

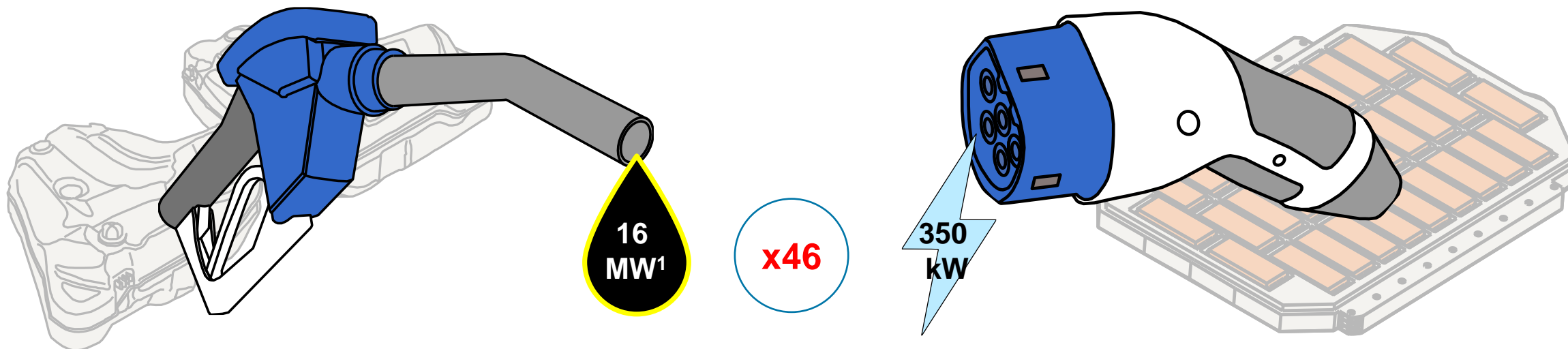
2024 MathWorks
中国汽车年会

快速充电探索: 从电芯到电池组的仿真 Simscape Battery 新功能

杨兴, MathWorks



为什么提及电池快充 和燃油车对比

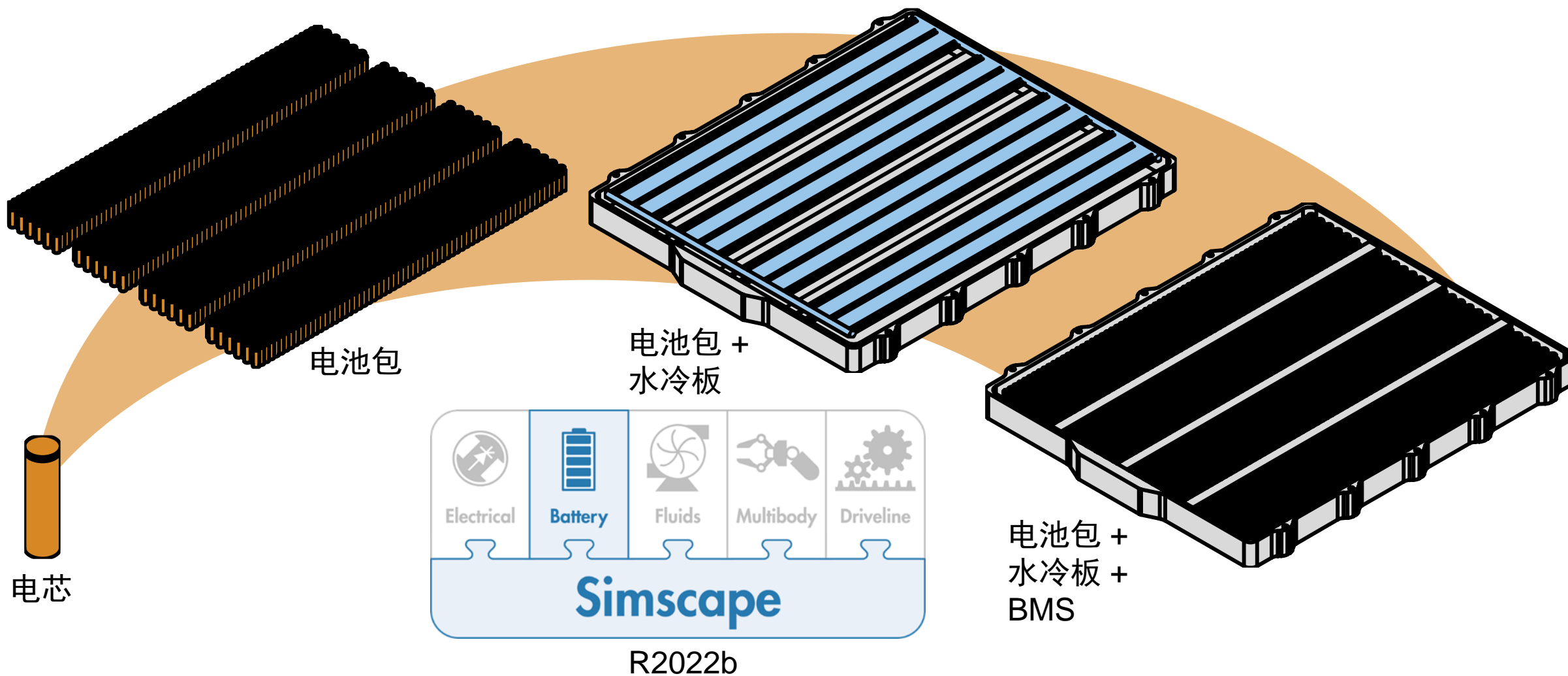


- 电池快充任务经常需要对电芯特性行为有更深入的研究
- 不合适的电池快充策略会加速电芯老化
- 需要有恰当的**温度和电流控制**
- 这个复杂领域的探讨，离不开**仿真模型**

¹M. Sterner, I. Stadler, "Energiespeicher: Bedarf, Technologien, Integration", 2014

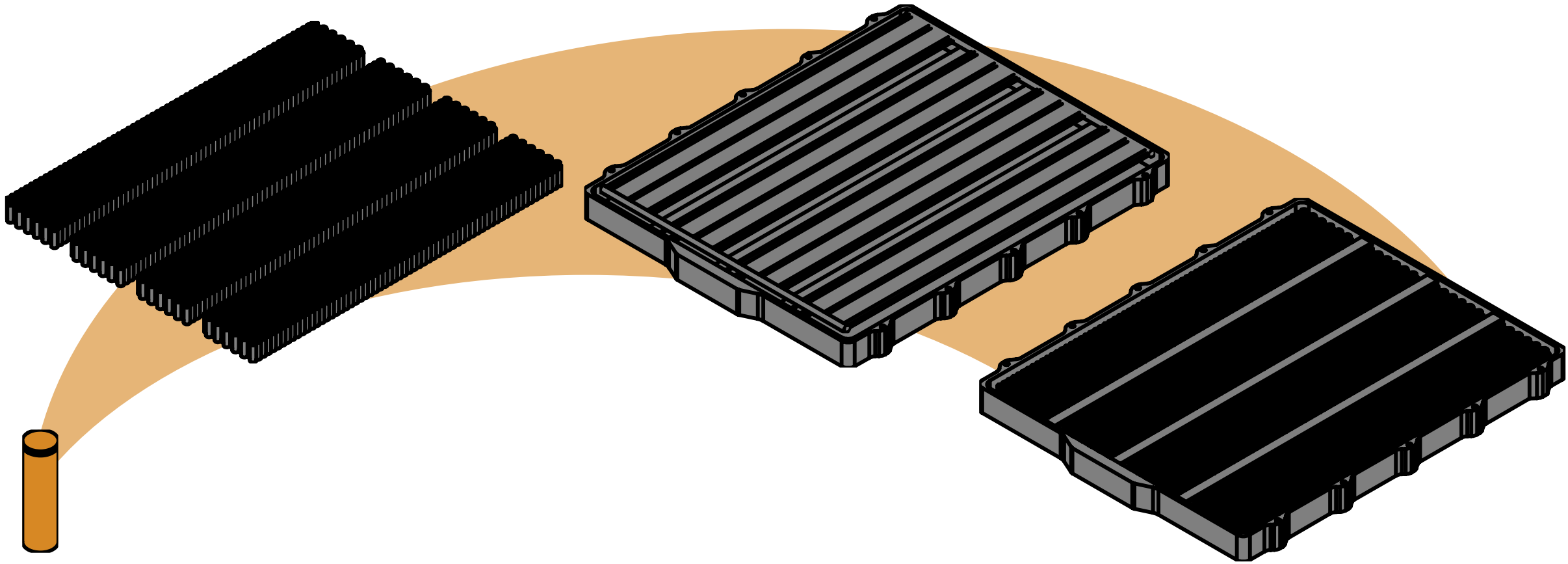
今日大纲

Simscape Battery 新功能



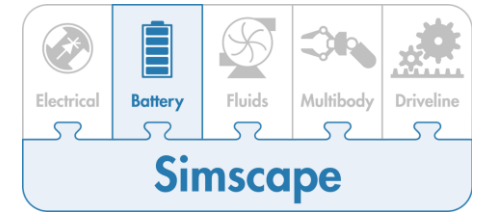
电芯模型

特性与新功能

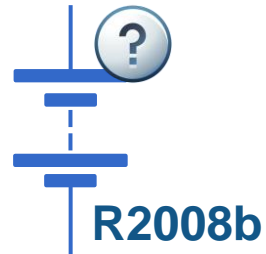


现有的电芯模型

根据需要选择合适的模型



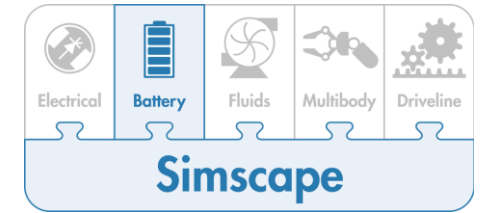
Battery Equivalent Circuit Block



模拟对象	Battery	Battery (Table-Based)	Battery Equivalent Circuit
Can be used to build packs (Battery Builder or API)	No	Yes	Yes
Electrical parameters (R_0 , R_1 , C_1 ...)	Constants	SOC/T dependent	SOC/T dependent
Maximum Number of RC blocks	5	5	3
Hysteresis Model	No	No	Yes
Reversible heat Model	No	No	Yes
Fade and Calendar Aging	No	Yes	Yes
Possibility to Inject Faults	No	No	Yes

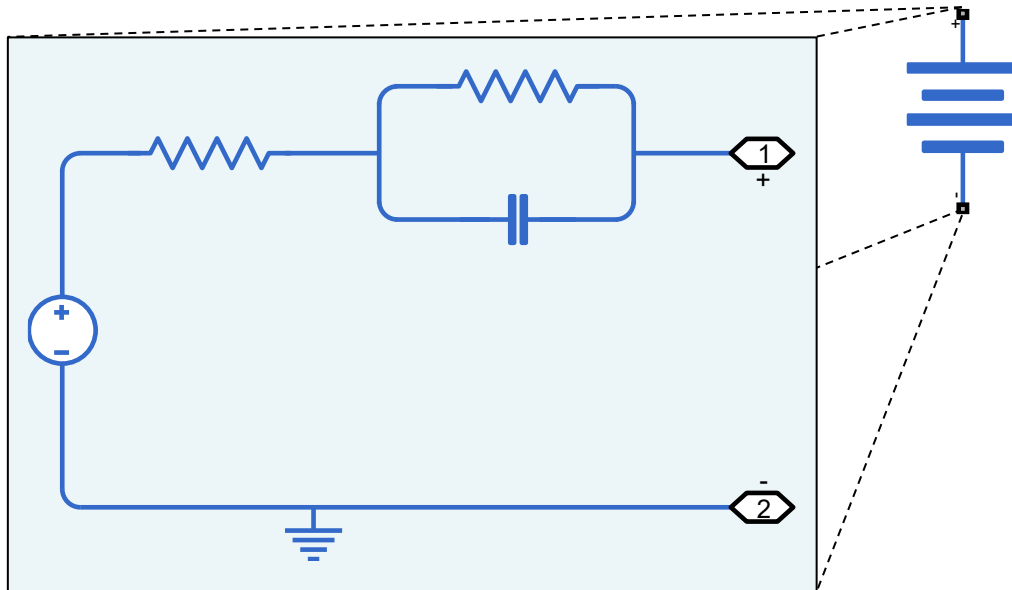
新电化学电芯模型

根据需要选择合适的模型



经验模型

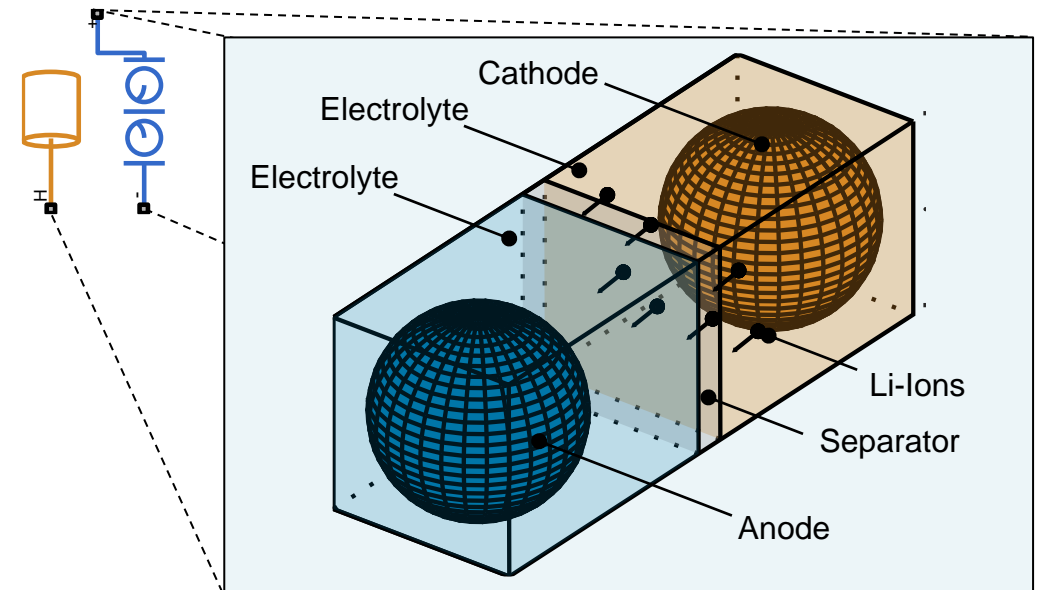
- [Equivalent Circuit Model \(ECM\)](#)
- 实现简单且容易理解
- 表达的特性有限



电化学模型

R2024a

- [Single Particle Model \(SPM\)](#)
- 精度提高以及合适的复杂度
- 需要详细的参数

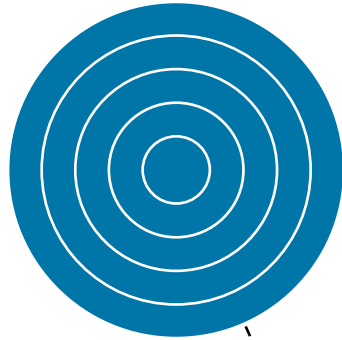


单粒子模型 Single Particle Model

基本假设

Anode Particle

$$D_a \frac{\partial c_a}{\partial r}(R_a, t) = \frac{J_a}{a_a F}$$

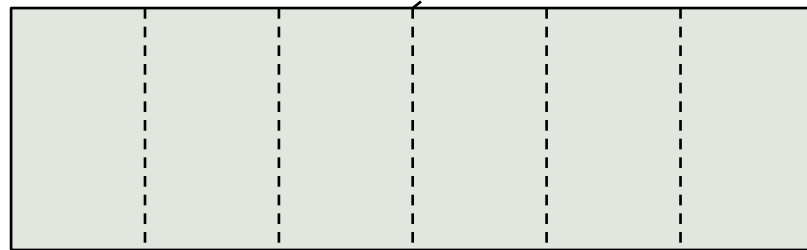
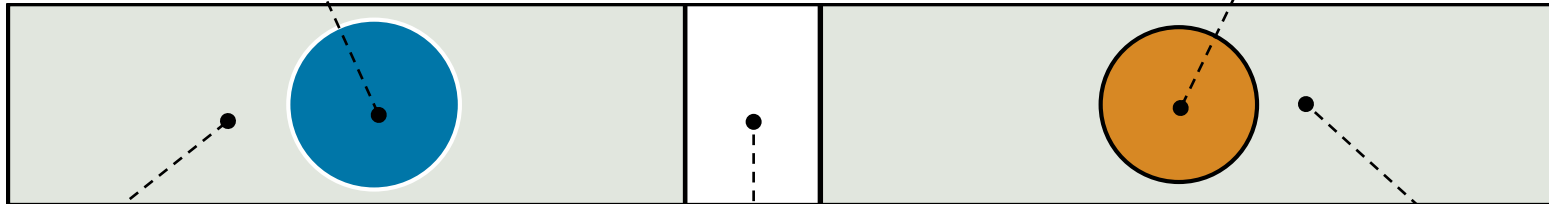
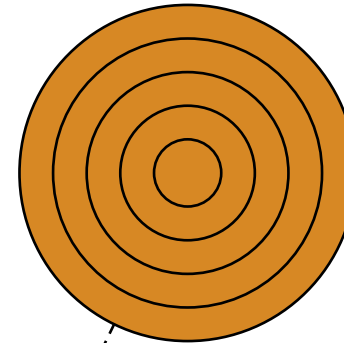


Charge Transfer

$$J_{a/c} = j_0 \left(e^{\frac{\alpha n_e F}{RT} \eta} - e^{-\frac{(1-\alpha) n_e F}{RT} \eta} \right)$$

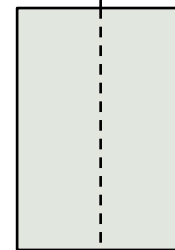
Cathode Particle

$$D_c \frac{\partial c_c}{\partial r}(R_c, t) = \frac{J_c}{a_c F}$$



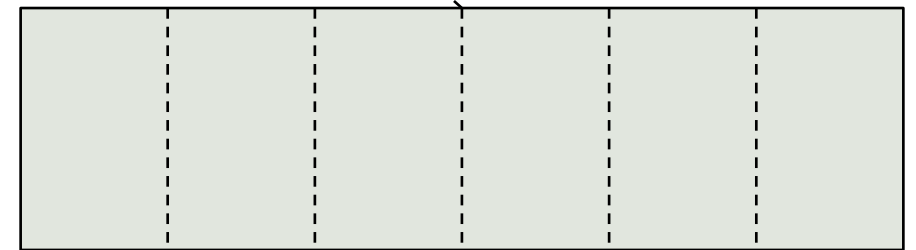
Electrolyte Anode Side

$$\varepsilon_a \frac{\partial c_e}{\partial t}(x, t) = \frac{\partial}{\partial x} \left(D_e \frac{\partial c_e}{\partial x}(x, t) - \frac{J_a(1-t_0^+)}{F} \right)$$



Separator

$$\frac{\partial c_e}{\partial t}(x, t) = \frac{\partial}{\partial x} \left(D_e \frac{\partial c_e}{\partial x}(x, t) \right)$$



Electrolyte Cathode Side

$$\varepsilon_c \frac{\partial c_e}{\partial t}(x, t) = \frac{\partial}{\partial x} \left(D_e \frac{\partial c_e}{\partial x}(x, t) + \frac{J_c(1-t_0^+)}{F} \right)$$

单粒子模型 Single Particle Model

模块参数化

电极/隔膜/电解质区域的几何尺寸以及离散化设置

电极材料属性, 比如扩散率、电导率、活性材料体积分数等等

电解质属性, 比如体积分数、电导、扩散率, 迁移数等等

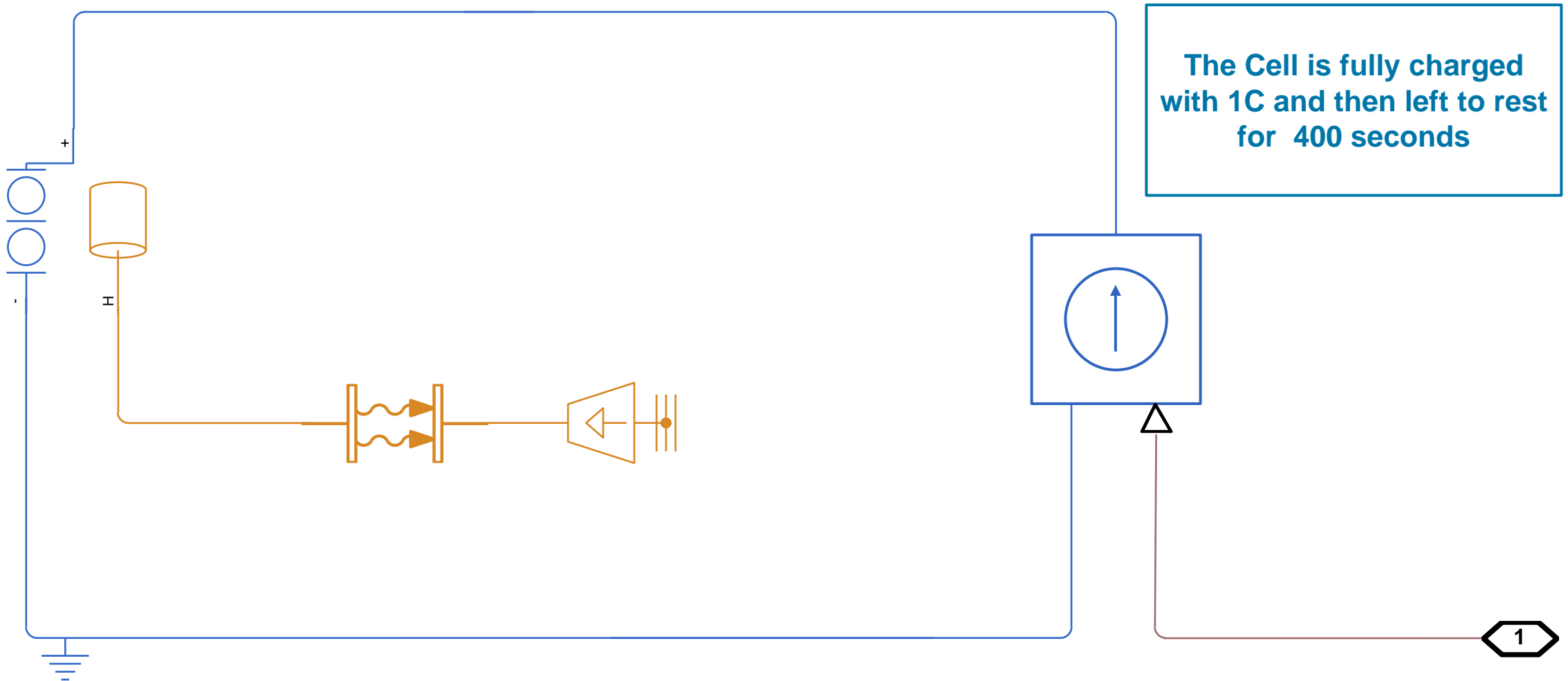
电极电荷转移常数

热质以及材料活化能

NAME	VALUE
> Main	
> Geometry	
> Electrodes properties	
> Electrolyte properties	
> Reaction kinetics	
> Thermal	
> Initial Targets	
> Nominal Values	

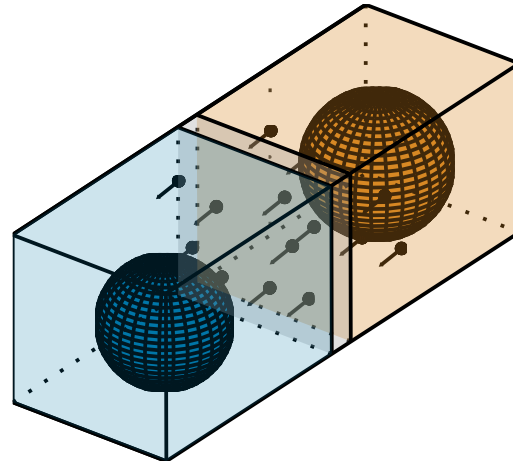
单个充电周期

SPM 模型



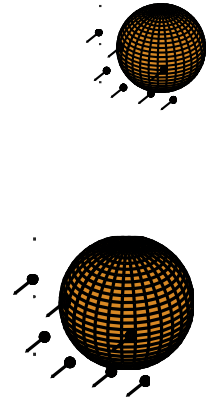
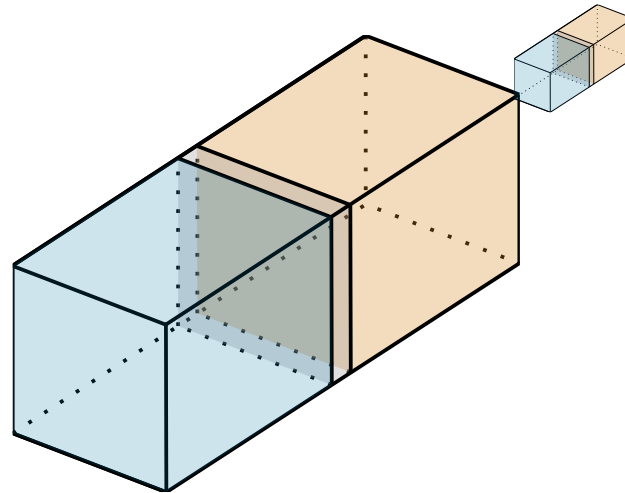
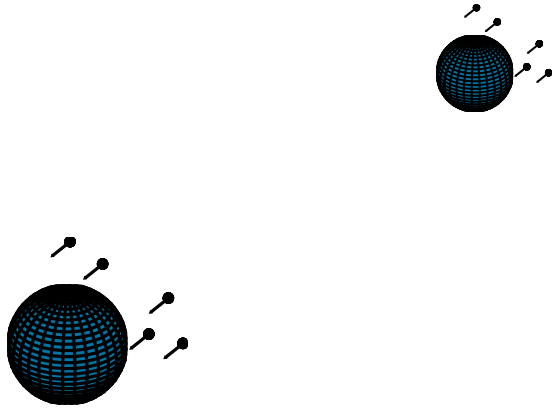
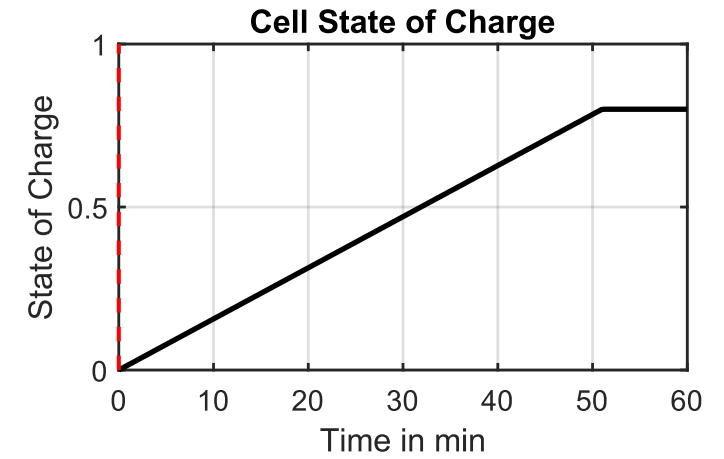
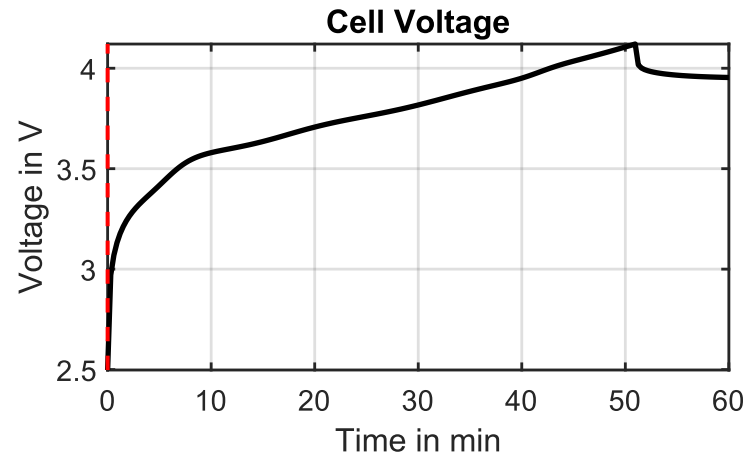
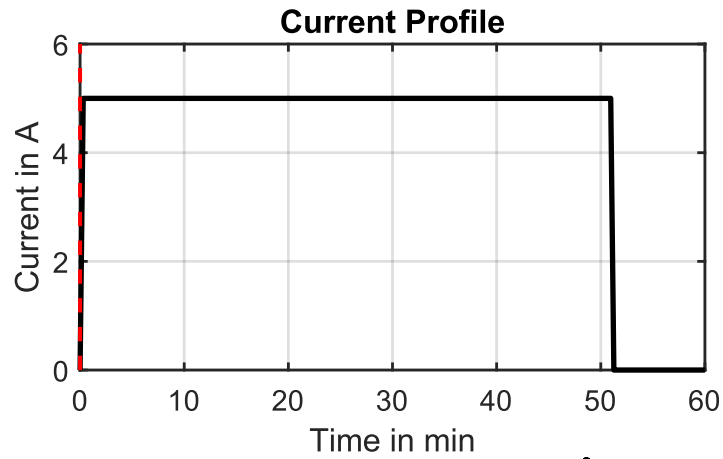
Simscape Battery 的电化学模型

充电过程 (from 0% to 80% SOC)



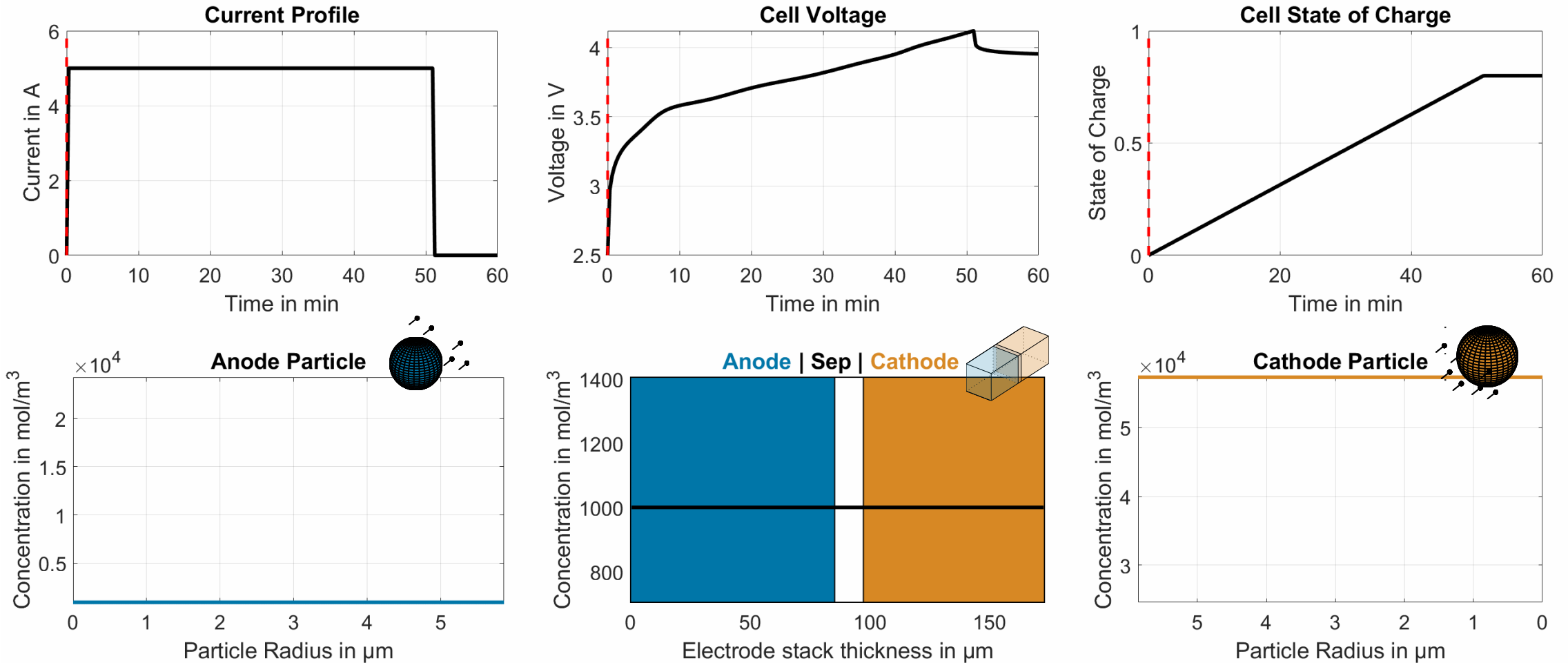
Simscape Battery 的电化学模型

充电过程 (from 0% to 80% SOC)



Simscape Battery 的电化学模型

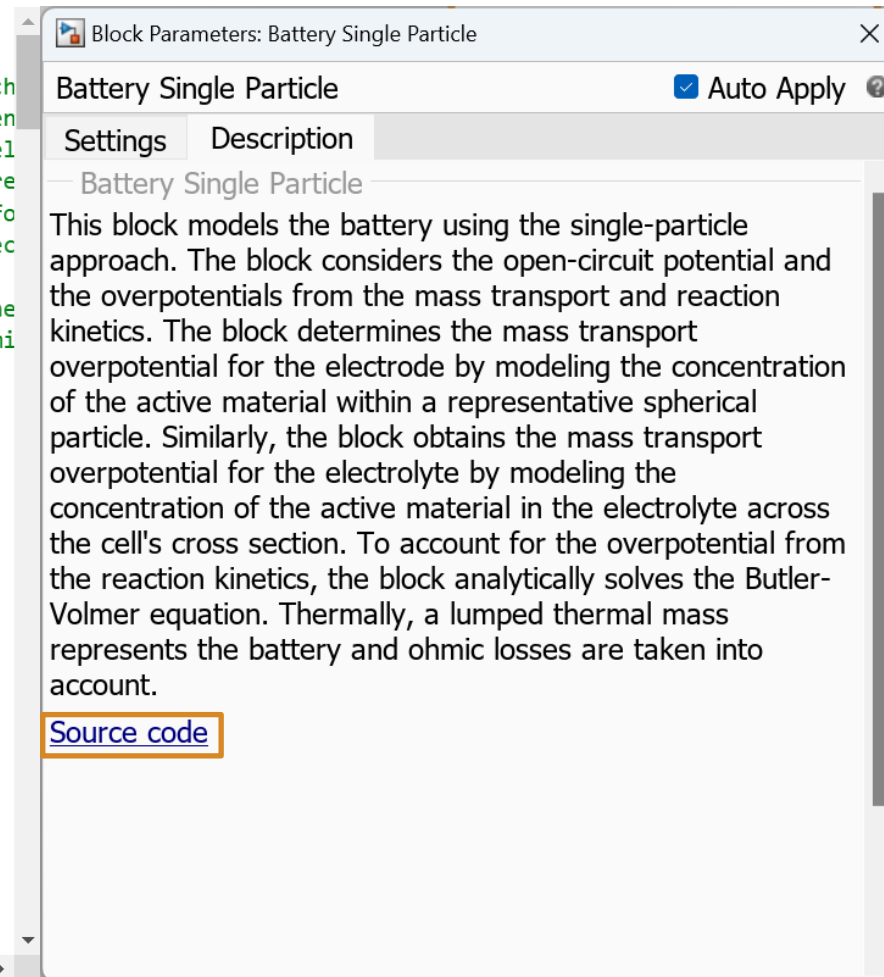
充电过程 (from 0% to 80% SOC)



SPM 模型开源

基于现有的模型基础框架轻松修改

```
1 component batterySingleParticle
2     % Battery Single Particle
3     % This block models the battery using the single-particle approach
4     % The block considers the open-circuit potential and the overpoten
5     % The block determines the mass transport overpotential for the el
6     % by modeling the concentration of the active material within a re
7     % Similarly, the block obtains the mass transport overpotential fo
8     % by modeling the concentration of the active material in the elec
9     % across the cell's cross section.
10    % To account for the overpotential from the reaction kinetics, the
11    % Thermally, a lumped thermal mass represents the battery and ohmi
12
13    % Copyright 2023 The MathWorks, Inc.
14
15
16    nodes
17        p = foundation.electrical.electrical;
18        n = foundation.electrical.electrical;
19        H = foundation.thermal.thermal;
20    end
21
22    parameters
23        % Main
24        ExtrapolationMethod = simscape.enum.extrapolation.nearest;
25
26        % Geometry
27        ThicknessAnode = {3.4E-5,"m"};
28        ElectrolyteLayerCountAnode = 10;
29        ThicknessSeparator = {2.5E-5,"m"};
30        ElectrolyteLayerCountSeparator = 5;
```



Block Parameters: Battery Single Particle

Battery Single Particle Auto Apply

Settings Description

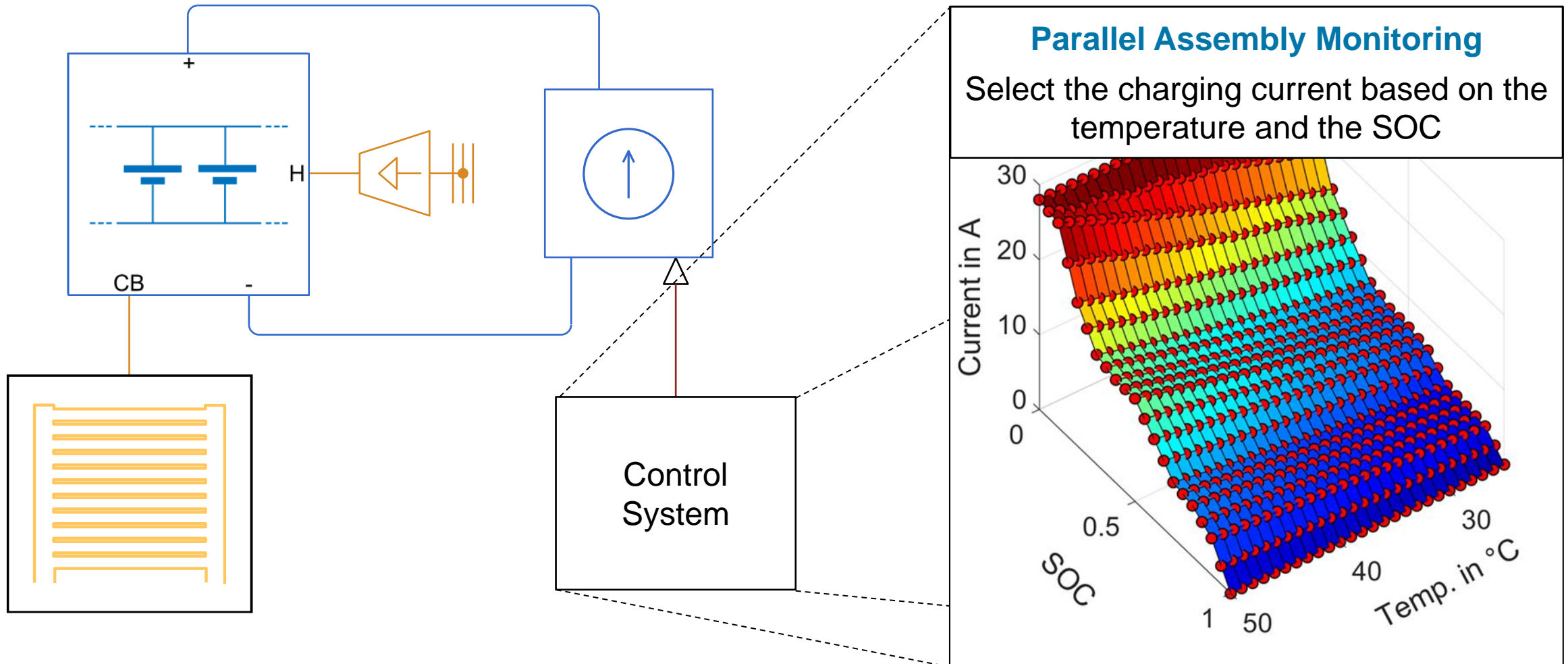
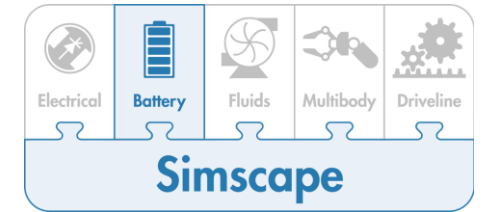
Battery Single Particle

This block models the battery using the single-particle approach. The block considers the open-circuit potential and the overpotentials from the mass transport and reaction kinetics. The block determines the mass transport overpotential for the electrode by modeling the concentration of the active material within a representative spherical particle. Similarly, the block obtains the mass transport overpotential for the electrolyte by modeling the concentration of the active material in the electrolyte across the cell's cross section. To account for the overpotential from the reaction kinetics, the block analytically solves the Butler-Volmer equation. Thermally, a lumped thermal mass represents the battery and ohmic losses are taken into account.

[Source code](#)

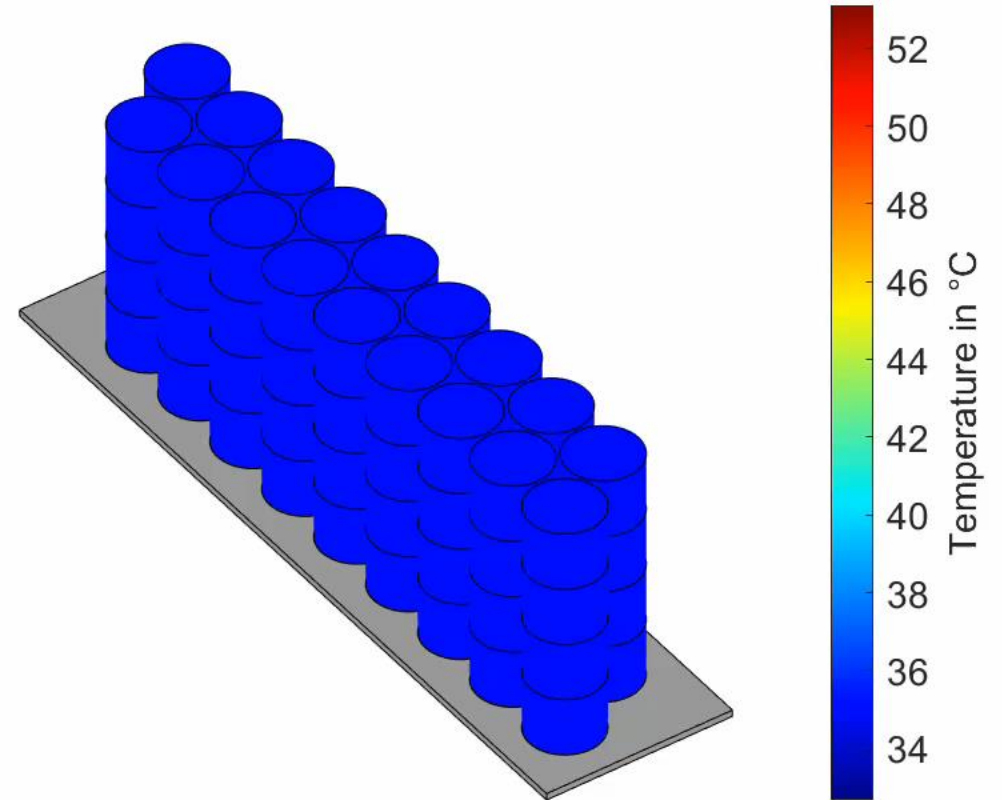
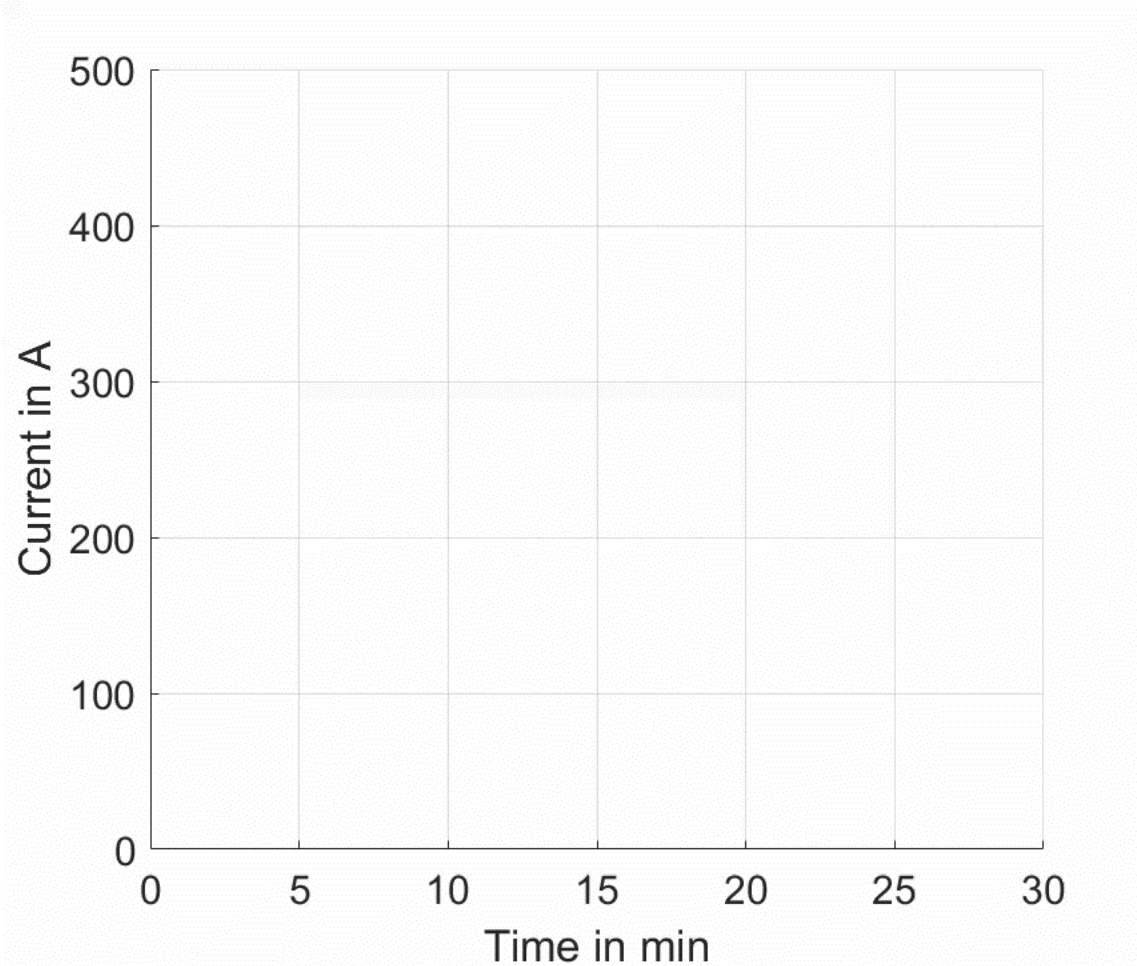
从电芯到并联组

并联组快充



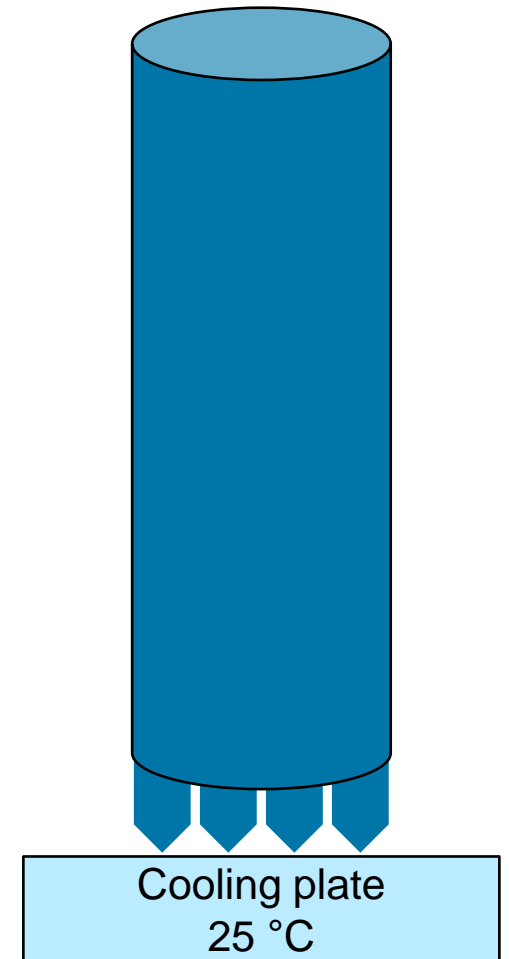
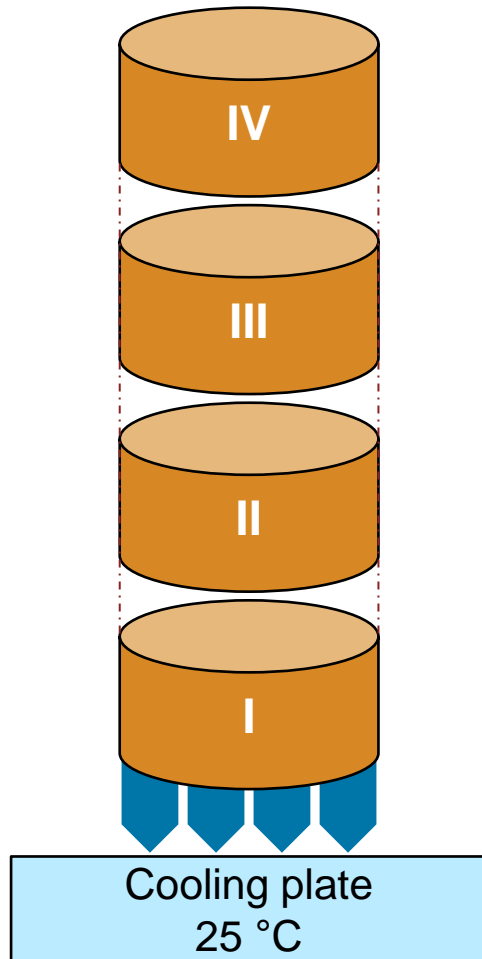
从电芯到并联组

并联组快充



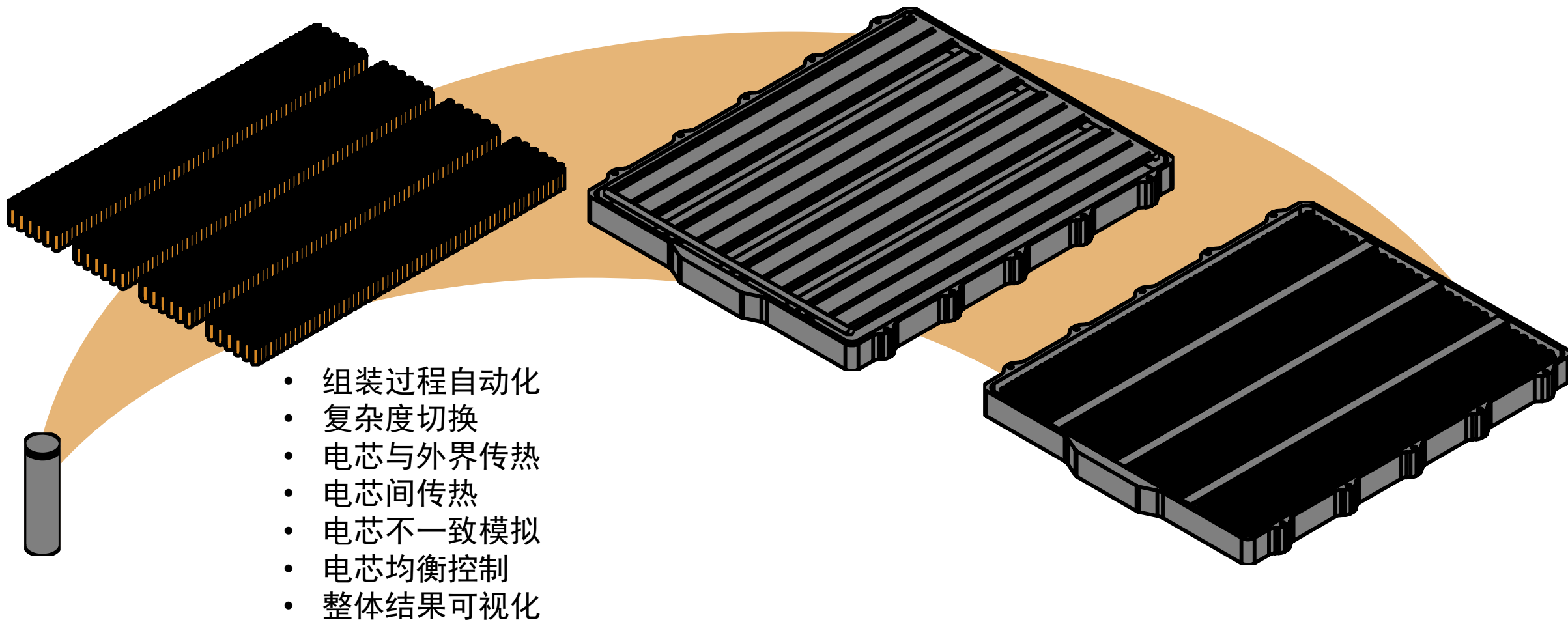
热模型空间离散化

能获得的电芯充放电温度数据对比

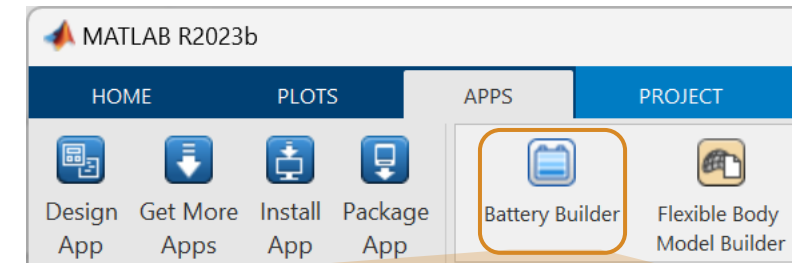


模组以及电池包建模

特性与新功能



基于 MATLAB 脚本的构造函数简单易用... 以及 Battery Builder App



```

EDITOR PUBLISH VIEW
+ New Open Save Compare
FILE NAVIGATE CODE ANALYZE SECTION Run Step Stop
1 % Import the battery builder
2 import Simscape.Battery.Builder.*
3
4 % Create the cell
5 cell = Cell(Geometry = CylindricalGeometry);
6
7 % Create the parallel assembly
8 pAsmb = ParallelAssembly(Cell=cell,...
9     NumParallelCells=48,...
10    Topology="Hexagonal",...
11    Rows =4);
12
13 % Create the module
14 mAsmb = Module(ParallelAssembly=pAssembly,...
15    NumSeriesAssemblies=4,...
16    StackingAxis="Y");
17
18 % Create battery chart
19 BatteryChart(Battery = mAssembly)

```

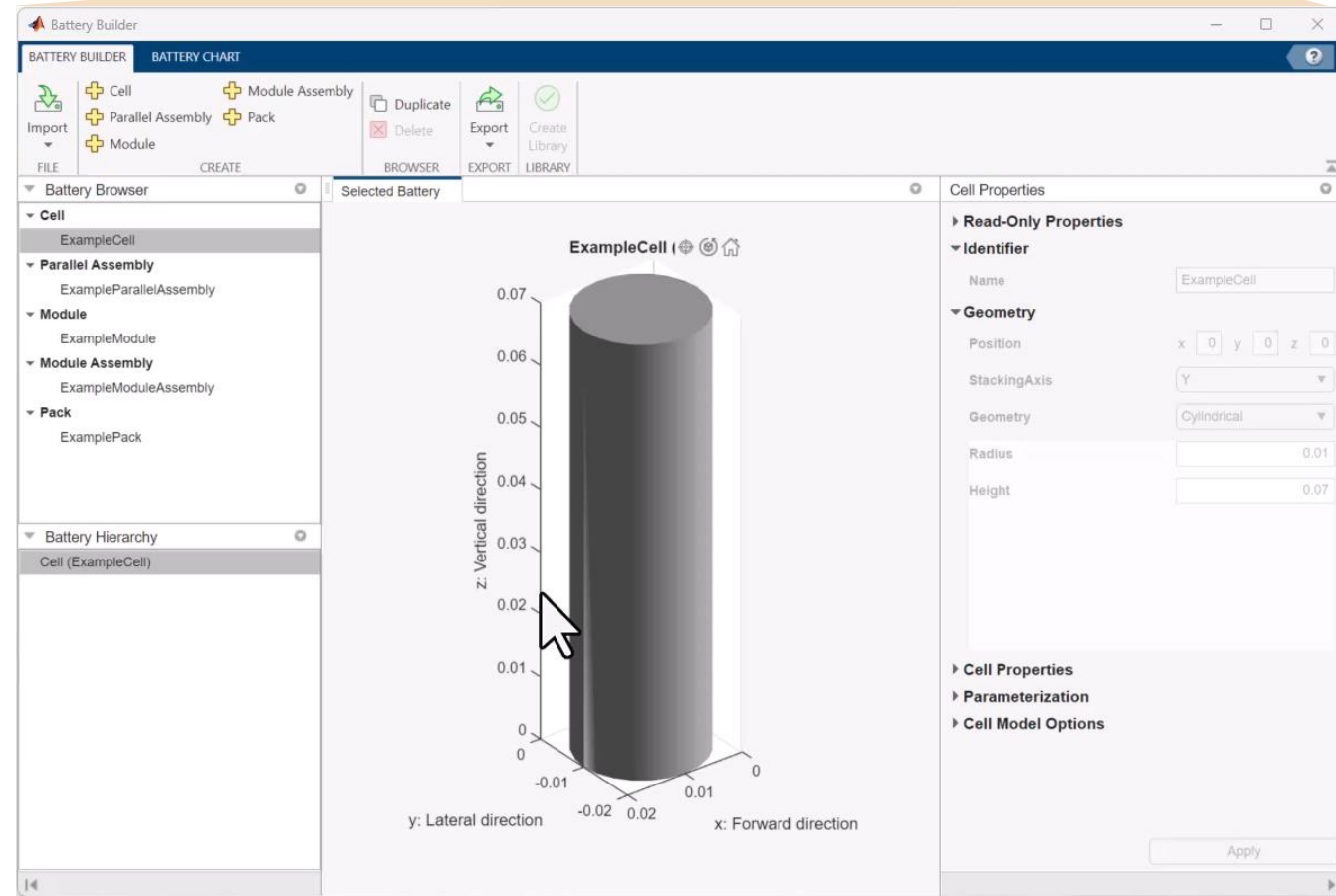
R2023b

```

EDITOR PUBLISH VIEW
+ New Open Save Compare
FILE NAVIGATE CODE ANALYZE SECTION Run Step Stop
1 % Create the cell
2 cell = batteryCell(batteryCylindricalGeometry);
3
4 % Create parallel assembly
5 pAsmb = batteryParallelAssembly(cell,48,...
6     Topology="Hexagonal",...
7     Rows=4);
8
9 % Create the module
10 mAsmb = batteryModule(pAssembly,4,StackingAxis="Y");
11
12 % Plot the Battery Chart
13 batteryChart(mAssembly)

```

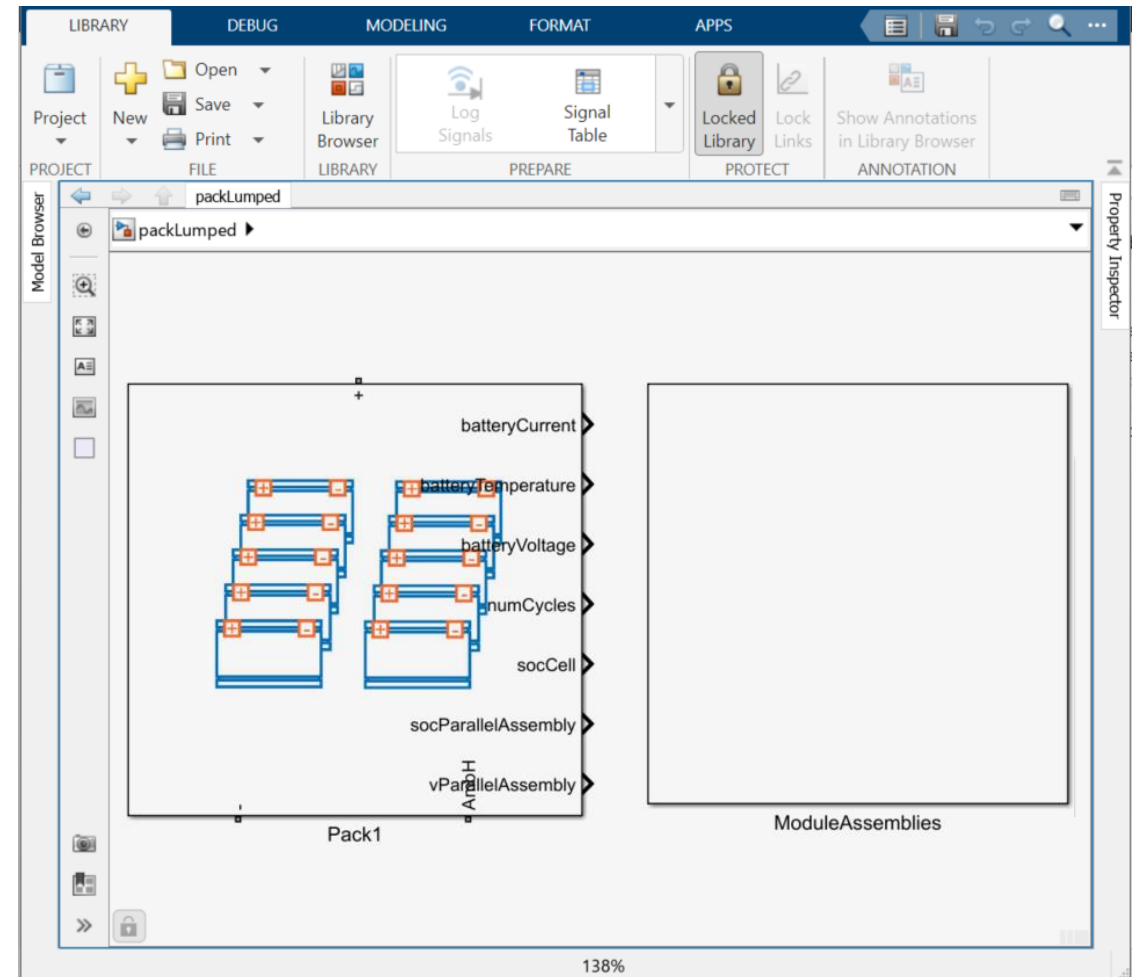
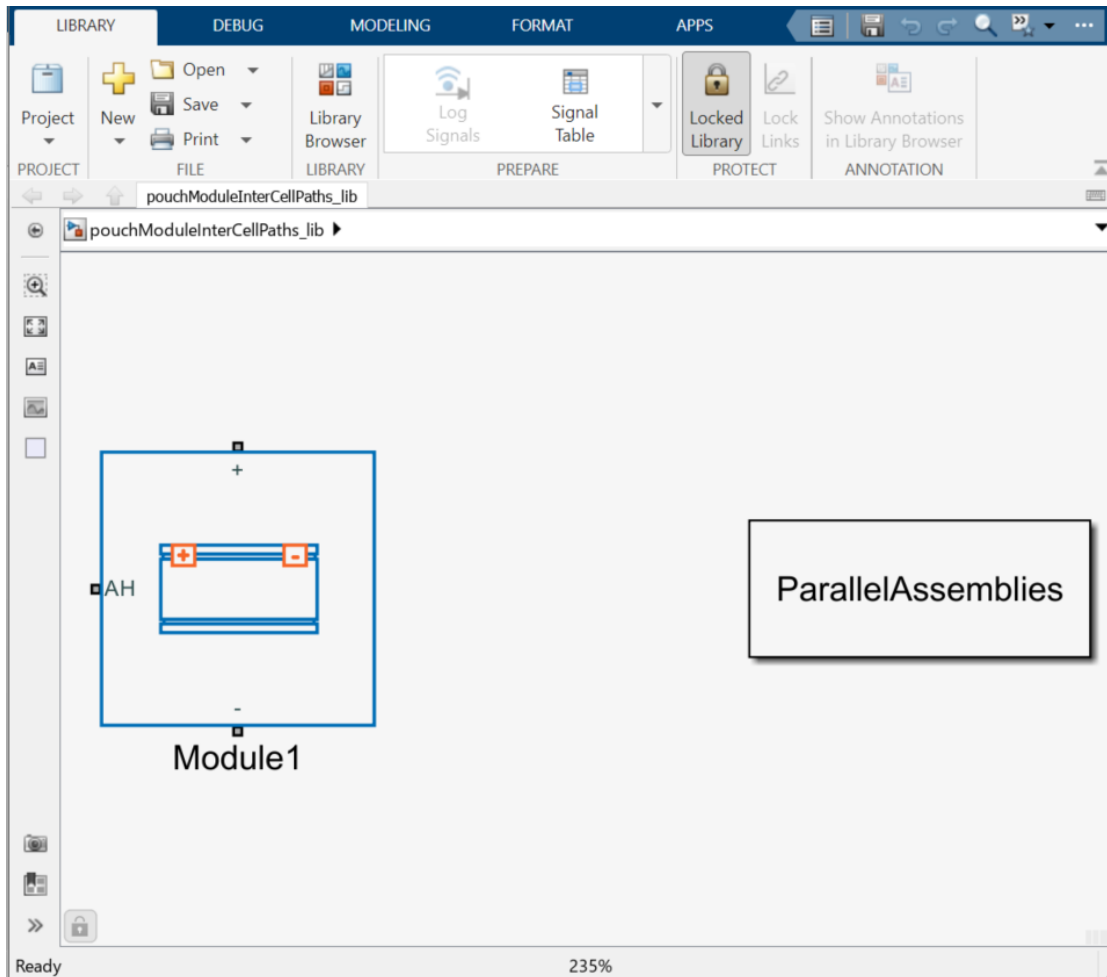
R2024a
进一步简化使用



» [Battery Builder](#)

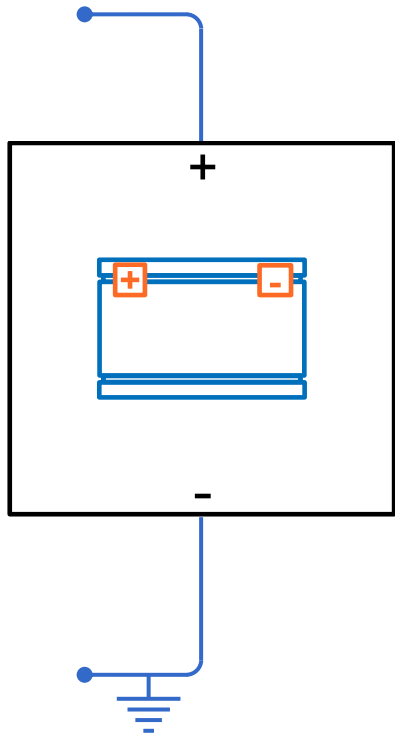
自动生成各层级电池模块库

Library 示意图

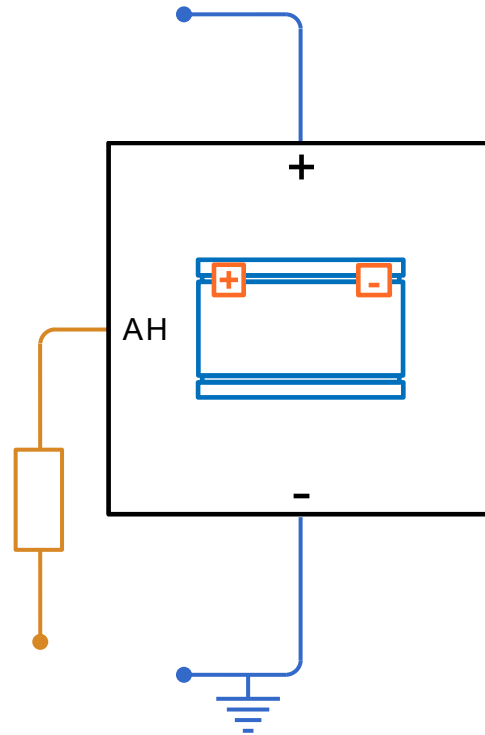


关于模组

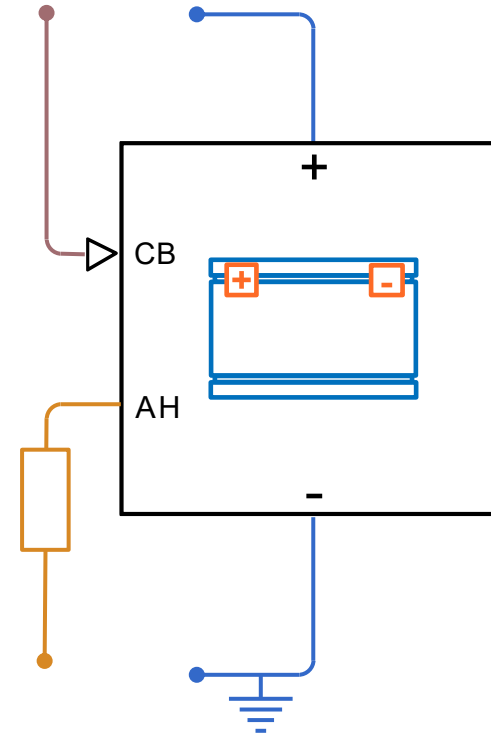
电池包通常会包含若干个模组



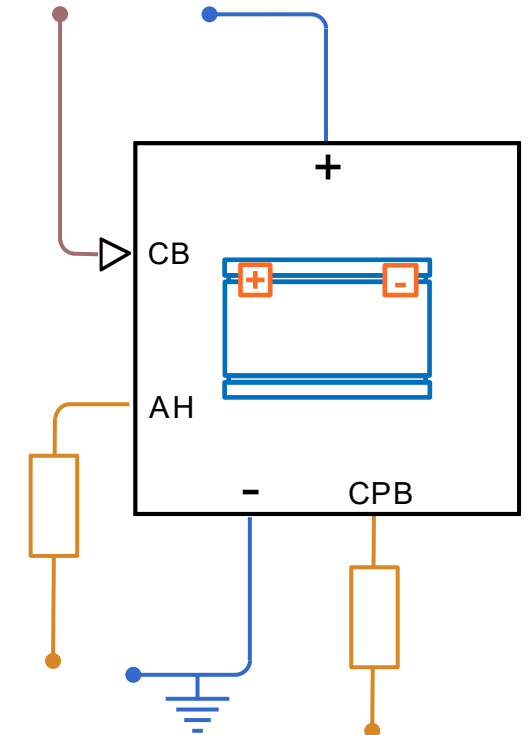
**Electric
Connection**



**Thermal Path
Ambient**



**Balancing
Signal**

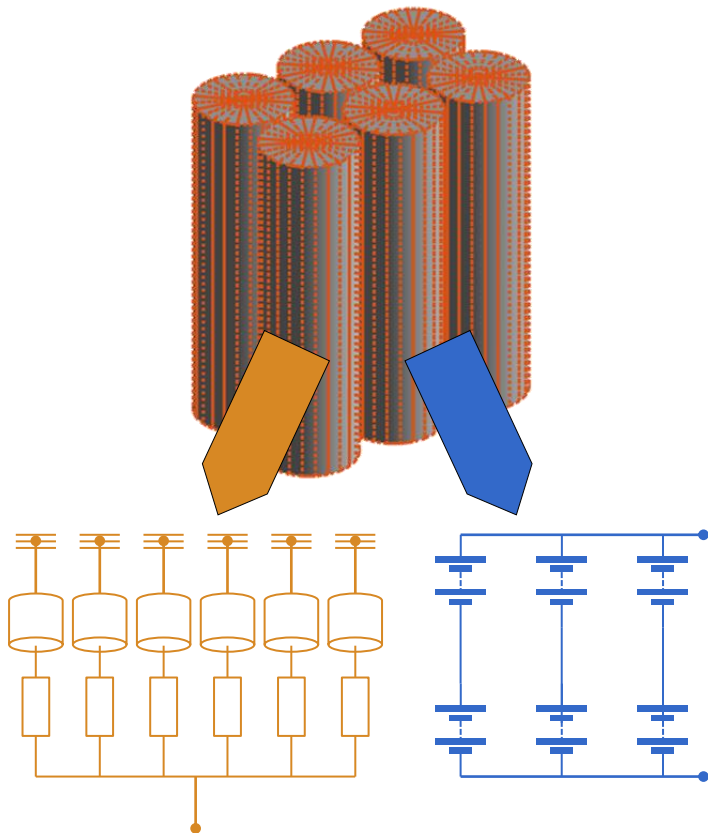


**Thermal Path
Plate**

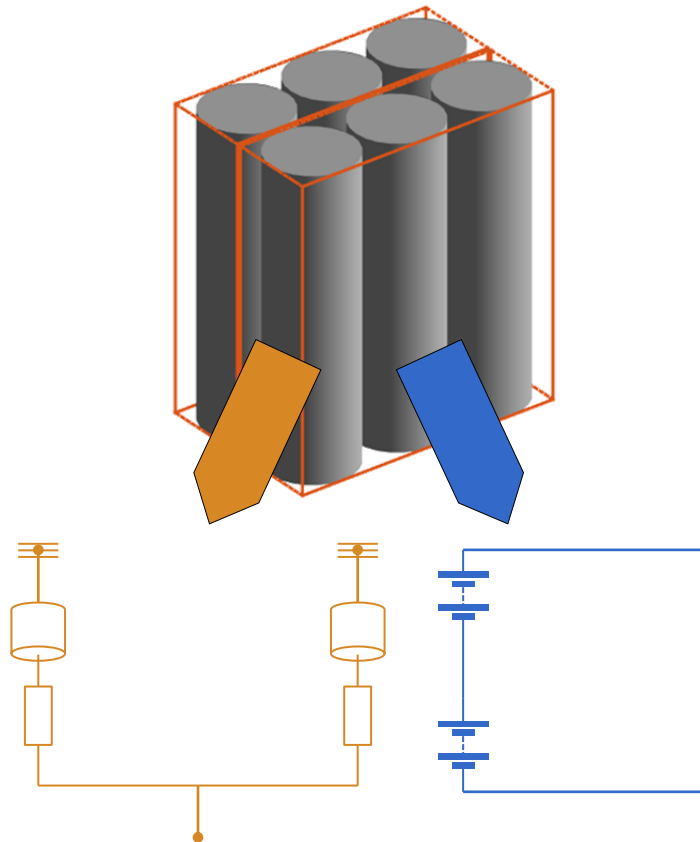
仿真速度和精度的平衡

随时切换合适的模型细节等级参数

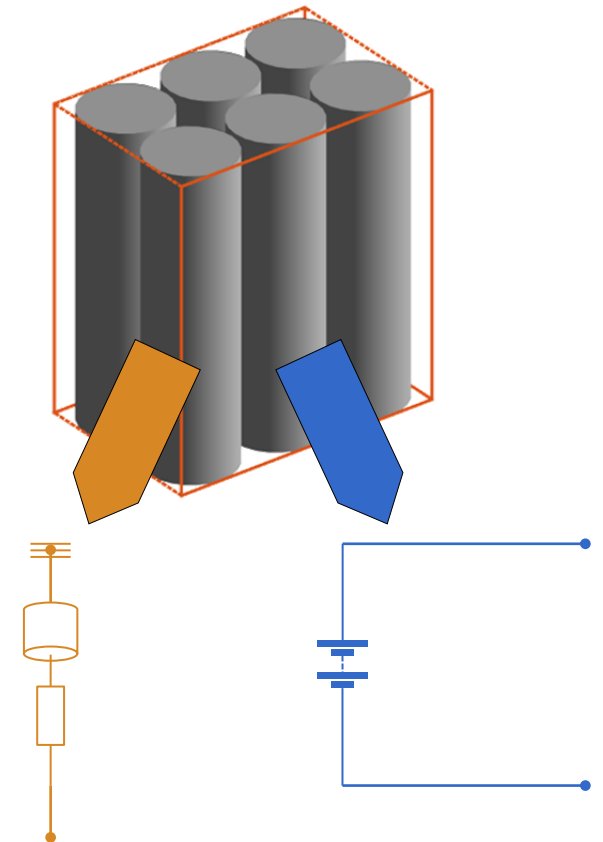
Detailed



Grouped



Lumped

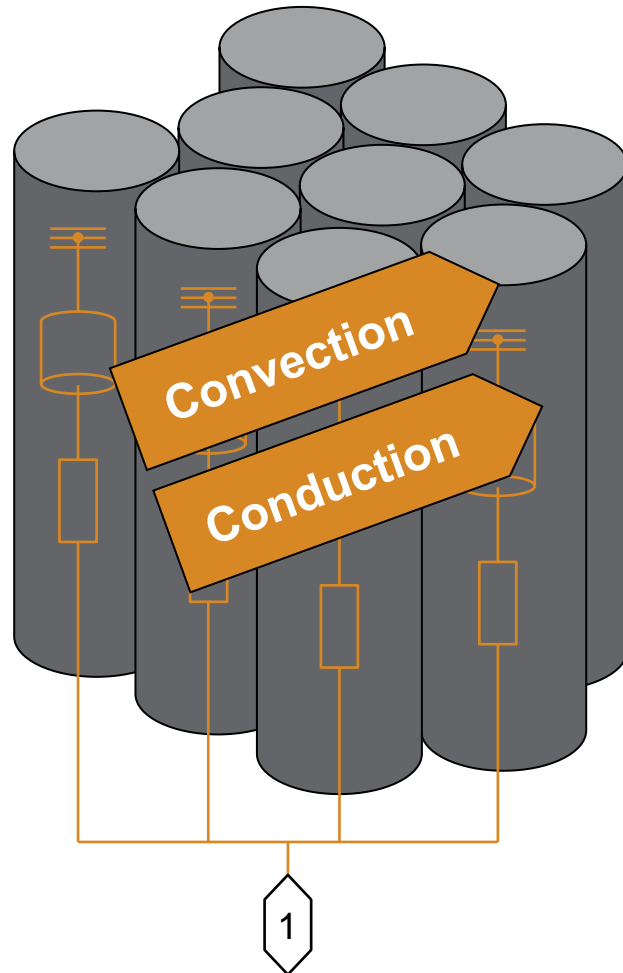


» [More to Model Resolution](#)

模组对外热模型

模组和外界环境(空气/冷却水板)之间的热传导、热对流

Thermal path to ambient



Block Parameters: ModuleType1

ModuleType1 Auto Apply

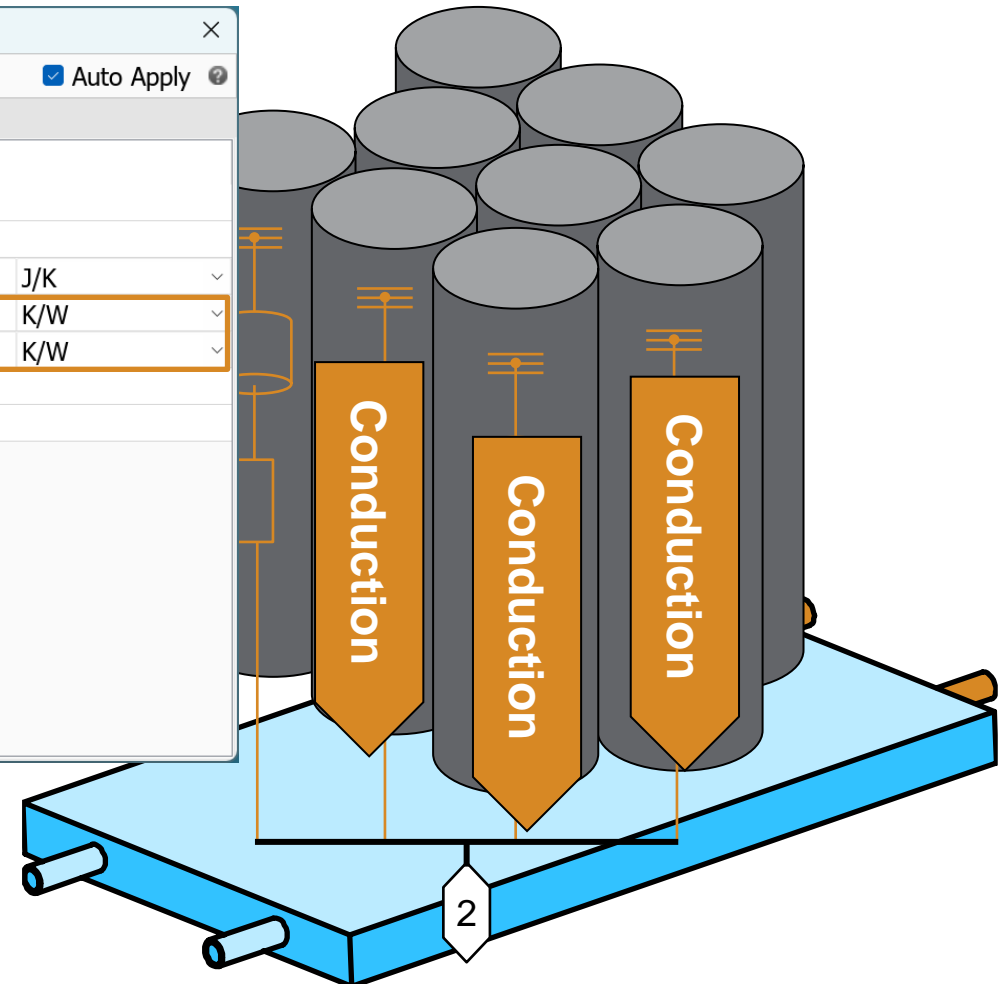
Settings Description

NAME	VALUE	
> Main		
> Thermal		
> Thermal mass	100	J/K
> Cell level coolant thermal ...	1.2	K/W
> Cell level ambient thermal ...	25	K/W
> Initial Targets		
> Nominal Values		

AH

A small schematic diagram of a block labeled 'AH' with a '+' sign at the top and a '-' sign at the bottom. The block has two ports, one with a '+' sign and one with a '-' sign.

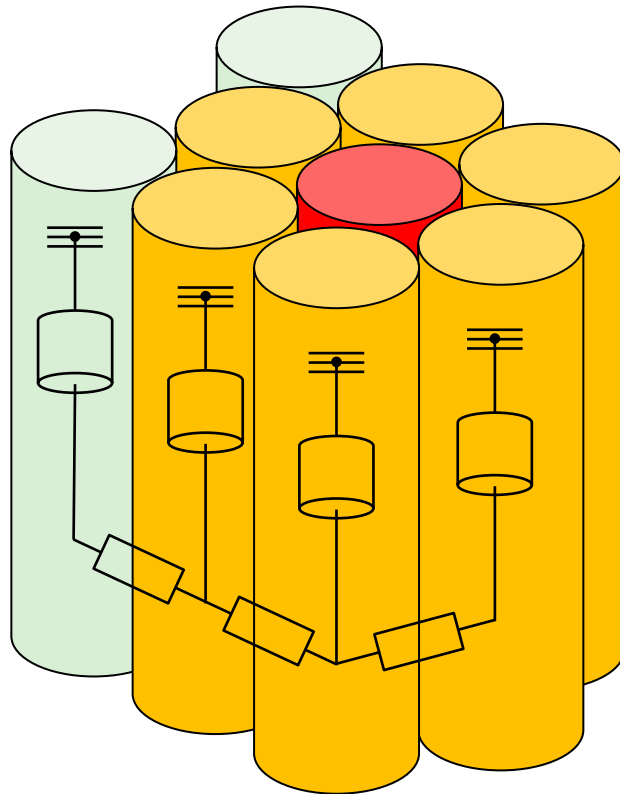
Thermal path to cooling plate



模组内部热模型

模组电芯之间的热传导、热对流、热辐射

Inter cell path



Block Parameters: Module1

Module1 Auto Apply

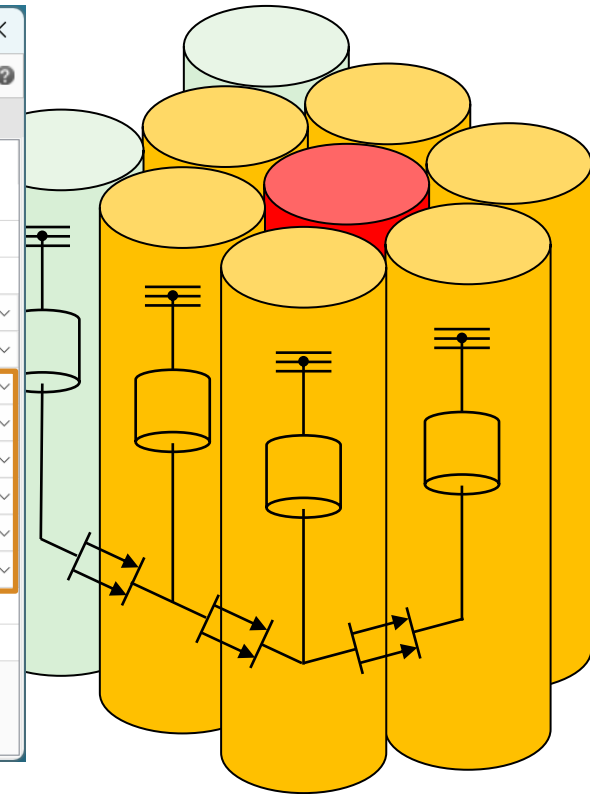
Settings Description

NAME	VALUE	
> Main		
> Dynamics		
> Thermal		
> Thermal mass	100	J/K
> Cell level ambient thermal ...	25	K/W
> Inter-cell thermal path resi...	1	K/W
> Inter-cell radiation heat tr...	1e-3	m ²
> Inter-cell radiation heat tr...	1e-6	W/(K ⁴ *m ²)
> Inter-parallel assembly the...	1	K/W
> Inter-parallel assembly are...	1e-3	m ²
> Inter-parallel assembly co...	1e-6	W/(K ⁴ *m ²)
> Initial Targets		
> Nominal Values		

AH

A schematic diagram of a battery cell, labeled 'AH'. It shows a rectangular cell with a positive terminal (+) on the top and a negative terminal (-) on the bottom. The cell is connected to a circuit, with arrows indicating the direction of current flow.

Inter cell radiative path



» [Module with Inter-Cell Heat Exchange](#)

模组电芯参数分布设置

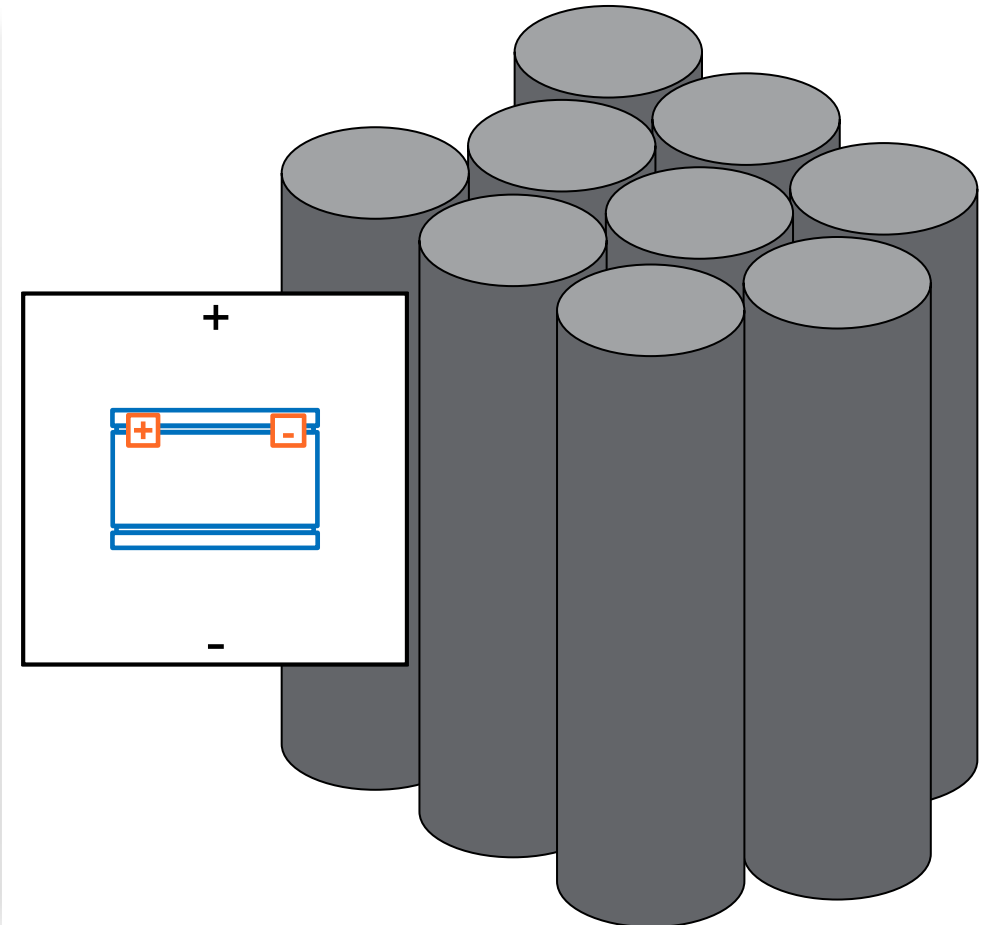
电芯参数差异性

R2023b

Block Parameters: Module1

Module1 Auto Apply

Settings	Description	VALUE	
▼ Main			
>	Vector of state-of-charge v...	[0, .1, .25, .5, .75, .9, 1]	<1x7 double>
>	Percent deviation for SOC ...	zeros([52, 1])	<52x1 double>
>	Open-circuit voltage, V0(S...	[3.5057, 3.566, 3.6337, 3.7127, 3...	V
>	Percent deviation for V0 v...	zeros([52, 1])	<52x1 double>
>	Terminal voltage operatin...	[0, inf]	[0,Inf] V
>	Percent deviation for V_ra...	zeros([52, 1])	<52x1 double>
>	Terminal resistance, R0(S...	[.0085, .0085, .0087, .0082, .0083...	Ohm
>	Percent deviation for R0_v...	zeros([52, 1])	<52x1 double>
>	Cell capacity, AH	27	A*hr
>	Percent deviation for AHCell	zeros([52, 1])	<52x1 double>
	Extrapolation method for a...	Nearest	
▼ Thermal			
>	Thermal mass	100	J/K
>	Percent deviation for ther...	zeros([52, 1])	<52x1 double>
	Configurability	Compile-time	
>	Cell level ambient thermal...	25	K/W

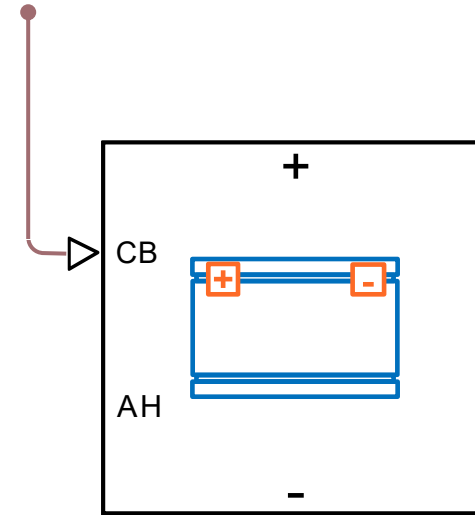
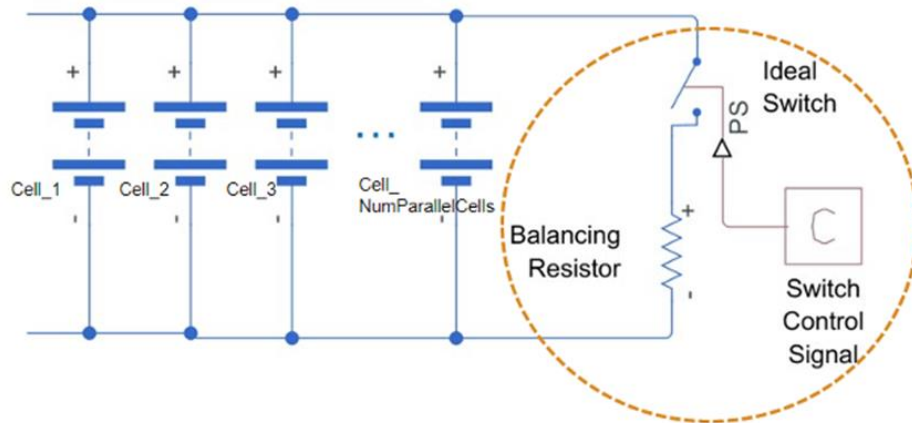


» [Apply Parameter Variation to Cells in Module](#)

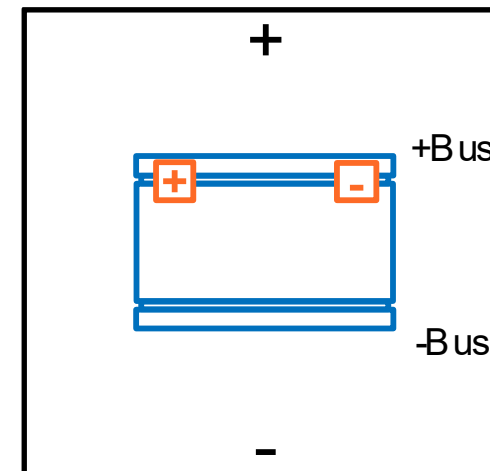
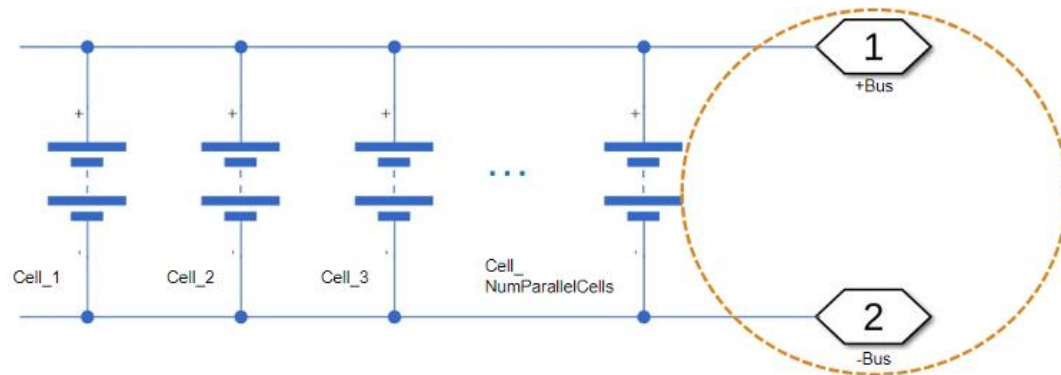
新的均衡控制端口

自定义均衡控制策略

the only available strategy is "Passive"



Starting from 24a "External"

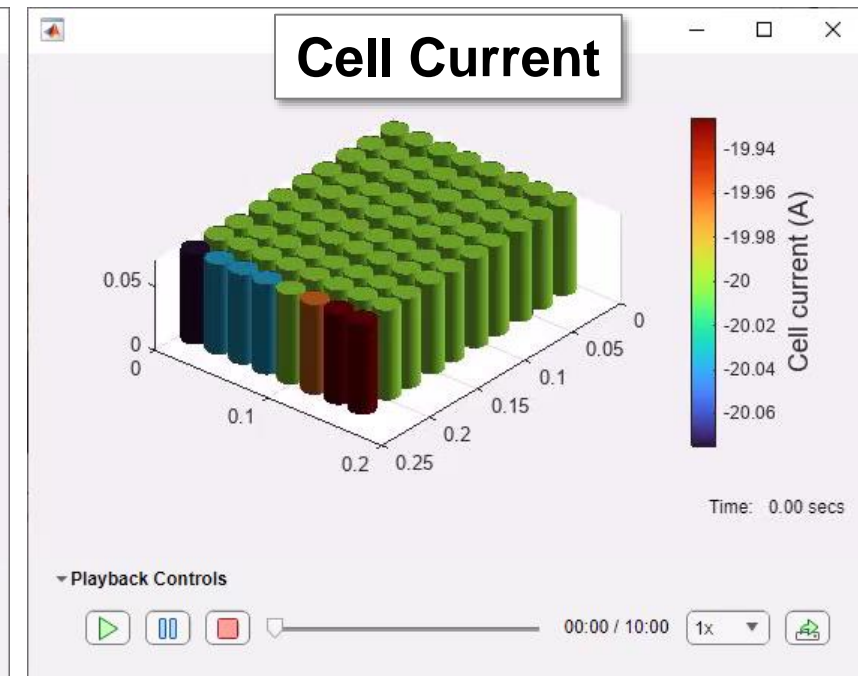
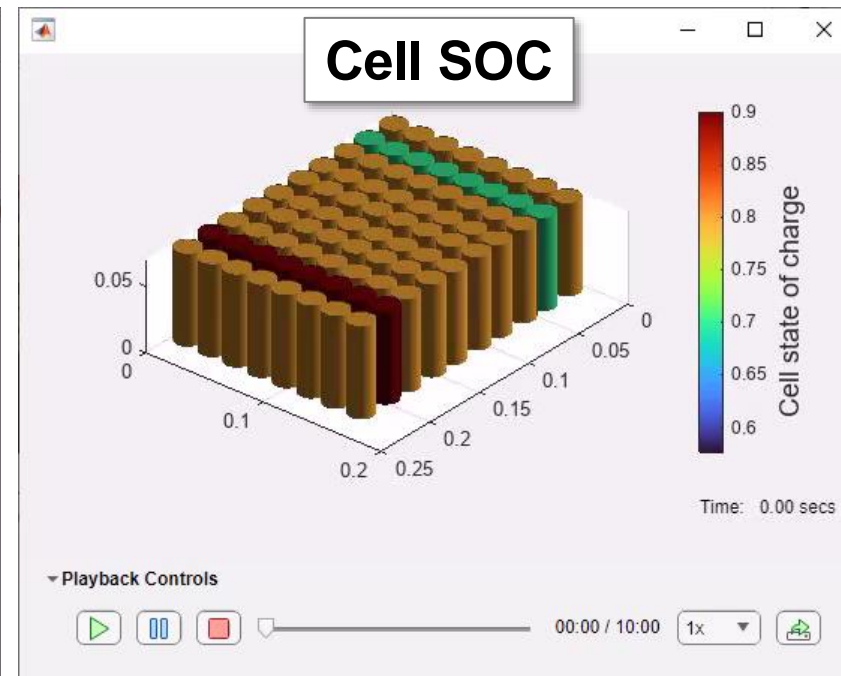
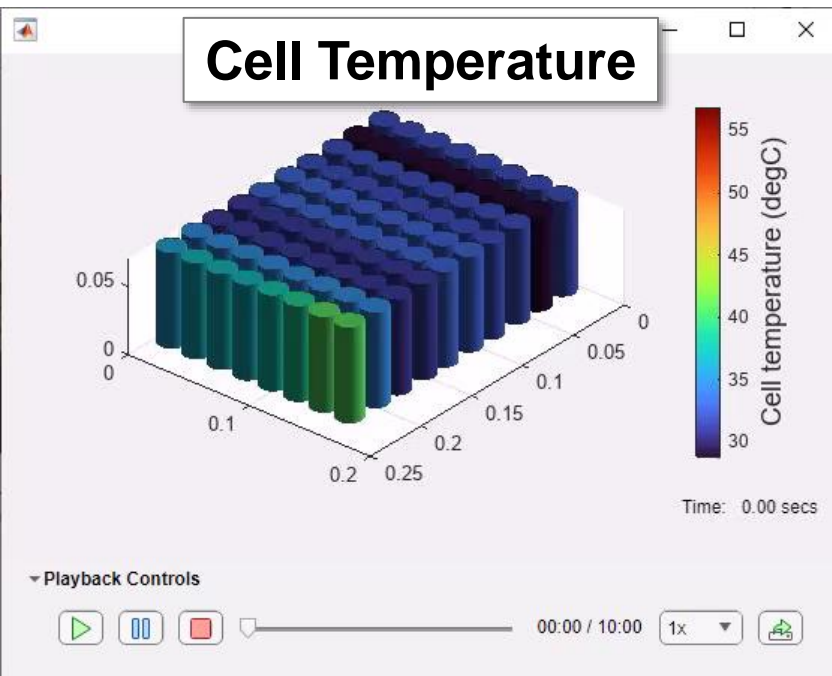
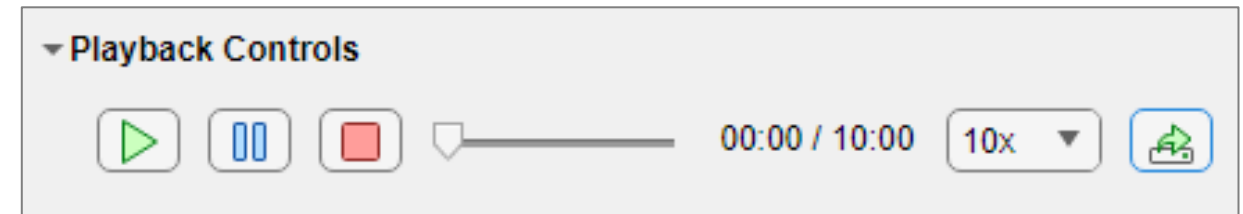


custom balancing strategy

Simscape Battery 结果显示

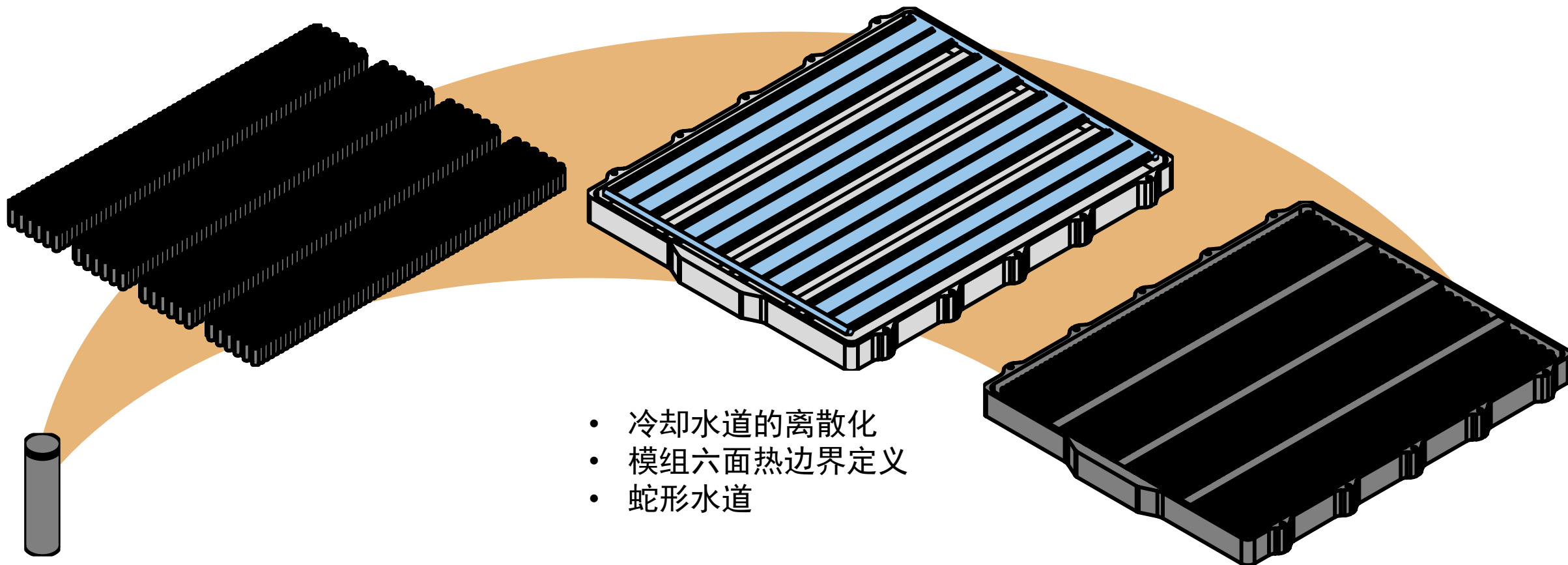
R2023b

- Animate battery pack visualization with simulation results
 - Display quantities such as current, temperature, and SOC for each cell within the battery pack
- Use playback controls to control animation and save to a video file



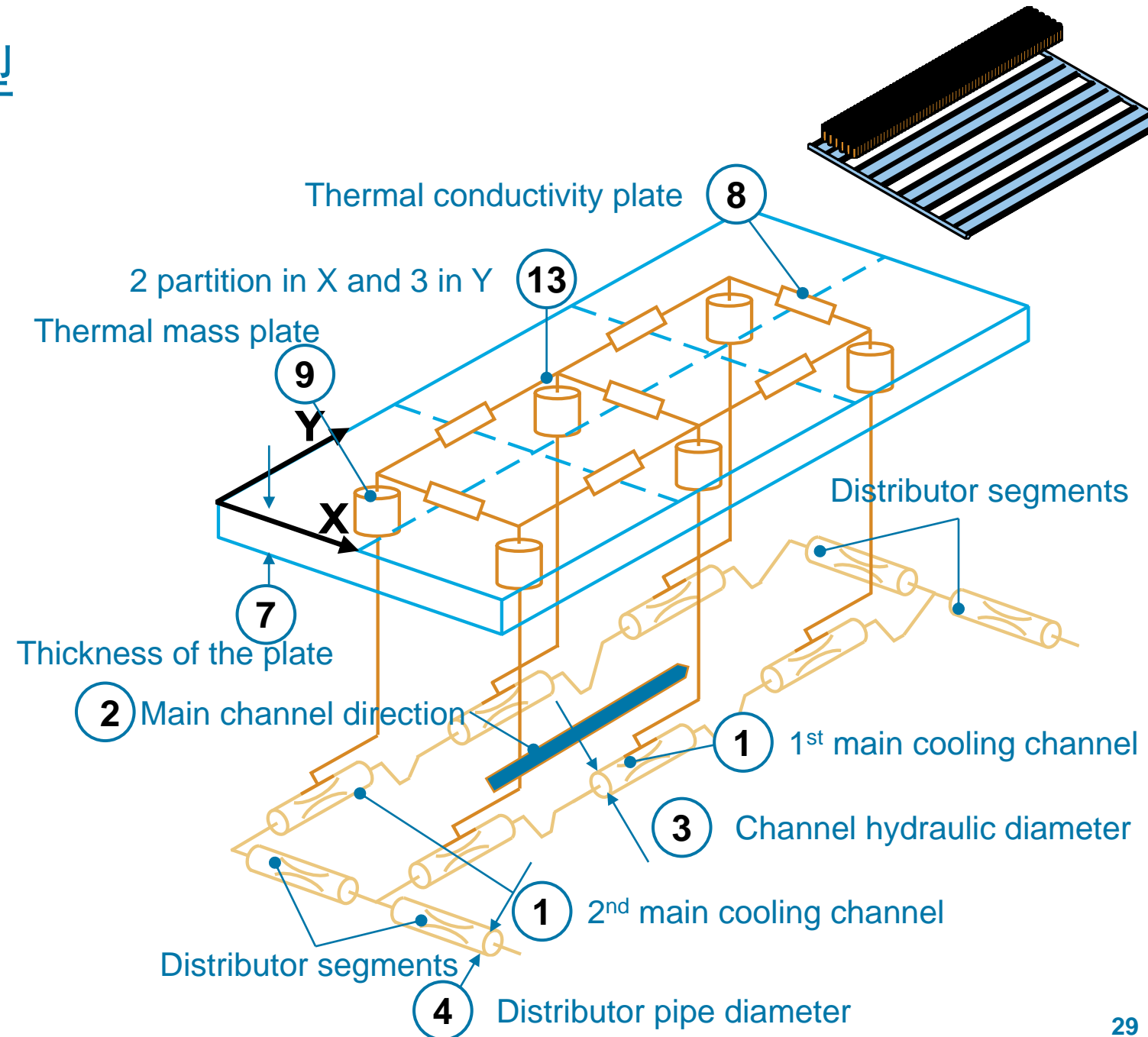
冷却板模型

特性与新功能



冷却水道的离散化解析模型

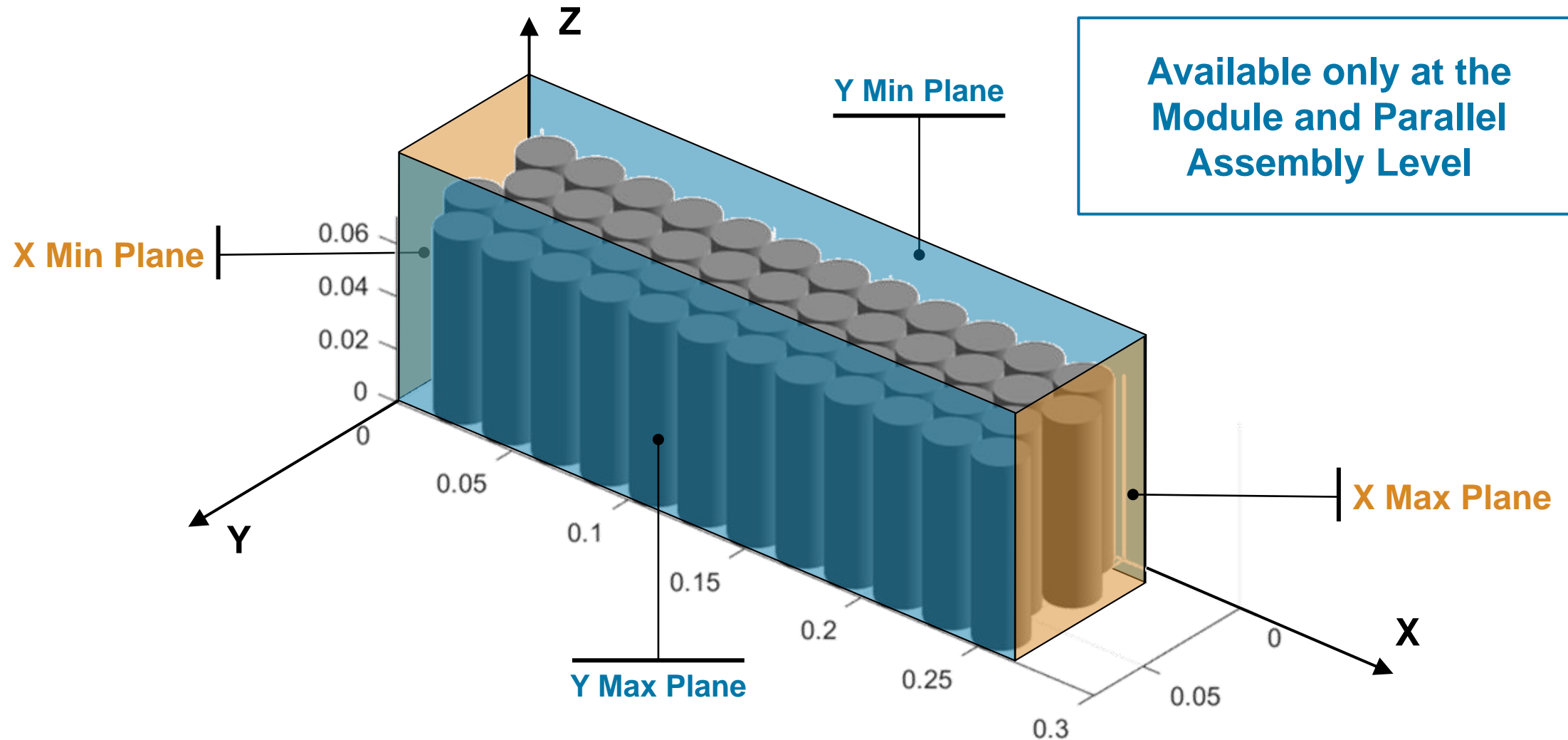
- The 1st elementary block (modeling the cooling channels) is the Pipe (TL) block
- The 2nd elementary block (modeling the plate material) is the thermal mass
- The number of pipes/thermal masses depends on the plate discretization



暴露更多热端口 自定义冷却环境

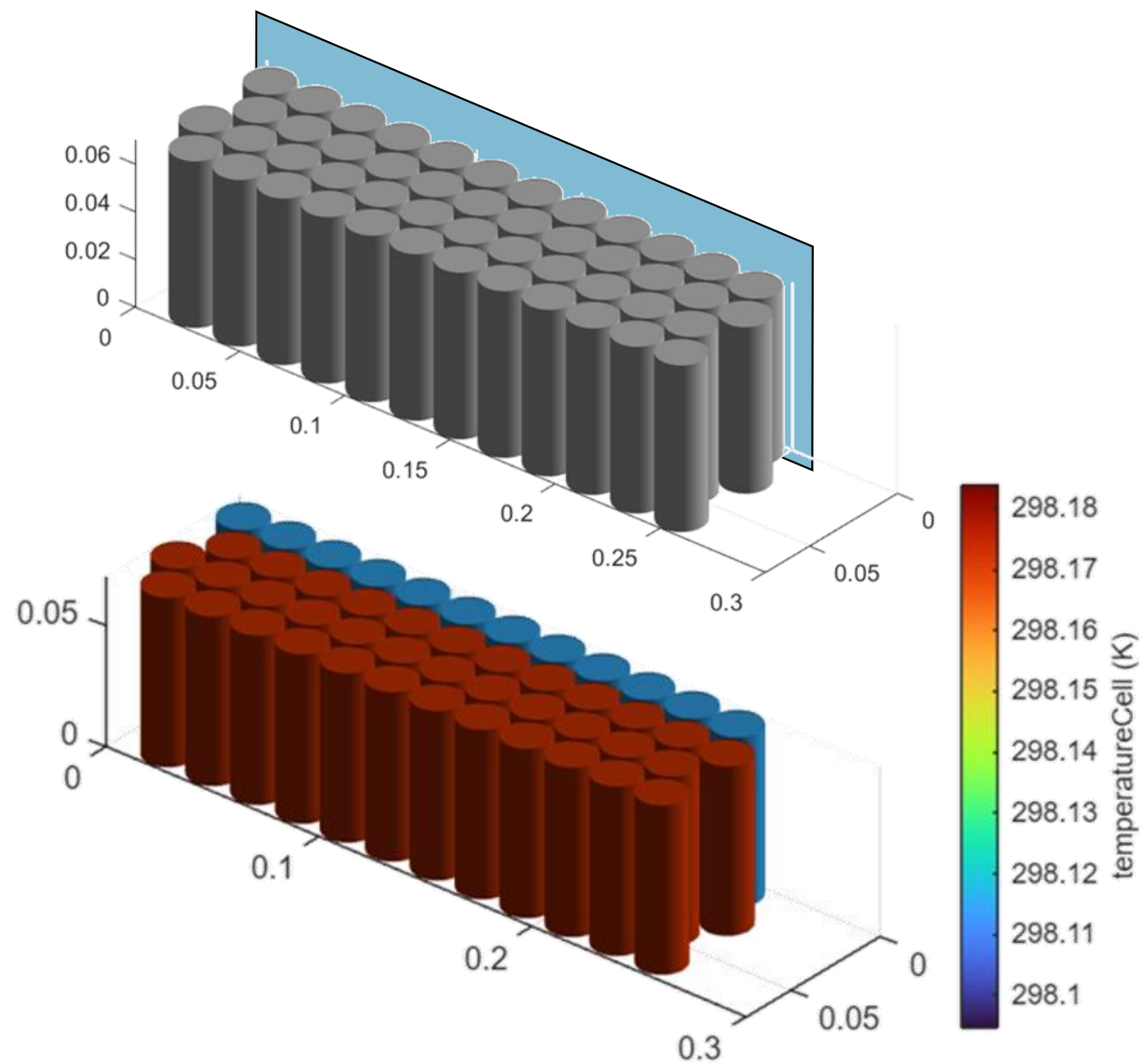
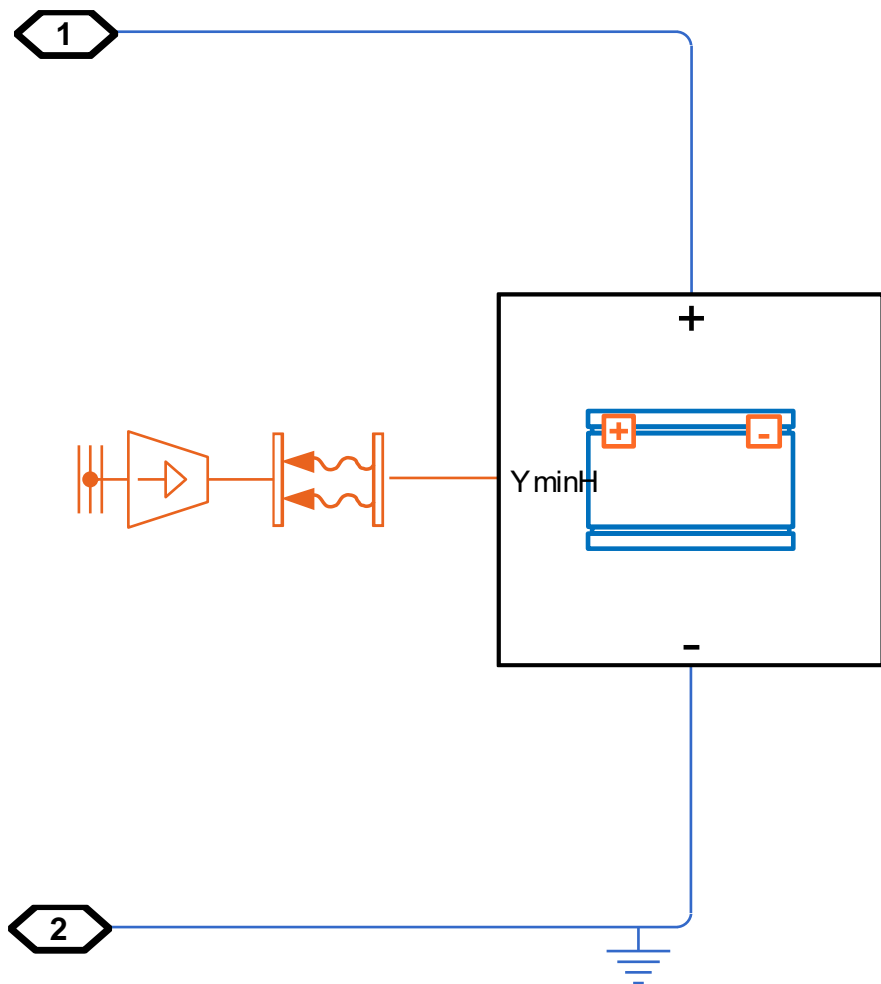
R2024a

Available only at the
Module and Parallel
Assembly Level



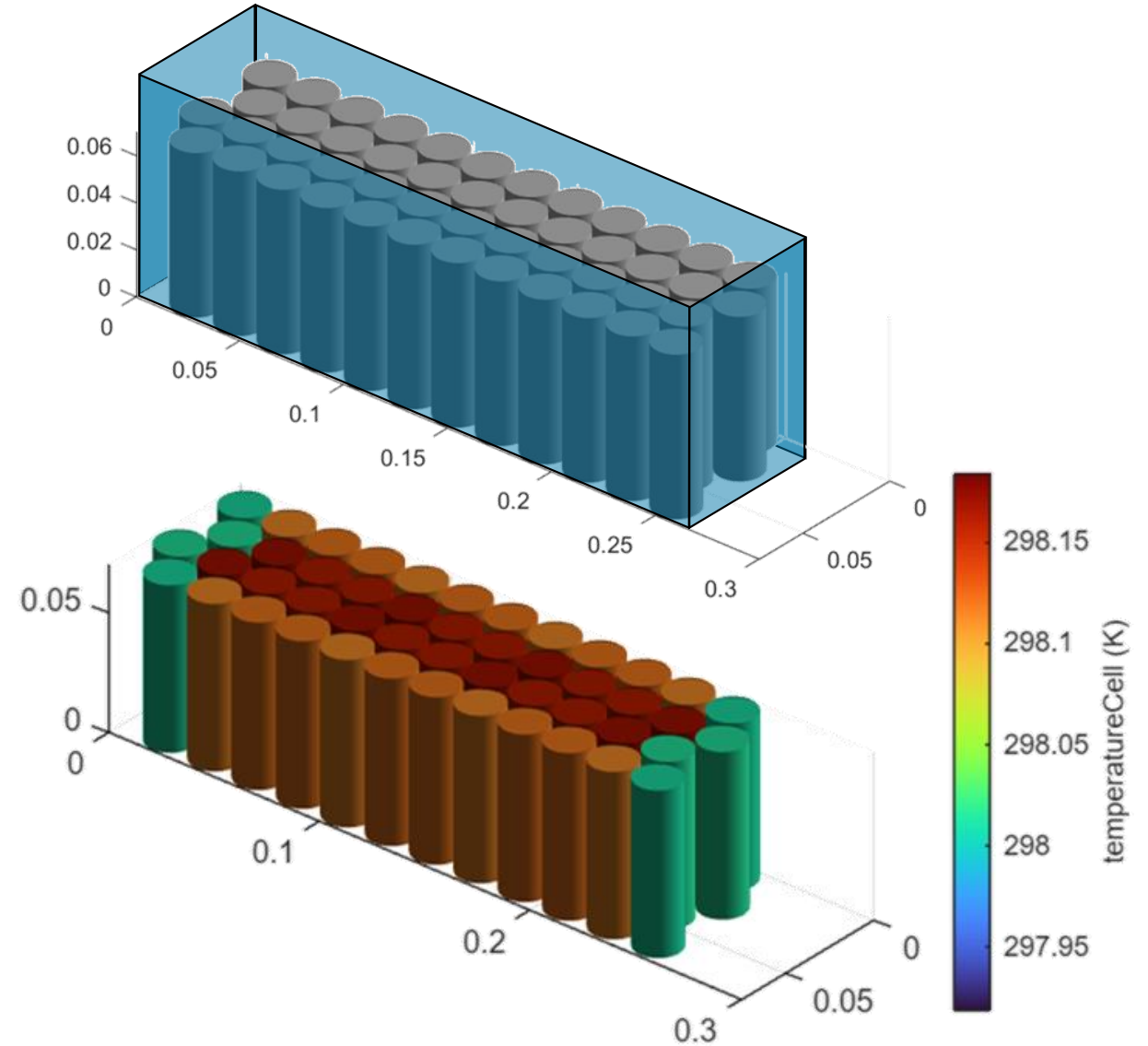
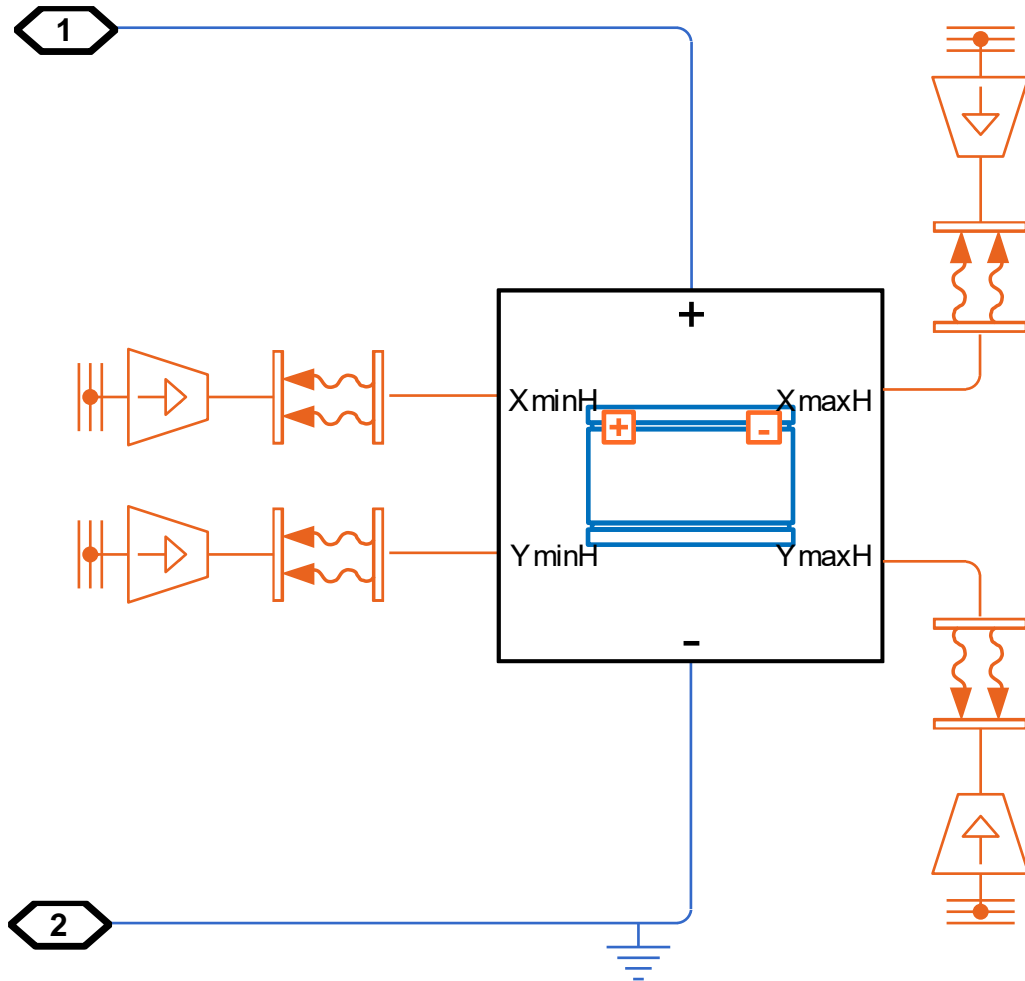
暴露更多热端口

比如 Ymin 侧面热对流



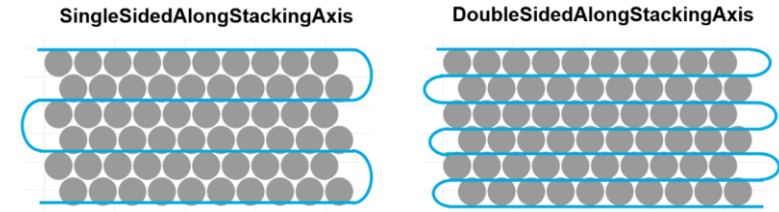
暴露更多热端口

所有侧面热对流



新蛇形板模型 New Serpentine Plate

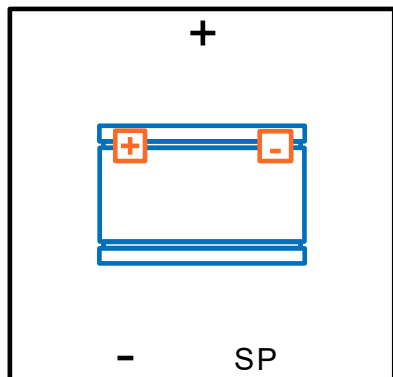
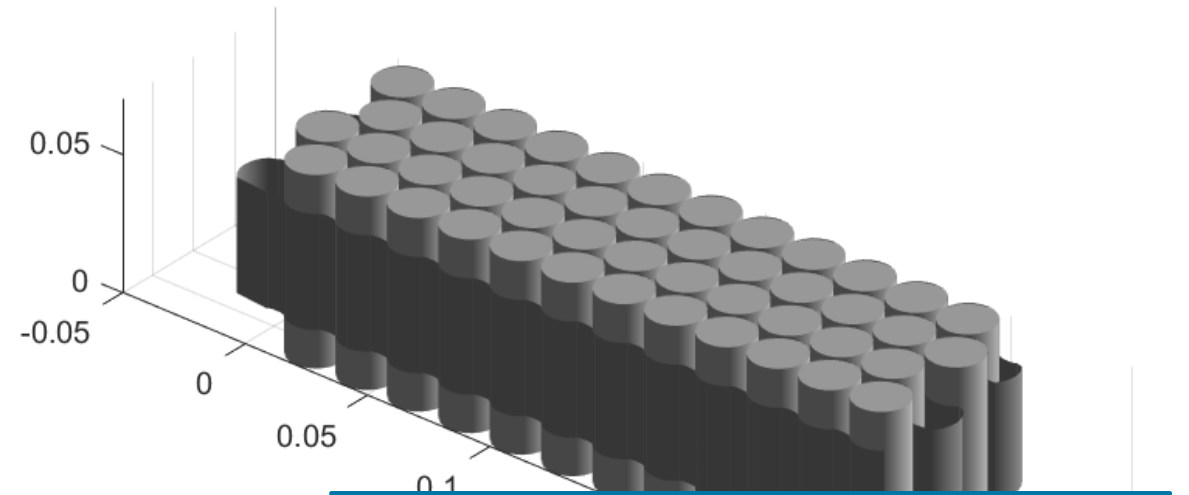
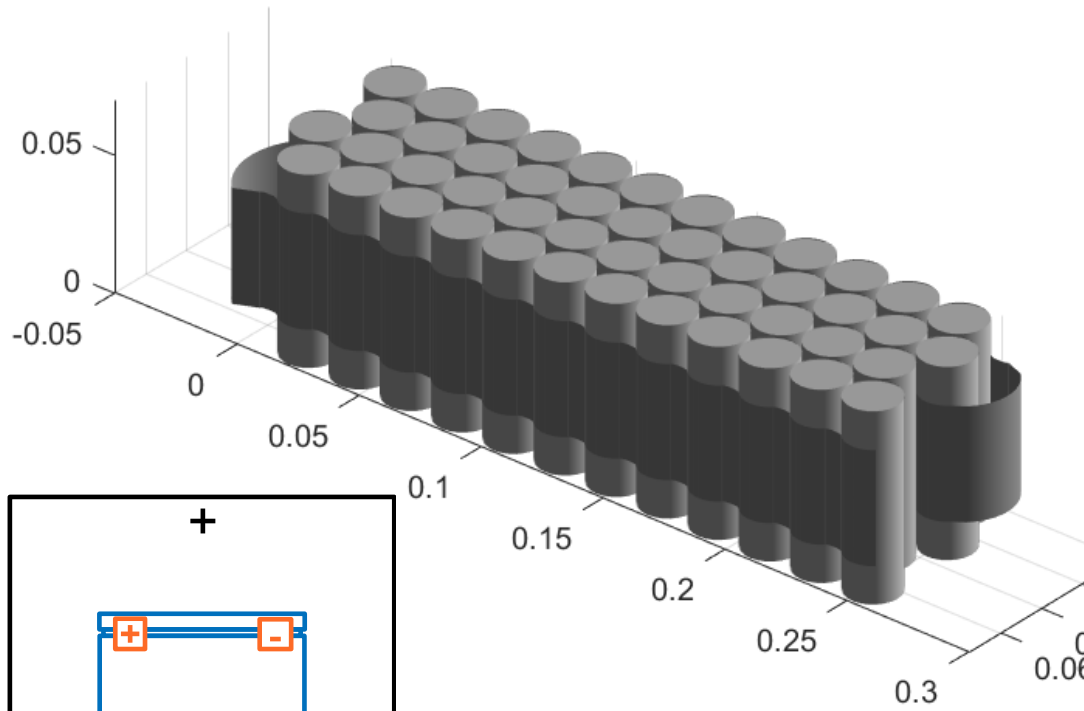
针对圆柱电芯



R2024a

Single Sided

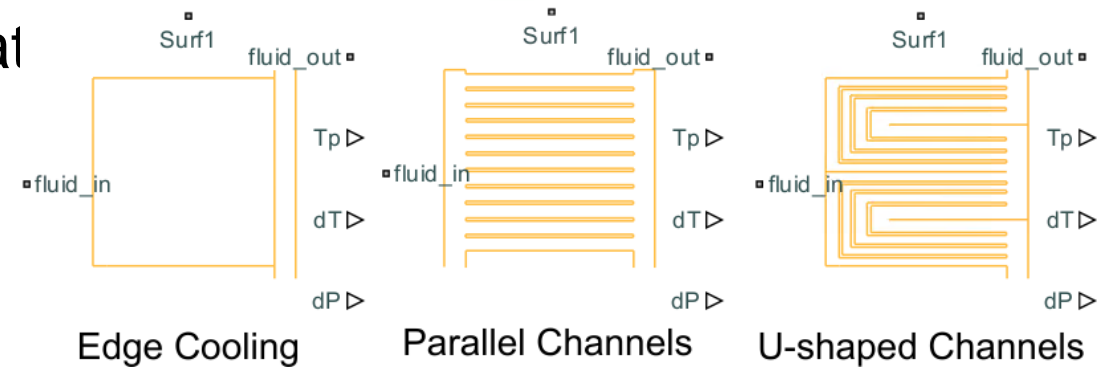
Double Sided



Available only at the Module and Parallel Assembly Level

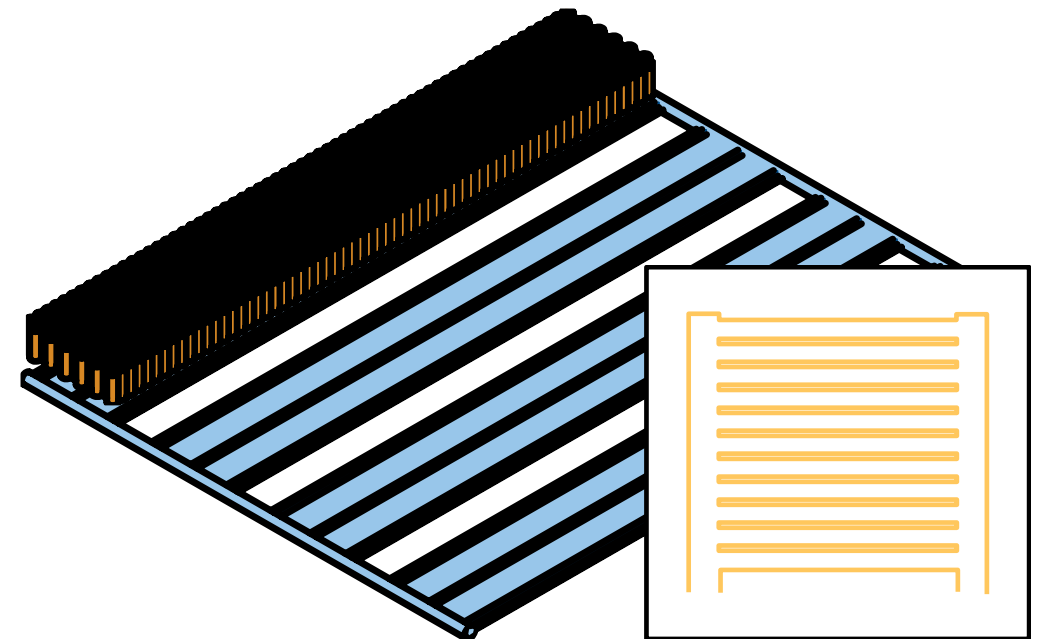
评估冷却系统拓扑结构 选型

- The cooling plate blocks model the heat transfer between battery, liquid cooling system, and environment
- Different cooling plate topologies
 - Edge, parallel channel, U-shaped channel
 - Single- and double-sided plates

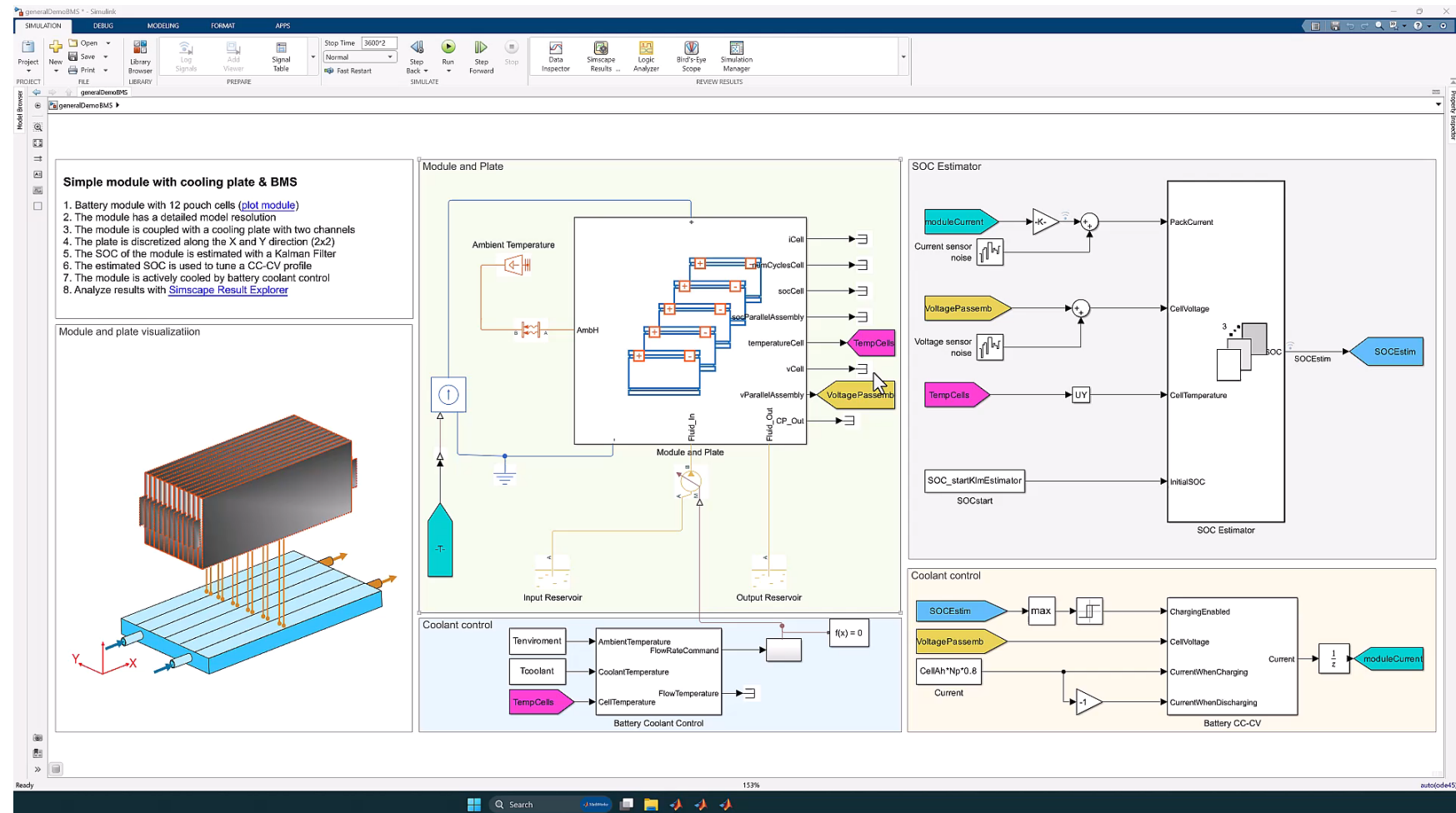


Challenge

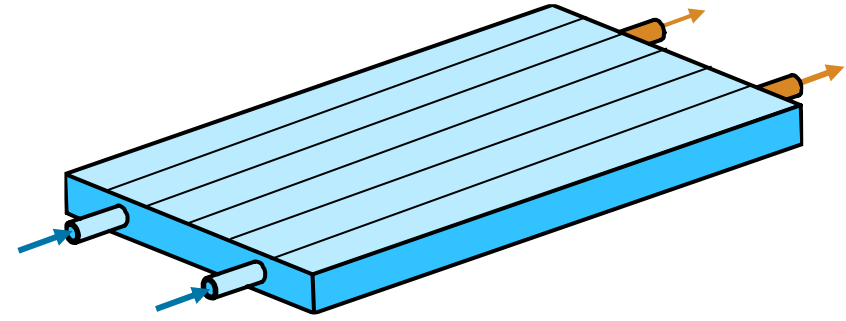
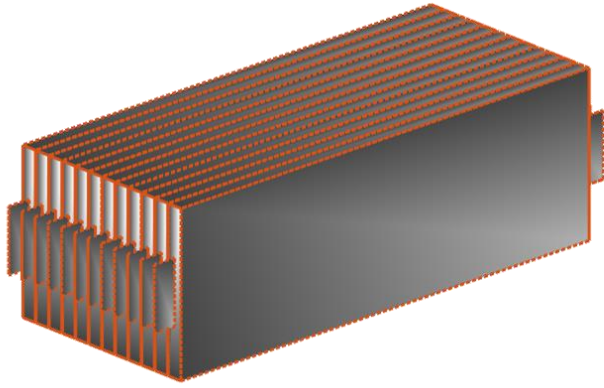
It is almost impossible to define a plate blocks which account for all possible configurations



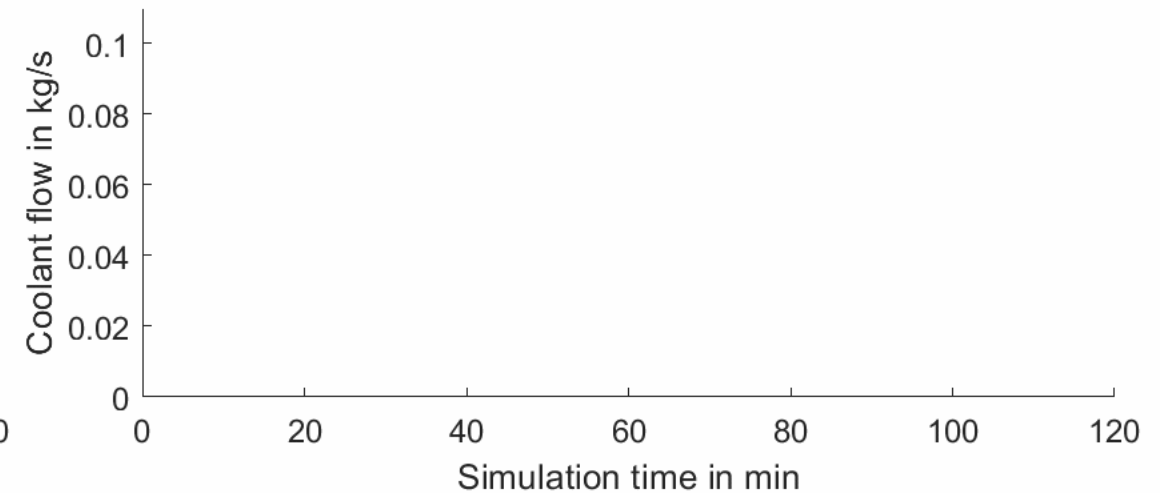
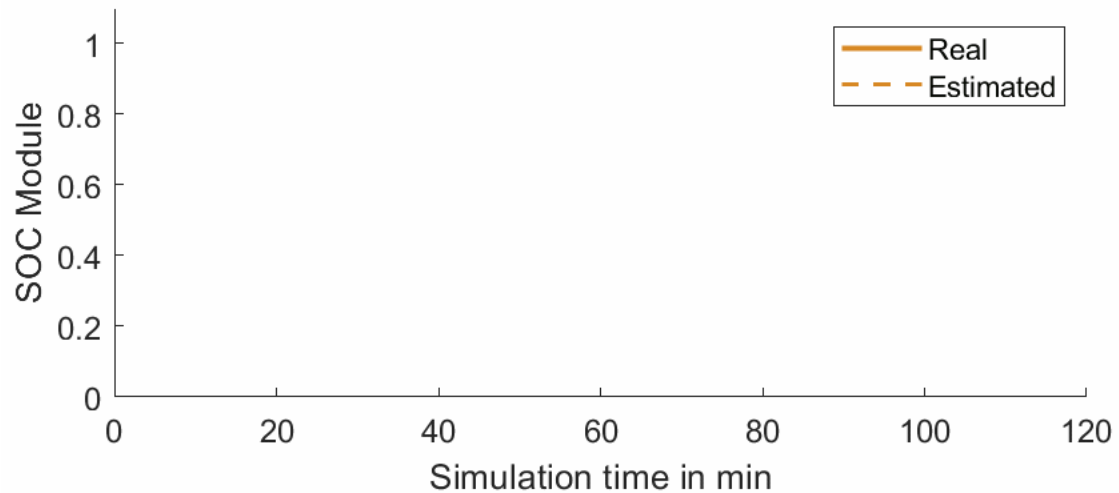
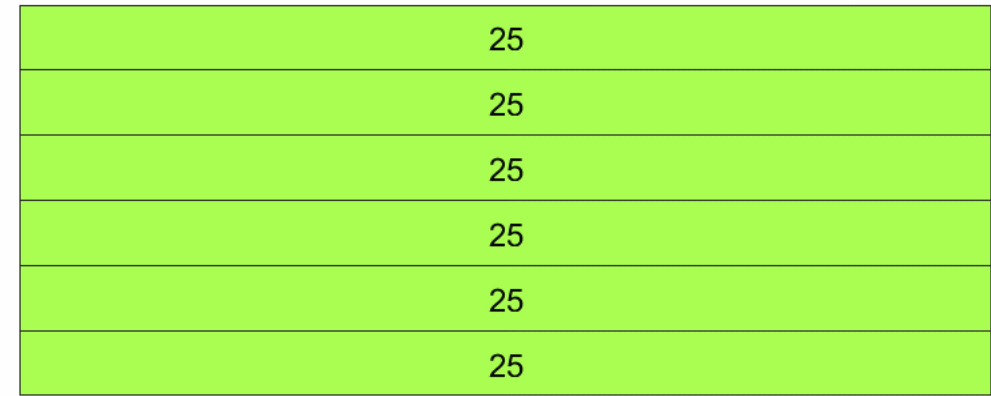
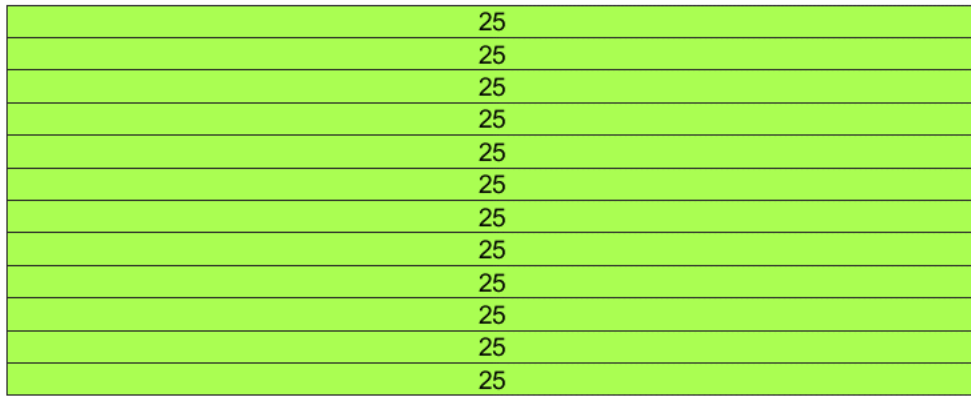
电池包/冷却板/BMS模块 案例模型



电池包/冷却板/BMS模块 仿真结果

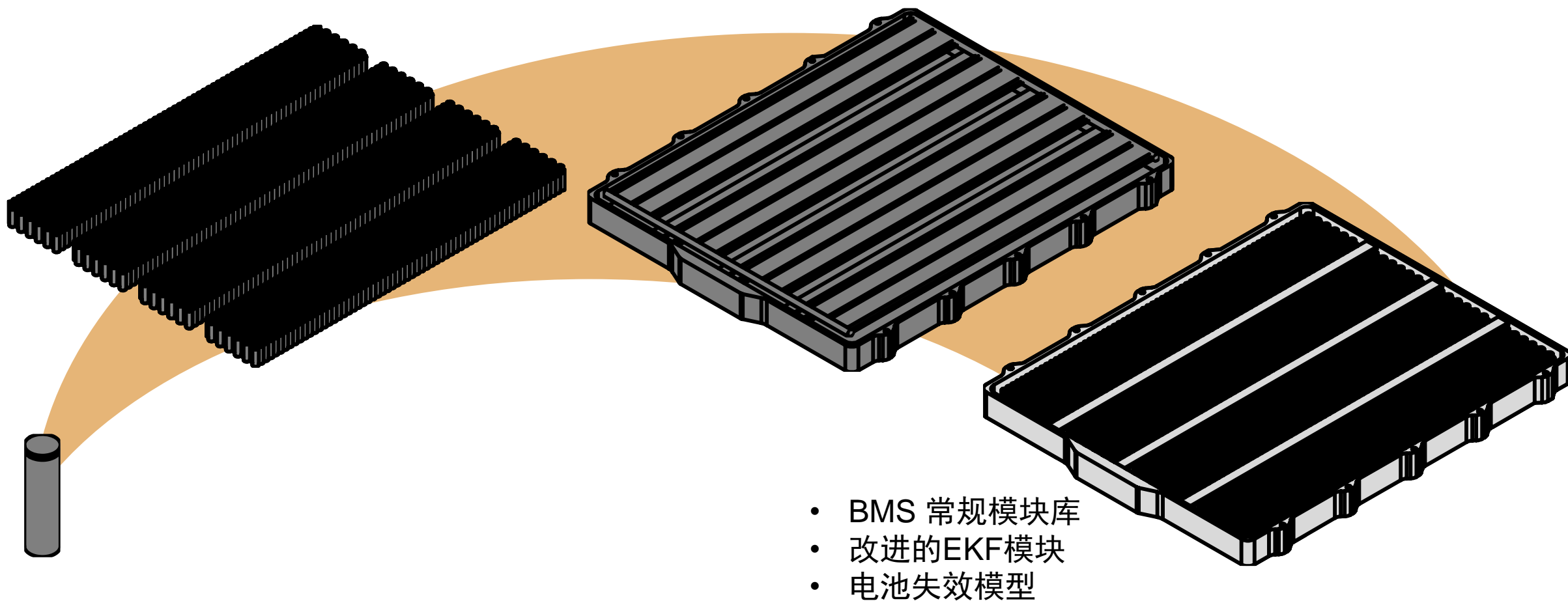


电池包/冷却板/BMS模块 仿真结果



BMS 算法模块库

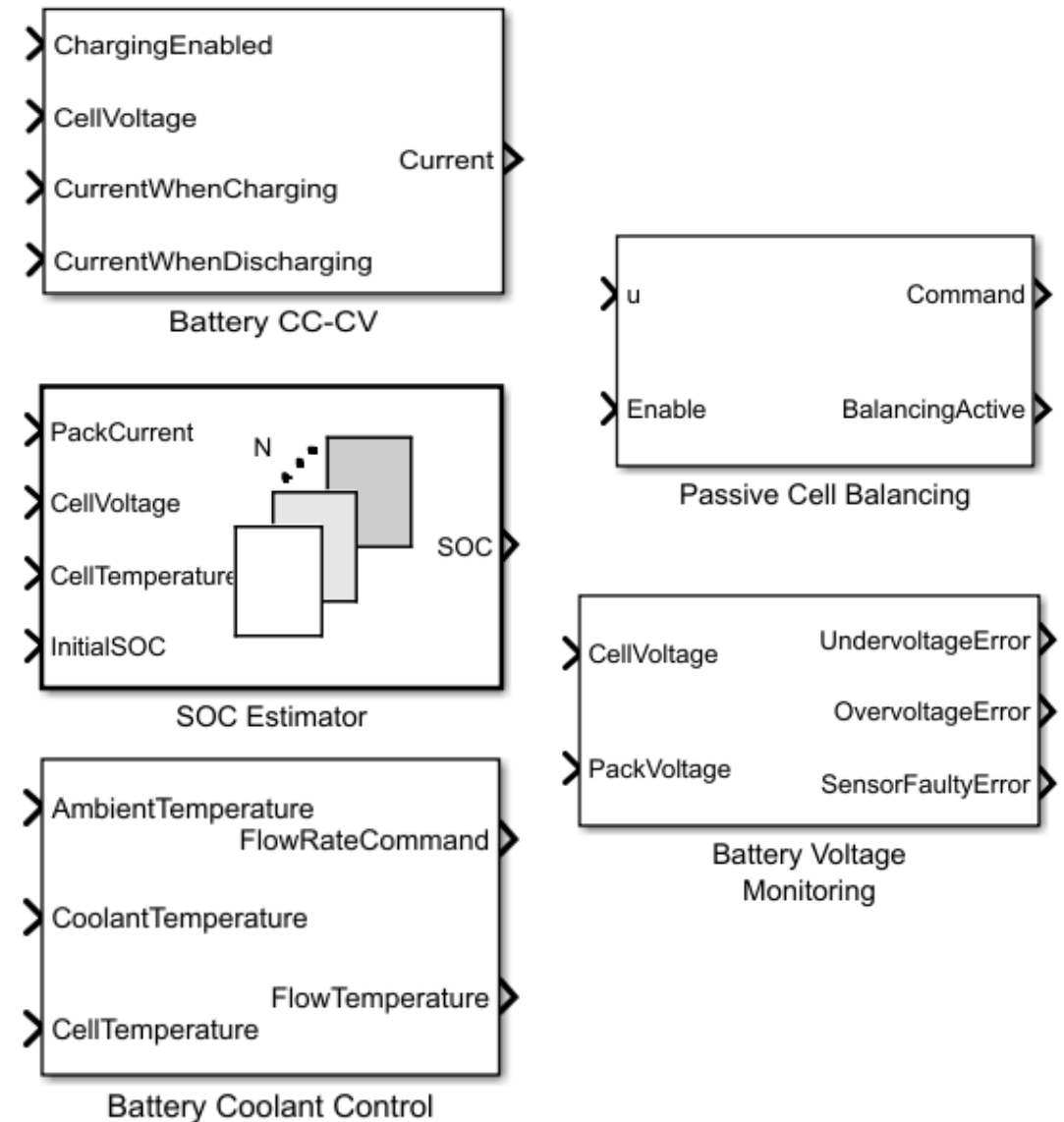
特性与新功能



BMS 模块库

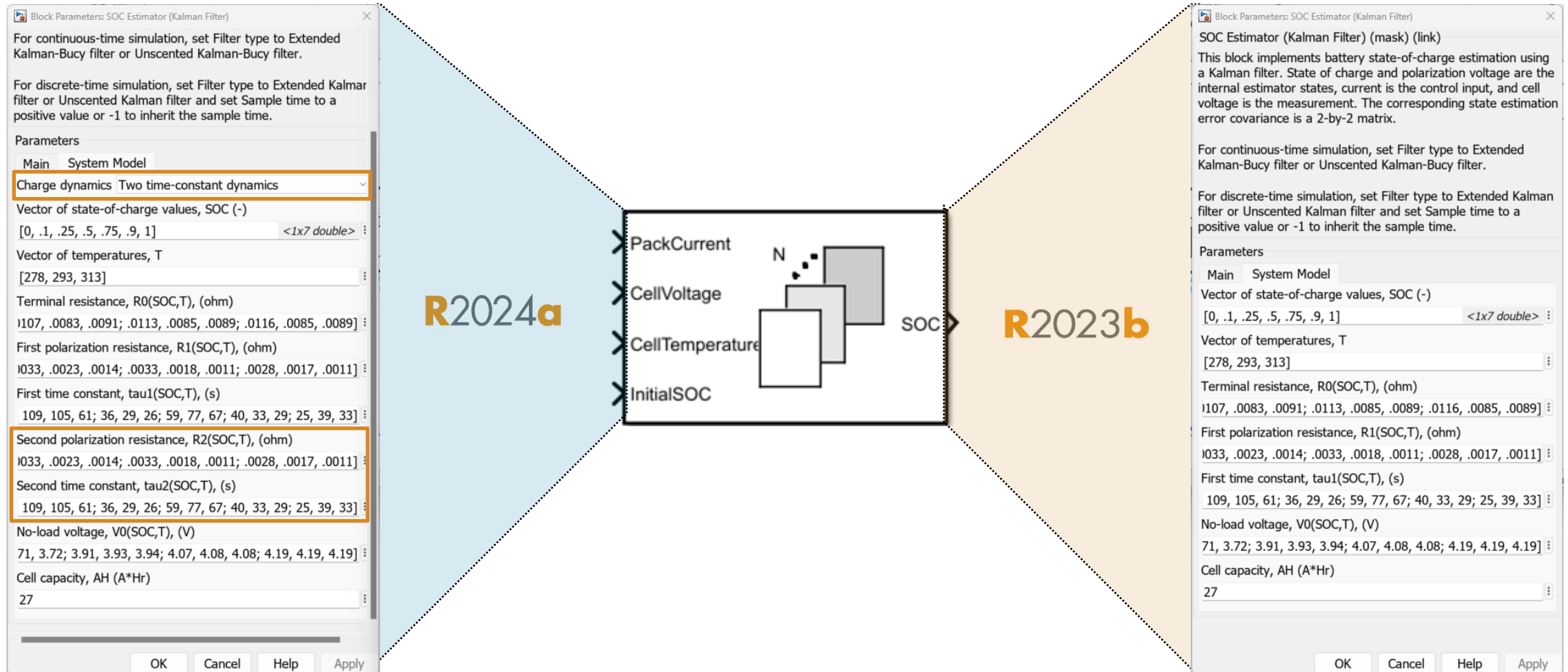
概览

- Charge and discharge
 - CC-CV, current limits
- Passive cell balancing
- Estimators**
 - SOC, SOH, SOE**
- Protection
 - Current, voltage, temperature monitor
 - Fault qualification
- Thermal management
 - Coolant and heater control



改进的等效电路电池模型

针对各 SOC 和 SOE estimator 模块

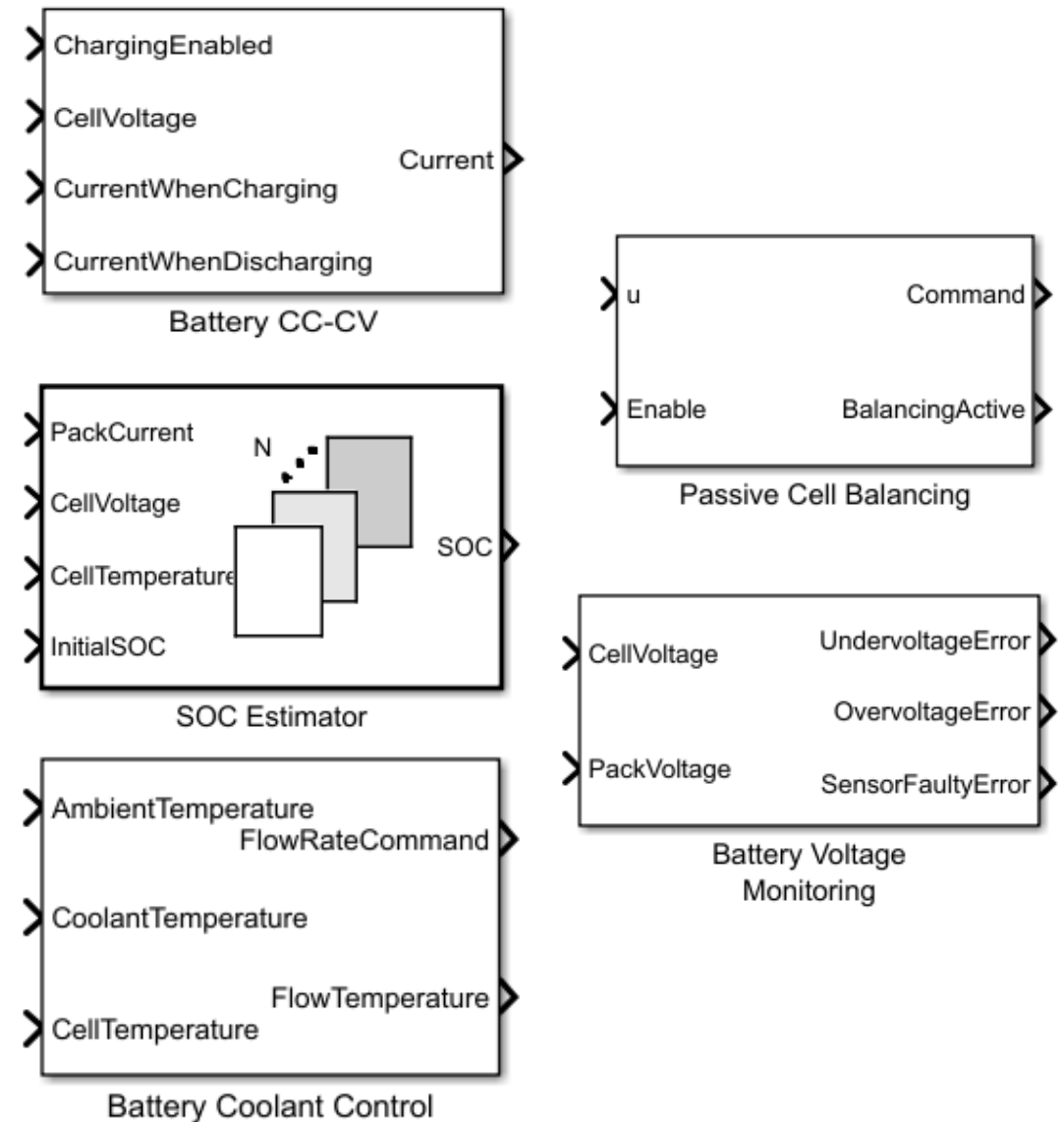


» [Charge and Discharge Battery Module with State of Charge Estimator](#)

BMS 模块库

概览

- Charge and discharge
 - CC-CV, current limits
- Passive cell balancing
- Estimators
 - SOC, SOH, SOE
- **Protection**
 - **Current, voltage, temperature monitor**
 - **Fault qualification**
- Thermal management
 - Coolant and heater control



失效仿真 Faults

R2023b

Block Parameters: Module1

Module1 Auto Apply

Settings Description

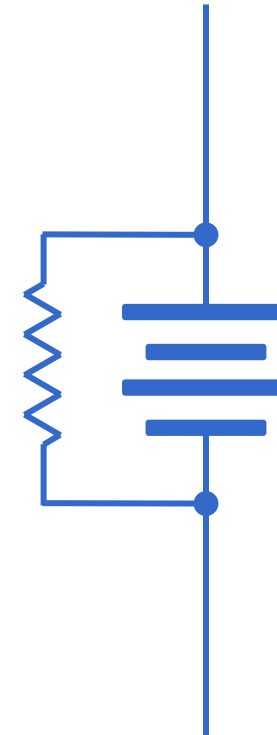
NAME	VALUE
> Main	
> Open Circuit Voltage	
> Overpotential	
> Thermal	
> Initial Targets	
> Nominal Values	
> Faults	
ParallelAssembly1/Cell...	Add fault
ParallelAssembly1/Cell...	Add fault
ParallelAssembly1/Cell...	Add fault

AH

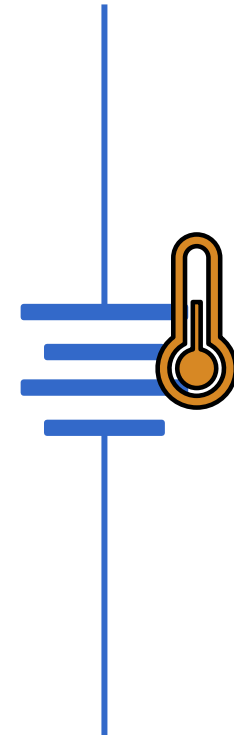
Additional Resistance Fault



Internal Short Fault



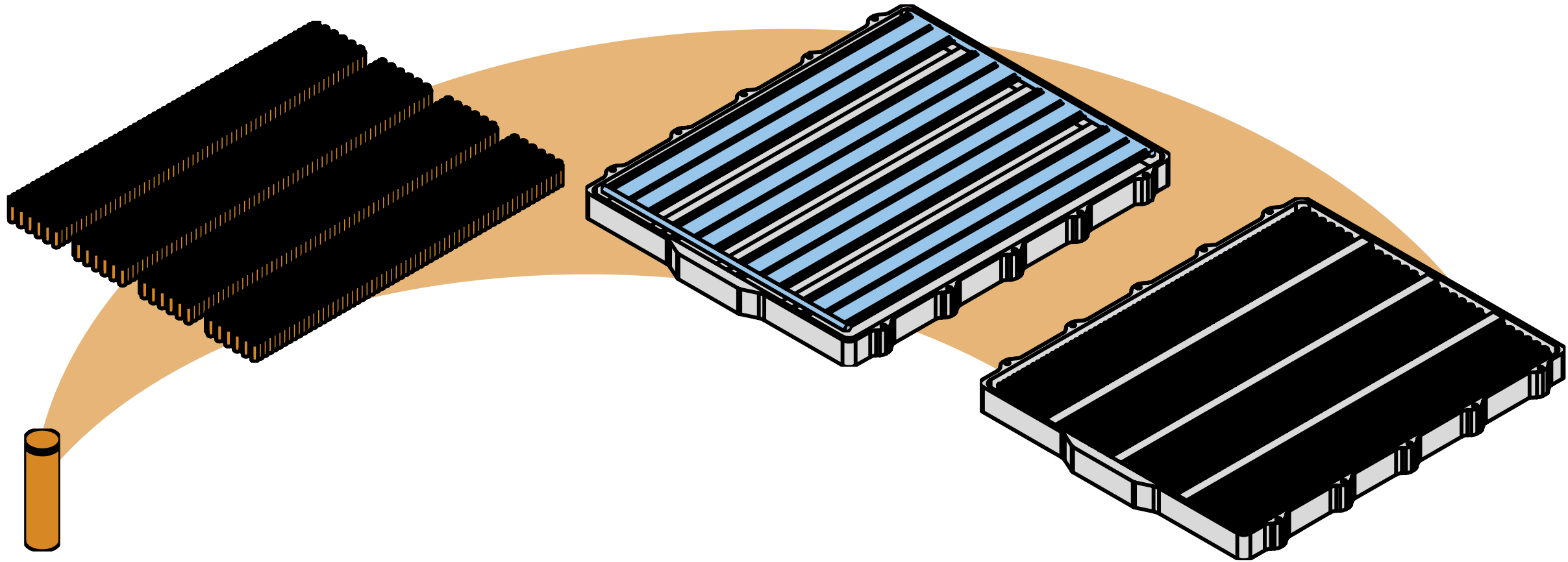
Exothermic Reaction



» [Inject Faults in Battery Models](#)

一些资料

Onramp and Training



入门教程以及培训: Simscape Battery Onramp Now Available

Training - Tasks

Course Overview > Battery Systems > (2/2) The Training Env

Task 1

This model represents a simple battery management system with a constant current-constant voltage charging algorithm. You will observe the battery operating between specified safe charging limits.

By the end of this course, you will create a model like this and add temperature influence on the battery charging algorithm.

For now, you can explore this model to familiarize yourself with the training environment.

TASK

Connect the signal named `BatteryPack_ChargeLevel` to the Scope block. Click **Run** and double-click the Scope block to observe the battery charging and discharging. The battery starts charging at 30% and then stops charging at 90%.

Click **Submit** to move to the next task.

Hint | See Solution | Reset

The diagram shows a battery pack model with 'iCell' and 'vCell' outputs. It is connected to a 'NewPack' block. A 'Scope' block is connected to the 'BatteryPack_ChargeLevel' signal. The circuit includes a 'Current' block, a 'Relay' block, and a 'ChargingEnabled' block. A 'Maximum Charging Current' block is set to 15, and a '-1' gain block is used to invert the current signal for discharging. The 'InitialSOC' block is set to [0.3, 0.3].

Self-Paced Online Courses

Home | My Courses | Online Training Suite

Simscape Battery Onramp

Start course

Learn the basics of simulating a simple battery management system (BMS) for safe charging/discharging in various temperatures. Use Simscape to simulate battery packs and their heat exchange and algorithms like coulomb counting and constant-current (CC) constant-voltage (CV) charging.

Course modules

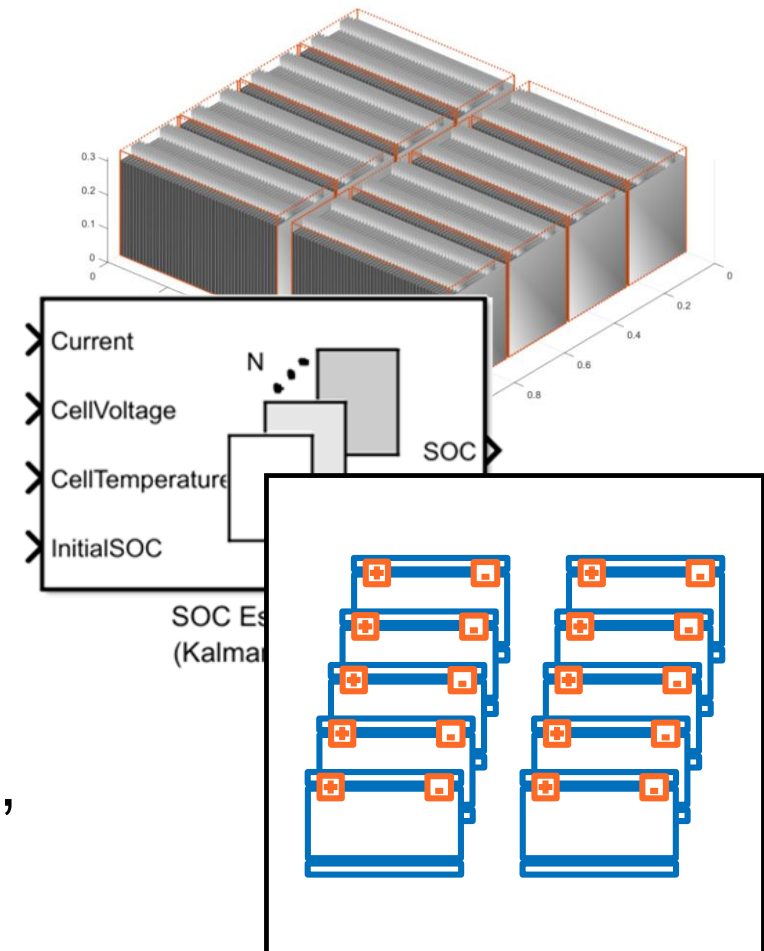
- [> Course Overview](#)
- [> Battery Discharging Circuit](#)
- [> Battery Pack Modeling](#)
- [> Battery Pack Charging Algorithm](#)
- [> Conclusion](#)

入门教程以及培训:

New Instructor-Led Training

After this two-day training you will be able to:

- Model a cell unit including thermal and fading characteristics
- Perform cell characterization
- Construct battery packs and attach cooling plates
- Estimate State-Of-Charge and State-Of-Health
- Design the key functionalities of a battery management system including supervisory control, cell balancing, and fault diagnosis



2024 MathWorks 中国汽车年会

谢谢!



冷却水道的离散化解析模型

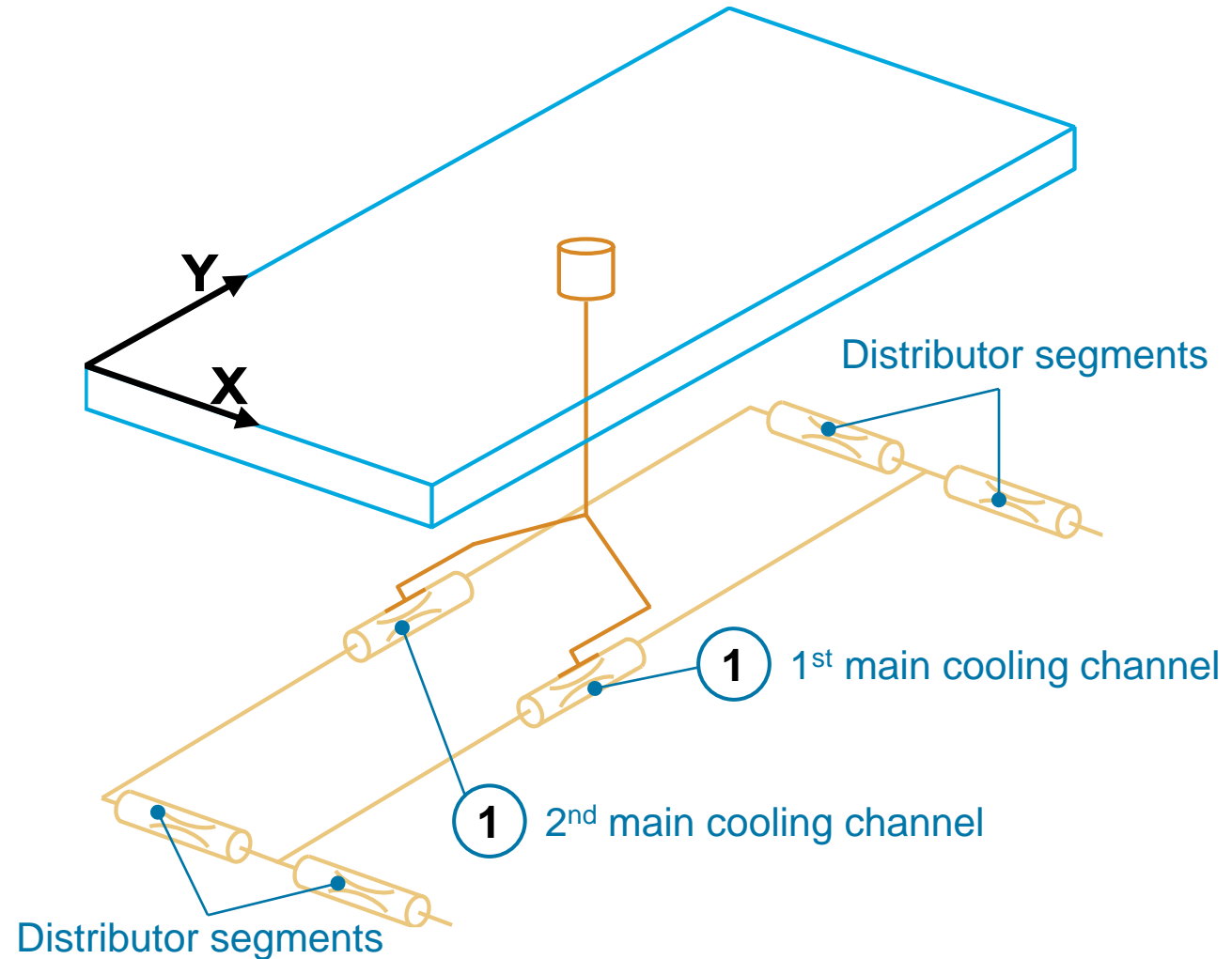
Parallel Channels Plate | Design | Number of Channels

Block Parameters: Parallel Channels

Parallel Channels Auto Apply

Settings Description

NAME	VALUE
> Interface	
> Plate Material	
> Fluid Properties	
> Design	
Number of coolant channels	2
Select channel orientation direction	Channels along Y axis
> Coolant channel hydraulic diameter	0.005 m
> Distributor pipe diameter	0.005*2 0.01 m
> Coolant channel and distributor roughn...	1.5e-05 m



冷却水道模型的离散化解析

Parallel Channels Plate | Design | Channel Orientation (in Y)

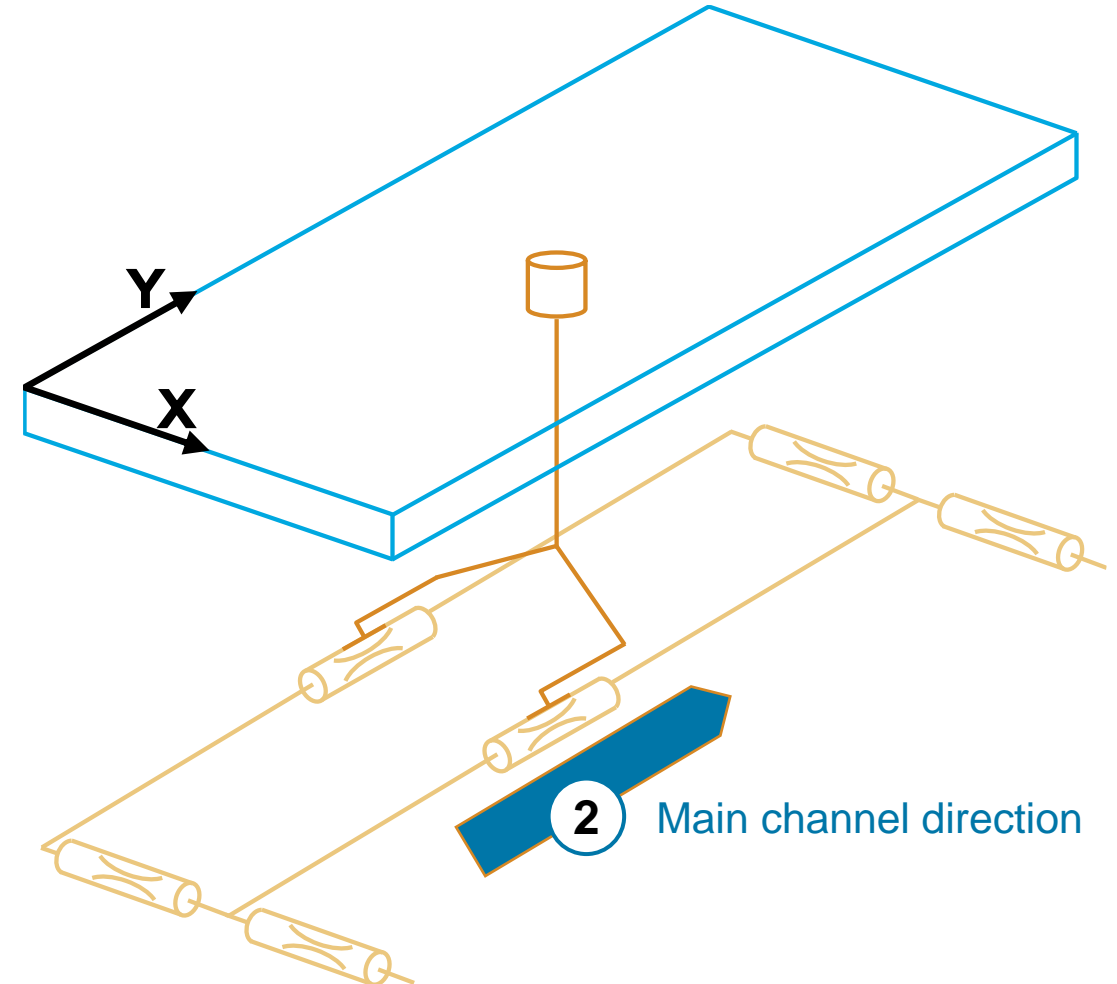
Block Parameters: Parallel Channels

Parallel Channels Auto Apply

Settings Description

NAME	VALUE
> Interface	
> Plate Material	
> Fluid Properties	
> Design	
Number of coolant channels	2
Select channel orientation direction	Channels along Y axis
> Coolant channel hydraulic diameter	0.005 m
> Distributor pipe diameter	0.005*2 0.01 m
> Coolant channel and distributor roughn...	1.5e-05 m

2



冷却水道模型的离散化解析

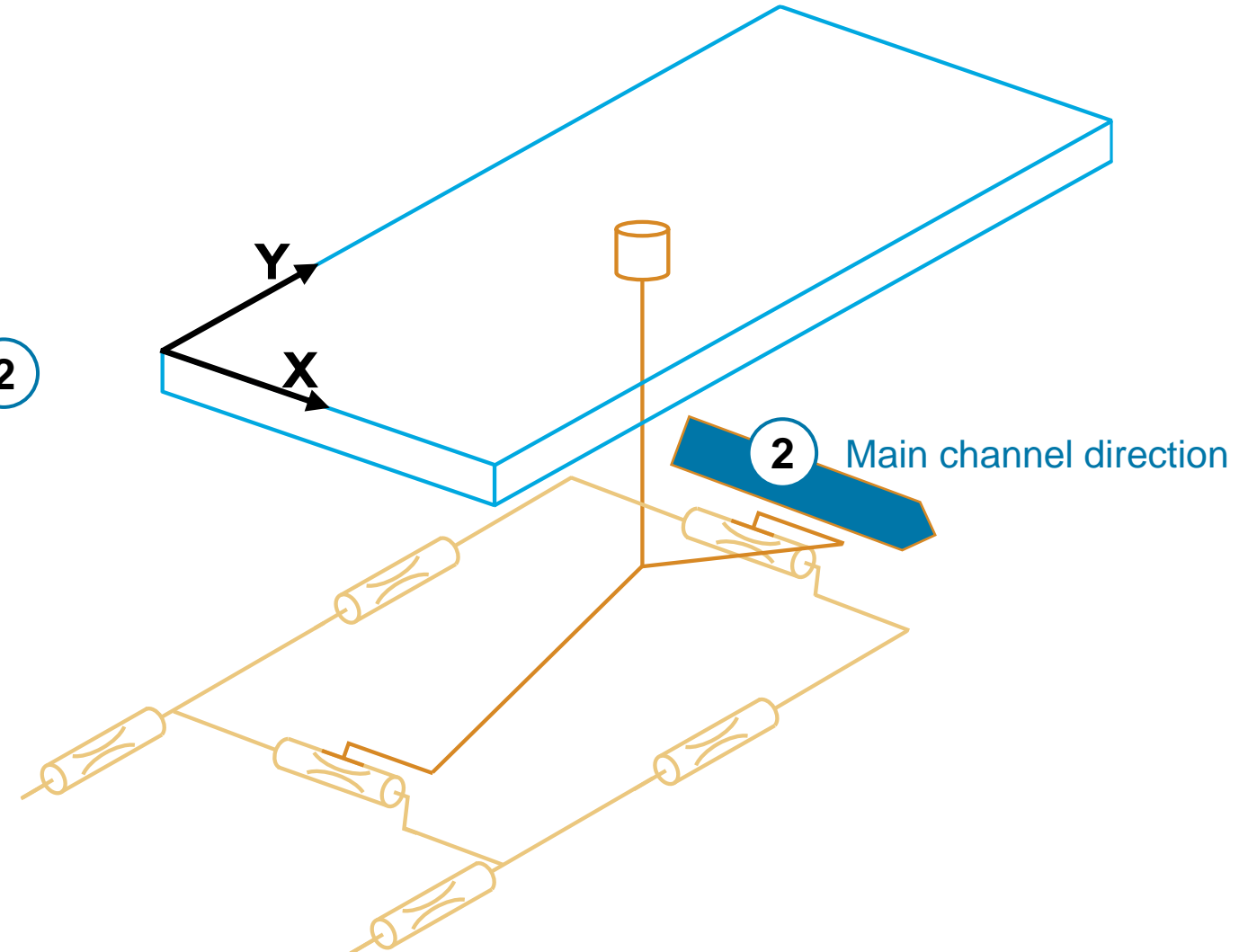
Parallel Channels Plate | Design | Channel Orientation (in X)

Block Parameters: Parallel Channels

Parallel Channels Auto Apply

Settings Description

NAME	VALUE
> Interface	
> Plate Material	
> Fluid Properties	
> Design	
Number of coolant channels	2
Select channel orientation direction	Channels along Y axis
> Coolant channel hydraulic diameter	0.005 m
> Distributor pipe diameter	0.005*2 0.01 m
> Coolant channel and distributor roughn...	1.5e-05 m



冷却水道模型的离散化解析

Parallel Channels Plate | Design | Channel & Distributor Diameters

Block Parameters: Parallel Channels

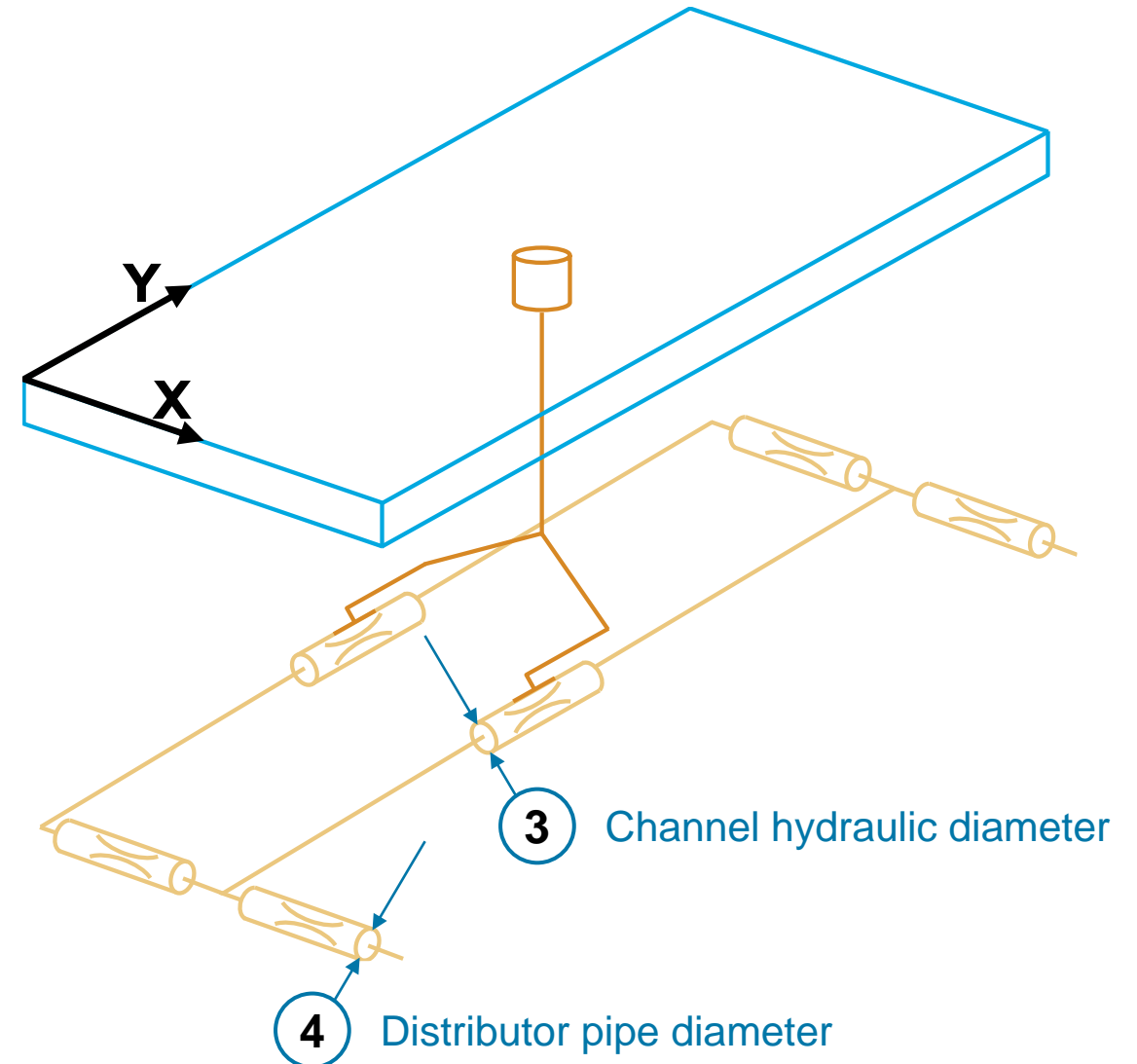
Parallel Channels Auto Apply

Settings Description

NAME	VALUE
> Interface	
> Plate Material	
> Fluid Properties	
> Design	
Number of coolant channels	2
Select channel orientation direction	Channels along Y axis
> Coolant channel hydraulic diameter	0.005 m
> Distributor pipe diameter	0.005*2 0.01 m
> Coolant channel and distributor roughn...	1.5e-05 m

3

4



冷却水道模型的离散化解析

Parallel Channels Plate | Design | Channel Roughness

Block Parameters: Parallel Channels

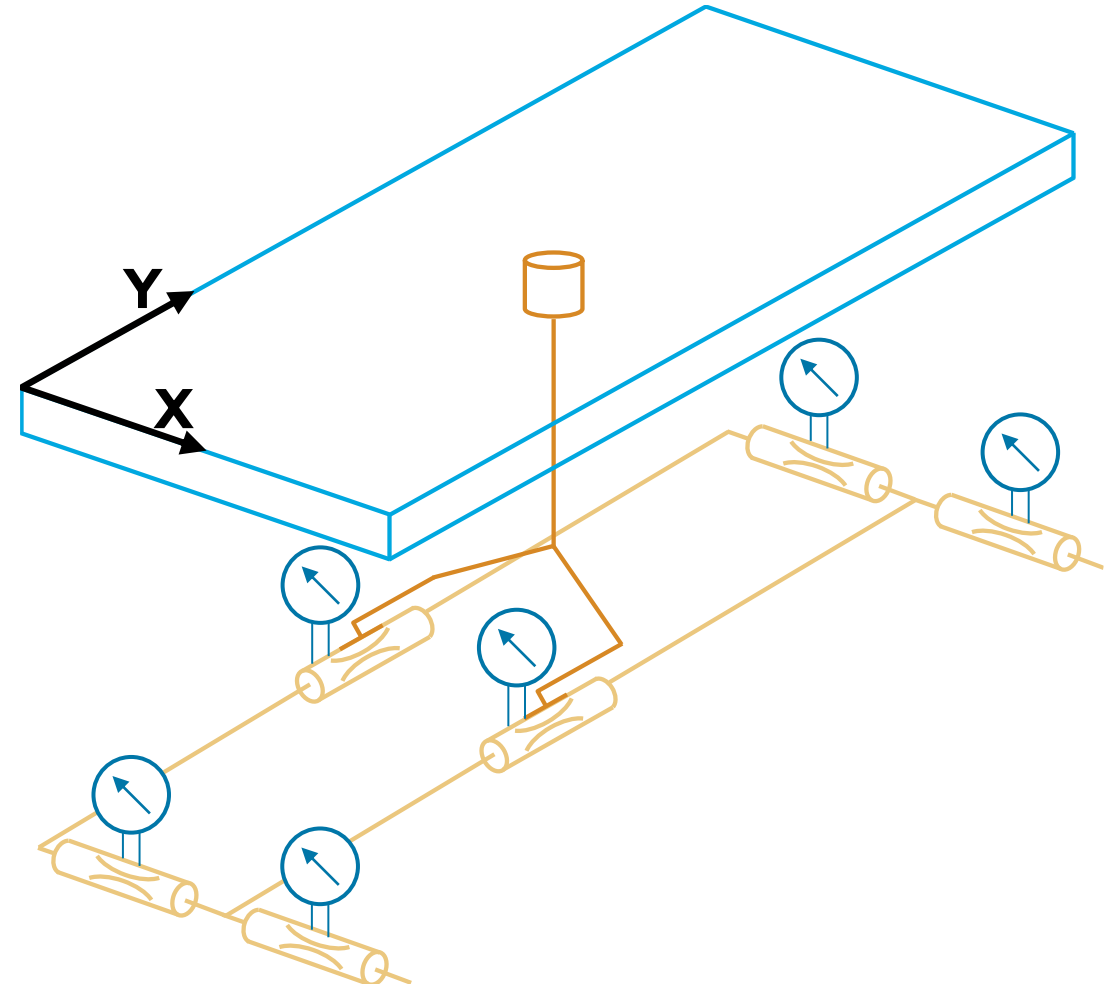
Parallel Channels Auto Apply

Settings Description

NAME	VALUE
> Interface	
> Plate Material	
> Fluid Properties	
> Design	
Number of coolant channels	2
Select channel orientation direction	Channels along Y axis
> Coolant channel hydraulic diameter	0.005 m
> Distributor pipe diameter	0.005*2 0.01 m
> Coolant channel and distributor roughness	1.5e-05 m

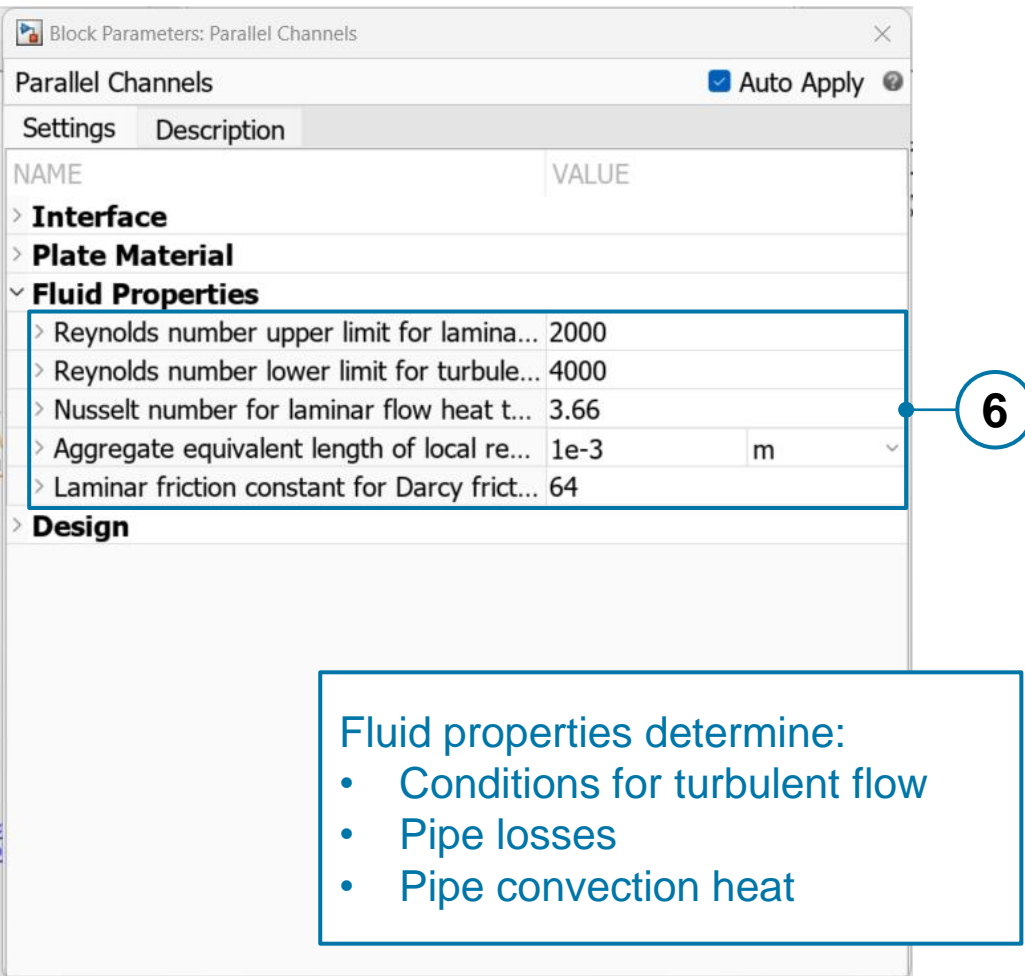
5

Roughness value is applied on all pipes (coolant channels and distributor pipes)



冷却水道模型的离散化解析

Parallel Channels Plate | Fluid Properties | Flow parameters



Block Parameters: Parallel Channels

Parallel Channels Auto Apply

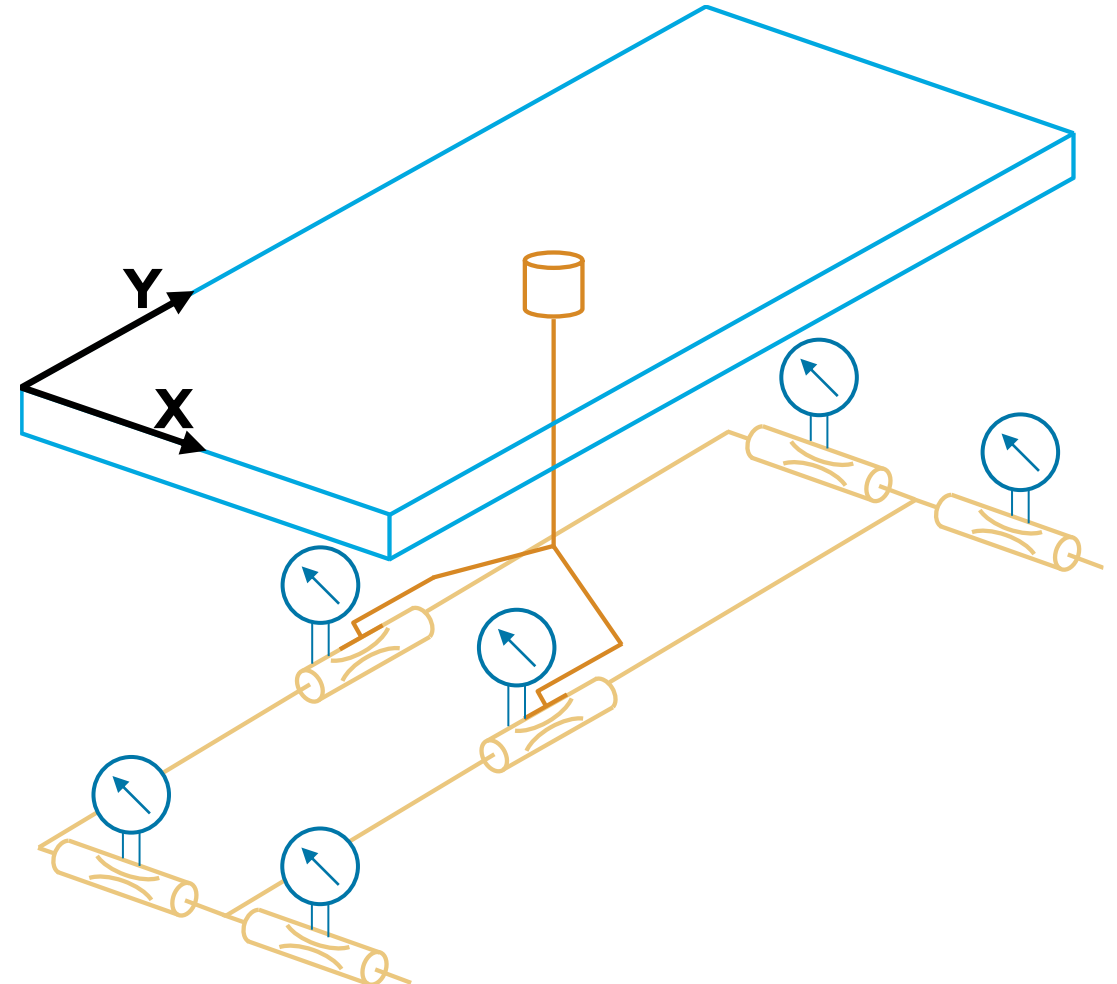
Settings Description

NAME	VALUE
> Interface	
> Plate Material	
> Fluid Properties	
> Reynolds number upper limit for lamina...	2000
> Reynolds number lower limit for turbule...	4000
> Nusselt number for laminar flow heat t...	3.66
> Aggregate equivalent length of local re...	1e-3 m
> Laminar friction constant for Darcy frict...	64
> Design	

6

Fluid properties determine:

- Conditions for turbulent flow
- Pipe losses
- Pipe convection heat



冷却水道模型的离散化解析

Parallel Channels Plate | Plate Material | Thickness

Block Parameters: Parallel Channels

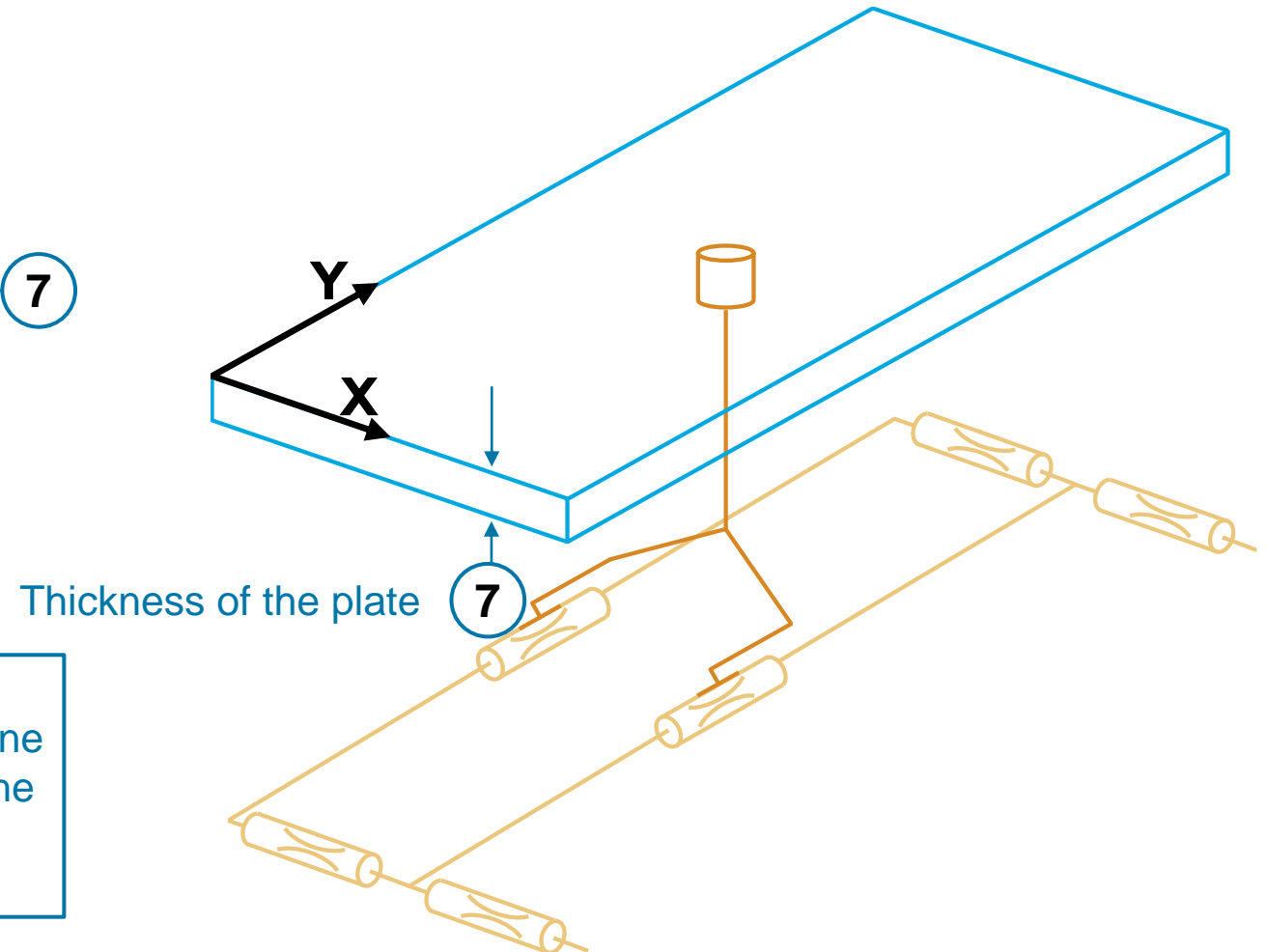
Parallel Channels Auto Apply

Settings Description

NAME	VALUE	
> Interface		
> Plate Material		
> Thickness of cooling plate material	2e-3	m
> Thermal conductivity of cooling plate m...	20	W/(K*m)
> Density of cooling plate material	2500	kg/m ³
> Specific heat of cooling plate material	447	J/(K*kg)
> Initial temperature of the cooling plate ...	300	K
> Fluid Properties		
> Design		

7

The thickness is used to determine the volume (and subsequently the thermal mass) of the plate



冷却水道模型的离散化解析

Parallel Channels Plate | Plate Material | Thermal Conductivity

Block Parameters: Parallel Channels

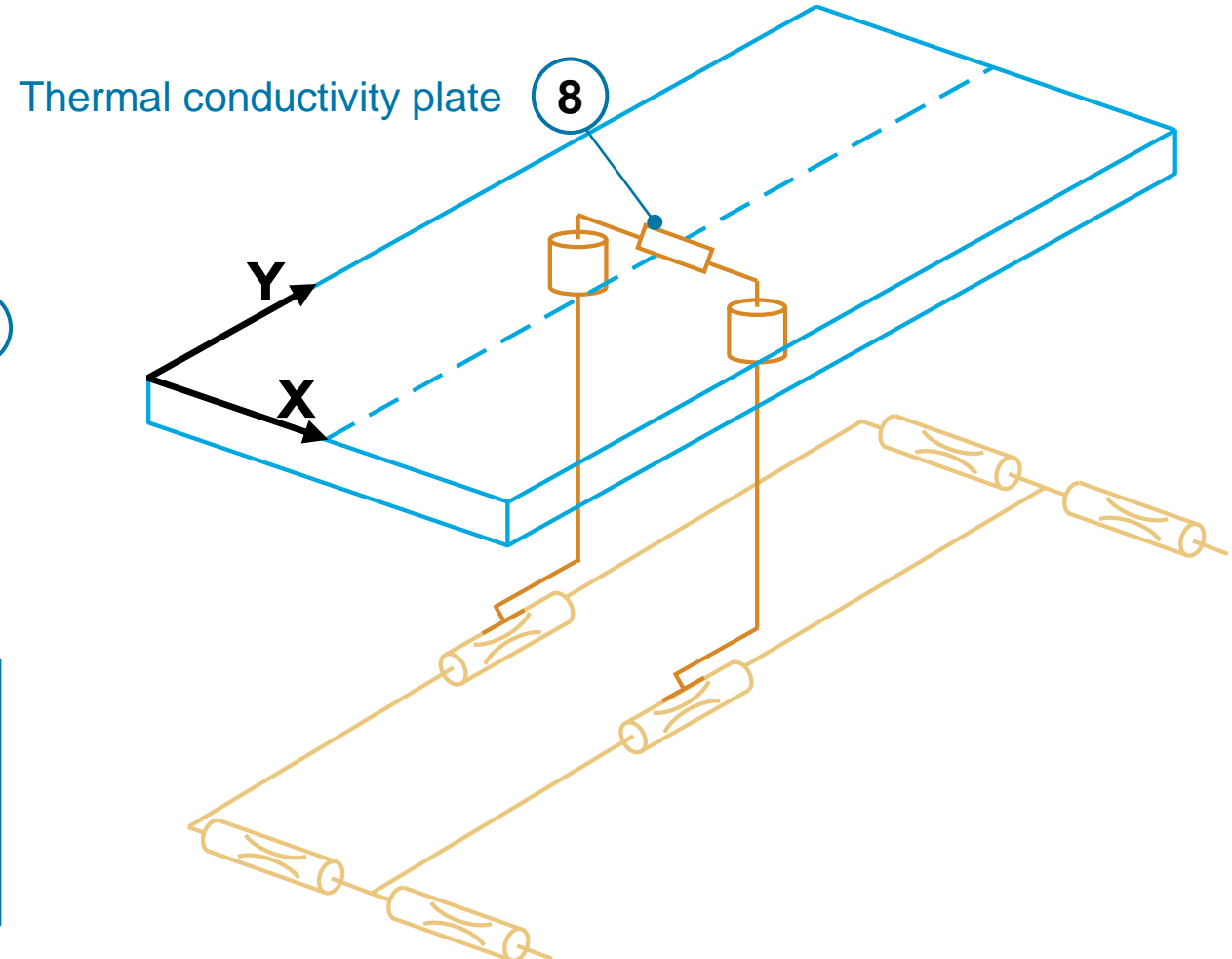
Parallel Channels Auto Apply

Settings Description

NAME	VALUE
> Interface	
> Plate Material	
> Thickness of cooling plate material	2e-3 m
> Thermal conductivity of cooling plate m...	20 W/(K*m)
> Density of cooling plate material	2500 kg/m ³
> Specific heat of cooling plate material	447 J/(K*kg)
> Initial temperature of the cooling plate ...	300 K
> Fluid Properties	
> Design	

8

Describes heat exchange between different plate segments



冷却水道模型的离散化解析

Parallel Channels Plate | Plate Material | Thermal parameters

Block Parameters: Parallel Channels

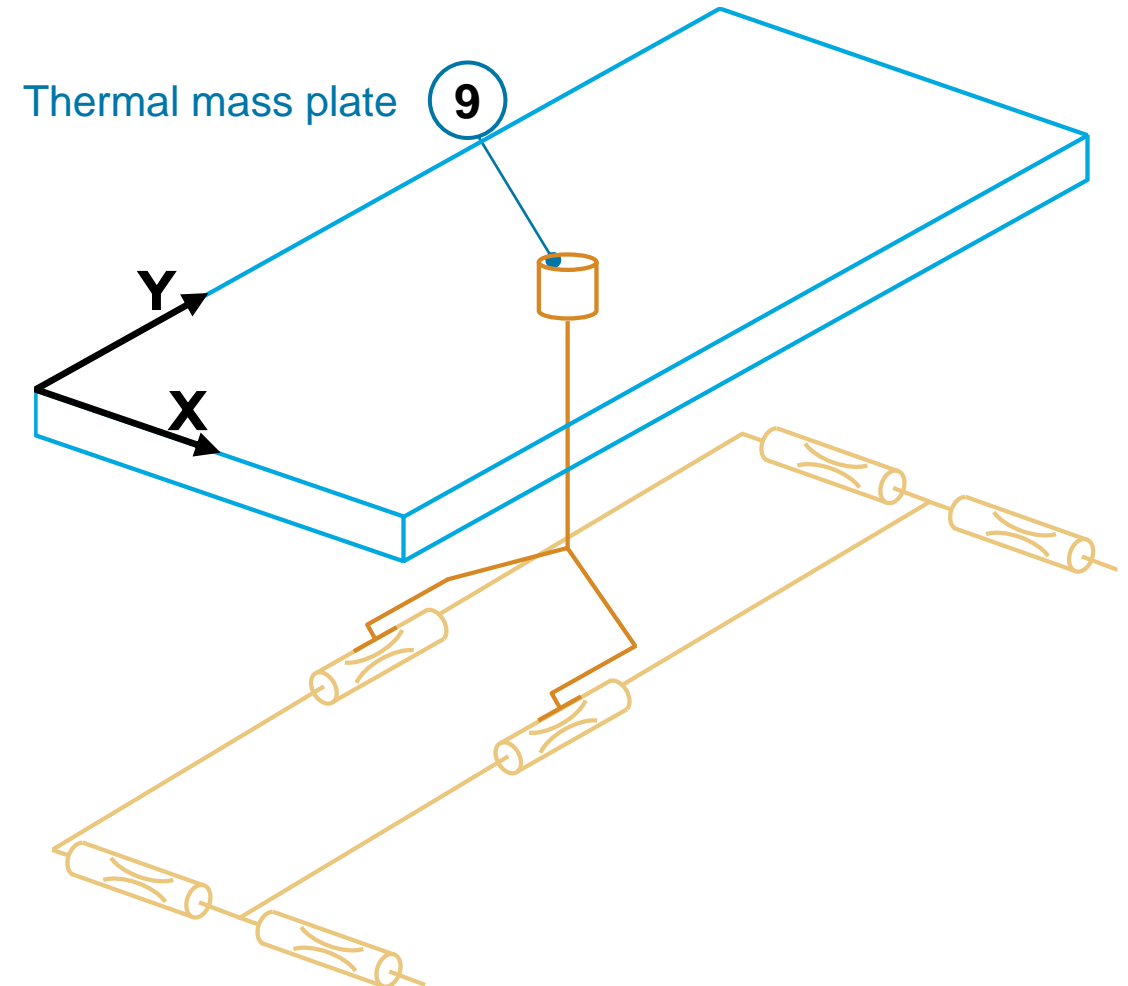
Parallel Channels Auto Apply

Settings Description

NAME	VALUE	
> Interface		
> Plate Material		
> Thickness of cooling plate material	2e-3	m
> Thermal conductivity of cooling plate m...	20	W/(K*m)
> Density of cooling plate material	2500	kg/m ³
> Specific heat of cooling plate material	447	J/(K*kg)
> Initial temperature of the cooling plate ...	300	K
> Fluid Properties		
> Design		

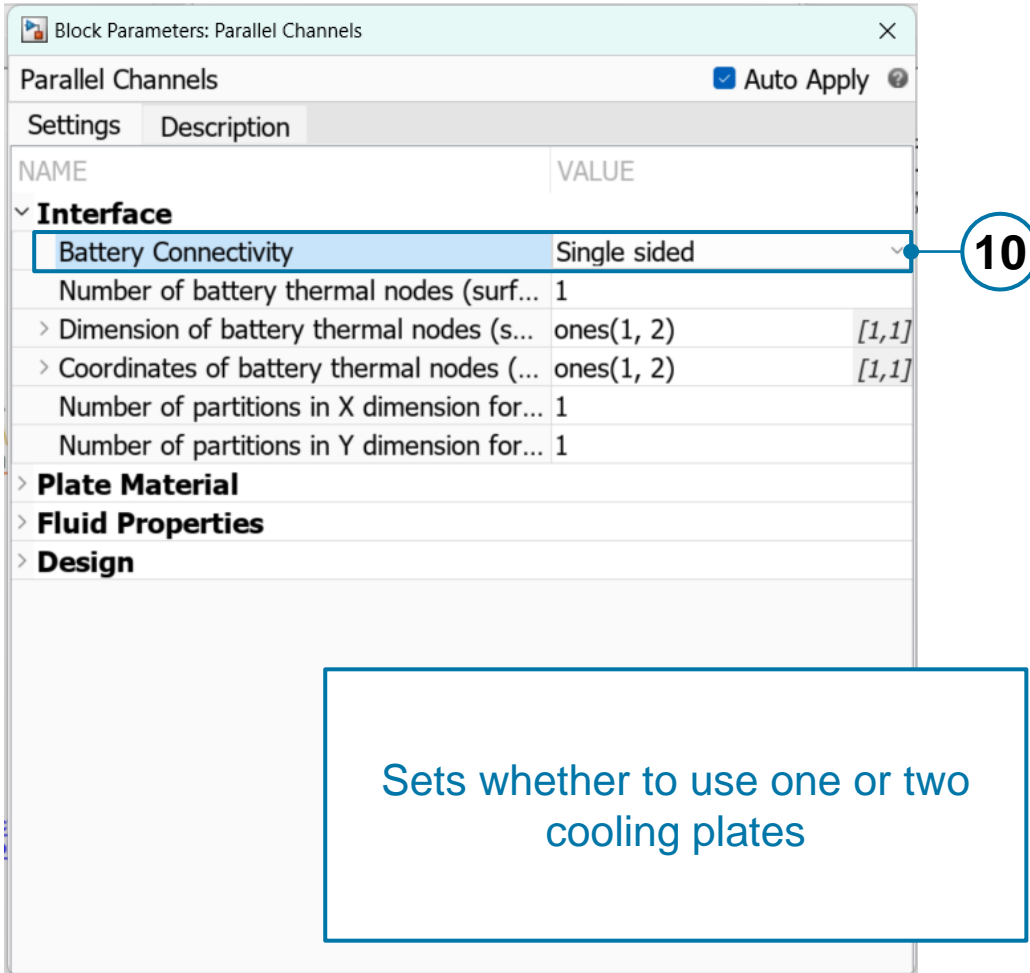
9

The density and specific heat are used to determine the thermal mass of the plate



冷却水道模型的离散化解析

Parallel Channels Plate | Interface | Battery Connectivity



Block Parameters: Parallel Channels

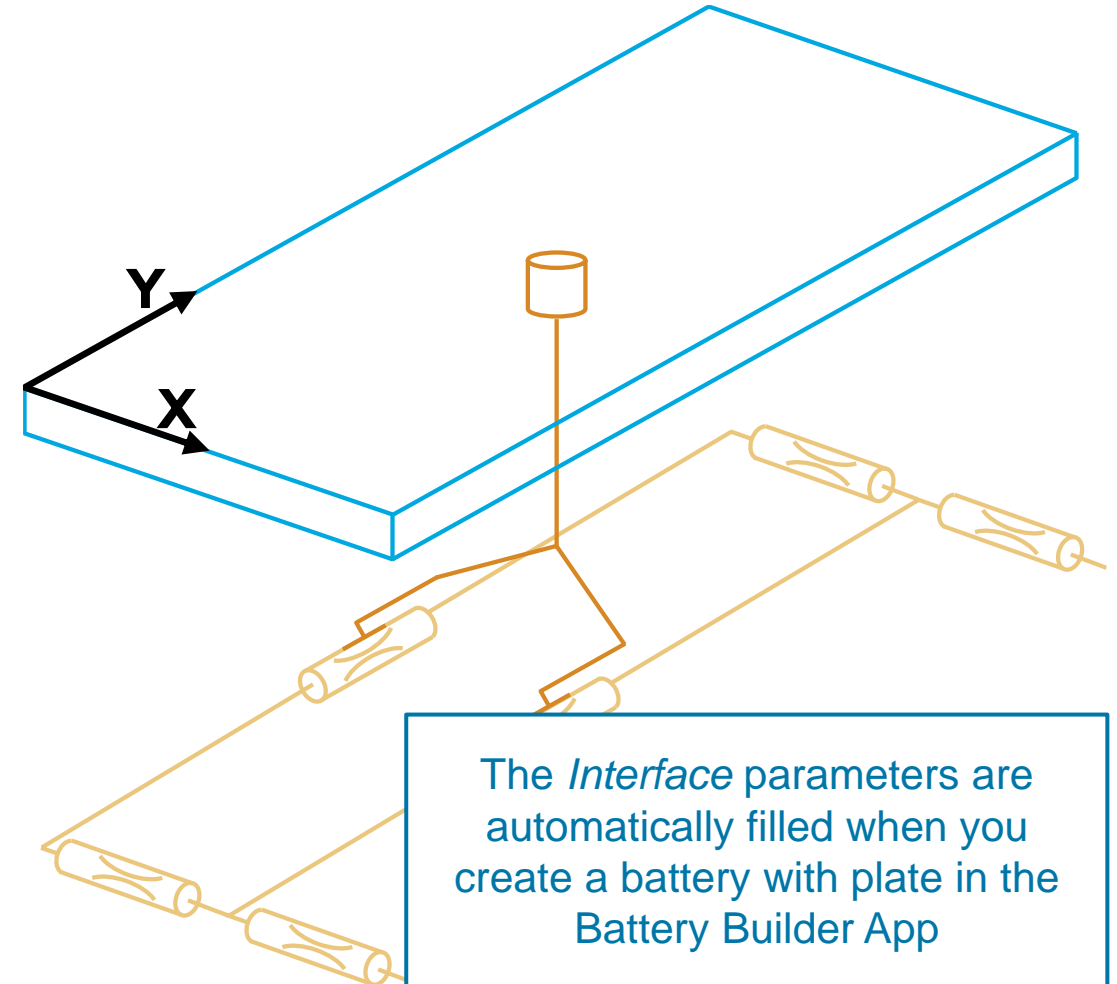
Parallel Channels Auto Apply

Settings Description

NAME	VALUE
Interface	
Battery Connectivity	Single sided
Number of battery thermal nodes (surf...	1
> Dimension of battery thermal nodes (s...	ones(1, 2) [1,1]
> Coordinates of battery thermal nodes (...)	ones(1, 2) [1,1]
Number of partitions in X dimension for...	1
Number of partitions in Y dimension for...	1
> Plate Material	
> Fluid Properties	
> Design	

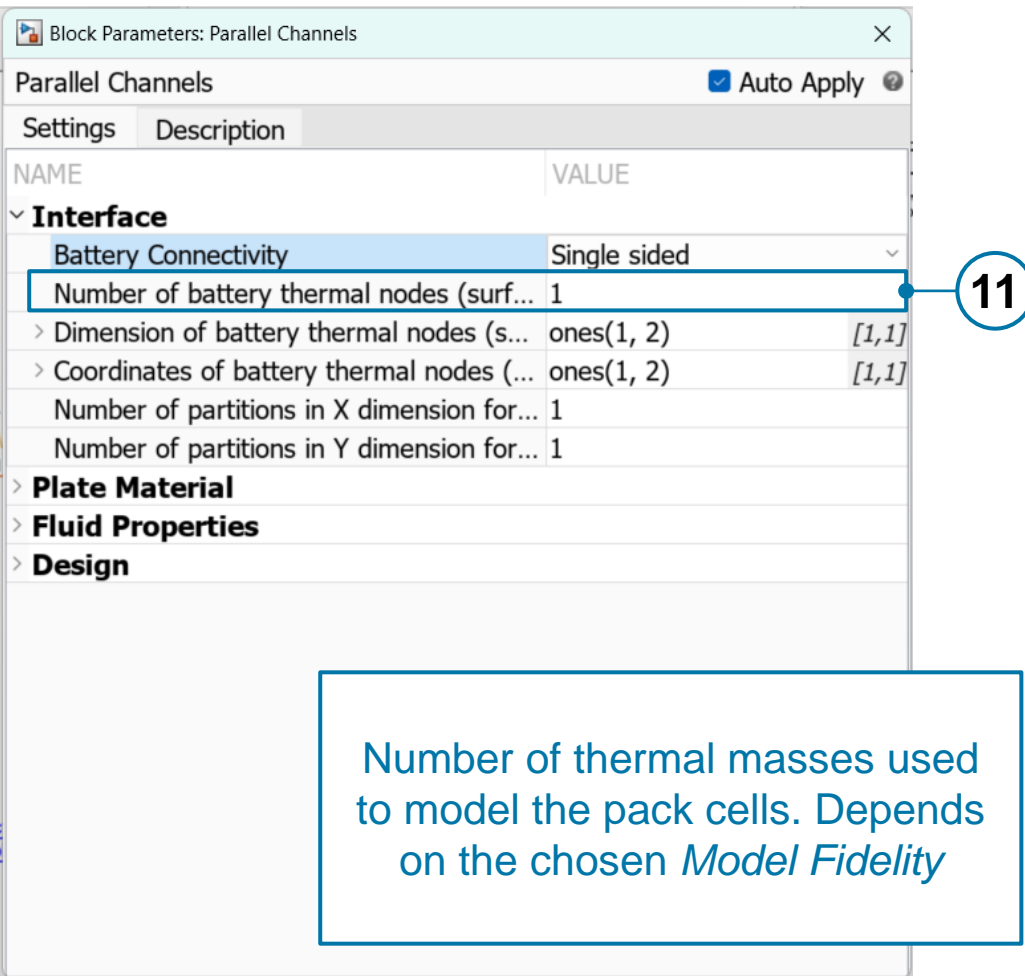
10

Sets whether to use one or two cooling plates



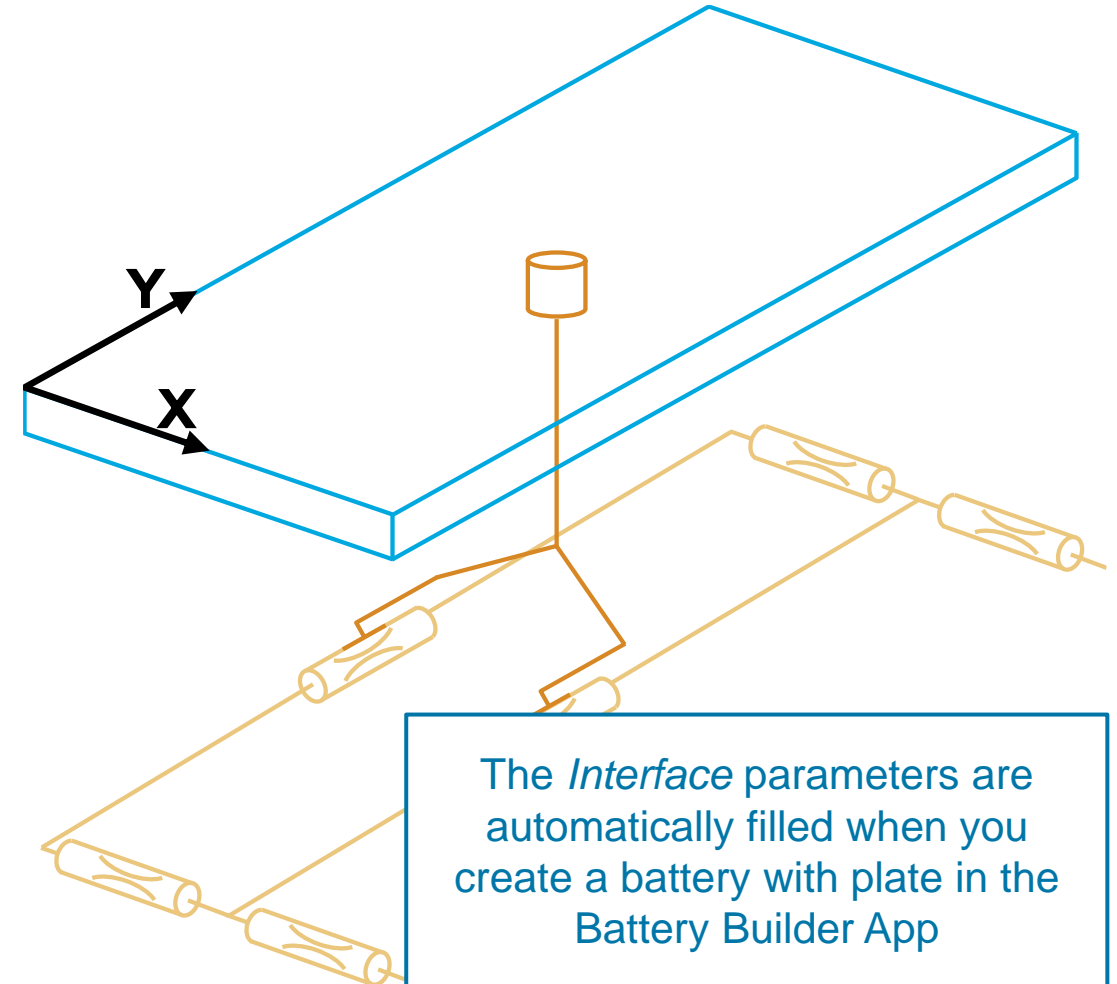
冷却水道模型的离散化解析

Parallel Channels Plate | Interface | Number of Battery Nodes



NAME	VALUE
Interface	
Battery Connectivity	Single sided
Number of battery thermal nodes (surf...)	1
> Dimension of battery thermal nodes (s...	ones(1, 2) [1,1]
> Coordinates of battery thermal nodes (...)	ones(1, 2) [1,1]
Number of partitions in X dimension for...	1
Number of partitions in Y dimension for...	1
Plate Material	
Fluid Properties	
Design	

Number of thermal masses used to model the pack cells. Depends on the chosen *Model Fidelity*



冷却水道模型的离散化解析

Parallel Channels Plate | Interface | Dimension and Position of Battery Nodes

Block Parameters: Parallel Channels

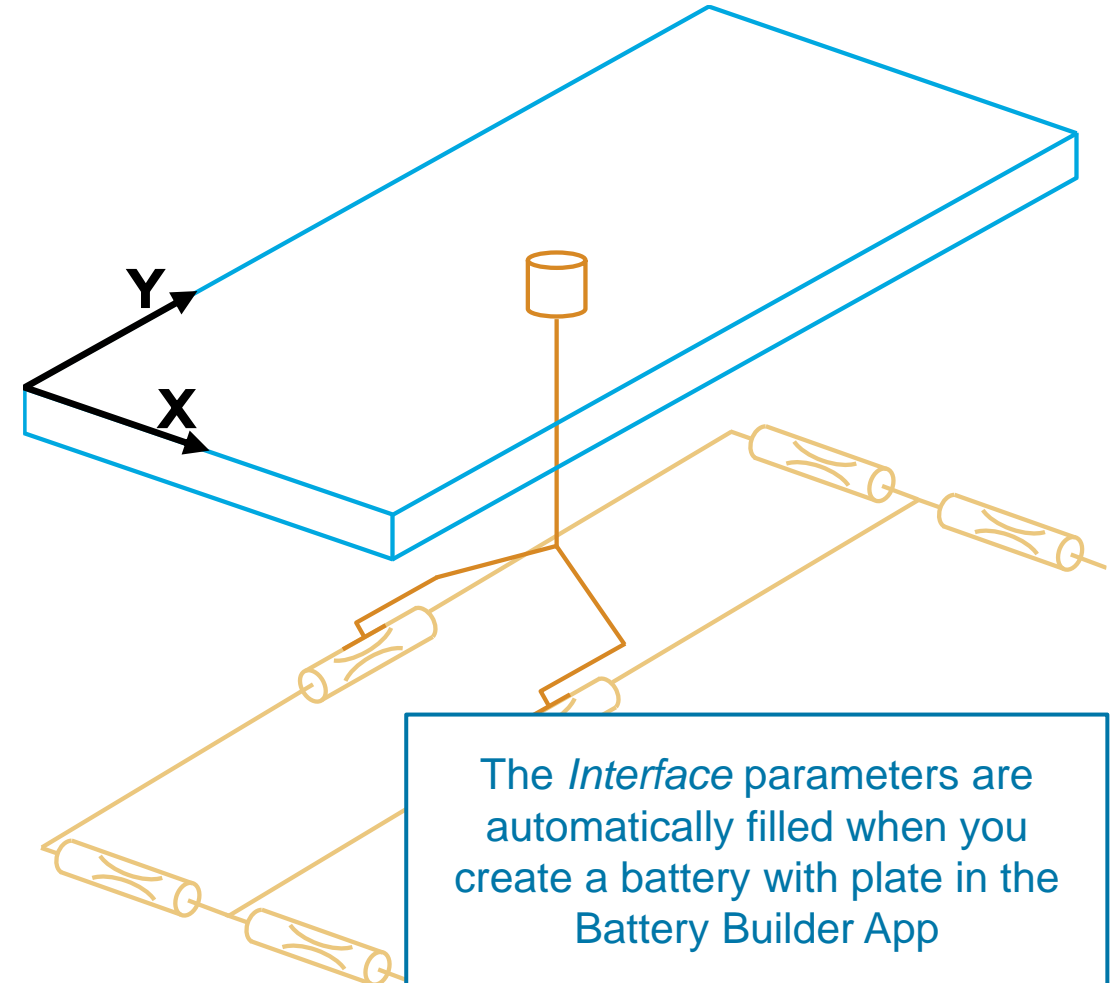
Parallel Channels Auto Apply

Settings Description

NAME	VALUE
Interface	
Battery Connectivity	Single sided
Number of battery thermal nodes (surf...	1
> Dimension of battery thermal nodes (s...	ones(1, 2) [1,1]
> Coordinates of battery thermal nodes (...)	ones(1, 2) [1,1]
Number of partitions in X dimension for...	1
Number of partitions in Y dimension for...	1
> Plate Material	
> Fluid Properties	
> Design	

12

Position AND dimensions of the battery cells. Needed to estimate where the cell are positioned and what the contact surface with the plate is



冷却水道模型的离散化解析

Parallel Channels Plate | Interface | Partitions

Block Parameters: Parallel Channels

Parallel Channels Auto Apply

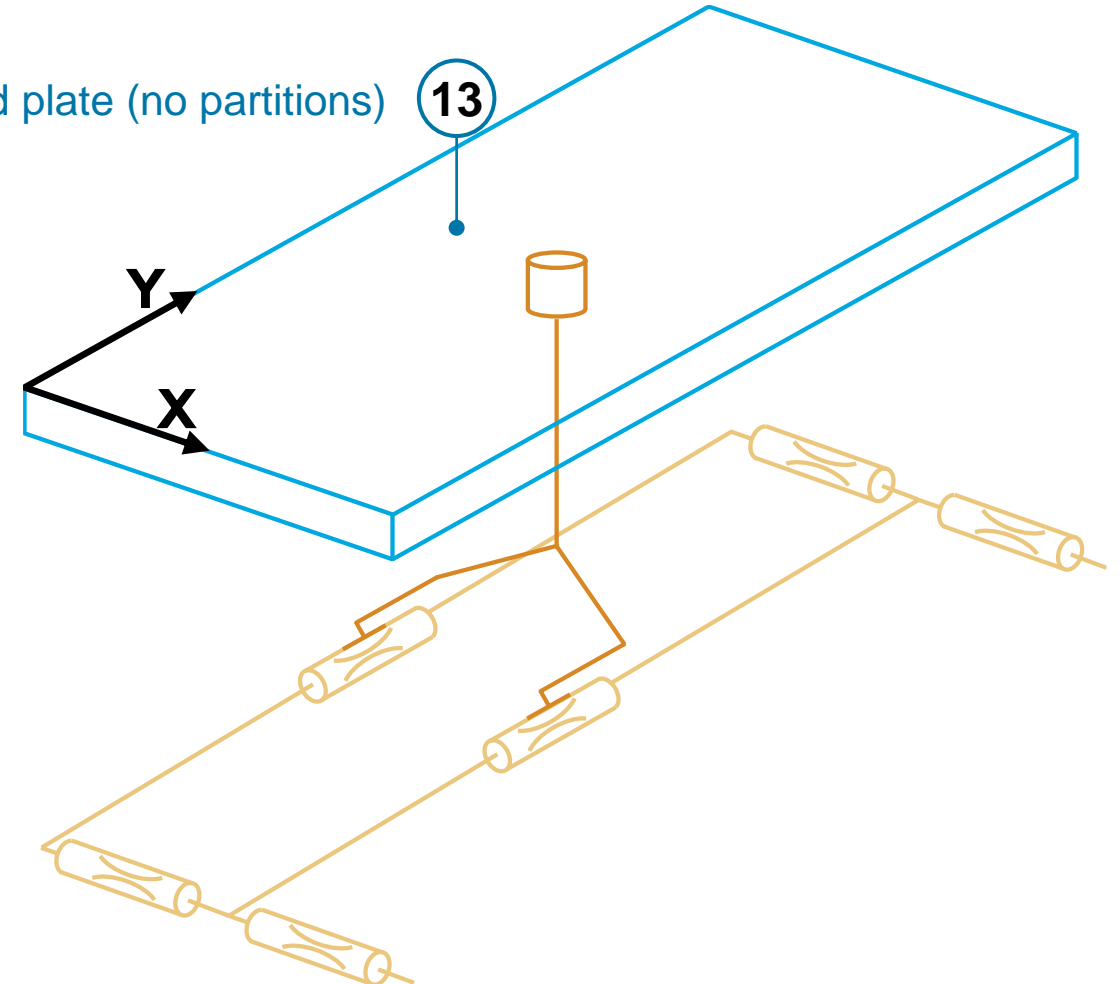
Settings Description

NAME	VALUE
Interface	
Battery Connectivity	Single sided
Number of battery thermal nodes (surf...)	1
> Dimension of battery thermal nodes (s...)	ones(1, 2) [1,1]
> Coordinates of battery thermal nodes (...)	ones(1, 2) [1,1]
Number of partitions in X dimension for...	1
Number of partitions in Y dimension for...	1
Plate Material	
Fluid Properties	
Design	

13

Discretization of the plate. In how many segments is the plate divided?

Lumped plate (no partitions)



冷却水道模型的离散化解析

Parallel Channels Plate | Interface | Partitions

Block Parameters: Parallel Channels

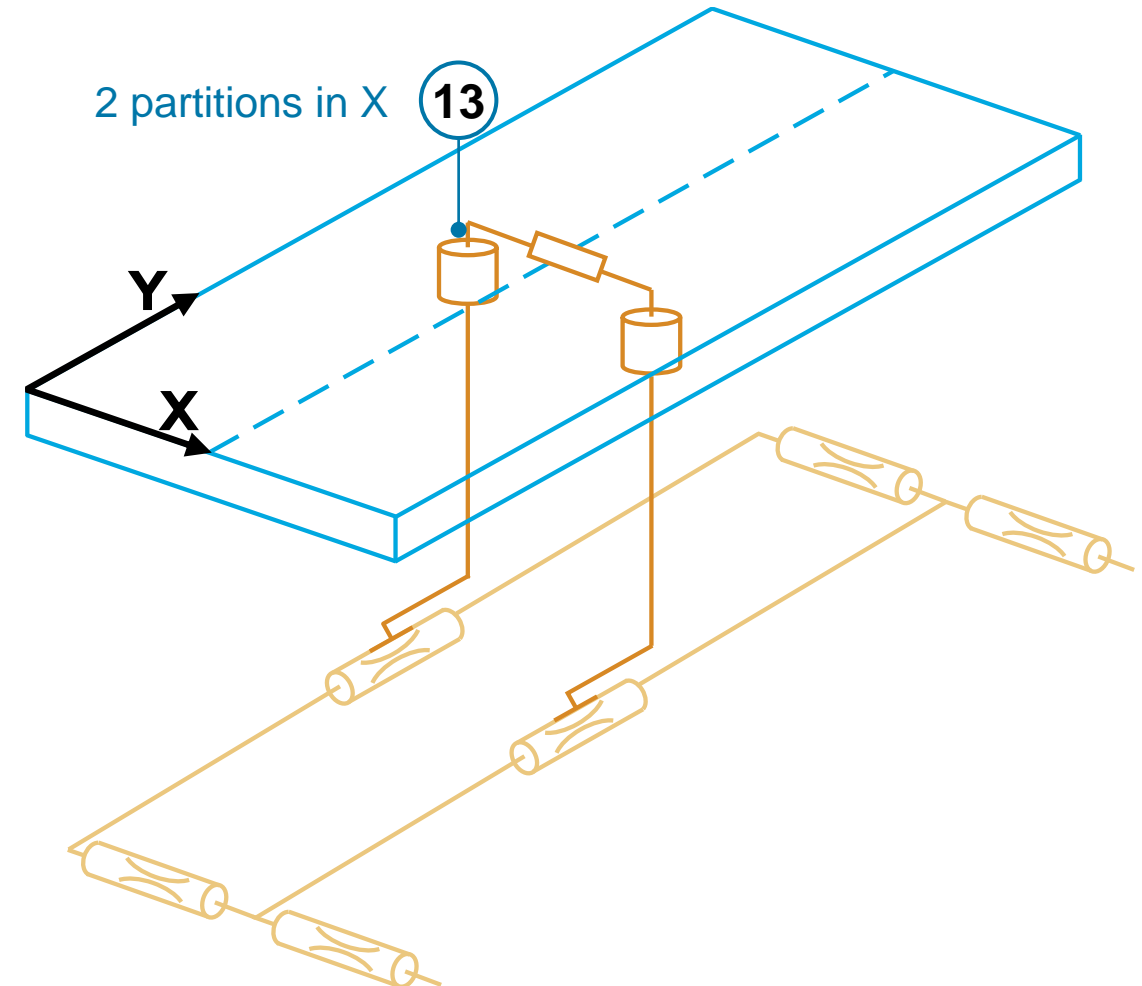
Parallel Channels Auto Apply

Settings Description

NAME	VALUE
Interface	
Battery Connectivity	Single sided
Number of battery thermal nodes (surf...	1
> Dimension of battery thermal nodes (s...	ones(1, 2) [1,1]
> Coordinates of battery thermal nodes (...)	ones(1, 2) [1,1]
Number of partitions in X dimension for...	1
Number of partitions in Y dimension for...	1
Plate Material	
Fluid Properties	
Design	

13

Discretization of the plate. In how many segments is the plate divided?



冷却水道模型的离散化解析

Parallel Channels Plate | Interface | Partitions

Block Parameters: Parallel Channels

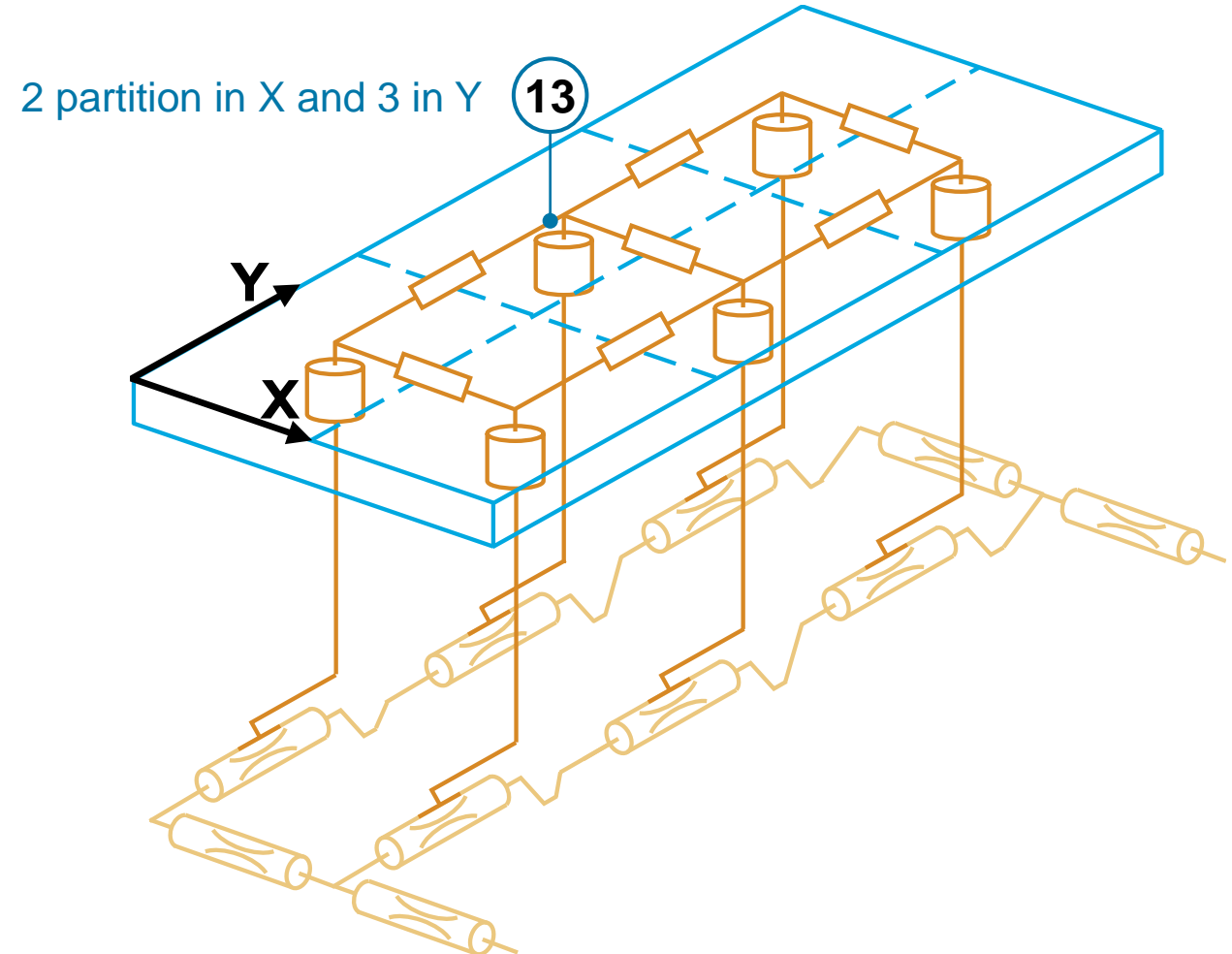
Parallel Channels Auto Apply

Settings Description

NAME	VALUE
Interface	
Battery Connectivity	Single sided
Number of battery thermal nodes (surf...	1
> Dimension of battery thermal nodes (s...	ones(1, 2) [1,1]
> Coordinates of battery thermal nodes (...)	ones(1, 2) [1,1]
Number of partitions in X dimension for...	1
Number of partitions in Y dimension for...	1
Plate Material	
Fluid Properties	
Design	

13

Discretization of the plate. In how many segments is the plate divided?



R2023b

R2024a