Geant4 based simulation background index of steel cryostat

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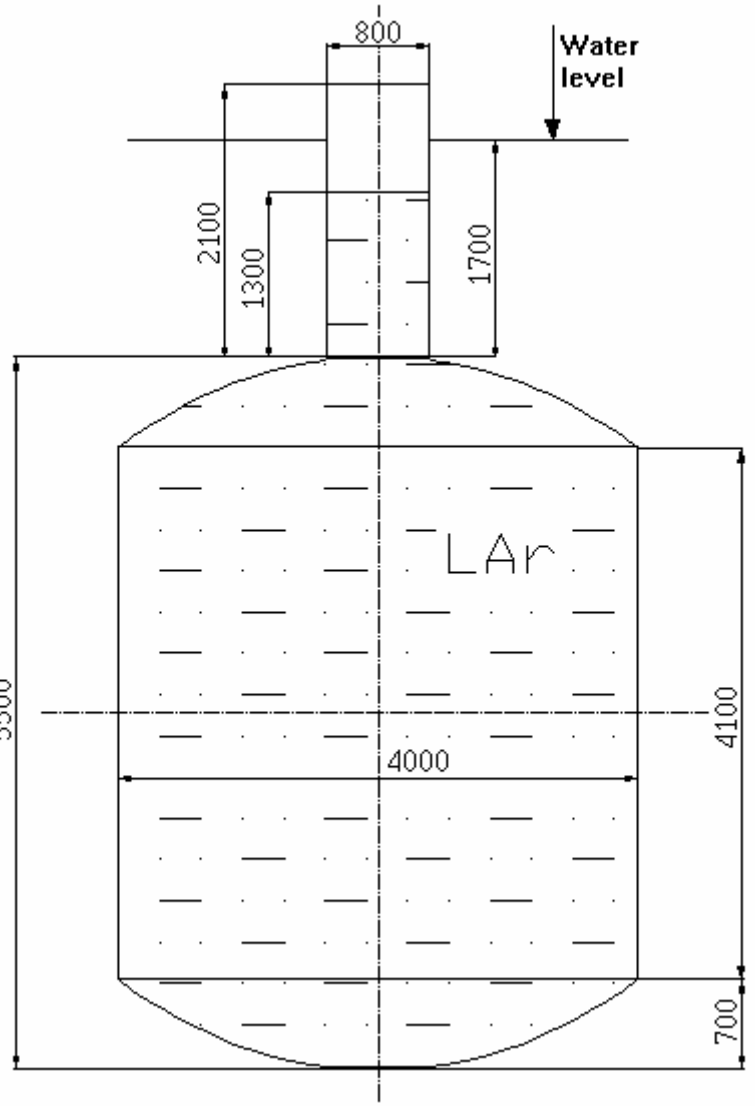
The purpose of this work is to calculate of the background index from the stainless steel cryostat. Calculations were done on the program named GSG (Geant4 Simulation for GERDA) based on Geant4 library package. To decrease time of simulation two methods were used.

Geometry of the cryostat using in simulations

The geometry of the cryostat is shown in the figure. The thickness of walls of the cryostat is 30 mm. The cryostat is filled with liquid argon. Events were detected by the block of 9 cylindrical crystals placed in the center of the cryostat. Each detector has weight 2 kg. The anticoincidences between different detectors were taken into account.

Gamma events from the Tl-208 lines (2.615 MeV) were registered in 1.8-2.3 MeV energy region. Steel activity is 1 mBq/kg of Th-232.



Method of simulation

Calculations were done by Monte-Carlo method on the program based on Geant4 library package. To reduce time of simulation, the program disregards all events below 1.8 MeV. It was achieved by using two methods of cutting off useless events.

1) Energy cut. Every gamma track which lost in shield more than 0.815 MeV (2.615 MeV – 1.8 MeV) is rejected. This method reduces time of simulation in about 5 times.

2) Angle discrimination. Gammas from steel are generated in the cone with certain vertex angle. This angle is equal to the angle of scattering after which the energy of the gamma will be equal to threshold. This method reduces the number on events needed to achieve the same accuracy in 8-10 times.

In summary: total performance improvement is 40-50 times. Average performance is ~2×10^5 events per second on Pentium III 1.3 GHz.

Results of simulation.

1 gbu = 10^{-4} events/(kg•yr•keV)

	Geant4 Simulation for GERDA, gbu	Direct Gamma Transport, gbu
Cylindrical part	2.03 ± 0.27	2.2 ± 0.18
Upper and bottom part	(4.74 ± 1.07)x10^{-2}	(5.1 ± 0.6)x10^{-2}
Total	2.08 ± 0.27	2.25 ± 0.18

Summary

- There was created program named GSG based on Geant4 library. The performance of this program is 40-50 times more than of baseline Geant4 program.
- The background index of SS steel cryostat accepted for GERDA is $(2.08 \pm 0.27) \times 10^{-4}$ events/(kg•yr•keV) for steel activity 1 mBq/kg of Th-232.
- This result is in good agreement with the result of Direct Gamma Transport program (Valeriy Gurentsov's program).