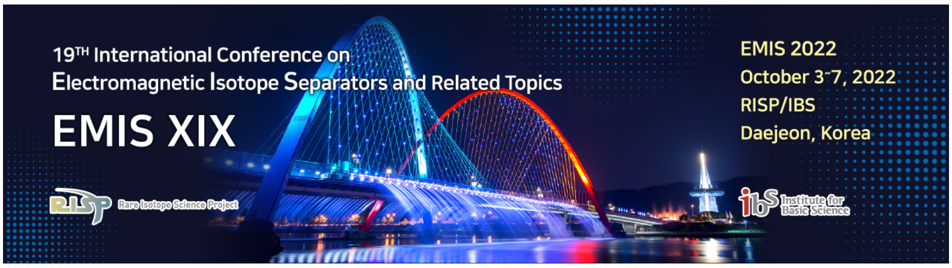

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Constraints and characterization for use of in-beam diamond detectors in neutron-induced fission experiments

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Neutron-induced reactions on actinides are used to study the fission process and to populate neutron-rich isotopes for nuclear spectroscopy. Such studies often benefit from direct measurement of the emission time, mass and/or kinetic energy of fission fragments, thus requiring efficient detectors with good time- and energy resolution. In the case of in-beam operation of the fission fragment detectors with intense thermal neutron beams, additional constraints occur due to the beam-induced background and high radiation dose from neutron-induced reactions and the stopped fission fragments. Diamond detectors, which have fast timing response, good energy resolution and radiation hardness, are expected to satisfy these requirements and are anticipated to be used in such applications.

Diamond detectors of different type (single crystal or polycrystalline) and sizes from different manufacturers were characterized with the aim of developing innovative instrumentation for fission fragment detection applications. The detector characterization was carried out at the LOHENGRIN spectrometer at Institut Laue-Langevin with mass- and energy-separated fission fragment beams. Various fission fragments ranging from mass 84 to 144 with energies from 36 to 100 MeV as well as light ions such as alphas and tritons were used. Very good timing (~10 ps RMS) and energy resolution (<2% RMS) with high detection efficiency (~100%) was observed for single-crystalline detectors. Still, a significant pulse height defect as large as 50% charge carrier loss was observed. Polycrystalline diamond detectors presented still very good timing resolution (17~34 ps RMS) but poor energy resolution and low detection efficiency (<30~80%) due to incomplete charge collection. Based on these benchmark results, possible fission fragment detector designs and installation options at in-beam experiments will be discussed.

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