Chromaticity measurement using beam transfer function in high energy synchrotrons

X. Buffat, S.V. Furuseth and G. Vicentini

CERN, Geneva, Switzerland

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Motivation

- Measurement and correction of the chromaticity is needed to optimally damp collective instabilities (→ high chromaticity) while limiting detrimental effect on the single particle dynamics (→ low chromaticity)

- The most common measurement technique based on energy modulation is not compatible with high intensity operation due to large induced losses

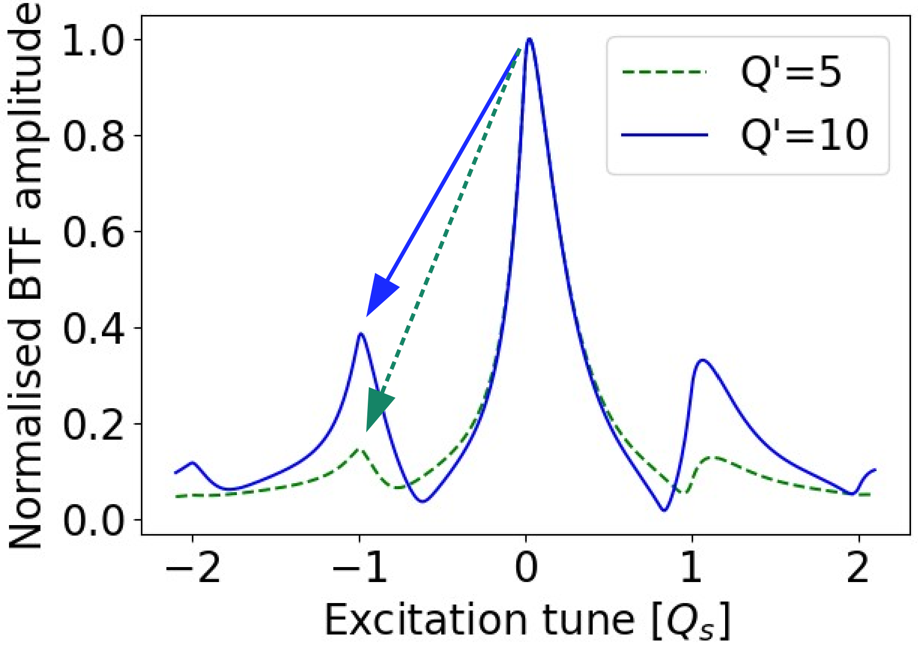
- The transverse Beam Transfer Function (BTF) can be measured on a single bunch, even during multi-bunch operation, thanks to fast kickers and pickups

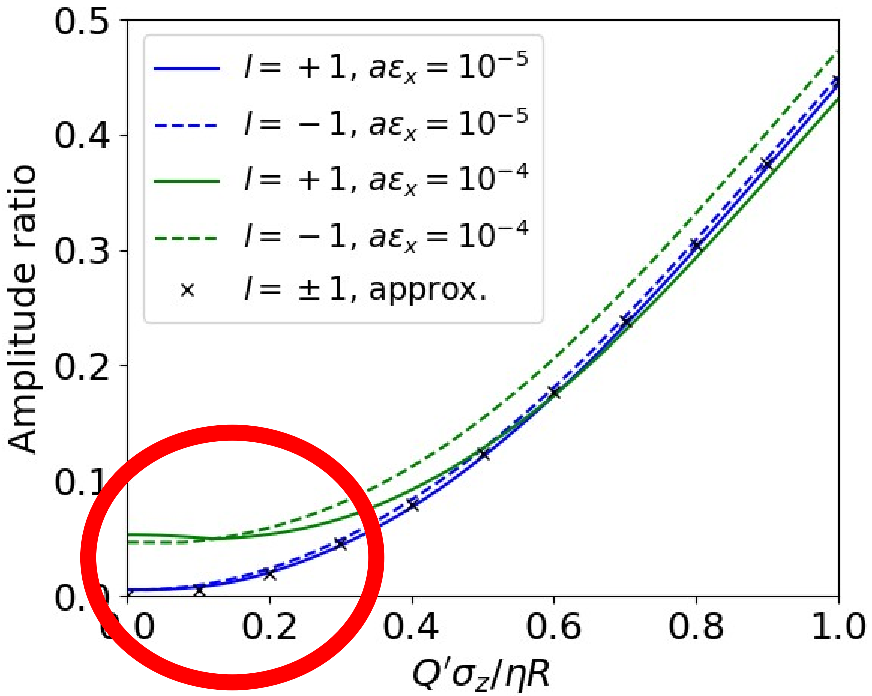
→ **The BTF depends non-linearly on several parameters, we seek to extract reliably this information with different algorithms**

Amplitude ratio of sideband ±1 to the main peak

- For an r.m.s. detuning much smaller than the synchrotron tune:

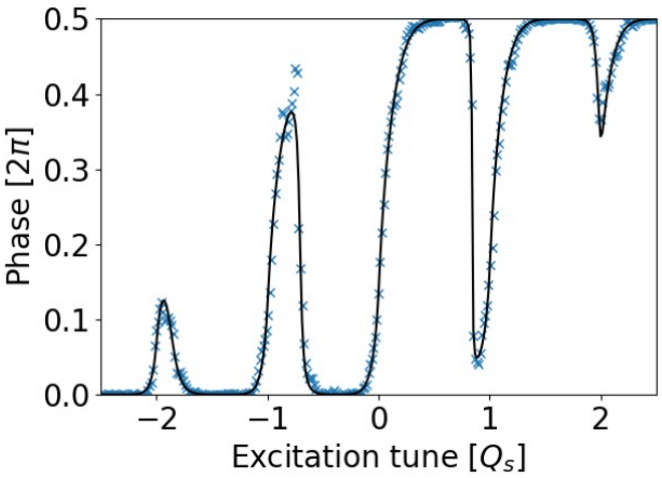
$$R_a = \frac{w_{\pm 1}(Q')}{w_0(Q')} \qquad w_l^G(Q') = ^{-\left(\frac{Q'\sigma_z}{Q_s\beta_z}\right)^2} I_l\left(\left(\frac{Q'\sigma_z}{Q_s\beta_z}\right)^2\right)$$

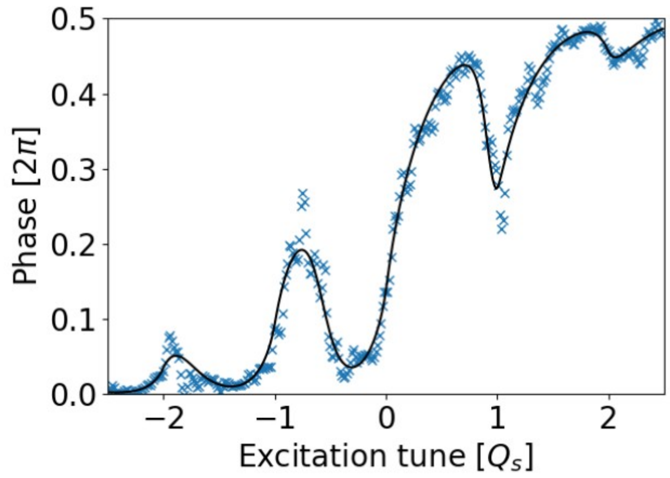


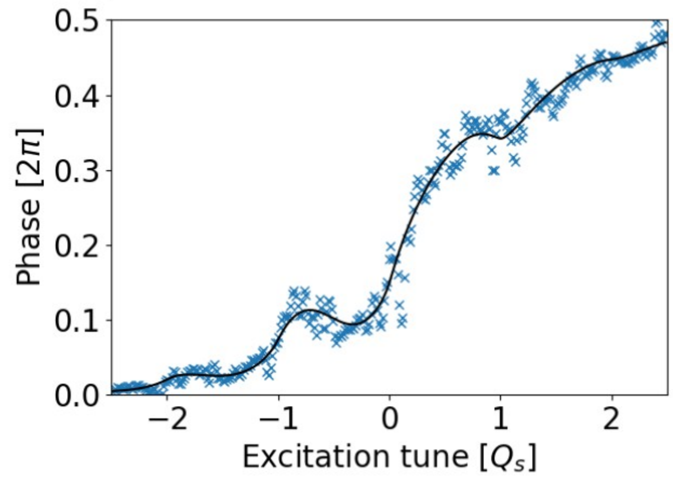


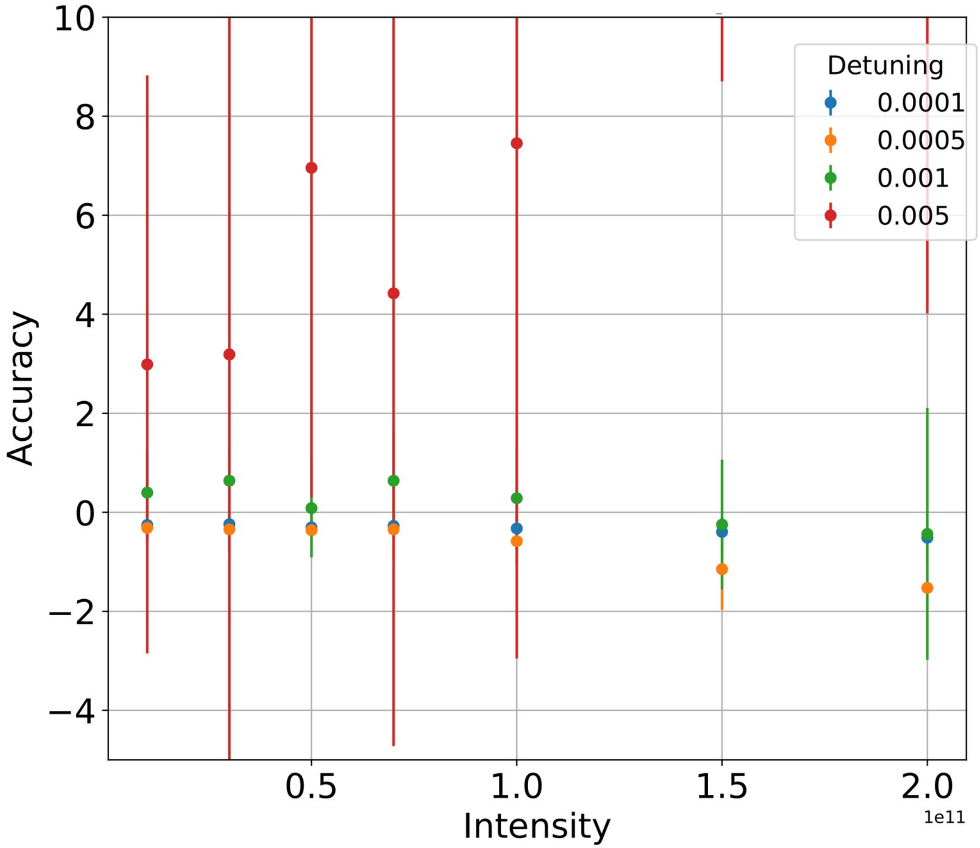
- Simple an accurate solution for low detuning and no wakefields

Non-linear fit

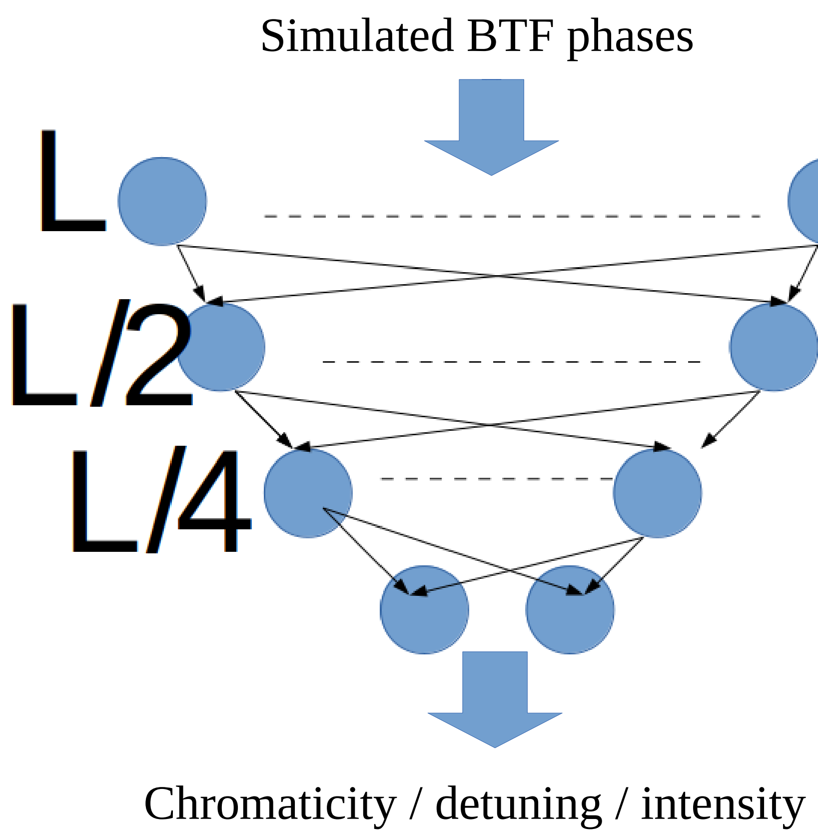


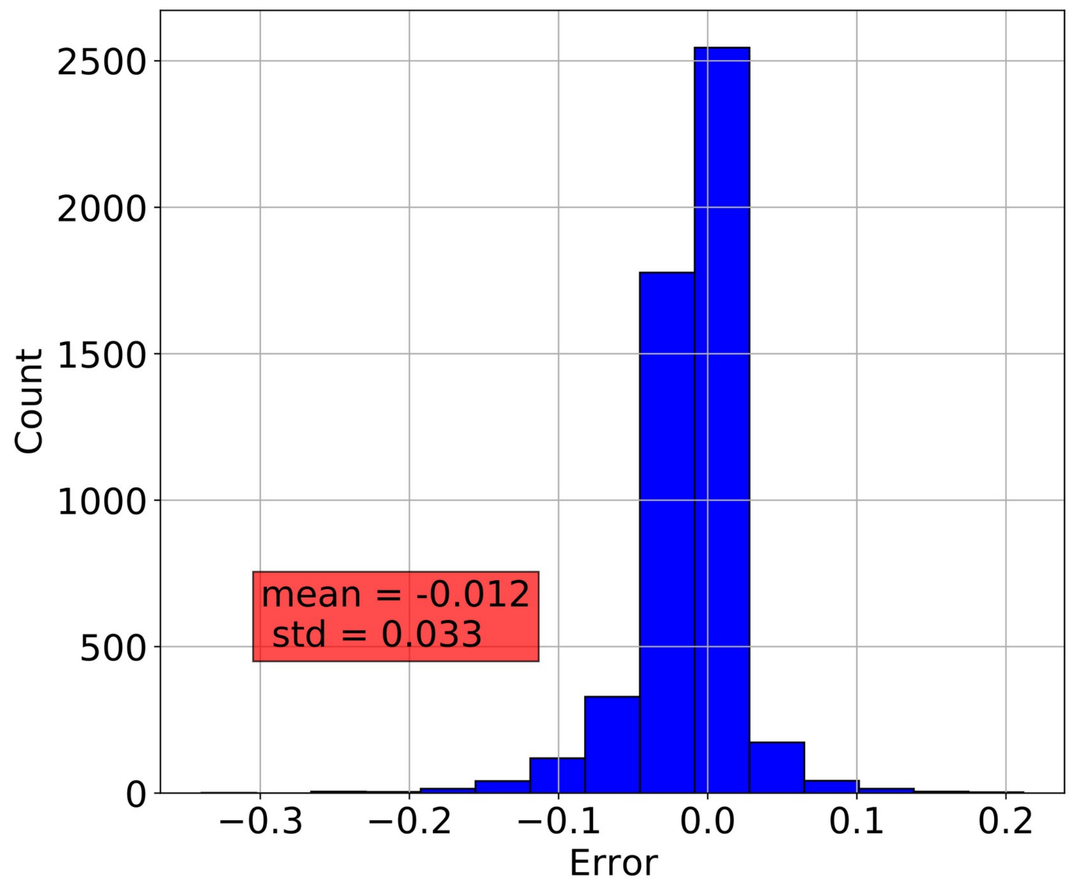






- The non-linear fit tends to fail for high detuning as the signal from the sidebands in the BTF phase weakens
- An accuracy in the order of few units can be obtained with a non-linear fit
  - **The fitting function needs to take into account the impact of the wakefields**





- The 4-layer neural network yields better accuracy on a wider range of parameters

→ Next step: experimental tests

Does a network trained on simulation data work on experimental data ?