HL-LHC: brainstorming on tools for optics and tracking

LCU meeting

Introduction

With the LH-LHC project we might have the opportunity to improve our tool-chain for optics and tracking studies.

In the following each slide will introduce a problem type and the tools we have with their merits and shortcomings to start a discussion.

Comments are based on my knowledge, to be checked and updated during the discussion.

Contents

- Optics
- Aperture
- Correction of field imperfections
- Dynamic aperture
- Working point optimization
- Dynamic effects

Optics

Problem: design new layouts and optics solutions (Twiss parameter, chromatic correction and orbit from injection to collision)

Tools: madx and matching module

- sufficient for most necessities
- chromatic models recently changed and not completely documented
- matching layout variables more complicated than necessary
- no nested matching for constrained optimizations
- we may think of a conformity test suite for LHC optics solutions
- Automatic matching for squeeze (while loop?)

Aperture

Problem: define physical apertures and check aperture margins (n1).

Tools: madx and aperture model, python script by JB Jeanneret

- well established
- still some software glitch in madx
- collimation team models, tools and observables seems to be different . Can we use the same? Are default parameters for n1 from n2 correct?

Correction of field imperfections

Problem: design and validate field imperfection correction strategies

Tools: (1) madx orbit correction, (2) fortran codes from
S. Fartoukh, (3) PTC normal, (4) PTC twiss, (5) frequency analysis

- (1,2) well established for the LHC, SLHCv2, SLHCv3
- (3,4) need more documentation for the element Hamiltonians and options
- Implement freq analysis tools in madx (dynap exists, but can be improved)
- (amplitude detuning and Q'' in madx strict (in PTC are available but more complicated to use))
- Better integration between ptc and madx to calculate parameter dependent quantities
- (3,4) PTC-madx does not support corrector families, therefore PTC with parameters not fully exploitable (maybe getting to slow, not a priority)
- Coupling and chromaticity is not well supported in madx strict

Dynamic aperture

Problem: compute estimates for maximum amplitude of long lasting particles.

Tools: prepare machine (makethin and mad6t), track particles (sixdeskenv, sixtrack), post process (sixtrack and fortran codes)

- well established
- makethin requires rematching, lot of time lost (and it is not accurate), can be avoided using thick linear elements (fix madx first for chromaticity)
- incomplete documentation for post processing (how are amplitudes computed?) (but in progress)
- incomplete documentation for the sixdeskenv (but in progress)
- collimation tools depend on thin model and sixtrack, not very flexible, need attention to not to break them

Working point optimization

Problem: choose tunes to identify best working points,
needs input from collective effect (landau octupoles) and beam beam (synchro betatron resonances)

Tools: sixtrack, madx, ptc, frequency analysis, dynap module

- madx: complete but slow (good for footprints, not for tracking 106 turns), non linear crab kick not ready, no 6d beam in madx, complete 4d in madx?
- sixtrack: incomplete bb 6d not ready, non linear crab kick not ready
- sixtrack: crab cavity to be documented and expanded
- ptc: very slow, beam beam not ready, non linear crab kick ready? (available in PTC strict but not wired to madx)

Dynamic effects

Problem: impact of time dependent strength variations, power supply ripple, ground motion, crab cavity

Tools: madx thintrack, PTC

- thintrack: works only for thin lenses
- PTC track does not have the update functionality
- Sixtrack: has power supply ripple, ramping cravity, ac dipole