ILC Projects at the University of Pennsylvania-Lockyer

Abstract

The University of Pennsylvania is involved in three superconducting RF projects: The Penn Virtual Cavity (PVC) a linux or web based simulation tool; a hardware based Real Time Simulator; and piezo electric crystals and coaxial tuners to control the cavity oscillation frequency. The PVC will help design the RF system for the ILC and the RTS has potential for developing critical control and low-level RF software for the ILC.

Penn Virtual Cavity (PVC)

The Penn Virtual Cavity is Superconducting RF (SRF) cavity simulator modeled as an L-R-C circuit. It includes every component involved in controlling the precise oscillations (1.3 GHz) of the electric fields inside the cavities. It is useful for testing the effect of each component on the system and is used as a learning tool for non-experts to get a general idea of the RF characteristics of the SRF cavities. The simulation has accompanying documentation and is used by Fermilab (Nagaitsev, Chase). The web based interface and program can be found at http://einstein.hep.upenn.edu/ keungj/simulation.html. Justin Keung, a graduate student has been the main author of this work with guidance from DESY, Fermilab, Cornell, SLAC, and KEK.

The PVC includes such effects as: Master Oscillator Phase Jitter; variable cavity Q, Q-drop; Lorentz force detuning; piezo feedback and feedforward parameters for the π and $8/9\pi$ modes; waveguide and ADC constant calibration errors; beam loading, mechanical resonance, cable and electronic delay; and Klystron power ripple and jitter, overshoot, a phase turn on curve, and much more. This is a sophisticated tool and we continue to develop it in collaboration with our colleagues, primarily Fermilab.

Real Time Simulator (RTS)

The Real Time Simulator goal is to incorporate the PVC into an FPGA based system, along with appropriate interfaces to simulate in real time the behavior of an ILC-RF Unit. The model is based on Schilcher's thesis. First order differential equations are solved as difference equations and incorparated into the FPGA. We use the simulink software package. Lorentz detuning has been modeled as well as the basic RF filling equations. Initially work has demonstrated the Lyrtech VHS-ADAC board using the Virtex-II FPGA is fast enough for our needs.

Other important applications include training the control system to deal with exception handling without the need for expensive hardware on the floor. Anna Grassellino, a gradute student, just finishing 1.5 years of study, is the main person on this project. The work will continue this summer with tests at Fermilab being planned to interface with the DESY SIMCON system.

Cavity Tuners

The third project was related to coaxial tuners and piezo crystals. This was a collaboration with Carlo Pagani and colleagues at Milano and Cornell University, Hasan Padamsee and Mathias Liepe. The tuner was received from Milano and in collaboration with Cornell, we assembled a single unit on a two cell copper cavity provided by Cornell. We purchased the cryogenic motor, gear drives, produced custom parts, and designed a simple test circuit board to control the piezo crystals. We then performed a set of measurements to demonstrate the system worked as expected. The assembly was delivered to Cornell for use with their ERL project. Five systems are being duplicated for their ERL injector. This project is complete. This was primarily the work of Walt Kononenko and Mitch Newcomer from the Penn instrumentation group.

We have, at the request of Mishra and Fermilab, received another tuner and titanium helium cryostat from Milano. The goal is to provide the horizontal test cavity system being constructed at Fermilab with a coaxial tuner and piezo crystal system. We have produced another set of custom parts, and are in the process of ordering motor, drives, and crystals. We plan to deliver a tuner piezo system in the summer once it is tested at Penn. We are working with Mark Champion (Fermilab) on this project. Again this work is done by Kononenko and Newcomer. Once complete, we will not pursue this further and Fermilab will take it over.