

LiDAR simulation toolchain using Ansys ecosystem

DVN LiDAR conference

Fabien Bastide

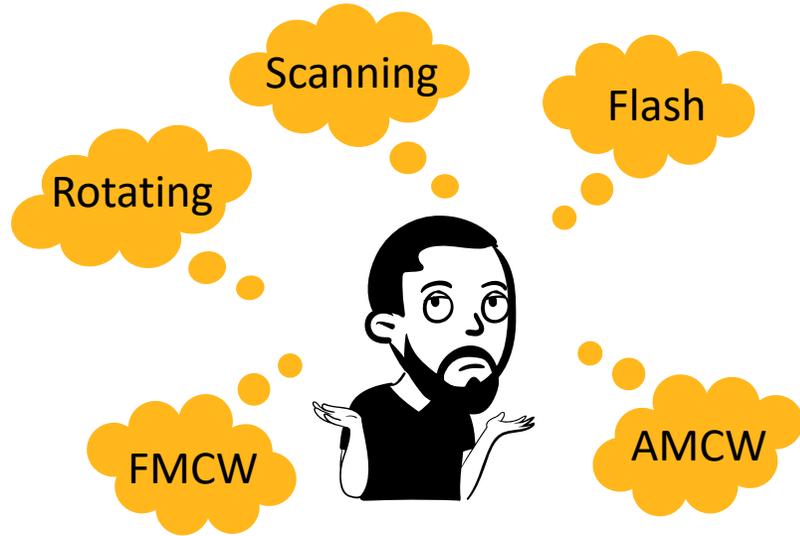
Application Engineering Manager

Optical Camera and LiDAR solution

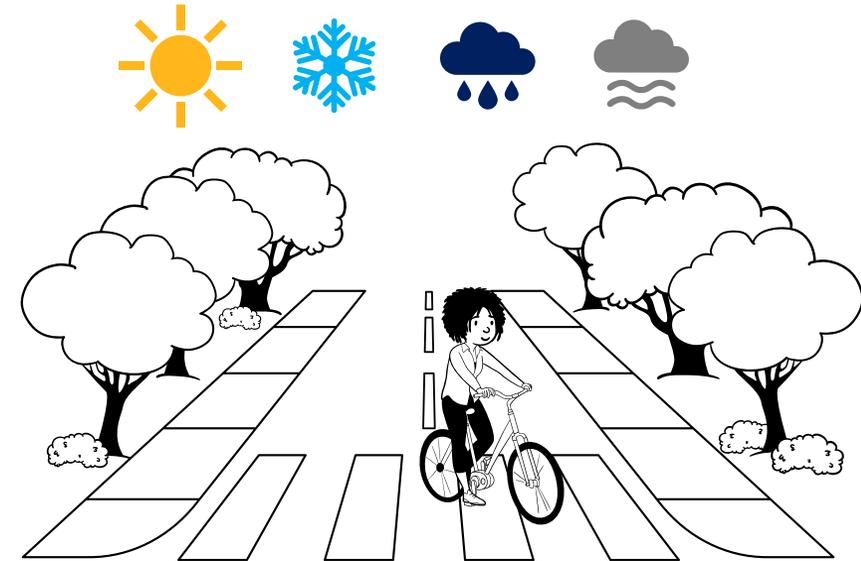


Challenges in LiDAR process: why simulation is important?

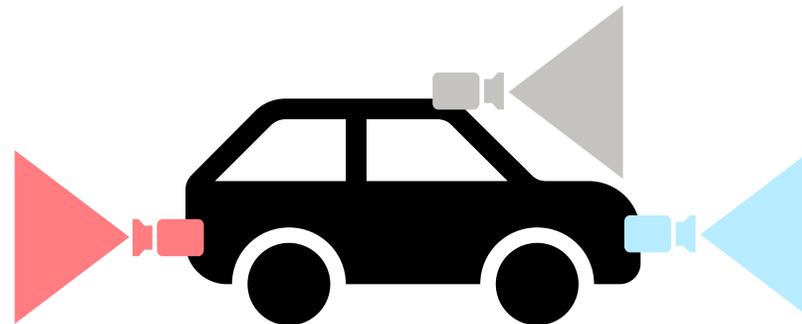
WHICH LiDAR TECHNOLOGY TO CHOOSE?



SCENARII



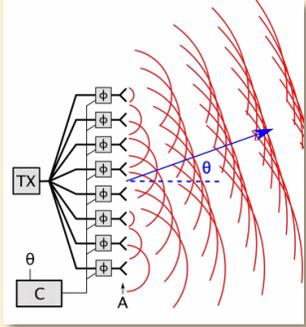
PACKAGING



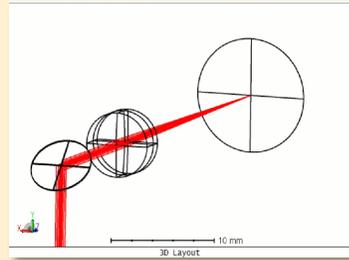
Virtual design Workflow using Ansys tools

LiDAR Hardware Design

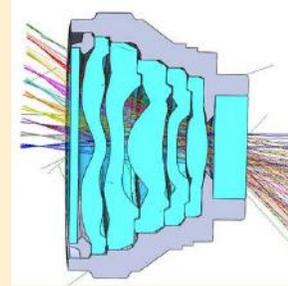
Photonic Design



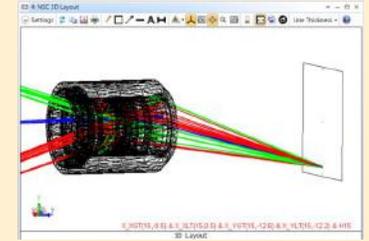
Optical Design Optimization & Tolerancing



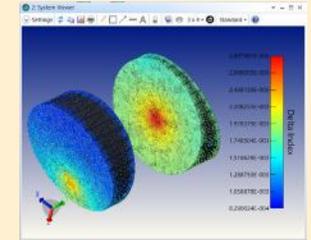
Optomechanical Packaging



Stray Light Analysis

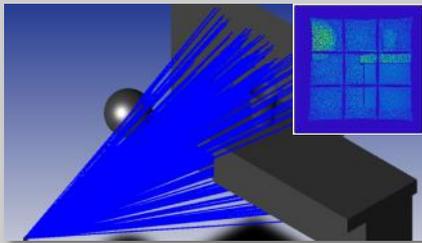


Structural & Thermal Analysis



Simulated System Performance

Time-of-Flight & System Efficiency

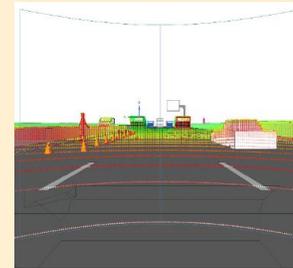


Environment Integration & System Impact



Sensor-to-Vehicle Integration & ADAS

LiDAR-Vehicle Placement Optimization



Advanced Scenario Validation



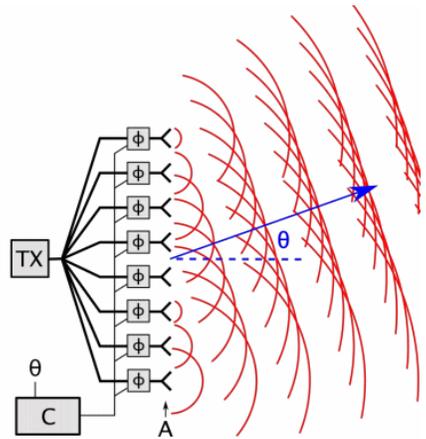
LiDAR Hardware Design

Ansys

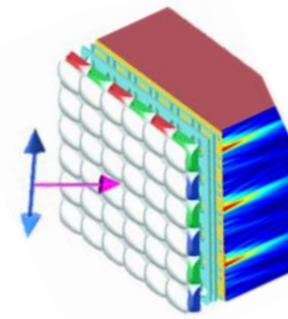
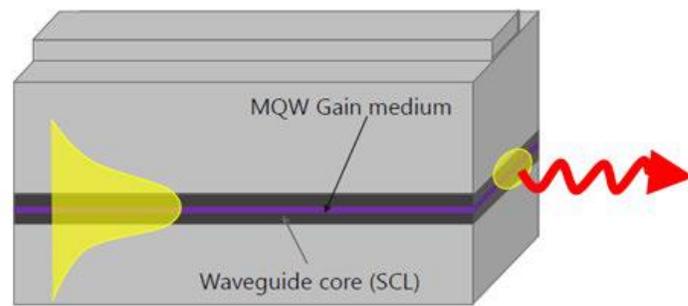
Photonic Design

Design source emission at photonic component level to obtain target emission characteristics

- Beam shape
- Angle of emission
- Export far-field emission as ray sets for ray tracers



Tx



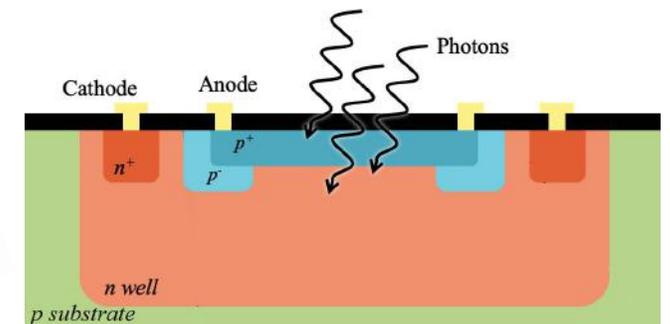
Rx

Design receiver

Photon to Electrons. Transmission, absorption, secondary emission.

Electric field simulation

Avalanche triggering probability calculated from electric field and e-h location



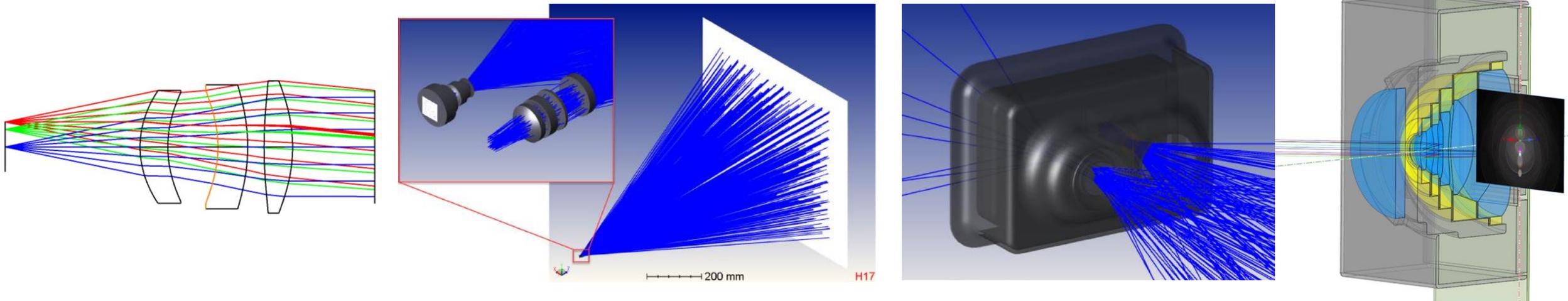
Optical Design & Optomechanical packaging

Optical Design, optimization and tolerancing

- Optical material definition
- Industry standard analysis methods to track system performance
- Optimize for Tx/Rx module criteria

Mechanical housing consideration in the design

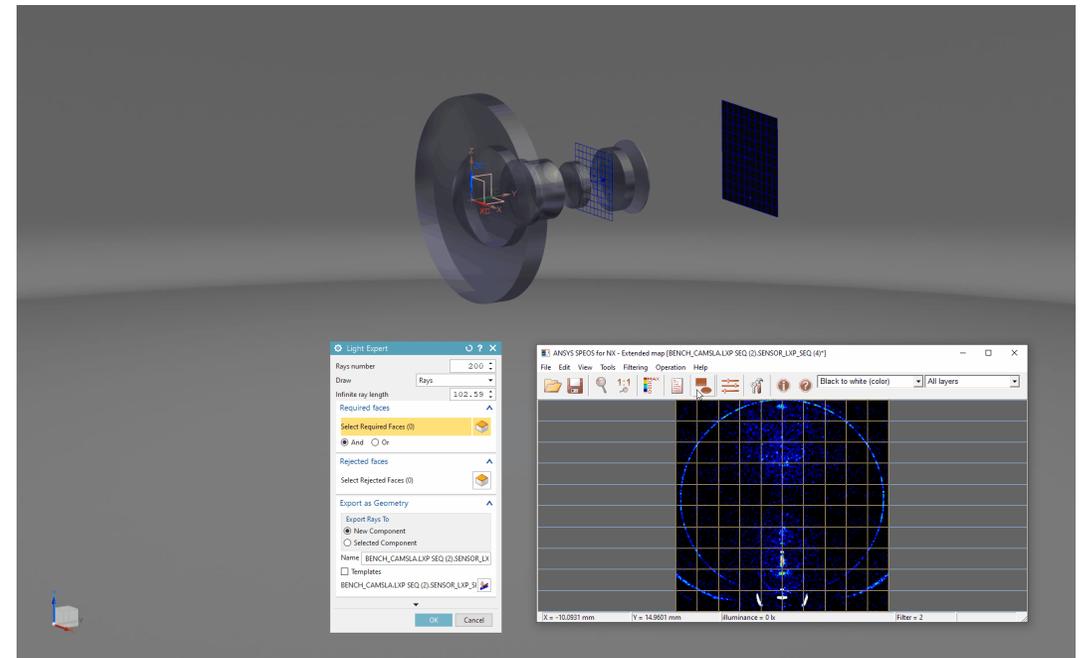
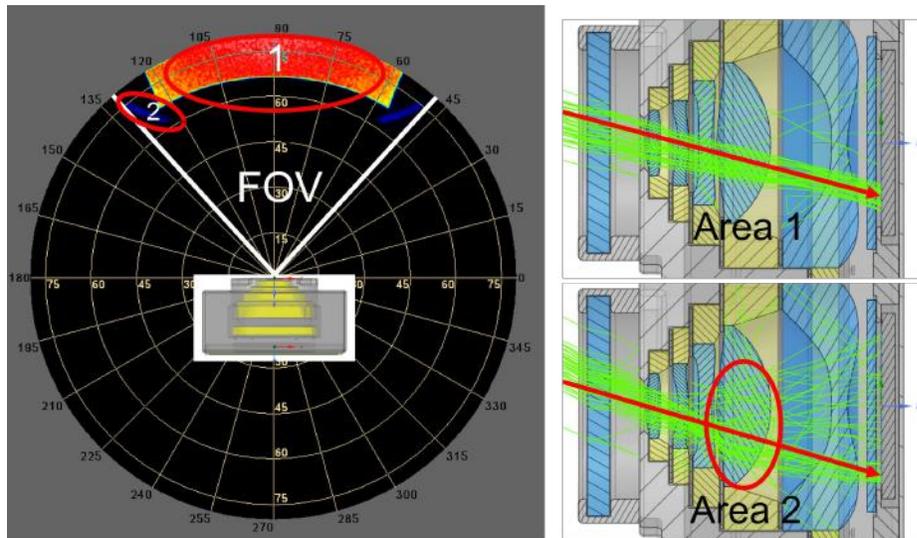
- Seamlessly transition optical design specification to CAD environment
- Incorporate or design mounting structures
- Consider impact of both optical and mechanical components in optical performance metrics



Straylight analysis

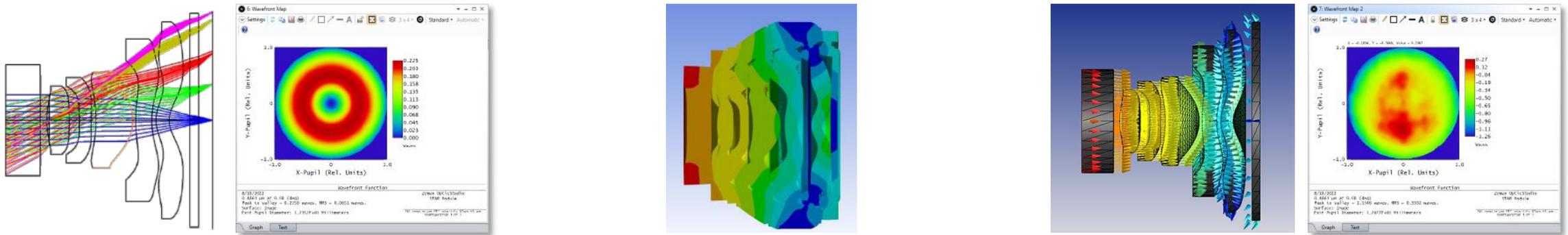
Identify **stray light paths** while considering both optical and mechanical components.

- Visualize specific ray paths with layout tools
- Analyze energy contribution of different paths/sequences
- Separate sequences with layers on sensors
- Quantify the image deterioration contributor

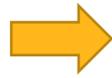


Structural Thermal Optical Performance

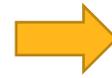
Anticipate the thermal impact on optical performance thanks to a seamless workflow:



 **Optical Simulation
(Nominal)**



 **Thermal &
Structural Analysis**



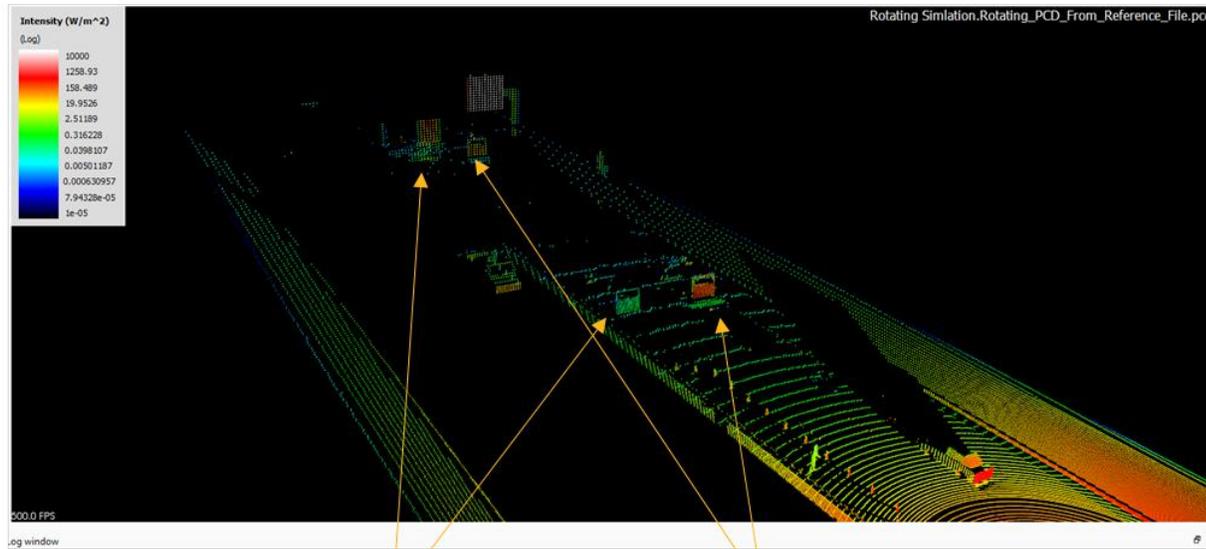
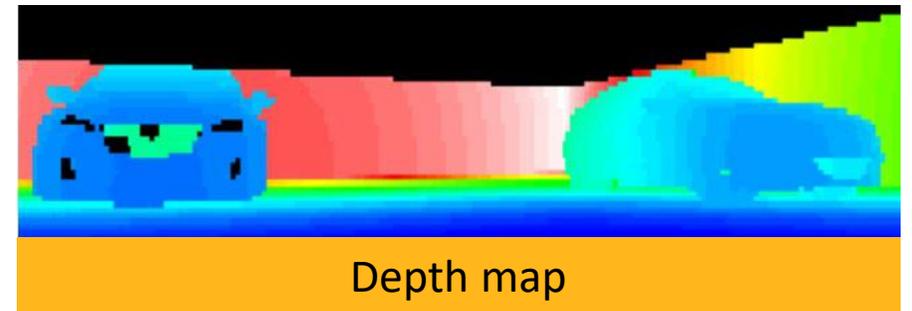
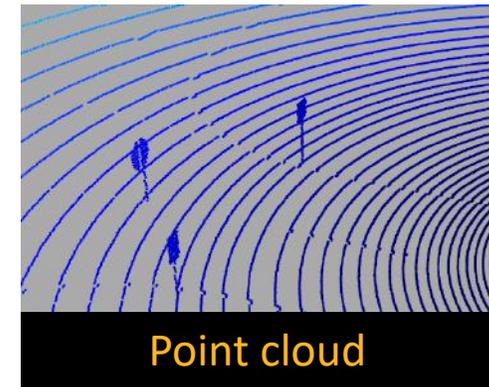
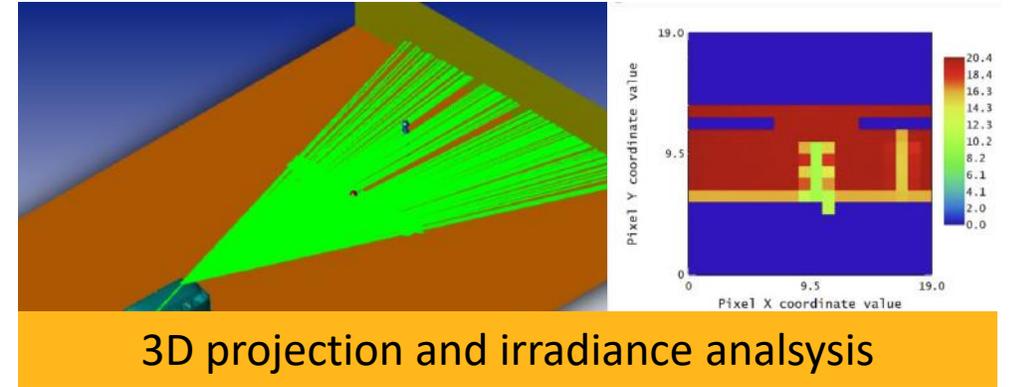
 **Optical simulation
(Degraded)**

Simulated System Performance

Ansys

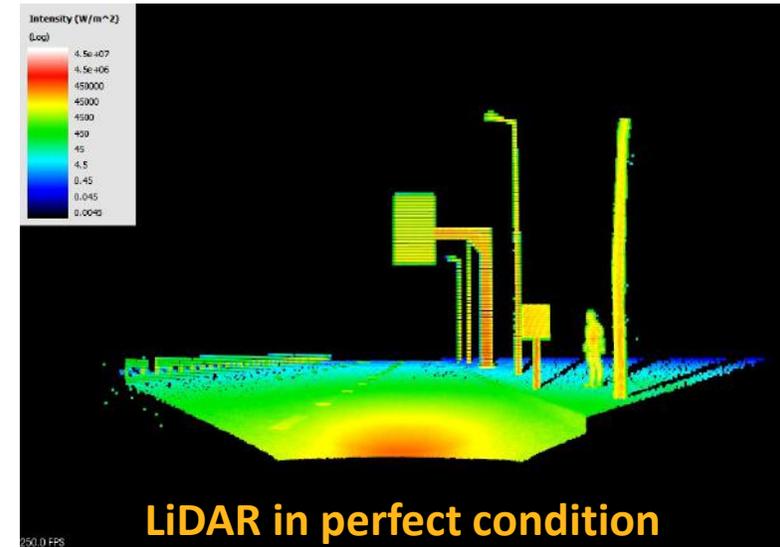
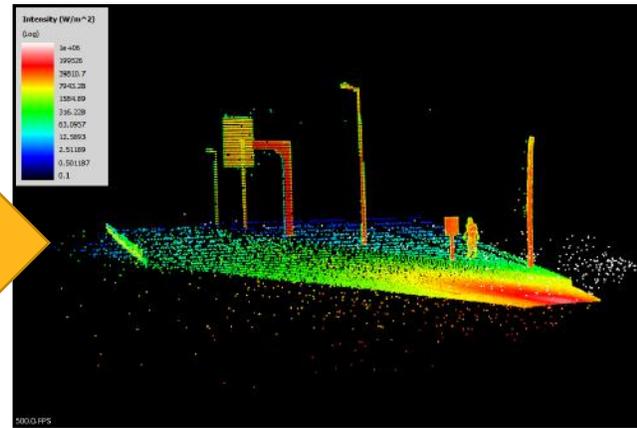
Time-Of-Flight & System Efficiency

- Easily perform comparison studies
- Output **point clouds** representative of lidar model's theoretical hit points on scene
- Using **flexible API** tools, users can customize the analysis for their needs

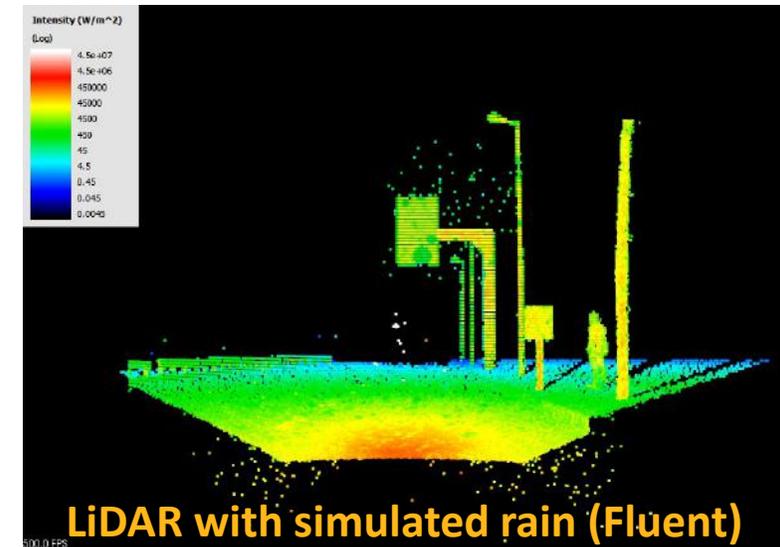


Environment Integration & Effects on LiDAR

- Validate LiDAR deployment in various weather conditions
- Rapid prototype and “what if” scenario testing reduce dependence on physical testing, lowering development cost



LiDAR in perfect condition



LiDAR with simulated rain (Fluent)

Sensor-to-Vehicle Integration & ADAS

Ansys

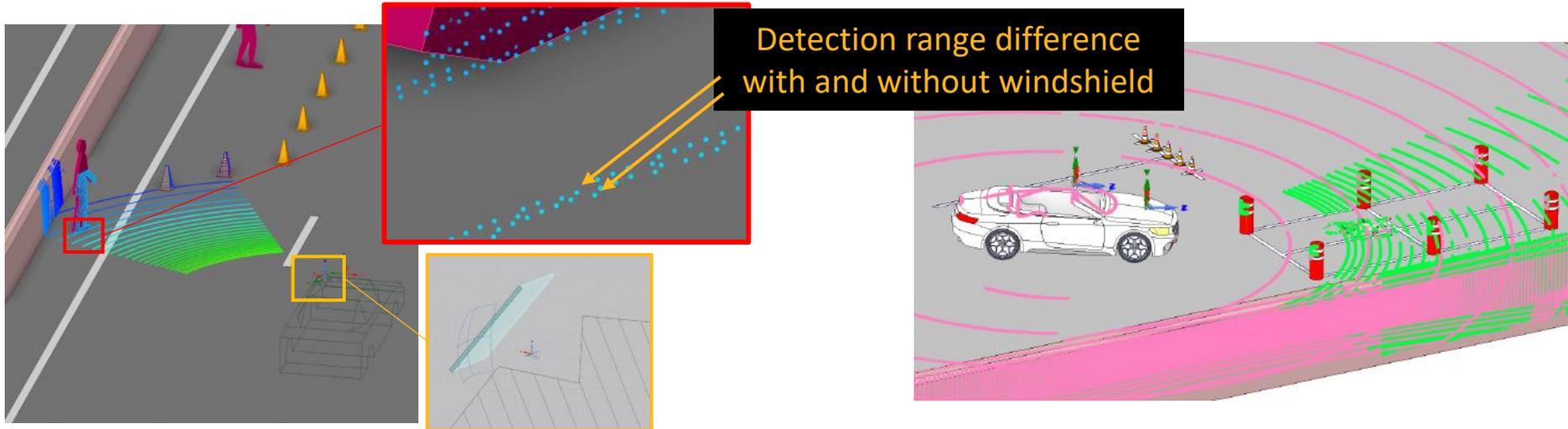
LiDAR Placement and packaging

Easily compare

- Evaluate different type of LiDAR
- Consider different type of integration (headlamp, roof, behind windshield)

Optimal Position

- Avoid occlusions by vehicles and other geometry
- Avoid sensor cross-talk



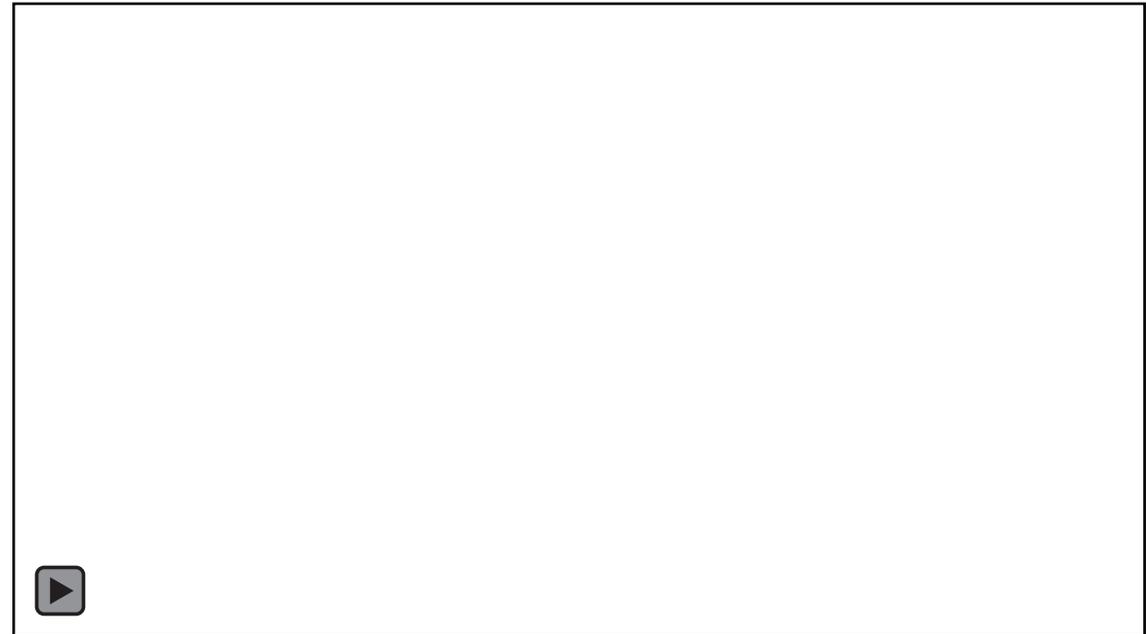
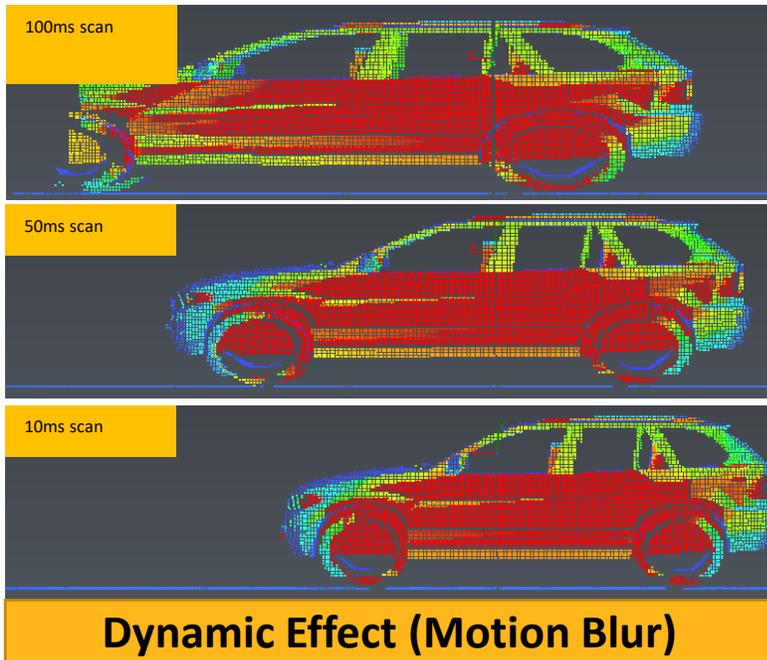
Automatize testing for design validation

- Overlay point cloud and camera images to optimize for **sensor fusion**
- **Scriptable interface** to automate test procedure

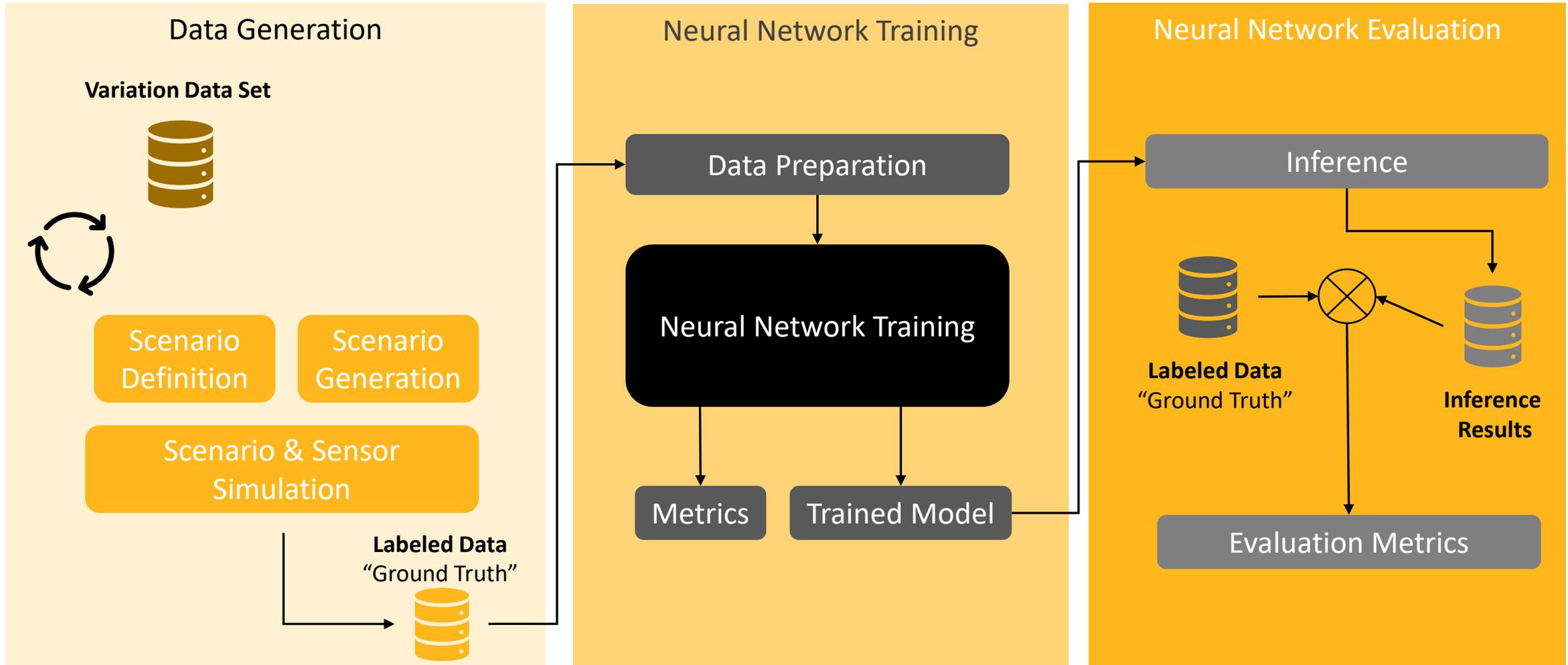
Real-time Physics-Based Ray-Tracing

Connection to Driving Simulator to solve the software development challenges

- Virtual algorithm training and testing.
- System-level performance analysis.
- Perception algorithm optimization.
- System robustness tests.
- Closed-loop simulations.
- SiL, MiL, HiL enablement.
- Safety standards analysis.



Physics Based Lidar as an Enabler for Machine Learning



Take Away: Ansys simulation tool chain for LiDAR systems

LiDAR systems are nowadays developed in many areas, the most popular ones being autonomous driving or consumer electronics space, for several functions, such as **examination**, **detection** or **mapping** of objects.

