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Challenges and requirements for neutron dosimetry at laser-driven accelerators

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Over the past 40 years, laser wakefield acceleration (LWFA) has been developing at a dramatic rate, from a conceptual notion into a concrete reality. Many petawatt (PW) and multi-PW facilities are operating or under-construction worldwide presenting a novel and exiting alternative to conventional accelerators. In fact, with current technology, the expected particle energies are up to 100 GeV for electrons and at the GeV order for protons. While beam intensities can be as high as 10^9 - 10^{10} electrons and 10^{10} - 10^{12} protons per laser shot. In these conditions, fast and high-energy neutrons are generated as secondary particles. Furthermore, by optimizing experimental setups, laser-driven neutron sources are subsequently produced.

Neutron dose measurements at laser-driven accelerators are pivotal and concurrently arduous. Indeed, the generated primary and secondary radiation fields are mixed and non-monochromatic. They exhibit a challenging time structure as they follow the laser pulses which are typically in the sub-picosecond regime. This poses severe limitation on any measurement device and complicates the correct interpretation of the collected data. Additionally, there is a lack of well-established reference standards and procedures for metrology and dosimetry of neutrons at laser facilities.

In this contribution, we present the difficulties associated with neutron dose measurements at laser-driven accelerators. We, as well, highlight the needs both for adequate detection systems as well as for traceability to internationally recognised reference standards. We present the use case of multi-PW laser-driven ELI Beamlines facility as a concrete example.

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