Optics Repository, Documentation and Product Breakdown Structure

Ghislain ROY -- 134th FCC-ee Optics Meeting

12th March 2021

- **Optics repository and Documentation**
  - Initial thoughts based on experience and discussions with a few people
  - This talk should trigger reflexion and discussions
  - You are all encouraged to contact me with your thoughts, experience, needs and requirements

- **Product Breakdown Structure**
  - A primer with timeline

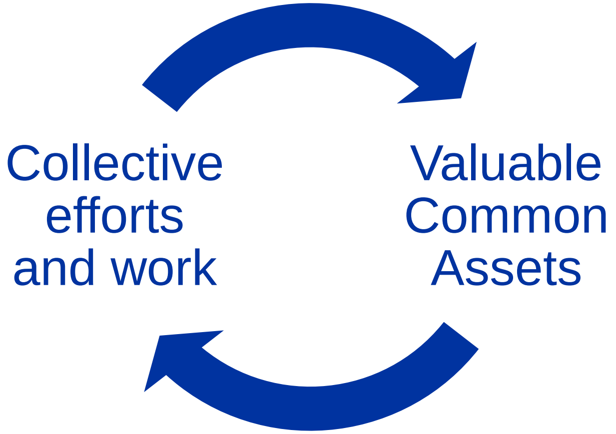
Optics Repository

- **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.**
  - In industry we would invoke Intellectual Property.
  - Although we must publish the results of our work, we do not have to make it public before publication.

- **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

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"

    Who ? John Doe or Julia Double ? Why ? When ? Where exactly ? …

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**

  tmp1.txt and *toto.dat* have no place there. Keep them in your private space if you need them. I do!

- **Everybody in the team has ReadOnly access**
- **Few people, a team of librarians, have ReadWrite access**

Current situation for FCC : Gitlab

- https://gitlab.cern.ch/fcc-optics/FCC-ee-lattice
- **Needs identification**
- **109 members in the team;**
  a few are "developers" with RW access
- **Master and two branches**
- **Two versions of the optics**
  - 213 (CDR) and 217 (post CDR) at 4 energies each
  - Optics in one single file
  - Not much more…

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

- **Gitlab is good for code development,**
  master is the reference set and branches are for development, exploration…

How many reference optics do we need ?

- **Name versions with "publication friendly names"**
  proposal: V21.02 for the second reference version in 2021

- **Each reference version can have multiple filesets**
  - 4 different energies
  - Multiple optics configurations ?
    no ramp or squeeze as in LEP, but do we want detuned optics as well ?
  - 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
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 line

Good practice and return on experience

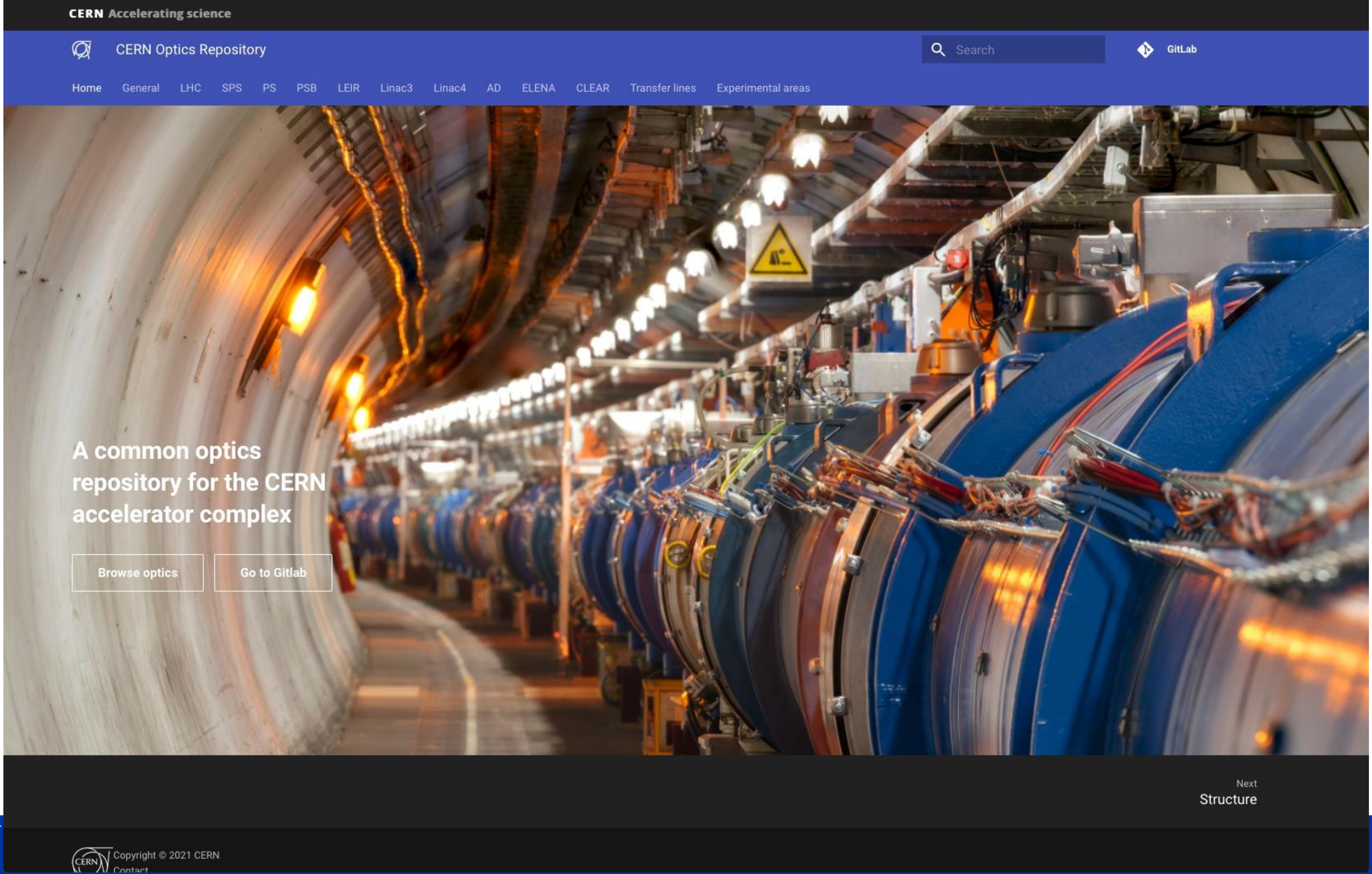
- **Optics files must be complemented with**
  - Test jobs (*madx* | *numdiff or other tools*)
  - Sample jobs (MAD-X or SAD)

- **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 HUGE macro libraries of LHC…

- MAD-8 had a SAVE / RELOAD feature to dump a binary representation of a machine (CPU dependent) and later reload it. This saved some time and ensured consistency across studies.

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 !!**


CERN Accelerating science
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SPS
PS
PSB
LEIR
Linac3
Linac4
AD
ELENA
CLEAR
Transfer lines
Experimental areas
A common optics repository for the CERN accelerator complex
Browse optics
Go to Gitlab
Next
Structure
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Contact

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…

FCC Optics repository

- Based on Gitlab
- Web interface for information retrieval and browsing
- Links of stable reference versions on AFS and EOS
- Documentation and website stored in Gitlab
- Based on standard IT-provided tools as much as possible
- Owned and maintained by service accounts and e-groups
- Complemented by a review procedure…

Reference Optics sets

- **When a new reference set is ready for publication**
  AND it passes all the tests…

- **Organise a review** (special FCC-ee optics meeting ?)
  where everyone contributes to QC evaluation (is anything broken in their studies ? are there any adverse effects?)**,**
  including a review of the associated documentation (clear and useful ?)**.**

- **When the review is positive the new set can be published on Gitlab (either as merge or as a new master version), appears on website and is linked on EOS and AFS**

- **Procedure to be written and agreed upon.**

Extension of repository

- **The repository shall be extensible to**
  - FCC-ee Booster
  - Transfer lines
  - FCC-hh

- **The repository shall also be extensible to specialised and linked studies**
  - Aperture model
  - Collimation studies
  - Machine Detector Interfaces
  - Impedance model
  - …

Plans

This presentation is meant primarily to trigger reflexion and discussion; nothing is fixed at this point….

Next steps are:

- **Further collect your thoughts, needs and requirements**
- **Build a "demo" website for FCC-ee based on existing files on Gitlab**
- **Deploy the links on AFS and EOS through automated process**
- **Setup a branch on Gitlab for a first "engineering" revision of the latest "217 2-IP nosol" optics, in view of standardising elements** (e.g. magnet lengths)

  This last point is not just an OCD but is needed for the PBS.

Product Breakdown Structure

- Milestone in WP2 ; due on 1st July 2021
- Draft version for “engineering check” in early June
- Initial effort now,
  to be established as a process on the medium term through the feasibility phase
- Huge task needs kickstarting

What is a PBS ?

CERN MT/95-02 (DI)
LHC Note 315

WHAT TO BE IMPLEMENTED AT THE EARLY STAGE OF A LARGE-SCALE PROJECT

Gérard Bachy, Ari-Pekka Hameri*

This paper addresses the importance of the actions to be taken before the project planning phases begin. The approach taken stems from the production planning paradigm, with emphasis on the product, rather than on the process. It is argued that a complete part list or product breakdown structure (PBS) is the absolute prerequisite for the design of a successful work breakdown structure (WBS) for a project. This process requires the definition of the design and configuration disciplines during the engineering phase. These critical issues of concurrent engineering and

improved delivery performance. For a large-scale project the analogy with production management provides us with the following statement: **the project organization should be formulated to correspond to the work-breakdown structure, which is dictated by the product structure**.

This paper is structured in the following way. First, the product breakdown structure (PBS) and how it is constructed, managed and controlled, is treated. The PBS is the same as a bill-of-material or part-list. As the PBS describes only the product itself, an assembly breakdown structure (ABS) is needed to describe the assembly sequence of the final system. Whether the product is a satellite

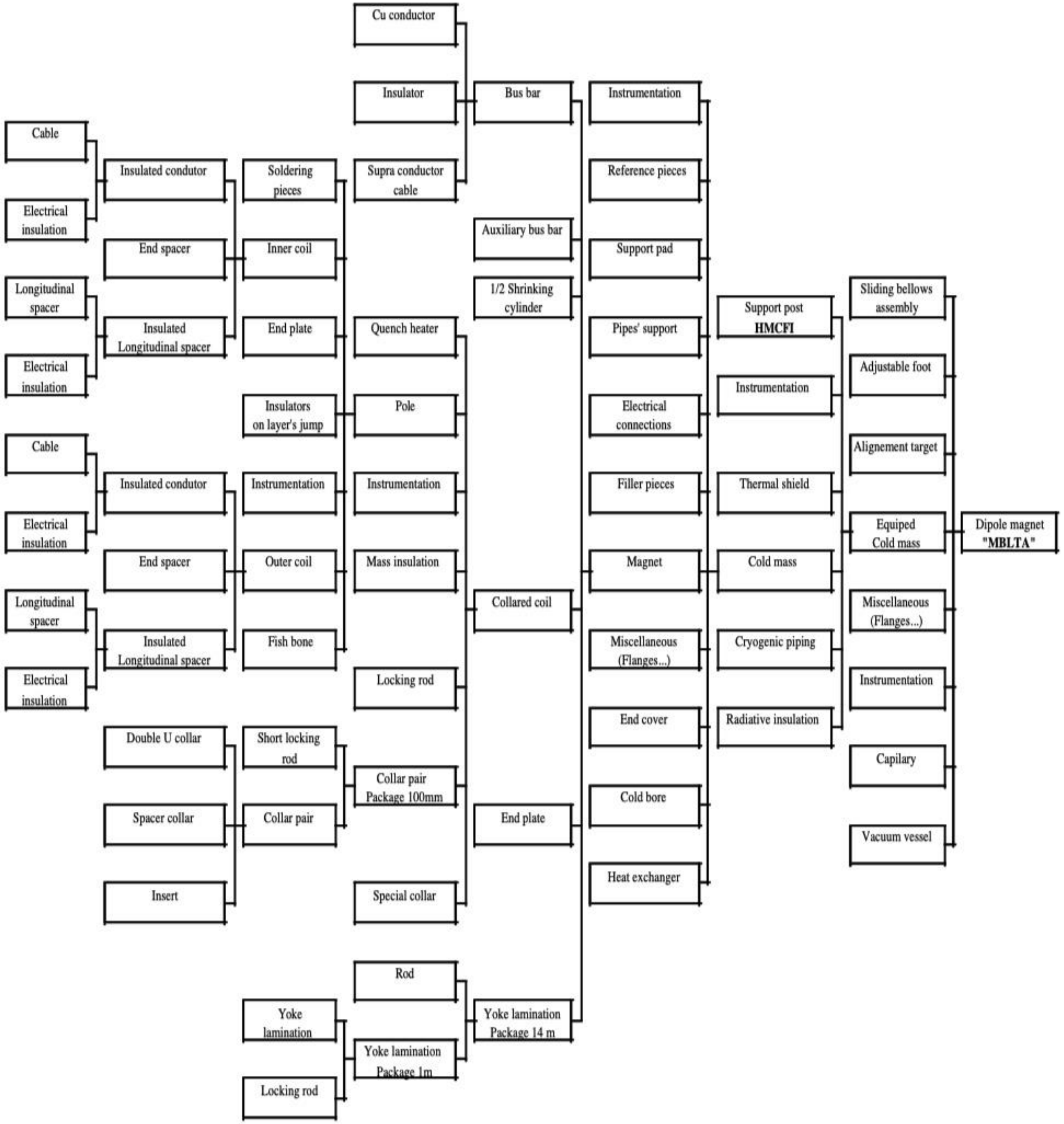

Figure 3. A draft PBS for the dipole cryomagnets.

FCC-ee PBS… at top level

1 Collider

More...

2 Booster

3 Injector

4 Transfer lines

5 Underground Infrastructures

More...

6 Surface Infrastructures

7 Physics Detectors

8 Enabling Facilities

More...

9 Software and Control Systems

More...

8 Enabling Facilities

Close

8.1. R&D facilities

8.2. Facilities related to construction

8.3. Manufacturing facilities

8.4. Assembly facilities

8.5. Test facilities

8.6. Storage facilities

8.7. Operation facilities

8.8. Maintenance facilities

FCC-ee PBS

- **Cannot provide everything in a such a short time…**
- **But we can**
  - structure the top level tree
  - start exploring the “collider” branch
    for a given configuration (e.g. ttbar)
    down to the individual elements in the MAD-X sense

Hence why we need an engineering revision of
the optics with standardisation of elements

  - List all elements required on and around the beam lines
    (beam pipes, vacuum equipment, instrumentation)
  - Start involving equipment groups for completeness
    at equipment level

1 Collider

Close

1.1 Main Magnets

Close

1.1.1 Dipoles

Close

List all dipole types with numbers and reference to characteristics in the Optics files on GitHUB or Zenodo

1.1.2 Quadrupoles

Close

List all quadrupole types with numbers and reference to characteristics in the Optics files on GitHUB or Zenodo

1.1.3 Sextupoles

Close

List all sextupole types with numbers and reference to characteristics in the Optics files on GitHUB or Zenodo

tous les sxtupoles ont des alims indépendantes

1.1.4 Higher order multipoles

Close

List all other multipole types with numbers and reference to characteristics in the Optics files on GitHUB or Zenodo

FCC-ee PBS

- **Long term effort which needs to take into account**
  - Naming conventions
  - Databases and documentation systems (EDMS, CDD…)
  - Standard engineering processes at CERN

Involve all accelerator support groups

- **Start with a Web and Excel-based representation**
  - Elements
  - Number of instances
  - Basic characteristics
  - Requirements (eg powering, cooling, controls, DAQ…)

Involve all accelerator equipment groups

FCC-ee PBS

- **Work has started…**
- **Optics team mostly involved through the collider description at element level**
- **Any help is welcome !**

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