High Luminosity LHC

Follow-up of HL-LHC Annual meeting

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Collecting points picked-up during the discussion. Thanks to all of the contributors/presents

The HiLumi LHC Design Study is included in the High Luminosity LHC project and is partly funded by the European Commission within the Framework Programme 7 Capacities Specific Programme, Grant Agreement 284404.

Field quality

- Significant reduction (down to 8 σ) of the dynamic aperture with latest error tables provided by WP3.
  - Need to identify the main drivers
  - Effect of beam screen (including shielding) not included yet
  - Definitions and conventions need to be clarified (still some doubts)
- Sensitivity to multipolar corrector settings to be further studied in particular for higher orders where observables for optimization might be non-trivial

Impedance

- Progress with the modellization of the impact of crab cavities on beam stability and on the impedance reduction.
  - The transverse mode at 920 MHz in the DQW design should be reduced for beam stability considerations
- Evaluation of:
  - Triplet BPMs (two beams) ➔ design available
  - Y chamber (two beams)
- Are we evaluating the behaviour of the components installed in common areas w.r.t. two beams?

Heat Loads

- Need to have Tables for the various contributions to heat loads for the various beam screens (in IR1/2/5/8 and in the arcs) for nominal parameters.

Beam screen type	Synchrotron radiation [W]	Impedance [W] 20/70 K	Luminosity debris [W]	Electron cloud SEY 1.3/1.4 [W]	Comments
Q1	xx	yy20/yy70	zz	Ww1.3/ww1.4	Coating with SEY <1 required
…..					
Q6	xx	yy20/yy70	zz	Ww1.3/ww1.4	Coating with SEY <1 required

Beam screen type	Synchrotron radiation [W/m]	Impedance [W/m] 20/70 K	Debris from beam gas [W/m]	Electron cloud SEY 1.3/1.4 [W/m]	Comments
Arc dipole	xx	yy20/yy70	zz	Ww1.3/ww1.4	ccc
Arc quad	xx	yy20/yy70	zz	Ww1.3/ww1.4	ccc

Heat loads

- Can we run at 1.08 ns (2.5 eV.s at 16 MV)
- Should we run at 12 MV as today? Can we do that?
- Is there a minimum bunch length at which we should level to avoid further upgrade of the kickers?

Electron cloud

- Need for baffles behind pumping slots confirmed for the dipoles ➔ need to cross check with the triplets and agree on design with vacuum team (size and number of pumping slots)

  ➔implication on pumping speed

  ➔Implications on impedance

- Recent beam tests seem to confirm that electron cloud in the dipoles plays a role for stability (and can be suppressed):
  - Can we confirm that we can run above threshold on the main quadrupoles with no issues on stability?
  - Can we infer anything on the role of electron cloud in the triplets/matching sections (although we plan coating)?

Beam screen and Energy deposition

- Great progress in the design of the beam screen but need a technical review to clarify tolerances and contributions to them (particularly critical for Q2/3)/mechanical behaviour during quenches:
  - Straightness
  - Longitudinal and transverse weldings
  - Optimization of the thickness of copper as a balance between quench behaviour and impedance
  - Tungsten shielding plays an important role during quenches ➔ longitudinal segmentation?
  - D1 shielding thickness could be reduced by 1 mm to maintain constant aperture

Beam screen and Energy deposition

- Integrated radiation dose between Q2a and Q2b: mainly due to interruption of the shielding at the interconnects ➔ possible new design to be studied allowing increased longitudinal coverage
- Mitigation measures:
  - Operation with constant normalized LRBB separation to reduce the crossing angle at least during he levelling phase ➔ implications on DA
  - Regular swap of the crossing plane ➔ implication on crab cavities
  - VV crossing with regular swap ➔ LRBB compensation
- Sensitivity to MCBX settings?

Machine Detector Interface

- TAXS aperture at 60 mm seems to be acceptable from machine/experiment protection considerations
- Issue with flange dimensions to be addressed on CMS side/VAXS and BPM integration on the ATLAS side to be confirmed (end of January?)
- No clear indications that Pile-up (up to 200) and pile-up density are an issue
- Luminous region up to 12-13 cm r.m.s. longitudinally seems to be acceptable

Beam-beam

- Goal for the emittance growth rate due to CC noise:
  - Should be small as compared to emittance growth due to IBS
  - Tune spread to be considered for estimations of emittance blow-up. We should assume the worst case with LHCb operating at high luminosity (essentially head on).
- Impact on DA of the levelling at constant BBLR
- Margin for crossing angle reduction
- Dynamic β beating due to HOBB. To be studied.

Optics measurement and correction

- Is the precision of the tune measurement at 5×10^{-5} feasible at all?
  - Requirements on powering configuration for triplet ➔ single main power converter
  - Instrumentation?
  - Can this be relaxed if amplitude information of the BPM can be guaranteed with good accuracy? (1%?). Feasible?
  - Need to update LHC instrumentation specifications?
- b2 uncertainty for the triplet is critical (aim for 1 unit ➔ now at 10 units)
- Correction strategy for triplet field errors with corrector package needs to be tested in LHC

LHCb

- β^* limited to ~2 m with IP shift
- No significant gain to go to levelling beyond $1x10^{34}$ cm^{-2} s^{-1}. Intermediate scenarios (e.g. $0.5x10^{34}$ cm^{-2} s^{-1} - B. Schmidt) to be considered
- Beam-beam simulations are required to assess impact on DA and luminosity lifetime (other than burn-off)
- Can we stand 3 IPs with full Head-On Beam Beam Tune Spread? Mitigation measures to reduce the tune spread?

Collimation

- Can we dynamically varying the collimators during β^* levelling to minimize impedance at the beginning of the fill when intensity/brightness is higher?

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