Preliminary Design of an FFAG to 25 GeV for the IDS

J. Scott Berg
Brookhaven National Laboratory
NFMCC Collaboration Meeting
19 March 2008

Linear Non-Scaling FFAG

- Larger number of passes through RF
- Arc accepts factor of 2 or more in energy
- Reasonable magnet aperture
- Accelerates using high-frequency RF
- Simple (FODO, doublet), identical cells
- Linear combined-function magnets
- Sufficient drift for RF cavity

Design Goals

- Accelerate from 12.6 GeV to 25 GeV
- 30 mm normalized transverse acceptance
- Two 201 MHz SCRF cells per lattice cell
  - Time variation with transverse amplitude
- Four empty drifts for injection/extraction
- Drift lengths: 2 m (FODO)/3 m (doublet)
- Optimize for cost including decays

Parameters

	FODO	Doublet
Cells	62	61
D radius (cm)	9.5	10.3
D peak field (T)	7.6	8.4
F radius (cm)	20.7	20.6
F peak field (T)	3.4	3.1
Circumference (m)	462 m	463 m
RF Voltage (MV)	1526	1450
Decay loss (%)	3.5	3.7

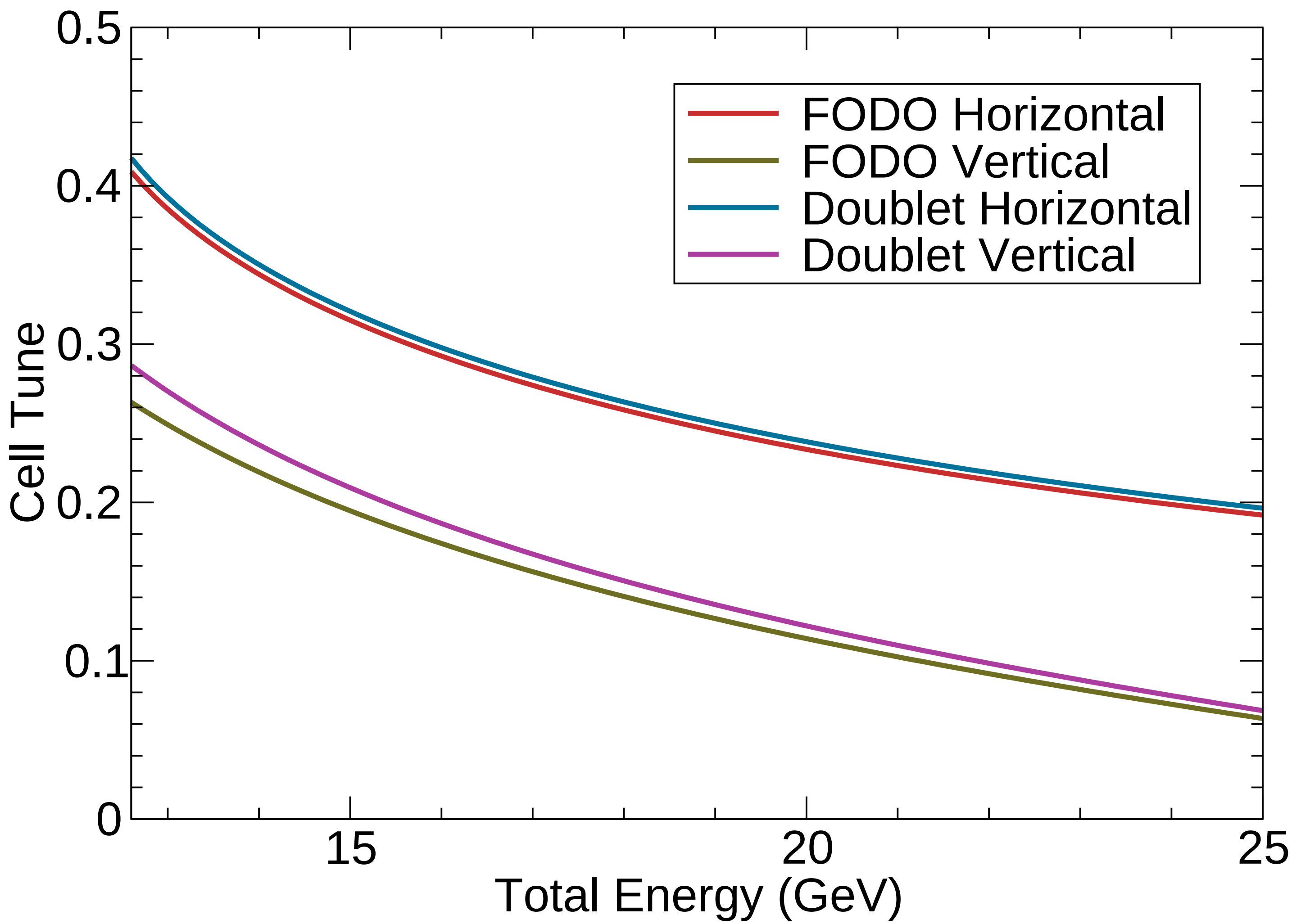
Lattice Design Discussion

- FODO and doublet lattices very similar
  - Costs, size comparable
  - Both have somewhat over 8 turns
  - Doublet needs slightly less voltage
  - Doublet has higher field, larger D magnet
- Biggest difference: longer (3 m vs. 2 m) drift in doublet

Injection

- Septum followed by kicker in subsequent drift
- 2 cm separation between circulating beam and injected beam at septum
- Ideal tune septum to kicker: 0.25
- Horizontal injection
- Prefer septum just before defocusing magnet
  - Defocusing magnet pushes beam out
  - Beam smaller near defocusing magnet

Lattice Tune



BROOKHAVEN NATIONAL LABORATORY

Injection Parameters

	Doublet D First	Doublet F First	FODO First	FODO Second
Kicker Field (T)	0.62	0.62	0.88	1.19
D Radius (cm)	11.0	16.1	9.2	9.9
F Radius (cm)	20.9	33.5	13.2	18.7

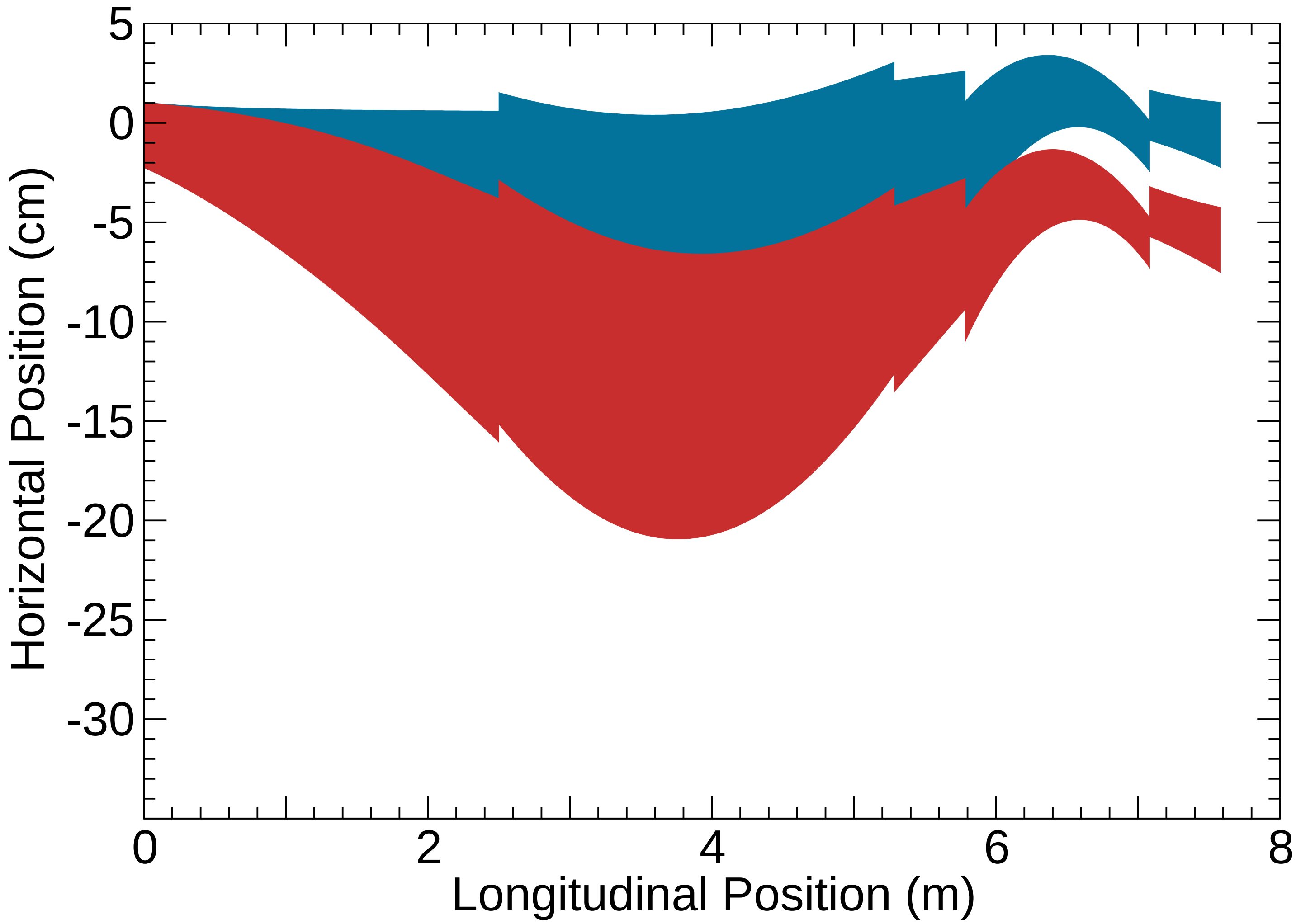
Injection: Commentary

- Kicker fields too high (0.5 T goal)
  - Better in doublet: longer drift
  - Use second kicker
- Magnet aperture needed close to design
  - Except when F near septum
  - Outside "good field region," but not for long
  - FODO slightly better than doublet

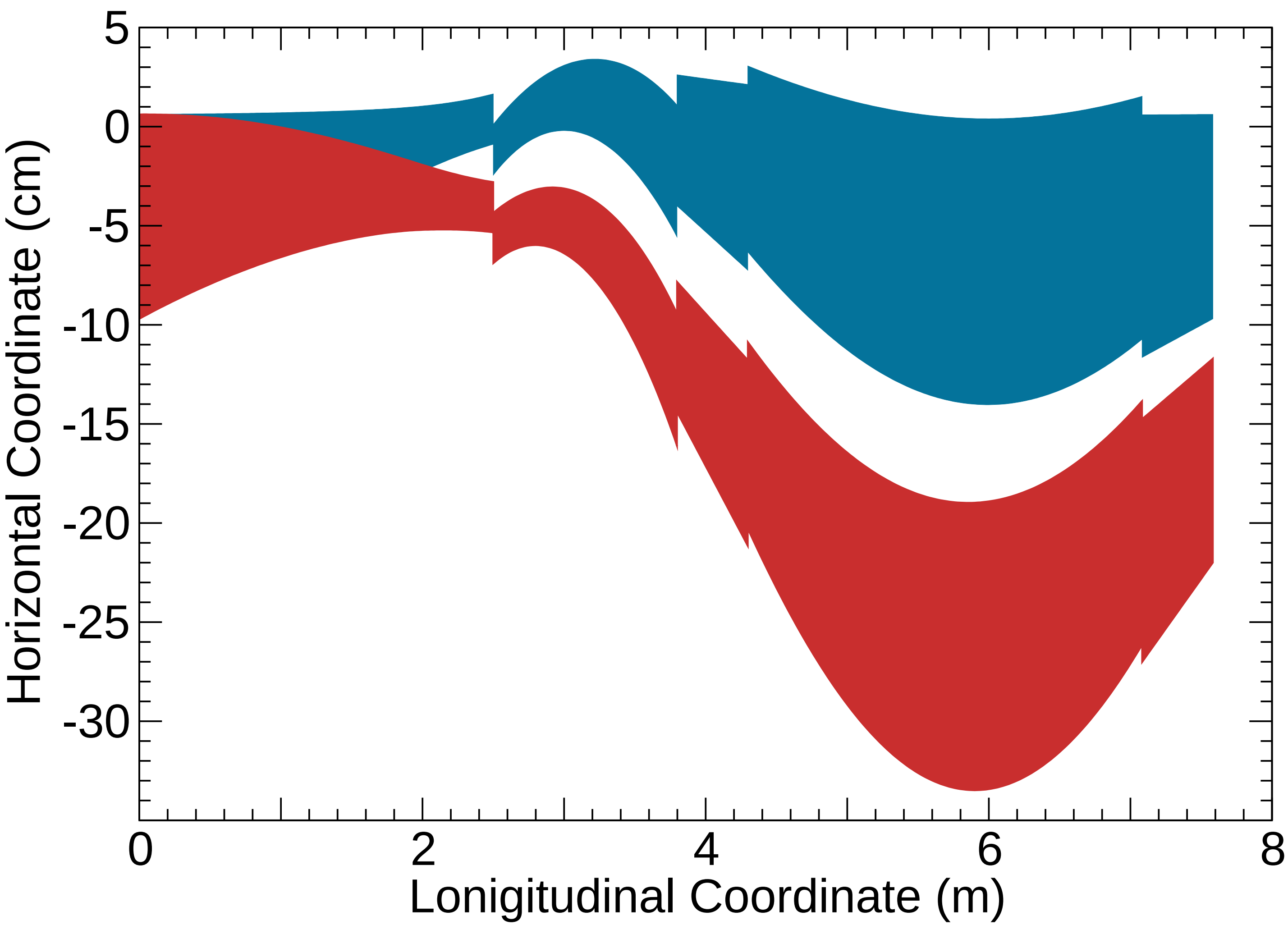
Injection
Doublet Commentary

- F near septum requires too much aperture
  - Want to avoid special magnets
  - Symmetry breaking bad for FFAGs
- Doublet must either inject or extract wrong way
  - Could inject vertically, extract horizontally
    - Tunes near 0.25 for both these

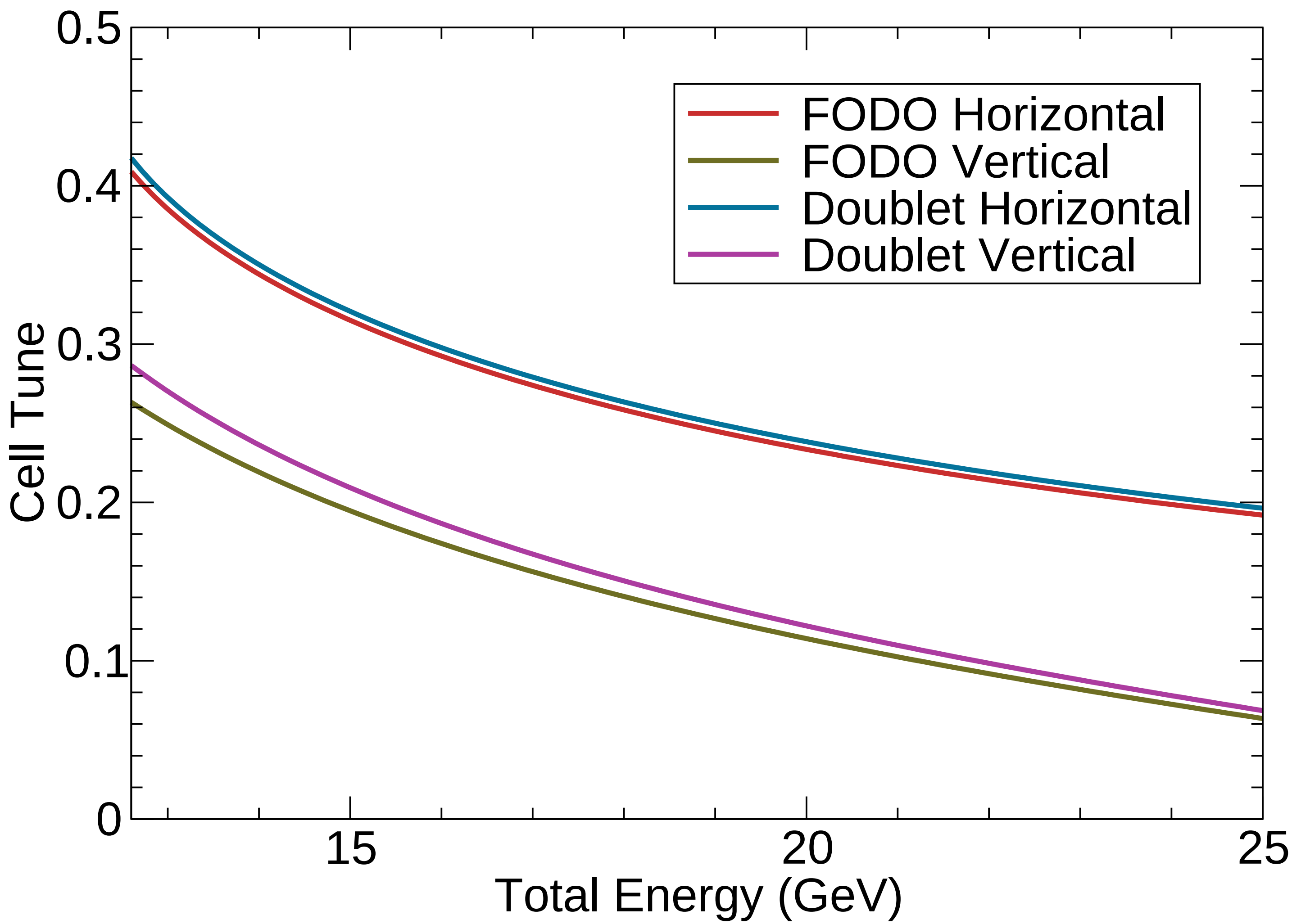
Injection
Doublet, D Near Septum



Injection
Doublet, F Near Septum



Lattice Tune



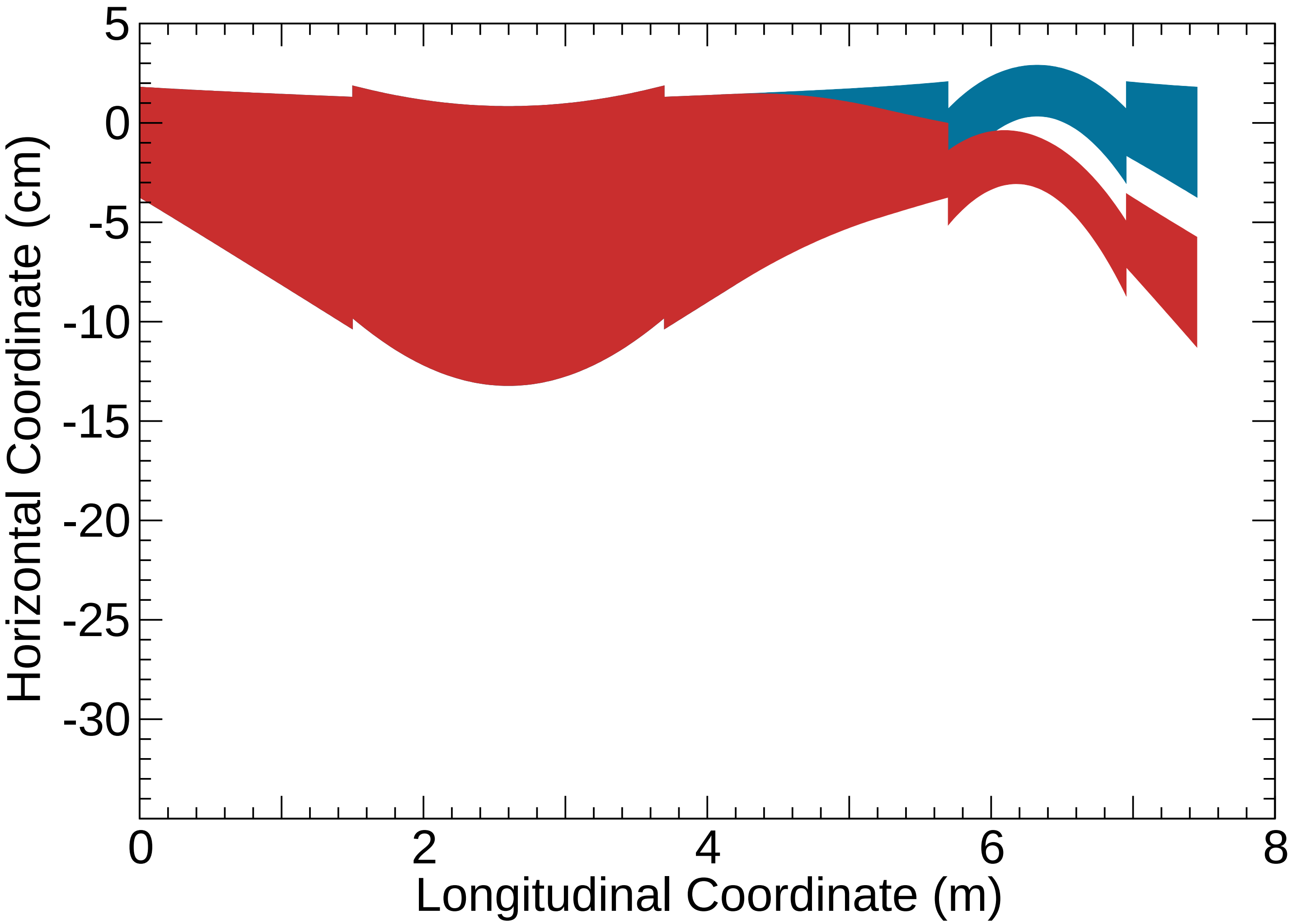
BROOKHAVEN NATIONAL LABORATORY

Injection
FODO Commentary

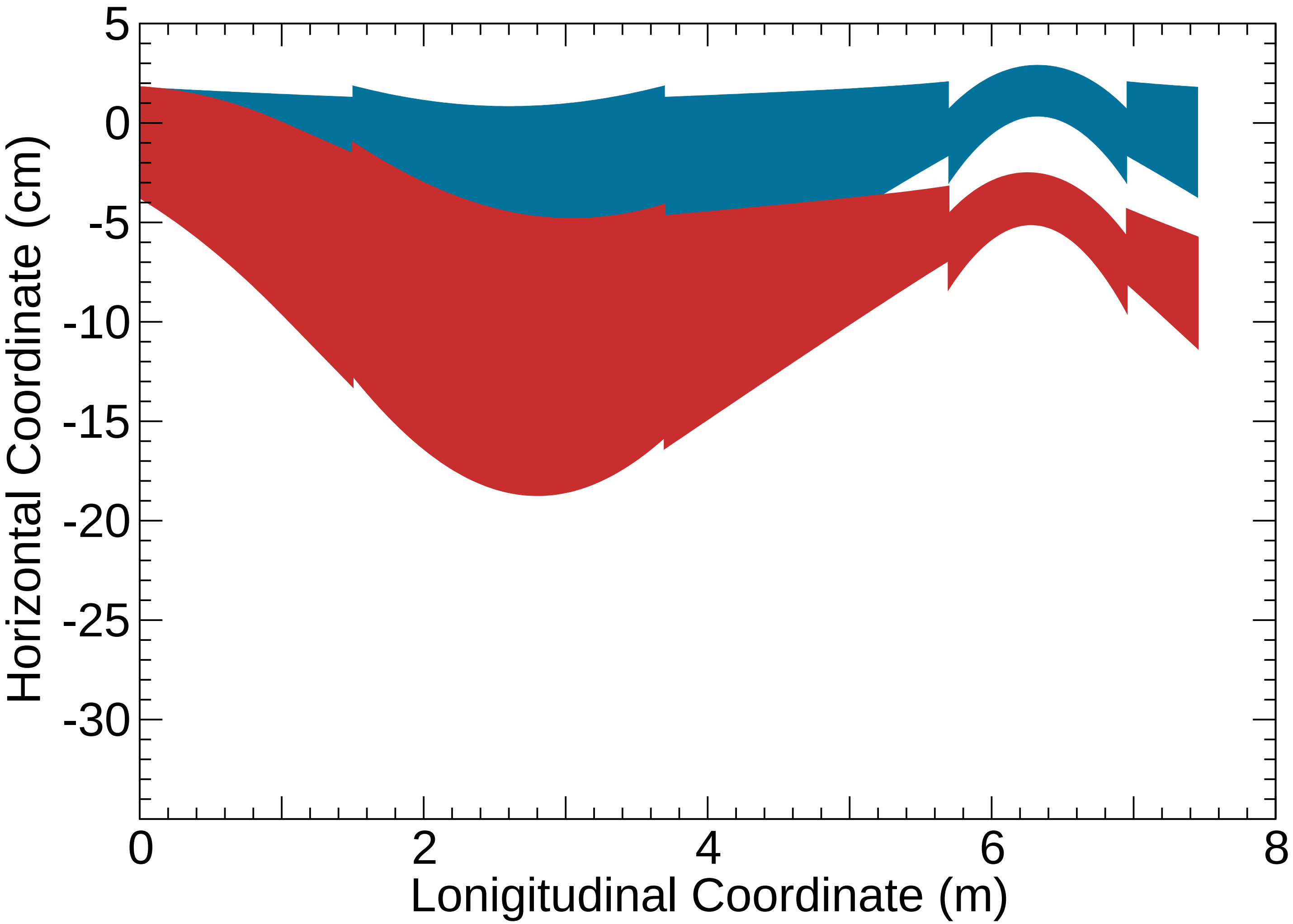
- Injection and extraction with D near septum
- Kicker in first drift more effective
  - Horizontal tune high
  - Most phase advance in D
    - First drift about 0.25 away
- Kickers half of length for doublet

BROOKHAVEN NATIONAL LABORATORY

Injection
FODO, Kicker in First Drift



Injection
FODO, Kicker in Second Drift



Tasks

- Design simplistic at this point
  - Compute longitudinal parameters more carefully
  - Study performance under tracking
  - Study less expensive option (fewer cavities)
- Injection
  - Study 2-kicker solutions
  - Consider vertical injection with doublet