Geant4 Monte Carlo simulations for the optimization of spatial dose distributions of clinical relevance with laser-driven proton beams.

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The main purpose of this work is to quantitatively study the possibility of delivering dose distributions of clinical relevance with laser-driven proton beams in order to investigate the feasibility of these beams for multidisciplinary applications, included the medical ones. In particular, a Monte Carlo application has been developed with the toolkit Geant4 aiming to simulate the ELIMED (MEDical and multidisciplinary application at ELI- Beamlines) beam line which is being installed at ELI-Beamlines in Prague (CZ) [1]. The beam line will be used to perform irradiations for multidisciplinary studies, aiming to demonstrate the possible use of optically accelerated beams for therapeutic purposes [2]. The ELIMED application, developed with the Geant4 code, accurately simulates each single element of the beam line, designed to collect the accelerated beams and to select them in energy, and it has been validated with reference transport codes [3]. The final aim of this work is to try to quantitatively answer the question if such kind of beam lines, and specifically the systems developed for ELIMED in Prague, will be actually able to transport beams not only for multidisciplinary applications but also for delivering dose patterns of clinical relevance, which are worth to explore possible medical applications. On this regard, an original approach for actively shaping, through the magnetic energy selection system, depth dose distributions to achieve clinical spread out Bragg peaks will be also presented.

[1] J. Pipek *et al.*, J. Instrum. 12 (03) (2017) C03027

[2] F. Romano *et al.*, Nucl Instrum Methods Phys Res Sect A (2016); 829:153-158

[3] G. Milluzzo *et al.*, Nucl Instrum Methods Phys Res Sect A (*in press*)