EPFL Activities relevant to FCC-ee tuning

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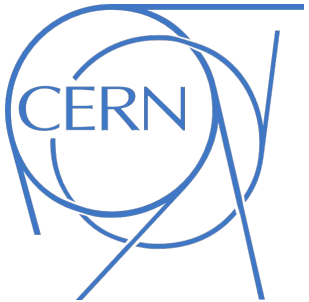

CHART funded project at EPFL

CHART funded project focused on the development of critical FCC-ee simulation tools and beam dynamics studies.

- The goal is to develop critical simulation software for missing functionalities with the aim to contribute to the relevant beam dynamics studies for the FCC-ee

Within this framework, strong collaborations have been established to coordinate efforts with:

- ESRF (S. White) for the development of pyAT and sharing of lightsource expertise
- CERN-ABP (R. de Maria, G. Iadarola) on the development of Xsuite and finding synergies between LHC activities and FCC-ee.
- CERN Collimation (A. Abramov) for exploration of pyAT for collimation studies
- D. Shatilov for the 6D beam-beam developments and FCC-ee tuning

Current relevant efforts within EPFL project

1. Development of a generalized lattice manager to improve model creation and interface between different codes (F. Carlier) https://indico.cern.ch/event/1088545/
2. Development of self-consistent 6D beam-beam in Xsuite with the goal to perform FCC-ee tuning including beam-beam (P. Kicsiny) https://indico.cern.ch/event/1088545/
3. Optimization of optics and tracking for FCC-ee (G. Simon)
4. Study spin polarization simulations under perturbations of misalignments and magnetic errors for FCC-ee energy calibration studies (Y. Wu)

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From:

January 2022:	Ph.D. student on optics, dynamic aperture and lifetime optimization in FCC-ee
February 2022:	Post-doc on electron cloud studies for FCC-ee
Early 2022:	Post-doc on machine learning applied to dynamic aperture studies for FCC

The goal of model manager Xsequence

Model conversions:

- Centralize lattice conversions to the different codes of interest
- Integrate existing conversion tools into a coherent platform
- Offer an expandable platform for users to contribute tools for specific conversions

➡ Currently contains conversions between MAD-X, pyAT, SAD, and Xsuite

Management of dependencies, knobs and errors:

- Simplify the management of errors and tuning knobs
- Offer translation of dependencies and knobs between some codes
- Ensure model consistency between platforms for comparative simulations

➡ Currently contains dependencies manager in Python (‘xdeps’) and translation of knobs under study

Lattice handling

- Provide a platform to easily manipulate lattice through control of elements, insertions and slicing

Development and outlook of xsequence

Xsequence is currently actively developed in collaboration with R. de Maria and G. Iadarola (CERN)

The development is synergetic with current code developments efforts in ABP at CERN in the frame of Xsuite (https://indico.cern.ch/event/1071856/)

- Allows to bring current code development efforts for the LHC to the FCC-ee community

Next steps

- Include generalized description of errors and misalignments
- Offer dependencies translation between several platforms (MAD-X, pyAT, Xsuite)
    - Will help creation and sharing of knobs between platforms
- Integrate existing tools for further lattice conversions.
- Explore use of xsequence for lattice version control

The package is published on Github, including examples: https://github.com/fscarlier/xsequence

A recent talk can be found here: https://indico.cern.ch/event/1088545/

Where can EPFL contribute?

- BPM orthogonality errors are not included
- BPM resolution / accuracy tolerance from us (BI will only work on this in 2022)
- DA and lifetime calculations
- Solenoid imperfections to be considered
- Tapering imperfections
- Local corrections need to be implemented to target spikes in Dy and coupling matrix elements.
- Non-linear corrections: lifetime, DA, chromatic aberrations, amplitude detuning, RDTs, etc.
- Design of IP knobs to control IP parameters in an orthogonal fashion
- Design of global knobs for control of fundamental parameters e.g.: Tunes, chromas, coupling, chromatic coupling, amp. det., etc.
- Profiling simulation and look towards speeding up algorithm
- Development of a modular code base compatible with Xsuite / pyAT
- Simulate optics measurements
- Apply correction technique to low energy, Z lattice
- Determine how to apply measure optics quickly
- LOCO
- 3-6 COD method as used in SuperKEKB
- AC dipole
- Single kick
- Simulation of commissioning process
- Optics generation: Commissioning optics and more realistic lattices (BPMs, etc.)
- ...?

EPFL can make meaningful contributions to:

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Perhaps important? Lattice version control to ensure equal models between codes