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Experiment Concepts of Heavy-Ion Driven Plasma Acceleration with Muon Beams at the HIAF

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The muon beams decay quickly at low energy. Therefore, it is important to rapidly accelerate the muon beams to higher energy to ensure sufficient lifetime for beam manipulations or further acceleration. Plasma acceleration offers higher acceleration gradients compared to conventional RF cavities. It is the most promising acceleration method for muon research projects at the HIAF facility. The HIAF can provide multiple proton or heavy ion beams at the same time, which can be utilized to produce muon beams by hitting targets and drive the plasma oscillations to provide acceleration fields. Preliminary simulation studies indicate that employing heavy ion beams in the HIAF to drive plasma oscillations, or wakes, through self-modulation instabilities can accelerate the muon beams from 800 MeV to 1.95 GeV within a length of 0.6 m. Ongoing research on plasma acceleration of muon beams at the HIAF will focus on introducing the generation and cooling simulation results to refine the existing plasma acceleration scheme based on self-modulation instabilities, and finding a way to enhance the energy gain of the muon beams in this scheme. Additionally, new plasma acceleration mechanisms will be explored to efficiently utilize the energy carried by the high intensity heavy ion beams.

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