# 115th Meeting of the LHC Collimation Study Group

April 26, 2010

*Present*: S. Redaelli (chairman), A. Rossi (scientific secretary), D. Wollmann, R. Bruce, O. Aberle, A. Bertarelli, A. Dallocchio, G. Bellodi, J. Jowett, H. Day, S. Lundgren (SLAC), E. Metral, N. Mariani, R. Appleby, R. Versaci, K. Roeed, V. Vlachoudis, F. Cerutti, V. Parma, G. Bregliozzi.
*Excused*: R. Assmann, K. Kershaw, J-Ph. Tock.

## 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
    f) FLUKA work

2. Special reports :
    a) Warm/Cold losses at 3.5TeV – FLUKA team
    b) Results from collimation setup – D. Wollmann, BE/ABP
    c) Generating machine collimation settings from beam data – R. Bruce, BE/ABP

## 3 List of actions from this meeting

| Action | People | Deadline |
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(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

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

- The sorting of cabling (on resolver modules) for collimators TCTH.4L8.B1 and TCTVB.4L8 will be performed by A. Masi during the 3 days access foreseen this week (week 17). (DONE)

### 1.2 Remote and beam commissioning (S. Redaelli BE/OP)

- The collimation system is working nicely.
- The hardware does not show any problem, a part from the cabling errors mentioned above.
- The system was qualified at top energy (3.5 TeV per beam), squeezed beam (beta* = 2m in all IPs), 3 bunches of 1E10 p/b. A gain of a factor of 10 in luminosity has been achieved. See also the LHC Programme Coordination web pages at http://lpc.web.cern.ch/lpc/.
- There are no known issues that would prevent us to go to higher intensity (nominal LHC bunch).

### 1.3 Phase II activities at CERN (A. Bertarelli, EN/MME) – see slides

#### Cryo-collimators

- A. Bertarelli showed a preliminary study on Cryo-collimators, comparing warm (room temperature) and cold solutions.
  Room temperature collimators:
  - They start from the assumption of 1m long Tungsten jaw, without 5$^{th}$ axes motor (there would be interference with the other beam line), RF connections as for the other warm collimators.
  - Alessandro favoured a design with single jaw collimators as it would reduce the overall complexity. Single jaw (on the inner side of the ring) collimators should be suited for proton operations (see T. Weiler presentation at the Collimation Phase II Review meeting in April 2009).
  - J. Jowett pointed out that for ions we need 2 jaws (see G. Bellodi presentation at the Collimation Phase II Review meeting in April 2009). Moreover in IR2 we would definitely need a second jaw.
  - F. Cerutti added that he estimated that a fraction of the protons will be deflected on the outer side of the ring (results will be presented in the next meeting).
  - Preliminary studies on a separate second jaw (including a fixed absorber) on the outer side of the ring have been launched. The disadvantage would be that the two jaws would be independent and require separate alignment, making therefore difficult centring them on the beam axes.
  - Questions from Alessandro:
    - Is cool-down before collimator installation possible? Safety issue?
    - Do we need to bake-out? (G. Bregliozzi reply that this is necessary if the room temperature solution is chosen).
    - Is 200mm tapering necessary?
    - Are BPM's needed at cryo-collimators (S. Redaelli replied yes, since there are no other BPM close by).

  Cold temperature collimators:
  - For the fully cold design, the jaw is attached to the E-line (60 K) via a heat dissipater in Copper and an Aluminium plate.
- It was pointed out that Tungsten becomes fragile at low temperature.
- J. Jowett added that for ion operation a heat load of 25W for 10h is foreseen.

### 1.4 Phase II activities at SLAC (S. Lundgren) – see slides

- Tank assembled with BPMs and TT4.
- EM mounted on RC1 prototype.
- Actuator in place and tested on rotatable jaw.
- Coming up in the next month:

- Mount RF Foils to RF bearings and determine which material and thickness is most suitable
- Weld Flanges on to BPM Housings
- Mount jaws, tank and BPMs for Stretched Wire tests.

### 1.5 Cryo-collimators (V. Parma TE/MSC)

- V. Parma said that they are reviewing the concept presented by A. Bertarelli in terms of cryo-continuity and vacuum.
- They are also revisiting design of bass bars to try and make it more compact.
- A regular weekly meeting is being put in place. A representative of the Collimation Team should be named to give inputs for the specifications. J. Jowett asked to be invited for issues concerning ion operation.

### 1.6 FLUKA studies (F. Cerutti EN/STI)

- Studies on a possible 0.5 m Tungsten absorber are ongoing. The results will be presented soon.

## 2 Special topics

### 2.1 Warm (update) & cold losses at 3.5 TeV (K. Roeed EN/STI) – see slides

*K. Roeed* (fellow working in the FLUKA team) presented on behalf of the FLUKA team the latest results on direct proton losses on warm and cold sections in IR7, for 3.5TeV beams.

Warm losses:

- Dose to MBW & MQW coils from showers are estimated to be a factor 2-3 lower than at top energy.
- The MQW aperture used in FLUKA is consistent with drawings and 0.5mm larger than what used by SixTrack.
  A. Rossi commented that the aperture used in SixTrack is extracted from the database and may contain tolerances.
- The highest load from direct proton losses is seen by last quadrupole in Q5 (MQWA.A5L7)
- The peak dose from direct proton losses is found to be negligible with respect to losses induced by collimator showers(two orders of magnitude lower)

Cold losses:

- Losses in the cold regions come mainly from single diffractive (SD) scattering.
- At 3.5TeV and nominal intensity the peak power deposited in the cold sections is larger than at 7TeV, consistently with cross section probabilities for SD events.

### 2.2 Collimator setup for 450GeV and 3.5TeV - Results (D. Wollmann BE/ABP) – see slides

*D. Wollmann* presented on behalf of the Collimation Team, presented the procedure used to set up collimators centred on the beam and some results on beam position and size as measured with collimators, as well as beam losses.

- The setup performed after the reference orbit and optics are established.
- Future setups (with same beam parameters) rely on the reproducibility of orbit and optics (so far proven very good). The beam position has been measured to vary less than 200 μm over different fills.
- So far no re-alignment has been necessary.
- It has been possible to inject at these low intensity with TCP's set at 6 σ (nominal).
- 450 GeV setup: TCLA's (downstream of other collimators) are moved to a nominal gap of 4.5 σ to determine a known edge of the beam. The other collimators are moved one by one, proceeding in the opposite direction as the beam, to the edge of the beam. The real beam size is recalculated and the collimators retracted to the number of beam σ pre-established by collimator studies. The hierarchy of the collimators is rechecked after the setting.
  - Some discrepancy between measurements of the beam centre position from BPM's and during collimator setting may be due to differences in relative alignment.

    - The beam size so measured was compared to independent measurements (beta-beat measurements) and to the expected values. For beam 1, the collimator setting gives consistently smaller values.
    - The verification of the setup was carried out by creating 'slow' betatron and momentum losses (varying the tune or the RF frequency respectively) and errors could be found and adjusted.
- 3.5TeV setup: procedure modified due to the small beam size and very slow repopulation of the halo, which cause scraping deeper and deeper into the halo during setup, so that reference edge is no longer defined by TCPs but by last collimator moved into beam.
    - Measure only beam centre; and set collimators to intermediate settings with nominal beam size at 3.5TeV.
    - For TCT's setup the reference TCP's were also moved to the beam edge after each collimator centring to make sure they remain the primary collimators.
    - Beam excitation during setup would speed up the repopulation of the halo but can lower the life time.
    - Current 3.5TeV collimator setup shows leakage into SC arcs and experimental regions during momentum losses.

## 2.3 Generating machine collimation settings from beam data (R. Bruce, AB/ABP) – see slides

*R. Bruce* showed how he implements settings automatically.

- Collimator jaw positions, warnings and dump thresholds need to be defined in the control system.
- Settings are generated automatically since
    - They depend on the machine optics, emittance and running conditions (injection/collision).
    - During ramp, settings and thresholds change as a function of beam energy.
    - Settings and functions (time dependence of the settings) need to be changed after every modification of the optics.

No beam time has been yet reserved to test the functions that he produced.