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Low-pressure TPC detector for studying photonuclear reactions at astrophysical energies with gamma-ray beams at ELI-NP

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The Extreme Light Infrastructure-Nuclear Physics (ELI-NP) facility will provide monochromatic, high-brilliance and polarized gamma-ray beams, which can be used to study nuclear reactions of current astrophysical interest through the inverse photo-dissociation processes and detailed balance principle. In particular, of special interest are (p, γ) and (α, γ) reactions that regulate the ratio of C and O and those that burn ^{18}O and, therefore, regulate the ratio between ^{16}O and ^{18}O in the Universe. For instance, the benchmark inverse kinematic reaction ^{12}C(γ, α)^{16}O can be investigated down to 1 MeV in the centre-of-mass reference frame, where experimental data from direct experiments are sparse.

A dedicated Time Projection Chamber (ELITPC) with an active gaseous target kept under low pressure is being developed at University of Warsaw, IFIN-HH/ELI-NP and University of Connecticut. The active target volume of ELITPC will be about $35 \times 20 \times 20$ cm^3 and will be centered around gamma-beam axis. The reaction products stopped in the gas will produce primary electrons that drift towards charge amplification structures made of Gas Electron Multiplier (GEM) foils. The three-dimensional kinematics of the photo-dissociation events will be reconstructed from about 10^3 signal strips, arranged into redundant, 3-coordinate system.

High intensity γ beams are expected to be available at ELI-NP ($\sim 10^7$ photons/bunch, 100 Hz bunch repetition rate). The beam-induced background has been studied using Monte Carlo techniques for different γ beam profiles, in order to optimize the expected signal to background ratio. Several scaled demonstrator detectors were constructed and tested with alpha-particle and X-ray sources.

The results from ongoing R&D activities for this project will be presented.

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