LHC Operation Committee

Notes from the meeting held on 14th June 2011

1. UFOs in the LHC- T. Baer (slides)

Tobias presented the analysis of the UFOs in the LHC during 2010 and 2011.

UFOs with Beam Dump: in 2010, 18 fast beam losses (over 10 turns) provoked a beam dump. In 2011, there have been 11 beam dumps due to UFO events so far which occurred mainly in the region of the injection kicker magnets.

UFOs below threshold: a detailed analysis of the logging database made by E. Nebot showed that in 2010 other 113 events could be defined as UFOs but they did not develop in a beam dump. In 2011, events that give fast losses above 1E-4 Gy/s in two BLMs in 40 m are analyzed as UFO events. So far, 8000 automatic triggers have been registered. Over a verified sub-set of 300 events, Tobias showed that 65% are UFO type losses, 15% are ambiguous cases and 20% are false triggers. For the analysis of the data, additional cuts are applied which depend on the specific analysis. For example, only flat top events for losses above 2E-4 Gy/s are taken into account. With this additional constrain, only 74 events remain from the initial 300 of which 96% are UFOs and 3 are ambiguous cases. Most of the events are far below dump threshold.

Location: At top energy, UFOs are distributed all around the collider with 7% of them occurring around the injection kicker magnets. At 450 GeV, UFOs occur mainly at the MKI's in point 2 and point 8.

Rate: On average 10 UFOs per hour are detected during stable beam operation.

Peak signal: no clear dependency of peak loss neither with beam intensity nor with bunch intensity.

Loss duration: UFOs are faster for increasing beam intensity and those with higher peak signal seem also to be faster than those with lower peak losses.

UFOs at MKIs: UFO events at the MKIs at 450 GeV are all below threshold with the exception of one event on 6/6/2011. In total 679 possible events at MKIs caused 9 beam dumps and most of them occurred before going into stable beams. During the scrubbing run, it was observed that UFOs at 450 GeV occur mostly in the first 10 minutes after an injection. No correlation could be found with vacuum activity. A bigger fraction of the UFO events are detected at point 8.

Future work: for the future, an improvement in the diagnostics of the UFOs detection is foreseen as well as a better localization of the MKI UFOs increasing the number of BLMs at the MKIs location. Also some machine studies as well as simulations are foreseen to better understand the phenomena as defining the quench limit to define more accurate thresholds for the BLMs.

Comments: concerning the UFO peak losses versus beam intensity: F. Zimmermann commented that it seems that the peak loss is decreasing with intensity as expected from simulations of dust particles apart few points with higher signal. *Bernd commented maybe worth verifying the peak loss versus beam intensity for distinguishing also among beam energies and removing the MKI related UFOs (unclear). Do you mean that in order to check the dependence of the peak loss on intensity we should normalize with respect to the energy at which the losses occur?* Tobias commented that high peak loss events are easier to be detected than lower ones. So the high peak loss points cannot be neglected and a correlation with energy is biased by the detection efficiency.

2. LHC Longitudinal Blow-up – P. Baudrenghien (slides)

Assuming a broad band impedance model the threshold impedance above which a single bunch becomes longitudinally unstable increases with the 5th power of the bunch length and for that reason it is preferable to blow-up the longitudinal emittance. Bunch shortening occurs during acceleration and for nominal bunch intensity this lead to beam instability due to the lack of Landau damping as happened on 15th May 2010 in an attempt to ramp a nominal single bunch without longitudinal emittance blow-up. This year is even more important due to the larger RF capture voltage used which results in a bunch shortening increased by a factor two respect to last year.

To blow-up the longitudinal emittance of a bunch a method tested in the SPS, which applies phase noise to the beam, is used. The noise spectrum is controlled during the energy ramp while the amplitude of the excitation follows an improved algorithm to compensate for the bunch shortening and to reach at the end of the ramp the target bunch length.

With respect to 2010 this year the problem is more evident because of the shorter ramp duration and capture voltage mismatched at injection leading to shorter bunches. This requires a faster excitation as soon as the energy ramp starts with a non-adiabatic control of the blow-up leading to larger fluctuations in the longitudinal distribution and in the measured bunch length.

Philippe showed some cases where the controlled blow-up worked fine and some cases where the jumps in the bunch length appear again. An important improvement could come from the bunch length calculation rate used as feedback for the blow-up algorithm. Another important improvement to apply is to make the correction from the algorithm as adiabatic as possible to avoid bunch profile jumps as seen for some cases. Last but not least keep observing during the blow-up the cavity phase noise in order to improve the correction algorithm.

Comments:

Concerning Beam profiles: R. Stainhagen commented that a Gaussian fit is probably not realistic and the bunch shape looks more parabolic. Philippe said that parabolic profiles are likely to be a more realistic approximation because as inferred from the observation that the particle population which ends in the abort gap is much less than what expected with Gaussian longitudinal tails.

Concerning blow-up algorithm: V. Lebedev asked whether the longitudinal profile measurement is compensated for the effect of the cable length. R. Stainhagen commented that the effect of the cables is very small with respect to the effect of the pick-up transfer function. G. Papotti added that the effect of cables and pickup transfer functions are taken into account in the BQMLHC bunch length calculation algorithm.

3. Abort Gap Population Calibration – A. Boccardi (slides)

To monitor the abort gap population evolution during operation an Abort Gap Monitor as been developed and calibrated. The abort gap monitor uses 10% of the beam synchrotron radiation light produced in the BSR monitor. Calibrations are required after every technical stop or more often to compensate for the strong dependency on alignment and the local aging of the photocathode caused by a very focused light beam which hits the photocathode. Introducing a diffusor to diffuse the light hitting the photocathode has mitigated these two issues. The mirrors alignment is another important issue since at every technical stop a steering of the optic line is needed and a little misalignment affects strongly the light collected since the optics line is 30 m long. The measurement of the light collected as a function of energy has to be repeated after every TS but should stay constant if the alignment is correct.

After the last TS a calibration of the instrument has been performed and a summary table of all the calibration factors is available. For the future a study of signal to voltage settings will be done in order to have an automatic setting based on the system signal level.

Comments:

Concerning the automatic calibration: P. Baudrenghien asked if and when the automatic calibration will be possible. A. Boccardi replied only when all the list of future implementations will be accomplished and this means by the end of June then after TS an automatic calibration of the BSRA will be possible. G. Arduini remind the importance of a calibrated BSRA and therefore it will be foreseen after every TS to have BI BSRA expert for the first ramp with pilot bunch to calibrate the system and introduce the new calibration factors in the BSRA. **ACTION: BI expert for BSRA present after TS during first energy ramp with pilot bunch to calibrate BSRA.**

Concerning the possibility to interlock the BSRA readings to beam dump: Jan asked if and when one can think of using the BSRA as monitor of the abort gap population to decide for a beam dump or not as for example if an RF trip occurs. A. Boccardi replied that in this case one has to decouple the BSRA from the BSRTs. This means big changes in the telescope and building a complete new optics line. W. Höfle commented that if the abort gap cleaning works why not keeping it on during physics and no interlock would be needed.

4. Abort Gap Cleaning: status at 450 GeV and issues/plans at 3.5 TeV-D. Valuch (slides)

The ADT excites the beam in the abort gap that then hits the collimators and unwanted particles are cleaned. The excitation is applied in a determined time window and by a synthesized signal. The amplitude of the excitation is currently at 10% of the available kick strength. The abort gap cleaning test on the 30th April 2010 showed an increase rate of 0.0387 mm/turn with the 10% strength applied. The abort gap cleaning and injection gap cleaning tasks are implemented in the sequencer and the control parameters in LSA. Injection cleaning occurs in the horizontal plane while abort gap cleaning in vertical plane. The parameter settings are now user independent while they will be changed at next TS so to have different settings at Injection and during physics. At injection abort gap/Injection gap cleaning is routinely used.

At 3.5 TeV an agreement on the cleaning strategy is needed. The main points to clarify are when and how to start cleaning, what type of excitation to use to avoid sudden losses while cleaning to avoid beam dumps.

Conclusions: Cleaning settings as gating, cleaning mode, frequency of excitation amplitude etc are all static. Some will be different for 3.5 TeV operation (tunes, excitation, cleaning sequence). All critical settings are the same for injection and flat top. An important issue is the fact that cleaning is not compatible with tune measurements. Daniel also mentioned that the excitation is done for the AGC at the beginning of the abort gap then the pulse is a 1 microsecond long pulse out of the 3 microseconds abort gap length. The cable extends the pulse also to first bunches outside the gap because of some signal reflection in the cables which is compensated but still present.

Comments: G. Arduini asked what should be tested at 3.5 TeV. W. Hofle replied that at 3.5 TeV the AGC has been already tested by M. Meddahi and E. Shaposhnikova. It is important to evaluate the non-linear chromaticity at 3.5 TeV to evaluate effects on the tune range. The strategy for the implementation of the abort gap cleaning should be addressed by the rMPP, this could be done during the ramp-up phase after a technical stop.