Job Summary: Research Support Specialist

Cornell Laboratory for Accelerator-based Sciences and Education (CLASSE)

Aadeetya Shreedhar (as889)
Electrical and Computer Engineering
Work term: Summer 2012

1. Co-op Work Assignment

1.1 Overview of CLASSE

CLASSE develops and operates facilities needed to research particle accelerators, particle physics and photon science. CLASSE includes Cornell University’s electron-positron collider, a high energy synchrotron, the Superconducting Radio Frequency research group, a test facility for a next-generation accelerator based X-ray light source, and the Energy Recovery Linac (ERL). CLASSE also conducts research and development of crucial technologies for the International Linear Collider, a TeV-scale electron-positron linear collider proposed as the next major particle accelerator after the Large Hadron Collider at CERN.

1.2 Overview of ERL

X-ray beams generated by synchrotrons are indispensable for the study of a range of materials from airplane wings to protein structures. Synchrotron users demand less divergent and more mono-energetic X-ray beams with increased brightness in order to study samples on a nanosecond scale. Shorter, sub-picosecond pulses allow for time resolved study of chemical and physical processes.

Linear accelerators can provide beam quality that is significantly better than current synchrotron designs, but must do so at smaller beam currents. A 5 GeV beam (needed to produce hard X-rays) with a current of 100 mA (as is typical in synchrotrons) would have a beam power of 500 MW. This is roughly the capacity of a nuclear reactor. Unlike circular synchrotrons, a linear collider cannot store accelerated particles for several hours, and hence must generate small beam currents. The Cornell ERL aims to decelerate the electron beam and restore its energy into the fields of the accelerating cavities. The ERL will combine the excellent beam quality of a linear accelerator with the high beam current of a synchrotron - and provide significantly improved X-ray beams.

2. Selected Projects

A broad definition of my role: electronics systems design and development for the ERL prototype injector.
2.1 Laser Position Detector (LPD)

The ERL uses a laser to generate an electron beam. The quality and intensity of the electron beam is very closely related to how precisely the laser can be aimed at its target. The LPD measures the laser beam’s position. A feedback system uses the measured data to re-position the laser beam.

I worked on the first revision of this system in my previous work term. I tested the system and found that the system wasn’t working as expected. We identified two major problems:

- The ultra-high speed op-amps we used were oscillating and produced an unstable output
- Insufficient heat sinking caused the board to heat up very quickly

My main task during the summer was to identify parts of the circuit I designed to eliminate or mitigate the problems noted above. I re-designed and simulated the LPD system using CAD tools and scripts.

I also designed a verification and validation procedure. We populated the PCB that houses the system in stages and tested each part of the circuit independently. This new revision of the system works as expected (testing is still underway).

Another important part of this project was effectively communicating the board’s design and usability. All my work at CLASSE is documented, but this project had particularly stringent documentation demands. The LPD will be used by physicists who may not necessarily be familiar with the board’s design. As the ERL and specifications for the laser mature, it is likely that new iterations of the LPD will be required. The board’s design was documented well enough to minimize resources required to design future iterations of the LPD.

The documentation also instructs users on how to tune the LPD to optimize it for use with different incident optical power levels.

3. Evaluation

3.1 Work Environment

Before working at CLASSE, I associated fast-paced work schedules, steep learning curves, rigid dead-lines and pervasive cost-consciousness only with large private-sector corporations. The last 6 months have changed my perceptions. CLASSE is an academic institution with graduate students, post-docs, engineers and senior staff scientists. CLASSE employees always have deadlines: for publishing papers, submitting grant proposals and making sure the ERL development stays on schedule. Staying on schedule and cost-consciousness is particularly important in the current economic situation where government agencies find it difficult to defend funding high-energy physics.

An average day in CLASSE is fairly relaxed, and does not reveal the pace of work because of the prevalent work-ethic. Independent initiative is emphasized. I work largely un-supervised. CLASSE does not have a stream of employee-enrichment programs. How much I get out of my co-op position is largely up to me.
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3.2 People
I have an assigned supervisor and mentor, an engineer (Mr. Dobbins). My personal experience has been fantastic. Initiative goes a long way in CLASSE. In general, people at CLASSE are approachable and willing to pass on their skills and experience.

3.3 Assignments
I enjoyed the assignments given to me, and felt that they gave me exactly the experience I was looking for in a co-op. They were challenging, and required a significant amount of independent learning. I found that course work at Cornell did not prepare me to execute the kind of tasks I was given, but they did teach me to ask the right questions.

Note: CLASSE is located in Cornell's Ithaca campus and a description of housing, transportation and recreational activities is redundant.