Status of the octupole thresholds in the LHC

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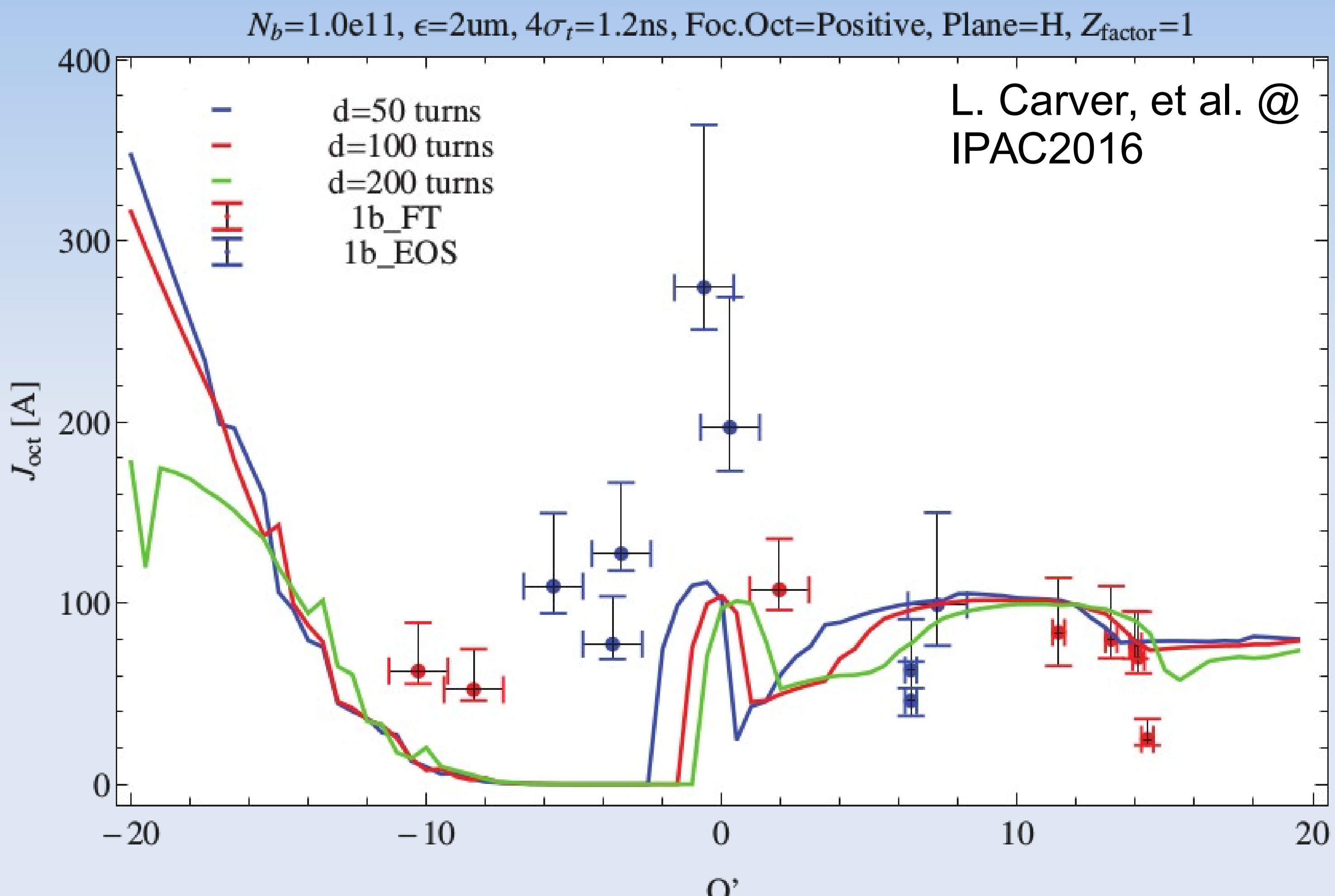
- Brief recap of octupole threshold measurements from 2015 to 2017
- Some observations in 2017
- The return of the edge bunches instability

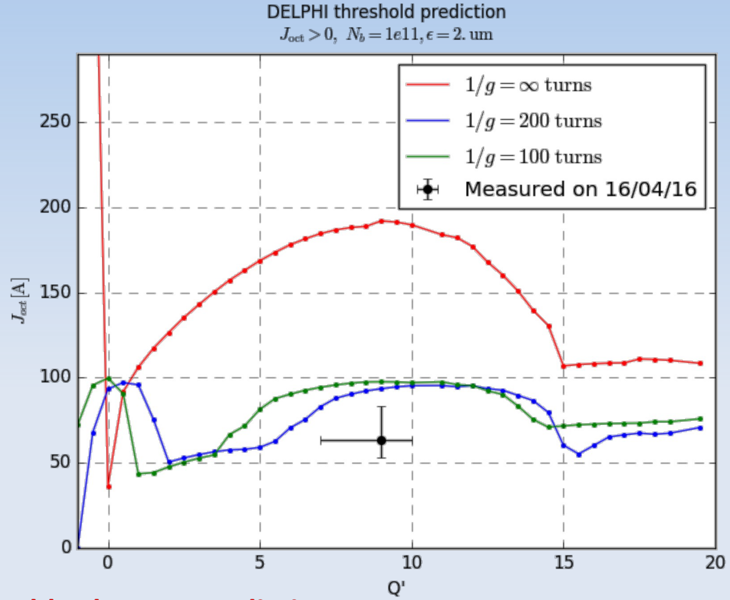
2015



- Good agreement between observations and predictions with operational Q'
- Discrepancy at negative Q' can be partially explained taking into account the transfer function of the ADT
- Discrepancy around Q'=0 is still subject to studies

2016

- TCSG.*7 at **7.5 sigma** (2016)

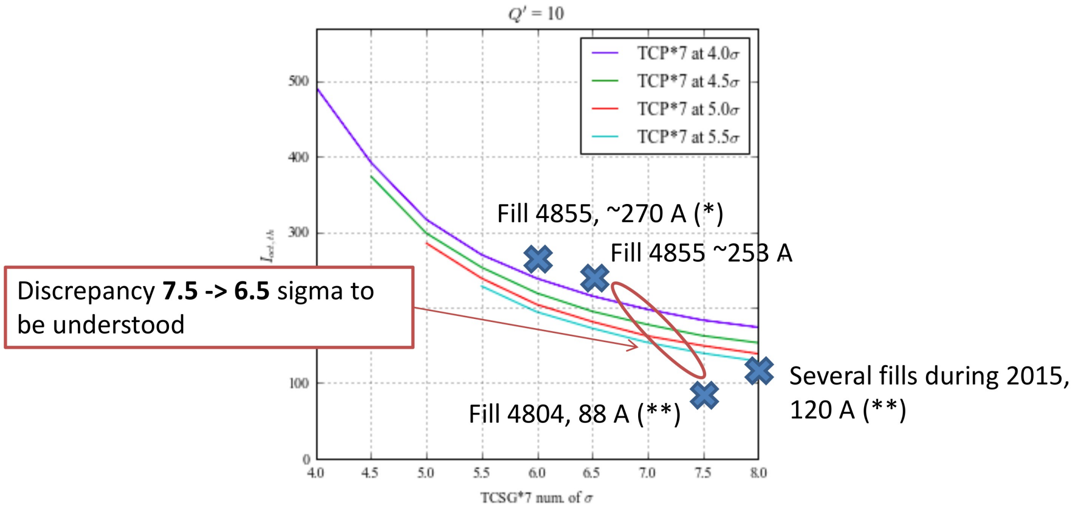


- **Reasonably close to prediction.**

N. Biancacci, et al. @ ½ Day Internal review review of LHC performance limitations (linked to transverse collective effects) during run II (2015-2016)

Summary of octupole thresholds measurements

LHC 40cm squeezed optics, 100 turns damper, and 1.2e11 bunch in 2um emittance.



Measurements scaled to 1.2e11 in 2um emittance if needed.
(*) Scaled to H plane from V plane considering the factor ~1.2 from impedance.
(**) Scaled to 40cm squeeze with the factor ~1.1 from impedance.

- A discrepancy in the order of 30% was observed with a reduced gap at the TCSG's

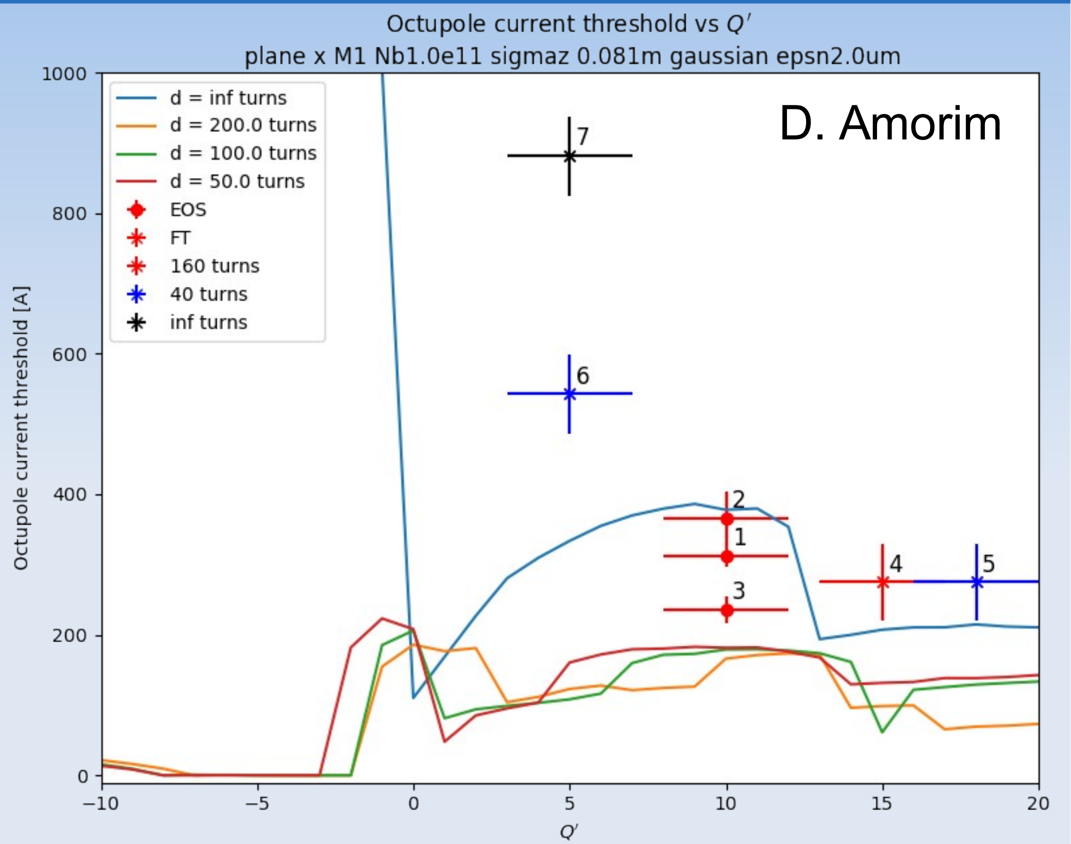
2017

- Discrepancies larger than a factor 2 are observed at all Q'
- Several MDs suffered from these instabilities due to the absence of long-range interactions providing additional tune spread w.r.t. operation
- During physics, instabilities were observed at the end of the squeeze each time the tune / coupling were not fully under control

→ Isolate contribution of the impedance and of Landau damping by analysis of rise times / tune shifts / mode number

→ Many instabilities to analyse (some are missing from the list still) :

https://docs.google.com/spreadsheets/d/1xiPDCZ-y-WoaFInM8VASNwo7uIWWFwH_iJ257hrZMbQ/edit#gid=0



1,2,3 : Commissioning tests
4,5 : ADT noise MD (high intensity single bunches)
6,7 : TMCI MD

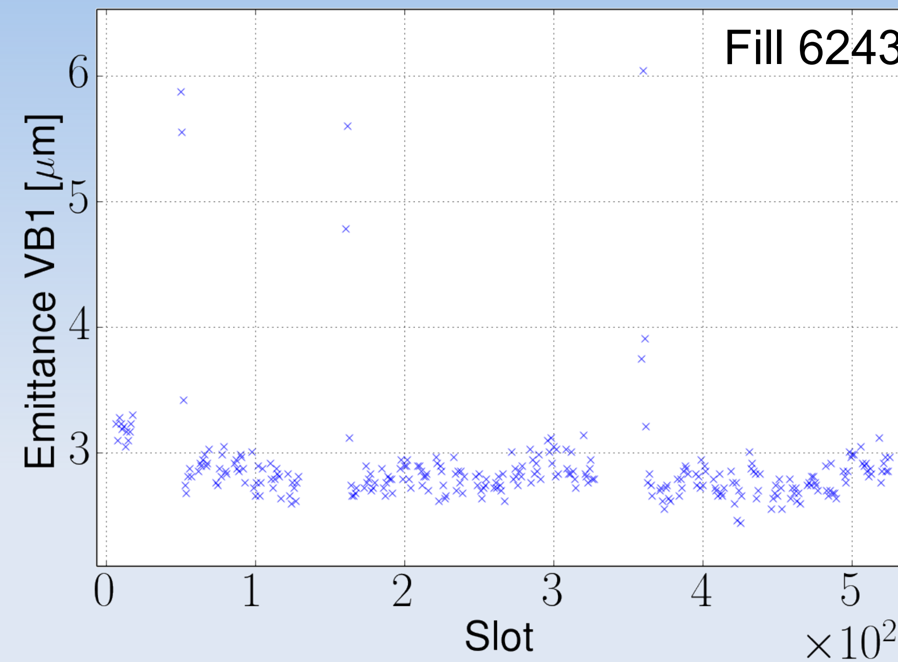
Selected observations in 2017

- Single bunches and head of trains are always more critical in B1, both H and V
  - Beam-beam is excluded in all the tests (no collision in any IPs)

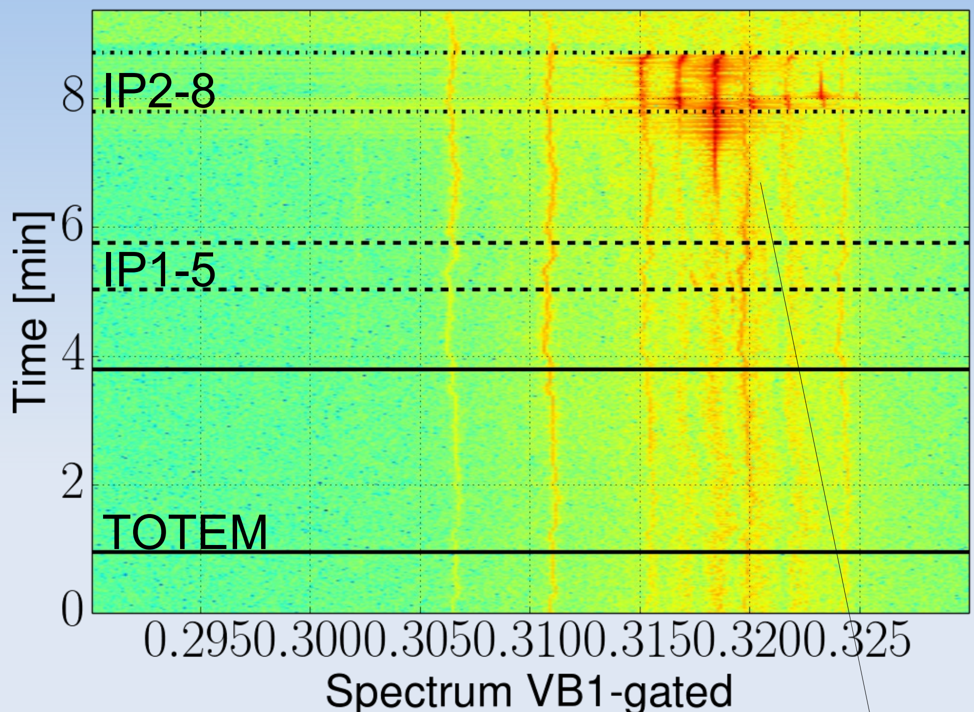
    → In regular operation it is likely that the contribution to the tune spread of long-range interactions stabilities the instability
  - The presence of remaining / trapped e-clouds or ions (e.g. from 16L2) that would be cleared by the passage of the first bunches of the train is excluded by the second train instability MD, where a single bunch and a 12b train were placed in front of a train, without impact

    → Unless the re-population is shorter than the gap between two SPS batches
  - The impact of a energy dependence was excluded by the second train instability MD, where the two trains had different energy deviation (full detuning scheme), but both behaved similarly
- A high latency was observed for the start of the instability
  - ~7 minutes during the second train instability MD
  - ~40 minutes in a test during the commissioning
  - The high latency is compatible with a mechanism based on slow diffusion that would deteriorate the beam distribution and consequently the stability diagram

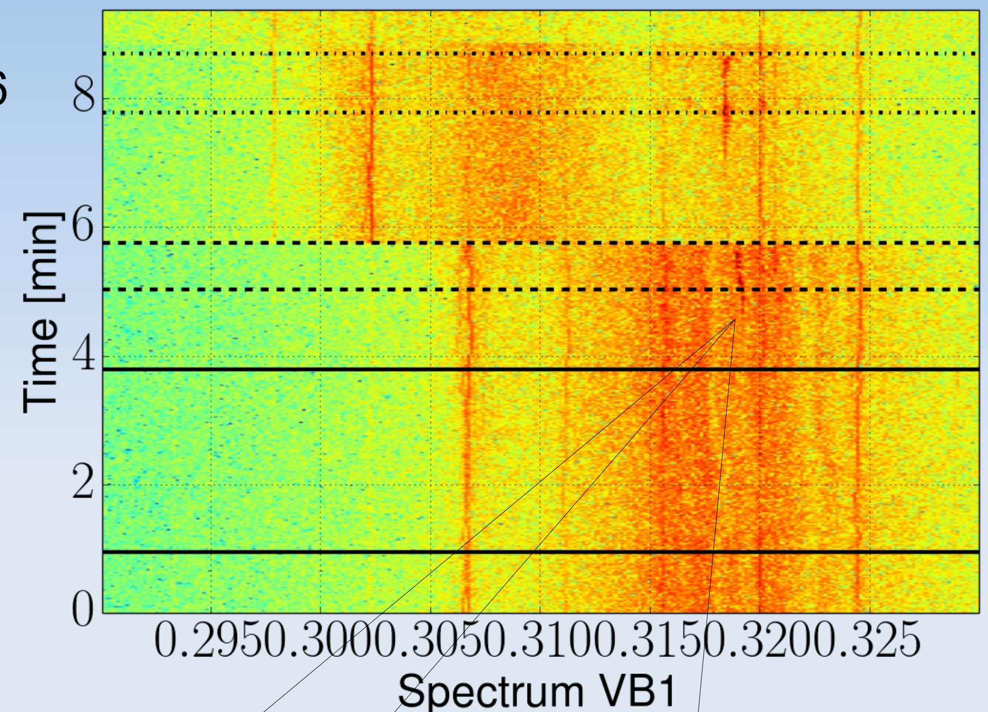
    → Instability w/o ADT indicate that it is not the source of this mechanism



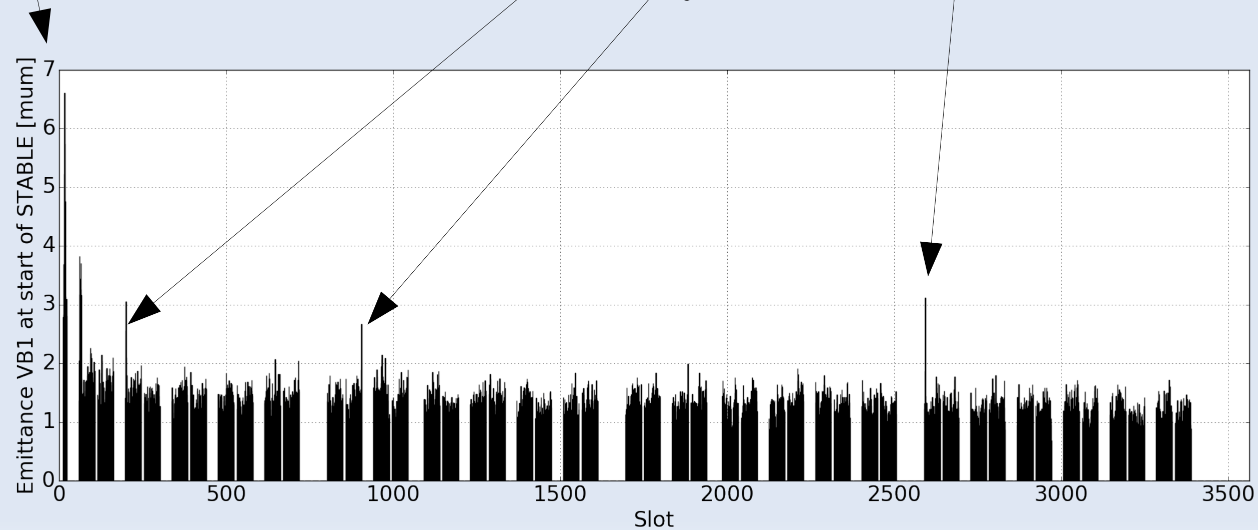
12b + few edge bunches (½ day review)



Fill 5276



- Instability of the 12 non-colliding bunches was observed regularly at the beginning of the year
- Selected bunches became unstable after the TOTEM bump, before or during the collapse of IP1-5



The return of the edge bunches instability

- This weekend, a strong variation of coupling was measured between end of the squeeze and collision
  - Effect of the separation bump ?
  - TBC...

Counting of unstable bunches over fills 5080 to 5102 (2016)