Early Results from Tracking Studies

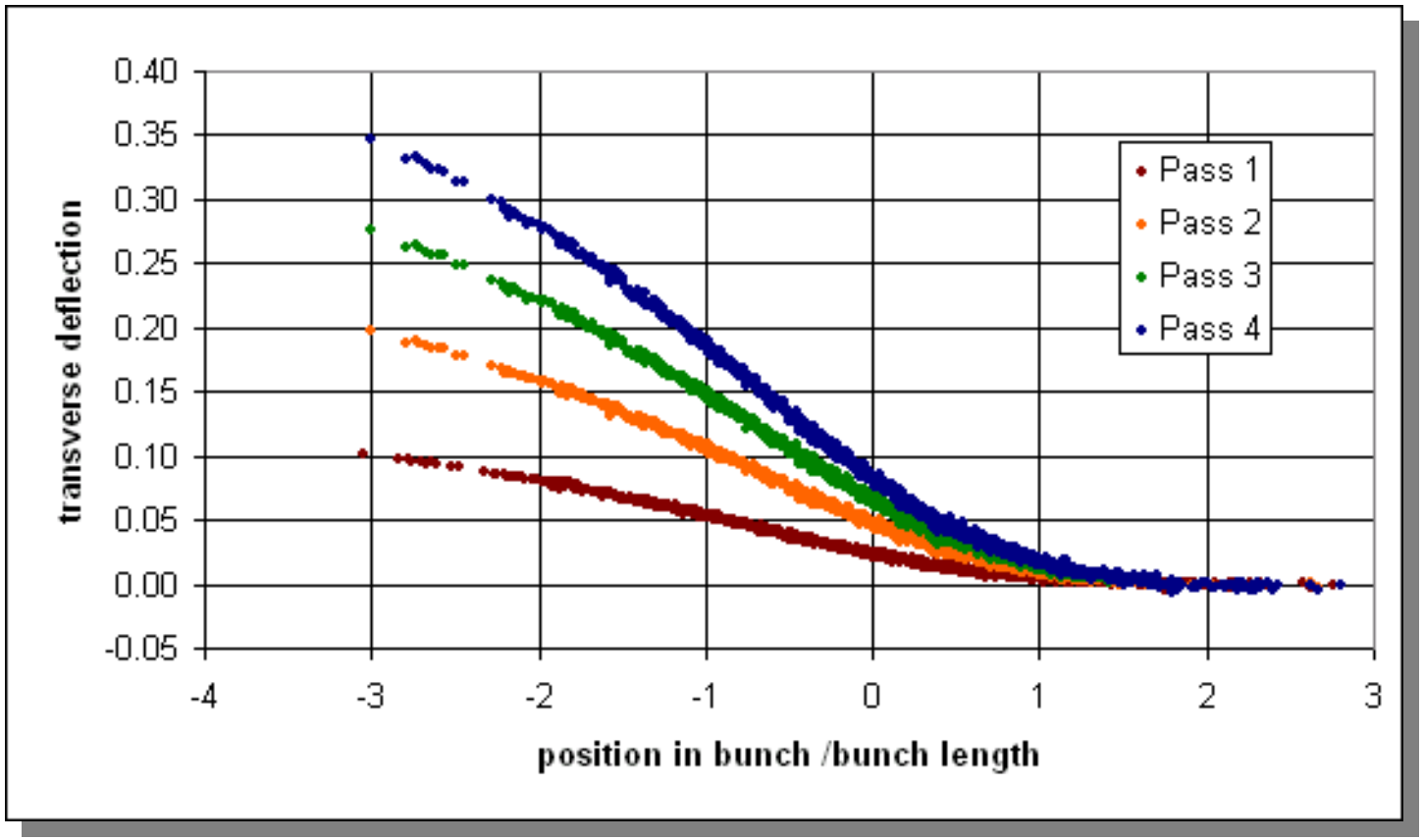
- Aim to simulate bunch passage through the whole machine
- Need to preserve small values for longitudinal and vertical emittance
- Consider the effects of wake fields in the linac
  - mainly transverse, but also longitudinal
- Consider the effects of machine imperfections
  - misalignments (static and dynamic) in linac, magnets
  - optics errors
  - injection errors
- Study correction and tuning strategies and scenarios

The Simulation Code

- MERLIN
  - C++ class library for accelerator beamline simulation
  - developed by Nick Walker (DESY) in the context of studies for the TESLA main linac and beam delivery system
  - rigorously benchmarked against other simulation codes (MAD, LIAR, ELEGANT) as part of TRC studies
- What can it do?
  - tracking (macroparticles) through standard (or user-defined) components
  - straightforward to add physical processes
    - wake fields, synchrotron radiation, (eventually IBS, spin tracking)
  - misalignments of individual components and/or girders
    - includes 2D ATL ground motion model
  - storage ring dynamics
- What can it not do?
  - more of a simulation than a design tool

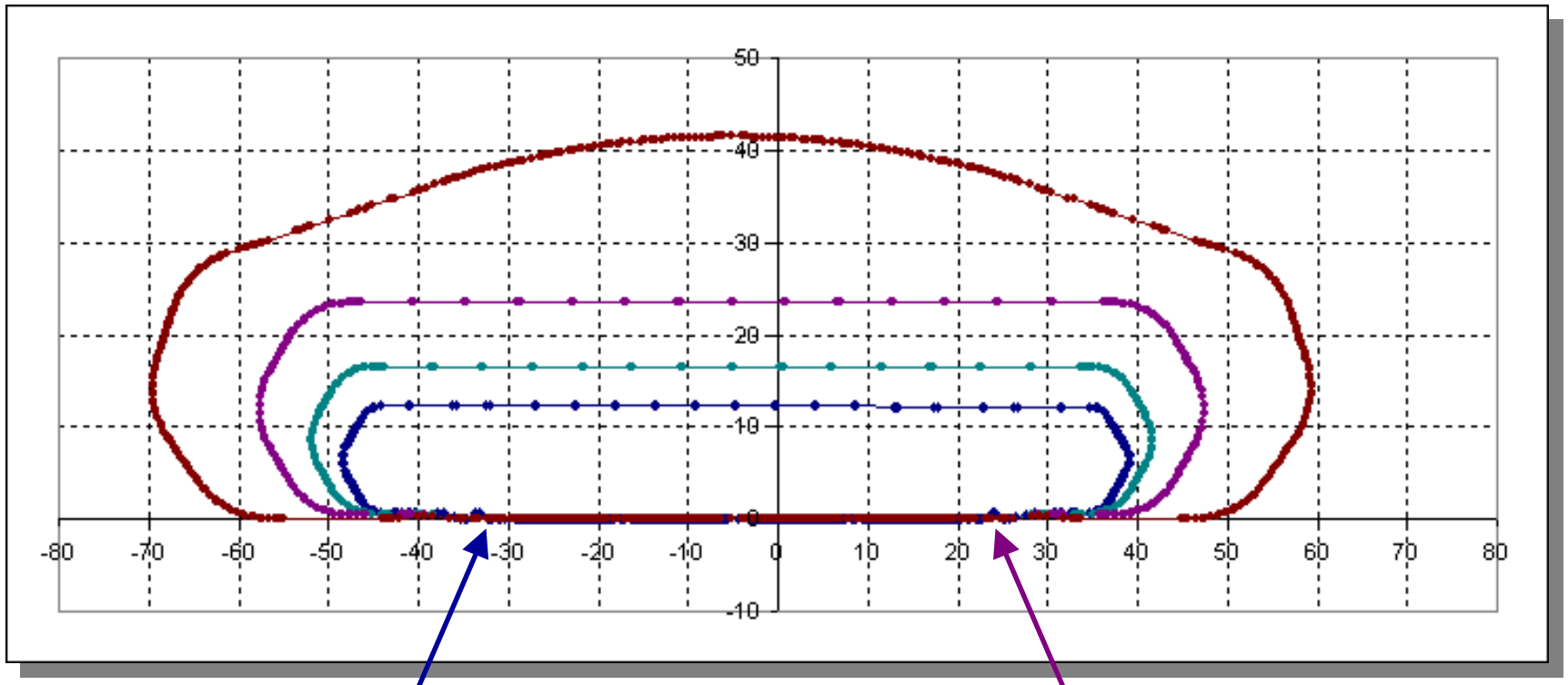
Wake Fields

- Benchmarked against analytical estimates by Stefano and Sasha
  - tracking bunch with small vertical emittance, and some vertical offset
  - bunch extracted from end of linac immediately re-injected



Tracking Full Beamline

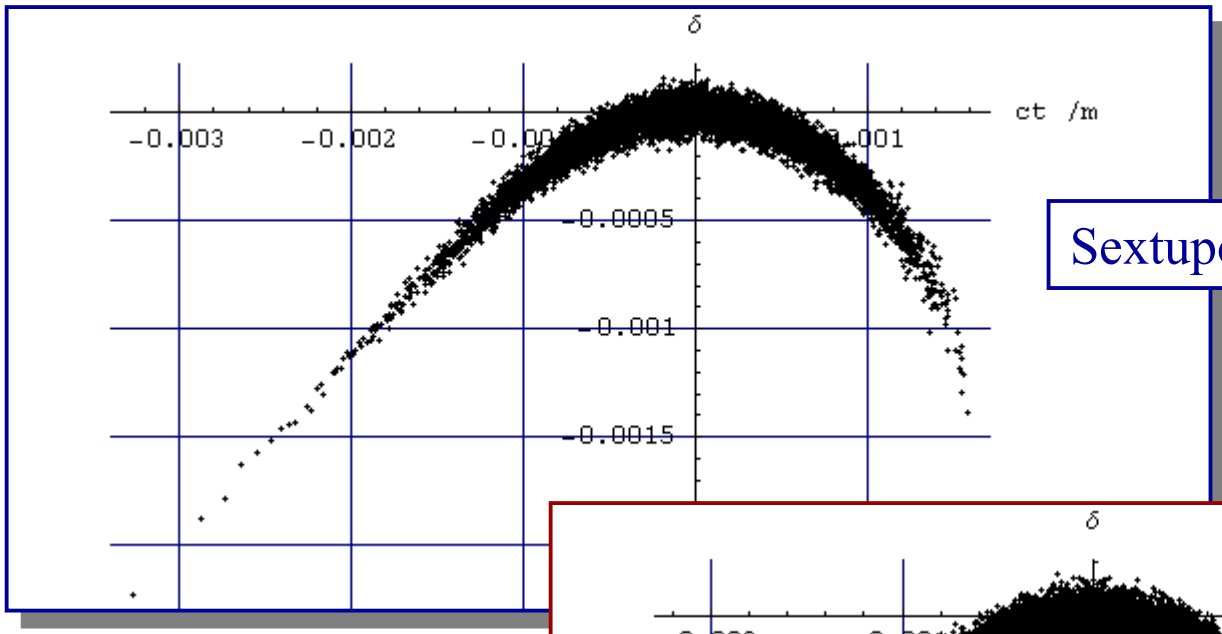
- Unique definition for linac
  - —same misalignments automatically apply on each pass



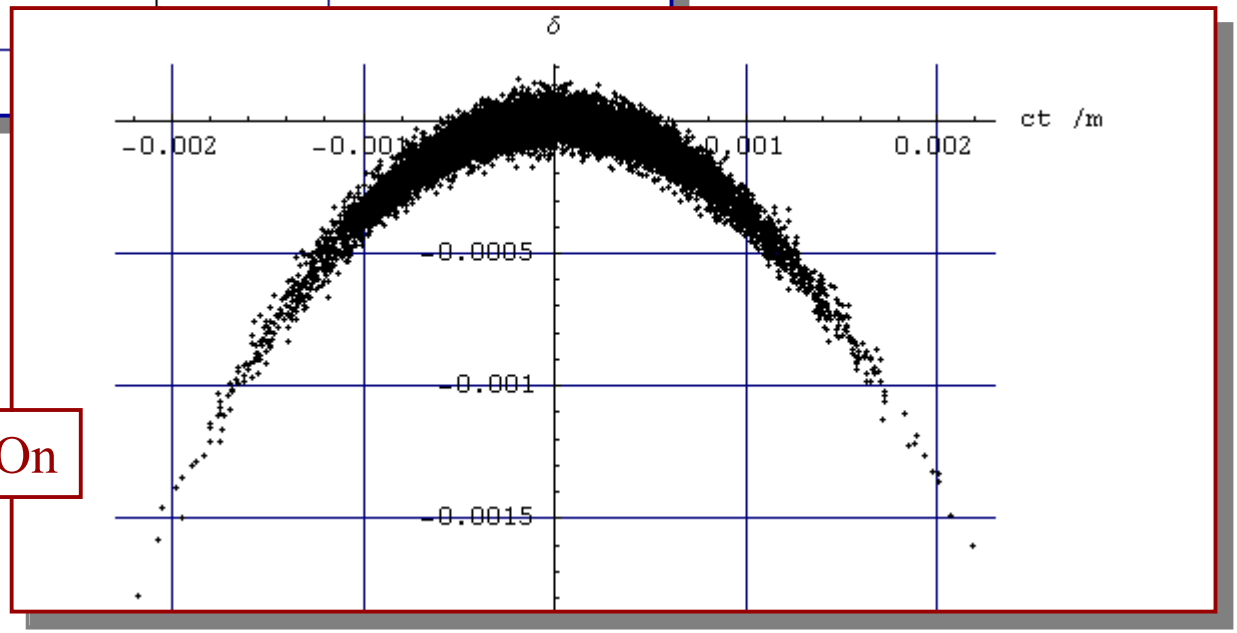
Start point 120 MeV

End point 2.52 GeV

Longitudinal Phase Space

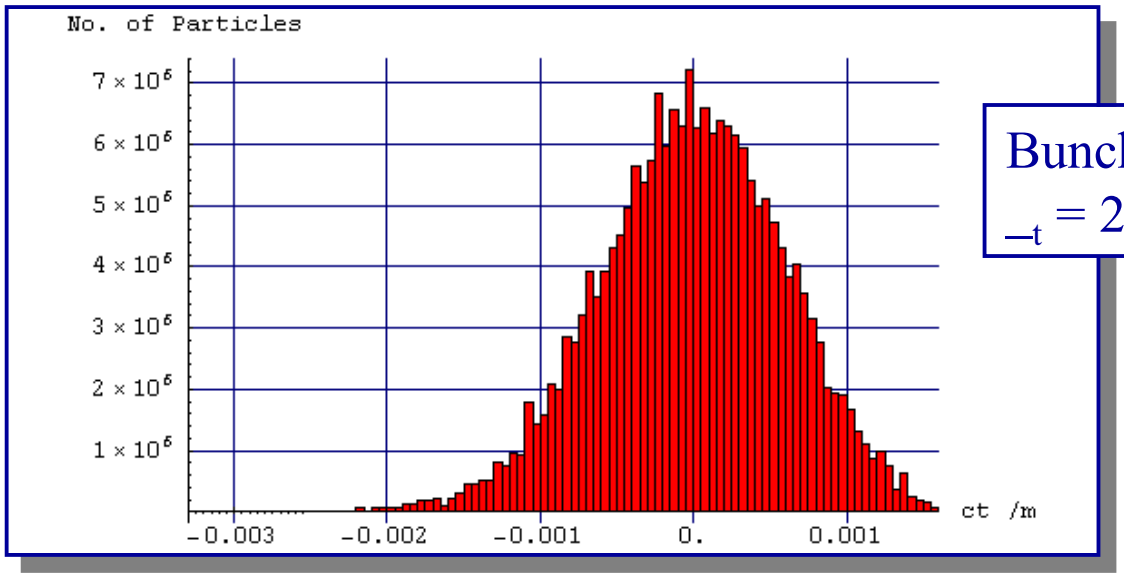


Sextupoles Off

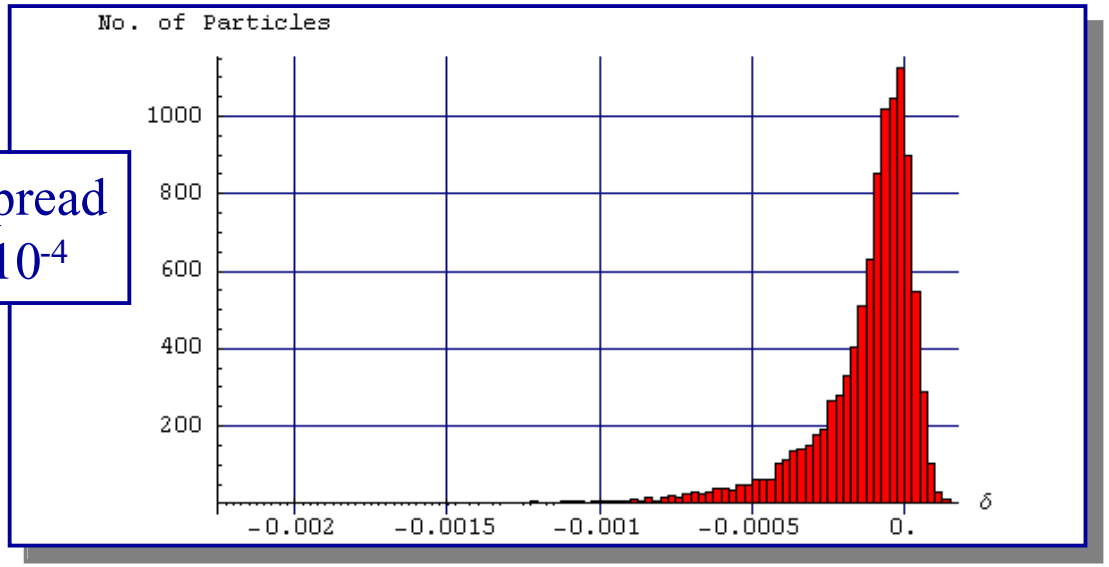


Sextupoles On

Bunch Length and Energy Spread

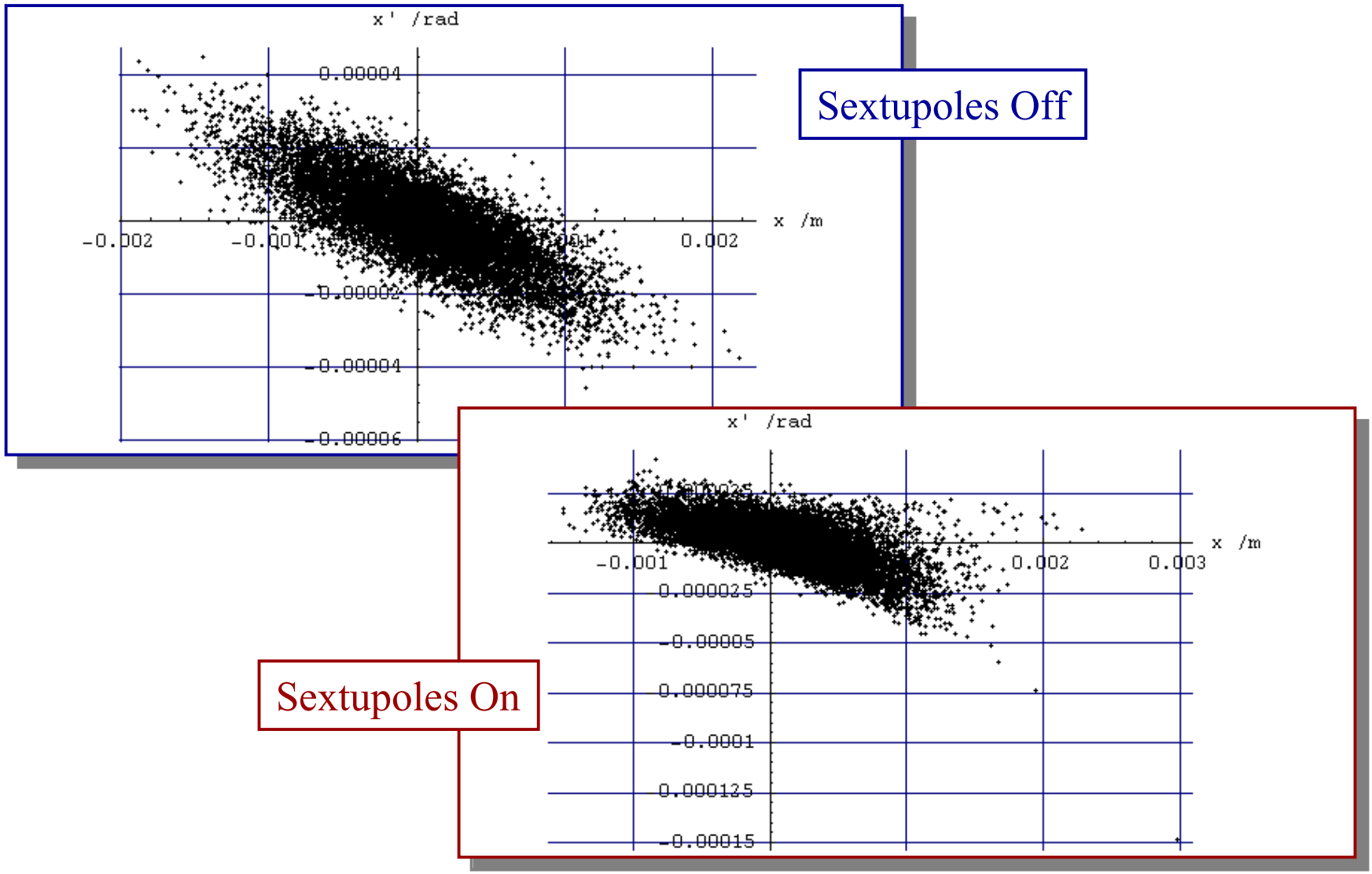


Bunch length
σ_t = 2 ps



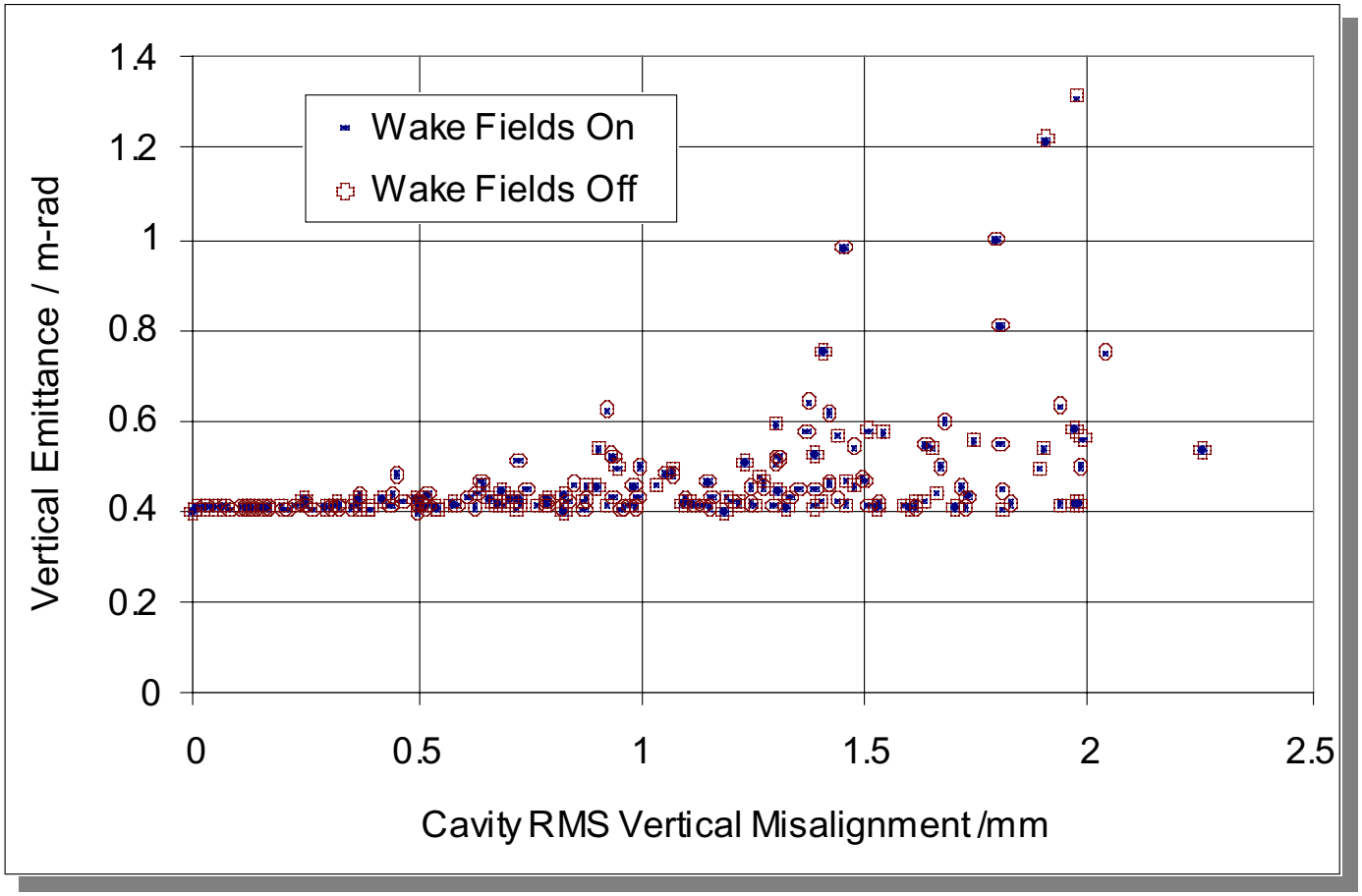
Energy Spread
$\sigma_\delta = 1.8 \times 10^{-4}$

Horizontal Phase Space



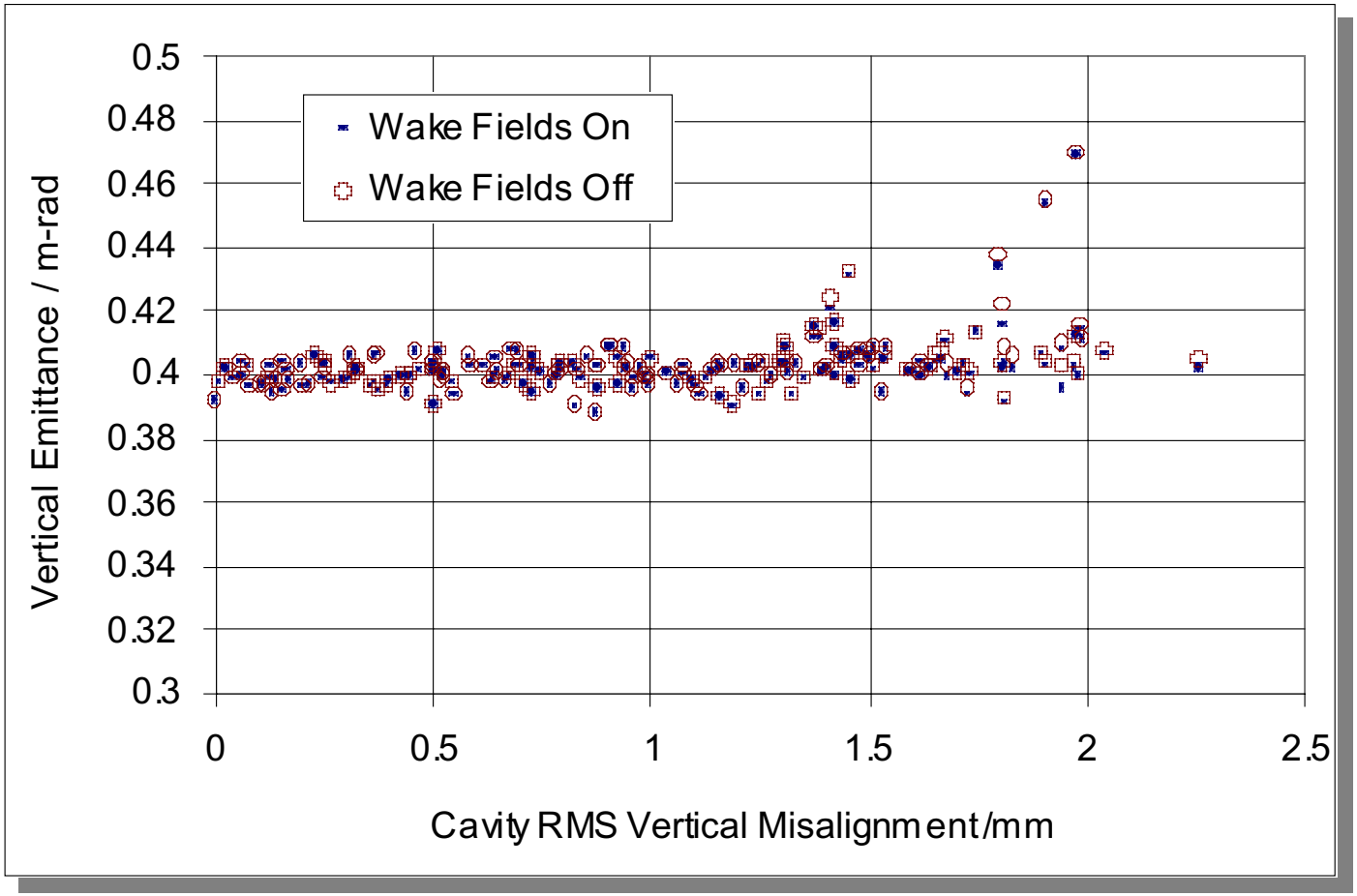
Vertical Emittance Preservation

- Cavity misalignment distorts the orbit
- Sextupoles couple horizontal emittance into the vertical plane



Vertical Emittance Preservation

- Sextupoles turned OFF
- Second-order terms from dipoles included



What s Next?

- Longitudinal wake fields
  - beam loading
- Further studies of misaligned cavities
- Effects of misaligned magnets
  - diagnostic and correction system
- Other effects
  - dynamic misalignments (ground motion)
  - long-range wake fields
  - synchrotron radiation from the undulators