LHC-Beam Commissioning Working Group

Notes from the meeting held on
26 May 2009

Present: Reyes Alemany, Gianluigi Arduini, Ralph Assmann, Helmut Burkhardt, Oliver Brüning, Stephane Fartoukh, Massimiliano Ferro-Luzzi, Eugenia Hatziangeli, Delphine Jacquet, Brennan Goddard, John Jowett, Verena Kain, Mike Lamont (chair), Malika Meddahi, Mirko Pojer, Laurette Ponce, Bruno Puccio, Stefano Redaelli, Frank Schmidt, Ralph Steinhagen, Stefan Roesler, Ezio Todesco, Jan Uythoven, Walter Venturini Delsolaro, Simon White, Frank Zimmermann.

Excused: Massimo Giovannozzi, Marek Strzelczyk, Jörg Wenninger.

1. Follow-up from the last minutes

- RBAC issues and possible strategies for testing new releases: Eugenia Hatziangeli said that a test bed environment is being put in place for FESA, RDA and timing libraries with the aim to be ready by end of June, beginning of July. Test bed for other core applications is being worked on in order to allow transparent checks of new releases, while not disturbing the accelerator control system. Until the test bed environment is ready, delayed release procedure will be used. The overall goal being to ensure a well controlled release process and fully debugged new releases.
- Post-generation sanity checks before beam tests: Stefano Redaelli presented the latest progress on the LSA optics checks performed with the MADX online (slides). The aim is to verify the consistency of the settings imported into LSA for the various LHC optics. Using the MADX online, two levels of checks can be done: one uses the SettingExtractor application, where LSA-K settings are extracted in a MADX compatible format and MADX is launched to check the consistency with the strengths. The other check is done at the level of the LSA-current settings (from FiDel) and launching the SettingExtractorFiDel allows to check the consistency with the magnet fields (and in turns, the MADX strengths and Twiss outputs). The differences in Ks and twiss functions can be plotted using MADX online. Detailed comparison can be made using a dedicated application written by Frederico Roncarolo.
  In conclusion: tools are now in place to check the K values imported from LSA, and improvements are being worked on (comparison with data base optics -twiss outputs-, calculation of Ks from Is -FiDel model- to get MADX input from different sources).
  Stefano confirmed that this tool is available for both beams and the checks will be done explicitly for beam 1 and beam 2. The tool can be extended to the correctors - knowledge of the field errors is then needed, which comes from Fidel, and could be imported in the MADX file with the other information.
- Sign of the magnetization component for the transfer functions of some magnets must be flipped in LSA. **Follow-up: Marek Strzelczyk.**

2. News from LMC (Mike Lamont)

The detailed minutes written by Frank Zimmermann of the LHC meeting held on 20 May will be available here. Items covered:

- Risk to underground structures from He release;
- Update one resistive measurements;
- Decrease energy extraction time for dipoles & quads;

- Running through winter;
- Protection of electronics in US85;
- Sector 3-4 repair;
- Shutdown progress and planning.

Mike Lamont presented some of these subjects (slides). Results of the M3 splice resistance (Copper) measurements for each of the warm sectors were shown. For the 4-5 cold sector, temperature variation makes the measurements much more difficult and discussion are one going on the follow up strategy concerning the larger resistances measured.
The latest LHC draft schedule was presented and shows a slippage of 1-2 weeks, including for the TIs injection tests.

3. Dry Run week 21 (Verena Kain, Stefano Redaelli)

Stefano Redaelli summarised the dry run preparatory work performed on Friday 22 May. RF tests were performed to switch on/off the RF power with the operational applications from the CCC, i.e., RF power application and RF sub-sequences driven with the LHC sequencer. Overall, the test was successful because all the available statuses could be checked and the power converters could be switched on and ramped to the nominal voltages. A list of To-Dos was compiled and will be followed-up by OP teams.

Verena Kain added that follow-up actions will be addressed this week. The detail planning is available at
https://espace.cern.ch/mddb/Activity%20Tracking%20Tool/Activity%20Tracking%20Welcome.aspx?View=%7b593B6E53%2dF6F9%2d4485%2d8646%2dE7E683D0F681%7d&FolderCTID=0x012001&SelectedID=32

Access system will be tested this week end, the whole LHC will be close. TI 8 dry run is scheduled for Tuesday 2 June where all equipments will be re-checked, in view of the beam tests of 6-7 June.

4. Running conditions / requirements from experiments – Massimiliano Ferro-Luzzi

Massimiliano Ferro-Luzzi reminded that 50-100 pb^{-1} provide good data at 10-8 TeV, as with 200-300 pb^{-1} at 10-8 TeV, the LHC starts competing with Tevatron for Higgs masses around 160 GeV (slides). After the 2009 Chamonix workshop, the goal for the LHC first running period was set to an integrated luminosity of more than 200 pb^{-1} operating at 5 TeV per beam. Therefore, assuming an overall “efficiency factor” of 0.1 - 02, in order to reach few 100 pb^{-1} in a run of less than 10 months, a luminosity of the order of 1e32 is needed.
Requests from the experiments were given -details in slides.
It was reminded that the main LHC limitations may come from: i- the collimation cleaning efficiency vs. quench level which mostly limits the total beam intensity; ii- the aperture limitations in the inner triplets, which gets worse with the external crossing angle; the beam-beam effects which limit the bunch population. In addition come special complications, from IP8 where one polarity is worse than the other one and from ALICE with the request of special bunches.
For the filling scheme, two steps were distinguished:

1- Without external crossing scheme
   a. Start point: 2X2;
   b. Equidistant N X N scheme (43X43 - 156X156).
2- With external crossing scheme
   Many bunch spacing possibilities: 75, 50, 25 ns;

Note: the short spacing introduces long range encounters in the IR, in turns reducing the reach in bunch charge. Also, the crossing angle reduces the aperture in the triplet which in turns reduced the reach in β*;

For the 2009-1010 LHC run, using 50ns bunch spacing has the advantages of distributing the luminosity over the 4 IPs in a very flexible and optimal manner, to be more favourable in terms of beam-beam effects and would give the highest possible luminosity while waiting for the phase 2 collimation system –LHC Project Note 415 by Werner Herr.

An overview table on the steps for luminosity increase during the 2009-1010 LHC run was presented. It was stressed that the final choice will all depends on the experience accumulated with beam, the results in terms of luminosity and the operational time needed to go back and forth between different bunch spacing / pattern version.

Comments:

Mike Lamont clarified that after one month of commissioning, the machine will be ready for one on one operation, unsqueezed.

Stephane Fartoukh said that fixing the β*once for all at the beginning (e.g. 2 m at 5 TeV) would help much in the LHC commissioning stage. Fixing the optics during the commissioning and varying the bunch scheme and bunch intensity to improve the required luminosity could be done in a first stage, and only when limits appear, switch on the crossing scheme.

The β*=3 m was felt too pessimistic, and a β* of the order of 2 m a more likely scenario.

Summary of the discussion in respect of operational commissioning strategy:

The route to maximum luminosity in 2010 will clearly depend on operational experience with beam. Depending on the constraints encountered, options might include:

- In the phase of operating with 156X156 bunches, keep the physics optics with β*=2 m during the luminosity optimisation process, and progressively increase the intensity per bunch to 9e10. This will have the advantage to stay with limited energy stored in the machine, while not changing two parameters at the same time.
- If the total intensity is limited by quench levels / cleaning efficiency it might be of interest to push the β* down towards 1 m. Reducing the aperture in the inner triplets, the need to understand and control the non-linear fields of the triplets, the need for excellent knowledge of the triplet's transfer functions would all have to be mastered if this option is to be explored. 156x156 at β*= 1m with, say, 9e10 would clearly be an interesting options for some prolonged luminosity production.
- β*=2 m is the assumed minimum for operation with a crossing angle and would be the starting point for bring the crossing angle on and increasing the number of bunches above 156 per beam. A drop in bunch intensity would be appropriate at this stage to avoid a step function in total intensity etc. There is also the possibility to increase β* if necessary at this stage. There, therefore, would be a hit to take in integrated luminosity production at this stage.

Massimiliano will discuss the strategy further with all involved and will report back to an upcoming LHC Beam Commissioning meeting. A report on the 2009-2010 physics target parameters will be written and loaded in EDMS with #931921v2.

Next meeting

Tuesday 2 June 2009, **15:30**, 874-1-011. Agenda will be sent in due time.

Malika Meddahi