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Geant4 simulation of the ELIMED/ELIMAIA beamline, an open Users beamline for irradiation with laser-driven ion beams

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The main direction proposed by the community of experts in the field of laser-driven ion acceleration is to improve particle beam features (maximum energy, charge, emittance, divergence, monochromaticity, shot-to-shot stability) in order to demonstrate reliable and compact approaches to be used for multidisciplinary applications, thus, in principle, reducing the overall cost of a laser-based facility compared to a conventional accelerator one and, at the same time, demonstrating innovative and more effective sample irradiation geometries.
The mission of the laser-driven ion target area at ELI-Beamlines (Extreme Light Infrastructure) in Dolní Břežany, Czech Republic, called ELI Multidisciplinary Applications of laser-Ion Acceleration (ELIMAIA), is to provide stable, fully characterized and tuneable beams of particles accelerated by Petawatt-class lasers and to offer them to the user community for multidisciplinary applications. The ELIMAIA beamline has been designed and developed at the Institute of Physics of the Academy of Science of the Czech Republic (IoP-ASCR) in Prague and at the National Laboratories of Southern Italy of the National Institute for Nuclear Physics (LNS-INFN) in Catania (Italy). In particular, the final section of the beamline, that includes the beam focusing, the energy selection, the dosimetric and sample irradiation parts, constitutes the so-called ELIMED (ELI MEDical and multidisciplinary applications) portion.
At ELIMED, controlled proton and ion beams, with energy ranging from 5 to 250 MeV, will be transported up to the in-air section where absolute dosimetry will be carried out with dose-rate independent devices. A transmission, dual-gap air ionisation chamber will provide the on-line measure of the dose at the irradiation point contemporary permitting the correction for the ion recombination effects. The maximum expected error in the final dose released to the sample is expected to be within 5%. ELIMED first irradiation is scheduled for 2020 when the first radiobiological campaign for in-vitro cells irradiation is expected.
In order to plan the first experiments a dedicated Geant4 application, fully simulating the entire beamline, has been realised. The application reproduces all the beamline transport elements, including detectors and the dosimetric device.
In this work, the status of the ELIMED/ELIMAIA beamline will be reported along with a complete description of the Geant4 application realised. The expected final beam characteristics, in terms of dose per pulse, dose-rate, beam spot size, directly derived by Monte Carlo simulations, will be discussed, as well. Perspective in the use of the Geant4-DNA package to apply Geant4 in the special case of high-dose-rate beams will be also discussed.

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