FCC collimation design meeting #12

Notes from the meeting held on 17th July 2017

Participants:
R. Bruce [chair], A. Langner [scientific secretary], Y. Alexahin*, M.I. Besana, A. Faus-Golfe*, E. Gianfelice-Wendt*, A. Krainer, R. Martin, A. Mereghetti, N. Mokhov*, J. Molson*, A. Narayanan*, D. Schulte, M. Syphers*, Y. Zou
* via Vidyo

During the meeting there was a request for a reference to the baseline parameters of FCC-hh which are listed in (1). Furthermore, a website (2) has been created which lists these parameters as well as additional information. It is planned to update this website regularly. Inputs and suggestions for material to add are very welcome.

(1) **https://fcc.web.cern.ch/eurocircol/Documents/WP1/Milestone%20and%20Deliverables/D1.1/FCC-1509301400-EuroCirCol-D1-1.pdf**
(2) **https://fcc.web.cern.ch/Pages/fcc-hh.aspx**

Status of studies on betatron cleaning at injection for FCC-hh (Y. Zou)

Summary:
- The betatron cleaning has been simulated for injection energy using the latest lattice. The cold losses are all below the LHC quench limit without the DS collimators and neglecting imperfections.
- Considerations for the aperture tolerance were shown, based on the loss scenario of the collimation cleaning for different beam lifetimes. Assuming a beam lifetime of 1h, which is based on LHC experience would result to an aperture tolerance of 15.5 σ considering the LHC quench limit.
- Future work will include to consider imperfections of the collimator alignment and the beam size, the influence of DS collimators, and further beam loss scenarios.

Discussion:
- R. Bruce clarifies that for the aperture studies, it was assumed that something is blowing up the beam, and that all losses outside the betatron collimation insertion occur locally at one bottleneck over a length of 3 m.
- R. Bruce remarks that the latest lattice version for injection has an orbit issue which leads to unusual high losses in the experimental insertion. R. Martin confirms that there are inconsistent default settings related to the spectrometer dipole, which will be fixed in the next lattice version and that he can provide a temporary fix in the meantime.
- R. Bruce adds that currently the collimator setting in beam sigmas at injection is the same as at top energy and might be revised.
- N. Mokhov comments that the LHC quench limit for FCC at injection is pessimistic and that the magnet study group should define this limit for FCC. R. Bruce confirms.
- E. Gianfelice-Wendt asked which software was used for loss maps. Y. Zou replied he used SixTrack with K2.
- D. Schulte mentions that the energy ramp might be a dangerous situation for the beam cleaning. R. Bruce replies that for the LHC the collimators are moved dynamically during the ramp so that top energy is the most critical scenario.

Status of off-momentum collimation studies for FCC (J. Molson)

Summary:

- The current status of the momentum collimation system has been presented, which is a scaled version of the LHC system. Loss maps were presented using the current lattice and including the dispersion suppressor (DS) collimators.
- Inside the momentum collimation section, cold losses occur at the end of the section just before the DS collimators.
- Significant losses are also observed in the following experimental insertion (IPG).

Discussion:

- D. Schulte comments regarding the losses in IPG, that not all losses which are coloured blue in the plot are cold losses. R. Martin adds that in the next iteration of the lattice the D1 and D2 magnets will be warm. R. Bruce comments that it is important to know the characteristics of the particles which are lost before the experiment. J. Molson agreed to look into this.
- R. Bruce adds, that the losses at the start of the ramp were considered to be the most critical loss scenario with off-momentum particles during regular LHC operation and this case should be studied also for FCC.
- A. Krainer comments that the DS collimators are not optimally placed for the momentum collimation insertion, as there is not a negligible dispersion in the straight section as for the other IRs. Moving the DS collimators by one cell could mitigate the losses observed just before the DS collimators.
- R. Bruce suggests that as a next step, before starting dedicated simulations of off-momentum collimation with other tools, N. Mokhov could start to simulate the betatron cleaning at top energy to check if the different tracking tools will give consistent results compared to the results from J. Molson which were presented at IPAC17.

Update on Energy Deposition in Betatron Cleaning Insertion (M.I. Besana)

Summary:

- An update of the energy deposition studies has been presented. In comparison to the previous presentation (minutes), simulations are done additionally for a shorter primary collimator (TCP), and for a vertical halo. The loss scenario assumes a beam lifetime of 12 min and a total power of 11.8 MW
- For the vertical halo, the power fraction on the warm dipoles is slightly lower than for the horizontal case. The power fraction on collimator jaws is slightly higher, with one TCP and one secondary collimator (TCSG) above 200 kW.
- The peak power density is higher on the vertical TCP with 4 $kWcm^{-3}$ and for the TCSG it is again located on the support (800 $kWcm^{-3}$).
- Simulations for the shorter TCP show an inconsistency and investigations are ongoing.
- Future work will include using a TCSG with thicker jaws, to avert the peak power density at the support.

Discussion:

- N. Mokhov comments that a power fraction of 45 percent onto the tunnel wall is very large and should be fixed locally. D. Schulte comments that it might not be a big issue, since it is only for short durations and there is no groundwater nearby. R. Bruce adds that also for LHC the collimation system is not absorbing the main portion of the lost energy, however one should still check e.g. the activation of the tunnel as people need to work there.
- R. Bruce comments that concerning the warm dipole losses, A. Langner is looking into changing the optics for smaller beam separations, which could result to shorter and weaker dipoles.