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Shielding and activation calculations for a 3-10 PW ELI high intensity laser facility

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In recent years the dramatic rise in attainable laser intensity has triggered a strong evolution of the research field, that is associated with the non-linear laser-matter interaction: production and acceleration of electrons up to 1 GeV over accelerating distances around 1 mm (to be compared to the 100 m, that are typical for conventional accelerators) are a visible result of this evolution.
At the existing laser facilities in the 100 TW range, low-emittance protons are accelerated up to 20-30 MeV energies from thin (few tens of micrometers) solid metallic targets. The present limit in terms of kinetic energy has been recently set at the LANL 200 TW Trident laser facility, where from micro-cone targets proton energies in excess of around 67.5 Mev have been observed.
The production of laser-accelerated, high energy and high current particle beams requires a proper shielding assessment, especially when high intensity laser systems operate in repetition rate (typically in the range 0.1-10 Hz).
The ELI (Extreme Light Infrastructure) future facility in Czech Republic is one of the four european facilities foreseen in this project: different optional laser beam-lines will offer a versatile electron source and proton/ion source, emitting in an unprecedented energy range (until around 40 GeV at 10 PW, for the electron case). For this facility a first extensive study, that includes shielding and activation calculations for the most critical cases, has been performed. Starting from analytical calculations, as well as from dedicated simulations, the main radiation fields produced in the laser-matter interaction have been defined. These fields have been then characterized as "source terms" in a full simulation with the Monte Carlo code FLUKA, where the produced secondary radiation has been studied to assess a proper shielding. The unique features of the FLUKA code, i.e. the possibility to calculate in the same simulation the development of the electromagnetic and hadronic showers in a very large energy range and the neutron production and transport until the thermal energies, as well as induced activity and residual dose rates, have been a key point for this choice.
The first results for the ELI shielding, together with the activation calculations, that drove several material solutions, are here presented and discussed.

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