Detailed feasibility study of a gamma ray detector system for nanosatellites using GEANT4 simulations

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Contents

Introduction

High energy astrophysics

Aim of the simulation

The main aim of the paper, therefore this thesis is to optimize the scintillators of the CubeSats (miniaturized satellites) in the Constellation Gamma satellites. The second aim is to understand how the material of the CubeSat would affect the gamma photons that the satellite is meant to detect.

The Constellation Gamma (ConGa) fleet

The simulated setup

HAMAMATSU S13360-6050CS

datasheet of QE:

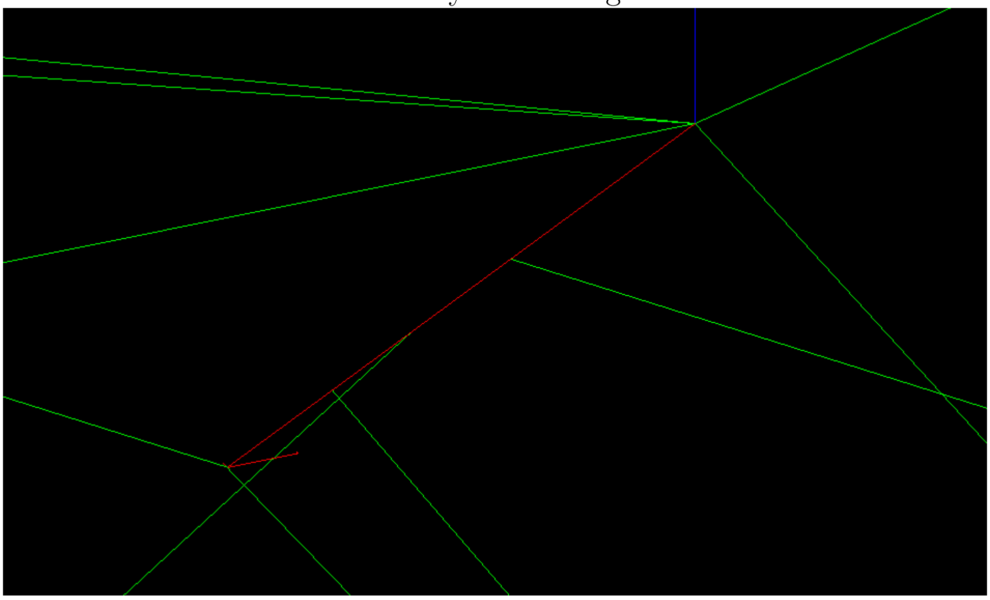
esr foil: Please check "ESR from 3M" company. e.g.,

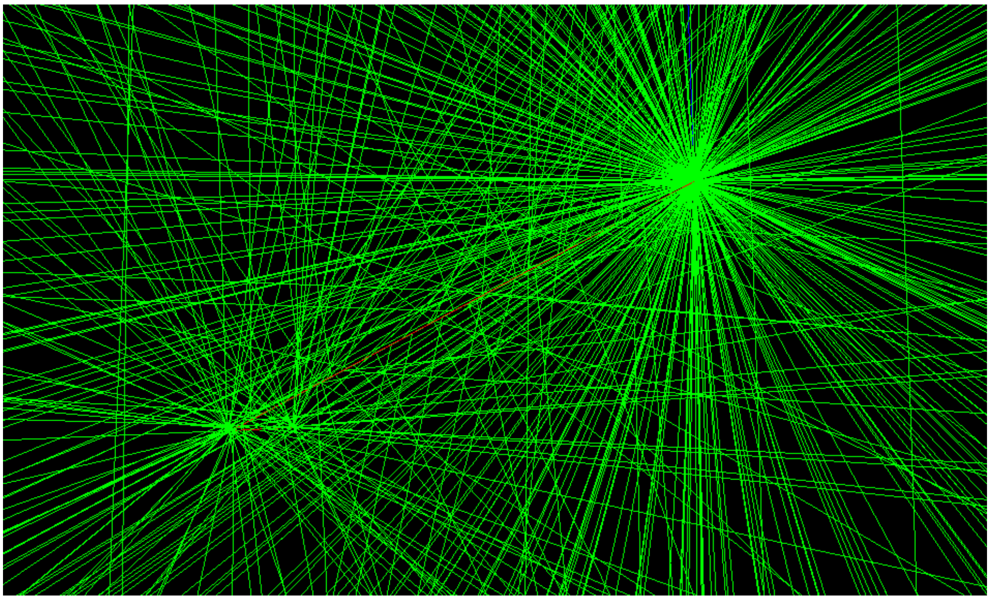
Simulation

In order to understand how the γ photons – that the CubeSat is meant to detect – interact with the matter of the satellite simulations are needed. In a simulation it is also possible to determine the optimal geometry that would lead to the best GRB detection.

The Geometry... XXX TRacking (Geant4)

The cross section for photoeffect is far the largest by far for low energy gamma photons. The ionized nuclei and the secondary electrons generates scintillation.





Also the nuclei that is ionized by the gamma produces photons.

Fine tuning the optical parameters

Most relevant parameters:

- absoprtion length of the scintillator material
- scintillation yield

Setup

Size of the scintillator is, the aluminium housing thickness is, the size of the SiPM is...
Parameters of the CsI(Tl) scintillator REF

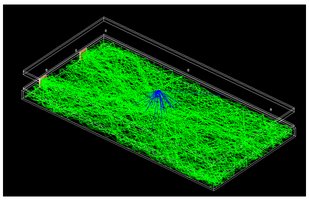
- Scintillation yield (Number of photons produced by given keV depleted in the scintillator)
- The energy spectra of the produced scintillation
- The time constant of the scintillation photon creation
- The absorbtion length of the optical photons
- Birks constant?

Optical parameters of the materials and surfaces:

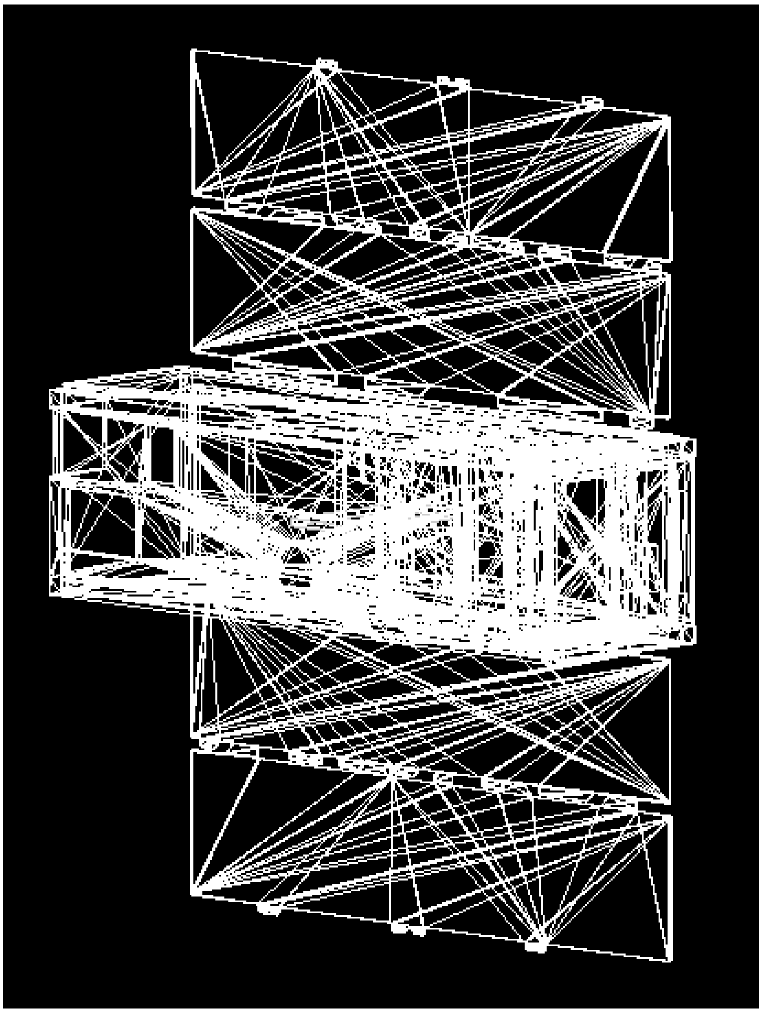
- Refractive indices of all relevant materials
- Reflection
- The detection efficiency of the SiPM detectors

1 channel setup

2 channel setup



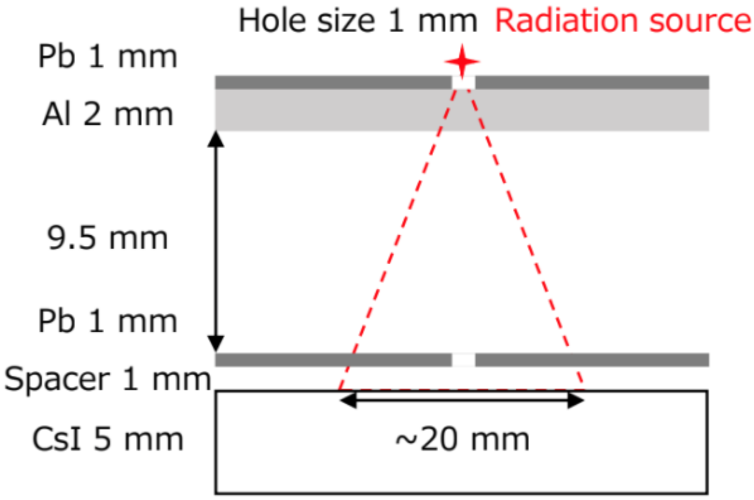
The satellite

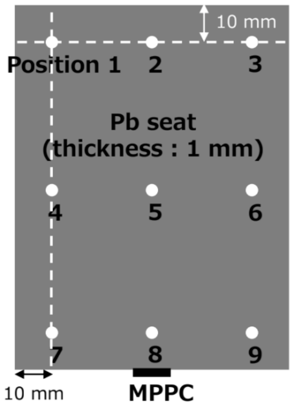


Results of the simulation

Comparison of the results of the simulation with experiments

1 channel read out:





The experimental results:

Pos. of source	1	2	3	4	5	6	7	8	9
Pos. of main peak	0.642	0.664		70.7	0.743		0.598		

The parameters set in the simulation: reflectivity: 0.995 and absoprtion length of 40 cm:

Pos. of source	1	2	3	4	5	6	7	8	9
Pos. of main peak	0.3389	0.3256	0.3355	0.3521	0.3555	0.3522	0.2060	1	0.203

The parameters set in the simulation: reflectivity: 0.995 and absoprtion length of 50 cm

Pos. of source	1	2	3	4	5	6	7	8	9
Pos. of main peak	0.4013	0.3917	0.3981	0.4045	0.4172	0.4140	0.2580	1	0.2739

Reflectivity of 0.997 and abs. length of 60 cm

Pos. of source	1	2	3	4	5	6	7	8	9
Pos. of main peak	0.4588	0.4587	0.4697	0.4734	0.4700	0.4737	0.3388	1	0.3365

X-ray fluorescence

Histogram without fluorescence, turned out in LXeEMPhysics line 140-159
Histogram with flo

Simulation of background in space

Optimalization of the scintillator detectors

Conclusion

Acknowledgment

References

[1] C. Shalem, R. Chechik, et al.,
Advances in Thick GEM-like gaseous electron multipliers—Part I: atmospheric pressure operation,
Nuclear Instruments and Methods in Physics Research A, vol. 558, page 475-489, 2006