ASTERICS project presentation

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ASTERICS

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

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)
- Vehicle energy simulation (HVAC) and optimization

Optimal Electric Vehicles, in terms of performance (range, reliability, durability and efficiency),
- Reduced development and testing lines

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WP1 Driving cycle «builder» tool

- Real-world data used to build tailored cycles
- From representative cycle to multi-variated cycles
  - System testing
  - Control tuning
WP2 – Battery Models
measurement → parameter fitting → simulation

Measurement Data
(OCV, Current, Temperature, Dynamic)

Parameter Fitting Tool

Results:

x measurement curves
- fitted curves

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

CRUISE

03-07-2014
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

![Graph showing behavior of on-state voltage drop \( V_C \) and thermal resistance \( R_{\text{th}} \) at a power cycling test with \( \Delta T_j = 123 \text{ K} \)]

Fig. 11.39 Behavior of on-state voltage drop \( V_C \) and thermal resistance \( R_{\text{th}} \) at a power cycling test with \( \Delta T_j = 123 \text{ K} \)
WP4 Simulation models & virtual prototyping with SRM

- **Finite element magneto-static**
  - SRM magnetic characteristic

- **SRM dynamic simulation**
  - Control design and optimization
  - SRM dynamics
  - Wrong energy flows

- **Finite element transient**
  - Iron losses estimation

- **Accurate model**
  - Component simulation
  - Energy flows
  - Cooling design

- **Flux as a function of current and angle**

- **Current waveform for each operating point**

- **Iron losses as a function of speed and torque**

**30-07-2014**

EGVI
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

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, ...
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Integrated and Open Development Platform

Powertrain Integration Step 3
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Integrated and Open Development Platform

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Powertrain Integration Step X

VIRTUAL

REAL

Battery
Electric Motor
Transmission
IC Engine
Controls

Total Vehicle System Simulation incl. Variants
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 Topics for Testing Technologies

Testing Technologies

Advanced Test Beds
Battery
Inverter
E-motor
Charging Infrastructure Testing


Research & Development
Production & Market

26-11-2014 Capire – GA-Meeting
Research Topics for Testing Procedures

Testing Procedures

Automated Test Procedures
Testing methods & virtual testing
Hybrid system testing methodologies
Data management

2014 2016 2018 2020 2022 2024 2026

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Thank you for your attention

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