LHC Beam Operation Committee

Notes from the meeting held on 8th March 2011

1. Comments on commissioning

Jorg summarized the actual situation at the LHC:

- Rogelio and team will try to determine possible differences β* of IP1 and IP5 with k-modulation measurements and AC-dipole measurements of the β–functions and equalize them at a value of 1.5 m at IP1 and IP5 if needed
- The collimation set-up is proceeding well and everything will be prepared by the end of the week.
- It is planed then to smoothly move to stable beams. After discussions at the rMPP meeting level it is decided to start collisions with few number of individual bunches over the week end then move to more next week. Massi is preparing the filling schemes for physics runs. A 8 bunch injection is under commissioning at this moment after injection tests will be performed on trains of 24 bunches.

2. Aperture measurements – R. Bruce (slides)

Roderik presented the results of the aperture measurements performed over the last days. The measurements can be distinguished between Global aperture measurements and Local measurements at the IRs triplet locations. For both measurements he described the experimental set up and he highlighted 3 different analysis normalizations ("methods") he applied to the data. Results obtained were compared to 2010 results.

- **Global aperture measurements:** They set all primary collimators (Target Collimator Primaries) with open jaws and they induce a beam transverse blow-up by crossing the 3rd order resonance with the circulating beam. The signals from the Beam Loss Monitors along the machine are recorded and they identify aperture bottlenecks along the machine. Then they start closing the primary collimators in defined steps to enhance the losses at the TCPs until the aperture bottleneck is shadowed by the TCPs. The known gap of the collimator defines the aperture of the machine. The data coming from the BLM system are analyzed by using three different normalizations and they all agree in within 1 σ. The locations of the machine bottlenecks are consistent with 2010 measurements and the aperture amplitude consistent with 2010 values.
- **Local aperture measurements at triplet locations:** with all collimators retracted, the global aperture is known from previous measurement: they apply orbit bumps in steps of known amplitude and they monitor the losses at triplet magnets and at the global machine bottlenecks with the BLMs. When the triplet aperture is reached it shadows the global one, then the triplet

aperture is defined as the sum of global aperture plus the orbit excursion. The BLM data are then analyzed using three different normalizations as for the previous case. The 2011 measurements show 1 σ larger aperture at IP1 and IP5 triplets than what assumed in Evian. Only IR8 shows bottleneck at the TCTVB.4RB and not in the triplet, which is not understood yet.

Conclusions: the global measurements of 2011 show the same bottlenecks as in 2010, with a machine aperture around 11.5-13 σ, while in 2010 it was found to be up to 1.5 σ larger. A finer analysis is needed. The local scans in the triplet magnets show that the aperture in the triplets is above 15 σ, at least 1 σ larger than the assumptions made for EVIAN calculations. Nevertheless, they need to study implications to β*.
Future Work: the aperture at the triplets will be checked using the bump method as proposed by S. Redaelli defining the beam edge using the primary collimators and increasing the bump amplitude till losses are observed. The same method has been used in 2009. Another verification as proposed by Ralph is to measure in the dispersion suppressor downstream of IR7 in the region of the highest cleaning inefficiency, this will be done in the next days.
All results should then be compared to 2009 measurements.
Comments:
Concerning the methods used: S. Fartouk expressed his doubts about the method used for the global aperture measurements to produce a beam blow-up by use of the 3rd order resonance because there is no knowledge of the beams shape with this method and it is not controlled. R. Assman answers that for this measurements they do not need to know the beam shape the aperture in sigma of the beams comes from the nominal position of the collimators moreover they look at 1-2 sec losses which give high statistics and a phase space mixing of particles during this time is expected. G. Arduini commented that a controlled transverse blow up of beams to induce the losses would be preferable. R. Schmidt also mentioned that collimation should also rely on cryogenic system instrumentation outputs, which can detect losses.
Concerning the aperture results: Jorg expressed his satisfaction to see the extremely big aperture at the triplet locations, which is consistent with what was measured in the past with the bump method with S. Redaelli in 2009 (slides have been shown). Jorg showed also how the 2009 results compared to the machine mechanical aperture. At that time they found a practically zero orbit (assumptions where always for a 3mm excursion) and tolerances far better than what specified and in perfect agreement with mechanical aperture model. Brennan asked how one translates these aperture values in n1? Ralph explained that the n1 evaluation comes from assuming 3mm orbit excursion, which is much smaller, and better tolerances than specifications. They still need loss maps for β* of 1.5 m at injection, and if no leakages are found at the triplets then the machine is in safe status. Jorg confirmed they will check with bump method at least at one triplet location.

3. Recent LBDS triggering issues – B. Goddard (slides)

Brennan explained the LHC beam dump TSU problem highlighted by an external review in 2010. He explained the upgrades implemented as a follow up of the suggestions of the external technical review (conclusions of the review were presented the 11th February 2011 at the MPP). The TSU firmware upgrade has been implemented as proposed by the review and the new system has been tested over the last two months in laboratory without any problem therefore it has been installed to substitute the old one. During machine checkout 3 shifts were required for definitive testing over machine real sequencing but they have not been respected (time inadequate). Two main problems regularly appeared with nominal machine sequences:

Spontaneous triggers of the TSU generated by the module B occur over many days and has been solved by rolling back partially to the 2010 firmware version on the 3rd March 2011.

Asynchronous dump issues are still not understood. They decided to go back to full 2010 version of the TSU on 4th March 2011.

Since the system is back to the 2010 TSU version, no problems have been observed so far with the spontaneous triggering issue, while the arming problem persists. This could be a problem with the interface to the Beam Interlock System on the TSU board (named CIBO). An access is planned tomorrow to replace the CIBO hardware, which could help to identify the problem. Brennan highlighted some lessons for the future most important points are that when a system changes are "approved" the recommissioning implications should be identify and adequate time for testing should always be allocated.

Comments:

Concerning testing time: M. Lamont commented that adequate time should have been claimed despite the running for commissioning of the accelerator and asked if there is technical knowledge at the MPP level about consequences in testing and commissioning.

Concerning the commission of the 2011 version of the TSU M. Ferro Luzzi asked if it is worth stopping and testing properly the new version since this loss of redundancy in such an important system, could have detrimental effects if it occurs? Ralph also asked if we have any intensity limitations due to this? Brennan said due to this there are no intensity limitations and it is a rare event, it needs a combined failure but they plan to update it during the next technical stop. He proposed to wait for the outcome of the access to replace the CIBO. Massi then replied if it is worth anticipating the technical stop then to update the whole system.

4. AOB

Jorg mentioned that in two weeks time there will be the first meeting of the LHC machine development working group. Ralph mentioned they are collecting all MDs requests and a first draft of the MD planning and/or priorities will be discussed in that occasion.