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Impact of Magnetohydrodynamic (MHD) Instabilities on Beam Dynamics in High-Energy Particle Accelerators.

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• **Title**: Impact of Magnetohydrodynamic (MHD) Instabilities on Beam Dynamics in High-Energy Particle Accelerators.
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Abstract: The research will combine theoretical analysis, numerical simulations, and experimental validations to provide a comprehensive evaluation of significantly affect the stability and performance of plasma in accelerators. In high-energy particle MHD effects on beam dynamics.

This study explores the influence of magnetohydrodynamic (MHD) instabilities on beam dynamics within high-energy particle accelerators. MHD instabilities, which arise due to the interaction between magnetic fields and conductive fluids, can accelerators, these instabilities have the potential to distort magnetic confinement, induce beam loss, and reduce the efficiency of particle acceleration. This research examines key MHD phenomena, including kink modes, tearing modes, and resistive instabilities, and analyzes their impact on beam trajectory, coherence, and overall accelerator performance. By simulating various accelerator configurations and plasma parameters, we aim to quantify the thresholds for instability growth and develop strategies for mitigating their adverse effects. These findings could lead to improved control mechanisms in next-generation accelerators, enhancing both precision and reliability in experimental outcomes.

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