MD results of the vertical instability at PS transition energy of LHC-type bunch

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MD triggered by discussions with G. Rumolo and E. Métral.
Fundamental the help of H. Damerau.

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Introduction

It is known that one of the critical instabilities of the PS is the vertical instability at transition [E. Métral, S. Aumon, M. Migliorati, N. Wang].

This is one of the hard intensity limit for the TOF bunch BUT it is not currently limiting the LHC performance. It is a single-bunch effect depending on the bunch peak current (i.e., its intensity and longitudinal emittance).

Is this instability going to be a problem for the HL-LHC and LIU-PS LHC bunches? What is our margin?

Last July with 3 MD sessions we tried to provide an answer.
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The MD cycle

Single bunch (single batch) injection in h7 and then handshaking h7→h21 not to split the bunch intensity (H. Damerau), bunch bleeding observed.
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First threshold scan (15.07)

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Second threshold scan (26.07)

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Data from 15.07 (□) and from 26.07 (○).
Third threshold scan (27.07)

Systematic scan on a wide range.
Conclusions

A vertical instability threshold limit of \( \approx 210 \times 10^{10} \) ppb @ \( \approx 1 \) eVs was observed. The instability is qualitatively similar to the TOF one. Possibly further adjustment (i.e., \( \gamma \) jump) can push this limit by avoiding lower bunching factor due to longitudinal quadrupolar oscillations after transition.