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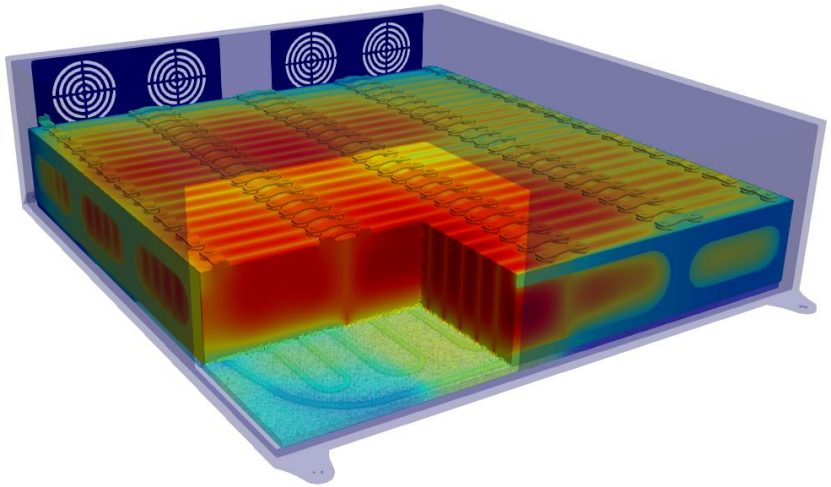
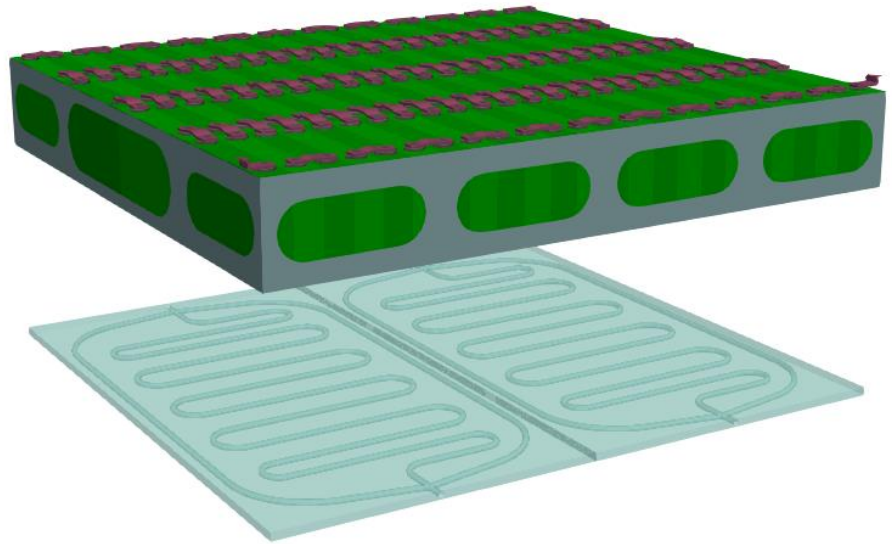


Heat transfer in electric car’s battery pack

Overview of model



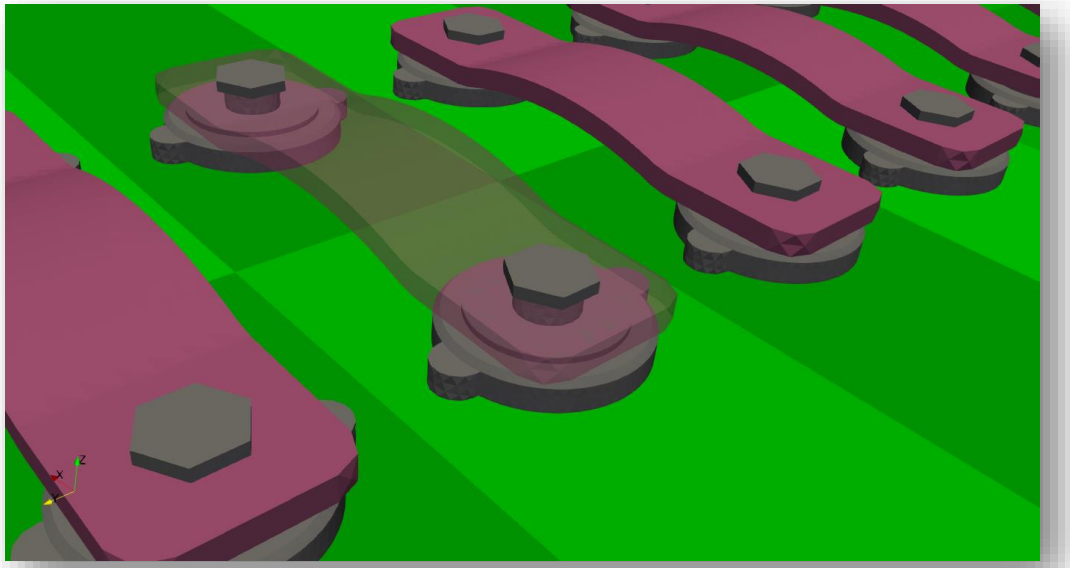
This use-case example presents how to perform simulation of heat transfer in electric car's battery pack in Q-Bat software.

The model consists of 96 lithium prismatic cells (96s1p), terminals, connectors, holders and casing.

Two cooling plates are used to maintain the optimum temperature range in the battery packs.

Current profile, boundary and initial conditions are selected to simulate electric car driving.

Model assembly



- All components are aggregated in one assembly and contact regions between them are created.

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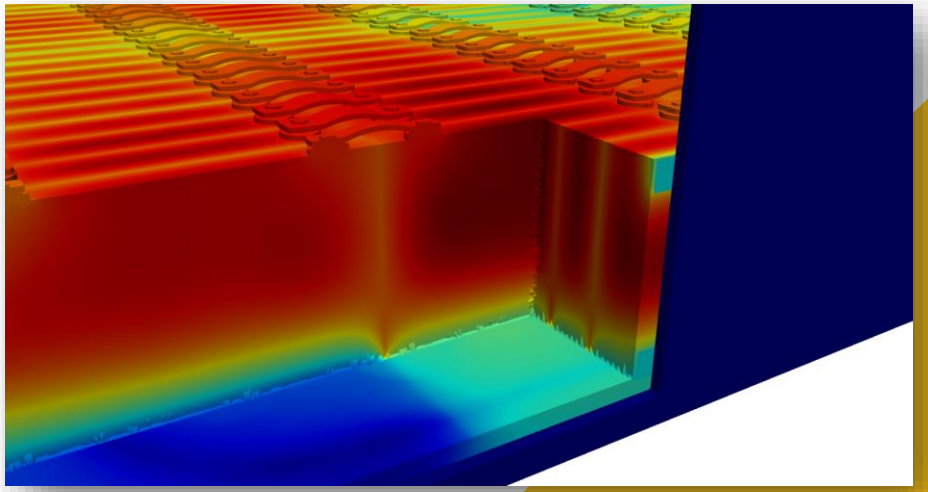
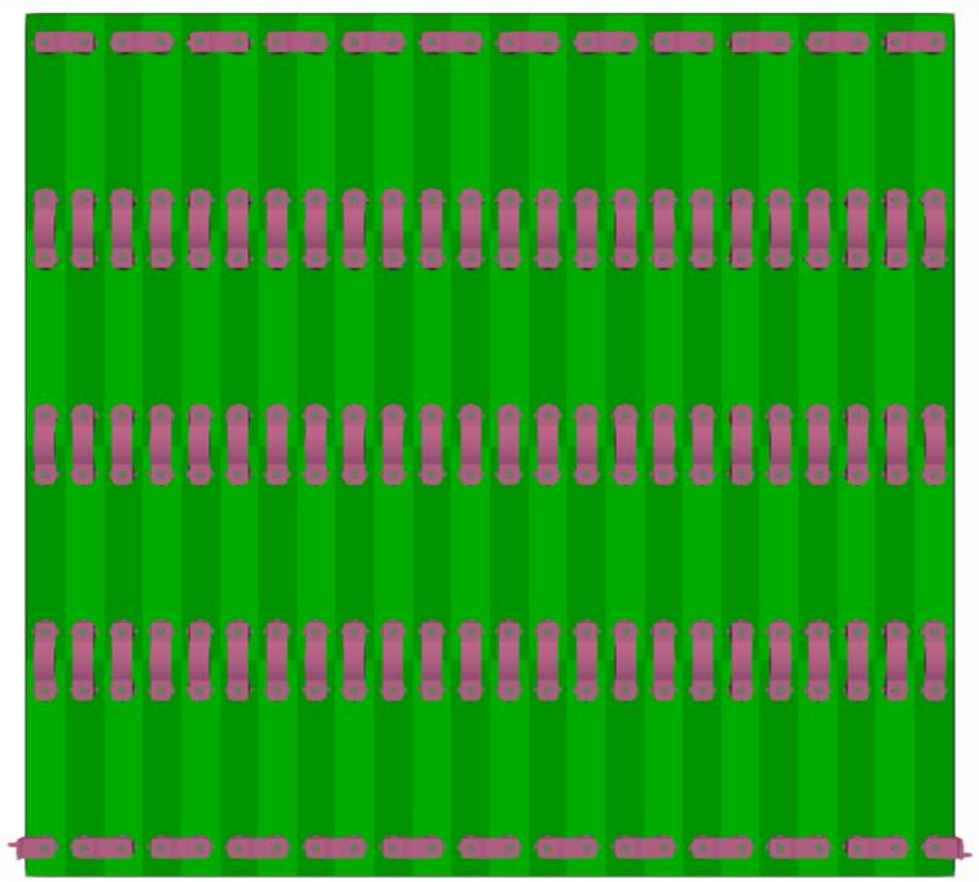
Thermal model

- Heat generated uniformly across cell volume
- A domain of air inside the casing is modelled as a passive heat component. The contacts between adhering compontents and the surrounding air are specified. The value of the heat transfer coefficient is calculated by the equations for natural convection and applied to the model.
- Robin boundary condition is assigned to the casing outer boundaries.
- Battery pack has cooling system located under the cells.



Electric circuit



- 96 cells connected in series
- 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 as RC circuits
- Heat generation in the cells is uniform

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Prototype properties

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

Part	rho	cp	λx	λy	λz
Cell	2670	498	11	3	13
Casing	1055	1300	0.185	0.185	0.185
Casing vent	1055	1300	0.185	0.185	0.185
Connector	890	385	397	397	397
Holder	2690	901	238	238	238
Terminal	2690	901	238	238	238
			λ	ν	μ
Coolant	1000	4000	0.39	0.00001	0.001

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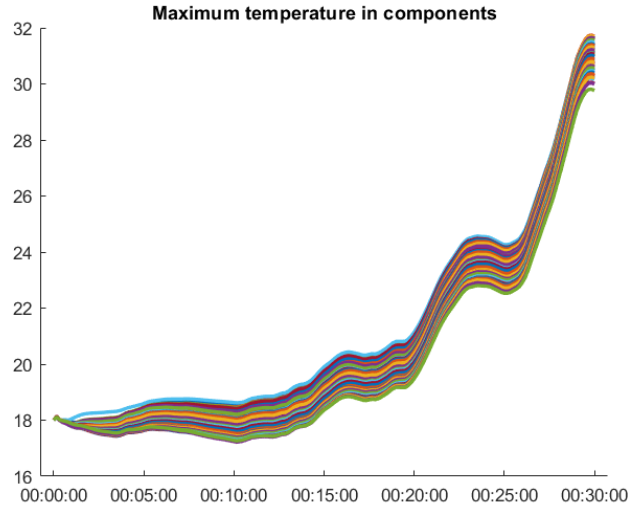
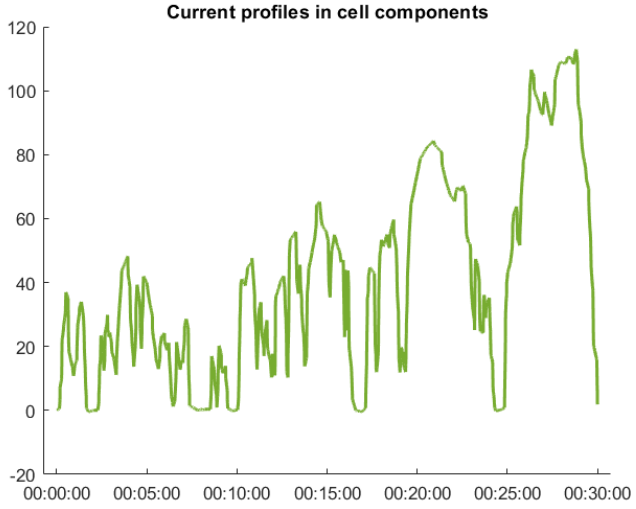
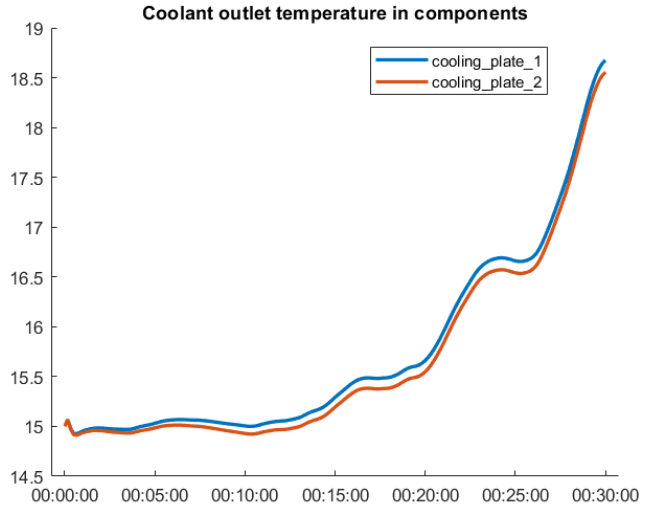
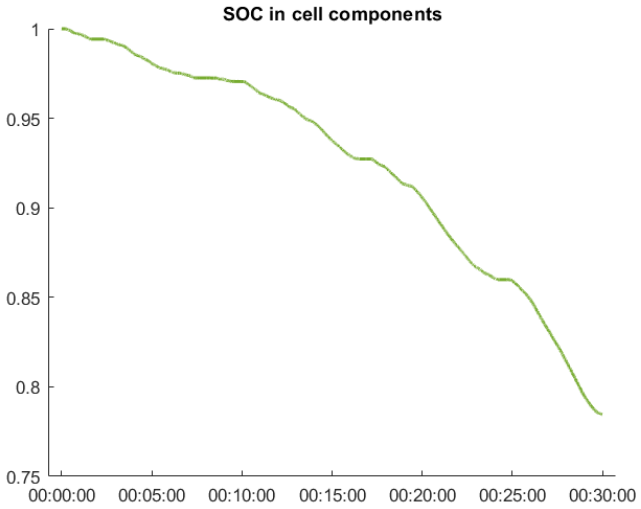
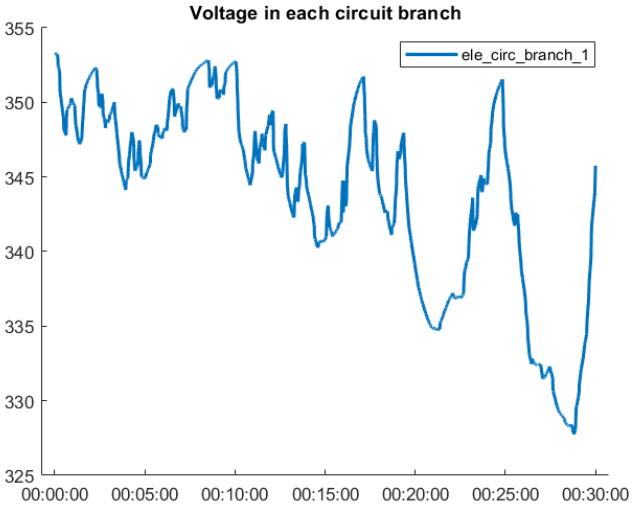
Simulation results

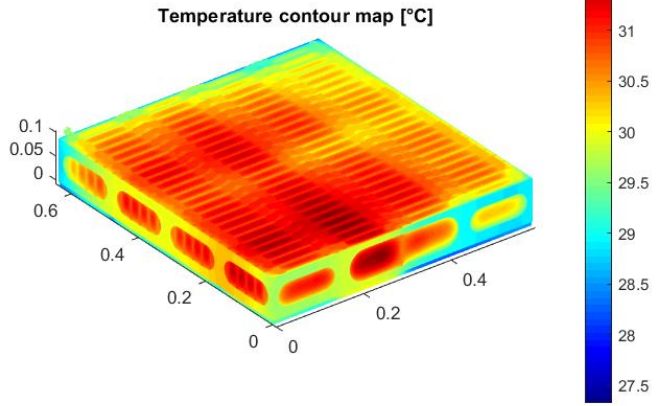








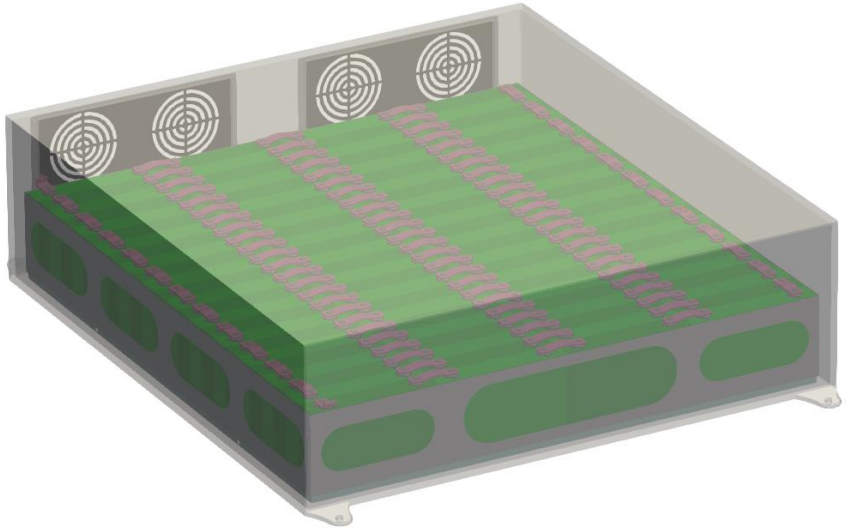




Summary

The model consists:

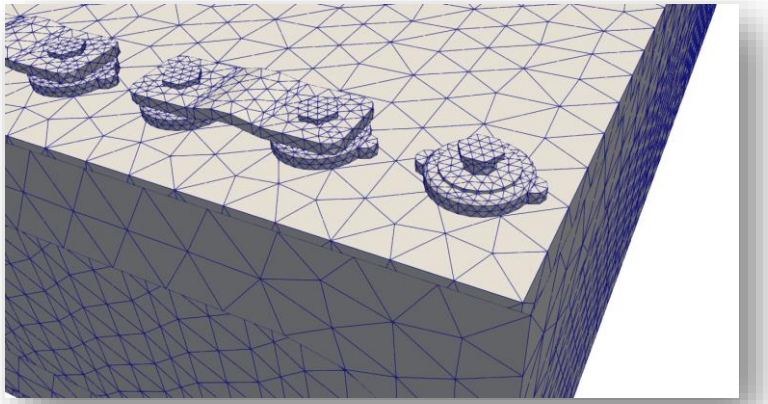
- 9 prototypes,
- 391 components,
- 4 728 403 mesh elements,
- 1281 contacts regions.



The simulation time is 76 minutes for a 30 minute driving profile.

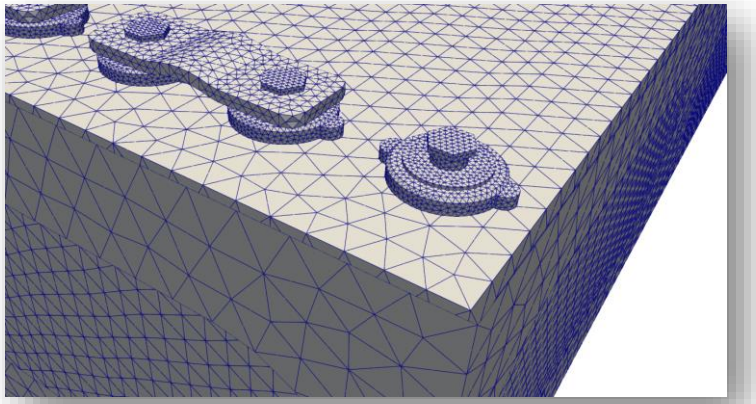
Mesh sensitivity study

Coarse mesh (1 859 756 elements)

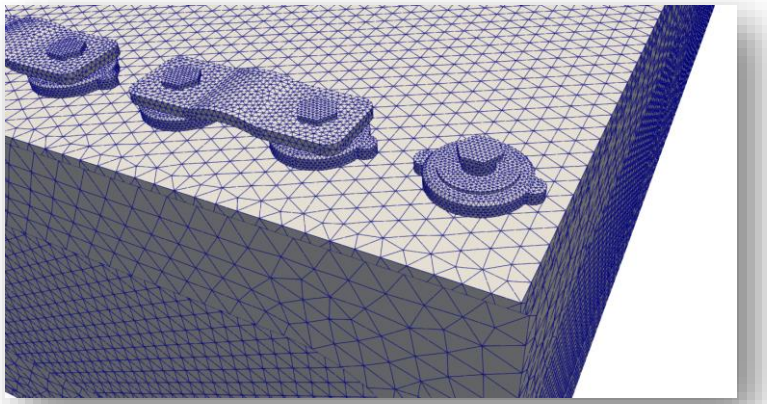


In this case, it is shown how to check for a mesh independent solution. Three meshes with the different numbers of elements are prepared and used in simulation to compare the results.

Mediu mesh (4 728 403 elements)

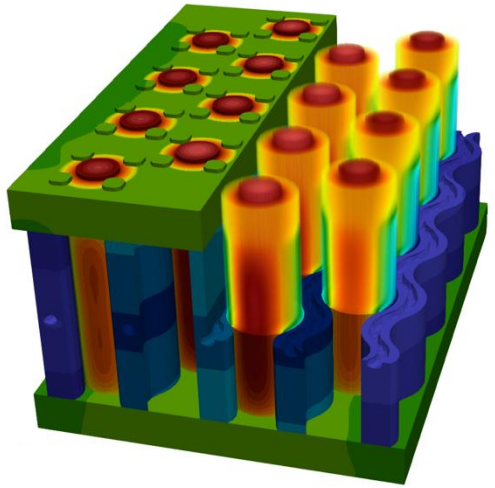


Fine mesh (9 002 162 elements)



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