LHC Beam Operation Committee

Notes from the meeting held on 11th September 2012

Participants

1. Plans and Goals of the Scrubbing Run – G. Rumolo (slides)

G. Rumolo presented the plans and goals for the LHC scrubbing run that is scheduled for the beginning of October 2012 (from 4/10 until 8/10). He gave an overview of the scrubbing run history and explained that the SEY at the beam screen is derived from heat load measurements. In 2011, the SEY in the arcs was reduced from 2.1 down to 1.52 (still above the limit of 1.4) after 50 h machine time with 25 ns beam. A little increase in SEY, inducing a worsening of the beam lifetime, was measured in 2012 but it was reduced from 1.65 to 1.55 at the end of 4 hours operation with 25 ns beam showing a faster reconditioning.

G. Rumolo explained that to improve the scrubbing efficiency one should operate with an intensity of 1.1-1.3e11 ppb, 3 μm emittance, start with trains of 144 bunches and then move to 288 bunches (details of possible filling schemes can be found in the slides). The Q20 SPS optics would be preferred. During the run, the experimental solenoids and dipoles should be on, LHCb polarity positive and the e-cloud solenoids at the MKI should be on, except for long periods without injections*. The vacuum interlock should be temporarily relaxed. No issues are expected but RF, damper HOM and the temperature at MKI (new MKI will be installed in point 8), BSRT (new hardware) and collimators has to be monitored and the TDI has to be moved to parking when stopping filling for more than 15 minutes.

G. Rumolo presented a detailed planning of the run and the foreseen measurements. Special studies will be dedicated to chromaticity thresholds, emittance blow-up, e-cloud dependence on bunch length and orbit position, and SEY in the straight sections. Depending on the heat load and in case of too low bunch intensity (LSS6 BPM interlock, a new new logic might be implemented during TS3 to be tested and approved by MPP) a dump and a new refill will be needed.

A test at 4TeV will be performed to study electron cloud build-up, interplay with synchrotron radiation and scrubbing. This will allow to investigate the difference between 25 and 50 ns beams in terms of heating, UFOs and in view of the long-range beam-beam MDs. Trains of 72 bunches will be initially used. The maximum beam intensity will be defined at the end of the scrubbing run and will depend on beam stability, heat load and vacuum conditions.

*** M. Barnes commented by e-mail that the pressures at the MKIs has to be constantly monitored and that anti e-cloud solenoids should be used accordingly to try and keep the pressure below a certain limit (to be specified before the MD). A high pressure could induce a deconditioning of the kickers and increase the risk of flashover during subsequent injections. The need to limit the pressure rise could prevent from switching the solenoids off during long periods without injection. Moreover, if the integrated pressure passes the present SIS thresholds, a 1-2 hour access will be needed for MKI sublimation plus time for an extended soft-start: even if the integrated pressure does not pass the SIS threshold, if it approaches the threshold, subsequent access may be required, ahead of the next TS, to sublimate and run an extended soft-start.**

Discussion:

B. Dehning asked what the maximum intensity of the circulating beam would be.
G. Arduini answered that in total there will be 2748 bunches of 1.3e11 ppb, that is 3.57e14 protons.

G. Papotti asked what the time needed for observations at 4TeV is in order to evaluate if these studies could be performed during MD3 in parallel with other measurements.
G. Arduini replied that according to the cryogenics experts 2 hours are needed for stabilizing the temperature and the beam screen cooling circuit parameters equilibrium and 2 hours for observing the evolution of e-cloud and UFOs.
He added that the option of opening the primary collimators to more than the present 4.3 sigma has to be considered. This would probably require extra loss maps and thus further beam time.

B. Gorini commented that the request of the experiments for a physic run with 25 ns beam is not yet clear.
G. Arduini highlighted that this could require a β^* different than nominal and additional setting up time. A smaller emittance and a reduced intensity could allow overcoming this limit.

2. Status and Prospects of Q/Q' measurements – R. Steinhagen (slides)

R. Steinhagen presented an update on the status of tune and chromaticity measurements with the BBQ. This is a very robust system with a wide range of applications but it presents some limitations like the lack of specific bunch-by-bunch information. The BBQ selects the highest signal between all bunches and, since the peak selection depends on several parameters (bunch length oscillations, intensity variations and β-

oscillations) it can trigger on different bunches, from turn to turn, giving a noisy signal (i.e. during the energy ramp with longitudinal blow up or in case of ADT kicks).
R. Steinhagen gave also an overview on the Head-Tail Monitor. He explained that the biggest limitation comes from the resolution of the digitizer system. The best resolution is 100 μm so that only head-tail oscillations bigger than 200/300 μm could be detected; such oscillations normally induce a beam dump before being detected.
The option of using a frequency instead of a time-domain signal to detect head-tail modes is considered. The presence of a peaked signal in a high frequency channel (CH n ≥ 1 corresponding to 0.5 GHz) would give a qualitative indication of head-tail instabilities. A new front-end prototype of a parallel spectrum analyzer has been produced and tested in the SPS showing interesting results: a clear signal measured at 4 GHz and, after a while, an attenuated signal also at 400 MHz (m≥ 1 head-tail motion?). The same system has been installed in the LHC; it will split the signal from a regular B1-V head-tail monitor and is ready to be tested. Chromaticity measurements via the ratio between the tune and Qs side-bands could be performed as well as bunch by bunch measurements, gating the signal and/or operating outside the ADT bandwidth.
A similar prototype is being prepared to replace the B1 BBQ system and could be installed during the next TS. Some time should be allocated to test the new systems.

Discussion:

G. Arduini highlighted that, for the head-tail monitor system, the time-domain signal should be kept in parallel with the frequency-domain to provide also a quantitative information.
R. Steinhagen confirmed but explained that the present system has a memory limit since it was not designed for repeated measurements. An upgrade of the system would require a new budget.
G. Arduini suggested trying to use the existing head-tail monitors reducing the amount of data (less bunches over a smaller number of turns).
E. Metral agreed and suggested to test the old head-tail monitor with one bunch at top energy, decreasing the octupole current and looking at the rising head tail modes.
B. Salvant pointed out that with the present system it is not possible to perform measurements in parallel in the horizontal and vertical plane.

R. Steinhagen explained that this in principle is possible but not exposed by the present GUI (for compatibility reasons with the SPS system) and the fact

that the number of data is doubled may -- based on the past experience -- increase the probability to crash the system.

J. Wenninger asked if any application exists already to display the data from the new systems.
R. Steinhagen answered that there is no application running on a FESA server but it is possible, through remote desktop, to visualize real time acquisitions and perform offline analysis. No resource is now available for a release on a FESA server.

G. Papotti asked if any dedicated time was allocated in the BI MD slot to test the new systems.
R. Steinhagen answered that initially the monitors will be tested with nominal fills and during the intensity ramp up; dedicated MD time will be requested only later.

Recommendation: The LBOC recognizes the importance of having an additional tool to identify qualitatively head-tail motion, but it considers that this cannot substitute the time domain signal from the head-tail monitor. The LBOC recommends the implementation of new hardware for the fast acquisition and analysis of the intra-bunch transverse motion in time domain during LS1 while it requires that for the time being time domain signal over a few bunches is provided reliably in the horizontal and vertical plane possibly triggering at injection and for a few thousands turns.

3. LHC Performance with Low-Emittance H=9 Beam – Focus on Emittance Preservation – M. Kuhn (slides)

M. Kuhn reported on the results of emittance preservation studies performed with h=9 beam in the LHC. The injectors provided a small emittance beam: an emittance of 1 μm was measured for 1.1e11 ppb at flattop in the SPS. The LHC was filled with 6 nominal 50 ns bunches (1.7e11 ppb) follwed by 32 h=9 bunches. The SW interlocks for the wire scanner intensity limits had to be increased by the expert and measurements could not be performed in the LHC during the squeeze (BSRT instead). The emittance derived from luminosity was compared with wire scanners measurements at collision. Measured β functions were used at injection and flat-top (no measurements during energy ramp) and the error bars were calculated taking into account statistical errors due to averaging and errors on β measurements.

No emittance growth was measured at injection. In the vertical plane, the emittance grew by less than 10% during the full cycle from injection up to collision and no measurable blowup was observed during the injection plateau.
An increase of 40% was measured for the horizontal emittance with a strong blowup already during the injection plateau, probably due to IBS.
For both beams, emittances were conserved during the squeeze.
For h=9 small emittance beam, a non-negligible difference was found between luminosity and wire scanners data; the reason of this discrepancy is under investigation. The convoluted emittance for the h=9 beam increased by 50% from injection to collision (slightly worse than nominal physics fills with 50 ns beam: 40% increase).

Discussion:

J. Wenninger asked how the errors on the luminosity were calculated.
M. Kuhn answered that she considered a 15% error on β* and 5% on the crossing angle.

R. Steinhagen commented that the β functions could change during collision because of tune shifts induce by head on beam-beam. A measurement with separated beams could be performed for consistency.

4. AOB

J. Wenninger asked about the foreseen plans for the wire scanners after the vacuum leak problem in point 4.

B. Dehning explained that this kind of wires never had issues with vacuum before. They measured the resistivity of all the wires and looked at the number of scans performed. The wire causing the problem performed 10000 scans but this was not the scanner with the largest number of scans. The plan is to move to the spare wires which made a smaller number of scans.

5. Next meeting

Tuesday, 18/09/2012: **LBOC meeting (15:30 in 874-1-011).**