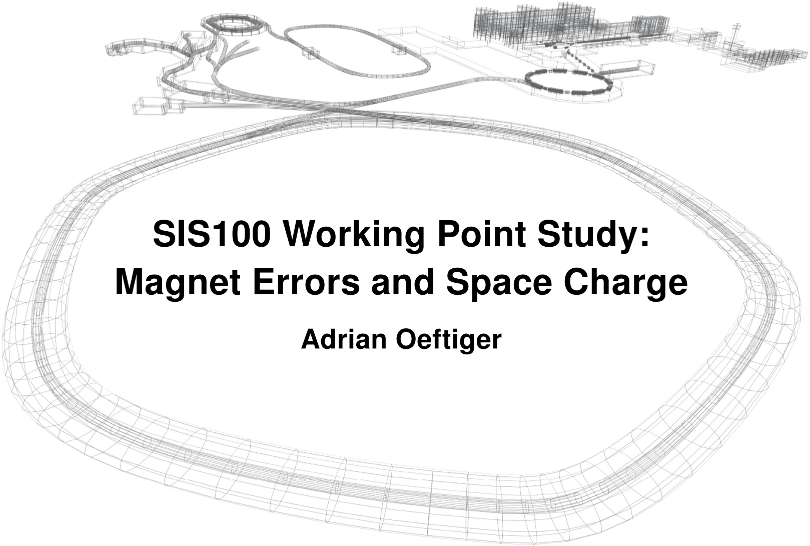


SIS100 Working Point Study: Magnet Errors and Space Charge

Adrian Oeftiger

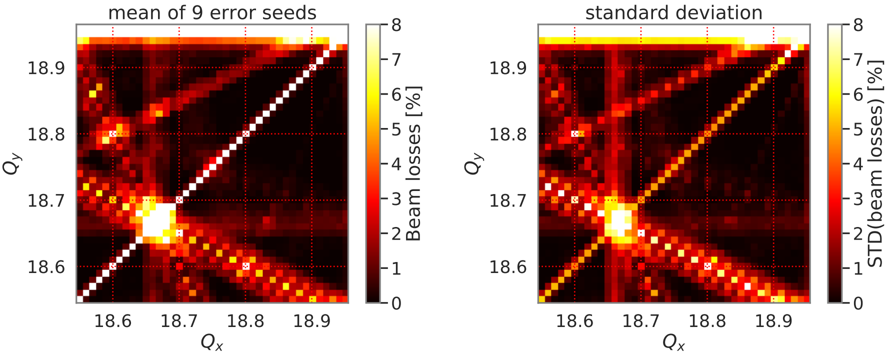
Notations

Definitions of space charge (SC) models:

- **fixed frozen SC**: a semi-analytic Gaussian field map in the transverse plane (employing the Bassetti-Erskine formula), and a Gaussian longitudinal line charge density
  - ⟶ typically run with 1000 macro-particles
  - ⟶ computed once in the beginning with a certain $\sigma_{x,y,z}$, no updates
  - ⟶ fixed center of the field-map, no centroid offset taken into account
- **centroid-aware frozen SC**: same as *fixed frozen SC*, but the centroid offset is subtracted before and re-added directly after the kick
- **adaptive frozen SC**: same as *fixed frozen SC*, no update of the centroid offset, but the $\sigma_{x,y,z}$ are continuously updated (at regular turn intervals or even each kick)
- **self-consistent PIC**: 2.5D slice-by-slice transverse Poisson solver
  - ⟶ typically run with 1×10^6 macro-particles on $128 \times 128 \times 64$ grid cells
  - ⟶ extends to a fixed size of $2 \times 12\sigma_{x,y}$ in the transverse and $2 \times 2 \times 1.5\sigma_z$ in the longitudinal plane

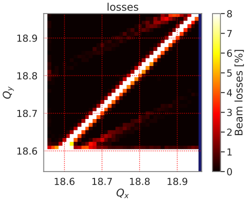
With all errors, no SC

Adding all magnet errors (multipoles, misalignments) for 9 error seeds:

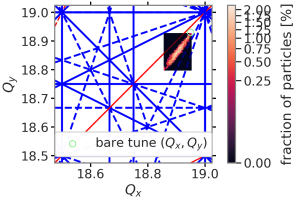


No errors, with fixed frozen SC

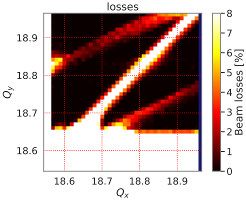
Loss width of half-integer resonance stop-band changes with ΔQ_y^{SC}:



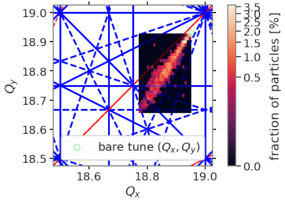
(a) losses for $\Delta Q_y^{SC} = 0.13$



(b) corresponding tune footprint



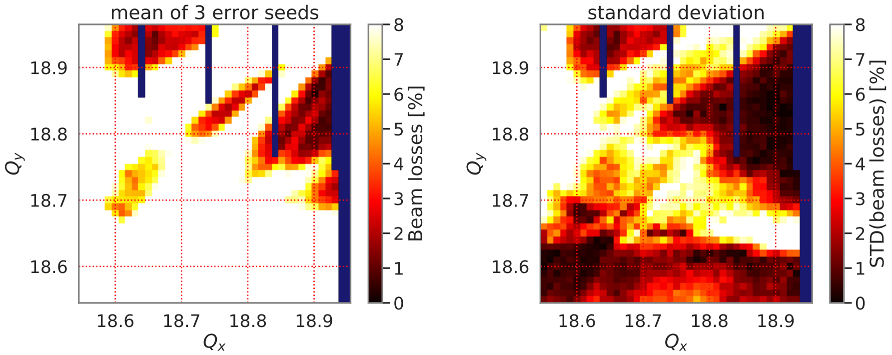
(c) losses for $\Delta Q_y^{SC} = 0.30$



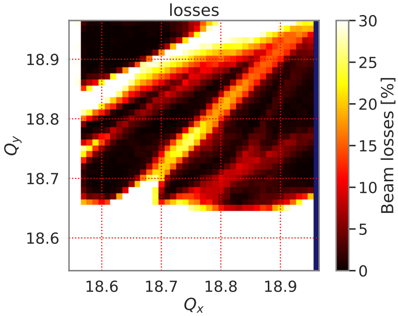
(d) corresponding tune footprint

With all errors, with fixed frozen SC

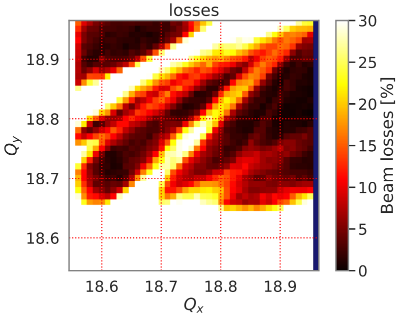
Adding all magnet errors (multipoles, misalignments) for 3 error seeds:



All misalignment errors but only up to linear errors, $\mathcal{O}(k_n) \leq k_1^\ell, k_1^s$, behaves almost the same as all higher-order multipole errors included – for the fixed frozen SC model:



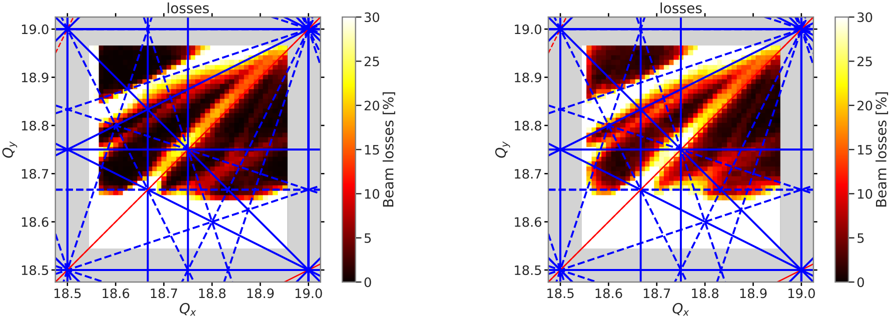
(a) up to linear error order



(b) all error orders

Comparison: linear errors vs. all errors, with fixed frozen SC

All misalignment errors but only up to linear errors, $\mathcal{O}(k_n) \leq k_1^\ell, k_1^s$, behaves almost the same as all higher-order multipole errors included – for the fixed frozen SC model:



(a) up to linear error order

(b) all error orders

Further studies

To do:

- ✗ cold lattice only, with fixed frozen SC – no magnet errors
- ✗ all errors (warm lattice), with centroid-aware frozen SC
- all errors (warm lattice), with PIC
  - ⟶ running but need to cross-check loss mechanism between SixTrackLib and PyHEADTAIL