Impedance with smaller beampipe diameter

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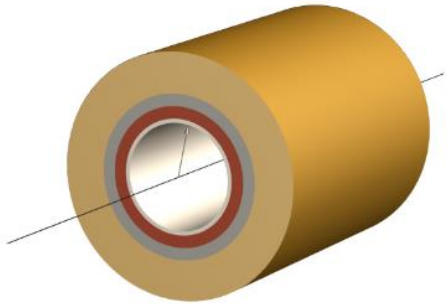
Acknowledgements: collimation, vacuum and RF groups

Main impedance sources

Resistive wall

It is the largest impedance source for FCC-ee evaluated so far. NEG coating is needed to mitigate the electron cloud build-up in the positron machine and for pumping reasons in both rings.



IRON	$\Delta = \infty$	$\rho = 6.89 \cdot 10^{-7} \Omega m$
DIELECTRIC	$\Delta = 6\ mm$	$\rho = 10^{-15} \Omega m$
COPPER	$\Delta = 2\ mm$	$\rho = 1.66 \cdot 10^{-8} \Omega m$
NEG	$\Delta = 150\ nm$	$\rho = 10^{-6} \Omega m$

$$Z_{\parallel}(\omega) = C\frac{Z_0\omega}{4\pi cb}\left\{[sgn(\omega) - i]\delta_2 - 2i\Delta\left(1 - \frac{\sigma_1}{\sigma_2}\right)\right\}$$

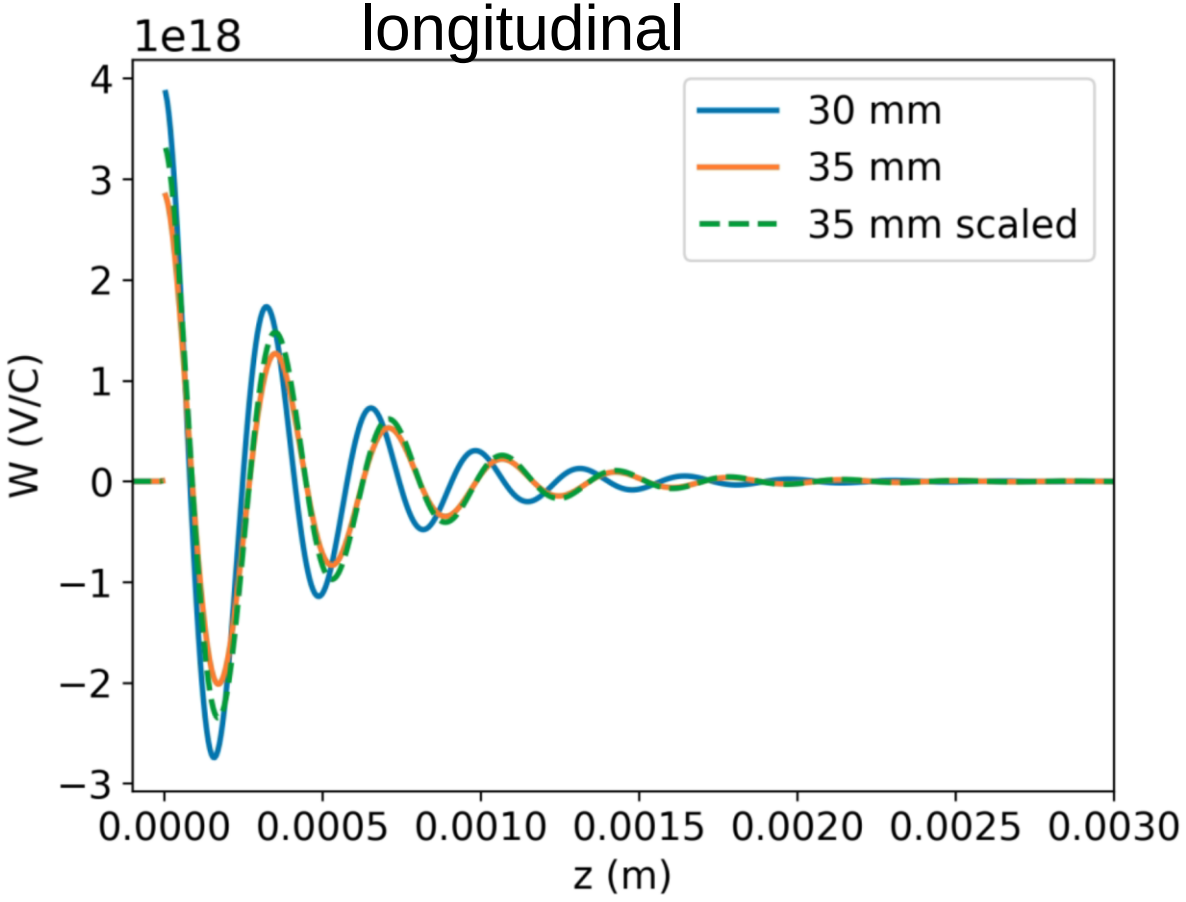
$$Z_{\perp}(\omega) = C\frac{Z_0}{2\pi b^3}\left\{[sgn(\omega) - i]\delta_2 - 2i\Delta\left(1 - \frac{\sigma_1}{\sigma_2}\right)\right\}$$

Since the transverse dipolar wake goes as $1/b^3$, passing from 35 to 30 mm means an increase in impedance and wake amplitude of $35^3/30^3 = 1.6$

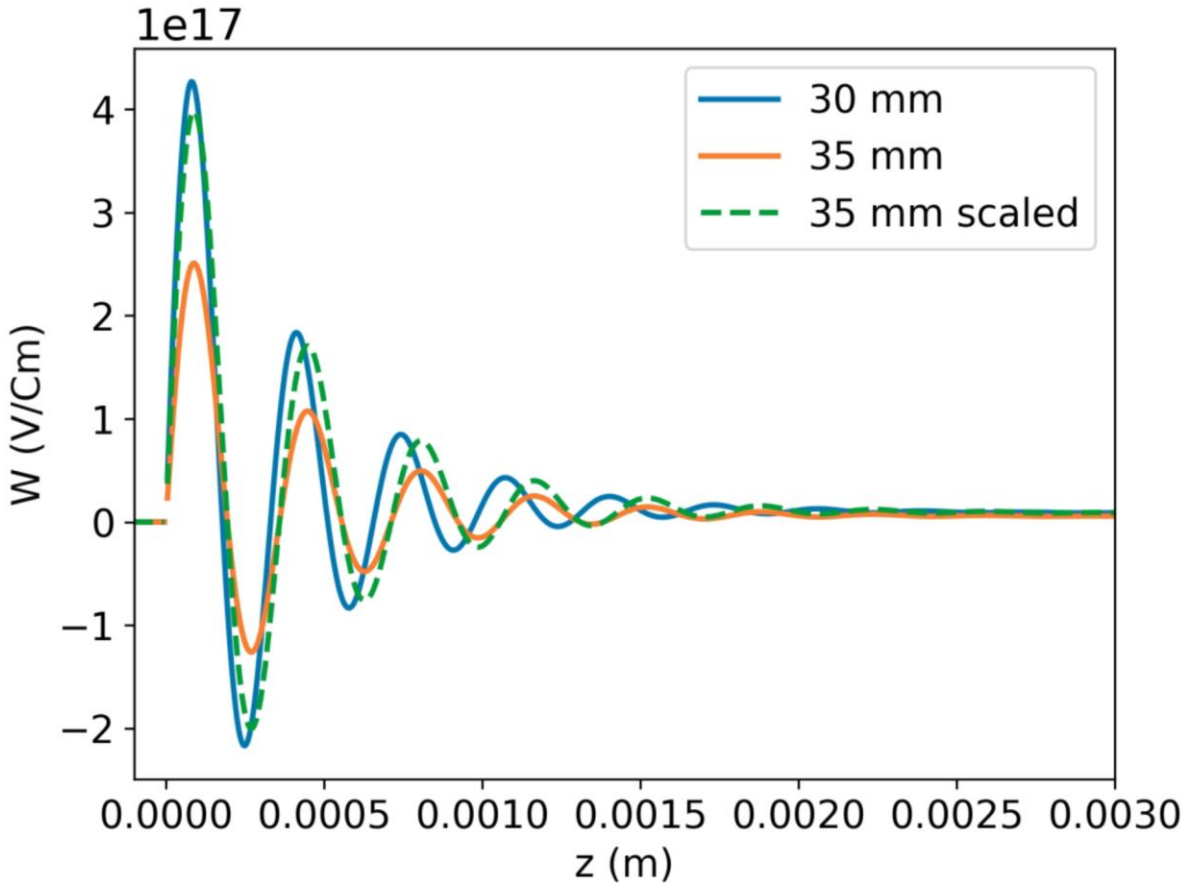
Main impedance sources

Resistive wall wakefield

longitudinal

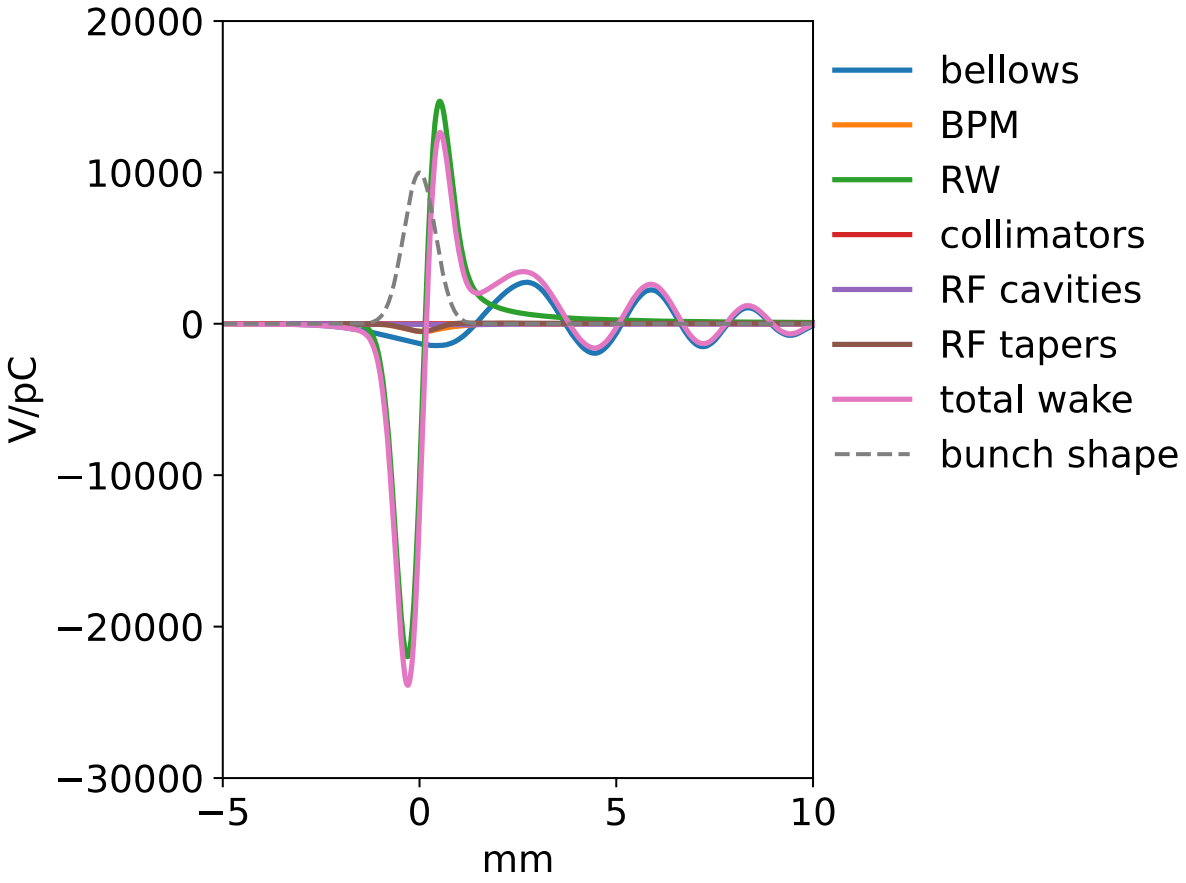


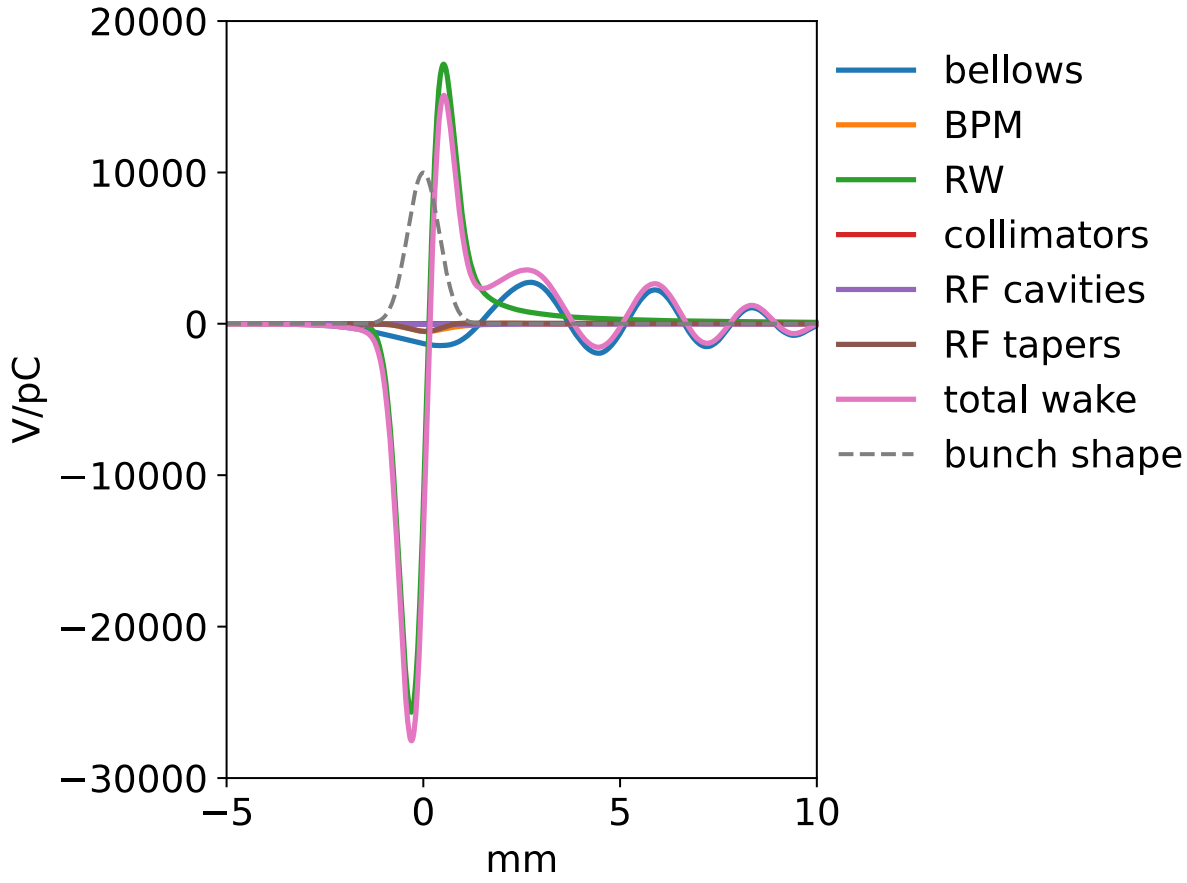
transverse



Main impedance sources

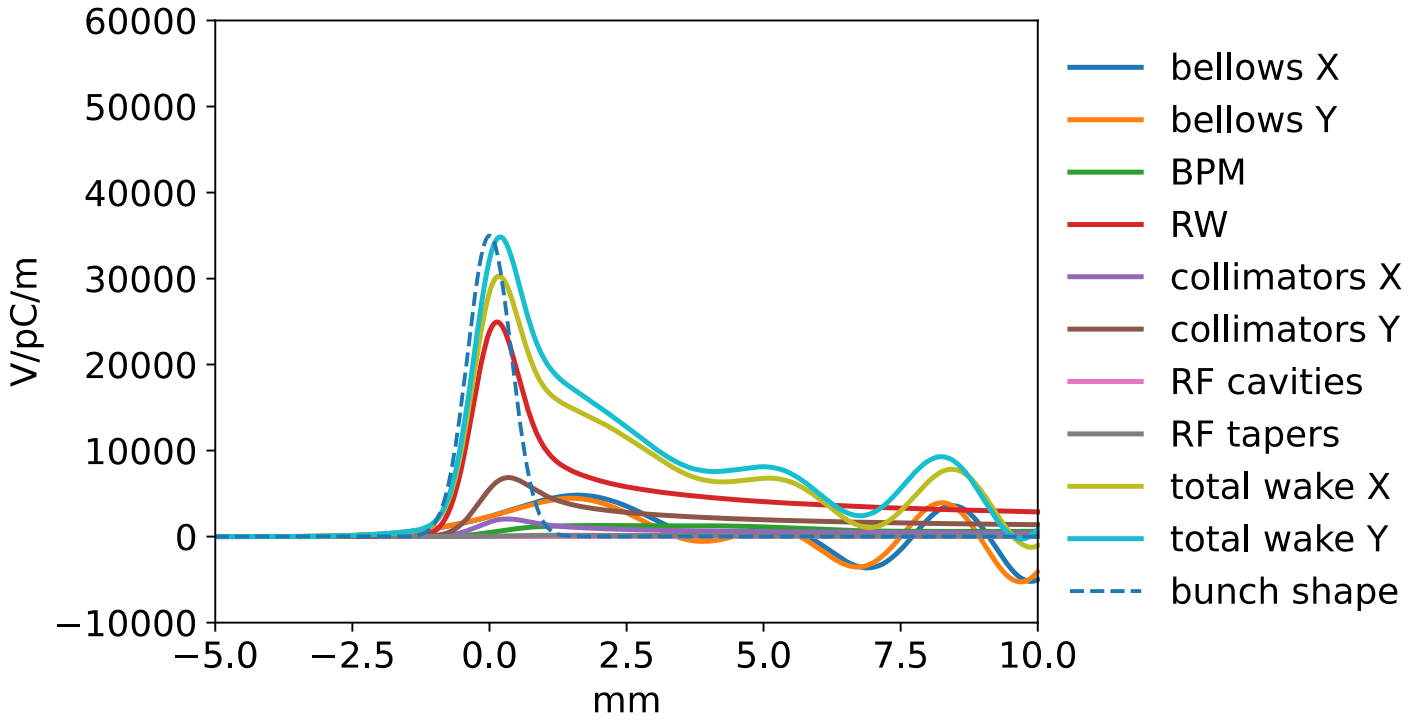
Total wakefield: longitudinal

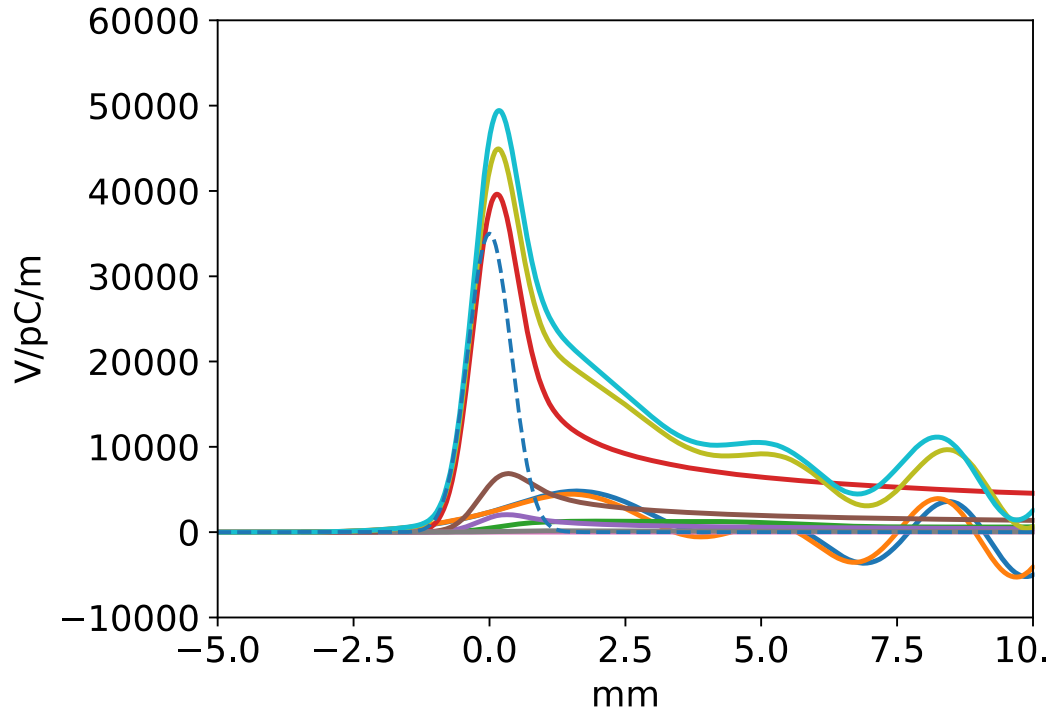




Main impedance sources

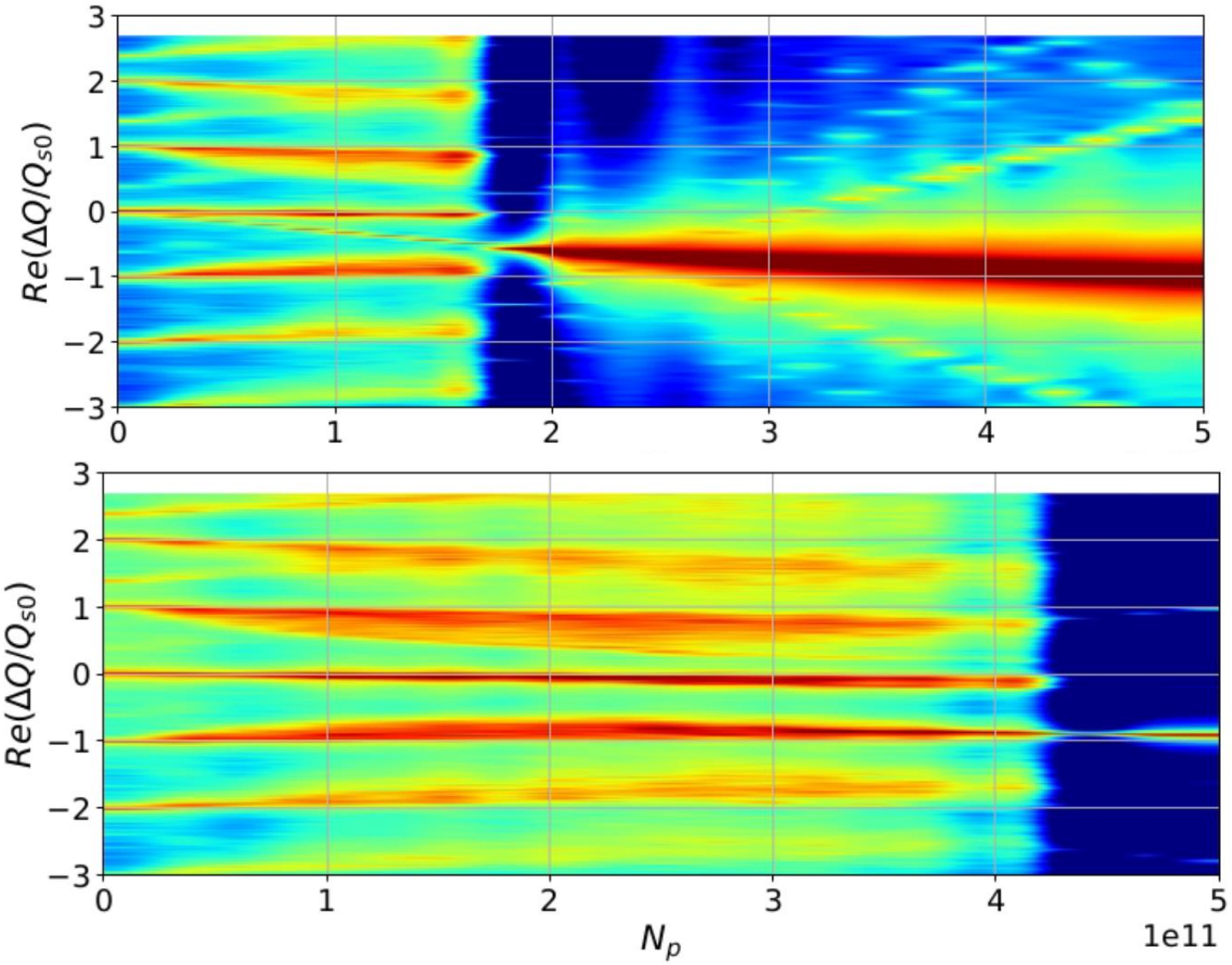
Total wakefield: transverse





A reduced beam pipe will increase the impedance of many other devices, as bellows and BPMs

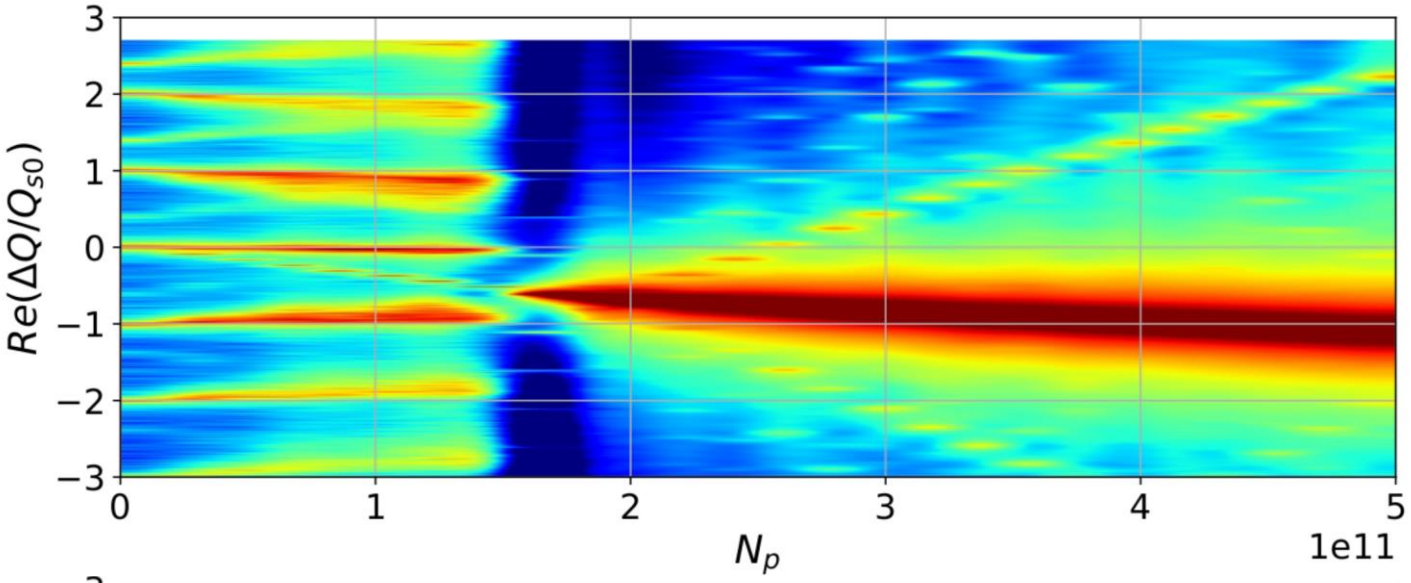
Transverse Mode Coupling Instability



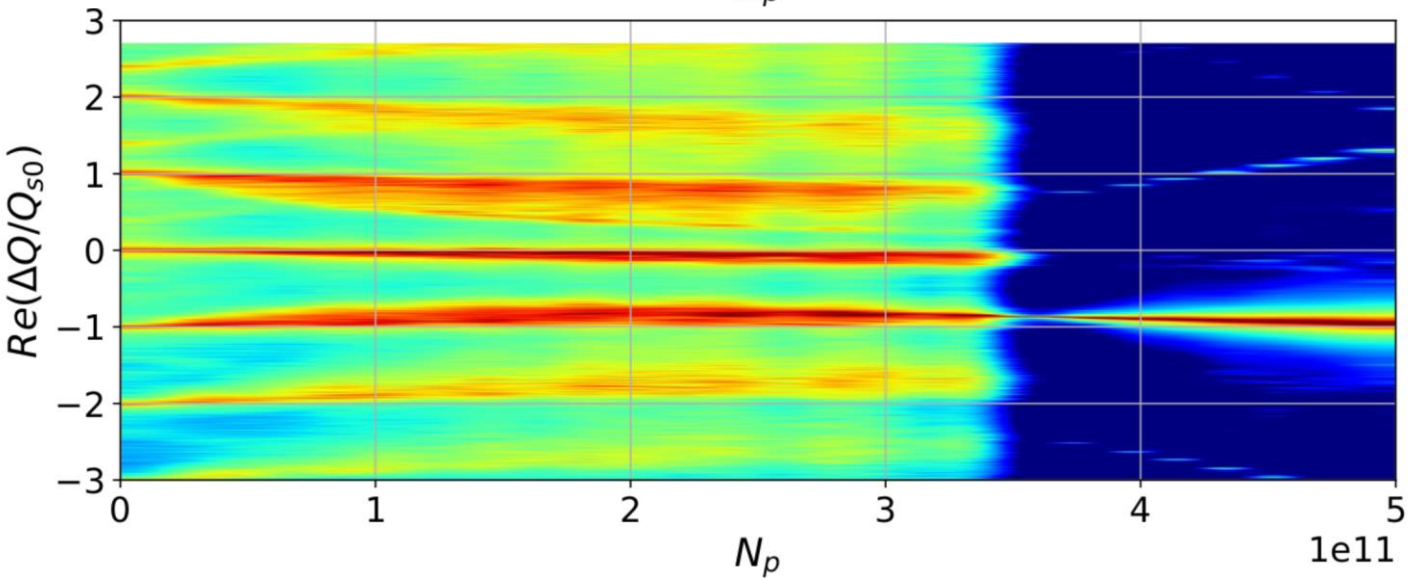
Y-plane: no feedback, 35 mm pipe radius

Y-plane: feedback, 4 turns damping time, 35 mm pipe radius

Transverse Mode Coupling Instability



Y-plane: no feedback, 30 mm pipe radius



Y-plane: feedback, 4 turns damping time, 30 mm pipe radius

We must remember that a reduced beam pipe will increase the impedance of many other devices, as bellows and BPMs

Beam-beam

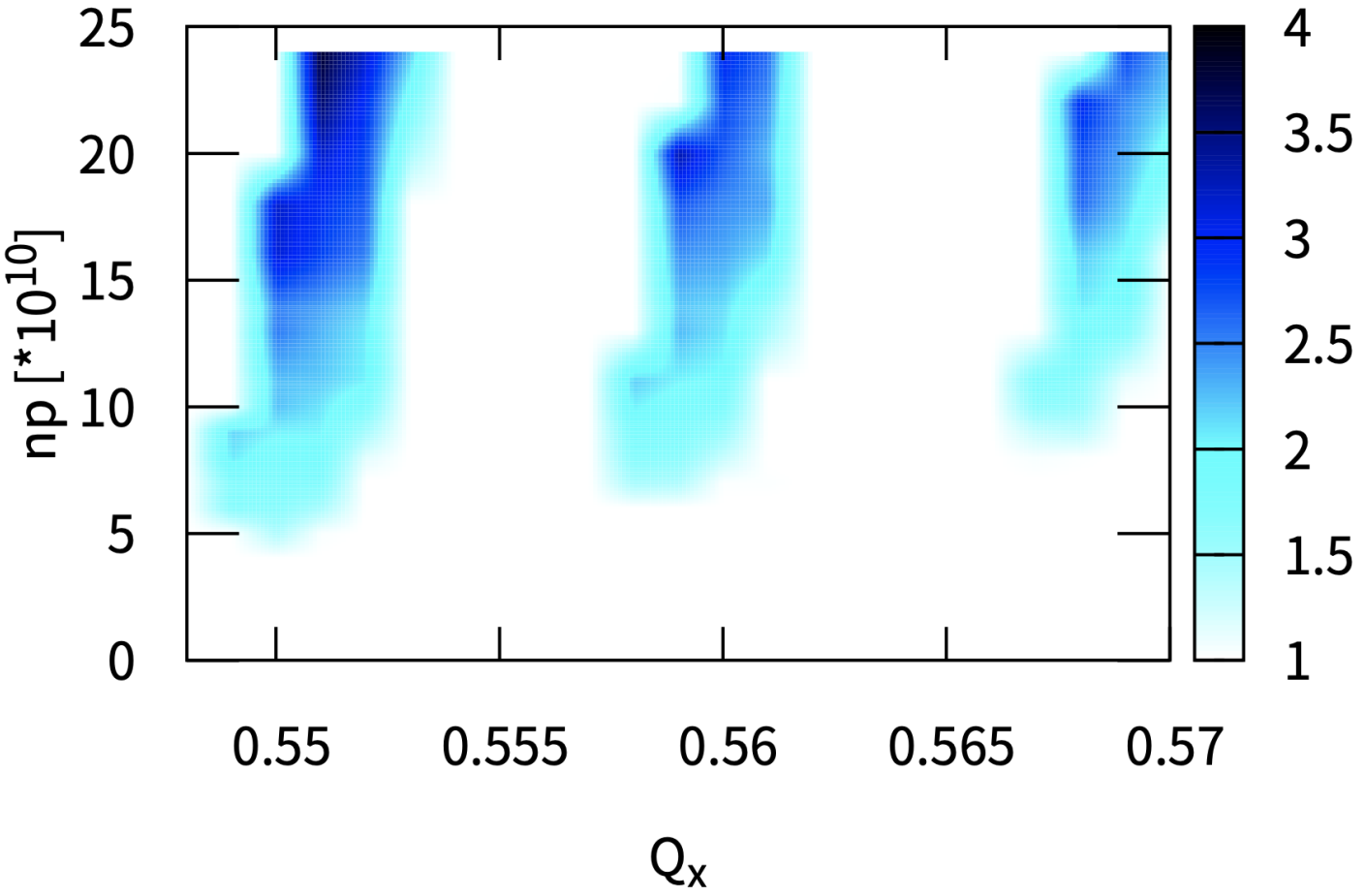
Studies have been performed by including longitudinal and transverse (both horizontal and vertical) impedances:

1) the X-Z instability gets stronger when the horizontal impedance is included, even if the stable tune areas are not affected
2) a new vertical instability can arise when the vertical impedance is taken into account
3) this instability may limit the choice of betatron working points available for stable collider operation
4) positive vertical chromaticity is an effective tool to suppress the vertical instability and a stable collider operation can be achieved

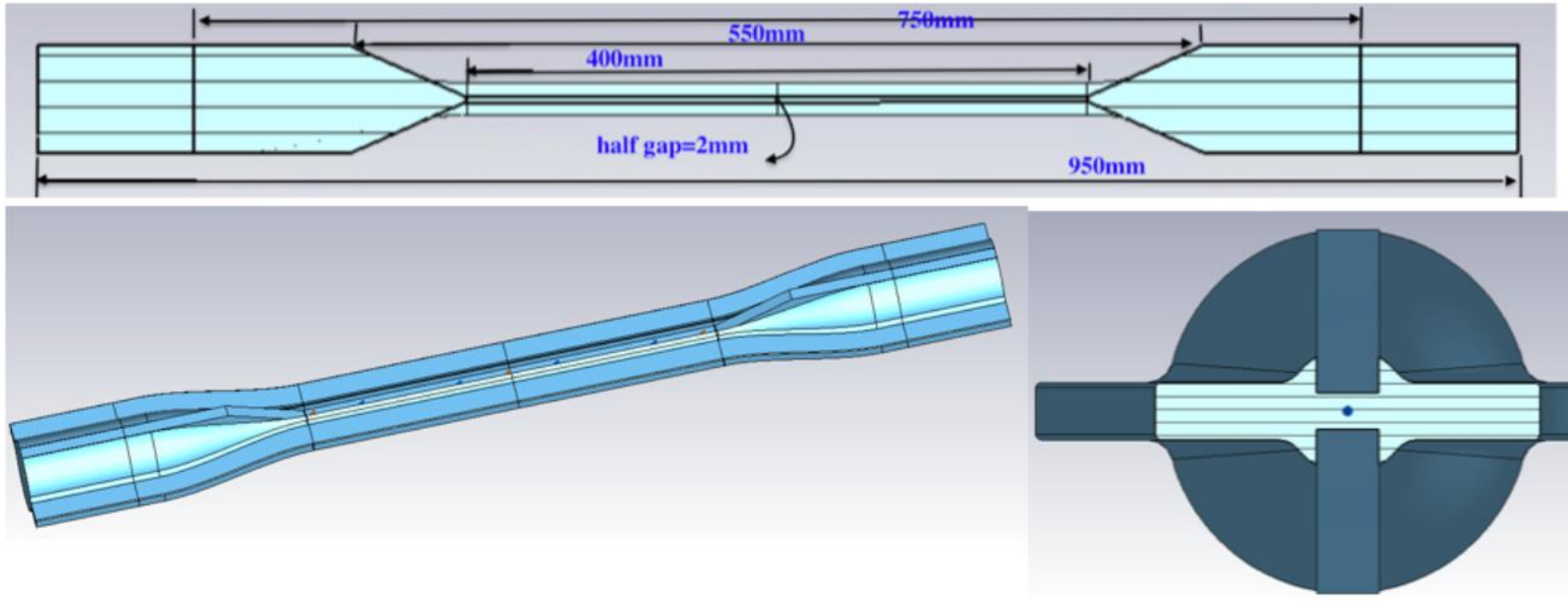
Beam-beam

Horizontal beam size blowup during bootstrapping injection with $Zx/Zy/Zl$, Q_y = 0.610, Q_y'=5, and $\beta_x^* = 10$ cm (necessary to cope with the X-Z instability)

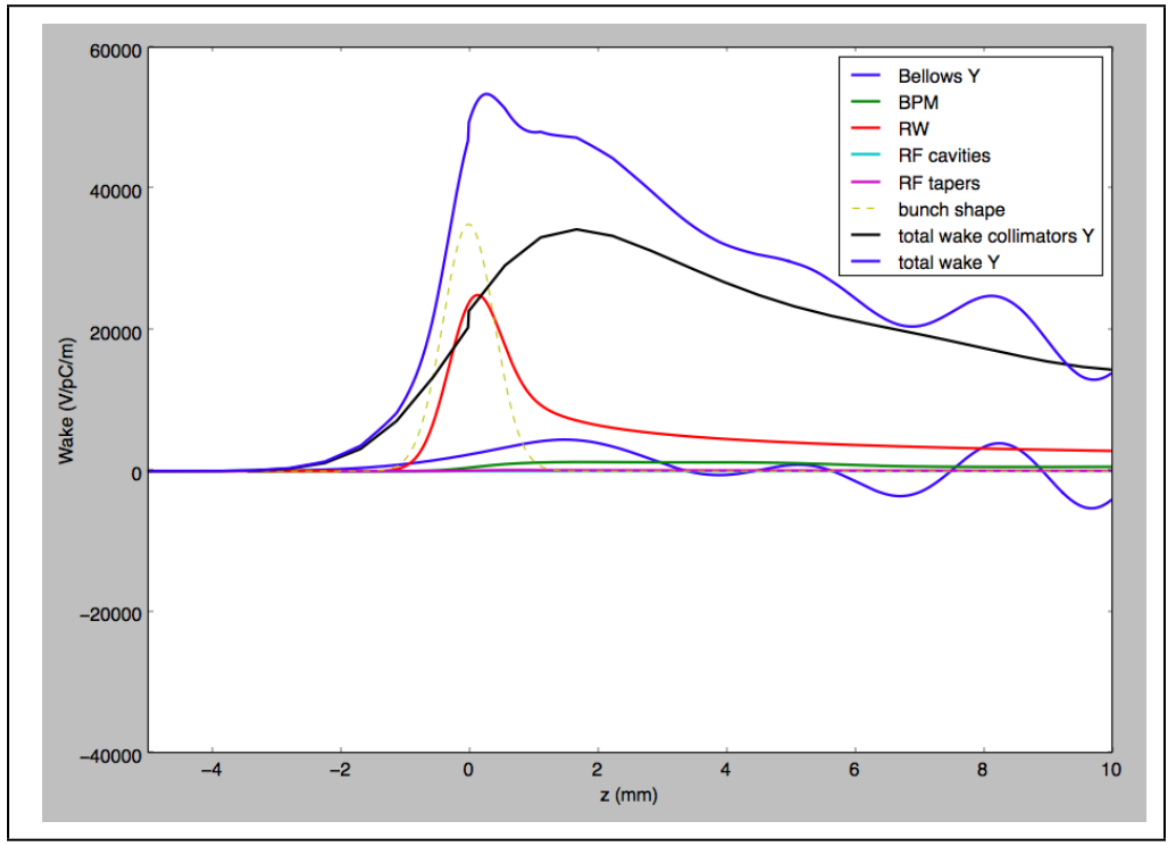
This is the situation with a pipe of 35 mm and without taking into account the geometrical contribution of the collimators.

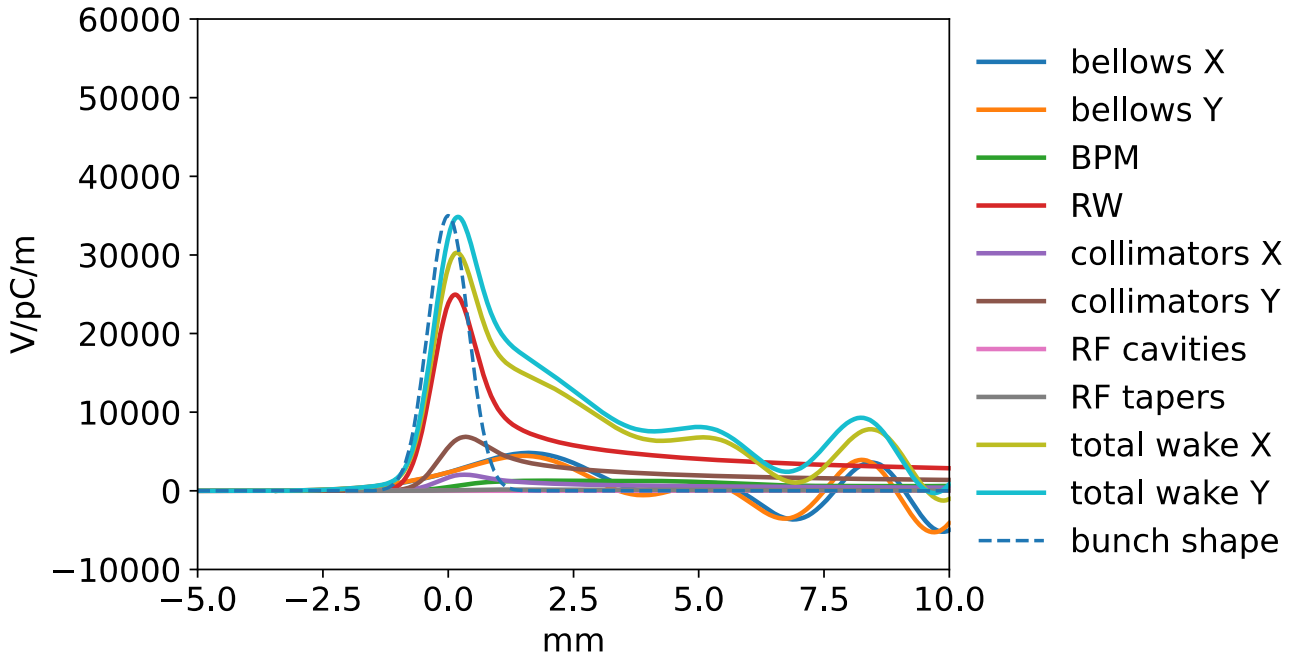


Geometrical wakefield of collimators

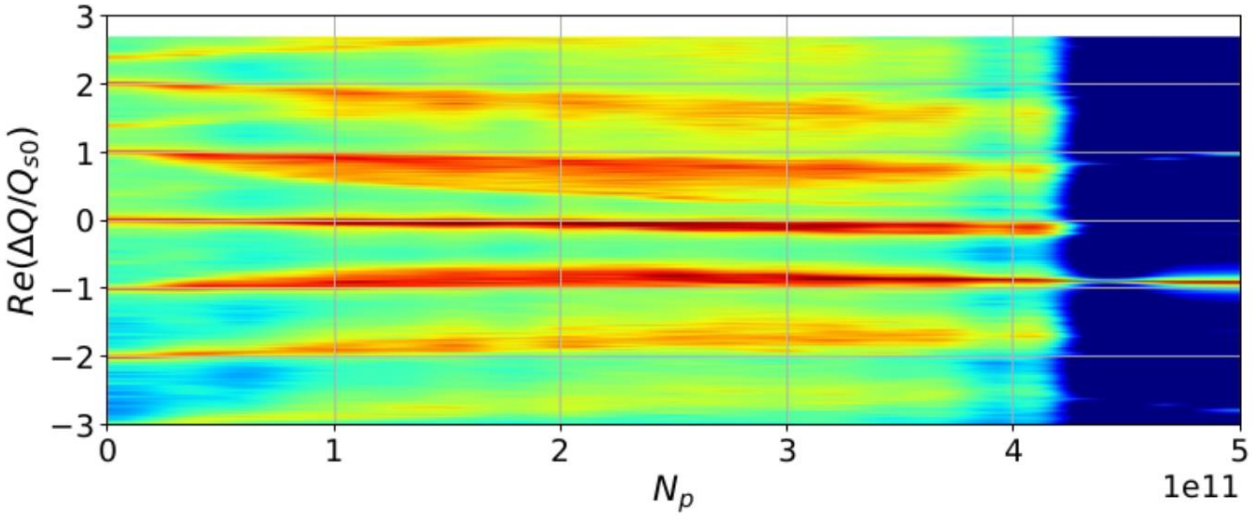


Geometrical wakefield of collimators

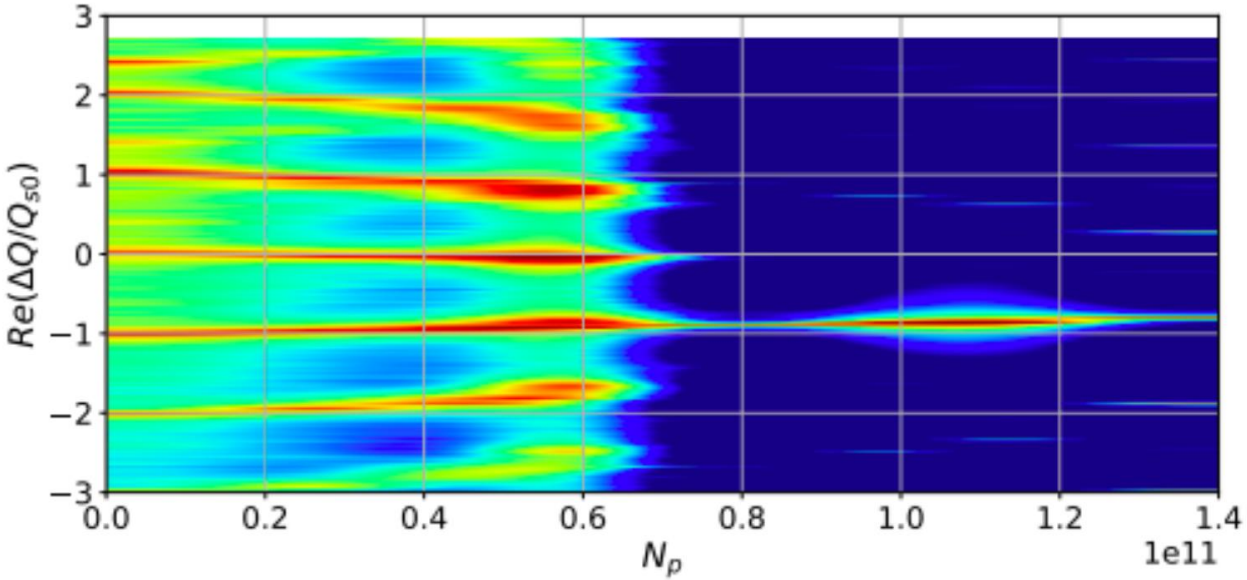




Transverse Mode Coupling Instability



Y-plane: feedback,
4 turns damping time
without geometrical wake of
collimators



Y-plane: feedback,
4 turns damping time
with geometrical wake of
collimators