New data on the germanium activation at sea level

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Experimental cross sections

- Cross sections for production of radioactive isotopes from natural and enriched (^{76}Ge) germanium targets with 100 MeV protons with have been measured at INR RAS accelerator.

	Natural Ge		Enriched Ge
Proton energy, MeV	101	660	114
Experimental, mBn	34.0 ± 3.3	10.8±2.2	4.6 ± 0.4
Rudstam, mBn	29.0	12.1	4.94
Geant4, mBn	75.4	21.3	25.2

Cosmic protons and neutrons spectra

Activation calculation

- Using experimental cross sections Rudstam spallation formula was corrected and included in Geant4 program.
- Simulation was done for 40 kg powder of GeO_2 and for 2 kg germanium crystal (Ø8 cm x 8 cm).
- SHIELD results were received for metallic germanium with dimensions Ø42 cm x 27 cm.

Activation rate

	Activation rate, $(kg \cdot day)^{-1}$	
	SHIELD	Rudstam at Geant4
Ge crystal (Ø8 cm x 8 cm, 2 kg)		
Natural Ge	80.8	42.8
Enriched Ge	5.6	8.74
Depleted Ge	88.1	50.9
GeO_2 powder (Ø42 cm x 27 cm, 40 kg)		
Natural Ge	-	28.3
Enriched Ge	-	6.12
Depleted Ge	-	34.8

^{68}Ge background index

- Effective time of exposure of germanium at sea level is equal to 30 days.
- For natural and depleted germanium ^{68}Ge concentration is equilibrium.

	GeO_2, $(kg \cdot y \cdot keV)^{-1}$	Ge, $(kg \cdot y \cdot keV)^{-1}$
Natural Ge	2.4	3.7
Enriched Ge	$4.2 \cdot 10^{-2}$	$6.0 \cdot 10^{-2}$
Depleted Ge	3.0	4.4

Summary

- Based on experimental cross sections activation rate of germanium was calculated.
- Background index for enriched germanium ($4.2 \cdot 10^{-2}$ cts/(kg·keV·year)) is too high for second stage of experiment.
- Background index for natural and depleted germanium is extremely high. Such crystals cannot be recommended for using in experiment.