Meeting Minutes of the
150th FCC-ee optics design meeting and 21st FCCIS WP2.2 meeting

Indico: https://indico.cern.ch/event/1118297/
When: 24.02.2022 14:30-16:30 CET

Agenda

Presenter	Title
M. Migliorati	**Impedance budget and single bunch instability for 4IP parameters**
Y. Zhang	**Beam-beam simulation with 4IP parameters and analysis work of combined effect between Beam-beam and longitudinal impedance**
M. Koratzinos	**Cold SSS assembly: new parameters**

1 General information

F. Zimmermann opens the meeting by reviewing the minutes of the last meeting. On the actions from the last meeting, **F. Zimmermann** notes that the wiggler parameters have to be adjusted to keep the energy spread under 52 MeV. **K. Oide** remarks that he found an issue in his previous studies and will present new results in the next meeting.

F. Zimmermann comments that two white papers on FCC-hh and FCC-ee will be written as input for the Snowmass process.

2 Impedance budget and single bunch instability for 4IP parameters

M. Migliorati presents a review of the impedance budget and single bunch stability for the new 4 IP parameters. The thickness of the NEG coating has been increased from 100 nm to 150 nm, as suggested by **R. Kersevan**. The imaginary part of the impedance increase slightly, while the real part remains the same. Using CST Studio, a form factor of the full beam pipe including the winglets has been derived and is used to scale from a round beam pipe to a realistic model. A more realistic model of the bellows is used, and the number of bellows in the FCC-ee is estimated to be around 20000.

The total longitudinal impedance is shown, with the bellows and the resistive wall being the biggest contributors. Work is ongoing to include the collimators.

Bunch length and energy spread for different bunch population using the new 4 IP parameters, but excluding the effect of beamstrahlung. For the nominal bunch population of $2.5 \cdot 10^{11}$ at Z, a microwave instability occurs and bunch length increases. Similar so, a transverse mode coupling instability occurs below the nominal bunch population.

F. Zimmermann asks why there is an asymmetry for the TMCI between the two planes. **M. Migliorati** replies that this is due to the winglets. **K. Oide** notes that if beam pipe is elongated in the vertical plane, this could cancel out the quadrupole component.

However, if bunch length and energy spread for a scenario with beamstrahlung are used, neither of these issues is present.

F. Zimmermann asks what collimator settings are assumed. **M. Migliorati** replies that work is ongoing, with a first estimate provided by the collimation group, but these numbers are likely to change. **A. Abramov** adds that only the numbers for the betatron collimation system were provided, as those collimators are closest to the beam. More collimators will be provided at a later point. **F. Zimmermann** notes that carbon is used for the collimators. However, in SKEKB, carbon collimators were soon removed as they had a too large contribution to the impedance. **A. Abramov** replies that during discussions with **M. Migliorati**, the resistive wall contribution was not expected to be dominant, but only the geometric one. As such, the material should not contribute much. He adds that LHC type collimators are assumed for now, but the model will be revised at a later point.

M. Koratzinos asks if the power loss per system and over the whole machine is known. **M. Migliorati** notes that changes so far are small, and the numbers should be similar to what was presented in the CDR.

G. Schiwietz notes that high frequency components seem to be strong and a difference in the wake potential between the different contributions is seen. He asks what the impact on the energy broadening is. **M. Migliorati** replies that a very short bunch is assumed here. However, for the convolution, a longer bunch length is then used and the effect is smeared out.

A. Rajabi comments that development of VaciSuite is progressing well and may soon be used perform similar studies for comparison.

F. Yaman asks if the photon absorbers in the winglets have been considered. **M. Migliorati** answer that this has been studied in the past and had no big impact.

3 Beam-beam simulation with 4IP parameters and analysis work of combined effect between Beam-beam and longitudinal impedance

Y. Zhang presents on beam-beam simulations with 4 IP parameters and on the combined effect of beam-beam and longitudinal impedance. Focus is put on the Z operation mode. For the nominal parameters, a scan over the horizontal tune shows no stable area. This is also the case when changing the chromaticity to either 2 or 5 units, whereas in the CDR case, it was found that chromaticity does increase the stable area. A scan with a lower bunch population also does not show a stable tune area. However, with a lower horizontal β^* of 0.1 m, and including chromaticity, some small area of stability for both nominal and reduced bunch population was found.

In the past, a beam-beam instability was found in strong-strong simulations. A scan over the horizontal tune is performed including beamstrahlung and with and without the effect of longitudinal coupling impedance. Including the impedance decrease the stable area and also shifts the frequency. Bunch distribution in the longitudinal plane and distribution of Q_s is compared between the two cases. Including longitudinal impedance shows the instability threshold at 40 % of the nominal bunch population, whereas without it increases to 60 %. The effect of the distribution of synchrotron tune on the resonance structure has been studied. Including the longitudinal impedance also excites all parity modes.

K. Oide asks if the collision timing has been adjusted when including the longitudinal impedance. **K. Ohmi** replies that the same longitudinal impedance for both beams was assumed and that then the timing should remain the same.

M. Zobov notes that with the current 4 IP parameters, no good working point has been found. He adds that the change in β_x^* may help, but could have a drastic impact on the dynamic aperture. **K. Oide** comments that the DA is already small, but reducing the crab waist to 80 % could increase the DA. **D. Shatilov** adds that when including misalignments the momentum acceptance will decrease, and crab waist may be reduced, at the cost of luminosity.

K. Oide asks if negative chromaticity has been tried. **Y. Zhang** replies that this has not been tested, but could be done in the future. **F. Zimmermann** adds that also the momentum dependence of β^* could be included. **K. Oide** replies that in the design, there should be no momentum dependence of β^*.

4 Cold SSS assembly: new parameters

M. Koratzinos presents on the assembly of a cold short straight section. Lengths of the different elements follow the redesign of the latest layout. The baseline design has changed from two 1.5 m to three 1 m to ease manufacturing and assembly, and accordingly all elements were split. Different distribution of the various elements in the three units will be looked into in the future.

F. Zimmermann asks if the BPMs are included in this design. **M. Koratzinos** replies that this has not been done, and inquires how many BPMs will be needed in this assembly. **K. Oide** asks if the BPMs will be in the cold mass, or at room temperature. **T. Raubenheimer** notes that in case of issues with the BPM, the whole cryomodule will need to be replaced.

F. Zimmermann asks how much space is left between segments. **M. Koratzinos** replies that the distance between elements is 50 mm. **F. Zimmermann** asks how tapering will be included. **K. Oide** and **M. Koratzinos** reply that quadrupoles in one SSS will be powered with the same strength.

Follow-up items

TASK
Check dynamic aperture for β_x^* of 0.1 m at Z.

45 Participants:
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