ECPD 2021
European Conference on Plasma Diagnostics

Neutron and charged particle detectors tests with laser-driven neutron beams at DRACO for nuclear physics experiments

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In recent works at 150 TW HZDR (Dresden, Germany) DRACO laser system (4.5 J on target in 30 fs), bright proton beams up to 10 MeV and high repetition rate were demonstrated, reaching an interesting milestone for neutron production. This is relevant for applications in nuclear physics in particular, considering that this energy allows for neutron production via the conventional ^{9}Be(p,n) and ^{7}Li(p,n) reactions, as it is done in medium size accelerators such as the CNA HISPANOS facility (Seville, Spain). In addition, with the femtosecond technology in laser systems, pulses with even shorter duration can be produced. This is especially interesting for time-of-flight experiments, allowing higher neutron energy resolution.

The feasibility of carrying out nuclear physics experiments with laser-driven neutron beams is subject to the response of the detectors currently used in conventional neutron sources. As the behavior of the detectors is strongly affected by the environment (in terms of gamma flash sensitivity, electromagnetic noise, signal pile-up and dead-time), a series of dedicated tests must be done, not only for characterizing the energy and spatial distribution of the neutrons produced, but also for optimizing the production, detection and analysis techniques commonly used in the nuclear physics experiments to be implemented in the laser acceleration environment.

In this work, a set of different detectors used by the nuclear physics community for varied purposes and applications is proposed, allowing a comparative study in real conditions with the neutron beams produced in a medium-size accelerator facility (HiSPANoS@CNA) and in a laser facility (DRACO@HZDR). This set includes liquid and plastic scintillators for fast neutrons, Li-glass detectors for thermal/epithermal neutrons, $LaBr_3$ detectors for gamma detection; and diamond, gas and silicon detectors for (n,chp) and (n,f) reactions. A neutron camera and neutron dosimeters are also considered.

The experiments have started at HISPANOS and will continue during Spring and Summer 2021 at DRACO within the framework of Laserlab-Europe Initiative and partially funded by the H2020 ARIEL (Accelerator and Research Reactor Infrastructures for Education and Learning) project.