Multibeam K/Ka-Band Antenna Array for Satellite and Aircraft

Stefan Lindenmeier, Engelbert Tyroller, Andreas Krause

Department of RF-Technology at the
Universität der Bundeswehr München

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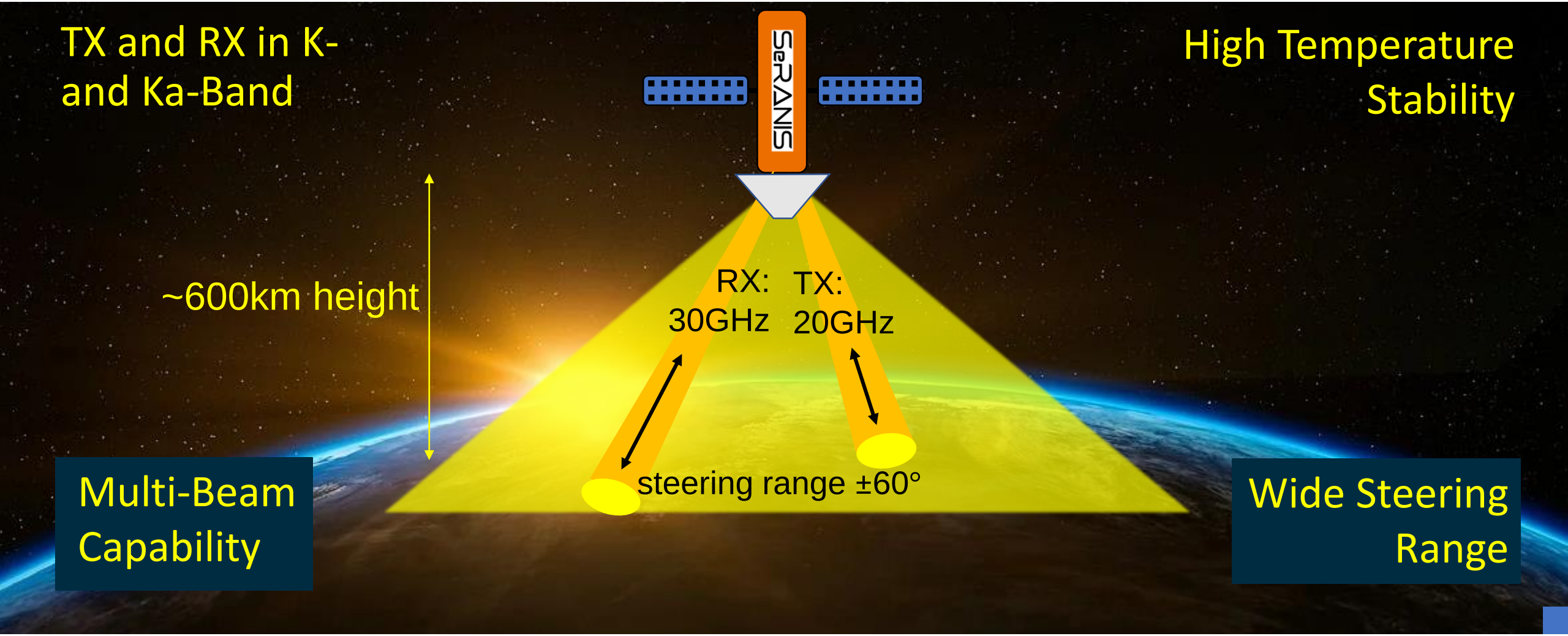
1. K/Ka-Band-Antenna Array



Outline

- Requirements
- Basic Principle
- Simulation Model
- Antenna Patterns
- Prototype
- Measurements
- Conclusion

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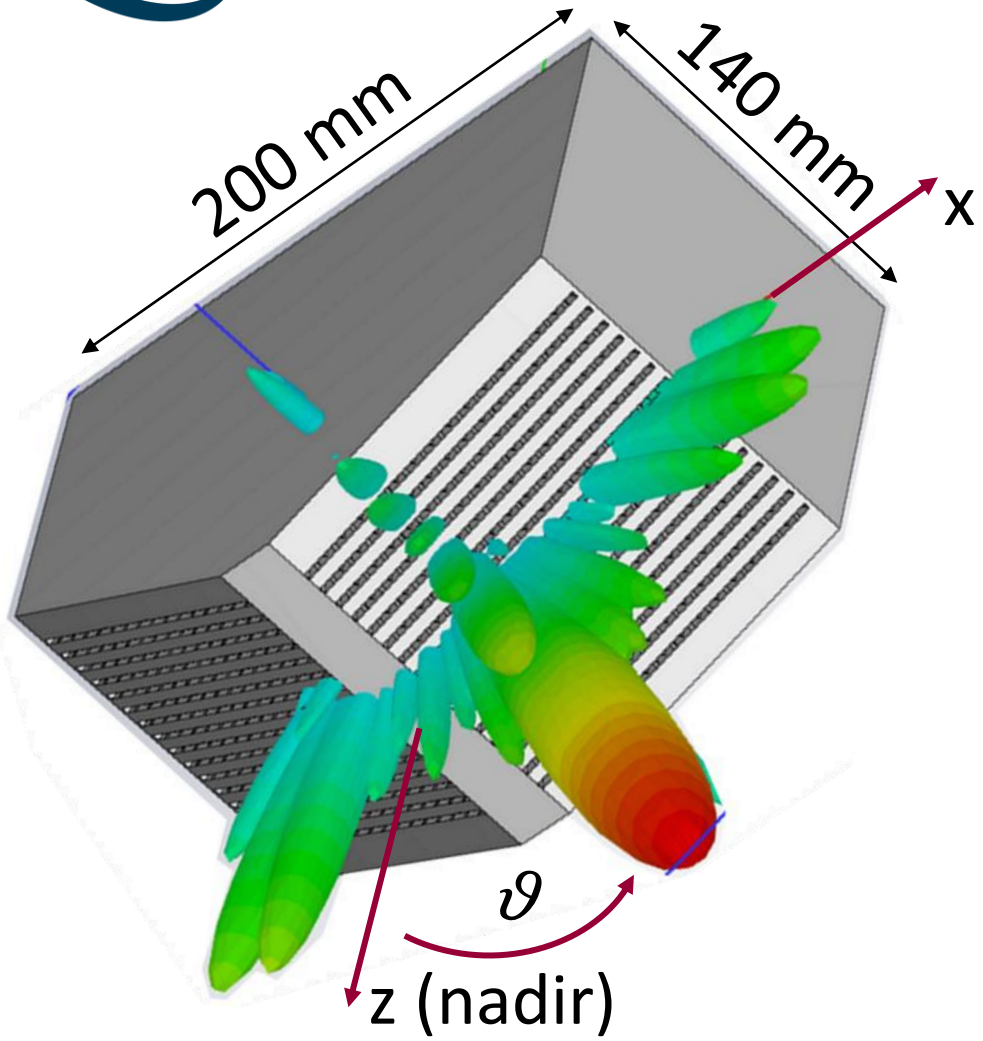
New K/Ka-Band Antenna Array Concept



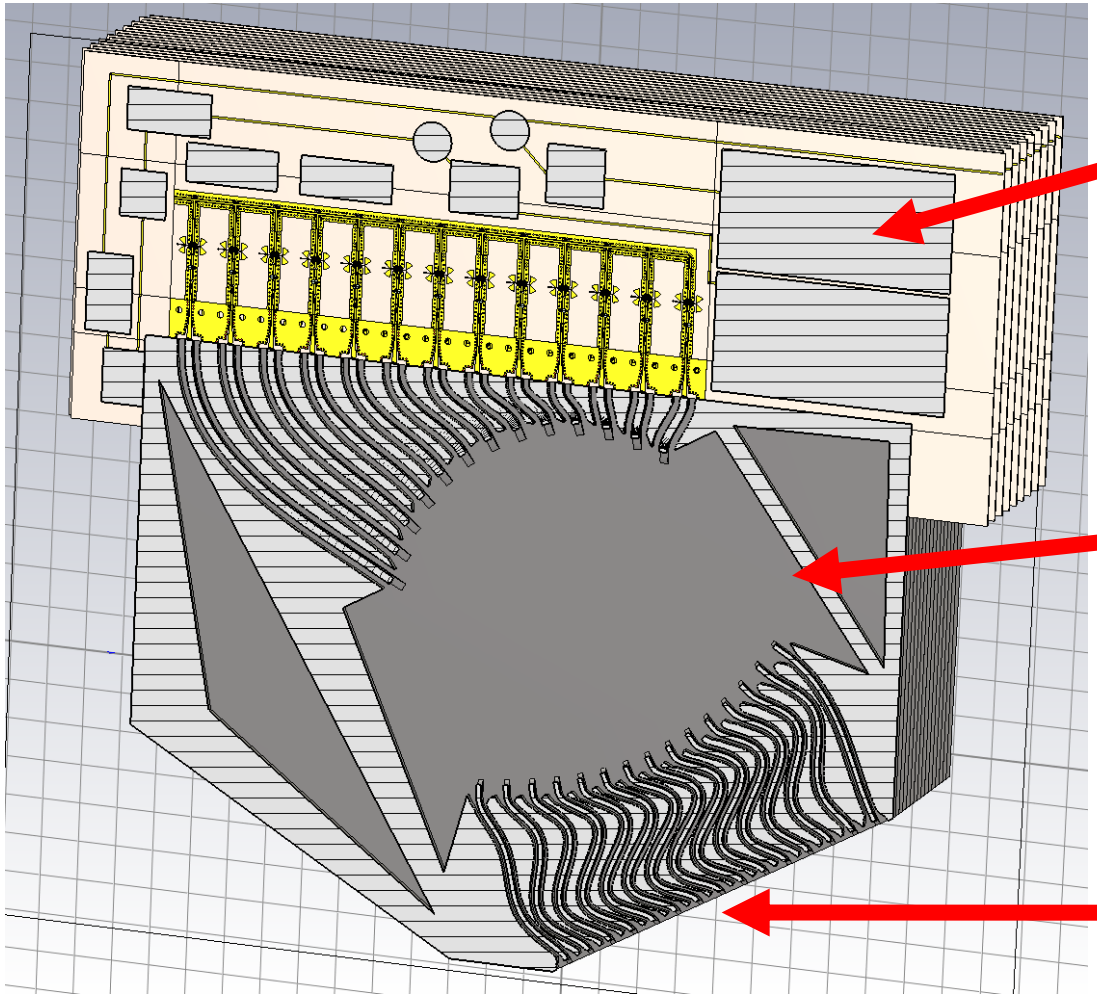
- Two 2D arrays, for frontside and backside
- Each 2D array consists of 16 linear arrays
- Each linear array contains 11-15 hollow waveguide radiators
- Steering range front 2D-array: -60° to 0°]
- Steering range back 2D-array: 0° to 60°

→ Steering range ϑ = ± 60° in x-z-plane

- Steering range in y-z-plane: ϑ = ± 40°
- Multiple beams possible

New K/Ka-Band Antenna Array Concept

Structure of **16 Layers,** each containing:



Bi-directional frontend and active **power distribution** circuits for 20 GHz and 30 GHz

Electromagnetic lens in an alumina body in hollow waveguide technology

Array of radiators

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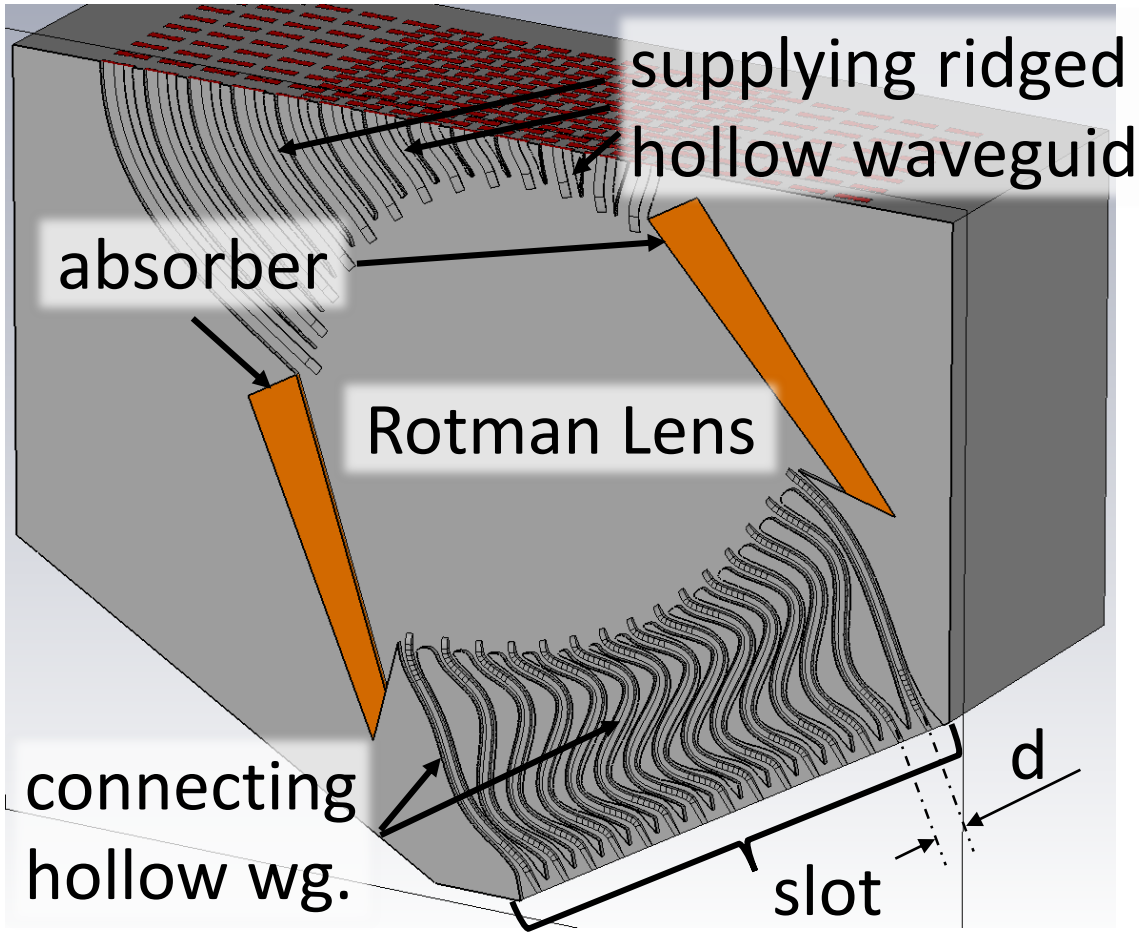
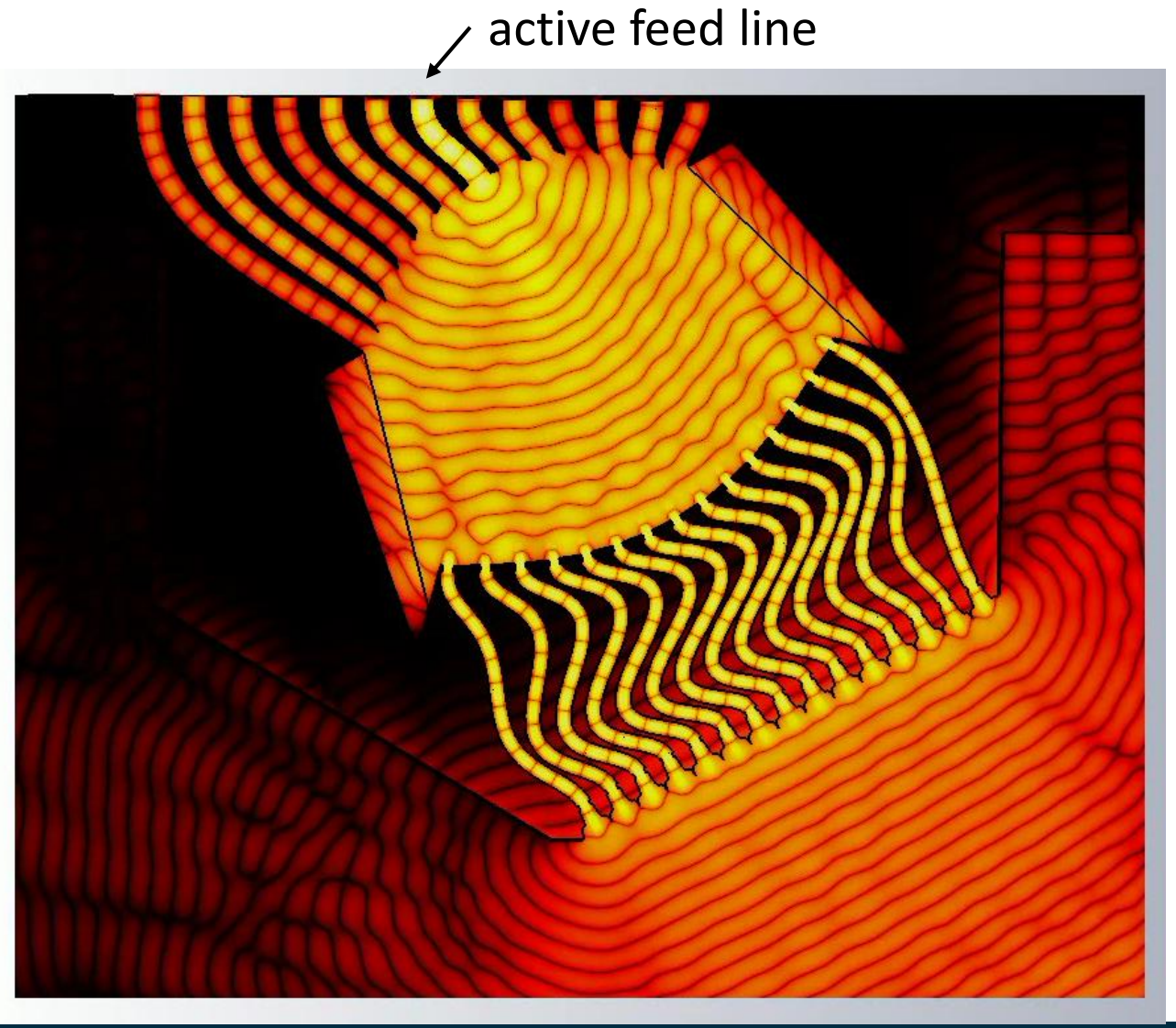
Basic Principle and Simulation Model



- cut through layer (3D layer)
- red squares on top = RF power input
- d = .55λ @ 24.2 GHz (center *f*)
- consists of aluminum

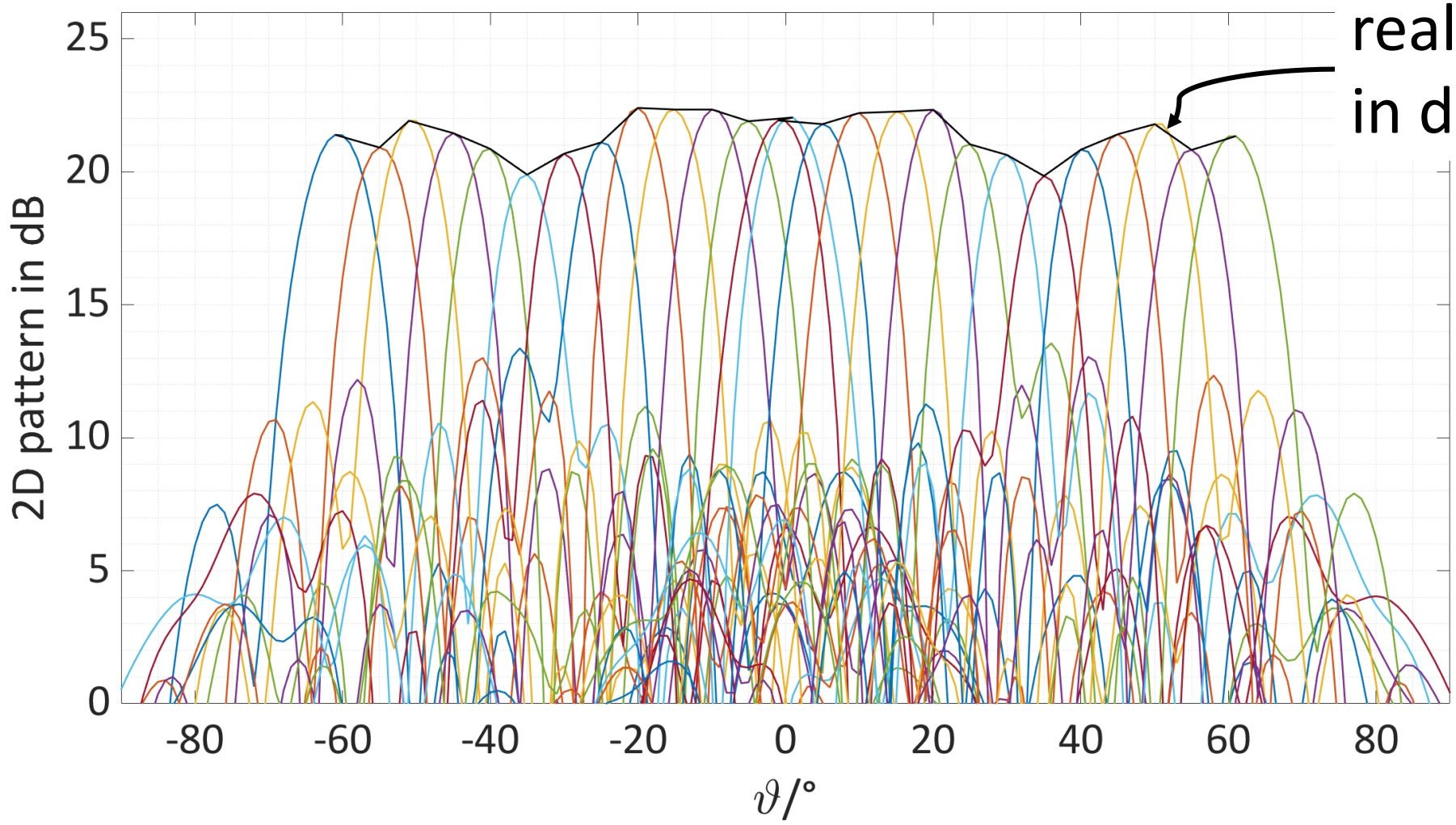
Simulation @ 30 GHz



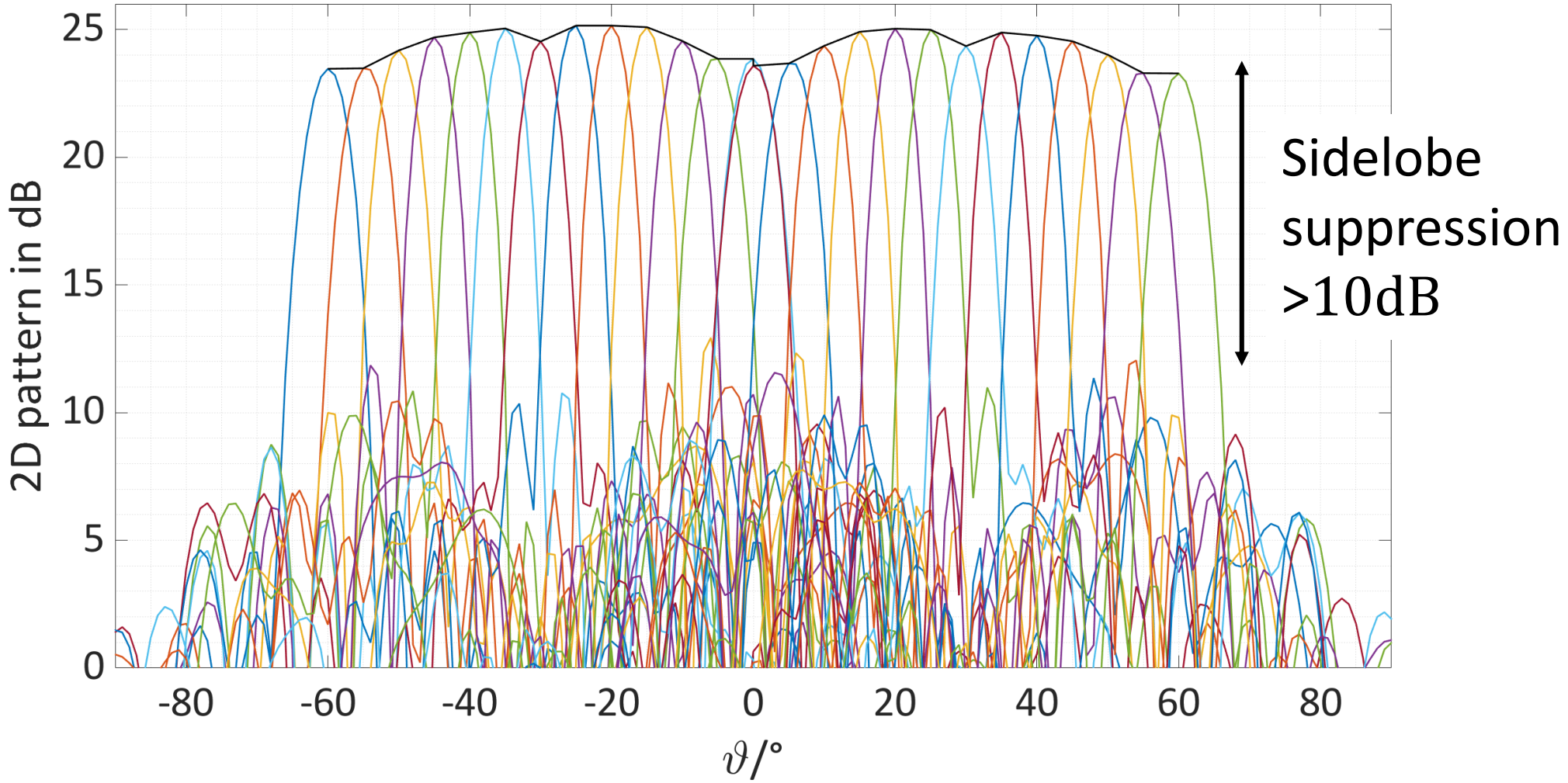
Electromagnetic lens for power distribution

Waves propagating in the chosen direction

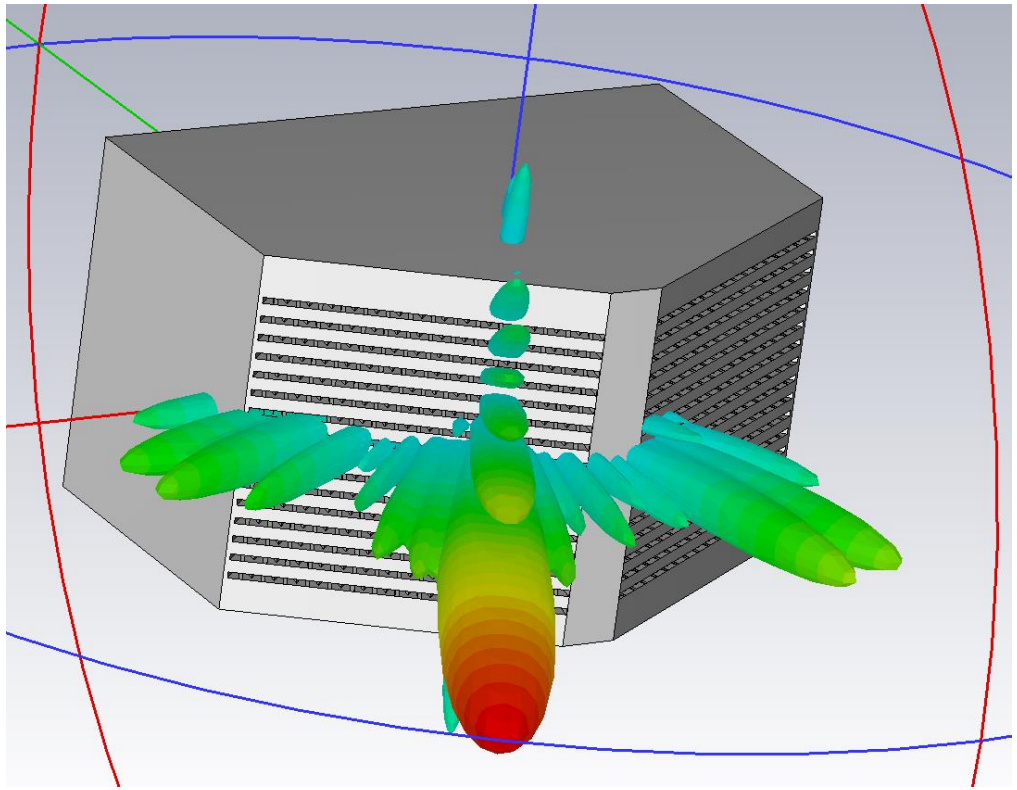
Simulated Radiation Patterns @ 20 GHz

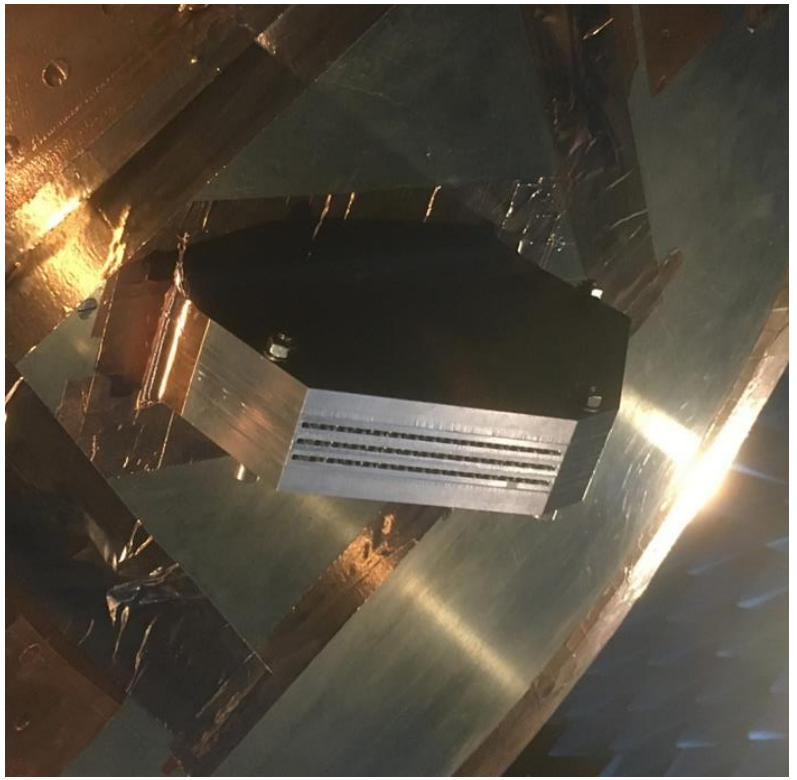


Simulated Radiation Patterns @ 30 GHz



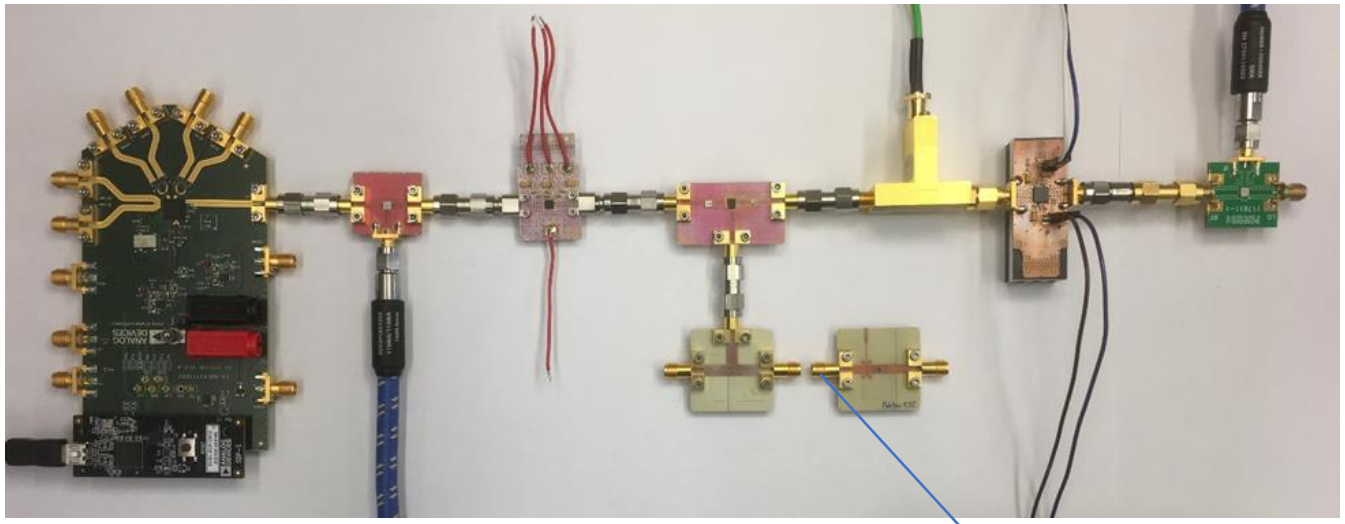
Simulation Model and first Prototype

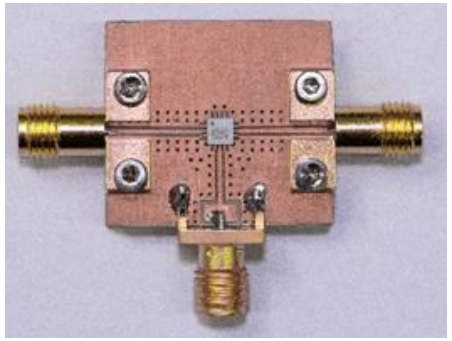


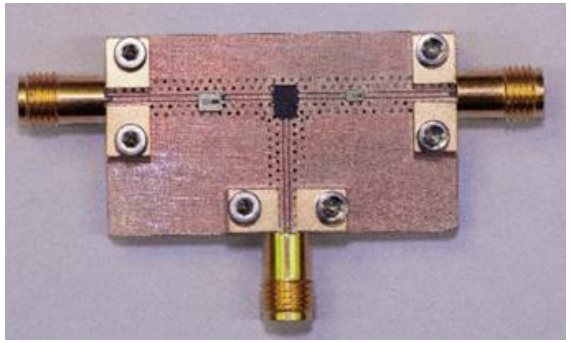


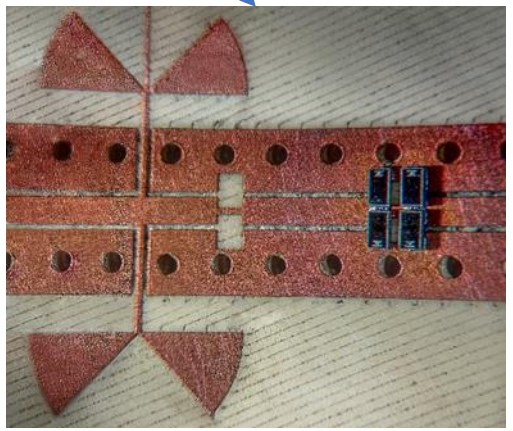
Active RF-Microwave Circuits

Test Setup of Frontend Circuit Components for advanced investigations









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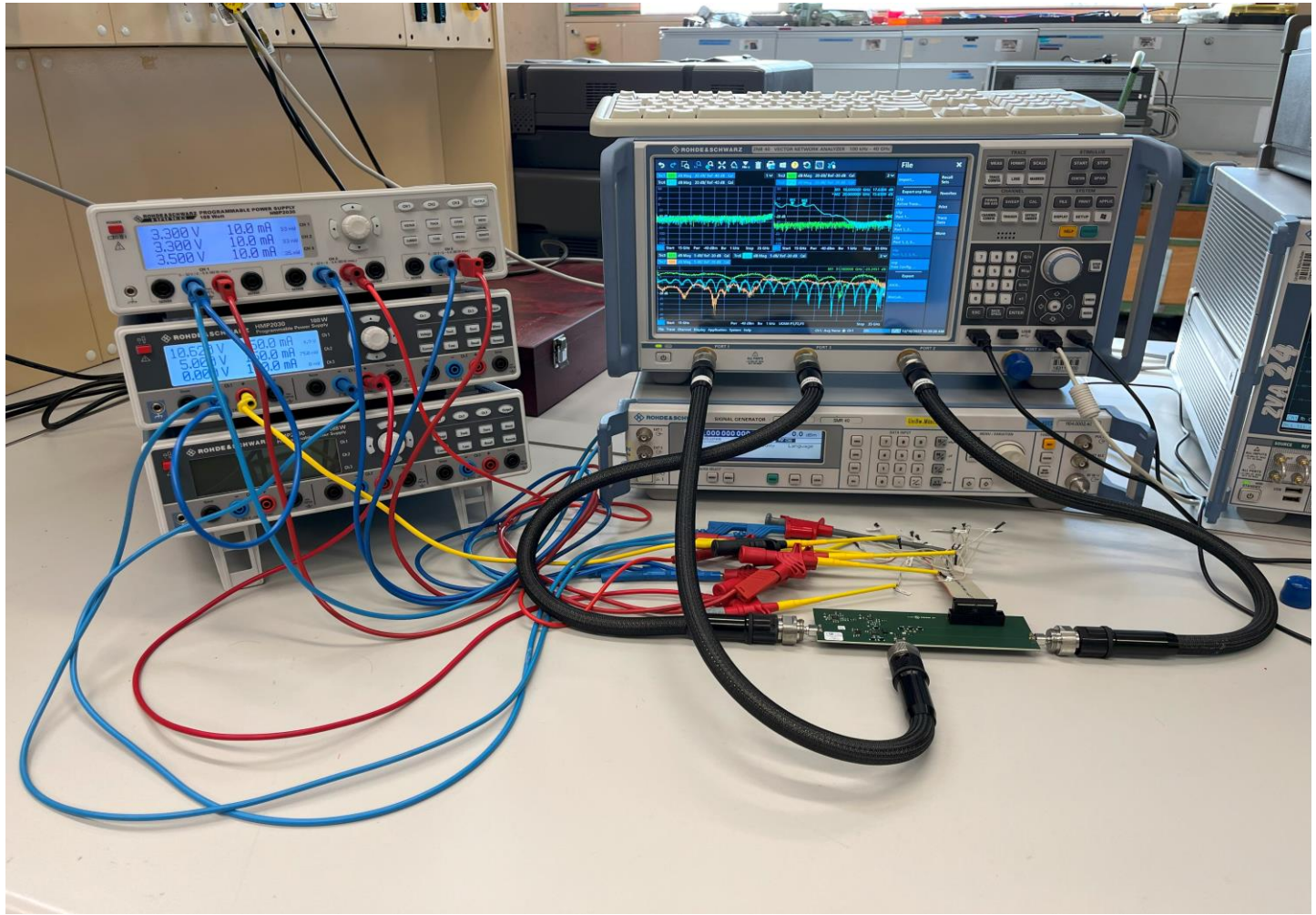
Test of new Frontend PCB‘s



Combination in one Frontend PCB ready and working!

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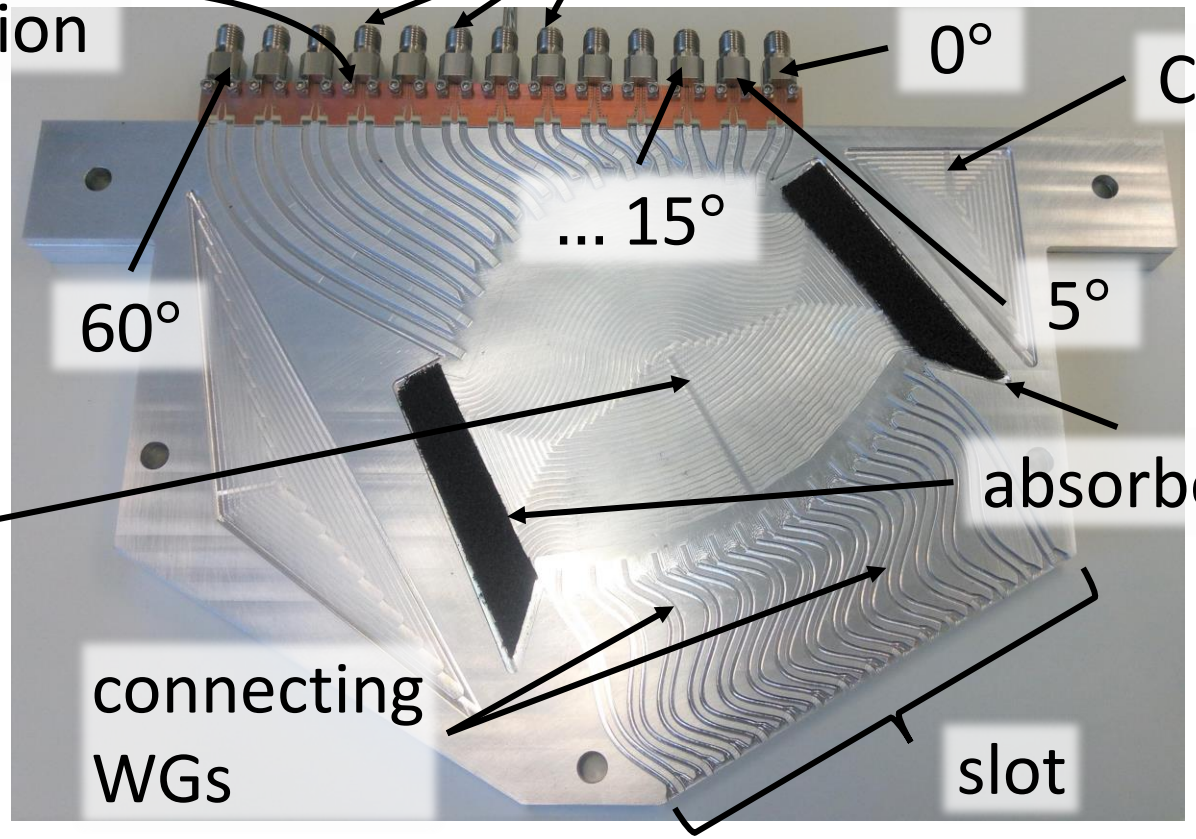
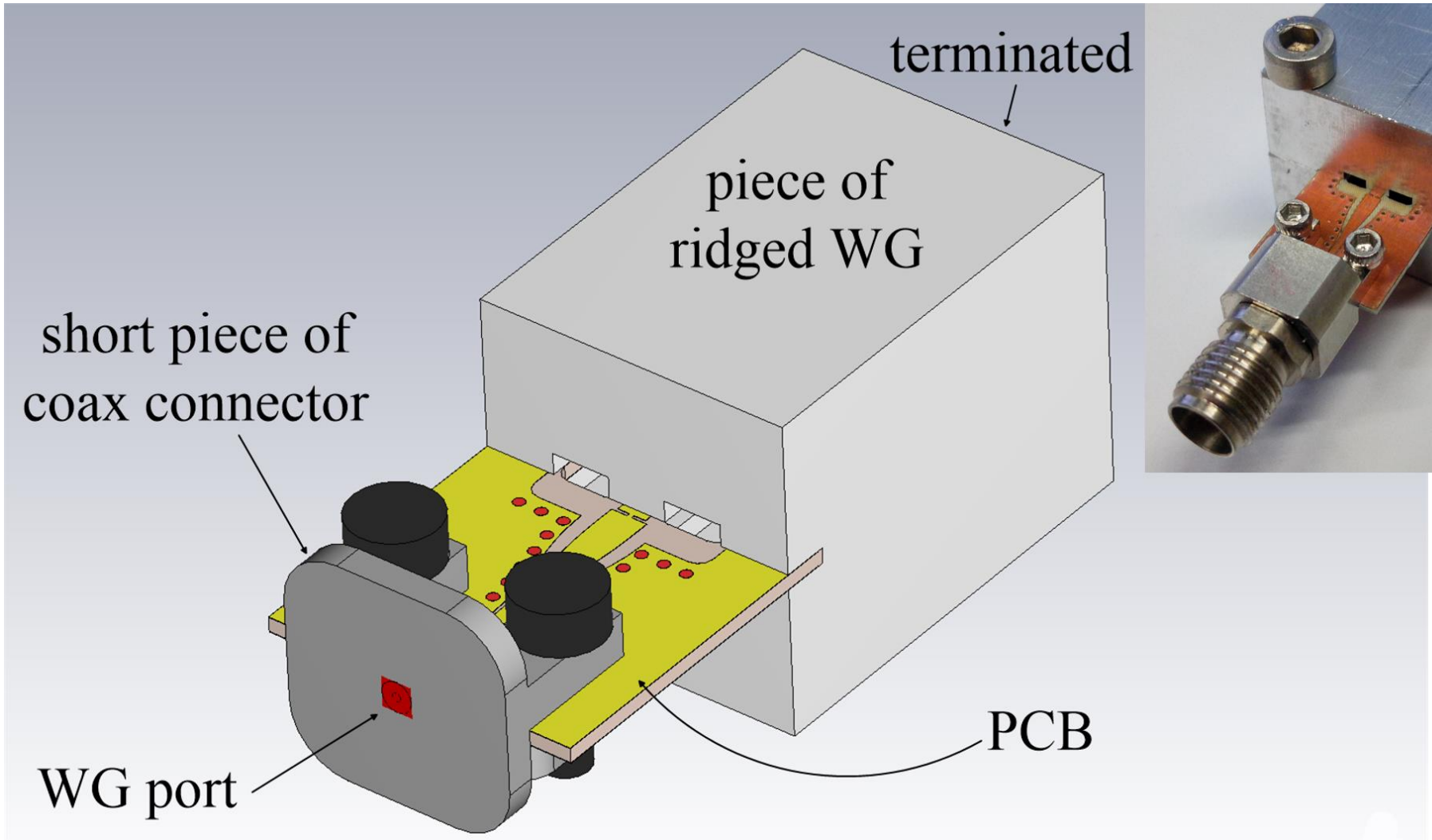
Prototype of Passive Power Distribution



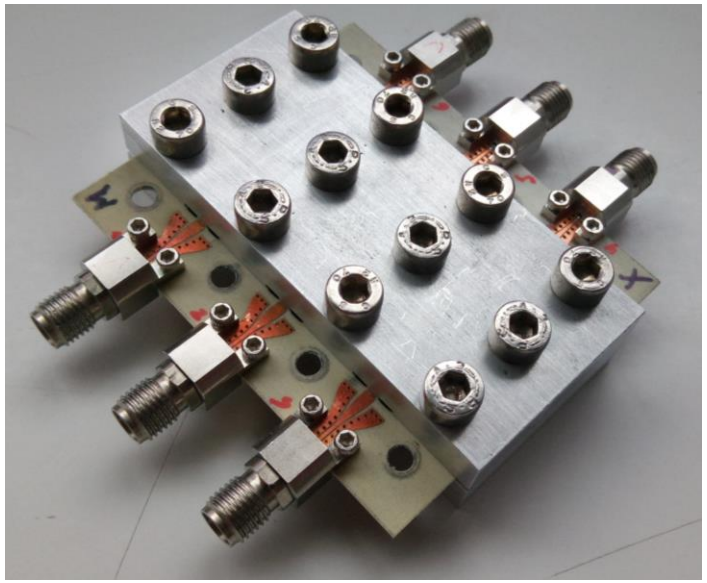
input-port dependent steering-angle (5° steps)

Transition PCB to ridged WG, Test-Structure



Transition Measuremens

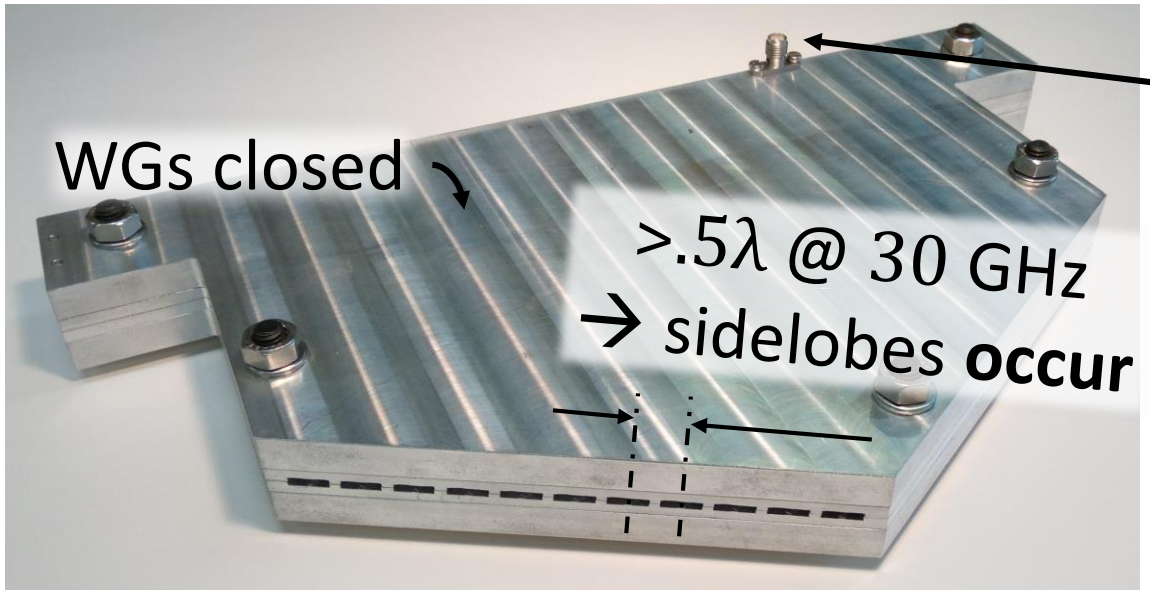
- Test Structure contains 3 separate double transitions
- Ridged WG length 30mm
- Measurement of return loss and twice the insertion loss
- Insertion loss contains beside the transition losses caused by 15mm of ridged WG and 0.2dB caused by the connector

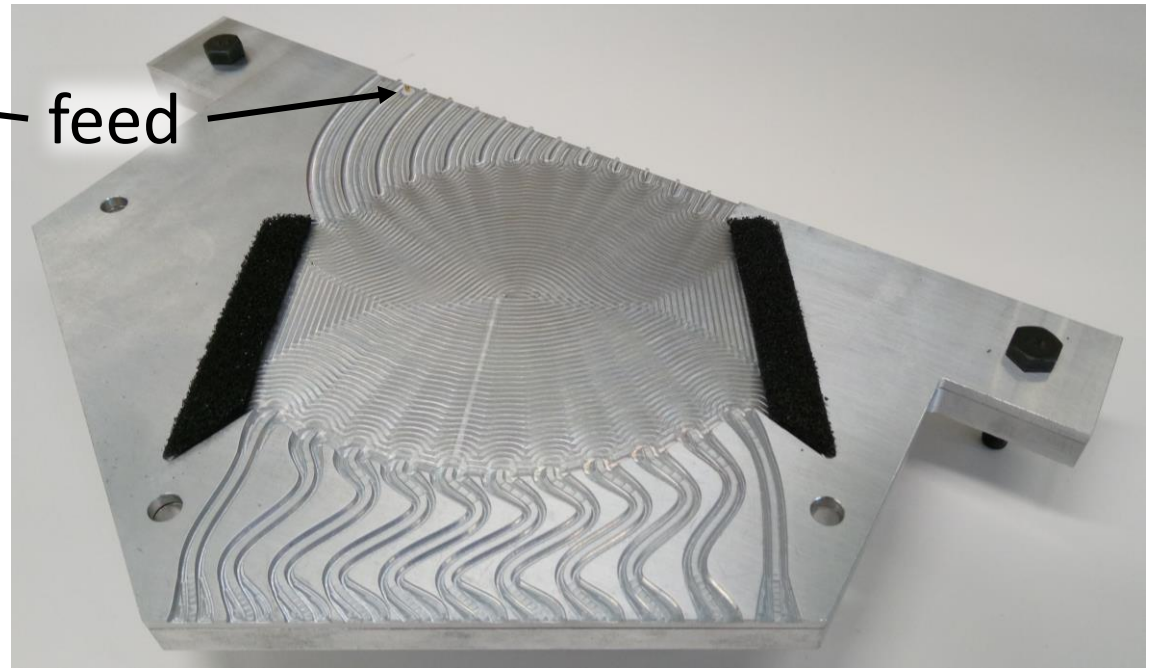


	20GHz	30GHz
Return loss	<-15dB	<-20dB
Insertion loss	1dB	1.7dB

Hardware Demonstrator One Layer

- Realization different to prev. 3D model
- **Example** of **one antenna layer** for verification → **only one port fed**

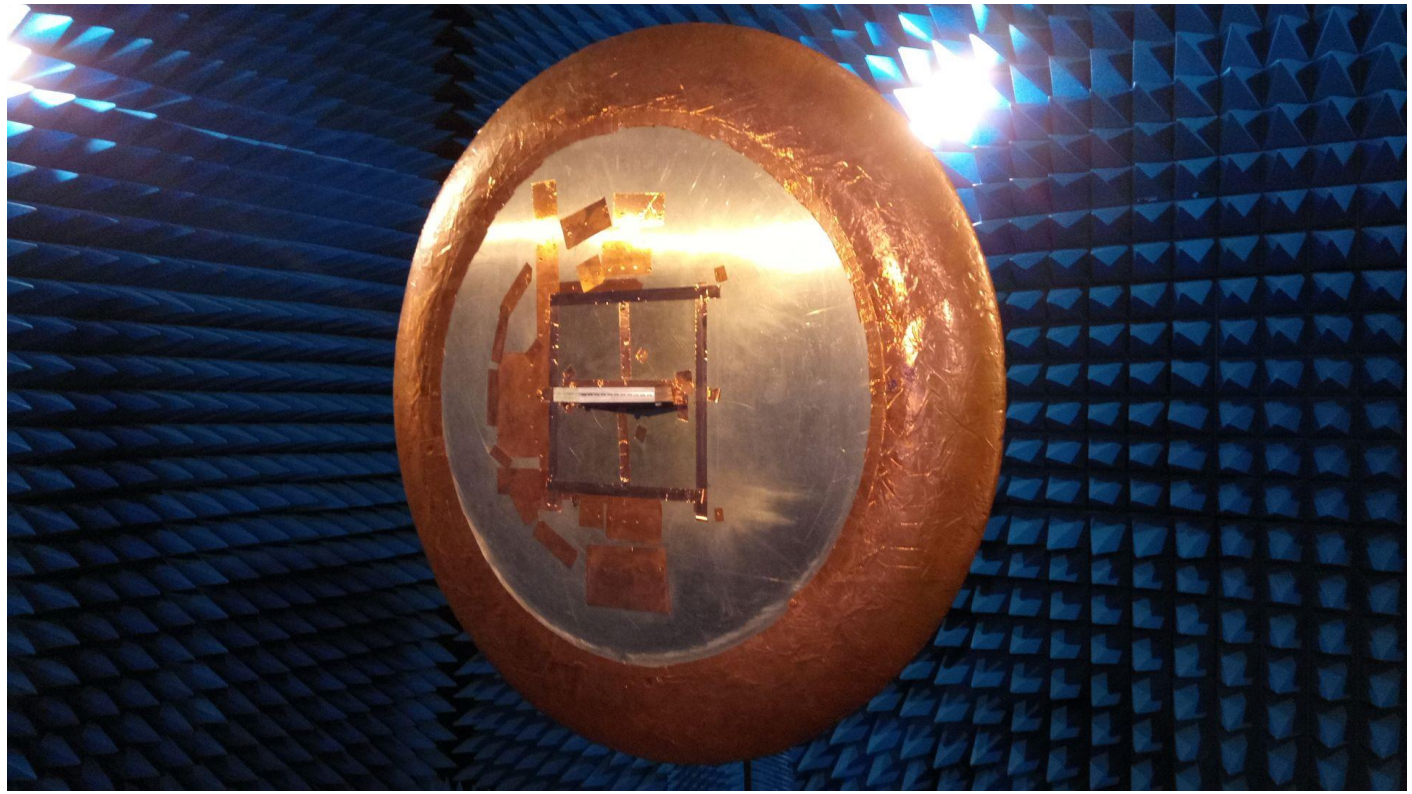




Measured and Simulated Antenna Patterns

- Evaluation of simulated results of new antenna in Anechoic Chamber of the RF-Institute

- GND-plane with bent edges emulates satellite‘s surface



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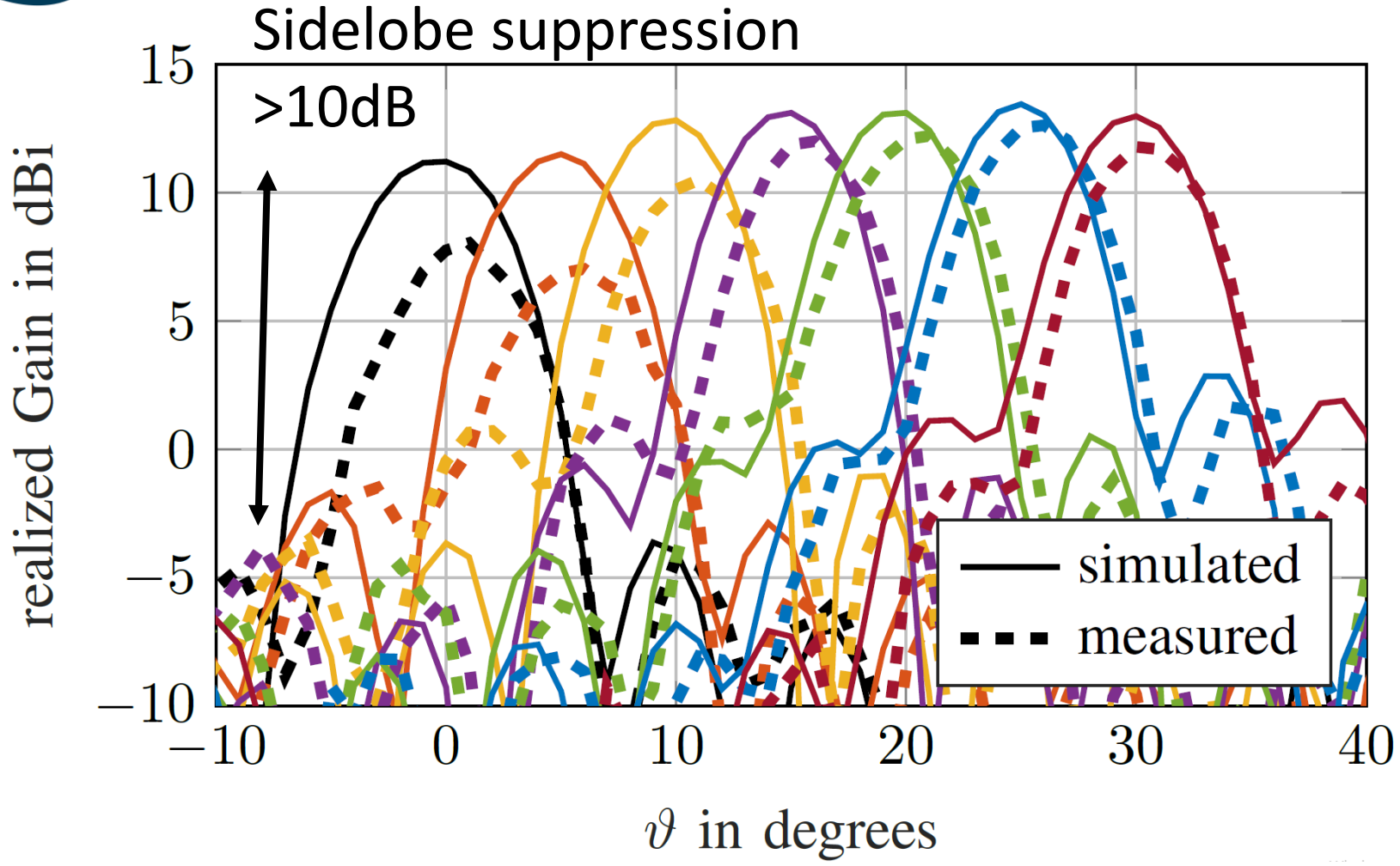
Measured and Simulated Patterns



- **Gain per Layer: 8-12 dBi**
- **Plus Additional Group Factor of 16 layers: 12dB**

→Complete Gain: 20-24 dBi

Conclusion

- New antenna module for K- and Ka band presented & evaluated
- allows beam steering @ 20 & 30 GHz for Tx and Rx in two directions between 60° forward and -60° backward and between --40° to 40° sideways around nadir
- Up to eight independent beams steerable at the same time
- Realized Gain = 20-24 dBi for both frequencies (case: one beam)
- Antenna has robust mechanical design, is robust against sun radiation and works also as a heat sink for TX-amplifiers