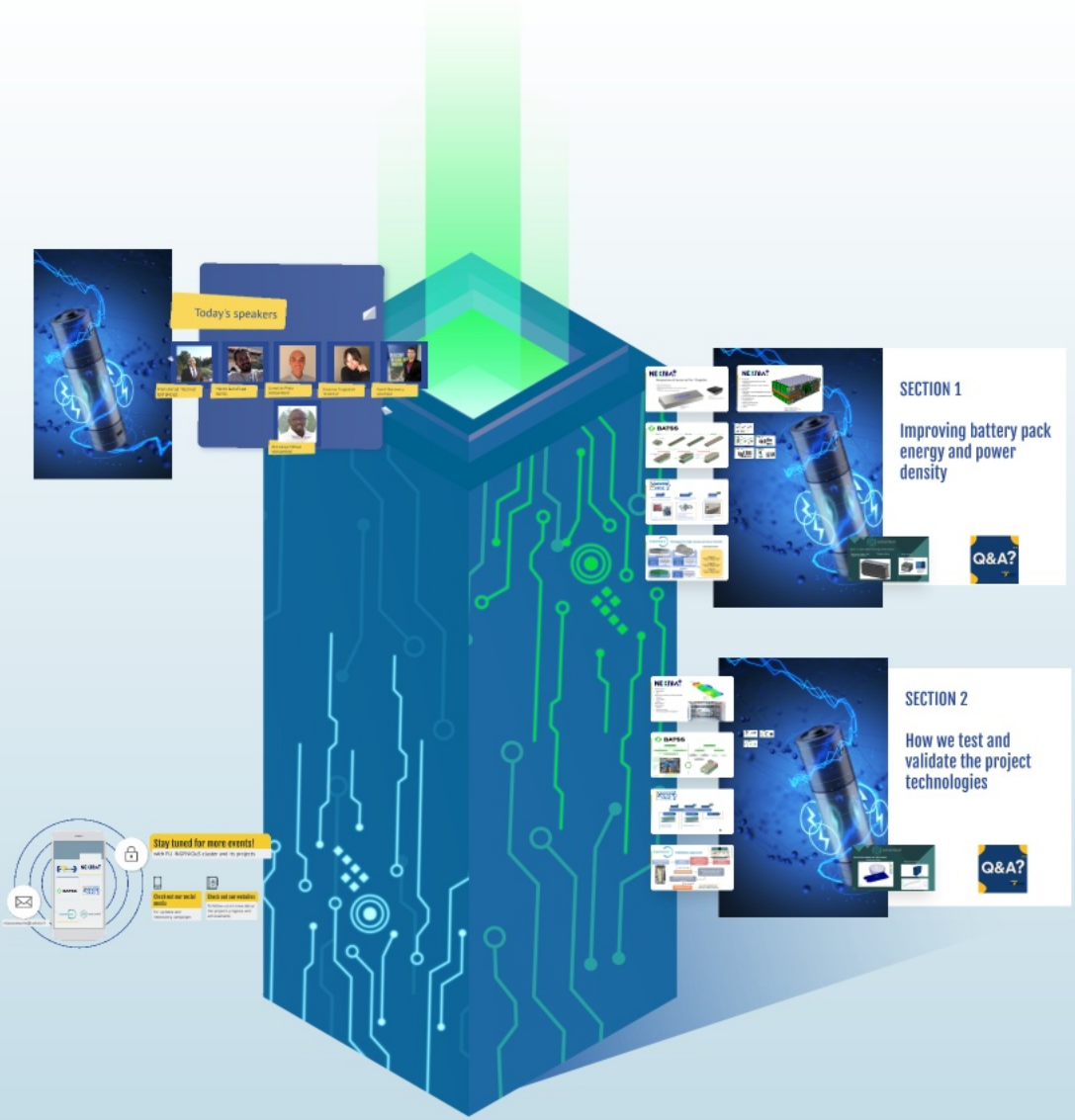
EU-IGENIOUS BATTERY CLUSTER

NEXT GENERATION BATTERY SYSTEMS: SMART PACKING FOR MAXIMUM POWER



6 November 2025

NEXTBAT BATSS VersaPRINT TEMPEST extended

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VERSAPRINT

Katarina Fragiadaki
TEMPEST

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NEXTBAT

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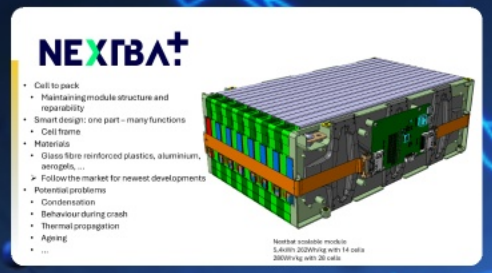
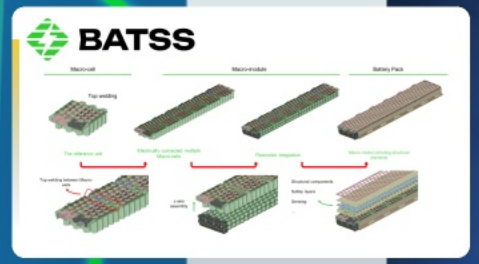
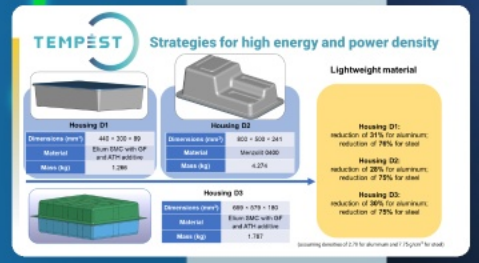
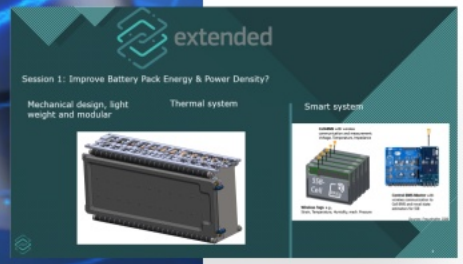
VERSAPRINT









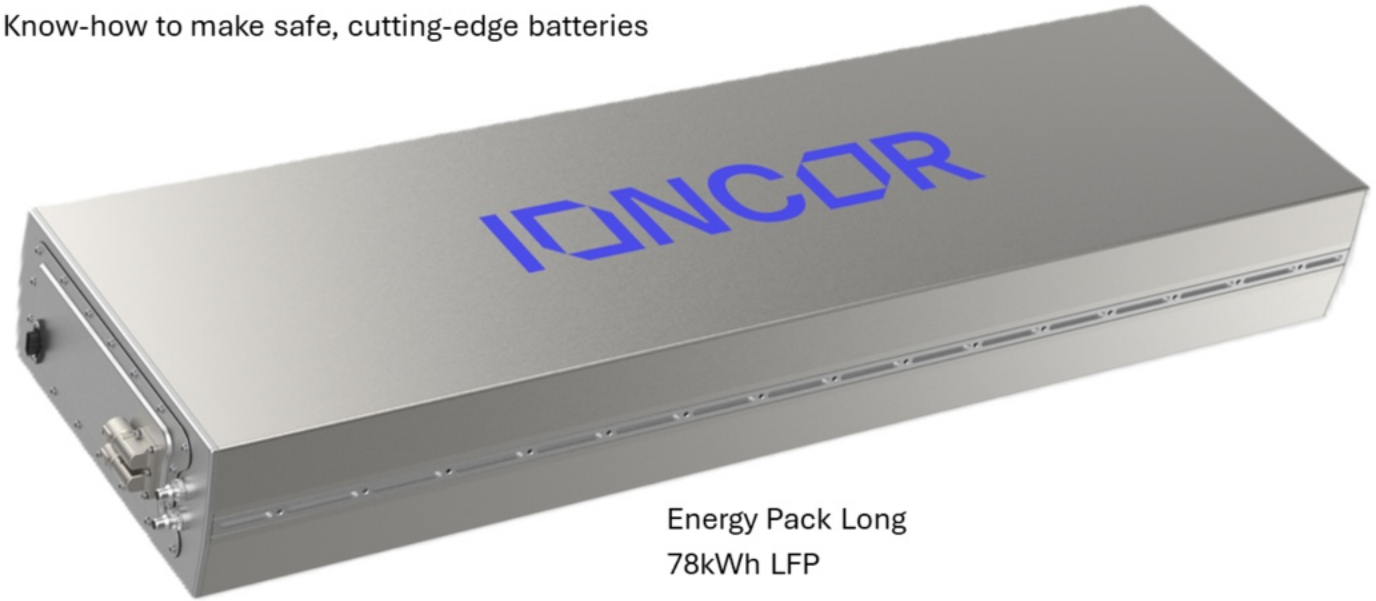
SECTION 1

Improving battery pack energy and power density

NEXTBAT

Perspective of Ioncor as Tier 1 Supplier

- Over 3 million batteries built
- Expertise with serial production
- Strong understanding of automotive, heavy duty and off-highway use cases
  - ➢ Know-how to make safe, cutting-edge batteries

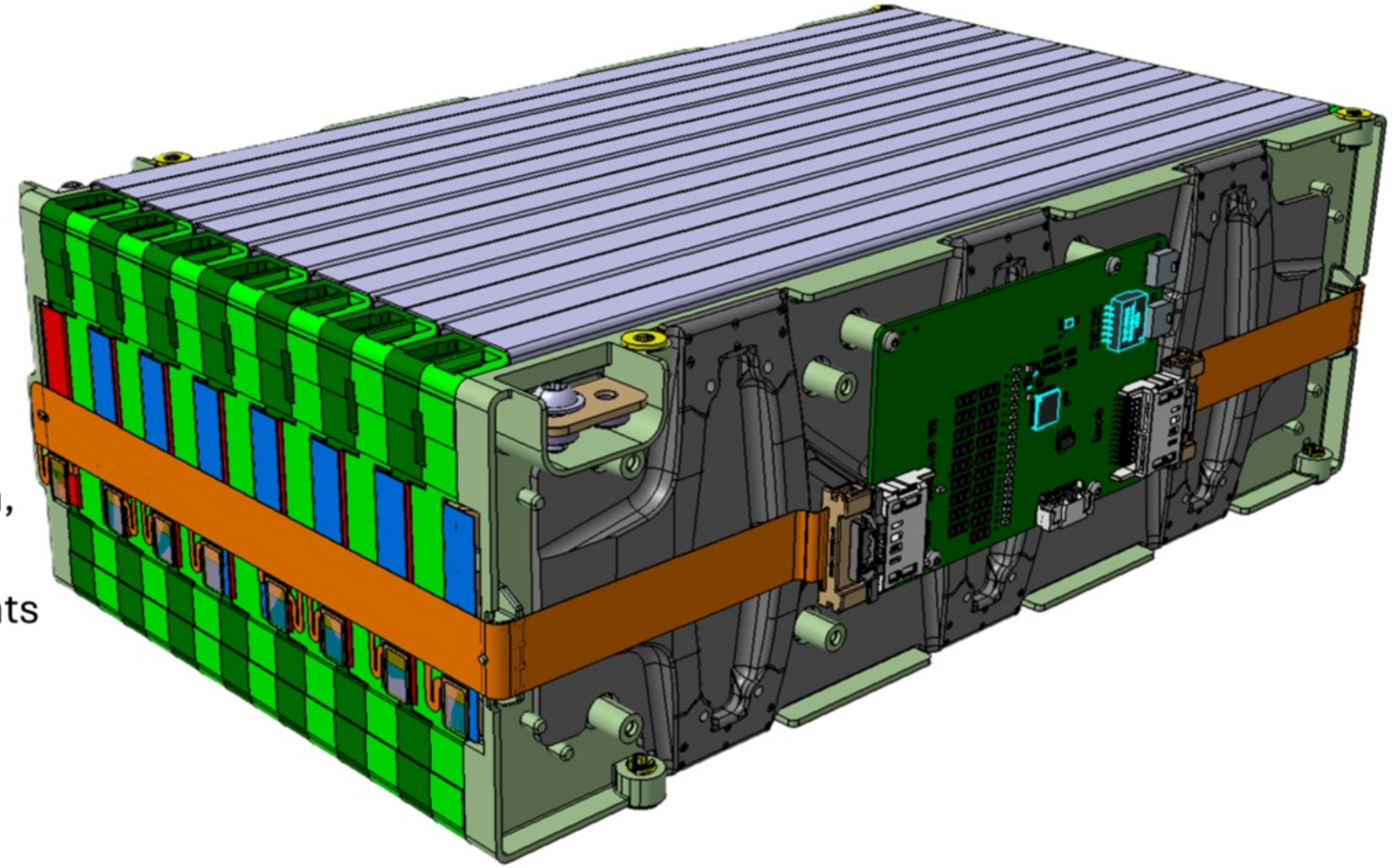


Energy Pack Long
78kWh LFP

Power Pack
40kW peak power from 2kWh LTO

NEXTBAT+

- Cell to pack
  - Maintaining module structure and reparability
- Smart design: one part – many functions
  - Cell frame
- Materials
  - Glass fibre reinforced plastics, aluminium, aerogels, …
  - ➢ Follow the market for newest developments
- Potential problems
  - Condensation
  - Behaviour during crash
  - Thermal propagation
  - Ageing
  - …



Nextbat scalable module
5,4kWh 262Wh/kg with 14 cells
280Wh/kg with 28 cells

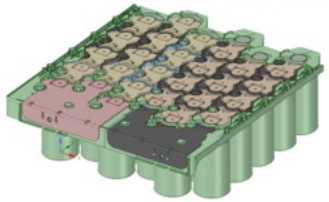
BATSS

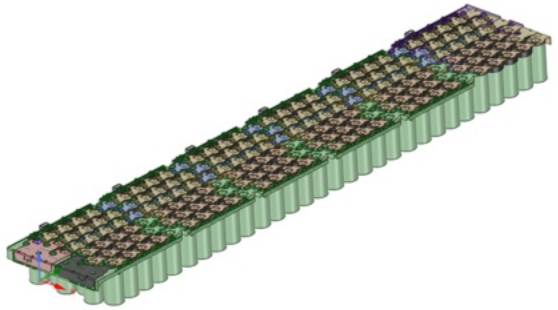
Macro-cell

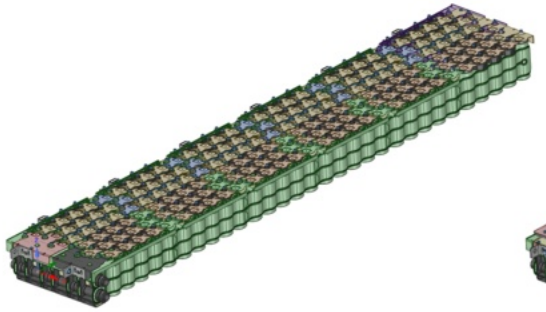
Macro-module

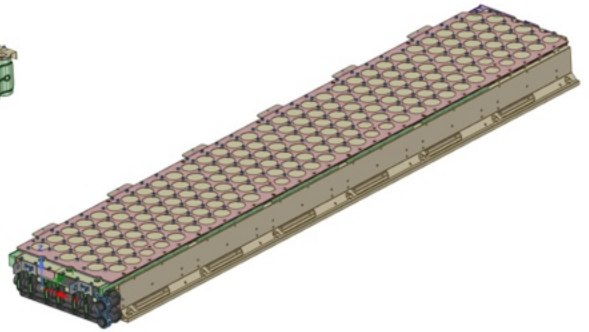
Battery Pack

Top welding









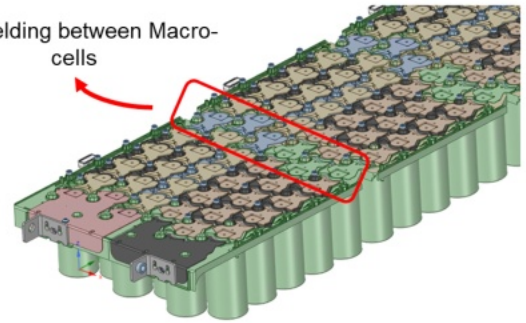
The reference unit

Electrically connected multiple Macro-cells

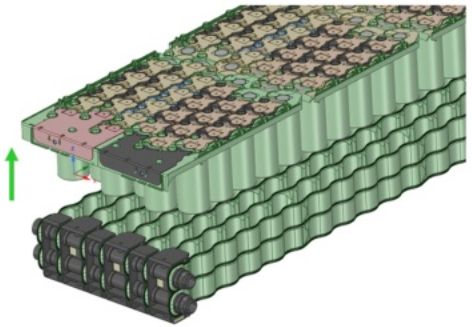
Flexcooler integration

Macro-modul including structural elements

Top welding between Macro-cells



z-axis assembly

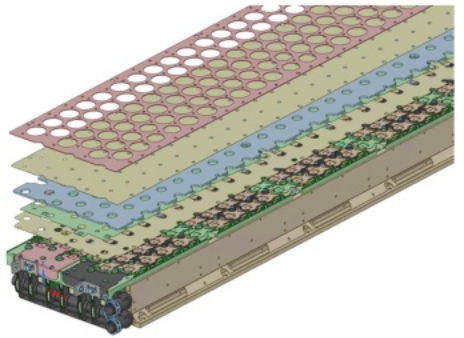


Structural components

Safety layers

Sensing

…



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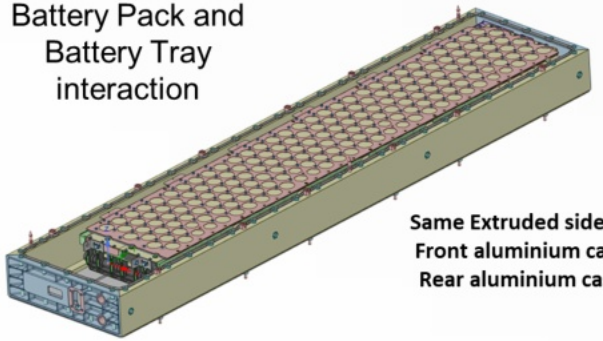
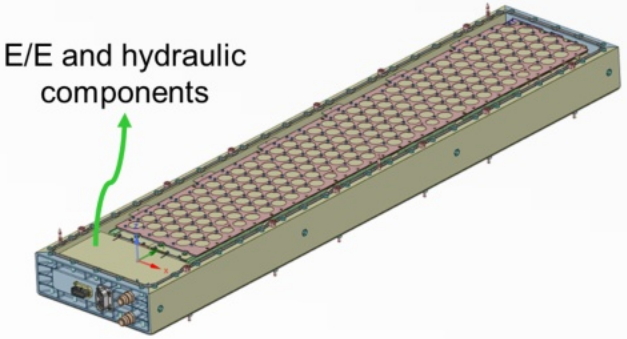
Battery Pack and Battery Tray interaction

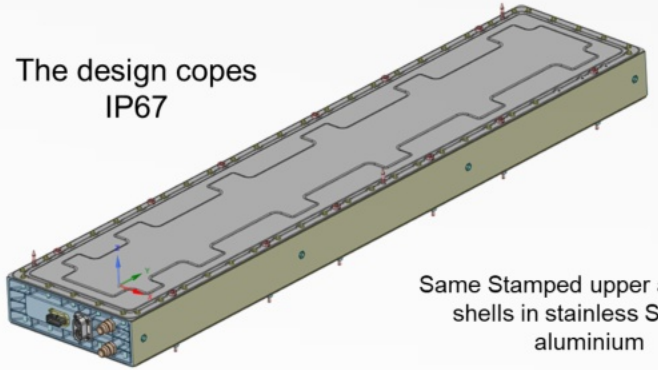


Same Extruded side walls
Front aluminium casting
Rear aluminium casting

E/E and hydraulic components

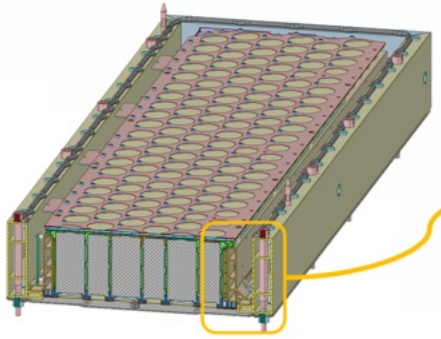


The design copes IP67

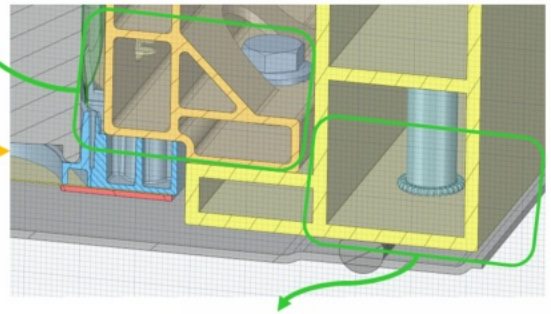


Same Stamped upper and lower shells in stainless Steel or aluminium

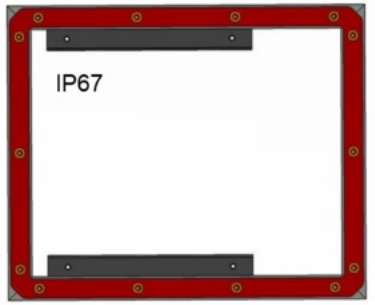
Battery Pack and Battery Tray **interaction** — E/E and hydraulic components integration — Battery Tray enclosure by shells



Battery Pack



Battery Tray



Seal thickness of 2,0 mm for better alignment with the final rivet height

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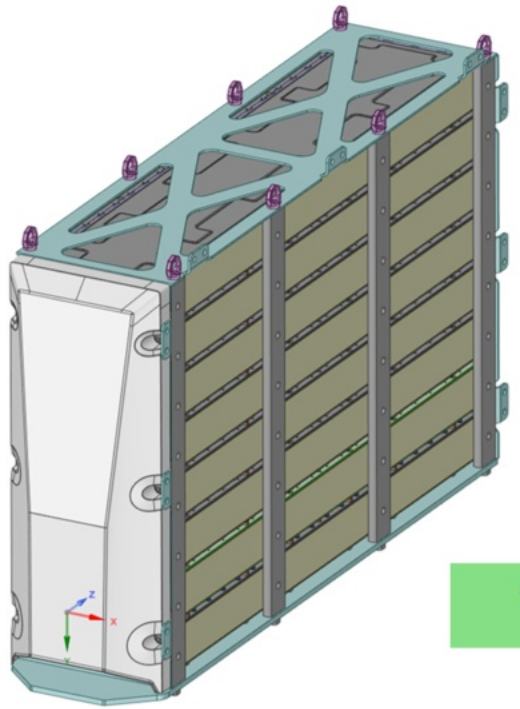
Marine application



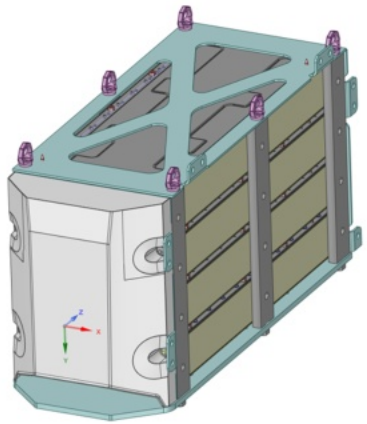
(L X W X H) (mm)

Tray → 2000 X 450 X 142 (1 level)
Housing → 2000 X 450 X 1200 (8 stacked)

Modular and scalable characteristics

Same design **concept** for **different applications**

Off-road application



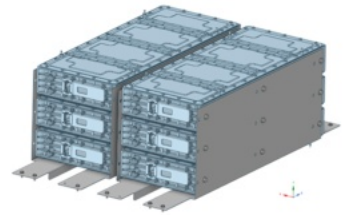
(L X W X H) (mm)

Tray → 970 x 450 x 142 (1 level)
Housing → 970 X 450 X 568 (4 stacked)

2nd Life concept Fulfilment

Battery Tray direct integration

Stationary application

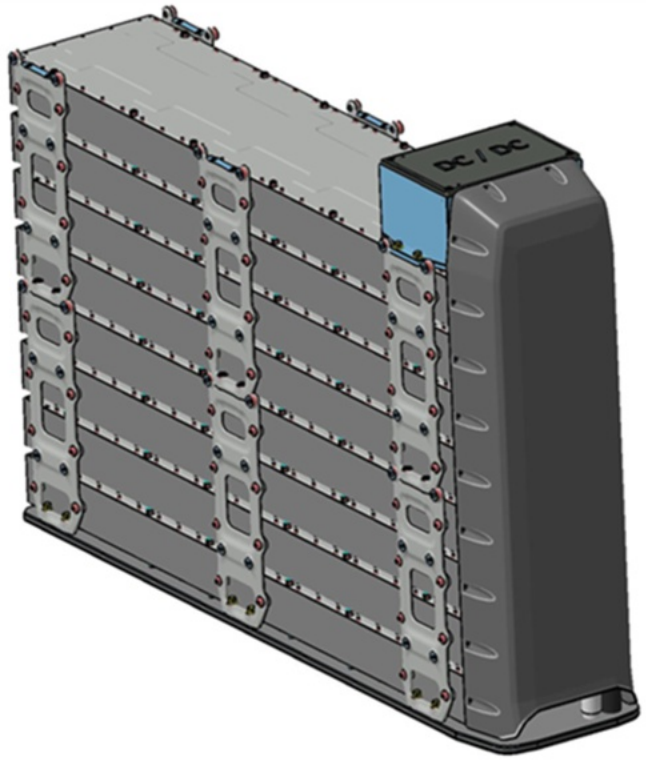


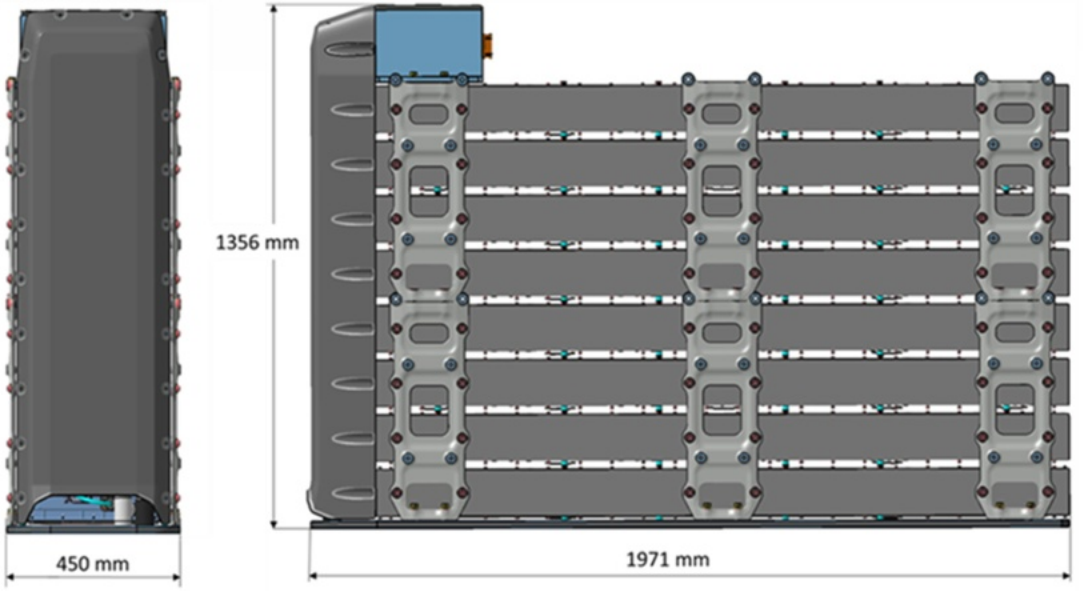
(L X W X H) (mm)

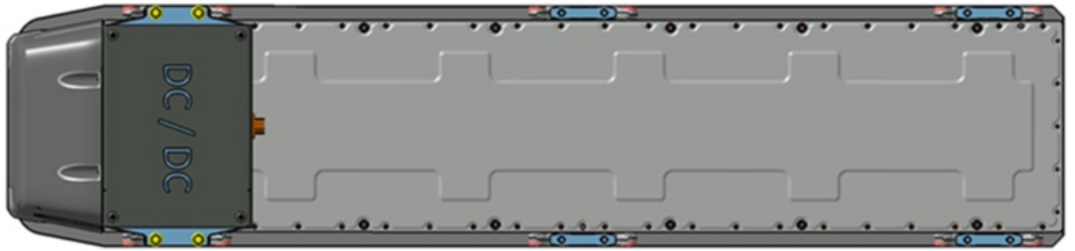
Tray → 970 x 450 x 142 (1 level)
Housing → 970 X 900 X 426 (6 stacked in 2 columns)

BATSS

MARITIME







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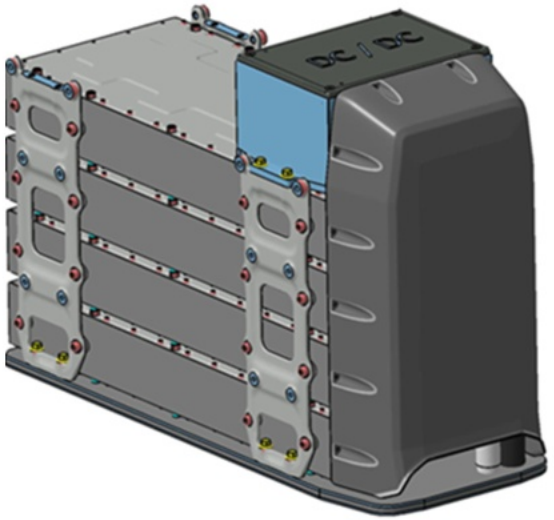
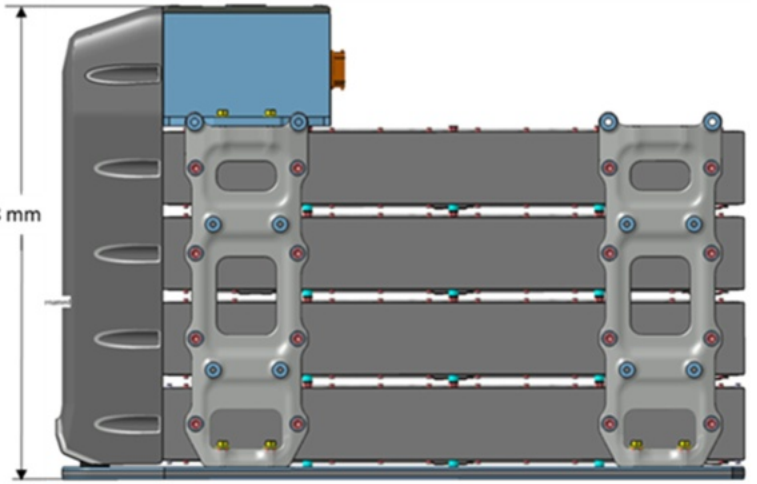
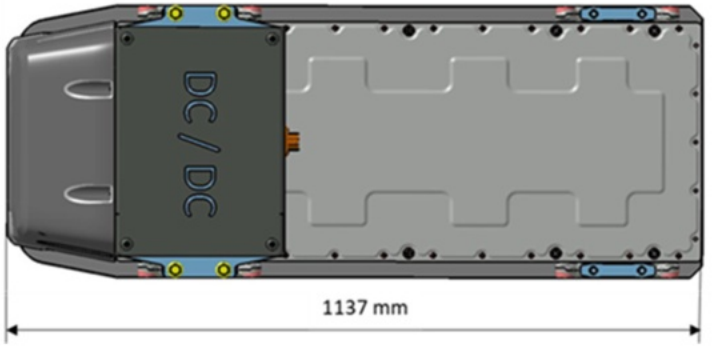
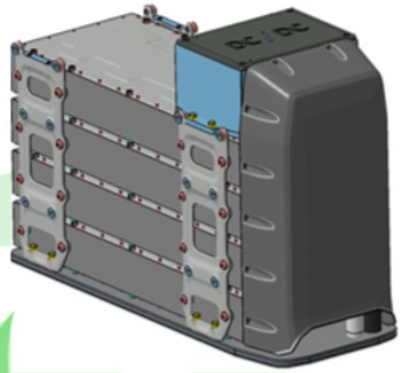
OFF_ROAD



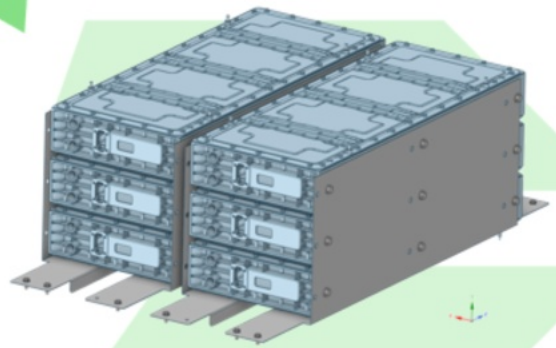




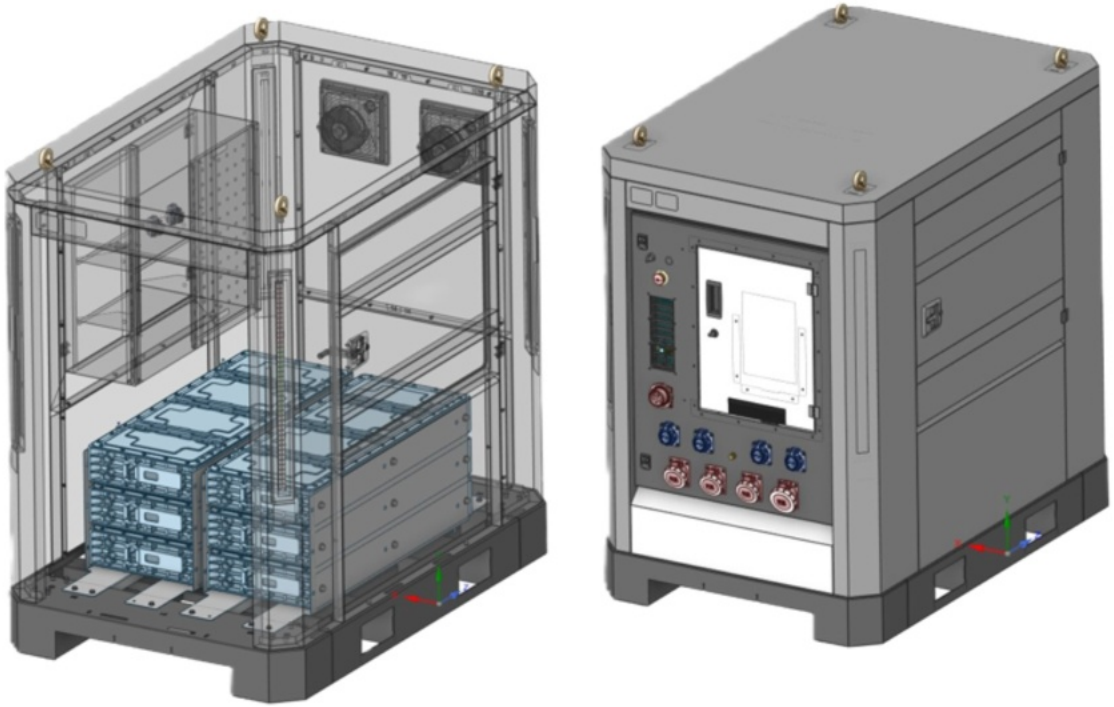
BATSS



Direct integration of 6 Off-Road Trays



Stationary (2nd Life)



Versa PRINT

At cell level

Better thermal management for high power

→ Printed micro-channels on the cell surface

100A, 2C → -33% temperature reduction

At module level

Multifunctional component for reduced mass

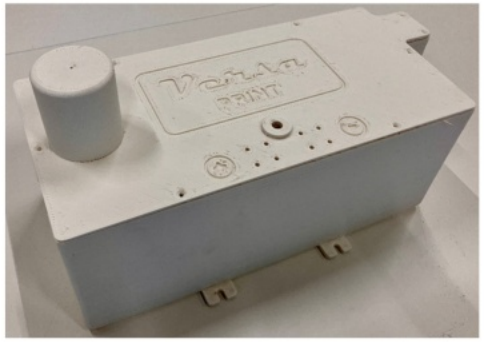
→ Multifunctional busbars

- ✓ Electrical contact between cells
- ✓ Thermal dissipation
- ✓ Easy dismantling
- ✓ Connectivity to external connector
- ✓ Mechanical deformation absorption

At system level

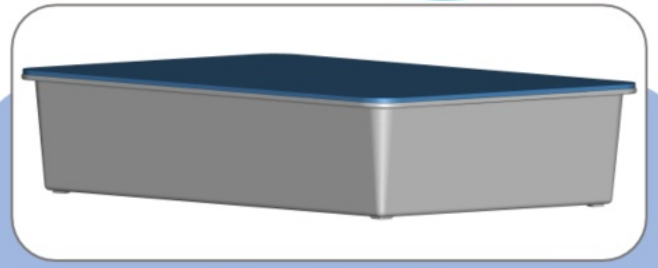
Lightweight material

→ Self-Reinforced Polymer (SRP) casing



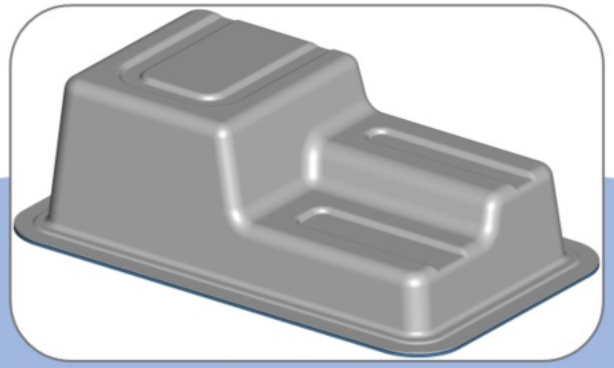
- ✓ -30% mass reduction vs Aluminum
- ✓ PETG composites

Strategies for high energy and power density



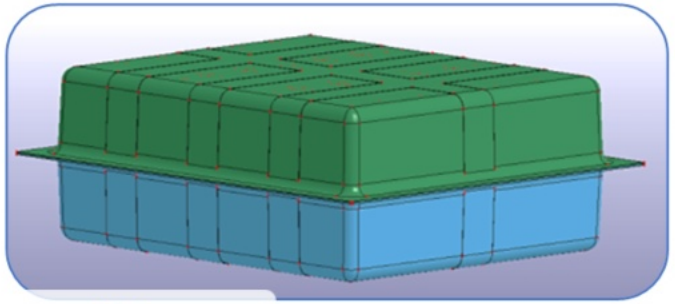
Housing D1

Dimensions (mm³)	440 × 300 × 89
Material	Elium SMC with GF and ATH additive
Mass (kg)	1.266



Housing D2

Dimensions (mm³)	800 × 500 × 241
Material	Menzolit 0400
Mass (kg)	4.274



Housing D3

Dimensions (mm³)	659 × 579 × 180
Material	Elium SMC with GF and ATH additive
Mass (kg)	1.787

Lightweight material

Housing D1:
reduction of **31%** for aluminum;
reduction of **76%** for steel

Housing D2:
reduction of **28%** for aluminum;
reduction of **75%** for steel

Housing D3:
reduction of **30%** for aluminum;
reduction of **75%** for steel

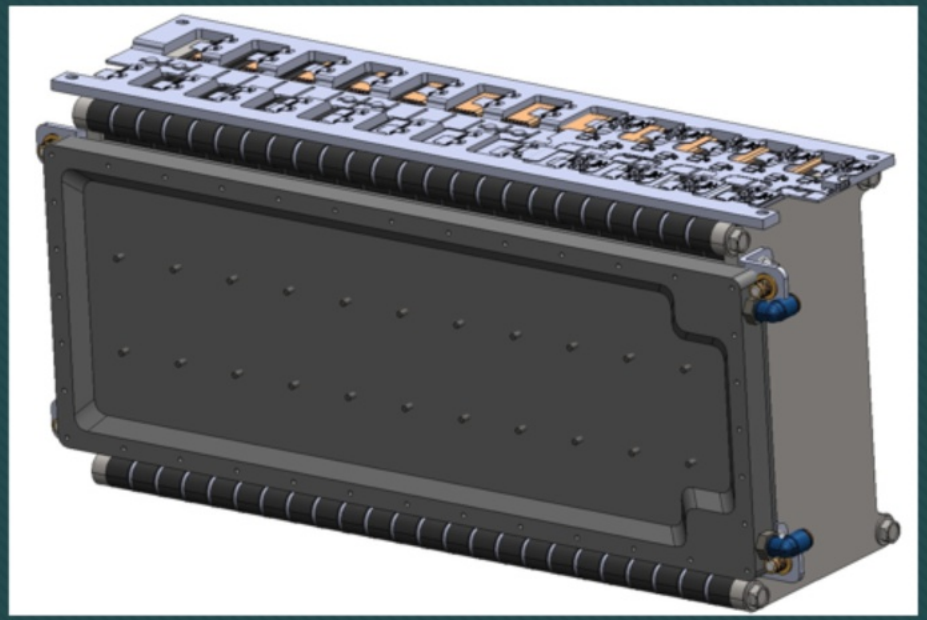
(assuming densities of 2.70 for aluminum and 7.75 g/cm^3 for steel)

extended

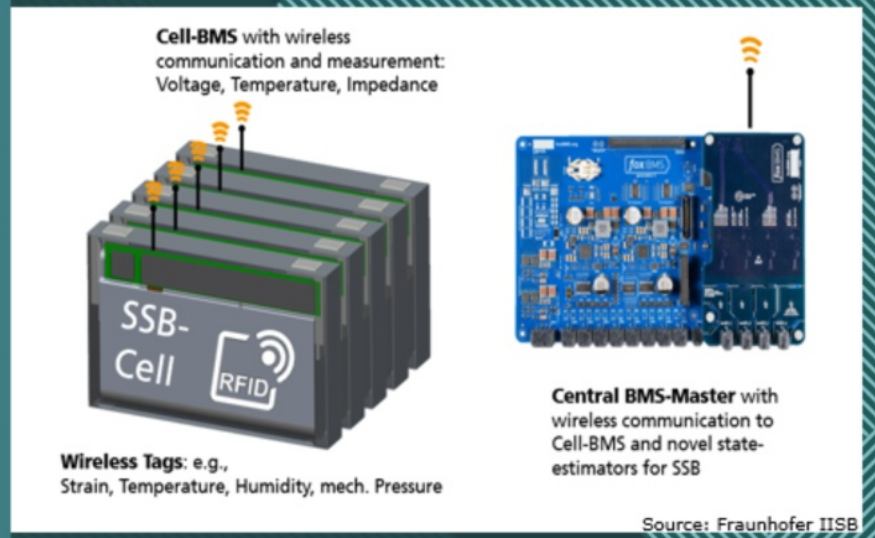
Session 1: Improve Battery Pack Energy & Power Density?

Mechanical design, light weight and modular

Thermal system



Smart system



Q&A?

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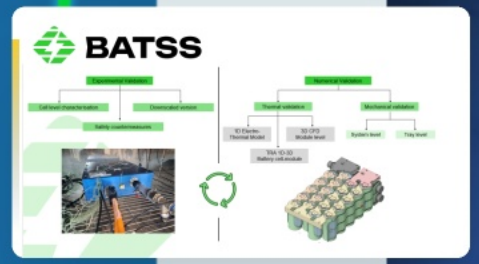
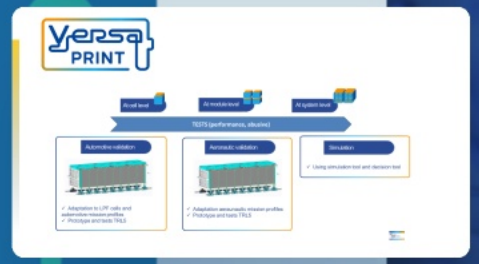
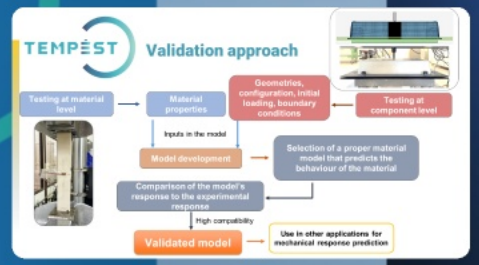
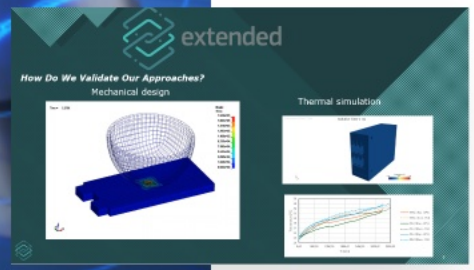






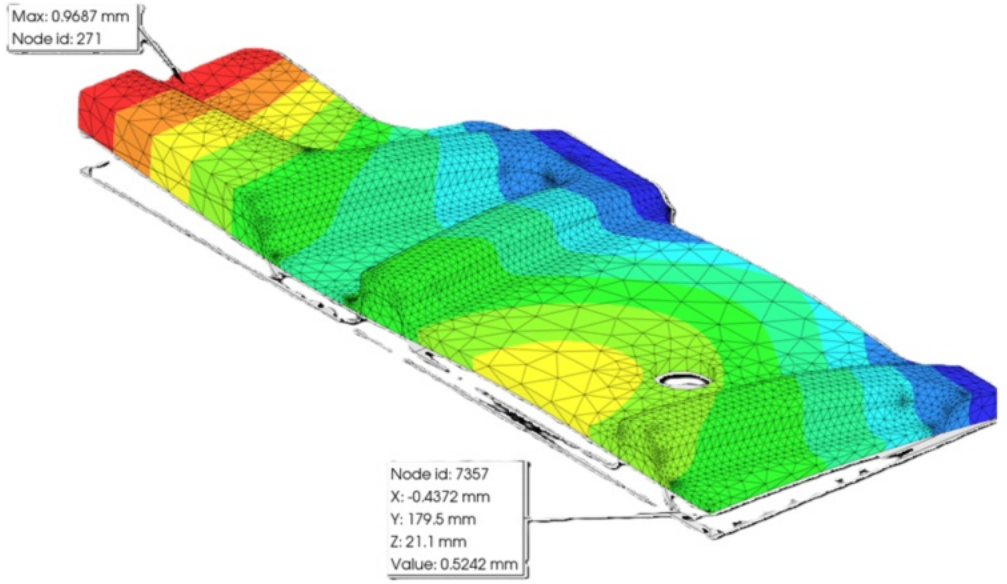


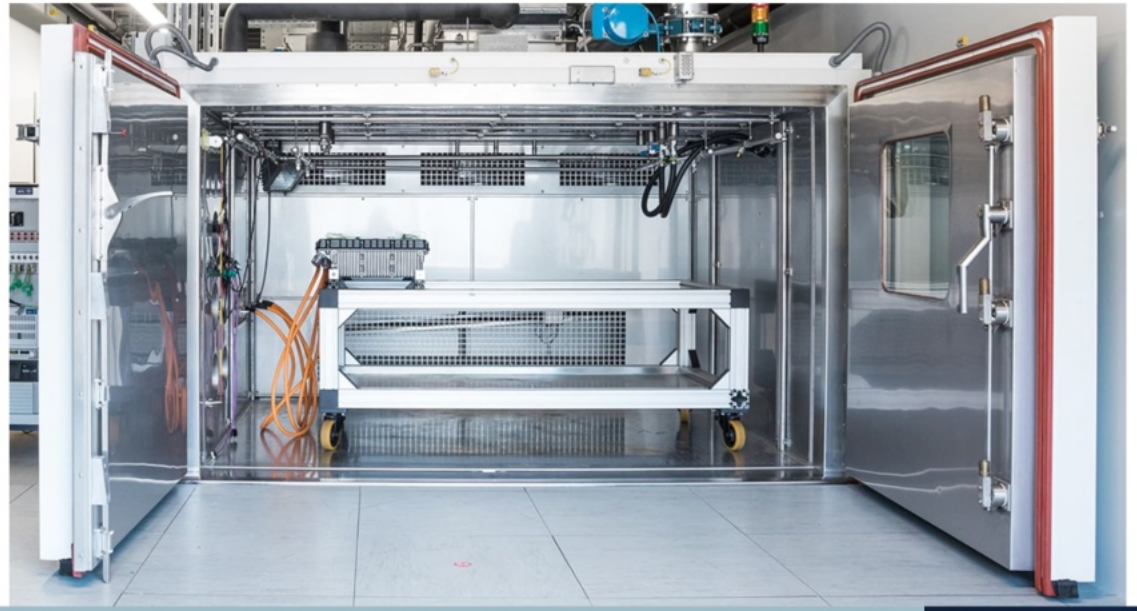
SECTION 2

How we test and validate the project technologies

NEXTBAT

- FEM Simulation
  - Mechanical
  - CFD
- Performance testing according to ISO12405
  - Capacity
  - Fast charging
  - Ageing
- BMS validation
- Safety testing
  - Vibration
  - Mechanical shock
  - Thermal propagation management

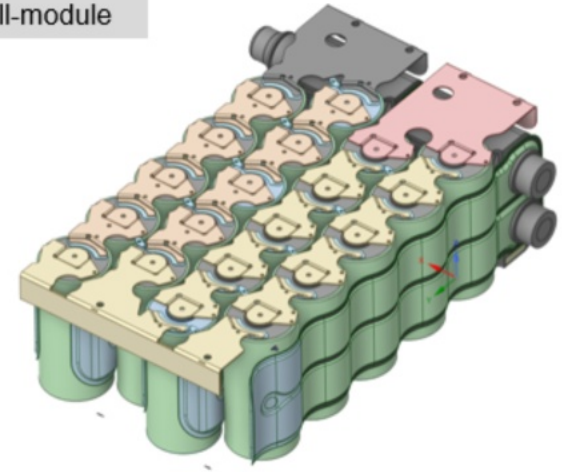




BATSS

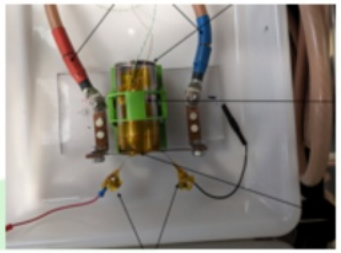
- Experimental Validation
  - Cell level characterisation
  - Downscaled version
  - Safety countermeasures

- Numerical Validation
  - Thermal validation
    - 1D Electro-Thermal Model
    - 3D CFD Module level
    - TRA 1D-3D Battery cell-module
  - Mechanical validation
    - System level
    - Tray level

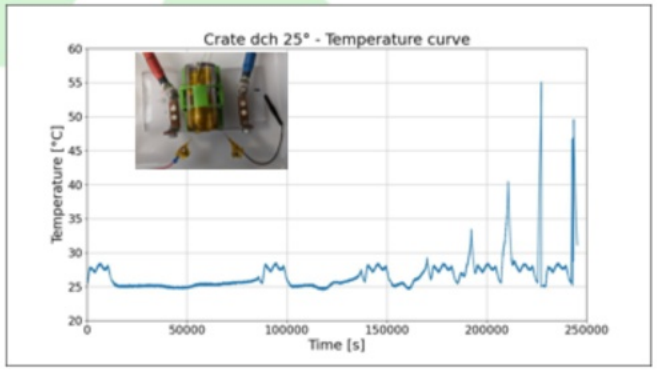


BATSS

Cell level characterisation



- Hysteresis
- Pulse test
- C-rate test
- Thermal conductivity
- Specific heat
- Heat Generation



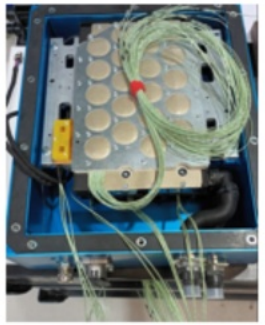
Experimental information to validate the

Proposed design

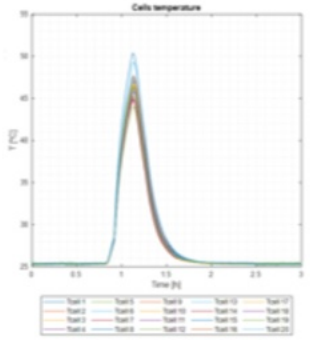
&

Numerical models

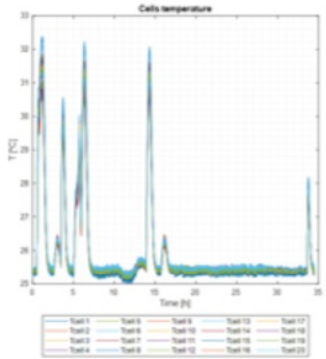
Downscaled Module level characterisation



Fast-charge profile (2,65C)



Operational profile



1D Electro-Thermal Model

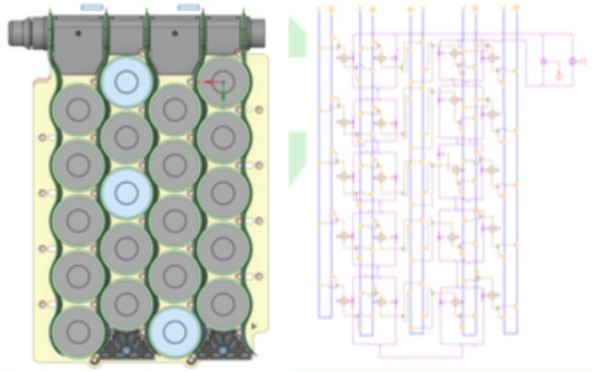
TRA 1D-3D Battery cell-module

3D CFD Module level

BATSS

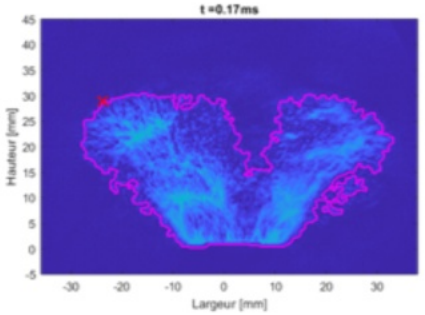
Electro - Thermal and safety simulations

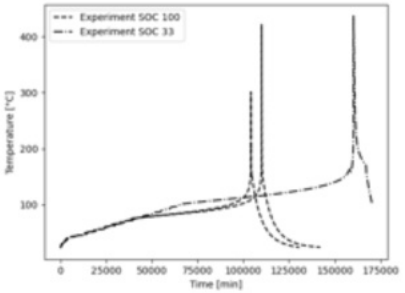
1D Electro-Thermal Model



- Parametric evaluation
- User profile integration
- System level evaluation
- .....

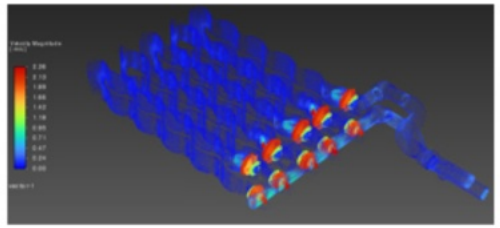
TRA 1D-3D Battery cell-module

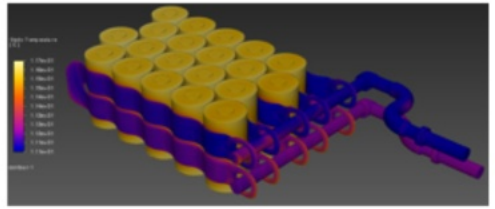




- Venting process evaluation
- Safety material definition
- Critical situation analysis
- .....

3D CFD Module level



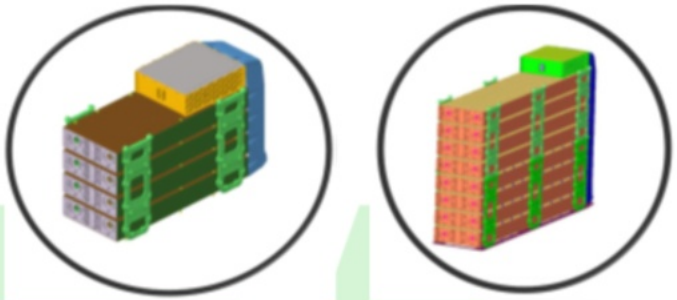


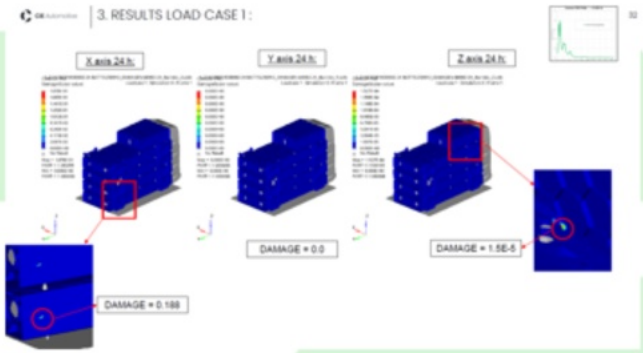
- 3D thermal response
- Hydraulic design evaluation
- Design proposal
- .....

BATSS

Mechanical simulations

System level





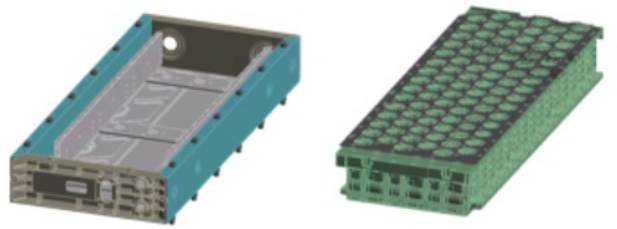
Design mechanical performance evaluation at 2 different levels and considering

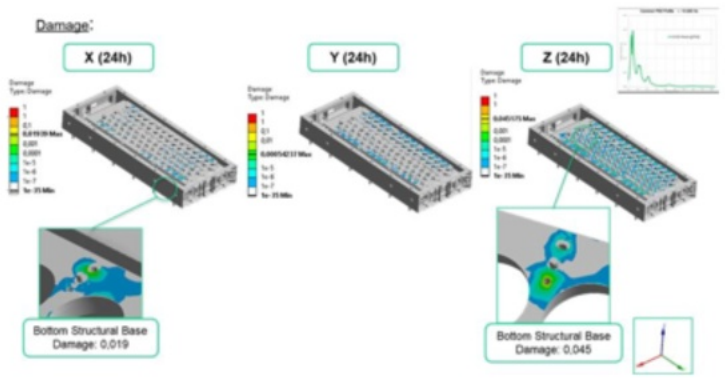
Specific working conditions

&

Specific standards

Tray level





Versa PRINT

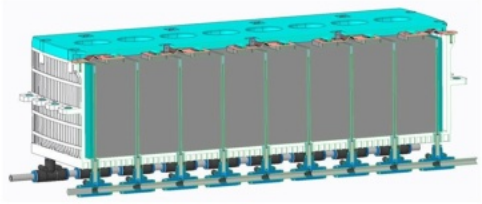
At cell level

At module level

At system level

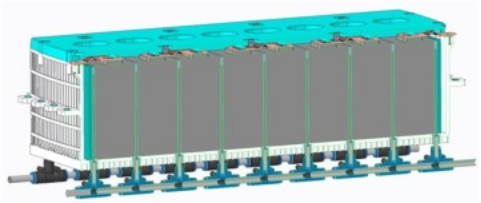
TESTS (performance, abusive)

Automotive validation



- ✓ Adaptation to LPF cells and automotive mission profiles
- ✓ Prototype and tests TRL5

Aeronautic validation



- ✓ Adaptation aeraunautic mission profiles
- ✓ Prototype and tests TRL5

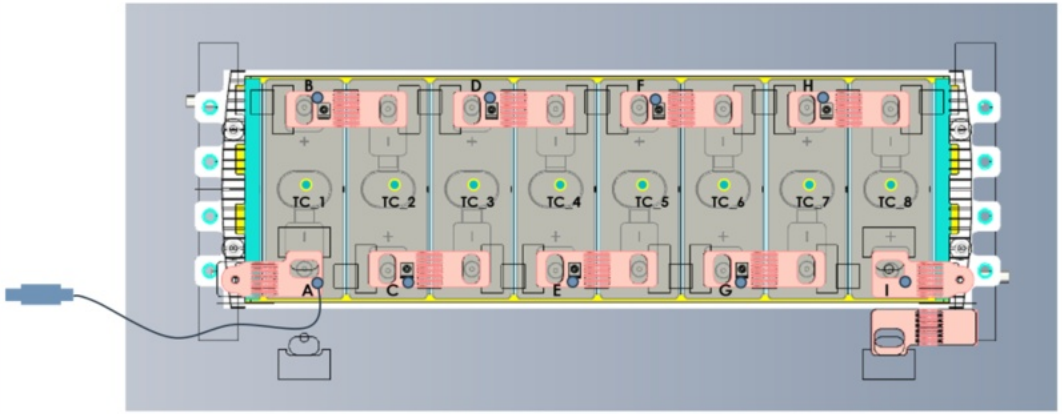
Simulation

- ✓ Using simulation tool and decision tool

Validation approach within VERSAPRINT

Session 2: ***How to validate our approach ?***

At module level



✓ Prototype with instrumentation to record:
- Cells voltage
- Cells current
- Cells temperature (bottom)

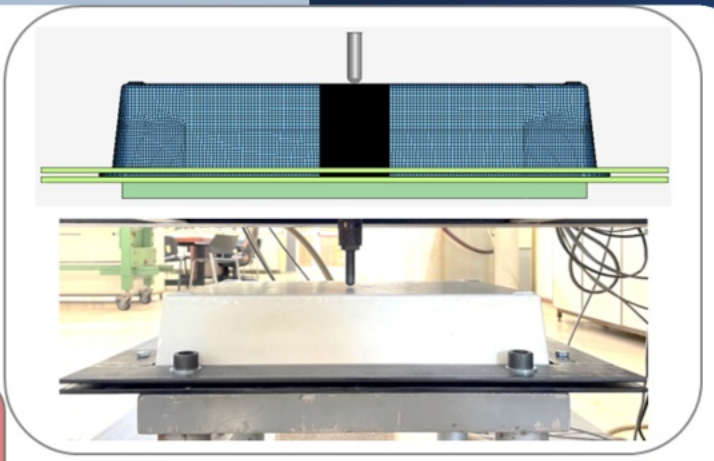
✓ List of tests:

- ISO 12405-4 Energy and capacity at RT
- ISO 12405-4 Energy and capacity at different temperatures and discharge rates
- ISO 12405-4 Power and internal resistance
- ISO 12405-4 No Load SOC Loss
- ISO 12405-4 Cranking power at low temperature
- ISO 12405-4 Cranking power at high temperature
- WLTP (light vehicle VS heavy duty tbc)

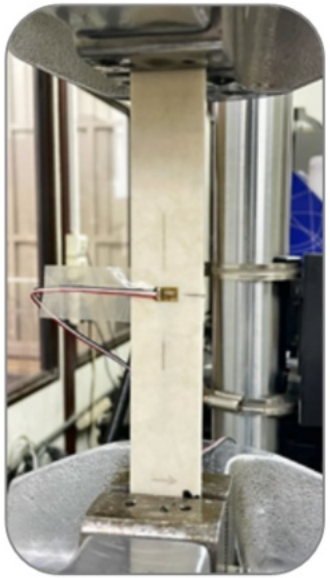
- R100 e3 Vibration test
- Thermal propagation test

TEMPEST

Validation approach



Testing at material level



Material properties

Geometries, configuration, initial loading, boundary conditions

Testing at component level

Inputs in the model

Model development

Selection of a proper material model that predicts the behaviour of the material

Comparison of the model's response to the experimental response

High compatibility

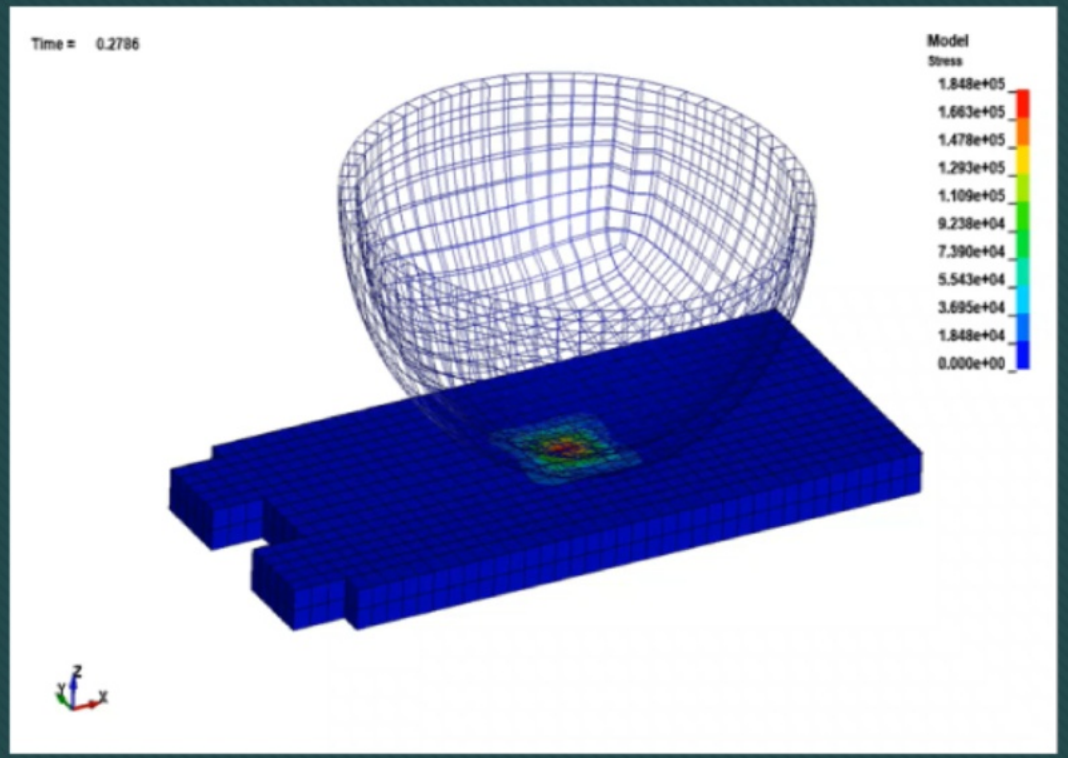
Validated model

Use in other applications for mechanical response prediction

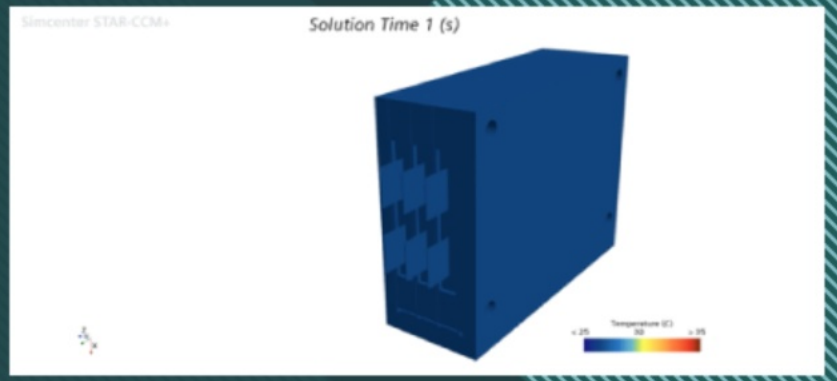
extended

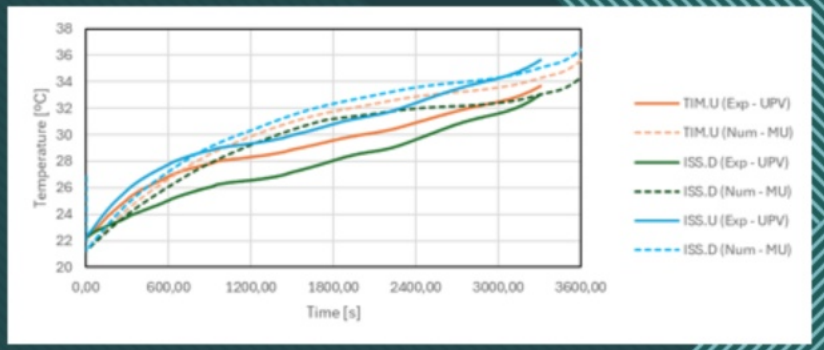
How Do We Validate Our Approaches?

Mechanical design



Thermal simulation





Q&A?

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