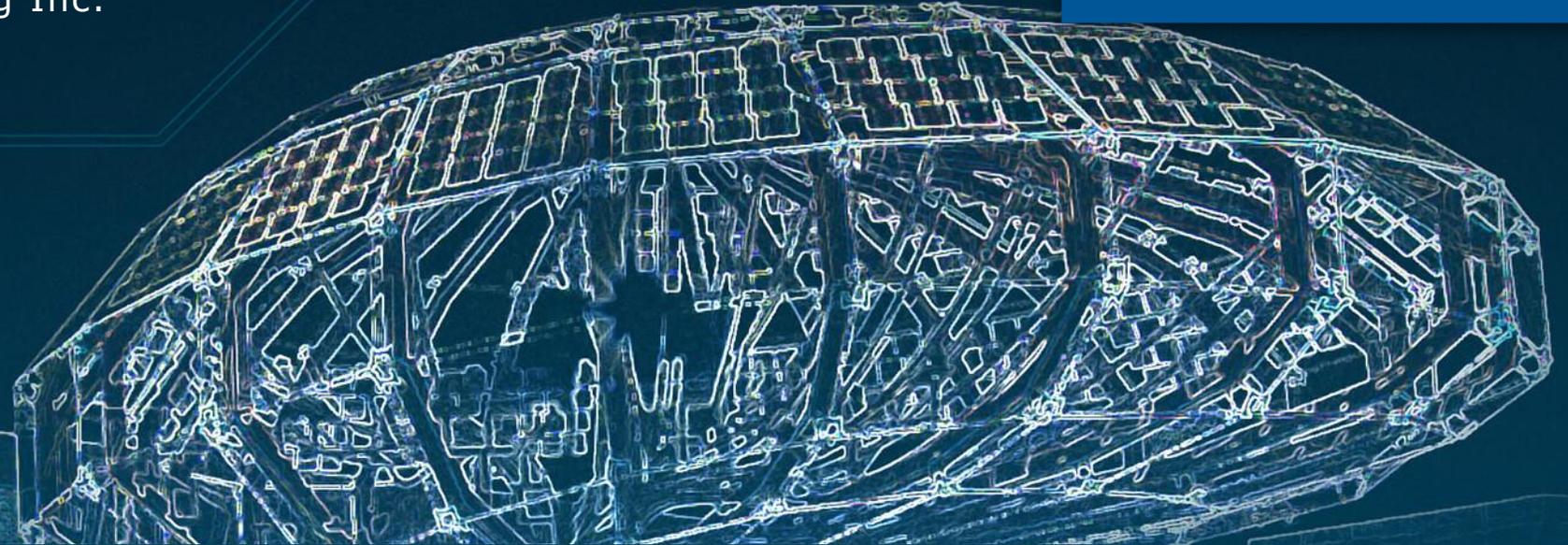


AVL



AVL Powertrain Engineering Inc.



# PreonLab SPH - the fastest CFD

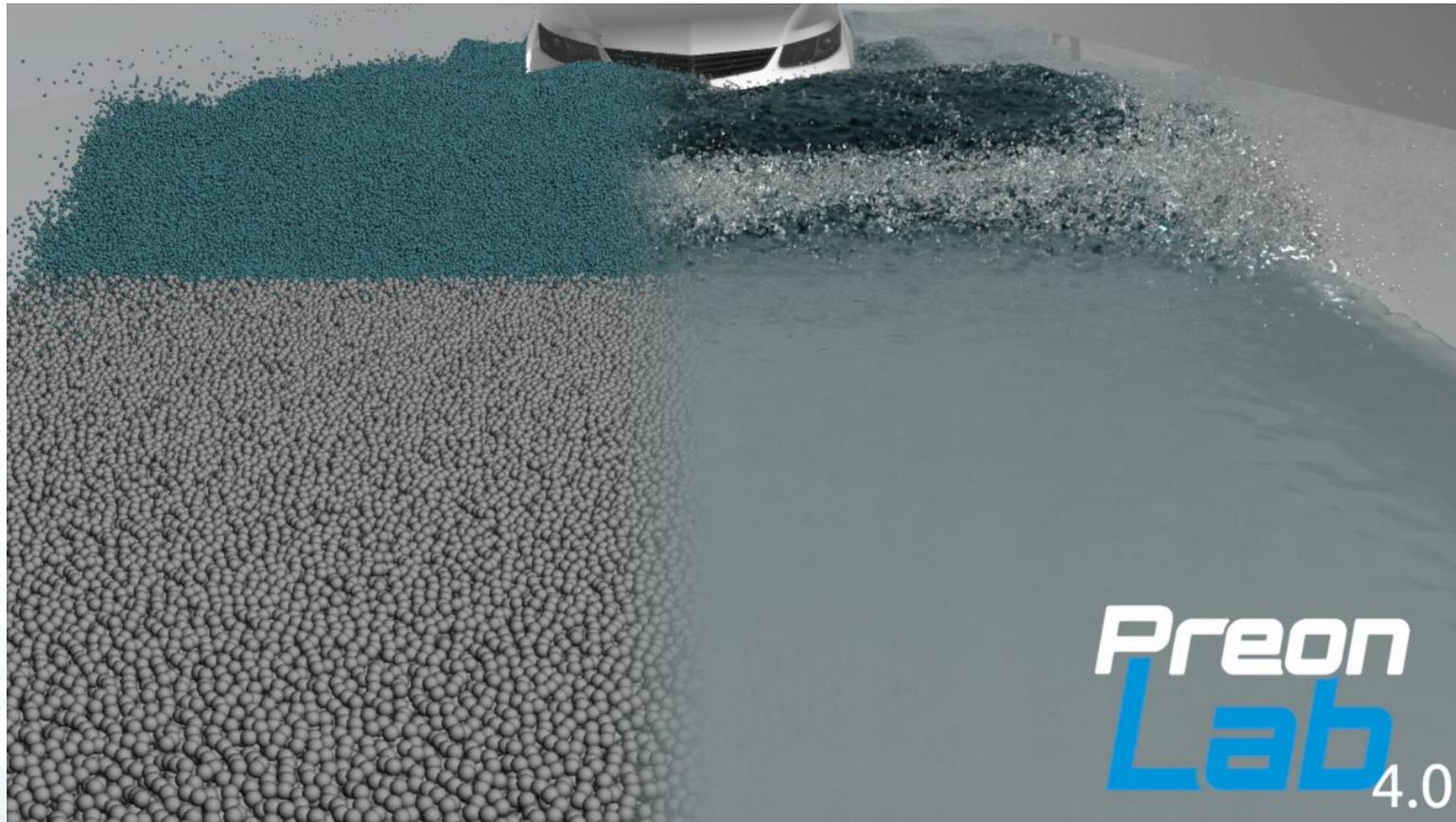
Update and Release 4.0

# Car suspension model improvement

**Preon  
Lab**

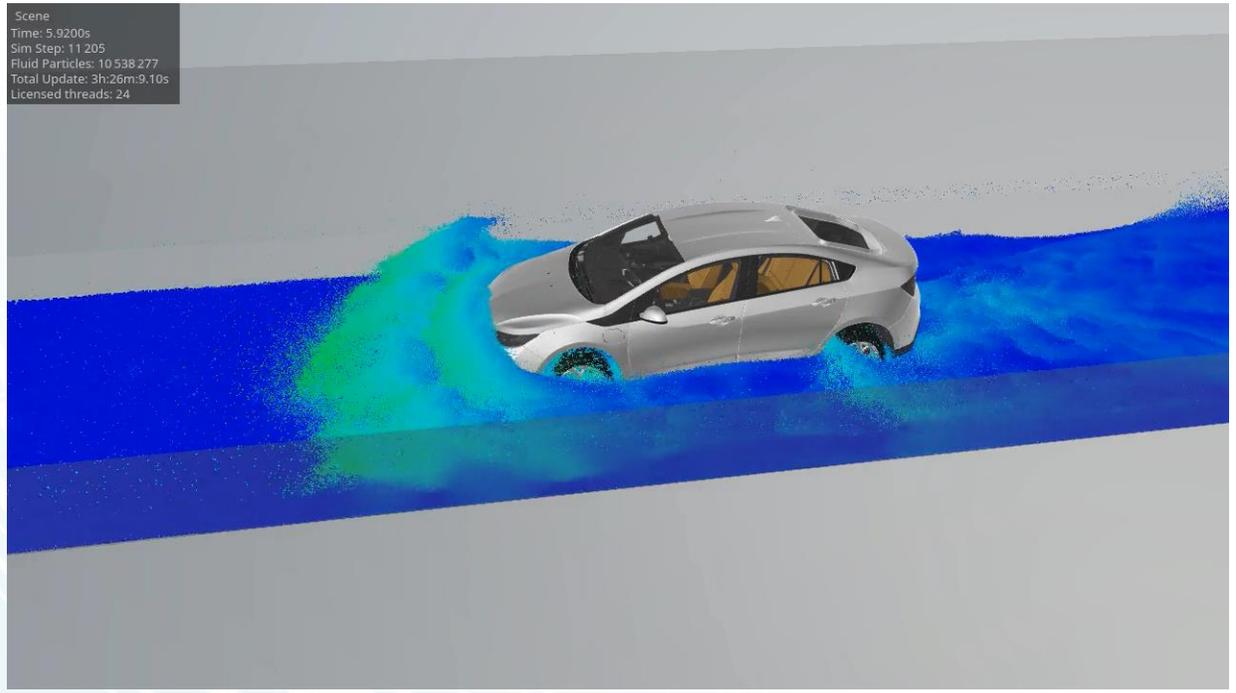
Water Wading

# Local refinement

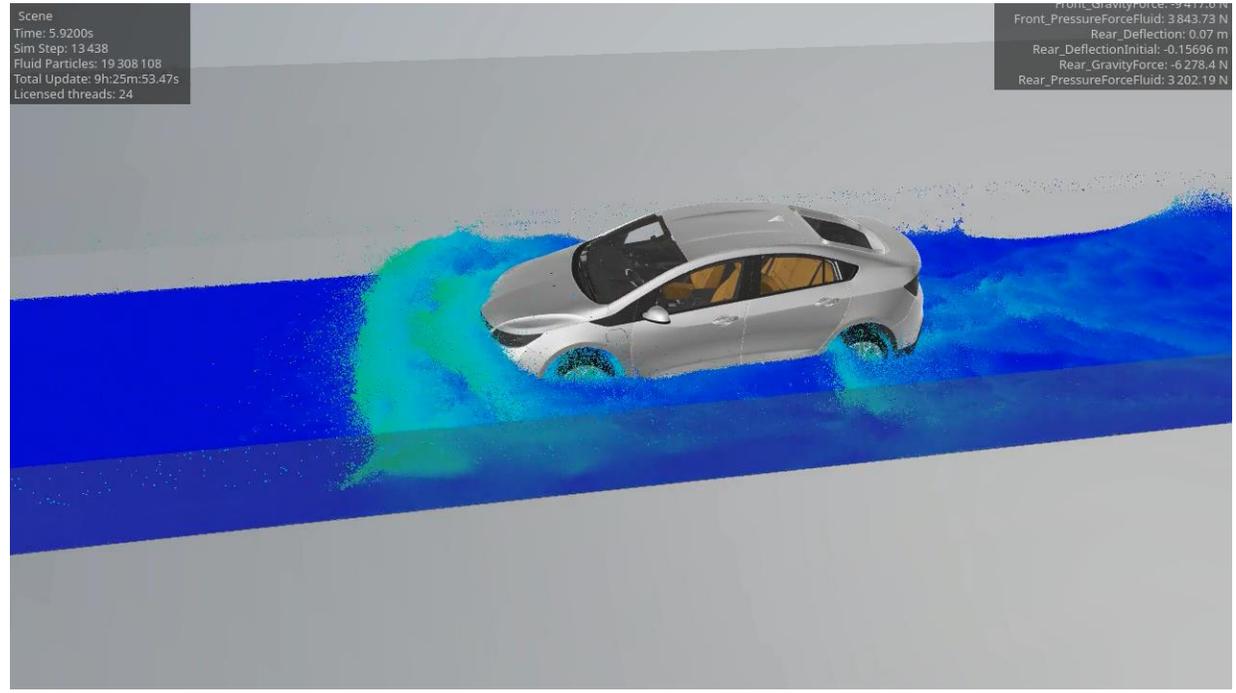


Local refinement algorithm (novel approach invented by FIFTY2)  
Two-level refinement and coarsening

# Local refinement



Refinement around car  
Time: 9h45min

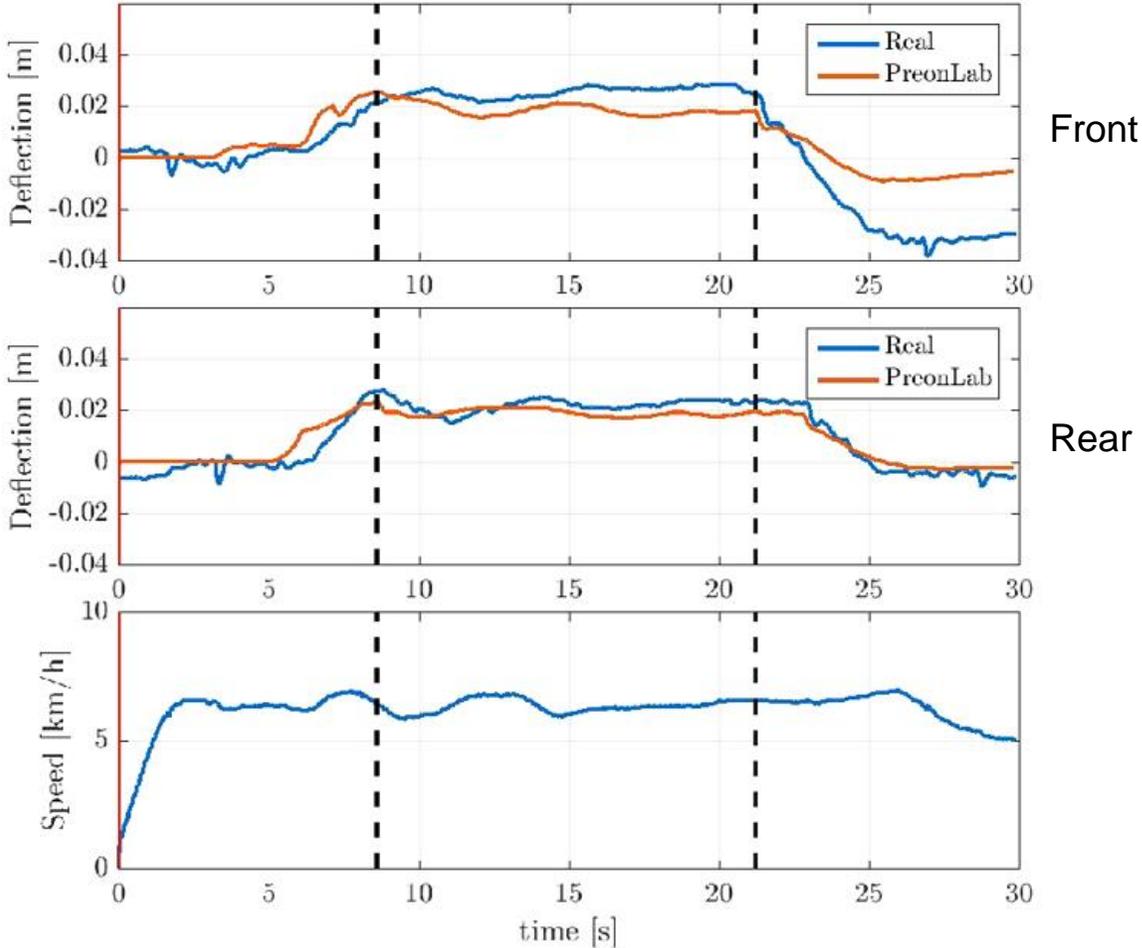


Uniform resolution  
Time: 17h





# Test 1 – 6 km/h



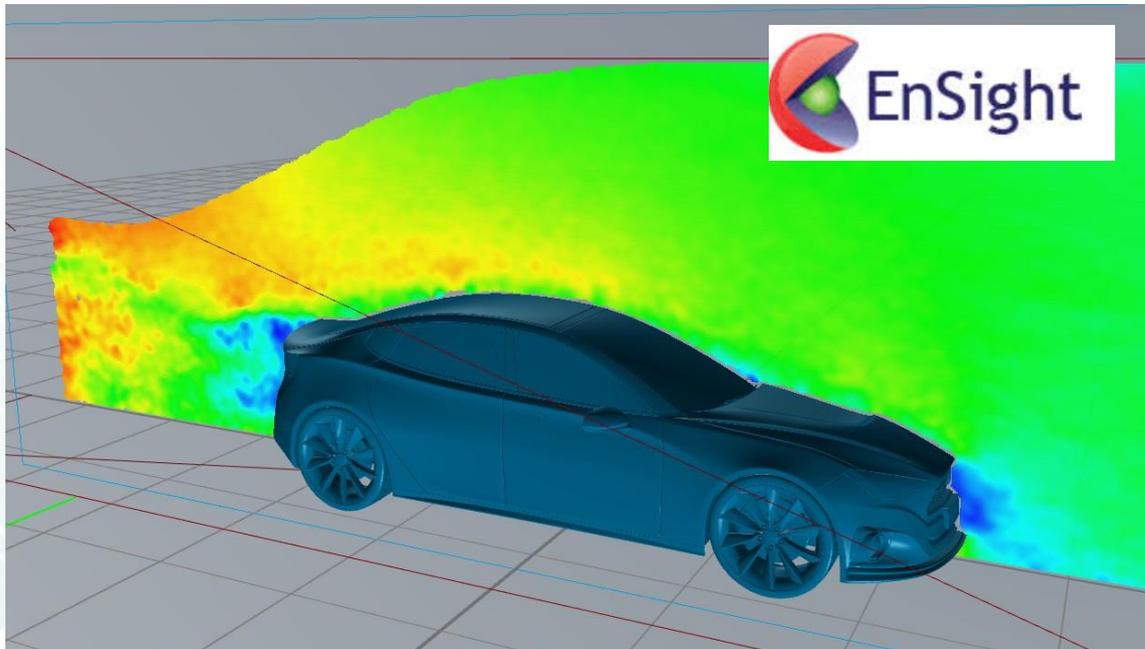
# Non-Newtonian fluids

**Preon  
Lab**

Non-Newtonian fluids

Different flow behavior indices

## Transient airflow import

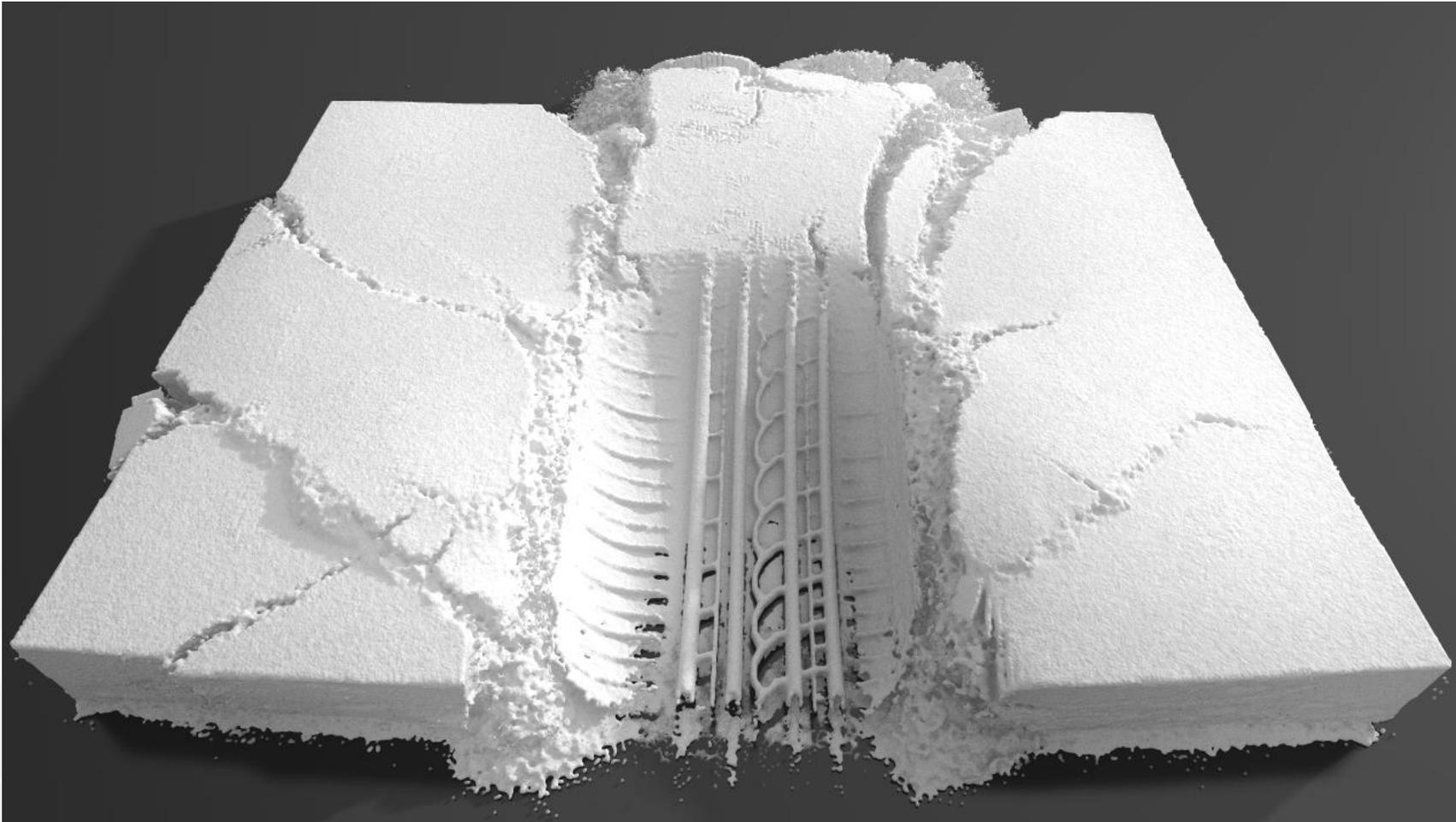


- Transient airflow import via EnSight Gold format
- Crucial for vehicle soiling
- Application areas: cameras & sensors  
ADAS / AD

# Snow Solver Improvements

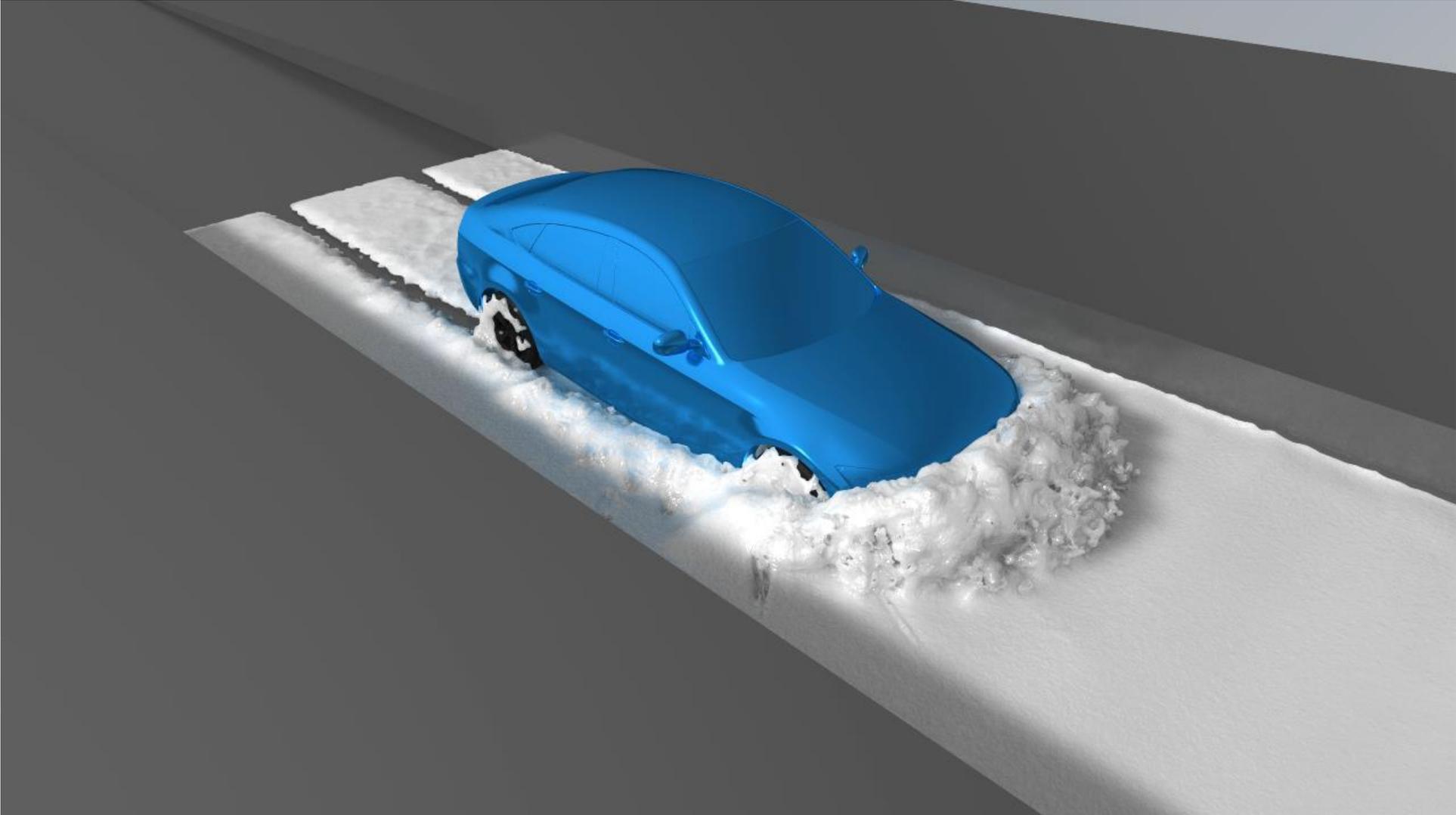


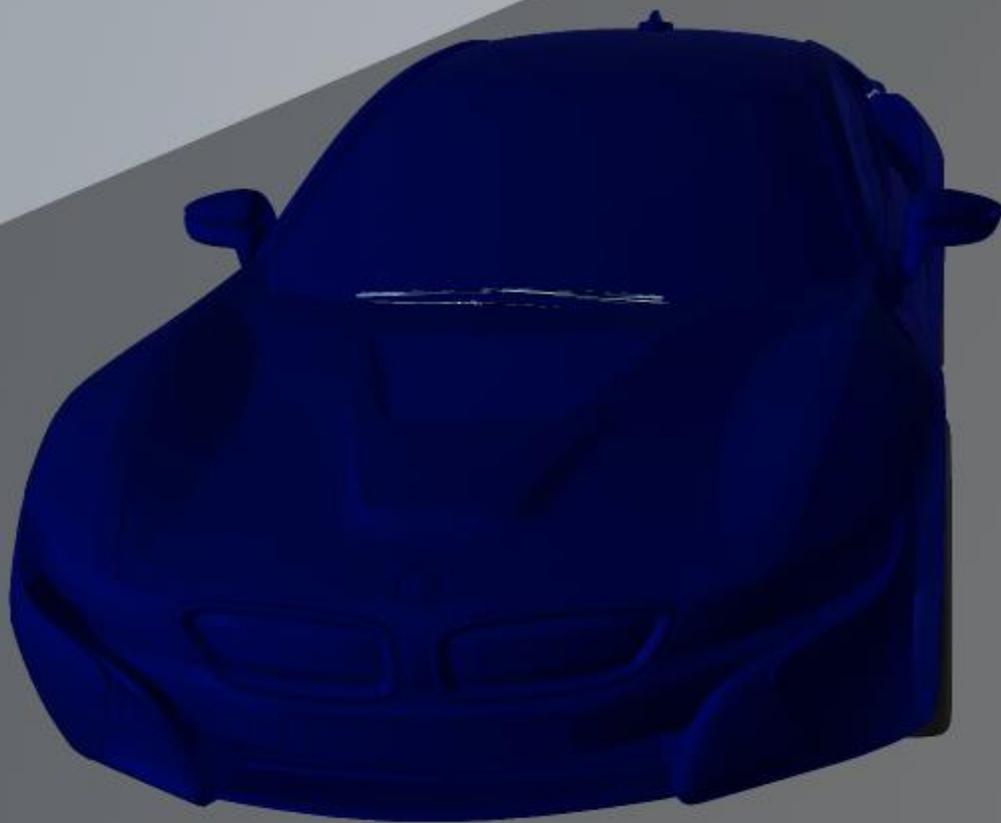
## Snow – advanced rendering

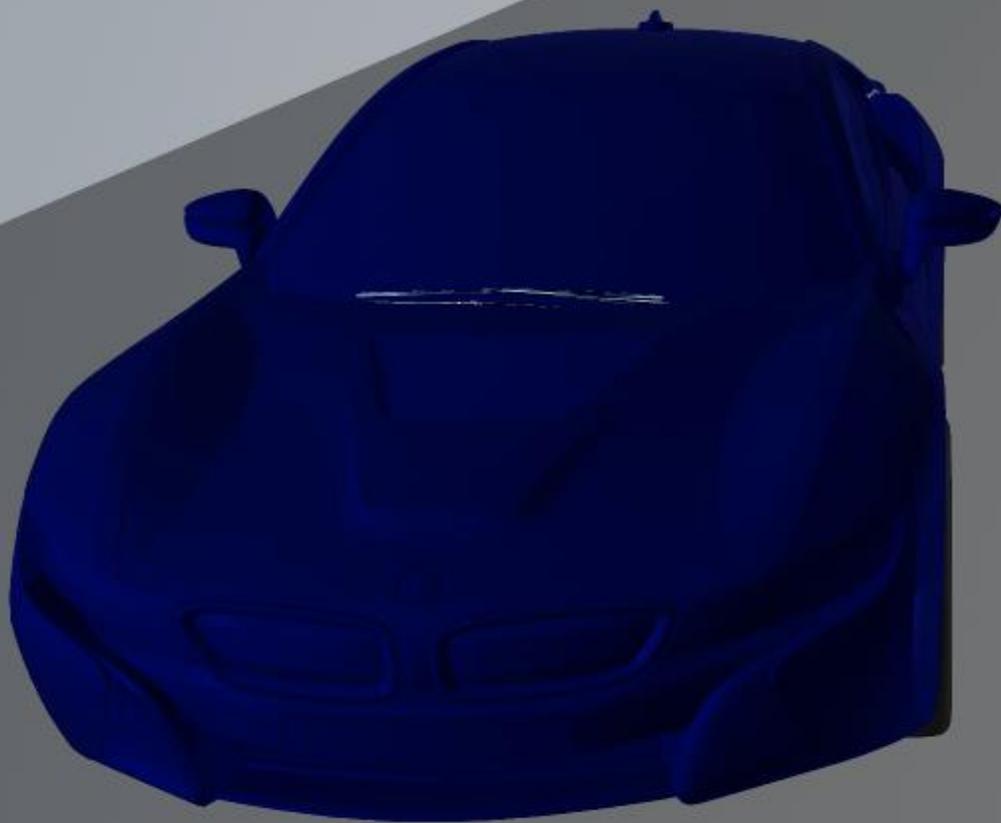


Particle-based, semi-implicit snow solver (invented by FIFTY2)  
Preon renderer – new snow material and improved capabilities

# Snow "wade"

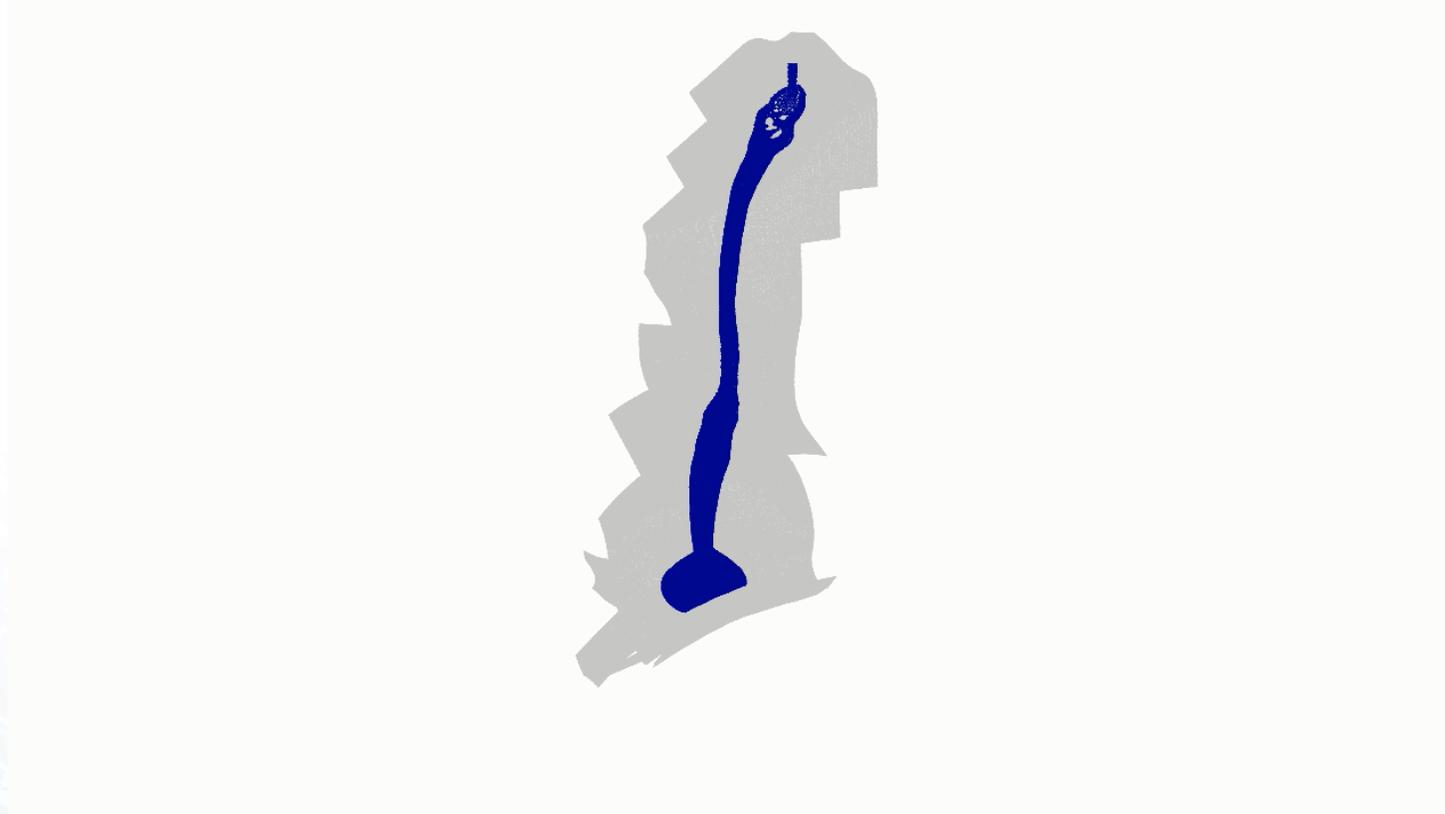






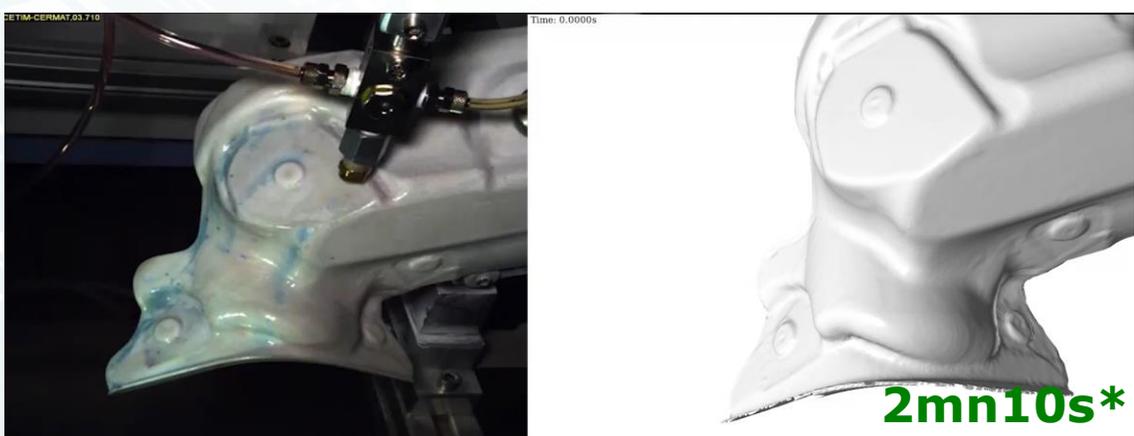


# Dynamic sampling



- Solids are only sampled in proximity of fluid
- Saves computation time and memory for most applications

# Leakage

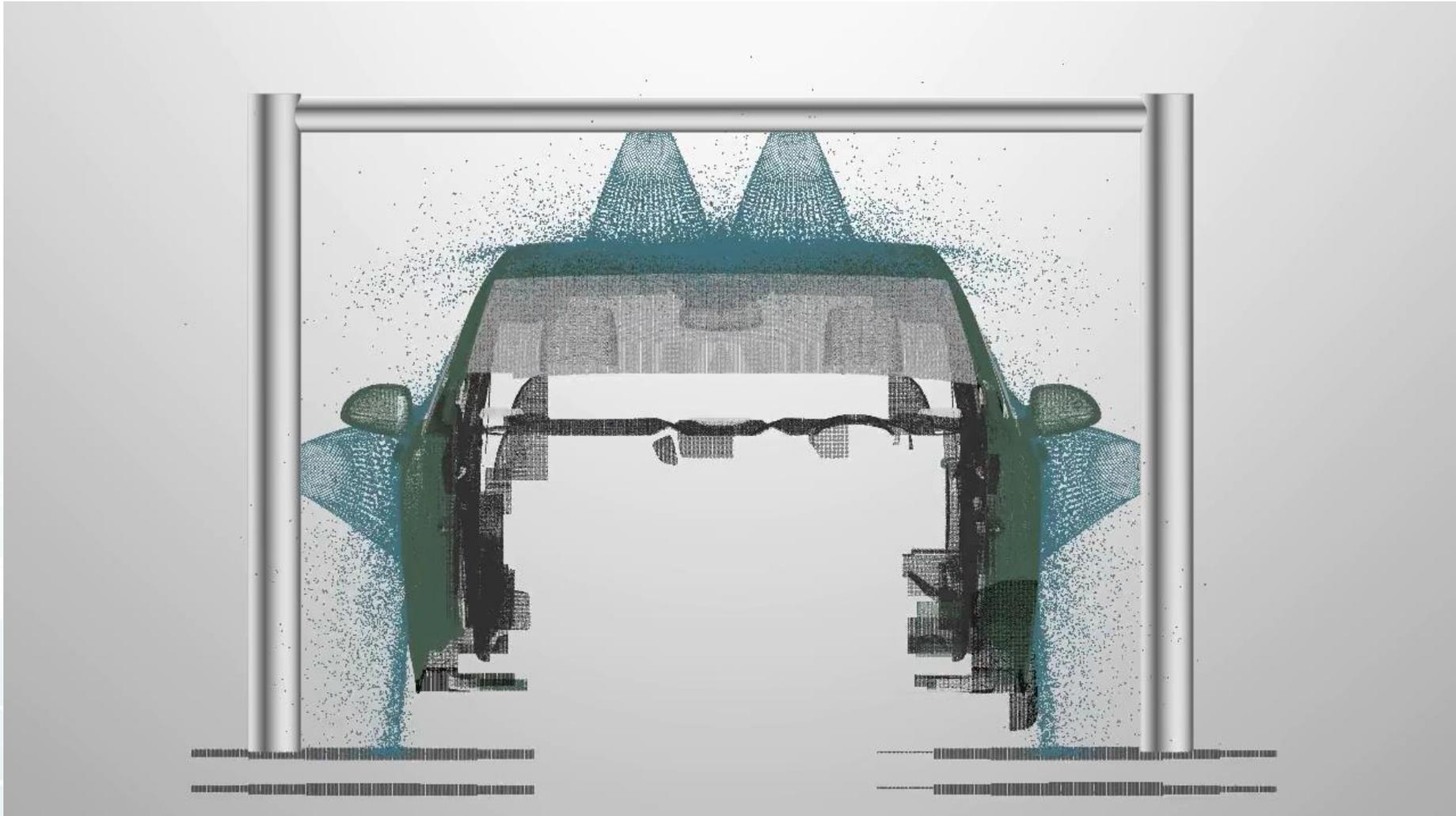


**Oil flow path is correctly recovered by PreonLab simulation**

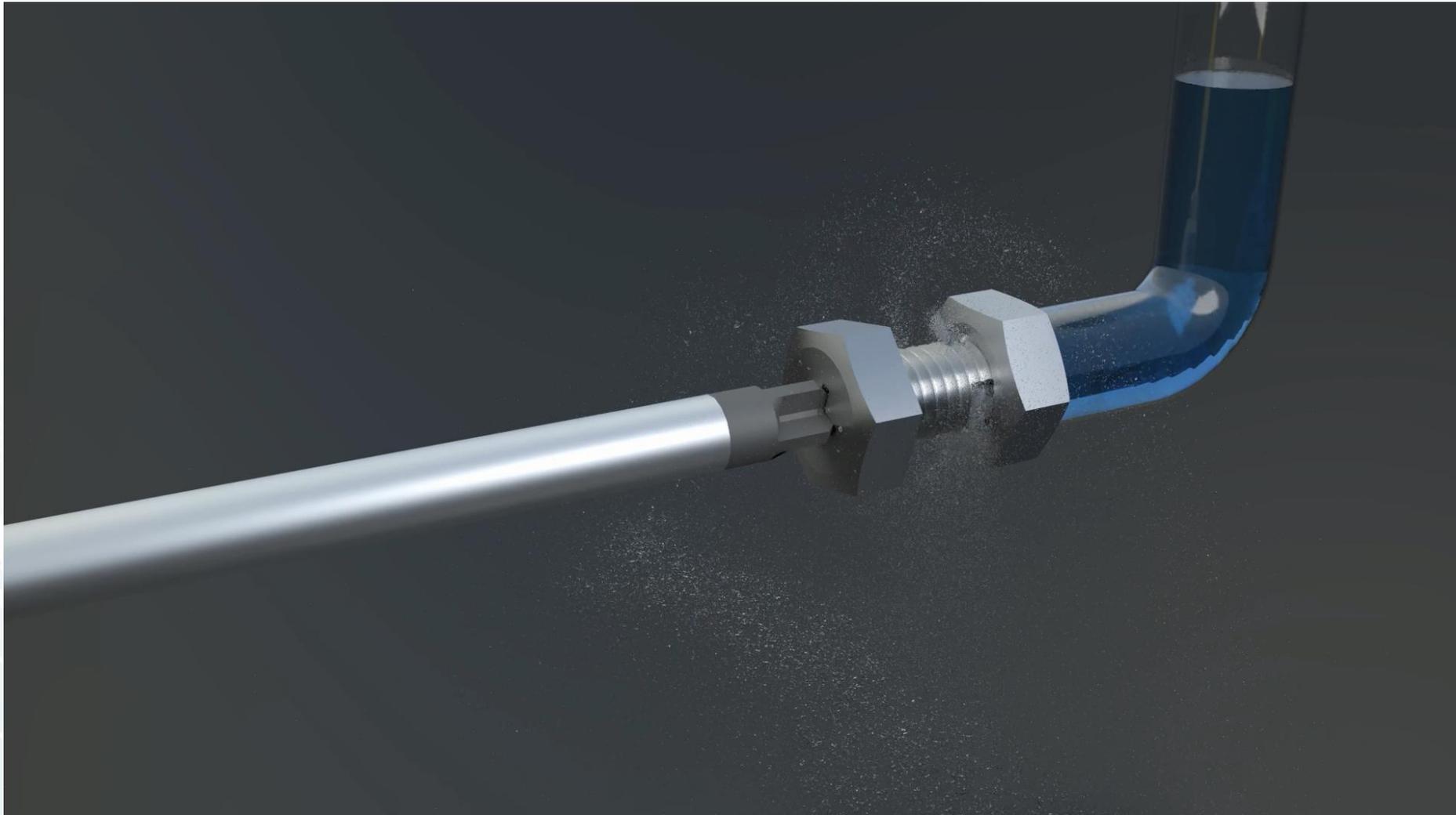
**Calculation time much faster than other solutions, even other SPH**

\*Wall clock time using 48 CPU's.

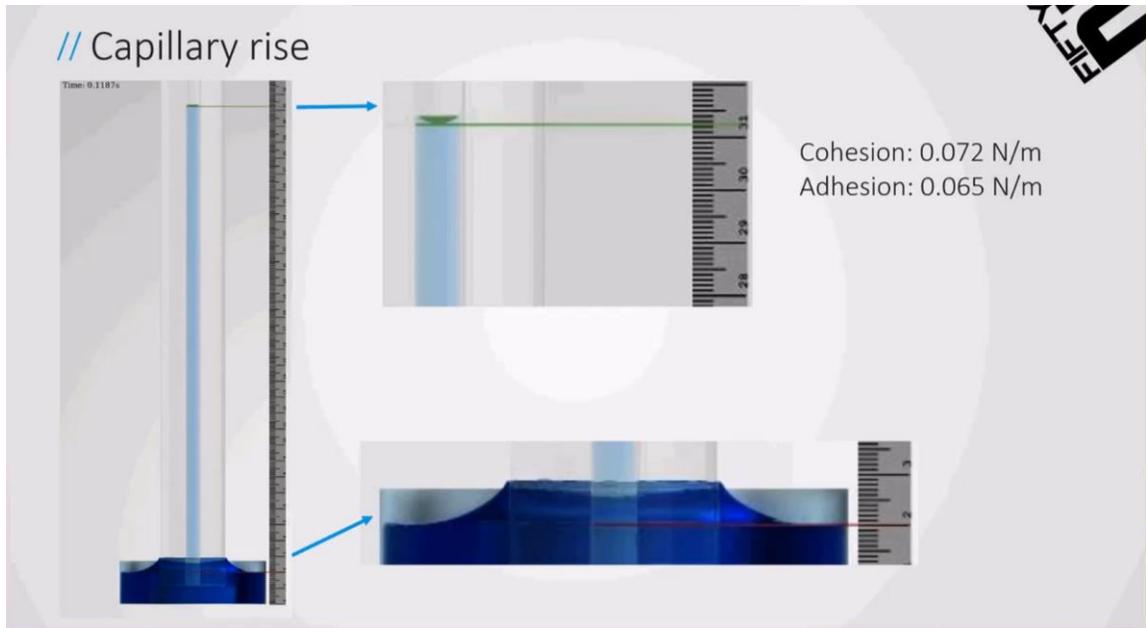
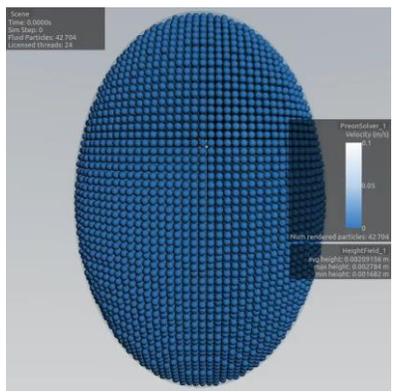
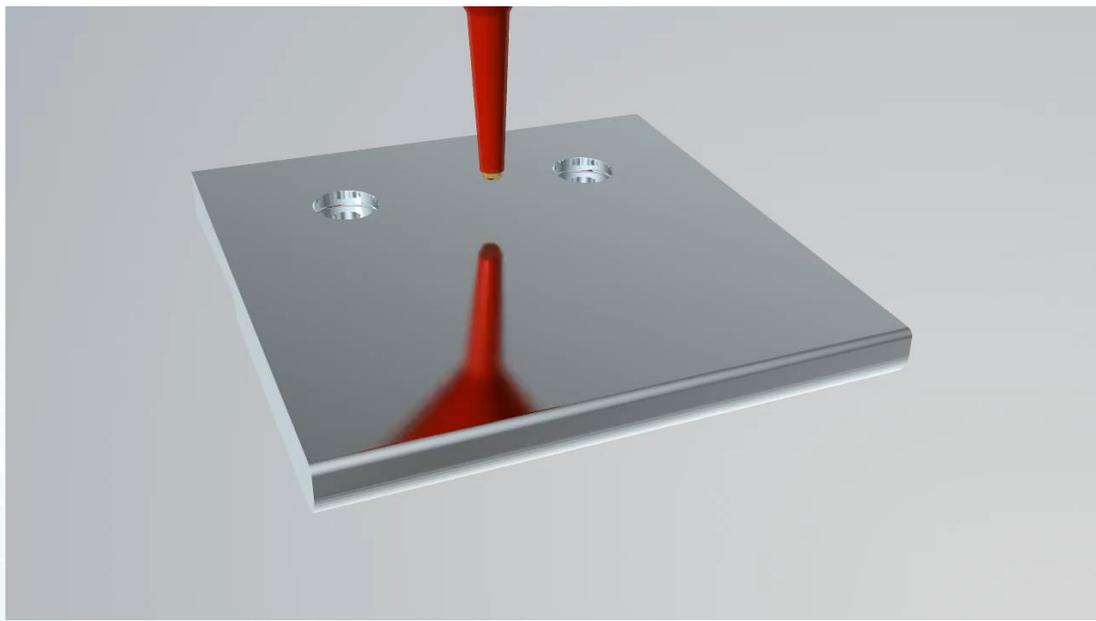
# Dynamic sampling



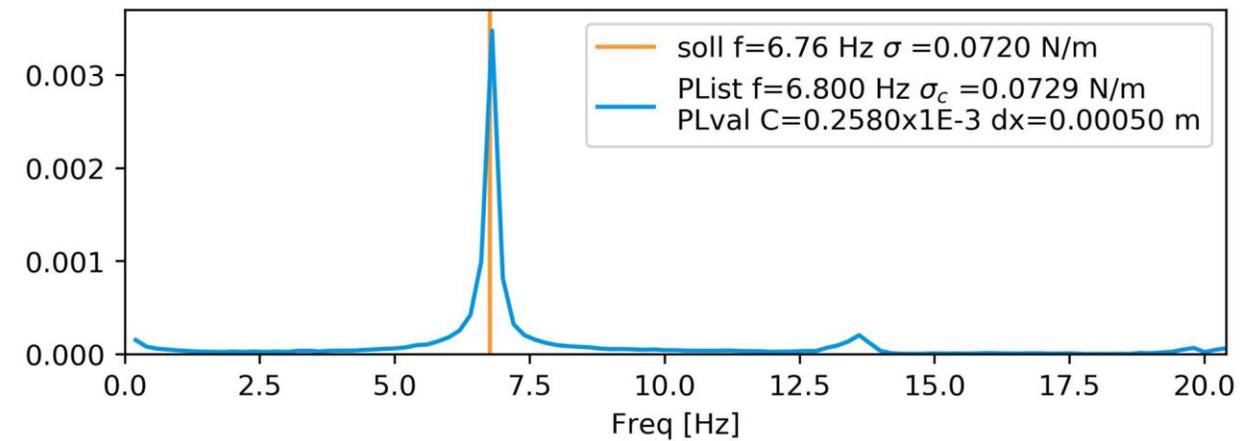
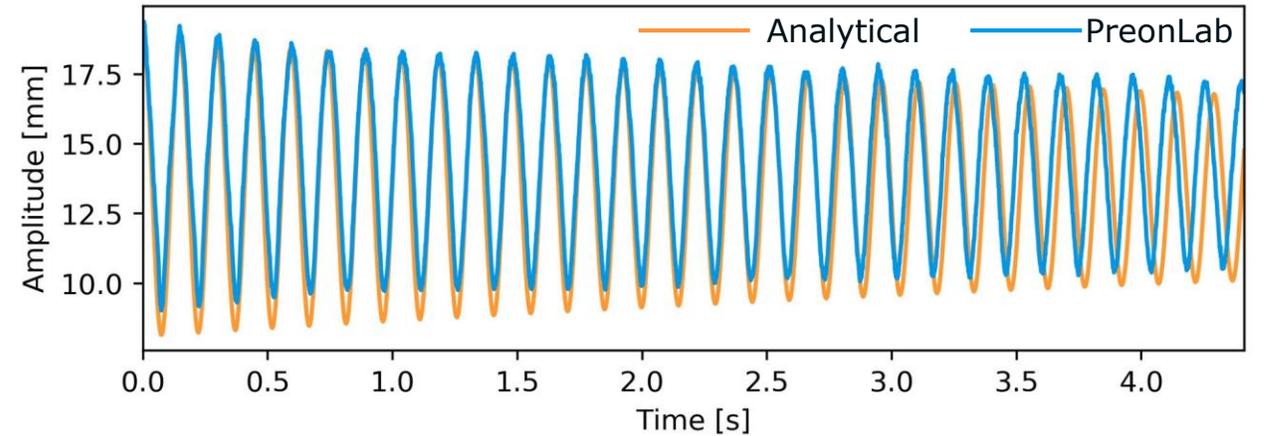
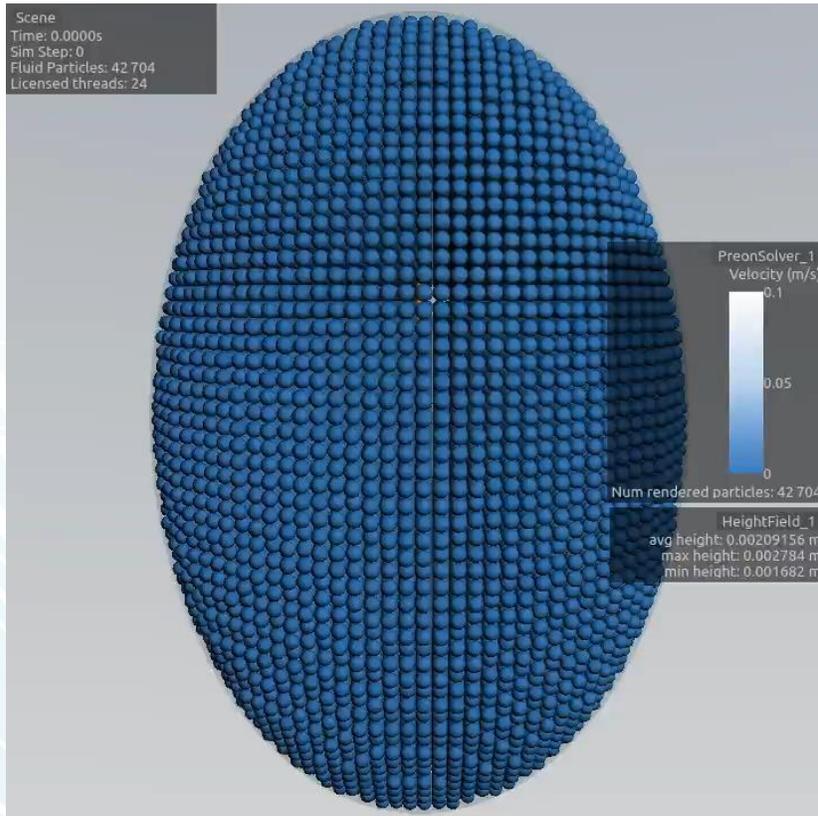
# Rigid-body solver MPI



# New Cohesion Model

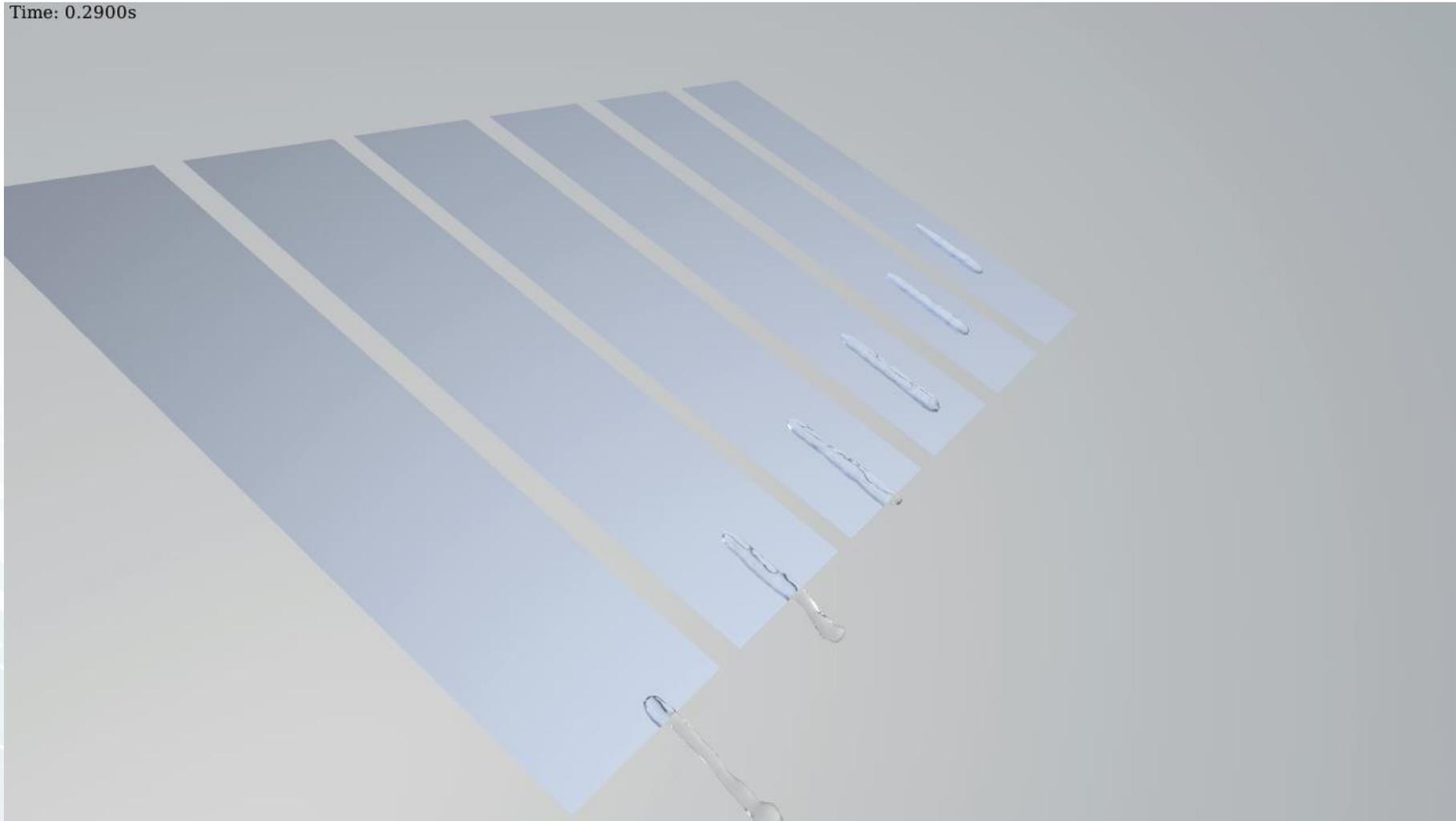


# Improved surface tension - Oscillating droplet



- droplet diameter 14 mm
- 42.000 particles (0.5-1 mm)

# Droplet run off



Planes just differ in adhesion, all other properties same, fluid is water

# Validation – Lid Driven Cavity 2D



Validation Benchmark

Lid-driven Cavity

# Validation – Planar Poiseuille Flow



Validation Benchmark

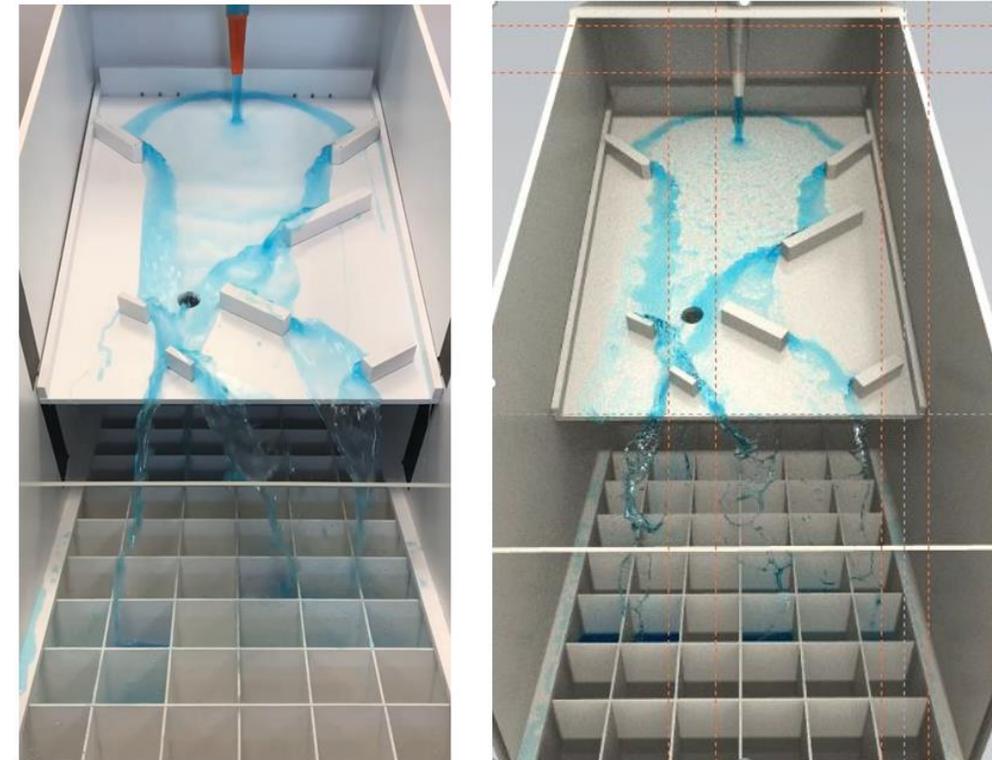
2-D Poiseuille Flow

# Incline Plane Benchmark

## Fazit

- Ergebnisse der Simulation stimmen mit Versuchsergebnissen in vielen Bereichen sehr gut überein
- korrekte Darstellung der Wellenausbildung des Wassers im Wasserbecken
- täuschend echte Darstellung des Fließverhaltens auf den Ebenen
- realistische Wiedergabe der Einschnürung der Wasserströmungen durch abnehmenden Wasserdruck
- Verteilung in der Kaskade zeigt nur geringe Abweichungen zu den Messdaten
- sehr geringe Berechnungszeit bei einem Einsatz von 96 CPU pro Simulation

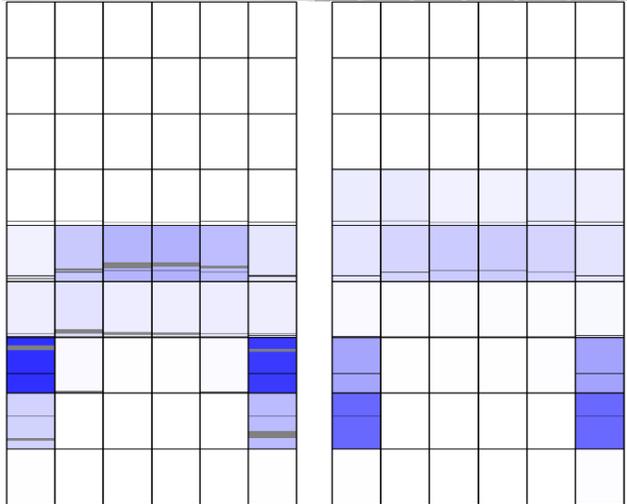
Ausschnitt aus Lastfall 3



# Incline Plane Benchmark

Measurement

Simulation





# Benchmark total vehicle



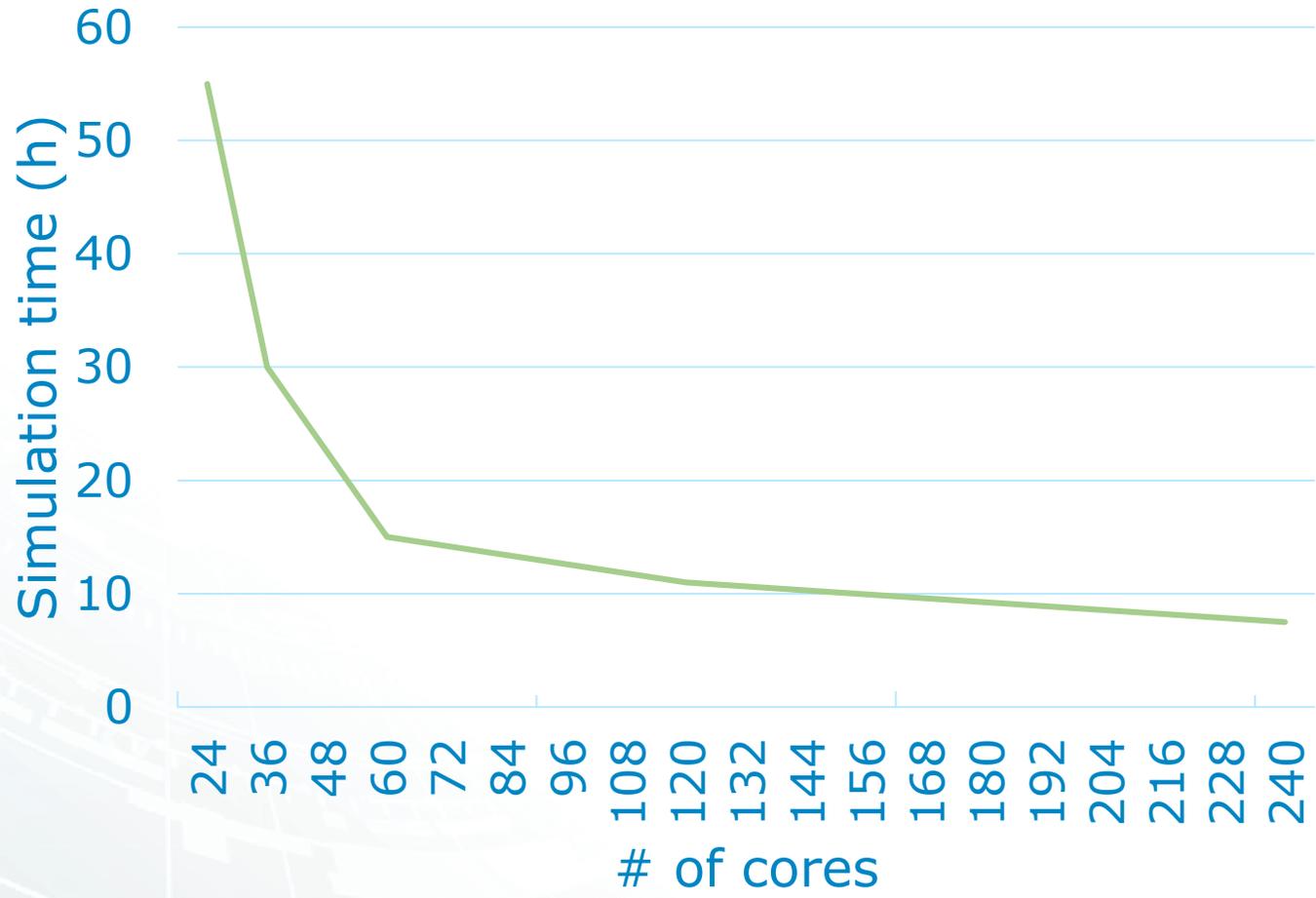
Number of nozzles	143
Flow rate per nozzle	80mL/s
Simulation resolution	2mm
# fluid particles	4.5 mio
Physical time	30 s



High-Performance Computing Center | Stuttgart

Sandy Bridge (E5-2670)  
 12 physical cores per node  
 64 GB RAM per node  
 Infiniband interconnection

# Benchmark total vehicle



# Summary



- Consideration of full geometrical complexity
- Superior performance
- No mesh-generation
- Consideration of complex rigid body kinematics
- Powerful post-processing and visualization

Virtualization Approved

Thank You



[www.avl.com](http://www.avl.com)

