MARS Simulation:
Energy Deposited in "Crosshairs"
1 - Aluminum

Introduction

A thin aluminum plate located at z = 360 cm was inserted in a MARS simulation to determine the energy deposition. The plate had dimensions of 2.5cm in x, 0.1cm in y and 2.5cm in z. It is offset from the beamline by 0.25cm or 0.45cm in y. The purpose of the plate in NuMI is to provide a thin scattering object to help determine the position (and extent) of the proton beam.

Results

Two runs were made using 10 nodes and 50K pot each. The geometry file included the target and Horn 1 only. The crosshair plate was just downstream of the horn. The plate was divided into 5 equal recording volumes along x. Due to the small volumes (0.125 cm^3) only a small fraction of primary protons or secondary particles interact in this plate. The simulation time was reduced by increasing the number of interaction / scattering centers in the plate an order of magnitude, using a density of $\rho = 27$ g cm^{-3}. Since the collision length for Al is ~43cm for πp (26 cm for pp) the number of secondary re-interactions is small.

The table T1 lists the results of this simulation. The energy deposited is given in the native MARS units (GeV g^{-1} pot^{-1}) and in a more useful form for engineering calculations (J g^{-1} $pulse^{-1}$) where one pulse is defined as 4×10^{13} pot.

Assuming a specific heat of 0.9 J g^{-1} °K^{-1}, the temperature rise is approximately 2.1°K and 0.8 °K for the peak at an offset of 0.25 cm and 0.45cm respectively.

x bin (cm)	dE (r=0.25cm) GeV g^{-1} pot^{-1}	dE (r=0.25cm) J g^{-1} $pulse^{-1}$	dE (r=0.45cm) GeV g^{-1} pot^{-1}	dE (r=0.45cm) J g^{-1} $pulse^{-1}$
-2	$0.55\pm0.08\times10^{-4}$	0.36 ± 0.05	$0.03\pm0.02\times10^{-4}$	0.02 ± 0.01
-1	$1.09\pm0.11\times10^{-4}$	0.71 ± 0.7	$0.31\pm0.11\times10^{-4}$	0.20 ± 0.07
0	$1.90\pm0.15\times10^{-4}$	1.22 ± 0.10	$0.67\pm0.19\times10^{-4}$	0.43 ± 0.12
1	$0.98\pm0.14\times10^{-4}$	0.64 ± 0.09	$0.70\pm0.17\times10^{-4}$	0.46 ± 0.11
2	$0.38\pm0.05\times10^{-4}$	0.25 ± 0.03	$0.38\pm0.12\times10^{-4}$	0.25 ± 0.08

Table 1. The energy deposited in the aluminum plate at two distances from the beam.

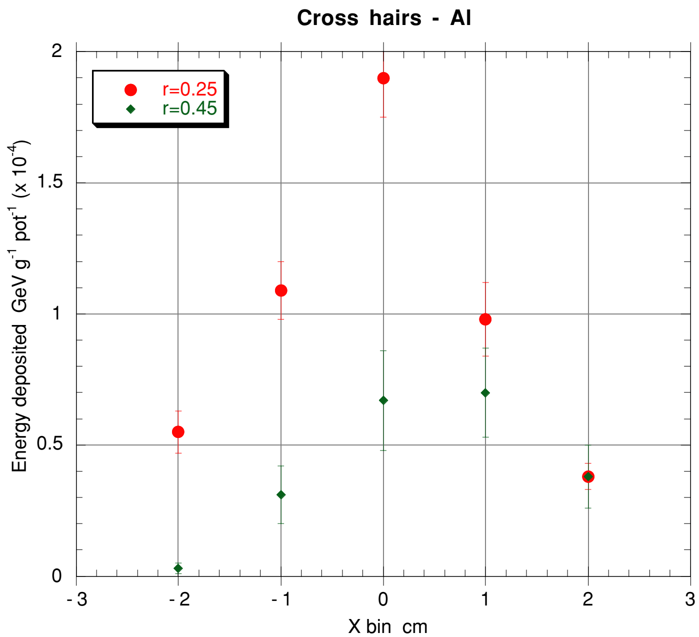

Figure 1. The energy deposition in the aluminum plate in the five volumes shown in Figure 2.

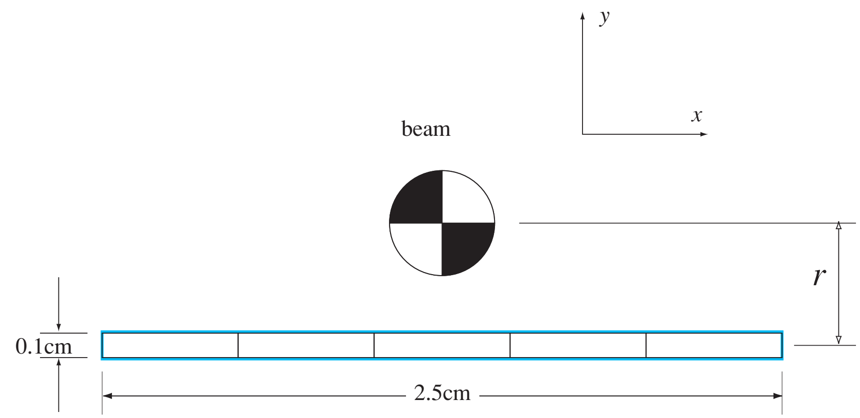

Figure 2. Schematic of plate section transverse to the beam. The values of r were 0.45 and 0.25 cm. The five recording volumes have their long dimension parallel to the beam $\Delta z = \Delta x = 2.5$ cm.