93rd Meeting of the LHC Collimation Working Group, February 4th, 2008

Present: Oliver Aberle, Paul Anton Letnes, Ralph Assmann (chairman), Giulia Bellodi, Dariusz Bocian, Till Tobias Bohlen, Markus Brugger, Helmut Burkhardt, Roland Chery, Bernd Dehning, Andres Gomez Alonso, Barbara Eva Holzer, Daniel Kramer, Michel Jonker, Mike Lamont, Marco Mauri, Elias Métral, Alessandro Masi, Laurette Ponce, Valentina Previtali, Christian Rathjen, Ernst Radermacher, Stefano Redaelli (scientific secretary), Stefan Roesler, Federico Roncarolo, Benoit Salvant, Mariusz Sapinski, Marc Vanden Eynden, Thomas Weiler.

Comments to the minutes and follow-up of actions

Minor comments received by the scientific secretary have been incorporated in the final version of the **minutes**.

Follow-up of open actions from last meeting (January 21st, 2008):

- The configuration for the collimator inputs into the BIC's has been agreed upon after an off-line follow-up triggered by A. Masi. Final table addaed to our web page.
- T. Weiler collected the last round of comments to finalized the steps in MTF for the collimator hardware commissioning procedures.
- The properties of the new collimator FESA class (LHCCollimator v1) were finalized (M. Jonker, A. Masi, S. Redaelli) and the development within ATB-LPE has started.

Agenda of this meeting

- TOTEM controls (E. Radermacher).
- Collimator transverse impedance measurements (B. Salvant)
- Beam scraping at the SPS for LHC injection (P. Anton Letnes)
- Direct proton losses and beam gas interaction in IR7 (M. Mauri)

List of actions from this meeting

Action	People	Deadline
Provide to AT-VAC a list of locations for additional temperature sensors in the collimation insertions	R. Assmann	Mid. Feb.
Procurement/set-up of the third collimator prototype for impedance measurements	O. Aberle	Summer 2008
Additional impedance measurements on Tungsten collimators and on the final collimator CFC material.	R. Assmann Imped. team	April 2008
Definition of energy deposition studies for Phase I system	R. Assmann	Mid. Feb.

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

The next meeting will be Monday, February 18th, 2008.
Provisional agenda: **http://lhc-collimation.web.cern.ch/lhc-collimation/**

Minutes of the meeting

1 A.O.B.

C. Rathjen stated that it will be possible to **add additional temperature gauges** in the collimator insertions because spare channels are available. This requires a prompt follow-up: the additional measurement points should be determined as soon as possible in order to pull the required cables. R. Assmann welcomed this proposal. He will provide a list of possible locations after consulting the people involved (from proton loss and energy deposition studies).

2 TOTEM control issues (E. Radermacher)

E. Radermacher presented the requirements for the TOTEM controls. More details are also available in the EDMS note 863466 on Roman pot operational scenarios and in the **EDMS note 873014** (not yet distributed) on controls issues.
The low-level controls are based on the solution adopted for the LHC collimators: the same stepping motors will drive the Roman pots and LVDTs Linear Variable Differential Transformers), calibrated on surface to an accuracy of about 50 μm, will be used to monitor the pot position. Motor drivers and position survey are controlled with one PXI system. On the other hand, there are differences with respect to the collimator solution: (1) One PXI CPU is responsible for drive and survey functionalities (two separated CPU are used for the collimators); (2) LVDT sensors are only calibrated on surface there are no procedures for the re-calibration in the tunnel; (3) LVDT readings are not used for interlocking purposes.
The **general approach** from the TOTEM team (see slide 11) is to copy/clone as much as possible from the collimator controls. E. Radermacher stated that about **0.5 FTE** would be needed to follow-up controls issues, to adapt the existing software to the TOTEM requirements and to system commissioning. However, these required resources are not available within the TOTEM group and hence Ernst **asked support from the AB Department**.
R. Assmann commented that it will be crucial to treat the Roman pots as collimators in order to make sure that the correct setting hierarchy with respect to the beam will be respected. Ralph asked if there are principle problems to achieve that with the present architecture and what are the requirements to adapt our software for the Roman pot controls. For the top level, S. Redaelli commented that there are no principle problems for the setting generation however a significant amount of work must be invested to prepare the software for the Roman pots. The top level can only work if the TOTEM FESA class will provide the same functionality as the one of the other collimators. As we have now to focus on the control setup with the new FESA architecture (see collimation meeting of January 21st, 2008) and with the hardware commissioning, it will not be possible to put resources on this project.
A. Masi commented that the ATB control team does not have resources to help the colleagues of TOTEM. He also warned that there are significant differences between the two low-level solutions and therefore it will be very difficult to just clone the software that is being developed for the collimators. He stated that there should be someone from the TOTEM team looking after the PXI software preparation.
In **conclusion** the collimation working group endorsed the approach proposed by TOTEM for the Roman pot controls however it appeared that the required resources are presently not available within the collimation team and therefore the manpower issue must be solved at the management level.

Triggered by the list of operational scenarios at page 8, S. Redaelli asked whether the Roman pots will moved outside of the beam as soon as the machine state will change to "UNSTABLE_BEAMS". M Deile replied that this will be the case. R. Assmann commented that,

unlike what was presented by E. Radermacher, it must be possible to move the pots also during the machine mode "ADJUST_BEAMS": this is when the collimators will be set and it will also be necessary to move the Roman pots in order to understand the relative settings with respect to the other collimators in the ring.
S. Redaelli warned that the draft note for the TOTEM controls specifications has not been distributed yet even though it appears in EDMS as version 3. M. Jonker distributed a draft to the collimation team before this meeting. Stefano has comments that would like to transmit to the authors. E. Radermacher replied that the note was not distributed yet in order to collect first the feedback from the commissioning working group but will be distributed for engineering check soon.

3 Collimator transverse impedance measurements (B. Salvant)

B. Salvant reported on the status of collimator transverse impedance measurements. Direct impedance measurements were performed with the coil method proposed by F. Caspers *et al.* (see the collimation meeting of July 12th, 2007. Additional results were also reported to the ABP-LCU meetings of December 3rd, 2007 and June 18th, 2007. In this meeting, the results obtained so far were presented and the plans for future measurements on collimator prototype were discussed.
B. Salvant recalled the results of recent simulations performed by T. Kroyer that agree very well with the prediction from theory. The impedance reduction at frequencies below about 50 kHz is confirmed by detailed simulations that use a finite-element solver optimized for low-frequency. The coil measurements with the coil method also confirm this behaviour. E. Métral pointed out that this is the first time when theory, simulations and direct measurements agree about the predictions of the impedance "by-pass" effect, which so far was not yet experimentally demonstrated.
The coil measurements have been performed so far with (1) samples of TCDI graphite material and (2) machined Copper material used for the collimator jaw. The next step is to perform measurements on a real collimator. It was **agreed** that the **third collimator prototype will be used** for these measurements. The horizontal configuration and the fact that the upper tank cover is opened will ease the experimental procedure. O Aberle is the contact person who will follow-up the prototype procurement. Measurements have to be done in a laboratory with controlled temperature previous measurements proved that this is a critical parameter. Temperature changes of about 1 degree induce an effect comparable to the change of material from Copper to Graphite!
R. Assmann welcomed these **very good results**. We can now be more confident about the impedance "by-pass" model, which the LHC operation relies on (collimator impedance would be orders of magnitude higher of this effect did not exist). We will receive soon spare samples of the final collimator Carbon materials, which features a lower resistivity than the TCDI's used so far. He proposed to measure (1) the impedance of the final material as well as (2) the one of a Tungsten collimator (a spare will also be available soon). This will be followed-up off-line.
H. Burkhardt commented that recently it has been found that the feedback noise is lower than what originally foreseen. It will probably be possible to keep the feedback on all the time at 7 TeV whereas before the baseline was to rely only on the Landau octupoles. This could further reduce the instabilities from impedance.

4 Beam scraping in the SPS for LHC injection (P. Anton Letnes)

Paul Anton Letnes is a technical student who worked with H. Burkhardt on the control application for the SPS scrapers, which will be used to clean up the tails of the LHC beams

in the SPS to optimize the LHC injection losses. Potentially the beam scraping at the SPS could also ease the LHC beam cleaning at injection. Paul also worked on the analysis of the scraping efficiency and on SPS beam loss studies. He presented his work to the collimation working group to gather comments.
An important issue is the scraper survival in case of beam failures. Preliminary FLUKA simulations suggest that the scraper will be significantly damaged in case of full LHC beam impacts. With the present SPS hardware it is not possible to interlock the scrapers on beam loss signals because these devices are too fast compared to the response of the SPS BLM system. Another issue is that the secondary collimators that are placed behind the scraper are not effective in catching the induce losses. These are slow devices that have to be kept at large amplitudes in order not to interfere with the injected beam. As a result of that, the secondary particles after interacting with the scraper are mainly induced in the SPS aperture. This observation is also confirmed by preliminary `SixTrack` simulations that P. Letnes setup for the SPS. Paul showed that there is a **good understanding** of the scraping mechanism and of the loss generation.
P. Letnes concluded with a list of questions (see page 14 of his slides) and asked **feedback on his work**. People who have comments are encouraged to contact him.
S. Redaelli asked it if is foreseen to **request MD time** during the 2008 SPS run. H. Burkhardt replied that this option is presently under discussion. We could envisage an early MD before summer (end of Paul's contract), possibly combined with collimation studies. Helmut believes that it is worth studying the re-population of beam tails, which was not fully understood in the previous MDs.

5 Direct proton losses and beam gas interaction in IR7 (M. Mauri)

M. Mauri presented results of FLUKA simulations on (1) direct proton losses in the magnet aperture and (2) beam gas interaction in IR7. **Direct proton losses** in the beam screen of superconducting magnets are taken as FLUKA input from the output of the aperture program BeamLossPattern used in the tracking studies (inputs were provided by C. Bracco). M.Mauri found that the two most critical elements are the **MQ11R7** and the **MBB9R7** that show peak losses up to **3 mW/cm^3**. The accuracy of the results is limited by statistics because only few particles are lost in each element. R. Assmann commented that this is limited by CPU power (only a few 10^{-5} particles are lost downstream of IR7).
Simulations of **beam gas losses** are performed with approximate estimate for the beam gas density and composition because no detailed data are yet available. This study provides estimates for the peak energy deposition in the magnets as well as estimates of the maximum beam gas density before quenching. It is found that the most critical element is the dipole **MB.A8R7** with a peak energy deposition of about **308 GeV/proton**. The corresponding maximum tolerable gas density is about **2.8×10^{16}molecules/cm^3**. R. Assmann suggested to check with A. Rossi the availability of recent estimates for gas population in IR7.
R. Assmann commented that within a couple of weeks there will be a meeting between the FLUKA and the collimation proton study teams about the plans for the energy deposition studies required for the Phase I collimation system. A series of FLUKA inputs have been collected from the proton loss team and we will assign to them a priority ranking. More news will be reported to the next meeting.

The next meeting will be Monday, February 18th, 2008.