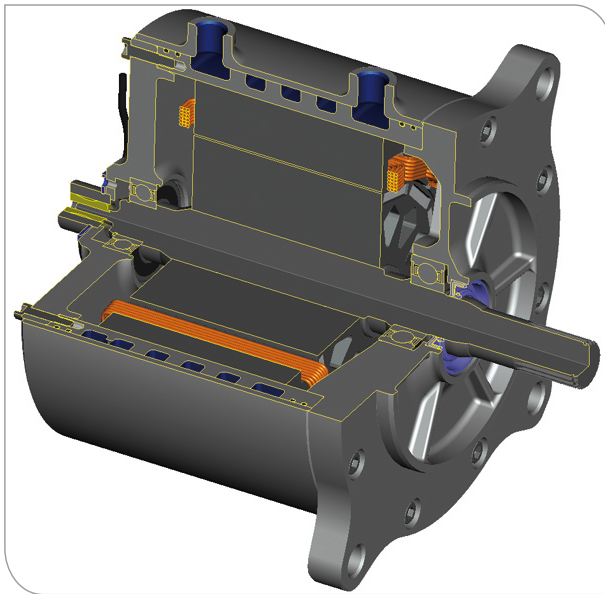
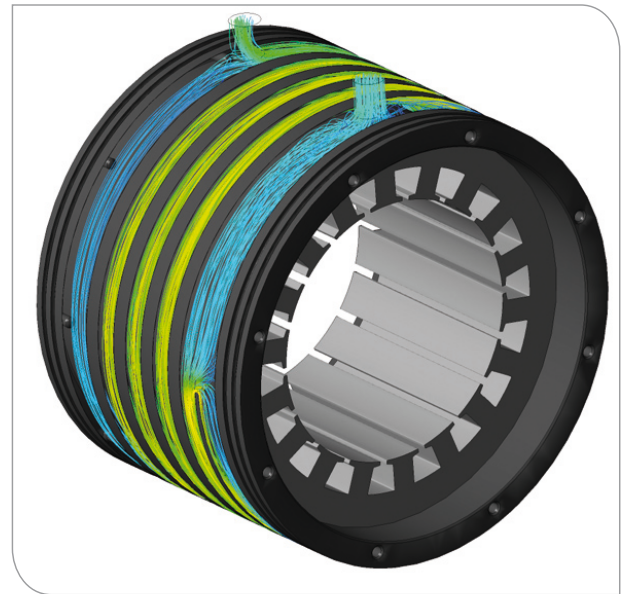


Design and prototyping of electrical machines



CAD model of an interior permanent magnet synchronous motor with single tooth winding



Water jacket cooling calculation with computational fluid dynamics (CFD) in Ansys

Increasing the power density

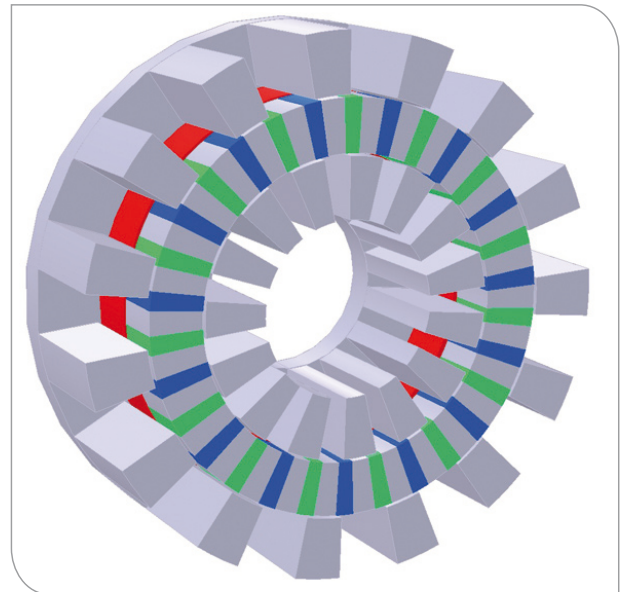
Traction motors for electric (EV) and hybrid electric vehicles (HEV) have some special requirements that set them apart from conventional electric motors, which are widely used in industrial applications. For industrial applications the motor weight is not crucial but the production costs have to be low and the efficiency has to be high enough to reach the desired efficiency label. Additional requirements for automotive traction motors are even higher efficiencies and especially low weight and small size. In order to achieve these requirements a group of engineers at the

Elektrotechnisches Institut (ETI) develop new concepts to significantly increase the power density of electric traction motors. This can be achieved with increased motor speeds, better cooling technologies and new machine topologies. The power output of electric motors is proportional to torque and motor speed but contrary to an increased motor speed an increased torque leads to an increased weight. There is a project in which traction motors with up to 30.000 rpm are calculated, designed and tested. Because the heat in such motors is created in a much smaller volume, there is only a small surface to dissipate the heat and new cooling technologies are needed to keep the winding temperatures low.

New soft magnetic materials

Soft magnetic composite materials (SMC) are mainly composed of ferromagnetic powder particles surrounded by an electrically insulated layer, which can be more easily and cost-effectively manufactured than electrical steel. This new kind of material demonstrates several advantages over traditional laminated steel cores. One of the most important properties is the three-dimensional (3D) isotropic ferromagnetic behavior. Based on this attribute many new concepts of electrical machines could be realized, which show the potential such as high torque density and power density, high efficiency and a simple coil structure.

At the Elektrotechnisches Institut (ETI) different novel and advantageous machine concepts, which can only be realized with SMC materials, should be researched and evaluated with respect to the system costs and manufacturability. Subsequently, the detailed design and construction of the best suited concept will be carried out. At the end of the project the construction of a prototype and the validation with measurements should be accomplished.



Transverse flux motor with SMC-Material

Prototype construction

In order to validate new machine concepts prototypes have to be build and tested. Apart from some production steps with very high machine investments for example laser cutting, most of the production steps are done at the Elektrotechnisches Institut (ETI). The newly built test bench for electrical machine at the "KIT East Campus"

offer excellent feasibilities of measurement and test. The test stands include a power range up to about 200kW and motor speeds up to 18,000 rpm. Even electrical drives with much higher motor speeds can be tested with a special transmission gearing.

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