



Ageing and efficiency Simulation & TEsting under Real world
conditions for Innovative electric vehicle Components and Systems

ASTERICS project presentation

Horst Pfluegl, AVL List Graz
Coordinator ASTERICS

ASTERICS

- Start date: 1/10/2012
- End date: 30/09/2015
- Total budget: 4.3 M€
- Total EU funding: 2.7 M€



CENTRO
RICERCHE
FIAT

VOLVO

SIEMENS

THIENeDrives



GUSTAV KLEIN
POWER SUPPLIES - since 1948

FH JOANNEUM
University of Applied Sciences



University of Ljubljana

Impact

- **Reduction of overall development time and testing efforts for FEV and components by 50%**
- **Enable improvement and optimization of overall efficiency and performance of FEV by at least 20%**

ASTERICS- Advanced energy Simulation & TEsting under Real world conditions for Innovative electric vehicle Components and Systems

Real world conditions

- Drive cycles, usage profile
- Environment
- Identify stress scenarios

Advanced testing

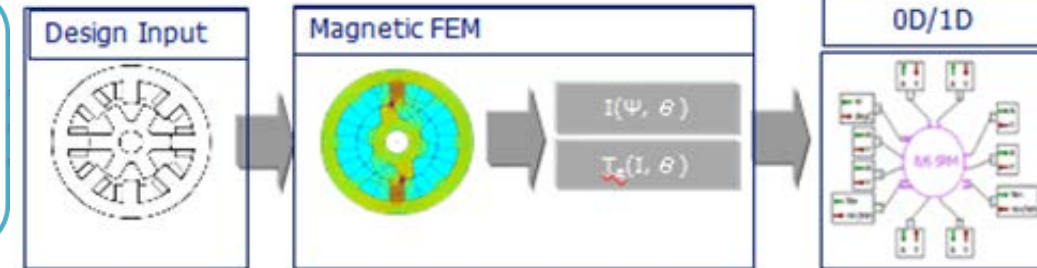
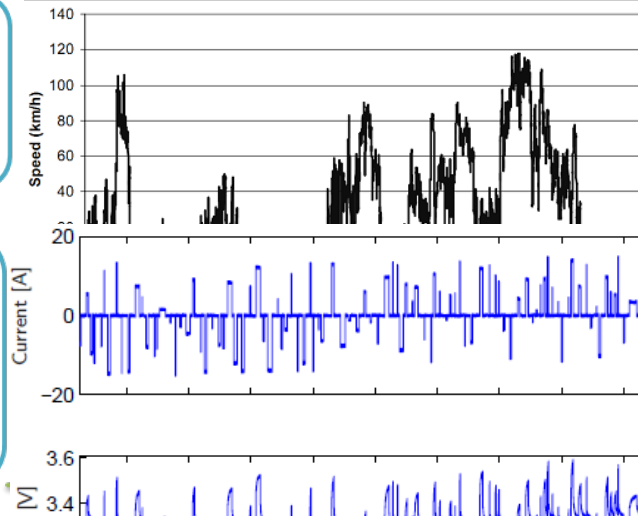
- Accelerated testing (ageing)
- Test bench (e-drive line)
- SiL, MiL, HiL (combinations)
- Sophisticated test approaches (DoE, online-adaptations)

Models (Battery, inverter, E-motor)

- Parametrised, predictive,
- Ageing, thermal, electric, mechanical,
- Scalable (accuracy vs. Real-time)

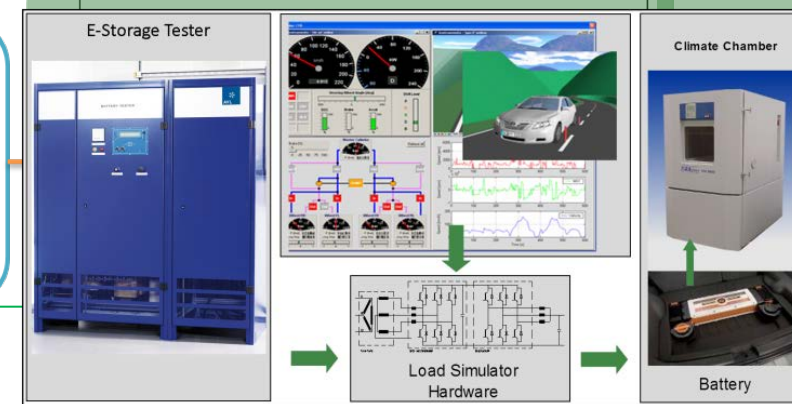
Total system

- E-driveline system models
- 1D vehicle models
- integrated battery, inverter, e-motor model (Interfaces)
- Vehicel energy simulation (HVAC) and optimization



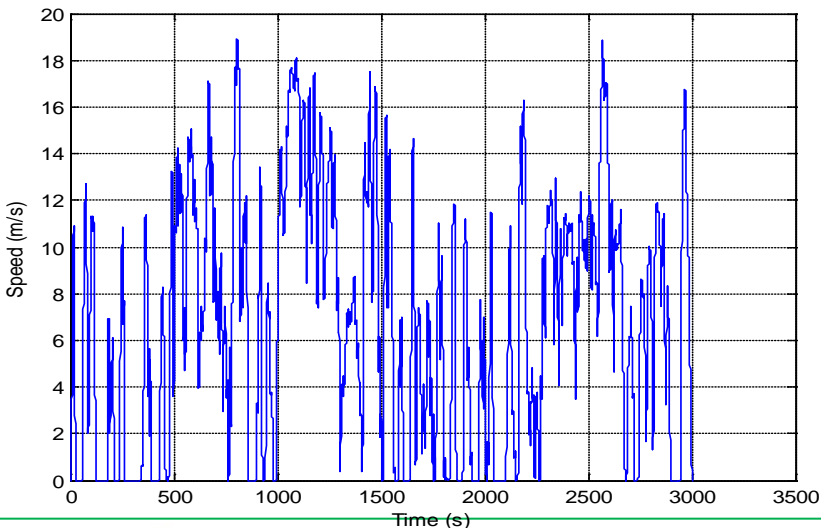
- **Optimal Electric Vehicles**, in terms of performance (range, reliability, durability and efficiency),

Reduced development and testing lines



WP1 Driving cycle «builder» tool

- Real-world data used to build tailored cycles
- From representative cycle to multi-variased cycles
 - System testing
 - Control tuning



Build cycle using driving cycle data

Define cycle building parameters

Target cycle distance (m)

Acceptance parameters (max:12)

Acceptance threshold (%)

Max attempts

Contour levels in the resulting plot

Max proposals to be saved

Vehicles


☐ Quadricycle ☐ Small LDV ☒ Passenger

Clusters

☒ 1 ☒ 2 ☒ 3 ☒ 4 ☒ 5 ☒ 6 ☐ 7 ☐ 8 ☐ 9

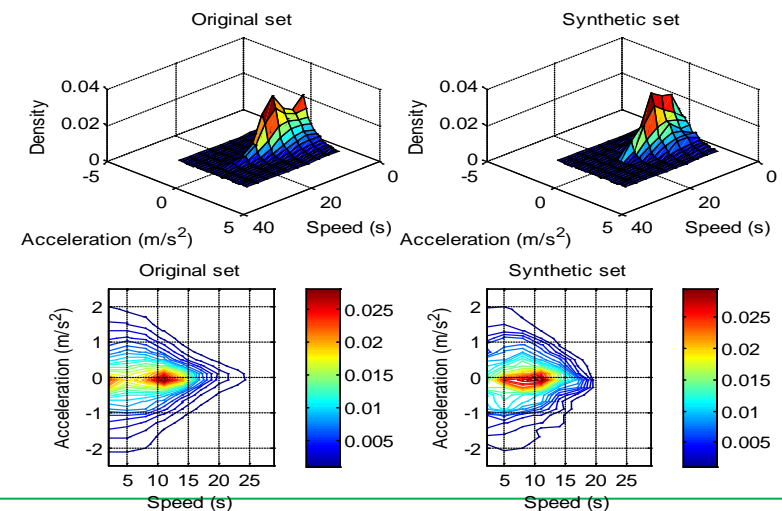
Execute
 (Warning: old data will be overwritten)

Visit Asterics homepage



Asterics

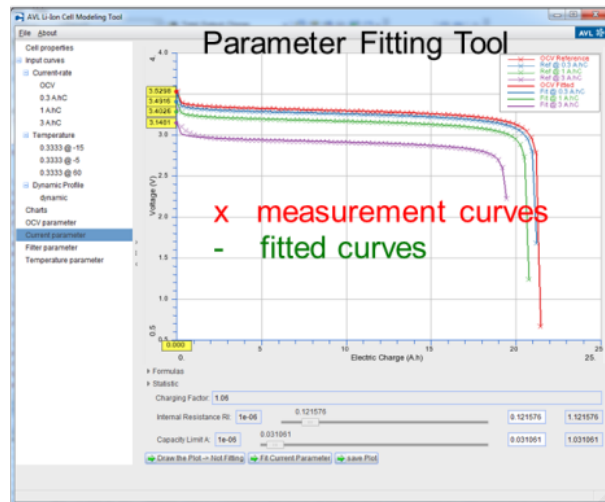
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WP2 – Battery Models

measurement → parameter fitting → simulation

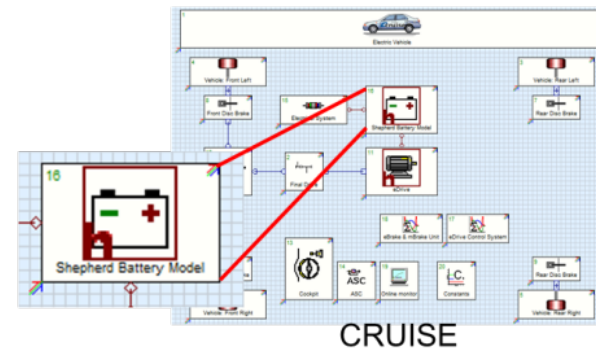
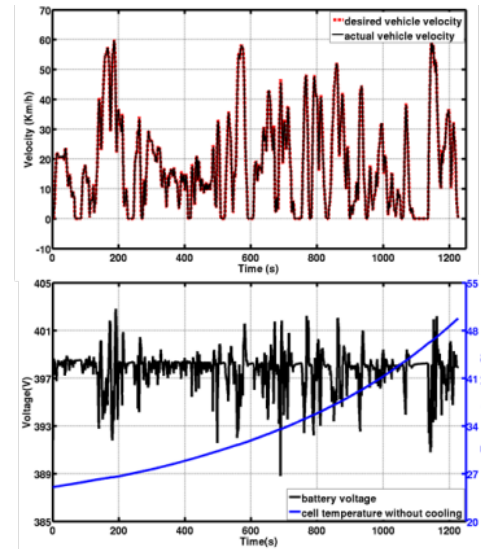
Measurement Data
(OCV, Current, Temperature, Dynamic)



Fitted Parameters for empirical equations (OCV, Current, Temperature, Dynamic)



Results:

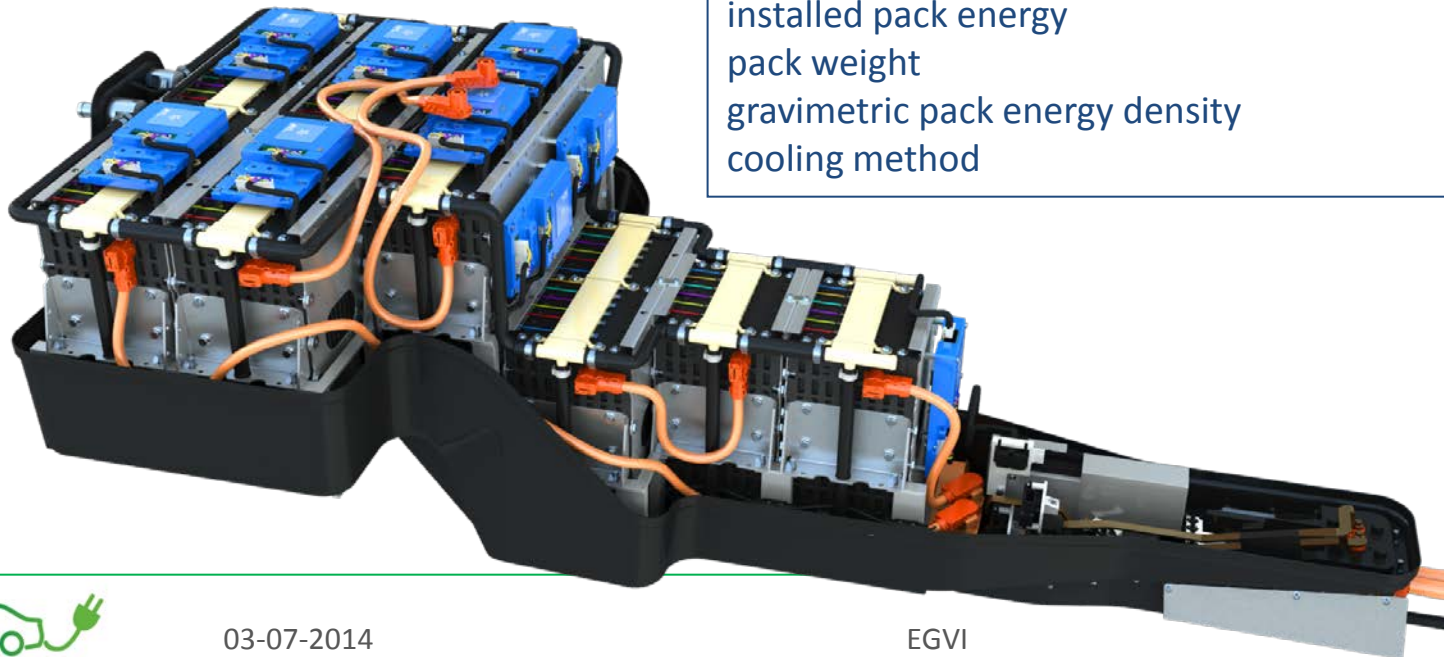


Battery Simulation on Pack-Level



Battery Pack Details

nominal cell voltage	3,75 V
cell capacity	41 Ah
configuration	180s1p
number of cells	180
nominal pack voltage	675 V
installed pack energy	27,6 kWh
pack weight	242 kg
gravimetric pack energy density	114 Wh/kg
cooling method	liquid



WP3 – Inverter models and tests

- Stressors in **accelerated reliability tests** are typically *temperature, voltage, current, humidity or vibrations*
- Advanced inverters with **high power** ranges above 100kW in connection with **high speed motor drives** up to 22000rpm

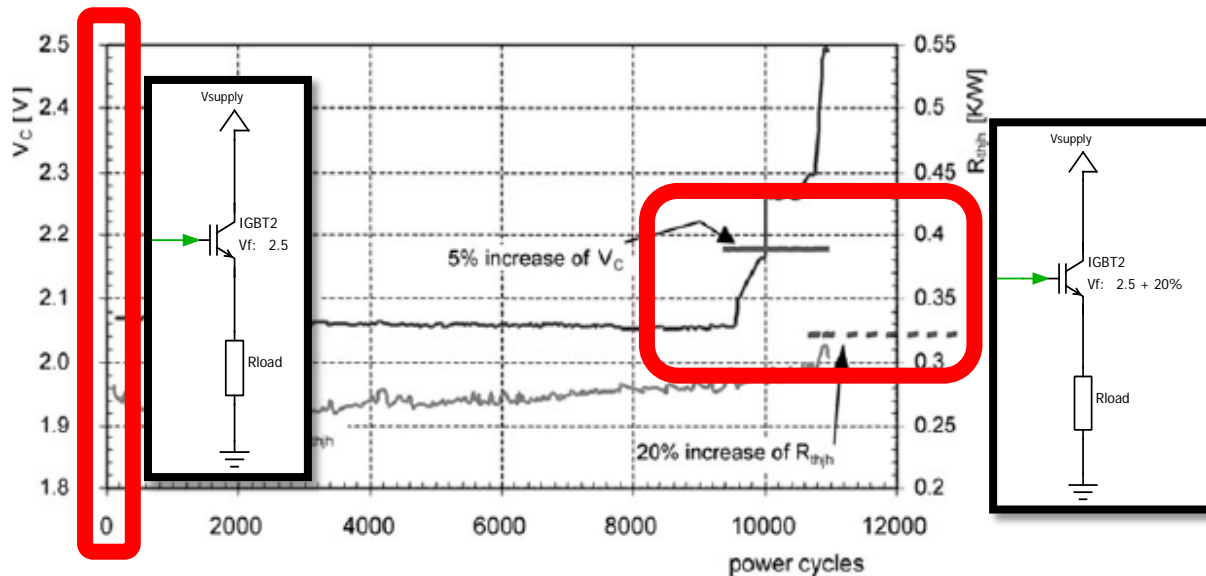
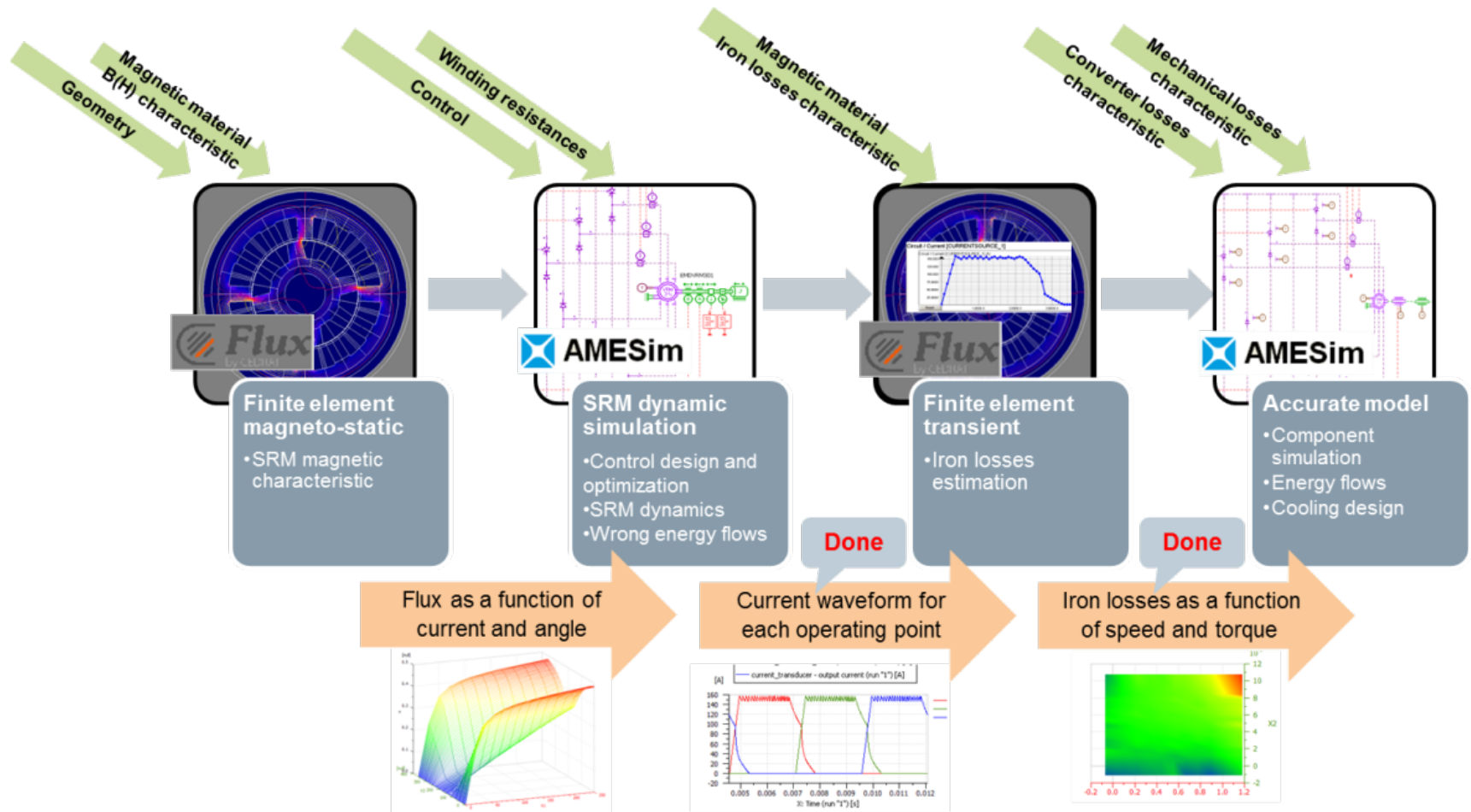


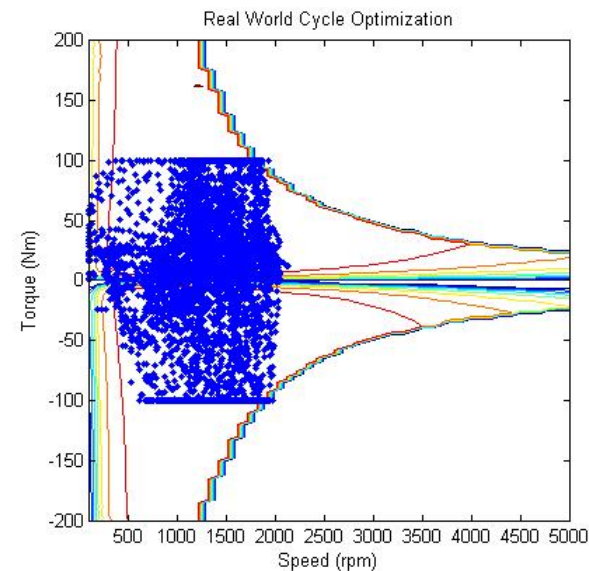
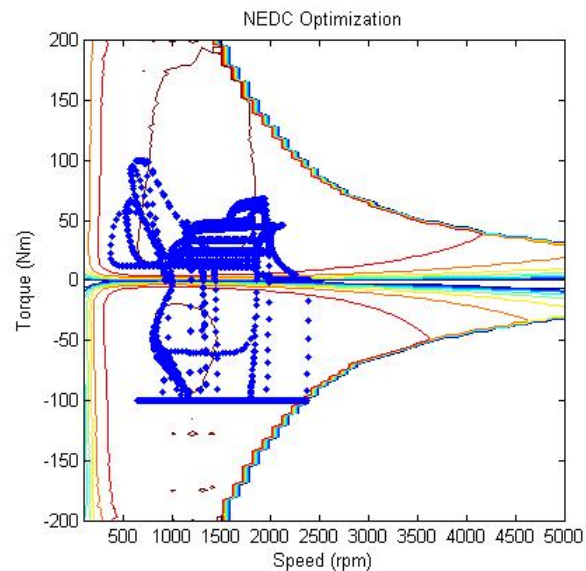
Fig. 11.39 Behavior of on-state voltage drop V_C and thermal resistance R_{thjh} at a power cycling test with $\Delta T_j = 123$ K

WP4 Simulation models & virtual prototyping with SRM

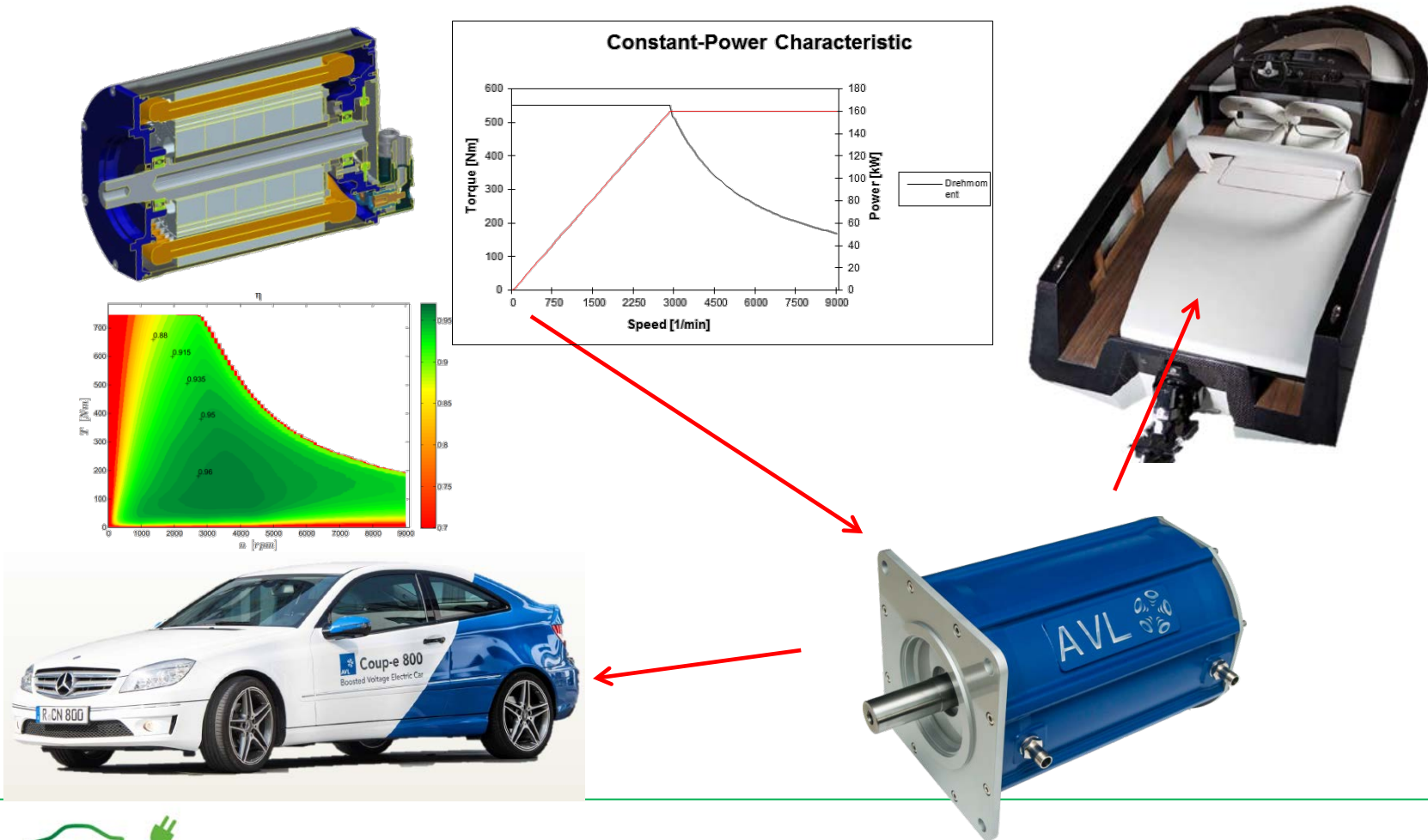


WP4 Simulation models and virtual prototyping, PMSM

- Apply Genetic Algorithms to cycle representation
 - Faster E-drive optimization (using GAs)
 - Faster testing via condensed cycles

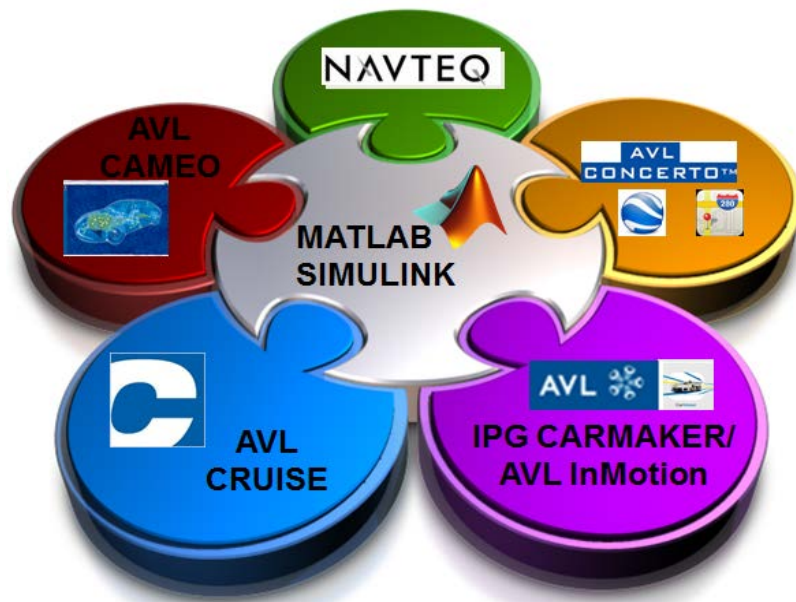


Use e-motor physical parameters to create simulation models – Application example



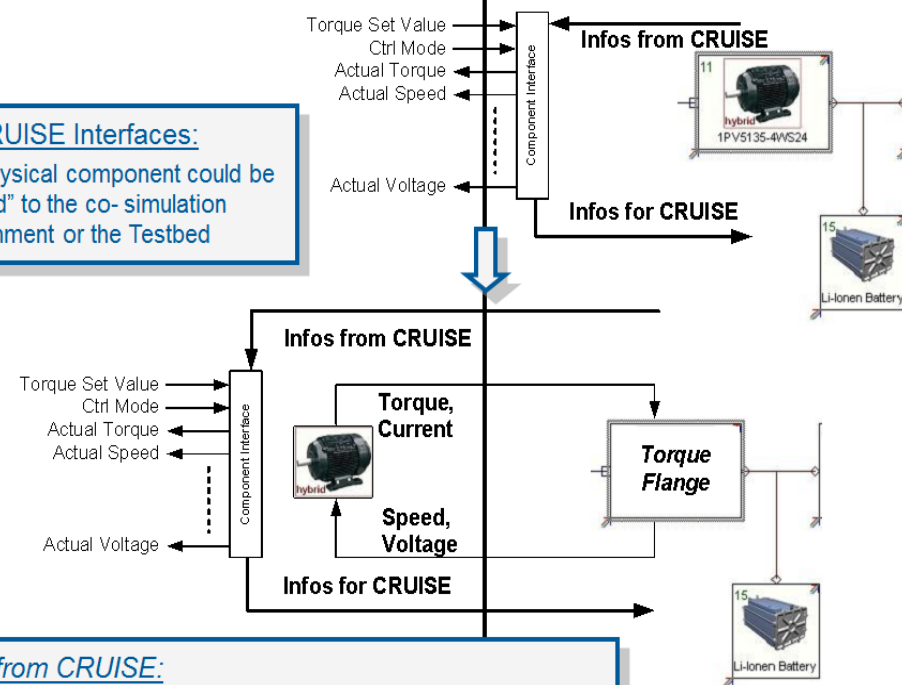
WP5 – System Simulation

Integration of simulation models for EV-components in co-simulation environments



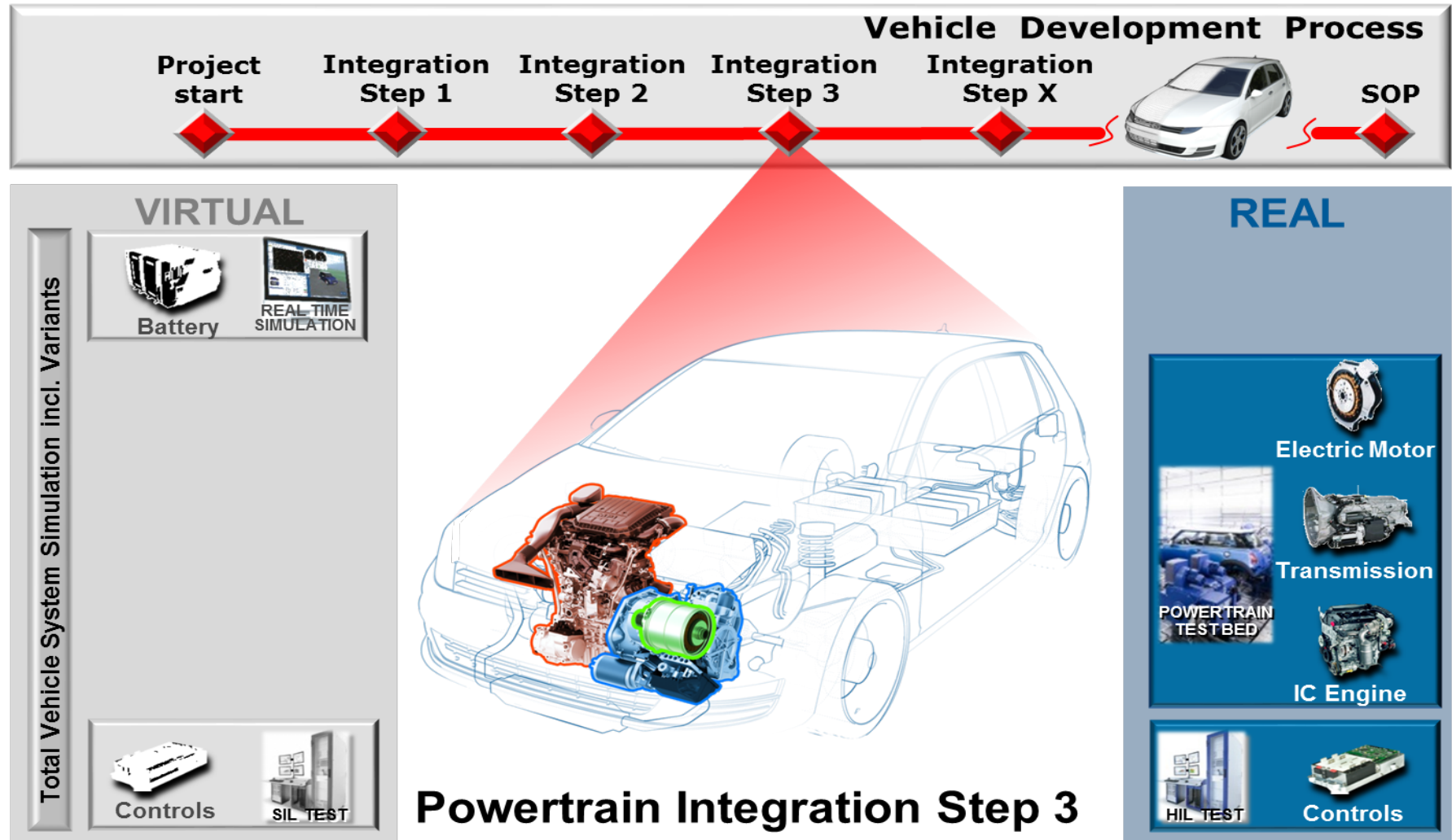
SIMULINK – Co Sim. Environment

All CRUISE Interfaces:
The physical component could be “moved” to the co-simulation environment or the Testbed

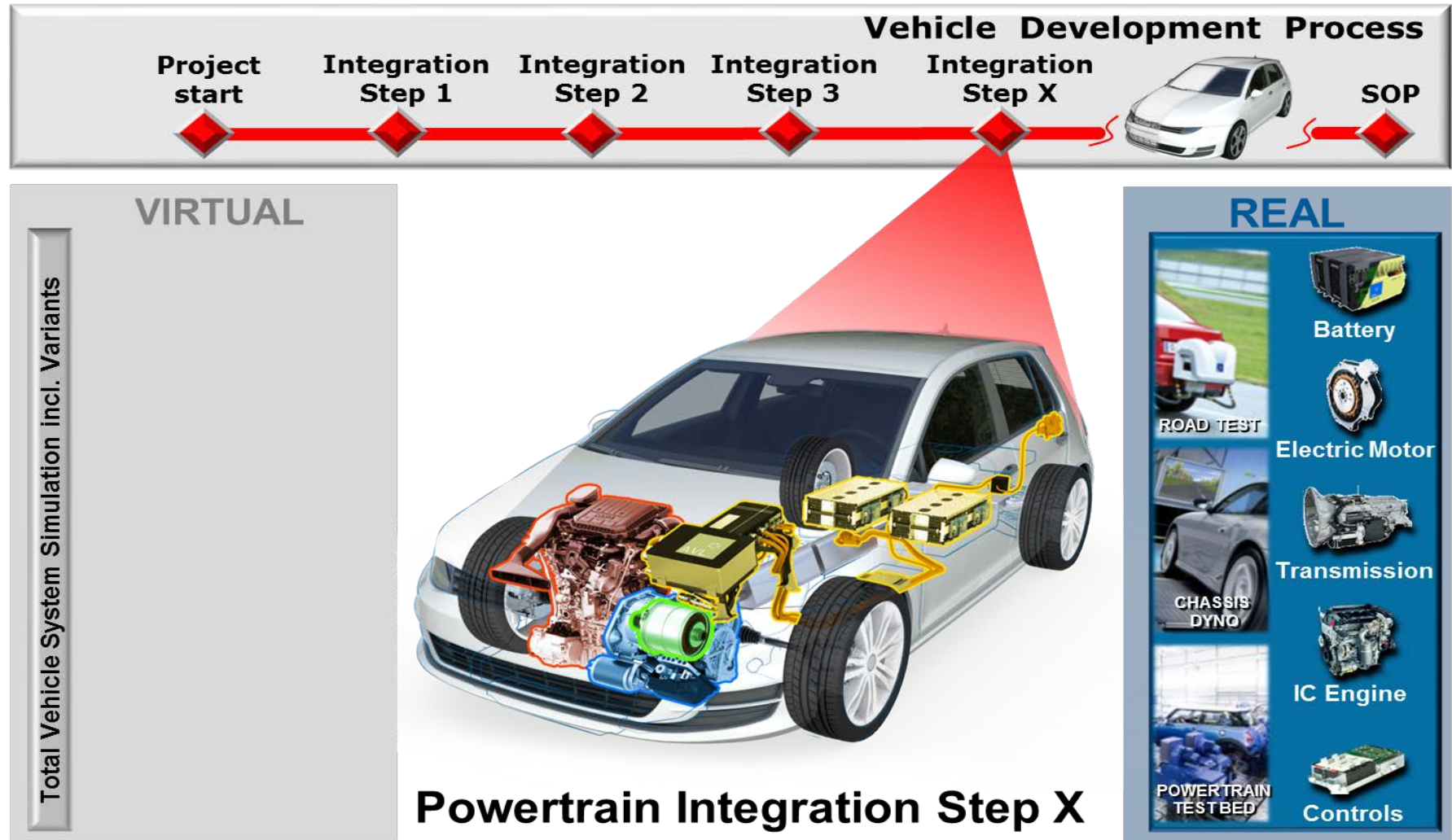


Infos from CRUISE:
The component(s) require several env. Information to operate properly (in automotive env.)– e.g. temperature, ...

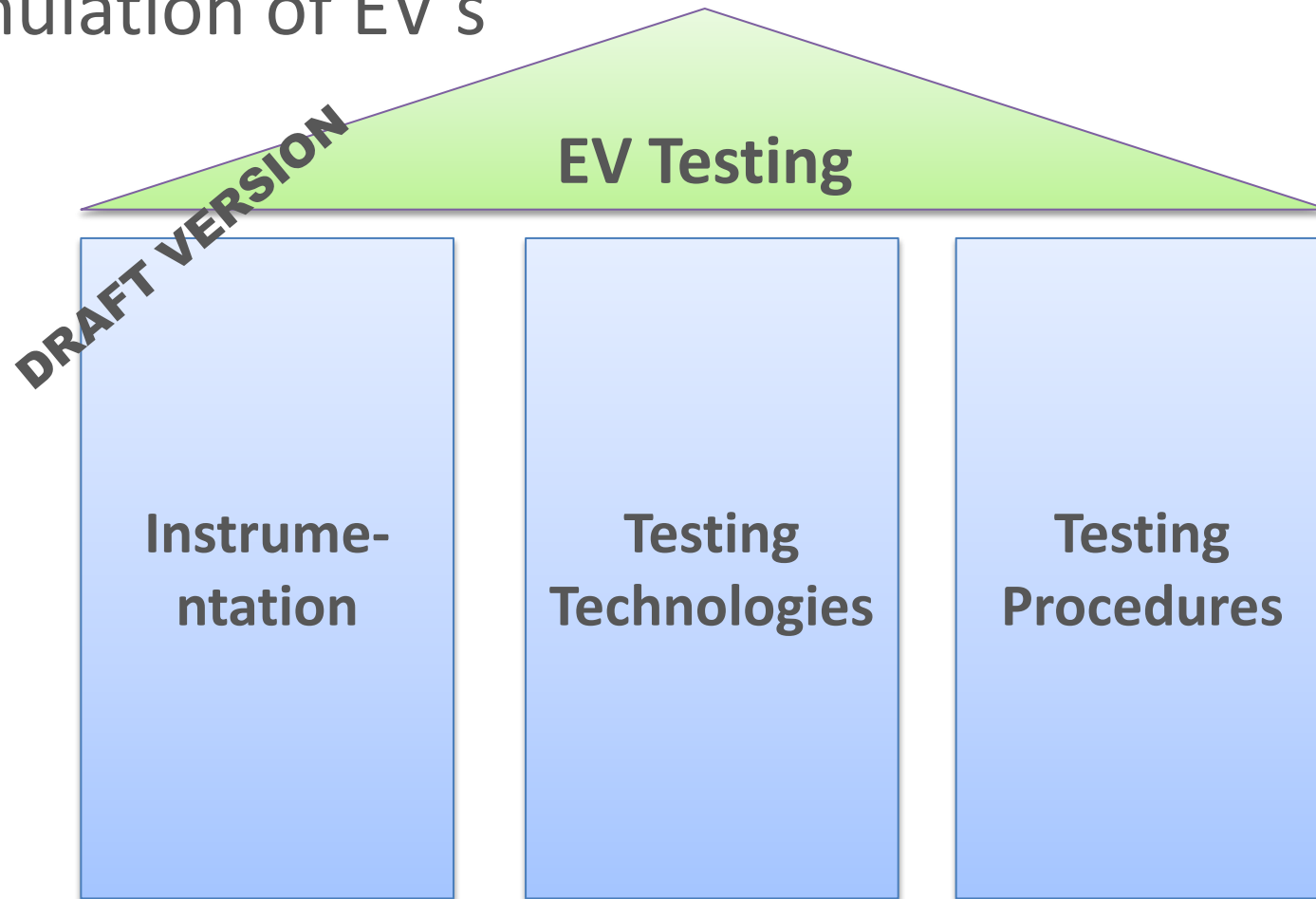
Integrated and Open Development Platform



Integrated and Open Development Platform



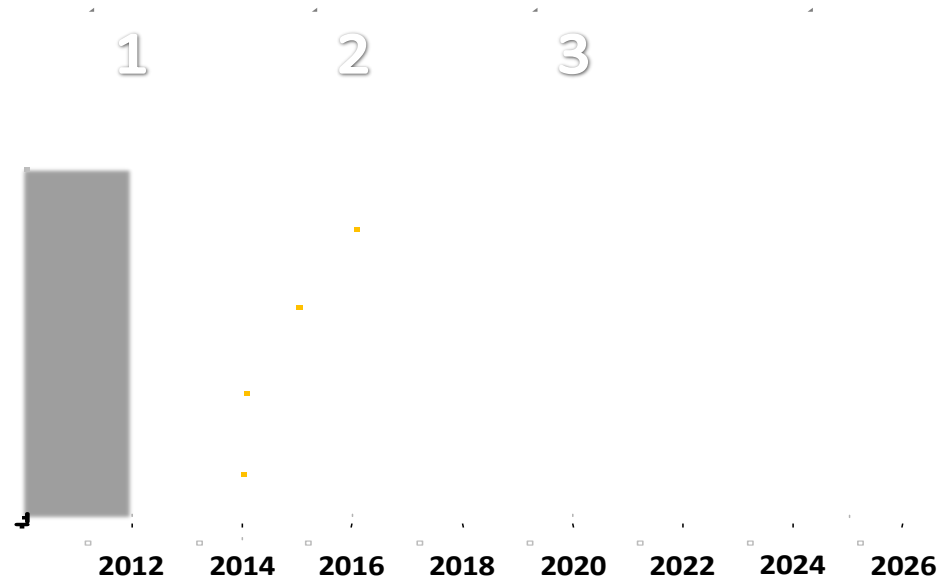
Future Research Topics for Testing and Simulation of EV's



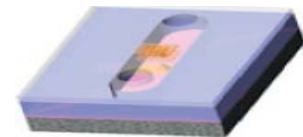
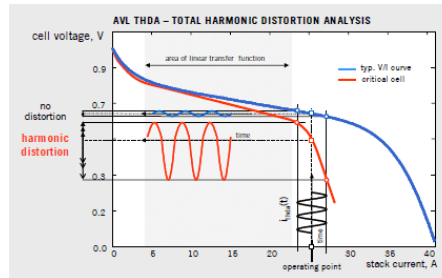
Research Topics for Instrumentation

Instrumentation

Diagnosis and Analysis Technologies
Fast Electric Values Measurement and Phenomenon Analysis
In-vehicle Measurement
Advanced transducers and sensors



Research & Development
Production & Market



Research Topics for Testing Technologies

Testing Technologies

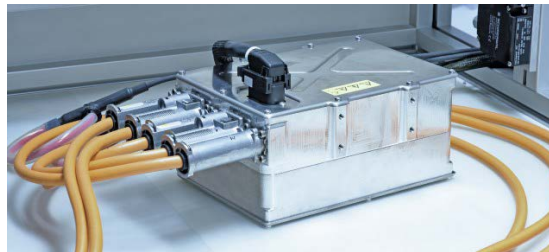
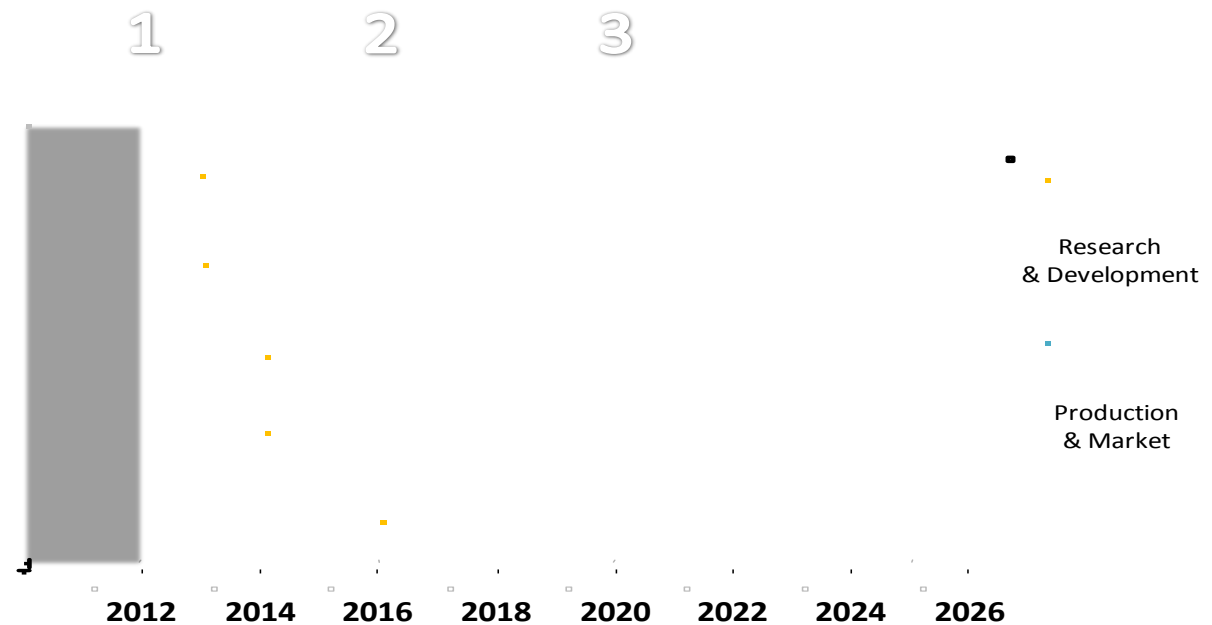
Advanced Test Beds

Battery

Inverter

E-motor

Charging Infrastructure Testing



Research Topics for Testing Procedures

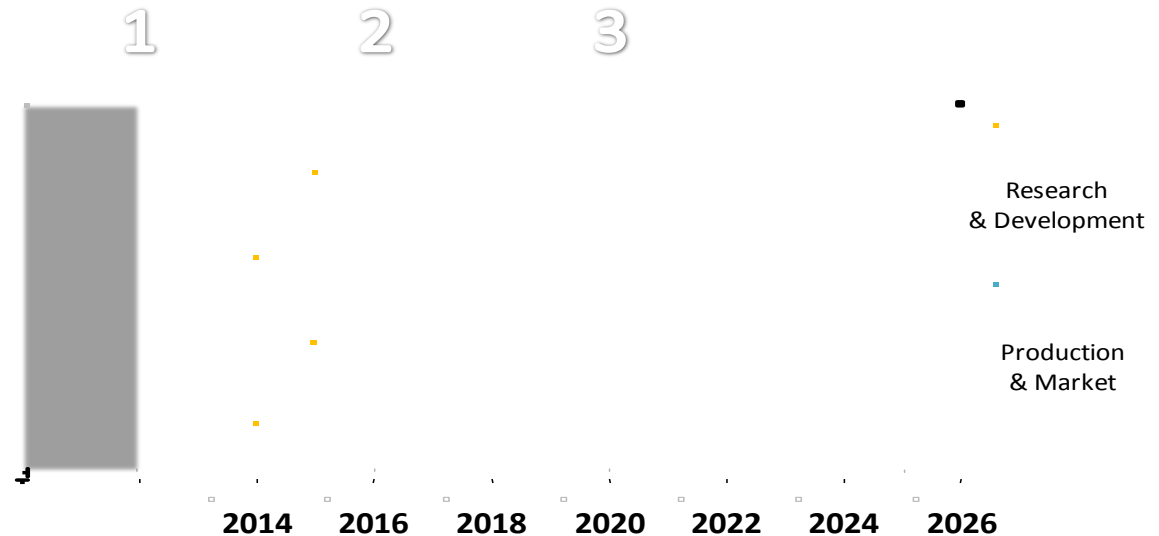
Testing Procedures

Automated Test Procedures

Testing methods & virtual testing

Hybrid system testing methodologies

Data management



Thank you for your attention

<http://www.asterics-project.eu>
horst.pfluegl@avl.com

Disclaimer

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