Scaling VFFAG eRHIC Design

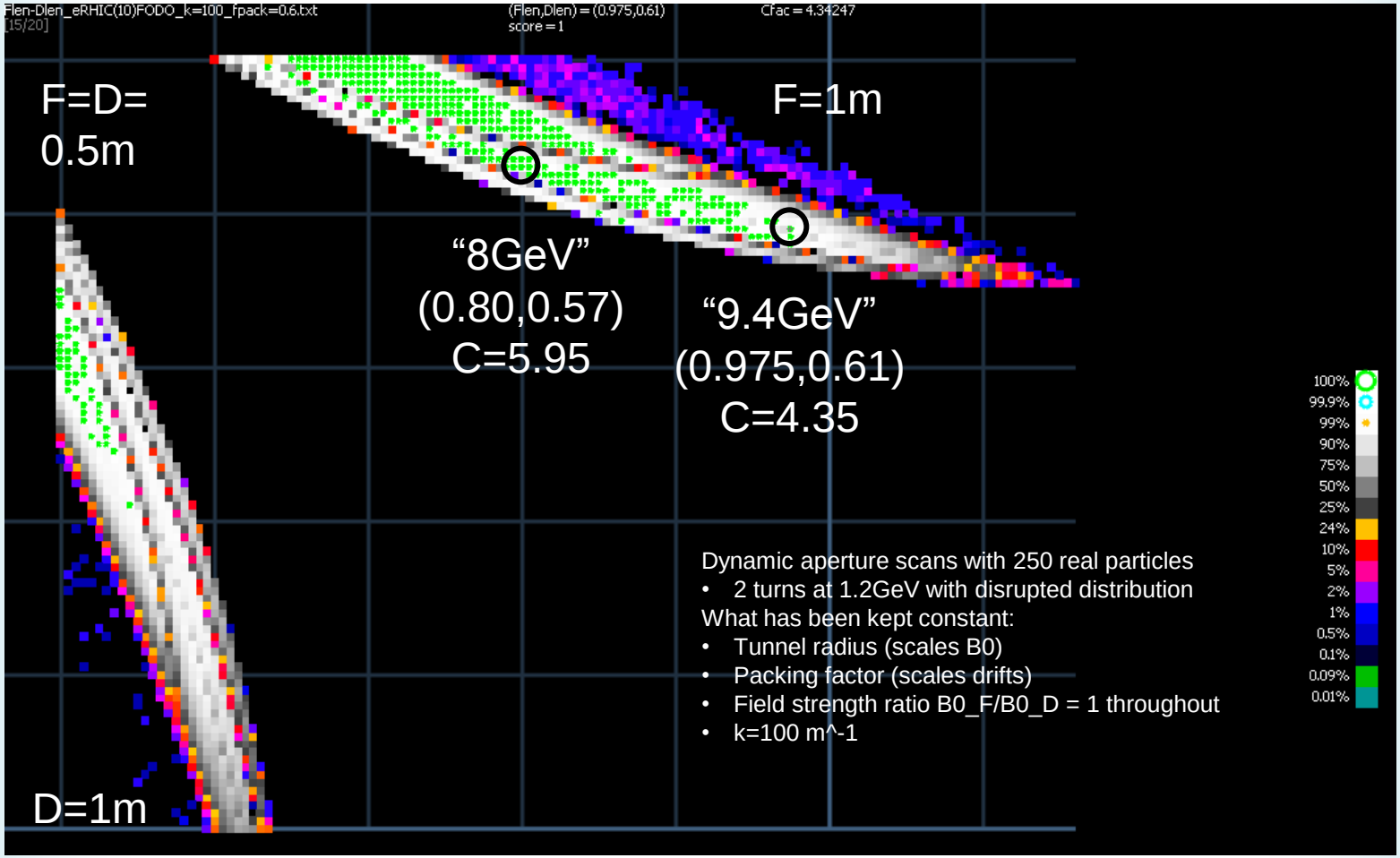
Progress Report 3

Last time:

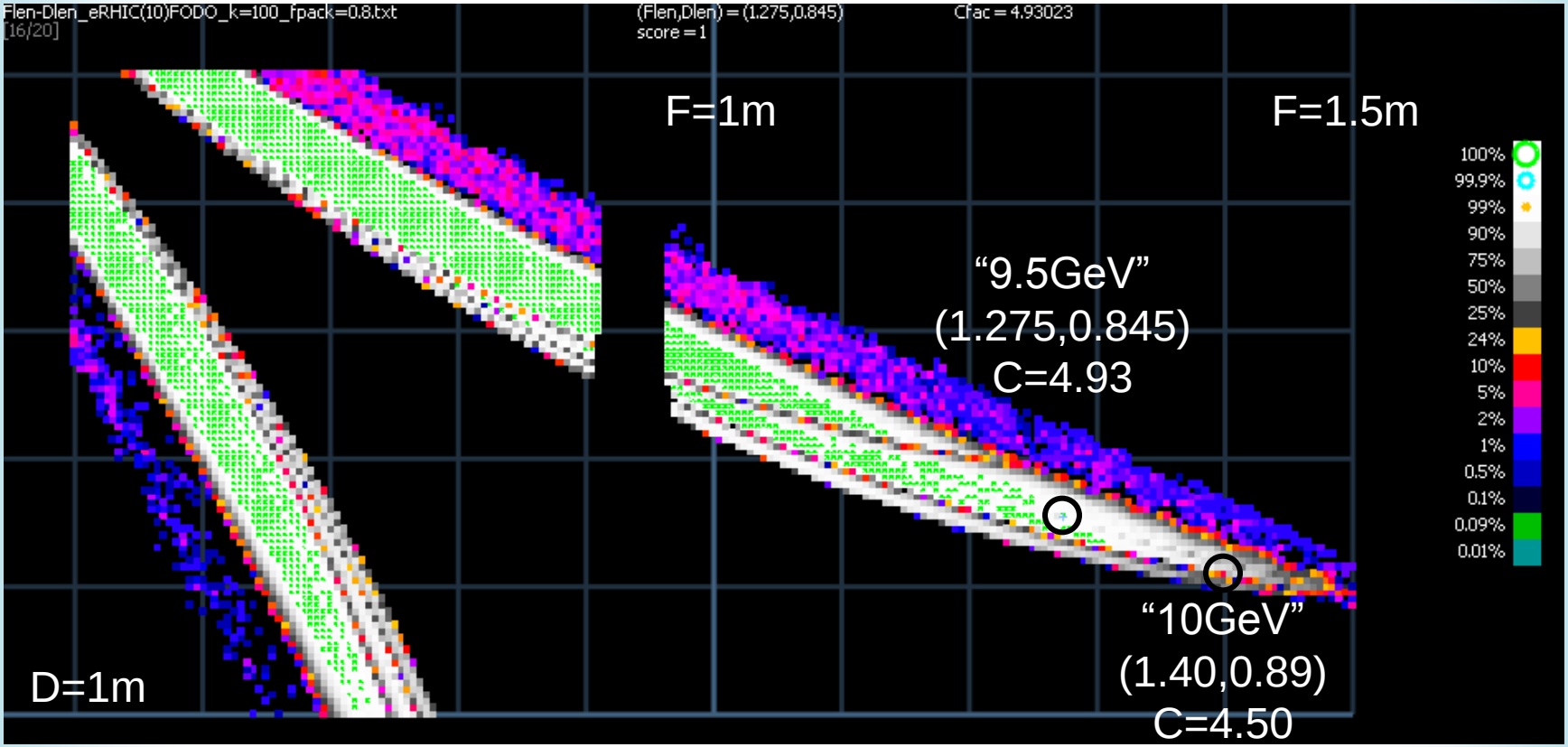
- Found FODO lattices capable of 8 and 10GeV
  - 8GeV lattice very robust
    - Orbit excursion of 3cm without errors seemed possible
  - 10GeV lattice exhibited resonance behaviour
- Running long dynamic aperture scans of FODO stability for 60% and 80% packing factor

I. FODO Parameter Space & 9.4/9.5GeV Lattices

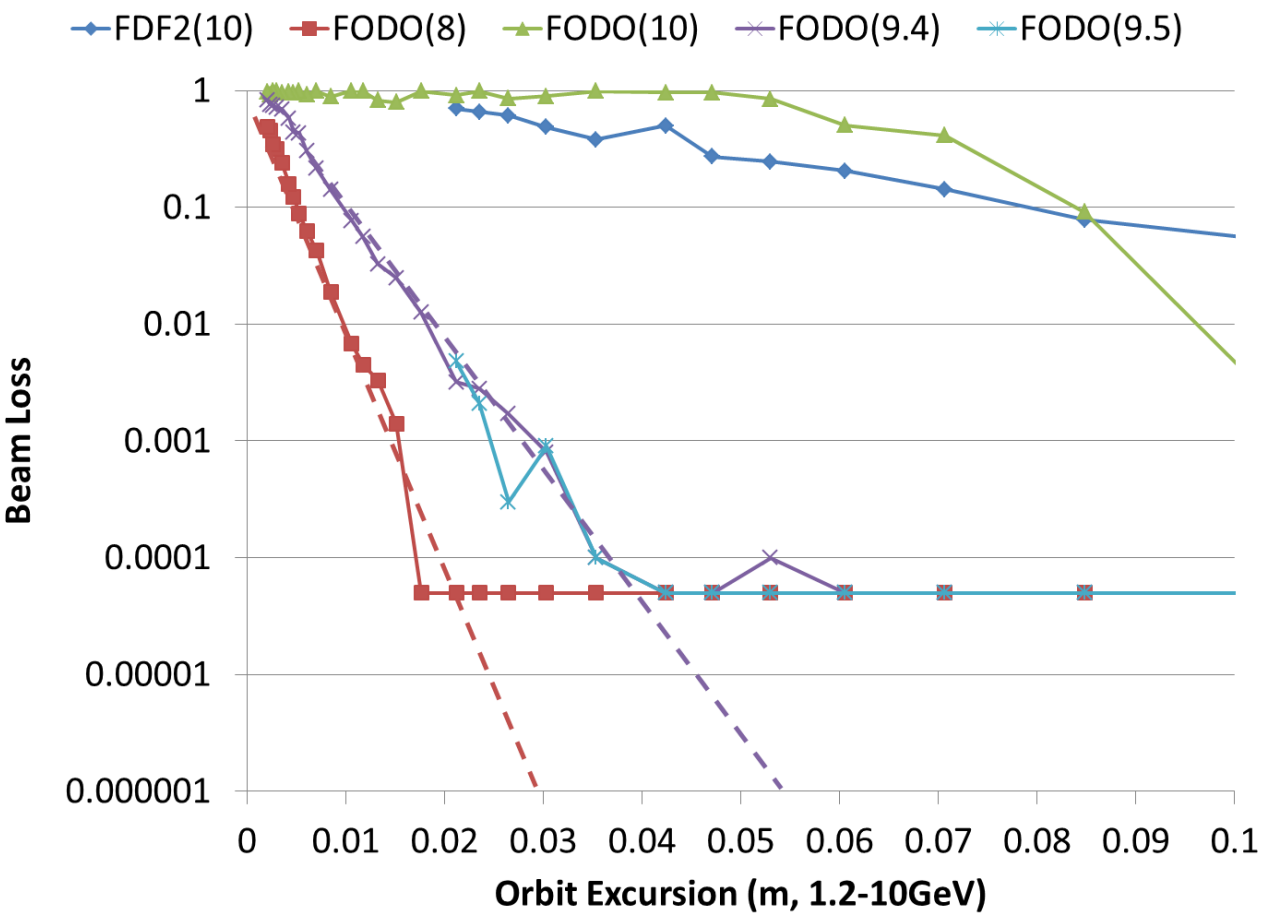
FODO lattice, 60% packing factor



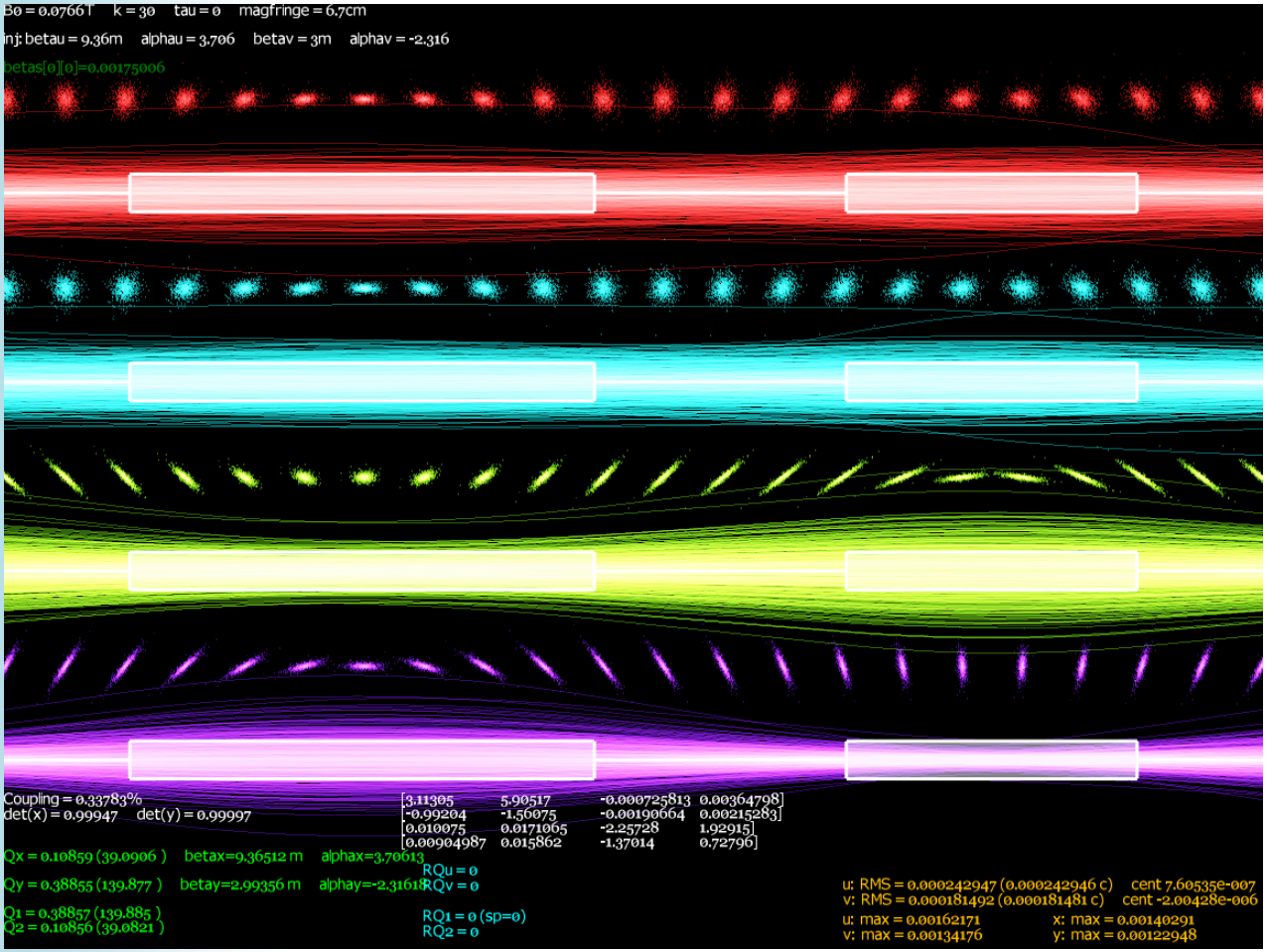
FODO lattice, 80% packing factor



Loss performance with scaling k



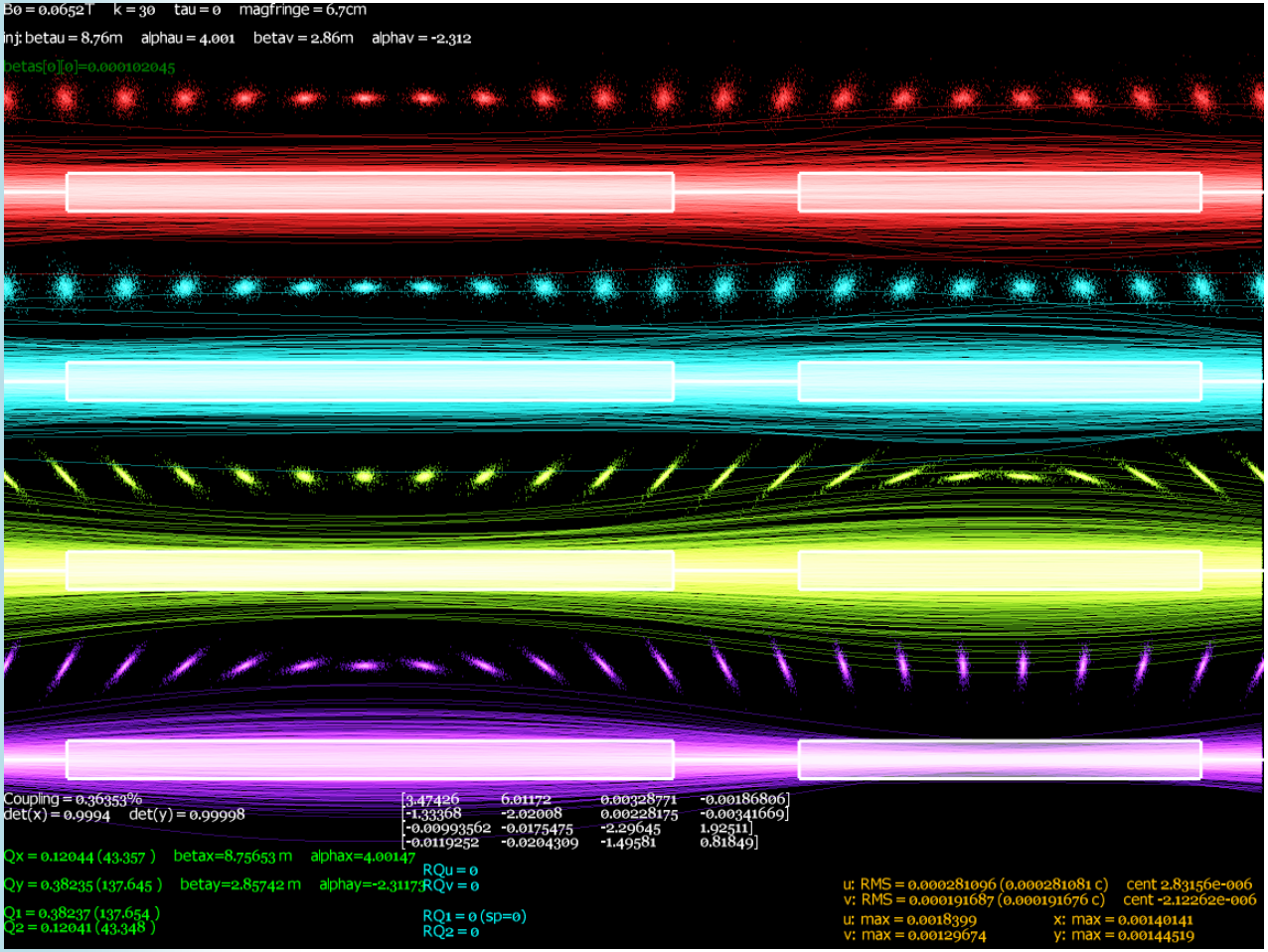
9.4GeV/60% pack FODO lattice



Species: Electrons
Injection energy (MeV): 1200
Extraction energy (MeV): 9400
Lattice: FODO
Magnet B0 (T): 0.0766
Magnet k (m^-1): 30
Magnet tau: 0
Magnet fringe length (m): 0.067
F Magnet length (m): 1.78
D Magnet length (m): 1.114
Drift length (m): 0.965
Injected normalised emittance (m.rad): 19.36381158822e-6
Injected beta u (m): 9.36
Injected beta v (m): 3
Injected alpha u: 3.706
Injected alpha v: -2.316
Injected distribution: ExpTails
Designed for tracking in: S

Cell length = 4.824 m
Orbit excursion = 0.0686006 m
Bending radius = 378.66 m
Packing factor = 0.59992
Circumference factor = 4.34535
Emax_eRHIC = 9.47752 GeV

9.5GeV/80% pack FODO lattice



Species: Electrons
Injection energy (MeV): 1200
Extraction energy (MeV): 9500
Lattice: FODO
Magnet B0 (T): 0.0652
Magnet k (m^-1): 30
Magnet tau: 0
Magnet fringe length (m): 0.067
F Magnet length (m): 2.328
D Magnet length (m): 1.543
Drift length (m): 0.484
Injected normalised emittance (m.rad): 19.36381158822e-6
Injected beta u (m): 8.76
Injected beta v (m): 2.86
Injected alpha u: 4.001
Injected alpha v: -2.312
Injected distribution: ExpTails
Designed for tracking in: S

Cell length = 4.839 m
Orbit excursion = 0.0689533 m
Bending radius = 378.603 m
Packing factor = 0.79996
Circumference factor = 4.93121
Emax_eRHIC = 9.55964 GeV

Tunes

Lattice	Qu (deg)	Qv (deg)	Qu	Qv
FDF2(10)	82.7	255.5	0.230	0.710
FODO(8)	64.3	133.6	0.179	0.371
FODO(10)	41.1	158.5	0.114	0.440
FODO(9.4)	39.1	139.9	0.109	0.389
FODO(9.5)	43.4	137.6	0.120	0.382

II. Synchrotron Radiation Power

SR in arcs for 50mA, sum all turns

Top Energy (GeV)	Turns	Linac (GeV)	FODO 9.4GeV/60%	FODO 9.5GeV/80%
10	9	1.1	13.64 (MW)	13.17 (MW)
10	8	1.2375	12.18	11.77
10	7	1.4143	10.74	10.38
10	6	1.65	9.31	9.00
9.5	9	1.0444	11.11	10.74
9.5	8	1.175	9.93	9.59
9.5	7	1.3429	8.75	8.46
9.5	6	1.5667	7.59	7.33
9	9	0.9889	8.96	8.65
9	8	1.1125	8.00	7.73
9	7	1.2714	7.06	6.82
9	6	1.4833	6.12	5.91

III. Arc Magnets Specification

Use FODO 9.5GeV/80% lattice

- By=B0 e^ky (and Bx=0) for x=0
  - k=30m^-1, B0=0.0652T (field at 1.2GeV)
- By=0.5160T, y=68.95mm at 9.5GeV
- By=0.7604T, y=81.88mm at 14GeV
  - Use for high energy, reduced current operation
- Good field region x: -3 to 3mm, y: -3 to 83mm
- F, D magnet lengths: 2.328m, 1.543m
- 61.418m radius of curvature (B0_D = -B0_F)

IV. Future Work

Next steps (roughly in this order)

- Redo simulations with weighted particles in tails (down to 1e-6 and beyond)
- Error (misalignment) study
  - Include logs of emittance growth, centroid offset
- Develop “straight” cell for full ring lattice
- Open issue concerning emittance growth from synchrotron photon emission
- “End-to-end” tracking of full ring