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

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ABSTRACT

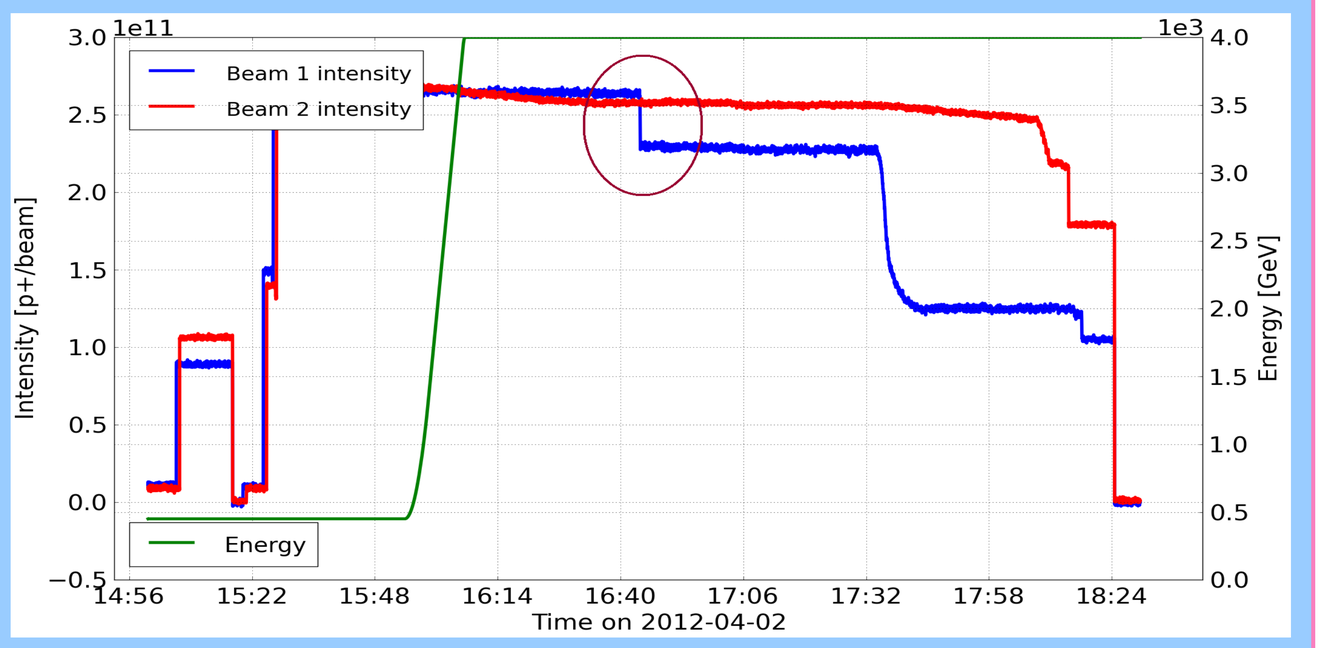
Transverse collective instabilities are one of the most important limitations to achieve the highest luminosities in the LHC and have been regularly observed during the LHC Run I.

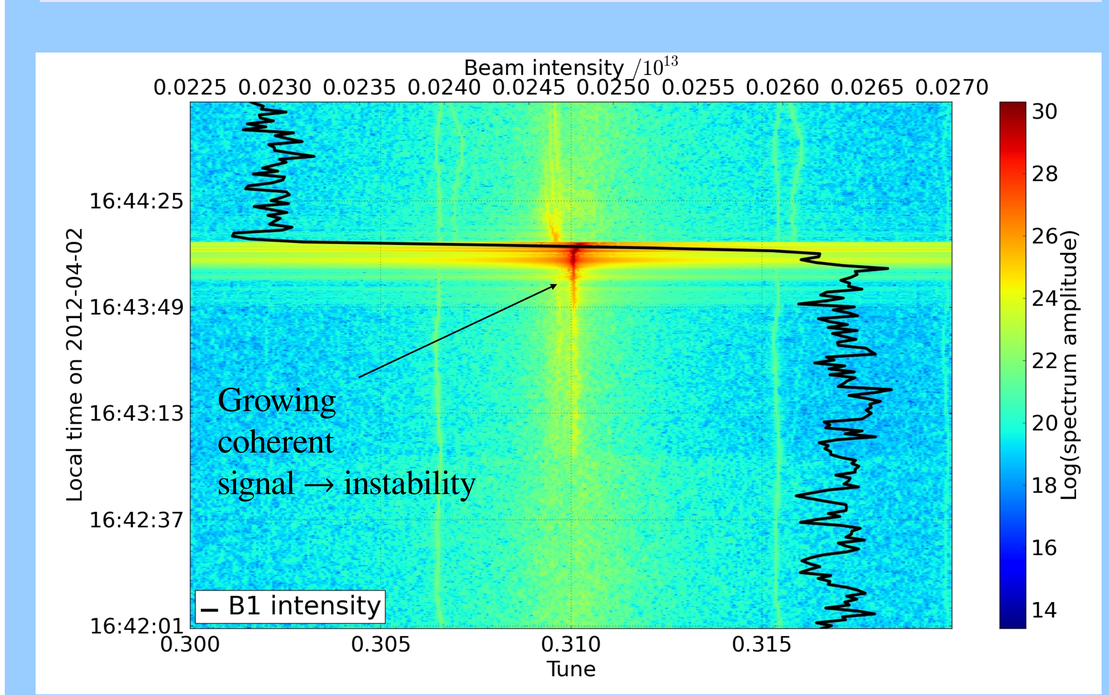
A complete understanding of the observed instabilities requires simulations/theories as close as possible to reality. This will then allow predictions for the future operation of the LHC as well as for HL-LHC.

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 the 2nd of April, during the collimator's "loss maps".

- ADT was switched off.
- After the end of the squeeze.
- Focusing octupole current I_{oct} = -406 A.





HEADTAIL SIMULATIONS

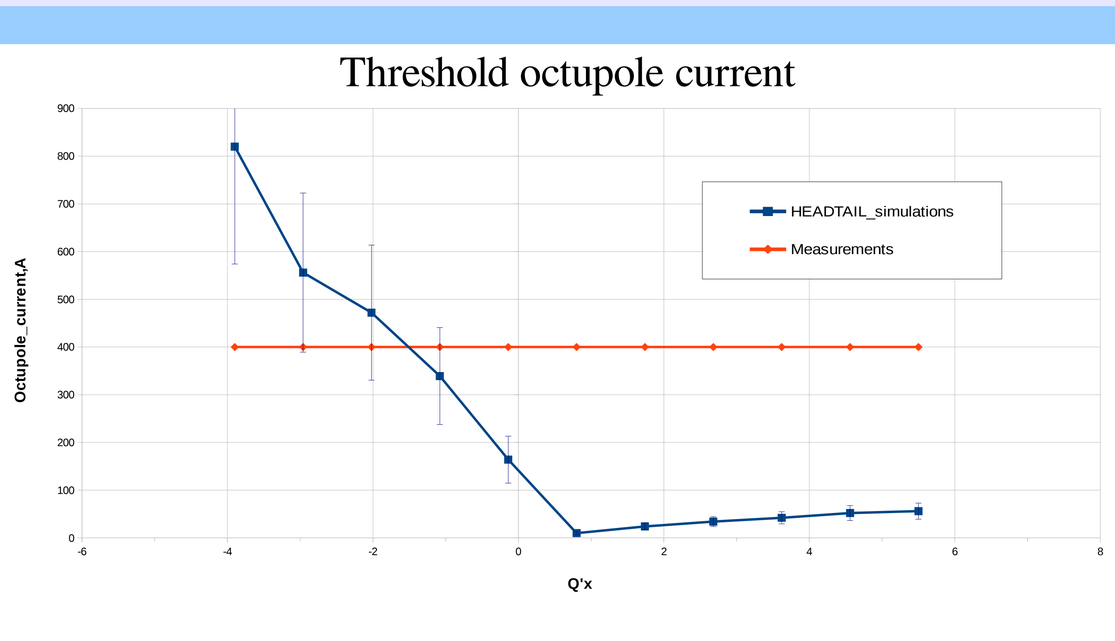
One of the ways to verify the correctness of the theory in understanding of impedance model for LHC is to do:

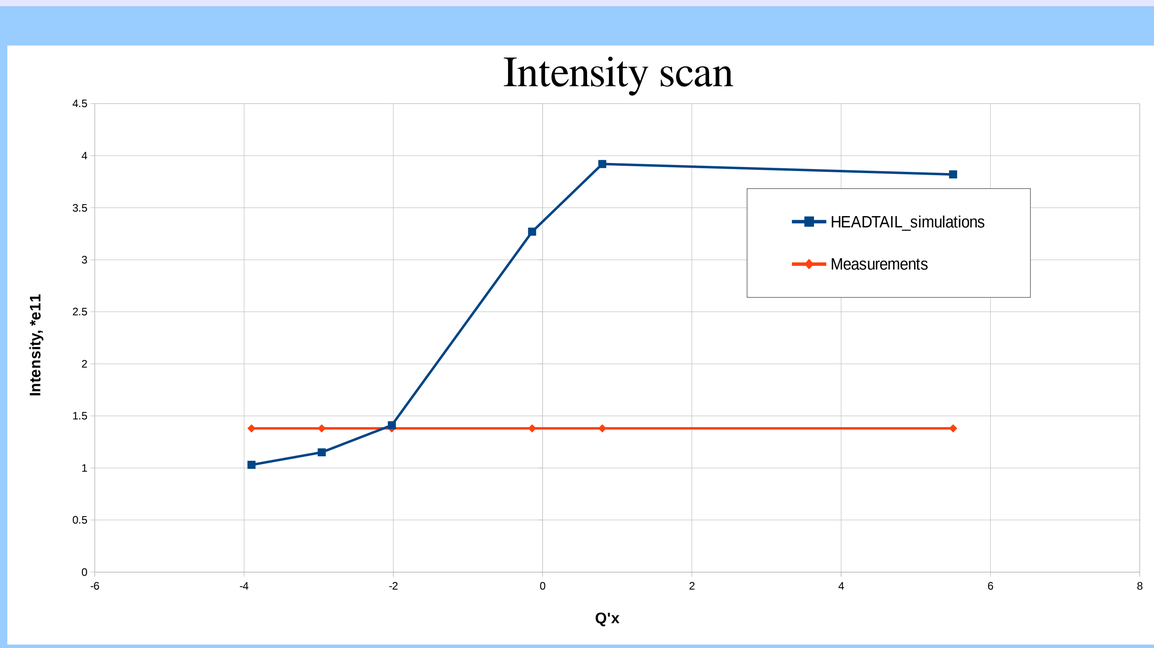
- the octupole current scan: to define threshold current for the beam stabilization;
- the scan of beam intensity: to find the intensity, at which can be reproduced the observed instability with the same rise time with focusing I_{oct} = -406 A.

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.
- Having the chromaticity -2 in the measurements, the current LHC impedance model can be approved and could explain the rise time observation. But most probably the impedance model should include some still lacking contributions, thus the chromaticity may differ and can be slightly higher than that.





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