Simulations of the Stage 2 FFA Injection Line of LhARA for Evaluating Beam Transport Performance

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A new, novel facility for radiobiological research, the Laser-hybrid Accelerator for Radiobiological Applications (LhARA), has recently been proposed. LhARA will be a two-stage facility with the first stage employing laser-target acceleration to produce intense proton bunches of energies up to 15 MeV. The second stage will subsequently accelerate the beam in an FFA ring up to 127 MeV. Optimal performance of stage 2, however, will require an emittance reduction of the stage 1 beam due to the FFA's nominal dynamical acceptance. Here, we demonstrate a new optical configuration of LhARA's stage 1 lattice that will provide this reduced emittance. The profile of the laser-target generated beam is far from an ideal Gaussian, therefore two start-to-end Monte Carlo particle tracking codes will model beam transport performance from the laser-target source through to the end of the stage 2 FFA injection line. The Geant4-based Beam Delivery Simulation (BDSIM) will model beam losses and the collimation that is crucial to LhARA's energy selection system, and General Particle Tracer (GPT) will model the space-charge effects that may impact performance given the emittance reduction.