APPENDIX D

RADIATION AND INTERACTION LENGTHS

The particles generated by $p\bar{p}$ collisions at the DØ interaction region penetrate the solenoid. In order to calculate the interaction probability of the particle in the solenoid the radiation and interaction lengths of all the materials in the solenoid need to be known. Table D.1 shows the radiation and interaction lengths of all the major elements that make up the solenoid. The total radiation length is 0.87, and the total interaction length is 0.18. Table D.1 is calculated for particles that are generated at the center of the detector (Z=0) and which penetrate the solenoid at normal incidence ($\pi/2$). The superconductor is assumed to be uniformly distributed over the width of the conductor, and engineering details such as helium and nitrogen piping and coil support elements are neglected. The radiation and absorption lengths of the materials that make up the solenoid are shown in Table D.2

For particles which are generated at Z=0, but which are incident on the solenoid at angles other than $\pi/2$ radians, the interaction and radiation lengths are shown in Figures D.1 and D.2, respectively. In these figures, the incident angle is parameterized as the pseudorapidity η given by:

$$\eta = -ln(tan(\theta/2)),$$

where θ is the scattering angle relative to the incident particle direction. The particles at $\eta = 1.4$ ($\theta \approx 0.48\ rad = 27.7^0$) go through approximately 2.0 radiation lengths, and 0.4 interaction lengths of material in the magnet.

For electron identification, a preshower detector is installed just outside the cryostat of the solenoid. Between the cryostat and the preshower detector, a specially shaped lead sheet is mounted to aid in electron identification and to compensate the response of the preshower detector for the effects of additional material in the solenoid. To make a uniform value of 2 radiation lengths around the central region, as shown in Figure D.3, the thickness of the lead sheet is calculated, taking into account the radiation length of the solenoid. The thickness of this lead sheet is shown in Figure D.4. Because the interaction region is spread out about Z = 0 by about 30 cm total width, it is appropriate to approximate the thickness of this sheet in a few discrete values.

Table D.1: Radiation and Interaction Lengths for Particles Normally Incident on Solenoid				
Item	**Material**	**Length**	**Radiation Length**	**Asorption Length**
Inner Vacuum Shell	Al	6.4 mm	0.072	0.016
Inner Radiation Shield	Al	1.6 mm	0.018	0.004
Conductor	Al	27.2 mm	0.306	0.069
	Cu:NbTi	2.8 mm	0.175	0.019
Insulation	G10/Epoxy	4.4 mm	0.023	0.008
Support Cylinder	Al	15.0 mm	0.169	0.038
Outer Radiation Shield	Al	1.6 mm	0.018	0.004
Outer Vacuum Shell	Al	7.9 mm	0.089	0.020
Totals			0.87	0.18

Table D.2: Radiation and Interaction Lengths of Selected Materials		
Material	X_0	Λ_I
Aluminum	8.9 cm	39.4 cm
Cu/NbTi	1.6 cm	15.0 cm
G10	19.4 cm	53.6 cm

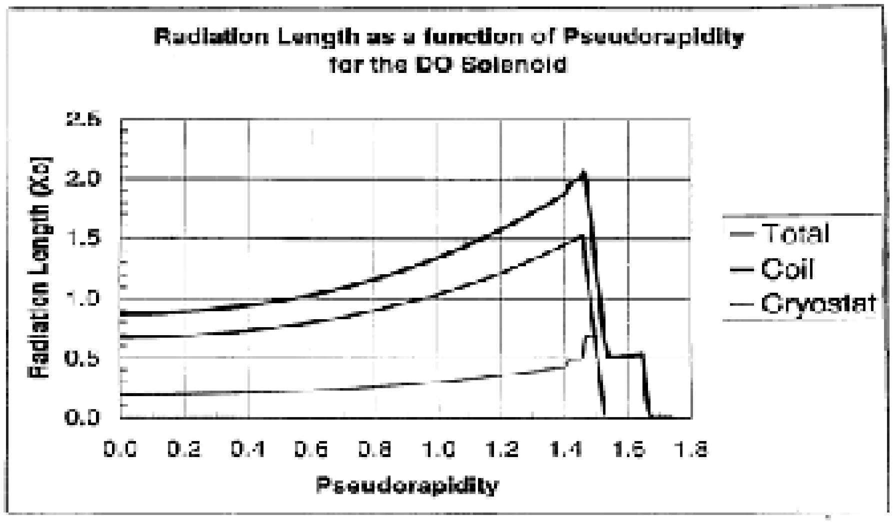

Figure D1. Solenoid radiation length as a function of η

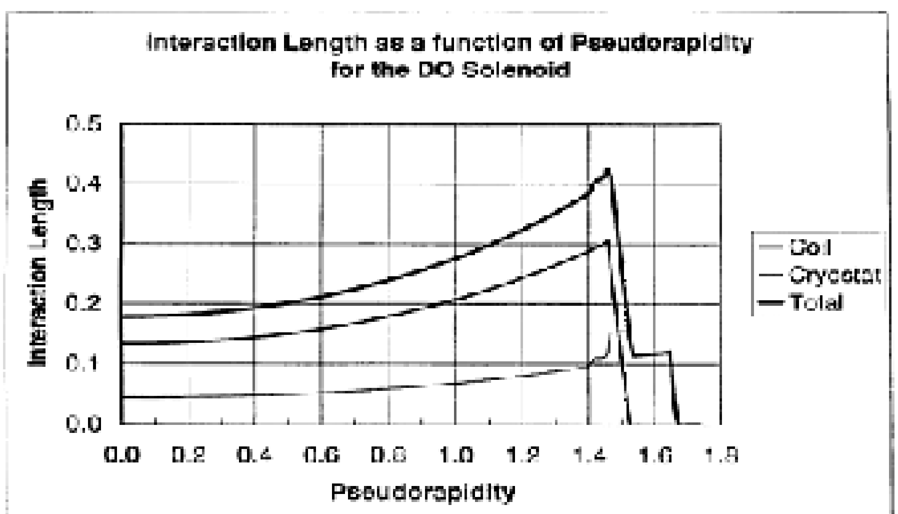

Figure D2. Solenoid interaction length as a function of η

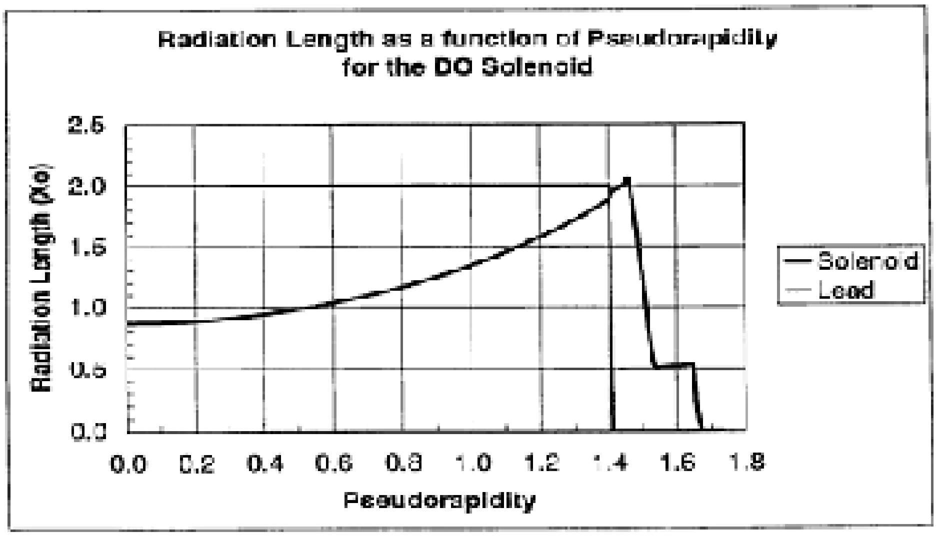

Figure D3. Adding lead to "level" magnet thickness to 2 X_o

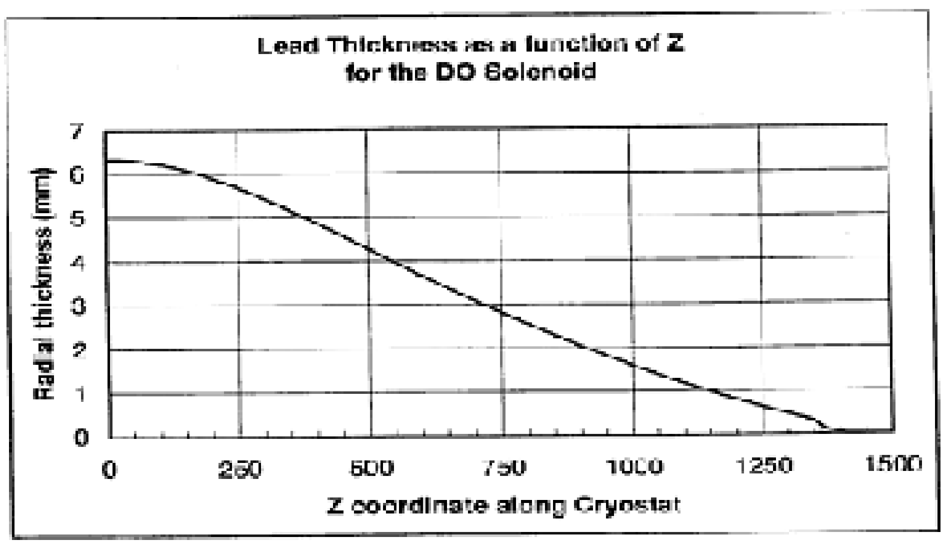

Figure D4. Required shape of lead for $2X_o$ total thickness