

Virtual Prototyping at BMW Group.

BMW EfficientDynamics
Weniger Emissionen. Mehr Fahrfreude.



BMW Group
F. Christel

PRACE Industry Seminar
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07.09.2009

BMW Group



Virtual Prototyping at BMW Group.

Overview.

1. Hardware / Architecture
2. Simulations at BMW
3. FEM-Simulation
4. CFD-Simulation
5. CFD Thermal Management & Aerodynamics
6. Future Development
7. Summary & Conclusion

Virtual Prototyping at BMW Group.

Hardware: Evolutionary process.



1990s Central Computing
Cray Mainframe

1994 RISC SMP
UNIX Servers



2001 Commodity Systems
Intel, Linux

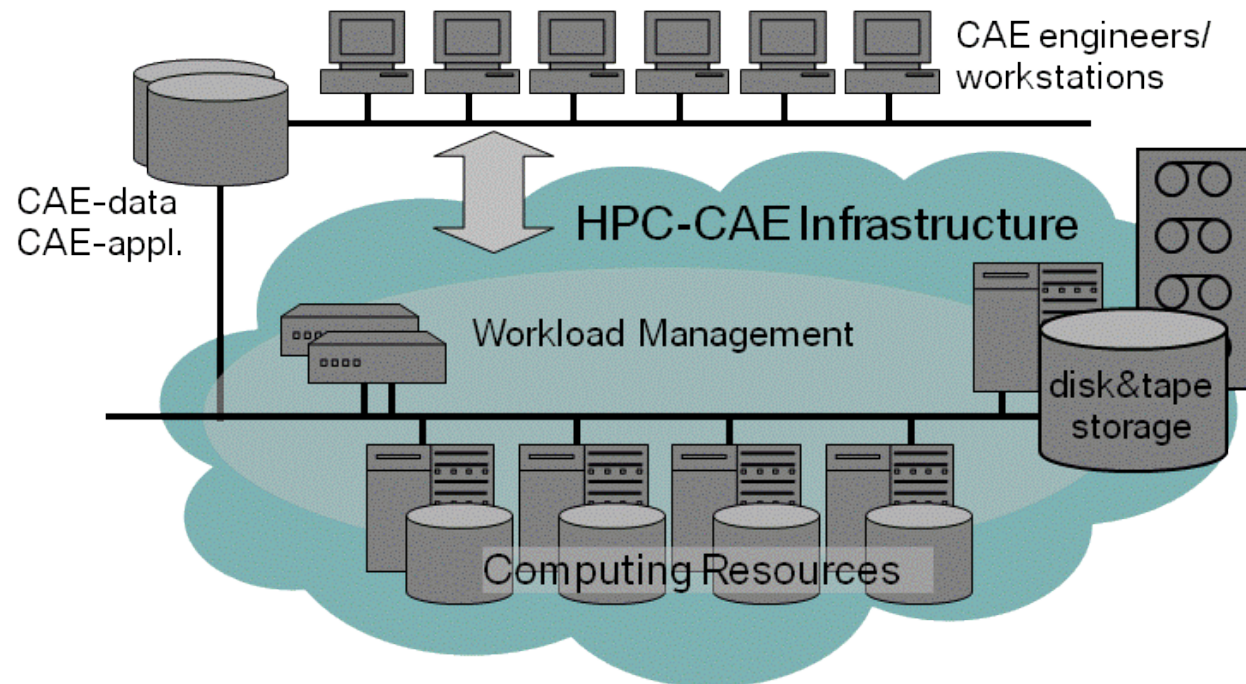


2007 HPC Cluster Grid

Virtual Prototyping at BMW Group. Architecture.

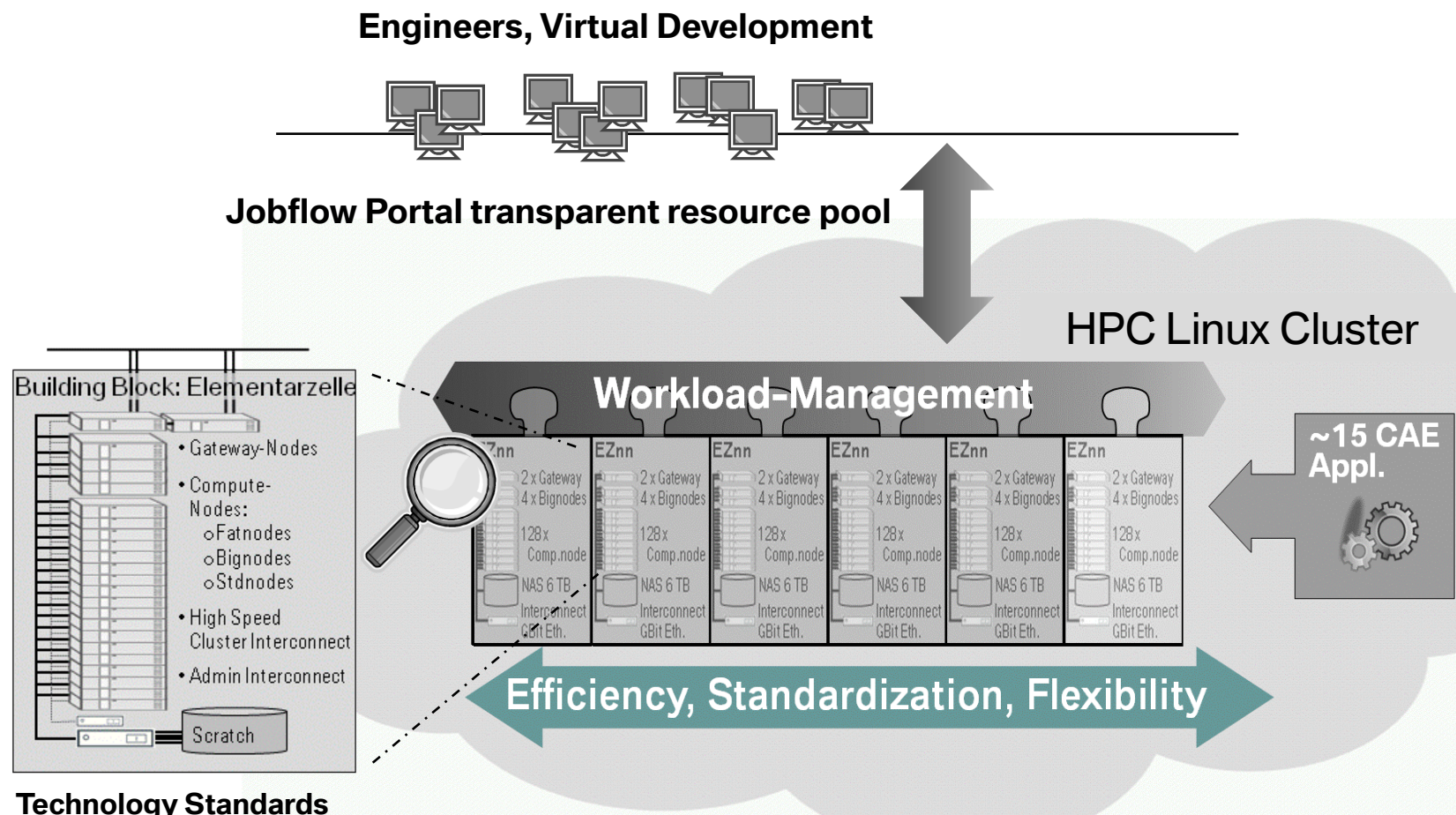
High Performance Computing Service:

- Optimized infrastructure for computational applications.
- Complete infrastructure platform for application integration.
- Transparent access to compute capacity via jobflow.
- Central resource/workload management.



Virtual Prototyping at BMW Group.

Hardware / Architecture.

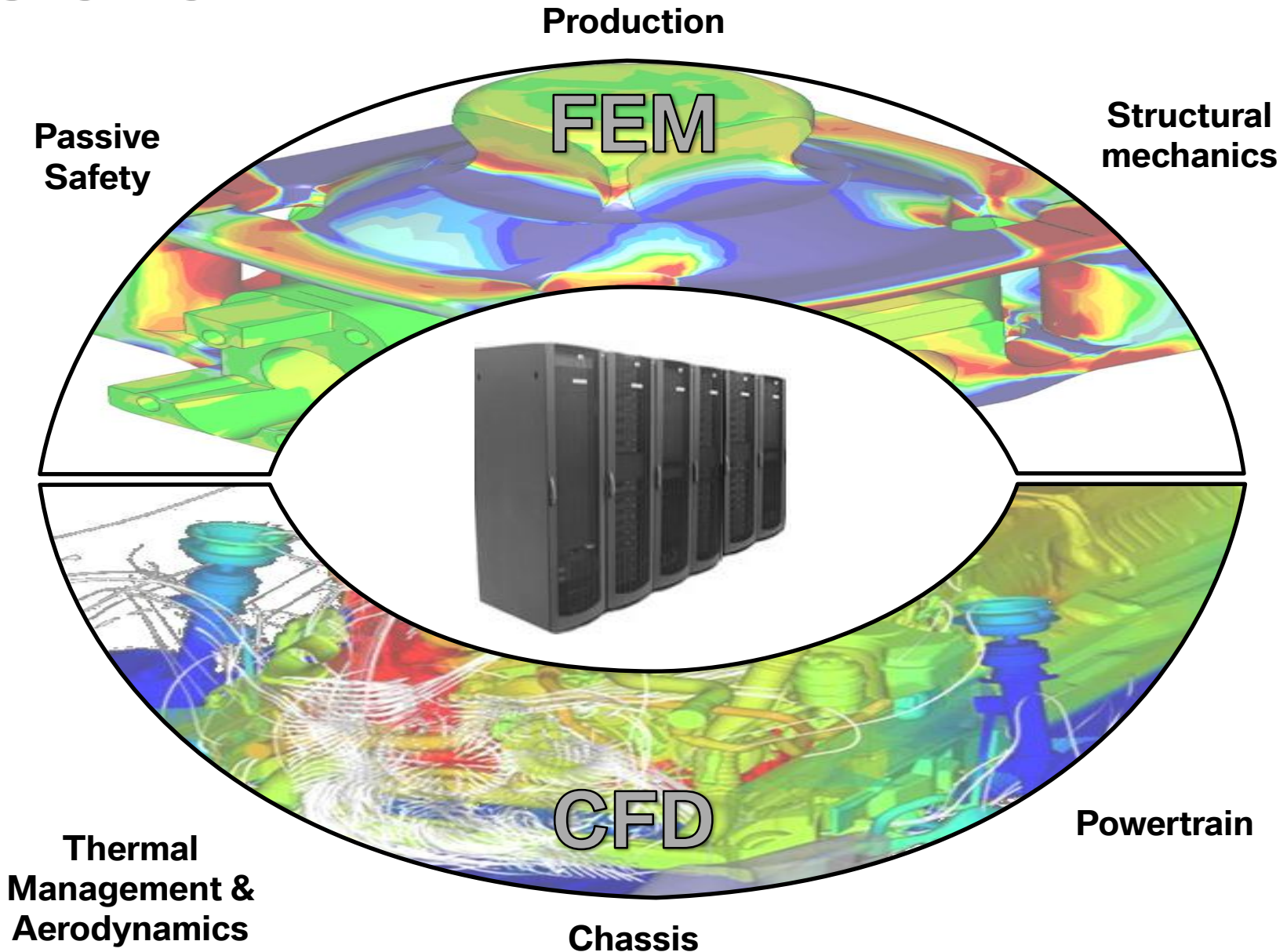


Technology Standards

- Intel® Xeon® EP (5160, 5570)
- Ethernet GBit
- NAS Storage

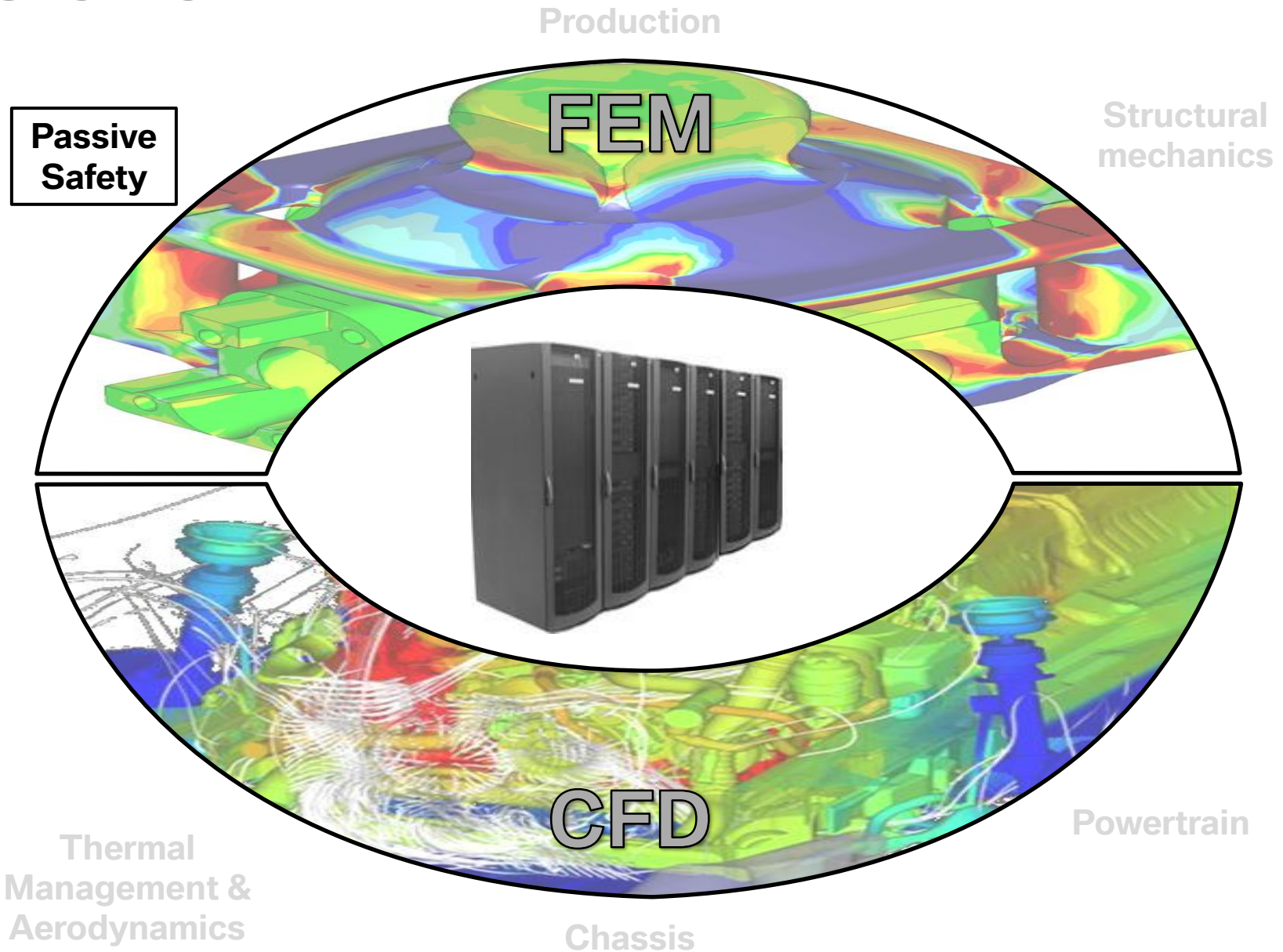
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Overview.



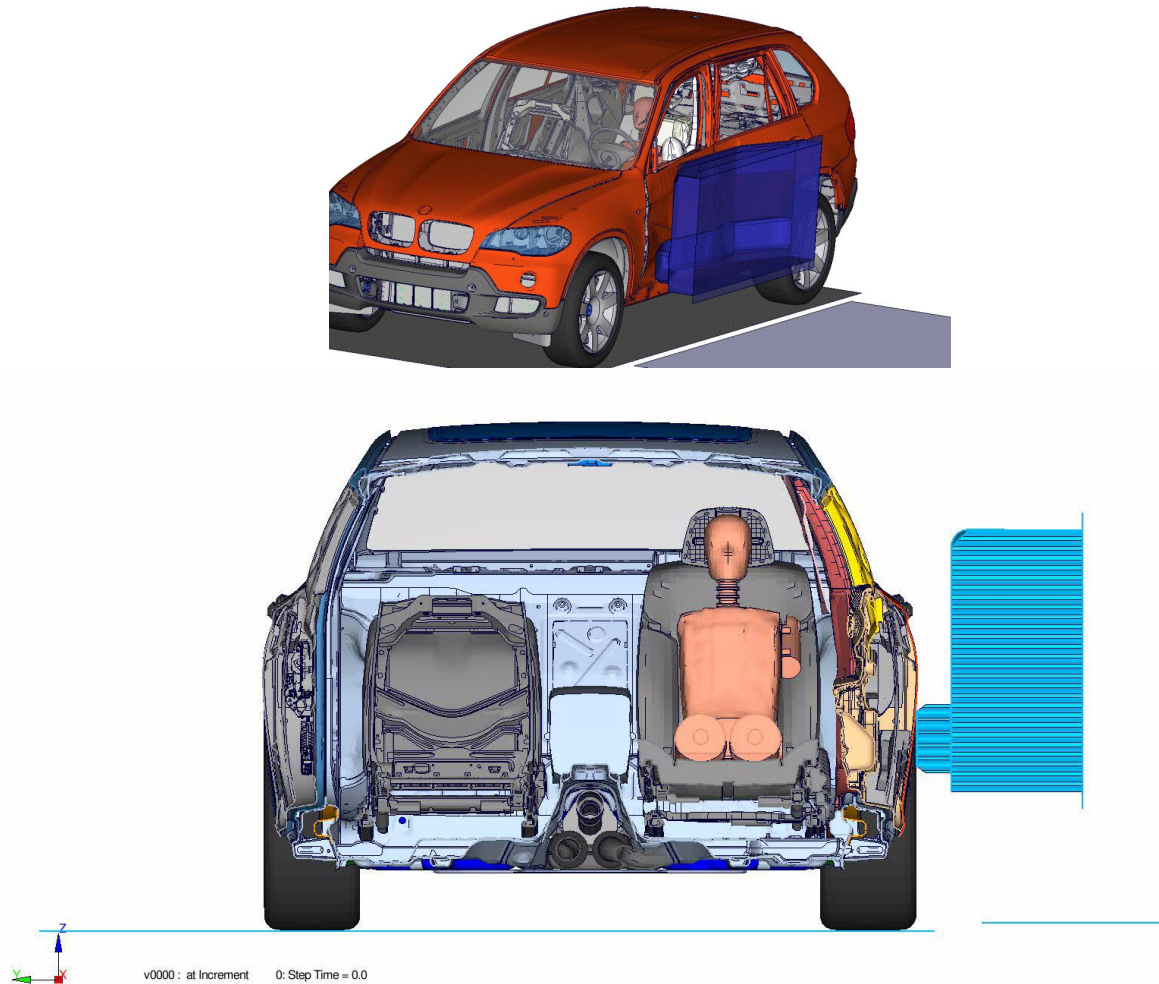
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Overview.



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FEM Passive Safety: Side Impact Crash.

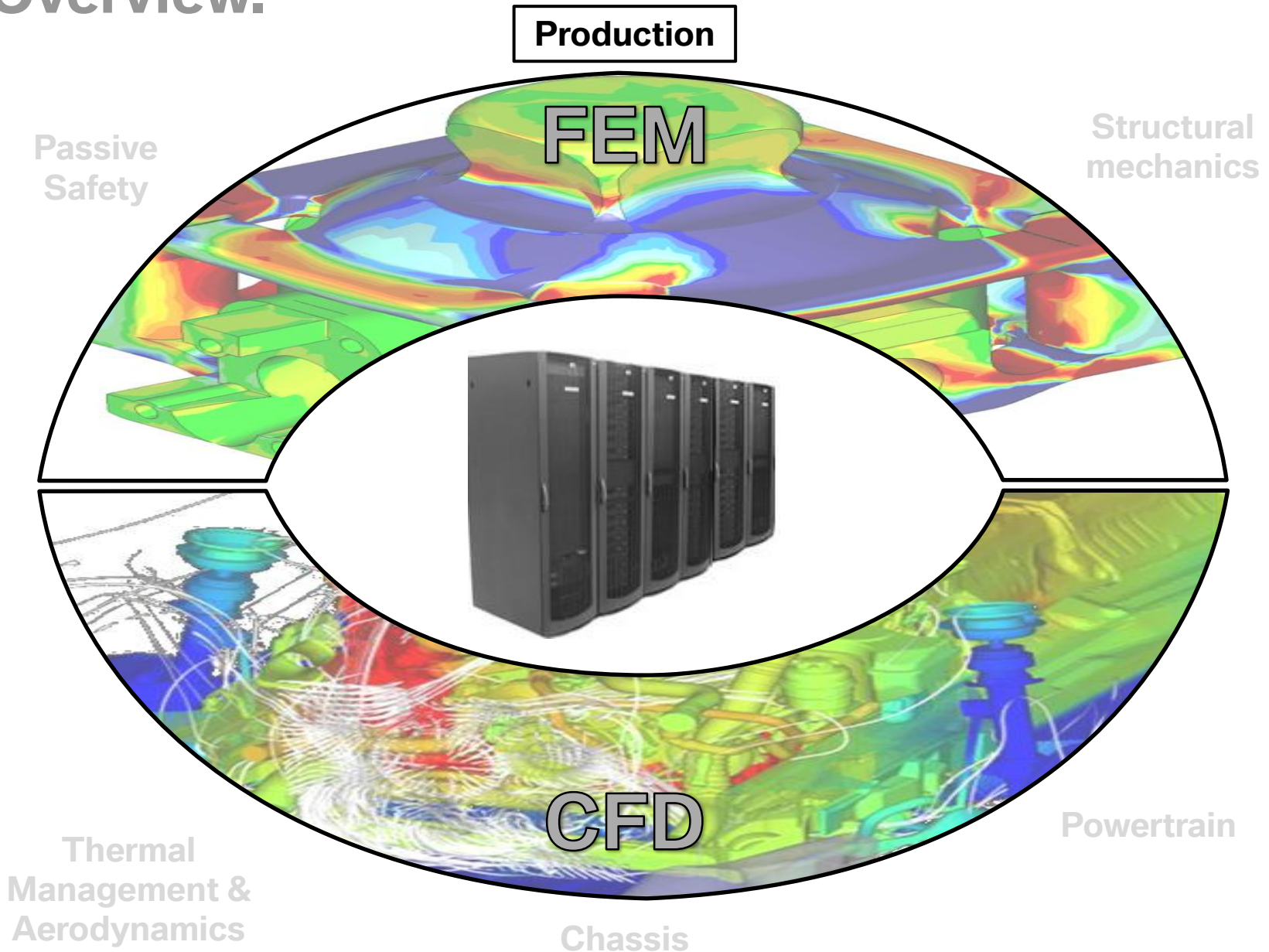


Tool: Abaqus

Calculation Time: On 8 CPUs: 20-50 h

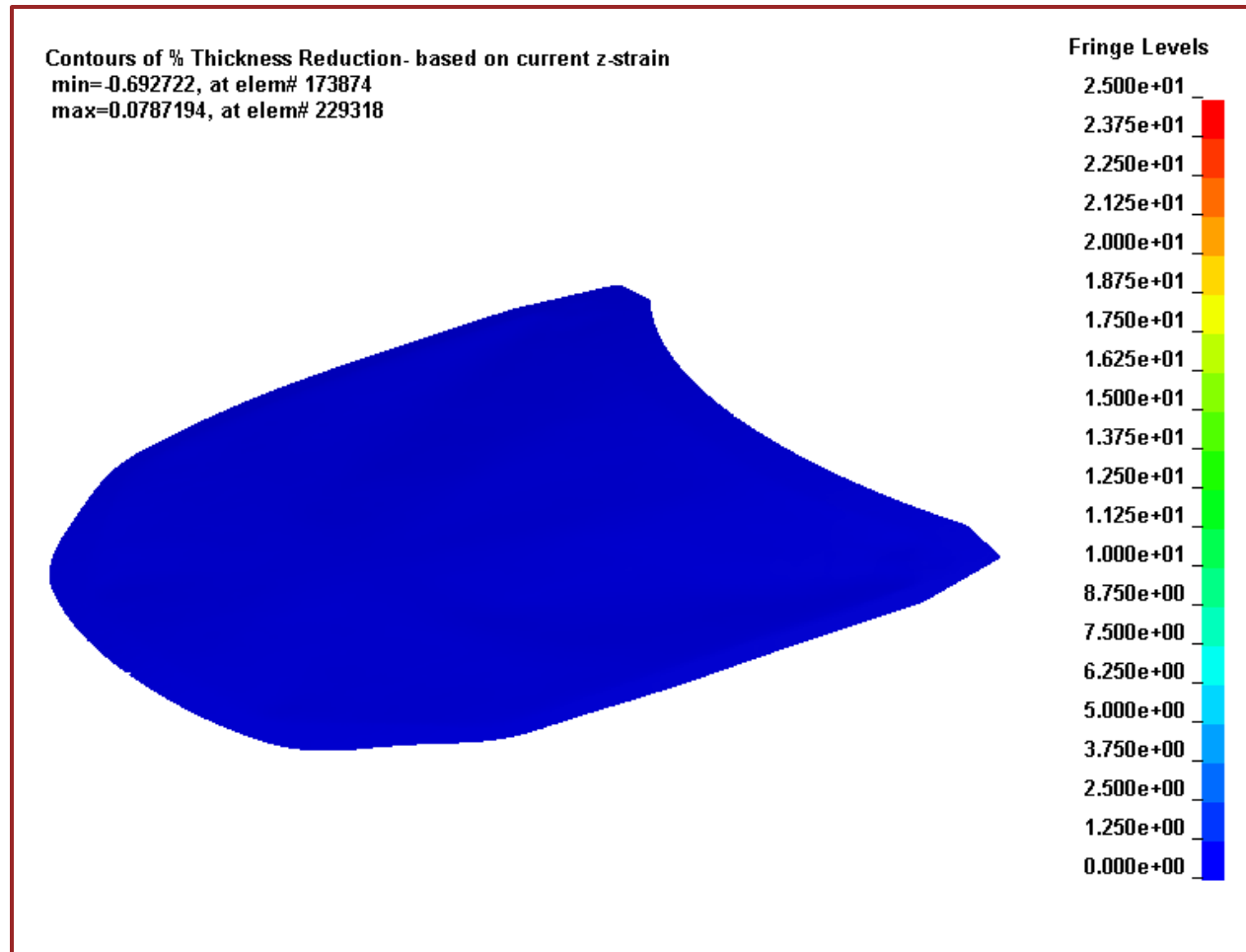
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Overview.



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FEM Production: Deep Drawing.

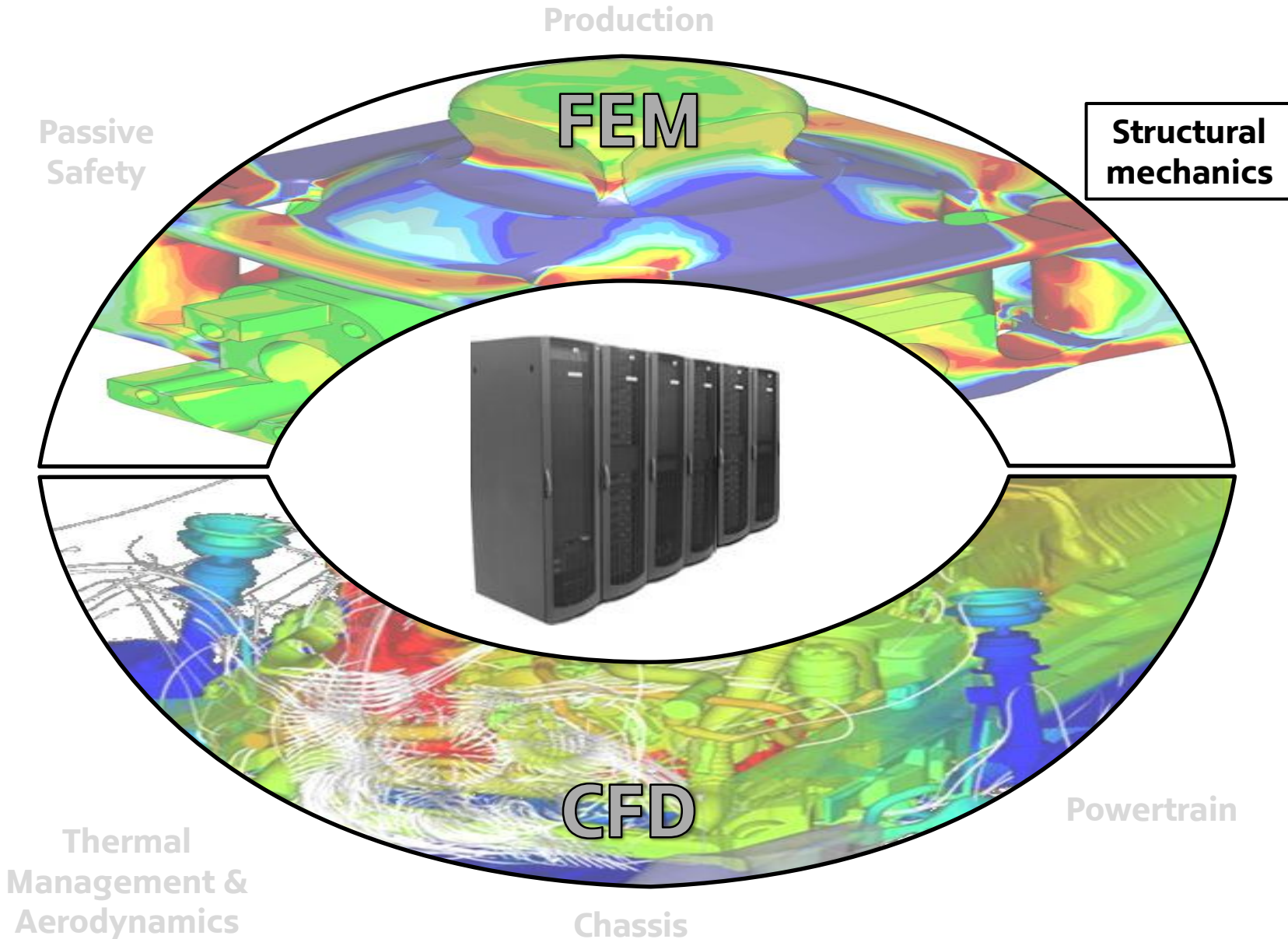


Tool: LS Dyna

Calculation Time: On 4 CPUs: 10 h

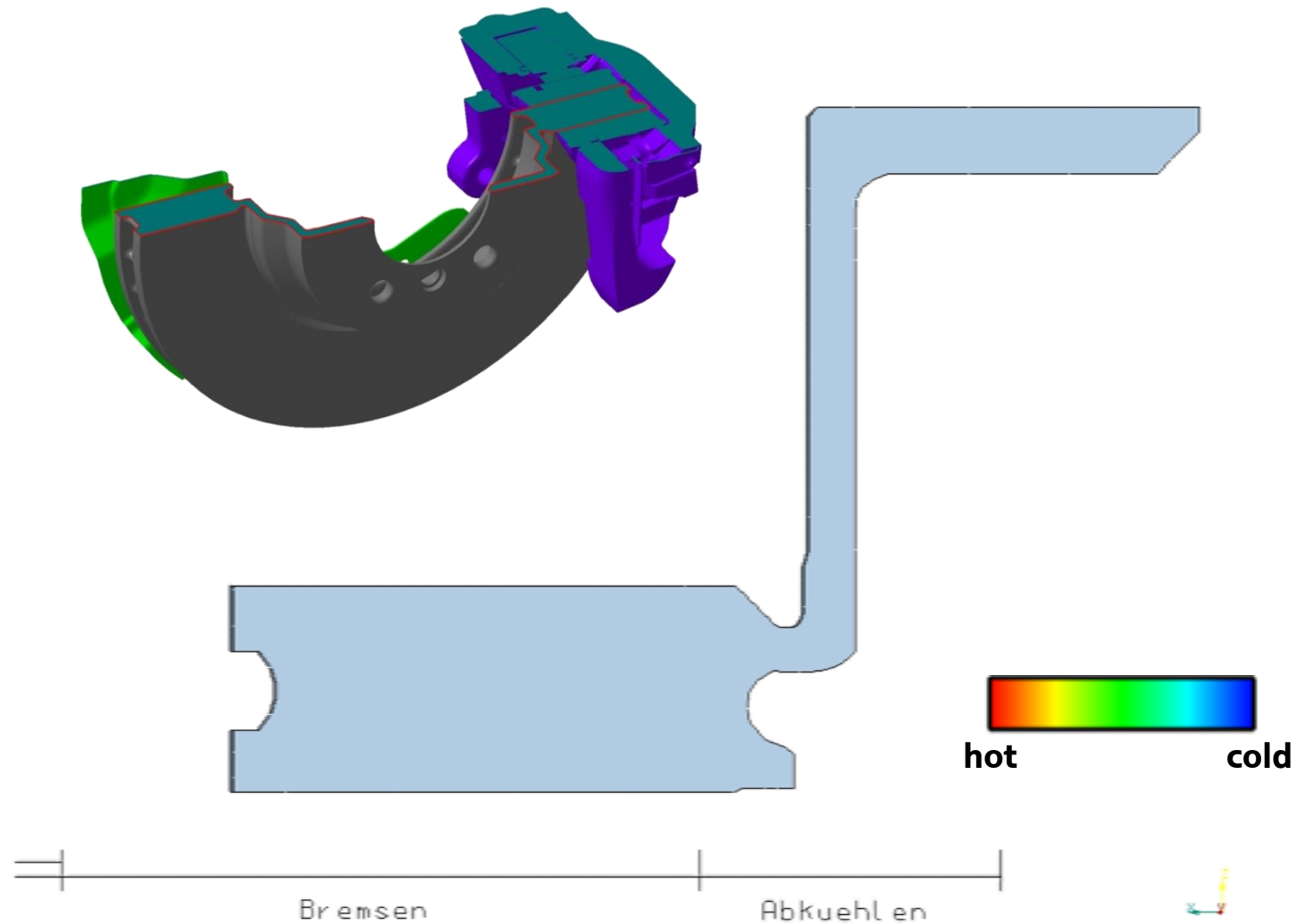
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Overview.



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Structural Mechanics: Thermal Expansion.

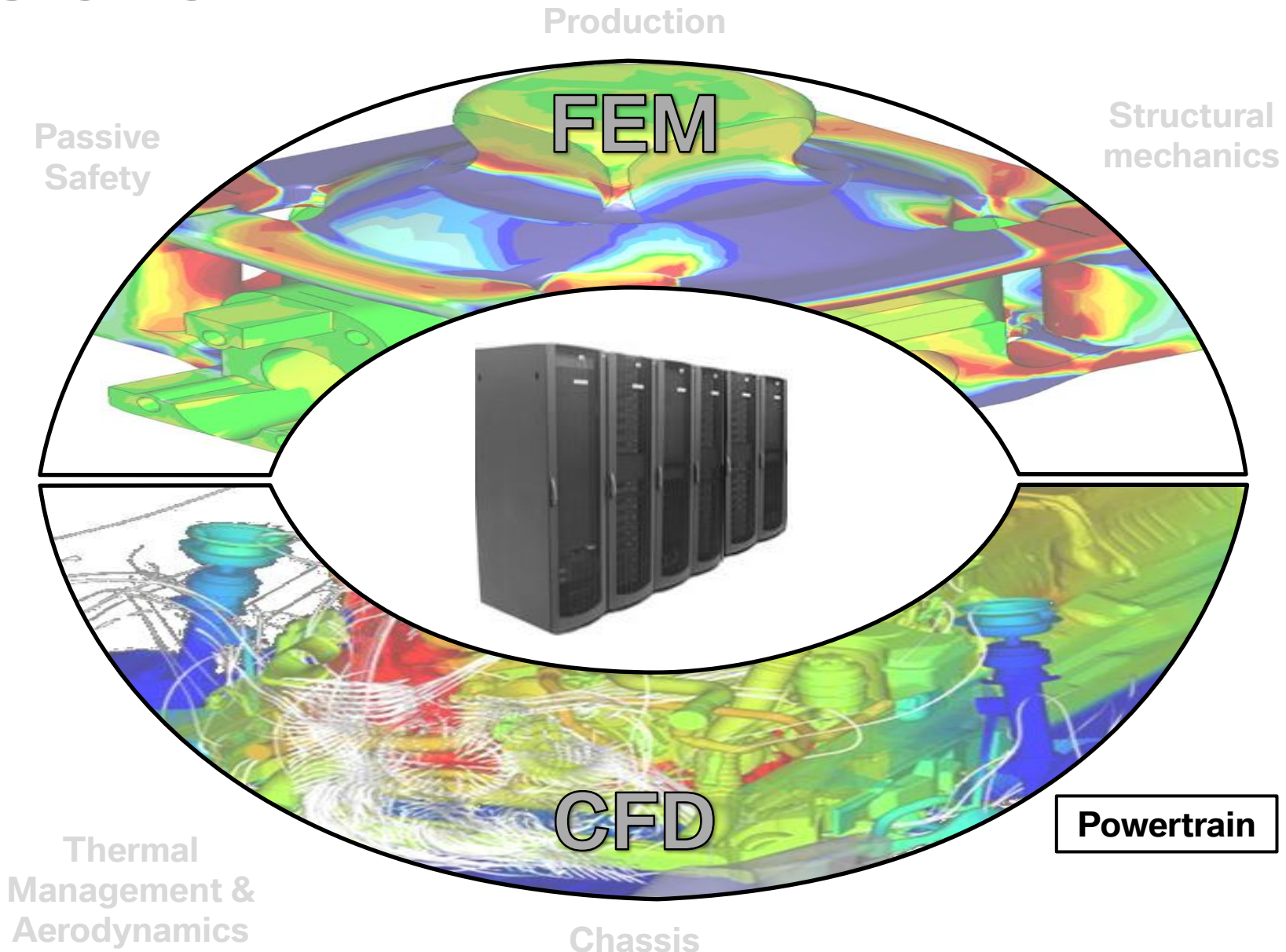


Tool: Abaqus

Calculation Time: On 2 CPUs: 30 min

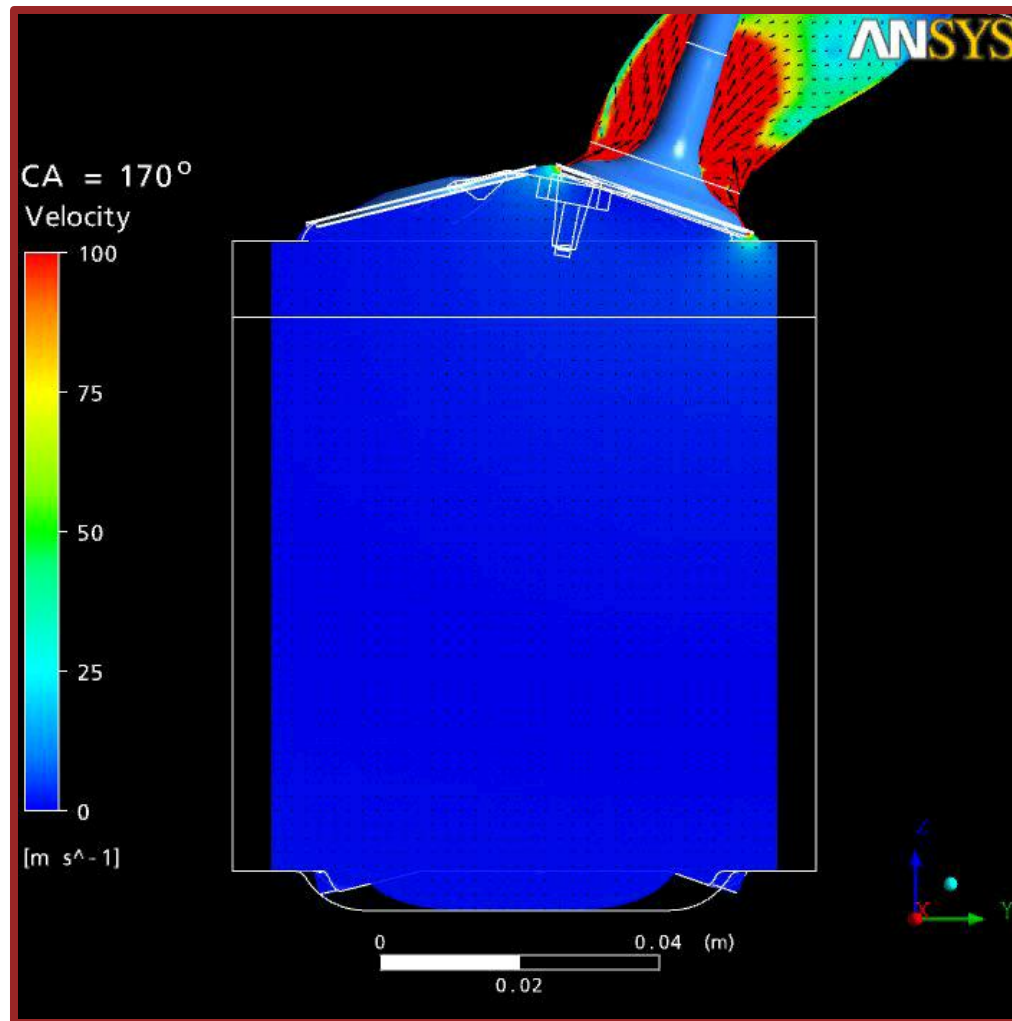
Virtual Prototyping at BMW Group.

Overview.



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CFD Powertrain: Incylinder Simulation.

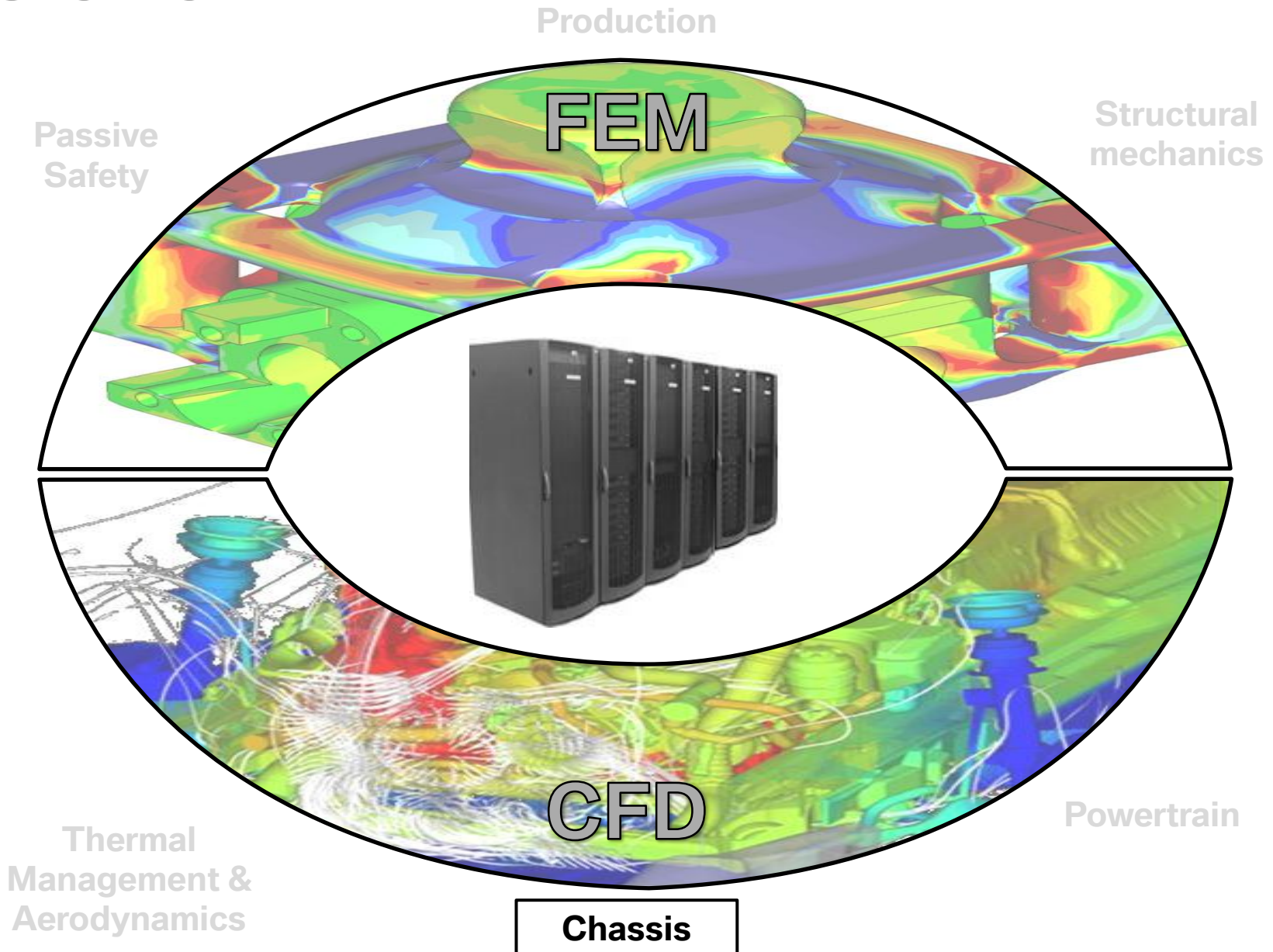


Tool: ANSYS-CFX

Calculation Time: On 8 CPUs: 240 h

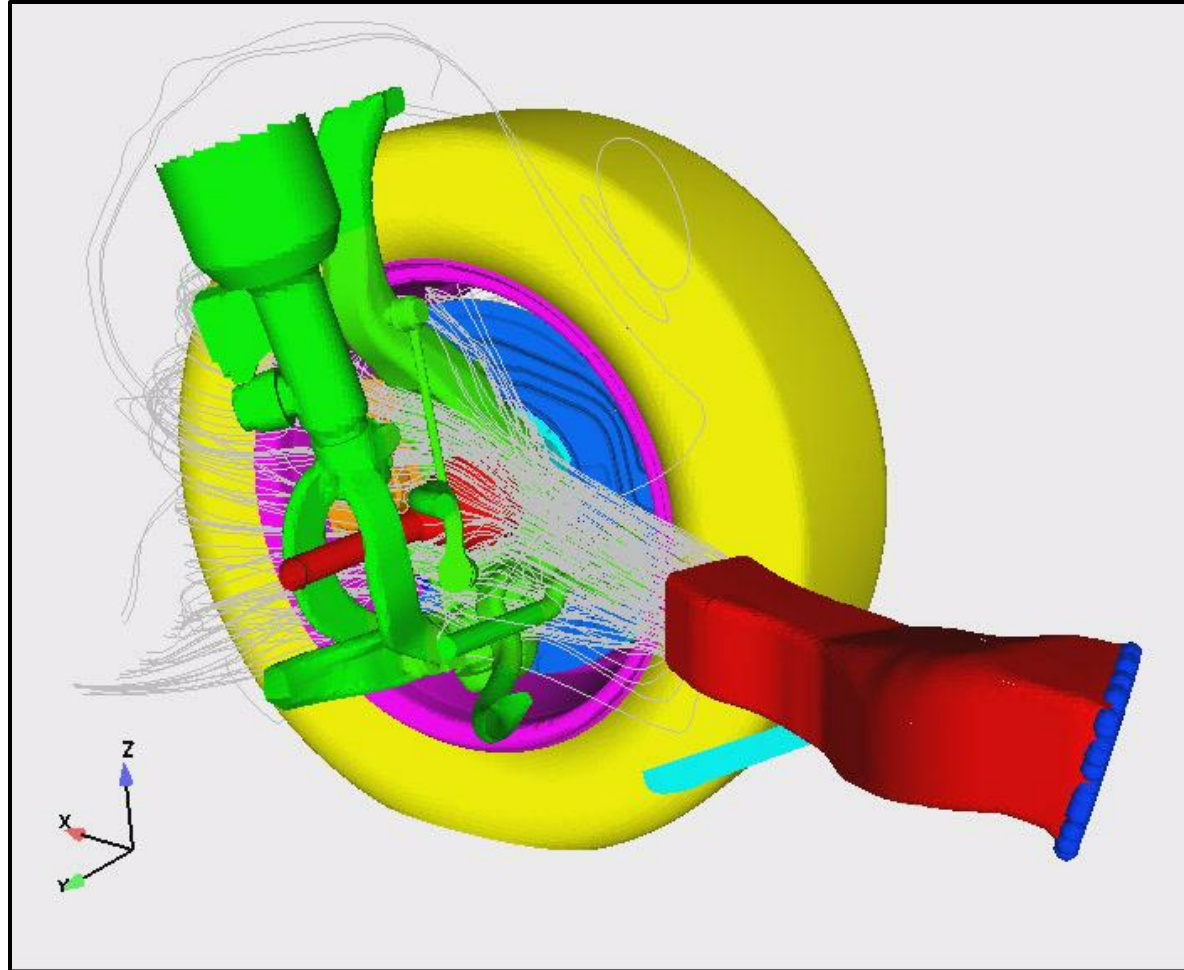
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CFD Chassis: Brake Cooling.

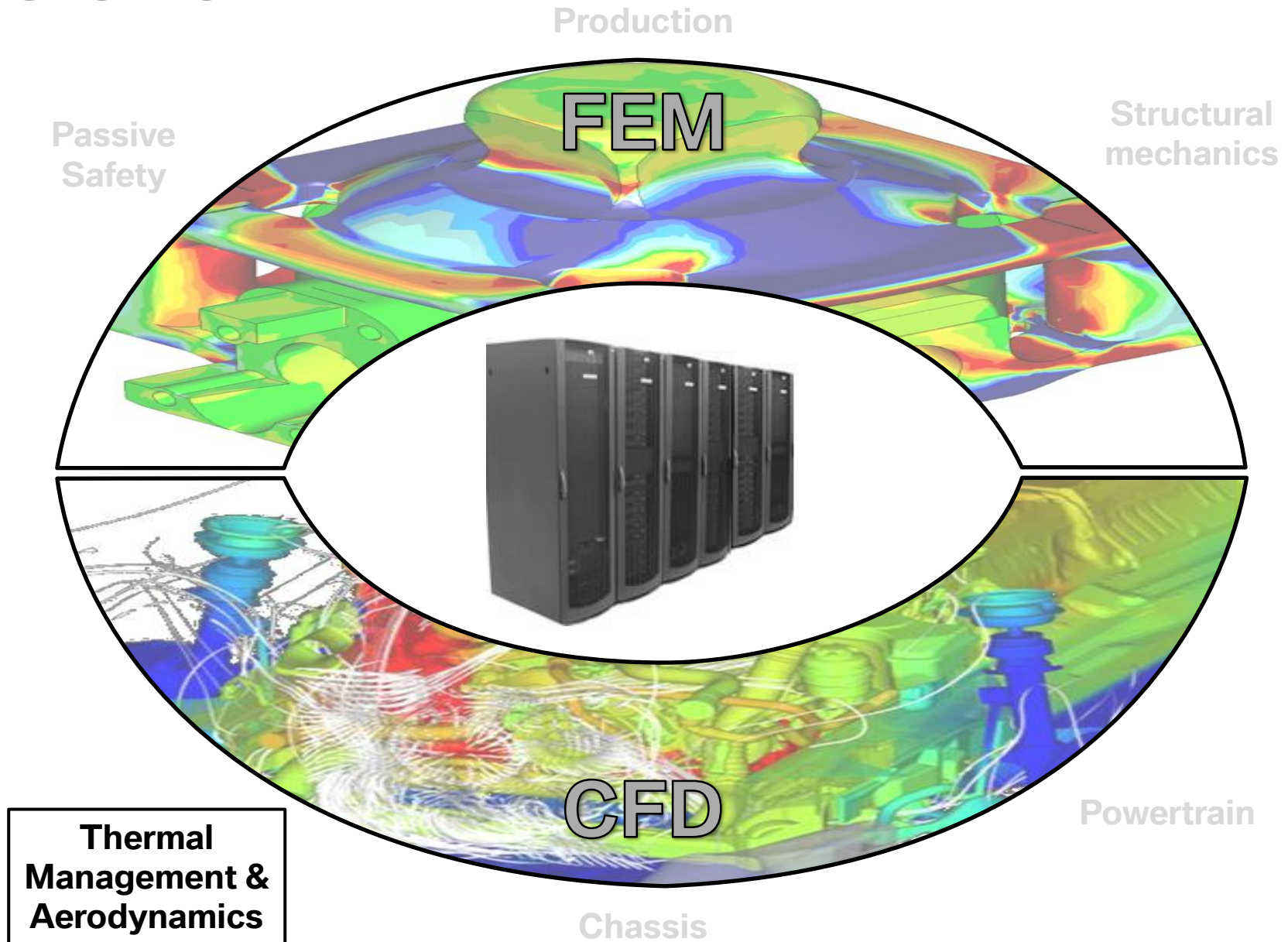


Tool: Star-CD

Calculation Time: On 16 CPUs: 120 h

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Overview.

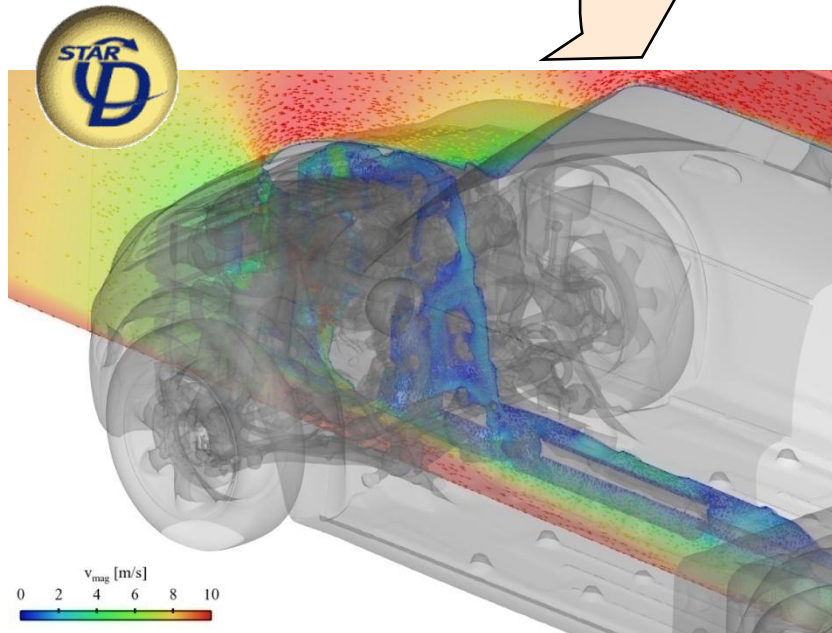


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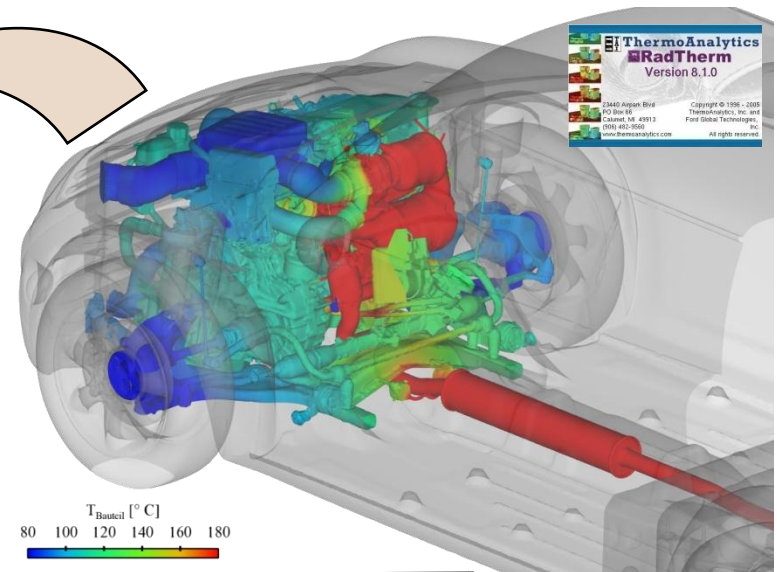
CFD: Thermal Management.

Automatically coupled calculation

Convection



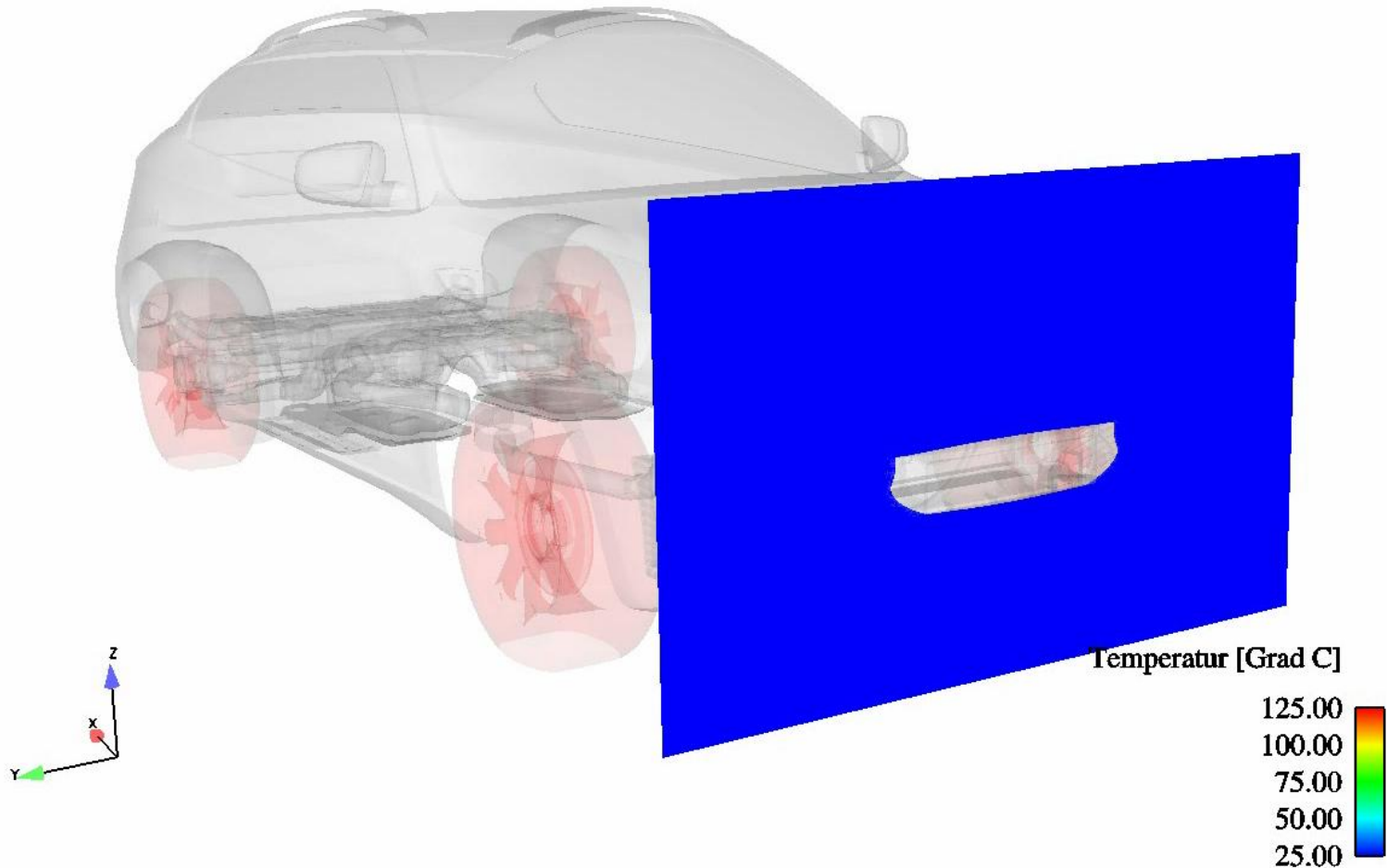
Conduction and Radiation



8-10 x

Virtual Prototyping at BMW Group.

CFD: Thermal Management.

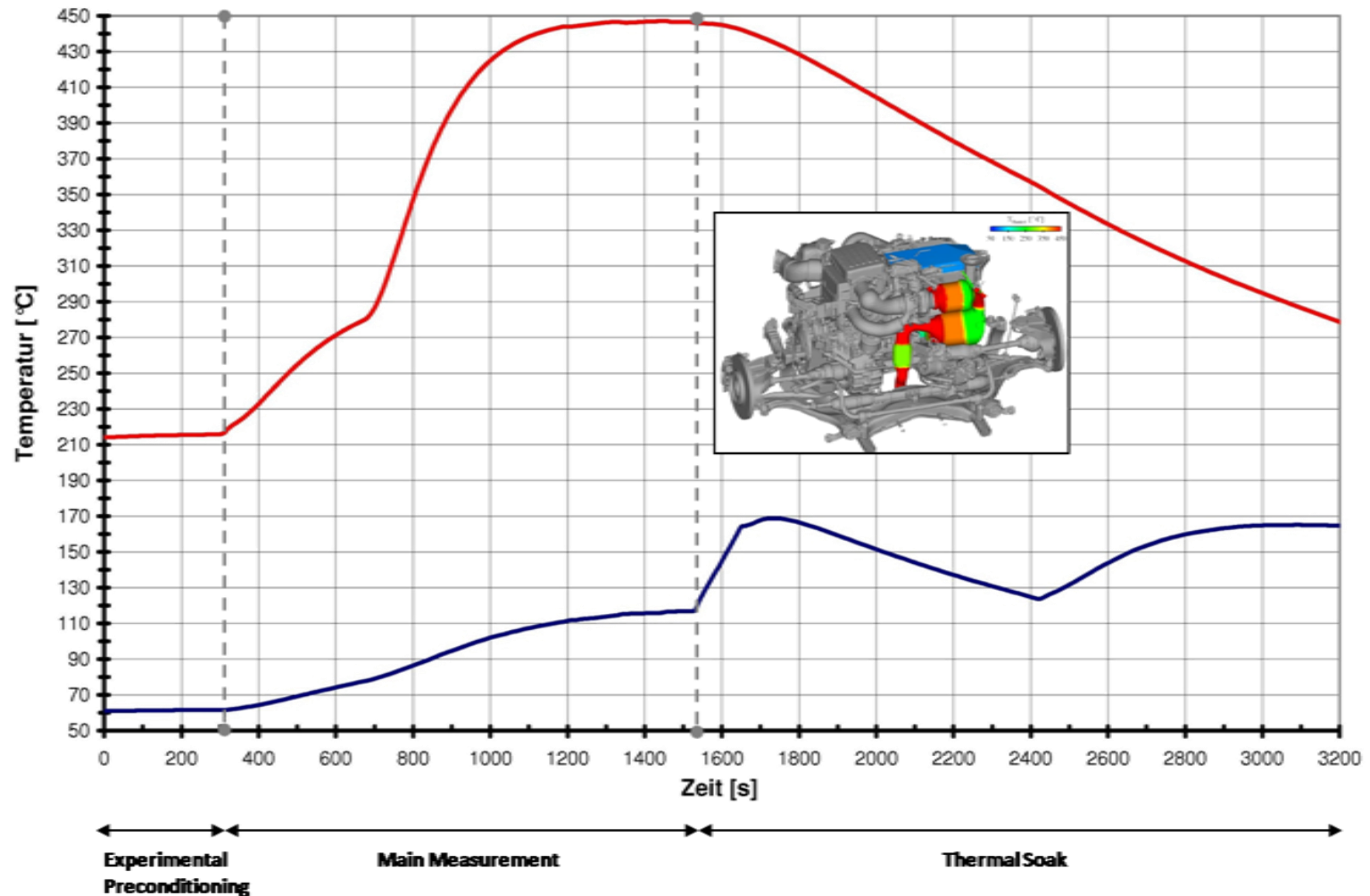


Tool: Star-CD coupled with RadTherm
Calculation Time: On 8 CPUs: 240 h

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CFD: Thermal Management.

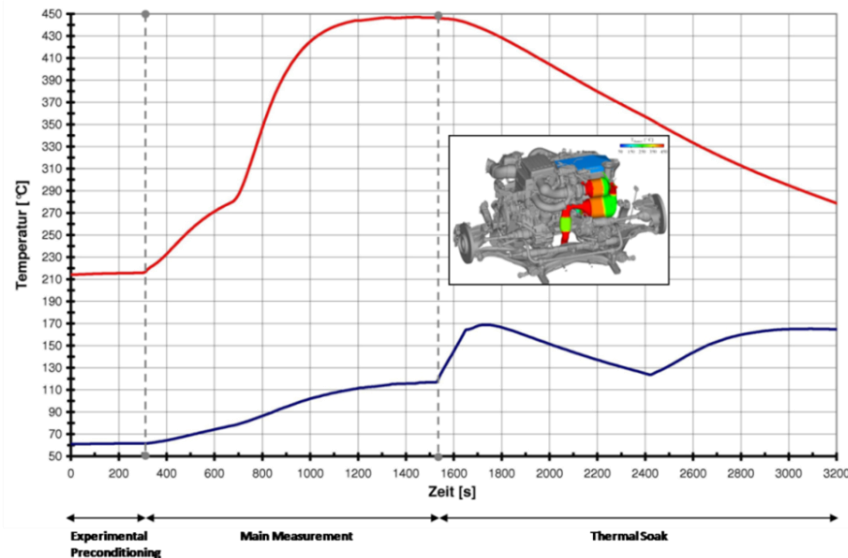
Future Development Simulation of “Thermal Soak”



Virtual Prototyping at BMW Group.

CFD: Thermal Management.

Future Development “Thermal Soak”



Tool

Transient “All-in-one calculation” (convection, conduction, radiation and heat storage) in Star-CCM+.

Hardware

Calculation duration of a complete vehicle model (> 40 million cells) in the order of months.

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Summary & Conclusion.

Summary

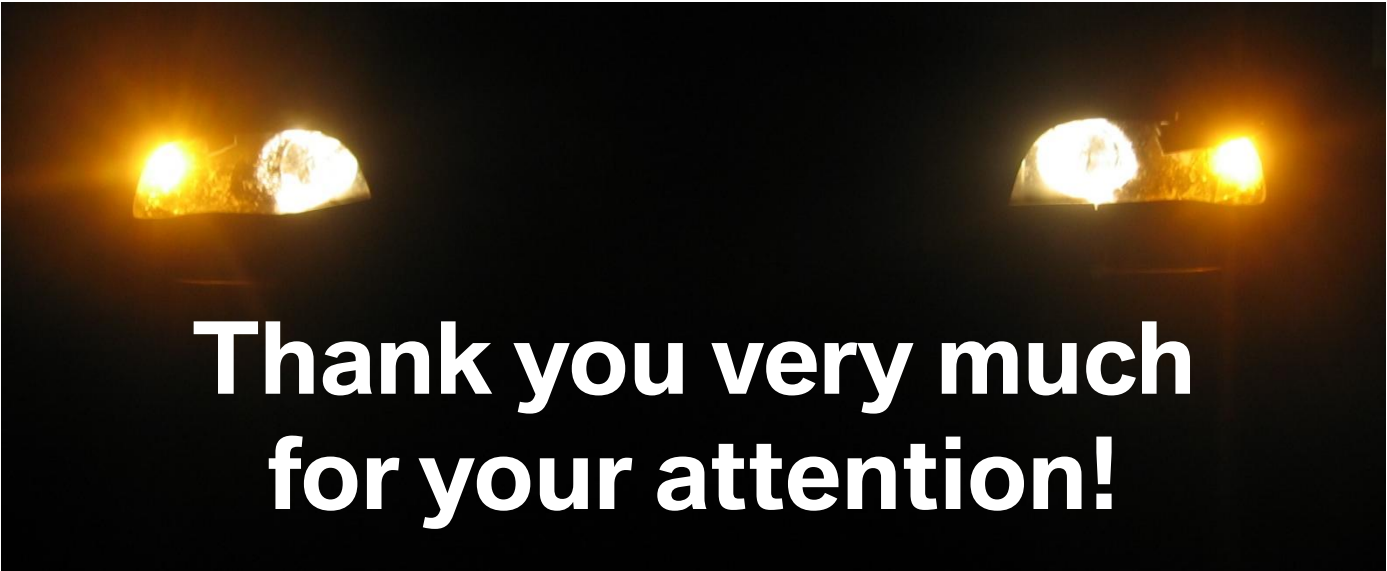
- 7 FEM applications running on HPC Cluster Grid.
- 8 CFD applications running on Cluster.
- High utilization of the cluster ($> 80\%$).

Conclusion

Using more complex models or considering more design alternatives in a shorter time frame requires access to faster and secure “on demand” resources.

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The image shows two glowing yellow headlights on a dark background, likely representing a car at night. The headlights are positioned on either side of the text.

**Thank you very much
for your attention!**