Trim in Q1 for $\beta^*$ measurements

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Goals of $\beta^*$ measurement

★ Ensure beam aperture & machine protection. Requires $\approx 10\%$ accuracy in $\beta^*$

★ Provide same luminosities to CMS and ATLAS within 5% rms. Requires 2% accuracy in $\beta^*$
Techniques to measure $\beta^*$

★ K-modulation:
  ▶ **without tune feedback.** Demonstrated accuracy in LHC $\approx 1\%$.
  ▶ with tune feedback

★ $\beta$ from amplitude of betatron oscillations with calibrated BPMs.
K-modulation accuracy versus Q1A trim

Potential solution: Q1a trim?

- Factor 2 improvement in $\beta^*$ control (round optics):
  
  Adding trimA1

Target reached!
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

This was tried in the LHC in 2016:

Late response of feedback, partial correction...
Systematic error from Q1 $\beta$-beating in MQTs:

Systematic error above random error for $\Delta Q > 0.01$. 
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:
  - $\rightarrow 3\%$ in round
  - $\rightarrow 5.5\%$ in flat

Significant improvement but not enough, lumi imb. 8%

WP2 meeting to address feasibility of 1 or 5 mm.
K-modulation without tune feedback is the best technique for $\beta^*$ control. Current configuration gives 11% luminosity imbalance (4% in $\beta^*$).

The only known solution to meet the 5% luminosity imbalance tolerance (2% in $\beta^*$) is the Q1A trim with 30 Amps.

Longitudinal alignment uncertainty has limited impact on $\beta^*$ control. 1 mm uncertainty gives 8% luminosity imbalance (3% in $\beta^*$). How good could it be?