Advancing Battery Innovation:
Insights from the twinBATT Cluster

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AccCellBaTACBI

Accelerated Cell- and Battery Testing

5th May 2025 – Lorenzo Berzi

Project Overview

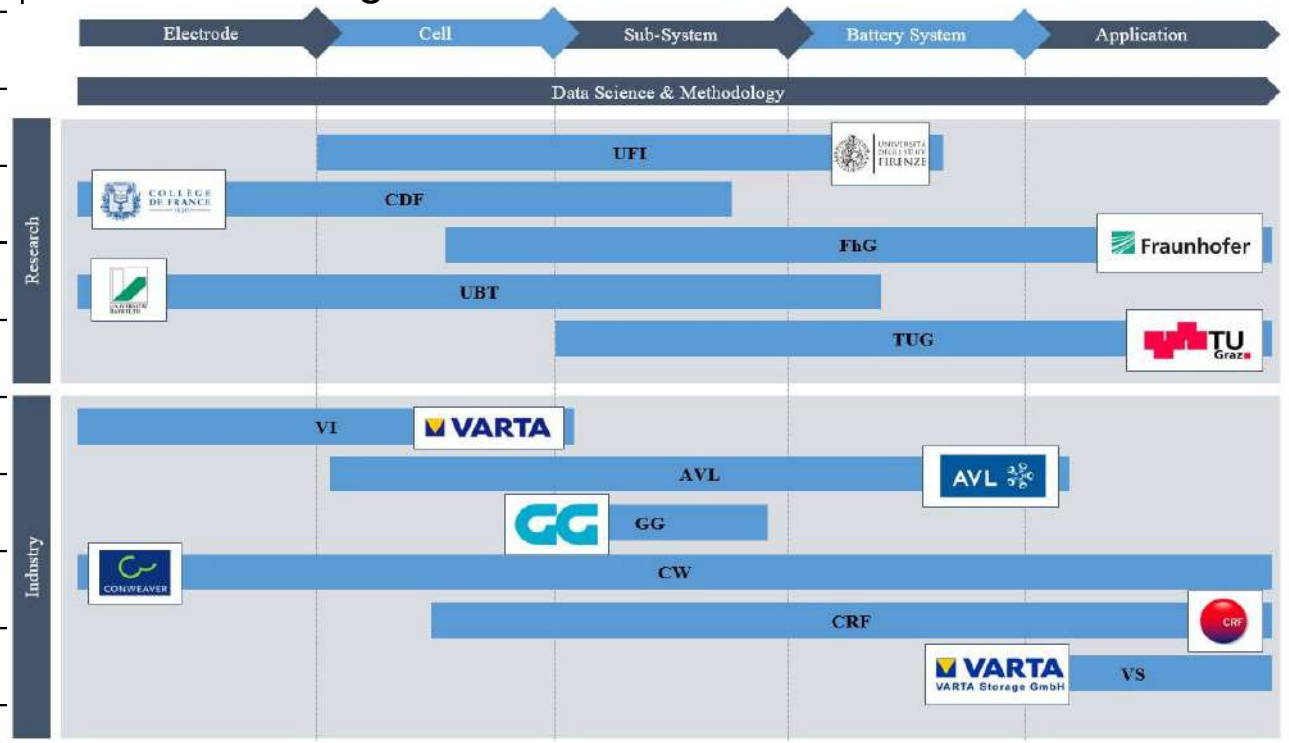
AccCellBaT

Participant Organization Name	*Short Name*
AVL List GmbH (Coordinator)	AVL
Collège de France	CDF
Conweaver GmbH	CW
Centro Ricerche FIAT	CRF
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.	FhG
Gebauer & Griller Kabelwerke Gesellschaft m.b.H.	GG
University Bayreuth	UBT
Graz University of Technology	TUG
University of Florence	UFI
Varta Innovation GmbH	VI
Varta Storage GmbH	VS

HORIZON-CL5-2022-D2-01-07 call

Running from 04/23 – 03/26 (3 years)

4.98M€ funding



	2023									2024												2025												2026		
	April	May	June	July	August	Septem	Octobe	Novem	Decem	January	Februa	March	April	May	June	July	August	Septem	Octobe	Novem	Decem	January	Februa	March	April	May	June	July	August	Septem	Octobe	Novem	Decem	January	Februa	March
Duration (months):	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Project Phases:	Requirements						Modelling						Methodology & data						Use case & hw built						Sim. & testing						Optimization					

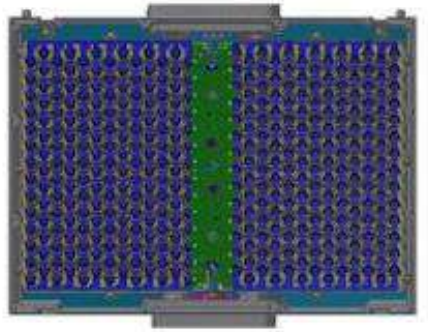
We are here

Motivation

VARTA Storage

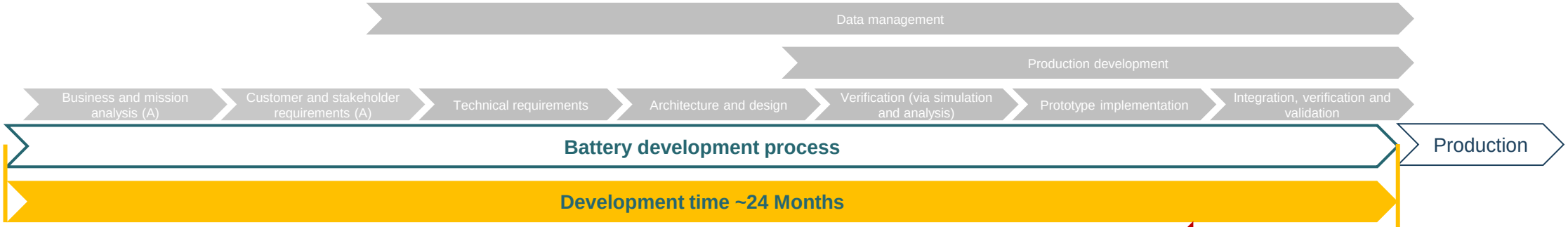
Fraunhofer

AccCellBaT



Use case automotive:
FIAT 500

Use case stationary:
VARTA.wall



Reduce development test time by:

➔ Substantially improved cell, battery sub-system and -system measuring and modelling (Objective 1)

➔ Accelerated cross-sectorial battery system testing methodology (Objective 2)

➔ Advanced data provisioning and automation within the battery verification and validation process (Objective 3)

Time reduction potential >30%

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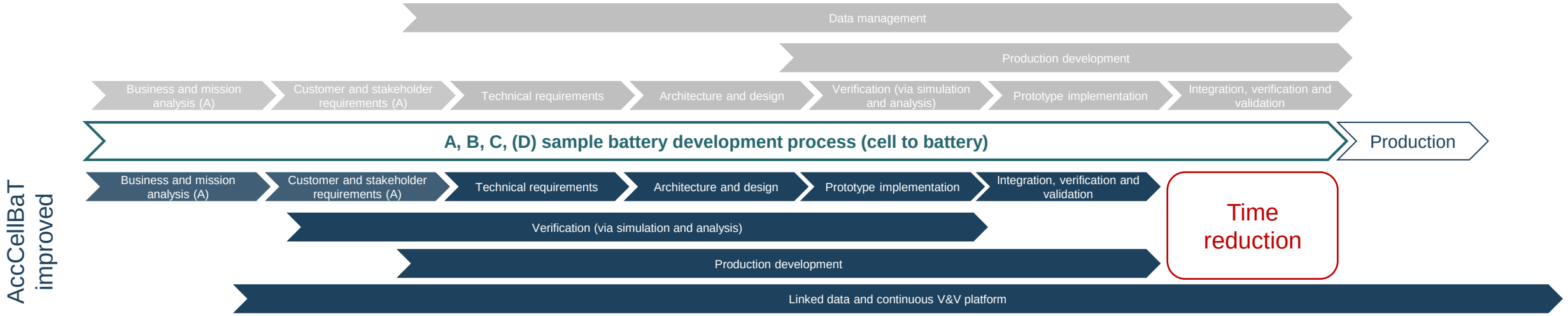
Project acceleration strategy



SoTA battery development process struggles in terms of virtual verification activities (weak simulation models, no availability of parameters, etc.).

Increase cost and time effort in testing.

AccCellBaT

- Improves the development process with cutting-edge simulation models enriched with parameters from advanced cell measurement technologies.
- Creates a linked data platform ensure that information is available when required and linked with the necessary additional information (context)
- Pushes verifcation and validation activites to be continuous.

Selected AccCellBaT methods that improve the development process

- Multidisciplinary requirement definition
- Tailored model development
- Smart cell advanced measurement method
- Linked data management method
- Hybrid DVP development
- Measures of project succe

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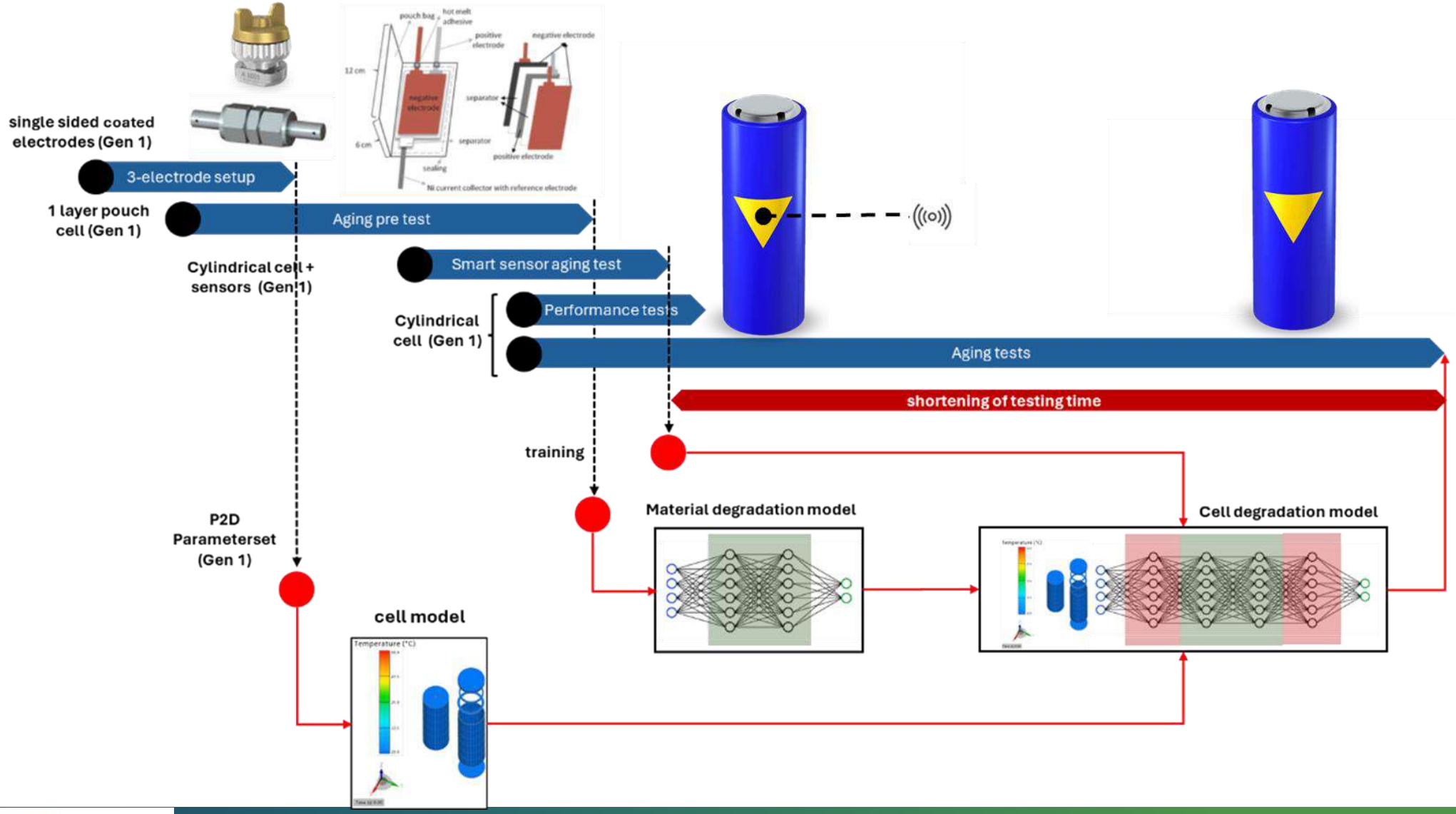
Tailored model development – *Cell*

VARTA Innovation



Tailored model development – *Cell to Module and Battery*

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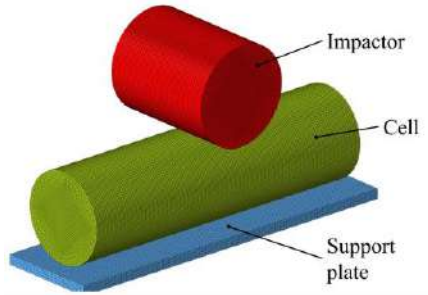
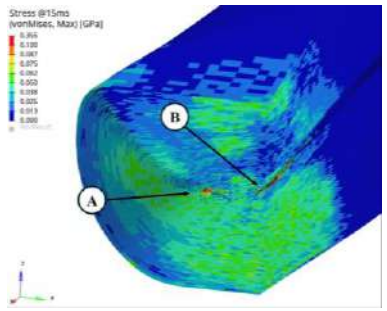
Domain | Model Design | Simulation

Mechanical model

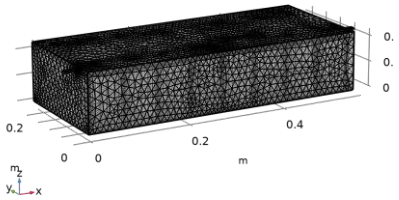
- Deformation
- Separator fractur
- Internal Short Circuit (ISC)

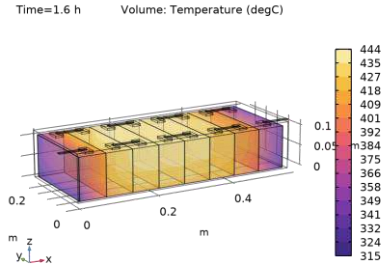




Thermal model

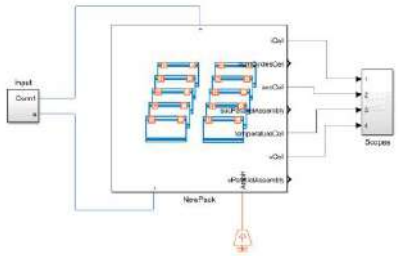
- Temperature

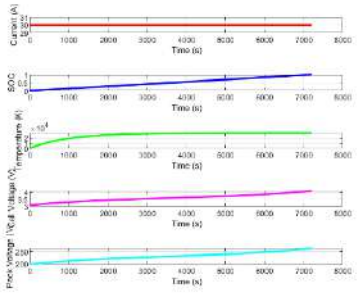




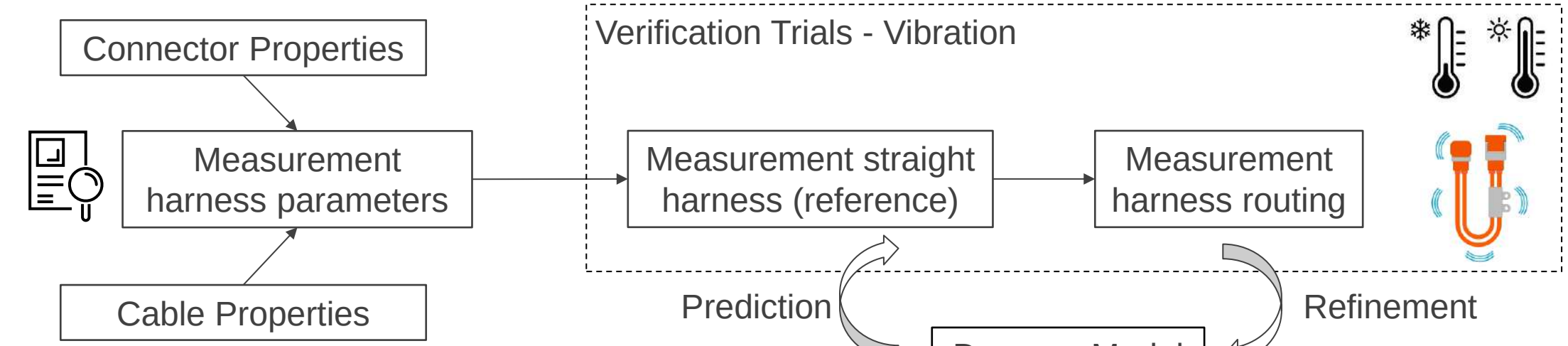
Electrical model

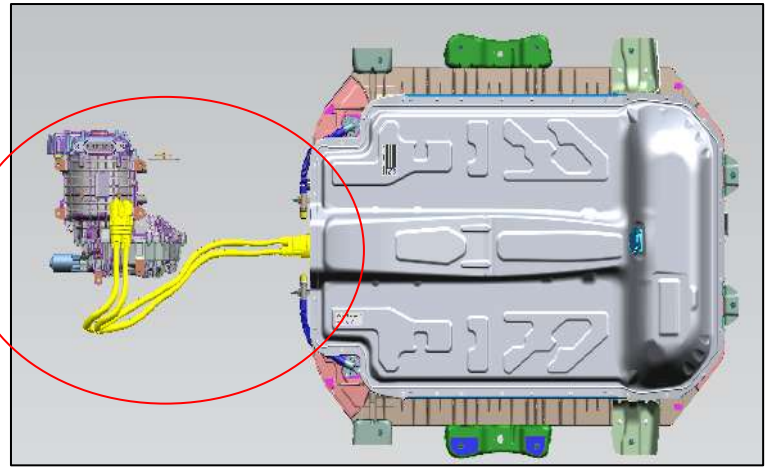
- Current
- Voltage
- Resistance



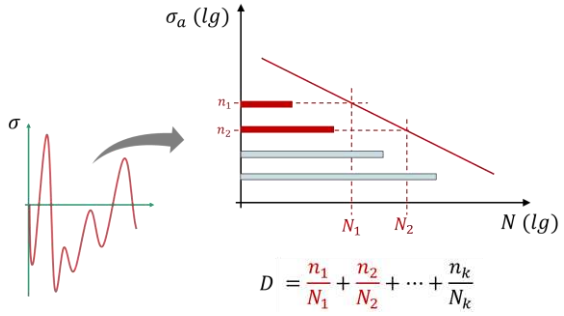


Tailored model development – *Wiring Harness*





Main use case: Traction HV-wiring BEV Fiat 500



→ Scaling for different cables and connector sizes

→ Adjustment depending on harness routing

Digital product verification

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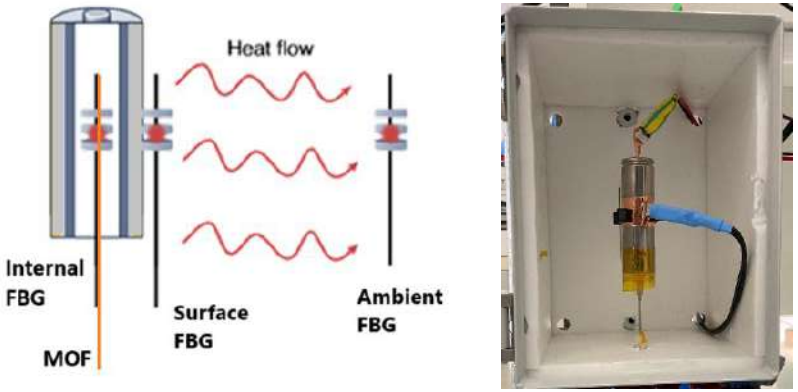
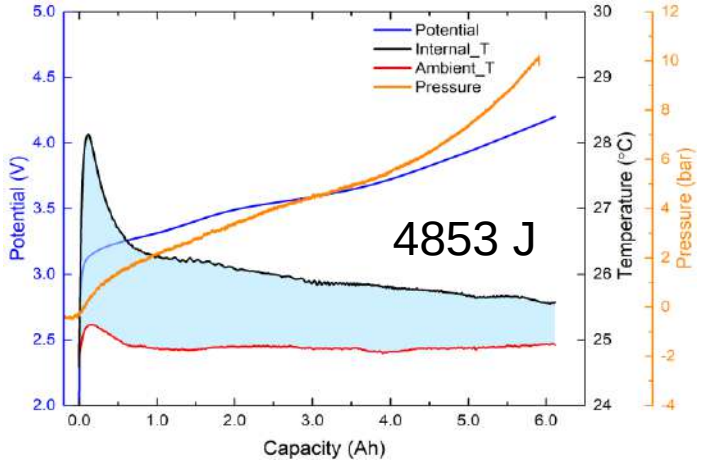
Smart cell advanced measurement method

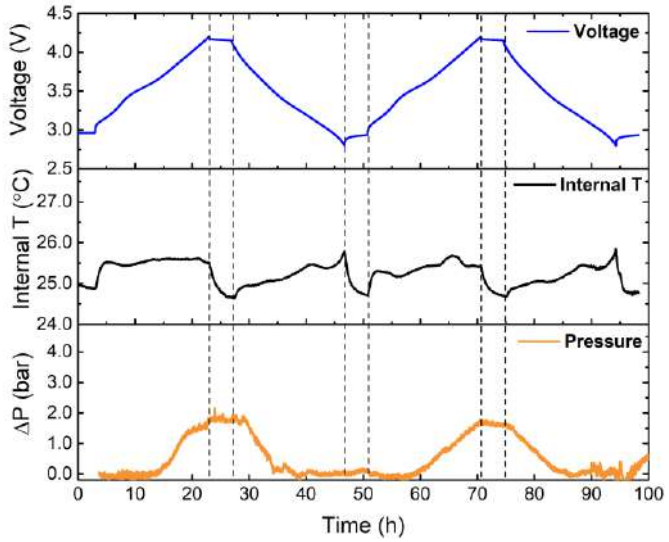
(1) Optical calorimetry



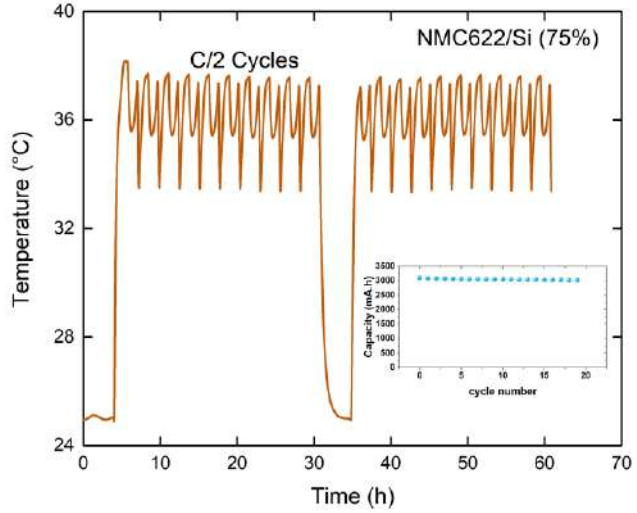
(2) SEI formation (C/20)



(3) 2nd and 3rd Cycles (C/20)



(4) 1-20 Cycles (C/2)



(1) Optical calorimetry: 3 FBGs sensors for temperature analysis. MOF as pressure sensor.

(2) Heat released during SEI formation and significant pressure rise during the first charge.

(3) Pressure steps during the 2nd and 3rd cycles → expansion of silicon?

(4) High internal temperature during cycling.

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Linked data management method

CONWEAVER

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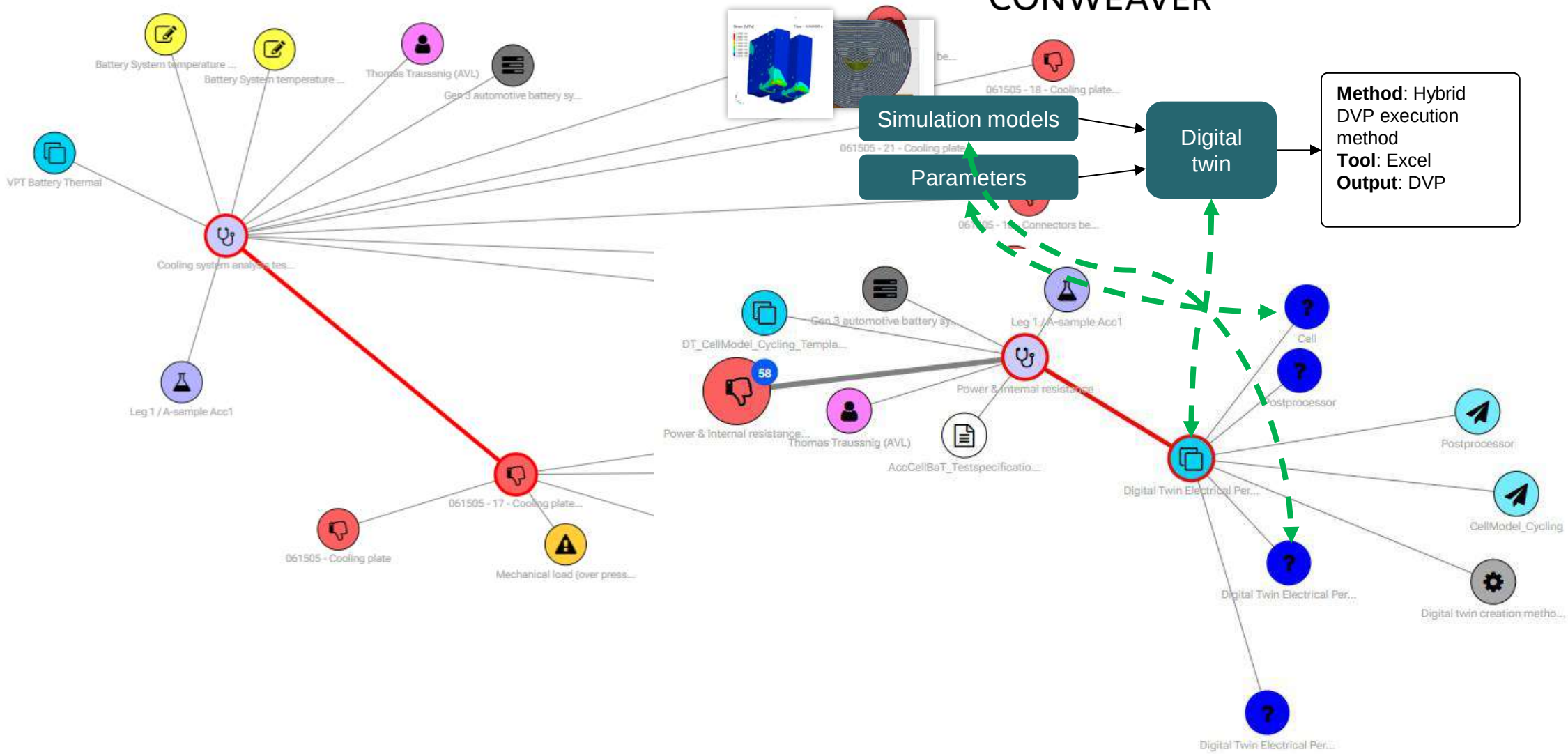
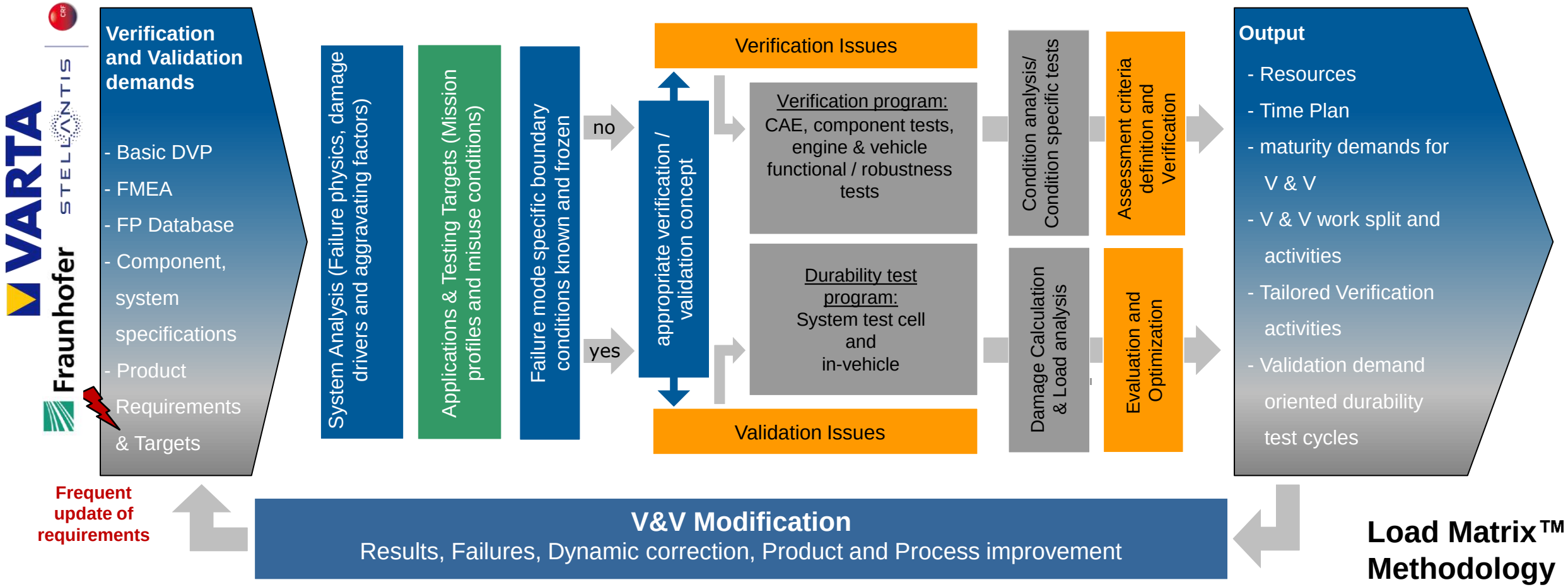


Hybrid Design verification and validation plan development

Focus: battery system testing methodology yielding up to 30% time reduction
hybrid Design verification & validation plan (merge digital and phyiscal testing)



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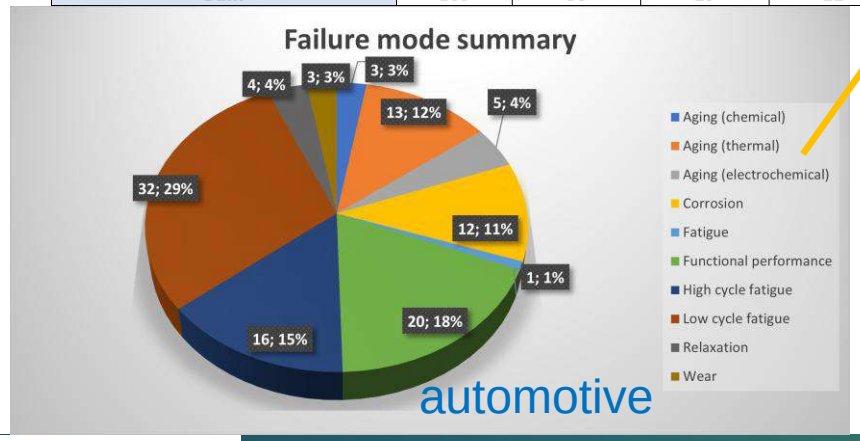
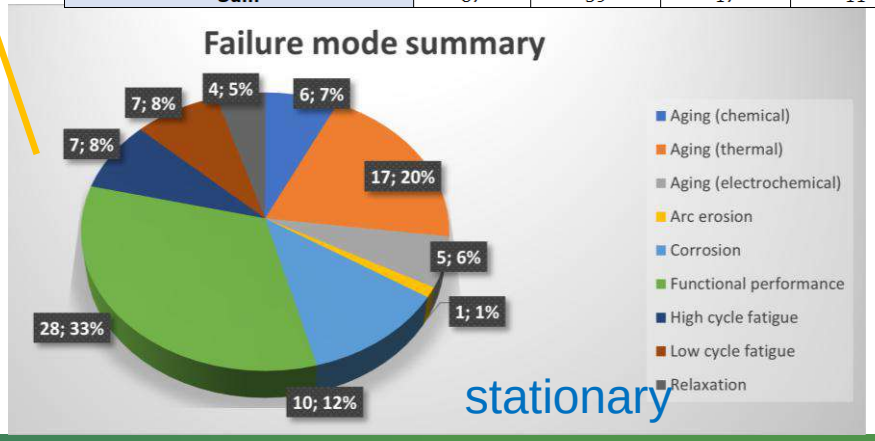
Hybrid Design verification and validation plan development

Failure mode	Subsystem / Component	Loss of function	Effect on system level (Failure observation) (System level 2 - BT)	Failure location (System level	Function group (System level	Cause of failure (System level 4&5)	Failure mode/ Failure	Classification of Failure Effect	Damaging operating conditions (System level 1 -	Aggravating conditions System related	Aggravating conditions Environment related
060000	Complete Energy storage system (ESS) - BT										
060500	Battery modules										
060505	Battery module										
060510	Cell stack										
060511	Battery Cell										
1	Battery cell	Loss of Power Degradation of Power	HVBS is unable to deliver or receive power/energy, decrease in capacity is observed	Cell	Ensure Energy Storage and Power Delivery, Ensure Reliability	Thermal Load (Overheating)	Aging (Thermal)	Class II	Vehicle operation; aggravating conditions are dominant	Cell Chemistry and Cell Properties	Vehicle operating in Environmental conditions e.g. hot ambient conditions
3	Battery cell	Loss of electrical isolation, Loss of insulation Electrolyte Leakage	Leakage of electrolyte, HVBS subject to heat reaction, possible fire or explosion	Cell Housing (Structure of the cell or Cell Canister, burst disc)	Ensure Safety	Mechanical and thermal Load (Thermal Cycling)	Low Cycle Fatigue	Class I	Vehicle operation; aggravating conditions are dominant	Cell Chemistry and Cell Properties; Cell Stack Design	Vehicle operating in Environmental conditions e.g. hot ambient conditions

Failure mode overview	Failure mode summary	Category 'Valdiation'	Category 'Monitoring'	Category 'Verification'
Aging (chemical)	3	3	0	0
Aging (thermal)	13	7	4	2
Aging (electrochemical)	5	4	1	0
Corrosion	12	0	8	4
Fatigue	1	0	0	1
Functional performance	20	13	6	1
High cycle fatigue	16	13	2	1
Low cycle fatigue	32	15	6	11
Relaxation	4	2	1	1
Wear	3	1	1	1
Sum	109	58	29	22



Failure mode overview	Failure mode summary	Category 'Valdiation'	Category 'Monitoring'	Category 'Verification'
Aging (chemical)	6	6	0	0
Aging (thermal)	17	11	3	3
Aging (electrochemical)	5	5	0	0
Arc erosion	1	1	0	0
Corrosion	10	0	6	4
Functional performance	28	20	6	2
High cycle fatigue	7	6	0	1
Low cycle fatigue	7	6	1	0
Relaxation	4	2	1	1
Wear	2	2	0	0
Sum	87	59	17	11



Measures of project success

Fraunhofer AccCellBaT

Key performance indicators

- Monitor progress towards specific goals
- Track and evaluate performances and improvements in WP2 to 7 that *cumulated* achieve time-to-market reduction by 30%

$K_{\text{sim}}, K_{\text{test}}, K_{\text{auto}}$ Simulation efficiency, Testing efficiency and Degree of automation

$$K = p_1\, p_2 \Delta$$

- p_1 is the component that evaluates the **fulfillment of a product requirement**
  - $p_1 = 1$ when the requirement of the product, such as energy density, is reached
  - $p_1 = 0$ when the requirement of the product is not reached
- p_2 is the component that evaluates the **maturity or certainty** of a method or information
  - $p_2 = 0 \ldots 1$ according to the calculation of the confidence index of the method or information
- Δ evaluates the **improvement**, e.g., saving of time.

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Status and outlook

Requirements, system concept and state of the art assessment elaborated
Main damage drivers identified, models for key battery elements elaborated

✓ assigned to Objective 1, accomplished (M1 & M2)

➔ cell development to be brought to final development stage; model scale up in progress

Battery system testing methodology set-up and tailored for AccCellBaT battery systems

✓ assigned to Objective 2, methodology set up and available for use cases

➔ application of methodology in the form of hybrid design verification and validation plan (DVP); integration of models in the form of digital twins and confidence index methodology to be adapted in the 2nd period of the project; validation of 30% test time reduction for battery development

Set up of linked data management platform done; crosslinking and integration of data/models/documents in AccCellBaT launched; AccCellBaT process concept defined

✓ assigned to Objective 3, method framework and battery development process available; linked data management platform available; process acceleration strategy in M1 (accomplished)

➔ integration of data into linked data management platform to be intensified; making hybrid DVP ‚executable' via linked data management platform together with reliability assessment

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