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A Space Charge Compensation Study for Matched Positive Ion Beams in a Low-Energy Beam Transport Line

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This study investigates the space-charge neutralization of a positive ion beam by electrons generated during ionization as the beam passes through injected gas. A three-dimensional electrostatic particle-in-cell (PIC) simulation is employed to model this process. Various types of injected gases are considered, and their effects on the transient times for space-charge compensation (SCC) are compared. Secondary electrons and ions, produced through collisions between the ion beam and the neutral gas along the beam's path, are introduced into the simulation using a Monte Carlo generator. These secondary particles contribute to the overall space charge, which combines with the primary ion beam's space charge. The injection and accumulation of secondary electrons and ions are time-dependent and continue until the total space charge density reaches saturation. The study focuses on a 2.4-meter low-energy beam transport (LEBT) line equipped with two solenoid magnets at the KOMAC Beam Test Stand (BTS) facility. Typically, the proton beam energy is 25 keV, with a peak beam current between 10 and 15 mA. The experiment explores the speed and degree of SCC by varying the gas injection conditions. The results of this study are compared with beam simulations that include the generation and tracking of secondaries, providing a unique understanding of the transport of low-energy ion beams and their matching into the RFQ.

Paper submission Plan

Best Presentation

Yes

Contribution track

ICABU WG2. Beam Physics, Diagnostics & Novel Techniques

Primary author: COSGUN, Emre (UNIST)

Co-authors: Dr KIM, DongHwan (KAERI (KOMAC)); MOON, SeokHo (KAERI (KOMAC)); Prof. CHUNG, Moses (POSTECH); Prof. HUR, MinSup (UNIST)

Presenter: COSGUN, Emre (UNIST)

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