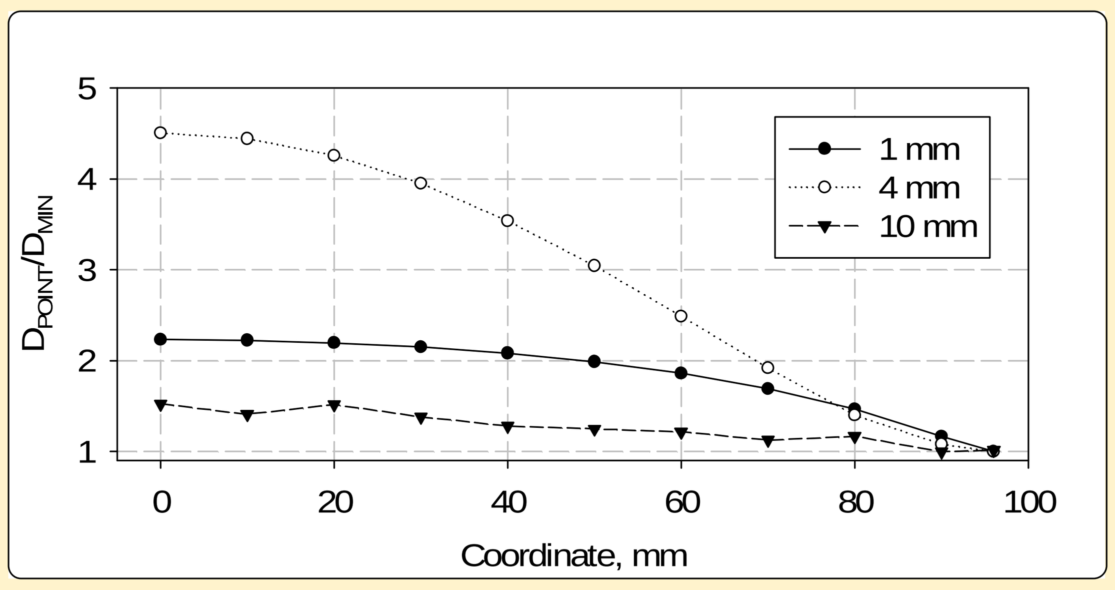
ABSTRACT
Comparison calculation of TID in electronic module was done using 3D_SPACE and SPENVIS for test circle orbit: altitude 1000 km, inclination 60 degrees, mission duration 5 years. Distribution of total dose on module surface was estimated.

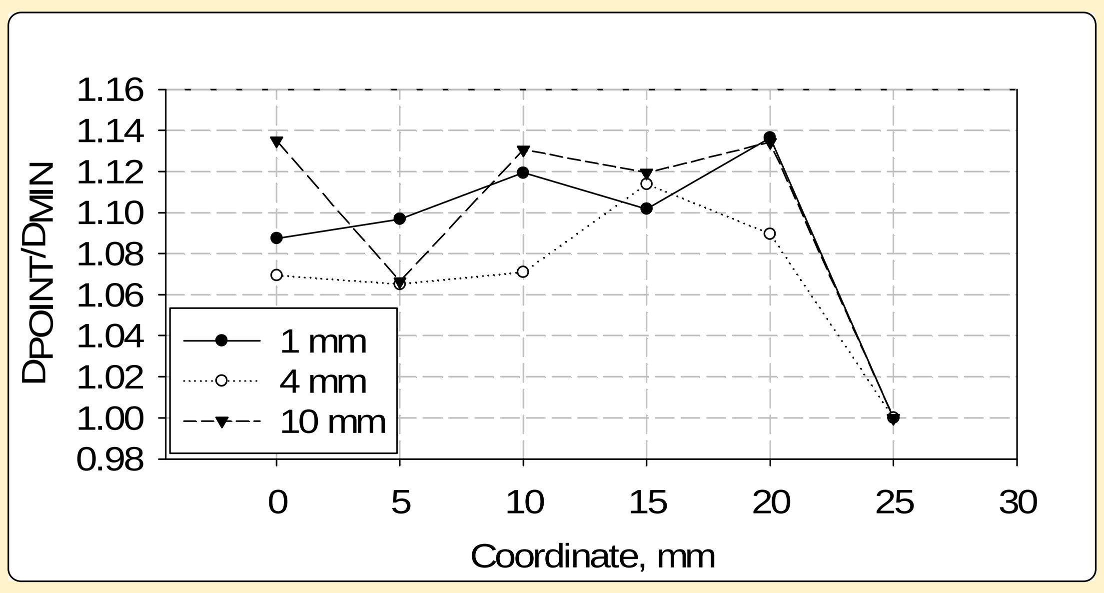


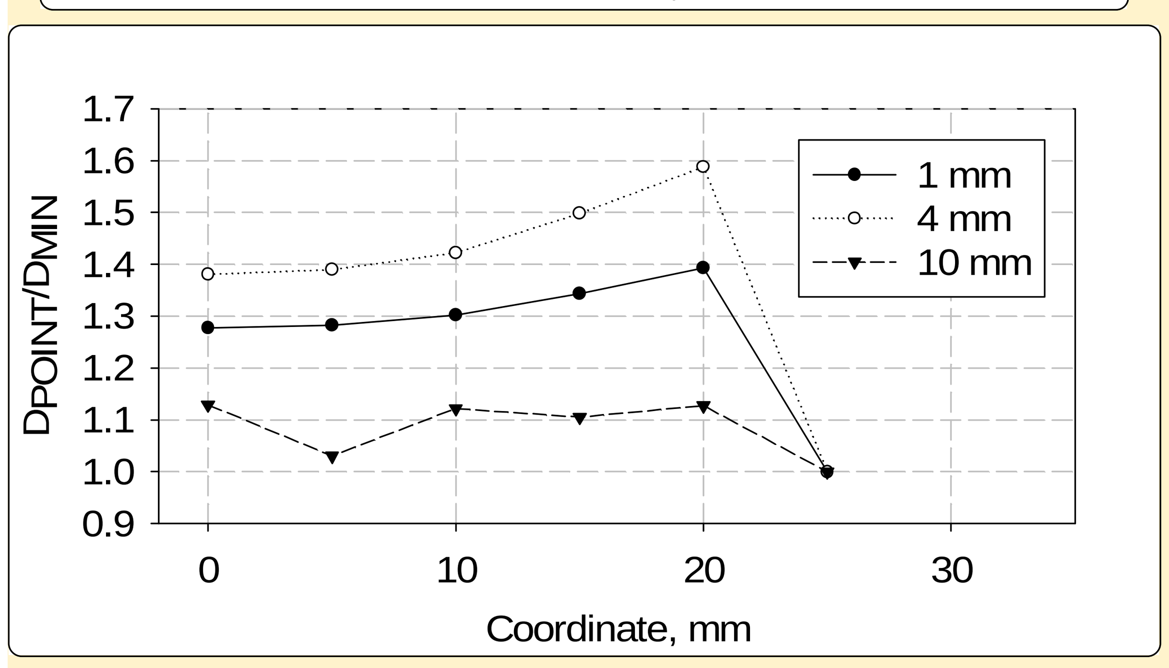
Dose at the centre of the Al sphere from trapped protons and electrons calculated by SPENVIS (model SHELDOSE-2Q) and 3D_SPACE.



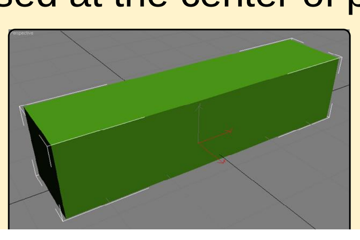


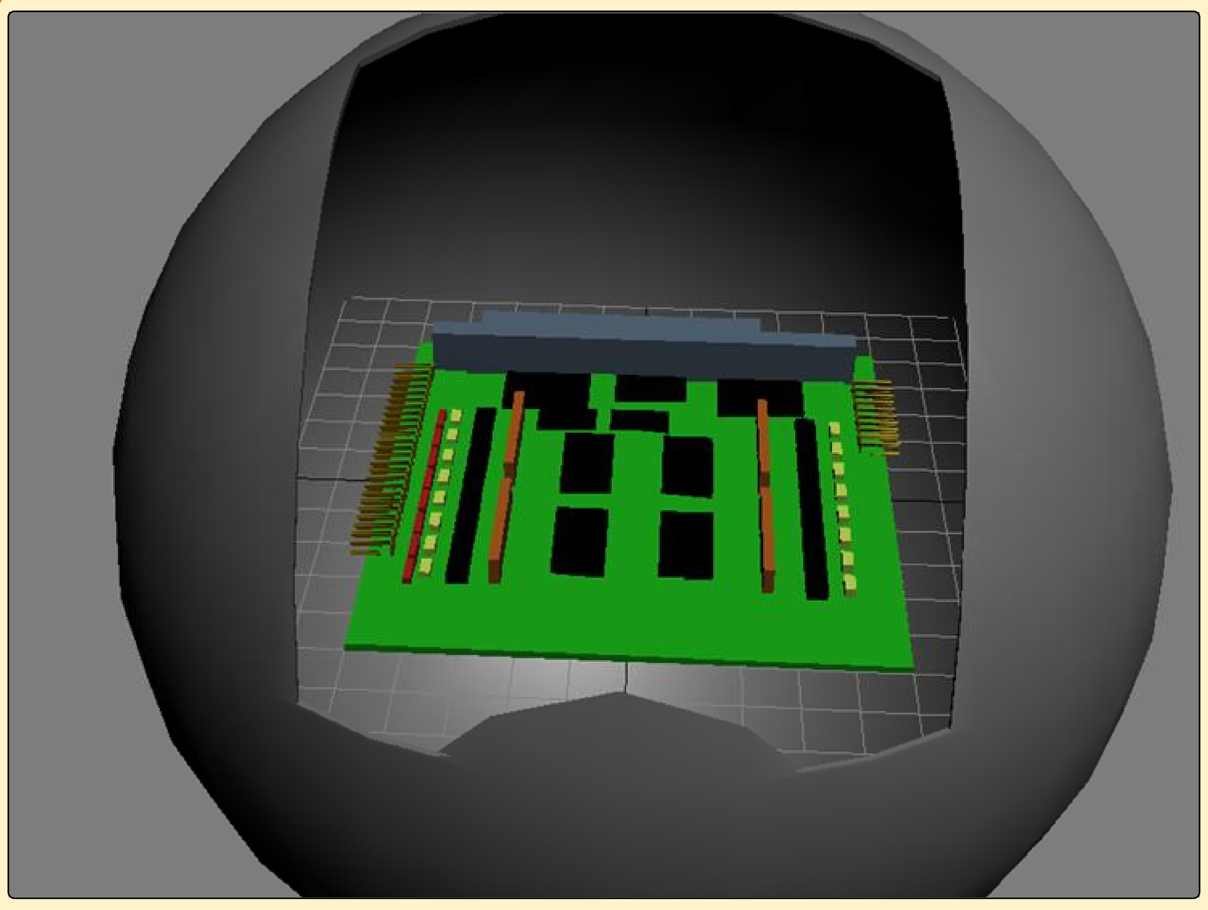
Dose vs radius coordinate at the Al sphere for 1, 4 and 10 mm shield thickness. Trapped protons (top view) and electrons (bottom view).



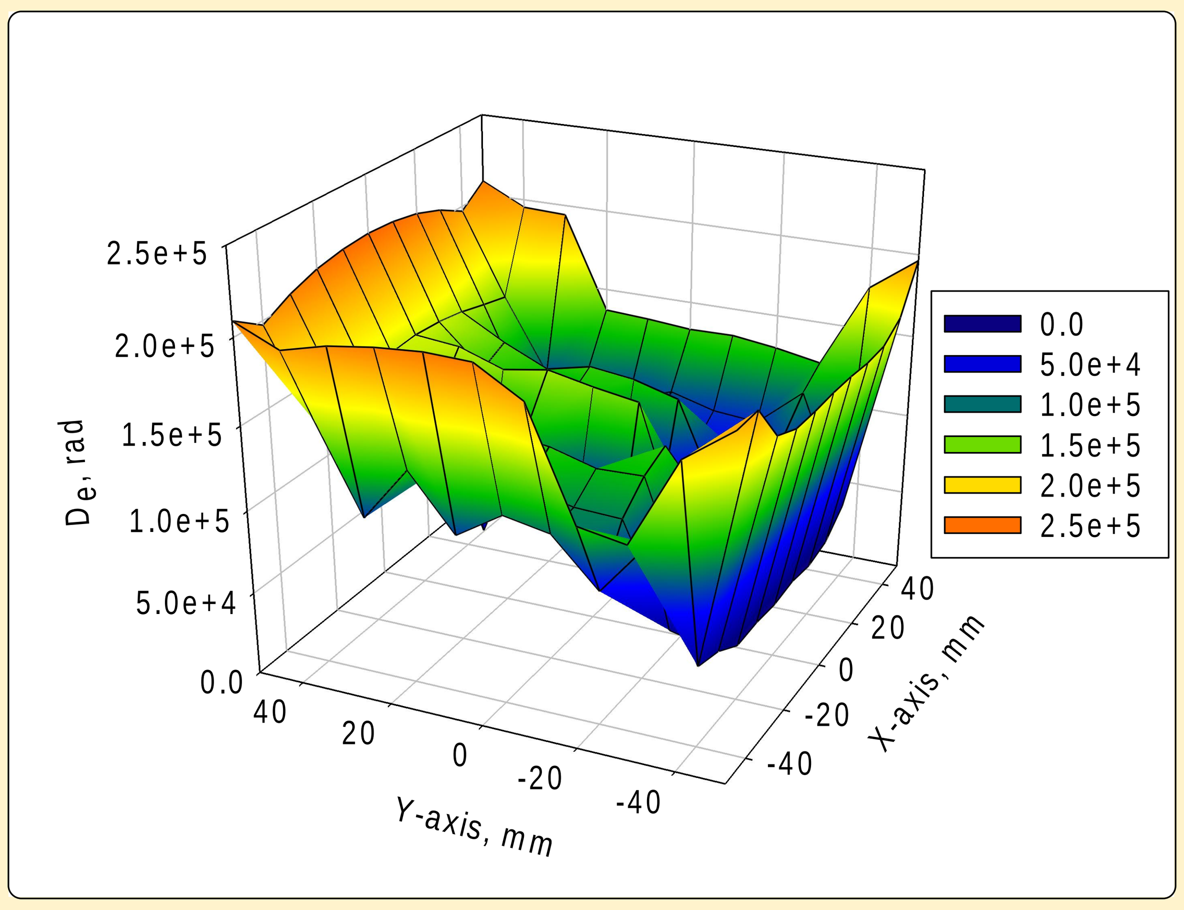


Dose vs coordinate at the Al parallelepiped for 1, 4 and 10 mm shield thickness. Trapped protons (top view) and electrons (bottom view). Test points for dose calculation located at the central axis among long side of the parallelepiped (see figure below). Coordinate origin disposed at the center of parallelepiped.

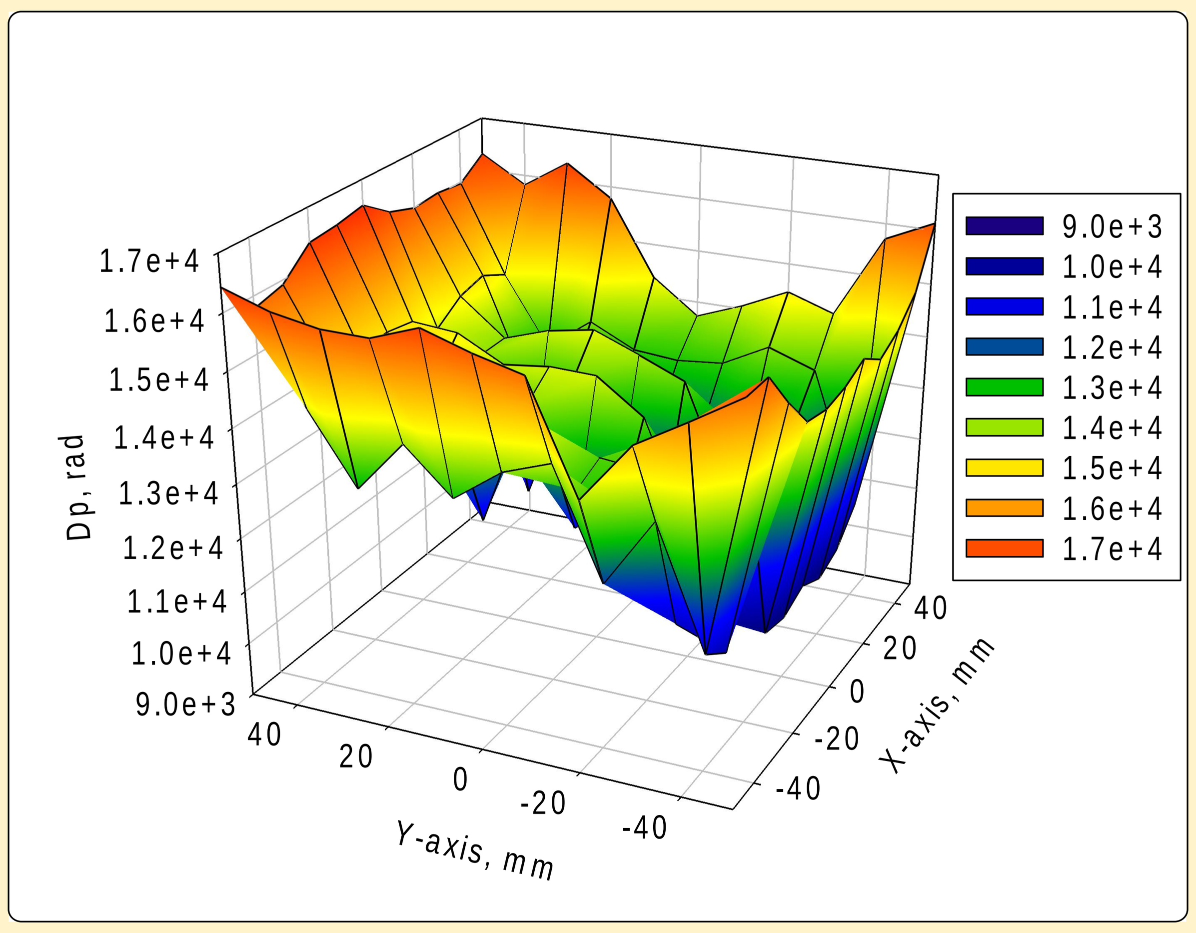




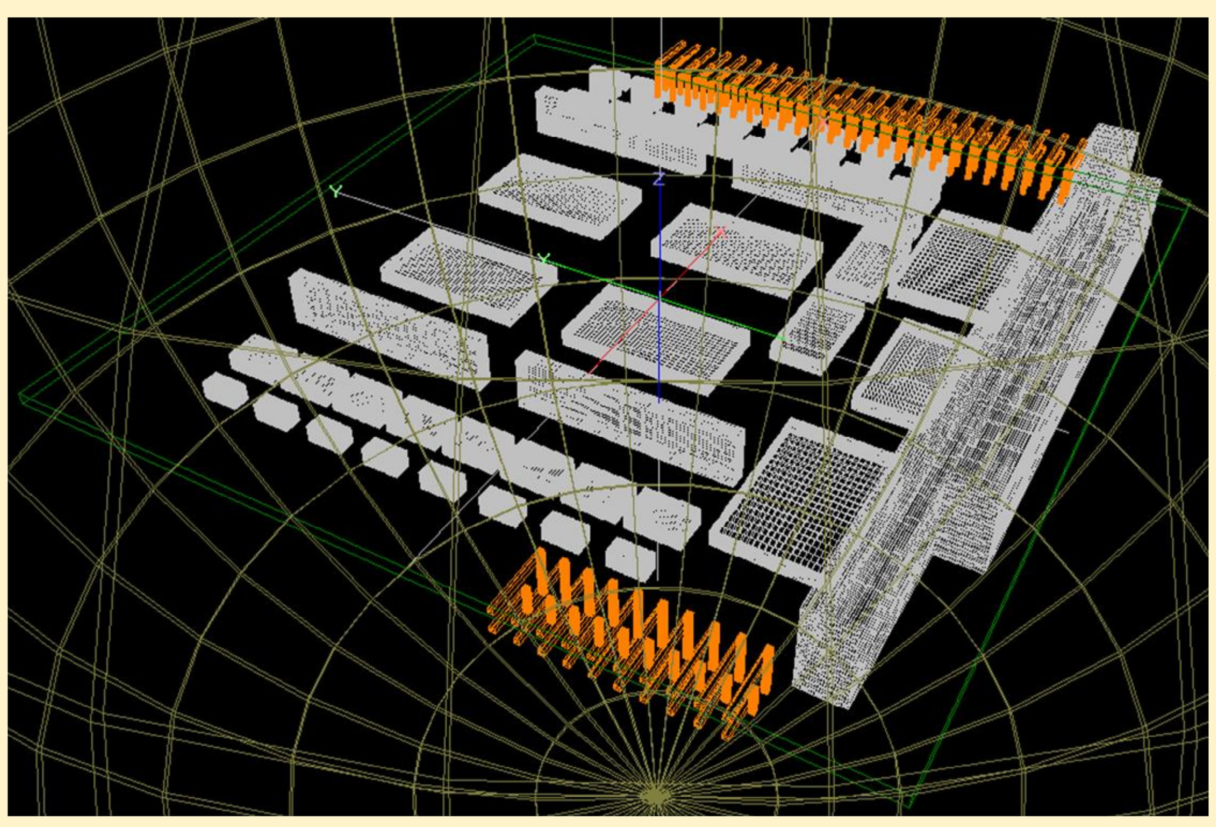
System on module DM6856HR-5V 3D-model made in 3D MAX. Module located inside the Al sphere 1 mm thickness shield.



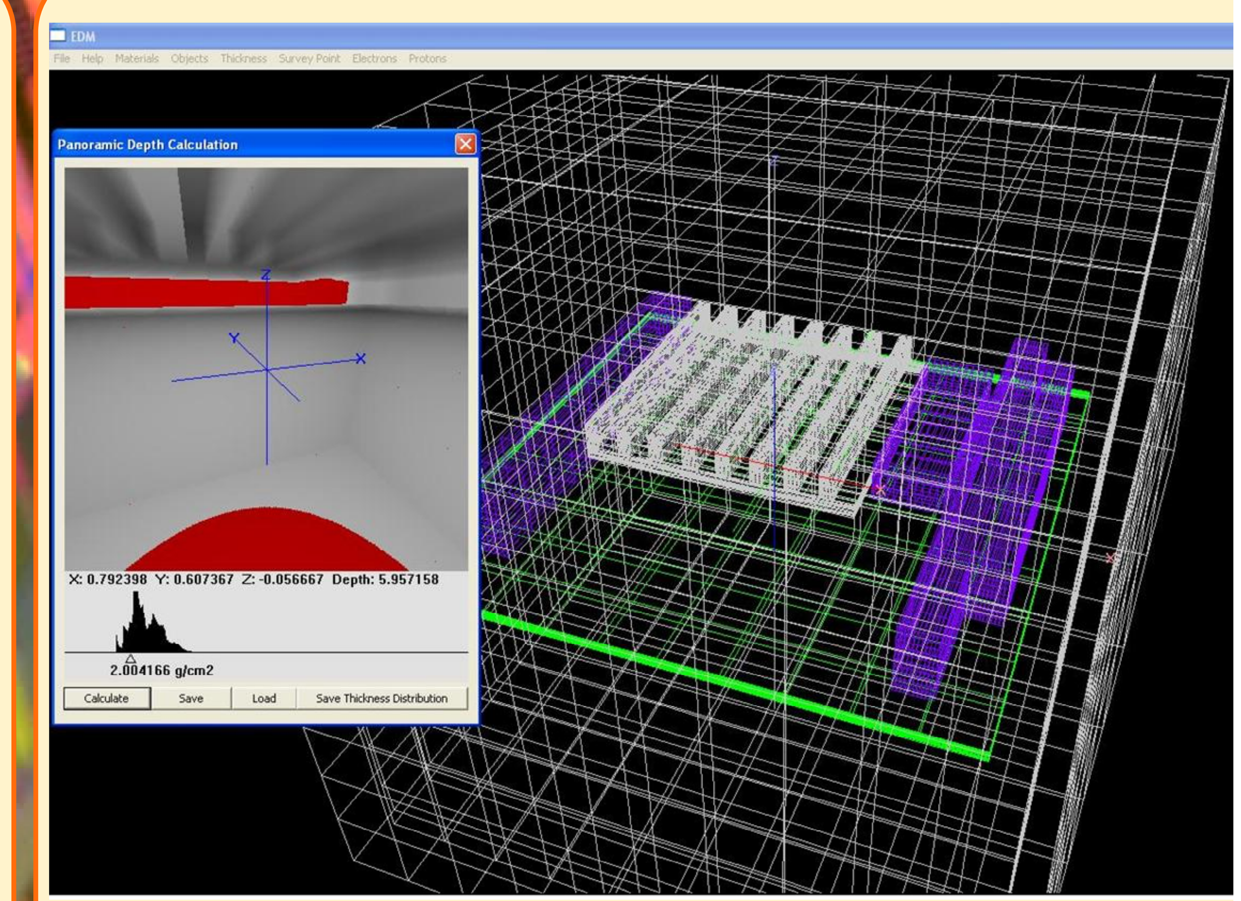
Dose (Si) distribution due the electrons.
Dose calculated at the same point (100 uniformly spaced points) as a function of X-Y plane coordinates. Maximum D_{MAX}/D_{MIN} ratio equals to 6,75.



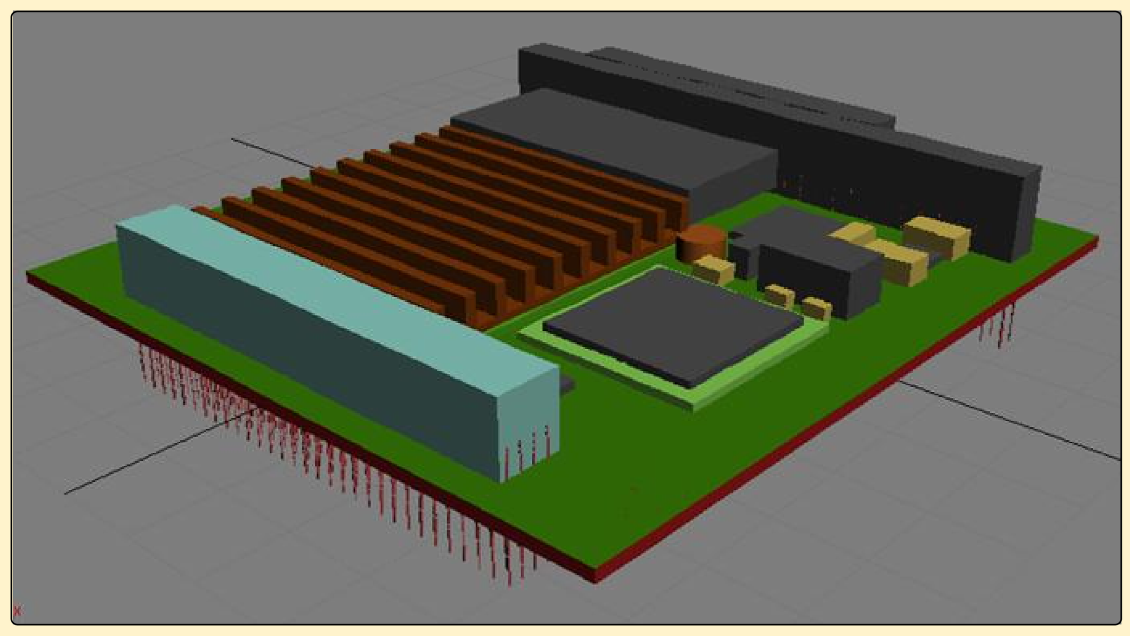
Dose (Si) distribution due the protons.
Dose calculated at the same point (100 uniformly spaced points) as a function of X-Y plane coordinates. Maximum D_{MAX}/D_{MIN} ratio equals to 1,63.

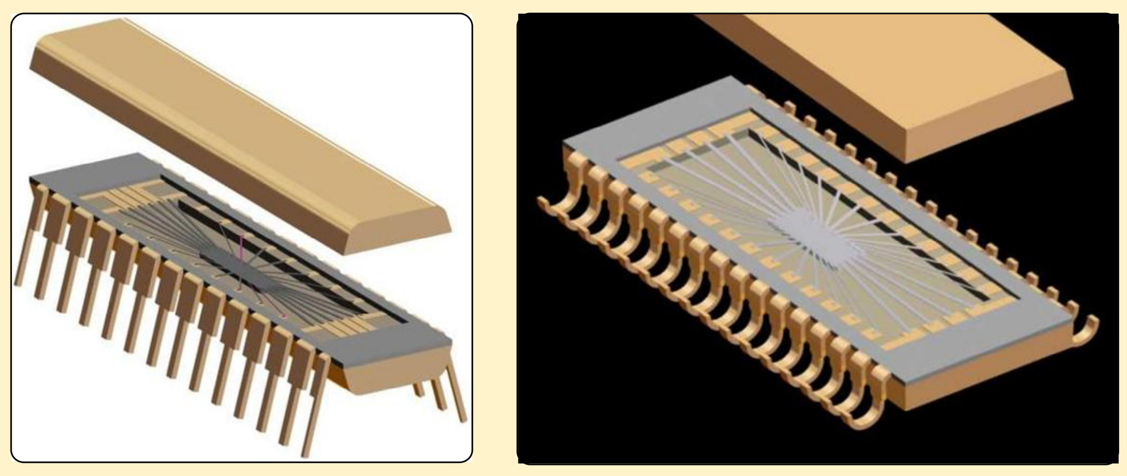


DM6856HR-5V module in 3D_SPACE view. Spatial arrangement corresponds with two dose distributions showed above.



Main window of the 3D_SPACE software. Panoramic depth calculation example.
On the right side – system on module geometry at the centre of the Al cube. On the left side – panoramic depth calculation for the processor under heat sink. Grey and dark grey colors correspond to effective Al shielding more than 2 g/cm^2 and red color correspond to effective shielding less than 2 g/cm^2. This tool is useful to define weak spots in the shield.





Objects examples for TID distribution modeling: CME136 module and IC’s.

CONCLUSION

The paper presents the TID distribution due the trapped electrons and protons in the systems on module surface. The distribution is calculated in several steps. The first step is calculation of the effective Al shielding thickness. At the same point we calculate 4π thickness by optical method (ray-tracing method). The second stage is dose calculation from trapped electrons and protons. To estimate dose from electrons irradiation tabulated Monte-Carlo calculation is used. TID distribution at the system on module or satellite-borne equipment may have significant non-linearity.

3D_SPACE software has:
+ Fast algorithm;
+ Weak-spots in the shield visualization;
+ Export geometry from CAD design in the 3DS format;

At present version:
— There is no possibility of materials exporting;
— Equivalent thickness calculated to aluminum.

At present, work is continuing to improve methods for calculating the dose due the protons and electrons taking into account difference of materials.

ACKNOWLEDGEMENT

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