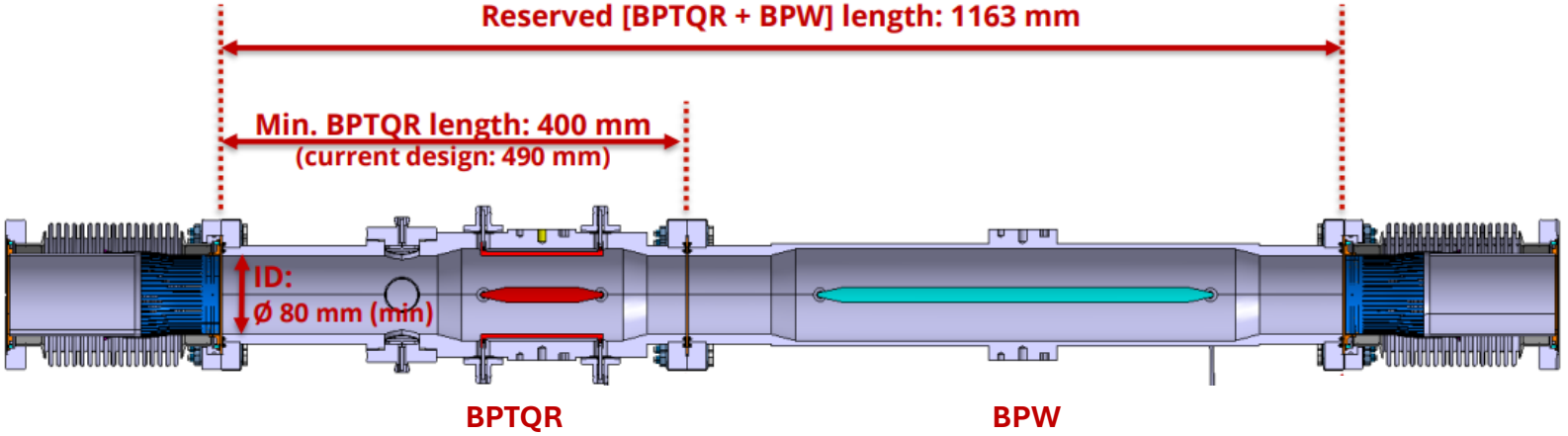
HL-LHC high bandwidth BPMs: preliminary impedance studies

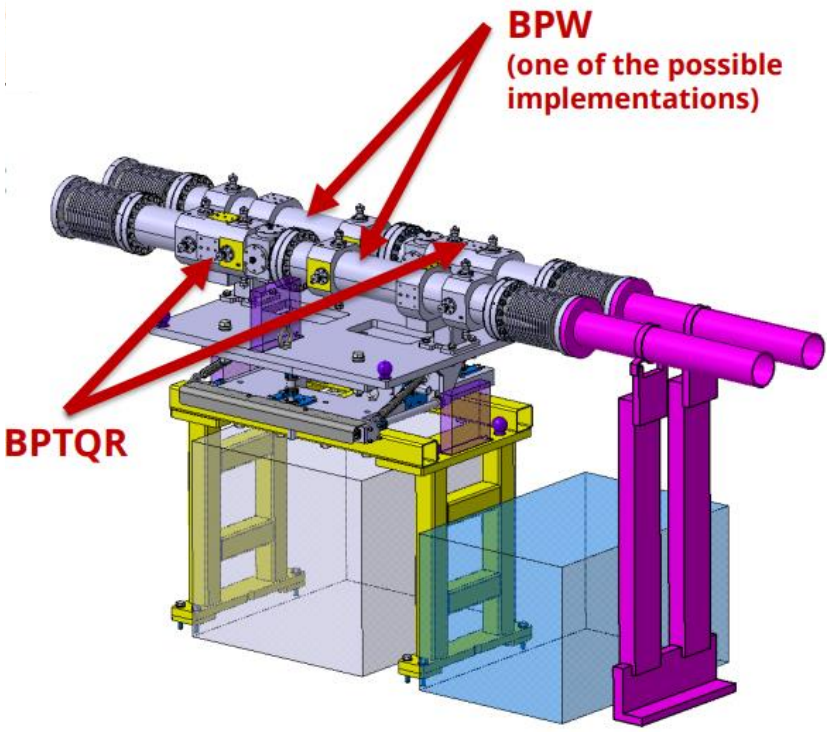
C. Antuono, N. Mounet

Acknowledgements: L. Giacomel, M. Krupa

Background

- Ongoing efforts to choose the best possible technology for the high-bandwidth beam position monitors in the HL LHC era.
- Two different BPMs in the CC region (see M. Krupa at the BPM review)
  - Installed in a common support
- **BPTQR**: BPM for CC amplitude noise feedback
- **BPW**: BPM for CC and instability diagnostics



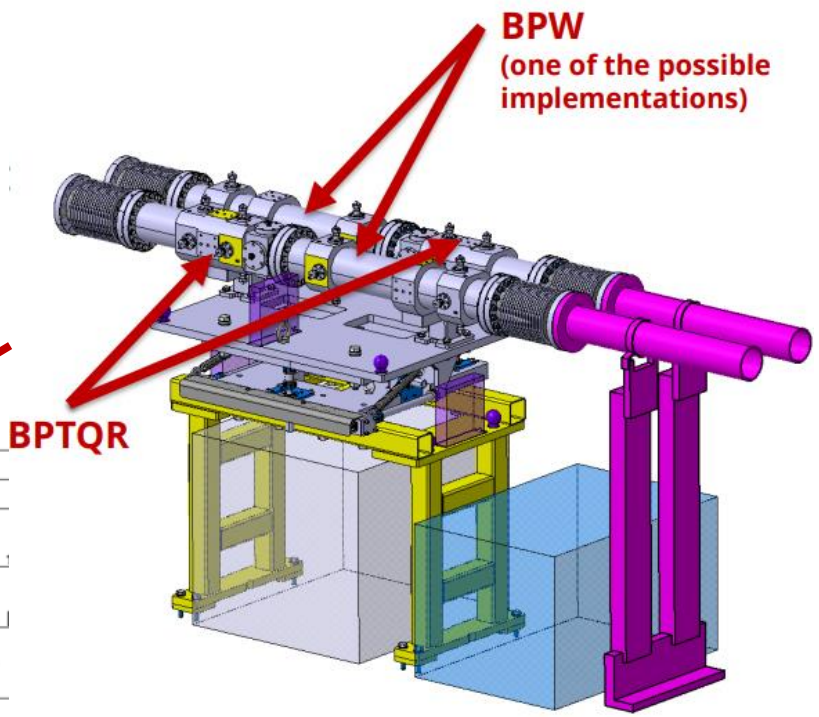


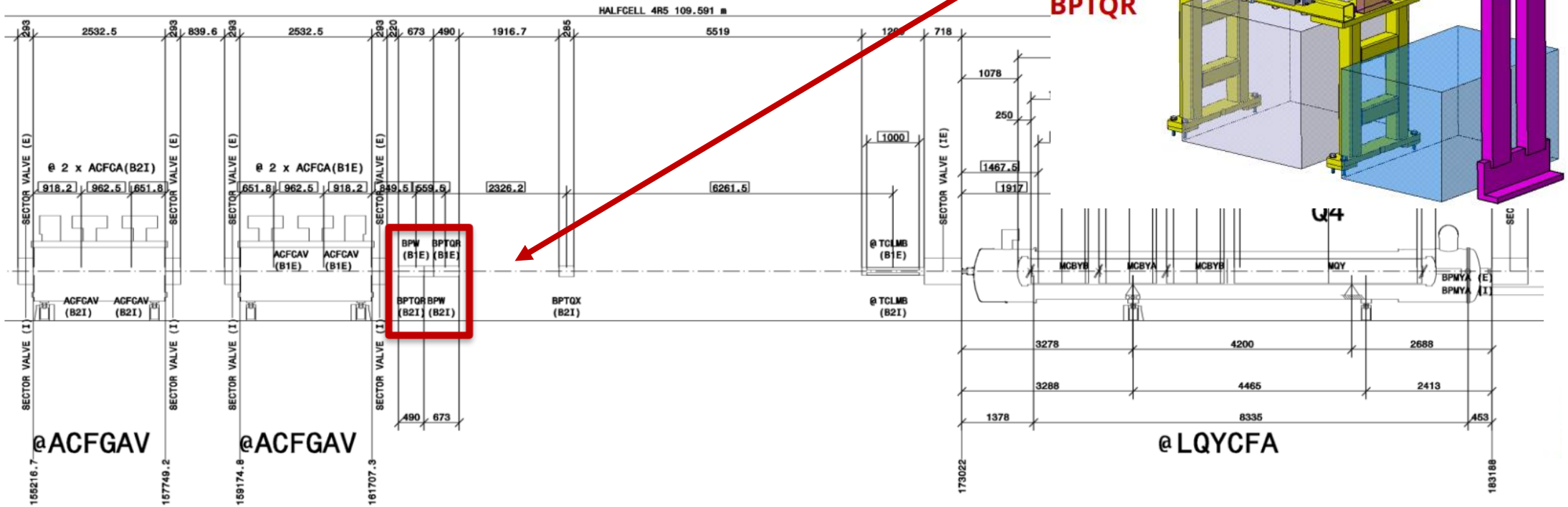
Courtesy of M. Krupa

Background

- Two different BPMs in the CC region (see M. Krupa at the BPM review)
  - Installed in a common support
- **Eight BPWs and Eight BPTQRs** on the CCs side (far from IP)

$$8\ BPMs\ (per\ beam)\begin{cases} 4\ BPW\ \rightarrow 2xIP1, 2xIP5 \\ 4\ BPTQR \rightarrow 2xIP1, 2xIP5 \end{cases}$$





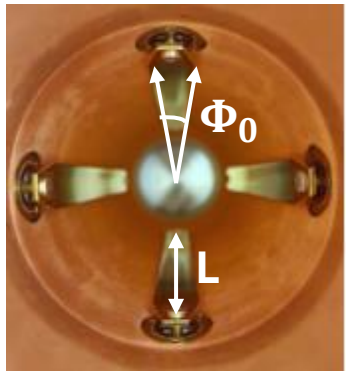
Preliminary Impedance studies: relevant parameters and scenario

- Study on the impact on the **total transverse impedance at flat top**
- Assumptions and specifications:
  - Specific design ongoing: impedance computed with analytical model
    - Ng formula for stripline BPMs
  - Geometric properties (length, electrode length etc.) found in the HL-LHC review link
  - Computations performed without CCs

$$Z_0^{\parallel} = 2Z_c\left[\frac{\phi_0}{2\pi}\right]^2\left[2\sin^2\frac{\omega L}{c} - i\sin\frac{2\omega L}{c}\right]$$

$$Z_1^{\perp} = \left[\frac{Z_0^{\parallel}}{\omega}\right]_{\text{pair}}\frac{c}{b^2}\left[\frac{4}{\phi_0}\right]^2\sin^2\frac{\phi_0}{2}$$

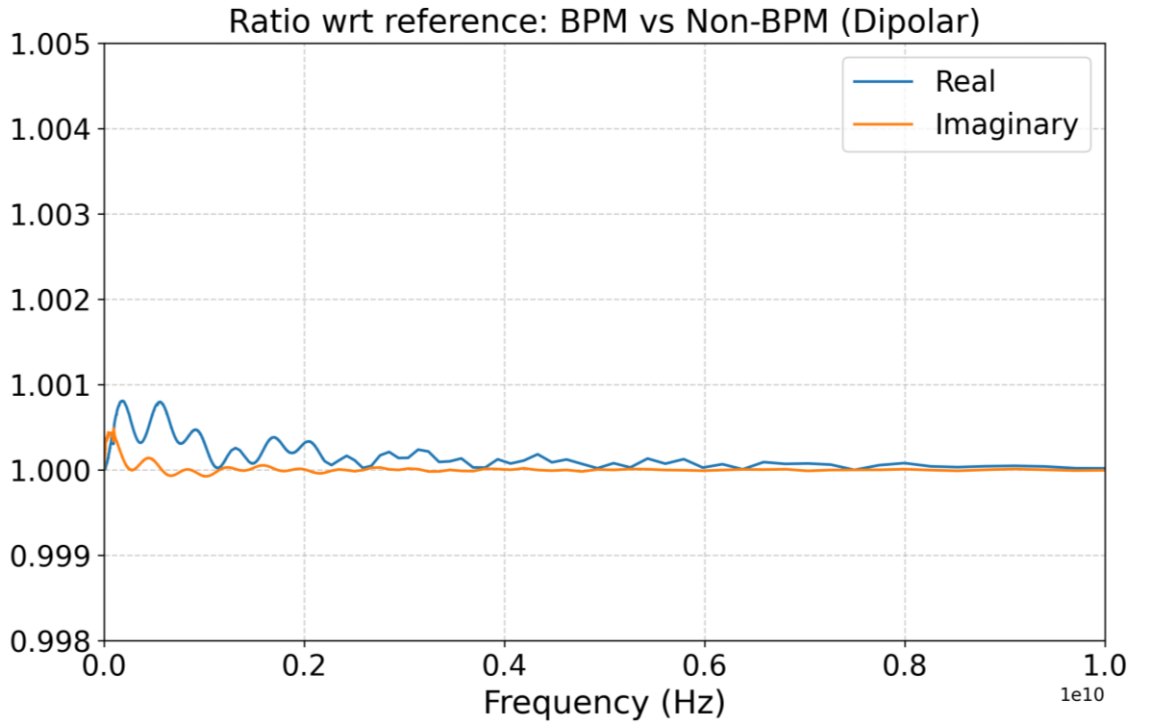
BPM type/name	Elect. length L	Radius b	Angle Φ_0
BPW	400 mm	45.5 mm	0.3 rad
BPTQR	120 mm	45.5 mm	0.3 rad



For this preliminary computation I assumed each BPMs (1 BPW and 1 BPTQR) on the same location **at each side of the CC per IP** (per beam)

Pos.	Avg. β_x	Avg. β_y
BR.1	~459 m	~722 m
BL.1	~720 m	~461 m
BL.5	~724 m	~470 m
BR.5	~470 m	~724 m

Preliminary Impedance studies: results

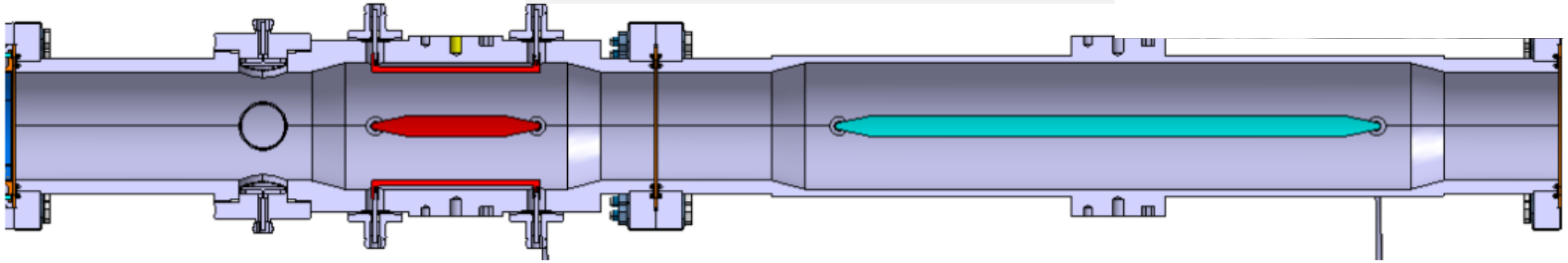


- Less than 0.1% of increase in the horizontal plane (similarly in y)
  - small but not totally negligible
  - Model used is very preliminary → follow-up needed (use of a realistic model)

Next steps

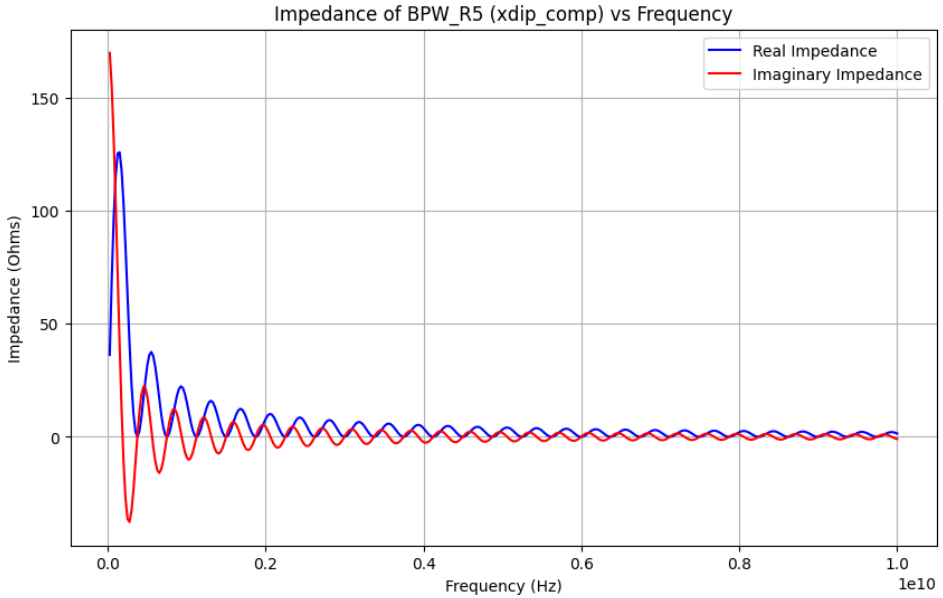
- Compute impedance from the **3D realistic model** with the latest design considered (or more)
  - If needed, assess the precise impact on stability through Oct. threshold computation

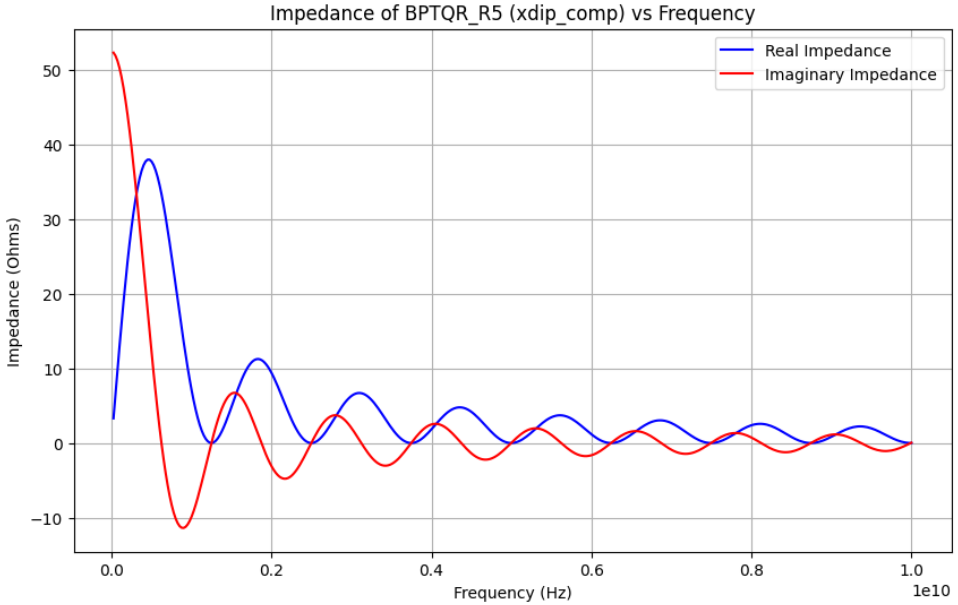
Example of Realistic model

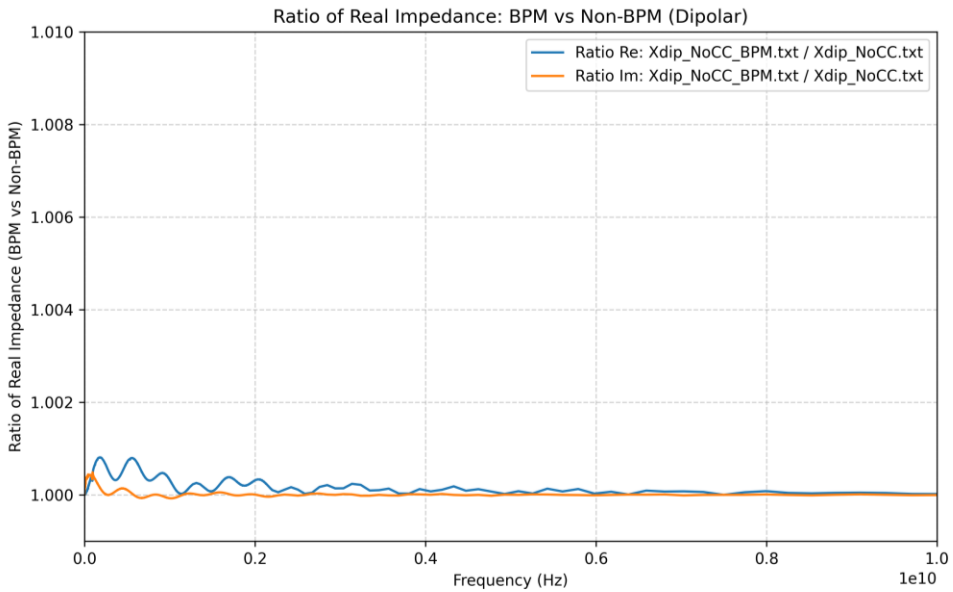


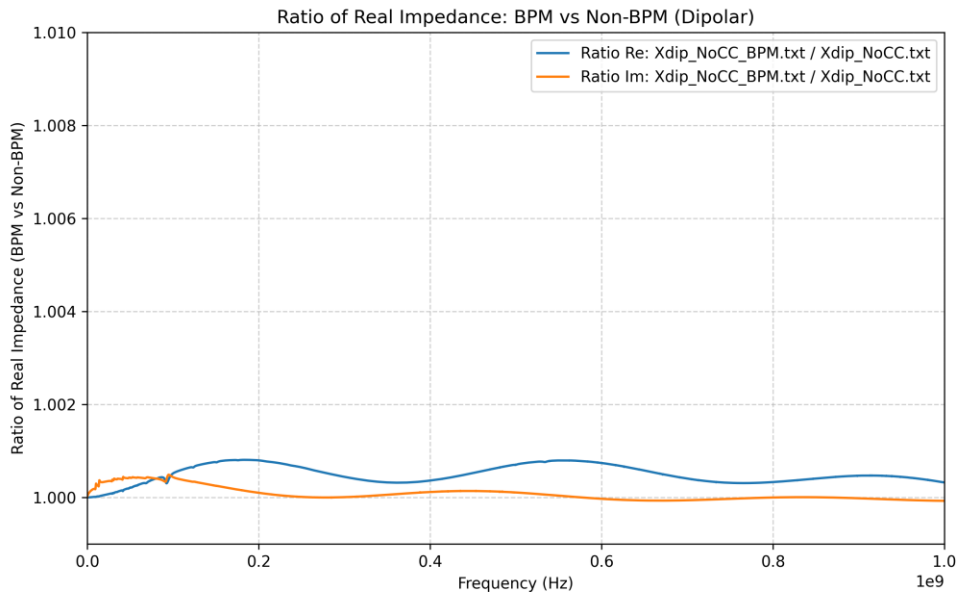
Thank you!

Backup


Impedance of BPW_R5 (xdip_comp) vs Frequency
Real Impedance
Imaginary Impedance
Impedance (Ohms)
Frequency (Hz)
1e10


Impedance of BPTQR_R5 (xdip_comp) vs Frequency
Real Impedance
Imaginary Impedance
Impedance (Ohms)
Frequency (Hz)
1e10


Ratio of Real Impedance: BPM vs Non-BPM (Dipolar)
Ratio Re: Xdip_NoCC_BPM.txt / Xdip_NoCC.txt
Ratio Im: Xdip_NoCC_BPM.txt / Xdip_NoCC.txt
Ratio of Real Impedance (BPM vs Non-BPM)
Frequency (Hz)
1e10


Ratio of Real Impedance: BPM vs Non-BPM (Dipolar)
Ratio Re: Xdip_NoCC_BPM.txt / Xdip_NoCC.txt
Ratio Im: Xdip_NoCC_BPM.txt / Xdip_NoCC.txt
Ratio of Real Impedance (BPM vs Non-BPM)
Frequency (Hz)
1e9