Beam Dynamics

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1 Simulation tools (Bmad)

1. Tools for computing and propagating trajectories and spin by linear and nonlinear maps, lie maps, runge kutta integration, and simplectic integration.
2. Structures with data types optimized for study of beam dynamics.
3. Beam line elements can be represented by multipoles, analytically, or by 2 or 3 d maps and time dependence.
4. Routines to compute and propagate twiss parameters.
5. No formal tools for modeling interaction with materials, which are included ad hoc with custom routines.
6. Integration interface with other accelerator modeling codes is relatively straightforward as the data structures are more or less common
7. The model includes M5 line, injection channel fields, inflector field, in ring kicker, electrostatic quads, collimators, fiber harp planes, calorimeter planes, tracker planes. Variety of representations of quad and kicker fields
8. scattering in inflector end coils is included with custom multiple scattering and energy loss code
9. Detectors (harps, calorimeters, trackers) are represented as r-z planes. Azimuth, and location in r-z define acceptance
10. Includes muon decay and propagation of decay positron

2 Injection /inflector

- Concept of injection through inflector
- Injection channel components and apertures
- Inflector overview
- Design of beam optics (twiss parameters) to optimize transmission through inflector into ring
- Description of fields through iron, fringe, inflector
- Trajectory through injection channel-inflector
- Propagation of twiss parameters through injection channel

- algorithm for specifying beam parameters at entrance to iron to be compatible with waist in inflector
- Sensitivities to misalignment and inflector field
- Sensitivity to final focus errors
- Inflector angle
- Effect of scattering in inflector end coils
- Transmission efficiency
- Measurement of dependencies and transmission

3 Fast kicker

- Muon capture - overview of injection and capture - trajectories, kick angle, bunch length, momentum dependence
- Design specifications - achieved specs
- Kicker design
- Dependence of capture and residual CBO on kicker parameters
- Measurement of capture vs kicker parameters
- Description of pulse shape, field profile, multipoles, remnant field

4 Storage ring guide field, beam optics

4.1 Linear optics

- Weak electrostatic focusing, tunes, β, η, curvature
- CBO
- Dependencies - quad voltage
- measurement of CBO frequency and amplitude vs

4.2 Nonlinearity

- Nonlinearity: quads multipoles and B-field and multipoles
- Resonances

4.3 Chromaticity, tune spread, decoherence

- Theoretical derivation of chromaticity - contributions
- Determination of chromaticity via simulation - dependence on details of quad field model
- Measurement of chromaticity - significance
- Amplitude dependent tune - and quad nonlinearity
- Decoherence - evolution of the distribution

4.4 Collimation and scraping

- quad ramp
- RF quad
- lost muons