Trim in Q1 for β^* measurements

R. Tomás, J. Coello, A. Garcia
and M. Hofer for WP2

March 30, 2017

Goals of β^* measurement

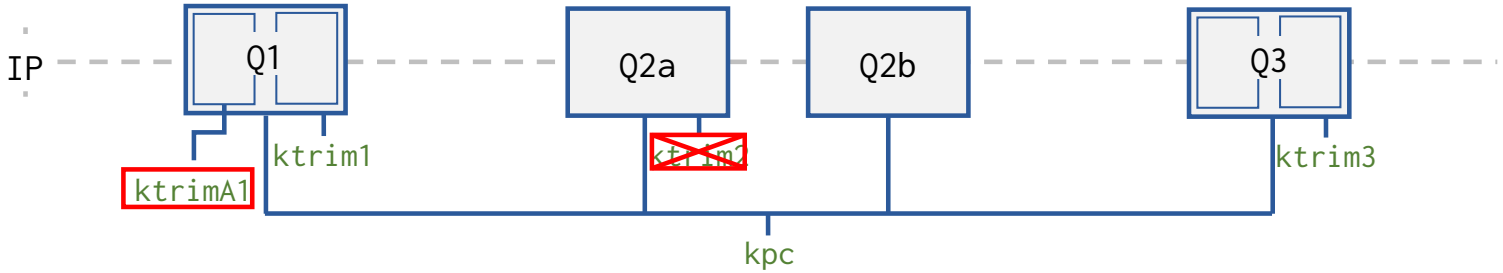
- ★ Ensure beam aperture & machine protection.
  Requires ≈10% accuracy in β^*
- ★ Provide same luminosities to CMS and ATLAS within 5% rms.
  Requires 2% accuracy in β^*

Techniques to measure β^*

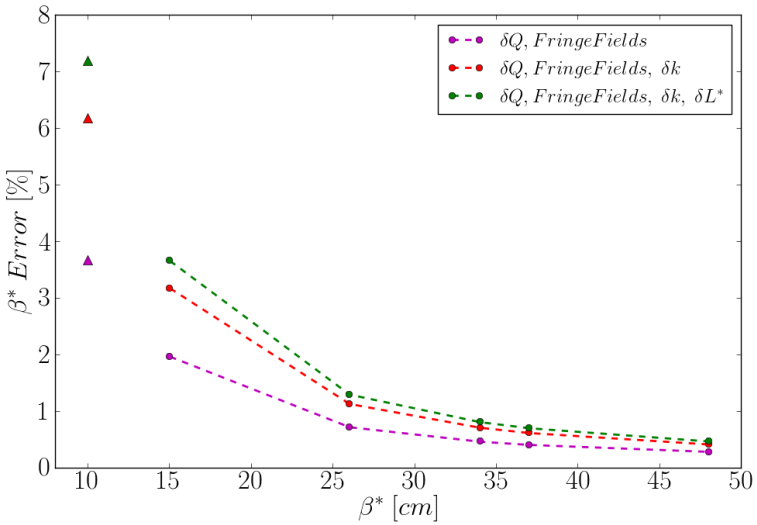
- ★ K-modulation:
  - **without tune feedback**. Demonstrated accuracy in LHC $\approx$1%.
  - with tune feedback
- ★ β from amplitude of betatron oscillations with calibrated BPMs.

K-modulation accuracy versus Q1A trim

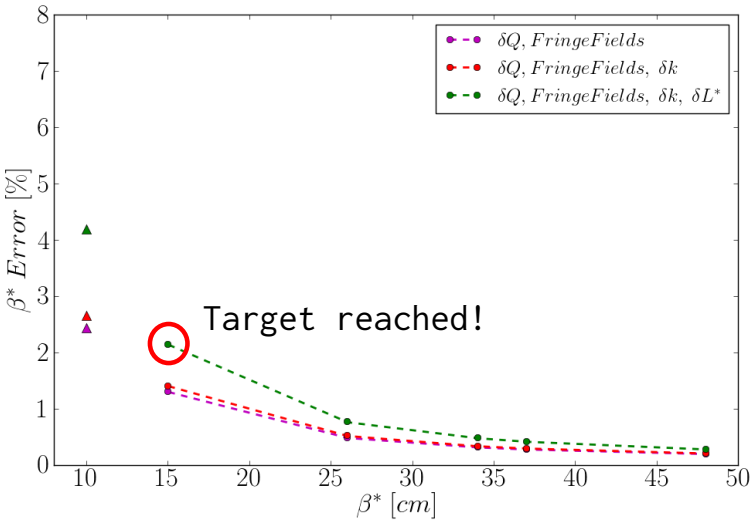
Potential solution: Q1a trim?



- Factor 2 improvement in β^* control (round optics):



Adding trimA1

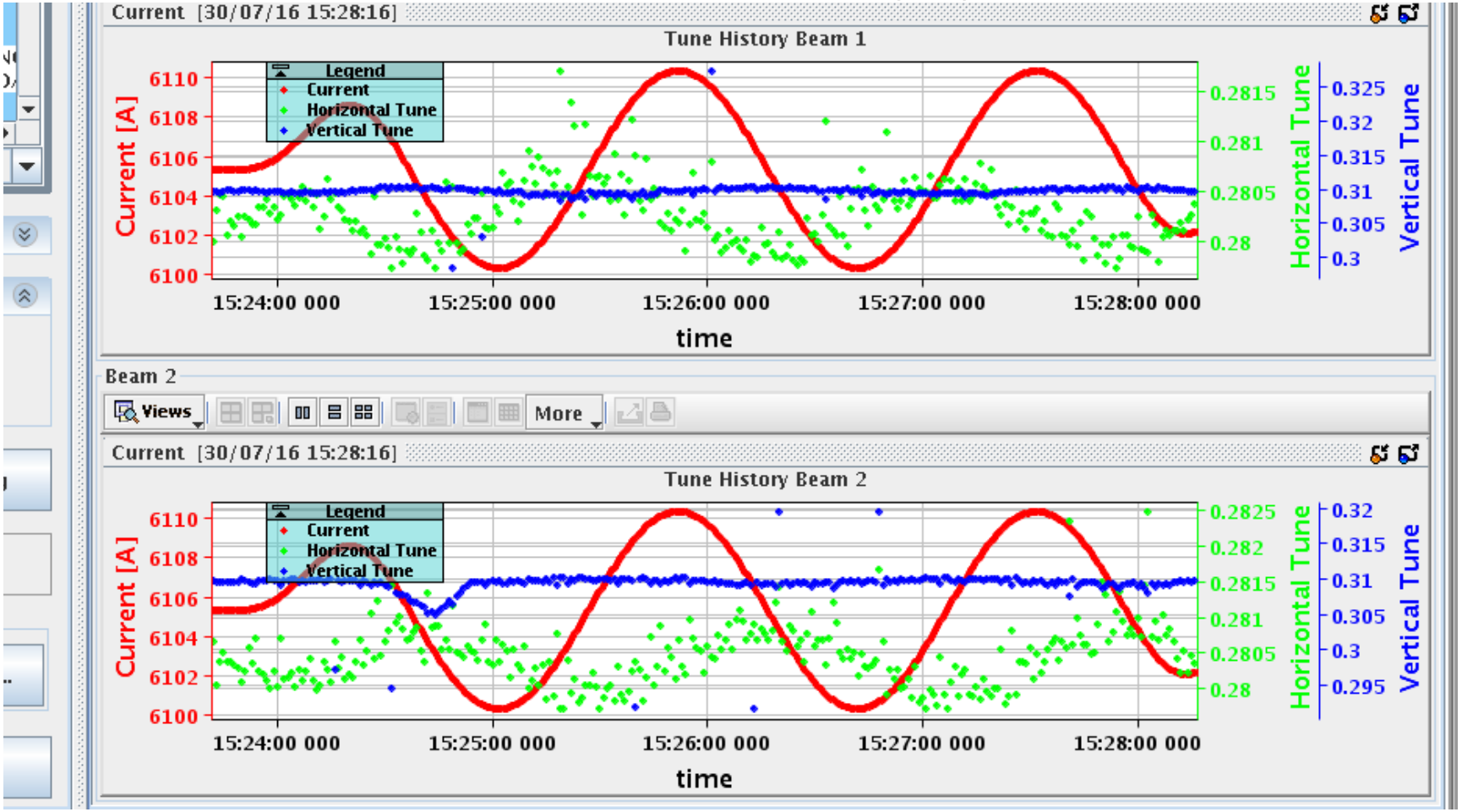


Target achieved for round 15cm optics and approaching the spec for flat 10/40cm optics.

J. Coello in 2017 HL-LHC Circuit Review

K-modulation with tune feedback I

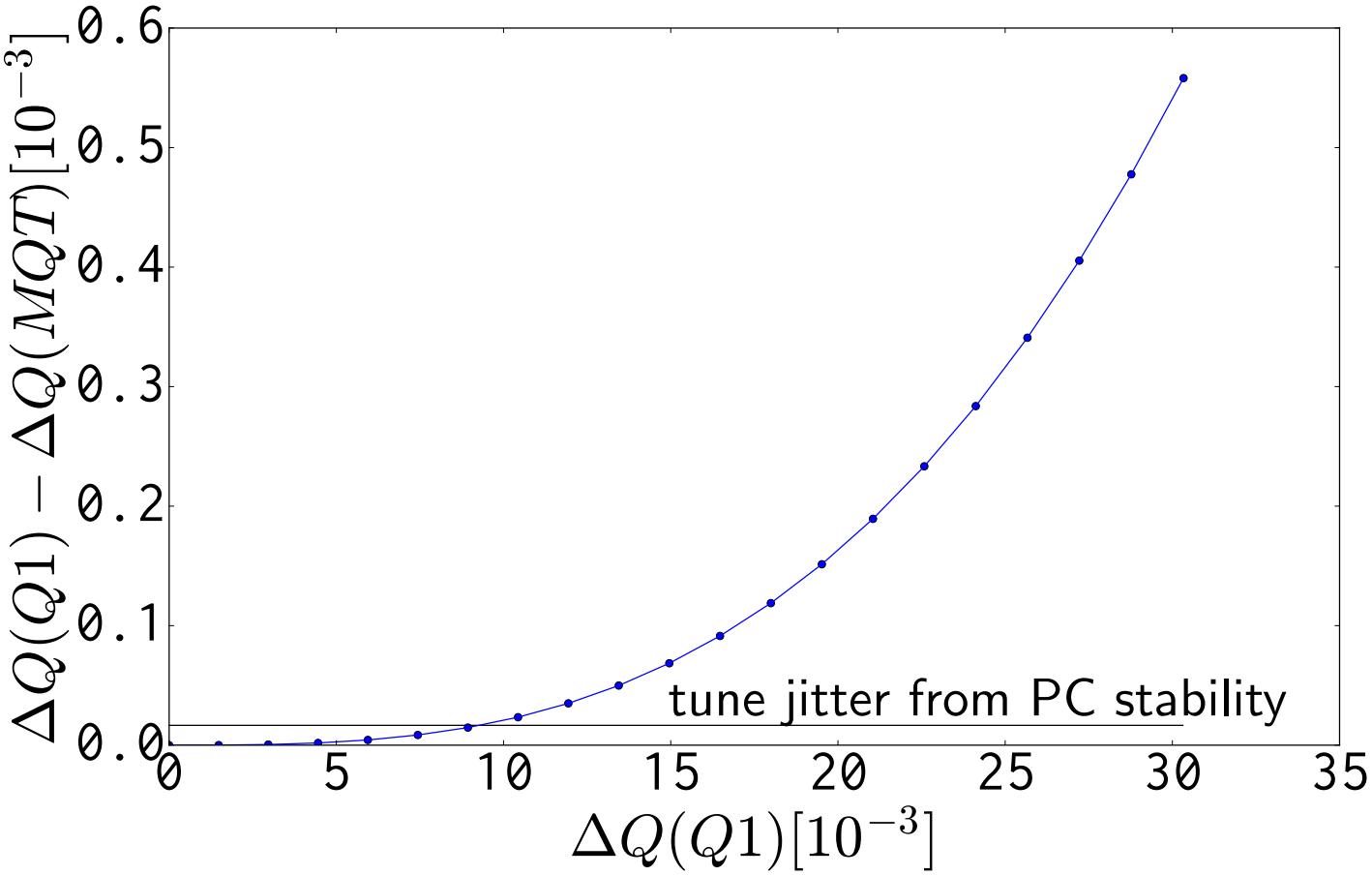
This was tried in the LHC in 2016:



Late response of feedback, partial correction...

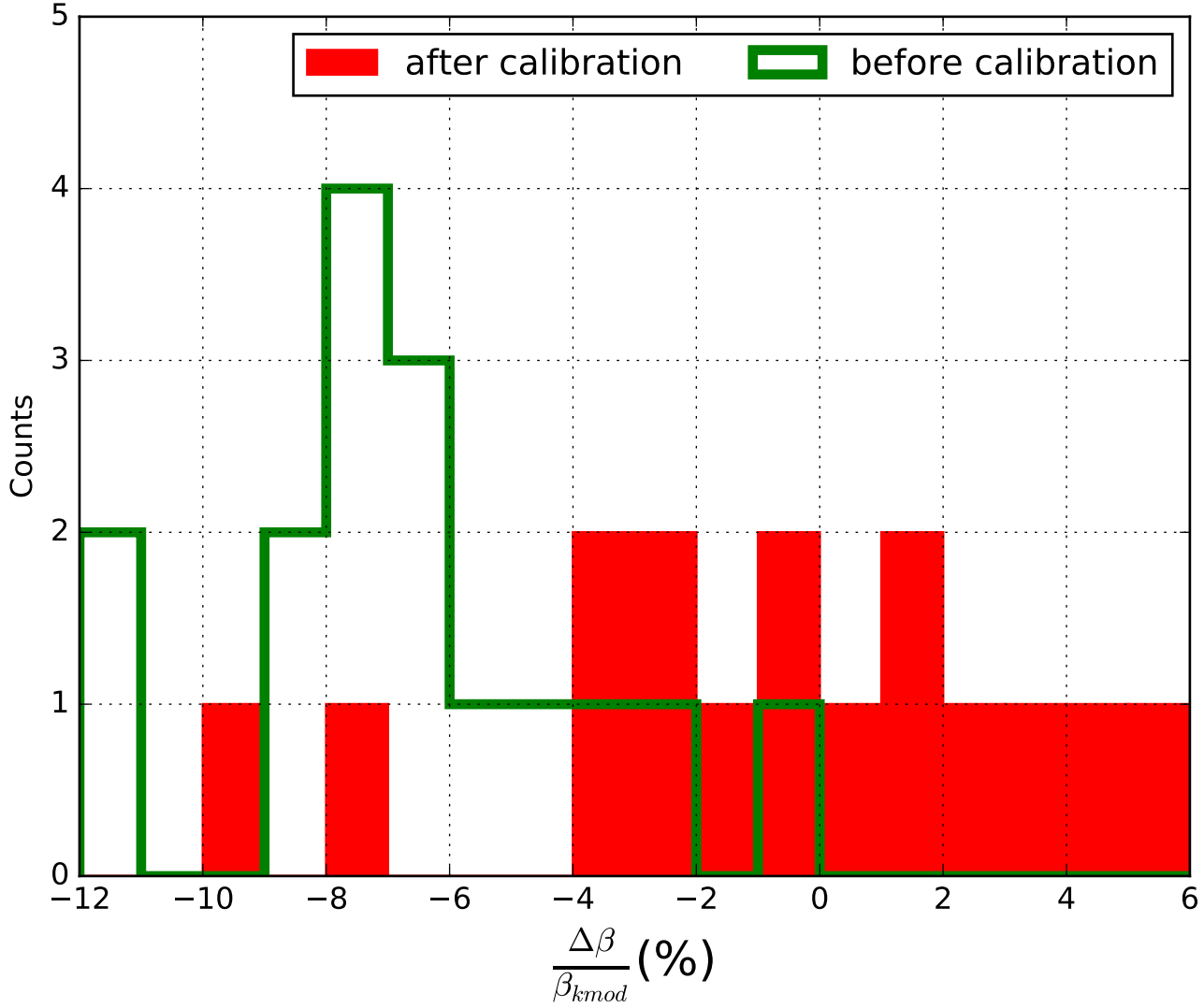
K-modulation with tune feedback II

Systematic error from Q1 β-beating in MQTs:



Systematic error above random error for ΔQ >0.01.

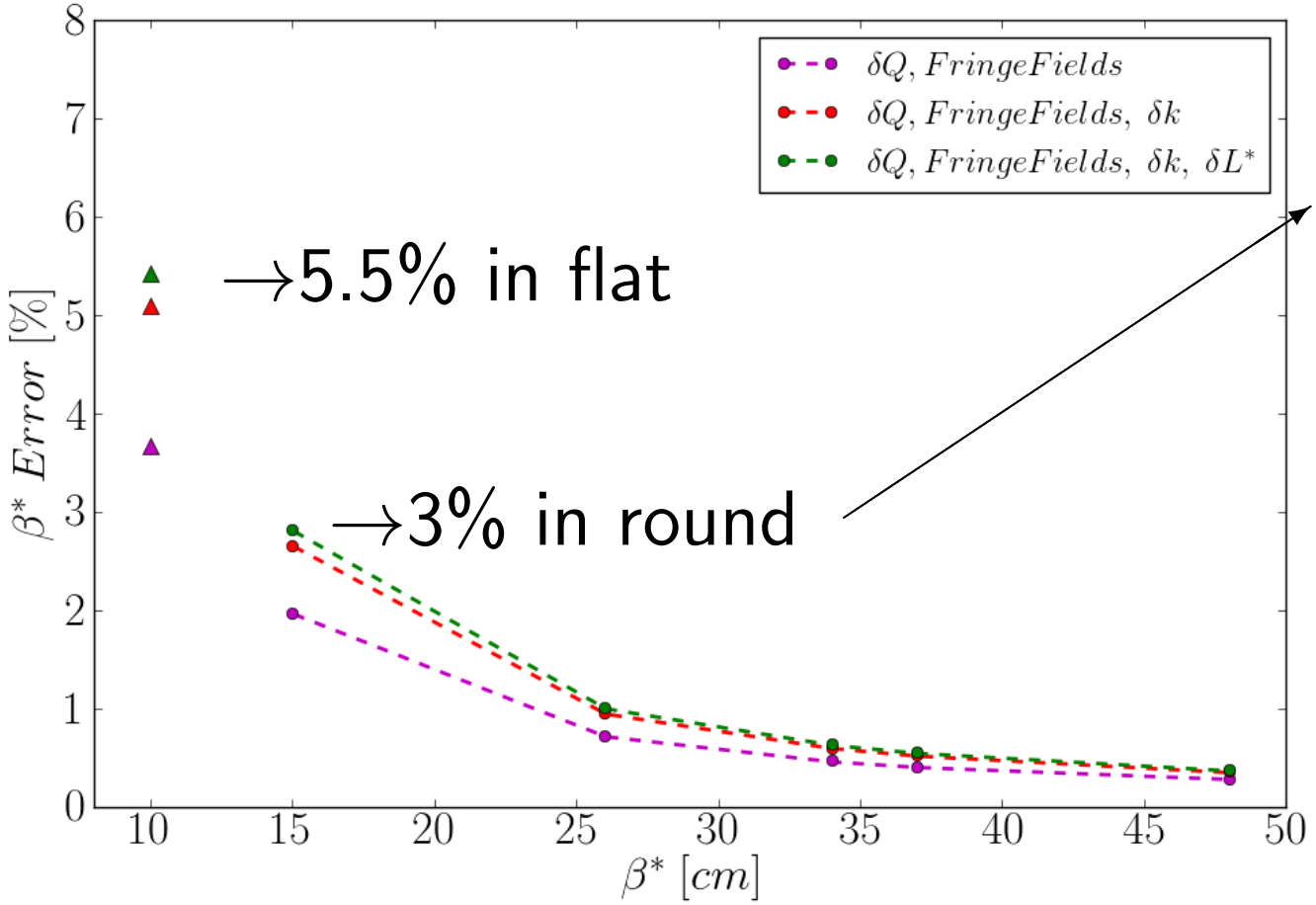
β from amplitude - BPM calibration



Optics-measurement-based BPM calibration helps improving the accuracy but does not reach requirement.

Tightening imperfection tolerances?

- ★ Uncertainty of 10 units in MQFX TF could not be reduced (we already asked)
- ★ Improve longitudinal alignment accuracy from 5 mm to 1 mm for all triplet quadrupoles:



Significant improvement but not enough, lumi imb. 8%

WP2 meeting to address feasibility of 1 or 5mm.

Summary

- ★ K-modulation without tune feedback is the best technique for β^* control. Current configuration gives 11% luminosity imbalance (4% in β^*).
- ★ The only known solution to meet the 5% luminosity imbalance tolerance (2% in β^*) is the Q1A trim with 30 Amps.
- ★ Longitudinal alignment uncertainty has limited impact on β^* control. 1 mm uncertainty gives 8% lumi. imbalance (3% in β^*) How good could it be?