Transverse Impedance Coaxial Wire Measurement In An Extended Frequency Range

E. Ergenlik, D. Le Guidec, P. Lepercq, A. Gamelin, C. Bruni
IJCLAB, CNRS/IN2P3, Université Paris-Saclay, Orsay, France

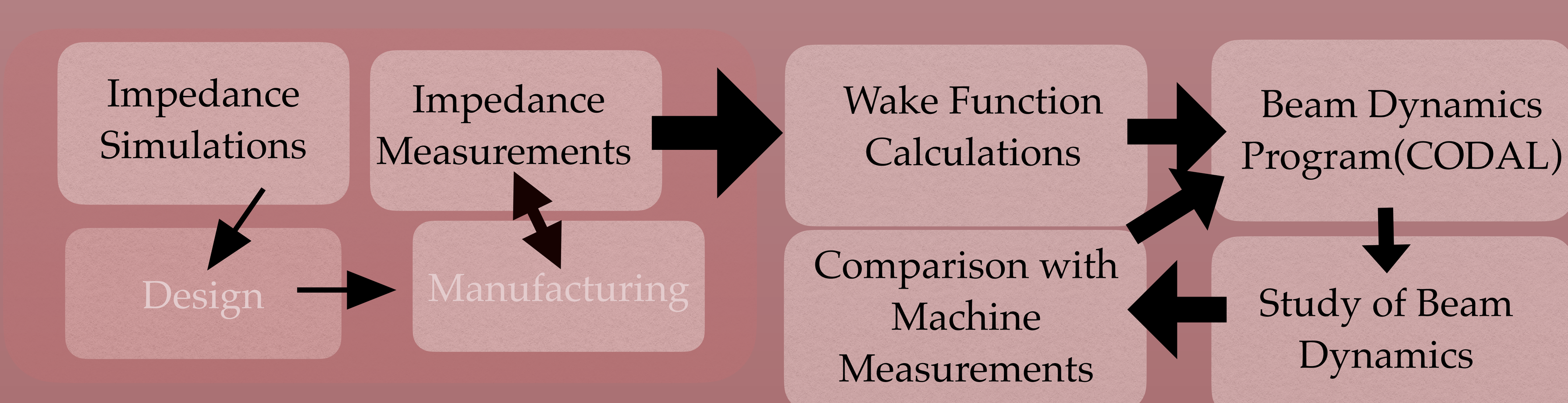
Abstract

The low energy accelerators are tend to have some instabilities especially the beam coupling impedances which comes from the interaction between the beam and accelerator components. As long as the longitudinal impedance are important, transverse impedance determination is crucial for determine the instabilities which will affect the working efficiency of the accelerators. However due to their small amplitudes and measurement setup configuration they are hardly measurable especially in wide frequency ranges. We developed a specific setup for small diameter pieces (28-40mm) for moving and two wire transverse impedance measurements. The dipolar and quadrupolar impedance measurement even with a few Ohm level up to 6 GHz for the bellows of ThomX will be presented. Also the comparison with electromagnetic simulations have been performed and can be seen for dipolar impedance measurements.

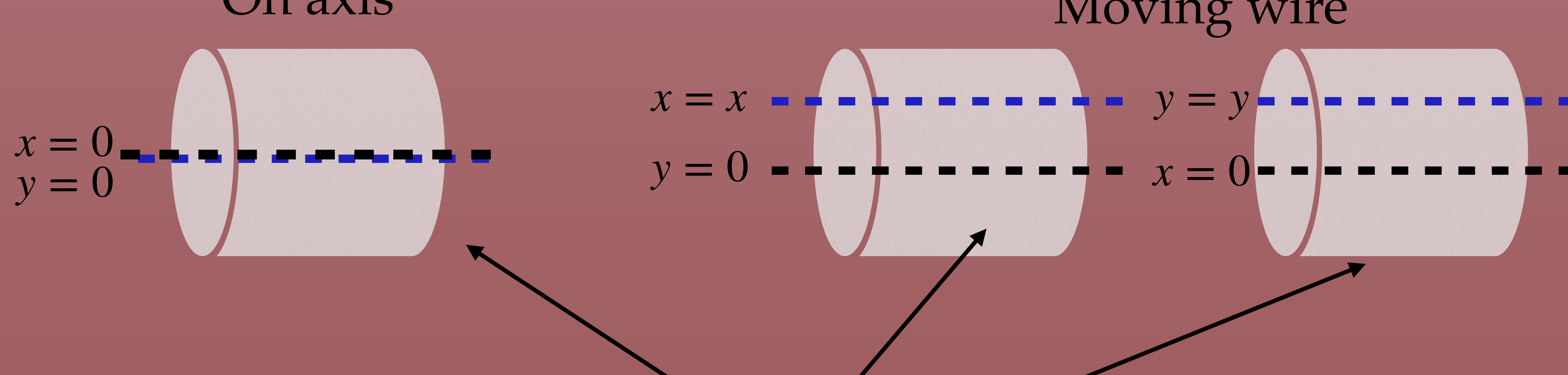
Introduction

The geometric impedance comes from the change in the beam pipe structure. It can be split in two terms as the dipolar and quadrupolar impedance. Both dipolar and quadrupolar terms are related with the transverse momentum kick. Dipolar component is only affected by the sources particle location as a result of coherent effect which is transverse deflecting field. On the other hand, quadrupolar terms are depend on the witness particle location which gives incoherent effect like the focusing or defocusing field.

Methodology



Theory



$$Z_T = Z_L + Z_{1x}x^2 + Z_{1y}y^2$$

where Z_L is the longitudinal impedance which was measured at the center, Z_{1x} and Z_{1y} are the measured impedance coefficents with and wire offset with x and y respectively.

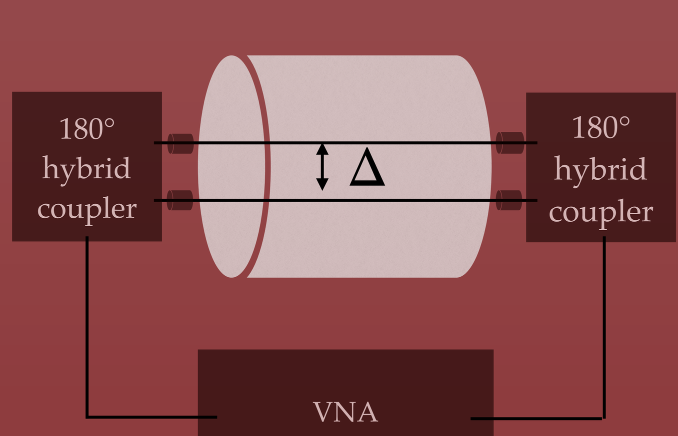
The general transverse impedances are:

$$Z_x = Z_{dipx} - Z_{quadx} = \frac{c}{2\pi f} Z_{1x}$$

$$Z_y = Z_{dipy} + Z_{quady} = \frac{c}{2\pi f} Z_{1y}$$

The coefficient Z_{1x} and Z_{1y} are extracted by fitting a parabola.

Two wire

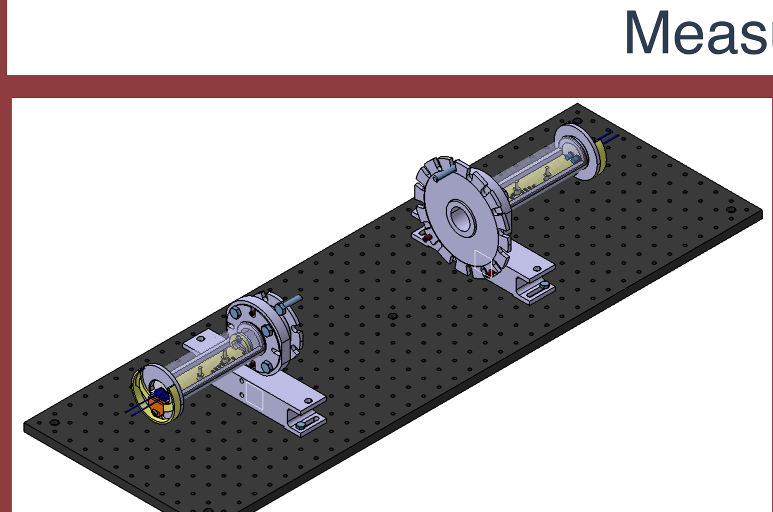


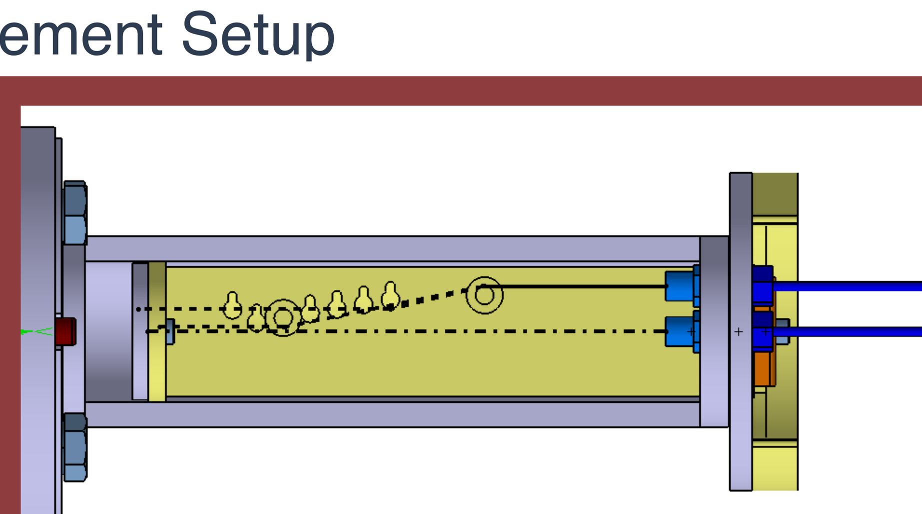
Two wire method contains two wires driven with opposite phases which only gives the dipolar contribution of the impedance

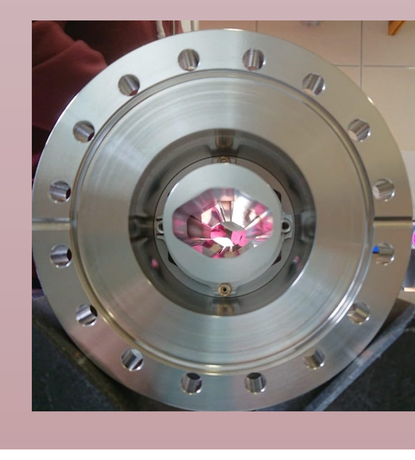
$$Z_T = \frac{cZ}{2\pi f \Delta^2}$$ where Δ is wire spacing.

$$Z = -2Z_L \ln\left(\frac{S21_{DUT}}{S21_{REF}}\right)$$

Measurement Setup

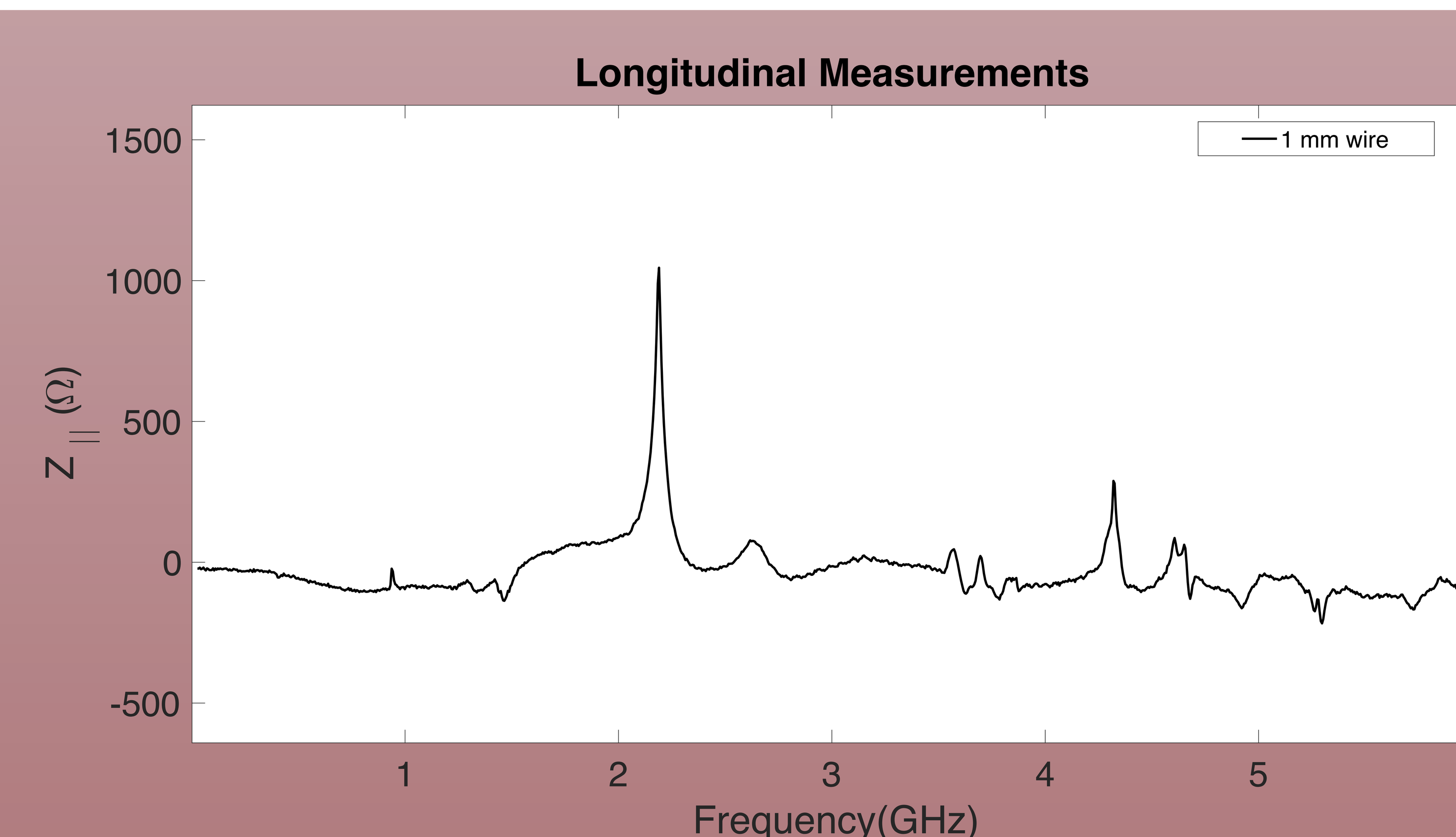


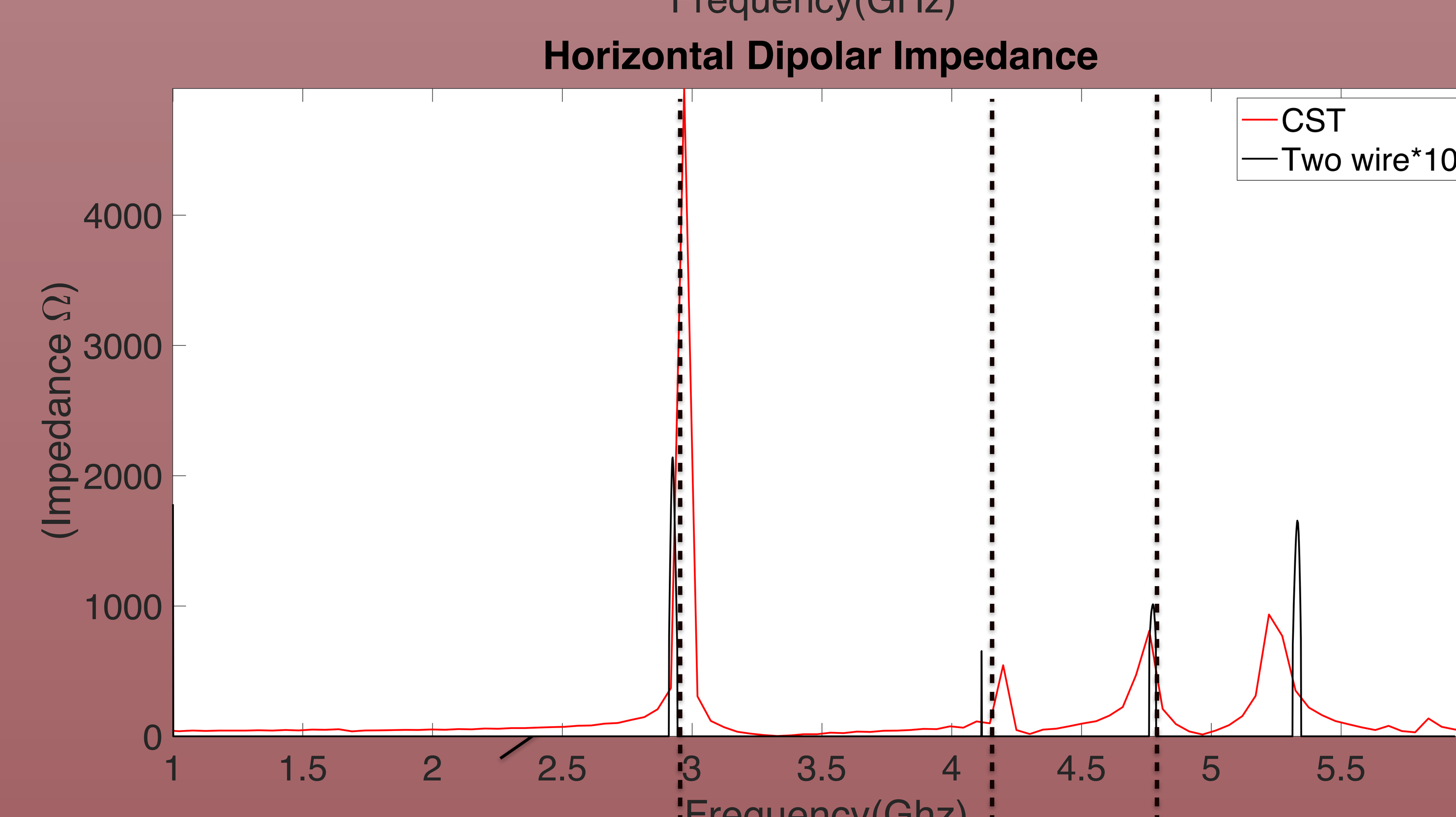


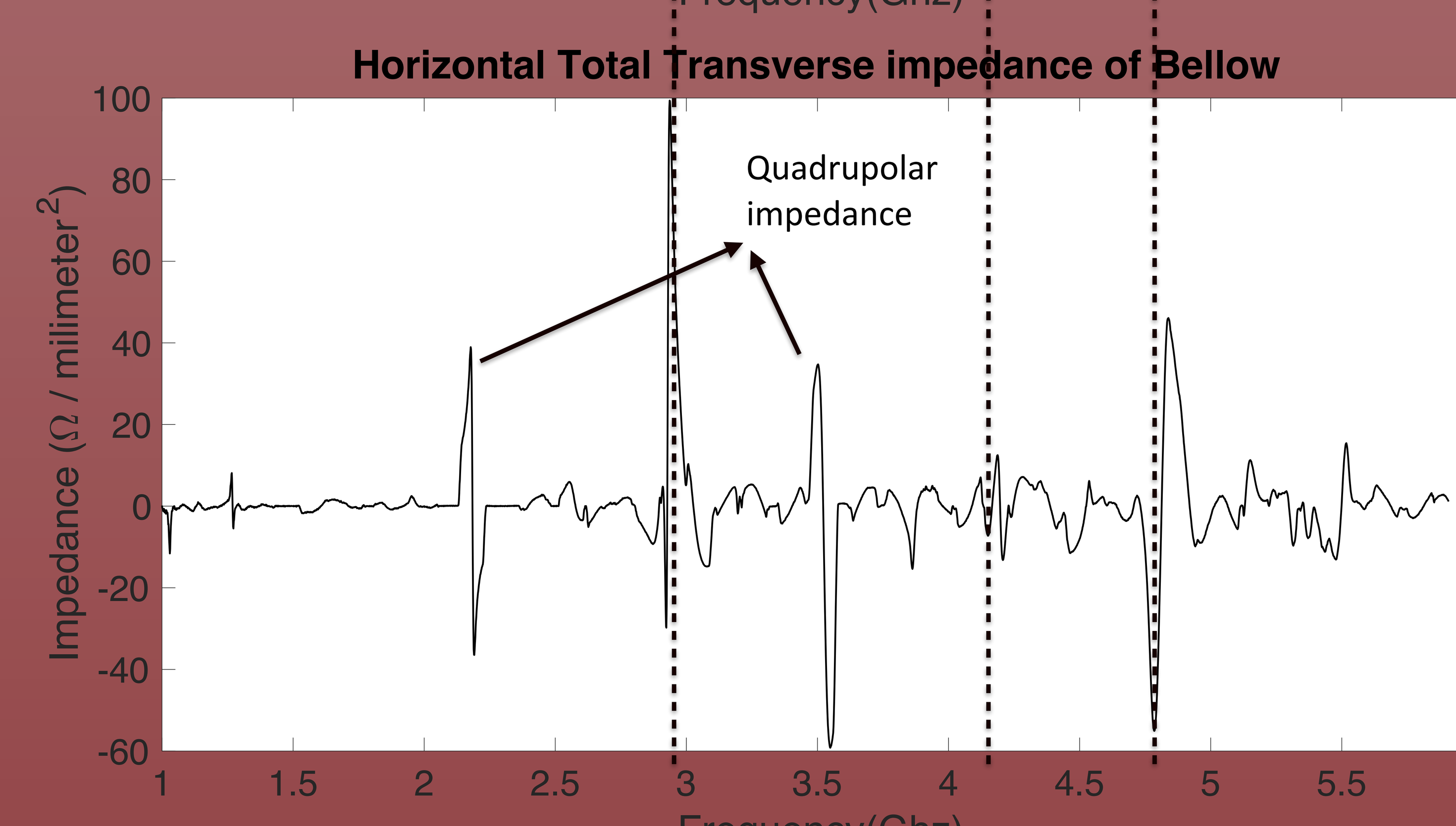


The beam pipe of the Thomx has dimensions of 28 and 40 mm. For two wire measurements 5mm and 1cm offset were chosen. For moving wire measurements with on axis, 4 mm, 5mm, 6mm and 6.5 mm offsets are chosen.(it is around between %10 to %25 of the pipe diameter)

Results







Conclusion

The impedance measurement of bellows were performed to check the reliability of the setup and the efficiency of the rf fingers which will add to bellow for suppressing the impedance. As can be seen from the figures the simulations and measurements are quite comparable in the frequency span. The frequency shifts between measurements and simulation is around %2. There is attenuation on the signal due the wires however it can be solve with normalization. The setup is ready for the other accelerator components.

References

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