1 Powering scheme for HEL (D. Mirarchi) [slides]

Summary of the presentation

DM presented the powering scheme for the electron beam produced by the HL-LHC hollow electron lens (HEL). The electromagnetic fields should act only on the tails without any effect on the beam core, thus increasing the diffusion speed of the halo particles and depleting the halo population. Four working modes are taken into account with a maximum current of 5 A at 10 keV and several requirements have been defined to explore different efficiencies in the halo depletion rates:

1. For machine protection purposes, in case one needed a witness halo for beam loss diagnostic purposes, e.g. early detection of dust particles falling into the beam, it should always be possible to keep one train of 72 bunches (1.8 $\mu$s) or 288 bunches (7.2 $\mu$s) without HEL excitation and this requires that the e-beam should be switched off at least 3 times in one turn.

2. In order to be able to select the witness train arbitrarily in the bunch filling scheme, a rise/decay time of the e-beam of 200 ns is required; this also fits into SPS injection gap (allowing intra train selection of bunches)

3. Possibility to select from 1 train of 12-48 bunches to full beam (excluding abort gap), corresponding to an e-beam pulse length in the range from 1.2 $\mu$s to 86 $\mu$s

4. Possibility to select the e-beam current turn by turn.

Discussion

- SS asked clarification about DC working mode. DM replied that the e-beam is still pulsed and switched on/off within the 3 $\mu$s abort gap, so the flat top is 86s $\mu$s long, with same current at every turn.

- SR asked if there will be any issue to work in DC. SS replied that this depends on modulators. At BNL, the e-beam can run for hours thanks to modulators based on MOSFET features. Fermilab uses Marx modulator and in this case there is a limit of the max duration of the pulse.

- AP suggested that the stability of the electron beam current (determined by the stability of the modulator) should be specified as a first step.

**Action:** refine HEL specs in terms of electron beam current stability, repetition rate and bandwidth.
2 Design of HEL collector (G. Gobbi) [slides]

SR recalled that the increase of the acceleration voltage from 10 kV to 15 kV was motivated by a significant reduction of the beam energy estimated in simulations by the e-beam dynamics team. Therefore, the specs were revised and we should consider 75 kW as target (pending final simulations by the e-beam dynamics team giving the final energy of the e-beam with a current of 5 A).

Summary of the presentation

GG presented the current design of the e-beam collector, placed at the end of the HEL and used to collect electron beam and dissipate its energy. The main challenges are the max power to be absorbed of about 75 kW and an initial flow speed of the water to be maintained below 1 m/s to avoid cavitation/erosion/corrosion issues. Thermal simulations have been performed considering two materials (Cu and CuCr1Zr) and assuming an initial load of 50 kW (the initially specified voltage was 10kV) with an initial water velocity of 1m/s, showing very similar results. However, CuCr1Zr is recommended due to its higher softening temperature. Another simulation has been performed for CuCr1Zr with a realistic load of 75 kW, resulting in a higher temperature of the collector and $\Delta T$ water. A full prototype should be manufactured within the end of the year.

Discussion

- GT suggested to check with vacuum experts the specifications for keeping outgassing under control. Also, the entrance aperture seems to be very large and it might allow for backscattered e-. DP commented that the interface with the vacuum pipe is not yet finalized, but it should reduce the effective aperture of the collector entrance and additional magnets will avoid backscattering.

- AP pointed out that the power density could have a significant impact on the actual cooling efficiency. DP replied that for these studies they need inputs from tracking simulations.

- AP also suggested to add some instrumentation to look at the beam profile from the back of the collector. DP replied that in the case of instrumentation the cooling circuits should be redesigned.

- SR suggested to study if the present collector can also be used with gaussian e-beam.

Action for SR: check specs for outgassing control.

Actions for BINP:

1. provide the output of beam dynamics simulations to repeat thermal studies on the region where the electron are deposited

2. provide inputs about electron distribution in collector before June

3. provide inputs about electrodes and coil dimensions within August
3 Update on IR7 layout for a collimation system with 8 crystals (M. D’Andrea) [slides]

Summary of the presentation

MdA presented studies on the integration of an 8-crystal collimation layout in IR7. At the moment there are 4 crystals in the LHC installed on the external side (H) and on top (V) of the beam pipe, while the additional ones need to be installed on the internal/bottom side of the beam pipes. Ideally the same goniometer should host two crystals for each plane but this may require a significant redesign of the goniometer devices. Therefore, alternative positions have been identified by means of semi-analytical studies (see table below).

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<tr>
<th>Crystal</th>
<th>Slot</th>
<th>Position [m]</th>
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<tbody>
<tr>
<td>B1H - current</td>
<td>TCSM.D4L7.B1</td>
<td>19918</td>
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<tr>
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<td>TCSM.A5L7.B1</td>
<td>19898</td>
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<tr>
<td>B1V - current</td>
<td>TPCV.A6L7.B1</td>
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<td>B1V - new</td>
<td>TCSM.A6L7.B1</td>
<td>19834</td>
</tr>
</tbody>
</table>

Discussion

- RB asked if a statistical analysis of orbit drifts (main motivation to use 8 crystals) has been done. SR replied that these studies are ongoing.