Microwave Transmission Methods to Characterize Electron Cloud Build-Up in CESRTA

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Synchrotron photons radiated by positron and electron beams circulating in CESR result in the emission of low energy (few eV) photoelectrons from the vacuum chamber walls which can form an “electron cloud” in the vacuum chamber. The density of electrons can be significantly enhanced when the electrons from the cloud are accelerated by the beam and strike the chamber walls to produce additional secondary electrons. Interaction of a high intensity beam with the resulting cloud can lead to bunch-by-bunch tune shifts, emittance growth and the onset of beam instabilities. In order to design the next generation of high intensity rings, such as the International Linear Collider damping rings (ILCDR), it is crucial to understand the build-up of the cloud and methods to suppress it. The CESR Test Accelerator (CesrTA) program is presently utilizing microwave transmission techniques to characterize the build-up of the electron cloud in a variety of accelerator vacuum chambers. The presence of the cloud induces a phase shift in the transmitted waves that depends on the density of the electron plasma. This REU project will focus on understanding the details of microwave transmission in real vacuum chambers by carrying out bench measurements on accelerator beam pipe sections, by participating in beam measurements in CESR during the July CesrTA machine studies period, and by modeling the interaction of the EM waves with the cloud to determine the cloud density through simulations.