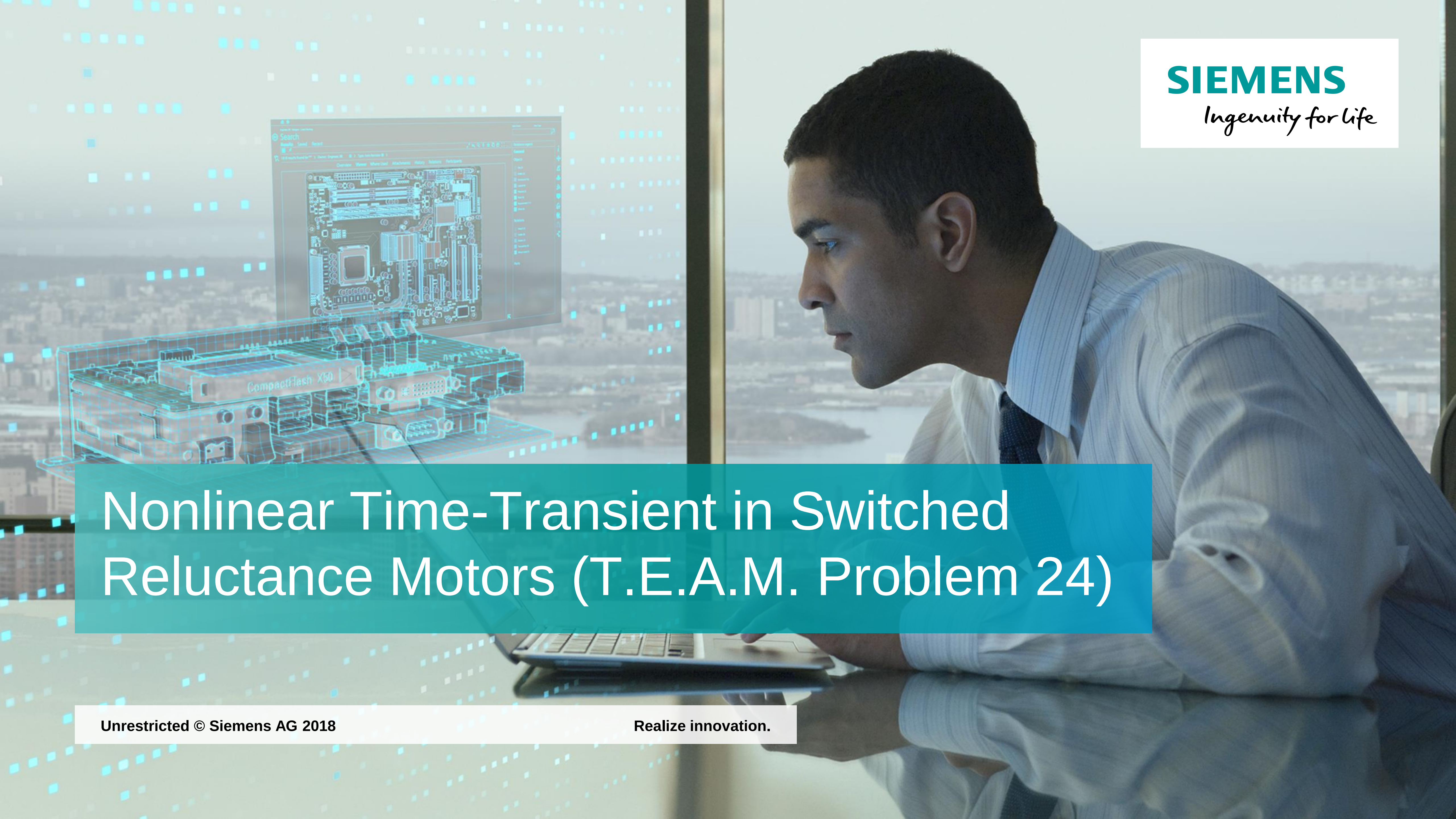

Nonlinear Time-Transient in Switched Reluctance Motors (T.E.A.M. Problem 24)

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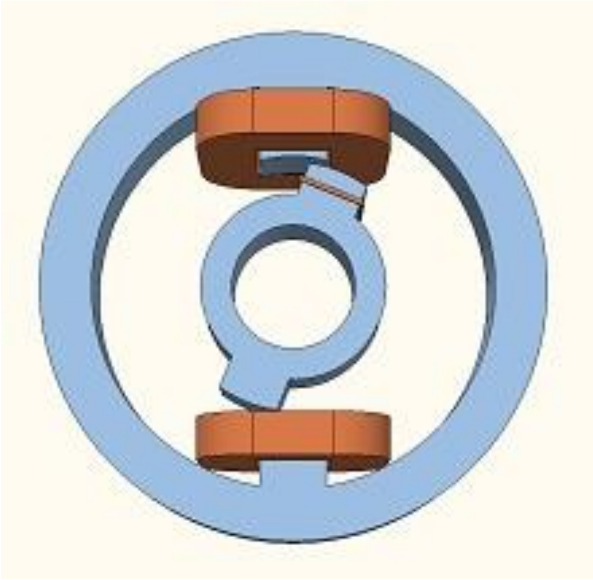
Nonlinear Time-Transient in Switched Reluctance Motors (T.E.A.M. Problem 24)

This is a test rig of configuration similar to that of a switched reluctance machine. It is made of solid medium-carbon steel and mounted in a nonmagnetic cage which can rotate about a stainless steel shaft. This example shows a nonlinear transient problem, which was solved by simcenter MagNet's Transient 3D solver.



Each stator pole has a 350-turn coil around it, and the rotor is fixed at 22 degrees relative to the stator. A step voltage of 23.1 V is applied to the series connected coils. A search coil is wound around a rotor pole to measure the total magnetic flux, and a Hall probe measures the y-component of the magnetic flux density at a specified position in the air gap between rotor and stator. Finally, a piezoelectric transducer measures the torque on the rotor.

Using Simcenter MAGNET's Transient 3D solver, the current, torque, rotor pole flux and the air gap point flux density are calculated. The simulation results agree well with the measured data published in the problem definition.

The following is based on the Testing Electromagnetic Analysis Methods (T.E.A.M.) problem #24: Nonlinear Time-Transient Rotational Test Rig. The benchmark can be found on the International Compumag Society's website.

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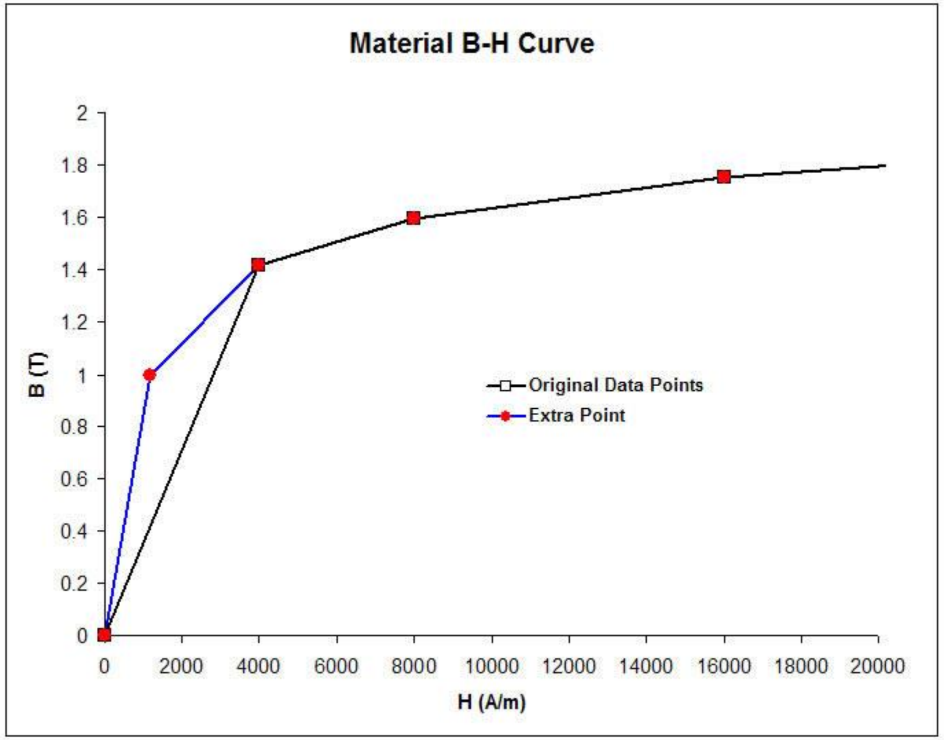
MATERIAL MODELING: B-H CURVE



Material properties are critical to accurate calculations. The T.E.A.M. problem specifies the material B-H curve, but there are not enough data points in the critical region at the "knee" of the B-H curve. By adding one more data point to the material curve, good agreement with experiment was obtained. The graph above shows where the extra point was added in relation to the original published data.

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MAGNET'S COIL CURRENT RESULTS

This graph plots the result of the coil currents as simulated in Simcenter MAGNET for the test rig switched reluctance machine.

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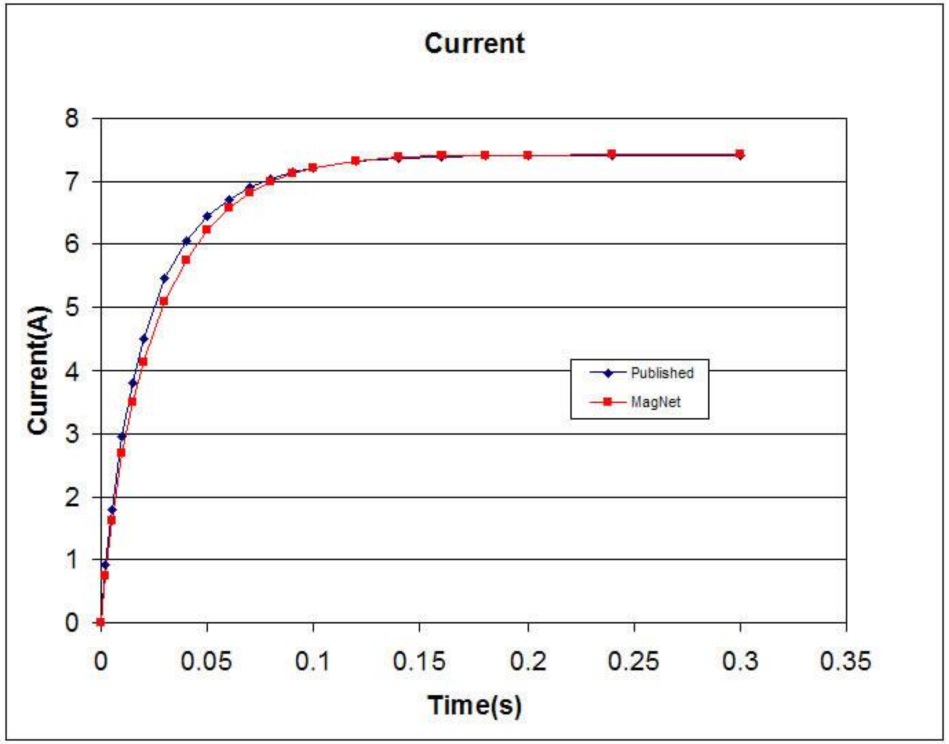
COMPARING MEASURED VS SIMULATED COIL CURRENTS



Comparison of the coil currents between the published T.E.A.M. data and the results obtained from Simcenter MAGNET. The steady state current agrees exactly, since this depends only on the DC resistance of the coils, which is specified. The error in the transient current can be attributed to both experimental error and material modeling error (due to insufficient material data).

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MAGNET'S TORQUE RESULTS

This graph plots the result of the torque as simulated in Simcenter MAGNET for the test rig switched reluctance machine.

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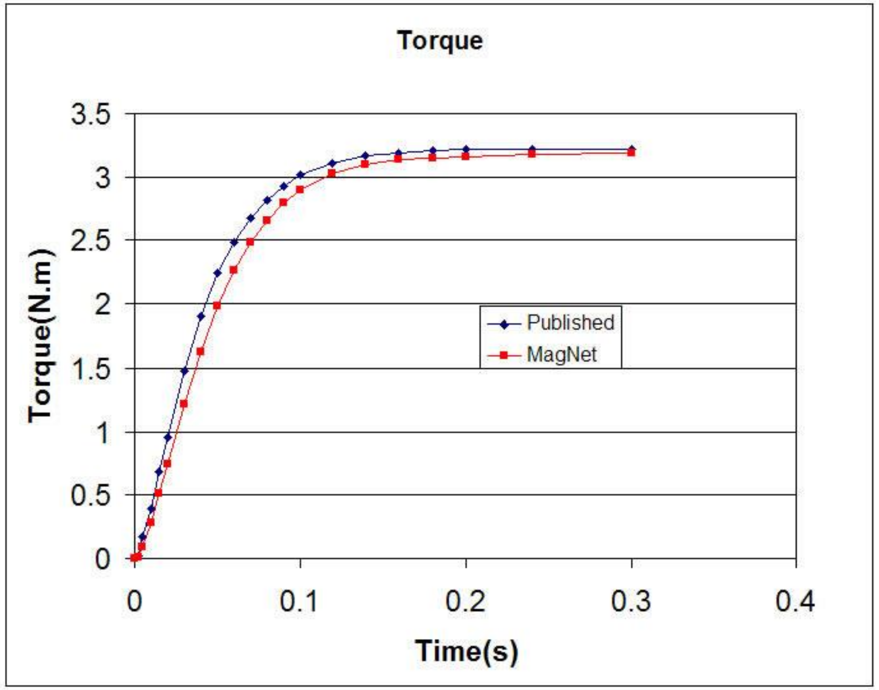
COMPARING MEASURED VS SIMULATED TORQUE



Comparison of the torque values between the published T.E.A.M. data and the Simcenter MAGNET results. Since Magnet uses a half model, the result is half of the total torque. Torque is one of the more difficult quantities to compute accurately, but these results show that Simcenter MAGNET's torque calculation is accurate.

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MAGNET'S ROTOR FLUX RESULTS

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This graph plots the result of the rotor flux as simulated in Simcenter MAGNET for the test rig switched reluctance machine.

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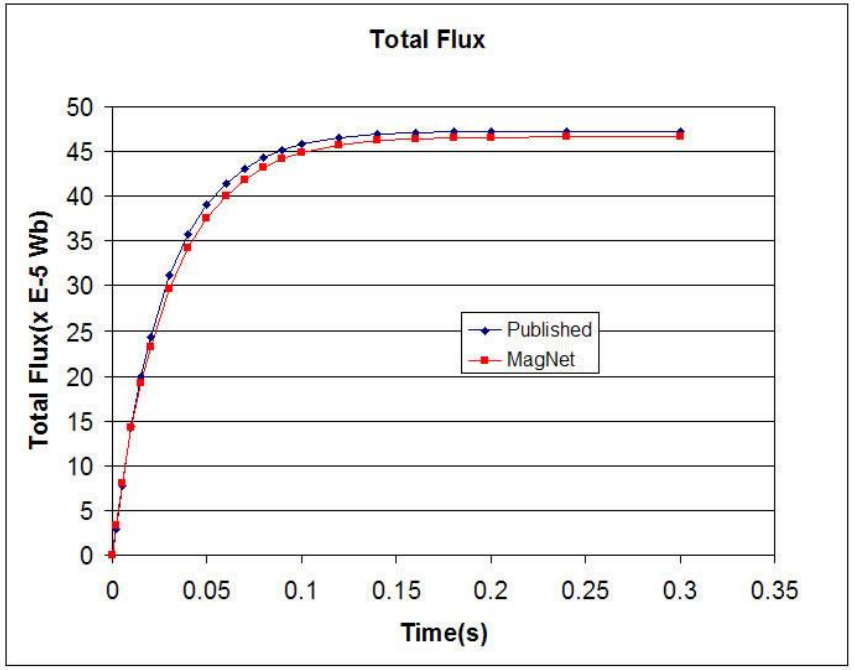
COMPARING MEASURED VS SIMULATED ROTOR FLUX



The comparison of the total flux through the rotor pole, measured with the open-circuited sense coil, is shown in this graph.

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MAGNET'S FLUX DENSITY RESULTS

This graph plots the result of the flux density as simulated in Simcenter MAGNET for the test rig switched reluctance machine.

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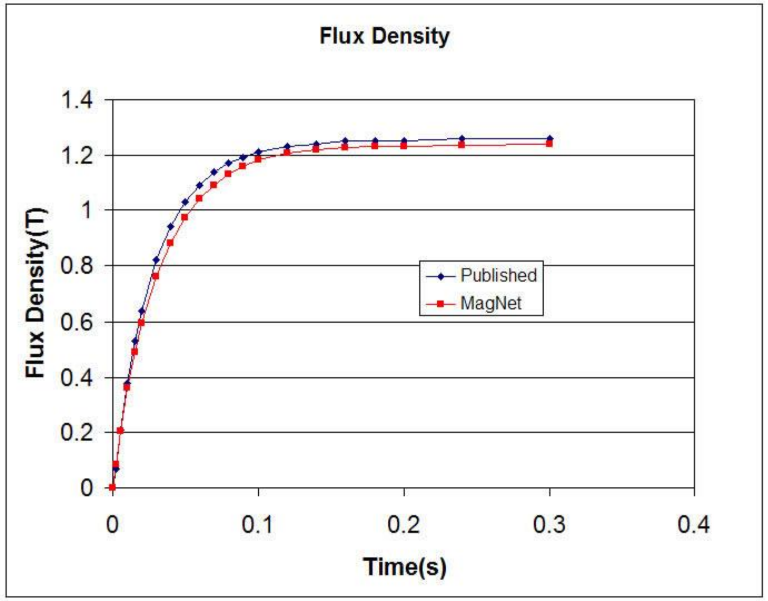
COMPARING MEASURED VS SIMULATED FLUX DENSITY



The flux density values obtained from Simcenter MAGNET are compared with the published T.E.A.M. data. The experimental data was obtained using a Hall probe in the air gap. In Simcenter MAGNET, the field sampler tool allows quick and easy plotting of any field over either space or time, and of course it is even possible to probe inside components, something a Hall sensor cannot do.

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