LHC-Beam Commissioning Working Group

Notes from the meeting held on
5 October 2010

Present: Carmen Alabau, Nicholas Aquilina, Gianluigi Arduini, Roger Bailey, Tobias Baer, Wolfgang Bartmann, Giulia Bellodi, Chandra Bhat, Philippe Baudrenghien, Andrea Boccardi, A. Bogacz, Chiara Bracco, Oliver Brüning, Xavier Buffat, Andy Butterworth, Rama Calaga, Christian Carli, Pierre Charrue, Lene Drosdal, Massimilano Ferro-Luzzi, Brennan Goddard, Rossano Giachino, Per Hagen, Delphine Jacquet, Lars Jensen, John Jowett, Yngue Levinsen, Django Manglunki, Malika Meddahi, Tom Mertens, Ryoichi Miyamoto, Giulia Papotti, Mario Pereira, Tatiana Pieloni, Stefano Redaelli, Federico Roncarolo, Elena Shaposhnikova, Katarina Sigerud, Matteo Solfaroli, Ralph Steinhagen, Marek Strzelczyk, Ezio Todesco, Rogelio Tomas, Glenn Vanbavinckhove, Walter Venturini Delsolaro, Daniel Wollmann, Frank Zimmermann.

Excused: Markus Albert, Reyes Alemany, Ralph Assmann, Florian Burkart, Helmut Burkhardt, Roderik Bruce, Marija Cauchi, Octavio Dominguez, Stephane Fartoukh, Ed Ciapala, Guy Crockford, Riccardo De Maria, Laurent Deniau, Bernd Dehning, Kajetan Fuchsberger, Marek Gasior, Massimo Giovannozzi, Jean-Jacques Gras, Werner Herr, Wolfgang Höfle, Eva Barbara Holzer, Verena Kain, Witold Kozanecki, Emanuele Laface, Thibaut Lefevre, Mike Lamont, Ewen Maclean, Alick Macpherson, Aurelien Marsili, Valerie Montabonnet, Gabriel Mueller, Eduardo Nebot, Annika Nordt, Lasse Normann, Kazuhito Ohmo, Mirko Pojer, Laurette Ponce, Bruno Puccio, Stefan Roesler, Adriana Rossi, Mariusz Sapinski, Rüdiger Schmidt, Andrzej Siemko, Frank Schmidt, Benjamin Todd, Jan Uythoven, Gianluca Valentino, Daniel Valuch, Jörg Wenninger, Simon White, Uli Wienands, Marco Zanetti, Markus Zerlauth.

1- Comments and Follow-up from the last minutes

Christian Carli: Updated version of his talk presented last week (slides) concerning the ion injection schemes and restrictions due to the LHC injection kicker timing (mainly driven by the abort gap keeper). Even the original 62 bunches per ring EARLY scheme described by Roger Bailey and Paul Collier in the LHC project note 323 has to be slightly adapted to cope with these restrictions. The 140 bunches/ring scheme is not compatible either, due to the same reasons and would have to be adapted to a 128 bunches/ ring scheme. It would also have the implication that bunch 1 of beam 1 would not meet bunch 1 of beam 2 at the usual places and convention would have to be reviewed. Could be solved by shifting one train by a few slots? To be investigated and reported next week. **Follow-up: Christian Carli**. How many non-colliding bunches are need by experiments: 1 only. If we have much more, and this is the case with the 128 bunches/ring scheme, mainly limited by the abort gap.

Ralph Steinhagen reported on the BBQ observations made during the 200b injection tests done last night and the second 200b filling and ramp of the first physics fill. The ADT gain was changed and the ramp was started as usual. B1-H dropped out for some minutes despite the reduced intensity. B2 was fine all along the ramp though while having slightly higher bunch intensities (1.1e11 p/b). This possible “intensity” effect was to be further investigated.
Marek Gasior (email): BBQ: According to the measurements performed during the 200-bunch test filling of Monday morning, voltages in the order of 200 V were measured on the BBQ detectors. This is well beyond the expected 150 V for which the design was made.

The measurements were done only on the development system, so it cannot be excluded that for some system channels the voltage can be even higher. Therefore, the observed noise increase during recent ramps could be possibly explained by excessive leakage currents in the BBQ detectors due to operating the diodes and capacitors close/above their nominal breakdown specs. Such hypothesis will be investigated and Marek Gasior will build a high-voltage version of the detectors which should be good to some 300 V at the expense of small (some 3 dB) sensitivity degradation for the pilots. The ordered special components should come on Wednesday and for Thursday, and the team asked for an access to install the thing in the tunnel.
Clarification: some attenuators won't be sufficient, as the detector input is high impedance to avoid problems with power dissipation in small HF components (high voltage is enough). The termination (12W) of the stripline pick-ups is done only at the downstream ports, swallowing also the pulses fully reflected from the upstream ports with the detectors.

2- LHC beam commissioning: progress and issues

Monday morning summary of Week 39 - slides from M. Lamont, M. Meddahi, J. Uythoven.
Main observations during week 39 – Malika Meddahi - slides
Items with high priority in the operation consolidation: Q-feedback, coupling in squeeze (see below), BCT readings, PLL commissioning, vacuum around IPs.
Beam loss: Understanding of the beam loss seen on BLMQI.02R1.B1 in fill 1389 is on-going. **Follow-up: Bernd Dehning**.
Roger Bailey: Already 13hrs of stable beams with 200b have been accumulated. Next step -moving on to 248b- will probably take place around Thursday 7th October, if all pre-requisites are fulfilled.

Luminosity observations - Uli Wienands (slides send by email). Comparisons were made between the fills of 26 Aug and 4 Sept. When comparing luminosity estimated from intensity & BSRT: missing about 40% and 60% luminosity respectively for the 2 fills. Known problem and BSRT calibration on-going.

Abort Gap Monitoring: Andrea Boccardi – (slides)
The cleaning of the abort gap took place over about 2 μs and is nicely observed on the Abort Gap monitor. Please check the slides of Andrea Boccardi and the animation at the end of his presentation illustrating very nicely the abort gap population evolution and the cleaning efficiency. A continuous population (very small number of protons) of the abort gap was observed. The settings used were really pushed to the limits, in normal conditions we would not have measured anything. The Abort Gap Monitor gives calibrated values during "normal" operation.

Emittance evolution during the abort Gap cleaning: Federico Roncarolo (slides)
During the abort gap cleaning tests, emittance measurements have been performed and showed that the emittance evolution was not worst than the natural emittance increase which takes place at 450 GeV. This result is very encouraging and if it is confirmed then Wolfgang Hofle suggested that the cleaning at 450 GeV of the abort gap is performed during the coming filling for physics. **OP follow-up: Mike Lamont**.

Calibration of losses and un-bunched beam at injection: Philippe Baudrenghien for Brennan Goddard (slides) and summary from the LIBD dedicated meeting held on 5th October (Brennan Goddard)
Observations:
The uncaptured beam was measured at about 0.3% at present and is expected to increase to around 1%. It will result in line density of 2.6e8 p+/m for nominal beam (as estimated and published in 2002). It was confirmed that the losses on TDI come from

uncaptured beam (8/86 us). The losses are maybe 20% higher with sweep c.f. over injection of pilot. The calibration with beam shows that the dump limit is 3e6 p+/m which implies that we need to gain a factor 100 in dump limit for nominal 25ns filling. We are commonly at 30% of the dump limit for the present 16b injection (100-150-200b) and it is expected to get worse for 75 and 50ns. The analysis of the recent injections has shown that many (>10) monitors per beam are above 10% of dump limit. The effect of shielding TCDI 29205 in TI2 is not obvious - needs controlled experiment. LHCb BCM is often at 30% of dump level for injection

Possible mitigation:

- improving RF capture: not possible, already optimised
- BLM thresholds/filters/disconnection: maybe factor 10 to gain in some places
- Shielding downstream TDI: needs full study and not obvious to design - will help LHC/ALICE.
- BLM sunglasses: major system changes required and not for short-term
- cleaning 'injection gap': major changes to abort gap cleaning needed, not for short term

Actions: (Follow-up: Brennan Goddard)

- Realistic scenario for intensity increase '10 and '11, with numbers on beam load on TDI
- Present BLM system: detailed list of monitors affected, margin on thresholds, check where filters can be added, check if any monitors can be disconnected
- Shielding: get FLUKA model from R.Appleby and adapt for TDI study (load cases?), check effect on LHCb/ALICE and at BLM locations, check what improvement from realistic shielding
- BLM sunglasses: formulate outline requirements (BG), first brainstorming to organise on possibilities
- 'injection gap' cleaning - investigate possibilities

Squeeze optimisation – Stefano Redaelli (slides)

Motivations: i) tune corrections applied by the Tune-Feedback getting large (as observed over the last 6 fills)- ii) the Tune-Feedback during the squeeze switching off at around 4 m, due to the large coupling at that location- iii) beam losses at some steps during the squeeze, in particular for beam 2.

Summary of the improvements: the tune corrections by the Q-FB after the feed-forward corrections were very small so the corrections applied were very efficient. The correction of the coupling in the squeeze has been done. The beam losses are smaller for beam 1, improvements to be confirmed for beam 2 on the next squeeze.

3- Heavy ions, parameters and commissioning updates– John Jowett (slides)

Updates since the 1st September

Filling scheme: Luminosity × 2 for ALICE, x 1.8 for ATLAS,CMS

Longitudinal parameters: The longitudinal emittance may grow by itself. We seem to be safe w.r.t transverse blow-up. The emittance blow-up from RF noise would be mainly desirable to keep longitudinal emittance constant. Short bunches are preferred.

Machine protection: Discussion at MPP on 1 October and Safe Beam level agreed (2.5 times less charge than p).

TCTVs in IR2: crucial question for collimation. Can we open them for ALICE ZDC ?

John Jowett said that a possible early ion test run is being discussed and would take place week 42, for about 16-24 h if SPS RF is ready. Motivations: tests the fast-commissioning concept and the detectors. So the test is only useful if there is a reasonable chance of some collisions. Proposal: 1 or 2 bunches/beam. Crossing angles, collimation, etc. as for p-p. RF capture, ramp, no squeeze, collide.

Stefano Redaelli: Initial tests with safe beams are probably required, maybe with no crossing angles.

4- Update on the K modulation – Rogelio Tomas (slides)

Rogelio Tomas presented the K modulation measurement results done on 21 September where asymmetry between positive and negative powering of the quad were measured. The error due to coupling and tolerance from the simulations were shown.
Rogelio Tomas clarified that what matters is the global quantity of the coupling, not the local one.
Betas at the IR3 collimators were evaluated using K modulation on Q4L3 and Q5L3. 10% of beta beat was measured in V at QT4L3 and 3% in H at QT5L3, in agreement with the AC dipole measurements.
Summary:

- K-modulation is a delicate measurement
- It needs good coupling $\Delta Q_{min} < 0.0035$ for the "good" δk sign and $\Delta Q_{min} < 0.001$ for the "bad" δk sign
- Using the measurement that separates the tunes the large discrepancy disappears.
- K-modulation in IR3 does not show large optics errors
- Need to re-measure (low intensity, K-mod and AC dip). Request for a dedicated ramp and 1 hr of beam time at flat top.

5- 75ns or 50 ns bunch spacing – Gianluigi Arduini (slides)

Reasons for changing the bunch spacing? Anticipating potential problems for next year operation: i) more insight in present and potential vacuum issues – ii) beam-beam at injection and flat-top – iii) e-cloud effects – iv) capture efficiency with shorter spacings – v) behaviour of Beam Instrumentation and RF/damper with tighter spacing- vi) exploration of luminosity production with tighter spacings (backgrounds, lifetimes, etc.)
Status of the injectors:
50 ns: ready, still need a few shift in each injectors – 75 ns not yet set-up with this bunch spacing : about 1 week maximum needed in the injectors.
Impact on the LHC injection/Injection protection:
2 shifts required to set-up the transfer lines (steering and TCDI alignment if needed)
No impact on collimation set-up provided that the starting assumption is satisfied and that we do not change bunch intensity.
Impact on Beam dump systems: Closer bunch spacing will increase the amount of beam transmitted in the case of an asynchronous dump, and hence the risk of damage in case of any protection failure. But there is no sharp limit, and the increase in risk factor on this basis is maybe 2-3
Transverse feedback: 2 shift needed (75 ns easier)
RF: no dedicated time required, mostly observation
Strategy: Start with bunch trains of 8 (12) bunches and collisions with 3x8 bunch/beam. Intensity ramp-up policy to be defined – In collaboration with **Joerg Wenninger**.
Conclusions:

- 50 ns beam can be ready in the injectors in a few days. 75 ns beam would take longer (~1 week). The preferred flavour should be identified.
- No significant difference in commissioning time between 50 and 75 ns beam in the LHC: 4 to 5 shifts (beam time)
- Switching back and forth from 50(75) ns to 150 ns might take time if we need to set-up again the transfer line collimators (1 shift if the TCDIs are to be re-adjusted, couple hours otherwise)
- Would go with the potentially more demanding case (50 ns)

6- A.O.B - None

Daily 8:30 HWC meeting in the CCC conference room (09:00 at weekends).
Next meeting: **12 October 2010,** 15:30, 874-1-01.

Malika Meddahi