

Helen Report: Validation of RADMON simulation

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I present here a report of the activities performed at CERN, as participant of HELEN Program, from February, 21 to April, 5, 2006.

Radiation in the underground areas of the LHC accelerator is produced when the proton beams interact with any material close to the beam (residual gas, beam pipe, magnets, dumps, collimators, etc). These initial interactions produce many secondary particles at lower energies like protons, neutrons, pions, kaons, etc. If the energy of these secondary particles is sufficiently high, they may cause further inelastic interactions.

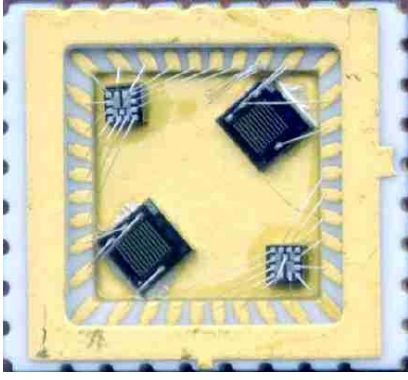
The CERN RADMON group has selected and cataloged semi-conductor sensors to be used for radiation monitoring purposes. These sensors will be used in the LHC environment as radiation monitoring devices. However, the use of inappropriate materials around the sensors can modify the chips response. This can induce errors in the measurement, therefore it is interesting to have a study of the effect of the packaging on the sensor response as function of materials and thicknesses.

I used a simulation of the RADMON detectors based on the Geant4 toolkit. With this we will be able to determine the best design and the materials to be used for the Radiation Monitor (RADMON). Detailed information about the RADMON project can be found in [1, 2]. Figure 1 shows a RADMON device in (a) and its simulation using Geant4 in (b).

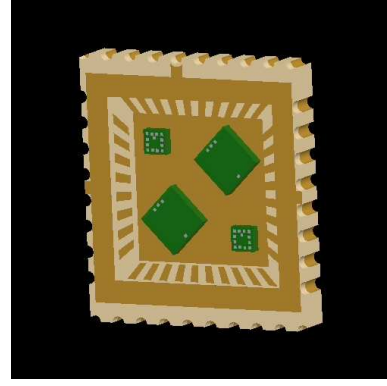
The goals of the simulation study are:

- A quantitative analysis of the energy cut-off introduced by the packaging as a function of the particle type.
- A quantitative analysis on how the materials and thicknesses affect the cut-off thresholds.
- A quantitative analysis of the spectrum of particles (primaries and secondaries) arriving on the dosimeter volume as a function of the incoming spectrum.
- A quantitative analysis of the radiation environment of IRRAD 2 facility where several experimental data has been taken by the CERN RADMON group [3].

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(a)



(b)

Figure 1: In (a) a RADMON device, in (b) Geant4 model of a RADMON device. The sensitive parts of the detector are the black ones in (a), or green in (b). The packaging is the yellow structure where the sensitive part is mounted.

I started to study the RADMON project and to work with the simulation program using monoenergetic protons with energies 254 MeV, 150 MeV and 50 MeV for different thickness of the packaging, in order to study the behaviour of the total energy deposited with respect to the thickness of the packaging of the detector. The results can be seen in figure 2. It is clear there is practically no dependence of the total deposited energy with the thickness of the packaging, independent of the incident proton energy. I also started to do the simulation with monoenergetic neutrons, as well as with the neutron spectrum from the nuclear reactor at Ljubljana (where test data was taken using a prototype of RADMON), but it required much more CPU time than the protons, therefore the statistics we had (number of simulated events) was very low. I do not show the results here because they showed the typical low statistics fluctuation and no conclusion could be taken at that time.

Since I came back to Brazil, I have done the simulation using monoenergetic photons and I am now running the program using the photon spectra from the Ljubljana reactor in order to compare my results with the experimental ones. The neutrons will be simulated at INFN-Genova. In parallel I am studying the detector and the Geant4 LowEnergy package used in the simulation.

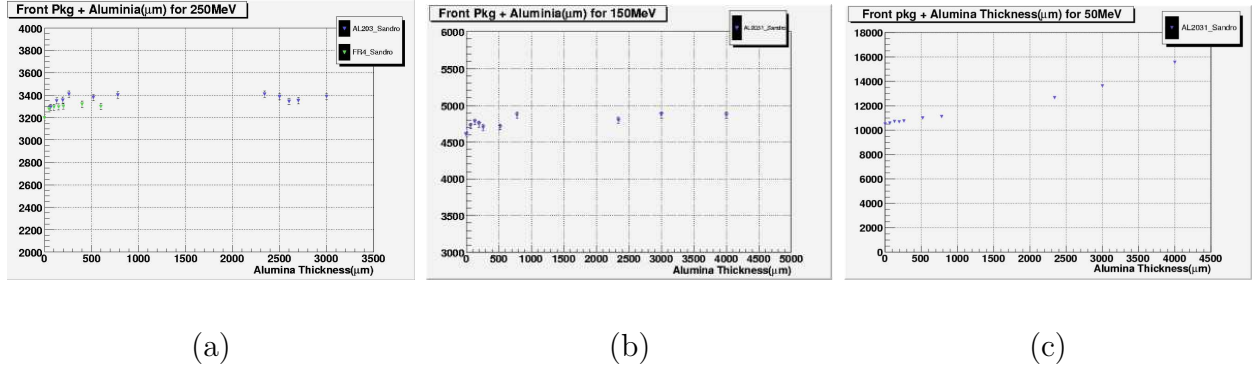


Figure 2: Total energy deposit versus pkg thickness (μm) of protons: with 254 MeV in (a), with 150 MeV in (b) and with 50 MeV in (c).

Acknowledgements

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References

- [1] <http://www.ge.infn.it/geant4/hep/radmon/>
- [2] R. Capra, M. Glaser, M. Moll, M. G. Pia, F. Ravotti, **Geant4 Simulation of a Packaging for Solid-State Radiation Monitoring Sensors**, Work presented at the SPENVIS and GEANT4 Workshop, Leuven (Belgium), 3-7 October 2005.
- [3] <http://lhc-expt-radmon.web.cern.ch/>