REU Program 2010
Cornell University

J.A. Crittenden
14 December 2009

— Project Description —

ILC Damping-Ring R&D with the Cornell Electron Storage Ring Test Accelerator

The reconfiguration of the Cornell Electron Storage Ring (CESR) from an electron-positron collider to a test facility for state-of-the-art accelerator physics R&D is now complete and the experimental program well underway. Data-taking periods are planned for April and July 2010. The focus of these investigations will be synchrotron-radiation-induced electron cloud formation and optics design for extremely small beams such as are required at a future high-energy linear e^+e^- collider. The widespread enthusiasm in the particle physics community for the discovery potential of a 20-mile long International Linear Collider (ILC) to study the interactions of 500 GeV *electrons and positrons has resulted in a global effort to which the Cornell Laboratory for Accelerator-based Sciences and Education is making a variety of essential contributions. In particular, the need for extremely small beam sizes necessitates the design of novel damping rings which will serve to produce such small beams at 5* GeV *prior to their acceleration in the linacs. A critical performance limit of the damping rings is the buildup of electron clouds in the evacuated beam-pipe, clouds which are produced by photo-emission from the beampipe walls bombarded by synchrotron radiation. These clouds can become so dense for the very intense ILC beams that their electric fields distort the guide-field optics, causing beam loss. CESR has been charged by the National Science Foundation to characterize and understand the physics of cloud formation and to study a variety of mitigation techniques. This REU project will focus on measurements obtained from dozens of retarding-field analyzer detectors strategically placed around the ring in dipole, quadrupole, and wiggler magnets with differing vacuum chamber designs. Advanced cloud buildup modelling software will serve to understand the underlying physics and the effectiveness of the various mitigation techniques.*

I. Prerequisites

Familiarity with classical electromagnetism equivalent to two semesters at the undergraduate level. Familiarity with Maxwell's equations, electric and magnetic fields and the Lorentz force.

II. Literature

A. Standard introductory texts on accelerator physics, such as *An Introduction to the Physics of High-Energy Accelerators* by Edwards and Syphers. The physics and formalism of longitudinal and transverse particle motion as described in chapters 1-3 of this text should be studied prior to beginning this REU project.

B. CESR notes and tutorials on CESR design and operation

III. Software Tools

A. UNIX/Linux operating system and Fortran 90 programming language

B. CERN Physics Analysis Workstation data analysis and display package (`(http://wwwasd.web.cern.ch/wwwasd/paw/components.html)`

C. Custom electron cloud modelling software