Discussion on Muon Collider Lattice in TEVATRON TUNNEL

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Larger number of Cells does not significantly reduce the Strength of the bending field

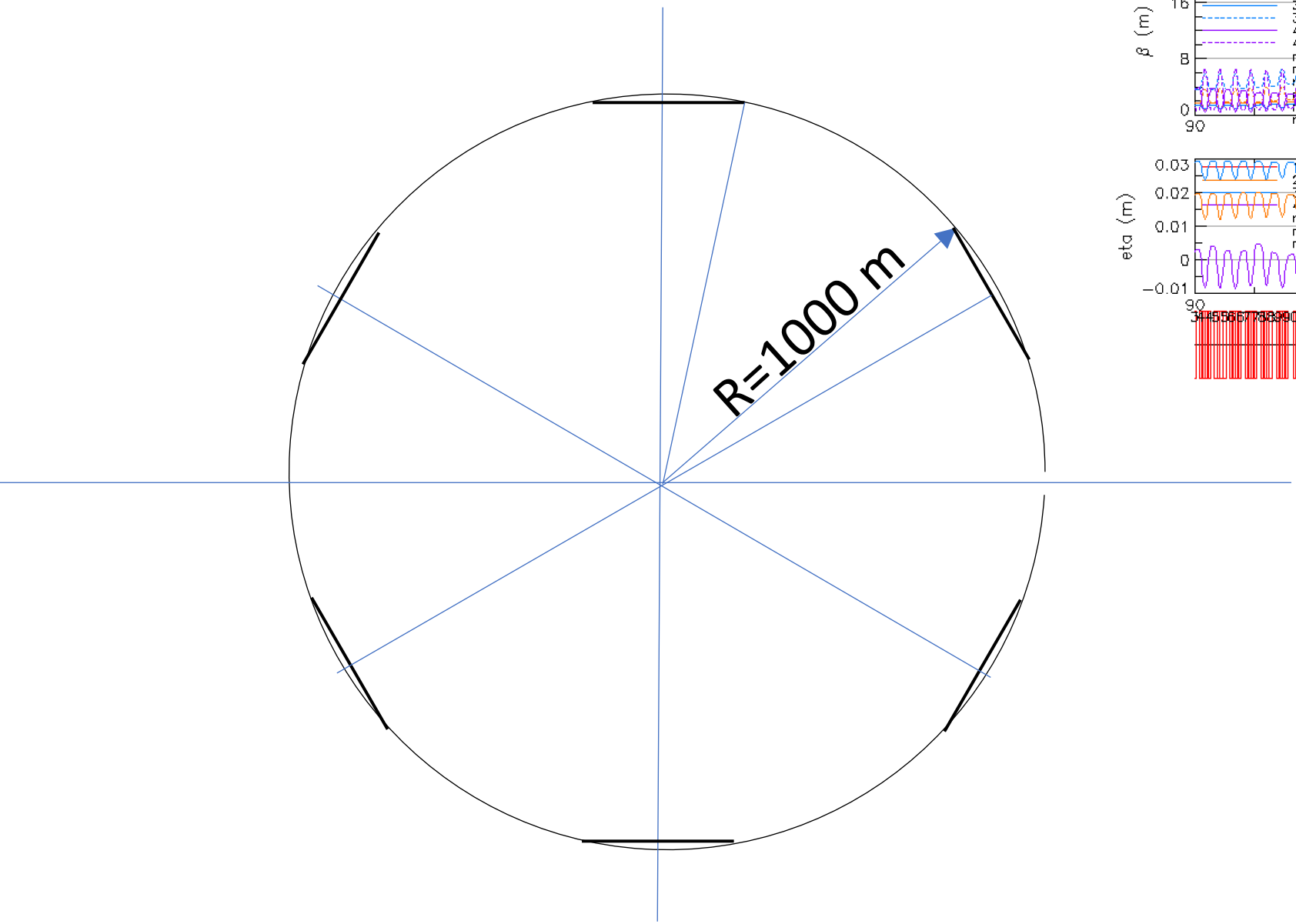
$$\theta = \frac{L_D \cdot B_D}{BRHO} \qquad B_d = \frac{BRHO \cdot \theta}{L_D}$$

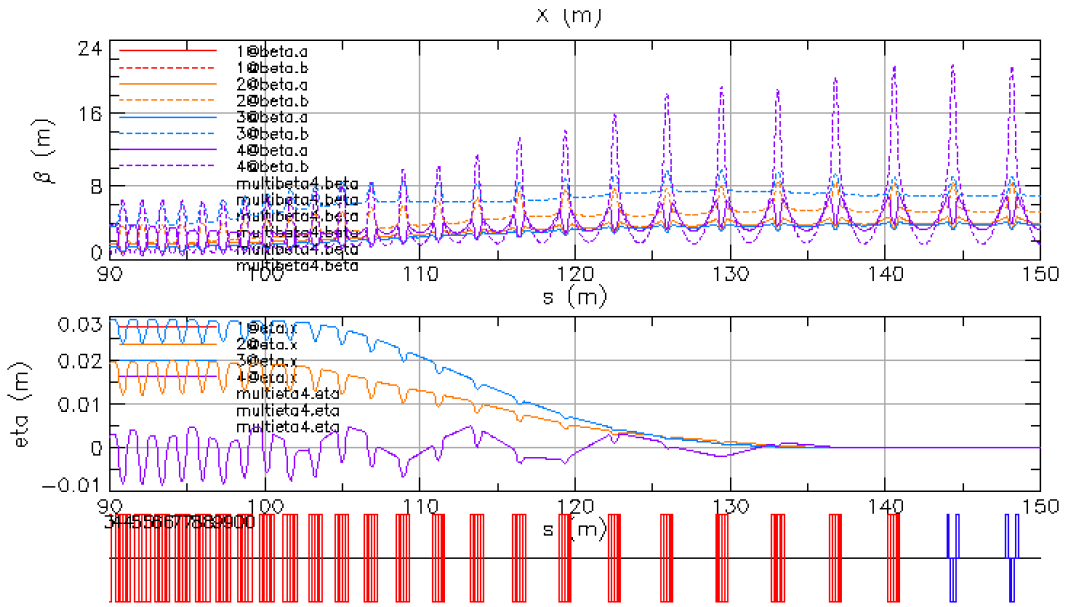
$$L_{CELL} \cong \frac{2\pi R}{N_{Cell}} = L_{QD} + L_{BD} \approx 2 \cdot L_D \quad (L_{QD} \approx L_{BD})$$

$$L_D = \frac{2\pi R}{2 \cdot N_{Cell}} \qquad B_D \approx \frac{BRHO \cdot 2\,N_{Cell}}{2\pi R} \frac{2\pi}{N_{Cells}} \approx \frac{2 \cdot BRHO}{R}$$

BRHO=12675.43561263, R~997m BD= 12675.43561263/997= 12.7136 T

Sketch of the TEVATRON





LATTICES for Muon Collider @ TEVATRON

ANGLE OF ONE ARC PARA = 0.9472 = 54 degrees

- 5 TeV 72 Cells,

GF=783.006 T/m, GD=-232.17154,

Xmin= -80.92123 mm

ANGD	BYD	ANGF	BYF
0.009906156	12.871111291	0.003249400	12.871111291

BLD	QLF	LCEL	DL3P	NCEL
9.755555556	3.200000000	13.155555556	0.100000000	72.00

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LITTLE BETTER OPTIMIZED 72 CELLS PER ARC

72 cells, **GF=470.929, GD=-413.075**,

BLD	QLF	LCEL	DL3P	NCEL
6.355555556	6.600000000	13.155555556	0.100000000	72.000000000

Xmin= -57.16556, Xmax= 57.86438 mm, nux_max=0.37076,nuy_min=0.038,

BYD	**BYF**
12.87111 T	**12.8711 T**

68 Cells

GF = 411.321, GD = -382.166 T/m

BYD (T) BYF

12.8600 12.8600

x_max= 63.98 mm, Xmin= -63.581 mm,

QLF	DL2P	BLD	RATIO	ANAR
7.200000000	0.100000000	6.529411765	1.102702703	0.947200000

ANGD	ANGF	RDIP	RQF
0.006624527	0.007304884	985.641891892	985.641891892

BLD	QLF	LCEL	DL3P	NCEL
6.529411765	7.200000000	13.929411765	0.100000000	68.000000000

62 Cells

GF = 338.360 GD = -322.17258

BYD BYF

12.843573612 T 12.843573612 T

ANGD	ANGF	RDIP	RQF
0.007779259	0.007498160	986.908783784 m	986.908783784 m

BLD	QLF	LCEL	DL3P	NCEL
7.677419355	7.400000000	15.277419355	0.100000000	62.00

Xmin= -76.409 mm Xmax= 77.64799

Aperture = 154 mm

52 Cells

GF = 338.360 T/m GD = -322.17258 T/m

BYD	BYF
12.843573612 T	**12.843573612 T**

ANGD	ANGF	RDIP	RQF
0.007779259	0.007498160	986.908783784	986.908783784

BLD	QLF	LCEL	DL3P	NCEL
7.677419355	7.400000000	15.277419355	0.100000000	62.000000000

Xmin= -76.409 mm Xmax= 77.64799

Aperture = 154 mm

52 Cells 2TeV→5 TeV

GF = 239.2578 T/m GD = -224.98 T/m

QLF	DL2P	BLD	RATIO	ANAR
8.600000000	0.100000000	9.415384615	0.913398693	0.947200000

ANGD	ANGF	RDIP	RQF
0.009519911	0.008695474	989.020270270	989.020270270

BLD	QLF	LCEL	DL3P	NCEL
9.415384615	8.600000000	18.215384615	0.100000000	52.000

BYD	BYF
12.816153514	12.816153514

GF = 261.472906180840 GD = -202.091804711524

Xmin=-108.745 mm, x_max= 109.315, nux=0.37943, nuy_min= 0.03837

Aperture = 218.06 mm

42 Cells 2TeV→5 TeV

GF = 153.5906 T/m **GD = -150.0034T/m**

QLF	DL2P	RATIO	ANAR
12.000	0.100000000	1.159153634	0.947200000

ANGD	ANGF	RDIP	RQF
0.010445010	0.01210737	991.131756757	991.131756757

BLD	QLF	LCEL	DL3P	NCEL
10.352380952	8.600000000	22.552380952	0.100000000	42.000

BYD	BYF
12.788850247	12.788850247

Xmin= -166.74614 mm, x_max= 167.11 mm, nux= 0.36917, nuy_min= 0.03623

APERTURE: 333 mm

46 Cells 2TeV→5 TeV

GF = 186.1714 T/m **GD = -182.8820 T/m**

QLF	DL2P	BLD	RATIO	ANAR
11.000000000	0.100000000	9.391304348	1.171296296	0.947200000

ANGF	RDIP	RQF	
0.009483415	0.011107889	991.131756757	991.131756757

BLD	QLF	LCEL	DL3P	NCEL
9.391304348	11.000000000	20.591304348	0.100000000	46.00

BYD	BYF
12.799757582	**12.799757582**

xmin= -135.5807 mm, x_max= 135.23122 mm, nux= 0.37819, nuy_min= 0.03475

APERTURE: 270 mm

Superconducting magnets for the LHC upgrade

Table 6: IR Quadrupole Parameters.

Parameter	**Q1**	**Q2**	**Q3-Q5**
Aperture (mm)	80	110	160
B_{max} coil at 4.5 K (T)	12.76	13.19	13.49
G_{max} apert at 4.5 K (T/m)	281.5	209.0	146.0
G_{op} (T/m)	250	187	130
Inductance at G_{op} (mH/m)	3.57	6.58	12.88
Stored energy at G_{op} (kJ/m)	493.0	771.3	1391.8
F_x at G_{op} (kN/m)	1790	2225	2790
F_y at G_{op} (kN/m)	-2180	-2713	-3380

Circular and OVAL Muon Collider Superconducting magnet designs

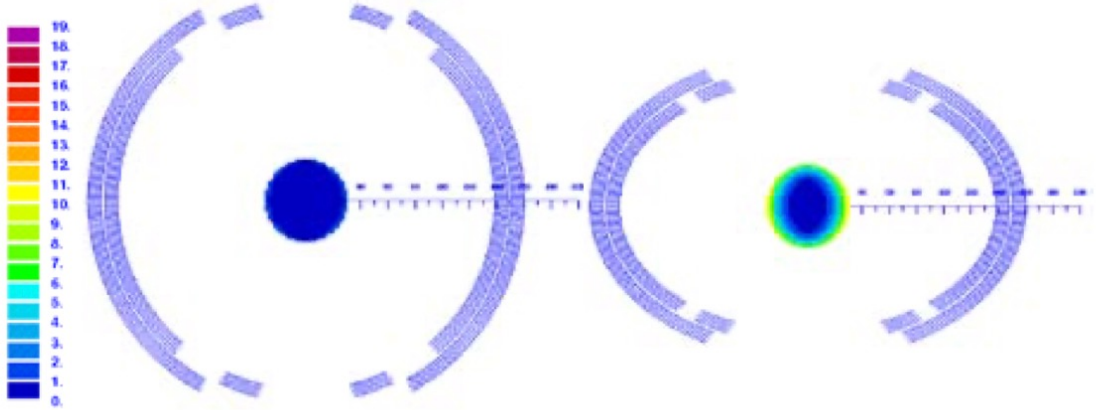
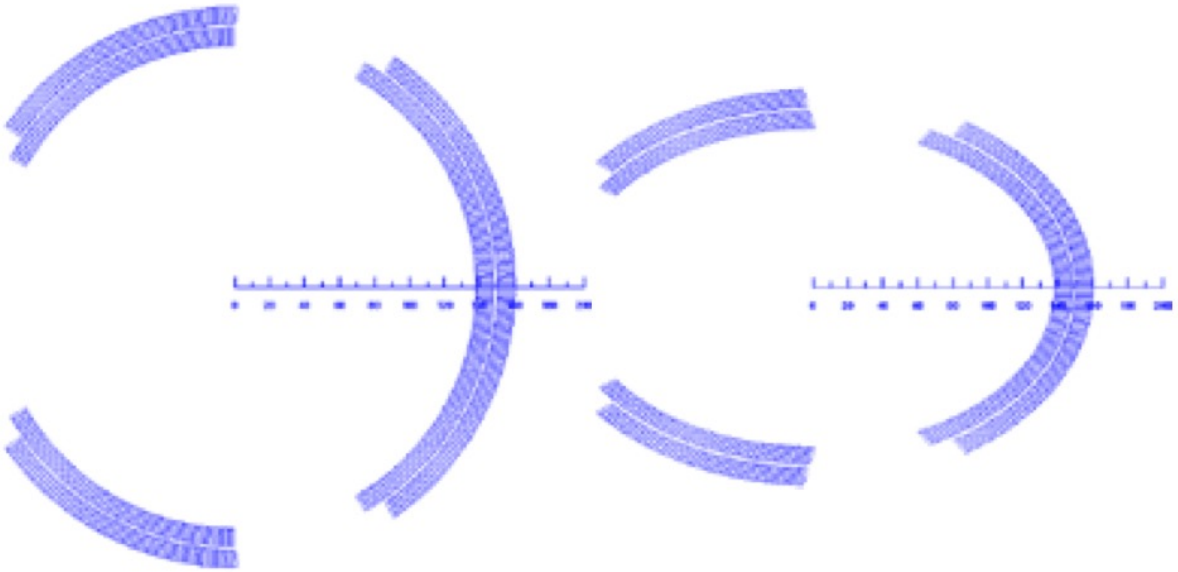
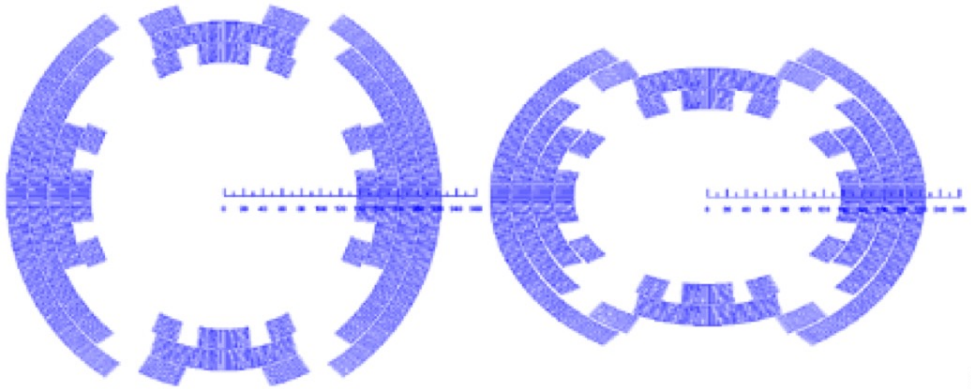


Figure 2: Circular vs. Elliptical aperture dipole. The colour-scale represents the sum of the high-order harmonics in units (1 unit = 10^{-4} of the main field).





(b)

Figure 5: Circular vs. Elliptical aperture of a nested Dipole and Quadrupole magnets.