Characterization of a laser-driven neutron source for applications

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The most intense neutron beams in the world are based on quite large accelerators or nuclear reactors, limiting their applications and the transfer of knowledge outside research centres and huge facilities. In addition, the production of much shorter and more intense neutron beams is interesting for astrophysics, fission and fusion technologies, material analysis, radiation to electronics, neutron radiography and medical applications, among others.

Recently, the neutron beams' users community is focusing its attention in laser-driven ion sources as a cheaper and more compact alternative to conventional accelerators for neutron production. A laser-driven neutron source inherits the short temporal structure of the laser pulse (~ ps) and can achieve a high instantaneous neutron flux, similar and even higher than those of conventional neutron beams. These features are especially relevant for nuclear physics applications based on time-of-flight measurements.

Laser-driven neutron applications rely on detection systems commonly used in nuclear physics experiments with conventional neutron sources whose behavior is still not characterized in the new environment resulting from the laser-plasma interaction and the significant particularities of a laser-driven source.

This work describes the first tests done in a PW-class laser-driven neutron source (DRACO@HZDR, Dresden, Germany) for different neutron detectors, identifying the strengths and weaknesses of each kind of responses and pinpointing the needs and improvements required in future tests to be able to characterize the energy and spatial distributions of the neutrons produced, and also to identify the neutron reaction channels that can eventually be studied as well as to ascertain the possible applications of this kind of neutron sources.