STATUS REPORT

Study of the Performance of a Scintillator Based Electromagnetic/Hadronic Calorimeter and Study of the BeamCal

Personnel and Institution Requesting Funding

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Project Overview

We have proposed the design of a scintillator based calorimeter consisting of 5 cm square tiles where alternating layers are offset by 2.5×2.5 cms leading to an effective granularity of 2.5 cm^2 with a reduction of 4 times the number of readouts. We need to prove that this granularity is sufficient to obtain the resolution needed to separate W's and Z's. Our group is working on the simulation software to carry out this study. We propose that this geometry can also be applied to the hadronic calorimeter. This geometry then would reduce substantially the cost of the detector while maintaining adequate resolution to separate Ws and Zs.

We are also learning how to operate the silicon photodetectors (SPDs) proposed by our Russian and now Japanese collaborators. We are also studying the long time light transmission properties of fibers bent into 2 cm radii. This study is going on and will continue for a year or more.

We have begun, at the request of the Beam-Cal group to help with the design of the Beam-Cal calorimeter for the 20 mrad crossing angle case.

We have made contact with our mechanical engineering faculty to carry out a study of how to build the calorimeter modules with the thin (0.5 X_0) Tungsten plates while maintaining their flatness. Lack of funding has kept us from making any progress in this effort.

Status Report

Our group has been working with the SLAC group to learn and use the software being developed. We have written the geometric description of our calorimeter geometry for every one of the detectors (SiD, LCD, GLD) being proposed. This geometry has been installed in the SLAC repository. We are now running GEANT events to develop the parameters that will be used in the calculation of the Chi-Square that would separate the showers produced by the two photons from a π^0 decay when compared to a single photon of the same energy. This requires producing the covariant matrix elements as a function of the position of the shower in the calorimeter. This work is now going on and will occupy us most of 2006. We expect to produce the Chi-Square separation between a single photon and the two photons from a π^0 decay for all possible directions and energies of the π^0. This work is being carried out by the students.

Jason Gray, our graduate student, has written code to trace all charged tracks through the calorimeter and remove their hits in order to clarify the shower patterns. This work is in collaboration with Dr. Milstein from Fermilab. This work will continue and will be used to determine the neutral hadronic interactions both in the electromagnetic and hadronic calorimeters. This work will continue in 2006.

The development of the pattern recognition code to pick up the photon showers and resolve the various single photon contributions needs the participation of a senior research associate dedicated to this problem. The present rate of progress with students is hampered by the amount of time they have available to dedicate to this project.

In January of 2006 we will hold a software workshop meeting in Boulder, Colorado in order to make progress in this effort. The help of the SLAC group in attendance will be of great help to us.

We are developing our expertize in operating the silicon photo detectors (SID). This effort is severly hampered by our lack of electronic engineering help and the lack of available electronic

equipment in our group. We are purchasing equipment slowly within the available funds we have. We have been able to observe very clear signals from the SIDs using a blue diode transmitting light thorugh a fiber but we have not been able to separate the signals from the individual photoelectrons; namely the pulse height analyzer just gives us a single broad gaussian distribution. We are unable to understand why this is the case since our various circuit elements are identical to those used by groups which clearly observe separately the multiple photo-electron peaks. We are working intensely to resolve this problem and this will continue in 2006. Learning how to operate these devices is critical in our effort.

We are studying the light transmission stability of fibers bent in a 2 cm radius. This is a long term project and is proceeding normally. We are including the study of the light transmission in a fiber that has been annealed at temperatures of about 100 C^0.

We have been requested to help with the design of the Beam-Cal for the 20 mrad crossing. We are beginning to work on this problem to understand how we can detect with very high efficiency the high-energy electron-positron from the two photon process. This is crucial in order to remove a serious background to the SUSY signals.This work is being carried out by our research associate Jinlong Zhang and our student, Paul Steinbrecher. This work is continuing in 2006.

FY2006 Project Activities and Deliverables

In 2006 we will continue to develop the software to do the pattern recognition of the photon showers in our electromagnetic calorimeter design. Unless we can get the funding for a research associate this program will develop very slowly and may have to continue into 2007. At the moment this work is being carried out by students.

We will continue to study the long time light transmission properties of a non-annealed and an annealed fiber bent into radii of 2 cms. This study is proceeding and may take 2 years to determine clearly whether the light transmission deteriorates with time. This work will continue into 2006 and 2007.

We will continue to develop our expertize in operating the SPDs. The lack of electronic engineering help makes it difficult to make progress in this effort. This work will occupy my time and that of two students during the first half of 2006. Once we can observe the single photo-electron peak we will proceed to study cosmic-rays to understand the number of photo-electrons observed when a mini-particle (high energy muon)traverses a tile. This work will take place during the rest of the year 2006.

We will initiate in 2006 the simulation effort of the Beam-Cal design for the 20 mrad crossing case.

FY2007 Project Activities and Deliverables

The activities in 2007 depend on the funding allocation in 2006 and 2007. If we can not get the support for a research associate and partime support of an electronic engineer's time in 2006 the effort in 2007 will consist in a continuation of the effort being carried out in 2006. This implies that in 2007 we will continue to improve our photon shower pattern recognition techniques and will continue to study the SPDs.

If the appropriate funding is allocated in 2006 we will propose to begin the construction of a calorimeter module to take to a beam line and study its resolution and pattern recognition characteristics to compare with our simulation results.

Budget Justification

We are requesting full funding of a Research Associate to work on this project and part time support of an Electronics Engineer in 2006 and full time in 2007 if a module is to be built. We have an Electronics Enginner on site working in the JILA complex in C.U. that is interested in working in our project. We are requesting funding for about 50

For students we are requesting funding of one graduate student. Our present graduate student plans to move to our CMS obligations so that he can begin his research towards the doctorate. We would like to hire a graduate student to continue his work. The undergraduates are funded by the University through the UROP and Work Study programs.

The request for this staff funding covers all of 2006. If we need to build a calorimeter module in 2007 we request funding for a full time electronics engineer to help with the electronics design of such a module.

The request for equipment in 2006 is for electronics equipment and to cover the cost of development of extruded scintillator panels (in collaboration with Fermilab).

The fringe benefits for the research associate and electronics engineer consist of 21.6% of salary; for graduate students it is 6.3%. The overhead is 49% of all costs not including equipment or tuition for the graduate student.

Two-year Budget, in then-year $
University of Colorado at Boulder

Item	FY2006	FY2007	Total
Electronics Eng.	50,000	100,000	150,000
Research Associate	45,000	47,000	92,000
Graduate Student	25,000	26,000	51,000
Total Salaries Wages	120,000	173,000	293,000
Benefits(21.6%)	20,520	31,752	52,272
Benefits(6.3%)	1,575	1,638	3,213
Total Benefits	22,095	33,390	55,485
Total Sal.,Wag.,Ben.	142,095	206,390	348,495
National Inst.	15,000		15,000
Extruded Scint.	25,000		25,000
Tungsten Plates	10,000		10,000
Electronics	25,000		25,000
Module Construction		200,000	200,000
Total Equipment	75,000	200,000	275,000
Mater. and Supp.	5,000	20,000	25,000
Other Costs (Tuition)	6,500	7,000	13,500
Travel	5,000	10,000	15,000
Total Direct Costs	232,595	443,390	675,985
Overhead (49%)	74,037	115,831	189,868
Total Cost	306,632	559,221	865,853