IDS-NF: FFAG Status

J. Scott Berg
Brookhaven National Laboratory
IDS-NF Accelerator WG Status Update
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Outline

- Injection and extraction
- Base lattice update
- Orbit distortion from special magnets
- Chromaticity correction

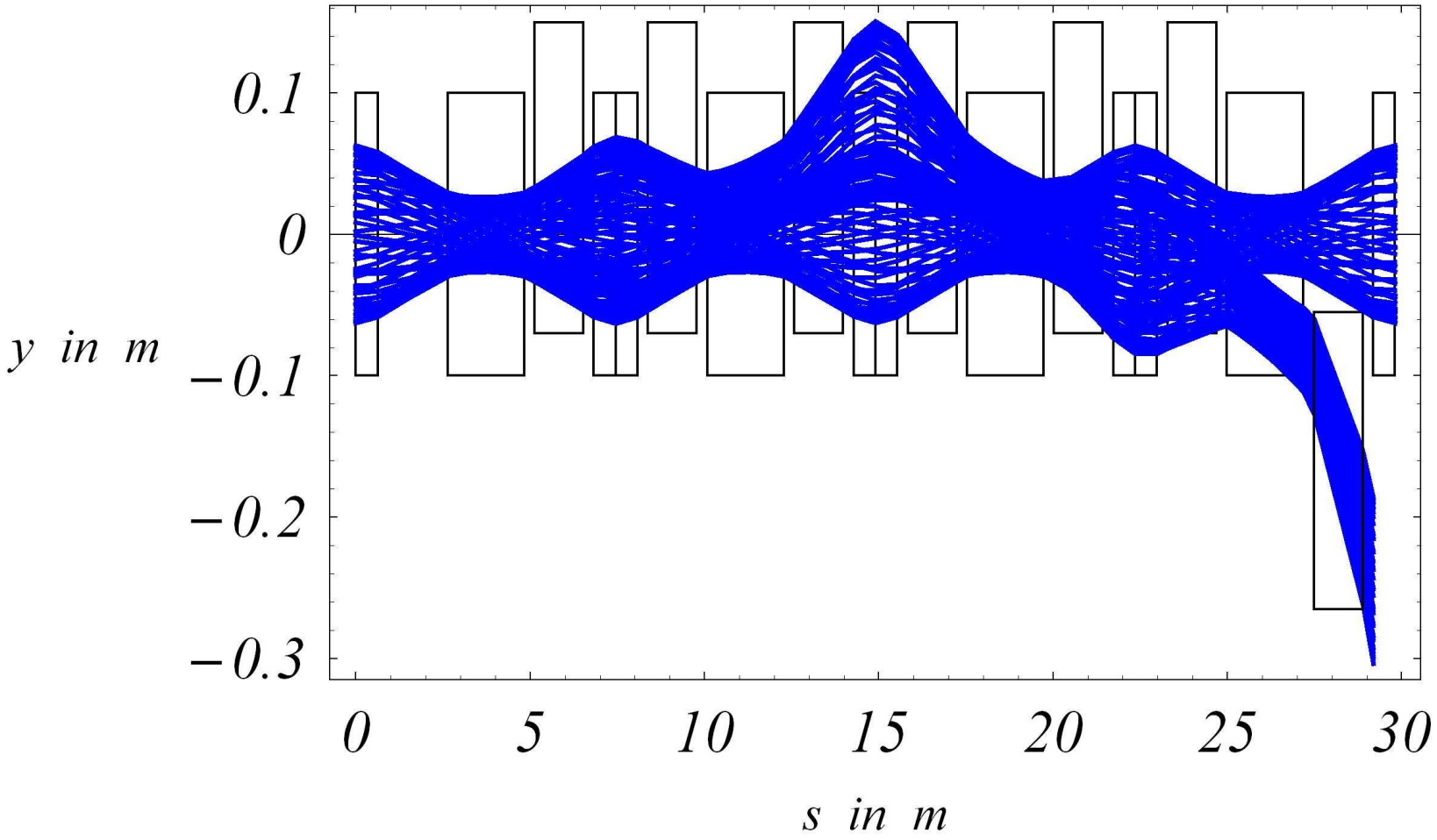
Injection and Extraction (Pasternak, Kelliher, Aslaninejad)

- Injection and extraction done for FODO
- Vertical chosen for all
  - Low beta functions horizontally: by design!
- At least 6 kickers needed
- 1.4 m kicker length
- Desire kicker field $<$ 0.1 T
- Share kickers for two signs
- Trajectories require larger aperture magnets

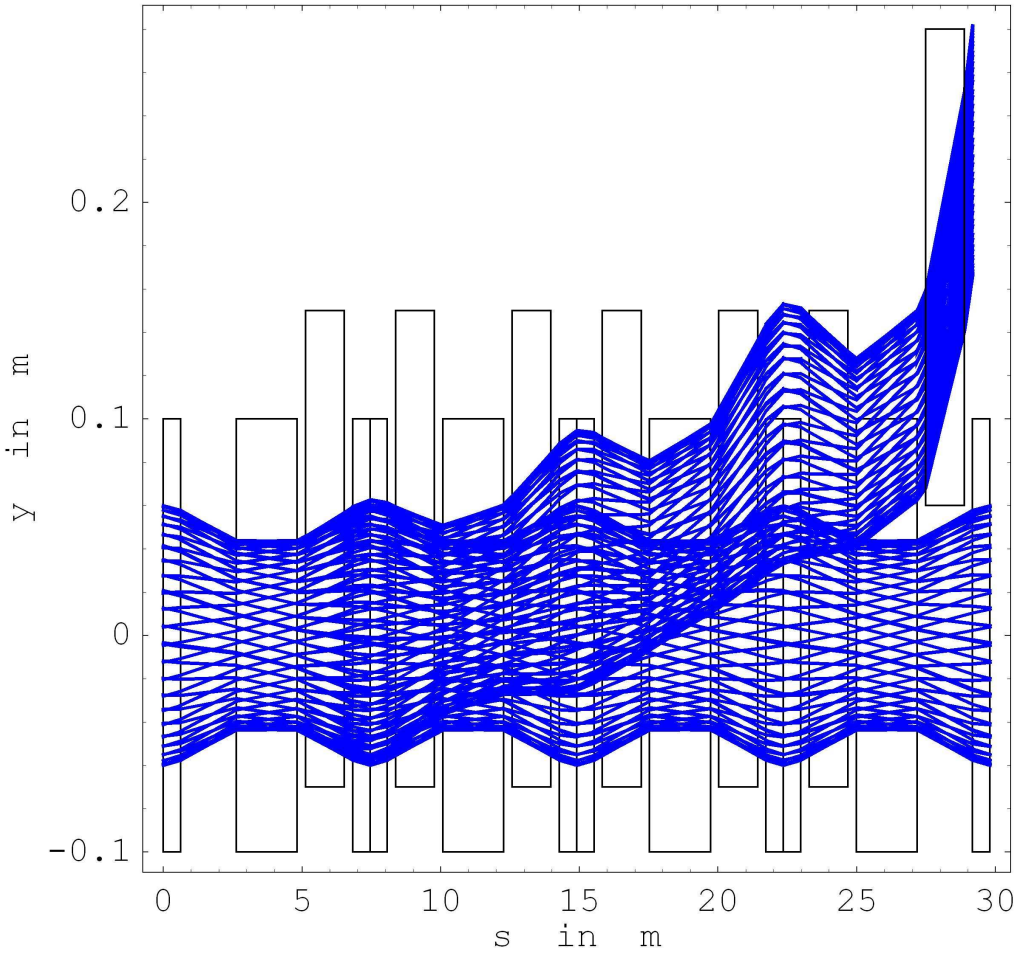
Injection and Extraction Parameters

	Inject 6	Inject 10	Extract
Kickers	6	10	6
Kicker field (T)	0.12	0.08	0.10
Septum field (T)	2.5	2.5	4.0

Injection Trajectories



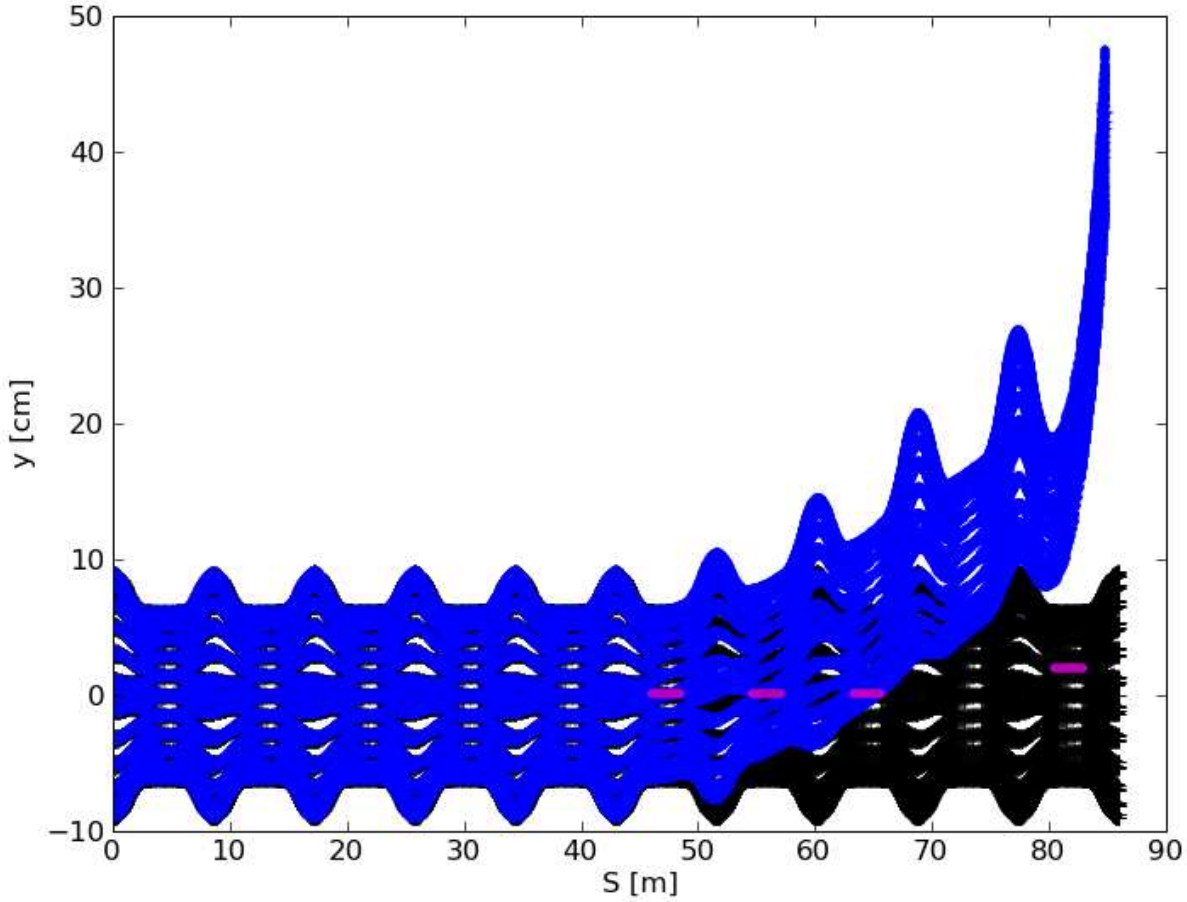
Extraction Trajectories



Triplet Extraction (Kelliher)

- Extraction for triplet case
  - Two cavity per cell, long drift
  - 2.4 m kickers
- 3 kickers, fields under 0.1 T
- 2 T septum, 2 cm clearance

Triplet Extraction



Injection and Extraction
Future Work

- Finish triplet configuration
- Vary kicker strengths, keeping symmetry

Base Lattice Update (Berg)

- More free drifts for kickers/septa $[(6+2)\times 2]$
  - Kickers shared between signs, not septa
- 4 free drifts for random hardware
- Multiple of 4 cells (symmetry)
- Total 20 free drifts
- Don’t add unnecessary drifts
  - Large transverse amplitude: average gradient important

Base Lattice
New Parameters

	FCDC	FCDC	FDFCC	FDFCC
Cells	62	68	55	60
D radius (mm)	95	94	125	102
D field (T)	7.6	6.4	7.3	7.9
F radius (mm)	207	200	167	144
F field (T)	3.4	3.1	3.9	4.0
Avg. Grad (MV/m)	3.3	2.8	2.8	2.6
turns	8.7	9.0	10.6	13.0
Length (m)	462	521	445	393
Cost (A.U.)	176	170	181	155

Base Lattice
New Parameters

	FDFC	FDFC
Cells	70	80
D radius (mm)	92	87
D field (T)	7.7	7.0
F radius (mm)	122	115
F field (T)	4.2	4.0
Avg. Grad (MV/m)	1.9	1.6
turns	16.2	17.3
Length (m)	422	479
Cost (A.U.)	144	142

Base Lattice Analysis

- Triplet and FODO only
  - Symmetry for injection/extraction
- New lattices have modestly lower cost
  - More turns
  - Large effect in two-cavity triplet
- Penalty is lower average gradient
  - Increases problems from transverse amplitude

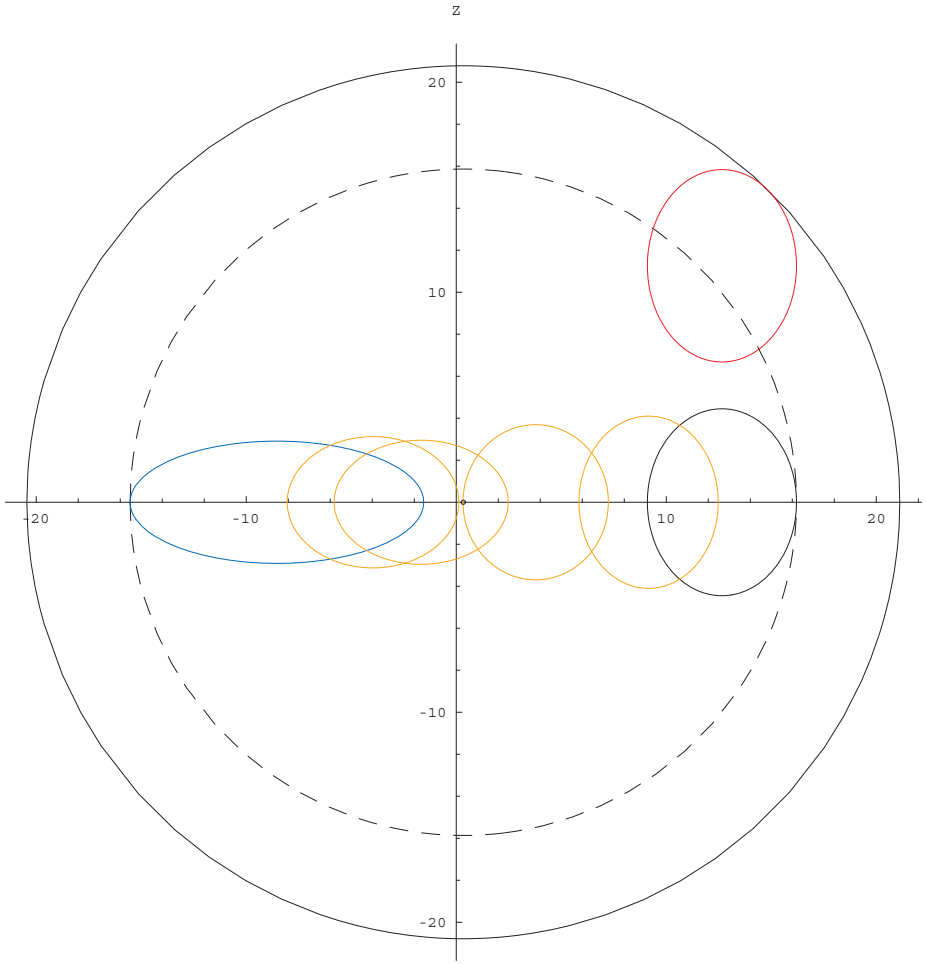
Base Lattice
Small Corrections to Make

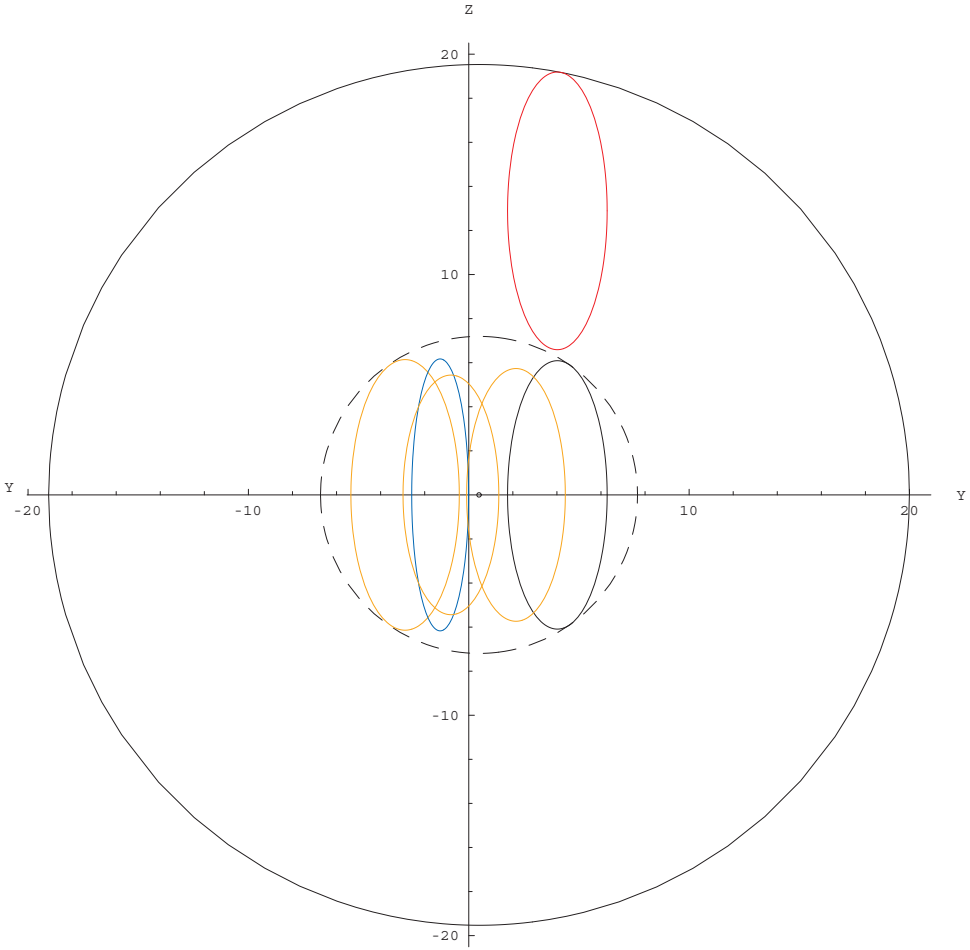
- Correct for asymmetric time of flight
  - Average over transverse amplitudes
- Integer harmonic of RF frequency
- Integer plus half turns
- Maybe fewer drifts for triplet?
- Expect very small changes

Orbit Distortion from Special Magnets (Kelliher)

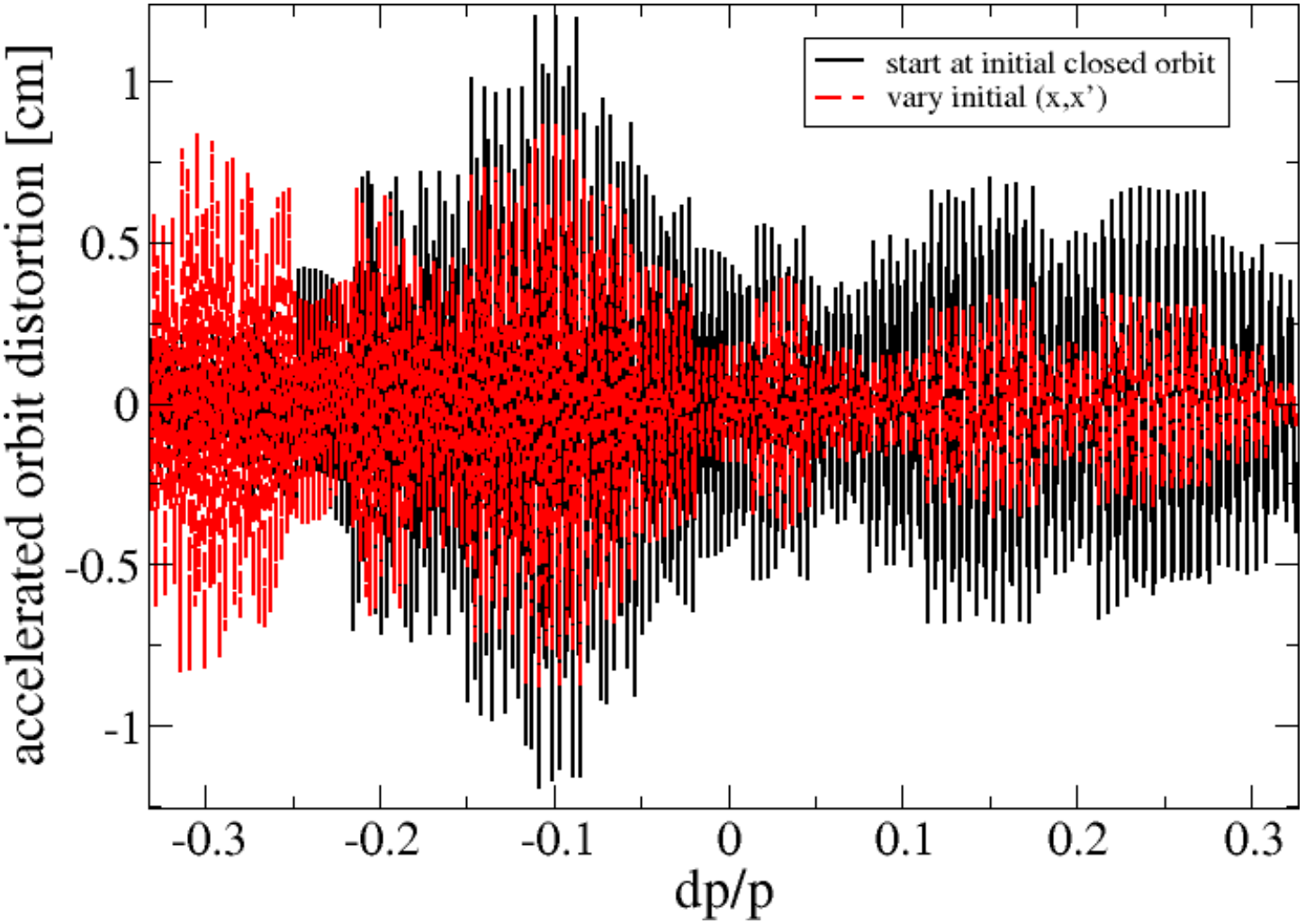
- Beam goes outside magnet aperture in injection/extraction region
- Need special magnets
- Different field profile
- Change fringe field extent (Zgoubi)
- Accelerated orbit distortion: 1 cm

Beam in Special Magnets





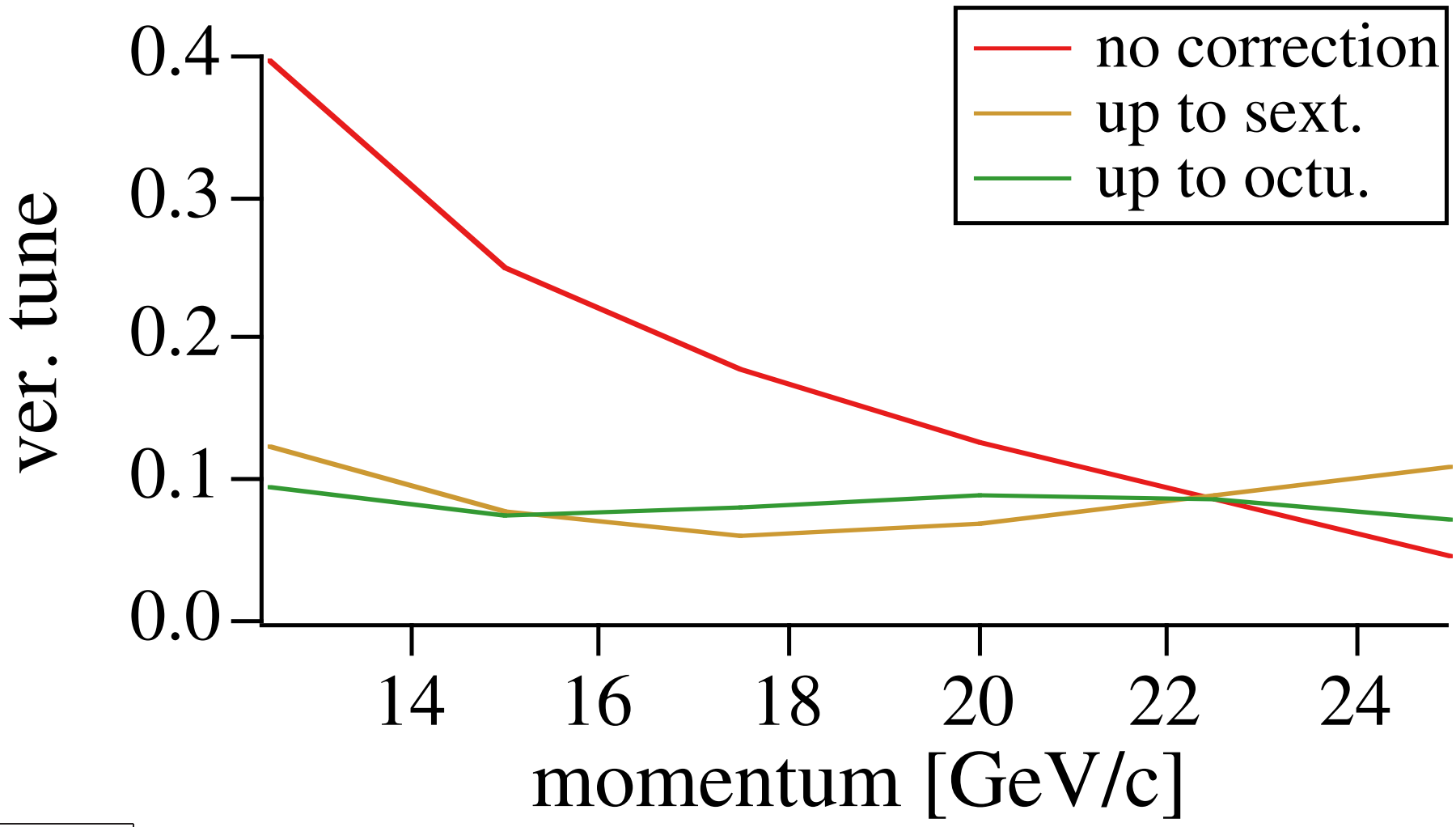
Accelerated Orbit Distortion



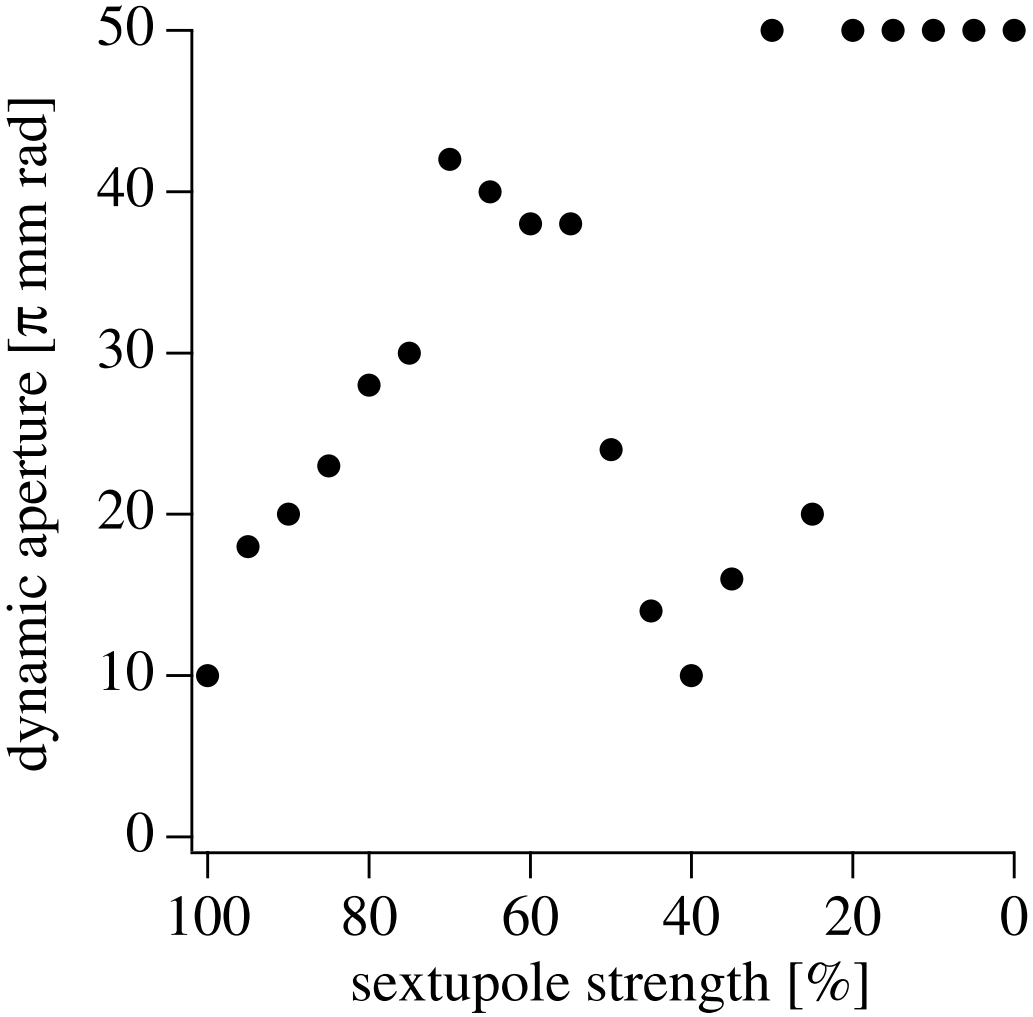
Chromaticity Correction (Machida)

- Sextupole components: correct chromaticity
  - Fix time of flight dependence on transverse amplitude
- Dynamic aperture reduced significantly
- Partially correct: improve dynamic aperture
  - Drop in dynamic aperture: 1/3 resonance
- Dynamic aperture further reduced with errors
- Increased aperture: compute cost

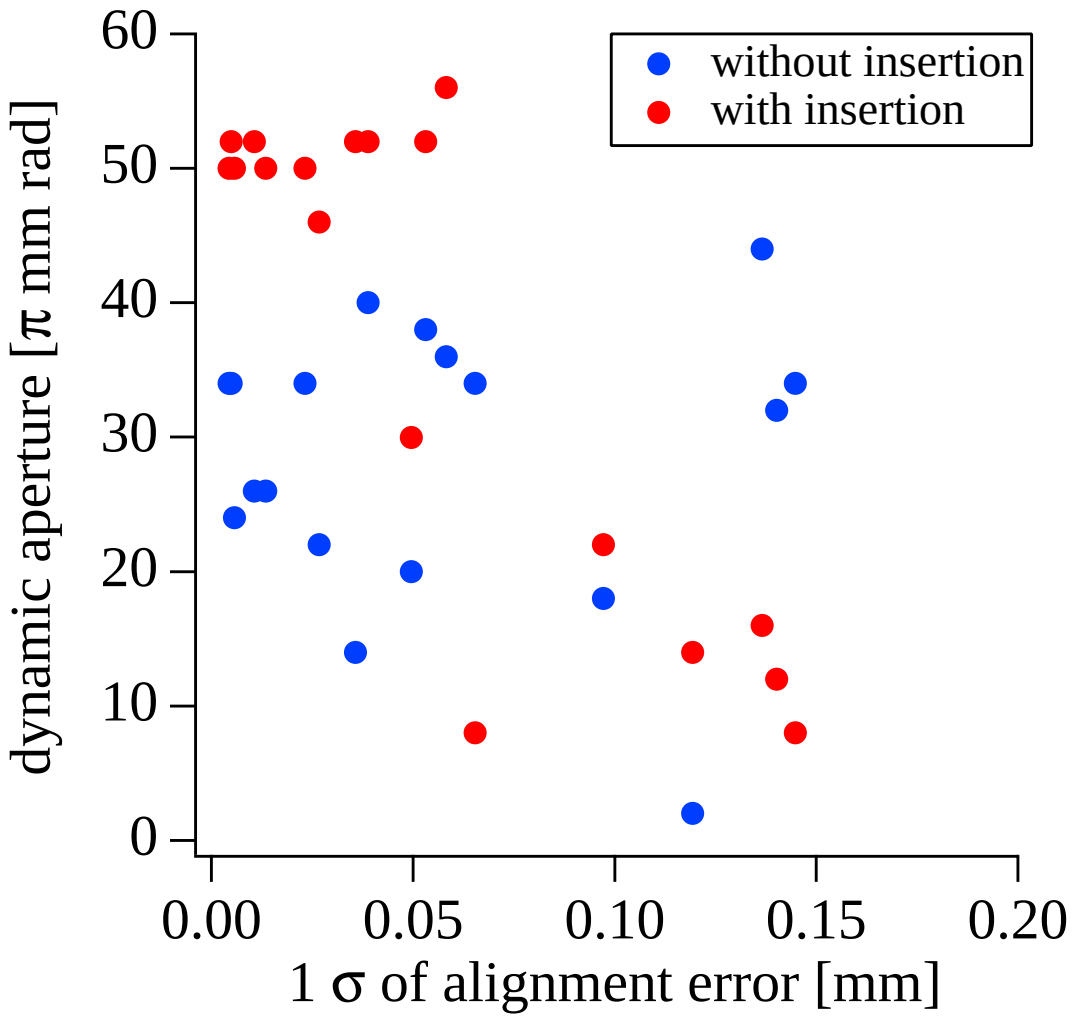
Tune With and Without Chromaticity Correction



Dynamic Aperture vs. Chromaticity Correction



Dynamic Aperture with Errors



Insertions (Machida)

- Want longer drifts for injection/extraction
- Chromaticity correction makes insertions work better
- Even seem to work with partial correction (70%)
  - Won't work without chromaticity correction
  - Hurts dynamic aperture very little

Magnet Discussion

- Little advantage in combined-function winding
  - Proposed earlier in Japan: verify
- Helical winding can avoid end multipoles
- Need to start looking at hardware
  - Especially kickers