MBTS - Multi-physics Battery Test Systems

ACCURATE MODELS FOR YOUR OWN BATTERY

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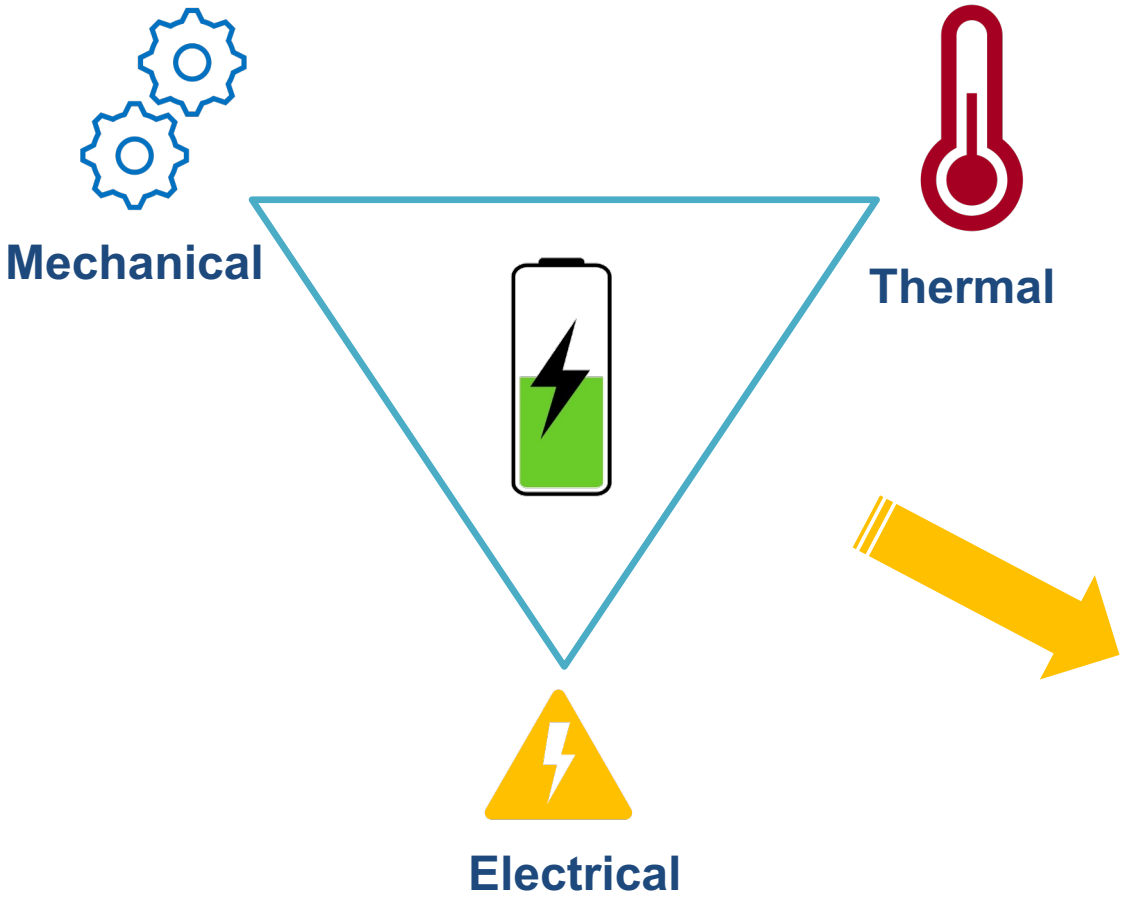
The problem

Batteries are influenced by many non-linear phenomena



Wide margins of safety / Damages during batt. work-life

Unknowns in the design phase, results in uncertainties

State of the Art

Climatic chamber

https://www.avl.com/en-de/testing-solutions/e-mobility-testing/battery-testing/avl-battery-cell-ts

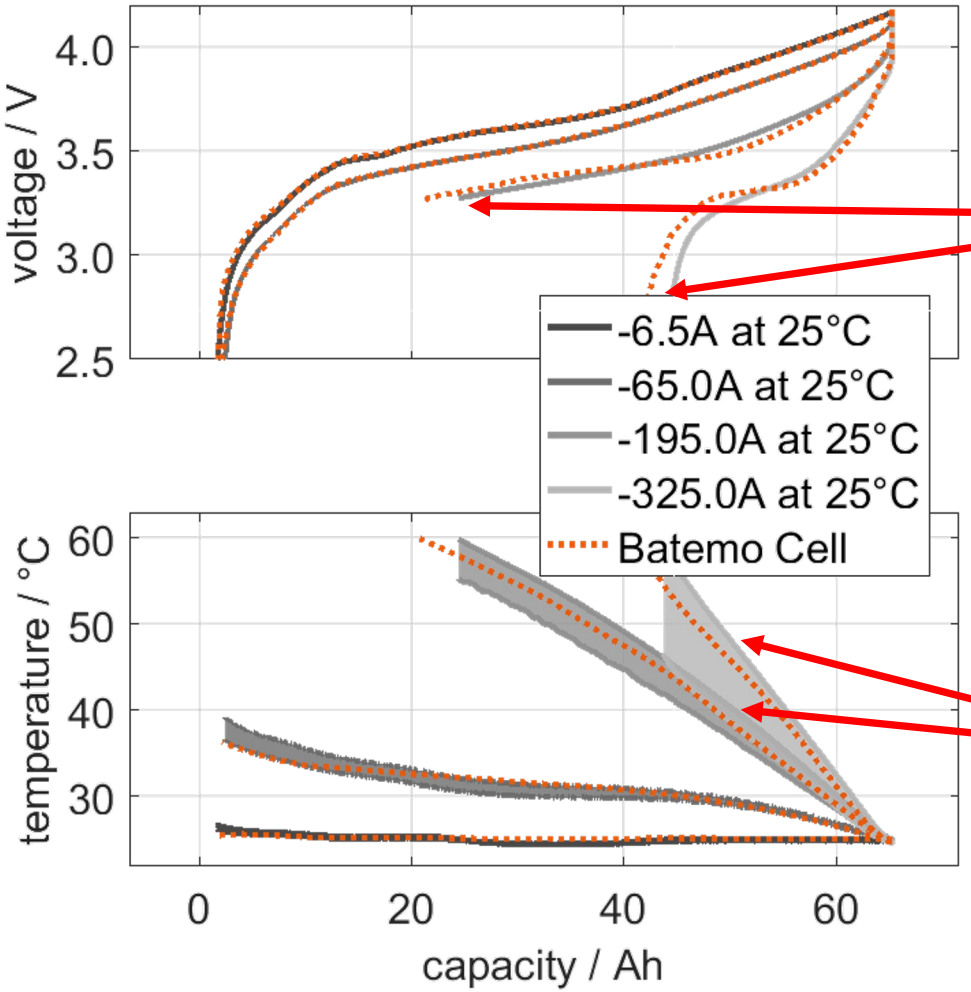
No pressure control

Slow thermal conditioning

Indirect batt. temperature control (air/liquid)

State of the Art

Climatic chamber - BATEMO



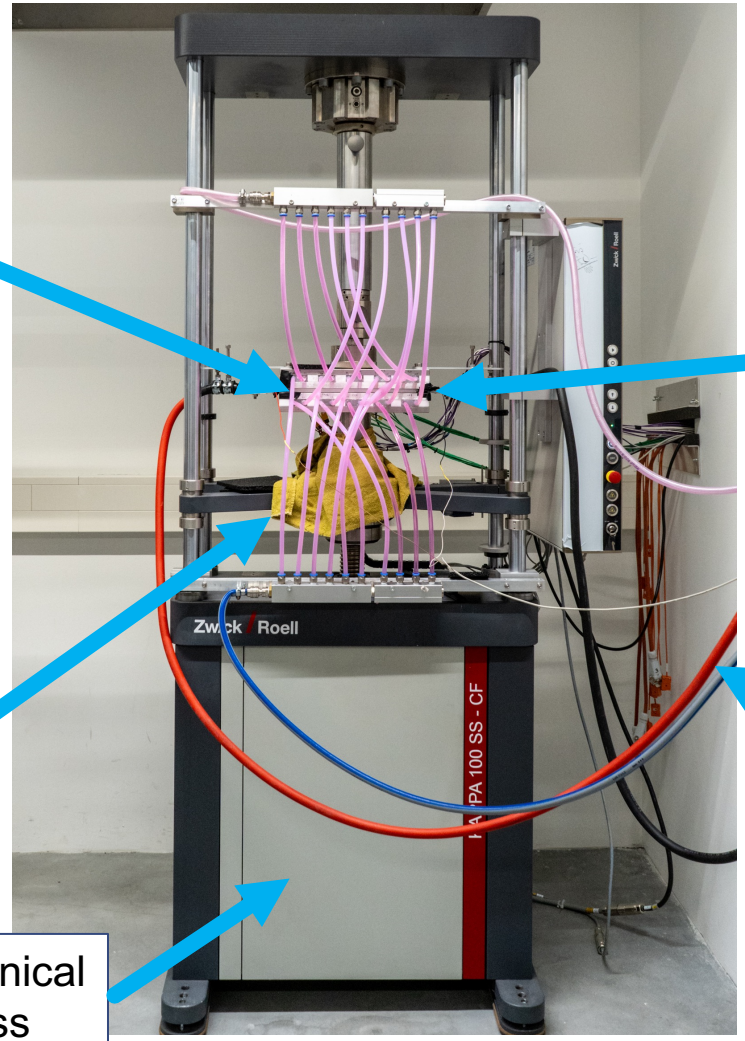
Test interrupted due to overheating

Excessive cell temperature build up

Source: BATEMO https://www.batemo.de/products/batemo-cell-library/lg-chem-e66a/

Our solution

An all-in-one battery testing technology



Li-ion cell

Primary cooling system

Secondary cooling system

Electrical cycler

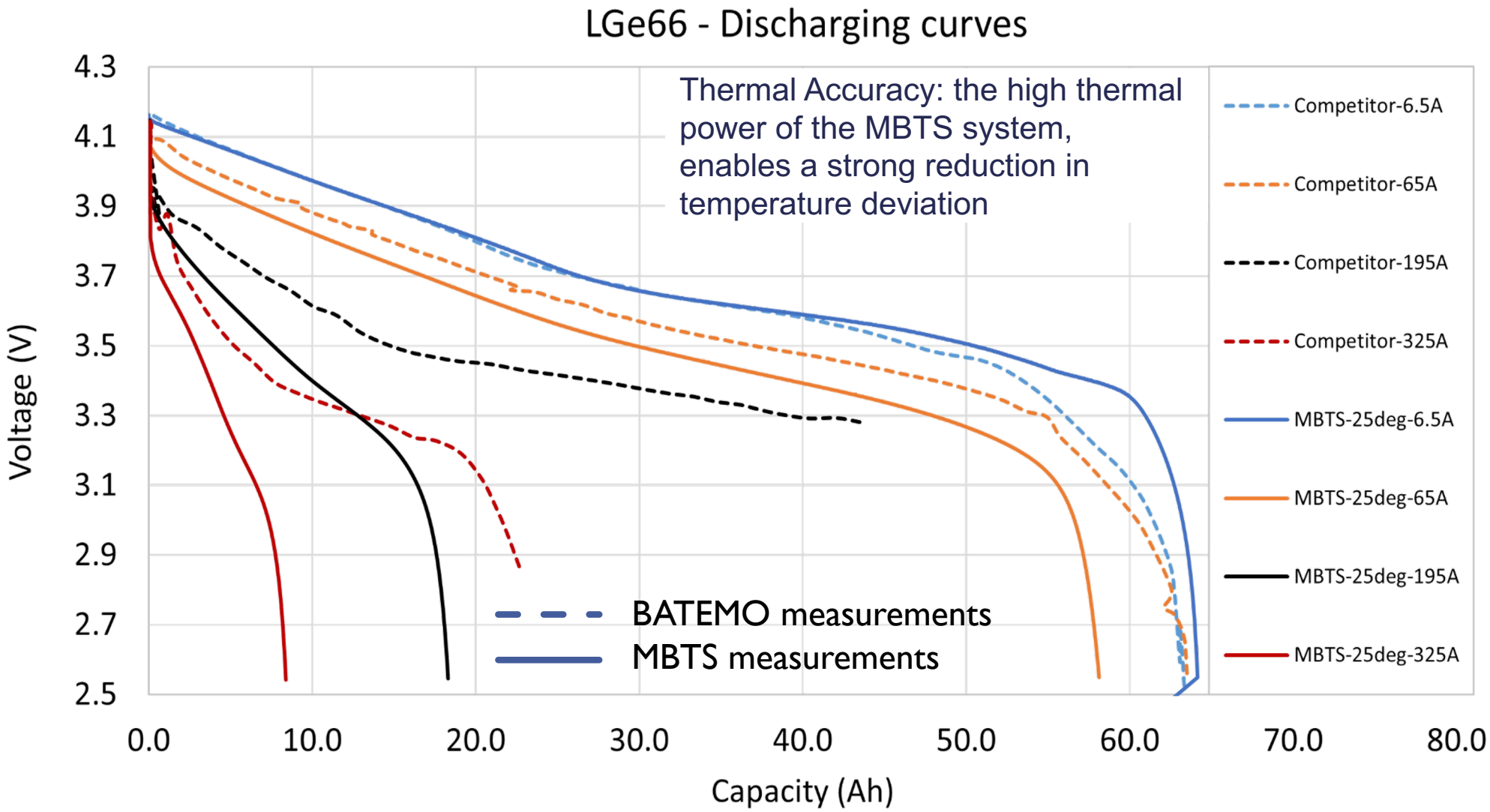
Mechanical press

Higher data quality

Better cell models

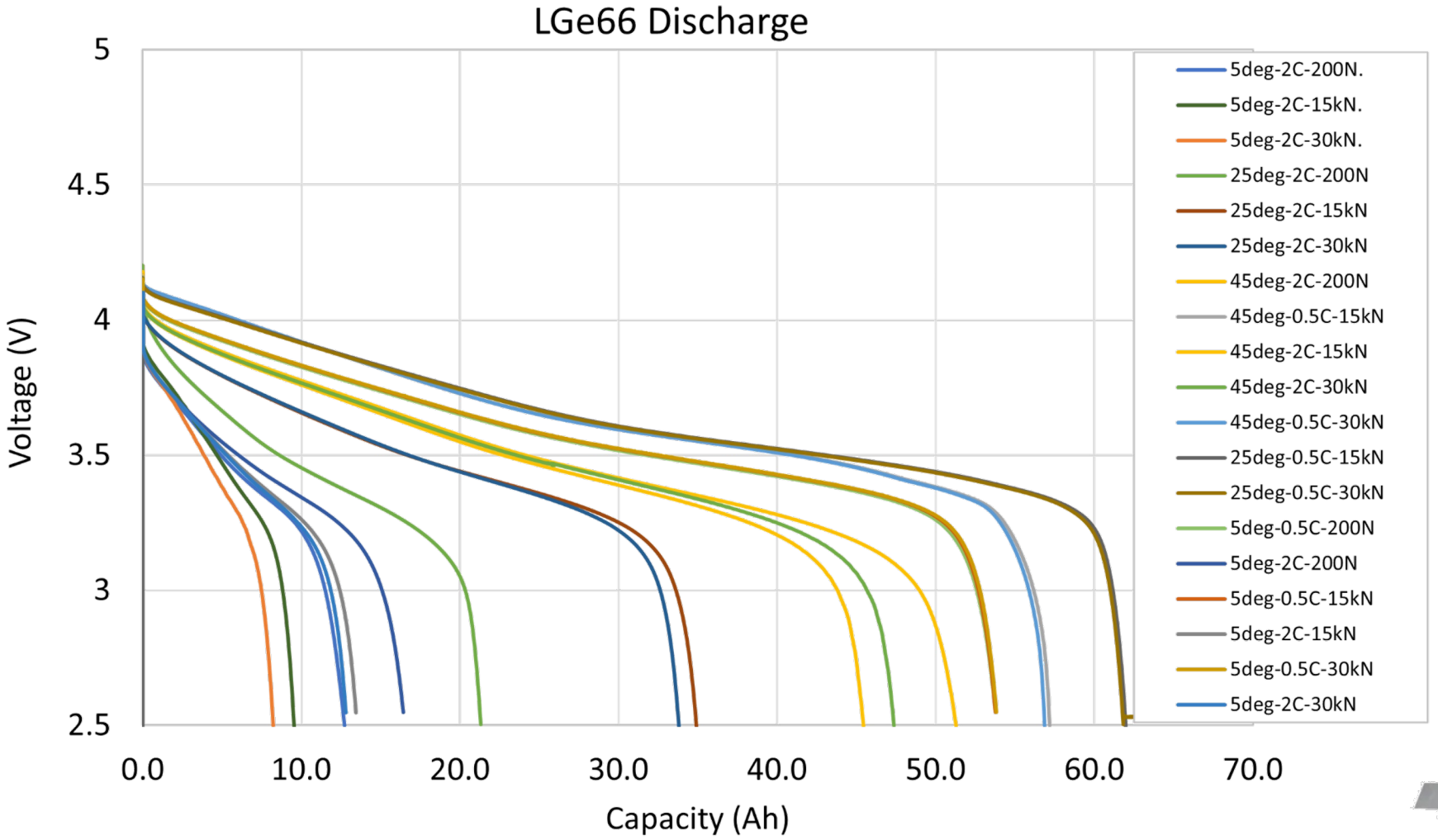
Improvement of battery performance

True Temperature Testing



Which battery are you trying to manage?

Different conditions generate different cell behaviours



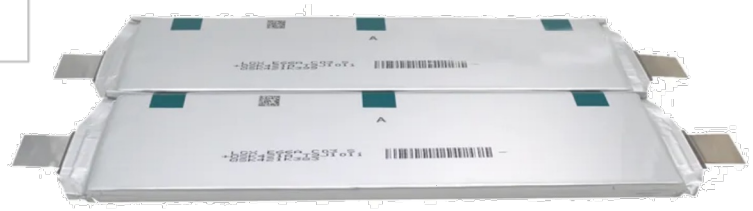
Discharge behaviour under differente temperatures, pressures and C rates

LGe66

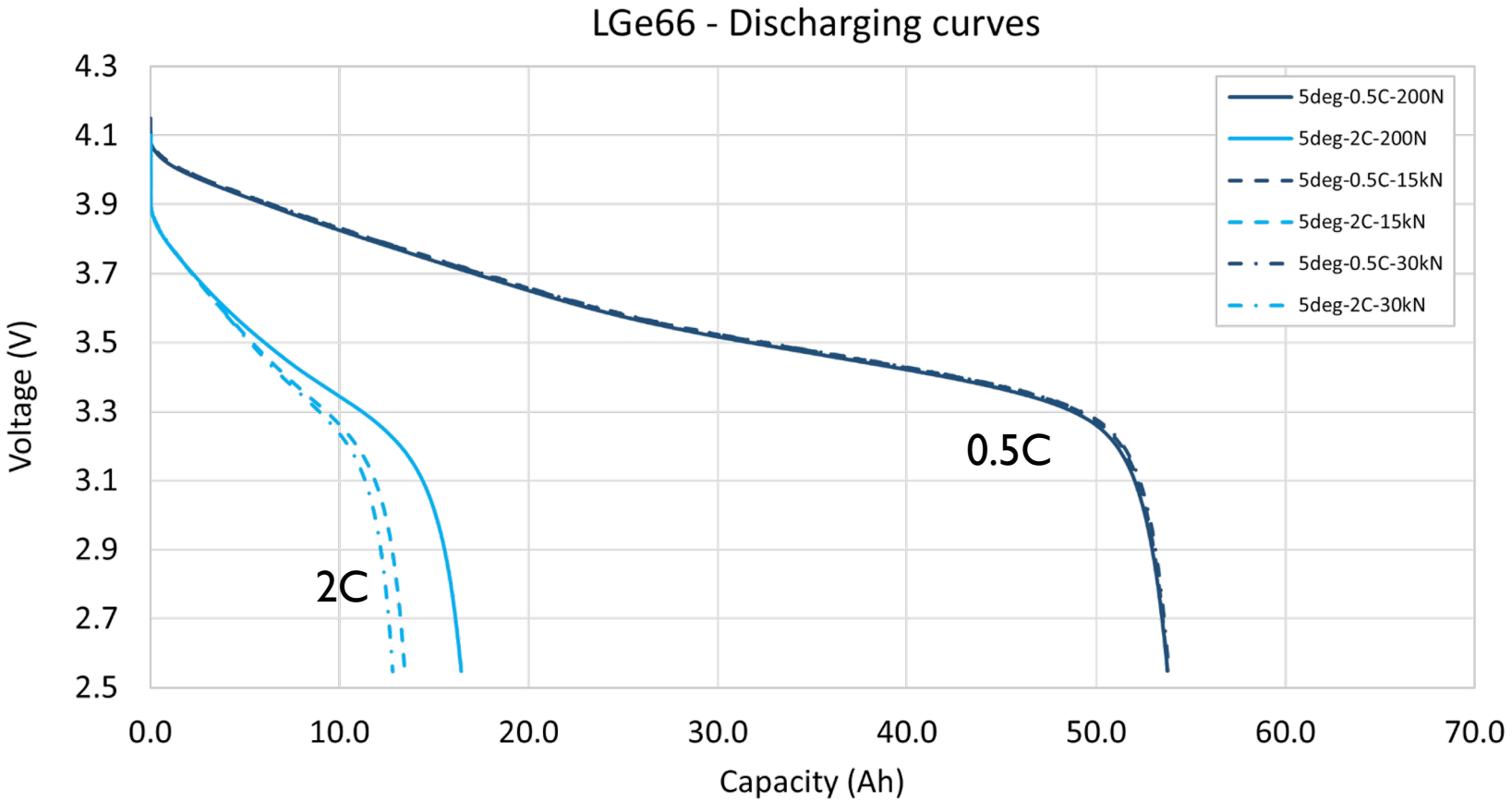
(Porsche Taycan, Jaguar I-pace,…)

60 Ah nominal 4.2-2.5 V range.

259 Wh/kg (648 Wh/l) and 1.16 kW/kg (2.90 kW/l)



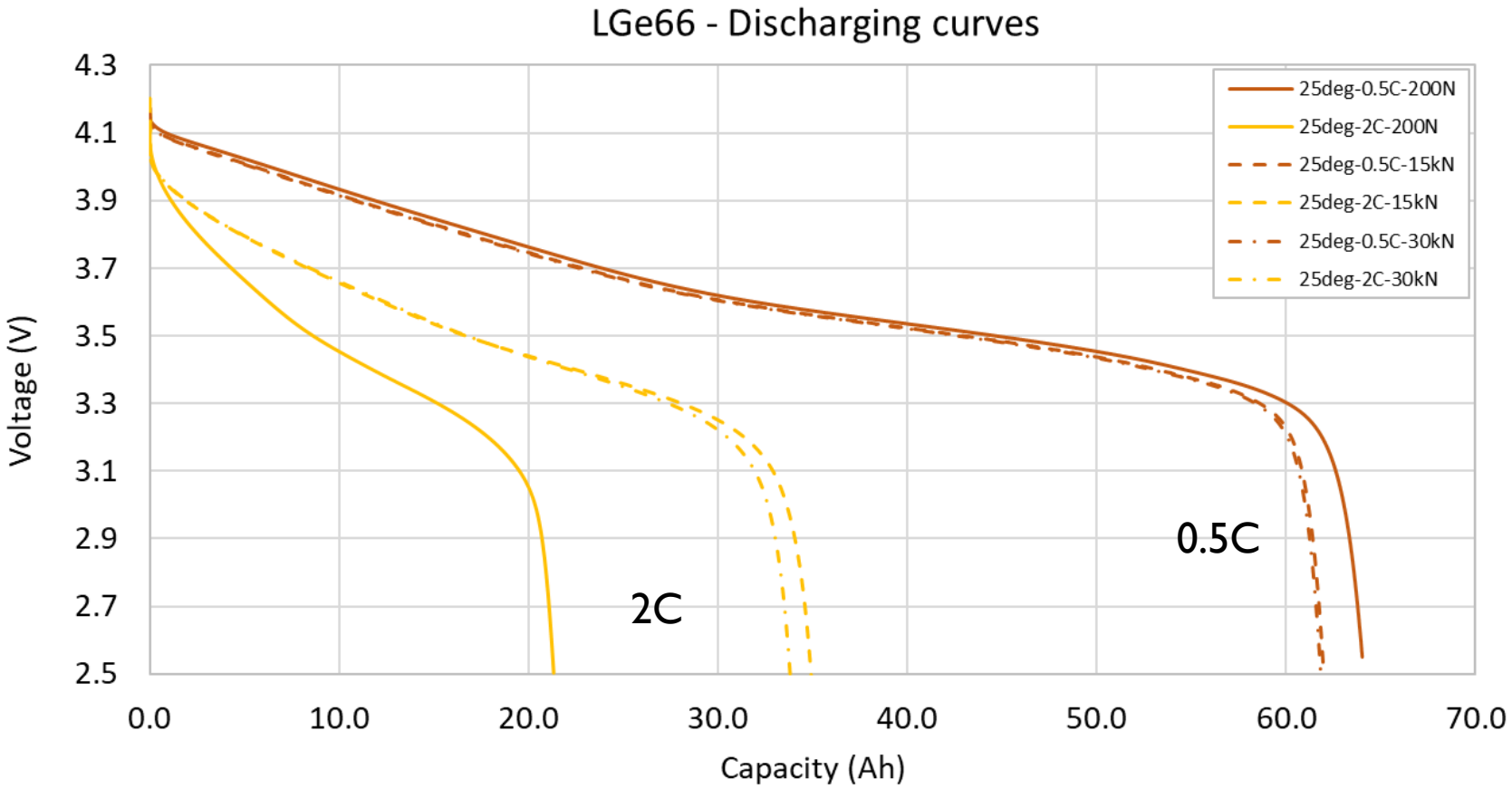
Pressure influence @5°C



At low temperatures, for high C rates, the pressure has a detrimental effect

At low C rates, the effect is negligible

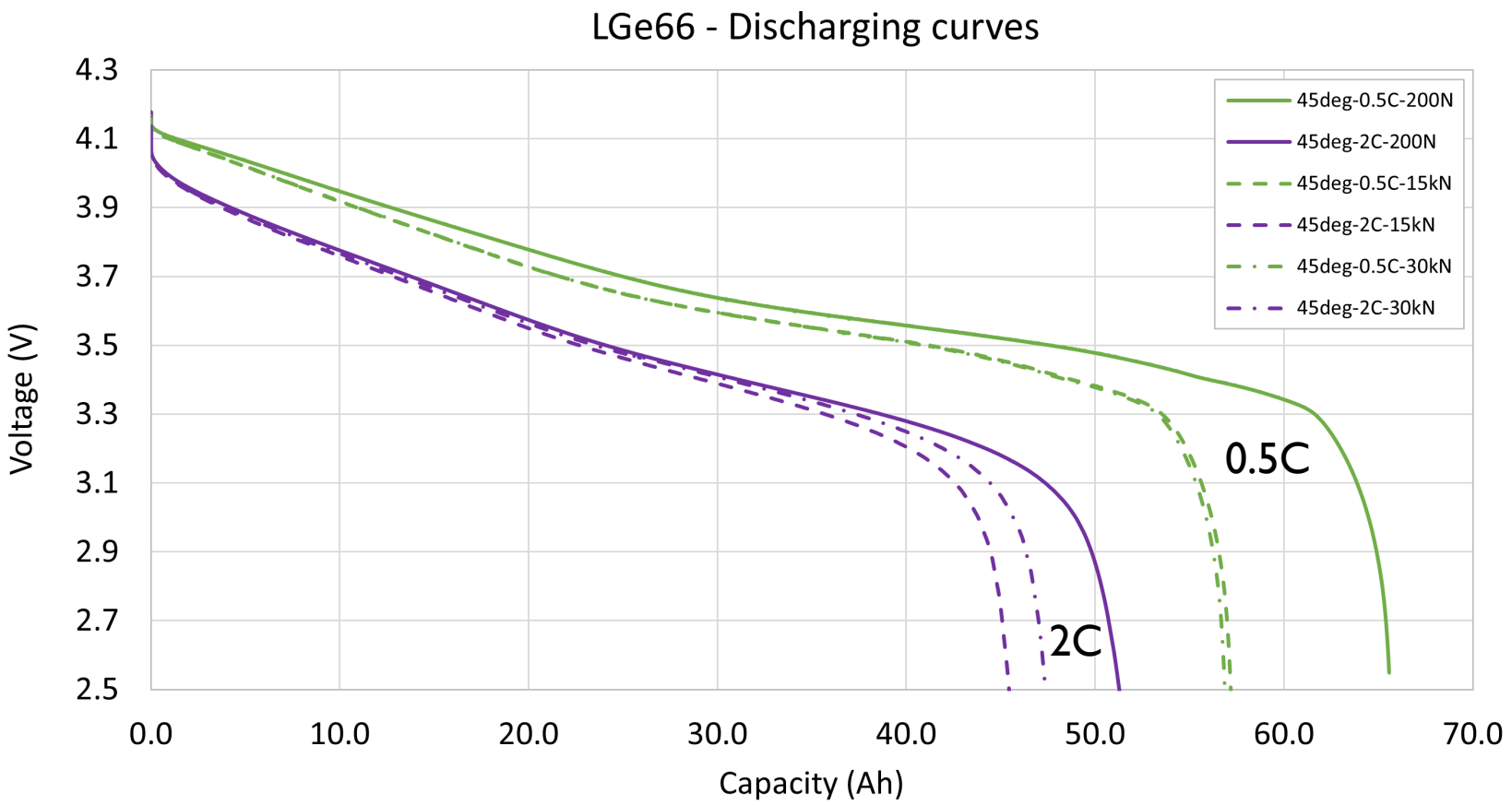
Pressure influence @25°C



At high C rates, higher pressure induces a **significant increase** in the overall available energy.

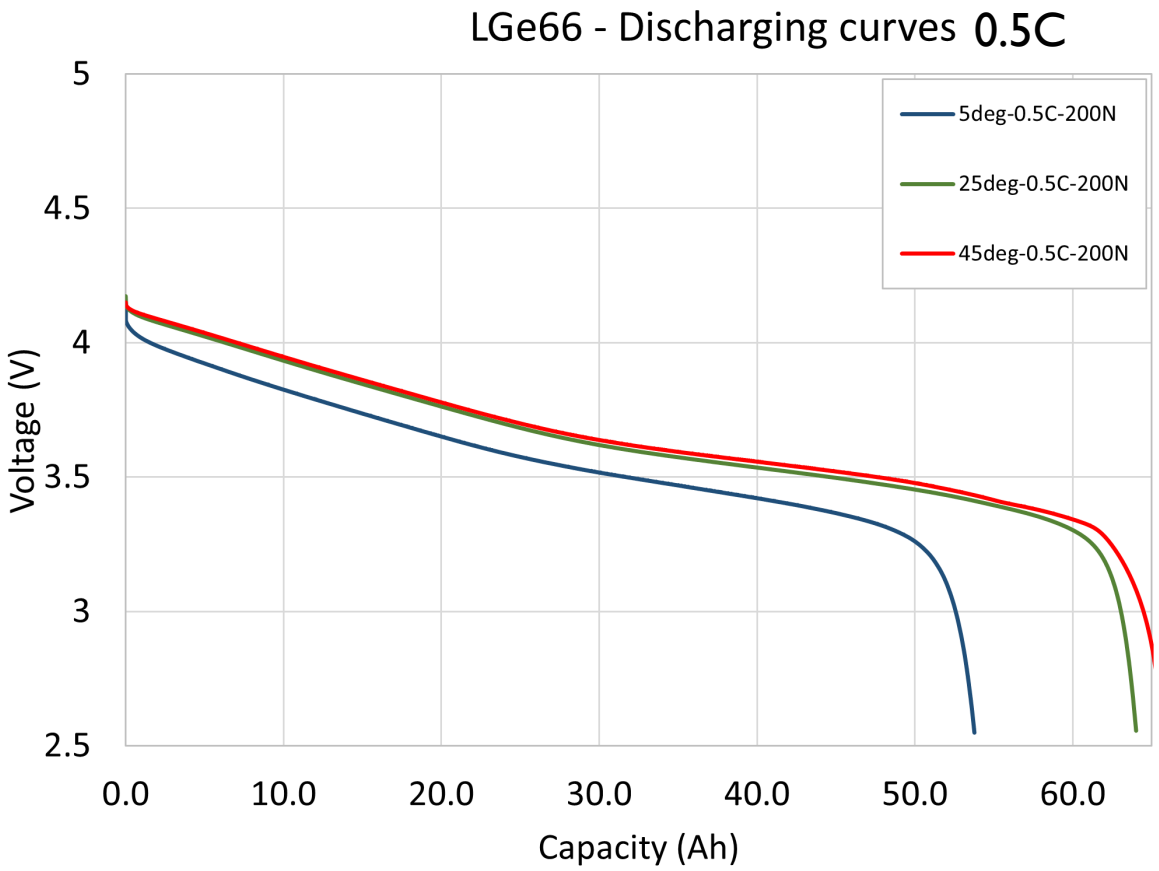
At low currents the effect is the **opposite**

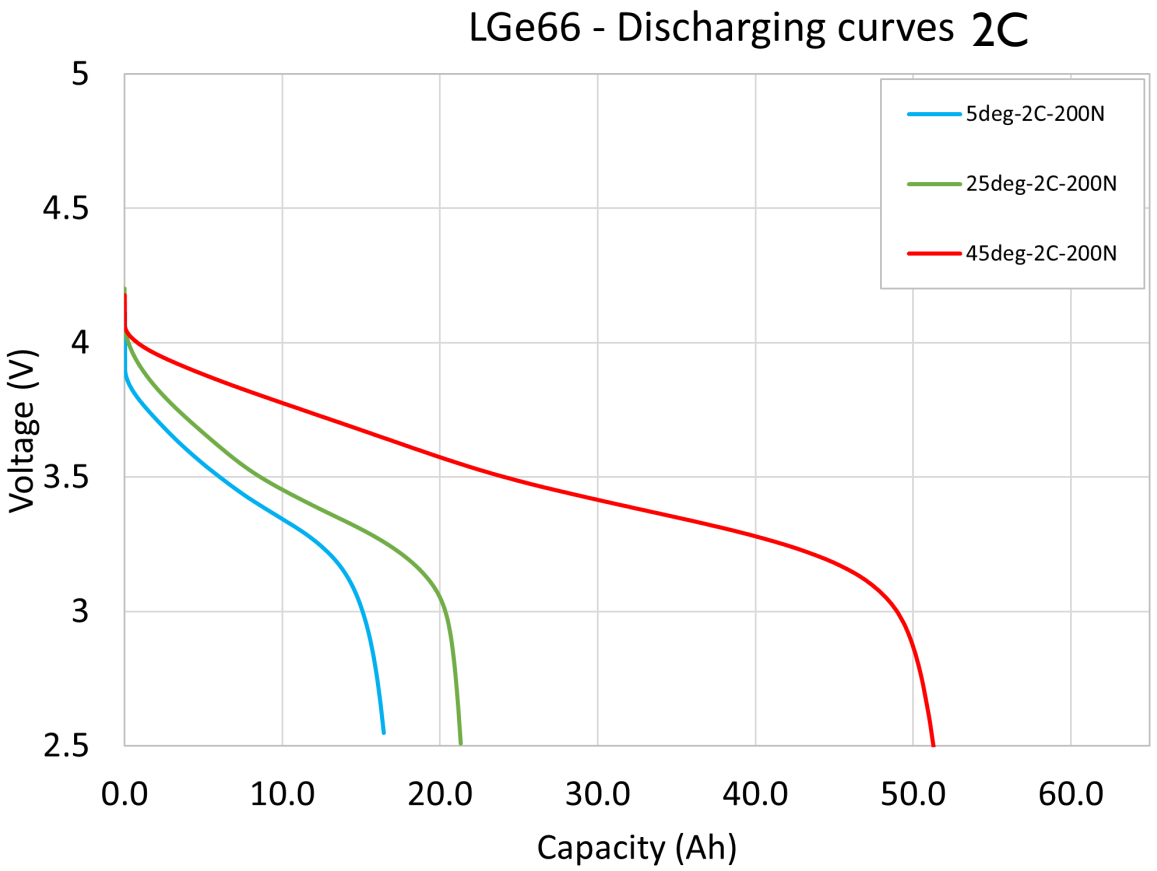
Pressure influence @45° C



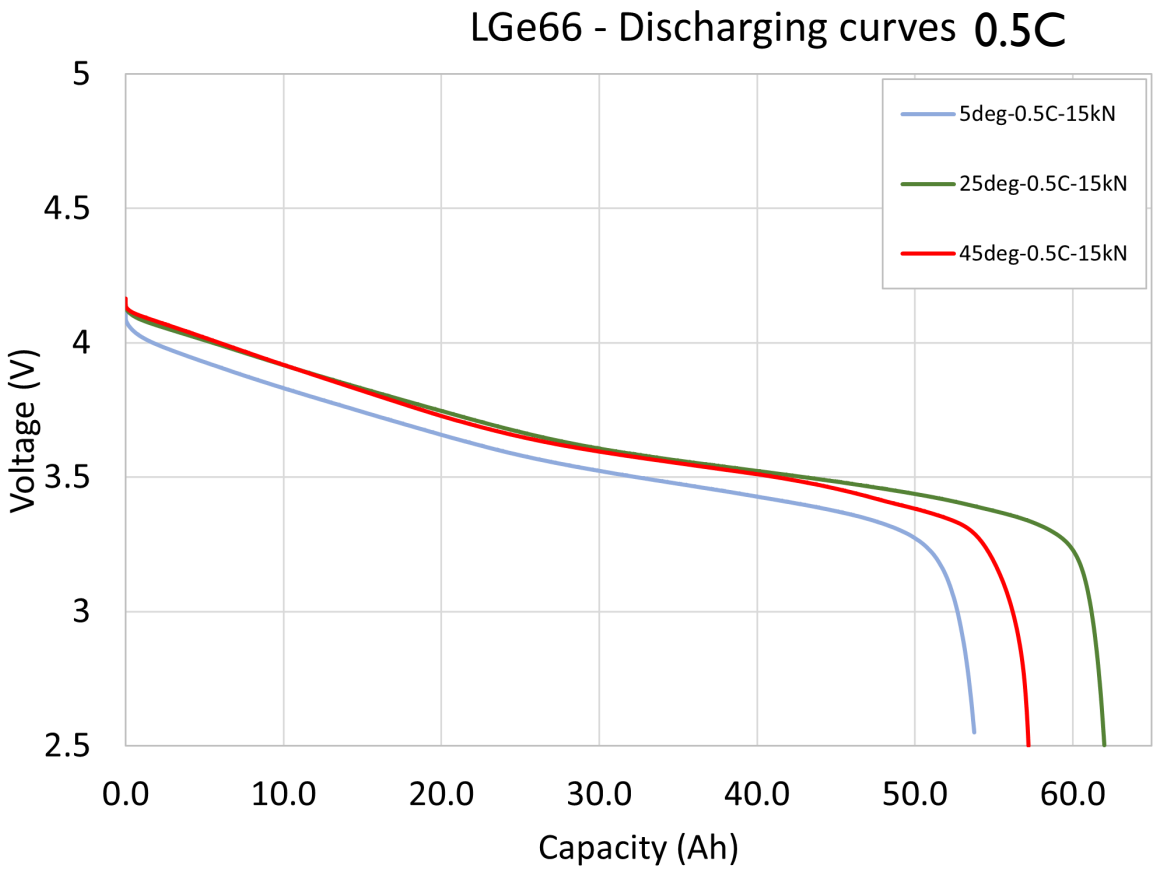
At high temperatures, the pressure effect always decreases the energy avaiable, with a higher effect at high C rates

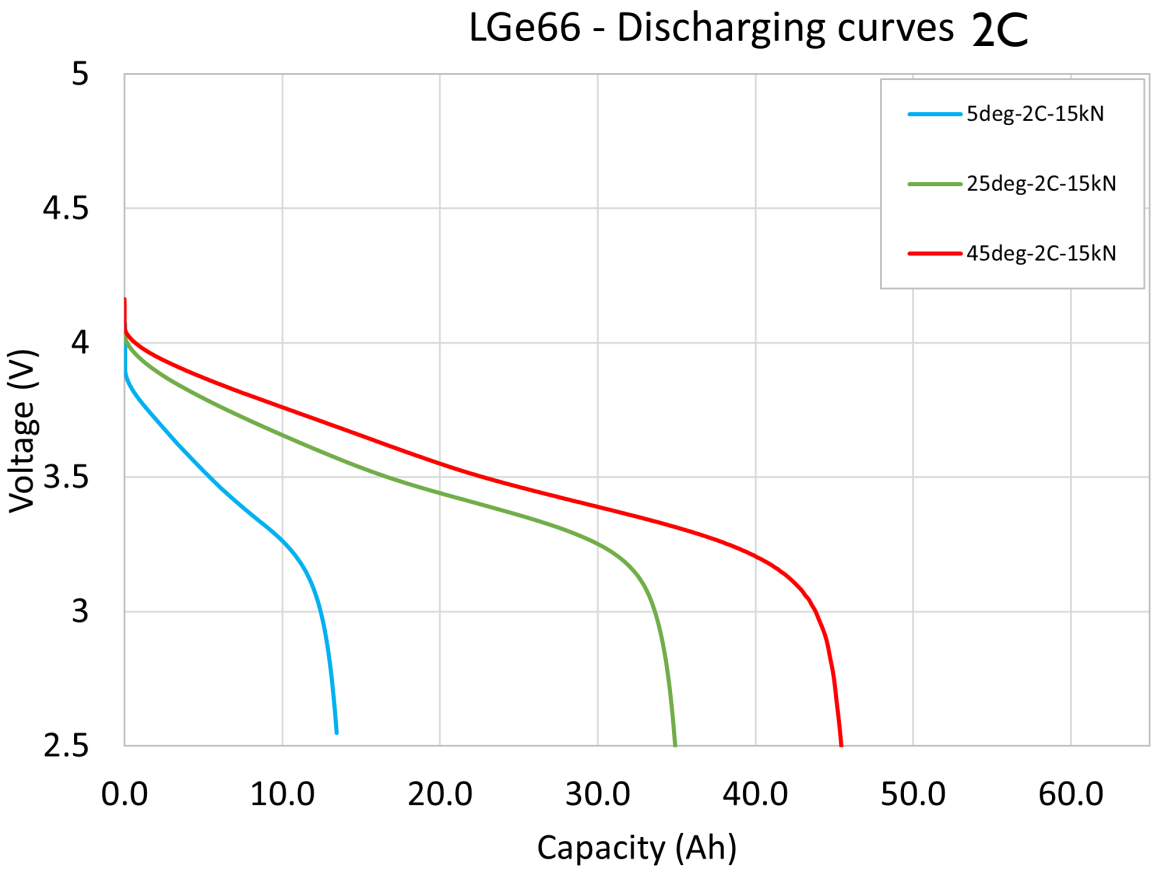
Temperature influence @200 N (0.01 Mpa)



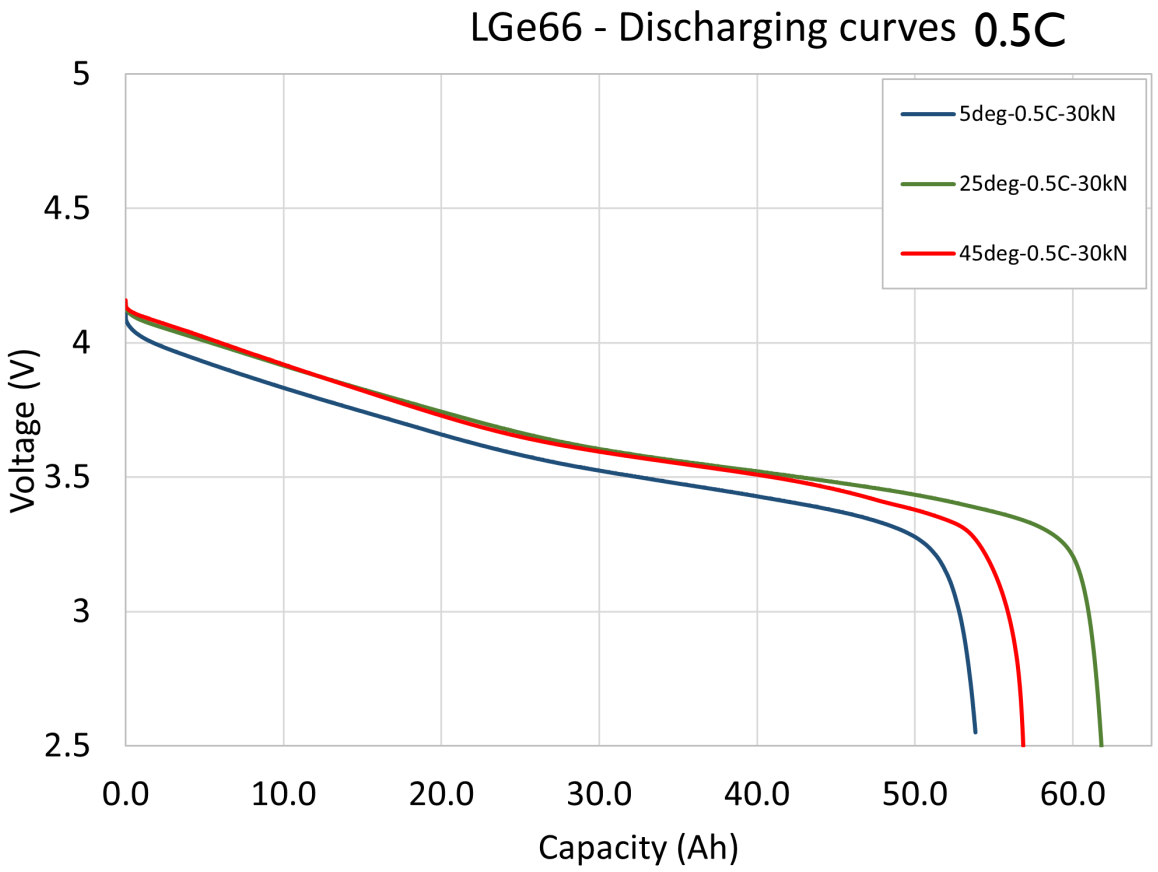


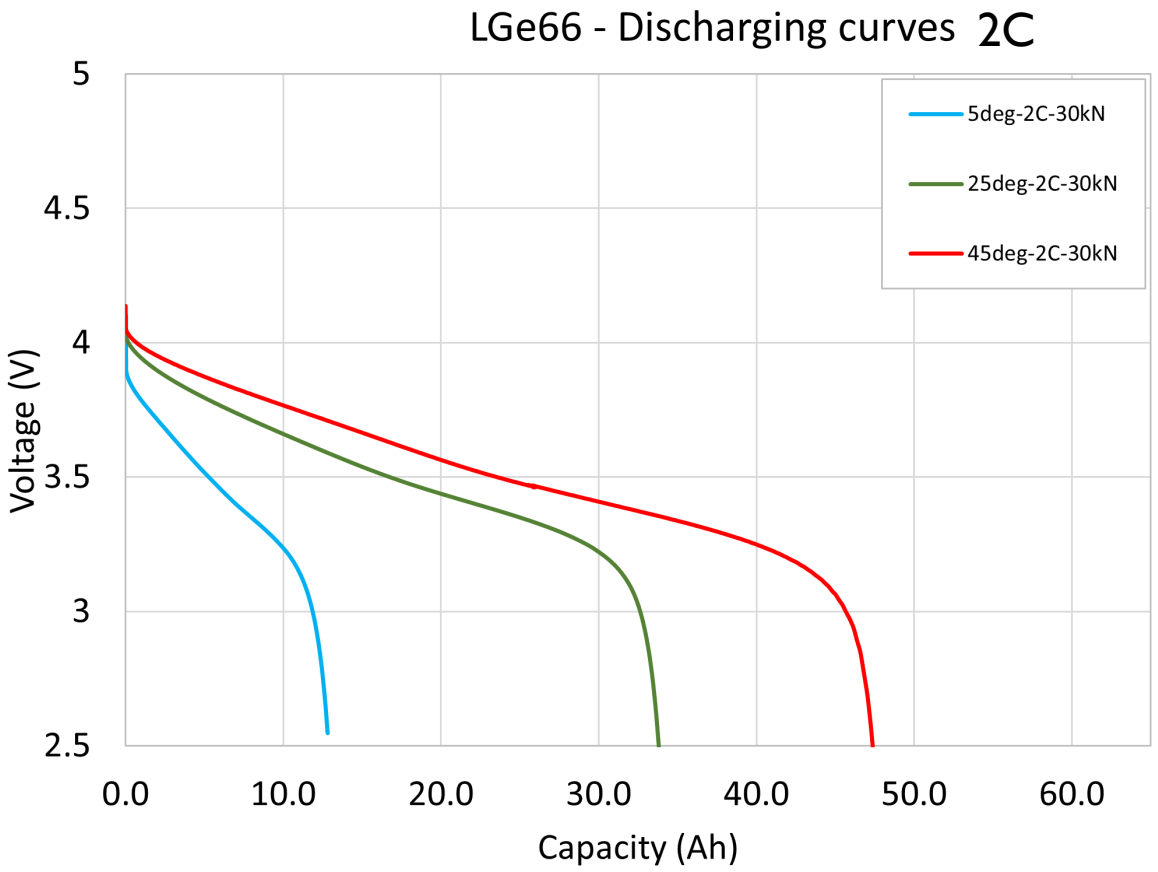
Temperature influence @15000 N (0.5 Mpa)





Temperature influence @30000 N (1 Mpa)





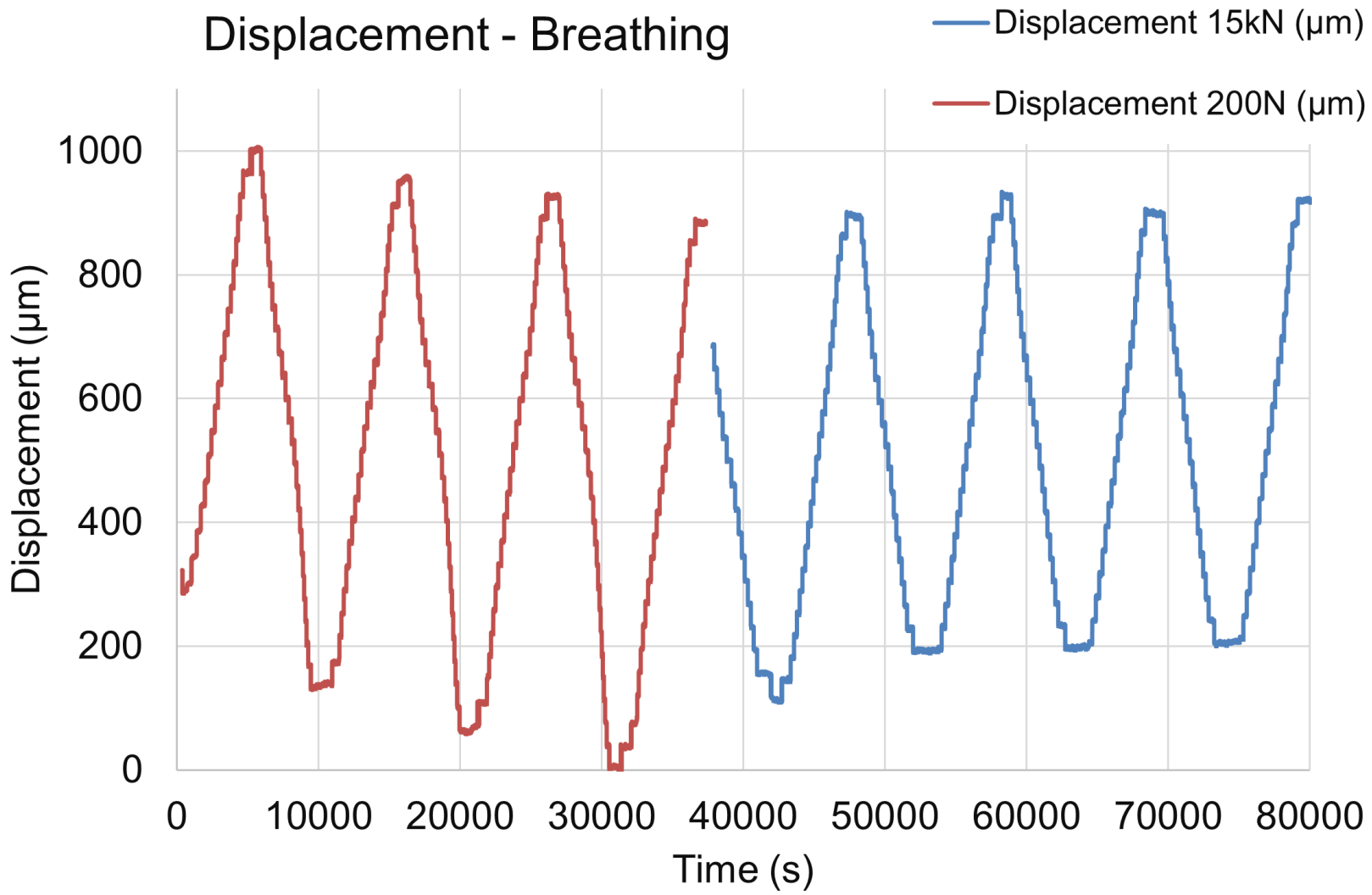
The optimal parameters for each case

0.5C - Ah	5°C	25°C	45°C
0 MPa	54	65	66
0.5 MPa	54	62	57
1 MPa	54	62	57

2C - Ah	5°C	25°C	45°C
0 MPa	17.5	21	52
0.5 MPa	13	34	47
1 MPa	12.5	35	45

Nominal capacity is 65 Ah

Breathing-Swelling



Mechanical Accuracy:

The stiffness, breathing, swelling and thermal expansion analysis is at nanometric precision. The press can be controlled both with force and displacement

Testing portfolio

A complete solution for all battery development needs

MBTS BATTERY TEST SYSTEMS

Electrical

- Charging/discharging curves up to 510 A
- Hybrid Power Pulse Characterization
- Electrical profiles up to 80 V and 510 A
- Electrochemical Impedance Spectroscopy analysis
- Definition of equivalent circuit model based on measurements

Thermal

- Cell surface temperature Charge/Discharge
- Controlled temperature with dynamic behavior
- Fixed/Dynamic spatial temperature gradient over the cell
- Heat flux map generation

Structural

- Mechanical characterisation of cell
- Stiffness measurement under thermal/electrical load
- Swelling measurements under load
- Constant pressure relaxation
- Dynamic stiffness response

Ageing

- Electrical cycling at specific c-rate
- Electrical cycling with pressure/temperature
- Electrical cycling with specific constraint displacement
- Measurement of electrical capacity during ageing

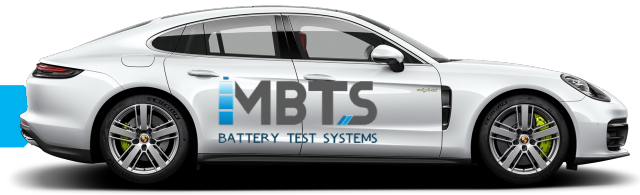
Swelling

- Swelling due to charging/discharging
- Swelling due to state of charge
- Decoupling of swelling from ageing
- Measurement of electrical capacity degradation

Benefits of the technology

Increase of driving range and durability for the same car

+10% Driving Range



+20% Battery Lifespan

+ Durability

+ Safety

MBTS Cell Model

Better BMS Calibration

Improved Battery

Design

Improved

Performances

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MSc Mechatronic Engineering

6 years Simulation Engineer at AVL
4 years Project Assistant at VSI - TU Graz
1 year Battery Specialist at Samsung SDI

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Dr. tech. Mechanical Engineering

1 years Simulation Engineer Magna Steyr
4 years Simulation Engineer FTG - TU Graz
2 years researcher and founder Aalto

MBTS
BATTERY TEST SYSTEMS

Zwick / Roell

Strategic Partner

THANK YOU