

LHC-Beam Commissioning Working Group

Notes from the meeting held on 24 November 2009

Present: Carmen Alabau, Reyes Alemany, Gianluigi Arduini, Ralph Assmann, Roger Bailey, Tobias Bär, Wolfgang Bartmann, Luca Bottura, Chiara Bracco, Helmut Burkhardt, Andy Butterworth, Rama Calaga, Ed Ciapala, Laurent Deniau, Octavio Dominguez, Lene Drosdal, Stéphane Fartoukh, Massimiliano Ferro-Luzzi, Kajetan Fuchsberger, Christoph Kurfuerst, Rossano Giachino, Eliana Gianfelice, Massimo Giovannozzi, Brennan Goddard, Per Hagen, Barbara Holzer, Hitomi Ikeda, Delphine Jacquet, Lars Jensen, Rhodri Jones, John Jowett, Verena Kain, Ioan Kozsar, Mike Lamont (chair), Yngve Levinsen, Aurélien Marsili, Malika Meddahi, Giulia Papotti, Mario Pereira, Bruno Puccio, Stefan Roesler, Mariusz Sapinski, Frank Schmidt, Rüdiger Schmidt, Katarina Sigerud, Ralph Steinhagen, Ezio Todesco, Rogelio Tomas, Jan Uythoven, Glenn Vanbavinckhove, Walter Venturini Delsolaro, Jörg Wenninger, Simon White, Daniel Wollmann, Frank Zimmermann.

Excused: Oliver Brüning, Eugenia Hatziangeli.

1. Comments

None.

2. News from LMC – Mike Lamont

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

- Report on the powering test: Well done ... still some work in S12 to be done;
- Time estimate to go to 6 kA: 4 weeks \pm 2 weeks;
- Quench protection system upgrade discussed;
- Beam interlock system: review done. Very good feedback, encouraging conclusions;
- LHC schedule: continues as planned!

3. LHC beam commissioning –Round table

Planning of the beam start-up: [link](#)

Comments on the commissioning work done since Friday 20 November:

Jorg Wenninger: Establishing the closed orbit was done by averaging the first few turns, and once more this method proved to be very efficient. Dispersion measurements for both beams agree very nicely with the model prediction.

Ralph Steinhagen: B1: Tunes were very close to nominal. Chromaticity was very far off, had to be moved by \sim -16 units in order to establish good lifetime. Coupling corrected down to 10^{-3} , but as soon as re-cycle performed, then coupling back to 0.01. Measurements started with beam 2, more to be done. All measurement tools are in place.

Mike Lamont: As soon as the beam is back again, we should first check the beam parameters (tune, chromaticity, coupling) and then continue with the programme.

Ed Ciapala: RF: B1 finished. B2 in progress. Work on the radial loop will continue, also have to revisit the capture frequency and the capture in the SPS.

Kajetan Fuchsberger: Kick response measurements were done with circulating beam, 90% of the beam 1 correctors have been checked, and about 10 BPMs showed possible wrong polarity. Measurements are missing for ½ of a sector. Kick response measurements must be done for B2.

Rhodri Jones: most of these B1 BPMs had cross-cables in the tunnel; for the BPMS, they are O.K. in one side of the IP, for the other side, possible sign and polarity errors are being checked.

Rhodri Jones: BCTFR: the phases are now set correctly. This is to be done as well for the BPMs. Data are available for B1, need to be done for B2, and for that, stable circulating beam needed.

To be done: Try PLL and use it to measure chromaticity on line. Wire scanners are functioning (timing issue sorted out).

A list of required BI actions has been established and is being worked on.

Jörg Wenninger: Post mortem of the BPMs: no turn-by-turn data available yet. This is needed for the FMCM studies.

Gianluigi Arduini: Undulators: The one at the right of P1 has a cryogenic problem, which requires an intervention in the tunnel. The one at the left of P4 must be commissioned. Gianluigi and Rüdiger are in discussion with the QPS team and will know the commissioning schedule of this undulator by the end of this week.

Mike Lamont for Stefano Redaelli: Aperture measurements were performed in vertical plane, pointed to some aperture limitations, which are checked vs expectation. Measurements to be done in the horizontal one.

Mike Lamont: 2 beams in the LHC. Thanks to Simon White for steering the beams in the IPs.

Mike Lamont: Trial ramp: Verena Kain sets the beam dump at 600 GeV. Beam was lost vertically on the third order resonance, fully beam loss at about 550 GeV. Also, already at the start of the ramp, 1/3 of the beam was lost, due to minor tune changes. The possibility to try a tune feed forward was debated.

Beam transfer systems - Brennan Goddard ([slides](#))

- MKI kickers twice had “missings”: Now looking back to logging to find the cause.
- Injection aperture – P8: Problem hinted at in 1st sector test and confirmed in 2nd sector test. Vacuum colleagues realigned after each sector test, on different elements. Monday measurements showed that the problem is solved, aperture limitation is where expected (MSI). Still to understand the origin of the misalignment.
- Beam dump systems: no systematic checks done yet (time to be allocated). B1 and B2 extracted O.K.
- LBDS energy tracking: two ramps were done, with trims of Q4, RBs at 1.2 TeV and RBs at 450 GeV. Tripped at the right levels, worked perfectly. Will be documented in EDMS.
- LBDS asynchronous beam dump events observed a few time, came when RF is performing re-synchronisation. Time needed with the RF colleagues to investigate and try to reproduce these asynchronous beam dump events.
- TCDQ /TCSG setting up: Same procedure was used with circulating beam. Very different response, almost no signal on the TCDQ, no spikes on TCSG. Need more time to re-measure and investigate.
- Asynchronous dump test done: TCDQ and TCSG6 at nominal positions at 8σ . Collimators at 7σ , beam was debunched by switching the RF off. Dump-sweep over

the aperture with beam in abort gap. Losses only on TCDS and TCDQ as expected. To repeat, leaving more time to the beam to debunch.

- Losses at injection: significant fraction of the beam was lost with collimator in, could start setting up the TCDs in the TIs or perform beam scrapping in the SPS. But first, the energy matching between the SPS and LHC will be performed and a reference orbit in the LHC established.

List of issues have been collected and will be worked on. Requests for beam time were made. To Note: it would be interesting to switch on the bumps (external crossing and separation bumps) as soon as possible, in order to perform the machine optimisation.

Beta beat measurements - Rogelio Tomas ([slides](#))

Measurements were done for beam 2. Beta beats in 2008 were very large. This year, data taken during the last days show much smaller beta beating values. The difference between the 2008 and 2009 beta-beating measurements is explained by the correction of an aperture swap found in 2008. Larger horizontal beta beat is located in S23 and is below 20%. In the vertical plane, the larger values are at few locations at around 40%. Possible sources for this beta beating are being investigated. If iterative corrections are applied, than a global beta beat correction can be made (with trim correctors used at the level of e^{-5}). Ezio Todesco: in the data analysis, to remember that magnet transfer functions are known to a few per mil, but cannot be wrong by few percent.

What changed the tunes during ramp #1 - Luca Bottura ([slides](#))

Luca Bottura showed the sextupole currents as a function of time, together with the horizontal and vertical tunes which were measured. The vertical tune correlates very well with the sextupole current, but not the horizontal tune. A total of 0.02 tune change was measured. Effects of spool pieces at injection will be checked and more thoughts given on this observation.

First partial LHC collimator setup - Ralph Assmann ([slides](#))

First collimator setup with the LHC beam: The standard method works for b1 and b2 in IR3 and IR7. The vertical beam sizes were more or less as expected. The horizontal beam size differences are to be understood. Puzzling beam response to collimator movement in IR6, both for TCDQ and the associated TCSG.

Collimator scan in IP7: beam scans done, full beam scraped with a collimator jaw. It allowed determining beam offsets and beam size. Results of the beam intensity as a function of the jaw position were shown.

Collimator scan in IP3: beam center and beam size given.

Situation after this first partial collimator setup:

- Beam1: Primary collimation at "nominal" 5.7 sigma (nominal emittance) in IR7 (betatron halo) and 8.0 sigma in IR3 (momentum halo).
- Beam1: Tungsten collimators set up fully in IR7 to 10 sigma and one in IR3 to 10 sigma.
- Beam1: Dump protection in IR6 not successfully set up but set to nominal settings.
- Beam2: IR3 fully set up to nominal injection settings.
- Sigma refers to nominal emittance and adjusted beta.
- Accuracy: about +/- 0.2mm (limited by available beam time).
- Multi-stage cleaning afterwards: Good for injection and first ramp.

First multi-stage betatron and momentum cleaning after first partial collimation set-up: no un-expected losses in the arcs, experimental insertions. Maybe first sign of off momentum losses in the dispersion suppressor? Data to be analysed further.

Summary:

- Excellent start and very promising performance after initial setup of 20% of collimators...
- Need to analyze data in detail: efficiency, loss rates, losses in dispersion suppressor (predicted limitation), ...
- Still a way to go (do all collimators, puzzles in IR6, horizontal beta, ...).
- Propose to schedule several collimation setup periods to allow us approaching the nominal system and checking various issues (lifetime vs collimator setting, injection losses, impedance, cleaning efficiency, ...). Best: around 6h per period, both beams.
- Of course need systematic approach...
- Then we can be ready in Feb/March 2010 for higher intensity (remember 2010 goal: 40 MJ).

5- Planning for the next few days – Roger Bailey.

Link to the programme [link](#)

Updates for tomorrow:

TU	N	8	Kick-response, finish B1, then B2	B1/B2, pilot	finish B1, then B2
WE	M	8	Initial commissioning of beam dumping system, beam 1 and 2	B1/B2	Aperture, extraction trajectory, LBDS BI
WE	M	8	OP/BI - energy matching/ capture/BPM PM	B1/B2, pilot	OP & BI, injection oscillations
WE	N	8	Aperture		
TH	M	8	LINEAR OPTICS - assuming capture mode - establish referenc	B1/B2, pilot	First look at MKQA
TH	A	8	Trial ramp ?	B1, pilot	Stop at 700 GeV

Inputs for future LHC commissioning plans:

Jörg Wenninger: FMCM and BIC tests both require the availability of post mortem events with beam. MPS and BLM checks are ready to start.

Ralph Assmann: should decide on a target date for “enough well established” beams before moving on with the protection system setting-up.

Roger Bailey: Pre-cycling of the machine is to be established.

Stephane Fartoukh: Do we want to correct the linear machine now? Is beta beating considered O.K. at a level of 50%?

4. A.O.B

Daily 8:30 & 17:00 meetings in the CCC conference room.

Next meeting

Tuesday 1st December 2009, 15:30, 874-1-011. Agenda will be sent in due time.

Malika Meddahi.