AGENDA
The meeting was devoted to the problem of optimizing Dynamic Aperture at HL-LHC Injection

General information (R. Tomás)
1 Dynamic Aperture at HL-LHC Injection (N. Karastathis)

MEETING ACTIONS

Nikos Investigate DA for larger chromaticity and lower octupole current and for tunes closer to the diagonal

Elias Provide an update on beam stability at injection and possible new Q', octupoles and tunes based on simulation predictions and latest MD observations.
In the absence of Gianluigi Rogelio is chairing the meeting. Minutes of the previous meeting have not been released yet.

1 Dynamic Aperture at HL-LHC Injection (N. Karastathis)

Nikos presented results of a parametric study of Dynamic Aperture (DA) at Injection with high chromaticity, octupole current, and long-range beam-beam. The study has been performed using the parameters from the OP Note with a 2.5 μm emittance in order to provide some margin.

Beam intensity does not play a big role in DA degradation, but an increase of the octupole current from 20 to 40 A, on the contrary, shrinks DA significantly. This is so because the beam-beam tune shift is of the order of $10^{-4}$ and it is in the shadow of the octupole detuning, which is of the order of $10^{-2}$.

The optimal Working Point (WP) depends on the octupole polarity. In general, the negative polarity provides a slightly larger maximum attainable DA close to the diagonal due to the impact of a 3rd order resonance. At the nominal WP of (0.27, 0.295) the DA is about $3\sigma$ for -20 A and about $4\sigma$ for +20A; for the OP octupole current of -40 A the DA is below $3\sigma$. According to a scan of octupole currents and chromaticities, in order to achieve a DA above $6\sigma$ one needs the octupole not to exceed -12 A for $Q'=20$ for the negative polarity or +15 A for the positive polarity.

Magnetic field errors may further decrease the DA by up to $0.5\sigma$ depending on the octupole current and the WP. This margin has to be taken into consideration. Accounting for the errors, at $Q'=15$ one finds a range of acceptable DA of $7\sigma$ for WPs between (0.282, 0.297) and (0.295, 0.310) and octupole currents between -10 A and +10 A.

- Elias noted that based on the simulation results, the values of octupole current at chromaticity presented in the OP Note seem unfeasible and have to be optimized. Yannis emphasized that the simulated DAs are consistent with present experience at LHC. Rogelio raised a question on the need to have margin in emittance and octupole strength. Nicolas pointed out that in 2018 there were many days when LHC had to operate at 45-50 A.
- Elias raised a concern that the demonstrated area of large DA might be incompatible with beam stability. Nicolas proposed investigating larger $Q'$ as it seems more effective in stabilizing the beam at Injection that the octupole current. Nikos noted that $Q'$ does not have a large impact on DA. Rogelio proposed to conduct a search for a region of larger $Q'$ and lower required octupole current (Action: Elias, Nikos).
- Elias mentioned that the need for beam stabilization comes primarily from the electron cloud trapped in the quadrupoles, which drives instabilities in both transverse planes. Studies suggest the impact will be less critical at larger intensities; this is currently being investigated. Rogelio proposed to have a presentation at WP2 with a review of the injection instabilities and parameter phase space (Action: Elias). Sergey suggested not to rely on the favorable dependence of the electron cloud density as a function of bunch population as it might be challenging to control.
• Rogelio inquired why the WPs near the diagonal were excluded from consideration. Elias answered the linear coupling is the reason. Rogelio suggested to look at coupling corrections; conceptually one should be able to control both linear coupling and Laslett tune shifts to work closer to the diagonal. Yannis suggested it would provide some enhancement of DA, although not a large one.

Reported by S. Antipov