

Beam-based Diagnostics

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Motivation

Charged particle storage rings are used for a variety of science and technology applications --- for example as synchrotron radiation light sources for biology, chemistry, and materials science, as colliders for high-energy physics or as damping rings to reduce the beam emittance for linear colliders. To achieve small equilibrium emittances or to minimize the beamsizes at the interaction points, strong quadrupoles are necessary to focus the beam, resulting in large chromatic aberrations. The correction of those aberrations requires strong sextupoles creating non-linearities, which can cause the particle motion at large amplitudes to become unstable (dynamic aperture). The dynamic aperture limits the performance in many current accelerators. To optimize the performance a good knowledge of the machine model is required. To achieve the required accuracy of the machine model, beam based measurements have proven to be essential.

Schedule*

- 9:00-11:45 lectures, Gazebo room
- 13:00-14:00 computer lab, El Monte room
- 14:15-~16:30 discussion/lectures, Gazebo
- 21:00-22:00 lecturers available, La Cantina

*Friday – course ends at noon.

Problem sets

- Distributed noon Monday-Thursday
- Due following morning Tuesday-Friday

Grades

- Based on problem sets and class participation. (No exam.)

Lectures

MORNING+AFTERNOON LECTURES: 9:00-11:45, 14:15-16:30

Monday: BASICS

review of accelerator physics (transverse, longitudinal)
tune, chromaticity, dispersion measurement, beta functions
orbit; orbit correction; beam-based alignment

Tuesday: UNCOUPLED LINEAR OPTICS

orbit response matrix analysis
analysis of turn-by-turn orbit data
model independent analysis

Wednesday: COUPLING

beam size measurement
methods of coupling correction

Thursday: LARGE AMPLITUDE DYNAMICS

Lifetime
injection efficiency
measurement of dynamic aperture
measurement of energy aperture
characterization of resonances
tune shift with amplitude
insertion device effect on dynamic aperture

Friday: MISC.

energy calibration
impedance characterization using turn-by-turn and closed orbit measurements
measurement of nonlinear momentum compaction
mode spectra for multibunch instabilities (guest lecturer: Jim Sebek)