

Update on wire scanner impedance studies

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With the help of William Andrezza, Bernd Dehning, Ray Veness and the
BI technicians and workshop, and the 4 port VNA from BI.

Questions to be answered

- Can we install the mechanism in the SPS – no effect on beam?
- Is the wire likely to survive in the parking position?
- Is the wire likely to survive when scanning?

Can we answer these questions with the tools we have?

- Simulations

- Small details can not be modelled by the meshers
- Wakefield solver probably blind to most medium details due to hexahedral mesh → only left with eigenmode solver that does not treat losses very well.
- It is not clear that the simulation tool handles well the wires
- Many unknowns concerning the device (in particular the connection of the wire)
- Discrepancies and misunderstandings between 3D model and real device
- Not possible to import the latest model from William due to the version change of CATIA
- Complicated CATIA model not well digested by CST, very large number of mesh cells, very long simulations, difficult to do parameter scans
 - very large error bars and low confidence in simulations

- Measurements

- We cannot get the shunt impedance of the modes from the measurements (only frequencies and Q factors) → measurements alone do not give enough information
- Require a huge amount of time and manpower (both from BI and impedance team side) since many scans should be performed for many configurations, R&D study, nothing standard.
- Component not complete and not ready: motor not available made it difficult to move the fork precisely (could not move at all at the beginning).
 - We did not converge yet on a simulation model that is satisfactory
 - We do what we can, but clearly not an ideal situation to give accurate results

Chronology of measurements

- Empty tank
- Tank and drum without fork
- Tank and drum with fork
- Tank and drum with fork and Fritz wire
- Tank and drum with fork and ferrites
- Tank and drum with fork and all mode coupler
- Tank and drum with fork and copper tapes to shield the drum cavity

→ Huge amount of measurements

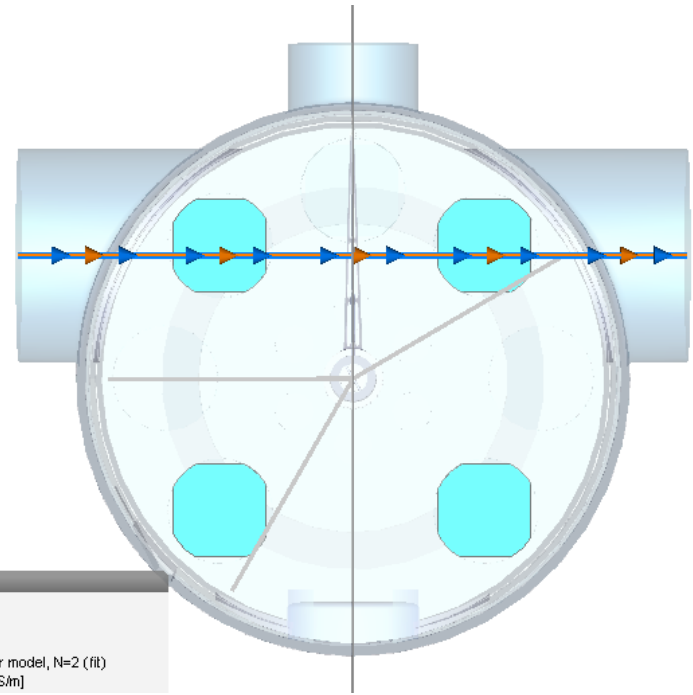
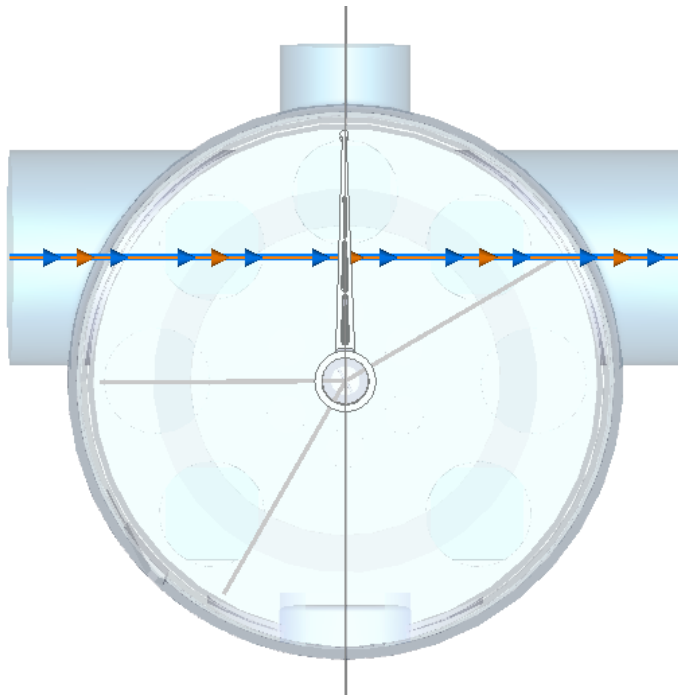
- See slides of Nicolo

Simulations

Impact of new wirescanner on beam

- Proposed strategy for acceptance:
 - Use the Wakefield solver, assuming that it is relevant enough for the beam
 - broadband impedance
 - Compare with Eigenmode simulations
 - harmful modes for the beam
- Checks of proposed configurations/solutions, knowing that the wire is probably very sensitive to details that we cannot model
 - Ferrites
 - “Fritz Wire”
 - Copper tapes

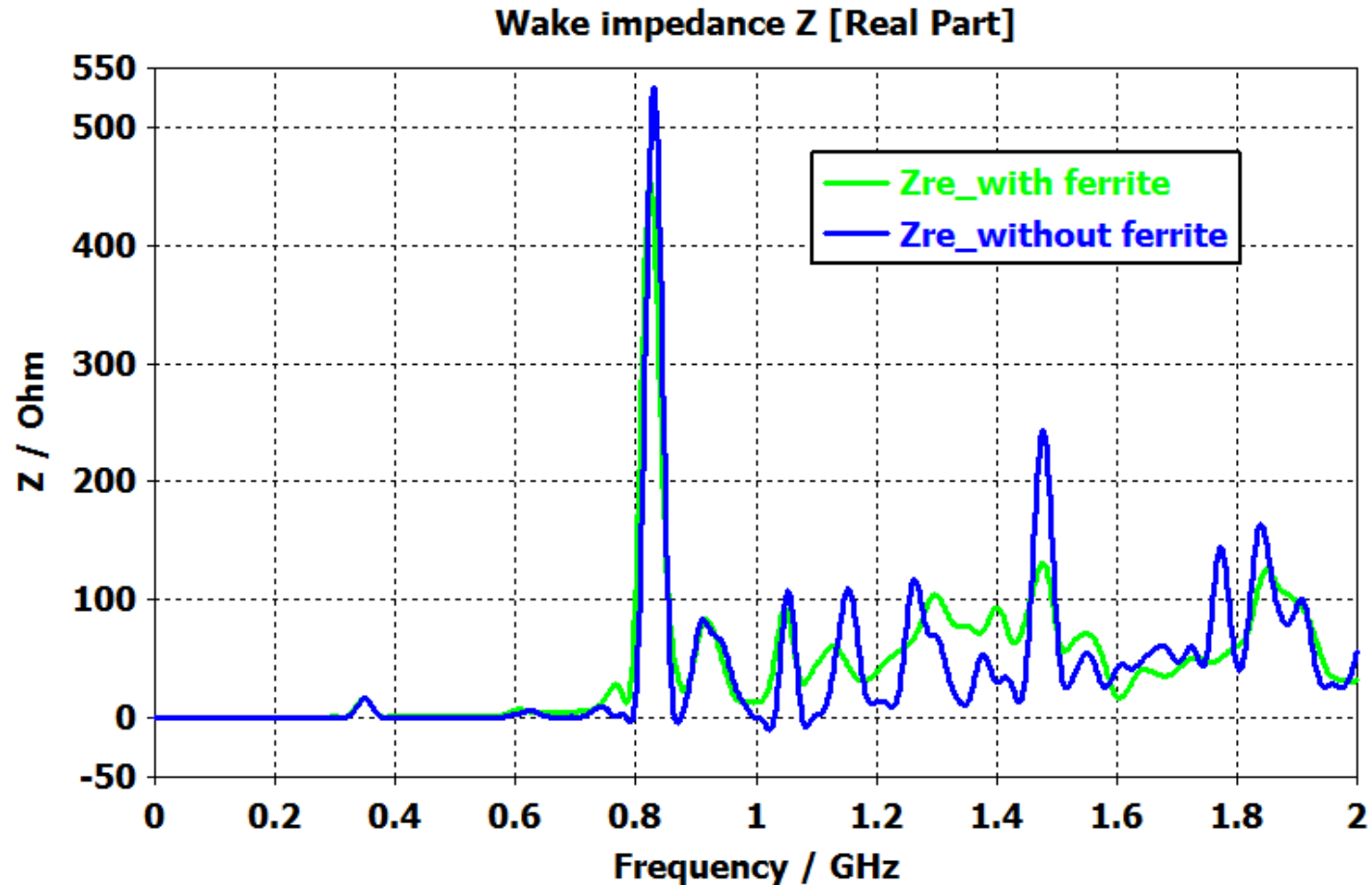
Comparing with and without ferrite: 3D model



component2:ferrite	
Material	TT211R
Type	Normal
Epsilon	12
Disp. mue	Nth order model, N=2 (fit)
El. cond.	0.0001 [S/m]

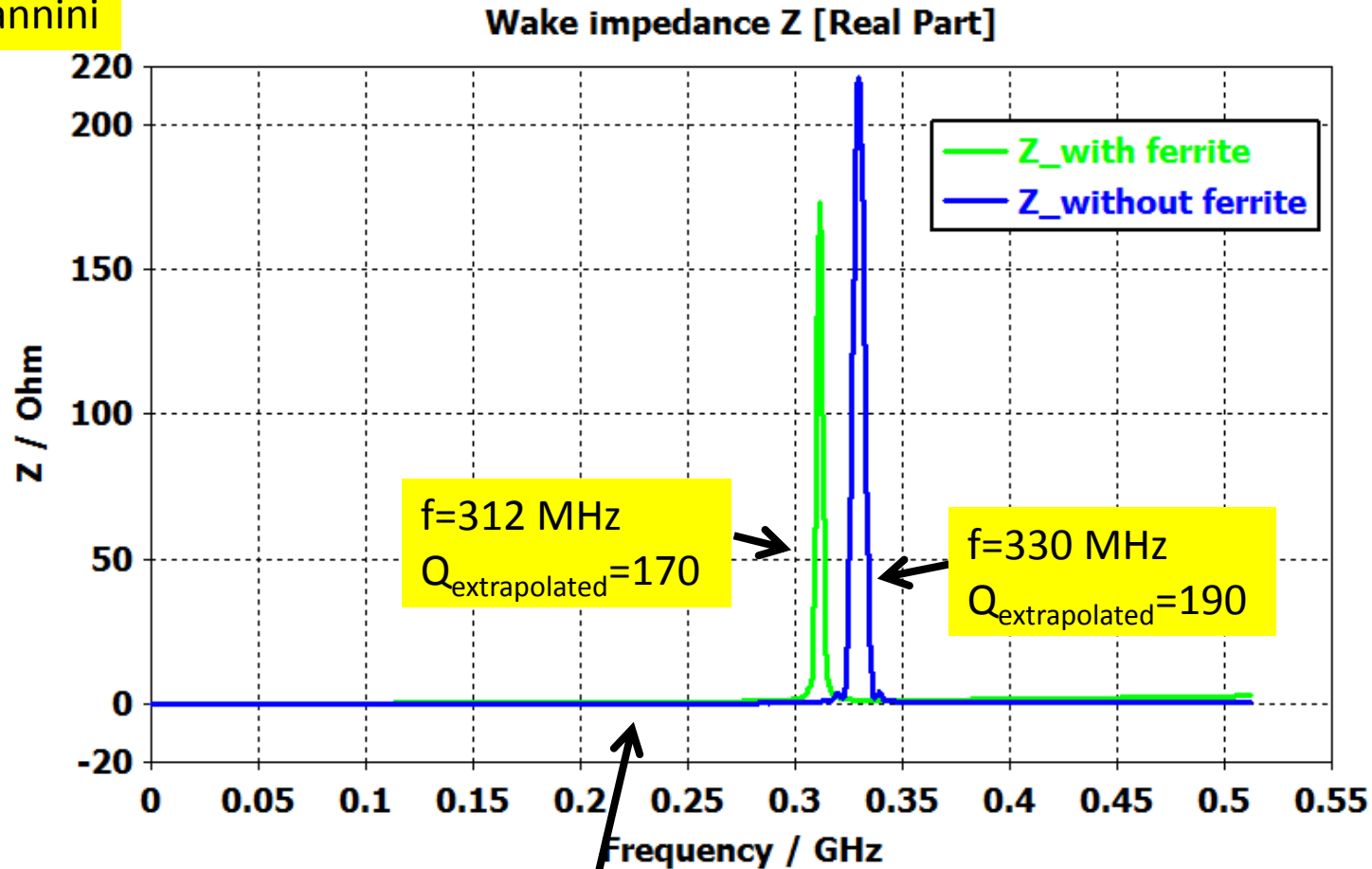


Comparing with and without ferrite



Comparing with and without ferrite

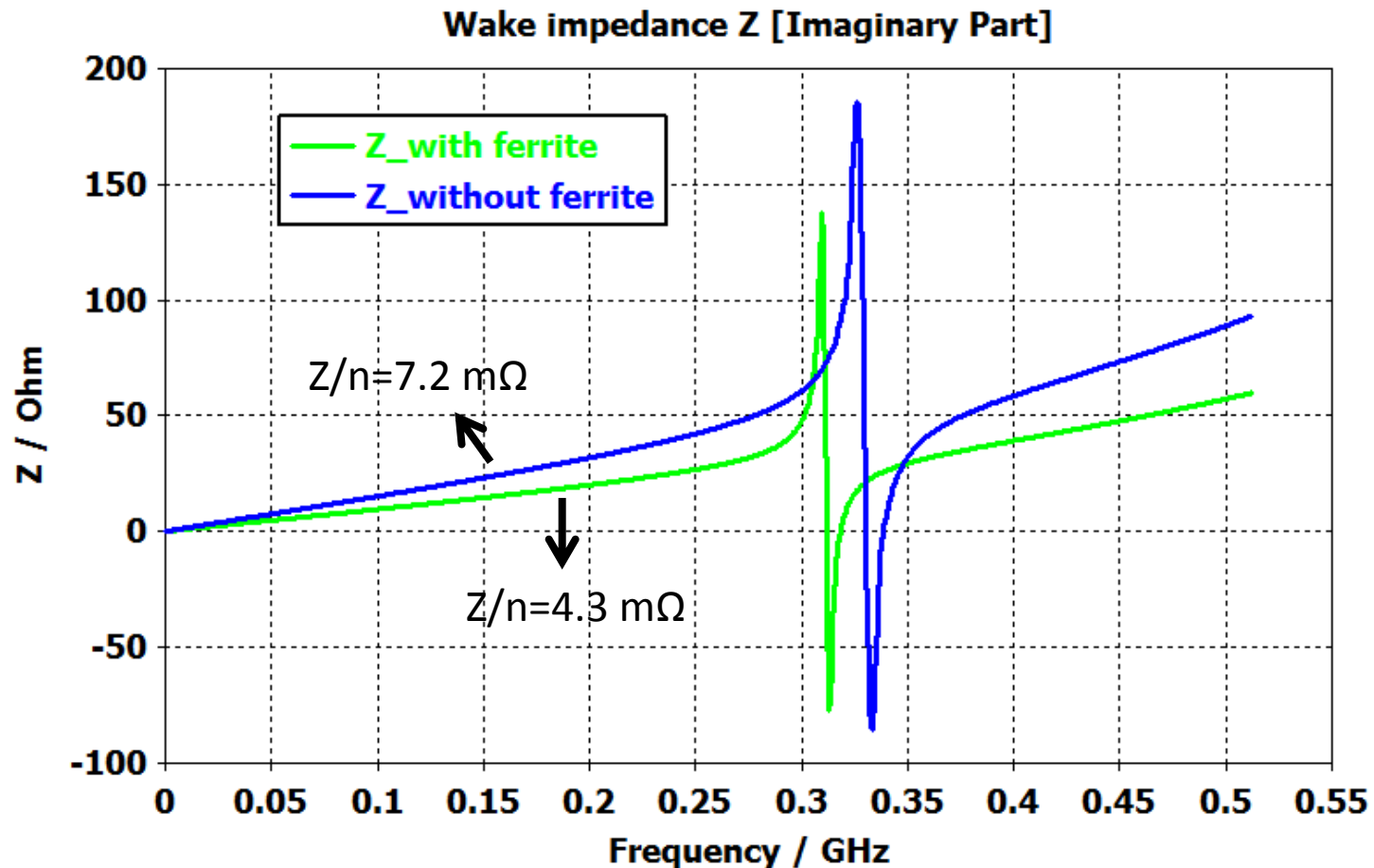
Carlo Zannini



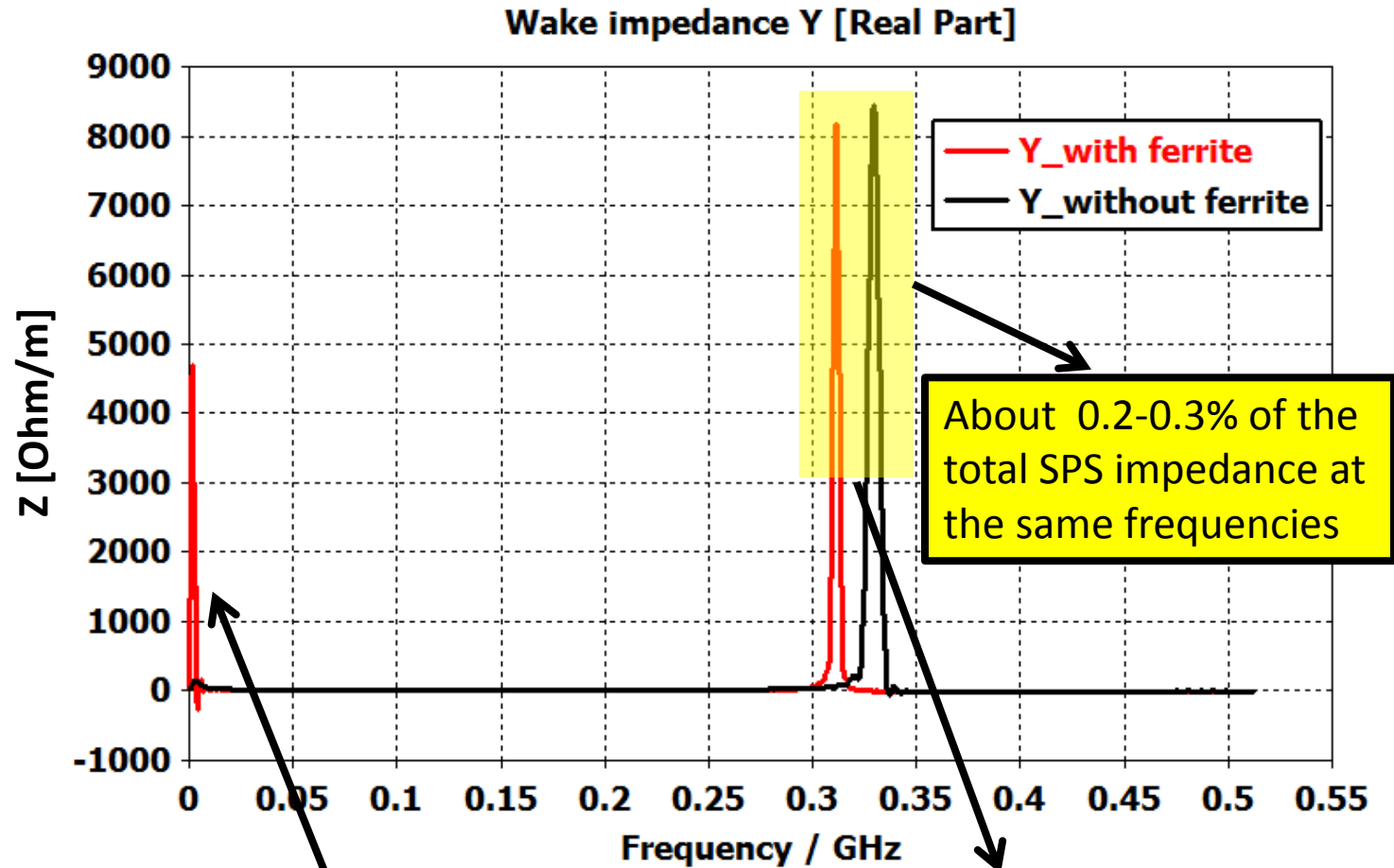
First mode (between drum and tank) probably killed by PEC cells

Longer wakes should be simulated to properly estimate the Q values from wakefield simulations

Comparing with and without ferrite: longitudinal broadband impedance



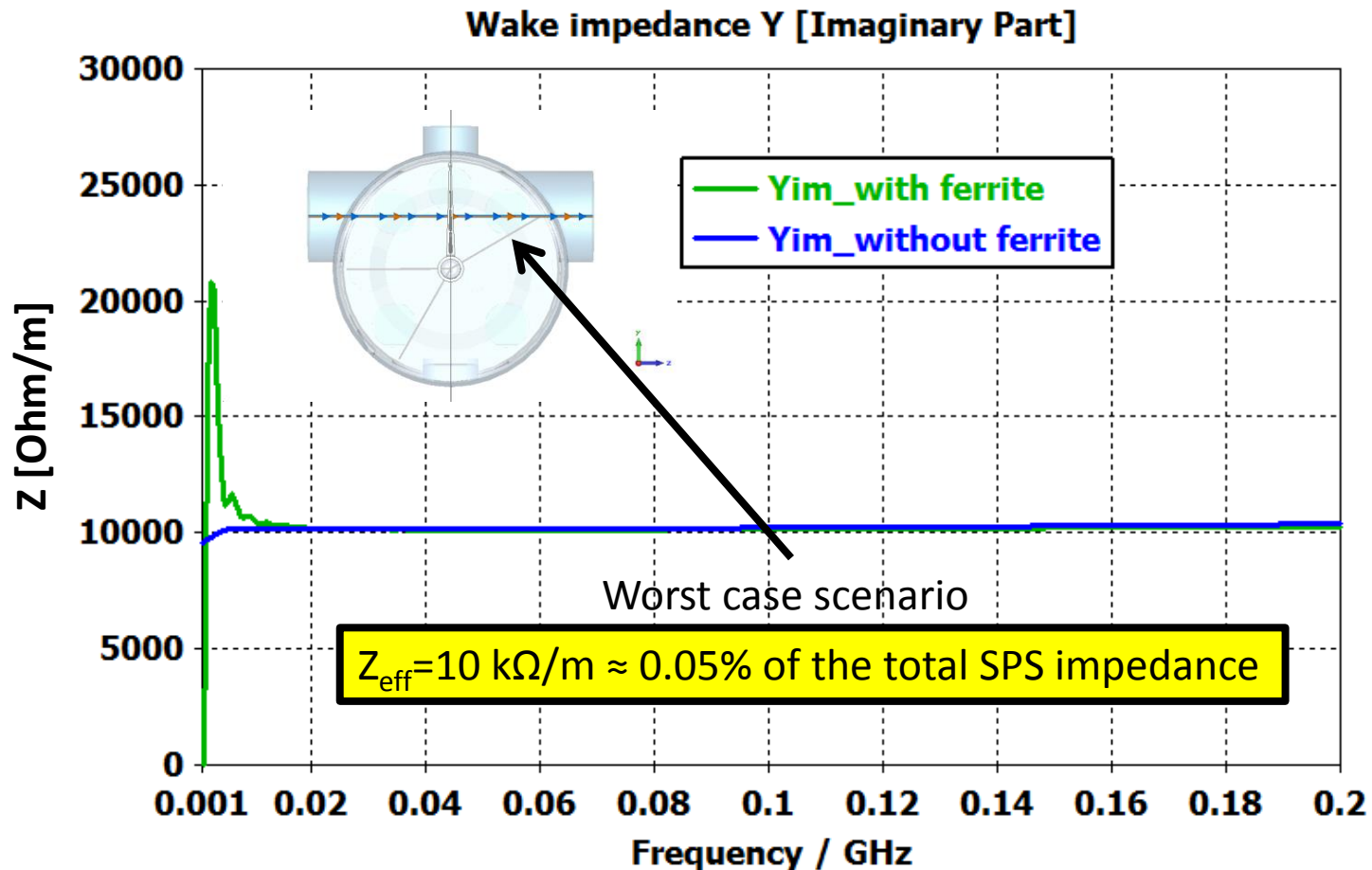
Comparing with and without ferrite



Carlo Zannini

$f \approx 1.6$ MHz

Comparing with and without ferrite: transverse broadband impedance

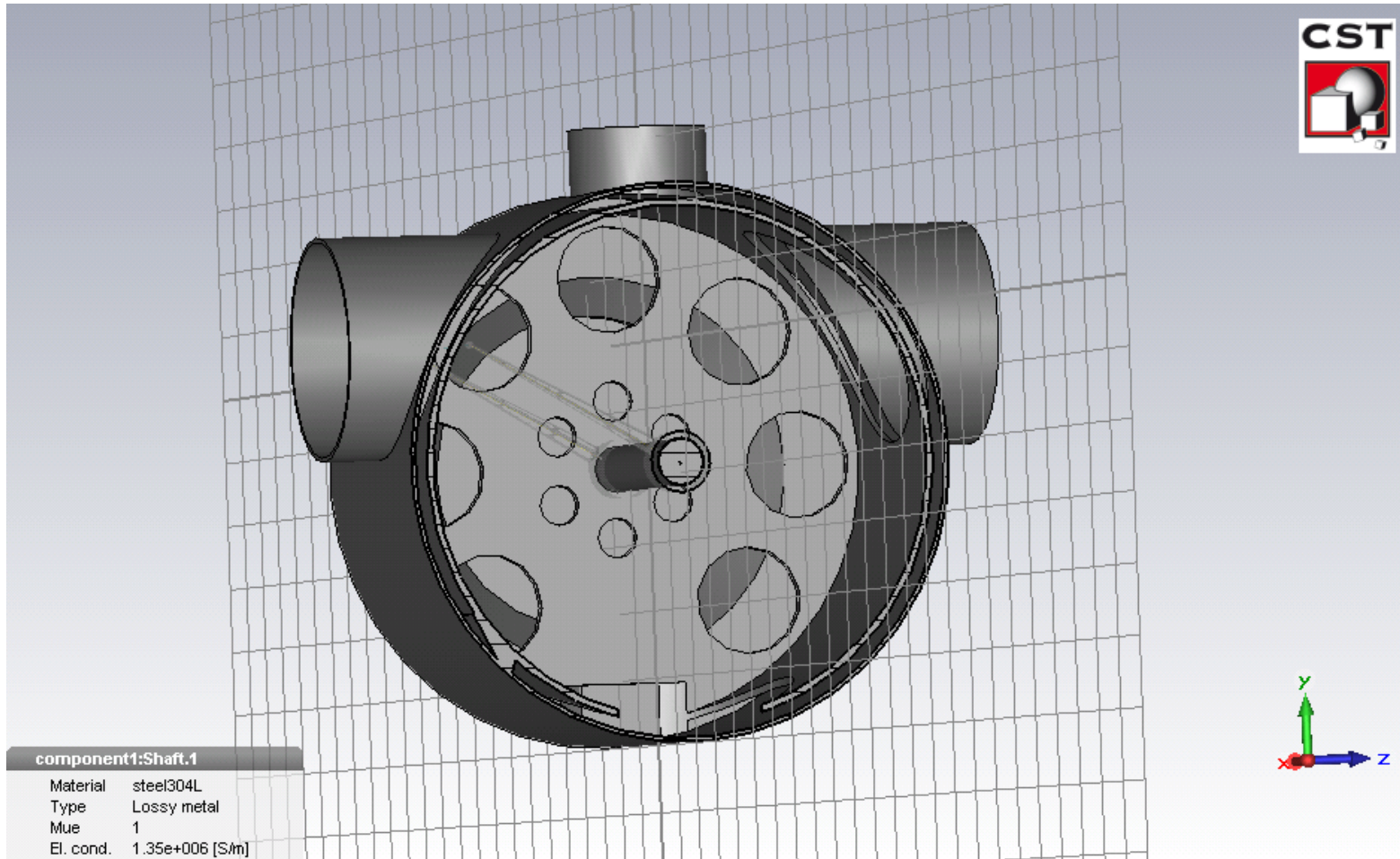


→ Also small contribution compared to the SPS impedance model

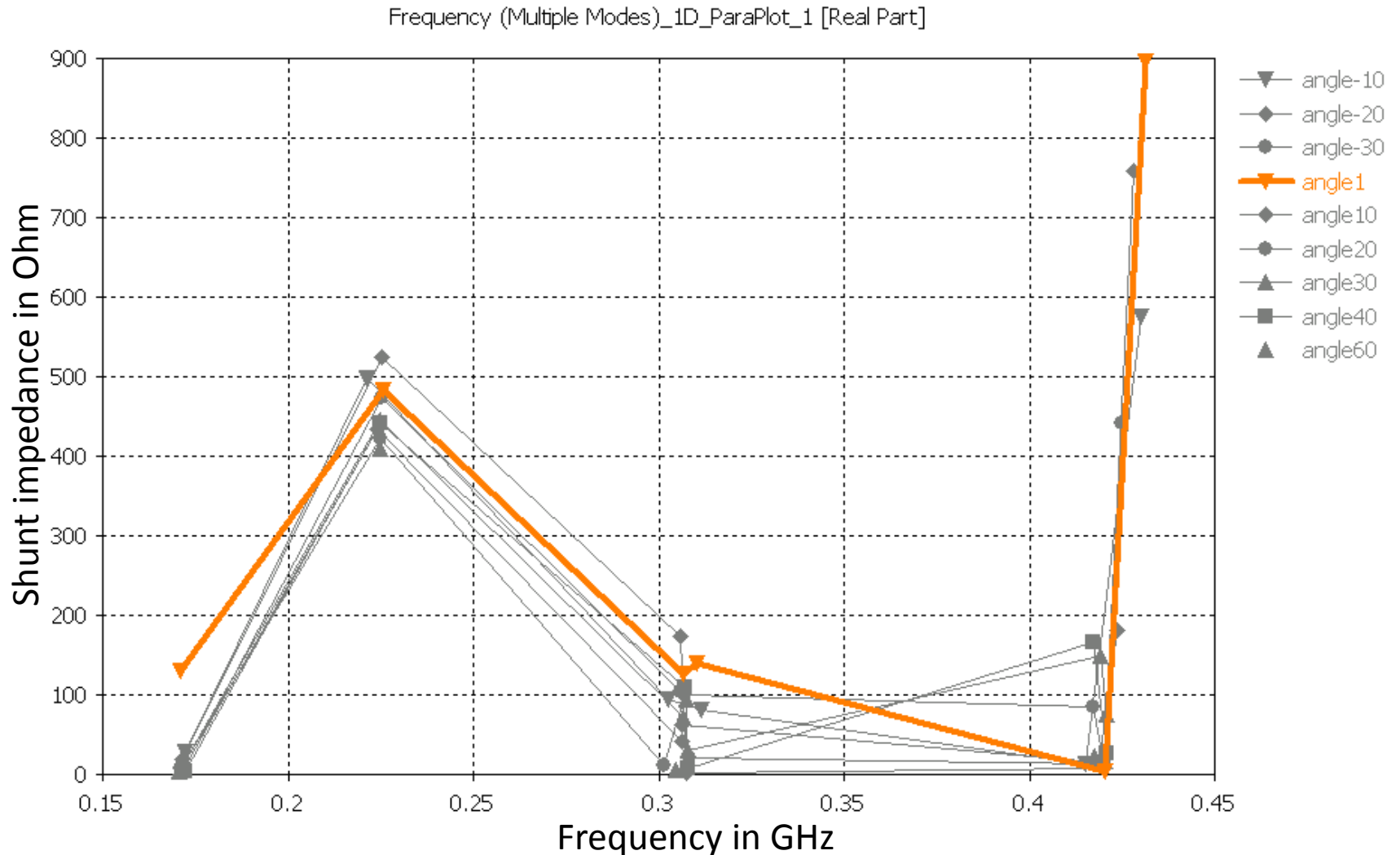
Impact of new wirescanner on beam

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Eigenmode simulations

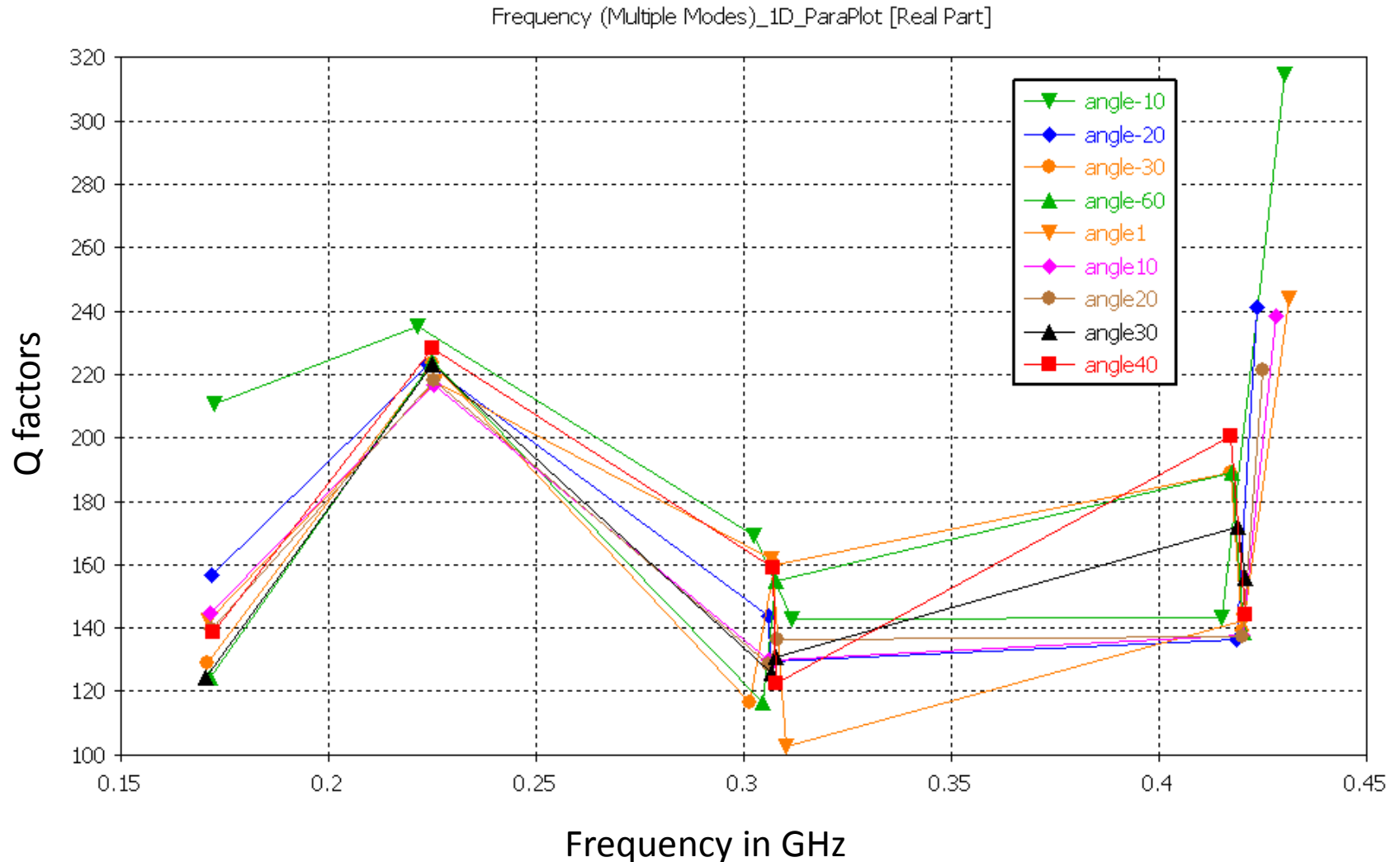


Eigenmode simulations



→ Longitudinal impedance of these modes very small compared to the longitudinal impedance of SPS

Eigenmode Q values

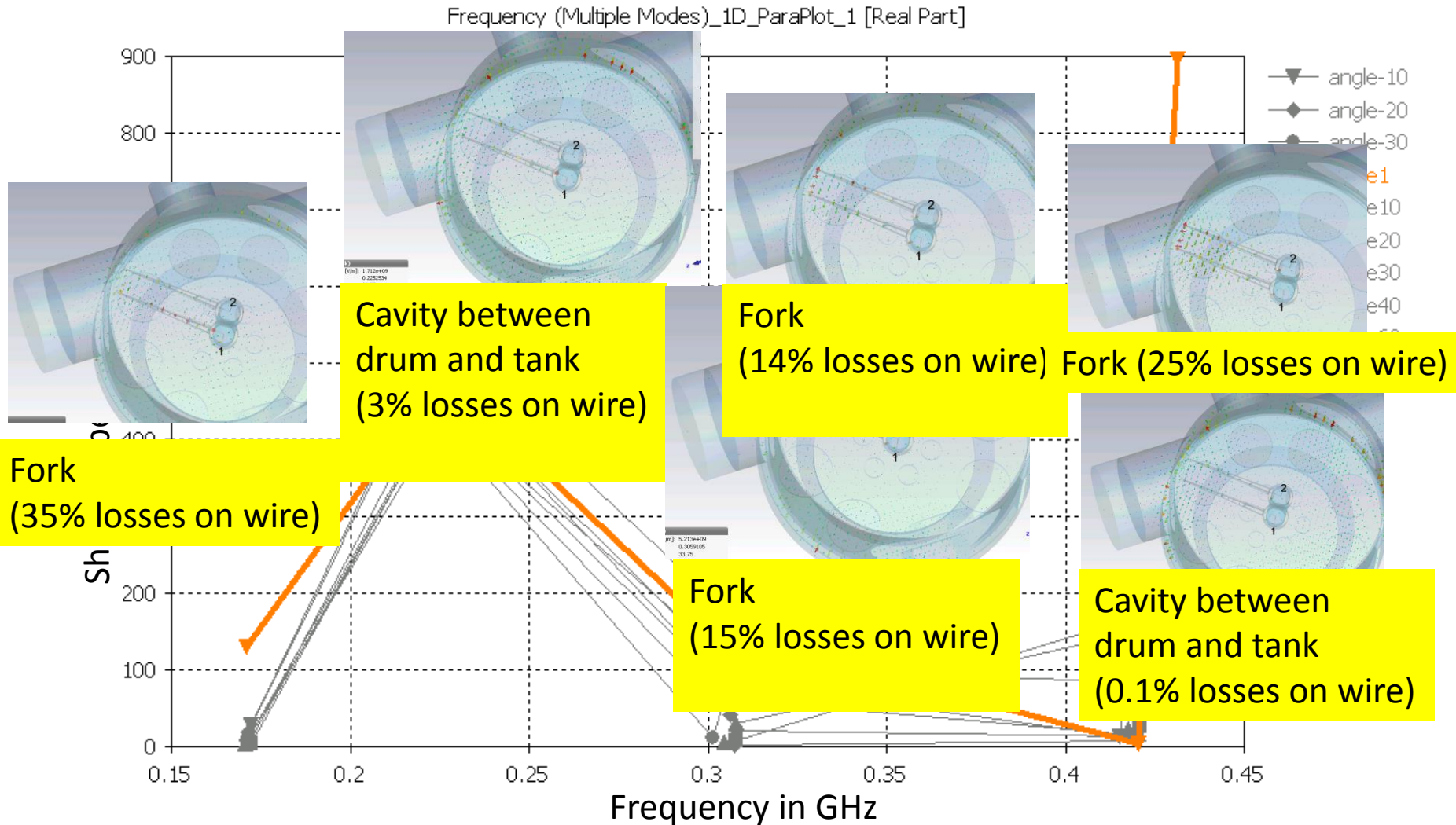


→ Q values quite independent of the fork angle between 100 and 200

Conclusion for the acceptance

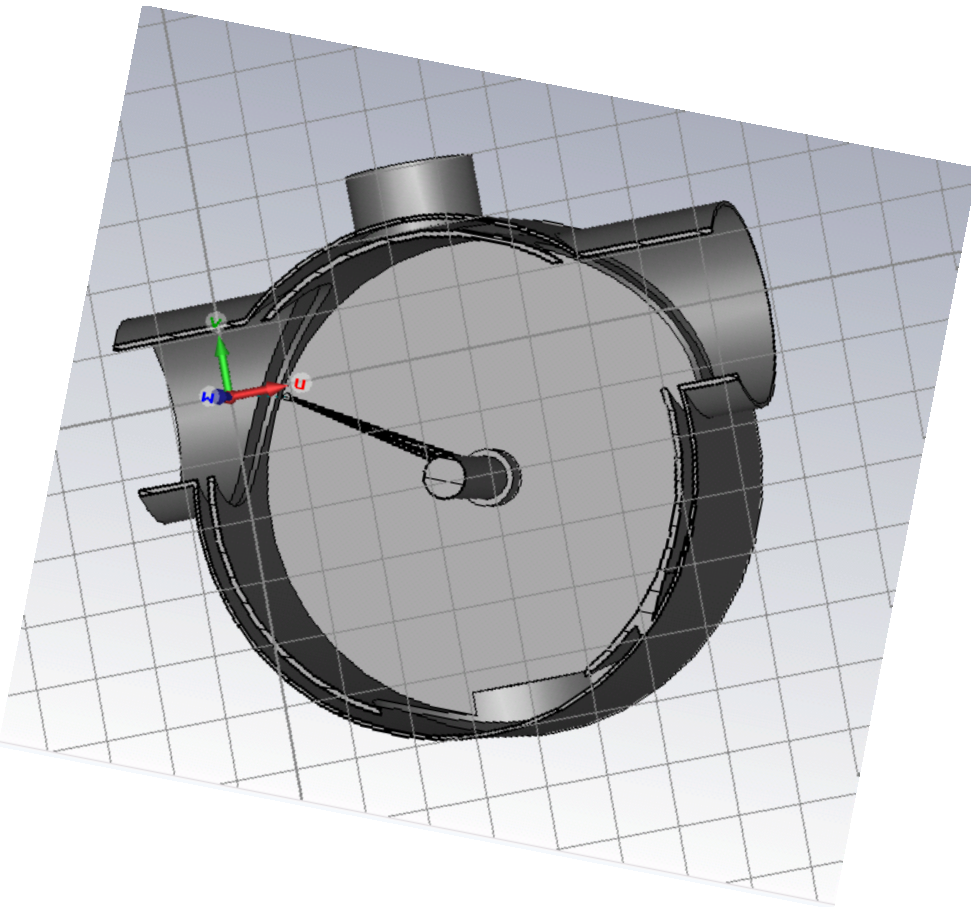
- It is an ongoing work with still many unknowns and we cannot exclude surprises.
- However, with the information we have, simulations and measurements seem to agree that the SPS wirescanner with the mechanism would not be harmful for the SPS beam.
- Now what about the wire?

Eigenmode simulations

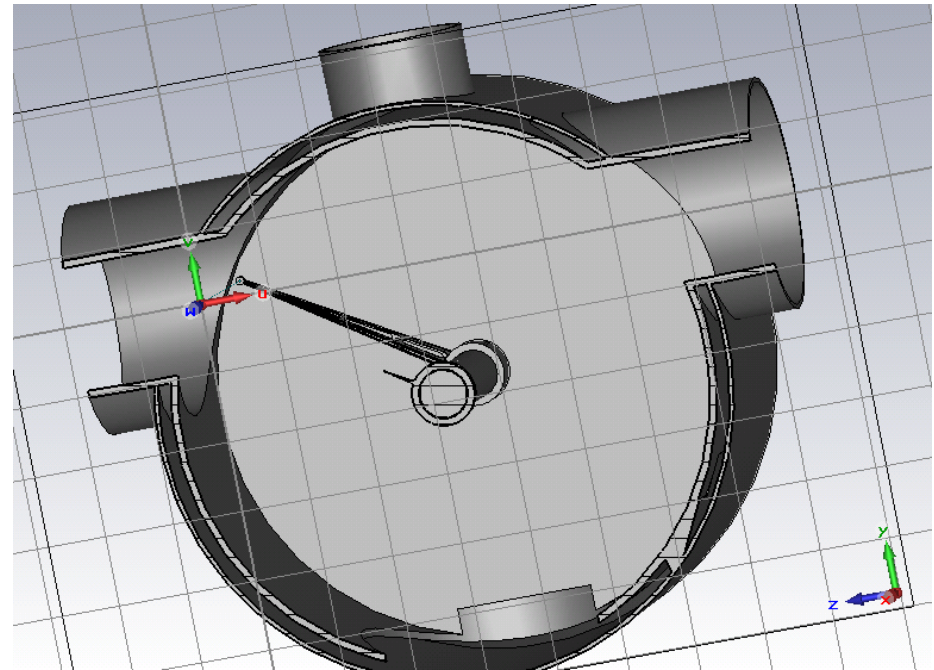


→ Hitting a beam spectral line could lead to significant power deposited on the carbon wire

Comparison with case with filled holes between the tank and the drum

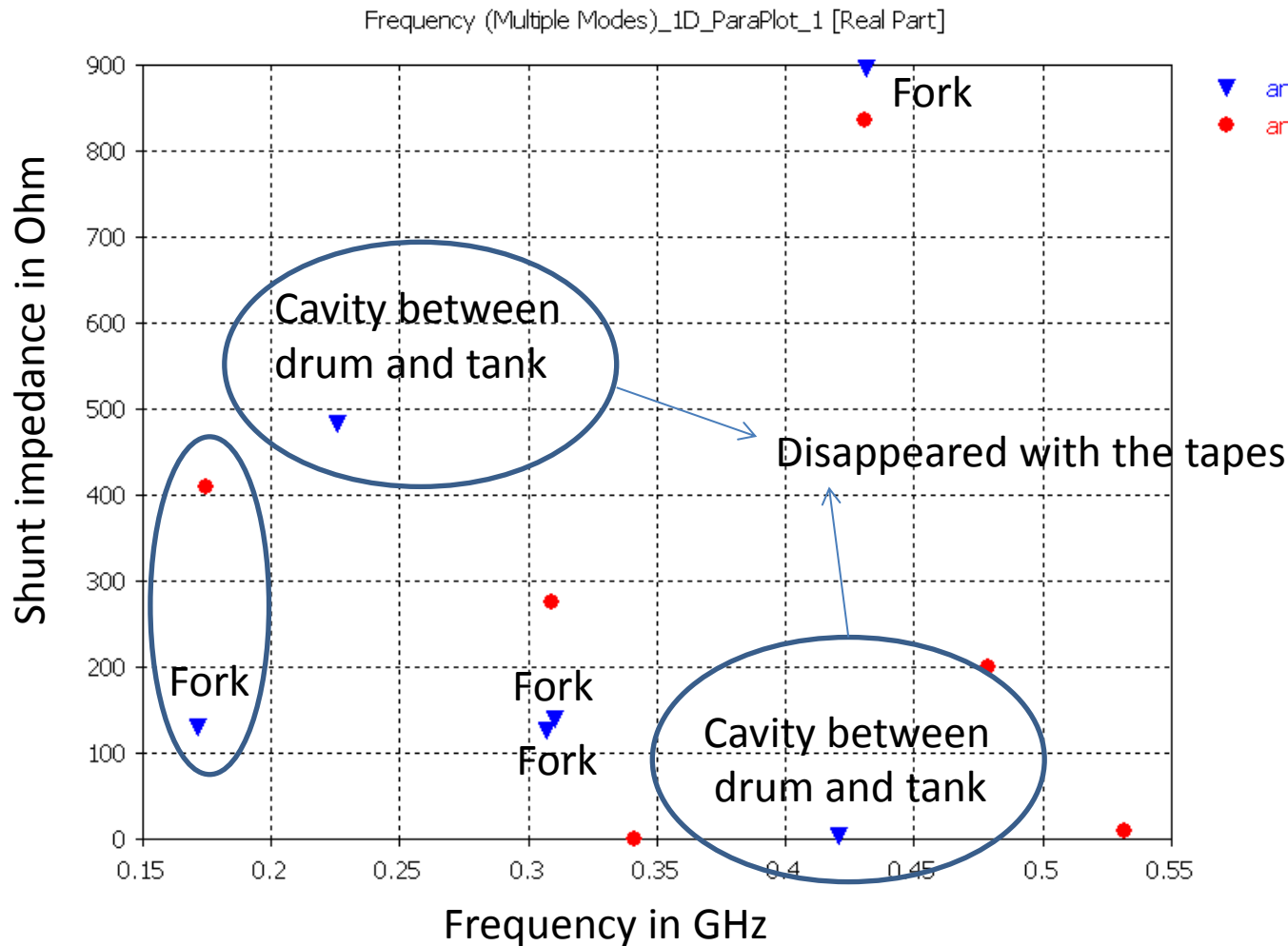
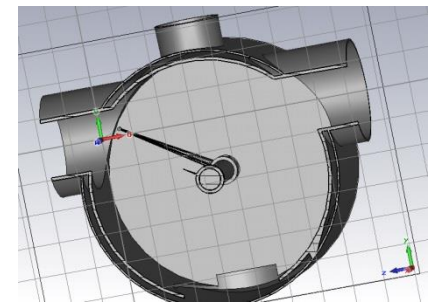
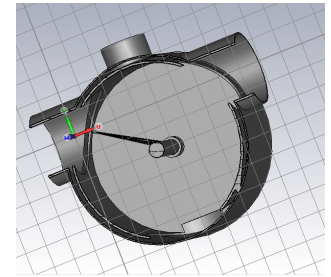


Without “copper tapes”



With “copper tapes”

Comparison with filled holes



→ 1st and 2nd fork modes are much worse with the copper tape. The hole is playing the role of the all mode coupler? Also seen in simulations.

Heat load on the wire in case of hitting a SPS beam spectral line

Mode	frequency	% on wire	R at parking (Ohm)	P at parking Injection/top energy	R in beam	P in beam Injection/top energy
1	170 MHz	35%	7	0.2 W / 0.3 W	130	3.8 W / 6 W
3	310 MHz	15%	5	0.1 W / 0.1 W	130	0.4 W / 1.6 W
4	315 MHz	14%	95	0.2 W / 1.1 W	140	0.3 W / 1.6 W
6	420 MHz	25%	15	0.002 W / 0.2 W	900	0.7 W / 12 W

Nb=1.35e11;

M=4*72;

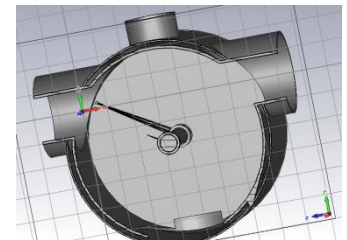
Injection bunch length: 3 ns

Top energy bunch length: 1.6 ns

→ Simulated frequency change with rotation of the fork is not that large for the 1st mode (~ 1 MHz) but is much larger for the 6th mode (~10 MHz)

Impact of new wirescanner on beam

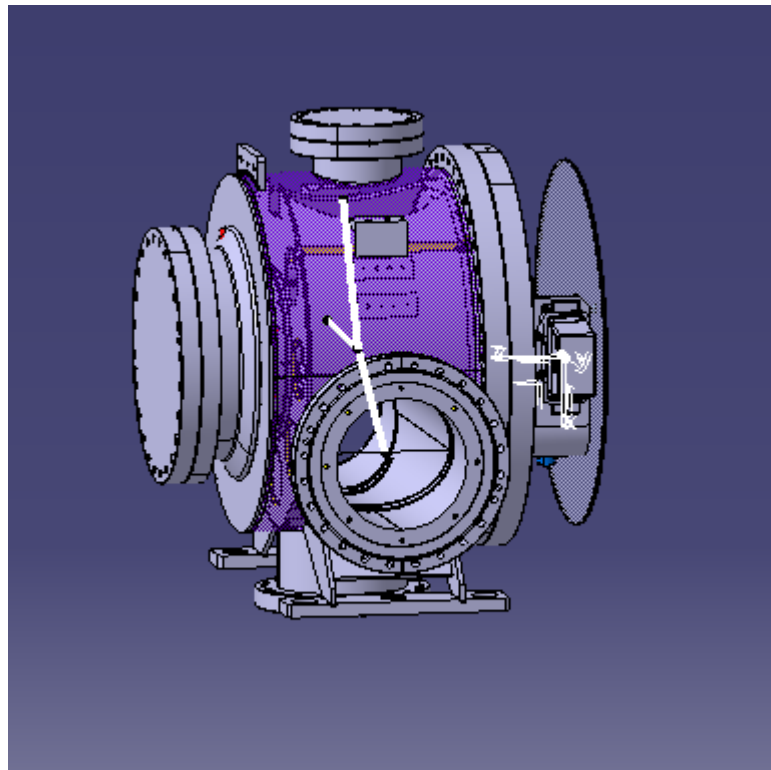
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- Checks of proposed configurations/solutions, knowing that the wire is probably very sensitive to details that we cannot model
 - Ferrites → not very efficient
 - “Fritz Wire” → could help but seems to depend on the mode
 - Copper tapes → seems worse for the wire
 - Plate solution does not work well with the very large incoming aperture

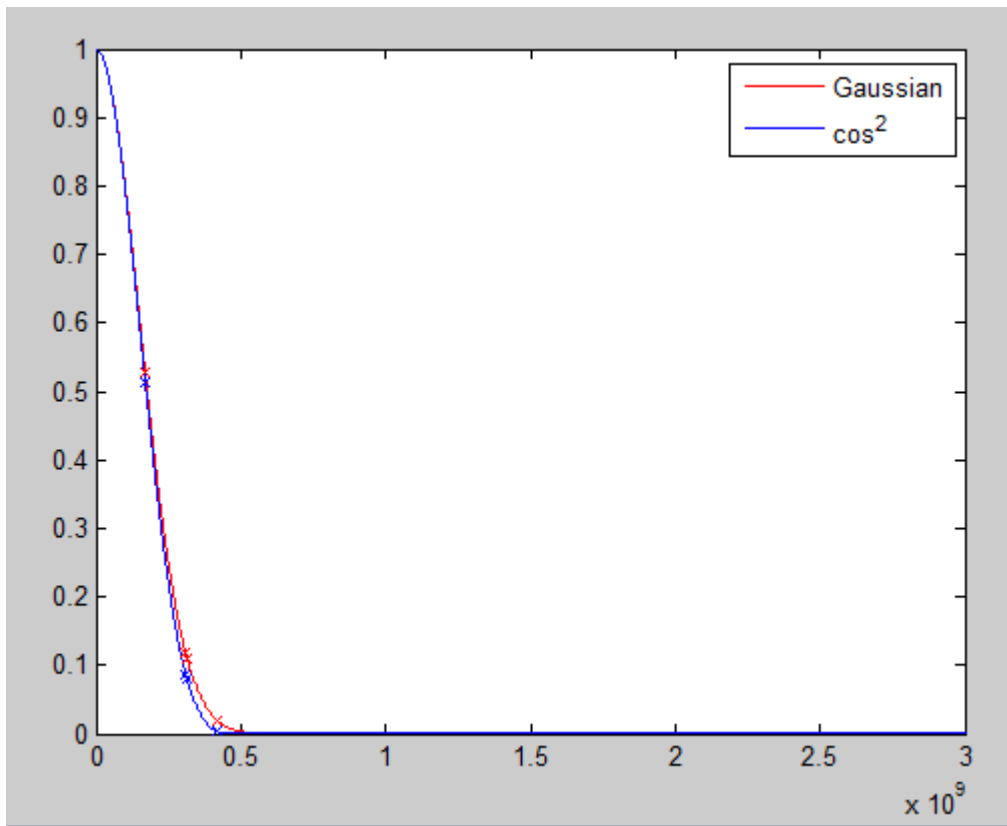


Where are we?

- huge amount of work from both BI and impedance team side, in particular for the measurements.
- With the information we have, there is no showstopper for installation of the new prototype tank in the SPS for the 2015 run (conclusion from impedance meeting on Monday).
- Agreement between simulations and measurements is not yet satisfactory to be confident on the wire heating. Many modes in both measurements and simulations. We can therefore not guarantee that the wire will survive in parking position, and more studies (in particular with beam) are needed.

effect on beam





Eigenmode analysis

