



Dr. Gerald Sammer

Performance Optimization of Battery Cell, Module and Pack Testing



Scaling battery testing – but the smart way!

Performance optimization of battery cell, module and pack testing

WELCOME!



Today's Presenter



Dr. Gerald Sammer

Principal Business Field Manager, Battery & Cell.

M.Sc. in computer science and a Ph.D. in economics.

32 years professional experience in computer science.

24 years experience in automotive technologies.

AVL representative in the technical steering committee of the ASAM standardization group for automotive standards.

AGENDA

AVL
Company

Key Aspects
of Optimized
Testing &
Validation

Lab Process
Efficiency

Intelligent
Test
Optimization

Facts and Figures



Global Footprint

Represented in 26 countries

45 Affiliates at over 92 locations

45 Global Tech and Engineering Centers (including Resident Offices)

1948

Founded

10,700

Employees Worldwide

12%

Of Turnover Invested in Inhouse R&D

70+

Years of Experience

68%

Engineers and Scientists

2,500

Granted Patents in Force

97%

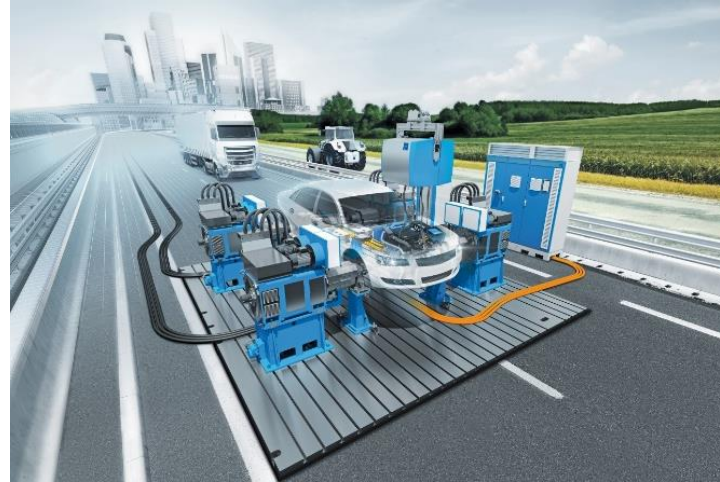
Export Quota

Three Disciplines Under One Roof



ENGINEERING SERVICES

- Design and development services for all elements of ICE, HEV, BEV and FCEV powertrain systems
- System integration into vehicle, stationary or marine applications
- Supporting future technologies in areas such as ADAS and Autonomous Driving
- Technical and engineering centers around the globe



INSTRUMENTATION AND TEST SYSTEMS

- Advanced and accurate simulation and testing solutions for every aspect of the powertrain development process
- Seamless integration of the latest simulation, automation and testing technologies
- Pushing key tasks to the start of development



ADVANCED SIMULATION TECHNOLOGIES

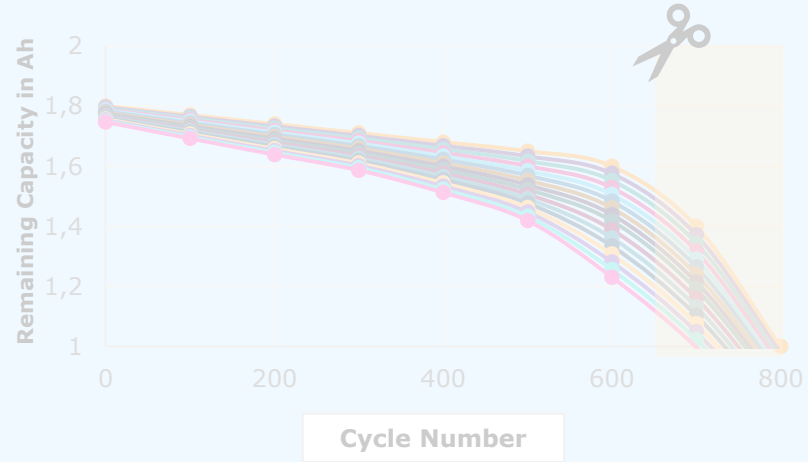
- We are a proven partner in delivering efficiency gains with the help of virtualization
- Simulation solutions for all phases of the powertrain and vehicle development process
- High-definition insights into the behavior and interactions of components, systems and entire vehicles

Key Aspects of Optimized Testing & Validation

Lab Process Efficiency



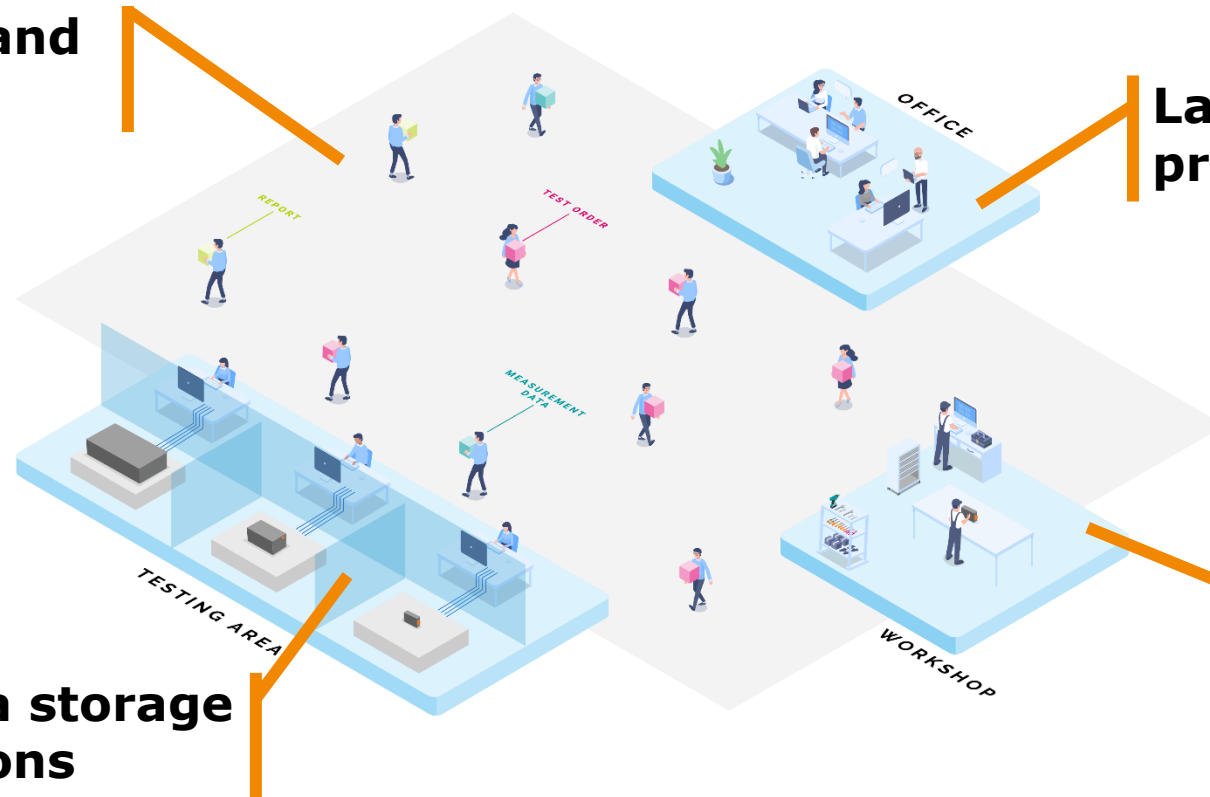
Test Methodology



Battery Lab with Low Maturity

KPIs not defined and measured

Lack of digitalization and process automation



Disconnected data storage in different locations

Manual planning processes

Optimize The Lab Process

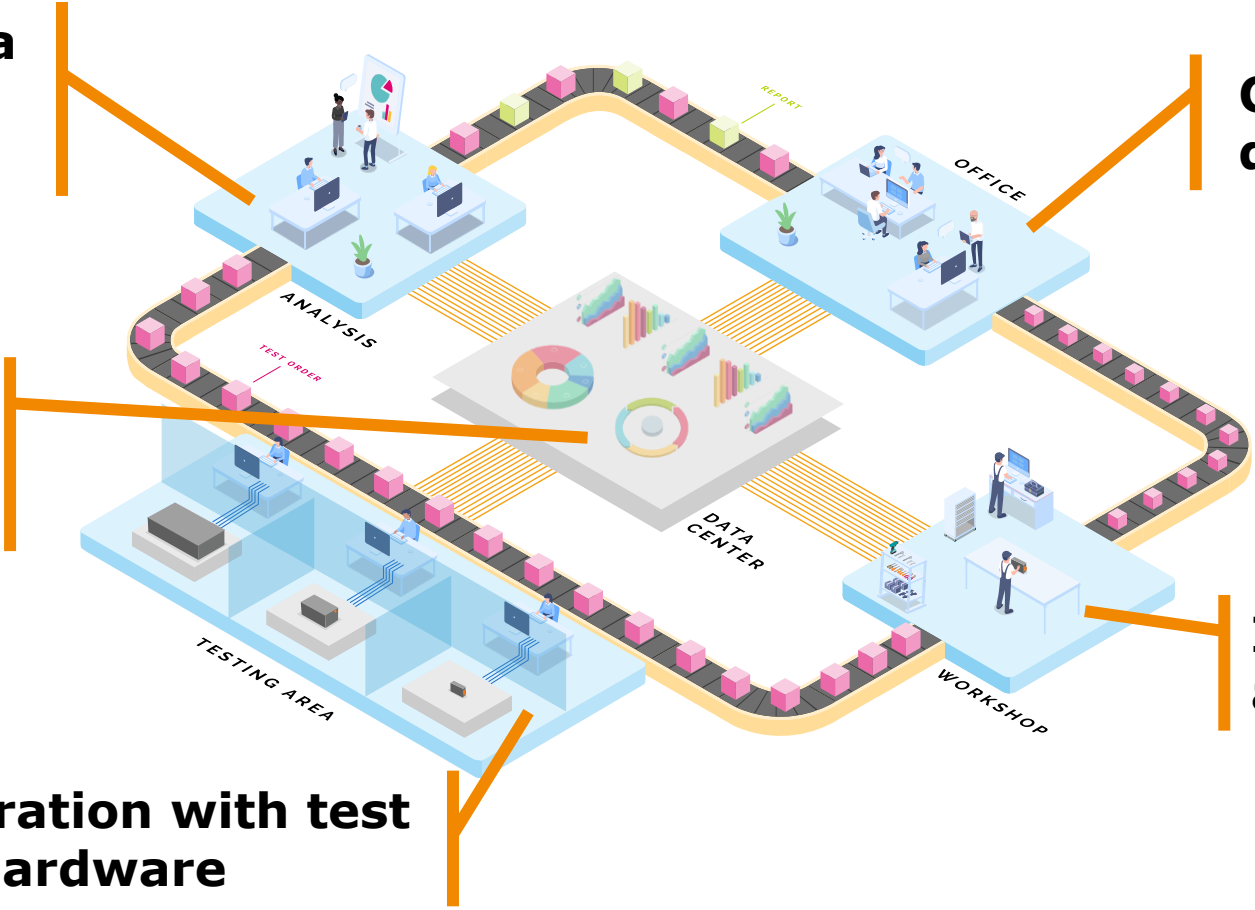
Automated data analysis and processing

Clear test requests and defined processes

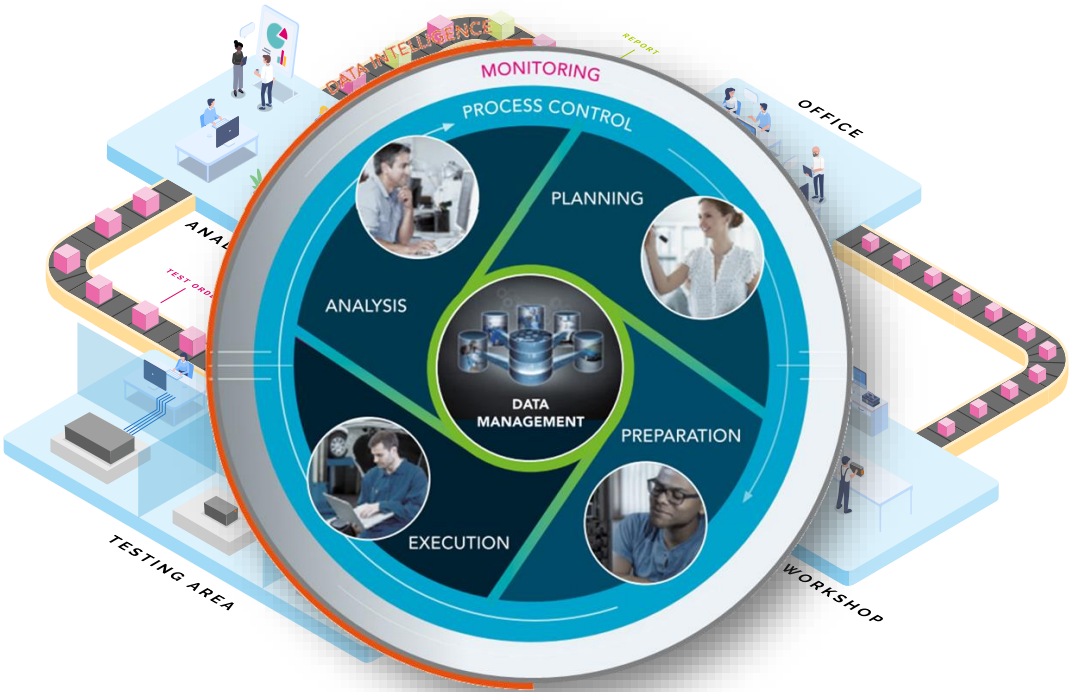
KPI driven lab performance monitoring

Intelligent scheduling and task management

Seamless integration with test automation & hardware



AVL Lab Management™



- ### Asset Management

 - ✓ Equipment & UUT Management
 - ✓ Maintenance & Calibration
- ### Process Control

 - ✓ Work Order Management
 - ✓ Planning & Scheduling
- ### Data Management

 - ✓ Data Integration (AVL & 3rd Party)
 - ✓ Data Harmonization & Lifecycle
 - ✓ Automated Data Processing
- ### Monitoring

 - ✓ Online Status View of all Testbeds
 - ✓ Dashboarding of KPIs
- ### Energy Management

 - ✓ Energy Monitoring
 - ✓ Energy Control
 - ✓ Energy Planning & Prediction
- ### Data Intelligence

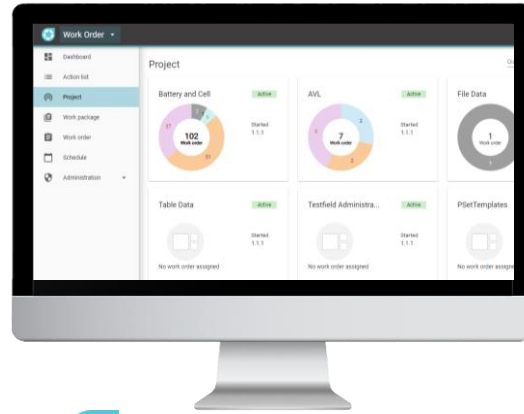
 - ✓ Analyse & Visualize Results
 - ✓ Reports & Statistical Evaluations
 - ✓ Explorative Data Analysis
- ### Reference Processes

 - ✓ Battery Cell Test
 - ✓ Battery Module/Pack
 - ✓ Propulsion Test
 - ✓ Vehicle Test

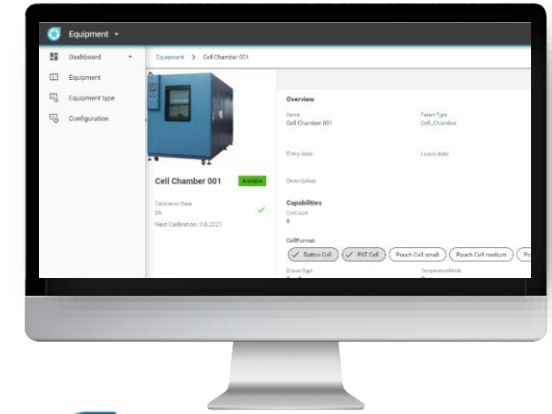
Modern Look & Feel, Scalable IT Technology & Deployment



Data Management



Process Control



Asset Management



Energy Management

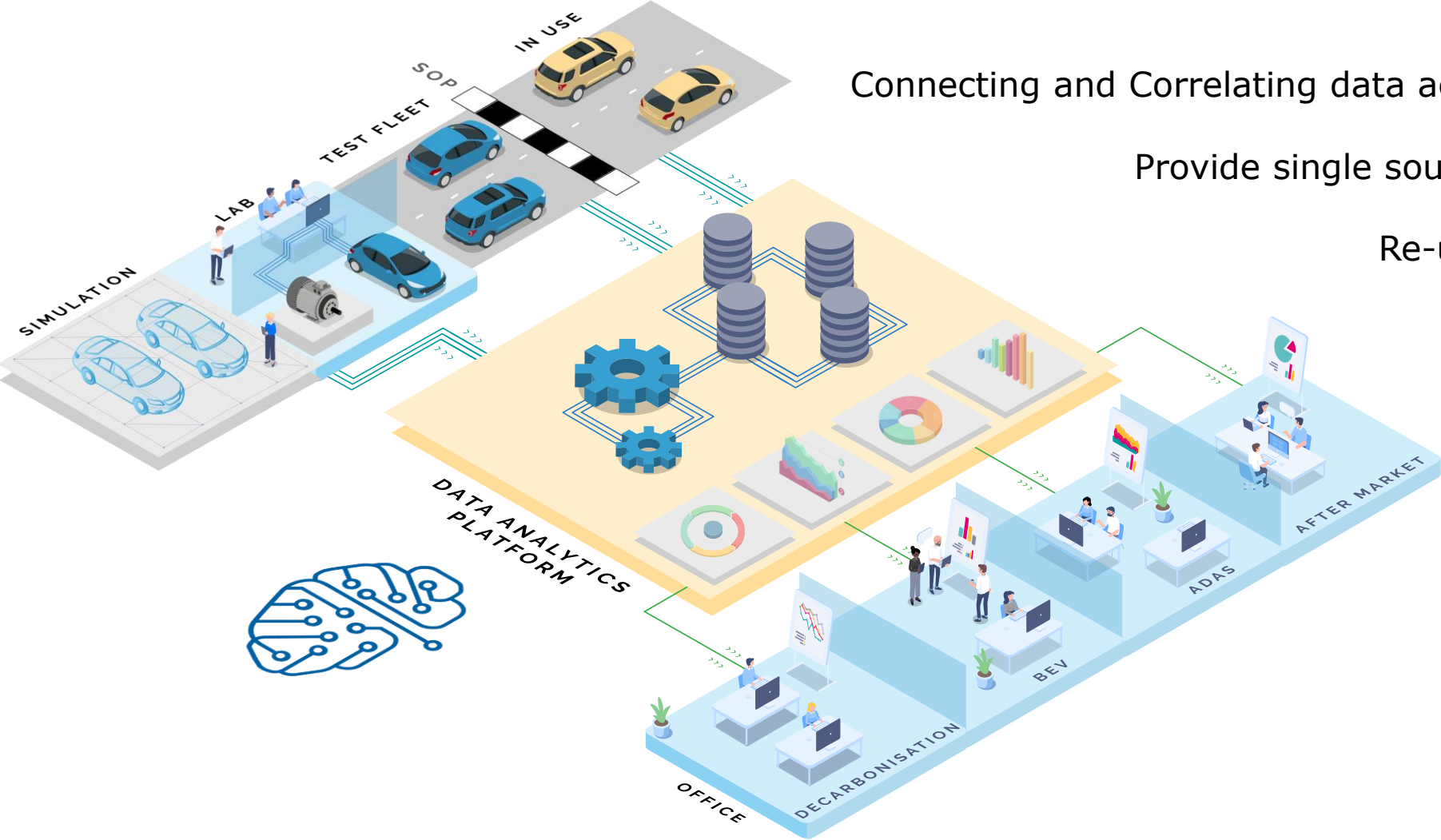


Data Intelligence



Lab Monitoring

AVL Data Analytics Platform

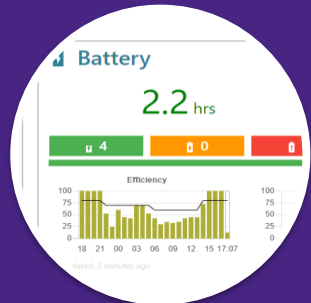


Connecting and Correlating data across development phases

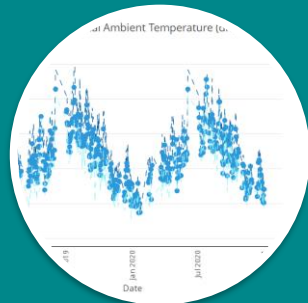
Provide single source of truth to all domains

Re-use data instead of re-test

AVL Lab Management for Battery Benefits



Maximize utilization of test resources



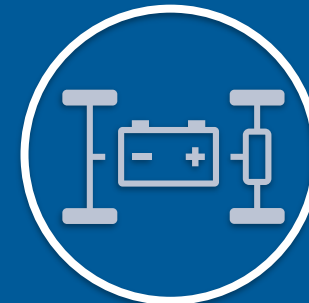
30-60% increase in value added data



Optimize energy consumption



Minimize human induced errors



AVL battery expertise on board

Reference: Volkswagen Germany Battery Cell Lab in Salzgitter



- ✓ Optimized planning of tests and resources
- ✓ Short reaction times and reduced downtimes
- ✓ Full traceability of data
- ✓ Faster and solid product decisions

Reference: Northvolt AB Performance & Life (P&L) Laboratory



©Northvolt

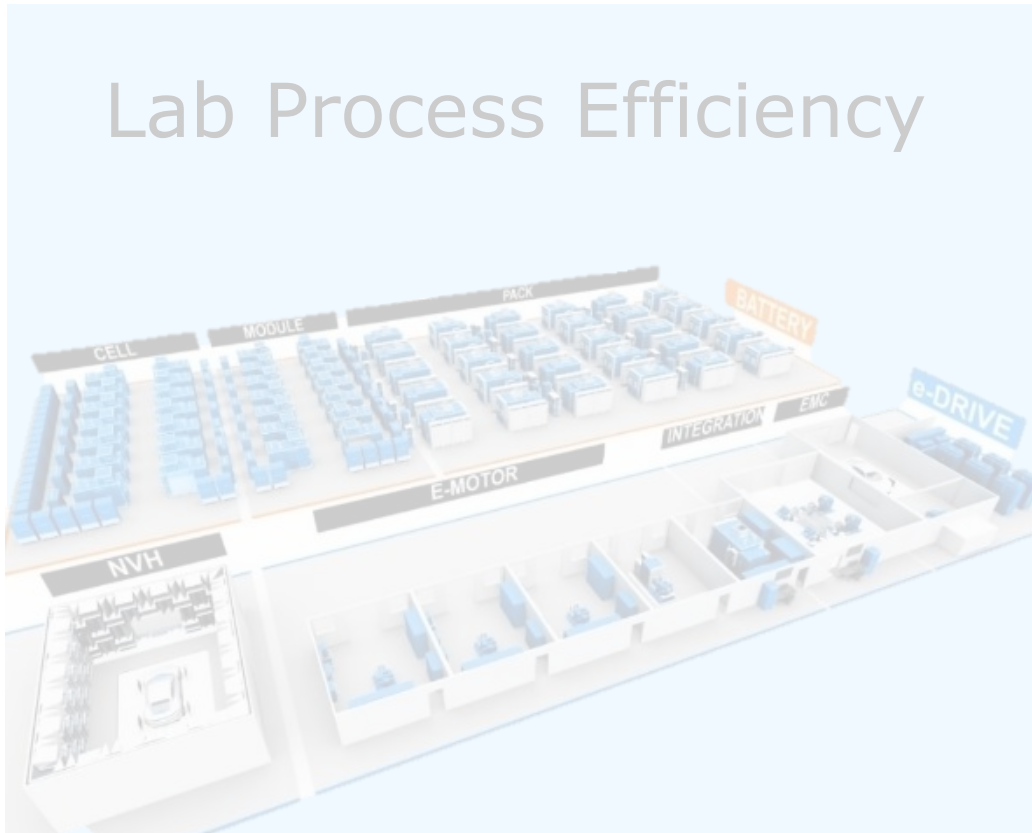


Improve the productivity of battery P&L lab

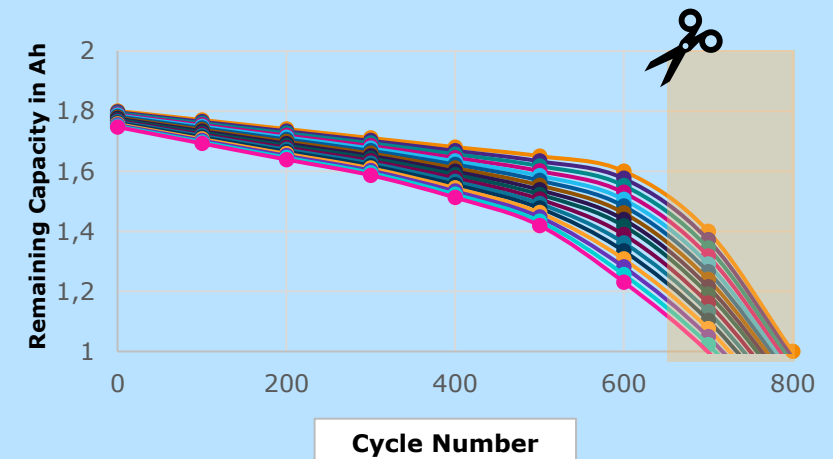
- ✓ Flexible scaling according to future test demands
- ✓ Integration of cycler systems from different vendors
- ✓ Process automation starting from the test request
- ✓ Intelligent scheduling procedures
- ✓ Traceability throughout the process

Key Aspects of Optimized Testing & Validation

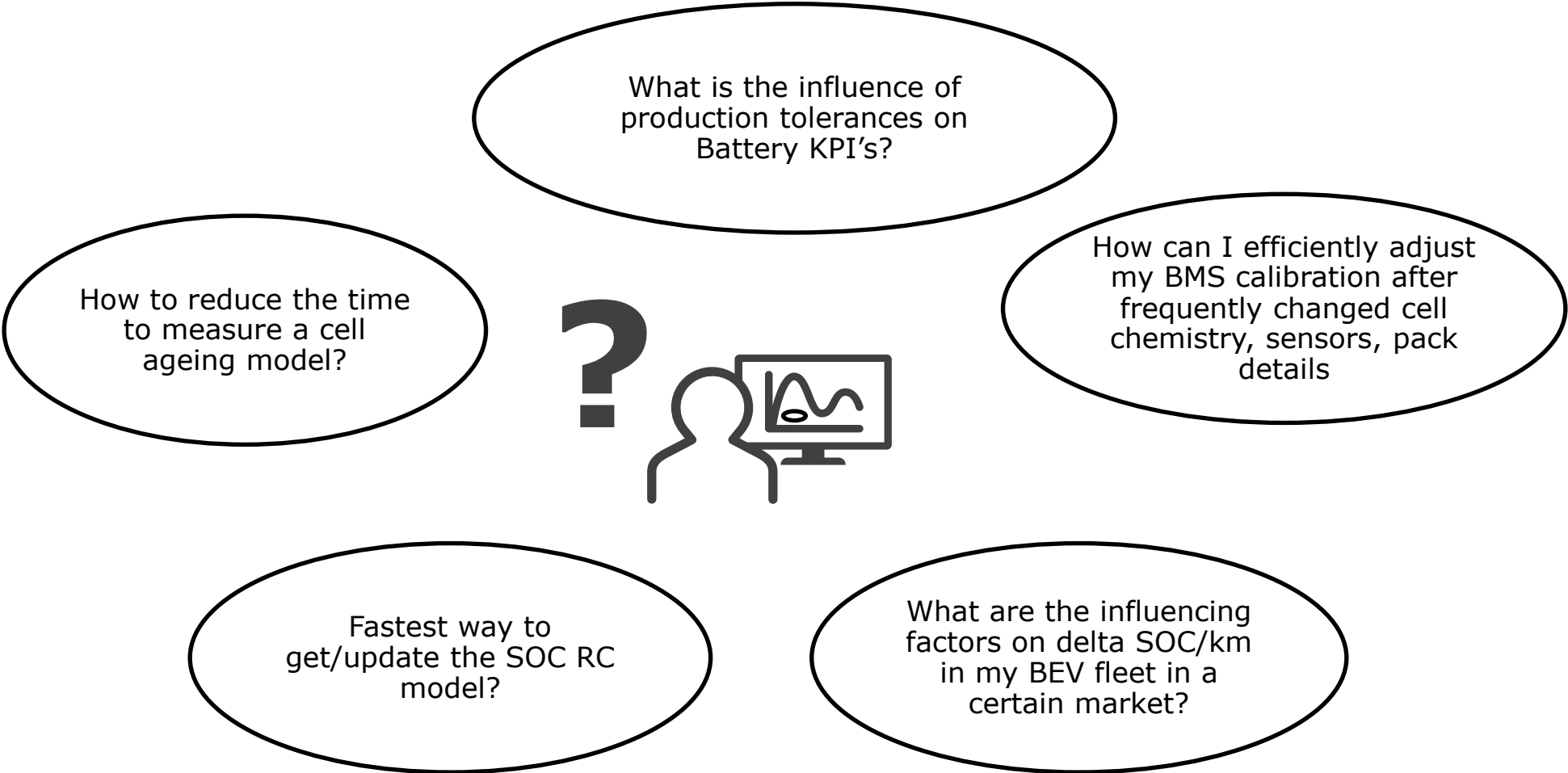
Lab Process Efficiency



Test Methodology

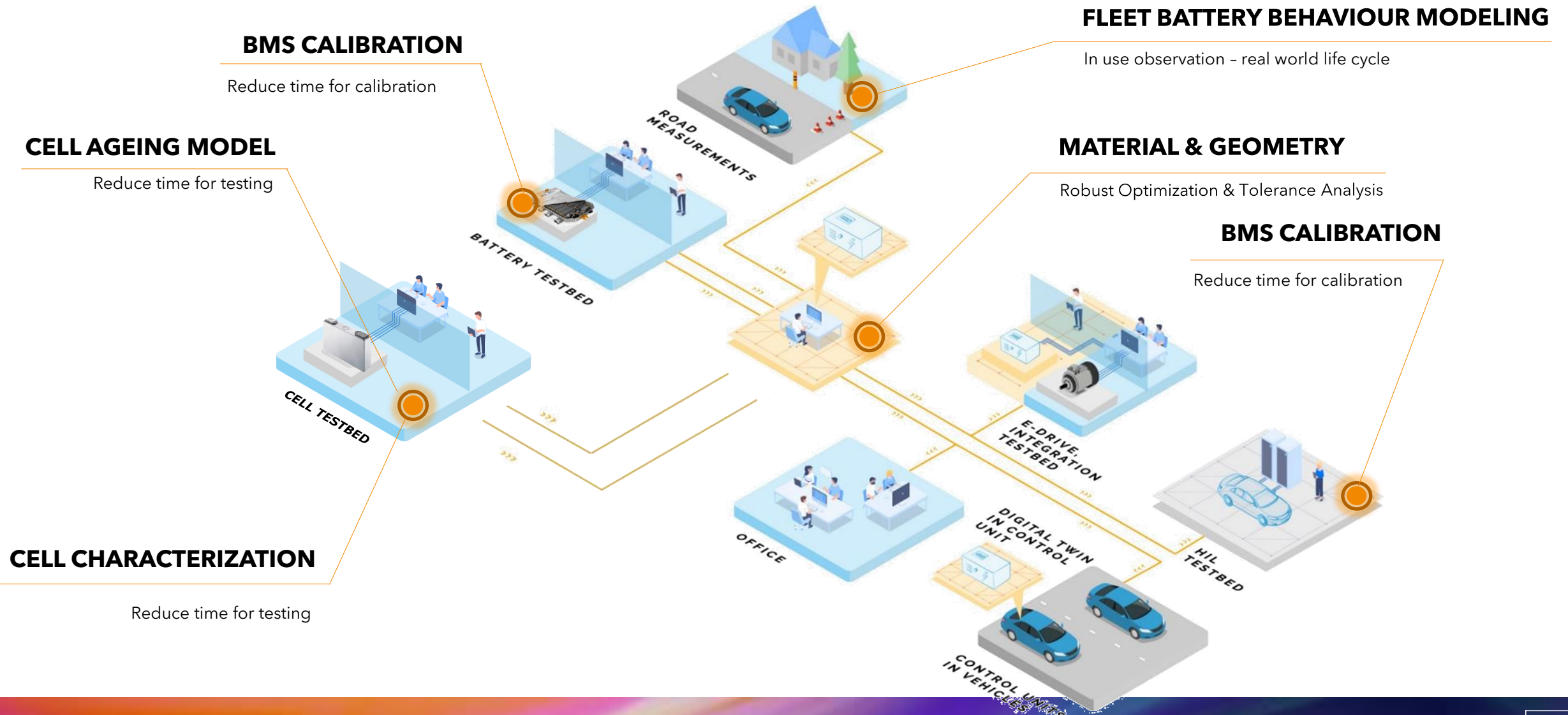


Challenges in Battery Development & Test



Battery Development Environments

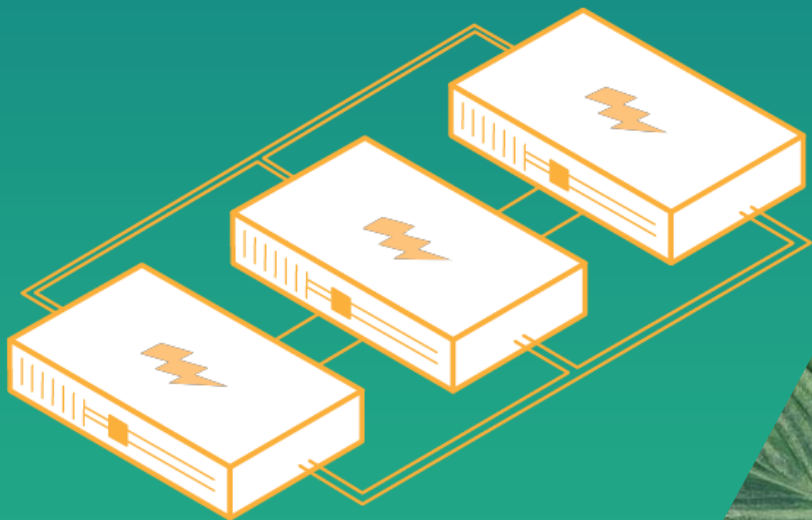
Where can AVL help?





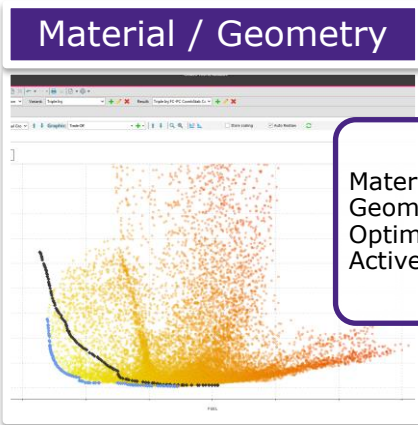
AVL CAMEO 5™

Enter the Cosmos of Smart Cell Development

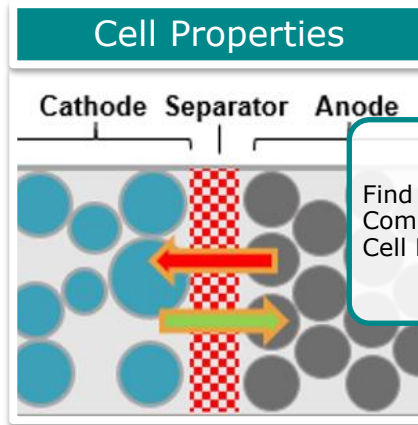


AI driven Test Optimization

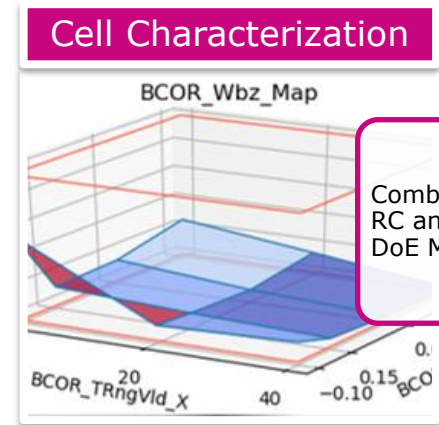
CAMEO 5™ Use Cases for Battery



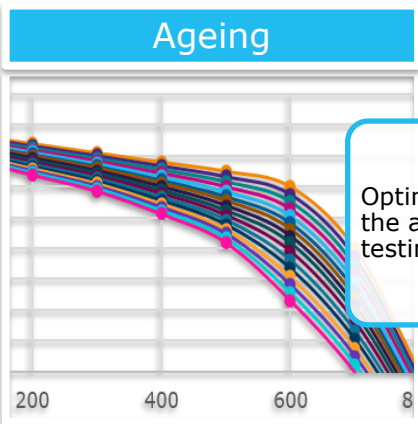
Material & Geometry Optimization using Active DoE



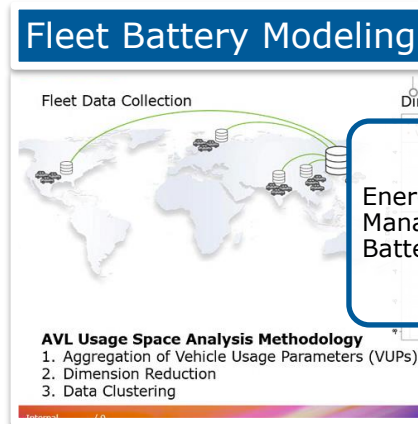
Find Optimum Combination of Cell Properties



Combination of RC and Active DoE Model

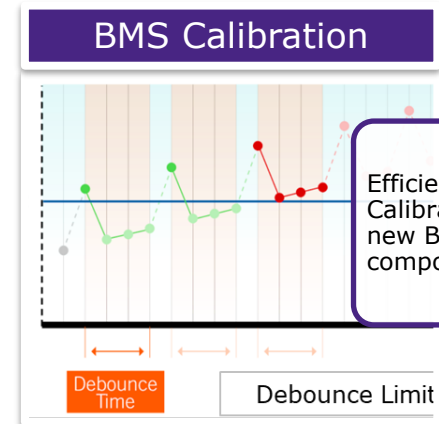


Optimization of the ageing testing process



Energy Management & Battery KPIs

- AVL Usage Space Analysis Methodology**
1. Aggregation of Vehicle Usage Parameters (VUPs)
 2. Dimension Reduction
 3. Data Clustering

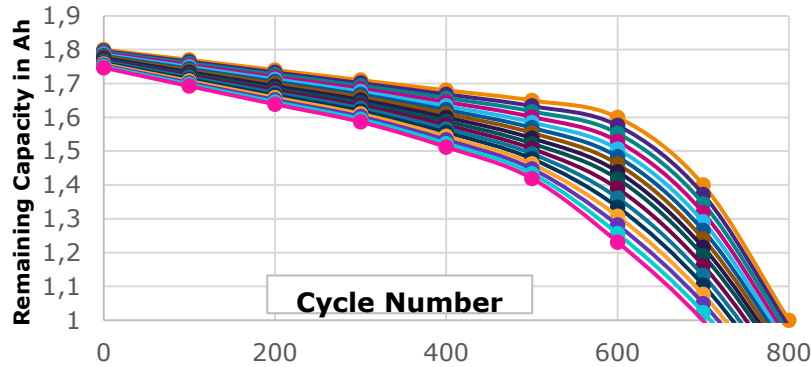


Efficient Calibration for new Battery components

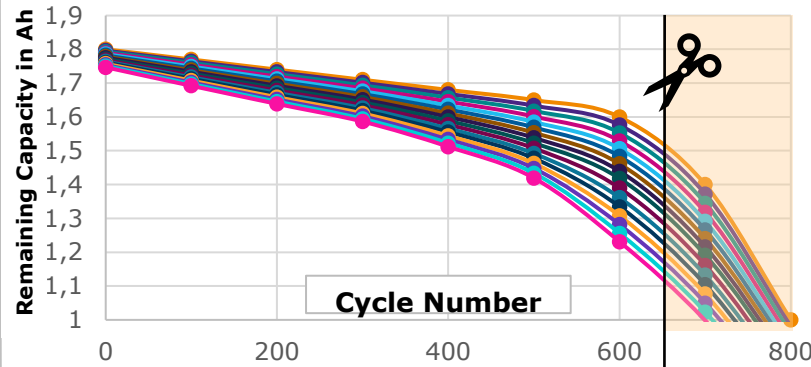


Reduction of Ageing Measurement Time

Use Ageing Information from Faster Ageing Cells for Extrapolation



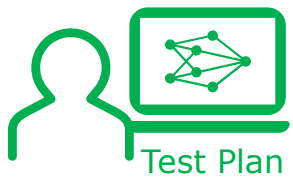
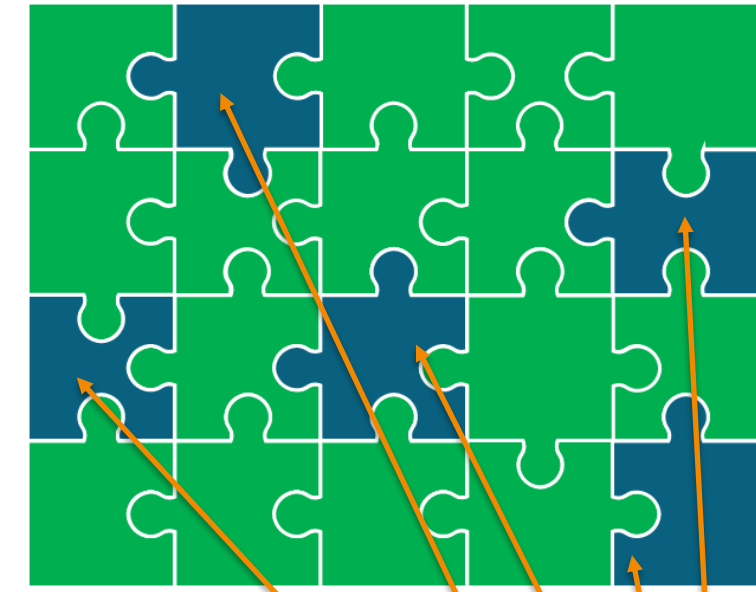
End of Test after X cycle



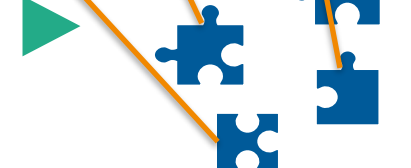
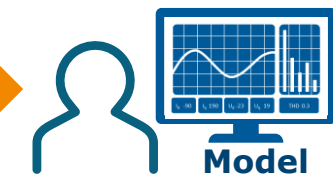
End of Test after X minus 20% cycle

Reduce testing time by trimming the design points which need longer ageing time

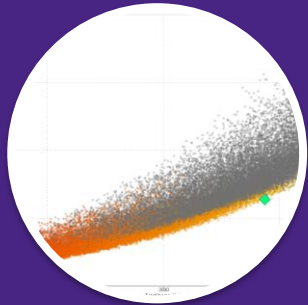
Model uses the data from faster ageing cells to predict the EoL characteristics of the slower ageing cells



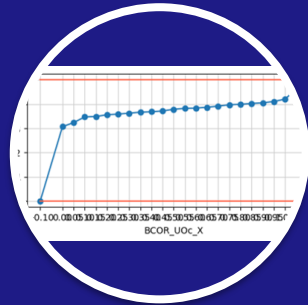
BENEFIT: Reduction of test time by 20%



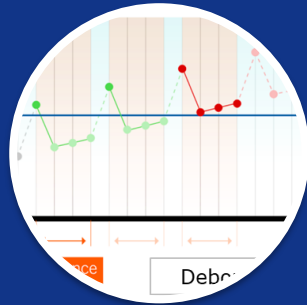
CAMEO for Battery Benefits



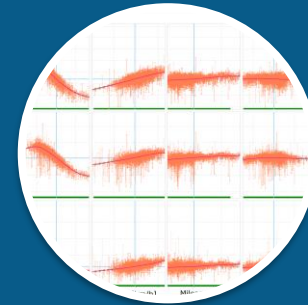
Workflow for
Material &
Geometry
**Optimization
and Tolerance
consideration**



Active DoE to
speed up cell
characterization &
ageing
measurements



Proven and off the
shelf intelligent
automation to
generate or adapt
your **BMS
calibration**



AI based **Battery
Fleet data
modelling**



Well established
with **worldwide
support and AVL
Battery
expertise** on
board



Dr. Gerald Sammer

Thank You!

Contact me for further information: gerald.sammer@avl.com