LHC Beam Operation Committee

Notes from the meeting held on 9th August 2011

Participants

1. Beam screens temperature control Update summer 2011 (Arcs - Triplets - Stand-alone) – S. Claudet (slides)

S. Claudet presented the actual status of the beam screens temperature control in the arcs, triplets and stand-alone magnets. For each case, he showed a schematic view of the cooling loop and pointed out stabilities and singularities.
Temperature in the arc beam screens is well controlled between 13 K and 17 K. The important role played by the increase of the bunch length to >1.2 ns (lower beam induced heat load), when operating with high intensity beams, has been highlighted. All the arcs show a similar behavior with few singularities. Tomography investigation is foreseen to check eventual local discontinuities that could increase the load due to image current (already seen in 2010). For these singularities, no evident related effects on the vacuum and the beam have been observed up to now. An increase of about 6 K, sometime (but not always) related to beam optimizations and orbit changes, has been measured on 8 channels during physics and could be related to a bad cooling or additional heat loads; this does not have an effect on the global stability.
Temperature stability at the triplet beam screens is trickier since it affects directly the vacuum and the beam. An automatic control on the temperature during injection and the energy ramp has been implemented and allows having a more stable condition with a peak temperature of 22-23 K. P8 has been equipped with cryo-bakeout.
Stand-alone magnets: temperature is stabilized between 15K and 20 K by keeping the cooling valves open at 40%-60%. Q6 family represents the most critical case, it needs nominally 80% valve range and, for Q6R5 only, the cryo operator has to open manually the valves to 90% during the ramp. This will be automatized during the next TS (it was done during SPS magnet replacement and works in automatic now).

Discussion:

P. Baudrenghien underlined that a bunch length >1.2 ns is problematic for the RF system. S. Claudet answered that, right now, the automatic control of the valves allows being less sensitive to bunch length but, never-the-less, a longer bunch is beneficial also for collimation and kickers.
M. Lamont asked if a beam screen temperature of 22-23 K at the triplet is still good from the point of view of vacuum.
V. Baglin answered that as far as there is no excess of gas physisorbed on the beam screen surface everything is fine. Some vacuum increase is observed during temperature rise during which physisorbed gas is flushed away but, when the temperature is constant, the vapor pressure decreases. S. Claudet added that there is margin to further reduce the temperature by a couple of K if this can help.

2. Beam spectrum measurements and remarks on bunch length – T. Mastoridis (slides)

T. Mastorids presented few slides on beam spectrum measurements performed on July the 8th. The aim of the measurements was to better understand the bunch distribution and try to investigate any eventual correlation with beam screens and MKI heating.
It was found that the high frequency spectra for the two beams differ (see slides for details) and this could explain the losses observed, for B1, during collisions. Moreover, both spectra show a significant power around 1.6 GHz. The overlap with a kicker resonance, which could explain the MKI heating, has to be investigated. Blowup during the energy ramp and agreement with theoretical models is also under study and a series of measures should be taken to improve statistics.

T. Mastoridis explained that the difference between bunch length for two beams is within the spread of the individual bunches; it's then hard to define a correspondence between bunch length and beam lifetime. With the help of OP, a correlation between losses and bunch by bunch length should be systematically analysed.

Discussion:

J. Wenninger asked if the difference in bunch length is within the spread between individual bunches also at injection. P. Baudrenghien confirmed and explained that the spread is even bigger at injection.
J. Uythoven asked if the spread could be due to a lack of statistic.
G. Papotti answered that the measurement was performed with a sampling frequency of 5 s and averaging over 1380 bunches, the spread observed is then real.
G. Arduini asked if one beam shows longer longitudinal tails than the other.
P. Baudrenghien confirmed adding that this could explain the different behavior of the two beams during collision.
M. Lamont asked about investigation on MKI resonance at 1-2 GHz. P. Baudrenghien suggested to perform end of fill measurements changing the bunch length and monitoring the MKI temperature. J. Uythoven commented that these are long measurements due to the long time response of the temperature sensors.

3. Vacuum observation in LSS2 and 8 – V. Baglin (slides)

V. Baglin presented several vacuum observations in the injection regions, recovery conditions and investigation on possible causes.
He looked, in particular, at behavior of vacuum at the TDI in point 2 during the first MKI erratic (July 28th at 16:30: 144 bunches dumped at the TDI): vacuum increased instantaneously up to 2e-5 mbar and the recovery worked as expected.

He explained that the temperature increase of 10 K observed at Q6R2, during a scrubbing run, is not compatible with nuclear scattering with residual gas and the origin is then still unknown.
The origin of the pressure spikes observed at the D1 in point 8 is also unclear. Electron cloud was excluded since no effect was observed when switching on and off the solenoids. Results of studies from MC NEG transmission with MonteCarlo simulations disqualified also the option of a pressure bump in the area of the ion pumps close to TCTH/TCTV collimators. A gas load in the middle of the vacuum sector could explain the observations but is very unlikely; X-rays investigation will be performed during the next TS to check RF fingers status.
Pressure spikes were also observed, over a short period, at D1 right of 2. The first hypothesis was the malfunctioning of some ion pumps; tests were carried out by switching OFF/ON the pumps and the pumps were working. The anomalous behavior did not show up anymore but no explanation has been found.
V. Baglin concluded pointing out the globally good performance of the vacuum system.

Discussion:

M. Lamont asked why a pressure bump at the TCT location is excluded since pressure increases when losses are recorded at these collimators.
G. Arduini commented that it is not easy to define if losses produce pressure increase or vice versa.
V. Kain added that a pressure change is also observed when moving the collimator jaws.
V. Baglin repeated that the NEG should anyhow absorb what is produced at the TCTVB collimators and no pressure increase should be recorded at the D1L8 with the exception of methane. Moreover, pressure did not always increase in case of losses at the TCTH.

4. MKI erratic: hardware and electronics related aspects – M.J. Barnes (slides)

M. Barnes described the MKI system and the related electronics. He explained in detail the circumstances of the two erratic events which happened on July the 28th.
In the first case (16:30), the erratic happened when the PFN was charged to its nominal voltage. The fault detection and re-triggering worked correctly, no circulating beam was affected by the MKI pulse but extraction from the SPS was not inhibited. The kickers were already discharged and therefore unable to kick during the extraction of 144 bunches which were dumped at the TDI as per design.
In the second case (18:03), the erratic happened during (500 μs) the PFN charging process (at 33 KV). Detection and retriggering did not work, MKI C pulsed for about 9 μs and the circulating beam was swept over the aperture and grazed the TDI (17% of the nominal kickers' strength). Extraction from the SPS was this time inhibited.
Both events were caused by a faulty switch which has been replaced; no more erratics have happened up to now. A detailed investigation of the switch revealed

damaged components and occasional missing G1 trigger pulses – which may cause premature aging of the thyratron and thus increased rate of erratics. Several G1 trigger units will be replaced, with a new version, at the earliest opportunity.
The reason why detection and interlock did not work as expected is still under investigation.

Discussion:

J. Wenninger commented that when the MKI system goes to fault the injection is not inhibited. The fault should be detected faster and injection stopped while, up to now, only BLM and beam flag presence prevented the injection.
B. Goddard added that experts have to check the system before any acknowledgment in case of fault.

5. MKI erratic: beam related aspects – C. Bracco (slides)

C. Bracco presented the effects of the two MKI erratics on the beam and machine protection related aspects.
She explained that the worst error scenario corresponds to the injected and/or circulating beam grazing the TDI jaw (86% - 14 % of the nominal kicker strength respectively). During the first event, when the full batch of 144 bunches was dumped at the TDI with a big impact parameter, losses were concentrated right downstream the TDI and no magnet quenched.
During the second erratic the circulating beam was kicked with 17% of the nominal strength for about 9 μs; this corresponds to 150-190 bunches grazing the TDI. Losses were recorded far downstream in arc 23 and three magnets (D1L2, MQXL2 and D2R2) quenched. The XPOC analysis of the dumped beam showed that 173 bunches were missing, in agreement with expectations. At least a factor of 2 higher losses have to be expected in case of operation with 25 ns and higher bunch intensity.
RadMon and BLM crosschecks of the two events allowed to estimate that 65% of the missing beam was stopped at the TDI.
This event had a smaller impact on the machine than the flashover event happened on April 18th when 12 magnets quenched. This time the grazing impact parameter was slightly bigger and the TCLIB was set in a safer position (8.3 σ instead of 6.8 σ).
On the other hand, ALICE was heavily affected.
A preliminary BLM analysis of data from these two events, flashover and MD on Q6 quench margin at injection was also presented.

Discussion:

R. Schmidt asked if all the detector systems are off during injection. This could prevent from future damage and he suggested that systems which take a longer time could be switched on during ramp already. He underlined that indeed the impact of

MKI erratic on LHC was not very severe and that detector sensitivity (ALICE, LHCb) is the limiting factor.
B. Goddard suggested to consider carefully this scenario in view of plans to decrease aperture around experiments. An extrapolation of the worst failure case including the reduced aperture should be done and discussed with the experiments.
V. Kain suggested that the losses in ALICE are likely to be due to secondary particles and FLUKA simulations are needed.
B. Dehning informed that FLUKA simulations of similar events have been done for the triplet magnets.
B. Goddard added that equivalent simulations are ongoing for LHCb by R. Appleby.
Markus Zerlauth informed that that the ALICE problem concerning the calibration system of the inner detector seems to be permanent and added that, before the incident, about 60% of the system was operational, since the incident only 20%.

6. Upcoming meetings:

Tuesday, 16th August: LSWG meeting. Planning of upcoming MD block.
Tuesday, 23rd August: **next LBOC meeting (15:30 in 874-1-011)**.