A Simulation Study for a New Coordinate Detector

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1 Introduction

A Geant4 simulation was done for a new coordinate detector to be used in Hall A at Jefferson Lab. The detector consists of an array of 333 scintillator bars, each with dimensions 3 mm x 30 mm x 1000 mm. The scintillator bars are made of C_2H_2 with a density of 1.032 g/cm^3 and a C/H ratio of 9/10. The detector is located 6 m from the center of the target, and is rotated 28 degrees from the beam axis. The target is a 40 cm tube of LH_2 with a 1 cm radius, and is oriented longitudinally along the beam axis. The density of the target is 0.0708 g/cm^3. Another simulation was done using an identical setup, but with a 15 cm plastic absorber placed inbetween the target and the detector. The absorber was made of CH_2 with a density of 1.032 g/cm^3 and a C/H ratio of 1/2. It had dimensions 100 cm x 15 cm x 100 cm, and was placed 10 cm in front of the detector plane. A beam of 11 GeV electrons was delivered directly to the beam.

2 Results

The first simulation was done without the plastic absorber. Table 1 shows the rate per bar for different energy deposition thresholds. The rates are calculated assuming 70 μA.

Table 1: Rate per bar for different energy deposition thresholds (assuming 70 μA current). No absorber present.

Energy deposition (MeV)	Rate (Hz)
> 0.01	1.71 x 10^{10}
> 1.0	7.89 x 10^{9}
> 2.0	2.60 x 10^{9}
> 3.0	8.42 x 10^{8}
> 4.0	2.26 x 10^{8}
> 5.0	6.30 x 10^{7}
> 6.0	2.62 x 10^{6}

A separate study was done using Geant3, the results of which are shown in Fig. 1. This simulation assumed a total solid angle of 0.1 sr and a beam current of 10 μA. My detector array has a cross section of 1 m x 1 m and is 6 m away from the target, giving a solid angle of 0.028 sr. To compare my rates with those of the Geant3 simulation, I scaled my results by a factor of 333 bars $\times(10\mu A/70\mu A) \times (0.1sr/0.028sr) = 170$. These scaled rates (Table 2) are consistent with the results shown in Fig. 1.

Figure 1: Geant3 simulation. Right side vertical axis indicates the rate in Hz.

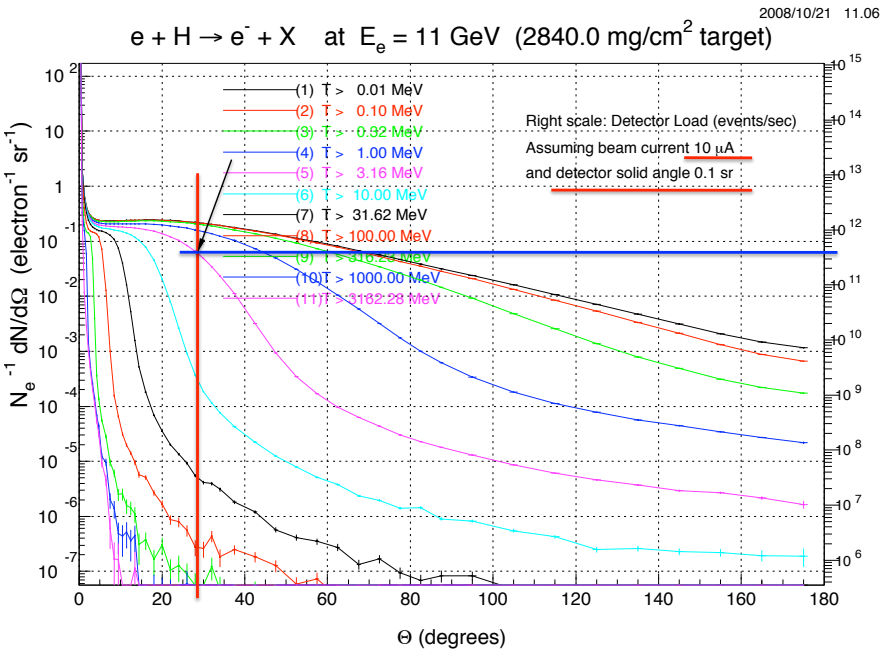

Table 2: Rates scaled by 170 to compare to Geant3 simulation.

Energy deposition (MeV)	My rate (Hz)
> 0.01	2.91 x 10^{12}
> 1.0	1.34 x 10^{12}
> 2.0	4.42 x 10^{11}
> 3.0	1.43 x 10^{11}

The results of the simulation with the 15 cm plastic absorber present are shown in Table 3. The type of particles with deposited energy > 0.01 MeV is

electrons: 8.9 MHz
photons: 157.7 MHz

Table 3: Rate per bar for different energy deposition thresholds (assuming 70 μA current. 15 cm absorber is in.

Energy deposition (MeV)	Rate (Hz)
> 0.01	1.66 x 10^8
> 1.0	5.71 x 10^6
> 2.0	8.58 x 10^5
> 3.0	1.34 x 10^5
> 4.0	4.20 x 10^4
> 5.0	1.57 x 10^4
> 6.0	1.31 x 10^4

As a check, the initial kinetic energy of particles incident on the detector was plotted as a function of energy deposited in the detector. The energy deposited by a particle traveling through the detector should never exceed the energy of the particle before entering the detector, which is demonstrated in Fig. 2.

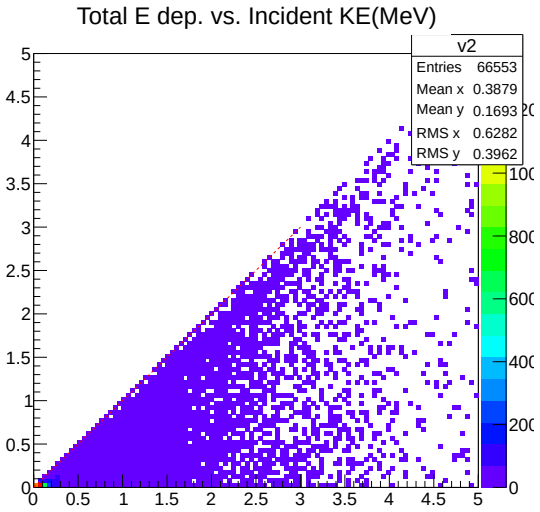

Figure 2: Initial kinetic energy of a particle vs. the energy deposited by the particle in the detector. Units are in MeV.