LHC Beam Operation Committee

# Notes from the meeting held on 22nd May 2012

There were no comments to the minutes of the previous meetings which were approved. G. Arduini reminded P. Charrue that there was an action on him. He will report at the next meeting. **Action. P. Charrue**

## Observations from bunch-by –bunch Luminosities (G. Papotti)

G. Papotti presented an analysis of the bunch-by-bunch luminosity evolution during fills in 2011 and 2012 . The aim of the study was to possibly improve luminosity performances during collision by studying systematic effects and it proved to be a good tool to disentangle sources of emittance blow-up in the injectors and in the LHC. The bunch-to-bunch spread in specific luminosity is larger than 20%. Understanding the origin of that spread could allow improving the integrated luminosity performance as the overall spread seems to be larger than the variation of the specific luminosity during the fill. The luminosity evolution is assumed to decay following an empirical law based on a double exponential behavior. Giulia showed a few examples where some structures related to the quality of the beam form the injectors can be identified. As an example Giulia showed the effect of the PS extraction kicker ripple affecting the first bunches of each PS train. Other examples included the difference between PSB rings and between the two PSB injection into the PS and the effect of the non-nominal SPS injection kicker rise-time.

#### Discussion:

S. Gilardoni commented that the observed effect of the **PS extraction kicker ripple** was mitigated by changing the synchronization of the kicker to avoid 2 bunches not being on the flat-top of the kicker pulse when extracting. This cure will not be applicable for the 25 ns beams due to the tighter extraction gap.

J. Jowett commented that the **double exponential fit** is an arbitrary law and it might be interesting to check if one can relate luminosity evolution to any physics model.

J. Jowett also commented that previous studies indicated that the fraction of the intensity decay that cannot be accounted for from burn-off could be explained by debunching resulting from IBS. R. Assmann commented that this should then be equal for all bunches and not show a trend along the batch.. Gianluigi and Mike commented that the use of the total cross section for the estimation of the burn-off might be too pessimistic as the particles undergoing elastic interaction might not be lost but contribute to the emittance blow-up. E. Meschi commented that to be precise on that contribution one should perform a Montecarlo simulation. Gianluigi suggested checking if in the SPS we have longer bunches at the end of the batch and whether this could explain the difference in performance along the bunch trains. Giulia commented that nevertheless the bunch lengths should be equalized during the ramp, by the controlled longitudinal emittance blow-up.

R. Assmann pointed out that what we are discussing about is **0.5-1% per hour emittance growth** effect which is excellent.

M. Lamont suggested having some **online display** or automatic plots to be used to spot effects from the injectors or in the LHC rapidly. Giulia commented that the data are not available on line and they are published by the experiments after the end of the fill. She added that a technical student is going to work on that under her supervision. E. Meschi commented that the bunch-by-bunch luminosity data could be made available on-line but corrections are applied by off-line analysis at the end of a fill. Gianluigi noted that relative values of the bunch-by-bunch luminosity and specific luminosity mater and for that the BRAN data could be used and re-normalized with the total instantaneous luminosity data if needed.

R. Assmann mentioned one should calculate the effect of **radiation damping**, J. Jowett mentioned that at 7 TeV it is about 24 hours.

**Action: Develop an on-line tool for bunch-by-bunch luminosity and specific luminosity monitoring. G. Papotti with OP.**

## Tune Footprint during collisions (X. Buffat)

X. Buffat presented an application The Beam-Beam Footprint Viewer developed to understand and have an approximated estimate of beam-beam tune shifts and spread for the different bunch configurations (filling schemes) and collision patterns (leveling with separation, tune, changing working point and or intensities). This application could be used to have an estimate of what a change in working point and/or intensities can give on the tunes of single bunches while colliding. The calculations take into account beam-beam interactions head-on and long-range for single particles at different amplitudes to show the detuning with amplitude. The calculations do not take into account any dynamic beta effects. The calculated beam-beam part is an approximation, which nevertheless gives a reliable picture of the collider tune configuration. One can spot in the tune diagram the tunes of special pacman and super-pacman bunches and have an estimate of the Landau damping areas for the different bunch families. The initial purpose of the application was a direct comparison with single bunch tune measurements, which might be available in the future. Xavier showed the functionality of the application where one can calculate the footprint while we change the separation at one IP as during a leveling procedure. The application takes the needed inputs from the control system of the LHC some parameters should be input from the user. The calculations are done by use of JMAD and then the footprint is plotted and some manipulations are allowed (change of WP or intensity scaling). The bunch-by-bunch intensities can be loaded from the logging database and single bunches can be selected for the calculations via the GUI. The machine optics is taken from the available database options and some IP setting can be changed by the user (crossing angles, separation at the IP, spectrometer polarity etc.). To compute the footprint for one single bunch it takes approximately 1 minute and this represents a limit if one wants to calculate the full LHC beam (1380 bunches per beam). An improvement will be to define some representative families per filling scheme in order to have the extreme cases. Xavier presented also a list of future developments, which are in the pipeline and he would like to have some feedback from the users (OP, ABP etc) to define some priorities depending on the real needs during operation. An important point to develop is to make the application faster and move to on-line mode.

#### Discussion:

R. Tomas proposed to speed-up the calculation to make use of **parallel machines** available already. In that way the calculations for different bunches could be done in parallel. He also suggested contacting I. Papaphilippou to include also **diffusion coefficient calculations** to the footprint.

R. Schmidt and R. Assmann mentioned that it would be **worth selecting bunches depending on sudden losses** to spot immediately bunches loosing during a fill to see if it is tune related instead of preselected bunches representative of the different collision families.

M. Lamont asked if the contribution of octupoles is included and Xavier replied in the affirmative. T. Pieloni mentioned that the final aim of the application would be to also incorporate single bunch tune measurements as Xavier mentioned but also to plot on top of the tune position of the single bunches the losses of the bunches to possibly spot losses related to the tunes. G. Arduini suggested that Xavier shows how to use the viewer to the EiCs and operators in more details and collect feedbacks about to improve the functionalities.

J. Jowett noted that in the past he had proposed means of displaying different beam-beam equivalence classes (<http://cdsweb.cern.ch/record/488278?ln=en> ). Gianluigi suggested adding that to the beam-beam viewer

The following requirements have been identified:

* parallelize the code to speed-up the calculation for group of bunches;
* pre-define representatives of beam-beam equivalence classes;
* implement a display for the beam-beam equivalence classes according to the filling scheme;
* display the tune footprint of bunches with the highest and lowest loss rate dynamically

**Action: X. Buffat**

## AOB (G. Arduini)

- **BSRTs Application occupying a console**: Gianluigi noted that it should not be necessary to have an application running in a console to keep the BSRT emittance scan active. A solution based on a server should be found. Barbara Holzer will verify with BI colleagues. **Action: B. Holzer.**

- **Head-Tail monitor and Multi Turn application**: there is a need to make these two instrument acquiring automatically triggered when an instability occurs via the BBQ eigenvalue amplitude in order to catch any instability. R. Schmidt suggested that fast losses could be used to trigger the acquisition as well. **Action: B. Holzer.**

## **Upcoming meetings:**

**Tuesday, 5th June 2012 15:30 in 871-1-011: LBOC**

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Reported by T. Pieloni