Argonne NATIONAL LABORATORY

… for a brighter future

U.S. Department of Energy

THE UNIVERSITY OF CHICAGO

Office of Science U.S. DEPARTMENT OF ENERGY

A U.S. Department of Energy laboratory managed by The University of Chicago

ILC Damping Ring Lattice Work

Louis Emery presenting Aimin Xiao's results

ILC 2007 WS, DESY, Germany,
May 31th 2007

Discussion of Lattice Issues

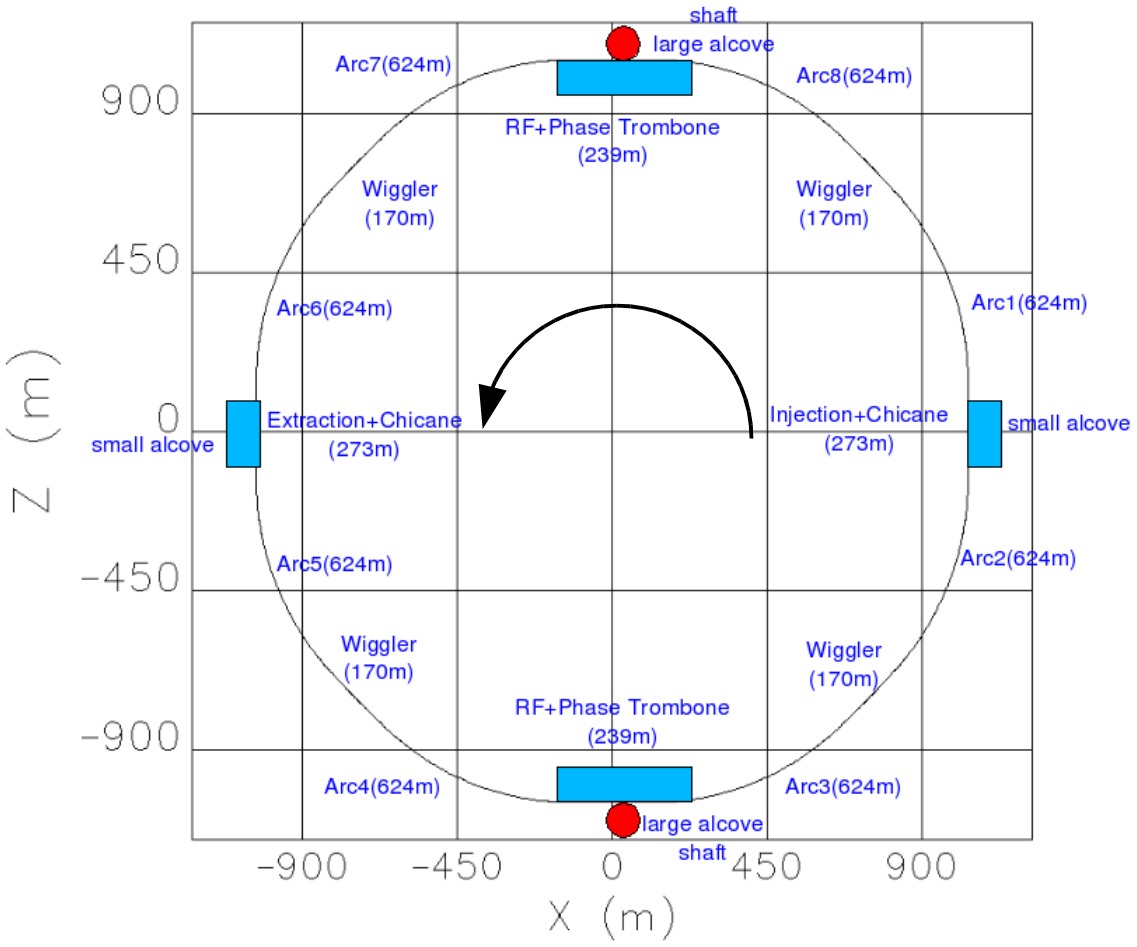
- Many items covered during Monday afternoon discussion
- Key action items (short term):
  - Additions to lattices (Aimin Xiao and Yi-Peng Sun)
    - Timescale: Implement as much as possible by LCWS07
    - List:
      - » Need to update RF configuration [done]
      - » Circumference Adjustability [done]
      - » Abort dump [not done, but no special optics needed we think]
      - » Phase Trombone [done]
      - » Lumped Injection/Extraction Kickers [done]
      - » Implement separated injection/extraction straights [done]
      - » Add correctors (dipole and skew quad) to lattice definition for LET studies [not done]
      - » Add BPM locations [not done]
      - » Nomenclature for naming elements around ring [not done]
      - » Specify apertures [not done]
      - » Return to greater symmetry in the ring [yes]

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 don't interfere with each other



Lattice Design Changes since March 2007

- Updated RF configuration
  - from 4 RF cavity per cell -> 2 RF cavity per cell
  - separated RF between e^- and e^+ rings
  - total length is 4x of original design
- Circumference Adjustment
  - Chicane series with ±7 mm (10^{-6}) adjustment
  - 16% increase in emittance (x and y planes)
- Abort dump
  - Kicker is allowed to be very strong (lots of space available)
  - No special abort section is needed
  - Arc has lots of free space for abort kicker and septum

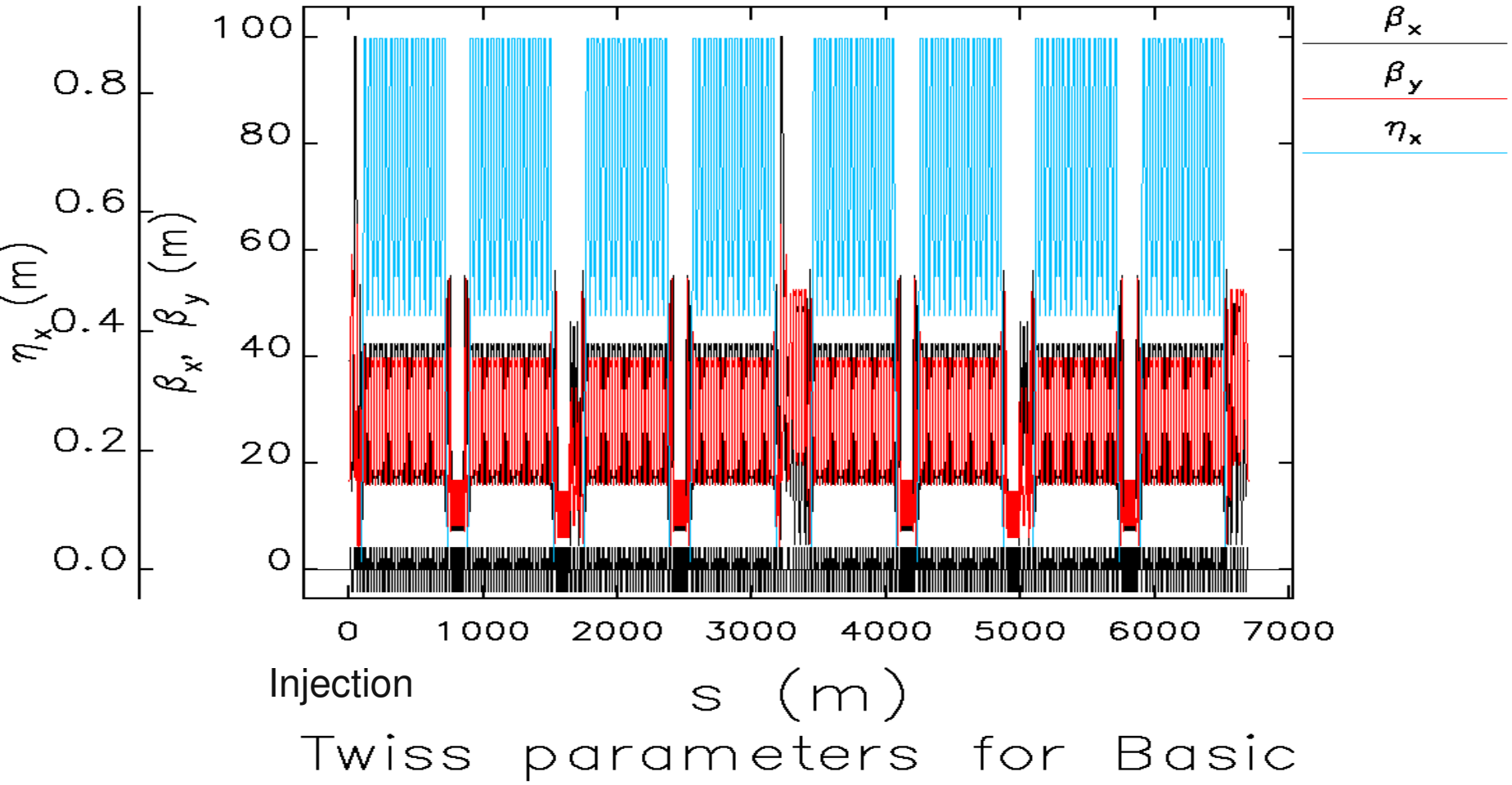
Lattice Design Changes since March 2007

- Phase trombone
  - In overlapping RF straight sections
  - Possibly not useful because of spoiling dynamic aperture that depends on straight section phase advances
  - Need range specification. Created sections with 0.5 total tune range
- Specify apertures
  - 25 mm internal aperture of vacuum chamber
- Not done yet:
  - Add correctors (dipole, skew quadrupoles)
  - BPMs
  - Nomenclature

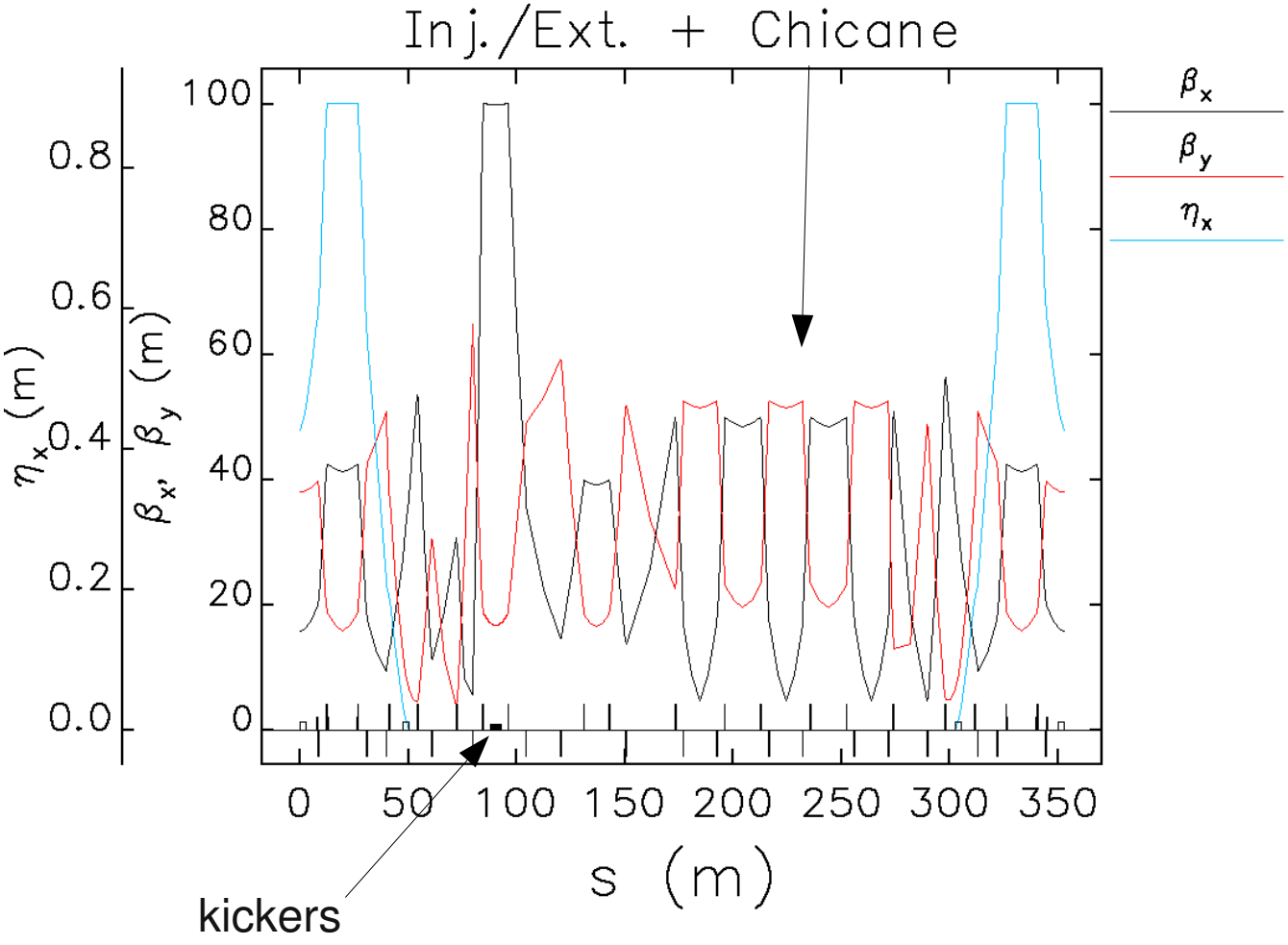
Lattice Assembly Summary

- Eight arcs
- RF and Phase trombone together
- Chicane and injection/extraction together
- Wiggler alone
- Need to optimize phase advance of straight sections for dynamic aperture

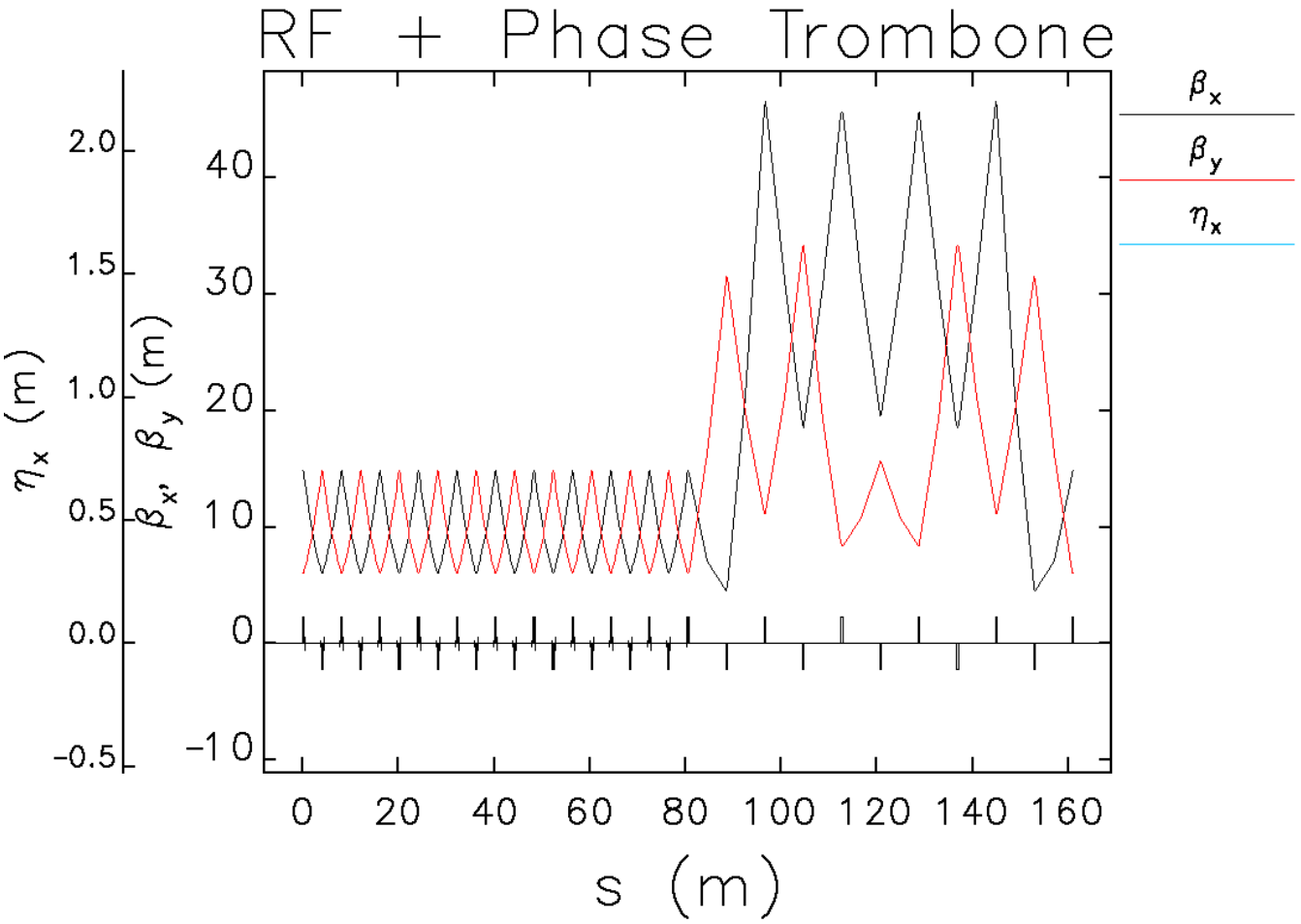
Present OCS8, Eight Arcs



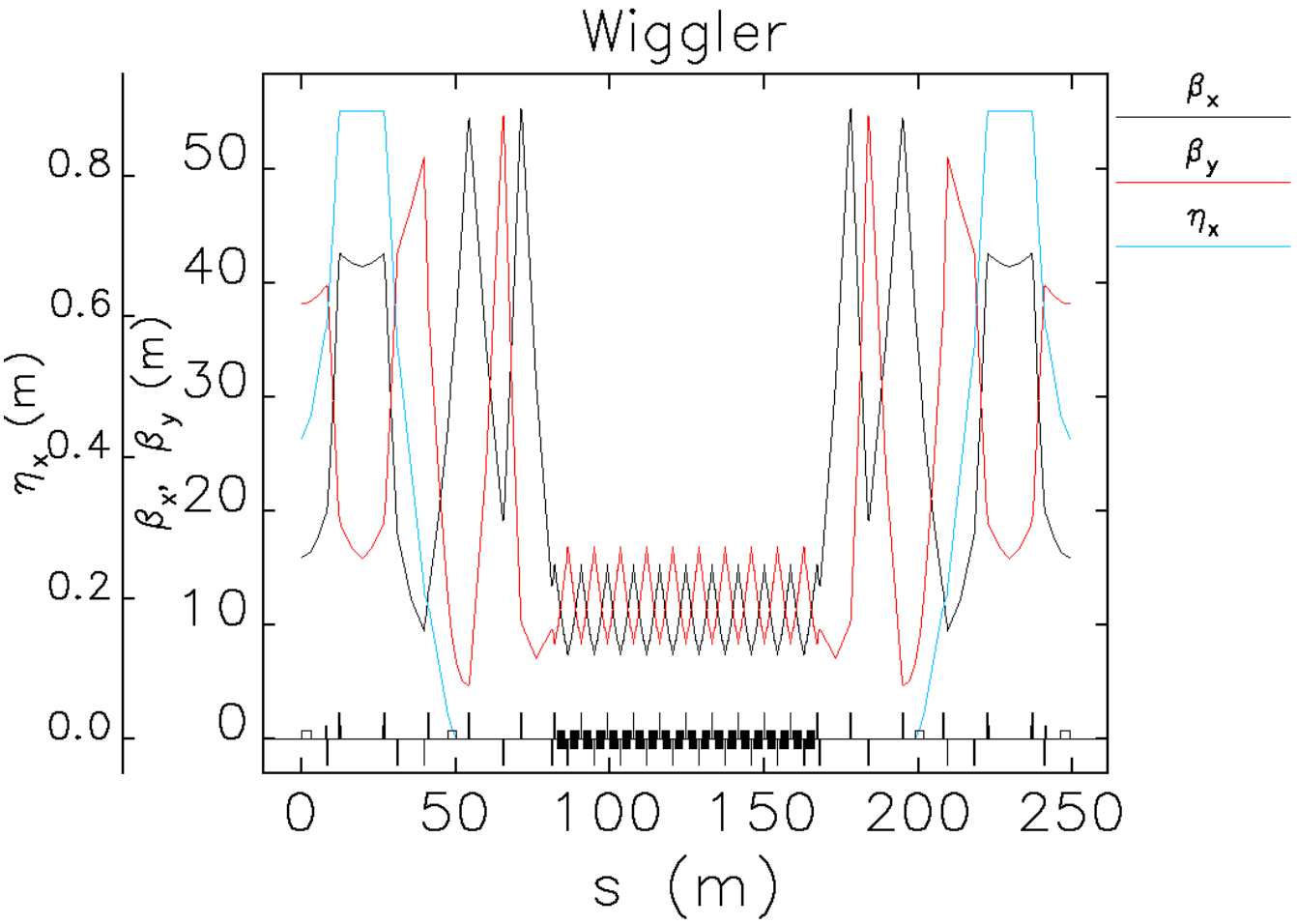
Injection or Extraction plus Chicane



RF and Phase Trombone



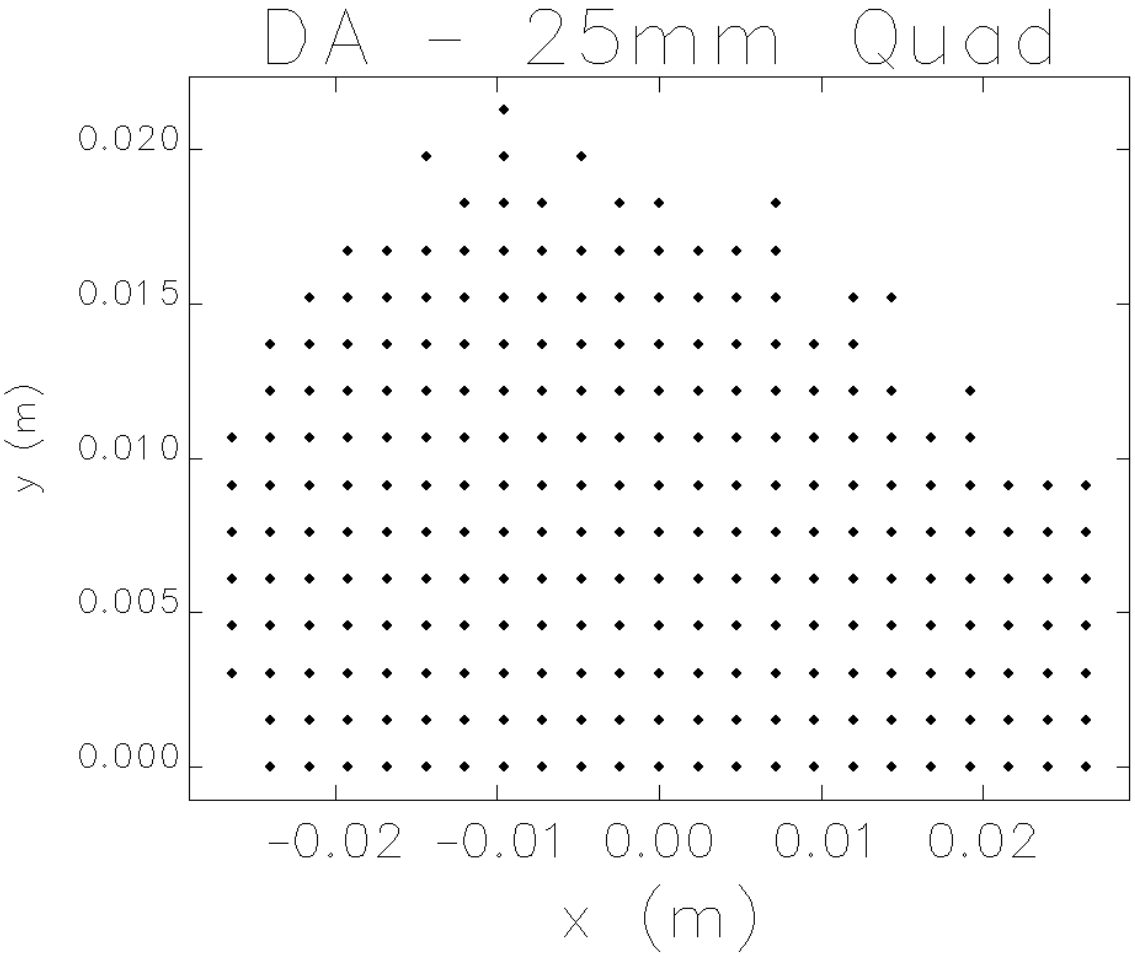
Wiggler Section



Dynamic Aperture with Multipole Errors

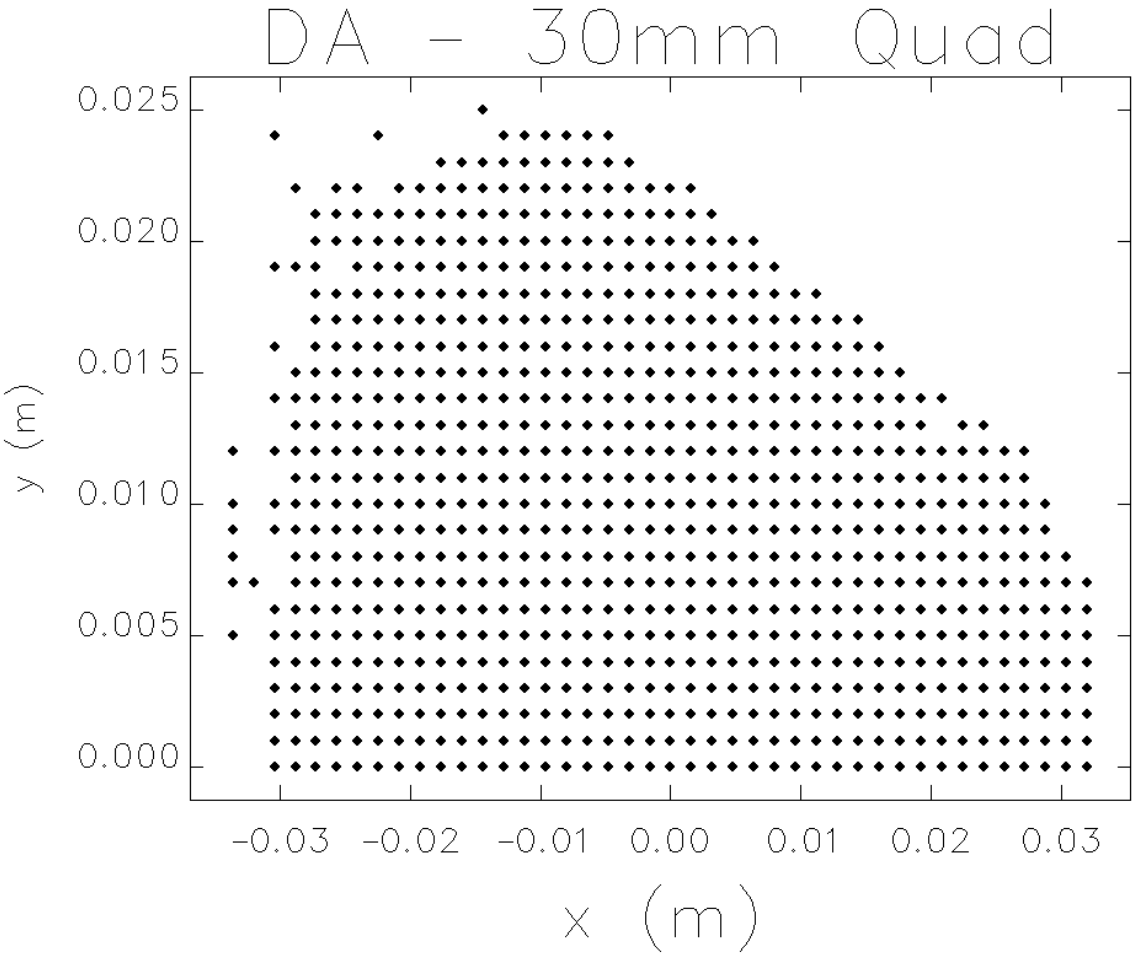
- After comparing dynamic aperture with multipole errors for several lattice variations we eventually realized that the assumed multipole error must be consistent with the injection beam size and optics
  - Actual multipole errors depends on quadrupole aperture (use PEP magnet data with aperture scaling)
  - Quadrupole apertures are decided from phase space of injected beam, β functions, and space for collimation, orbit error and vacuum chamber wall
- Previously multipole errors were fixed for testing different lattices. Lattices had the same shrunken DA, which wasn't a fair evaluation of lattice robustness
  - Multipole field increase rapidly past pole “radius”
  - e.g. For a 25 mm-aperture quadrupole, the DA was always about 25 mm

DA with Multipole Errors of 25 mm-Aperture Quadrupoles



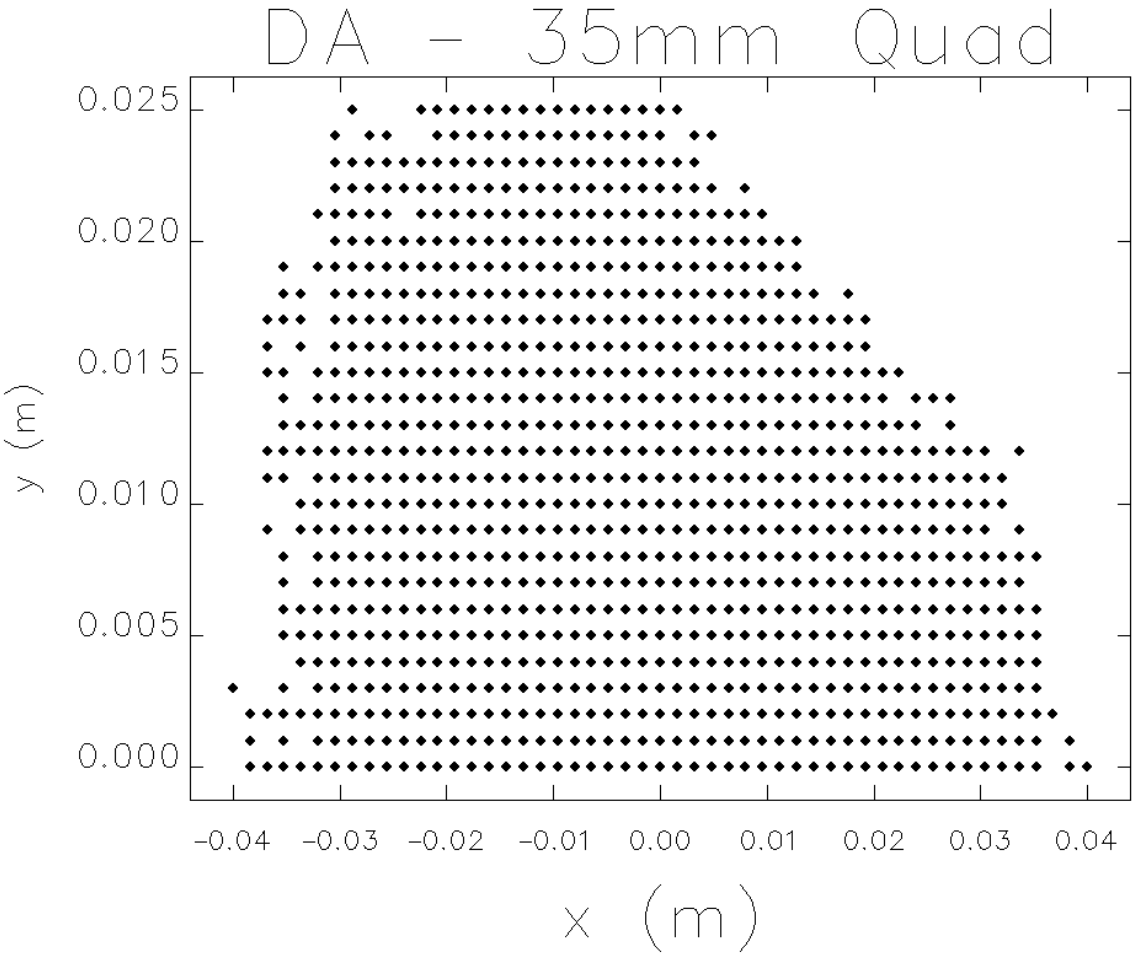
Ideal DA is about
35 mm in x

DA with Multipole Errors of 30 mm-Aperture Quadrupoles



Ideal DA is about 35 mm in x

DA with Multipole Errors of 35 mm-Aperture Quadrupoles



Ideal DA is about 35 mm in x

Availability of Lattice

- Dynamic aperture (straight section phase advance) still needs to be optimized
- Lattice will be available after July 1st
  - MAD-format and elegant-format inputs