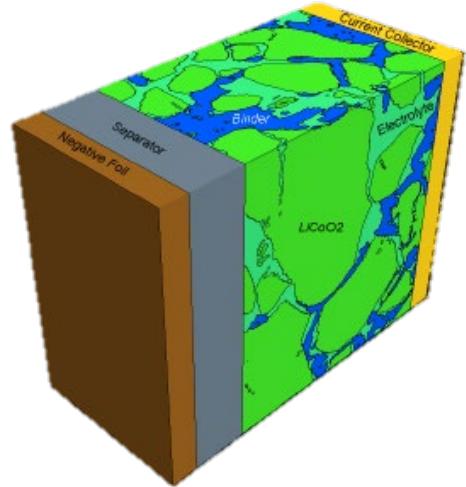


Simcenter Battery Modeling Solutions

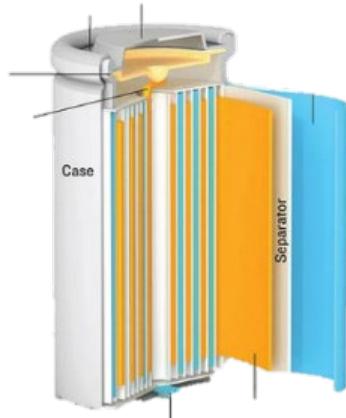
The Battery Modelling Process

From micro-structure electrochemistry to cell, pack and system design



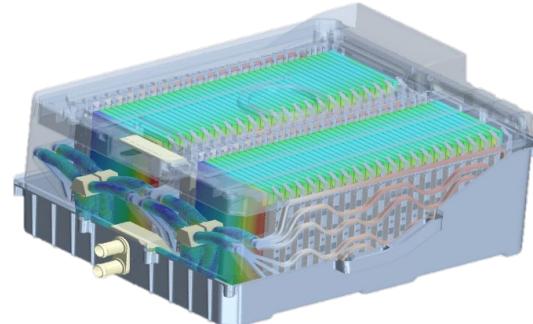
Micro-Structure Electrochemistry

- Virtually test SEM produced electrode geometry
- Conduct design studies on new concepts



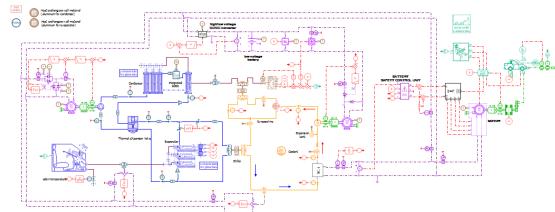
Virtual Cell Design/Test

Detailed geometrical representation coupled to performance model to build cell digital twin



Battery Pack Design

Flow, thermal & electrochemistry analysis of complex power systems
Study detailed spatial effects at cell, module & pack level

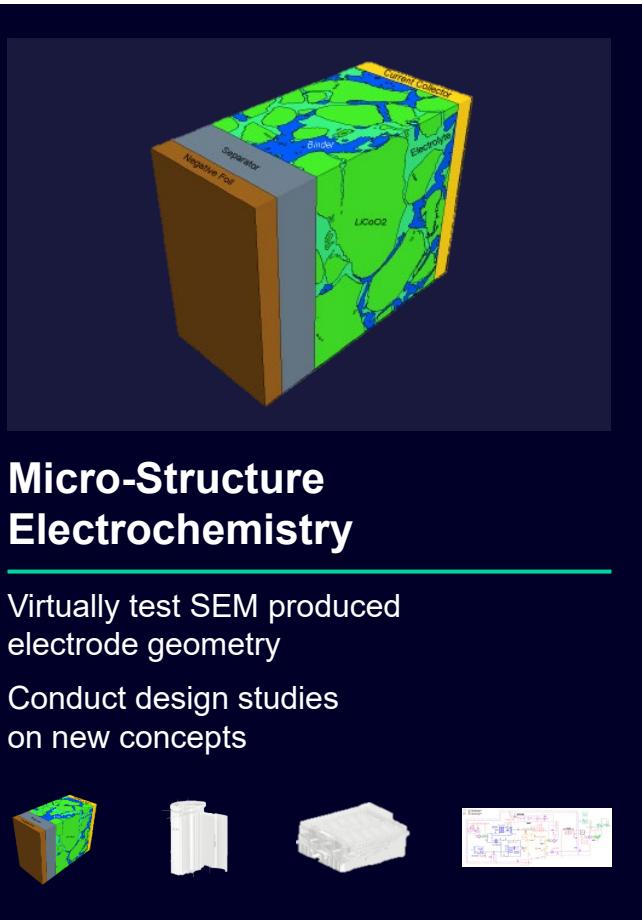


System Design

Simulate electrical & electromechanical systems from concept design to control validation

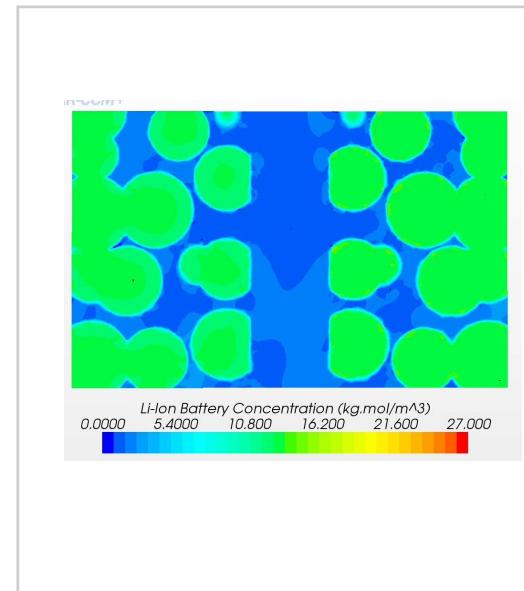
Simcenter STAR-CCM+

Electrode design

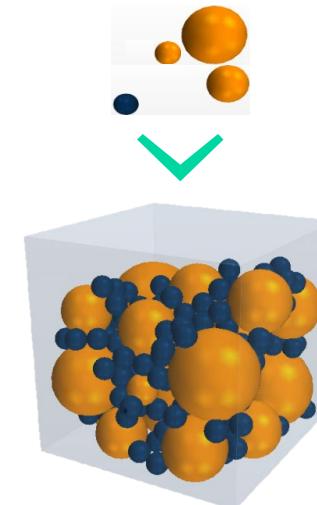


Predict the spatial distribution of ions and potential within an arbitrary, multi-phase micro-structure region

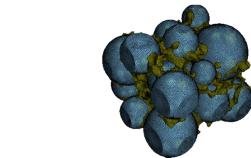
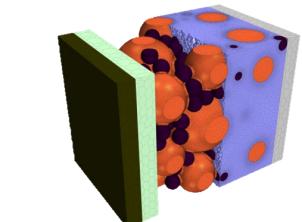
- Electric potential in solid and electrolyte regions
- Salt concentration in electrolyte
- Concentration of Li in active parts of electrode



Active Material



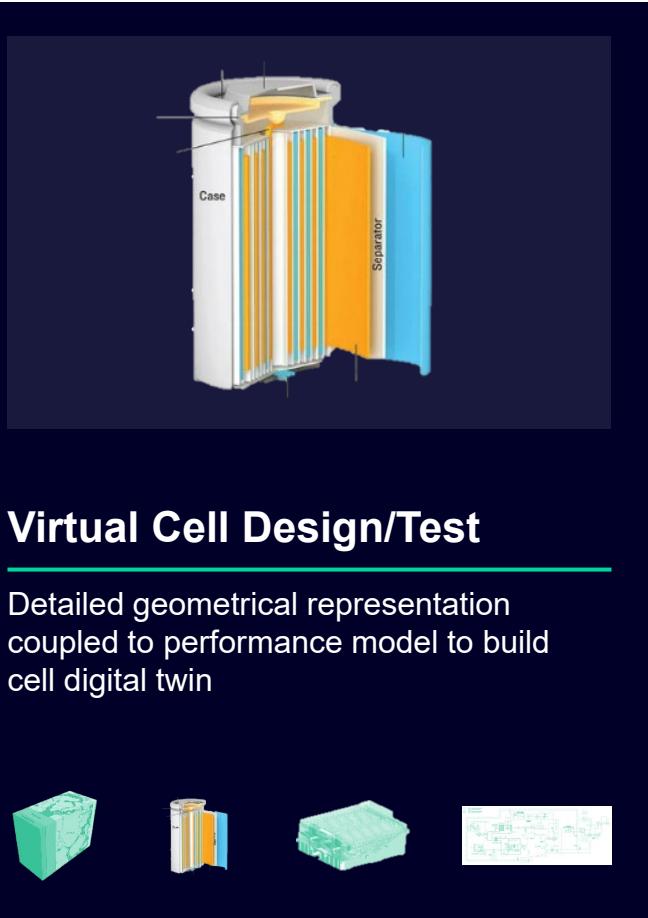
3 Phases model



Use Simcenter STAR-CCM+ CAD tool to improve binder's realism

Simcenter Battery Design Studio

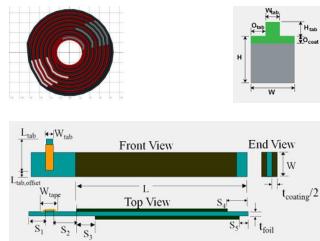
Cell design



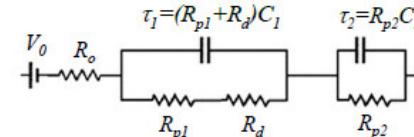
Design and analyze electrochemical reactions and detailed geometry of battery cells

- Design optimization
- Cell characterization
- Physics-based and equivalent circuit models
- Simulations of: Duty cycles, aging, abuse

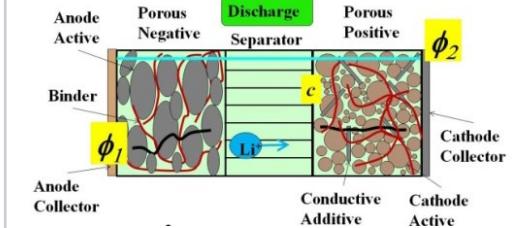
Design



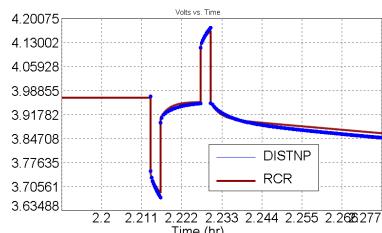
ECM



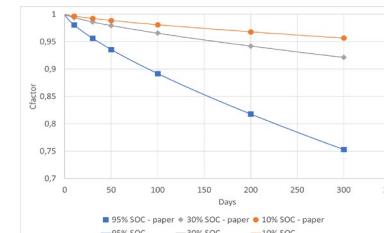
Physics-based



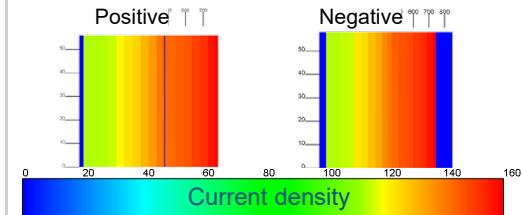
Pulses



Aging

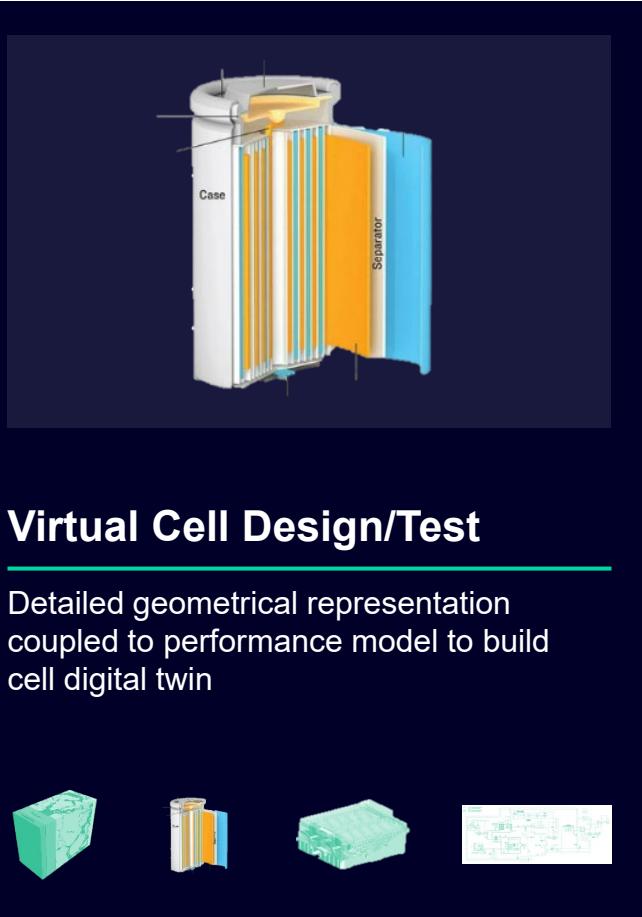


Dedicated post-processing



Simcenter STAR-CCM+

Cell design

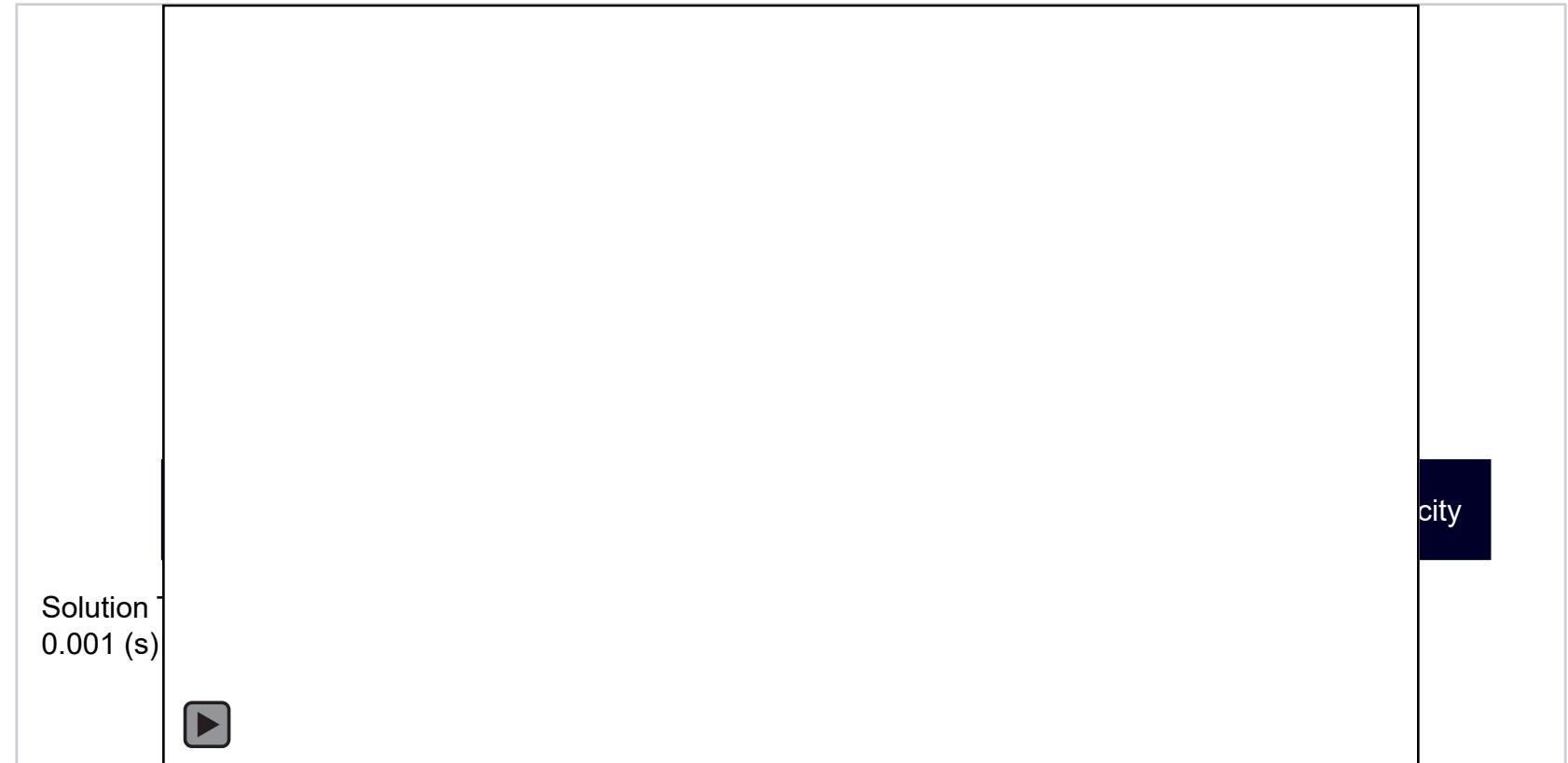


Virtual Cell Design/Test

Detailed geometrical representation coupled to performance model to build cell digital twin



Safety analysis at the cell level including combustion



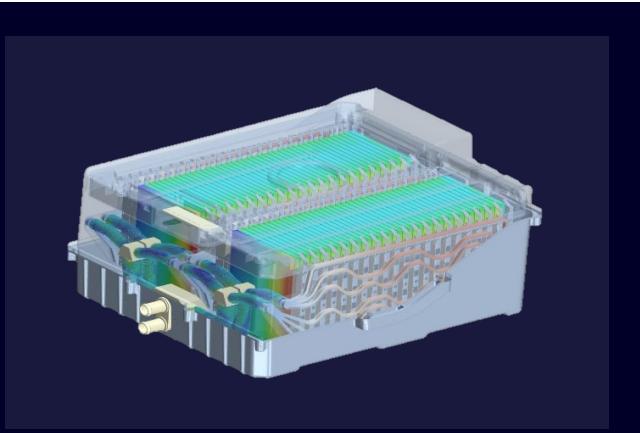
Solution
0.001 (s)



city

Simcenter STAR-CCM+ Batteries

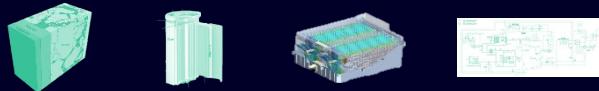
Module and pack thermal design



Battery Pack Design

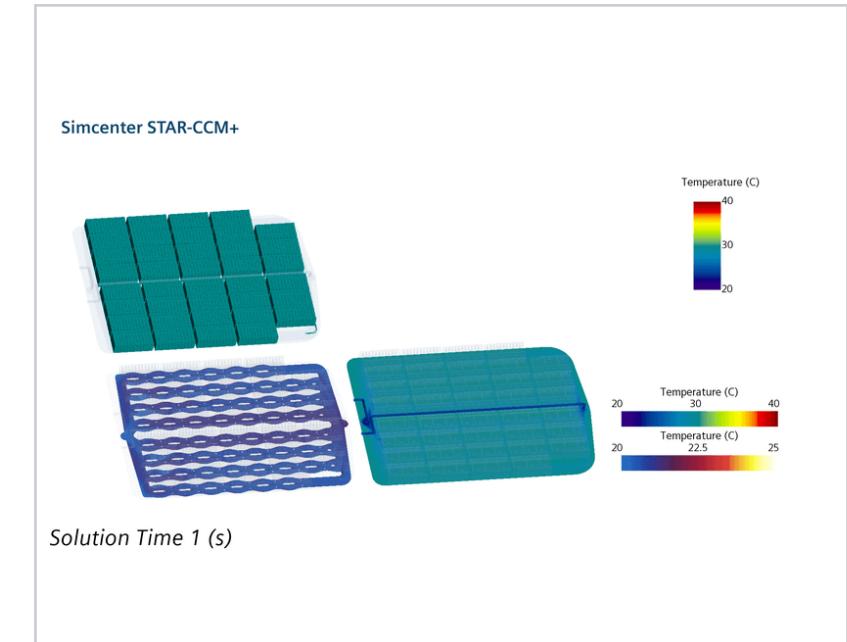
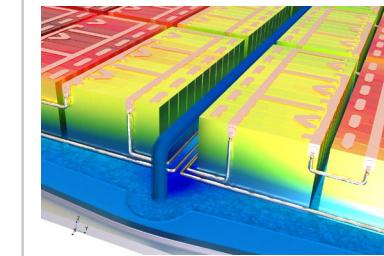
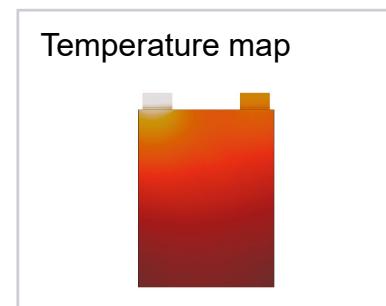
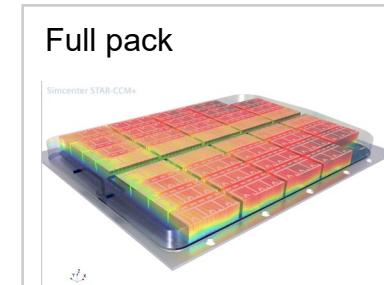
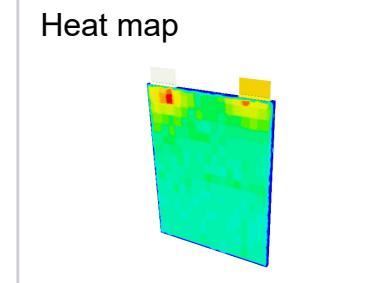
Flow, thermal and electrochemistry analysis of complex power systems

Study detailed spatial effects at cell, module and pack level



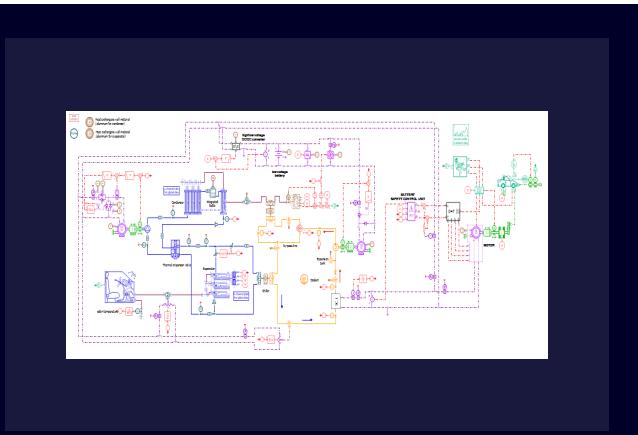
Calculate 3D thermal, fluid and electrochemical properties of battery modules and packs

- Electro-thermal simulation through coupled resolution of cell electrochemical behavior with thermal environment
- Computes the **cell heat 3D distribution**
- Resolves **complex cooling system** of various types (air, liquid, multi-phase)



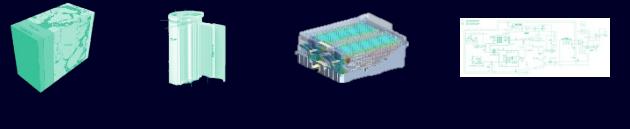
Simcenter Amesim

Solution Capabilities



System Design

Simulate electrical and electromechanical systems from concept design to control validation



Assess the energy performance of electrochemical storage systems integrated in xEVs

- Obtain battery performance requirements
- Pre-size the battery pack
- Early battery pack performance validation
- Battery pack requirement validation
- Battery cooling validation
- Aging analysis
- Thermal runaway indication

