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Project Outline - Particle Physics Simulator

Experimental nuclear and particle physicists make extensive use of particle simulation routines for both detector development and performance studies. These routines, generally referred to as *Monte Carlo* analysis, define detector geometries and materials, and "swim" particles through the detectors, simulating physical processes such as energy loss, multiple scattering, and curvature in magnetic fields. *Monte Carlo* routines may also simulate higher order physical processes, such as particle decays and interactions (pair production, δ-rays, hadronic showers, etc.), thus giving realistic predictions of experimental results. An unfortunate consequence of this realism is that such routines become quite large, and require a long time to understand and utilize.

I will create a particle simulator which includes the most fundamental physical processes, so as to be useful, while remaining small and simple enough that a user can quickly retrieve and run the package. This project will give me further insight into computer simulation of particle physics, which has profound importance to my field of interest. More importantly, the routine should provide a student with ready access to the visualization of particle physics, which cannot be easily achieved with full-scale simulation packages, yet can be extremely helpful in understanding phenomena.

My overall goals of the project include:

- correctly simulating physical processes common to all particles in transport through media (energy loss, multiple scattering, magnetic fields, particle decay)
- both graphical visualization of the particle trajectories as well as plotting of physical parameters (for quantitative analysis)
- modularization of code, so that a user can easily extend the package to include additional physical processes
- compact and simple enough so that a user can retrieve and compile the code and be running the program in 5 minutes

I will use the *Xforms* graphics library to perform displays and plotting, while keeping the program interface on a command line level. For simplicity, I plan to use *C* exclusively. All material and particle definitions, as well as execution commands, will proceed though simple command line statements which can alternatively be read in through input files. In this manner, the user can switch between complex apparatus without recompiling the code.