LhARA pre-CDR Meeting: Space Charge

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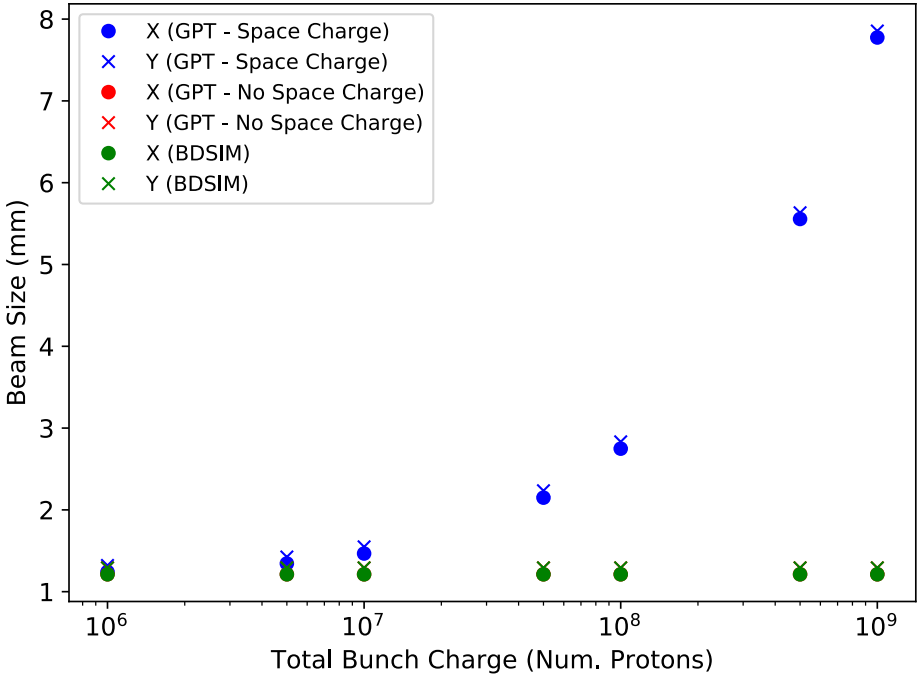
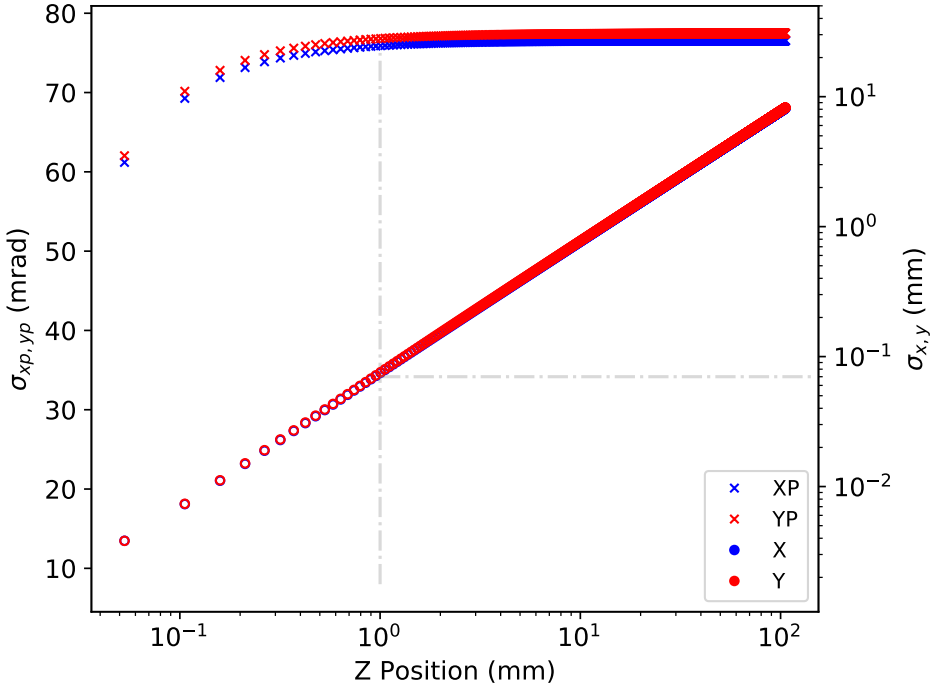
Space Charge Simulations – Bunch Charge



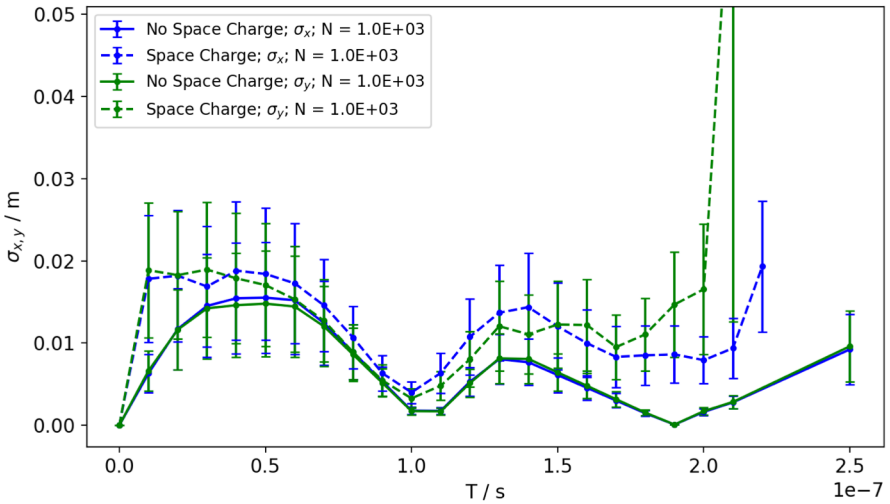
- Effect of space charge – beam size recorded after travelling through a 10 cm long drift. CCAPV4 GPT model beam parameters.
- Beam size growth increasing with increased charge - expected behaviour.
- BDSIM matches GPT simulations without space charge - expected behaviour.
- GPT fails when simulating higher charge - unsure why.

Space Charge Simulations – Beam Divergence



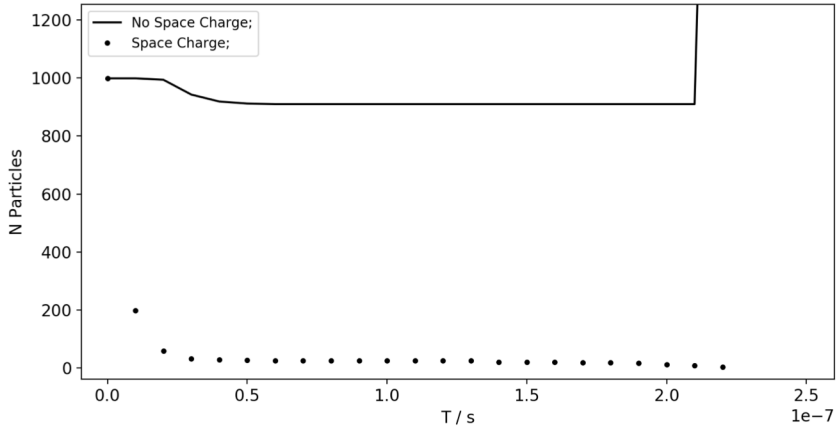
- Small time steps throughout the drift for highest bunch charge (1e9 protons).
- Effect of space charge on the bunch diminishes after ~ 1 mm - little change in transverse momentum.
- Bunch size at that Z position is ~ 0.07 mm - indicative that beams of that size and larger might be accurately tracked without space charge effects.

Space Charge Simulations – CCAPV4

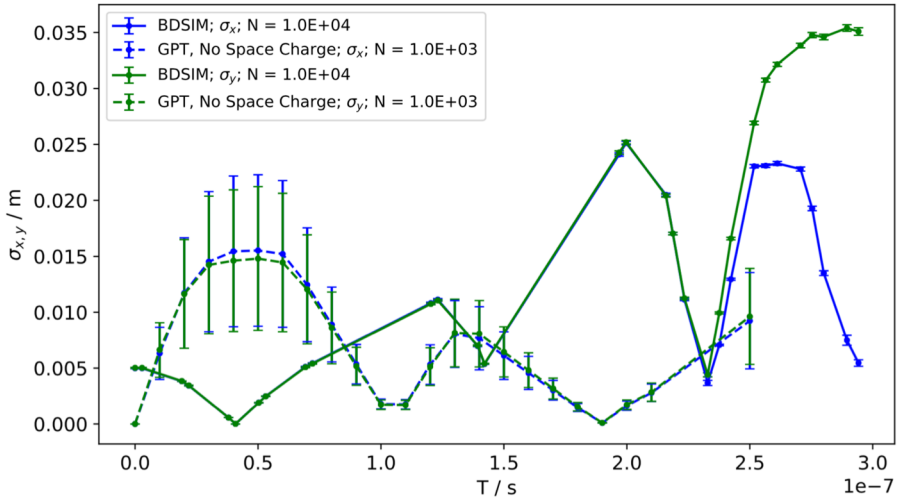


- Similar optics with & without space charge
- Low statistics - save computational time
- Disparity occurs in the region where space charge is present – first few cms of the lattice

- Severe losses at the start of the machine (capture section) with space charge
- < 1% transmission to machine end
- Unknown cause of increase in no space charge simulation at the end – assumed bug in file reader.



Space Charge Simulations – CCAPV4 & BDSIM



- Lattices unchanged – ran as provided, except:
  - BDSIM options altered off to speed up simulations
  - Transform added to make the vertical bend vertical
- Differences in lattice definitions in BDSIM and GPT:
  - Initial distribution dimensions
  - Lattice lengths (missing vertical bend).
- Will resolve
- Python library written for automated comparison
  - No analysis (post GPT run) needed.

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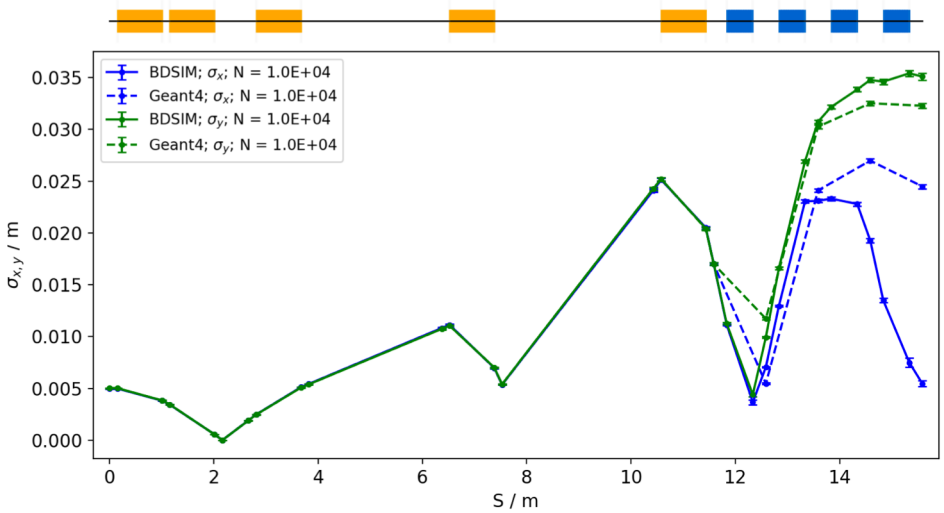
Space Charge Simulations – BDSIM Integrators



- Checked BDSIM default integrators (matrices) vs Geant4 integrators (RK4)
- No differences until transform
- Satisfied that solenoid tracking is correct but a bug is clearly present in BDSIM integrators
  - Will add to fix-list
  - Continue using G4 integrators.