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No. 18

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DESIGN OF THREE BENDING MAGNETS FOR USE WITH BEAM FROM TARGET TO EIGHT-INCH PIPE

The first of the three bending magnets was an 18D72. The initial beam entering the magnet was assumed to be perpendicular to the magnet's face and the beam was bent at the center of the magnet. The angles of bend φ were calculated with the use of the formulas

$$\varphi = L/\rho, \rho \text{ (in.)} = 1313.24 \frac{P(\text{GeV/c})}{B \text{ (kG)}}$$

where L is the effective length of the magnet (79 inches), p is the momentum, and B is the field on the magnet assumed to be in my calculations 20 kG.

Then I calculated the drift distance of the 25 GeV/c beam from the 18D72 until the ray was 18-inches from the floor. At this point the front face of the first 18C72 magnet was constructed with its base on the 25 GeV/c beam line. For the rest of my calculations I used this ray, which was bent 2.9°, as my base line. I then traced several beams each of which satisfied one of the following conditions; the ray which would leave the 18D72 at the top edge; the ray that would strike the front top edge of the 18C72; the ray which would strike the top of the middle portion of the 18C72; the ray that would leave the middle of the edge of the 18D72; and the ray that hit the center of the middle of the 18C72. Finally, I calculated the path of the 28.9 GeV/c beam from the 18D72 to the 18C72 magnet.

After that was completed, I took the two extreme rays in the 18C72 magnet, the 25 GeV/c (at the bottom) and the 8.98 GeV/c (at the top), and calculated their bends in the second 18C72 magnet. The formula used was:

$$\sin \beta = L/\rho - \sin \alpha$$

where α is the angle of the entering beam, L/ρ is the angle the magnet bends the beam, and β is the angle of the beam leaving the magnet. Remember the angle β is corrected since I am using the 2.9° line as a base (just a simple subtraction of 2.9° from the angle α). Also I used 18 kG for B.

I then calculated the distance of the 25 GeV/c ray from the middle of the first 18C72 magnet to a point where the beam was nine inches off the base line. This point marked the position for the center of the middle of the final 18C72 magnet. I also did a trace of the 8.98 GeV/c ray from the first to the second 18C72 magnet middle. Then I once again calculated the bend angles of the rays in the magnet. This third magnet bent the beam parallel to the base line.

Finally, the 8-in. pipe was located on the horizontal dividing line of the magnet at the end face of the second 18C72.

Therefore, the first 18C72 was used as an angular steering magnet and the second as a position magnet. Also all the calculations done were based upon certain simplifying assumptions such as, the initial beam being perpendicular to the face of the 18D72, the 18C72 magnets were located on the 25 GeV/c base line, and all calculated angles resulted from using the maximum field on each magnet.

The following is a list of data for the positions of the magnets:

1 - 18D72:	Front	x = 0-in. y = 18-in.	
	Middle	x = 39.5-in., y = 18-in.	
	End	x = 79-in., y = 18.- in.	Graph #1

1 - 18C72:	Front-top	x = 216.4-in., y = 26.98-in.
	middle	x = 216.8-in., y = 17.99-in.
	bottom	x = 217.3-in., y = 9-in.
	Middle-top	x = 255.86-in., y = 28.97-in.
	middle	x = 256.3-in., y = 19.9-in
	bottom	x = 256.78-in., y = 10.99-in.
	End - top	x = 295.3-in., y = 30.97-in.
	middle	x = 296.79-in., y = 21.98-in.
	bottom	x = 296.26-in., y = 12.99-in.

Graph #1 and #2

2- 18C72:	Front-top	x = 423.8-in, y = 37.49-in.
	middle	x = 424.29-in. y = 28.5-in.
	bottom	x = 424.75-in. y = 19.5-in.
	Middle-top	x = 463.28-in. y = 39.49-in.
	middle	x = 464.19-in y = 30.52-in.
	bottom	x = 464.65-in. y = 21.51-in.
	End-top	x = 502.7-in. y = 41.99-in.
	middle	x = 503.19-in. y = 32.50-in.
	bottom	x = 503.6-in. y = 23.5-in.

Graph #2

BEAM POSITIONS

At 18D72

Top edge - 5.28 GeV/c at 13^{o}

Middle edge - 11.9 GeV/c at 5.9^{o}

Bottom edge - 25 GeV/c at 2.9^{o}

Graph #1

At 1st 18C72

Top front edge - 7.9 GeV/c at 8.9^{o}

Center of middle - 13 GeV/c at 5.28^{o}

Top of middle - 8.98 GeV/c at 7.67^{o}

Graph #1 and #2

From 1st 18C72 to second

Top of middle - 8.98 GeV/c at 2.14^{o}

Bottom of middle to center of 2nd 18C72

25 GeV/c at 2.48^{o}

Graph #2

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