Continental
The Future in Motion

## Senses for Safety

Driver assistance systems help save lives

# Automated Driving and the need for Virtual Validation

Summary of the SafeMove Project
& Outlook for VIVALDI/DVIP™

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2020-11-12

Bundesministerium für Bildung und Forschung

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SensePlanAct

# Agenda

1. Radar for Automated Driving
2. The need for Virtual Validation
3. SafeMove - Radar Raytracing
4. VIVALDI and DVIP™

# Solutions for Automated Driving

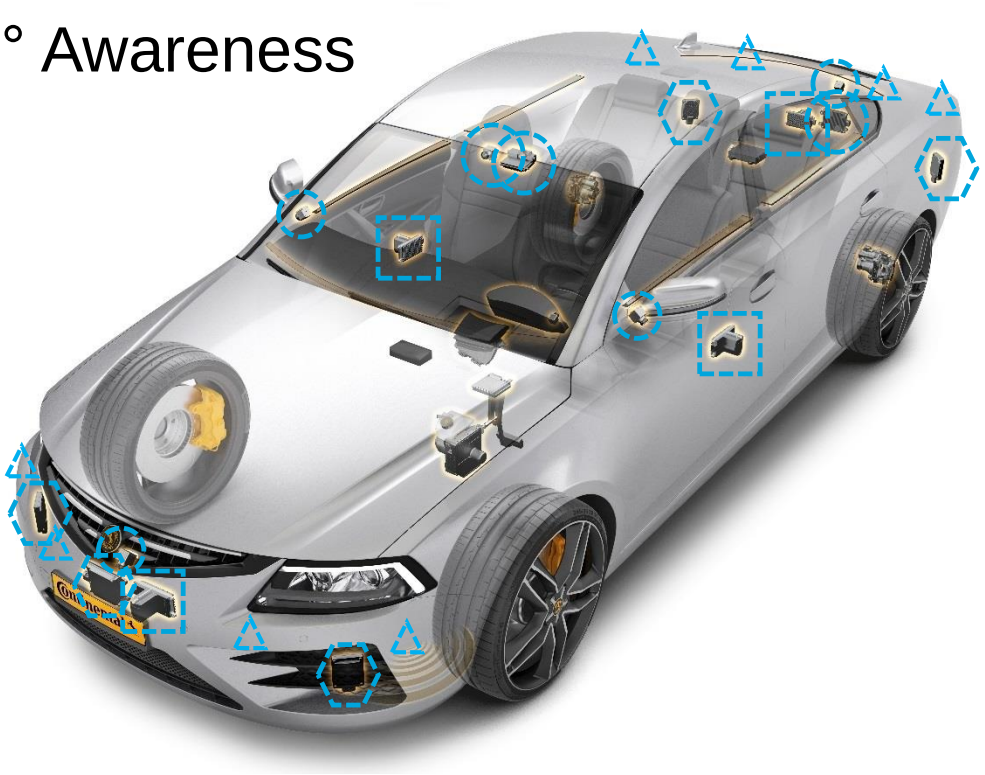
## .. Vision Zero


Assisted and Automated Driving are based on ….

…the Chain of Effects

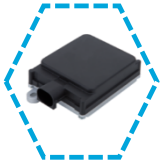
# The Senses

## Seamless 360° Awareness



Camera

3D Flash Lidar



Long Range Radar

Surround View

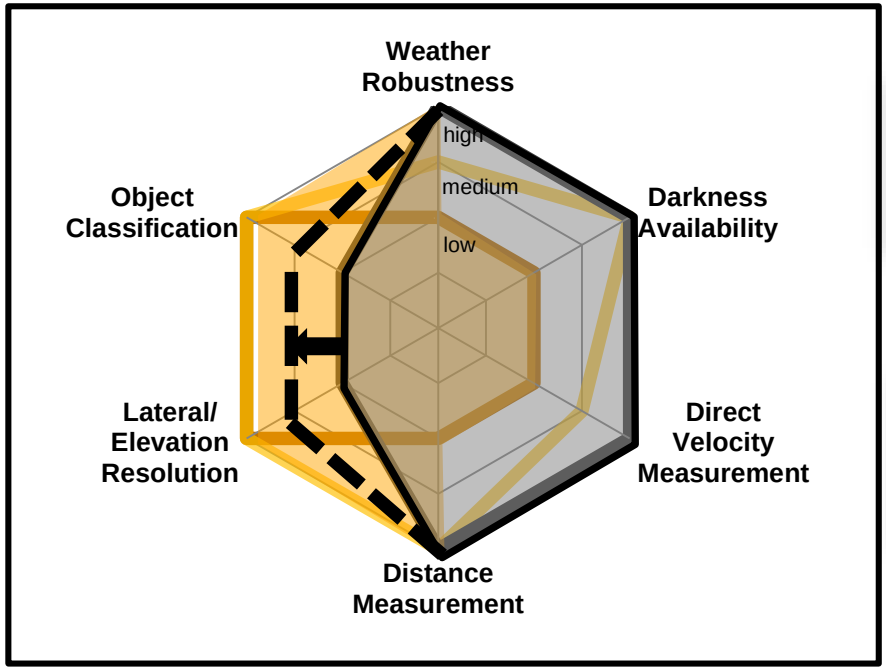
Ultrasonic

Short Range Radar

# The Senses

## Redundant Sensing Under All Conditions



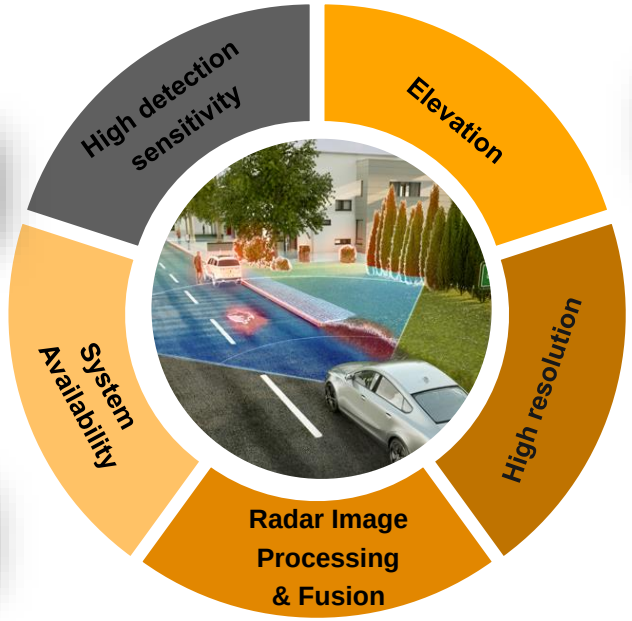




Standard Radar Sensors
For Assisted Driving

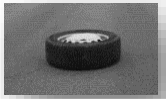
Future Radar Sensors
For Automated Driving

# Radar for Automated Driving

## Next Generation




*Non overridable ground obstacles*



Source: ADAC

*Adverse weather conditions*



*Complex traffic scenarios*


*UnderrConcept ble elevated objects*

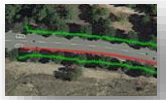


Source: Swiss Park

*Stationary targets / early & comfortable System reaction*

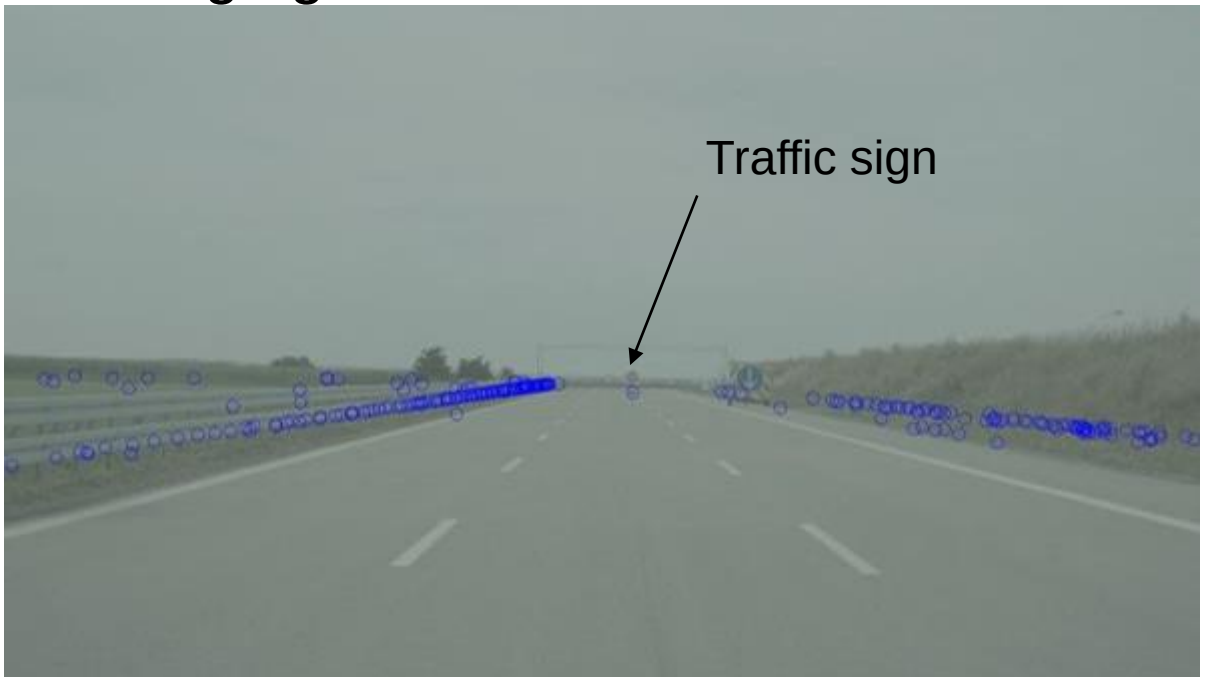


*Road boundaries / Land marks*




# Radar for Automated Driving

## An imaging radar !




- ARS540
- 300m detection
- Full beamformer in azimuth and elevation
- Enhanced pulse compression wave form

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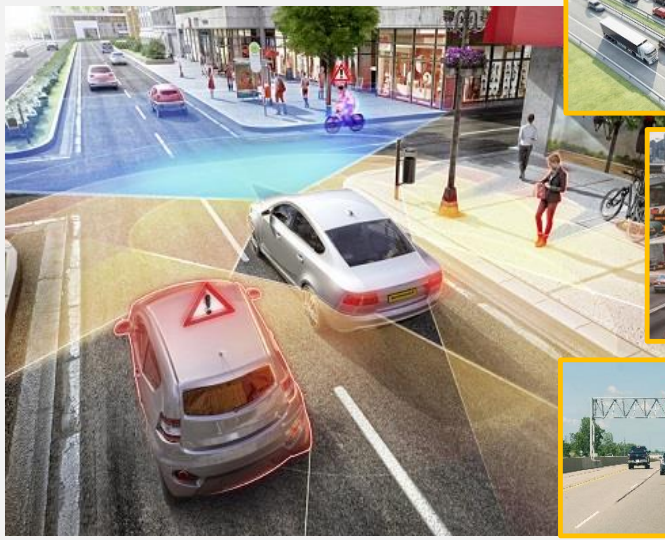
# Validation for Automated Driving

## Sensor Validation “Real World” …

*The Continental fleet currently drives 15,000 km per day, generating 100 Terabyte of data*

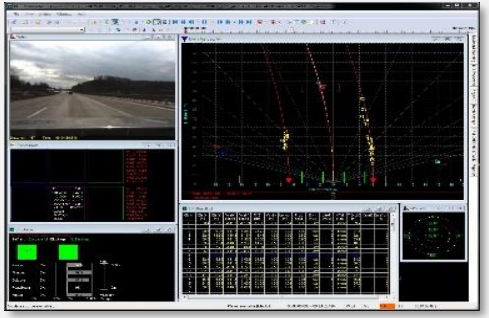
**Road Environments**

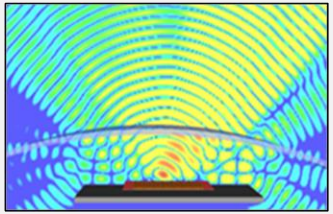



**Proving Grounds**

# Validation for Automated Driving

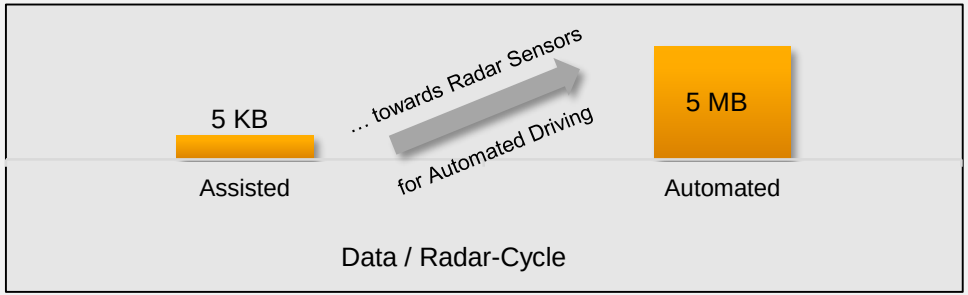
… will be supported by extensive Virtual Validation



**Radar Mounting Simulation**

- **Software-In-Loop Simulation**
- **Hardware-In-Loop Simulation**
- **Vehicle-In-Loop Simulation**



# Why virtual validation is important


- Managing complex driving scenarios is one of the biggest challenges on the way towards autonomous mobility.
- Continental established its own Supercomputer for vehicle AI system training, powered by NVIDIA DGX.
- New cluster reduces development time from weeks to hours.
- Main use cases: Deep Learning, Simulation and Virtual Data Generation.
- TOP500 list of supercomputers: Computing performance amongst the most powerful in the worldwide automotive industry.

# Virtual Validation for Radar

- Validation using virtual scenarios is “state-of-the-art” for **Camera** technologies. Continental uses artificial scenarios for all camera systems, including front-camera, SV camera and interior camera systems.
- **Radar**
  - Continental was one of the first companies to use Over-The-Air (OTA) Radar-Target Simulators (RTS) in development and in production as early as 2015.
  - In 2016 Continental developed a Radar-Camera Fusion HiL which can be operated with recorded “real-world” scenarios as well as virtual scenarios.
  - The setup above has been extended to 7 OTA-RTS within the SafeMove project (Workstream 1 of ***SafeMove***, see presentation of Matthias Hein).
  - In addition, a raytracing validation tool chain has been developed with Partner **dSPACE** which operates at baseband frequencies (Workstream 2 of ***SafeMove***).

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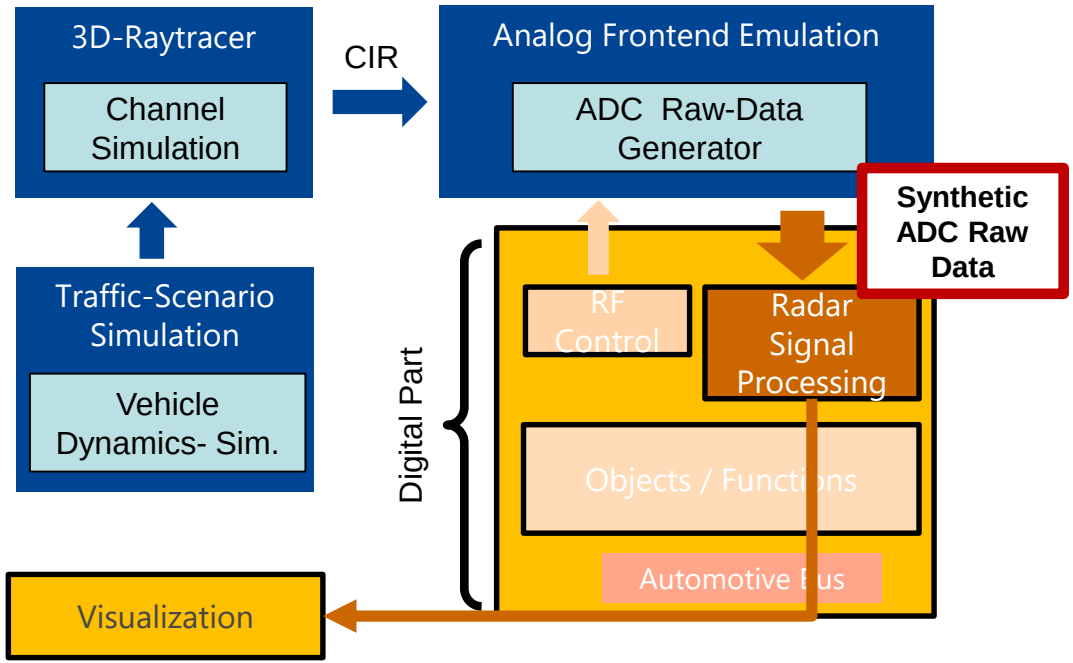
# Current Approach

- **Radar ECU (Digital Part)**
- **Analog Frontend Emulation**
- **3D-Raytracer**
- **Traffic Scenario Simulation**
- **Visualization**






F&E-Verbundvorhaben *SafeMove* – Systemvalidierung von Fahrzeugradaren mittels drahtloser Techniken, gefördert im Förderschwerpunkt "IKT 2020 - Elektroniksysteme für das vollautomatisierte Fahren (ELEVATE)" durch das Bundesministerium für Bildung und Forschung

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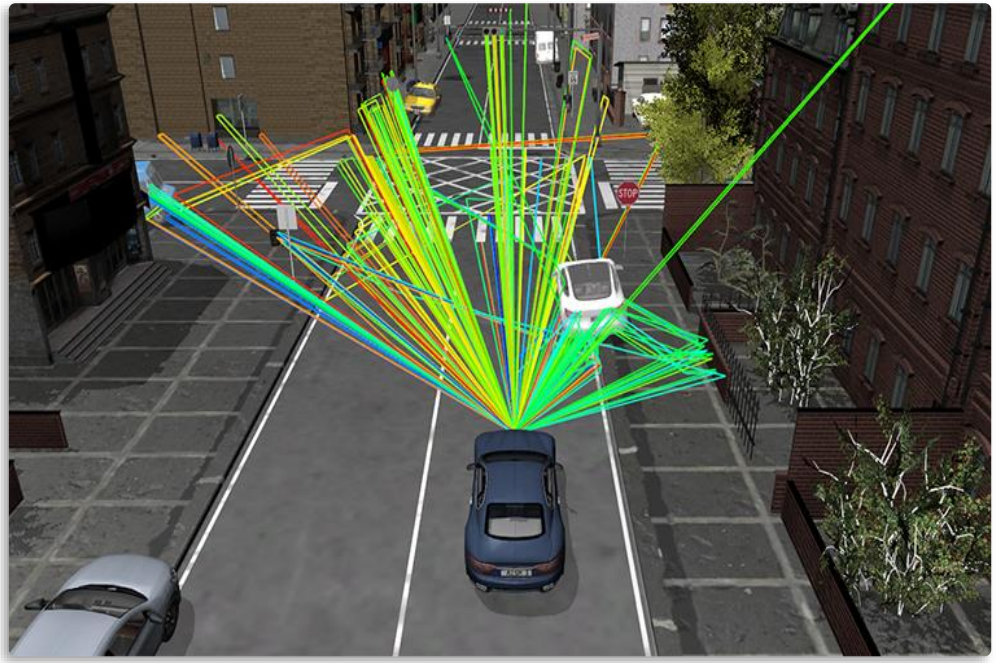
# Real-Time Radar Raytracing



- **Generic output (Channel impulse response)**
- **All ray path data**
  - Fully polarimetric
  - Path length
  - Doppler velocity
  - Interaction points
    - Positions
    - Velocities
- **Benefit for Continental**
  - Optimization of sensor performance
  - Optimization of Radar signal processing and tracking
  - Optimization of vehicle functions
- **Benefit for OEMs**
  - Optimization of vehicle functions
  - Software-in-the-loop simulations on vehicle level

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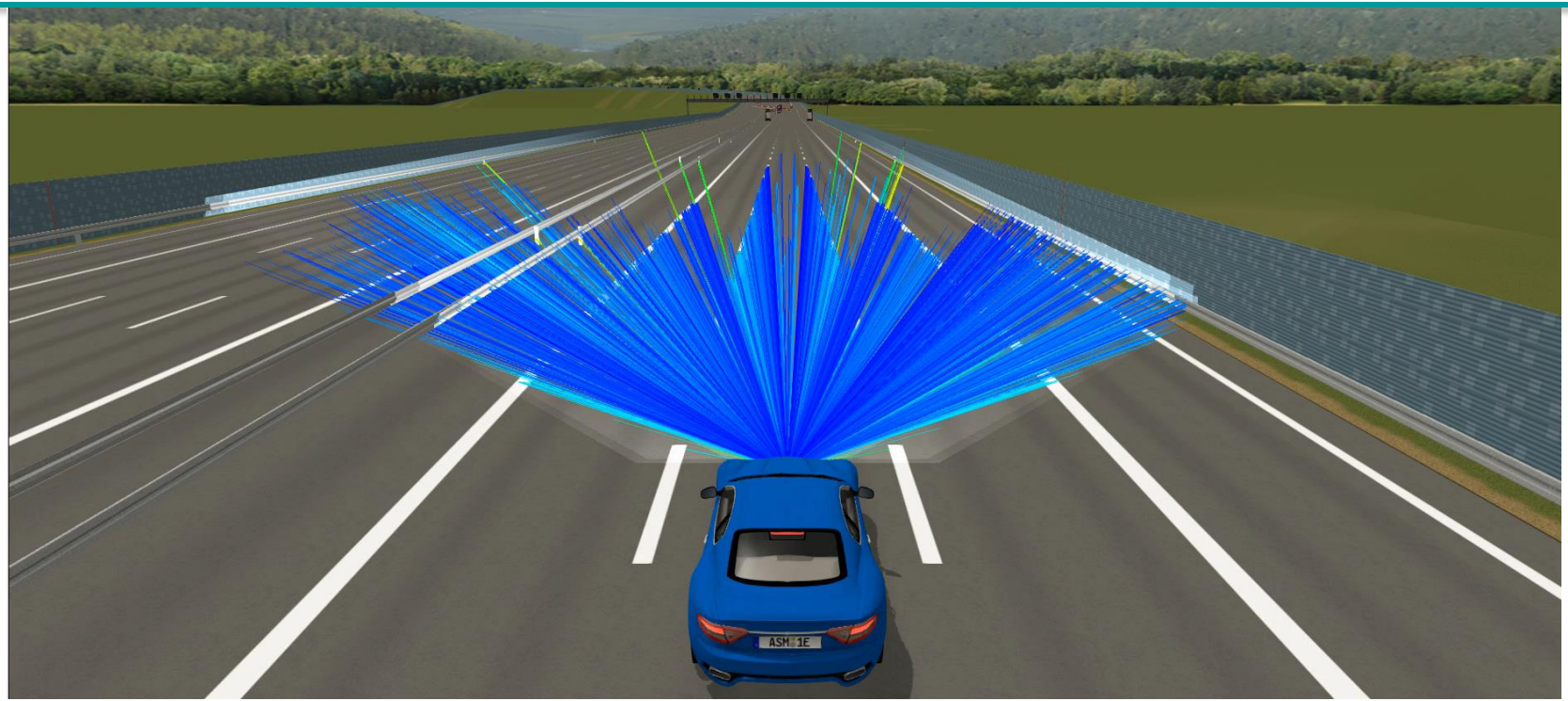
# Real-Time Raytracing



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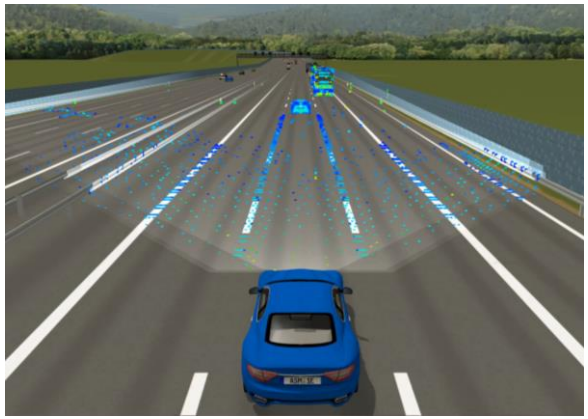
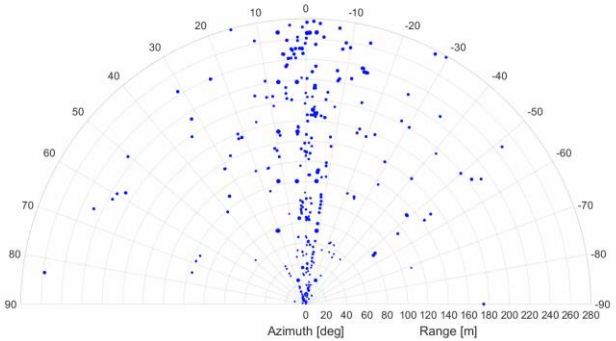
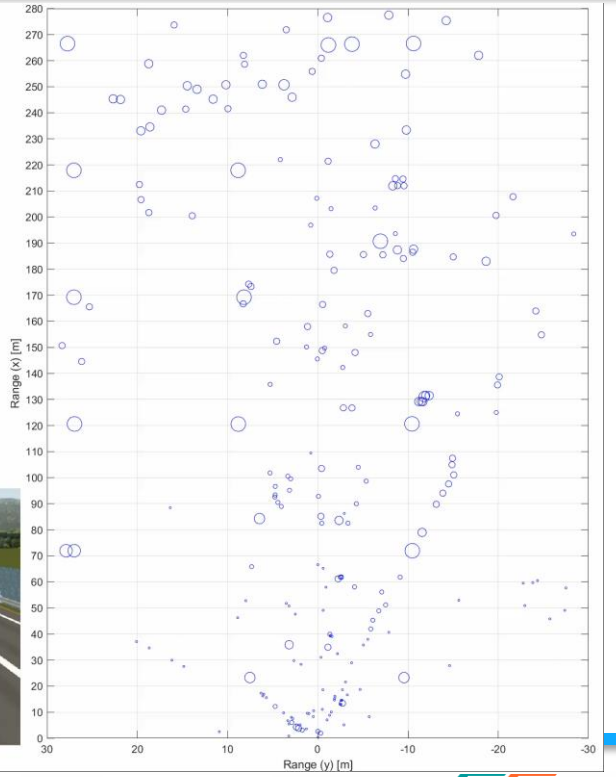
# Results – Real-Time Raytracing + 6th Gen. Radar







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# For more technical details, see

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International Workshop on Automotive Radar
for Fully Automated Driving

**Raytracing Simulations in Automotive Radar Tests**

Sebastian Graf, dSPACE
Andreas Löffler, Continental

Session 5.3

F&E-Verbundvorhaben *SafeMove* – Systemvalidierung von Fahrzeugradaren mittels drahtloser Techniken, gefördert im Förderschwerpunkt "IKT 2020 - Elektroniksysteme für das vollautomatisierte Fahren (ELEVATE)" durch das Bundesministerium für Bildung und Forschung

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# DVIP™ and VIVALDI
## In close cooperation

***VIVID = 2 projects***

- **DVIP™** (Driving Intelligence Validation Platform) **2019-04..2023-03**
- **VIVALDI** (Virtual Validation Tool Chain for Automated and Connected Driving) **2020-10..2023-09**
- Strategic funding by the Japanese Cabinet Office (CAO)
  and The German Federal Ministry of Education and Research (BMBF)
  https://www8.cao.go.jp/cstp/english/20200602_sipadus.pdf

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- **3 workstreams for VIVALDI**
  - (1) Extension of OTA-ViL (Vehicle-in-the-Loop) at the University of Ilmenau
  - (2) Setup of an “AVL driving cube” at KIT Karlsruhe (incl. OTA HiL)
  - **(3) Optimization of Radar, Camera and Lidar raytracing & verification with test data in 5 proving ground scenarios (NCAP) und 5 critical real world scenarios**

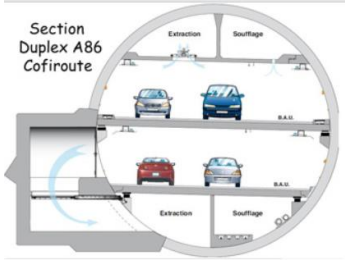
TOYOTA NISSAN HONDA TECHNISCHE UNIVERSITÄT ILMENAU KIT Continental DAIMLER AVL IPG AUTOMOTIVE

# VIVALDI

## Key targets for Continental








Ponte 25 de Abril

- The key target for Continental within VIVALDI is the PoC (proof-of-concept), that virtual validation is identical to real-world test driving within certain KPIs
- The KPIs are derived together with the OEMs
- In order to achieve this
  - Test drives will be performed in real world
    - Continental proving ground in Memmingen, city of Kempten and critical scenarios (see above)
    - Some tests can be repeated in Tokyo / Odaiba
  - These drives will be “virtualized” within a scenario generator & rendering SW framework
  - The outputs of the sensor setup are then compared between “virtual validation” and “real-world test drive”

# Summary

- Managing complex driving scenarios is one of the biggest challenges on the way towards autonomous mobility.
- Continental established its own Supercomputer for vehicle AI system training.
- Main use cases: Deep Learning, Simulation and Virtual Data Generation.
- Virtual validation is a state-of-the-art technology for Camera development.
- Virtual validation for Radar will be investigated in detail within the VIVALDI project.
- Continental is proud to establish a framework for virtual validation with Japanese and German OEMs and its industrial and academic partners within DVIP™ and VIVALDI.
- We gratefully acknowledge the support of CAO and BMBF

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# Safe and Dynamic Driving towards Vision Zero


SensePlanAct