Computer Graphics
Summary, Applications, and Outlook

Matthias Teschner

UNI FREIBURG

Introduction to Computer Graphics

Rendering	Modeling	Simulation

Homogeneous Notation

Ray Casting	Bézier Curves	Particle Fluids
Rasterization	Piecewise Polynomial Curves	
Phong		

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Simulations / Renderings vs. Experiments / Real-World Videos

- Less expensive
- Faster
- More flexible
- Less dangerous

… if sufficiently accurate

Application

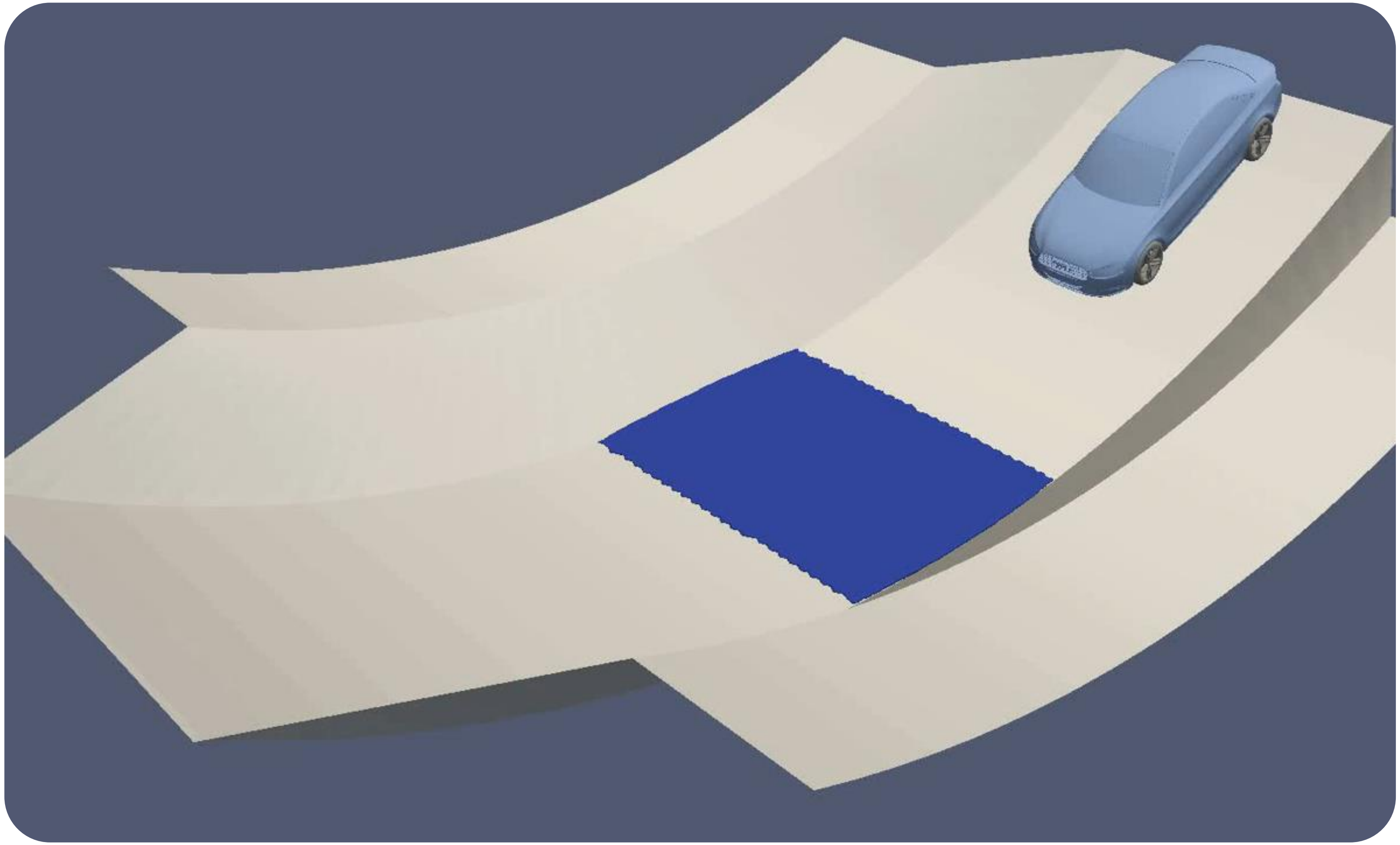
The Ford Motor Company of Australia

Challenges

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

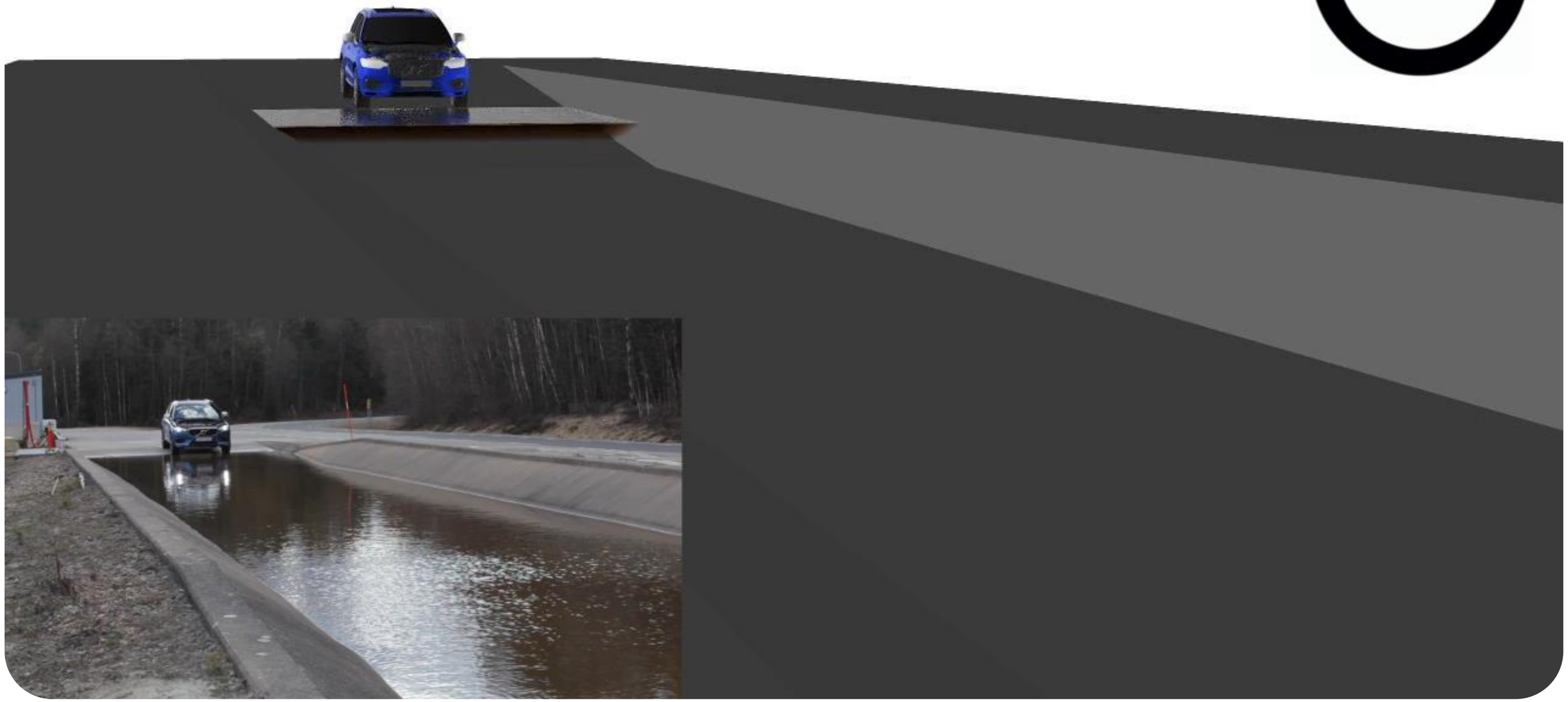
The Ford Motor Company of Australia

State-of-the-Art in 2014



Merkle & Partner
Commercial CFD
Product

Current State-of-the-Art

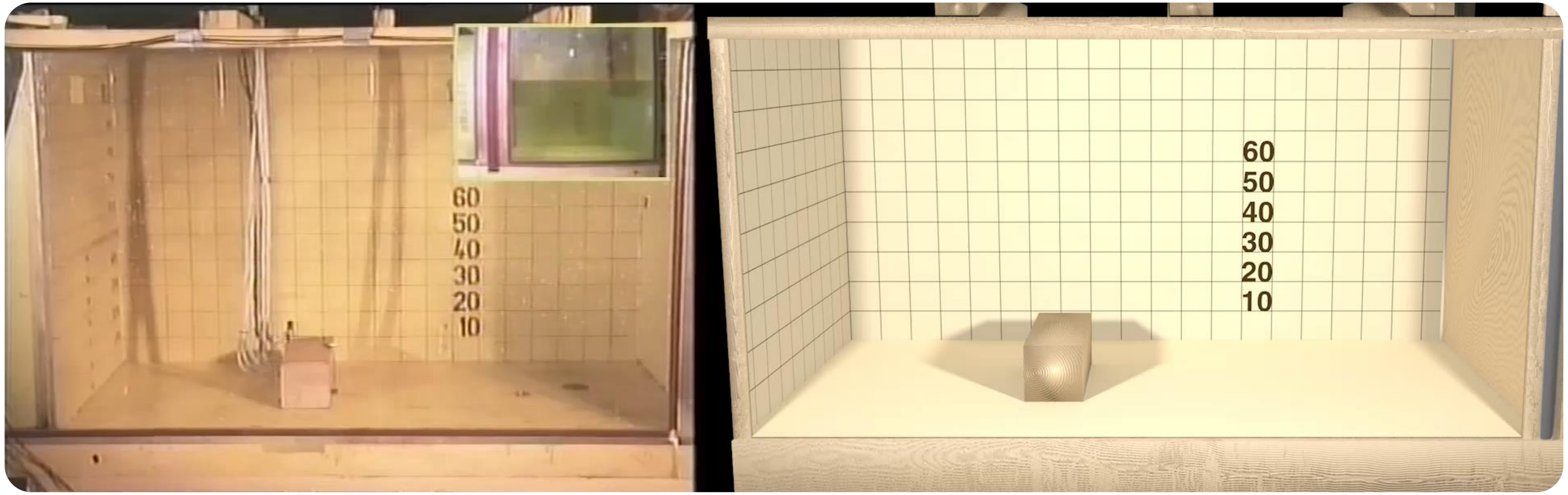


Johan Idoffsson
Chalmers University

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	

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Further Applications

- Medicine
- Climate Research
- Entertainment
- …

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Modeling - Simulation - Rendering

© Spellwork Pictures

Modeling

Rendering

Modeling - Simulation - Rendering

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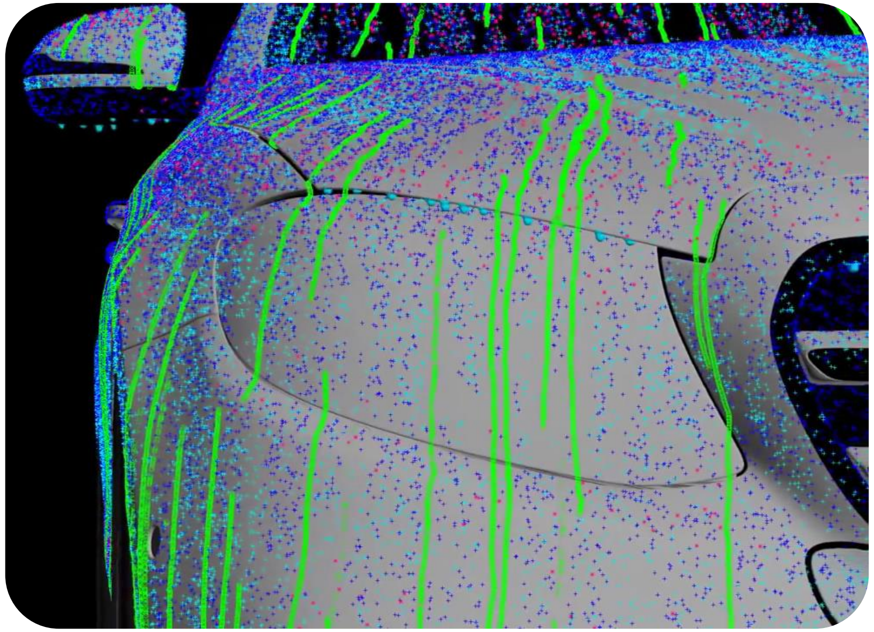
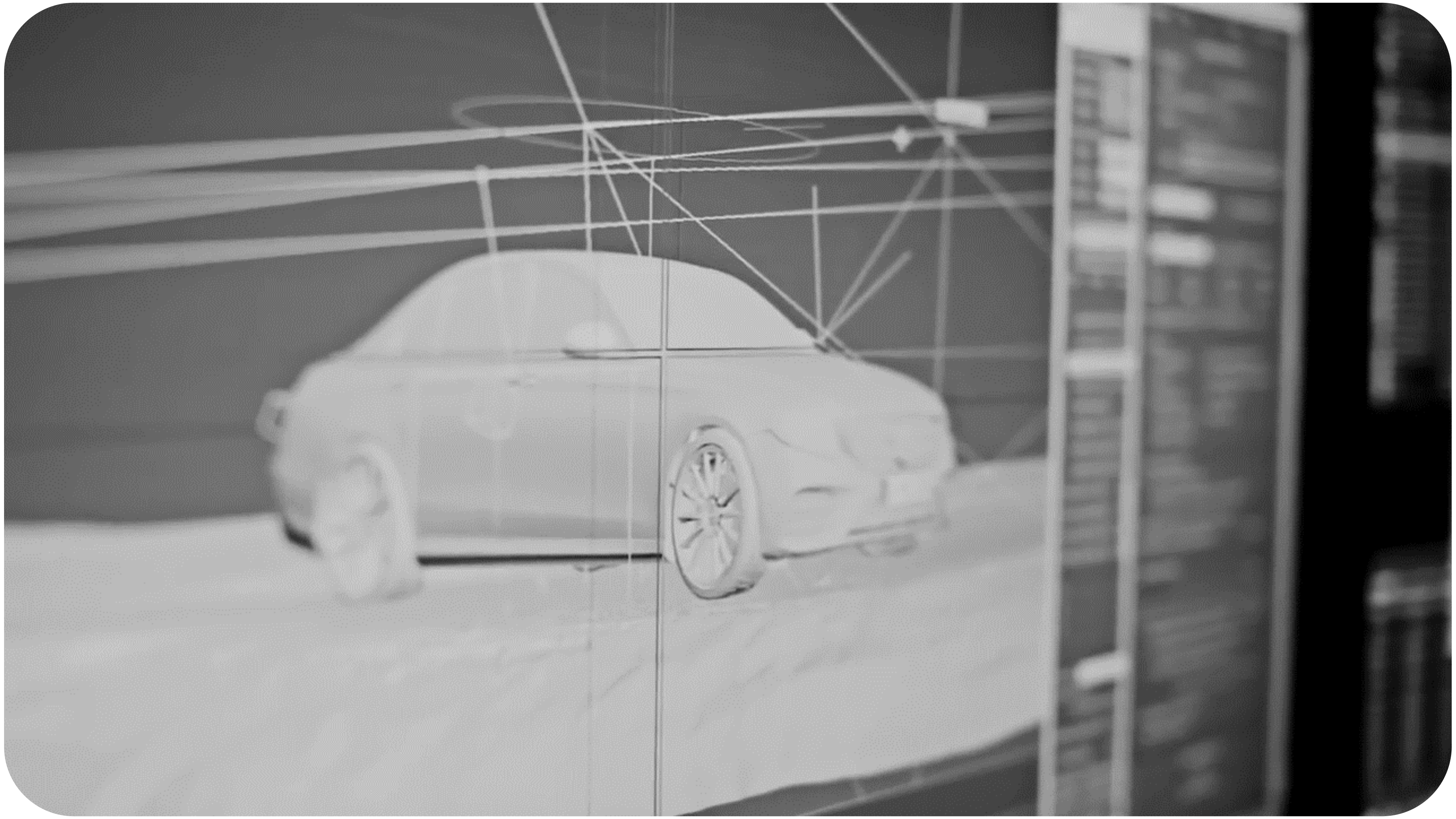

Simulation


Rendering

Modeling - Simulation - Rendering



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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

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Rendering Equation

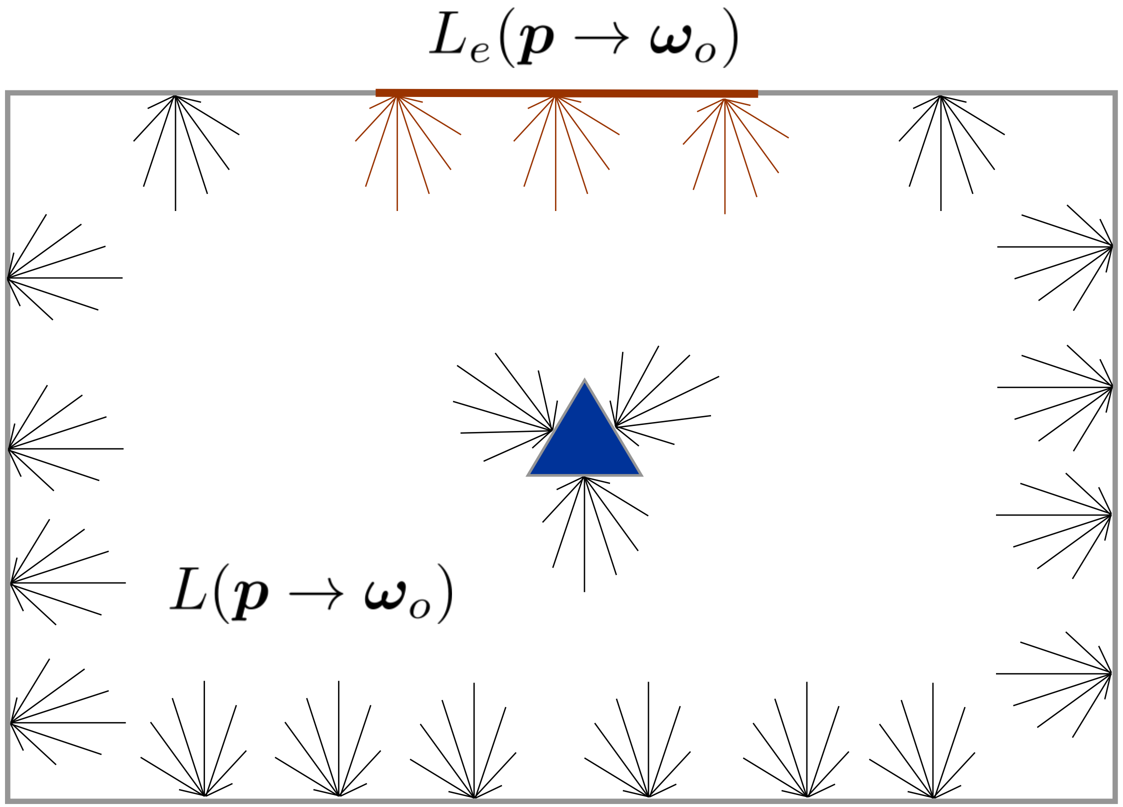
$$L(\boldsymbol{p} \rightarrow \boldsymbol{\omega}_o) = L_e(\boldsymbol{p} \rightarrow \boldsymbol{\omega}_o) + \int_\Omega f_r(\boldsymbol{p}, \boldsymbol{\omega}_i \leftrightarrow \boldsymbol{\omega}_o) L(\boldsymbol{p}' \leftarrow \boldsymbol{\omega}_i) \cos(\boldsymbol{\omega}_i, \boldsymbol{n}_p)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

- 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.

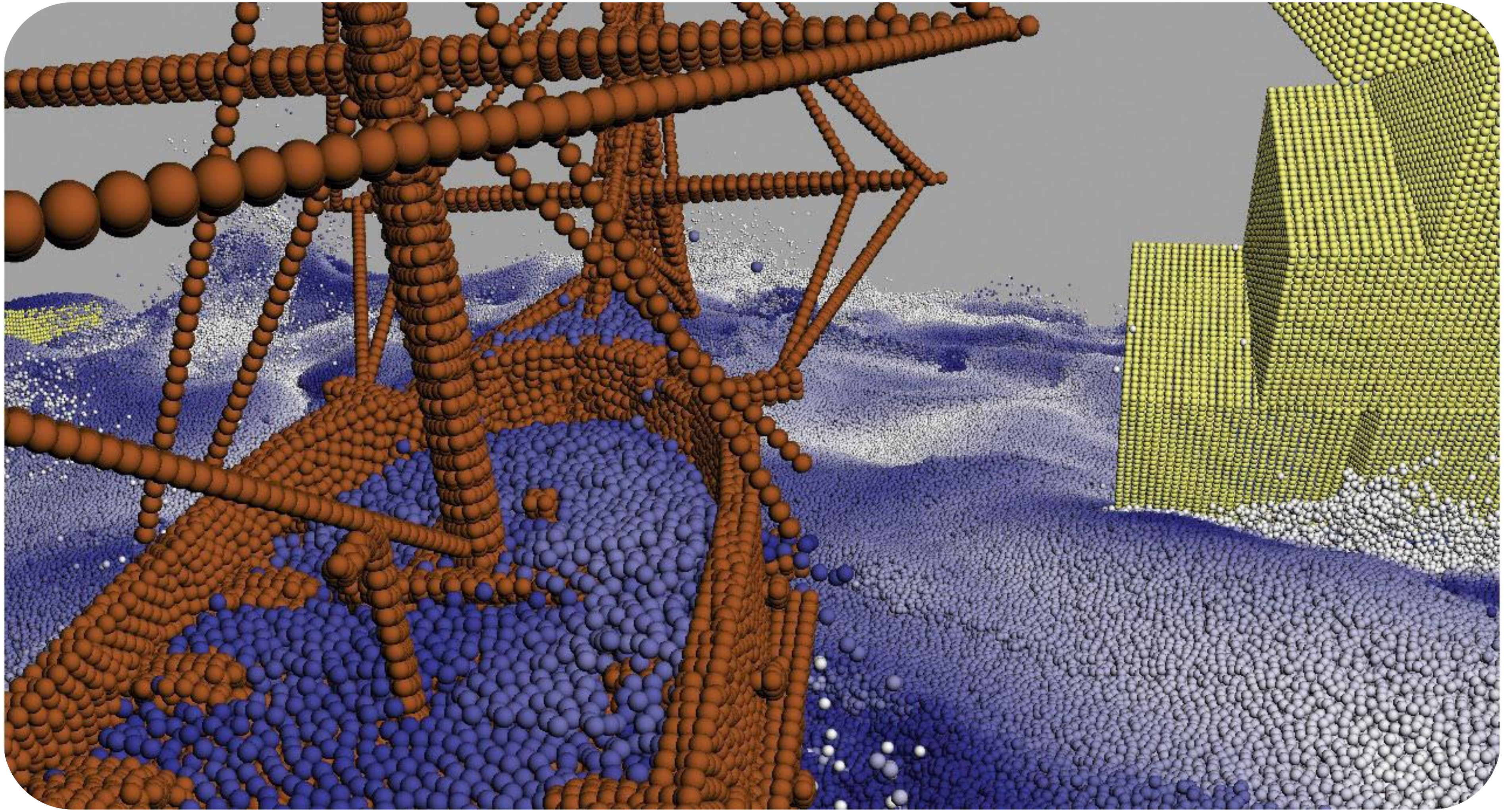
Solving the Rendering Equation

– 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.

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Image Processing

- Slides, recordings, information on
  - https://lmb.informatik.uni-freiburg.de/lectures/image_processing/
- First class on
  - Tuesday, June 13, 14:15

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