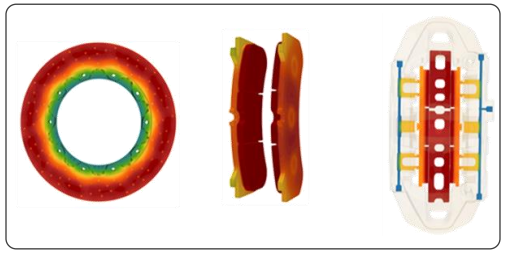
FEV Brake Particle Measurement & Simulation

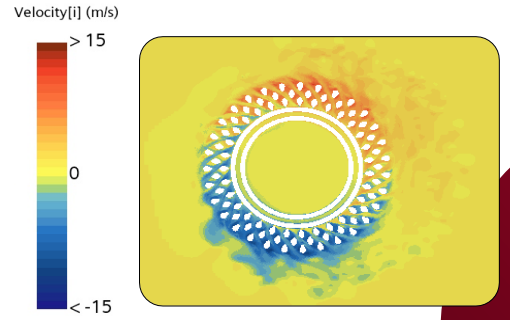
FEV SIGNATURE SOLUTIONS

Assess your brake particle reduction measures early in the development process



FEV offers

- UN Global Technical Regulation No. 24 compliant measurements for brake particle emissions.
  - **PM10**: Fine particles ≤ 10 µm
  - **PM2.5**: Fine particles ≤ 2.5 µm
  - **SPN10**: Solid particle number
  - **TPN10**: Total particle number
- 3D-CFD simulation of brake thermal behavior with FEV's advanced physical-empirical emission models
- Virtual testing to complement and reduce physical measurements with X-in-the-loop testing saving costs
- Coverage for both light-duty and heavy-duty vehicles (HDV regulations effective 2030)



Why FEV

- **Proven expertise:** 45+ years of automotive engineering excellence, trusted by global OEMs and Tier-X suppliers to deliver innovative, production-ready solutions with deep domain expertise in the domain of testing and advanced simulation
- **Complete lifecycle support**: From concept to series maturity, including design, simulation, prototyping, testing, industrialization, and implementation
- **Customer-centric solutions:** Transparent and customizable, enabling you to extend, integrate, and scale your own development

FEV Signature Solutions – v20260331

*) Quelle: https://www.zf.com/products/de/testsystems/anwendungen/test_systems_for_brakes/test_systems_for_brakes.html

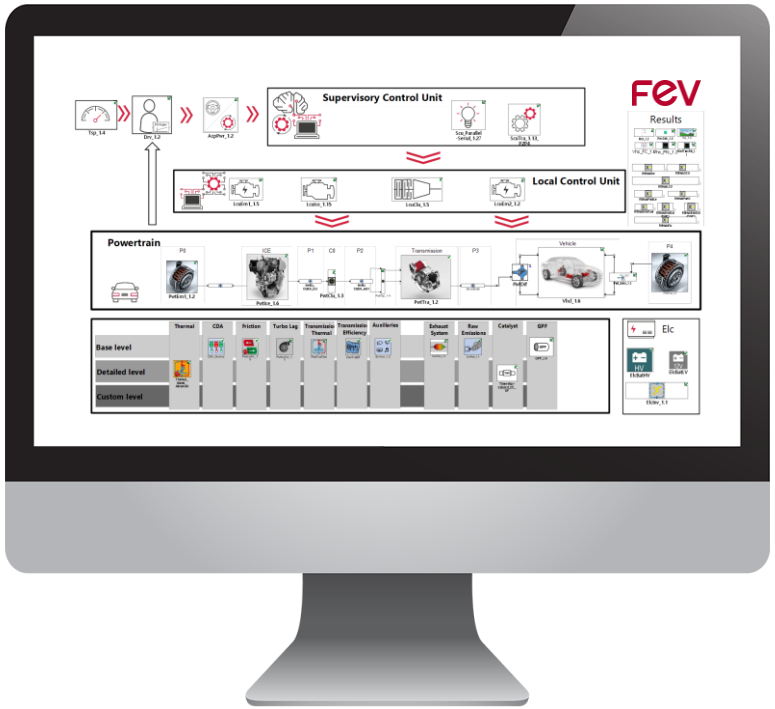
Reference project FEV propulsion
Simulative brake emissions estimation

CLIENT: GERMAN AUTOMOTIVE OEM

- Client required assessment of brake particle emission reduction potential for a target vehicle – comparing conventional WLTP brake cycle operation with hybrid operating strategy to assess whether reduction is below c-factor of UN GTR No. 24

FEV involvement

- FEV developed a dedicated brake emission model for the target vehicle. The model was calibrated based on test data from FEV's database and integrated into a virtual vehicle environment.
- Simulative testing quantified brake particle emissions for both conventional and hybrid operating strategies across the WLTP brake cycle, identifying the recuperation-based reduction potential for the brake family



Predictive Simulation
Quantitative emission reduction predicted by simulation was subsequently confirmed through physical testbench validation at customer facility.

FEV supports you in simulation-driven brake particle testing from model to testbench

01

Measurement & data preparation

02

Thermal modelling for brake disc

03

Particle emissions model calibration

04

Implementation in vehicle model

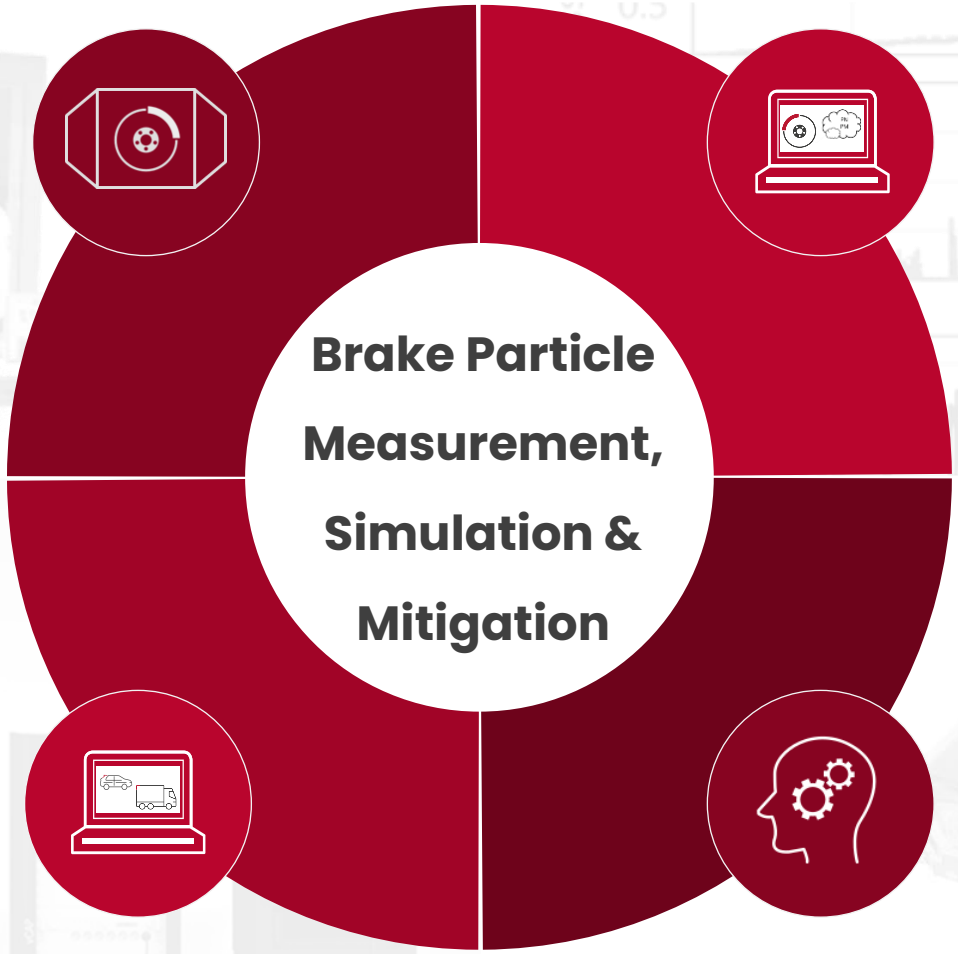
05

Simulative emission assessment

06

Verification & validation on testbench

FEV's holistic physical and simulative testing environment enables compliance estimation for brake families across vehicles and boundary conditions



MEASUREMENT & VALIDATION

UN GTR No. 24 compliant brake particle measurements for PM10, PM2.5, SPN10 and TPN10

Testbench capabilities for LDV and HDV brake emission certification

ADVANCED SIMULATION

3D CFD thermal modeling coupled with physical-empirical emission models

Virtual assessment of brake particle emissions across driving cycles

X-IN-THE-LOOP TESTING

Bridging virtual development and physical prototype testing

CONTROL DEVELOPMENT

Advanced control strategies to mitigate brake induced emission in electrified vehicles

Get in touch with us for further information

www.fev.com/en/signature-solutions