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P1.46: N3G Experiment: Front-End Electronics and Mechanical Advances

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In the framework of modern gamma spectroscopy, the high-flux and high-damage experiments highlight the need for a new generation of detectors, based on electrons-collecting electrodes. The N3G (Next Generation Germanium Gamma detectors) experiment is aimed at achieving this goal, by applying the PLM (Pulsed Laser Melting) doping-technique [1] to hyper-pure germanium (HPGe) crystals. N3G is also aimed at realizing an innovative detector containment system complete of contact structures and front-end electronics.

The electrodes of the detector are connected to the readout electronic chain through a flexible printed circuit board (PCB). It is realized on a Kapton substrate and enveloped around the detector itself. The crystal and its flexible connections are placed inside an aluminum canister set on vacuum. The canister is closed by a specifically designed flange, which is equipped with six feed-through connectors for the signals, a high-voltage rod and a vacuum inlet. The design of the entire canister has been thought to be compatible with the cryostats available at LNL. The functionality of the contact system has been tested with a gold-coated germanium crystal.

The Front-End Electronics (FEE) being developed for the experiment is based on an ASIC (Application-Specific Integrated Circuit) Charge Sensitive Preamplifier (CSP) realized in AMS C35B4C3 (350 nm) technology. It is characterized by 8MeV dynamic range, which can be extended up to 40MeV thanks to an innovative fast-reset system [2]. Below the saturation threshold, set by the power supply voltages, the pre-amplifier shows an excellent linear behavior and a 1.08 keV resolution, expressed as FWHM and referred to 1 MeV events. Above the saturation threshold, the energy information on the interactions that bring the pre-amplifier into saturation can be retrieved thanks to the fast-reset circuit: the time it takes to remove the charge excess from the input node of the CSP is proportional to the charge itself and, consequently, to the energy of the saturating interaction. For event of energies greater than 15MeV, a resolution, expressed as FWHM, better than 0.11% was measured. A second version of fast-reset circuit, characterized by zero power consumption, has been implemented on a second ASIC preamplifier. It extends the dynamic range of the device up to 190 MeV, with a linearity error lower than 0.2%.

[1] C. Carraro et al., Applied Surface Science. 509 (2020)
[2] S. Capra et al., IEEE Transactions on Nuclear Science. 69 (2022)

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