



# Power Distribution Networks in Multilayer LTCC for Microwave Applications

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**EASTON** 

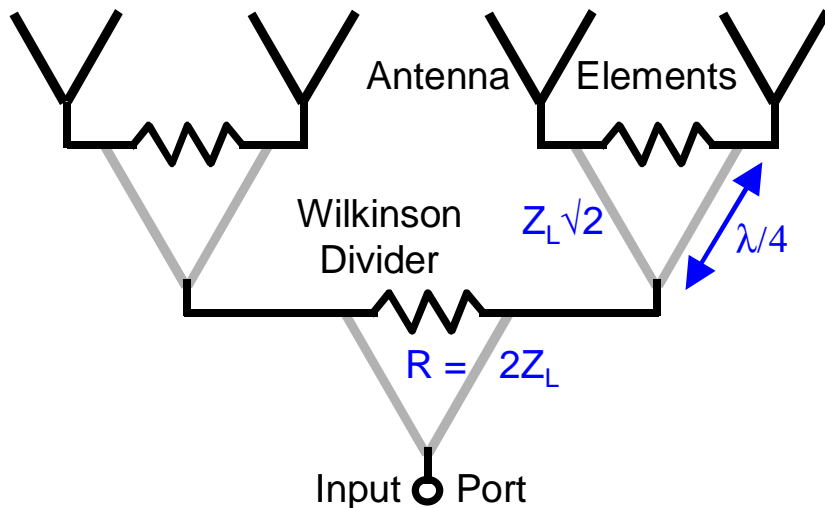


Projekträger des



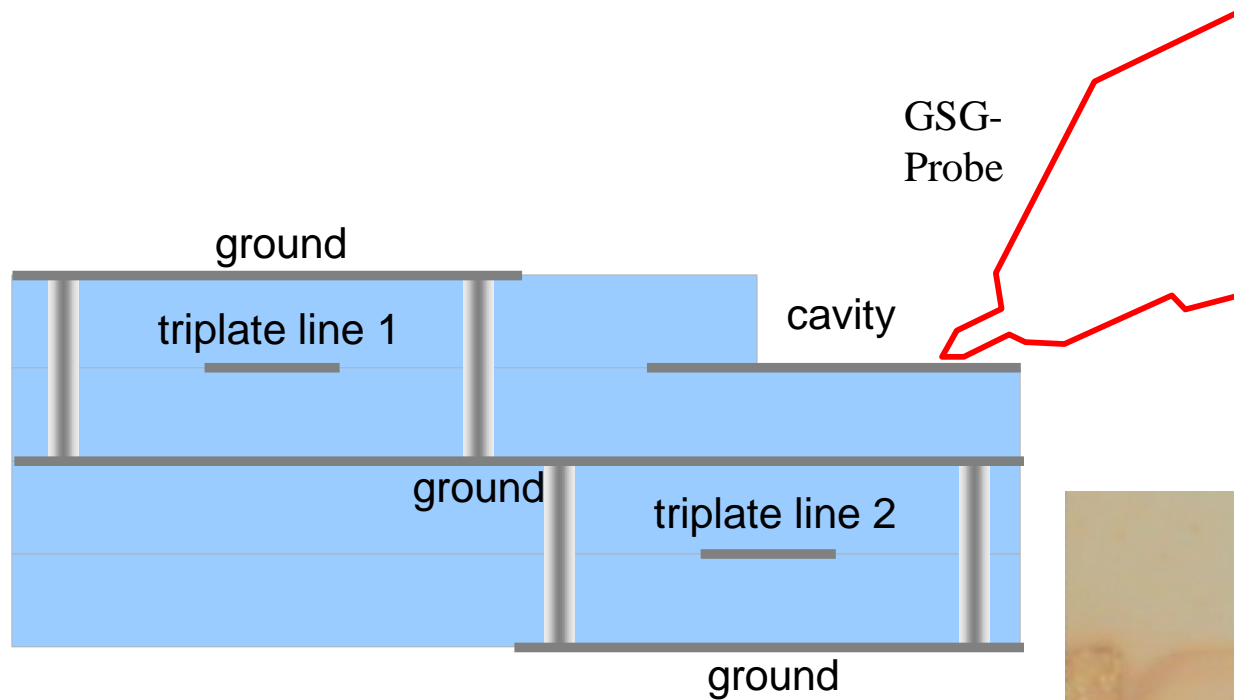
Förderkennzeichen:  
50 YB 0007

# Overview



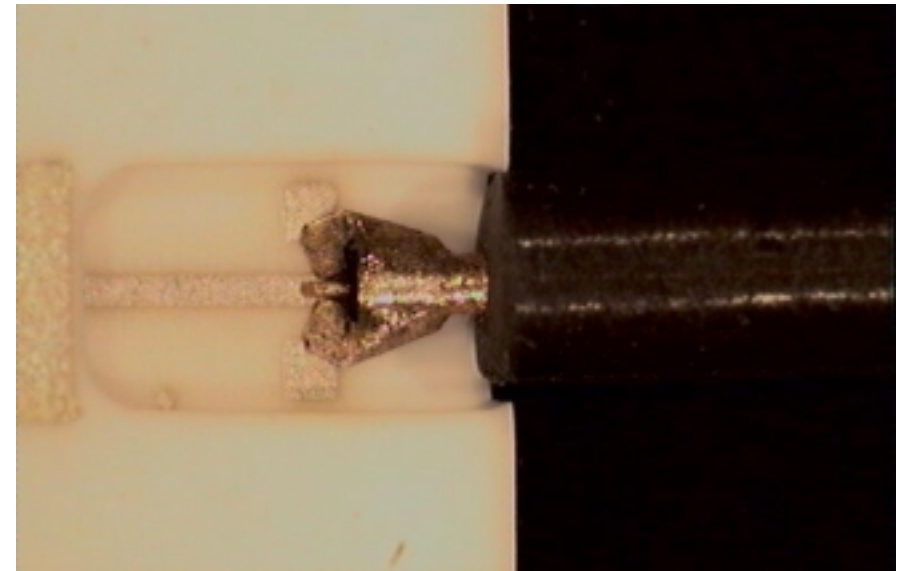
- Design and Measurement
- Components
- System Integration

# On Wafer Probe

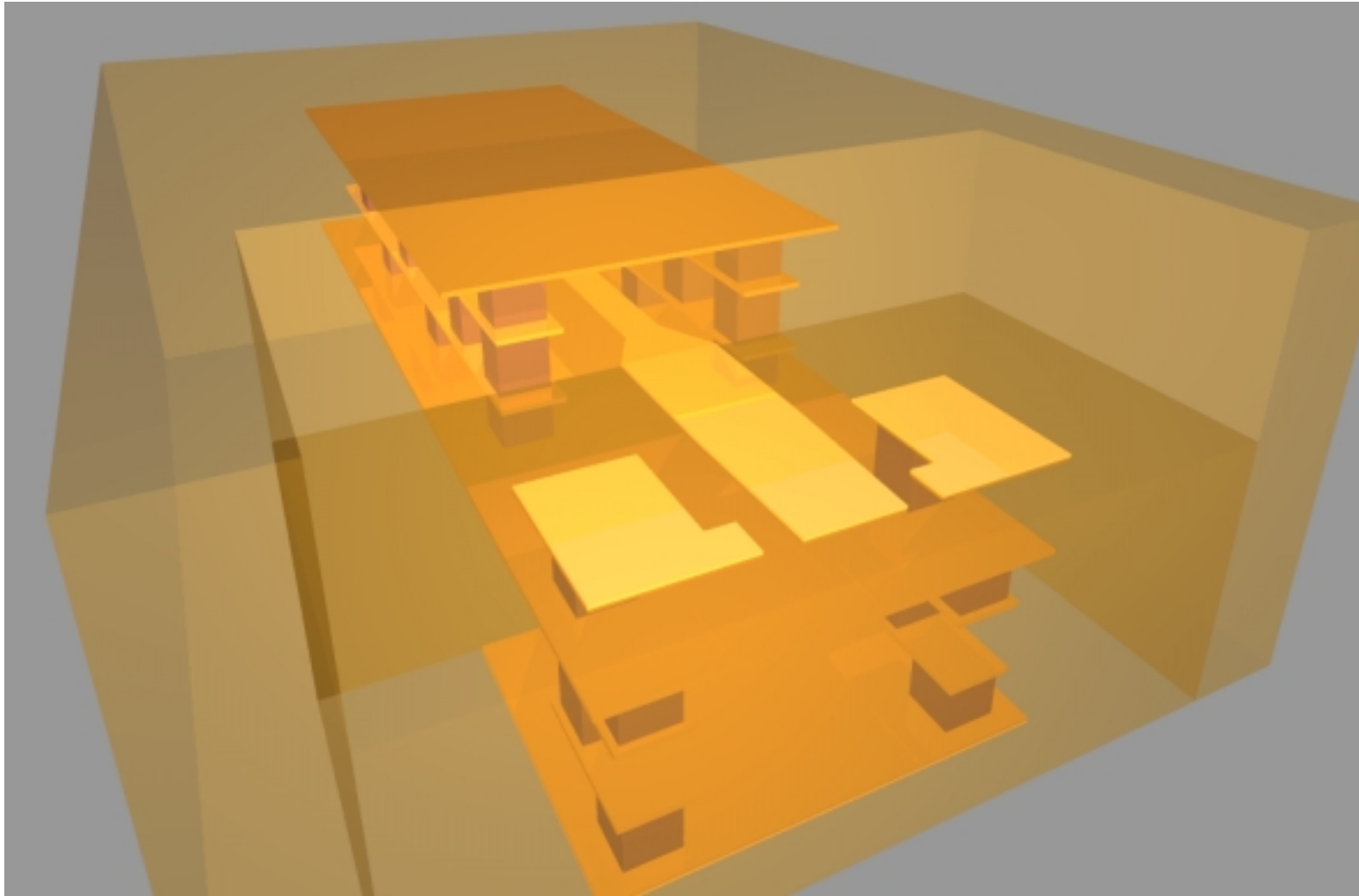


Cross Section of the  $\mu$ W-Port

Top-View



# Transition: Probe Pad 50Ω Stripline



3D View of Simulation model

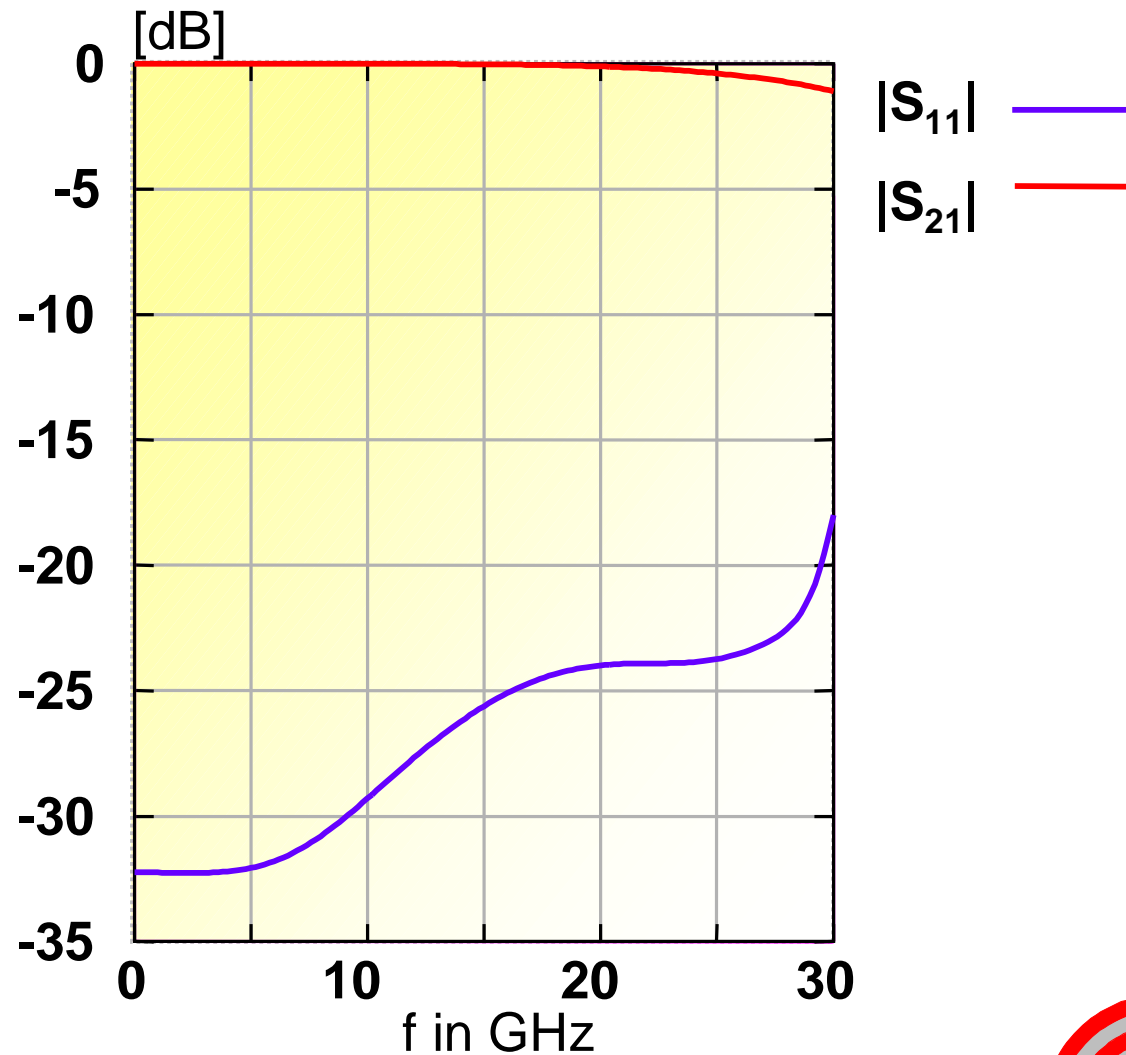
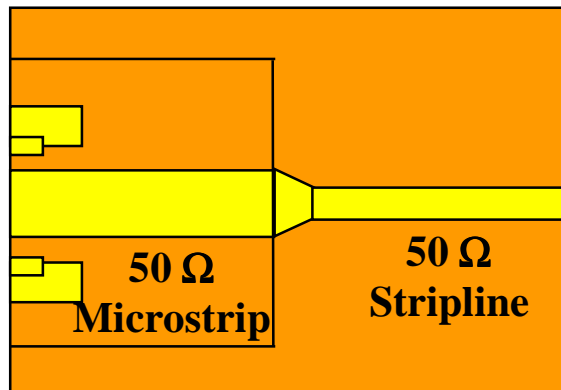


# Transition: Probe Pad

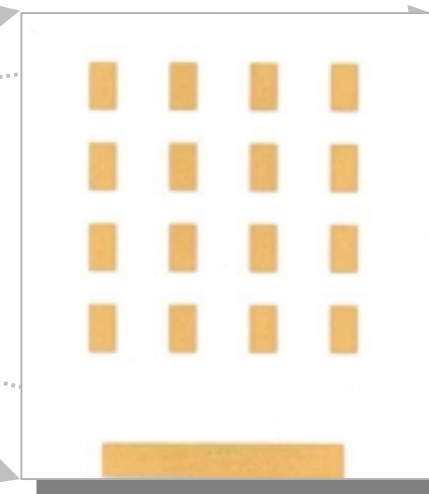
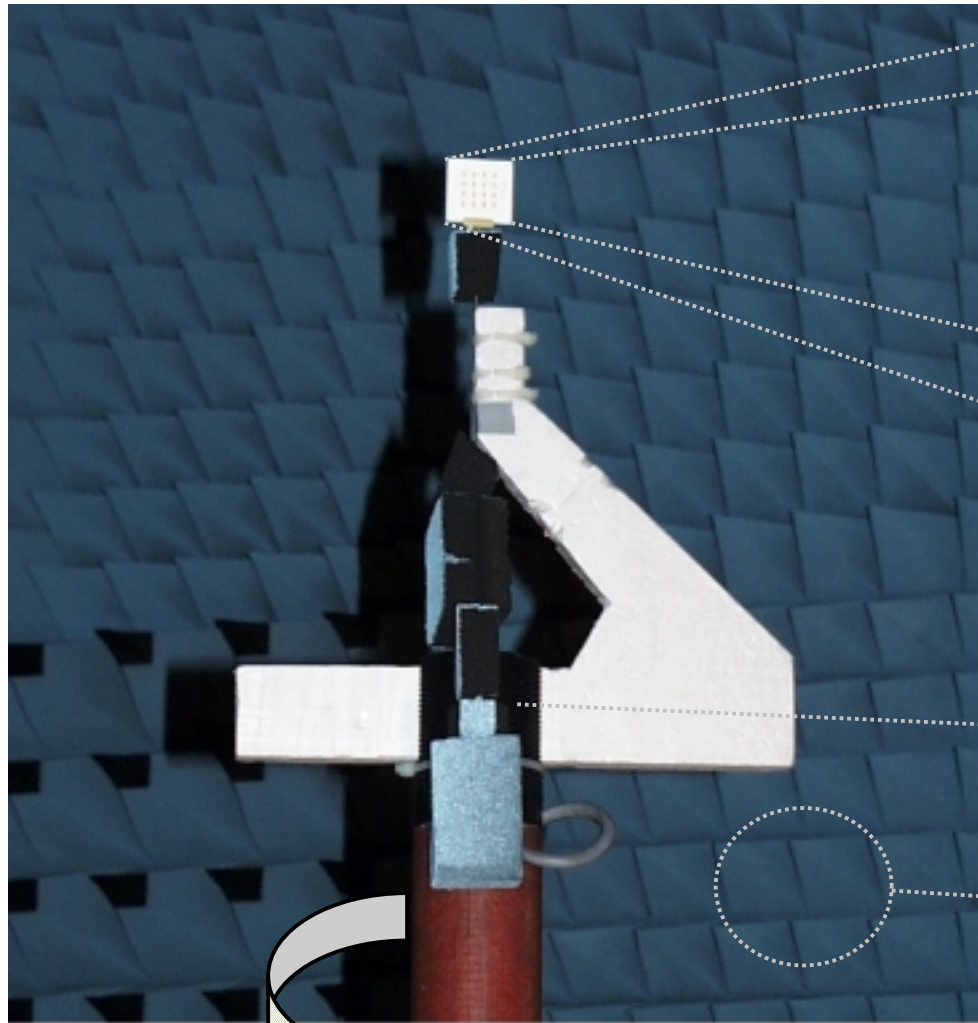
# 50Ω Stripline

Simulation Results:

Top View:



# Antenna Measurement in Anechoic Chamber



Patch Antenna

Positioner

Absorbers

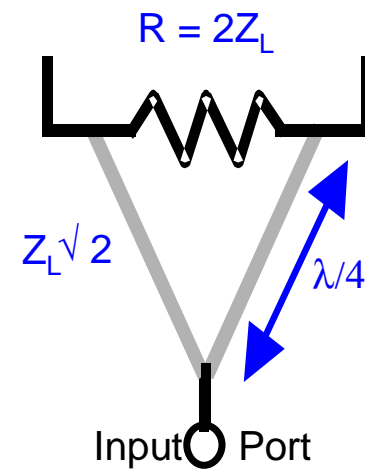
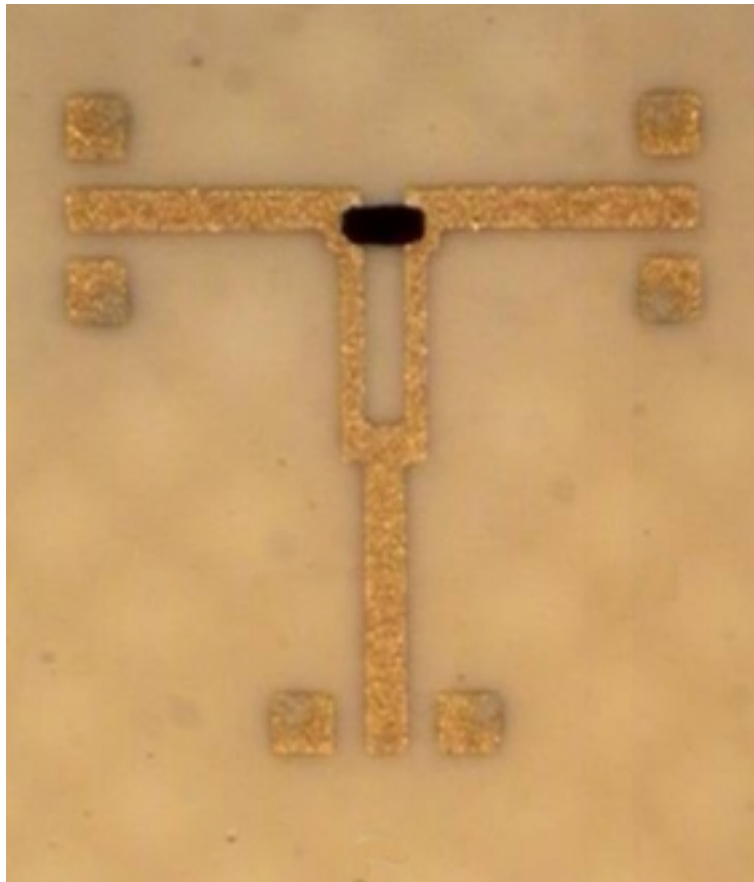


# Components

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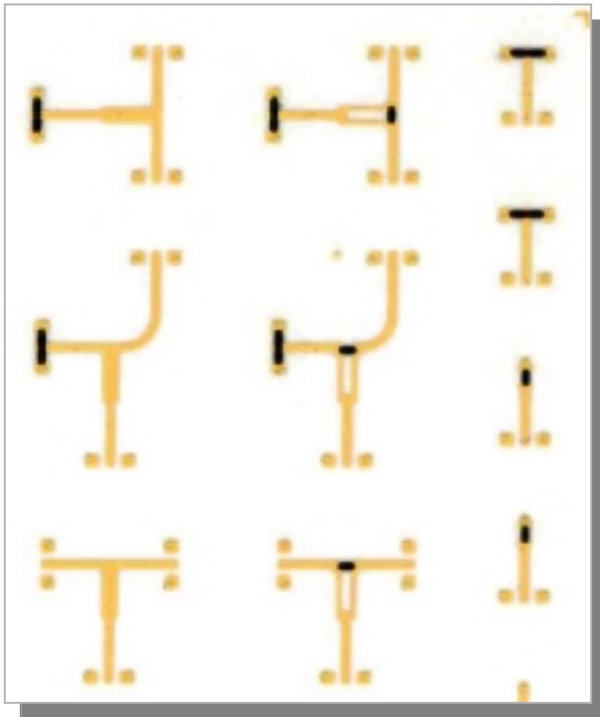
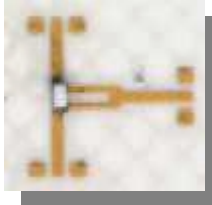
- Wilkinson Power Divider
  - Transmission lines
    - Microstrip
    - Triplate
  - Resistor
- Patch Antenna
- Active Devices

# Wilkinson Power Divider



# Power Dividers on LTCC

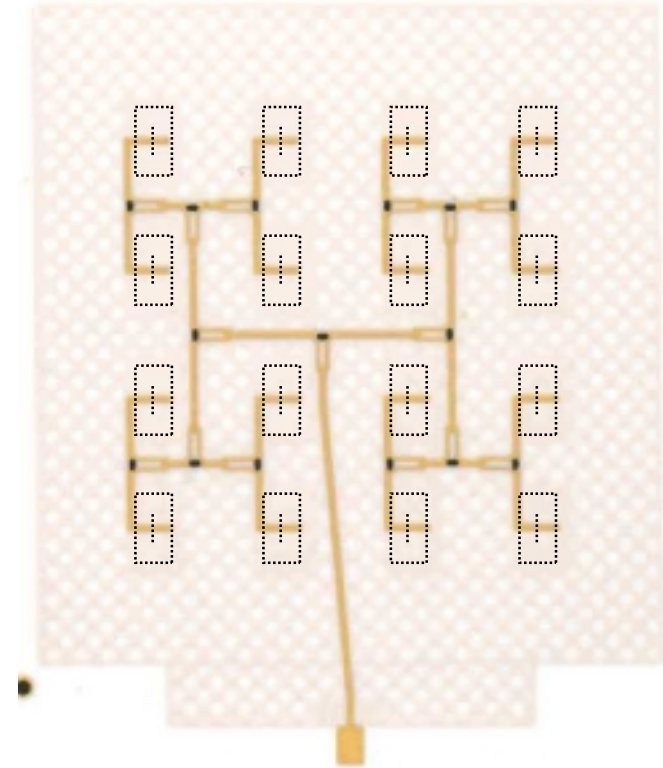
## Wilkinson Power Dividers and T-Junctions



Test Structures

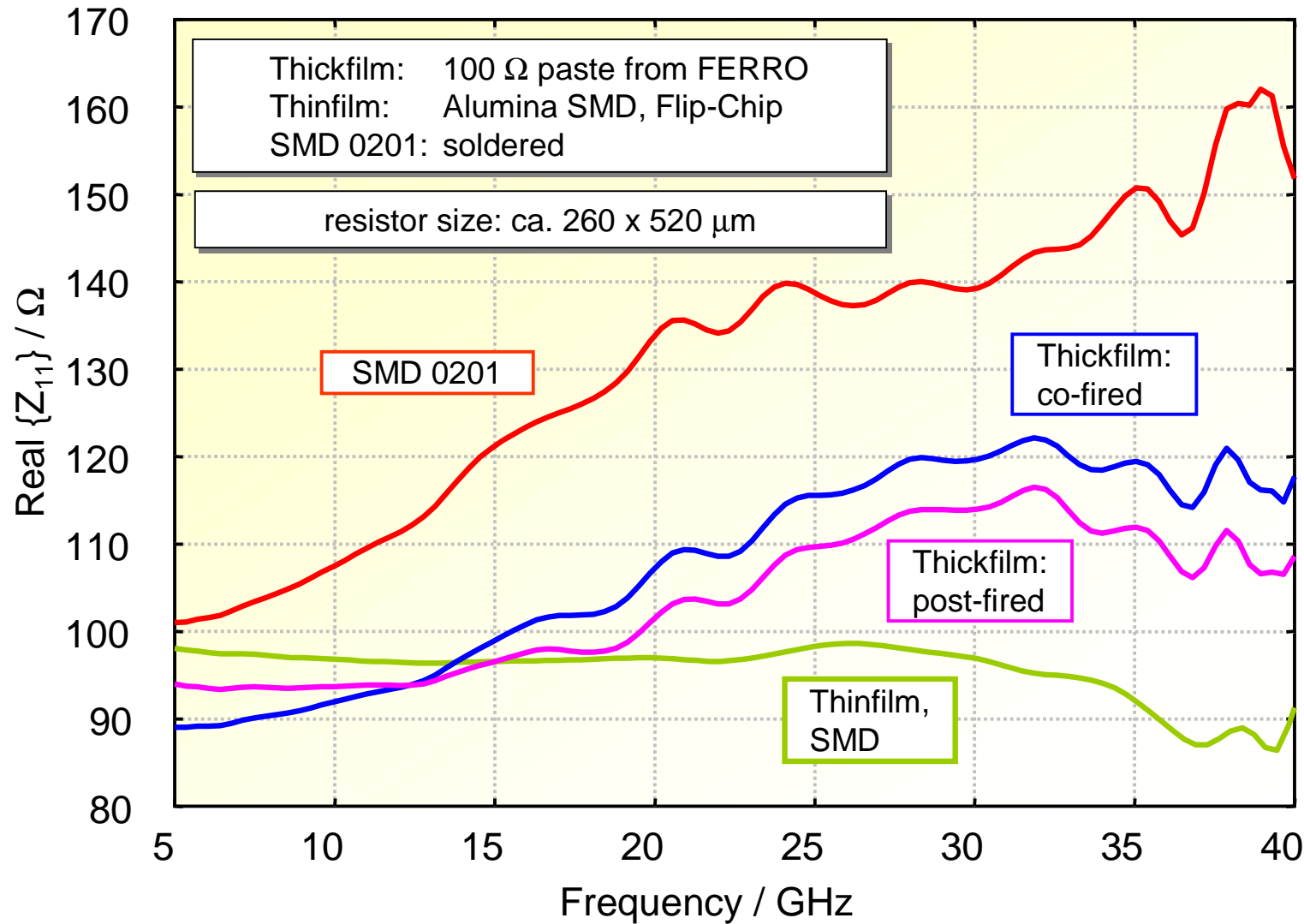


2x2 Patch Antenna

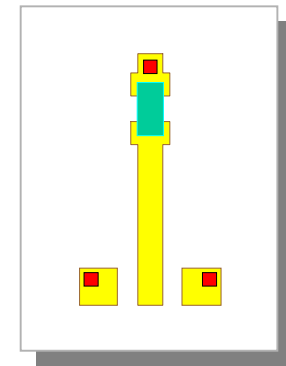


4x4 Patch Antenna

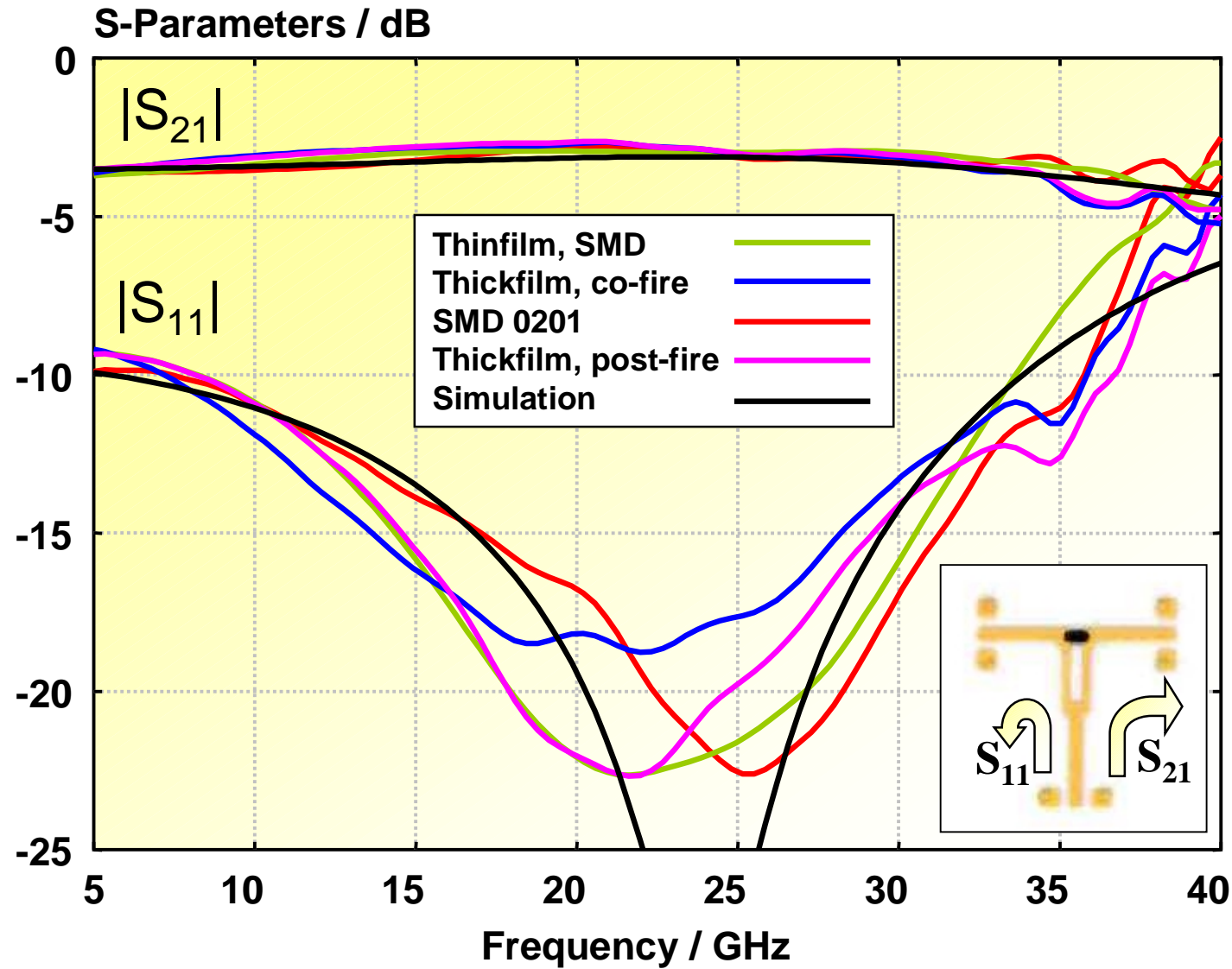
# 100Ω Resistor on LTCC



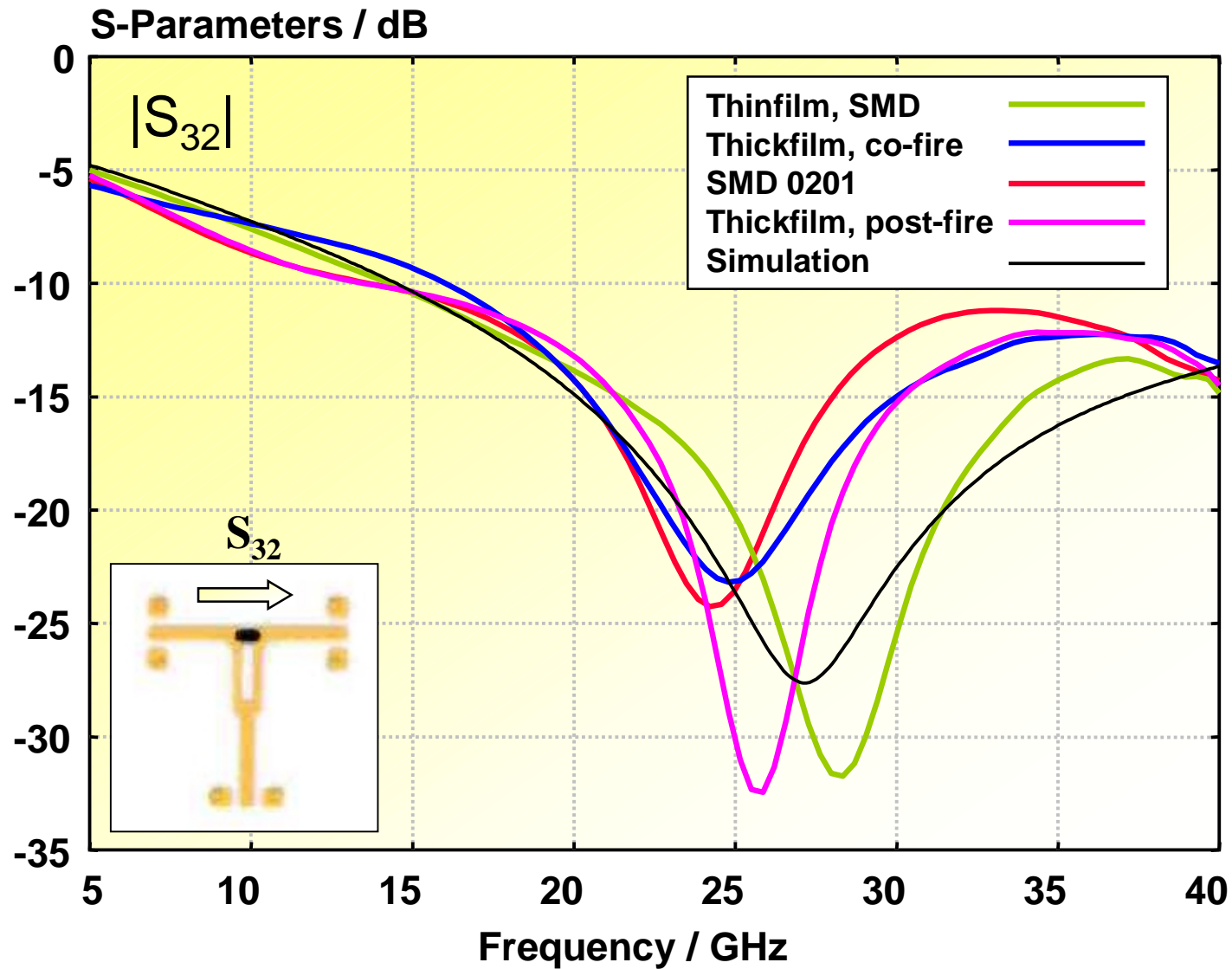
test structure:  
1 x 100 Ω  
with via



# Wilkinson Divider on LTCC



# Wilkinson Divider: Isolation



# 1:8 Divider LTCC vs. PTFE

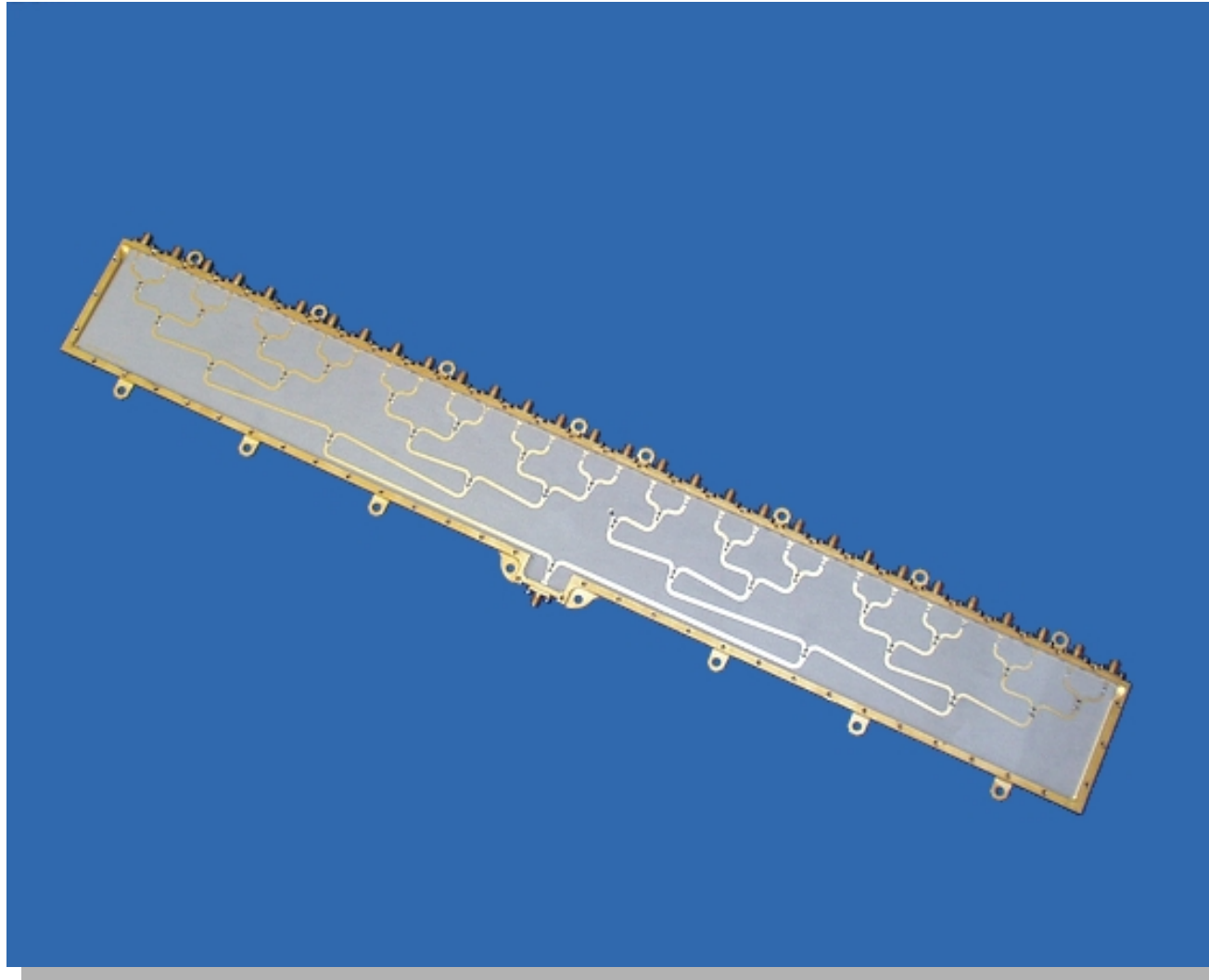
	LTCC: DuPont 951	PTFE Composite: RT/Duroid 6002
waveguide	triplate: thickfilm Au	Microstrip line: Cu
permittivity	7.8	2.94
sheet resistance of conductor	5 mΩ (Au) 3 mΩ (Ag)	1.1 mΩ (½ oz. Cu)
50Ω-line width	425 μm	1950 μm
line loss factor	0.24 dB/cm	0.038 dB/cm
line length	46 mm	144 mm
total line losses	1.1 dB	0.55 dB
outer dimensions <sup>+</sup> [mm]	58 x 24 x 0.7	176 x 67 x 0.8* 200x 90 x 14**
weight <sup>+</sup>	3.2 g	≈ 215 g
TCE [ppm/K]	5.8	16* 24**

<sup>+</sup> no connectors  
\* PTFE substrate  
\*\* Al housing

Comparison of 1:8-divider networks in LTCC and PTFE technology for 10GHz



# 1:30 Divider on PTFE



Length  
650 mm  
25,6"

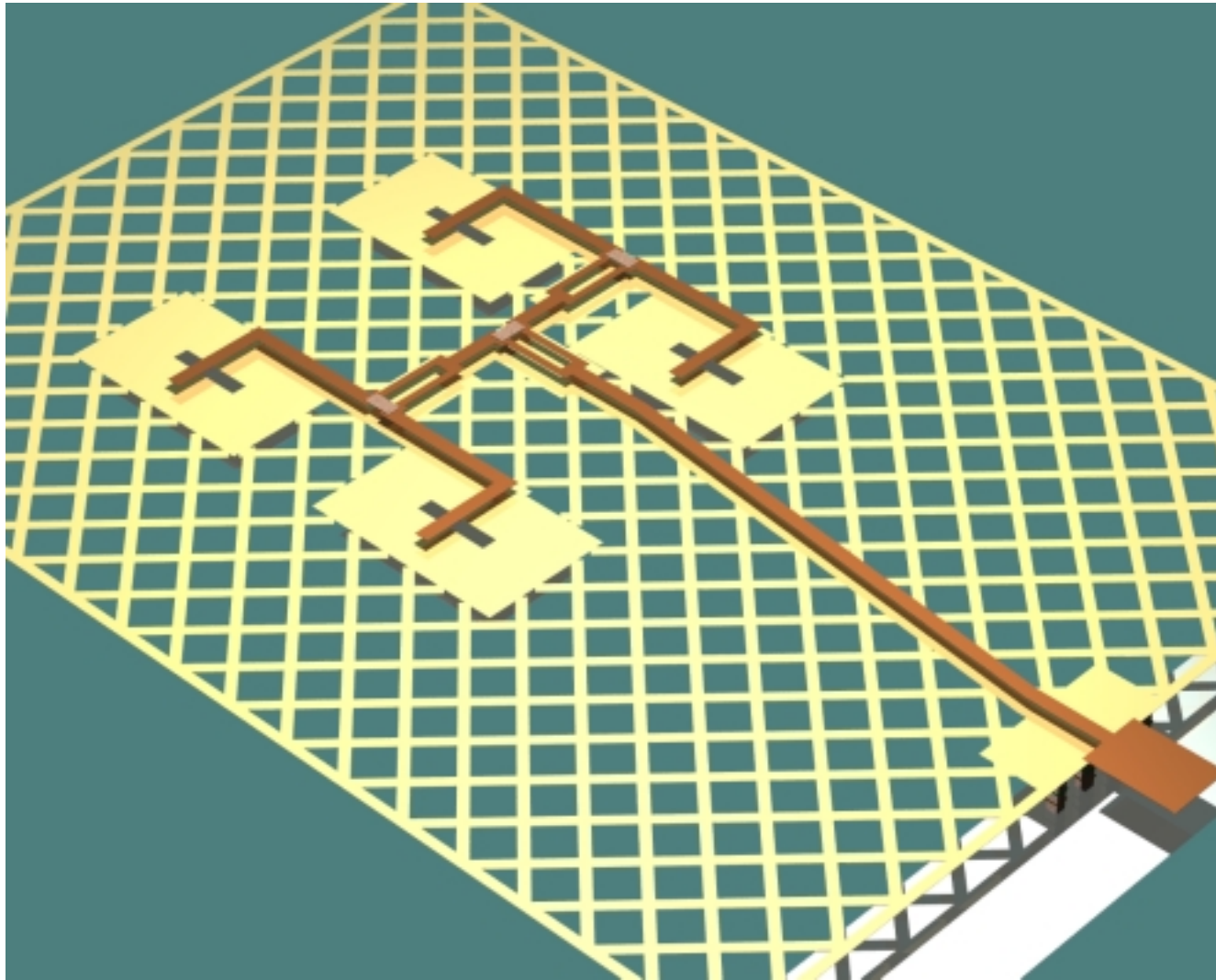
# Patch Antenna

- 2x2 and 4x4 patch antenna with
- different feeding networks
  - T power divider
  - Wilkinson power divider with
    - thick film resistors
    - thin film resistors
    - SMD resistors
- measured gain: 14.5 dBi (4x4 patches)  
8.2 dBi (2x2 patches)
- measured matching about 15 dB
- measured efficiency about 65 %

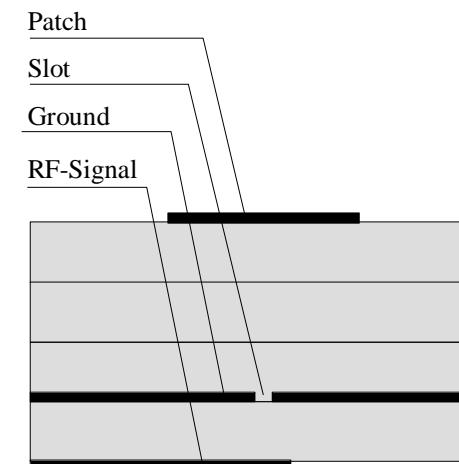
**ISM-Band:  
24.125 GHz**



# 2x2 Patch Antenna

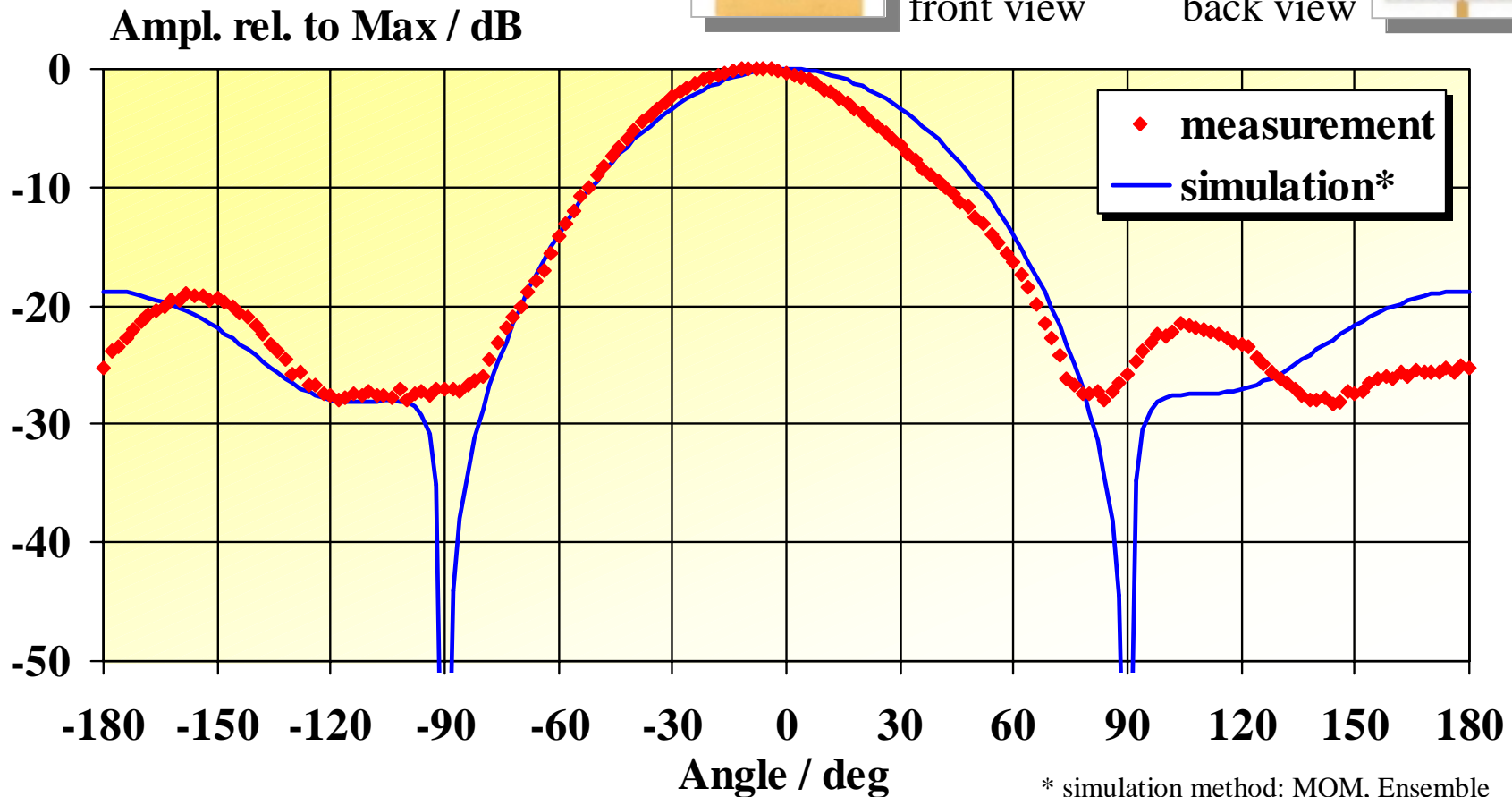
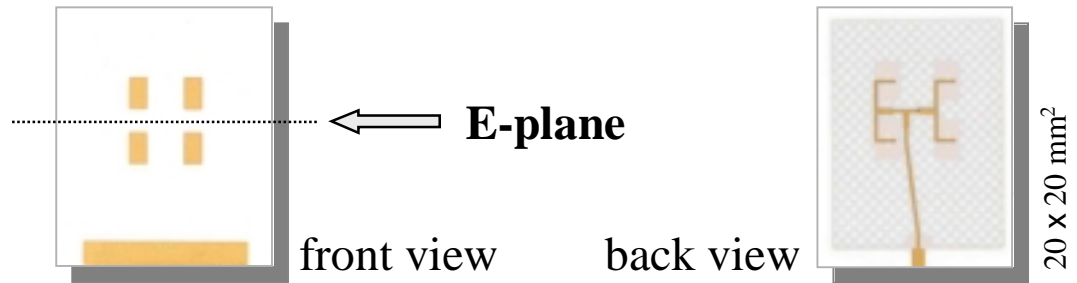


- 2 x 2 Patches
- aperture coupling
- microstriplines
- ground mesh
- Wilkinson-dividers



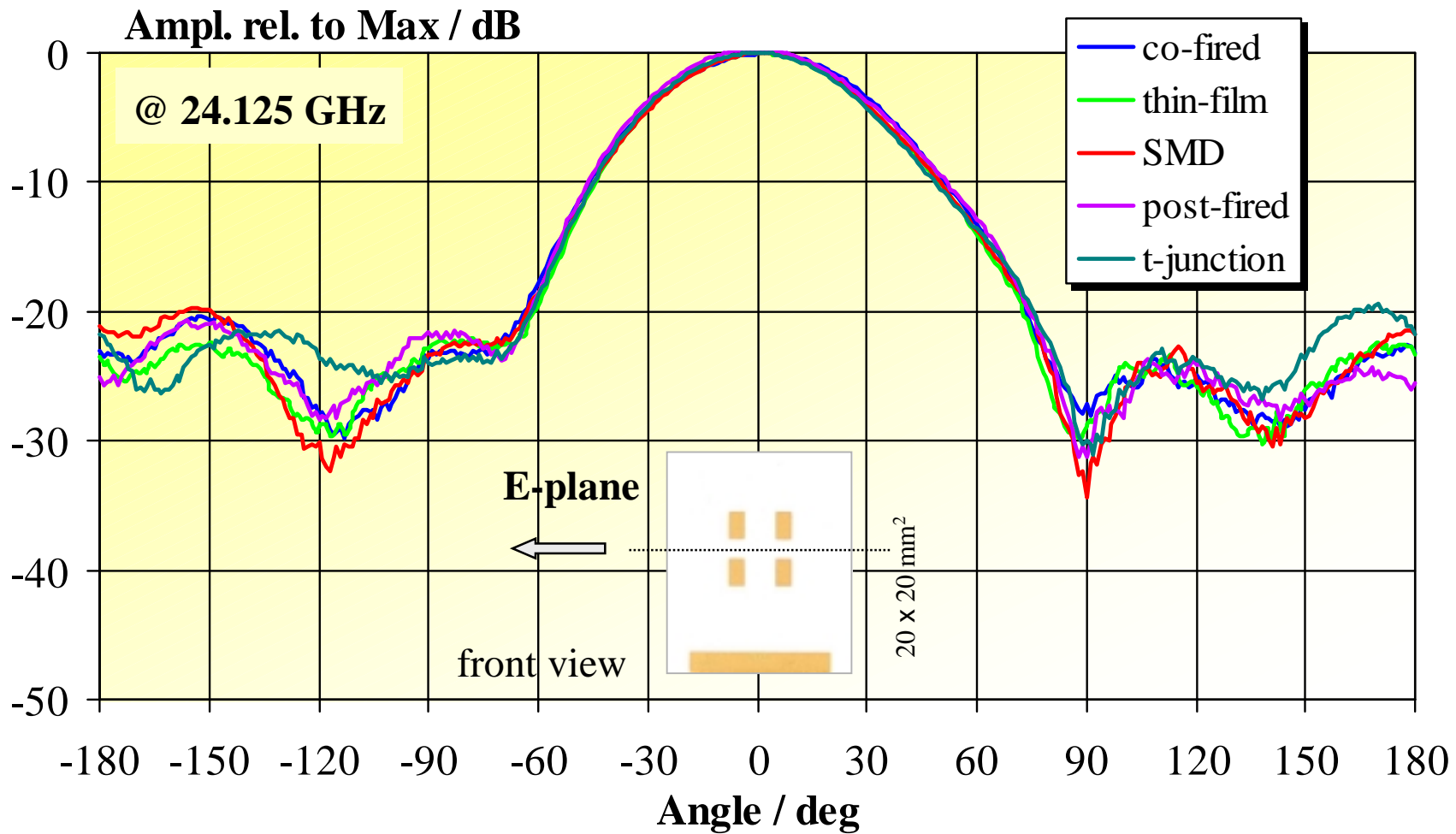
# 2x2 Patches, E-Plane

with T-Divider  
@ 24.125 GHz



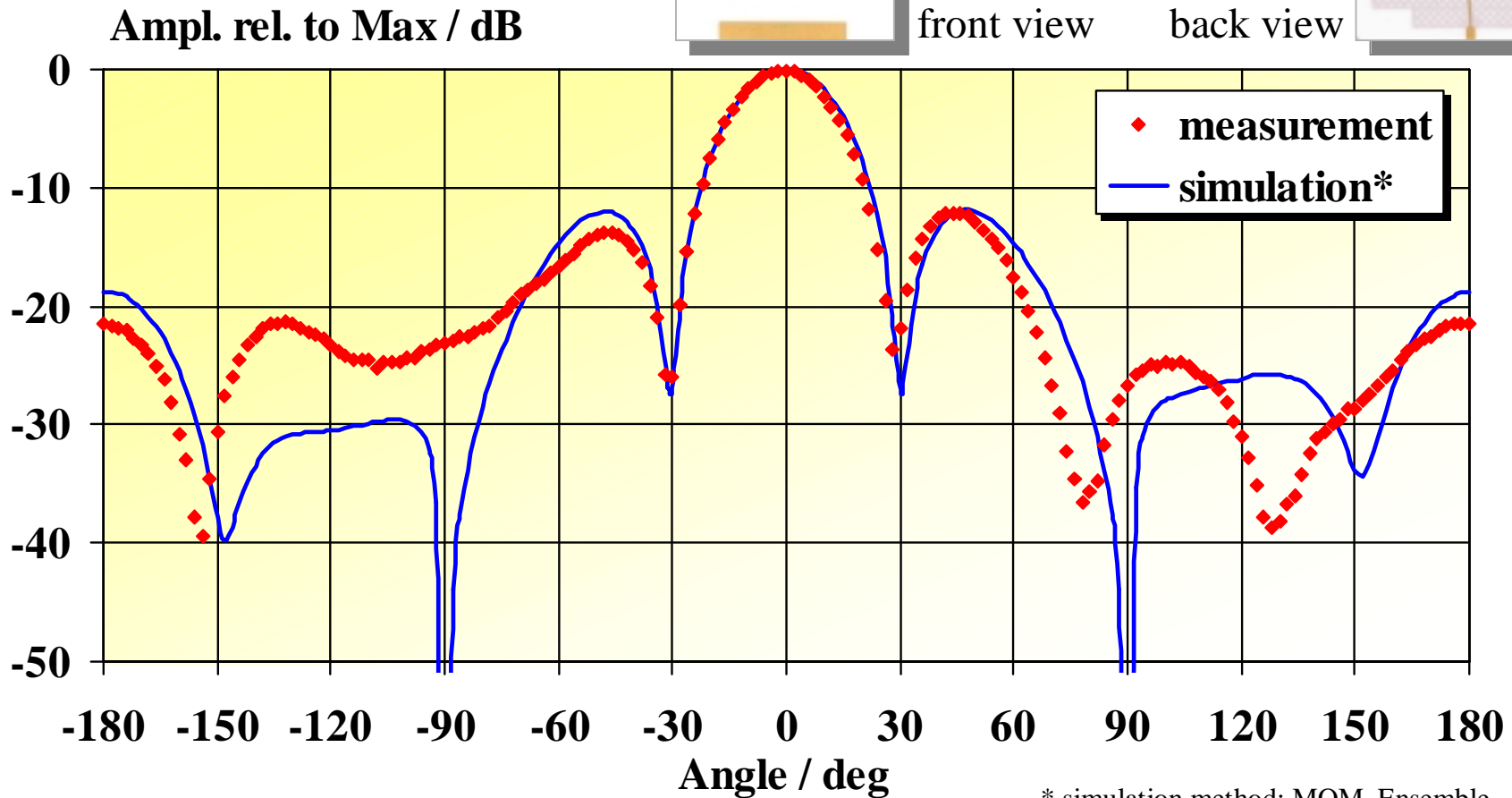
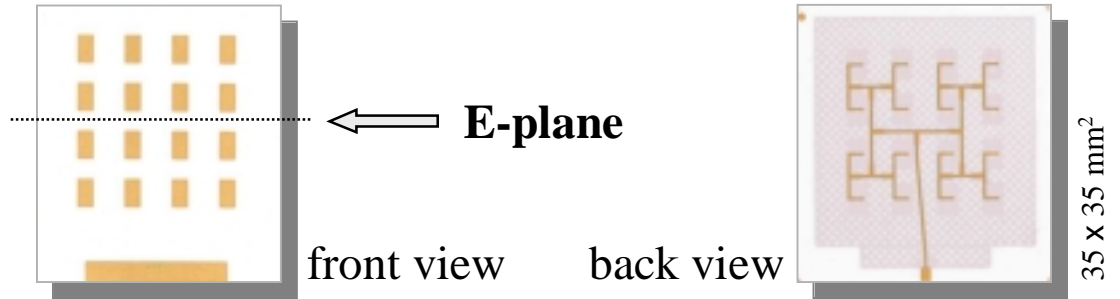
\* simulation method: MOM, Ensemble

# 2x2 Patches, E-Plane



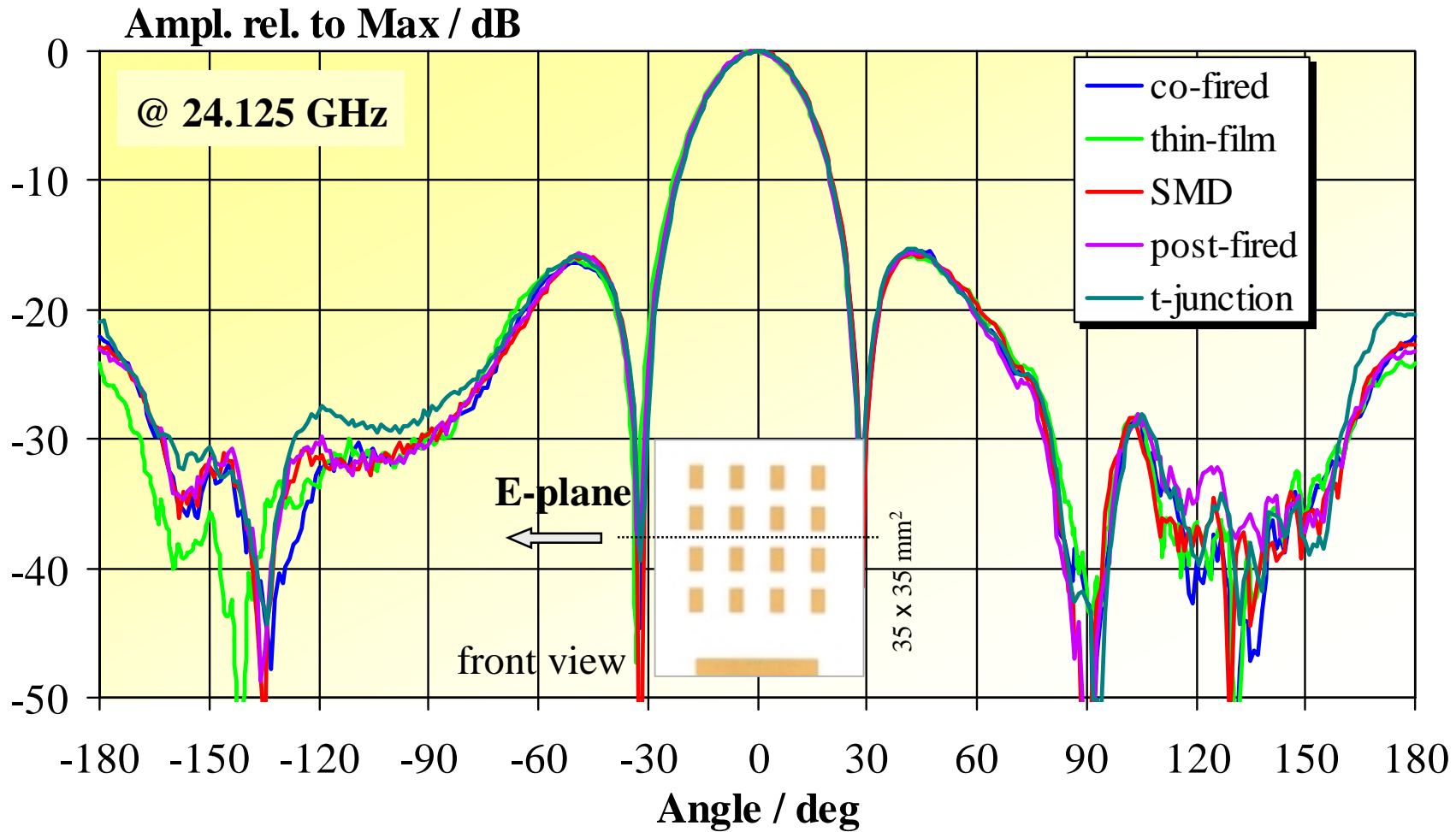
# 4x4 Patches, E-Plane

with T-Divider  
@ 24.125 GHz

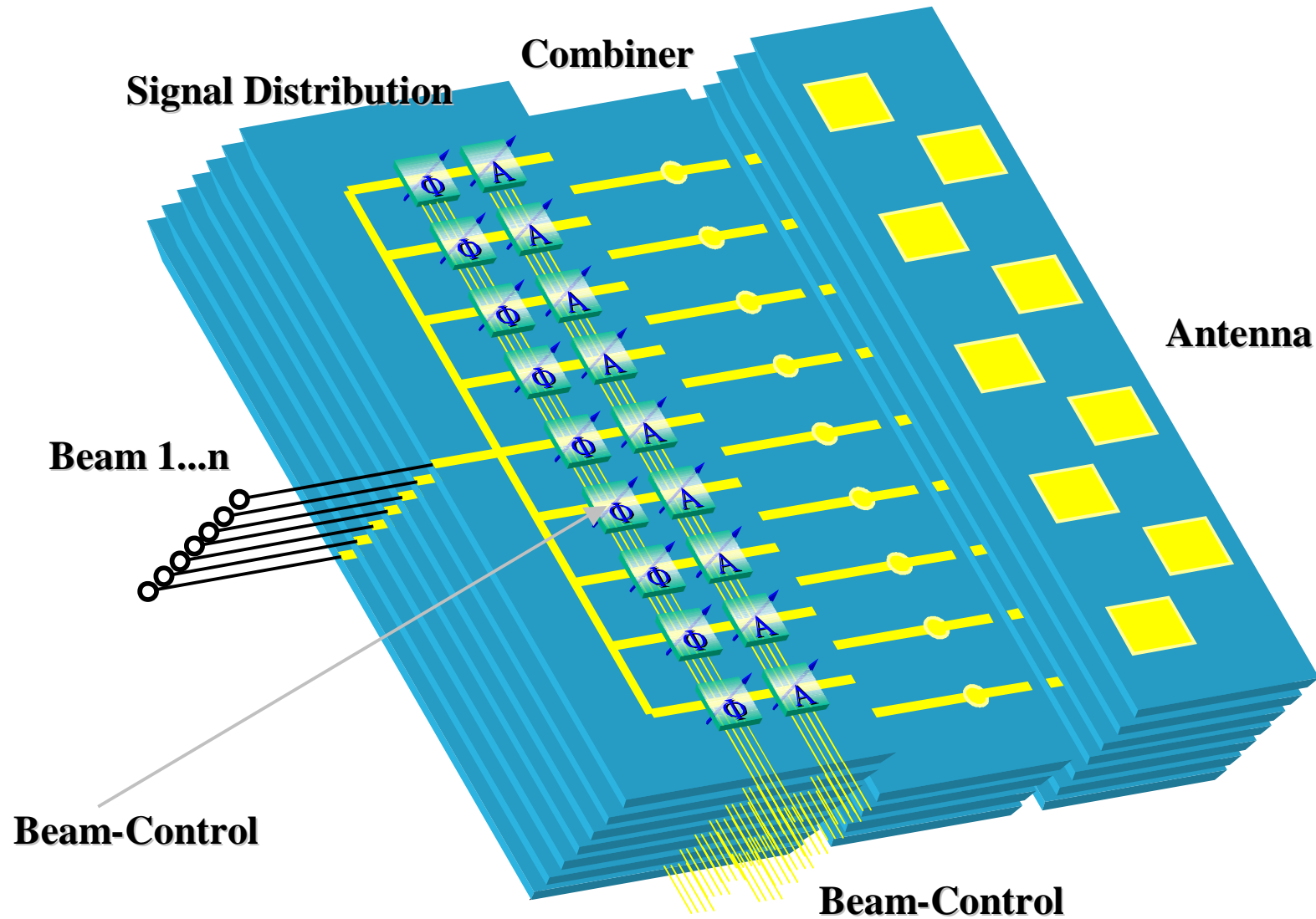


\* simulation method: MOM, Ensemble

# 4x4 Patches, E- Plane



# System Integration on LTCC





# Summary

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Thickfilm resistors and conductors can be used  
in microwave feeding networks

High degree of integration

Economic

<http://www.ltcc.de>

