

LHC Beam Operation Committee

Notes from the meeting held on 12th June 2012

Participants

1. Analysis on Recent Beam Instabilities - E. Metral ([slides](#))

E. Metral reported on the beam instabilities observed in the LHC, the theoretical studies and models for single and coupled bunch instabilities and on the measurements during MD and end of fill studies.

He explained that, according to the present model, the sign of the chromaticity changes completely the scenario. A small positive chromaticity (1-2 units) induces slow (200 ms growth time) head tail (mode 0) instability that can be damped with the ADT. Mode 1 is excited by a positive chromaticity but octupoles can be used to damp this instability. A higher chromaticity requires increasing the current in the octupoles.

A negative chromaticity (up to -10 units) determines an intrinsic damp of high order instabilities, but a fast growth of mode 0. Moreover mode 0 could be non-coherent and thus difficult to be damped with the ADT.

E. Metral explained that several MD and end of fill studies were carried out to benchmark the experimental data with the theoretical ones and validate the models. He affirmed that a good agreement was in general found but that a main discrepancy consisted in the octupole current needed to damp the high order modes (factor 5-10 higher than predictions). The need for a higher current could be explained by larger impedance, undetected drift of the chromaticity to negative values during the squeeze and a non-perfect compensation of the ADT or something wrong with the used models (studies done only in stationary conditions, beam-beam contribution, Q" and interplay mechanisms not included). He added that recent measurements with squeezed optics showed that chromaticity was indeed negative.

E. Metral gave an overview of all the instabilities observed during the full LHC operation period. He explained that they were mainly in the horizontal plane and were generally cured by increasing the current in the octupoles (now at 500 A very close to the limit of 550 A). He affirmed that one could envisage optimizing the ADT to operate with a slightly negative chromaticity and thus solve the problem of the available octupole current. According to preliminary studies performed by A. Burov and N. Mounet the beam could be stabilized by reducing the gain of the ADT.

E. Metral concluded pointing out the importance of the control and knowledge of tunes and chromaticity for all the fills and the need for MD time to have a better understanding of the instabilities observed in order to overcome possible operational limitations.

** E. Metral reported on the same topic also at the LMC on June 13th 2012 (see [slides](#)). Two additional points were discussed: sign of the octupoles and TMCI. This should be an issue if the imaginary part of the transverse impedance is larger than a factor ~ 2 compared to the used model. The question if this is the reason why we need a much larger octupole current than predicted AND the ADT gain is so high was addressed.

Discussion:

E. Meschi asked if a current of 500 A in the octupoles is really needed?

J. Wenninger answered that the present operational experience confirms this.

E. Chapochnikova commented that different models could explain the observed results. For example, peaks at certain frequencies (different from broad band model) could exist and determine a higher impedance.

E. Metral confirmed that but reminded that MD and other studies showed a good agreement with the models. He believes that the interplay between different effects determines the main discrepancies.

E. Chapochnikova added that machine studies with single bunch are the only way to have a real validation of the models.

E. Metral agreed but explained that just a limited machine time was allowed for impedance studies.

W. Hofle asked how the ADT should be optimized to work with a negative chromaticity. He affirmed that if the instability growth is faster the ADT gain should be increased.

A. Burov answered that, according to his studies, the gain should be instead lowered (see [slides](#), not presented during this meeting).

E. Metral explained that a stability region exists and the gain should be reduced to fall in this region in case of negative chromaticity.

J. Wenninger asked if the collimator contribution to machine impedance is fully understood.

E. Metral answered that several MDs were done in the SPS and confirmed the theoretical predictions.

R. Assmann reminded that the inductive bypass could not be measured in the SPS and could play a non-negligible role in the LHC.

W. Hofle commented that the available diagnostic does not allow to determine if the instability observed is head tail or not.

E. Metral agreed and pointed out that head-tail monitors should be made operational in the LHC on this purpose.

M. Lamont asked what the dependence of beam instabilities on the bunch intensity is?

E. Metral answered that it is linear but depends also on emittance and collimator settings.

E. Metral asked if it is realistic to assume that chromaticity changed during operation.

M. Lamont answered that the tune is very reproducible and thus also chromaticity should be stable but measurements are not regularly done. He added that the recent measurements showed that a negative chromaticity could have been present, during stable beam, since the last technical stop.

E. Metral asked if any change was observed in terms of losses during squeeze and stable beams.

R. Assmann answered that during the last squeeze some bunches showed losses of the order of 1-2% similarly to what observed few weeks ago.

T. Pieloni commented that slightly lower losses were measured for the 3 LHCb private bunches but that this could be explained by a slower change of the LHCb polarity.

A. Burov asked if e-cloud could give a significant contribution to impedance?
G. Rumolo replied that e-cloud in the LHC is not strong enough to give a real contribution.

2. AOB - P. Charrue

Control experts have been moved from building 936 to building 966 (new building in front of 866) for the next 18 months.

3. Next meeting

Tuesday, 25/06/2012: **LBOC meeting (15:30 in 874-1-011).**