Measurements on RF-fingers/ Status Report

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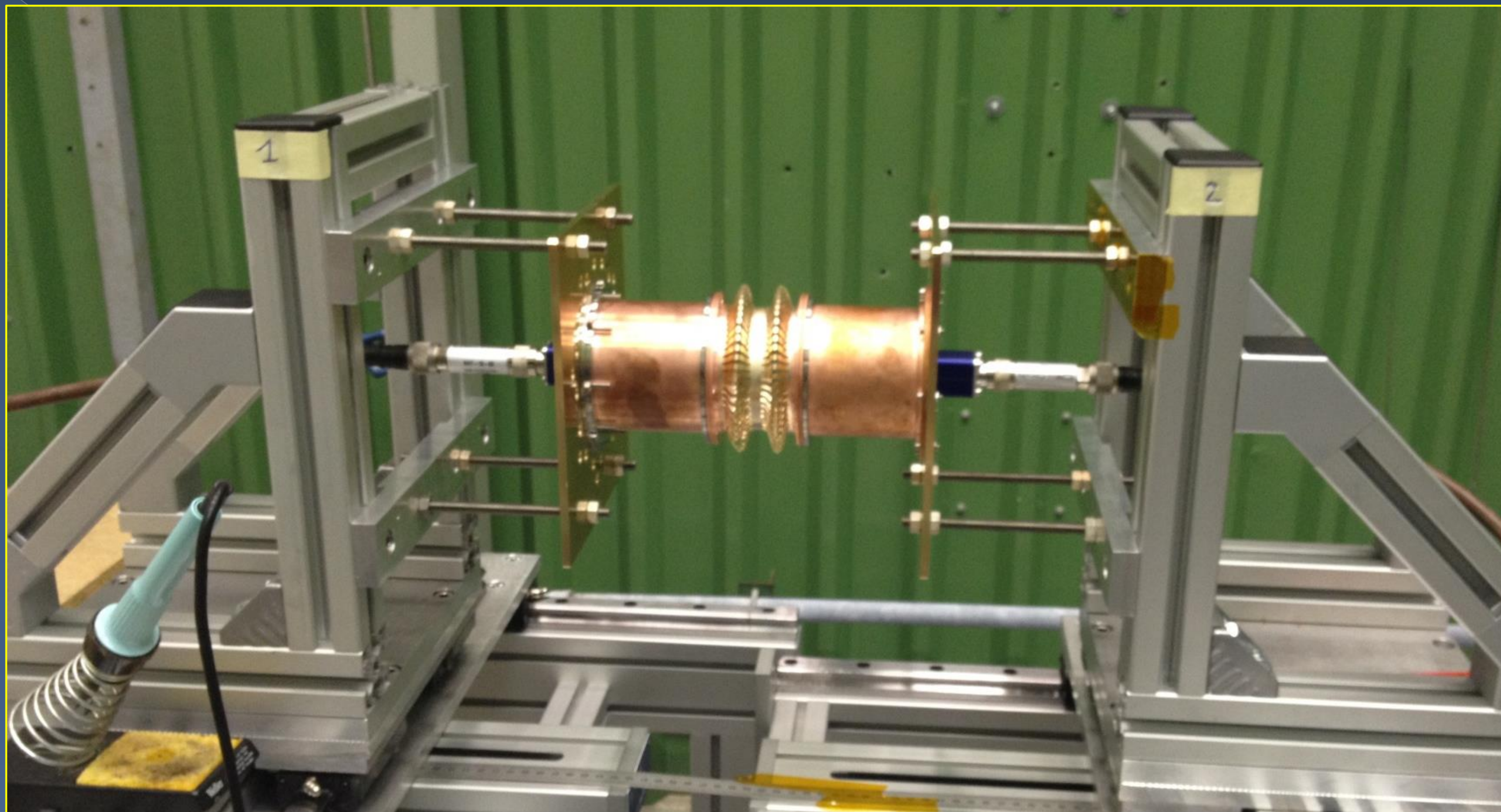
Evaluation of the RF-fingers "new design" for Triplet

Combined effort of BE/RF and BE/ABP groups, and goes in 2 steps:

1. RF-measurements to evaluate RF-fingers
   in the 2-convolution and the 3-convolution design in terms of resonances, and unexpected effects;

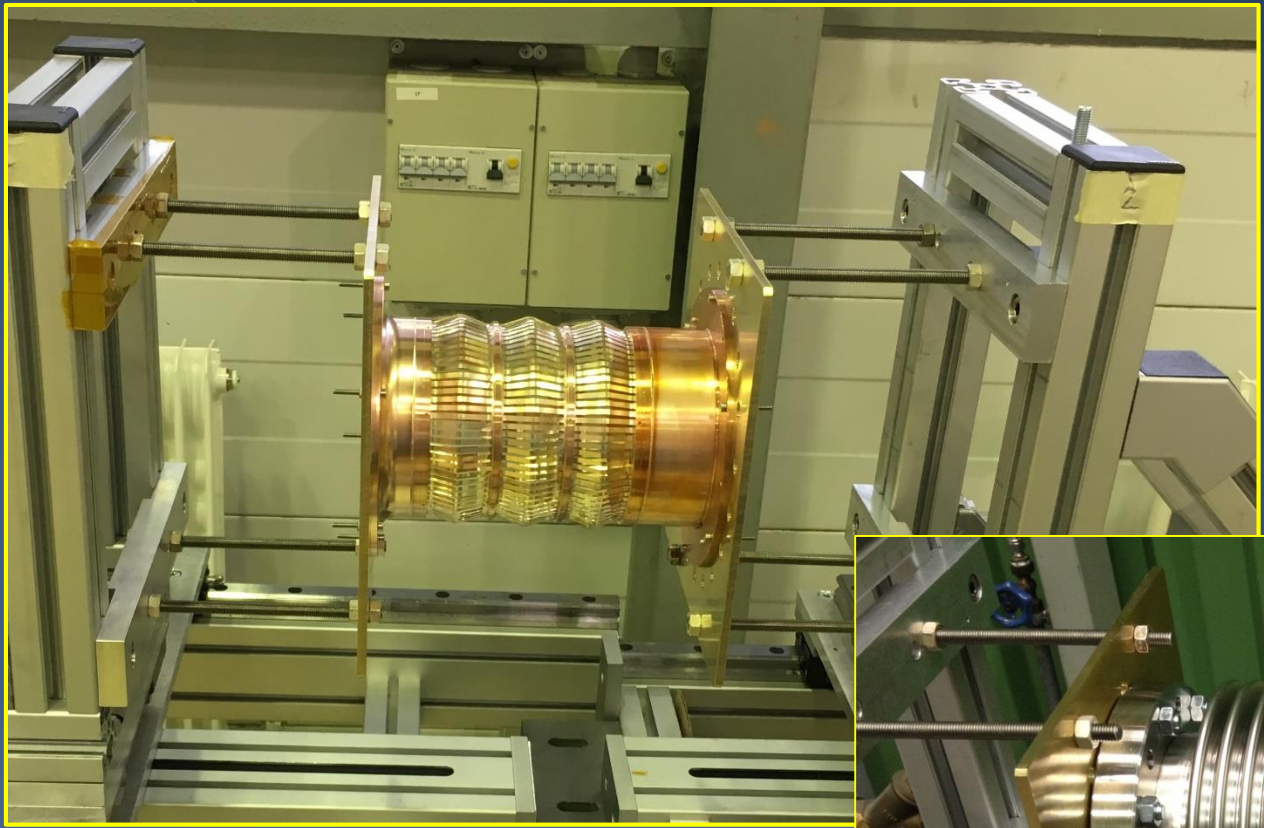
2. Wakefield simulation of the object for final decision of acceptance or rejection of these RF-fingers.

Case 1:
2-convolution RF-finger (ID=80mm)

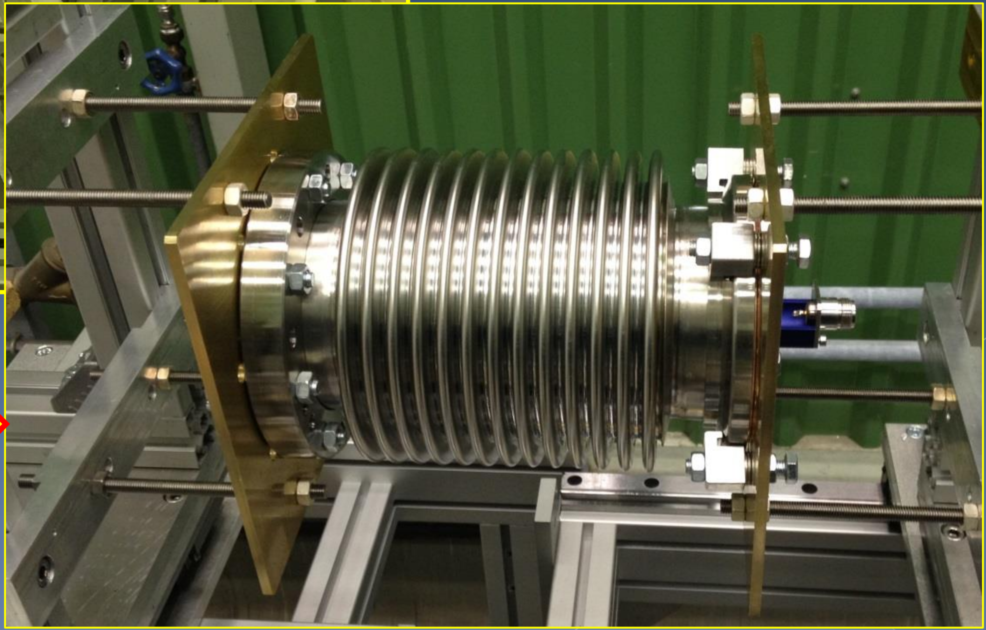


Remark:
Similar measurement was already taken by Olav Berrig on RF-fingers with lesser inner diameter BUT without outer bellows mounted.
(see impedance meeting of 06-Nov-2012);

Case 2:
3-convolution RF-finger (ID=111mm)

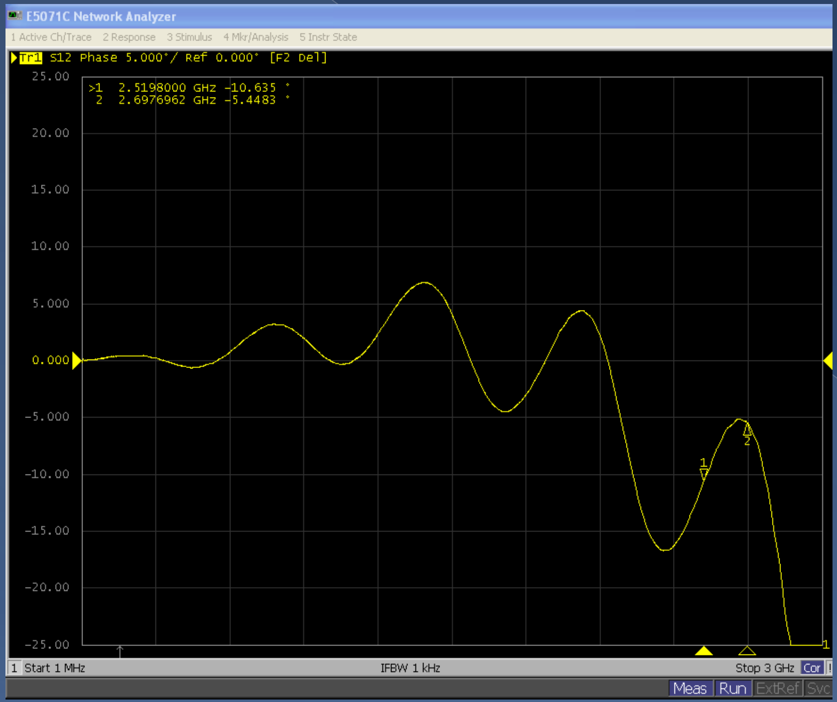


For a correct evaluation, the outer bellows have to be mounted (in both cases) to catch the radiated fields.

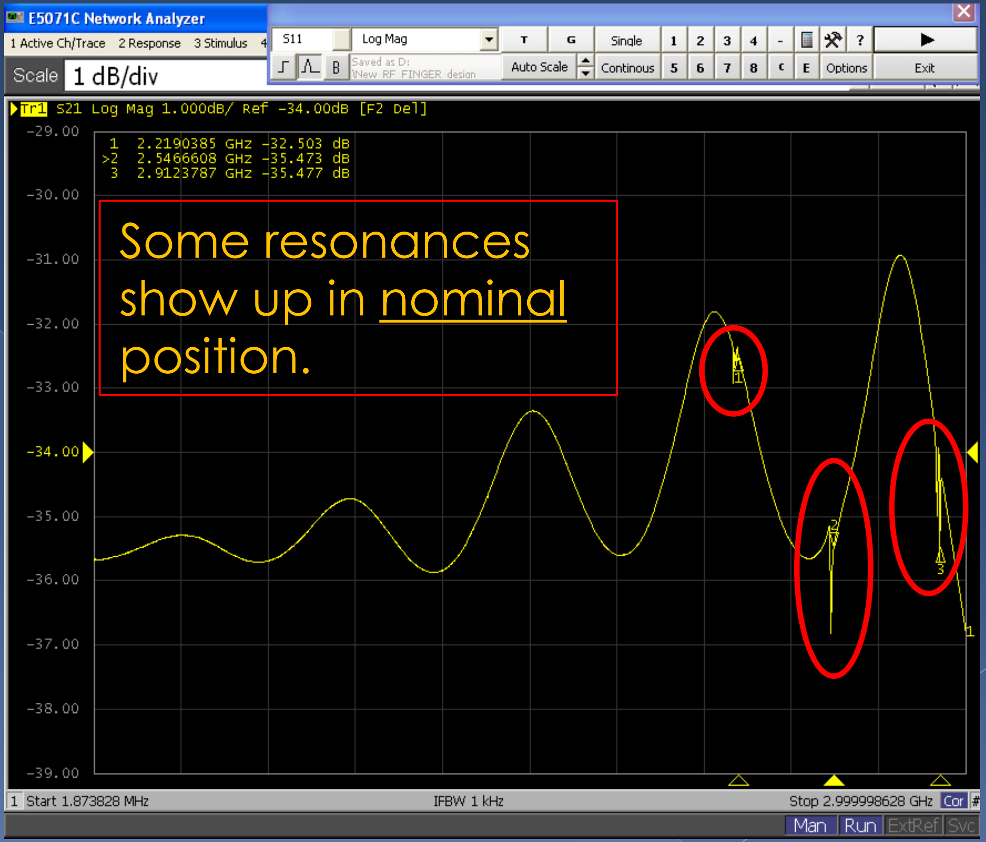


Example:
2-Convolution RF-fingers Measurement in Frequency Range

Without bellows mounted



With bellows mounted



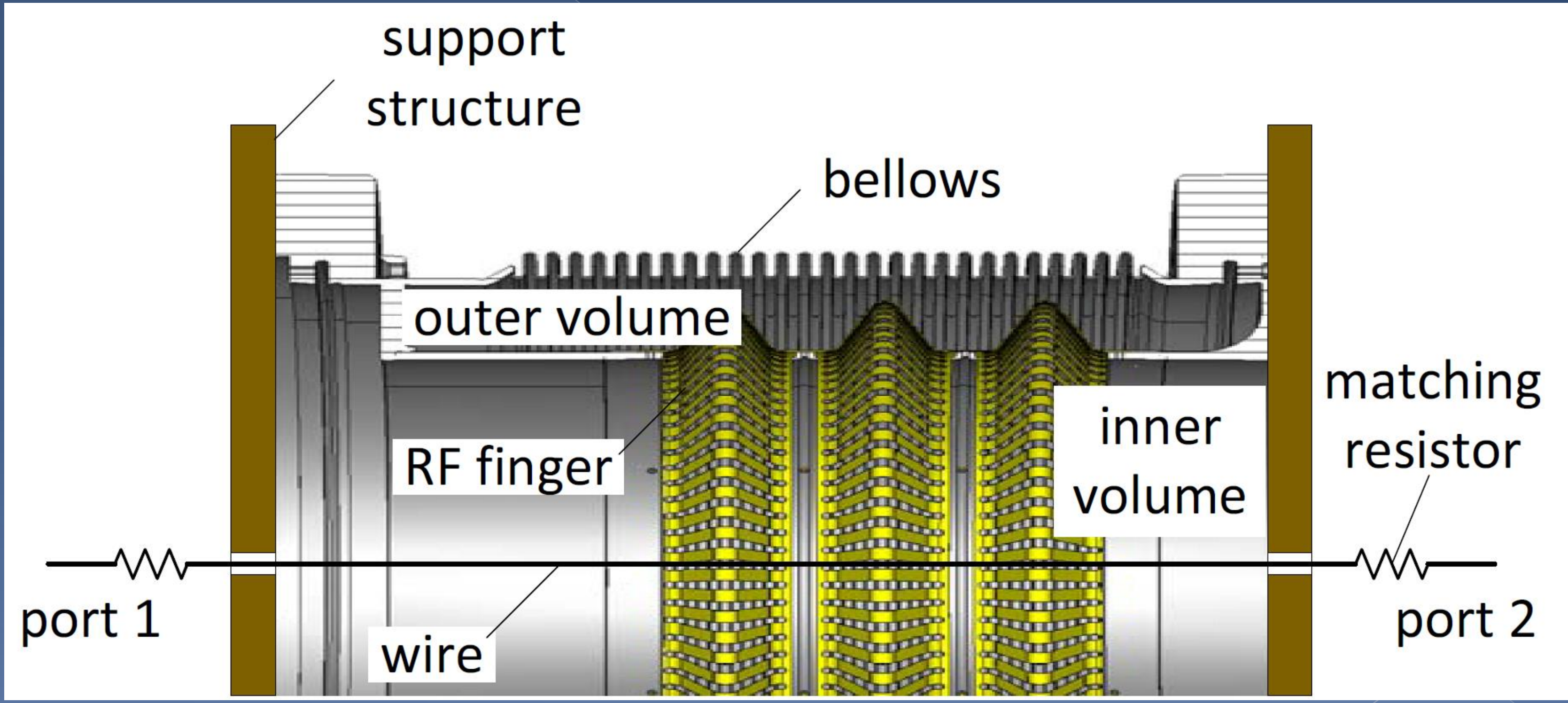
For a correct evaluation, the outer bellows have to be mounted (in both cases) to catch the radiated fields.

This is a problem for the measurement method.

Measurement Method and the "Object" (1/3)

The structure WITH the outer bellow becomes "nested coaxial line"

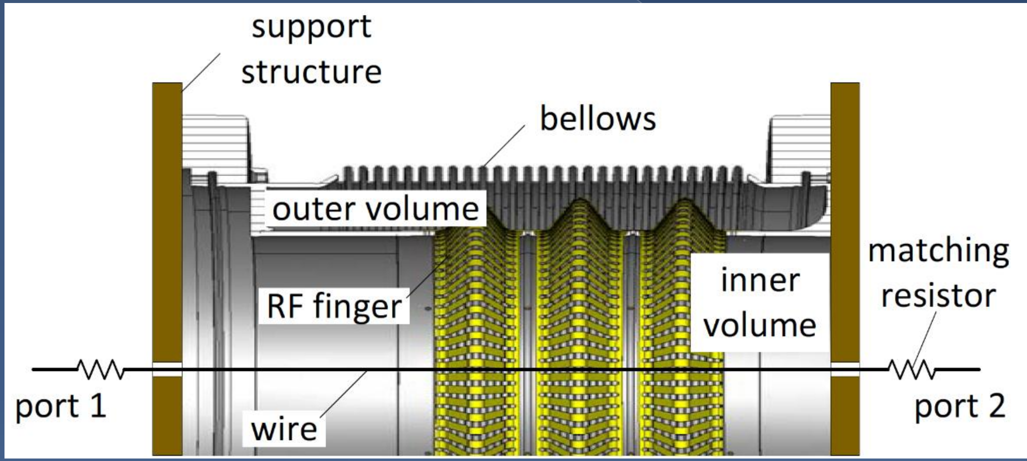
→ *We could see* ***high-Q resonances*** *when the outer bellow is mounted;*
→ *electromagnetically, lumped element simulations show that the structure behaves like a two-coupled resonator.*

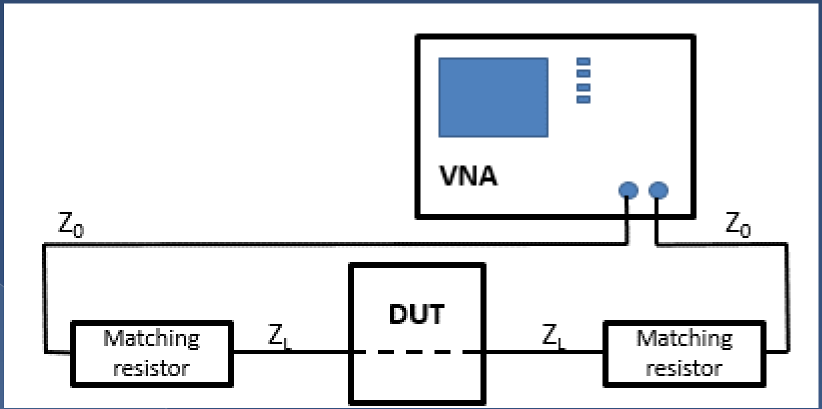


Measurement Method and the "Object" (2/3)

The structure WITH the outer bellow becomes "nested coaxial line" with two nested coaxial volumes (inner and outer).

Coupling via RF-finger slits.





Standard measurement methods are:

- *(Beam-simulating) wire method, and*
- *Probe measurements.*

Measurement Method and the “Object” (3/3)

- **Wire method is generally unsuited to measure high-Q resonances**;

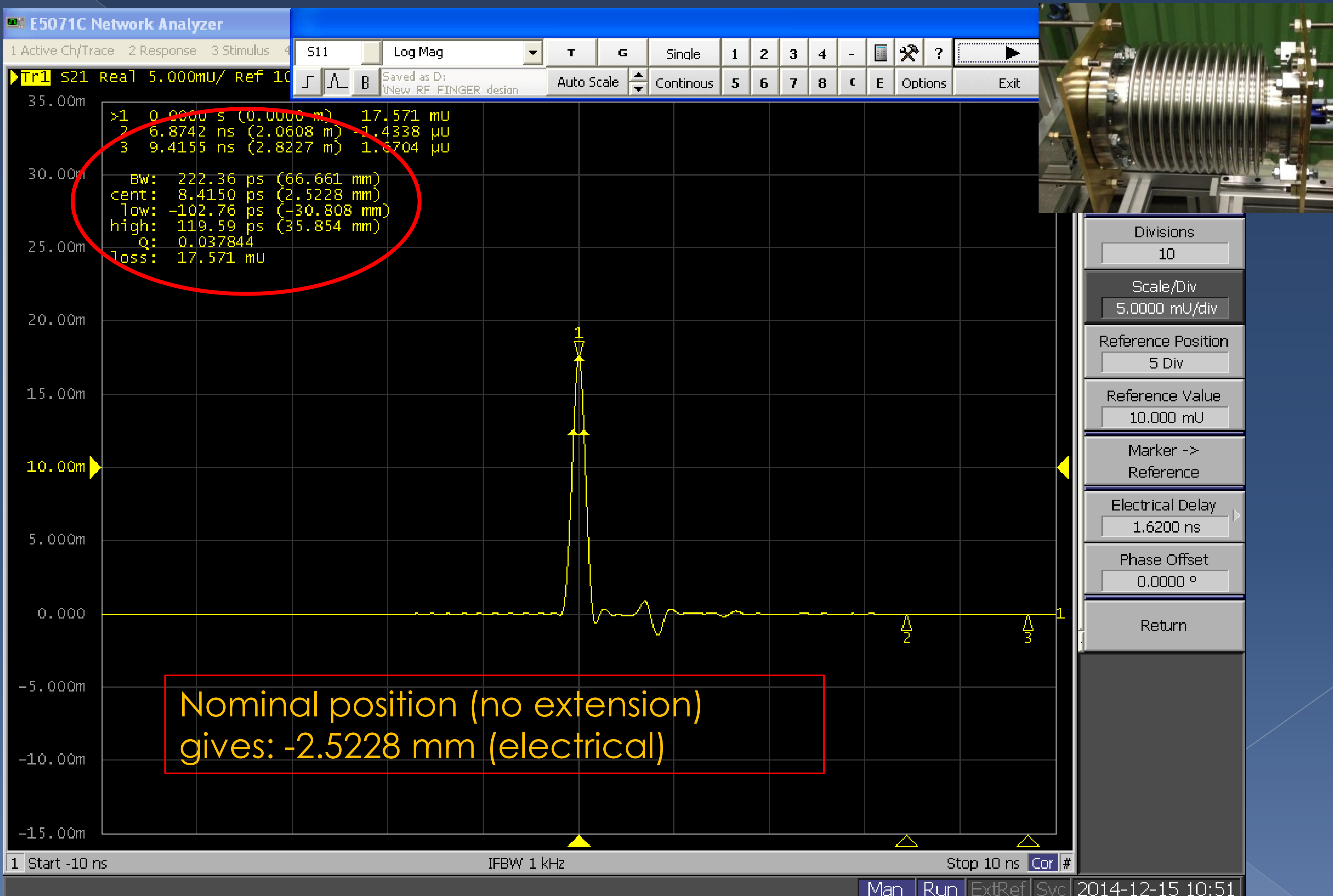
- Measurement with probes-on-axis gives resonances of the inner volume, only.
- Measurement of outer volume in frequency range (e.g. with probes) would require to drill a hole in the outer bellows;

- None of the two methods is suited here.

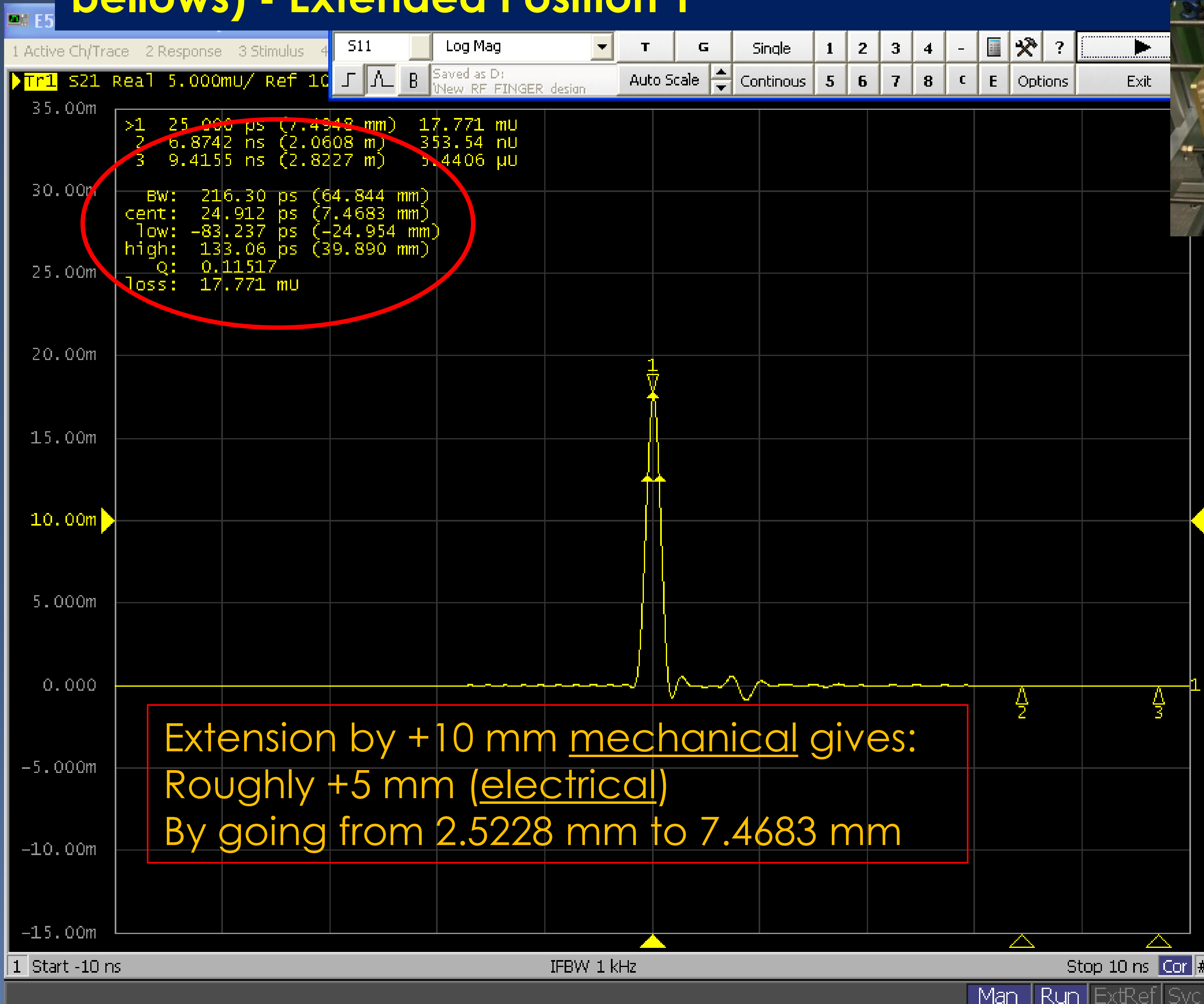
- Thus, we used **wire method in TD transmission** to determine the resonances of the **outer volume**.

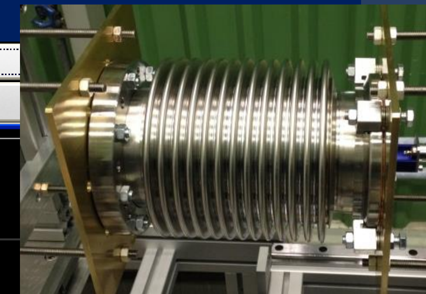
- Wire measurement is “standard”, i.e.: 0.5 mm wire diameter and matching resistors; the measurement in time domain and its evaluation is not.

Results of 2-convolution RF-fingers (measured WITH outer bellows)



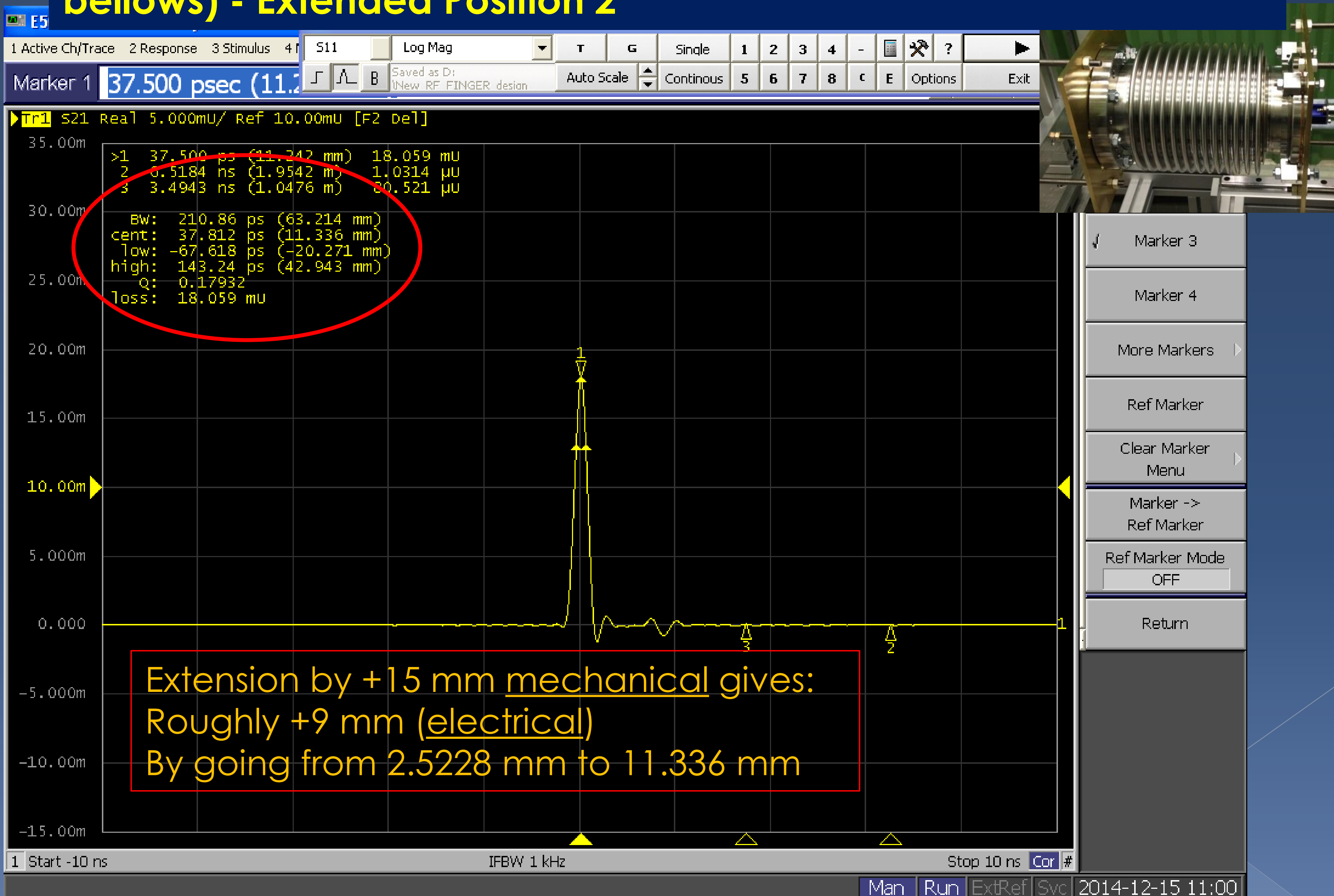
Results of 2-convolution RF-fingers (measured WITH outer bellows) - Extended Position 1





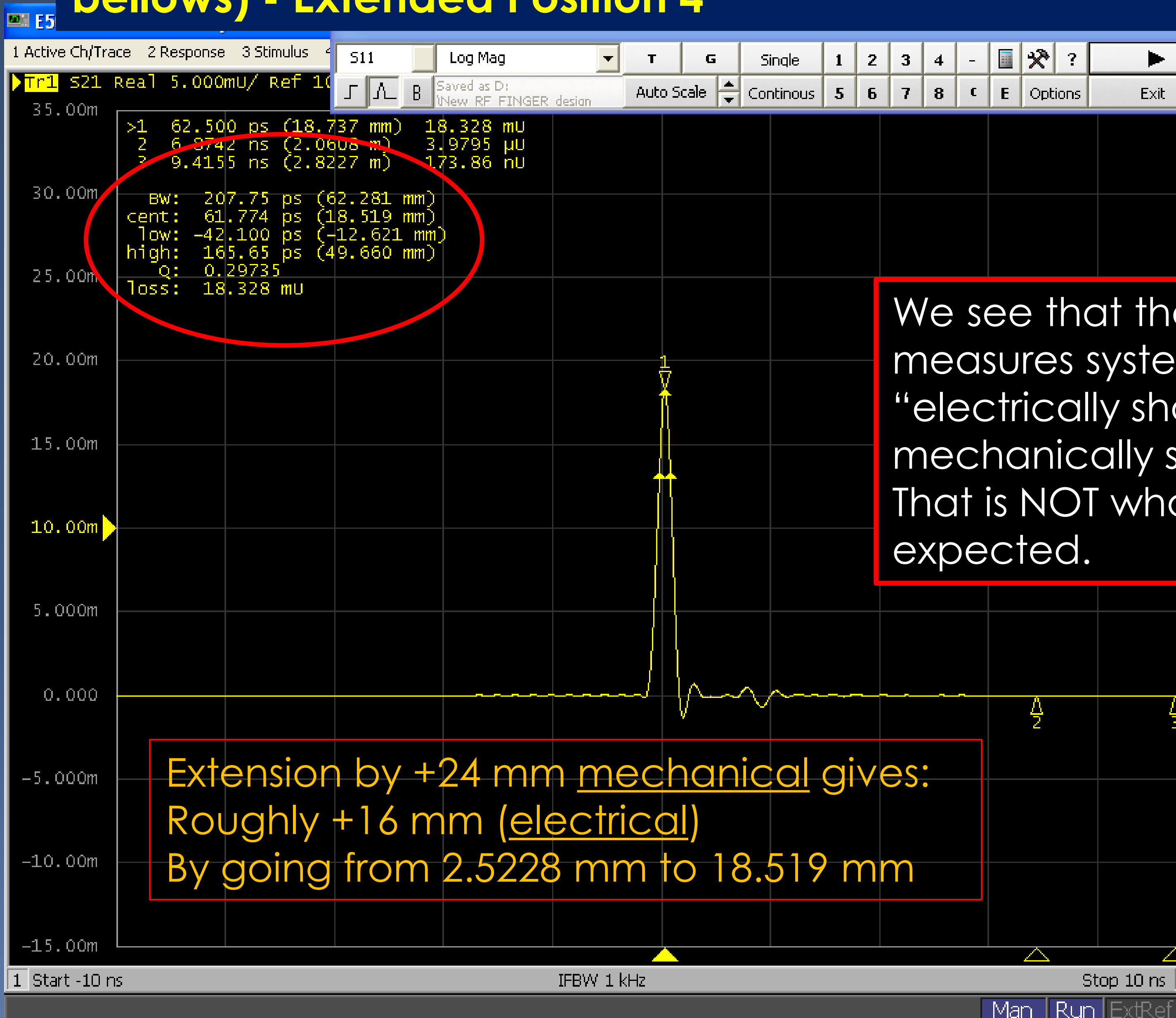
Extension by +10 mm mechanical gives:
Roughly +5 mm (electrical)
By going from 2.5228 mm to 7.4683 mm

Results of 2-convolution RF-fingers (measured WITH outer bellows) - Extended Position 2



Extension by +15 mm mechanical gives:
Roughly +9 mm (electrical)
By going from 2.5228 mm to 11.336 mm

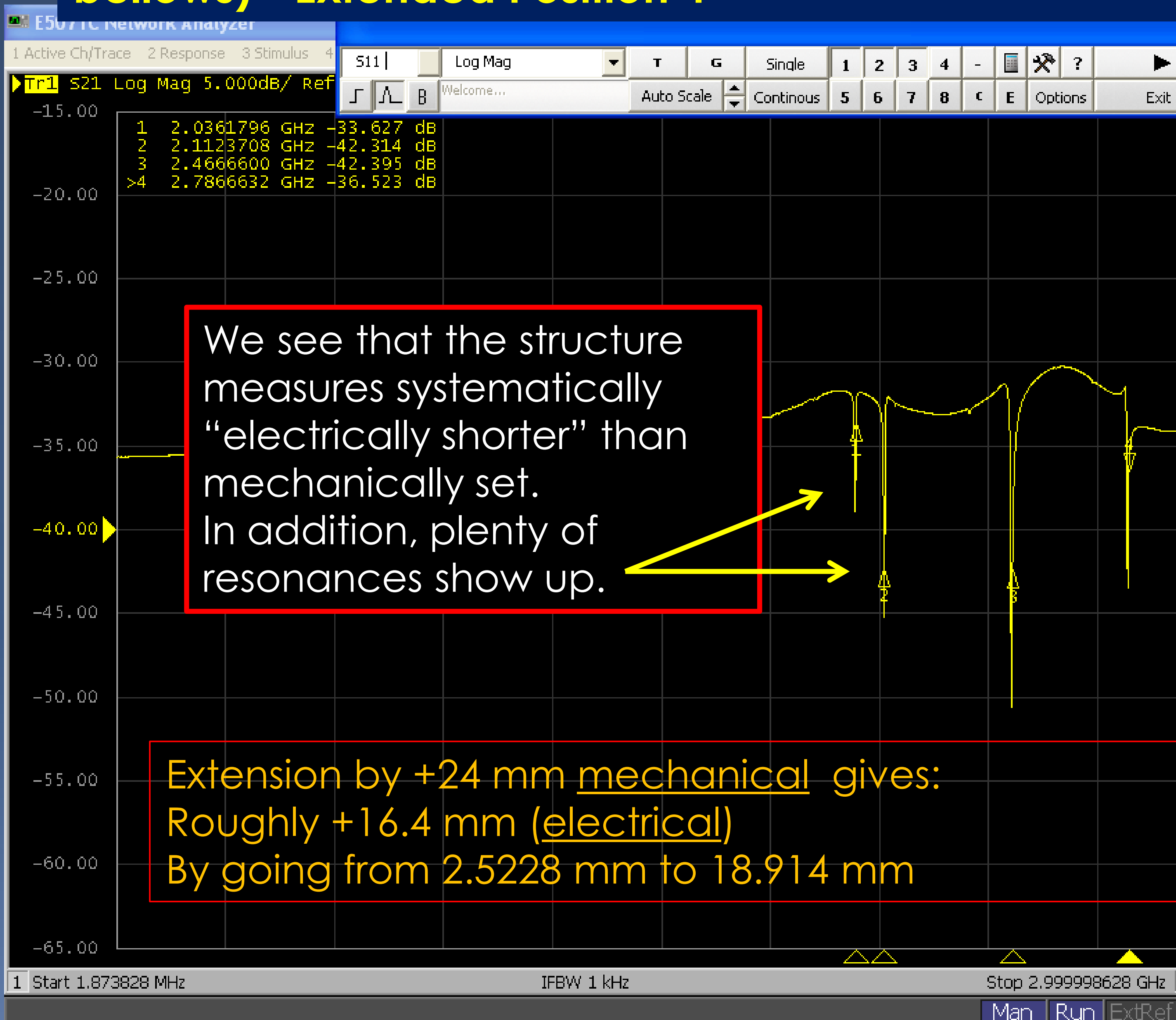
Results of 2-convolution RF-fingers (measured WITH outer bellows) - Extended Position 4

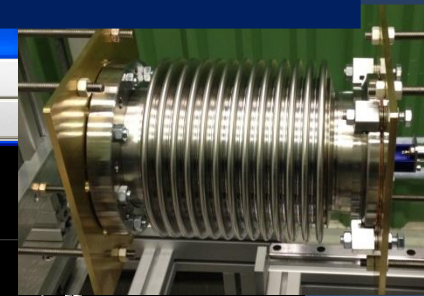


We see that the structure measures systematically "electrically shorter" than mechanically set.
That is NOT what we expected.

Extension by +24 mm mechanical gives:
Roughly +16 mm (electrical)
By going from 2.5228 mm to 18.519 mm

Results of 2-convolution RF-fingers (measured WITH outer bellows) - Extended Position 4





We see that the structure measures systematically “electrically shorter” than mechanically set.
In addition, plenty of resonances show up.

Extension by +24 mm <u>mechanical</u> gives:
Roughly +16.4 mm (<u>electrical</u>)
By going from 2.5228 mm to 18.914 mm

Results of 2-convolution RF-fingers (measured WITH outer bellows)

- The measured difference between electrical and mechanical length can be directly expressed as a change in signal phase with an equivalent electrical delay.

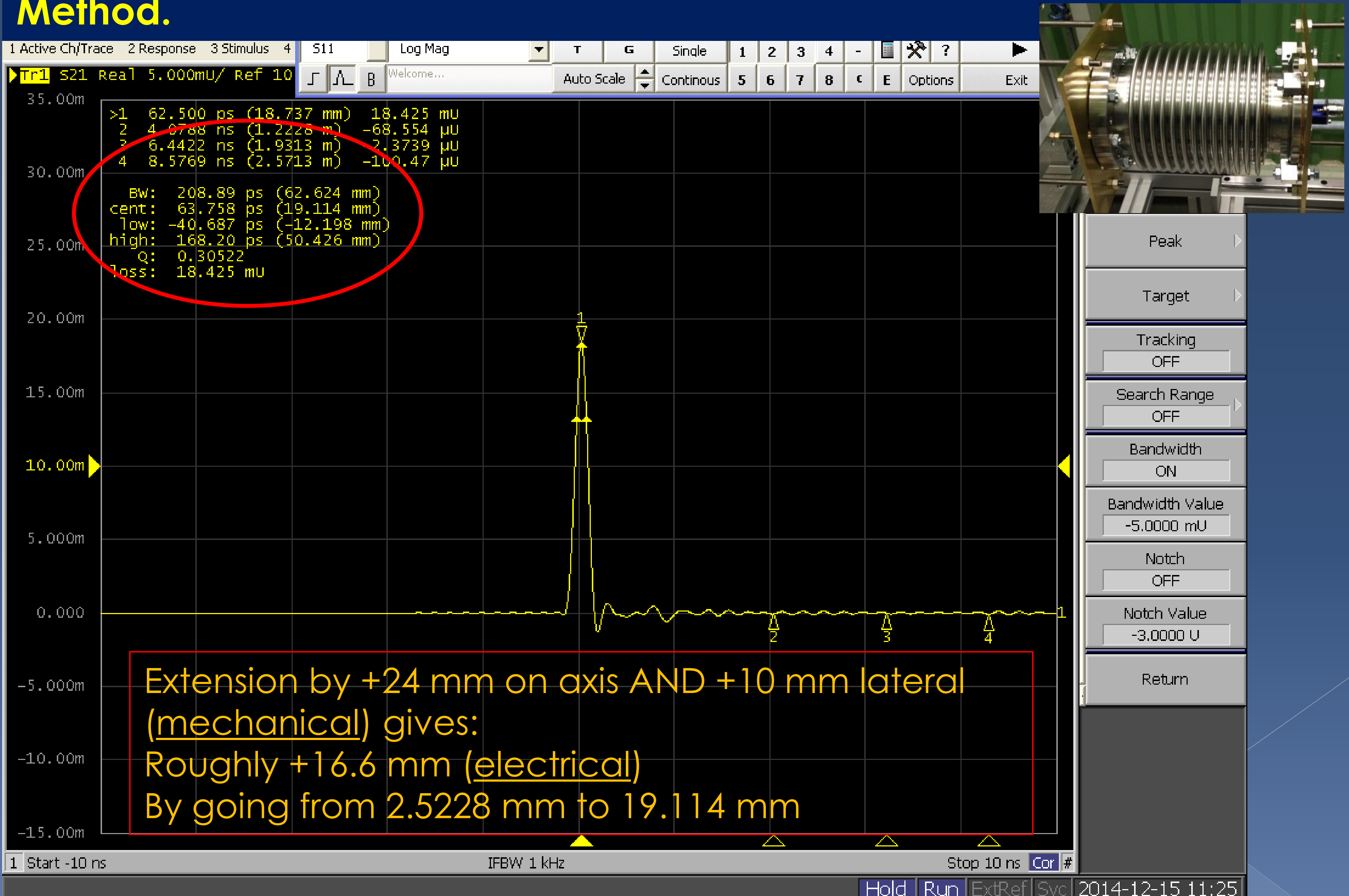
- This electrical delay can be attributed to the imaginary part of an impedance arising from the observed resonances that are located at higher frequencies.

- **This might become a show-stopper for these type of RF-fingers.**

- Simulations of the structure are required (and have been started in ABP by K. Sjobaek and B. Salvant), but these thin RF-fingers are extremely difficult to handle in EM-codes.

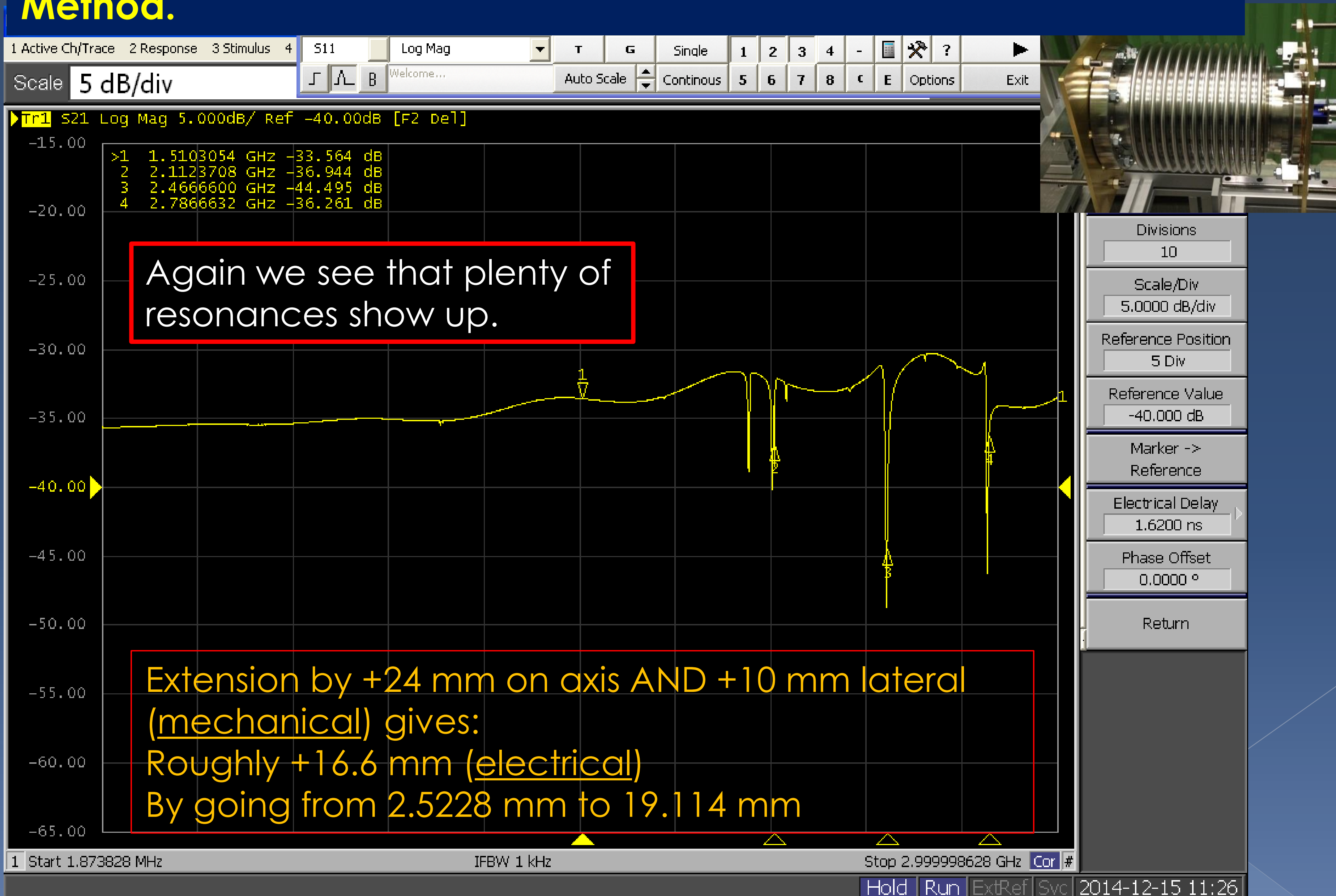
- **STILL: we need these simulations!**

2nd Part: Also Lateral Movements can be Evaluated with this Method.



Extension by +24 mm on axis AND +10 mm lateral (mechanical) gives:
Roughly +16.6 mm (electrical)
By going from 2.5228 mm to 19.114 mm

2nd Part: Also Lateral Movements can be Evaluated with this Method.

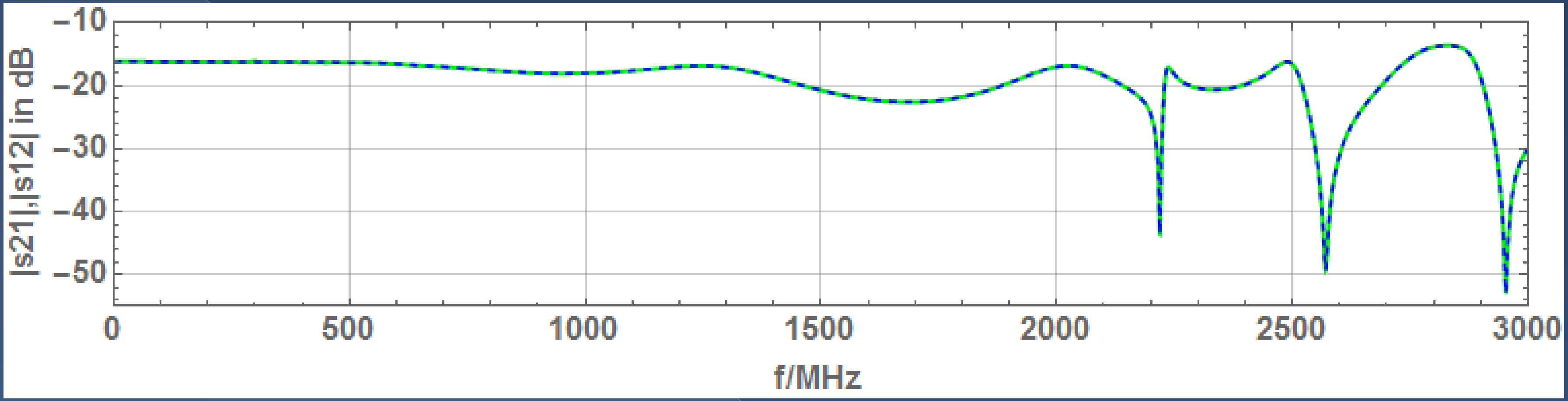


Again we see that plenty of resonances show up.

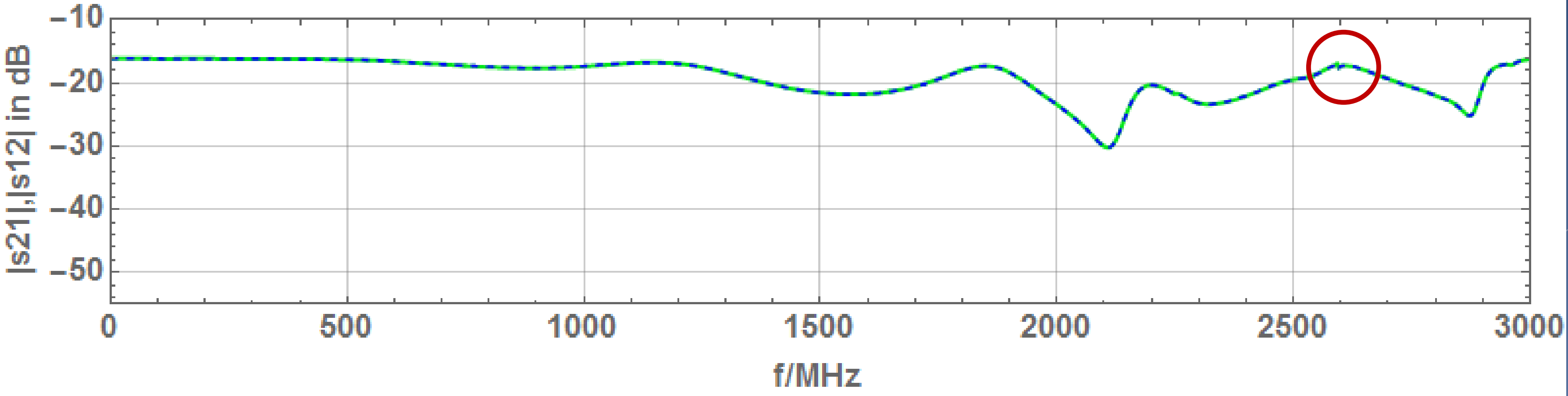
Extension by +24 mm on axis AND +10 mm lateral (mechanical) gives:
Roughly +16.6 mm (electrical)
By going from 2.5228 mm to 19.114 mm

Additional Problem: Results of 3-convolution RF-fingers

Measurements without bellows mounted

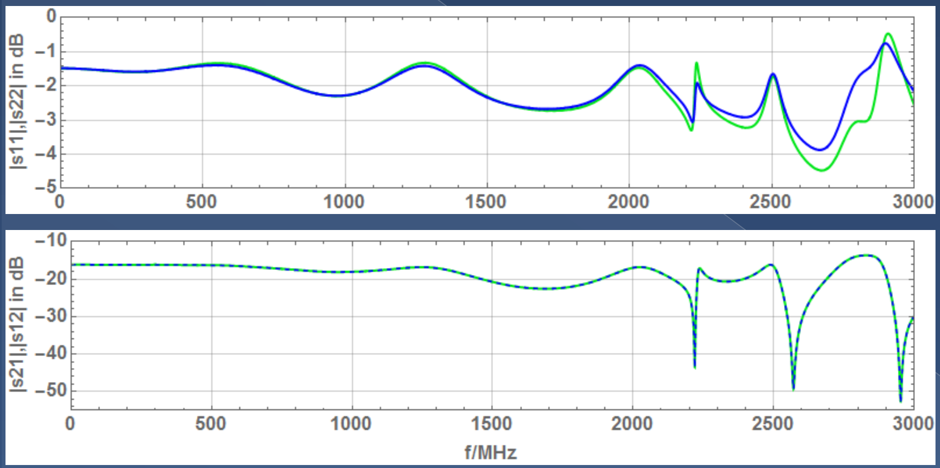


Measurements **with** bellows mounted

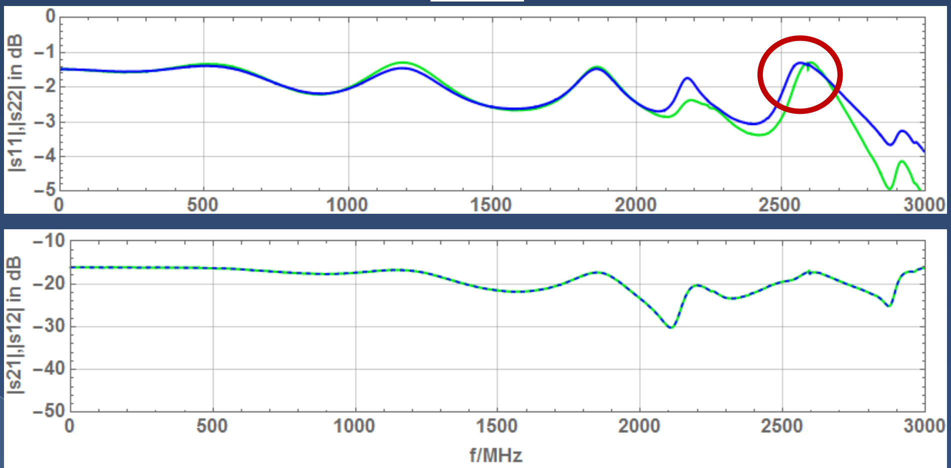


Additional Problem: Results of 3-convolution RF-fingers

Measurements without bellows mounted



Measurements **with** bellows mounted



- Problem is that the resonances WITH bellows for the 3 convolution RF-fingers become very weakly coupled. Only small dips remain visible.

- This is not yet understood. We hope that we can learn from the simulations in this case!

We need these simulations!

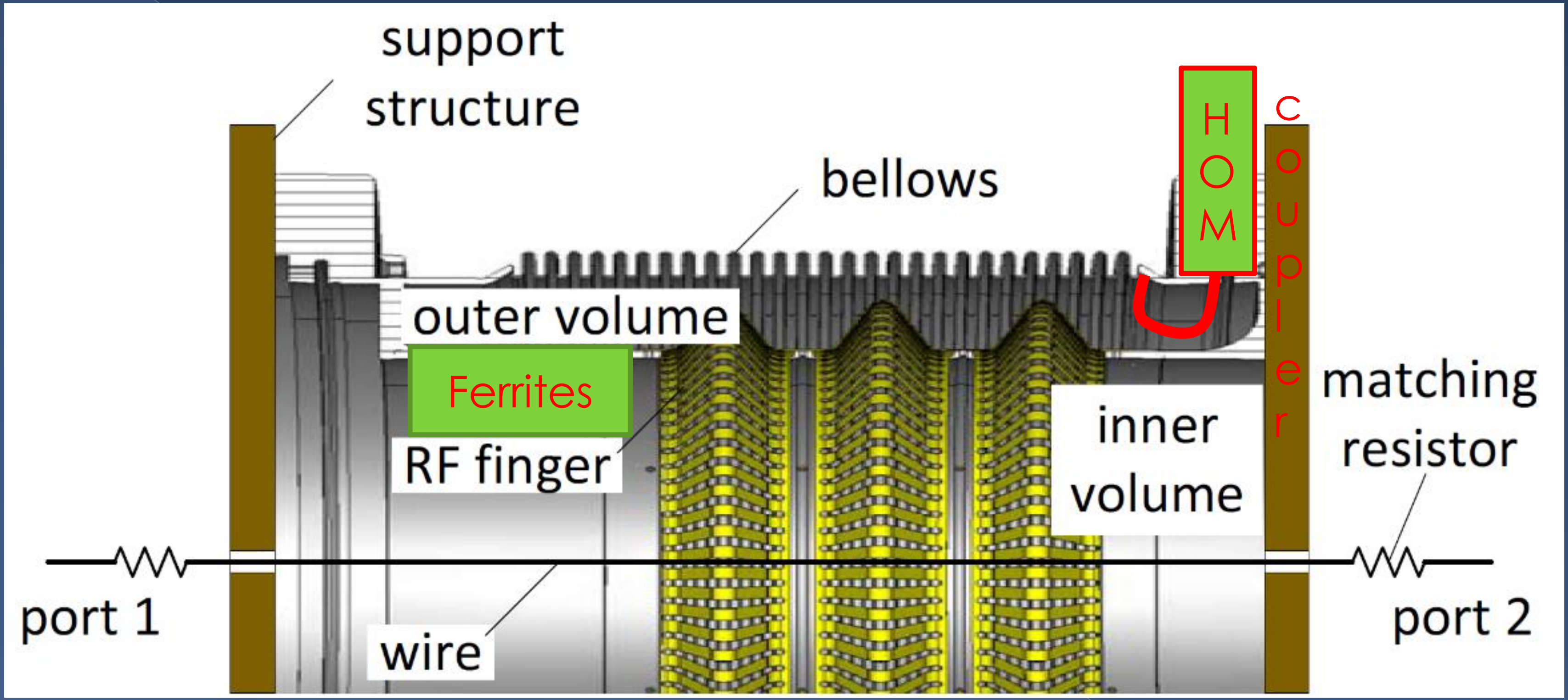
CONCLUSIONS & Next Steps

- For the 2-convolution RF-fingers, the measurements are very well understood. The new method works very well.
- We observe that high-Q resonances build up in the outer volume of the structure.
- It has to be evaluated, how critical these resonances are for beam impedance.

- For the 3-convolution RF-fingers, we also see resonances in the outer volume, but the coupling of these resonances drops to very low values if the bellows are mounted.
  This makes the evaluation of the resonances very difficult and the reason for this behaviour is not yet fully understood. We hope that we can learn from the simulations in this case!

We need these simulations!

Next Steps - Mitigation



If the high-Q resonances from the outer volume pose a problem, we propose to consider damping in-situ with absorbers or with a small HOM coupler.

Thank you for your attention!