Cornell ERL-FFAG Lattice

Using Dejan’s doublet arc cell
Reason for Using Doublets

• Shifting the F and D magnets together gives a larger drift (still only 10.1cm) without sacrificing much focussing strength

• This is the same tradeoff EMMA made
Dejan’s 100 cells/turn, 11.5 m diameter Cornell Lattice

True quadrupole with offset

\[ B_F = -0.170 + 52.973 \times x = 0 \]
\[ x = 0.170/52.973 = 3.2 \text{ mm} \]

Combined function \( B > 0 \)

\[ BD = 0.655 + (-35.33) \times x = 0 \]
\[ x = +18.53 \text{ mm} \]
Orbits in Real Space in Muon1

Orbits not exaggerated, cm grid shown
Central multicoloured line is “reference curve”
Cell Tunes

![Chart showing the relationship between energy (MeV) and cell tune (cycles) for Qx and Qy.

- **Qx** has a higher cell tune compared to **Qy**.
- The cell tune decreases as energy increases.

September 2014  Stephen Brooks, FFAG’14
NB: this lattice is calculated for the ambitious selection of energies 112, 212, 312, 412MeV, assuming a 12MeV injector and 100MeV linac. Lower energies will proportionately reduce the maximum fields.

For $6+4*80 = 326$MeV top energy, this would be $0.684T$
TOF and Path Length per “Turn”
Synchrotron Radiation per "Turn"

Total loss over full cycle = 3.94 keV
= $10^{-5}$ of top energy beam power
Adiabatic Matching to Straight

- Over 20 cells, reduces dipole and angle according to $3x^2 - 2x^3$ where $x = (\text{cell #})/21$
  - 50-cell 180° arc becomes 40 cells plus 20 half-curvature matching cells
- Corrects orbits to ±0.7mm from centre line
Oval Layout in Cornell L0E Hall

28.744m = 9.244m for linac + 2*4m splitters + 2*5.75m arcs

11.873m
Errors 100um RMS in XYZ Positions

Lowest energy beam lost here
Errors 50um RMS in XYZ Positions
Errors 20um RMS in XYZ Positions
1% RMS Quad Strength Errors

Lowest energy beam reacts most violently
0.5% RMS Quad Strength Errors
Systematic Sextupole $120T/m^2$

$0.012T @ 1\text{cm} = 1.4\%$ of max field magnitude
This is about the most before beam loss occurs
4m Splitter Attempt (just dipoles)

0.08T “pre splitter” to inject/extract 12MeV beam
0.8T splitter dipole
1m grid squares

Note unusual order of dipoles to give regular 5-6cm spacing
4m Splitter Attempt (zoom)