Transverse coherent instabilities in the LHC and HL-LHC: from understanding to predictions

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ABSTRACT

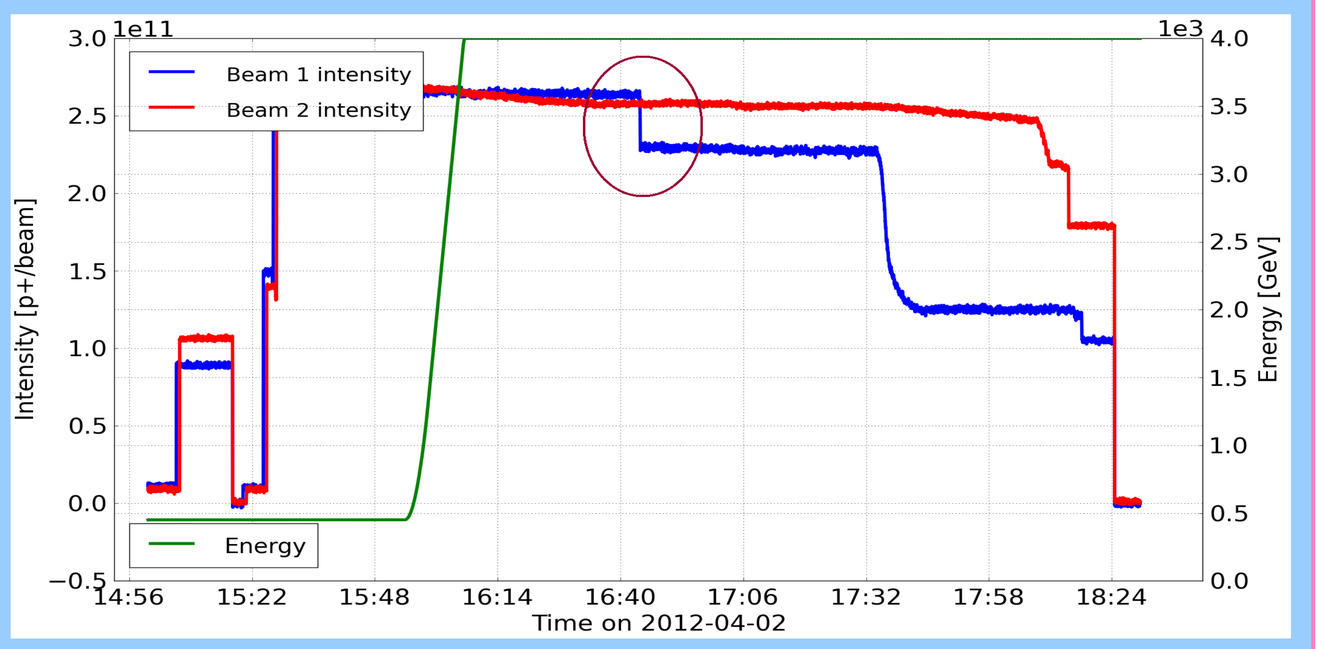
Transverse collective instabilities are one of the most important limitations to achieve the highest luminosities in the LHC and have been regularly observed during the LHC Run I.

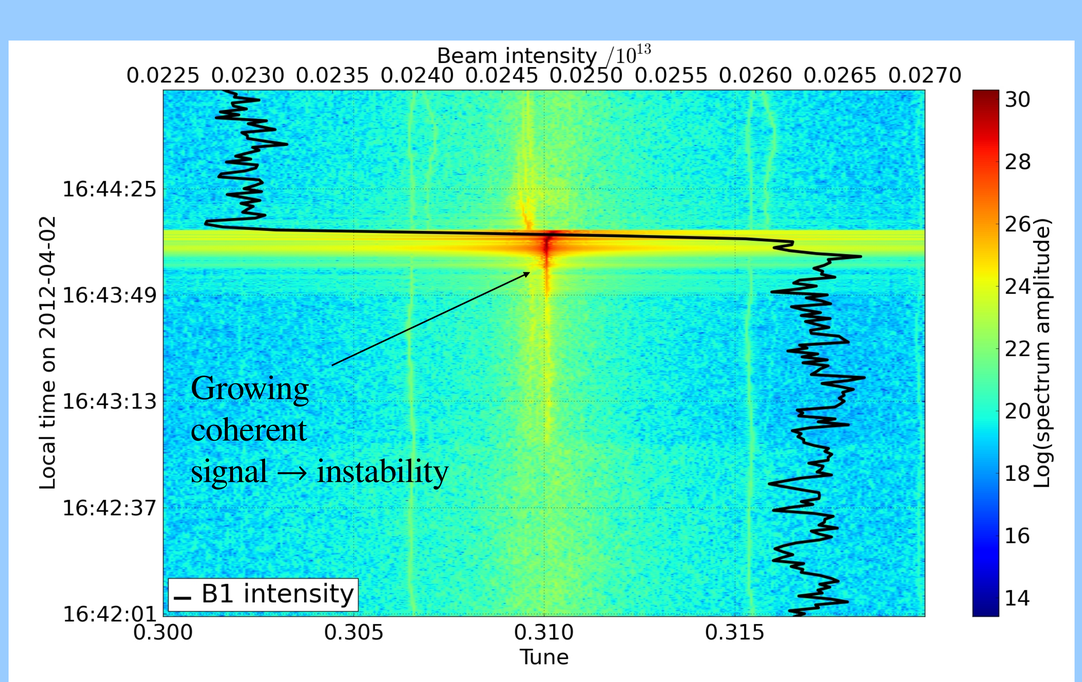
A complete understanding of the observed instabilities requires simulations/theories as close as possible to reality. This will then allow predictions for the future operation of the LHC as well as for HL-LHC.

WHAT TO DO?

In 2012, in LHC were observed some single-bunch instabilities during normal operation, which can be studied with HEADTAIL simulations. For instance, the instability on 2nd of April, during the collimator's "loss maps".

- ADT was switched off
- After the end of the squeeze
- Focusing octupole current I_{oct} = -400 A





HEADTAIL SIMULATIONS

One of the way to verify the correctness of the theory in understanding of impedance model for LHC is to do:

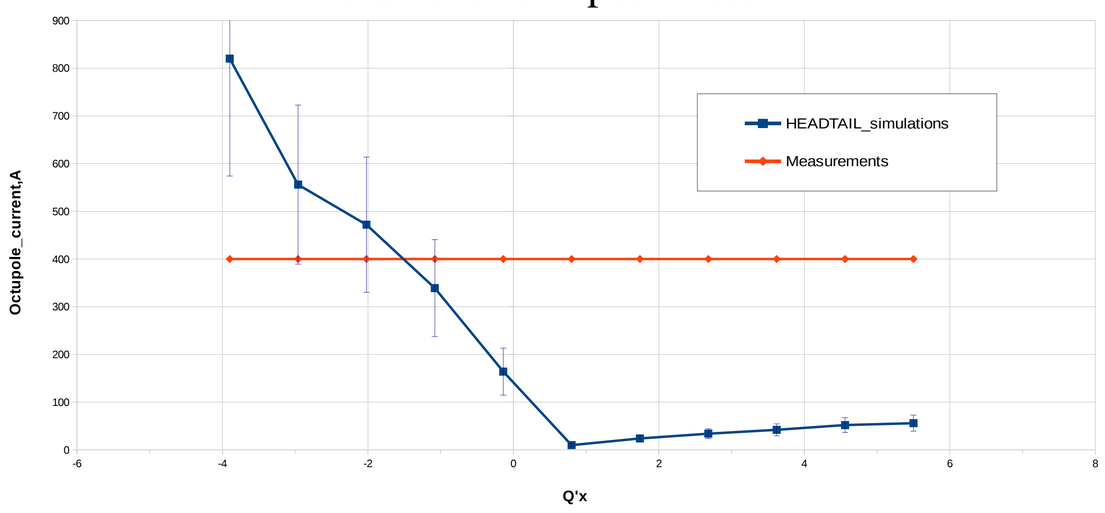
- the octupole current scan: to define threshold current for the beam stabilization;
- the scan of beam intensity: to find the intensity, at which can be reproduced the observed instability with the same rise time with focusing I_{oct} = -400 A.

Unfortunately, is not always possible to have all the data for the simulation, that's why for both cases was done also a chromaticity scan.

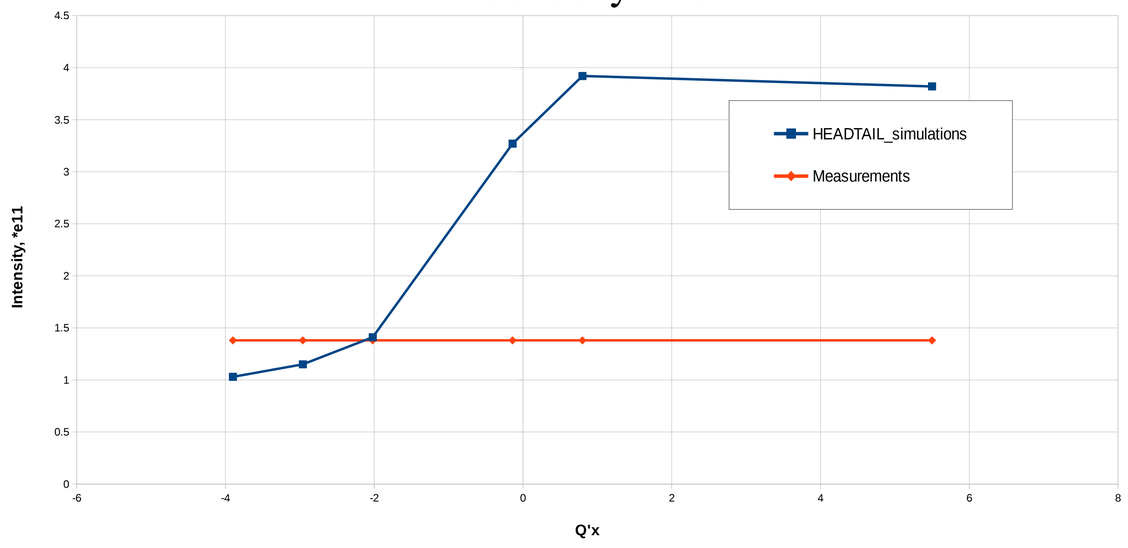
CONCLUSIONS

- Comparison between the octupole current during the measurements and from HEADTAIL simulations confirms, that the current depends largely on the value of chromaticity, than on growth rate.
- The comparison between threshold for octupole current from simulations and the current in measurements gives, that $Q'_x \geq -2$.
- To receive the rise time = 2.52 s (as in measurements with the intensity = 1.38e11) we have to have $Q'_x \approx -2$.

Threshold octupole current



Intensity scan



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