

96th Meeting of the LHC Collimation Working Group, June 6th, 2008

Present: Ralph Assmann (chairman), Giulia Bellodi, Till Tobias Bohlen, Markus Brugger, Roderik Bruce, Helmut Burkhardt, Rocio Chamizo, Bernd Dehning, Simone Gilardoni, Barbara Eva Holzer, Verena Kain, Yacine Kadi, Daniel Kramer, Michel Jonker, John Jowett, Mike Lamont, Roberto Losito, Marco Mauri, Alessandro Masi, Laurette Ponce, Valentina Previtali, Christian Rathjen, Stefano Redaelli (scientific secretary), Stefan Roesler, Mariusz Sapinski, Thomas Weiler.

Comments to the minutes and follow-up of actions

No comments to the previous minutes.

Follow-up of open actions:

- M. Jonker updated the FESA software of the CSS collimator class for the SPS prototype. The same functionality provided by the old class is ensured. The change is fully transparent for the interfaces to the low- and top-level control layers. Therefore, the frozen 2007 software can be used for the SPS collimator control (note in particular that the FESA version 2.8 is used).

Agenda of this meeting

- ICOSIM results for different computation of ion cross sections in the collimator material (G. Bellodi).
- Planning for the 2008 collimator MD's at the SPS (S. Redaelli)
- Preliminary results of TI2 collimator beam commissioning (S. Redaelli)
- Simulations of beam pipe heating and BLM thresholds (M. Brugger)

List of actions from this meeting

Action	People	Deadline
Improve on-line analysis tools for the beam-based alignment of the transfer line collimators	Collimation + Inj. teams	asap
Follow-up SPS MD planning for the collimator beam tests	S. Redaelli	–
Calculate the thresholds for BLM readings from the max. loss rates specified in p/s for all the collimator types	BLM team	Before beam oper.
Collimator dump thresholds for ion operation	J. Jowett	2009

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

The next meeting will be announced.

Provisional agenda: <http://lhc-collimation.web.cern.ch/lhc-collimation/>

Minutes of the meeting

1 ICOSIM results for different computation of ion cross sections in the collimator material (G. Bellodi)

G. Bellodi presented the results of new ICOSIM simulations with updated values for the ion interaction cross-sections. The simulation tools have been upgraded to use cross-sections values calculated by FLUKA and MARS instead than the old look-up tables originally implemented by H. Braun (Pshenishnov's model). Details of the FLUKA and MARS simulation setup are available in Giulia's slides.

The comparison of simulation results shows that there are **significant differences** between the cross-section values calculated by the two simulation codes. Typically, differences up to **30%** are found on the estimate of the single cross-section values for various ion species. Correspondingly, if the different models are used for the full beam loss simulation studies, the following estimates of **maximum peak deposited energy** into the superconducting magnets are found (for the nominal LHC ion beam):

- Old model with look-up tables: **30 W/m**
- Cross-section values from FLUKA: **20 W/m**
- Cross-section values from MARS: **4 W/m**

J. Jowett commented that it was expected to have differences between the previous model and FLUKA. On the other hand, the large difference between FLUKA and MARS are not expected. R. Assmann remarked that the difference between FLUKA and MARS is much larger than the standard safety factor of 2 that is normally quoted by A. Ferrari. S. Gilardoni commented that a factor 2 can be expected for the estimates on individual cross-sections (which fits with the findings).

Responding to a question by R. Assmann, G. Bellodi commented by comparing the simulations with different models we see only variations of the height of loss peaks and not the occurrence of new loss locations. Thus the detection of ion losses will be covered with the present BLM layout that was determined by using the old model.

G. Bellodi asked feedback from the collimation working group on her **proposal** to use from now onwards the FLUKA estimates for the cross-section values and to quote the difference from MARS as an error estimate. The people agreed with this proposal.

2 Planning for the 2008 collimator MD's at the SPS (S. Redaelli)

S. Redaelli reported on the hardware status of the SPS collimator prototype in LSS5 and on the planning for the 2008 beam tests.

An **hardware problem** was encountered by M. Jonker and T. Weiler during preliminary tests performed without beam to validate the new collimator CSS FESA class. While the jaws were being moved, a discrepancy of several millimeters appeared between requested settings and measured jaw positions. The problem was traced to a **loss of steps** of one of the old LEP stepping motors used for the SPS prototype. This issue was fixed by the ATB team by replacing all the stepping motors with LHC motors. The intervention was carried out during the machine stop of June 9th. Now the collimator is **back in operation and ready for beam tests**.

R. Losito commented that one motor axis experienced an increased torque and the motor power was not sufficient anymore to move the jaw. Responding to a question by R. Assmann,

R. Losito stated this problem must not be seen as a warning sign for the LHC but should be considered as a specific problem related to the usage of old LEP stepping motors.

The requests for **MD time** are summarized at page 4 of S. Redaelli's slides. This will be followed up in the MD meetings to optimize the schedule with the various parts involved (see also the tentative schedule at page 3). S. Redaelli also commented that as far as the BLM acquisition chain is concerned, it was agreed with the BLM team that all the software will be frozen to the 2007 version and will not be updated to follow the LHC concentrator development.

R. Losito asked if it is planned to have the SPS collimator operational for 2009. In this case, should we update the hardware to the LHC? R. Assmann replied that we should keep the collimator operational without changing the hardware.

3 Preliminary results of TI2 collimator beam commissioning (S. Redaelli)

S. Redaelli presented the preliminary results of the collimator commissioning with beam at TI2, performed during the beam tests of June 15th. See also the [minutes](#) of the LTI meeting of June 26th for more details on the performed beam tests.

About 5 hours of beam time, with good beam availability, were dedicated to set-up three collimators in TI2 (TCDIH.20607, TCDIV.29012 and TCDIH.29050). The 4 collimators further downstream in TI2 were also fully operational but did not see beam because it was stopped at the TED downstream of the TCDIH.29050 collimator. Tests were performed with single bunches of about 4×10^{10} protons, which provided good reproducibility of the key beam parameters (orbit, emittance, intensity) and of the BI responses.

The following aspects could be covered during beam tests:

- beam-based alignment with BLM signal;
- calculation of beam size from beam scraping;
- establishment of beam-based settings within the LSA collimation tools;
- establishment of protection settings and verification with beam.

The results are described in detail in S. Redaelli's slides. In addition, we also deployed for the first time the full logging of the collimator position survey properties (first validation of the final LHC system).

Overall, the beam commissioning of the system was **very successful**. We could achieve beam-based alignment accuracies in the order of magnitude of $50 \mu\text{m}$, the estimated beam size was in agreement with independent estimates from screen measurements. All the controls systems worked as expected, including the interlock limits. The LSA implementation proved to be adequate for the beam operation. R. Assmann commented that as a next step we should focus on improving the on-line data analysis for the determination of the beam-based parameters ([Action](#) for the collimation and injection teams).

During the beam tests, a **problem** was encountered with the measurements of the LVDT "Left-Upstream" of the TCDIH.29050 collimator: occasionally it showed a beam-induced noise of amplitude up to 100 mm. A "jump" of the LVDT readout signal was induced every time the beam impacted on the collimators jaws. The problem could be reproduced systematically during about 2 h and then disappeared by itself, before the low-level experts could investigate in detail the fast acquisitions of expert properties.

Noise level from magnet pulsing, which was found for the first time in last year's beam tests, was also investigated. To reduce this effect special **electromagnetic screens** were installed

on the TI2 collimators. These screens proved to be effective: for comparable current levels in the magnet circuits, the e.m. noise was reduced by up to a factor 10. The largest noise is now about $20\ \mu\text{m}$, the only exception being the “Left-Upstream” sensor of the TCDIH.29050 (noise of $\approx 100\ \mu\text{m}$). This is the one that showed problems associated to the beam passage and therefore it will be changed as soon as possible.

4 Simulations of beam pipe heating and BLM thresholds (M. Brugger)

M. Brugger reported on FLUKA studies performed as a follow-up of the request by C. Rathjen to determine hot-spots in the betatron cleaning region where to install additional temperature gauges (see the [minutes](#) of the LHC collimation working group meeting of Feb. 4th, 2008). Markus looked at the heating of the beam pipe along the whole insertion and found peak values up to $10\ \text{W}/\text{cm}^3$ (see details in Markus’ slides). These results will be transmitted to the VAC team to determine the optimum locations for new temperature sensors.

R. Assmann commented that the pipe heating is considerable and reminded that in the past the collimation project requested to have cooled beam pipes but this solution was not implemented by AT-VAC.

M. Brugger also reviewed the available FLUKA results for BLM studies. The motivation for the review of these results is to convert the [collimator damage thresholds](#) provided by R. Assmann into interlock values for the BLM readings. A lot of simulation data is available however this is mainly related to the the case of the nominal beam cleaning. R. Assmann stressed that we need calibration studies for the case of direct proton impacts on the collimators, in particular for the collimator types TCT and TCLA that are the most fragile. B. Dehning added that for the TCT’s the BLM mounting is not the same as for the other collimator types and a model should be developed for this case. This work is ongoing.

B. Dehning asked if we should used the values of deposited power into the collimators of the total energy. R. Assmann responded that the **total deposited power** should be used. The BLM team should report back about the determination of the thresholds for the BLM readings calculated from the values provided by R. Assmann ([Action](#) for the BLM team).

R. Assmann asked J. Jowett whether we should use the same thresholds for ions and for protons or if there are special requirement for ions. John replied that he will follow this up ([Action](#) for J. Jowett).

The next meeting will be announced.