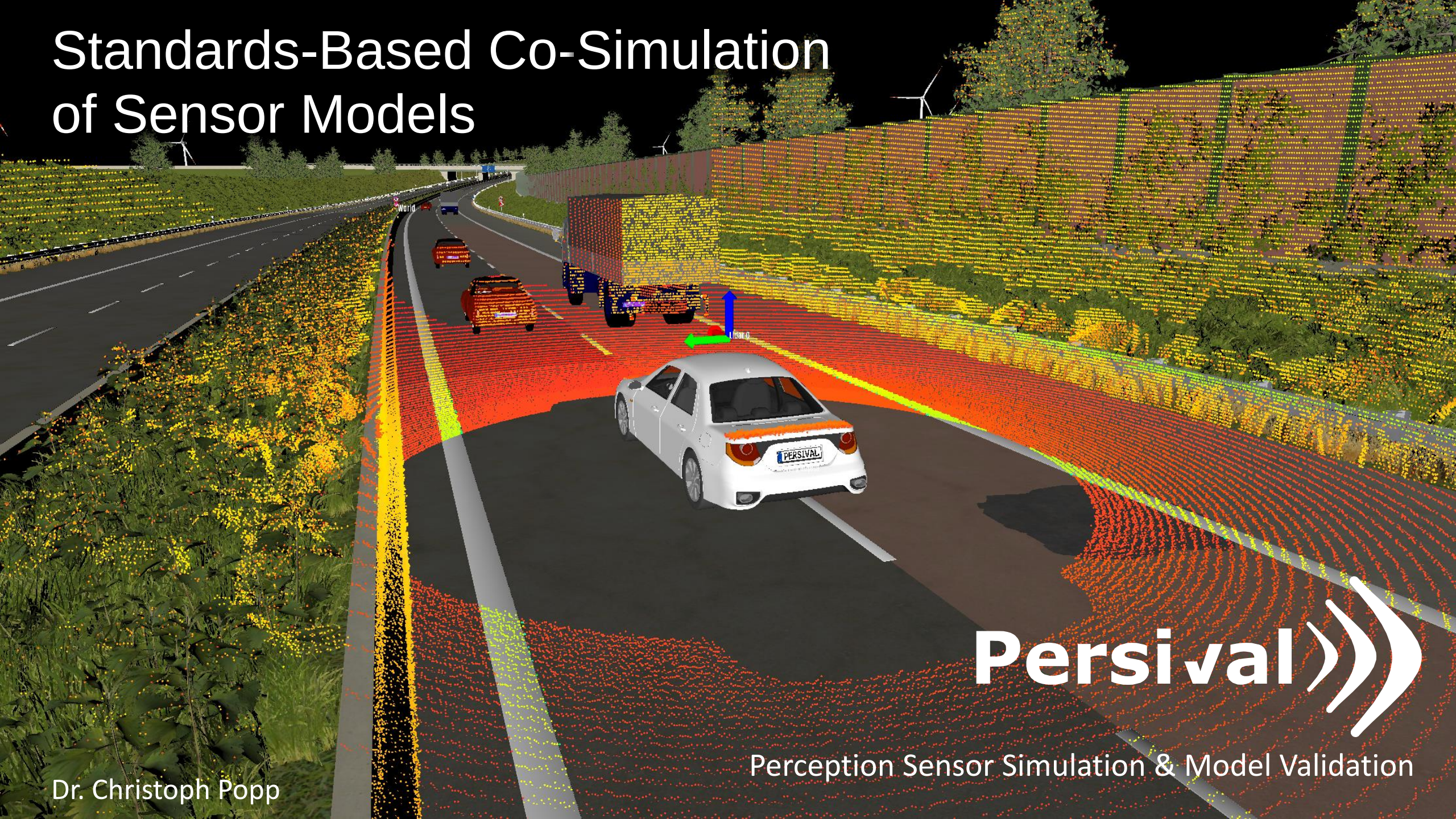
Standards-Based Co-Simulation of Sensor Models



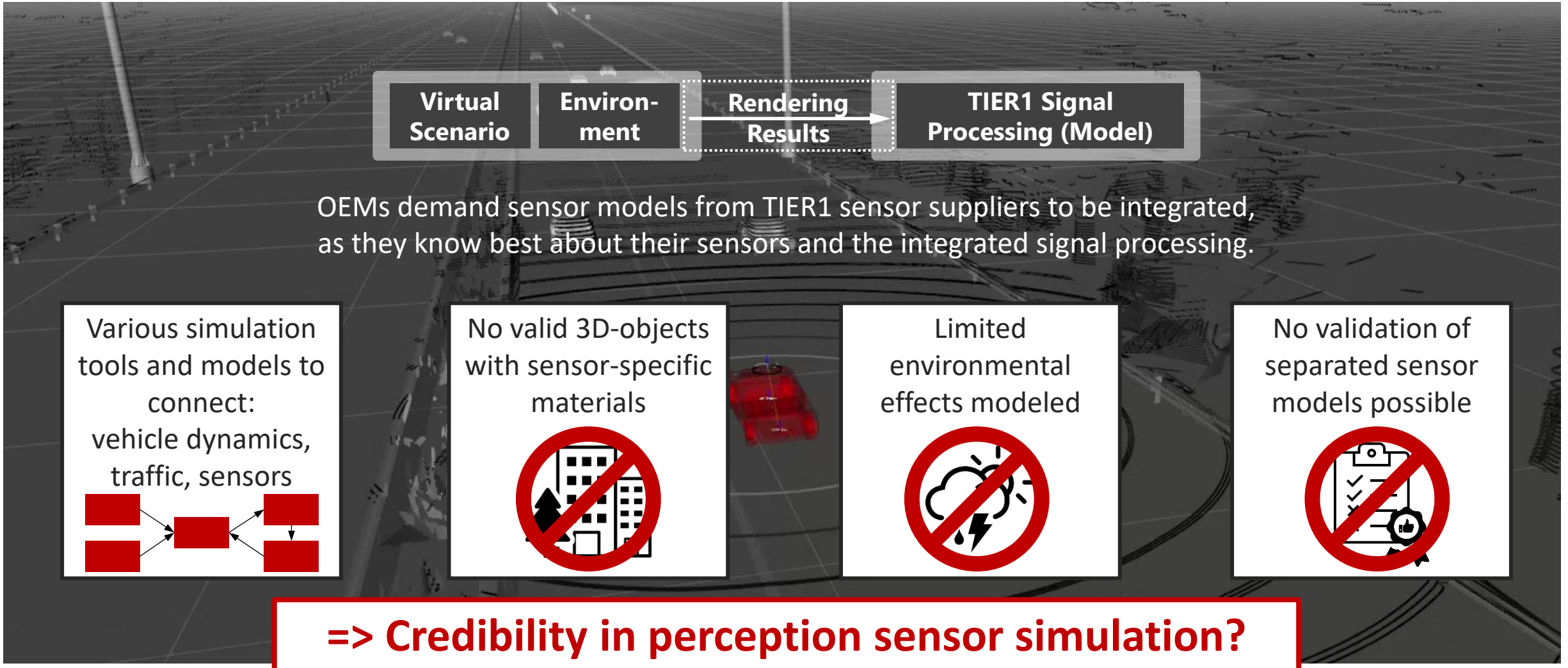
Persival

Perception Sensor Simulation & Model Validation

Dr. Christoph Popp

Status Quo: Separated Sensor Simulation

Separation of Environment and Sensor Simulation



OEMs demand sensor models from TIER1 sensor suppliers to be integrated, as they know best about their sensors and the integrated signal processing.

Various simulation tools and models to connect: vehicle dynamics, traffic, sensors

No valid 3D-objects with sensor-specific materials

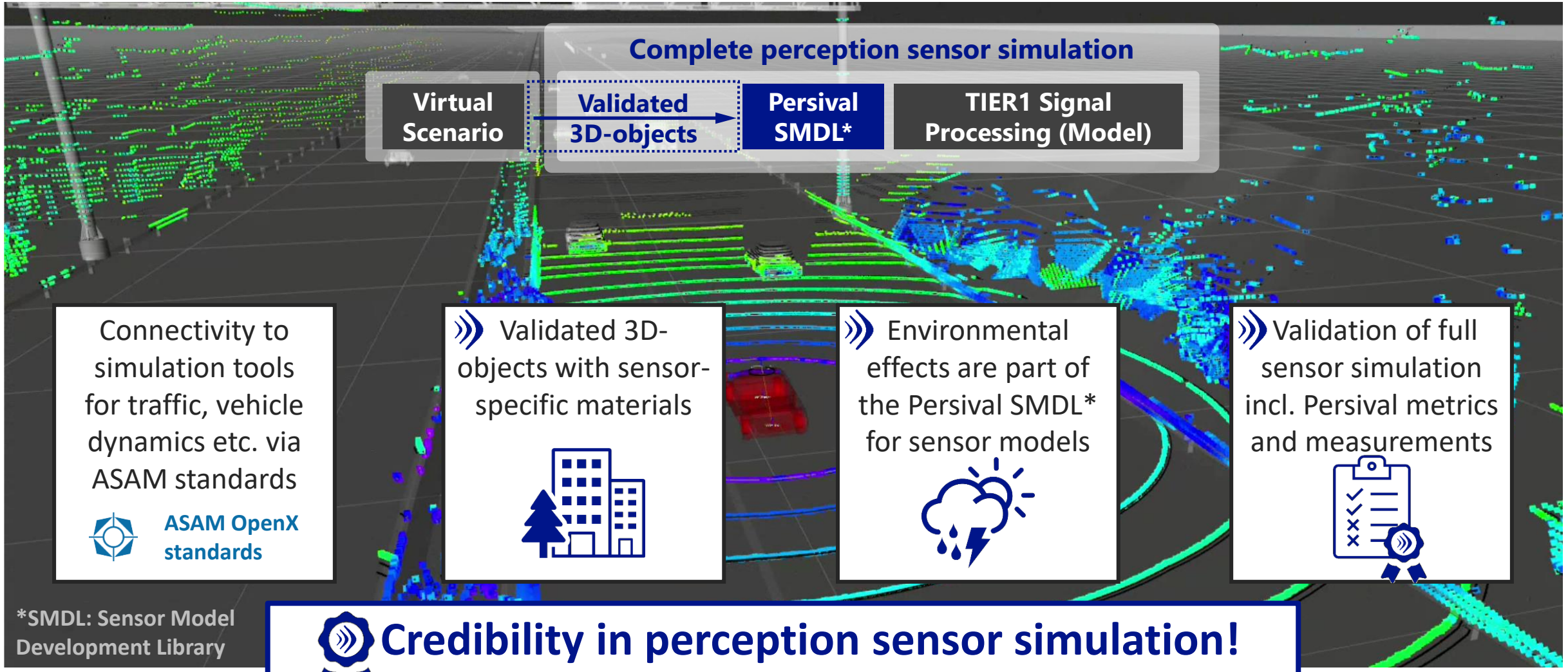
Limited environmental effects modeled

No validation of separated sensor models possible

=> Credibility in perception sensor simulation?

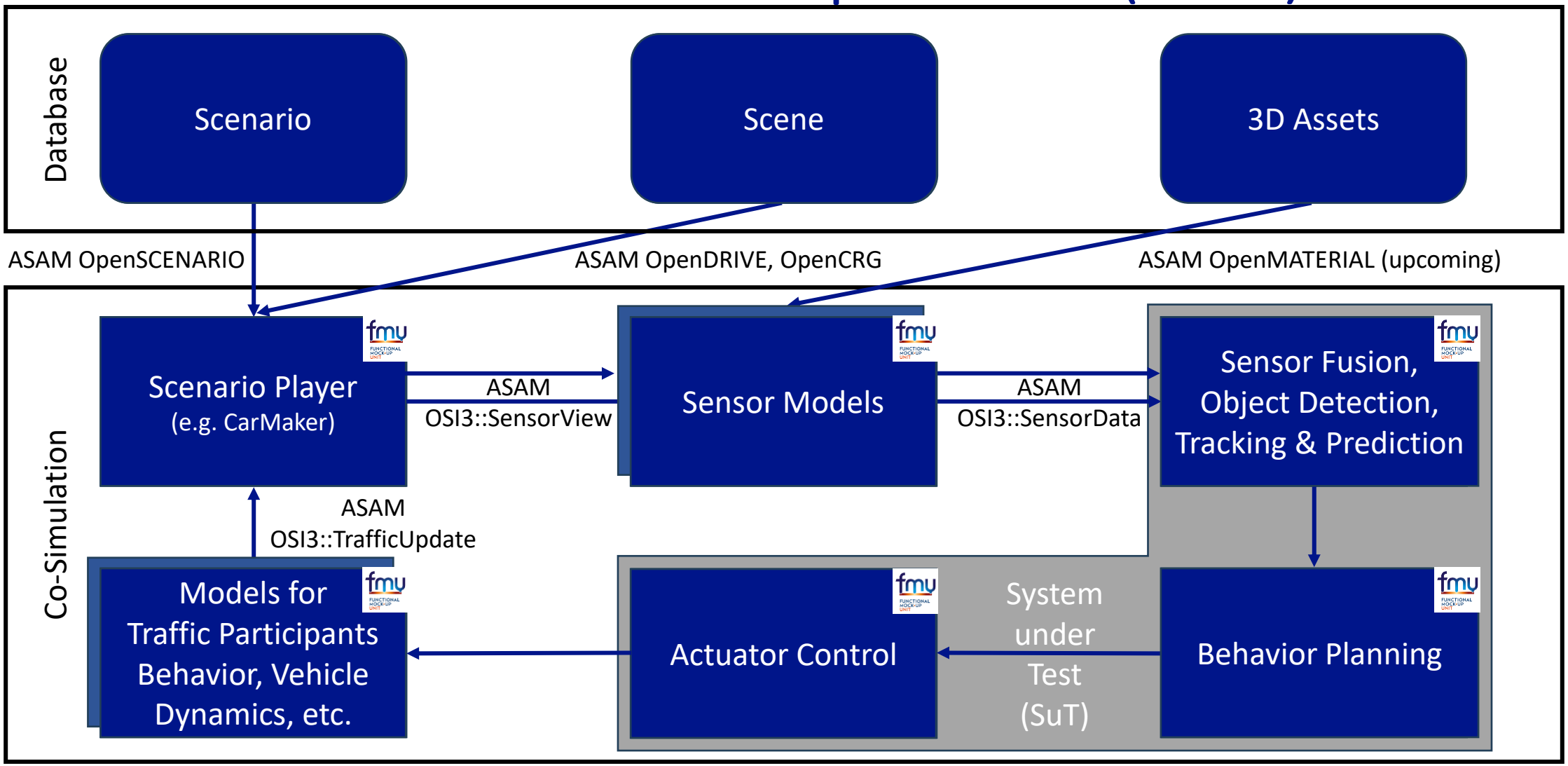
Our Solution for Credible Sensor Simulation

Holistic Sensor Model Development and Continuous Validation



Simulation Architecture

Co-Simulation of Multiple Models (FMUs)



How the Sensor Simulation Works

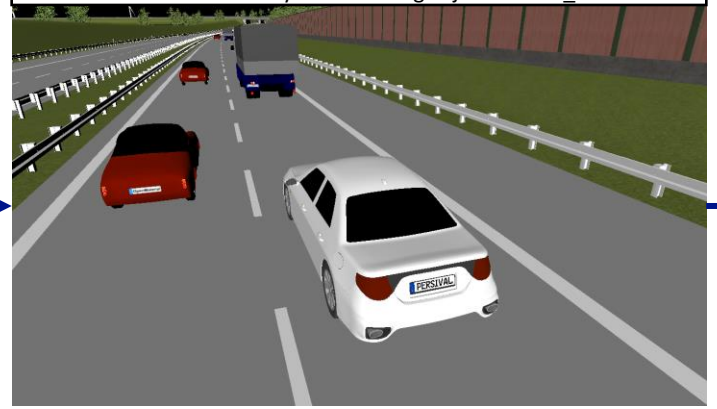
From Input over 3D Environment, Ray Tracing to Model Output

Load Static Environment

3D model referenced by osi3::GroundTruth::model_reference

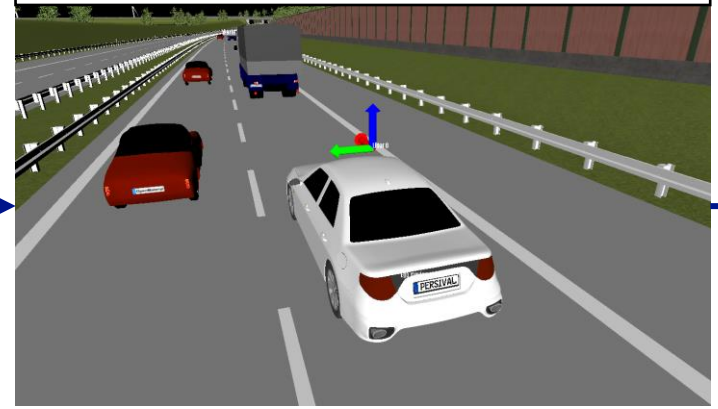
Load/Update Moving Objects

3D models referenced by osi3::MovingObject::model_reference



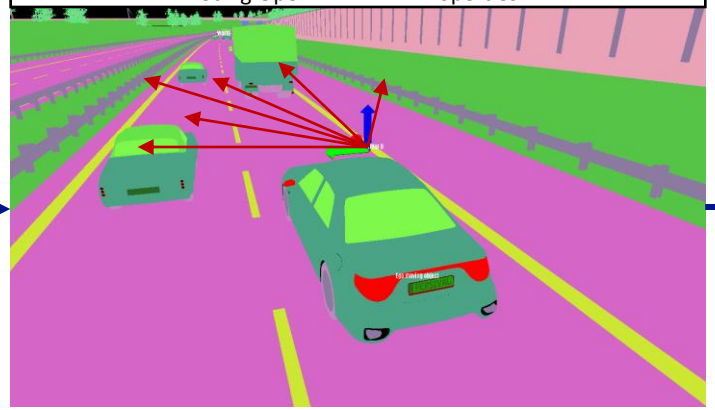
Set Sensor Position

Set via the SMDL API



Custom Ray Tracing

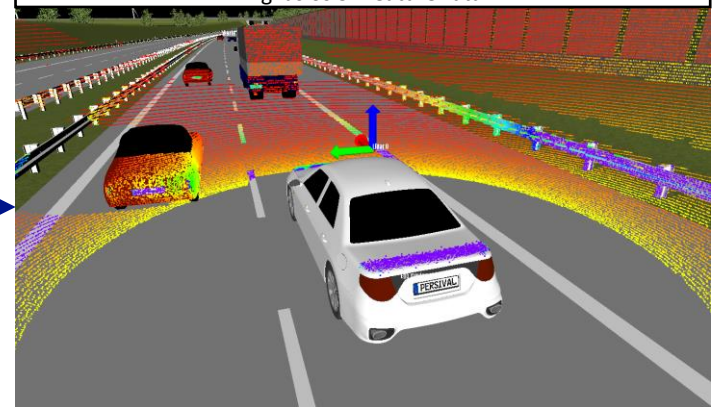
Using OpenMATERIAL Properties



TIER1 signal processing
BLACK BOX

Model Output

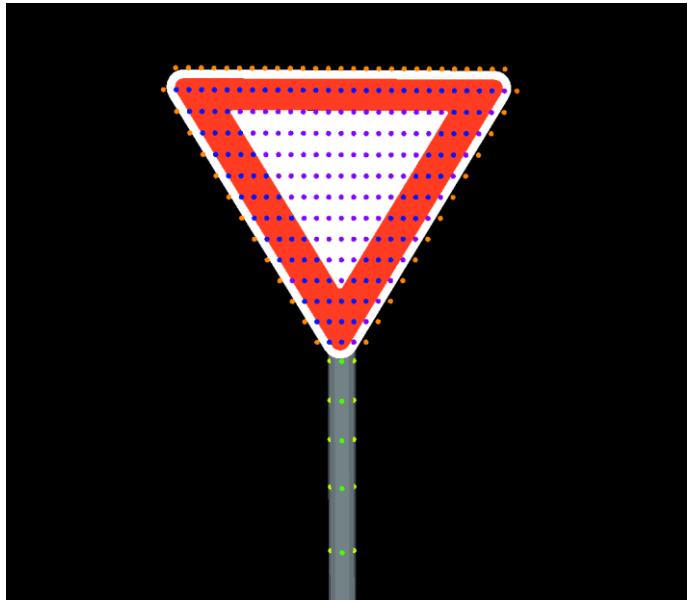
E.g. as osi3::FeatureData



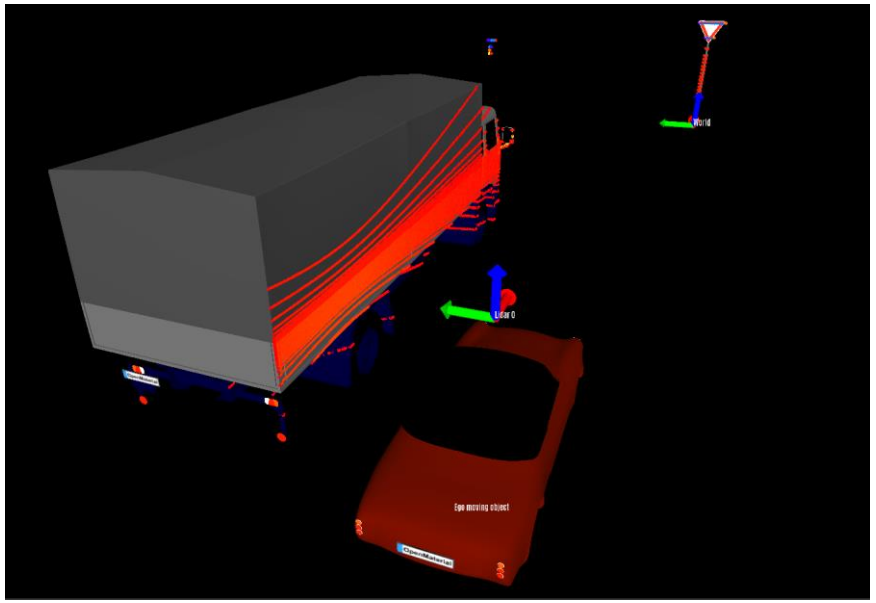
Automotive Lidar Sensor Simulation

Excerpt of possible effects In lidar data to simulate

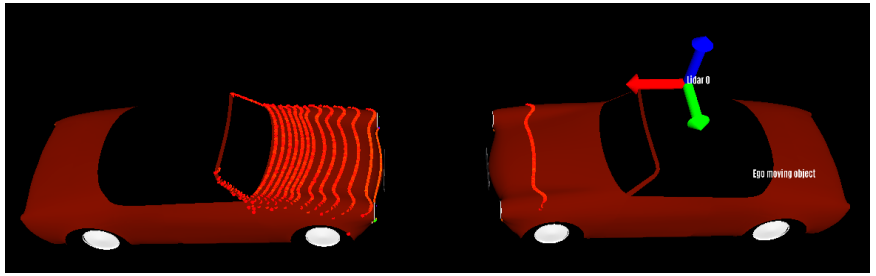
Bleeding

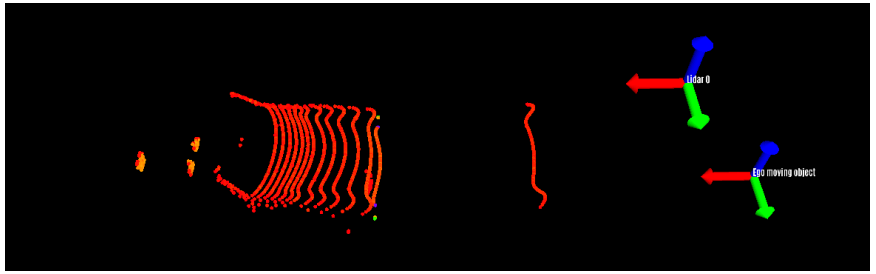


Reflection on Glass

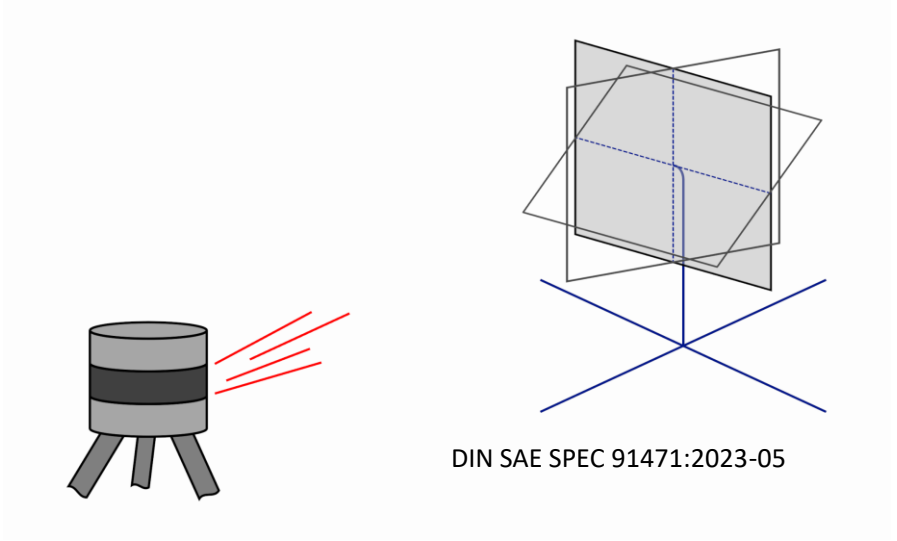


Transmission through Glass





Data Collection for Credible Simulation



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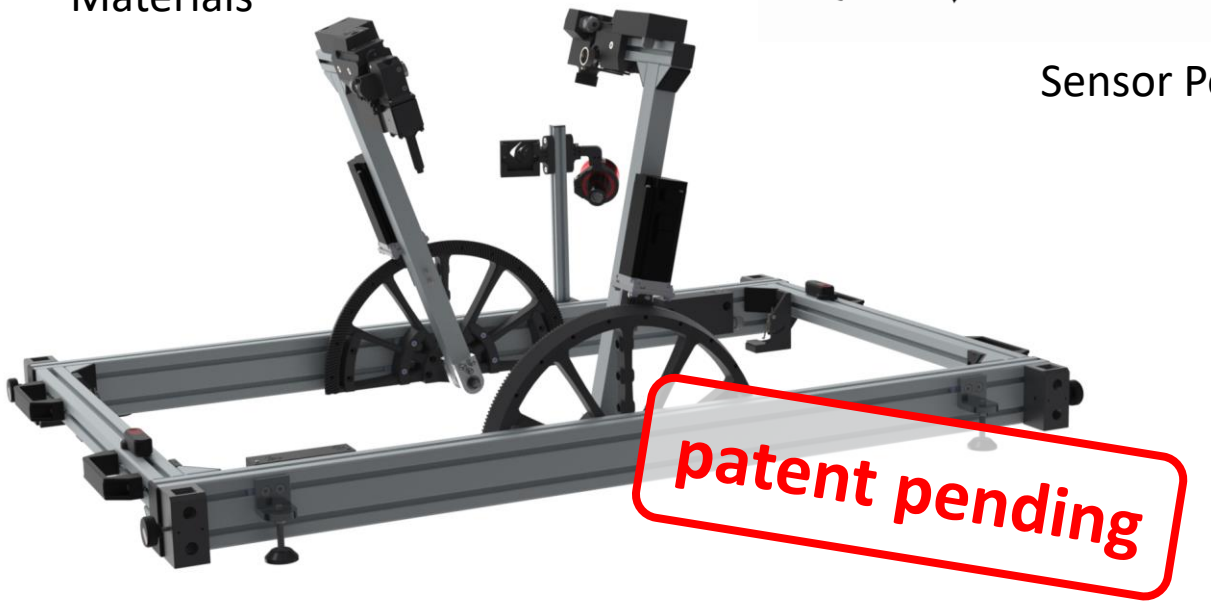
Sensor Performance

Materials



Weather Influence

3D Assets

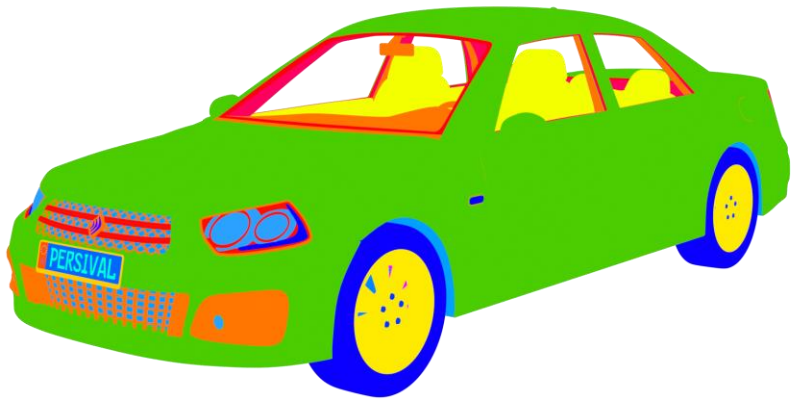
Creating Custom 3D Worlds

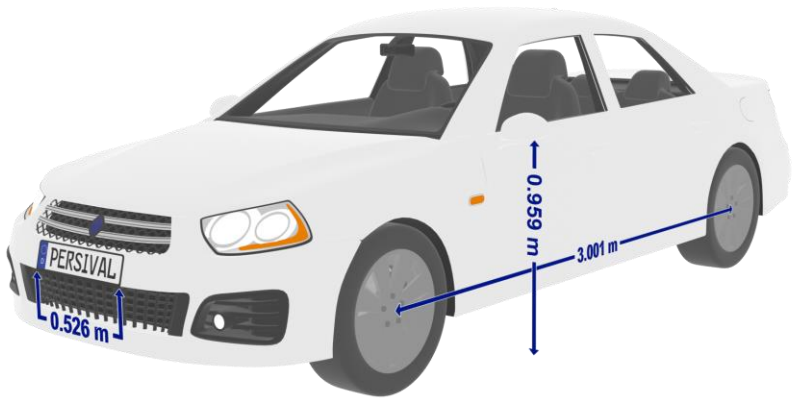
3D Assets
Simulation-Ready 3D Models

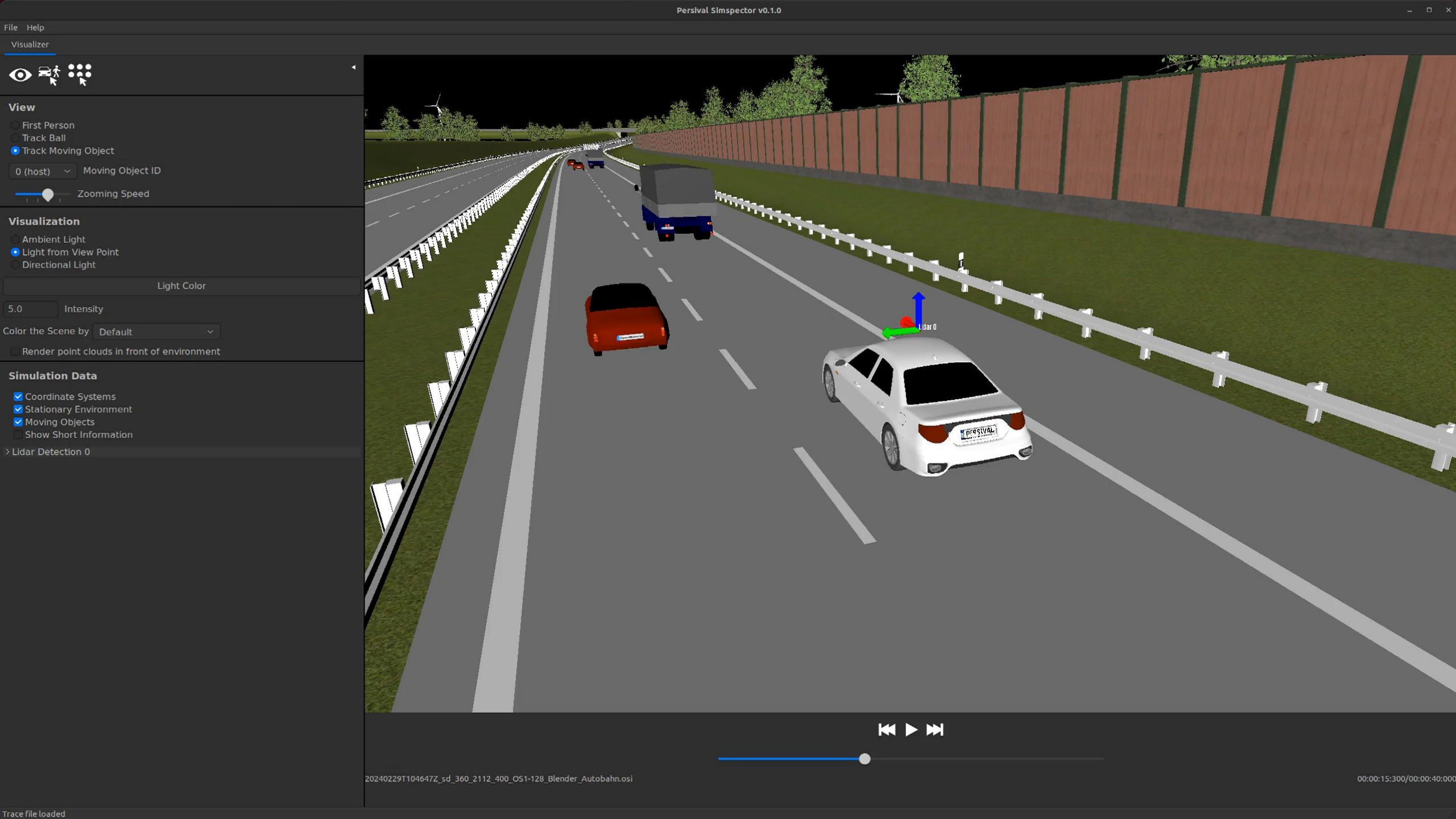
High Regard for Asset Quality
Clean meshes.
No panel gaps or scanning artifacts.
Polycount and mesh granularity tuned for sensor simulation.

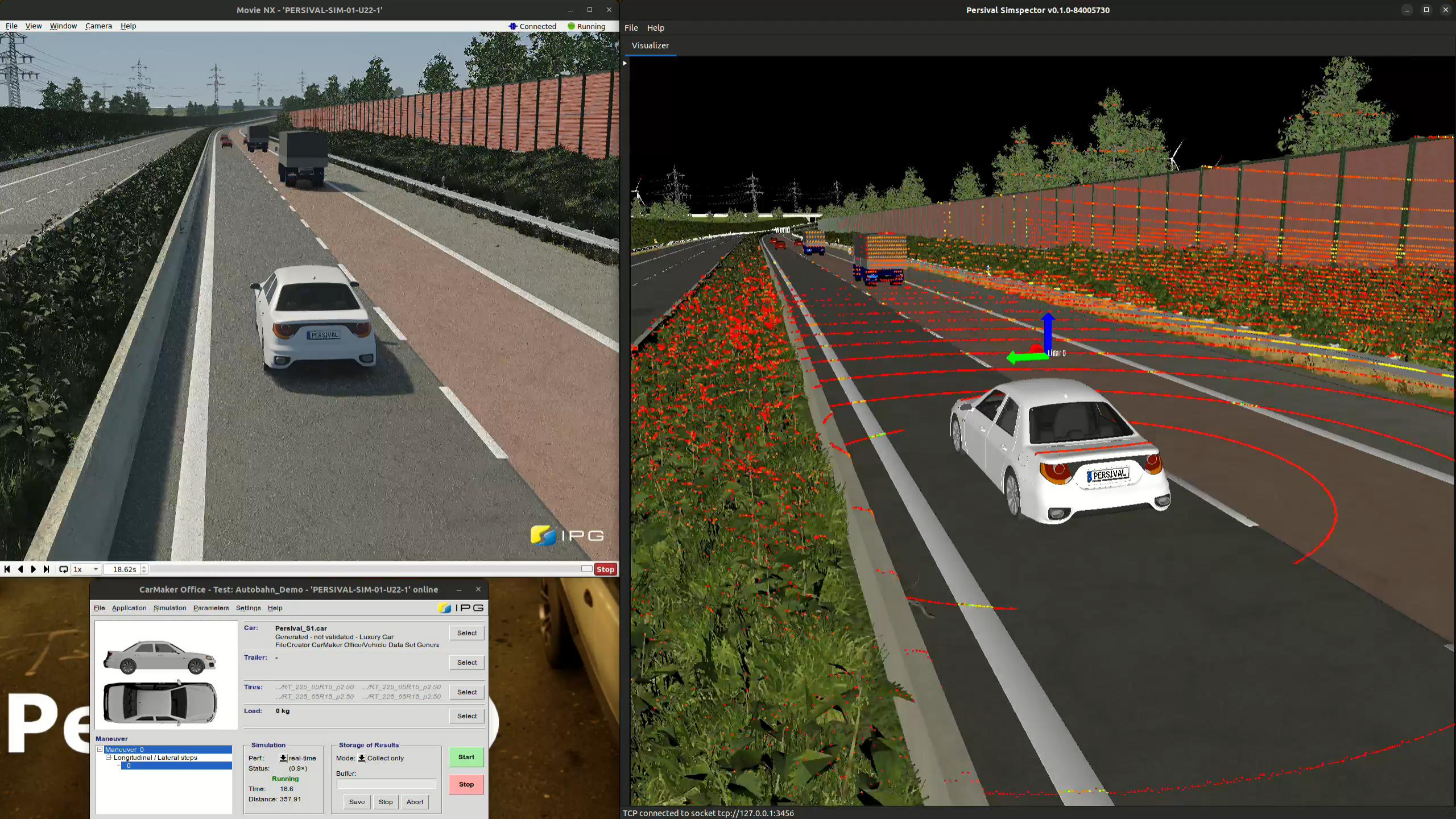
Material Assignment
PBR Materials.
Linked to wavelength dependent physical material properties.

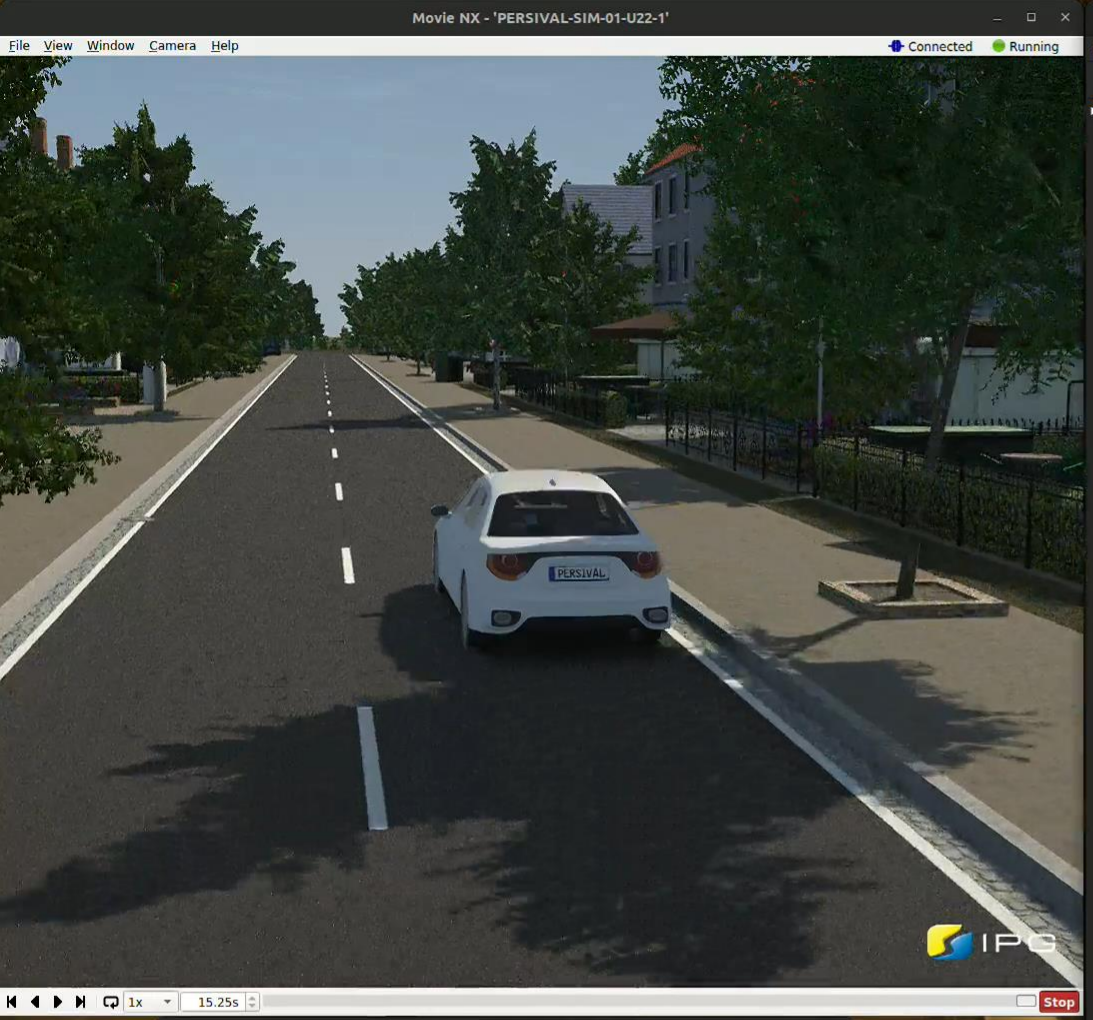
Plausibility Checks
Object dimensions checked with sample measurements on real world objects.

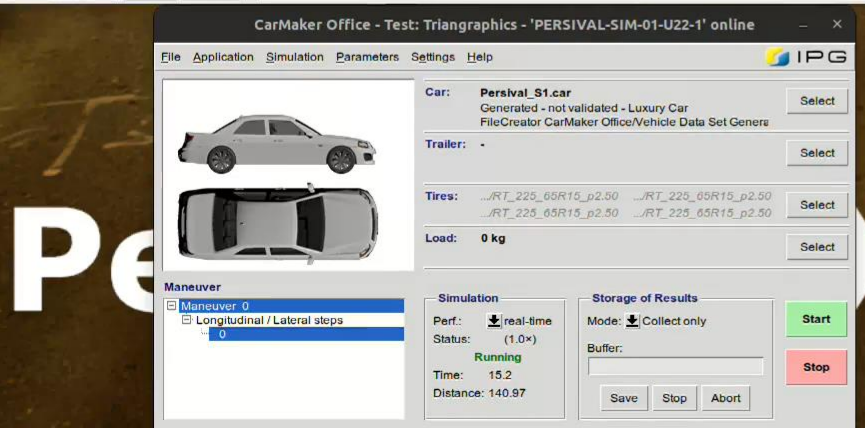





Persival Simspector v0.1.0
File
Help
Visualizer
View
First Person
Track Ball
Track Moving Object
0 (host)
Moving Object ID
Zooming Speed
Visualization
Ambient Light
Light from View Point
Directional Light
Light Color
5.0
Intensity
Color the Scene by
Default
Render point clouds in front of environment
Simulation Data
Coordinate Systems
Stationary Environment
Moving Objects
Show Short Information
Lidar Detection 0
Lidar 0
20240229T104647Z_sd_360_2112_400_OS1-128_Blender_Autobahn.osi
00:00:15:300/00:00:40:000
Trace file loaded


Movie NX - 'PERSIVAL-SIM-01-U22-1'
File View Window Camera Help
Connected
Running
IPG
1x
18.62s
Stop
CarMaker Office - Test: Autobahn_Demo - 'PERSIVAL-SIM-01-U22-1' online
File Application Simulation Parameters Settings Help
Car:
Persival_S1.car
Generated - not validated - Luxury Car
FileCreator CarMaker Office/Vehicle Data Set Genera
Select
Trailer:
-
Tires:
.../RT_225_65R15_p2.50
Load:
0 kg
Maneuver
Maneuver 0
Longitudinal / Lateral steps
0
Simulation
Perf.:
real-time
Status:
(0.9×)
Running
Time:
18.6
Distance:
357.91
Storage of Results
Mode:
Collect only
Buffer:
Save
Stop
Abort
Start
Stop
Persival Simspector v0.1.0-84005730
File Help
Visualizer
lidar0
PERSIVAL
TCP connected to socket tcp://127.0.0.1:3456


Movie NX - 'PERSIVAL-SIM-01-U22-1'
File View Window Camera Help
Connected
Running
PERSIVAL
IPG
1x
15.25s
Stop


CarMaker Office - Test: Triangraphics - 'PERSIVAL-SIM-01-U22-1' online
File Application Simulation Parameters Settings Help
IPG
Car: Persival_S1.car
Generated - not validated - Luxury Car
FileCreator CarMaker Office/Vehicle Data Set Genera
Select
Trailer: -
Tires: .../RT_225_65R15_p2.50 .../RT_225_65R15_p2.50
.../RT_225_65R15_p2.50 .../RT_225_65R15_p2.50
Load: 0 kg
Maneuver
Maneuver 0
Longitudinal / Lateral steps
0
Simulation
Perf.: real-time
Status: (1.0×)
Running
Time: 15.2
Distance: 140.97
Storage of Results
Mode: Collect only
Buffer:
Save
Stop
Abort
Start
Stop


Persival Simspector v0.1.0-84005730
File Help
Visualizer
Lidar 0
PERSIVAL
COCKTAILS
TCP connected to socket tcp://127.0.0.1:3456
Virtual environment by TRIANGRAPHICS
Intelligent Terrain Solutions

Persival

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