PhD29:
Wire measurements

Laura Karina Pedraza, Nuria Fuster, Daniel Esperante, Benito Gimeno

PhD Journal, 31/03/2026

laura.pedraza@ific.uv.es

PhD29: Wire measurements

LabRF meeting, 30/03/26

IFIC INSTITUT DE FÍSICA CORPUSCULAR

Introduction

I. Methodology
   A) Setup
   B) Coarse measurements
   C) Fine measurements
   D) Angle impact
   E) Resolution estimation

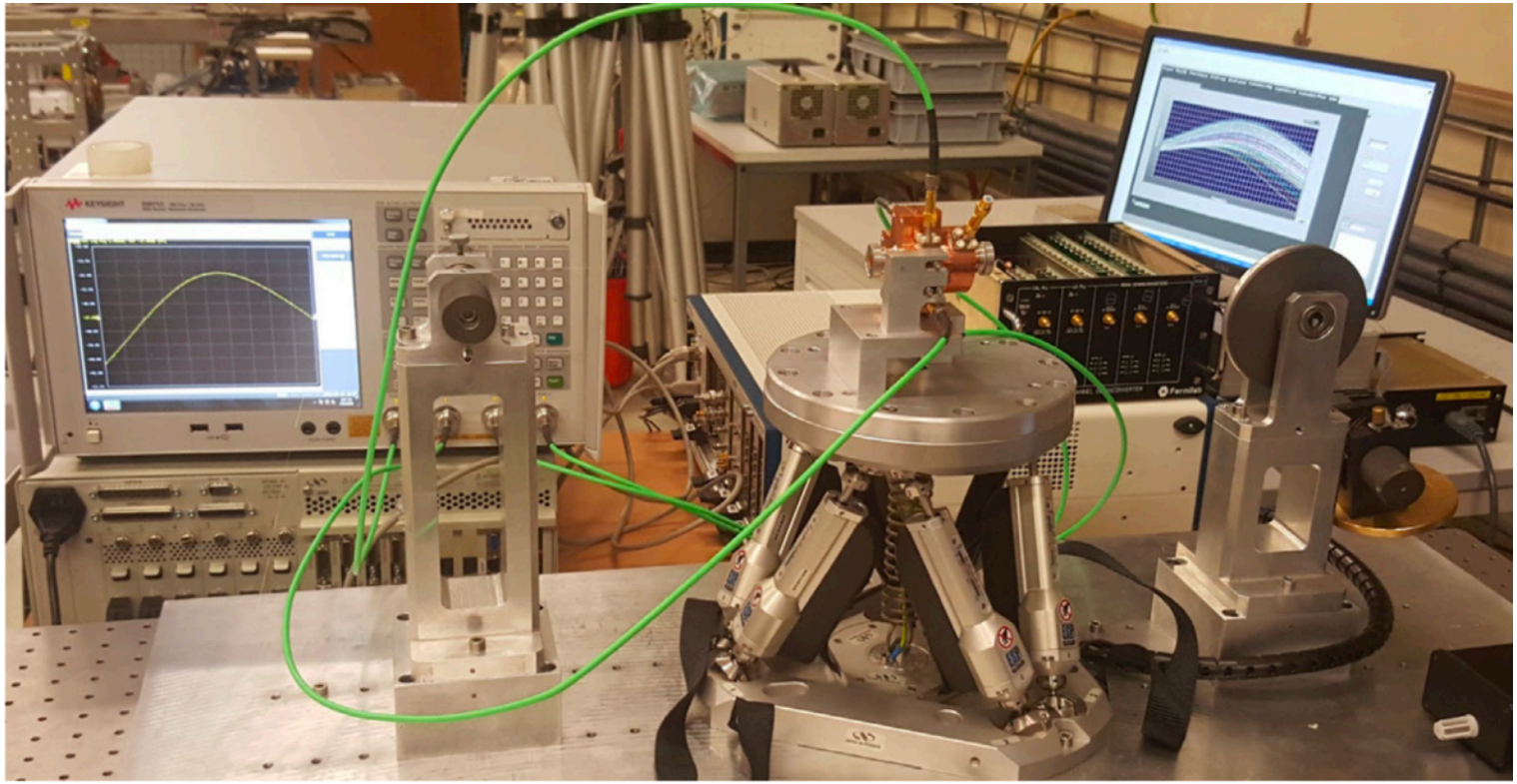
II. Preparation

Conclusion

I. Methodology

A) Setup

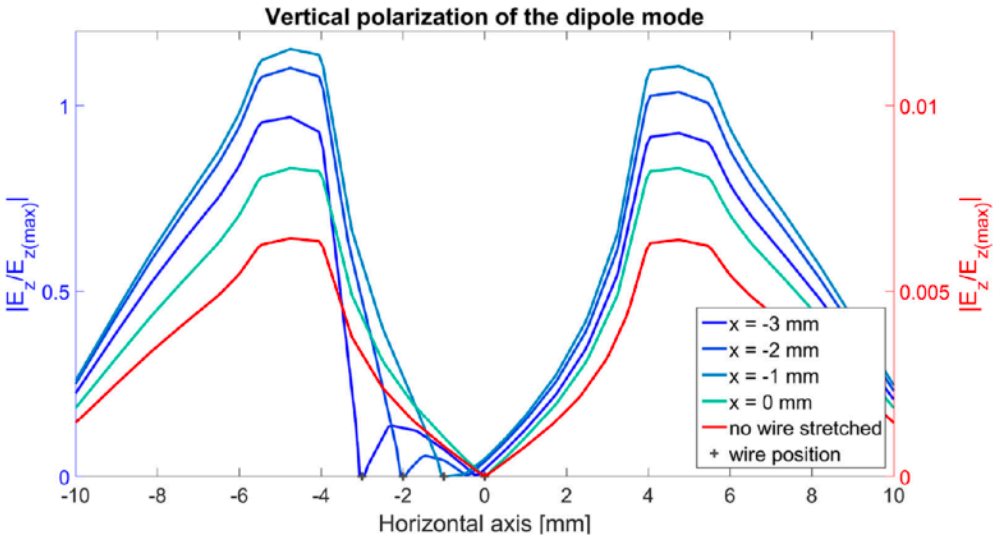
Characterization and alignment of a resonant cavity beam position monitor for the Compact LInear Collider (CLIC) project at CERN
S. Zorzetti, M. Wendt



I. Methodology

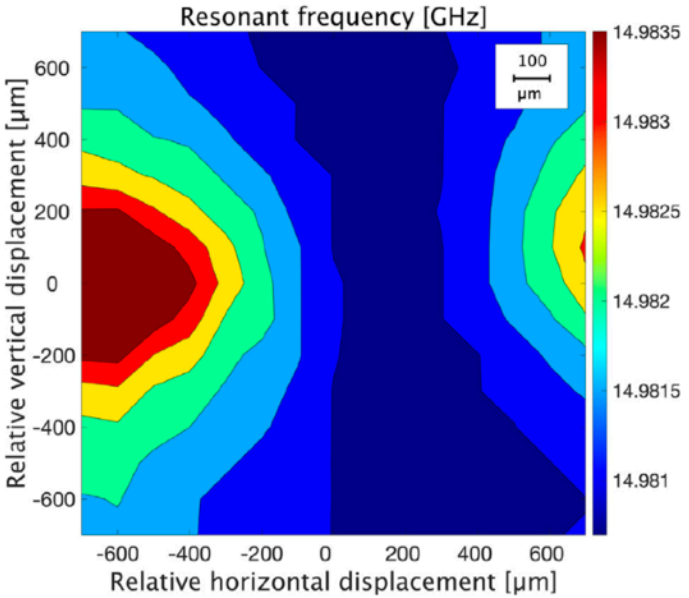
B) Coarse measurements

The wire imposes Et = 0 at the surface, imposing a change on the E field of the dipole mode



Frequency impact:

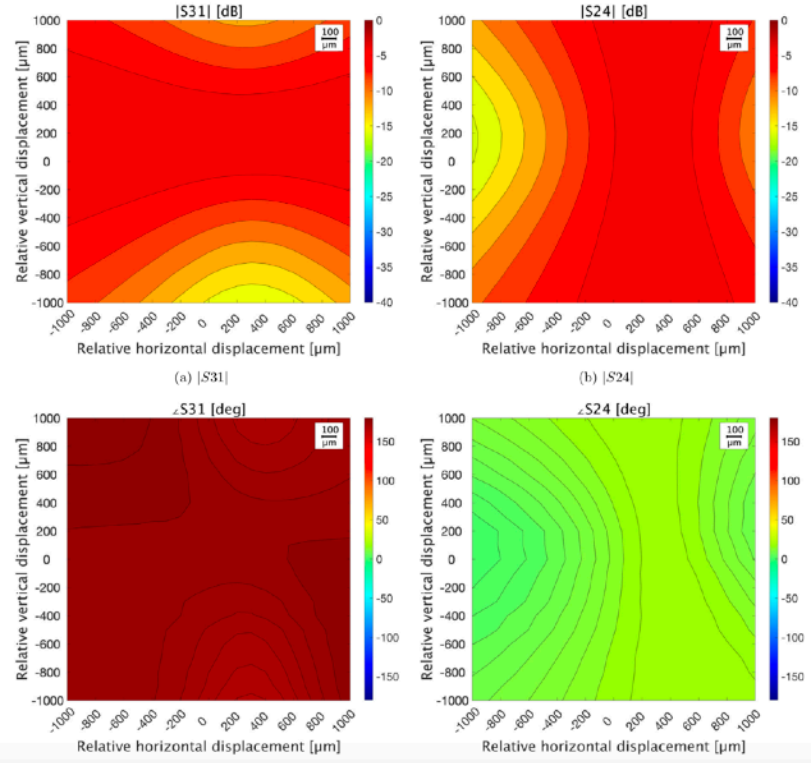
According to the Slater theorem, the wire produces a shift in frequency as well:



I. Methodology

B) Coarse measurements

Transmission between orthogonal ports:

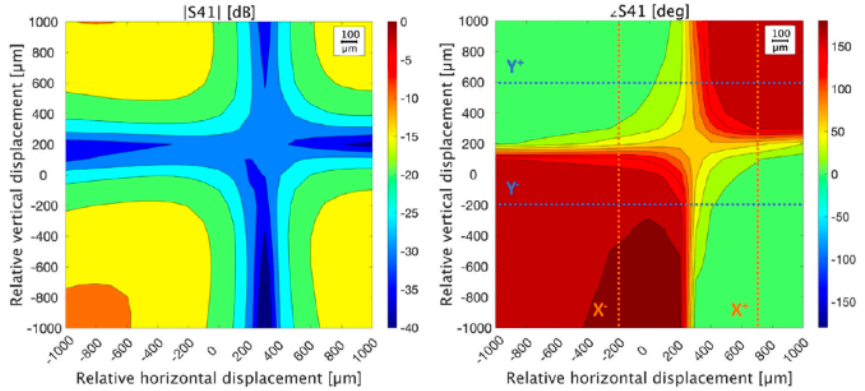


(a) $|S31|$ (b) $|S24|$

If the wire is located in the electrical center, the coupling to the electric field components is minimum, and the power transmission between those opposite ports is maximum.

Transmission between adjacent ports:

In the electrical center, the power transmission between two adjacent ports is reduced to a minimum. The phase argument 'jumps' as the wire crosses the electrical center, which offers a particular high sensitivity and resolution to locate the electrical center.



(a) $|S41|$ (b) $\angle S41$

I. Methodology

C) Fine measurements

We select two horizontal and two vertical linear scans, always with the orthogonal axis fixed, the steps are indicated as dotted lines in the graphic.

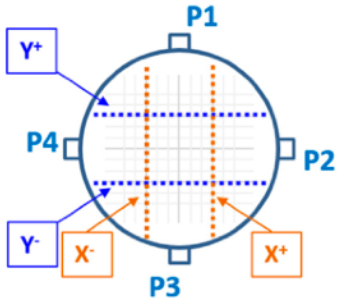
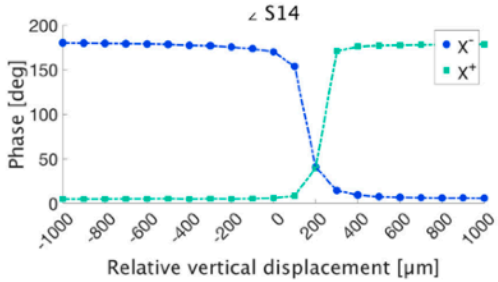
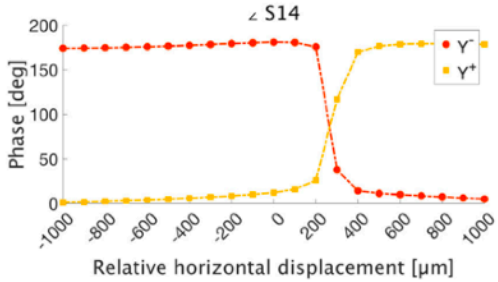


Fig. 8. BPM electrical center location method through wire scan on the linear directions.

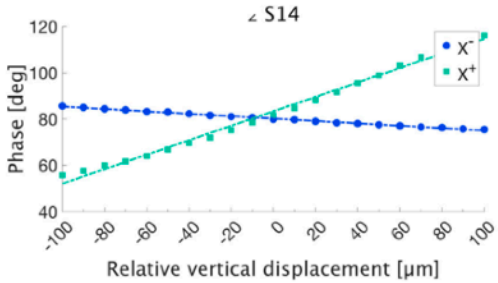


(a) $\angle S14$ vertical scans.

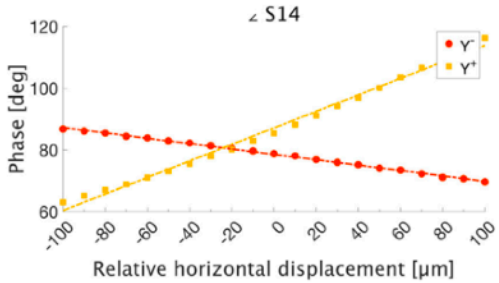


(b) $\angle S14$ horizontal scans.

Fig. 11. Phase response of $S14$ for two linear scans in steps of 100 µm.



(a) $\angle S14$ vertical scans.



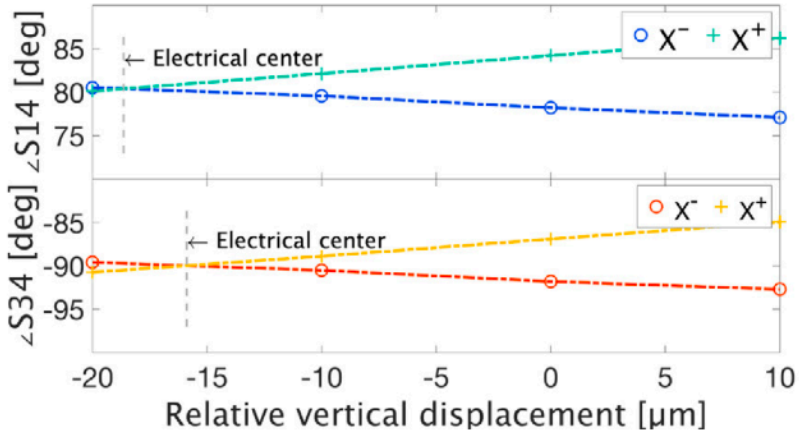
(b) $\angle S14$ horizontal scans.

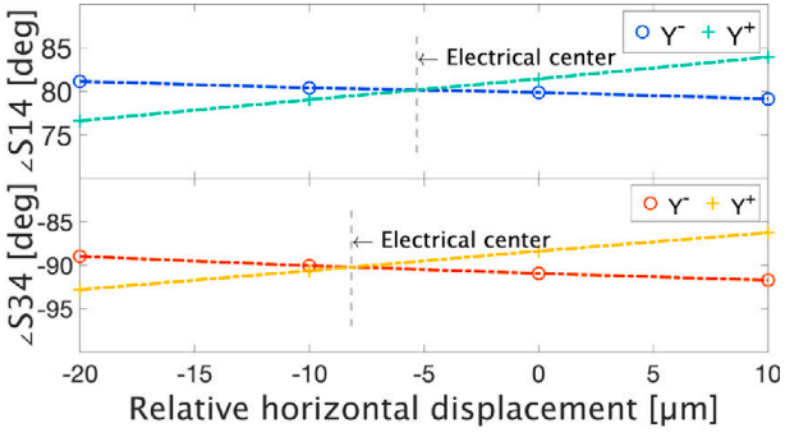
Fig. 12. Phase response of $S14$ for two linear scans in steps of 10 µm.

I. Methodology

D) Angle impact

Following the above method of the adjacent port signal analysis, we can collect and analyze four S-parameters, $\angle S14$, $\angle S34$, $\angle S12$ and $\angle S23$ to locate the electrical center. Ideally, all four datasets should report the same value for the electrical center.

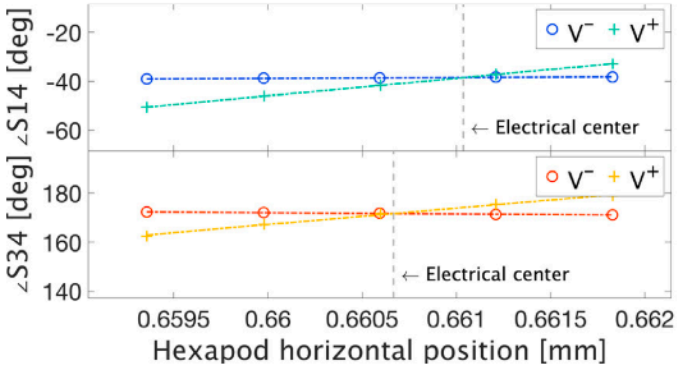




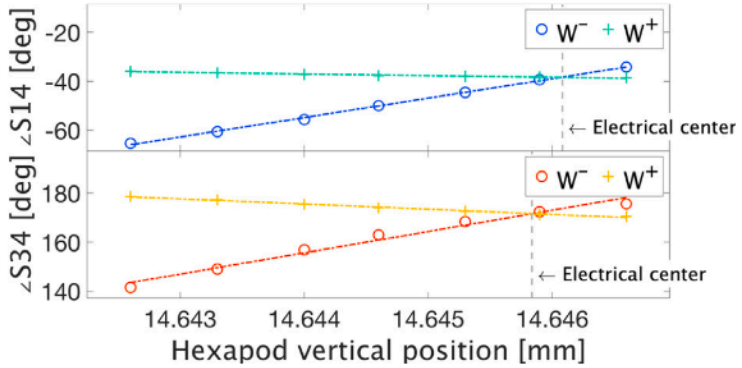
I. Methodology

D) Angle impact

However, comparing the results of the linear position scans of e.g. $\angle S14$ and $\angle S34$ reveals a small, but clearly identified difference in the location of the electrical center. A scan of the cavity BPM around the two angular directions (v and w) should be performed.



(a) $\angle S21$ and $\angle S41$ horizontal scans.



(b) $\angle S21$ and $\angle S41$ vertical scans.

Table 3
Electrical center coordinates referred sensed by the hexapod feedback hardware.

Axis	Hexapod position					Average	Variance
coordinate	S21	S41	S14	S34	Unit		
X	0.6613	0.6611	0.6610	0.6607	mm	0.6610 mm	0.26 μm
Y	14.6498	14.6499	14.6488	14.6498	mm	14.6461 mm	0.13 μm
W	0.00409	0.0071	0.0104	0.0267	deg	0.0041 deg	10.13 mdeg
V	−0.8345	−0.8540	−0.8540	−0.8842	deg	−0.8345 deg	20.53 mdeg

I. Methodology

E) Resolution measurement

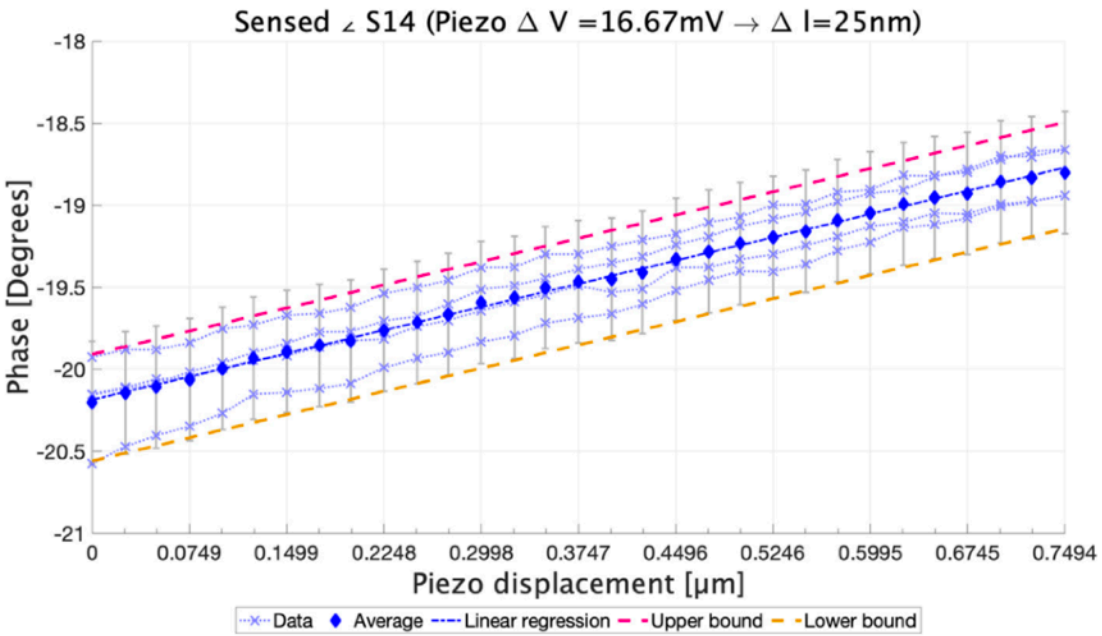


Fig. 15. S-parameter phase measurements for a linear scan with a step size of 25 nm.

To study the BPM resolution through the wire-based approach, the test bench was improved by adding a piezo stack. Now a relative nanometric movement between the BPM and the stretched wire is possible while sensing the position.

The actuator is mounted on the hexapod and drives the BPM on a single direction (vertical axis). To reduce the impact of environmental factors, tests were repeated several times and averaged. Fig. 15 shows the linear dependency between the nanometric piezo elongation (25nm) versus the adjacent ports phase argument of the scattering parameters. The gradient of the slopes is the resolution potential in the nanometric regime.

PhD29: Wire measurements

LabRF meeting, 30/03/26

IFIC INSTITUT DE FÍSICA CORPUSCULAR

Introduction

I. Methodology
   A) Setup
   B) Coarse measurements
   C) Fine measurements
   D) Angle impact
   E) Resolution estimation

II. Preparation

Conclusion

Conclusion

Next: - SVD analysis
- DDC alternative: mean value on amplitude and phase over the whole waveform

Thank you for your attention

We gratefully acknowledge the ATF staff for their assistance during the installation and BPM measurements. Special thanks to Toshiyuki Okugi, Alex Aryshev, and Konstantin Popov for their support. We also thank Toshihiro Matsumoto and Hiroshi Kaji for providing the necessary equipment for the measurements.

This work has the support of "Plan de Recuperación, Transformación y Resiliencia (PRTR) 2022 (ASFAE/2022/013)", funded by Conselleria d'Innovació, Universitats, Ciència i Societat Digital from Generalitat Valenciana, and NextGenerationEU from European Union.
This work was partially supported by the European Union's Horizon Europe Marie Sklodowska-Curie Staff Exchanges programme under grant agreement no. 101086276.

laura.pedraza@ific.uv.es

Back-up slides