Very partial analysis of the PSB instability measurements of January 2013

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Acknowledgements: A. Findlay, M. McAteer, E. Métral.

Previous works on the subject

- D. Quatraro's PhD thesis: ”Collective Effects for the LHC Injectors: Non-ultrarelativistic Approaches”, CERN-THESIS-2011-103 – Bologna University, 2011.

- V. Kornilov, ”Head-Tail Instability and Beam Break-Up Instability with Strong Space Charge”, talk at the Space-charge 2013 mini workshop, 16-19 April 2013.

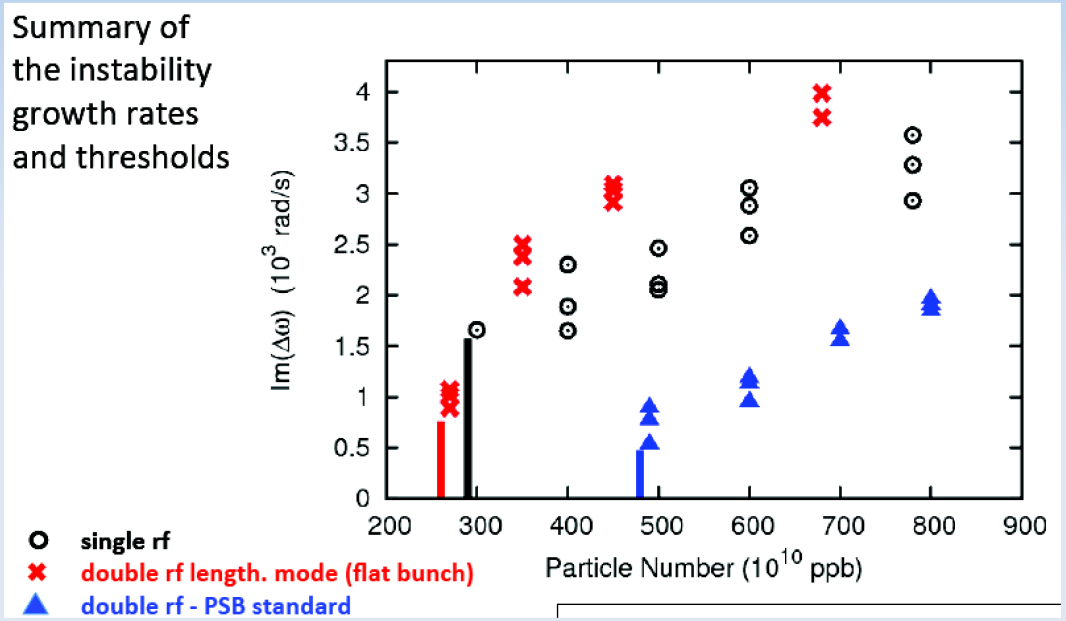
Outline of the measurements

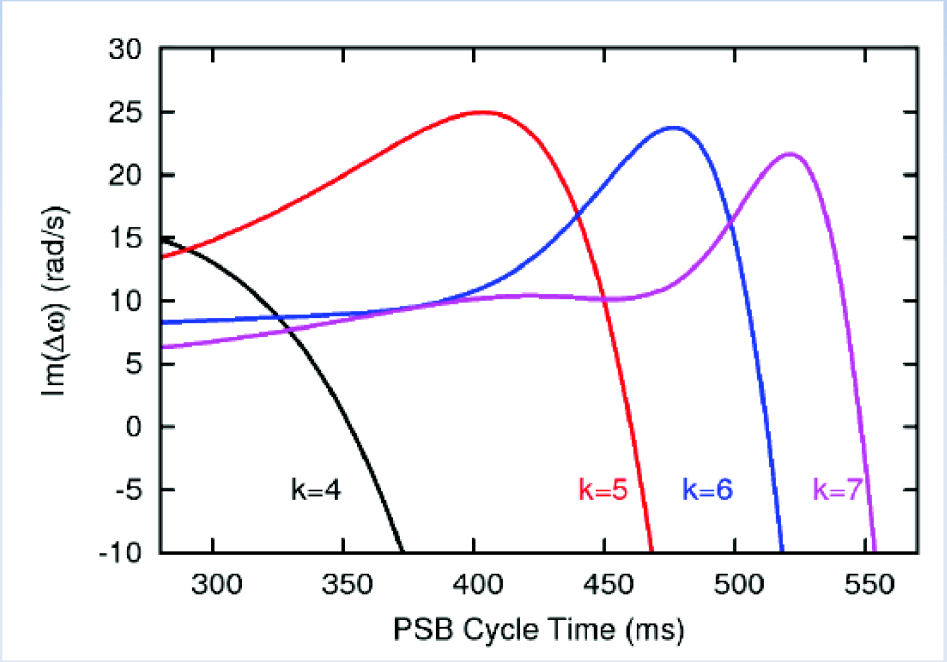
- Measurements on the ”first instability” in Hor. (at ~380 ms in the cycle):
  - with / without feedback (and damper gain scan),
  - scanning intensity,
  - scanning the longitudinal bunch profile (flat bunch – short bunch – single-RF) & scan in second RF cavity voltage (C04),
  - Scanning sextupole current (chromaticity) – thanks to Meghan McAteer.

- Measurements on the ”second instability” in Hor. (at ~490ms in the cycle):
  - with / without feeedback,
  - scanning intensity,
  - scanning bunch profile.

From V. Kornilov (talk at SC 2013)

- ”First instability” imaginary frequency shift from exp. and simulation (with RW impedance), as a function of bunch profile





Measurement

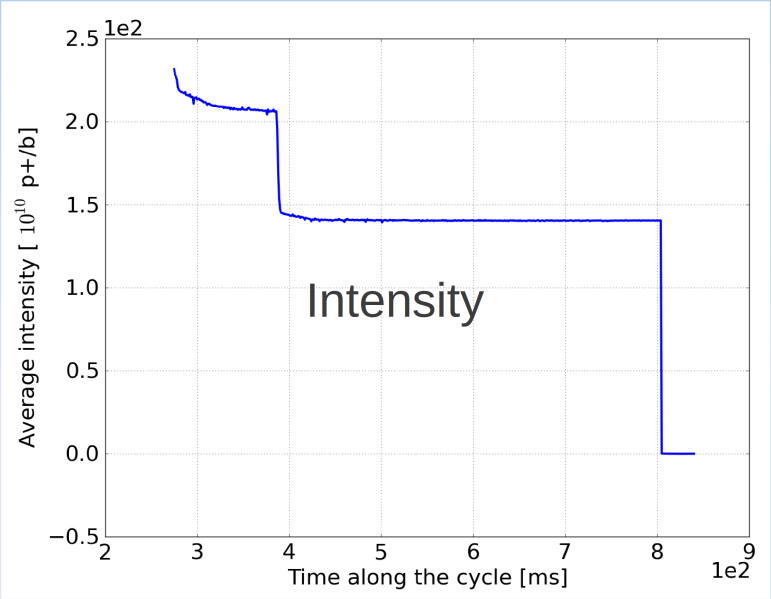
Simulation

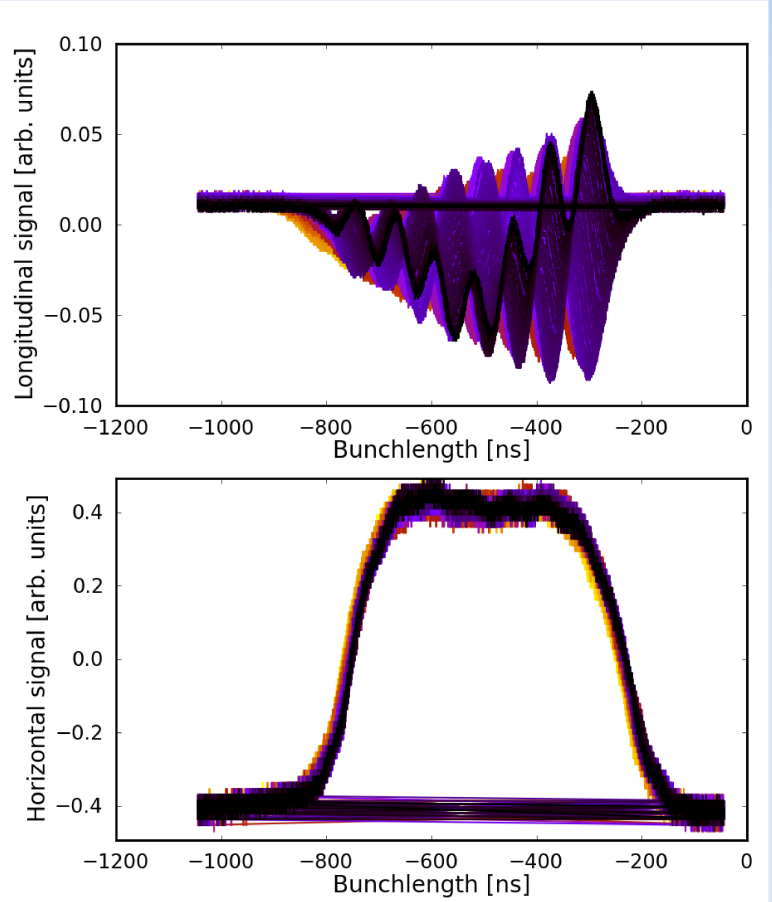
→ growth rates from RW impedance are orders of magnitude smaller than measurements.

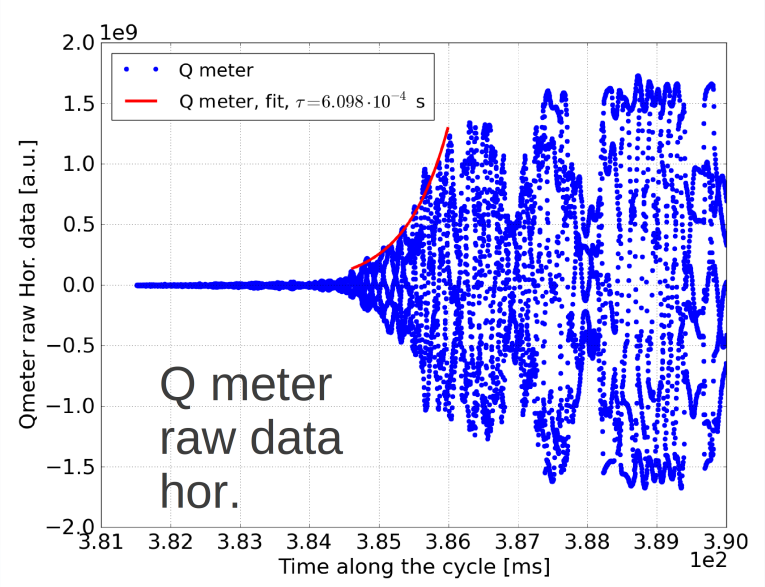
→ bunch profile dependency quite unexpected (for me).

From Jan. 2013 measurements

- Typical ”first instability” (here with flat bunch, ~2e12 p+, 20A in sextupoles i.e. ξ_x=-1):



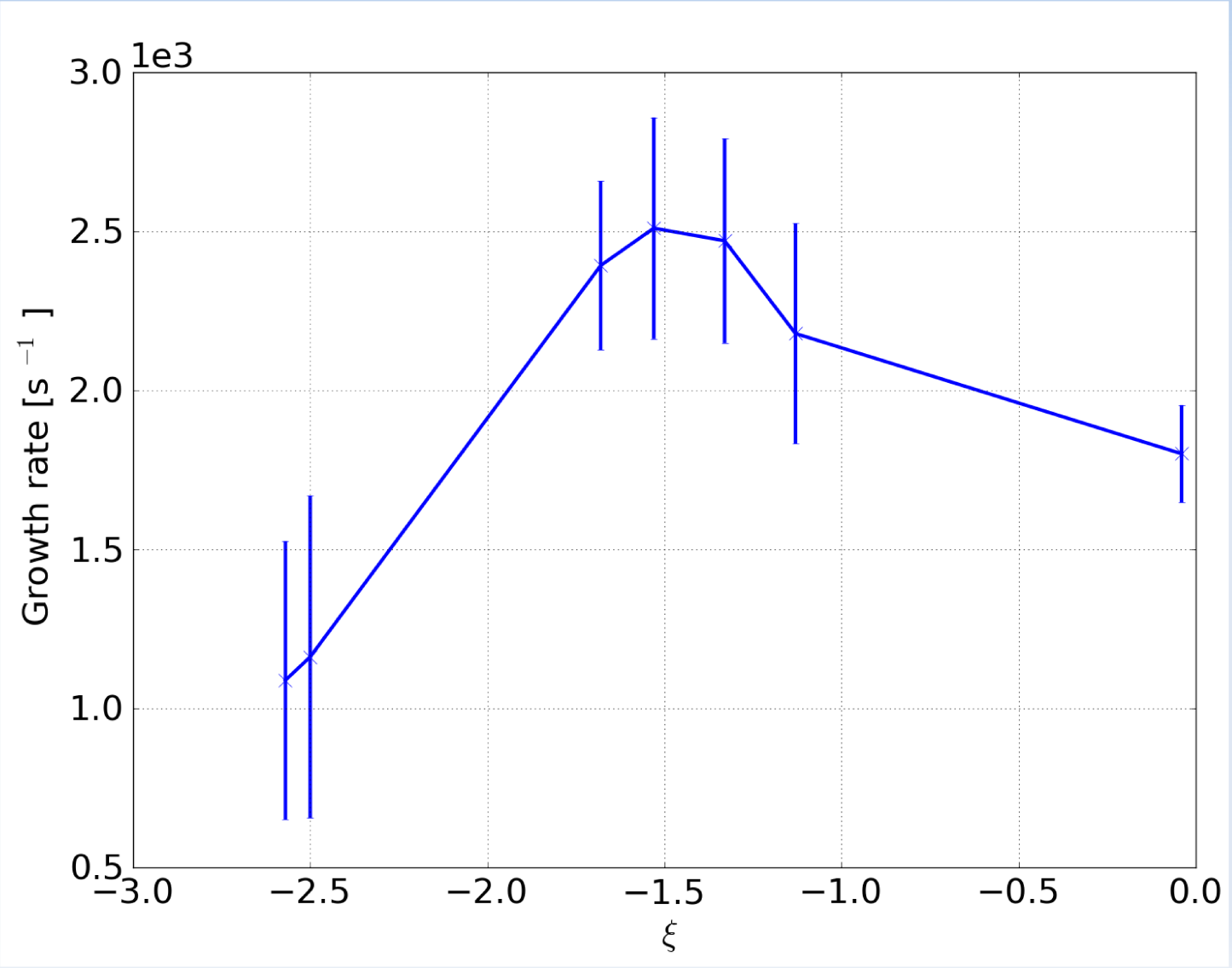




Scope (hor. and long.)

From Jan. 2013 measurements

- ”First instability” growth rates as a function of chromaticity (flat bunch profile, 3.2-3.6 10^{12} p+):



Work still to be done

- Still one month of data to look at carefully (lots of systematic measurements were taken).

- Still many unexplained features in these instabilities:
  - why only at specific times for the cycle (for specific energies) ?
  - Magnitude of the growth rates.
  - Bunch profile & chromaticity dependency.

→ missing ingredients (needed to model them) are probably both on the side of the impedance model and of beam dynamics (accurate space-charge model, non-ultrarelativistic dynamics, etc.)