For discussion during the WBF session

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Motivations for a WBF for HL-LHC

- 1) In 2012, the End-Of-Squeeze Instability could not be cured even if
  - ~ Maximum ADT (transverse damper) gain
  - High chromaticities (~ +15 units) *=> Used in fact during full cycle*
  - ~ Max current in the Landau octupoles (max = 550 A)

- 2) DA simulations and measurements in the LHC clearly revealed the bad impact of such high chromaticities
  => BBLR compensation scheme to be compared to reduction of chromaticity & octupoles with a WBF as ~ the same order of magnitude is discussed: ~ 1-2 σ in DA

DA vs. chromaticity (without beam-beam)

- See e.g. IPAC15 paper from R. de Maria et al. "DYNAMIC APERTURE STUDIES FOR THE LHC HIGH LUMINOSITY LATTICE" (https://cds.cern.ch/record/2112249/files/CERN-ACC-2015-0177.pdf)

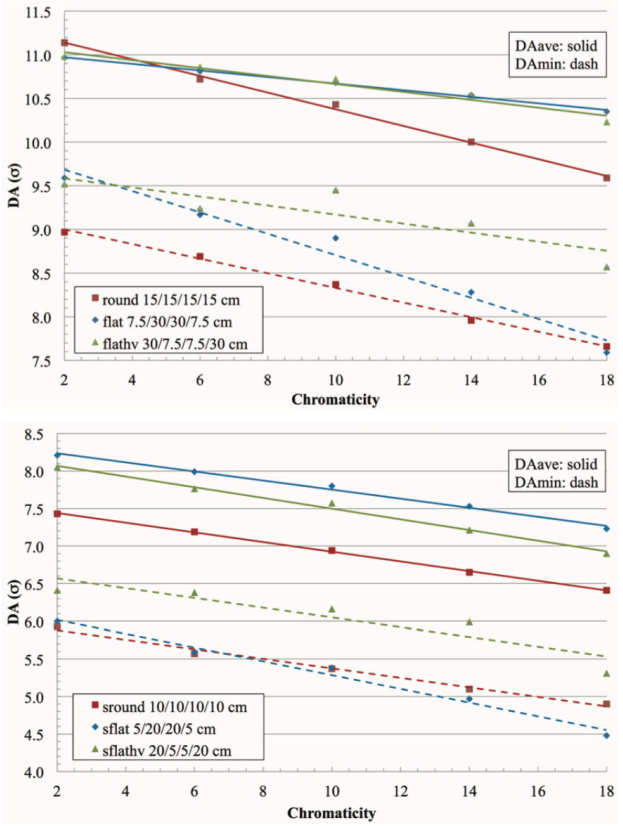
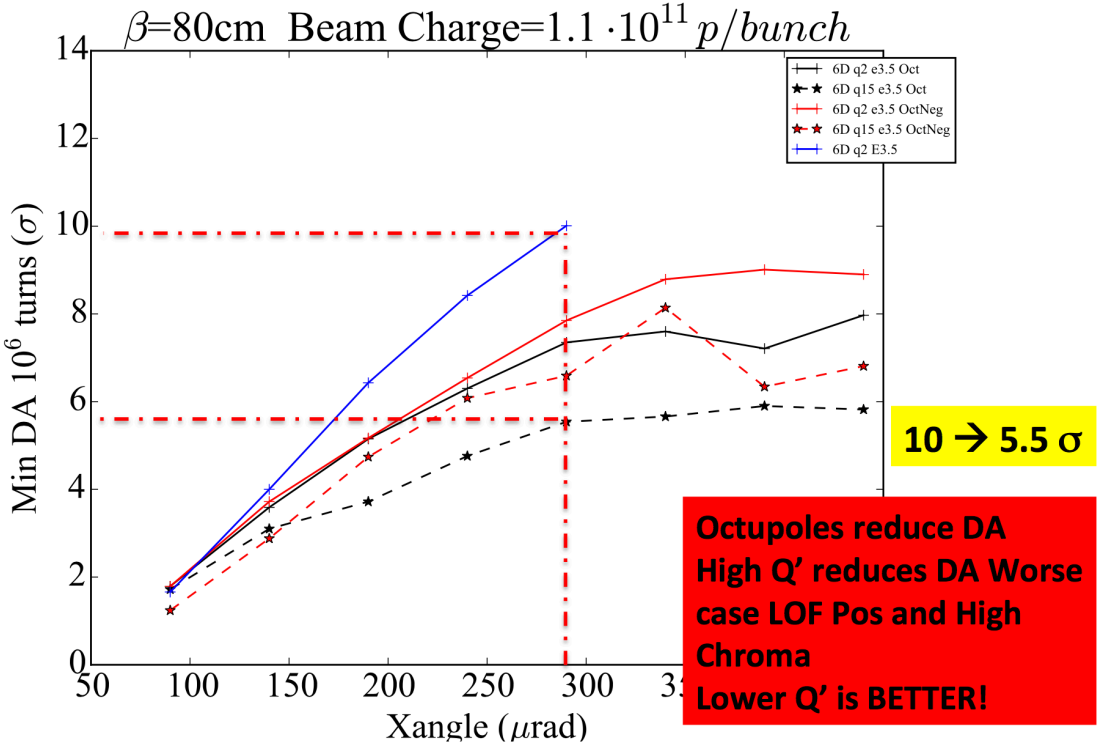


Figure 4: Top: Minimum and average DA vs linear chromaticity for `round`, `flat` and `flathv` lattices. Bottom: Minimum and average DA versus linear chromaticity for `sround`, `sflat` and `sflathv` lattices. The four numbers in the legend refer to the β^* values in IP1 and 5, respectively.

DA vs. chromaticity (with beam-beam): LHC

- See e.g. talk from T. Pieloni et al. at CERN internal HSC section meeting (https://www.dropbox.com/s/6a3710ljp4bkxiw/Instability2015_March.pdf?dl=0)



10 → 5.5 σ

Octupoles reduce DA
High Q' reduces DA Worse case LOF Pos and High Chroma
Lower Q' is BETTER!

DA vs. chromaticity (with beam-beam): HL-LHC

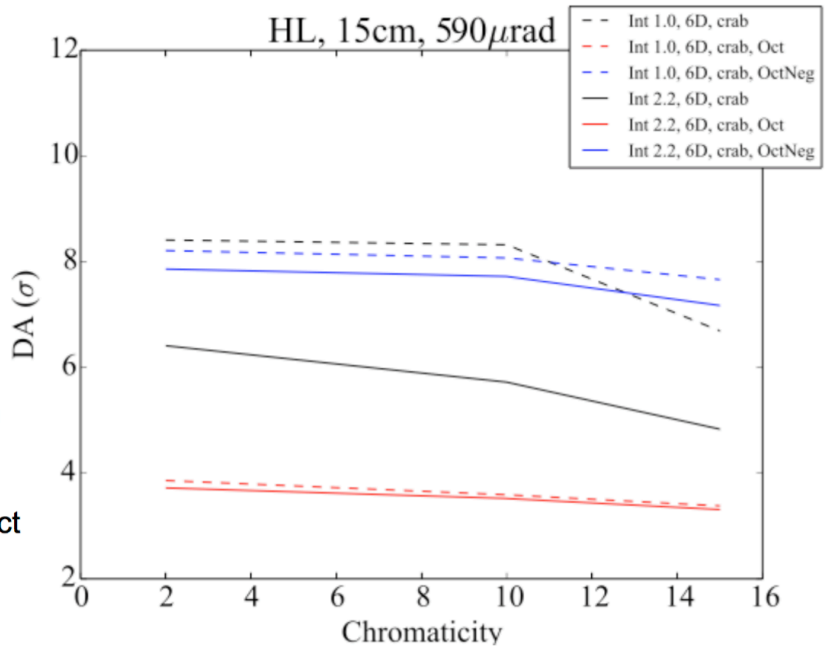
- See e.g. talk from T. Pieloni at CERN internal HiLumi WP2 meeting (https://indico.cern.ch/event/376194/contributions/889750/attachments/749816/1028676/DATL10_april_2015_ppt.pdf)

In collision

IP1 and IP5 colliding head-on DA reduced by head-on part

•Negative polarity better DA
•Positive polarity worse DA
•Only Beam-beam between the two

Can we use the Oct to compensate BBLRs?



Chromaticity reduces DA: stronger effect with octupoles OFF

DA improvement from BBLR wire compensation

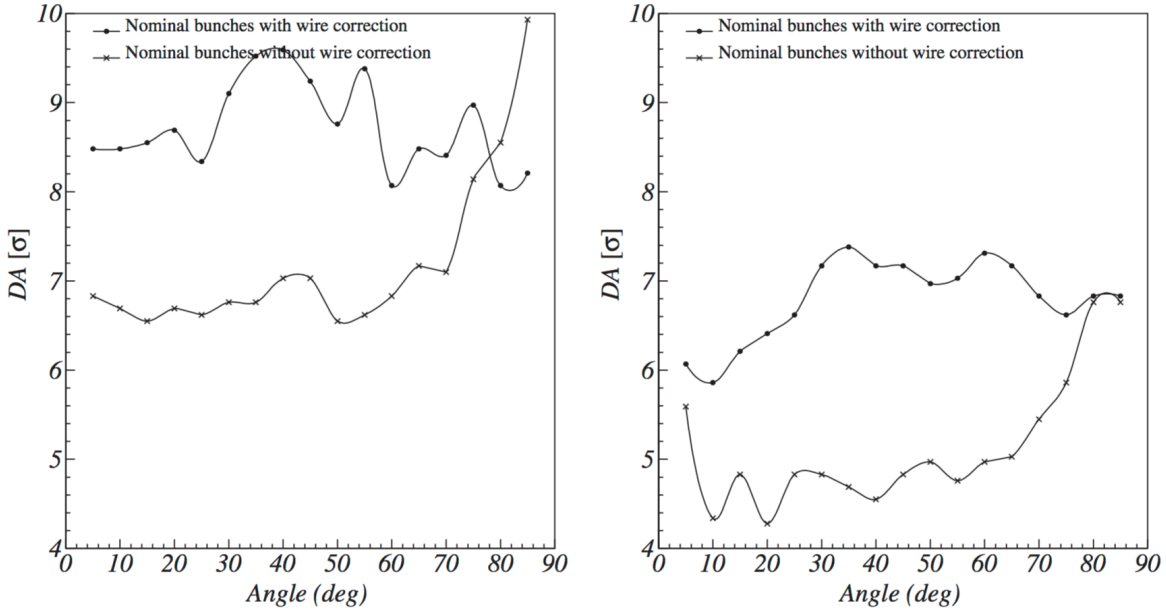
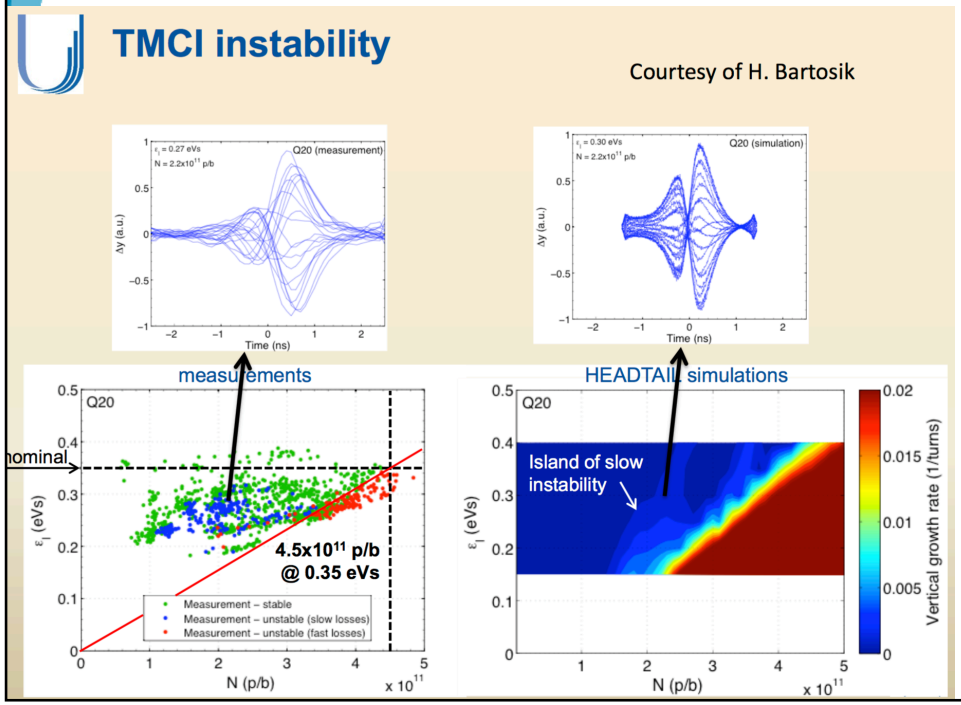


FIG. 9. Nominal bunches and HL-LHC baseline configuration at nominal [(a) with $\Theta_c = 590$ μrad] or reduced [(b) with $\Theta_c = 450$ μrad] crossing angle, corresponding to the first and second column of Table I: 1,000,000 turns dynamic aperture in collision, as a function of the phase space angle, with or without LR compensation, expressed in terms of beam sigma. Each particle is tracked with an initial momentum offset of 2.7×10^{-4} corresponding to two thirds of the LHC rf bucket half-height at 7 TeV.

SPS MD as POP for the WBF

=> Need a sufficiently reproducible instability with vertical intra-bunch motion

Single-bunch



Multi-bunch

- See e.g. IPAC16 paper from H. Bartosik et al. (http://ipac16.org/proceedings/papers/mopor022.pdf)

⇒ First experiences with injecting batches of 72 bunches with N ≈ 2E11 p/b showed that the beam suffers from transverse instabilities in both planes, depending on the SPS settings. In particular, a vertical instability appeared when the vertical chromaticity setting was very close to 0. This manifested itself as a single-bunch-type instability mainly affecting the tails of the batches

⇒ Seems to be perfect as i) initial idea to damp e-cloud instability and ii) could see if chroma can be kept very close to 0.

Procedure?
=> Example of a similar study we did in the past

- See e.g. PRL paper from G. Rumolo et al. on Dependence of the Electron-Cloud Instability on the Beam Energy (https://www.bnl.gov/magnets/magnet_files/Publications/BNL-80270-2008-JA.pdf) => Stay at injection energy for the WBF MD

=> Tail of the 4th batch alone affected by a vertical single bunch instability