LHC-Beam Commissioning Working Group

Notes from the meeting held on
22 June 2010

Present: Ralph Assmann, Roger Bailey, Wolfgang Bartmann, Chandra Bhat, Luca Bottura, Andy Butterworth, Guy Crockford, Laurent Deniau, Lene Drosdal, Lyn Evans, Marek Gasior, Rossano Giachino, Massimo Giovannozzi, Brennan Goddard, Werner Herr, Wolfgang Höfle, Lars Jensen, John Jowett, Emanuele Laface, Mike Lamont, Malika Meddahi, Gabriel Mueller, Lasse Normann, Giulia Papotti, Mario Pereira, Mirko Pojer, Bruno Puccio, Rüdiger Schmidt, Elena Shaposhnikova, Matteo Solfaroli, Ezio Todesco, Jan Uythoven, Jörg Wenninger.

Excused: Carmen Alabau, Gianluigi Arduini, Reyes Alemany, Tobias Baer, Philippe Baudrenghien, Oliver Brüning, Helmut Burkhardt, Chiara Bracco, Rama Calaga, Pierre Charrue, Ed Ciapala, Bernd Dehning, Octavio Dominguez, Stephane Fartoukh, Massimilano Ferro-Luzzi, Kajetan Fuchsberger, Per Hagen, Eva Barbara Holzer, Delphine Jacquet, Verena Kain, Thibaut Lefevre, Yngue Levinsen, Alick Macpherson, Ryoichi Miyamoto, Laurette Ponce, Stefano Redaelli, Stefan Roesler, Adriana Rossi, Mariusz Sapinski, Frank Schmidt, Andrzej Siemko, Katarina Sigerud, Ralph Steinhagen, Marek Strzelczyk, Rogelio Tomas, Glenn Vanbavinckhove, Walter Venturini Delsolaro, Simon White, Uli Wienands, Daniel Wollmann, Marco Zanetti, Frank Zimmermann.

1- Comments and follow-ups from last meetings

- Pierre Charrue (by email): control issues with WorldFIP:
  - 1 May: WFip failure was due to a bad cabling in a connector of the QPS. The QPS team fixed the cabling and since then the WFip is working OK.
  - 16 June: a WFip repeater (PO) stopped working and had to be replaced. The Controls group could not trace the fault in the repeater which was then sent back to the manufacturer for deeper analysis. More news soon.
  - 20 June: a WFip repeater (Cryo) had its power supply exploded and had to be replaced. This repeater is also sent to the manufacturer for deeper analysis. The Controls group is also in contact with the electrical group to make sure there was no overshoot in the mains which could have explained this incident. More news soon.
- 10 A/s: Start the commissioning of the 10A/s during the ramp down combo and Pre-cycle, as soon as stable luminosity operation is on-going. But not yet to be implemented in the ramp.

2- Highlights / Issues from the last week of operation – Malika Meddahi – Gianluigi Arduini (slides)

- **Injection**:
  - Robust over-injection of 2b of 1e11 with all TDI BLMs unmasked (problems yesterday? Some transfer line instability issues?). Chromaticity at injection sets to 2 for both planes both beams.
  - The use of the transverse damper at 450 GeV is very effective (last night the recorded emittance were: B1: H= 2.6 & V= 2.1 B2: H= 3.0 & V= 3.0). The RF transverse damper synchronisation is to be sorted out (piquet to be called each time; RF controls problem). **Follow-up: Wolfgang Höfle**
    To be done (Wolfgang Höfle): 1 remaining PU to be commissioned; Noise reduction; Vector sum mode of operation to increase bandwidth of the system

- The qualification of the beam dumps from extreme orbit positions at point 6 (TCDQ), for parallel and angled bumps has been performed for both beams of 1e11 (Brennan Goddard and team). Bumps were driven in 0.5 mm steps until orbit excursion interlock in P6 triggers. The beam dumps looked very clean from the losses. Investigations are going on to clarify the B2 positive vertical angled bump which causes an interlock on the wrong BPMS - BPMSA.R6 and BPMSB.L6 crossed? **Follow-up: Brennan Goddard + BI**.

  To be done:

  Injection systems: Brennan Goddard + team
  - Priority 1: TDI alignment checks wrt beam loss measurements
  - Priority 2:
    - Injection steering clean-up, followed by TCDI (TDI, TCLI?) verification
    - Access for MKI8 kicker delay jitter measurements

  Beam dump systems: a few remaining MPS checks to perform at 450 GeV.

- **Ramp**:
  - Robust ramp – repeated several time with reproducible performance – still some continuous blow-up. The chromaticity was measured and feed-forward corrections had been applied (3 systematic iterations, Gianluigi Arduini and Ralph Steinhagen). The chromaticity is now controlled to 2 at injection, along the ramp and at 3.5 TeV
  - Transverse damper, long. blow-up, tune and orbit feedbacks are ON through the ramp : smooth. The gain on the damper has been reduced along ramp (less broad tune peak)
  - Longitudinal blow-up is triggered by the start ramp event – switch off automatically at the end– and is very effective. (Andy Butterworth, Elena Shaposhnikova, Philippe Baubrenghien and teams). The bunch length decreases from 1.6 ns during the ramp and the long. Feedback is keeping it at around 1.4 ns
  - To follow-up:
    - The continuous small transverse blow-up
    - Longitudinal beam blow-up: beam time in parallel with the regular operation to fine tune the method
    - Potential issue observed with peaks appearing on the tune spectrum at ~50 Hz multiples perturbing tune tracking with damper ON. No additional blow-up observed (instrumental issue?)
- **Squeeze and beyond**:
  - Robust squeeze to 3.5 m – Tune, orbit FB on - One stop at 7 m to drive the collimators
  - Collapse of the separation bumps – beam observations in the next talk by Werner. After each bump collapse, the non-closure was corrected with the separation's knob correctors.
  - Luminosity scans performed for all IPs – Introduced after the bump collapse action
  - Introduced the crossing angle in IP1 (-100 μrad) and IP5 (+100 μrad)
  - Saved a new reference orbit
  - Beta beating measurements: R. Tomas, R. Miyamoto, G.Vanbavinckhove
    Beta beating below 20 % in H plane and below 30 % in the V-plane (similar to 2 m after correction) - possible localized errors in IP2 and IP8. Also it was the first time that the amplitude of the chromatic beta-beating wave was computed. Brennan Goddard: How these measurements compare with the beta beat values measured during the squeeze (e.g. 5, 2.5m)? **Follow-up: Rogelio Tomas**.
- **Protection devices:**

- **Collimators**: Ralph Assmann, Roderik Bruce, Stephano Redaelli, Daniel Wollmann
  - Performed and completed the setting-up of the collimators at 3.5 TeV, unsqueezed
  - During the squeeze (at 7m) the TCTs are moved as protection for the triplets (to settings equivalent to 15 sigma nominal half gap at 3.5TeV).
  - Performed and completed the setting-up of the collimator at 3.5TeV, squeezed, with separation on.
  - Re-calibration of the TCT's at 3.5 TeV, 3.5 m with separation off, crossing angle, collision rate optimised - All tertiary collimators were adjusted to the new golden orbit –
  - Added the position thresholds for squeeze and physics settings of the tertiary collimators. Limits adjusted to +-0.5 mm around target positions
  - TCDQ function with modified settings from Brennan for Wed 23rd
  - Adapted sequences to include threshold settings and checked sequence operation
  - Loss maps showed correct hierarchy for the collimation system
  - Beam-based work finished for collimation, given golden orbits and optics. Ready for stable beams from collimation side
- **Asynchronous beam dump at 3.5 TeV**: Brennan Goddard &team

  In progress: 1 of 2 tests done together with analysis.

  Conditions of the 1st test: 2.5e10 in single bunch per beam, squeezed 3.5m, colliding etc. TCSG/TCDQs set with ~0.5 sigma (real) retraction. A 2mm orbit bumps were introduced at the TCDQs to move the beam away from TCDQ by 3 sigma. The filters introduce on the P6 BLMs worked nicely - not saturated. As expected, a large leakage around P6 was measured and the only other losses around ring were localized on the collimators and TCTs. The loss factors between TCDQ/TCDS and TCTs were between 4e-4 and 4e-7. A factor 4e-4 from TCDQ to TCTH.4R5.B2 suggests that a maximum of 0.4% of a single bunch can impact TCT, until we move to bunch trains. This agrees with expectations. More detailed analysis in on-going on the results, especially concerning quench limits, BLM thresholds and behaviour of BLMs with filters. From this test, Brennan Goddard concluded that no problems were seen with the dump protection setup.

  Injection to collisions: Comments:

  Elena Shaposhnikova: over the last days, the longitudinal SPS beam blow up was too large. The ramp should not start with a bunch length of 1.8 ns but 1.6 ns. Otherwise, indeed uncaptured beam is observed during the ramp;

  Ralph Assmann - Brennan Goddard –Jörg Wenninger: Need to have a new sequence driving all the new settings (manual typing is the source of possible errors) and should be included in a sequence (for the moment, it takes 45 minutes by hand): **Action: Mike Lamont**;

  Margin for the luminosity scans is still 5 sigma. At 3.5 m need to be revisited to define the space allowed for luminosity optimization;

  Rüdiger Schmidt: BLM threshold to be re-revisited to avoid becoming a limitation in the future;

  Wolfgang Höfle: Emittance measurements should be taken with care as they strongly depend on the gain sets in the Wire Scan application during the measurements, and seems to change during the ramp, changing the resulting data. What should be taken? Same question was asked concerning the BRST results on emittance measurements. **Follow-up: BI.**

3- Observations with colliding beams – Werner Herr (slides)

Werner Herr reported on the observations made during the first high intensity collisions at β^*=3.5m. With IP 1 and IP 8 separation bumps collapsed, when collapsing in turn the separation bump in IP 2, a decrease in intensity was measured. Same observation was made when at last, IP 5 separation bump was collapsed. These losses happened when the beams were put into collisions (i.e. when the luminosity scan values were added). An emittance increase was measured in both planes, more pronounced in the vertical planes. But again measurements have to be taken in care (**BI** to check the emittance measurement conditions vs gain).
Summary of the observation made during collapsing bumps: No problems initially. Before collapsing IP5, tune split of 0.002 was applied. The beam loss observed when lumi-scan trims were applied, looked like a transient but coherent motion, and quickly damped.
Reminder:

- Tune split can avoid coherent oscillation driven by beam-beam, not an excitation;
- Tune split already from unequal collision pattern;
- The applied tune "split" brings beam 1 and beam 2 together!

Summary of the observations made during the introduction of crossing angles:

- No effect on beam lifetime, rather well closed, small coupling into other plane;
- No additional transverse scan required;
- Expected loss of luminosity: 0.5%, consistent with observations;
- Don't be afraid of crossing angles, they are just bumps!

Recommendations towards higher intensity:
The working point is not necessarily optimized: must make tune scan to find the best tunes for this configuration, checking on lifetime, background, luminosity …
Have to find a strategy to collide beams: All at once? To be tried first? Fast or slow?
Define a strategy for implementation of tune trims, orbit trims, IP optimization etc.
Discussion:
Lyn Evans: when the working point is better understood and defined, a “preventive” tune correction should be put in before colliding the beams. Orbit offsets are also bringing side effects which make the b-b effects worst.
Werner Herr: To not use the ADT while beams are in collisions.
Ralph Assmann: should switch off the octupoles, and at least reduce their strengths. Beams could be put in collisions longitudinally as well.
Strategy for next fill: 3 bunches per beam, switch off the octupoles and then put the two crossing angles, collapsed all the separation bumps at once and introduce the luminosity scan values.

4- LHC beam commissioning plan for the summer – Mike Lamont (slides)

In the next days, the LHC should be moving to nominal intensity multi-bunch operation. LHC should be steadily running at, or around, 1MJ over the summer and a certain period should be spent in accumulating experience at this level, in order to check how stable and reproducible the machine is. It was proposed that in parallel, train commissioning is introduced during August. It could be done in parallel with the setting-up of the ramp at 10A/s.
Tentatively: Week 26: 4x4 bunches; Week 27: 8x8; Week 28: 12x12; Week 29: TS; Week 30: 20x20; Week 31-34: 24x24.
Ralph Assmann: Important to try the 20x20 scheme (>1 MJ) before the week 29 Technical Stop to make sure there is no problem before all experts are gone.

Daily 8:30 HWC meeting in the CCC conference room (09:00 at weekends).

NO MORE 17:00 meeting. Next meeting: **29 June 2010,** 15:30, 874-1-01.

Malika Meddahi