



Contribution ID: 261

Type: Oral

Measurement of nm Electron Beam Sizes using Laser Interference by Shintake Monitor

Thursday, 5 June 2014 17:30 (20 minutes)

The Shintake Monitor is an essential beam tuning device installed at the interaction point of ATF2 to measure its nm order vertical e- beam sizes (σ_y). *It is crucial for verifying ATF2's Goal 1 of focusing σ_y down to 37 nm in order to verify a final focus system of linear colliders featuring the Local Chromaticity Correction scheme. The e- beam collides with a target of laser interference fringes, and σ_y is derived from the modulation depth of the resulting Compton signal photons measured by a downstream gamma detector. Shintake Monitor is the only existing device capable of measuring σ_y as small as 25 nm, and can accommodate a wide range of σ_y from 20 nm to a few μm with better than 10% accuracy by switching between several laser crossing angle modes. Major hardware upgrades contributed to suppressing errors and the demonstration of measurement stability of 5 - 10%. In 2013, continuous measurement of the smallest ever σ_y of below 65 nm has been achieved. Analysis of systematic errors indicates the possibility that smaller beam sizes have been achieved. This paper describes the monitor's design concepts and performance, and an extensive study of errors with the aim of high precision in measuring the even smaller σ_y^* anticipated to be achieved at ATF2 in near future.*

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Session Classification: II.a Experiments & Upgrades

Track Classification: Experiments: 2a) Experiments & Upgrades