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Secondary Radiation in Laser-Accelerated Proton Beamline (LAP)

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Abstract : Radiation pressure acceleration (RPA) and target normal sheath acceleration (TNSA) are the most important methods of Laser-accelerated proton beams (LAP) planning systems.LAP has inspired novel applications that can benefit from proton bunch properties different from conventionally accelerated proton beams. The secondary neutron and photon produced in the collision of protons with beamline components are of the important concern in proton therapy. Various published Monte Carlo researches evaluated the beamline and shielding considerations for TNSA method, but there is no studies directly address secondary neutron and photon production from RPA method in LAP. The purpose of this study is to calculate the flux distribution of neutron and photon secondary radiations on the first area ofLAP and to determine the optimize thickness and radius of the energyselector in a LAP planning system based on RPA method. Also, we present the Monte Carlo calculations to determine the appropriate beam pipe for shielding a LAP planning system. The GEANT4 Monte Carlo toolkit has been used to simulate a secondary radiation production in LAP. A section of new multifunctional LAP beamlinehas been proposed, based on the pulsed power solenoid scheme as a GEANT4 toolkit. The results show that the energy selector is the most important source of neutron and photon secondary particles in LAP beamline. According to the calculations, the pure Tungsten energy selector not be the proper case, and using of Tungsten+Polyethylene or Tungsten+Graphitecomposite selectors will reduce the production of neutron and photon intensities by approximately ~10% and ~25%, respectively. Also the optimal radiuses of energy selectors were found to be ~4 cm and ~6 cm for a 3 degree and 5 degree proton deviation angles, respectively.

Keywords : neutron, photon, flux distribution, energy selector, GEANT4 toolkit
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