118th Meeting of the LHC Collimation Study Group

July 05, 2010

Present: R. Assmann (chairman), A. Nordt (scientific secretary), R. Bruce, D. Wollmann, O. Aberle, G. Bellodi, T. Markiewicz (SLAC), S. Redaelli, N. Mariani, V Parma, N. Mounet, F. Carra, A. Bertarelli, G. Smirnov.
Excused: A. Masi, J. Jowett, E. Metral, J-Ph. Tock, J. Wenninger, A. Ryazanov, A. Dallocchio.

1 Comments to the minutes

No comments to the previous minutes.

2 Agenda of this meeting

1. Regular collimation status reports:
   a) Hardware and tunnel activities, if any
   b) Remote and beam commissioning
   c) Phase II activities at CERN
   d) Phase II activities at SLAC
   e) Cryo-collimators integration and interfaces
   f) FLUKA work

2. Special reports :
   a) Collimation set-up for ion commissioning – G. Bellodi, BE/ABP
   b) Vertical impedance for IR3 combined cleaning – N. Mounet, BE/ABP

3 List of actions from this meeting

Action	People	Deadline
Follow up debugged version of collimator low-level control system	S. Redaelli	
Follow up an additional HW for HiRadMat testing	T. Markiewicz	
Follow up rotation drive tests and re-building both RF races on the 2nd jaw	T. Markiewicz	
Follow up HiRadMat tests in SPS	O. Aberle	
Strategy for the collimation set-up	R. Assmann	
Verification of damage levels (Ion beam)	G. Bellodi	
BLM thresholds for ion beams	B. Dehning and team	
Organize meeting together with Elias E. concerning the HiRadMat tests	R. Assmann	

(Complete list at http://lhc-collimation.web.cern.ch/lhc-collimation/action.htm)

The next meeting will be on July 19th.

Minutes of the meeting

1 Regular collimation status reports

1.1 Hardware and tunnel activities (O. Aberle EN/STI)

- No important news.

1.2 Remote and beam commissioning (S. Redaelli BE/OP and R. Assmann BE/APB)

- Stefano R. reported that a bug was found in the collimator low-level control system. The settings for the limit functions are deleted from the memory if one re-loads them into the system after having armed the PRS (position readout survey) unit. This was done several times for the TCSGs in IP6 because the operation sequence for these collimators is shared with the TCDQ. The latter has frequent setting problems that require repeating the sequence. The bug caused a lost of 2 ramps with beams. For the moment, we are working with the bug but a fix is available and will be deployed during the next technical stop.
- Other than that the system works well. Settings for injection, ramp and squeeze have been used routinely for the last two weeks of operation with higher intensities.

1.3 Phase II activities at CERN

- Ralph mentioned that details for Phase II will be discussed in the LHC collimation upgrade review on 8th of July 2010.
- See also the slides presented at http://indico.cern.ch/conferenceDisplay.py?confId=100156.

1.4 Phase II activities at SLAC (T. Markiewicz, SLAC) – see slides

- Tom M. reported that P. Gander has finished the torque tests on 11th of June 2010. Much more testing of the rotation drives and the actuators was done. Measurements of the alignment and parallelism gave an excellent result.
- The parts for the pawls (ratchet) of the rotation drive have been developed, prototyped, fabricated, installed and have been tested.
- It turns out to be problematic when using 1mm Rhodium balls in RF race and the plan to have smooth rotation and low contact resistance has been abandoned.
- The bearing will be made mechanically only. The race on the first jaw has been rebuilt already and the race on the second jaw will be rebuilt starting on 6th of July.
- The RF contact will be made through a ~6cm arc of wavy Rhodium coated BeCu. This results in having the same ≤0.1 mOhm contact resistance as previously measured and the contact at beamline.
- Alessandro pointed out that it is needed to check whether Rhodium coated stainless steel is working well in vacuum.
- The final part of the construction is to build the mounting bracket. The mounting bracket must hold the Rhodium coated foil, restrain the RF foil from rotating and it must maintain the curvature. In addition it will hold a thermistor. A first prototype has been made and tested and a second version of a plastic prototype will be ready by 6th of July.
- Tom presented a list of RC tasks to be completed asap, including: complete rotation drive tests in the lab, re-building both RF races on the 2nd jaw for a smooth operation. In order to switch out all stainless screws for molybdenum screws, the final four “wavy arcs” for contact resistance and Rhodium plate must be fabricated as well as the four mounting brackets for the arcs, thermistors and RF foils. For the final cleaning it is foreseen to use acetone and alcohol for all parts and a chemical cleaning of the upper vacuum tank vessel. The bellows are already vacuum-fired and leak checked. The welding of the bellows to the jaw supports and to the base plate will be done in a real clean room. Also the reassembling of the jaws on the base plate and the final alignment and test of all the parts will be done in the clean room. Note for the reassembling of the jaws: Cu tubing is now bent down and brazed to the feed-throughs. In addition the vacuum tank needs to be welded and the rotation drive has to be tested. A vacuum bake-out and the final

test of the rotation drive have to be done. And finally shock monitors will be installed and the paperwork for the shipping will be prepared.

- The letter of support for SLAC participation in Phase II Construction project will be sent from SLAC Associate Lab Director for Accelerators to Steve Myers. There was much dialog with DOE for an increased financial support. The DOE Review takes place on July 15-16.
- What needs to be discussed with the relevant people is the SLAC participation in RC prototype testing at CERN after delivery. A decision on the nature of future prototype work has to be taken. Should there be support with instrumentation for the existing prototype (laser, micrometer, etc.). Is an additional HW for HiRadMat testing needed (i.e. non-vacuum, non cooled Glidcop jaws with the next generation support and rotation system)? Is a second prototype needed? If so, what exactly is needed and until when?
- Alessandro asked if tests will be made with the cooled and non-cooled jaws: what if the beam hits the water? Tom explained that such tests are foreseen in the SPS set-up.
- There will be a dedicated meeting together with Elias E. concerning the HiRadMat tests.

1.5 Cryo-collimators integration and interfaces

- Ralph mentioned that details for Cryo collimators will be discussed in the LHC collimation upgrade review on 8th of July 2010.
- See also the slides presented at http://indico.cern.ch/conferenceDisplay.py?confId=100156.

1.6 FLUKA studies

- Ralph mentioned that also the news from FLUKA studies will be discussed in the LHC collimation upgrade review on 8th of July 2010.
- See also the slides presented at http://indico.cern.ch/conferenceDisplay.py?confId=100156.

2 Special topics

2.1 Collimation set-up for ion commissioning: initial studies (G. Bellodi, BE/ABP) – see slides

G. Bellodi presented her latest studies on the collimation set-up for ion commissioning.

- A list from J. Jowett from Feb. 2009 about the set-up from start to first collisions of Early Ion beam was presented. This list needs to be updated. Probably the collisions at 450 GeV can be skipped as well as the squeeze. The details need to be specified and John will discuss it with Mike L. Approximately 1 week of set-up is needed.
- The parameters for the Early Ion beam were shown and different quench limits (in W/m) according to different energies. The quench limit for 2.7 TeV is ~9.2 W/m. Also the injection and collision optics settings were presented (zero crossing angles, zero separation bumps). There are only minimal changes from the machine`s "proton" configuration.
- Stefano asked whether the real damage and quench levels for safe beam are known and Ralph said that the studies for ion beams are done by FLUKA. The results have to be looked up.
- The first set-up is for beam 1, betatron collimation, injection at 450 GeV/A and 12min lifetime. The resulting loss maps showed that some losses were distributed outside IR7 DS, but with a level of less than 0.05W/m. The maximum load was found to be on TCP.B6L7.B1 with 23W. The collimation inefficiency is appr. 2.2 %.
- The results for the first set-up for beam 1 but at collision energy (3.5 TeV/A, β*=2m, 12min lifetime), betatron collimation, show that there are no losses outside IR7 DS, the maximum load is on TCP.B6L7.B1 with 120W. The expected inefficiency is 3.5% ; and the corresponding simulations but for momentum cleaning show a maximum load on TCP.6L3.B1 with 250W, losses before IP3 and an inefficiency of 3.8 %.
- For beam 2, betatron collimation, 3.5 TeV/A, β*=2m, 12min lifetime the simulations show a maximum load on TCP.B6R7.B2 with 103W and an inefficiency of 14%. For the momentum collimation the max. Load is on TCP.6R3.B2 with 254W and the inefficiency is 4.5%.

- The difference between IR 3 and 7 is due to the fact that there is only one TCP in IR3. Therefore one expects a factor 2 higher load on the TCPs.
- Then a different scenario was presented: only the TCP were closed (5.7σ (IR7) and 12σ (IR3)) and all other collimators were opened. For betatron collimation (beam 1), 3.5 TeV/A, β*=3.5m, 12min lifetime the maximum load was found to be on TCP.B6L7.B1 with 122W. Some losses were found before the DS but less than 0.5W/m. The results for the inefficiency are 3.3%. For momentum collimation a maximum load was found on TCP.6L3.B1 with 250W and an inefficiency of 2.5%.
- For the beam-based ion collimation commissioning it is planned to use the reference orbit for a single nominal bunch at 3.5TeV/A. The cleaning and protection needs to be verified with provoked beam losses in IR3 and IR7.
- The results for the different scenarios show that in all cases the losses are expected to be below the quench limit.
- The strategy for the collimation set-up needs to be defined in more details. Ralph pointed out that for the collimation set-up for ion beam only the TCPs will be set-up and the other collimators will be used for protection.
- There was the question whether the BLM thresholds need to be adapted for ion beams (Bernd D. will be asked). In addition Roderik B. showed in the past that the expected BLM signals at quench level are the same as for protons. Therefore the initial BLM thresholds for Pb beams should be the same as for protons.
- Giulia should follow up the verification of damage limits together with Vassilis.

2.2 First comparison between phase 1 and IR3MBC (N. Mounet, BE/ABP) – see slides

N. Mounet (and E. Metral) presented the latest results on combined momentum and betatron cleaning in IR3.

- Note: The results presented are preliminary and several effects like temperature are not taken into account.
- In the last presentation E. Metral pointed out that there is a difference for the vertical impedance for IR3 combined cleaning compared to phase I settings.
- The horizontal impedance for multibunch modes will be better in phase II but the vertical impedance will be worse. In particular, there is a huge tune shift (~1.3×10^{-3}) with IR3MBC option.
- The results on horizontal and vertical dipolar (driving) impedance were shown and a much stronger vertical impedance with IR3MBC w.r.t phase I (above 10^5 Hz) could be confirmed.
- The largest impedance contributions in the IR3MBC configuration are coming from 4 TCSGs (4R3.B1,A5R3.B1,B5R3.B1,5L3.B1). For those horizontal collimators we have only a very small halfgap due to a small σ (from small β_x) and a quite large β_y. This leads to the large vertical impedance, but not to a horizontal large impedance since β_x is 10 times smaller.
- The largest contribution for the vertical dipolar impedance was investigated as well. Above a few MHz, one single IR3MBC collimator gives the same imaginary part as the totality of the phase I collimators.
- The presented results show that at 7 TeV, with the IR3MBC option, the horizontal impedance is lower than in phase I. But the vertical impedance is much larger (for the imaginary part: factor 1.5 at 10kHz and factor 3 at 10GHz).
- In consequence, the multibunch transverse instability that was thought to be the most critical effect at 7 TeV, is a more critical issue than in phase I (well beyond the stability diagram).
- Since also the tune shift is expected to be very large, other problems could occur. This needs to be discussed in further detail.
- The effect on single-bunch stability of such an impedance could be even worse since the factor between IR3MBC and phase I increases at high frequencies. There are headtail simulations planned in order to check this issue.
- Alessandro was asking for the contribution of the cryo collimators to the impedance. Ralph and Nicolas answered that the contribution is expected to be small for the current configuration of these collimators.