Minutes of 2nd Collimation Upgrade Specification Meeting

Participants: R.W. Assmann (RA), A. Bertarelli (AB), G. Bellodi (GB), R. Bruce (RB), F. Burkart (FB), F. Cerutti (FC), B. Dehning (BD), B.E. Holzer (BEH), J. Jowett (JJ), E. Nebot Del Busto (EN), V. Parma (VP), L. Lari (LL), S. Redaelli (SR) (Chairman), B. Salvachua Ferrando (BS), M. Sapinski (MS), M. Schaumann,
Excused: S. Roesler (SRo), A. Rossi, L. Rossi, J.-P. Tock, D. Wollmann.

1 Analysis of ion quench MD (S.Redaelli)

Slides prepared by D. Wollmann and S. Redaelli on behalf of the MD team are available at this link. Additional supporting material: (1) slides by M. Sapinski and (2) summary table by E. Nebot Del Busto on achieved loss rates versus quench limits. N. Mokhov provided recent quench estimates of the triplet magnets based on the Tevatron experience.

1.1 Summary of the presentation

SR presented preliminary estimates of **LHC ion intensity reach** at 7 TeV based on the scaling of the maximum loss rates achieved during the ion **quench MD at 3.5 TeV** done on Dec. 6th, 2012, based on an analysis by D. Wollmann. A discussion was organized to synchronize the main massages on LHC performance reach from collimation cleaning before Chamonix2012 as this topics will be mentioned in talks by SR, RA, RB and JJ.

The summary of achieved loss rates during three attempts of maximizing losses on the TCPs in IR7 (third-order resonance method) are given in the following table, extracted from the MD note in preparation.

Ramp	Beam	$(dI/dt)_{max}$ [charges/s]	$(dI/dt)_{time}$ [ms]	Dump RS	Magnet
1	B2	2.7×10^{11}	75	RS06	Q9.L7
2	B2	2.5×10^{11}	100	RS07	Q19.L7
3	B2	4.9×10^{10}	1000	-	-
3	B1	1.1×10^{11}	200	RS07	Q11.R7

SR and DW propose to consider the case when loss rates were achieved for the longest duration of 1 s (third ramp, for B2) as opposed to the other cases when the beams were dumped the beam after 75 ms to 200 ms due to high losses. The BLM running sums (RS) that exceeded dump thresholds are given. The cases with faster losses correspond to higher loss rates in terms of charges per second but to smaller total losses. For the case with losses over 1 s, the assumed **quench limit** used to set BLM thresholds was **exceeded** by a factor 1.6 in RS09. The estimated total intensity reach for ion beams at 7 TeV is about $1.9{\times}10^{13}$ charges, i.e. **5.7 times the nominal intensity** of $3.4{\times}10^{12}$ charges. This assumes:

1. a pessimistic quench limit for the DS magnets, as wed did not quench;
2. a **factor 4.5** reduction of quench limit between 3.5 TeV and 7 TeV (A. Verweij, p. c.);
3. a **factor 2** larger energy deposition per impacting ion between 3.5 TeV and 7 TeV;

4. a **minimum lifetime of 1 h** for ion beams;
5. no change in cleaning performance of the system (the MD was carried out with relaxed collimator settings whereas at 7 TeV nominal settings will be used).

Clearly, there are various pessimistic assumptions. In particular, a factor 5 could be used for the lifetime based on the BCT measurements, giving a performance reach of **25-30 times** larger than the nominal intensity.

1.2 Discussion

The presentation triggered a lively discussion. RA commented that in his opinion (1) we should use the faster loss rates (ramps 1 and 2 in the table above) to estimate the loss rates. In addition, he considered previous estimates on quench limit scaling that indicate a factor 3 change between 3.5 TeV and 7 TeV (taking into account both contributions from higher beam energy and current in the magnet coils), i.e. a factor 3 more optimistic than the factor 9 from points 2. and 3. above. RA suggested to request a detailed presentation about the new figures if they have changed with respect to previous assumptions. In addition, RA considers that the figures presented for lifetime are too pessimistic. See as reference what was presented at the Collimation Review in June 2011.

JJ pointed out that losses from betatron cleaning are only one contribution to the performance reach: another important aspect are the losses around the experimental regions: (1) how losses from physics debris compare to the quench limits? (2) what is the magnet lifetime in presence of these continuous losses? SR suggested to compare the achieved loss peaks in the DS of IR7 during the quench test with what is measured during standard luminosity fills (**Action: SR, MS**). The item (2) requires inputs from the magnet builders.

JJ also warned that ALICE is planning an upgrade to allow a peak luminosity larger by a factor 5-6 than what was achieved. This should be taken into account for future estimates.

EN and MS pointed out that the monitor used to calculate the ratio of achieved loss rate to assumed quench limit is not the appropriate one because is it placed at an unfavorable location (see slides by MS). In addition, the onset of losses had different behaviour for the different cases achieved in the MD. RA commented that this is not relevant for the maximum intensity reach, which depends only on appropriate scaling of the total losses, but only to set BLM thresholds.

RB pointed out that recent analysis of BLM data by BS indicated worst beam lifetime achieved during the year than what originally assumed. RA suggested that in case of doubts, one should use the data from the BCT measurements and calculated manually the lifetime because the BLM method is not reliable. SR pointed out that in the past both methods were compared and the BLM method gave a factor 3–5 worst. This is why SR and DW conservatively used 1 h for the ions even if the BCT published lifetimes indicate about 5 h. SR also commented that for the BLM analysis, one should take into account the losses in the experimental regions and in IR3, as only the losses in IR7 are taken into account.

It was **agreed** on the following conclusive remarks for the discussions at Chamonix:

- The clear message that for ions there are no expected limitations from betatron cleaning should be given.

- We cannot yet conclude on the ion performance reach from losses in the experimental regions. The achieved loss rates in the DS-L7 during the MD will be compared to the losses in the DSs of IR1/2/5 to infer the margins to assumed quench limits.
- For protons, the 7 TeV predictions are still above nominal intensity but we need to review carefully the quench limit scaling from 3.5 TeV.
- For proton calculations, a minimum lifetime of 1 h should be used.

The detailed analysis of all available data will continue after Chamonix.

2 Report from CCFS meeting (V. Parma)

CCFS stands for Cold Collimator Feasibility Study. VP's slides available at this link.

2.1 Summary of the presentation

VP reported the status of cold collimator design and integration from the CCFS meeting. Even though the baseline for the integration with the 11 T dipole is based on the warm design of the DS collimator, whose development is well advanced due to the work on the combined betatron-momentum cleaning in IP3, the team is now re-considering the various options and the possibility to adopt a cold collimator design. Assuming that the new layout must fit into the length of a standard cryo-dipole (15.67 m), one could fit two shorter 11 T dipoles and 1 collimator. Preliminary integration studies indicate that a likely scenario is to use 5.3 m–long for the dipoles, the space left for the collimator would be 3.7 m for the cold design. It remains to be seen if it would better to have a arrangement like dipole–dipole–collimator (D–D–C) or dipole–collimator–dipole (D–C–D). Note that previous integration studies were based on a 4.5 m space for the warm collimator (1 m jaw).

Various technical challenges speak against a cold collimator. In particular, the vacuum behaviour seems critical. This preliminary figures must be verified once there will be a better estimate of the beam loads on the collimators. For the moment, this was only studies for the IR3 and not from the physics debris. Two different options for the collimator cooling are also under investigation: 80 K or 5–20 K. It is important to get updated figures about the expected heat loads before concluding on these options.

2.2 Discussion

RA pointed out that the layout D–D–C is preferable for optics considerations than the D–C–D. SR commented that on the other hand, for catching off-momentum beams the options D–D–C with collimator at the end could be optimized. **Action: for the two options, we need to study orbit shifts and aperture constraints.**

JJ commented that th load on the DS collimator in IP2 will be about 25 W. This will increase by a factor 5 if case of ALICE luminosity upgrade. Losses will rise rapidly when the beams are put in collision and then remain nearly constant for the duration of the fill, following the evolution of the luminosity versus time. AB stressed the importance up upgrading soon the figures of heat loads on the cold collimators. Previously, a figure of 40 W was assumed for the collimators in IR3. The possibility to have 125 W would essentially rule out the cold collimator option **Action: ColUSM team.**

Issue with reference orbit and magnet shift: action to be assigned.

3 Dry-run of Chamonix talk (S.Redaelli)

Presentation cancelled due to lack of time. See the final version presented at the Chamonix2012 workshop.

4 A.O.B.

JJ reported that Rainer Schiker from the ALICE collaboration is studying the possibility to add detectors like Roman pots in the dispersion suppressors of IR2. He contacted JJ about the possibility to take this into account in the design of cold collimator. SR suggested that R. Schiker presents details of this proposal at a dedicated ColUSM meeting so that the various teams will be informed and take this request into account early on in the collimator design. Follow up after the meeting: a tentative date (to be confirmed) was set for March 16th, 2012.

5 Next meeting

The next meeting will be held on
February 24th, 2012, 15:30–17:00.
Room: 874-1-011 (CCC).

Tentative agenda: to be announced.