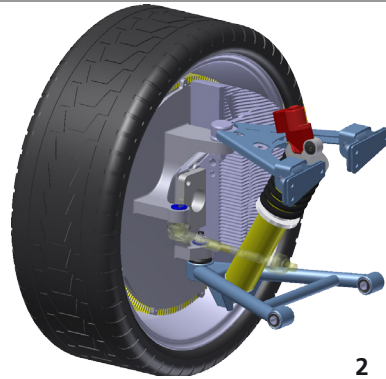


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- 1 *Simulation for wheel geometry design*
- 2 *Electrified axle*
- 3 *Wind tunnel analysis for the cooling effect*

EFFICIENT AND FUNCTIONAL - AIR-COOLED DRIVE UNIT

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Within the Fraunhofer System Research for E-Mobility (FSEM II) project, 16 different Fraunhofer institutes are jointly drafting solutions for the future of e-mobility. The three Fraunhofer institutes IISB, IFAM and LBF are pooling their expertise in the "Drivetrain/Chassis" cluster for an innovative air-cooled electrified drivetrain with adaptive chassis damper. This consists of

- Air-cooled wheel hub motor,
- Air-cooled drive inverter,
- Multi-level DC-DC converter,
- Adaptive chassis damper,
- Rim for promoting cooling air.

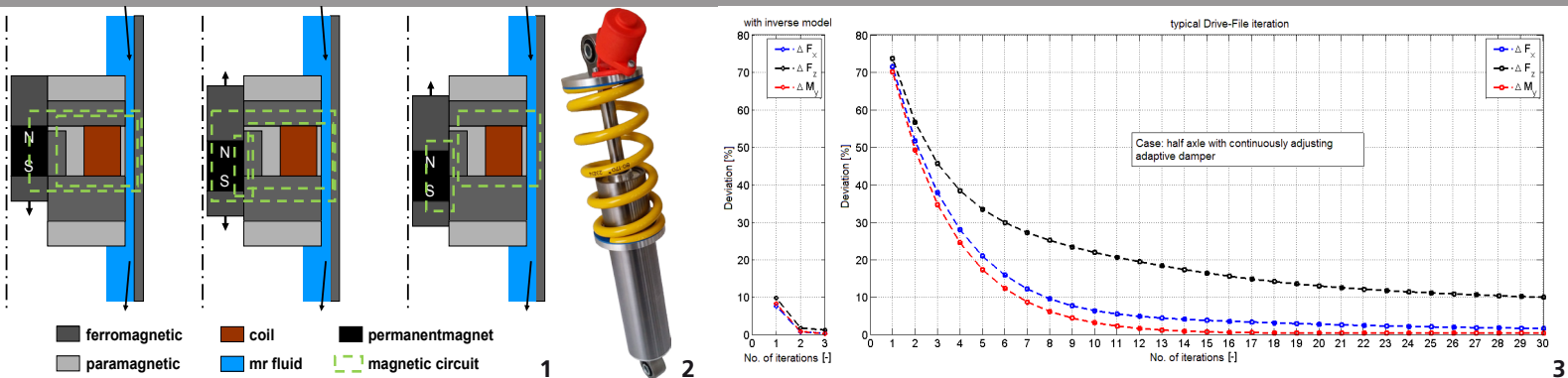
The Fraunhofer LBF skills:

Cooling-air-optimized rim

The influence of the wheel disk design was studied to improve the air flow and the wheel-side forced convection associated with it. In addition to the cooling effect

and better flow, the decision criteria used were the result of the numerical structural durability calculation and the possible weight. The rim was developed and designed according to the boundary condition for increased tire-sprung dimensions. The tests in the wind tunnel showed that the wheel design has a significant impact on the cooling behavior and that the design with propeller spokes is beneficial in assisting wheel-side convection depending on the design goal.

For example, when using wheel hub motors, taking the approach of optimum cooling air routing with low weight and a structurally durable design resulted in a 20-inch lightweight rim design **with cooling air routing improved by 5% and a weight of only 10.55 kg.**



- 1 Basic principle of the damper
- 2 Adaptive damper
- 3 Drive-File-Generation: iteration progress with the adaptive damper

Adaptive chassis damper

A magnetorheological damper featuring **innovative and energy-efficient magnetic field management** was developed to reduce the influence of the increased tire-sprung masses and to ensure maximum driving comfort. Magnetorheological fluids are suspensions of a carrier fluid and ferromagnetic particles. Solid body bridges which lead to an increase in the transferable shear stress are formed under the influence of the magnetic field. The hybrid magnetorheological damper utilizes this effect to adjust the damper stiffness in a vehicle: the stronger the magnetic field, the higher the damping force. When used in vehicles, it is thus possible to make any necessary long-term adjustments to the damper stiffness by readjusting the permanent magnet. The coil current is varied to achieve short-term, rapid adjustments of the damper setting.

Testing concept for more efficient testing of structural durability

In vehicles with subsystems stressed by variable forces, these subsystems must first be tested on the test rig with regard to their structural durability. With the multi-channel servohydraulic test rigs typical in this field, considerable effort is often required to determine the control signals ("drive files") before the test starts. The derivation of drive files is a particular problem if adaptive components are part of the test.

Rather than the usual mapping of system dynamics, a physical non-linear model of the test rig and test specimen is created which records the effects of the non-linear system dynamics and is also able to map the dynamic behavior of adaptive components. The following **advantages** emerged in numerical studies using the model of a three-channel servohydraulic

test rig and a half-shaft subassembly with a non-linear adaptive damper:

- The iterative optimization of the drive file converges significantly faster than when using the previously usual linear transfer matrix. There is **considerable potential for saving time and costs** when preparing the test - examples illustrate a deviation **below 1% after 3 iterations** instead of a deviation of 3.6% after 10 iterations
- no particular difficulties are encountered when **recording the continuously adjusting characteristics of adaptive components** with the result that they pose no problem for this form of drive-file generation.