

Activity report of the FCCee Lumi CHART project since May 2022

Design of collider beam optics:

Revisions are made on the beam optics since the CDR:

- 4 IP, 8 shafts.
- Adopted the new tunnel layout of PA-31 series, from 1.0 to 3.0 (newest), characterized by SLSS = 1400 m, LLSS = 2032 m, Circ = 90657.4 m, $\Delta_{IP} = 10.201$ m.
- Changed the separation of e+e- from 30 to 35 cm.
- Designed the Long-long straight section (LLSS) for inside-outside beam exchange and the RF in one of them.
- Designed the RF section for Zh/tt with shared RF.
- Designed the Short-long straight section (SLSS) including the IP.
- Each SLSS incorporates sections for polarimeters and polarization wigglers.

https://indico.cern.ch/event/1237189/contributions/5222868/attachments/2578585/4446935/Optics_Oide_230119.pdf

<https://indico.cern.ch/event/1186798/contributions/5062582/>

Optimization of the beam lifetime

Noticed that the legacy way of optimization of the dynamic aperture (DA) was not sufficient to ensure the beam lifetime given by the lattice nonlinearity. The "legacy way" means to optimize the survival of particles in the phase space starting at a particular location in the ring. This is probably due to the situation that the initial phase and amplitude must cover the entire phase space, requiring much large number of test particles. Due to computing limitations it is difficult to perform, esp. in the optimization process, which needs thousands of samples. This situation is more severe at Z with large momentum spread enhanced by the beamstrahlung under relatively long radiation damping time.

Thus, a robust and efficient method to evaluate the beam lifetime is required, and this will be one of the subjects of research for the next period.

https://indico.cern.ch/event/1178975/contributions/4952198/attachments/2488857/4273897/ZLifetime_220804_Oide.pdf

Evaluation of beam vibration and required precision of beam position monitors and feedback

As the small beam spot size at the IP ($\sigma_y^* \approx 35$ nm), the estimation of the beam vibration is crucial. As the first step, the beam vibration caused by the coherent and random ground motions has been estimated. As the result, it was found that a beam feedback based on the detection of beam-beam deflection is necessary up to 10 Hz. The requirements on the beam position monitors (BPMs) are within reachable range of performance by currently available technology, at a glance.

<https://indico.cern.ch/event/1186798/contributions/5062667/>

<https://indico.cern.ch/event/1209598/contributions/5092252/>

Evaluation of center-of-mass energy at each IP under machine errors

The determination of the center-of-mass energy is a crucial point for the physics of FCC-ee. Various machine errors such as misalignments of magnets deviates the beam energy along the beam orbit. An estimation was done by a simulation with possible misalignment of magnets. The resulting deviation of the CM energy is about 0.5 ppm.

https://indico.cern.ch/event/1181966/contributions/5041336/attachments/2510397/4314893/WP2_220919_Oide.pdf