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E8371

Simulating Lighting Conditions in Production Ergonomics with NVIDIA OptiX

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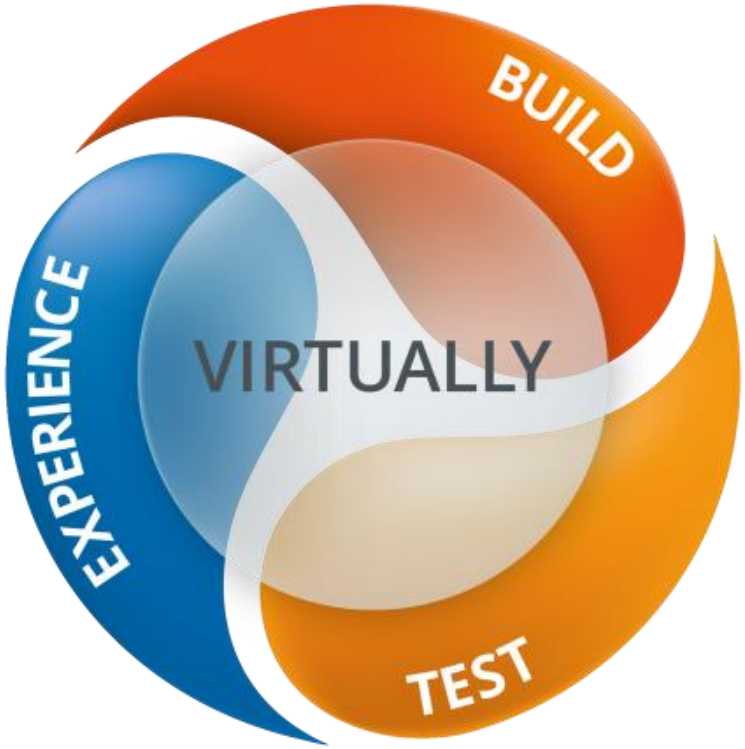
AGENDA

- Introduction
- Helios Rendering Architecture
- OptiX Backend
- AI Denoising
- Ray Tracing on HMDs
- Example Applications
- Demo

INTRODUCTION



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Introduction

Production Ergonomics

- Ergonomics important aspect of
  - Manufacturing systems
  - Maintenance procedures
- Visibility under real world lighting conditions
  - Affects efficiency of human operators
- Need to simulate light propagation
  - Monte-Carlo path tracing
  - GPU accelerated

HELIOS RENDERING ARCHITECTURE

Helios Rendering Architecture

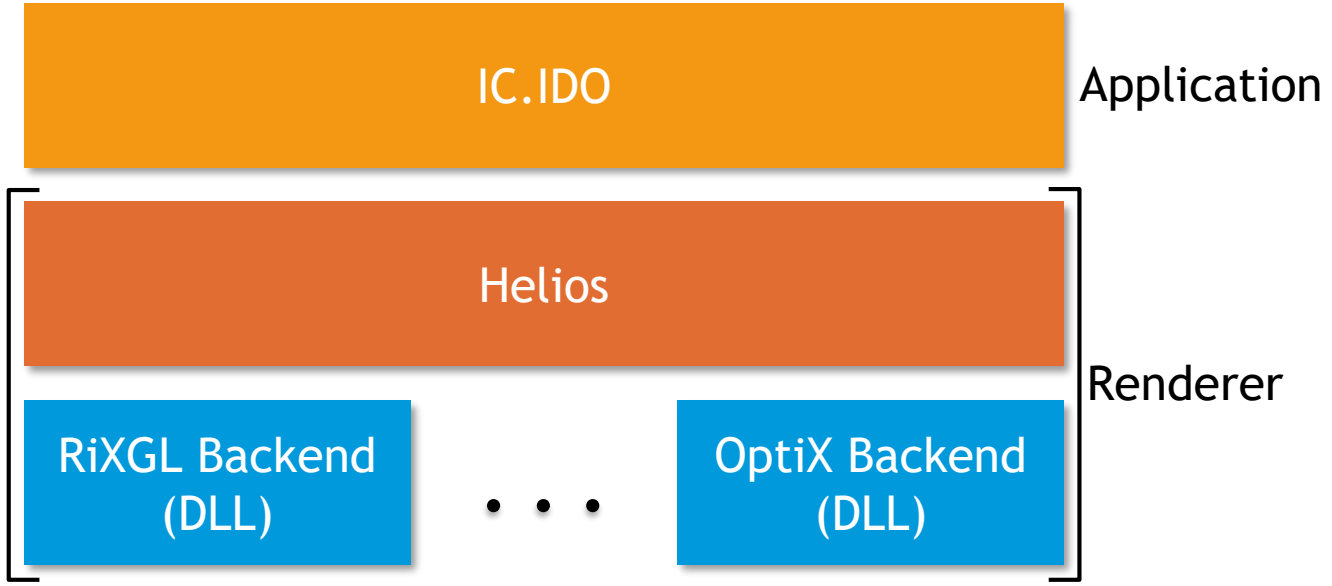
Requirements

- Lightweight
  - Not a full-blown scene graph, let application handle this
  - Replicate as few data as possible
- High performance
  - Exploit specific/low-level GPU features
  - Must be able to get close to the metal
- Extensible
  - Leverage external rendering frameworks, such a NVIDIA RiX or OptiX
- Support for various rendering algorithms
  - Rasterization, ray tracing, hybrid modes
  - CAD rendering, photo-realistic rendering, scientific visualization, …

Helios Rendering Architecture

Overview

- Helios renderer supports a variety of rendering technologies
- Encapsulated in Backends, e.g.,
  - RiXGL: rasterization
  - OptiX: ray tracing
- Backends as dynamic libraries (DLLs)
  - Loaded and unloaded at runtime
  - Can be switched arbitrarily
- Helios controls render graph, e.g.,
  - Hybrid rendering
  - Frame composition



OPTIX BACKEND

Helios OptiX Backend

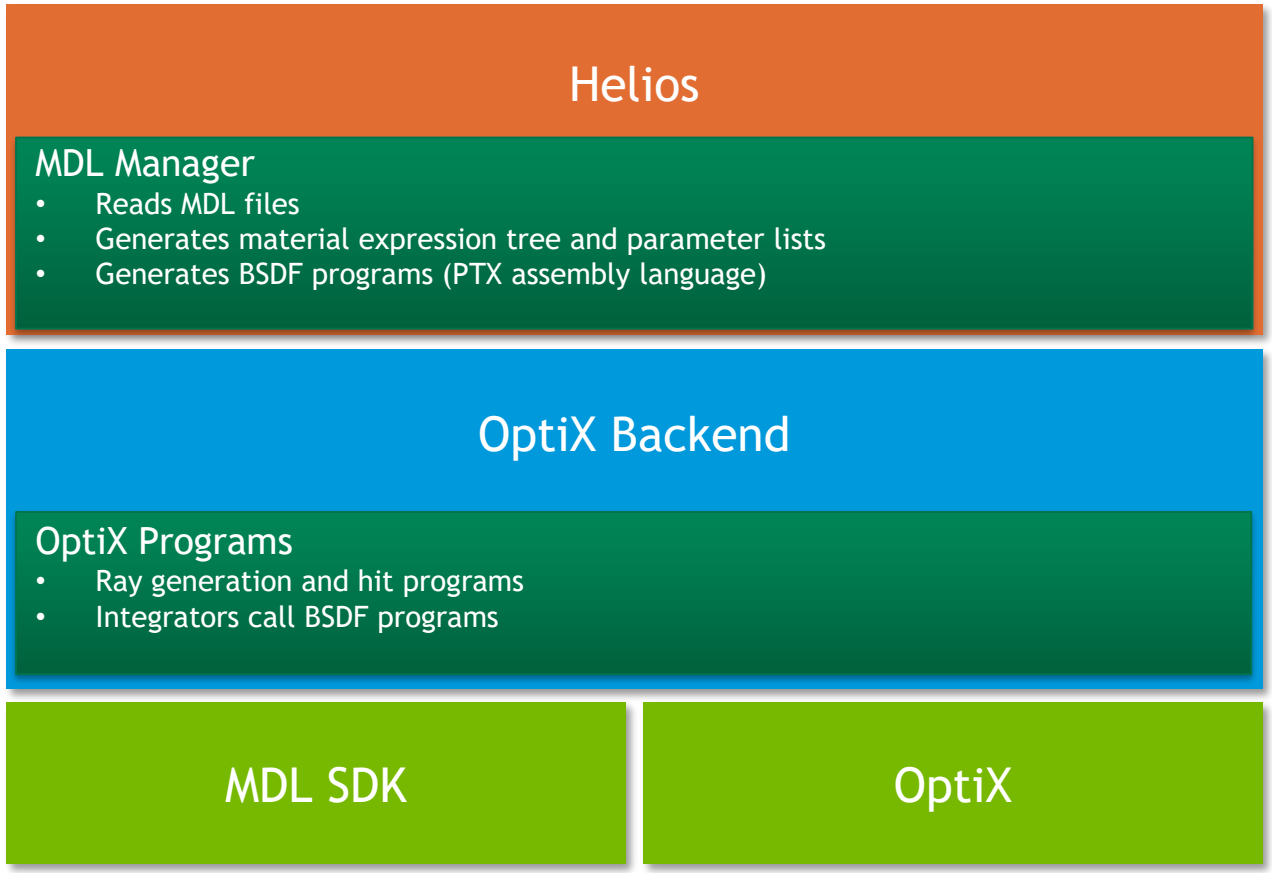
Overview

- Based on NVIDIA OptiX:
  - Programmable GPU ray tracing pipeline
  - Single-ray programming model using C++
  - AI accelerated rendering

- Implements a range of physically based rendering algorithms
  - Whitted ray tracing, Ambient Occlusion, Global Illumination
  - Generates precomputed lighting data (e.g., texture baking)
  - Separation of BSDF and integrator code (surface shading / light transport)
  - Supports Material Definition Language (MDL)

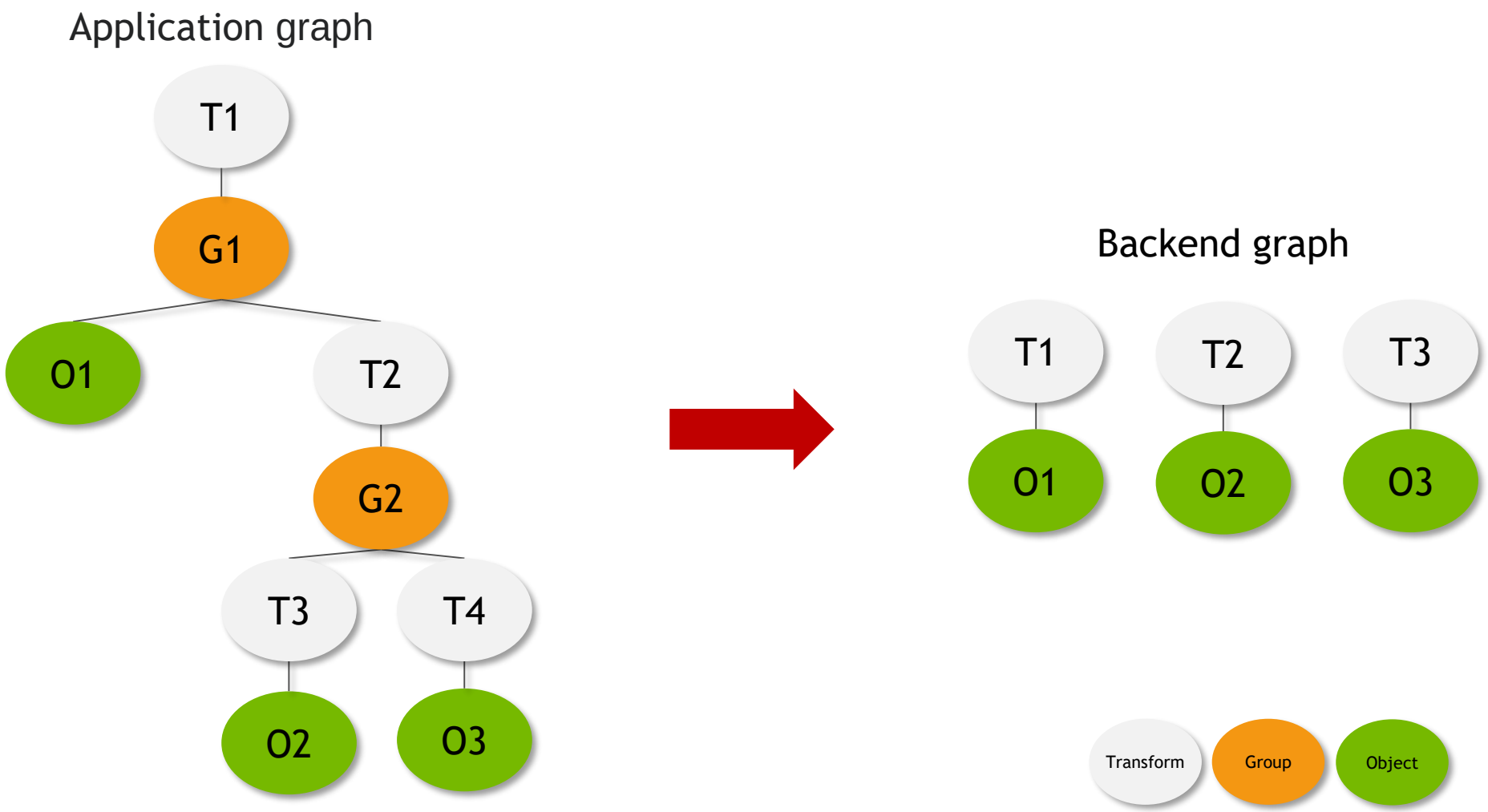
Helios OptiX Backend

Overview



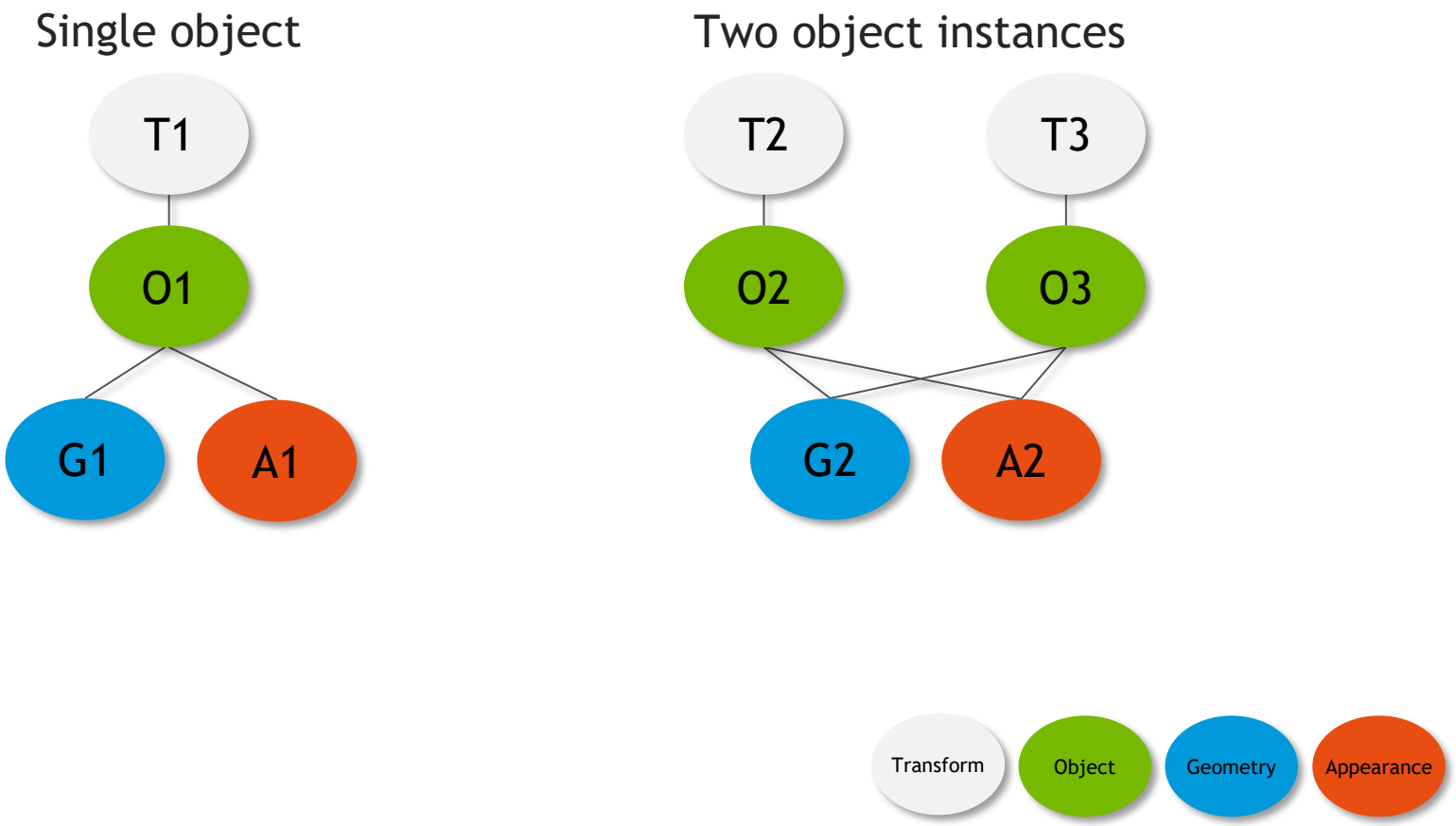
Helios Objects

Scene Hierarchy Flattening



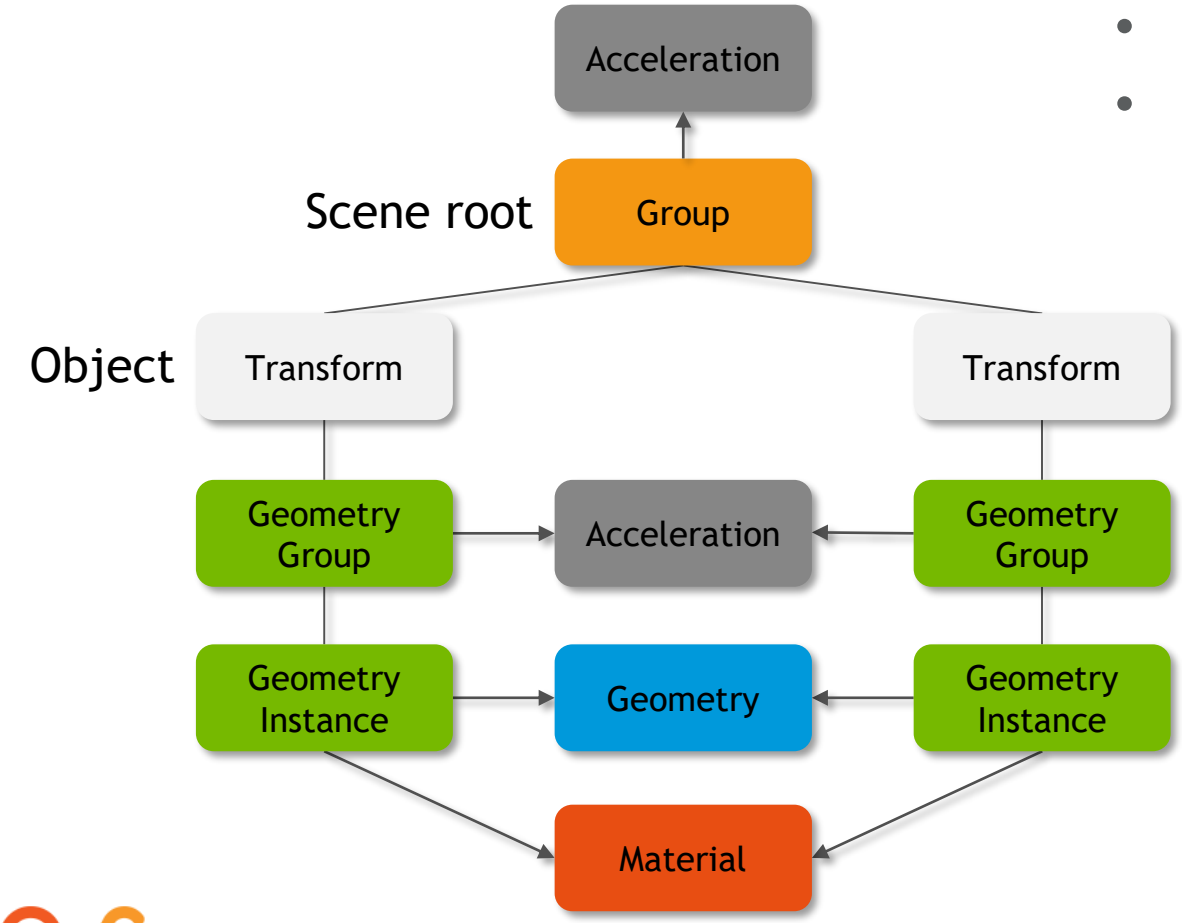
Helios Objects

Shared Geometry and Appearance

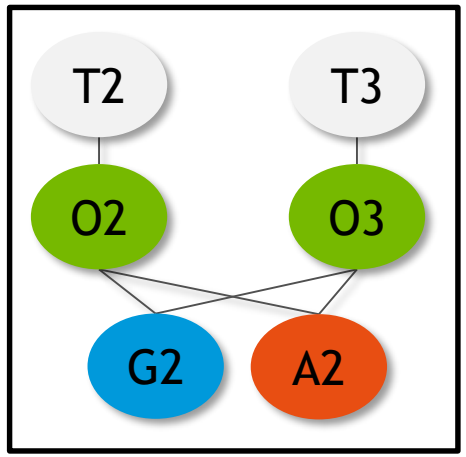


OptiX Node Graph

Helios Objects as OptiX Node Graph

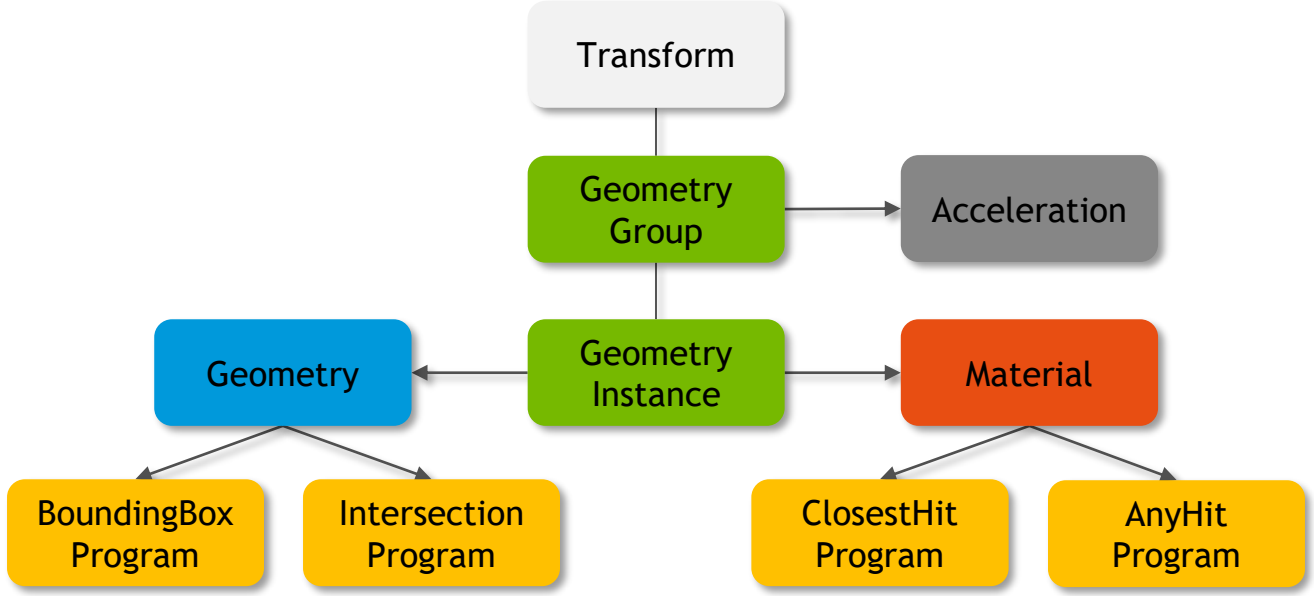


- Two-level acceleration hierarchy
- Increased performance when using RTX



OptiX Node Graph

OptiX Programs



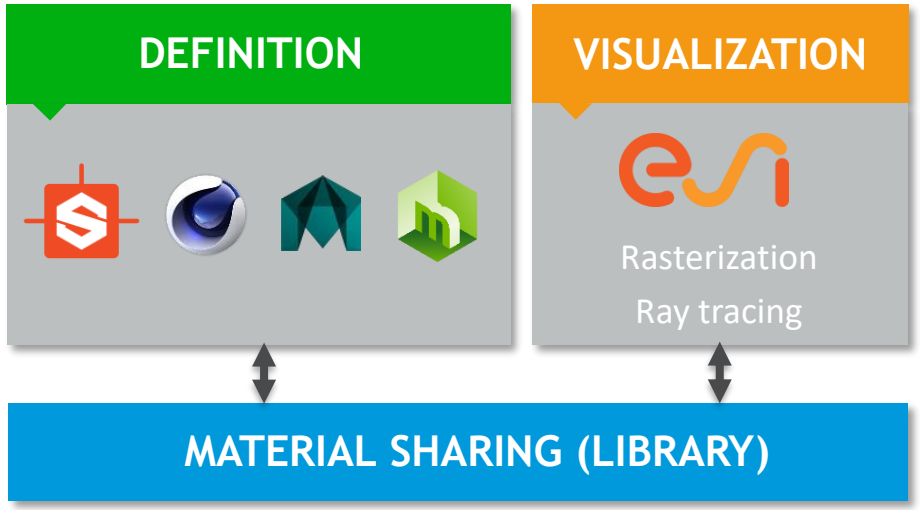
Motivation for using MDL

Future-Proof Material Handling

- Realistic appearance
  - Physically based rendering
  - Support of measured materials
  - Material layering (e.g., clear coating over wood)

- Exchangeability and flexibility
  - Consistent look across renderer, platforms, applications
  - Vendor, renderer and platform independence
  - Share centralized material assets
  - Use of material libraries by 3rd-party providers

Courtesy of NVIDIA

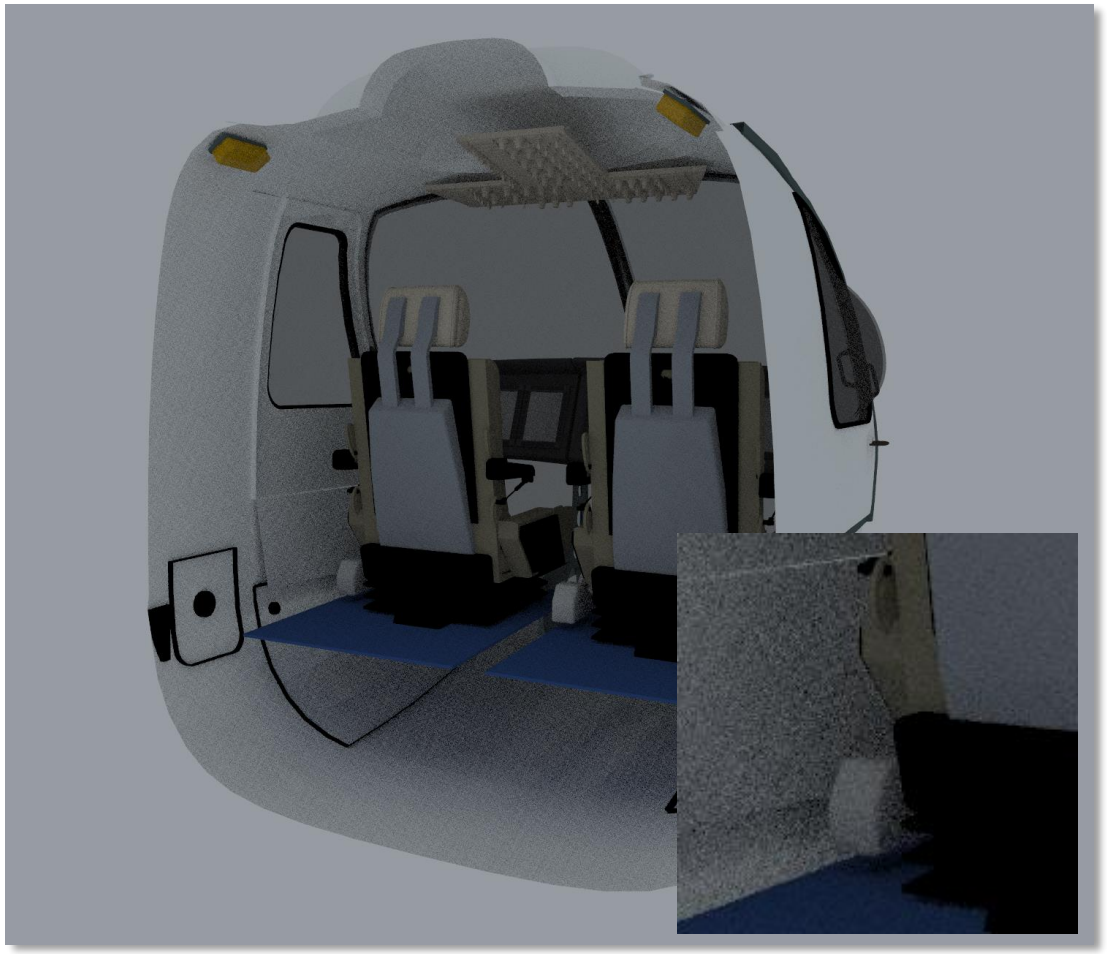


AI DENOISING

Global Illumination

Stochastic Monte-Carlo Noise

- Global illumination path tracer
  - Computes indirect light transport
  - Monte-Carlo sampling
    - Solves high-dimensional integrals
    - Exhibits stochastic noise
  - Takes long to generate **smooth** images



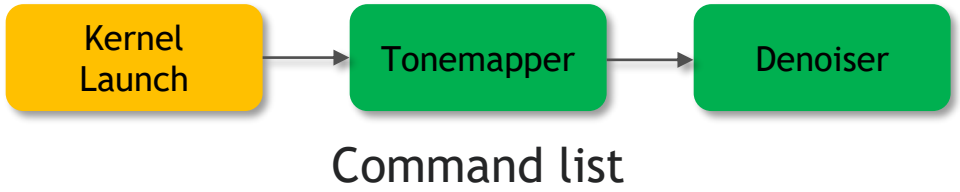
AI Denoising

OptiX Postprocessing

- Postprocessing pipeline since Optix 5.0

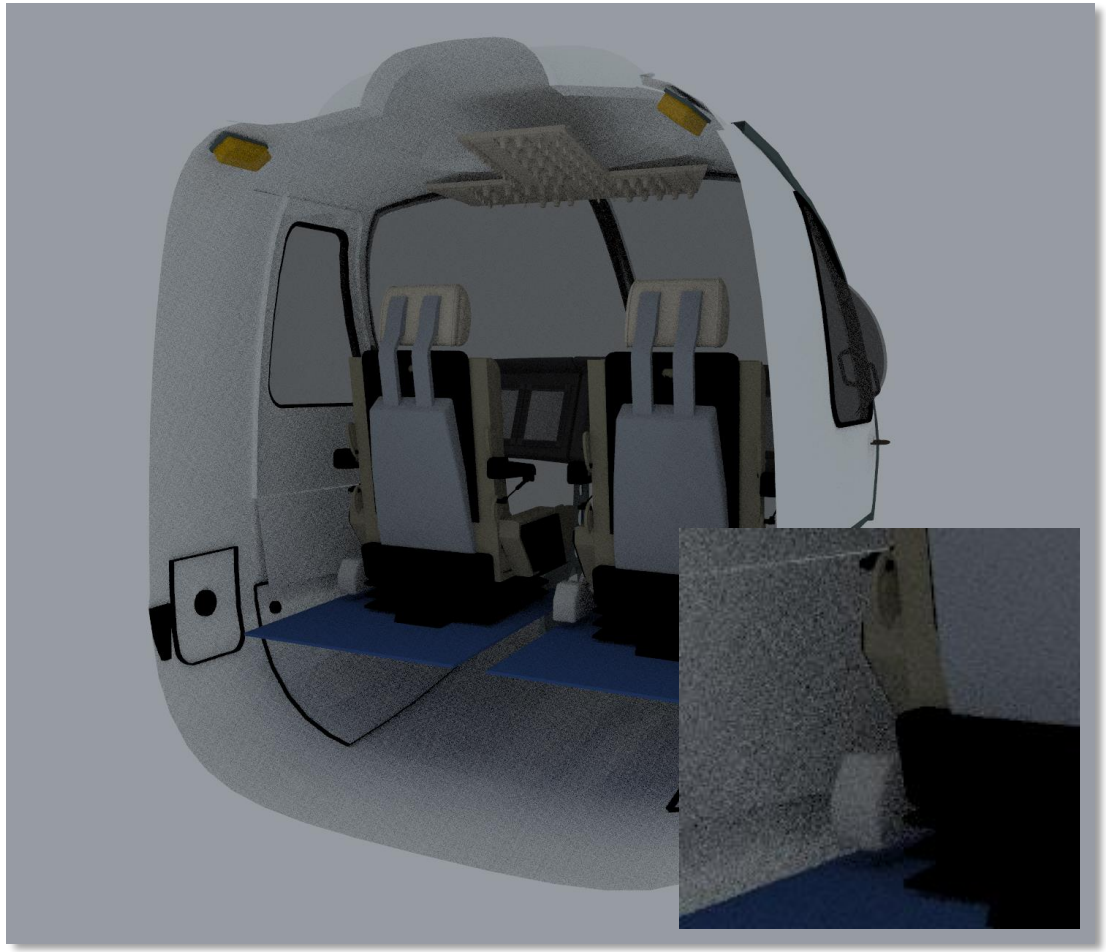
- OptiX command list consists of
  - Kernel launch stages
  - Postprocessing stages
    - Tone mapping
    - Denoiser filter

- Denoiser stage
  - Deep neural net (uses Tensor cores)
  - Trained to detect and remove noise

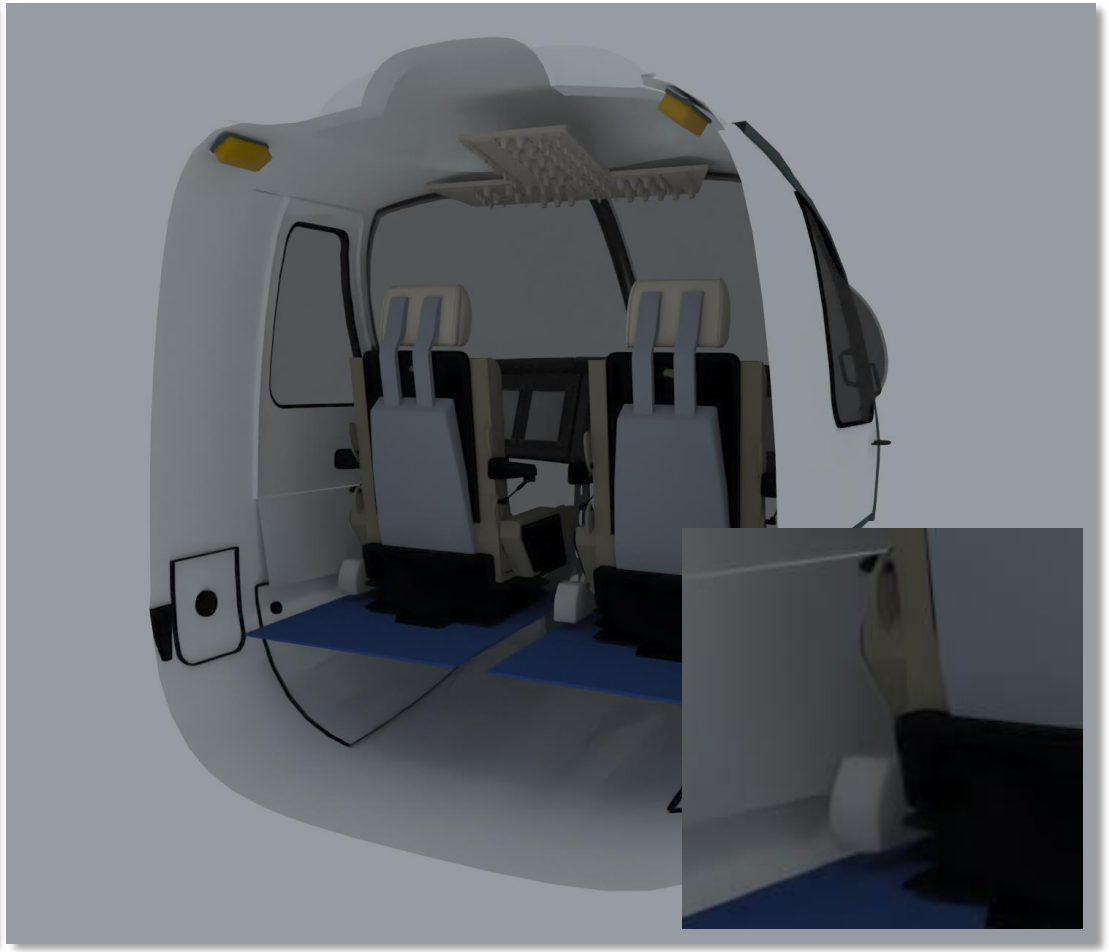


Deep Learning Denoiser

Filtering Noise in Postprocess



Plain path tracing (20 iterations)



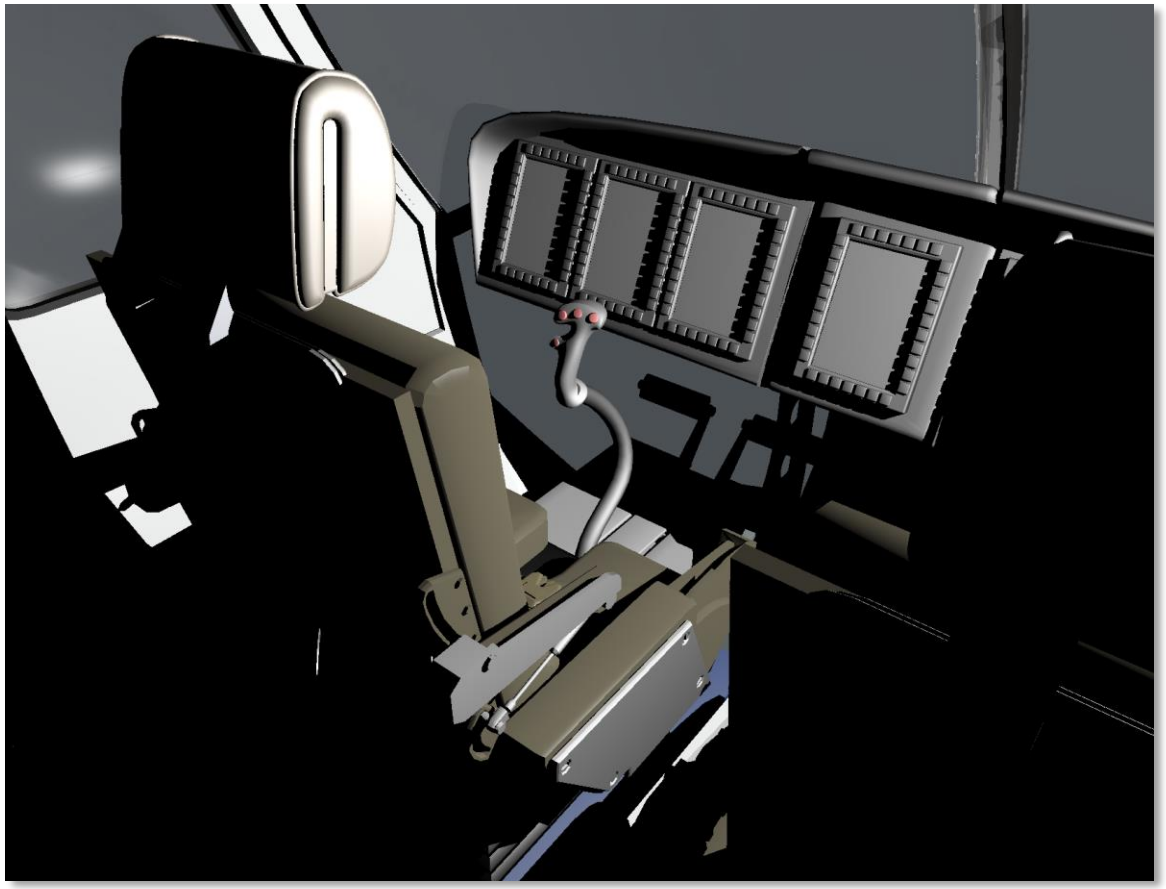
Path tracing + denoiser (20 iterations)

RAY TRACING ON HMDS

Ray Tracing on HMDs

Example

- Whitted style ray tracing possible on HMDs
- Helicopter cockpit
  - 180.000 triangles
  - 1 point light source
- Example setup
  - Oculus Rift
  - Quadro RTX 6000
  - OptiX 5.1 + RTX
  - 40 – 80 frames per second



EXAMPLE APPLICATIONS

Example Applications

Lighting Conditions in Micro-Factory

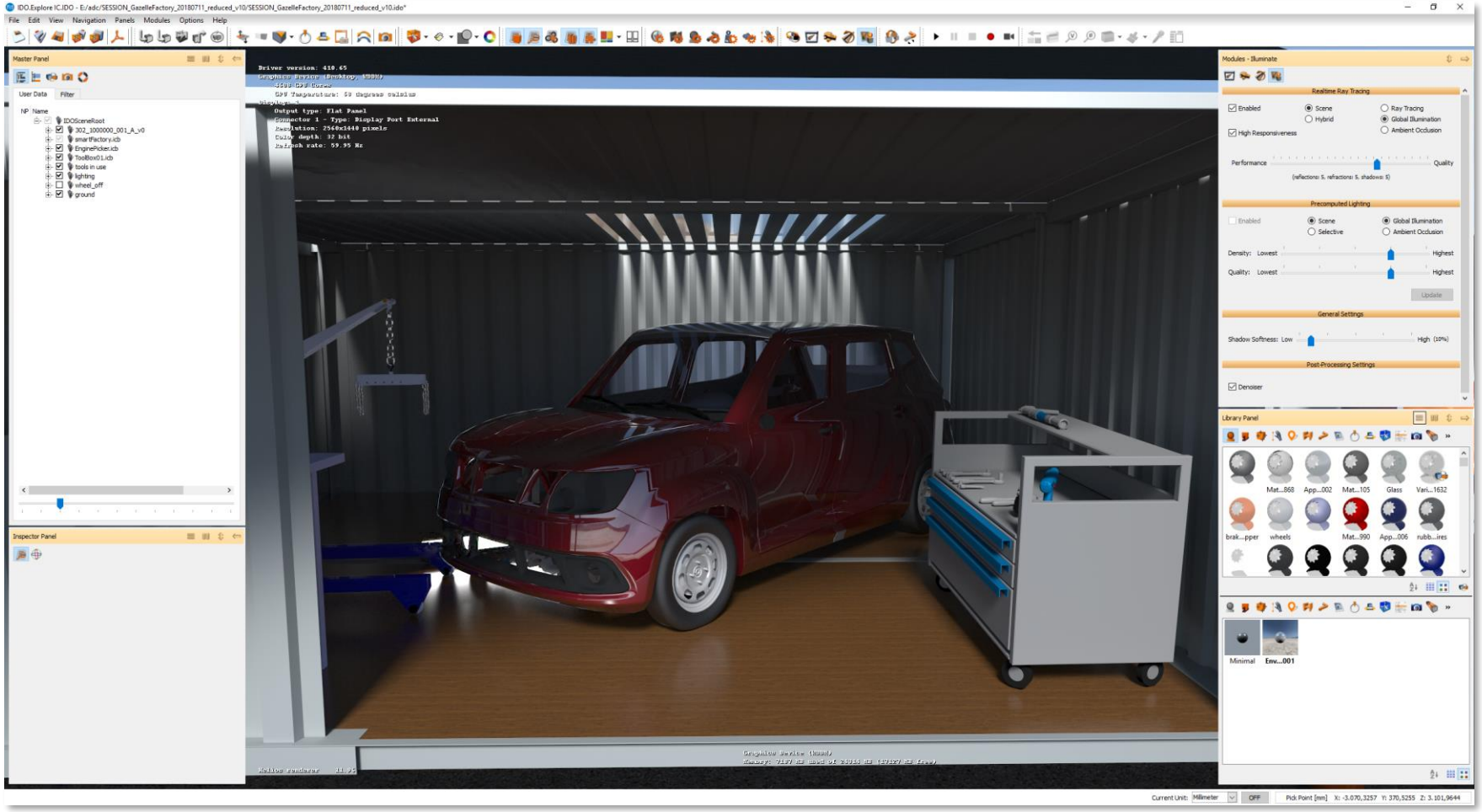
- Gazelle Tech micro-factory
  - Local car assembly
  - Relocation of production to customers
  - Suited for emerging countries

- Workspace Lighting
  - Illumination in tight spaces
  - Depends on local environment
  - Changes when factory is moved

www.gazelle-tech..com

Lighting Conditions in Micro-Factory

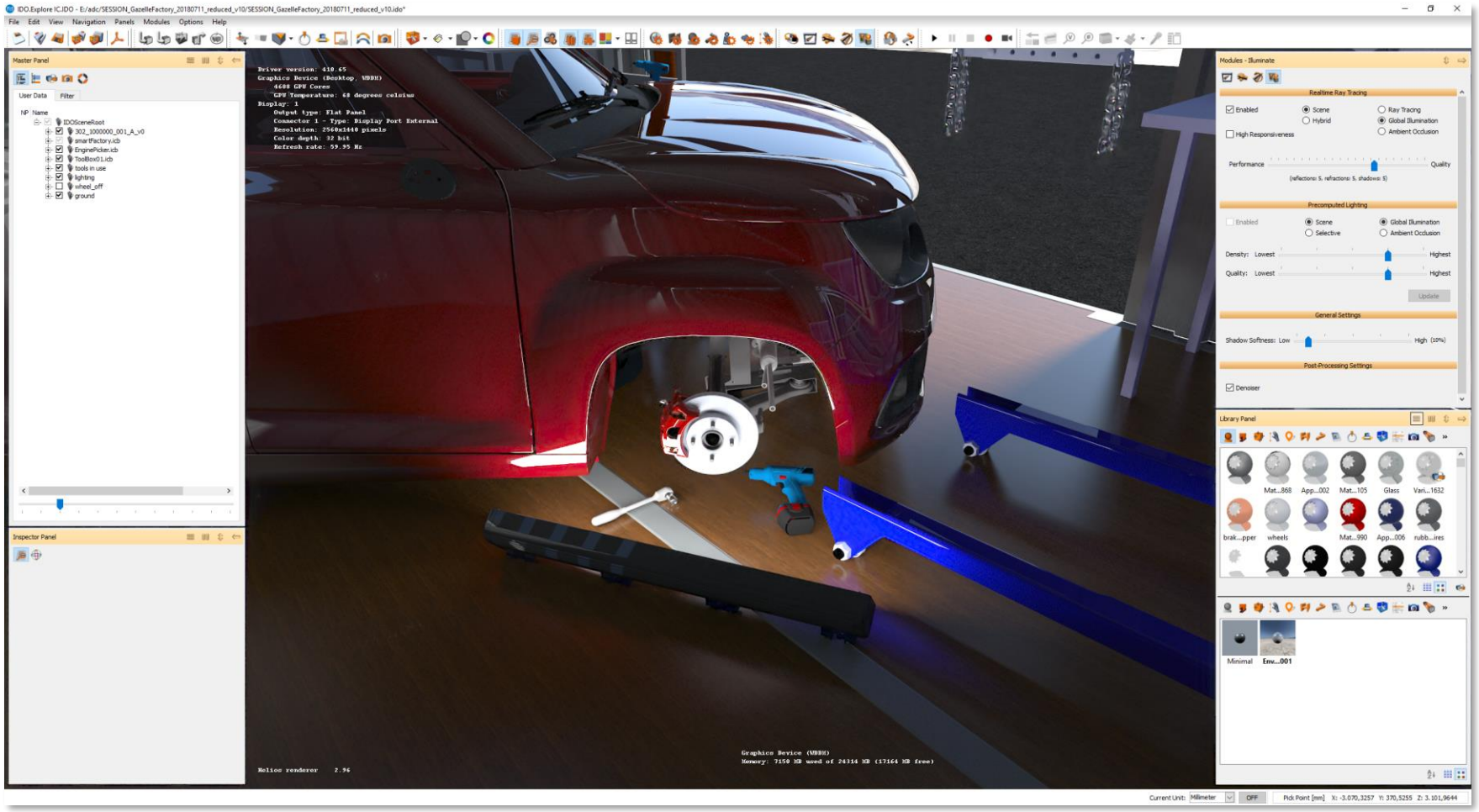
Global Illumination Simulation



IC.IDO 12.1 on Quadro RTX 6000

Lighting Conditions in Micro-Factory

Global Illumination Simulation



IC.IDO 12.1 on Quadro RTX 6000

DEMO

THANK YOU