Continental: the latest advanced radar technology

2nd DIVP Technical Seminar

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コンチネンタル オートノモス・モビリティー・ジャパン株式会社

Continental: the Latest Advanced Radar Technology

› 発表者プロフィール

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■ 人の命を少しでも多く救うことに貢献するということをPersonal Missionとして、医療機器業界からオートモーティブ業界 ADAS分野へ

■ 最新Radar Technologyと製品を世の中に広めることによりVision Zeroへ貢献し続けていく

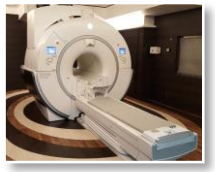
背景 / 目的

■Automotive Radar SensorのLeading CompanyであるContinental社の最新Radar Technologyの紹介

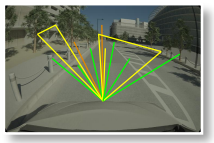
■Gen.6 Radarを使ったDIVPとの協業についての紹介

経歴

Medical Equipment Industry
- **RF** engineer (~MHz, not GHz)
- System Architect
- Program Management



Automotive Industry (Continental)
- Program Management, **Radar**/System
- **Strategy & Business Development**
  - Business Development
  - Product Management
  - Regulatory Affair
  - **Innovation & Partnership**



骨子

■Continental/Business Area Autonomous Mobility (BA AM) Overview

■Continental Imaging Radar (ARS540/ARS640)

■Continental Surround Radar(SRR630/SSR630) with 77/79GHz

■Collaboration with DIVP

Continental Group Structure and History

Group Sectors

Automotive

Business Areas

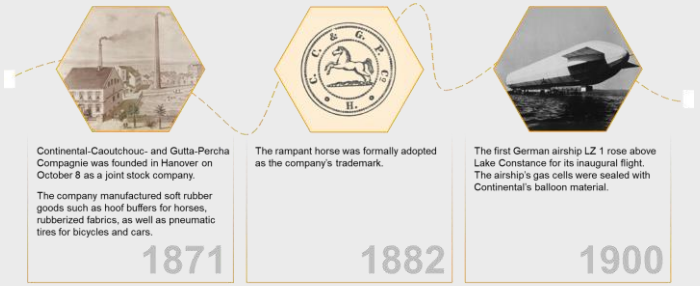
- Safety and Motion
- **Autonomous Mobility**
- User Experience
- Architecture and Networking
- Software and Central Technologies

Tires

- Original Equipment
- Replacement APAC
- Replacement EMEA
- Replacement The Americas
- Specialty Tires

ContiTech

- Industrial Solutions Americas
- Industrial Solutions APAC
- Industrial Solutions EMEA
- Original Equipment Solutions
- Surface Solutions



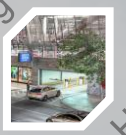
OUR VISION

Autonomous Mobility for You.

Anywhere.
Anytime.

OUR WAY FORWARD TO A FULL STACK PORTFOLIO

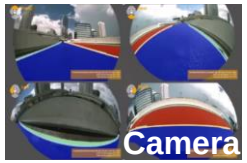
FUNCTIONS — SOFTWARE

Cruising 
Safety 
Parking 
Human Vision 

PERCEPTION

Sensor Data Fusion & Comprehensive Environment Modelling 

Detection



SENSOR PROCESSING — HARDWARE

Camera 
Radar 
LiDAR 
Ultrasonic 
ADCU 

Continental Radar – Leading innovation for your safety and comfort

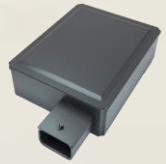
4D Imaging Radar

- Performance benchmark Radar for most robust and reliable L3-L5 AD Systems

Long Range Radars

- Focused sensing for highest range and precision for a safe and comfortable journey
- Smallest in-class volume product, leading the standard for next generation vehicles

Surround Radars



- 360° coverage for various safety and comfort functions
- Scalable volume product with best in-class value to cover current and upcoming regulations
- Premium product with market leading technology to push boundaries for AD

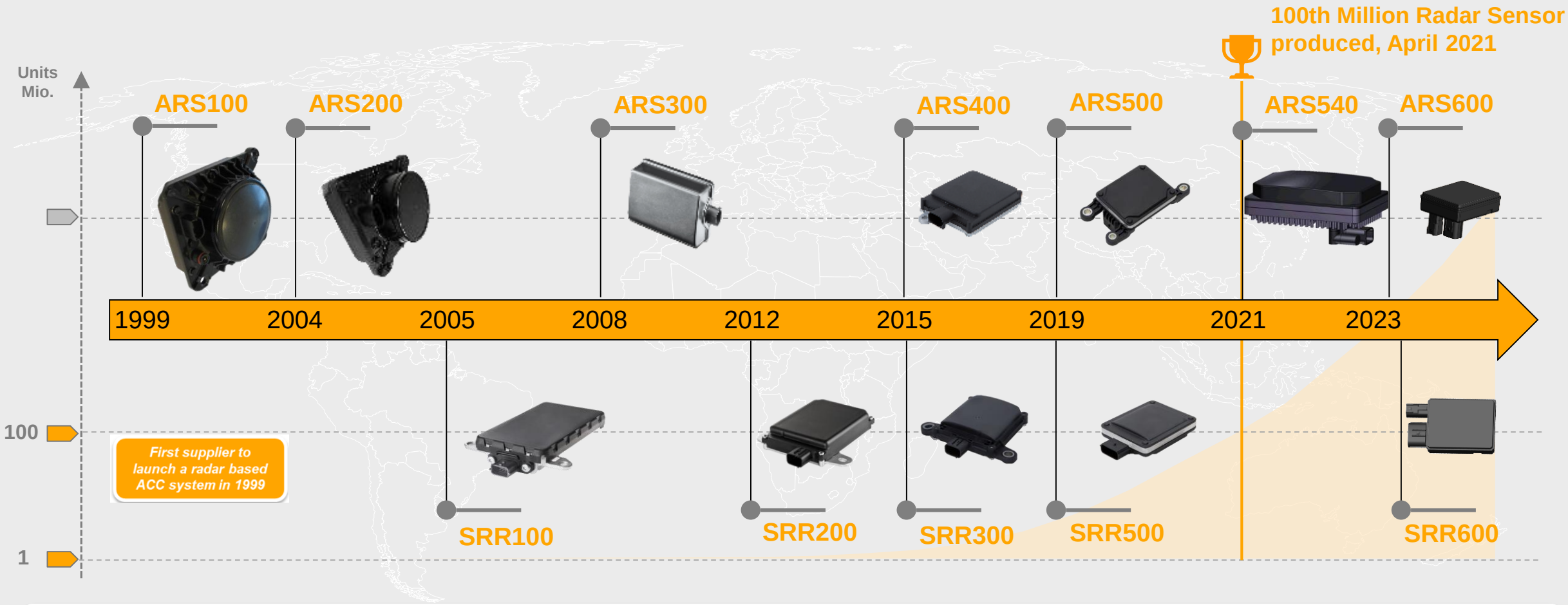
Satellite Radars

- Optimized surround and long-range Radars for high-performance fusion-based ADAS Systems (in combination with ADCU)
- Patented signal processing enables unmatched efficiency for flexible ADAS system setups

Comprehensive Radar portfolio to match your needs and expectations

ADAS – Pioneering Automotive Radar Technology

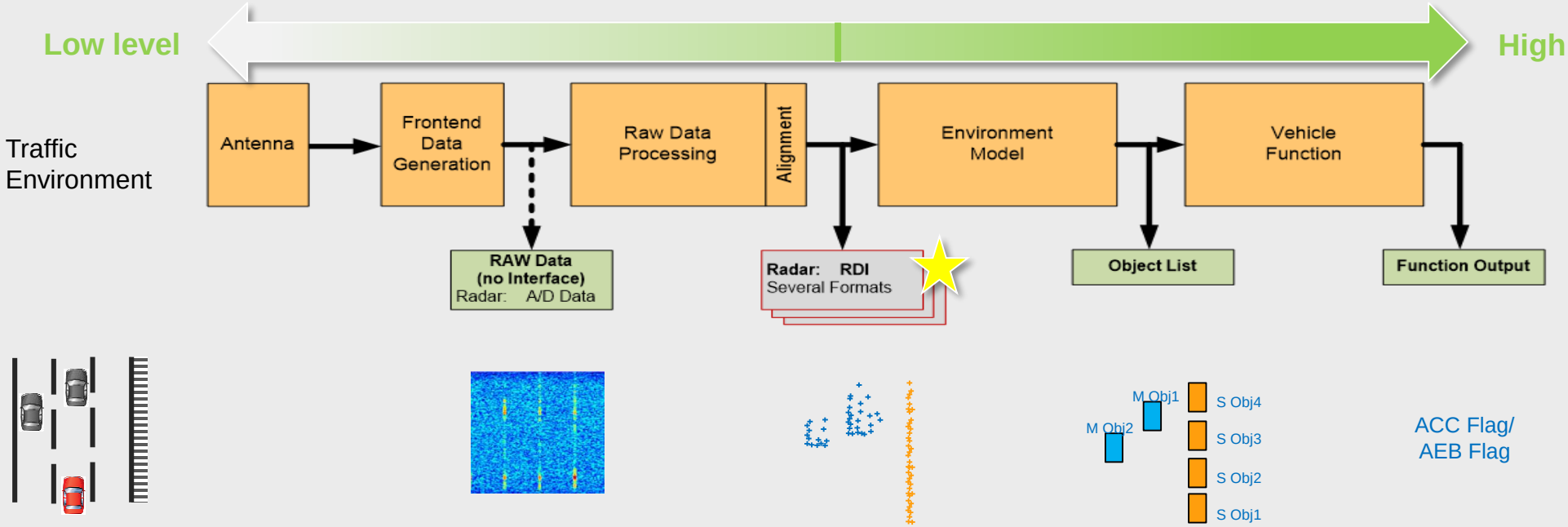
History and Outlook for Long Range Radars and SurRound Radars



Longstanding experience with leading, high performance Radar Technology

Signal processing chain and output

New trend of radar technology



Output	Content	Features
FFT1	Spectrum data	Compressed data on 100Mbps (Continental IP)
RDI	**Single shot Radar image**	**HW independent (calibrated and aligned)**
Object List	Tracked and classified objects	Sensor technology independent
Function Output e.g., ACC, AEB Objects	Assessed and selected objects/ Deceleration request	Direct input to ACC controller/ Direct input to brake system

Radar Point of Cloud

FFT: Fast Fourier Transformer
RDI: Radar Detection Interface defined by ISO23150

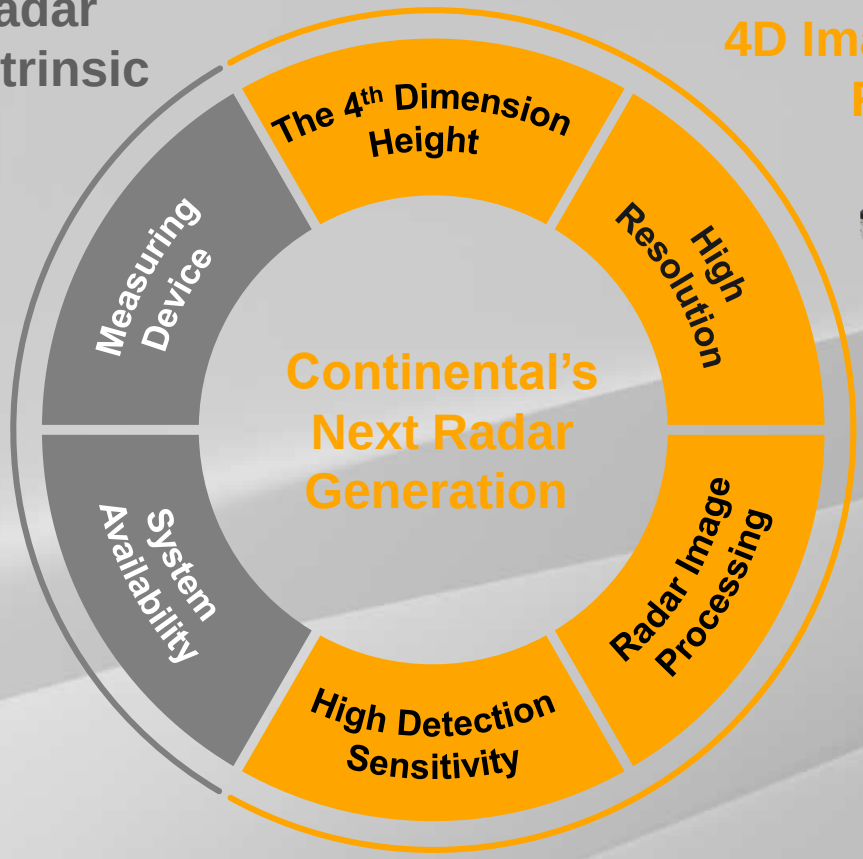
Radar – Fundamental for ADAS and AD

4D Imaging Radar Securing Technology Leadership

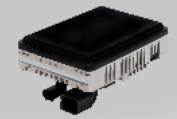
Precise distance and speed in real-time

Adverse weather conditions

Radar intrinsic



4D Imaging Radar



Underridable elevated objects

Non overridable ground obstacles

Road boundaries

Debris/potholes

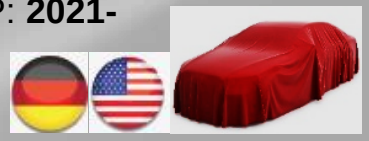
Complex/dense traffic

Landmarks

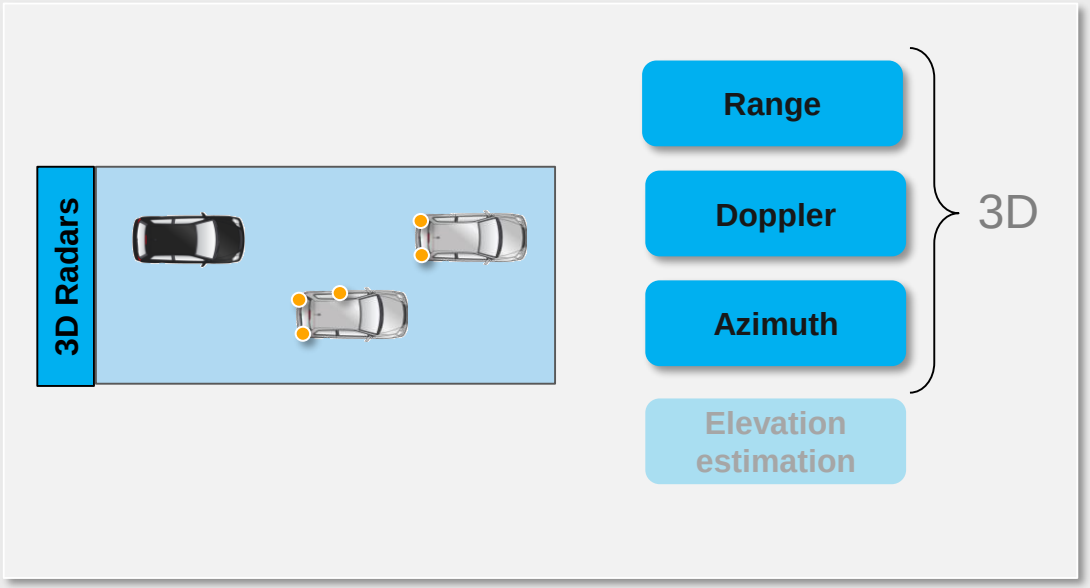
Success

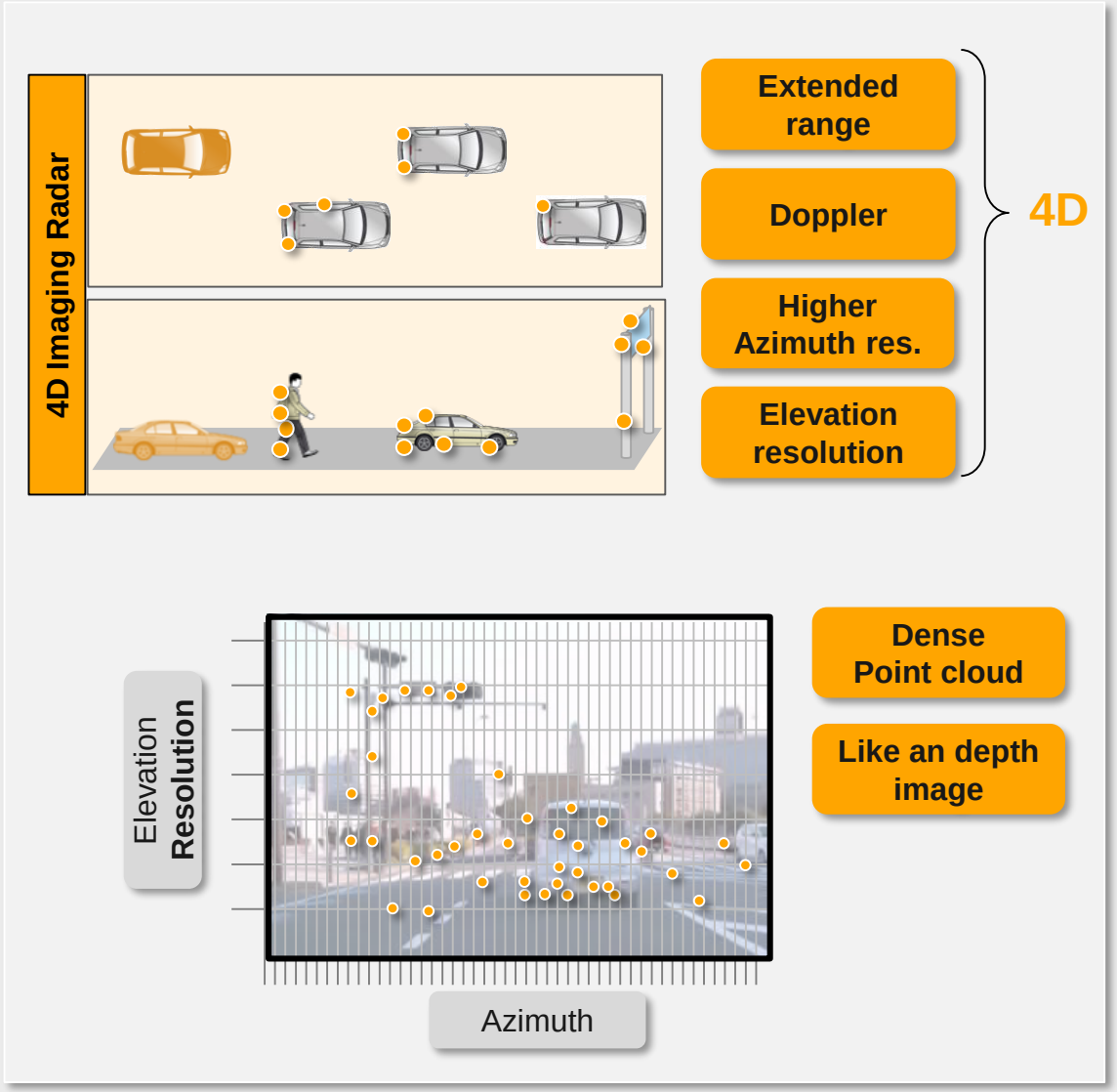
First to market

SOP: **2021-**



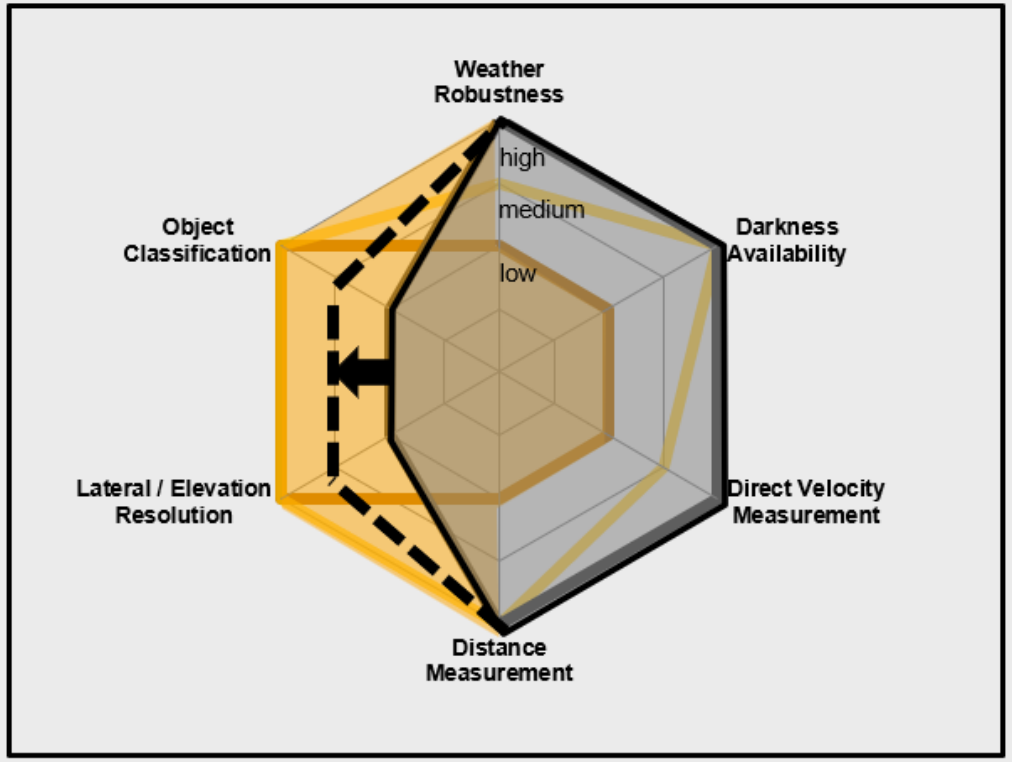
Definition of 4D Imaging Radar





4D imaging radar provides high density radar point cloud (RDI) in azimuth and elevation as well as velocity

Radars for Assisted Driving ⇔ Radars for Automated Driving



Standard Radar Sensors For Assisted Driving

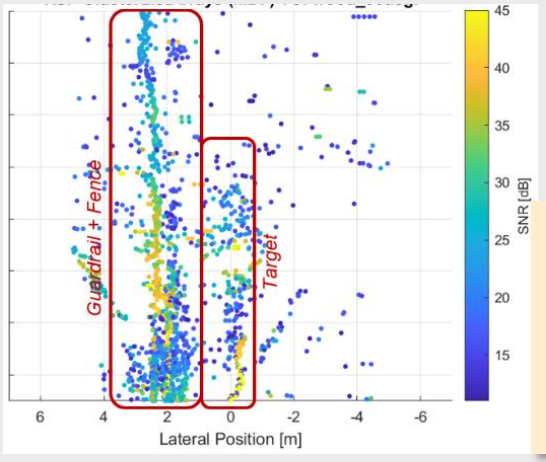
Future Radar Sensors For Automated Driving

4D Imaging Radar enables higher resolution, accuracy and reliable detection

Automated Driving: Important Scenarios

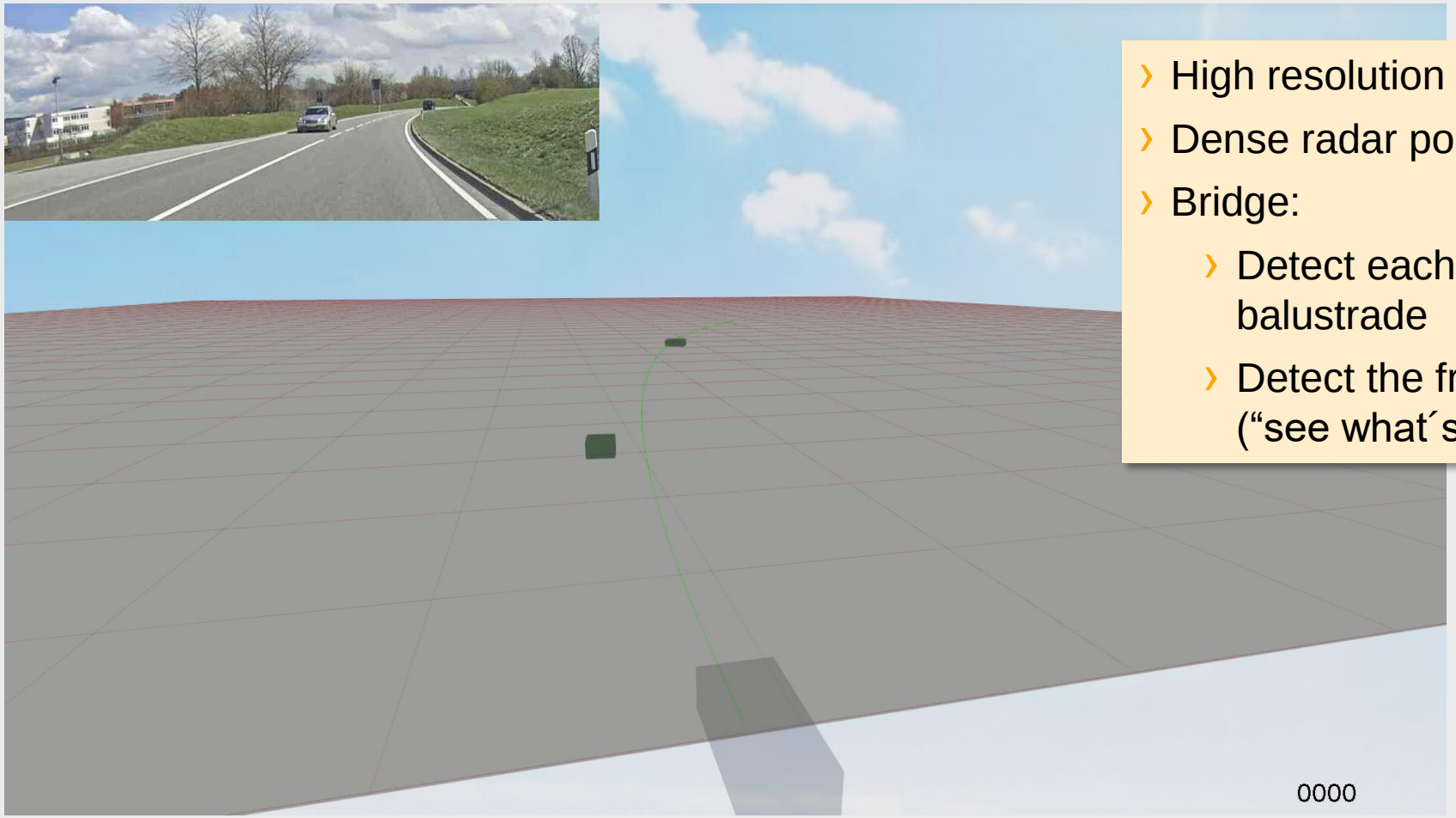
› **Separation** in azimuth, two target at far rage at **under metal bridge**

› **Lost object detection** with 8Mp camera



› Azimuth separation from guardrail & metal fence and **small lost object** together

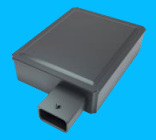
4D Imaging Radar :
Dense point cloud and elevation measurement



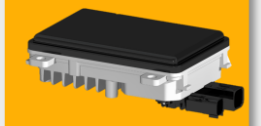
- High resolution
- Dense radar point cloud
- Bridge:
  - Detect each individual post of the balustrade
  - Detect the front and the rear balustrade (“see what´s behind the scene”)

Comparison Standard Radar / Imaging Radar / Lidar

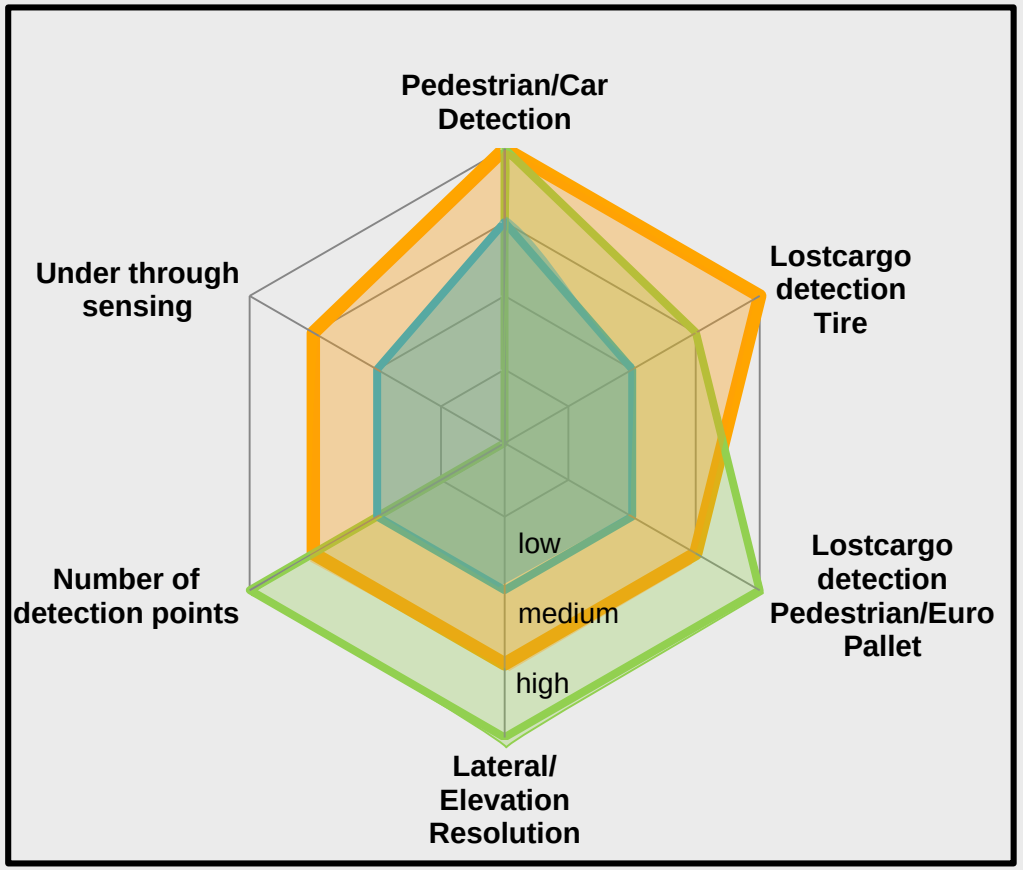
Standard RADAR

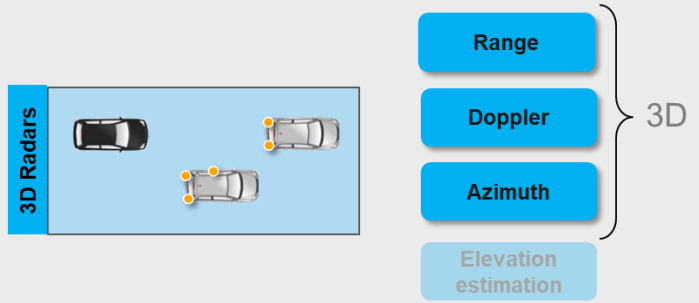


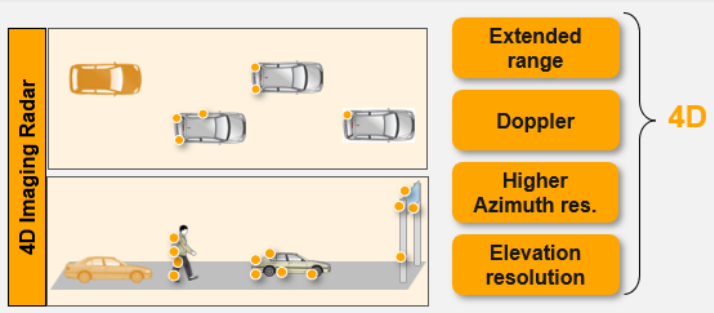
Imaging Radar



LIDAR



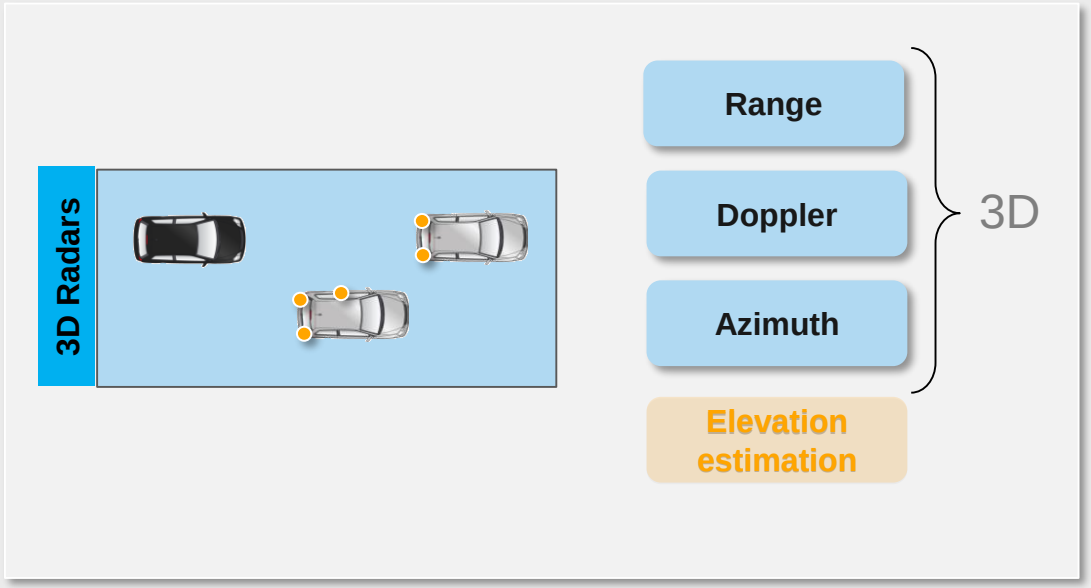


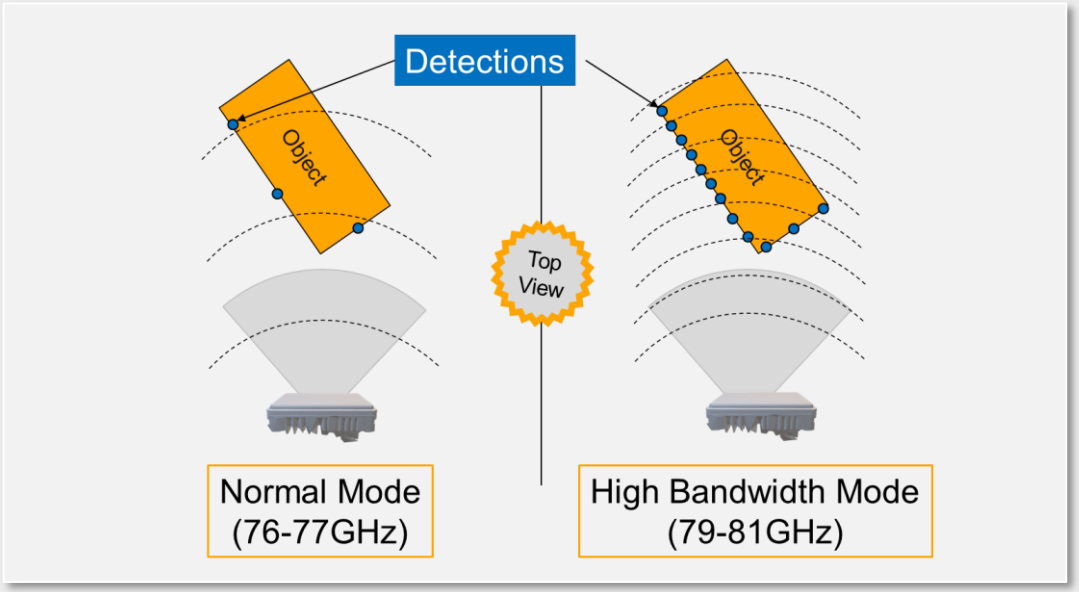


› Best balance of performance and cost for L3/L4, **L2p as well**

Imaging Radar enable to expand detection capability and reliability with affordable cost for Lv3 and above, L2p as well

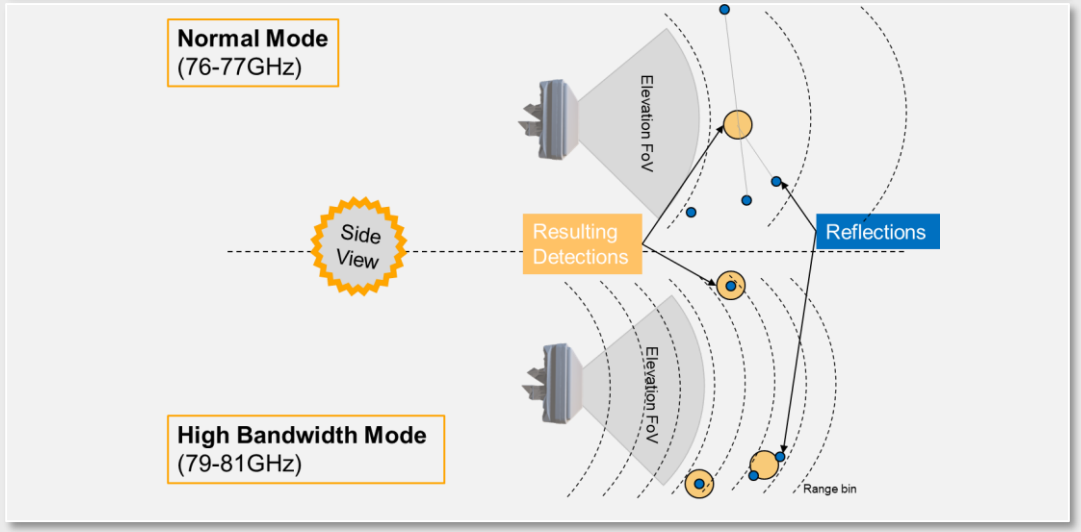
What is High Bandwidth Mode





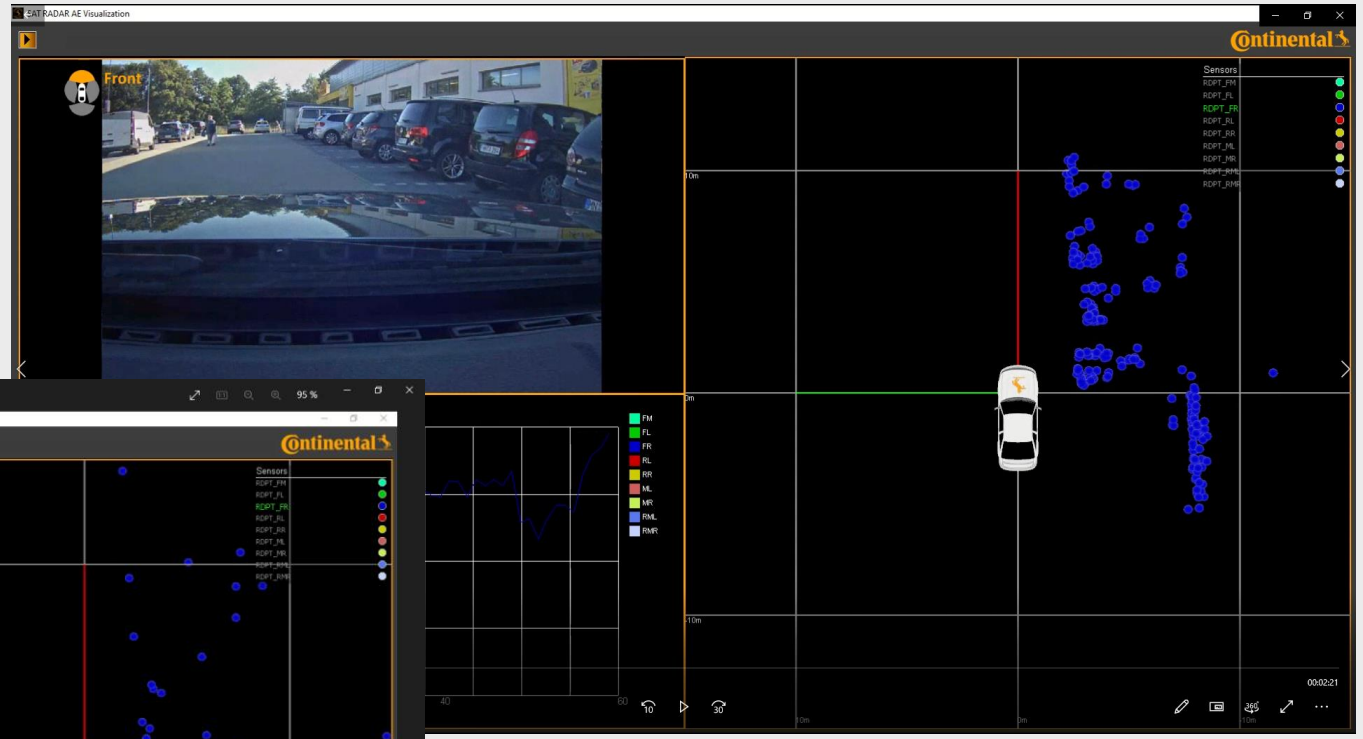
Higher distance resolution and high density of radar point cloud

Due to the high bandwidth, more detections per space volume(azimuth & elevation) can be expected

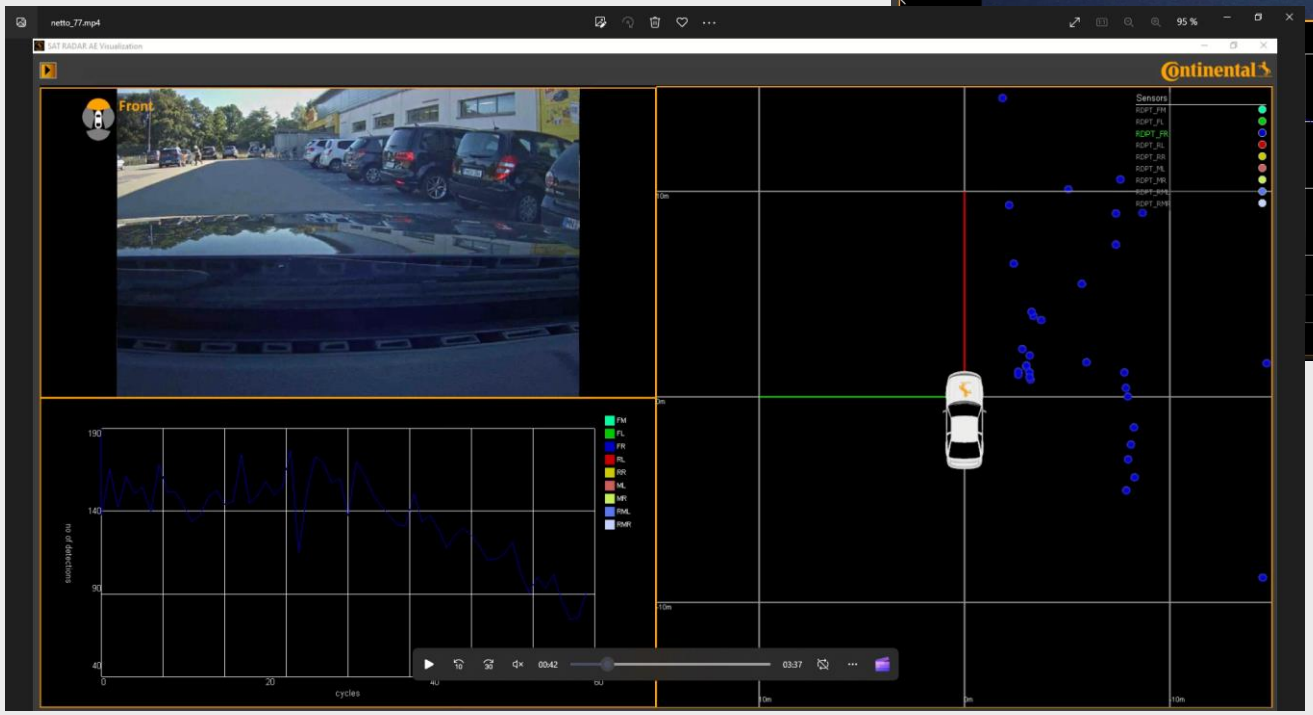


Normal vs. High bandwidth (HBM)

High bandwith Mode



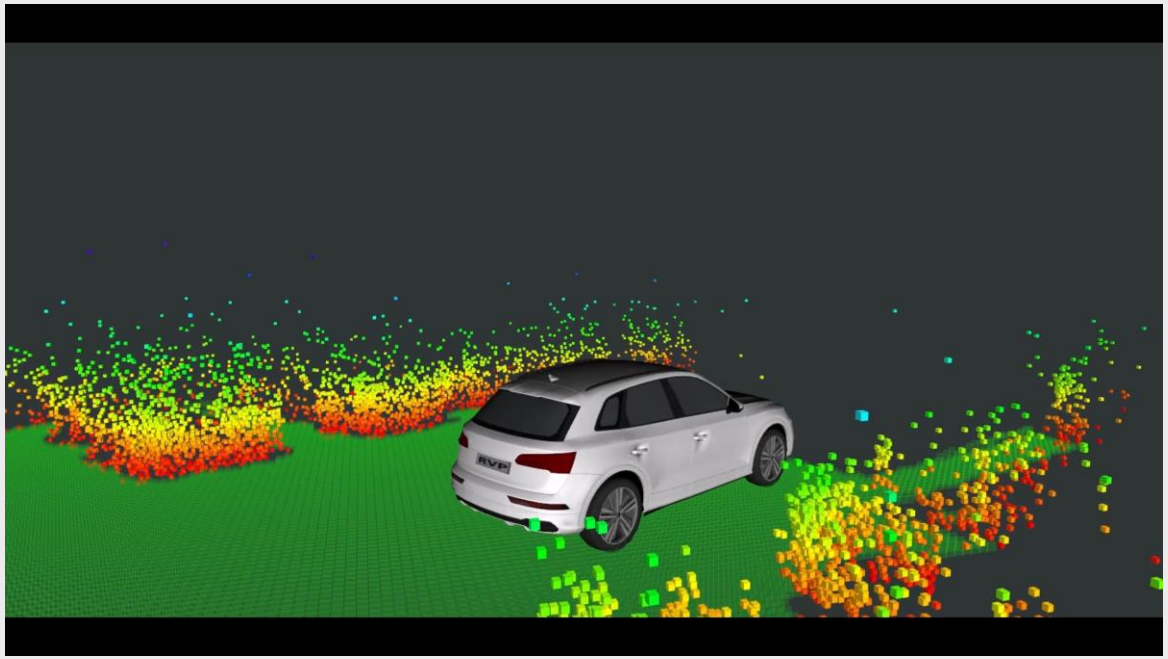
Normal Mode

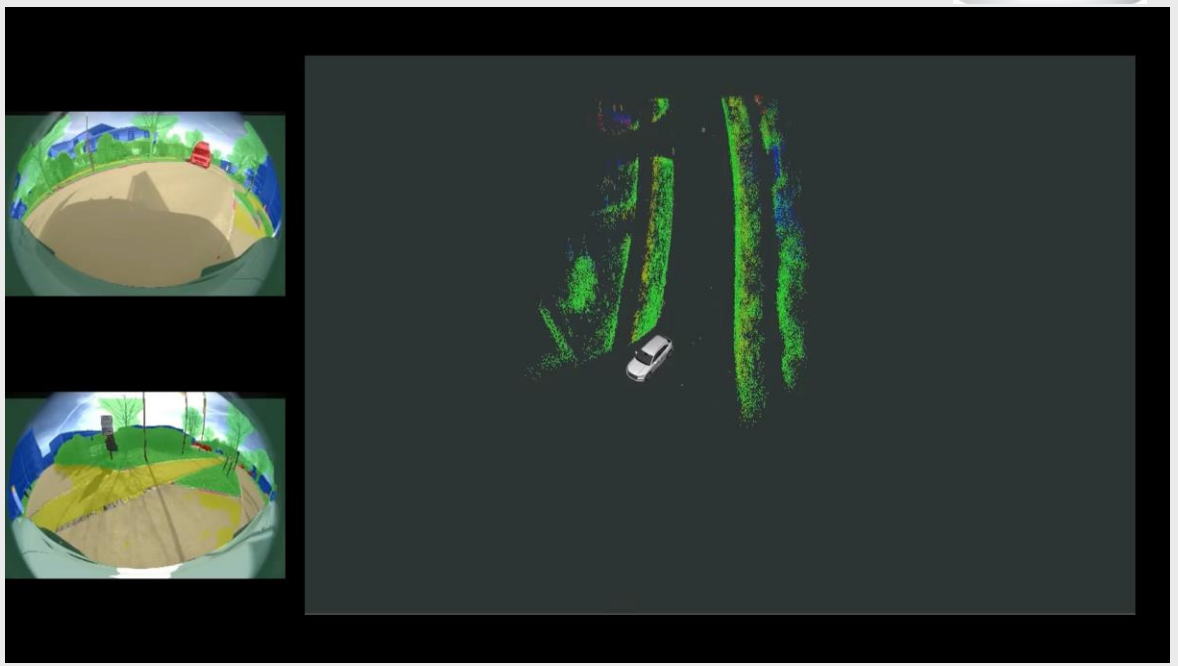


Dens point cloud from parked vehicles

Radar Vision Parking

Low level fusion of neural network processed camera and high resolution satellite radar.



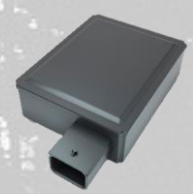


Benefit

- **Cost efficient** technology (Camera, Radar) are providing high function performance
- **Satellite radar** are generating more value add, e.g. curb stone height estimation, high resolution maps.
- **Environment modelling** ensures increased sensors performance

Challenge
to Radar Sensor Model Simulation

Continental



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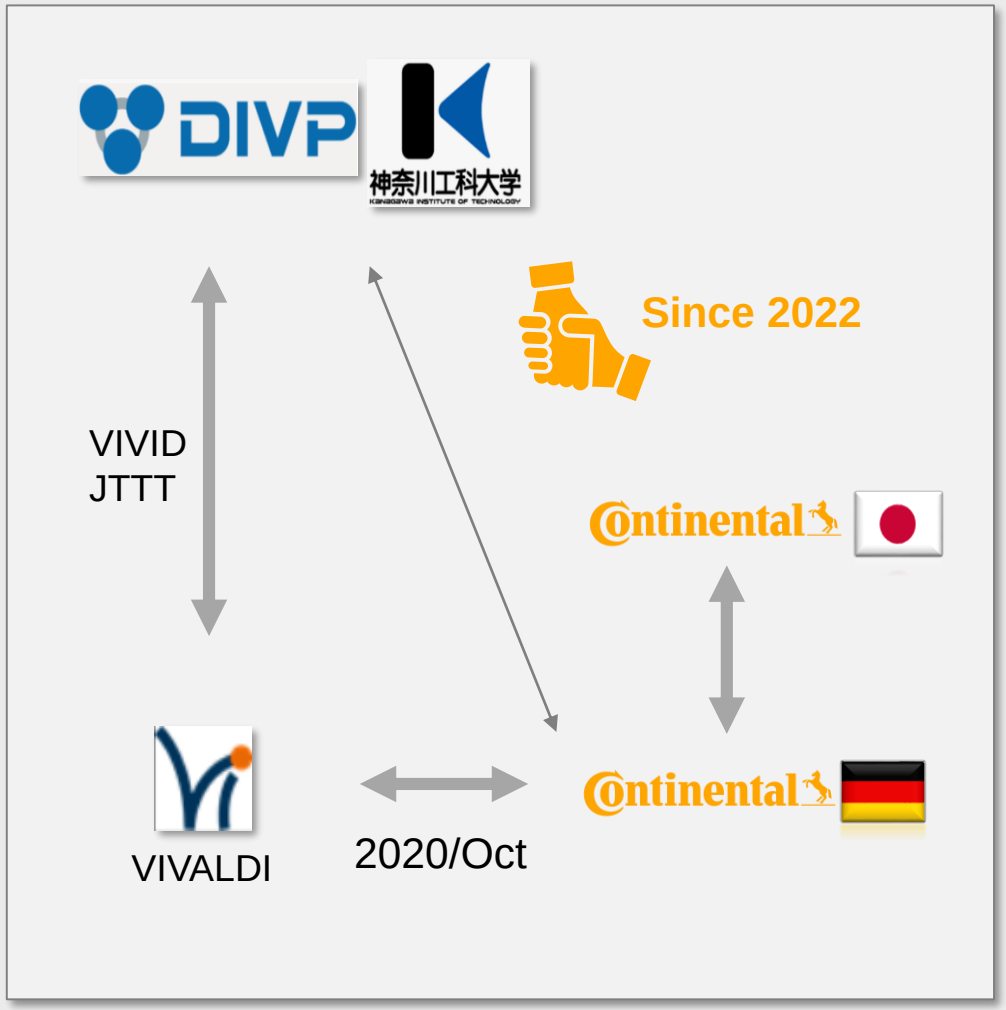
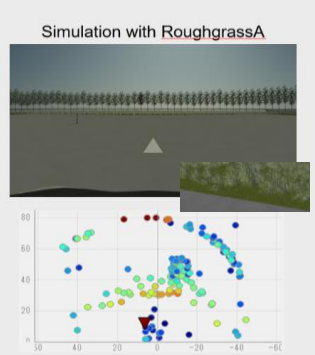
DIVP

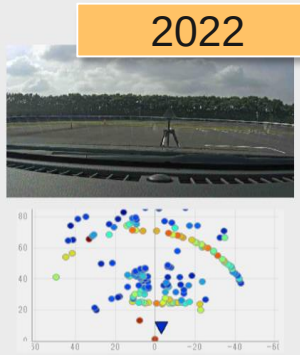
Driving Intelligence Validation Platform

Relationship between DIVP and Continental Japan

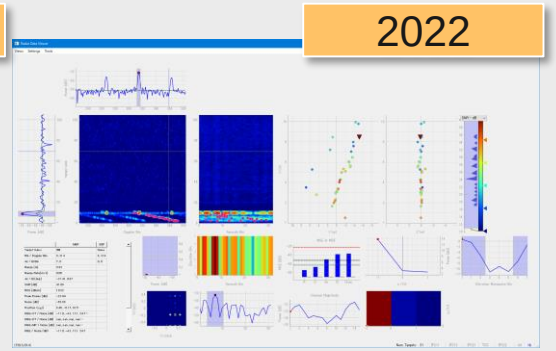




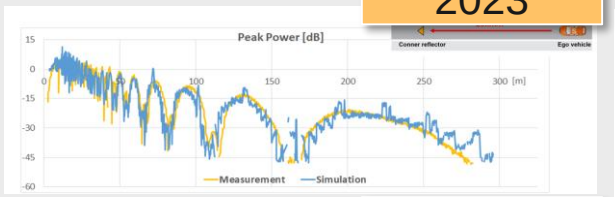
2022



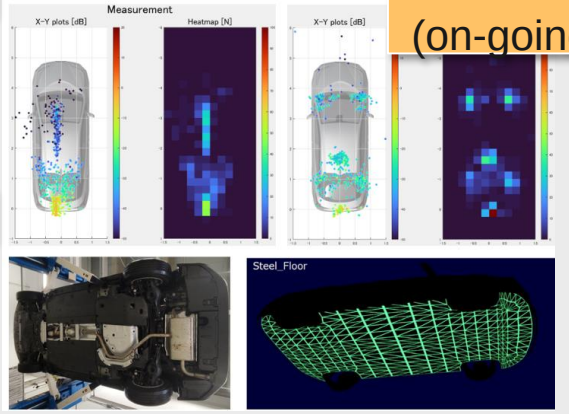
2022



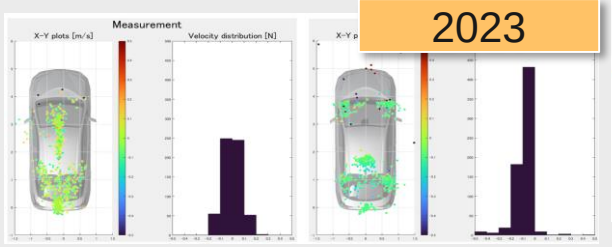
2023



2024
(on-going)

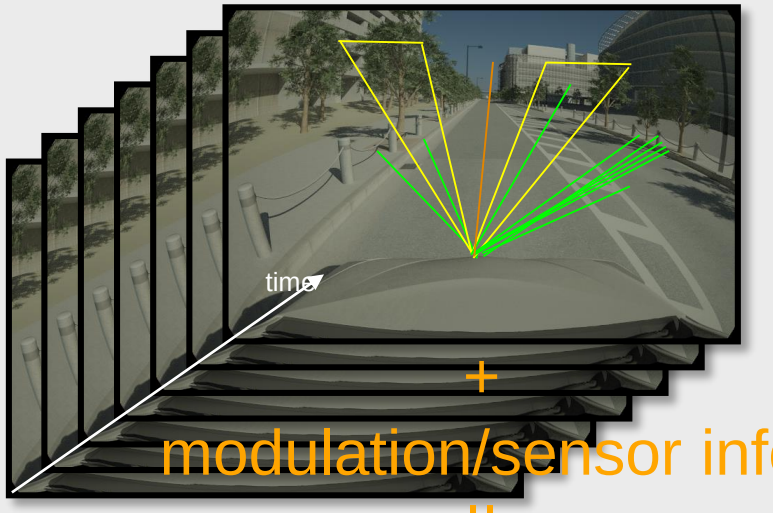


2023



Continental Radar Model adaptation to DIVP

Connect the DIVP output (Ray tracing) to Continental's Radar perception



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modulation/sensor info

=

ADC data / scene, channel and chirp

DIVP

SDM Generator

Test Data Generation

3D model, scenario

Traffic log file

MATLAB/Simulink® (DIVP Toolbox)

Scenario Reader / Merge

Radar Rendering (Ray tracing)

Radar Baseband / Signal Processing

Viewer

Continental

Simulation Toolchain for DIVP

Radar Rendering bump file

I/F conversion

VCM Virtual Channel Model

RAW(ADC) data

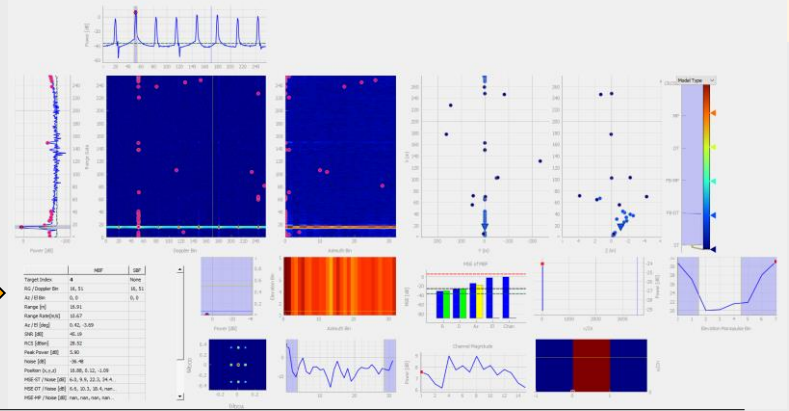
Antenna design RHC config

Radar Signal Processing

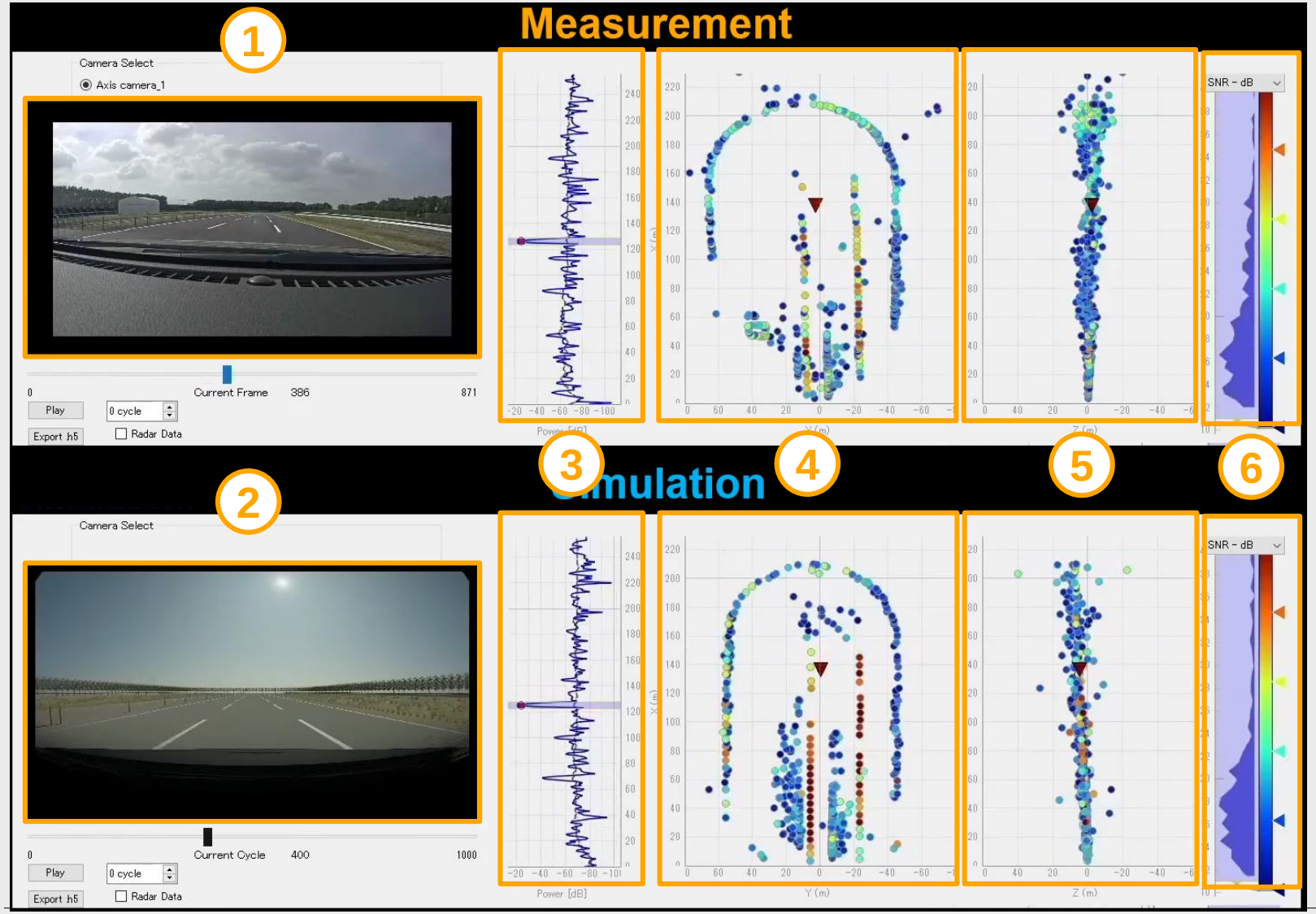
Raw Signal Processing

Viewer

FFT, peak detection etc

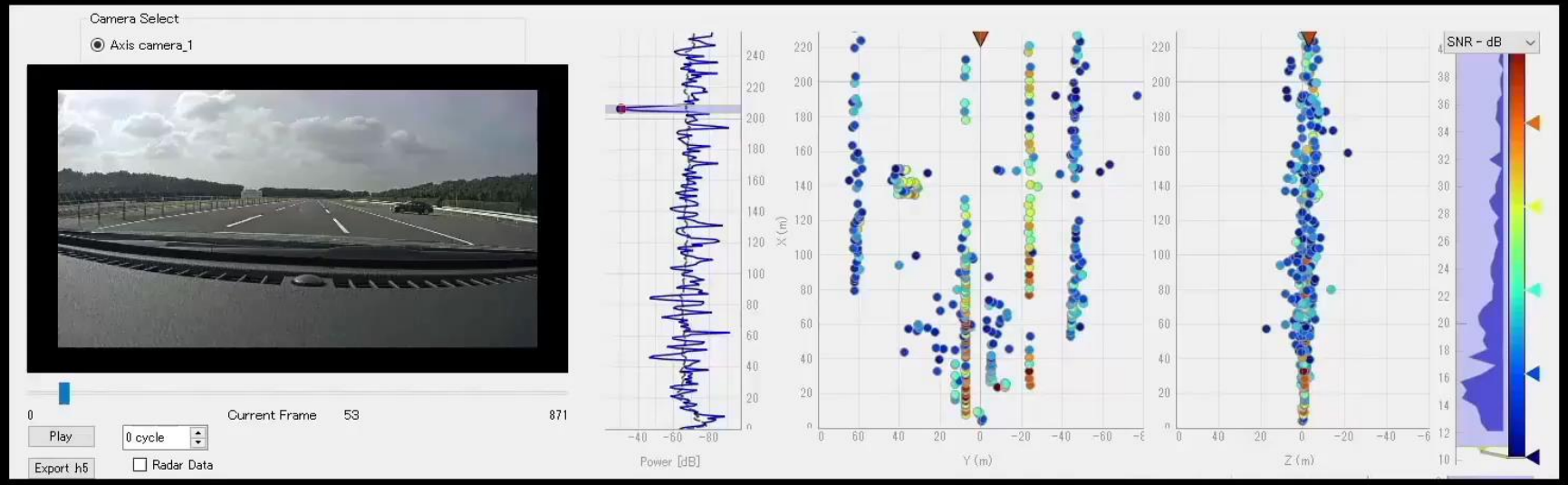


Simulation on DIVP and actual measurement

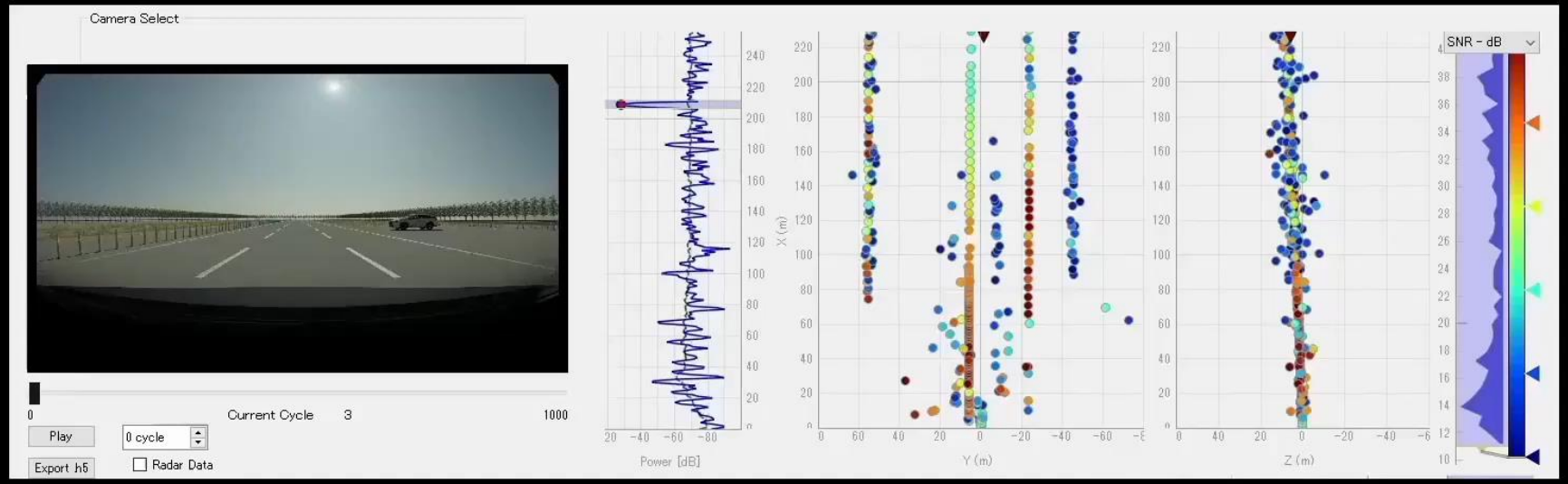


1. Reference camera image
2. DIVP sample camera image
3. Range-FFT
4. Radar RDI X-Y plot
5. Radar RDI X-Z plot
6. SNR distribution

Measurement:

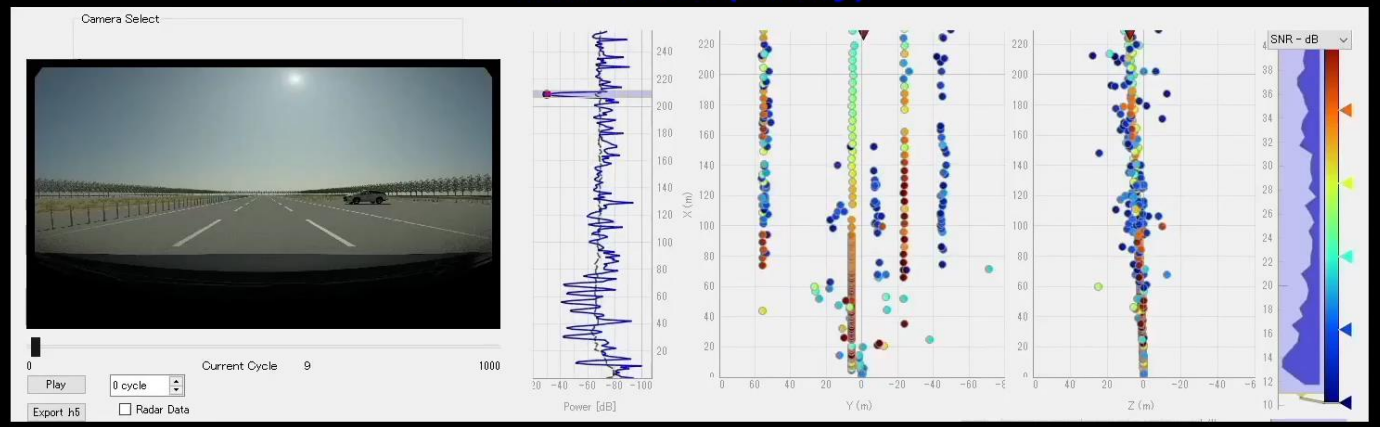


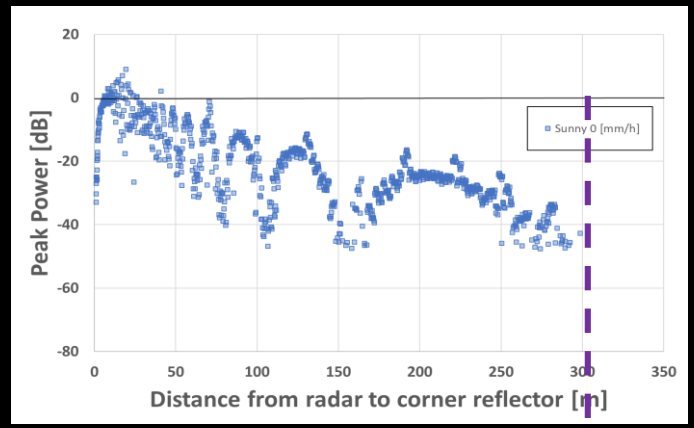
Simulation:



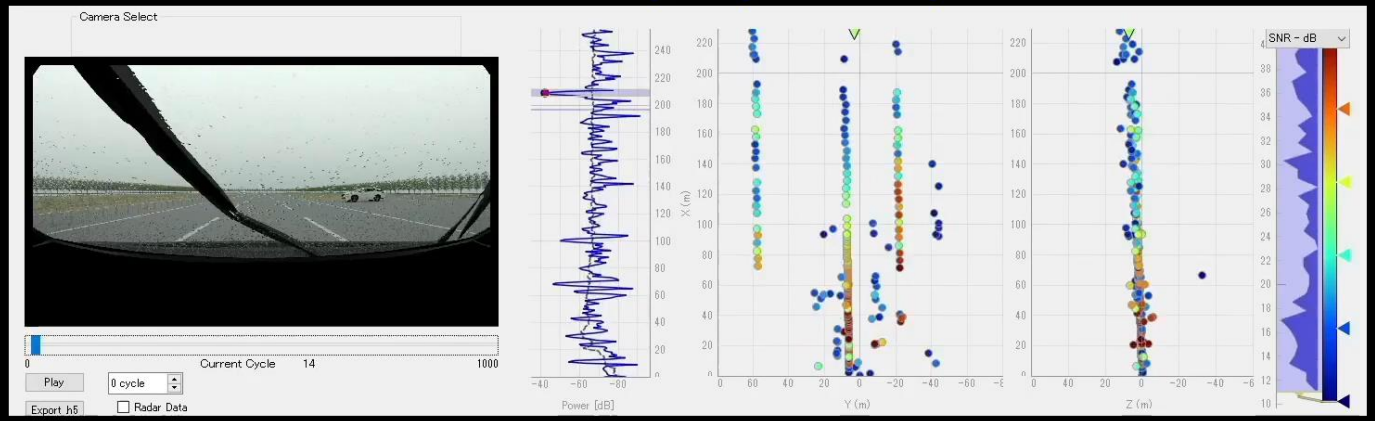
Simulation at Sunny and Rainy

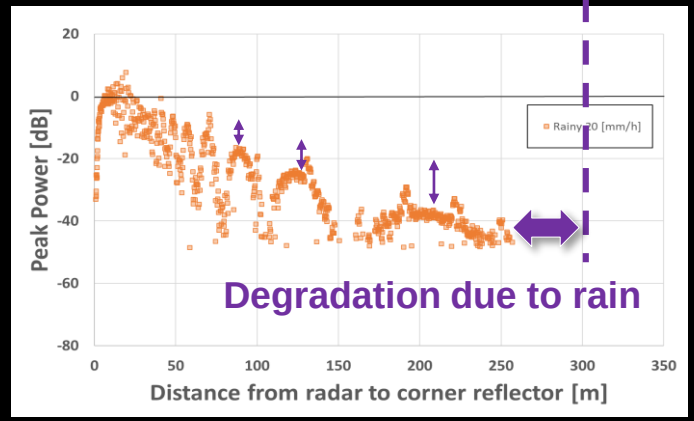
Simulation (Sunny)





Simulation (Rainy: 20mm/h)





Detection performance degradation by rain is simulated well

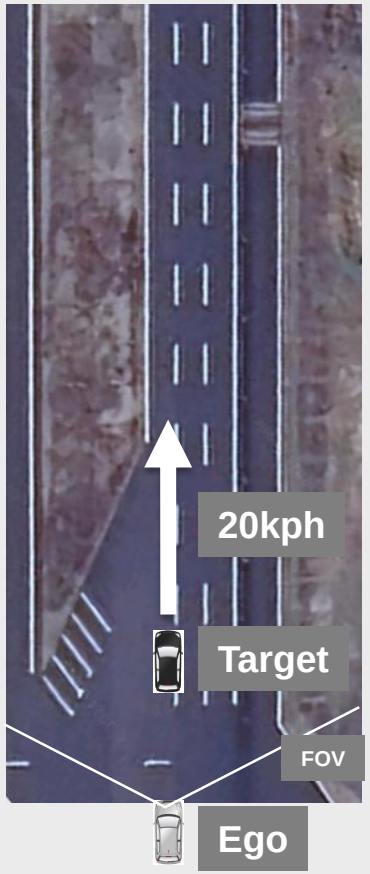
Simulation Tool Chain Integration

Measurement
(Real data + SW on radar ECU)

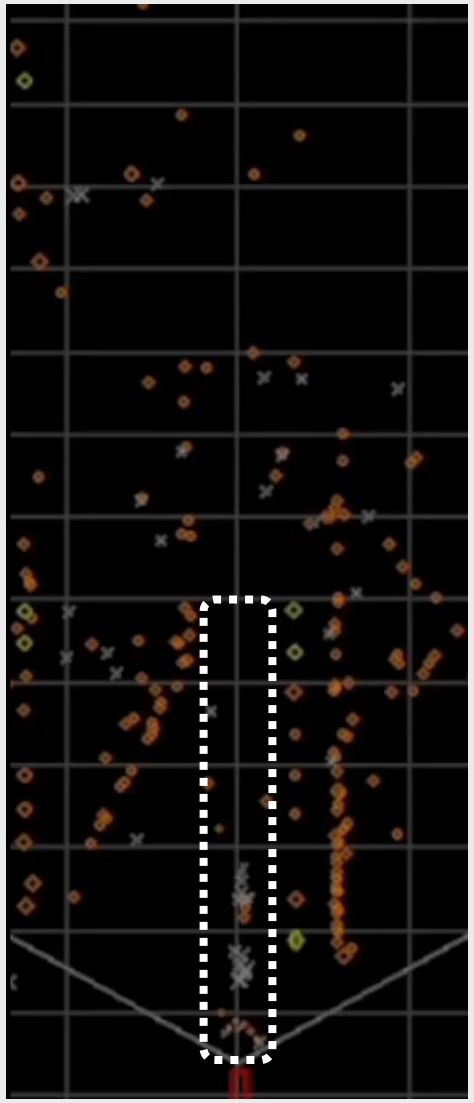
Identical

Simulation tool chain
(Simulation Data + SW on radar ECU)

Scenario



Measurement



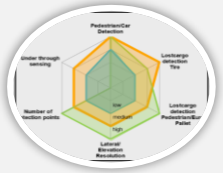
Simulation

Tool chain integration (synthetic data and actual radar processing) is also on-going well

Summary

Continental is always challenging new technologies

Leading the imaging radar market



Imaging radar for **L2p market**

High bandwidth mode also makes higher resolution

Radar Sensor Model Simulation with DIVP ongoing and further update coming soon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