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Implementation and simulation of a rectilinear cooling channel in BDSIM

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Muon colliders offer high-luminosity, multi-TeV collisions without significant synchrotron radiation but require further exploration of muon production, acceleration, cooling, and storage techniques. A proposed 6D cooling demonstrator aims to extend the MICE experiment's validation of transverse ionization cooling to also reduce longitudinal emittance, using bunched muon beams and incorporating RF cavities for reacceleration. The cooling lattice includes solenoids for tight focusing, dipoles for beam dispersion, and wedge absorbers for differential energy loss. This paper presents a complete implementation of cooling channels for BDSIM, a Geant4-based accelerator simulation tool, using appropriate analytic field models to account for fringe-field-dominated magnets. Components have been tested individually and validated against other tracking codes such as G4BeamLine. A tracking study leveraging this implementation is presented, simulating and optimizing a rectilinear cooling channel for the 6D cooling demonstrator. The analysis incorporates beam parameters from existing proton drivers, using outputs from targetry and capture system designs.

Footnotes

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