WS WTh-02 (EuMC/EuRAD)

Implementing Radar Target Stimulation on an Automotive Testbed

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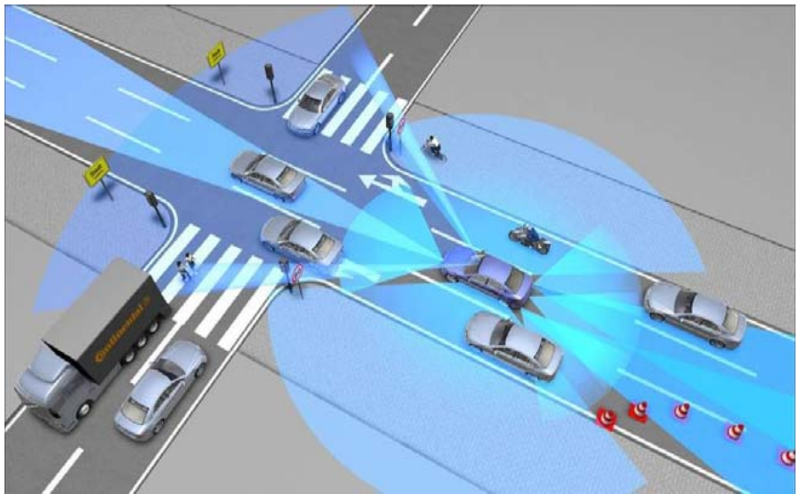
Why Radar Target Stimulation

- Increasing functionality of Advanced Driving Assistance Systems (ADAS) depend on radar sensors
- Supports early adoption of Autonomous Driving (AD)

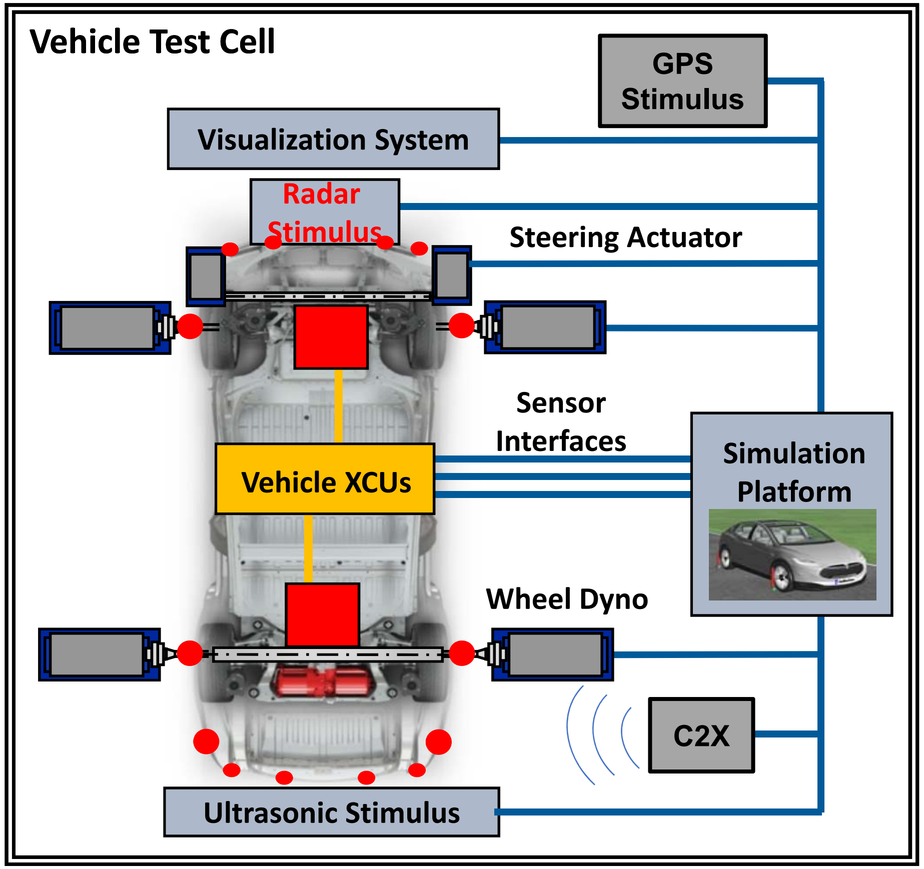
- Reliability during interference needs to be studied
- Verification of ADAS and AD in complex scenarios
- Millions of real world test kilometers are not affordable



from: http://articles.sae.org/10794/

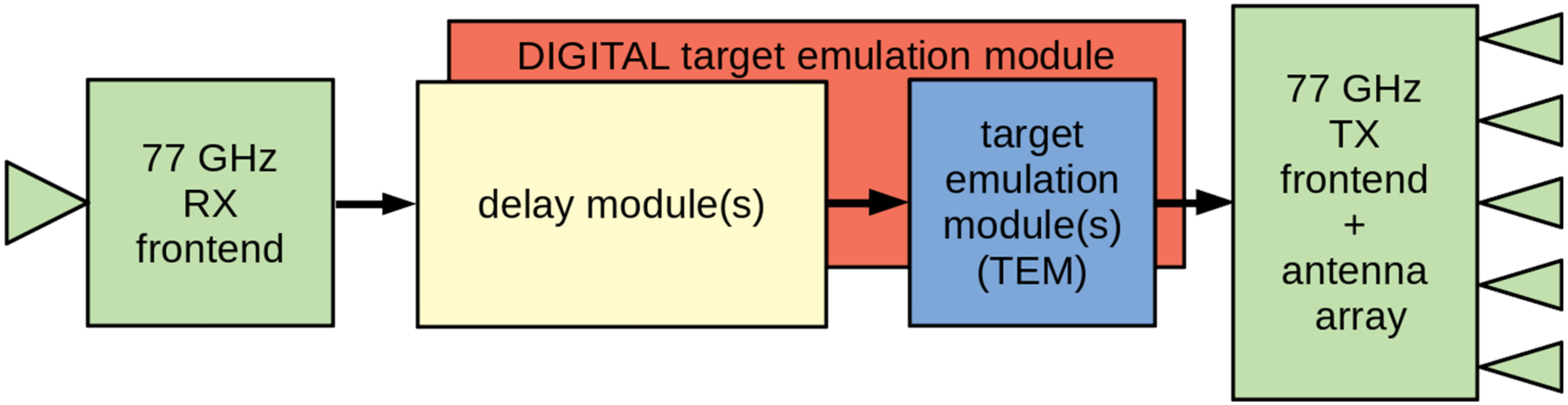
Vehicle Stimulation

- Torque
- Ultrasonic sensors
- Steering actuator
- Camera
- Car2X
- GPS
- Radar sensor
- LiDAR

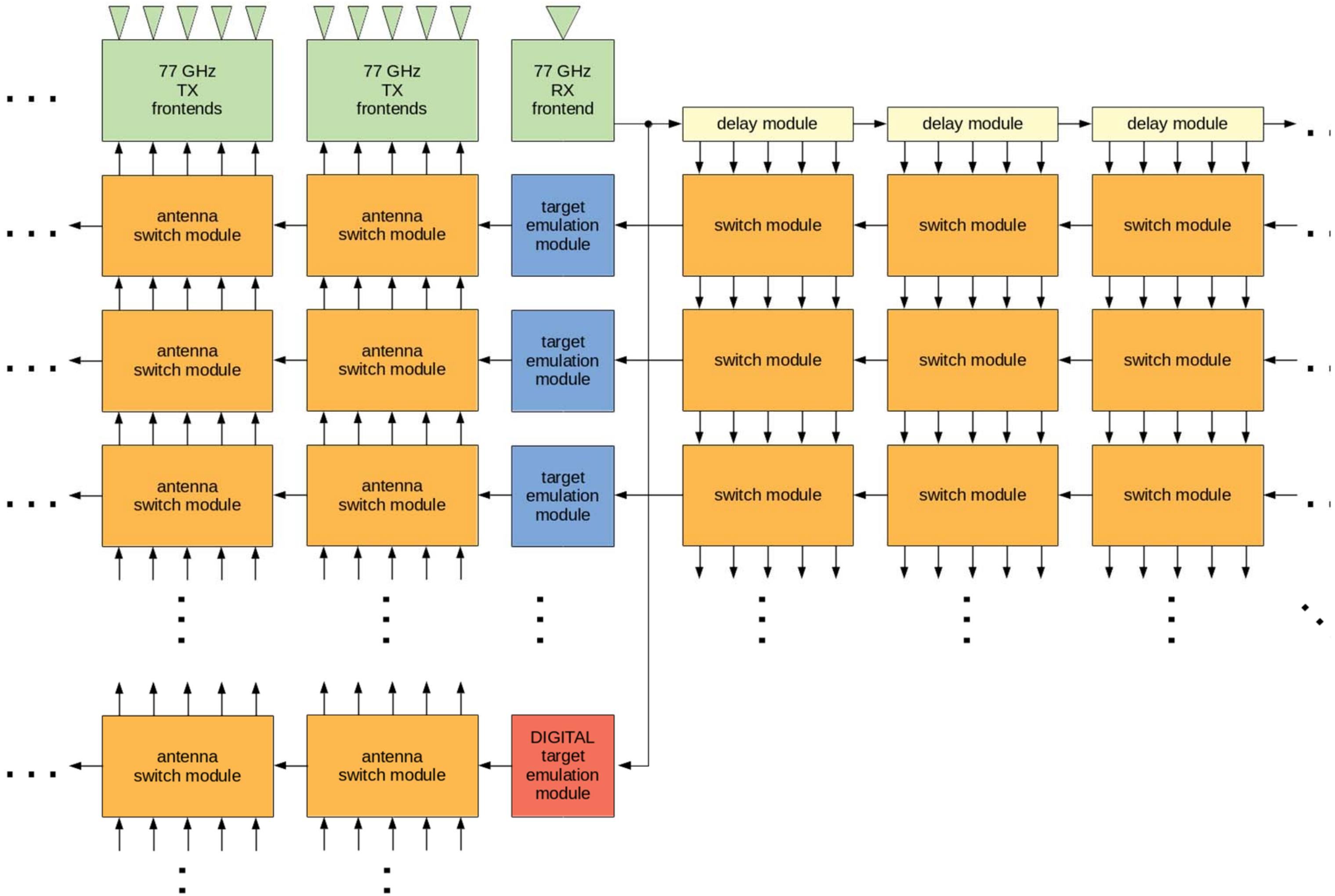


Basic Concept

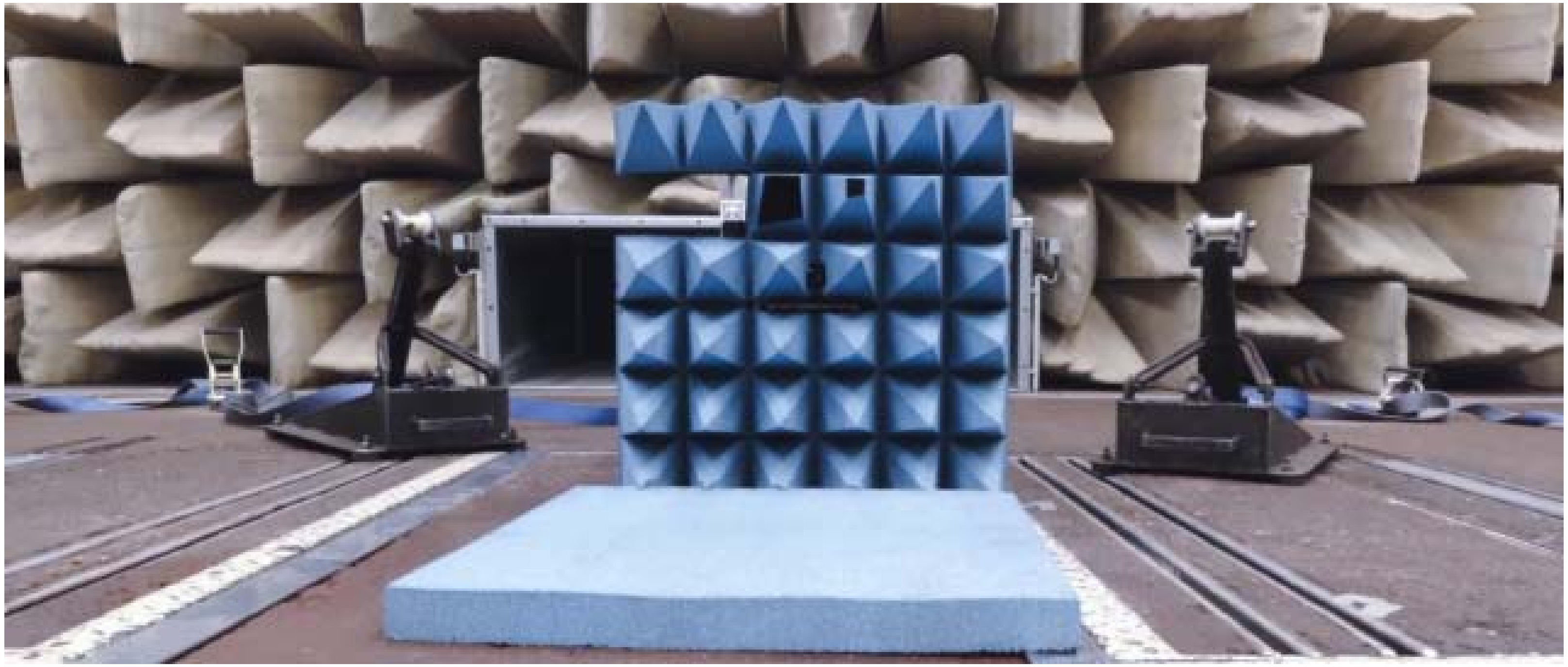
- Processing at intermediate frequency (2 GHz)
- Modular design
- Scalability
- Addition of interference signals possible



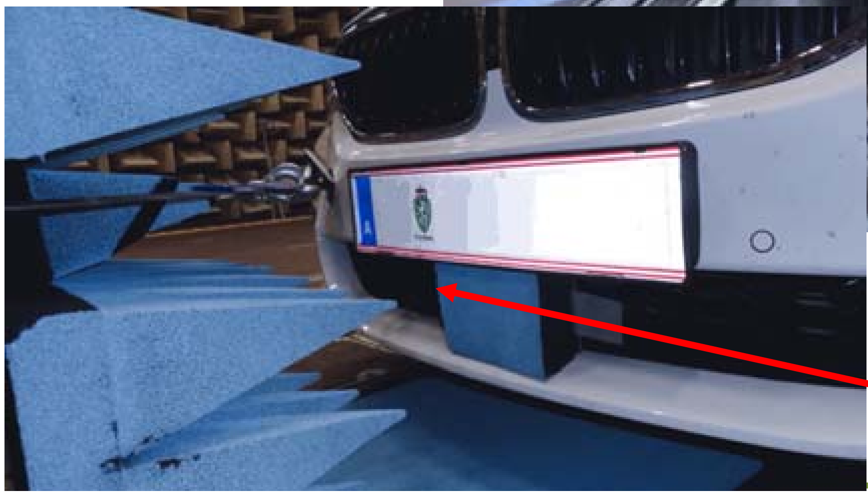
Overall Concept



Demo On a Dyno Testbed



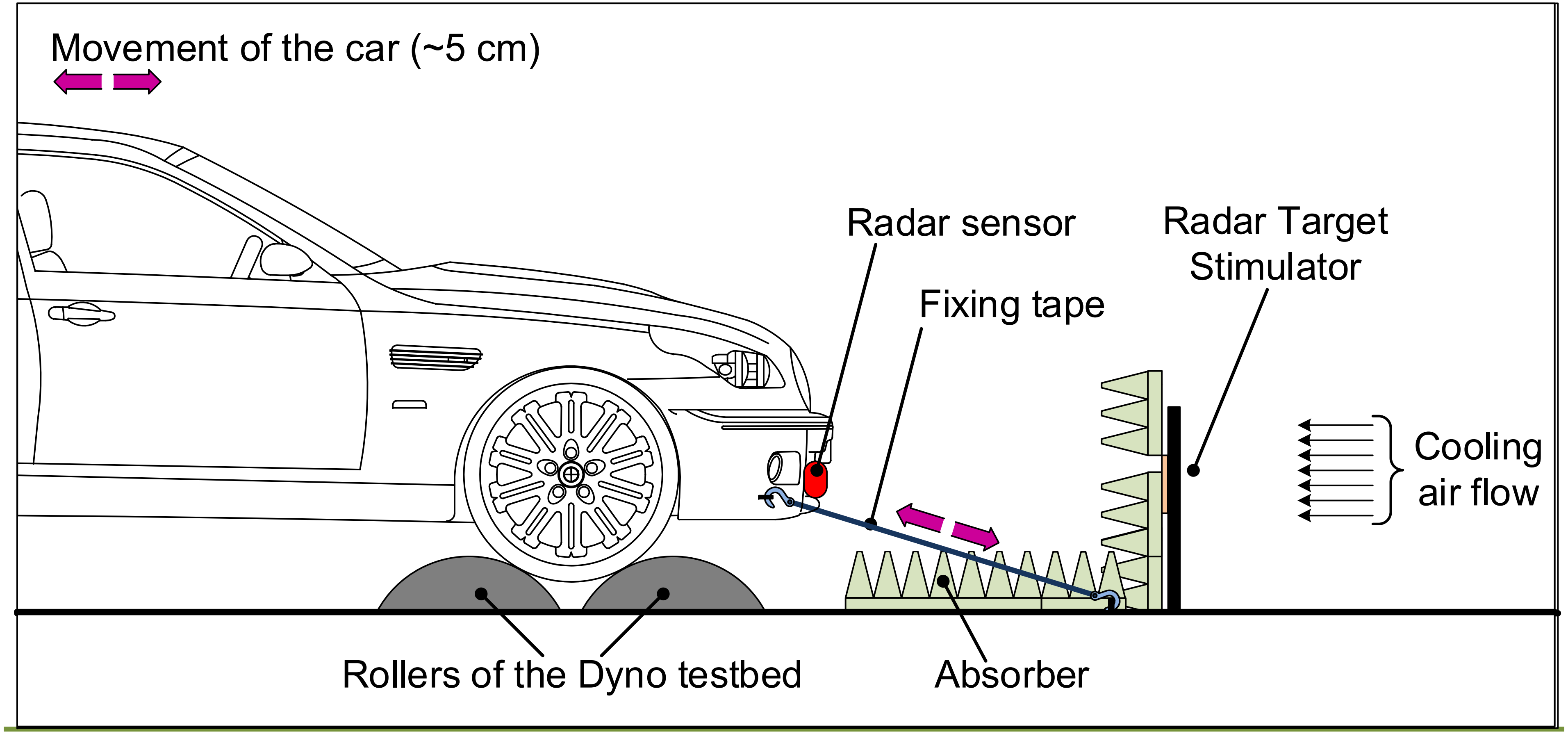
What Did We Avoid To Tell You?



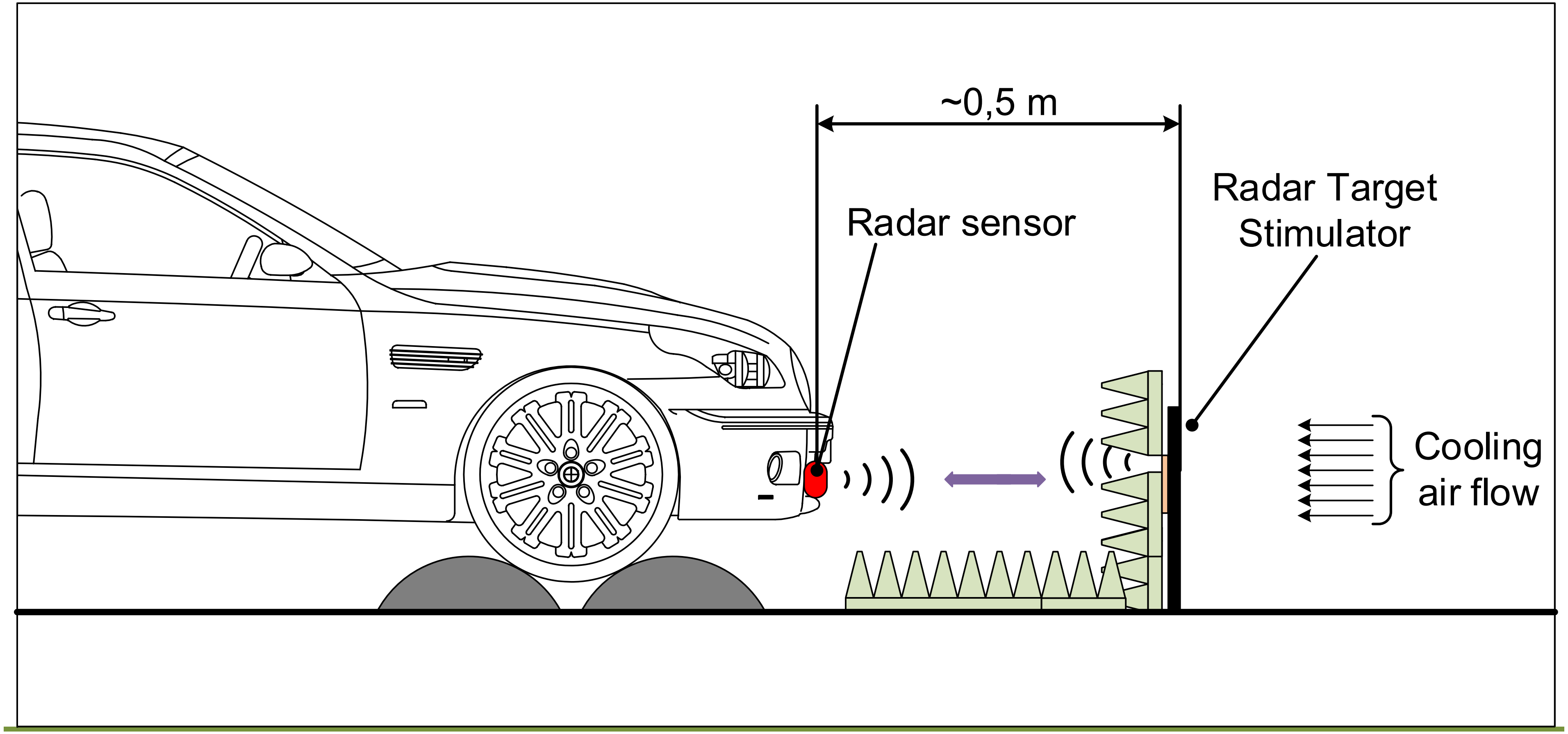
BMW mounted on a Dyno testbed

Radar Target Stimulator (RTS) mounted in front of the sensor

Car On a Dyno Testbed



Car On a Dyno Testbed
Radar Wave Propagation



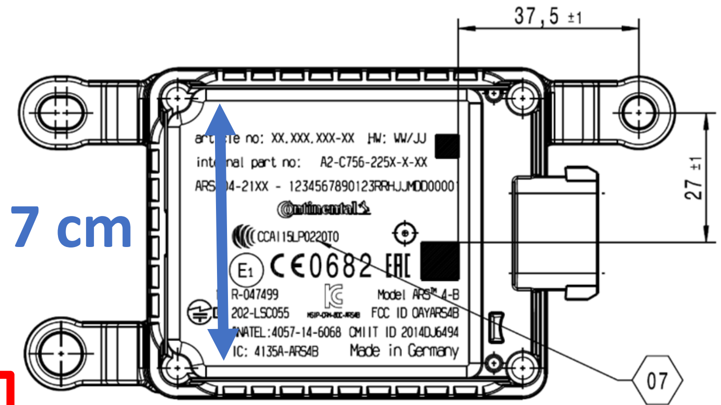
Fraunhofer Distance for a Radar Sensor

estimated for a Continental ARS-408

based on 7 cm max. antenna dimension

Fraunhofer distance @ 80 GHz:

$$\frac{2D^2}{\lambda} = 2{,}6\ \mathrm{m}$$



Taken from:
Short Description ARS 408-21 (Premium) Long Range Radar Sensor 77 GHz Technical Data Version 1.03 en

At a distance of 0.5 m to the RTS we will recognize an influence of the antennas

Car On a Dyno Testbed
Interaction Sensor vs. Stimulator

Testbed environment:

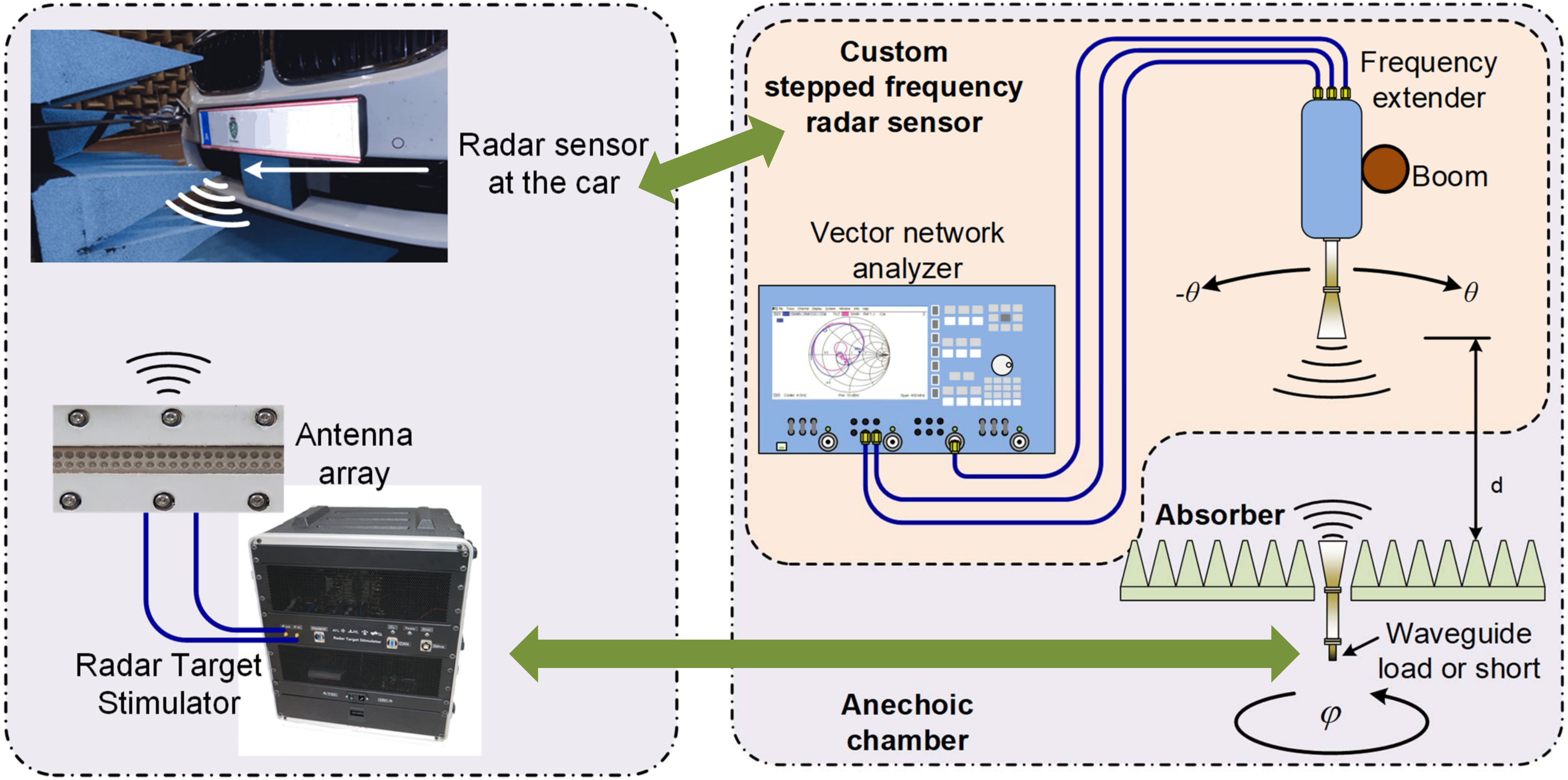
- Industrial environment with limited space
- Close stimulation distance desired

Questions imposed:

- Do sensor and the stimulator antennas influence each other?
- Does the clutter introduced by the stimulator antenna distort the sensor?
- Influence of the stimulator antenna pattern?

⇒ **Measurement of the interaction between sensor vs. stimulator desired**

Interaction Sensor vs. Stimulator
Resulting measurement setup



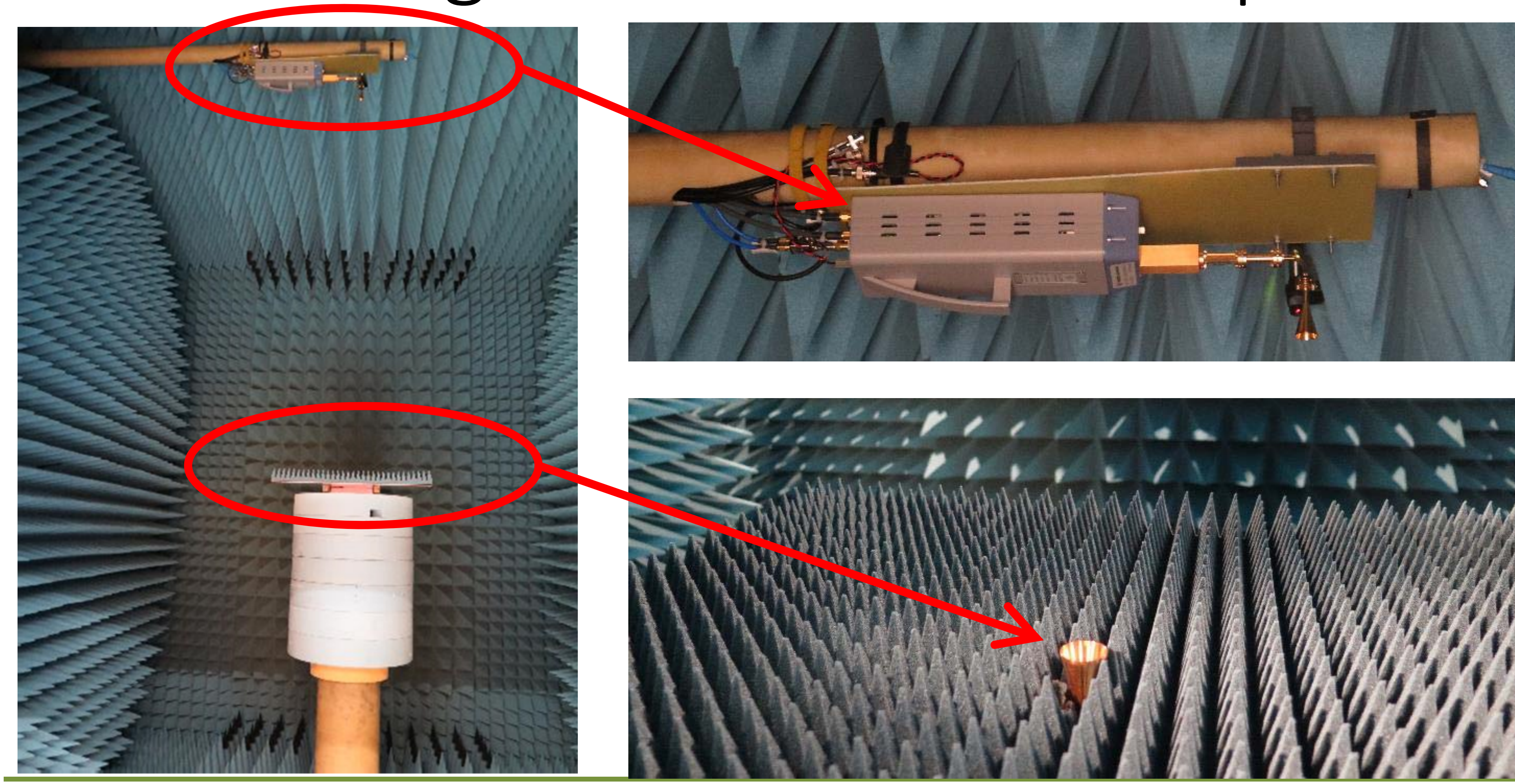
Custom radar sensor Requirements

- Flexible configurable sensor
- Capable of conducting high dynamic measurements
- Capable of conducting wideband measurements
- Full control of the gathered data

➡ Using a vector network analyzer (VNA) as a custom radar sensor

➡ Locate the measurement setup in an anechoic chamber

Interaction Sensor vs. Stimulator
Resulting measurement setup



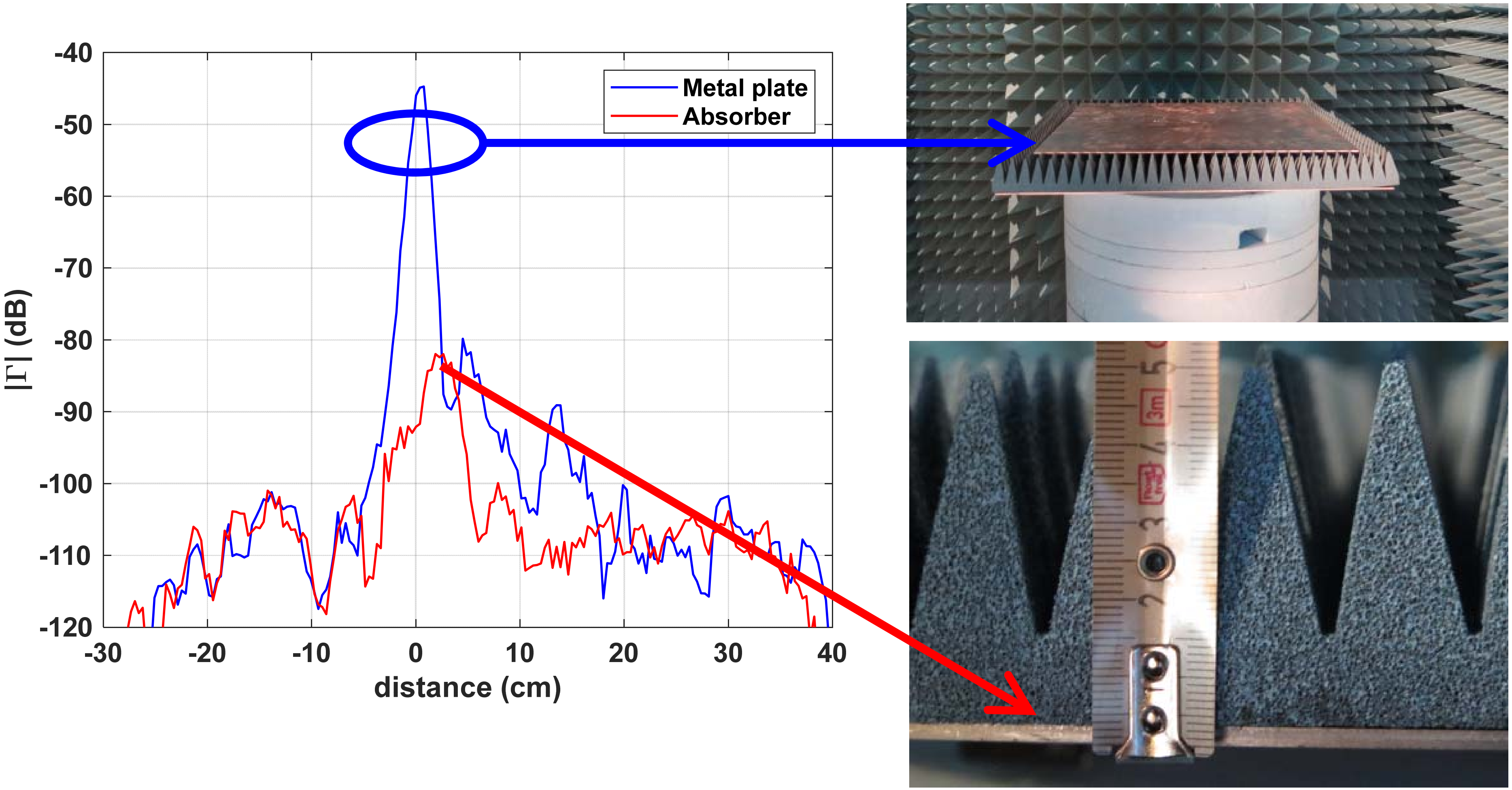
Measurement setup parameters

- Reference horn: Quinstar E-Band, 20dBi
- Frequency range: 70 – 90 GHz, step size 10 MHz
- Calibration: E-Band waveguide SOL calibration
  at the reference horn flange
- Analyze the measurement results in the time domain (synthetic range profile)
- Measurement distance resolution (free space)

$$\Delta d = \frac{c_0}{2B} = 7.5\ \text{mm}$$

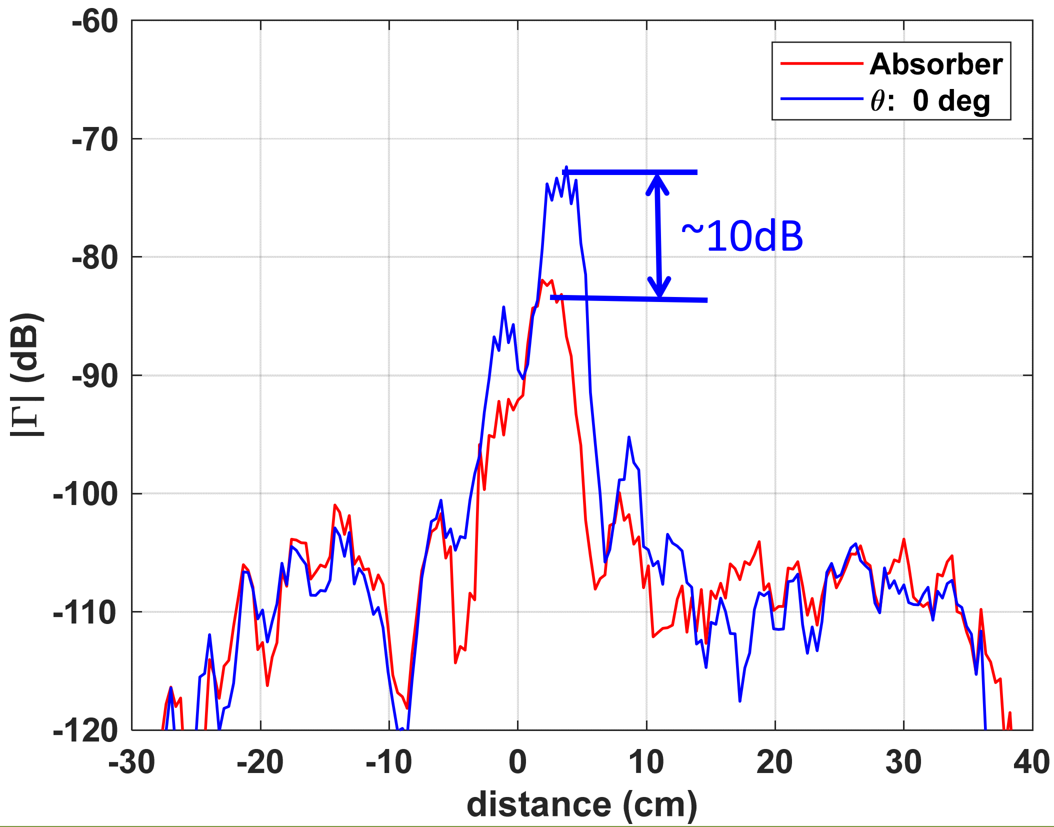
- Unambiguous range: 15m

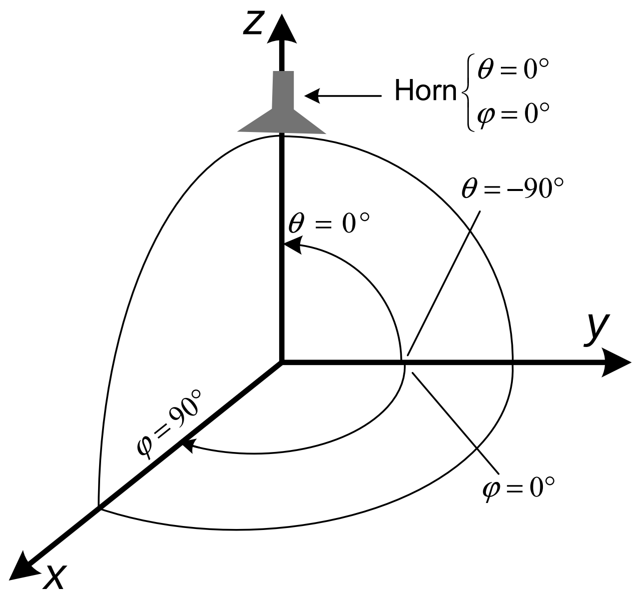
Chamber characterization



RTS horn antenna measurement

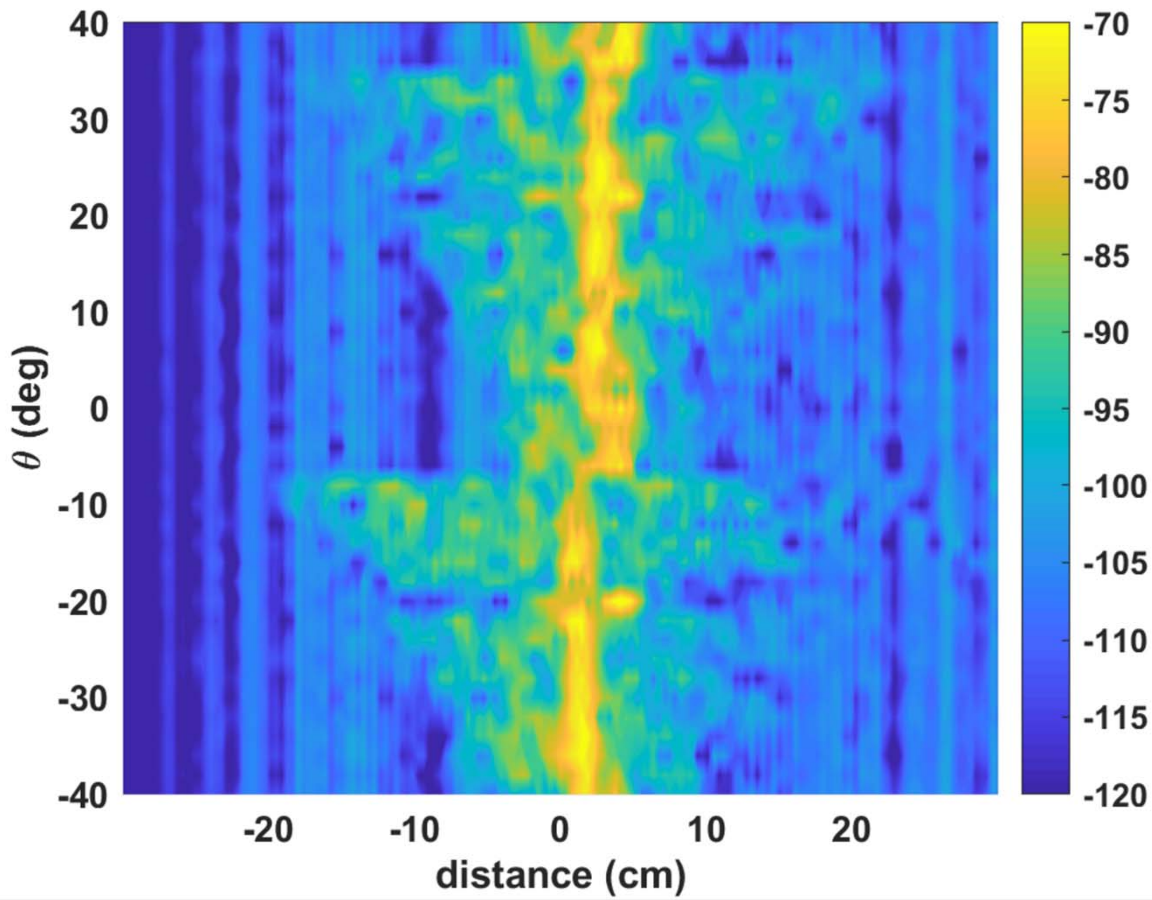
- Waveguide output terminated
- co-polarized

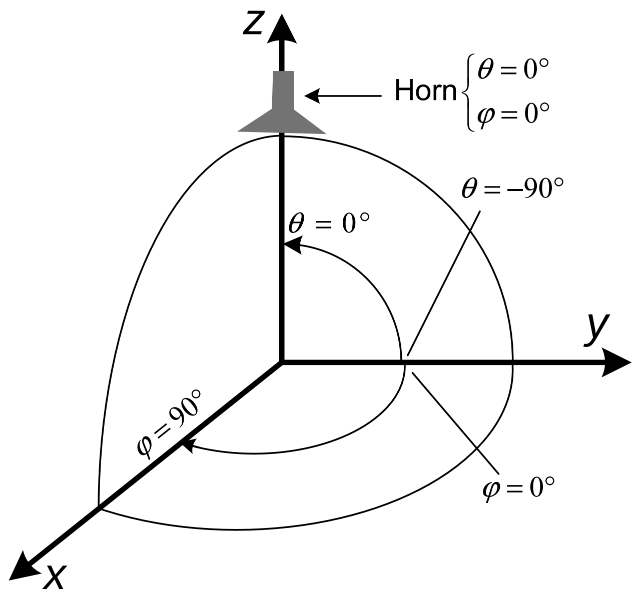




RTS horn antenna measurement

θ-sweep

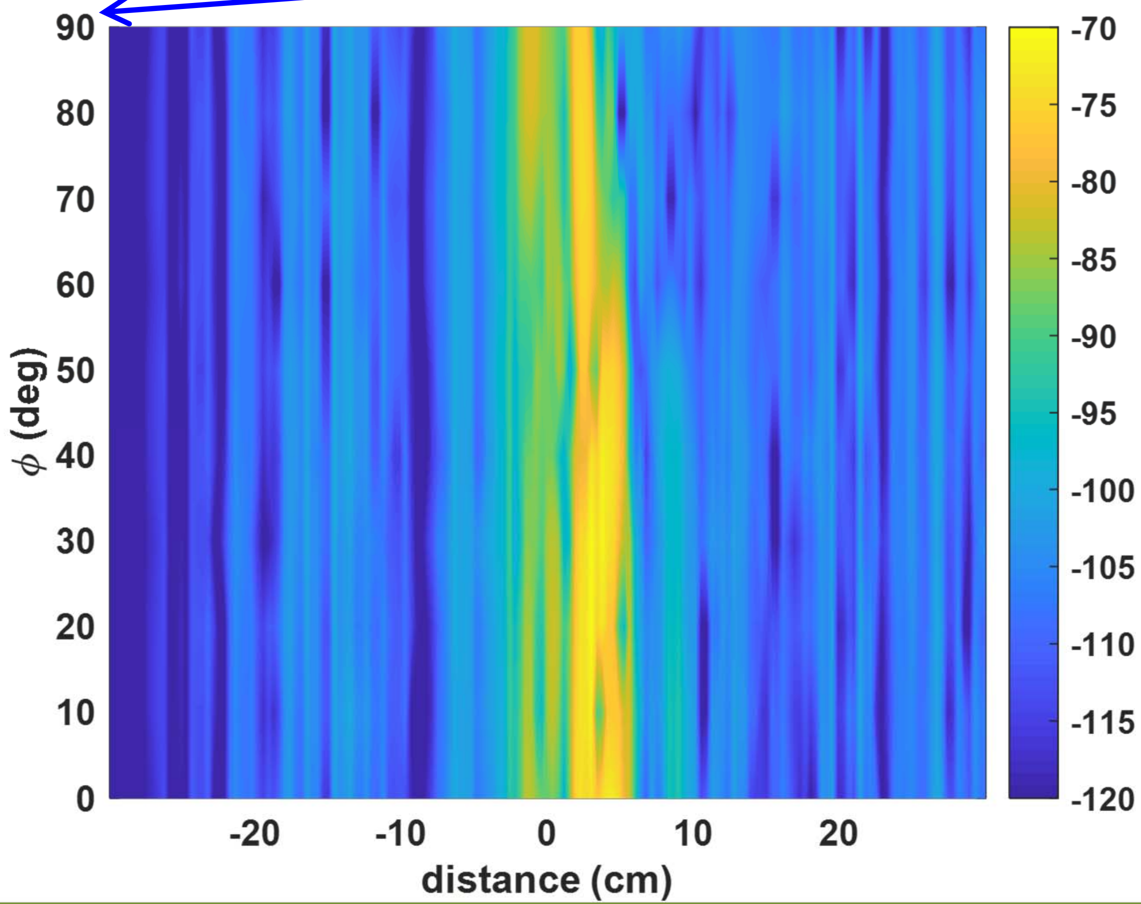


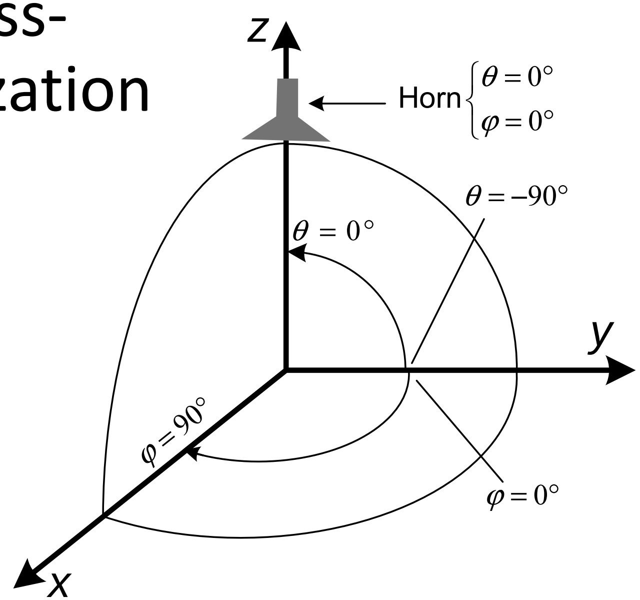


RTS horn antenna measurement

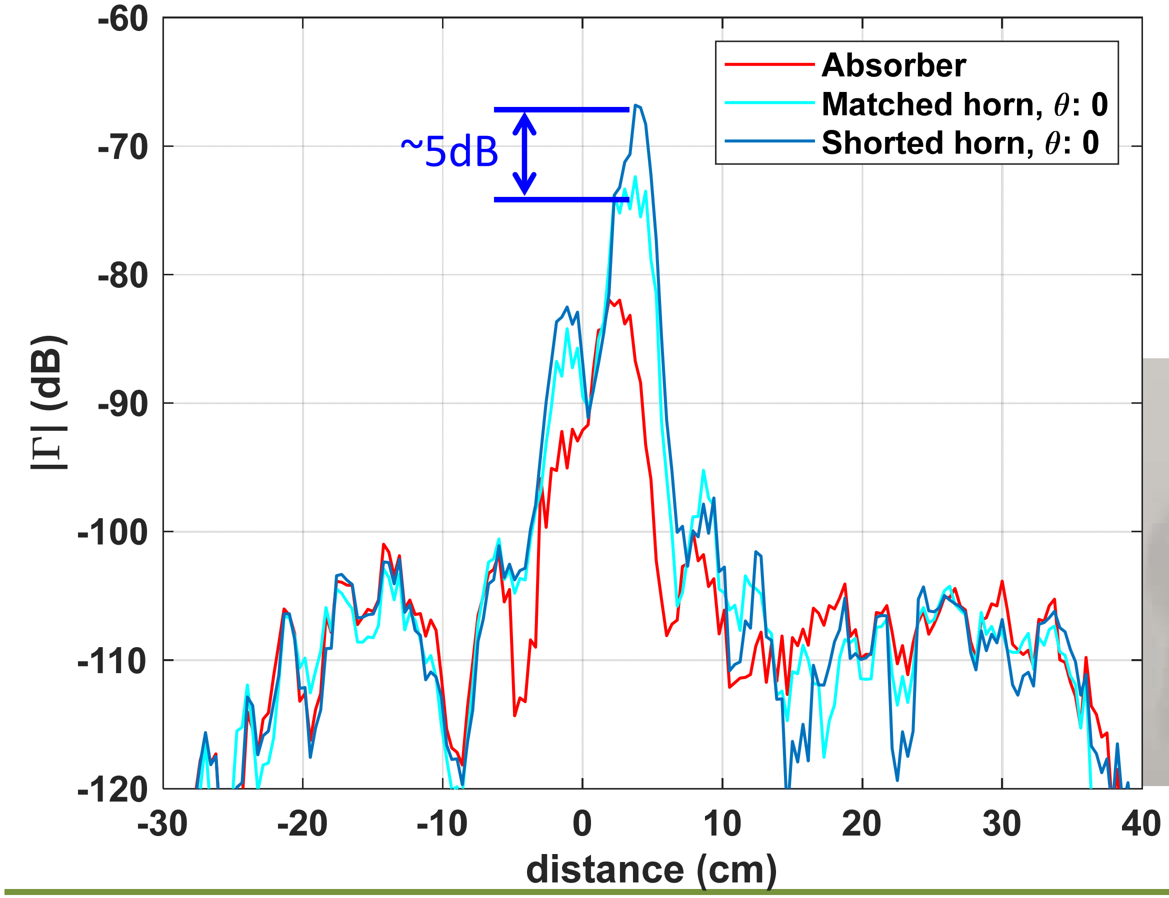
θ = 0, φ-sweep

cross-polarization



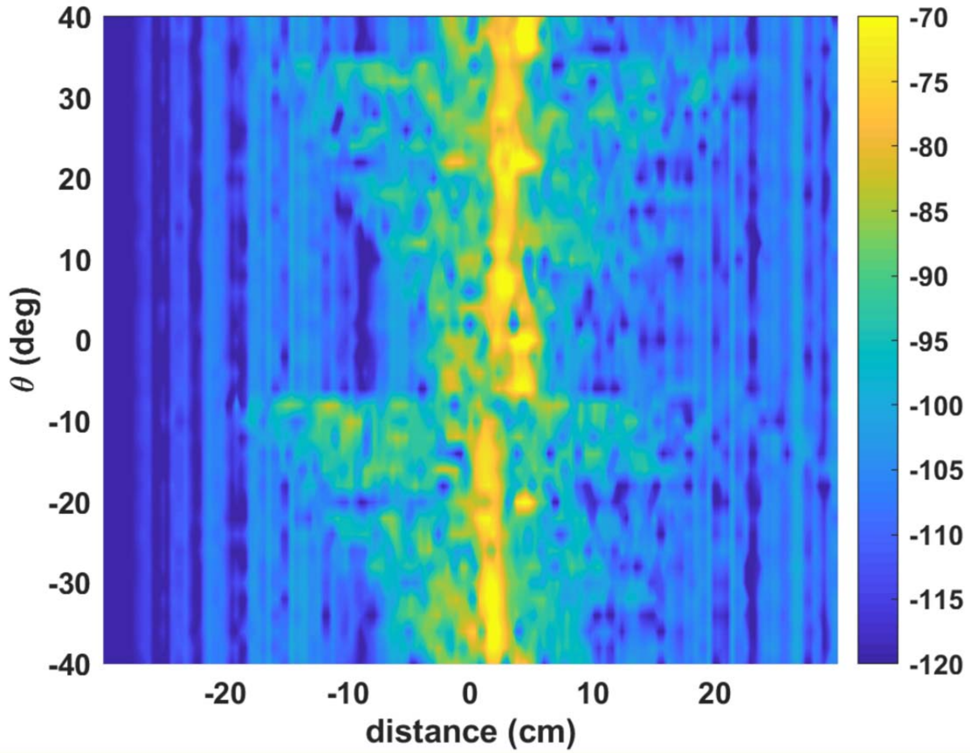


RTS horn antenna measurement Shorted waveguide input

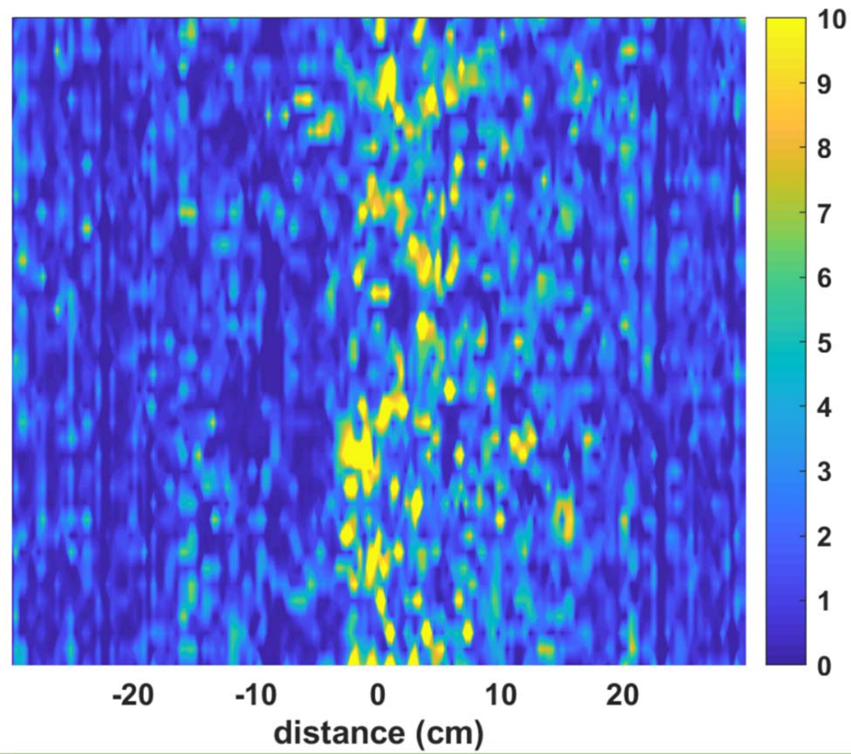


RTS horn antenna measurement Shorted waveguide input

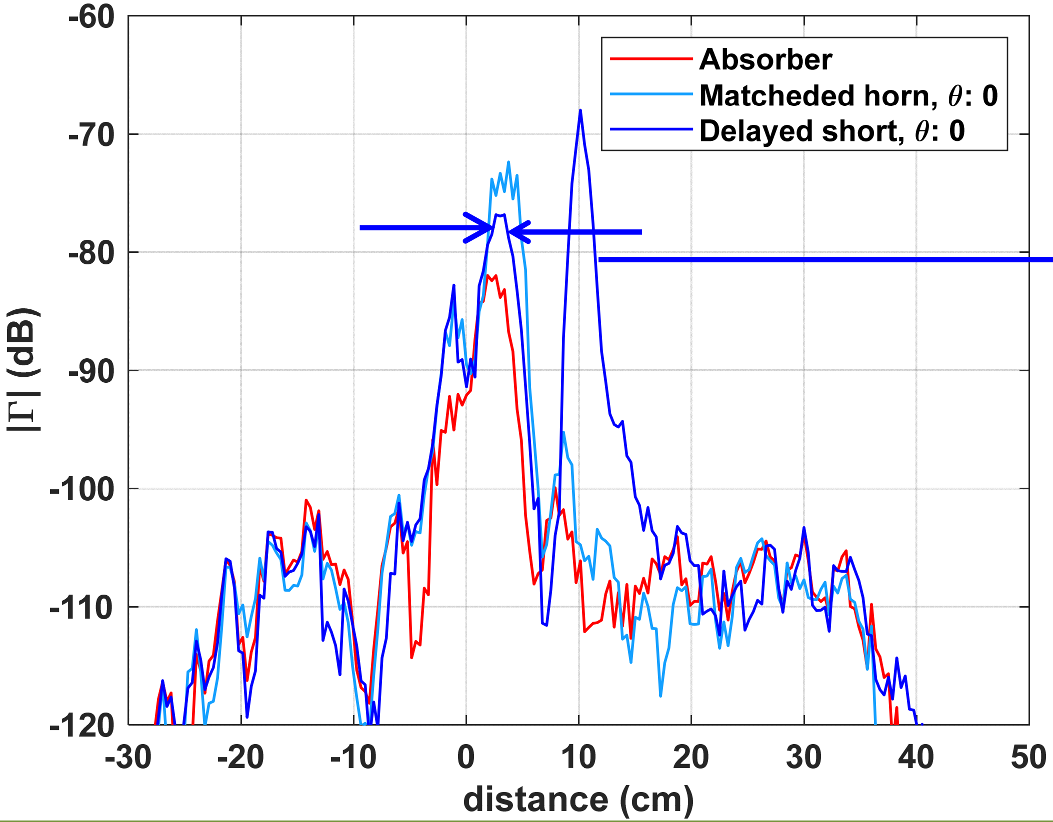
$|\Gamma_{\text{shorted ant.}}|$ (dB)

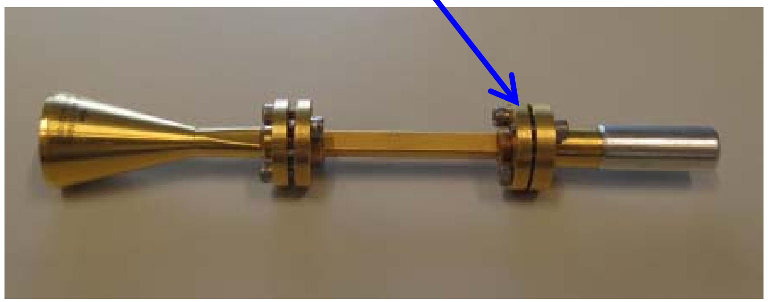


$|\Gamma_{\text{shorted}}| / |\Gamma_{\text{matched}}|$(dB)

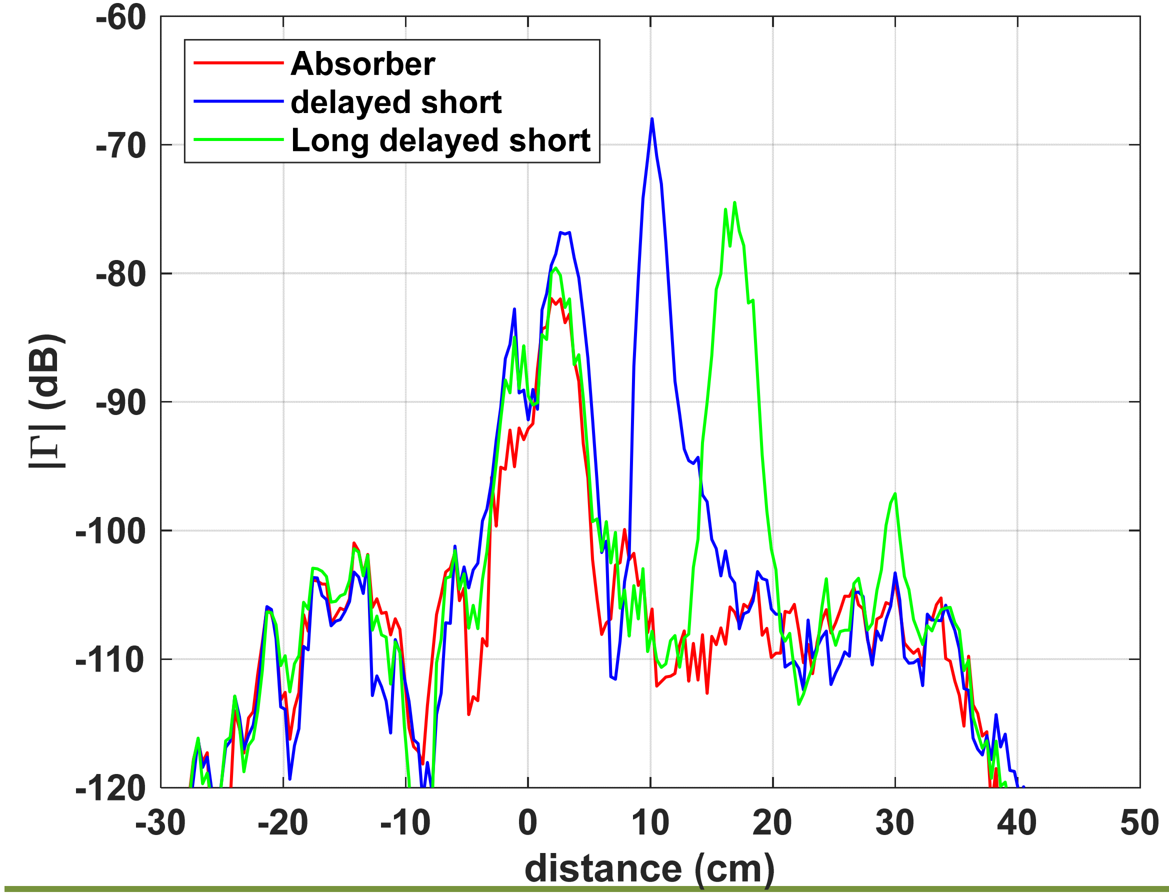


RTS horn antenna measurement
Delayed short

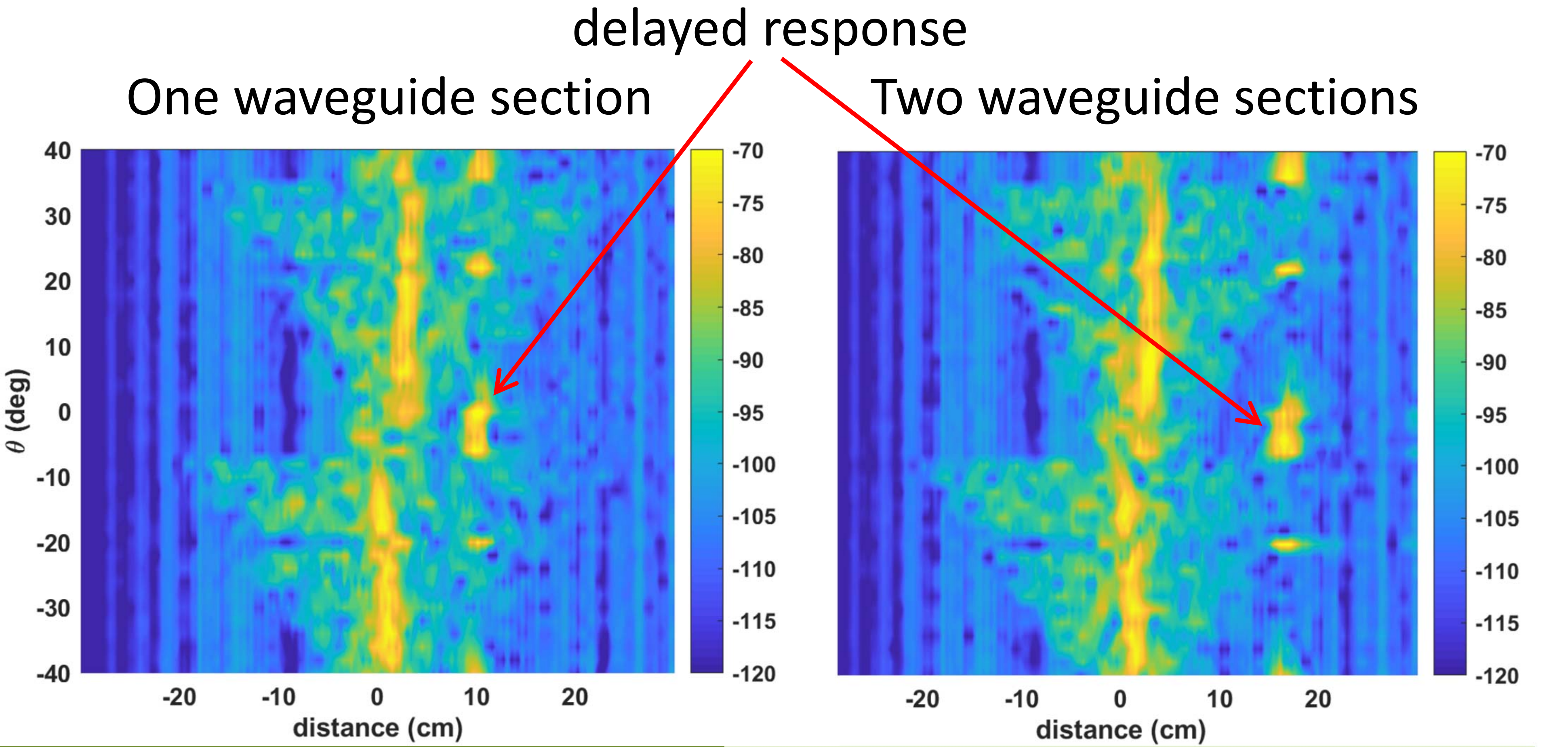




RTS horn antenna measurement Short + two waveguides

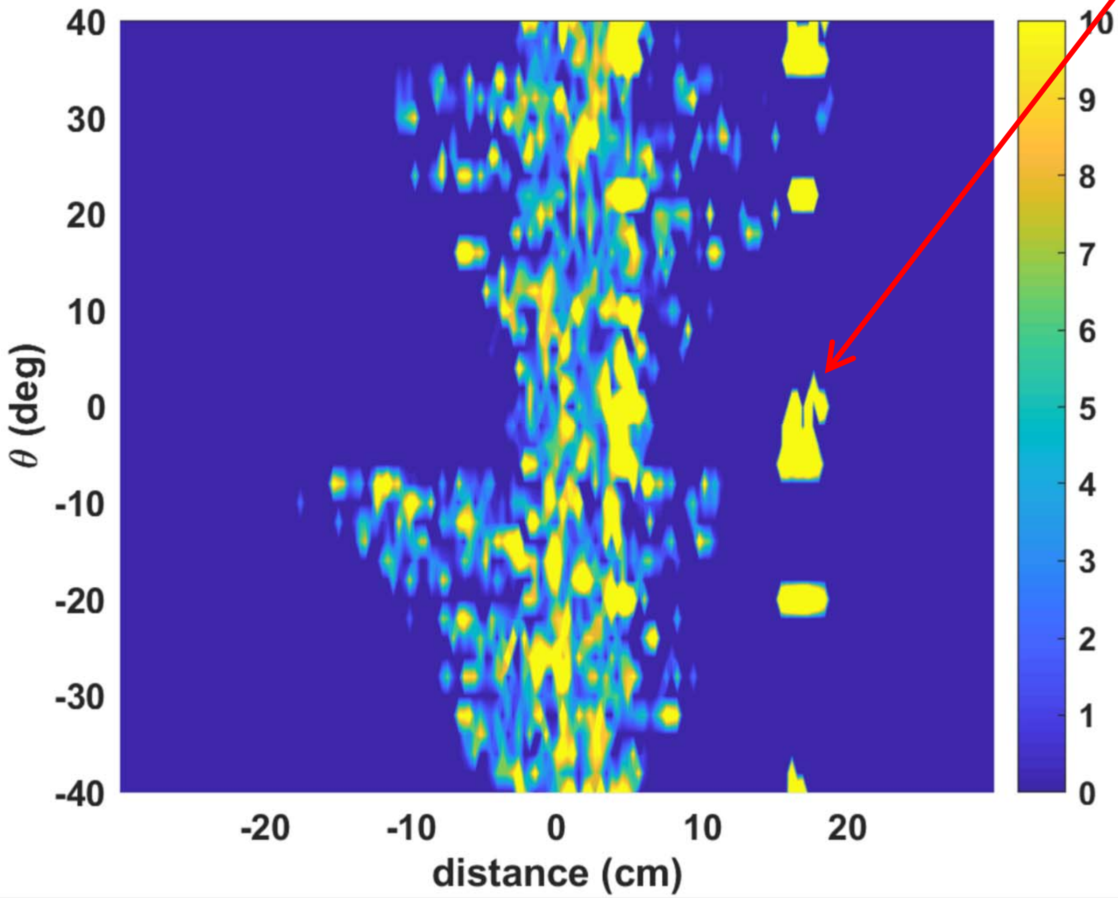


RTS horn antenna measurement Shorted waveguide input comp.



RTS horn antenna measurement

$|\Gamma_{\text{shorted, 2 delays}}| \, / \, |\Gamma_{\text{shorted}}|$ (dB)



delayed response

Limit for the calculation:

$$\left\{\frac{|\Gamma_{\text{shorted,2 delays}}|}{|\Gamma_{\text{shorted}}|}\right\} > -95 \text{ dB}$$

Conclusion & Future Challenges

Conclusion:

- RTS antennas and surrounding absorbers are important to minimize clutter
- Antenna acts as a scatterer and as waveguide interface

Future challenges:

- RTS antenna design with low radar cross-section
- Multi-target objects to trigger object classification of the radar sensor
- Frequency & bandwidth

Any questions?

WTh-02 Test Procedures & Solutions...

3. October 2019

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