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Operational Experience with ATF2 Beam Diagnostics

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The aim of the ATF2 test accelerator at KEK, Japan is to demonstrate the feasibility of the compact, local-chromaticity correction style of final focus system (FFS) optics envisioned for the next generation of energy frontier lepton linear colliders (such as ILC or CLIC.) It also serves as a test bed for ILC/CLIC related diagnostic devices.
The magnetic optics employed in the ATF2 FFS has extraordinarily tight tolerances: the sensitivity of the focused beam size to both small errors in relative magnetic field strength (typically of order 1e-4 and down to 1e-6 in the case of the final doublet) and position and rotation errors in the installation (typically a few 10' s of micro-metres, 100 micro-radians) lead to challenging problems in the commissioning and tuning of the system. One has to rely on complicated tuning procedures to recover beam size from fabrication and installation 'errors'.
Simulations show that, in principal, the system can be tuned to provide a vertical waist with the expected 37nm vertical waist size. The achievement of this tuning requires a lot of high-performance diagnostic devices working well and with high reliability. The beam tuning algorithms developed also require a high degree of automation, leading to a complex integration of various diagnostics into cross-system feedback controls etc.
Some of the specific diagnostic systems required for tuning are discussed from the point of view of machine tuning, e.g. High-resolution cavity BPMs used for accurate orbit steering and feedback and for beam-based alignment. Multiple OTR systems used for fast online emittance measurements. High-precision and high-stability power supplies used for the FFS magnets. Precision mover systems used for magnet control, dealing with slow ground-motion-induced orbit drift and low-dispersion orbit establishment. A pair of special-purpose high-resolution cavity BPMs with demonstrated resolution <10 nano-metres are being developed with a goal of achieving ˜<2 nano-metre position readback at the vertical beam waist.

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