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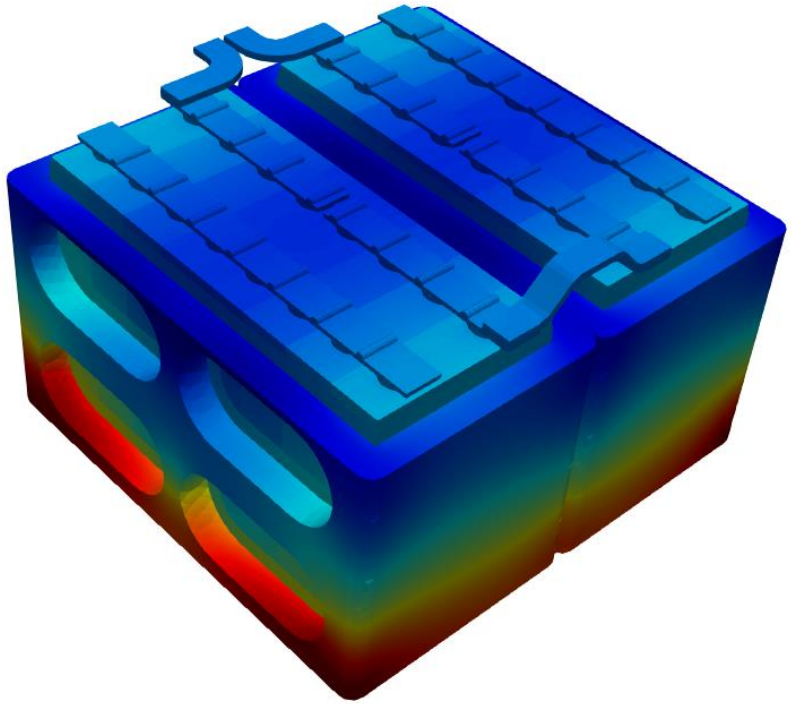
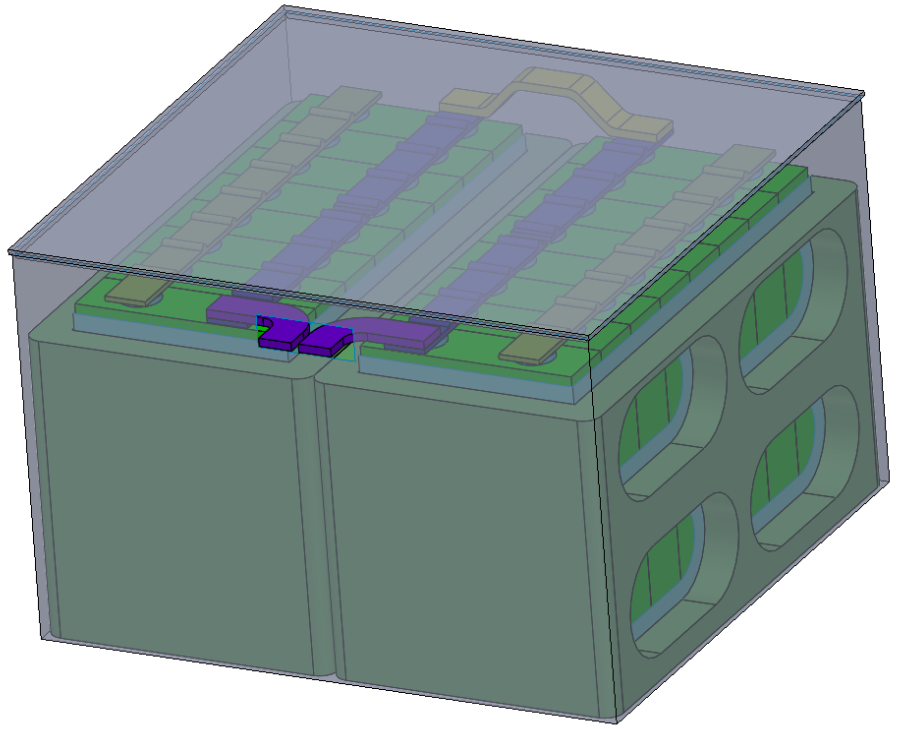


Q-Bat use case

Battery pack fire test

Overview of model

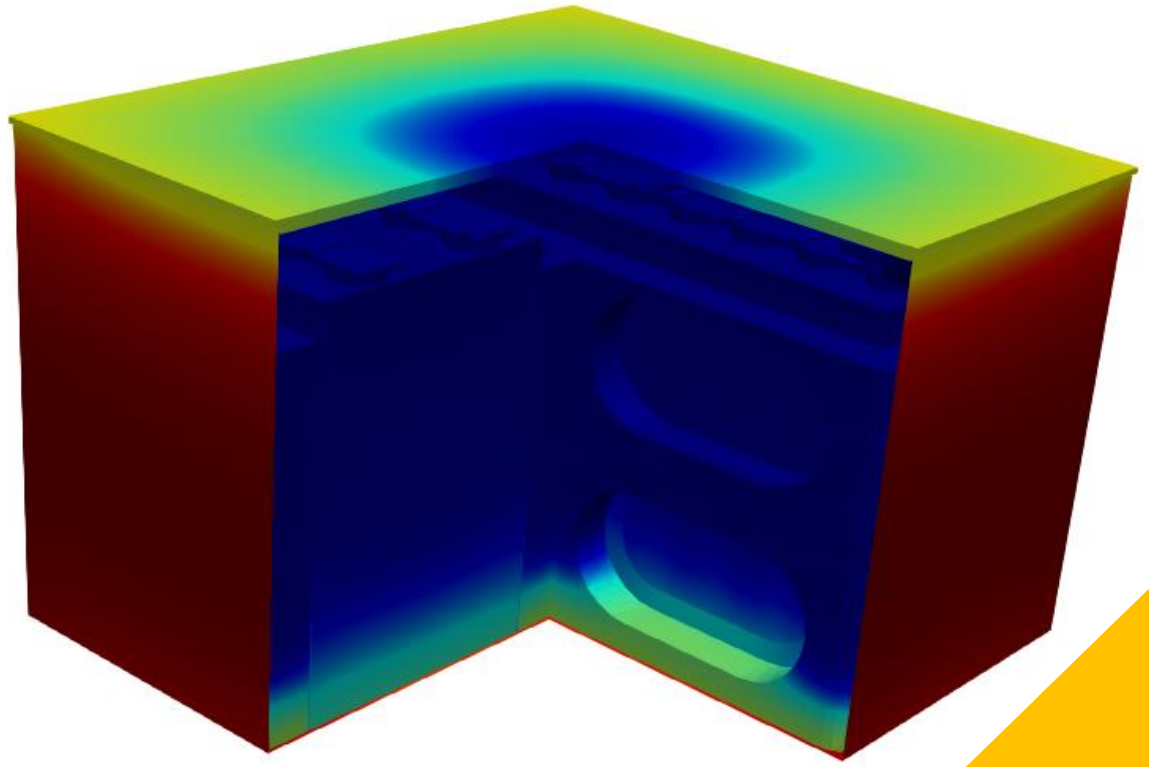


This use case presents how to perform simulation of heat transfer in a generic battery pack during fire test in Q-Bat software.

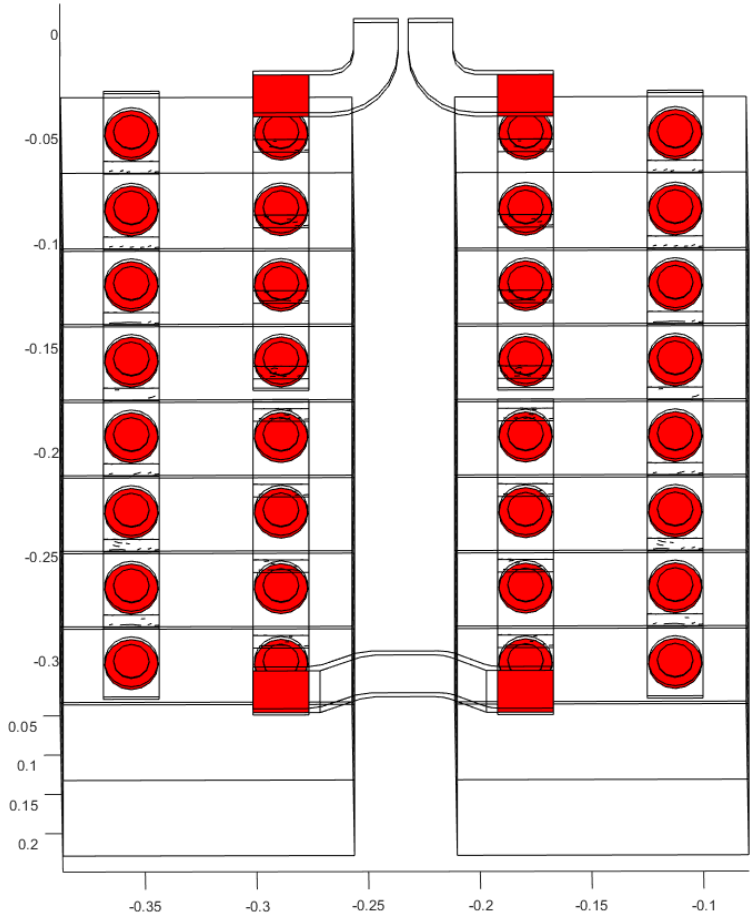
The model consists of 16 prismatic Li-ion cells (4s4p), terminals, connectors, bus burs and casing.

Thermal model

- Heat generated uniformly across cell volume
- Thermal contacts set to transfer heat between chosen surfaces
- Additional heat generation in connectors and bus bars due to losses
- Convective boundary condition is assigned to the casing outer boundaries.
- Ambient temperature of 25 °C



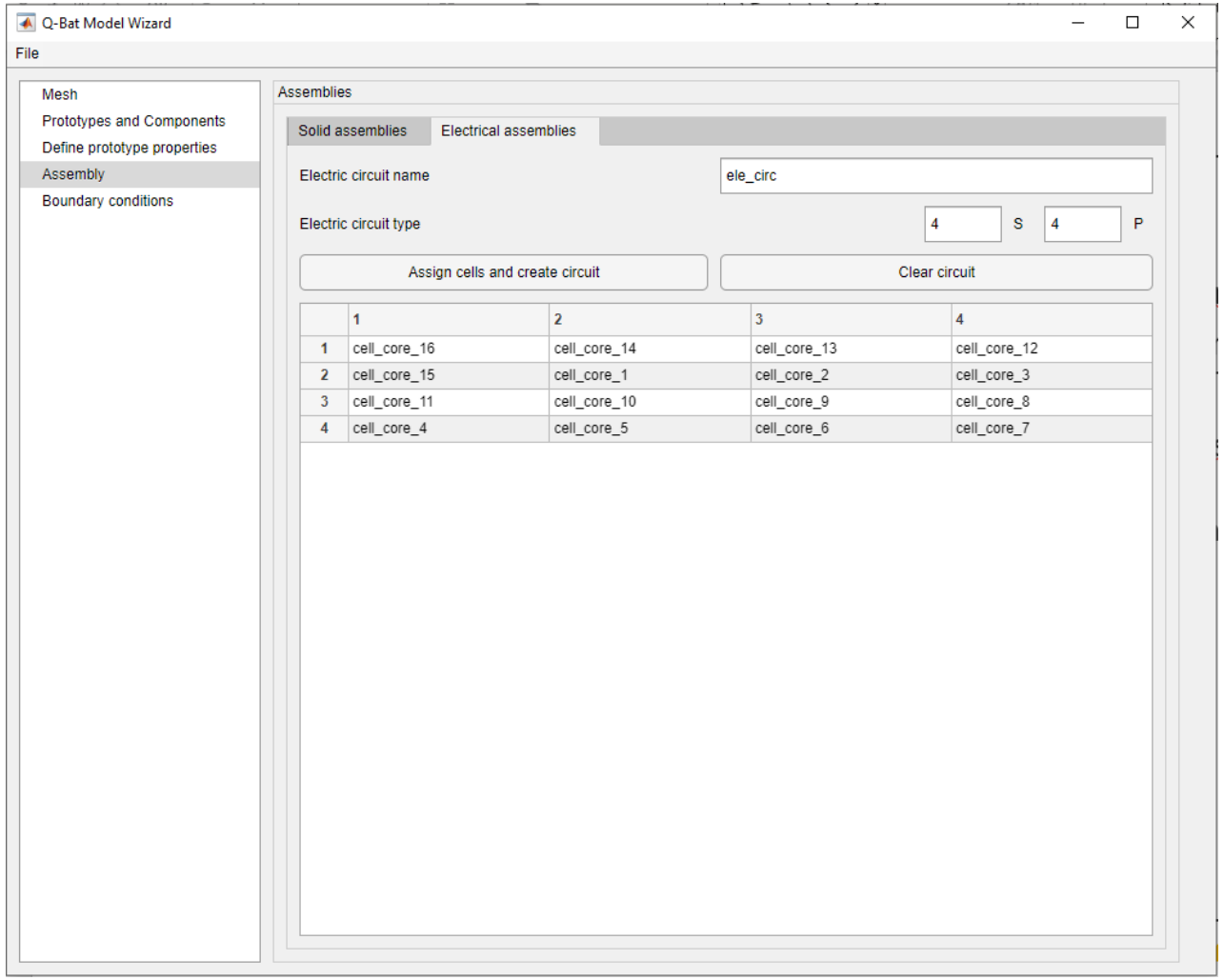
Model assembly



Contact regions created between bus bars, connectors and cell terminals shown.

- All components are aggregated in multiple assemblies and contact regions between them are created.
- Different contact conductivities are set.
- Overall 152 contact regions.

Electric circuit



- 16 cells connected in 4s4p circuit
- Heat generation is set by specifying the electrical properties of the cell (capacity, voltage, resistance) and applied current load that varies in time
- Cells are modelled using RC equivalent circuit model

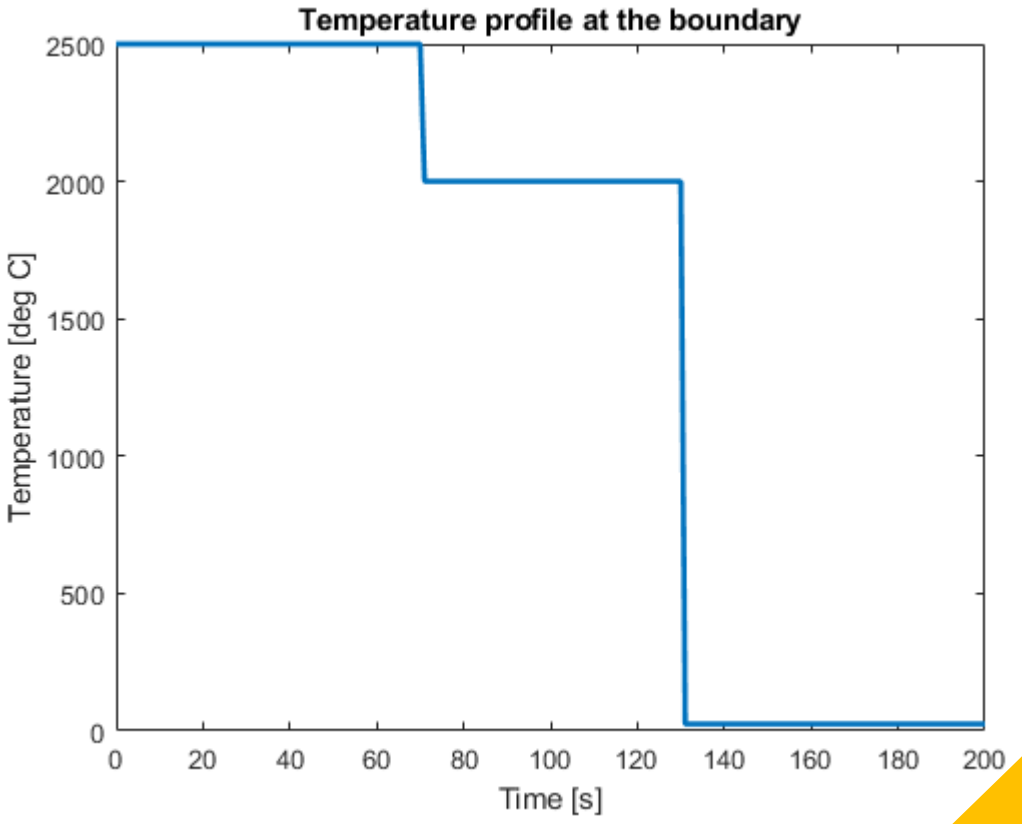
Prototype properties

- Material properties of the cells and heat comoponents are defined in the Excel spreadsheet

Part	rho	cp	λ_x	λ_y	λ_z
Cells	1960	1012	21.15	21.15	1.92
Outer casing	7870	481	89	89	89
Inner casing	2700	896	167	167	167
Connectors	2700	896	167	167	167
Bus bars	8890	385	388	388	388
Terminals	7870	460	52	52	52
Holders	1200	1200	3	3	3

Simulated conditions

- Operation of battery pack during fire test which consits of 3 phases:
  - 70 s of direct contact with a fire source
  - 60 s of indirect contact with a fire source
  - up to 3 hours of cooling to the ambient temperature
- Heating due to contact with a flame is simulated as convective boundary condition applied to casing outside surfaces. Air temperature for convective boundary condition is changing in time to model different phases of the test, as shown in the picture.
- Simulation is divided into 2 parts:
  - 120 s of operation with time step of 1 s to simulate phase 1 and 2
  - 12000 s of operation with time step of 100 s to simulate phase 3



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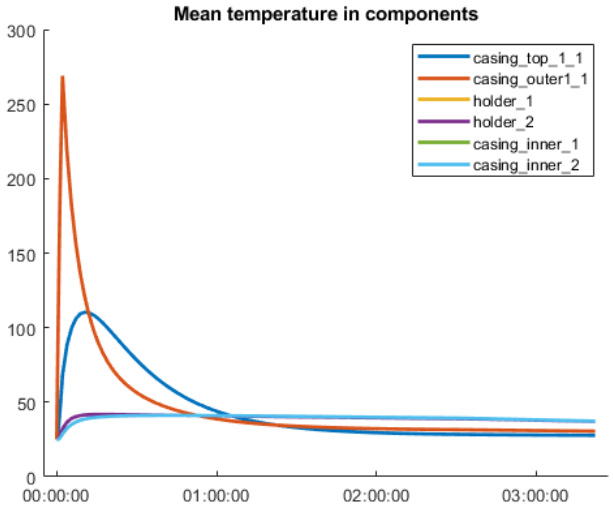
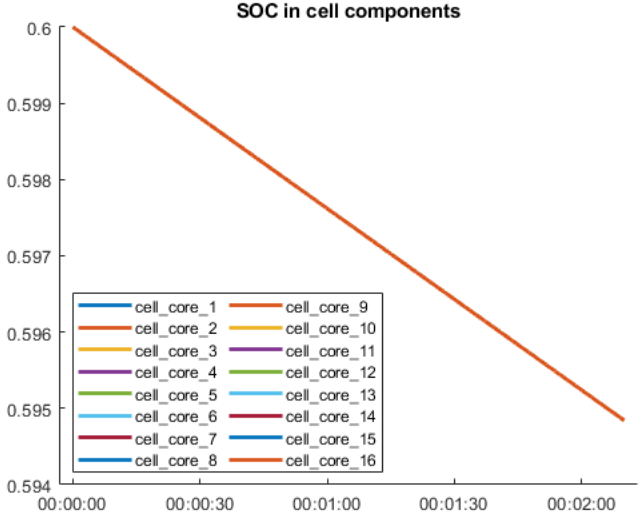
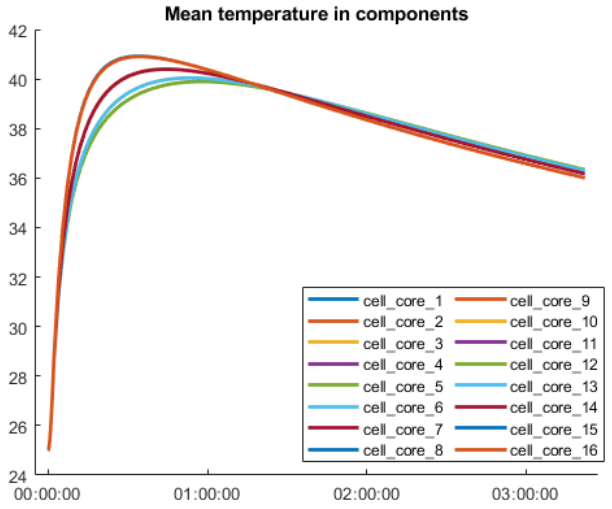
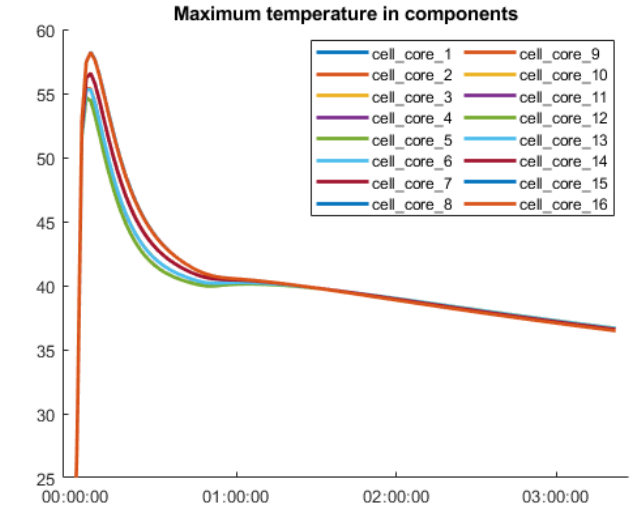
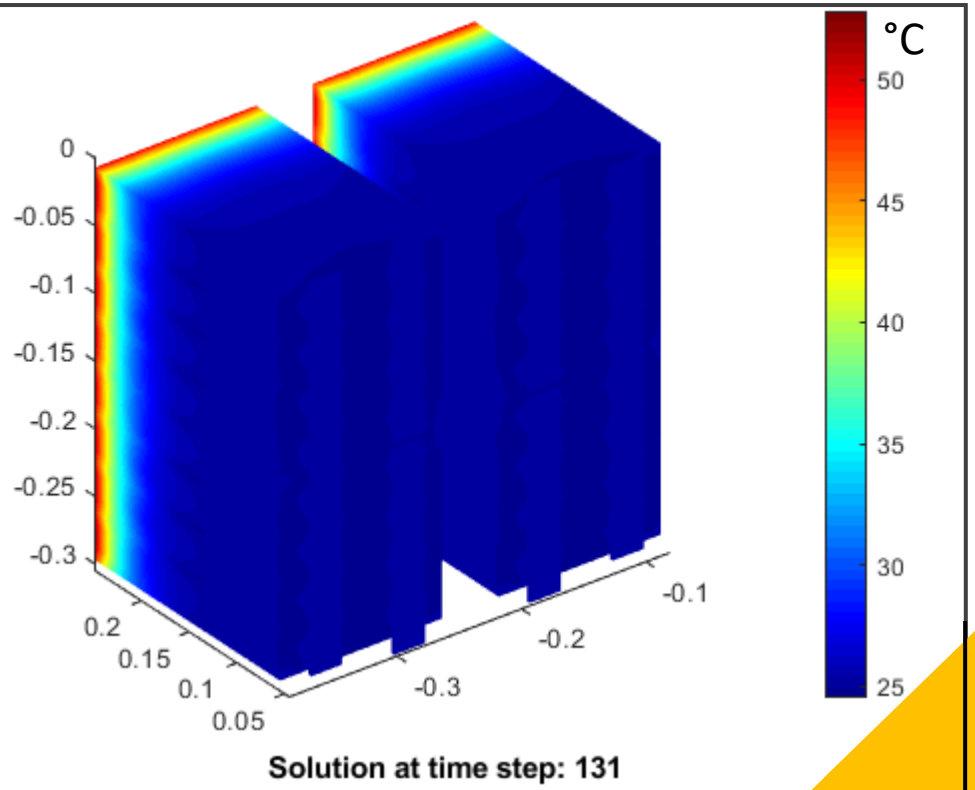
Results











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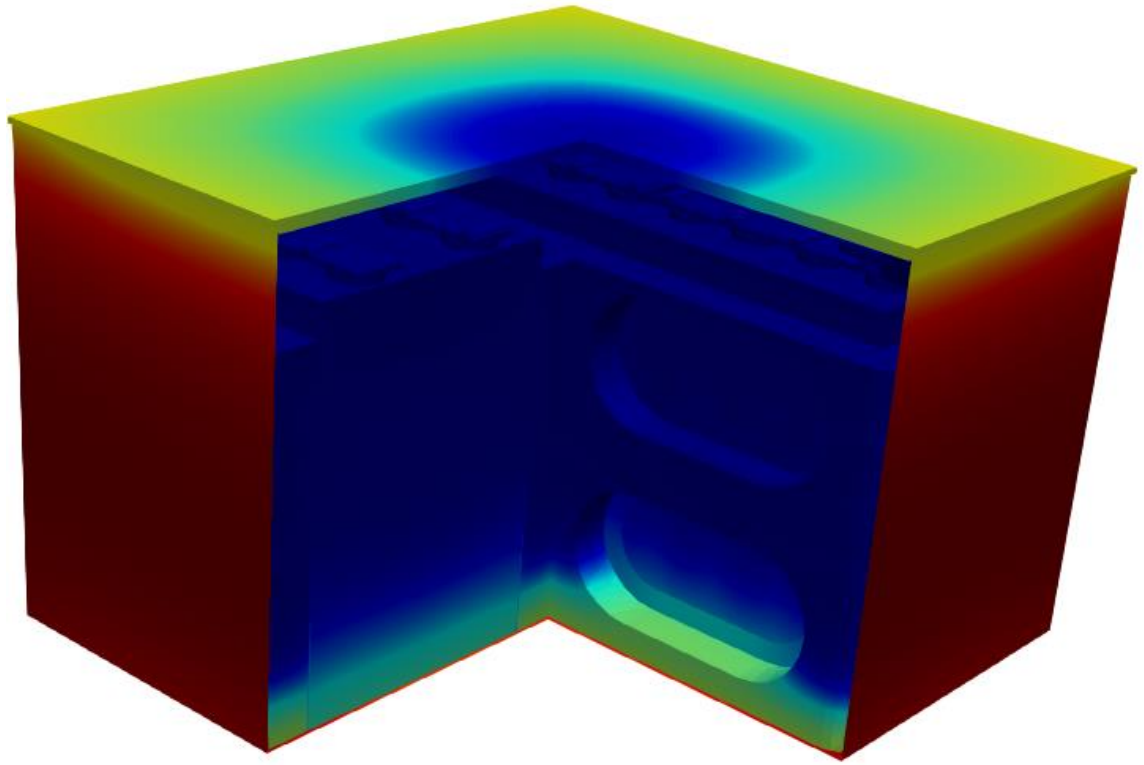
Summary

The model consists of:

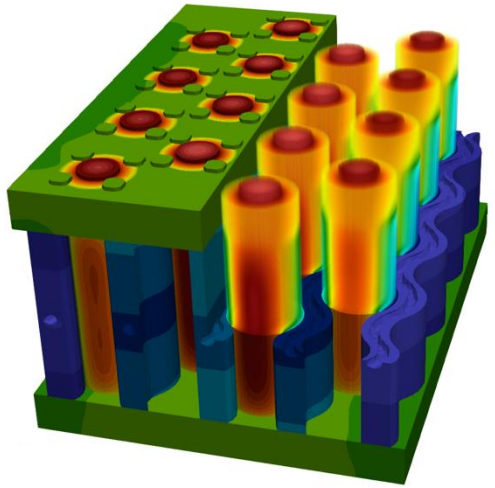
- 10 prototypes,
- 63 components,
- 440 000 mesh elements,
- 198 contact regions.



The overall simulation time is only **10-20 minutes**.

Learn more

- Q-Bat is a MATLAB-based product for real-time battery thermal simulation in 3D with CFD-like accuracy. Its main features are:
  - Near real-time execution
  - Accurate 3D data of battery temperature distribution
  - The capability of exporting the model to the Simulink
  - Fast model definition via dedicated GUI and TUI.



- To learn more:
  - QuickerSim https://emobility.quickersim.com/
  - Q-Bat product page https://www.mathworks.com/products/connections/product_detail/quickersim-q-bat.html

- For a free Q-Bat lite license, visit QuickerSim licensing website https://licensing.quickersim.com/

- To get **full version trial** write to q-bat@quickersim.com