CERN practical days - RF

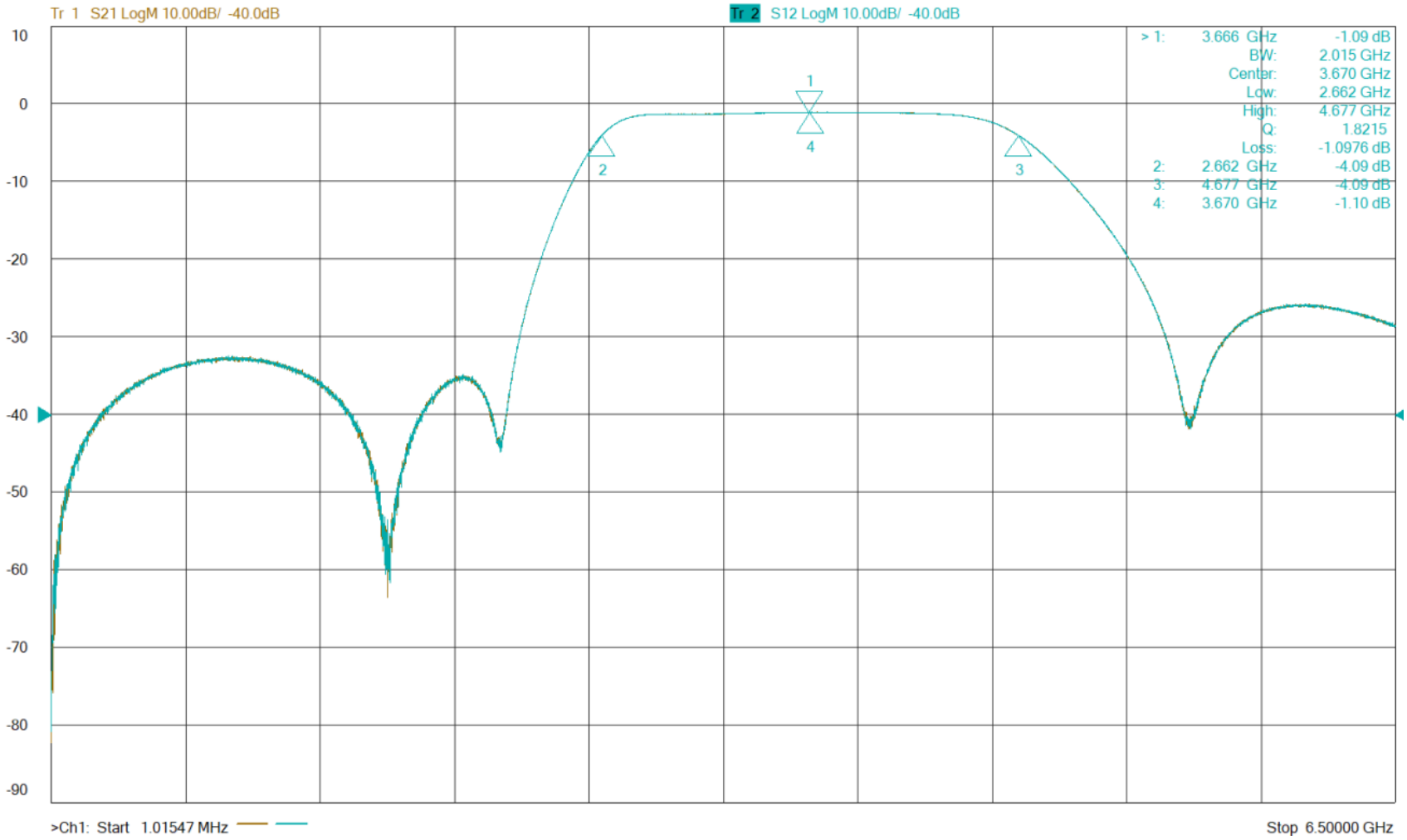
09:00

Ruben Heine Marvin Noll

14.03.2022

Outline

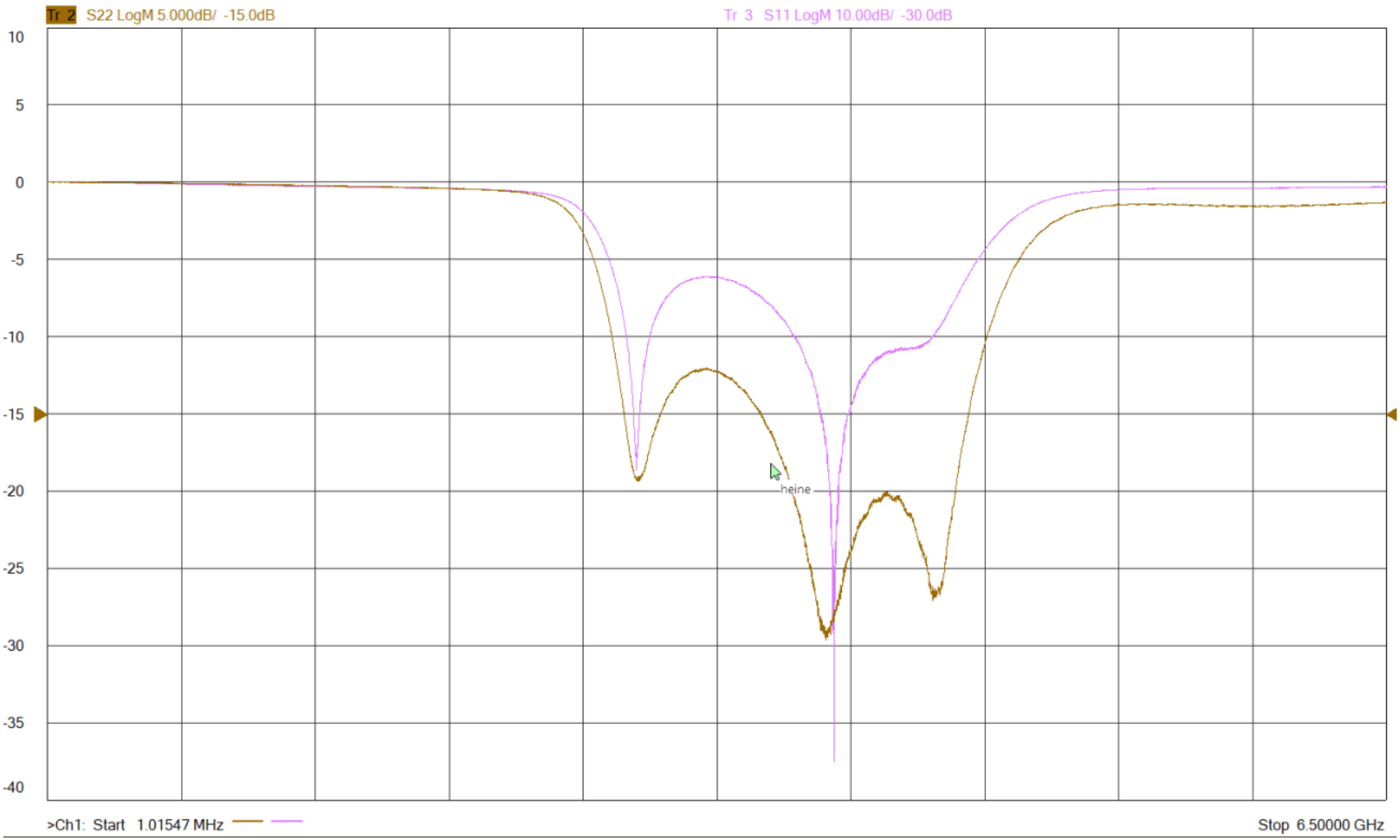
Band Pass Filter (1) - Transmission S_{12}, S_{21}



$$BW = 2.015\,\text{GHz}, \quad f = 2.66\,\text{GHz}...4.67\,\text{GHz}$$

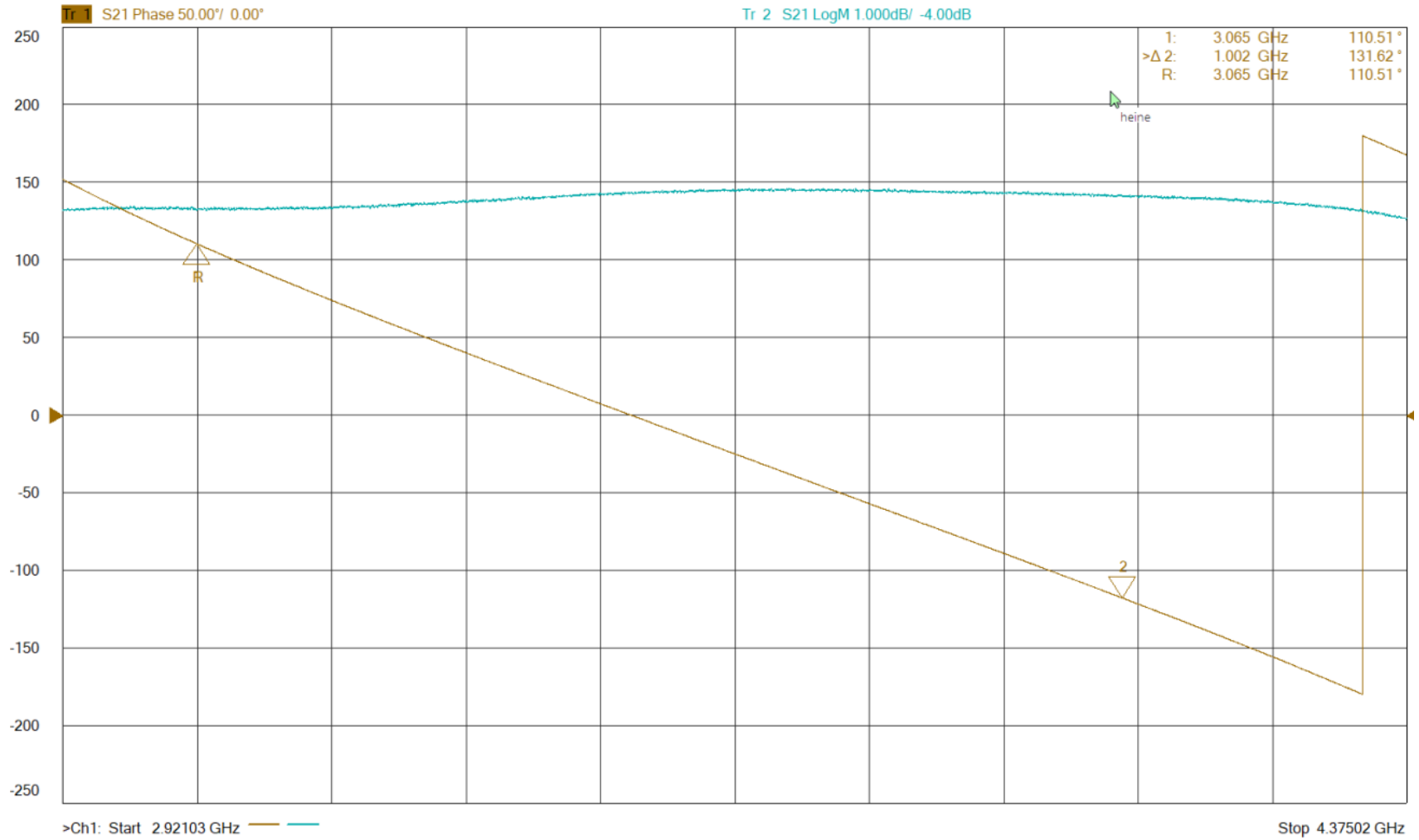
$$S_{21} \approx S_{12} \Rightarrow \text{Reciprocal}$$

Band Pass Filter (2) - Input/Output Reflection S_{11}, S_{22}



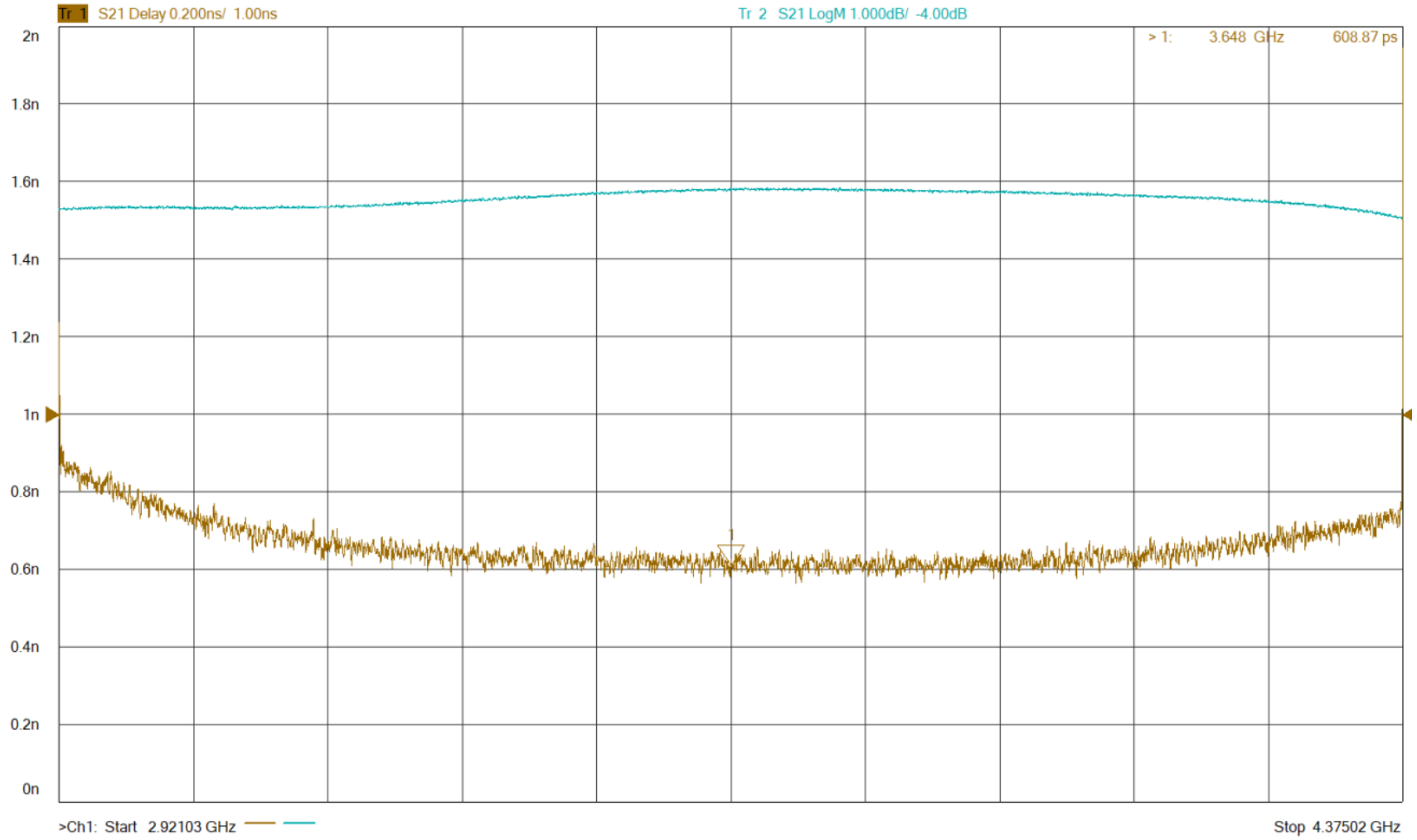
$$S_{11} \neq S_{22} \Rightarrow \text{Non symmetric}$$

Band Pass Filter (3) - Phase $\angle S_{12}$



$$t_g = -\frac{\mathrm{d}}{\mathrm{d}\omega}\angle S_{12} \approx -\frac{\Delta\angle S_{12}\ [\mathrm{rad}]}{\Delta\omega} = \frac{(360° - 131.62°)\cdot \pi/180}{2\pi \cdot 1.002\,\mathrm{GHz}} = 633\,\mathrm{ps}$$

Band Pass Filter (4) - Group Delay t_g



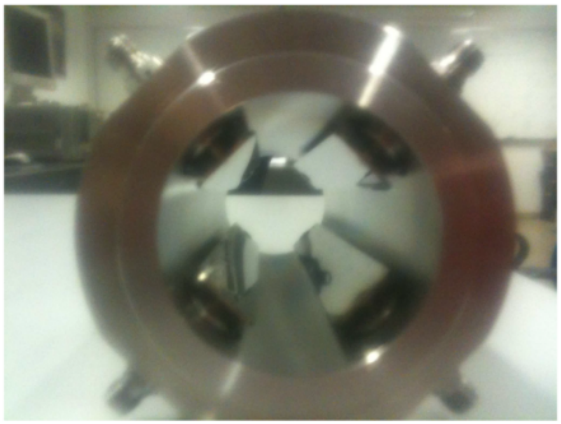
From group delay plot: $t_g = 608.87\,\mathrm{ps}$

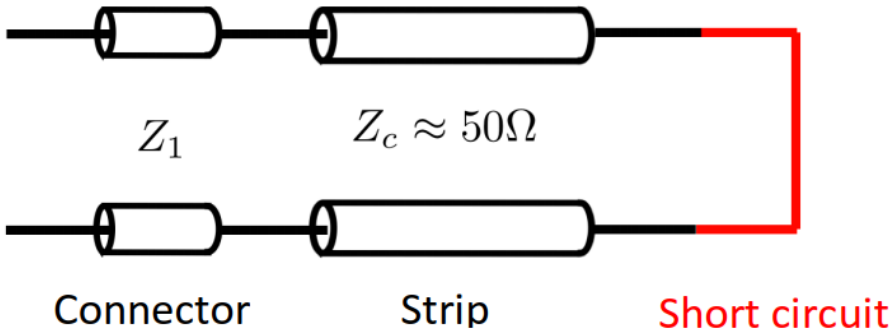
Strip-Line BPM (1) - Intro

Reflectometry for 500 MHz and 50 Ohm

a. Connector

b. Strip line
   - Four 14cm strips
   - Short-circuit termination

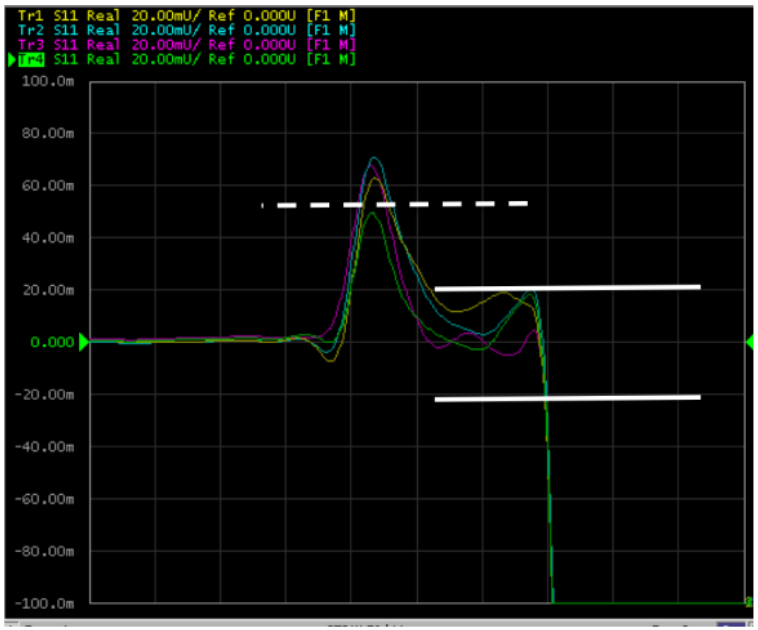




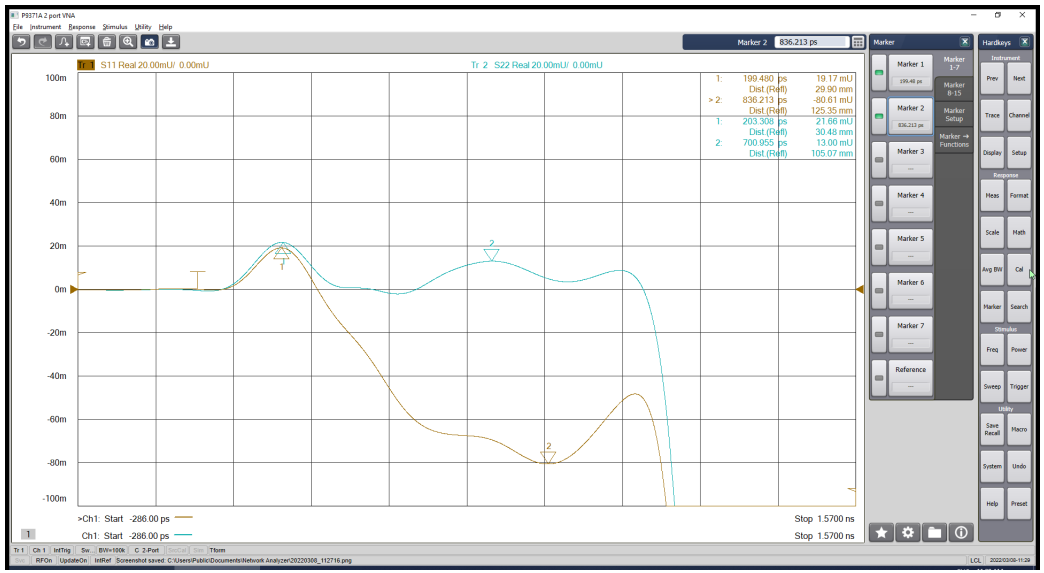
(a) Strip line: image and circuit

Strip-Line BPM (2) - Time Domain Reflectometry

- Measuring S11 in time domain to check acceptance criteria
  a. Connector: $+50mU$
  b. Strip line: $-/+20mU$
- Strip line *blue* in specs, *gold* not



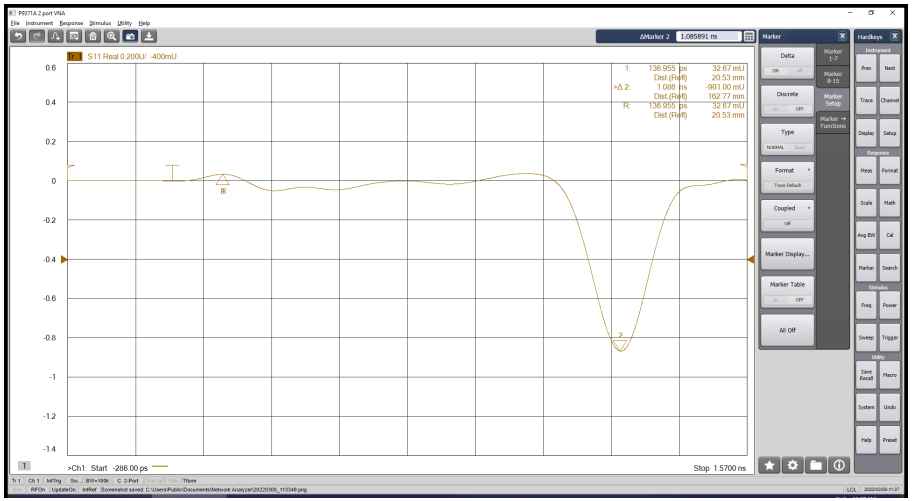
(b) TDR Aim



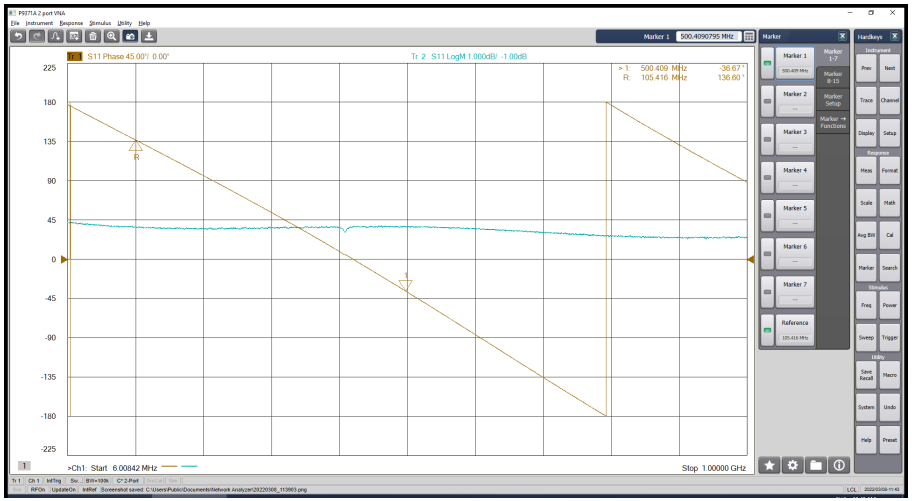
(c) TDR Reproduced

Strip-Line BPM (3) - Frequency Domain Characterization

- Strip-line length from S11
  - from S11: $1.086ns$, $162.77mm$
  - from phase: $1.218ns$, $182.58mm$
  - from group delay: $1.32ns$, $197.87mm$
- Cross-talk from S21
  - Maximum reflection of $-25.25dB$ at $797.68MHz$
  - Reflection of $-53.06dB$ at operation frequency $500.00MHz$



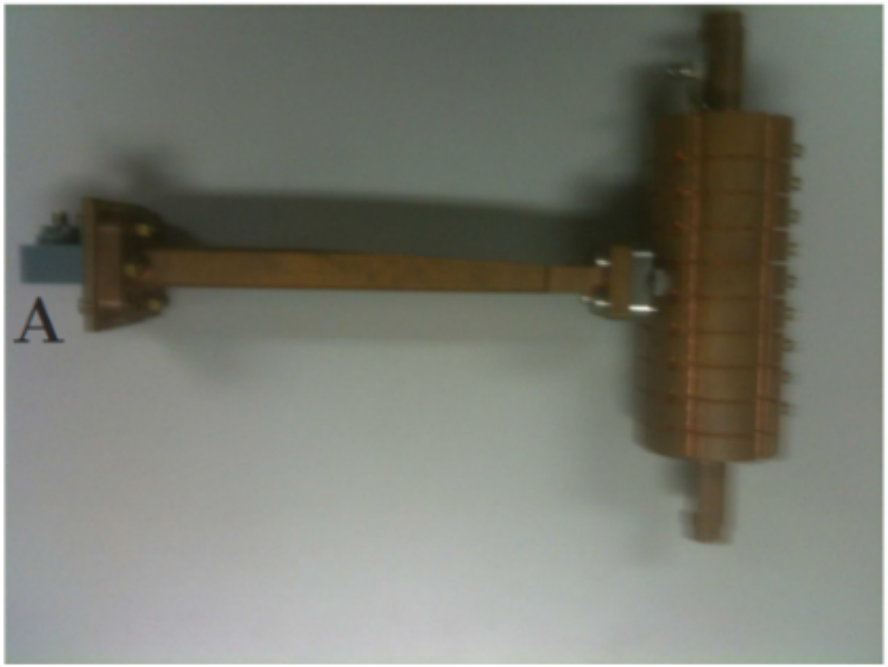
(d) Calculation from S11



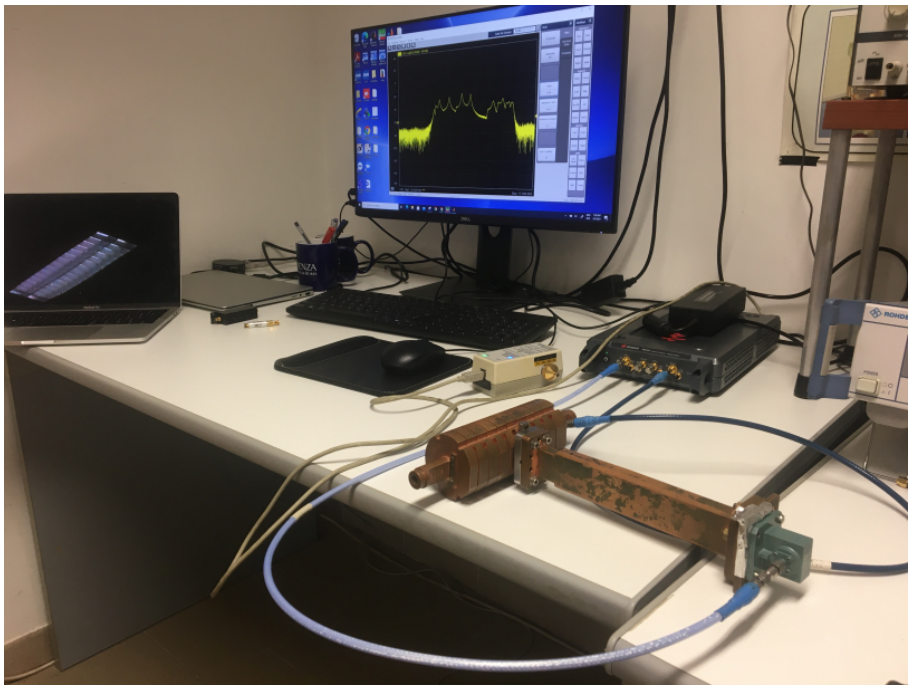
(e) Calculation from phase

RF - cavaties (1) - Intro

- Multi cell cavity in X-band
- Operating mode at 11.424 GHz
- Under coupled antenna



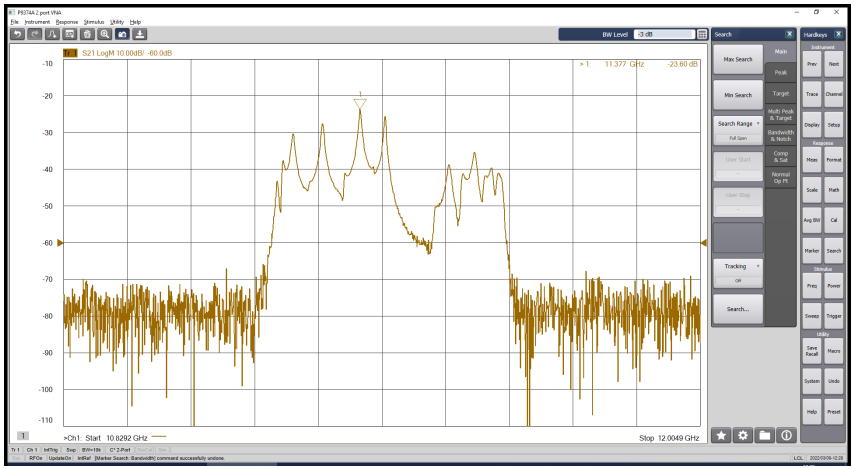
(f) Multi cell cavity



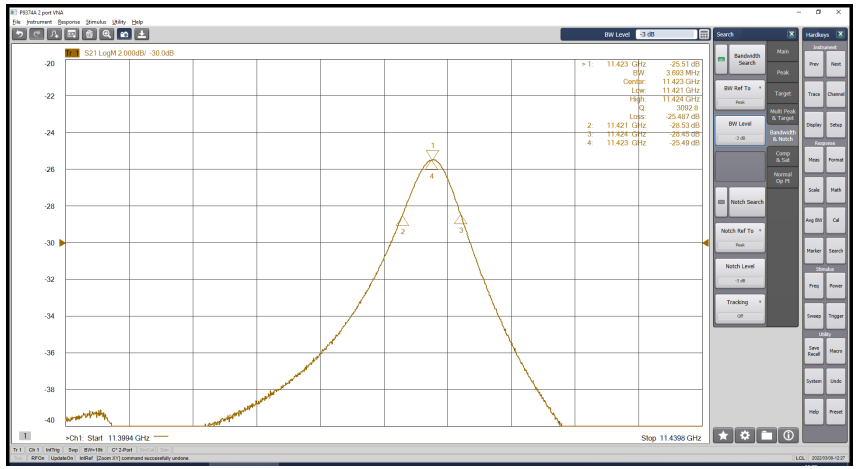
(g) Setup

RF - cavaties (2) - Transmission measurement

- Identify different modes
- Calculated Q from the $3dB$ bandwidth: 3093



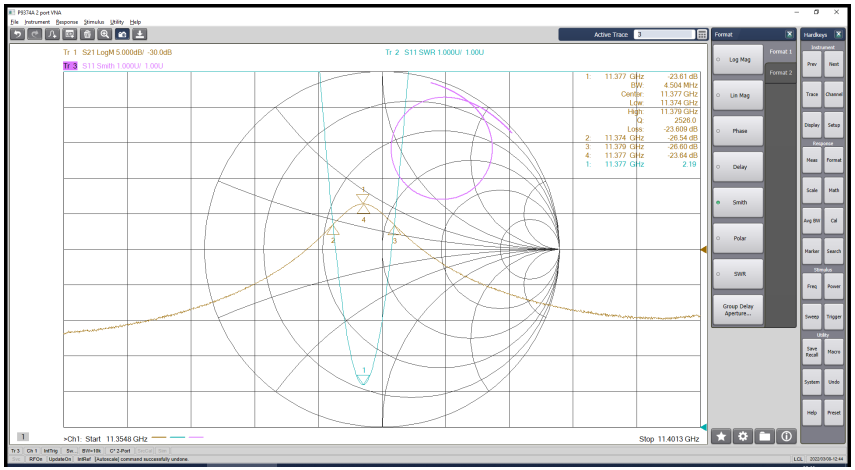
(h) All modes (S21)



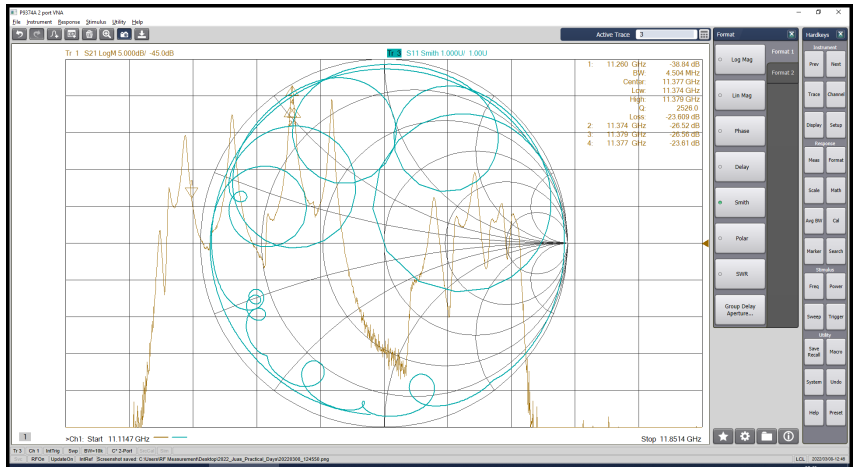
(i) Q for a certain mode

RF - cavaties (3) - Transmission measurement

- Identify SWR
- Under coupling (S11 in Smith Chart)



(j) Caption a



(k) Caption b

Useless Repetition (Manfred Wendt)

- Stuff
- More Stuff

RF Cavity, Coupling, Smith Chart (Fritz Caspers)

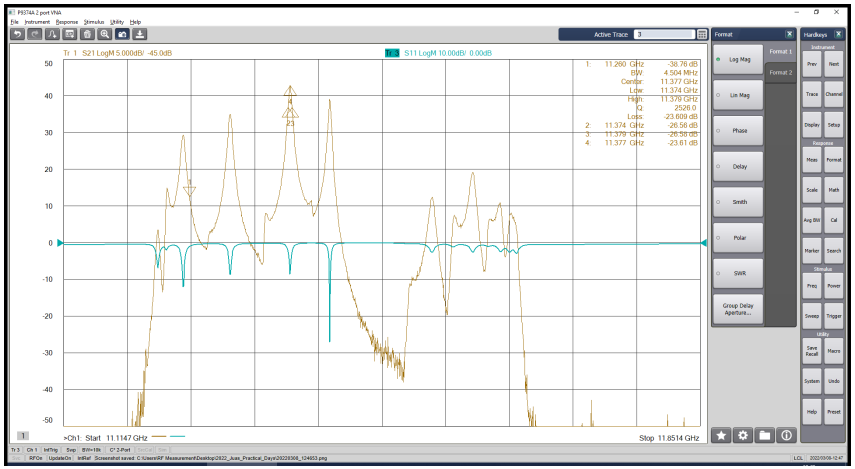
- Two Antennas in cavaty
  - Longitudinal field antenna
  - Coupling loop
- Under-, over- and critical coupling

Resume

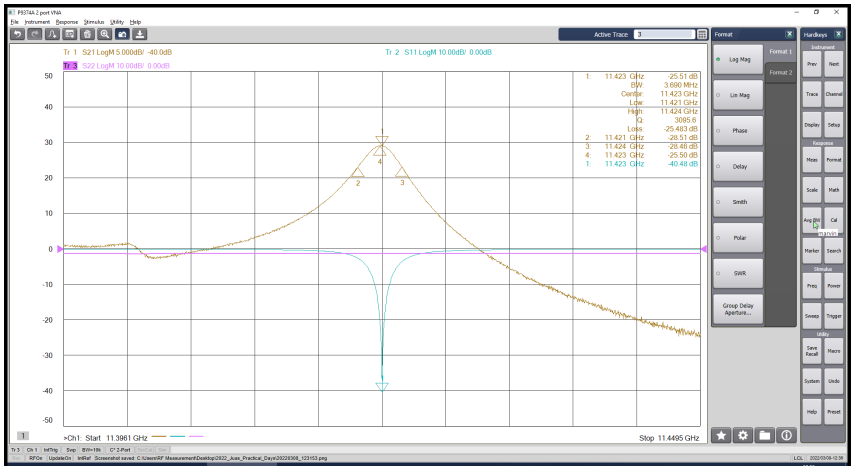
- Network Analyser
  - Time and Frequency Domain
  - Scattering parameter, Impedance, SWR, phase
  - Calculation of Q, reflexion coefficient
- Spectrum Analyser (Modulation)
- Cavities
- Coupling
  - Under, over and critical coupling
  - Smith chart

(l) Cavity setup

Appendix (1) - Multi mode cavaty



(m)



(n)