Proposal to the
University Consortium for a Linear Collider

August 30, 2002

Proposal Name Application of CLEO tracking to a TPC

Classification (accelerator/detector: subsystem)

Detector: tracking

Personnel and Institution(s) requesting funding

D. P. Peterson, R. S. Galik, B. K. Heltsley, Cornell University

Collaborators

none

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Project Overview

Hardware studies of proposed tracking detectors for the linear collider provide measurements of spatial resolution and signal width characteristics in controlled, low track-multiplicity conditions. However, detector performance in terms of track-parameter resolution and track-reconstruction efficiency, in the complex event environment expected at the linear collider, must be inferred through simulation. Simulations can include most of the effects that distort the detector signals, including noise, hit efficiency, signal overlap, and non-Gaussian tails of the response functions. While simulated events can be made to closely match real data, the ability to provide relevant predictions of the tracking resolution and efficiency in high track-multiplicity events also requires a mature pattern recognition algorithm. The ability to make informed comparisons of competing tracking technologies requires such mature pattern recognition, optimized to tolerate signal complications, for each technology.

We propose to develop a track pattern recognition algorithm for a time projection chamber (TPC) that is based on the algorithm currently used by CLEO. The goal is to develop a mature algorithm that will provide relevant, robust predictions of the tracking resolution and efficiency in simulations of various TPC readout configurations while varying the signal complications described above.

CLEO successfully uses a pattern recognition algorithm employing an initial phase based on identifying unbroken strings of low precision "hits" in the dense array of readout cells of a small cell drift chamber. The localized strings are readily identified in very complicated events; we anticipate an advantage in noise rejection over more global approaches to pattern recognition. This method is adaptable to a TPC because the CLEO drift chamber cell-level information and granularity are similar to that of the pad level information provided by a TPC. The track density in a TPC at the linear collider can be similar to that observed in CLEO when TPC hits are pre-selected to come from roads limiting the z projection.

The optimization of any track reconstruction algorithm to handle special cases (e.g., curling tracks, kinked tracks, highly overlapped tracks, pattern recognition in an extreme noise environment) is dependent on an understanding of how an approach fails in such cases. The current CLEO pattern recognition benefits from a diagnostics package that provides graphical and console information at intermediate steps of the algorithm. The developer is able to make detailed investigations of conditions leading to the final result. The diagnostics package, including the graphics, would be applied to the TPC implementation and is particularly suitable for conversion to JAVA.

While the algorithm is currently coded in FORTRAN our ultimate goal is to fully convert it to an object oriented language for compatibility with existing full-detector simulation efforts that use physics event generators.

To provide results in the short term, efforts are underway, with the help of Mike Ronan of LBL, to wrap the FORTRAN version in JAVA for compatibility with the LCD simulation package. At this time, the LCD package does not provide a full simulation of signals. However, signal simulation, and distortion, can be added to an interface between the LCD package and the pattern recognition package. The FORTRAN version can also be used, in a stand-alone way, to predict tracking resolution and efficiency for tracks in jets parameterized in terms of track density, taking into account many of the signal complications.

FY2003 Project Activities and Deliverables

In the first year, we will complete various modifications of the FORTRAN version including detector specific changes and structural changes that will facilitate the the conversion to an object oriented language. The conversion to an object oriented language will be started. We will complete the wrapping of the FORTRAN version in JAVA and measure tracking efficiency within the LCD simulation package.

The first year deliverable will be a report on the variation of track-parameter resolution and track-reconstruction efficiency with respect to track momentum, track density, spatial resolution of the detector, detector segmentation, signal width in r-ϕ and z, and noise density. It will use only a TPC with idealized geometry with detector signal response added to the FORTRAN program.

FY2004 Project Activities and Deliverables

In the second year, we will continue the conversion to an object oriented language. We will make changes to the pattern recognition to maintain compatibility with the LCD full-detector simulation as that effort evolves to includes more detector geometry and signal response.

The second year deliverable will be a more refined report on the variation of track-parameter resolution and track-reconstruction efficiency including detector geometry and signal response and noise generation provided by the LCD full-detector simulation.

FY2005 Project Activities and Deliverables

In the third year, we will complete the conversion to an object oriented language and compatibility with an existing full-detector simulation effort. We will complete detector design simulation studies in response to the needs of the community.

Budget justification

Cornell will provide reallocation of resources to this project in the form of support for research staff who will supervise the students and complete most of the tracking-device specific adaptation of the code (D. Peterson) and coordinate the conversion to an object oriented language (B. Heltsley). In addition, much of the coding will be performed by students supported by the Cornell LEPP base grant. However, funding is required for an additional desktop computer installation with an enlarged screen area that is compatible with the diagnostic graphics. Funding is also required for travel for consultation with others working on track simulation.

Three-year budget, in then-year K$

Institution: Cornell University

Item	FY2003	FY2004	FY2005	Total
Other Professionals	0	0	0	0
Graduate Students	0	0	0	0
Undergraduate Students	0	0	0	0
Total Salaries and Wages	0	0	0	0
Fringe Benefits	0	0	0	0
Total Salaries, Wages and Fringe Benefits	0	0	0	0
Equipment	3	0	0	3
Travel	4	4	4	12
Materials and Supplies	0	0	0	0
Other direct costs	0	0	0	0
Total direct costs	7	4	4	15
Indirect costs	0	0	0	0
Total direct and indirect costs	7	4	4	15