

This document provides an overview of the available facilities and instrumentation at the laboratory.

Some instruments listed in this document can also be used for measurements performed outside of our facilities or for outdoor measurements.

This infrastructure and instrumentation can be used for research projects inside the BFH as well as for customer's purpose.

Please feel free to contact us for further information.

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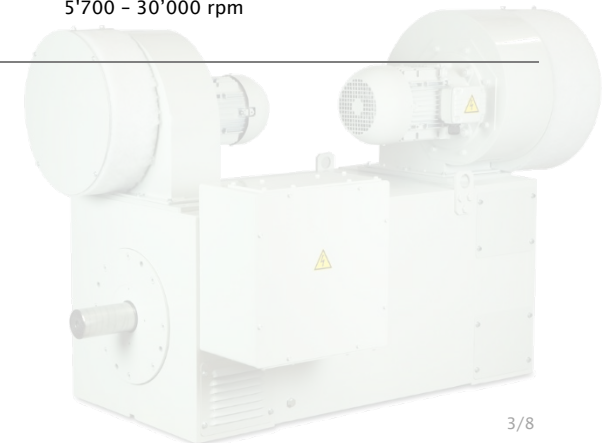
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Infrastructure

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1. Dynamometers

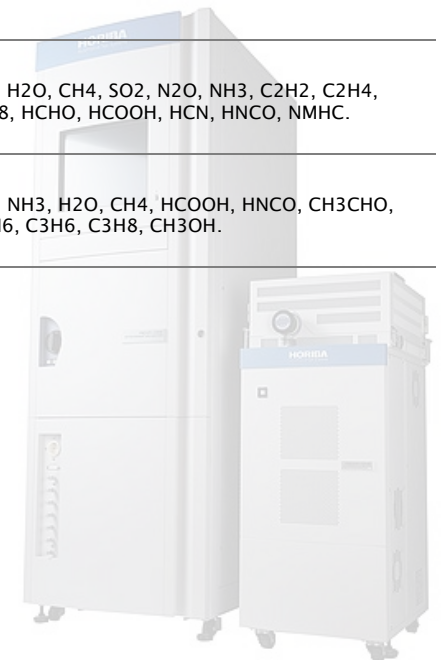
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|-------------------------------------------------------------|---------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| Chassis dynamometer 1 <i>4-wheels drive</i> | Designed for legal exhaust gas measurements for light duty vehicles $m < 2500$ kg | max. speed: 180 km/h wheelbase: 1600 - 4200 mm max. axle load: 2000 kg |
| Chassis dynamometer 2 <i>2-wheels drive / 2-wheelers</i> | Designed for legal exhaust gas measurements for light duty vehicles and 2-wheelers | max. speed: 200 km/h max. axle load: 2000 kg |
| Engine dynamometer A <i>diesel</i> | Schenk W450 | Eddy current brake power: max. 450 kW torque: max. 1750 Nm speed: max. 5'500 rpm |
| Engine dynamometer B <i>diesel</i> | ABB | Asynchronous load machine power: max. 200 kW torque: max. 970 Nm speed: max. 4'500 rpm |
| Engine dynamometer C <i>gasoline/gas</i> | Schenk W40 | Eddy current brake power: max. 40 kW torque: max. 75 Nm speed: max. 17'000 rpm |
| Small engine dynamometer D <i>chain saw</i> | Vibrometer 2WB65 | Eddy current brake power: max. 12 kW torque: max. 75 Nm speed: 5'700 - 30'000 rpm |



2. Gas Analyzers

| | | |
|----------------------------------------------|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Exhaust Gas Analyzer (diluted gases, CVS) | Horiba MEXA One C1 | Measured components: CO ₂ , CO, O ₂ , NO _x , NO, THC, CH ₄ . |
| Exhaust Gas Analyzer (diluted gases, CVS) | Horiba Mexa 9500 | Measured components: CO ₂ , CO, O ₂ , NO _x , NO, THC, CH ₄ . |
| Exhaust Gas Analyzer (raw gases) | Horiba misc. | Measured components: CO ₂ , CO, O ₂ , NO _x , NO, THC, CH ₄ . |
| Exhaust Gas Analyzer (raw gases) | Horiba / Siemens misc. | Measured components: CO ₂ , CO, O ₂ , NO, THC, N ₂ O. |
| Chemiluminescence Detector | Ecophysics CLD800 | Measured components: NO _x , NO ₂ , NH ₃ . |
| Chemiluminescence Detector | Ecophysics CLD700 | Measured components: NO _x , NO ₂ . |
| FTIR spectrometer | AVL SESAM FTIR | Measured components: CO, CO ₂ , NO, NO ₂ , NO _x , H ₂ O, CH ₄ , SO ₂ , N ₂ O, NH ₃ , C ₂ H ₂ , C ₂ H ₄ , C ₂ H ₆ , C ₃ H ₆ , C ₄ H ₆ , C ₃ H ₈ , HCHO, HCOOH, HCN, HNCO, NMHC. |
| FTIR spectrometer | A&D BOB-1000FT (PEMS) | Measured components: CO, CO ₂ , NO, NO ₂ , N ₂ O, NH ₃ , H ₂ O, CH ₄ , HCOOH, HNCO, CH ₃ CHO, HCHO, C ₂ H ₂ , C ₂ H ₄ , C ₂ H ₆ , C ₃ H ₆ , C ₃ H ₈ , CH ₃ OH. |

CVS Constant Volume Sampling
 FTIR Fourier Transform Infrared spectroscopy
 PEMS Portable Emissions Measurement System



3. Portable Emissions Measurement System (PEMS)

| | | |
|-------------------|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Gas PEMS | HORIBA OBS-ONE GS02 / GS12 | Measured components: CO, CO ₂ - heated NDIR, NO _x , NO, NO ₂ - heated dual CLD, THC - heated FID, pitot flow meter for engine for exhaust flow measurements, CAN-Interface. |
| Gas PEMS | HORIBA OBS-ONE GS02 / GS22 | Measured components: CO, CO ₂ - heated NDIR, NO _x , NO, NO ₂ - heated dual CLD, THC / CH ₄ - heated dual FID, pitot flow meter for engine for exhaust flow measurements, CAN-Interface. |
| Gas PEMS | A&D BOB-1000FT (FTIR) | Measured components: CO, CO ₂ , NO, NO ₂ , N ₂ O, NH ₃ , H ₂ O, CH ₄ , HCOOH, HNCO, CH ₃ CHO, HCHO, C ₂ H ₂ , C ₂ H ₄ , C ₂ H ₆ , C ₃ H ₆ , C ₃ H ₈ , CH ₃ OH. |
| PN - PEMS | Horiba OBS-ONE PN | PEMS for Nanoparticle counting. concentration: 0 - 5.0E7 #/cm ³ size: 23 - 1000 nm |
| PN - PEMS | Testo NanoMet 3 | PEMS for Nanoparticle counting. concentration: 1.0E4 - 3.0E8 #/cm ³ size: 10 - 700 nm |
| Rugged Enclosure | HORIBA OBS-ONE RE | Rugged Enclosure for off-road measurements. |
| Portable Analyzer | Anapol EU-5000 | Measured components: CO ₂ , CO, NO ₂ , HC, SO ₂ , temperatures. |

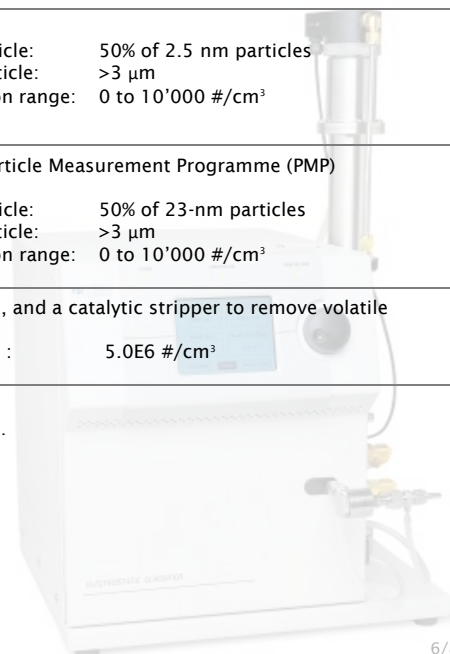
FTIR Fourier Transform Infrared spectroscopy
PEMS Portable Emissions Measurement System
PN Particle Number



4. Particle Counters and Classifier

| | | |
|-------------------------------------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SMPS 3080 | DMA 3081 + CPC 3010 | Particle type: Solids and non-volatile liquids particle size range: 10 to 1000 nm |
| SMPS 3938 | DMA 3081A + CPC 3772 | Particle type: Solids and non-volatile liquids particle size range: 10 to 1000 nm |
| SMPS 3936 | DMA 3085 + CPC 3788 | Particle type: Solids and non-volatile liquids Particle size range: 2.5 to 150 nm |
| Condensation Particle Counter (CPC) | TSI CPC 3010 | Particle size range min. detectable particle: 50% of 10 nm particles max. detectable particle: >3 µm particle concentration range: 0 to 10'000 #/cm ³ |
| Condensation Particle Counter (CPC) | TSI CPC 3772 | Particle size range min. detectable particle: 50% of 10 nm particles max. detectable particle: >3 µm particle concentration range: 0 to 10'000 #/cm ³ |
| Condensation Particle Counter (CPC) | TSI CPC 3788 | Particle size range min. detectable particle: 50% of 2.5 nm particles max. detectable particle: >3 µm particle concentration range: 0 to 10'000 #/cm ³ |
| Condensation Particle Counter (CPC) | TSI CPC 3790 | Conform to GRPE Particle Measurement Programme (PMP) particle size range min. detectable particle: 50% of 23-nm particles max. detectable particle: >3 µm particle concentration range: 0 to 10'000 #/cm ³ |
| Nanoparticle Emission Tester | TSI NPET 3795 | Built-in 10:1 dilution, and a catalytic stripper to remove volatile particles. max. concentrations : 5.0E6 #/cm ³ |

CPC Condensation Particle Counter
 SMPS Scanning Mobility Particle Sizer Spectrometers - consist of an Electrostatic Classifier with a Differential Mobility Analyzer (DMA) coupled with a Condensation Particle Counter (CPC).



5. Combustion Analysis

| | | |
|---------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------|
| Kislter KiBox | KiBox To Go / 2893A | Onboard combustion analysis – mobile cylinder pressure indication system for real-time data |
| Cylinder pressure sensors | | Various piezoelectric pressure sensors, spark plug with pressure sensors, glow plug adapter for cylinder pressure sensors. |
| Crank angle sensor | | |

6. Simulation and Hardware in the Loop (HiL)

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|---------------------------|---------------------|------------------------------------------------------|
| IPG Automotive Carmaker | Software | Real-time car simulation. |
| IPG Automotive Truckmaker | Software | Real-time truck simulation. |
| IPG Automotive Xpack4 | Hardware | Hardware platform implemented on engine dynamometer. |
| Typhoon HIL406 | Software + hardware | For use with components. |

7. Weighing Facilities

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|---------|------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Scale A | Mettler Toledo XP64001L | Maximum Capacity: 64100 g readability: 0.1 g application: weighing of DPF (soot load) |
| Scale B | Mettler Toledo Micro Balance XP2U with climatic chamber | max. capacity: 2.1 g readability: 0.0000001 g / 0.1 µg application: weighing of filters (PM emissions) |

8. Miscellaneous

| | | |
|-------------------------------|--------------------------------------------------|--------------------------------|
| PC Oscilloscopes | PicoScope 4425 with automotive diagnostic kit | |
| CAN-interfaces | Vector, CSS-electronics, PEAK | |
| GPS-Logger | Racelogic VBox-Micro | |
| Network analyzer, power meter | GMC Instruments PQ-Box 100 | Electric vehicles measurements |
| Power Meter | E-MobilBox | Electric vehicles measurements |
