Optimized Non-Scaling FFAG Lattices; Staging Scenarios for Oscillation Physics

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FFAG Workshop

Optimization Parameters

- Pole tip fields: 7 T, 30% buffer
- Long drifts: 2 m; short drifts, 0.5 m
- 7.5 MV acceleration per cell
- Aggressive parameters for longitudinal phase space area
- 201.25 MHz RF

Triplet FFAGs at Various Energies

E_{min} (GeV)	1.25	2.5	5	10
E_{max} (GeV)	2.5	5	10	20
w	1/4	1/6	1/8	1/12
Cells	56	59	74	93
D Length (cm)	31	56	85	128
D Radius (cm)	15.9	11.6	8.6	6.5
D Field (T)	1.9	3.5	4.1	4.5
D Gradient (T/m)	-23	-23	-27	-30
F Length (cm)	11	18	29	45
F Radius (cm)	12.1	10.1	8.3	7.3
F Field (T)	0.4	-1.8	-2.3	-2.7
F Gradient (T/m)	41	42	47	50
RF Voltage (MV)	420	443	555	698

Conclusions: Lattices at Different Energies

- 1.25–2.5 Lattice is of questionable value. Use RLA/Linac.
- 2.5–5 is borderline. Check cost, maybe go to RLA.
- Cost ber GeV definitely seems to be increasing
  - Number of cells only go down weakly
  - Apertures go up, although lengths go down
  - RF Voltage per GeV of acceleration goes up rapidly

Different Lattice Structures, 10–20 GeV

Type	FDF	FD	FODO 1 RF	FODO 2 RF
Cells	93	101	113	82
D Length (cm)	128	101	81	99
D Radius (cm)	6.5	5.3	6.1	6.4
D Field (T)	4.5	4.9	4.8	5.6
D Gradient (T/m)	-30	-36	-30	-24
F Length (cm)	45	81	60	74
F Radius (cm)	7.3	9.5	11.0	13.8
F Field (T)	-2.7	-2.2	-1.9	-2.3
F Gradient (T/m)	50	43	39	31
RF Voltage (MV)	698	758	848	1230

Conclusions: Different Lattice Structures

- FDF triplet as the least RF voltage
- Far fewer cells in FDF
- Magnets never improve sufficiently much in other lattices
- FDF is the clear winner

Electron Model Lattice

- Choose S-Band (2.856 GHz) over X-Band (11.4 GHz)
  - RF Drift disproportionately short with X-band
  - S-Band readily available
- Choose 0.2 T pole tips: magnets too short otherwise
- 15 cm RF drift, 5 cm between magnets
- $w = 1/2$, giving lots of range to explore longitudinal acceptance
- Run 30 MHz ferrite loaded also to explore resonances

Cells	25
D Length (cm)	11.3
D Radius (cm)	1.28
D Field (T)	0.139
D Gradient (T/m)	-3.76
F Length (cm)	3.93
F Radius (cm)	1.81
F Field (T)	-0.080
F Gradient (T/m)	5.88
RF Voltage (MV)	12.5
RF Power (MW)	2.5

Staging Scenarios for Oscillation Physics

- BNL neutrino physics group more interested in lower energy beam, maybe with variable energy
- Can create staging scenario:
  - Start with beam out of linac
  - Build each subsequent acceleration stage while running previous stage
  - Each stage has relatively low cost
  - Requires a second storage ring when getting above about 5 GeV
  - Can still finish up with doing Geer's physics scenario
- Avoids multiple baselines