The Global COE Program
"The Next Generation of Physics, Spun from Universality and Emergence"
Bilateral International Exchange Program (BIEP, invite) report
Send report to: Your responsible Professor in Kyoto University
gcoe-biep@scphys.kyoto-u.ac.jp , gcoe-office@scphys.kyoto-u.ac.jp

2011/10/25

Invited Student

Name	**Kevin Connolly**
University and Country	**University of Washington**
Grade	**Ph. D Candidate, Graduate Student**
Phone and FAX	**415-517-6213 (Phone), 206-685-0635 (Fax)**
e-mail address	**hbar@uw.edu**
URL	
Name and Position of Ph.D. advisor	**Professor Jeff Wilkes**
e-mail address of Ph.D. advisor	**wilkes@phys.washington.edu**

Responsible Researcher in Kyoto University

Name	Nakaya Tsuyoshi, Akihiro Minamino
Group and Faculty	High Energy Physics
Position	Professor, Associate Professor
e-mail address	t.nakaya@scphys.kyoto-u.ac.jp
Phone and FAX	(81)-75-753-3870 (Nakaya-san) (81)-75-753-3849 (Minamino-san)

Research Project

Title	**Summer Work at T2K's ND280**
Duration	**July 8th, 2011 --- October 4th, 2011**

Please summarize your activities and results during your stay in Kyoto University.
Also please describe how your stay has been beneficial to the graduate students in the host institute. You ca
a sheet, if you need more space.
You can also write any comments and requests to the GCOE program.

The work performed this summer while supported by the GCOE program falls roughly into two main categories: A research project concerning the study of momentum reconstruction and energy scale, along with calibration of the MIP response in the ND280 P0D detector, and then smaller miscellaneous efforts on various topics. I will try to give a brief description of the main research effort of this summer, along with comments on the various smaller portions of work carried out and conclude with some comments on various events attended during the summer stay in Japan.

A majority of my time and effort over the summer period was spent studying momentum reconstruction, materials energy loss and possible calibration methods. The Toka-to-Kamkioka (T2K) experiment has a "production" site in Tokai where a 30GeV proton synchrotron at JPARC is used to generate an intense neutrino beam. This neutrino beam is studied at the Near Detector

complex (also in JPARC), ND280, before traversing nearly 300km to the "detection" site located in Kamioka, the location of the Super-Kamiokande Water Cherenkov Detector. One of the multiple sub-detectors in the ND280 complex is the Pi-0 Detector, or P0D. The P0D's primary purpose is to measure the neutrino-induced Pi-0 production cross section on water, which is a major background for the electron neutrino appearance oscillation analysis, one of T2K's foremost research goals. Because the interest is to study this cross section on water the P0D is a complex detector as far as material and structure goes. It is composed of 40 layers of cross bar scintillator, interleaved with layers of lead, brass, and 25 fillable-drainable water layers to study water-in, water-out cross section comparisons (which subsequently allow analyzers to infer the cross section on water specifically).

The foundation of this summer's research was in the idea of using a backward-going cosmic ray sample. Given that the T2K experiment has a neutrino beam there is a sense of direction within the ND280 complex, namely the direction of the neutrino's flight. Downstream of the P0D are various sub-detectors, but the immediate downstream neighbor detector is a Time Projection Chamber (TPC) which provides good vertex and momentum resolution. Thus, by specifically examining backward-going cosmic rays one can analyze events that first pass through the TPC and then immediately enter the P0D. The P0D reconstruction and analysis currently has no momentum reconstruction, but by using the TPC-measured momentum value of the cosmic rays prior to entering the P0D a variety of interesting studies can be performed.

By careful accounting of all P0D materials and their areal densities, the gram/cm^2 length of the P0D was calculated, along with the expected energy loss of tracks traversing various materials in the P0D. By using the TPC momentum along with the P0D direction and track length measurements, studies of the energy loss and momentum verse track length were performed for both water-in and water-out data and Monte Carlo. The first results of these studies confirmed to good agreement an understanding of the materials and energy loss as expected, giving a preliminary measure of dE/dx consistent between data and MC, along with setting the foundation for possible momentum reconstruction in the P0D based on track length. This work also resulted in my participation of learning how to generate official cosmic ray MC, a simulation sample useful to the entire ND280 complex.

Additional to the primary goal of studying energy loss and momentum reconstruction in the P0D a few other observations were made. The current calibration method was implemented in the early stages of the experiment when statistical samples of cosmic rays were not yet collected, and it was shown that a much more precise calibration could take place. The previous method had the P0D segmented into 20 YZ and 20 XZ regions, and the new system promoted by this summer's work will have the P0D calibrated at a resolution of 640 YZ and XZ regions. Furthermore, with the increased statistics and the demonstrated understanding of energy loss in the materials, the MIP response was studied and calculations of p.e.-to-MeV values were shown to be possible.

Over the summer I also had the opportunity to participate in the Kyoto University high energy physics summer camp. At this meeting I had the unique opportunity to be introduced to the work of the various faculty and graduate students of Kyoto University physics department, listening to many student presentations and discussions. Also important was the opportunity to spend time with the students and faculty in informal settings to help foster friendship and familiarity with colleagues I would have otherwise not been able to get to know so well.

The conclusion of the summer research opportunity was a combination of meetings and presentations. The T2K experiment had a multi-day software meeting which was very interactive and resourceful with students, faculty and researchers from all countries participating. The official T2K collaboration meeting followed the software meeting, and immediately following the collaboration meeting I was invited to return to Kyoto University and give a presentation at the physics department weekly seminar. At this presentation I got to meet directly with the members of the Kyoto University physics department and report on my research efforts over the summer, introduce them to a sub-detector system that has primarily been operated and worked on by US universities, and to get constructive feedback about possible considerations for the next research steps.

Overall the summer was incredibly productive and a wonderful opportunity for research and interaction with the Kyoto University physics department. I am especially grateful for being given the opportunity to meet so many collaborators in Japan and am certain it will enrich my research future having made such acquaintances.

[Reference:高エネルギーなセミナー] “Backward-Going Cosmics in T2K's ND280”
http://www-he.scphys.kyoto-u.ac.jp/seminar/index.html

Kyoto HEP Summer Camp Group Photo