# LHC Beam Operation Committee

## Notes from the meeting held on 17th April 2012

### 1. Orbit Feedback Issues Status and Plans (Jean-Jacques Gras)

J.-J. Gras gave an introduction to the functionality of the orbit feedback. Changes with respect to 2011 are that the complete reference orbit is now set as one vector, including e.g. crossing bumps. Consequently, dynamic changes of the complete orbit reference are used in 2012.

J.-J. Gras explained an issue where the **reference orbit goes to zero** due to an erroneous handling of concurrent threads running on the orbit feedback service unit (OFSU) server**. The problem has been identified and a new version of the server is ready for testing.** In the meanwhile, several mitigation measures are introduced, which include an **SIS interlock** if the active reference orbit is zero and **sequencer checks** of the reference orbits.

A second (unrelated) issue is **frequent OFSU crashes.** Due to a persistency issue on reference variables, the OFSU might not recover correctly after such a crash. **A memory leak was found in the OFSU**, which could be a potential reason for the crashes. **The new OFSU server version includes a corresponding fix.** As temporary mitigation, the **OFSU server is restarted before each fill** and a **SIS interlock** was implemented which checks for crashes of the OFSU.

Since in the worst failure case, no catastrophic damage is expected, it was agreed to continue operation with the temporary mitigations in place. **During Technical Stop #1 the new OFSU server version will be deployed.**

*Discussion:*

**J. Wenninger commented that in 2011 as in 2012 generally all IR BPMs are used for the orbit feedback. No systematic changes in the masking of IR BPMs were done.**

J.-J. Gras noted that **since the temporal mitigations are active, no case of zero orbit references was observed**. Probably the reboot of the OFSU server is also beneficial for this issue.

J. Wenninger explained that during the ramp, one single orbit change is made. Between the two discrete reference orbits, a linear interpolation over the whole ramp duration is applied. For the squeeze, linear interpolations are used to move from one orbit reference to the next (in total 10 references).

## 2. Leveling Test: Machine Experience Preliminary Results (Tatiana Pieloni)

T. Pieloni explained that during the fills 2488 and 2489 luminosity leveling tests with transverse separation in ATLAS and CMS were done. **The luminosities were leveled to 95% (0.4σ separation) and 75% (1.1σ separation).** In the second case a strong non-linear beam-beam force is expected. T. Pieloni showed that simulations predict a small emittance growth of about 8%/hour for nominal LHC parameters with maxima at 0.4σ and 1.5σ separation.

During the leveling tests, **no significant impact of the transverse separation on emittance growth and lifetimes was observed** so far. For the 1.1σ separation test a beam-beam tune shift is observable.

T. Pieloni elaborated on sudden losses during fill 2488. The losses seem to be correlated to a leveling in LHCb but independent of the leveling in ATLAS and CMS. **Initially, four bunches of beam 2 have strong losses which are then transmitted via beam-beam interactions to colliding partner bunches.** A strong coherent transverse excitation is expected to be the cause of the losses. The source of the excitation is not understood.

***Discussion:***

T. Pieloni added that in one case no luminosity for CMS was gained back when reducing the separation. In this case, the LHCb luminosity was leveled at the same time, which might implicate that **there is a coupling between the transverse separations at the different IPs**. G. Papotti added that there was already in 2011 a correlation between leveling in IP8 and the luminosity in IP5.

J. Wenninger commented that a test of luminosity leveling with dynamic $\beta^*$ is probably only possible during the squeeze. With the current controls system, other options are difficult to realize.

## 3. Chromaticity Decay and Snapback (Nicholas Aquilina)

N. Aquilina explained the double exponential model of the chromaticity decay during injection. From 2011 measurements, the decay amplitude for 4 TeV operation was estimated to be about 19 units (16 units for 3.5 TeV). In 2012, systematic chromaticity measurements were done for three fills. Based on these measurements, the decay amplitude was estimated to be about 17 units. **The latest FiDeL model is used since 6th April and keeps the chromaticity within 1 unit over 20-30 minutes.**

N. Aquilina elaborated on the model used for snapback compensation. **In the 2012 measurements the snapback was found to decay slower than what is used for the current snapback correction** (based on series magnet measurements).

At 4TeV, the chromaticity decays by about 5 units with a time constant of 100s. A correction using the spool pieces is in place and active.

***Discussion:***

J. Wenninger asked if the snapback correction could be changed after the technical stop. M. Lamont agreed that this would be a good time.

M. Strzeczyk asked concerning the chromaticity correction at 4TeV, why there is so much difference in the fitted tau values for the different beams and planes. He pointed out that if the chromaticity decay would be due to a b3 of the dipole magnets, the value should be the same for all cases. E. Todesco replied that for each case a fit with four free parameters is used, which implies a large freedom for each parameter. M. Strzeczyk suggested to do a combined fit for all beams and planes.

**DECISION: Change of the parameters for the snapback correction according to the results of the 2012 measurements during Technical Stop #1.**

## 4. Simulations of IBS for Protons in 2012 (Michaela Schaumann)

M. Schaumann introduced the Collider Time Evolution (CTE) program which is used to simulate the intra-beam-scattering (IBS) and explained the parameter space covered by the simulations.

M. Schaumann presented the simulated evolution of intensity, emittance, bunch length and IBS growth rate for different initial bunch intensities, emittances and bunch lengths at 450GeV and 4TeV. In accordance with expectations, a smaller initial bunch length leads to less particle losses from the bucket but larger growths of transverse and longitudinal emittances. Concerning the predicted luminosities, the first effect is dominant, **leading to larger integrated luminosities for a bunch length of 1ns compared to 1.5ns.** A comparison with MAD-X simulations shows a good agreement of the results, where expected.

**During collisions, the intensity loss due to IBS is up to 5% within 6 hours** (compared to up to 12% intensity loss due to luminosity burn off). The increased emittance blow-up starts to saturate at about 1.3ns initial bunch length.

***Discussion:***

G. Arduini notes that the initial assumption of a Gaussian beam distribution is probably too pessimistic. He also adds that the voltage at injection could be changed since there is no strong reason for keeping it at 6MV.

S. Fartoukh asked if the losses due to IBS can be measured. M. Schaumann replied that **a comparison of the simulations with measurements is ongoing** but not too advanced yet. **R. Assmann pointed out that the losses due to debunching should mainly occur in the momentum cleaning. Calibrations to deduce the number of lost particles from the BLM signals are available.**

J. Wenninger added that in 2011 a transverse emittance growth of about 10% per hour was observed at injection.

**R. Assmann informed that there is an MD foreseen with different longitudinal bunch lengths, which could be interesting for the IBS studies.**

## Upcoming meetings:

**Tuesday, 24th April 2012 15:30 in 871-1-011: LBOC**

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Reported by Tobias Baer