Optics considerations for HL-LHC
(with a simplistic and pessimistic approach)

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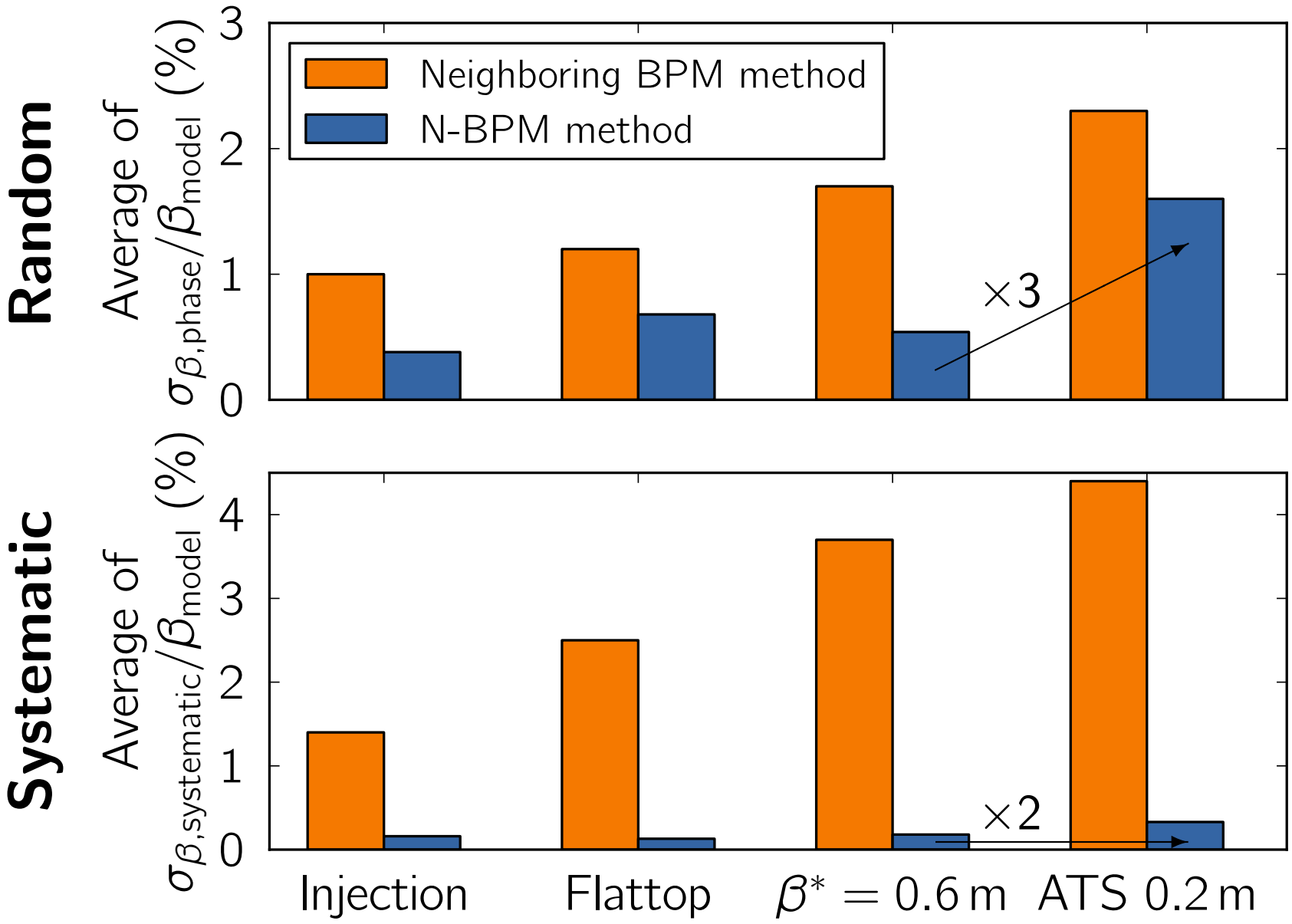
Exp. ATS optics measurement resolution



MQXF error and global corrections

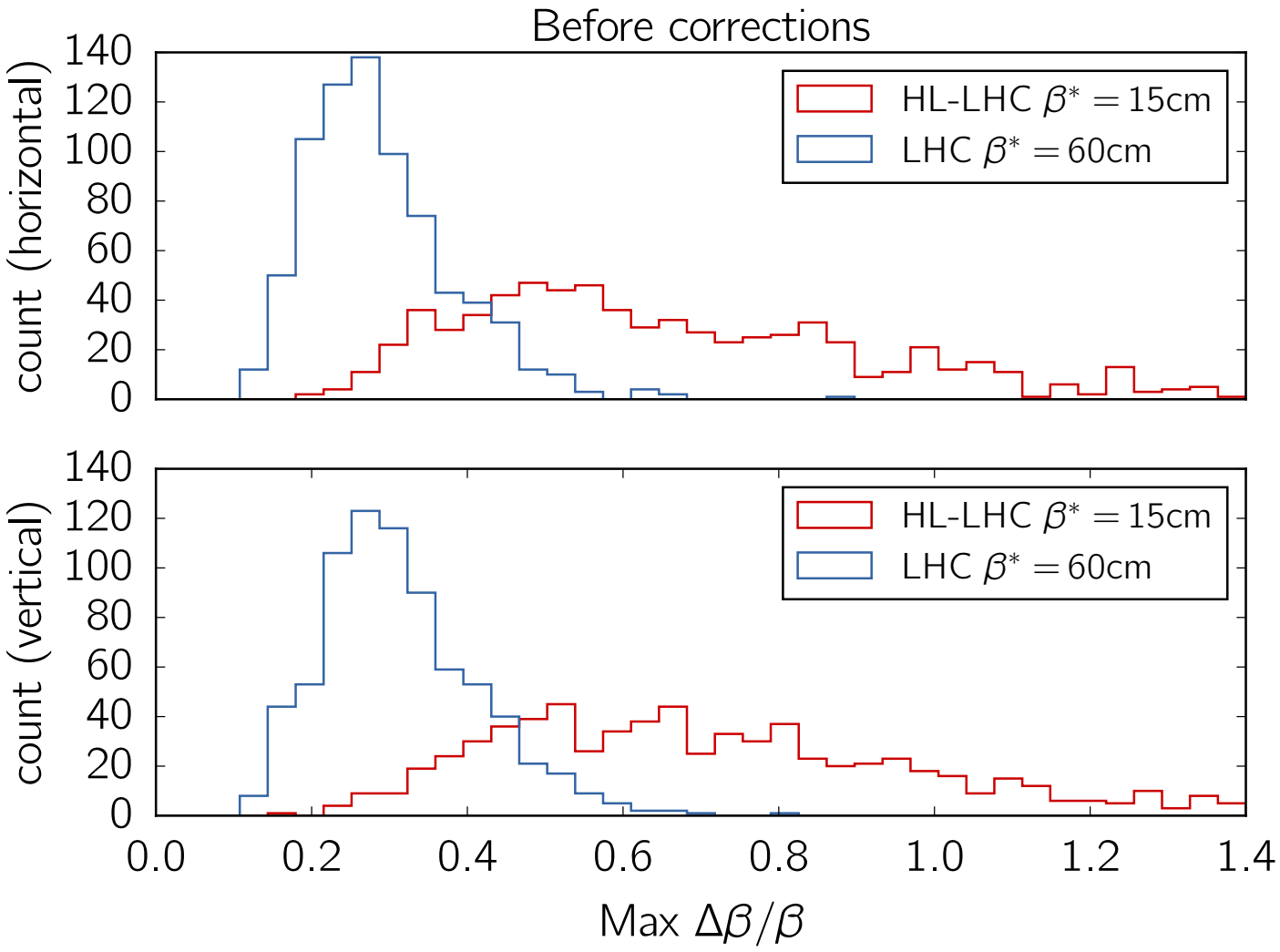
- ★ From Ezio MQXF b_2 error is 10^{-3}
- ★ global corrections ($\vec{c} = R^{-1}\vec{b}$) are done after local corrections (segment-by-segment)
- ★ For global corrections we assume MQXF error has been effectively reduced by a factor 5 to 2×10^{-4} thanks to local corrections

Errors for global correction simulation

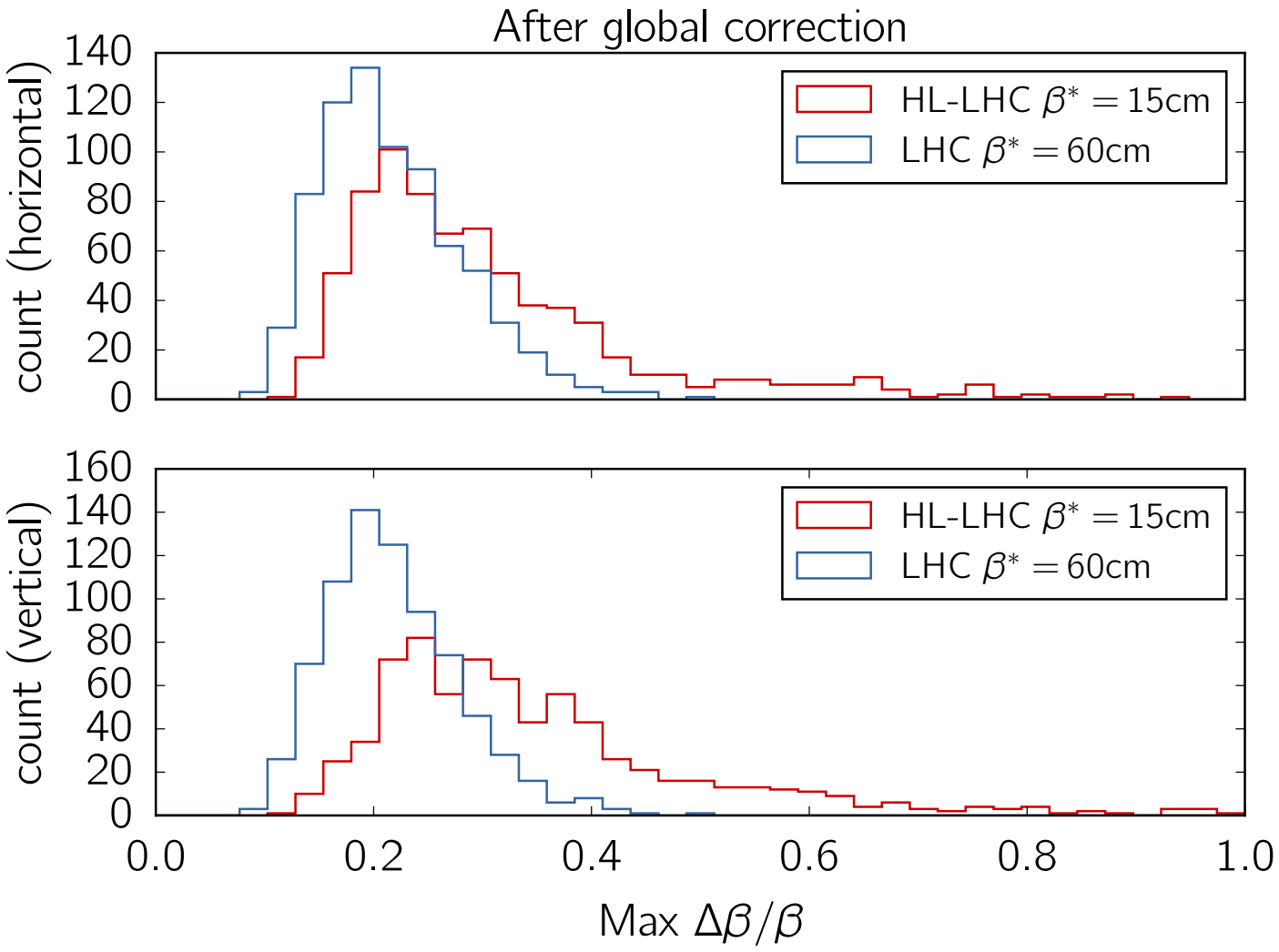
longitudinal quadrupole misalignment 1mm
transverse sextupole misalignment 1mm
dipole b_2 errors as tabulated

Quadrupole	**Error relative to their main field (10^{-4})**
MQ	2×18
MQM	2×12
MQY	2×7
MQXA/B	2
MQW	16
MQT	78
MQXF	2
MQYY	10
MQYL	2×7

β-beating simulations before global corrs

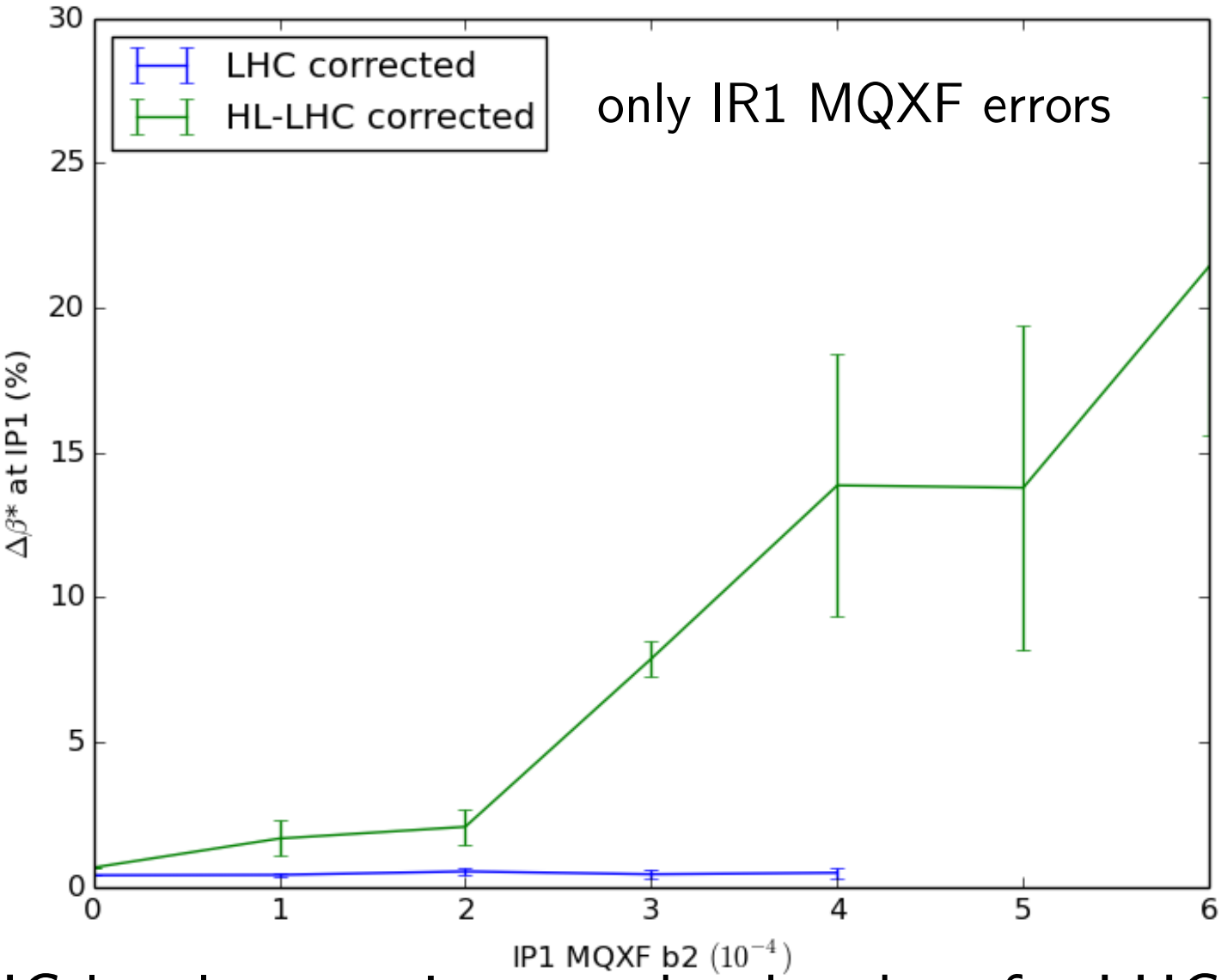


Global correction simulations (1 iteration)



HL-LHC global corrections are harder than for LHC

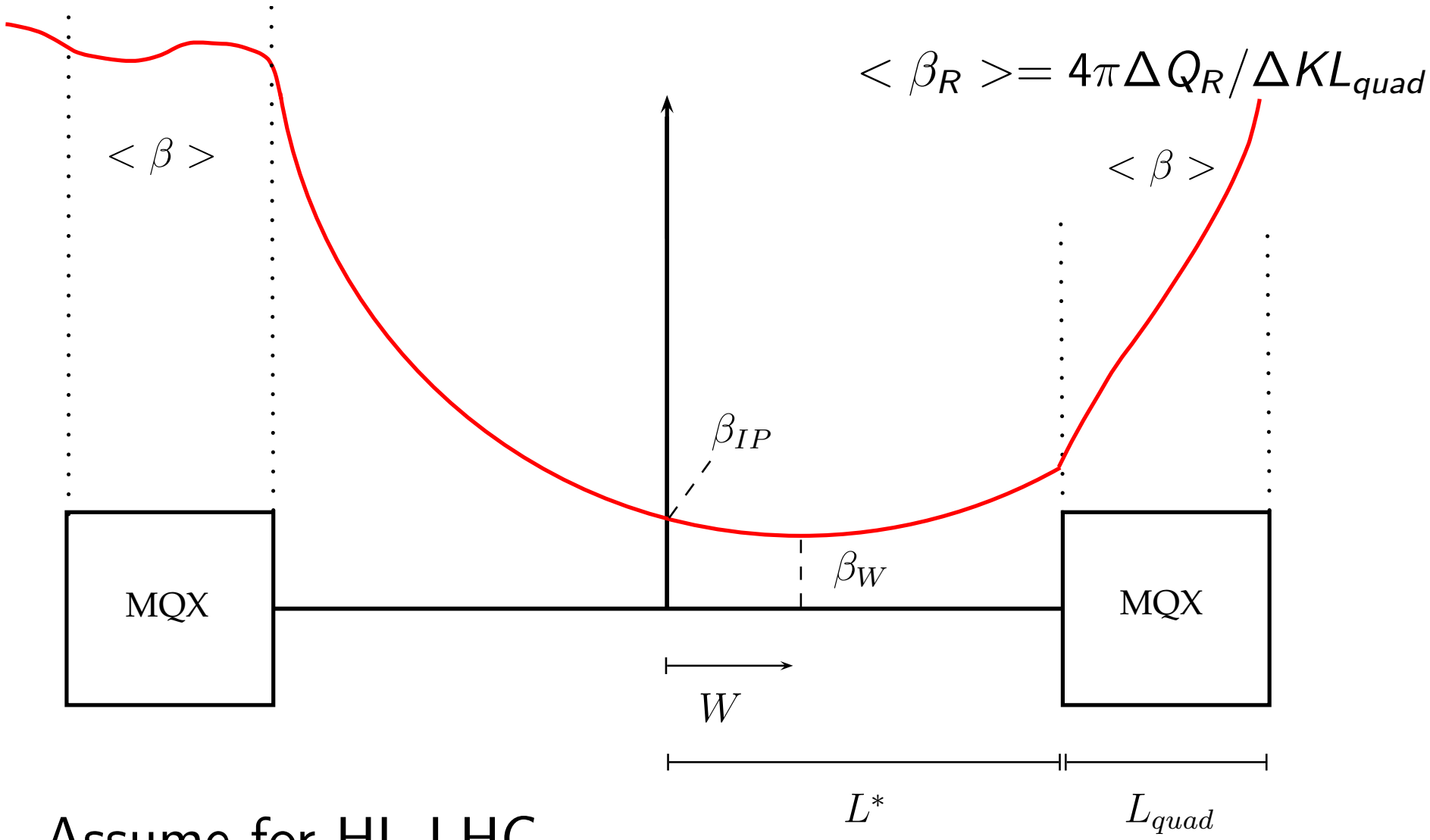
β^* after local correction (simulations)



HL-LHC local corrections are harder than for LHC

(improved segment-by-segment needed)

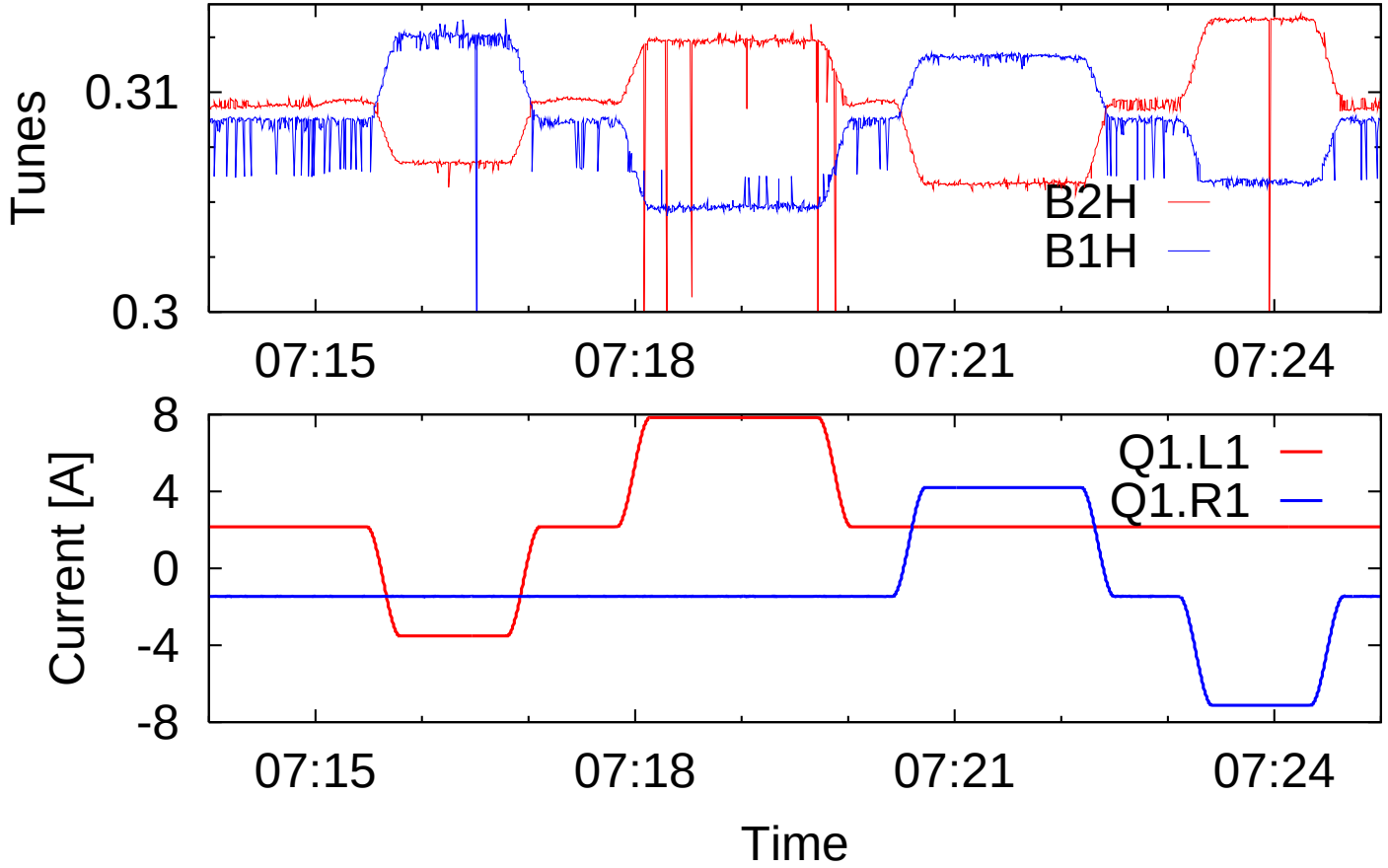
K-modulation



Assume for HL-LHC

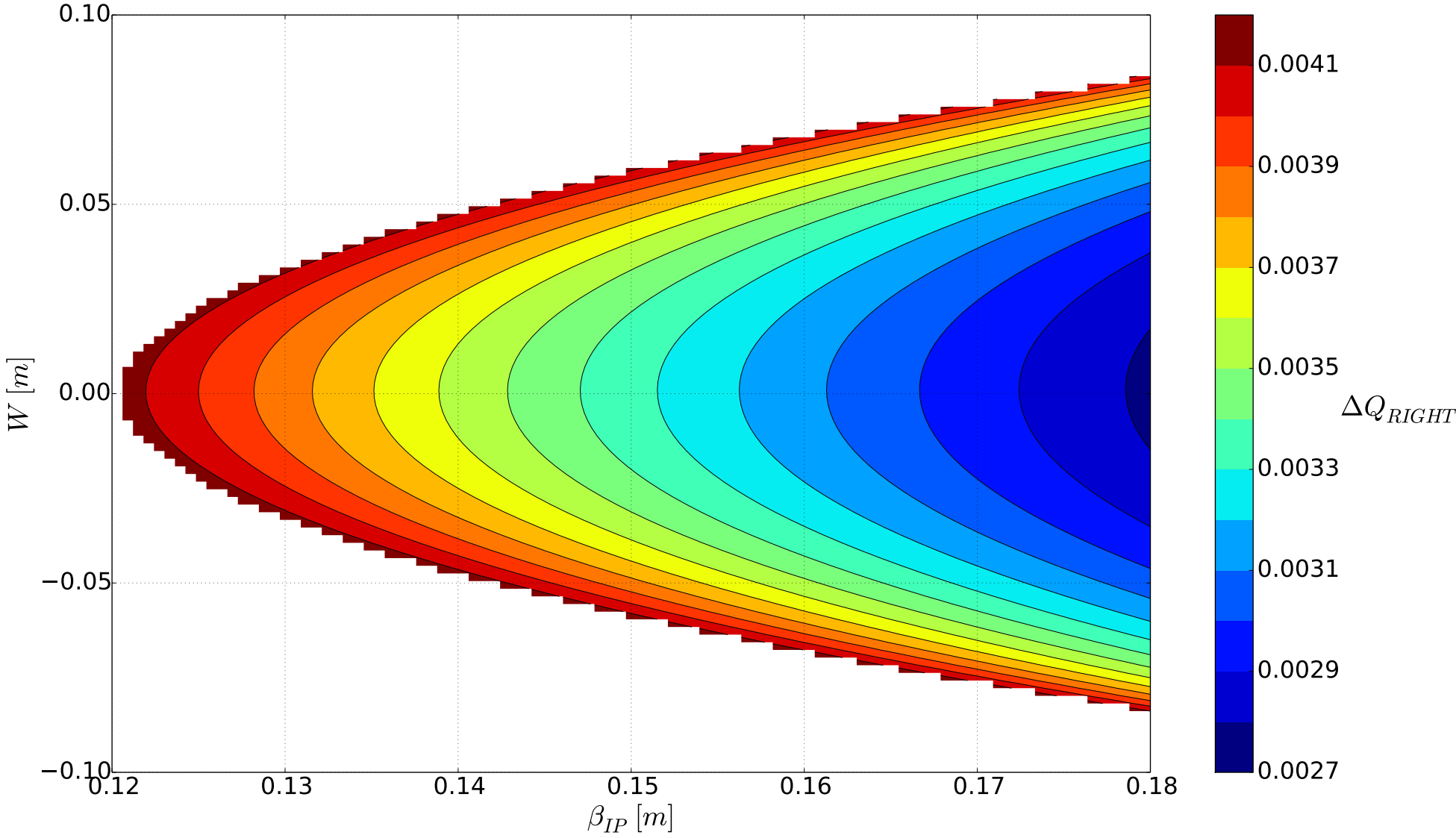
ΔQ_R and ΔQ_L tune measurement error of 10^{-5}

K-modulation - LHC example

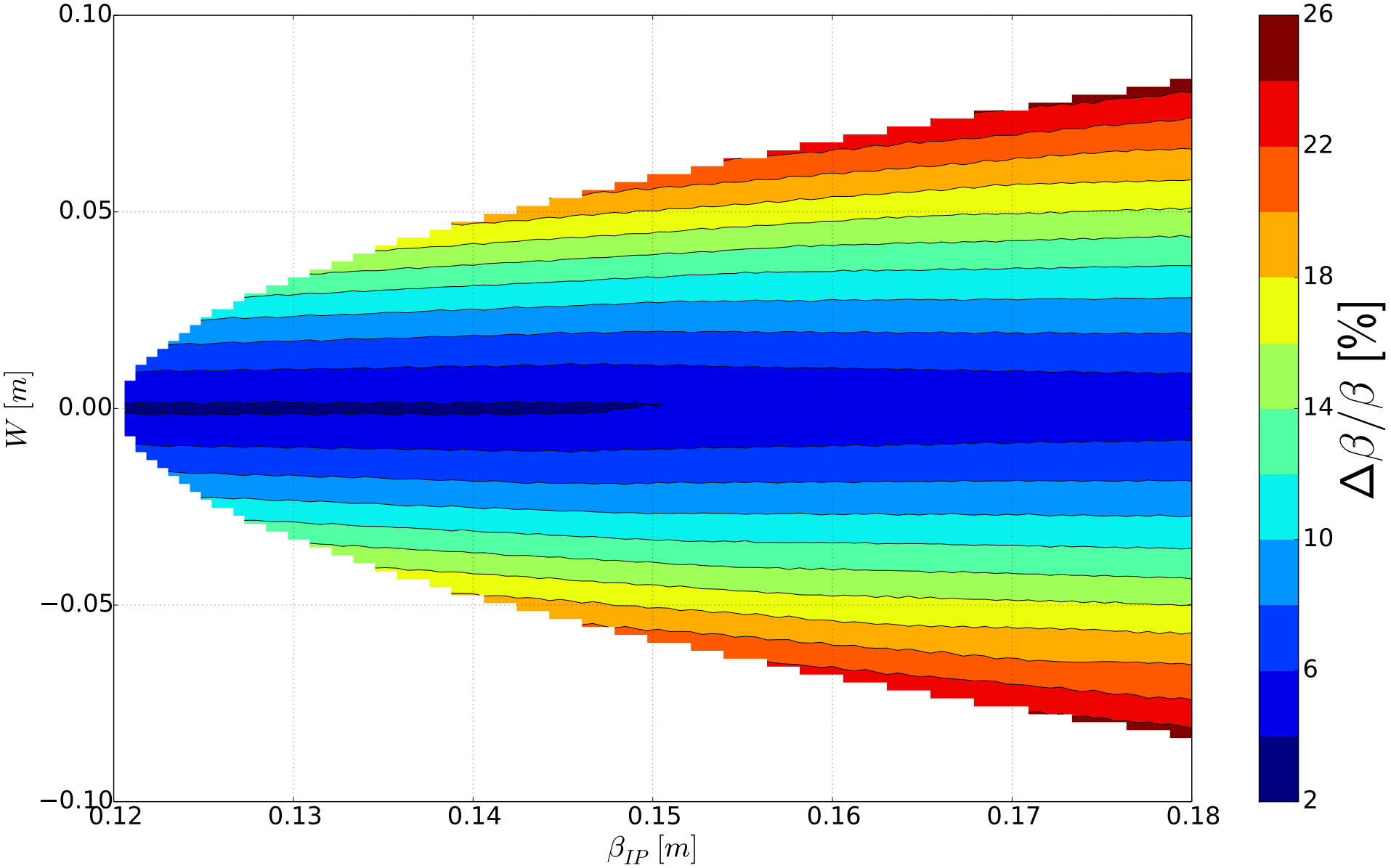


tune measurement resolution of 10^{-4} after data filtering.

K-modulation - HL-LHC simulations

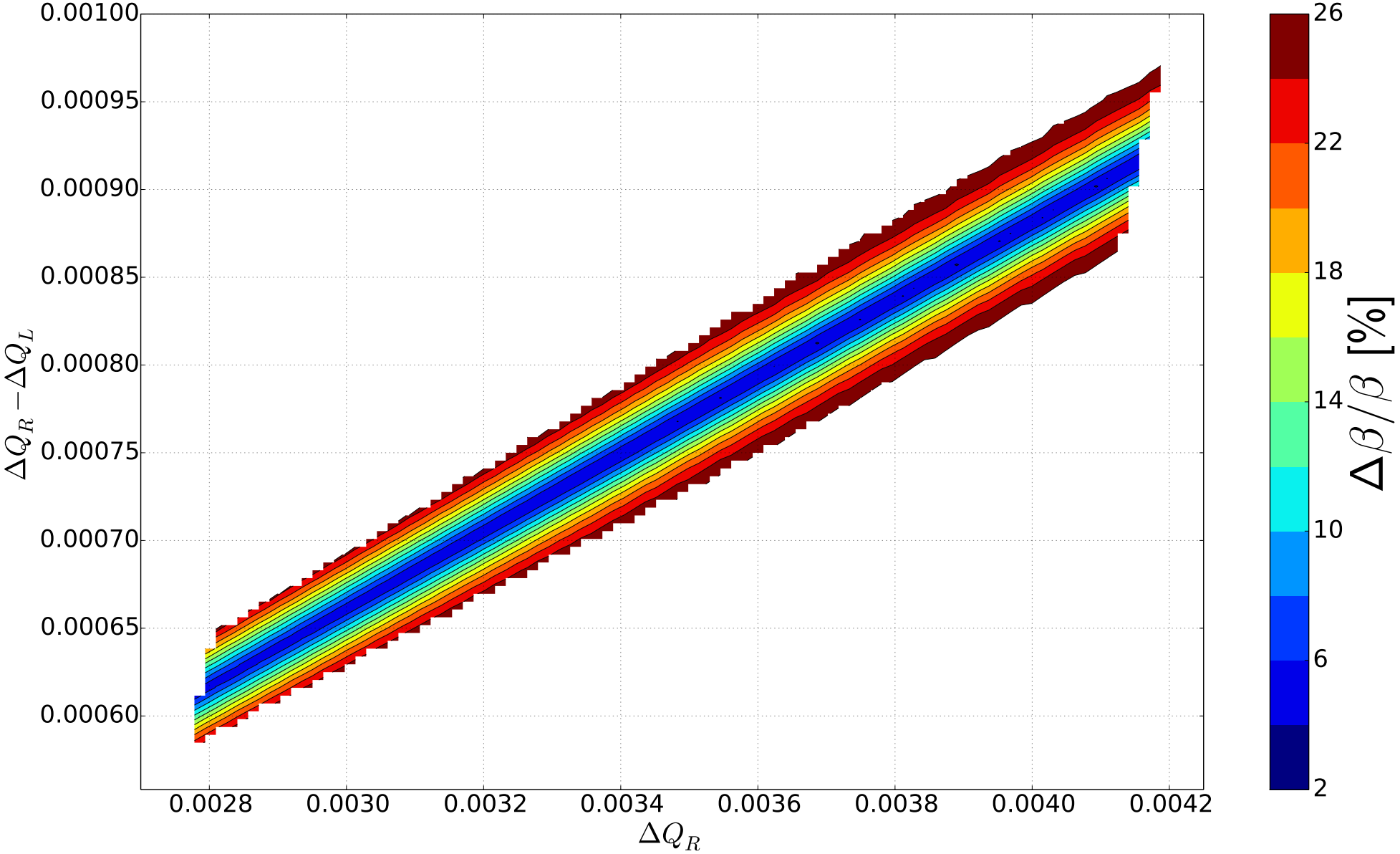


β^* resolution - HL-LHC simulations

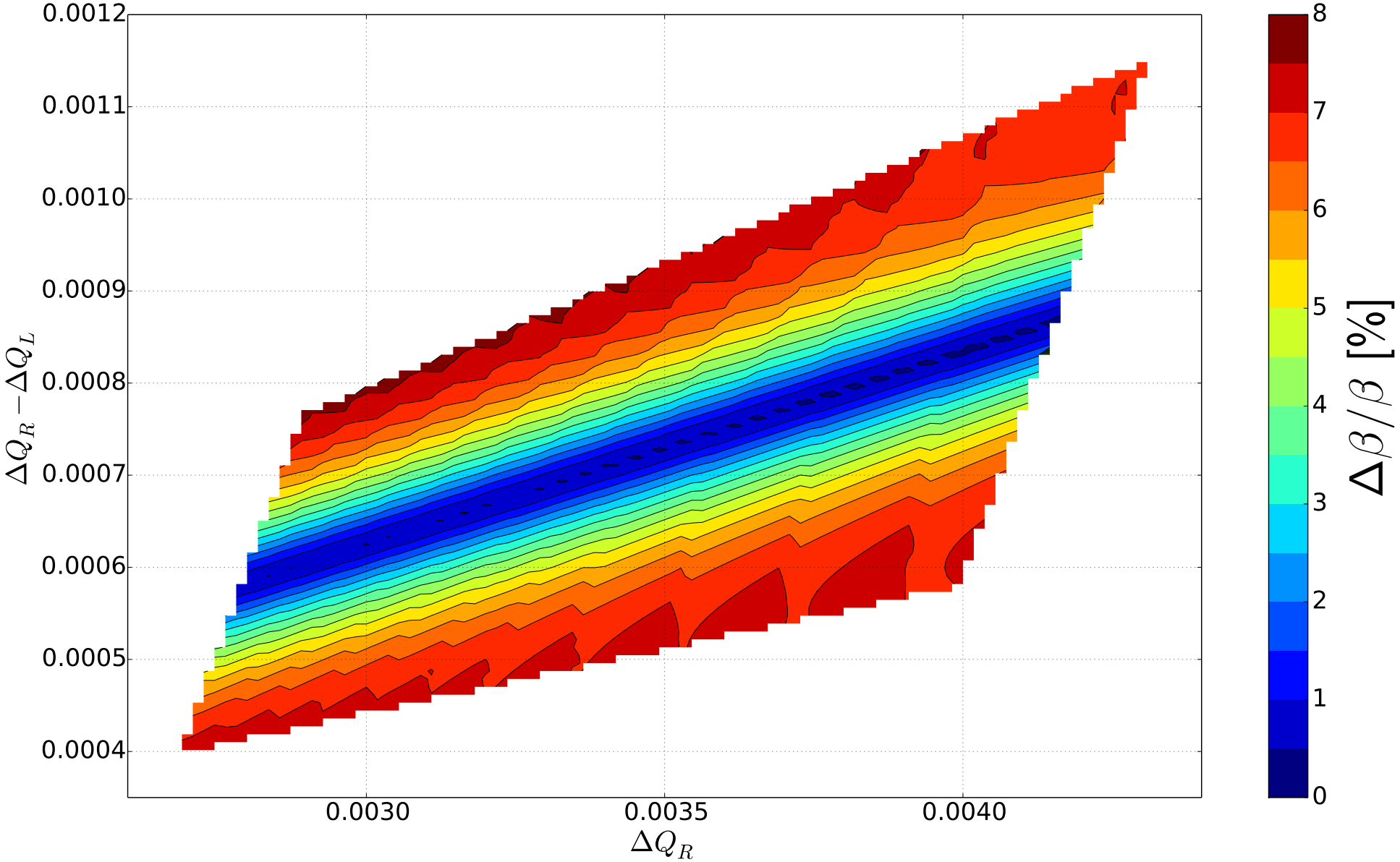


β^* resolution very sensitive to actual β^* and w

β^* resolution - HL-LHC simulations



β^* resolution - LHC simulations



As usual, LHC is much easier.

β^* leveling optics commissioning

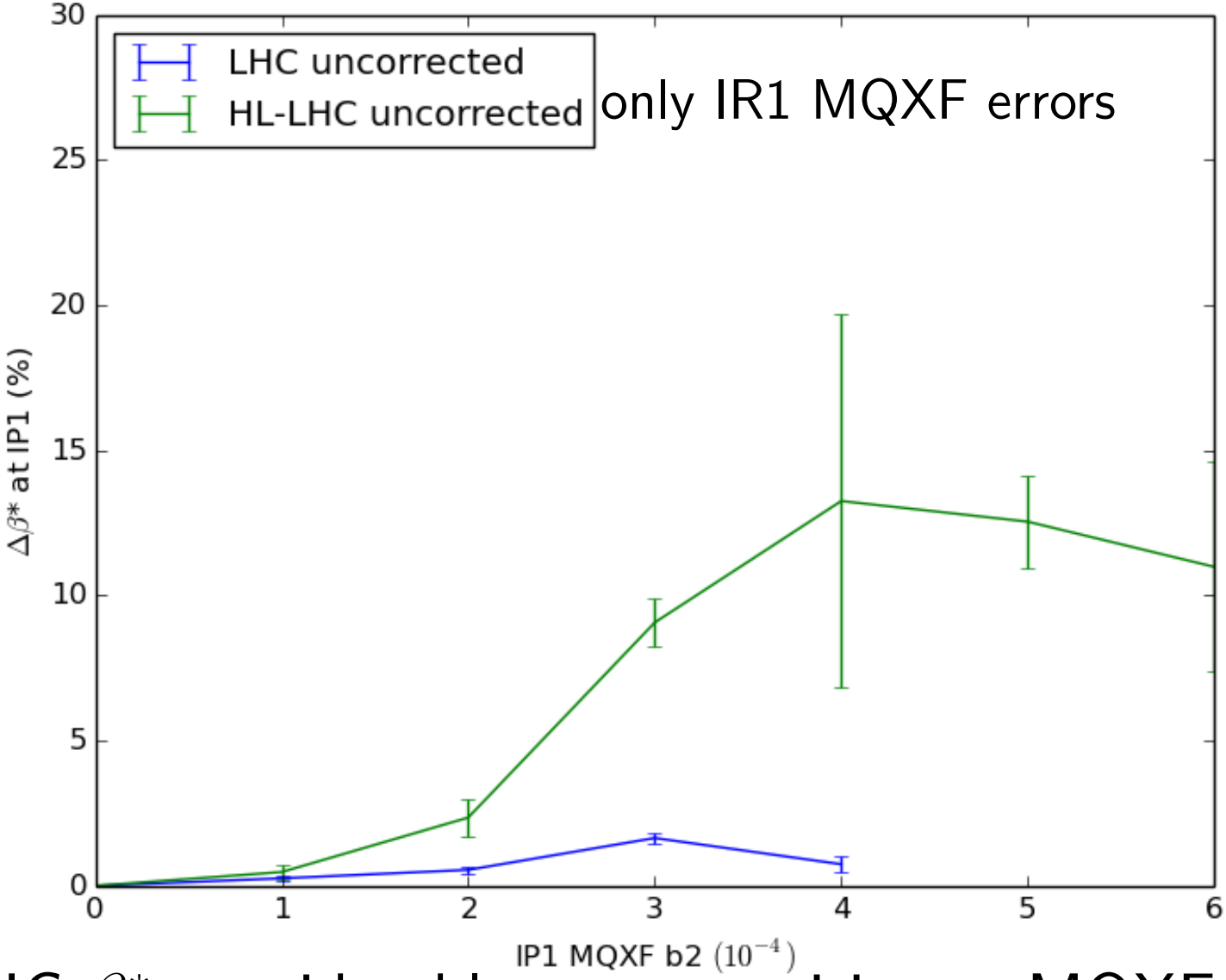
- Between β^* =0.7m and 0.15m there are about 30 steps changing β^* by 5%
- Doing optics commissioning as in 2012 might take about 7 shifts
- *à la carte* β^* is currently not conceivable but we will work on it
- Other aspects to be tested are: larger β^* at injection, ramp & squeeze, ATS optics corrections (never tested with success!)

Summary

- ★ Regarding optics commissioning HL-LHC is harder than LHC
- ★ Many improvements to come: algorithms, longer AC dipole, high resolution DOROS BPMs, etc.
- ★ Ezio's tolerance of $b_2 = 10^{-3}$ for MQXF is rather high. Can we request a lower one, 2×10^{-4}?
- ★ K-modulation requirements: Tune measurement better than 10^{-5} and bipolar trims in the triplets
- ★ Experimental demonstration required

Extra slides

β^* before local correction (simulations)



HL-LHC β^* considerably more sensitive to MQXF errors than LHC