Dynamic Aperture for eRHIC

2018 April 6, eRHIC IR meeting

IR Nonlinearity & DA

- According to RHIC operational experiences, dynamic aperture is mainly reduced by lattice non-linearity, IR field errors, and beam-beam.
- Without BB, DA is about 10 sigmas without IR nonlinearity. It drops to about 6 sigmas with IR nonlinarity.
- Without IR nonlinearity, DA is about 10 sigmas without BB. It drops to about 6 sigmas with BB.
- With IR nonlinearity and BB, DA is about 5 sigmas.

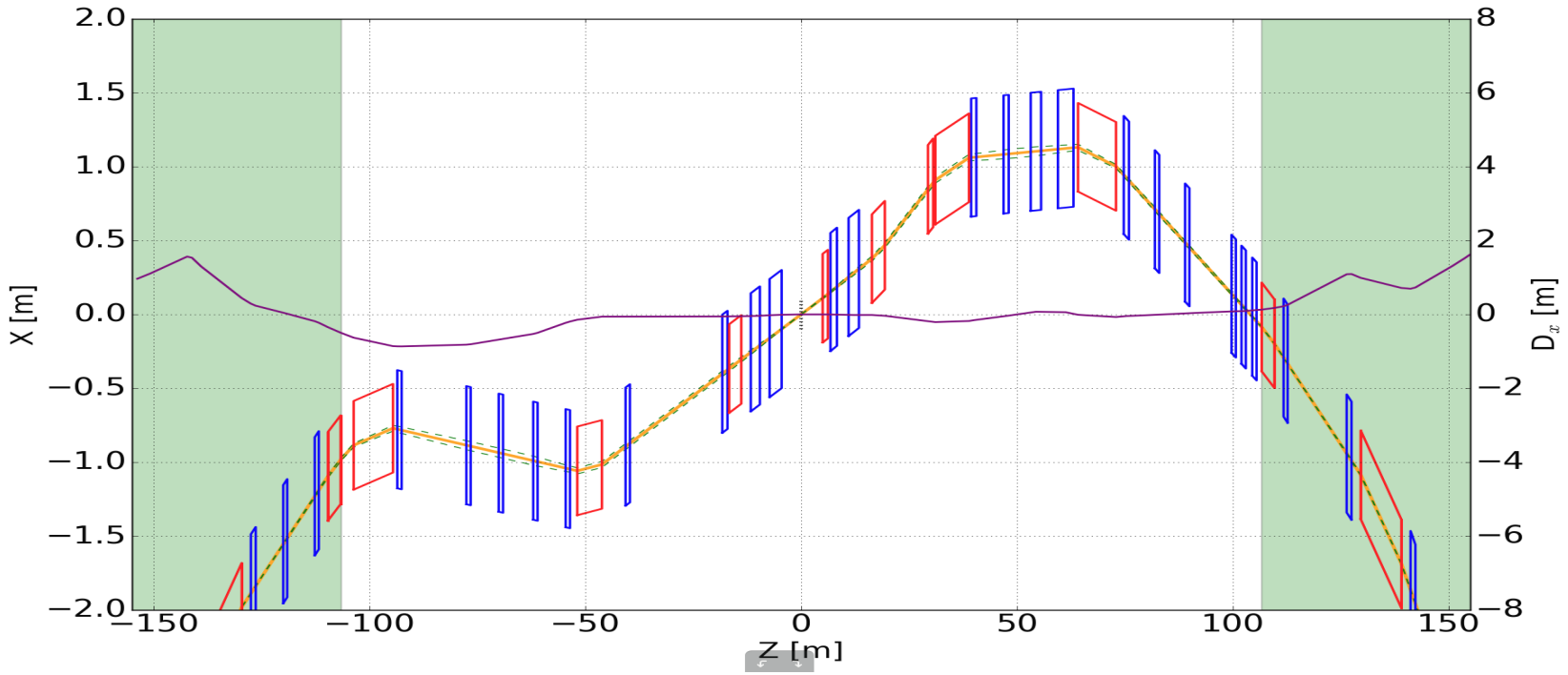
IR Nonlinearity Sources

- High order (> quadrupole) field components in interaction regions are our concern since beta functions are very large there.
- For dipole: mainly sextupole (b2 component)
- For quadruple: mainly 12-pole (b5 component)
- For RHIC DA calculation, we installed multipole field errors up to 22-poles.
- DA calculation shows it is hard to say which component is dominant.

eRHIC IR Nonlinearity

- IR region: +/- 160 m from IP
- Information needed for DA:
  → all field errors up to 22-poles are needed, including systematic and random errors
  → stray field from other ring magnets or common magnets

$$(B_y L)^M + i(B_x L)^M = B(R_r)L\left[10^{-4}\sum_{n=0}^{N_{max}}(b_n^M + ia_n^M)\frac{(x+iy)^n}{R_r^n}\right]$$



Very Preliminary DA for eRHIC

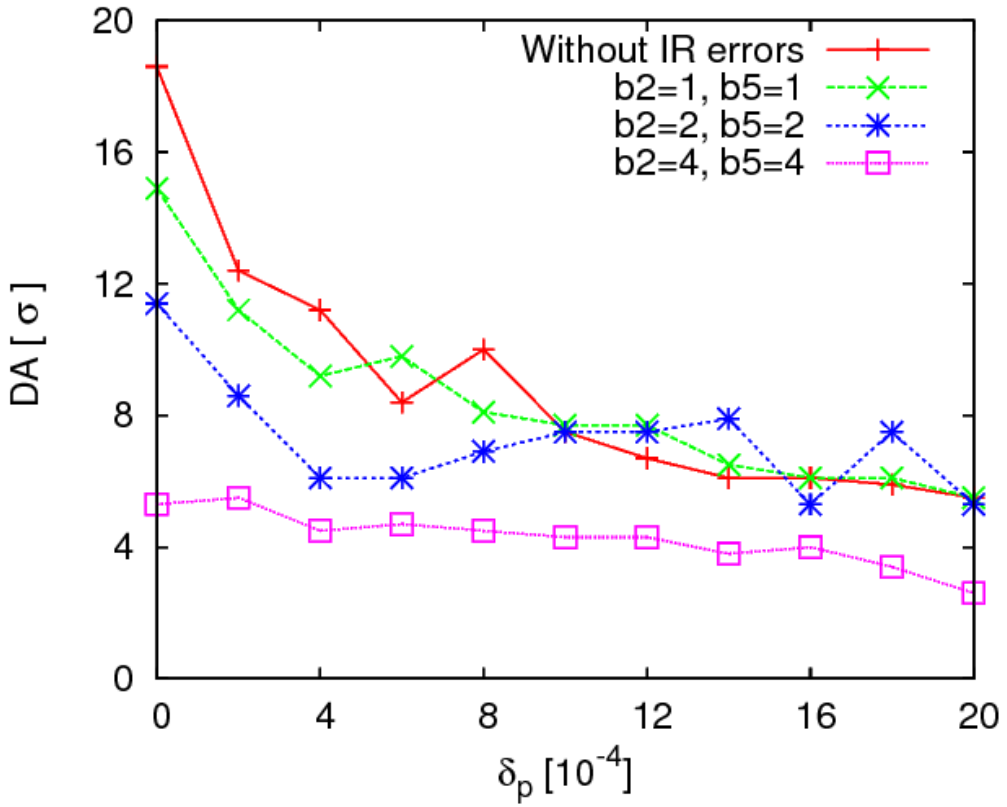


Figure 1: Calculated 10^6 turn dynamic aperture with beam-beam interaction and IR nonlinearities.

DA calculation and Filed Limit

- DA calculation can be used to check the effect of IR magnets.
- DA calculation also can be used to set the limit of IR nonlinear components.
- IR nonlinear correction:
  - → spool pieces in magnets (b2 → b5, a2->a5)
  - → stand-alone low order correctors
  - → beam-based correction.