EDAG GROUP

ZERO PROTOTYPE LAB
VIRTUAL NIGHTDRIVE

"ADVANTAGES AND CHALLENGES OF REAL-TIME VIRTUAL NIGHT DRIVES WITH UNREAL ENGINE 5 IN EDAG´S ZEROPROTOTYPELAB"

YOUR GLOBAL MOBILITY AND
INDUSTRIAL ENGINEERING EXPERTS

EDAG

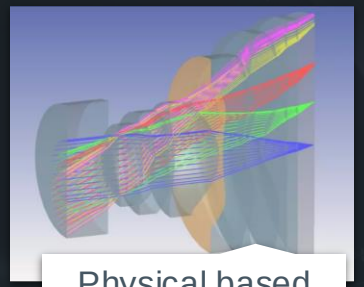
ZERO PROTOTYPE LAB / NIGHT DRIVE
AGENDA

1. MOTIVATION
2. SOLUTION APPROACH
3. ZERO PROTOTYPE LAB
4. CORRELATION BETWEEN OPTICAL SIMULATION AND VIRTUAL WORLD
   - PROBLEMS IN 2025
   - SOLUTIONS IN 2026
5. GENERIC APPROACH FOR BEAM PATTERN ADJUSTMENT IN VIRTUAL WORLD
   - WORKFLOW FOR GENERIC PROJECTIONS
   - VISUALIZATION - IES TO UE5/WORLDSIM
6. SUMMARY & OUTLOOK

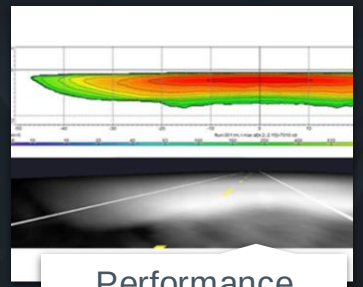
ZERO PROTOTYPE LAB / NIGHT DRIVE
MOTIVATION

OPTICAL SIMULATION

Legal Framework

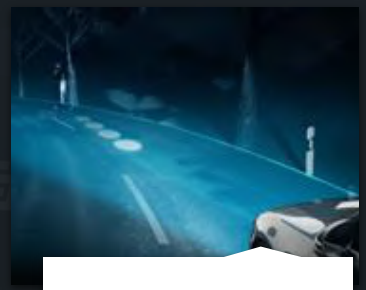


Physical based simulation

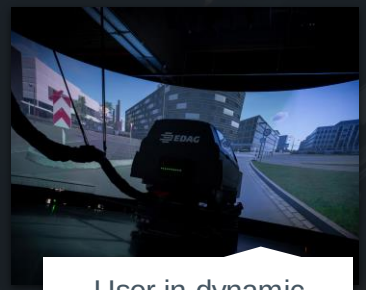


Performance targets

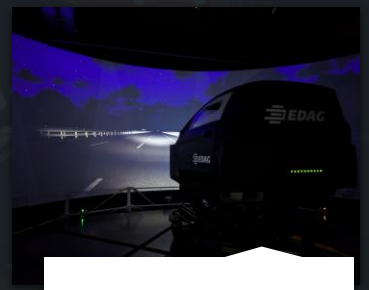
PERCEIVED EXPERIENCE



Functional behaviour

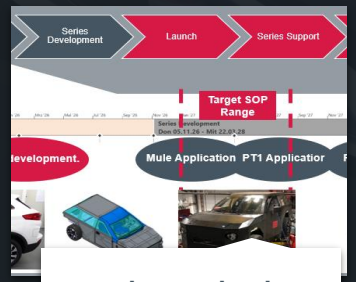


User in dynamic motition

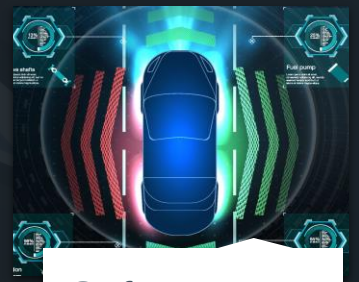


Immersive experience

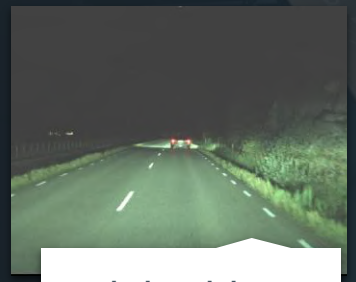
ZPL



Project timing

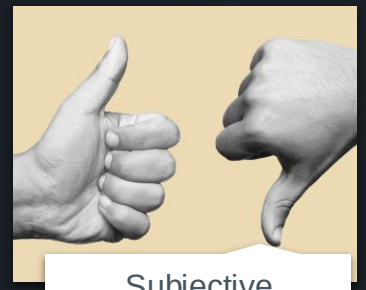


Software I&V



Night drives

Late decisions



Subjective decisions

Shorter project time

HARDWARE BASED VALIDATION

DECISION MAKING

ZERO PROTOTYPE LAB / NIGHT DRIVE
MOTIVATION SUMMARY

PROBLEM:

- LIGHTING SYSTEM DECISIONS ARE NO LONGER BASED ON PHOTOMETRY ALONE
- FUNCTIONAL COMPLEXITY FOR EXTERIOR LIGHTING IS INCREASING

- USER PERCEPTION EMERGES:
  - IN MOTION
  - IN CONTEXT
  - UNDER DYNAMIC DRIVING CONDITIONS

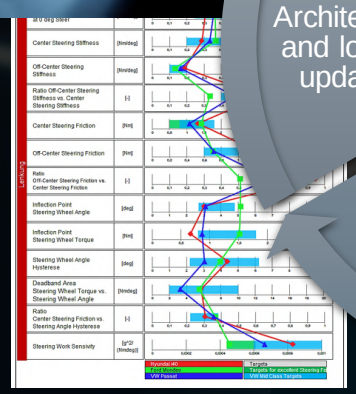
STATUS QUO:

- OPTICAL SIMULATIONS OFFER ACCURACY, BUT LACK EXPERIENTIAL VALIDATION
- VIRTUAL ENVIRONMENTS OFFER IMMERSION, BUT SOMETIMES LACK PHYSICAL CORRELATION

MOTIVATION:

- THE MOTIVATION IS TO CORRELATE BOTH WORLDS
  → ENSURING THAT VIRTUAL NIGHT DRIVES REPRESENT WHAT IS CALCULATED IN OPTICAL SIMULATION

ZERO PROTOTYPE LAB / NIGHT DRIVE
EDAG SOLUTION APPROACH



Software Update

Functional parameter tuning

Functional Update

Mechanical design Update

Hardware Update

Architecture and logical updates

Virtual Development

Benchmark

Mule Application

PT1 Application

PT2 Application

Anfang Mit 01.01.25

Portfolio Don

Jan '25 | Mrz '25 | Jan '27 | Mrz '27 | Mai '27 | Jul '27 | Sep '27 | Nov '27 | Jan '28 | Mrz '28 | Sep '28 | Nov '28

Production Don

Ende Don 28.12.28


EDAG


VI-GRADE

ZERO PROTOTYPE LAB / NIGHT DRIVE
USE CASE OVERVIEW

ZEROPROTOTYPELAB

DEVELOPMENT AND BENCHMARKING FOR BEAM PATTERNS BASED ON IES REAL-TIME RENDERING

GENERIC DEVELOPMENT FOR PROJECTIONS IN MAIN FUNCTIONS USING LUMINOUS MODELER

DEVELOPMENT OF FUNCTIONAL BEHAVIOR FOR MAIN FUNCTIONS:
- LOW BEAM
- HIGH BEAM
- AFS
- ADB

LIGHTLAB

ZERO PROTOTYPE LAB / NIGHT DRIVE
USE CASE 1

ZEROPROTOTYPELAB

DEVELOPMENT AND BENCHMARKING FOR BEAM PATTERNS BASED ON IES REAL-TIME RENDERING

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Correlation between optical simulation and Unreal Engine 5 World Sim to be analyzed and verified

LIGHTLAB

ZERO PROTOTYPE LAB / NIGHT DRIVE
USE CASE 1 - CORRELATION WORKFLOW

Gonio Measurement
- Measurement of reference beam pattern

IES processing
- Preparation of .IES

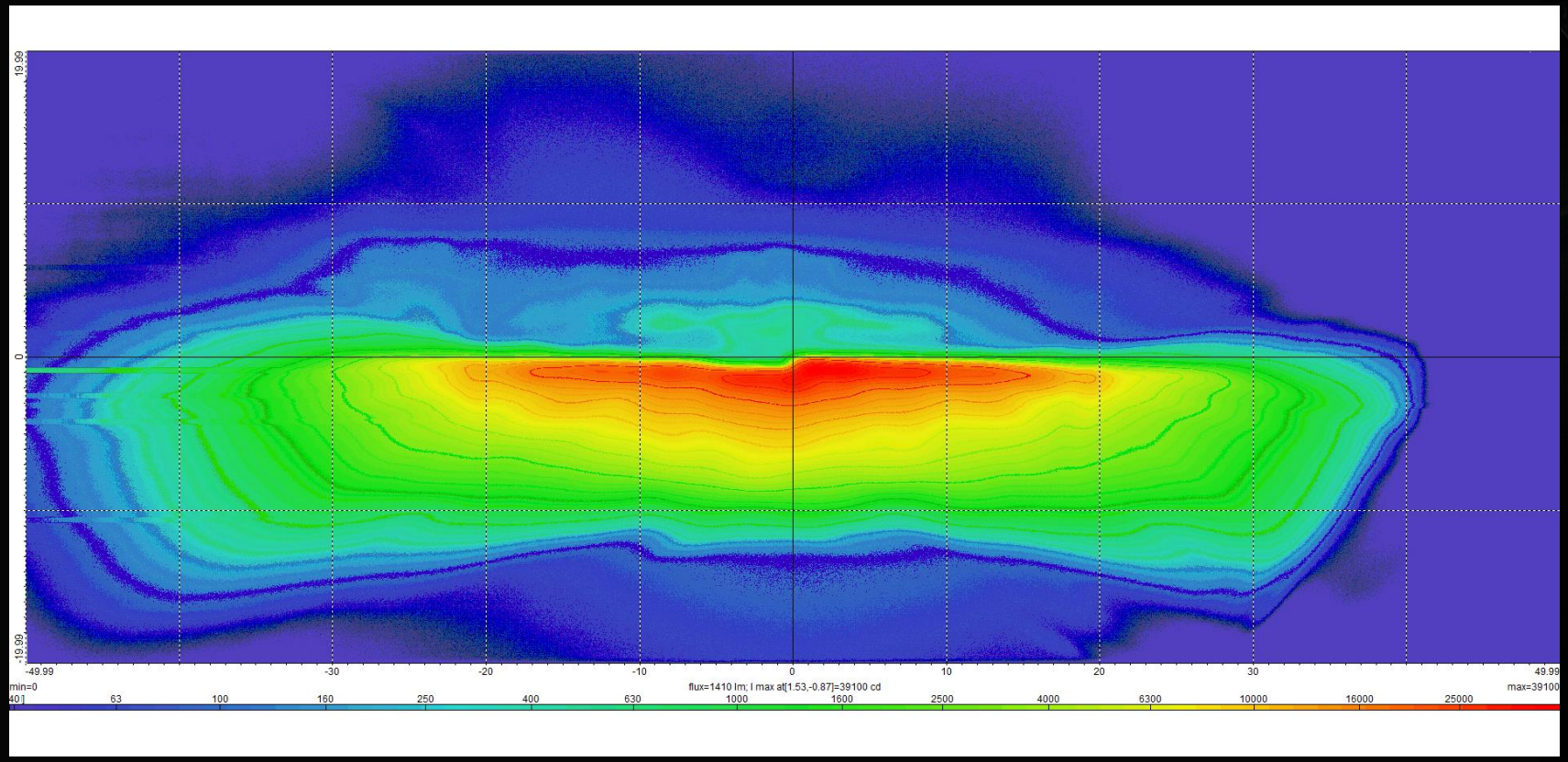
IES Adjustment
- Implement specific artefacts for qualitive correlation check between LS and UE5

Build correlation environment
- 5 meter grid for bird eye view & 10 meter wall in WorldSim

Comparison
- Compare results of optical simulation to UE5 / WorldSim results

ZERO PROTOTYPE LAB / NIGHT DRIVE
USE CASE 2 - PROJECTIONS

Benchmark Measurement in LightLab



ZERO PROTOTYPE LAB / NIGHT DRIVE
USE CASE 1 - CORRELATION

Type 1:

- Creation of reference track with 5m grid
- Checking illumination in H and V or width and distance

→ Left headlight only

Birds Eye View, 5m Grid

Type 2:

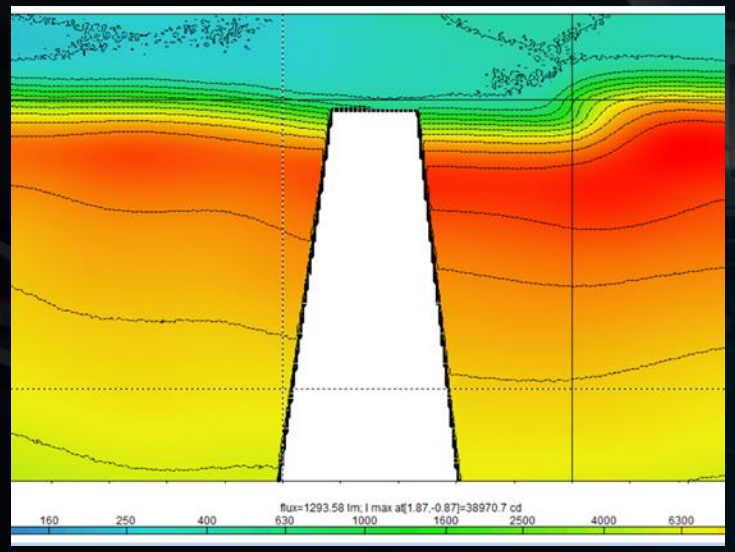
- Creation of reference with reflection surface at a distance of 10m
- Checking the illumination and evaluating the light-dark boundary in terms of correct representation

→ Left headlight only

POV 10m wall

ZERO PROTOTYPE LAB / NIGHT DRIVE
USE CASE 1 - CORRELATION

- Generation of artifacts/inhomogeneities in the reference light distribution for evaluation of the display in UnrealEngine5 (reference = ies file)
- CAD > LucidShape > Roadrunner (create scenario) > **VI World Sim (ZPL – DeskSim)**

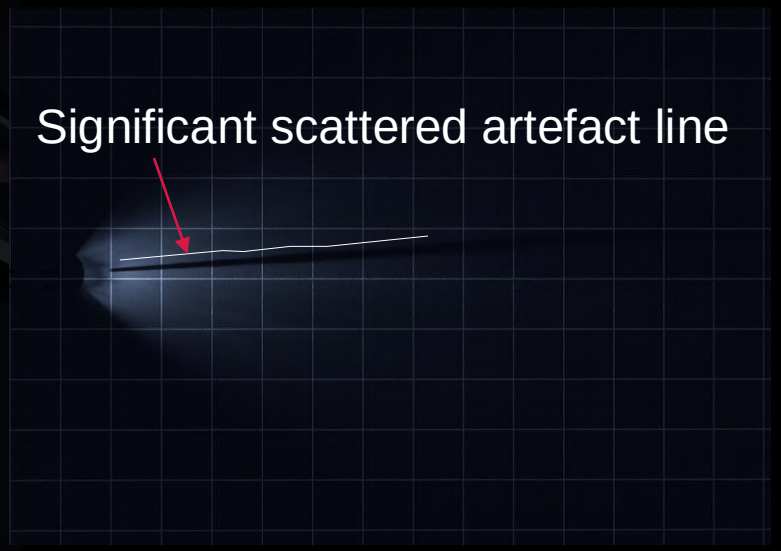


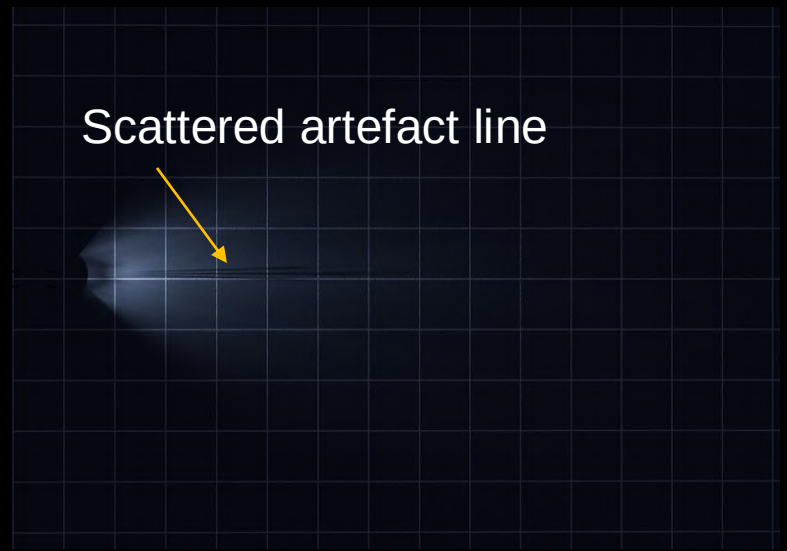
Lucid Shape Masking Zoom

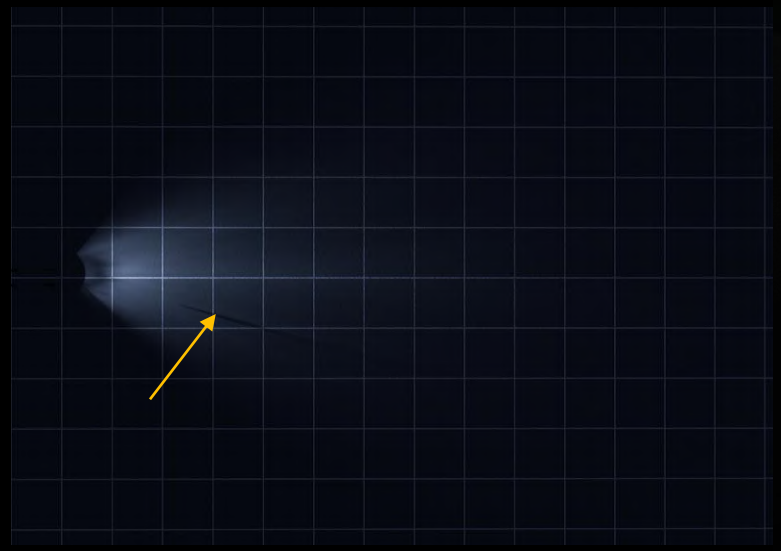
Delta: 0,02
90MB File

Simulation VI World Sim, 10m

ZERO PROTOTYPE LAB / NIGHT DRIVE
USE CASE 1 - CORRELATION







ISSUE:

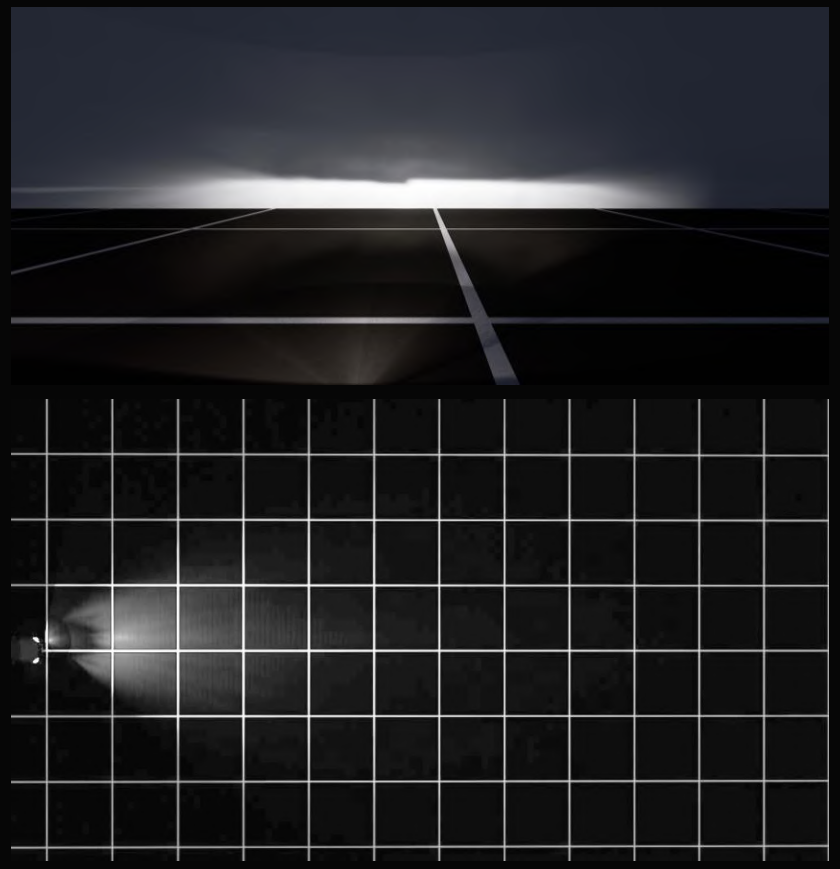
Compression rate for real time visualization in WorldSim / UE5

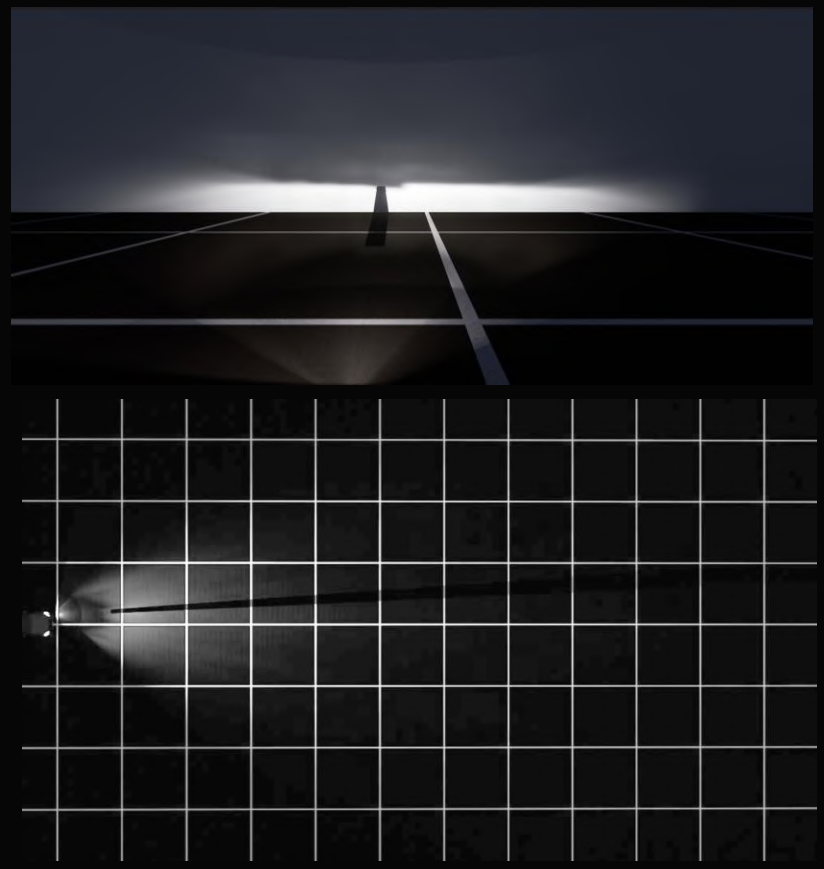
SOLUTION:

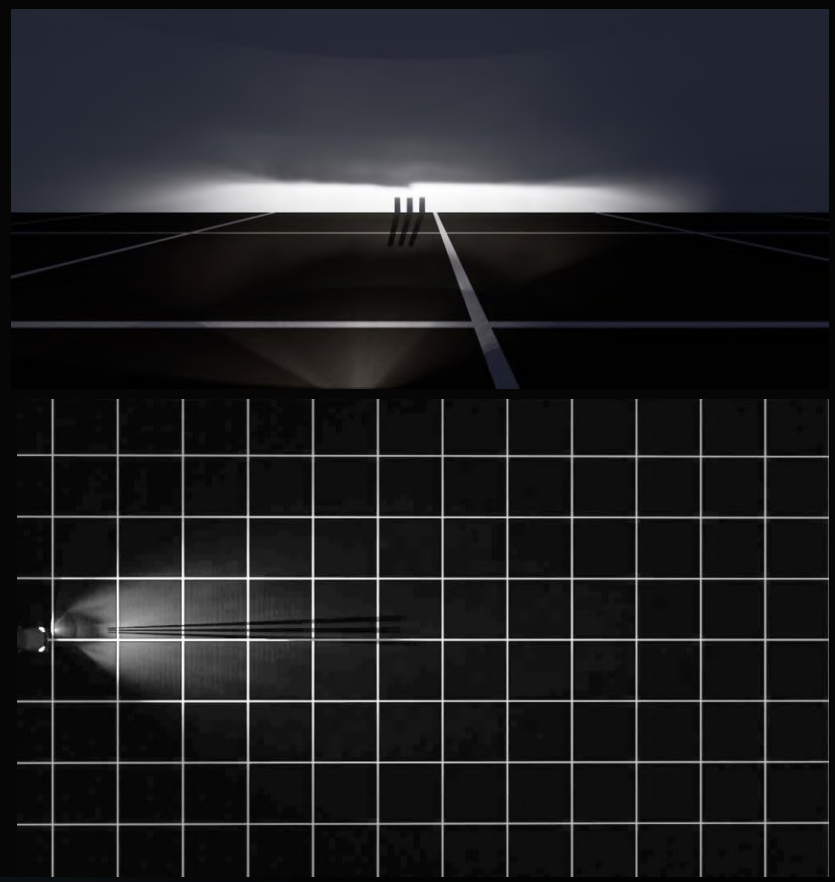
Adjust compression rate and real time operation performance

ZERO PROTOTYPE LAB / NIGHT DRIVE
USE CASE 1 - CORRELATION

Adjust compression rate and real time operation performance

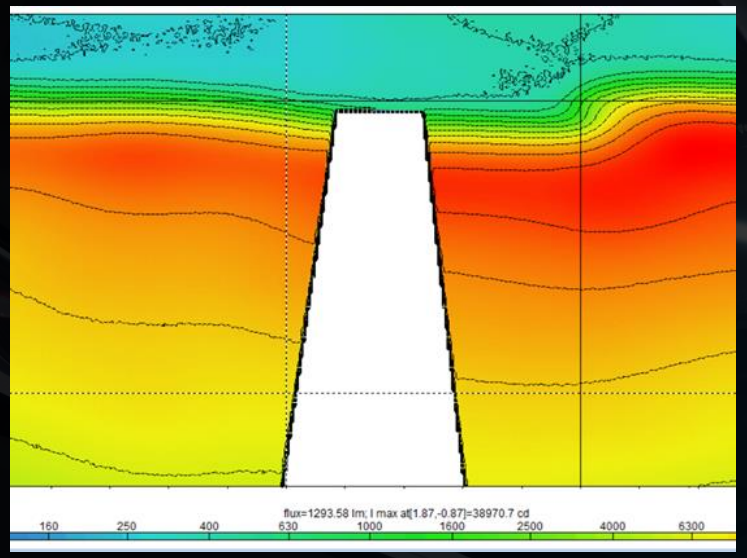






ZERO PROTOTYPE LAB / NIGHT DRIVE
USE CASE 1 - CORRELATION

Display of artefacts in Unreal Engine 5 has been optimized to an acceptable level in real – time operation



Lucid Shape Masking Zoom

Delta: 0,02
90MB File

Updated Status

Old Status

ZERO PROTOTYPE LAB / NIGHT DRIVE
USE CASE 2

ZEROPROTOTYPELAB

DEVELOPMENT AND BENCHMARKING FOR BEAM PATTERNS BASED ON IES REAL-TIME RENDERING

GENERIC DEVELOPMENT FOR PROJECTIONS IN MAIN FUNCTIONS USING LUMINOUS MODELER

DEVELOPMENT OF FUNCTIONAL BEHAVIOR FOR MAIN FUNCTIONS:
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- HIGH BEAM
- AFS / ADB

SIL / Mathlab Interface

Correlation between optical simulation and Unreal Engine 5 World Sim to be analyzed and verified

LIGHTLAB

ZERO PROTOTYPE LAB / NIGHT DRIVE
USE CASE 2 - PROJECTIONS

Why do we need projections in exterior lighting ?

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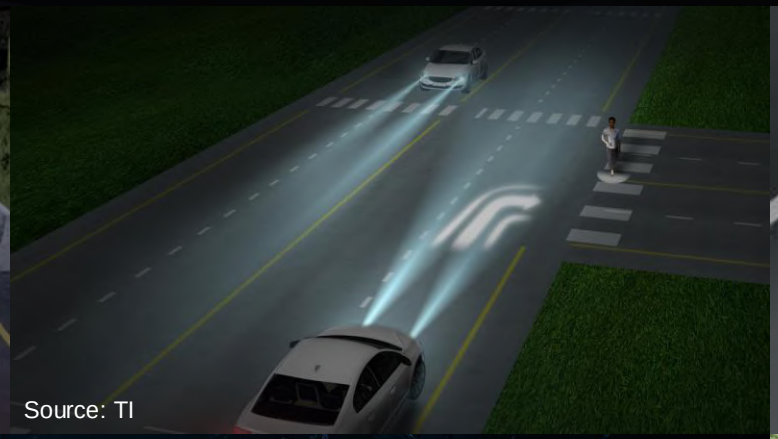
USE CASE 2 - PROJECTIONS

Status Quo: Exterior lighting projections


Source: TI


Source: TI

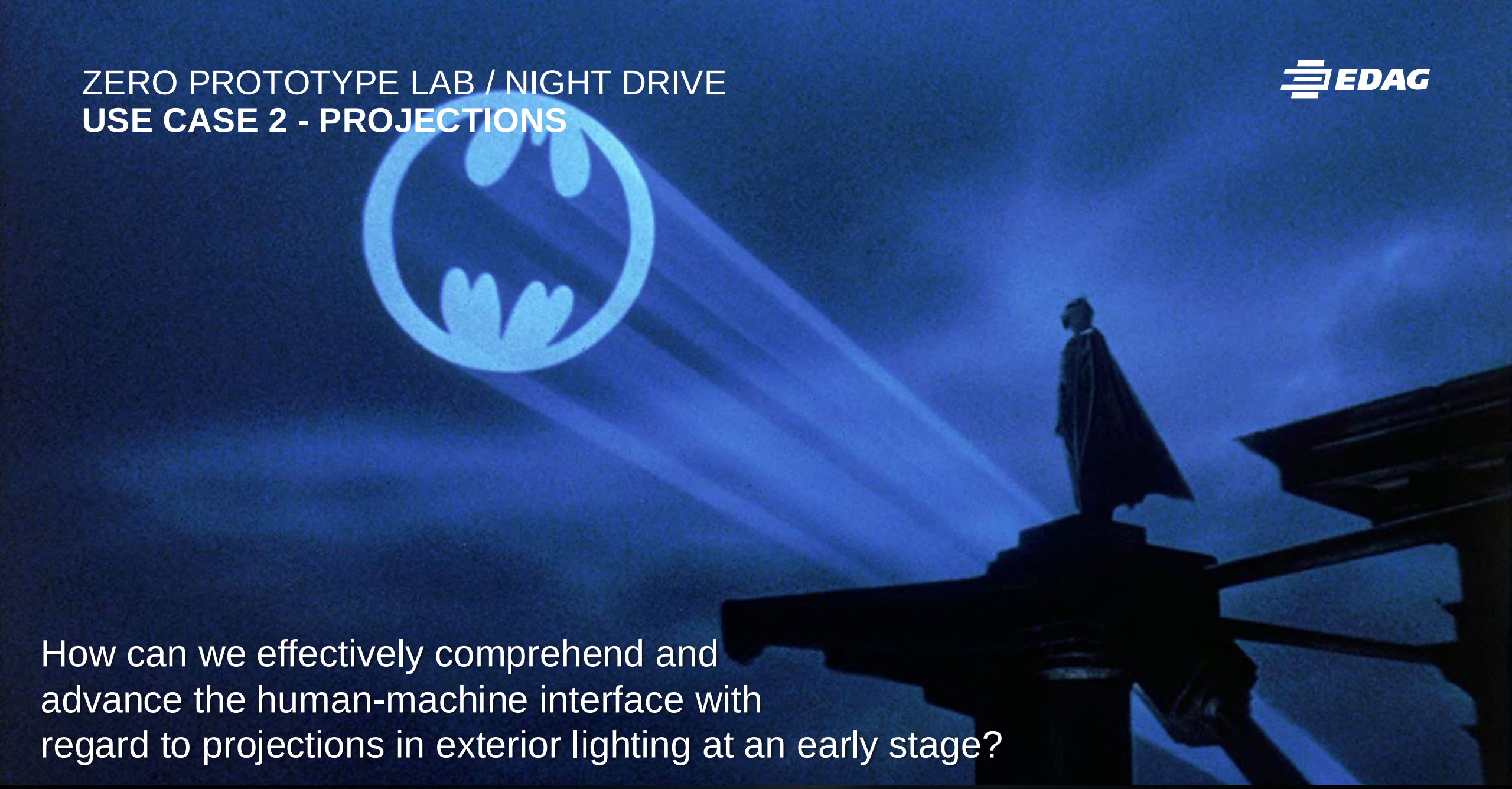

Source: TI


Source: Mercedes


Source: Mercedes


Source: Audi

ZERO PROTOTYPE LAB / NIGHT DRIVE
USE CASE 2 - PROJECTIONS



How can we effectively comprehend and advance the human-machine interface with regard to projections in exterior lighting at an early stage?

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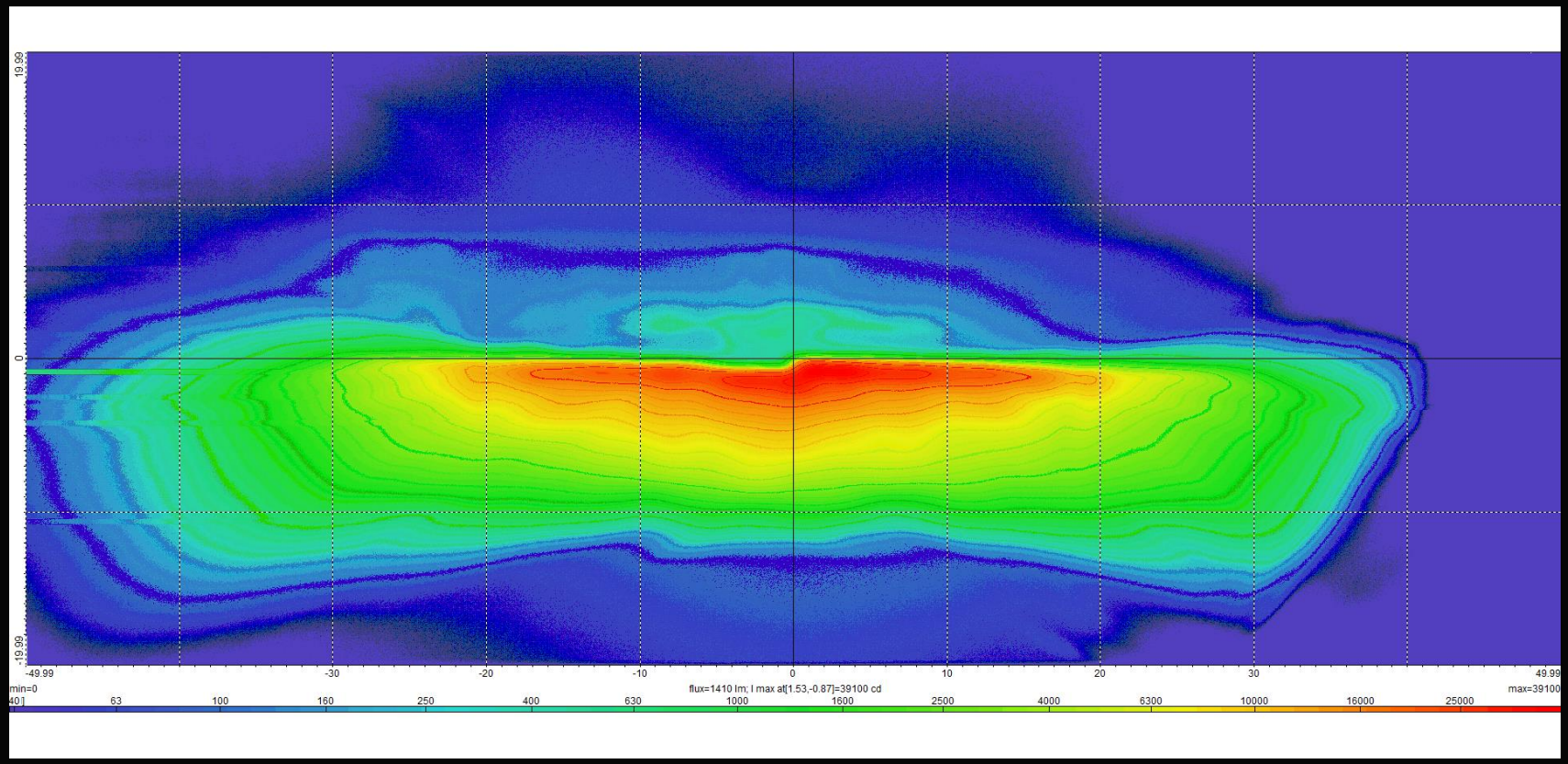
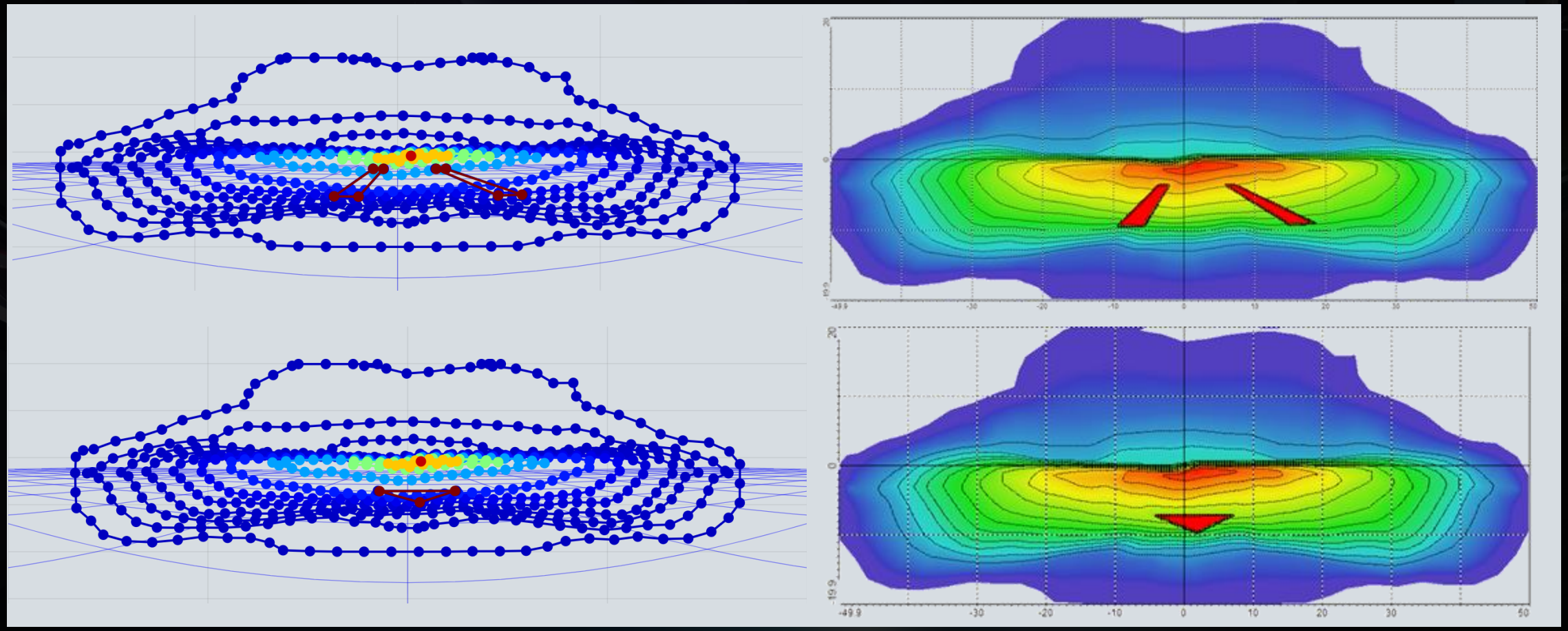
USE CASE 2 - PROJECTIONS

Reference IES | Luminous Algorithms | IES Import



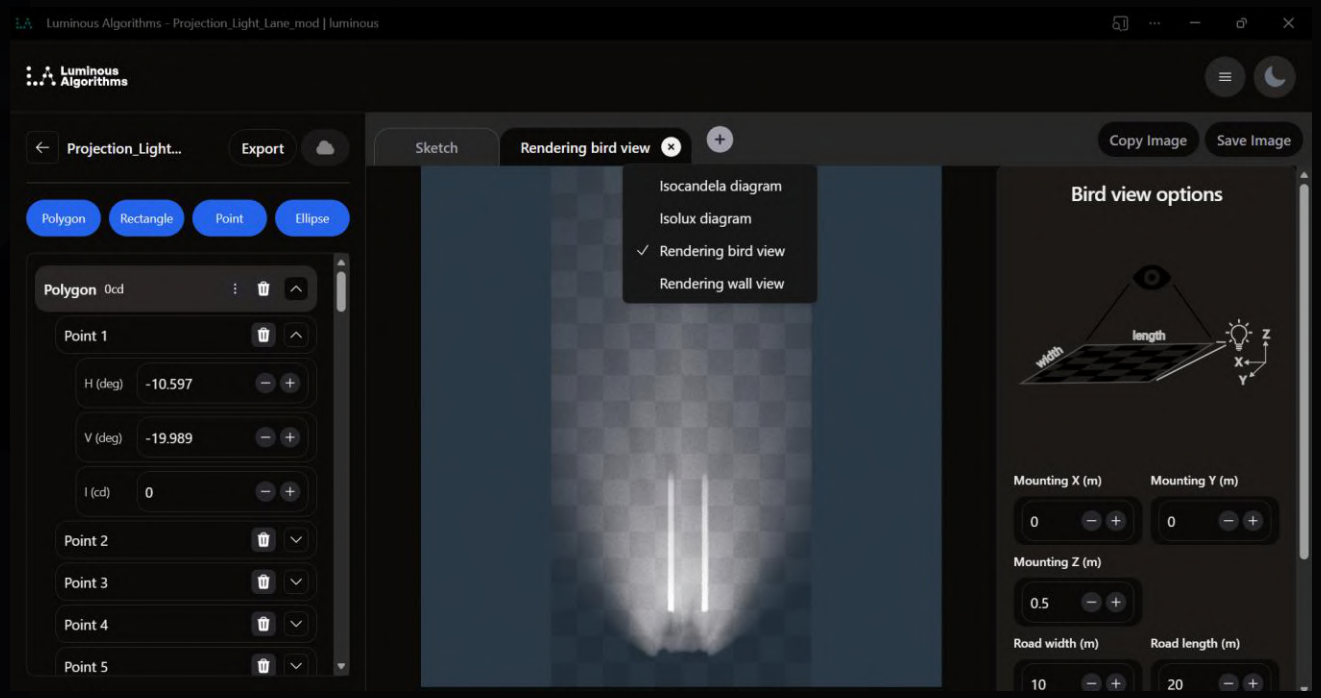
ZERO PROTOTYPE LAB / NIGHT DRIVE
USE CASE 2 - PROJECTION SYSTEMS

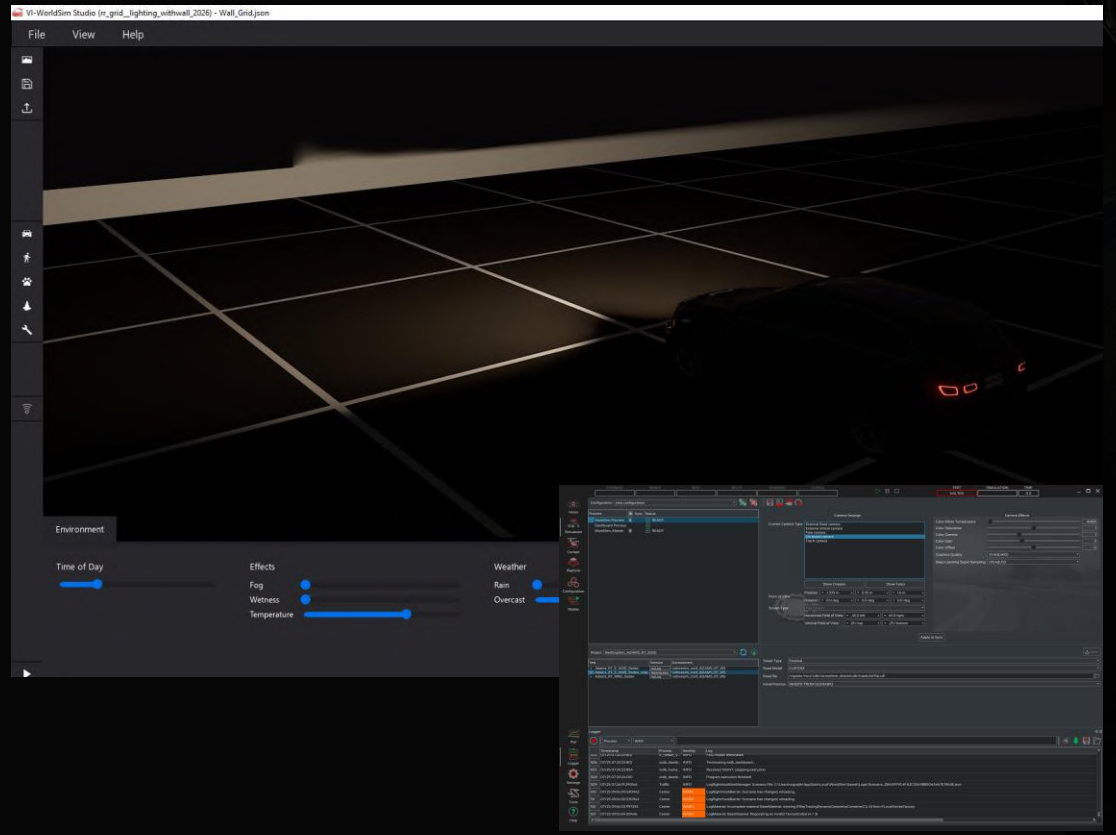
Luminous Algorithms | IES Import | WorldSim / UE5



ZERO PROTOTYPE LAB / NIGHT DRIVE
USE CASE 2 - PROJECTION SYSTEMS

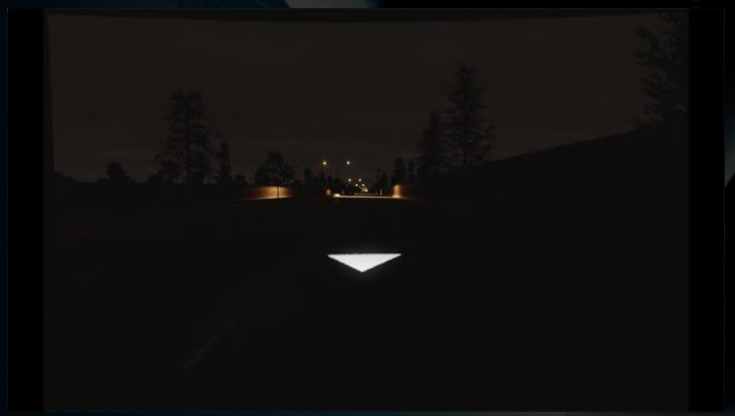
Luminous Algorithms | IES Import | WorldSim / Unreal Engine 5





ZERO PROTOTYPE LAB / NIGHT DRIVE
USE CASE 2 - PROJECTION SYSTEMS

Luminous Algorithm | IES Import | WorldSim / Unreal Engine 5



ZERO PROTOTYPE LAB / NIGHT DRIVE
SUMMARY & OUTLOOK

Summary:

- The objective was to validate a UE5-based real-time simulation for night driving and exterior lighting assessment
- A robust correlation between optical simulation (IES-based) and Unreal Engine / WorldSim visualization was successfully demonstrated
- Identified artefacts were mainly caused by real-time compression effects and were significantly reduced by optimized compression settings
- The Zero Prototype Lab enables early, perception-based lighting decisions without physical prototypes

Outlook:

- Further validation using LMK measurements and expert/user evaluations is planned
- Extension of the approach to adaptive lighting functions
- Extending functional development possiblites by using existing Mathlab Simulink logic including SIL interface

THANK YOU!