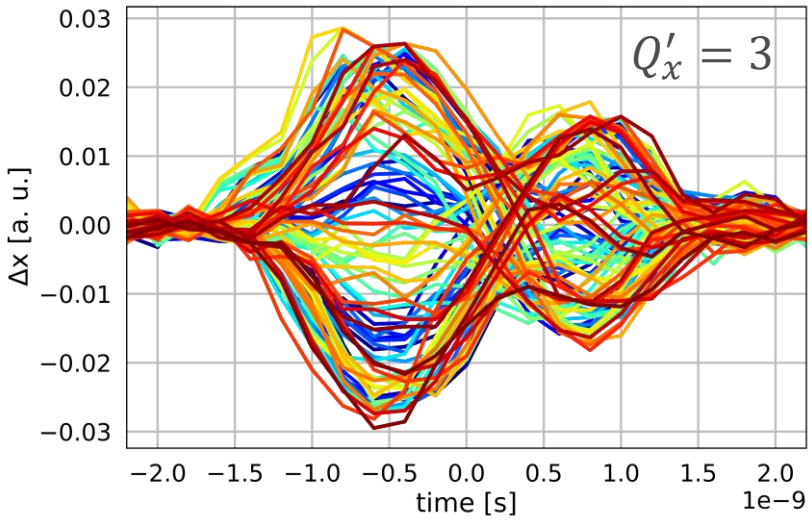
Studies of horizontal instabilities in the CERN SPS

Mario Beck – 01. May 2018 – IPAC 2018 Vancouver, Canada

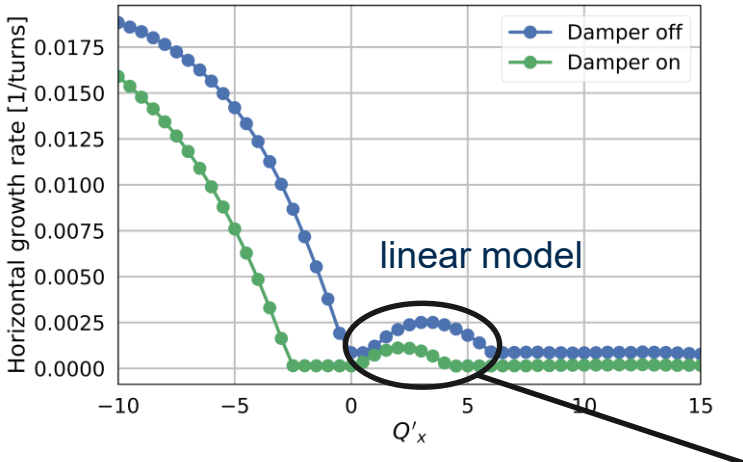
Motivation for the studies

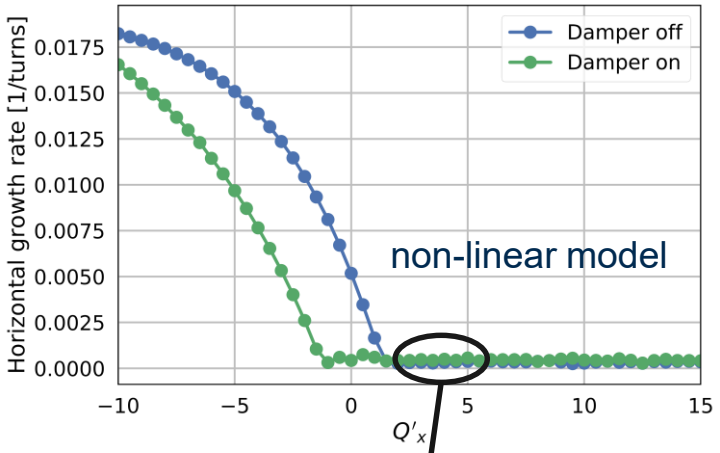
- For the LIU project the SPS is supposed to accelerate intensities, nearly twice as high as the current ones.
- Understanding the horizontal single bunch instabilities occurred during recent high **intensity (2e11 ppb)** multi-bunch runs in the SPS.

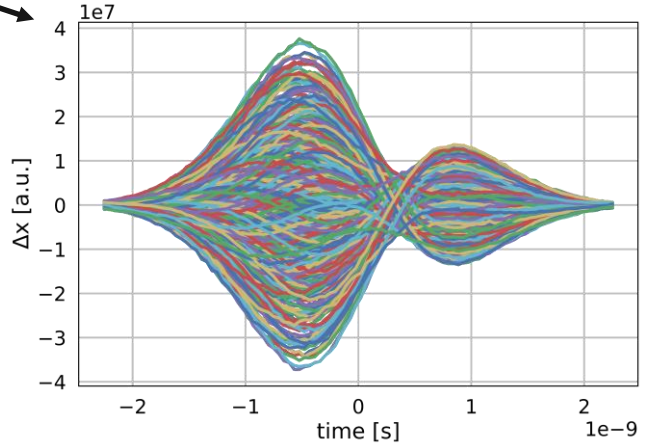


- Studies to validate the horizontal impedance model have been extended to study instabilities occurring for high intensities in the horizontal plane.

PyHEADTAIL Simulation



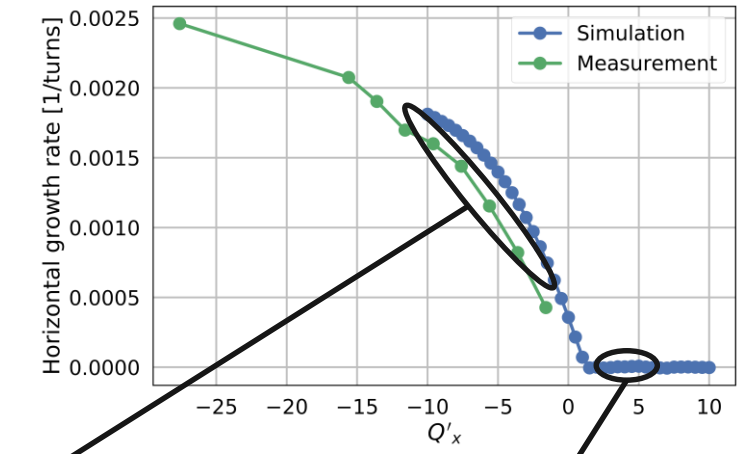


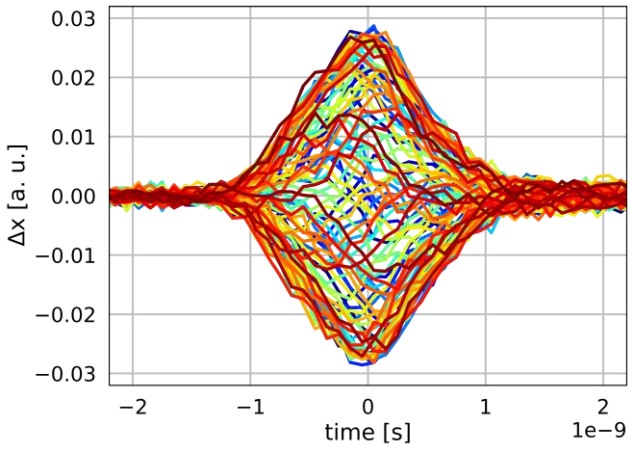


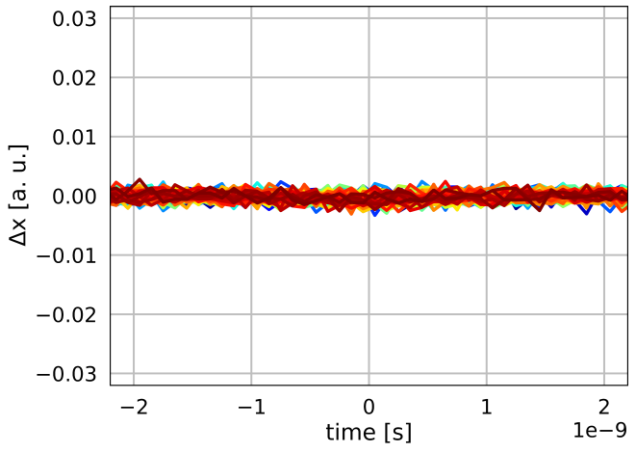
- Single-bunch simulation.
- Trying to reproduce the observed mode one.
- **Intensity = 2e11 ppb** and $\varepsilon_z = 0.35$ eVs.
- Damping rate = 100 turns.
- Studies refer to the Q20 optics.

Observations in the machine

- Single-bunch measurements in the SPS.
- Validating the simulations. (The simulation here was run with the parameters of the measurement)
- Intensity = **2e10** ppb and ε_z= 0.35 eVs.

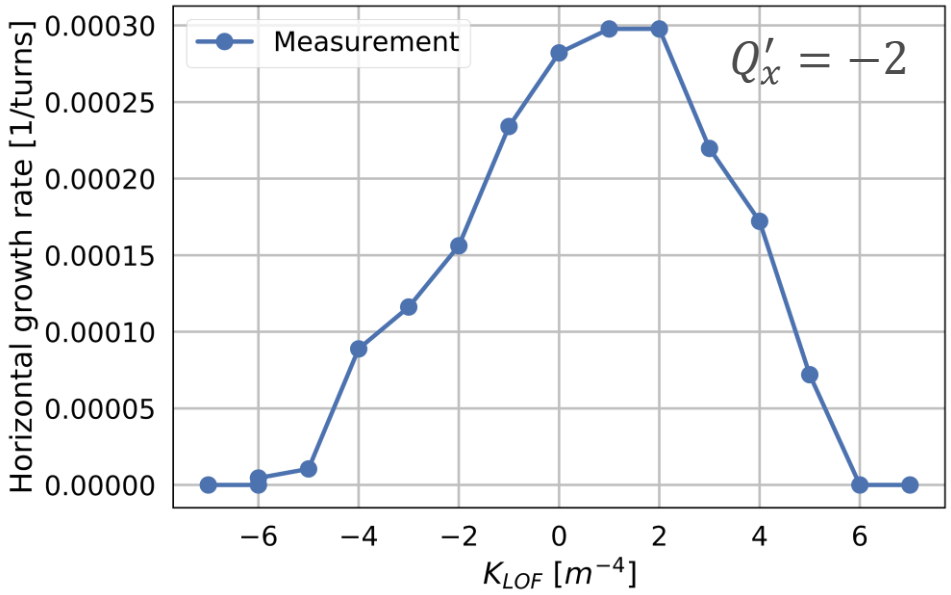






Octupole scan

Trying to use the Landau octupoles in the SPS with their magnetic strength K_{LOF} to damp a mode zero provoked by negative chromaticity.



Conclusion

- Simulations show that for higher bunch intensities a horizontal mode one can develop in the SPS in chromaticity regions where it has not been observed before. The instability can be damped using higher chromaticities.
- The simulations have been validated by measurements.
- Landau damping introduced by octupoles has been studied as an alternative to stabilize the beam. A measured octupole scan showed that reasonable magnetic strength values are sufficient to damp instabilities.

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Thank you for your attention !

Non–linearities in the SPS

Measured fractional tune in the SPS (Q20). Data was used for the non-linear simulations.