Proposal to the University Consortium for a Linear Collider

October 7, 2002

Proposal Name

Optimization of LC detector elements for physics analysis.

Classification (accelerator/detector: subsystem)

Detector: calorimeter (+ tracker).

Personnel and Institution(s) requesting funding

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Collaborators

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Project Overview

While much work has been done on the development of individual detector elements for LC detectors, no optimization has been performed to coordinate properties (such as granularity) amongst the tracker and EM+HAD calorimeters for physics analysis. For instance, an analysis tool receiving much attention currently is "energy flow", an aggregate quantitity constructed from tracking and calorimetry information. Without bias towards tracking and calorimetry technologies, we propose to develop simulations of benchmark physics analyses for a variety of detector parameters. More specifically, we propose to focus on minimal Standard Model Higgs boson production (and the main backgrounds) as our physics benchmark. Using current expertise we have in studies of the ATLAS calorimeter, we intend to create energy flow, jet definition, and jet-jet mass algorithms tailored to several choices of calorimeter granularity and longitudinal segmentation; a third parameter would be the particular calorimeter material and its response to different particle types. From these studies we hope to optimise Higgs boson mass resolution and the signal-to-background sensitivity.

In addition to the simulation-based studies, we will develop readout electronics for calorimeter prototypes under study at ANL and NIU. The goal of this electronics development is to beam-test prototypes on a short time scale. For both the simulation work and the electronics design, we anticipate collaborative work with ANL and NIU. In particular, NIU is helping to develop the standard ALCPG simulation package, for which we envision developing a GRID implementation.

A number of institutions are expressing interest in working on "energy flow" (in addition to those mentioned already: U of Illinois at Chicago, U of Kansas, U of Texas at Arlington, U of Colorado, Boston U, U of Oregon, and SLAC). Our group at the University of Chicago is currently working on energy flow assessment and jet definition software for the ATLAS detector at the LHC, and this activity already is being conducted in collaboration with ANL. Thus, it is logical for our group to embark on such studies for the LC, and we intend to do this within the auspices of the LC calorimetry group which is coordinating the activities of the various institutions. However, it is worth noting that the project proposed in this proposal is different from energy flow development insofar as the main target of the study is to optimize the detector systems; energy flow is only one aspect of physics analysis which will be considered.

We expect to have sufficient manpower to produce significant results within the three-year period. Andersen, Blucher, and Oreglia are senior personnel who will devote significant effort to the project. Other senior personnel are performing similar research for the ATLAS experiment and will contribute greatly through their instruction of students and the postdoc(s).

Outreach in this program will be realized through the participation of 2-6 undergraduate students, both University of Chicago students and also REU students from other universities. Every summer, the University of Chicago Physics Department supports 15-20 female and minority undergraduates to participate in physics research programs; we expect to be able to support two of these REU students in the proposed research.

FY2003 Project Activities and Deliverables

In year-1 we will develop a simulation package based on the existing framework, but with more general treatment of the calorimeter options. Using this tool, we will generate datasets of standard physics processes. At the same time, we will be able to integrate into the detector simulations group to develop further the framework for Monte Carlo simulation of physics processes in the 2 standard detector configurations. This study will involve development of (or modification of existing) algorithms for energy flow, jet definition, and jet energy scaling suited to the Higgs boson analysis under study. We especially expect to benefit from comparisons of similar techniques under development by our group for use with the ATLAS detector at the LHC.

Additionally, the new EFI/ANL GRID computing team has expressed interest in creating a platform for large-scale Monte Carlo production which we intend to use for the LC studies.

FY2004 Project Activities and Deliverables

During year-2, physics analyses will be refined and comparisons of signals and backgrounds will be made for the range of detector parameters under consideration. At this point we will be able to comment on how calorimeter technologies under consideration compare to the optimization of our study.

In this year we will also develop electronics for calorimeter prototypes and beam tests of ANL and NIU calorimeter prototypes. The Chicago EFI electronics design group has a long history of development of such systems, and has recently designed the hadron calorimeter electronics for ATLAS. We feel that the ATLAS design can be exploited at low overall design cost.

FY2005 Project Activities and Deliverables

In year-3 decisions on the calorimeter technology should have been made, and we will refine the design of calorimeter electronics. We will also support development of physics analysis and the use of GRID networking for the generation of large Monte Carlo datasets.

Budget justification

The first-year budget supports only undergraduate research assistants and travel. In the remaining years a graduate student is taken on and also a postdoctoral RA is added (at the 50% level in year-2 and full time in year-3); the travel allowance is increased accordingly. The “Other direct” category is for graduate student tuition.

Three-year budget, in then-year K$

Institution: University of Chicago

Item	FY2003	FY2004	FY2005	Total
Other Professionals	0	22	45	67
Graduate Students	0	21	21	42
Undergraduate Students	6	6	6	18
Total Salaries and Wages	6	49	72	127
Fringe Benefits	1	5	10	16
Total Salaries, Wages and Fringe Benefits	7	54	82	143
Equipment	0	0	0	0
Travel	3	5	10	18
Materials and Supplies	0	0	0	0
Other direct costs	0	12	14	26
Total direct costs	10	71	104	185
Indirect costs	5	31	48	84
Total direct and indirect costs	15	102	152	269