

## LHC-Beam Commissioning Working Group

Notes from the meeting held on  
**23 March 2010**

Present: Carmen Alabau, Gianluigi Arduini, Roger Bailey, Tobias Baer, Chiara Bracco, Oliver Bruening, Helmut Burkhardt, Rama Calaga, Laurent Deniau, Lene Drosdal, Stephane Fartoukh, Massimiliano Ferro-Luzzi, Kajetan Fuchsberger, Rossano Giachino, Massimo Giovannozzi, Brennan Goddard, Per Hagen, E. Barbara Holzer, Lars Jensen, Mike Lamont, Thibaut Lefevre, Yngue Levinsen, Alick Macpherson, Malika Meddahi, Ryoichi Miyamoto, Gabriel Mueller, Giulia Papotti, Mario Pereira, Stefan Roesler, Frank Schmidt, Andrzej Siemko, Katarina Sigerud, Marek Strzelczyk, Michael Sullivan, Benjamin Todd, Ezio Todesco, Rogelio Tomas, Jan Uythoven, Glenn Vanbavinckhove, Walter Venturini Delsolaro, Jorg Wenninger, Simon White, Uli Wienands, Daniel Wollmann, Frank Zimmermann.

Excused: Reyes Alemany, Ralph Assmann, Wolfgang Bartmann, Roderik Bruce, Pierre Charrue, Verena Kain, Delphine Jacquet, Laurette Ponce, Bruno Puccio, Stefano Redaelli, Adriana Rossi, Ralph Steinhagen.

### 1. Comments and follow-up from previous minutes

None.

### 2. LMC News

Summary notes from previous LMC meetings, written by Brennan Goddard or Frank Zimmermann, are available [here](#).

### 3. HWC news – Andrzej Siemko

The question was asked whether the 2 A/s ramp rate limitation could soon be increased. Andrzej Siemko reminded that this limitation was put in place after the two quench events, one triggered by the new QPS system –50 quenches-, and the other one by the old QPS systems -30 quenches.

Concerning the nQPS quench event, the origin of the problem was traced to the functionality of the sunglass filter and cured by changing the threshold settings of nQPS.

Concerning the event linked to the old QPS, the problem is not yet solved. However the cause is understood and originates from a coincidence of two transient effects produced by the power convertor (passive filter creating oscillations on the circuit) and by the fast discharge from the switch opening. This coincidence can trigger the magnet and unfortunately, the amplitude of the oscillations is proportional to the ramp rate, thus limiting the ramp rate to 2 A/s.

The hardware teams are considering several actions:

- Delay one of the transient oscillations, from the power convertors, to make it happen slightly later; this was tested but not satisfactory.
- Delay the switch opening. The solution has been studied and tests of the prototype cards are already in progress. This will decouple the 2 effects but it is not yet sure that it will be sufficient.

In parallel, the solution to decrease the amplitude of the oscillations is being investigated. A solid proposal exists from the power convertor side, with the modification of the passive

filter which would therefore be able to decrease slightly the amplitude. Feasibility tests are planned.

Concerning the already under-taken solution -adding snubber capacitors- the production is coming to the end.

Increasing the ramp rate is therefore linked to:

- Modification of the electronics to delay the switch opening (500ms). As of today, the first prototype exists, the modification of the cards is on-going and the cards will be replaced in two sectors and validated. Installation and tests can be done in 2 sectors in one day, starting as of mid-next week. If this solution is validated, a campaign of taking-out the installed cards, modifying them and installing them 2 sectors by 2 sectors, can be launched and is estimated to take about 4 days in total. But as of today, there is no clear proof that it will be sufficient.
- Early April, test of the snubber capacitor implementation could start and would take 2 months to complete the full installation.
- Reduce the amplitude of the passive filter in the power convertor could be performed over a one month time.

In conclusion, the question of increasing the ramp rate time could be revisited in about a one month time.

Additional points:

- All required changes can be implemented in a staged approach.
- Andrzej Siemko confirmed that no margin exists for the moment in the 2 A/s limitation.
- The short ramp now skips the exponential section –now parabolic-linear-parabolic instead of parabolic-exponential-linear-parabolic. The corresponding gain in the ramp time is 27 min, and so far seems to be O.K.
- Ezio Todesco: Concerning the implementation in Fidel of the ramp-rate dependence, Ezio Todesco clarified that in this early phase of commissioning, it was decided not to implement the snapback correction in a dynamic way. The snapback is computed under certain hypothesis of pre-cycling and is loaded in LSA. If the pre-cycling conditions are changed, a new table has to be generated. This has been done to have more transparency and to reduce the complexity in this phase. The corrections are now the same corrections of 2009, i.e. about 0.1 units of b3 at the beginning of the ramp. This is done since the increase due to the pre-cycle going from 2 kA to 6 kA (about a factor five) should be compensated by a similar decrease due to the lowest ramp rate (10 A/s to 2 A/s). Even though there are no measurements in 2 A/s conditions, the smooth ramps seem to confirm the validity of the approach.

#### **4. LHC beam commissioning progress: outstanding issues – round table**

- Mike Lamont: Commissioning of the tune feedback is continuing -Ralph Steinhagen and Quentin King.

- Brennan Goddard: Spurious trigger of beam dump: beam dump event seemed to have indeed been triggered by the beam dump system. Etienne Carlier said that it might originate from noise on the analysis signal which is monitoring the state of the generator. It is under investigation. Benjamin Todd had analysed all the events and confirmed that BIS responded as it should have done.

- Marek Strzelczyk: implemented the b2-b3-b4-b5 predictions, based on the latest field model. Active on the first time for the short ramp.

- Mario Pereira: Tune feed forward: RQTF and RQTD trims are incorporated. As soon as the orbit feedback is switched down, the same feed forward will be done. Incorporation of actual trims: no yet done.

- Brennan Goddard: Initial set up of the TI 2 TCDIs was performed, and the collimators were retracted until full checks are performed. Injection was checked vs. higher intensity

and emittance variation and all beam parameters were into specs. Work is in progress to prepare for higher intensity and 3.5 TeV stable beam conditions.

- Simon White: Collapse of all the separation bumps was done at high energy, no problems.

Planning of the LHC beam for the next days – [link](#)

## **5. Beta beat and coupling at 450 GeV and 3.5 TeV – Rogelio Tomas – Massimo Giovannozzi** ([R. Tomas slides](#)) ([M. Giovannozzi slides](#))

- The 450 GeV beta beat reproducibility between start-end of March 2010 was established after the RQ4.LR7 bad setting was found and corrected (back to 20-30% beta beat, both beams and both planes). There are small changes in the vertical plane. To be understood.
- 3.5 TeV: at this energy, AC dipole must be used to measure the beta beat. Excitations done did not blow up the beams and negligible losses were observed occasionally at the primary collimator.  
At 3.5 TeV, B1 beta beat looks good, comparable with 450 GeV, but the vertical plane is noisy. At 3.5 TeV, there were no corrections in the machine, trims are linearly removed down to 0 at 1.2 TeV.  
3.5 TeV B2 beta beating is as well very comparable to 450 GeV values with about 20% beta beat.
- Coupling of beam 1 at 450 GeV is small. For beam 2, there is however a large coupling (factor 10 larger than B1) and a global correction is not optimal. Hard to go to the collision tunes with such coupling!  
A local correction was prepared and required much less corrector strengths.  
Coupling at 3.5 TeV: the local correction implemented at 450 GeV was kept all the way through the ramp and iterated at 3.5 TeV. Identification of possible sources of coupling is being worked on and corrections will be tried in the machine.
- Segment by segment correction approach is being set-up for coupling.
- To note: b2 is corrected correctly all through the various energies.

## **6. Experience from the first ramps**

### **a- Orbit evolution and correction strategy – Kajetan Fuchsberger** ([slides](#))

- Ramp #917: flat incorporation from injection corrections: rms stay below 1.3 mm
- Ramp #973: simple incorporation of 3.5 TeV corrections, constant.
- Ramp #973: Excellent rms evolution vs. golden was shown: rms <0.5 mm.
- Reproducibility: is within collimator limits (120  $\mu$ m at 3.5 TeV)
- How to proceed: Apply a simple correction at max rms point and change the function manually. To be done until the orbit feedback is used together with the feed forward mechanism.
- Orbit change at TCDQ: well within tolerance, so far measured at < 1mm

### **b- Beam size evolution– Thibaut Lefevre – Federico Roncarolo**

During the ramp, the source of the light emission is changed from the undulator to the D3. When the light comes from different sources, the measurements are harder to decouple. So at some level of energy, the light from the undulator is removed. There is still a disagreement with the reading from the WS. In the vertical plane, the agreement is good up to 2 TeV as in the horizontal plane there is a disagreement even at low energy. Setting up and calibration of the systems is being done.

An automatic change to switch from the light of the undulator to the D3 between 450 GeV and 3.5 TeV is being commissioning.

Discussion:

- How far can we go with the undulator? Below 1.5 TeV: O.K.
- Brennan Goddard: Could provide yet another emittance measurements from the screens in the dump line.
- Comparison with the BPM reading is done in order to check the validity of the synchrotron light monitor reading.
- Implemented the measured values of the beta at the detectors.
- Need stable beam conditions for a few hours at various energies to continue the commissioning during the ramp

c- Bunch length evolution along the ramp – Giulia Papotti (slides)

- Bunch length at the end of the ramp longer than expected from scaling with energy. Additional slow blow up in stationary conditions observed, also to be understood. Possible sources of RF noise to be looked into.
- To note: LHC BQM to be calibrated.
- 50 Hz crossing the synchrotron frequency: possible source of blow up? But no difference between the slow and fast ramps.
- Data to be correlated with intensity monitors.
- Information to be logged in Timber.

**7. A.O.B.**

For the first 3.5 TeV collisions, it is planned that the separation bumps will be collapsed next Tuesday 30 March at 9:17. Efforts in LHC beam commissioning will continue in preparing all systems for this event.

**Daily 8:30 HWC meeting in the CCC conference room (09:00 at weekends).**

**Daily 17:00 Beam commissioning meeting /OP, CCC glass box.**

Next meeting: **6 April 2010, 15:30, 874-1-01.** Agenda will be sent in due time. **NO MEETING ON TUESDAY 30 March.**

Malika Meddahi.