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## Optics of Beam #B5

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No. 72

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OPTICS OF BEAM #B5

Introduction

Three beams now share the B target station; MESB, B1, and B5. It will be assumed that a tight focus must always be maintained at B for proper operation of the MESB. The remaining beams, B1 and B5, share common elements in such a way that B5 cannot be operated unless B1 is set to negative polarity above a momentum of  $\sim 8$  GeV/c.

B1 - B5 Sharing

1. Settings - The settings of the exclusive optical elements of beam #B5 have been recalculated due to the downstream movement of the B' target station by 15 inches. Table I lists the currents, shunt readings, and computer counts for the three compatible running conditions of B1; 8, 12, and 20 GeV/c negative polarity (note that 100 mv shunt reading  $\equiv$  4000 computer counts).

2. Transmission - Figures 1 - 3 show ray traces for the above mentioned running conditions. The rays plotted are  $\pm 1$  mr horizontally,  $\pm 1$  mr vertically, and  $\pm 1\% \Delta p/p$ . Limiting apertures of  $\pm 1.375$  in.

horizontally in Q7 and  $\pm 0.75$  in. vertically at the downstream end of the wall have been used to calculate the acceptances listed in Table II.

As there are no direct measurements of the proton beam divergence at the B target, we have done a reverse ray trace from the target to an upstream flag and this is shown in Figure 4. The beam size as measured by the flag is consistent with divergences of  $\pm 2$  mr horizontally and  $\pm 5$  mr vertically at the B target. Using these figures, the transmissions from B to B' have been calculated and are given in Table II. Also

given in Table II are the transmissions with a 2-in. tungsten target. This attenuates the proton beam by 50%, and introduces 2 mr of multiple scattering.

#### B5 Exclusively

1. Settings - Maximum transmission from B to B' is achieved when B5 has control of all the common transport elements. The calculated settings for this case are given in Table III. Magnet D1 must have a 2% ramp to compensate for the change in beam momentum. If no ramp is installed, the settings are the same except that the polarities of Q6 and Q7 should be reversed.
2. Transmission - Figure 5 shows a ray trace for the case where magnet D1 is ramped. The rays plotted are  $\pm 2$  mr horizontally,  $\pm 5$  mr vertically, and 1%  $\Delta p/p$ . The limiting apertures are  $\pm 1.375$  in. horizontally in Q6, and  $\pm 0.75$  in. vertically in the wall. Acceptances and transmissions both for this case and for when D1 is not ramped are given in Table II.

#### Conclusion

Optimum transmission to the B' target station is achieved when B5 has exclusive control of all magnets between B and B'. Compatible running of B5 and B1 is possible when B1 is set to negative polarity and the intensity requirement at the B' target station is  $\sim 2 \times 10^{10}$  protons per pulse.

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TABLE I  
 B1 Compatible Settings of B5

B1 Momentum (GeV/c Negative Polarity)	Magnet	Polarity	Current (amps)	Shunt (mv)	Computer (counts)
20	D3	A	2154	53.85	2154
	D4	B	240	30.00	1200
	Q6	B	1551	51.70	2068
	Q7	A	2157	71.90	2876
	P1 D5	as required B	as required 2750	68.75	2750
12	D3	B	836	20.90	836
	D4	A	91	11.40	455
	Q6	B	1663	55.43	2217
	Q7	A	2273	75.77	3031
	P1 D5	as required B	as required 2750	68.75	2750
8	D3	B	2347	58.68	2347
	D4	A	261	32.60	1305
	Q6	B	1683	56.10	2244
	Q7	A	2291	76.37	3055
	P1 D5	as required B	as required 2750	68.75	2750

TABLE II

Transmission to B' Target

B1 Momentum (GeV/c)	8	12	20	B5 Only (D1 ramped)	B5 Only (No ramp)
Acceptance ( $m_r H \times m_r V$ )	$\pm 0.60 \times \pm 0.55$	$\pm 0.70 \times \pm 0.60$	$\pm 1.2 \times \pm 0.95$	$\pm 1.8 \times \pm 4.9$	$\pm 1.2 \times \pm 4.9$
Transmission to B' (no target at B)	3%	4%	11%	88%	59%
Transmission to B' (2" W target at B)	1%	1.5%	4%	29%	19%

TABLE III

Exclusive Settings for B5

Magnet	Polarity	Current (amp)	Shunt (mv)	Computer (counts)
Q1	B	2465	61.63	2465
Q2	B	2465	61.63	2465
Q3	B	2469	61.73	2469
Q4	A	1489	59.56	2382
Q5	A	1489	59.56	2382
D1	B	1070	26.75	1070
D2	B	1070	26.75	1070
D3			Off	
D4			Off	
Q6	AA	1488	49.60	1984
Q7	B	2002	66.73	2669
P1		As required		
D5	B	2750	68.75	2750

NOTE: If D1 is not ramped, reverse polarities of Qy and Q7.

XMAX	DX1	YMAX	DY1	P	DP	1 %
4.000	0.00100	4.000	0.00100	28.500	0.010	
0.036						XIV
0.072						XIV
0.108						X I+Y
0.144						X I-Y
0.180						X I-Y
0.216						X I-Y
0.252						X I-Y
0.303	01					X I-Y
0.356	02					X I-Y
0.418	03					X I-Y
0.474	04					X I-Y
0.521	05					X I-Y
0.558	05					X I-Y
0.617						X I-Y
0.677						X I-Y
0.706						X I-Y
0.736						X I-Y
0.765	D1					X I-Y
0.795	D1					X I-Y
0.824	D2					X I-Y
0.854	D2					X I-Y
0.883						X I-Y
0.913						X I-Y
0.942						X I-Y
0.972	D3					X I-Y
1.001	D3					X I-Y
1.030						X I-Y
1.060	WALL					X I-Y
1.089	WALL					X I-Y
1.118	WALL					X I-Y
1.147	WALL					X I-Y
1.176	WALL					X I-Y
1.206	WALL					X I-Y
1.235	WALL					X I-Y
1.264	WALL					X I-Y
1.293	WALL					X I-Y
1.322	WALL					X I-Y
1.351	WALL					X I-Y
1.381	WALL					X I-Y
1.410	D4					X I-Y
1.439						X I-Y
1.468						X I-Y
1.497						X I-Y
1.526						X I-Y
1.555						X I-Y
1.584						X I-Y
1.613						X I-Y
1.642						X I-Y
1.671						X I-Y
1.700						X I-Y
1.729						X I-Y
1.758						X I-Y
1.787						X I-Y
1.816						X I-Y
1.845						X I-Y
1.874						X I-Y
1.903						X I-Y
1.932						X I-Y
1.961						X I-Y
1.990						X I-Y
2.019						X I-Y
2.048						X I-Y
2.077						X I-Y
2.106						X I-Y
2.135						X I-Y
2.164						X I-Y
2.193						X I-Y
2.222						X I-Y
2.251						X I-Y
2.280						X I-Y
2.309						X I-Y
2.338						X I-Y
2.367						X I-Y
2.396						X I-Y
2.425						X I-Y
2.454						X I-Y
2.483						X I-Y
2.512						X I-Y
2.541						X I-Y
2.570						X I-Y
2.599						X I-Y
2.628						X I-Y
2.657						X I-Y
2.686						X I-Y
2.715						X I-Y
2.744						X I-Y
2.773						X I-Y
2.802						X I-Y
2.831						X I-Y
2.860						X I-Y
2.889						X I-Y
2.918						X I-Y
2.947						X I-Y
2.976						X I-Y
3.005						X I-Y
3.034						X I-Y
3.063						X I-Y
3.092						X I-Y
3.121						X I-Y
3.150						X I-Y
3.179						X I-Y
3.208						X I-Y
3.237						X I-Y
3.266						X I-Y
3.295						X I-Y
3.324						X I-Y
3.353						X I-Y
3.382						X I-Y
3.411						X I-Y
3.440						X I-Y
3.469						X I-Y
3.498						X I-Y
3.527						X I-Y
3.556						X I-Y
3.585						X I-Y
3.614						X I-Y
3.643						X I-Y
3.672						X I-Y
3.701						X I-Y
3.730						X I-Y
3.759						X I-Y
3.788						X I-Y
3.817						X I-Y
3.846						X I-Y
3.875						X I-Y
3.904						X I-Y
3.933						X I-Y
3.962						X I-Y
3.991						X I-Y
4.020						X I-Y
4.049						X I-Y
4.078						X I-Y
4.107						X I-Y
4.136						X I-Y
4.165						X I-Y
4.194						X I-Y
4.223						X I-Y
4.252						X I-Y
4.281						X I-Y
4.310						X I-Y
4.339						X I-Y
4.368						X I-Y
4.397						X I-Y
4.426						X I-Y
4.455						X I-Y
4.484						X I-Y
4.513						X I-Y
4.542						X I-Y
4.571						X I-Y
4.600						X I-Y
4.629						X I-Y
4.658						X I-Y
4.687						X I-Y
4.716						X I-Y
4.745						X I-Y
4.774						X I-Y
4.803						X I-Y
4.832						X I-Y
4.861						X I-Y
4.890						X I-Y
4.919						X I-Y
4.948						X I-Y
4.977						X I-Y
5.006						X I-Y
5.035						X I-Y
5.064						X I-Y
5.093						X I-Y
5.122						X I-Y
5.151						X I-Y
5.180						X I-Y
5.209						X I-Y
5.238						X I-Y
5.267						X I-Y
5.296						X I-Y
5.325						X I-Y
5.354						X I-Y
5.383						X I-Y
5.412						X I-Y
5.441						X I-Y
5.470						X I-Y
5.499						X I-Y
5.528						X I-Y
5.557						X I-Y
5.586						X I-Y
5.615						X I-Y
5.644						X I-Y
5.673						X I-Y
5.702						X I-Y
5.731						X I-Y
5.760						X I-Y
5.789						X I-Y
5.818						X I-Y
5.847						X I-Y
5.876						X I-Y
5.905						X I-Y
5.934						X I-Y
5.963						X I-Y
5.992						X I-Y
6.021						X I-Y
6.050						X I-Y
6.079						X I-Y
6.108						X I-Y
6.137						X I-Y
6.166						X I-Y
6.195						X I-Y
6.224						X I-Y
6.253						X I-Y
6.282						X I-Y
6.311						X I-Y
6.340						X I-Y
6.369						X I-Y
6.398						X I-Y
6.427						X I-Y
6.456						X I-Y
6.485						X I-Y
6.514						X I-Y
6.543						X I-Y
6.572						X I-Y
6.601						X I-Y
6.630						X I-Y
6.659						X I-Y
6.688						X I-Y
6.717						X I-Y
6.746						X I-Y
6.775						X I-Y
6.804						X I-Y
6.833						X I-Y
6.862						X I-Y
6.891						X I-Y
6.920						X I-Y
6.949						X I-Y
6.978						X I-Y
7.007						X I-Y
7.036						X I-Y
7.065						X I-Y
7.094						X I-Y
7.123						X I-Y
7.152						X I-Y
7.181						X I-Y
7.210						X I-Y
7.239						X I-Y
7.268						X I-Y
7.297						X I-Y
7.326						X I-Y
7.355						X I-Y
7.384						X I-Y
7.413						X I-Y
7.442						X I-Y
7.471						X I-Y
7.500						X I-Y
7.529						X I-Y
7.558						X I-Y
7.587						X I-Y
7.616						X I-Y
7.645						X I-Y
7.674						X I-Y
7.703						X I-Y
7.732						X I-Y
7.761						X I-Y
7.790						X I-Y
7.819						X I-Y
7.848						X I-Y
7.877						X I-Y
7.906						X I-Y
7.935						X I-Y
7.964						X I-Y
7.993						X I-Y
8.022						X I-Y
8.051						X I-Y
8.080						X I-Y
8.109						X I-Y
8.138						X I-Y
8.167						X I-Y
8.196						X I-Y
8.225						X I-Y
8.254						X I-Y
8.283						X I-Y
8.312						X I-Y
8.341						X I-Y
8.370						X I-Y
8.399						X I-Y
8.428						X I-Y
8.457						X I-Y
8.486						X I-Y
8.515						X I-Y
8.544						X I-Y
8.573						X I-Y
8.602						X I-Y
8.631						X





XMAX	DX1	YMAX	DY1	P	DP	I %
4.000	0.00100	4.000	0.00100	28.500	0.010	
1 m						
0.036						XIY
0.072						XIY
0.108						XI-Y
0.144						XI-Y
0.180						XI-Y
0.216						XI-Y
0.240						XI-Y
0.252						XI-Y
0.248						XI-Y
0.230						XI-Y
0.219						XI-Y
0.218						XI-Y
0.228						XI-Y
0.246						XI-Y
0.263						XI-Y
0.281						XI-Y
0.299						XI-Y
0.316						XI-Y
0.334						XI-Y
0.351						XI-Y
0.369						XI-Y
0.386						XI-Y
0.404						XI-Y
0.422						XI-Y
0.439						XI-Y
0.457						XI-Y
0.474						XI-Y
0.492						XI-Y
0.509						XI-Y
0.527						XI-Y
0.545						XI-Y
0.562						XI-Y
0.580						XI-Y
0.597						XI-Y
0.615						XI-Y
0.632						XI-Y
0.650						XI-Y
0.668						XI-Y
0.685						XI-Y
0.703						XI-Y
0.720						XI-Y
0.738						XI-Y
0.755						XI-Y
0.793						XI-Y
0.981						XI-Y
1.177						XI-Y
1.100						XI-Y
0.942						XI-Y
0.785						XI-Y
0.628						XI-Y
0.471						XI-Y
0.314						XI-Y
0.157						XI-Y
-0.000						XIY

Figure 3. B5 with B1 at 20GeV/c

0.036  
0.072  
0.108  
0.144  
0.180  
0.216  
0.263  
0.326  
0.407  
0.512  
0.600  
0.660  
0.686  
0.691  
0.695  
0.699  
0.703  
0.708  
0.712  
0.716  
0.720  
0.724  
0.728  
0.732  
0.735  
0.739  
0.743  
0.746  
0.750  
0.753  
0.757  
0.760  
0.764  
0.767  
0.771  
0.774  
0.778  
0.781  
0.784  
0.788  
0.791  
0.795  
0.798  
0.781  
0.620  
0.440  
0.362  
0.310  
0.258  
0.207  
0.155  
0.103  
0.052  
-0.000

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