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Scintillators in high-power laser driven experiments

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Bunches of electrons, protons, ions and high energy photons produced during the interaction of Ultra High Intensity (UHI) laser pulses with matter, have received considerable attention throughout the last decade. The main characteristics of these new sources are their short durations (ns), their high fluxes (1012 particles) and their small dimensions (100µm). These bunches are already reaching kinetic energies of hundred MeV for protons and GeV for electrons and the associated Bremsstrahlung photons, which is amply enough to induce observable numbers of nuclear reactions in matter [1]. Unfortunately, such high-power lasers cannot shoot several times per hour. Nevertheless, new UHI lasers operating at high repetition rate like APOLLON in Paris, or ELI in Prague and Bucharest, will start shooting their first pulses in the very next years. This new generation of UHI lasers will be able to accelerate particles at repetition rates up to 10 shots per second, which will make possible to perform laser driven nuclear physics experiments accumulating statistics from shot to shot. Unfortunately, the flux of background particles generated during the laser matter interactions (mostly soft X rays) leads to an instantaneous huge energy deposit (µJ) in the scintillators usually outfitting nuclear physics experiments. It makes them blind during milliseconds after incident particles passed through the target. These extreme conditions for gamma spectroscopy require the use of fast scintillator and the study of their energy dissipation process (afterglow, etc…). The signals of scintillators cannot be treated as usual with standard photo-multiplier tubes associated with slow spectroscopic amplifiers and peak sensing analog-to-digital converters. We must use fast scintillators read with new kind of photo detectors (HPD) which present large signal dynamics, connected to a digitizer. With such system, we succeed to detect some 162 keV gammas rays emitted from radionuclide with 63µs half-life, created by one UHI laser shot [2].
After presenting the specificities of the background emission during the laser-plasma acceleration process, I will present the strategies of detection we have adopted to perform gamma spectroscopy in the future laser-driven nuclear physics experiments.

References :
[1] M.Tarisien et al., Rev.Sci.Instr. 82 (2011) 023302
[2] F. Negoita et al., AIP Conference Proceedings 1645, 228 (2015)

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