# PhD27:
# New BPM measurements

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# PhD27: New BPM measurements

LabRF meeting, 24/02/26

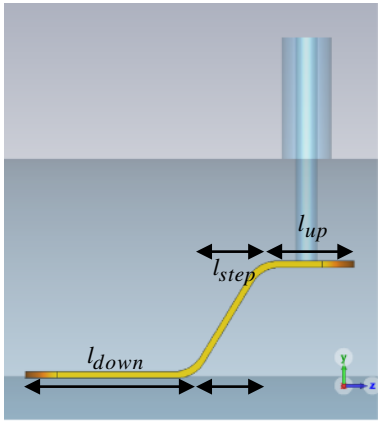
Introduction

I. Parameters of the BPM

II. RF measurements
   A) Medida VNA con el feedthrough 3 apretado
   B) Medida VNA con el feedthrough 3 sin apretar
   C) Loaded quality factor

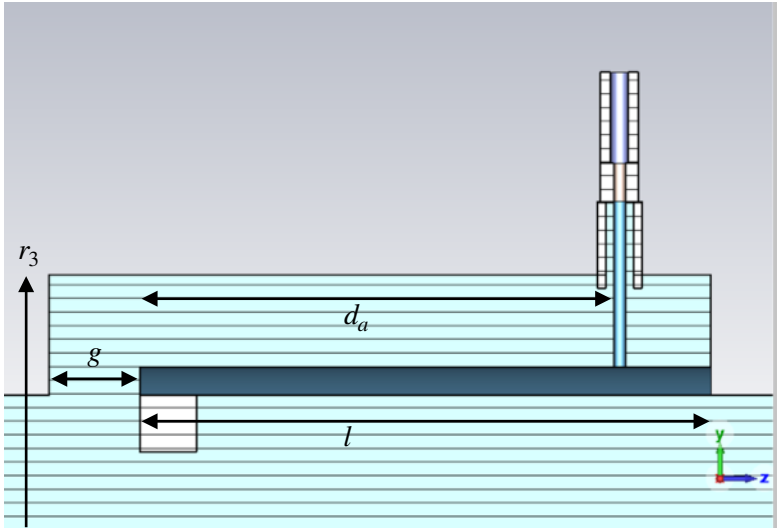
Conclusion

# I. Parameters of the BPM




$l_{up} = 4.5$
$l_{step} = 3$
$l_{down} = 8$

$a_{tab} = 3$
$r_{blend} = 1.5$
$e_{tab} = 0.3$




**Parameters optimisation (mm):**

$r_3 = 51.75$
$l = 53.3$
$d_a = 47$
$g = 10.25$

| Mode | Monopole | | | Dipole (on x) | | | | |
|---|---|---|---|---|---|---|---|---|
| | Freq (GHz) | $Q_L$ | R/Q (Ω) @ 5 mm | Freq (GHz) | $Q_L$ | R/Q (Ω) @ 5 mm | $S_{11}$ (dB) | $S_{12}$ (dB) |
| **CEA SACLAY** | 1.250 | 22.95 | 12.9 | 1.719 | 50.96 | 0.27 | -25.0 | -33 |
| **Optimization (ideal)** | 1.120 | 37.65 | 14.47 | 1.626 | 72.30 | 0.357 | -16.3 | -30.6 |
| **After inclusion of the tab and optimization** | 1.118 | 34.91 | 14.50 | 1.620 | 64.09 | 0.350 | -22.5 | -31 |

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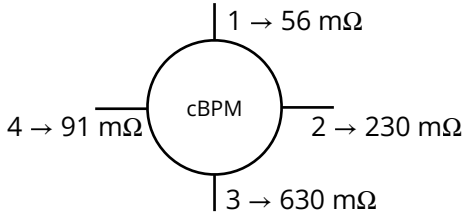
   B) Medida VNA con el feedthrough 3 sin apretar
   C) Loaded quality factor

Conclusion

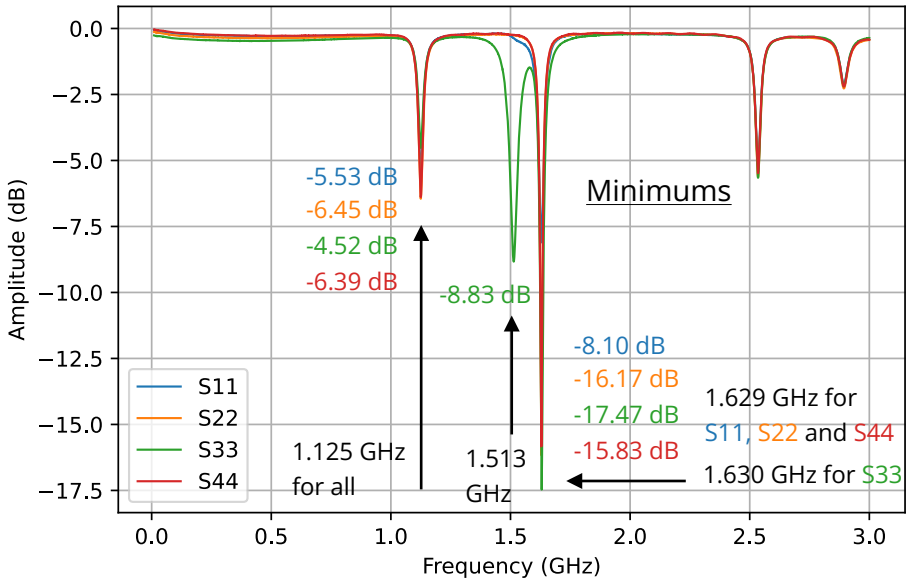
# II. RF measurements

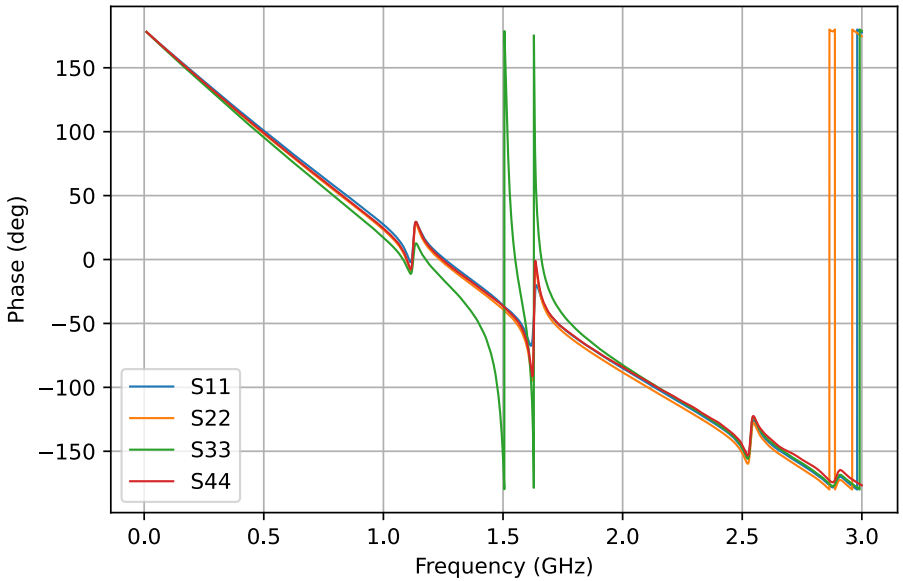
## A) Medida con el VNA con feedthrough 3 apretado




VNA calibrated for the 4 ports with window 10 MHz - 3 GHz and step of 300 kHz

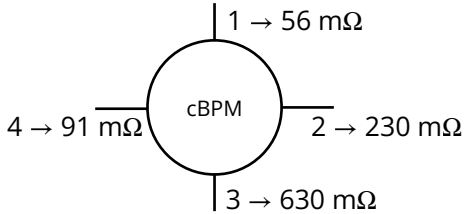
**Reflection**



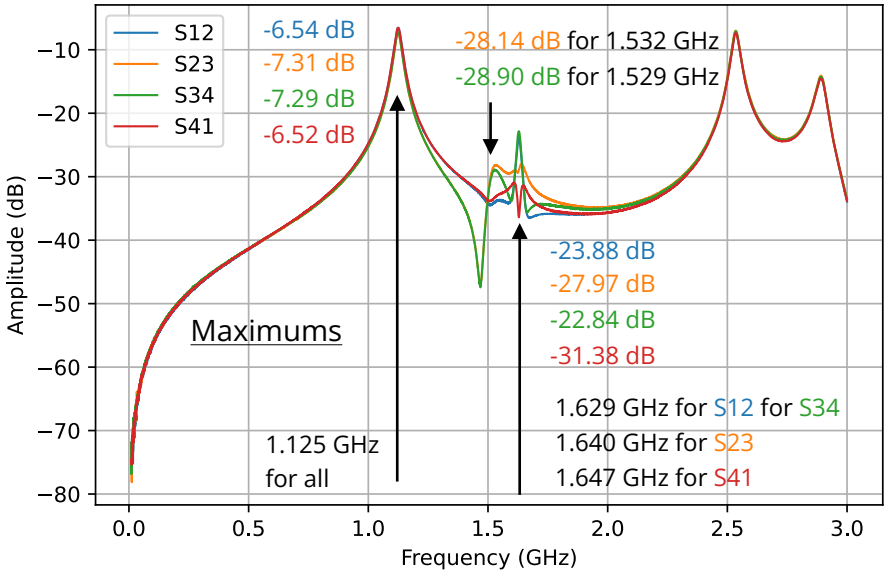
# II. RF measurements

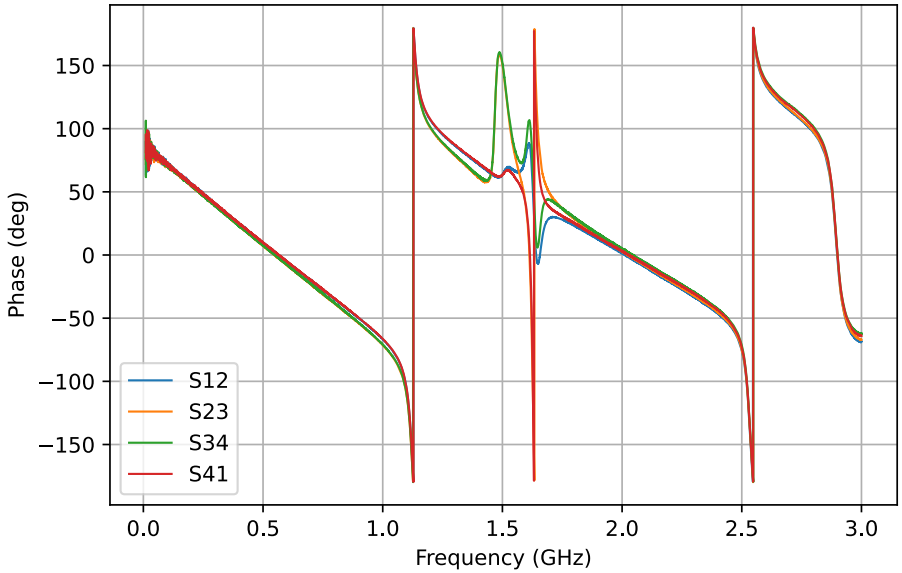
## A) Medida con el VNA con feedthrough 3 apretado




VNA calibrated for the 4 ports with window 10 MHz - 3 GHz and step of 300 kHz

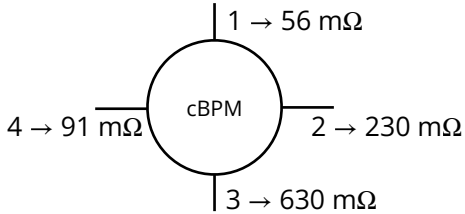
**Cross-talk**



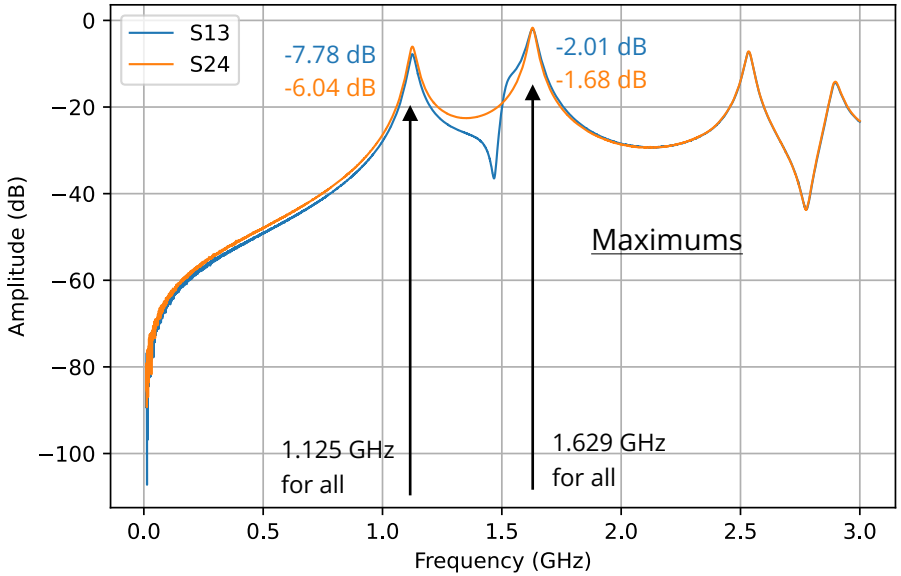
# II. RF measurements

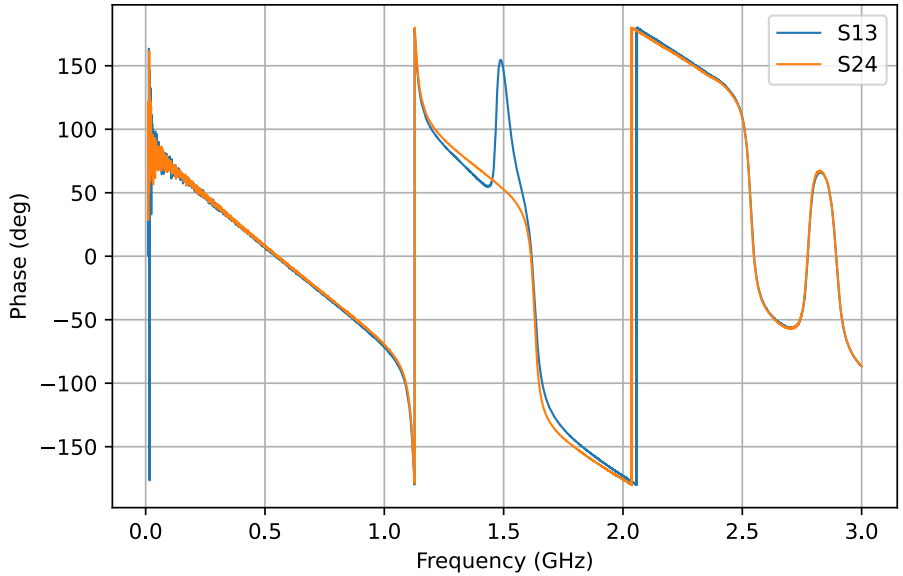
## A) Medida con el VNA con feedthrough 3 apretado




VNA calibrated for the 4 ports with window 10 MHz - 3 GHz and step of 300 kHz

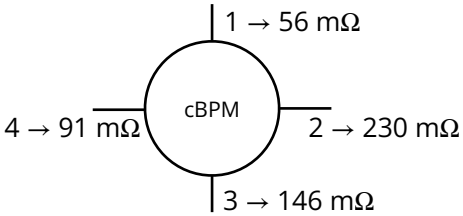
**Transmission**



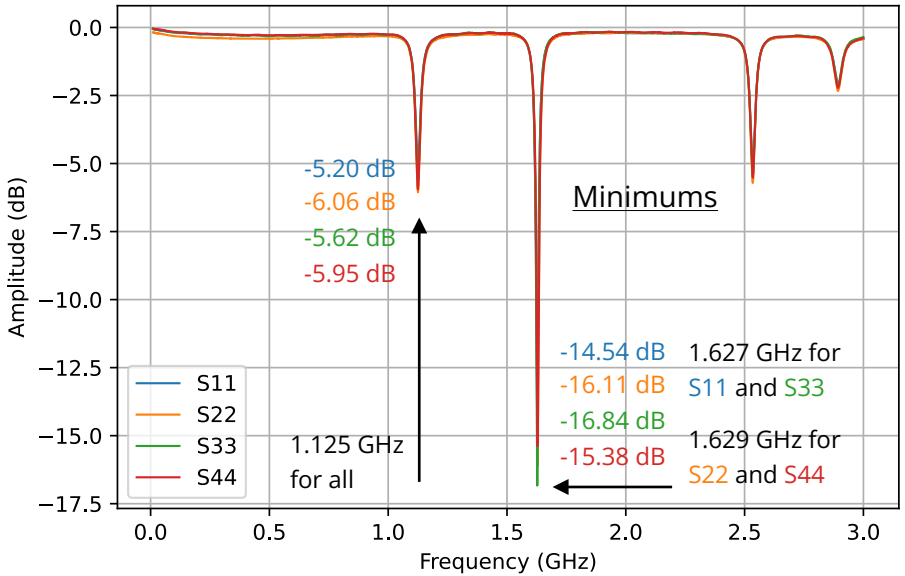
# II. RF measurements

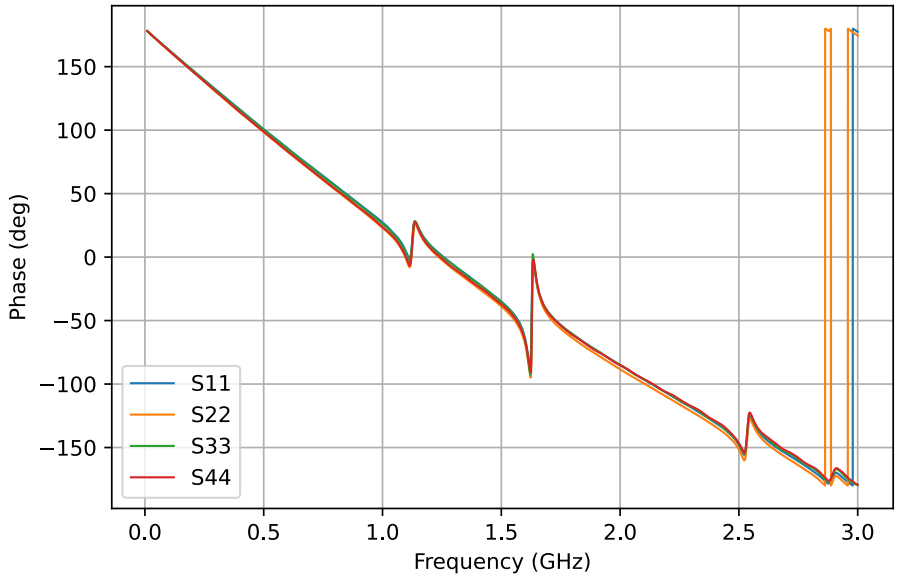
## B) Medida con el VNA con feedthrough 3 sin apretar




VNA calibrated for the 4 ports with window 10 MHz - 3 GHz and step of 300 kHz

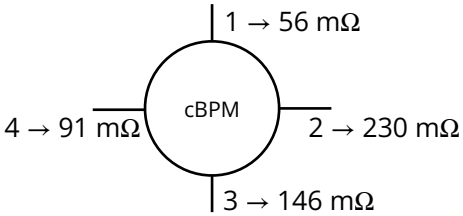
**Reflection**



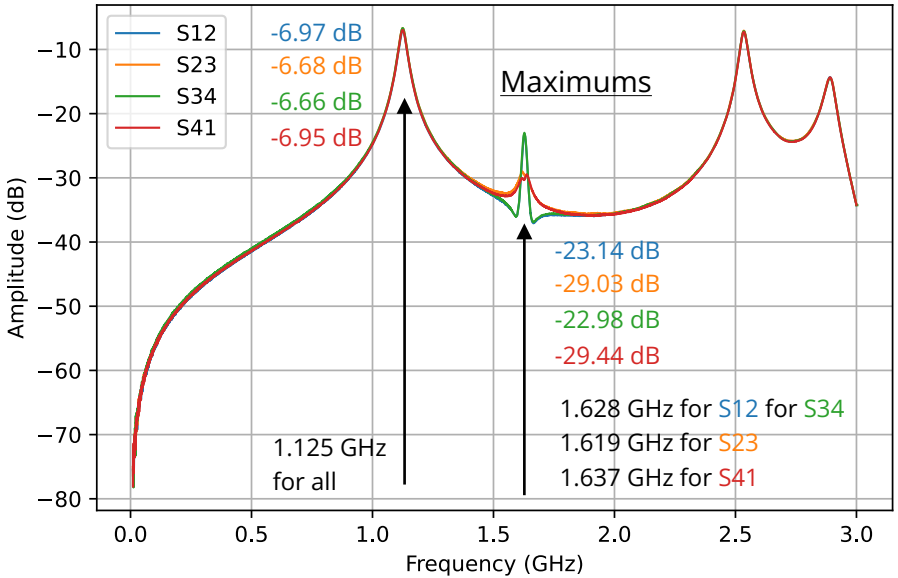
# II. RF measurements

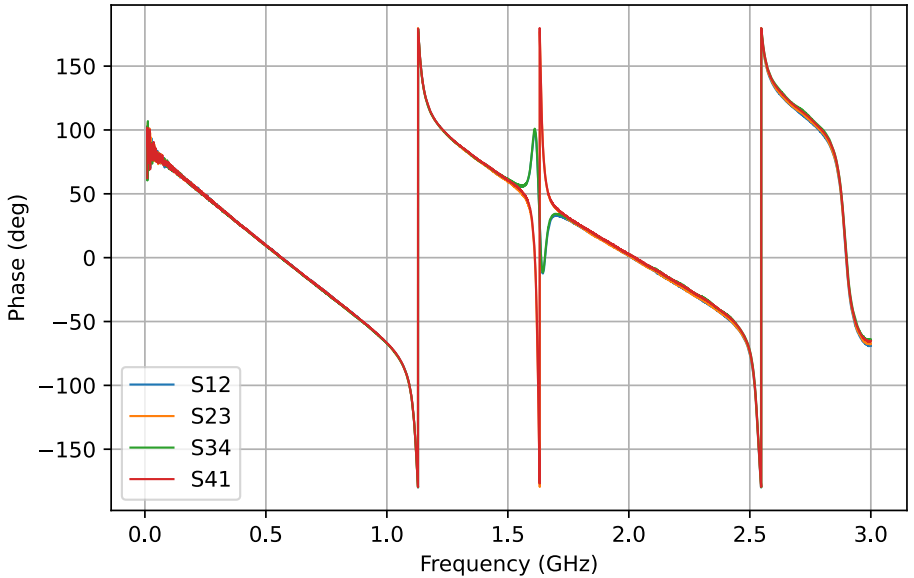
## B) Medida con el VNA con feedthrough 3 sin apretar




VNA calibrated for the 4 ports with window 10 MHz - 3 GHz and step of 300 kHz

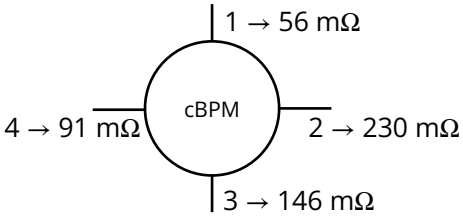
**Cross-talk**



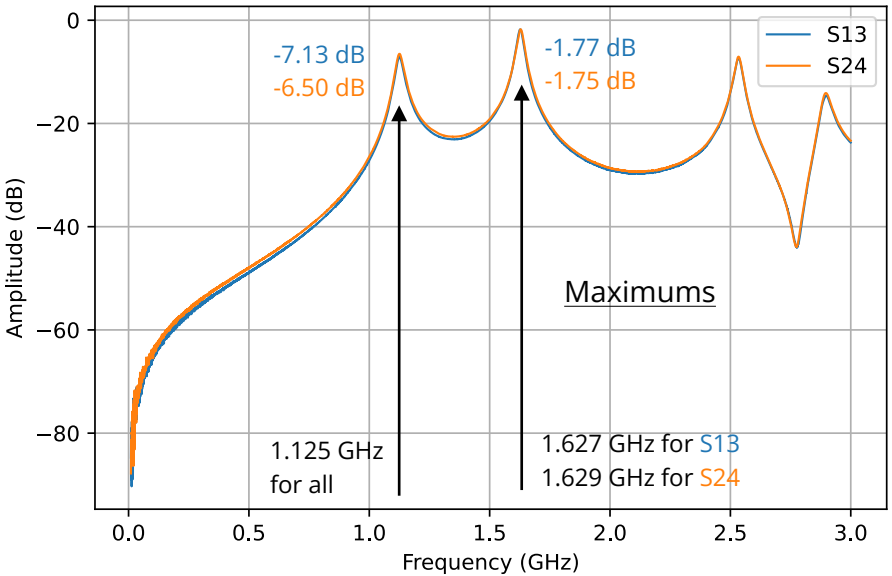
# II. RF measurements

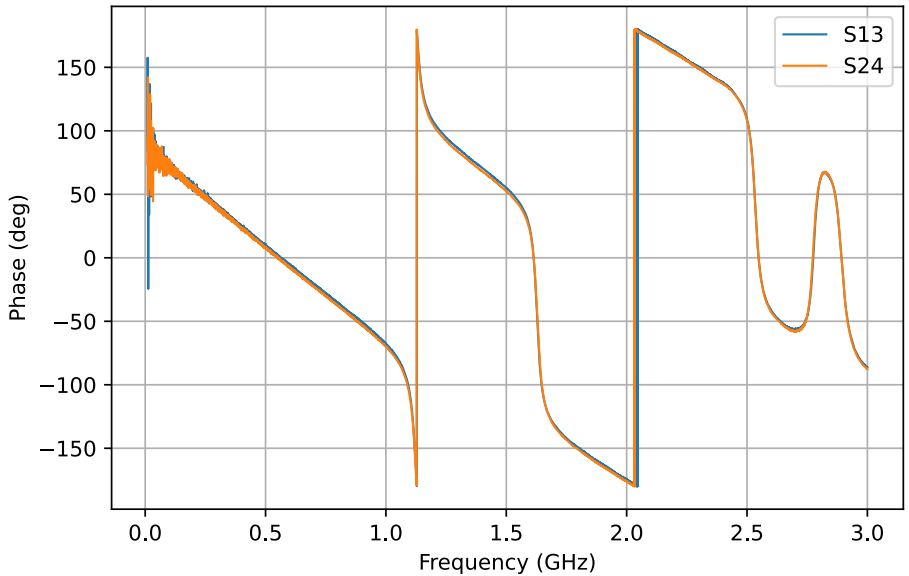
## B) Medida con el VNA con feedthrough 3 sin apretar




VNA calibrated for the 4 ports with window 10 MHz - 3 GHz and step of 300 kHz

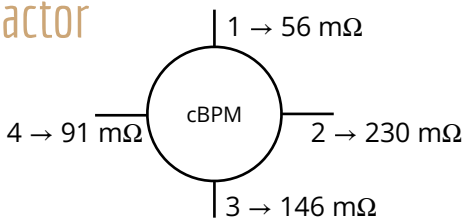
**Transmission**

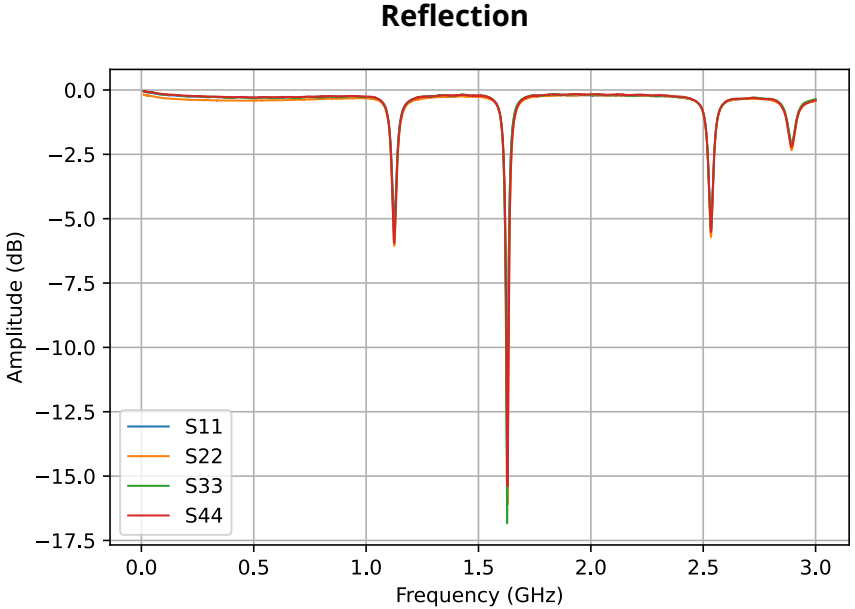


# II. RF measurements

## C) Loaded quality factor




=== Quality Factor Q for Port 1 (S11) ===
Frequency 1.125 GHz:
f0 = 1.1251 GHz
S_min = -5.20 dB
BW (-3dB) = 0.0309 GHz
Q = 36.41
Frequency 1.627 GHz:
f0 = 1.6270 GHz
S_min = -14.54 dB
BW (-3dB) = 0.0057 GHz
Q = 285.44

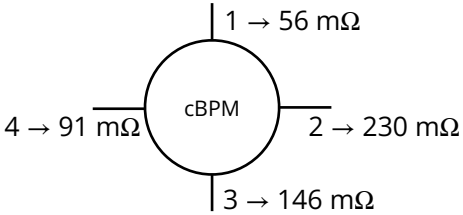
=== Quality Factor Q for Port 2 (S22) ===
Frequency 1.125 GHz:
f0 = 1.1254 GHz
S_min = -6.06 dB
BW (-3dB) = 0.0246 GHz
Q = 45.75
Frequency 1.627 GHz:
f0 = 1.6291 GHz
S_min = -16.11 dB
BW (-3dB) = 0.0045 GHz
Q = 362.02

=== Quality Factor Q for Port 3 (S33) ===
Frequency 1.125 GHz:
f0 = 1.1251 GHz
S_min = -5.62 dB
BW (-3dB) = 0.0273 GHz
Q = 41.21
Frequency 1.627 GHz:
f0 = 1.6273 GHz
S_min = -16.84 dB
BW (-3dB) = 0.0039 GHz
Q = 417.26

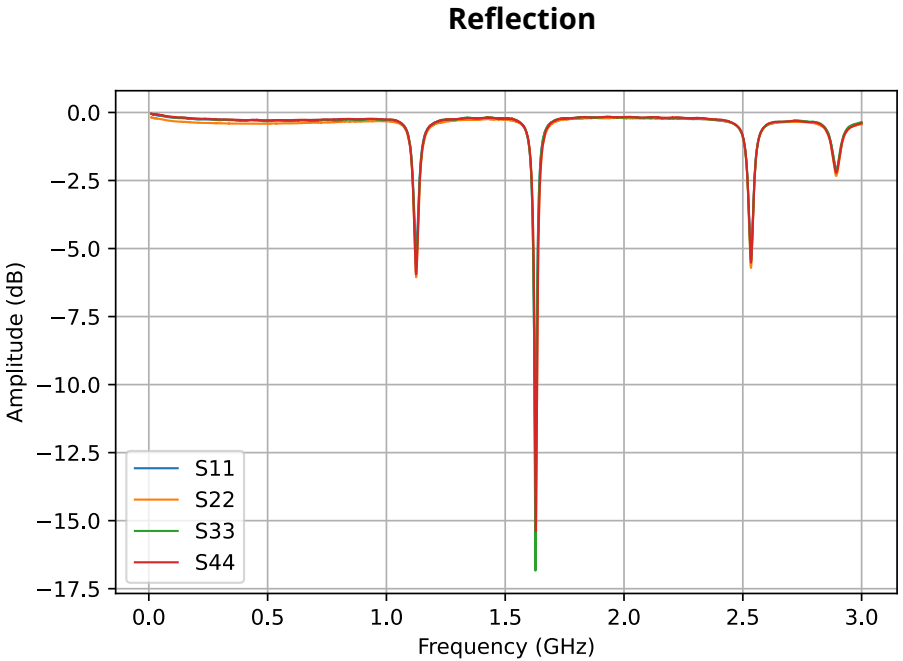
=== Quality Factor Q for Port 4 (S44) ===
Frequency 1.125 GHz:
f0 = 1.1251 GHz
S_min = -5.95 dB
BW (-3dB) = 0.0249 GHz
Q = 45.18
Frequency 1.627 GHz:
f0 = 1.6288 GHz
S_min = -15.38 dB
BW (-3dB) = 0.0051 GHz
Q = 319.37

# II. RF measurements

## C) Loaded quality factor




VNA calibrated for the 4 ports with window 10 MHz - 3 GHz and step of 300 kHz




Averaging over all 4 ports:

| Loaded Quality factor | | |
|---|---|---|
| | **Monopole mode** | **Dipole mode** |
| **Minimum frequency** | 1.125 GHz | 1.628 GHz |
| **S-param at minimum** | -5.71 dB | -15.72 dB |
| **Band-width (at -3 dB)** | 26.9 MHz | 4.8 MHz |
| **Loaded quality factor** | 42.14 | 346.02 |

# 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.

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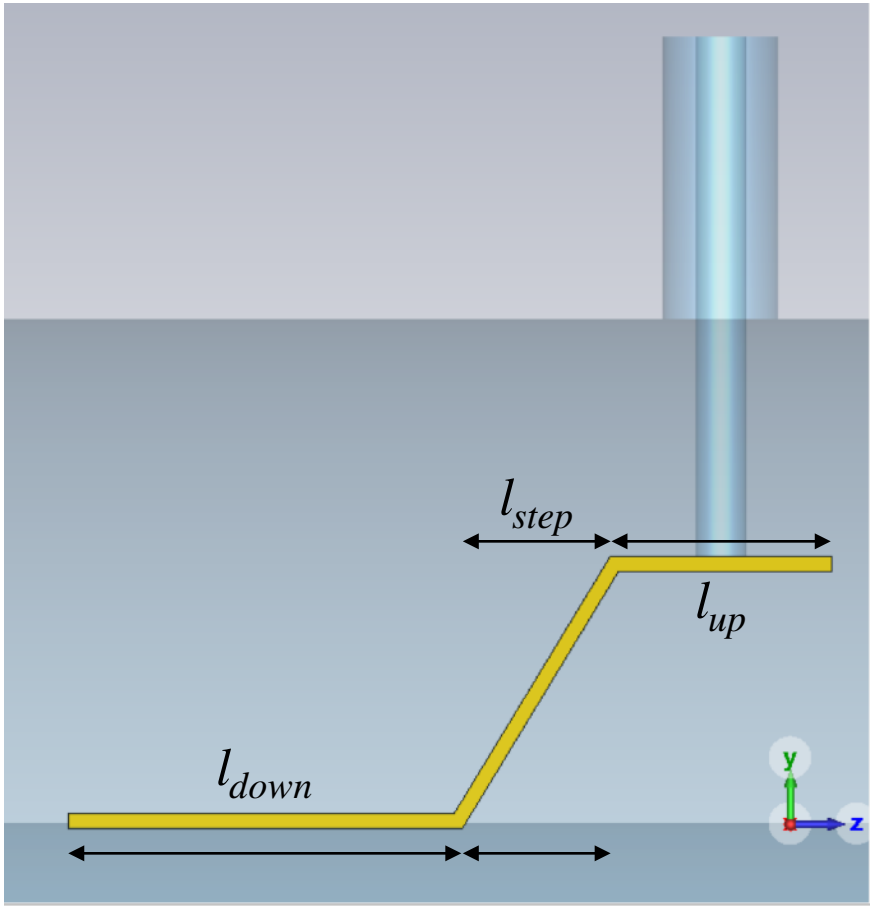
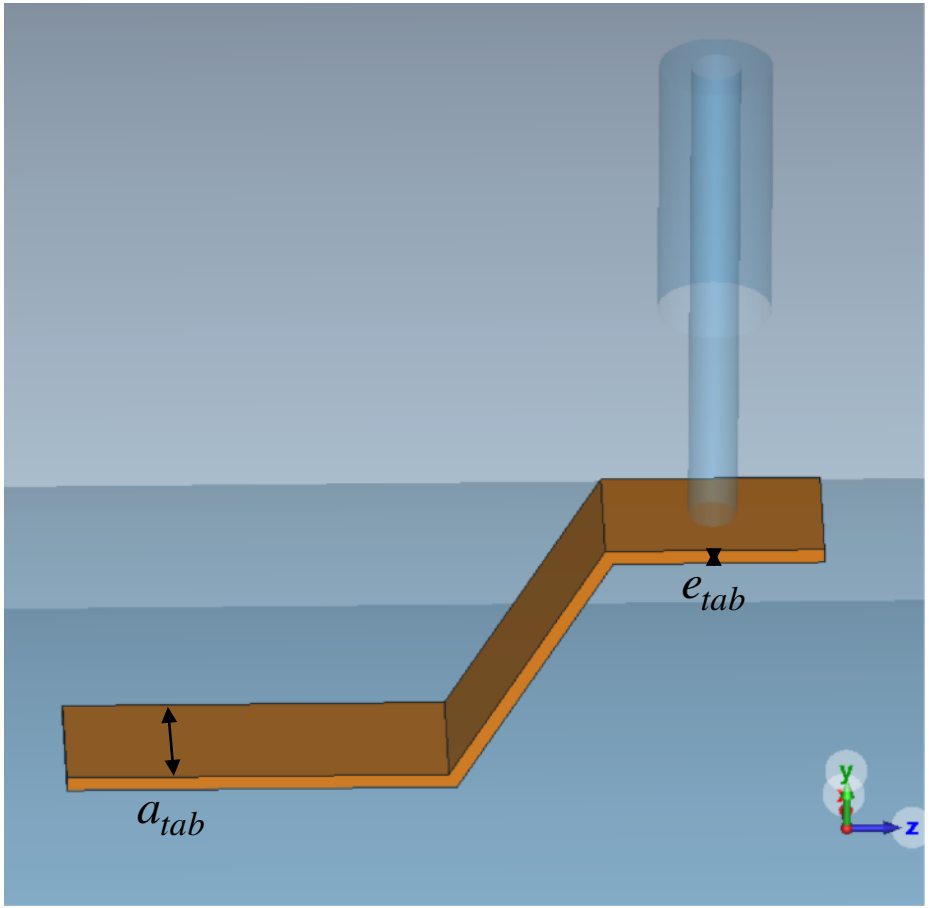
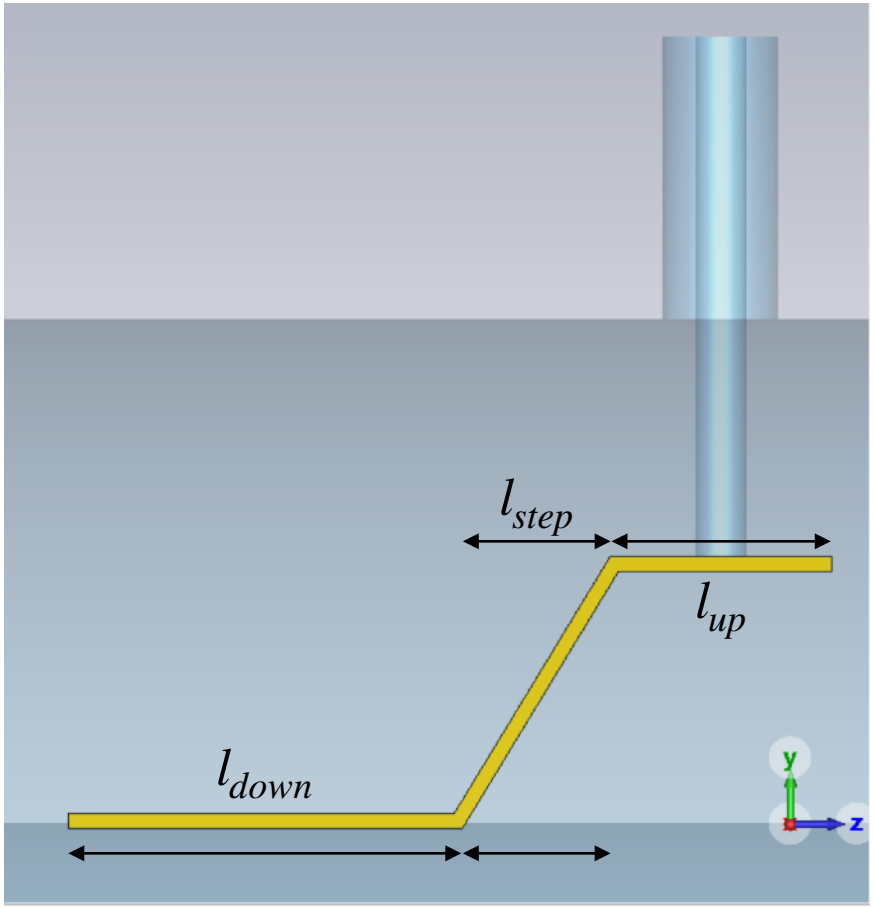
# Back-up slides

# A. Geometry BPM

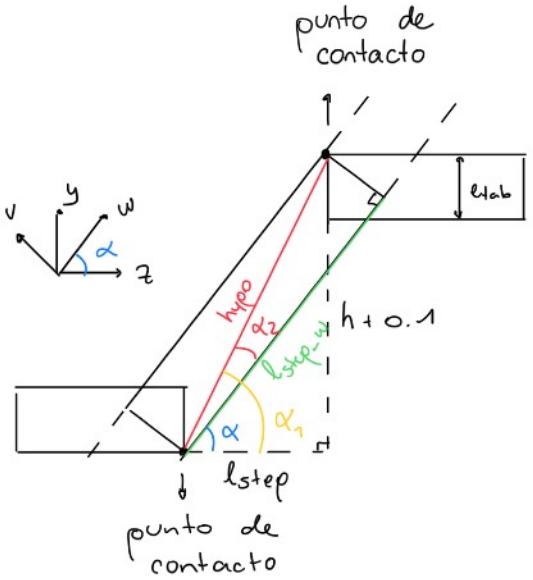


# A. Geometry BPM




Modelización en CST de la geometría de la pestaña para conservar el mismo grosor en todas partes:




$$hypo = \sqrt{l_{step}^2 + (h + 0.1)^2}$$

$$l_{step\_w} = \sqrt{hypo^2 - e_{tab}}$$

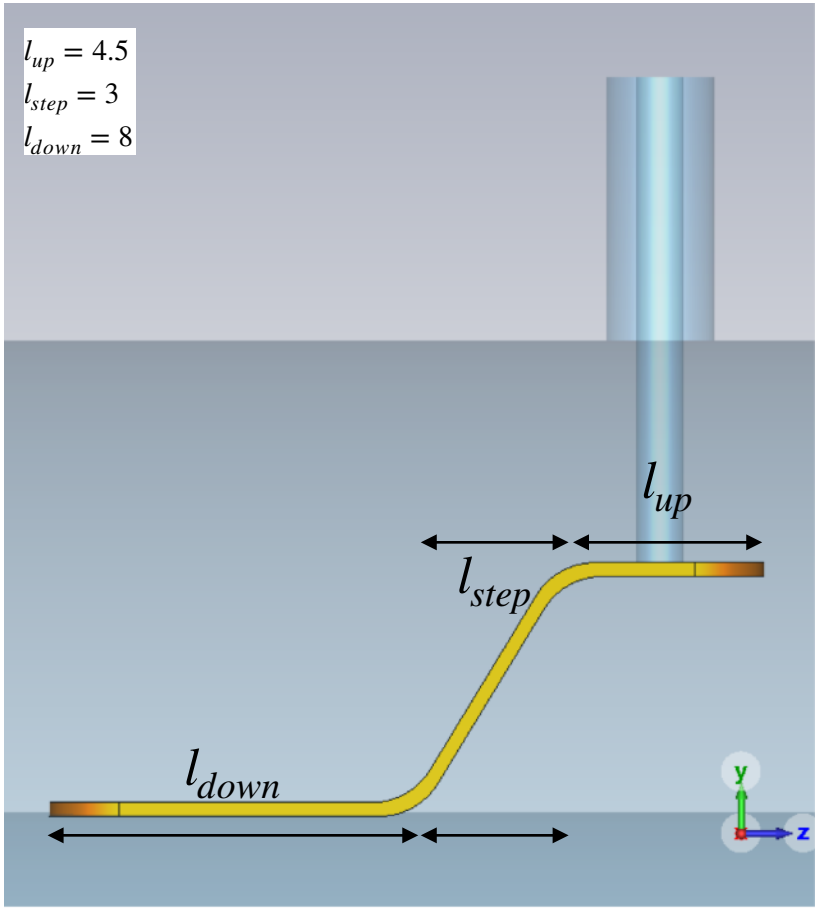
$$\alpha = \alpha_1 - \alpha_2$$

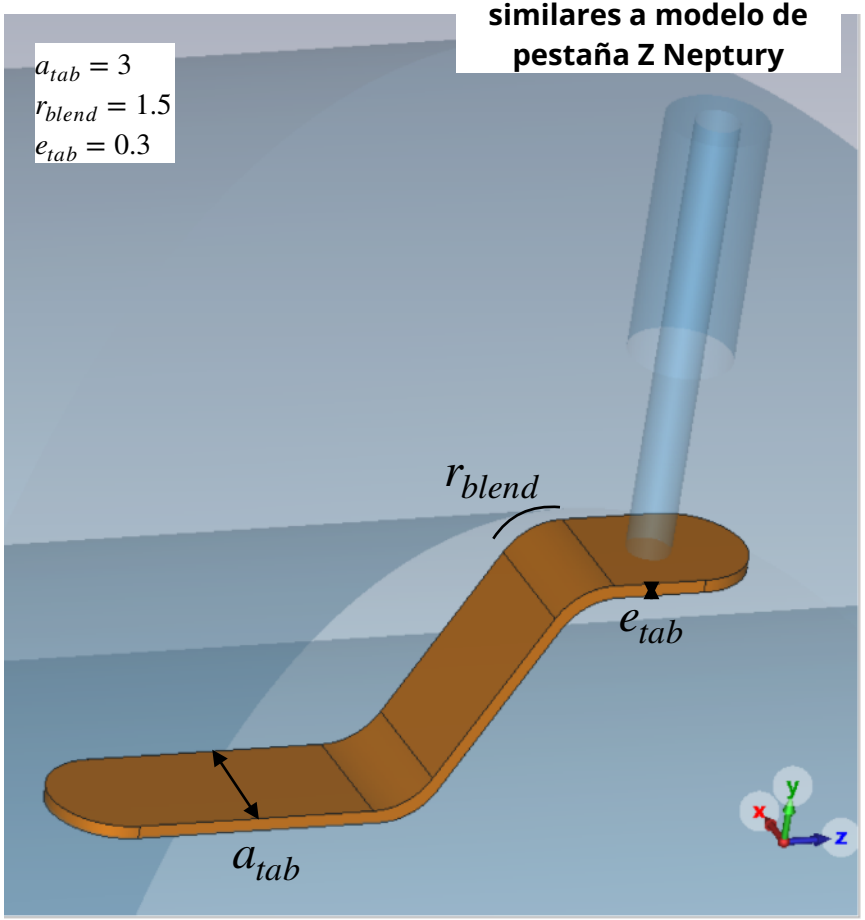
$$\alpha_1 = \tan^{-1}\left(\frac{h + 0.1}{l_{step}}\right)$$

$$\alpha_2 = \sin^{-1}\left(\frac{e_{tab}}{hypo}\right)$$

# A. Geometry BPM

**Dimensiones mas similares a modelo de pestaña Z Neptury**

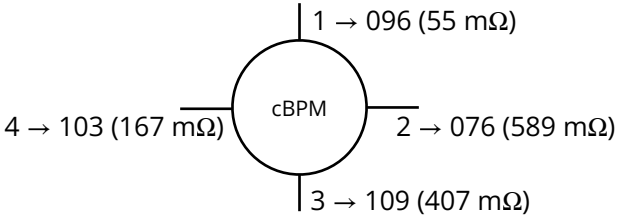


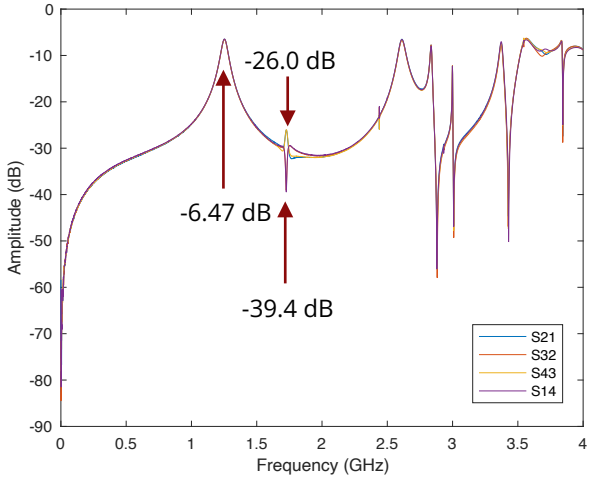
# B. The CEA Saclay cBPM

## 1. VNA Tests

- **S-parameters**

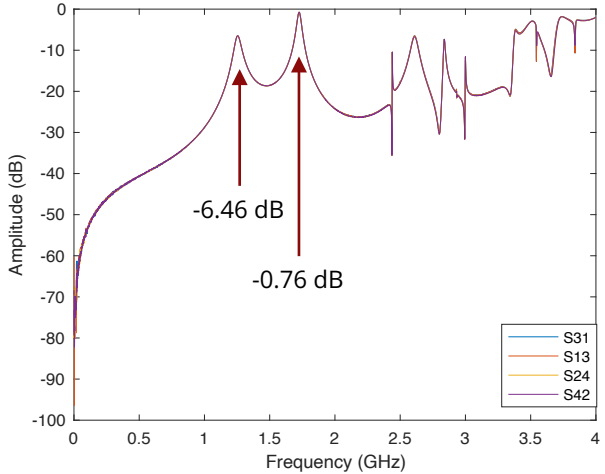



<u>Cross-talk:</u>
Between the 4 consecutive ports



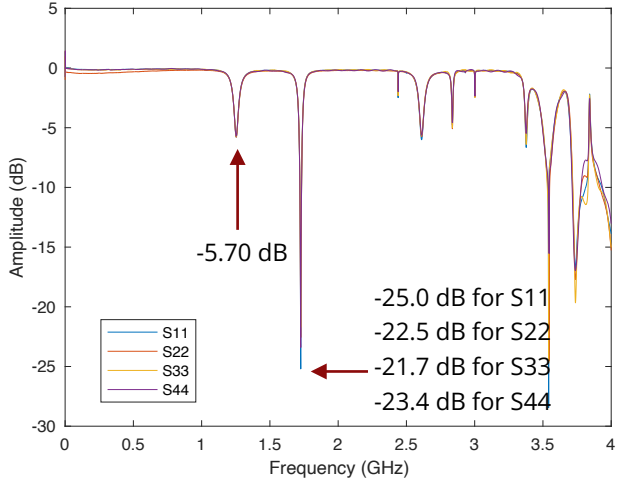

Measured as -33 dB according to bibliography

<u>Transmission:</u>
Between the opposite ports




Agrees with bibliography transmission measurements (±0.5 dB)

<u>Reflection:</u>
At the same port




Bibliography states that the difference in reflection between ports is ±0.07 dB