



Contribution ID: 677

Type: Verbal

Production of cosmogenic radionuclides in Ge spectrometers placed in deep underground: a comparison of measurements with Monte-Carlo simulations

Wednesday, 16 May 2018 09:15 (15 minutes)

Environmental and rare nuclear physics experiments require operation of Ge spectrometers in deep underground laboratories. Cosmic-ray background of Ge gamma-spectrometers is decreased to such low-levels that observation of cosmogenic radionuclides produced e.g. in germanium (^{68}Ge , ^{60}Co , ^{65}Zn , ^{54}Mn) and copper (^{54}Mn , ^{57}Co , ^{60}Co , ^{58}Co) is possible. There are several ways of activation of construction materials by cosmic rays:

1. during production of Ge crystals and cryostats in the factory and their transport to an underground laboratory all the construction materials are irradiated by secondary cosmic rays (nucleons, muons)
2. after installation of the Ge spectrometer in a deep underground laboratory the cosmogenic radionuclides produced at sea level (mainly the short-lived ones) are decaying
3. new generation of cosmogenic radionuclides may be produced even at deep underground by penetrating muons and their secondaries, as well as by neutrons originating from radioactive contamination of Ge spectrometer construction materials, detector shielding, and surrounding environment.

In this work we present experimental background gamma-ray spectra of the large-volume OBELIX Ge spectrometer operating in the deepest underground laboratory in Europe (Laboratoire Souterrain de Modane, 4,800 m w.e) just after its installation and several years later, and compare them with Monte Carlo simulations. The background simulation model is based on GEANT4 software package.

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Session Classification: RER 2

Track Classification: Radionuclides in the Environment, Radioecology