IAV’s Fuel Cell Expertise

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For further information please contact:
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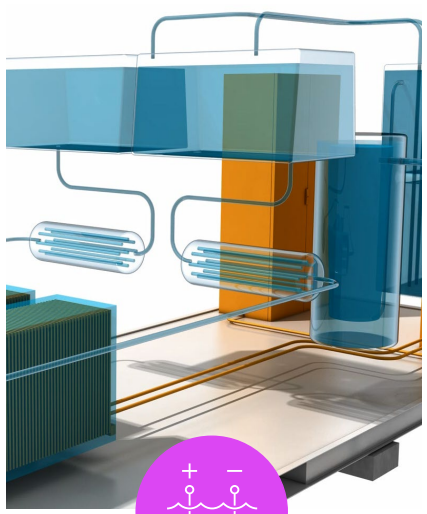
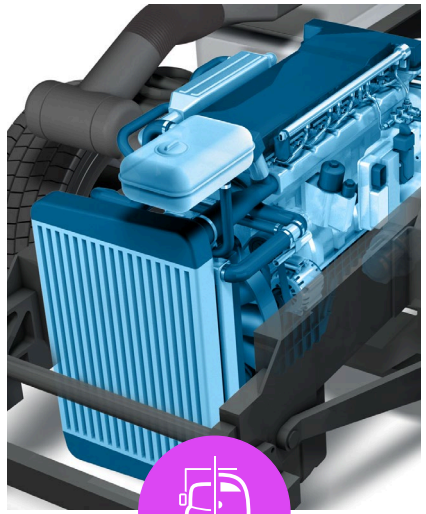
Hydrogen Systems Development @ IAV

H_2 Infrastructure layout, consulting and engineering



Electrolyzer System development



H_2 ICE and eFuel development

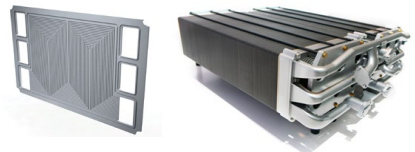
Fuel Cell development

H_2 Test facility consulting / engineering

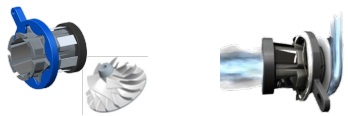
20+ Years IAV Expertise in Fuel Cell Vehicle Development

Component / subsystem ▶ **System** ▶ **Powertrain** ▶ **Integration**

FC stack



Air



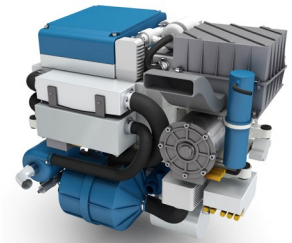
Coolant

H_2

Storage

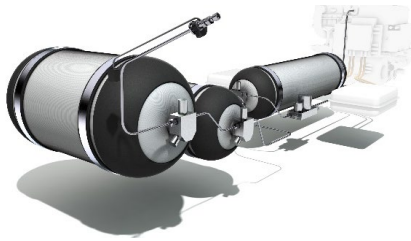
HV-Comp

FC system

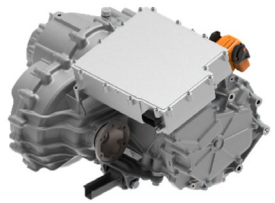


ECU development

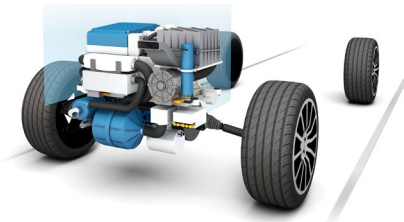
Storage system



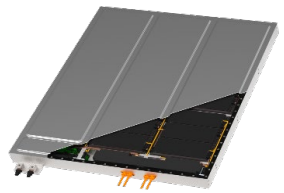
Drive unit



Powertrain integration



HV battery



Commercial vehicle

Passenger car / van

Non road machine

Model-based Development of Fuel Cell Powertrains

Component layout

- Definition of component size and layout during **concept phase**
- Investigation of the **interaction between components** in the system
- Definition of **control parameters**

FC/Stack optimization

- Optimization fuel cell stack parameters in terms of best **system/vehicle behavior**
- Definition stack layout for **different applications**

Definition operation strategy

- Determination of the **best** hybrid operation strategy in terms of different targets (performance, consumption, aging)
- Using **rule-based** up to **model predictive control**

IAV can support fuel cell vehicle development on different levels and areas by a model-based development.

Topology optimization

- Determination of fuel cell, battery and tank size during **concept phase**
- Definition of **hybrid operation strategy for different topologies**
- **Benchmarking** of different powertrain topologies in terms of different target values
- Tool development

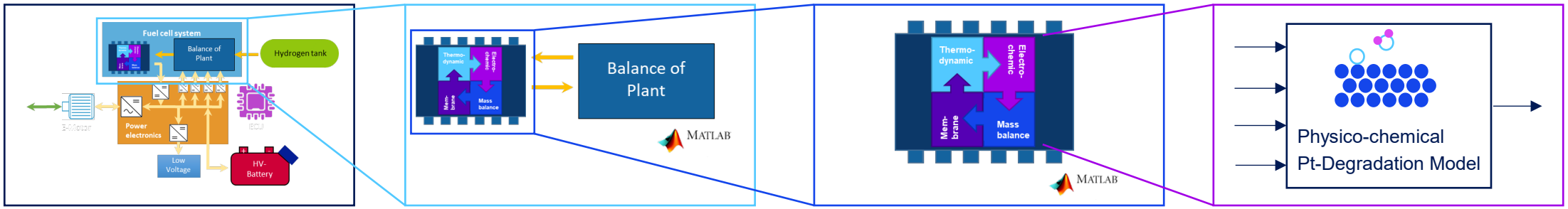
System performance

- Calculation of **performance data**
- Estimation **operation values** of the system

Durability analysis

- **Prediction** of long-life durability under different conditions
- Definition **hybrid operation strategy** considering degradation

PEM Fuel Cell System Model



Fuel Cell Powertrain Model

- Following powertrain components:
  - Fuel cell system model
  - Hydrogen tank model
  - HV battery (scalable)
- Different hybrid control
- Adapted to different applications (PC, CV, NRMM, Maritime, Aviation)

Fuel Cell System Model

- Based on cooling-, anode- and cathode loop including system components
- System components as data-driven or physical models depending on customers needs
- Validation of component and system models possible at IAV

Fuel Cell Stack Model

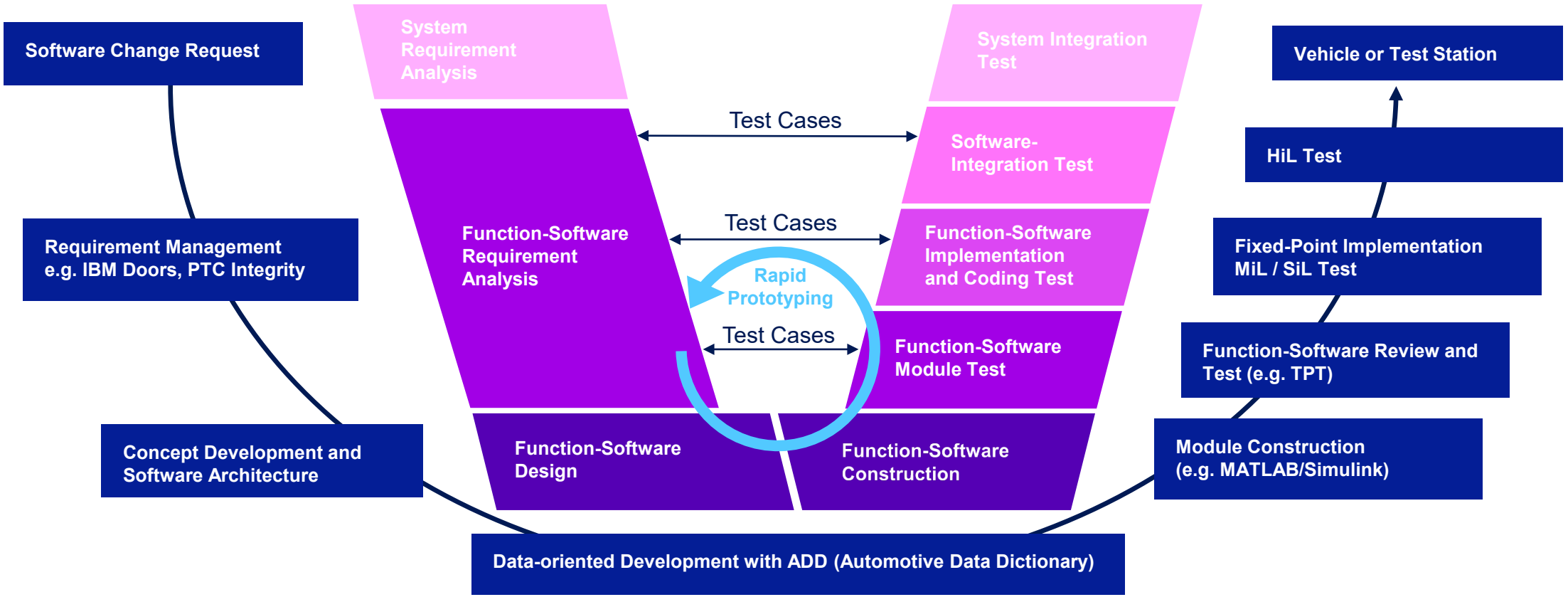
- 0D/1D model approach for fast calculation
- Physical model of the cell, contains:
  - Thermodynamic and heat-balance
  - Electrochemical model
  - Mass balance model
  - Membrane model and water management

Physico-chemical Pt-Degradation Model

- Includes different mechanisms
  - PtO formation
  - PtO dissolution
  - Pt redeposition
  - Pt^{2+} diffusion
- Stand-alone model
- Can be customized
- In-house validation

→ **The fundamental goal of the model development is real-time capability so that it can be run on control devices.**

Fuel Cell System – Software Development Process for ECU Functions



→ IAV provides engineering solutions for all software development steps, from requirement analysis to final test

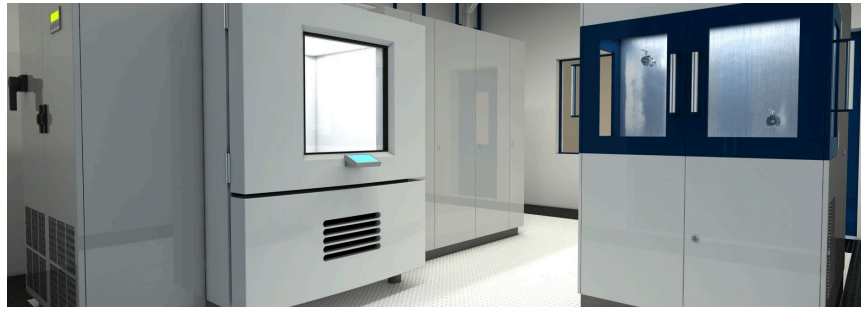
Testing and Validation @ IAV and IAV´s partner framework

Single Cell (2x)

Test Items
- Single Cell
- 5 to 50 cm²
- max. 120 W

Tasks
- Performance Tests
- Material Validation
- Degradation/Durability
- Poisoning Tests

Fuel Cell Short Stack (3x)



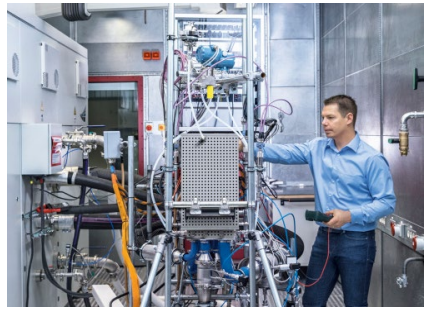
Test Items
- Short Stack
- 2 - 3 Cells
- max. 3 kW

Tasks
- Design Validation
- Performance Tests
- Environmental Simulation

Test Items
- Short Stack
- 10 - 20 Cells
- max. 15 kW

Tasks
- Operating Strategy
- Special Procedures
- Degradation/Durability

Fuel Cell Full Stack (2x)



Test Items
- Full Size Stack
- max. 400 Cells
- max. 180 kW

Tasks
- Performance Tests
- Design Validation
- Operating Strategy
- Durability Tests

Fuel Cell System (3x)

Test Items
- Complete System
- max. 180 kW
- -40 to +80°C

Tasks
- Performance Tests
- System Validation
- Integration Tests
- Function Development

→ **The right test facility line-up is necessary for model based requirement definition and efficient development**

Contact

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