SPS Enamelled flanges Simulations & Measurements Update

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Outline

- Introduction
- Simulations
- Measurements
- SPS BCTs
- Next Steps
- Conclusions

Introduction

- We keep tracking the, possibly, 1.4GHz microwave instability in the SPS.
- A new approach to the impedance calculation has been adopted.
  - Very promising results have been obtained
  - Only preliminary results will be shown today
- Convincing measurements have been obtained.
  - We can do it better

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- Introduction
- Simulations
  - Eigenmode Simulations
  - Frequency domain simulations
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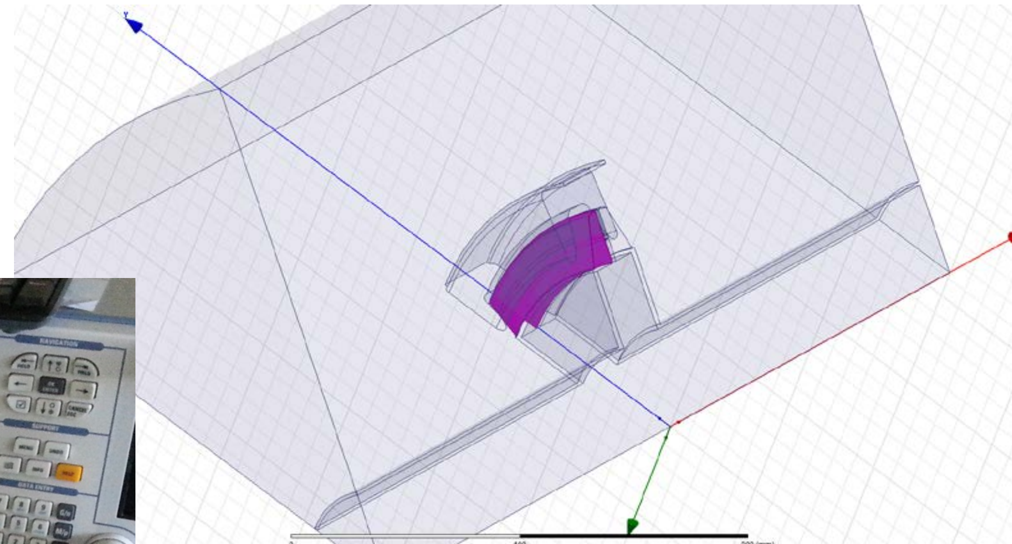
Simulations

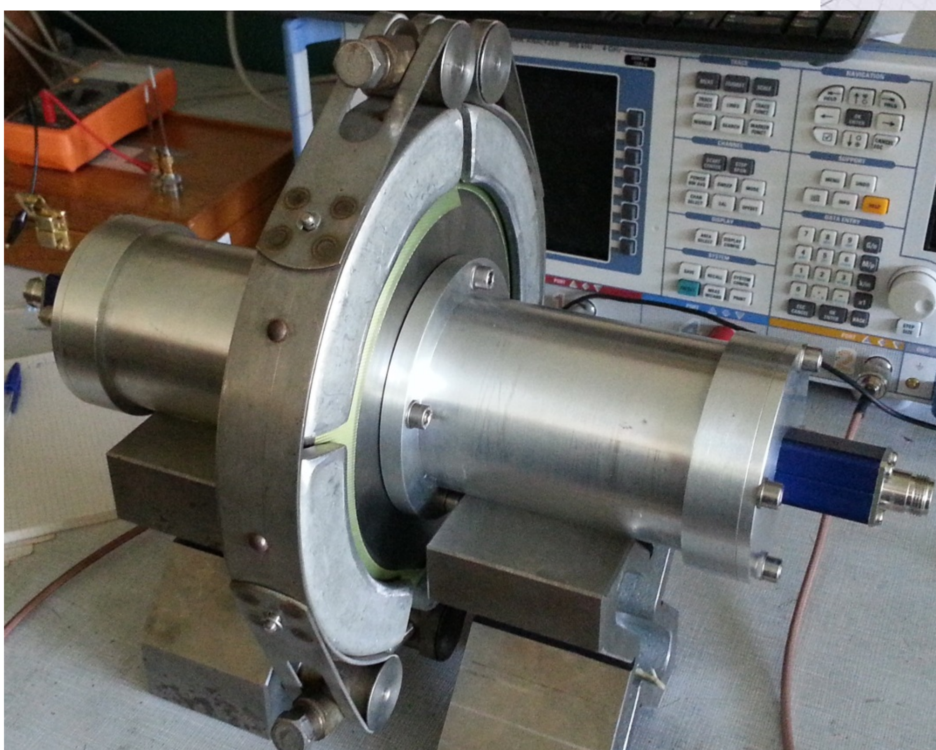
- After consulting the impedance group a new approach to the impedance calculation has been embraced.
  - Eigen-mode simulations (time consuming manual post-processing)
    - Structure closed by PEC
    - Structure closed by PMC

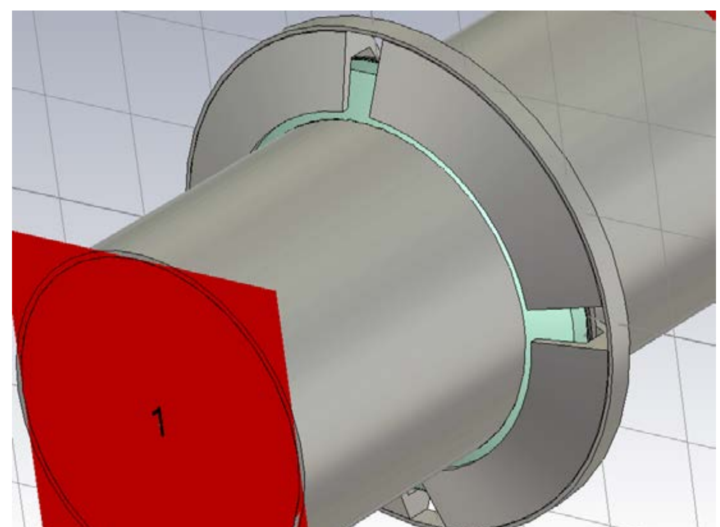
    Common resonances are boundary independent.
  - Frequency domain simulations (as suggested by A. Grudiev).
    - Accurate results
    - Radiation boundary conditions are used.
    - Beam loading taken into account
    - Time-consuming simulation – Narrow-band Analysis

Simulations

- The frequency domain simulations required to build the model in HFSS







Simulations - Eigenmodes

The enamelled flanges are open structures.

To run a eigenmode simulation we have to close the structure.

Closing the structure creates additional eigenmodes.

We simulate the structure under PEC and PMC boundary conditions.

Common eigenmodes are boundary independent and, thus belong to the structure and are not spurious solutions.

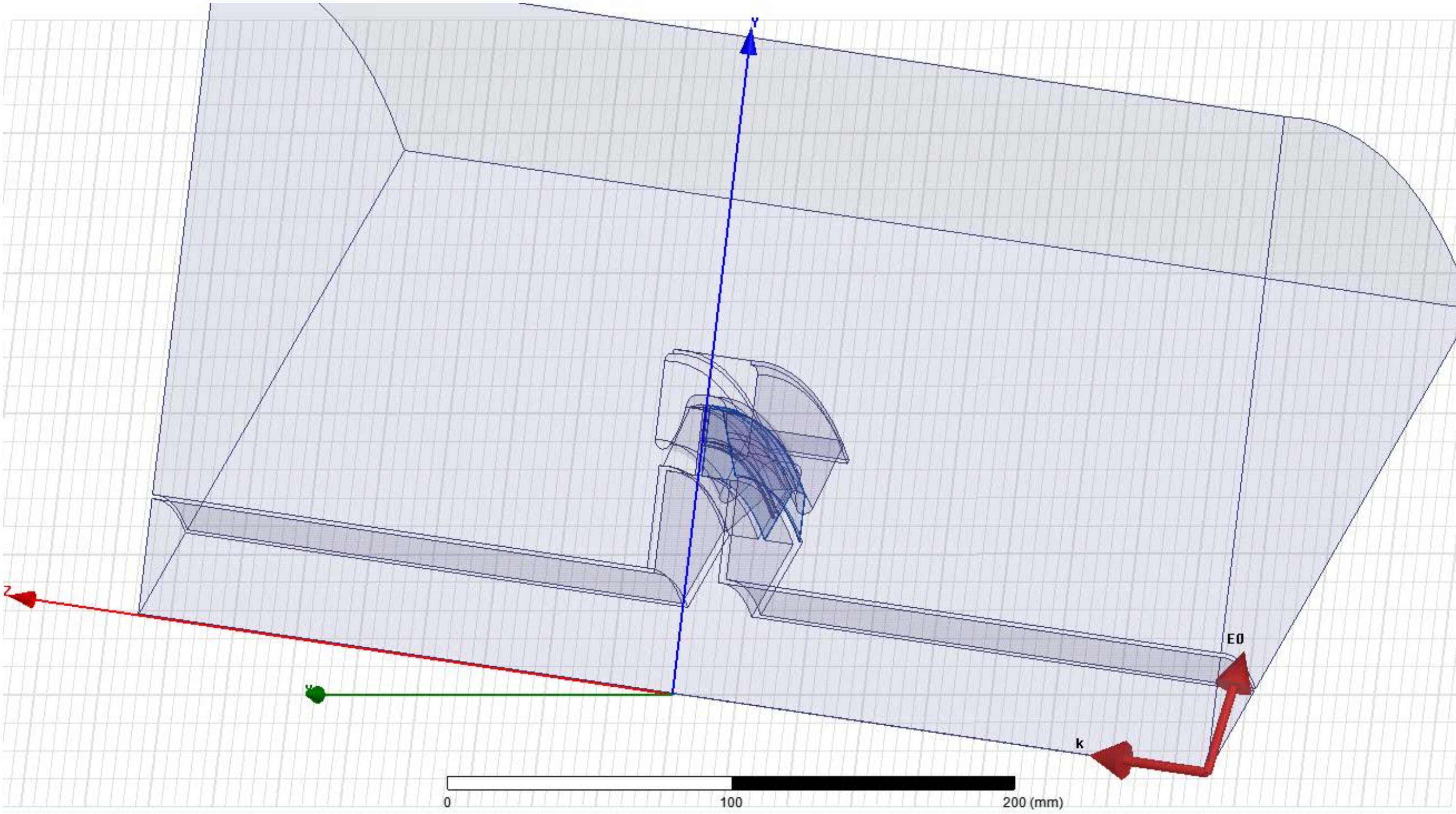
Simulations - Eigenmodes

Modes enclosed by PMCs	Freq. [GHz]	Q	Num. of half-wave variations in ϕ
1	1.5356	2860	0
2	1.5635	929	0
3	1.6470	3273	>0
4	1.6568	314	>0
5	1.771	2696	0
6	1.875	460	>0

Modes enclosed by PECs	Freq. [GHz]	Q	Num. of half-wave variations in ϕ
1	1.5371	1098	0
2	1.5500	3400	0
3	1.6437	540	>0
4	1.6595	600	>0
5	1.7670	1615	0
6	1.8687	400	>0

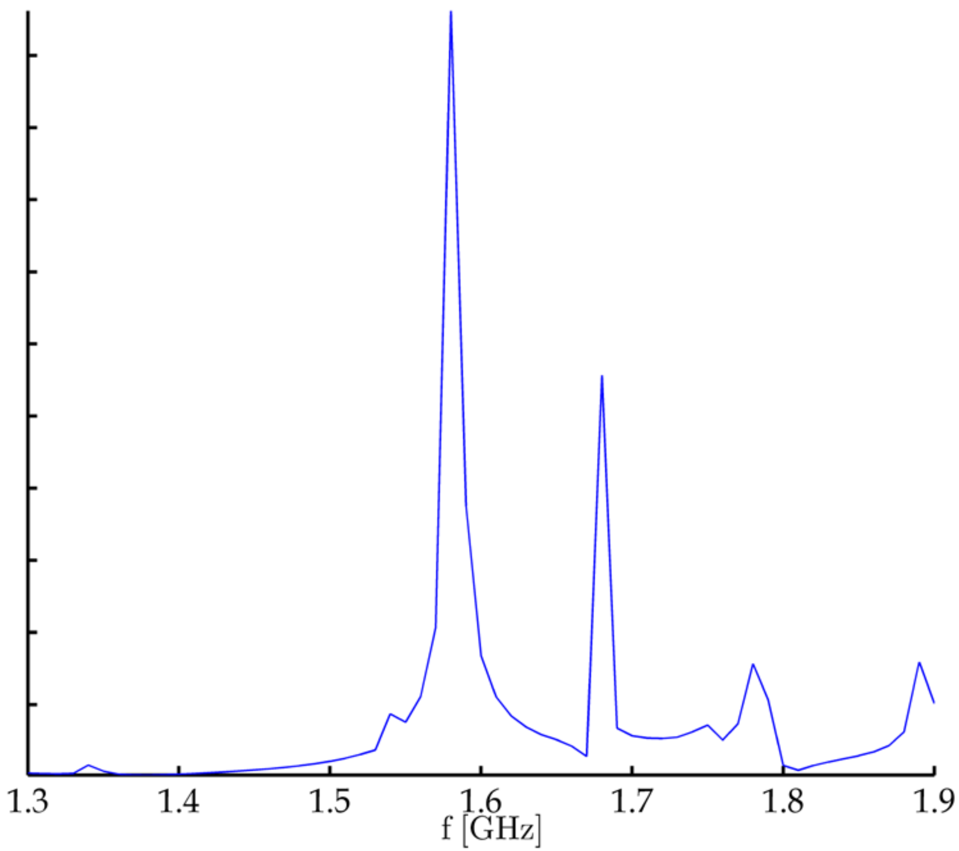
Simulations – Frequency Domain

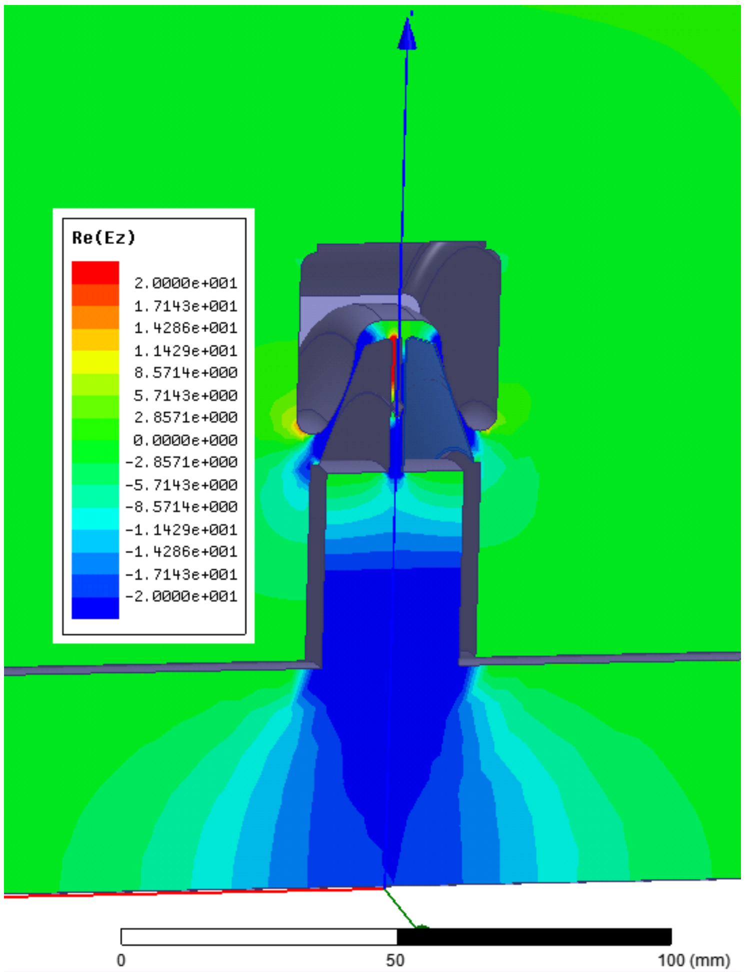
- Suggested by A. Grudiev.
- Method used to model the transient beam-loading in CLIC
- Structure excited by a plane wave travelling along the z axis.
- Usage of radiation boundaries



Simulations – Frequency Domain

Preliminary results correlate with the eigen-mode simulations





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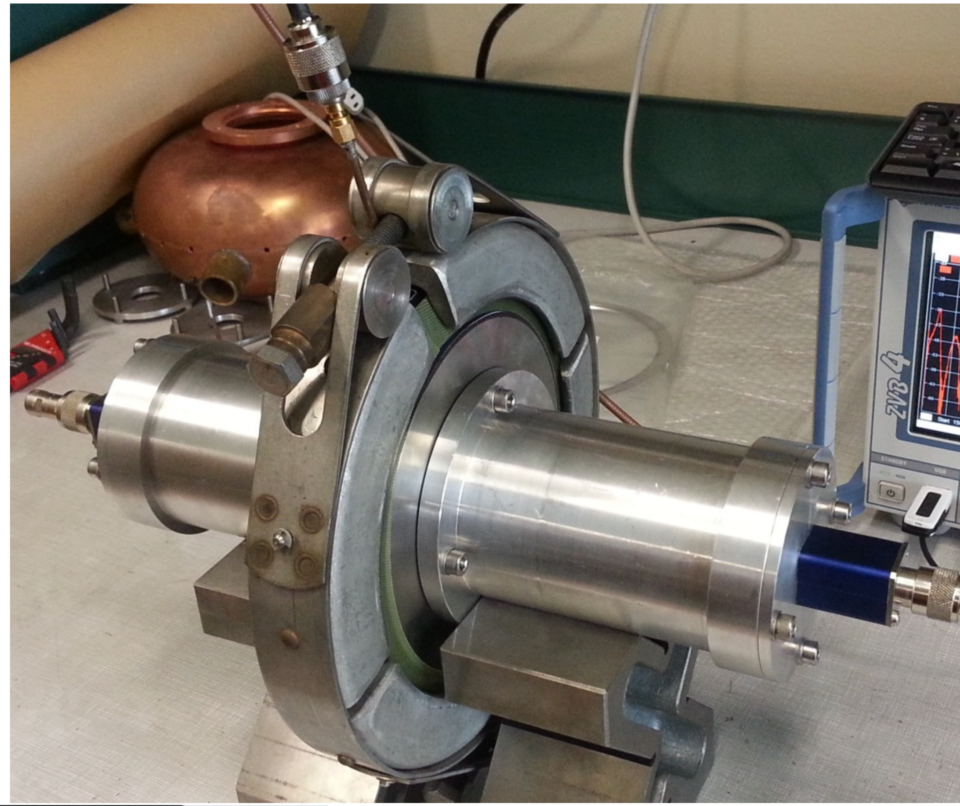
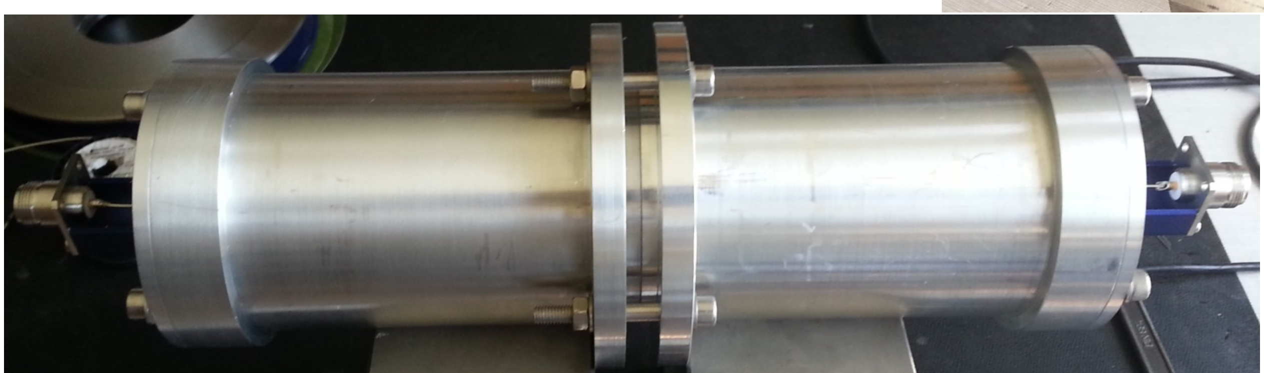
Measurements – ‘Naked’ Flange

We have attached two QD beam pipes to the enamelled flange provided by the vacuum group.

The structure is not too close to reality due to mechanical limitations.

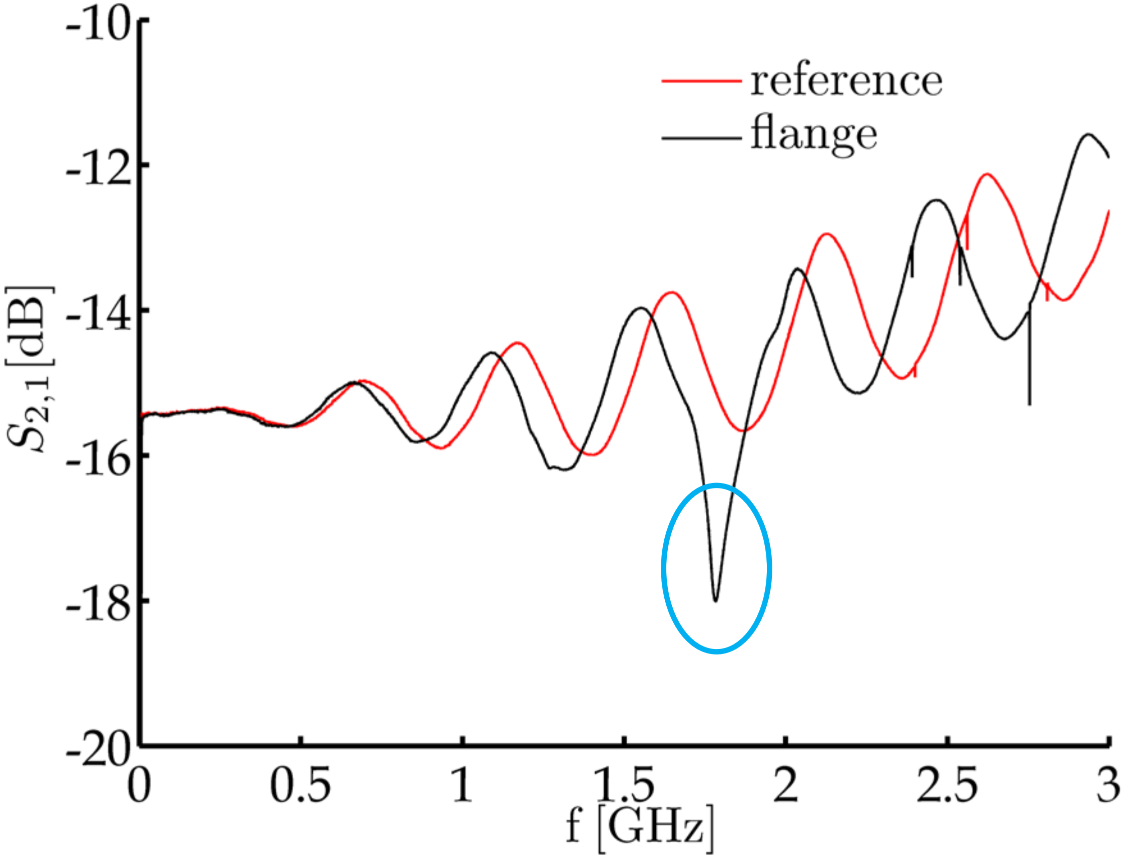
With the present set-up we cannot measure the impedance of the resonance of interest. However, we can assess its presence.





Measurements carried out with the help of Andrea Mostacci (Assistant professor at ‘La Sapienza’ University, Rome)

Measurements – 'Naked' Flange



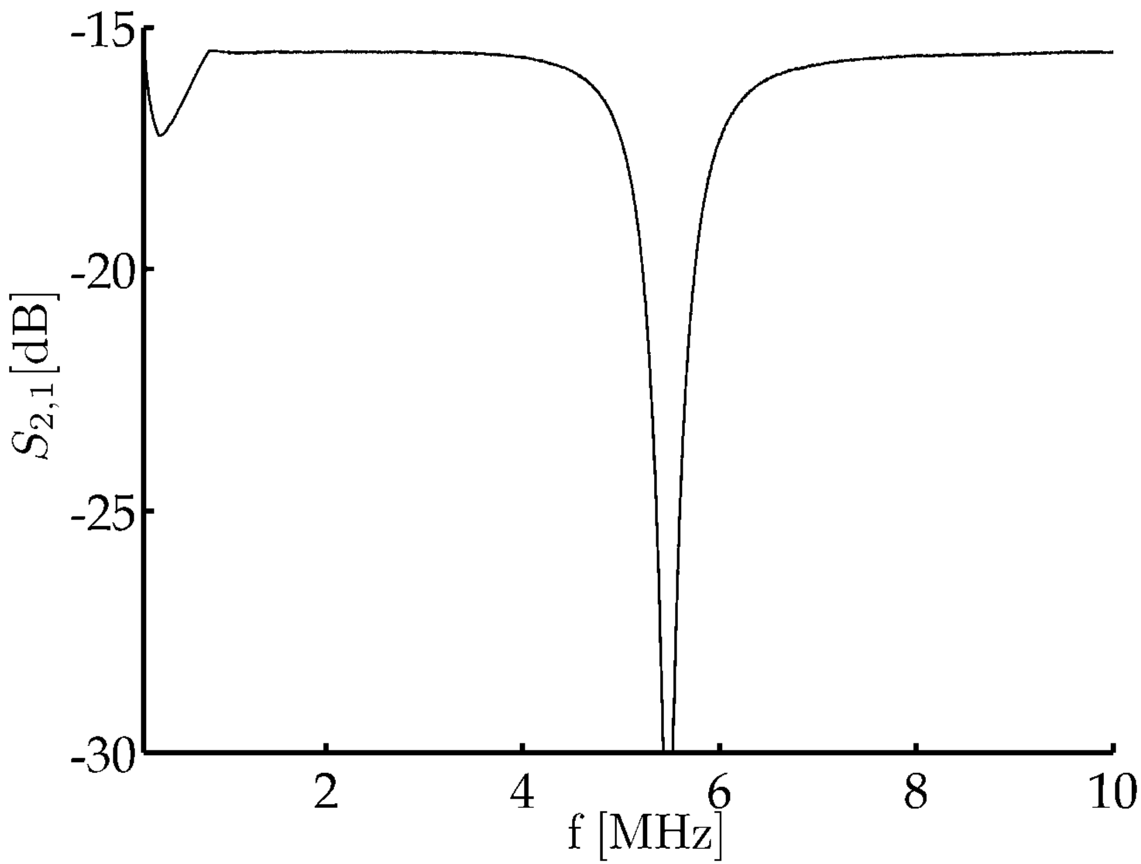
The resonance is barely distinguishable.

- The 'cavity' between flanges is shorter than in reality.
- The reference line length is shorter than the flange set up.

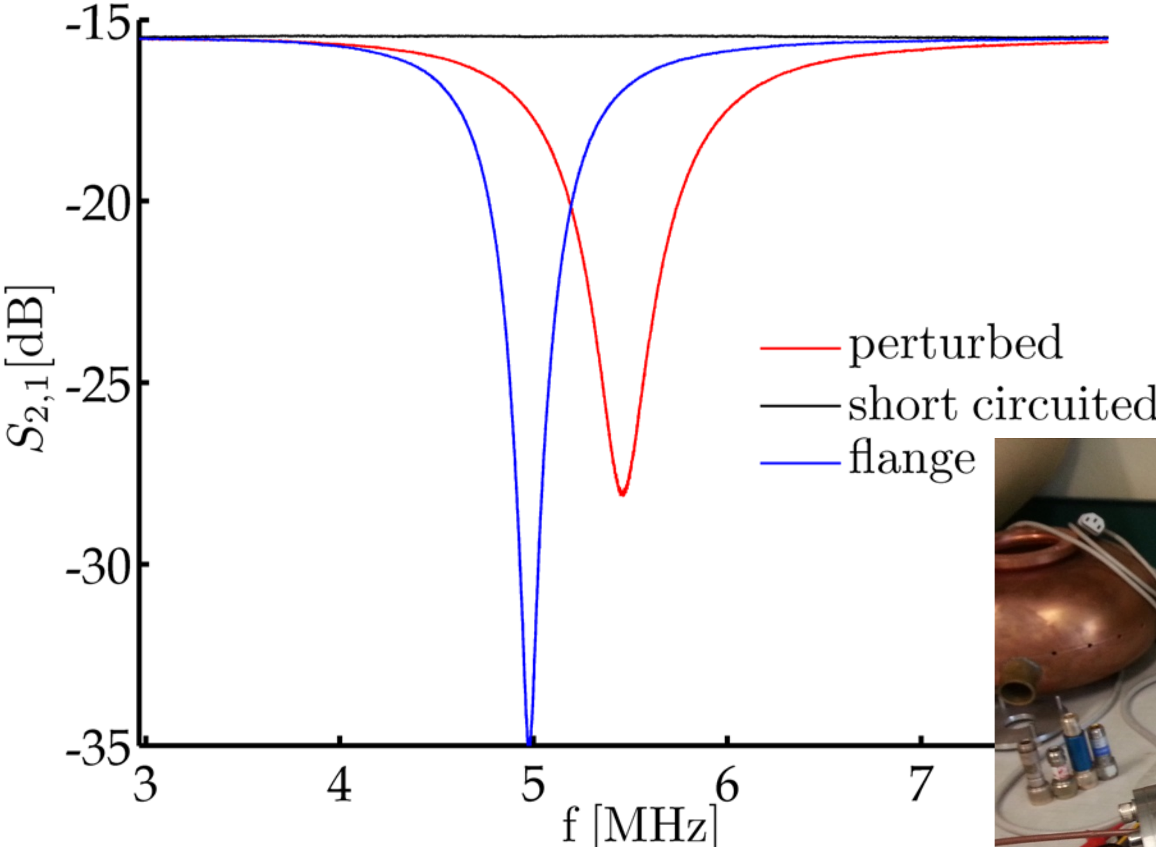
Simulations confirm the measured lower impedance and frequency shift.

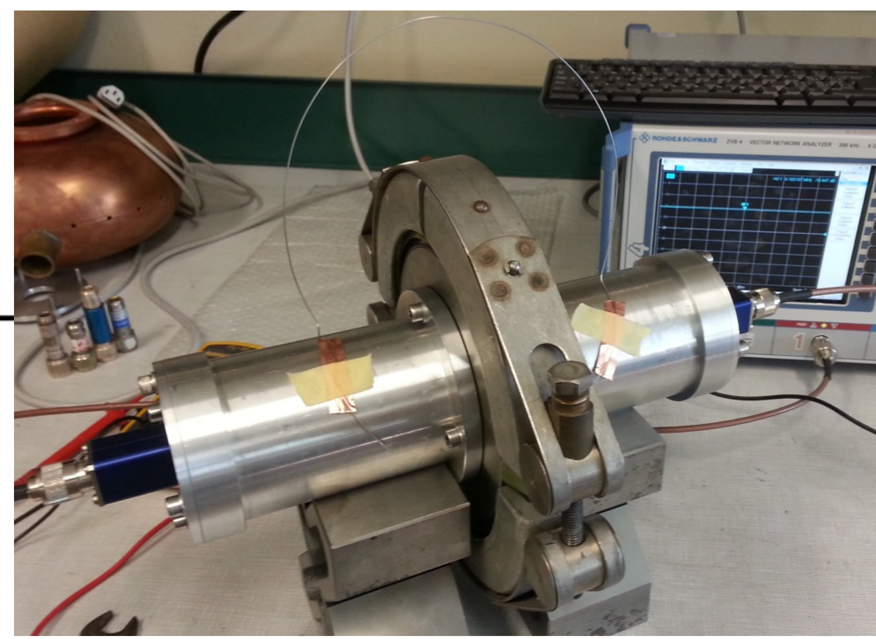
Measurements – 'Naked' Flange

Low Frequency behaviour of the enamelled flange



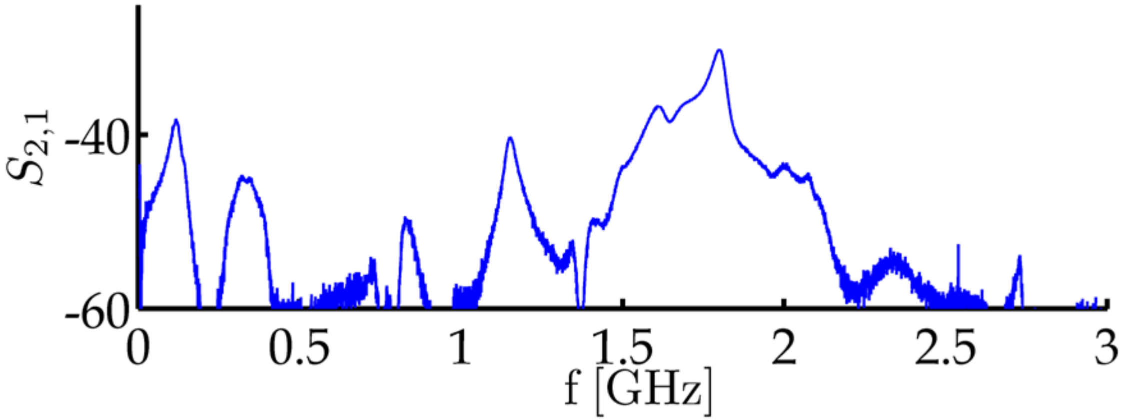
Measurements – 'Naked' Flange

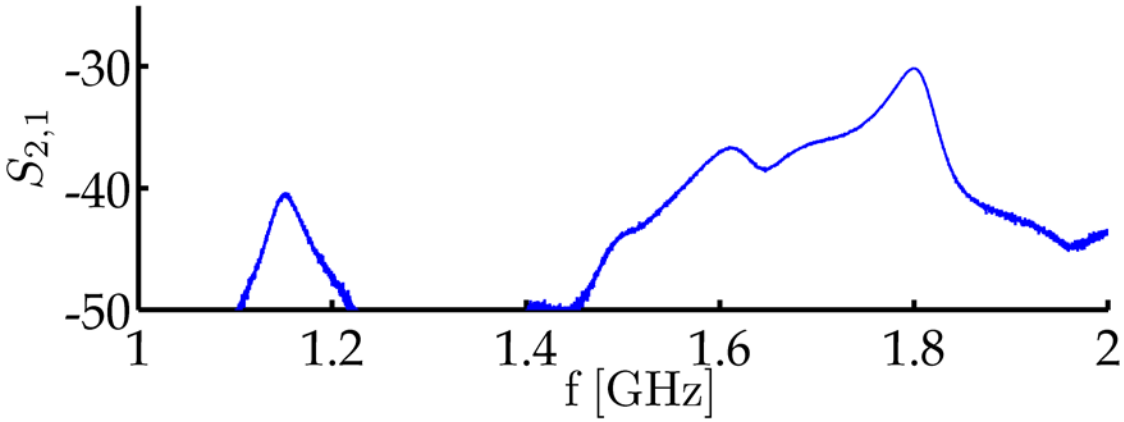


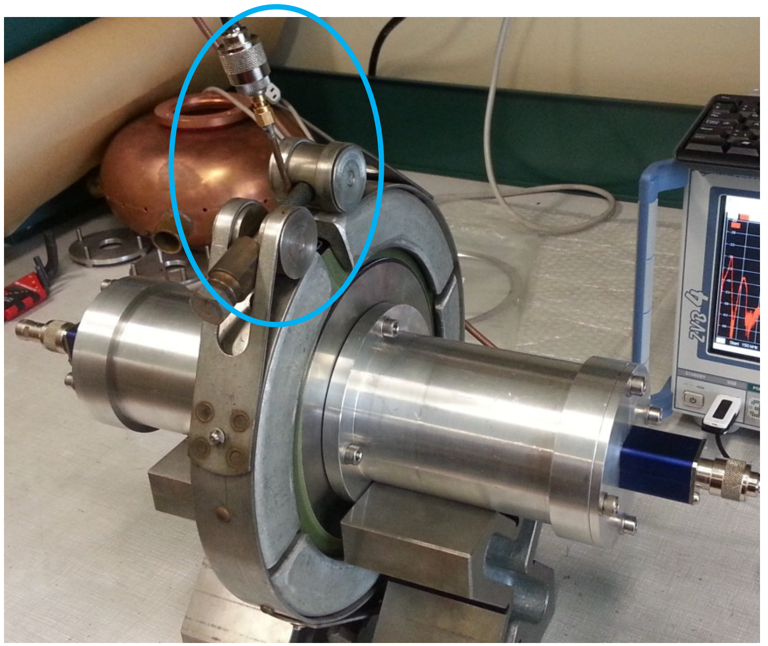


Measurements – 'Naked' Flange

Transmission measurement between the wire and an outer coaxial probe.





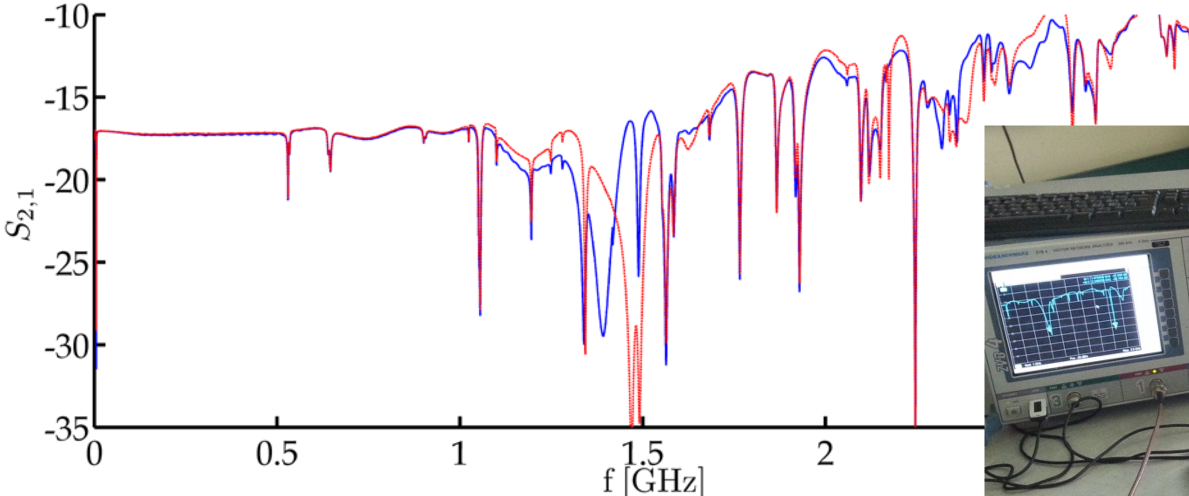


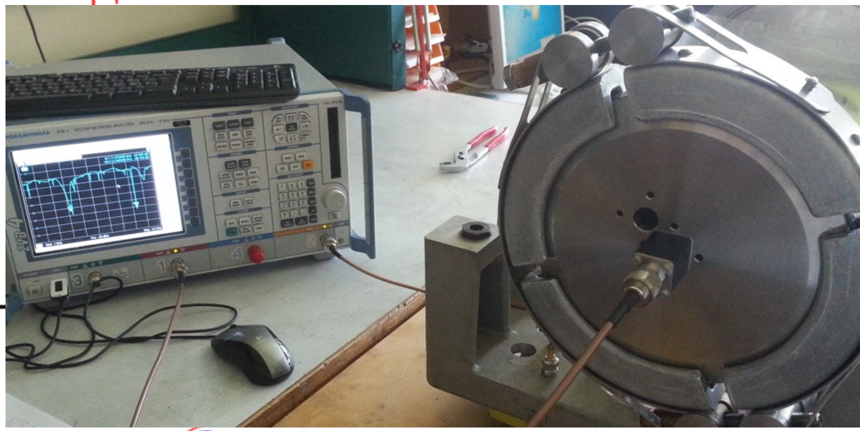
The inner conductor of the probe is touching the gasket.

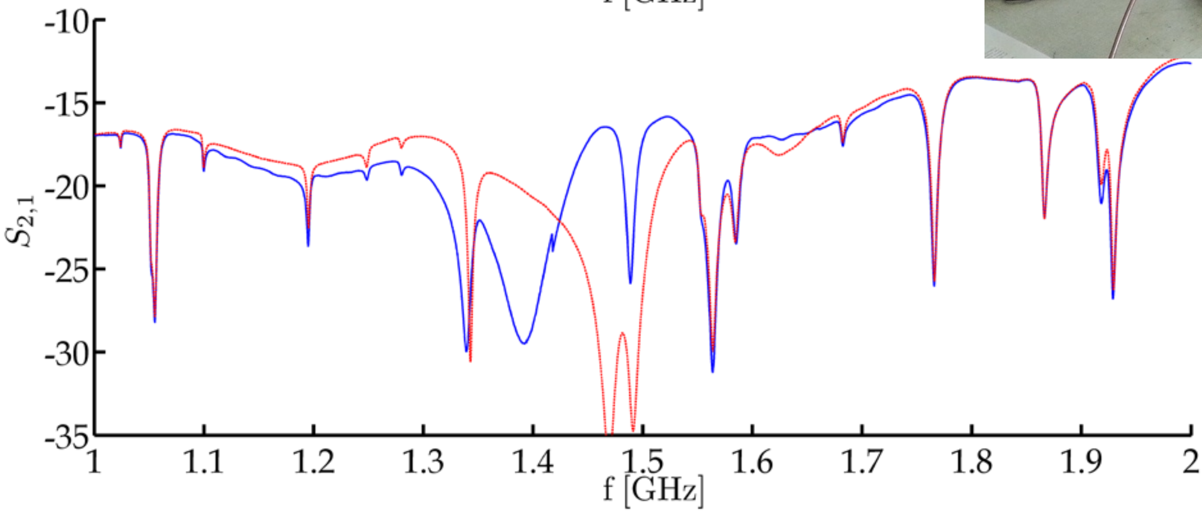
Measured Q around 50.

Measurements – BPH

In addition to the previous measurements, a second set of measurements were carried out in the complete BPH available in the lab.







A cleaner version of this measurement is under preparation.

Measurements

Good enough?

We still have room for improvement.

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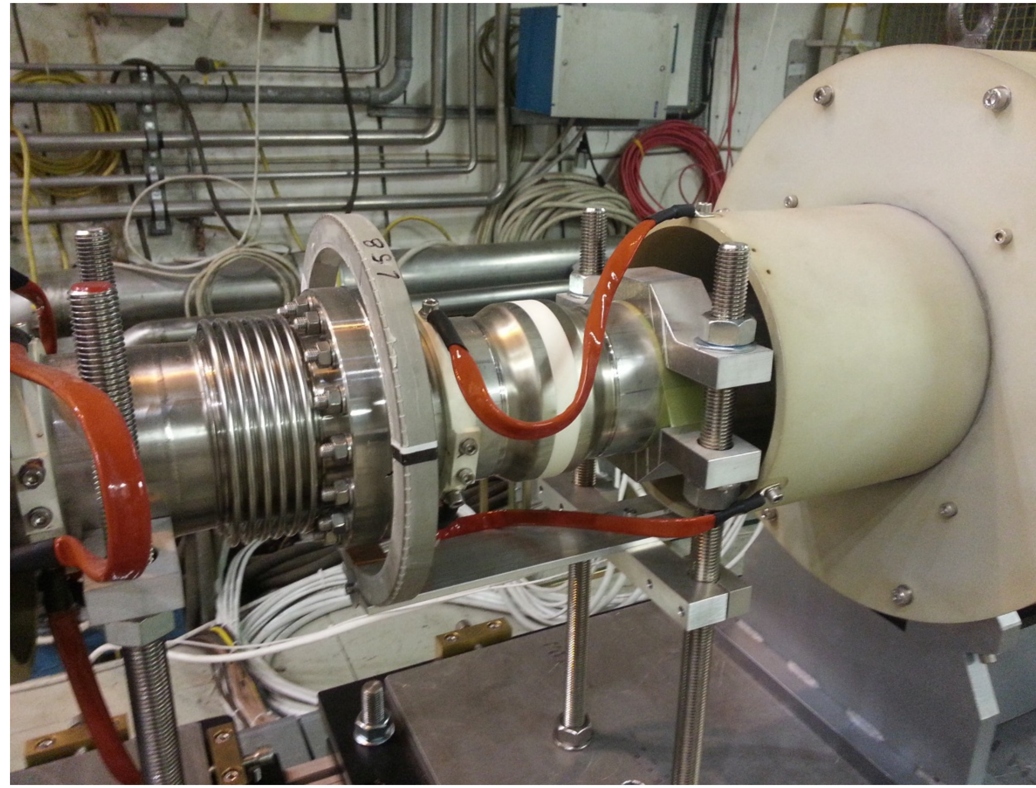
SPS BCTs

Two BCTs were found in LSS5.

After some research, Benoit found that there are five of these in the SPS.

Three installed in 1999 and the two in LSS5 installed in June 2012.

The ceramic ring in coated with a 30nm titanium metallization.



The impedance of these devices is unknown.

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Next Steps

- Simulations: Carefully implement the post-processing routines needed to compute the impedance and R/Q of the flanges.
- Measurements: Prepare the ‘cleaner’ BPH measurement.
  - Improve the ‘naked’ flanged setup?
- Complete a general survey of impedance dangerous elements in the machine (i.e. BCTs, unshielded pumping ports, etc.).
- Complete the ‘Thomas Bohl’: Flange counting and classification according to layouts.

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Conclusions

- We now have consistent simulation results.
  - Big step forward from the previous 'each-simulation-gives-a-different-impedance' state.
- We have measured the resonance predicted by simulations. The BPH measurement clearly showed a high impedance in the flange + below region.
- A dangerous element (BCT) has been found in the tunnel. The impedance of the device is unknown.

- Big step forward since last meeting. Still much work to be done.