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Time-resolved space charge compensation studies at the high-intensity KOMAC beam test stand

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High-intensity ion beams are inherently subject to significant space charge effects, which lead to complex beam dynamics and emittance growth, particularly in the Low Energy Beam Transport (LEBT) region. In this study, the dynamics and optimization of space charge compensation (SCC) of a high-perveance proton beam are investigated through a combination of 3D numerical modeling and time-resolved experimental measurements in the KOMAC Beam Test Stand (BTS). The BTS is an RFQ accelerator structure that accelerates pulsed proton beams to energies of up to 1 MeV with beam currents in the range of 15–20 mA. The transient evolution of the beam's phase space under varying SCC conditions is examined using Allison scanners. Parametric studies are conducted to assess the influence of beam current, injected gas species, pressure, and initial beam size on SCC dynamics. Nonlinear space charge effects are considered, particularly those influencing SCC efficiency and transverse emittance growth. A correlation between SCC and RFQ matching conditions is also examined, demonstrating the necessity of adjusting solenoid magnet settings to maintain optimal transmission efficiency.

Footnotes

Funding Agency

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Yes

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