LHC-Beam Commissioning Working Group

Notes from the meeting held on
15 June 2010

Present: Wolfgang Bartmann, Philippe Baudrenghien, Chandra Bhat, Andy Butterworth, Oliver Brüning, Pierre Charrue, Ed Ciapala, Kajetan Fuchsberger, Massimo Giovannozzi, Wolfgang Höfle, Michael Jaussi, Lars Jensen, Rhodri Jones, Mike Lamont, Aurelien Marsili, Malika Meddahi, John Molendijk, Gabriel Mueller, Bruno Puccio, Rüdiger Schmidt, Elena Shaposhnikova, Andrzej Siemko, Katarina Sigerud, Matteo Solfaroli, Ralph Steinhagen, Ezio Todesco, Jan Uythoven, Uli Wienands, Frank Zimmermann.

Excused: Carmen Alabau, Gianluigi Arduini, Ralph Assmann, Reyes Alemany, Tobias Baer, Roger Bailey, Helmut Burkhardt, Chiara Bracco, Rama Calaga, Guy Crockford, Bernd Dehning, Laurent Deniau, Octavio Dominguez, Lene Drosdal, Lyn Evans, Stephane Fartoukh, Massimilano Ferro-Luzzi, Rossano Giachino, Brennan Goddard, Per Hagen, Eva Barbara Holzer, Werner Herr, Delphine Jacquet, John Jowett, Verena Kain, Thibaut Lefevre, Yngue Levinsen, Alick Macpherson, Ryoichi Miyamoto Giulia Papotti, Mario Pereira, Mirko Pojer, Laurette Ponce, Stefano Redaelli, Stefan Roesler, Adriana Rossi, Mariusz Sapinski, Frank Schmidt, Marek Strzelczyk, Rogelio Tomas, Glenn Vanbavinckhove, Walter Venturini Delsolaro, Jörg Wenninger, Simon White, Daniel Wollmann, Marco Zanetti.

1- Comments and follow-ups from last meetings

- Pierre Charrue and Katarina Sigerud:
  LSA release version problem: Greg Kruk understood the issue, fixed it and is scanning other JAVA applications to make sure this problem will not happen. Reminder: the problem with Lumi Scan application was caused by a bug in a number rounding routine in one of LSA libraries. This rounding function was written long time ago (~2 years). It affected only actual settings (LHC) and was discovered after Mike Lamont configured precision in database for one of the LHC parameter types.
  LHC machine mode issue: The sequencer was not able to change the LHC mode. It was traced to a problem into the 'cfv-ccr-csglhc' VME crate. The expert looked carefully at this crate and finally rebooted it. This solved the problem and the machine mode change was possible again. Unfortunately, the Beam Interlock team did not find any obvious explanation and will keep monitoring this device. In short no log files indicated there was a problem and the front-end wasn't blocked.
- BSRA: see Rhodri Jones' presentation.
- All sectors have been tested for the 10 A/s ramp rate and are fully available for operation. Malika Meddahi reminded that due to the beam commissioning priorities, which have been agreed on at the last LMC, the commissioning of the 10 A/s ramp rate has been postponed in order to concentrate on the steps needed for the high bunch intensity operation and to provide luminosity operation. The request for commissioning the 10A/s has certainly not been forgotten, is an important and beneficial milestone in the long term, and will be addressed as of next week, in SF slots.

2- Highlights / Issues from the last week of operation – Malika Meddahi

- Squeeze was commissioned to 3.5 m, with separated beams (Joerg Wenninger and Laurette Ponce). Stepped through the squeeze with separation ON and orbit FB, stopped at 9, 7, 5 and 3.5 m. Constant orbit reference (same as inj.). As reference for the OFB, used the measured orbit at injection (for entire ramp and squeeze!). The corrections were incorporated into the settings, including part of the RT COD corrections. The RT kicks remained small (1-2 μrad rms). Q and Q' were stable and trims were only done at 3.5 m (for both). No losses along the squeeze.
- Controlled longitudinal beam blow up worked extremely well and all efforts are now done so it can be used operationally. See Andy Butterworth's presentation.
- Transverse damper system commissioning is almost complete (see Wolfgang Höfle's presentation) and showed very good results in controlling the transverse emittance of both beams in both planes. Also there, the system will be used in daily operation and required improvements to make it operational are being performed.
- The collimator setting up activities are in progress at 3.5 TeV, unsqueezed.

3- BI status for high intensity – Rhodri Jones (slides)

Rhodri Jones reported on the 2 MD periods which took place on May 28th and June 8th in preparation for the high intensity operation.

- **BPM** works on a bunch to bunch basis and only depends on bunch intensity. They are used in 2 sensitivity modes, with a swap mode at about 5e10. The 1st MD showed that B2 behaved as expected (sensitivity ranges seen to overlap as expected around 5e10) while B1 has a grey zone between 3e10 and 5e10, where neither sensitivity gave the required results. The reason for this is being investigated with one hypothesis being that the BPM intensity card is influencing the B1 power supplies. The maximum variation with intensity is less 200 μm for any BPM for both beams from 6e10 to 1e11.
  Outstanding Issues: i) Temperature variations (~50 μm/°C) –New software being tested to correct for this on-line; -ii) Influence of other beam on directional BPMs in the IRs - New firmware & software using synchronous mode & bunch selection being tested to overcome this, which may also help overcome B1 issues in high sensitivity
- **BCT systems:**
  Fast BCTs:
  Saturation of the operational system with bunches of 1e11 confirmed (attenuated signals from development system gave correct results). Attenuators to be added to operational systems during next technical stop- Have to ensure that this only affects the high bandwidth channel and not the low bandwidth channel providing the beam presence flag;
  Need to understand the remaining calibration issues - Why raw calibration still needs tweaking to align fast BCT with DCCT -The cause and effect of the signal tail in the trailing 25 ns slot;
  Fast BCT dependence on bunch length – Once attenuators are installed, should look carefully at response during ramp when no longitudinal blow-up is applied to verify that observed intensity variations with bunch length were due to saturation.
  DCCT:
  Switch to gain range 3 just above 1e11 protons to avoid fill pattern dependence - currently investigating possibility to eliminate range 4 for SMP data. Investigations continuing for source of this problem
- **Correcting the intensity stored in the logging data base**: Requested by experiments and currently working with CO to store corrected data in logging.
- **Wire scanner studies**: Signal dependence on acquisition delay: Need to space bunches by 900 25ns slots to measure individual sizes using current system. Slot selection now available from OP application.

- **Rest gas ionization monitor** (BGI) commissioning: emergency HV shutdown procedure will be modified to ensure that it does not lead to pressure rise. First images were successfully measured by the BGI.
- **Tune PLL system**: commissioning of the system will continue.
- **Status of the Abort Gap monitors**: 2 PMTs with 2 new amplifiers have been installed. New HV power supplies with output limitation are at CERN. SW to control them is currently being developed and tested. It will be only be possible/safe to put the AGM system into an automated mode after replacing the power supplies (next tech stop).

4- Controlled longitudinal beam blow up in the LHC: Updates – Andy Butterworth (slides)

Andy Butterworth reminded that the same SPS method and noise generation were used - band-limited noise inside synchrotron frequency band injected through phase loop.
Optimisation of the frequency band took place over two beam periods. The first beam period allowed deducing that the frequency spectrum did not cover correctly the centre of the bunch and the upper frequency was therefore adjusted to 1.1*synchrotron frequency. For the next ramp, the beam was blown up to 1.5 ns before the ramp, but the constant noise amplitude of 0.5 deg rms was not quite sufficient. On the next attempt, the feedback on BQM bunch length measurement was used, with modulation of the noise amplitude to control the blow up rate. This was very successful as the bunch lengths converged correctly to the 1.5 ns target. The blow up noise functions are now triggered by the start ramp timing event.
Next steps: to be tested with multiple bunches at 450 GeV.
What's needed to make it operational?

- Functions/settings to be managed by LSA
- Sequencer tasks – enable/disable, arm timing
- Bunch length feedback is currently done in a separate java application.

5- Transverse feedback damper commissioning status - Wolfgang Höfle (slides)

The status presented by Wolfgang Höfle focus on the nominal single bunch intensity:

- ✓ 8/8 damper beam position module settings for low intensity (up to $2x10^{10}$)
- ➢ **7**/8 damper beam position module settings for high intensity ($1x10^{11}$)
- ✓ Multi-bunch mode with peak hold (new firmware) deployed, to be tested with beam, good down to bunch spacing of 500 ns
- ✓ 8/8 1-T delay settings for phase-shifter and vector sum done
- ✓ 8/8 phase-shifter settings
- ✓ phase advances measured, vector sum mode prepared
- ➢ **2**/8 Fine tuning of phase-shifter by looking at tune shift

Few ramps were dedicated to the commissioning of the transverse damper systems and results from the oscillation damping trials at injection were shown with damper off/on. Comparison of tune spectra was shown for the pilot beam and for high beam intensity with the damper on and off for the same intensity. To be analysed in more details before drawing any conclusions.
The values of the beam emittances with nominal bunch intensity and 1 bunch per beam were summarized from the injection process to the end of the ramp. The strategy was to start with low chromaticity at injection and to increase the chromaticity right before starting the ramp. The damper gain was adapted during the ramp. Orbit and tune feedback were on during the ramp. There was a small emittance increase at 450 GeV of about 0.1 – 0.2 μm per 10 minutes. More emittance increase was measured during the ramp per unit of time: 0.4 - 0.6 μm per 10 minutes. Octupoles were off.
Minimum steps for the system to become fully operational:

- Solve re-synch problem with digital links;

- Commission use of the FGC to control and ramp gain –is prepared;
- Commission on/off mode.

Other steps:

- integration of on/off into ADT CCC application for better ergonomics;
- automatic selection of settings for different intensities, being developed, currently configured for nominal intensity.

Improvements:

- set-up missing PU for high intensity (H.Q9.B1);
- commission of vector sum;
- improved settings for high intensity for better S/N;
- tuning of settings, phase, gain (by looking at tune shifts);
- settings for intermediate intensities (if required);
- commission bunch train mode (150 ns trains) - strategy for operation between 150 ns and 500 ns to be defined;
- software for observation, display of bunch by bunch information.

6- A.O.B

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

Malika Meddahi