REU Program 2006
Cornell University

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— Project Description —

Characterization and Optimization of CESR Lattice Design

The 2006 REU program at the Laboratory for Elementary-Particle Physics will take place during a period when the Cornell Electron Storage ring CESR is operating at world-record production rates for mesons containing charm quarks. The success of the program depends on understanding the beam optics and dynamics in this unique storage ring design, which features twelve superconducting wiggler magnets dominating the radiation damping. Also unique to CESR among e^+e^- storage rings are the 'pretzel'-shaped orbits, which permit the transport of the bunched electron and positron beams in a single beam-pipe. Of particular interest for the optics design are the effects arising from the long-range beam-beam interactions at the parasitic crossing points, i.e. those other than the main interaction point at the CLEO detector. Software algorithms which include contributions from recent REU program participants are currently in use to predict and improve CESR performance. This project will provide the 2006 participant with insight into the physics of strong focusing in e^+e^- storage rings and contemporary investigations of beam dynamics as well as with practical experience in state-of-the-art lattice design.

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. Familiarity with practical applications of special relativity such as time dilation.

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

A. General-purpose software tools, such as the EMACS editor

1. LINUX and UNIX operating systems
2. Fortran 90 programming language
3. CERN Physics Analysis Workstation data analysis and display package (`(http://wwwasd.web.cern.ch/wwwasd/paw/components.html)`

B. Custom CESR beam-optics emulation software

IV. Research Program

Investigate beam orbits and optical functions for various CESR lattice designs with emphasis on their sensitivity to the long-range beam-beam interactions at the parasitic crossing points. Calculate and characterize the beam dynamical properties of these lattices using tracking algorithms presently implemented in the CESR custom software package.