



전력전자학술대회 - MathWorks 산업기술세션

MathWorks Korea 온라인 설문조사

온라인 설문조사에 참여해주신 분들중
추첨을 통해 **커피 기프티콘**을 보내드립니다!



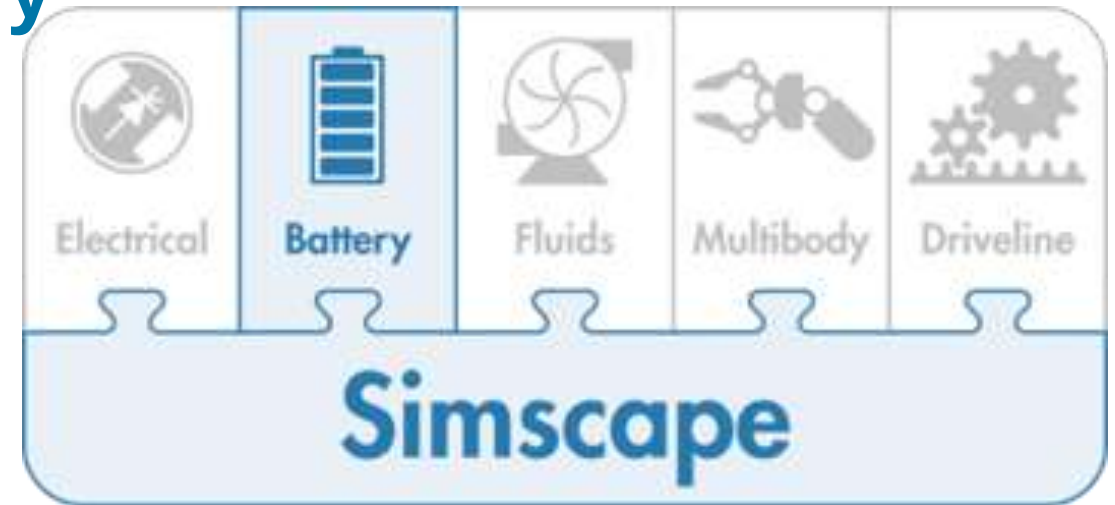
▶ QR 코드 스캔하여 설문 참여

<https://forms.office.com/r/e8mXh8zaF8>

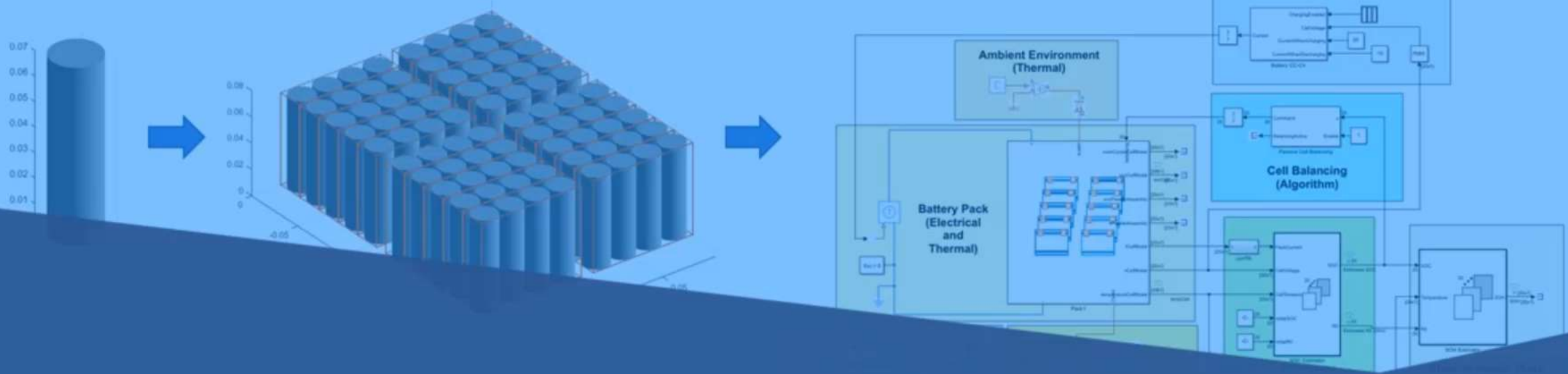
▶ 설문 URL을 통해 설문 참여



Introducing Simscape Battery



강효석 부장/Ph.D
Application Engineer
MathWorks Korea

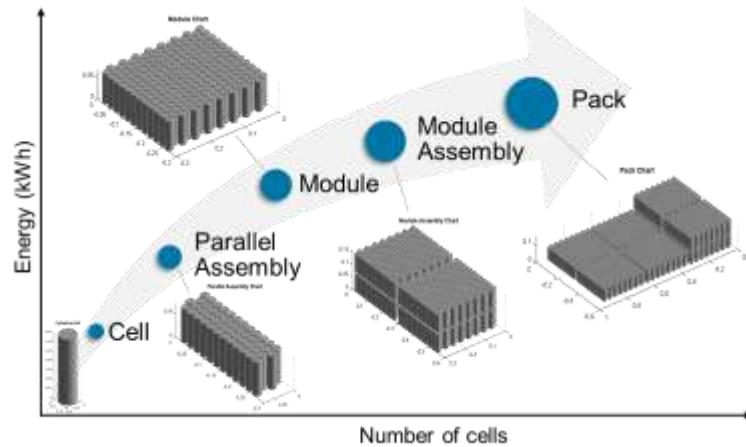


SIMSCAPE BATTERY

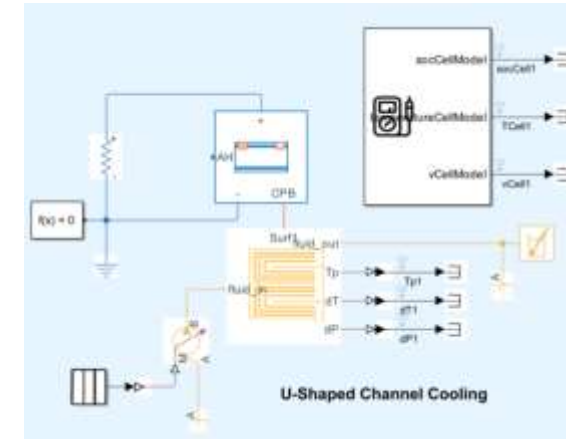
A THREE MINUTE TOUR
FROM CELL TO SYSTEM

Simscape Battery – Main Workflow Themes

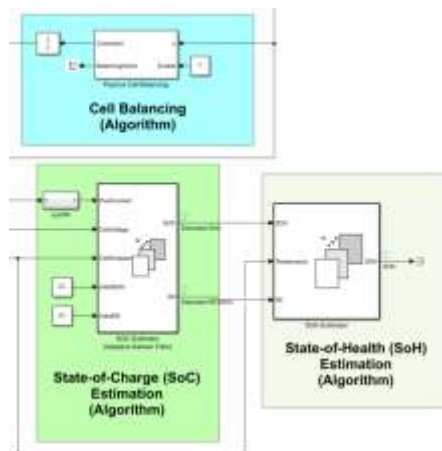
1. Battery Pack Design



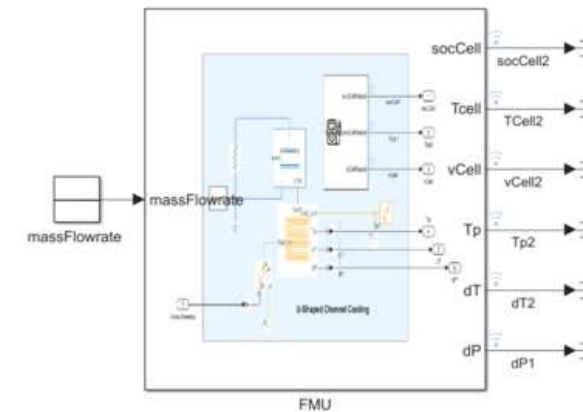
2. Thermal Management System Design



3. Battery Management System Design

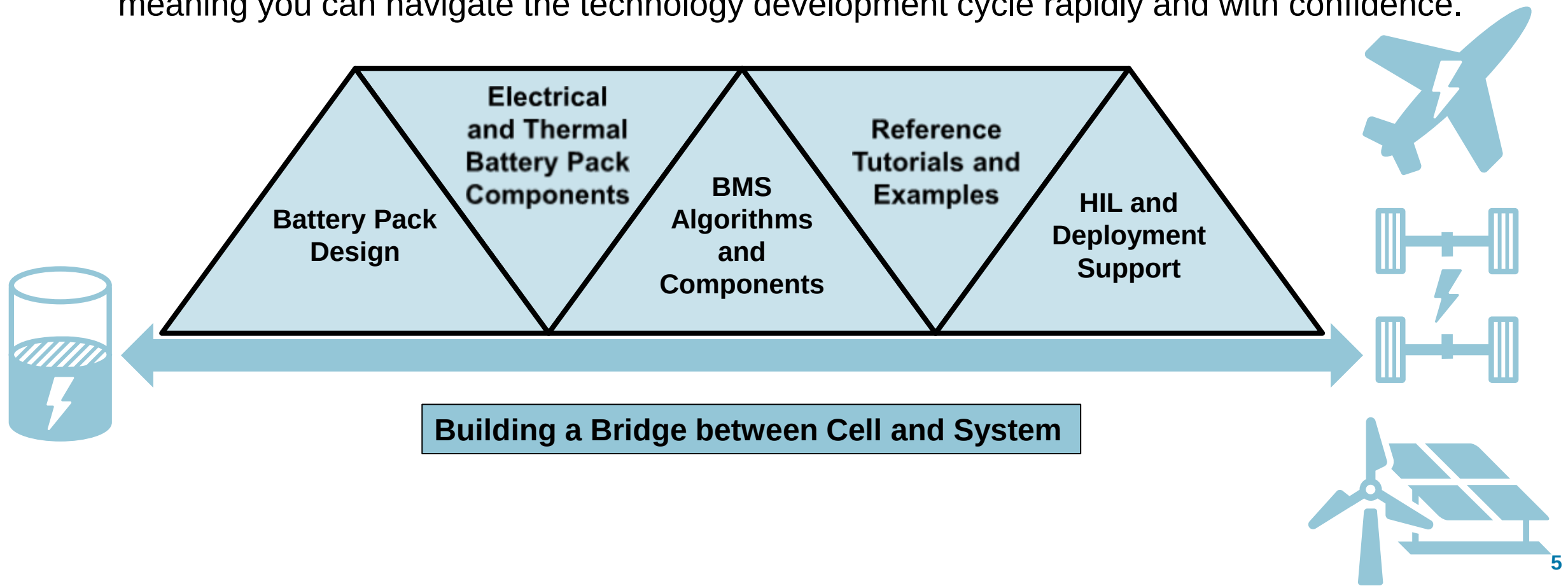


4. Support for Deployment and HIL



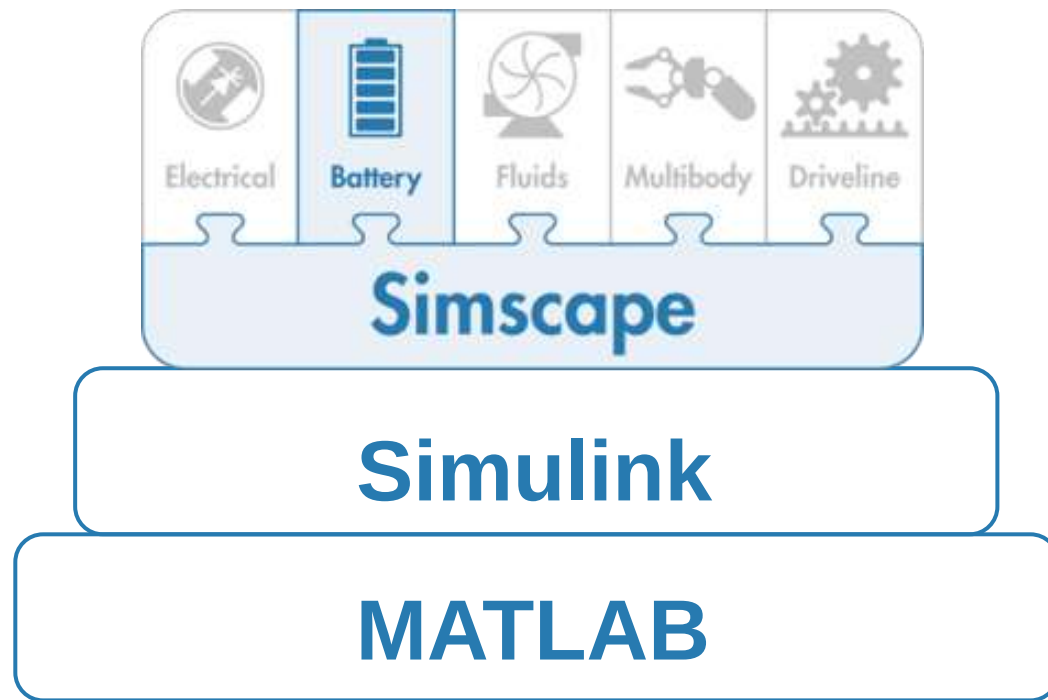
The Value of Simscape Battery

- Simscape Battery provides a framework that is assembled specifically to create a bridge between cell and system.
- The bridge directly supports upskilling as well as design exploration and design rigor, meaning you can navigate the technology development cycle rapidly and with confidence.



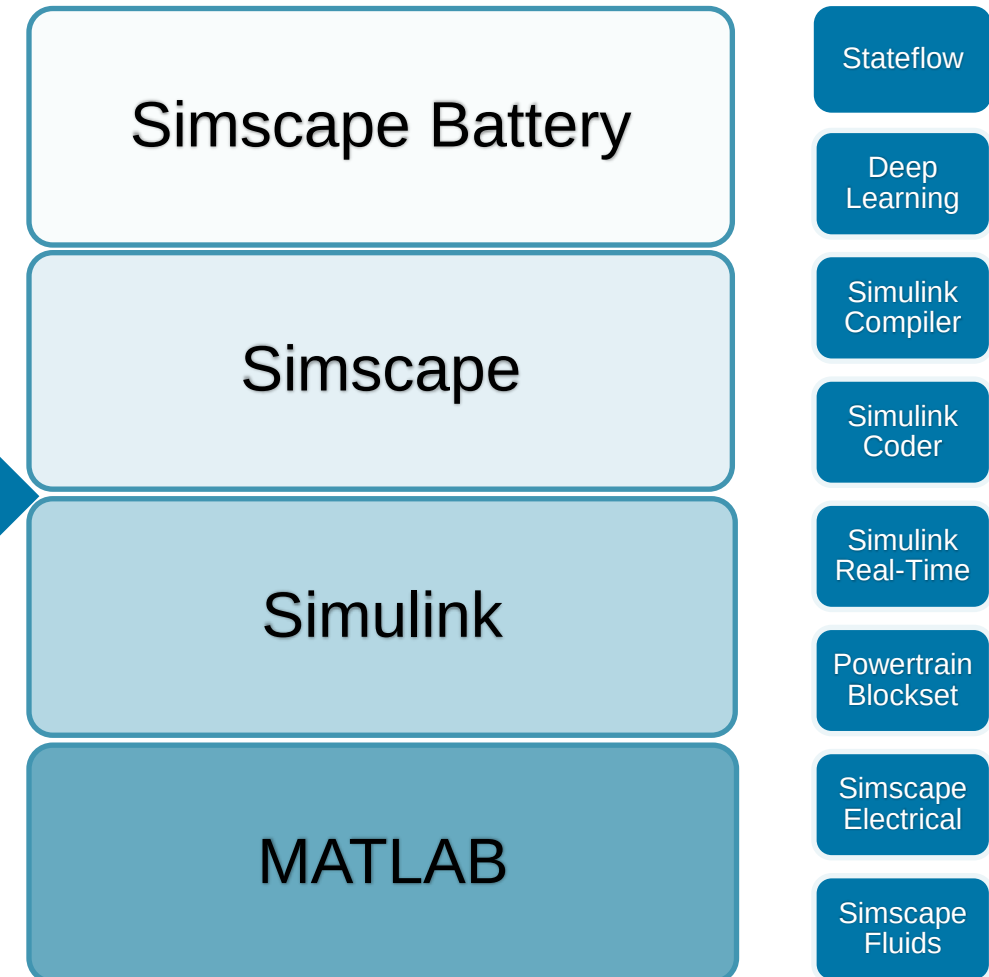
Technology Architecture

Technology Platform Strategy



Balanced Use
of Products

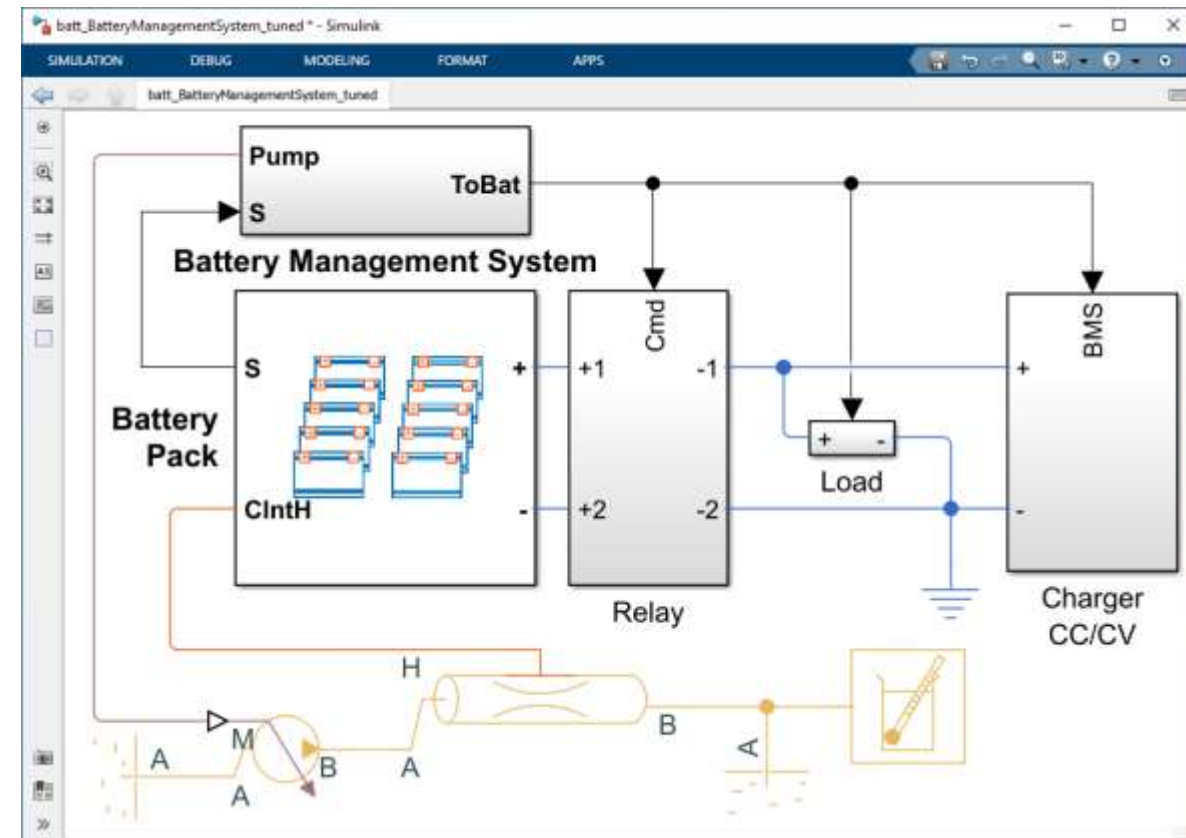
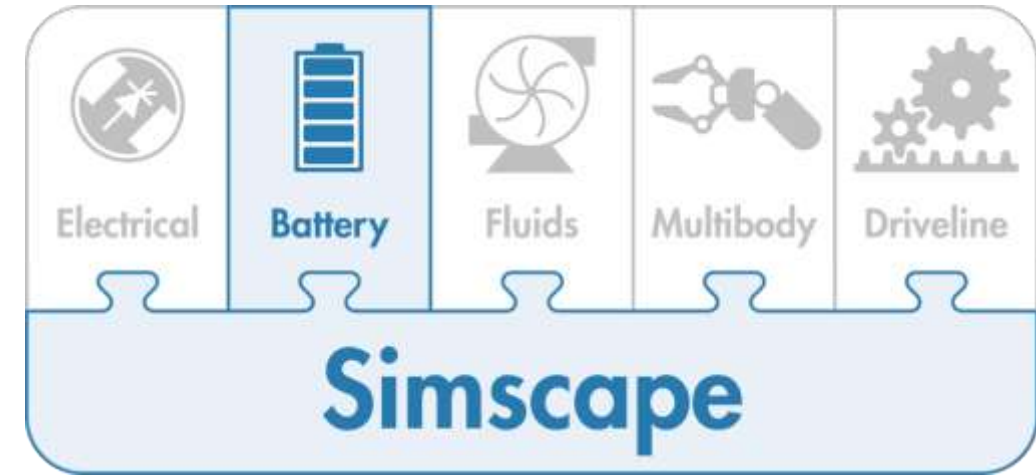
Clear Onramps



Simscape Battery

Overview

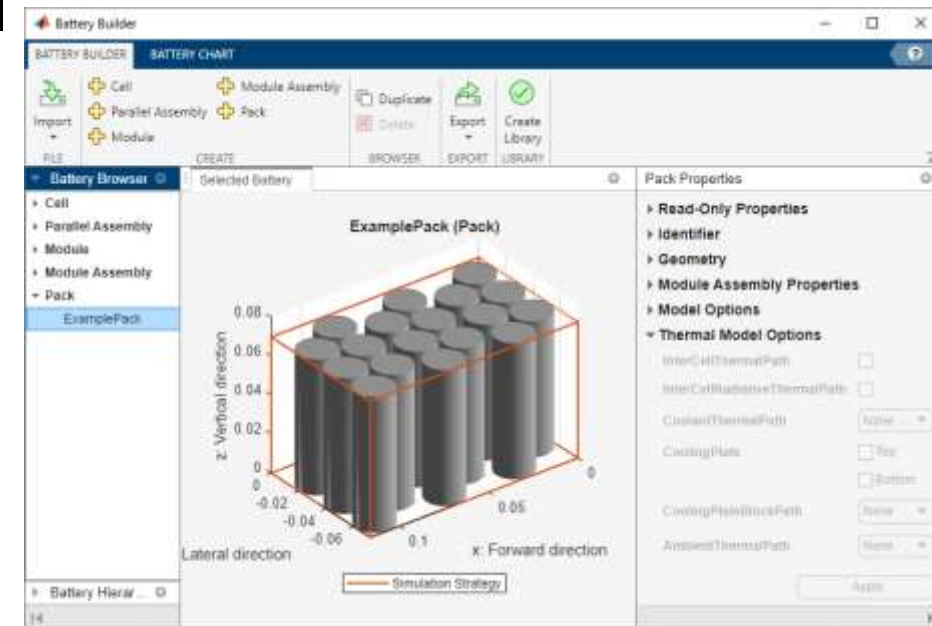
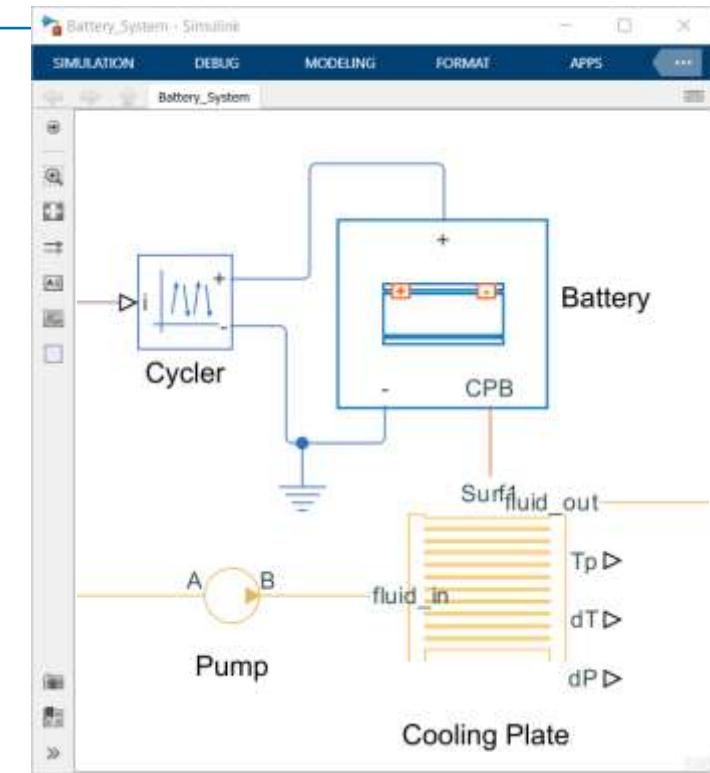
- Design and simulate battery and energy storage systems
 - Electrothermal cell behavior
 - Battery pack design
 - Battery management systems (BMS)
- With Simscape Battery you can
 - Evaluate pack architectures for electrical and thermal requirements
 - Verify robustness of discharge, charge and thermal management algorithms
 - Validate algorithms using HIL testing



Simscape Battery

Key Features

- Battery Pack Builder (MATLAB API, App)
 - Automatically assemble cell models into battery pack
 - Define electrical and thermal connections (series, parallel)
 - Adjust tradeoff of simulation speed and model fidelity
- Cooling plate models
 - Includes edge, parallel channel, and U-shaped channel
- Battery management algorithms
 - Includes charge/discharge, SOC, SOH, cell balancing, thermal management, protection
- Application-specific examples
 - EV charging, Microgrid with BESS
- Support for C-code generation



Battery Pack Builder

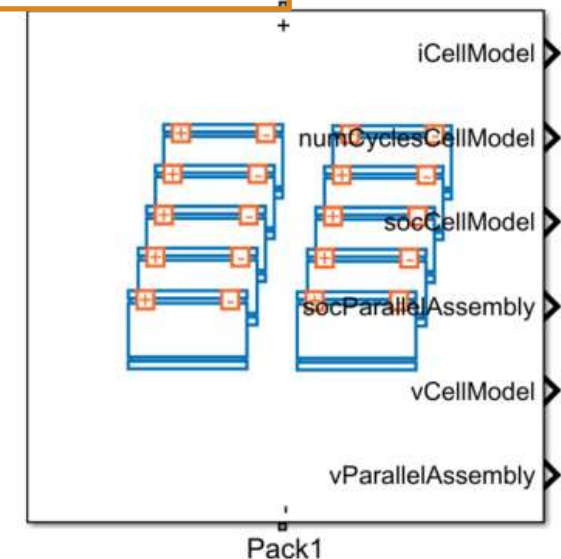
- Text-based design workflow with MATLAB API supports rapid pack design.
- Define the battery pack structure in as few as 6 lines of code.
- Automatically create a Simscape model of the pack in 1 line of code.**

```
>> import simscape.battery.builder.*  
>>
```

```
>> pouchGeometry = PouchGeometry();  
>> batteryCell = Cell(Geometry = pouchGeometry);  
>> batteryParallelAssembly = ParallelAssembly(Cell = batteryCell, numParallelCells = 3);  
>> batteryModule = Module(ParallelAssembly = batteryParallelAssembly, numSeriesAssemblies = 11);  
>> batteryModuleAssembly = ModuleAssembly(Module = repmat(batteryModule,1,2));  
>> batteryPack = Pack(ModuleAssembly = repmat(batteryModuleAssembly,1,5));
```

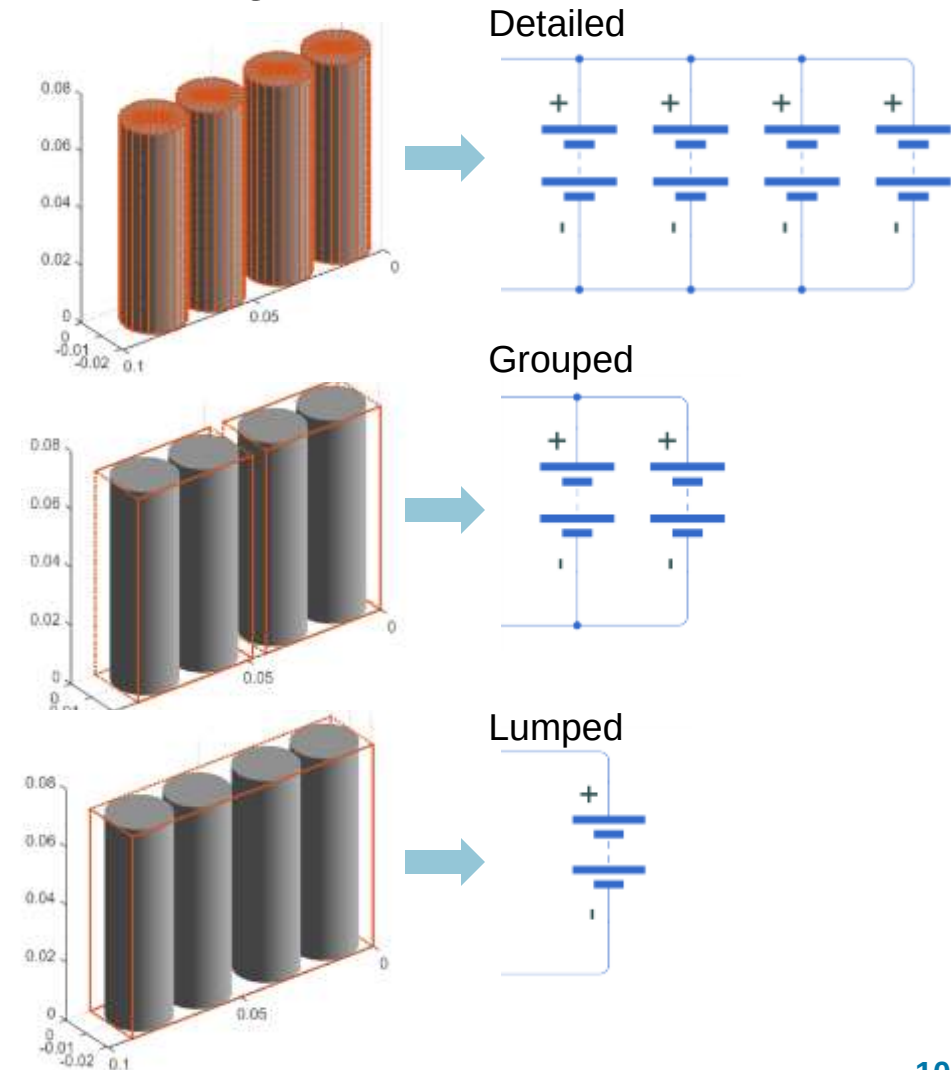
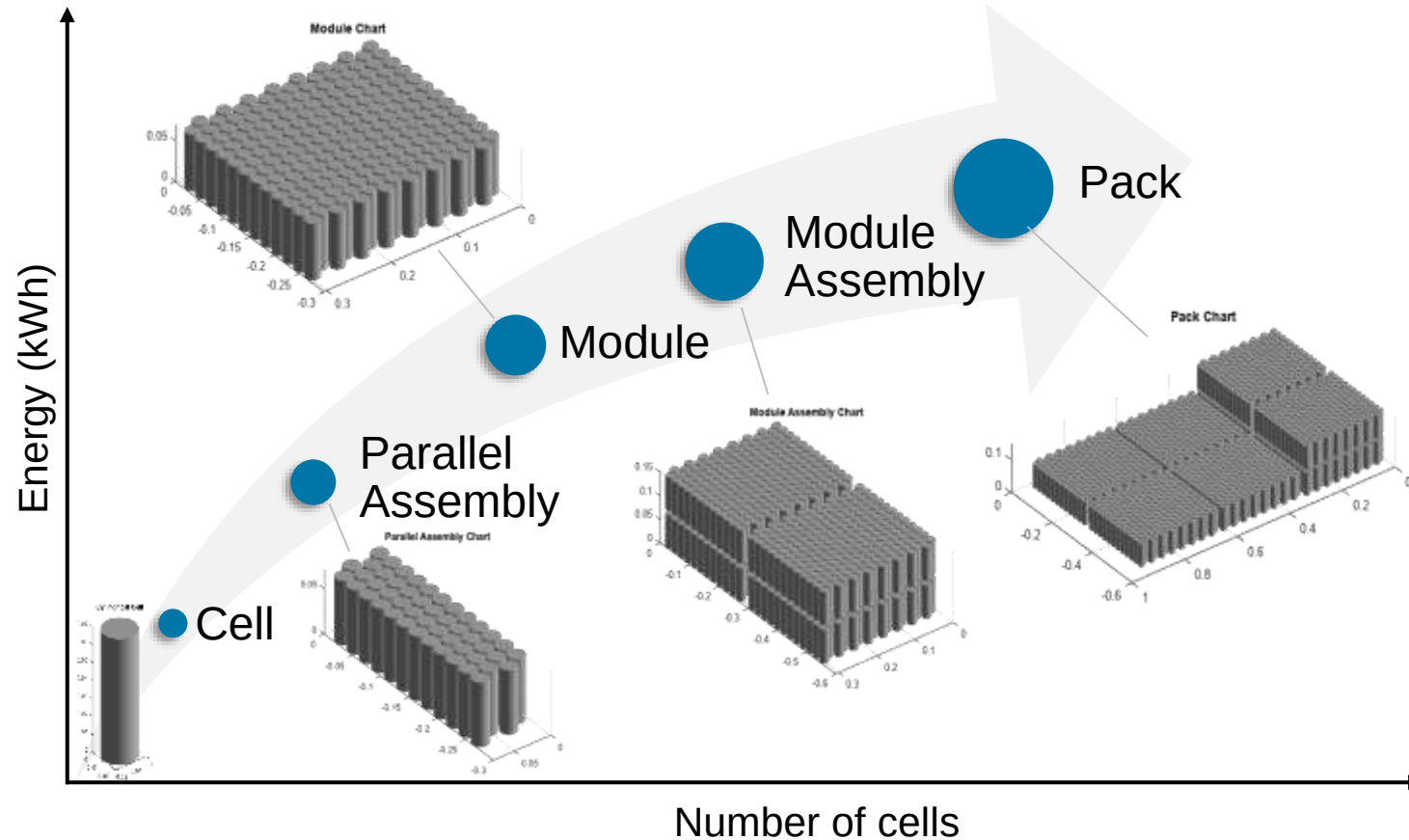
```
>>
```

```
>> buildBattery(batteryPack, "LibraryName", "packLibrary");
```



Battery Pack Builder

- Visualize the pack geometry and topology at each stage of the design.
- Define and visualize the simulation strategy.



Battery Pack Builder

- Define cell format, stacking and topology.
- Keep track of volume, mass and dimensions.

```
>> batteryParallelAssembly.CumulativeMass
```

```
ans =
```

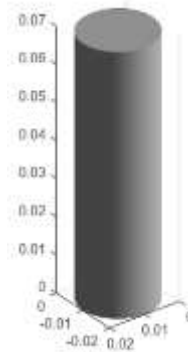
```
0.4000 : kg
```

```
>> batteryParallelAssembly.PackagingVolume
```

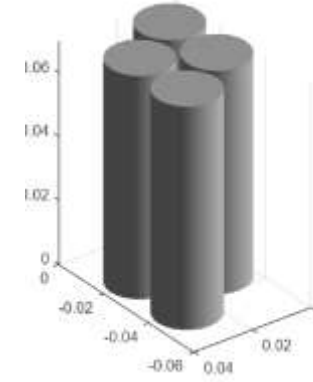
```
ans =
```

```
0.0082 : m^3
```

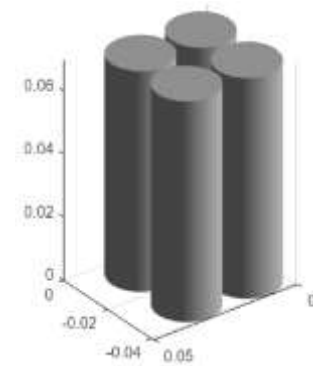
Cylindrical Cell



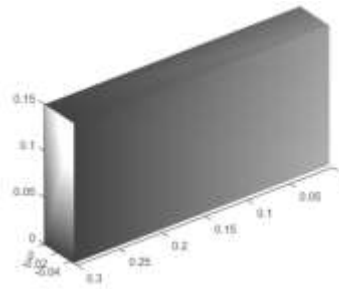
Hexagonal



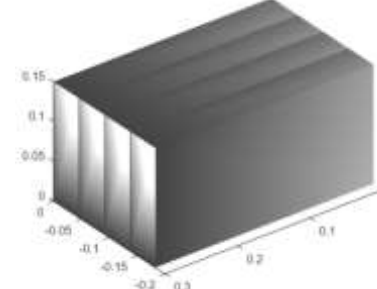
Square



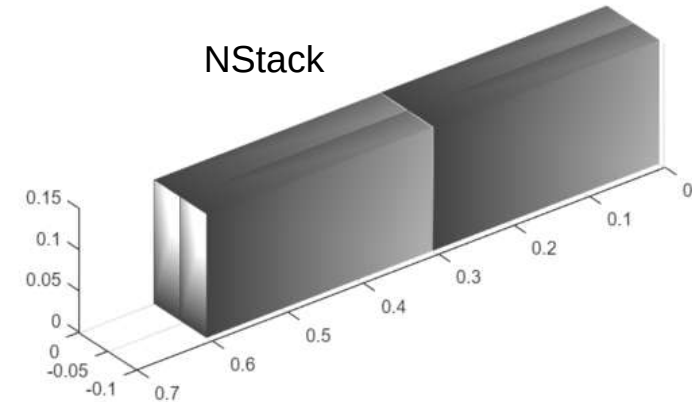
Prismatic Cell



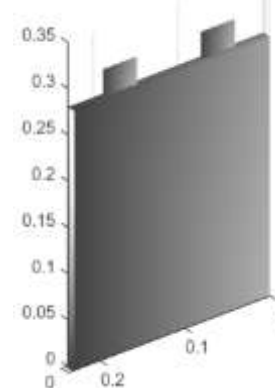
Single Stack



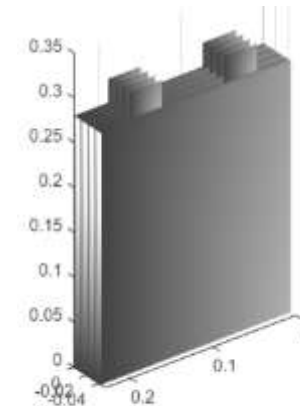
NStack



Pouch Cell



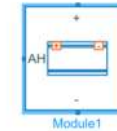
Single Stack



Battery Pack Builder

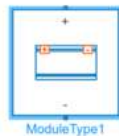
- Parameterize battery models from MATLAB scripts to support effective parameter management at scale and to support design space exploration.

```
>> buildBattery(batteryPack, "LibraryName", "packLibrary")
```



Block Parameters: Module1	
Module1 ☒ Auto Apply	
Settings	Description
NAME	VALUE
▼ Main	
> Vector of state-of-charge values, SOC	[0, .1, .25, .5, .75, .9, 1]
> Open-circuit voltage, V0(SOC)	[3.5057, 3.566, 3.6337, 3.7127, 3... V
> Terminal voltage operating range [Min Max]	[0, inf] V
> Terminal resistance, R0(SOC)	[.0085, .0085, .0087, .0082, .008... Ohm
> Cell capacity, AH	27 A*hr
Extrapolation method for all tables	
Nearest	
▼ Thermal	
▼ Initial Targets	
▼ Nominal Values	

```
>> buildBattery(batteryPack, "LibraryName", "packLibrary", ...
    "MaskInitialTargets", "VariableNames", ...
    "MaskParameters", "VariableNames")
```



Block Parameters: ModuleType1	
ModuleType1 ☒ Auto Apply	
Settings	Description
NAME	VALUE
▼ Main	
> Vector of state-of-charge values, SOC	ModuleType1.SOC_vec
> Open-circuit voltage, V0(SOC)	ModuleType1.V0_vec V
> Terminal voltage operating range [Min Max]	ModuleType1.V_range V
> Terminal resistance, R0(SOC)	ModuleType1.R0_vec Ohm
> Cell capacity, AH	ModuleType1.AH A*hr
Extrapolation method for all tables	
Nearest	
▼ Initial Targets	
▼ Nominal Values	



```

1 %% Battery parameters
2
3 %% ModuleType1
4 ModuleType1.SOC_vec = [0, .1, .25, .5, .75, .9, 1]; % Vector of state-of-charge values, SOC
5 ModuleType1.V0_vec = [3.5057, 3.566, 3.6337, 3.7127, 3.9259, 4.0777, 4.1928]; % Open-circuit voltage, V
6 ModuleType1.V_range = [0, inf]; % Terminal voltage operating range [Min Max], V
7 ModuleType1.R0_vec = [.0085, .0085, .0087, .0082, .0083, .0085, .0085]; % Terminal resistance, Ohm
8 ModuleType1.AH = 27; % Cell capacity, AH, A*hr
9
10 %% ParallelAssemblyType1
11 ParallelAssemblyType1.SOC_vec = [0, .1, .25, .5, .75, .9, 1]; % Vector of state-of-charge values, SOC
12 ParallelAssemblyType1.V0_vec = [3.5057, 3.566, 3.6337, 3.7127, 3.9259, 4.0777, 4.1928]; % Open-circuit voltage, V
13 ParallelAssemblyType1.V_range = [0, inf]; % Terminal voltage operating range [Min Max], V
14 ParallelAssemblyType1.R0_vec = [.0085, .0085, .0087, .0082, .0083, .0085, .0085]; % Terminal resistance, Ohm
15 ParallelAssemblyType1.AH = 27; % Cell capacity, AH, A*hr
16
17 %% Battery initial targets
18
19 %% ModuleAssembly1.Module1
20 ModuleAssembly1.Module1.iCellModel = 0; % Cell model current (positive in), A
21 ModuleAssembly1.Module1.vCellModel = 0; % Cell model terminal voltage, V
22 ModuleAssembly1.Module1.socCellModel = 0.4; % Cell model state of charge
23 ModuleAssembly1.Module1.numCyclesCellModel = 0; % Cell model discharge cycles
24 ModuleAssembly1.Module1.vParallelAssembly = repmat(0, 11, 1); % Parallel Assembly Voltage, V
25 ModuleAssembly1.Module1.socParallelAssembly = repmat(1, 11, 1); % Parallel Assembly state of charge
26

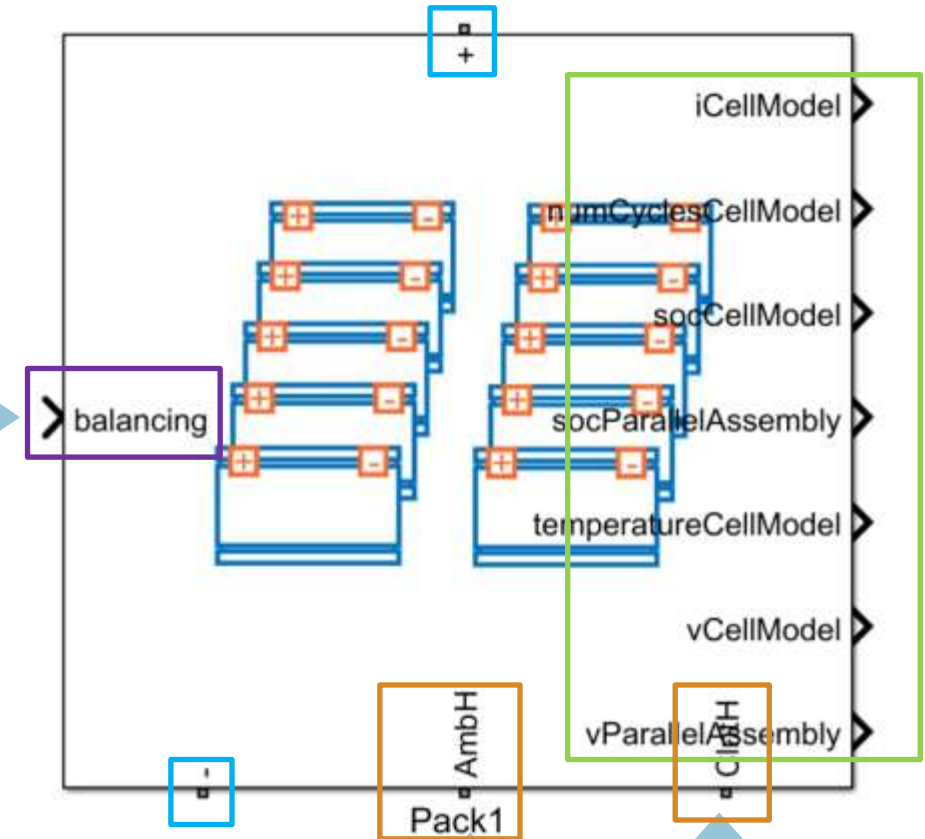
```

Battery Pack Builder

- Add temperature dependence, battery fade, battery aging and other cell characteristics.
- Add thermal ports that connect your battery pack to the ambient environment and to cooling systems.
- Add passive cell balancing circuits...

... define all this from MATLAB.

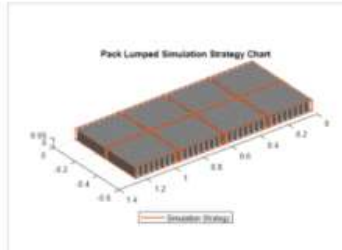
```
>> batteryPack.BalancingStrategy = "Passive"
>> batteryPack.AmbientThermalPath = "CellBasedThermalResistance"
>> batteryPack.CoolantThermalPath = "CellBasedThermalResistance"
```



Battery Pack Builder

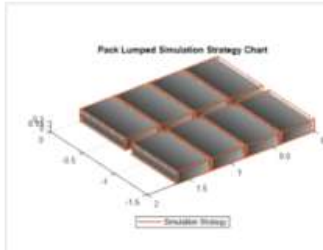
Battery Pack Modeling — Examples

R2022b



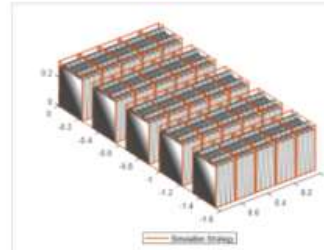
Build Detailed Model of Battery Pack From Cylindrical Cells

Create and build a Simscape™ system models for various battery designs and configurations based on cylindrical battery cells in

[Open Live Script](#)


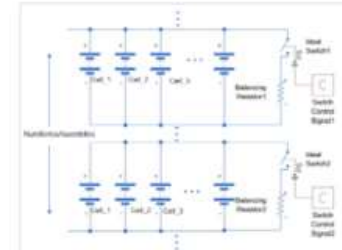
Build Detailed Model of Battery Pack From Pouch Cells

Create and build a Simscape™ system models for various battery designs and configurations based on pouch battery cells in Simscape™ Battery™.

[Open Live Script](#)


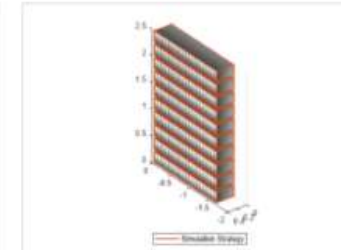
Build Model of Battery Pack with Cell Aging

Create and build a Simscape system model of a battery pack with cell aging.

[Open Live Script](#)


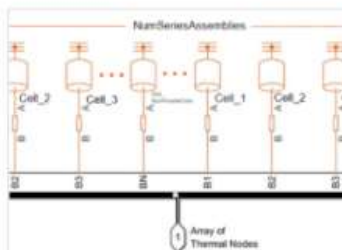
Build Model of Battery Pack with Cell Balancing Circuit

Create and build a Simscape system model of a battery pack with cell balancing circuit.

[Open Live Script](#)


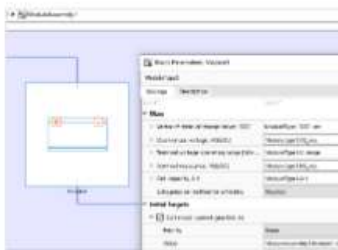
Build Model of Battery Pack for Grid Application

Create and build a Simscape system model of a battery pack for grid applications.

[Open Live Script](#)


Build Model of Battery Module with Thermal Effects

Create and build a Simscape system model of a battery module with thermal effects.

[Open Live Script](#)


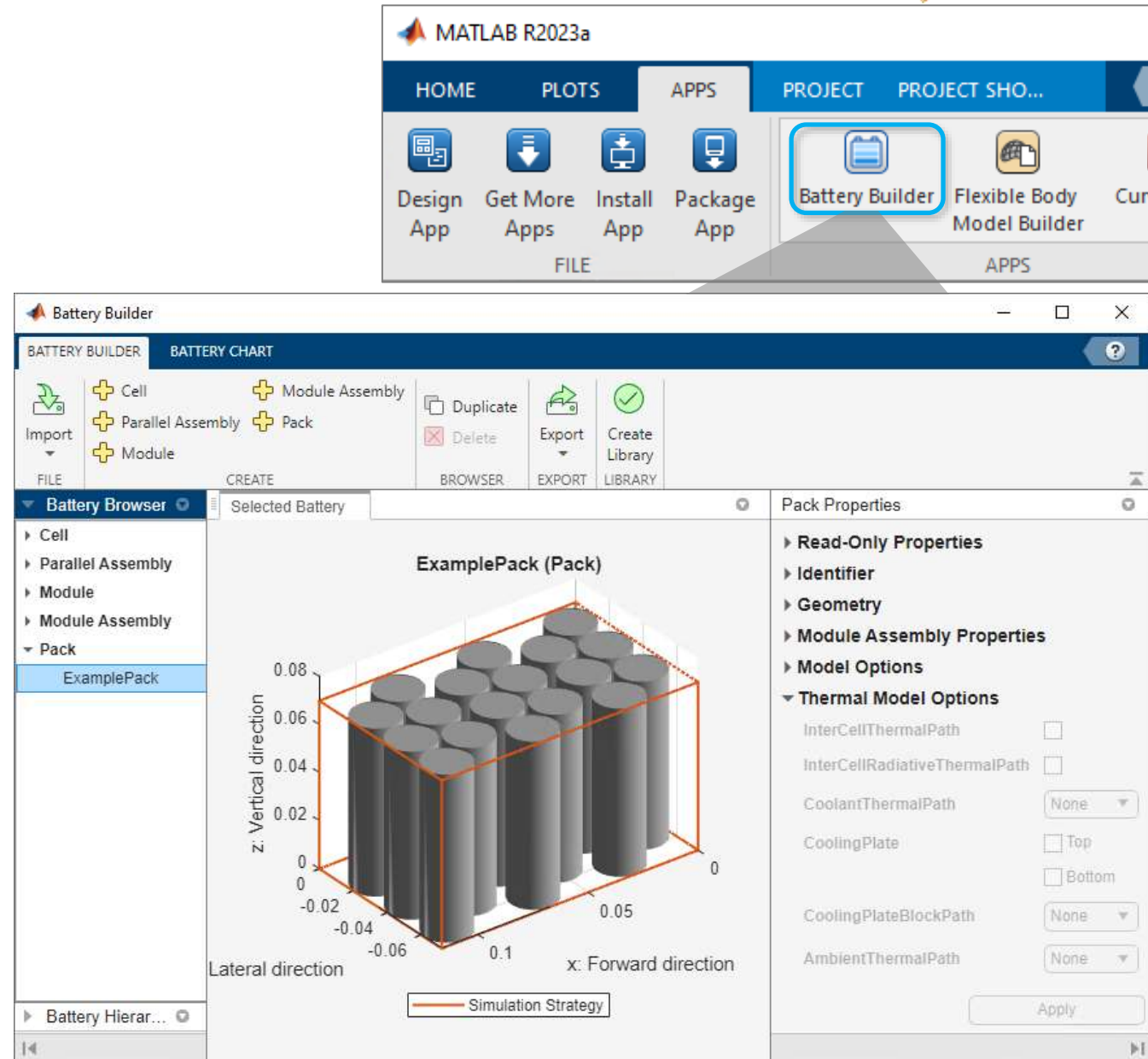
Build Model of Hybrid-Cell Battery Pack

Build a Simscape™ system model of a hybrid-cell battery pack with two sets of cell run-time parameters. The generated battery pack model

[Open Live Script](#)

Battery Builder App

- Construct battery pack models using interactive modeling app
 - Create new battery objects to model cells, modules and packs
 - Import existing battery objects from your workspace or MAT file.
 - Create a 3-D battery object plot, and export to a MATLAB figure
 - Inspect the battery object hierarchy
 - Edit the battery object properties, such as geometrical data and thermal boundary conditions.
 - Create a library model from an object



EV Fast Charging

Thermal Management



Power up to 350 kW



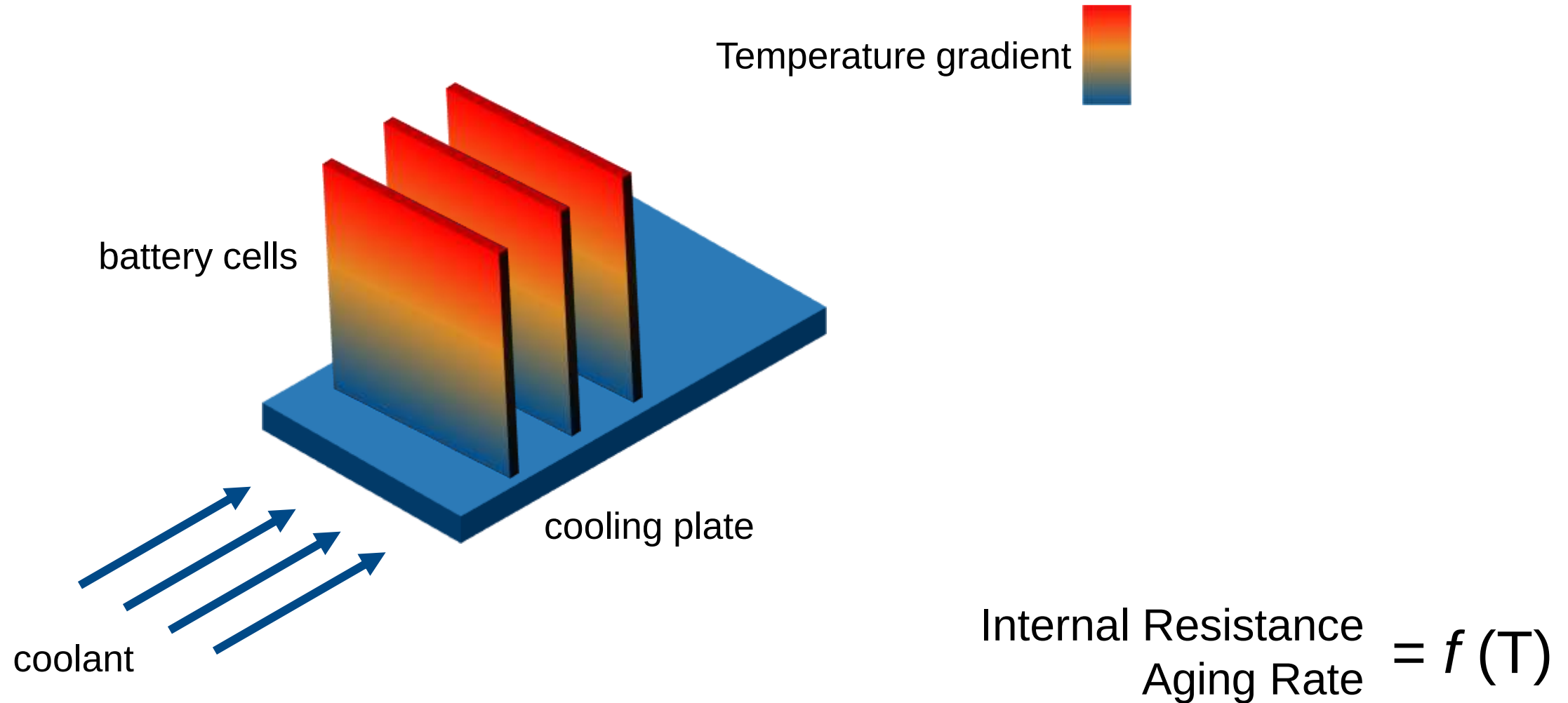
Large heat generation



Fast Aging

Thermal Management

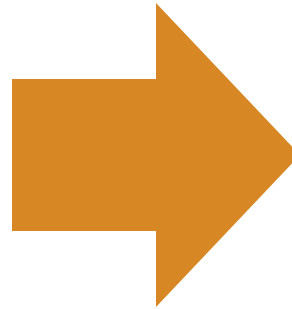
Pouch Cell with Bottom Plate Cooling



Temperature and Thermal Gradients

Effects

- Inhomogeneous current
- Uneven aging
- Accelerated degradation
- Localized heating
- Uncertain T monitoring



Requirements

Performance – Life – Safety

$$10^{\circ}\text{C} < T < 35^{\circ}\text{C}$$

$$\Delta T < 6^{\circ}\text{C}$$

Battery ∇T - Research

1388435.pdf (tum.de)

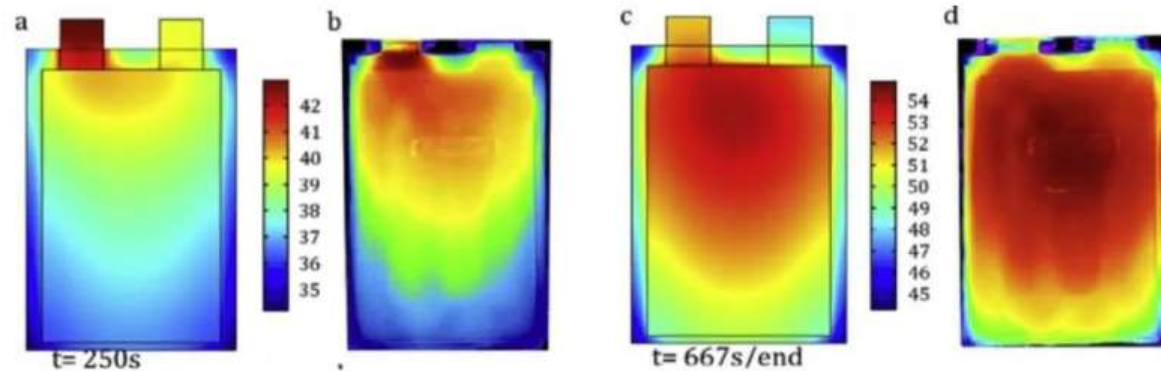


Technische Universität München
Lehrstuhl für Elektrische
Energiespeichertechnik
Prof. Dr.-Ing. Andreas Jossen



Temperature Inhomogeneity in Lithium Ion Pouch Cells

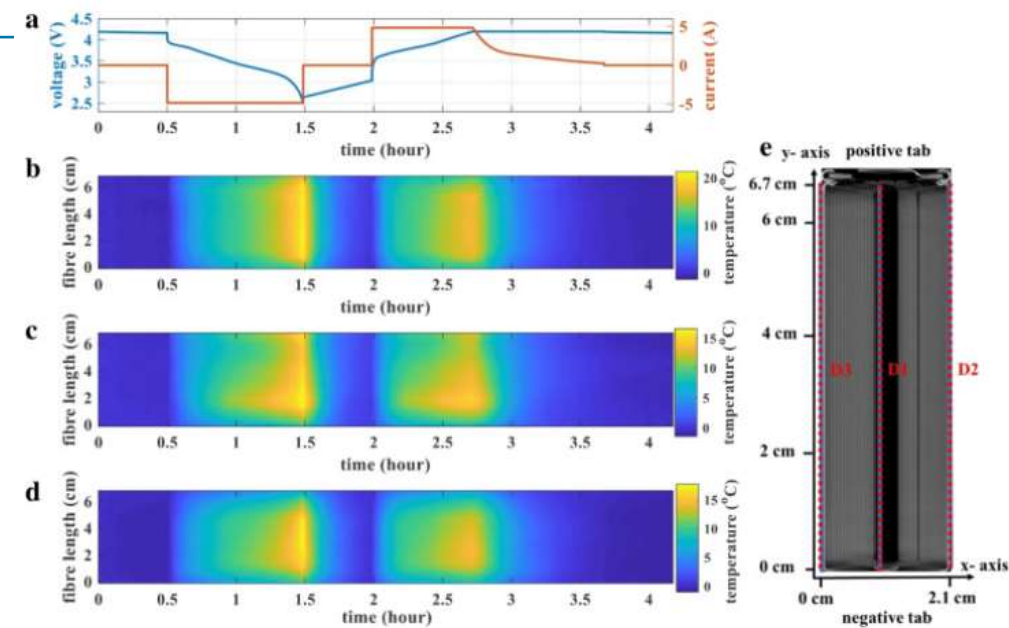
Nora Martiny



Surface temperature evolution of a pouch cell during 5C constant current discharge obtained by a) simulation and b) measurement at $t = 250$ s; c) simulation and d) measurement at the end of discharge/ $t = 667$ s

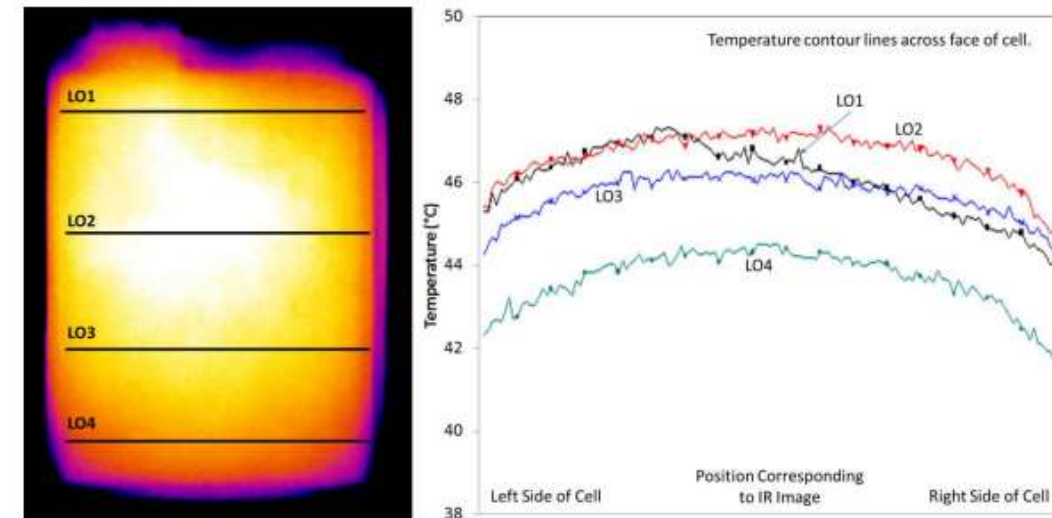
S. Goutam et al. [10.1016/J.APPLTHERMALENG.2017.07.206](https://doi.org/10.1016/J.APPLTHERMALENG.2017.07.206)

<https://www.sciencedirect.com/science/article/pii/S1359431117325565?via%3Dihub>



Yu et al., [Distributed internal thermal monitoring of lithium ion batteries with fibre sensors - ScienceDirect](https://www.sciencedirect.com/science/article/pii/S1359431117325565?via%3Dihub)

[Enabling Fast Charging - Battery Thermal Considerations \(osti.gov\)](https://www.osti.gov/biblio/1151111)

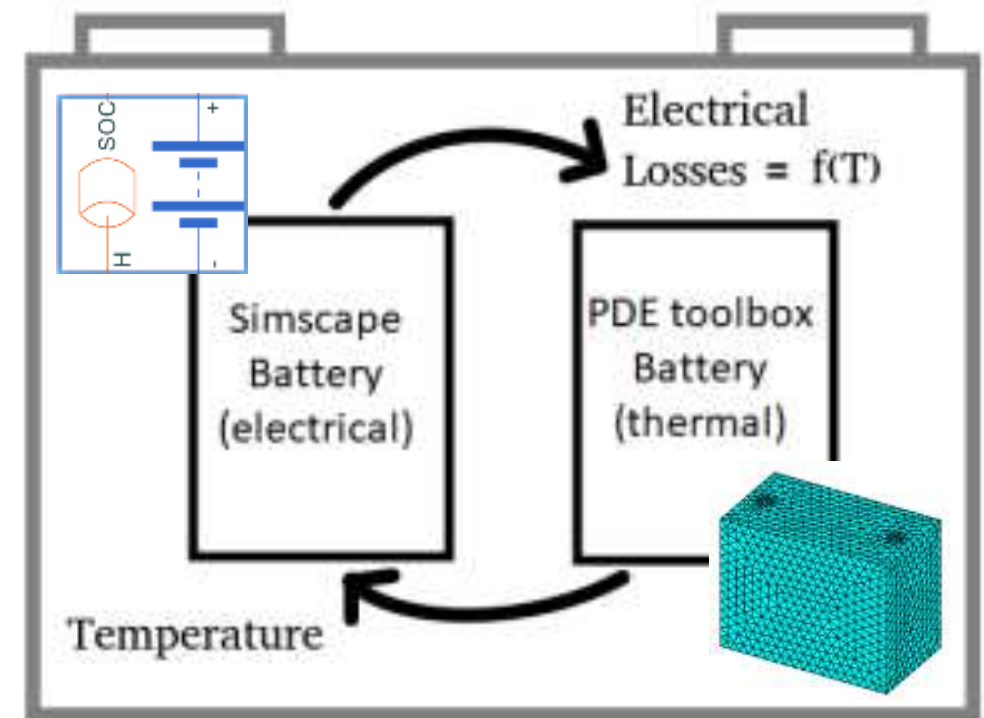


NMC/graphite, End of a 2C constant current discharge. SOC 100% to 0%

Solution

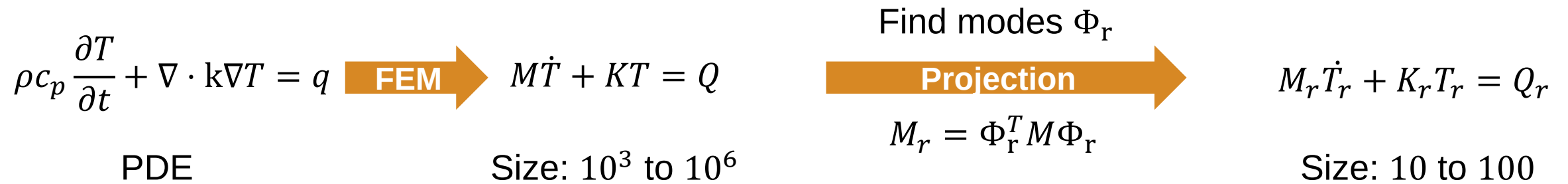
Combine Finite Element Analysis + System Level Simulation

- Electrical Domain - Battery Cell (**Simscape Battery**)
- Thermal Domain - Reduced Order Model from FEA (**PDE Toolbox**)



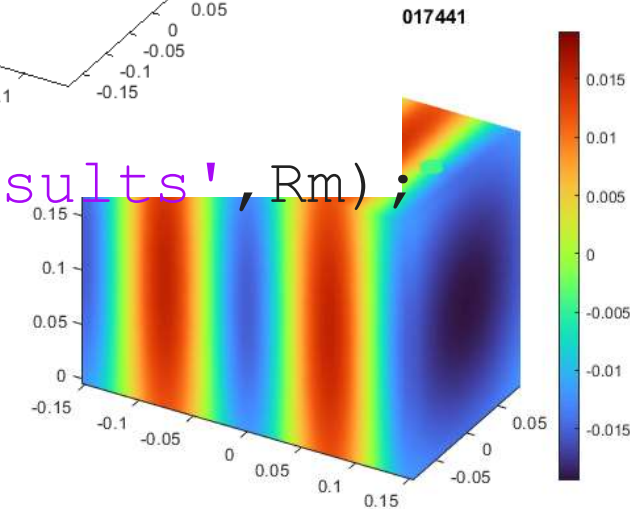
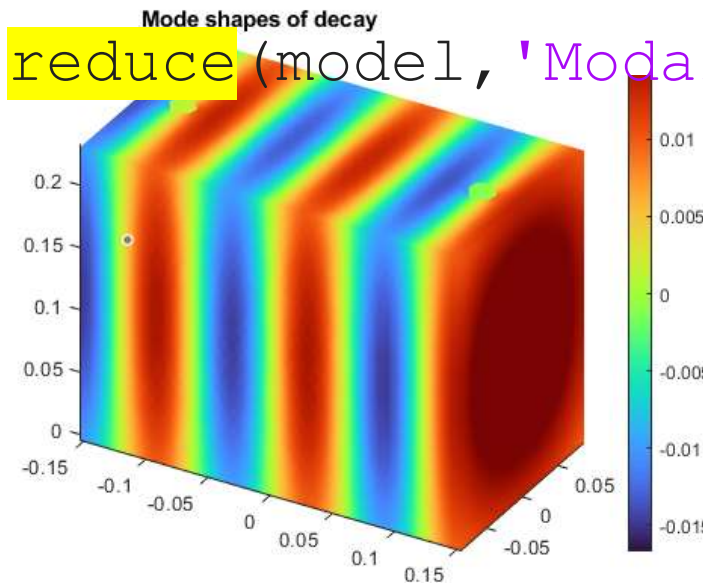
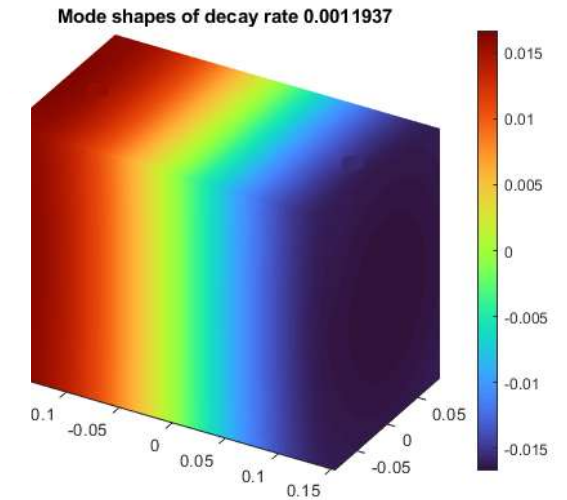
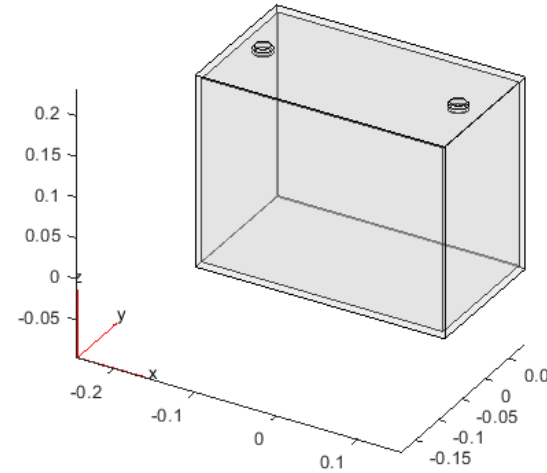
Battery Model (in this example)

Thermal Model Reduction



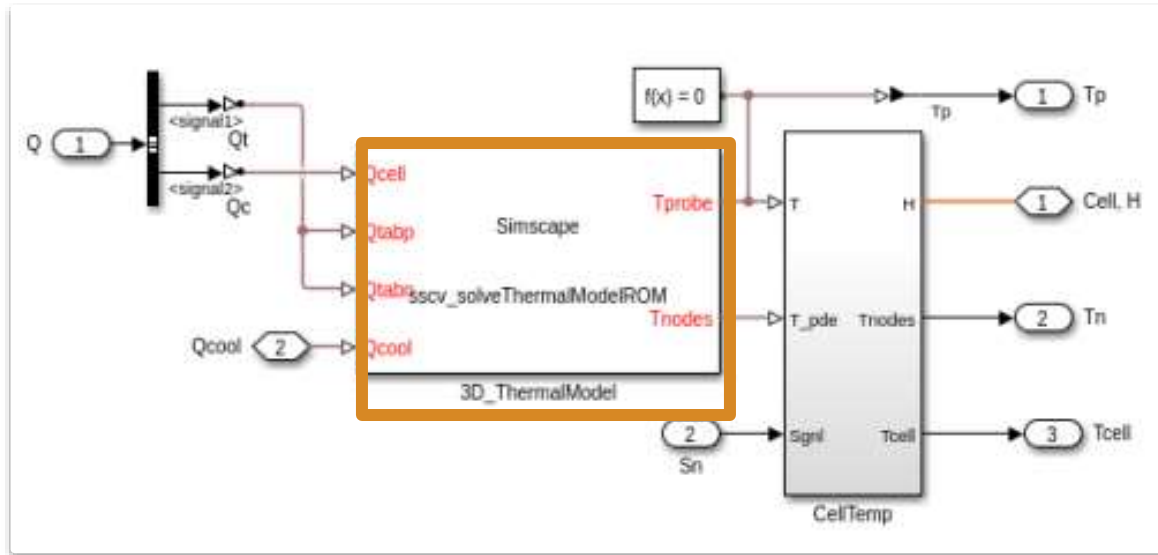
Thermal Model Reduction - Workflow

- 1- Create geometry
- 2- Create thermal problem as 'model'
- 3- Assign material properties
- 4- Mesh
- 5- Solve modal problem (no loads)
- 6- Reduce `rom = reduce(model, 'ModalResults', Rm);`



`Rm = solve(model, 'DecayRange', [-inf, 0.05]);`

Reduced Order Model (ROM) in Simscape Language



Block Parameters: 3D_ThermalModel

Reduced Order Model matrices and operations for battery cell thermal analysis

Auto Apply

SettingsDescription

NAME	VALUE
Parameters	
> Mass matrix	pde_rom.rom.M<15x15 double>
> Conductivity matrix	pde_rom.rom.K<15x15 double>
> Modal transformation matrix for probes	pde_rom.thermocouples.W<3x15 double>
> Heat loss from boundary	pde_rom.Q.boundaryLoad_full<15684x1 double>
> Cell volumetric heat generation	pde_rom.Q.heatGenUnit_full<15684x1 double>
> Positive tab volumetric heat generation	pde_rom.Q.heatGenUnitPosTab_full<15684x1 double>
> Negative tab volumetric heat generation	pde_rom.Q.heatGenUnitNegTab_full<15684x1 double>

$$M_r \dot{T}_r + K_r T_r = Q_r$$

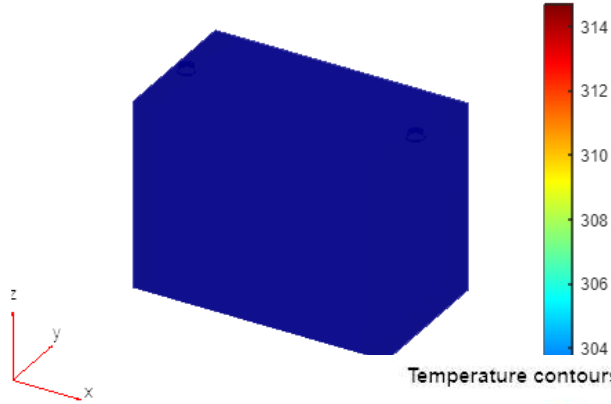
```

component sscv_solveThermalModelROM
% Reduced Order Model matrices and operations for battery cell thermal analysis
% Copyright 2022 The MathWorks, Inc.

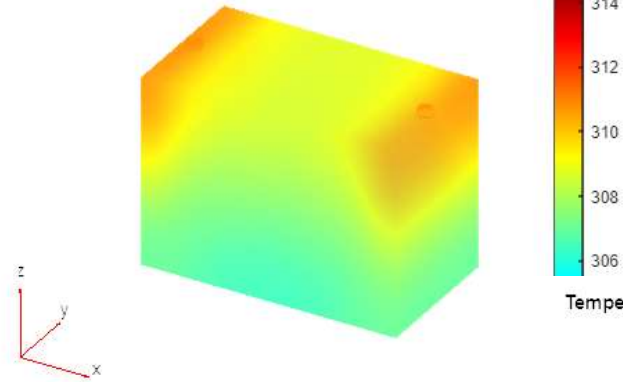
equations
    pdeTemp == T;
    romTemp == probeTransformMat*T;
    romMassMatrix * T.der + romCondMatrix * T == {romQmodalTransform*(...
        romQheatGenUnitFull*value(cellHeatSrc,'W')/jellyVolume + ...
        romQheatGenUnitPosTabFull*value(tabHeatSrcPos,'W')/posTabVolume + ...
        romQheatGenUnitNegTabFull*value(tabHeatSrcNeg,'W')/negTabVolume + ...
        romQboundaryLoadFull*value(heatLossToCoolant,'W')/coolingSurfArea...
    ), 'W'};
    
```


Temperature Distribution

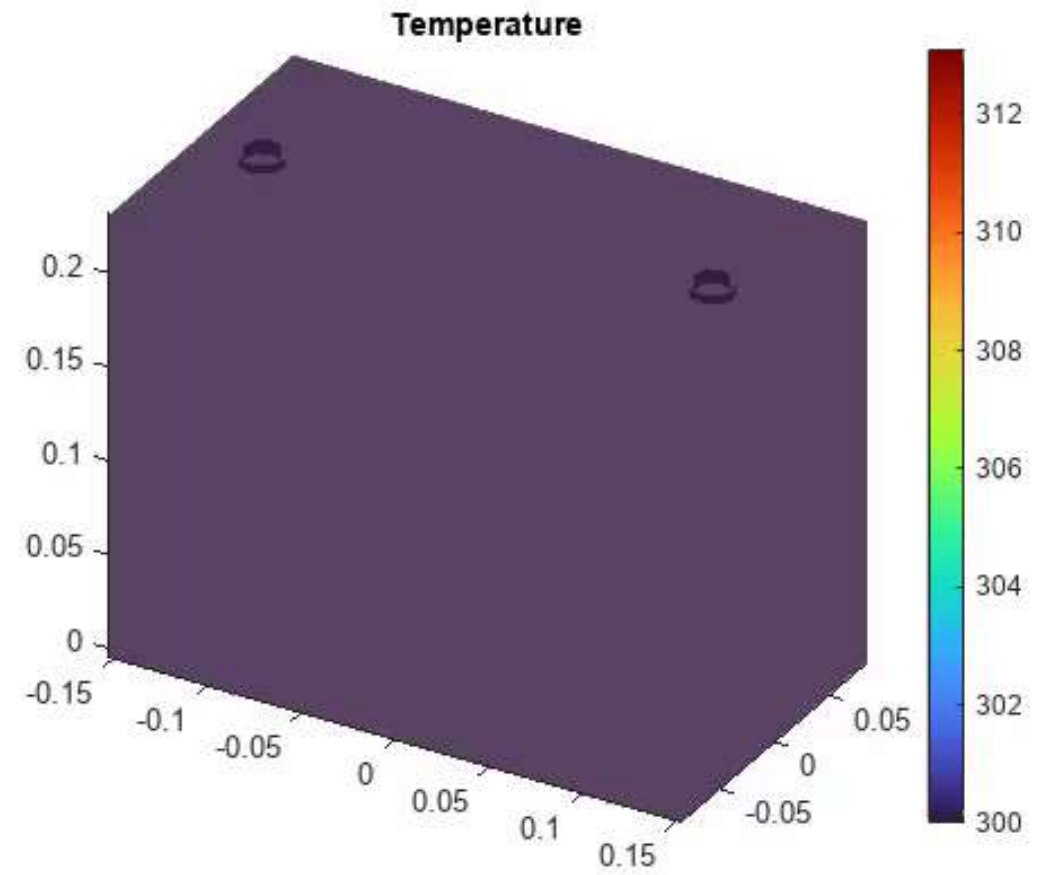
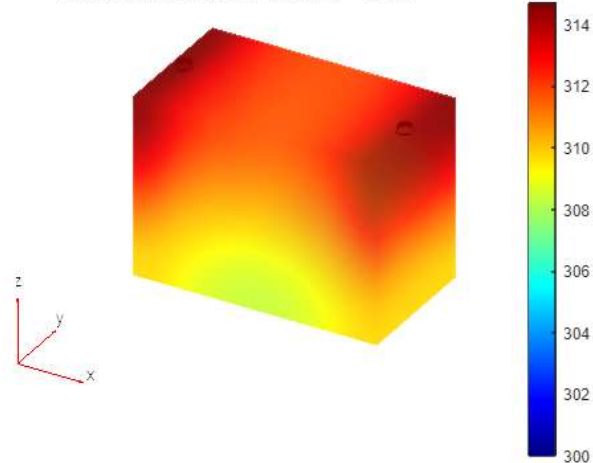
Temperature contours at time $t = 0.016667\text{min}$



Temperature contours at time $t = 5\text{min}$

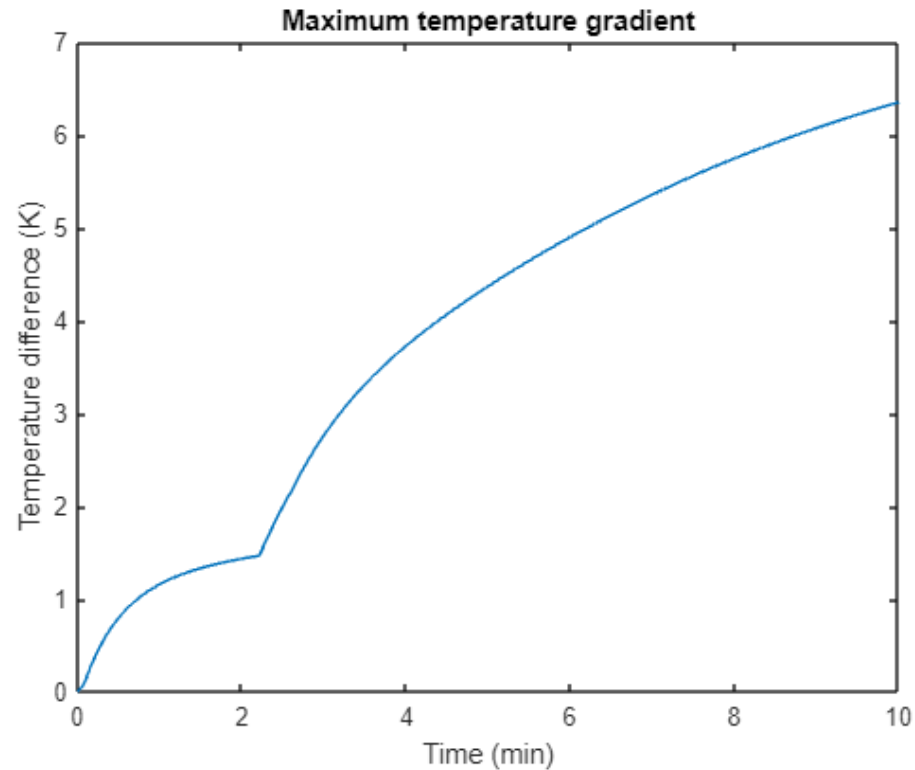


Temperature contours at time $t = 10\text{min}$

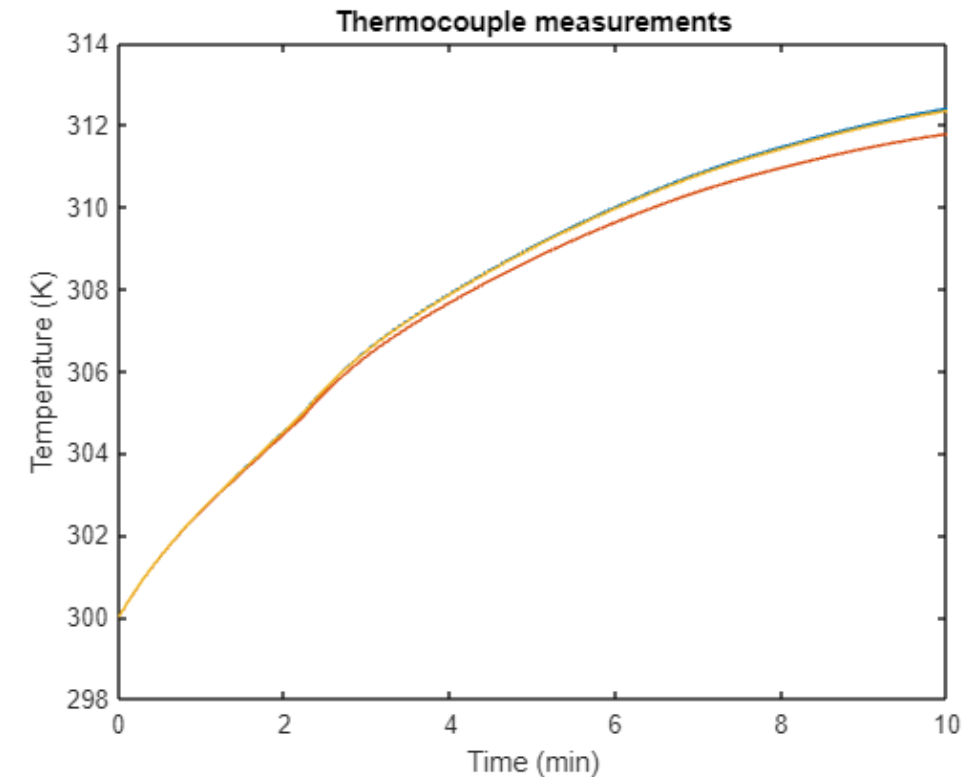


Thermal Differences

$$\Delta T_{\max} \sim 6\text{K}$$

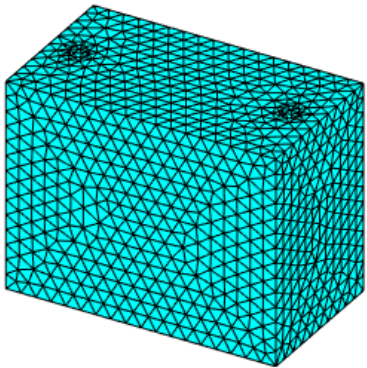


Thermocouple Readings

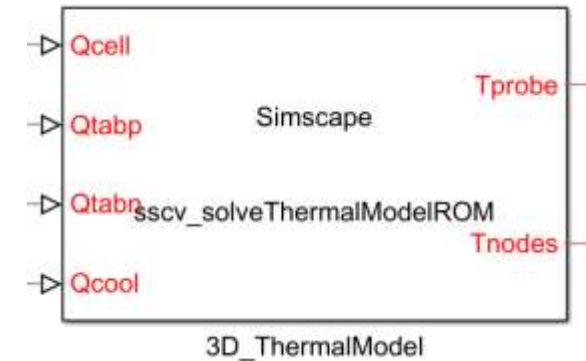


Summary

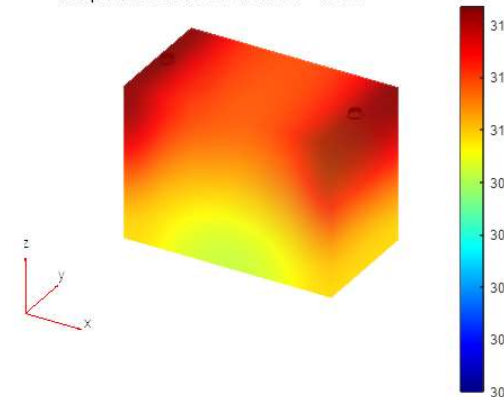
- Reduced Order Model of Battery Thermal Behavior
- FEA to System Level



```
Rm = solve(model, 'DecayRange', [-inf, 0.05]);  
rom = reduce(model, 'ModalResults', Rm);
```



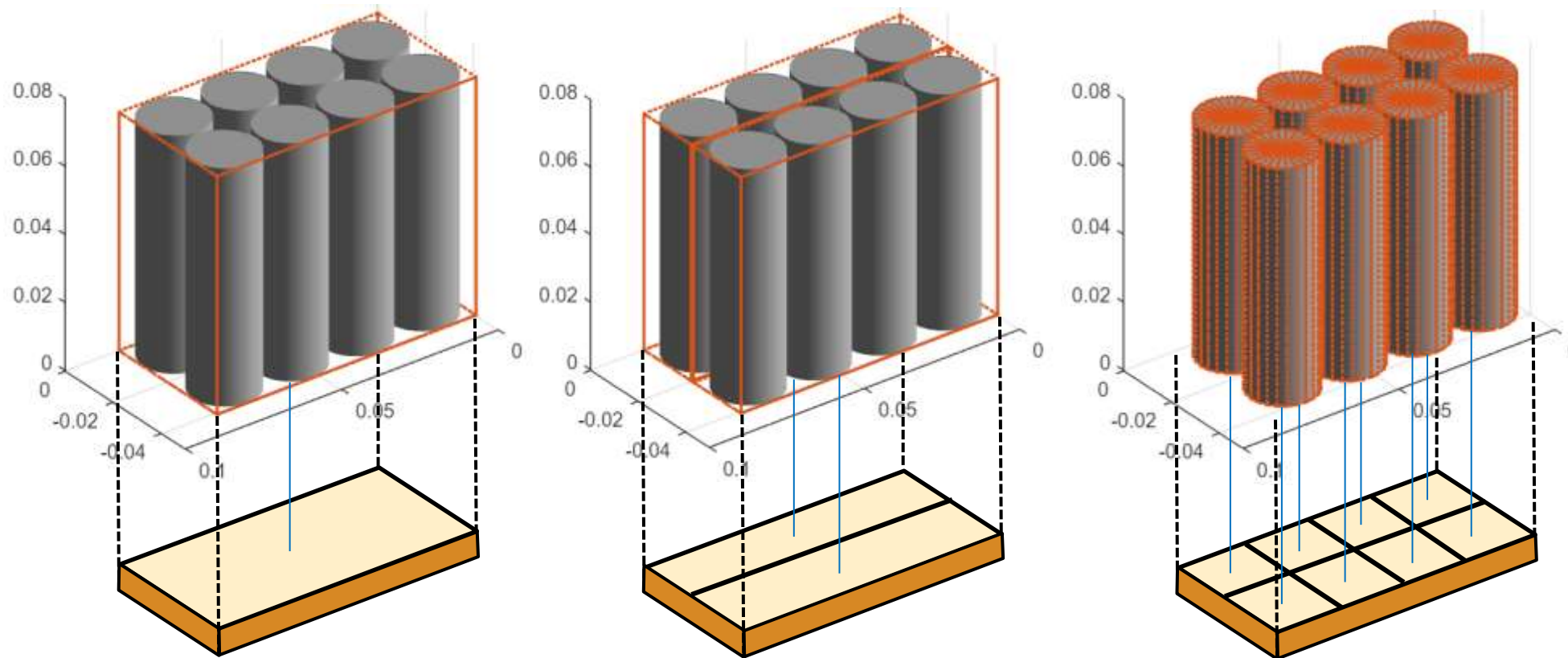
Temperature contours at time t = 10min



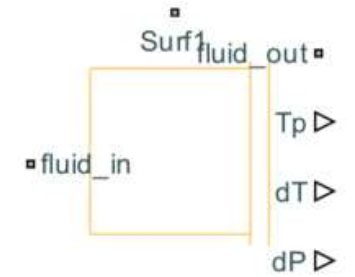
- Find Temperature Distribution
- Solve in Simulink

Thermal Management

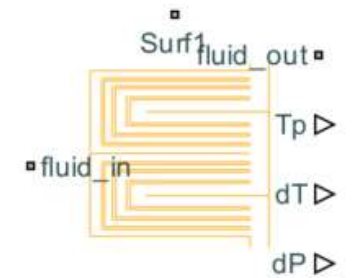
- Change the simulation strategy of cooling plates to meet your model resolution needs for the combined electrical and thermal system.



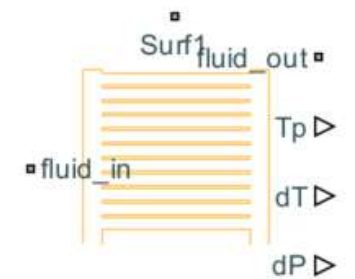
Cooling Plate



Edge Cooling



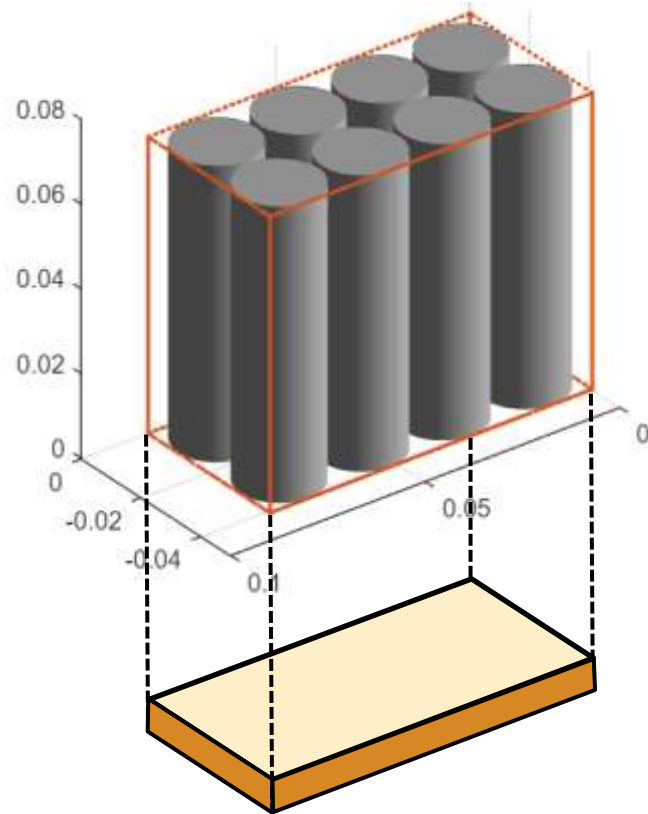
U-shaped Channels



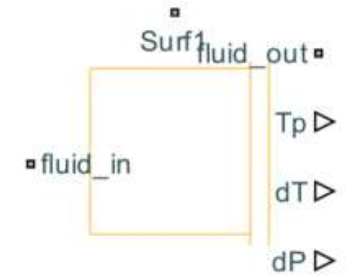
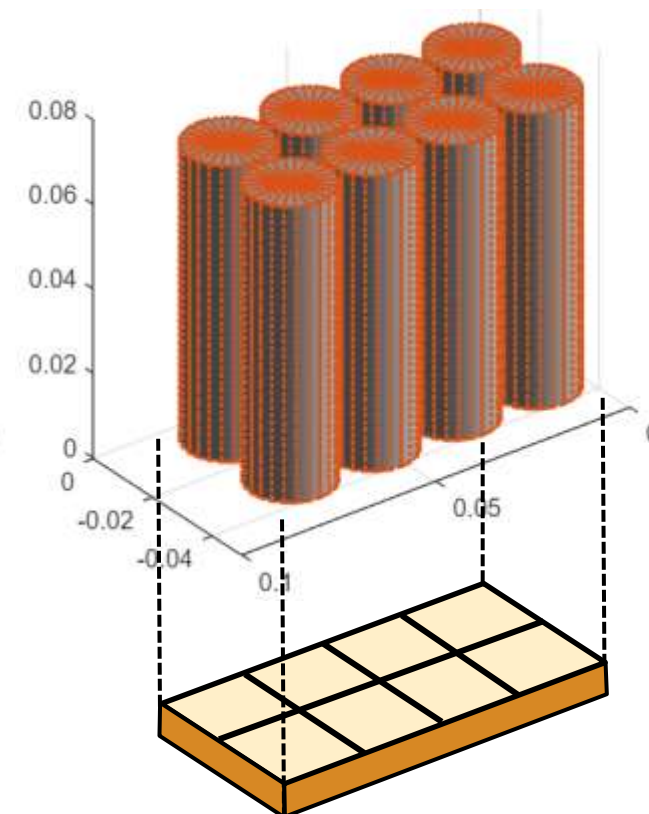
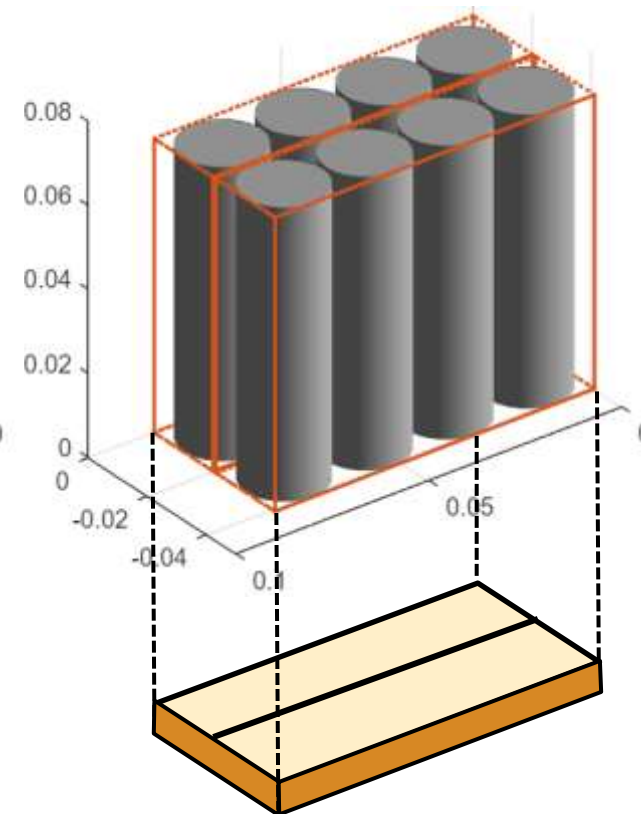
Parallel Channels

Thermal Management

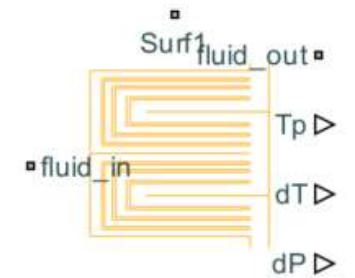
- Change the simulation strategy of cooling plates to meet your model resolution needs for the combined electrical and thermal system.



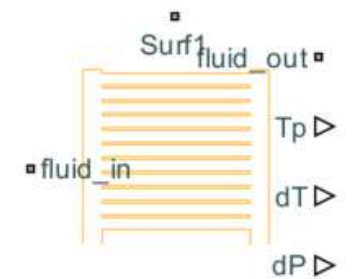
Cooling Plate



Edge Cooling



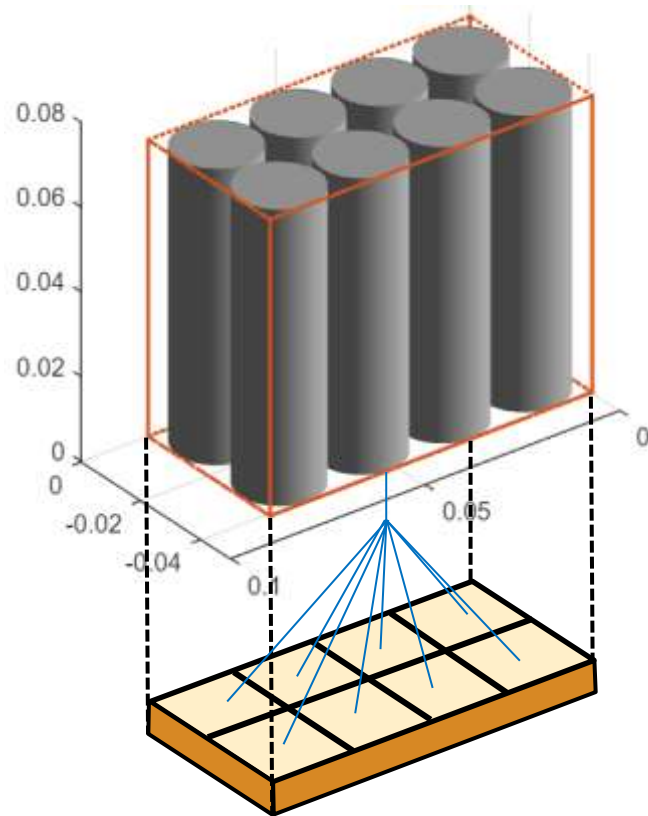
U-shaped Channels



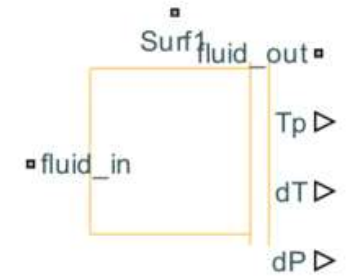
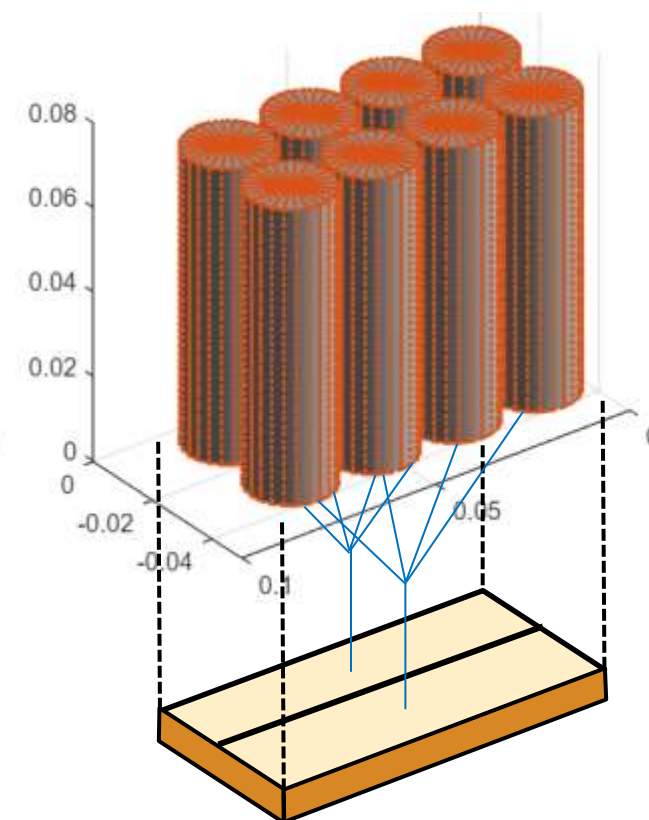
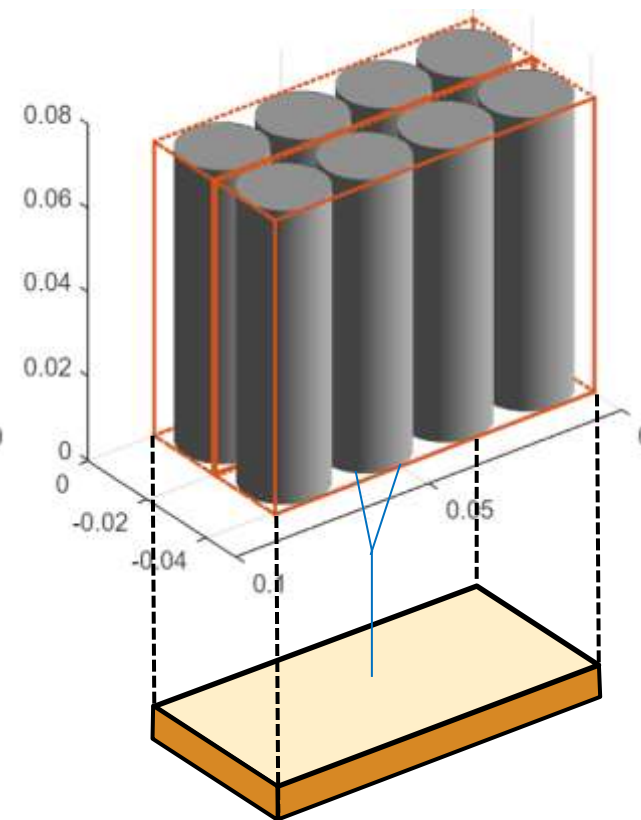
Parallel Channels

Thermal Management

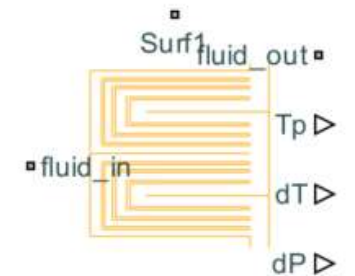
- Change the simulation strategy of cooling plates to meet your model resolution needs for the combined electrical and thermal system.



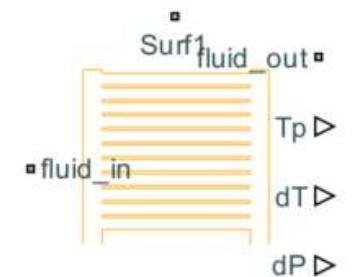
Cooling Plate



Edge Cooling



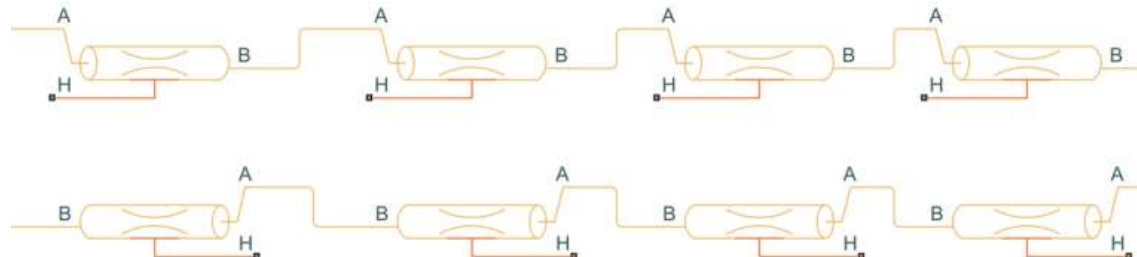
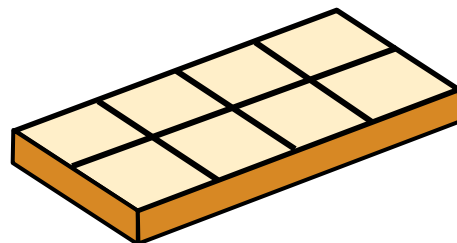
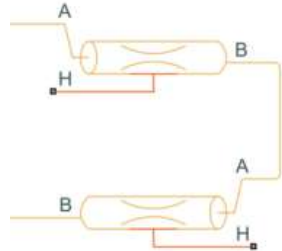
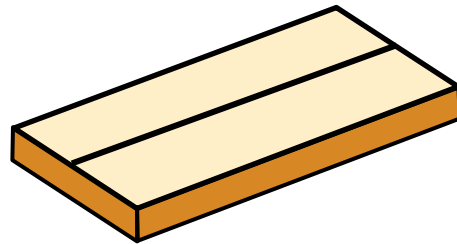
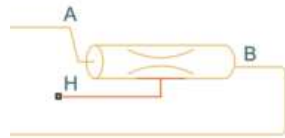
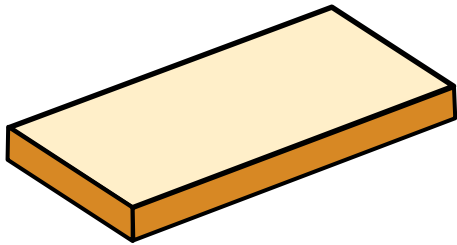
U-shaped Channels



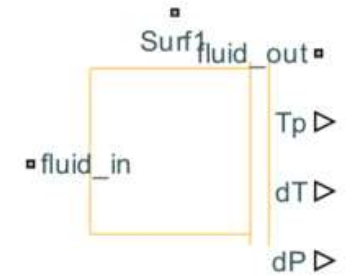
Parallel Channels

Thermal Management

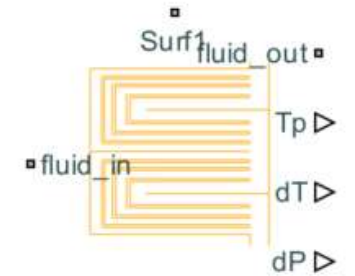
- Change the simulation strategy of cooling plates to meet your model resolution needs for the combined electrical and thermal system.



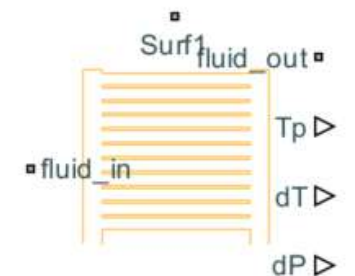
Connections dependent on cooling plate architecture



Edge Cooling

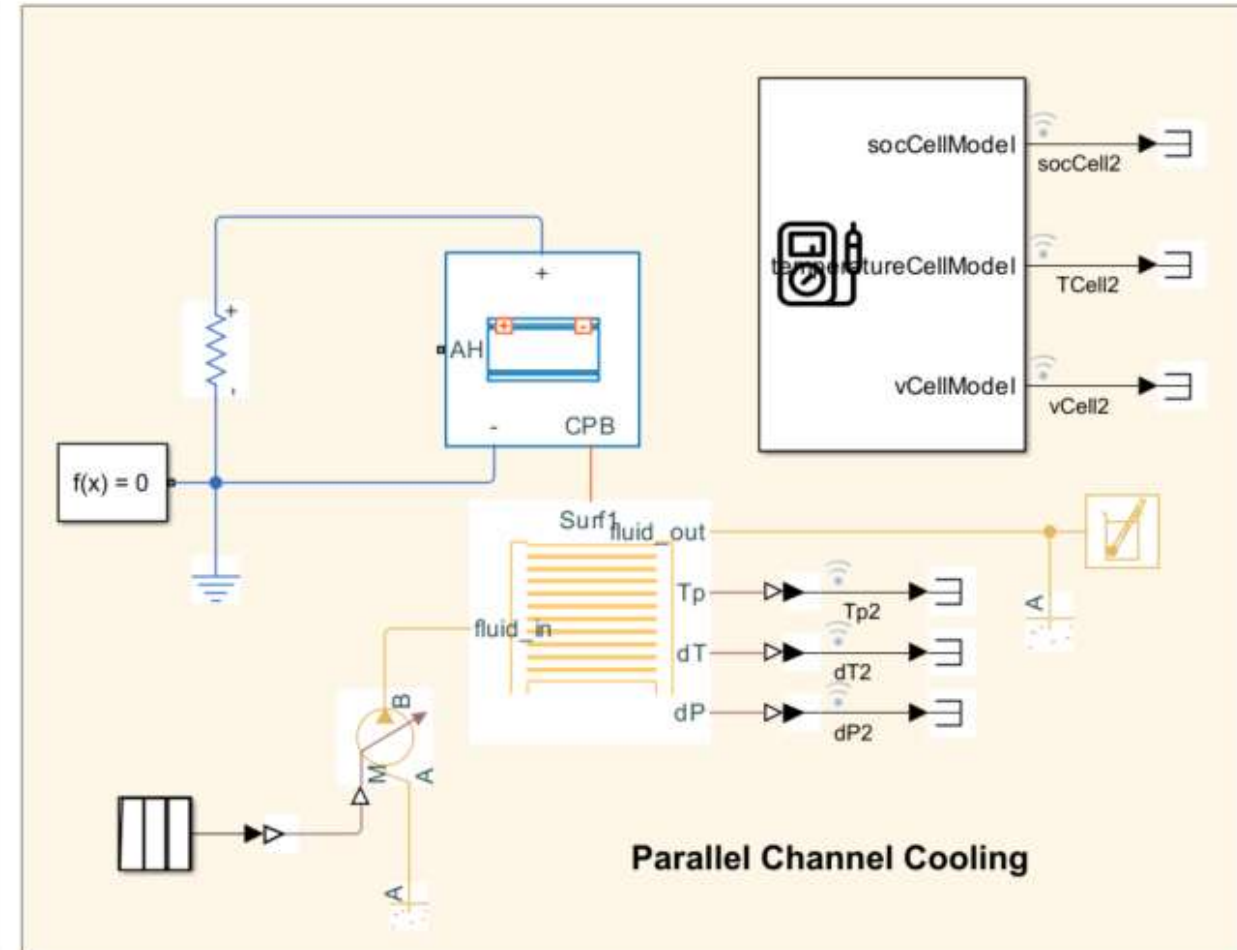
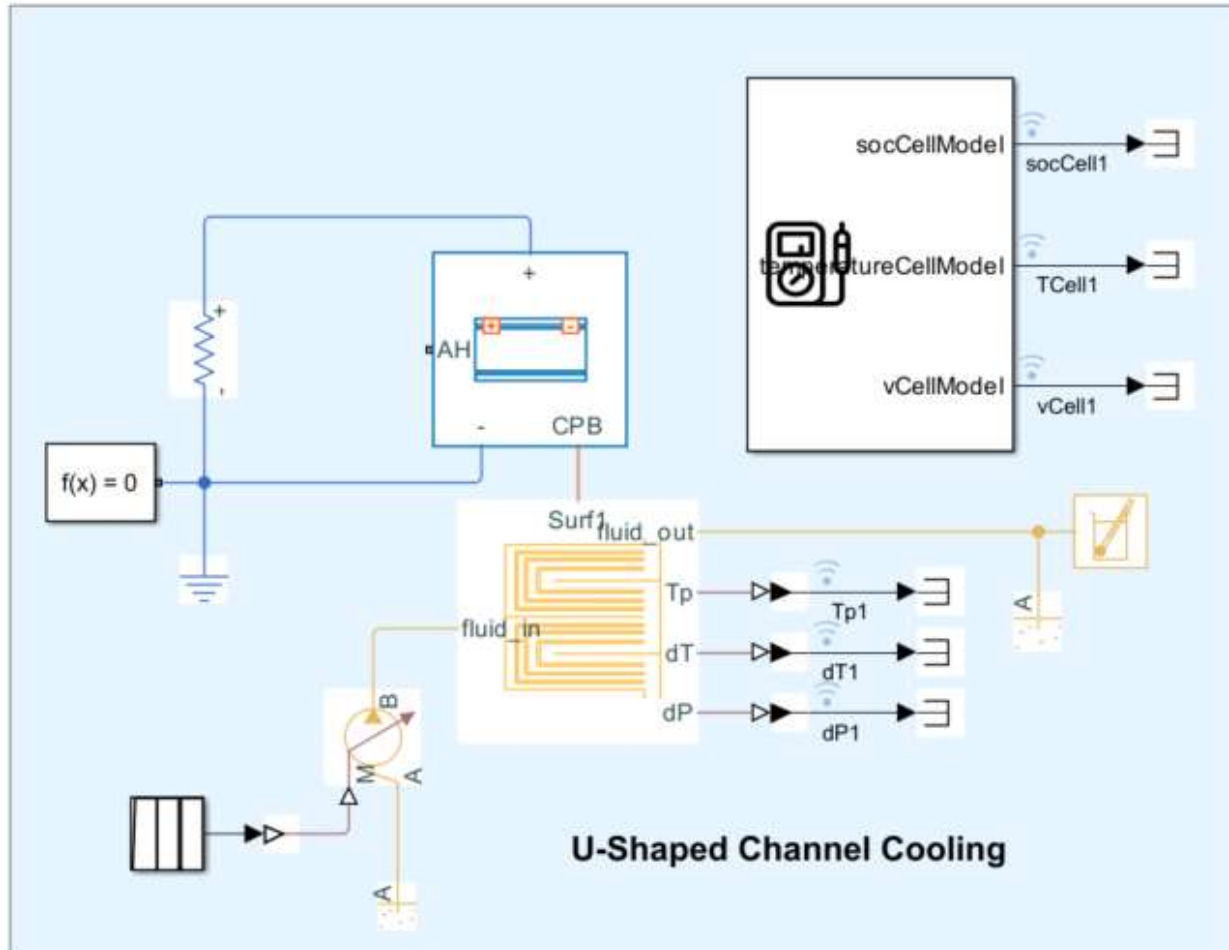


U-shaped Channels



Parallel Channels

- Build out your cooling systems with Simscape Foundation components (Thermal Liquid).
- Clear onramp to Simscape Fluids if additional modeling capability is needed.



Create and build a Simscape system model of a battery module with thermal effects.

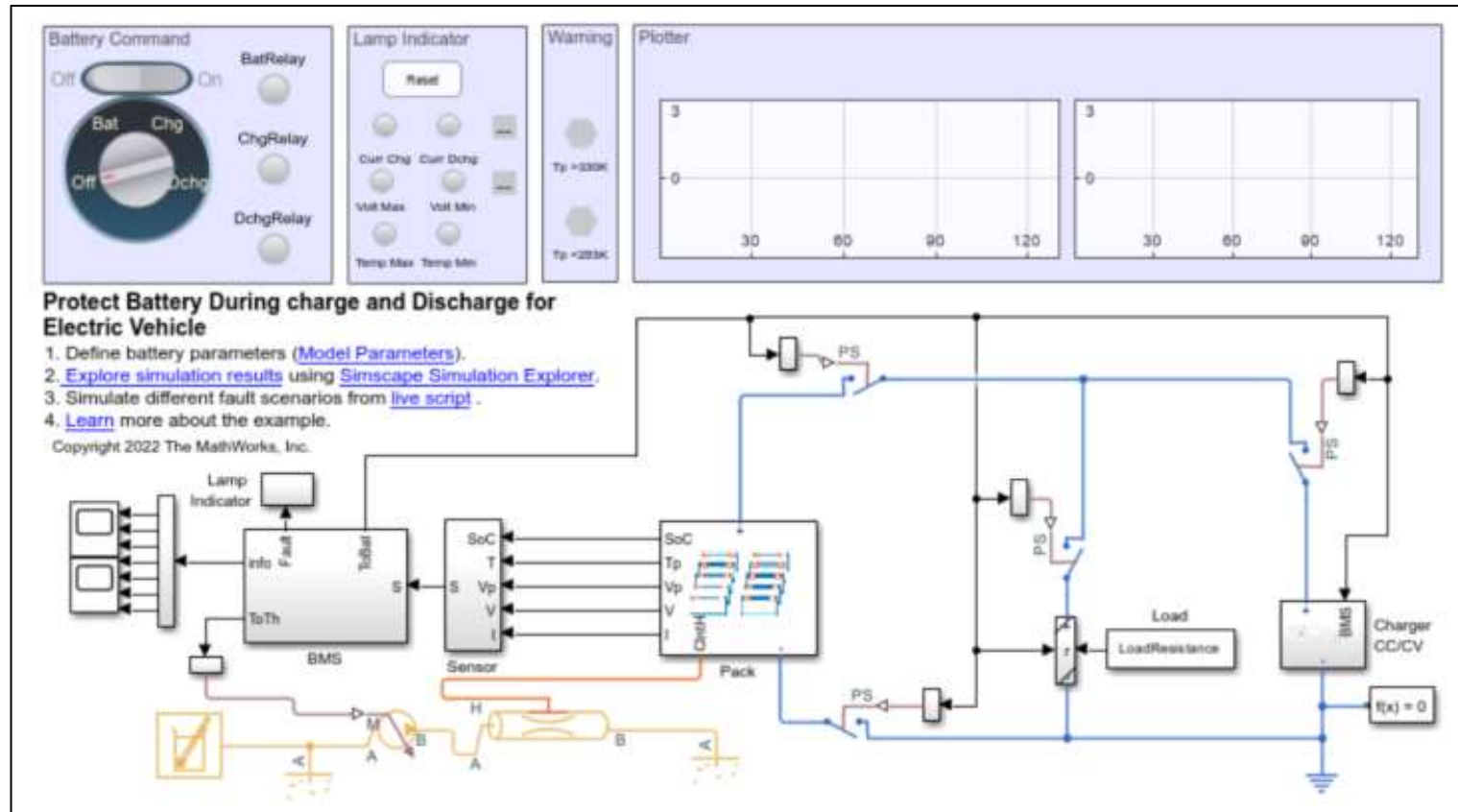
New and
 1. Define the
 Parameters
 2. Learn more
 Copyright ©

Evaluate a new and end-of-life (EOL) lithium-ion battery pack. With cell usage and time, the capacity of the cell degrades and the resistance

33

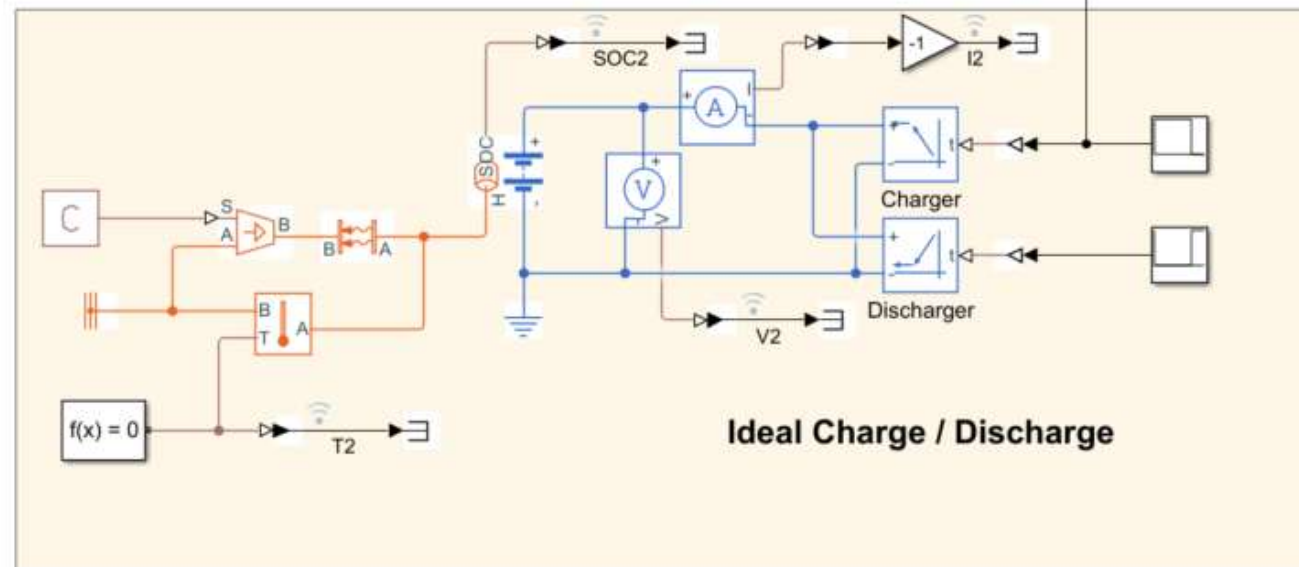
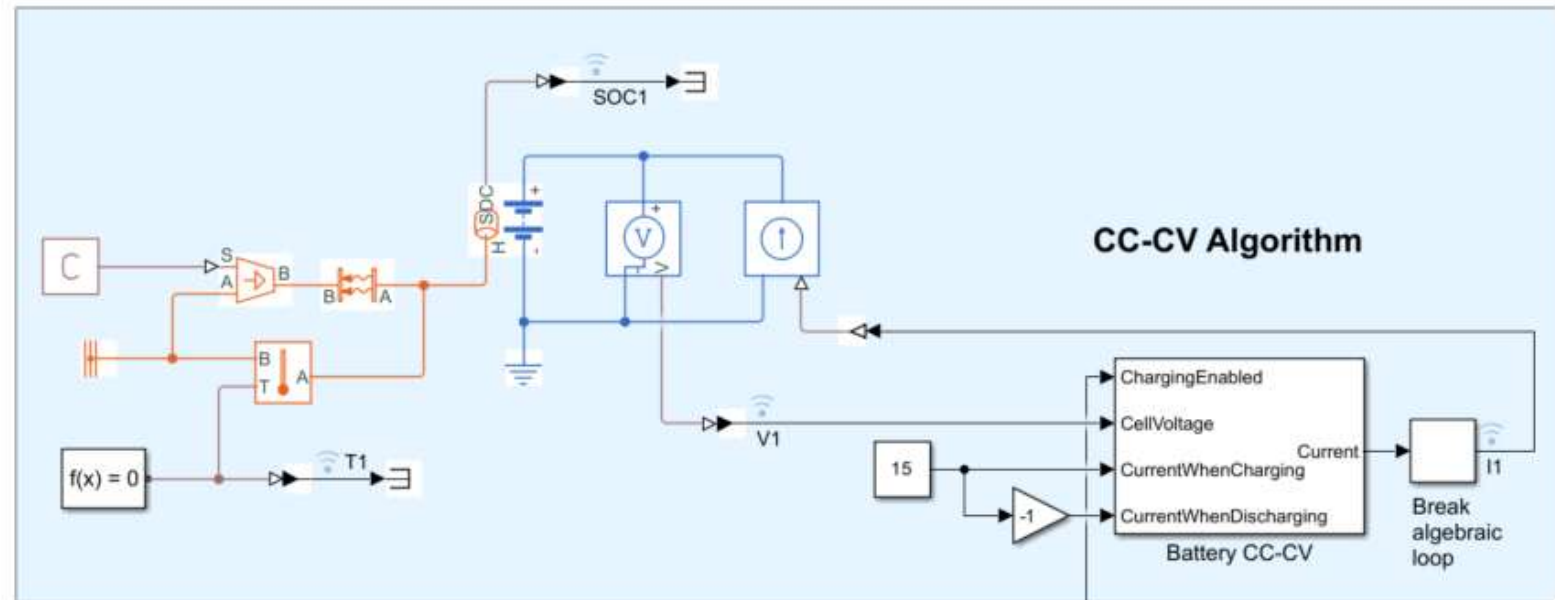
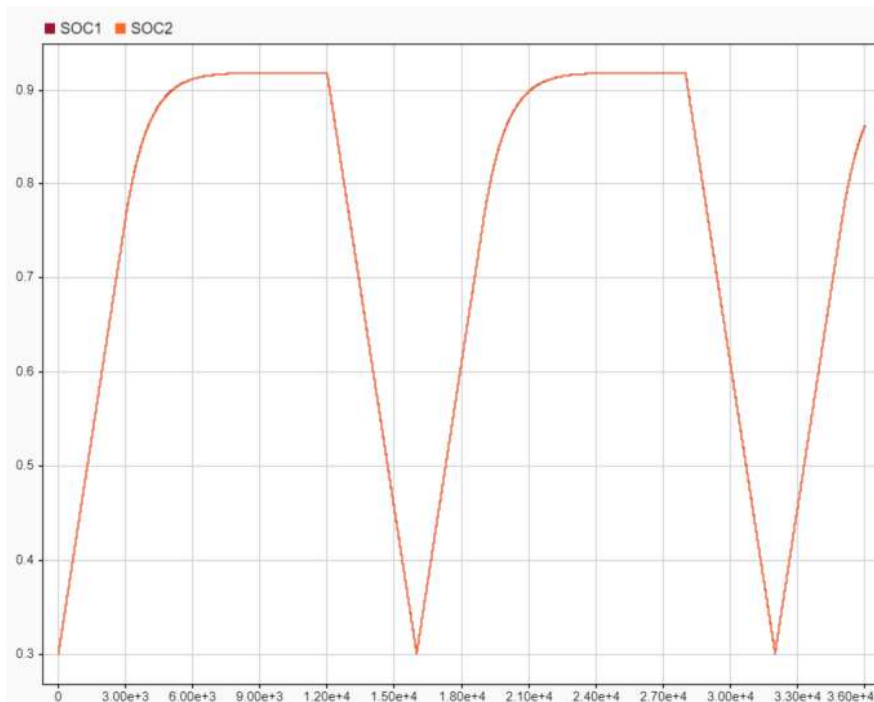
Battery Management

- Algorithms for cell balancing, current management, state-of-charge (SOC) and state-of-health (SOH) estimation, protection, and thermal management.
- Build out your electrical system with Simscape Foundation components (Electrical).
- Clear onramp to Simscape Electrical if additional electrical modeling capability is needed.



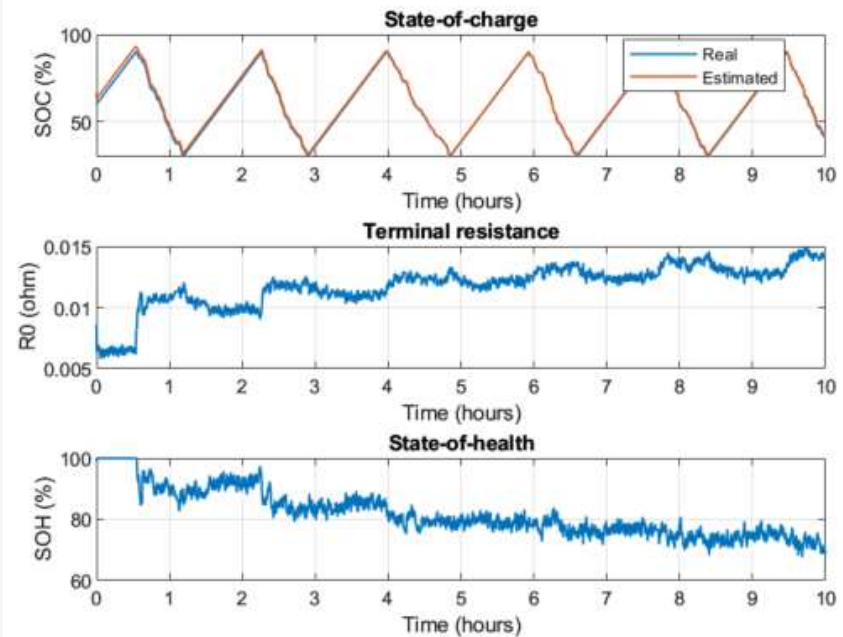
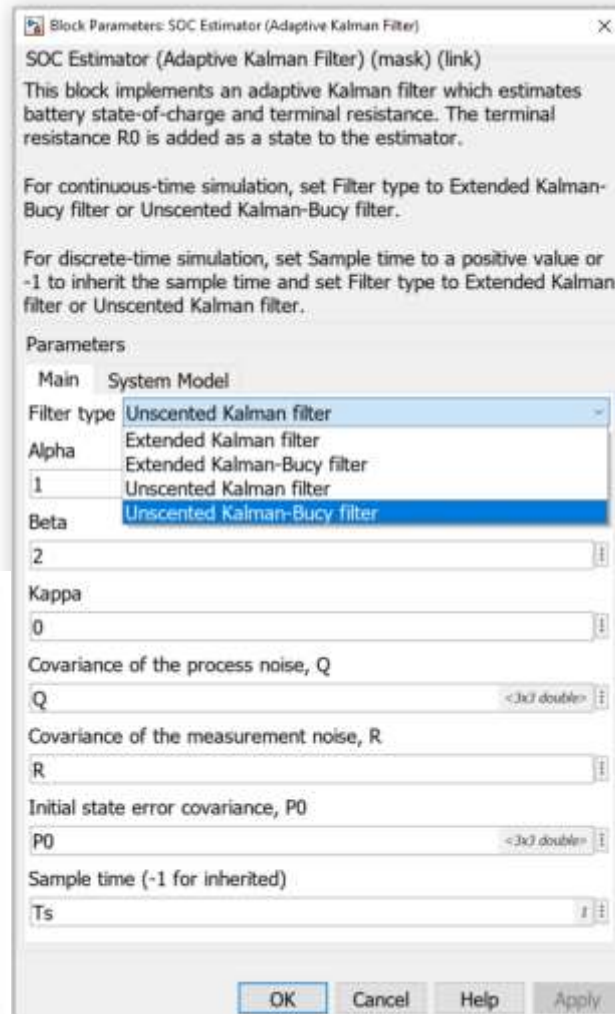
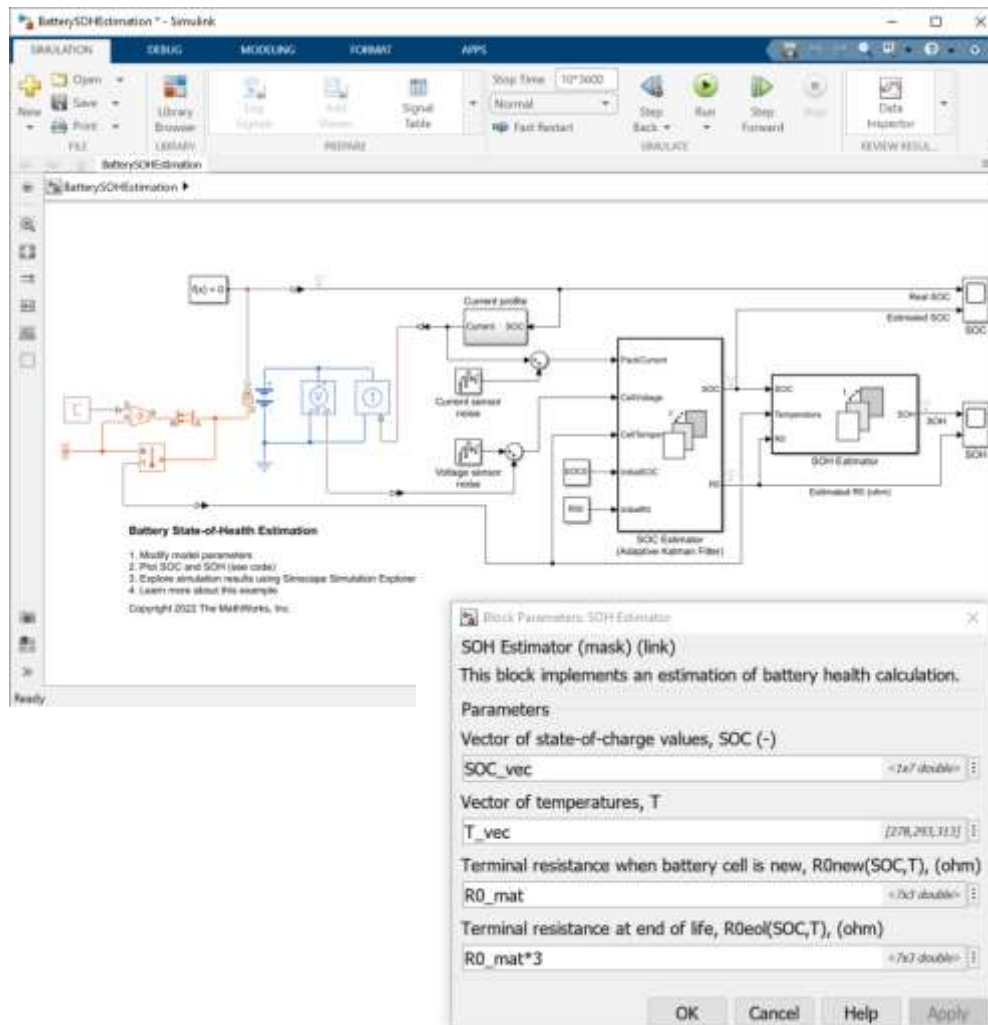
Battery Management

- Ideal charge/discharge components can be used to assess functional response of the battery pack prior to detailed control design.



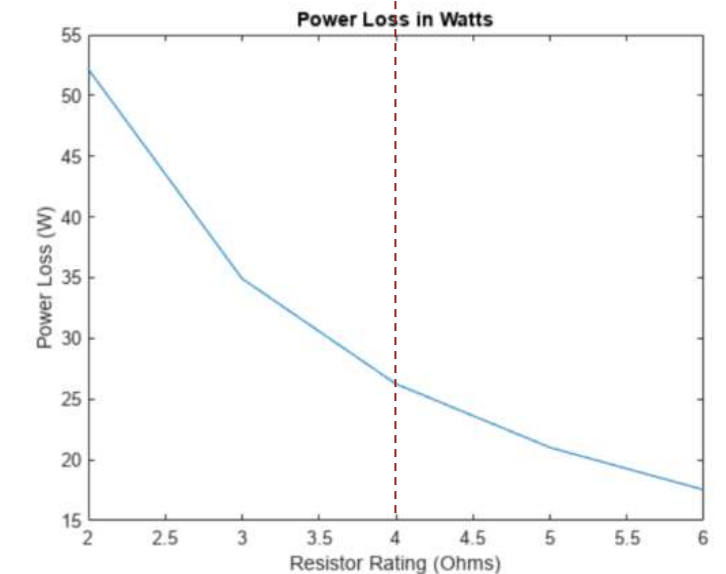
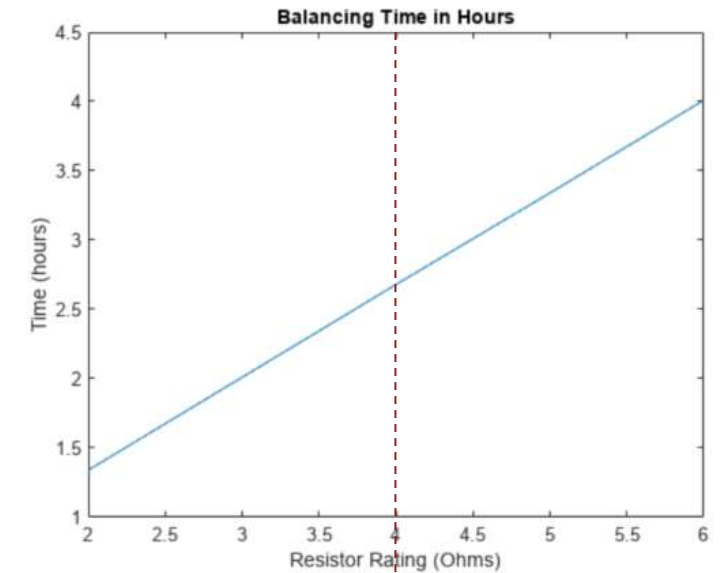
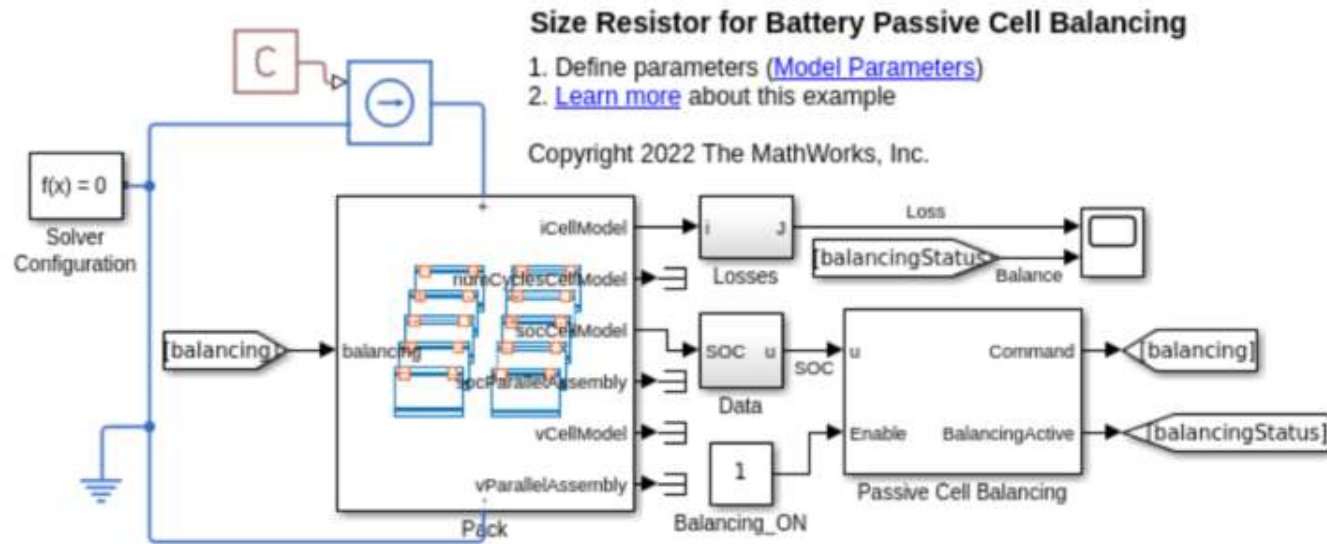
Battery Management

- A range of Kalman filters are available to estimate State-of-Charge (SOC), which can form an input to State-of-Health (SOH) estimation.



Battery Management

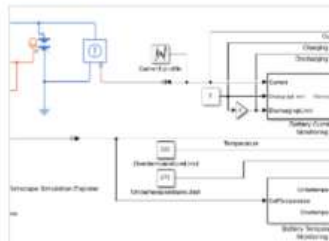
- Explore the design space by running multiple simulations programmatically.



Battery Management

Battery Management System – Examples

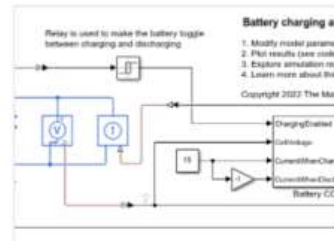
R2022b



Battery Monitoring

Use battery management system blocks to monitor the current and temperature of a battery. A random current and temperature profile is

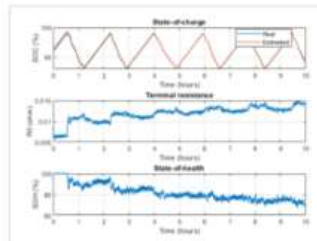
[Open Script](#)



Battery Charging and Discharging

Use a constant current and constant voltage algorithm to charge and discharge a battery. The Battery CC-CV block is charging and

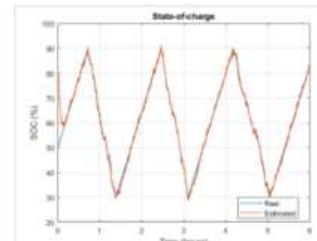
[Open Script](#)



Battery State-of-Health Estimation

Estimate the battery internal resistance and state-of-health (SOH) by using an adaptive Kalman filter. The initial state-of-charge (SOC) of

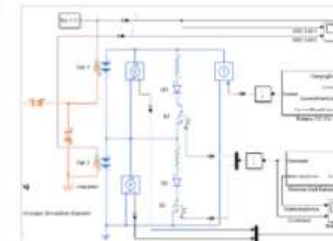
[Open Script](#)



Battery State-of-Charge Estimation

Estimate the battery state-of-charge (SOC) by using a Kalman filter. The initial SOC of the battery is equal to 0.5. The estimator uses an initial

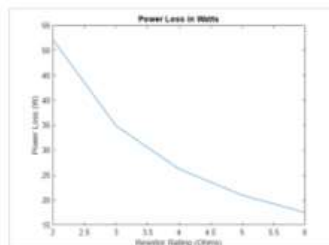
[Open Script](#)



Battery Passive Cell Balancing

Balance a battery with two cells connected in series by using a passive cell balancing algorithm. The initial state-of-charge (SOC) for

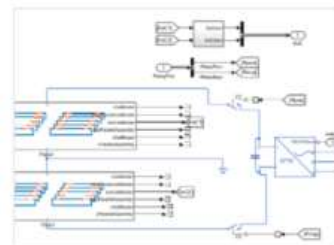
[Open Script](#)



Size Resistor for Battery Passive Cell Balancing

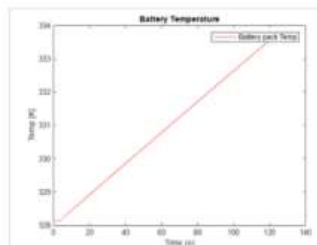
Implement a passive cell balancing for a lithium-ion battery pack. Cell-to-cell differences in the battery module create imbalances in the cell

[Open Live Script](#)



Peak Shaving with Battery Energy Storage System

[Open Live Script](#)



Protect Battery During Charge and Discharge for Electric Vehicle

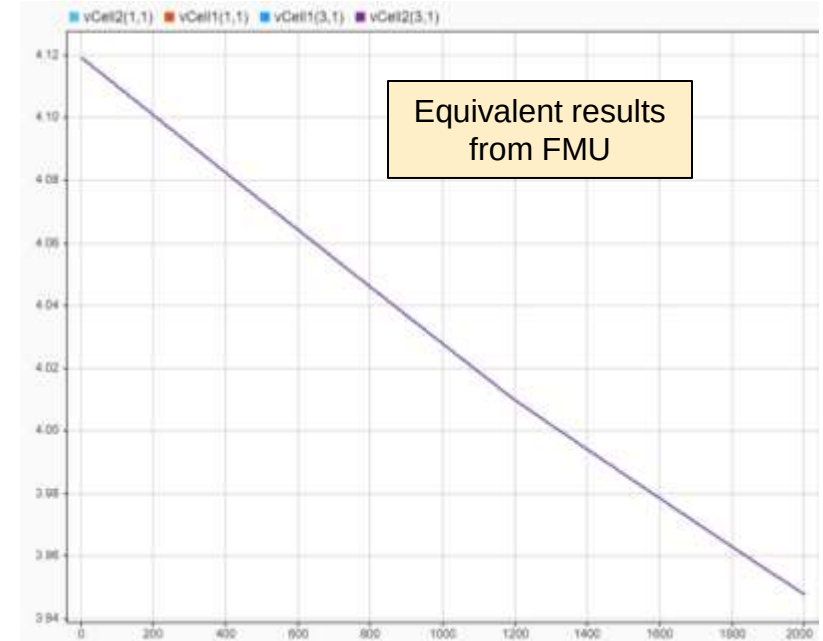
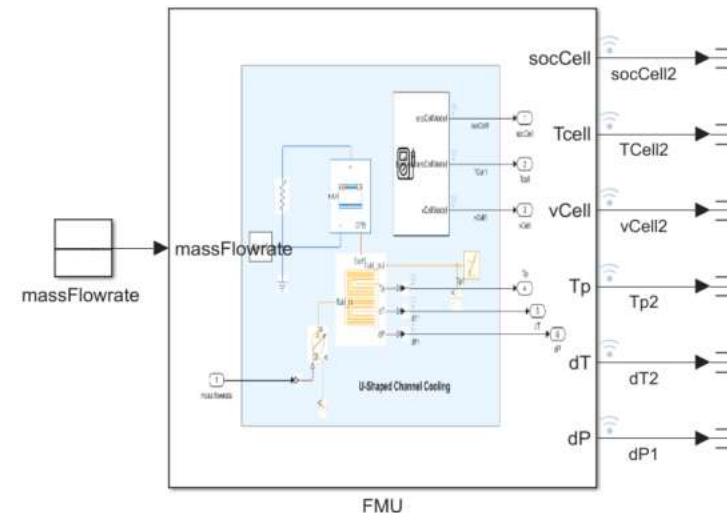
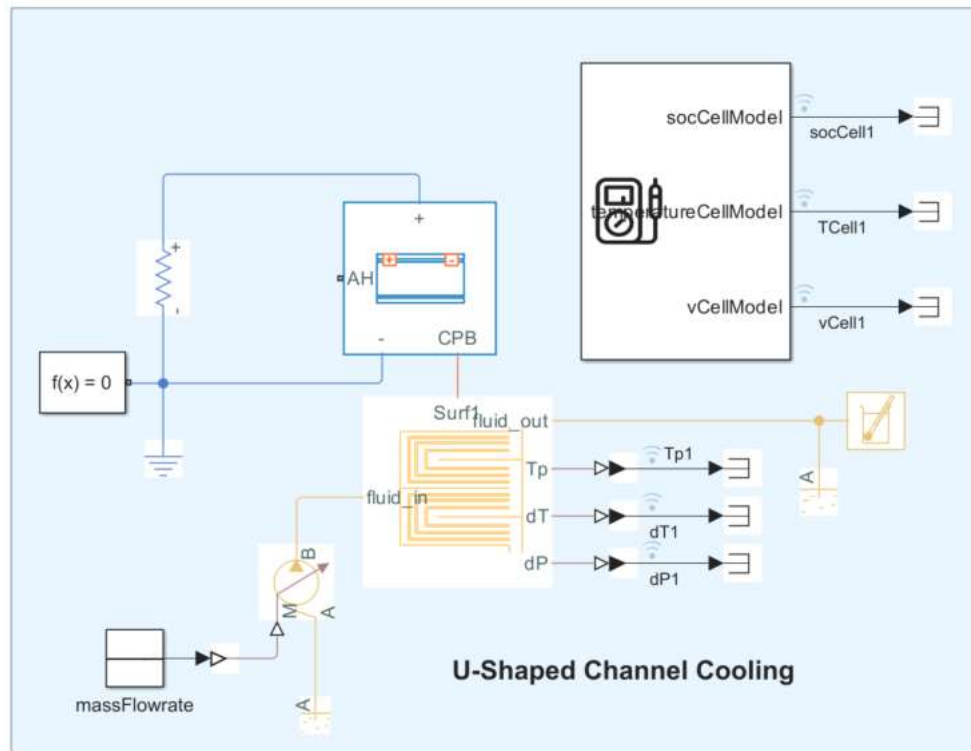
Efficiently charge and discharge a battery for an electric vehicle (EV) and handle battery faults. Portable electronics and EV widely use li-ion

[Open Live Script](#)

Deployment and Hardware-in-the-Loop (HIL)

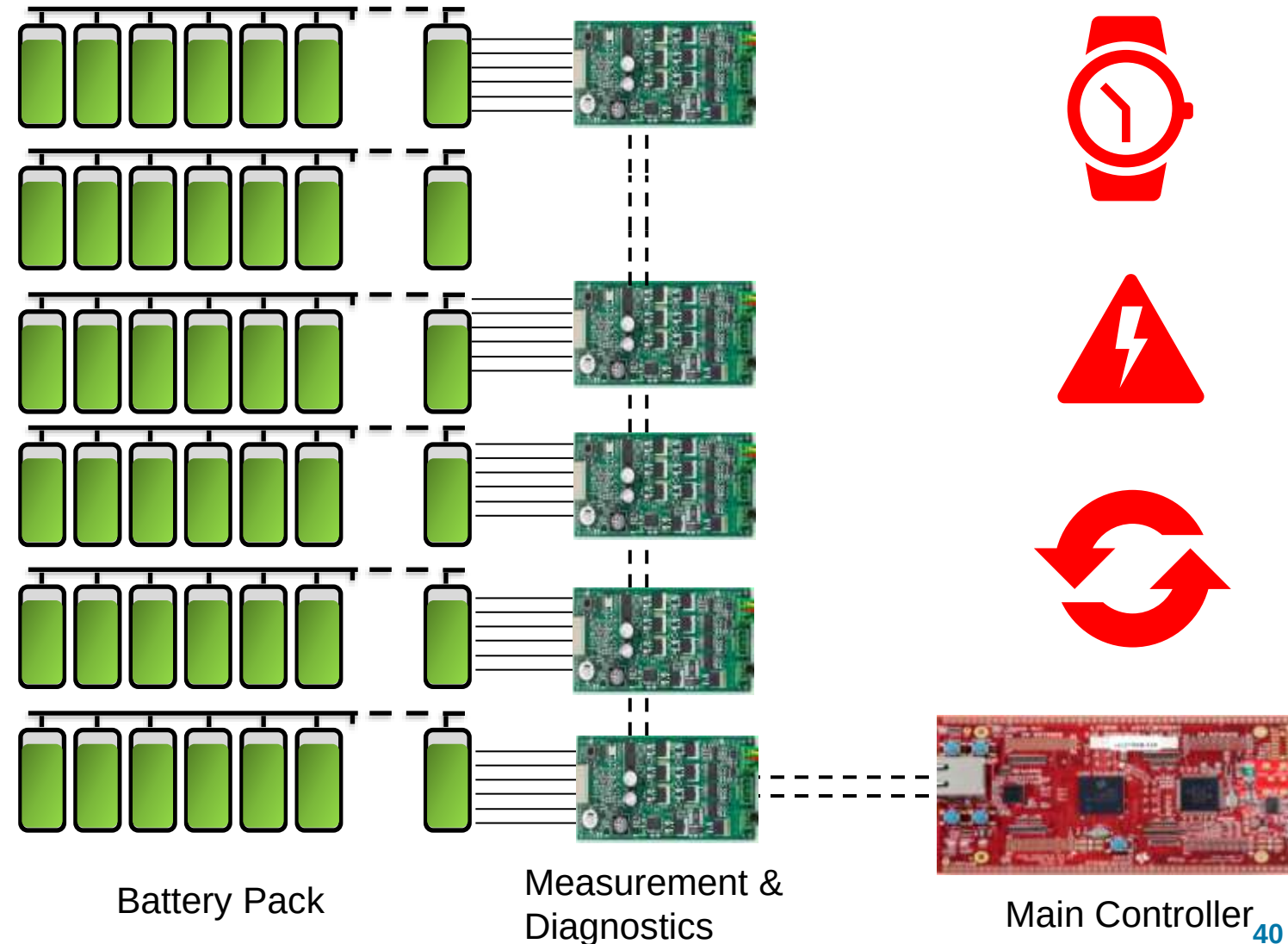
- BMS algorithms and Simscape Battery models are compatible with [Simulink Compiler](#), [Simulink Coder](#) and [Simulink Real-Time](#).
- BMS algorithms generate readable and efficient C/C++ code.

Example – Create an FMU from a Simscape Battery model



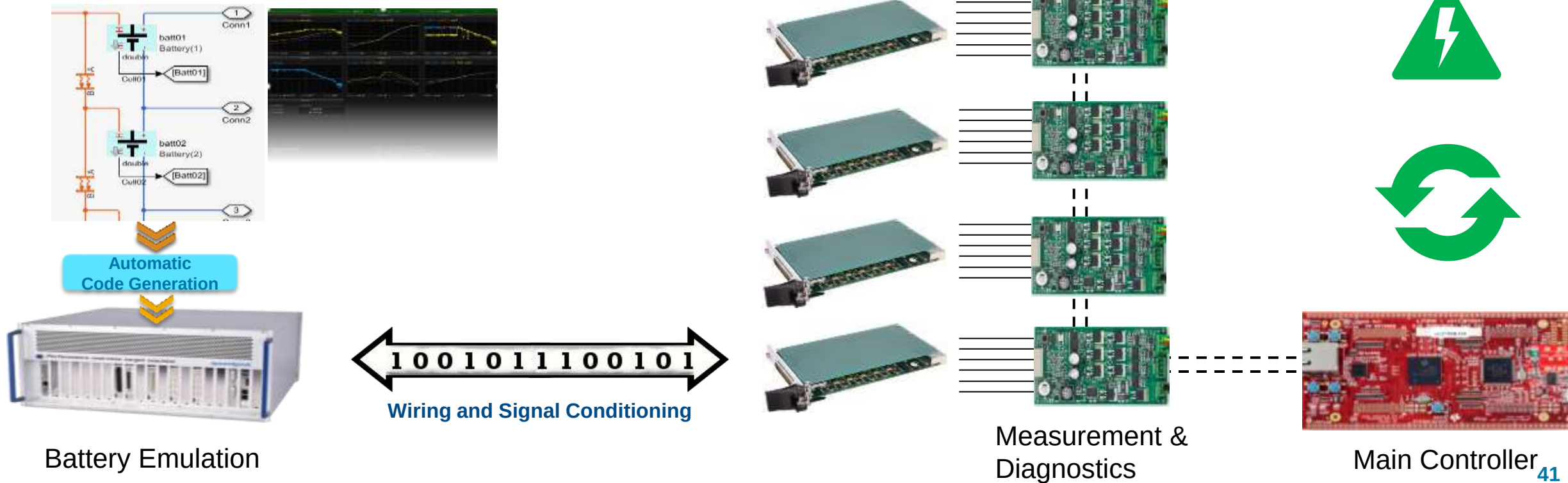
Real-Time Testing of Battery Management System

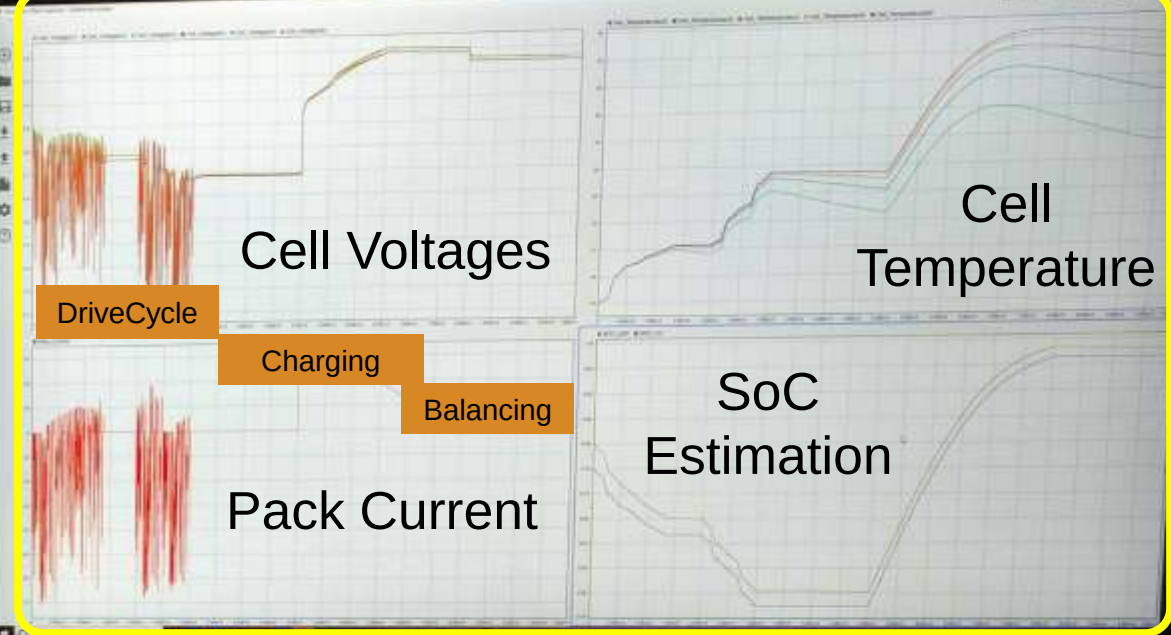
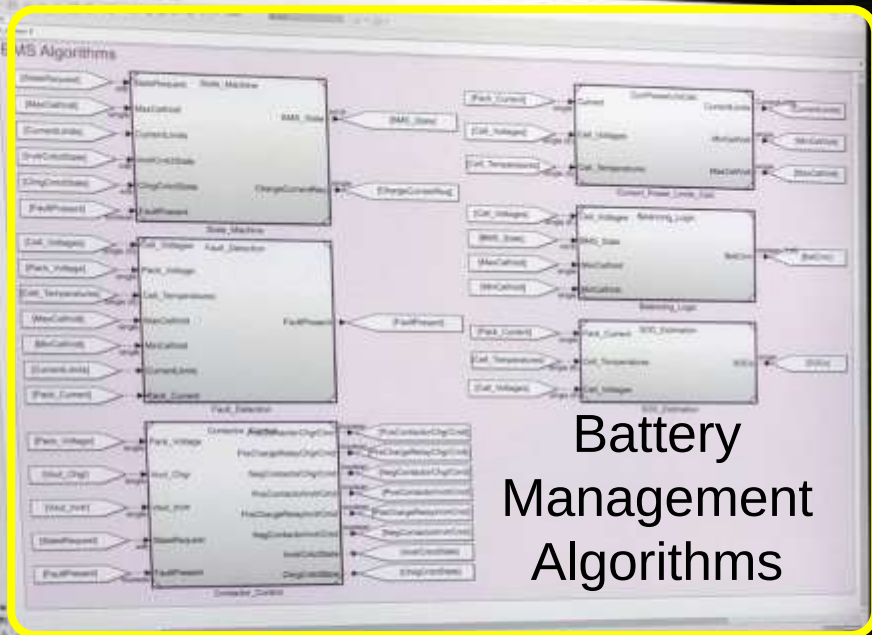
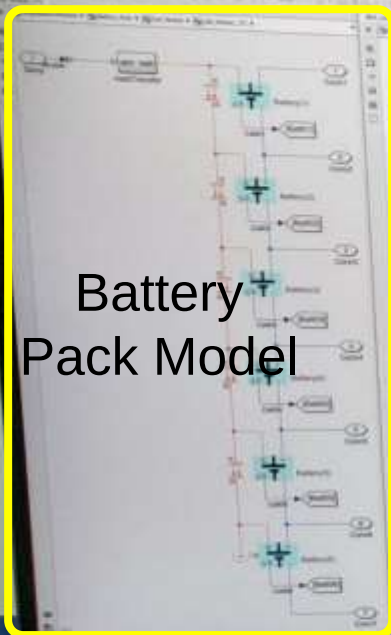
- Testing BMS with Battery Cells
 - Longer test cycles
 - Difficult to reproduce results
 - Difficult to test fault conditions
 - Limited test automation



Hardware-In-Loop Testing of Battery Management System

- Testing BMS with Emulated Battery Cells
 - Reduce testing time
 - Test fault conditions safely
 - Automate testing



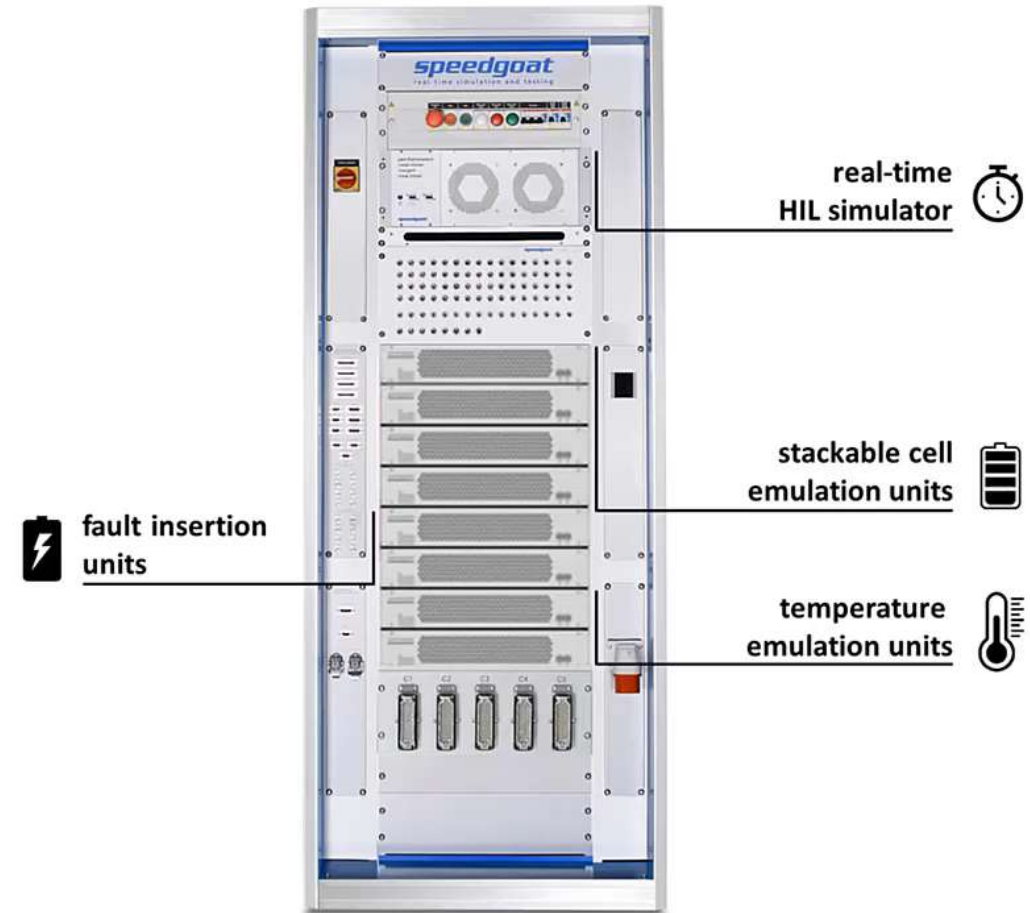


Simulink Host Computer



Speedgoat Target Computer with Battery Emulation Card – IO991-06

HIL Testing of Battery Management Systems



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Key Takeaways

- Simscape Battery provides a framework that is assembled specifically to create a bridge between cell and system.
- The bridge directly supports upskilling as well as design exploration and design rigor, meaning you can navigate the technology development cycle rapidly and with confidence.
 - Battery Pack Design, Electrical and Thermal Battery Pack Components, BMS Algorithms and Components, HIL and Deployment Support, Reference Tutorials and Examples
- Using the PDE Toolbox and Simscape battery, you can create a Reduced Order Model(ROM) of battery thermal behavior at the system level from FEA models.

On the Web

[Simscape Battery Essentials on MathWorks.com](#)


[Products](#)
[Solutions](#)
[Academia](#)
[Support](#)
[Community](#)
[Events](#)

Video and Webinar Series

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Simscape Battery Essentials

Simscape Battery™, a new product in the Simscape™ portfolio, has been developed to provide a technology development framework that is assembled specifically to create a bridge between cell and system. The bridge directly supports upskilling as well as design exploration and design rigor, meaning you can navigate the battery system technology development cycle rapidly and with confidence. The objective of this series is to provide engineers with a strong foundation for understanding and using the capabilities of Simscape Battery for both battery pack design and battery management system design. This series describes workflows that align with shipping examples and gives added insights where appropriate to enhance the learning experience.

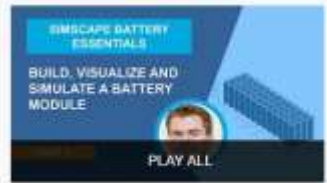


Part 1: Build, Visualize, and Simulate a Battery Module
Learn how to build, visualize, and simulate a battery module using Simscape Battery, a new product in the Simscape portfolio.



Part 2: Build and Parameterize a Battery Pack
Learn how to build and parameterize a battery pack using Simscape Battery, a new

[Simscape Battery Essentials on YouTube](#)



Simscape Battery Essentials

7 videos • No views • Updated today

Unlisted






Simscape Battery™, a new product in the Simscape™ portfolio, has been developed to provide a technology development framework that is assembled specifically to create a bridge between cell and system. The bridge directly supports upskilling as well as design exploration and design rigor, meaning you can navigate the battery system technology development cycle rapidly and with confidence. The objective of this series is to provide engineers with a strong foundation for understanding and using the capabilities of Simscape Battery for both battery pack design and battery management system design. This series describes workflows that align with shipping examples and gives added insights where appropriate to enhance the learning experience.

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Simscape Battery Essentials, Part 1: Build, Visualize, and Simulate a Battery Module
MATLAB 19:16
- 

Simscape Battery Essentials, Part 2: Build and Parameterize a Battery Pack
MATLAB 13:29
- 

Simscape Battery Essentials, Part 3: Configure a Battery Module with a Cooling Plate
MATLAB 14:18
- 

Simscape Battery Essentials, Part 4: Battery Passive Cell Balancing
MATLAB 8:13
- 

Simscape Battery Essentials, Part 5: Battery State-of-Charge Estimation
MATLAB 10:30
- 

Simscape Battery Essentials, Part 6: Battery Charging and Discharging
MATLAB 10:42
- 

Simscape Battery Essentials, Part 7: Thermal Analysis of New and Aged Battery Packs
MATLAB 7:26

On the Web

AI 기법을 사용한 전기 기술



전기 기술의 개발 및 운영에 AI(인공 지능) 기법을 적용할 수 있습니다.

전기 기술의 개발 공정에 AI를 통합할 수 있는 단일 환경에 대해 알아볼 수 있습니다. 엔지니어들이 어떻게 MATLAB®, Simulink®, Simscape™를 사용해 다음과 같은 작업을 수행하는지 알아볼 수 있습니다.

- ✓ AI 모델을 훈련시키기 위해 물리 기반 시뮬레이션으로부터 합성 데이터 생성.
- ✓ AI 기반 ROM(차수 축소 모델)을 생성하여 설계 공정 가속화 및 시뮬레이션 속도 향상
- ✓ 모터, 배터리, 전력 컨버터, 에너지 관리 시스템, 전기차 및 전력망 시스템의 AI 기반 제어 전략 구축, 훈련 및 테스트
- ✓ AI 기반 에너지 예측을 통합하고 AI 기반 예측 정비를 도입하여 전력 시스템 운영의 안전성 및 효율성 보장
- ✓ AI 알고리즘을 임베디드 기기 또는 엔터프라이즈 시스템과 클라우드 플랫폼에 배포

자세히 알아보기

- MATLAB을 사용한 딥러닝 - 개요
- MATLAB을 사용한 머신러닝 - 개요
- MATLAB 및 Simulink를 사용한 예측 정비 - 개요

HIL Testing of Battery Management Systems



Battery-driven electric powertrains are gaining importance in various industries. Electric cars, electric aircraft, e-bikes, and automated guided vehicles all rely on battery packs. As battery packs require battery management systems to operate safely

"Speedgoat together with MathW efficient workflow to design, test a

Questions?





전력전자학술대회 - MathWorks 산업기술세션

MathWorks Korea 온라인 설문조사

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