Description of Interest for the Next Linear Collider Research and Development Project

B. Baumbaugh, M. Hildreth, D. Karmgard,
A. Kharchilava, R. Ruchti, J. Warchol, M. Wayne

University of Notre Dame, Notre Dame, Indiana 46556

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In this document we describe briefly the areas of expertise and interest which could be of use to the research and development (R& D) project for a particle physics detector on the Next Linear Collider project. The High Energy Physics group at the University of Notre Dame has developed considerable expertise in fast response scintillation detectors. This expertise has enabled us to make significant contributions to the DØ central fiber tracker, and the Compact Muon Solenoid (CMS) hadron calorimeter projects. In addition, we conduct testing and characterization for a Small Business Industrial Research (SBIR) project on the development of new scintillation plastics in collaboration with the Ludlum Corporation of Lubbock, TX. One of us (MH) also has experience and interest in Beam Energy Measurement, which is of use for both the machine and the detectors. We believe that we can best serve the interests of the consortium by building on already existing areas of expertise.

From the development of small scintillating fibers with sufficient light output and response times through the construction and commissioning phases, the Notre Dame group has been one of the leaders of the DØ central fiber tracker project. We propose to continue this effort by studying the possibilities of using scintillating fibers as an "intermediate tracker" providing a precise position measurement at the inner edge of the large tracker and, more importantly, timing information for the charged tracks in the event. Removing out-of-time interactions can significantly improve the mass and energy resolution of the NLC detector. This particular project is being proposed as a joint initiative between Notre Dame and Indiana University. More information is available at: http://hep.physics.indiana.edu/~rickv/lc/inter_track_rand.html

Our group has been involved with the development of a scintillating calorimeter for the CMS project at the LHC. We have considerable knowledge of the development of scintillator for calorimetric purposes. We propose to join the NLC Calorimeter and Muon projects, and to study the achievable granularity in an HCAL design, as well as optimizing the scintillator for light output. All of this effort will also be relevant for the design of the NLC Muon system if a scintillating technology is considered. We also propose to study the possible methods for a readout system, e.g., wavelength-shifting fibers, clear fiber waveguides, electro-optical interfaces. At Notre Dame we already have considerable lab space (3,000 ft^2) and experienced lab personnel. We are set up for optical design and testing of scintillating fibers and plastics. We would like to study the possibilities of improving the propagation and timing resolution of fiber-optic waveguides by making geometric modifications to fibers to redirect the light propagated through an optical coupling to the most ecient paths through the fiber. Our work with both DØ and CMS has involved electro-optical interfaces of various sorts (VLPC, HPD), and we believe that we will be able to make significant contributions to a scintillating calorimeter or muon readout system.

Energy Measurement at the NLC will be an essentially technical challenge, where clever engineering solutions to the problems of nanometer-scale stability and resolution will be necessary. We are currently interested in developing a prototype support and position-monitoring system for the "magnetic spectrometer" option for Energy measurement, with the end goal being the design of the Energy Measurement system for the NLC. The space required in the accelerator footprint must be specified in advance in order to ensure that a device with the appropriate accuracy can be built. The "magnetic spectrometer" option is chosen as the focus primarily because it may be the only technique capable of achieving the 3×10^{-5} fractional error on the beam energy necessary for the W-mass measurement at threshold. An SBIR partnership for the development of Beam Position Monitor movers with sufficient range and precision may also be a part of this effort.

While we already have much of what we need to begin performing the necessary studies, some additional funding is necessary to support the effort. Personnel will be supplied in the form of part-time students, a part-time post-Doc (also working on CMS and DØ), and technicial labor. We can utilize the currently existing labor pool at Notre Dame, supplemented with students hired for part-time work. The detailed (draft!) budget breakdown for the different aspects of our proposal are presented in the tables, below.

Item	cost
Scintillating fiber + construction of ribbons	
(3 layers, 128 fibers each, 60 cm long)	$8k
Clear fiber, optical connectors	$8k
Prototype carbon fiber arc shell	
(mockup of inner barrel of a LC detector TPC)	$10k
Visible light photon counters [VLPC'S] and readout	
SVX version (explore latest versions	
available from Rockwell/Boeing)	$25k
Cryogenics and dewar for VLPC operation	
(refurished FNAL equipment? departmental dewar)	$20k
Data acquisition	$10k
Test Equipment	$10k
Refurbished ATLAS transition radiation straw	
tracker module + consumables	$20k
Personnel	$15k
Travel	$1k
Total	$127k

Table 1. Cost estimate for the scintillating intermediate tracker effort. Note that this project is a joint proposal with Rick Van Kooten at Indiana University.

Item	cost
Prototype Scintillating extrusions + readout fiber	$15k
Clear fiber, optical connectors	$8k
Photon Detectors and Readout	
Standard APDs/HPDs	$6k
New GAs hybrids	$6k
Readout	$10k
Test Equipment	$10k
Personnel	$30k
Travel	$2k
Total	$87k

Table 2. Cost estimate for the scintillating HCAL/Muon effort.

Item	cost
Test girders and supports	$15k
Vacuum chamber for isolation	$5k
Piezo movers and controllers	$6k
SPPE nano-mover (?)	$8k
Laser Interferometer	$8k
Test Equipment	$5k
Personnel	$15k
Travel	$2k
Total	$64k

Table 3. Cost estimate for the Energy Spectrometer effort. The nano-mover is a potential SBIR project.