

## LHC-Beam Commissioning Working Group

### Notes from the meeting held on 4 May 2010

Present: Carmen Alabau, Nicholas Aquilina, Gianluigi Arduini, Wolfgang Bartmann, Helmut Burkhardt, Andy Butterworth, Chiara Bracco, Roderik Bruce, Oliver Bruening, Pierre Charrue, Bernd Dehning, Laurent Deniau, Octavio Dominguez, Lene Drosdal, Lyn Evans, Massimiliano Ferro-Luzzi, Miriam Fitterer, Massimo Giovannozzi, Brennan Goddard, Werner Herr, Per Hagen, Wolfgang Hofle, E. Barbara Holzer, Lars Jensen, John Jowett, Emanuele Laface, Mike Lamont, Yngue Levinsen, Malika Meddahi, Gabriel Mueller, Mario Pereira, Mirko Pojer, Bruno Puccio, Frank Schmidt, Rüdiger Schmidt, Elena Shaposhnikova, Katarina Sigerud, Matteo Solfaroli, Ralph Steinhagen, Marek Strzelczyk, Ezio Todesco, Rogelio Tomas, Jan Uythoven, Jörg Wenninger, Simon White, Uli Wienands, Daniel Wollmann, Marco Zanetti, Frank Zimmermann.

Excused: Reyes Alemany, Ralph Assmann, Tobias Baer, Roger Bailey, Rama Calaga, Kajetan Fuchsberger, Rossano Giachino, Delphine Jacquet, Verena Kain, Thibaut Lefevre, Alick Macpherson, Giulia Papotti, Laurette Ponce, Stefano Redaelli, Stefan Roesler, Adriana Rossi, Glenn Vanbavinckhove, Walter Venturini Delsolaro.

#### 1- Comments and follow-ups from last meetings

Mike Lamont congratulated everybody for the success of the 450 GeV collision runs.

#### Update on snapback for the 3.5 TeV, 2A/s run - Ezio Todesco ([slides](#))

Snapback: Amplitude vs speed in B3. In January 2010 we showed that according to the new measurements the scaling coefficient  $g_3^{SB}$  was wrong for the 6 kA operation. After a new post processing of the measurements, scaling implemented in LSA (based on all SM18 measurements) proves to be correct.

Snapback: Amplitude vs speed in B5. For  $b_5$  we had no data up to 2010. Therefore the  $g_5^{SB}$  was set to the same value as  $g_3^{SB}$ , i.e. 0.176. The post processing of the new data taken in 2010 with fast measurement system gives  $g_5^{SB} = 0.028$

To be changed in FiDeL database and the new  $b_5$  spool piece correction to be generated.

Pre-cycling strategy: still stuck at 2A/s, at least for one month (still missing components to be changed. Changes planned for the next TS). Use previous physics run if no circuits fall down. Ramp to 6 kA with 2 A/s, with variable flat top (usually more than 1 h)

Precycle at 2 kA with 2 A/s if a circuit trips to zero. This does not ensure the same snapback, but is very small anyway.

$b_3$  snapback measured at 10 A/s, 6 kA precycle. One dipole measured several times in 2010. Amplitude about 0.5 unit. Fits with the law from N. Sammut, L. Bottura.

At 2 A/s it should be reduced by a further factor 5 i.e., go at 0.1, i.e. the same we had in 2009 running at 2 kA. We measured, but at 20 and 50 A/s. We should measure at 2 A/s when SM18 shutdown ends. Delay in schedule, hopefully SM18 back in May.

What do we have used from 18<sup>th</sup> March 2010 (6 kA, 2 A/s run):

Started with 0.1 unit correction – build by Marek Strzelczyk using the 2 kA, 10 A/s settings. There is an evidence of under-correction from operation. The correction was brought back to 0.5 units on 7<sup>th</sup> April 2010. It works well so far and remains to be understood.

#### **Controls infrastructure status report** - Pierre Charrue ([slides](#))

LHC controls security panel: Long list of accounts to be removed from the CO infrastructure after this meeting - APPROVED

OASIS settings and BQMLHC FESA class: no problem with neither FESA nor OASIS infrastructure. The OASIS settings were lost and had been brought back.

DIP CMW server was blocked: Due to a blocking in the central CMW logger. Removed dependence from the DIP gateways. More surveillance is implemented.

## 2- Reports from high intensity operation at 450 GeV : Observation, first analyses and outcomes – round table

### A - General operational observations, issues – Gianluigi Arduini

1. Inject and dump mode not working – fixed, linked to changes performed in the TS
2. Larger emittance of beam 2 in both planes as compared to beam 1: one potential issue. When over-injecting, the injection oscillations are corrected on the pilot and it is assumed that the corrections are identical for the higher intensity bunch but indeed the corrections are to be copied to the cycle on which the high intensity bunch is prepared. Can this be the origin of the problem? To be checked again.
3. Bunch length measurements: issues when going to higher intensity. The measurement find bunches where they should not be and the bunch length is not realistic (10 ns). Giulia Papotti is informed and the findings were also showed to Urs Wehrle and Philippe Baubrenghien. They will check on the HW side but Giulia Papotti should also check on the SW side (algorithm for the reconstruction of the bunch length).
4. BLM threshold at the TDI. BI has already intervened. Problem being followed-up. See Chiara Bracco's presentation
5. Calibration of the interlocked BPM with high intensity – to be urgently done.
6. BCT readings (individual bunch intensities) – logging was missing for some time.
7. Very good practice of writing summary of each shift : it is **proposed to continue it!**
8. Access procedures. We need to write a procedure for access with main circuits in standby. Although the magnetic machine is not exactly the same we have seen that the difference can be handled and we gain ~1-2 hours. This would reduce the time of the recovery. Laurette Ponce is writing a proposal. This kind of decision should not be left to individuals.
9. Reset of the U\_res signal for the undulator R4. For the moment this cannot be done during the pre-cycle as it requires ramping the undulator to less than 50 A and up again and it would take ~3 hours to do it. Issue submitted to MP3

### B - Beam-beam observations – Werner Herr, Emanuele Laface ([slides](#))

Observations made during the high intensity runs at 450 GeV were reported.

The bunch crossing scheme used for the 2x2 injection scheme was reminded, in particular it was stressed that bunch 1 of beam 1 encounters the most collisions (3), while the second bunch of beam 1 experiences only a single interaction. Collisions of bunches were successfully performed, with about the nominal intensity and tune shift at 450 GeV, with asymmetric collision scheme (PACMAN effects observed, as expected).

Stability: for  $10^{11}$  protons per bunch and full collisions and full beam-beam tune shift the lifetime was good for 10 h. The lifetime of bunch 1 in beam 1 was worse than bunch 2, most probably due to the different number of collisions (3 vs. 1).

IP2 separation scan (ALICE): To test the proposed separation to control the luminosity in IP2, a separation scan was done in IP2, moving the beams from a separation  $+2\text{mm}$  to  $+0.5\text{mm}$  (other side). Lifetime and emittance are unaffected during the separation scan. Conclusions on the tune shift could not be made yet. Stability of the

collision point to be checked. Very encouraging results for the high energy operation with luminosity reduced in ALICE.

When looking at the tune spectra, two frequencies appear for beam 1. As one bunch is making 3 collisions and the other 1, would this be coming from the different Beam Beam tune shift? Open the separation for IP2, 8 and 5. The first tune peak was shifting to the direction of the second peak. Removing finally the last collision point, the tune spectra presents only one frequency. The tune shift on beam 2 induced by beam 1 =  $-2.8 \times 10^{-3}$ , while the one on beam 1 induced by beam 2 =  $-1.2 \times 10^{-3}$ . So the tune difference is  $-2.44 \times 10^{-3}$ . And when measured on the tune spectra, the distance between the 2 peaks:  $\sim 2.8 \times 10^{-3}$ . This is an excellent agreement.

To continue the commissioning of the bunch by bunch beam instrumentation: highly needed for the beam-beam measurements which are upcoming.

A tune scan and a beam-beam deflection scan were done at the end of the run, but not yet analysed.

Comments:

Ralph Steinhagen: When both beams were put on the same vertical tune, the lifetime dropped.

Werner Herr: Please note that the estimated tune shifts are for the end of the run. Not for the start of the shift. During the test runs the tune shift was nominal and possibly even slightly higher, i.e. close to 0.004 per collision.

Lyn Evans: This is a great result and promising for beam-beam effects at 3.5 TeV. Will the nominal intensities (or close) be used for higher energies? No yet!

Lyn Evans: It is surprising that no IBS was observed.

### **C - Injection and beam dump systems** – Chiara Bracco ([slides](#))

Much work has been done in view of preparation and qualification of the injection and dumping systems – trajectory corrections – Injection protection devices setting-up – Over-injection – Injecting higher intensities – Losses on TCDI – Asynchronous beam dump.

Under-investigation: Beams dumped while over-injecting and, at seldom occasions, with injection of LHCINDIV bunches.

Related issues being followed-up:

- P6 interlock BPMs – response with high intensity (1.5 mm change! BPM signal to be calibrated with high intensity), and gain switching to demonstrate without dumping
- TL steering – need to tidy up corrections at downstream ends, then define a few correctors only for injection steering and lock this in
- B2 emittance – injection matching checks to be made
- Over-injection – TDI thresholds to check (esp. 10 - 655 ms) - to be checked with BI colleagues
- BLM saturation in dump region – monitors to modify –

### **D – Aperture measurements results** – Carmen Alabau ([slides](#))

Very interesting aperture measurements were performed in order to clarify the suspicious points found in March using global measurement. Local bumps have been applied, no significant bottlenecks found. The summary table of all the measurements performed was shown. Aperture is above 9 (H) and 11 (V) nominal sigmas. Detailed n1 calculations are under preparation. Off momentum aperture measurements remains to be done.

## **3- Plans for the next weeks of commissioning?**

**LHC Operation** - Mike Lamont reminded the list of the immediate goals:

- Qualify machine for higher intensity

- Nail down the operational sequence
- Finish commissioning of a lot of systems
- Deliver  $10 \text{ nb}^{-1}$  to the experiments in around 5 weeks

The path to go to 2MJ was reminded, together with the fact that about 2 weeks in between each intensity increase will be needed in order to accumulate experience and qualify the protection systems for the next intensity step.

### **Modus operandi of the next 5-6 weeks - sharing time between commissioning and physics** – Massimiliano Ferro-Luzzi ([slides](#))

2 modes of operation were proposed:

- Complete MPS setting-up and validation while constraining physics fills to nights and week-ends – and integrate operational experience during the week days. Aim for fills with ~4h at flat top overnight (Mon-Fri, ~5 attempts/week) then dump and EOF. And aim for long fills over week-end (2x >10h?) ~2 attempts/week. And repeat as long as MPS setting-up/qualification not finished.
- MPS setting-up / qualification complete: emphasis on operational experience and physics: Continuous physics fills all day long, all week long. And insert MD blocks as required. When reached 10 fills and 40 h flat top, decide on the next intensity increase (based on observations)

Comments: A lot of commissioning work is still needed, in particular for some essential systems which will be needed as the intensity increases. Consolidation of the operation of the machine (ramp, squeeze, beam separation) need as well time. The LHC is still in a big MD mode. And it is too early to separate it between physics and commissioning.

Not sure that the plan proposed is the most efficient in terms of efficiency, both in physics mode and commissioning mode. Not sure that a target of 2-3 weeks can already be set before moving to the 1<sup>st</sup> mode of operation to the second one.

#### **4- A.O.B.**

Lyn Evans: At the next Technical Stop: noise on all warm magnet PC will be suppressed. But in parallel we need to know if the energy dependence of the Hump effect is established or not. If not, then we could look at vibrations of the triplets.

**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: **11 May 2010**, 15:30, 874-1-01. Agenda will be sent in due time.

Malika Meddahi