DRAFT
Some Standardized Formats for End-to-End MCP-PMT Simulations

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1 Introduction

A goal of the LAPPD project is to be able to develop advanced MCP-PMT's using simulation to optimize the many parameters. This will require a realistic simulation of each step in the generation of the final digital output, including the creation of signal in the light source, transmission through the window, photo-conversion and emission in the photocathode, drifting in the 3 gaps in the stack, showering in the MCP pores, generation and transmission of signal in the anodes, and signal capture and digitization in the front-end electronics.

A modular simulation framework will allow each step can be worked on by several people in parallel, especially students, for whom the simulation is a great teaching tool. A common format for the interface between modules makes possible a simple common set of tools to print out intermediate results, make histograms, and do simple analyses.

Here we suggest a simple default format for each step in the chain. The format has two views, as described below.

2 Coordinate System and Units

The coordinate system is a right-handed Cartesian coordinate system, with z along the normal to the front face, pointing into the MCP-PMT and the x and y axes in the plane of the front face each parallel to an orthogonal edge The origin is taking at the center of the window face.

Typically the simulation starts with an incoming charged particle or photon entering the window at $x = 0, y = 0, z = 0$, and time $t_0 = 0$.

All distances are measured in microns and times in psec. All energies are in electron-volts (eV).

3 Formats

Two formats may be useful at different points in the evolution of the signal. The first, 'Particle-based', may be most useful early in the sequence, when the number of electrons is tractable. The second, 'Pore-based', may be more useful to simulate the generation of the signal at the anode by the shower, which may contain more than 10^7 electrons, and hence would present a formidable number of bytes per shower.

3.1 Header

At the start of each format below is a single header record, which records:

1. Job Name
2. Module Name
3. z of Interface Plane
4. Version Number
5. Date
6. Who
7. Number of incident particles
8. The depth in time stored in psec, N_{max}
9. Description

3.2 Particle-based

At each interface between modules, i.e. at a given value along the z-axis, each particle has recorded:

1. Particle Number
2. x
3. y
4. dx/dz (θ_x, or x-prime)
5. dy/dz (θ_y, or y-prime)
6. t
7. E

3.3 Pore-based

At the output of MCP2 there will be typically $10^6 - 10^7$ electrons, which at 7 words/particle would make too large a file for a run of many incident particles. Conseqently a pore-based format may be most useful for simulation of the electronics. This format contains the information per pore in 1-psec bins for the first 500 (??) psec for all pores that have a photoelectron making a first strike that generates at least one secondary in the pore. We assume that the total number of pores struck per event will not be large.

Time bins that have no electrons in them at the start of the list are not entered into the list; the list begins with the first non-zero bin, and all bins are included after that up to the maximum, which is N_{max} (default 500 psec) after t_0. We assume that the shape of the shower is the same in all time bins (this can be changed if it turns out to be not true in a significant way).

1. Pore number
2. Pore x
3. Pore y
4. Mean electron E
5. Sigma electron E

6. Sigma electron dx/dz
7. Sigma electron dy/dz
8. Index of first non-empty bin N
9. N_electrons in bin N
10. N_electrons in bin N+1
11. ...
12. ...
13. N_electrons in bin N_{max}

The End