Dipole gap and Q7 Aperture
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The dipole gap without chamber thickness and bake out elements, has to be determine based on the parameters we know today. The dipole gap should accommodate both matched and mismatch injection scenarios. We will assume emittance values from beam pipe note [1]. Figures 1 and 2 are Trace3d output out put for the mismatched and matched injection in the booster. The maximum beta function occurs at end of the first dipole in the case of the mismatched injection and has value of about 43.3 meters. In case matched injection maximum beta function occurs and the entrance of the dipole and has a value of 43 meters

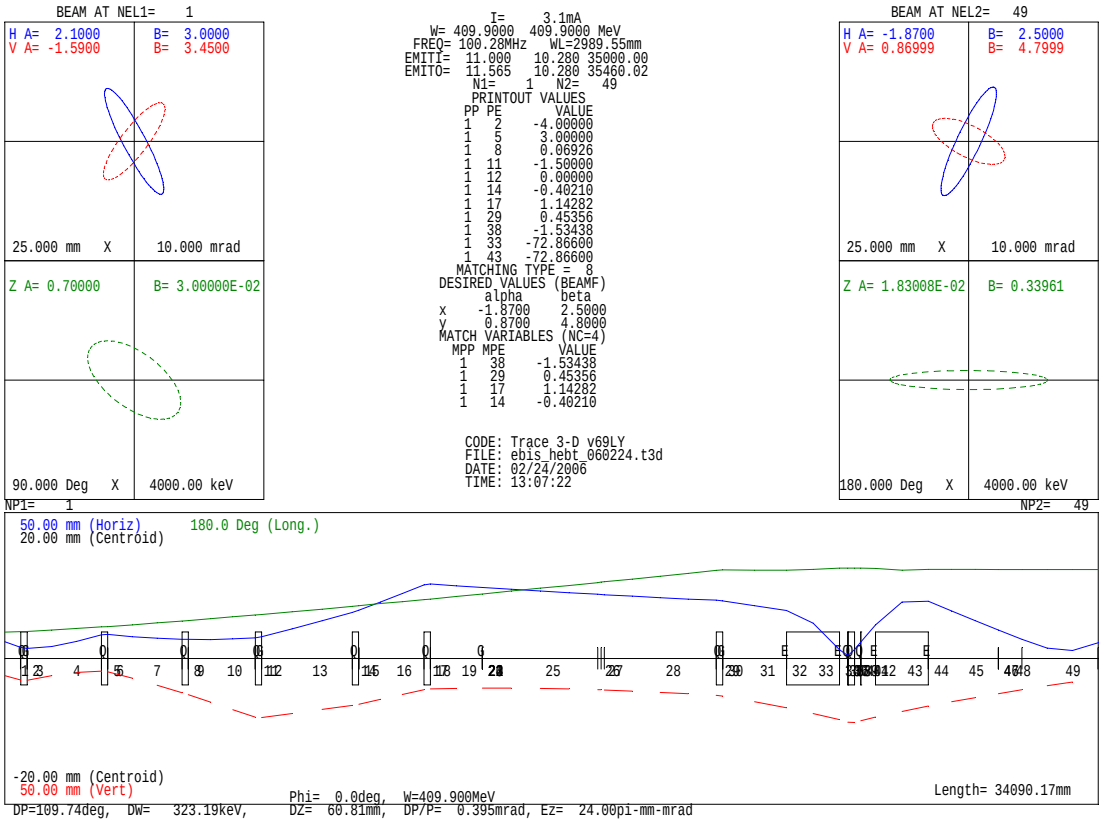

Figure 1: Trace out put for mismatched injection into the booster for Au^{32}. The maximum beta function in the bend is ~43.3 meters

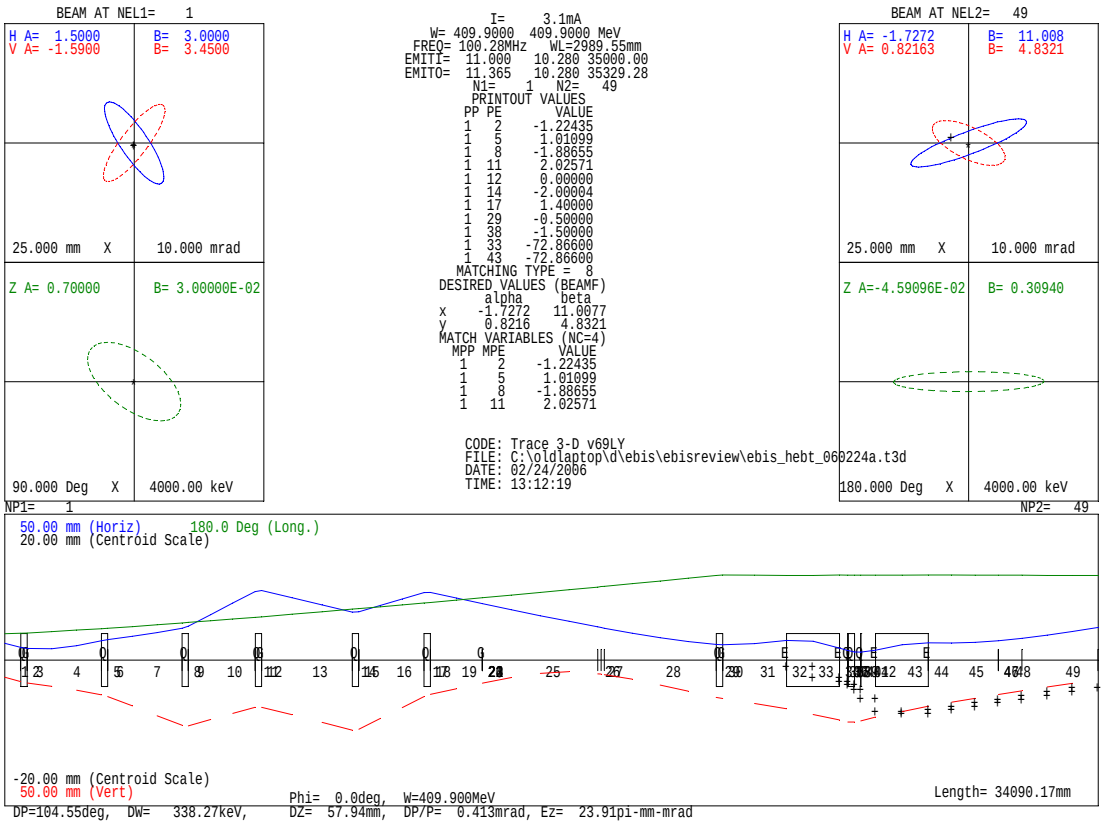

Figure 2: Trace3D out put for matched injection into the booster for Au^{32} with maximum beta function of about ~43 meters.

In case of the Au^{32}, un-normalized emitance is 11 mm mrad (5 rms) of emittance [1], and the maximum vertical beta function in the dipole region for mismatch injection is about 46 meters, therefore, the beam height is 2* √(11*43.3)= 43.6 mm. In case of matched injection into the booster, the maximum vertical beta function is about 43 meters, therefore, the beam height is 2* √(11*43)= 43.5 mm.

The budgeted emittance is factor of two higher than the simulated emittance, therefore, the maximum beam height is 43.6* √2 ~ 61.7 mm for Au^{32} ions for matched and mismatched injection in the booster.

Since emittance scales as q/m, the budgeted emittance for Deuterons will be 11*3*2=66 mm mrad (5 rms) and the maximum beam height will be 2* √(66*43.3) = 107.0 mm.

The recommended dipole gap, therefore
G=maximum beam height+ vacuum chamber thickness + bake out element thickness +clearance
= 107.0 + 2*3.175 +2*6.35+2*3.175 =132.4 mm

The maximum Horizontal beta function occur at end of 2nd dipole and has a value of 33.5 meter. The maximum horizontal aperture required for the beam 2*sqrt(66*33.5)=94.0 mm.

Aperture for the Q7

The maximum vertical beta function at quadrupole in between dipoles is about 47 meters. The beam pipe ID required is 2*sqrt(66*47)=111.4 mm

References:
[1] “Beam Pipe ID (in the wall) without NEG Pump”, D. Raparia, 2005/11/30

Appendix 1

Device	Length (mm)
RFQ	3800
MEBT	1788
LINAC	4000

HEBT LOCATIONS

Device	Center of Device	Distance (mm)	arc length (mm)	Dipole angle °	Radius of Dipole (mm)	Overall Distance (mm)
End of IH LINAC		0.00				0.00
		500.00				500.00
Q1	601.6	203.20				703.20
		2311.40				3014.60
Q2	3116.2	203.20				3217.80
		2311.40				5529.20
Q3	5630.8	203.20				5732.40
		2079.50				7811.90
Q4	7913.5	203.20				8015.10
		2827.40				10842.50
Q5	10944.1	203.20				11045.70
		2027.30				13073.00
Q6	13174.6	203.20				13276.20
		8908.72				22184.92
Q7	22286.52	203.20				22388.12
		1990.18				24378.30
D1		959.60	1653.28	72.866	1300	25337.90
		959.60				26297.50
		260.00				26557.50
Q8		203.20				26760.70

	654.00				27414.70
D2	959.60	1653.28	72.866	1300	28374.30
	959.60				29333.90
	4101.75				33435.65
INJ. PT.					33435.65