

Bunch length and impedance considerations

M. Zampetakis

R. Calaga, R. De Maria, B. E. Karlsen-Bæck, S. Kostoglou,
I. Karpov, H. Timko, R. Tomás



Bunch length assumptions

As found in [HL-LHC Run 4 proton operational scenario](#):

$$\sigma_G = \sqrt{\frac{4 - 2^{8/5}}{\ln 2}} \sigma_{q-G}$$

$$FWHM = 4\sqrt{2 - 2^{3/5}} \sigma_{q-G}$$

For HL-LHC at flat-top, an RMS bunch length (q-Gaussian) of 7.61 cm is expected. This is equivalent to:

$$\tau_{4\sigma}^{\text{rms}} = 1.02 \text{ ns}$$

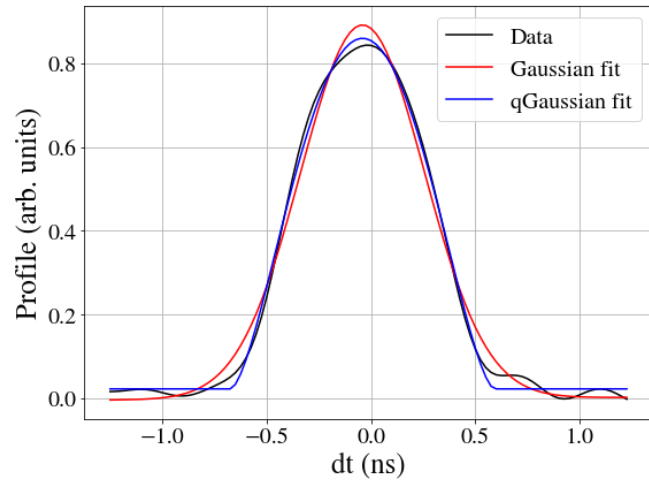
$$\tau_{4\sigma}^{\text{Gauss}} = 1.20 \text{ ns}$$

$$\tau_{4\sigma}^{\text{FWHM}} = 1.20 \text{ ns}$$

This agrees to the bunch length range of $\tau_{4\sigma}^{\text{FWHM}} = 1.16 - 1.26 \text{ ns}$ that was assumed in [Special Joint WP2/WP4 HiLumi Meeting](#)

Bunch length assumptions

Fill 9606 at flat-top:

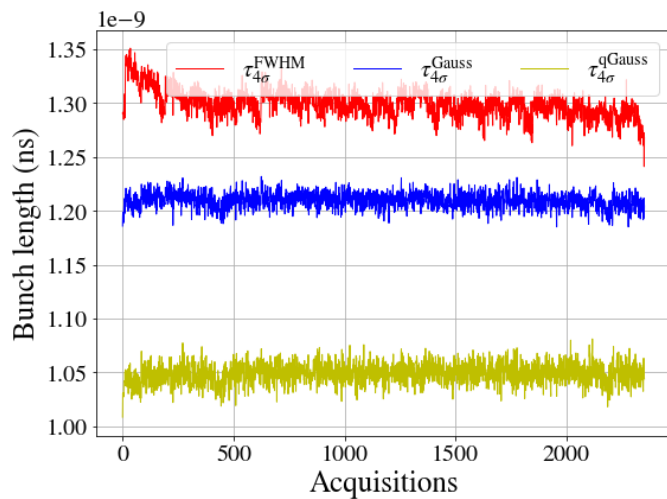


$$\tau_{4\sigma}^{\text{rms}} = 1.01 \text{ ns}$$

$$\tau_{4\sigma}^{\text{Gauss}} = 1.19 \text{ ns}$$

$$\tau_{4\sigma}^{\text{FWHM}} = 1.23 \text{ ns (1.28 ns with interpolation)}$$

For the whole duration:



Bellows ID212

Initial simulations at higher frequencies for unshielded bellows ID212:

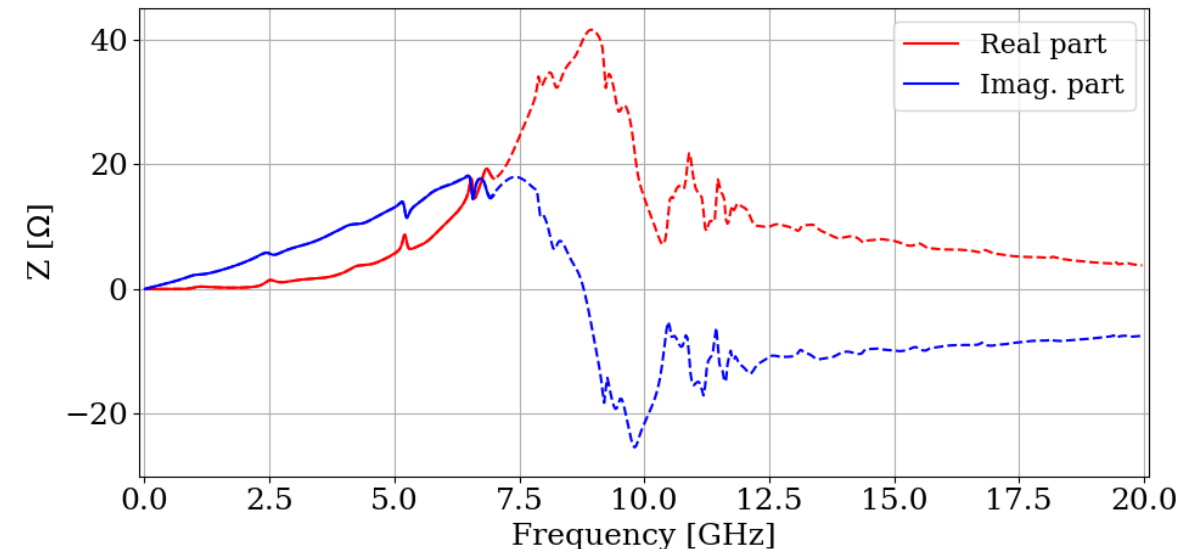
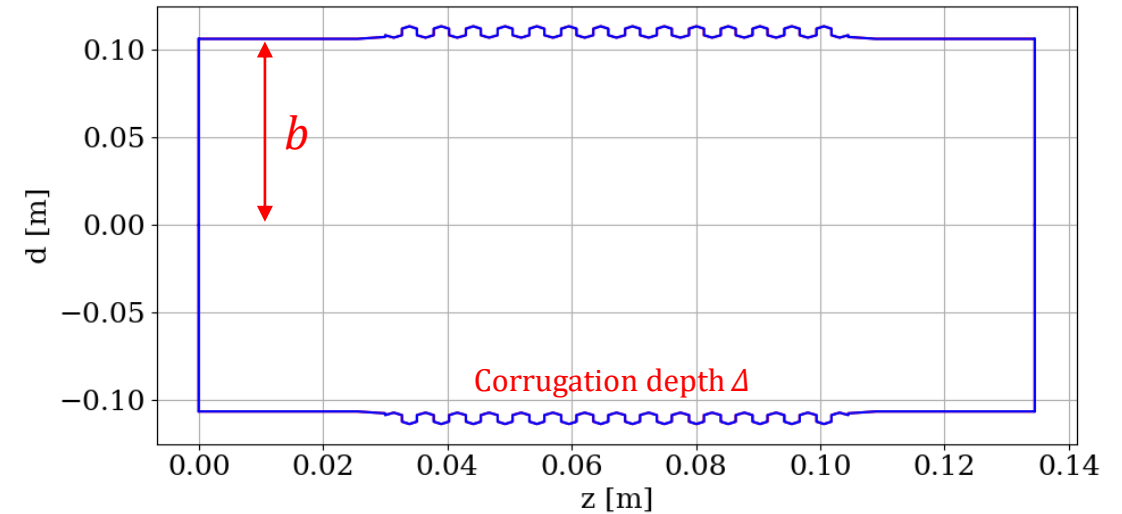
- Easy to simulate and not in the current impedance model
- Simulated with CST and ABCI for different frequency ranges ([83rd IWG meeting](#))
 - Good agreement between the two codes. Investigation on number of cells needed in CST
- Initial estimation of cut-off frequency ~ 2 GHz
 - **Unphysical impedance increase at higher frequencies?**

Mystery solved! (*input from Rama*)

- Bellow corrugations can affect the cut-off frequency*:

$$f_r \approx \frac{0.218c}{\Delta} \left(\frac{\Delta}{b}\right)^{0.052} \approx 8 \text{ GHz}$$

- Even higher frequencies than 7 GHz might be needed
 - Any other devices in the same situation?
 - How to proceed?



*B. Lambertson and Ng K-Y. "Beam Impedances of Position Monitors, Bellows and Abort Kicker", 1988, LBL-25385