TOWARDS STANDARDIZATION OF A SPECIFICATION AND TEST FRAMEWORK FOR AUTOMOTIVE LIDAR SENSORS

Dr. Adrian Zlocki, fka GmbH

Introduction & Motivation

- LiDAR technology is key for automated driving
- Many companies work on new LiDAR sensors for automotive applications
- New Lidar technologies allow advancement in perception quality
- Press announcements and advertisement promise high quality solutions

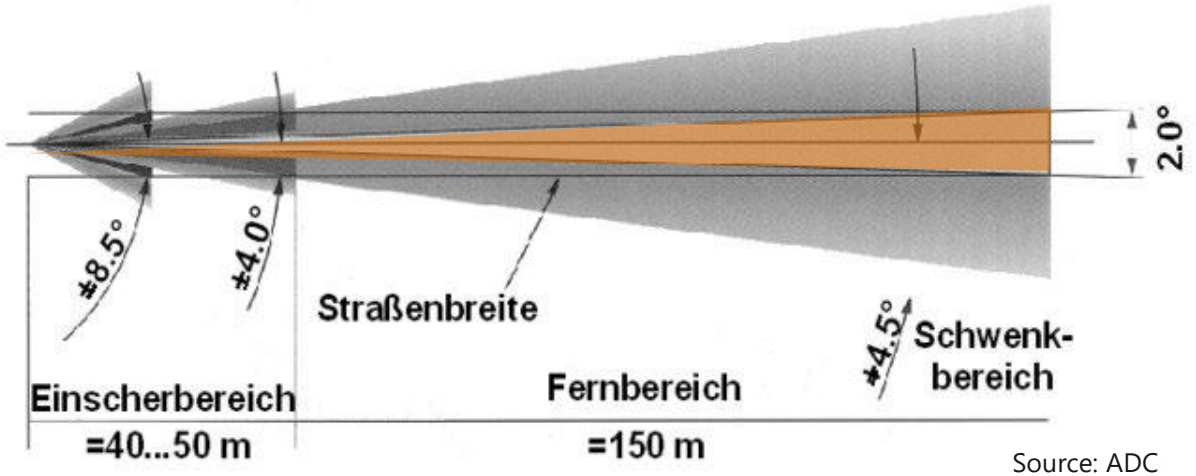
- How to perform assessment of automotive LiDAR sensors?
- A common specification and testing framework for LiDAR sensors is missing

Targets

- Intention
  - Make development, testing and specification more easy for suppliers
  - Make the selection and specification of LiDAR sensors more easy and efficient for OEMs
  - Make the automotive LiDAR market more transparent, profitable, safe and efficient
- Targets
  - Have a clear and generally accepted framework for specification and testing of automotive LiDAR sensors
  - Build a trustful basis for RFQs and introduction of the right product
  - Enable a clear market overview and segmentation of LiDAR sensors
  - Make Lidar comparable with other technologies
- Create a better and objective understanding of automotive LiDAR to consumer groups and other stakeholders
- Get DIN/SAE motivated to take our definitions and tests (not detailed tests description, but the developed branding of LiDAR qualifications) over into a framework

History

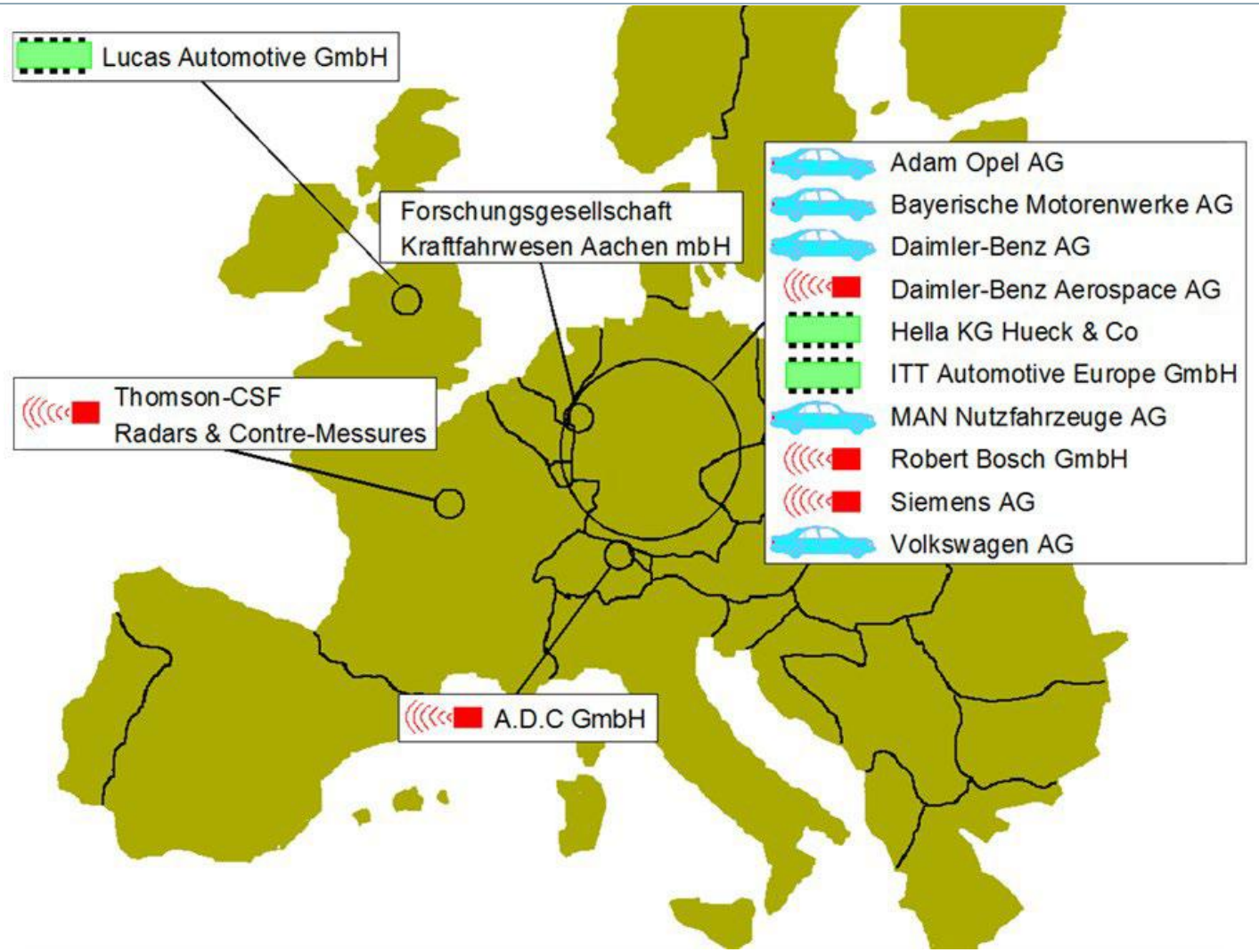
Source: ADC



Source: ADC

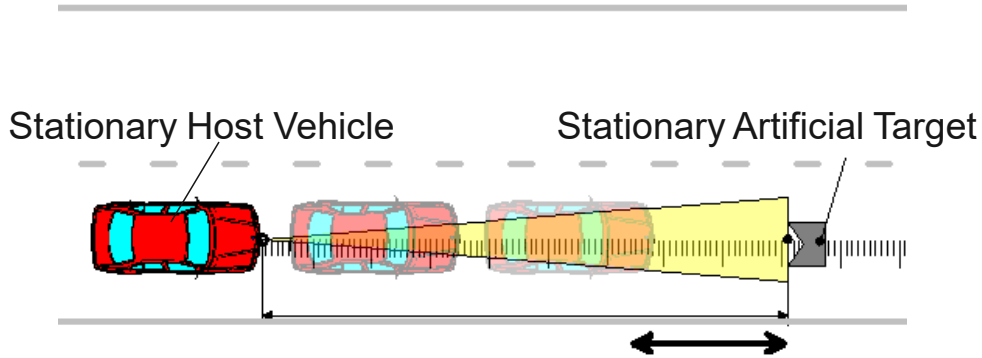
Specification of physical Sensor Tests at fka

- The first public demonstration of distance sensors within automotive applications is dated back to the PROMETHEUS project (1986-1994)
- Test methodology for reproducible and reliable tests are developed by a consortium (several OEMs & suppliers) under lead of ika/fka in 1996
- ika/fka sensor test catalogue for front facing sensors available since 1999
- Initial ADAS function: ACC and ACC relevant scenarios



Stationary Test Scenarios

- The basic tests aims to determine the sensor characteristics such as range, detection field, reaction time etc.
- Those almost static tests are conducted by means of artificial and real target vehicles.
- The tests can be divided, e.g.:
  - Maximum and minimum range
  - Target separation within one beam
  - Field of view
  - Dynamic behavior
  - Reaction time
  - Different targets (size, reflectivity etc.)
  - Different environment conditions

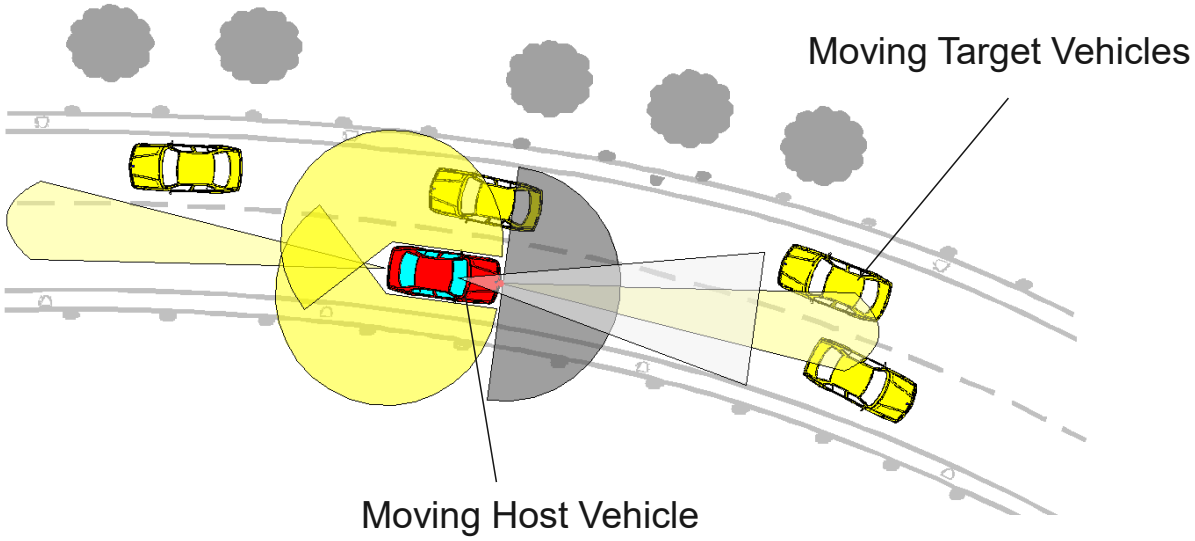


Scenario example:
Field of location with artificial target

Driving Tests in Dynamic Test Scenarios

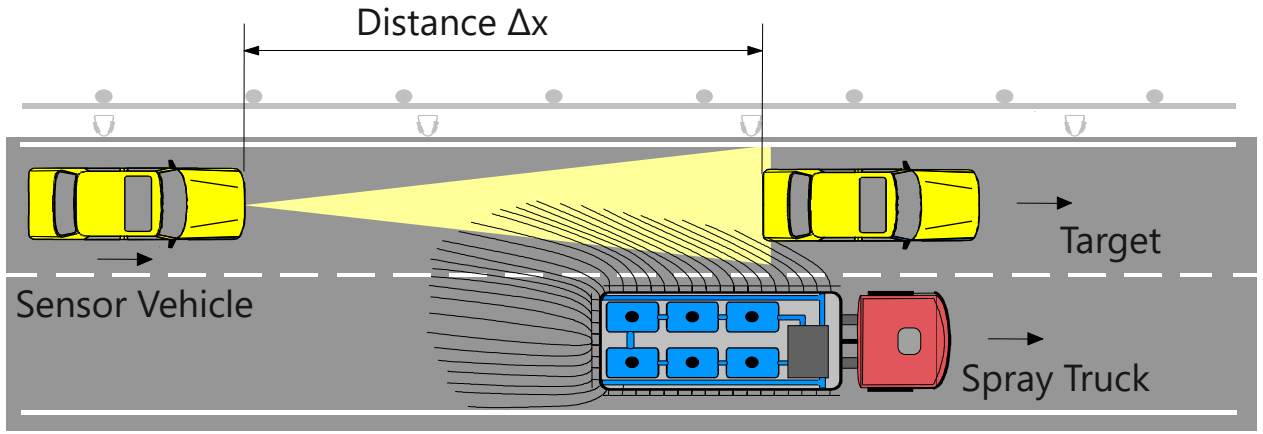
- The sensor characteristics under realistic road and environmental conditions are tested within the driving tests (light conditions, road topology, road radii etc.)
- The tests are conducted in open traffic, considering different curvatures and traffic situations (e.g. passing by vehicle, cut-in/ cut-out etc.)
- Each scenario is tested under specified conditions and is reproducible, due to standardized target vehicles and test tracks

Scenario example:
Passing by oncoming vehicle



Tools for physical Testing - Example Spray Truck

- Test possibilities
  - Reproducible artificial spray cloud
  - Different nozzle configuration for variation of spray density
- Technical data
  - 6 water tanks with an overall capacity of 6000 l
  - Pump delivery volume: 600 l/min at 6 bar

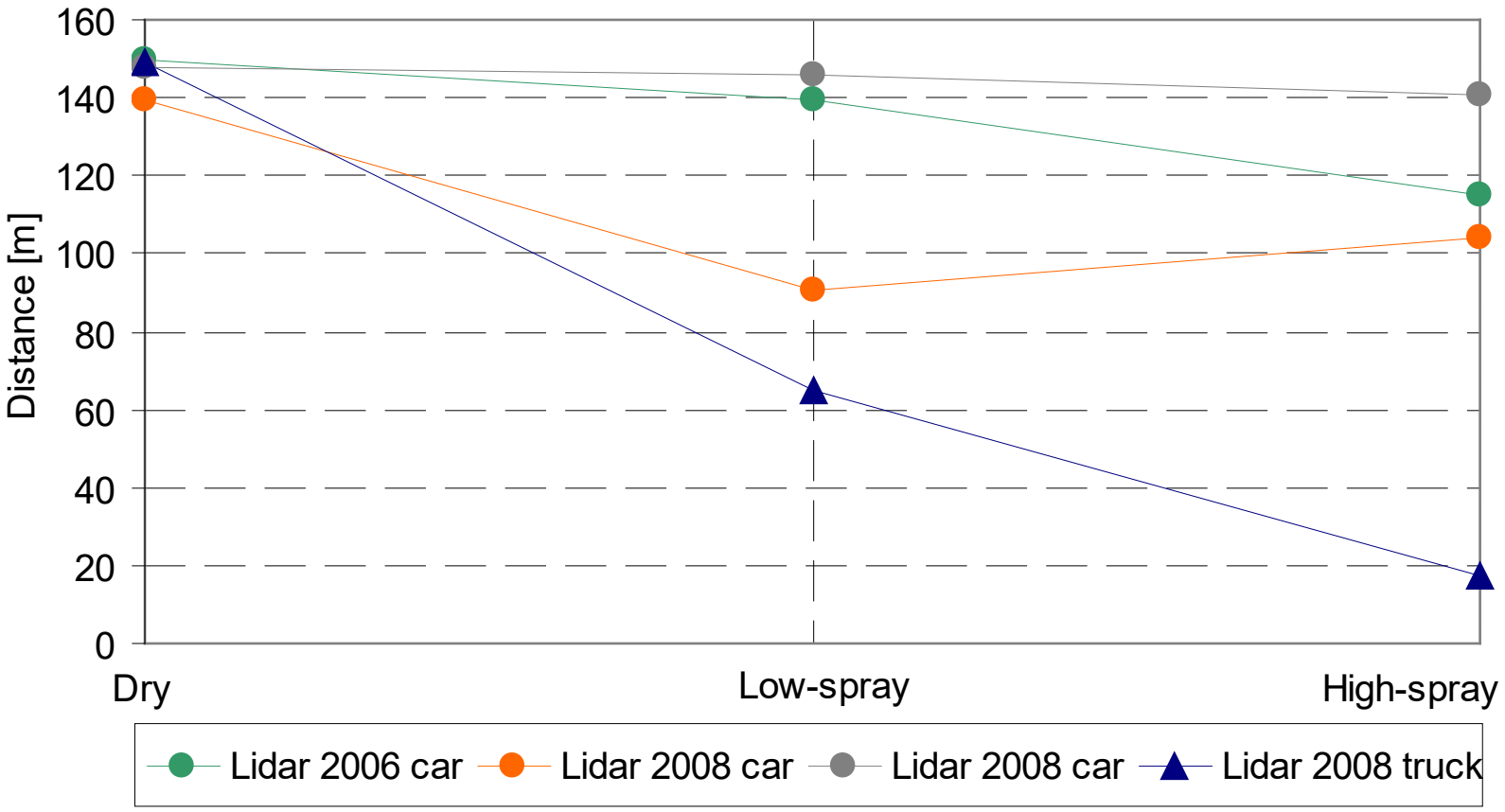


Scenario example:
Pass-by with Target Vehicle

Spray Truck Video

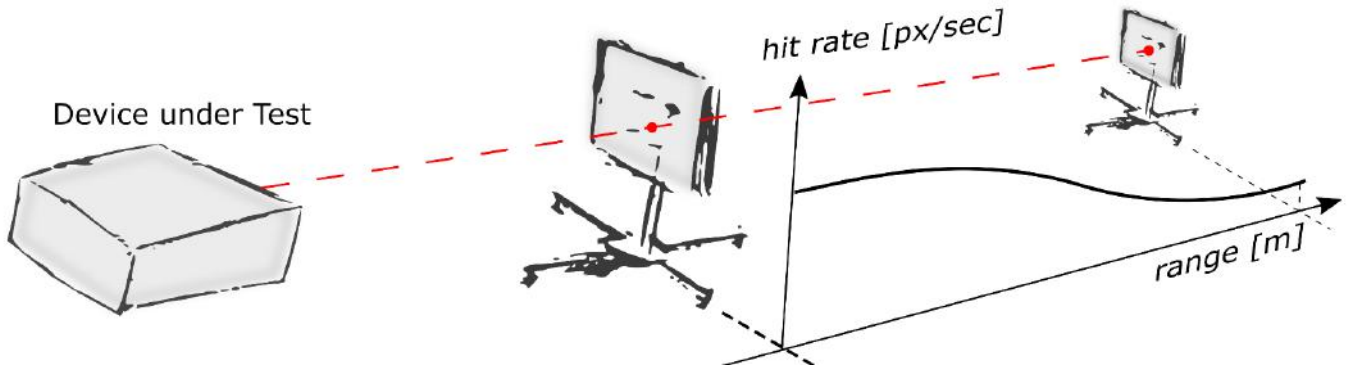
Examples from Testing - LiDAR Sensors Spray Tests

Scenario: Approaching Spray Truck at 80/120 km/h



- Detection range for LiDAR sensors depend on weather conditions
- Improvement in tracking algorithm provides good results for new LiDAR sensors
- Mounting position needs to be taken into account in algorithm development

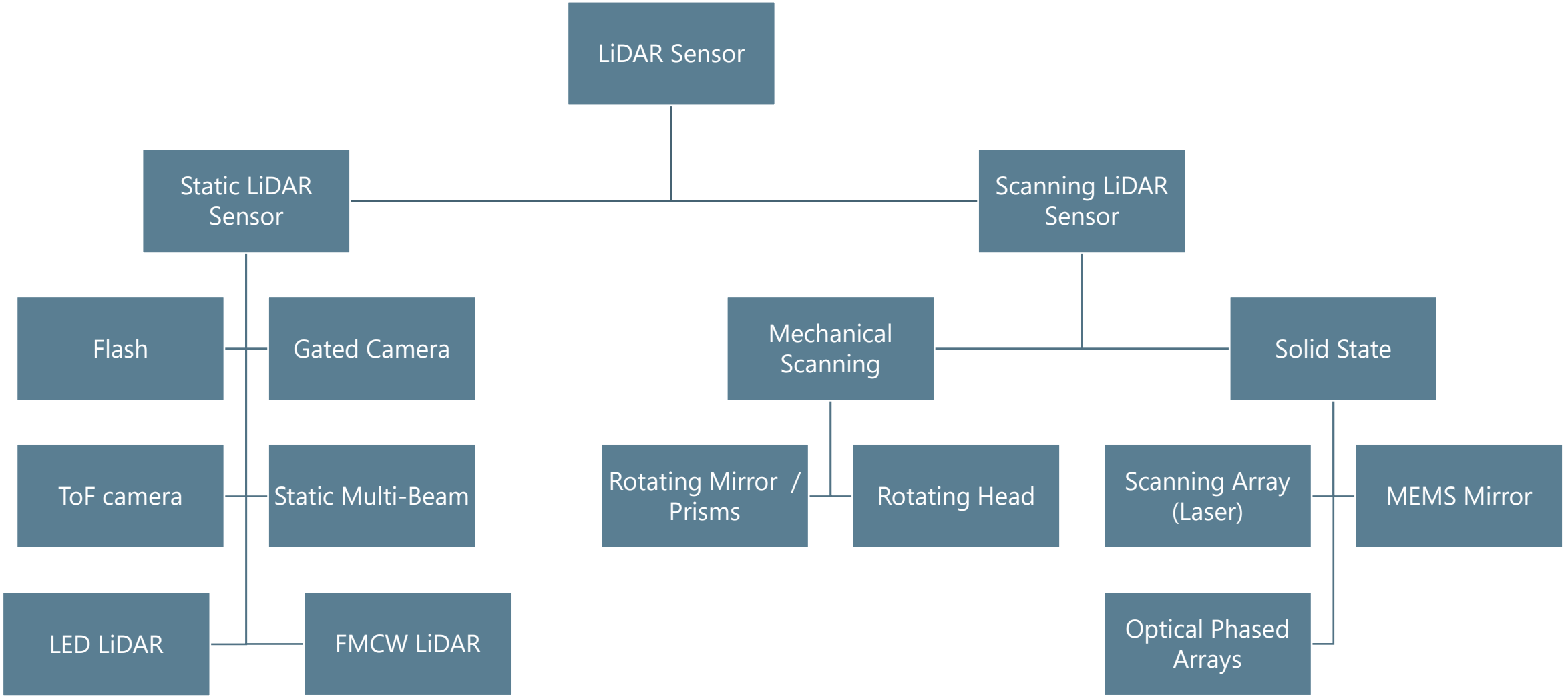
Methodology



Targets

- Provide common sensor specification and characterization guidelines
- Provide common and application relevant evaluation framework
- Perform comprehensible LiDAR sensor tests
- Provide evaluation results
- Provide comparison performance possibilities of LiDAR sensors

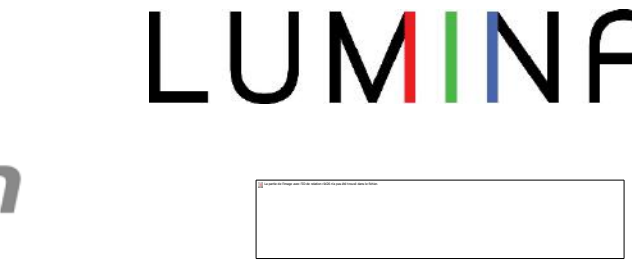
LiDAR Sensor Classification



Boundary Conditions

- Automated driving functions of level 3 or higher require LiDAR as additional sensor technology
- Increasing number of suppliers/start-ups offer solutions based on various technologies
  - Specifications contain different performance measures etc.
  - Performance measures are determined under varying test conditions
- OEMs and Tier 1s have huge efforts in order to select suitable LiDAR sensors that meet requirements
- Specification and Test Framework needs a harmonized test procedure for LiDAR sensors, in order to provide a
  - sound
  - transparent
  - comparable and
  - independent
  - evaluation of sensor performance
- Test procedure will provide function-independent performance metrics, test conditions and evaluation criteria

Partner



CREATING IDEAS & DRIVING INNOVATIONS

Scope

Specification

- Create generally accepted and understandable specification and characterization guidelines of automotive LiDAR sensors

Testing

- Create generally accepted of test description including
  - Test scenarios
  - Test methodology
  - Test tools

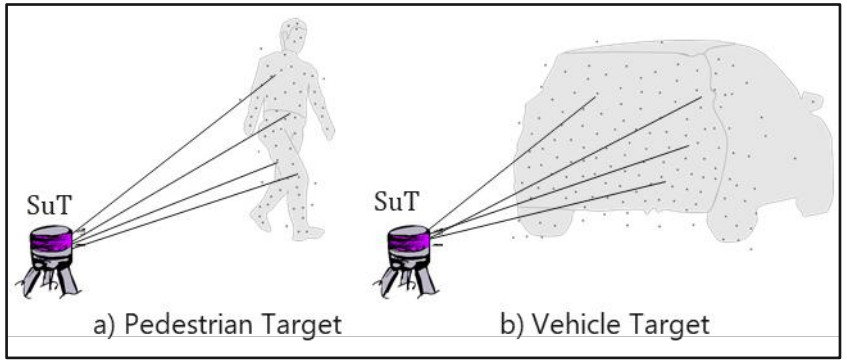
Standardisation

- Create DIN SAE SPEC

Test Scenarios

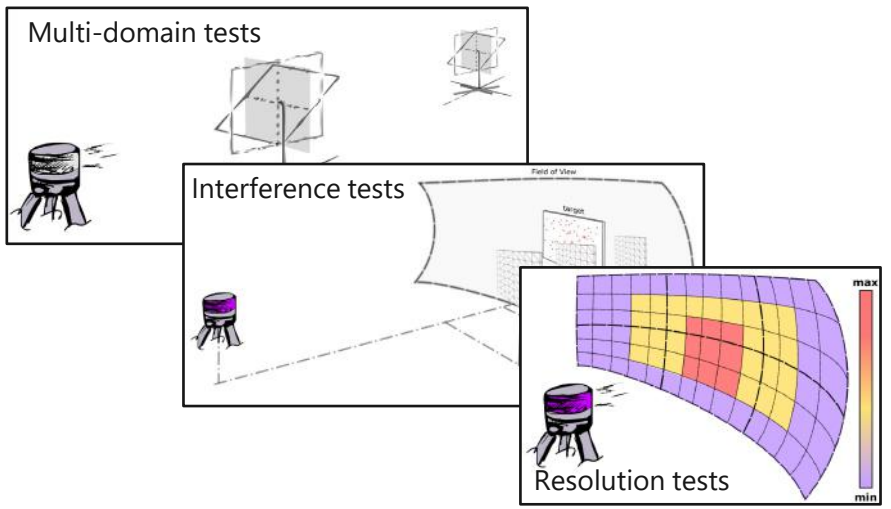
Scenarios

- Focus on sensor performance and **not on object detection**
- Scenarios designed for evaluation on point cloud level
- Use of simplified targets instead of real targets with complex geometries



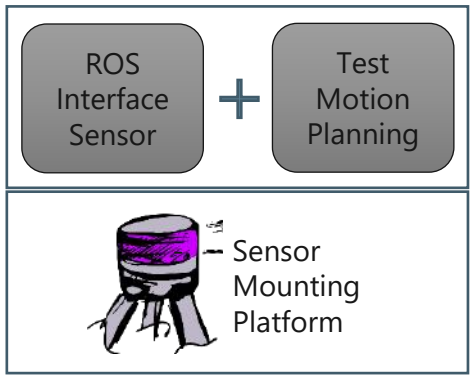
- Key Performance Indicators (KPIs) on point cloud level adapted to point cloud domain

- Scenarios are driven by a combination of:
  - Point cloud level testing
  - Adapted KPIs
  - Simplified targets

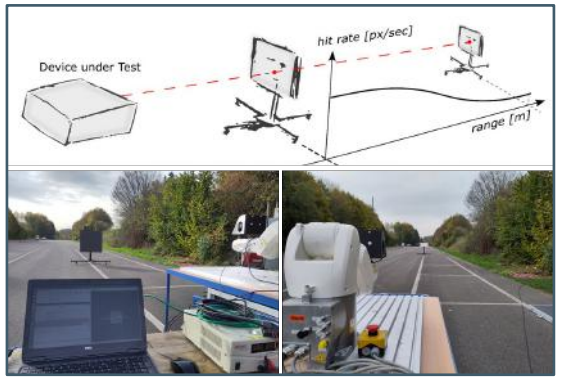


Testing Process

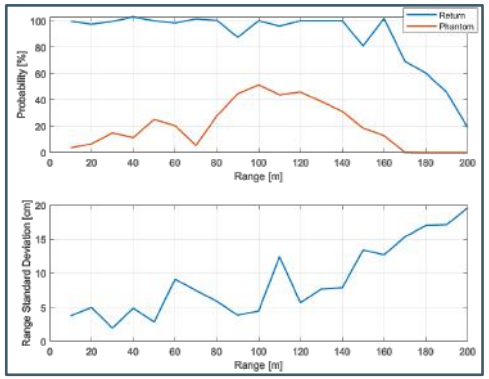
Test Preparation



Test Execution



Test Analysis



- Sensor oriented software development:
  - Update ROS drivers for new sensor
  - Integrate sensor in data recording tool chain
  - Adapt sensor motion platform to new sensor
- Sensor oriented hardware development
  - Sensor mounting platform
  - Sensor power supply

Scenarios

- False alarm rate
- Angular separability
- Radial separability
- » ...

KPIs

- Probability of detection
- Accuracy
- Precision
- ...

Development DIN SAE SPEC 91471

Assessment methodology for automotive LiDAR sensors

- Establishment of an assessment methodology for LiDAR sensors independent of the design of the sensor, the specification and the technological approach.
- Application to car manufacturers and sensor suppliers to allow a defined assessment of the sensor performance on point cloud level, e.g. the range, accuracy, precision and robustness of the measurements.
- Helping unify specification and testing.
- Support of R&D personnel, hardware and software sensor developers, test track operators, testing organizations and manufacturers of automated vehicles and ADAS/AD functions.
- Not in the scope: Establishment of functional safety requirements.

Schedule

Project conception

- Need for test methods
- Call for partners

Q2 2021 – Q4 2021

Q4 2021

Project launch

- Consortia kick-off
- Workshop on scenario brainstorming
- Workshop on LiDAR specification brainstorming

Concept validation

- Development of tools and scenarios
- Validation of analysis methodology

Q4 2021 – Q4 2022

Q3 2022 – Q1 2023

Standardisation

- DIN SAE SPEC 91471

Implementation & Benchmarking

- Application of developed methods
- Benchmarking of LiDAR sensors

Q1 2023 onwards

THANK YOU FOR YOUR ATTENTION