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 beamsize 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*

- Class meets from 9-12 and 14-17 daily
- Computer labs
  - Mo 15-16
  - Tue 15-16
  - Wed 10-12
  - Thur 9-10
  - (Fri 9-10)
- Not all time in class-room will be lectures, some time available for discussion, further computer tutorials, …
- At least 21:00-22:00 lecturers available in computer room and study room

*Friday – course ends at noon.

Problem sets

- Distributed at noon Monday-Thursday
  - Some written problems and some computer problems
- Due following morning Tuesday-Friday
  - Computer problems can be handed in late if computer room availability requires

Grades

- Based on problem sets, class participation, computer class, and final exam.

Lectures

- Monday:
  - o Introduction to main concepts of accelerator physics (CS)
  - o Review of basic measurements I (CS)
  - o Review of basic measurements II (JS)
- Tuesday:
  - o Closed orbit measurements, orbit stability, orbit feedbacks, beam-based alignment (GP)
  - o LOCO: Determining gradient errors using response matrix analysis (JS)
  - o Betatron phase advance measurements (CS)
- Wednesday:
  - o MIA: Model Independent Analysis (JS)
  - o Beam size measurements (JS)
  - o Introduction to coupling, Coupling diagnostics/correction (CS)
- Thursday:
  - o Lifetime, injection efficiency, frequency analysis (CS)
  - o Effects of insertion devices (JS)
  - o Resonance driving term analysis (CS)
  - o RHIC style orbit bump analysis of nonlinearities (JS)
- Friday:
  - o Coupled bunch stability/HOMs (CS)
  - o Broadband impedances (phase advance, bumps, ORM) (JS)
  - o Energy calibration (CS)