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Source Term Determination for Shielding Assessment of High-Power Laser-Plasma Experiments

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In an increasing number of experiments, high-power, high-intensity lasers hit targets and create plasma. The laser-plasma interaction will produce hot electrons with a Maxwellian energy spectrum and an electron temperature ranging from about 10 keV to 10 MeV for irradiance between 10^16 and 10^21 W/cm^2. The electrons interact in turn with the target, producing bremsstrahlung and possibly photoneutrons, resulting in a radiation field that must be contained by shielding. Since the physics of plasmas is very different from that of the common phases of matter, the shielding design cannot be carried out with only conventional tools.
Different, complementary approaches are possible: to use analytical formulas, to experimentally evaluate source terms to be used as input to established Monte Carlo codes, or to interface those codes with specialized Particle-In-Cell programs, which describe the generation and transport of particles in plasma.
At the Helmholtz-Beamline, which will operate as laser facility at the European XFEL, the shielding design of the High Energy Density (HED) Physics Instrument has been evaluated by using analytical calculations, cross-checked with measurements at the DRACO laser at the Helmholtz-Zentrum Dresden-Rossendorf (HZDR). On the other hand an extensive experimental campaign is planned at SLAC, where dedicated radiation measurements will be performed at the Matter in Extreme Conditions (MEC) short-pulse laser facility.

Summary

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