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AN IMPROVED F10 SWITCHYARD DESIGN

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Collider Accelerator Department

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AGS DIVISION TECHNICAL NOTE

No. 132

AN IMPROVED F10 SWITCHYARD DESIGN

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In a recent note[1] discussing options for improving the slow extracted beam, a design is given for a high efficiency switchyard to deliver beam from F10 to the existing A, B and C lines and to a new D line. Despite space limitations, this design is practical to build, and it should give excellent performance. Further study,[2] however, has led to an improved design based on Lambertson (steel septum) magnets. This improved design is more cost effective and less tightly constrained than that of Ref. 1.

A plan view of the improved switchyard is given in Fig. 1 and the component parameters are given in Table 1. The beam optics and the systematic procedure for adjusting the quadrupoles to get the desired beam sizes are the same as in the previous design. The beam splitting and switching uses both the horizontal and the vertical planes, as shown in expanded views in Fig. 2.

The initial split is in the horizontal plane, and is made by electrostatic splitters E_{1-3}. These make a four-way split as shown in Fig. 2a. Next come Lambertson magnets L_{1-2}, which bend in the vertical plane. Figure 3 is a view of the upstream end of L_1, showing the four horizontally split beam components at the entrance of L_1. This magnet bends the B and C beams up, as shown in Fig. 2b. Magnet L_2 is similar but oriented with its field on the opposite side; it bends D down. The striped parts of the beam components in Fig. 3 indicate the effect of beam divergence. The clear separation between shadows is 0.15 inches and the septum thickness at the top and bottom of the beamspots is 0.06 inches; the separation is therefore greater than the septum thickness by a factor of 2.5, compared to a typical value of 1.5 in the previous design.

The beams are next separated horizontally by Lambertson magnets L_{3-7}. A view of the upstream end of L_3 is given in Fig. 4, which also shows the separated beam spots at this point. This magnet is essentially a conventional dipole magnet with a hole drilled in its upper pole piece. Magnets L_3 and L_4 bend D and A to the left, while B and C pass undeflected in the hole in the upper pole piece. Magnets L_{5-7} are similar but bend D only.

The beam vacuum pipes for the Lambertson magnets are not shown in Figs. 3 and 4, but they are arranged in one of several possible ways to put the coils outside the vacuum.

Following the Lambertson magnet section, the D beam is made level by pitching magnet P_1; then it enters low powered magnets H_{1-3} which bend seven degrees each. The A beam is brought onto its existing line by C_{1-5}. The B and C beams are bent both horizontally and vertically by P_{2-3} and C_{6-9} to put them on the original B line; thick copper septum magnet S_1 then bends C onto the original C line.

Splitting ratios are changed by remote horizontal motion of E_{1-3} and L_{1-2} and current variation in C_{6-9}. The beam steering through the thick septum Lambertson magnets L_{3-7} does not need to change with splitting ratio.

The main advantages of the improved design over that of Ref. 1 are:

1. The septum clearances are greater.
2. The Lambertson magnets are less expensive than copper septum magnets, and they consume less power.
3. The electrostatic splitters are located together, which is advantageous from the point of view of vacuum and shielding.
4. Any beam, including the C beam, can be turned off for access while the other beams are on.

References and Footnotes

1. H. Weisberg, AGS Division Technical Note No. 131.

2. Suggestions by H. Brown and J.W. Glenn were crucial.

Table 1

Switchyard Components and Parameters

Element		Length	Field	Aperture, HXV
V_{1-3}	Combined horizontal and vertical vernier magnet	1 ft	5 kG (each plane)	3 X 3 in
SEC	Secondary emission chamber			
M_1	3H36	3 ft	<16 kG	3 X 3 in
$Q_{1-4,6}$	3Q52			
$Q_{5,7}$	3Q36			
W_{1-4}	SWIC profile monitor			
E_{1-3}	Electrostatic splitter, 0.002 in wire septum	10 ft	±35 kV/cm	±0.8 X 1.5 in
L_{1-2}	Thin-septum Lambertson magnet (see Fig. 3)	10 ft	2.5 kG	2 X 2 in
L_{3-7}	Thick-septum Lambertson magnet (see Fig. 4)	6 ft	13 kG	6 X 3½ in
$P_{1,3}$	3H18 bending vertically	1.5 ft	<16 kG	3 X 3 in
P_2	3H36 bending vertically	3 ft	<16 kG	3 X 3 in
H_{1-3}	6H288	24 ft	16 kG	6 X 1.5 in
C_{1-9}	5C90	7.5 ft	13 kG	5 X 1.5 in
S_1	0.33" copper septum magnet	12 ft	2.8 kG	3 X 1.25 in

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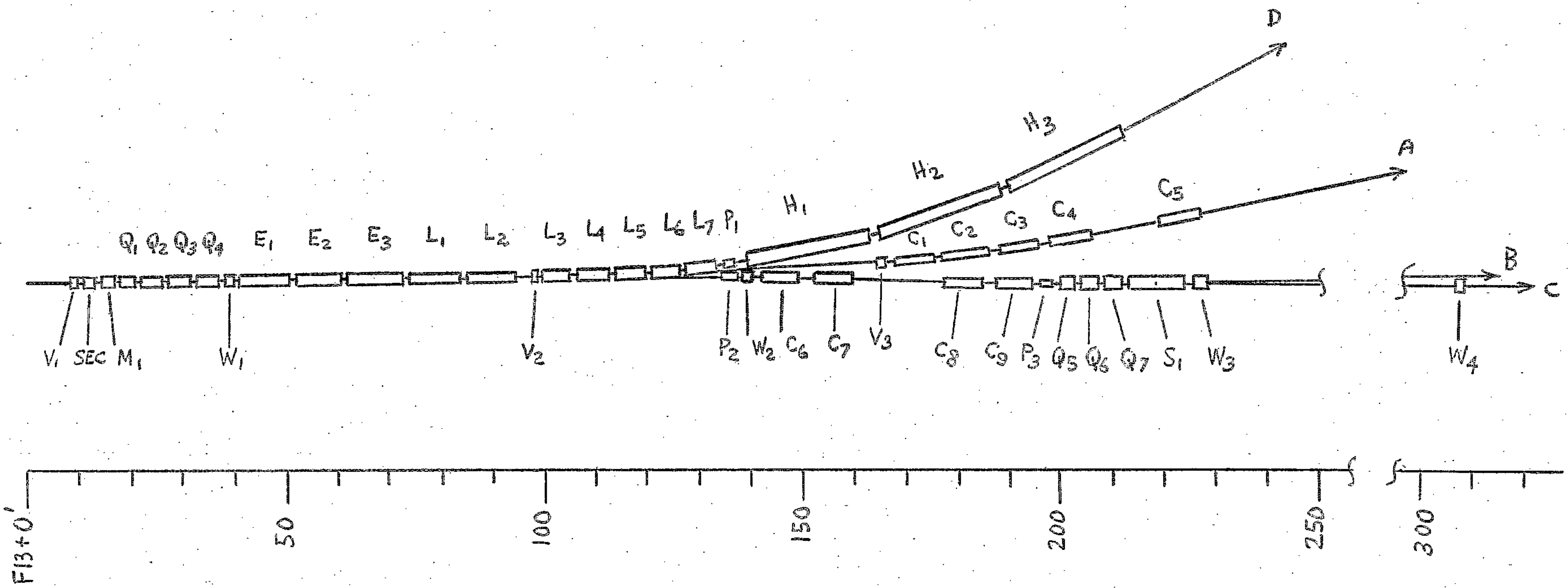

FIG. 1 - Improved F10 switchyard layout

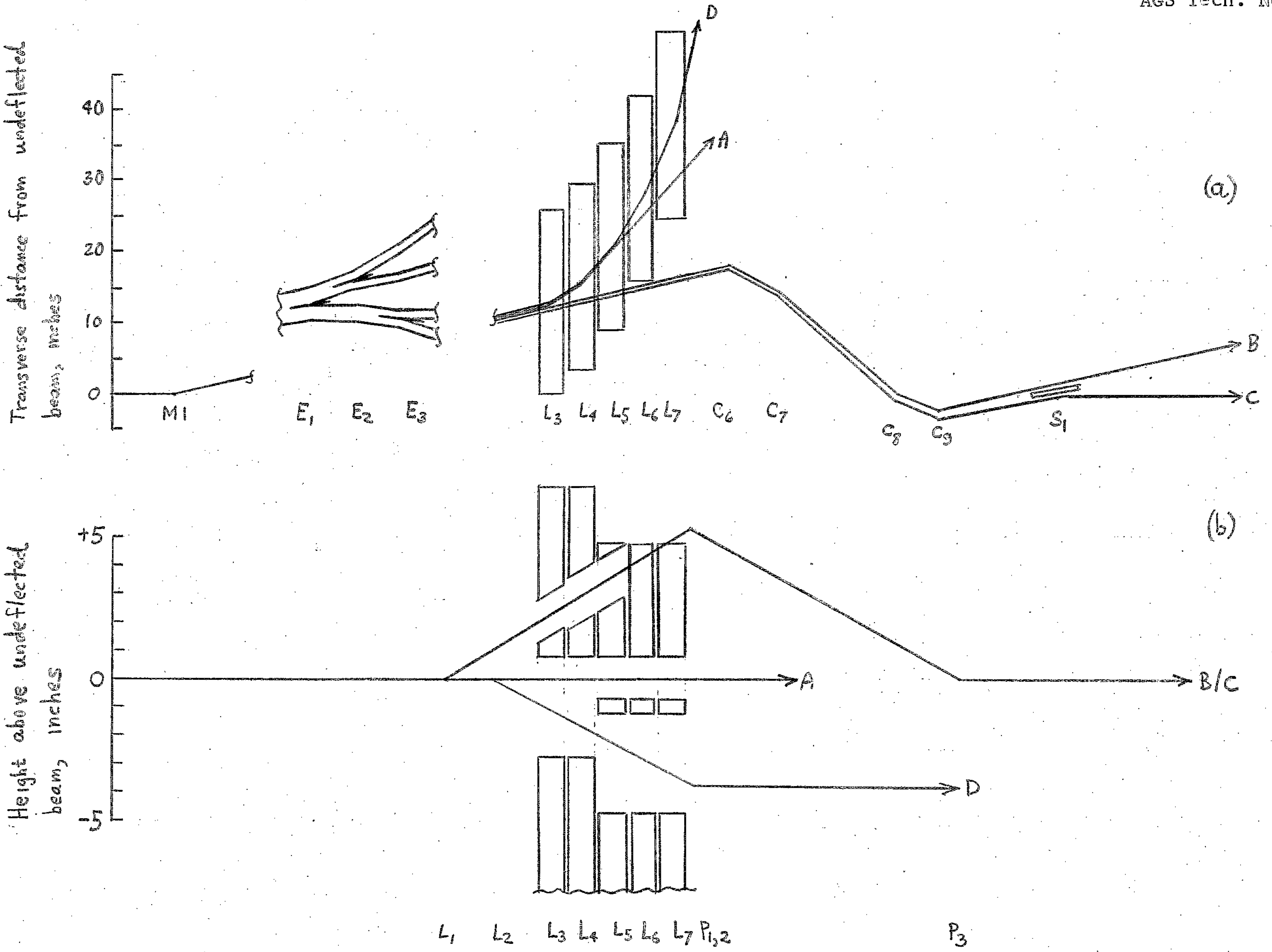

Fig. 2 - (a) Horizontal and (b) vertical beam trajectories

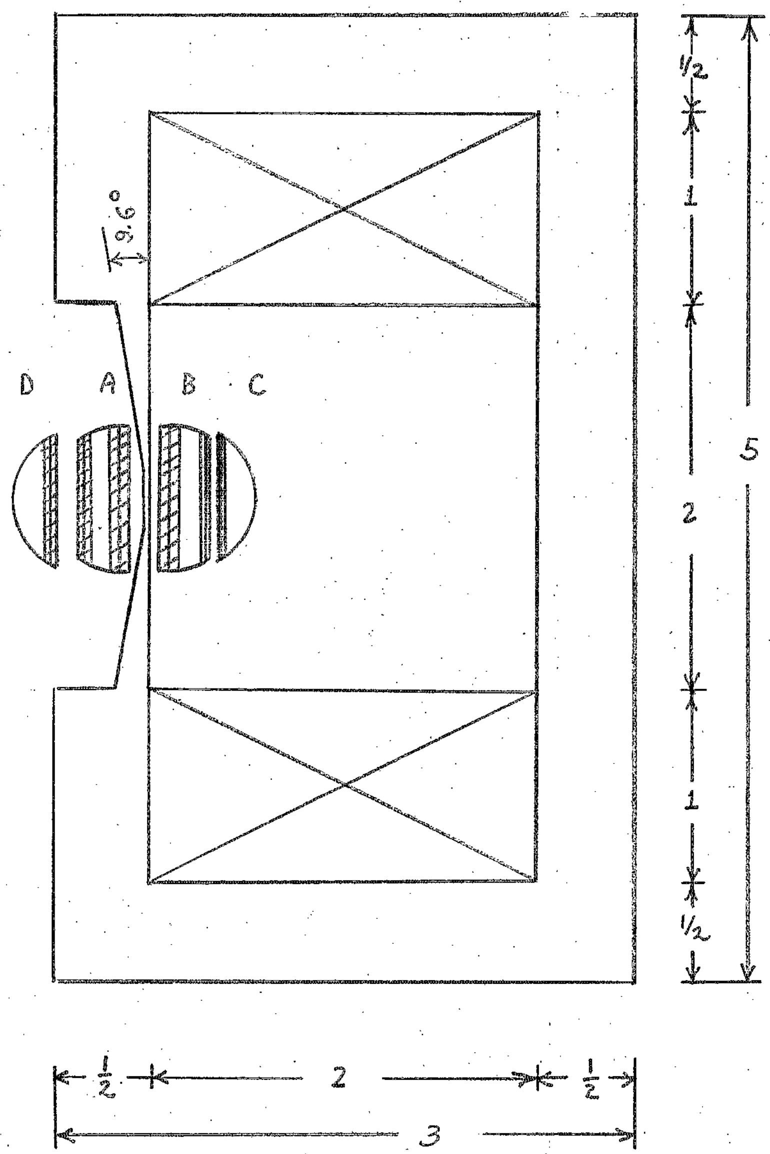

Fig. 3 - Upstream view of Lambertson magnet L_1, showing the four horizontally split beam components. The striped areas of the beam components indicate the effect of beam divergence on the septum shadows. This magnet bends the B and C beams up.

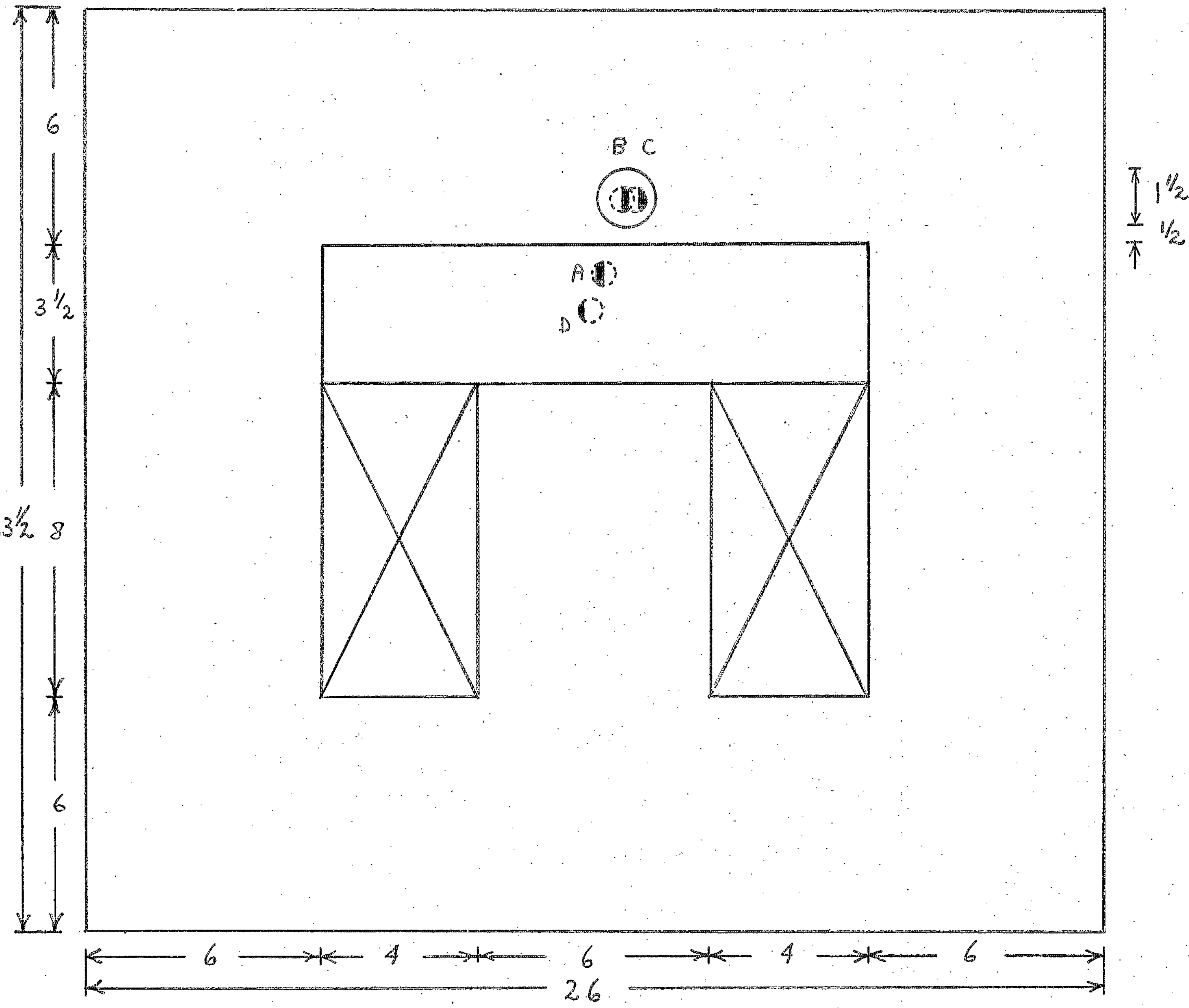

Fig. 4 - Upstream view of Lambertson magnet L_3, showing the four beam components that enter it. This magnet bends the D and A beams to the left.