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Magnetohydrodynamic effects in liquid lead target concept for Muon Colliders

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The use of liquid lead as a target material in particle accelerators is of significant interest due to its high density, high thermal power absorption capacity, and resistance to radiation damage. This makes it particularly well-suited for the high-intensity proton beams being studied for CERN's Muon Collider proposal, with powers ranging up to 4 MW. To minimize shock propagation and manage the intense thermal and mechanical stresses induced by the high-power proton beam, a free-falling liquid lead curtain is explored as a promising concept. However, the target region requires strong magnetic fields, around 20 T, to re-focus the secondary particles generated at the target, introducing complex magnetohydrodynamic (MHD) effects in the liquid metal flow. These effects, particularly caused by Lorentz forces and MHD losses, present challenges to achieving stable and efficient high-power target systems. This work presents multiphase MHD simulations that reveal flow instabilities and highlight potential concerns within the free-falling curtain concept. The findings provide critical insights into the feasibility of liquid lead targets for high-intensity beams.

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