Space Charge Waves, Mismatch, and Halo

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Overview

• Summary of recent LLNL / NPS work

• Proposed UMER Experiments

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SPACE CHARGE WAVES IN MISMATCHED BEAMS*

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LSP Simulations

- 207 mA, 10 keV electron beam injected into a uniform focusing channel
- Mismatch: >1%, 7%, 26%
- Perturbation: 20%, 60%, 100%
Results: Fast/Slow Asymmetry

Not understood; possibly due to strongly-convergent injection

Ongoing work: Theoretical description
Results: Nonlinear Wave Steepening

- Small-signal: SCW speed agrees with theoretical value
- Large-signal: SCW speed increases; leading-edge steepens
- Nonlinear CFM replicates steepening

\[ c_0 = \sqrt{\frac{2g\lambda_0}{4\pi\varepsilon_0 m\gamma^5}} \]

UMER Data
Results: Particle Ejection

1. No Perturbation
2. Perturbation Injection
3. Perturbation Mismatched
4. Particle Ejection Starts
5. Transverse Structure
6. Longitudinal Structure
Particle Ejection: Transverse Structure

- Ejection occurs once each mismatch period
- Generates “Cascades” of halo particles
Particle Ejection: Longitudinal Structure

\[ \dot{\lambda}_i = c_w \dot{\lambda}_e / (\beta c \pm c_w). \]

Ongoing work: Theoretical description
Proposed UMER Experiments

- Deliberately mismatch UMER beam; perturbed and unperturbed

- Single Turn: Phosphor screen to detect halo

- Multiturn: Bergoz FCTs, RWM, and BPMs to detect longitudinal structure
  - Question: Effect of Quadrupole channel? Simulate.
  - Halo-sampling Faraday cup?
    - Offers spatial and temporal resolution

- NPS students want to participate