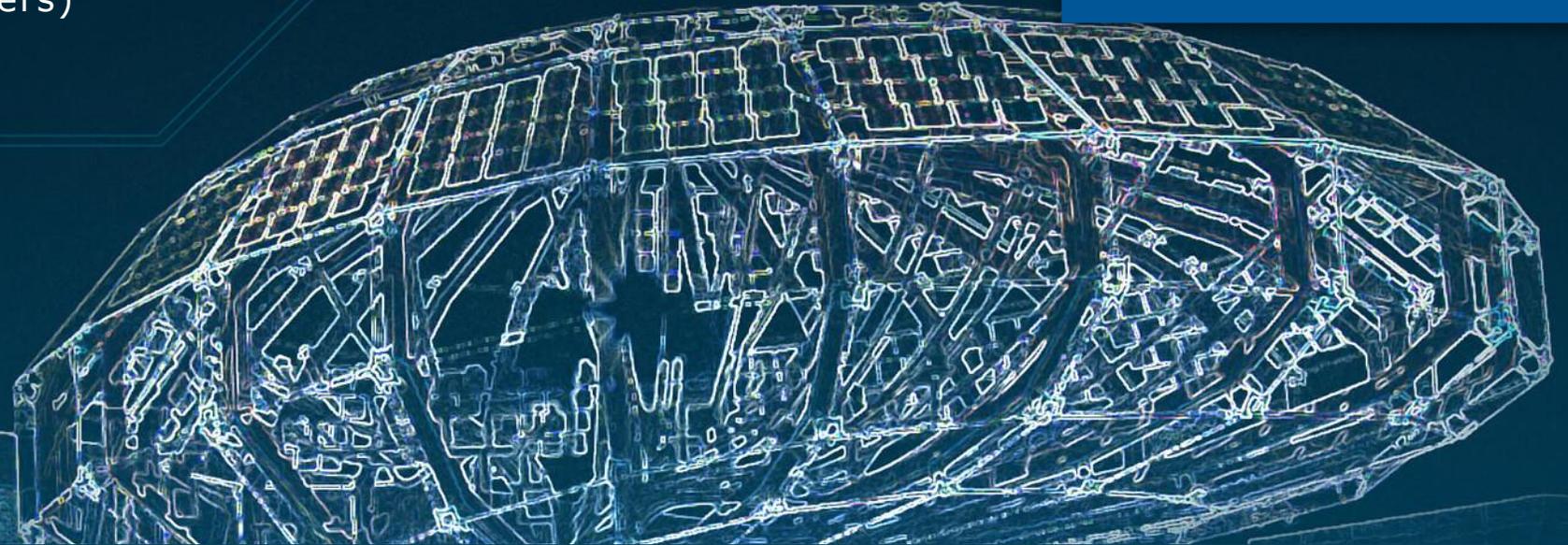


AVL



AVL List GmbH (Headquarters)

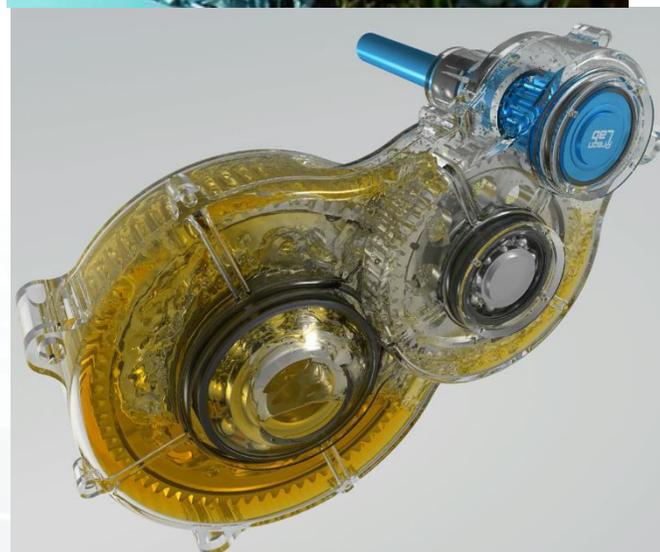


Engine & transmission lubrication modelling in PreonLab

David Greif

Liquid dominated flows

**Preon
Lab**

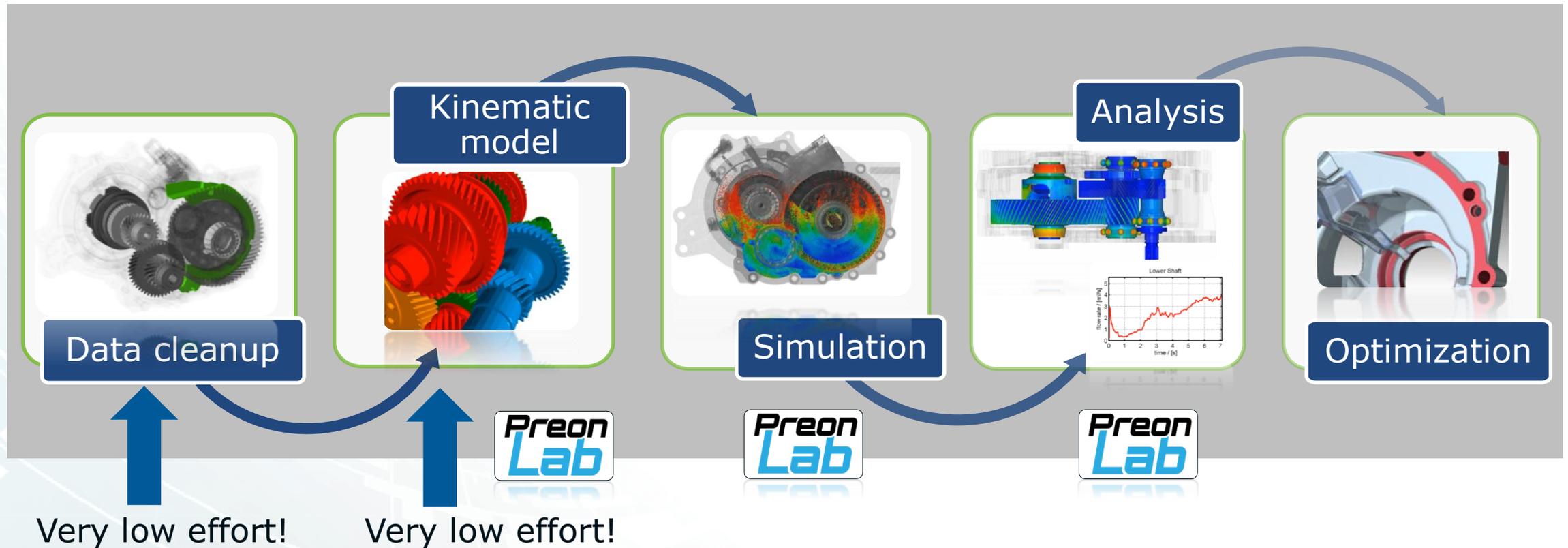


- Water passage / wading ✓
- Rain water management ✓
- Leakage / tightness tests ✓
- Lubrication / gear box / transmission ✓
- Tank filling / sloshing ✓
- Water splashing in naval applications ✓
- Hydro power / flooding ✓



Lubrication Development Simulation

Workflow



Rigid body solver parallelized



Preon Lab v3.1 Showcase

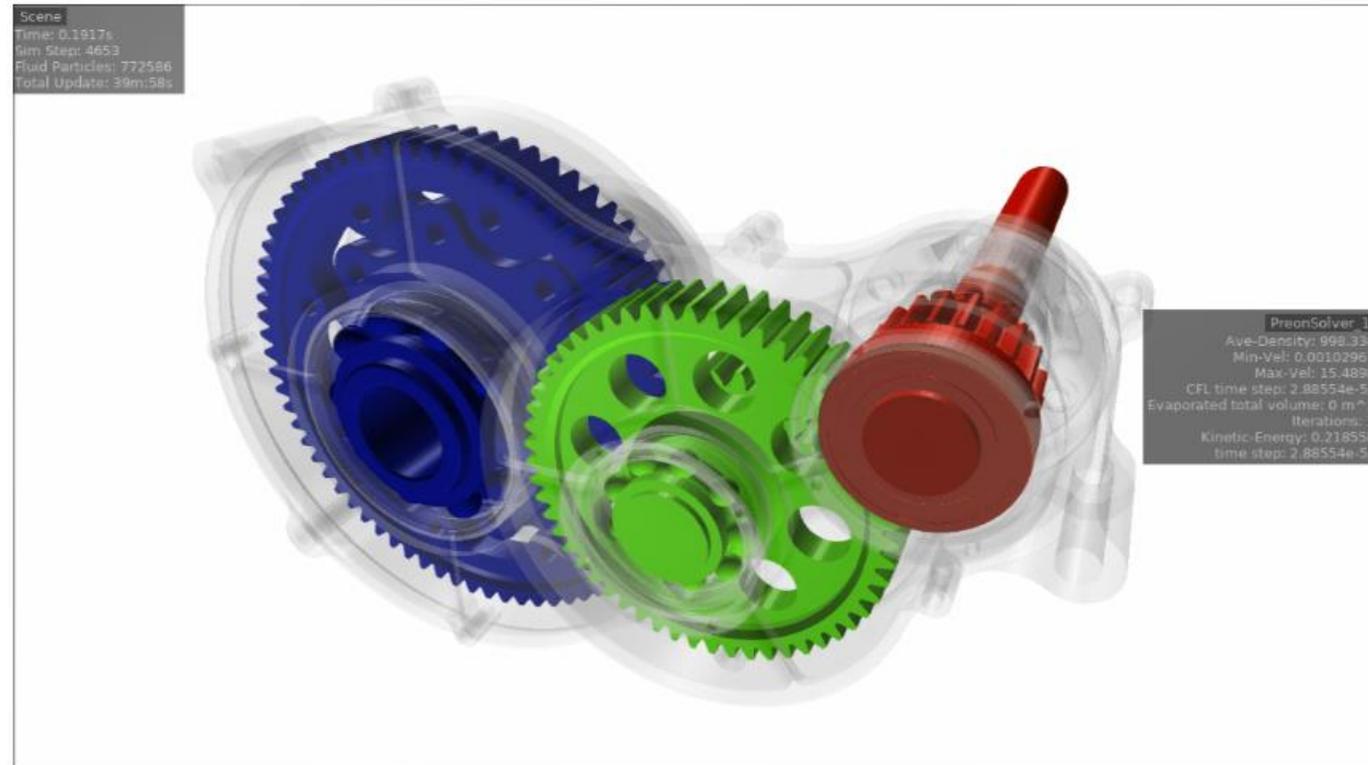
Gearbox model kindly provided by Aniket Malbari

Transmission example

MOTION DEFINITION

Shaft	rpm
High speed	3000
Mid speed	1091
Low speed	280,5

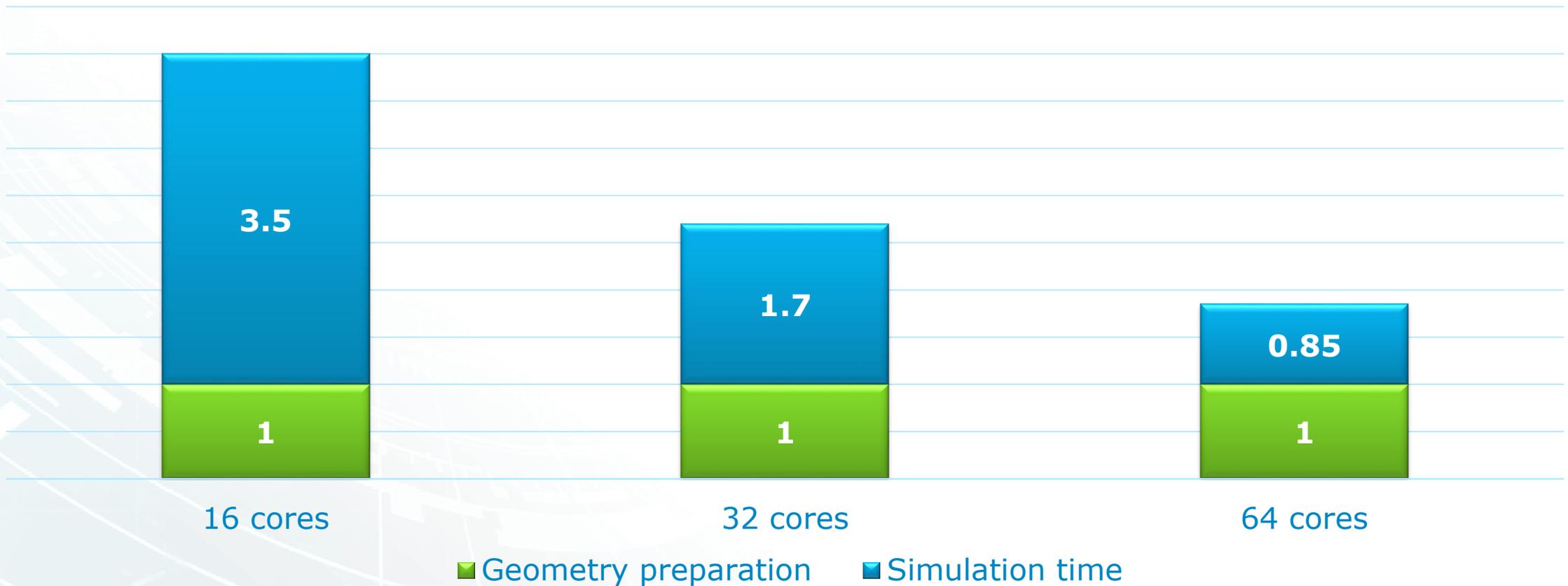
Solved by RBS



Transmission - Turnaround time

Physical time **0,8 [sec]= 50 revolutions** (high speed shaft)

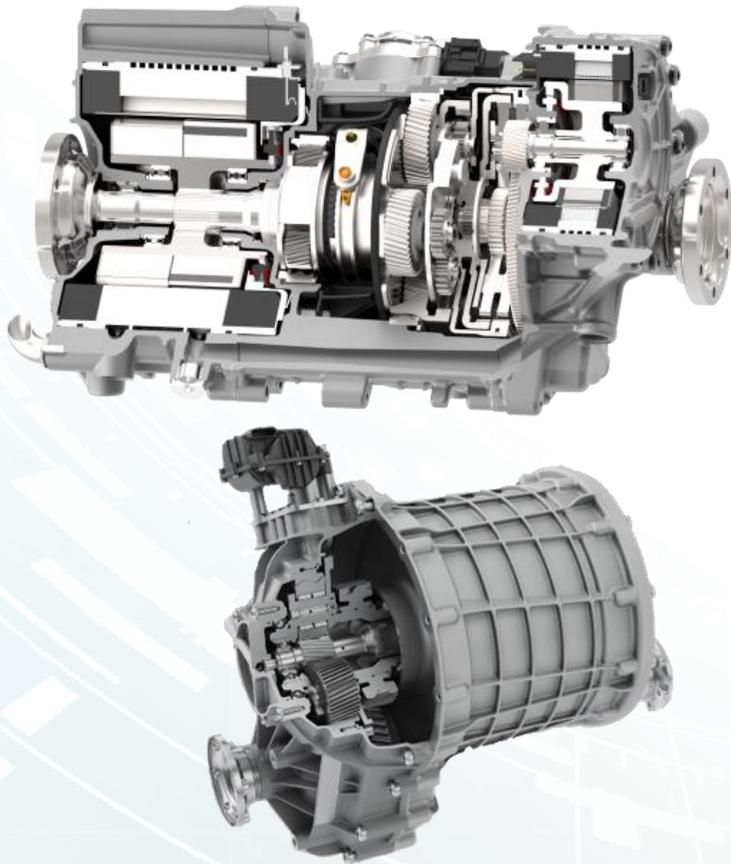
Time to results [hrs]



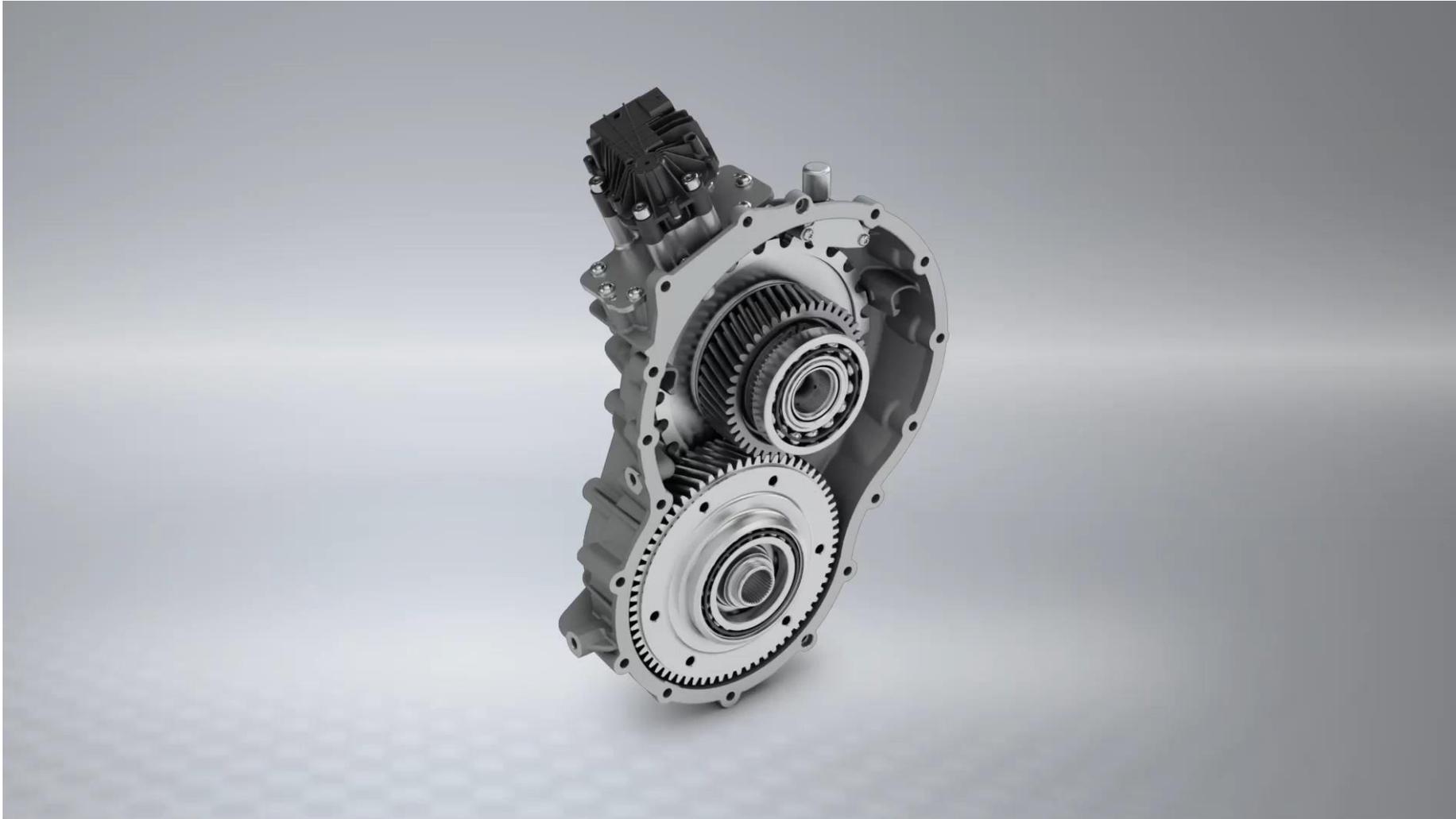
e-axle systems and e-gearboxes

e-axle systems

e-gearbox; axis-parallel and co-axial layouts



Achsparalleles eGetriebe



Messung: Volumenstrom

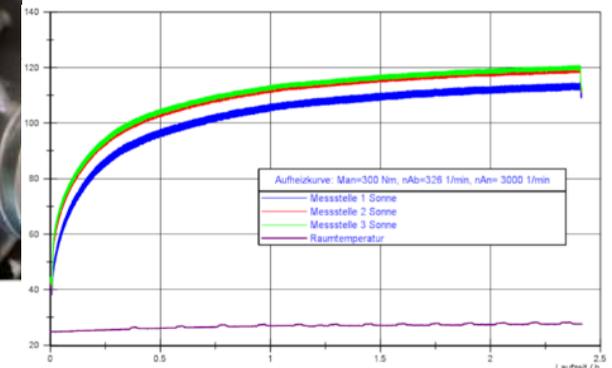


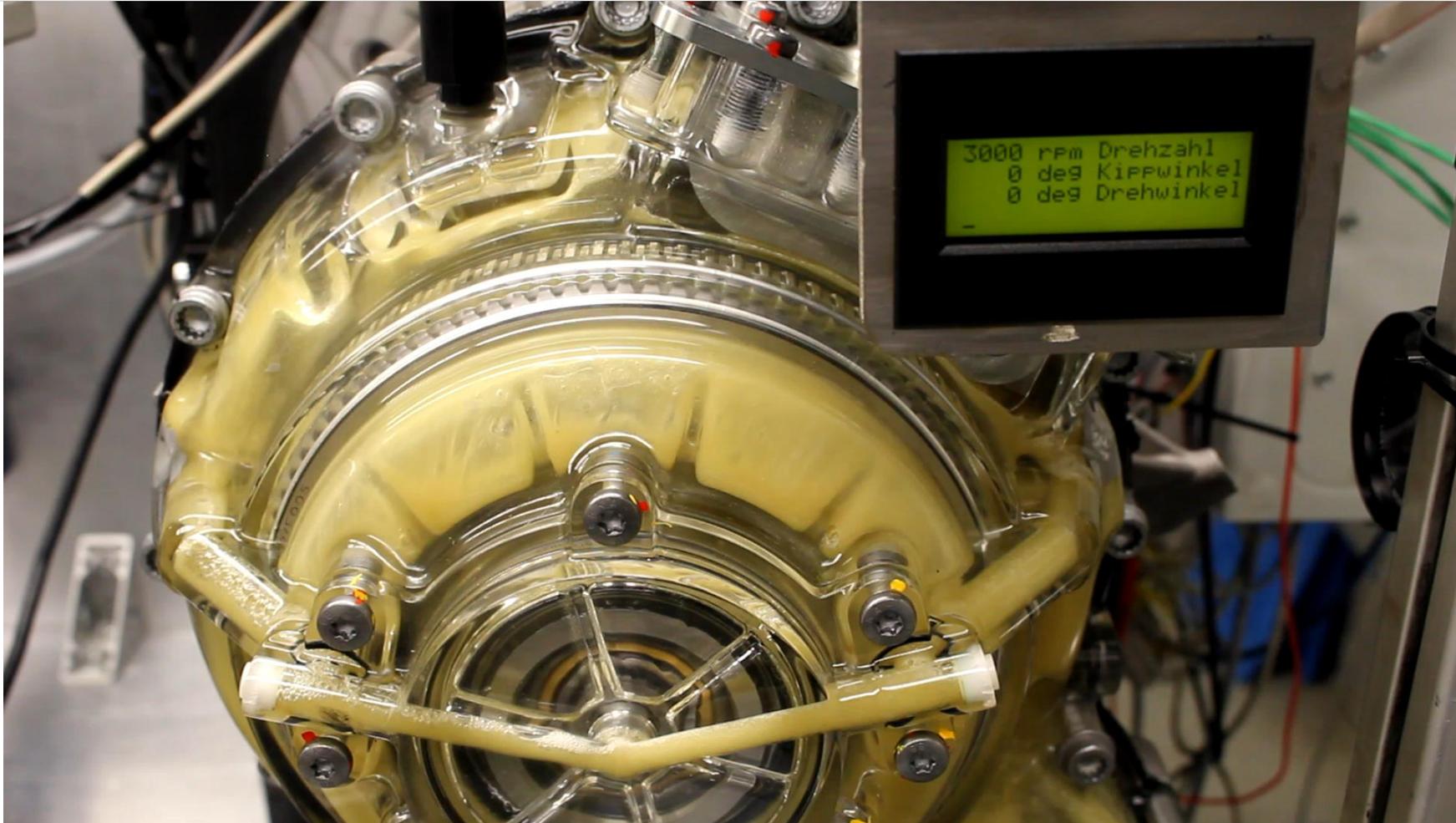
Nur an Beölungskanälen möglich!

Messung: Aufheizkurven



Transiente Temperaturverläufe



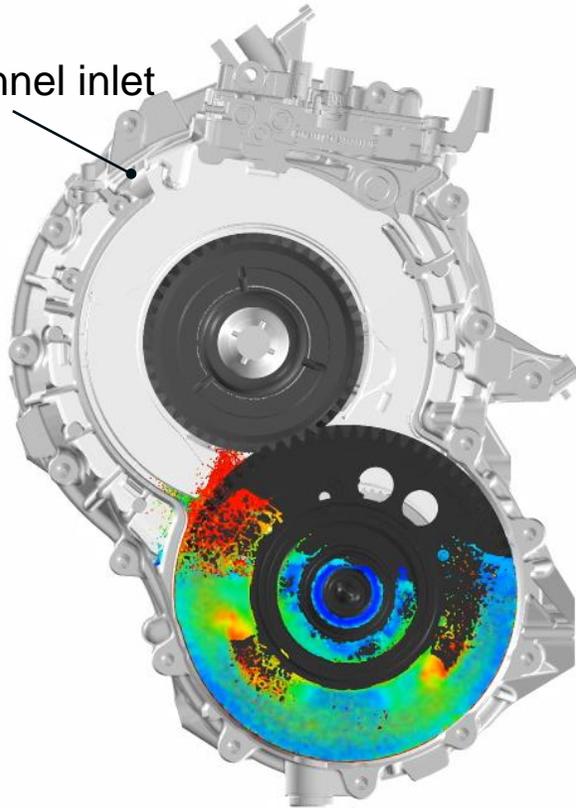


Begrenzte Auswertungsmöglichkeiten der Ölverteilung

Oil distribution simulation

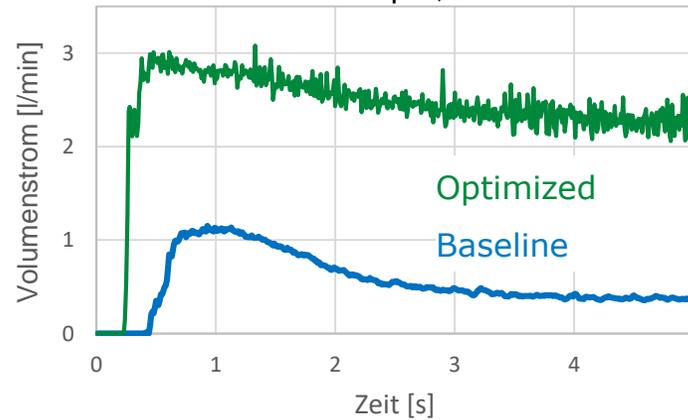
Baseline version

Oil channel inlet

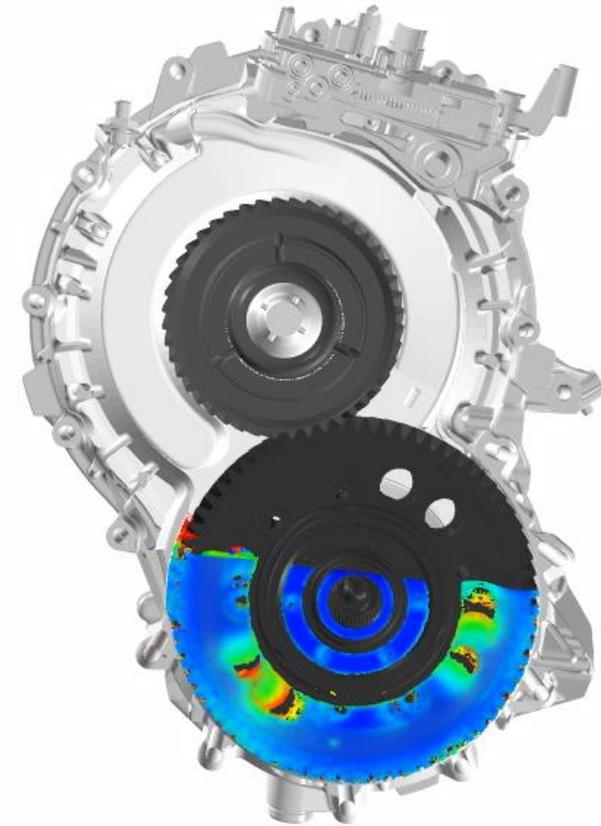


Volume-flowrate increased 5x

Provided oil quantity
7000 rpm, 90 °C



Optimized version



SCHAEFFLER AVL German Simulation Conference 2018

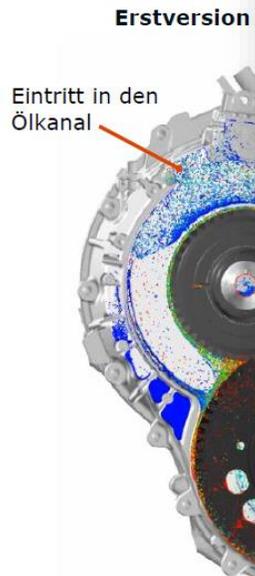


Simulation results have been verified by experiments.

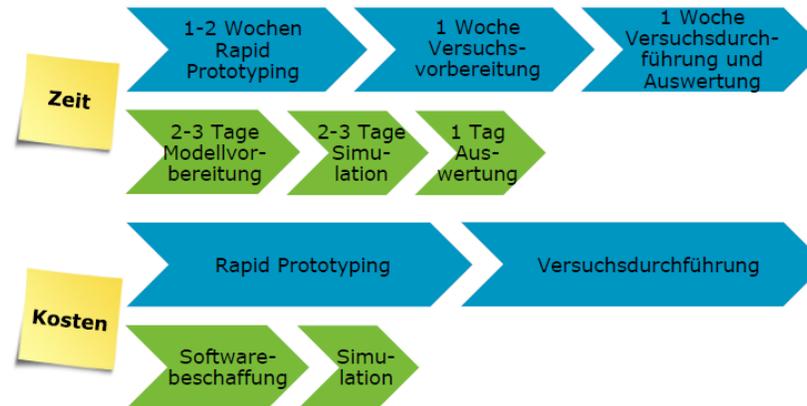
White paper by SCHAEFFLER

English version will be published

Beispiel z... Vorteile einer simulationsbasierten Beölungsentwicklung



Workflow einer Designiteration



Die Simulation der Ölverteilung mit PreonLab bietet signifikante Vorteile hinsichtlich Kosten und Zeit für jede Designvariante. Darüber hinaus bietet die Simulation umfangreiche Möglichkeiten zur Darstellung der Simulationsergebnisse im Post-Processing, welche wiederum ein tiefgehendes Systemverständnis für das optimale Design ermöglichen. Virtuelle Sensoren können an beliebigen – auch an für den Versuch unzugänglichen – Stellen platziert werden, um quantitative Aussagen zu erhalten. Dies ist auch während des Post-Processing möglich, nachdem die Berechnung des Lastfalls durchgelaufen ist.

Virtual Prototyping bietet durch den Einsatz von innovativen Simulationsmethoden ein enormes Potenzial zur Verkürzung von Entwicklungszyklen. Das netzlose SPH-Verfahren und der extrem performante Rechenkern ermöglichen PreonLab designbegleitende Untersuchungen verschiedener Beölungskonzepte. Die kurzen Durchlaufzeiten und das moderne Post-Processing erlauben eine kurzfristige und fundierte Bewertung der Ölverteilung im Getriebe.

„Der kombinierte Einsatz von Virtual Prototyping mit PreonLab und dem klassischen Versuch stellt für uns einen effizienten Weg in der Entwicklung der Beölungskonzepte für E-Achsen dar und unterstützt uns dabei, unsere Ziele hinsichtlich eines funktions-gerechten Designs möglichst früh im Entwicklungsprozess zu erreichen oder bei Bedarf zu modifizieren.“ Christian Dassler, Leiter R&D, Produktlinie E-Achse Getriebe, Schaeffler Technologies AG & Co. KG



- Simulation unterstützt den Design Ingenieur
- Einfache und schnelle Untersuchung von Designvarianten
- Reduktion von kosten- und zeitintensiven Hardware Tests



Objective: leakage prediction

Flammable liquid leak in engine bay : Oil, gasoline...



Contact

Hot part :
Catalyst, turbo...



Leads to



Car Fire Briefly Closes Beasore Road in Bass Lake

Sierra News Online (press release) (blog) - 19 sept. 2019

The driver stated that he thought an **oil leak** had spilled on to the **engine** manifold, sparking the **fire**. The man escaped without injury but the car ...



Objective: leakage prediction

Flammable liquid leak in engine bay : Oil, gasoline...



Leads to



Hot part :
Catalyst, turbo...



Safe flow path :



Simulation for parts design optimization

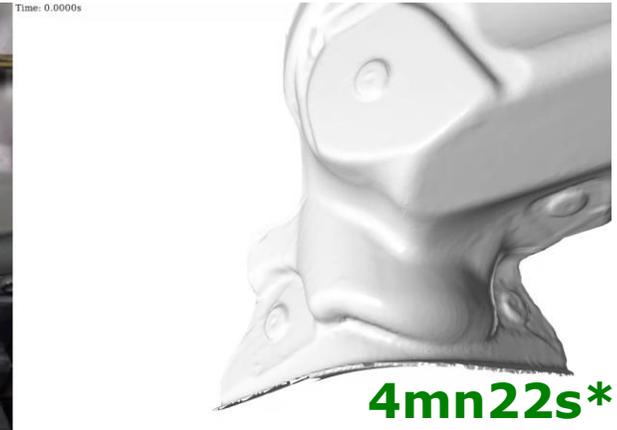


RENAULT



Validation

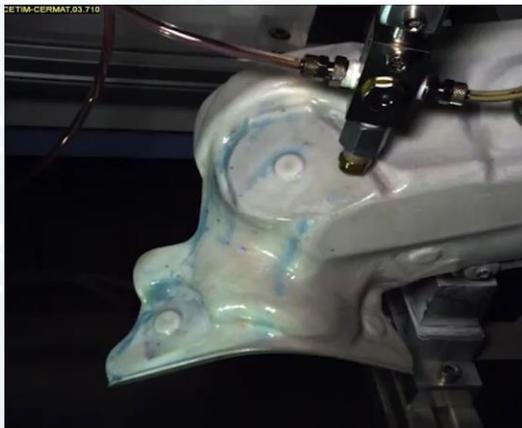
Comparison of tuned simulations with experimental videos



APPROVED

60mn47s*

4mn22s*



2mn10s*

Oil flow path is correctly recovered by PreonLab simulation

Calculation time much faster than other solutions, even other SPH

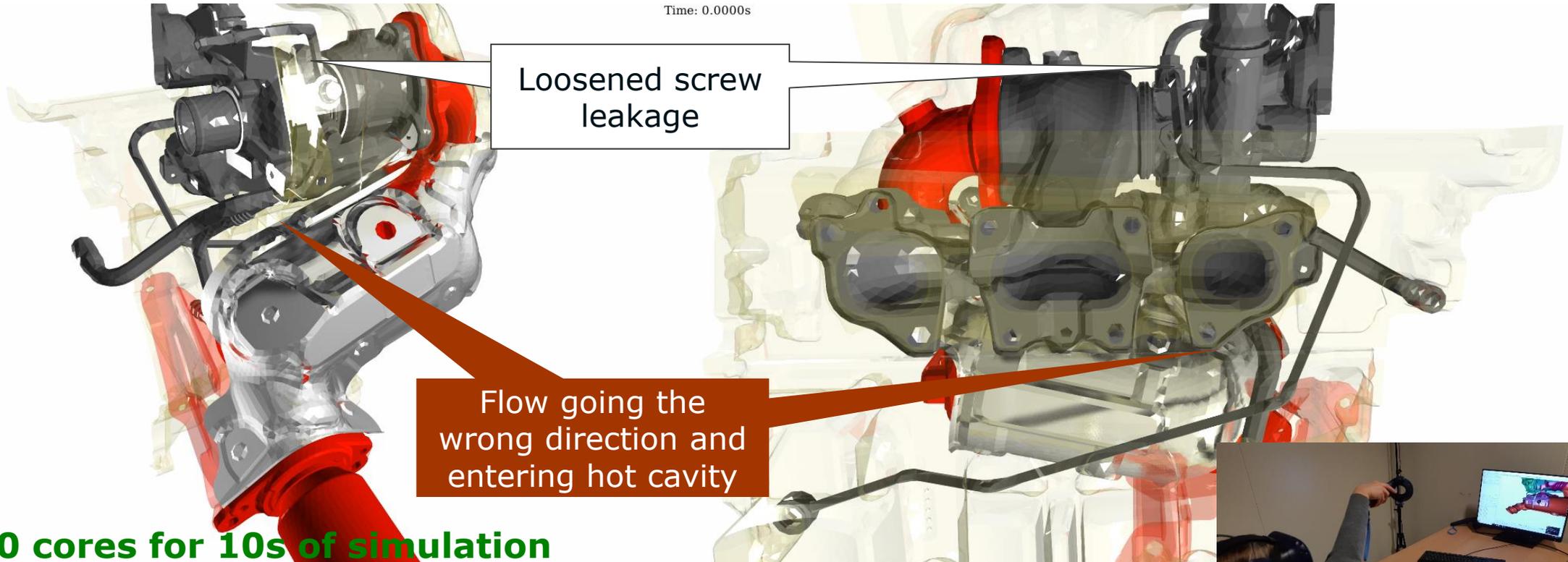
*Wall clock time using 48 CPU's.



Application to real engine

Oil leak on the whole RENAULT H5 engine using parameters from study

Time: 0.0000s

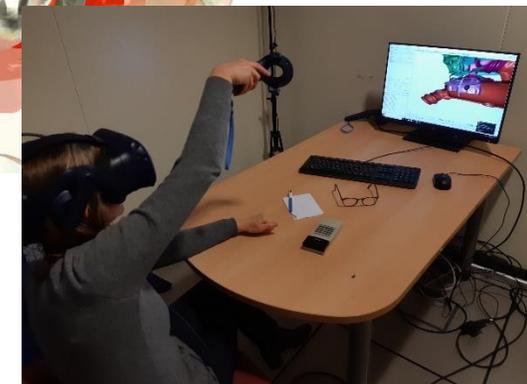


3h on 80 cores for 10s of simulation

Calculation is fast !

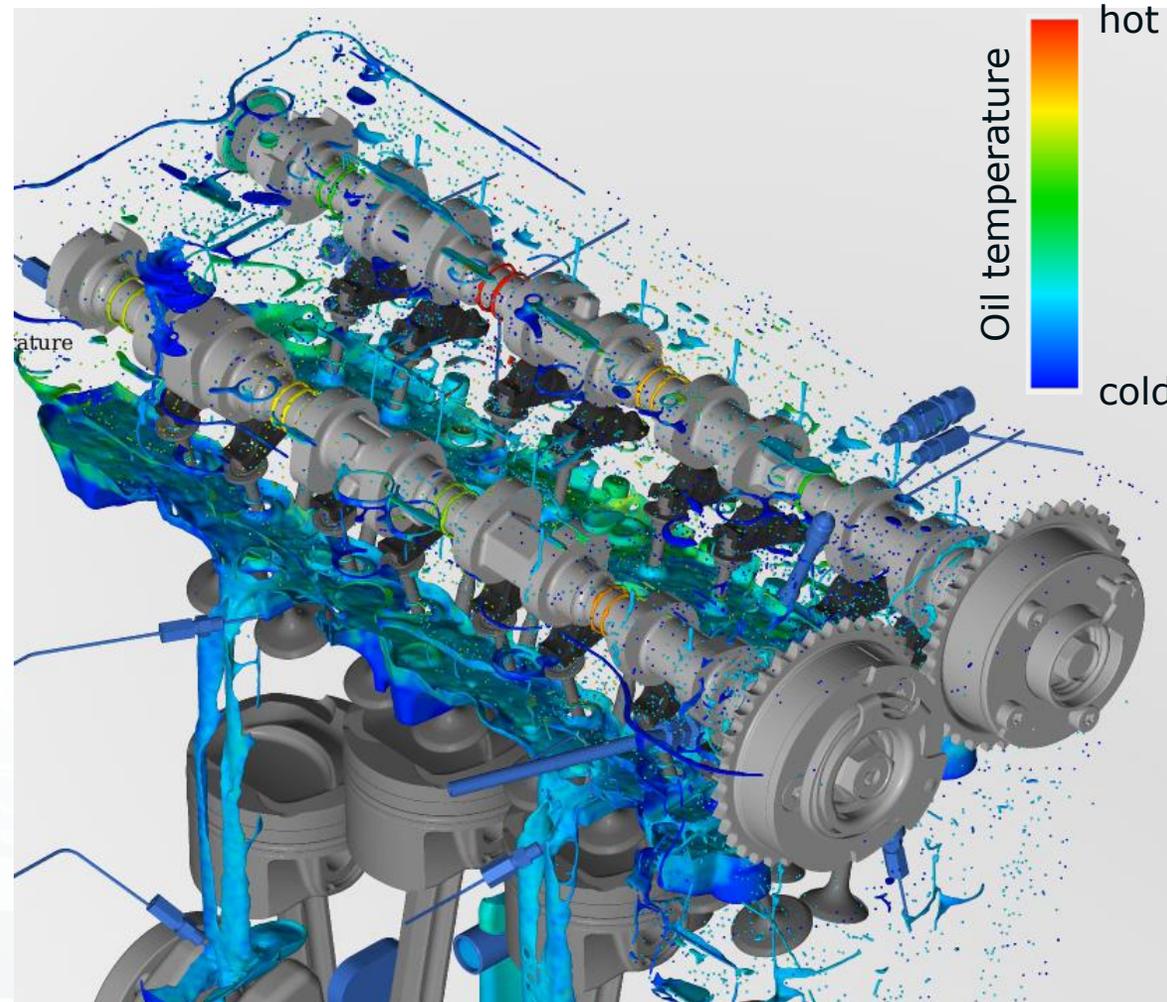
Dangerous situations is easily visualized.

Virtual reality post-process is supported thanks to third party software



Simulation Engine Oil Flow

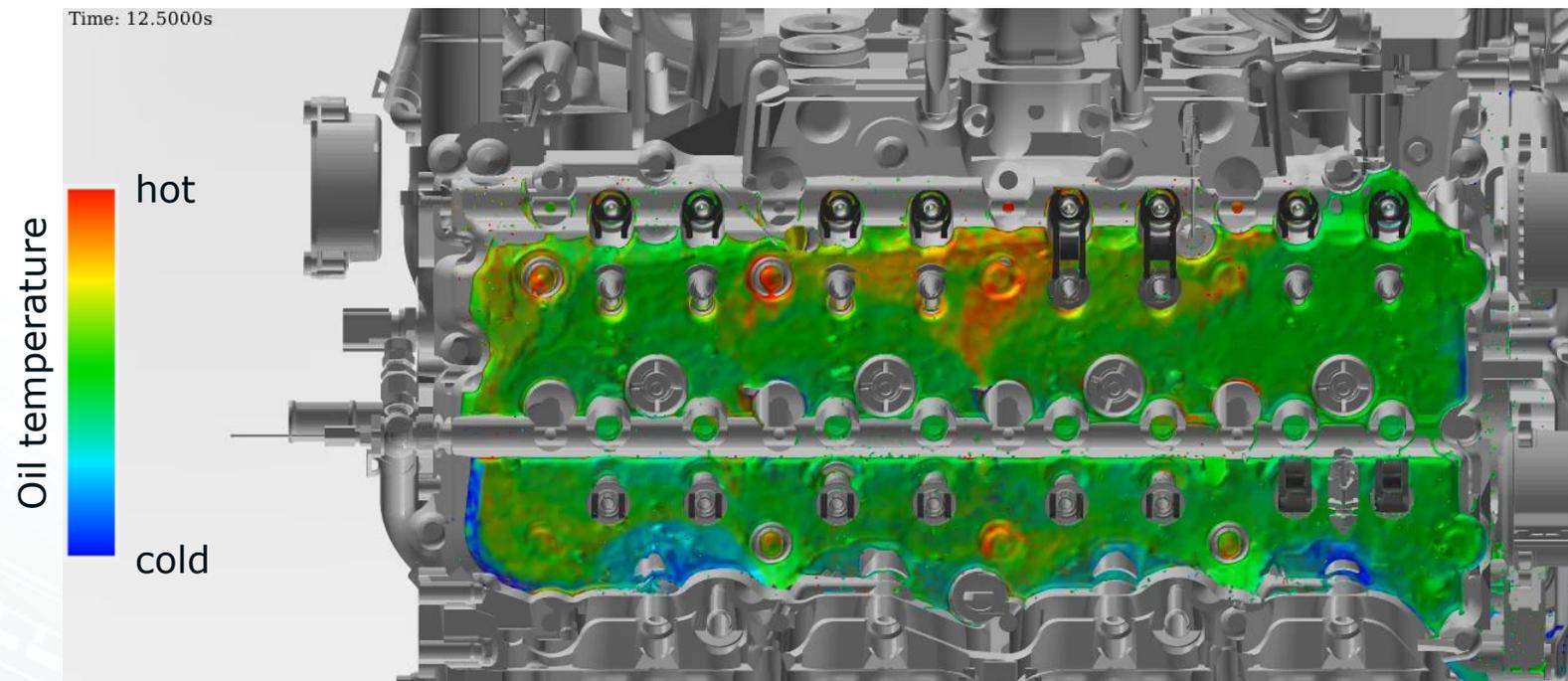
Oil distribution and oil temperature in cylinder head 1.100 RPM



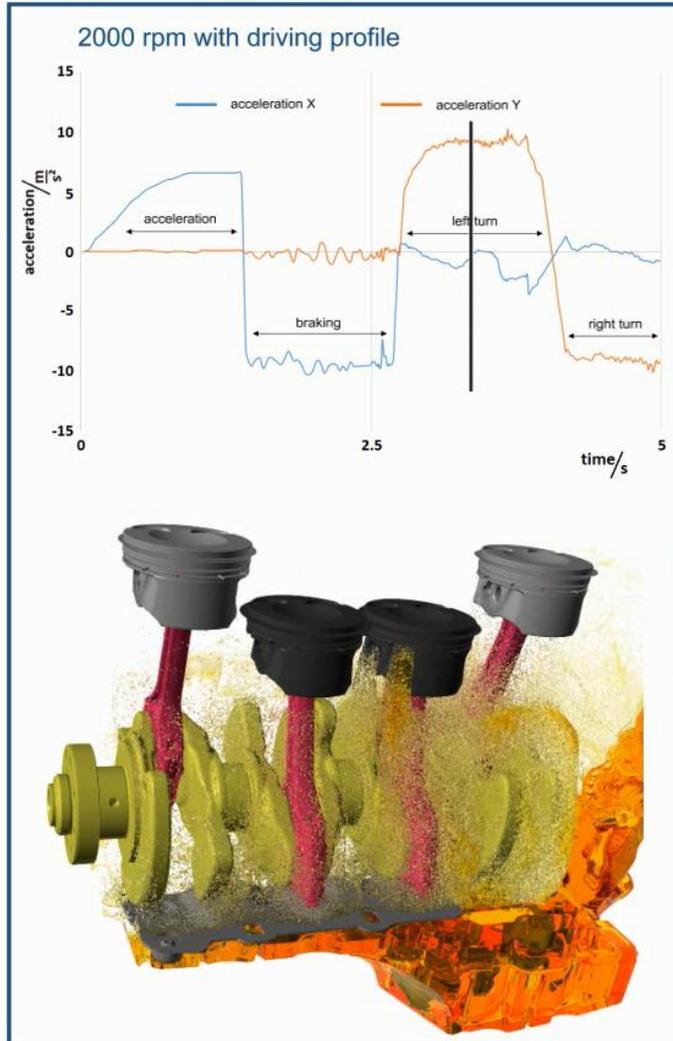
AVL German Simulation Conference 2018
 Stefan Diebald, AVL qpunkt

Simulation Engine Oil Flow

Oil distribution and temperature in cylinder head 1100 RPM



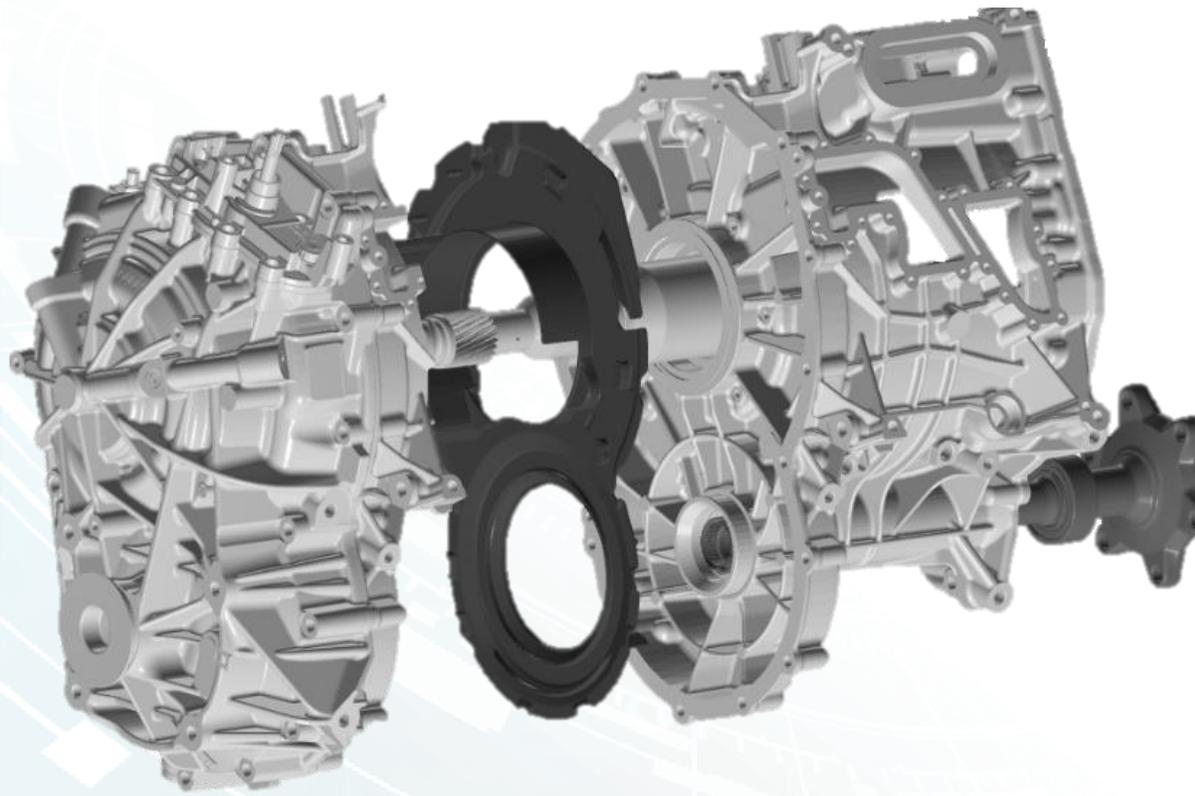
Crank case flow under **dynamic** conditions



movement overview in slow motion

extract of driving cycle with 2000 rpm
display of crankshaft's first interaction with oil

Summary



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

Thank You



www.avl.com

