LHC Beam Operation Committee

Notes from the meeting held on 30th October 2012

Participants

1. LHC Luminosity Lifetime Observations in 2012 – M. Hostettler (slides)

M. Hostettler explained that, for fills longer than 8 hours, the Luminosity decay can be empirically fitted by a double exponential representing an initially fast decay followed by a slower decay (excluding the luminosity scan periods). In stable beam, the Luminosity instantaneous lifetime increases from 7 hours, during the first 0.5-2.5 hours, up to 15 hours, during the last 2 hours. These parameters can be added to the Supertable, a plugin is being worked out with the help of A. Macperson.
Looking at the evolution of the peak Luminosity and Luminosity lifetime over 2012 one can see that, after TS2 and following some tuning of the beam in the injectors plus the inversion of the octupoles current, the first increased by ~20% while the second got worse by about a factor of 2 with a consequent reduction of the integrated Luminosity.
M. Hostettler explained that, using the TEVATRON approximation fit it is possible to estimate the optimum duration of a fill and that this depends on the preparation time (time between a beam dump and the next stable beam).
M. Hostettler also showed a preliminary analysis of the three fills with high ADT bandwidth during stable beams and the impacts on Luminosity. He explained that emittance growth, losses, lifetime and integrated Luminosity got worse with respect to standard operation. Losses show a pattern along the bunches in the trains which is different for beam 1 (higher losses at the end of the train) and beam 2 (higher losses at the beginning of the train); the reason for this difference is not yet understood. A selective blowup of the emittance (convoluted emittance from experiments for a round beam), is also visible but is not clearly related to the ADT bandwidth.

Discussion:

D. Valuch pointed out that the ADT settings during the three fills with higher bandwidth were not optimized for the 50 ns beam and this could explain the worsening in lifetime, losses and luminosity (see next talk).
W. Hofle agreed and explained that the same approach as for the abort gap cleaning should be used: first to do necessary fine adjustments in parameters and the toggle the ADT modes (standard/high Bandwidth) looking at the slope of the Luminosity lifetime.
G. Arduini added that operation with increased bandwidth should help mainly during critical periods like the end of the squeeze and not necessarily used in stable beam.

E. Chapochnikova commented that, in order to evaluate the evolution of the integrated Luminosity over the year, one should compare the different fills looking at the integration of the instantaneous Luminosity over a fixed time (i.e. first 3 hours).
M. Hostettler explained that, due to the higher peak Luminosity, the initial integrated luminosity didn't get worse over 2012 while deterioration can be observed at the end of the fills.

G. Arduini commented that integrated Luminosity got worse after TS2 also because the time without beam, due to the failure of different systems, increased and probably operation with inverse octupole polarity has not been fully optimized.

M. Lamont reminded that a useful tool, which was developed by A. Marsili, allows decoupling losses coming from the two beams and in the horizontal and vertical plane, by using reference cases defined with the loss maps. This tool could be used to have a better understanding of losses and Lifetime degradation.

2. Operation with ADT Increased Bandwidth - D. Valuch (slides)

D. Valuch gave a brief overview of the LHC Transverse Damper system and explained that normally the power amplifiers have a roll-off at 1 MHz and a digital filter is used for phase compensation. This allows removing the exponential tails of the impulse but limited bandwidth still introduces cross-talks between neighbor bunches and different damping times between bunches inside the batch.
This makes difficult damping single bunch instabilities, so feedback gain has to be increased significantly.
When full strength is not needed (outside injection) an increased bandwidth could provide a faster damping of higher frequency modes and could allow treating bunches individually without cross-talks. On the other hand the system might become more sensitive to precise setting up and drifts. Impact of potential increased noise injection still needs to be studied.
Operation with high bandwidth was commissioned and properly set up for 25 ns beam and 3 fills were dedicated to studies with 50 ns beam but with not optimized settings. Since fill 3212 the high bandwidth is operational during squeeze until collision; settings could be optimized to operate with the enhanced bandwidth also during stable beam (**requested1 hour at injection fully dedicated to damper setup**). Also abort gap cleaning could potentially profit from this operation mode (wider window and less effect on unwanted bunches) but the contribution of AC coupling has to be estimated.

Discussion

J. Wenninger asked if any improvement in beam stability was observed at end of the squeeze.
G. Arduini answered that a tiny difference was observed.
D. Valuch commented that the 1 turn delay has still to be corrected for operation with 50 ns beams and this could have a big impact.

A. Burov commented that, according to his simulations, the damper gain could be reduced by a factor of 2 when working with high chromaticity. He added that, in case of slightly negative chromaticity, one could operate with 0 octupoles current.

3. Stability of Luminosity Optimizations - J. Wenninger (slides)

J. Wenninger reminded that in 2012 beam instabilities and dumps due to losses became much more severe than in 2011 (more strict collimator hierarchy and higher current) and were mainly triggered by large offsets at collisions in IR1 and IR5. The possibility of squeezing the beam after collision to better stabilize the beams is considered for operation after LS1.
An analysis of all the Luminosity knob trims was done to define the reproducibility of the Luminosity optimizations. It was found that, for IR1 and IR5, orbit drifts up to 5 σ could be compensated and changes of the order of 1 σ were observed between different fills. Only half of the total 1.5 σ margin between TCTs and triplets was used up to now but, if the offset in μm stays the same, a better control in the orbit may be needed at 7 TeV (reproducibility would correspond to a separation of 1.7 σ).
One outlier was observed in the analysis and corresponded to a manual orbit correction at injection; only automatic corrections through the feedback (OFB) should be done. If manual corrections have to be made, they should be cancelled before starting the ramp. The OFB uses a Singular Value Decomposition algorithm and the question about the optimum number of eigenvalues is addressed (more eigenvalues would allow a finer control but the system would be more sensitive to bad BPMs).
An equivalent analysis for IR8 showed almost no dependence of the luminosity trims on LHCb polarity. Moreover, the average offset change showed to be so reproducible that test cycles could be skipped if not needed for parallel studies.

4. Next meeting

Tuesday, 06/11/2012: **LBOC meeting (15:30 in 874-1-011).**