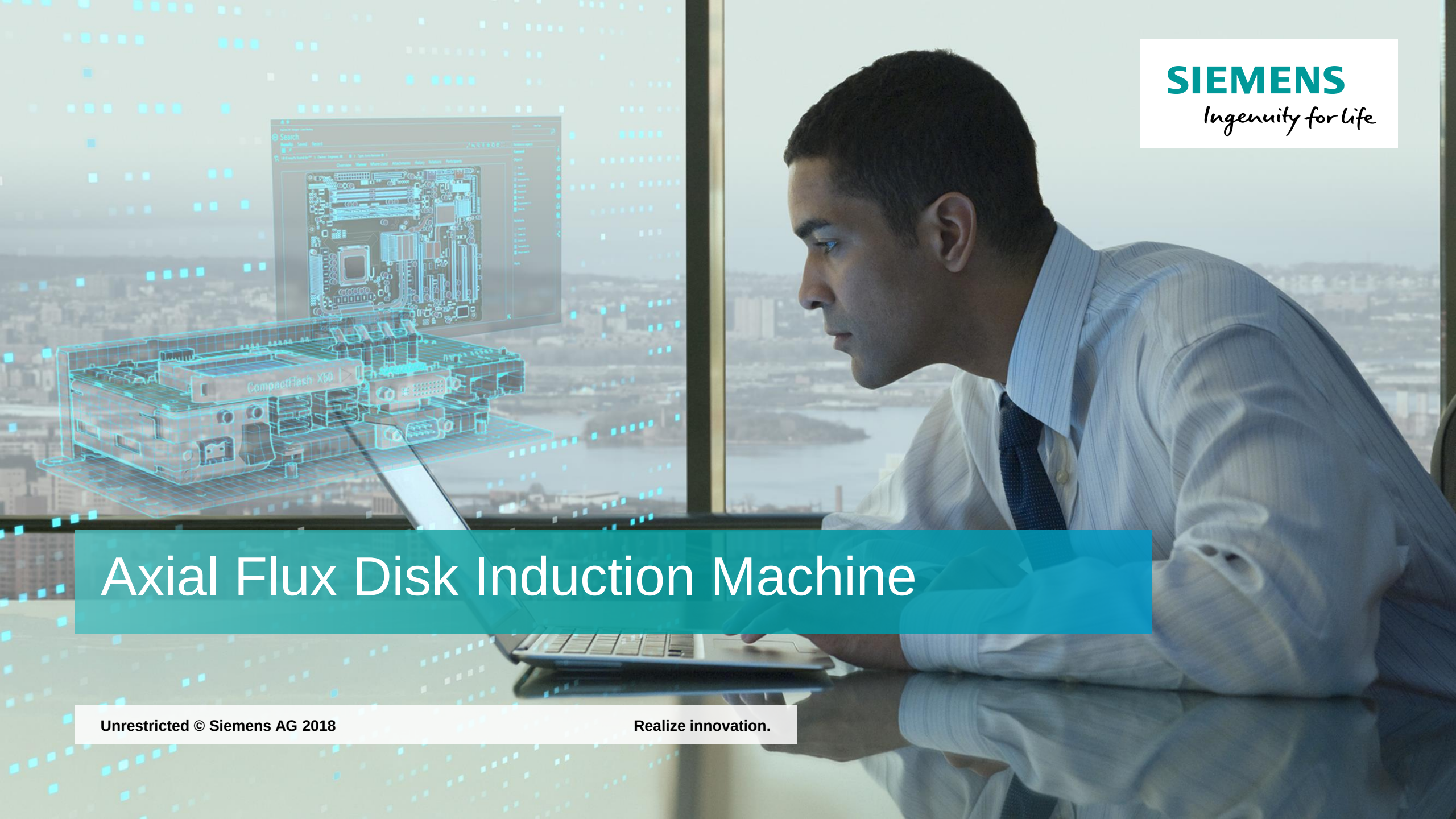

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Axial Flux Disk Induction Machine

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Axial Flux Disk Induction Machine

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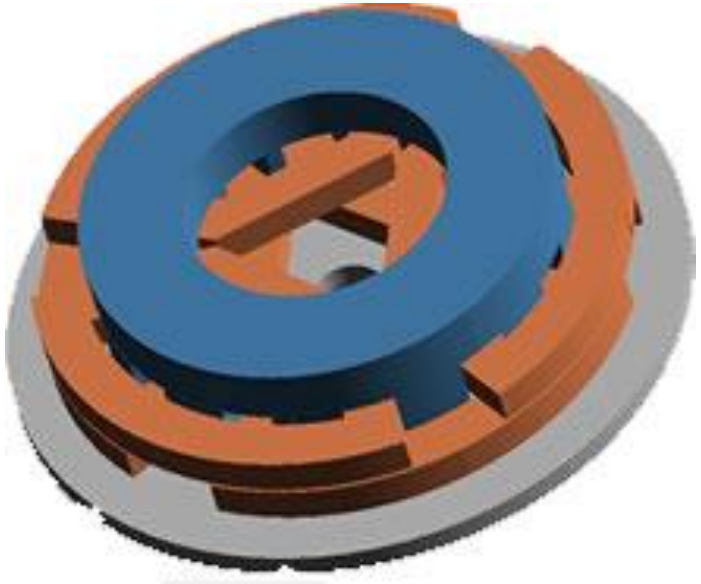
View the capabilities of the 3D Transient with Motion solver in a unique and truly 3D machine--an axial flux disk induction machine. The flux flows parallel to the axis of the rotor. Currents are induced in a flat disc-shaped aluminum rotor element. The 3D Transient with Motion solver was used to model both a run-up to synchronous speed and also to create a torque-speed curve. This particular machine (built and tested by the University of Bath, UK[1]) provided the opportunity to compare the Simcenter MAGNET results against measurements made on the real device, and to also show the accuracy and value of simulation with Simcenter MAGNET .



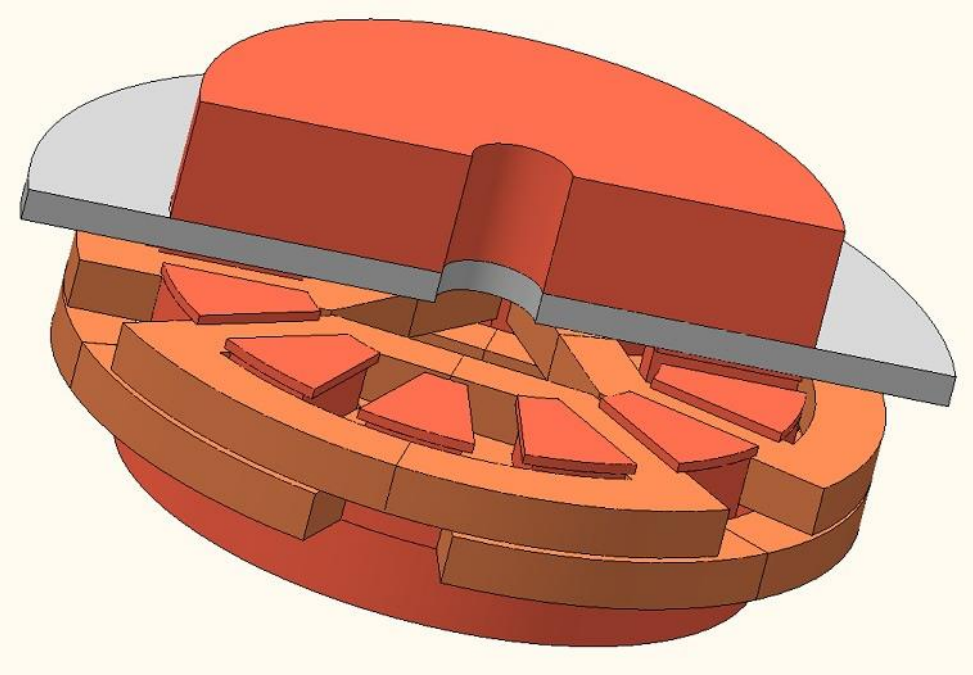
This type of machine is often specified when rapid changes in operating speed are required or the short axial length of the machine is crucial. Tight coupling is required between the field and motion solutions as the mechanical and electrical time constants are of similar magnitudes.

More details on the analysis of this machine (and other 3D motion problems) were published in the proceedings of COMPUMAG 2005[2].

[1] Rodger, D., Lai, H.C., Coles, P.C., Allen, N., Leonard, P.J., Roberts, P., "3D Finite Element Model of a Disk Induction Machine", Proceedings of the IEE 8th Internation Conference on Electrical Machines and Drives, EMD97, vol. 444, 1997, p. 148-149.

[2] D. N. Dyck, B. Forghani, C. S. Brett, J. P. Webb, D. A. Lowther, "A T-Omega Finite Element Method for Arbitrary Motion in 3D," Proceedings of the 15th Conference on the Computation of Electromagnetic Fields (COMPUMAG 2005), Shenyang, China, June 26-30, 2005.

CUTAWAY VIEW OF THE INDUCTION MOTOR



This image shows a cutaway view of the device — it consists of a three-phase, 4-pole, 12-tooth stator, an aluminum rotor disk in which the rotor currents will flow, and a rotor back iron region. The machine has an overall diameter of 184 mm and an axial length of 64 mm. The windings are each 290 turns, excited with 2.83A. The frequency of operation is 50Hz. The air gap thickness is only 1 mm.

STATIONARY, MOTION, AND REMESH REGIONS

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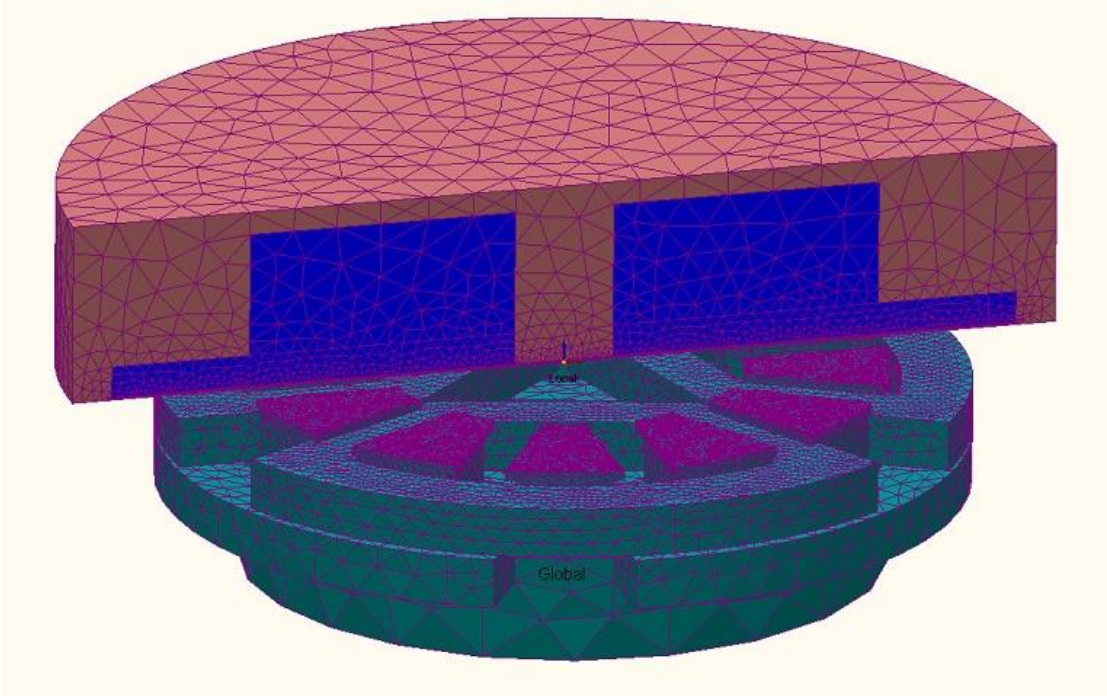
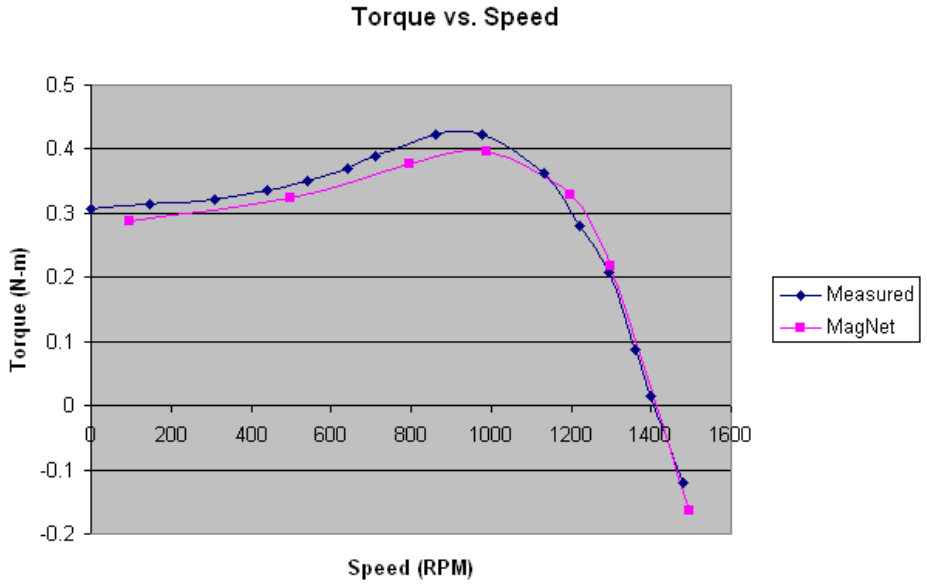


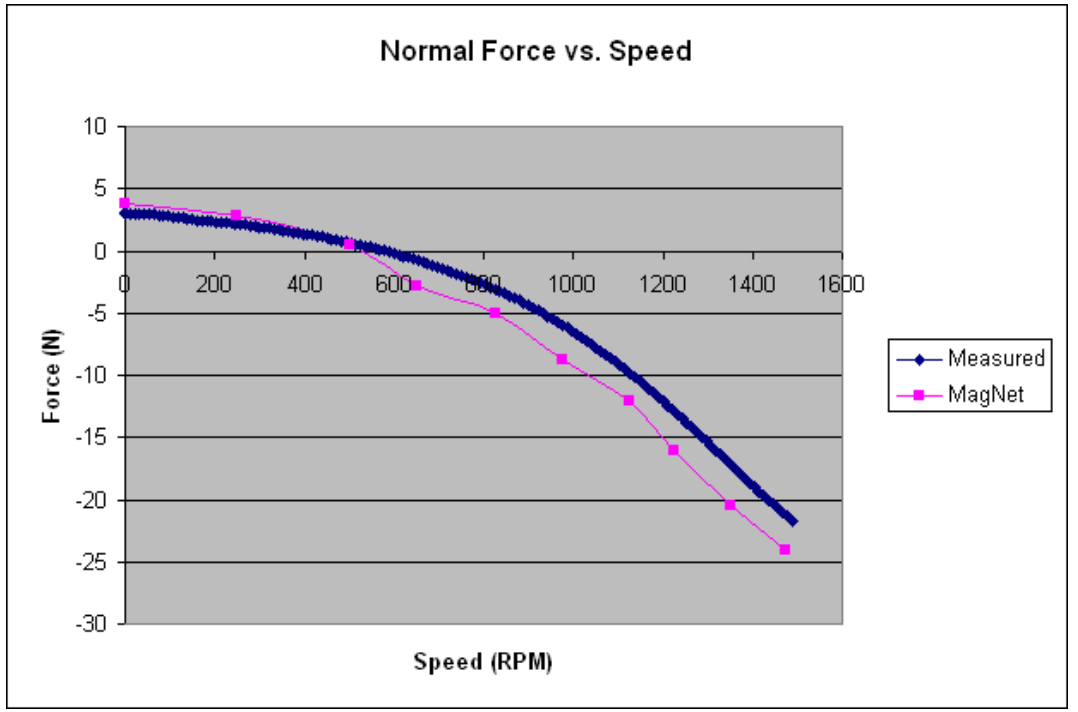
Simcenter MAGNET 's motion solver separates the problem into stationary, motion and remesh regions. Only the air surrounding the rotor is remeshed at each time step, keeping the meshing overhead low. The adjacent figure shows the mesh divided into static (green), motion (blue) and remesh (purple) regions. Various elements have been hidden for clarity.

COMPARISON OF TORQUE VS SPEED CURVES



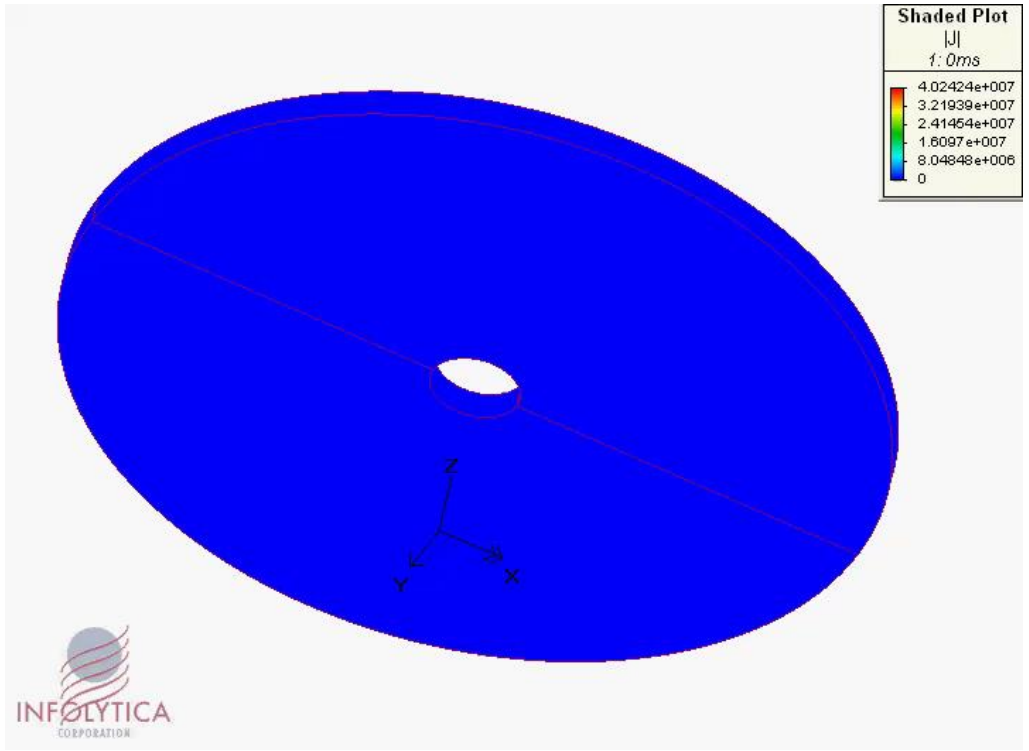
Here a comparison is shown between the torque-speed curves computed by Simcenter MAGNET as well as the experimentally measured values. The peak deviation (which is higher at low speeds and torques) is around 5%. This is well within the acceptable range, considering the complexity of the geometry, and the fact that the transient with motion simulation of induction machines is a difficult task, requiring good material models and accurate computation of magnetic fields, eddy currents and the equations of motion.

COMPARISON OF NORMAL FORCE VS SPEED CURVES



A graph comparing the simulated normal force (attracting the rotor towards the stator axially) with the measured values is presented here. Historically the computation of forces and torques is a difficult problem in electromagnetic simulations, and Simcenter MAGNET is able to give accurate results even when considering all potential sources of error, both in experimental measurement and in simulation.

EDDY CURRENT DENSITY IN THE ROTOR DISK



This animation shows the eddy current density in the rotor disk as the machine accelerates. A line across the diameter of the rotor allows the rotor"s speed and direction of rotation to be seen.