Continuation of Reconstruction Studies for the SiD Barrel Outer Tracker

Classification (subsystem)

Detector - SiD Barrel Outer Tracker

Personnel and Institution(s) requesting funding

Stephen R. Wagner - University of Colorado, Boulder

Collaborators

None at current time

Project Leader

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Project Overview

Further development of tracking code for SiD Barrel Outer Tracker. Determine whether backgrounds (BGs) at cold Linear Collider (LC) make long-shaping-time Silicon-strip detectors viable again. Investigate whether observed fall-off in tracking efficiency near jet core is due to the method of estimating efficiency that was used, and how much it can be improved with more sophisticated tracking algorithms. Improve base tracking classes in **hep.lcd**, the Java/JAS-based Monte Carlo (MC) reconstruction package, to make them more functional for tracking developers and those doing detailed physics analysis studies. Produce and support a SiD barrel reconstruction package that inter-operates with the other standard classes and packages to produce tracks which can be used by other groups for detector optimization and physics justification studies.

Broader Impact

The goal of this study is to assist in the design of a Silicon-based detector (SiD) for a LC experiment, driven by all of the particle physics discoveries and measurements possible at such a machine. One clear goal of this proposal is to involve the next generation of post-docs and physics undergraduates in this process. The Project Leader has an established record of mentoring undergraduates from underrepresented groups, and will certainly include them in this work if possible.

Results of Prior Research

The project being proposed here represents a continuation of work started while the Project Leader was at SLAC. This research was funded at that time by Research Division LC R& D funds from the SLAC base grant. The Project Leader has since moved to the University of Colorado (CU). We are submitting this LCRD proposal because there are no funds in the CU base grant to continue and expand the work begun at SLAC.

The research performed at SLAC was periodically presented at SiD tracking meetings and at several workshops. A summary of this work is *Pattern Recognition Studies for a Silicon Outer*

Tracker, SLAC-PUB-10991, to be published in the Proceedings of the 2004 International Conference on Linear Colliders (Paris).

These studies were based on the projection of already found tracks from the barrel CCD vertex detector (VXD) into the barrel outer tracker. The outer tracker was fully loaded with hits from other tracks and with the full complement of the various BGs expected at the warm LC. These studies showed that the long-shaping-time detector was quite challenged for lower momentum ($\sim$ 3 GeV/c) tracks with full BGs added in (efficiencies of $\sim$ 96.5%), but that these efficiencies could be improved by adding more spatial information ("tiling") or timing information, at the resulting cost of more material in the tracking volume and the resulting loss in momentum resolution.

The studies also demonstrated a loss in efficiency for high momentum ($\sim$ 50 GeV/c) tracks near the core of jets. While this is expected somewhat due to the increased density of hits in near the jet cores, and can be remedied *some* with more sophisticated pattern recognition, some of this may also be due to the fact the efficiency was evaluated for tracks *embedded* in real physics events, imposing a situation that real energy/momentum conservation might alleviate somewhat. The two-track resolution of the SiD tracker, compared with that of a detector with an outer TPC, is a subject deserving of further investigation.

Facilities, Equipment and Other Resources

The work (software development) described in this proposal is completely computer-based. The CU HEP group provides a compute farm, funded some from university money and some from the base grant, that is used for all HEP work done on-campus, and that farm will be available for this work also. There is also a pool of senior physicists at CU experienced in tracking at e^+e^- detectors and with silicon-strip detectors that will be available for consultation.

FY2005 Project Activities and Deliverables

Redo previous tracking studies with new estimates of BGs from cold LC. Fully Kalman-ize track fits from existing reconstruction package (**SODTrackFinder**), so that ambiguous hits (shared between two or more candidate tracks) can be optimally arbitrated between tracks. These ambiguous hits are the most likely cause of track finding confusion near the core of jets. Change MC truth method from embedded tracks to hit parent history so that we can evaluate tracking efficiency for multiple tracks in an event, and have multiple tracks to do hit arbitration between. Better incorporate any available z information into pattern recognition. Report progress and continue development at Snowmass workshop.

FY2006 Project Activities and Deliverables

Release beta version of track finding package for other groups to test. Adapt to improved simulation of detector hit response. Reactivate effort for stand-alone pattern recognition (in coordination with VXD-projected track finding) in the barrel outer detector.

FY2007 Project Activities and Deliverables

Participate in final optimization of the detector for LOI/TDR using developed tools. Continue to develop package and to support others using these tools.

Budget justification: University of Colorado, Boulder

The majority of the funding being requested is for half of a post-doc's salary for the 3 years. It is expected the other half of this post-doc's salary will come from the CU base DOE grant, and that they will spend the other half of their time on one of that grant's funded projects (BaBar, BTeV, or the neutrino program).

There is also a line to hire one undergraduate (at a time) for 10 hours/week during the school years and 40 hours/week during the summers. While we would like to get more undergraduates involved, we assume any additional ones will be funded through the CU Undergraduate Research Opportunities Program (UROP).

The Equipment funds are to provide desktop computing for those working on this project (including the Project Leader). The Travel request assumes one US conference or workshop and one foreign conference per year, except for 2005, which assumes two US conferences and two people at Snowmass for the full two weeks. The travel request includes the travel of the the Project Leader for the work proposed.

Inflation is calculated at 4% per year, benefits are calculated at 20% of salaries, and indirect costs are calculated at 50% of direct costs. All of these are approximately in line with those used in the CU base grant.

Three-year budget, in then-year K$

Institution: University of Colorado, Boulder

Item	FY2005	FY2006	FY2007	Total
Post-Doctoral Research Associate	22.5	23.4	24.3	70.2
Undergraduate Students	7.5	7.8	8.1	23.4
Total Salaries and Wages	30.0	31.2	32.4	93.6
Fringe Benefits	6.0	6.2	6.5	18.7
Total Salaries, Wages and Fringe Benefits	36.0	37.4	38.9	112.3
Equipment	2	2	2	6
Travel	6	3	3	12
Total direct costs	44.0	42.4	43.9	130.3
Indirect costs	22.0	21.2	22.0	65.2
Total direct and indirect costs	66.0	63.6	65.9	195.5