LHC Beam Operation Committee

Notes from the meeting held on 21st February 2012

Participants

1. Summary of 2011 commissioning and proposal for 2012 – J. Wenninger (slides)

J. Wenninger presented a first proposal for the 2012 machine re-commissioning. The draft schedule foresees 21 days of commissioning and 3 days of scrubbing just before Easter. Powering tests are expected to finish in week 10 then few days are left for machine checkout (LBDS, RF, etc.). DSO tests will start next week on March 1st and 2nd.

J. Wenninger addressed the question about which β* will be used reminding that 3 options were considered: 0.9 m, 0.7 m and 0.6 m. He explained that the biggest step is to move from 0.9 m to any smaller β* since tight collimator settings (already tested last year during end of fill studies) will be required and some issues are expected during the squeeze (i.e. orbit control and impedance). Moving from 0.7 m to 0.6 m requires some re-arrangement of the TCT collimators and determines a loss of retraction margin by 0.5 σ and a higher pile-up at the experiments. The proposal is to prepare both squeezed optics and to make the commissioning until 0.6 m with low intensity. Operation will then initially be performed with β* = 0.7 m with the option, if everything works fine, to move to 0.6 m later in the year.

Some other questions were arisen about the ALICE crossing angle (90 μrad ok?) and the change of the polarity of the vertical crossing angle in LHCb. J. Wenninger explained that, in order to avoid to have two separate TCT settings and to be able to go back easily to the old configuration, the polarity change should be done after collision. The option of having a crossing angle at 4 TeV in IR8 <220μrad is analyzed (any beam-beam problem?).

Concerning the bunch length, it was proposed to start with 1.2-1.25 ns and test longer bunches later.

The usual strategy will be used for the commissioning: (low intensity setup, injection, collimation, dump and then intensity ramp up) and some dedicated shifts will be used for BI, ADT, decay measurements, aperture measurements, loss maps and asynchronous beam dump.

J. Wenninger concluded explaining that IMPACT will be active during the full year of operation in order to keep track of the accesses. The coordinators will collect all the requests and sign IMPACT when the access will be needed.

Discussion:

R. Alemany Fernandez commented that, according to her studies, the TCT settings in IR8 should not depend on the separation in the vertical plane: one TCT setup should be enough for both polarities.

J. Wenninger answered that this is not the case since separation is needed in both planes when changing the polarity before collision. To be rechecked.

T. Pieloni commented that the beam-beam related effects for an angle <220μrad in IR8 should be tested with a train of several bunches; this would also allow to define the minimum achievable angle.
J. Wenninger answered that this would require at least 48 bunches while the answer should come earlier during the commissioning.
J. Uythoven asked if the only reason for operating with longer bunches is the evaluation of any heating effect.
J. Wenninger confirmed.
S. Fartoukh asked at which point of the commissioning schedule the ocutpoles will be tested.
J.Wenninger answered that this will be done during the intensity ramp-up.
A. Macpherson asked if high intensity beams should be produced in the SPS from the beginning of the commissioning period and if the option of dedicated super-cycles for the LHC filling is already foreseen.
J.Wenninger replied that the bunch intensity increase in the SPS will be done after the commissioning and that no decision has been taken yet about dedicated super-cycles.
E. Todesco asked the reason to go back to 0.7 m β* after the commissioning down to 0.6 m.
J. Wenninger answered that the main reason are the lower pile-up and the slightly better collimation tolerances.
S.Redaelli commented that it would be interesting to test ramp and squeeze down to 0.60 m also with higher intensity.
B. Gorini pointed out that experiments could make some pressure to use the 0.6 m optics; they would prefer a higher pileup (with some leveling) and a smaller β*.
S. Fartoukh suggested to close the secondary collimators to tight settings during the squeeze instead of during the ramp.
S.Redaelli replied that no particular issue is expected when applying tight settings already during the ramp. The highest losses were indeed observed during the squeeze. Tight settings during the ramp would allow to better distribute the losses.
J. Wenninger confirmed this and explained that it could be envisaged to close the primary collimators tighter for a short period to clean the beam halo and avoid loss spikes induced by 100 μm orbit jitters at the TCT during the squeeze.
S. Fartoukh asked if, in terms of aperture, a purely vertical crossing angle in point 8 at injection is possible.
V. Kain answered that this would create problems with the setup of the injection protection collimators (different for different polarity).
A. Siemko asked what will be the IMPACT policy for the piquet.
J. Wenninger explained that a special IMPACT is foreseen for the piquet and will allow to keep a history tracking for any status change (active/ non active).
J. Jowett confirmed that 90 μrad external angle with 3 m β* is ok for ALICE.

2. Re-commissioning of the LBDS and injection system – W. Bartmann (slides)

W. Bartmann presented the plans for the re-commissioning of the LHC injection and dump systems after the Christmas technical stop. He concentrated on the checks

with beam but reminded that a long list of tests without beam is foreseen to verify the status of the systems.
W. Bartmann highlighted that, beside the standard checks (see slides), additional tests will have to be completed to validate hardware and software modifications, new features, procedures and instrumentations. In particular:
- Dump system: new TSU firmware, TCDQ jaw re-calibration and β* interlock, new AGK window, TCDQ checks before any serious asynchronous beam dump, procedure in case of not working dump and measurements of the extraction channel aperture.
- Injection system: aperture scan with TDI jaws open (beam screen deformation), calibration of diamond detectors, TCLIA angular scan and separate beam process for injection protection collimators.
In total 7.5 shifts for machine checkout and 9 shifts for commissioning tests with beam have to be taken into account. Checks on TL stability can be done before having beam in the LHC (to the downstream TED).

Discussion:

W. Bartmann asked if β* values are already published and available for testing the new TCDQ interlock.
J. Wenninger confirmed that simulated β* values are ready and added that the interlock should be tested during the machine checkout period.
S.Redaelli commented that the β*interlock is needed only when moving the TCDQ during the squeeze while, at present, these collimators are closed during the ramp.
B. Goddard agreed but added that the TCDQ will have to be closed during the squeeze for the ATS optics MD.
S.Redaelli asked if the aperture checks at the TDI are for circulating or injected beam.
V.Kain explained that the aim is to evaluate if the overall lowering of the beam screen has any effect on the available aperture. Checks will be done with circulating beam but will be valid also for the injected one.
W. Bartmann added that this measurement should provide information also for understanding the TCLIA losses issue.

3. RF and ADT 2012 commissioning – T. Mastoridis (slides)

T. Mastoridis reported on the main changes which were applied to the RF system during the Christmas stop (modified klystrons, all LEP drivers and power supplies replaced, new cabling and dedicated bunch-per-bunch phase measurement) and explained that supplementary tests have to be added to the standard commissioning to check the new functionalities. One of the most outstanding upgrade of the system consists in the new longitudinal blow up that should allow more flexibility and a better control of the bunch length during the ramp (possibly improve heating, could reduce emittance increase due to IBS if used in batch-by-batch mode at injection).
T. Mastoridis spoke also about the bunch length and beam induced heating issue. He explained that, in order to quantify any eventual effect on the MKI and the beam

screens, the RF team proposes to start operating with 1.2-1.25 ns (as last year) and then increase and decrease the bunch length by 100 ps. A bunch length leveling scheme (acting on the voltage) is being discussed to keep the bunch length as constant as possible during physics.
T. Mastoridis presented the status of the ADT works planned for the Christmas stop and the proposed commissioning strategy (3-4 shifts required, see slides for details). He highlighted that a huge re-cabling campaign was prepared for LS1. The cables for 2 unites were replaced during the Christmas TS achieving noise reduction and cleaner response for the BPM.

Discussion:

S. Fartoukh commented that luminosity leveling could be obtained by varying the longitudinal offsets of the 2 beams.
G. Papotti reminded that this option would not allow for an independent leveling at the different IPs.
J Uythoven reminded that, even if in contradiction with the theory, an evident reduction in the MKI heating was measured as a consequence of bunch lengthening during a long fill (July 2011).
T. Mastoridis commented that it is difficult to tell if the heating was really due to longer bunches or to high frequencies in resonance with the kicker, so it would be helpful to repeat the steps from last July. Moreover, the readings of some temperature sensors were doubtful and should be rechecked.

4. Considerations for the optics commissioning at $\beta^* = 0.6$ m – G. Vanbavinckhove on behalf of R. Tomas Garcia (slides)

G. Vanbavinckhove presented, on behalf of R. Tomas Garcia, results on studies for the commissioning of the 0.6 m β^* optics. He explained that a good reproducibility of the injection optics was observed (<4%) but that old corrections (2010) are still applied while a new more stable optics has been deployed. Old corrections will be removed and new ones will be computed and implemented.
G. Vanbavinckhove reported on the ATS MD with $\beta^* = 0.4$ m. He explained that the MD was partially successful only for Beam 1: the calculated corrections reduced the beta-beating but the phase beat increased significantly in IR5. A closer look to IR5 allowed to discover that local corrections are stable up to 1.5 m but need to be recomputed for any smaller β^*. Based on this a commissioning strategy was proposed and consists in re-measuring the optics of the virgin machine throughout the LHC cycle, compute and apply local corrections versus β^* and apply global corrections at 0.6 m (5.5 non consecutive shifts: time for calculating and "digesting" the corrections before applying them, 2-3 days between local and global corrections).

Discussion:

E.Todesco asked if the triplets were used for the corrections
G. Vanbavinckhove confirmed this.

E.Todesco commented that he would not expect different corrections for β*<1.5 m since the current of the triplets stays constant. He asked to be provided with the transfer function variation to check if any compensation is possible.
S. Fartoukh explained that the effective correction changes as an effect of triplet longitudinal misalignment.
He asked if spurious dispersion is included in the correction of the beta-beat.
G. Vanbavinckhove answered that the correction for the horizontal dispersion is included in the local and global correction, in the sense that it is not spoiled nor further improved by the beta-beating correction.
R.Calaga added that pure beta-beating corrections would spoil the dispersion. Dispersion has anyhow to be big enough and not just at the noise level to be efficiently implemented in the corrections.
S. Fartoukh further commented that the global beta-beating correction indeed takes care to minimise the impact on the existing dispersion but not to correct it towards its nominal value.
During the last ATS MD (beta*=40 cm), S. Fartoukh added that peak dispersion up to 1.6 m was measured in the inner triplet (still w/o crossing angle), which is something to be worried about.
V. Kain commented that it would be interesting to know and include dispersion also at location of wire scanners.
G. Vanbavinckhove replied that this is already possible if dispersion measurements are conducted (extra time needed).
E.Todesco asked why correction for Beam 1 and Beam 2 differ.
G. Vanbavinckhove answered that the global correction is not done with common elements while the local correction is done with the common elements. No common correctors could be used as the global correction was computed for both beams separately

5. LHC beam loss pattern recognition application – M. Nagel (slides)

M. Nagel introduced a pattern recognition method for analyzing unknown loss profiles using the contribution of known loss scenarios as reference (loss maps during horizontal and vertical resonance crossing). He gave a detailed explanation of the method and techniques adopted and explained that any loss profile is considered as a 4D vector containing the loss under investigation, the reference scenario, linear combination of known losses and similarity with respect to reference (see slides for details). M. Nagel presented some practical examples and showed that this method gave a good response in all the cases analyzed.
A JAVA application which allows to select different references and perform online and offline analysis has been developed; first results are promising and the application could be used for collimation hierarchy checks.

Discussion:

J. Jowett asked if loss patterns different from the four bases vector, corresponding to b1 and b2 loss maps, can be considered.

M. Nagel answered that investigation is ongoing for IP3 longitudinal losses.
B. Holzer added that A. Marsili is studying the option of using IP3 and all the TCTs as canonic vectors (horizontal, vertical and longitudinal losses) to take into account luminosity debris and vacuum losses.
A. Siemko asked what is the sensitivity of the model to the reference vectors and if any information is provided in case of non-proper match.
M. Nagel answered that an error line s present which defines the good correlation between the loss pattern analyzed and the reference.
J. Wenninger asked if new reference could be added in the JAVA application.
M. Nagel answered that it is always possible to add, manually, new references.

6. Next meeting

Tuesday, 28/02/2012: **LBOC meeting (15:30 in 874-1-011)**.