

Two Designs of an 8 GeV FFAG Proton Driver

P. Meads and W. Chou

July 11, 2003

FFAG03 Workshop, Working Group 1

Parameter Comparison: FFAG *vs.* PD2

Parameters	FFAG	Proton Driver (PD2)
Circumference (m)	474.2	474.2
Injection kinetic energy (MeV)	600	600
Extraction kinetic energy (GeV)	8	8
Protons per bunch	3×10^{11}	3×10^{11}
Repetition rate (Hz)	105	15
Number of bunches	12	84
Protons per cycle	3.6×10^{12}	2.5×10^{13}
Protons per hour	1.36×10^{18}	1.36×10^{18}
Normalized transverse emittance (mm-mrad)	40π	40π
Longitudinal emittance (eV-s)	0.2	0.2
RF frequency (MHz)	7.5	53
Average beam current (μ A)	60	60
Beam power (MW)	0.5	0.5

Spiral FFAG Design

Parameter	c (m/s)	3E+08
Maximum Energy (GeV)	e (Coulomb)	1.6E-19
Injection Energy (MeV)	E0 (MeV)	938.256
Maximum radius (m)	% fringe	7.5 5% between + (5%/2) at edge
Maximum B Field [@Emax] (T)	Brf	120 Evgenij's rf parameters
Minimum B Field [@Emax] (T)	ferL	5.8
field index k	Q	100
recommended minimum k	fmjh	100
repetition rate (Hz)		
number of sectors N		
Azimuthal length of cell (m)		
Approx. straight section length (m)		

Spiral FFAG Design (cont...)

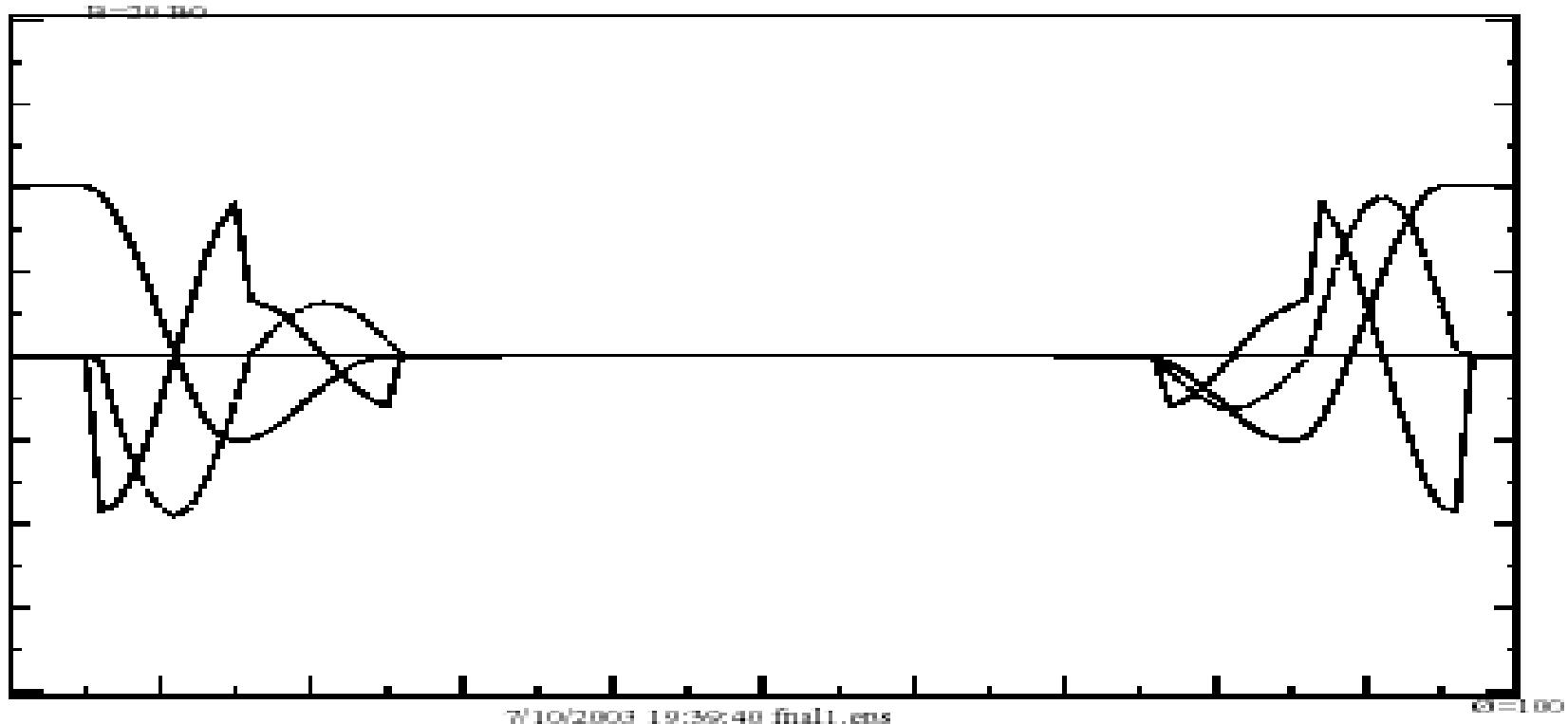
average current (Amps)	0.000625
gamma max	9.52646
gamma min	1.63948
gamma transition	13.70
beta max	0.99448
beta min	0.79244
Laslett tune shift (Qy) at injection	
B-rho max [T-m]	29.65010
B-rho min [T-m]	4.06607
injection radius (m)	74.676
radial width (m)	0.794
displacement of H0 ions (m)	0.640
#ions per pulse	3.7152E+13
width of plus plateau (%)	4.9108
width of minus plateau (%)	0

Spiral FFAG Design (cont...)

positive bend (degrees)	9.945
negative bend (degrees)	-4.320
approx. total bend (deg)	360.00
approx. total magnet width (m)	1.84
spiral angle (deg)	73.505
Qx	16.2500
Qy	16.3000
x: phase adv/cell (deg)	91.41
y: phase adv/cell (deg)	91.69
beta x max (meters)	11.01
beta y max (meters)	10.9
Resolution (nstep)	30

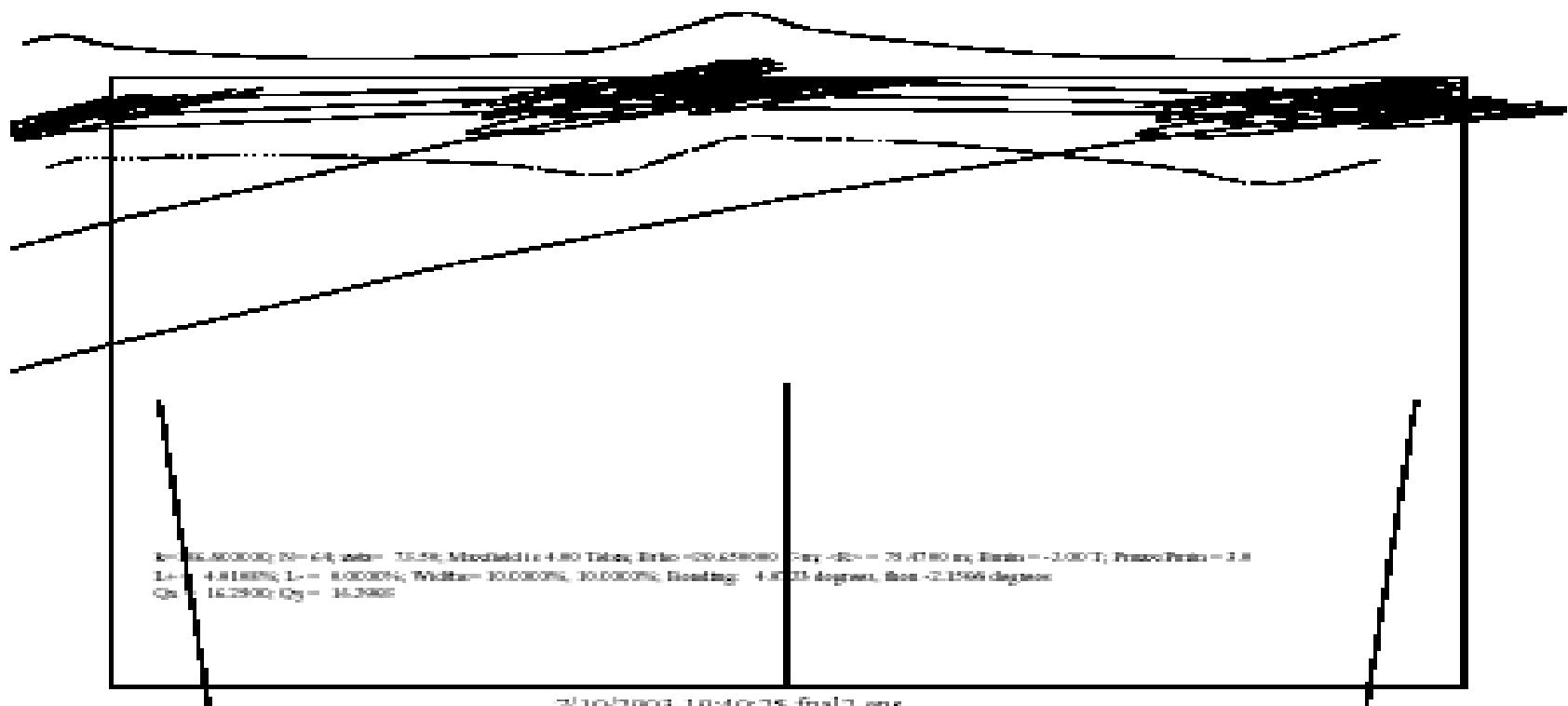
Spiral FFAG Design (cont...)

Magnetic field and its 1st and 2nd derivatives

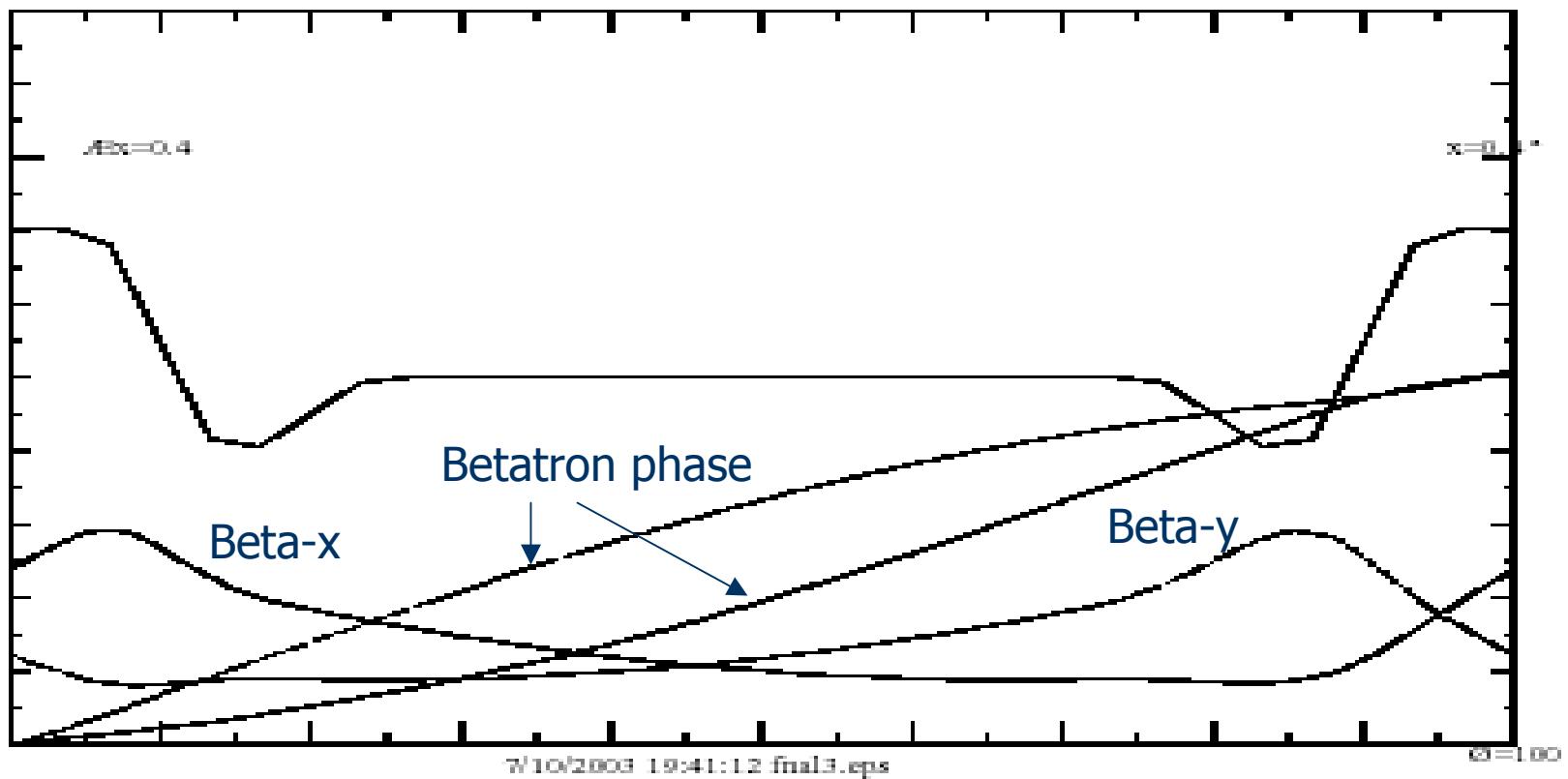


Spiral FFAG Design (cont...)

Magnetic field lines

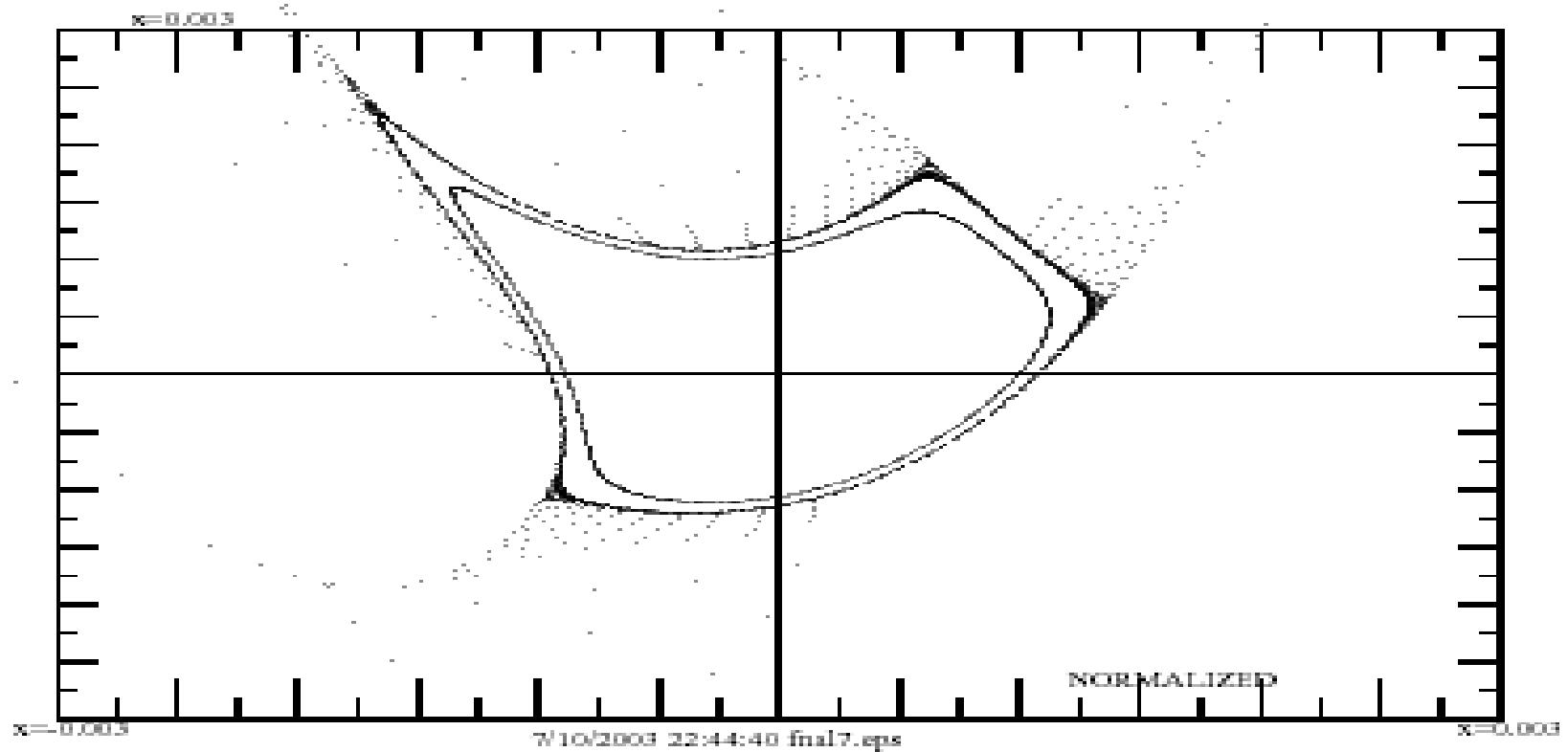


Spiral FFAG Design (cont...)



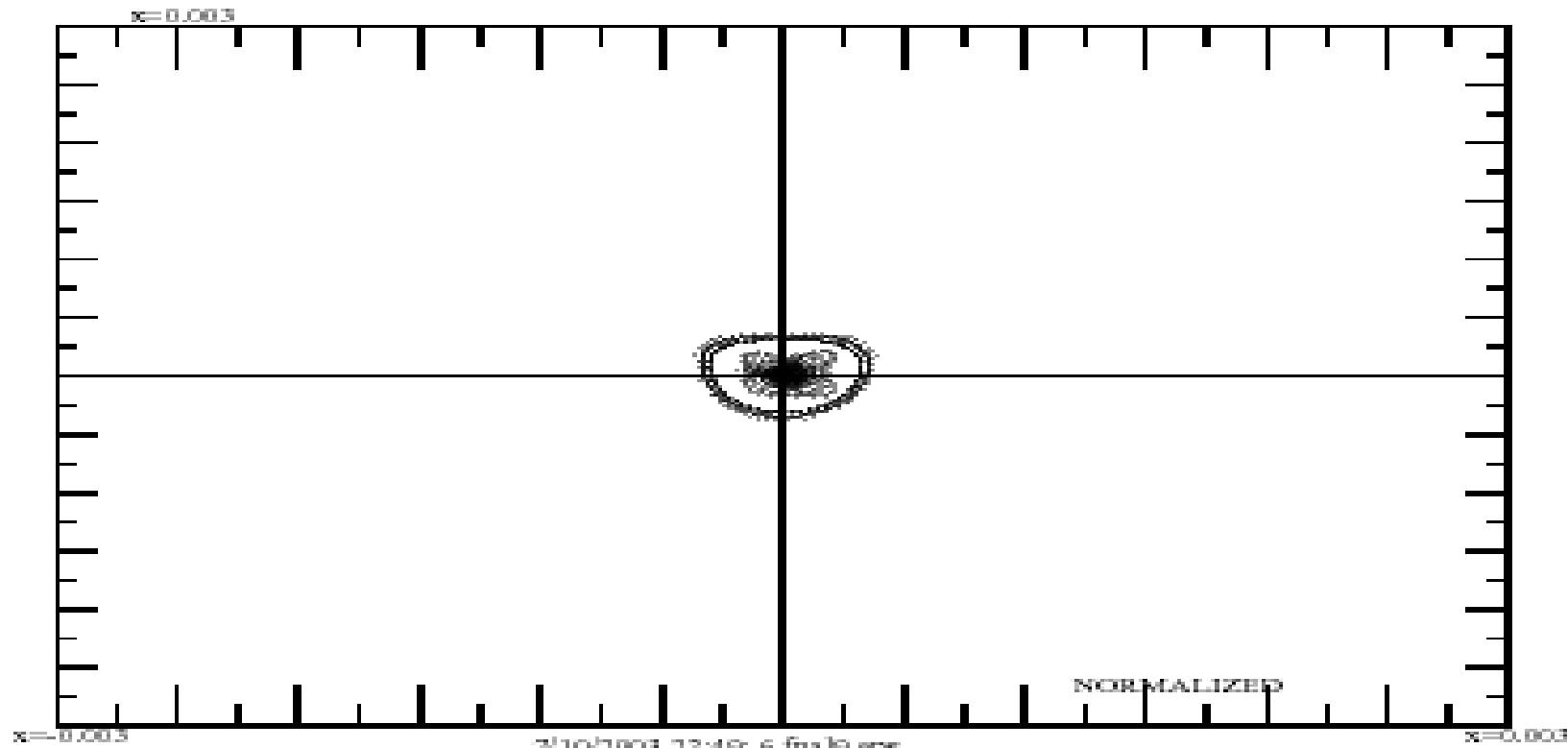
Spiral FFAG Design (cont...)

Horizontal acceptance without coupling (1047.7 pi mm-mrad)



Spiral FFAG Design (cont...)

Horizontal acceptance with vertical coupling



Radial FFAG Design

Parameter

	c (m/s)	3E+08
	e (Coulomb)	1.6E-19
	E0 (MeV)	938.256
	% fringe	7.5 5% between + (5%/2) at edge
Maximum Energy (GeV)	8	Brf 120 Evghenij's rf parameters
Injection Energy (MeV)	600	ferL 5.8
Maximum radius (m)	75.47	Q 100
Maximum B Field [@Emax] (T)	4	fmjh 100
Minimum B Field [@Emax] (T)	-2	
field index k	30.92	
recommended minimum k	120.0	
repetition rate (Hz)	105	
number of sectors N	32	
Azimuthal length of cell (m)	14.818	
Approx. straight section length (m)	4.736	

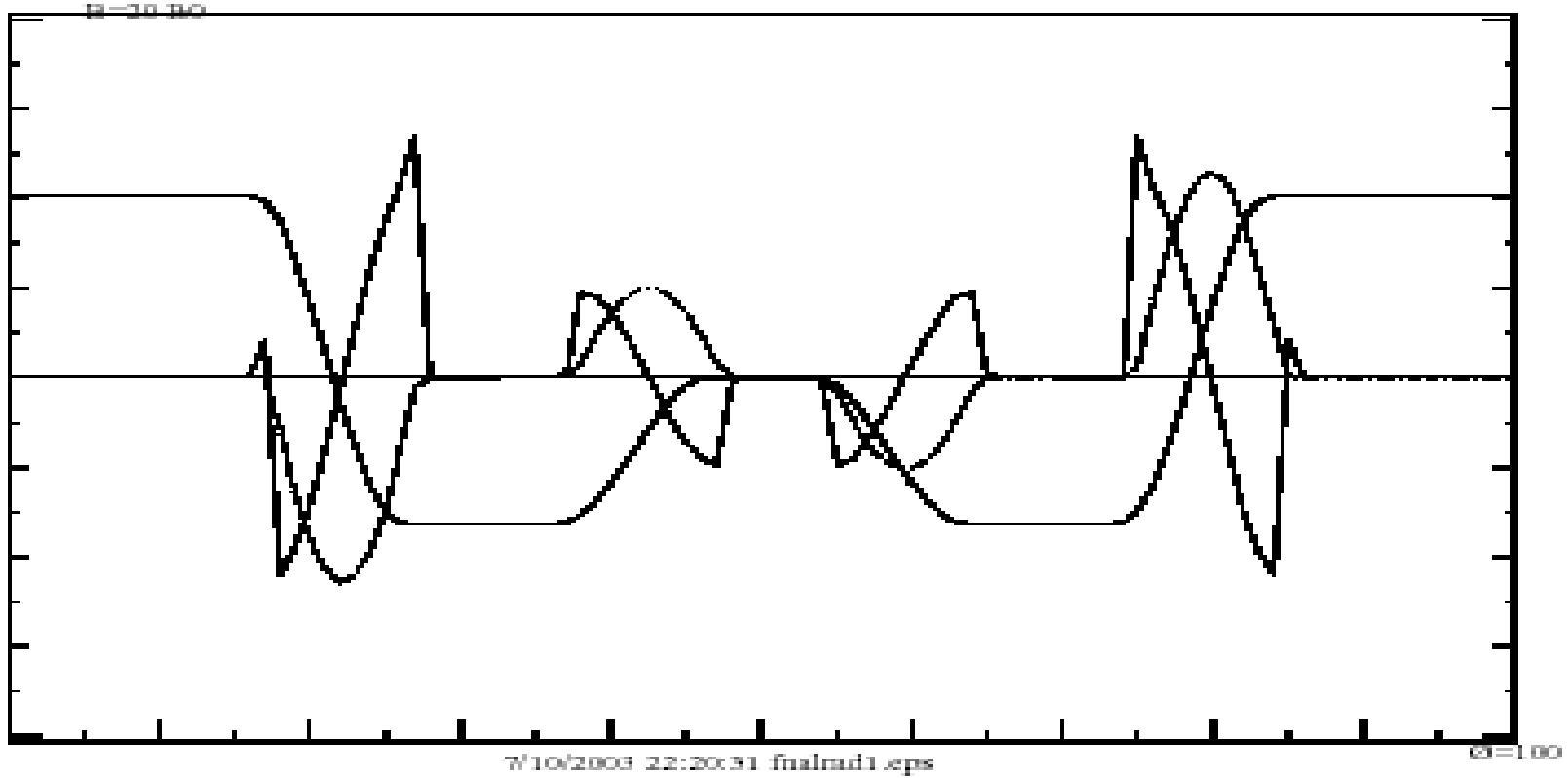
Radial FFAG Design (cont...)

average current (Amps)	0.000625
gamma max	9.52646
gamma min	1.63948
gamma transition	5.65
beta max	0.99448
beta min	0.79244
Laslett tune shift (Qy) at injection	
B-rho max [T-m]	29.65010
B-rho min [T-m]	4.06607
injection radius (m)	70.916
radial width (m)	4.554
displacement of H0 ions (m)	1.964
#ions per pulse	3.7152E+13
width of plus plateau (%)	16.1822
width of minus plateau (%)	10.3391

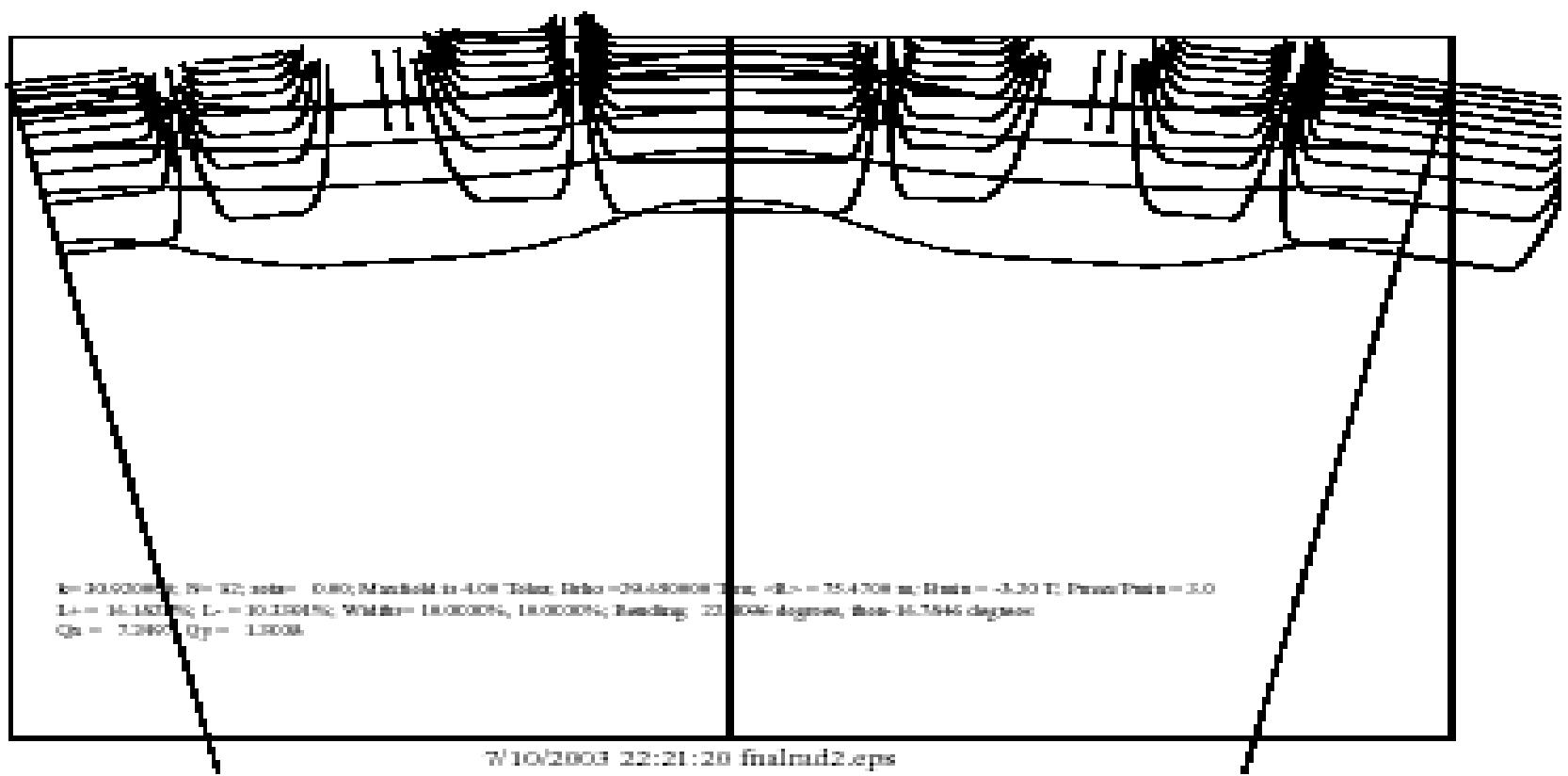
Radial FFAG Design (cont...)

positive bend (degrees)	44.198
negative bend (degrees)	-32.948
approx. total bend (deg)	360.00
approx. total magnet width (m)	10.08
spiral angle (deg)	0
Qx	7.2500
Qy	1.3000
x: phase adv/cell (deg)	81.56
y: phase adv/cell (deg)	14.63
beta x max (meters)	17.14
beta y max (meters)	71.91
Resolution (nstep)	30

Radial FFAG Design (cont...)

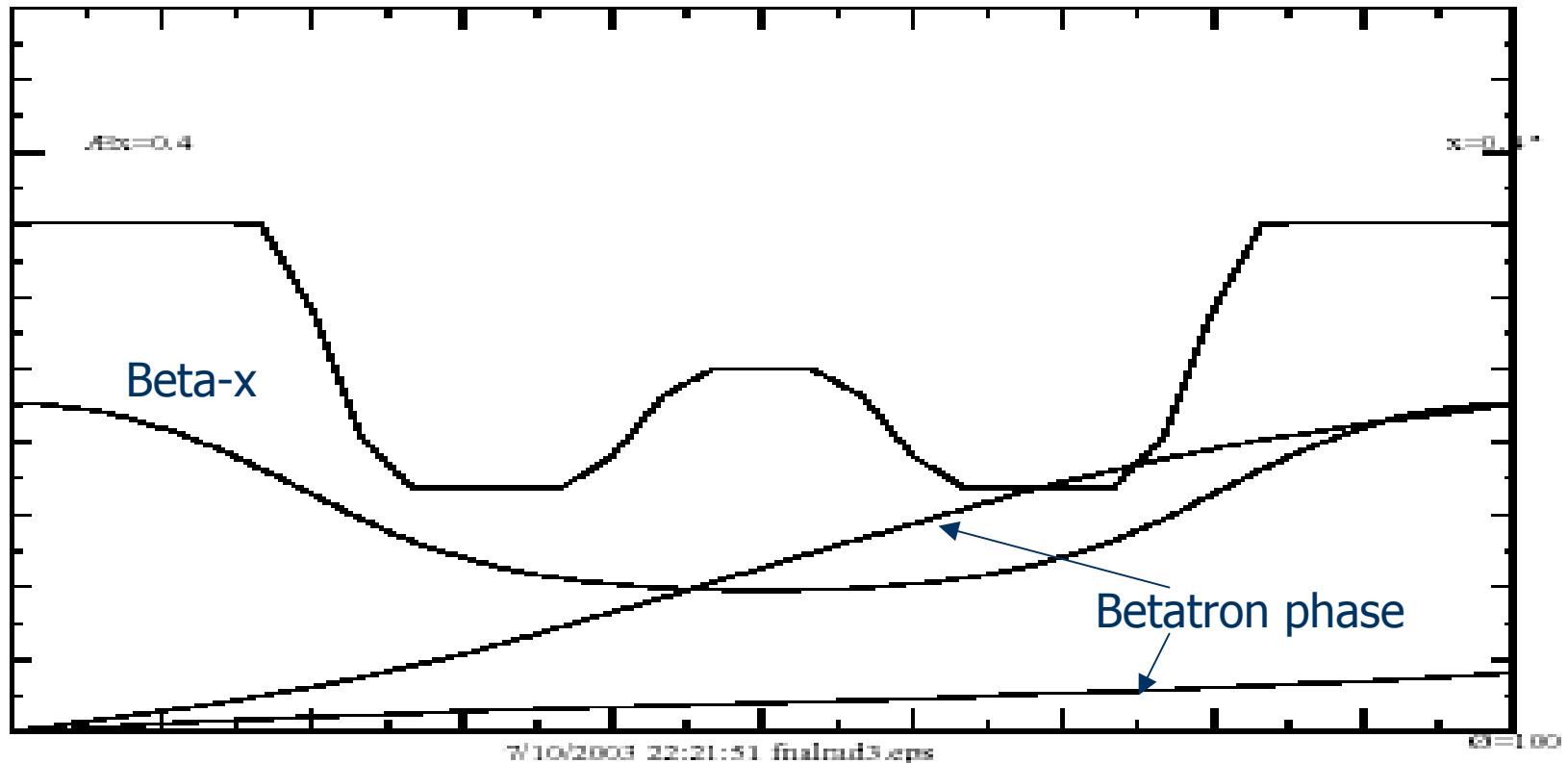


Radial FFAG Design (cont...)



Radial FFAG Design (cont...)

(beta-y too big for plot)



Conclusion

- ◆ The spiral design looks reasonable. But need to check the available space for RF.
- ◆ The radial design doesn't look good. In particular the magnet size as well as the vertical beta are too big.