



## Update on $\beta$ -beating from head-on and long-range in the HL-LHC

L. Medina<sup>1,2</sup>, R. Tomás<sup>2</sup>, X. Buffat<sup>2</sup>

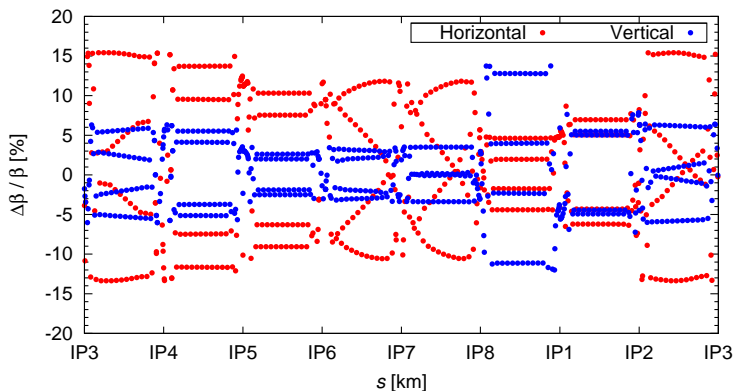
<sup>1</sup> División de Ciencias e Ingenierías  
Universidad de Guanajuato

<sup>2</sup> CERN, BE-ABP

113th HiLumi WP2 Meeting

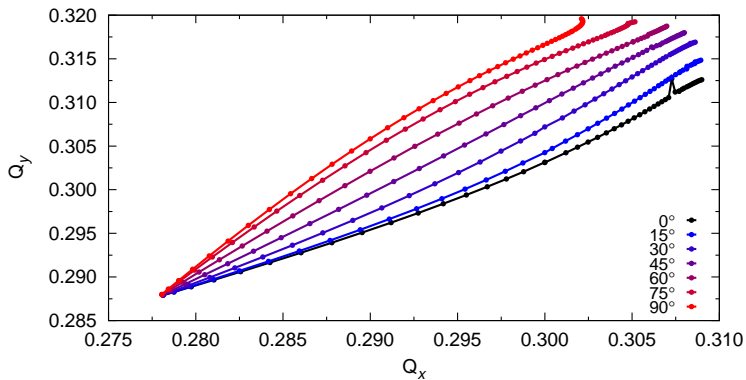
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## $\beta$ -beating at zero-amplitude for the latest baseline



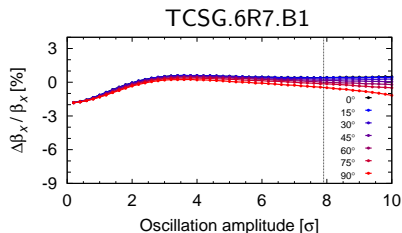
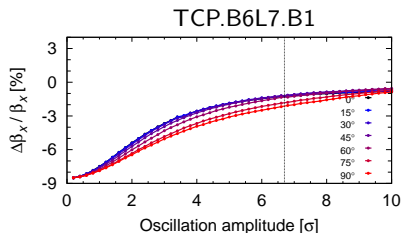
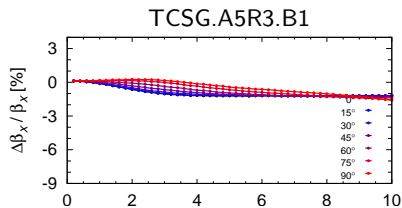
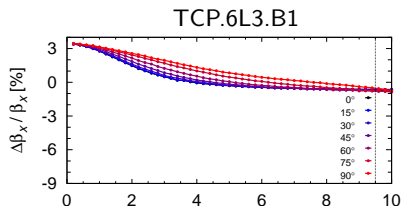
- ▶ Impact of  $\beta$ -beating on **performance** (e.g. luminosity imbalance) and on the **protection system**
- ▶ **Head-on** and **long-range** at the four IPs
- ▶ At the beginning of the fill:  $2.2 \times 10^{11}$  ppb,  $\beta^* = 64$  cm,  $\epsilon_n = 2.5$   $\mu\text{m}$
- ▶ Peak: 15 % (hor.) / 14 % (ver.); RMS: 8 % (hor.) / 5 % (ver.)

## Detuning with amplitude



- ▶ Particle amplitudes up to  $10\sigma$

## Amplitude-dependent $\beta$ -beating



- ▶ Impact on **collimators** (primary and secondary)
- ▶ The non-linear  $\beta$ -beating does not vanish with the particle amplitude
- ▶ Small  $\beta$ -beating for amplitudes larger than  $6\sigma$  → **Not a problem** (below the tolerance of  $\sim 20\%$ )

## Correction

- ▶  $\beta$ -beating at zero amplitude can be corrected with quadrupoles<sup>1</sup>
  - ▶ It may deteriorate  $\beta$  for particles at large amplitudes → collimators
- ▶ Non-linear correction currently under study

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<sup>1</sup>L. Medina et al, *Proc. 8th Int. Part. Accel. Conf.*, Copenhagen, May, 2017.  
<http://accelconf.web.cern.ch/AccelConf/ipac2017/papers/weoab2.pdf>