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SIMPACK-Usermeeting 21.-22.03.2006

**Application of SIMPACK for Simulating Valve Trains and
Timing Mechanisms at Mercedes-Benz Automotive Engines**

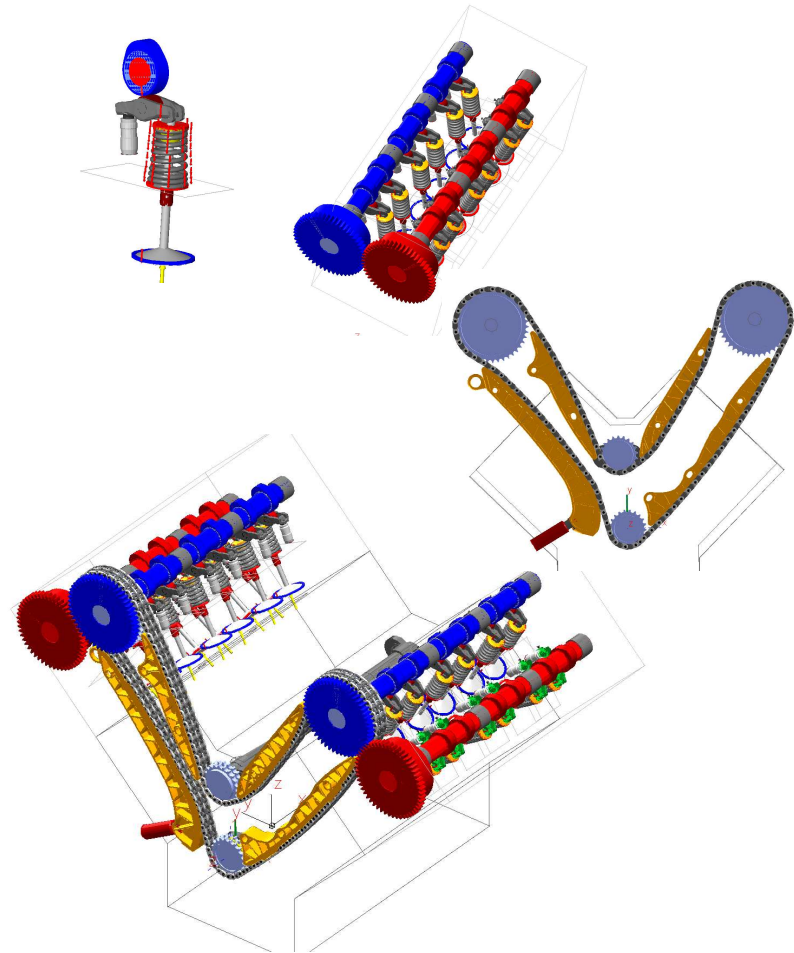
Franz Huber, EP/MTP

Application of SIMPACK for Simulating Valve Trains and Timing Mechanisms at Mercedes-Benz Automotive Engines

- How do we use SIMPACK.
- Simulation of a single valve train model.
- The cylinder head model with hydrodynamic bearing.
- Chain drive with flexible chain guides.
- Coupled model of valve train and chain drive.
- Conclusion.

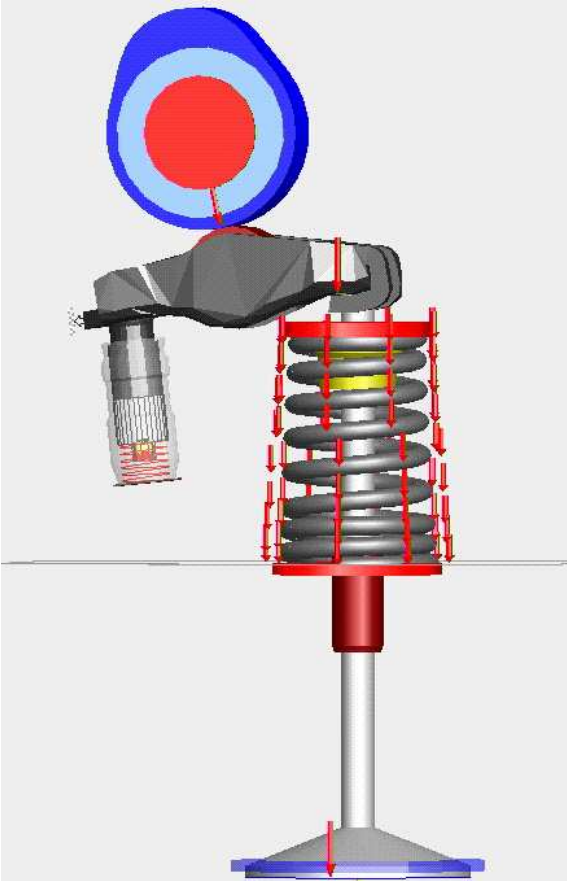
We use SIMPACK for the simulation of ...

- the dynamics of the valve train for all gasoline and diesel engines of Mercedes passenger cars and light weight trucks.
- the pressure and gap distribution in the hydrodynamic bearings.
- the dynamics of the timing system (chain drive, gear drive).
- the dynamic behavior of the coupled system of valve train and timing system.

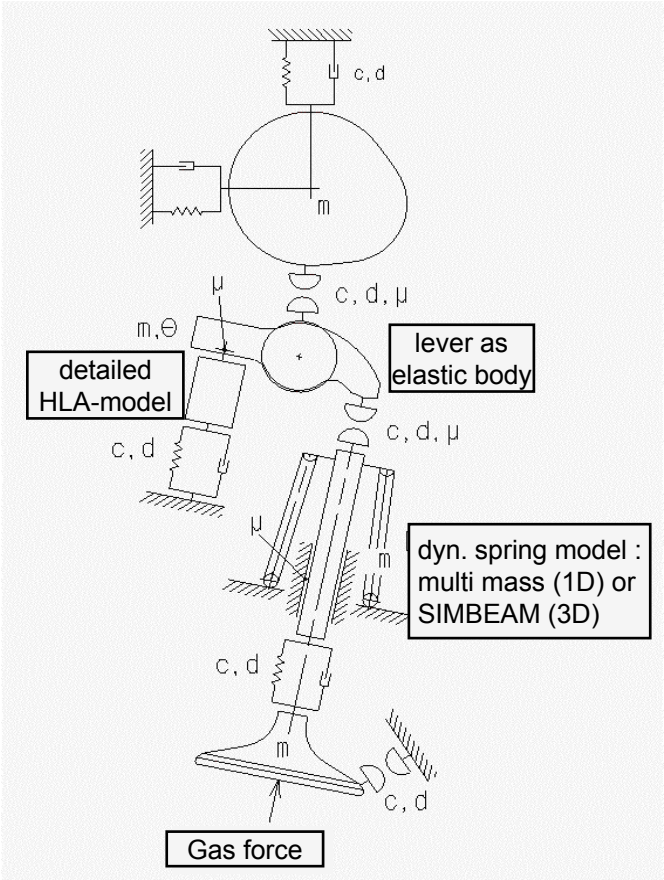


Description of MBS-model for single valve train simulation

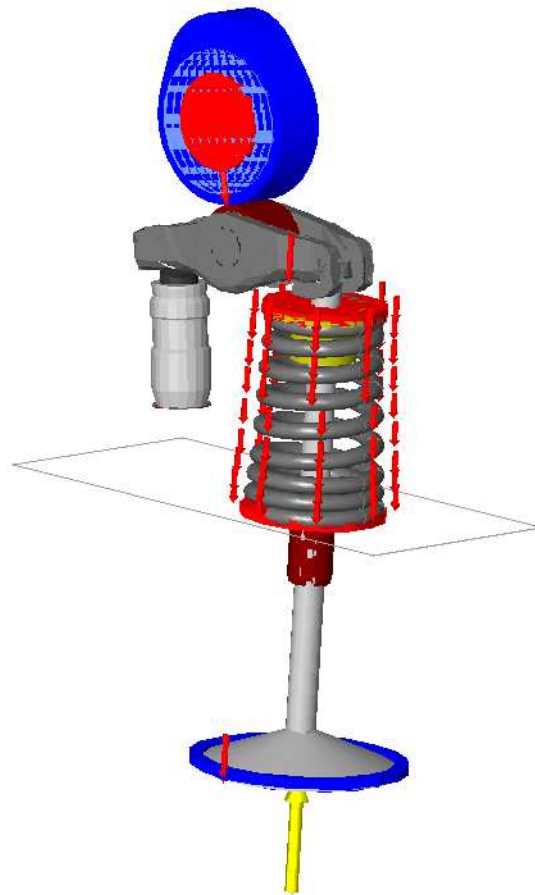
SIMPACK-model of single valve train



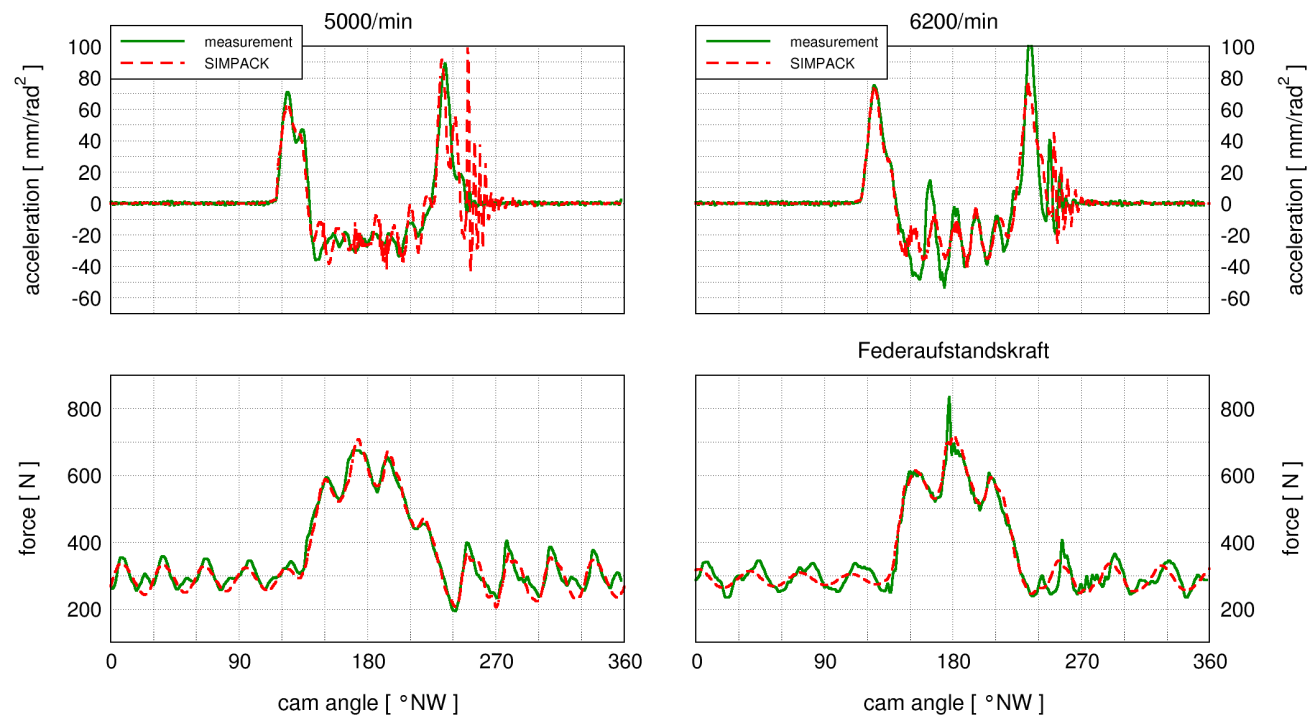
analogous model of single valve train



Animation of a single valve train simulation

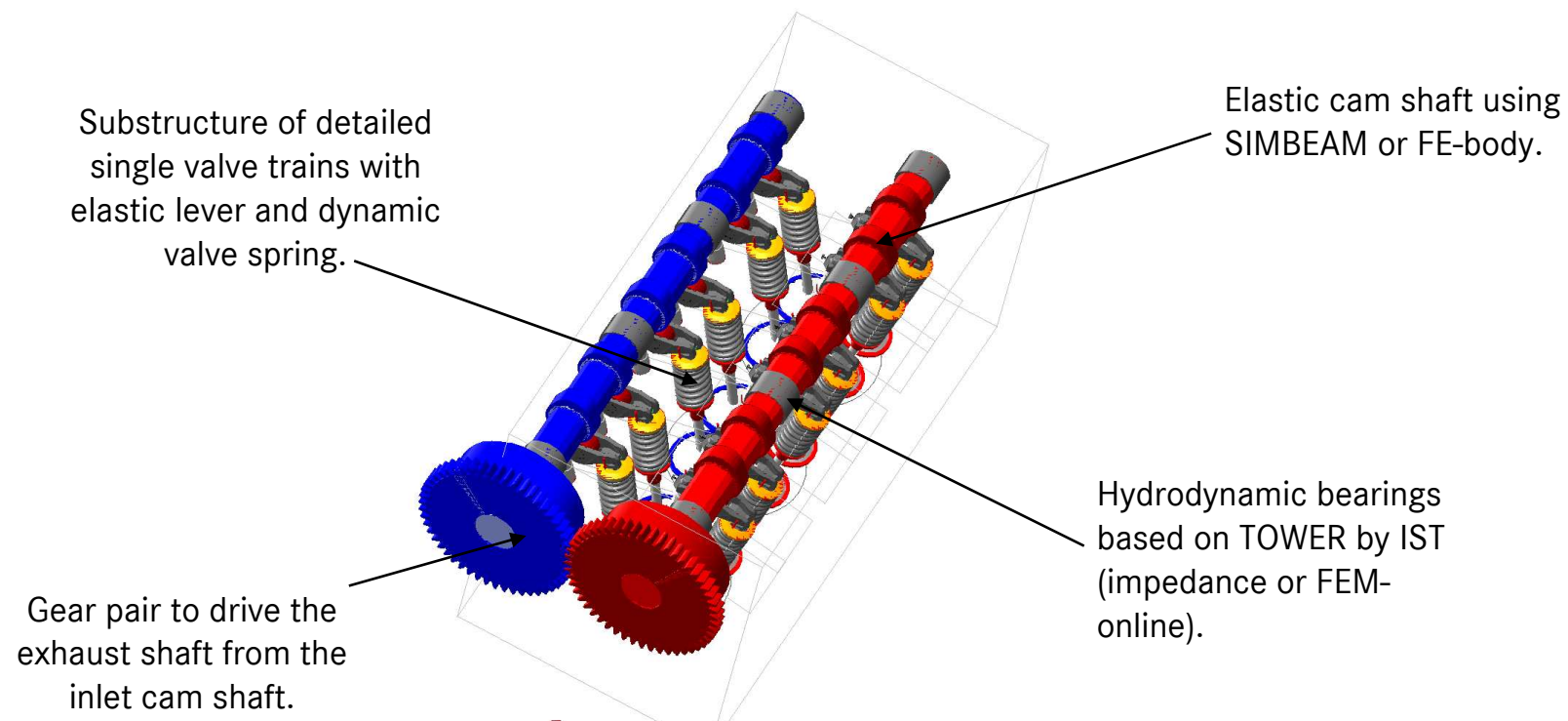


Results of single valve train simulations compared to measurements



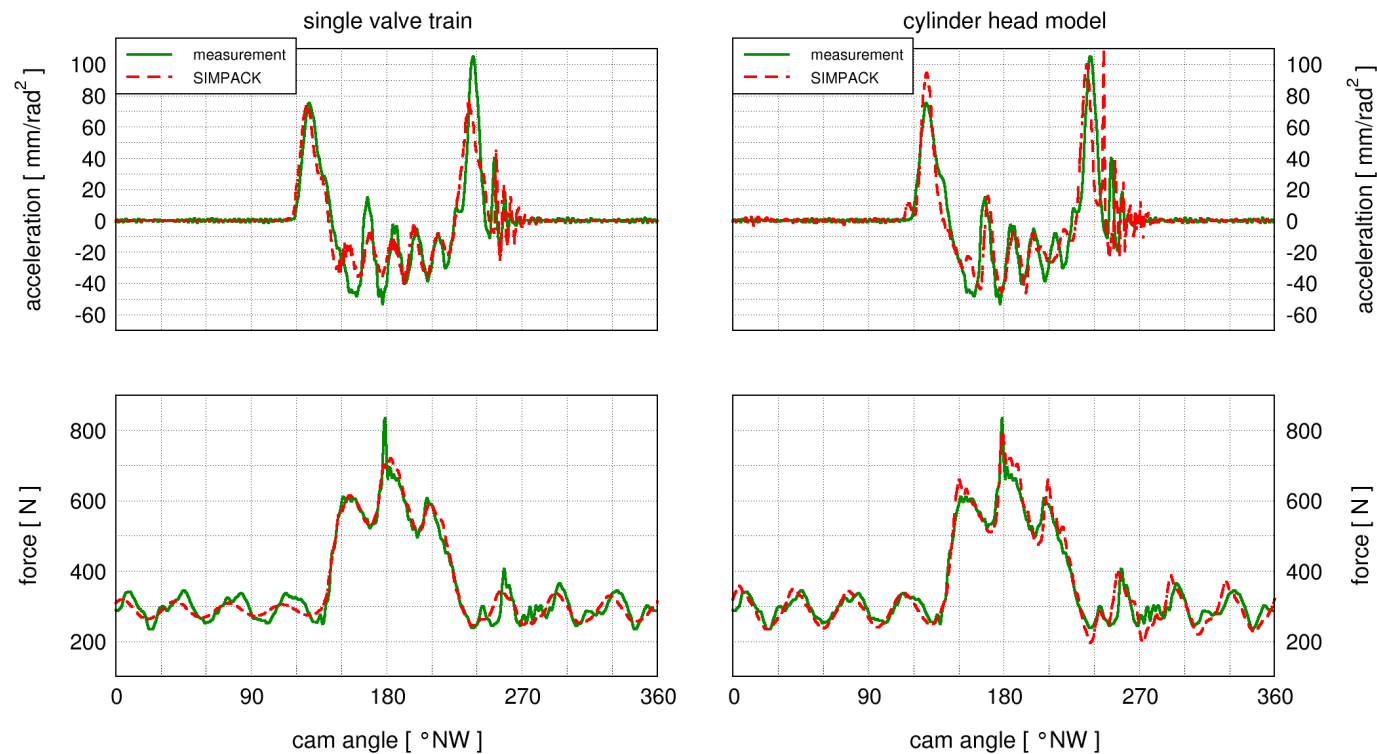
Good correlation of the simulation results of a single valve train and measured data. The simulation results get even closer to the measured data when modeling the whole cylinder head, but the simulation time is increasing remarkably.

Description of mbs-model for cylinder head model



The cylinder head model is used to investigate the interaction between the single valve trains. By applying the external forces from the chain drive it is possible to do detailed simulations of the valve train dynamic and the judgment of the hydrodynamic cam shaft bearings.

Results of single valve train and cylinder head compared to measurements

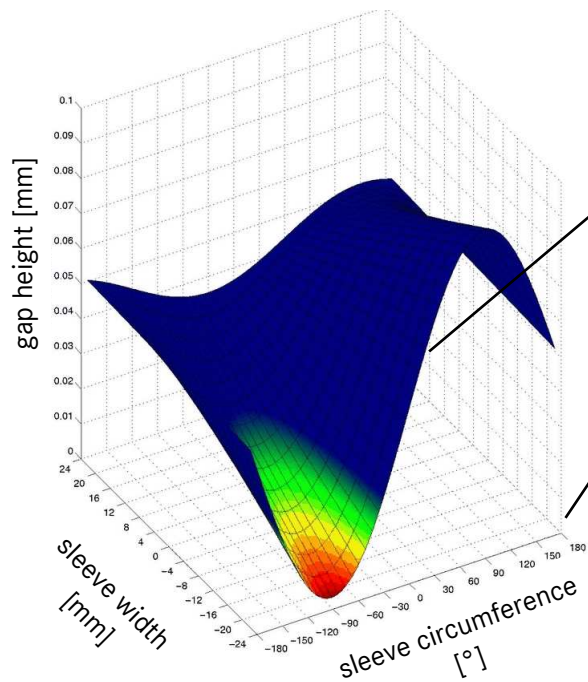


Comparison of the simulation time :
 single valve train : ~ 2 min

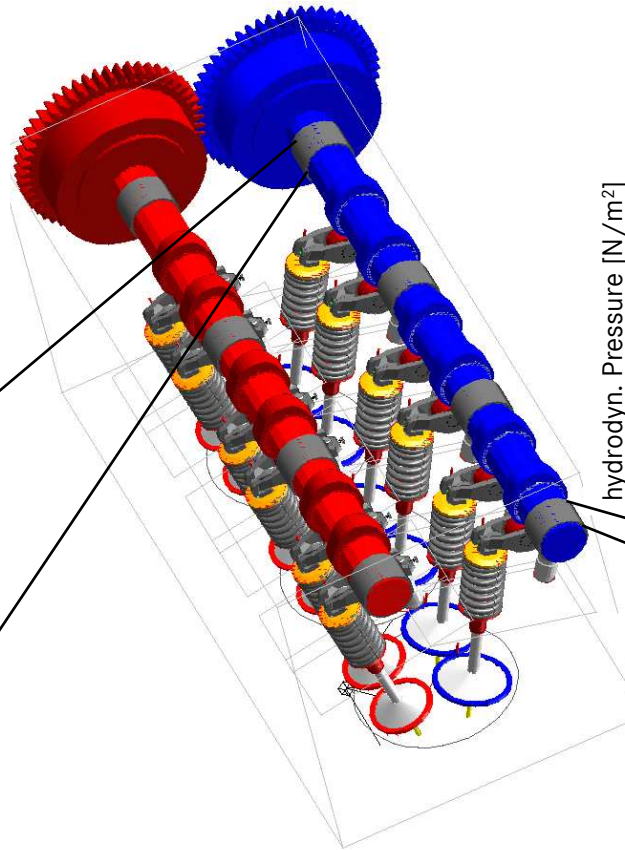
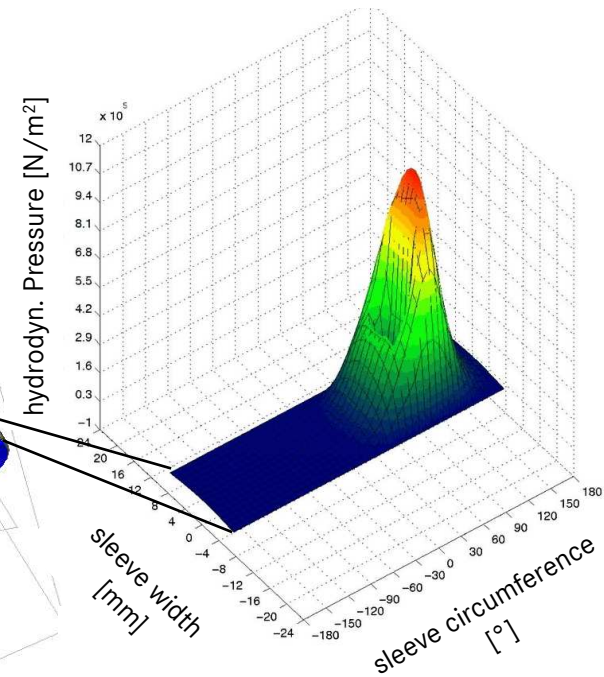
cylinder head model : ~ 60 min

Simulation of the hydrodynamic cam shaft bearings using TOWER by IST

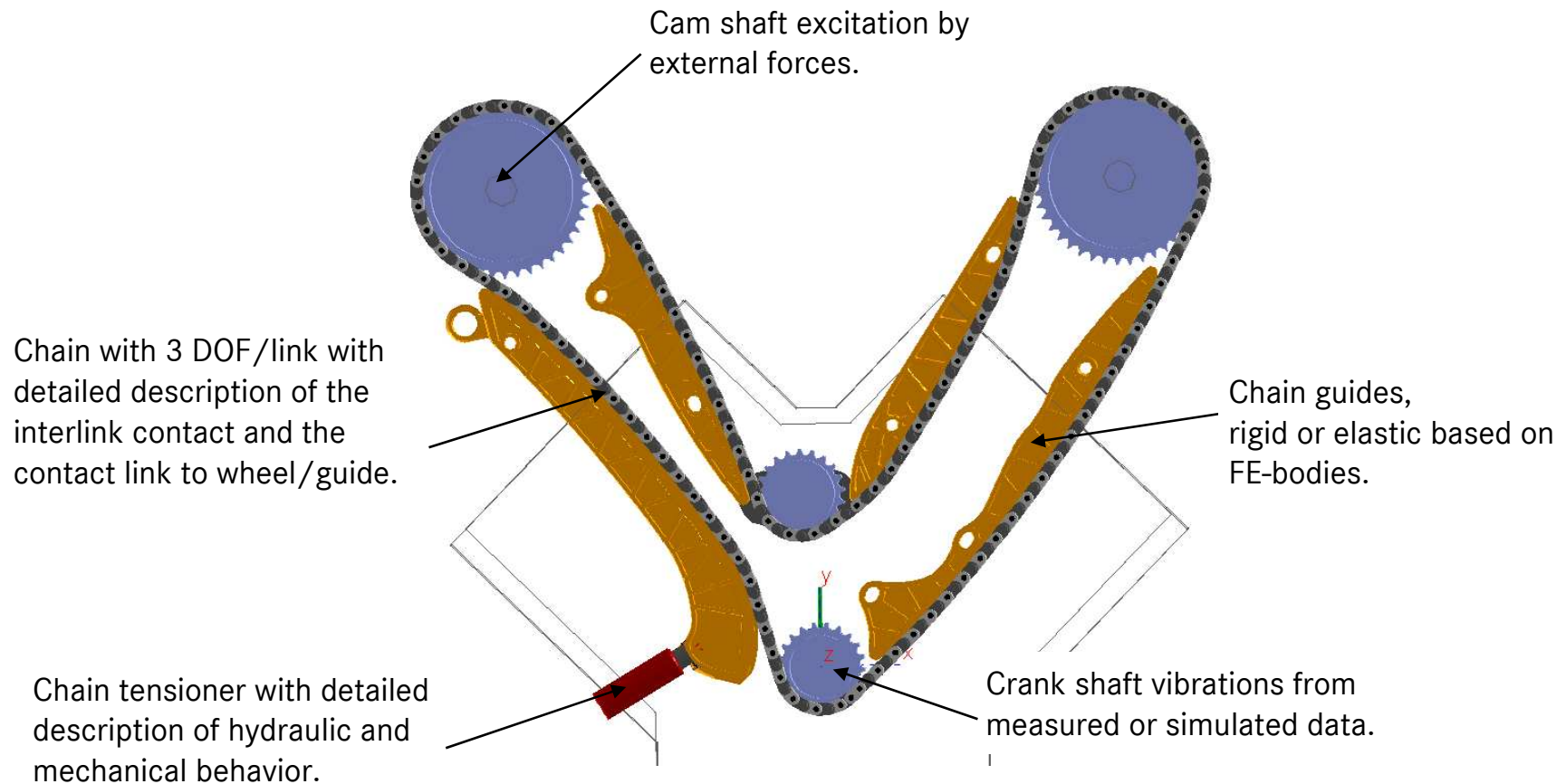
Distribution of the gap between sleeve and cam shaft.



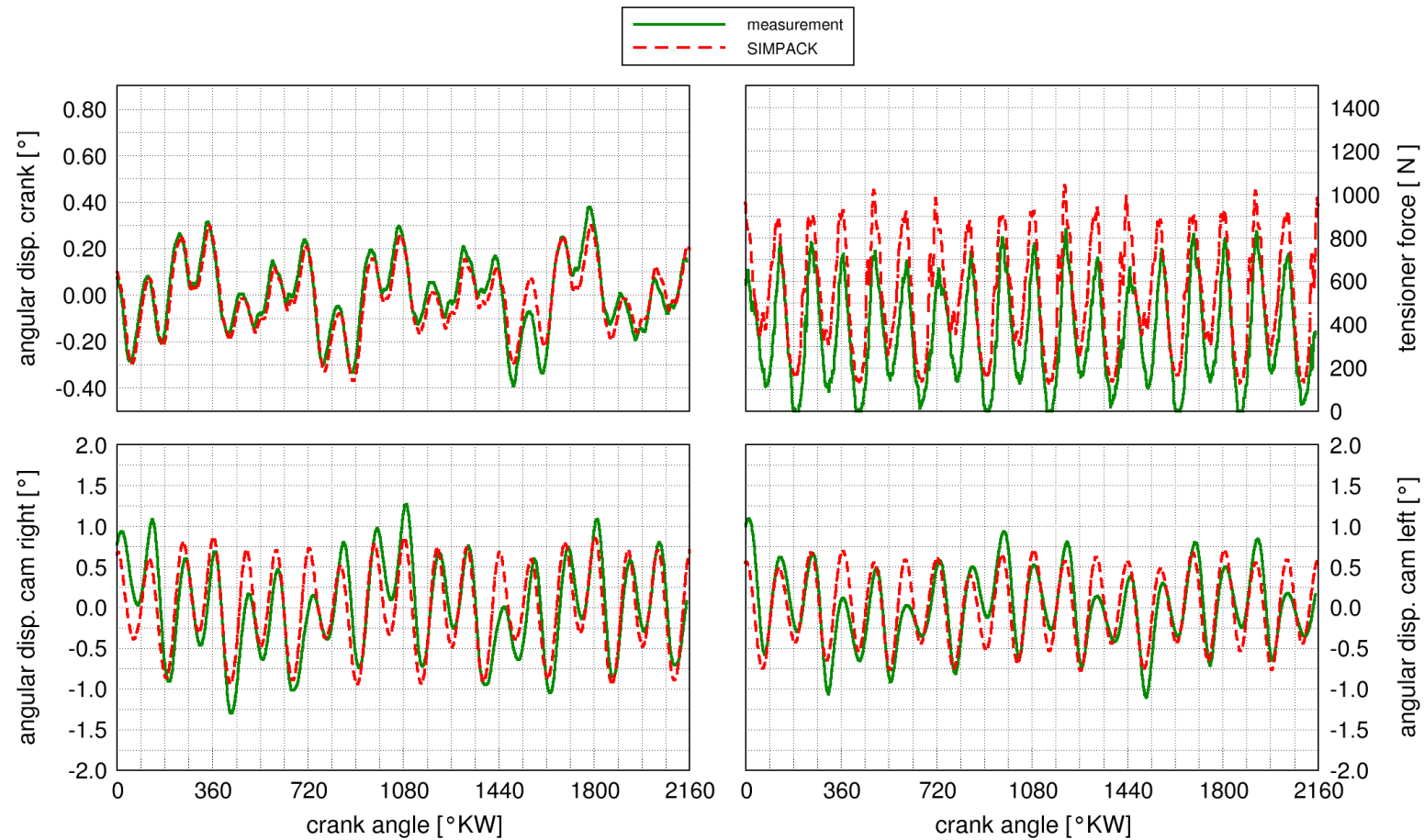
Distribution of the hydrodynamic pressure on the sleeve.



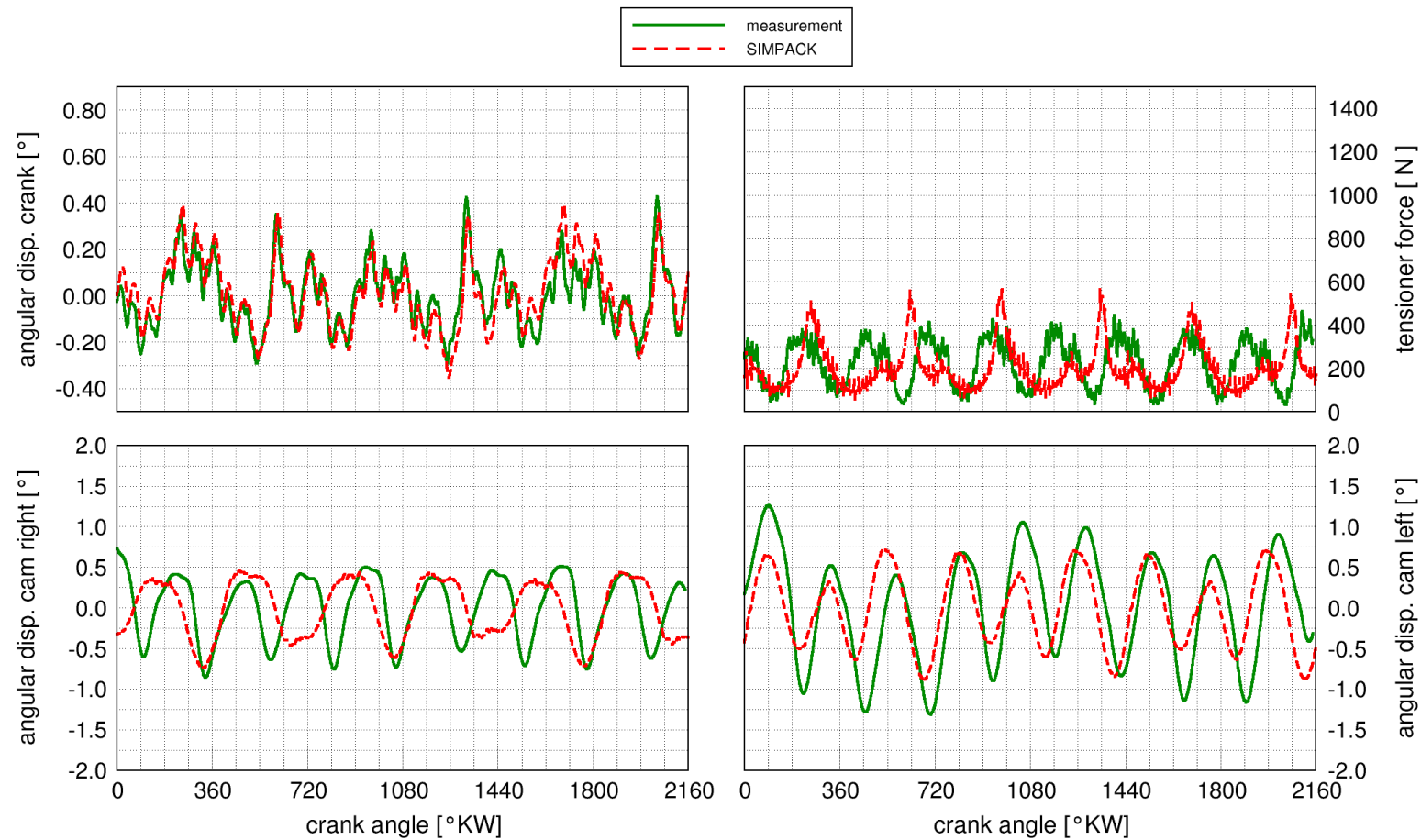
Description of the simple chain drive model



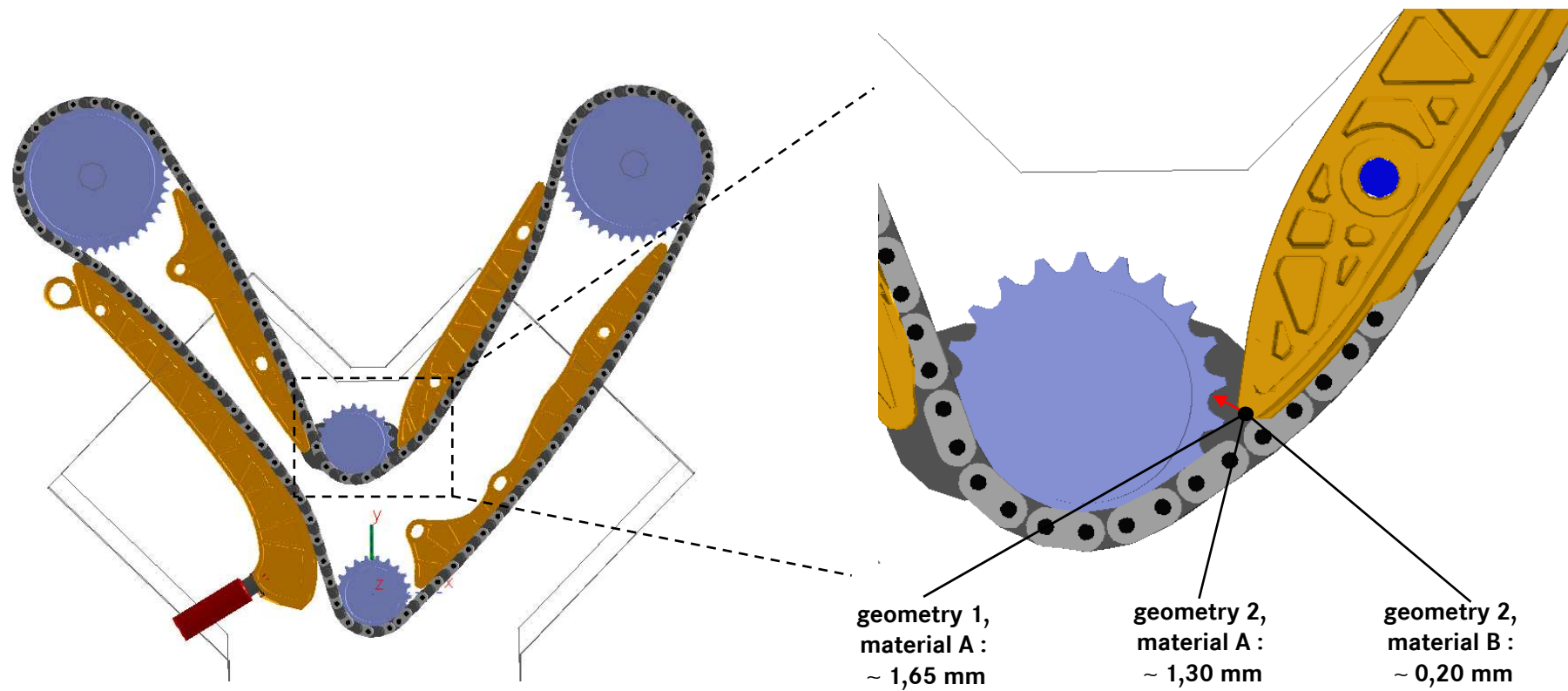
Results of simple chain model with rigid guides compared to measurements at 2500/min.



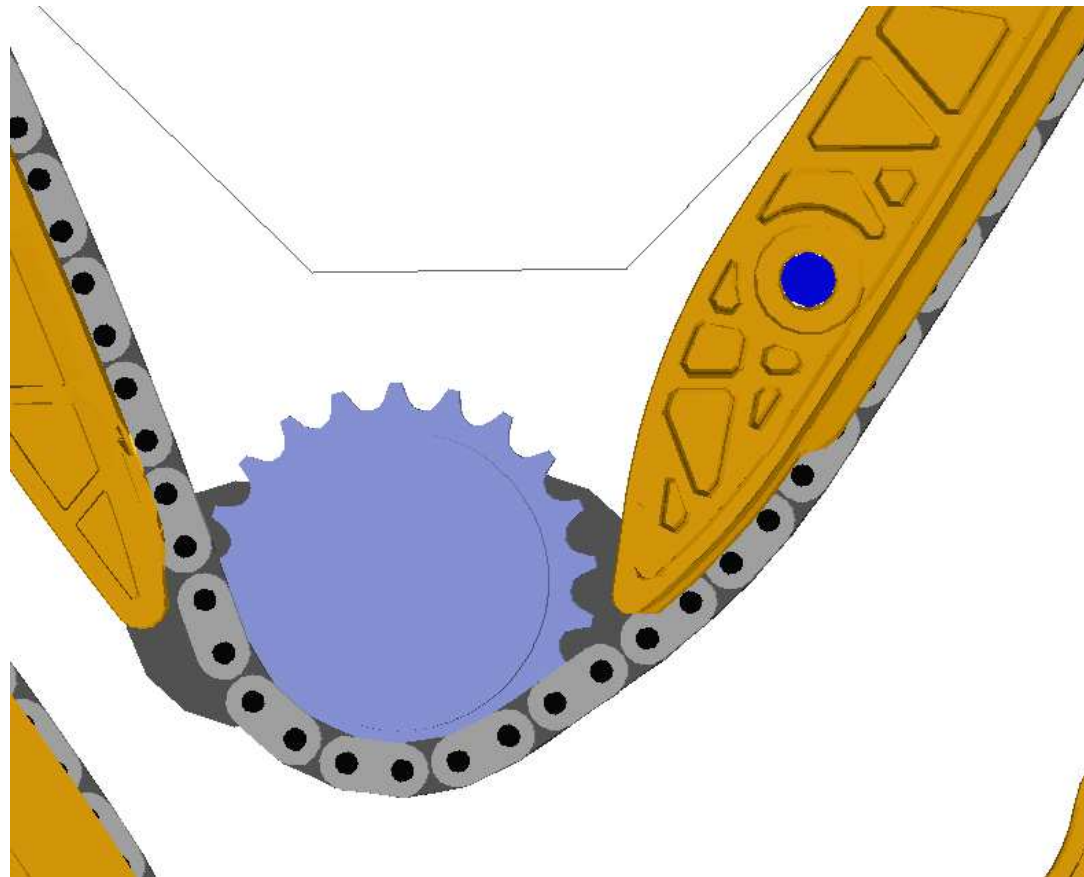
Results of simple chain model with rigid guides compared to measurements at 6000/min.



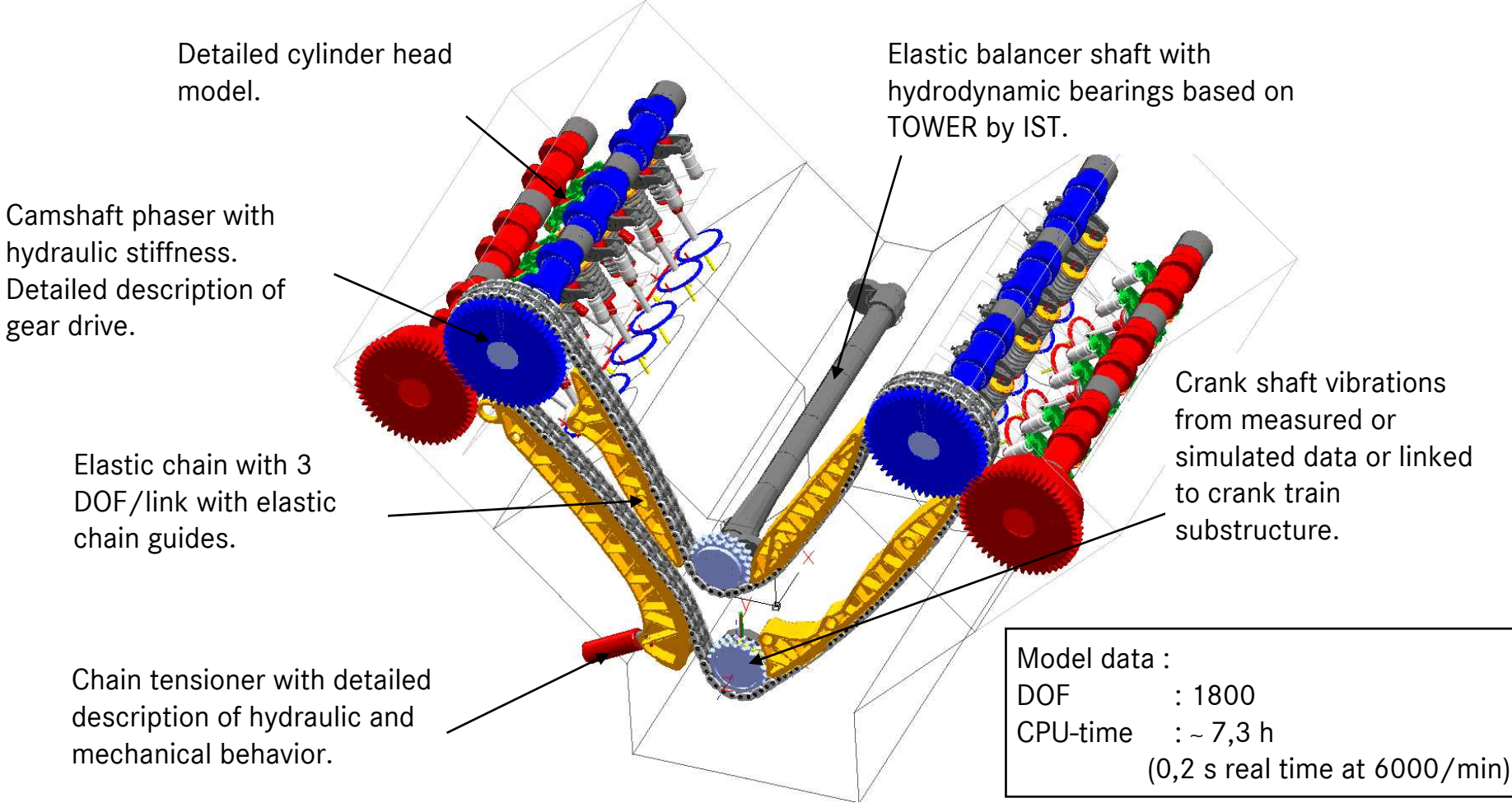
Maximum deformation of a chain guide depending on geometry and/or material



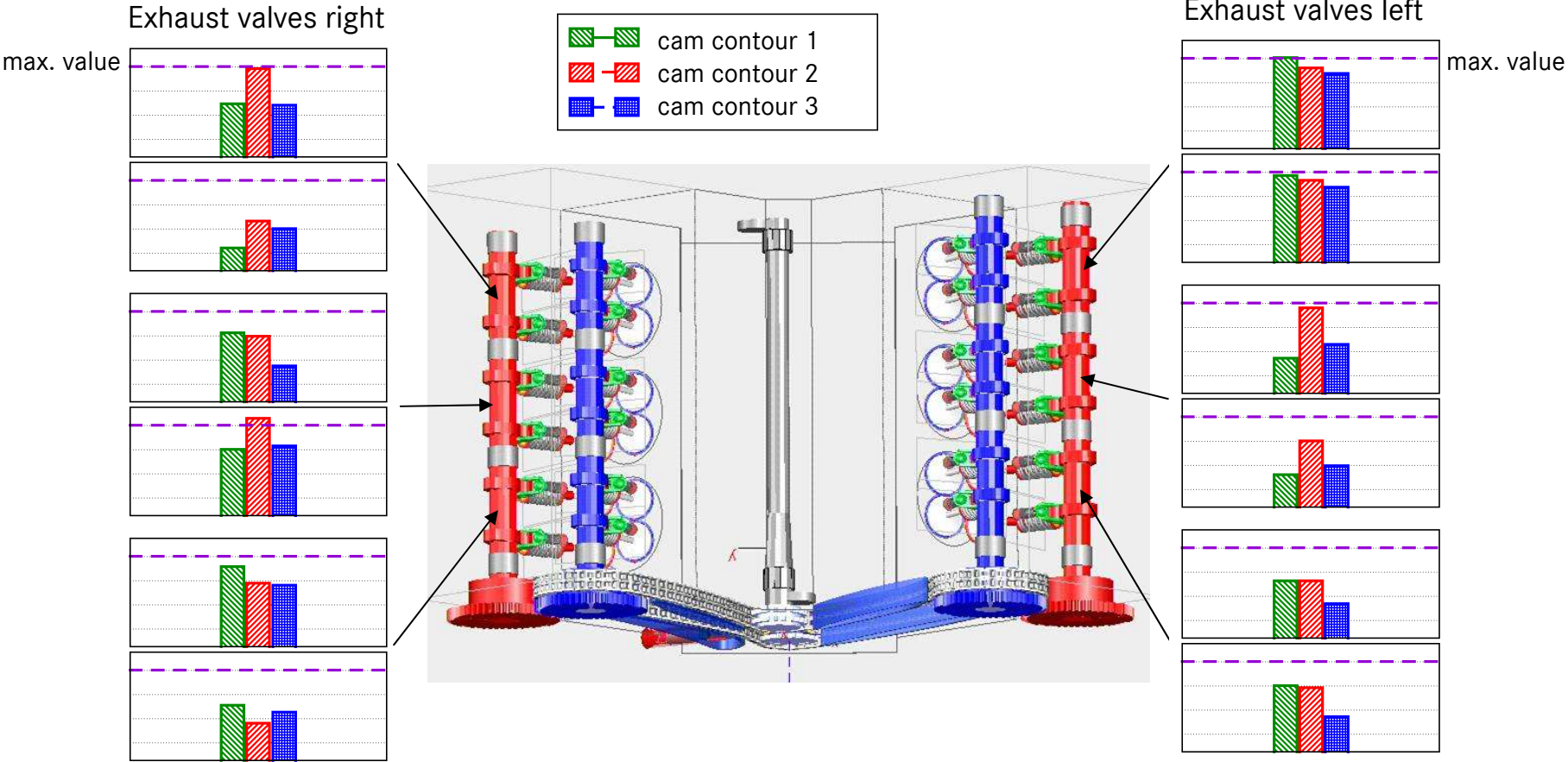
Animation : Dynamic deformation of a chain guide



MBS-model for coupled simulation of chain drive and valve train



Closing speed at different exhaust valves with various cam contours



Conclusion

- Depending on the problem, the substructure technique makes it easy to combine the various validated subsystems to a complex model including the interaction between each model.
- => The modular structure of the simulation models makes it possible to choose the most efficient models for each problem.
- By using fully parameterized substructures it is easy to adapt the existing model structures to new engine geometries with a minimum of modeling time.
- => Short response time to new requests or engine projects.

Well established simulation process at DaimlerChrysler to support the design and testing engineers in every stage of development to minimize the versions for hardware testing.

Thank you for your attention