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ILC Damping Ring Lattice Work

Louis Emery presenting Aimin Xiao's results

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U.S. Department of Energy

THE UNIVERSITY OF CHICAGO

Office of Science
U.S. DEPARTMENT OF ENERGY

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Lattice Design Continues since Jan 2006

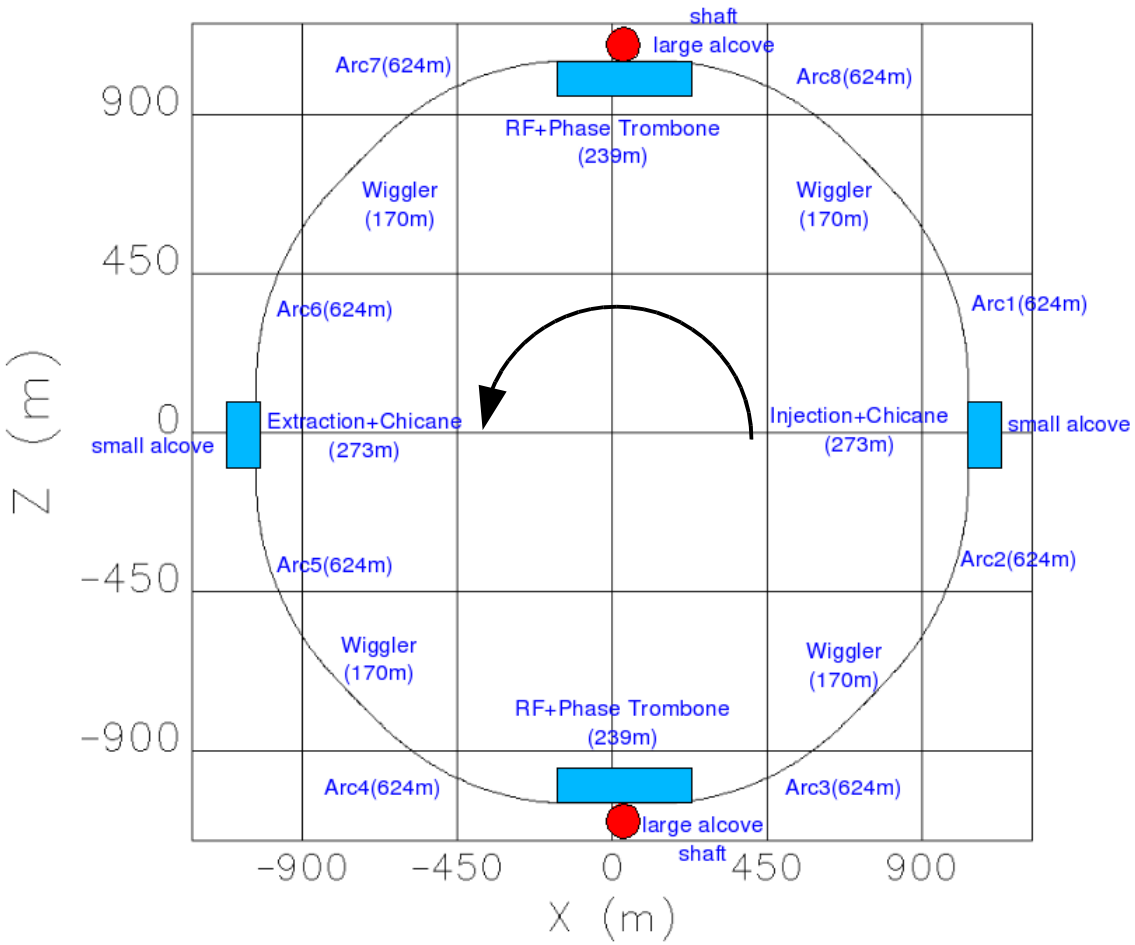
- Lattice design updates from engineering and cost requirements
  - Change number of arcs
  - Change location of injection and extraction
  - Add circumference-adjusting chicane
  - Add tune adjuster (phase trombone)
  - Demonstrate some momentum compaction (α_c) variability (later)
- Beam dynamics of lattice
  - Check workability of changes above

Lattice History

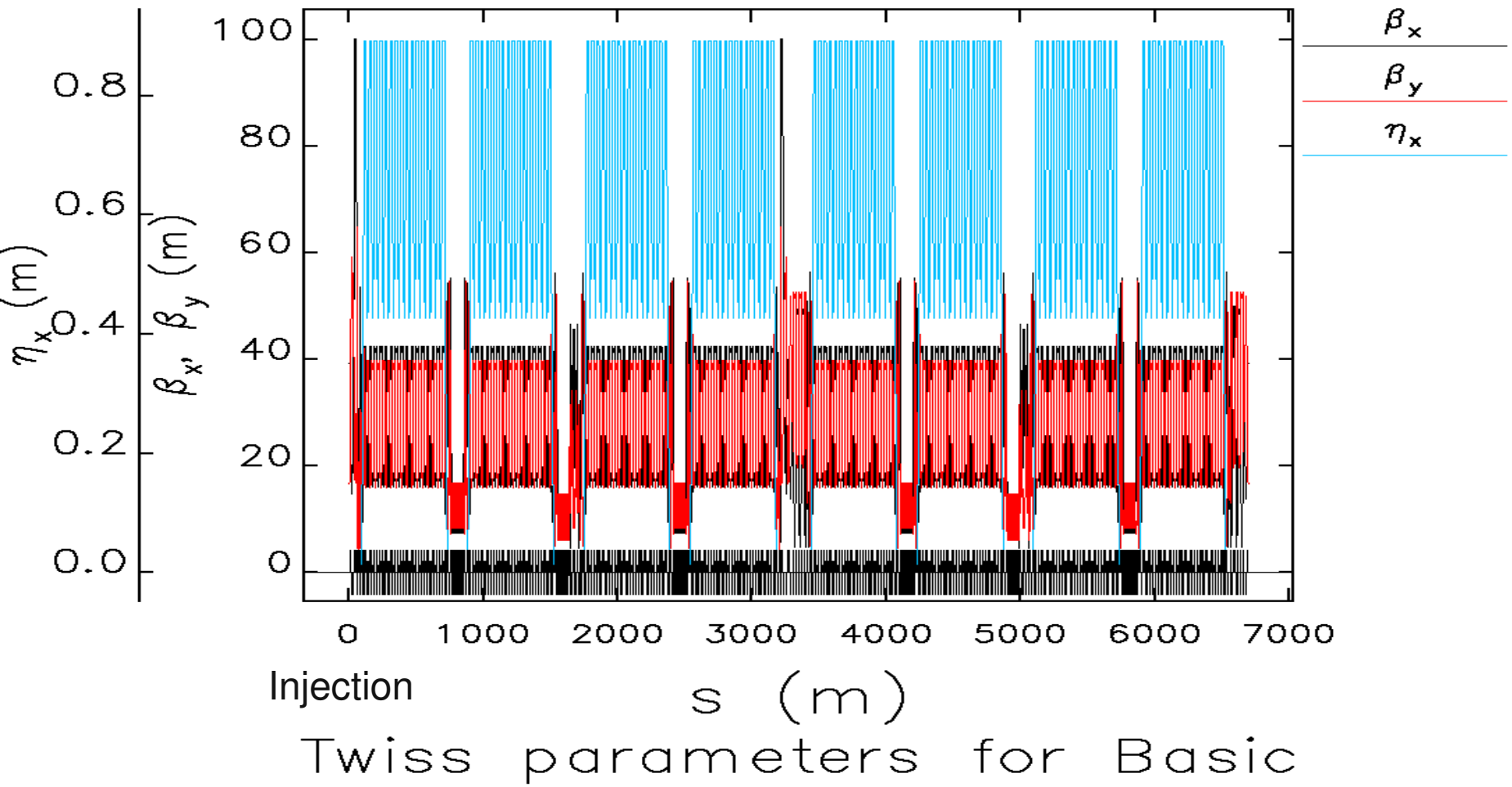
- OCS (Summer 2005): 12 superperiods, 6.1 km, α_c=1.6x10^{-4}, 192 dipoles
  - Good DA: high symmetry and phase advance of straight sections adjusted for maximal dynamic aperture
- Baseline Recommendation (Jan 2006) of lattice
- OCS6 (Jan 2006): Follow baseline recommendation, 10 (or 8?) arcs, two long straight sections, combined injection/extraction straight section, 6.6 km, higher α_c=4.2x10^{-4}, 120 dipoles
- OCS6: change to 6 arcs for cost reasons, DA calculations were done
- OCS8 (March 2007): change to 8 arcs to separate wigglers from rf sections

OCS8 Ring Layout

- Positron and electron rings on top of each other
- Rings are counter-rotating
- Injection and extraction lines on each side would be in same tunnel
- SC RF cavities from different rings wouldn't with each other



Present OCS8, Eight Arcs



Injection Region Reworking

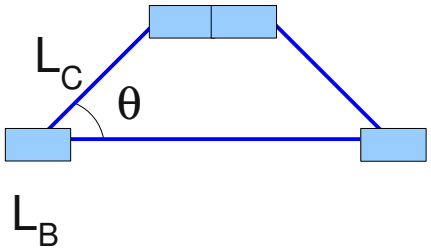
- Changed the assumption of pulser configuration on striplines which made the kicks stronger and allowed a simplification of injection
- All striplines are consecutive with no optics in between
  - 21 kickers of 0.04 mrad

Chicane

- Normal chicane path length change ds

$$ds = 2L_C\left(\frac{1-\cos\theta}{\cos\theta}\right) + 4\rho(\theta - \sin\theta)$$

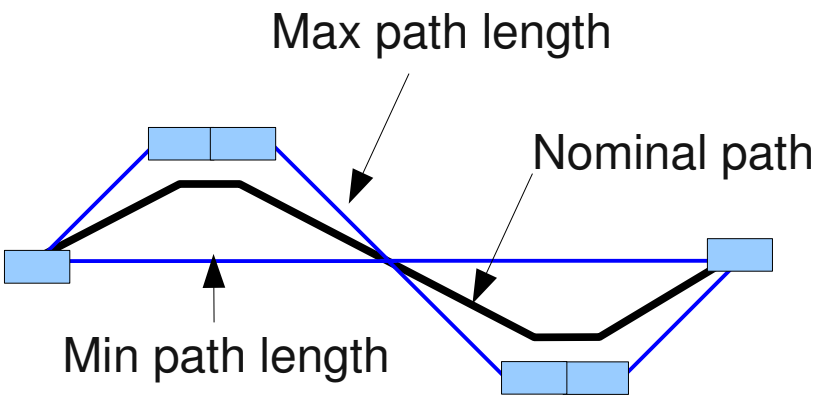
$$ds \approx \theta^2\left(L_C + \frac{2}{3}L_B\right)$$ for small bending angle



- Zigzag chicane

$$ds = 4L_C\left(\frac{1-\cos\theta}{\cos\theta}\right) + 6\rho(\theta - \sin\theta)$$

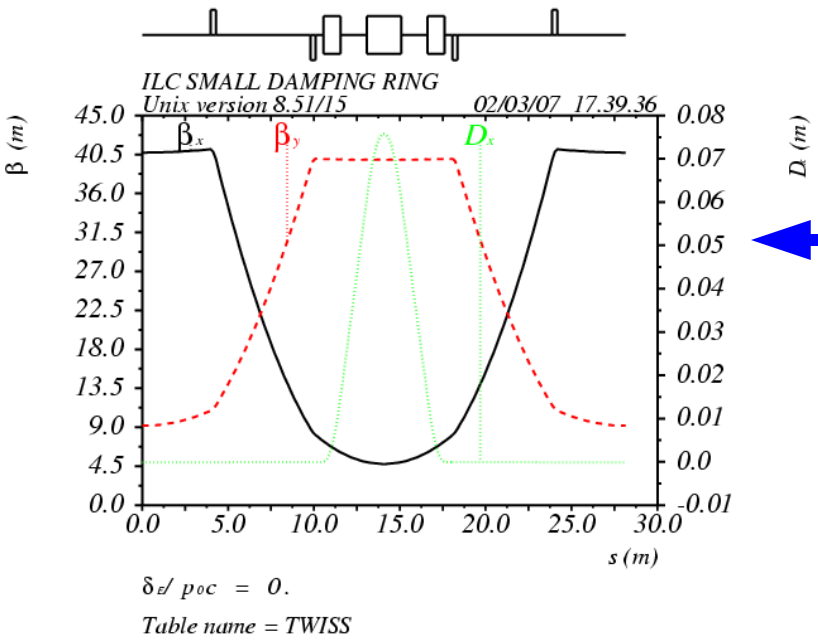
$$ds \approx 2\theta^2\left(L_C + \frac{1}{2}L_B\right)$$



Can put magnets and VC on movers to preserve aperture and impedance, e.g. APS bunch compressor

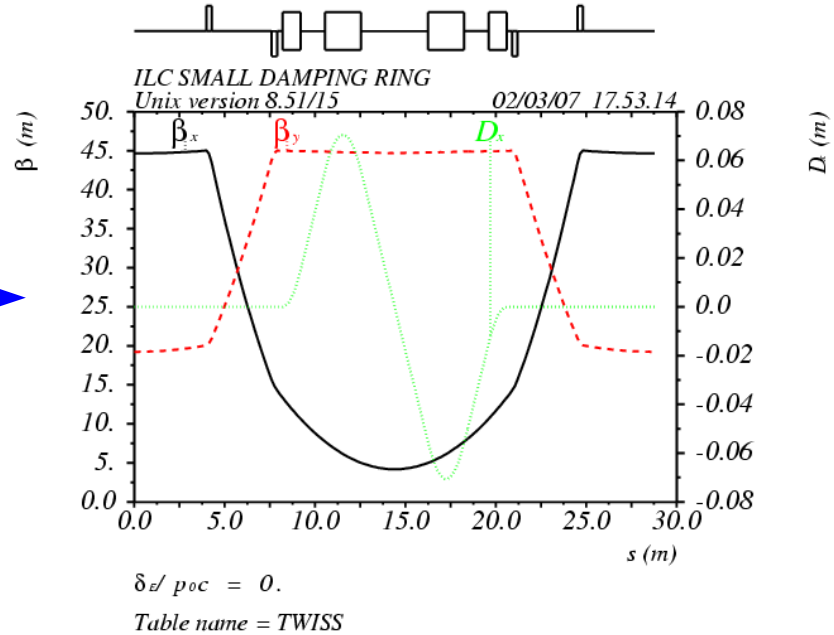
Ref.: Emma and Raubenheimer
www-project.slac.stanford.edu/lc/ilc/TechNotes/lccnotes/PDF/LCCNote_0008.pdf

Chicane



May have smaller emittance growth

More cells needed for getting the ds range we need



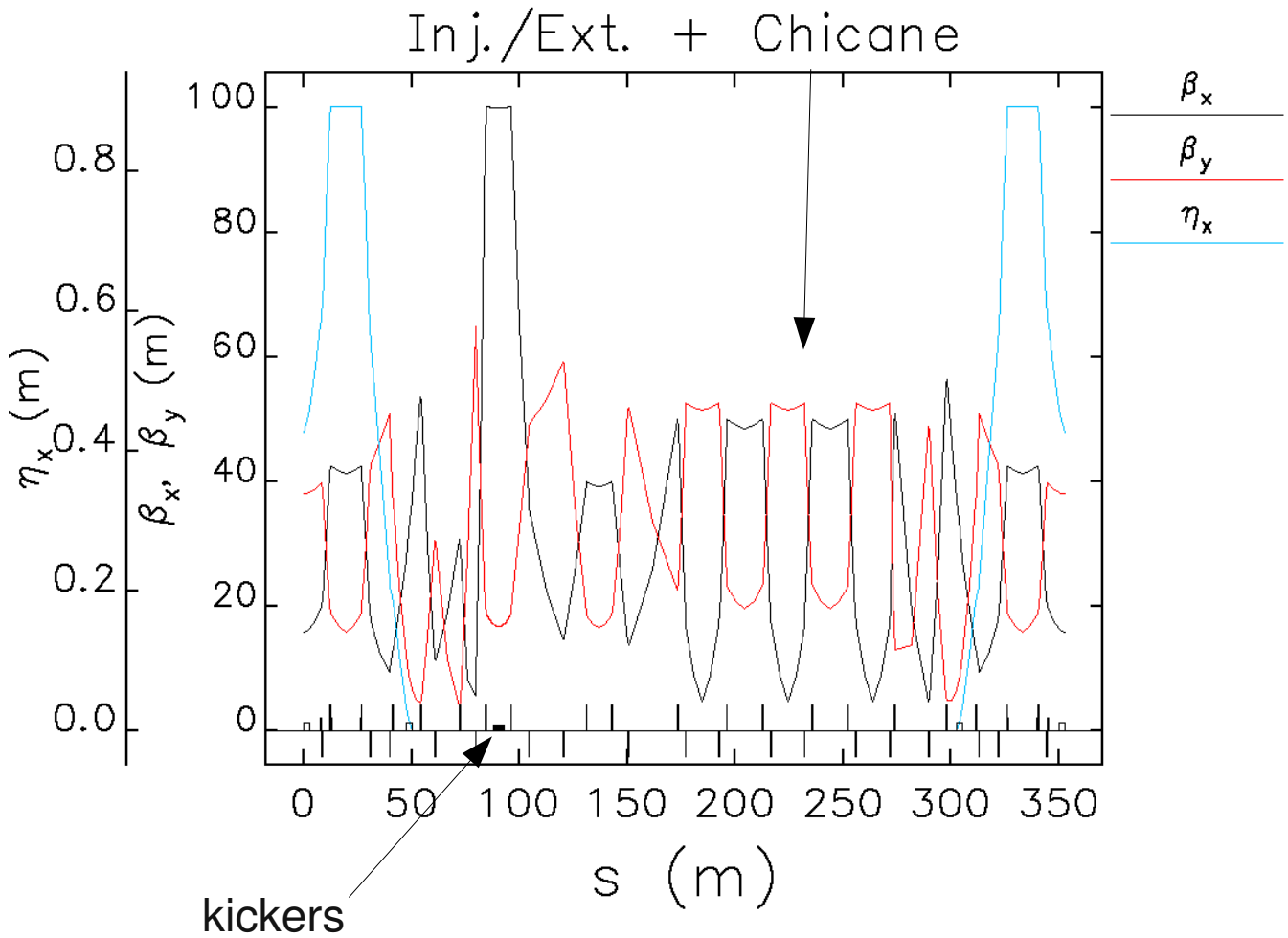
More compact than two of the type above

May have larger emittance growth

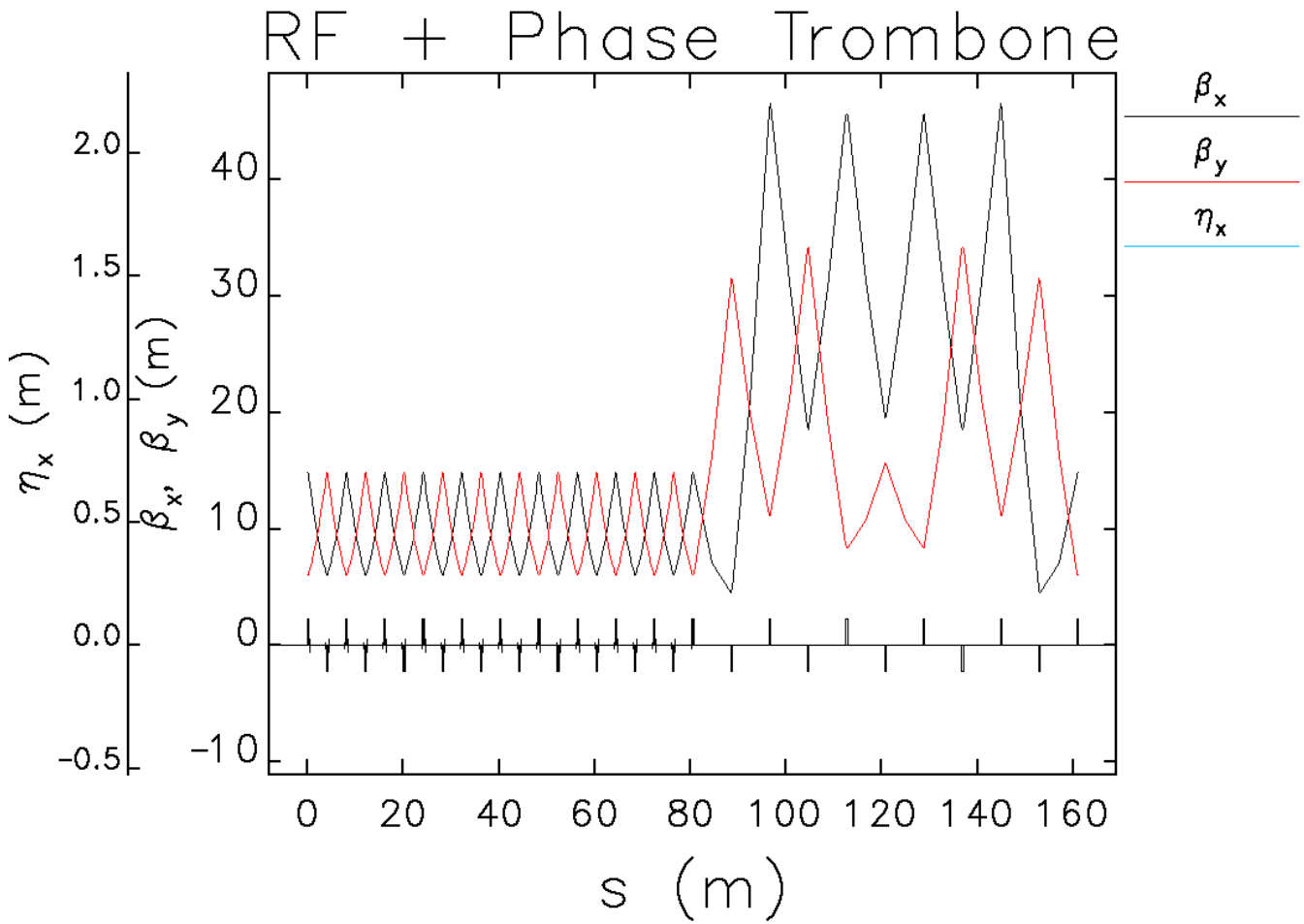
Chicane

- Assuming relative circumference error 10^{-6}
  - Required adjustment range ± 7mm
  - Using zigzag chicane, we need 4 units, emittance growth is about 16%
- Note: APS ring and booster had circumference error of 10^{-5}
- During DR commissioning, girders may be realigned uniformly radially to get within 2 mm of ideal (0.3 mm settability limit)
  - Need fewer chicane
  - Need input from alignment people on this.
- Because both rings are in the same tunnel, circumference will be within 2 mm, i.e. 0.3 mm relative misalignment.

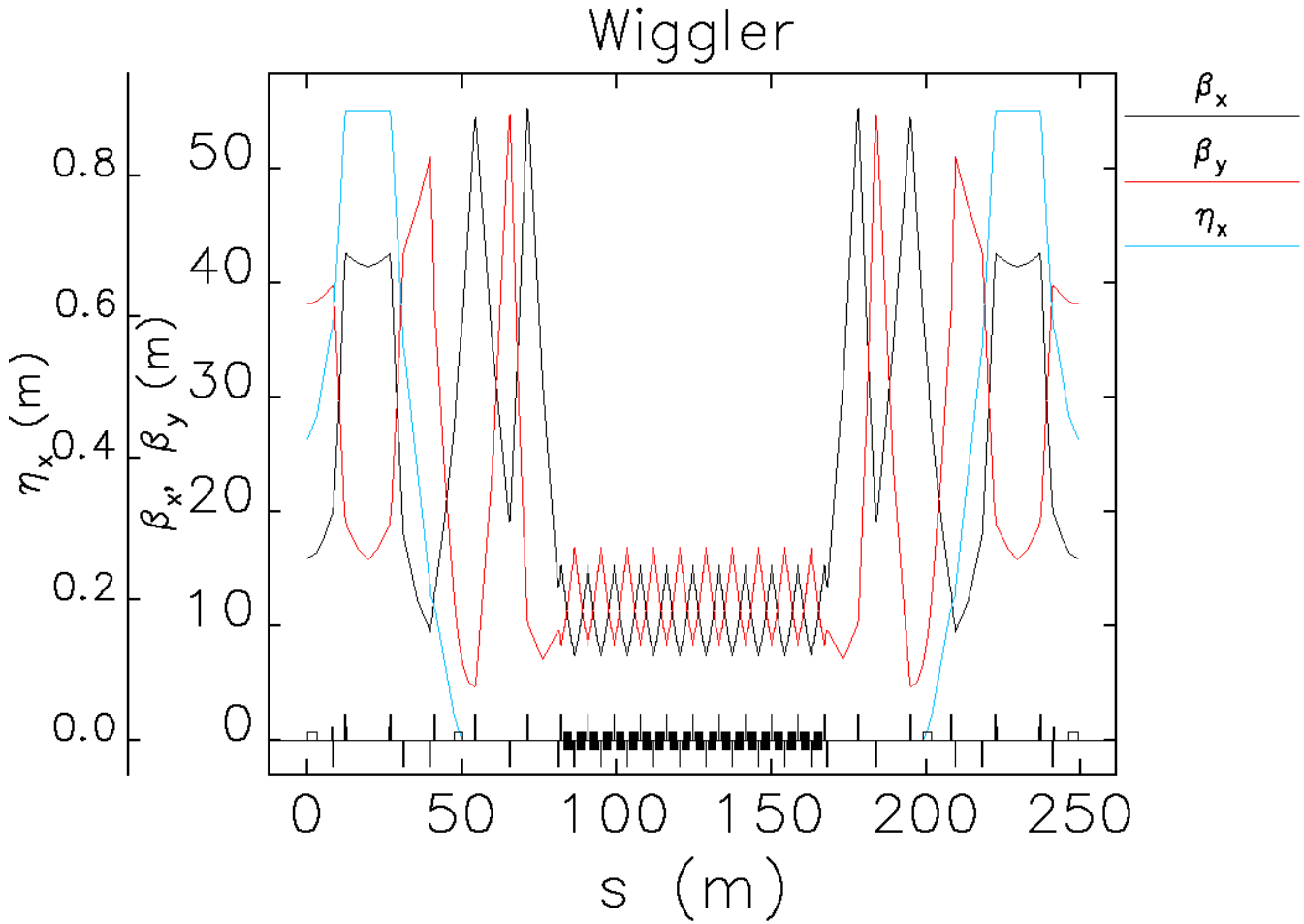
Injection or Extraction plus Chicane



RF and Phase Trombone



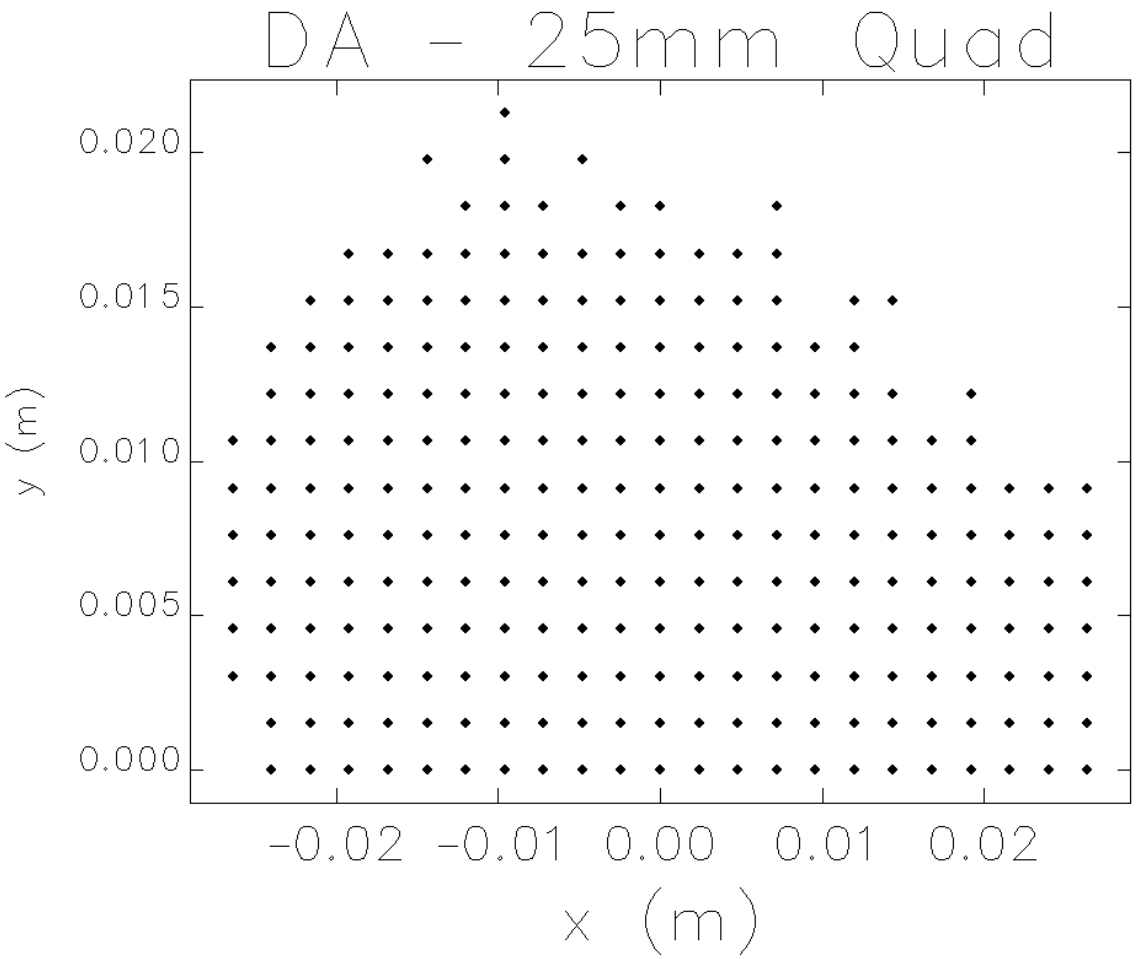
Wiggler Section



Dynamic Aperture with Multipole Errors

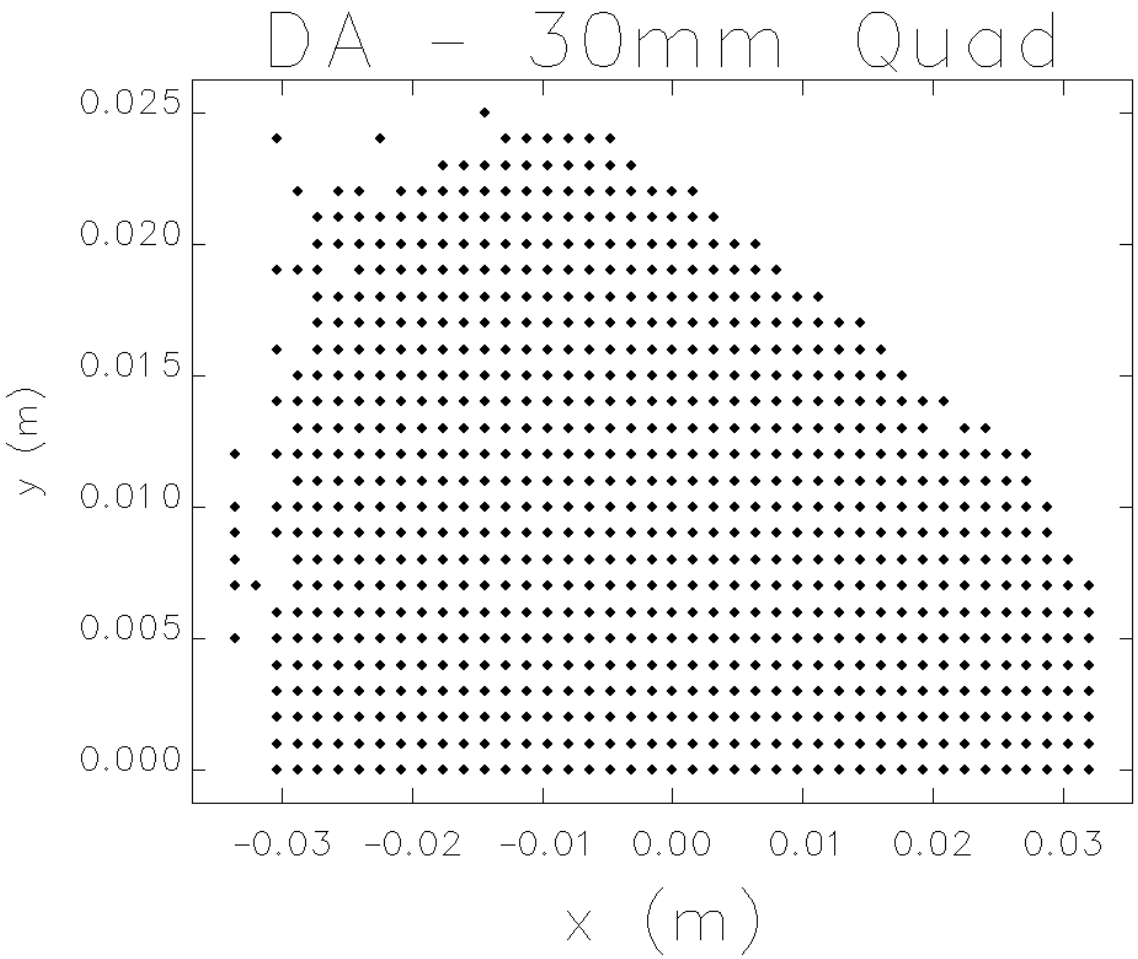
- After comparing dynamic aperture with multipole errors for several lattice variations we eventually realized that the assumed scale of multipole error must be consistent with the injection beam size
  - Actual multipole errors depends on quadrupole aperture
  - Quadrupole apertures are decided from phase space of injected beam, β functions, and space for collimation, orbit error and vacuum chamber wall
- Previously with fixed multipole errors, different lattices had the same shrunken DA, which wasn't a fair evaluation
  - For a 25 mm-aperture quadrupole, the DA was always about 25 mm

DA with 25 mm-Aperture Quadrupoles



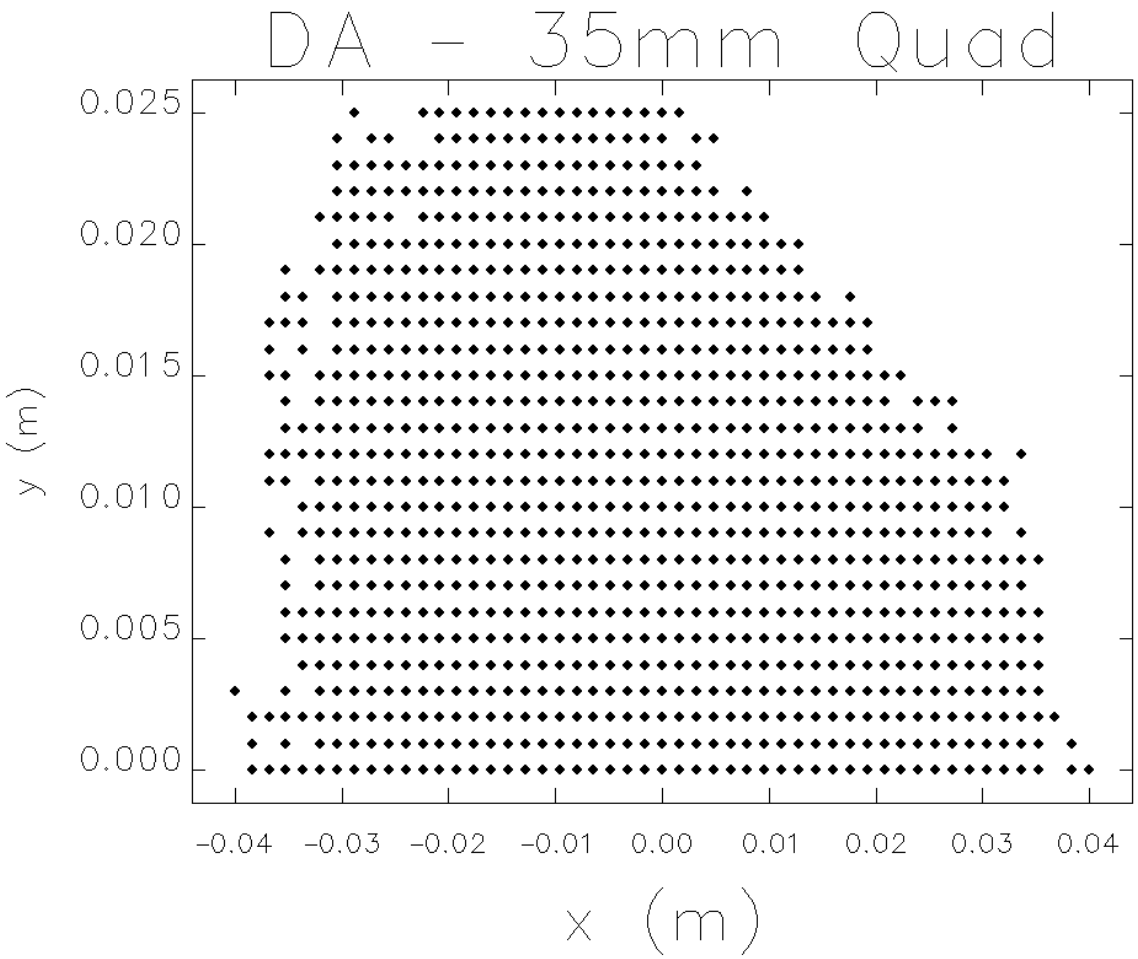
Ideal DA is about 35 mm in x

DA with 30 mm-Aperture Quadrupoles



Ideal DA is about 35 mm in x

DA with 35 mm-Aperture Quadrupoles



Ideal DA is about 35 mm in x