2025 NASA Aerospace Battery Workshop

VL10ES Cell and Batteries Qualification and Evolutions

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Agenda

1. Introduction : Saft/ADP/Space
2. VL10ES Gen 1 to Gen 2 transition
3. VL10ES Gen 2 qualification test results
4. VL10ES Gen 2 batteries
5. Conclusion

About Saft

- Saft specializes in **advanced technology battery solutions** for industry, from design and development to production, customization and service provision.

- **For more than 100 years (1918)**, Saft's longer-lasting batteries and systems have provided critical and safety applications, back-up power and propulsion for our customers.

- **Saft is a wholly owned subsidiary of TotalEnergies**, a broad energy company that produces and markets energies on a global scale: oil and biofuels, natural gas and green gases, renewables and electricity.

- Saft innovative, safe and reliable technology delivers high performance **on land, at sea, in the air and in space.**

A Wide Range of Offerings Designed for Specific Needs

Aerospace, Defense & Performance

TotalEnergies

Aerospace

- Backup power & emergency
- Engine & turbine starting for airplanes
- Communications, scientific & observation satellites
- Satellite launchers & space vehicles

Defense

- Military aircraft
- Submarines
- Weapons & torpedo systems
- Armored vehicles

Performance

- Formula 1, Formula E
- Workboats & ferries
- Cruise liners & luxury yachts
- Cargo & offshore vessels

Technologies

- Nickel batteries for aviation
- Lithium-ion batteries
- Silver-based batteries for military equipment

Aviation: AIRBUS, SAFRAN AEROSPACE · DEFENCE · SECURITY, BOEING

Defense: NAVAL GROUP, NORTHROP GRUMMAN

Marine: SOGESTRAN GROUP, Benetti

Space: ThalesAlenia Space, MDA, MAXAR

saft

Saft Satellite Battery History

- 12 Feb 1966 : **Diapason 1A** launch (NiCd)
- More than 750 Space NiCd batteries placed in orbit
- 10 first GPS satellite / Soho (SOlar Heliospheric Observator) Satellite Launch (1995).
- 1992 : NiH2 Cell/ Battery qualification and Gates Aerospace acquisition
- 1996 : Development of **Li-Ion satellite batteries** for Stentor (Technology Demonstrator Telecommunication Satellite in Orbit) from CNES
- 2000 : Stentor battery qualification : First “industrial” application to qualify large Li-Ion batteries for satellite mission.
- 2003 : Smart1 first ESA Moon Mission with full electric propulsion.
- 2004 : **W3A First GEO telecommunication satellite with Li-Ion Battery ever l**aunched. 21 years in orbit with 3 % energy loss.

- 2025 : 414 satellites launched with Saft Li-Ion batteries **and more than 1350 satellites equipped with different Saft chemistries**

Soho, ESA Credits

SMART1, ESA Credits

Airbus Amber

Introduction

- **VL10ES cell and batteries** have been developed to address all satellite market keeping the Saft DNA (performances, innovation, reliability and safety) :
  - GEO satcom and meteorological satellites
  - MEO constellations
  - LEO satellites and constellations
  - Exploration missions
- **VL10ES Gen 1 :** Cell QR has been successful in Dec 2024
- Battery qualification has been performed in parallel of the cell development
- Cell evolution qualification with **Gen 2** definition has been started to address second source critical materials and obsolescence.

CELL TYPE	VL10ES (F-size)
Dimensions (Ø x H)	**33 x** 103 mm
Weight	**210 g**
Volume	0.086 dm^3
Voltage range	2.7 V - 4.2 V
Nominal capacity	**> 12 Ah @ 4.2V, 20°C**
Nominal energy	**> 45 Wh @ 4.2V, 20°C**
Specific energy	**> 210 Wh/kg**
Internal resistance	≤ 22 mΩ @ 20% DoD / TBC
Operating temperature	+10°C / +40°C
Mechanical design margins	EWR & ECSS compliant

VL10ES Gen 2 Positive Active Material Qualification

- The VL10ES development already included the Gen 2 positive active material

- The Gen 2 positive active material has been tested during EM1 and EM2 development phases

- Same test plan has been conducted in parallel on Gen 1 and Gen 2 cells :
  - Electrical characterization (EOCV, Power, current and temperature)
  - Mechanical (vibrations and shocks)
  - Thermal tests
  - Safety

- VL10ES Gen 2 Delta qualification plan started in March 2024 based on the improved performance of Gen 2 vs Gen 1
  - Same qualification plan as per Gen 1
  - QR is planned Q1 26:
    - Main criteria : GEO/LEO mission fading reduction versus Gen 1 based on life tests

VL10ES Gen 2 Delta Qualification Plan

VL10ES -2 cell qualification

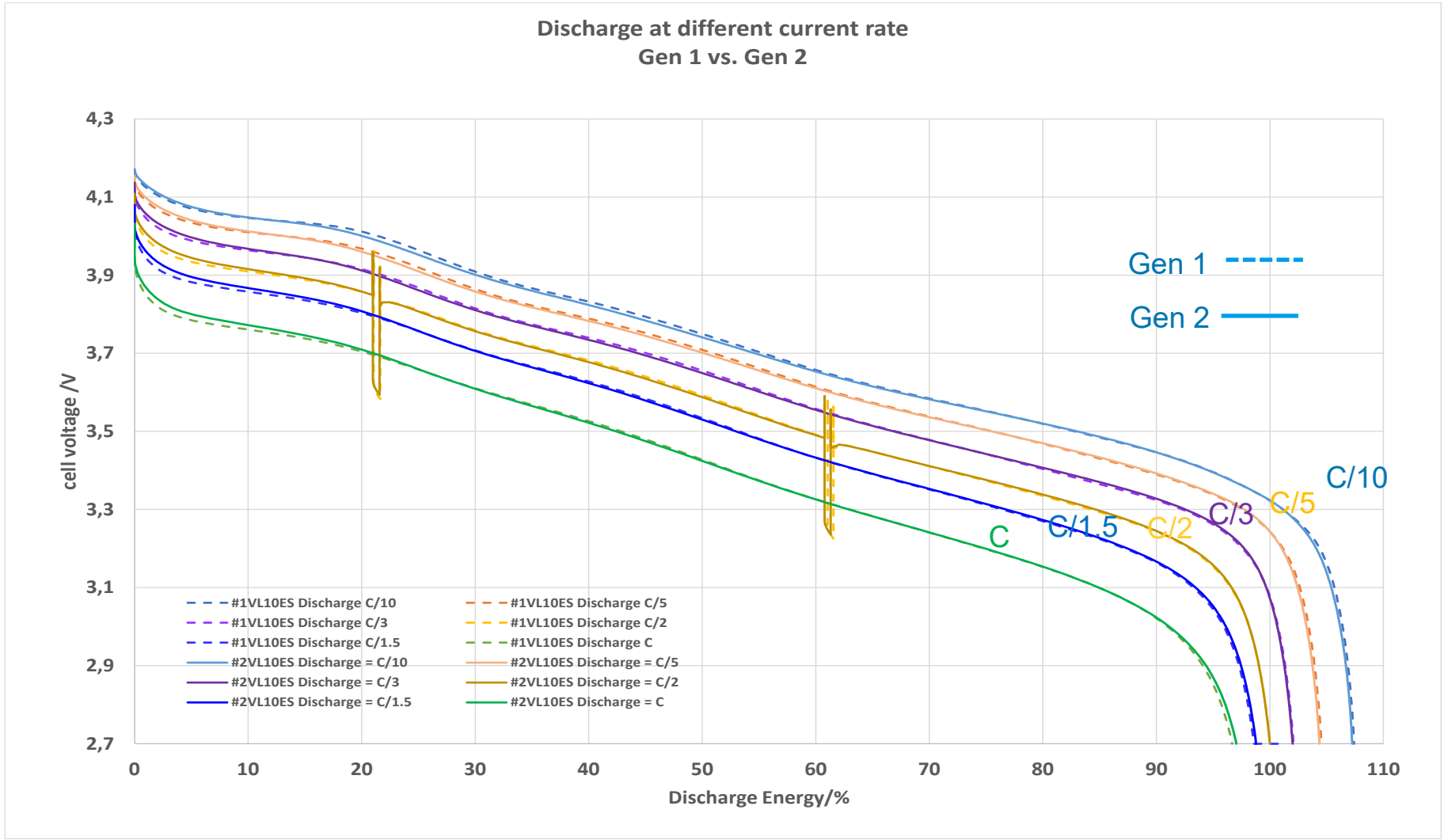
Electrical	Mechanical	Thermal	Life Tests	Safety
Dch vs T°	Vibration	T/V	LEO real time	Overcharge
Dch vs C rates	Shock	Dissipation	GEO semi-accelerated (EOR, PPS ,U cycles)	Over discharge / Reversal
Dch vs EOCV	T/V Cycling	Thermal Capacity	GEO accelerated	Ext. short
Dch vs Power rates	Leak Rate		Storage vs T° & SOC	Over temperature
Impedance, Ri			100% DoD	Nail / Pin Test
			Radiation Test	UN Transportation
				Exposure 60°C – 24 Hours

VL10ES Gen #1 and #2 Key Difference Linked to Positive Active Material

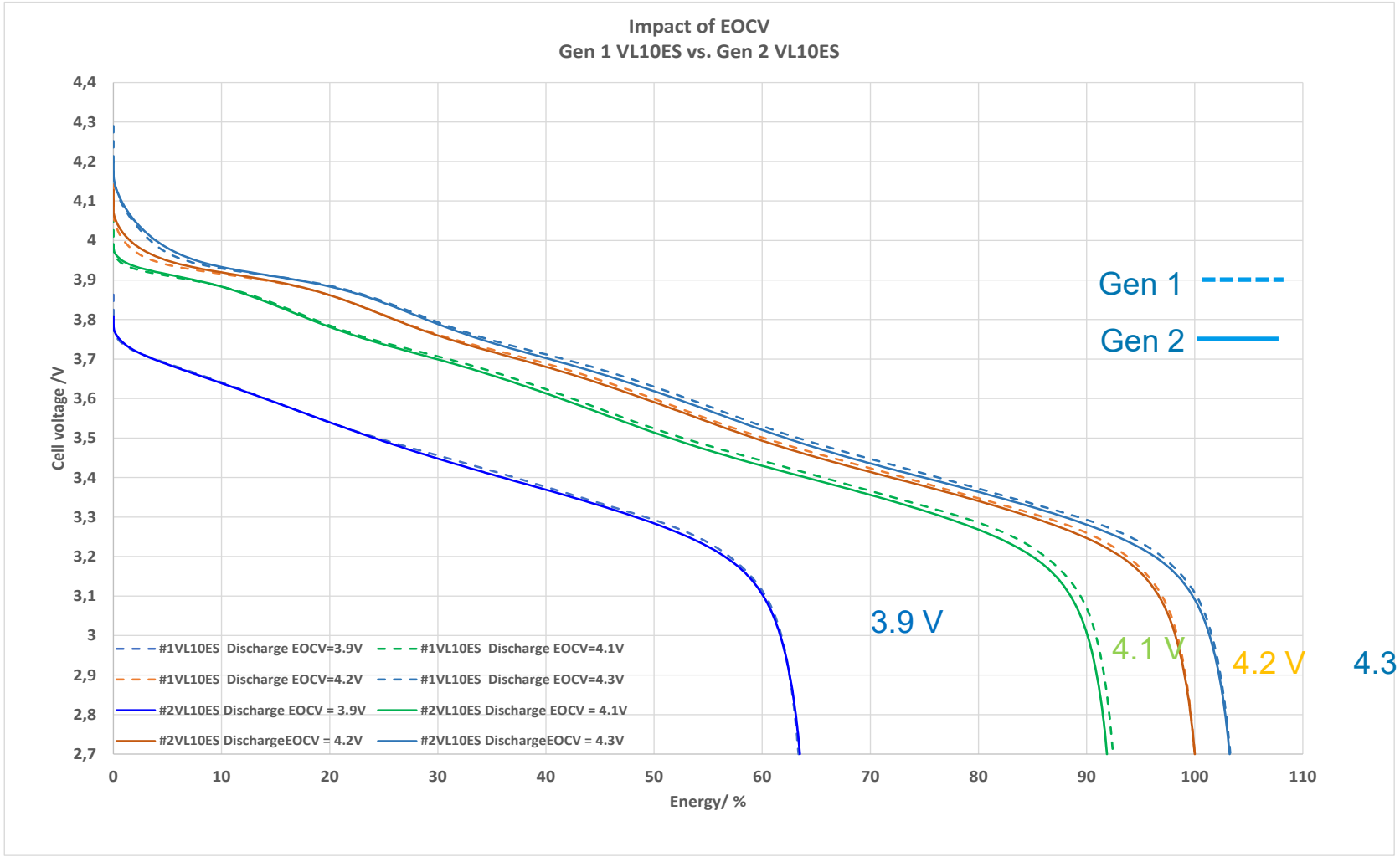
Items	VL10ES #1	VL10ES #2
Positive electrode	Base-line	Second source
Active Material	NCA Supplier 1	NCA Supplier 2
Conductors/Collector	Same	Same
Negative Electrode	Same	Same
Electrode Processes	Same	Same
Electrolyte	Same	Same
Separator	Same	Same
Mechanical parts	Same	Same
Cell Assembly Processes	Same	Same

- **Gen 2 Positive active material :**
  - Different Supplier vs Gen 1
  - Same NCA chemical composition
  - Same layered material structure
  - Similar particle shape and size
  - Similar processes

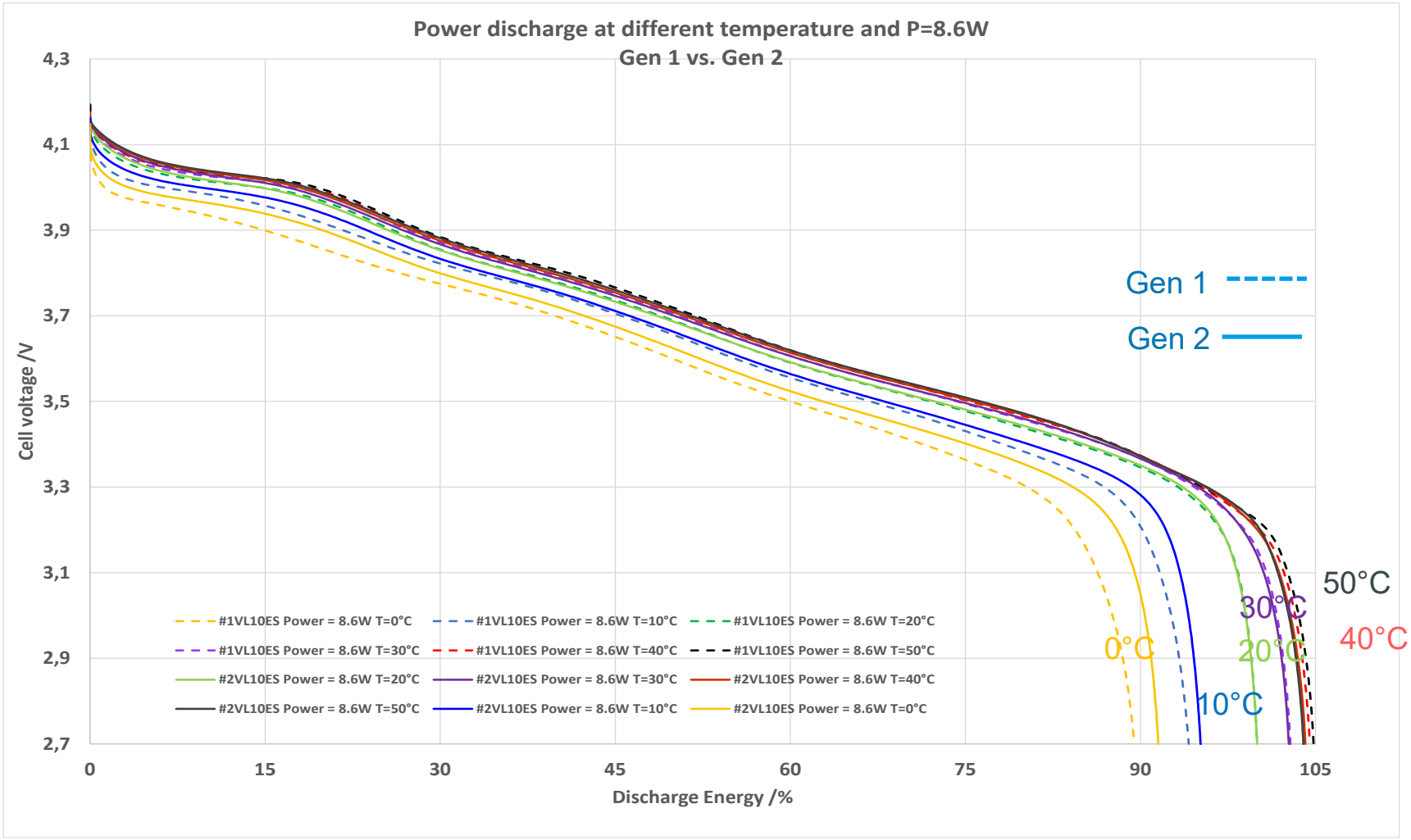
Energy Comparison Gen 1/Gen 2 vs Discharge Rate



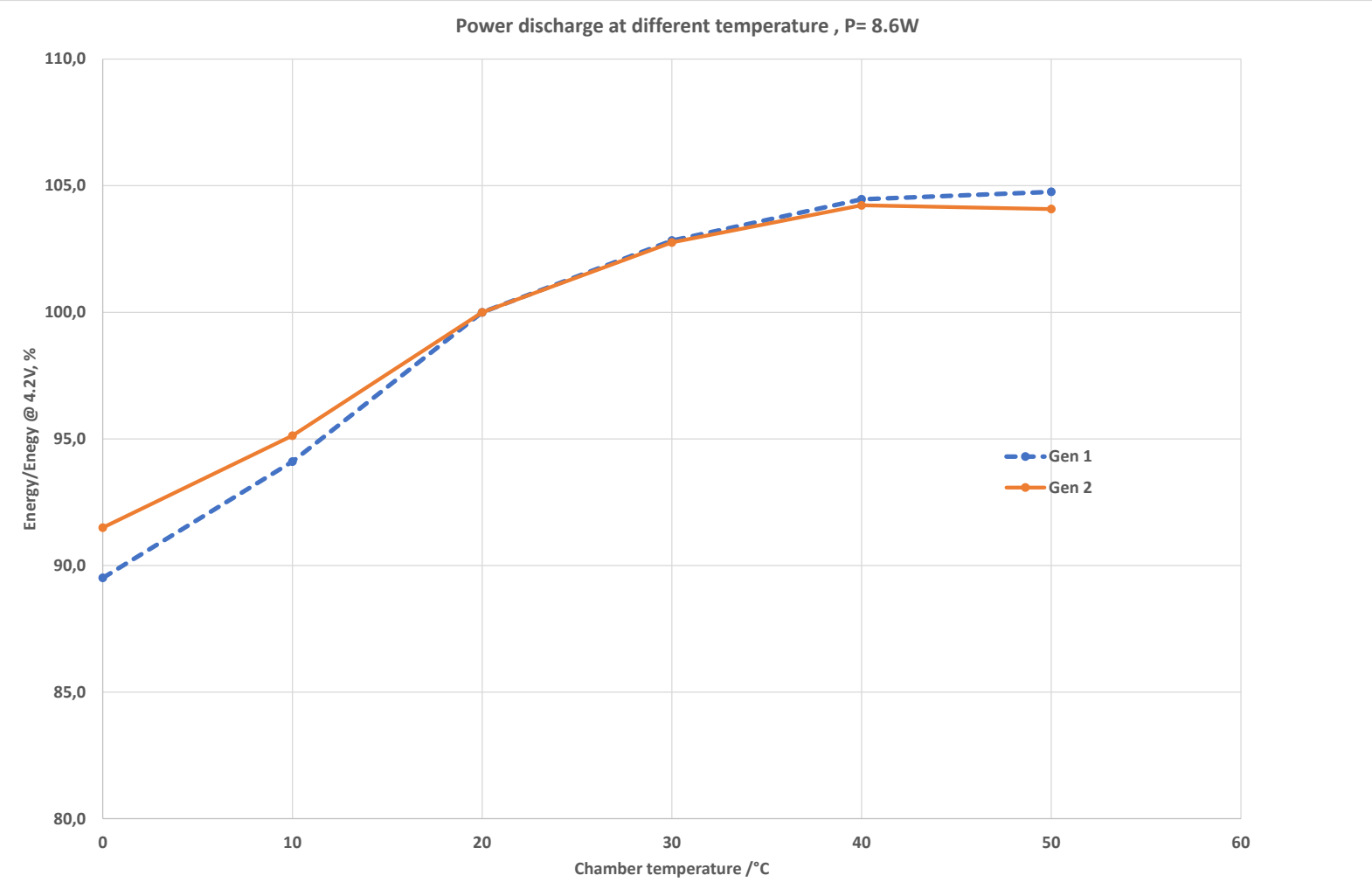
Energy Comparison Gen 1/Gen 2 vs Charge Voltage



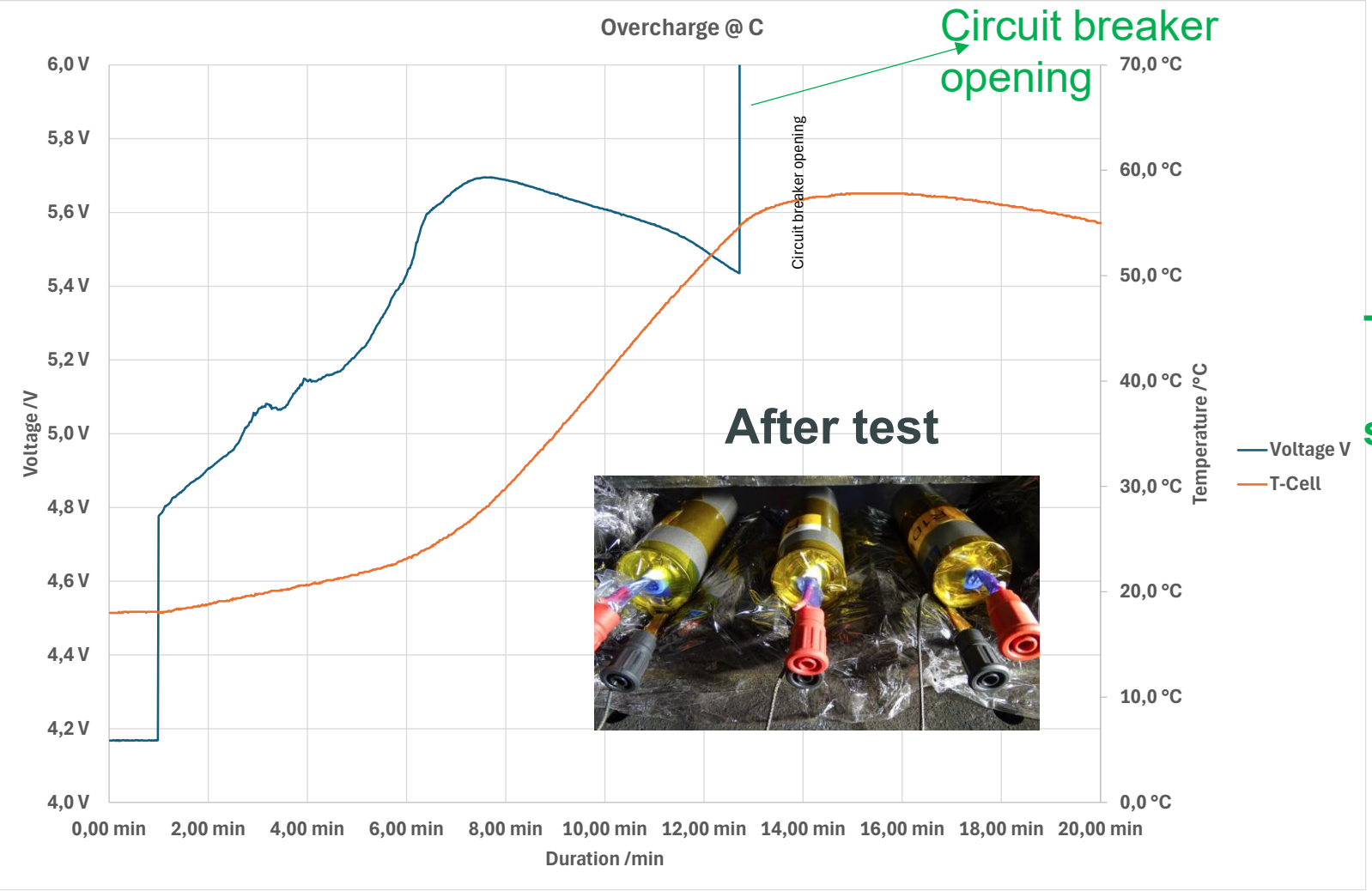
Energy Comparison Gen 1/Gen 2 vs Discharge Temperature



Energy Comparison Gen 1/Gen 2 vs Temperature

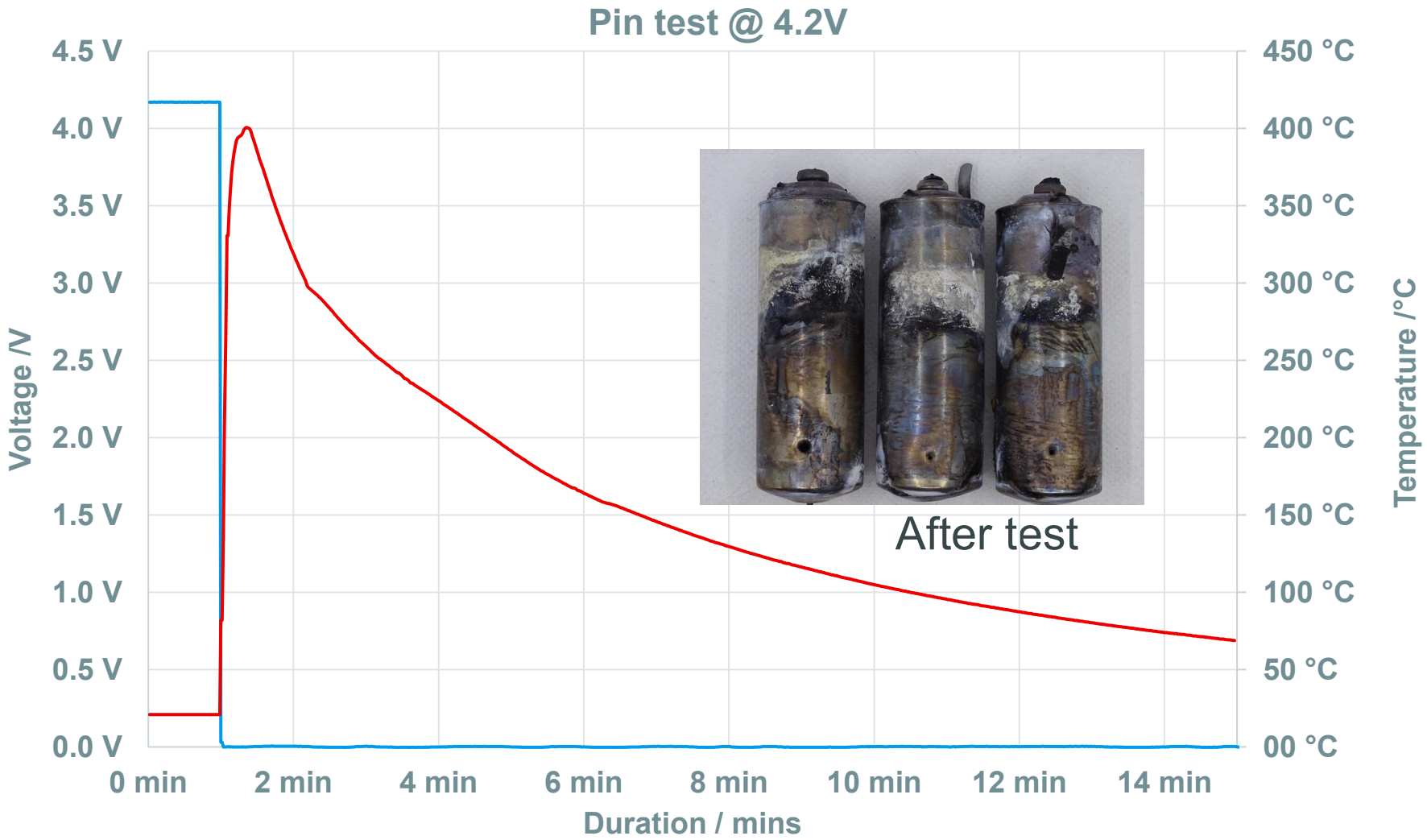


VL10ES Gen 2 : 1C Over-charge



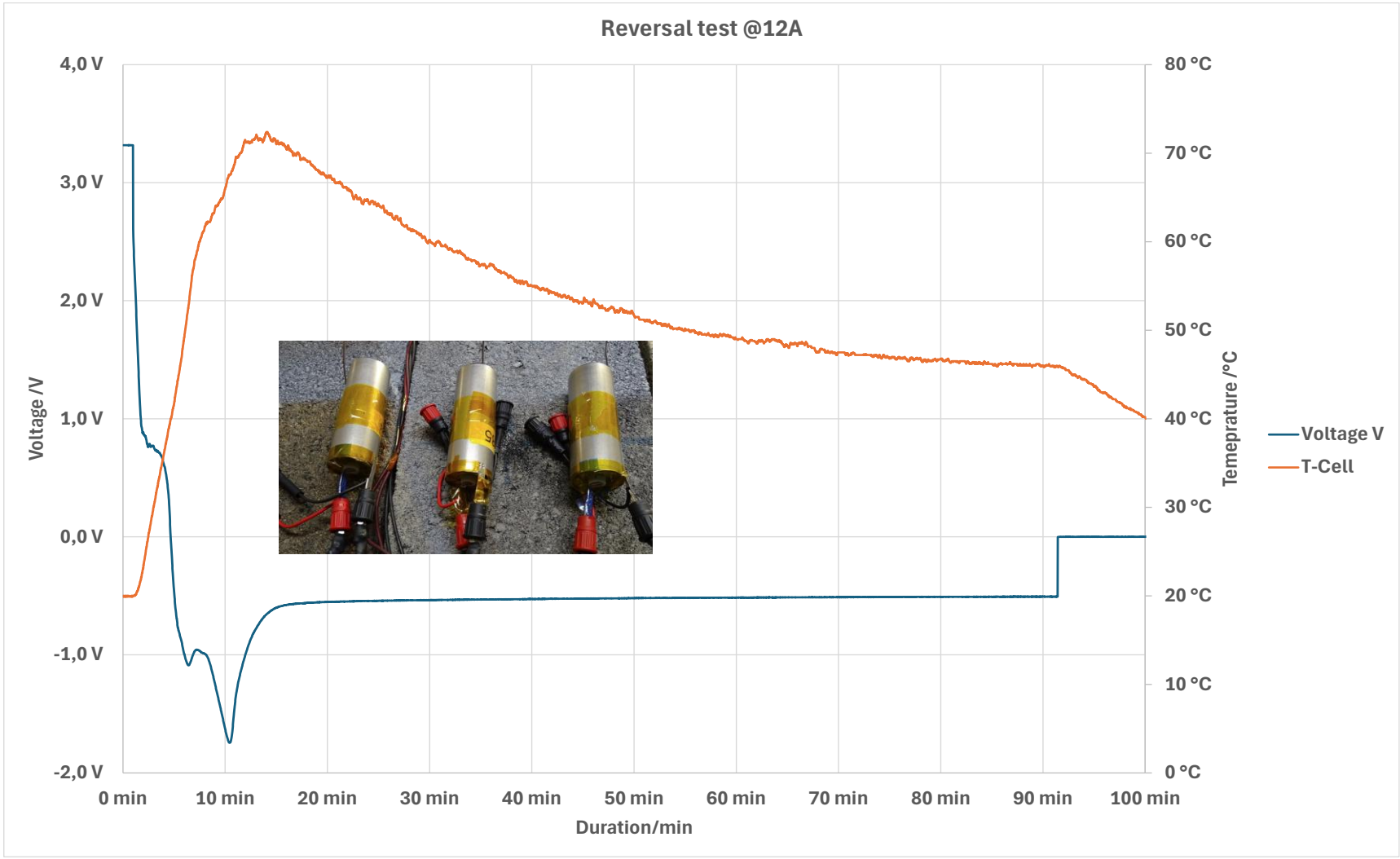
T < 60°C EUCAR2
No cell opening and structure change

VL10ES Gen 2 : Pin test 100% SOC – 4.2V



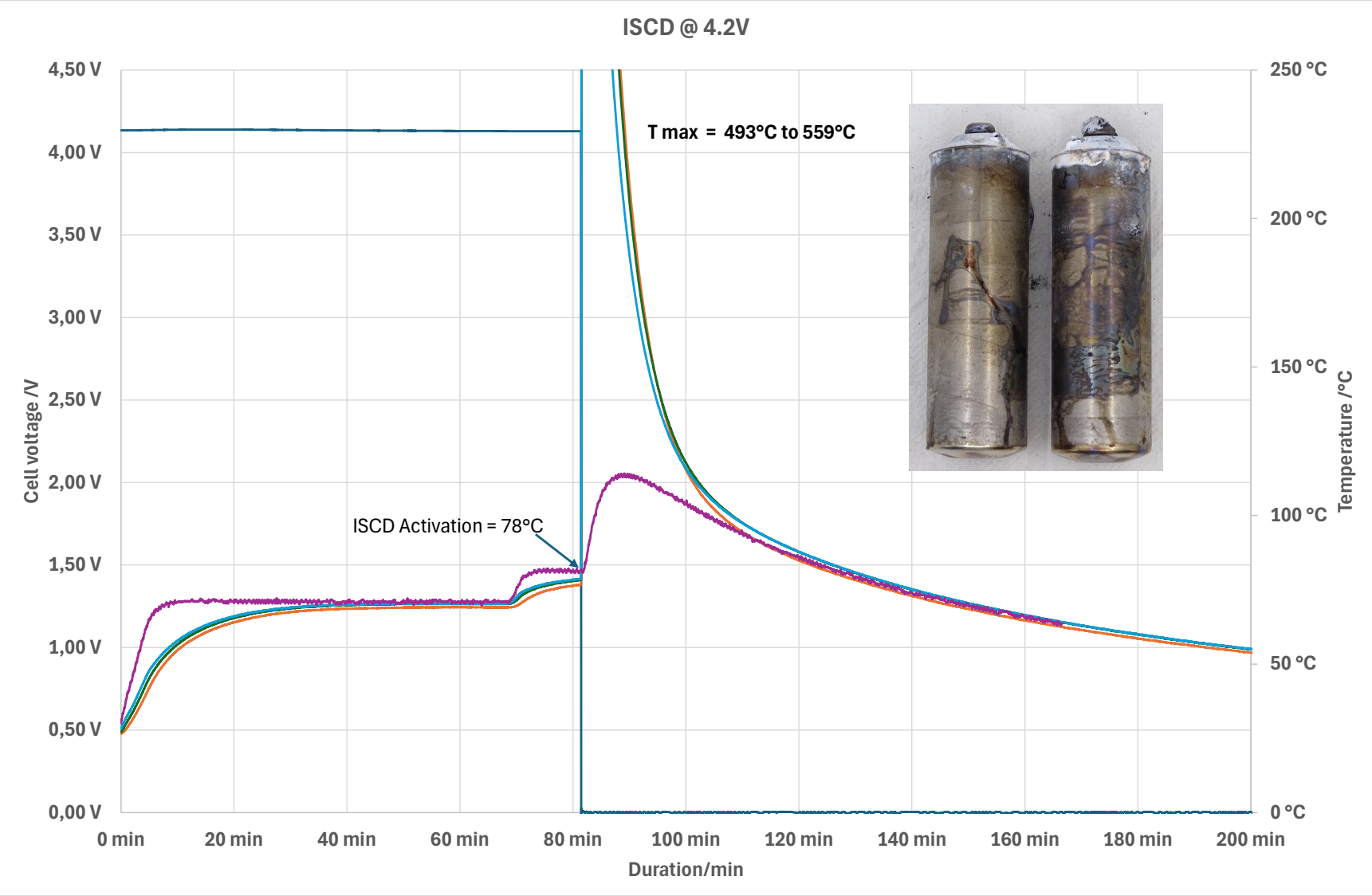
EUCAR5
2 vents opening
No cover ejection
No fire
No explosion

VL10ES Gen 2 : Reversal



T < 80°C EUCAR2
No cell opening and structure change

VL10ES Gen 2 : ISCD 100% SOC – 4.2V



EUCAR5
2 vents opening
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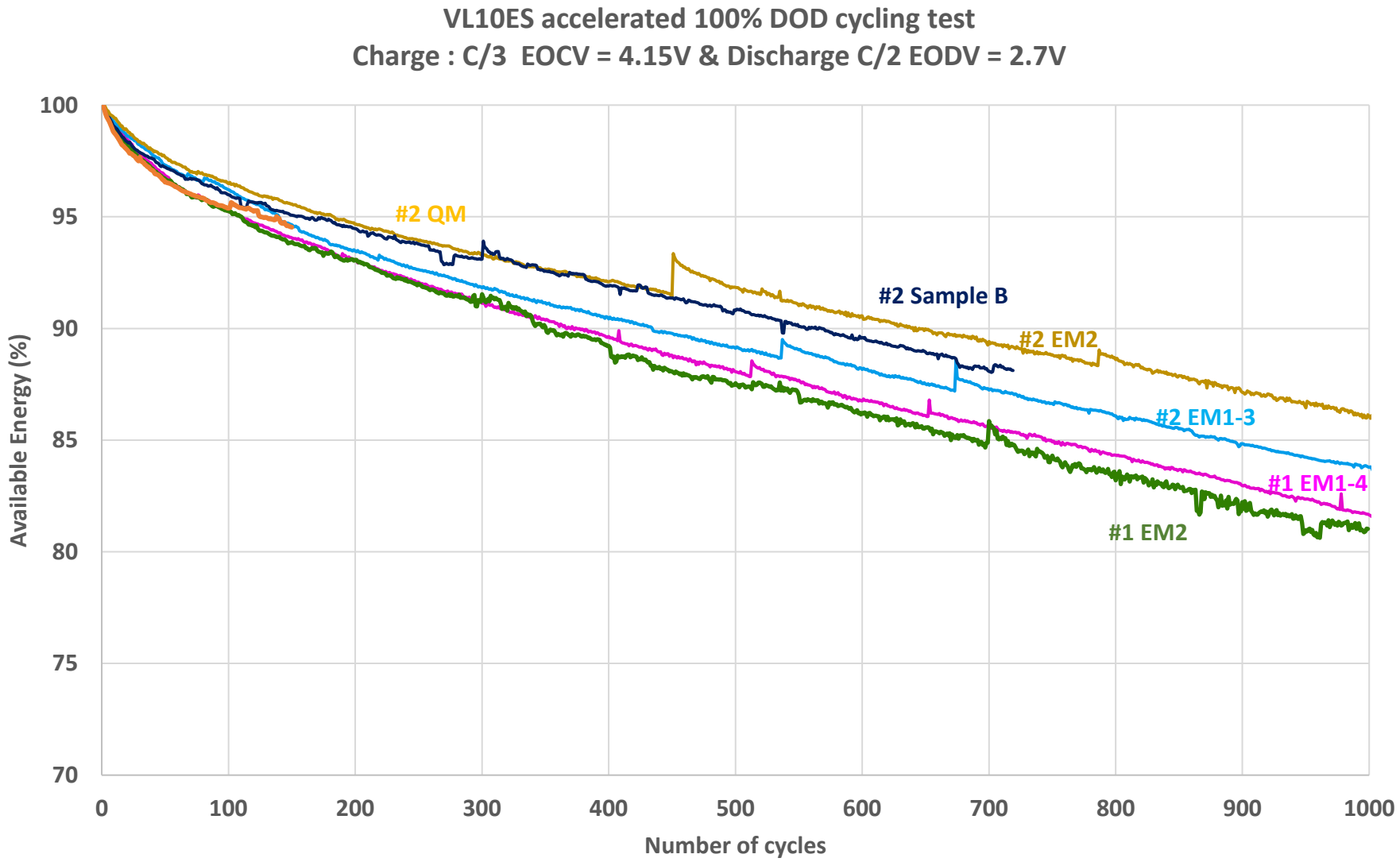
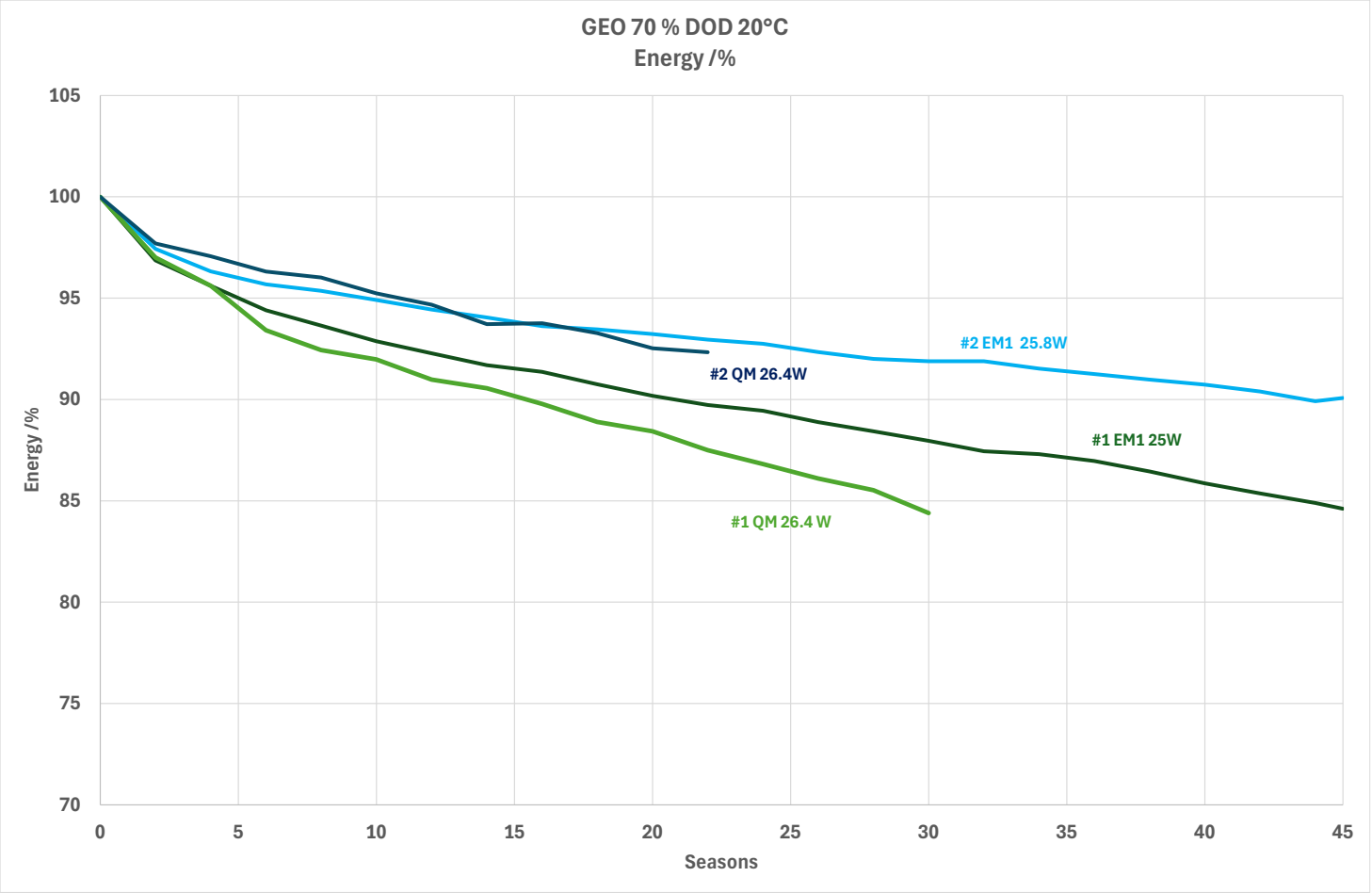
100% DOD Cycling Energy (#2 is Gen 2)



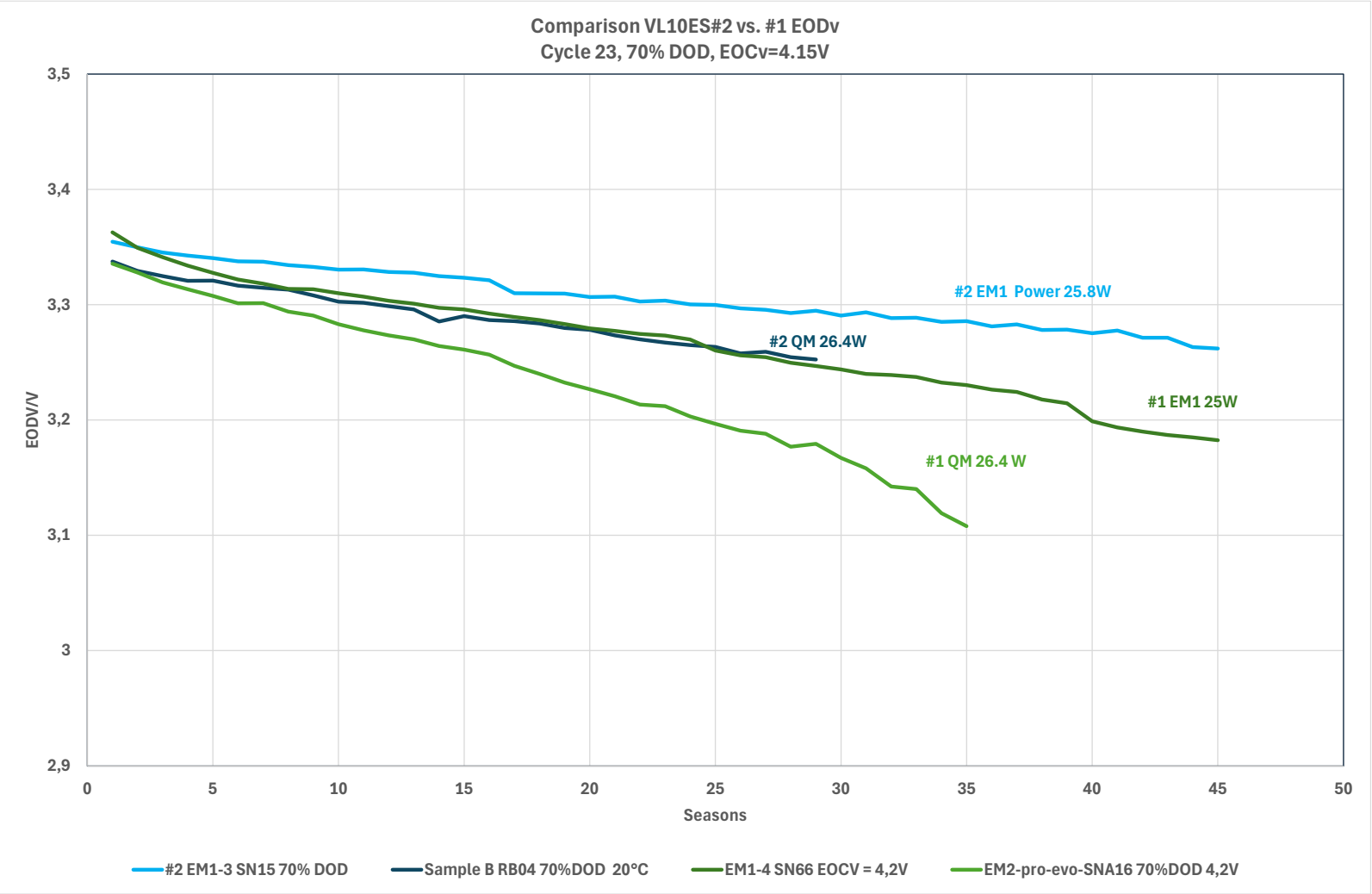
VL10ES#2 Serie 0 LT GEO 70 % DOD Energy Fading

- Gen 2 (#2) is showing a reduction of the fading versus Gen 1 (#1)

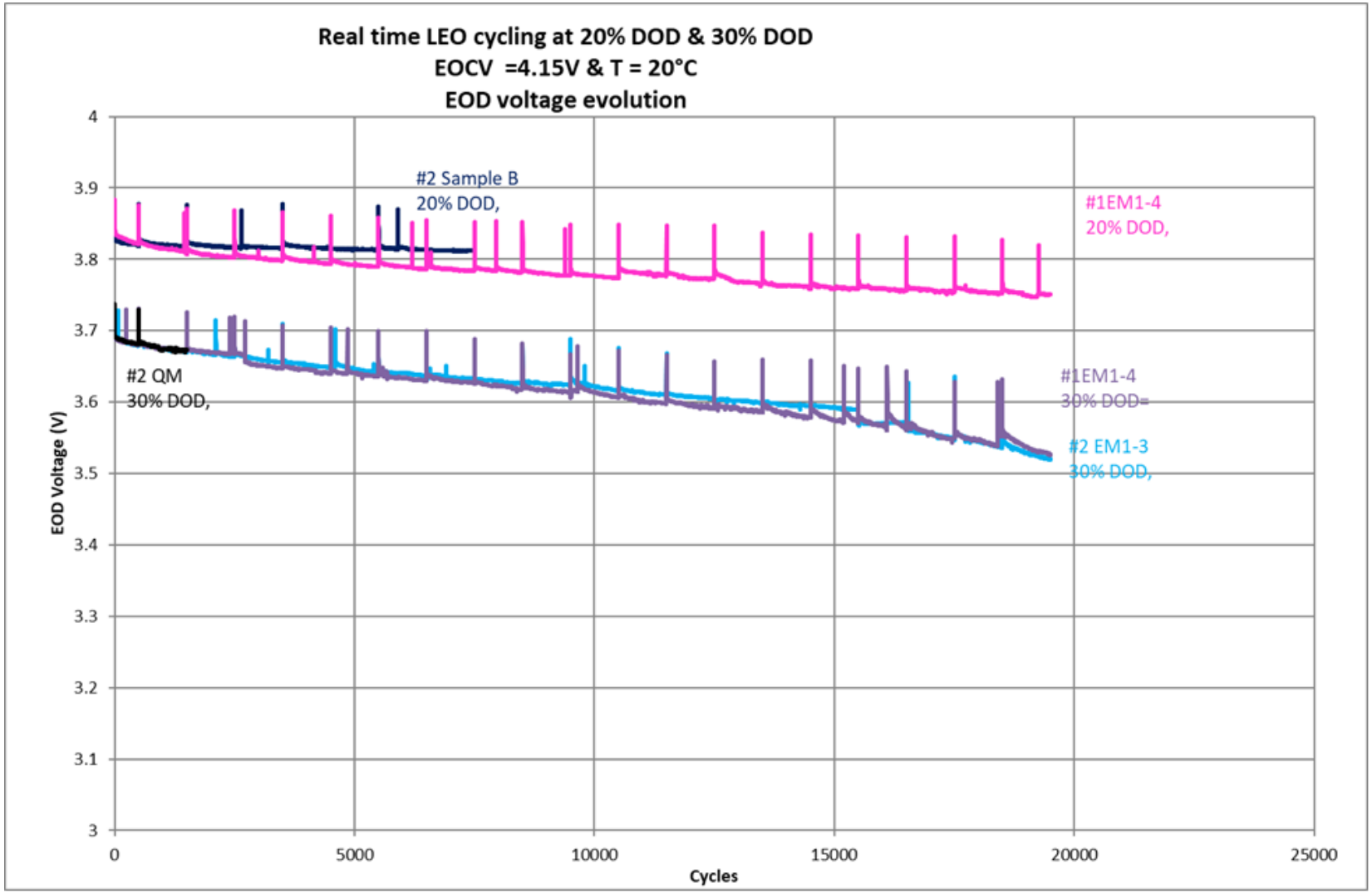


VL10ES#2 Serie 0 LT GEO 70 % DOD EODV

Gen 2 (# 2) is showing higher EODV versus Gen 1 (# 1)



VL10ES Gen#2 vs Gen#1 LEO 20 and 30 % DOD EODV Comparison



VL10ES Innovative Battery Concept

To answer to modularity (SP / PSP), to limits the no-recurring cost, a battery concept based on one main 4S pack

Independent block

With independent electrical, mechanical and thermal interface allowing easy replacement

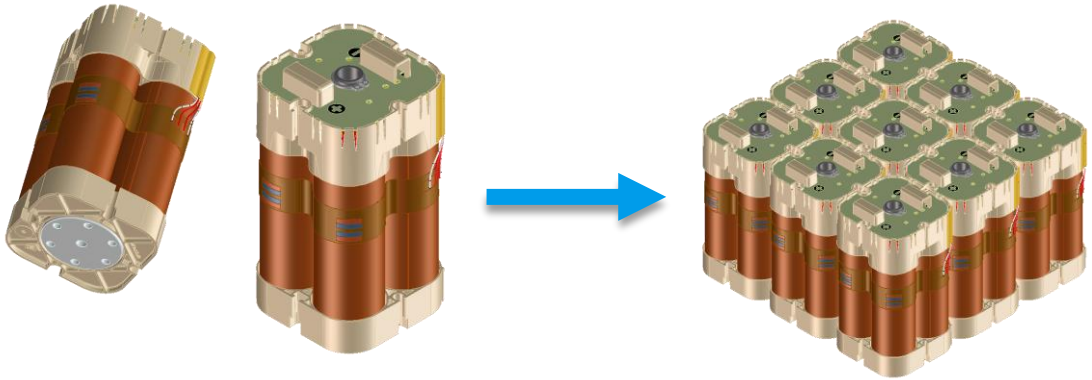
Modularity

Blocks are mechanically linked to each other like the pieces of a puzzle in order to reach larger S-P configuration

4S1P Block with SBS

4S1P block

12S3P Example



Individual Footprint
(mechanical / Thermal)

Autonomous electronics

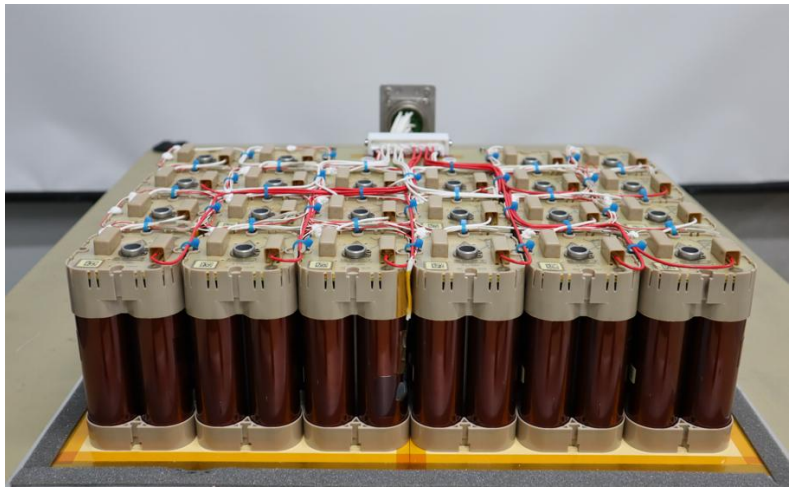
Each block is carrying its own autonomous electronics (4 Simplified Balancing System per block)

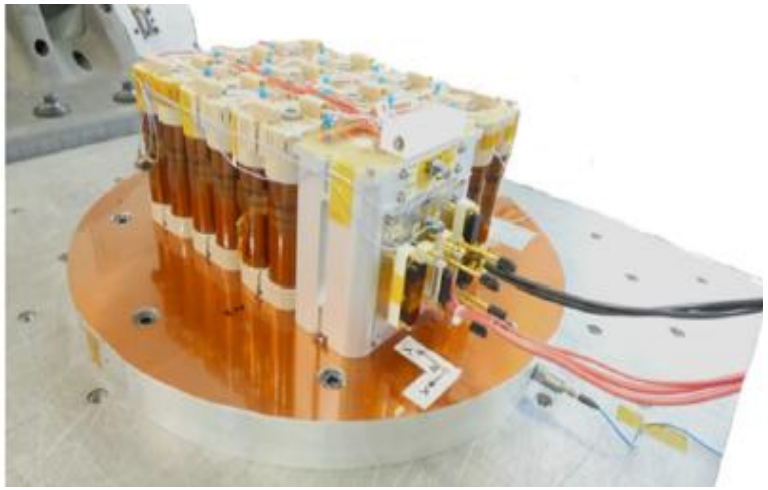
Assembly innovation

Each block is attached to the panel through a unique central screw.

Modular Battery range : 95 % Common Components

8S11P VL10ES





8S5P VL10ES

12S20P VL10ES

8S14P VL10ES

Conclusions

- VL10ES Gen 2 cell and battery qualification QR is planned in March 2026 for Data package consolidation. All tests have been successfully performed :
  - ✓Electrical tests including performance in temperature, power, current
  - ✓Environment tests
  - ✓Safety tests

- Cell Life Tests are still running : 45 seasons GEO already performed (15 years) and 20% DOD LEO cycles are showing lower fading versus Gen 1

- Gen 1 and Gen 2 cells are produced in parallel depending contracts

- 10 satellite contracts with Gen 1 and Gen 2 with a total of 350 batteries

- More than 50 batteries already delivered and some are ready for launch

ESPC Annoncement

ESPC 2026 https://atpi.eventsair.com/espc2026/

Thank you.