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EP & S DIVISION TECHNICAL NOTE

No. 2

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THE G-10 + 4.7° PION BEAM (4-16 GeV/c) AT THE BROOKHAVEN AGS

We describe briefly the beam transport system for the G-10 + 4.7° intermediate energy (4-16 GeV/c) beam at the AGS. The data supplied here are current as of March 1967. It is not anticipated that the upstream end of the beam (Q_{1-6} and D_1 in Fig. I) will be moved in the near future[1]. However, the remaining components of the beam may sometimes be rearranged, but the general properties of the system should not be greatly affected by such changes. The original layout of the 4.7° pion beam (1964-5) has already been described in some detail[2] and is illustrated in Fig. I. For a description of the design criteria and the methods used for optimizing the beam layout, see Reference 2.

The G-10 target is usually a 30-mil diameter, L-shaped Be wire. Most of the p-Be interactions which yield the desired pions take place in the horizontal arm of the "L", which is ½" in length and is pointed along the axis of the 10° separated K^- beam (Separated Beam #5). The effective horizontal dimension of the target is thus about 70-mils.

A schematic drawing of the beam optics is shown in Fig. II. Lens L_1 focusses the beam from the production target T at a slit S ("intermediate focus"). The beam is dispersed by the deflection manget D_1; the band of desired momenta passes through the slit S. The $\Delta p/p$ bandpass is proportional to the width of the aperture of S (½" slit corresponds to $\Delta p/p$ = 2% FWHM). Variation of the height of the aperture of S is a convenient intensity control. Lens L_2 refocusses the beam at the image point I. The momentum band accepted by the slit S is recombined by the deflection magnet D_2 into an (almost) achromatic image at I.

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Tables I,II and III give lists of the beam elements, the separation distances between them, and the values of other relevant parameters (fields, apertures, etc.). The field values given are the results of beam-tuning done in a recent experiment.[3] In general, the field values used agree, within 1-2%, with values calculated using beam-transport beam programs. Note that the value of the field in D_1 depends upon the radial position of the production target, R_T. However, any value of R_T can be made to yield the same intensity as the 4.7^o beam. Note also that the fields of Q_1 and D_1 do not depend linearly upon the particle momentum. These are consequences of the effect of the fringe field of the AGS G-11 magnet on the trajectories of the particles in the secondary beam.

To tune the beam, the following procedure has been followed in the past. First, set the magnetic fields at the values indicated in Table I. Keep D_2 fixed — this is used as the definition of momentum. Then maximize the beam flux by adjusting, in turn, D_1, Q_1, Q_3, Q_5, Q_7, Q_8, Q_9, D_1. (This is the order used in the present Cornell-BNL collaboration experiment[3]).

TABLE I

Beam Components

Positions and Apertures of Components

	Component Type	Length	Distance of Downstream End of Component From Beam Origin	Aperture	Remarks
1.	Fringe field	199	199		In this region particle trajectories can be calculated with BEAM program[4].
2.	Free Space	97	296		
3.	Q1, N8Q32	34	330	8"diameter	Vertically focussing
4.	Free Space	36	366		
5.	Q2, N8Q32	34	400	8"diameter	Vertically focussing
6.	Free Space	17	417		
7.	Q3,8Q48	52	469	8"diameter	Horizontally focussing
8.	Free Space	8	477		
9.	Q4,8Q48	52	529		
10.	Free Space	8	537		
11.	Q5,8Q48	52	589	8"diameter	Vertically focussing
12.	Free Space	8	597		
13.	Q6,8Q48	52	649	8"diameter	Vertically focussing
14.	Free Space	12	661		
15.	D1, 18D72	80	741	18"Hor.x6"Vert.	Deflection angle:2.89° cw
16.	Free Space	362	1,103		
17.	Collimator C	40	1,143	Typically ½"Hor.x½"Vert.	"Intermediate focus"¼"x¼"= ±½% $\Delta p/p$; ½"x½"=±1%: 1"x1"=±2%
18.	Free Space	257	1,410		
19.	D2,18D72	80	1,490	18"Hor.x6"Vert.	Deflection angle:1.99°

TABLE I (cont.)

	Component Type	Length	Distance of Downstream End of Component From Beam Origin	Aperture	Remarks
20.	Free Space	257	1,547		
21.	Q7,8Q48	52	1,599	8" diameter	Horizontally focussing
22.	Free Space	124	1,723		
23.	Q8,8Q48	52	1,775	8" diameter	Vertically focussing
24.	Free Space	111	1,886		
25.	Q9,8Q48	52	1,938	8" diameter	Horizontally focussing
26.	Free Space	1,161	3,099		Target for experiment

TABLE II

Beam Components

Current Strengths for Deflection Magnets (for R_T = +1.1")

Momentum (GeV/c)	Polarity	I(D1) (Units are shunt millivolts) (40A/mV)	I(D2) (Units are shunt millivolts) (40A/mV)
6	-	13.3	13.5
6	+	14.3	13.5
10	-	22.5	22.5
10	+	23.8	22.5
14	-	31.8	31.5
14	+	32.7	31.5
16.5	-	37.9	37.5
17.5	+	41.2	39.4

TABLE III

Beam Components

Field Strengths for Quadrupoles (for R_T = +1.1")

Momentum (GeV/c)	Polarity	I(Q1) units are shunt mV (25A/mV)	I(Q2) units are shunt mV (40A/mV)	I(Q3) units are shunt mV (25A/mV)	I(Q4) units are shunt mV (25A/mV)	I(Q5,6) units are shunt mV (25A/mV)	I(Q7) units are shunt mV (25A/mV)	I(Q8) units are shunt mV (40A/mV)	I(Q9) units are shunt mV (25A/mV)
6	-	29.0	23.5	27.3	27.5	13.0	20.5	22.0	24.0
6	+	23.5	23.0	27.5	27.5	13.0	18.3	21.7	24.3
10	-	49.0	36.5	46.5	46.0	22.8	31.0	36.7	40.8
10	+	41.8	37.0	46.5	46.0	22.8	31.7	36.7	40.8
14	-	70.0	51.5	64.0	63.5	31.0	48.0	51.5	54.5
14	+	59.0	51.0	65.0	63.5	31.5	46.0	51.5	54.5
16.5	-	85.5	56.0	75.7	74.5	36.8	50.0	64.5	66.0
17.5	+	85.0	59.4	80.2	79.3	39.0	53.0	64.0	70.0

References

1. J.R. Sanford, private communication
2. A.L. Read and R. Rubinstein, Brookhaven National Laboratory Report BNL-9213
3. 1967 Cornell-BNL Collaboration; J. Orear, A.L. Read, R. Rubinstein, D.H. White, et al.
4. E.D. Courant: Brookhaven National Laboratory, Accelerator Department Internal Report EDC-36

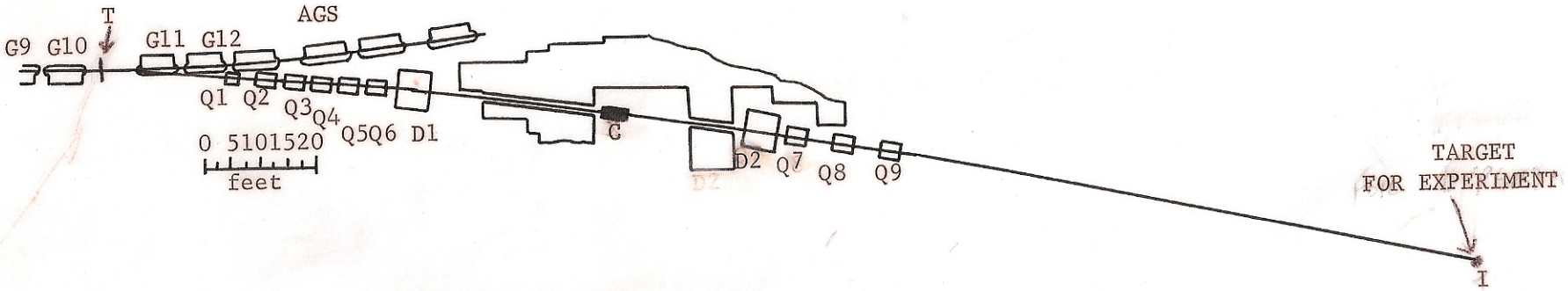

Figure 1 - Layout of Transport Components

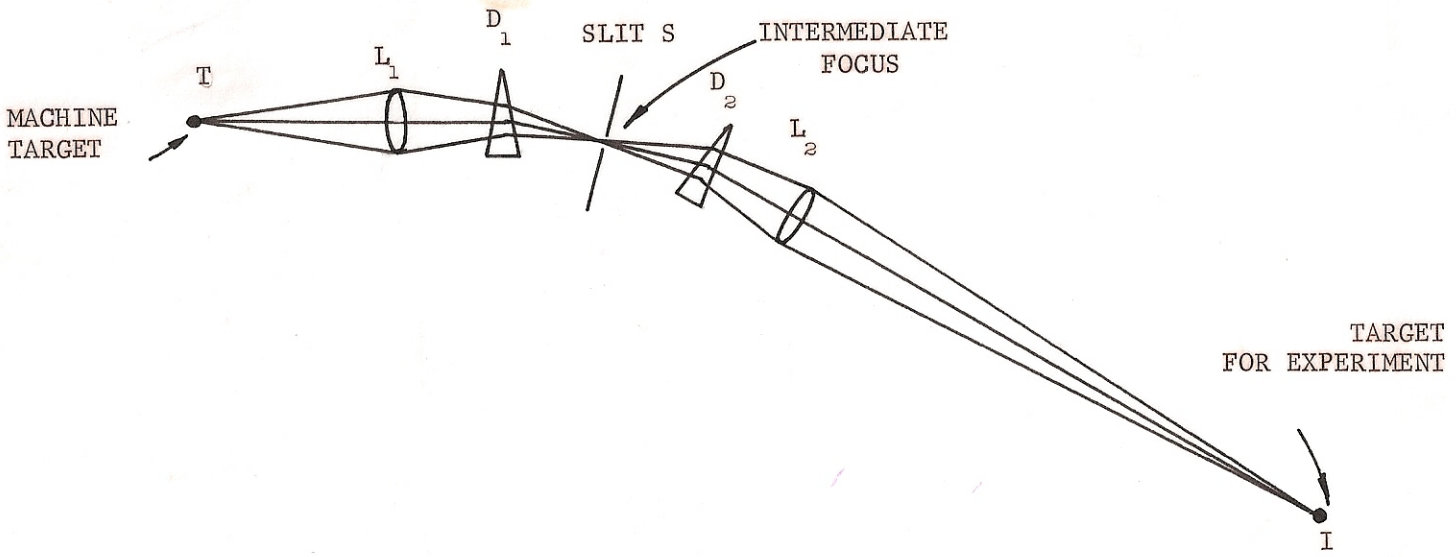

Figure 2 - Schematic of Beam Optics