116th Meeting of the LHC Collimation Study Group

May 10, 2010

Present: R. Assmann (chairman), A. Rossi (scientific secretary), , R. Bruce, O. Aberle, G. Bellodi, J. Jowett, S. Lundgren (SLAC), E. Metral, F. Cerutti, T. Wijnands, J-Ph. Tock.
Excused: D. Wollmann.

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) Update from FLUKA on cry-collimators – F. Cerutti, TE/STI
    b) Requirements for ion operations – G. Bellodi, BE/ABP

3 List of actions from this meeting

Action	People	Deadline
Look at possible changes deriving from the installation of cryo-collimators and their implications	O. Aberle	
Analyse what needs to be done to implement the combined momentum/betatron cleaning in IR3	O. Aberle	
Report on effects of power cuts (power convertor failure)	A. Masi	

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

The next meeting will be on May 10th.

Minutes of the meeting

1 Regular collimation status reports

- R. Assmann announced a weekly parallel technical meeting chaired by A. Bertarelli and V. Parma on the cryo-collimators in the dispersion suppressor regions in IR3. The goal is to confirm that there is no show stopper and to assess the feasibility for installation in the 2012 shutdown. There will be reports to the Collimation Working Group.
- Ralph asked O. Aberle if he could look into the warm sections of IR3. In particular at possible changes deriving from the installation of cryo-collimators and their implications. Furthermore, Oliver is requested to analyse what needs to be done to implement the combined momentum/betatron cleaning in IR3.

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

- No news.

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

- Collimator commissioning and setup proceed smoothly.
- More accurate settings at 450GeV could be implemented.
- Ralph reported that the collimation system is sensitive to power cuts. A power convertor failure needed an intervention. A. Masi will report on that.
- No tune shift measurements (to estimate collimator impedance) could be carried out so far.
- E. Metral added that F. Casper has made impedance measurements of TDI (see link). The results will be included in the overall impedance model of the LHC.
- Some doubts about possible damage to TCT at high energy were recently raised. The matter has been brought to LMC (see slides).
- R. Bruce will be presenting at LMC studies on settings of tertiary collimators in IR1 with crossing angle and different beta* (see slides).

1.3 Phase II activities at SLAC (T. Markiewicz, SLAC)

- The second jaw to be mounted on the 11th of May.
- The vacuum tank will be temporarily mounted to perform RF measurements that will be presented at IPAC.
- The regularity of the gap size during the rotation of both jaws will be checked before the end of the month.
- Thomas asked O. Aberle to send the procedure used at CERN to measure the torch so that they can repeat it at SLAC.
- In mid June or beginning of July there will be bake-out tests before the collimator is shipped to CERN.

1.4 Cryo-collimators integration and interfaces (J-Ph. Tock TE/MSC)

- No show stopper so far.

1.5 FLUKA studies (F. Cerutti EN/STI)

- New studies could be done on effects of misalignments.
- Benchmarking of FLUKA simulation against loss maps is planned.

2 Special topics

2.1 Update from FLUKA on cry-collimators (F. Cerutti, EN/STI) – see slides

F. Cerutti presented his last studies on cryo-collimator designs (single jaw collimator + fixed absorber or double jaw collimator).

Proton beam:

- Francesco reminded that, without cryo-collimator, a peak load of ~5 mW/cm^3 is estimated to hit on the MQ8 magnet (see also F. Cerutti presentation at the Collimation Phase II Review meeting in April 2009).
- With a double sided cryo-collimator, 1m copper jaws, the heat load to the MQ8 magnet would be a reduced from 5 to 1 mW/cm^3 (not dependent on opening below 30 σ). A further factor of 3 would be gained if tungsten is used instead of copper. With these arguments it was concluded to proceed with the design of cryo-collimators having 1m W jaw.
- Francesco also investigated the possibility of a single 1m jaw (on the inner side of the LHC ring), and one followed by a fixed absorber, 0.5m long on the external side at 15 mm opening. These solutions would offer some simplification in terms of mechanical design. Both cases show higher losses on MQ8.
- In terms of power on the cryo-collimator itself, the heat load would be reduced by 30% when going from 15 to 30 σ opening. Taking the impact distribution from T. Weiler results in 2009 (see T. Weiler presentation at the Collimation Phase II Review meeting in April 2009), one finds that when going from 30 to 15 σ opening about 50% more Single Diffractive scattered proton are intercepted. This fraction of protons (which have higher energy and smaller angles), if not intercepted, is not expected to hit the MQs just downstream the cryo-collimator, but rather to give origin to losses diluted downstream the DS regions.
- The function of a second jaw or a fixed absorber would not be to collimate directly the beam, but to intercept the shower generated at the internal jaw, and protons scattered at large angles. Given the net gain between a second movable jaw w.r.t. a fixed absorber, and the implications on collimator setup (it is impossible to centre the jaws on the beam with a single jaw collimator) it was decided to go for a double jaw design.

Ralph asked to what power we should specify the collimator, based on ultimate beam intensity. After the meeting, discussions brought to the conclusion of specifying the cryo-collimators for 200W per jaw for a maximum of 10s and 20W for continuous losses.

Lead ion beam:

- With lead ions, taking the results from G. Bellodi in 2009, the peak load without cryo-collimator is ~15 mW/cm^3 on MQ11.
- With cryo-collimator, 1m copper at 15 σ, the peak load would be ~1.5 mW/cm^3 on MQ8.
- In the case of ions, the second jaw will intercept direct ion losses, which would otherwise hit downstream the DS region.

In summary, the **cryo-collimator specifications** are:

1. Double sided tungsten jaws. The mechanical designs of both cases – one with 1m inner jaw and the second 0.5m external jaw in series, and 2 parallel 1m jaws – are being studied.
2. The jaws are specified for 200W per jaw for a maximum of 10s and 40W for continuous losses.
3. Tapering will be as for standard (Phase I) collimators.
4. No angular control foreseen.

2.2 Requirements for ion operations (G. Bellodi, BE/ABP) – see slides

G. Bellodi presented an update on cryo-collimators for Phase 2 ion collimation.

- Giulia used as starting point the study performed for the Collimation Phase II Review meeting in April 2009 (see G. Bellodi presentation), i.e. cryo-collimators installed in the DS region of IR7.

Lead ion beam:

- The power deposited at nominal ion beam parameters, for a 2 jaw collimator, is in the order of 150 W. This value goes up to ~250W for ultimate intensity.
- For copper collimators, the losses are mainly on the internal jaw:
  - TCRYO.AL7.B2: 98.9% of the total losses on this collimator will hit the internal jaw;
  - TCRYO.AB7.B2: 92% of the total losses on this collimator will hit the internal jaw.
  - Due to the different Δp/p distributions, different type of ions will impact on different collimators.
- With tungsten collimators results are similar as for copper collimators.
- Without the external jaw (i.e. with single jaw collimators), there would be losses in IR2 due to 0.2% inefficiency.

Argon 40 beam:

- The fraction of direct losses on the external jaw is much larger than for lead beam:
    - TCRYO.AL7.B2: 27% of the total losses on this collimator will hit the external jaw;
    - TCRYO.AB7.B2: 72% of the total losses on this collimator will hit the external jaw.
- The expected power deposition on cryogenic collimators (tungsten case) for the case of nominal Pb208 and Ar40 beams respectively at 7 TeV equivalent energy, 12min beam lifetime and cryogenic collimators gaps at 15 σ is

TCRYO.AR7	TCRYO.BR7	beam
180W	180W	Pb208
~1500W	550W	Ar40

  The bunch intensities assumed are of 7E7 ppb (Pb208) and 2E9ppb (Ar40), which would give a scaling factor of 6.3 in power deposition between the two cases (disregarding any differences in the physical processes of the two ion species.).
- As soon as new matched optics files are available, Giulia will repeat the simulations for IR3 and combined betatron/momentum cleaning.