AN OVERVIEW OF LIDAR TESTING FRAMEWORK
## DVN DEEP DIVE III
SAN FRANCISCO, USA

Amogh Sakpal (fka)

INFRASTRUCTURE

1 Innovation Center

2 Simulation Studio

3 Workshop&
Test Benches [1]

4 Driving Simulator [1]

5 On-site Test Track [1]

6 Proving Ground [1]

7 fka SV Inc., Santa Clara

[1] in Cooperation with our Partner Institute for Automotive Engineering (ika) and the Aldenhoven Testing Center GmbH

Santa Clara, USA

CREATING IDEAS & DRIVING INNOVATIONS

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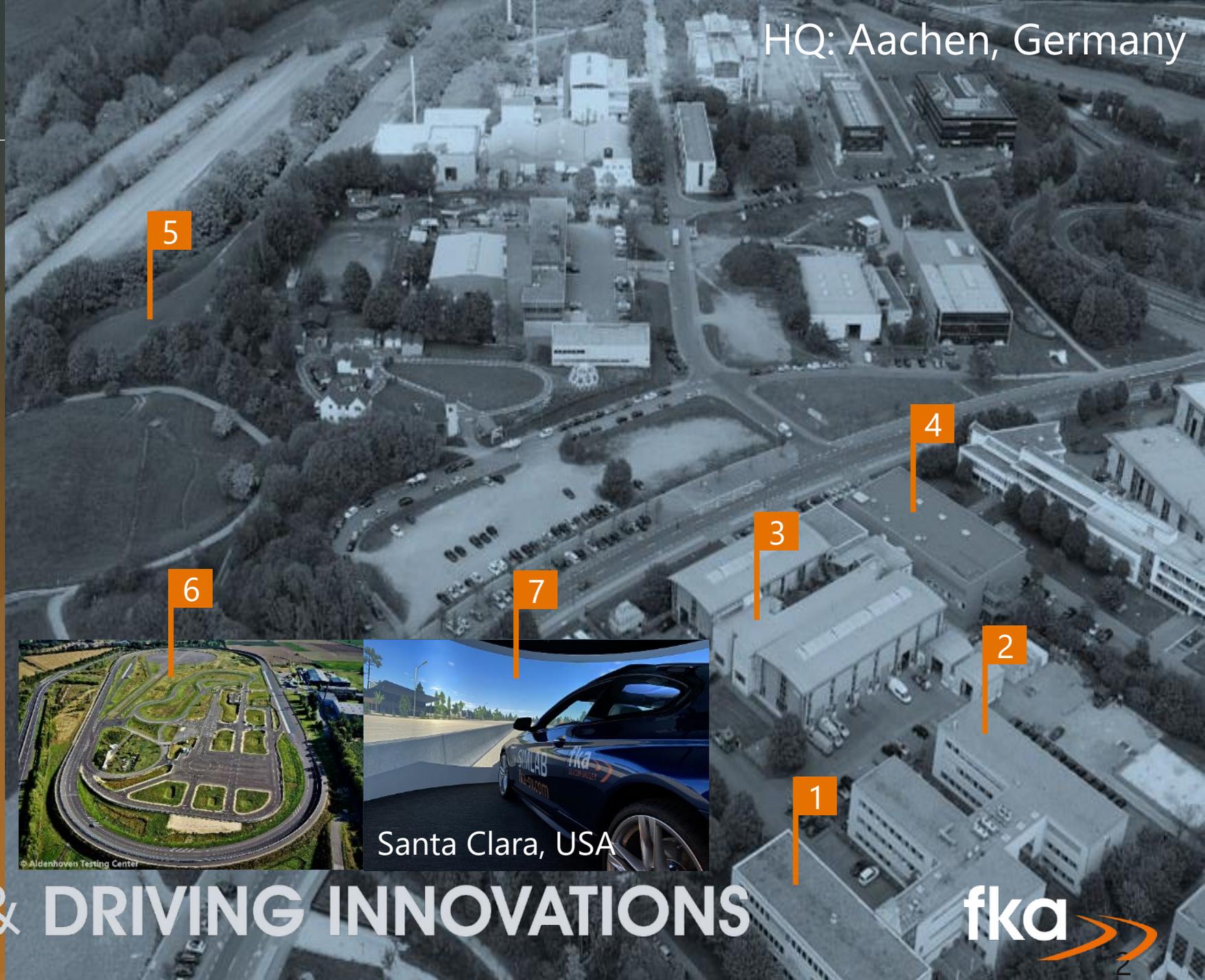
LiDAR Testing at fka

History *(2000 – 2020)*

- **fka Sensor Testing (2000 – 2020)**

  – LiDAR and RADAR sensors

  – ACC related scenarios

  – EU Consortium
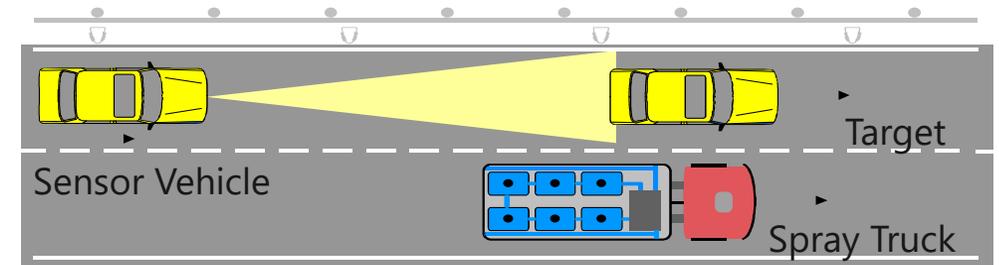
- **Test possibilities – Spray tests**

  – 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

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Scenario example:
Pass-by with Target Vehicle

Distance Δx

Target

Sensor Vehicle

Spray Truck

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LiDAR Testing at fka / DIN-SAE Specification

History *(2021 onwards)*

Project Conception

- Need for test methods
- Call for partners

Q2 2021 – Q4 2021

Concept & Validation

- Development of tools and scenarios
- Validation of analysis methodology

Q4 2021 – Q4 2022

Implementation & Benchmarking

- Application of developed methods
- Benchmarking of LiDAR sensors

Q1 2023 onwards

Q4 2021

Project Launch

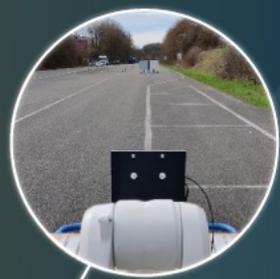- Consortium Kick-Off
- Workshops on scenario brainstorming
- Workshops on LiDAR specification

Q3 2022 – Q1 2023

Standardization

- DIN SAE SPEC 91471

Q3 2023 onwards

Further Test Methods

- Bad weather tests
- Contamination tests
- Interference tests

LUMINAR
Valeo
fka
DAIMLER TRUCK
MicroVision
Ford
INNOVIZ
TECHNOLOGIES

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LiDAR Sensor
Testing

Spray Tests

Sensor Platform

SuT
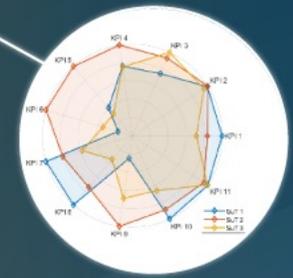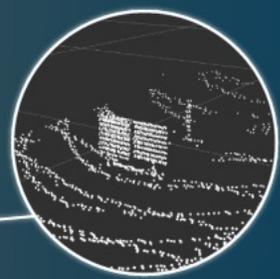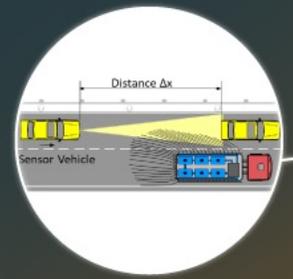
DIN SAE 91471

Ground Truth

Targets

29.08.2023

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LiDAR DIN SAE Spec 91471

OEMs

- Write RFQs for LiDARs
- Fair comparison for LiDARs
- Compliance with industry guidelines

Tier-1s

- Assess influence of components on LiDAR performance

Manufacturers

- Performance of own LiDAR vs. competition
- Analyse strengths & weaknesses
- Compliance with industry guidelines

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LiDAR Testing at fka / DIN-SAE specification

Base Framework – DIN 91471 *(2021 – 2023)*

- Applicable to all types of medium- to long-range LiDARS

- Focus on nominal weather and light conditions

- Sensor performance evaluation at point cloud level

- 7 static test scenarios

- 6 Simple geometry targets

    - 10%, 50% & 80% Lambertian reflectivity

    - Retro-reflectors

- Sensor motion Platform: KUKA KR 3 R540

    - Position repeatability: +- 0.02 mm

- Ground-truth (positions measured by surveying office)

    - 147 measured points (over length 440 Meter) with accuracy of 1 mm

- 12 key performance indicators (KPIs)

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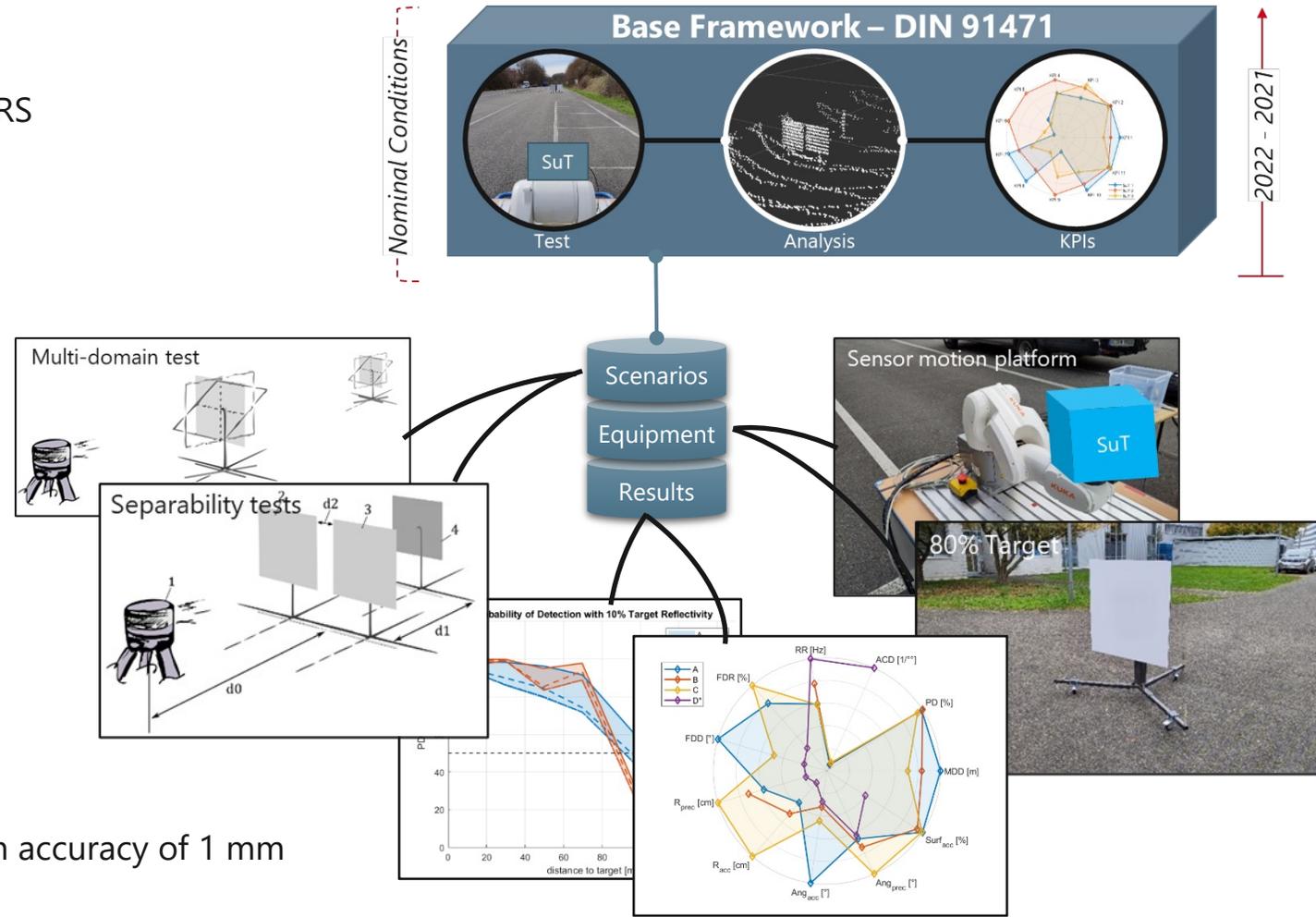
LiDAR performance in adverse conditions

Extension of LiDAR Testing Framework *(2023 – 2024)*

- Provide facts and data, to build a trustful basis for RFQs

- Robust testing procedures for adverse weather conditions & interference
→ support ISO, SAE, etc.

- Generic study regarding interference risks & critical traffic scenarios

- Insights into virtual simulation possibilities for LiDAR sensors

	Weather Tests (WT)	Contamination Tests (CT)	Interference Tests (IT)	
WP1: Project co-ordination & management				Project Manager
WP2a: Definition of test methods and scenarios	WP2a.1	WP2a.2	WP2a.3	Manager Testmethods
WP2b: Risk assessment of scenarios	WP2b.1	WP2b.2	WP2b.3	
WP3: Implementation of selected test methods	WP3.1	WP3.2	WP3.3	Manager HW Testing
WP4: Execution of selected test methods for sensors	WP4.1	WP4.2	WP4.3	
WP5: Overview of simulation tools for LiDAR testing				Manager Simulation
	Module Lead (WT)	Module Lead (CT)	Module Lead (IT)	

Base Framework – DIN 91471

Nominal Conditions

Test — Analysis — KPIs

2022 - 2021

Adverse Conditions

Weather Tests
- Rain
- Sun
- Fog
- …

Contamination Tests
- Dust
- Dirt
- Dead flies
- Water droplets
- …

Interference Tests
- LiDAR/LiDAR C2C
- LiDAR/LiDAR C2I
- LiDAR/other light sources
- …

2024 - 2023

Example — Rain Chamber Test

Example — Dust Cloud Test

Example — LiDAR/LiDAR C2C Test

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LiDAR performance in adverse conditions

Project Key Points

- **Project Output**

    - Standard definition of test methods for LiDAR performance evaluation under adverse conditions

    - Set-up of a selection of the defined test methods by fka

    - **Access to data and test results of LiDAR tests for one sensor provided by partner**

    - Access to anonymized test results of LiDAR tests

    - Detailed documentation of the project output and discussions (Full description of all testing -procedures, -scenarios, -targets)

    - One vote in all project related decisions (consideration of partner's inputs/use cases and influence test methods for LiDARs)

        - Participation on project meetings – at least three workshops (online) planned

        - Each partner nominates one responsible person, who is entitled to fully represent the partner in the project

    - Joint-testing week: use of fka interference test setup in Aachen for own sensor testing (Q1/Q2 2024)

    - Preparation and documentation of meetings (semester status reports)

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LiDAR performance in adverse conditions

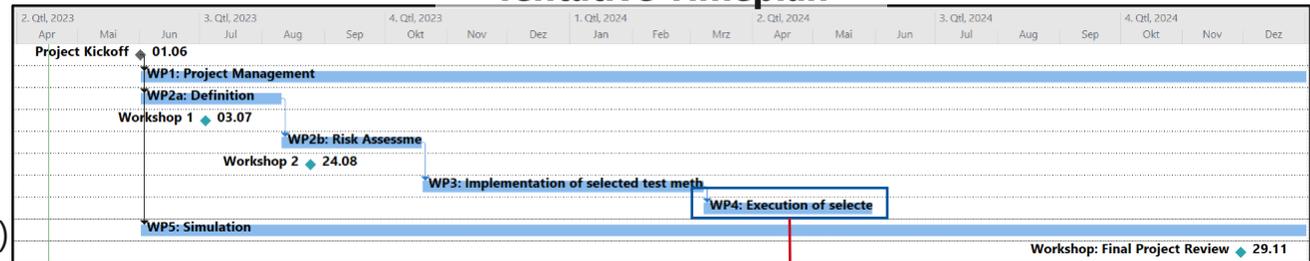## Project Key Points

Join Us!

- **Funding:**

  - Each partner (except DVN, FKA, ADAS_MC) pays a lumpsum in range of € 30.000 to fka at the beginning of the project

  - Reduced fees in case full participation is not needed

Tentative Timeplan

- **Timeline (tentative)**

  - Project Start: July 2023 (Kickoff September 2023)

  - Duration: 1.5 years

  - Final report & conclusions on 29 Nov. 2024 (DVN Conf)

  - Sensor tests planned for Q1/Q2 2024
  - Joint test week for interference tests

- **Contract Phase**

  - Set up of trilateral NDAs between fka, DVN and each individual partner joining the project

  - Set up of bilateral contracts between fka and each individual partner joining the project

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