

## LHC-Beam Commissioning Working Group

### Notes from the meeting held on 11 May 2010

Present: Carmen Alabau, Nicholas Aquilina, Gianluigi Arduini, Ralph Assmann, Chiara Bracco, Roderik Bruce, Oliver Bruening, Rama Calaga, Pierre Charrue, Ed Ciapala, Bernd Dehning, Laurent Deniau, Per Hagen, Wolfgang Höfle, Lars Jensen, John Jowett, Verena Kain, Mike Lamont, Malika Meddahi, Ryoichi Miyamoto, Gabriel Mueller, Giulia Papotti, Laurette Ponce, Bruno Puccio, Frank Schmidt, Rüdiger Schmidt, Elena Shaposhnikova, Ralph Steinhagen, Marek Strzelczyk, Ezio Todesco, Rogelio Tomas, Jan Uythoven, Walter Venturini Delsolaro, Uli Wienands.

Excused: Reyes Alemany, Tobias Baer, Roger Bailey, Wolfgang Bartmann, Helmut Burkhardt, Andy Butterworth, Octavio Dominguez, Lene Drosdal, Lyn Evans, Massimiliano Ferro-Luzzi, Kajetan Fuchsberger, Rossano Giachino, Massimo Giovannozzi, Brennan Goddard, Werner Herr, E. Barbara Holzer, Delphine Jacquet, Thibaut Lefevre, Yngue Levinsen, Alick Macpherson, Mario Pereira, Mirko Pojer, Stefano Redaelli, Stefan Roesler, Adriana Rossi, Katarina Sigerud, Matteo Solfaroli, Glenn Vanbavinckhove, Jörg Wenninger, Simon White, Daniel Wollmann, Marco Zanetti, Frank Zimmermann.

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

Per Hagen: b5 snapback: updated MQWA and MQWB transfer functions. Will be activated tomorrow (Marek Strzelczyk). Rogelio Tomas: This should fix the beta beating, so the knobs will be removed –see Rogelio Tomas presentation below.

Giulia Papotti ([slides](#)): Update on the bunch lengths. Recent issues and solutions were presented.

- Hardware side: Reflections and saturation observed with higher intensities i) intense bunches show up as longer, ii) two reflections merged into a long bunch -bug: distance still set for SPS RF. Access this morning to improve signal.
- VTU front end CPU. Fixed.
- OASIS settings lost due to misunderstanding i) needed recalibration, done last week; ii) will need further (small) recalibration with beam after today's access
- BQM : i) removed feature which was good only for long bunches; ii) calibration for cables and pickup implemented - low intensity bunch length corresponds to SPS extraction

Laurette Ponce: New access procedure written, waiting from comments on the first draft.

#### 2- LHC Beam Commissioning progress

##### A - Main issues of week 18 - Oliver Bruening (email)

- Access requests send to Mike Lamont -are by now taken care off.
- Jörg Wenninger had prepared a summary of outstanding issues for the MPS and LBDS studies to be ready to higher beam intensities – see summary of Mike Lamont below.
- Strategy for bringing the new collimator settings into operation. We can change the gain threshold for the BPMs from currently  $5e10$  to  $2e10$  and we could decide when to do the transition and when we start to use the new collimator settings. Rhodri

Jones had planned some tests on this for this week. Also, we had seen a reading change of the order of 1.5 mm during initial tests that was not reproduced during the calibration measurements by Ralph Steinhagen.

Ralph Steinhagen: If low gain is set when the intensity reaches  $5e10$ , the readings are spoiled by high non-linearity.

- Philippe Baudrenghien had started looking at the cause for the longitudinal bunch blow up at high intensities - missing phase signals observed during last week operation.
- Issue of larger Beam 2 beam size as compared to the Beam1 size during injection for equal beam sizes in the SPS. Mike Lamont mentioned that this might come from injection mismatch between the transfer line and the LHC and a mix up of the injection oscillation readings coming from the still circulating pilot and the over injected beam from the transfer line.

Verena Kain: kicker timing to be checked as well. Can be the source of the emittance growth through injection oscillation coming from the kicker field ripple, if it is larger than specification.

### **B – Optics measurements** – Rogelio Tomas ([slides](#))

The AC dipole worked very well with tune feedback on:  $Q'$  is the only obstacle for the AC dipole: to run the AC dipole adiabatically, the known tolerance is  $Q' < 7$ .

Beta beating vs energy: larger values are reached at 1.1 TeV and then the beta beating goes down. IR7 seems to be the dominant source.

Per Hagen just finished the MQW measurement campaign. At 450 GeV, Per Hagen's data agree with the beta beating corrections. The new magnetic measurements explain the observed optics errors at all energies. Implementing the new MQW calibrations in LSA should fix the optics along the ramp.

### **C – Collimation systems** – Ralph Assmann

The collimation team completed the collimation setting up at 450 GeV. The loss patterns were verified and are all as expected at the different locations. The data were impacted in IR3 by the large beam de-bunching, but even though the cleaning was still satisfactory

Only pending investigation: suspicion at the TDI location for beam 1: a larger beam size than expected was found for beam 1. Could come from the gap definition – factor 2 wrong? Or from a not yet understood optics feature? But this last hypothesis is not consistent with the beta beat measurements which show small beating at that location.

Next collimation commissioning activities: Ramping while closing the collimators. Planned for tomorrow at dry, and a second trial with beam this Thursday.

Then test the collimator moving in the ramp with  $1e11$ /beam and when complete, continue with the 3.5 TeV collimator setting-up.

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

Chiara Bracco presented the checks performed on the injection and beam dump systems in view of the higher intensities. They include injection checks, aperture verification for both circulating and extracted beams, TCDQ BLM calibration, and machine protection checks.

Remaining work:

- AGC to be done
- TCT scan in point 5 for BLM calibration
- MKI.P2 waveform
- Beam size measurement at the TCDQ at 3.5 TeV
- Check TCDQ settings at 3.5 TeV

- Synchronization tests of TCDQ positions and interlocks with other collimators during ramp and squeeze (first check w.o. beam)
- Sequencer task to check LBDS connected to RF operational before going to high intensity
- 'power off' test of the LBDS with beam circulating (not only in stand-by)

### **E – ADT commissioning with beam** – Wolfgang Höfle ([slides](#))

Wolfgang Hofle reminded the transverse feedback system principle, used to damp the transverse injection oscillations, to cure coupled bunch instabilities and to excite transverse oscillations for beam measurements.

In 2008, there was no dedicated beam time to commission the system. The setting up of the systems continued in 2009 and was ready for commissioning during dedicated beam time. Unfortunately this beam time was not allocated, at the exception of a short trial for the abort gap cleaning. During the technical stop 2009/2010, hardware improvements were done (e.g. a suitable filter installed to correct for the attenuation and group delay variation of dispersive cable with frequency).

In 2010, dedicated beam time was allocated, with a beam availability of almost 60%. Calibration of the kick strength was performed, for one vertical kicker of beam 2. The same work must still be done for both planes, both beams, all systems. Picture of the de-coherence of the beam 2 without and with damper was shown. Values from the latest beta beating measurements are to be added at the location of the pick-up in Q7 and Q9.

During the damper adjustment, observations of the tunes were done by Ralph Steinhagen. Observations: less broadening with lower gain reduction of tune peak, i.e. residual oscillations by more than 20 dB, not yet good for hump, enlarge tune range (bypass delays in signal processing FPGA firmware).

The transverse damper feedback system was left ON during the last long fills. Looking at the beam size from the BSRT, the values stay very constant, with no increase along the fill time.

#### To-do-list:

Fixed display for injection oscillations – logging/back-up of expert settings – Complete OASIS – sort tubes in power amplifiers to improve linearity

#### List of required shift:

- Use of 2 pick-ups on V.B2 with short delay, close loop, both modules, study with hump present, Adjustment of FB phase using tune shift – 1 shift
- Closing of loops for B1 – 2 shifts
- Commission beam LSA function to control gain and phase – 1/2 shift
- Calibration of kick strength for all planes and beams - 2 shifts
- Set-up for high intensity - at least 1 shift at each step.
- --- and perform an abort gap cleaning trial.

Jan Uythoven: After the completion of the beam 2 vertical kicker commissioning -which is almost finished- we could already perform an abort gap cleaning trial. And then proceed with the other transverse damper commissioning.

### **3- Plans for the next weeks of commissioning?** Mike Lamont et all ([slides](#))

**LHC Operation** - Mike Lamont reminded the list of the immediate goals and the work requirements between each of them:

- Step up in intensity to  $8e10$  per beam – in 4 bunches of  $2e10$  each
  - o BPM intensity calibration
  - o Collimation & OFB in ramp
  - o LBDS checks
- Review and consolidate the operational sequence

- Injection, ramp, squeeze
- Feedback ....  
A review will be organized next week.
- Step up in intensity to 2e11 per beam - 2 bunches x 1e11 per beam
  - Address the intermediate intensity issues
  - Commissioning 1e11 through operational cycle
    - Single bunch per beam up the ramp (collimators, OFB, RF)
    - Flat top (collimation, separation on, check beating)
    - Squeeze to **5 m** (separation, beating)
    - Collisions

To note:

- Leave bump separation fully on during the ramp.
- Remaining QPS board changes will be done during the next technical stop. After this, and all the necessary checks, the ramp rate will be increased from 2A/s to 10A/s.

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

On Tuesday 18 May, as of 14:00, the LHC Beam Commissioning meeting will be replaced by a review of the LHC operational sequence (injection, ramp, squeeze, feedbacks, references, sequencer, trims, settings, alarms, orbit correction, reference orbit, variations with intensity ... Agenda and invitation will be sent in due time.

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

Malika Meddahi