Contribution ID: **297** Type: **Oral report**

Background reduction in pulsed gamma beam experiments using segmented Germanium detectors

Friday, 24 September 2021 14:55 (25 minutes)

The Extreme Light Infrastructure-Nuclear Physics (ELI-NP) project is one of the most prestigious research infrastructures in the world due to its unique state-of-the art equipment, the facility will deliver the most brilliant high-energy gamma beams in the world, with unprecedented bandwidth and spectral density[1]. The multi-detector array (ELIADE –ELI-NP Array of DEtectors) is the gamma-ray spectrometer for Nuclear Resonance Fluorescence experiments (both for fundamental research and applications). It is made of eight segmented high-purity Ge clover detectors and 4 large LaBr3 scintillator detectors. The array is the able to detect with high efficiency gamma rays of energies up to several MeV in the presence of the radiation background produced by a gamma beam. Gamma-ray transition energies and angular distributions can be measured with high accuracy[2].
In order to reduce gamma-contamination from the gamma beam in the recorded spectra, the Clover detectors will be surrounded by a passive lead shield. The quality of spectra will be also improved by applying the active Anti-Compton Shield (ACS). The ACS consists of a back-catcher made of CsI crystals plus front and side shield made of BGO crystals. Based on the performed studies, a reliable Geant4 model of ELIADE array including active anti-Compton shields has been developed. It will be presented the Geant4 simulations for the Clover HPGe crystals, CsI and BGO detectors. In this study, the simulations were validated using measurements with standard calibration sources, the estimated impact of ACS to gamma-ray spectra recorded by ELIADE is discussed. The model will help to design NRF experiments for forthcoming experimental campaigns at ELI-NP using gamma beams from 2023.

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Session Classification: Section 3. Modern nuclear physics methods and technologies

Track Classification: Section 3. Modern nuclear physics methods and technologies.