Stefano Redaelli, 25-10-2005

65^{th} Meeting of the LHC Collimation Working Group, October 24, 2005

Present: Ralph Assmann (chairman), Chiara Bracco, Markus Brugger, Bernd Dehning, Massimo Giovannozzi, Daniel Kramer, Mike Lamont, Matteo Magistris, Manfred Mayer, Laurette Ponce, Suitbert Ramberger, Stefano Redaelli (scientific secretary), Guillaume Robert-Demolaize, Mario Santana-Leitner, Joachim Vollaire, Thomas Weiler.

1 Comments to last minutes (meeting of Oct. 24th, 2005)

Stefano Redaelli (SR) received the following comments to the minutes of last meeting:

- Bernd Dehning (BD) asked to explicitly include in the minutes of the last meeting the pending action on the setup of beam 2 tracking, which is being followed-up by the AB-ABP-LOC section.

- Suitbert Ramberger (SRa) disagreed with the statement that the CERN experience with LEP and SPS normal-conducting magnets is "encouraging" for the extrapolation to the LHC. The experience is rather inconclusive because the total radiation doses and dose rates were different from what is expected for the LHC.

The above comments have been implemented in the web version of last minutes.

2 Follow-up of pending actions

- BD received the drawings of BLM locations from Adriana Rossi and will check them. The approval process is on-going.

- Ralph Assmann (RA) followed up with Jean-Bernard Jeanneret the cross-check of the IR3 and IR7 energy deposition studies in order to understand the discrepancies between the effectiveness of the passive absorbers to shield the MBW's of the two IR's. This will be discussed in detail at the next visit of our IHPE colleagues.

- Thys Risselada and Massimo Giovannozzi from AB-ABP-LOC are following up the setup of the tracking model for beam 2 (`MADX` + `SixTrack`). Latest results will be reported at the LOC section meeting of tomorrow, October 25th, 2005.
  See `http://slap.web.cern.ch/slap/LOC_meetings/2005/meetings.htm`

- SRa has calculated the **electromagnetic force** on the **MBW coils**. At the maximum excitation current, the coil experience an **outwards force of 1.97 kN/m** and an **upwards force of 3.46 kN/m**. The upwards force reduces the stress on the epoxy spacer between the coils due to the coil weight (see discussion of the last meeting).
  RA asked if one can calculate the range of coil displacements that could be induced by such forces. SRa replied that he cannot easily perform this kind of calculations. It was agreed that the problem of MBW coil displacements should be kept in mind for future magnet designs, because the present design can certainly not be modified.

3 Estimates of annual proton doses (M. Lamont)

Mike Lamont (ML) revised the estimates of annual proton doses at the LHC. ML's new estimates have been published in the **LHC Project Note 375** (2005). Losses in the cleaning insertions (IR3/IR7), in the arcs and in the high-luminosity insertions (IR1/IR5) are discussed. The following mechanisms, which can induce beam losses, are taken into account: (1) beam gas scattering; (2) beam collisions at the interaction points; (3) halo production from various mechanisms; (4) Touschek scattering; (5) RF noise; (6) intra-beam scattering. The various cross-sections are calculated for the various operational conditions - such as injection, ramping, betatron squeeze, collision, etc. - and are added together to calculate the resulting beam lifetime. For example, it is found that during stable physics runs the **nominal single beam lifetime** is about **37 hours** and the **luminosity lifetime** is about **18 hours**.

In the assumption that **160 day per year** are available for physics runs, with and **operational efficiency of 70 %**, ML calculated the total number of lost protons for nominal and ultimate LHC performance. See ML's slides for details. ML's updated estimate indicates that the total number of proton lost in the cleaning insertions are approximately a **factor two lower** than what has been assumed so far. The new estimates for IR3 and IR7 are listed in the next table. Losses at injection are converted into 7 TeV equivalent losses. It is noted that the estimates for ultimate performance are about 50 % larger than for nominal performance. In the first year of the LHC operation, losses will be approximately a factor 4 less than at nominal performance.

	Nominal	Ultimate
IR3	6.3×10^{15}p	1.0×10^{16}p
IR7	2.3×10^{16}p	3.7×10^{16}p

Everybody welcomed the updated estimates of proton losses because they are approximately twice lower than what assumed so far. However, there was a greement that studies to optimize the collimation system performance should nevertheless continue with high priority, in particular in view of achieving the ultimate LHC performance.

4 Calculation of water activity in point 7 (J. Vollaire)

Joachim Vollaire (JV), who has joined the SC/RP team in February 2005 as a fellow, discussed calculations of water activation at the IR7. The water activation can be an issue at the LHC due to the high radiation environment at the betatron cleaning insertion. Notably, production of Tritium (^{3}H) and Beryllium (^{7}Be) is an issue because these isotopes have long decay times. It is noted that the ^{7}Be should be caught by the filters and hence its production could be less critical.

Simulations of water activation are carried out with FLUKA, after benchmarking with experimental data from a dedicated water activation experiment. Various water samples have been activated with secondary pulsed beams at 120 GeV and the fraction of produced radioactive isotopes has been compared with the FLUKA estimates. The comparison shows a very good agreement for the production of ^{7}Be and ^{24}Na. The ^{3}H is instead underestimated by a factor 2.5 and this is taken into account as a correction factor in the simulation results.

Water activation studies have been carried out by using Markus Brugger's FLUKA model of IR7. The model features a simplified geometry for collimators and warm magnets. Simulations are aimed at calculating the activation of the water in the various lattice elements, such as collimators and warm magnets, and of the water flowing in the ducts that pass through IR7. The following water circuits were considered:

- **Demineralized water circuit**. This is the most critical circuit because it is used for various components such as collimators and warm magnets. Simulations indicate that 6.4 ^{3}H nuclei and 0.9 ^{7}Be nuclei are produced per lost beam proton. The handling of this water requires special procedures.

- **Chilled water circuit**. This circuit is used to cool the ventilation convectors. The water activation is less then for the previous case but could be an issue because this water is also used in surface buildings.

- **Raw water circuit**. This is an open water circuit that passes through the collimation insertion. Simulations show that there are no activation problems in this case.

- **Water filling pipe**. This circuit is used to supply demineralized water to the various circuits when needed. Detailed estimates of water activation could not be done because the water flow is not defined. This water circuit is used only when needed and the water could stay for long times without being used.

In conclusion, the main issue comes from the **demineralized water circuit** used for collimators and warm magnets. The activation may reach values close to the legal limits in Switzerland. The French authorities will decide whether or not they will also accept the Swiss legislation.

RA commented that it would be much better to have a larger safety margin with respect to the legal limit of water activation. The water used to cool collimators and warm magnets should not be released. The results of the water activation simulations shall be transmitted to Paul Proudlock for the final choice on how to handle this issue.

It is also noted that the estimates of water activation presented by JV assumed larger annual proton doses than what was presented by ML (see previous section). The given number should be updated to take into account the latest proton loss scenarios.