CCAP Plenary Meeting:

Status report for the Stage 1 and Stage 2 beam transport work packages

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Recent Work: Stage 1

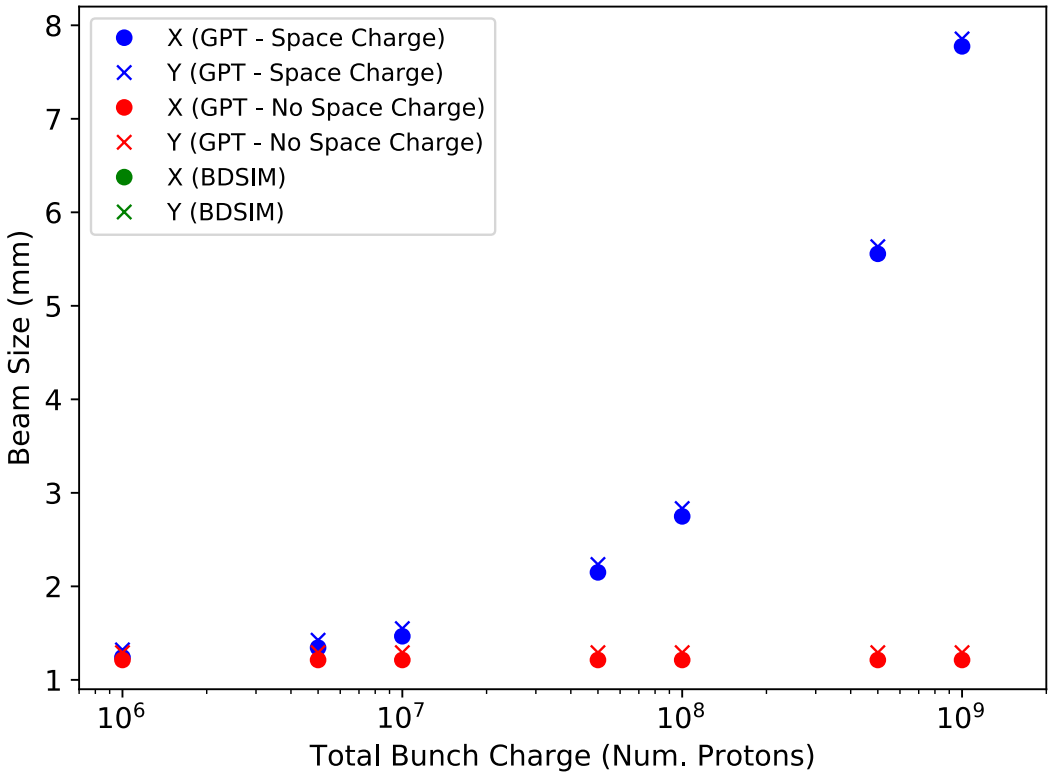
- Understand effects of space charge in stage 1.
  - Emittance growth at the start

- Subsequent effects along the transport beam line

- Applicability of BDSIM for subsequent simulations

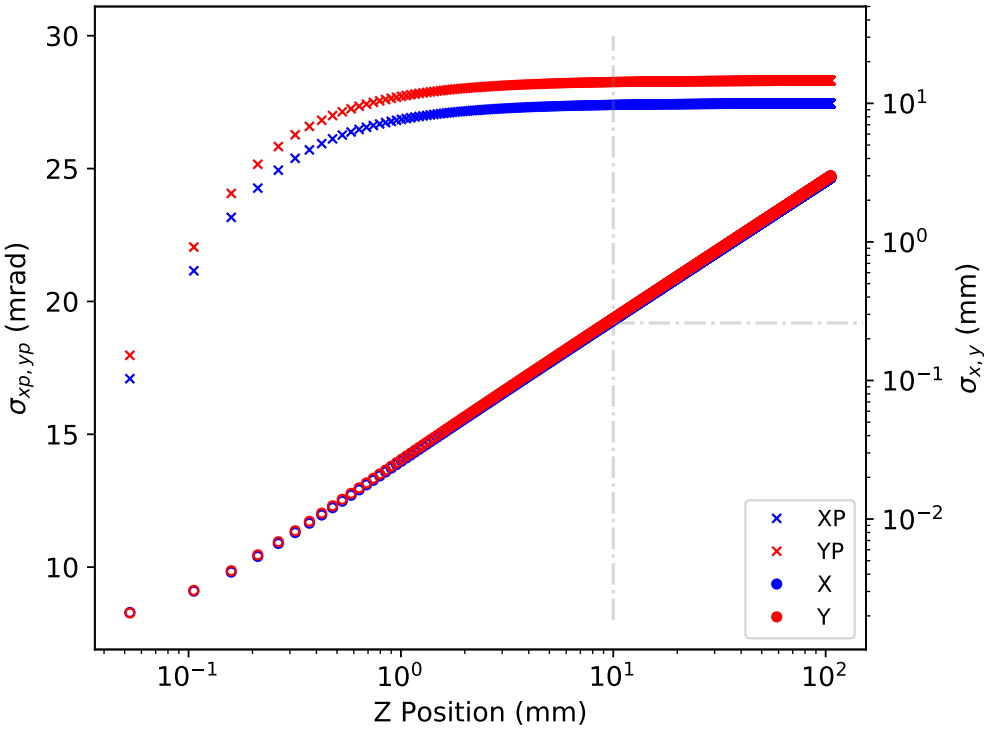
- Aim: Understand dynamics to develop extraction line for stage 2 injection

Space Charge Simulations – Bunch Charge



- Beam size recorded after travelling through a 10 cm long drift
  - LhARA GPT beam parameters
- Beam emittance growth increasing with charge
- BDSIM (Green) matches GPT (Red) simulations without space charge
  - Expected behaviour (BDSIM data hidden under GPT data).

Space Charge Simulations – Beam Divergence

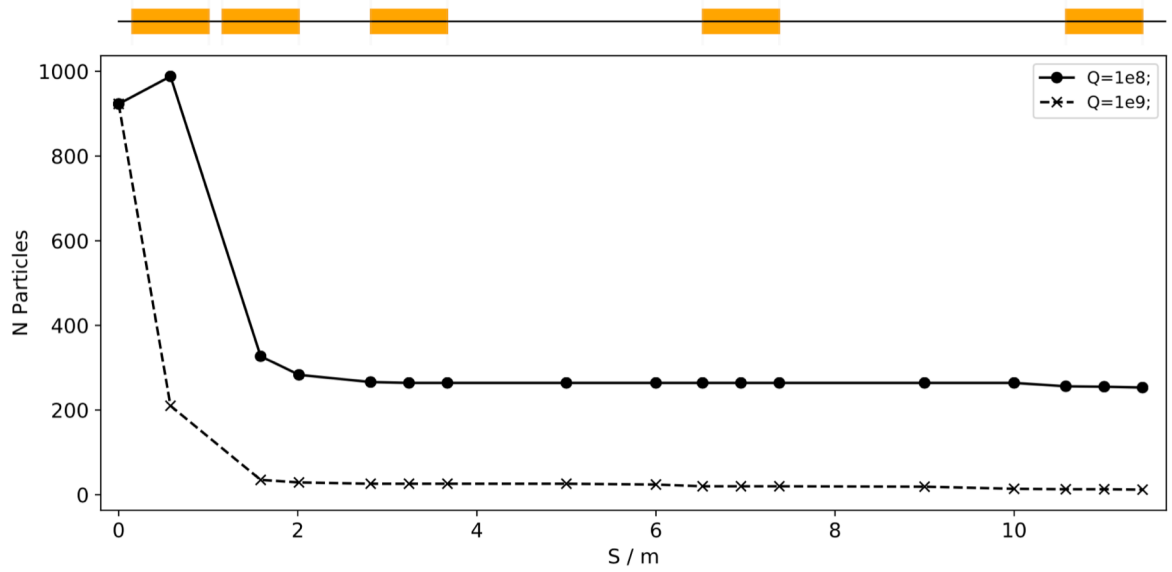


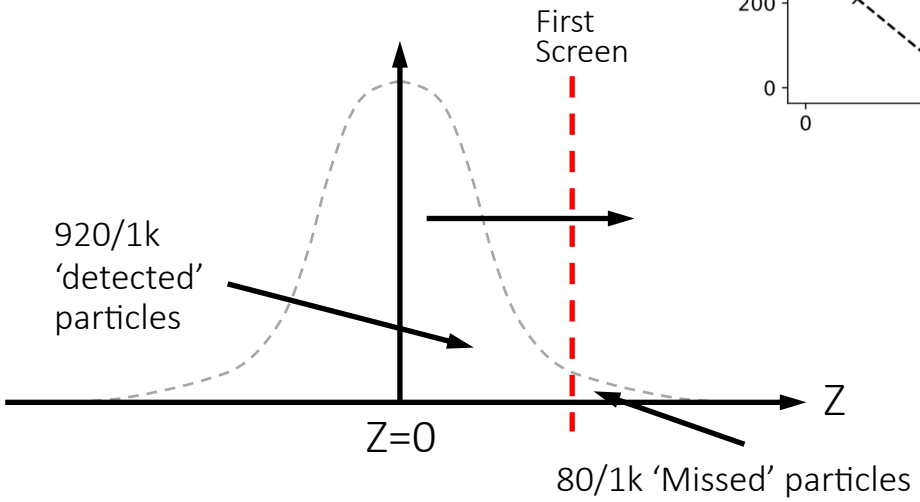
- Small time steps throughout the drift for 1e8 protons
- Effect of space charge diminishes after ~ 1 cm.
- Bunch size at that Z position is ~ 0.3 mm
  - Wider bunches might be accurately tracked without space charge.

- Space charge effect only pronounced for the first few cm's of beam line
  - Simulate that drift in GPT
  - Remainder should be simulated in BDSIM.

Stage 1 Beam Transport: Transmission

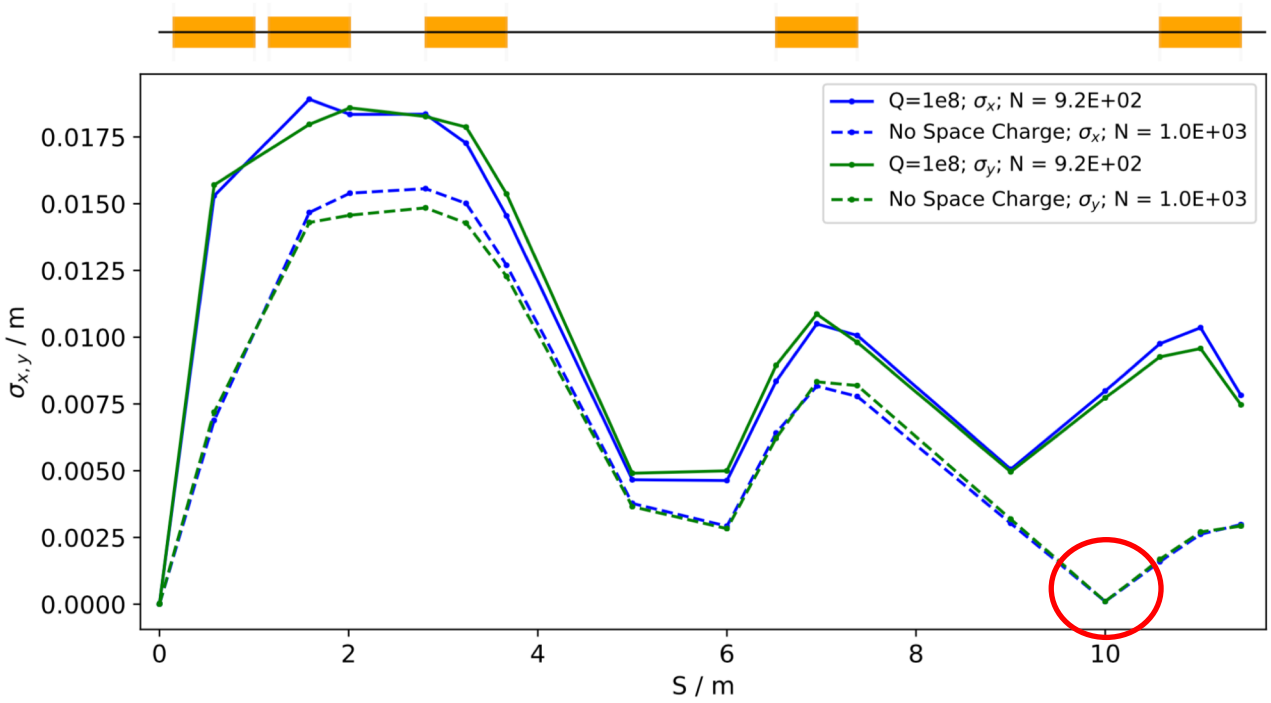
- Transmission improves from ~ 1% to ~25% when reducing initial bunch charge.





- First screen to record initial distribution moved
  - Recording at 0 misses half the distribution.
- Not far enough
  - Small number of particles start ahead

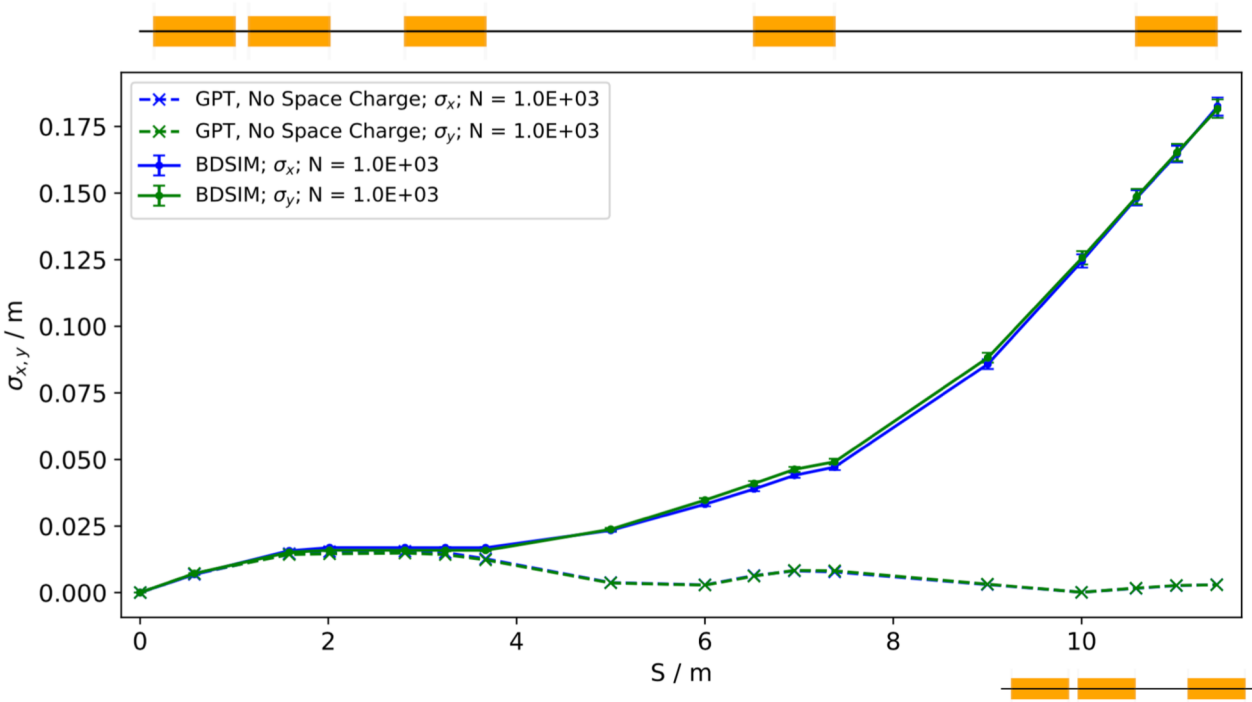
Stage 1 Beam Transport: Space Charge Effects



- Difference in beam optics due to initial emittance growth c/o space charge
- First few cm's with space charge crucial for accurate simulations

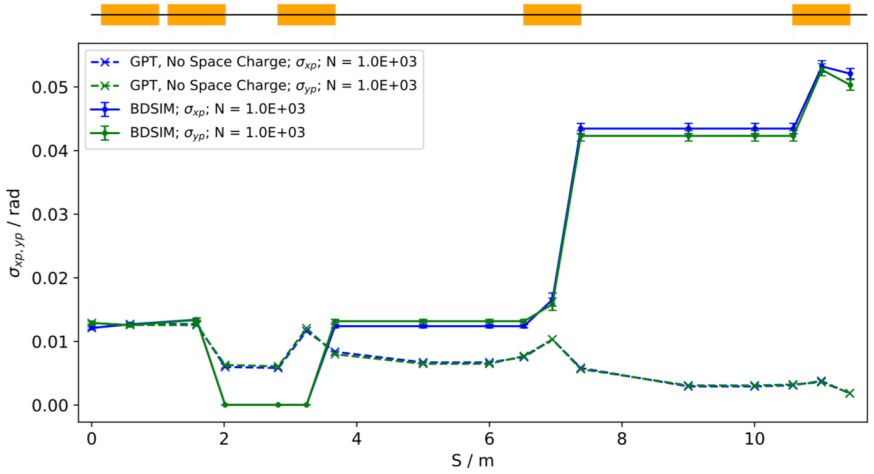
- Without space charge, the beam later focuses to spot size of around 0.1 mm.
- Further small beam sizes negated by emittance growth at the beginning.

Stage 1 Beam Transport: BDSIM



- Convert GPT generated particles coordinates recorded at t=0.
- Updated BDSIM model to match GPT model sample positions

- Optics diverge around the second solenoid
  - Will investigate this week
- Solenoid field descriptions identical.



Future Plans

- Investigate BDSIM stage 1 simulation results
- Run stage 1 with GPT beam after space charge emittance growth
- Expand model for 3 configurations: transport, abort, extraction
  - Run each as separate simulations
- Begin assembling stage 2 extraction line.