Minutes of the 47th WP2 Task Leader Meeting held on 17/04/2015

Participants: G. Arduini, C. Bracco, R. Bruce, H. Burkhardt, R. De Maria, M. Giovannozzi, J. Jowett, Y. Papaphilippou, T. Pieloni, S. Redaelli, J. Uythoven, A. Valishev, F. Velotti, A. Wolski.

Minutes, Follow-up of Actions, General Information (Gianluigi)

Stephane sent comments and plots on ideal wire compensator position and currents: a presentation will be arranged.

Riccardo verified that the crossing angle of IP8 and separation for the nominal scenario are compatible with aperture and strength (without non-conformities). It is possible to increase the half crossing angle to about 310 μrad (340 μrad without margins) provided the gradient during the ramp is kept below 205 T/m (the gradient originally accepted as compatible with high luminosity), otherwise the limit is 240 μrad for injection like optics.

The last HL-LHC technical committee (16/04) featured two presentations on the powering scheme of triplet and matching sections. The idea of powering D1 and D2 in series and D1 left and right emerged and should be evaluated further. During the meeting it was also noted that a trim power converter for Q1 is preferred for K-modulation.

A meeting took place to study the integration of the BPMs in the new layout L*=23 m is overall more promising than 24 m.

Stefano commented that the definition of the layout for TAN – D2 area is progressing.

Helmut informed that a meeting on a higher luminosity option for LHCb has been organized.

Minimum required machine aperture for injection failures (F. Velotti)

Francesco presented an overview of the injection protection system. For HL-LHC the TDI is going to be replaced by a new device (TDI-S) made of 3 separated blocks.

During the presentation it was noted that the settings of the spectrometers and the IR8 crossing scheme (based on the 2015 LHC optics) need to be implemented in the optics files. **Action: Riccardo to the update the optics files accordingly.**

Francesco illustrated the MKI and TDI failure scenarios: for the injected beam the MKI strength could vary between 0 and 125%, while for the circulating beam the MKI could kick from 0 and 125%. The injected beam kicked with 20% goes entirely on the TDI.

Two scenarios are simulated: 11% (or 9.5% for Beam 2) of the MKI kick is applied to the injected beam with the TDI at:

1) 6.8 σ (nominal settings)
2) 7.8 σ

and for both TCLIA/B at 6.8 σ.

The interaction with the collimators is modelled with scattering routines similar to SixTrack developed for this purpose and to be documented in the pycollimate code. For instance for scenario 2), a train of 288 bunches populated by 2.2 ppb with an normalized emittance of 2.1 μm would generate an halo that is populated by 5×10^{11} p from 7.2 σ (where 1σ is normalized to ε=3.5 μm and injection line β-functions). Gianluigi noted that at injection the bunch population is 2.3×10^{11} ppb. Roderik commented that the transverse beam distribution is not sufficient to know the amplitude distribution circulating in the machine as the beam divergence distribution is not taken into account. Massimo noted that a proper matching with the periodic lattice function needs to be performed. Stefano suggested tracking a full turn of scattered particles to have a direct measure of the circulating distribution.

The simulated transverse beam distribution is used as basis on which imperfection have been added to obtain a criterion for circulating injection aperture. Roderik noted that the tolerances used to compute the halo generation should be distinguished from the ones introduced on the circulating beam since the latter are included in the aperture calculations. Massimo noted that the imperfections used for the machine should correspond to latest presented by Roderik.

Parameters and tolerances for aperture margin evaluation at injection (R. Bruce)

The tolerances for the aperture evaluation at injection have been evaluated taking into account the experience of the LHC operations and aperture measurements. The approach is similar to the one that has been used for the review of the tolerances in collision and documented in the note (CERN-ACC-2014-0044).

It was noted that the reference emittance used for the estimations is not the beam emittance. Furthermore the physical beam emittances of the proton and ion beams are not the same. The definitions should be reviewed to avoid confusion.

It is expected that the machine will operate with the same achieved beta-beating and dispersion errors achieved in Run I, 10% and 14% respectively (reduced by half w.r.t the design report values).

The orbit tolerance should be 2 mm for closed orbit and 2 mm from injection oscillation (not accounted before) for a total of 4 mm (as before).

The energy error should be decreased to $6\ 10^{-4}$ ($4\ 10^{-4}$ for the momentum spread and $2\ 10^{-4}$ for the energy shift) instead of $15\ 10^{-4}$, since no chromaticity measurement is foreseen with full beam.

The new tolerances give more aperture margin compared to the old ones (10% more for the arc, for instance). For comparison the arc would have an aperture of about 14 σ without tolerances and 10 σ with the new tolerances.

In order to define an acceptable aperture the possible cases of asynchronous beam dumps, injection failures (see previous talk) and halo cleaning should be considered.

For asynchronous beam dumps a study on the “worst case” halo escaping from protection devices has been estimated by assuming a beam of 3.5 μm emittance and a bunch population of 2.2×10^{11} p (at injection 2.3×10^{11} pb should be assumed). Imperfections are introduced in the halo definition: 3.5 mm (equivalent to 1.8 σ) of orbit drifts corresponding to the BPM interlock at the TCQQ/TCSG and 10% of beta-beating (equivalent to 0.4 σ). The results show that 8.7 σ, round to 9 σ, is an acceptable aperture.

Cleaning studies give a limit around 6.7 σ without imperfections. Imperfections studies are difficult however it is not expected they could give limit beyond 9 σ. Additional studies are foreseen using 2D halo simulations.

Ideal parameters for Pb-Pb collision at the HL-LHC (J. Jowett)

ALICE is requesting an integrated Pb-Pb luminosity of 2.85 nb^{-1}/year/experiment after LS2 with a limit of 50 kHz in the interaction rate (similar requirements come from CMS and ATLAS). 10 nb^{-1} are requested by LS4. 50 ns spacing is assumed. Gianluigi asked whether 25ns or other bunch spacing could be used. John replied that in principle this could be accepted by the experiments provided the limit of 50 kHz in the interaction rate is respected although there would be questions related to crossing angles and other issues to clarify.
The luminosity sharing between ALICE/ATLAS and CMS is still under discussion and it is a key ingredient for the beam parameters choice and luminosity predictions.
A parameter list has been specified for 3 sharing scenarios. The scenarios have been evaluated with the CTE program to predict the variation of the beam parameters. 50 ns bunch spacing is used, for which 1100 bunches are foreseen for ALICE, 1.7 10^8 bunch population and 1.5 µm emittance. These are intended as a specification for LIU but go substantially beyond present expectations in assuming all bunches have the same intensity. Gianluigi noted that the average luminosity is shown as function of stable beam time and turn-around-time. Gianluigi proposed to use 24 days as days of physics to be consistent with Mike's assumptions. The values of the bunch population required at the beginning of a physics fill to obtain the integrated luminosity of 2.85 nb^{-1}/year should be estimated and from that the corresponding beam parameters at injection should be estimated.
Gianluigi proposed to use the same margins for transmission and emittance blow-up used for protons (95% intensity and 10% emittance blow-up in addition of the horizontal/vertical average blow-up due to IBS).

Report from Task Leaders:

Task 2.5 (Tatiana): Tatiana had comments on the operational scenario report to be followed up offline.

Reported by Riccardo and Gianluigi