Computer Graphics
Summary, Applications, and Outlook

Matthias Teschner

UNI FREIBURG

Introduction to Computer Graphics

Rendering	Modeling	Simulation

Homogeneous Notation

Rendering	Modeling	Simulation
Ray Casting	Bézier Curves	Particle Fluids
Rasterization	Piecewise Polynomial Curves	
Phong		

Simulations / Renderings vs. Experiments / Real-World Videos

- Less expensive
- Faster
- More flexible
- Less dangerous

... if sufficiently accurate

Application

The Ford Motor Company of Australia

Challenges

- Prototype
- Sensors
  - Wetting, pressure, volume, flow rate, pathline, ...
- Analysis
- Redesign
- Prototype
- ...

The Ford Motor Company of Australia

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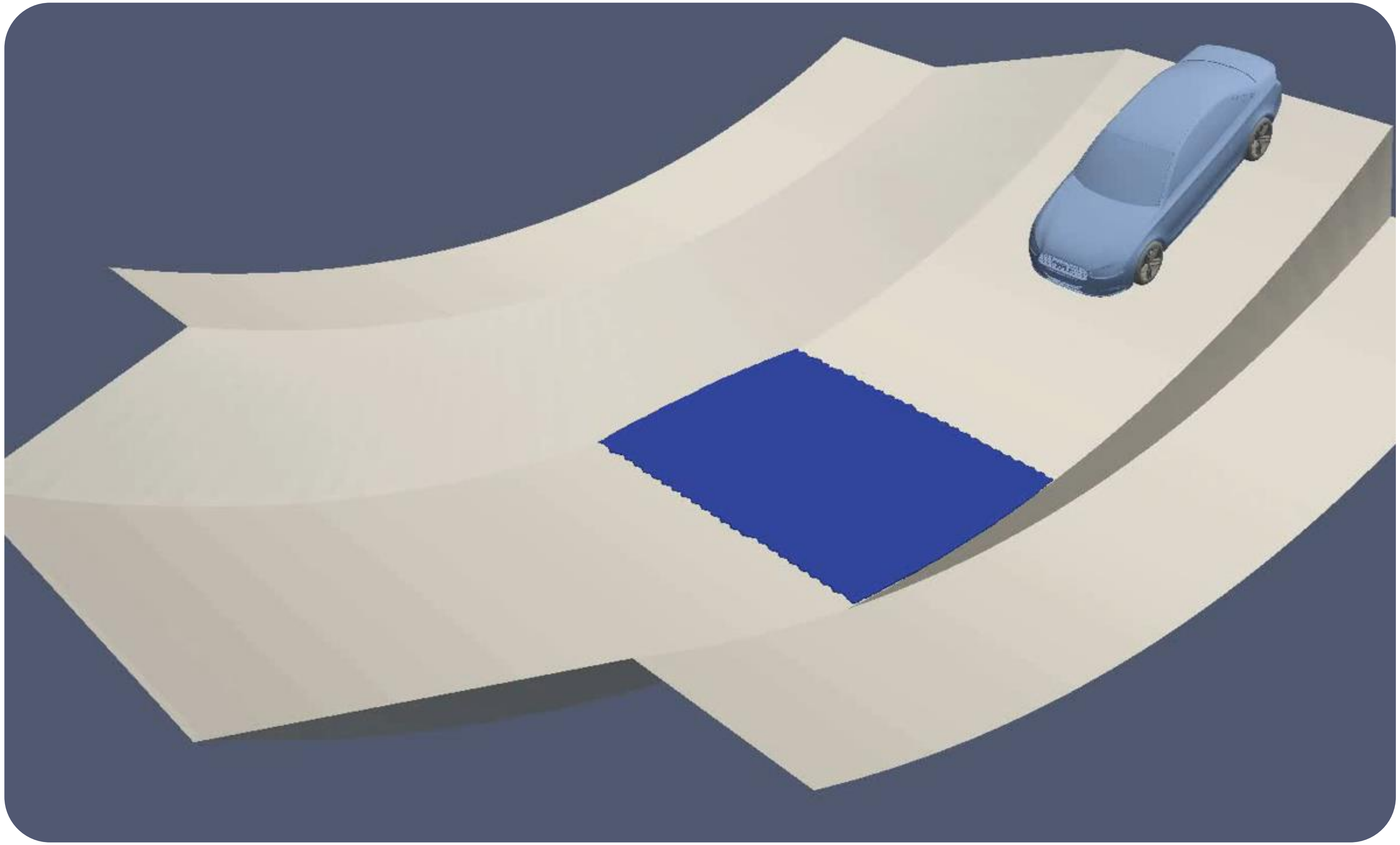
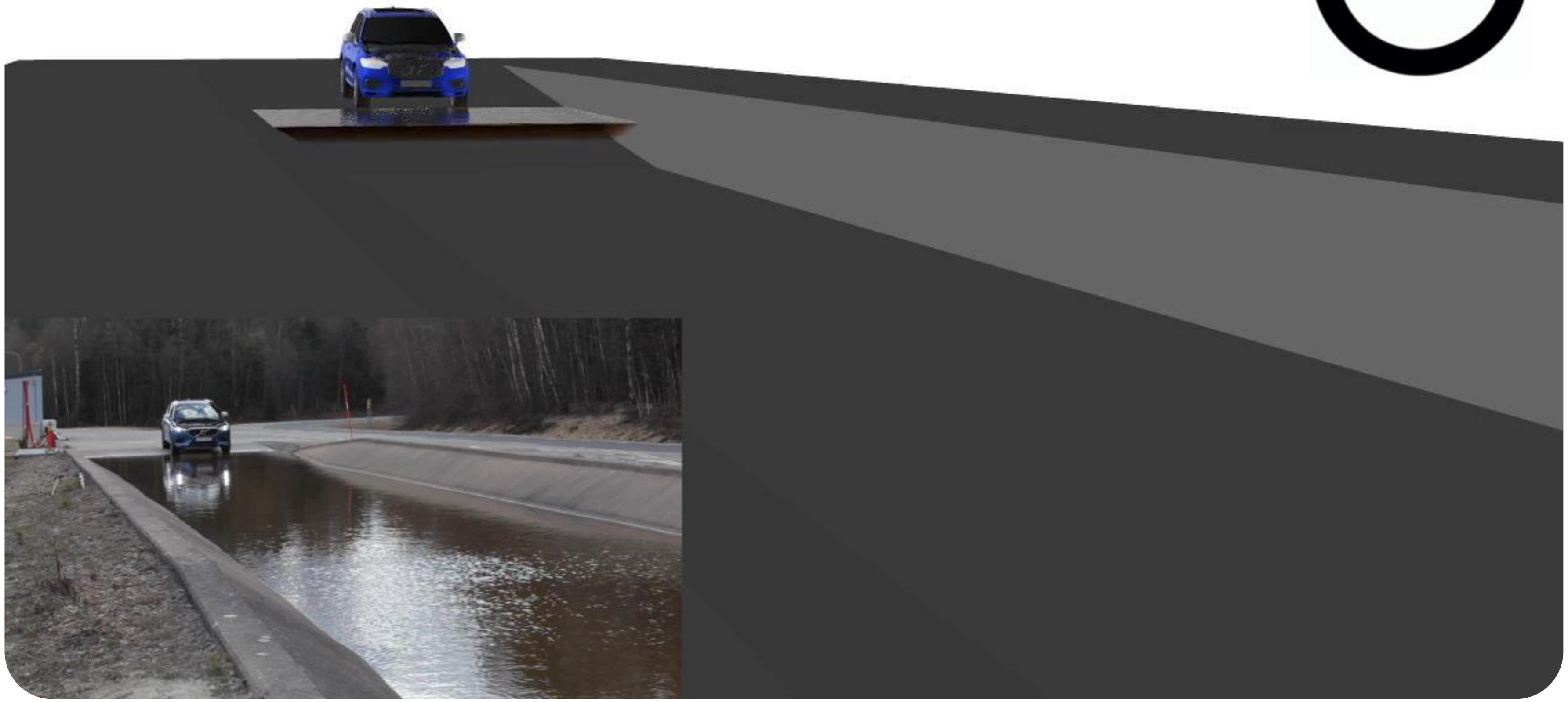
State-of-the-Art in 2014



Merkle & Partner
Commercial CFD
Product

Current State-of-the-Art

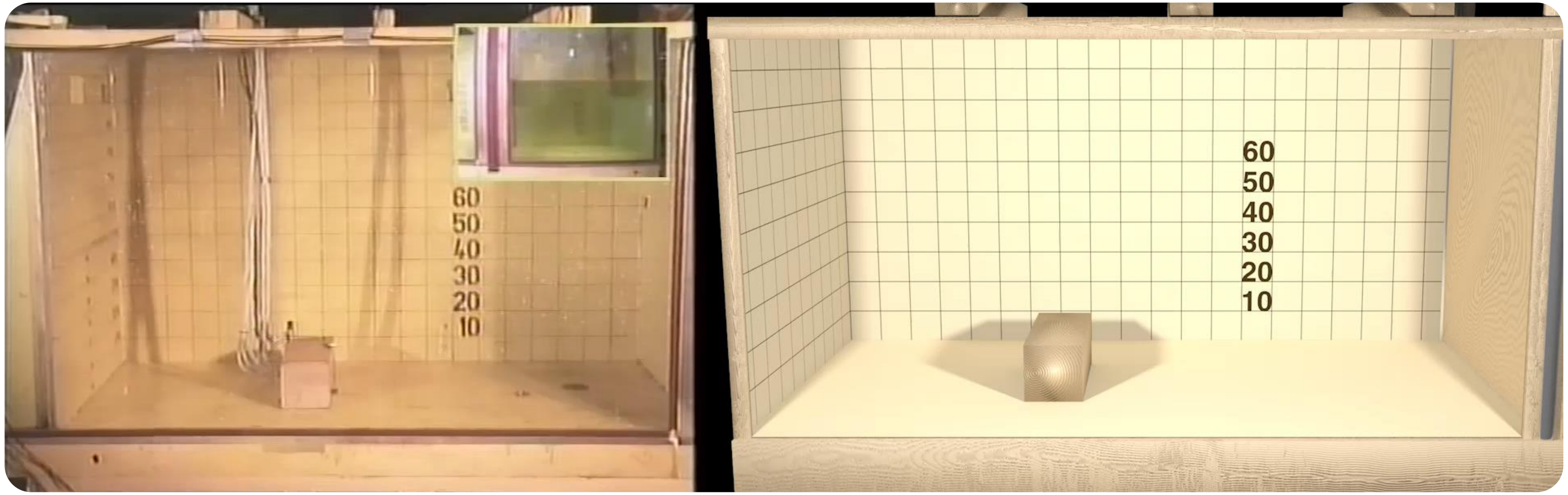


Johan Idoffsson
Chalmers University

Volvo Cars

PreonLab
FIFTY2 Technology

Evaluation



PreonLab
FIFTY2 Technology

Computer Science in Simulation

Efficiency	Usability	Reliability
Neighbor search	Boundary representation flexible, fast pre-proc.	Implicit formulations
Pressure solve large time steps	Pressure solver simple, intuitive setup	
Boundary handling large time steps	Monolithic solutions e.g. rigid-body solver	
…	Pre- and Postprocessing	

Further Applications

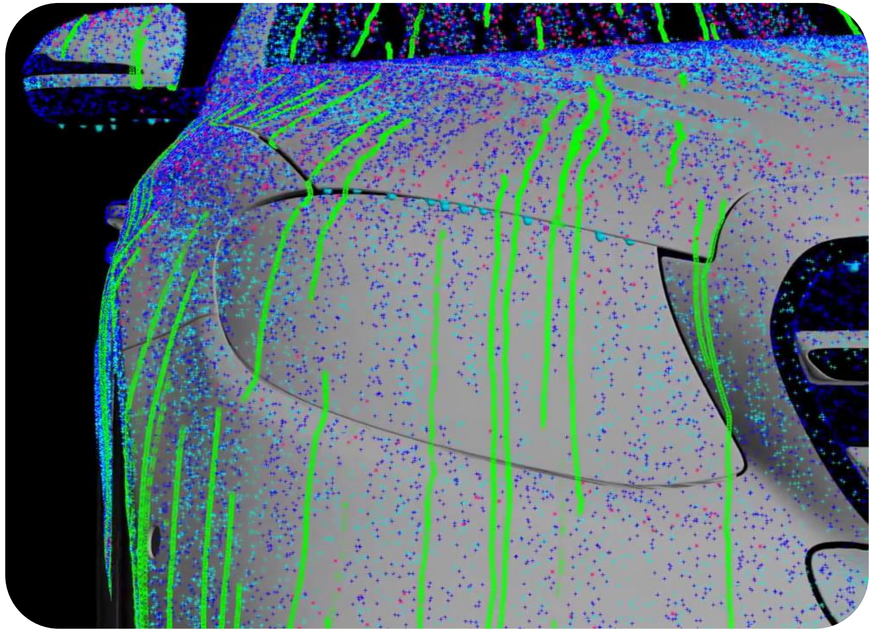
– Medicine
– Climate Research
– Entertainment
– ...

Modeling - Simulation - Rendering

Modeling

Rendering

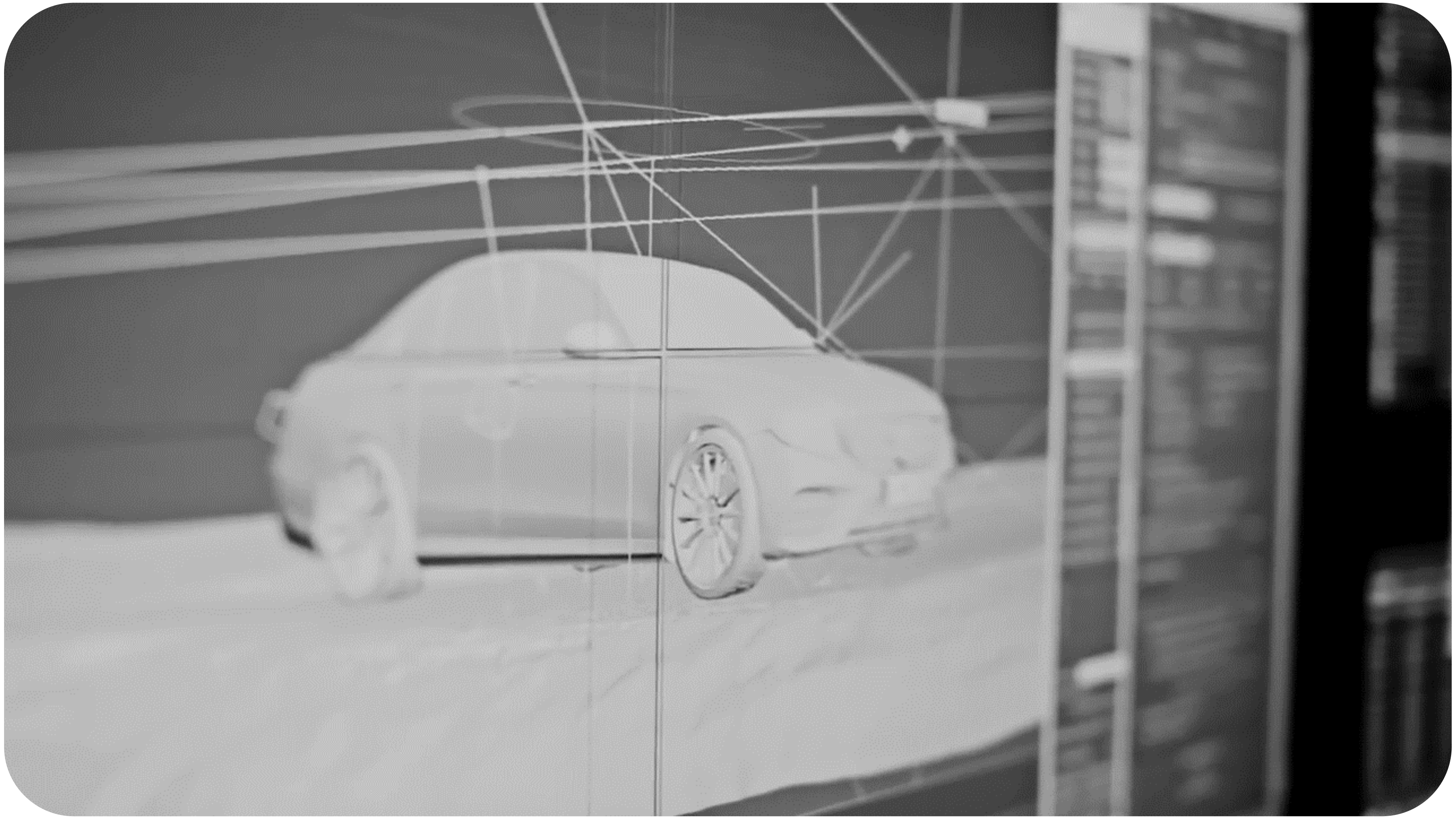
Modeling - Simulation - Rendering



Simulation

Rendering

Modeling - Simulation - Rendering



© Spellwork Pictures

Specialization Courses – Topics

Rendering	Simulation
Light: Radiometric Quantities	Particle Motion
Material: BRDF	Elastic Solids
Light / Material: Rendering Equation	Fluids (Particles and Grids)
Radiosity	Rigid Bodies
Stochastic Raytracing	Contact

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Specialization Courses – Concepts

Rendering	Simulation
Monte Carlo Integration	Smoothed Particle Hydrodynamics
Finite Element Modeling	Finite Differences

Linear Systems

Spatial Data Structures

Real Time Graphics / High Performance Computing

Rendering Equation

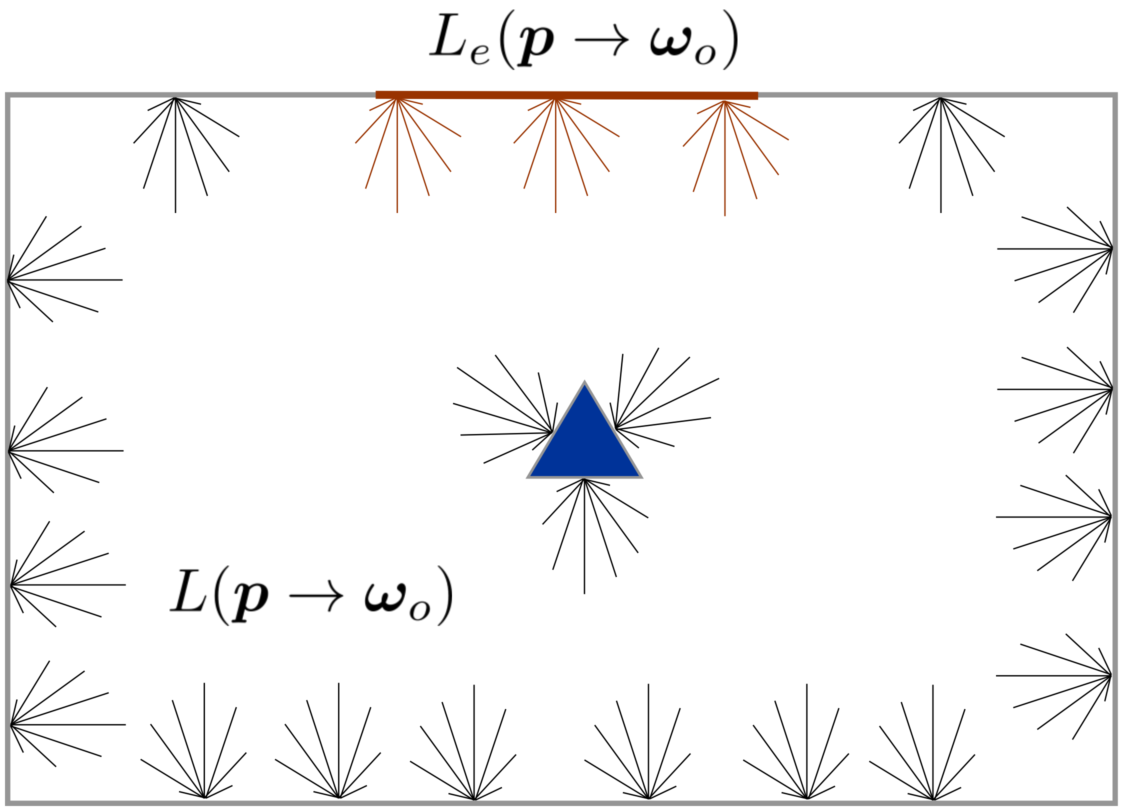
$$L(\boldsymbol{p} \rightarrow \boldsymbol{\omega}_o) = L_e(\boldsymbol{p} \rightarrow \boldsymbol{\omega}_o) + \int_\Omega f_r(\boldsymbol{p}, \boldsymbol{\omega}_i \leftrightarrow \boldsymbol{\omega}_o) L(\boldsymbol{p} \leftarrow \boldsymbol{\omega}_i) \cos(\boldsymbol{\omega}_i, \boldsymbol{n}_p) \mathrm{d}\omega_i$$

- Establishes relations between incident and exitant radiances
- Expresses the steady state of radiances in a scene
- Governs the computation of radiances from all scene points into all directions

Akenine-Möller et al.

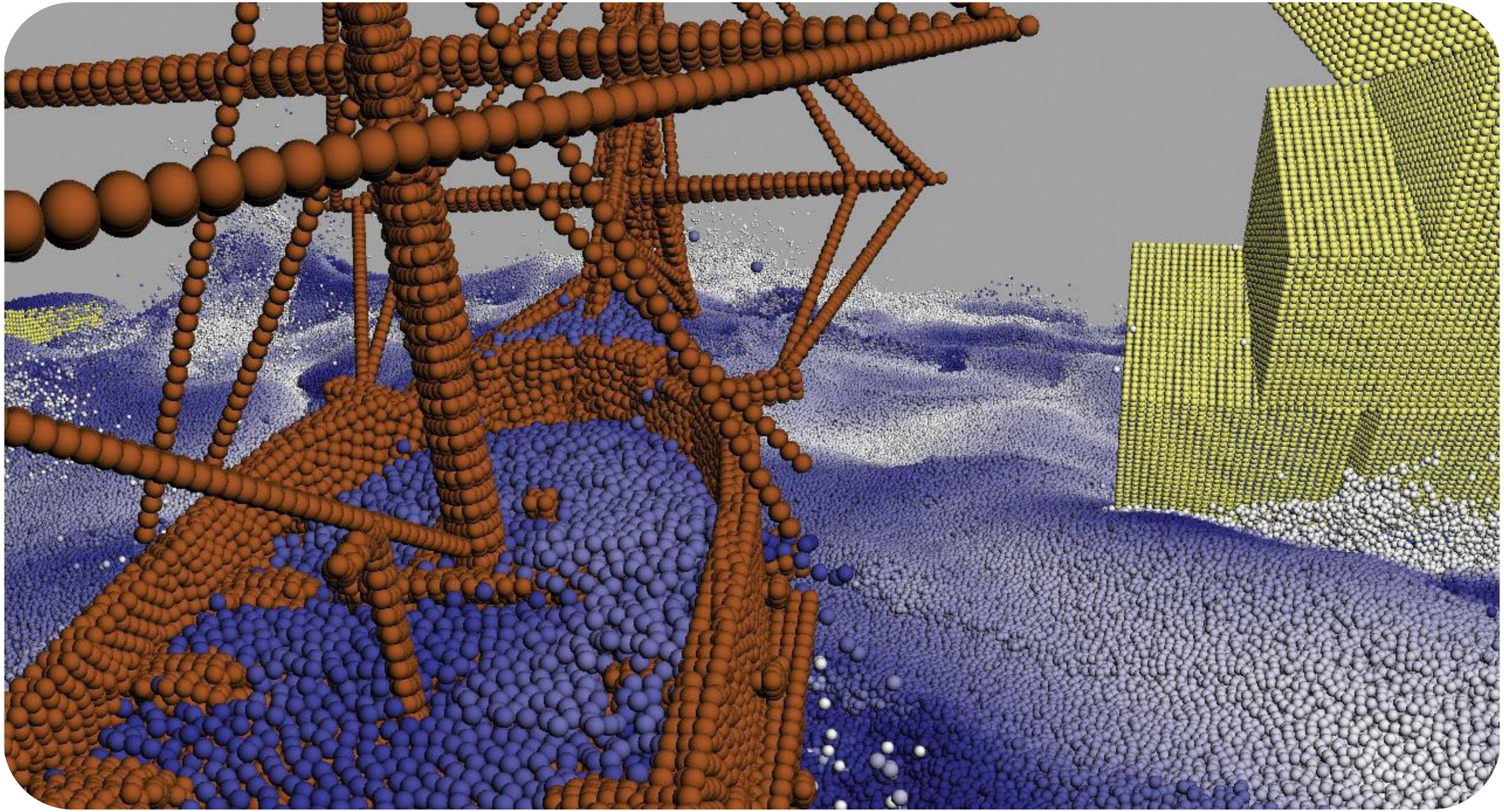
Solving the Rendering Equation

– Exitant radiances from all scene points into all directions



Cornell box

Particle Simulation



Projects – Theses

Rendering Track	Simulation Track
Simple Raytracer	Simple Fluid Solver
Data Structures	Data Structures
Stochastic Raytracer	Incompressible SPH Solver

Features / Performance / Research

Please contact me per email two / three weeks before the semester starts.

Image Processing

- Slides, recordings, information on
  - https://lmb.informatik.uni-freiburg.de/lectures/image_processing/
- First class on
  - Tuesday, June 11, 14:15

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