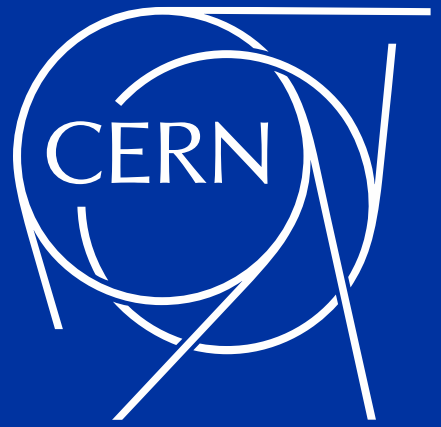


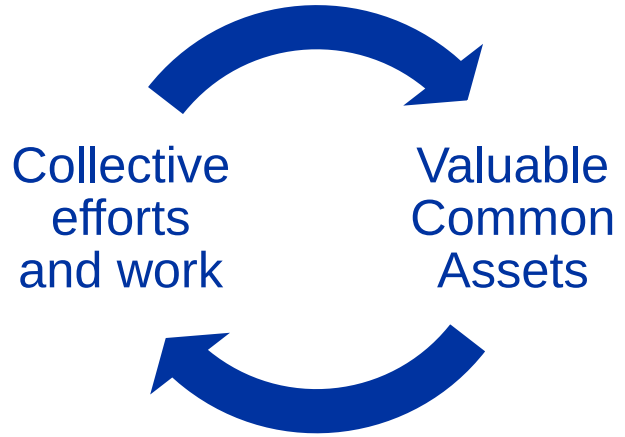

# Optics and Documentation Repository for FCC

Ghislain ROY -- FCCIS WP2 Workshop 2021

30th November 2021

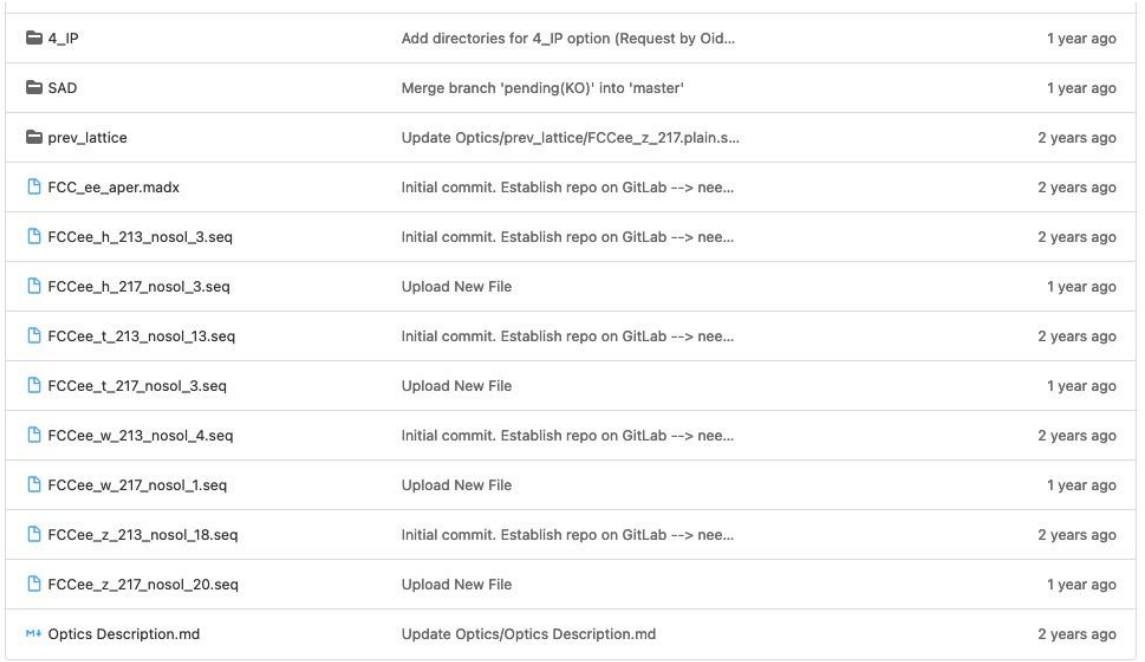
# FCC Optics Repository

- **Repository :  a place where we keep our common and valuable assets for FCC machine and optics design and development**
- **Our assets are immaterial but very valuable given the efforts and work invested to ensure best performance and operability of the FCC.**
- **Assets in the form of computer files and codes for now; later in databases…**
- **Common assets implies that within the team**
  they can be **shared**;
  they shall be easily **understood and mastered**;
  and they shall be easily **used further** and **built upon**
- **Loop over many years between now and FCC operation**
  - Asset volume and value will grow
- **FCC Optics repository must be easy and useful**



# Legacy situation for FCC : own Gitlab instance

- https://gitlab.cern.ch/fcc-optics
- **Hosts FCC-ee, FCC-ee-HEB, FCC-hh, FCC-eh**
- **Master and few branches for FCC-ee**
- **Several versions of the optics**
  - 213 (CDR) and 217 (post CDR) at 4 energies each
  - Optics in one single file
  - 301, a first 4-IP version, etc…



| | | |
|---|---|---|
| 4_IP | Add directories for 4_IP option (Request by Oid... | 1 year ago |
| SAD | Merge branch 'pending(KO)' into 'master' | 1 year ago |
| prev_lattice | Update Optics/prev_lattice/FCCee_z_217.plain.s... | 2 years ago |
| FCC_ee_aper.madx | Initial commit. Establish repo on GitLab --> nee... | 2 years ago |
| FCCee_h_213_nosol_3.seq | Initial commit. Establish repo on GitLab --> nee... | 2 years ago |
| FCCee_h_217_nosol_3.seq | Upload New File | 1 year ago |
| FCCee_t_213_nosol_13.seq | Initial commit. Establish repo on GitLab --> nee... | 2 years ago |
| FCCee_t_217_nosol_3.seq | Upload New File | 1 year ago |
| FCCee_w_213_nosol_4.seq | Initial commit. Establish repo on GitLab --> nee... | 2 years ago |
| FCCee_w_217_nosol_1.seq | Upload New File | 1 year ago |
| FCCee_z_213_nosol_18.seq | Initial commit. Establish repo on GitLab --> nee... | 2 years ago |
| FCCee_z_217_nosol_20.seq | Upload New File | 1 year ago |
| Optics Description.md | Update Optics/Optics Description.md | 2 years ago |

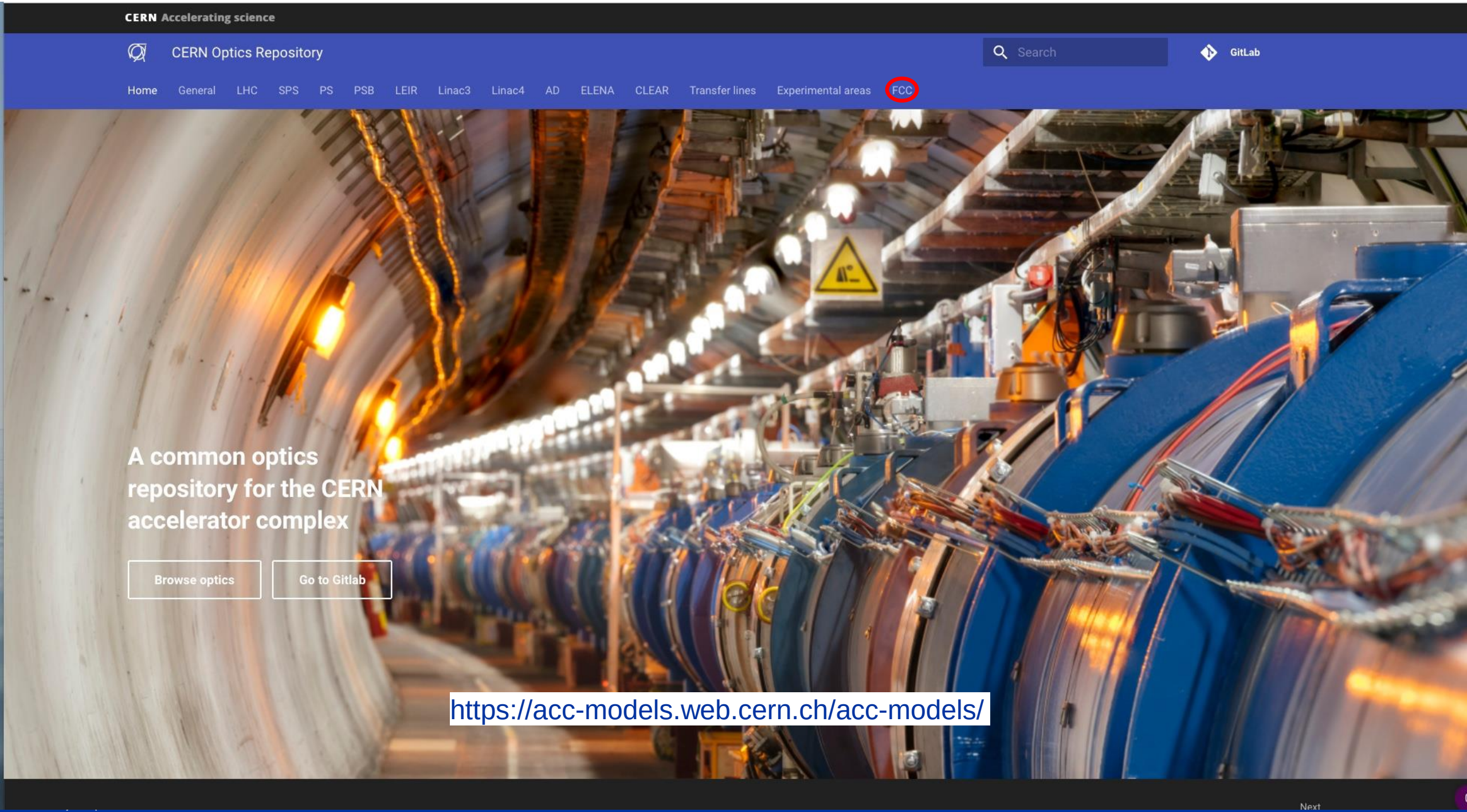
# CERN Optics repository
## https://acc-models.web.cern.ch/acc-models/

- **Based on Gitlab**
- **Documentation and website files also stored on Gitlab**
- **Website generated from files on Gitlab, including MAD-X output files for plots…**
- **Git clones of optics files are provided for easy linking through AFS and EOS:**
  - /afs/cern.ch/eng/acc-models/
  - /eos/project/a/acc-models/public
  - *'Call, file="/eos/project/a/acc-models/public/…'* in a MAD-X job
- **Most everybody probably goes to website for info and reference values, and calls EOS files from their MAD-X jobs for their studies. No Git cloning necessary unless you develop a new branch…**

# Migration to acc-models

- **After discussion, decision was taken to migrate the FCC Gitlab instance to acc-models**
  - Single place for all optics related files and documentation
  - Tried and tested model for storage, documentation, tests, deployment
  - Building upon the experience of acc-models maintainers; economy of resources, reusing recipes

- **Migration is ongoing… thanks to Alexander Huschauer and Riccardo De Maria**
  - FCC-eh already migrated; visible on Gitlab but not yet visible from website


CERN Accelerating science
CERN Optics Repository
Search
GitLab
Home
General
LHC
SPS
PS
PSB
LEIR
Linac3
Linac4
AD
ELENA
CLEAR
Transfer lines
Experimental areas
FCC
A common optics repository for the CERN accelerator complex
Browse optics
Go to Gitlab
https://acc-models.web.cern.ch/acc-models/
Next

CERN Accelerating science

CERN Optics Repository

Search

GitLab

Home General LHC SPS PS PSB LEIR Linac3 Linac4 AD ELENA CLEAR Transfer lines Experimental areas FCC

FCC

General

# Future Circular Collider Optics Repository

This website contains the official optics models for the Future Circular Collider. The repositories are available on Gitlab, AFS and EOS and can be accessed in the way described below.

**Locations of the repositories on Gitlab, AFS and EOS**

1) The different repositories are accessible on Gitlab using the following link:

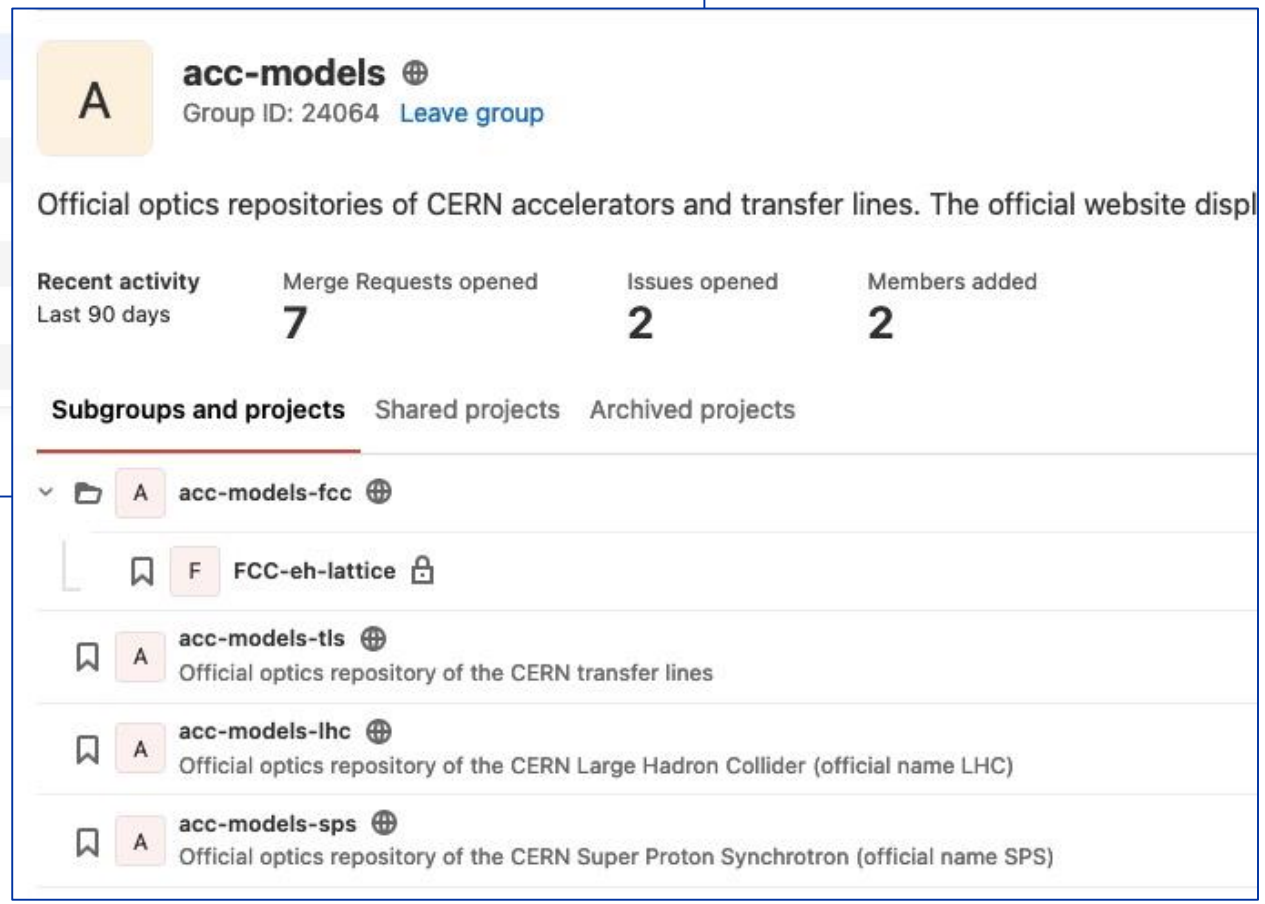
```
https://gitlab.cern.ch/acc-models/acc-models-fcc.git
```

2) The different repositories are also accessible on AFS:

```
/afs/cern.ch/eng/acc-models/fcc/
```

3) The different repositories are also accessible on EOS:

```
/eos/project/a/acc-models/public/fcc/
```

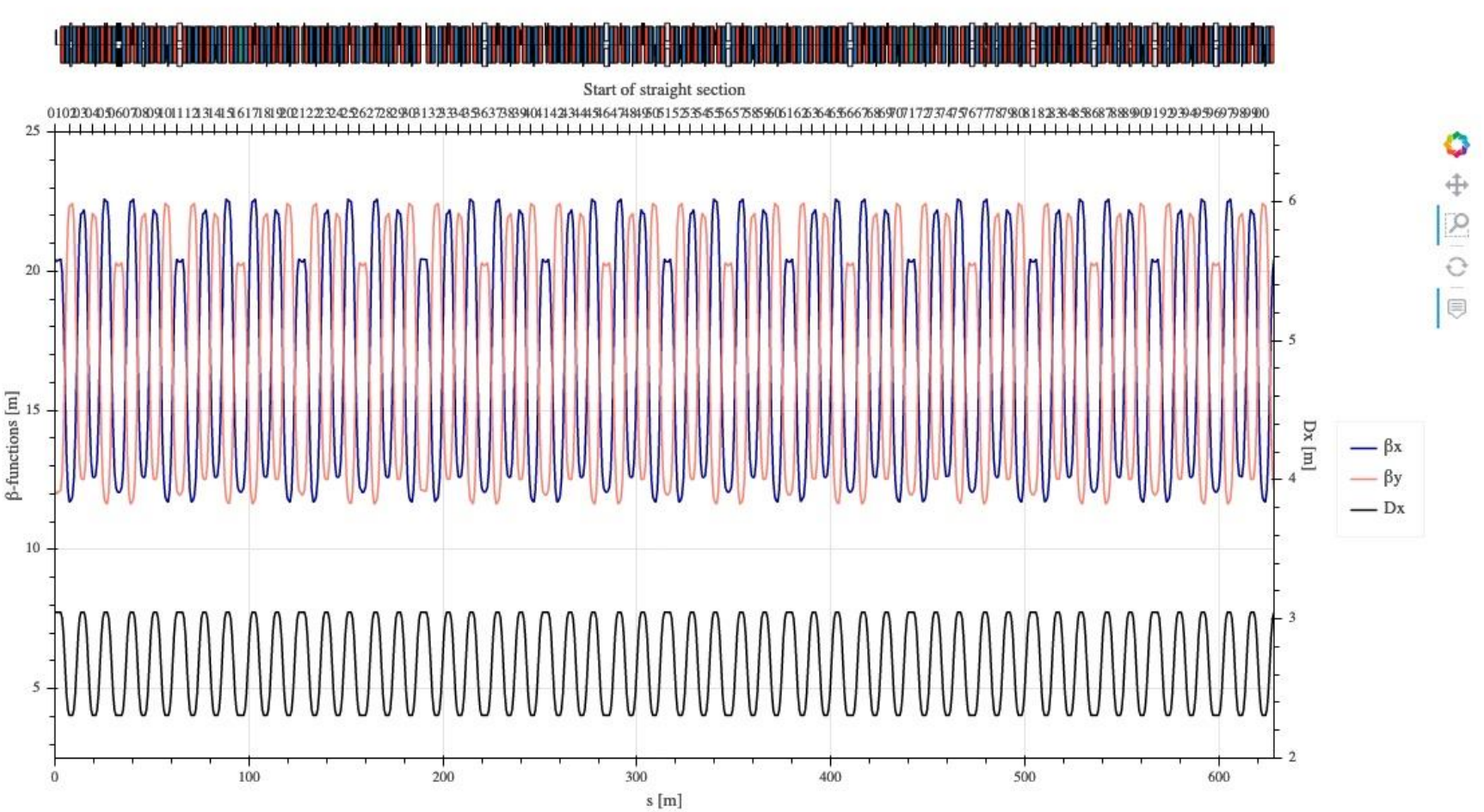


# Bare machine - proton injection energy optics



## Twiss functions

The Twiss functions of this configuration are shown in the interactive plot below. You can zoom in or hover over any curve to obtain more information about the function's value at a specific element. Below the plot, the Twiss table can be downloaded as TFS file or pickled Pandas DataFrame.



# Optics Repository

- **Some pitfalls:**
  - Newcomers need to find their way through the data and its history; avoid losing time in induction, self-exploration, digging for information
  - Avoid exploring a path already treaded ; document the loose ends and roadblocks
  - *Who remembers why we did it like this ?*
  - Using standardised version of the optics as firm ground for further studies (beam-beam, collimation,…) and for valid comparison between studies

- **Repository shall also hold pertinent documentation of the data files and the process that led to their development**
  - Documentation can be inline (comments to explain, guide, clarify…) or as extra files (or links)
  - Documentation also needs structuring and discipline

    *“JD: moved third collimator left of IP by 4cm”*

# How many reference optics do we need ?

- **Name versions with “publication friendly names”**
  proposal: V22.01 for the first reference version in 2022
  - Can build forward and backward, eg version 213 by Oide-san can be tagged V18.01

- **Each reference version can have multiple filesets**
  - 5 different energies (45.6, 80, 120, 175, 182.5 GeV)
  - Multiple optics configurations ?  Detuned/commissioning optics ? alignment optics ? …
  - 2 beams and therefore 2 sequences;
    but also two machines in some parts and different excitation sets.
    but avoid the beam2 paradigm of LHC !
  - 2 IP’s vs 4 IP’s
  - Thick lenses vs thin lenses
  - Study or MD optics

**Define the mandatory sets and the optional parts**
**Define the directory tree.**

# Good practice and return on experience

- **Avoid single file with everything**
- **Split optics and machine description in several files with “engineering” view**
  1. Element definitions ; “just the hardware”,
     with classes of elements and mechanical characteristics (length, basic aperture)
     *QD: Quadrupole, L=1.6, apertype=ellipse, aperture={0.3,0.1};*
  2. Symmetries of excitations; “no values, just logic”
     for example when two magnets are connected to the same bus-bar.
     *KQS0.L2 := KQS0.2 ; KQSQ0.R2 := KQS0.2;*
  3. Excitations of circuits; “Here be values !”
     *KQS0.2 = 0.3792;*
  4. Layout as LINE or SEQUENCE description; “only the geometry !”
     - Line description for conceptual studies, exploiting repetitions and symmetries… but define drifts !
     - Sequence descriptions have no drift but need to know precise positions; but can be nested and have relative positioning
  5. Specialised files: marker sets, instrumentation, detailed aperture models, solenoids, impedance…

- For each line we should have:
  - .dbx file for apertures
  - .ele file for elements definition
  - .seq for sequence definition
  - .str file for strength (can be more if more lines in

# Good practice and return on experience

- **Optics files must be complemented with**
  - Test jobs (*madx* | *numdiff or other tools*)
  - Sample jobs (MAD-X or SAD)

- **Sample jobs**
  - are used for example to build special configurations,
    e.g. tapering, installing solenoids, loading imperfections, install specific observation points, etc…
  - Can serve as “tutorial material” and are easily reused by cut and paste
  - in MAD-X or SAD language ; but avoid the large macro libraries of LHC…

# Good practice and return on experience

- **Tests are mandatory to evaluate the state of a development and ensure quality control before a new version is officially released.**
- **Provide specific MAD-X or SAD jobs with standardized results that can be validated, either internally or through post-processing. Automated process !**
- **Examples:**
  - Closure of the ring, basic Q and Q' values, optics functions at IP, optics functions at other specific locations (eg cavities, BI…), SR parameters at specific locations…
  - e+ vs e- ; thin optics vs thick optics …
  - Run SAD on translated MAD-X files; check results; run MAD-X on re-translated SAD files; check results
  - Translate to SAD and optimise momentum acceptance; check results
- **Tests provided by you as well !!**

# Optics Repository

- **Holds a structured set of files including the documentation**
- **Common approach to be decided together and then enforced collectively**
- **Quality Control to be implemented as a set of tools, and a common mindset**

- **Optics Repository is not a dump and shall only hold valuable data**

- **Everybody in the team has access to website and afs/eos replicates**
- **Few people, a team of librarians, have access to Gitlab as Developer or Maintainer**

# “Minor details…”

- **Next step is a link to layout databases**
  - Requires a change in naming conventions from “design” names to “engineering” names
  - Experience of existing accelerators will also help
  - Three prong asset management: DB, Git/Web, Filesystems

- **Custodian service accounts, not personal accounts. FCC.Optics@cern.ch**

- **Egroups for maintenance and information sharing.**

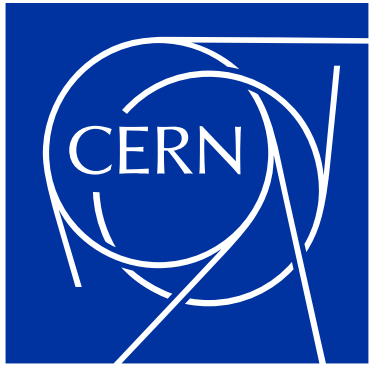
# Timeline…

**Given the “fluidity” of the FCC-ee study in 2021**

- Optimisation of siting and layout;
- 2IP’s vs 4IP’s;
- RF placement;
- Revisiting machine circumference for RF cogging;
- Injection scheme into HEB…

**there was little point in moving towards a more “rigid” repository system with full documentation, but as soon as decisions are made on these major options, including circumference and machine layout, it will be time to produce a first reference, engineering-oriented version of the optics fileset and document it on acc-models**

**And thanks to Michael Hofer for setting up and testing the first workflows**




home.cern