Phase space matching through injection channel

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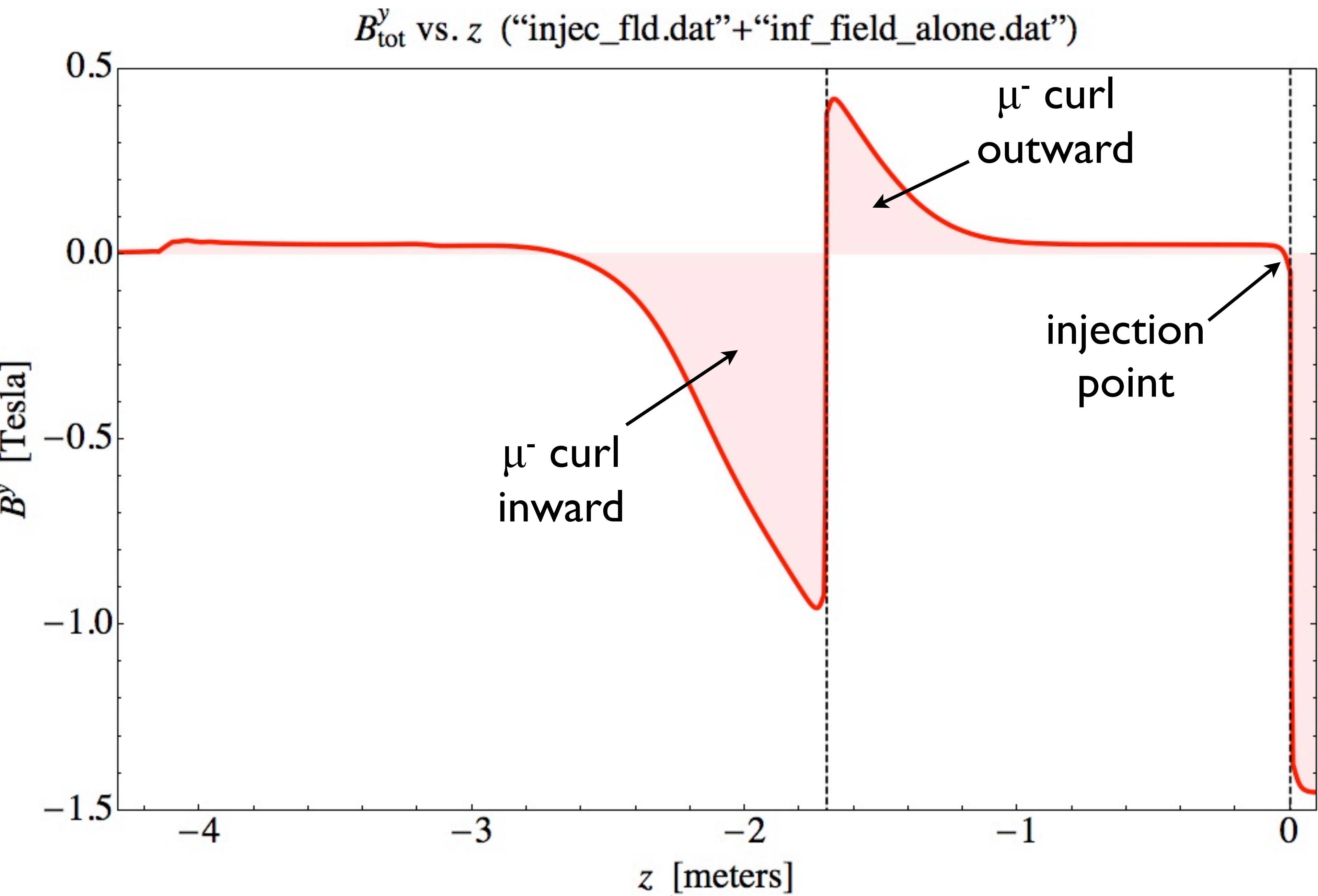
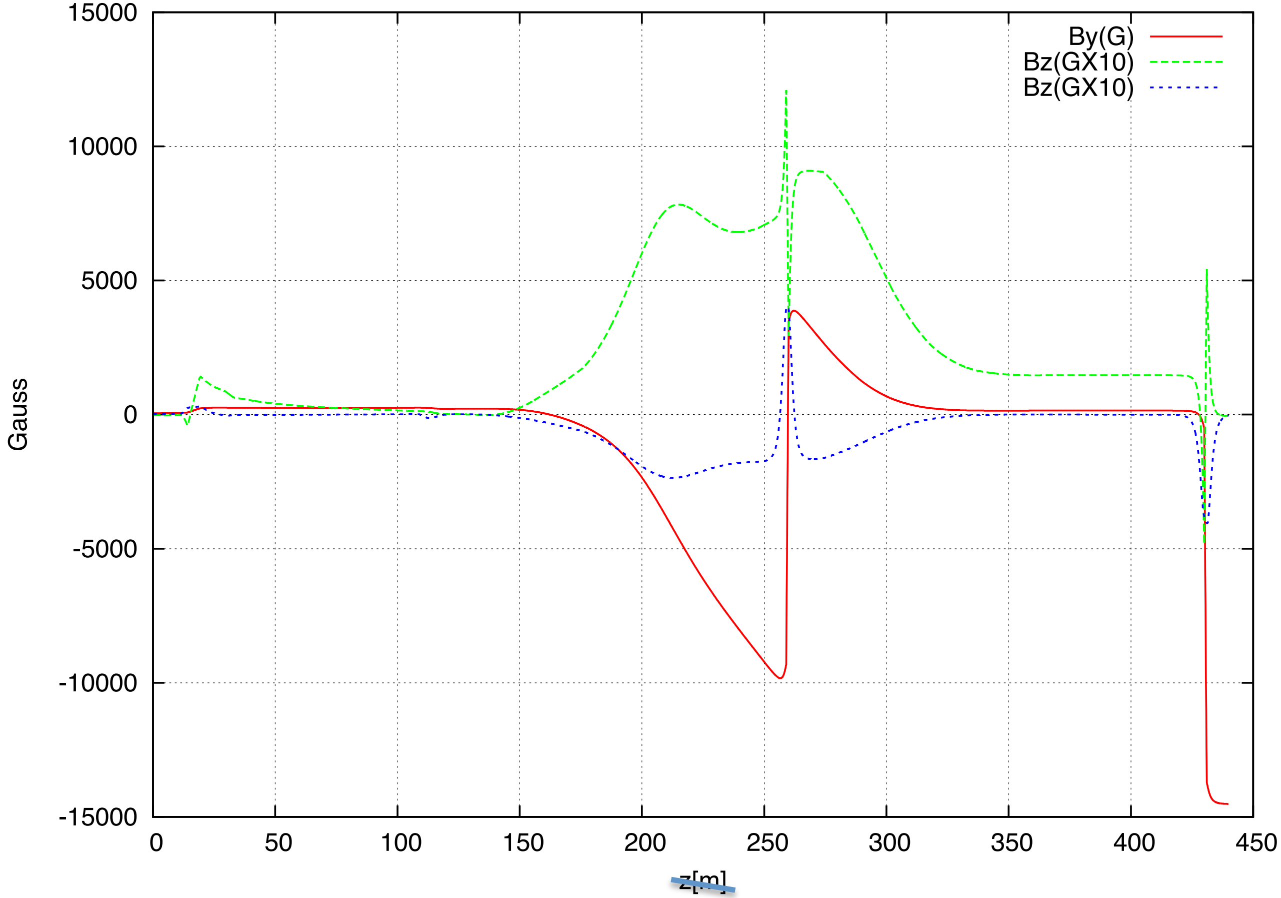
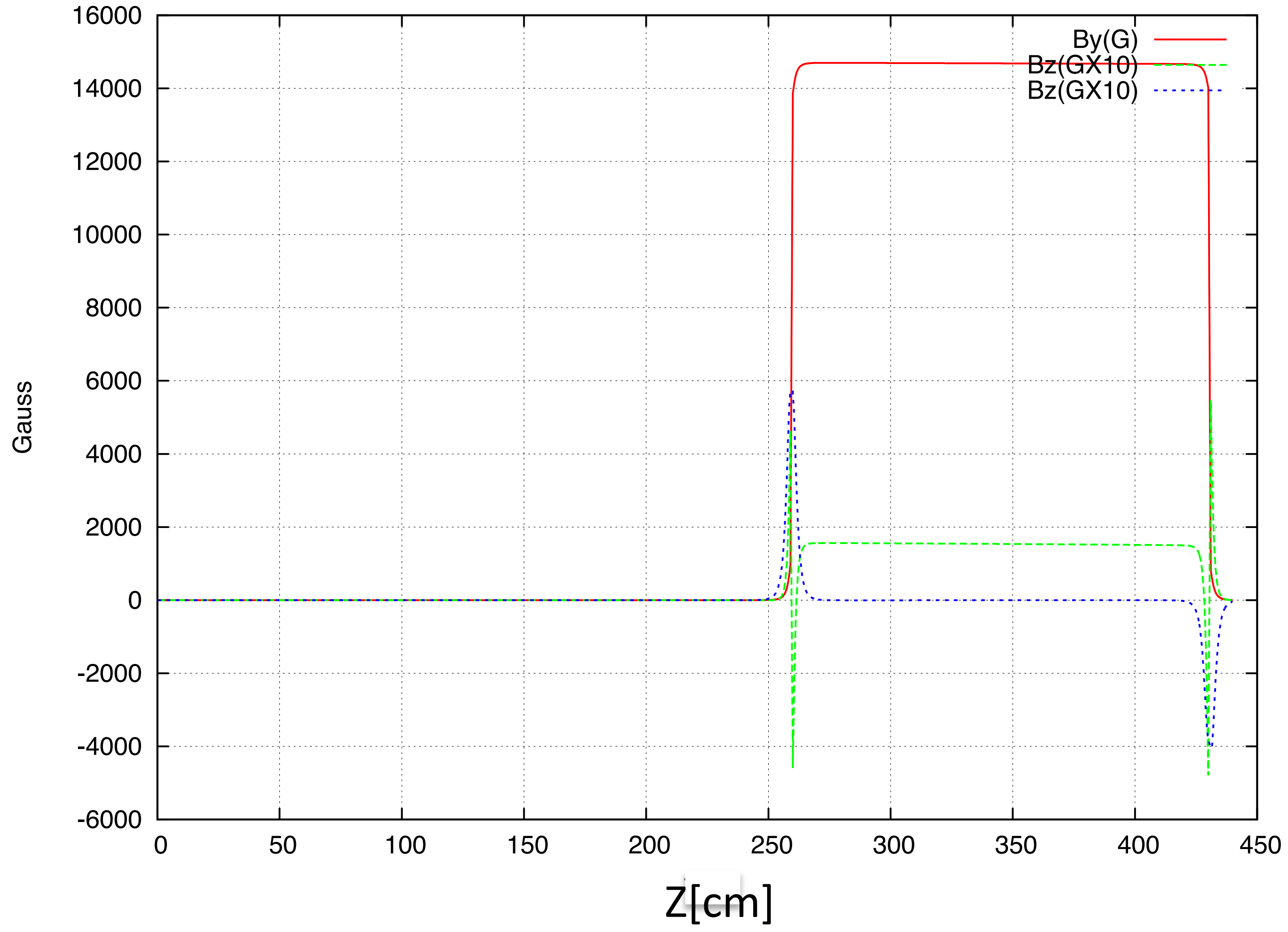
April 11, 2013


B^y_{tot} vs. z ("injec_fld.dat"+"inf_field_alone.dat")
B^y [Tesla]
z [meters]
0.5
0.0
−0.5
−1.0
−1.5
−4
−3
−2
−1
0
μ⁻ curl outward
μ⁻ curl inward
injection point

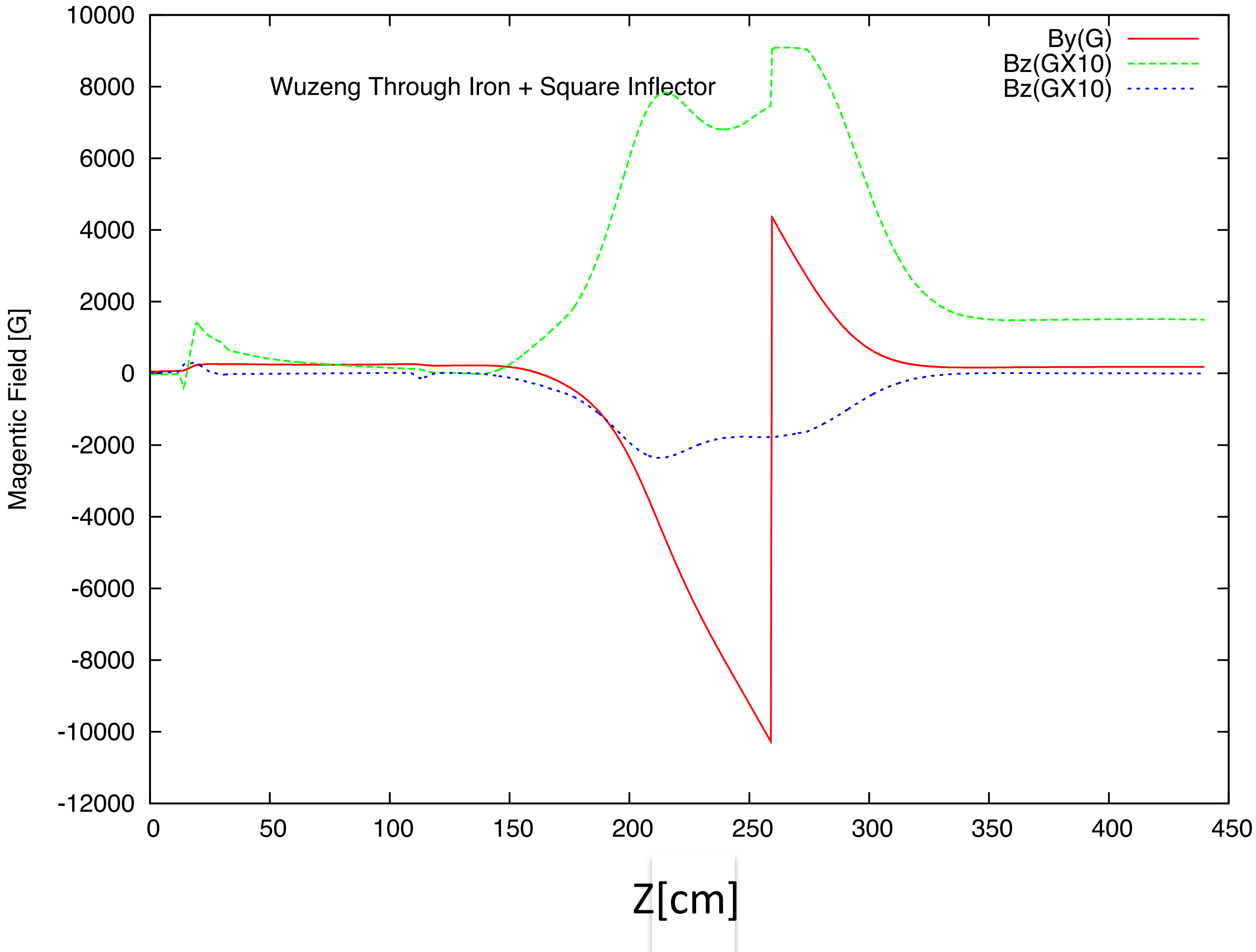


15000
10000
5000
0
-5000
-10000
-15000
Gauss
0
50
100
150
200
250
300
350
400
450
~~z[m]~~
By(G)
Bz(GX10)
Bz(GX10)

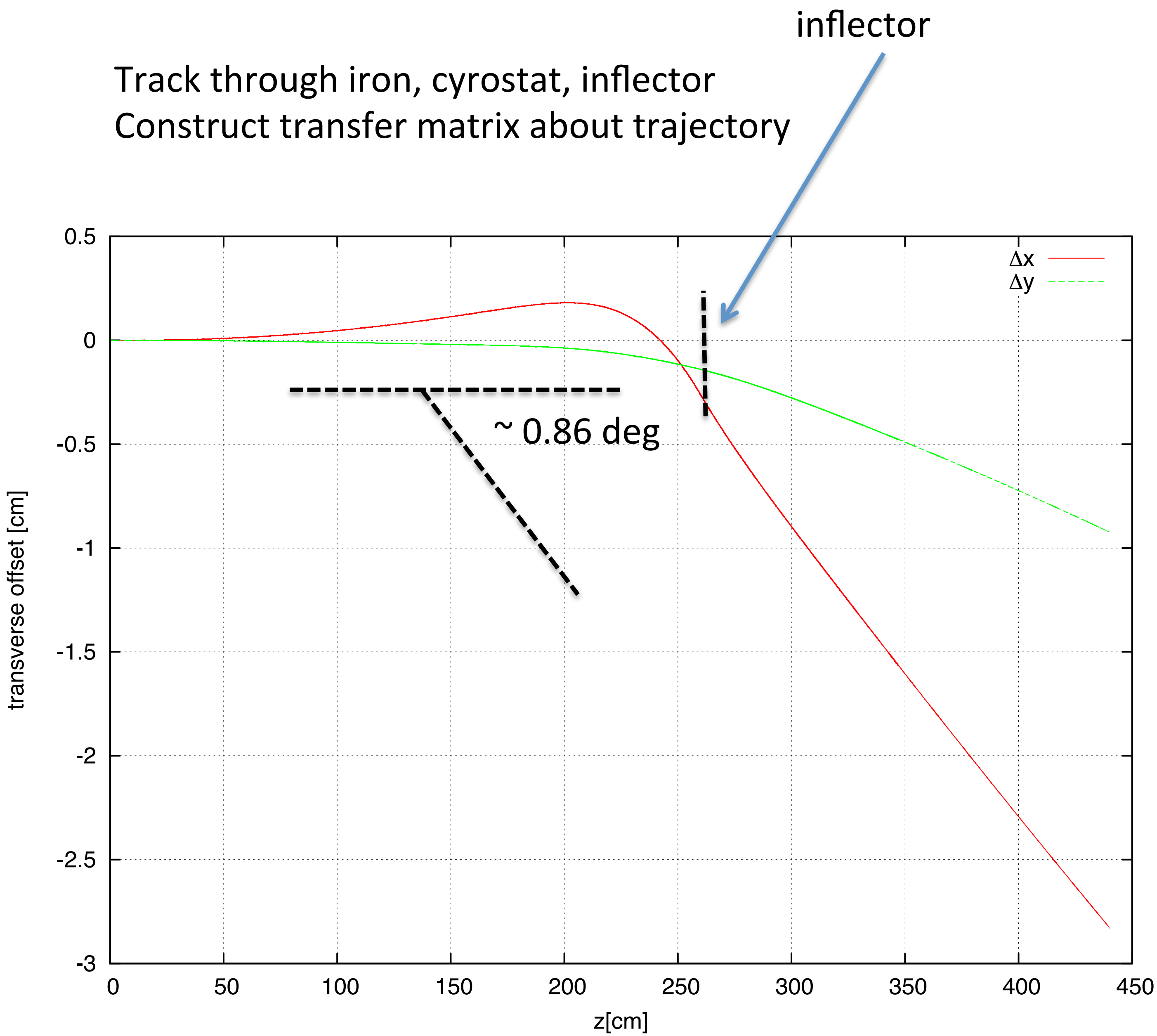
Z[cm]



By(G)
Bz(GX10)
Bz(GX10)
Gauss
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
-4000
-6000
0
50
100
150
200
250
300
350
400
450
Z[cm]


Wuzeng Through Iron + Square Inflector
By(G)
Bz(GX10)
Bz(GX10)
Magentic Field [G]
10000
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
-10000
-12000
0
50
100
150
200
250
300
350
400
450
Z[cm]

Track through iron, cyrostat, inflector
Construct transfer matrix about trajectory



Transfer matrix through iron, cryostat, inflector
Total length = 4.39m

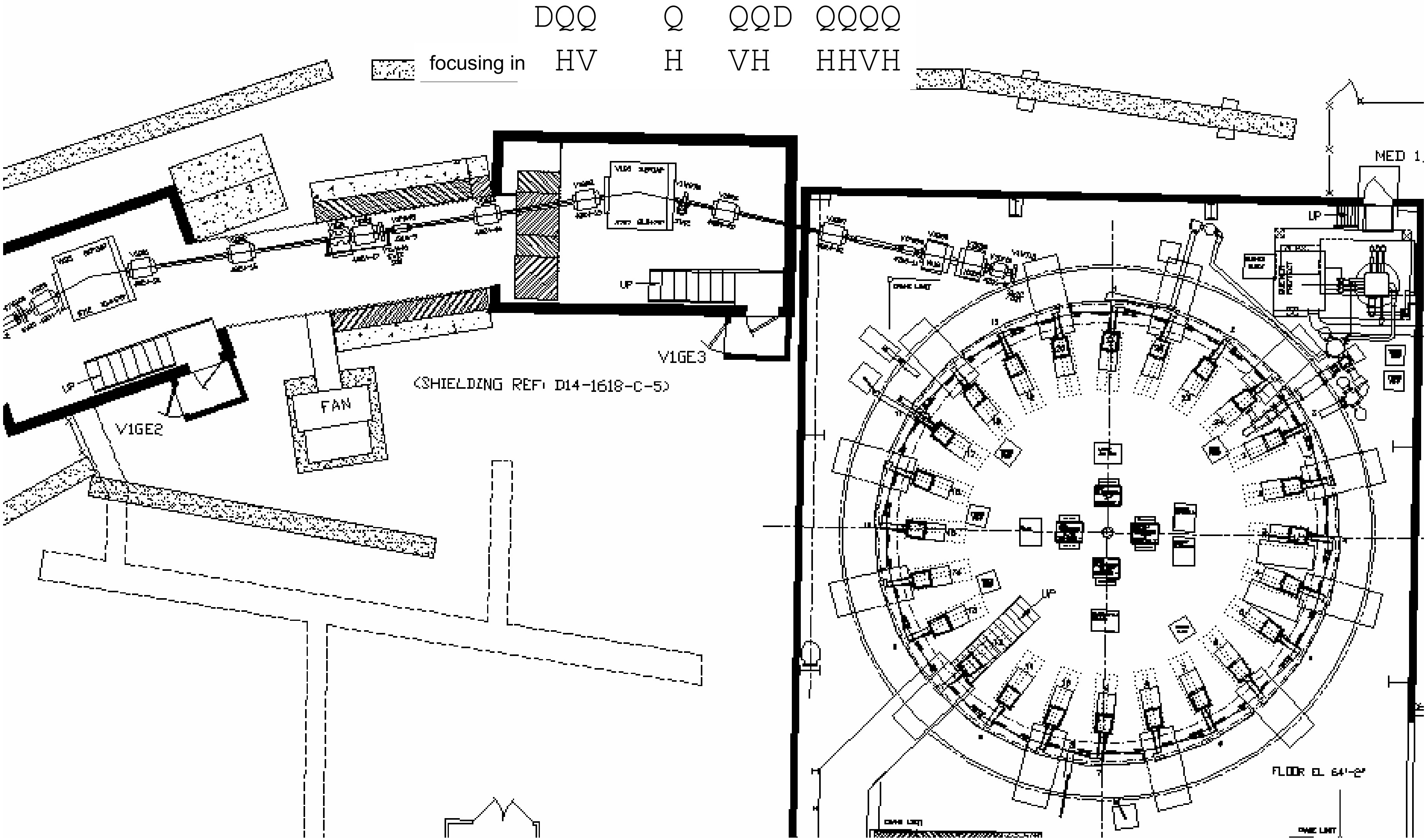
Transfer Matrix : Kick [Matrix symplectic error: 1.185E-02]

1.61951	5.68287	-0.10265	-0.12099	0.00032	0.02890	:	-2.820E-02
0.29750	1.65985	-0.03583	-0.05500	0.00025	0.00047	:	-1.318E-02
-0.08510	-0.05582	0.44649	3.19115	-0.00014	0.00884	:	-9.206E-03
-0.02370	-0.04136	-0.25378	0.40416	-0.00010	-0.00031	:	-5.138E-03
0.00776	0.04529	-0.00296	0.00323	1.00000	0.00046	:	-4.947E-13
0.00000	0.00000	0.00000	0.00000	0.00000	1.00000	:	0.000E+00

The 6X6 transfer matrix propagates the 6-d phase space vector

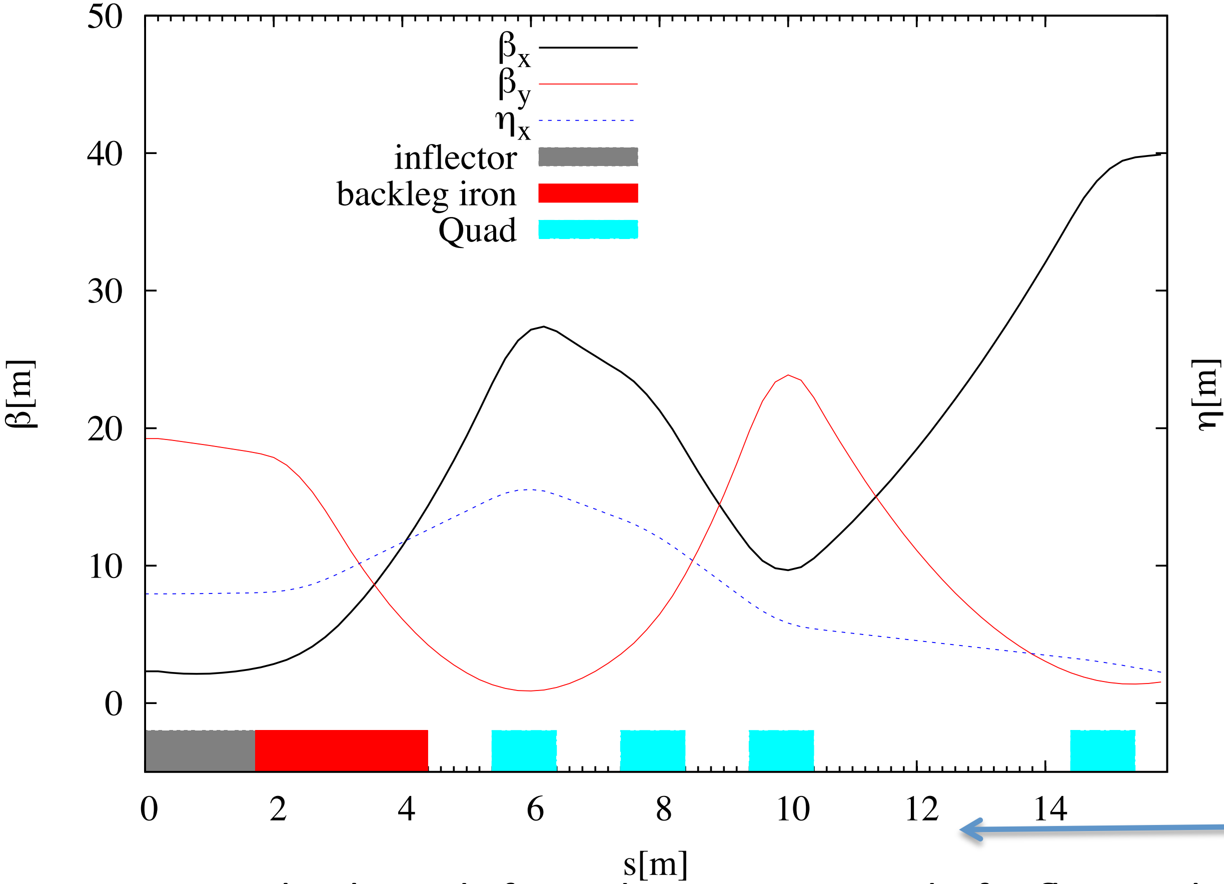
$$\mathbf{x} \rightarrow \begin{pmatrix} x \\ x' \\ y \\ y' \\ z \\ \delta \end{pmatrix}$$

E 821 V line D5 to g-2 ring



40 mm-mrad beam clears inflector if at exit
β_x=2.45, α_x= -0.41, β_y=19.1, α_y= 0.045

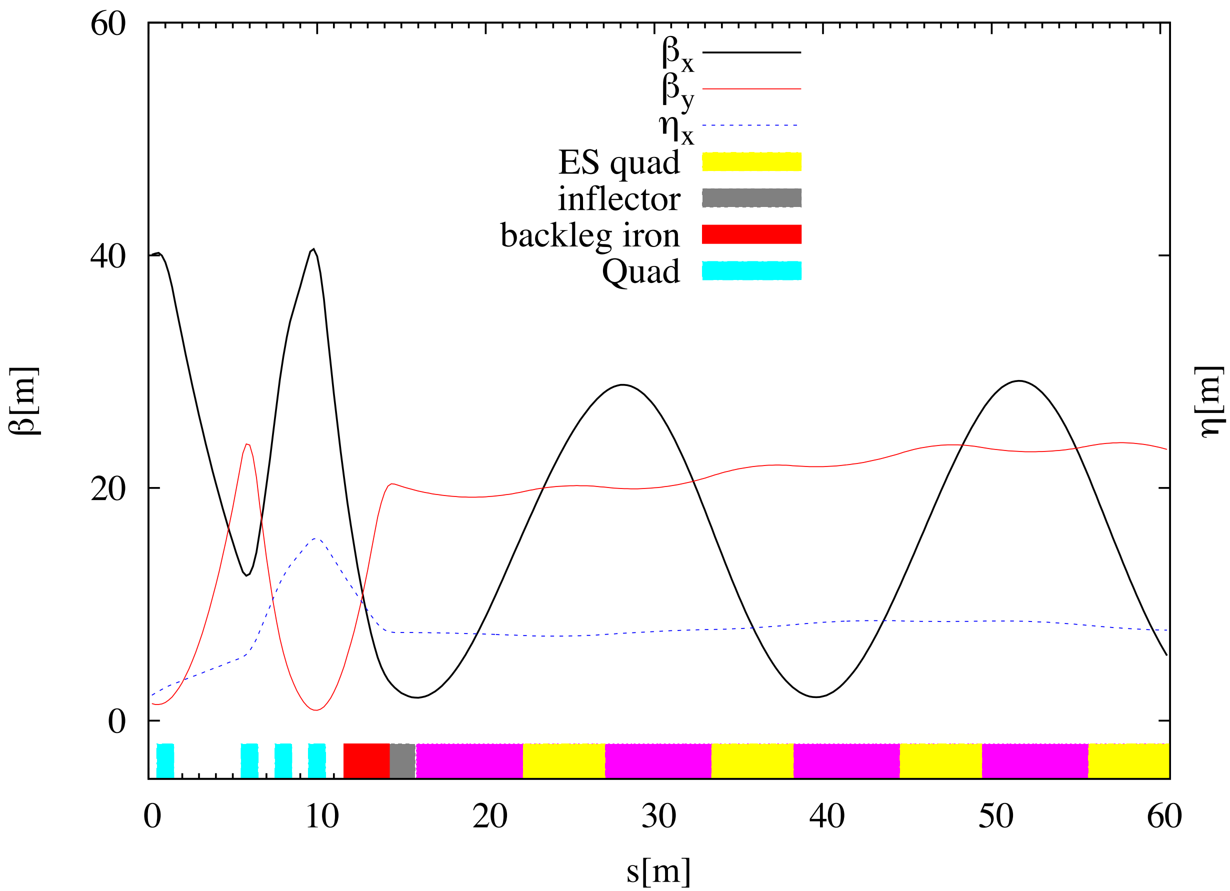
σ_E/E = 0.15% clears inflector if at exit
η= 7.96, η'=0.057



Quadrupoles optimized to minimize α,η, η' at entrance to beam line and with "reasonable" β

Beam travels right to left

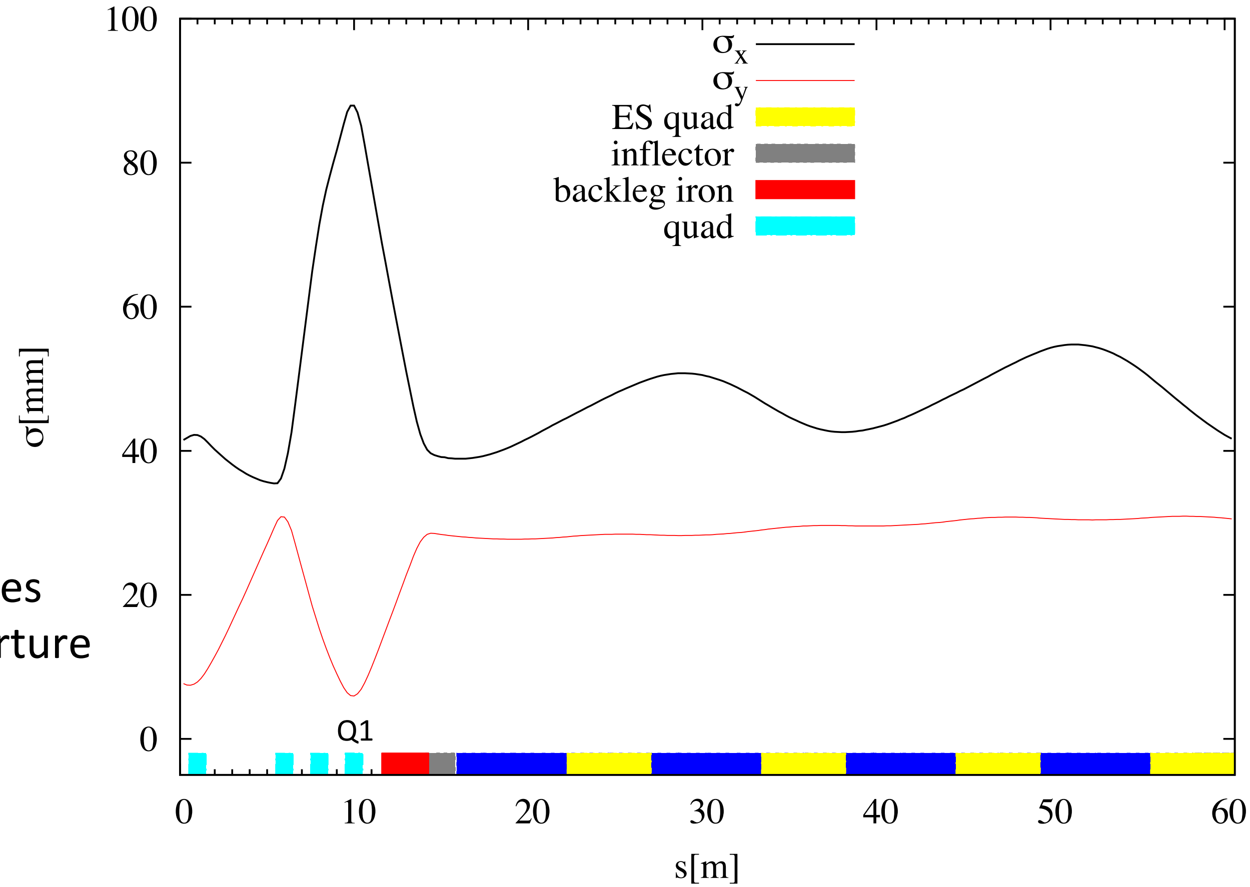
Propagate backwards from downstream end of inflector through backleg iron and through beam line quadrupoles



Beam travels left to right

Propagate forward through beam line quadrupoles, backleg iron, inflector and into ring

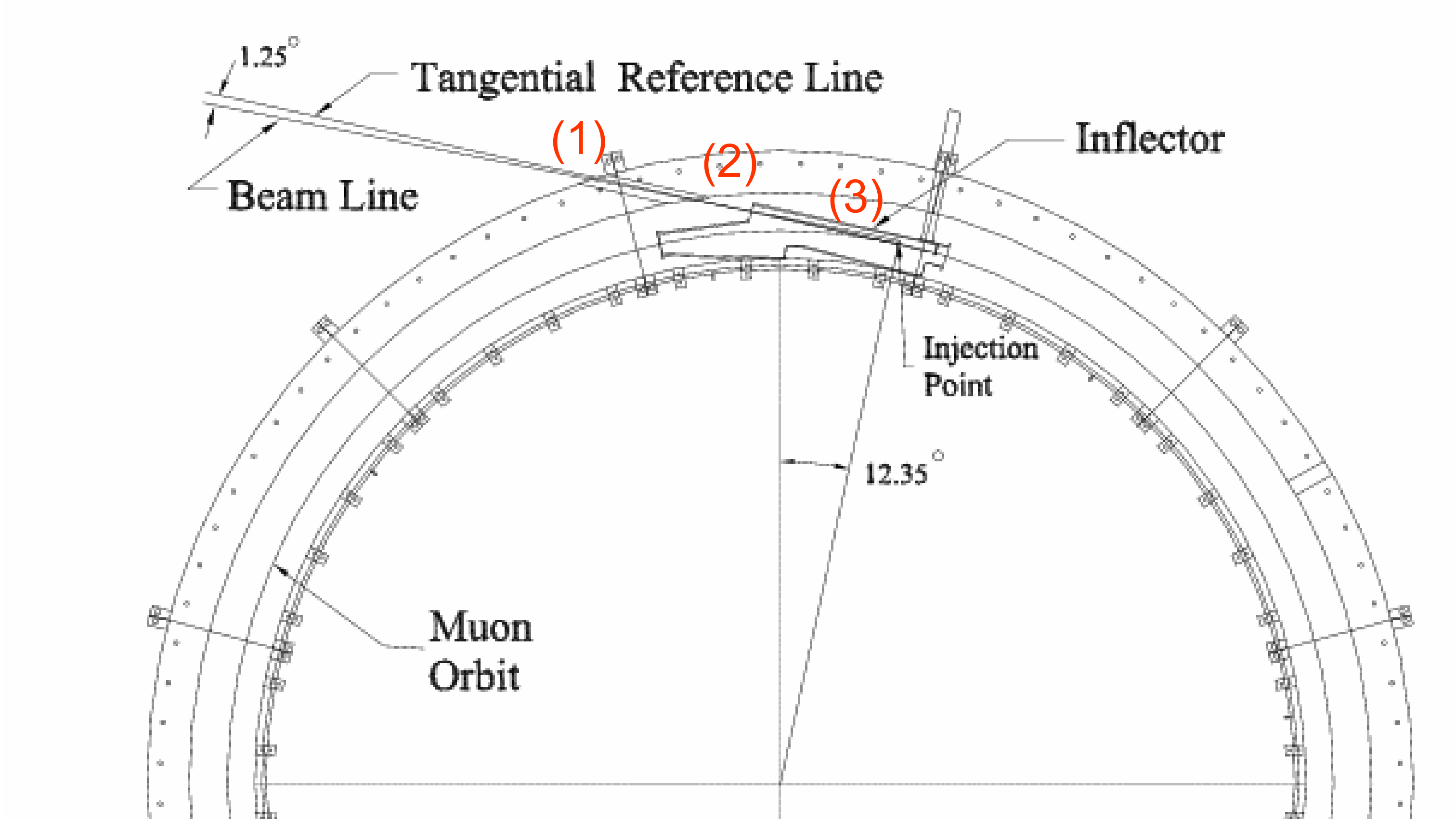
$\sigma = [\beta\varepsilon + (\eta\delta)^2]^{1/2}$
ε = 40 mm-mrad, δ = 0.5%



Q1 requires large aperture

Propagate forward through beam line quadrupoles, backleg iron, inflector and into ring

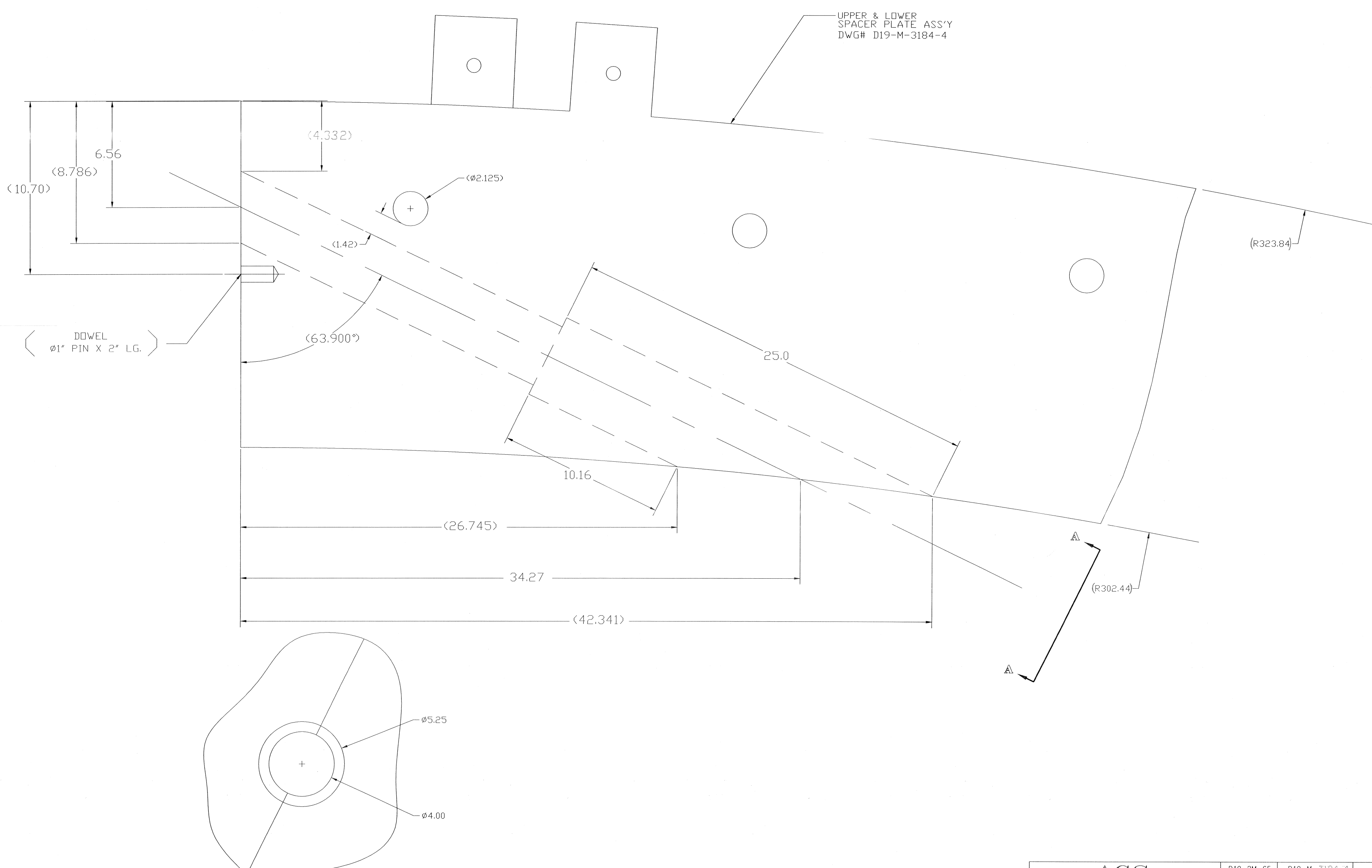
How do twiss parameters propagate through iron, cryostat, inflector into ring



(1) hole in back leg, (2) storage ring fringe field, (3) inflector channel

PLAN VIEW

(SHOWN SPACER LEFT SIDE)



VIEW A-A

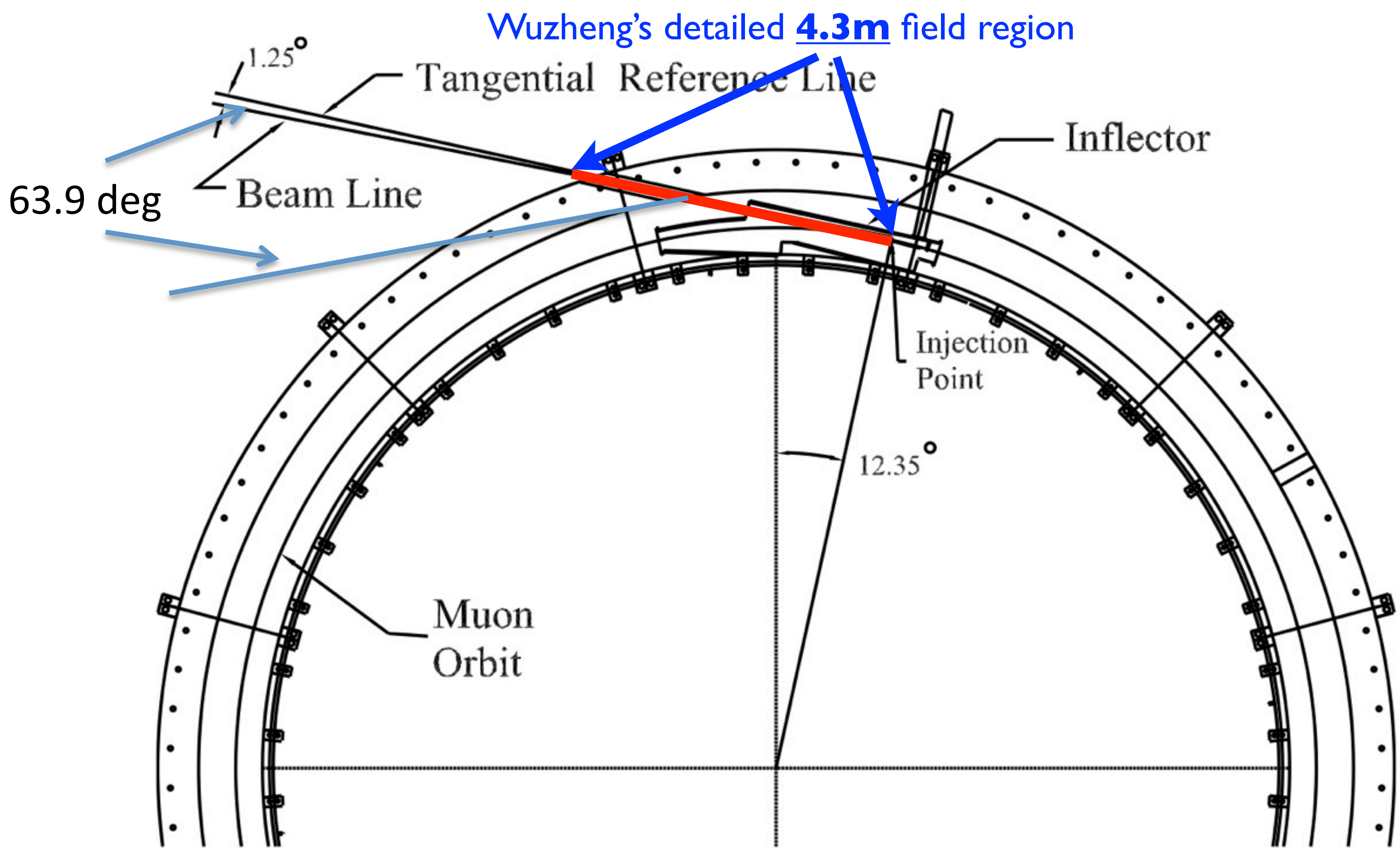
AGS				D19-2M-65	D19-M-3184-4	1	
				JOB NUMBER	USED ON DWG. NO.	NO. PER ASS'Y	
	INTERPRET DRAWING AS PER ANSI Y14.5M 1982	Q.A. CATEGORY A-3	DATE	BROOKHAVEN NATIONAL LABORATORY ASSOCIATED UNIVERSITIES, INC. UPTON, N.Y. 11973			
		DRAWN BY: ZION ARMOZA	2-15-94				
	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	CHECKED BY		AGS SUPERCONDUCTING DEVICES			
	DECIMAL TOLERANCES .X ±.030 .XX ±.015 .XXX ±.005 ANGULAR TOLERANCE ± .5°	SAFETY APPROVAL		MUON G-2 EXPERIMENT			
		VACUUM APPROVAL		INFLECTOR LINE B, ø4 & ø5.25 HOLE			
		DESIGN APPROVAL		D19-M-4337-5			REV. A
	125 FINISH / BREAK SHARP EDGES	ENGINEER APPROVAL: I. Pock		DRAWING NUMBER			
OUTSTANDING ECN	MAX. .03 MIN. .01	SUPVR. APPROVAL	2-17-94	MATERIAL: STEEL	SCALE: 1/2	WEIGHT: –	SHEET 1 OF 1

REV.	ZONE	ECN NO.	DATE	BY	CKR	APP.

ITEM NO.	QTY.	DESCRIPTION	MAT'L, DWG. NO. OR BNL NO.

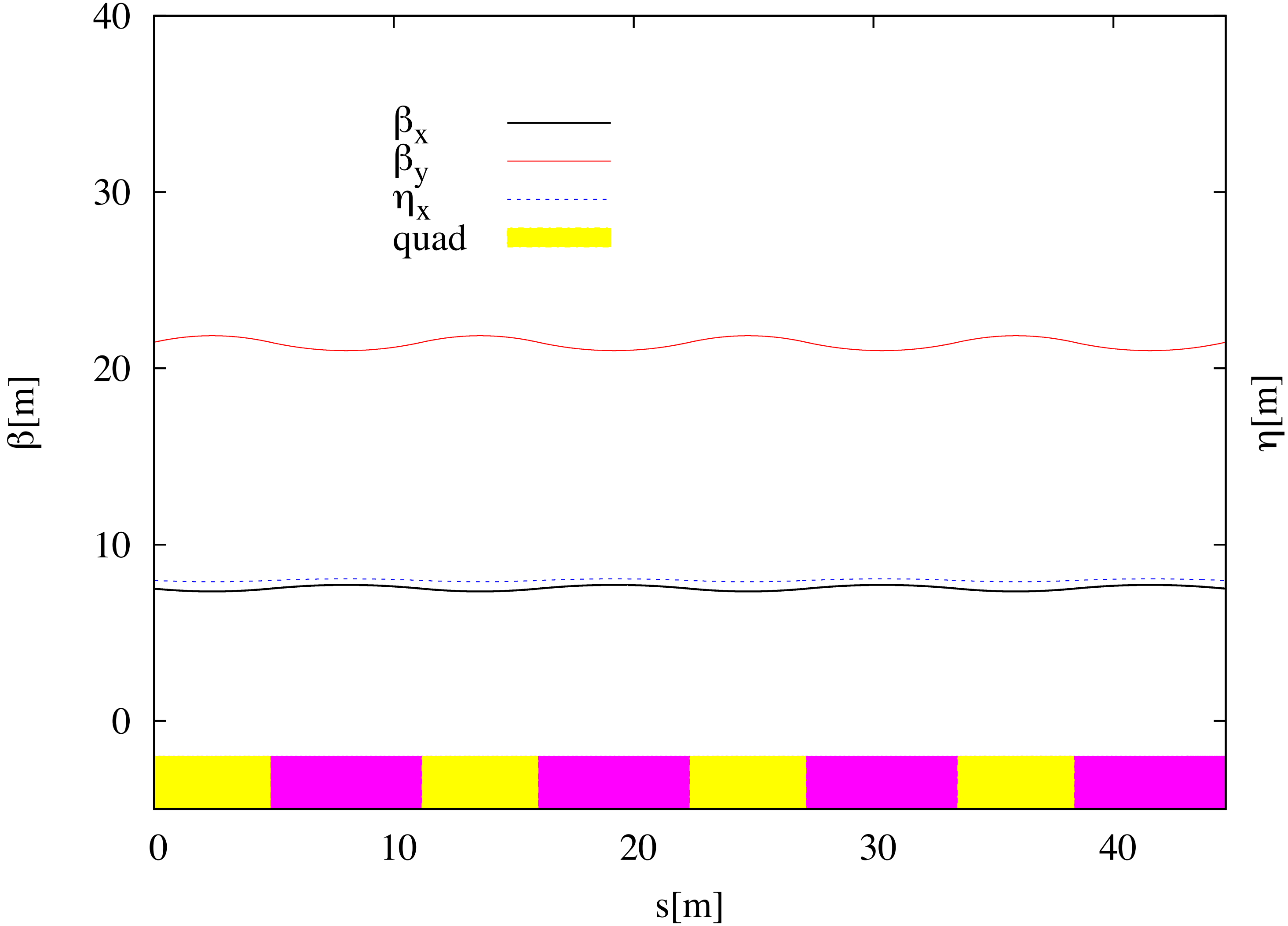
D19-M-4337-5

1 *AUTOCAD

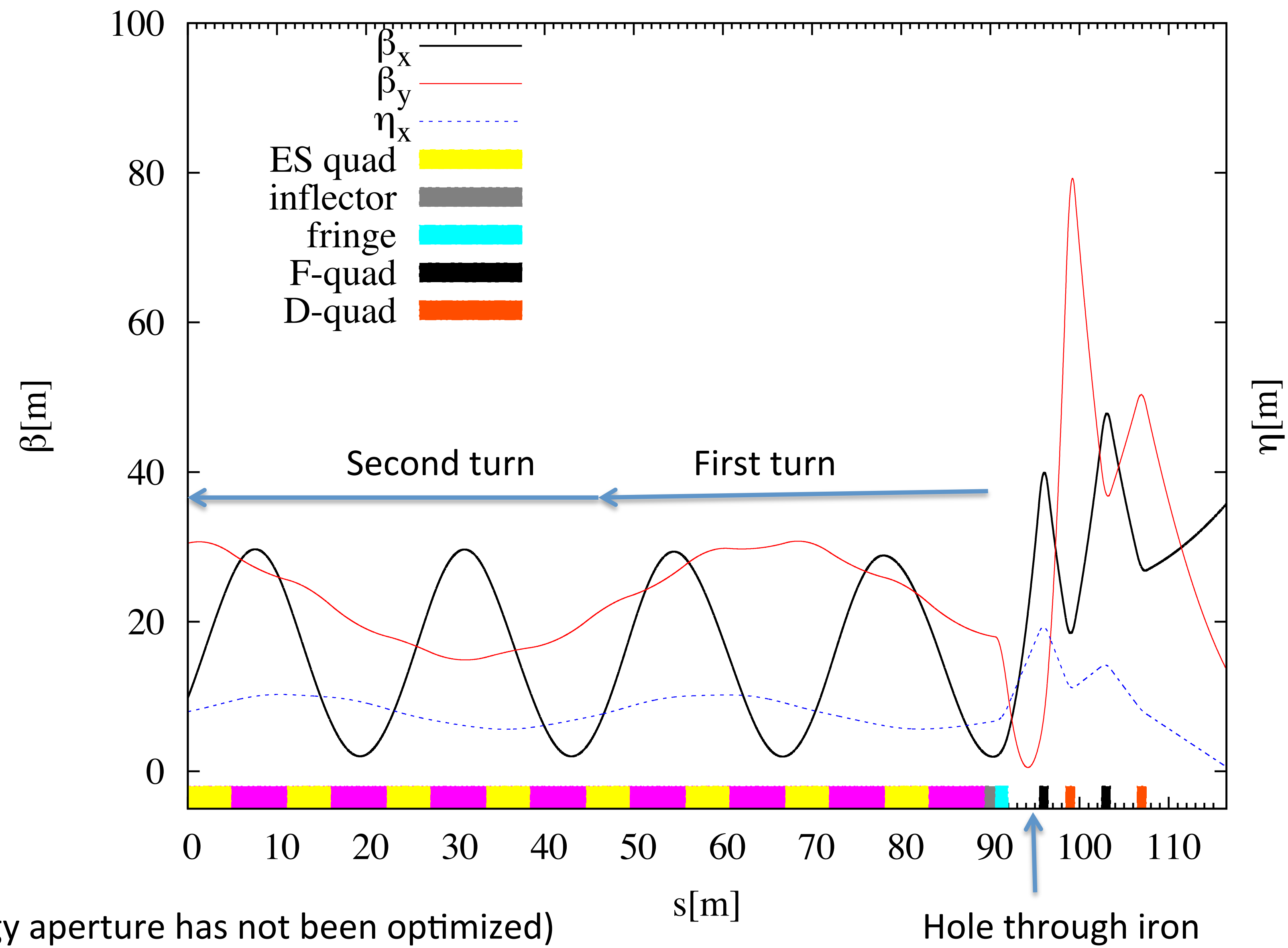


Effective gradient $G \approx (1+\cos(63.9))/2\ (\Delta B_y/\Delta R)$

Twiss parameters (A-matrix) is chosen to be single valued in ring



β,α at s=0 are chosen so that 40mm-mrad beam fits through inflector aperture.
Quads upstream of iron (F-quads and D-quads) optimized to achieve reasonable values at 120m



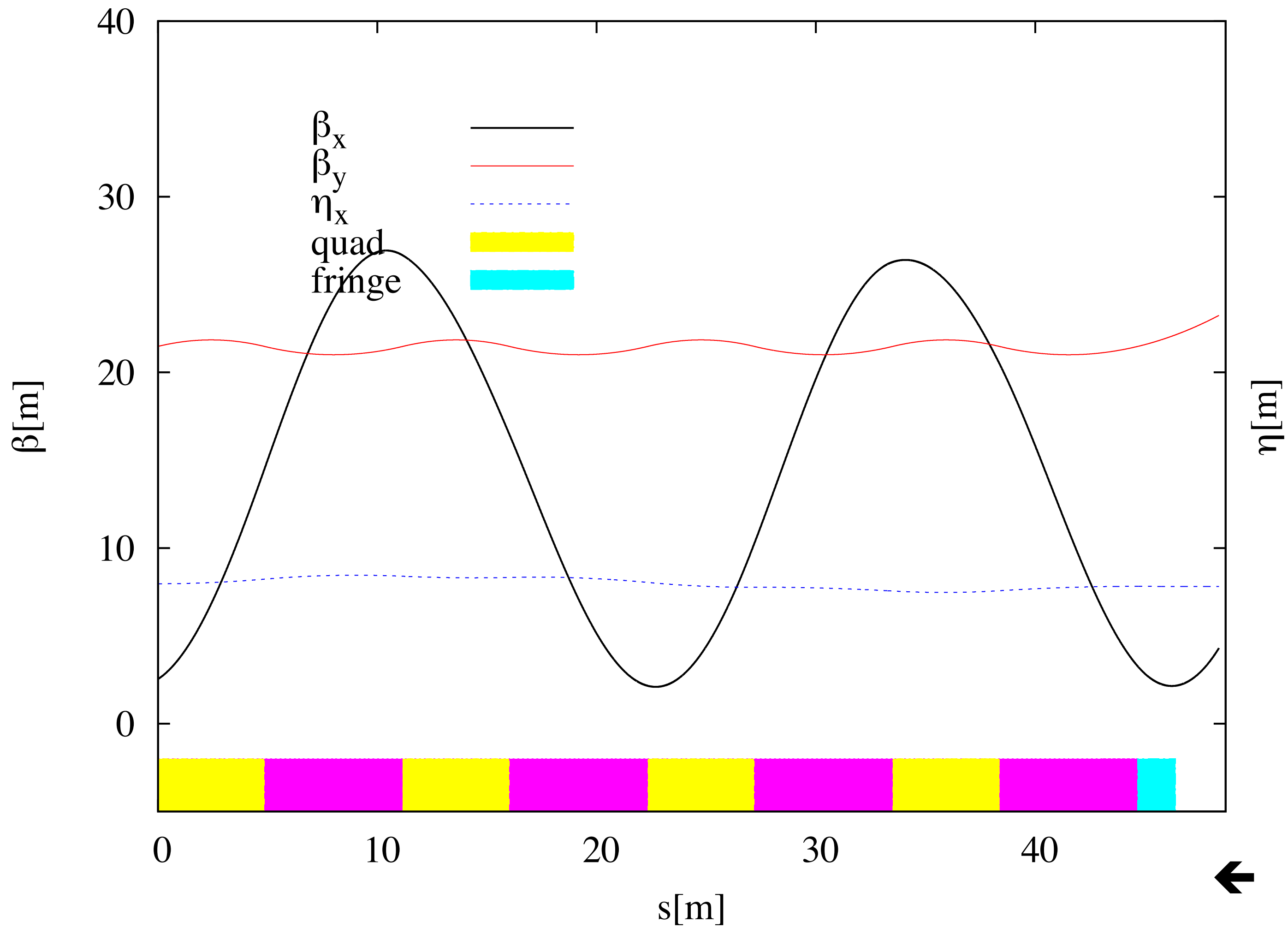
(Energy aperture has not been optimized)

Conclusion

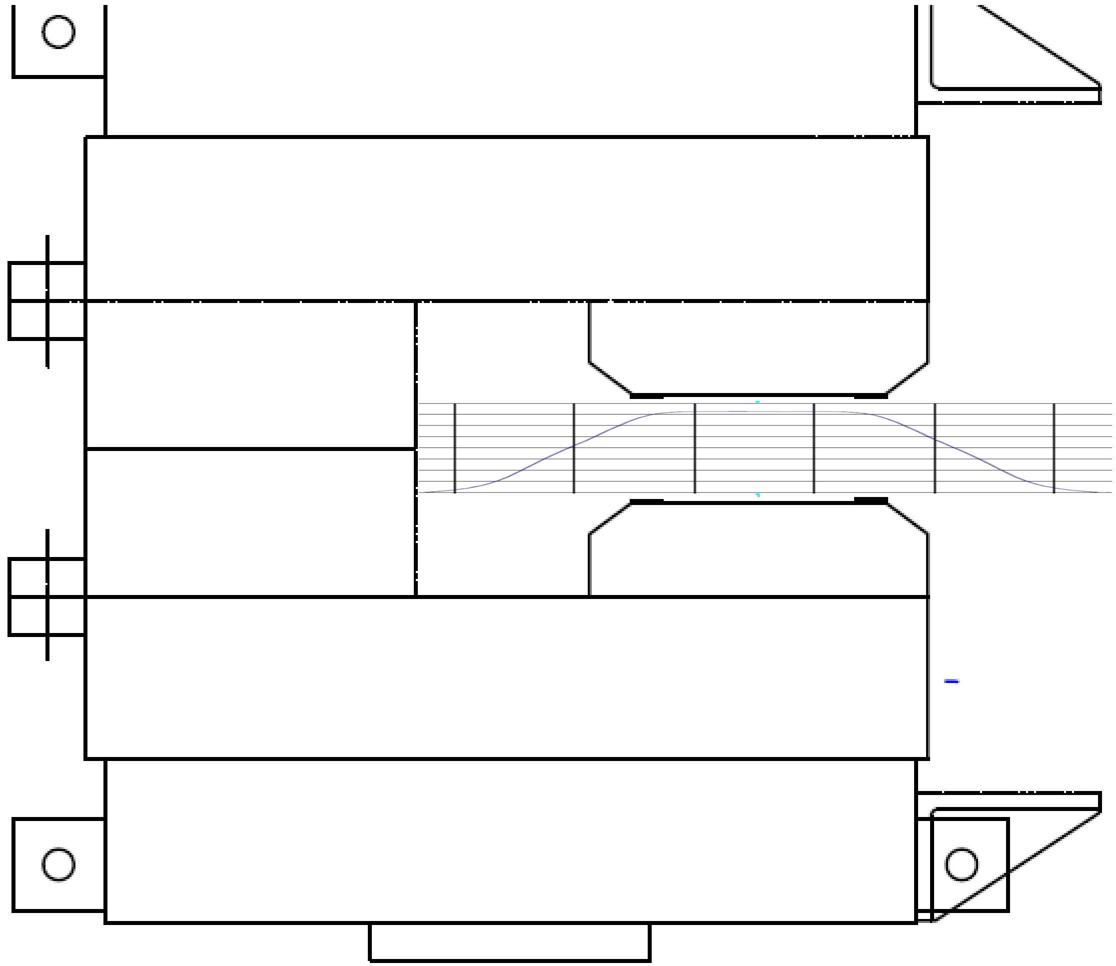
- There will significant horizontal defocusing in dipole fringe
- Better estimate of effective gradient will be determined from OPERA calculation of B-field along injection channel
- Place focusing quadrupole in the injection line as close to the iron as possible in order to most effectively compensate fringe defocusing

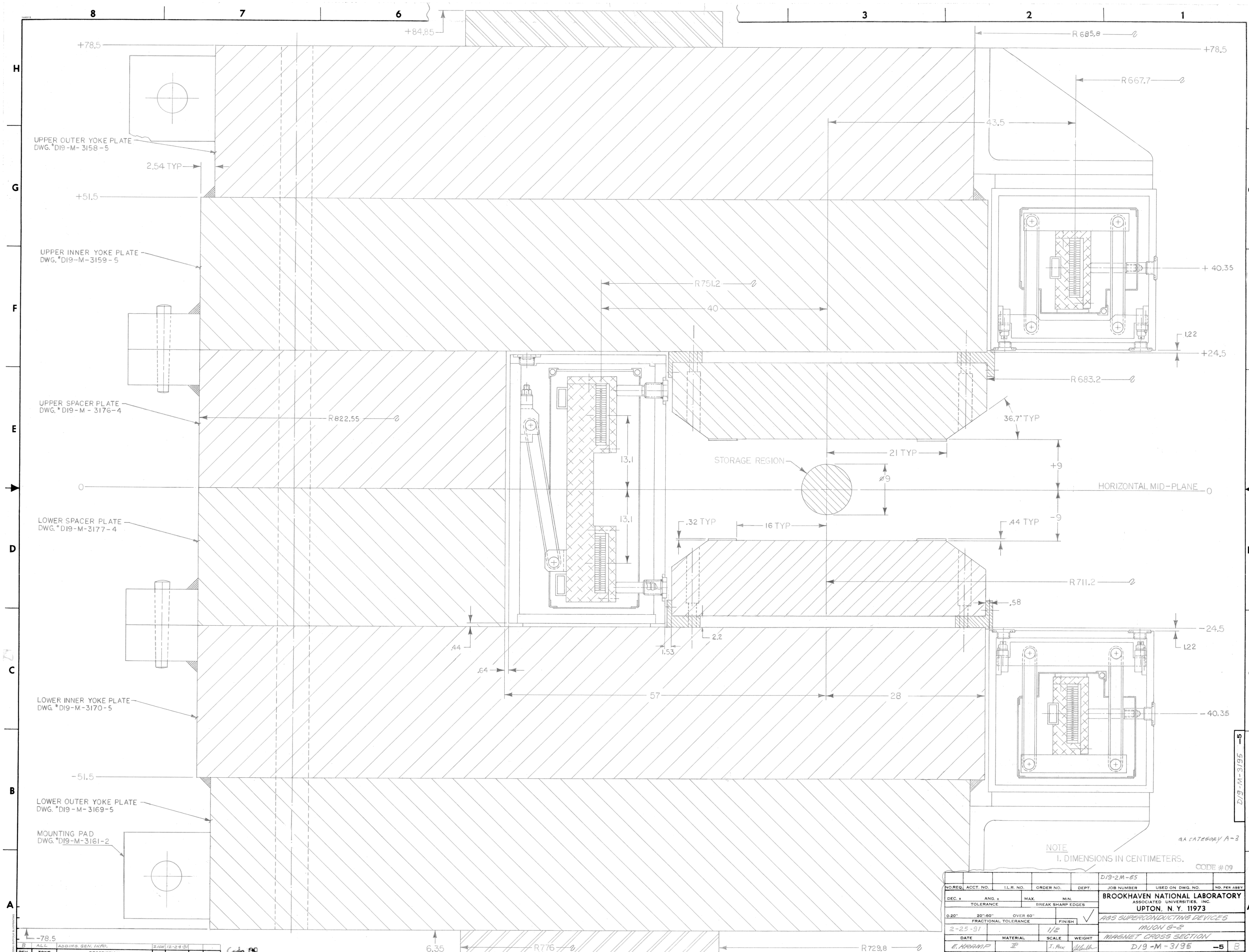
Suppose we choose β_x β_y at upstream end of inflector so that 40 mm-mrad so that most of the beam fits through the inflector aperture

(Assuming *ideal* inflector: zero field, opened ends)



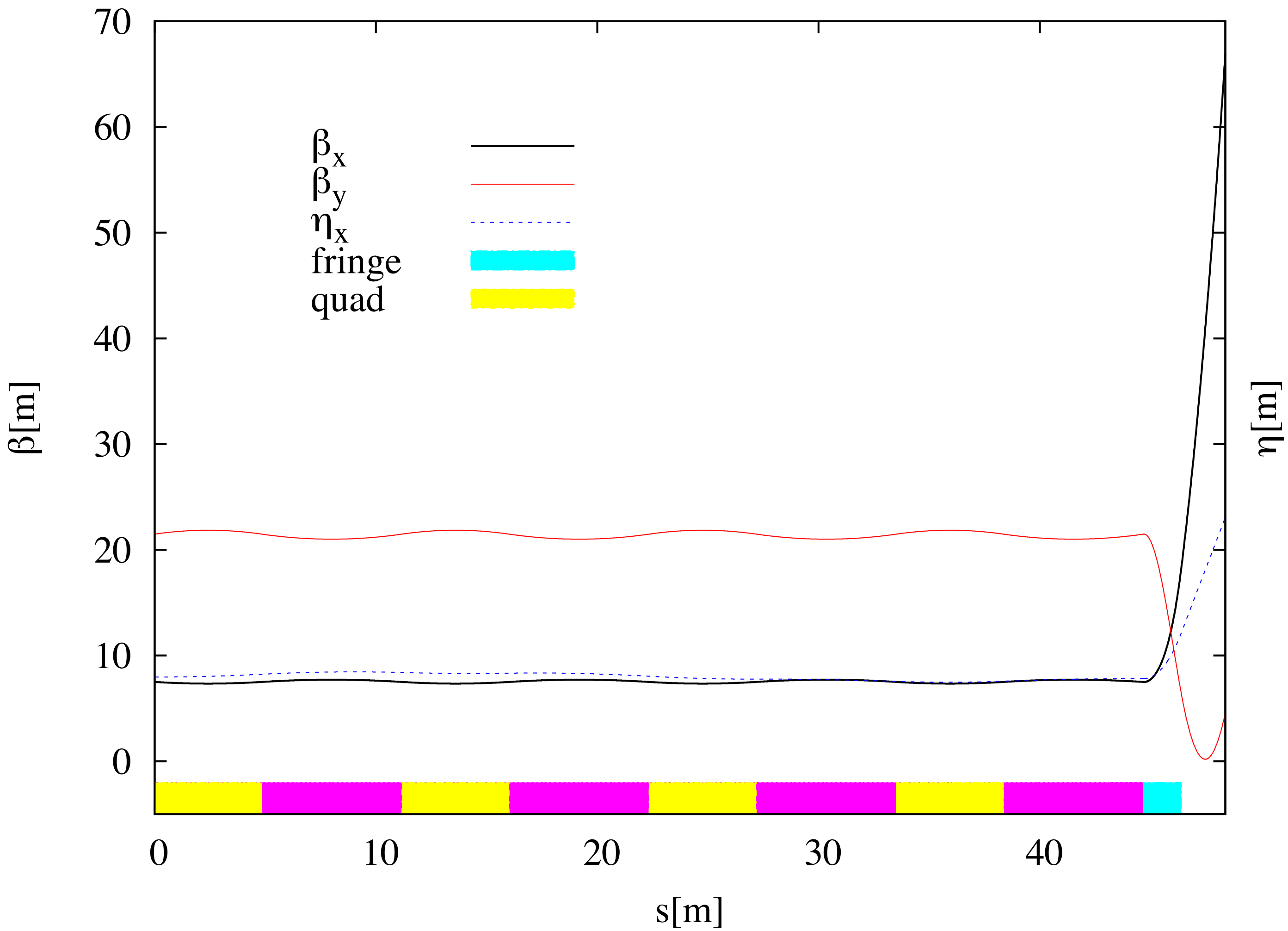
Cross Section of Storage Ring and Magnetic Field




UPPER OUTER YOKE PLATE
DWG. #D19-M-3158-5
UPPER INNER YOKE PLATE
DWG. #D19-M-3159-5
UPPER SPACER PLATE
DWG. #D19-M-3176-4
LOWER SPACER PLATE
DWG. #D19-M-3177-4
LOWER INNER YOKE PLATE
DWG. #D19-M-3170-5
LOWER OUTER YOKE PLATE
DWG. #D19-M-3169-5
MOUNTING PAD
DWG. #D19-M-3161-2
EXTERNAL PLATE, DWG. #D19-M-3183-4
STORAGE REGION
HORIZONTAL MID-PLANE
R685.8
R667.7
R751.2
R822.55
R683.2
R711.2
R776
R729.8
+84.85
+78.5
+51.5
+40.35
+24.5
+9
0
-9
-24.5
-40.35
-51.5
-78.5
2.54 TYP
43.5
40
36.7° TYP
21 TYP
16 TYP
.32 TYP
.44 TYP
ø9
13.1
13.1
1.22
.58
2.2
1.53
.44
.64
57
28
6.35
NOTE
1. DIMENSIONS IN CENTIMETERS.
BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.
UPTON, N. Y. 11973
AGS SUPERCONDUCTING DEVICES
MUON G-2
MAGNET CROSS SECTION
D19-M-3195
-5

Propagate backwards once around ring (cc) and then through fringe with gradient 3.625 T/m

The effective focusing is *very strong*



In the other direction:
Use the same β_x β_y that got beam through *idea*l inflector but this time include focusing of fringe.