AUTOMOTIVE RADAR PERFORMANCE CHARACTERISTICS

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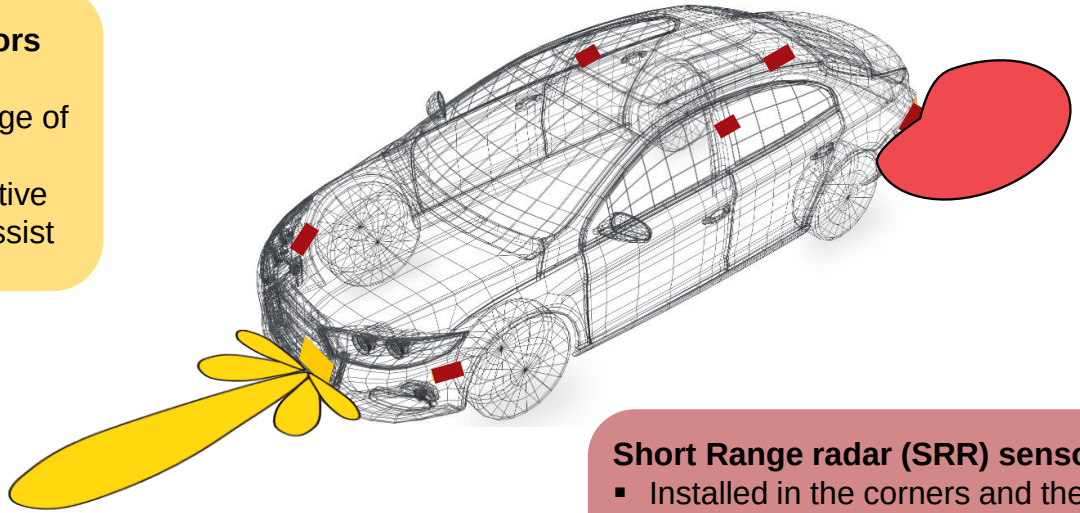
ROHDE&SCHWARZ
Make ideas real

AUTOMOTIVE RADAR – PRINCIPLE OF OPERATION AND EFFECTS OF INTERFERERS

THE SITUATION

Long Range Radar (LRR) sensors

- Installed in the front of a car
- Used to detect objects at a range of 200 m and beyond
- Provide services such as adaptive cruise control and traffic jam assist



Short Range radar (SRR) sensors

- Installed in the corners and the B pillars of a car
- Provide services such as blind spot detection and lane change assist
- Form a 360° radar cocoon around the car

potential installation point of SRR sensors

potential installation point of LRR sensor

THE TRENDS

More complex and powerful sensor technology

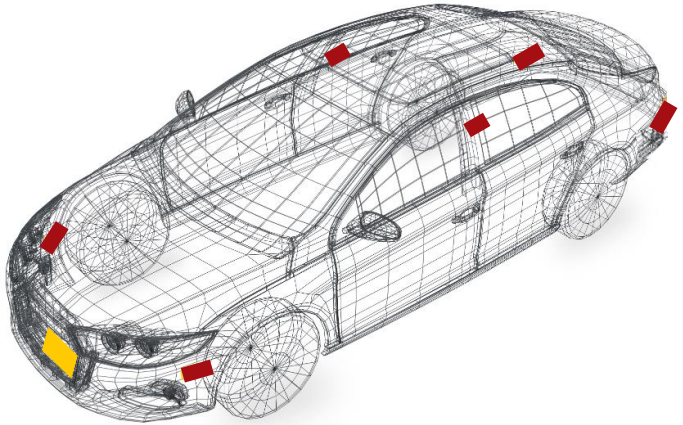
- Sensors e.g. LRR will use MIMO technology
- Advanced beamforming algorithms will help to provide better angular resolution
- Detailed and accurate imaging of the scenery especially for autonomous driving will become possible

Bandwidth increases up to 4 GHz in the 79 GHz band

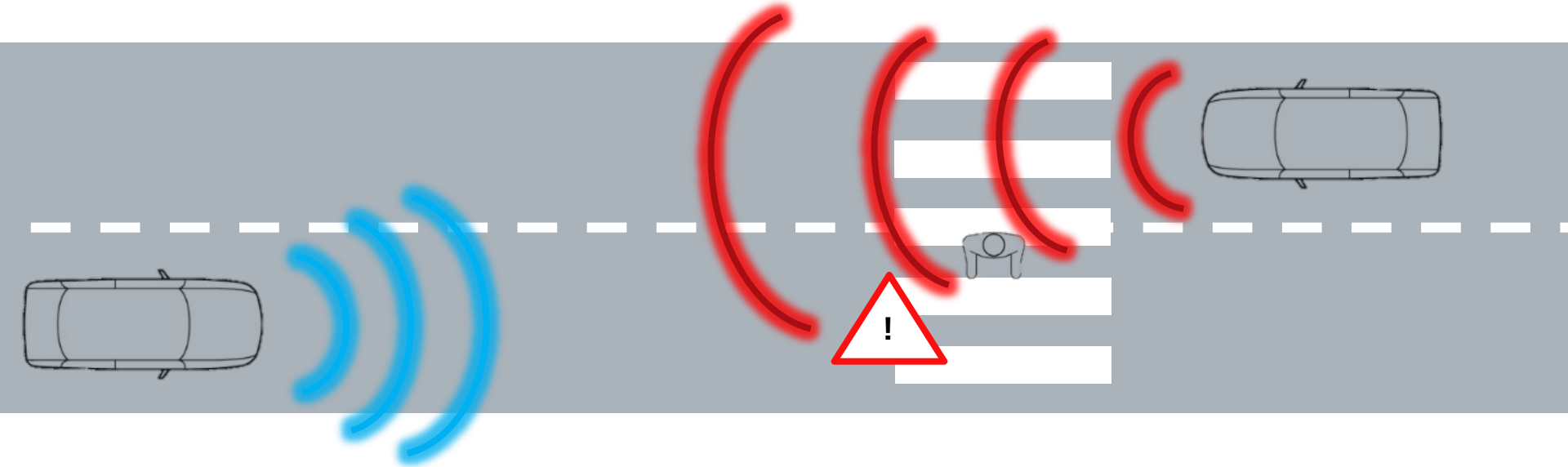
- Recognize and resolve objects in ultra short range
- Frequency hopping within automotive band to avoid mutual interference

Increase of number of radar sensors

- Interfering signals originate from transmit signals from oncoming traffic
- Mutual interference and interference from multipath



THE CHALLENGE



RED – RADIO EQUIPMENT DIRECTIVE IN TERMS OF AUTOMOTIVE RADAR

The Radio Equipment Directive (*2014/53/EU*) establishes a regulatory framework for placing radio equipment on the market. It is **mandatory** since June 2017 in Europe.

Important in context of automotive radar (but not limited to):

ETSI EN 303 396	(Short Range Devices – Meas. Techniques for Automotive Radar)
ETSI EN 302 858	(Short Range Devices – Radar Eq. in the 24-24.25GHz range)
ETSI EN 301 091-1/2	(Short Range Devices – Radar Eq. in the 76-77GHz range)
ETSI EN 302 264	(Short Range Devices – Radar Eq. in the 77-81GHz band)

Tests required:

Receiver Conformance	Transmitter Conformance
- Spurious emissions - In-band signal handling (receiver robustness to interferers) - Out-of-band signal handling	- OBW - Power level - Unwanted emissions (out-of-band and spurious)

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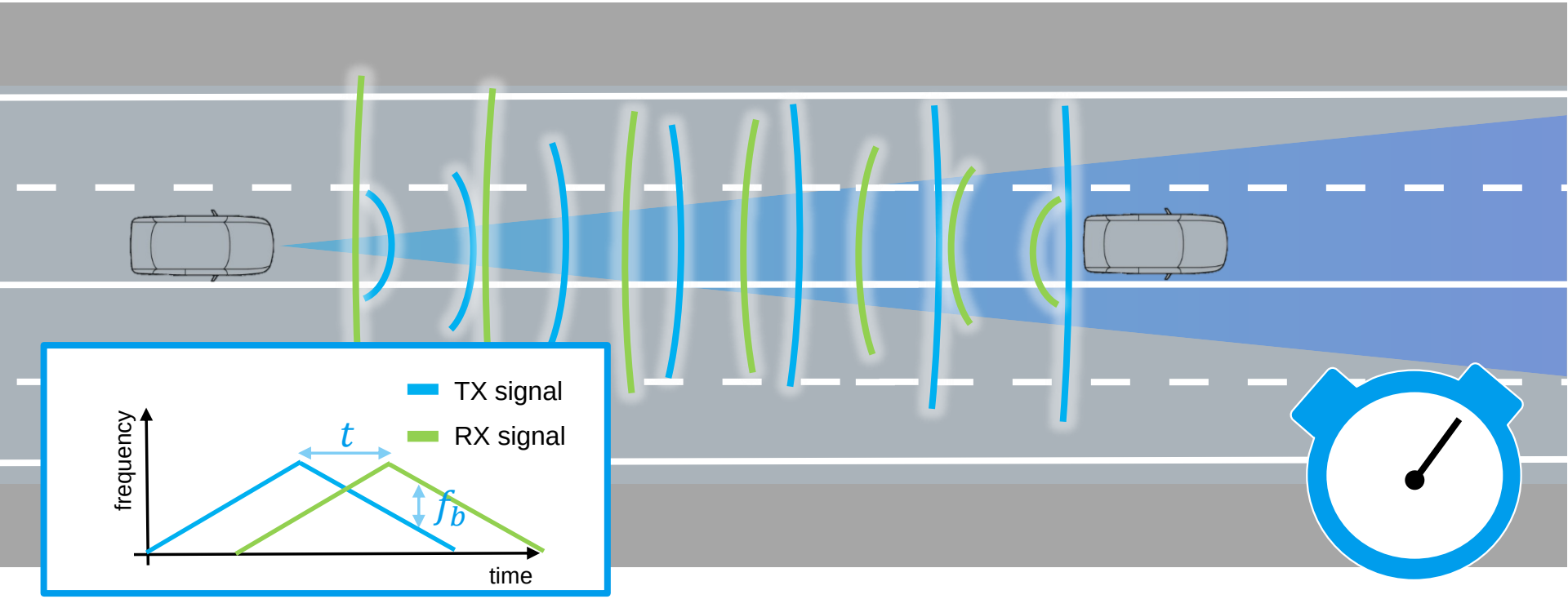
AUTOMOTIVE RADAR - FMCW



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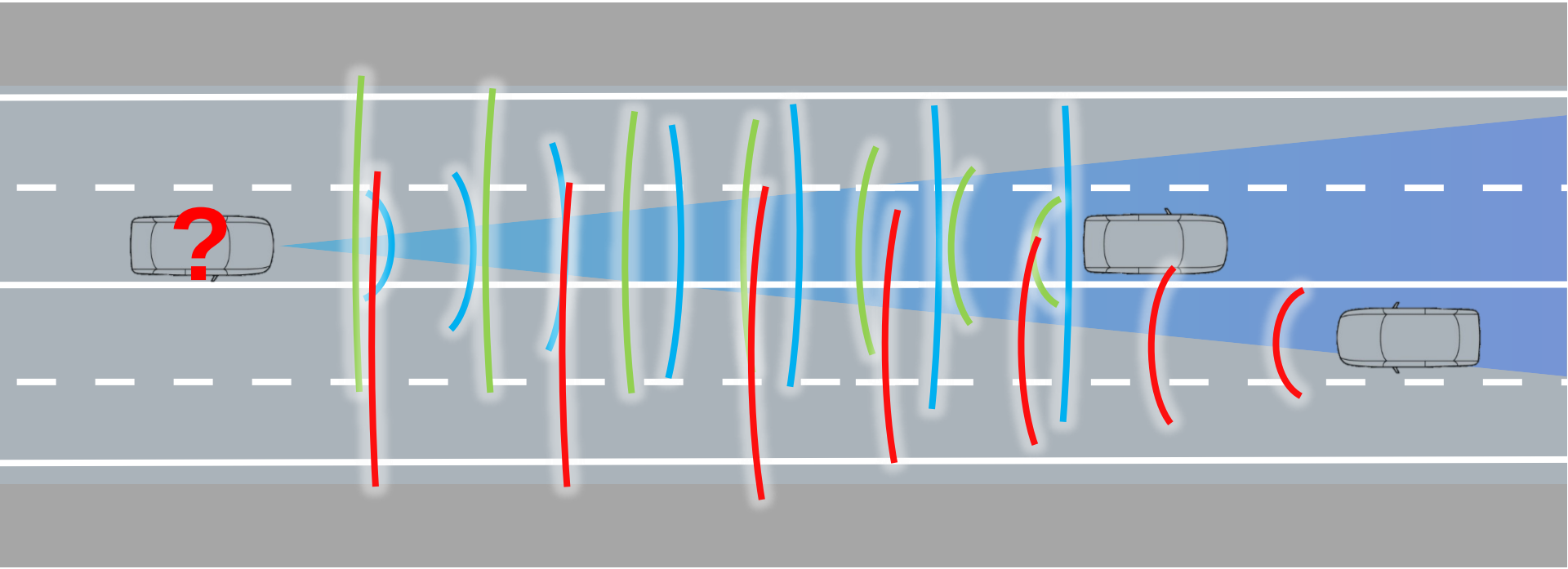
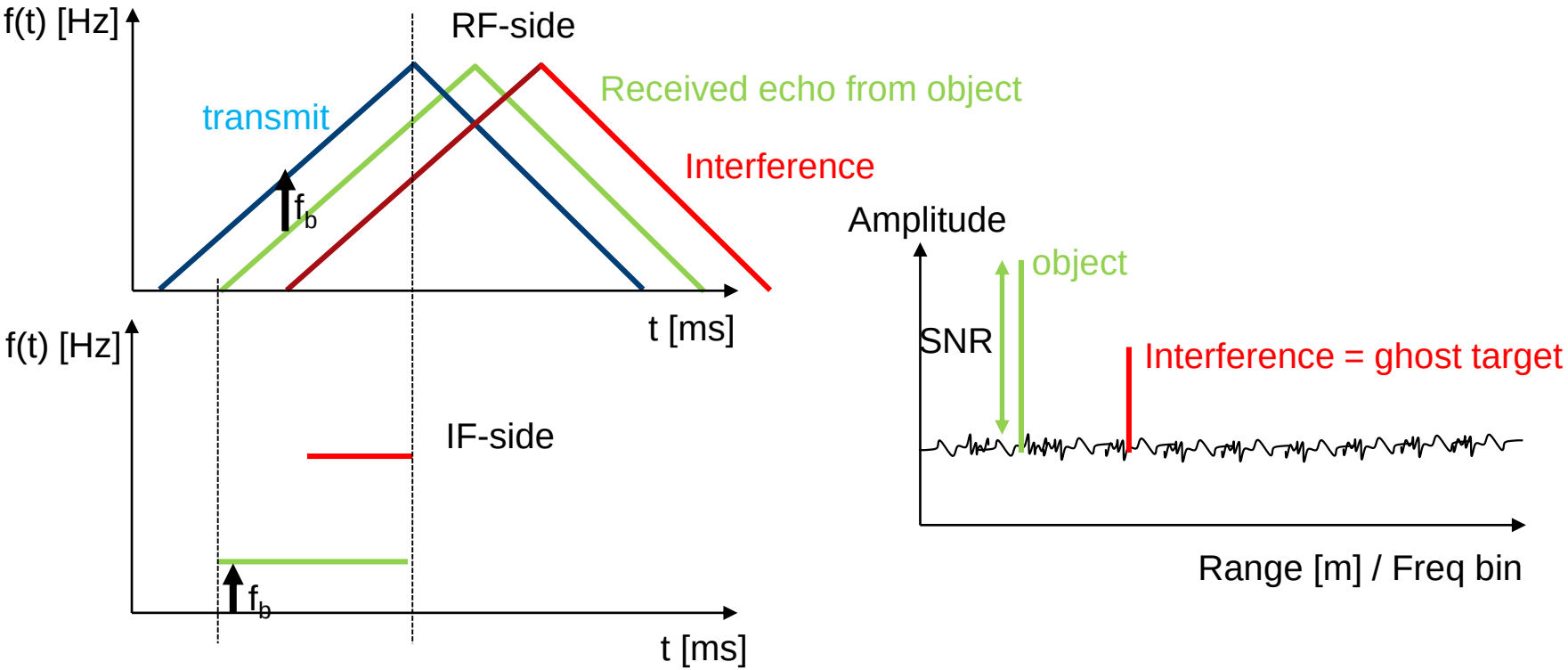
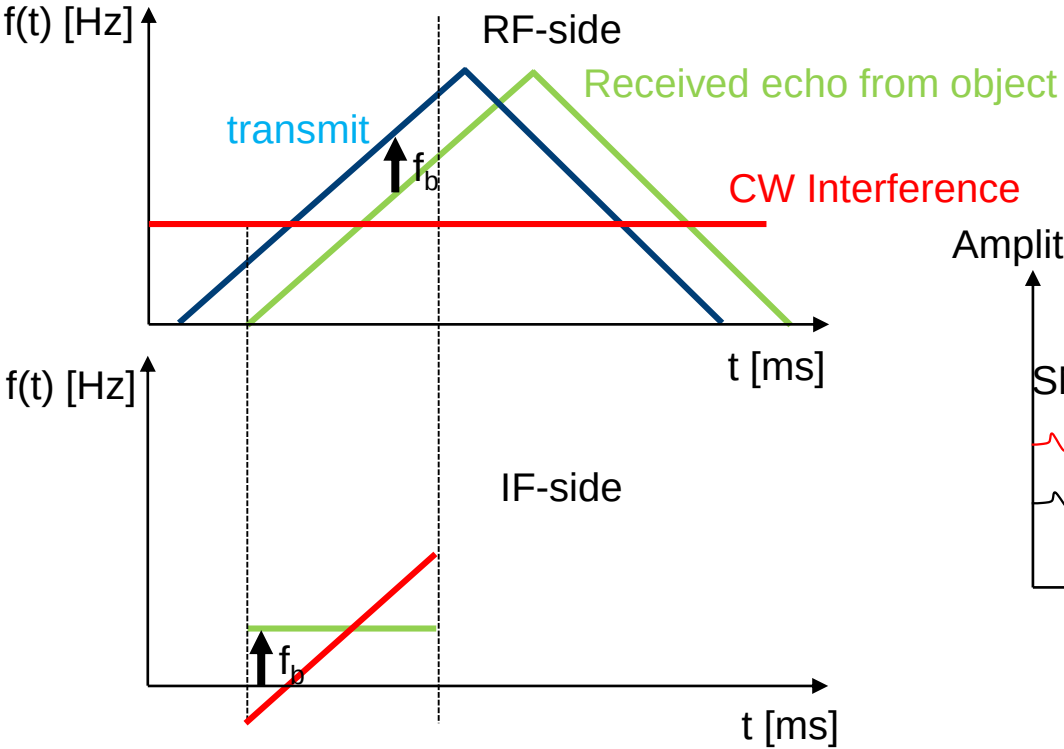
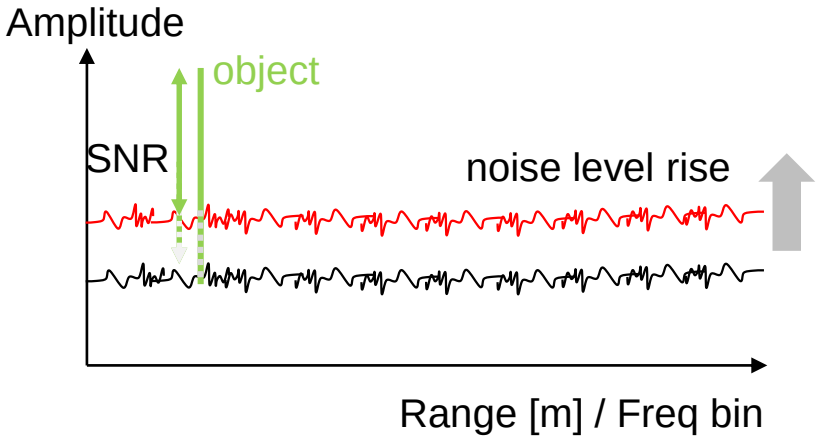


INTERFERERS - RADAR ECHO'S AND TIME ALIGNED CHIRPS



INTERFERERS – CW SIGNALS WITHIN THE RADAR SENSOR'S BANDWIDTH





REVIEW - INTERFERER MITIGATION TECHNIQUES

Interferer type / waveform	Impact on automotive radar sensors	Mitigation technique and principle		Effectiveness and applicability
CW	Deterioration of SNR	Hopping within the assigned radar band	STFT – restoring the received signal	Very effective – easy realization with signal processing
FMCW (chirp)	Additional ghost object		FMCW with phase coding	Good – higher effort needed

How to test and evaluate the mitigation techniques after implementation in the sensor?

TESTING THE ROBUSTNESS OF AUTOMOTIVE RADAR SENSORS

Solution for simultaneous radar echo and interferer generation based on a radar echo generator with upconverter for the interferer signal (e.g. R&S®AREG100A Automotive Radar Echo Generator)

19“
3 height
units

24 GHz

or

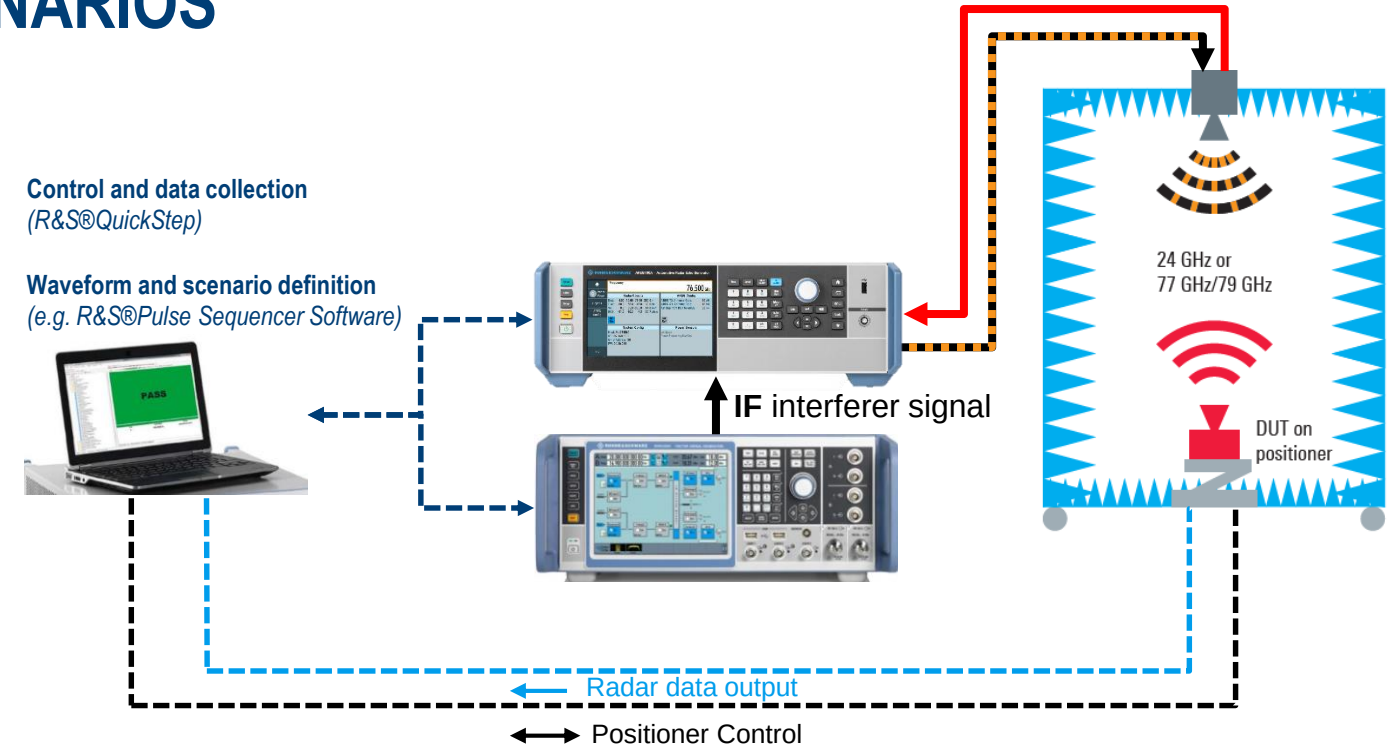
77 / 79 GHz

DUT

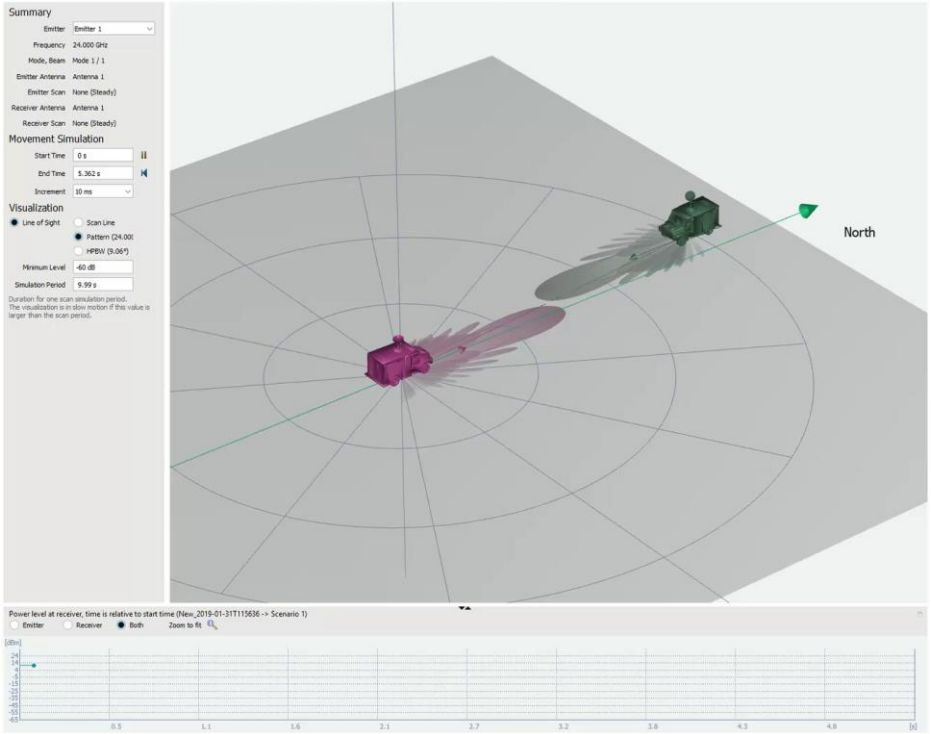
Automotive radar
sensor
(regular operation mode)

Radar Signal
Echo Signal

SIMULATION SETUP FOR ADVANCED INTERFERENCE SCENARIOS



EXTENSION TO REALISTIC STREET SCENARIO



The R&S®Pulse Sequencer can generate realistic scenarios, including but not limited to following parameters:

- Antenna patterns
- Any IQ modulated waveforms
- Driving tracks
- Velocities and accelerations
- Hopping
- …

SETUP

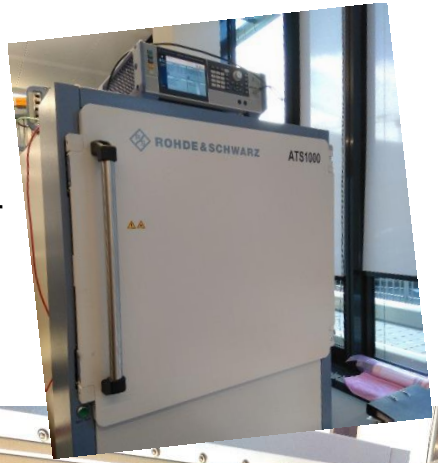
R&S®SMW200A Vector Signal Generator

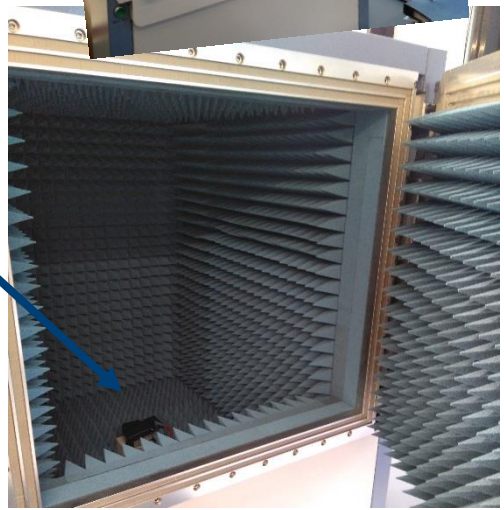
R&S®AREG
Automotive Radar Echo Generator

R&S®ATS1000
Shielded Chamber

Control, data collection

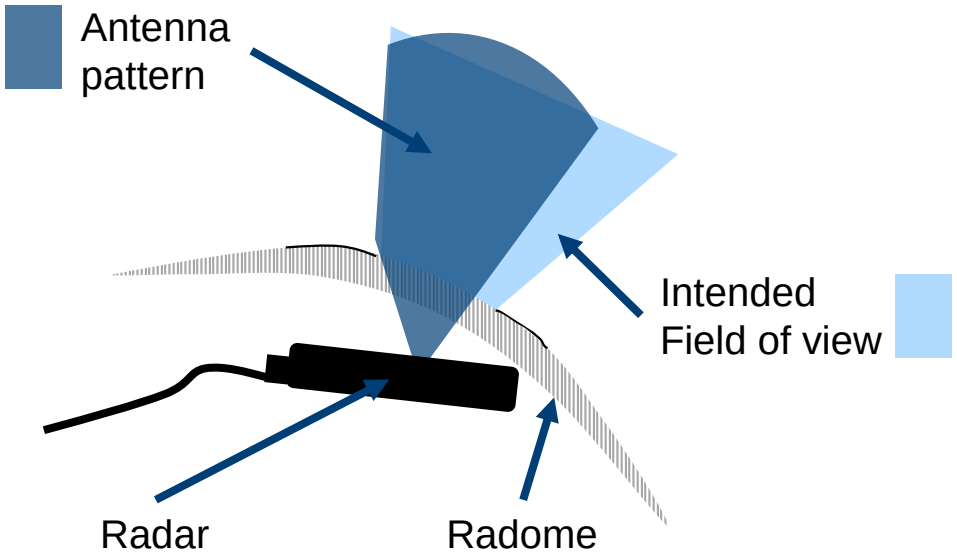
Radar sensor
under test





MOUNTING POSITION ACCURACY WITH R&S®QAR

MOUNTING ACCURACY MEASUREMENT
WHY IS IT NECESSARY?



- The radar is not necessarily fixed to the bumper or radome.
- It has to be ensured that the antenna pattern lies inside the intended FOV.

MOUNTING ACCURACY MEASUREMENT
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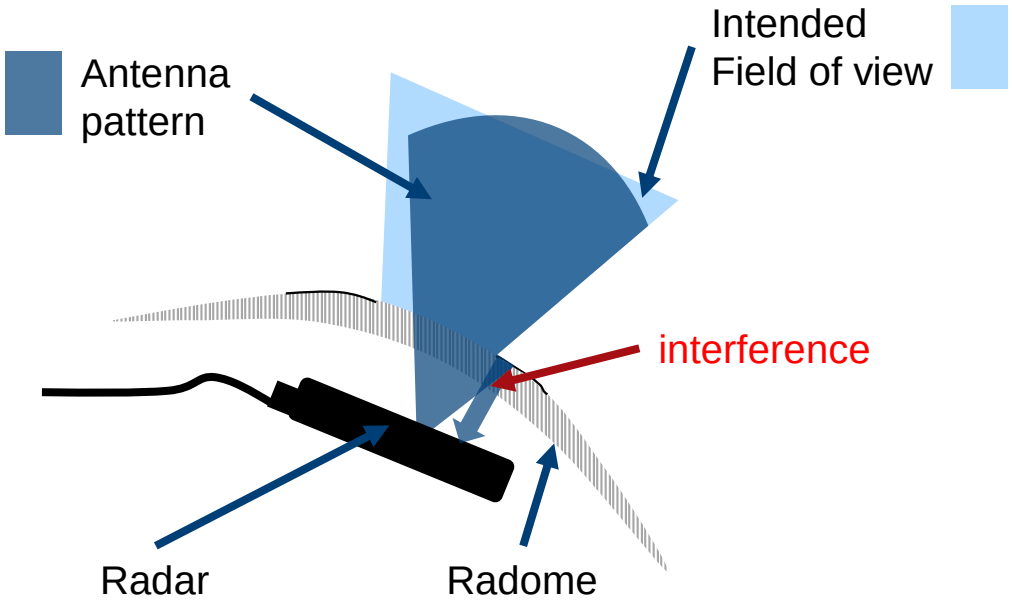

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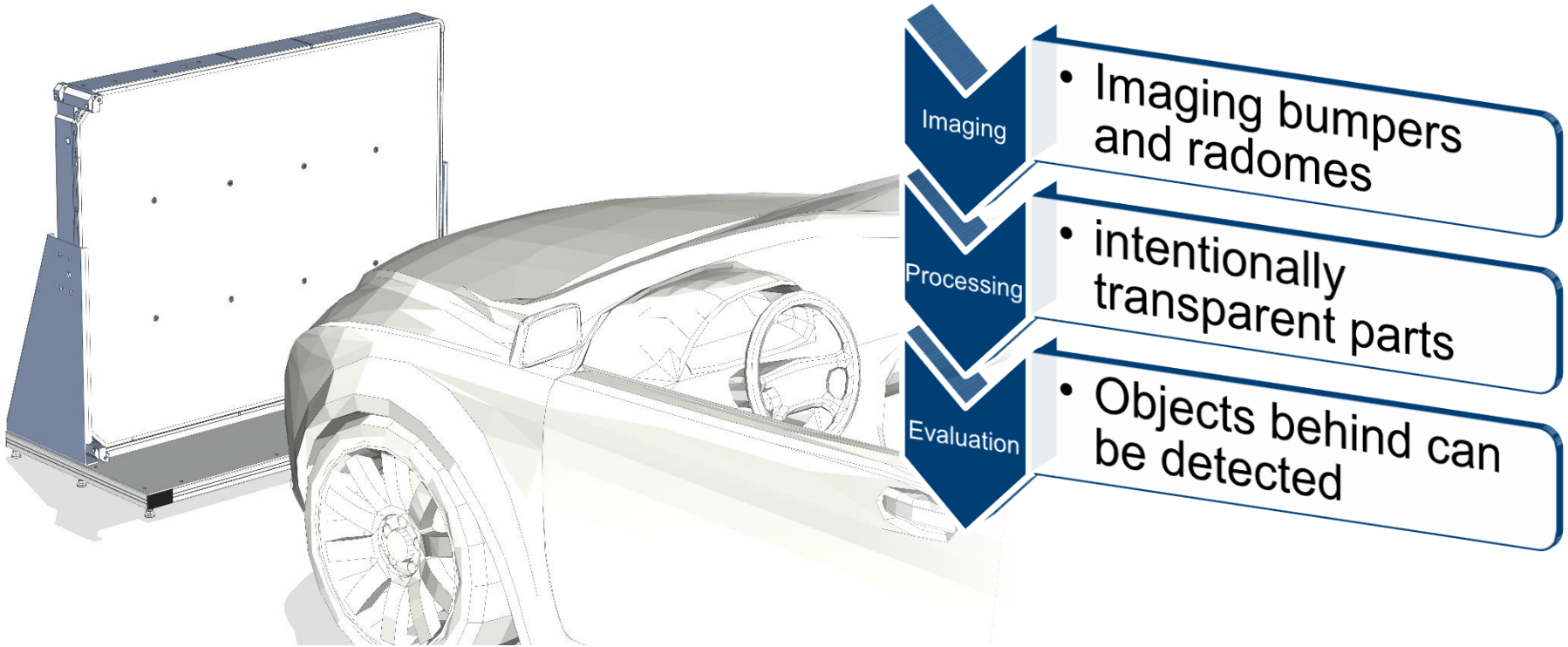
HOW CAN THE QAR BE OF HELP?



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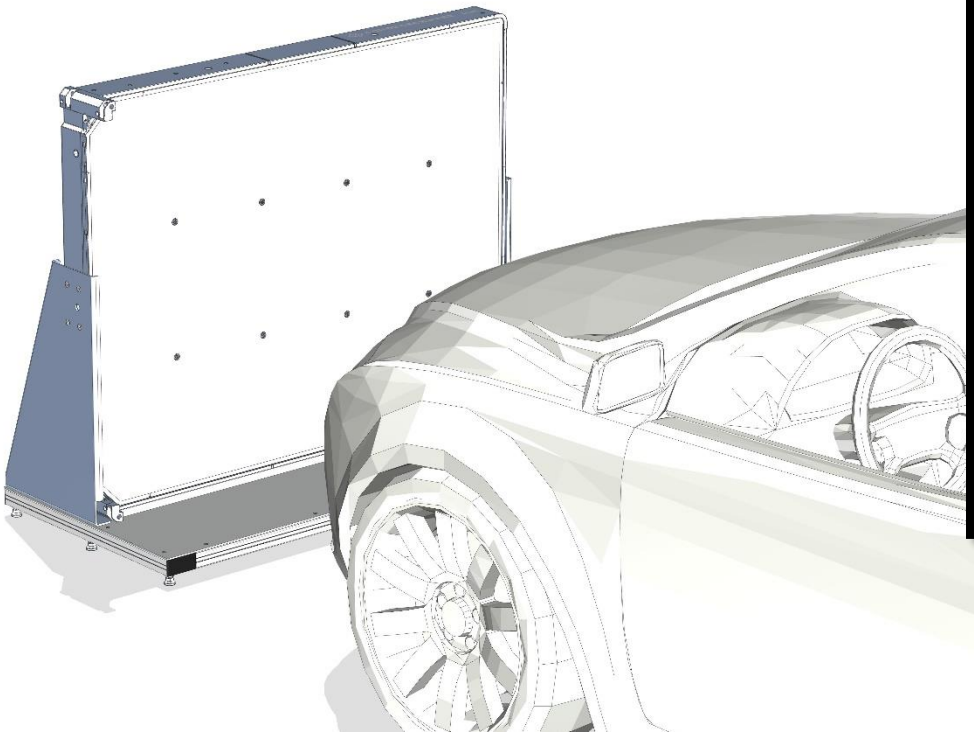

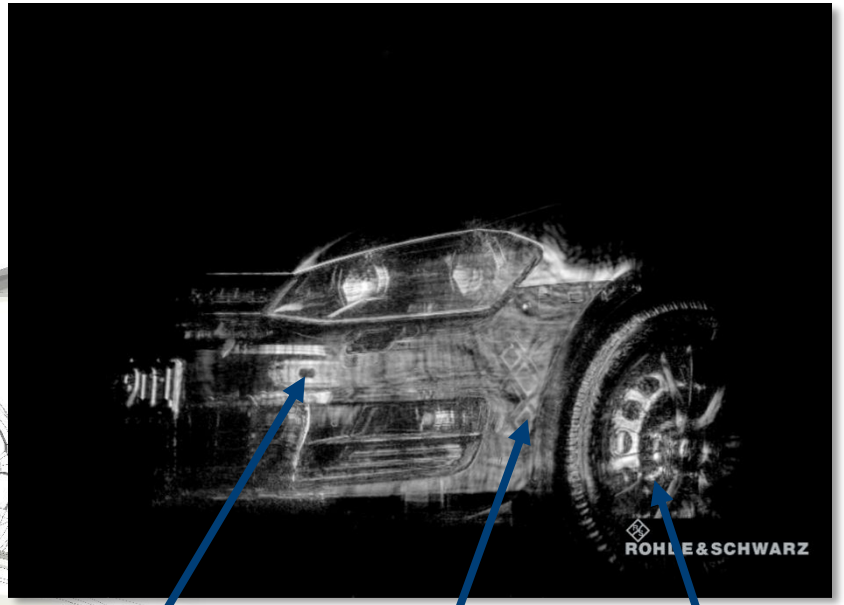

Ultrasonic Sensor

Structures in the bumper

Plastic rims

MOUNTING ACCURACY MEASUREMENT
HOW CAN THE QAR BE OF HELP?

- The QAR can look through the bumper.
- Raw data is used to locate x, y and z-position of the radar together with azimuth and elevation angle of the device.
- CAD data is necessary for correct classification.

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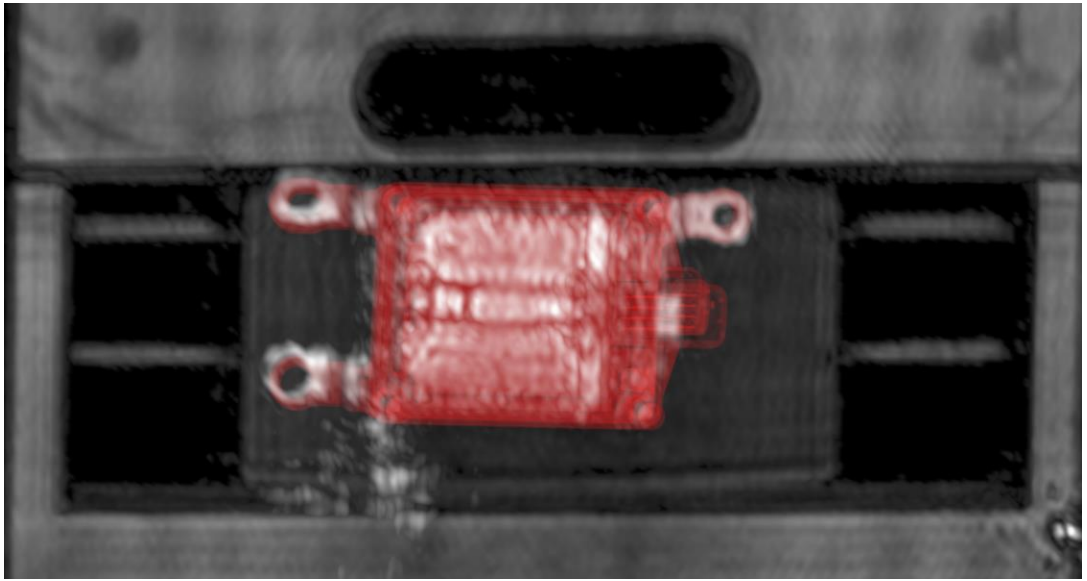

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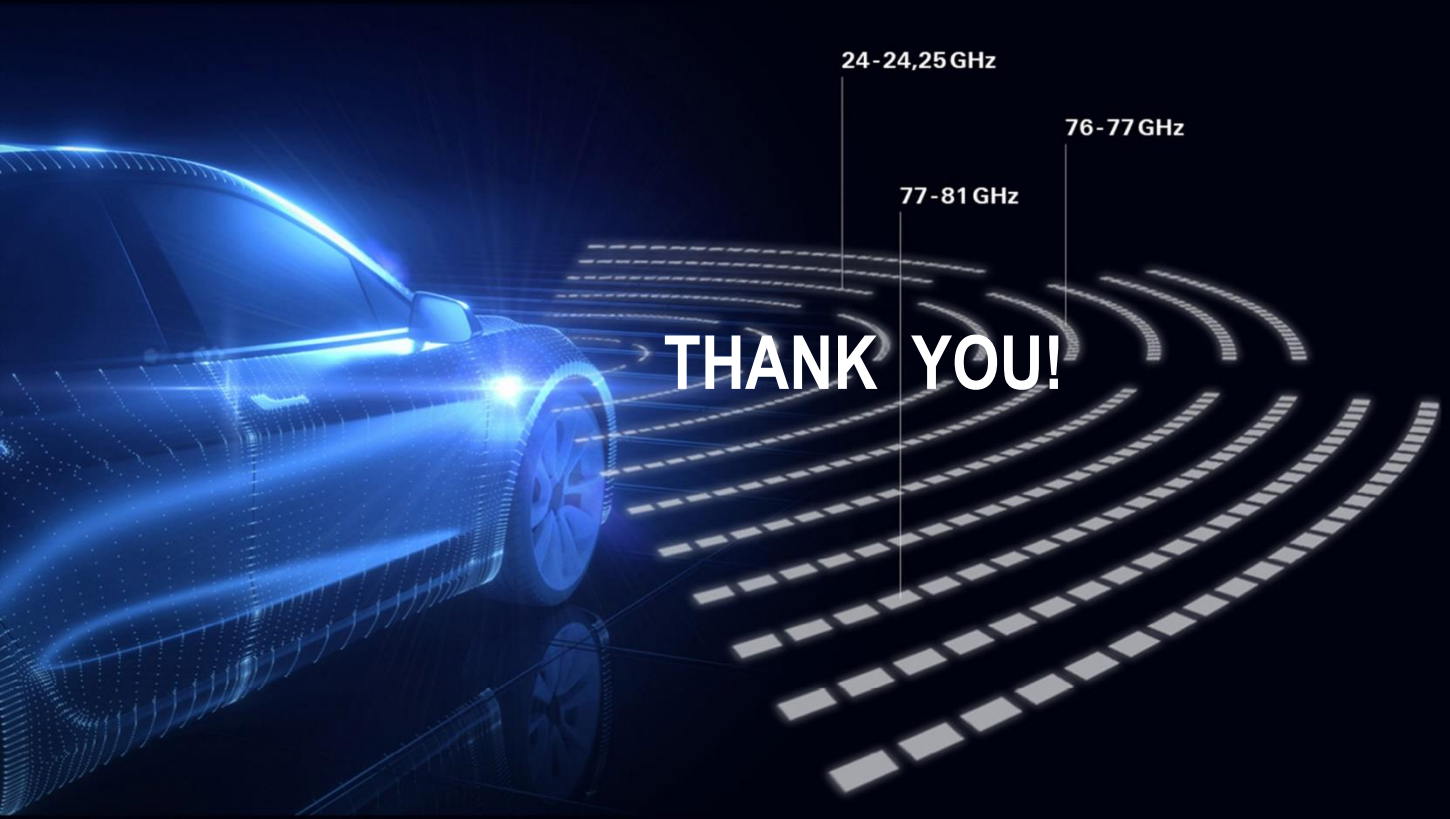

THANK YOU!