

November 12, 2014

Office of Nuclear Physics
SC-26/Germantown Building
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585-1290

Dear Dr. Rai:

I am writing to you to lend my support to the proposal by Dr. G.P.Gilfoyle to fund a Masters student as part of a joint University of Richmond/University of Surrey program that was successful in 2013. The proposal is part of the renewal application in Medium Energy Nuclear Physics entitled "Nuclear Physics at the University of Richmond" (G.P. Gilfoyle, PI). I am a scientific staff member at Jefferson Lab (JLab) and was part of the CLAS12 software group when this program at JLab was started. I am now leader of the CLAS12 software group. In that first year, Mr. Alex Colvill from Surrey was supported by a supplemental grant to Dr. Gilfoyle's DOE grant. His thesis entitled "Time of Flight Software for the CLAS12 Detector" fulfilled an essential need in the preparations for the start of data taking with the new CLAS12 detector being built as part of the JLab 12 GeV Upgrade. Below, I describe the Richmond/Surrey program, how it worked in 2013, and reasons for continued support.

The University of Surrey in the UK has a large undergraduate program that students typically complete in three years and receive the equivalent of a bachelor's degree in the US. The best undergraduate physics majors at Surrey are encouraged to apply to the Masters of Physics (M.Phys) program to receive a Masters degree in addition to their bachelors after one additional year of study. The essential part of the M.Phys is a research year where students spend 9 to 10 months working in a laboratory and writing a thesis based on their work. Students participating in this program have a level that is roughly equivalent to that of an advanced undergraduate or new graduate student in the US. After their research year they defend their thesis before a committee during their final semester at Surrey. In 2012, Gilfoyle selected Mr. Alex Colvill from a slate of candidates interested in working at JLab. Mr. Colvill was stationed at JLab from March to December 2013. Although Dr. Gilfoyle was his primary mentor, Mr. Alex Colvill

became an integral part of the CLAS12 software group and interacted regularly with me and other members of the group.

Mr. Colvill's M.Phys thesis was on the development of the reconstruction software for the time-of-flight (TOF) sub-systems in CLAS12. It was a significant success that filled an important need in our preparations to complete the JLab 12 GeV upgrade and begin data taking with CLAS12. Mr. Colvill's project contributed to the large software effort involved in the development of the event reconstruction code that will be used to reconstruct and analyze the very high data samples expected from CLAS12 (about 5-10 terabytes each day). There are two time-of-flight (TOF) sub-systems in CLAS12 (forward and central) among the ten major detectors in the baseline equipment. The software environment is unique. A modern, service-based architecture is being used that breaks the overall reconstruction problem into smaller pieces (called services) and manages the interaction of those components to make the code robust and flexible in a demanding, fluid environment.

Mr. Colvill has excellent computational skills, among the best I have seen for students at this point in their careers. He started the project on the forward TOF essentially from scratch. He took an existing service (for the electromagnetic calorimeter) and with little guidance had a version written in Java reading data and generating output in a standalone mode (*i.e.* running without the services for the other sub-systems) in about two weeks. To put in the reconstruction algorithms he started with the code for the previous, pre-Upgrade CLAS detector (written in Fortran). Within two more weeks he had a beta version of the reconstruction service working in standalone mode. He later studied ways to extend, optimize, and test the forward TOF reconstruction and also wrote the code for the central TOF reconstruction service. During this time a stress test was performed on the CLAS12 reconstruction chain. Billions of events were processed and all the existing, sub-system reconstruction services were used to see how the software would fare under realistic operating conditions. Mr. Colvill's TOF services were included in the chain and performed flawlessly. Mr. Colvill received first honors for his thesis, the highest award in the UK.

The Richmond/Surrey program is an excellent source of scientific talent. The students have a strong physics education (better than most US students at liberal arts institutions like Richmond) so they quickly climb the learning curve. The research year lasts long enough to complete a substantial project. The TOF reconstruction software written by Mr. Colvill has become part of the main CLAS12 reconstruction package and his thesis has been published as a CLAS-NOTE (a technical report for the CLAS

Collaboration). It is worth noting that support for capable students like these are an efficient use of resources.

To conclude, I would like to restate my support for Dr. Gilfoyle's proposal to continue supporting a Surrey M.Phys student. This program taps a useful source of scientific talent that makes efficient use of our resources in preparing for the start of data taking in CLAS12. The quality of the program can be judge by the success of the first year of the program at JLab.

Sincerely,



Dr. Veronique Ziegler