LHC-Beam Commissioning Working Group

Notes from the meeting held on

30 November 2010

1- Comments and following from last meetings

No comments.

2- Report from the ion operation – Ralph Assmann, Jan Uythoven.

Slides from the Monday 8:30 meeting, presented by Ralph Assmann.

Slides from Jan Uythoven.

To note:

- Quite intensive tuning in the injectors to keep ion intensity at the very high levels we now got used to (above design) – Source, Linac intensity, LEIR transmission, PS cavity and SPS transmission;
- Ion run going well, producing nice luminosities - Integrated luminosity > 6.4 μb^{-1}, week 47 peak luminosity: 2.9e25 cm-2 s-1;
- Performance is determined by the beam Intensity and beam quality (size) from injector chain and by the vertical B2 blow-up when switching off transverse feedback at injection;
- Ghost bunches developing at injection and may also be already at capture;
- The BCTFR readings are now corrected after switching to the HBW signal and the behavior is understood;
- Only remaining issue was how to perform the BCTFR calibration for the Van der Meer scans;
- All BI information – by Jean-Jacques Gras - can be found in the logbook http://elogbook.cern.ch/eLogbook/search.jsp?lgbks=60&keys=logbookid%3A60+AND+JJG . BI is now pushing to have both beams equipped for 2011 SU with proper FESA SW and useful logging;
- Philippe Baudrenghien (email): important to decouple the issue of “problems that satellite bunches may cause to physics” and “calibration of Fast BCT for VDM scans”. Concerning satellite bunches it would be nice to have, in a near future a spec on the maximum acceptable single satellite intensity (that is max in a single bucket) and the maximum acceptable total satellite intensity (that is integrated over the ring). Not much different from the request for specs on the capture loss: What percentage of the newly injected batch can we lose at injection and what total unbunched beam can we have in the machine at anytime;
- Van der Meer scan on Tuesday 30 November: Philippe Baudrenghien changed the RF settings to lock the voltage during injection, kept it low, as requested for the VdM scans. After start of ramp the BCTFR and DCBCT converge!
- Probably first beam induced quench observed on RQ9.R2 on November 25, 08:06:39 (tbc);
- Vertical blow-up of beam 2 to be followed-up: hump effects? It is clear that the ADT is damping injection oscillations correctly and thus contributes to achieving as low as possible emittances. It is suggested to dedicate a slot of 4 hours to ADT before the end of the run, to see if the gain is optimal at 450 GeV in order to minimize emittance increase by perturbations and quantify the effect of the damper. The expert for emittance measurements is needed for these studies;
- This week:
    - Continue producing more luminosity with 121 x 121 bunches

- Test injection with 8 bunches and see if it produces more luminosity
- Measure aperture of the triplets.

3- Preliminary findings from instability measurements during the 75 ns and 50 ns bunch spacing operation – Elias Metral (slides)

Elias Metral first reminded that with a single bunch, instability (from the machine impedance) is predicted and observed with octupoles off above 1-2 TeV/c (depending on the beam parameters). This is illustrated by the famous "Christmas tree", reproduced with HEADTAIL (Benoit Salvant): head-tail instability m = -1 + subsequent loss (revealing all the other modes). No problem during the last months when the octupoles were ON (K3 = -6 at top).
With many bunches, transverse coupled-bunch instability is expected, with a rise-time prediction of ~ 50 ms for the 25 ns operation (0 chromaticity, equidistant bunches etc.) and should be damped by the feedback. Chromaticity can help the damping process.
With bunch trains and chromaticities, it is being looked at (N. Mounet, extension of HEADTAIL code).
Ecloud recently observed: It represents a "generalized impedance" and the beam can also become "coherently" unstable.
For example, observations made in the SPS with LHC beams were reminded, with horizontal coupled bunch instability and vertical single bunch instability. The predictions for the e-cloud induced coherent instabilities, calculated by E. Benedetto, were reminded together with the LHC threshold values (4e9 p/b).
Measurements taken at 450 GeV with 50 ns bunch spacing in November 2010 were shown and show a vertical instability developing. The transverse instability seems to move from the tail to the head of the batch. The horizontal instability initially seen should be coupled-bunch type. The vertical instability could be the "TMCI-like" instability. Rise-time was ~ 0.4 s with Q' ~ 10. Could be stabilized with Q' ~ 18 (beneficial effect seen on the transverse emittances), as predicted in Elena Benedetto's PHD thesis.
It is difficult to disentangle from coupled-bunch instability induced by the machine impedance (more precise estimates needed from the simulations point of view. ongoing).
With 50 ns bunch spacing and 3.5 TeV operation: With transverse feedback off, the beam is still stable and when reducing the octupoles, the beam is, at some point, becoming unstable in H. This is certainly coming for the machine impedance (as already observed in the past. Analysis is still ongoing for the threshold stabilization from the octupoles).
With 75 ns bunch spacing at 450 GeV: Significant motion was observed on B1 only (in both H and V) after ~ 3-4 batches have been injected, while nothing was observed on B2. There were no growing coherent oscillations (but losses observed). Transverse feedback was on, no octupoles. Motion seems to be coupled between bunches, low-order mode. Intra-bunch motion was also observed (|m| = 1?). An increase of chromaticity from ~ 10 to ~ 20 units seems to have instantly killed this motion and the losses disappeared. The transverse CBI from machine impedance could explain all the features qualitatively (~ same in H and V) for B1. Analysis is ongoing (picture shown for nominal 25 ns bunch). B2 could be in fact stabilized by the TF if the chromaticities were small (however, they were the same as B1…).
Conclusions

- Difficult to conclude at this stage on the origin of all the observed instabilities;
- More simulations needed to make more precise estimates in the conditions of the experiment;

- Then, redo some controlled MDs;
- In the case of transverse coupled-bunch instabilities from (impedance and/or ecloud), they should be damped by the TF, and it is better to have the smallest chromaticity;
- One should not have TMCI from the machine impedance, therefore there is no reason to increase the chromaticity for that;
- The only reason to increase the chromaticity could come from the ecloud-induced vertical single-bunch "TMCI-like" instability, which was most probably observed during the 1st MD with 50 ns beam on 02/11/10 …

To note:

- ADT frequency dependant gain (bunch-by-bunch) will be optimised next year;
- 75 ns bunch spacing: easier than 50 ns but conditioning is also required for 75 ns bunch spacing to get to a large number of bunches and to ramp them. From the point of view of e-cloud effects it must be noted that according to simulations, in the presence of electron cloud, before seeing coherent effects like instabilities, incoherent effects leading to emittance blow-up are observed and are an issue.
- 50 ns: Trickier, beam conditioning to be done – chromaticity to be kept as small as possible, except in the case of the vertical instability observed.
- Calculation could be done taking as well e-cloud.

4- Beta-beating measurements and thick elements model for the LHC – Carmen Alabau (slides)

Carmen Alabau explained that the aim of her study was to establish the optics model which represents as best as possible the machine. The evaluation of the model was done by comparing the effect on the beta-beating of the remaining errors in the model with the measured beta-beating after performing correction of local errors in the IR's (R. Tomás, G. Vanbavinckhove, R. Miyamoto). The errors added were from magnetic field errors and from alignment errors. The codes used were MADX and PTC.

Conclusions:

- Beta-beating has been modeled including measured alignment errors and magnetic errors (injection / 3.5 TeV 3.5 m ß*).
- A complete model has been developed using PTC in order to include magnetic errors up to high orders in the thick elements.
- The order of magnitude of the remaining beta-beating after all corrections is in rather good agreement with the measured one.
- The main effect arises from the b_2 components (the effect from higher order magnetic errors is about 1-2%).
- A smaller effect arises when including measured alignment errors (max ~4%). The effect of the closed orbit is almost negligible, about 1-2%.
- A complete analysis is on-going to determine which model would represent well enough the machine status, including study of different seeds and study of solely systematic errors.
- The thick elements model is going to be implemented in the online model (G. Müller and K. Fuchsberger)

5- 2011 LHC HWC: updates- Mirko Pojer – Matteo Solfaroli (slides)

Mirko Pojer gave an update on the scheduling of the HWC activities: Powering tests will start the week before Chamonix (2 shifts per day). No shifts during the Chamonix meeting. The shifts will resume after Chamonix, 3 shifts/day, 7 d/week.
The general layout of the tests was given. It was decided to perform the electrical integrity validation only on high current circuits, despite the thermal excursions. The MSs and ITs will certainly go (far) above 80 K → full ElQA. MIC will be done on MSs and Its. Concerning the powering tests: Main focus on protection interlocks (QPS/EE, PIC, PC) --> almost all tests to verify the correct operation of interlock loops will be performed. Reduced number of other tests, according to expert requirements. Heat run for all circuits will be performed (8 hours) as last step.
The list of circuit specificities and non-conformities were given. In terms of resources, EPC, PIC, QPS, MP3 and OP will cover the needs.
Reminder of what LMC has recently endorsed:

- Installation of the snubber-capacitors on DQS for the dipole circuits
- Upgrade of all IPQ's and IPD's for 10V input and 500 Hz PM acquisition frequency
- Decommissioning of the existing main bus-bar protection systems and respective reconfiguration of the main circuit protection.
- Various software upgrades for the DQGPU's
- RRR measurements

Safety related aspects: Engineering specification written on electrical safety for interventions on or close to superconducting circuits during the winter shutdown.
New work acceptance tool will be put in place – when badging the access system will make a list of checks (ADAMS, listed for an activity...).

Concluding remarks:

- Tough planning;
- HC team is working on all test-related aspects -Powering test streamlining, Powering procedures (MP3), NCs, Implications of energy increase, Almost regular meetings with experts;
- Safety aspects are being considered;
- WAT will keep people away from the access consoles;
- Tracking of performed activity in the tunnel is the key for a fast restart;
- Machine check-out can start after the DSO tests.

A list of tests to be done without beam is being prepared and will be driven by OP.

6- AOB

Mike Lamont said that this meeting was the last 2010 LHC Beam commissioning meeting and thanked all contributors and members of the beam commissioning working group.

Malika Meddahi

LAST NAME	FIRST NAME	DEP/GROUP	Present
ALABAU PONS	Maria Carmen	BE-ABP-LCU	X
ALEMANY FERNANDEZ	Reyes	BE-OP-LHC	
AQUILINA	Nicholas	TE-MSC-MDA	
ARDUINI	Gianluigi	BE-ABP-LIS	X
ASSMANN	Ralph Wolfgang	BE-ABP-LCU	
BAER	Tobias	BE-OP-SPS	
BAILEY	Roger	BE-OP-LHC	
BARTMANN	Wolfgang	TE-ABT-BTP	X
BAU	Jean-Claude	BE-CO-HT	
BAUDRENGHIEN	Philippe	BE-RF-FB	
BELLESIA	Boris		
BELLODI	Giulia	BE-ABP-HSL	
BHAT	Chandrashekhara	BE-ABP	
BOCCARDI	Andrea	BE-BI-PM	
BOTTURA	Luca	TE-MSC-SCD	
BRACCO	Chiara	TE-ABT-BTP	X
BRUCE	Roderik	BE-ABP-LCU	
BRUNING	Oliver	BE-ABP	
BRUNNER	Olivier	BE-RF-KS	
BUFFAT	Xavier	BE-OP-LHC	
BURKHARDT	Helmut	BE-ABP-LCU	
BUTTERWORTH	Andy	BE-RF-CS	
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CALVIANI	Marco	EN-STI-EET	
CARLI	Christian	BE-ABP-LIS	
CARLIER	Etienne	TE-ABT-EC	
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DROSDAL	Lene	BE-OP-LHC	X
DUBOURG	Sylvia	BE-ASR-AS	
FARTOUKH	Stephane	BE-ABP-LCU	
FERRO-LUZZI	Massimiliano	PH-LBD	
FORAZ	Katy	EN-MEF-LPC	
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GAROBY	Roland	BE	
GIACHINO	Rossano	BE-OP-LHC	X
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IKEDA	Hitomi		
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JEANNERET	Bernard	BE-ABP-CC3	
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JONES	Rhodri	BE-BI	
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LEVINSEN	Yngve Inntjore	BE-ABP-LCU	X
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MACPHERSON	Alick	BE-OP-LHC	
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PIELONI	Tatiana	BE-ABP-ICE	
POJER	Mirko	BE-OP-LHC	X
PONCE	Laurette	BE-OP-LHC	X
PUCCIO	Bruno	TE-MPE-MI	X
REDAELLI	Stefano	BE-OP-LHC	
ROESLER	Stefan	DGS-RP-AS	
RONCAROLO	Federico	BE-BI-PM	
ROSSI	Adriana	BE-ABP-LCU	
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SCHMIDT	Rudiger	TE-MPE-PE	

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SOLFAROLI CAMILLOCCI	Matteo	BE-OP-LHC	X
STEINHAGEN	Ralph	BE-BI-QP	X
STRZELCZYK	Marek	BE-ABP-LCU	X
TERRA PINHEIRO FERNANDES	Mario	BE-OP-LHC	
THIESEN	Hugues	TE-EPC-MPC	
TODD	Benjamin	TE-MPE-MI	
TODESCO	Ezio	TE-MSC-MDA	
TOMAS GARCIA	Rogelio	BE-ABP-CC3	X
UYTHOVEN	Jan	TE-ABT-BTP	
VALENTINO	Gianluca	BE-ABP-LCU	
VALUCH	Daniel	BE-RF-FB	
VANBAVINCKHOVE	Glenn	BE-ABP-LCU	
VENTURINI DELSOLARO	Walter	BE-OP-LHC	X
VINCKE	Heinz	DGS-RP-AS	
VINCKE	Helmut	DGS-RP-AS	
WENNINGER	Jorg	BE-OP-SPS	
WHITE	Simon	BE-ABP	
WIENANDS	Uli	BE-OP	
WOLLMANN	Daniel	BE-ABP-LCU	
ZANETTI	Marco	PH-UCM	
ZIMMERMANN	Frank	BE-ABP-LCU	X
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