LHC Beam Operation Committee

Notes from the meeting held on 31st January 2012

Participants

G. Arduini reminded that the current in the trim quadrupoles will be limited to 200 A for this year due to the modifications implemented on the QPS to avoid spurious trips induced by the tune feedback. Last year, during operation and MDs, this limit has not been exceeded (always below ~100 A). No evident constraint was evidenced but potential issues for MDs have to be evaluated.

1. Considerations on the CMS Vertical Shift – M. Giovannozzi (slides)

M. Giovannozzi presented a follow-up on the proposed -2 mm vertical displacement of the two beams at IP5 to compensate the misalignment of the CMS pixel detector (see J. Wenninger's **slides** LBOC 24/01/2012). No evident limitation was found from the point of view of the magnet strength needed to generate the bump with the required specifications.
Aperture calculations were done at 4 TeV (β^*=0.6 m) for a 2.5 μm emittance beam with no halo and considering only beta beating tolerances. A reduction of n1 from 11.6 σ to 9.8 σ (for 3.5 μm emittance) was found at the triplets and determines a loss of 0.7 σ in the TCT collimator retraction.

Discussion:

G. Arduini asked if this reduction in the aperture could have an impact on the tight collimator settings and, as a consequence, on the minimum achievable β^*.
R. Bruce confirmed that this could be the case and estimated a minimum β^* of 0.7 m (to be confirmed).
S. Fartoukh commented that only the vertical TCT should be further closed to protect the triplets. The horizontal TCT could stay at the nominal position without reducing the retraction with respect the TCDQ and without limiting the minimum β^*.
G. Arduini suggested to collect and recheck all the related aspects and present a summary at the next LBOC meeting.

2. New IR6 Optics with Optimized Phase Between MKD and TCSG – S. Fartoukh (slides)

S. Fartoukh presented the results of his studies on a new IR6 optics with a phase advance of exactly π/2 between the MKD and the TCSG. He explained that, for the actual optics, this phase advance corresponds to ~95°. In case of single passage, as

during a beam dump, this difference corresponds to a degradation of the effective protection provided by the TCSG/TCDQ by 0.2-0.25σ (for a 3σ beam).
Specific constraints had to be taken into account for defining this new optics. Twiss parameters at IP6 and, in particular, the β function at the TCDQ and TDE had to be kept unchanged to avoid to increase the energy density at these elements. The strength of Q4 could not be modified in order not to vary the trajectory in the dump line.
The newly matched optics determines a 17% change in β and a loss of 0.5 σ in the aperture at the kicker side and a gain of the same amount at the TCDQ side. The β function is slightly reduced at the TDE with an energy density increase of 4% (still room for optimization). The trajectory in the dump line is almost unaffected and the 0.2-0.25σ gain in the effective protection of the TCSG, and therefore the TCDQ/TCT retraction, might potentially bring to a gain in β* of about 4-5%.

Discussion: see next talk

3. Beam Dump with New IR6 Optics – B. Goddard (slides)

B. Goddard analysed the implications of the changes induced by the new optics on the LBDS system. No major issue has been identified with the variation of the available aperture while the 7% reduction of the beam size at the TCDQ and the increased p+ density on the VDWB, BTVDD and TDE are potentially critical.
The new optics reduces the 'safe' intensity limits by about 0.1e11p+ for any given emittance; this should not be a problem for the 50 ns beam. It is known that the existing TCDQ jaw has robustness problems and would not survive in case of asynchronous beam dump with the nominal 25 ns beam at 7 TeV. Any increase in energy deposition on the TCDQ jaw should be avoided since it is difficult to determine the limits in case of different operational conditions. A new TCDQ design is under study and FLUKA simulations are needed to define the real sensitivity of the upgraded device to the beam size.
No impact is expected on the TCDQ setup and on the phase advance with respect to the TCTs.
Measurements of the β function show that, for Beam 2, the real phase advance between the MKD and the TCSG is indeed almost 90 degrees so that the new optics would worsen the situation. Constraints on beta beat phase advance and possible changes during operation have to be taken into account to develop the proposed new optics. As a first step the settings of the TCDQ/TCSG should be redefined with the measured β and the phase advance recalculated.
Finally, the implementation of the new optics would require some extra testing and validation time (1-2 shifts).
B. Goddard concluded stating that the new optics could be eventually used only after LS1 and after an accurate measure of the beam parameters.

Discussion:

S. Fartoukh commented that the problem of a higher energy density at the TCDQ could be solved increasing βy at this collimator.
S. Redaelli reminded that some bottlenecks were already measured in IP6. The aperture should be re-measured at this location and the beam possibly re-centered to gain some mm.
He added that the setup of just a limited number of collimators according to the measured beam parameters might not be possible since this could have an impact on the full hierarchy.
B. Goddard commented that it should be envisaged to apply this logic to all the collimators especially in view of operation with smaller β*.
S. Fartoukh confirmed that and added that optics specifications should be more strict for collimators which can be hardly affected by any optics error.

4. Cycle and Squeeze Structure – S. Redaelli (slides)

S. Redaelli presented a preliminary proposal of the machine cycle for the 2012 proton run. An overview of the cycle, functions, discrete processes, timing and beam parameters which were used in 2011 was shown.
The baseline for 2012 is to operate at 4 TeV with a β* of 60 cm in IP1 and IP5 and a partial squeeze to 3 m in IP2 to improve the satellites collision rate. A vertical crossing angle will be applied in IP8 (see R. Bruce's **slides** LBOC 24/01/2012). In order to reduce the turnaround time between two consecutive stable beams, it was proposed to remove the 6 minutes long decay plateau at flattop and to adopt new pre-cycle functions. The energy ramp up to 4 TeV will take 770 s and the same strategy as in 2011 will be applied for the crossing and separation schemes. The combined ramp and squeeze will not be used in 2012.
The removal of the decay plateau at top energy should avoid to artificially lengthen all the PC functions. For 2012, longer functions for the decay compensation should be applied only to the RCS. This would require a separate beam process for the RCS with the same ramp and a longer plateau.
The squeeze process has been optimized and the feed-forward strategy improved, the preparation of the settings definition and validation are ongoing.
The final official sequence will be deployed after Chamonix and once all the operational parameters will be approved; dry-runs should start as soon as possible.

Discussion:

S. Fartoukh commented that it is not possible to rely only on the RCS to correct ΔQ' both in the horizontal and vertical plane. Two knobs are needed and this would imply that the decay plateau should not be removed.
E. Todesco confirmed that and added that the RCS might be sufficient only if the effect is symmetric in both planes. Measurements with pilot at 4 TeV (scaling old measurements is not valid) have to be done to confirm if this is the case.

5. Update on Beam Induced Heating – B. Salvant (slides)

B. Salvant presented a follow-up of the beam induced heating studies discussed during the Evian workshop. He showed the list of elements which were affected by heating and highlighted the change of the status of the TDI which is now considered as "problematic" due to the big beam screen deformation found. He presented in details observations, simulations predictions and cures for MKI, ALFA detector, VTMSA, BSRT mirror, Q6R5 stand-alone and collimators. He explained that RF bench measurements and simulations predict a factor ~5 lower power loss at the MKI (for 50 ns beam) when using 24 screen conductors instead of 15. A bigger number of contacts could increase the risk of flashover; special rounded tips will be implemented to reduce this risk. Tests are performed in the lab and, if successful, one of this MKI will be installed during the TS in August.
A maximum temperature of 40 degree was measured for the ALFA roman pots and more heating in 2012 could induce some damage of the detector. The question if keeping the detector out has been addressed. A new design with shorter finger has been developed for the VMTSA double bellow to improve the RF contact (loss of 5th axis for the nearby TCTVB in point 8; the one in point 2 was removed).
Investigations are ongoing to understand the origin of the beam spot movement on the BSRT mirror when increasing the beam intensity. No clear explication has been found for the heating observed at the Q6.R5 stand-alone and the TCP collimator in point 7.
The deformation of the TDI beam screens and the origin of the heating at this location represent the most outstanding issue.
Preliminary simulations predict the presence of higher order modes for which a power loss of the order of 100 W could be expected and theoretical models predict also an additional power loss of the order of a few hundreds of watts. Measurements performed during an MD in parallel with UFO studies showed a phase error increase when moving the TDI jaws from injection setting to parking position. A power loss of the order of 1-2 kW can be calculated from the measured phase error.

Discussion:

R. Schmidt affirmed that more precise measurements should be performed to understand the effective power loss at the TDI when left at injection setting with a high intensity circulating beam.
B. Salvant agreed and added that it is possible to repeat the measurements and discriminate bunch by bunch.
G. Arduini commented that inputs for ANSYS simulations have to be clearly defined considering the contribution of annealing effect during bake out and physics with closed jaws.

6. Next meeting

Tuesday, 21/02/2012: **LBOC meeting (15:30 in 874-1-011)**.