Dynamic Aperture Calculation for BTev

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- General information for the calculation
- Single beam Dynamics
- Beam-beam Dynamics

General information

- **Btev base lattice at collision**
- **Included lattice non-linearities:**
  - **(1) high order multipoles of ARC magnets and B0&D0 IR magnets measured at collision**
  - **(2) high order multipoles of C0 LHC IR magnets (measured)**
  - **(3) chromaticity sextupoles**
  - **(4) feeddown sextupoles**

- **Working point: (0.585,0.575) (on both proton and pbar helices)**
- **Chromaticities: (0., 0.)**
- **Main parameters:**

Energy:1000GeV
Proton Bunch intensity: 2.7e11
Emittances (95%) (*πmm.mrad*): 20/15(proton/anti-proton)
Momentum deviation (dp/p)(δ_p): 8.7e-5

- **Three concepts:**

  (1) Tune shift: experienced by zero amplitude particles, one way to parameterize the strength of a kick.

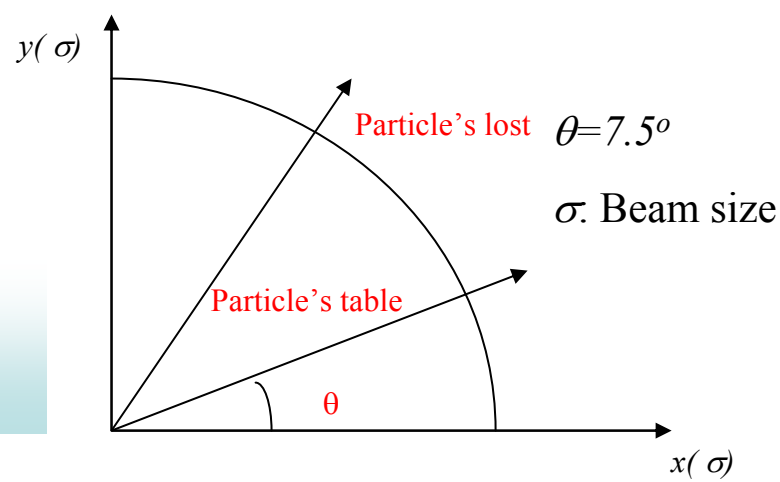
  (2) Footprint: a good measure of the strength of the nonlinearity

  (3) Dynamic Aperture (DA)

- **Tracking code**

  MAD: within 1 day(10^5 turns)

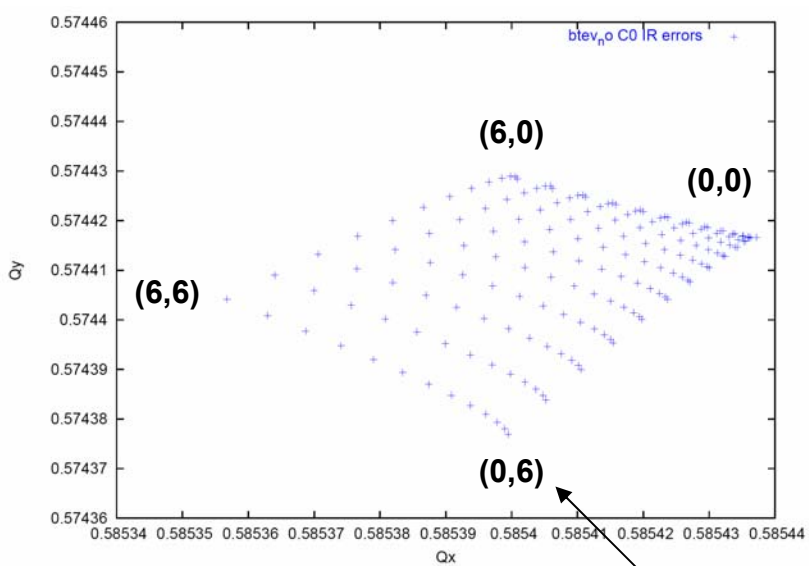
10^5 turns ➔
2 second in the Tevatron



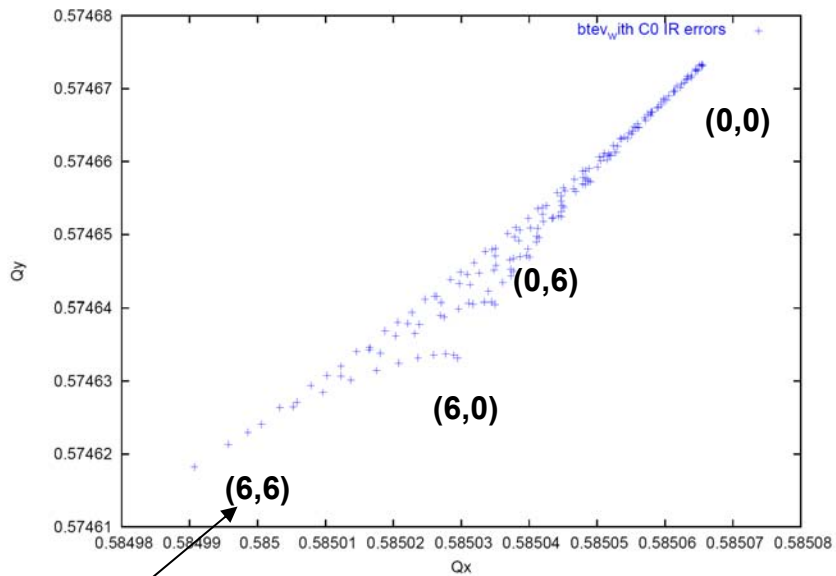
θ *is the angle of the particles in physical space*
We send particles along this angle in the initial amplitudes of (0-N) *σ to track* ***for*** **10^5 turns**

Tune footprint of single beam for BTev lattice

No C0 IR errors



with C0 IR errors

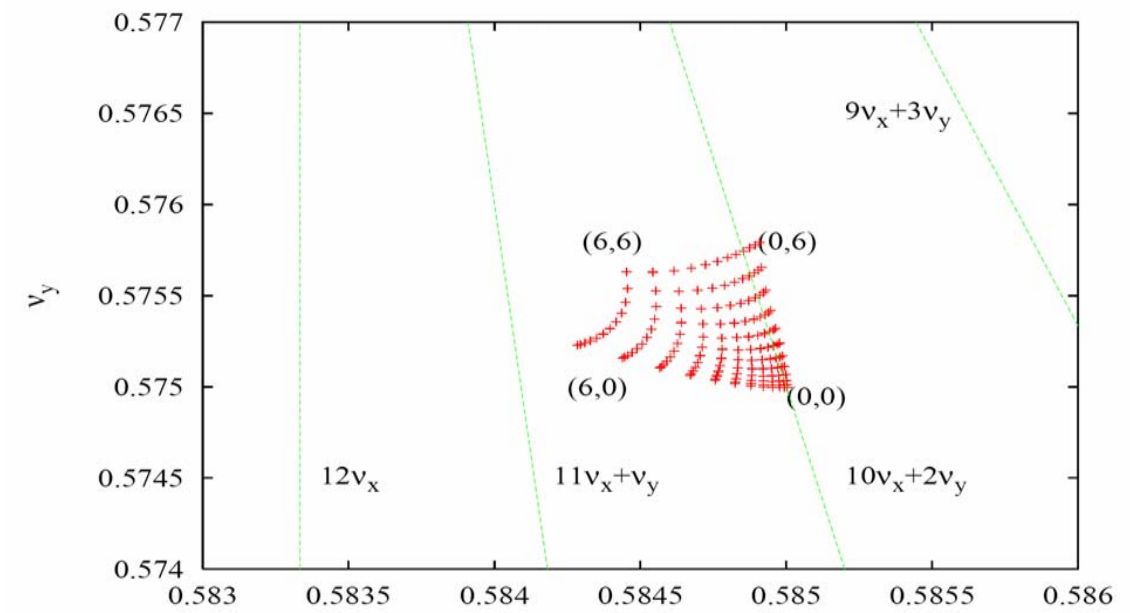


Initial amplitude(σ)

Tune spread:($\Delta\nu_x$,$\Delta\nu_y$)=(8.e-5,4e-5)

Tune spread:($\Delta\nu_x$,$\Delta\nu_y$)=(8.e-5,6.e-5)

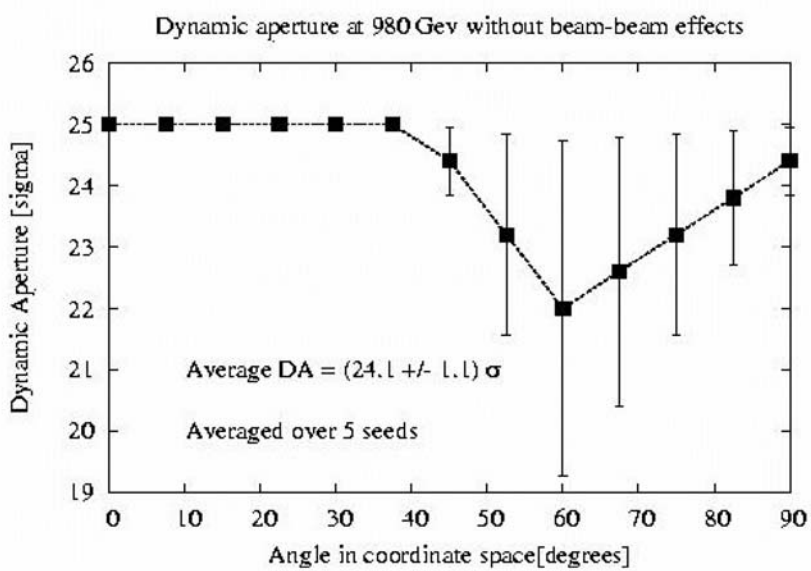
Tune footprint of single beam for RUN II lattice



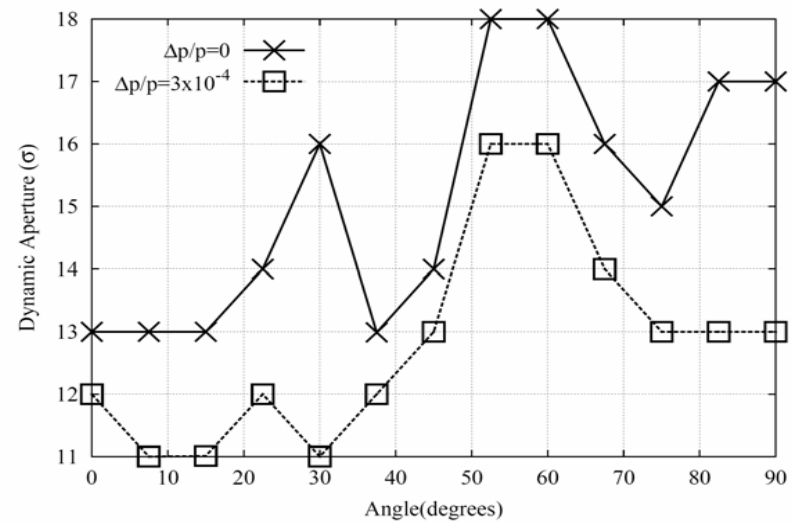
Tune spread:($\Delta\nu_x$,$\Delta\nu_y$)=(6.e-4,6.e-4)

Dynamic aperture of single beam

BTev lattice



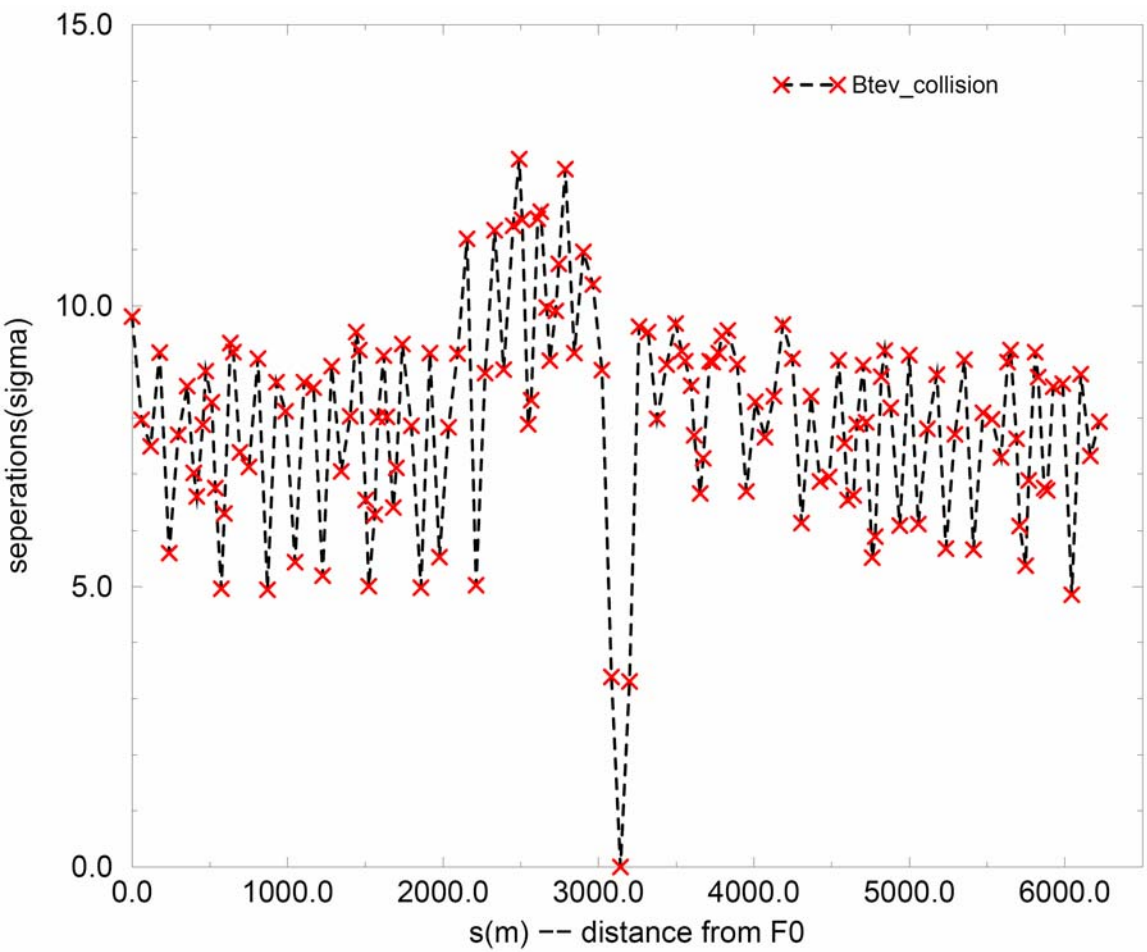
RUN II lattice



Average DA: (24. ± 1.) σ over 5 seeds

Average DA: (13. ± 2.) σ

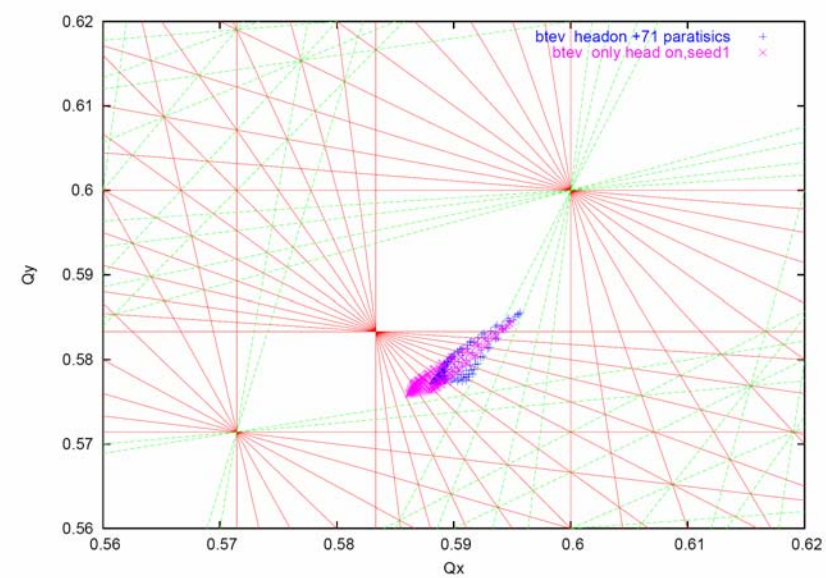
Beam Beam Separations at BTev Collision



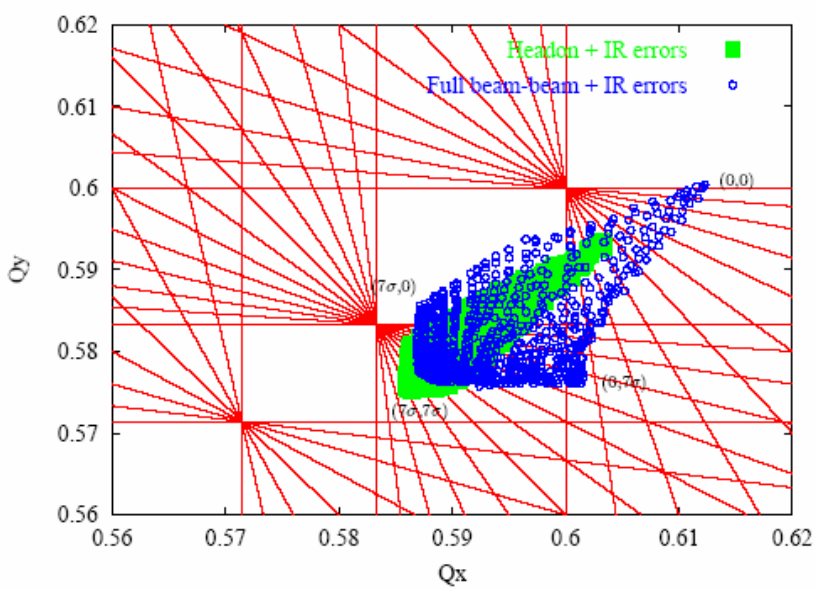
- There are totally 138 different crossing points around the ring.
- For each pbar bunch, there are one head on and 71 long-range interaction points

Tune footprints of beam beam

BTev lattice



RUN II lattice

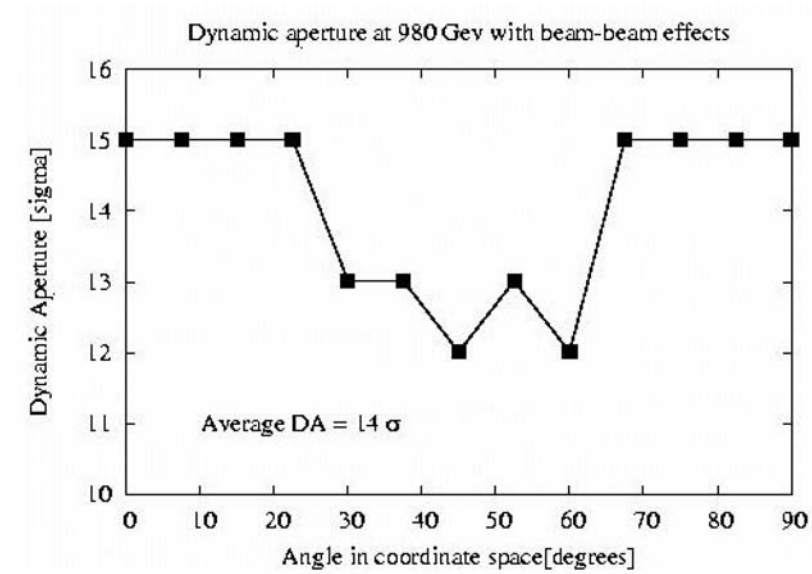


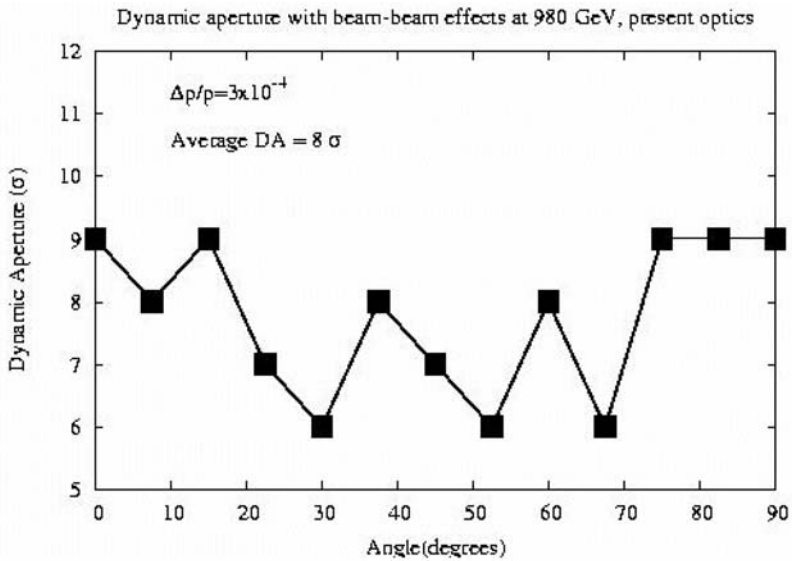
Tune spread:
($\Delta\nu_x$,$\Delta\nu_y$)=(8.e-3,9.e-3)

Tune spread:
($\Delta\nu_x$,$\Delta\nu_y$)=(2.3e-2,2.1e-2)

Mostly comes from Headon interaction(s)

Dynamic Aperture with beam-beam





Average DA: 14. σ
over 5 seeds

Larger than physical aperture set by collimator 8 σ

Average DA: 8.0 σ
Min.: 6 σ

Conclusion

- The average dynamic aperture of single beam is 24σ - well beyond the physical aperture of the low-b quads, and nearly twice as large as the single beam dynamic aperture calculated for Run II B0/D0 collisions

- The average dynamic aperture of beam beam is 14 σ, indicating that beam-beam effects reduce the aperture of the machine by a substantial 10 σ.
- It exceed the physical aperture set by the primary collimators(~8 σ), and roughly twice as large as the 8 σ average calculated for Run II B0/D0 collisions, and, furthermore, the C0 *minimum* dynamic aperture of 12 σ even significantly exceeds the *maximum* 9 σ dynamic aperture of the Run II lattice