Simulation and Reconstruction of Charged Particle Trajectories in an Atypic Time Projection Chamber

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1 Introduction

Summary of what this thesis aims to accomplish, description of the X17 IEAP CTU project. What do we use for the simulation and reconstruction (ROOT, Garfield, MetaCentrum).

1.1 ATOMKI Measurements

Short summary of results of measurements in ATOMKI.

1.2 X17 IEAP CTU

Short description of our detector. Why we use atypic TPC.

2 Time Projection Chamber

Description of TPC, working principle, standard vs our field layout.

3 Track Simulation

Single track in positive x direction or initial parameters randomization. Needed for reconstruction testing and determining of the achievable resolution.

3.1 Microscopic Simulation

Primary track simulated in HEED. Ionization electron drift simulated with AvalancheMicroscopic in Garfield.

3.2 Runge-Kutta Simulation

Trajectory simulation with 4th order Runge-Kutta.

3.3 Future?: Fast Simulation with the Ionization Electron Map

Primary track simulated in HEED. Readout parameters by interpolating the map. Diffusion from the map for randomization.

4 Track Reconstruction

Reconstruction of one track simulated with microscopic tracking in Garfield.

4.1 First Attempts

Using the same method as in standard TPC (calculating z from the drift time). Gas composition 90/10.

4.2 Ionization Electron Map

Explanation of the map. Simulated on MetaCentrum, workload distribution between multiple jobs. More electrons at one location to get statistics. Two methods of reconstruction using this map.

4.2.1 Gradient Descent Search

Gradient descent search of a point in the original space that gets mapped to the given point of the readout space (trilinear interpolation).

4.2.1.1 Trilinear Interpolation

Explanation of trilinear interpolation.

4.2.2 Interpolating in the Inverse Grid

Interpolating between known points in the readout space.

4.3 Discrete Reconstruction

Reconstruction with pads and time bins.

5 Energy Reconstruction

5.1 Cubic Spline Fit

Bad attempt at energy reconstruction using cubic splines.

5.2 Circle and Lines Fit

Energy reconstruction with circle and lines fit. Trilinear interpolation of the magnetic field. Tested on Runge-Kutta sample, future testing with microscopic simulations and map simulation. Preliminary 2D version and complete 3D version.

5.3 Runge-Kutta Fit

Single parameter fit with 4th order Runge-Kutta simulated track. Future testing with microscopic simulations and map simulation.

6 Conclusion

Here or at the end of each section.

References