Diesel Engine Development

SOLUTIONS FOR SUPERIOR PROPULSION
EFFICIENCY WITH LOWEST EMISSIONS
Founded in 1978, FEV is an internationally recognized leader in design and development of powertrain and vehicle systems and a supplier of advanced testing and Instrumentation systems. Professor Stefan Pischinger, President and CEO of the FEV Group, oversees the privately-owned global enterprise and maintains the company’s focus towards sustainable and significant contributions to the design and development of advanced gasoline, diesel and hybrid powertrains and alternative propulsion systems.

FEV’s founder, first president, and CEO, Professor Franz Pischinger, developed these company principles, which provide the foundation of our sustainable company development. The original four-person team, that analyzed the combustion system of internal combustion engines quickly evolved into a highly skilled engineering company with a service base that grew to include engine design, testing, calibration, vehicle integration and the development of test facilities for OEMs. Through a natural progression from engine to powertrain to vehicle, FEV’s engineering competencies have continuously expanded to provide customers with turnkey solutions. FEV is dedicated to keeping its position as a technology leader, and to maintaining that leadership. The company continually reinvests in internal R&D programs, developing value-orientated solutions to meet tomorrow’s mobility and transportation demands. These activities are strictly aligned to customer demands through focus on the individual definition and adaptation of development and business processes, while observing the highest standards of confidentiality. This philosophy, combined with our global customer support, is essential to the mutual success of both FEV and its customers.

With its World Headquarters and European Technical Center in Aachen, Germany, the FEV Group operates globally with its North American Technical Center in suburban Detroit, in the USA, and our Asian facilities in Dalian, China and in Pune, India.

FEV at a glance
- Full range engineering service supplier for powertrain development, including diesel, gasoline, hybrid & electric drivelines, transmission systems and chassis development
- Visit experience, based on a database of over 200 modern engines derived from ongoing benchmarking programs
- Engineering and construction of advanced testing facilities including test & instrumentation systems, end-of-line test benches and complete test centers
- Strong R&D programs to enable further progress in technology and to enhance FEV’s innovative strength
- Close working relationship with the RWTH Aachen University
From today’s point of view the modern Diesel engine represents the most cost-effective propulsion unit for lowest CO₂ figures in automotive applications and is globally on a substantial course of growth. Despite the continuous public discussion about electric vehicles in different scenarios depict diesel-powered cars still the backbone of vehicles with lowest CO₂ emissions in the field, absolutely competitive against more expensive hybrid solutions. Even under consideration of additional exhaust control systems deliver cars with modern diesel engines a highly attractive mix concerning and customer’s demands regarding comfort, fun-to-drive and total-cost-of-ownership. As a consequence, modern diesel engine technology represents a key element in global efforts to lower GHG emissions from transportation, even spreading out from currently classical diesel markets to new areas, including important future regions like vital emerging countries.

The general requirements for the current and future development of economically successful diesel engines are:
- Compliance with upcoming, most stringent emission standards and new regulations
- Attainment of lowest CO₂ outputs
- Realization of attractive and competitive driving performance
- Improvement of the already given benefit in cost-of-ownership status
- Reduction of the still existing diesel-specific shortcomings like power-to-weight ratio and NVH
- Implementation and adaptation of electrical assist functionalities

FEV GmbH drives the unbroken evolution of the Diesel engine in this complex profile of requirements in two major ways. On one hand with cutting-edge innovations in terms of new engine architecture features or novel system functionalities (see Figure 1), on the other hand with customer-oriented, high quality assistance in time-limited series production projects regarding engine integration and application for worldwide clients and markets, covering price-sensitive high volume mass production installations as well as dedicated calibration activities in the premium segment with extreme characteristic data, for the very ambitious core European market and the extremely challenging US market as well as for the strongly evolving markets of the emerging countries of the BRIC zone.

More than 240 highly skilled technical specialists in the business unit BD- “Passenger Car Diesel Engines” perform the authorized tasks from early research and advanced engineering to final SOP release including “after launch support”, covering all relevant disciplines counting engine design (see Figure 2), mechanics and NVH, combustion and aftertreatment, engine controls, software development and DQD, and utilizing advanced development tools (refer to Fig. 3) and latest methodologies from CAE to Doe with the focus of delivering highest quality and best customer satisfaction in time to the client. The new integrated structure of all relevant competencies under one roof strengthens FEV’s authority to deliver top engineering service to the global engine manufacturers, targeting towards attractive and innovative future diesel engines and servicing the growing global market demands concerning minimized pollutant emissions, lowest CO₂, refined appearance and superior driving performance at favourable cost-of-ownership figures.
FEV’s comprehensive process for holistic base engine design consists of a wide range of acknowledged methodologies including system and component benchmarking as well as bundled design expertise. The engine architecture and main design parameters for a new engine can be defined transparently and efficiently within the concept phase. Following the trend of cost-effective, modular engine families, even covering gasoline as well as diesel versions, the degree of communality is intensively monitored and optimized to design, functional and cost constraints. FEV design engineers are highly specialized in their dedicated fields. They have got high competencies in using the best all-new software products available like ProEngine™, CATIA V5™ or Unigraphics NX™ to generate full functional parametric CAD models with the highest level of maturity, quality and robustness. Mass production requirements as well as cost saving aspects are considered continuously, while keeping close contact to OEM manufacturing departments and involved system suppliers. Models and detailed drawings are managed and organized by state-of-the-art PDM system Windchill™. In order to support the increasing complexity of modern engines, regular exchanges with other disciplines like CAE, NVH, thermodynamics regarding simulation and testing aspects are integral part of FEV’s internal design process.

The current trend toward downsizing of engines requires new approaches to product design. FEV has investigated the design to support high peak firing pressure and increased thermomechanical load due to high power and torque density. Variable components are introduced in the base engine as well as in the peripheral components for gas exchange to comply with the demand of today and future emission regulations.

CAE - Quality increase through frontloading

Intensive use of CAE is mandatory to handle the conflicting demands of modern Diesel engine development: increasing mechanical and thermal loads caused by rising peak firing pressure and specific power output versus reduced weight and improved NVH behavior and minimized friction.

In this context CAE plays a key role for achievement of challenging product targets under consideration of reduced development budget and time.

FEV has successfully applied the full range of CAE methods in the field of powertrain mechanics and NVH development for many years, incl.:
- Dynamic Multi-Body Simulation (MBS)
- Finite Element Thermomechanical and NVH Analysis
- 1D and 3D Computational Fluid Dynamics (CFD)
- Combined Analyses (CIT, …)
- ...

The key to higher quality is the well-defined integration of the numerical analyses into the complete development process. The degree of model complexity corresponds to the maturity of the development.
Engine mechanics
and NVH

To meet the challenges of tomorrow’s engine targets concerning high and extended durability at minimized costs, the tailored involvement of advanced methods during the mechanical development represents an important key to success.

Some of FEV’s unique technologies are:

**Friction Optimisation**
Validated friction prediction tools are used during engine concept phase using the unique FEV friction database. It contains detailed friction results of more than 500 engines, generated by using the “strip-method”. As a result, an immediate feedback regarding potentials of design changes is obtained.
For detailed investigations of the friction between piston, piston rings and cylinder liner during fired engine operation, the dedicated FEV FFHO measurement reveals the dynamic friction forces in a crank angle domain. This information allows rating and optimization of new technologies such as:
- Innovative coatings
- advanced honing structures
- new piston ring designs

**Troubleshooting & Special Measurements**
Starting from a bird’s perspective, a failure is systematically analyzed by involving all relevant experts from the development process. A wide variety of Special Measurement techniques allows a detailed investigation at FEV. These deliver valuable input for the various CAE tools. Examples of Special Measurements:
- high dynamic main- and con-rod bearing oil supply investigations
- dynamic crankshaft, con-rod and piston loads or movements
- liner deformation
- on-line piston and valve temperature evaluation

**Worldwide Durability Testing**
Caused by worldwide engine production localization combined with different local fuel qualities, test capacities in different countries are mandatory. FEV therefore built up specific on-site durability know how to perform adequate durability tests in:
- Germany: Aachen, Bremerhaven
- USA: Detroit
- China: Dalian
- India: Pune

Specific fuel composition or quality related problems can be locally investigated and analysed. Additionally complete engine localizations or the substitution of engine parts by local supplier can be validated within FEV’s worldwide test locations.

Besides the well-known technology drivers like emission compliance, fuel economy improvement, performance increase and cost reduction, comfort refinement and noise reduction will become an additional key point of upcoming development activities, also driven by legal requirements. In this aspect, besides consequent detailed fine-tuning and optimization of components and complete subsystems, NVH benchmark identifies a substantial focus of general engine enhancement. FEV possesses an ultimate extensive database of more than 600 engines, serving the frontloading in engine layout and future orientated development work as well as valuable input in all kinds of typical NVH optimization issues.

Particularly two in-house developed optimization tools should be emphasized in this context:
- FEV VINS for reliable vehicle interior noise simulation out of PT mount vibration measurements
- OSL-Indicator breakdown of disturbing noises into individual noise types such as knocking, ticking, rattling and miscellaneous noise. Besides the qualification related to the international ranking scale the separated noise types are also audible as wav-files.
Benchmarking and weak point analysis

An important instrument for valuable assessment of new technologies is the benchmarking of vehicles and engines. FEV has a long-time benchmarking experience, which is the core of FEV’s immense engine database.

A typical benchmarking project with focus on powertrain and combustion system starts with screening tests of the vehicle, followed by tailored engine test bench investigations. Various tests are done for objective assessment of performance, emissions, efficiency and acoustic. FEV’s large databases and long-term benchmark experience enables a detailed ranking of new technologies and represents a highly valuable support for layout, design and target definition for new engines.

In addition to this “traditional” benchmarking, another topic with increasing importance, especially with regard to Diesel engines, is the detailed taxation of different exhaust aftertreatment technologies. FEV conducts vehicle and test bench investigations regarding efficiency and operational strategies for all kinds of aftertreatment concepts, e.g. SCR or LNT.

With special regard to active DPF regeneration, soot dilution is tested frequently within benchmarking projects. Moreover for a deeper look into single exhaust aftertreatment components, substantial chemical analysis can be performed in our chemical laboratory. For a detailed benchmarking of efficiency of new and aged aftertreatment components a highly capable synthetic gas test bench is available.

Besides the assessment of new technologies, FEV’s benchmarking and calibration experience can substantially support weak point analysis programs. Engine and calibration problems can be investigated, analyzed and re-engineered by experienced FEV staff.

The value that FEV provides has been validated by many automobile manufacturers all over the world that have commissioned FEV in several joined consortiums for widespread benchmarking activities of competitor products as well as their own engines and vehicles.
**Combustion and fuels**

Highlight of FEV’s Diesel combustion system development is the close interaction of simulation and experiment detailing every facet of the engine process. The strong capabilities of this tool chain are showcased by the development of FEV’s EU6+ demonstrator engine and vehicle, featuring FEV’s own HECS (Highly Efficient Combustion System) combustion system, containing:

- Layout and optimization of the two-stage boosted, combined HP and LP EGR air path concept by 10 gas exchange simulation with GT-Power®
- Optimization of the swirl flow level and uniformity utilizing D-CMD (Diesel Charge Motion Design) by 3D in-cylinder flow analysis with Star CD®
- Layout and optimization of piston bowl and injector nozzle specifications focusing on improved air utilization by combustion simulation with FEV KIVA
- Verification of combustion system hardware definition and optimization on single-cylinder test bench
- Performance and emission calibration and control optimization on multi-cylinder test bench
- Performance, emission and drivability verification with demonstrator vehicle

Together with FEV’s unmatched engine benchmark database these development enable FEV to take the lead or assist in any Diesel combustion system development project achieving current and future requirements.

For refined analysis, model verification and research purposes also advanced optical analysis methods are available:

- Visualization of injection and ignition behavior in FEV’s optical high pressure chamber
- Detail analysis of combustion process and emission formation in FEV’s transparent HECS Diesel engine

Within this sophisticated environment FEV strengthens its leading position in Diesel combustion development by further expanding the utilization of advanced technologies. Current focus of research includes:

- Advanced air-path variability by variable valve actuation to minimize fuel consumption and emissions and to offer new options regarding exhaust thermo management

- Adaptation of combustion system for alternative fuel formulations to meet the demands of the future including next generation bio-fuels and low CN fuels for combustion with increased homogenization

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**Utilization of future injection system capabilities like rail pressure up to 3000 bar and rate-shaping for further emission optimization**

**Important Fuel Parameters for Efficient, Low Emission Diesel Combustion Process**

**Synthesis of Hardware and Software: Fuel-Independent Vehicle Emission Performance**
1. Cycle Definition

2. Cycle Reduction

"Key points: "Modes"

Load spectrum by chassis dyno tests or simulation

3. DoE based modeling

"For each mode: DoE process"

But: No calibration optimization

4. Global Map Optimization

"Direct optimization of cycle emissions"

Map smoothness optimization

5. Validation

"Engine test bench"

"Chassis dyno testing"

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**New!** Direct optimization of complete maps

**New!** Integration of EAS

**New!** Simultaneous optimization for multiple cycles

**New!** Definition of global modes for efficient variant calibration

**New!** Global models

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**Key features & benefits**

- Simplified longitudinal vehicle and drive train model
- Calculation of engine speed and load from vehicle speed & known gear change profile
- Easy parameterization
- Saving and loading of vehicle model parameterization
- Denormalization of Heavy-Duty cycles based on full load and drag torque incl. NTE area
- Filtering of overrun and idle conditions

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**Bozys + Cycle Simulation**

**Key features & benefits**

- Optimal reduction of load spectrum to replacement modes by k-means clustering algorithm
- Free configuration of speed-load leverage
- Introduction of fixed user-defined modes in reduction process
- Merging of different local mode sets and optimized distribution of global modes
- Extraction of convex hulls
- Redistribution of dwell times for individual variants using triangulation

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**Emission tuning and governor calibration**

The simultaneous lowering of emissions and CO₂ to meet worldwide legal requirements marks a central aspect in future development work. A significant part of this development represents the application of the parameters in the ECU. For ensuring the partially conflicting requirements, a multiplicity of control algorithms is incorporated in the ECU. Besides the optimal calibration of the engine parameters describes a professional procedure to characterize the optimized input for the dataset the ultimate key for cost-effective, high-quality and robust vehicle calibration.

In order to efficiently optimize emissions as well as FE/CO₂, FEV has successfully established a comprehensive SW tool chain to perform these essential development tasks.

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**1. Identification Tests**

- Standardized transient test sequences
- Tool-aided test execution

2. Plant identification

- Automated data evaluation (step-detection, etc.)
- Automated determination of transfer behavior

3. Calibration optimization

- Automatic determination of controller parameters
- Consideration of input saturations
- Individual shaping of loop response

4. Validation

- In-vehicle validation of closed-loop controller performance

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**Powerful tool to calibrate & estimate impact of H/W changes**

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**Governor Calibration**

The current situation for fulfillment of the various demands is also described by various different operational modes, e.g. heating modes, etc., which demand a high number of transitional steps.

The governor calibration task has the goal to optimize the closed-loop control systems of all engine subsystems and to ensure best performance and drivability under all conditions, while respecting and guaranteeing the protection of all installed systems.

The typical governor calibration contains the tuning of all governors for fuel and air path, EAS temperature as well as vehicle functions, but will certainly increase with future, more electrified powertrains.

Also for these tasks FEV has developed a capable tool suite to assist the calibration engineer for highly efficient execution of these tasks. The FEV Governor Design Tool (GDT) allows to identify the open loop system, refine the closed-loop governor gains and to calculate the corresponding engine maps completely.

Finally, for the drivability calibration the FEV DrivabilityCalibrationExpert Tool Suite allows to perform specific driving maneuvers automatically, to robotically measure the relevant data and perform calculations for assessment of the vehicle behavior. This allows an efficient comparison between various calibrations and enhances the calibration process efficiency.

Due to the integrated, full chain process for engine/vehicle calibration at FEV delivers highly refined, robust and highly qualitative DP datasets to the customer in an attractive, compressed time frame, allowing secure emission compliance with attractive CO₂ behavior and silent engine appearance.
Emission controls and aftertreatment calibration

Modular Synthetic Gas Test Bench for Efficient Development Support

FEV has long term experience in the development and application of current diesel EAT technologies for passenger car, light- and heavy-duty as well as with stationary diesel engines in the fields of:

- Diesel Particulate Filters (DPF / PDC)
- NOx Adsorber Catalyst Technologies (NAC / LNT / NSC)
- Selective Catalytic Reduction System (SCR)

Diesel Particulate Filters
DPF’s will be mandatory for most diesel applications in the future all over the world. FEV has been working on DPF technology for more than 15 years, directly involved in the first series production applications in Europe. FEV’s current global activities in calibrating DPF technology include:

- Thermo management calibration
- External diesel fuel injector applications
- Oil dilution investigations
- Temperature governor calibration
- DPF system components assessment/benchmarking
- Calibration of loading and unloading models
- Maximum soot limit estimation
- Ash influence investigations
- Calibration of regeneration control strategies
- Sensor and actuator robustness investigations
- Application of climate corrections
- DPF desulfurization and white smoke limitation
- Consideration of LP-EGR application

FEV has been and is responsible for a large number of EAT series production projects. One of the first key projects was the development support of the PSA FAP-system initiative, which was the first reliable production DPF on the market.

NOx Adsorber Catalyst Technology
FEV has been actively involved in NAC technology for many years. Current calibration activities at FEV in the field of NAC technology include:

- NAC assessment / benchmark
- Rich engine calibrations
- Lean/rich transitions optimization
- Application of climate corrections
- Calibration of control strategies
- NOx loading and unloading models
- Desulfurization strategies
- Catalyst aging methodologies
- Application of external diesel fuel injectors / diesel fuel reformers

Selective Catalytic Reduction
FEV is as well widely experienced in calibration and investigation of SCR systems in several projects. The activities include:

- Synthetic gas test bench catalyst characterisation
- Calibration of urea dosing strategy and control modes
- Model adaptation with FEV’s TOPEX expert simulation tools
- Production and characterization of aged components
- Advanced hardware system investigations like distribution tests
- Heat mode calibration

Fleet Testing Calibration
FEV has its own calibration testing fleet with especially trained drivers. The calibration is tested on defined standardized driving cycles with a full range of data acquisition. The data acquisition can be used for:

- DPF / NAC / SCR benchmark
- Calibration of DPF soot loading and unloading models (by means of weighing)
- Ash loading investigations
- Fuel consumption investigations
- Oil dilution analysis
- Calibration of NOx models
- AdBlue consumption testing
- Urea deposit formation analysis
- Off-line model optimization with FEV’s TOPEX expert simulation tools
OBD and Function Development

Diesel engines (Fig. 1). Low pressure EGR, SCR or LNT aftertreatment systems and different grades of electrification/ hybridization will increase this complexity even further. On-Board Diagnostics (OBD) not only have their legislative obligations, but they also possess a strong impact on customer satisfaction and the OEM's image, on which the commercial success of the vehicle depends.

FEV offers significant knowledge and experience in OBD diesel vehicle calibration of any type of engine management systems and combinations. The increase of complexity of the OBD systems makes the use of numerical solvers and tools essential. These tools and methods are not only implemented for time and resource reduction, but also to ensure a robust calibration, fulfilling both the legislative and customer requirements. One example of the effective tool chain is FEV's ASM System. It allows the simulation of most sensors or actors failures without influencing the engine management system. Concerning the fulfillment of IUMPR, FEV's uses its dedicated Log File Database tool for the vehicle endurance run assessment.

Function Development

FEV function development is founded on a huge base of knowledge regarding engine development and calibration. This leads to highly efficient and comprehensive control structures using a minimum of calibration effort. The development platform used for the FEV Prototyping Diesel ECU (see Fig. 2) is the dSpace Micro Autobox. A full engine control for prototype engines is available, FEV furthermore supports the function development on ASG basis. The function development for emission based air path control has a long history within FEV. Figure 3 shows the latest version of the actual NOx based air path control which is able to run valve train variabilities, high and low pressure EGR including a connected exhaust throttle and the intake throttle (here not displayed), if necessary. The shown concept enables best possible emission robustness for series applications with nearly no variance between steady state and transient NOx emission.

Fig. 1: Picturing of SCR System Malfunction

Fig. 2: Schematic of FEV Prototyping Diesel ECU

Fig. 3: Function development: NOx based air path control

FEV’s OBD Passenger Car Calibration Capabilities:

- Global (e)OBD calibration integrated in turn key calibration projects or individual solutions
- Broad knowledge of many types of engine management systems
- Calibration work, in vehicle and on automated test benches using high level offline and online calibration tools
- OBD Function development of State-of-the-art and advanced concepts
- OBD validation programs and test trips for worldwide markets
- Home/mobility/certification support
- Global legislative contacts
Program management and quality policy

Long-term success and customer satisfaction means full gratification of comprehensive customer requirements and maximum contentment through high-quality engineering services. Realization of quality is an all-inclusive task at all managers and employees of FEV. Our quality consciousness is anchored by the core values in leadership and influenced by the principle of continuous adaptation to market needs.

FEV Project Management

Professional project management is a fundamental prerequisite of FEV for a tailored and efficient coordination, engineering and balancing of cost, compliance with defined quality criteria and thus ensuring the best results for our clients in time. In order to support our highly skilled project managers in their challenging engineering tasks customized qualification measures regarding project control and monitoring are applied.

Apprenticeship

The FEV-training program is designed towards the various requirements of high-quality engineering services and tailored adequately to the project constellations. In addition to enhance technical expertise in FEV project management and extended soft skills regular technical courses are performed besides the continuous training sequences, partially with external support.

Tools & Methodologies

For a structured and widespread processing of the individual project tasks and completion of specified projects targets all standards, guidelines and templates are summarized in an intranet-based FEV Project Management Site Map. The topics listed include all areas of project planning and controlling, organization and communication, as well as risk and issue management.

Traffic Light Charts

The most important monitoring and control instrument in the FEV project management environment is given by a explicit traffic light chart, which features on a regular monthly basis all relevant data and information regarding comprehensive project status, including adherence to schedule, customer satisfaction and project risks and opportunities. Through the regular compilation of these data deviations in the project scheme are identified in short term and the response time for appropriate corrective actions are shortened. Guided by the selected colors of the FEV-portfolio tool, various reports are generated for visualization.

Quality Gates (QG)

For internal review of the projects standardized quality gates are utilized to the specific project dates, set by the corporate quality management team, performing as an objective authority. Here is the implementation of project management at the end of the planning phase, during checks of project implementation and project completion. The respective QG is crossed, when a specified of project management criteria is met. If deviations are identified, appropriate measures are defined and then exactly monitored. The objective target is an increase in project performance by defining and ensuring reasonable standards of quality, transparency of project procedures, project documentation, and early recognition of potential risks and the timely application of corrective measures.

Project Review (PR)

In regularly scheduled project reviews at the management board level project status and details are communicated and discussed on the base of the traffic light charts and various further detail reports. Particular focus of the management board is directed to the best possible performance for FEV’s customer.

Cross-Functions (X-Function)

Rigorous engineering and management quality standards and continuous refinement of internal processes that have emerged to meet customer demands as best practices are considered as the best platform for comprehensive project success and customer satisfaction. The responsibility for the definition of rules and guidelines, the provision of templates and implementation of training sequences for know-how exchange is in the hands of cross-departmental acting Chief Engineers. In this role, the nominated Chief Engineer ensures his extensive project experience for the transfer of best practice solutions in general and FEV processes in all areas for continuous improvement in FEV-project management. This is the key element in achieving the ultimate objective of FEV GmbH. The highest quality in engineering performance and maximum reliability in order to be the best global partner for our worldwide customers.
FEV successfully performs research projects and development for many clients around the world, under strict confidentiality agreements. This includes almost all of the world’s vehicle manufacturers, as well as numerous suppliers for research, concept, combustion development, benchmarking, powertrain calibration and vehicle fleet testing projects. FEV engineers are proud to see vehicles on the roads each day that are equipped with powertrains and/or calibrations engineered and developed by FEV.

Additionally, collaboration with some of our clients provides information for common technical publications, media, or FEV publications such as FEV-Spectrum or TEC-Infos. The following represents a few examples of such projects and publications:

- Combustion System Definition and Development for PSA 2.0L DW10BTED4 for EURO-4
- DPF-Calibration of the PSA 2.0L DW10A TED for the PSA/Citroen for Peugeot
- 307/406/607 and Citroen C5
- Low CO2 Version of 1.6L DI Diesel for Volvo Car Corporation Drive-E Models of C30/S40/V50
- Low CO2 Version of 1.6L DI Diesel for PSA Blue Lion Model of 207
- Integration and Calibration towards EURO-6 compliance for 3.0L VR6 DI Diesel in Nissan/Infinity Vehicles
- Integration and Calibration towards EURO-6 standards of 2.5L/3.0L DI Diesel engines in Ford Ranger/Mazda BT50 vehicles for RoW applications
- NVH- and Combustion Development for all-new 2.7L V6 DI Diesel of PSA/FORD/Jaguar-LandRover
- Integrated Partner of Daimler-Benz for mechanical and thermo-dynamical development of 2.2L DI Diesel engine for several applications
- Calibration and application of 1.6L DI Diesel from Renault SA regarding EURO-5 and EURO-6 in the Scenic, Megane and Qashqai as well as Traffic vehicle portfolio
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