Contribution ID: **14** Type: **Talk**

Development of a GAGG-based low-background neutron detector

Friday, 4 October 2024 09:40 (20 minutes)

In rare events experiments, a precise knowledge of the environmental gamma and neutron backgrounds is crucial for the design of appropriate shieldings. The neutron component is often poorly known due to the lack of a scalable detector technology for the measurement of low-flux neutron spectra in a short time.
Thanks to their high gadolinium content, we are investigating the possibility of using scintillating $Gd_3Al_2Ga_3O_{12}$ (GAGG) crystals as portable neutron detectors, in alternative to 3He counters.
GAGG features a high scintillation light yield, good timing performance, and the capability of particle identification via pulse-shape discrimination. In a low-background environment, the distinctive signature produced by neutron capture on gadolinium, namely a ɣ-ray cascade releasing ~8 MeV of total energy, and the efficient particle identification provided by GAGG would yield a background-free neutron capture signal.
In this contribution, we will present the characterization of a first GAGG detector prototype in terms of particle discrimination performance, intrinsic radioactive contamination, and neutron response. We will then discuss possible further developments of this detector technology towards the realization of a portable setup for the neutron spectrum measurement in various locations of the INFN Gran Sasso National Laboratory (LNGS) laboratory.

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Session Classification: Neutron Background Mitigation