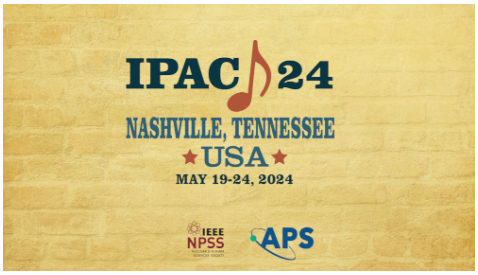

Contribution ID: **1619** Contribution code: **THPC41** Type: **Poster Presentation**

Study of flat-to-round-to-flat transformation at high space charge

Thursday, 23 May 2024 16:00 (2 hours)

We describe experimental, theoretical, and simulation activities testing Derbenev's 1998 proposal for using flat-to-round-to-flat (FTRTF) transformations to enable electron synchrotrons for ion beam cooling. FTRTF systems have also been proposed for storage-ring and single-pass light sources (FELs), beam sources, and microwave tubes. The experiment—based on a low-energy (5–10 keV) linear electron transport system—includes an electron source, beam-shaping aperture plate, quadrupole matching section, Derbenev skew-quadrupole vortex sections, and a long solenoid. Our theoretical efforts explore the optical conditions required to optimize the canceling of angular momenta at the core of the Derbenev system. The complexity of the beam dynamics requires the use of simulation codes—here WARP and OPAL—to model the system for comparison with experiment. To reduce the computational effort required for optimization, we introduce the use of the adjoint technique, well-known in plasma physics but not beam physics. Using 5–10 keV beams allows us to study beam dynamics over a broad range of space charge in an environment readily accessible to students.

Footnotes

Funding Agency

Work supported by USDOE under grant DESC0022009

Paper preparation format

Word

Region represented

North America

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Session Classification: Thursday Poster Session

Track Classification: MC5: Beam Dynamics and EM Fields: MC5.D01 Beam Optics Lattices, Correction Schemes, Transport