GT-SUITE Involvement in Research Projects with FVV

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GT Gamma Technologies

FVV

- Introduction

- Membership of Gamma Technologies in FVV

- Examples of FVV Projects

- Summary

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FVV – Introduction

- Established in 1956 as a German non-profit organization
  - 27 founding members
  - Today 153 members
- FVV is a network of:
  - OEMs and industrial engine manufacturers
  - Turbomachinery manufacturers
  - Suppliers: components and systems for automotive, industrial engine and turbomachinery industry
  - R&D service providers and engineering firms

Pie chart:
- 9% — OEMs
- 6% — Industrial engine manufacturers
- 7% — Turbomachinery manufacturers
- 43% — Suppliers
- 35% — R&D service providers

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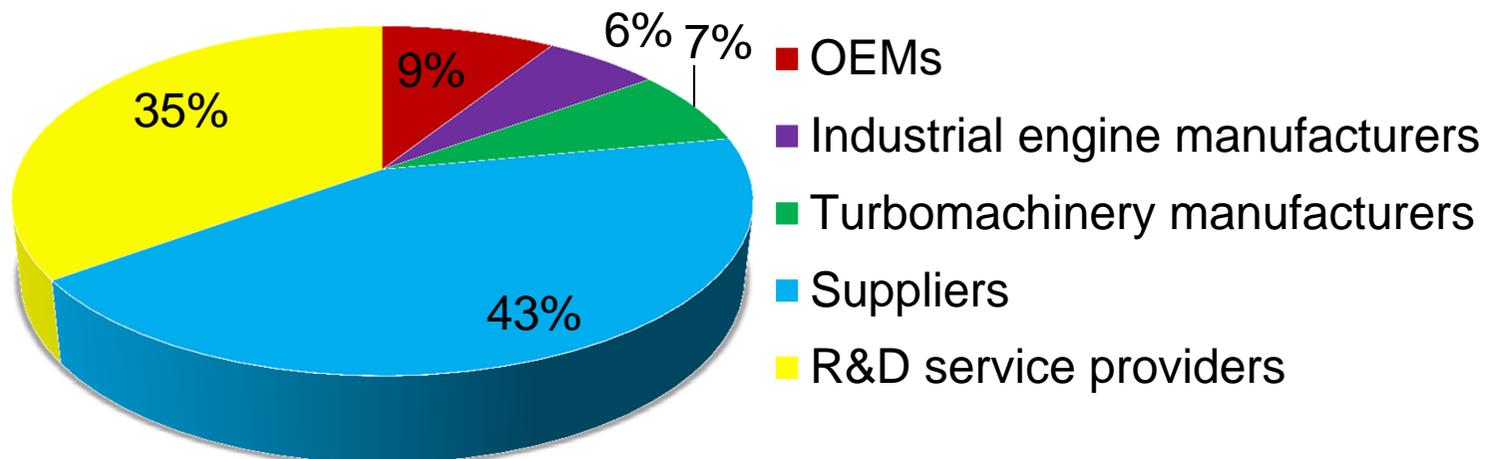
# FVV – Introduction

FVV – Members

FVV – Introduction

- Performs joint research projects at various research institutions
  - 30 universities and research centers
  - 80 research institutes
  - 300 scientists involved in FVV-projects
  - 3-5 BSc-, MSc-, PhD – thesis per project
- Goals:
  - Improve competitiveness of members by effective joint research
  - Establish dialogue between industry and universities
  - Practical training for graduate students in research and project management
  - Strengthen small and medium sized businesses
- Currently expanding from a German to a European platform

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FVV – Introduction

- Members can elect to join projects, or propose topics

  – Project duration from 6 months to 3 years

  – Funding of the projects is done with FVV's own resources or government (public) funding

  – Members of a project are expected to contribute hardware, test-results or other tools not available at the research institution
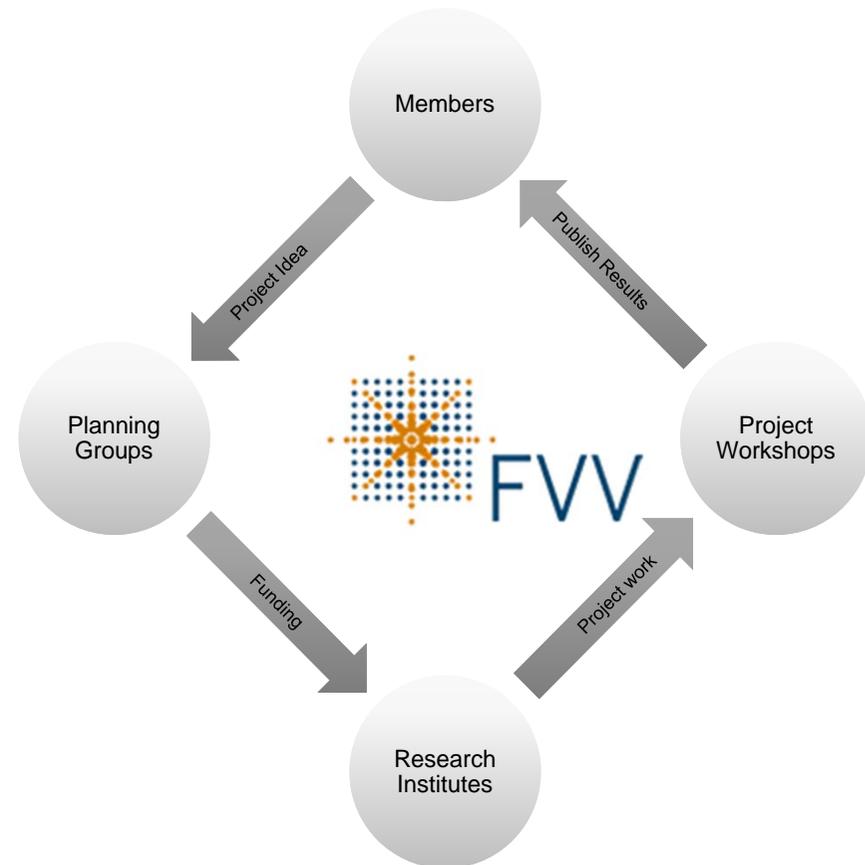
FVV Introduction

Main Areas of Research

- Engines I. – Complete Systems

  – New technologies, overall balance, etc.

- Engines II. – Mechanics and Acoustics

  – New materials and coolants, engine dynamics and acoustics, etc.

- Engines III. – Combustion Processes and Fuel Preparation

  – HCCI, hydrogen combustion, downsizing, etc.

- Engines IV. – Fuels with Focus on CO2 Emissions

  – Biofuels, synfuel, hydrogen and natural gas

- Engines V. – Exhaust Gas Recirculation

  – Catalytic converter modeling for reaction kinetics, etc.

- Turbomachinery

  – Aerodynamics, materials, optimization of components, etc.

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- Results of the projects are available to all members of FVV
  - Online database including archive of all projects
  - 930 projects have been finished since 1956
  - Includes interim and final reports, presentations and measured data
  - Any software developed within projects is also available as source code

- Project Language:
  - Historically, most publications are in German
  - Recently, many projects are done in English
  - Ongoing discussion to switch all projects to English
  - Projects with public funding are required to be in German

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FVV Membership of Gamma Technologies

- Gamma Technologies was invited to join FVV in 2007

  – GT is an active paying member

  – Participates in selection of projects

  – Participates in workshops

  – Contributes ideas to the research efforts

  – Supports students working on selected project

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Current Projects: No. 1139 (Turbocharging)

- Extended Turbine Mapping I and II
- Extend the measured areas of turbine maps
  - Small turbine speeds and mass flow
  - Variation of operating conditions
    - Turbine inlet temperature
    - Coolant temperature
    - Turbine back pressure
  - Different flow characteristics for twin scroll turbines
  - Measurement of axial forces on turbine shaft
- Goal: Improve predictive simulation by independent modeling of
  - Heat transfer to compressor
 - Friction
  - Aerodynamic Characteristics

Current Projects: No. 1139 (Turbocharging)

- Extended Turbine Mapping I resulted in a new method of modeling twin-scroll turbines
- Gamma Technologies was asked to create a template incorporating this method

  – FVV researchers can modify the compound if they have a need, and not wait for GT to develop new code.

  – As new requirements emerge, Gamma Technologies is open to requests for further improvement

  – Example: The actuator 'Temperature for Speed Reduction' in Turbine parts was added at the request of researchers working on this project
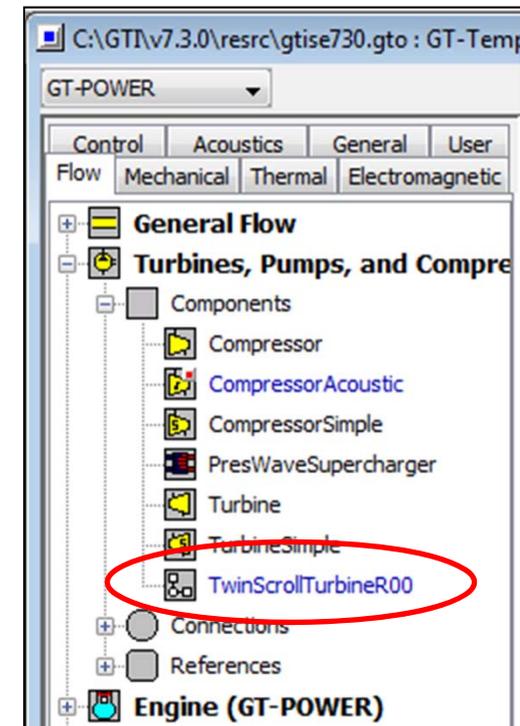
Current Projects: No. 1103 (Turbocharging)

- Pulsating Flow through turbines
  - Investigate efficiency of turbocharger turbine at admission with pulsating exhaust gas flow
  - Goal: Understand deviation of turbine efficiency at real engine operating points compared to steady-state measurements for turbine maps
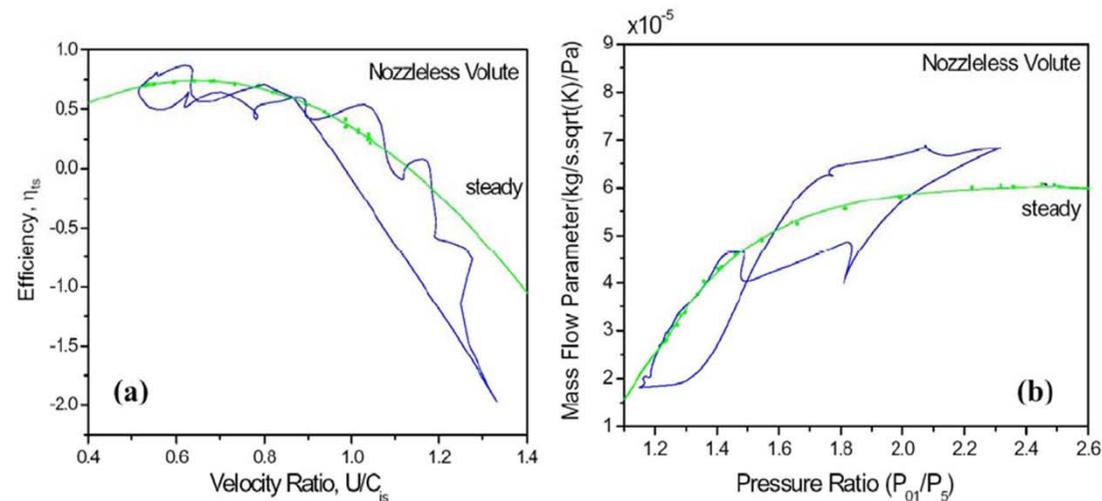
Current Projects: No. 1057 (Aftertreatment)

- Development, implementation and validation of a model for Diesel catalyst aging
  - Experimental setup to quickly age a catalyst
 - Develop a model in GT-SUITE to model aged catalyst performance
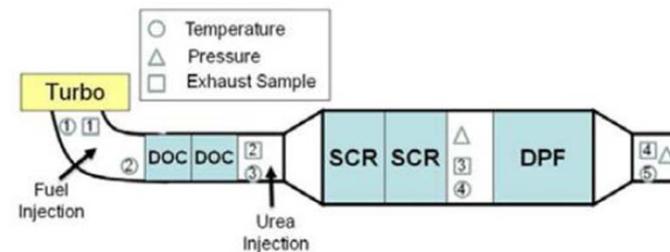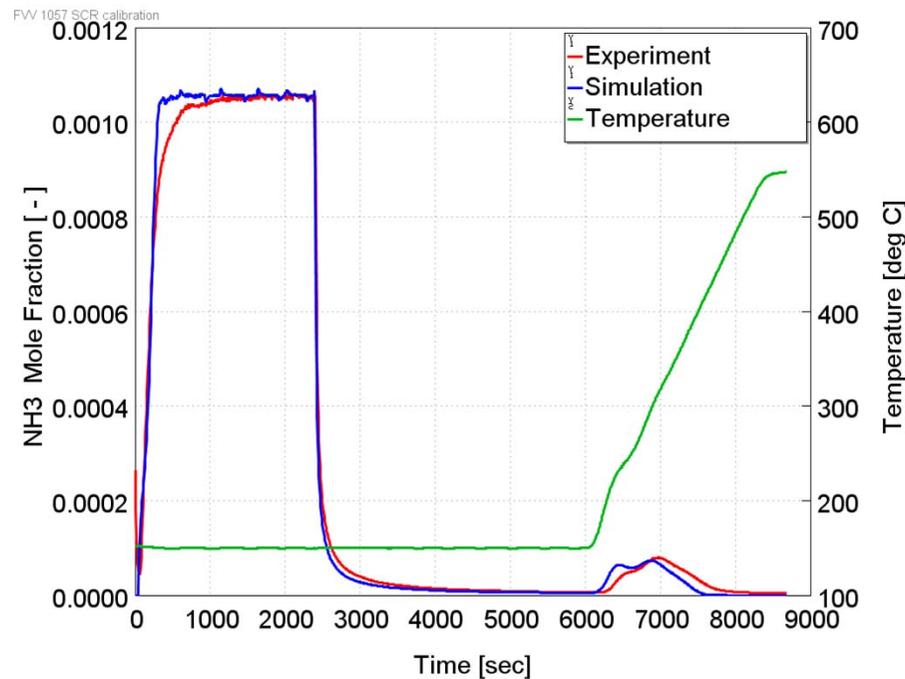
Current Projects: No. 1083 (Systems)

- Vehicle Thermal Management on battery operated vehicles
- VTM System Model of an electric car build in GT-SUITE
  - Development of a test bench to verify simulation results
  - Optimization of total energy balance of the vehicle, thermal preconditioning and energy consumption
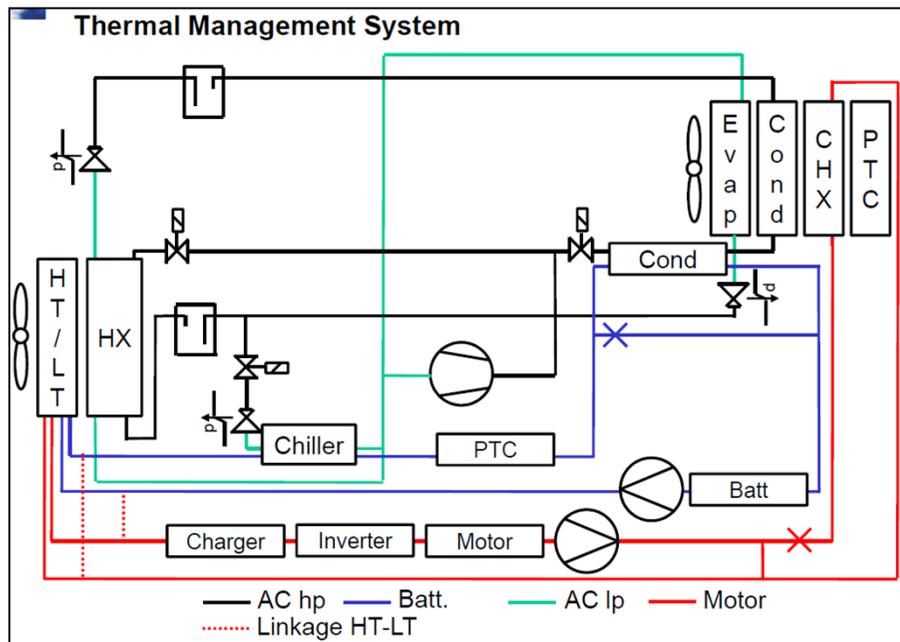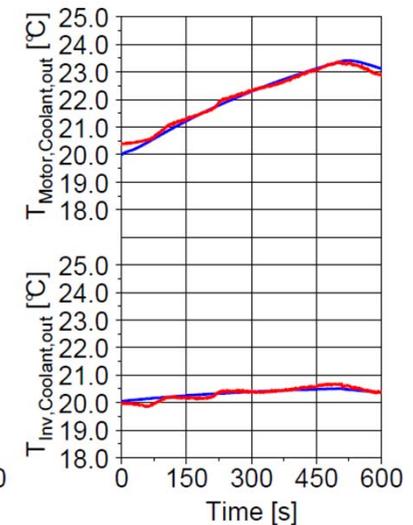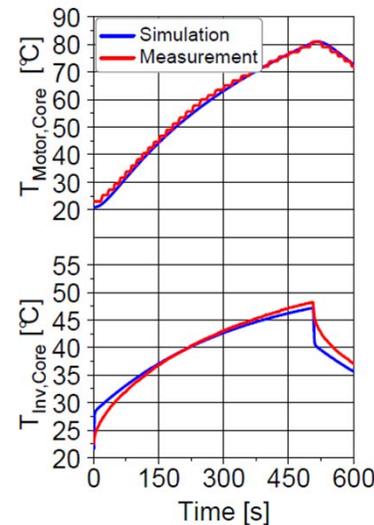
Current Projects: No. 1131 (Systems)

- Residual heat in the vehicle by thermochemical energy storage
  - Development of a complete vehicle model in GT-SUITE including cooling system, air conditioning and cabin model
  - Study on the impact of different heat storage methods and controls on fuel economy and comfort
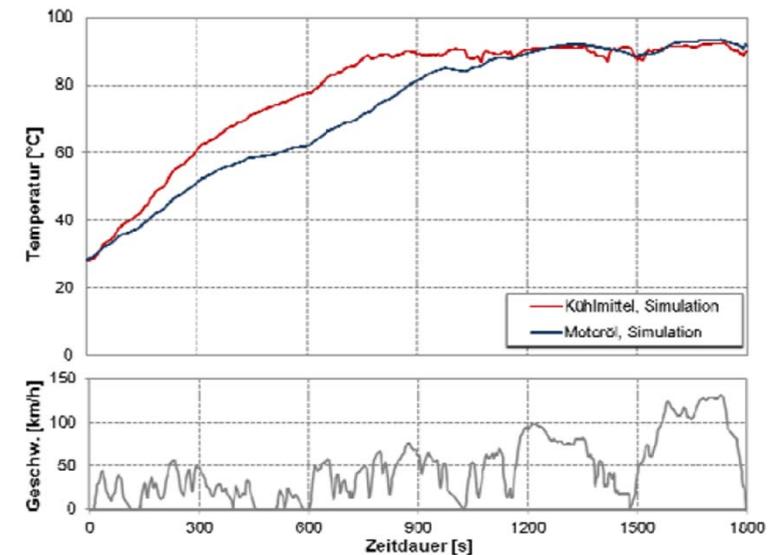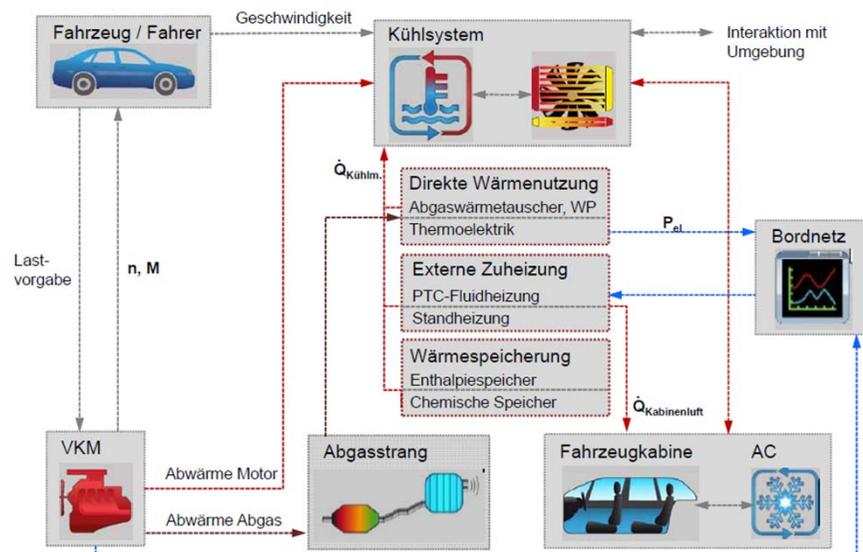
Current Projects: No. 1081 (Systems)

- Turbocharger Dynamics
  - Research on the interactions between turbochargers and internal combustion engines
  - Optimization of transient response of highly charged SI engines
  - Investigate best fuel consumption and best dynamic behavior
  - Detailed modeling of turbocharger in GT-POWER including heat transfer
  - GT-POWER detailed engine model used for optimization

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Finished Projects: No. 1041 (Systems)

- ## Small Displacement Gasoline DI Engine (Project 1041)
  - Design of a downsized GDI engine using biofuels to reduce CO_2
 - Study for extremely downsized SI engine
    - Target: 3 cylinder 0.8 liter with a specific power output of 120kW/l
    - Extensive use of 1-D simulation (GT-POWER) for 2-stage turbo-matching, gas-exchange
    - Power target achieved using E20 fuel

small capacity gasoline DI engine (project no. 1041)

engine specs: 0.8 l, 3-cyl., DI, CR = 11.0 & CR = 13.0 , (RON 95), E20, E85, DOHC 3V

WP I : concept finding	WP III : design	WP V : testing
• base engine: OM660	• cylinder head	• oil dilution
• integrated exhaust	• cooling	• part- & fullload
• cylinder head	• piston(CR = 11.0 & CR = 13.0)	• load jump

WP II : CAE	WP IV : procurement	WP VI : NEDC
• 1D-gas exchange simulation	• purchase	• cycle simulation
• 3D-CFD flow/coolant/injector	• production	
• valve-train kinematics	• buildup	

Pischinger, S. et al: Abschlussbericht zum Forschungsvorhaben Nr. 1041
FVV Informationstagung Motoren 2013, Heft R564, Bad Neuenahr 2013

Finished Projects: No.1026

- ## Heat2Cool – Use of exhaust gas energy
  - Investigate steam jet refrigeration system
  - variable nozzle geometry on the charge-air cooling to below ambient temperature
  - Goal: increasing efficiency in turbocharged internal combustion engines
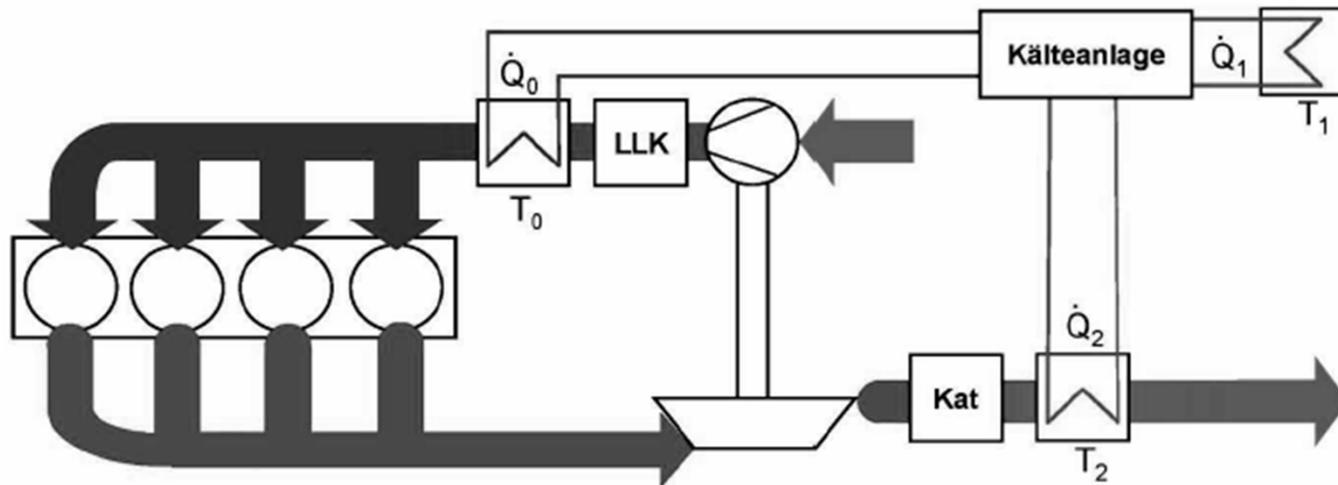
Kadunic, S. et al: Abschlussbericht zum Forschungsvorhaben Nr. 1026
FVV Heft 989, Frankfurt am Main 2013

Future FVV projects

- Modeling of the burn end zone at SI-engines considering the influence of the top land
  - Set up experiments to investigate influence of different parameters
  - Improve simulation of effects in cylinder during late phase of combustion
- VVT Diesel engines - Emissions vs. fuel consumption
  - Fundamental investigations of variable gas-exchange mechanism on diesel engines with full variable valve train regarding raw emissions, fuel consumption and exhaust temperature
  - GT-POWER will be used for the gas-exchange analysis
- Measuring and modeling of post oxidation effects by air flushing
  - Measurement of oxidation effects in the exhaust
  - Develop simulation model for the reaction in the manifold

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Summary

- FVV coordinates projects in engine research
  - Collects project proposals from members
  - Organizes funding at research institutes
  - Provides results to all members

- GTI participates in all phases of research projects
  - Project Definition
  - Technical support of projects
  - Workshops
  - Conferences