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Simcenter STAR-CCM+ electromagnetics

A fast, scalable tool for electromagnetic analysis in a multiphysics environment

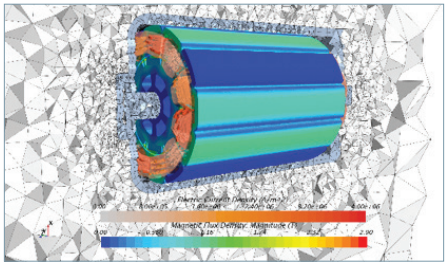
Benefits

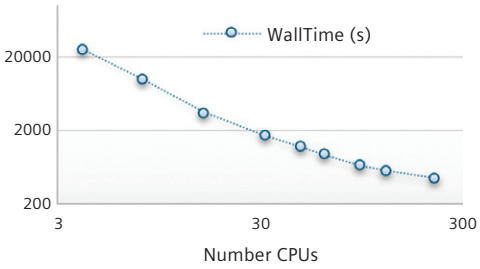
- State-of-the-art electromagnetic solver enables accurate analysis of low-frequency applications
- Single integrated multiphysics environment expands application coverage and improves physical realism
- Computational electromagnetics can be coupled with computational fluid dynamics (CFD)/thermal physics within the same simulation
- Finite volume and finite element discretizations of low frequency electromagnetism can be used in 2D and 3D
- Fast and scalable solvers allow analysis of industrial scale problems

Today's challenges in electromagnetics

Electrification is one of the major pillars of industrial innovation. In this field, modern design and optimization often require a multidisciplinary approach. For instance, the development of an electric motor may need to account for electromagnetics, heat transfer, fluid dynamics, structural mechanics, and noise and vibration. A realistic design of a circuit breaker may have to include radiation, wall ablation, contact erosion, ferromagnetism and fluid mechanics. To tackle such a level of complexity, advanced numerical simulations are an essential tool for a thorough, cost-effective and comprehensive analysis. The following are additional simulation challenges in electromagnetics today:

- Simulation engineers need to simulate all the required physics for truly innovative and reliable designs
- The number of simulation tools should be minimal and workflows user-friendly
- The selected physical models must provide the correct numerical formulation and discretization (finite volume (FV)/finite element (FE), time/frequency domain, 2D/2D-axisymmetric/3D)
- Results must be accurate with fast turnaround times





On the left is a realistic e-machine model in 3D. Mesh is 12.8 million elements.
Right, performance on an Intel Xeon CPU E5-2698 version e3, 2.30 GHz, InifiniBand QDR.

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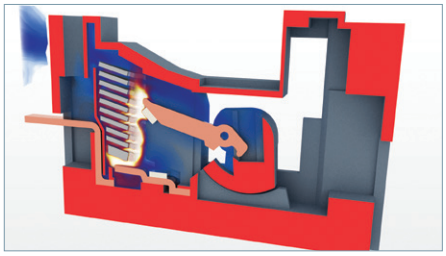
Simcenter STAR-CCM+ offers the solution

Simcenter™ STAR-CCM+™ software is a multipurpose CFD tool with expanding multiphysics capabilities. In a single integrated user interface, users can utilize a full suite of coupled physics models to build a high-fidelity digital twin of their real-life application. Moreover, the code benefits from a highly scalable high-performance computing (HPC) framework enables faster results.



Example of Simcenter STAR-CCM+ multiphysics showing a cross-section of a low voltage circuit breaker simulation.

With Simcenter STAR-CCM+, users can:

- Make use of an accurate, fast, scalable implementation of low frequency electromagnetics analysis
- Take advantage of a fast development cycle that quickly reacts to and anticipates market needs, releasing new, fully-featured versions three times a year
- Focus on making engineering decisions by reducing time otherwise spent in setting up complex workflows involving different, narrow-purposed tools

Multiphysics

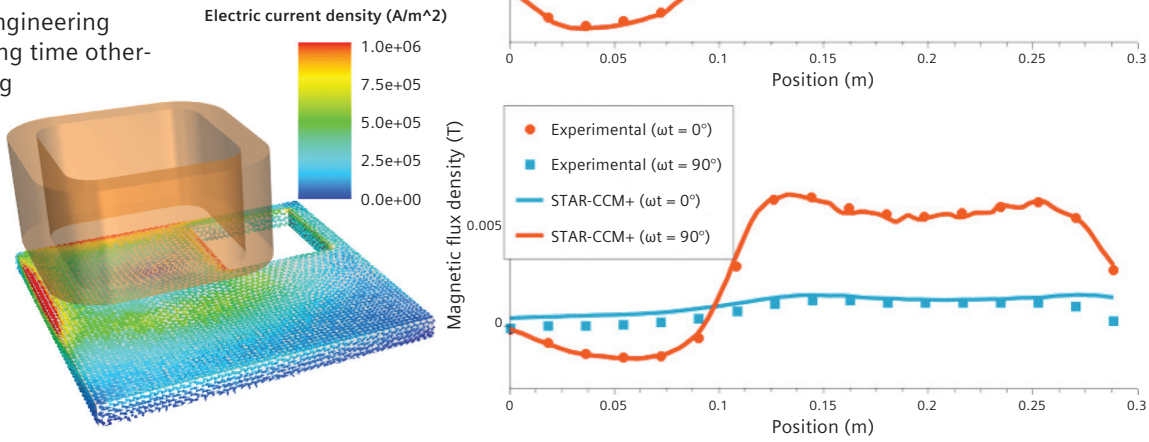
The ability of Simcenter STAR-CCM+ to couple several physics models in one single environment is one of its major advantages, giving users the most physical and accurate digital twin of their application. For example, to develop a robust and high-performance electric motor, simulation experts need to account for the effective cooling of the electric machine, whose simulation often involves advanced multiphase analyses (for example, oil-spray cooling). Similarly, prototyping a reliable circuit breaker often requires detailed simulations of complex physical phenomena.

Typical low frequency applications that are performed using multiphysics capabilities of Simcenter STAR-CCM+ include:

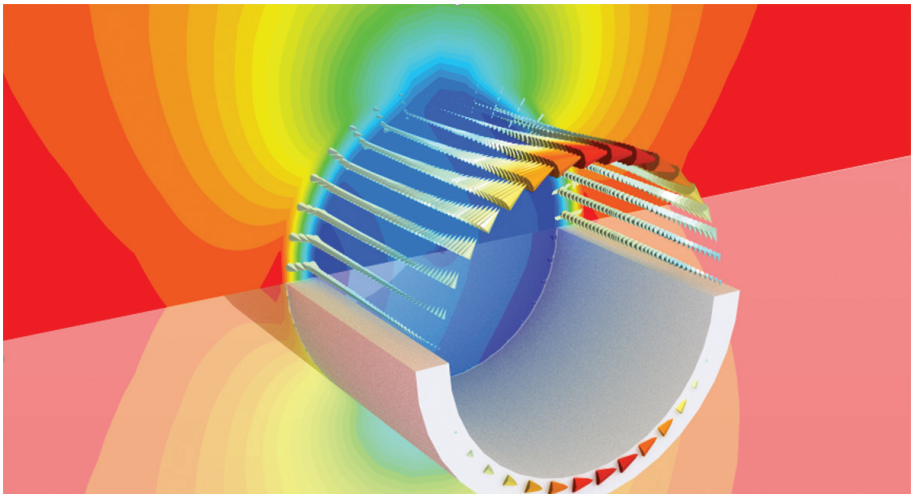
- Electric machines (motors, transformers, generators, converters) and their thermal management
- Magnetohydrodynamics and plasma arcs (circuit breakers, relays, welding devices, thermal spraying, plasma torches)
- Problems involving coupling with solid stress to assess mechanical strength under magnetic loads in short circuit events
- Induction heating and stirring
- Ohmic heating: busbars, fuses, etc.
- Actuators and loudspeakers
- Sensors and flow meters

Accuracy and performance

Users must have full confidence in their virtual models in order to take decisions based on computed predictions. Solution accuracy is paramount and cannot be compromised. For instance, accurate simulations help in understanding whether a switchgear prototype will interrupt a large short-circuit current at a certain voltage. Simulation experts dealing with electric machines need to quantify the impact of geometry changes on the torque supplied by the machine. Safety analysis (dielectric withstand, shielding, lightning protection) requires careful sizing of geometries and gaps between components.



Results from Compumag society benchmark case showing electric current density analysis on the left and comparison with experimental results on the right.



Simcenter STAR-CCM+ offers optimum accuracy, speed and performance – here's how:

- Best-in-class computational electromagnetics (CEM) models ensure coverage of different applications without compromising on speed
- Simcenter STAR-CCM+ models are consistently benchmarked with published results
- HPC framework enables excellent scalability, providing lower turnaround times on more than 200 cores on a cluster
- Users choose between direct and iterative multigrid solvers, taking advantage of their complementary strengths and performances on different mesh sizes
- The FE iterative solver handles large meshes (over 10 million elements) with excellent performance on large cases
- Siemens Digital Industries Software collaborates with relevant academic and industrial partners, whose expertise helps in strengthening accuracy and validation

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