John Nocita

Lee Teng Internship Outline

7/22/13

Measurement of Transverse Emittance for ASTA

My project is to develop a Java program to run on ACNET that processes data from digital cameras to determine the emittance of an electron beam. The cameras, positioned throughout the Advanced Superconducting Test Accelerator (ASTA), detect light given off by experimentally controlled targets introduced into the beam. ASTA, currently under construction, will eventually be used as a stage to test high-power, high-gradient superconducting RF cryomodules, especially for the International Linear Collider (ILC).

Transverse emittance is an important beam property because it dictates the physical size of the beam. Many factors can lead to emittance growth, causing the beam to be too large to safely fit through the beam pipe and other elements in the beam line. Diagnostics such as those implemented in this project enable measurements of emittance at various locations, especially before and after components being tested, to determine the effect of these elements on the size of the beam. To enable measurement at various positions, vacuum crosses with pneumatic actuators are used to lower devices into the beam only when needed. Scintillating YAG:Ce crystals and thin foil targets for Optical Transition Radiation are used to produce images of the beam; tungsten slits are used to isolate thin slits of beam that can be observed at varying distance, thus enabling measurement of divergence. A system of optics and networked cameras is used to view these images in real time.

This paper describes a Java application designed to run on the Accelerator Controls Network (ACNET) to acquire and analyze data from the camera stations at each vacuum cross. This program, an extension and modification of a similar program used at the A0 Photoinjector, is intended to allow for real-time calculation of divergence and emittance, and to graphically represent these values. Phase space is calculated using the formula: Emittance = a\*x^2 + b\*x\*x’ + g\*x’^2 where a, b, and g are the Courant-Snyder parameters alpha, beta, and gamma. Beam images with projections onto two transverse axes and Gaussian fits to that data are provided.

Proposed outline:

I : Introduction (ASTA setup, purpose; Emittance)

II : Measurement Hardware (OTR/Scintillation, Tungsten slits, vacuum crosses, cameras/optics)

III : Measurement Software (ACNET, A0PI Matlab program, experimental demands)

IV : EmittanceTool (Functions, features)

V : Results (emittance measurements, comparison with theoretical values)

VI : Conclusions