Meeting Minutes of the
134th FCC-ee optics design meeting and 5th FCCIS WP2.2 meeting

Indico: https://indico.cern.ch/event/1014448/
When: 12.03.2021 9:00-11:00 GVA time

Agenda

Presenter	Title
G. Roy	**Optics repository interface to Git, documentation, and plan for Product Breakdown Structure**
R. Bruce	**Plans for FCC-ee collimation studies**

1 General information

F. Zimmermann opens the meeting by introducing the newcomers. **M. Hofer** is joining as a fellow at CERN, working on the optics for the collimation insertion. **R. Bruce** introduces two new members of the collimation team. **A. Abramov** joins as a fellow at CERN working on both FCC-ee and FCC-hh collimation and **M. Moudgalya** joins as a master student from EPFL, looking into the aperture model.
As announced in the last meeting, the next FCC-week is planned to take place in the last week of June, with preparations currently ongoing.
Three reviews, organised by the IAC, are planned between 19.4 and 23.4, one focusing on the placement, one on the SRF system, and the last one on the FCC-ee injector.
The next FCC-ee optics meeting will take place the following week, on 19.3.2021.

2 Optics repository interface to Git, documentation, and plan for Product Breakdown Structure

G. Roy presents first thoughts and ideas on the optics repository for the FCC-ee and accompanying documentation, as well as a primer on the Product Breakdown Structure (PBS). The repository should serve as the place where common assets shared with all team members are stored, which in this case holds files and codes to describe layout, optics, and more of the FCC-ee. These are currently hosted on a Gitlab instance hosted by CERN. Ideas on improving the current situation and best practices to be established are presented, also based on experience with LEP and LHC optics development. Additionally, a Gitlab based website similar to the CERN acc-models webpage is planned to store relevant documentation.
An effort will be also put on providing an "engineering" version of the latest lattice in the near future where elements are standardized where possible, in view also of the PBS, which has to be provided by WP2 by 1.7.2021. Following the procedure previously used during the design of the LHC, the PBS should present a top-down view of the FCC-ee and its components with respective subparts, with input from all involved groups.

F. Carlier notes that with the current settings of the repository, data is not accessible without a CERN account, which makes contributing for collaborators outside CERN difficult and asks if this problem will be addressed. **G. Roy** replies that settings were chosen to keep control over the lattice and avoid fragmentation of the lattice development. However, access for collaborators should be ensured and if creation of accounts or through AFS or EOS is not possible, cloning to an external system could be an option, provided that control is maintained on it.
J. Bauche comments that work on the PBS has already started by **R. Losito** for the vacuum system. He also would like to know how it will be organized and to avoid multiple groups coming up with different solutions for the same issue. **G. Roy** welcomes that work has already started by multiple groups. The top level PBS then only needs to link to the work on the equipment level. Further discussion with the equipment groups will follow to check their status. **R. Losito** notes that he has been working on a work breakdown structure (WBS) rather than a PBS.
A. Blondel stresses the importance of the polarization in the program, its requirements in terms of hardware and optics should be included in the repository. **G. Roy** answers that for this case, placeholders can be included in the layout until tools and codes are available.
I. Efthymiopoulos comments that for the LHC and other CERN machines a layout database is used. His question is if at this point this will also be used for FCC-ee. **G. Roy** replies that people behind the layout database will be involved at a future point, but he thinks that at the moment it would be a bit too early and would result in unnecessary overhead.
F. Zimmermann notes that at the moment, three different layouts are proposed, with different circumference and straight section length, which might be reduced to one option after the review in April. In the case of moving forward with multiple options, multiple branches would have to be maintained. **G. Roy** agrees and adds that following the outcome of the review, a reference set for one layout should then be built. **F. Zimmermann** comments that also the booster, damping rings, and linac could be included in the repository. **G. Roy** answers that this integrated in the Gitlab repository should be no problem. **F. Zimmermann** also inquires about the website and ease of use. **G. Roy** replies that by the end of the month a demo website should be available to test and evaluate.
K. Oide comments that the optics repository should also ensure compatibility with the code base developed by EPFL. **G. Roy** and **F. Carlier** agree and discussion on that topic will follow.

3 Plans for FCC-ee collimation studies

R. Bruce gives an overview of the plans for the collimation system in FCC-ee. Notably, FCC-ee will have a significantly higher stored beam energy than previous lepton machines, with the stored 20.6 MJ comparable to the beam energy foreseen for the ion operation in HL-LHC. The role of the collimation system thus will be to protect equipment such as the superconducting final focus quadrupoles from damage and also reduce the background in the experiments. The general work plan is laid out, starting by defining the aperture model, study of the different loss scenarios, to the design of a collimation optics and tracking simulation and subsequently studies of collimator materials and energy deposition. The collimation section is currently foreseen to be place in point F, where care has to be taken to respect the constraints of the polarimeter, which will also be installed there. Currently, potential codes are examined for conducting tracking simulation, taking into account requirements such as beam-beam effects and beamstrahlung. Work will be reported in the FCC collimation meetings, with occasional updates in other meetings.

K. Oide comments that due to the top-up injection, collimation of the injected beam should be studied, with injection oscillations and beam-beam force exerted by other beam making this a critical scenario, as is also observed at SKEKB. **R. Bruce** agrees and adds that also extraction should be studied.
F. Carlier comments that BMAD should be able to run the full FCC-ee lattice soon, including photon tracking. **T. Pieloni** adds that including beam-beam effects is important effect for these studies and that the code development at EPFL has looked to include it from the start.

M. Koratzinos notes that the beam dump has not been discussed so far and that space should be reserved for it. **F. Zimmermann** replies that **B. Goddard**, **A. Apyan**, and **S. Ogur** have looked into it for the CDR. **K. Oide** adds that the intermediate straight sections have space reserved for the required elements. The beam dump for the FCC-ee is quite a lot smaller than the one from LHC and should be more easily integrated in one of the straight sections.
F. Zimmermann asks about a first guess on the mechanical design and material choice of the collimators as input for the impedance studies. **R. Bruce** replies that at this early stage, length and material should be defined. The technical details can then only be specified at a later point, and required input for impedance studies will be discussed with **M. Migliorati**. As a first assumption, the collimators will be modeled after the SKEKB ones and continuously refined. **M. Migliorati** agrees on the proposed plan. **F. Zimmermann** agrees that SKEKB collimators should be a good starting point, as measurements should be also available. **R. Bruce** notes that a different, more robust material will be needed.
K. Oide proposes to also look into more exotic collimation schemes including laser beam collimation or liquid collimators, which were tested in Novosibirsk. **A. Bogomyagkov** is not aware of tests using liquid mercury for collimation. Both **R. Losito** and **I. Efthymiopoulos** strongly emphasise that the use of liquid mercury is prohibited in the EU and is very difficult to handle.
M. Zobov asks if at the moment an estimate for the number of collimators can be given. **R. Bruce** replies that without a clear requirement profile and studies, an estimate is hard to give. As both LEP and LHC have around 100 collimators, in his opinion a similar number could be expected in the FCC-ee.
K. Oide notes that the proposed straight section is freely modifiable, with the current optics there serving only as a placeholder. **R. Bruce** agrees and as mentioned a first optics will be based on a scaled LHC version. Constraints maybe be posed by the polarimeter. **A. Blondel** adds that the polarimeter is only located on the outside beam, with the inside beam free of the constraints. **R. Bruce** asks if injection is foreseen for point B and point L. **K. Oide** replies that at the moment it is not clearly defined. **A. Blondel** adds that also wigglers should be taken into account. **K. Oide** notes that these could be installed downstream of the interaction point.
F. Zimmermann asks if a combined betatron and momentum collimation system is planned or if they will be separate. **R. Bruce** replies that it cannot be answered at the moment but one may naively start with a combined system.
A. Bogomyagkov replies to the previous comments about liquid mercury collimators, noting that experiments with liquid lead were conducted. Its usefulness for FCC-ee remains to be seen. **R. Bruce** adds that for the start, a conventional system is likely the preferred option. **F. Zimmermann** notes that crystal collimation could also be an option. **R. Bruce** replies that he is not sure if the use of crystals for leptons has been studied and could be looked into at some later point.
I. Efthymiopoulos comments that in the LHC, no events of irregular losses have occurred so far where the collimation system had to react. He asks what constraints taking these into account will add and if it is necessary to keep such scenarios. **R. Bruce** replies that in the LHC, one asynchronous beam dump event with low intensity bunches has been recorded. Such events might also occur due to for example misfire of the extraction kickers and the system should be designed to provide a safety layer before the beam is dumped. However, scenarios which are taken into account are up for discussions.
F. Zimmermann notes that in SKEKB, the minimum lifetime is specified to be 5 minutes compared to the FCC-ee's 18 minutes, and 1 minute is used in simulations there. He also notes that the situation in linear colliders might be similar and could be studied. **K. Oide** adds that nonlinear collimation could be studied too. **R. Tomás** comments that in CLIC and ILC, the first collimators were designed to be sacrificial. **F. Zimmermann** replies that this could be an option for FCC-ee, as well as the use of rotatable collimators. **R. Tomás** notes that as far as he remembers experiments using rotatable collimators in SLAC were not promising. **I. Efthymiopoulos** and **R. Bruce** comment that test were also conducted at HiRadMat, showing encouraging results.
R. Bruce notes that realistic scenario are failures of extraction kickers or magnets and fast instabilities. All cases the beam should be dumped as soon as possible, but during the response time the collimation system

ensures no damage is caused. **F. Zimmermann** adds that due to the top-up injection, the situation is quite unstable and certain losses are to be expected.

Next steps

TASK
Preparation of standardized FCC-ee layout version; Development and documentation of workflows for optics repository; "Demo" website for documentation

Participants:
A. Abramov, A. Blondel, J. Bauche, A. Bogomyagkov, M. Boscolo, R. Bruce, H. Burkhardt, P. Burrows, E. Carideo, F. Carlier, T. Charles, B. Dalena, I. Efthymiopoulos, O. Etisken, M. Hofer, B. Humann, P. Janot, J. Keintzel, R. Kersevan, M. Koratzinos, R. Losito, M. Migliorati, M. Moudgalya, N. Nikolopoulus, K. Oide, T. Pieloni, M. Reissig, G. Roy, L. van Riesen-Haupt, D. Shatilov, R. Tomás, F. Yaman, F. Zimmermann, and M. Zobov