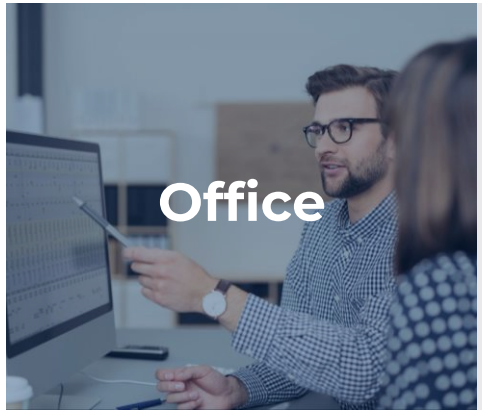
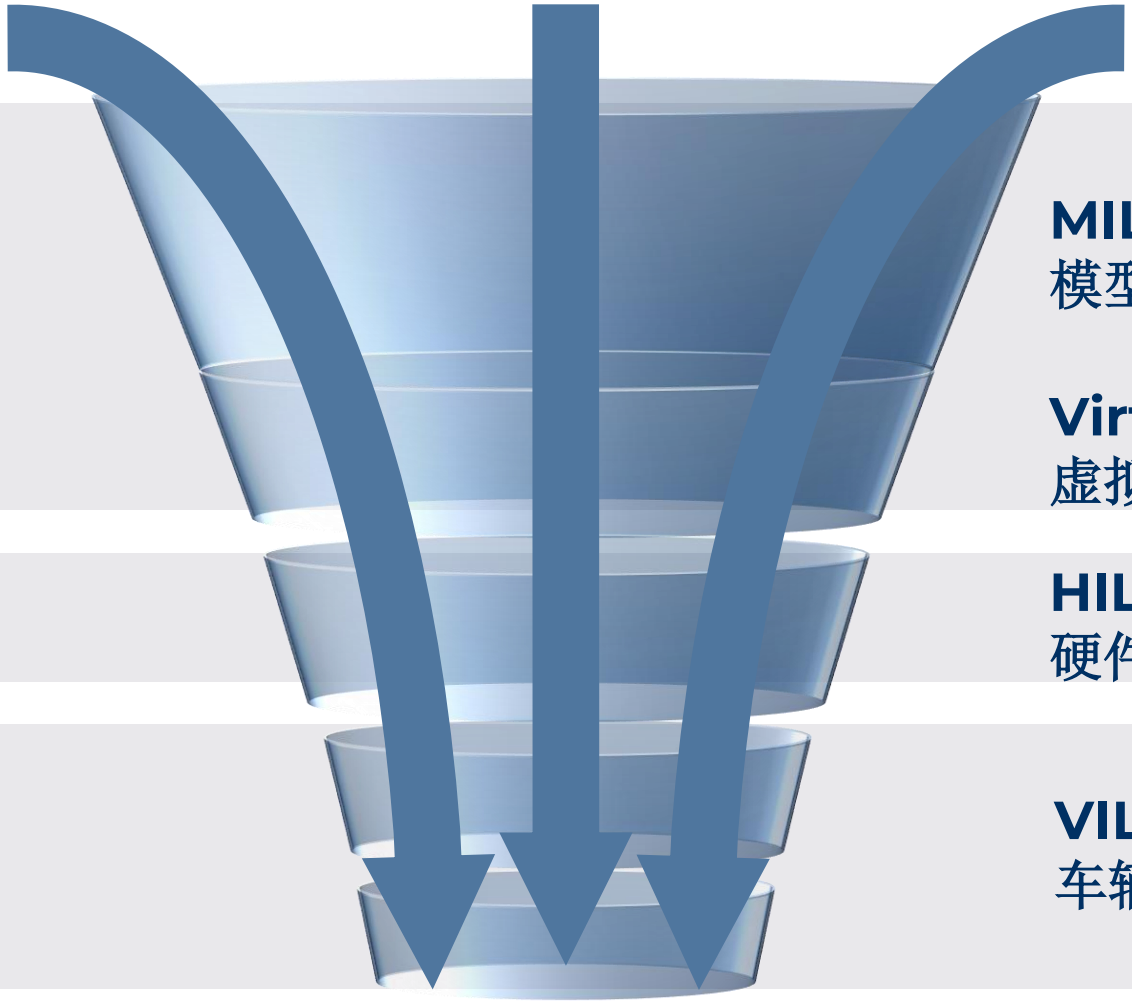
IPG在智能驾驶仿真领域的解决方案

Feng DING | IPG Automotive

Continuous Development , Continuous Testing

持续研发，持续测试





MIL / SIL
模型在环、软件在环

Virtual ECU
虚拟控制器

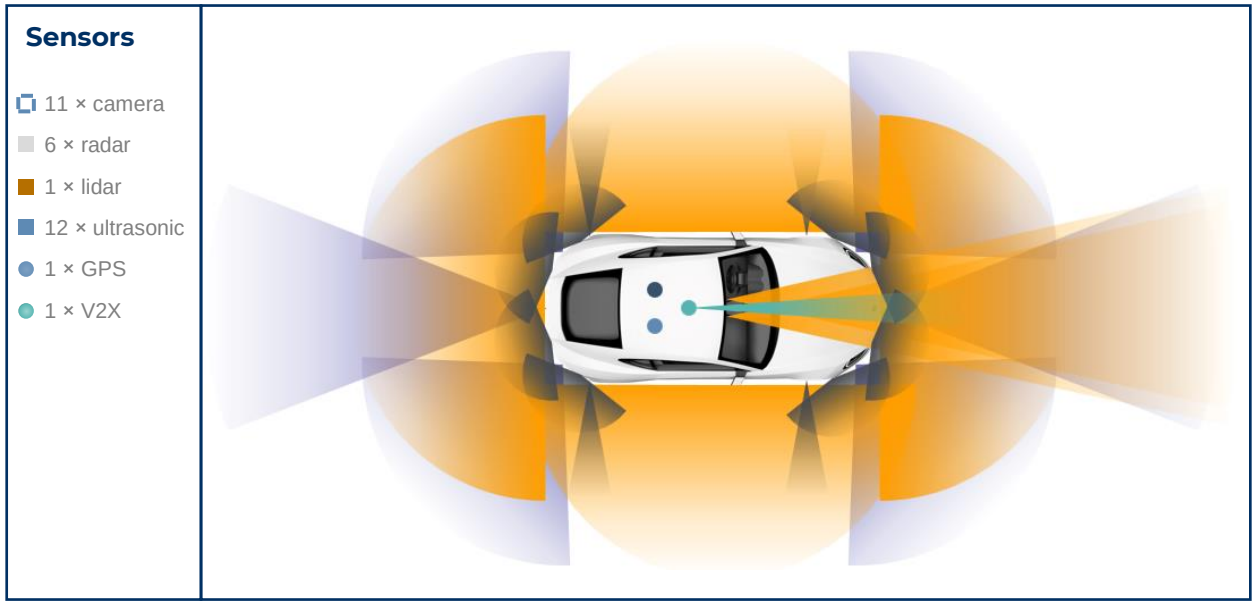
HIL
硬件在环

VIL
车辆在环

Challenges faced by ADAS testing
智能驾驶测试面临的挑战

Automated Driving (SAE Level 3+)

- Scene coverage and corner cases
  场景覆盖度和corner cases
- very high system complexity (i.e. 30+ sensors) | 系统复杂（多传感器）
- Realtime and computational load
  实时性和计算负载

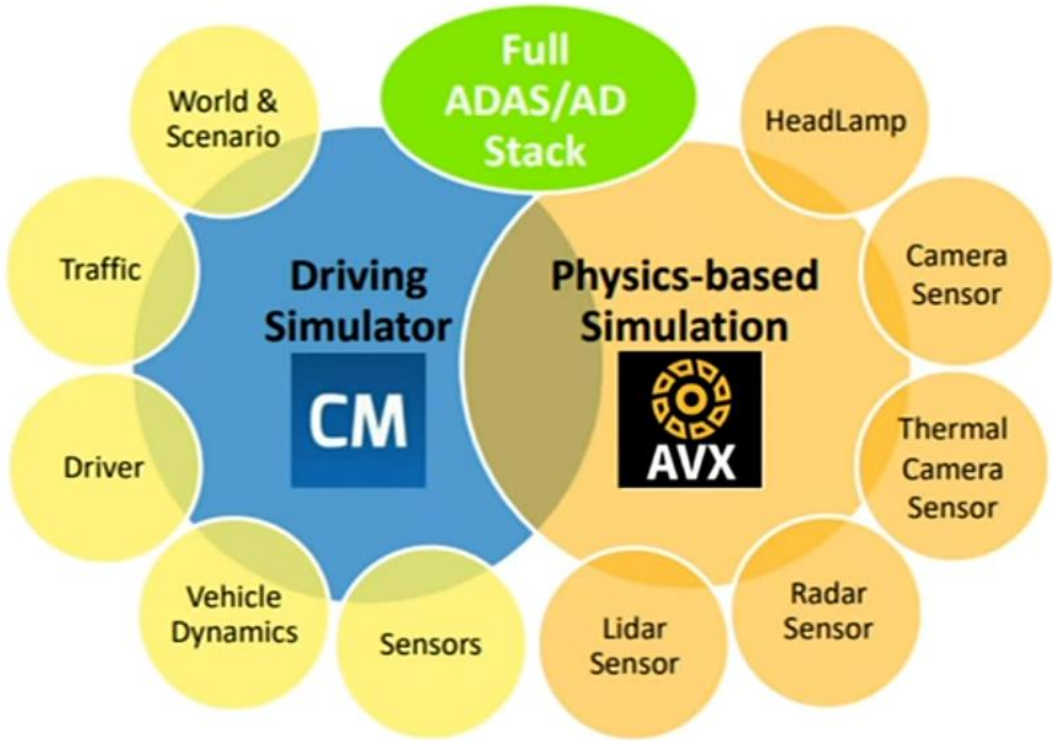


- ☐ How to perform scenario-based testing ? -> Scene Coverage
  如何进行基于场景的测试？-> 场景覆盖度
- ☐ How to ensure simulation accuracy? -> Especially for Vehicle & Sensor model
  如何保证仿真精度？-> 尤其是车辆 & 传感器建模
- ☐ How to build AV HIL Test bench? -> Realtime and communications
  如何搭建高阶智驾HIL测试台架？-> 实时性和通信

Collaboration between Ansys and IPG Automotive

IPG Automotive is market leader in simulation solutions consisting of software as well as hardware components for virtual vehicle development.

IPG Automotive是虚拟车辆开发领域中软硬件一体化仿真解决方案的市场领导者



Ansys is market leader in engineering simulation of physical phenomena.

Ansys 是工程物理级仿真领域的市场领导者。

IPG and ANSYS have started a partnership in August 2021.
IPG和ANSYS早在2021年8月开始合作
IPG and Ansys have developed an interface between Carmaker and AVXcelerate, respectively .
IPG和Ansys开发了CarMaker & AVXcelerate联仿的接口

MIL/SIL：Software Solution

软件方案

Scenario-Based Testing Strategy
基于场景测试的策略

+ Partner

Simulation
仿真

+ Partner

Proving ground
试验场

Real Road
实际路试

Virtualization & scalability

Pure software
纯软件

Unit tests
单元测试

System tests
系统测试

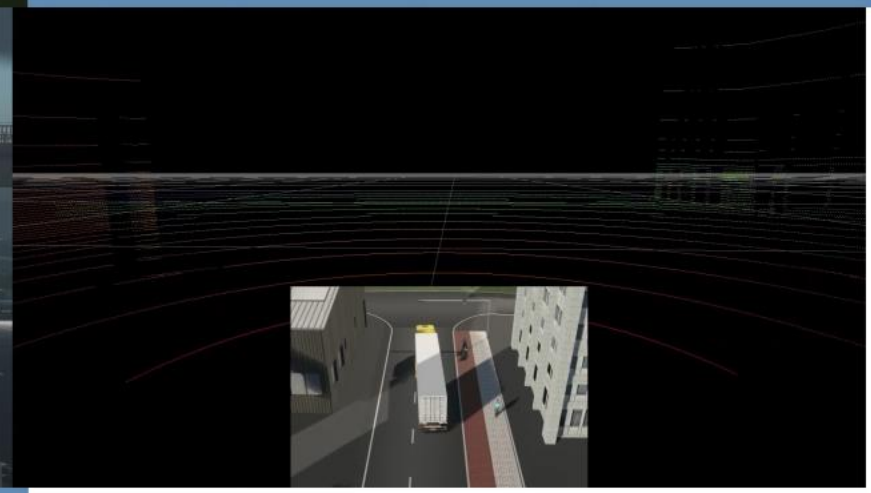
Software with hardware
嵌入式

Integration tests
集成测试

Vehicle on road
实车上路

Cost & effort

Off-road



Transportation

Platooning

Trucks

Off-highway

Scenario-Based Testing Process
基于场景测试的过程

Standards & Laws | 标准法规:
- ISO/SAE、UN/ECE
- NCAP、i-VISTA
- PEGASUS

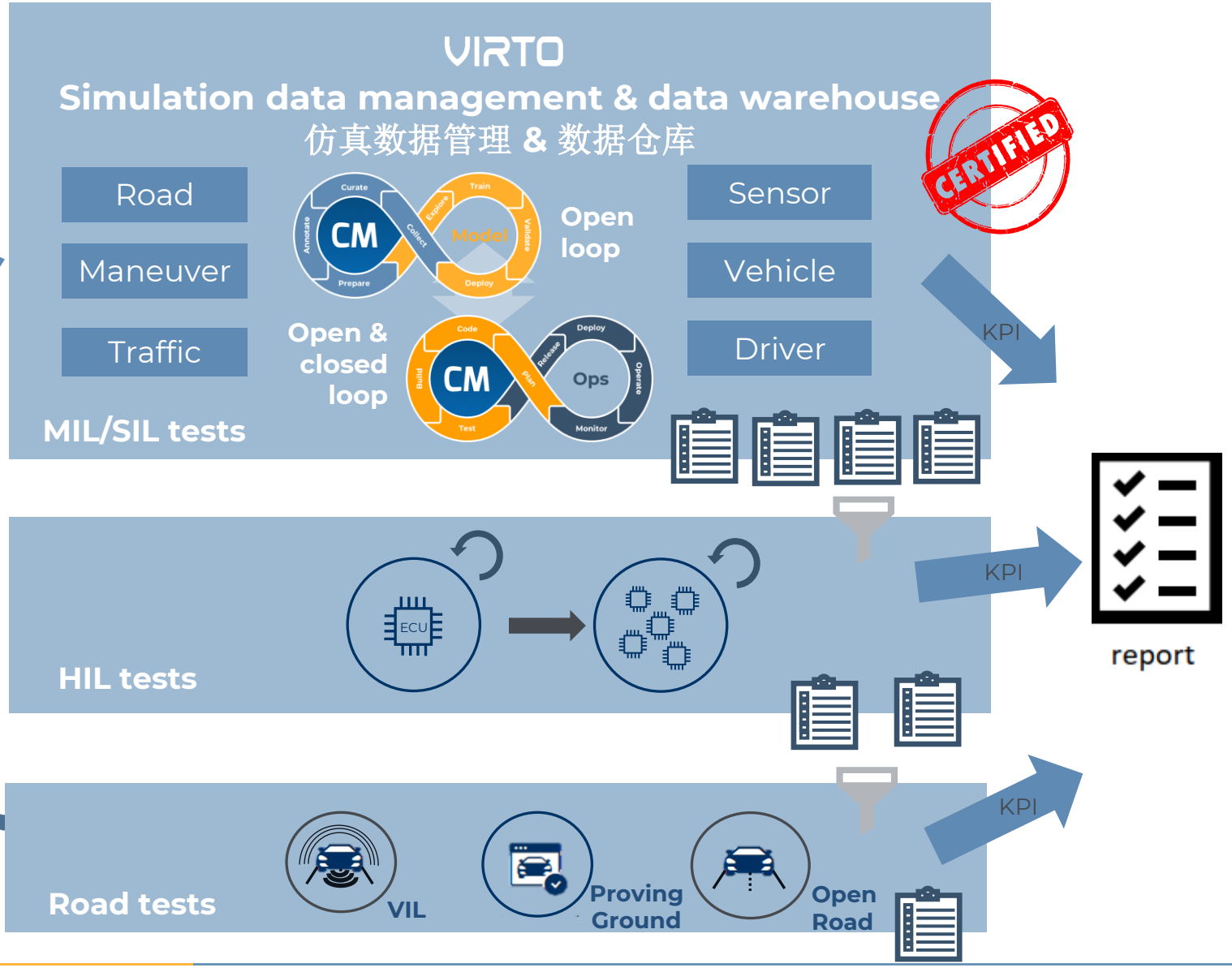
OEM & Tire1:
- Safe oriented | 安全
- Function Req | 功能需求

Real Road |实际道路
- Record data | 实采数据
- Accident data | 事故数据

Mis. | 其他：
- Custom scene | 自定义场景
- Simulation tool | 工具本身

Scenarios

Synthetic Data



Generating Scenarios
创建场景

Random scenarios | 随机场景

- Road API
- Swarm traffic | 随机智能交通
- Key-/NamedValues (via CarMaker Python API)
- Movie NX Python API

Scenario variations | 场景泛化

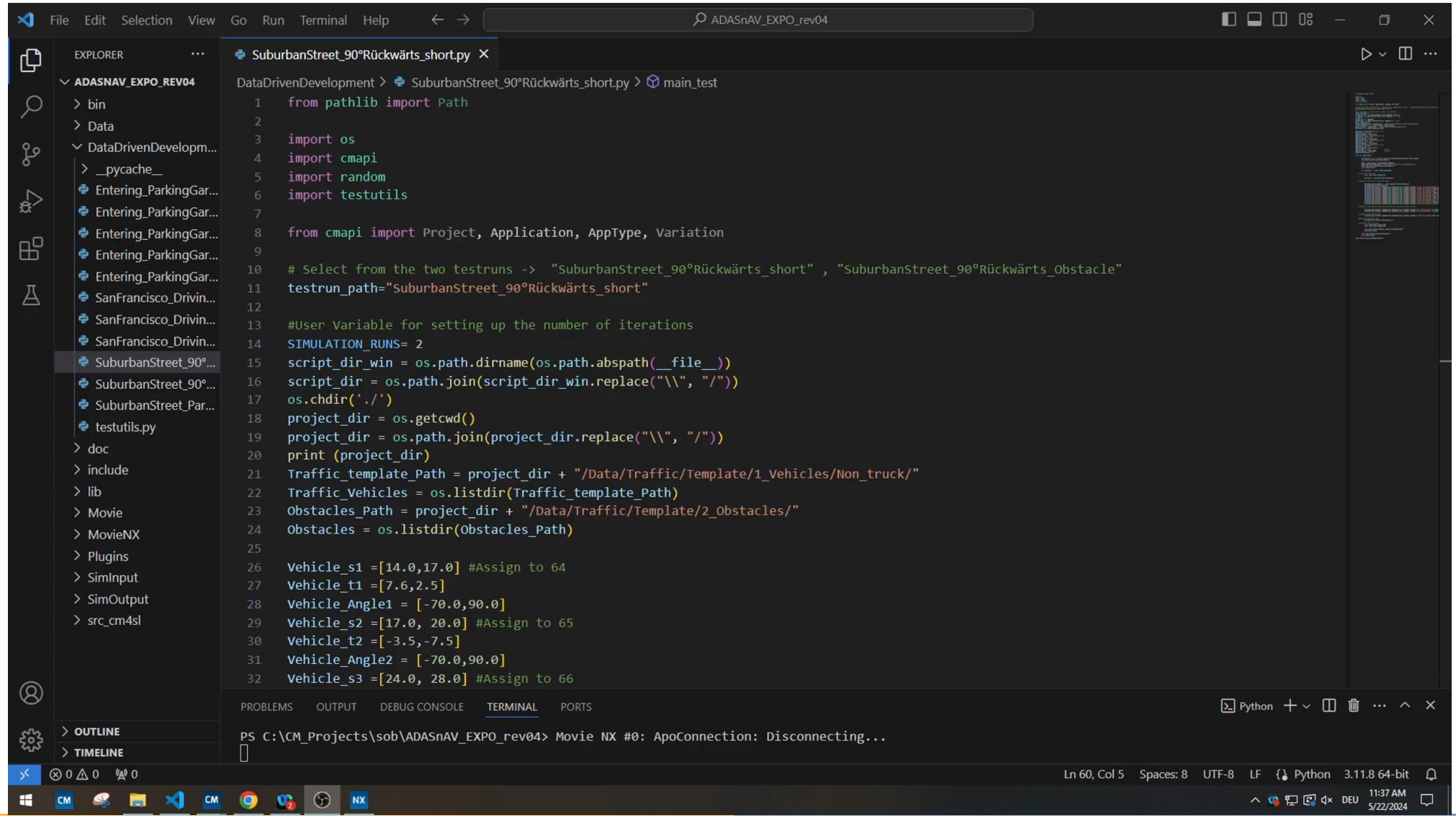
- Scenario Editor | 场景编辑器
- Key-/NamedValues (via CarMaker Python API)
- Movie NX Python API

Edge cases | 极限工况

- HD Scenarios & partners | 高质量场景（合作伙伴）
- Scenario Editor
- Custom asset import | 自定义元素导入

Demo: Variation of Parking HD Scenarios

演示：泊车高清场景的泛化



Vehicel Models: Open integration platform

车辆模型:开放的集成平台

Target Definition

Simulation Studies

Vehicle

Results

Model-in-the-Loop

Sub-system

Results

Software-in-the-Loop

Component

Results

Validation

Road Test

Vehicle test

Results

System-in-the-Loop

Test bed

Results

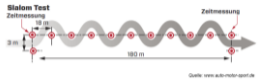
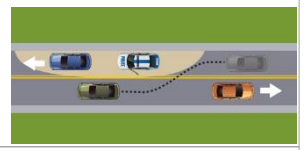
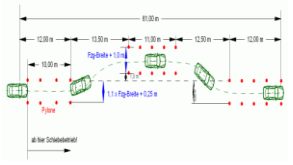
Hardware-in-the-Loop

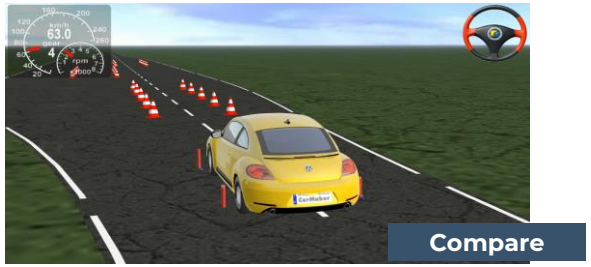
HIL test

Results

Vehicle Dynamics Attribute Evaluation
车辆动力学属性评估

Typical driving maneuvers 典型驾驶工况

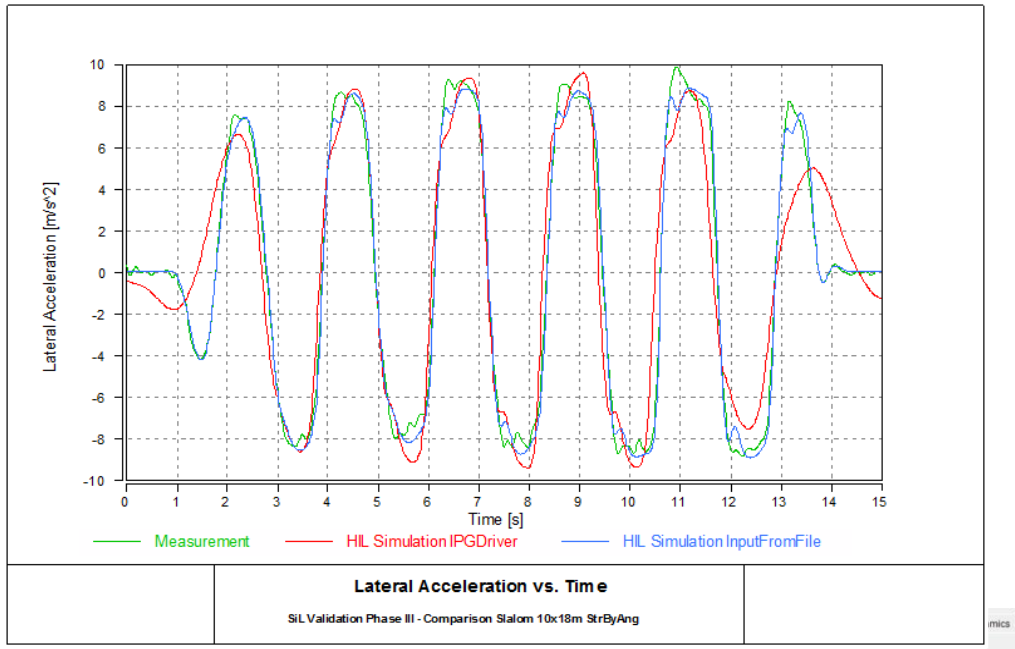
Driving Maneuver	Evaluation	Open Loop	Closed Loop	Picture
Handling Course	Evaluation of the driving behavior in extreme corning situations		X	
Slalom 10x18m 10x36m	Evaluation of the driving behavior in very fast course directions.		X	
Single Lane Change	Simulation of a evasive maneuver at the high way		X	
Double Lane Change 1 (FAST)	Simulation of a fast evasive maneuver with return to the lane (~120km/h; ISO 3888-1 Lane Change)		X	
Double Lane Change 2 (SLOW)	Simulation of a intensive evasive (obstacle avoidance) maneuver with return to the lane (~70km/h; ISO-3888-2 [VDA] Lane Change or „Elk Test“)		X	

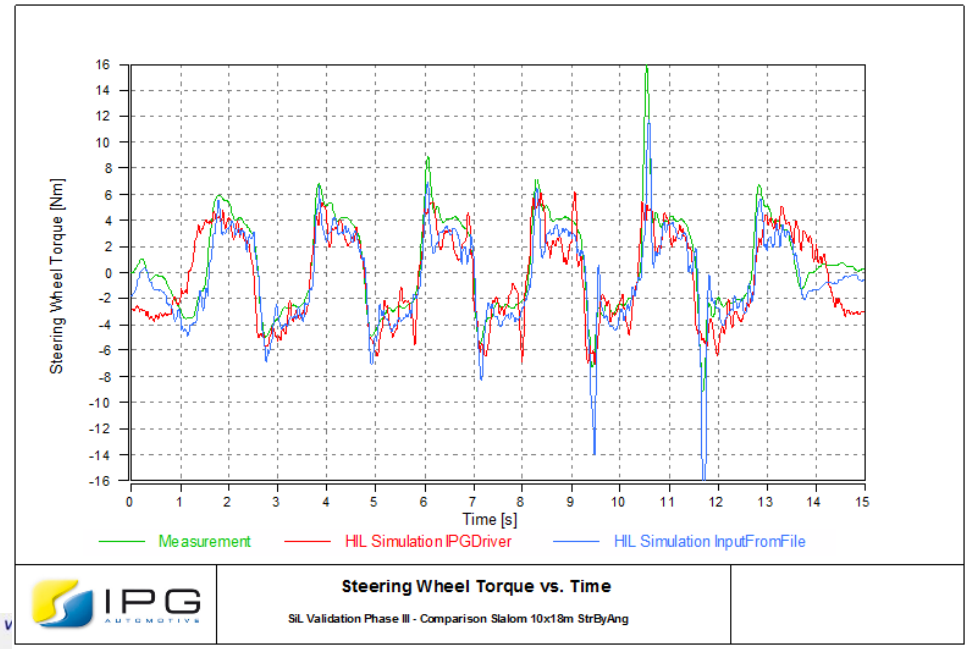


Vehicle model accuracy verification

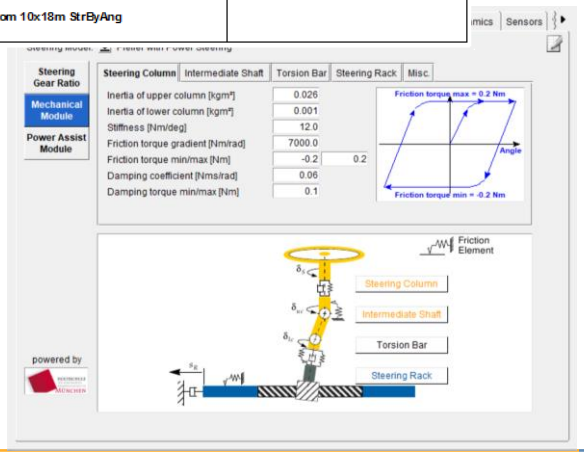
车辆模型精度验证

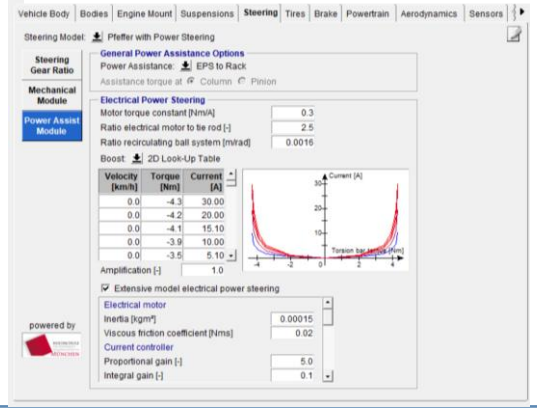
Sample function and test: Catch-up during virtual vehicle test → slalom



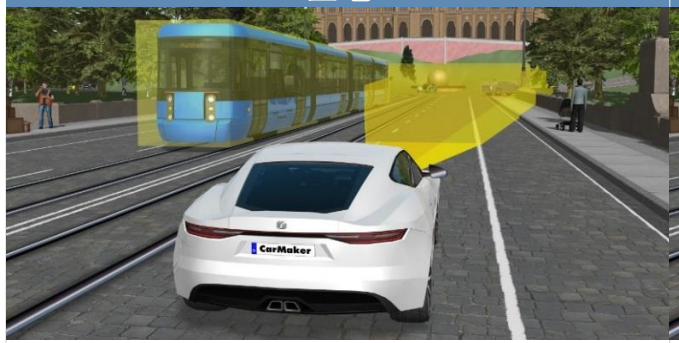
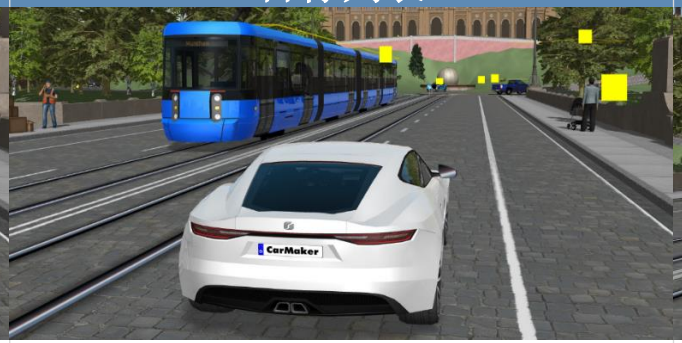
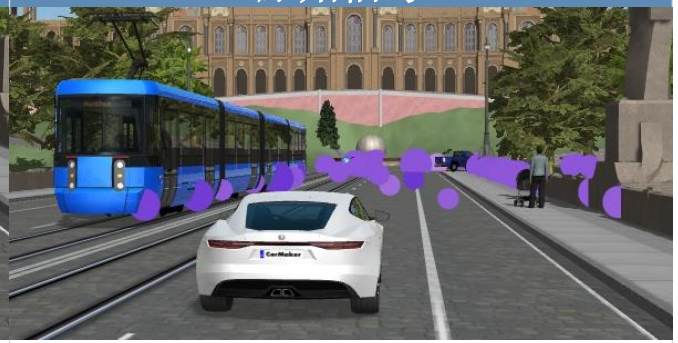


slalom测试结果验证





Sensor Models – Purpose-driven Fidelity
传感器模型 – 基于目的驱动的保真度

	Ideal 理想	HiFi 目标列表	RSI 原始信号
			
Use cases **案例**	▪ Basic function test | 基础功能测试 ▪ Reference sensor | 参考传感器	▪ Function test | 功能测试 ▪ Fail-safe test | 失效测试	▪ Perception algorithm development | 感知算法开发 ▪ Signal chain test | 信号链路测试
Features **功能**	▪ Output: object list | 输出：目标 ▪ Ground truth information|真值 ▪ Easy to parameterize | 易配参	▪ Output: object list | 输出：目标 ▪ Technology-specific errors | 特定技术问题 ▪ Physical phenomena|物理级现象 ▪ Post processing/ target selection included | 后处理/包括目标选择	▪ Output: raw signal | 输出：原始信号 ▪ Technology-specific errors|特定技术问题 ▪ Detailed physical effects|详细的物理效应 ▪ Validated | 验证

How to Generate Synthetic Data with CarMaker
如何利用CarMaker生成合成数据

Rich environments & scenarios
丰富的环境和场景

Realistic sensor data
逼真的传感器数据

Configurable annotations
可配置的标注信息

Dataset generator 数据集生成器

Data storage
数据存储

Synthetic Data for Corner Cases
合成数据下的Corner Cases

Joint solution with ANSYS

AVXcelerate & CarMaker

Active Headlamp

主动大灯

Active Headlamp Virtual Validation
主动大灯虚拟验证

工程目标

在复杂的物理环境下，例如夜间弯路上高速行驶的车辆，对主动前照灯验证非常重要。

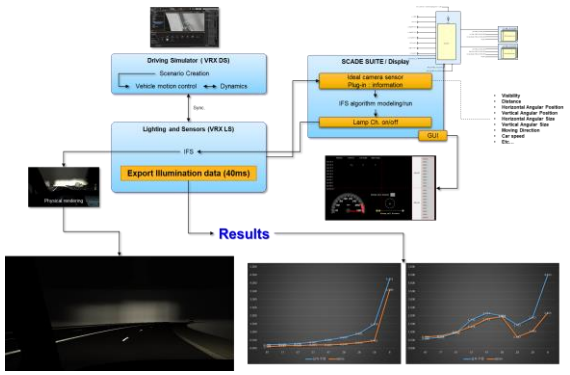
- 零风险，确保周围车辆安全，需设计无眩光远光灯。
- 根据周围环境，针对特定区域调暗前照灯。
- 设计像素级数字远光灯控制。

解决方案

- **算法设计：**轻松创建主动前照灯算法。(SCADE)
- **前照灯模拟：**轻松设置前照灯光学特性。(AVxcelerate Lighting and Sensors)
- **创建测试场景：**轻松创建测试场景。

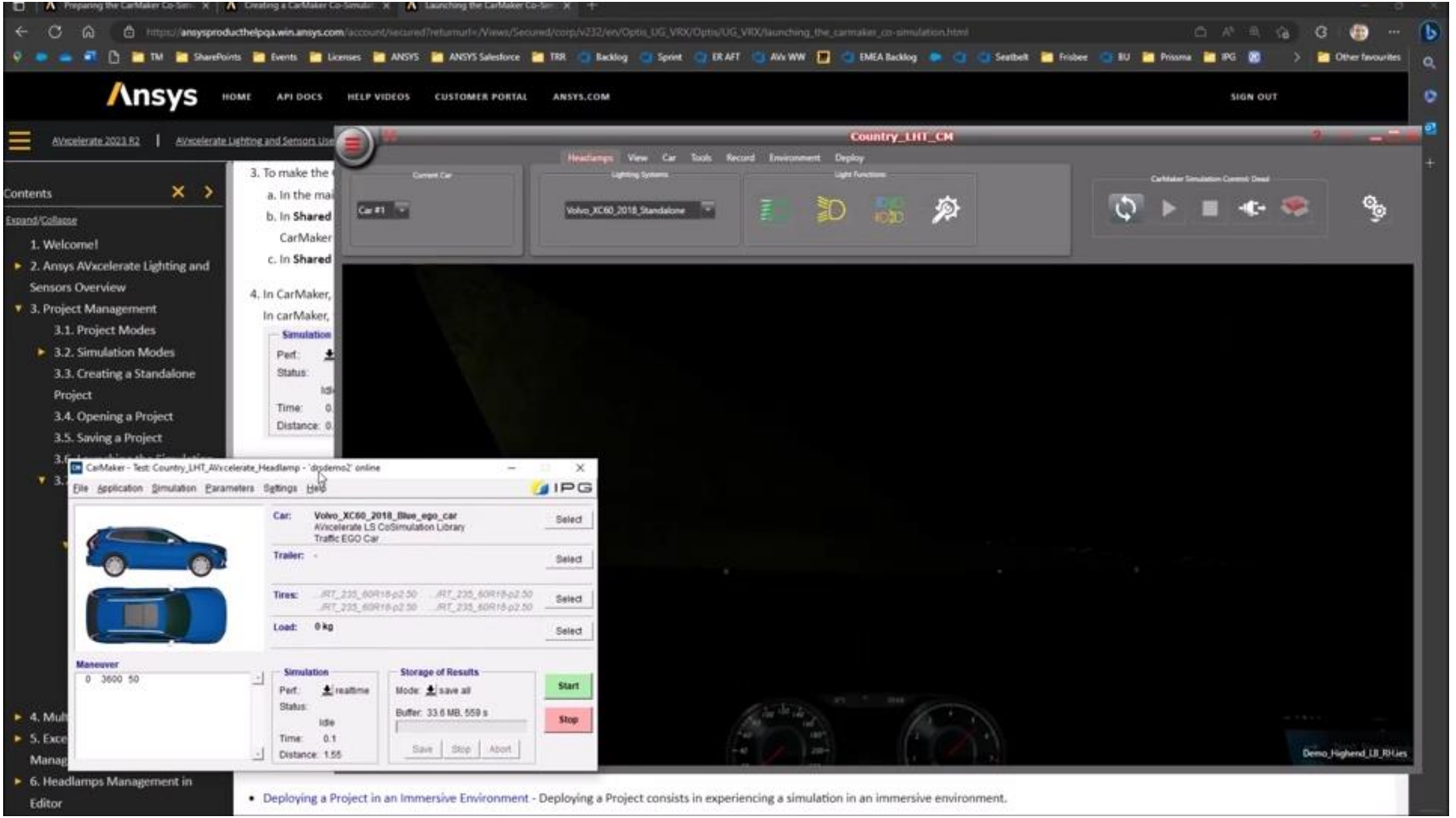
益处

- 虚拟验证前照灯性能，支持在设计各阶段的改进。
- 优化前方道路的可视性。
- 避免周围车辆的眩光和致盲，确保安全。



Simulation Architecture

Operational Scenario (Movie)


Ansys
HOME
API DOCS
HELP VIDEOS
CUSTOMER PORTAL
ANSYS.COM
SIGN OUT
Contents
Expand/Collapse
1. Welcome!
2. Ansys AVxcelerate Lighting and Sensors Overview
3. Project Management
3.1. Project Modes
3.2. Simulation Modes
3.3. Creating a Standalone Project
3.4. Opening a Project
3.5. Saving a Project
4. Mult
5. Exce
Manag
6. Headlamps Management in Editor
Country_LHT_CM
Headlamps
View
Car
Tools
Record
Environment
Deploy
Car #1
Volvo_XC60_2018_Standalone
CarMaker - Test: Country_LHT_AVxcelerate_Headlamp - 'dpdemo2' online
File
Application
Simulation
Parameters
Settings
Help
IPG
Car:
Volvo_XC60_2018_Blue_ego_car
AVxcelerate LS CoSimulation Library
Traffic EGO Car
Trailer:
Tires:
Load:
0 kg
Select
Maneuver
0 3600 50
Simulation
Perf:
realtime
Status:
Idle
Time:
0.1
Distance:
1.55
Storage of Results
Mode:
save all
Buffer: 33.6 MB, 559 s
Save
Stop
Abort
Start
Stop
Demo_Highend_LB_RHJes
Deploying a Project in an Immersive Environment - Deploying a Project consists in experiencing a simulation in an immersive environment.

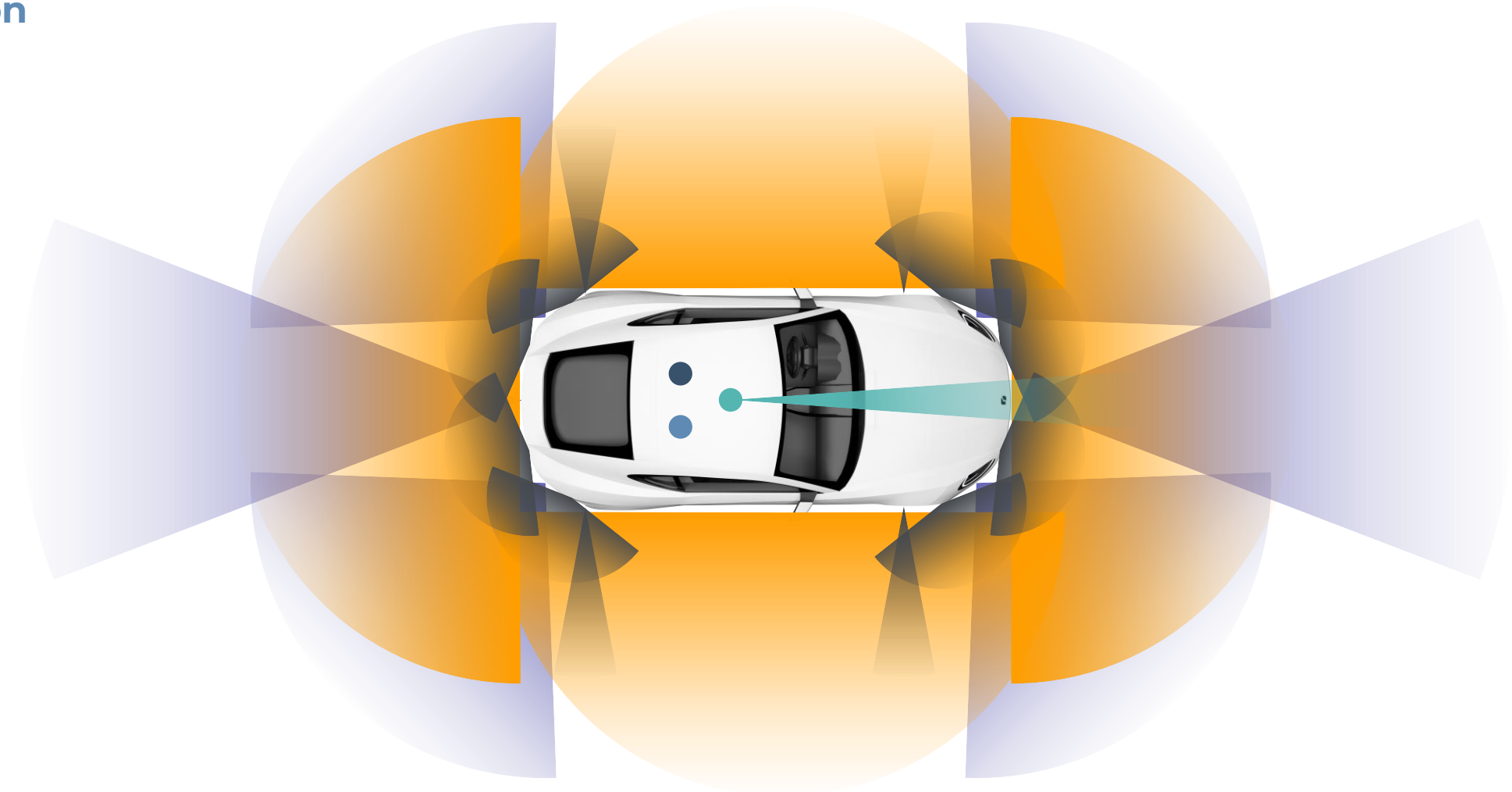
HIL&VIL：HIL Solution

HIL方案

High Level Autonomous Driving Sensor Configuration
高阶自动驾驶主流传感器配置

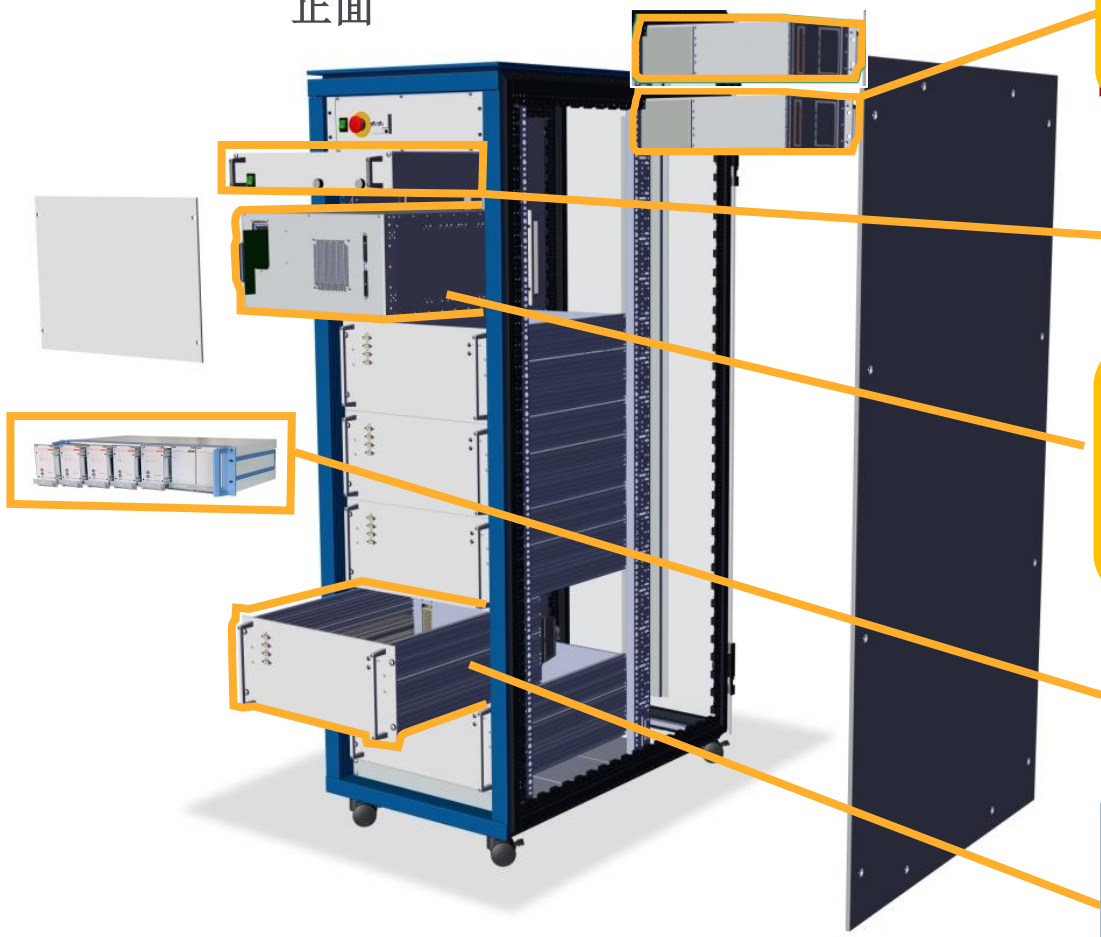
Sensor Distribution
传感器分布

- 11 × camera
- 6 × radar
- 1 × lidar
- 12 × ultrasonic
- 1 × GPS
- 1 × V2X



Hardware Platform
HIL硬件平台

HIL Front
正面



Real-time Units
Xpack4 实时系统

Power Supply
可编程电源

SensCompute-G8
高性能显卡服务器

Video interface Box
视频注入

Drive AGX Orin
待测件

HIL Back
背面

GPU and Sensor Cluster Configuration

GPU和传感器集群配置

Sensor Cluster Configuration

Cluster 1 to GPU 1	Cluster 2 to GPU 2	Cluster 3 to GPU 3	Cluster 4 to GPU 4
Sensor 1 Sensor 2 Sensor 3 ...	Sensor 1 Sensor 2 Sensor 3 ...	Sensor 1 Sensor 2 Sensor 3 ...	Sensor 1 Sensor 2 Sensor 3 ...
Radar	Camera	Lidar	Ultrasonic

GPU Configuration

Device 1/GPU 1

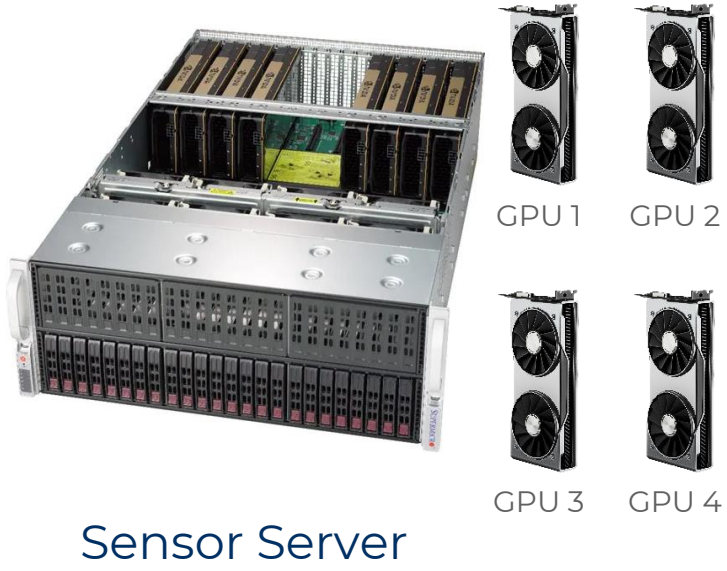
Device 2/GPU 2

Device 3/GPU 3

Device 4/GPU 4

GPU detected

Software | Hardware



Sensor Server

Outdoor Vehicle-in-the-Loop
室外车辆在环


IPG
AUTOMOTIVE
VEHICLE-IN-THE-LOOP
Ford

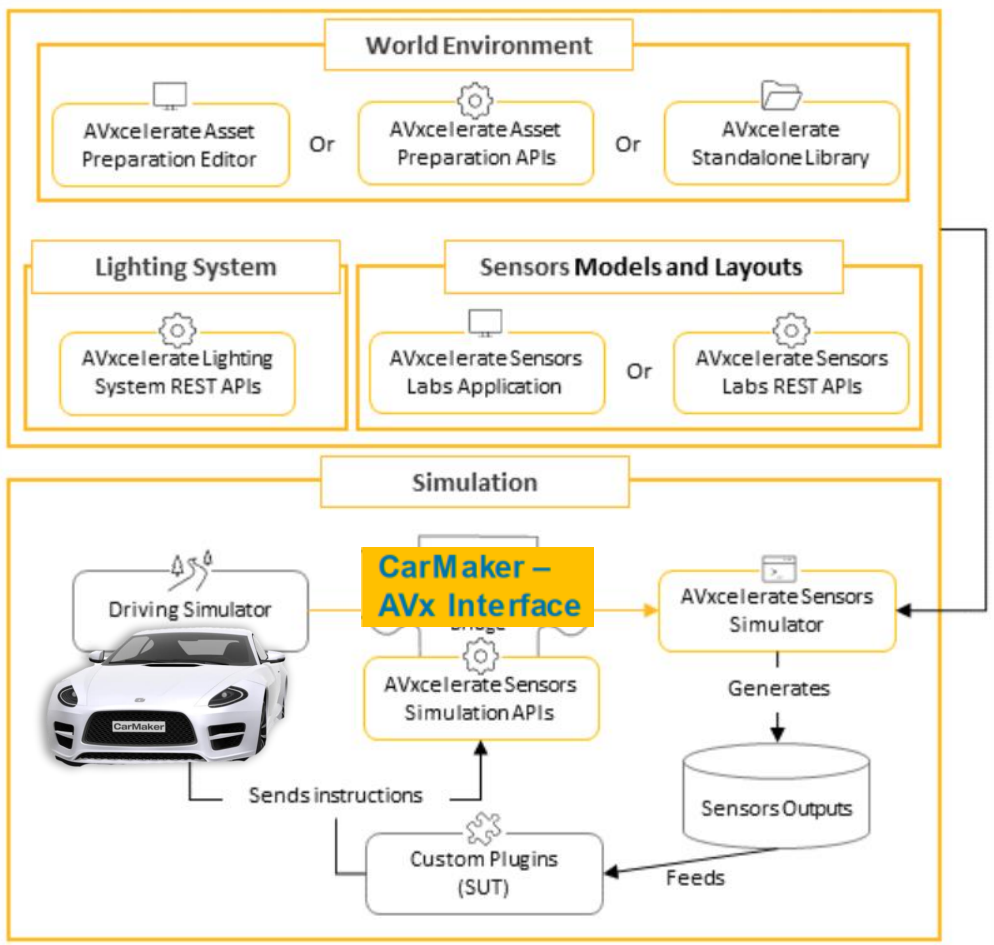
Joint solution with ANSYS

AVxcelerate Sensor & CarMaker

Camera Sensors

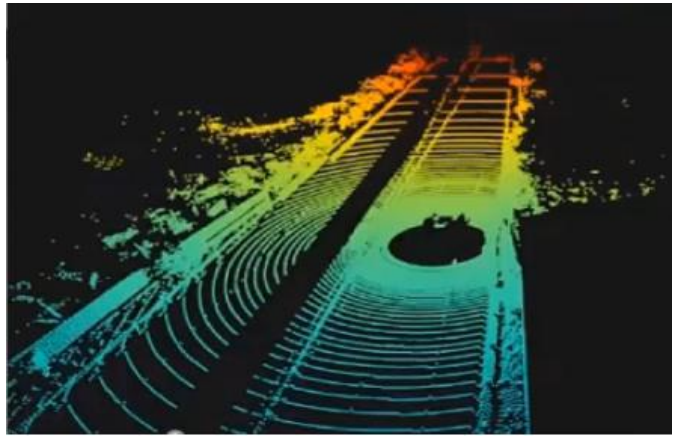
摄像头传感器

Camera Sensor Validation
摄像头传感器验证

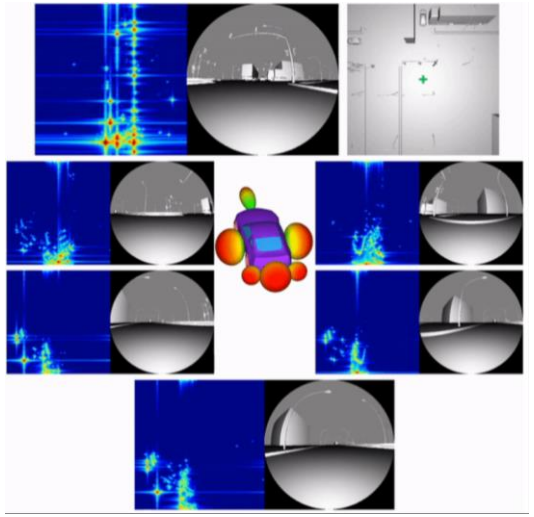


AVxcelerate Sensors Simulator Workflow

Ansys Real-Time Camera simulation



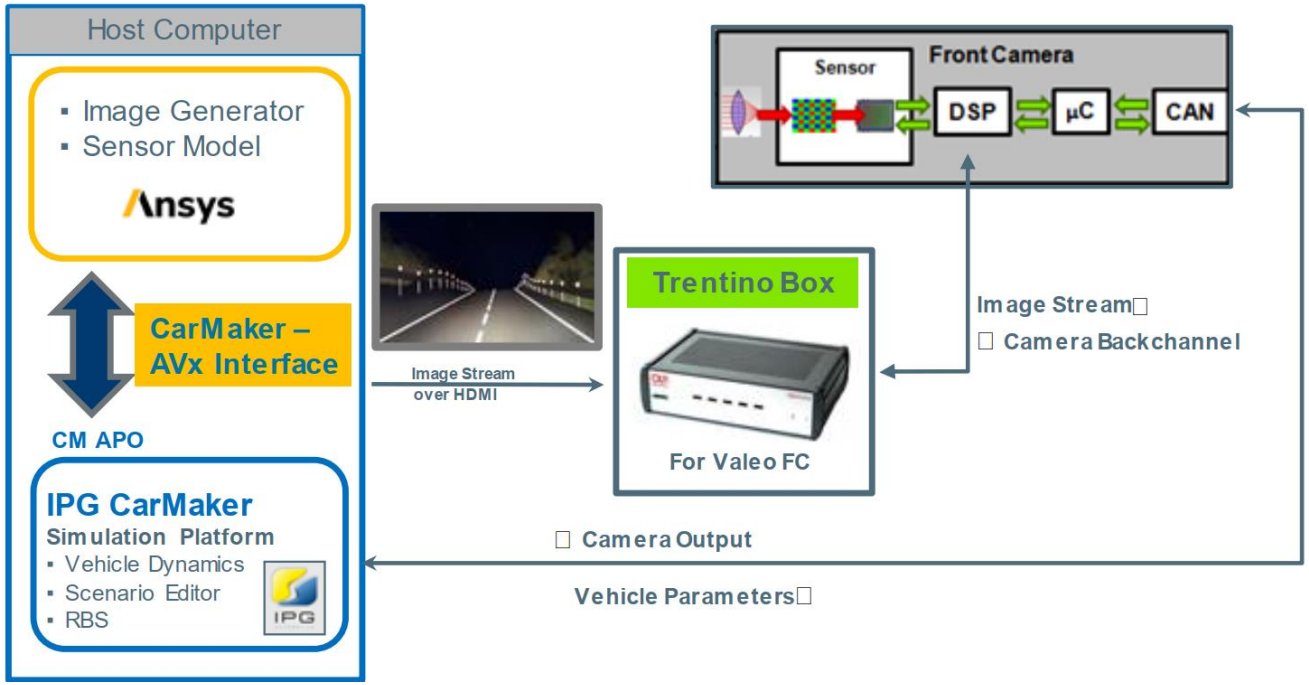
Ansys Real-Time Lidar simulation



Ansys Real-Time Radar simulation

Front Camera Injection Testing
前置摄像头视频注入测试

Example



软件配置:

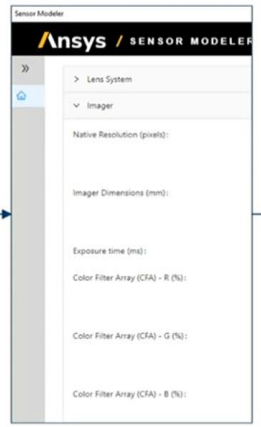
- CarMaker
- Ansys Avx
- Matlab & Simulink

硬件配置:

- Workstation with Nvidia GPU
- Trentino Box
- Front Camera
- Option: RTPC

Valeo Front Camera

AVx Sensors Modeler



AVxcelerate & CarMaker：Camera Injection Testing
摄像头视频注入测试

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www.ipg-automotive.com

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@IPG 中国
@亦佩捷
@亦佩捷

SOLUTIONS FOR VIRTUAL TEST DRIVING