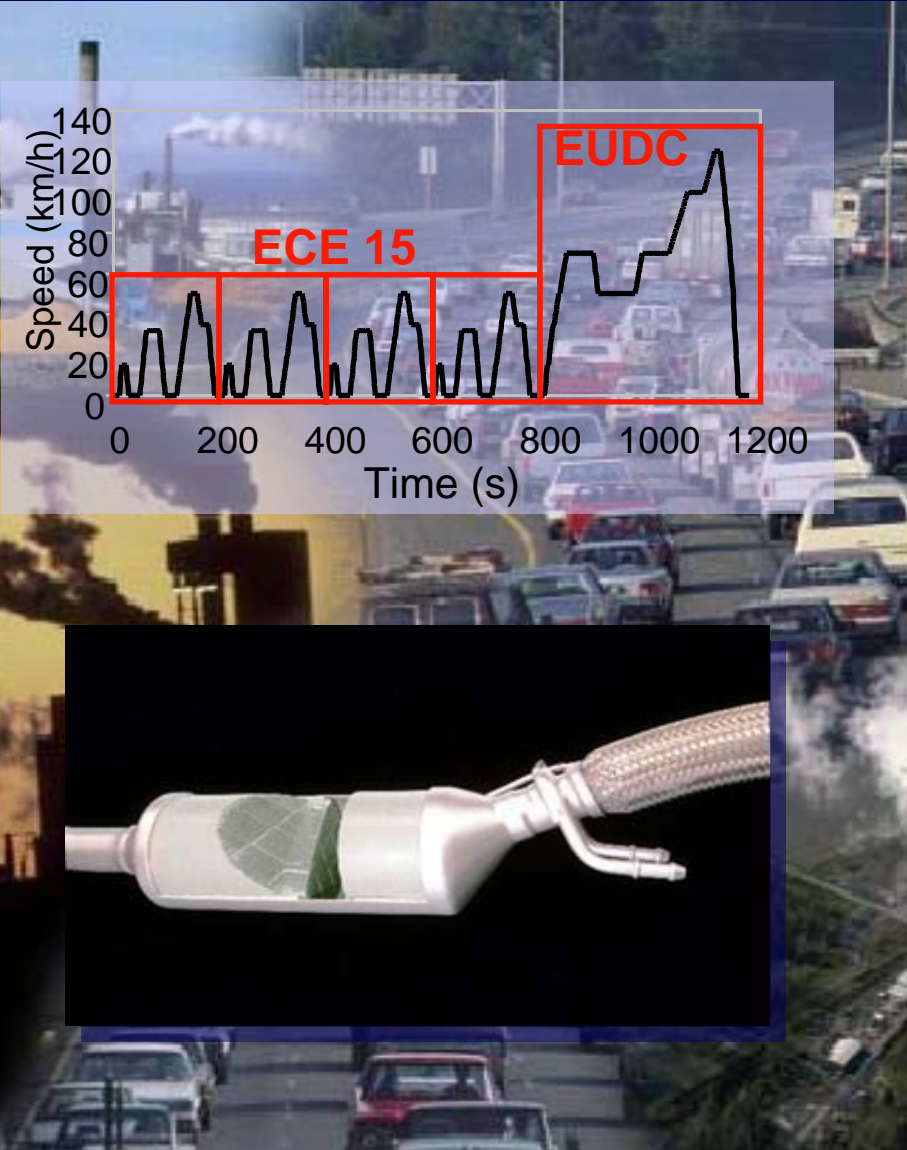




Highly sensitive soot measurement using photo acoustic technology as an answer to tighter legislative limits on particulates

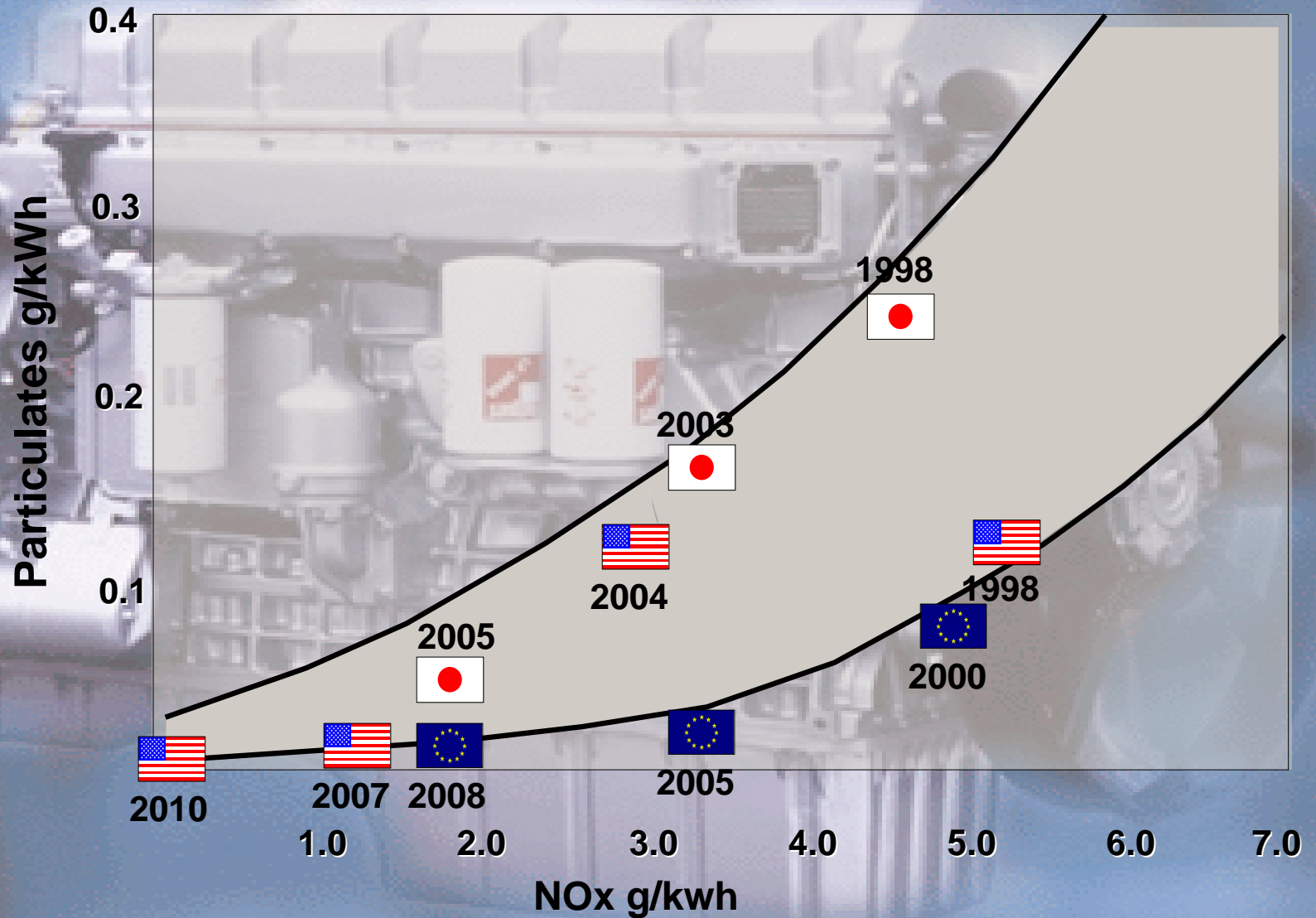
Manfred Linke



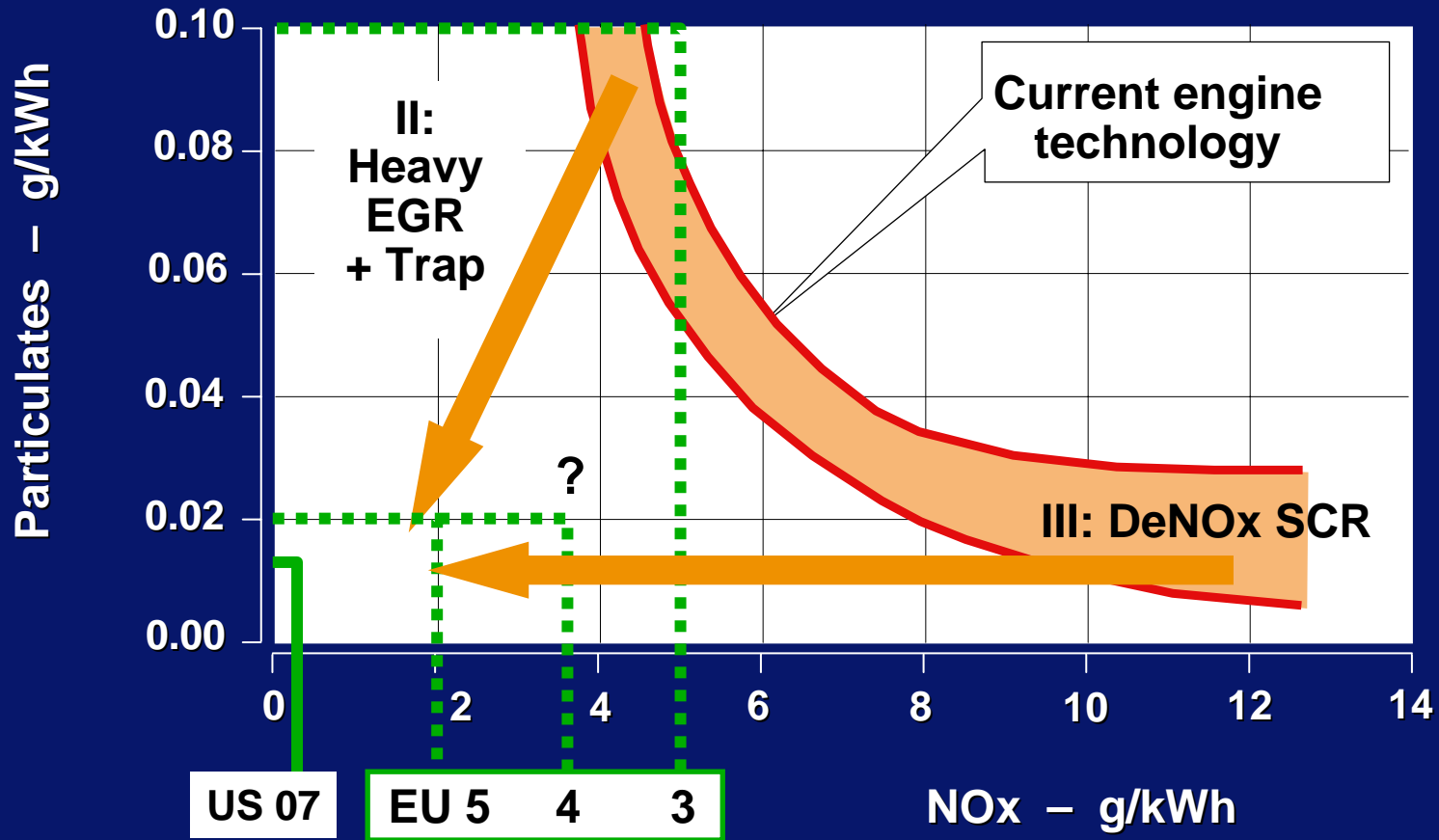


- Low sensitive soot measurement according to current and future legislation
- Emission measurement for exhaust after-treatment
- Measurement **upstream** and **downstream** of a DPF
- On-Board Measurement (PEMS)

Development of Heavy Duty Limits

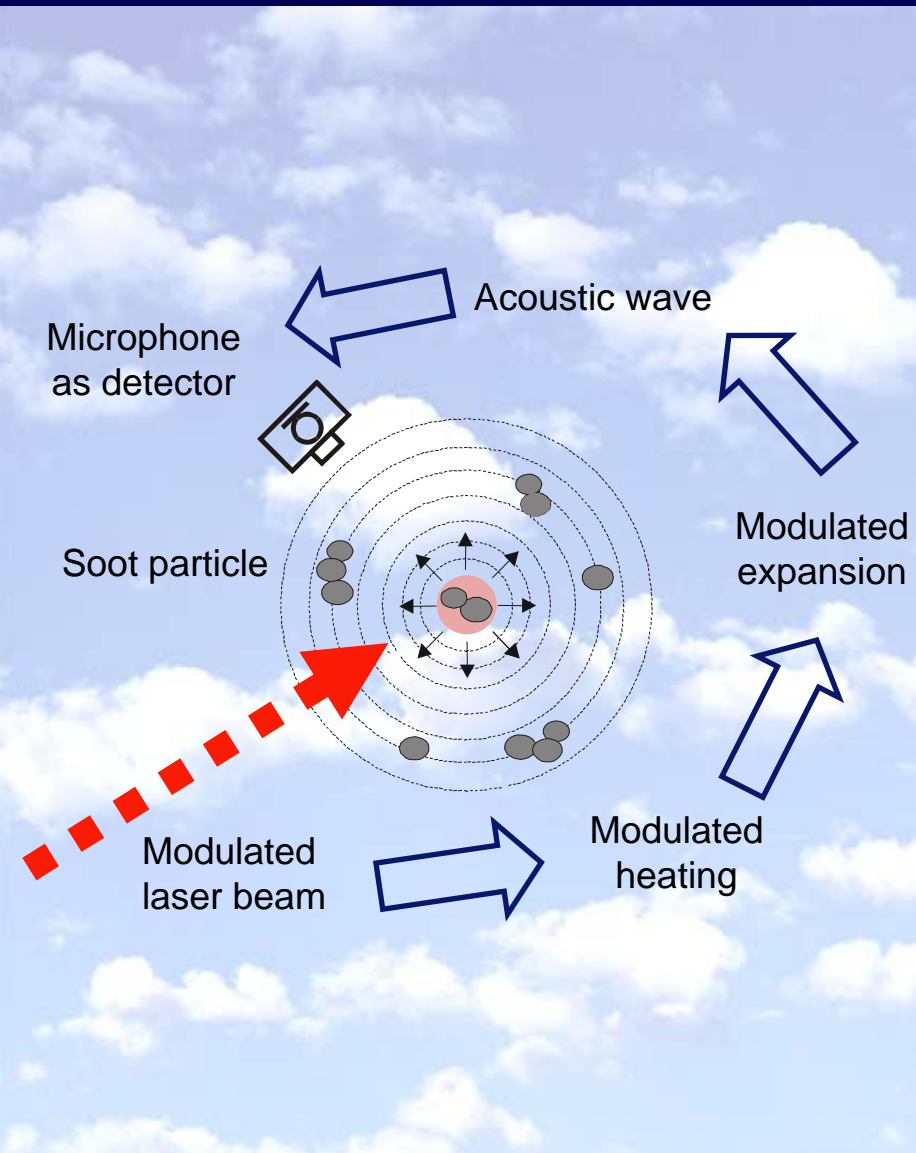


Emissions Reduction Scenarios

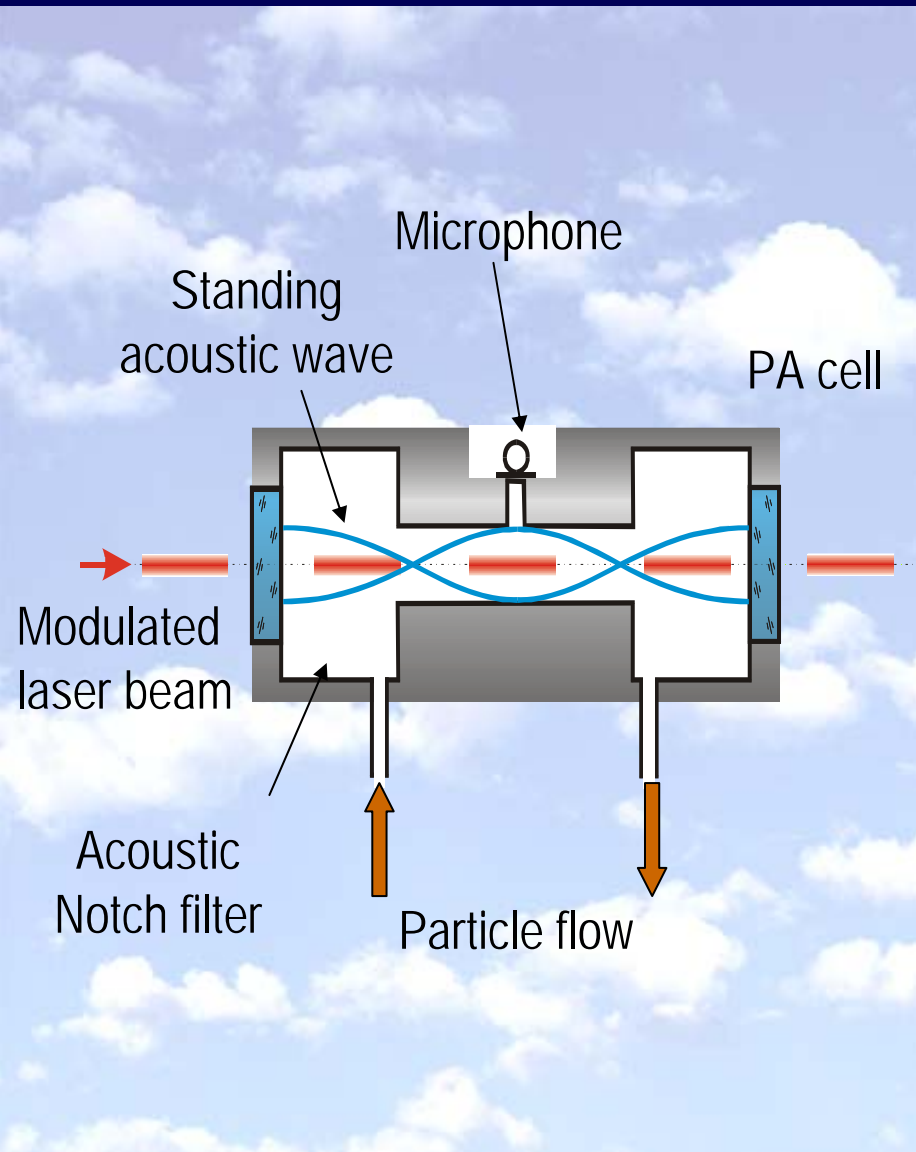




- Transient measurement of soot concentration
- With high sensitivity (detection limit typ. $\sim 5 \mu\text{g}/\text{m}^3$)
- Sensor signal is directly sensitive to soot concentration
- Different interfaces (RS232 with AK protocol, DIO, Ethernet,...)



- Diluted exhaust gas will be directed through a measuring chamber and thermally animated by a modulated laser beam
- Modulated heating produces periodic pressure pulsation, which will be detected by a microphone as acoustic wave
- Signal will be amplified in a pre-amplifier and filtered in a „Lock-In“- amplifier.



- Realisation as „resonant“ measuring cell
- Thereby a standing acoustic wave is generated

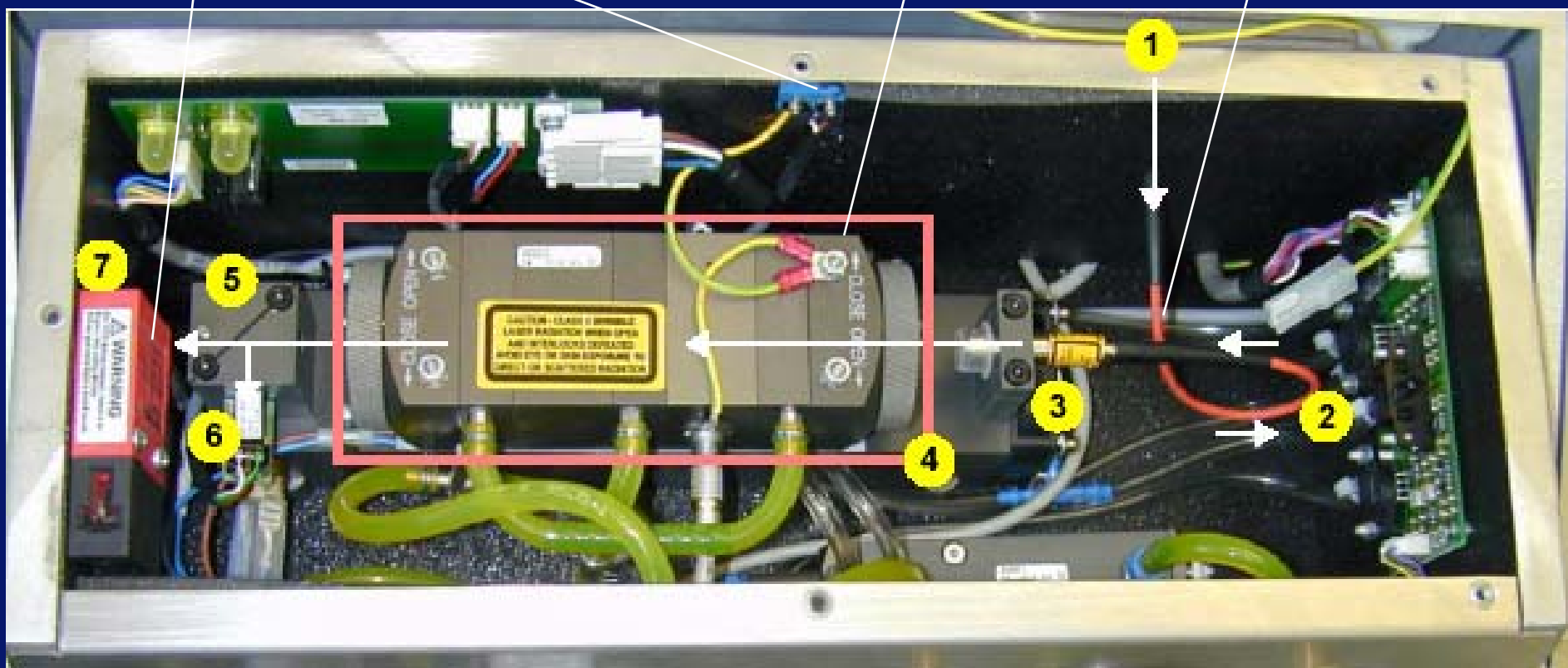
→ **Significant increase of sensitivity.**

AVL Micro Soot Sensor Inside

Safety switch

Measuring chamber

Fiber optic cable



Micro Soot Sensor with Conditioning Unit



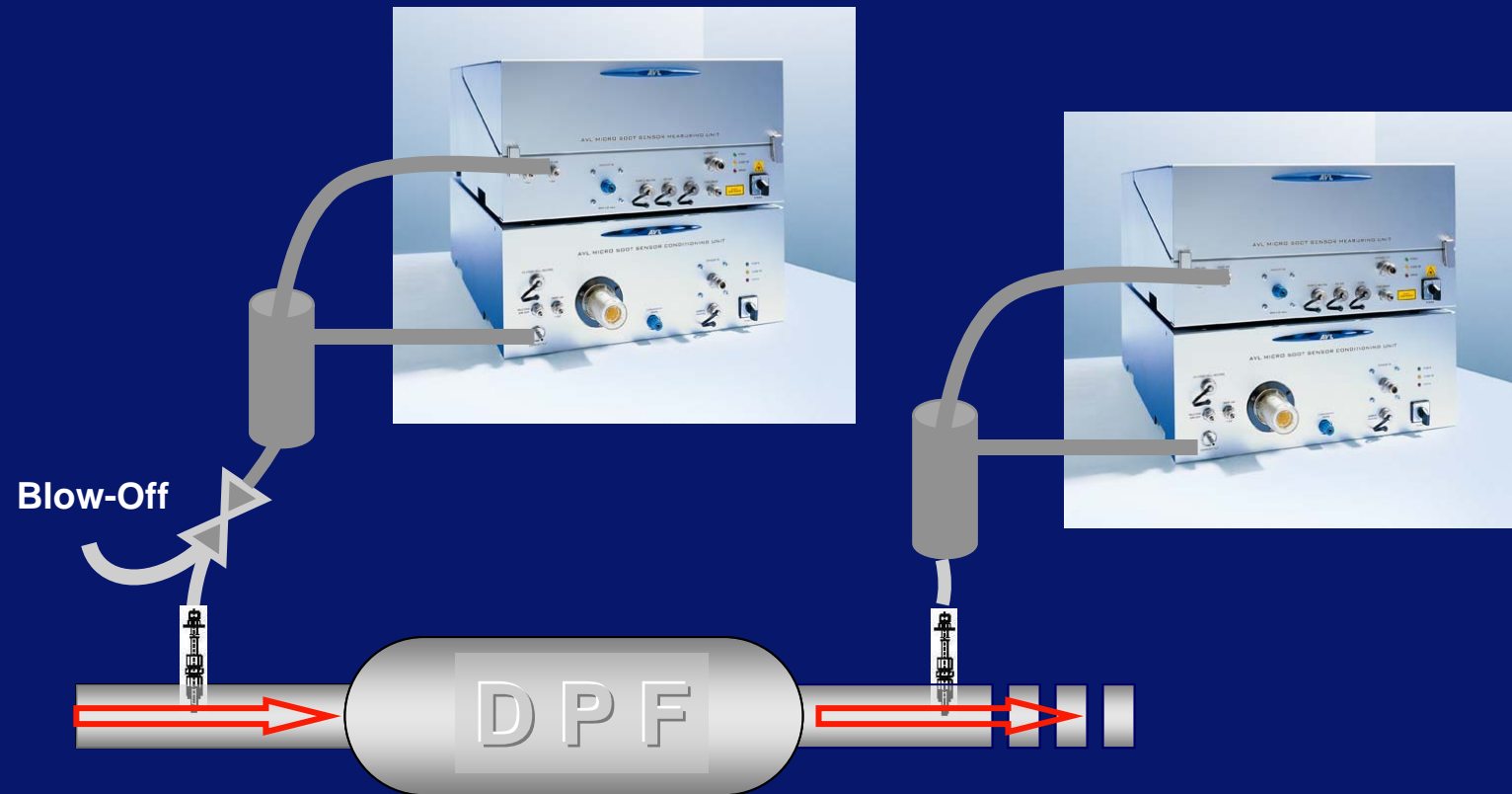
- Enables On-Board measurements
- Enables measurements upstream DPF
- Exhaust back pressures up to 2000 mbar
- Exhaust Temperatures up to 1000°C
- Conditioning Unit controlled by 483 SW via CAN bus



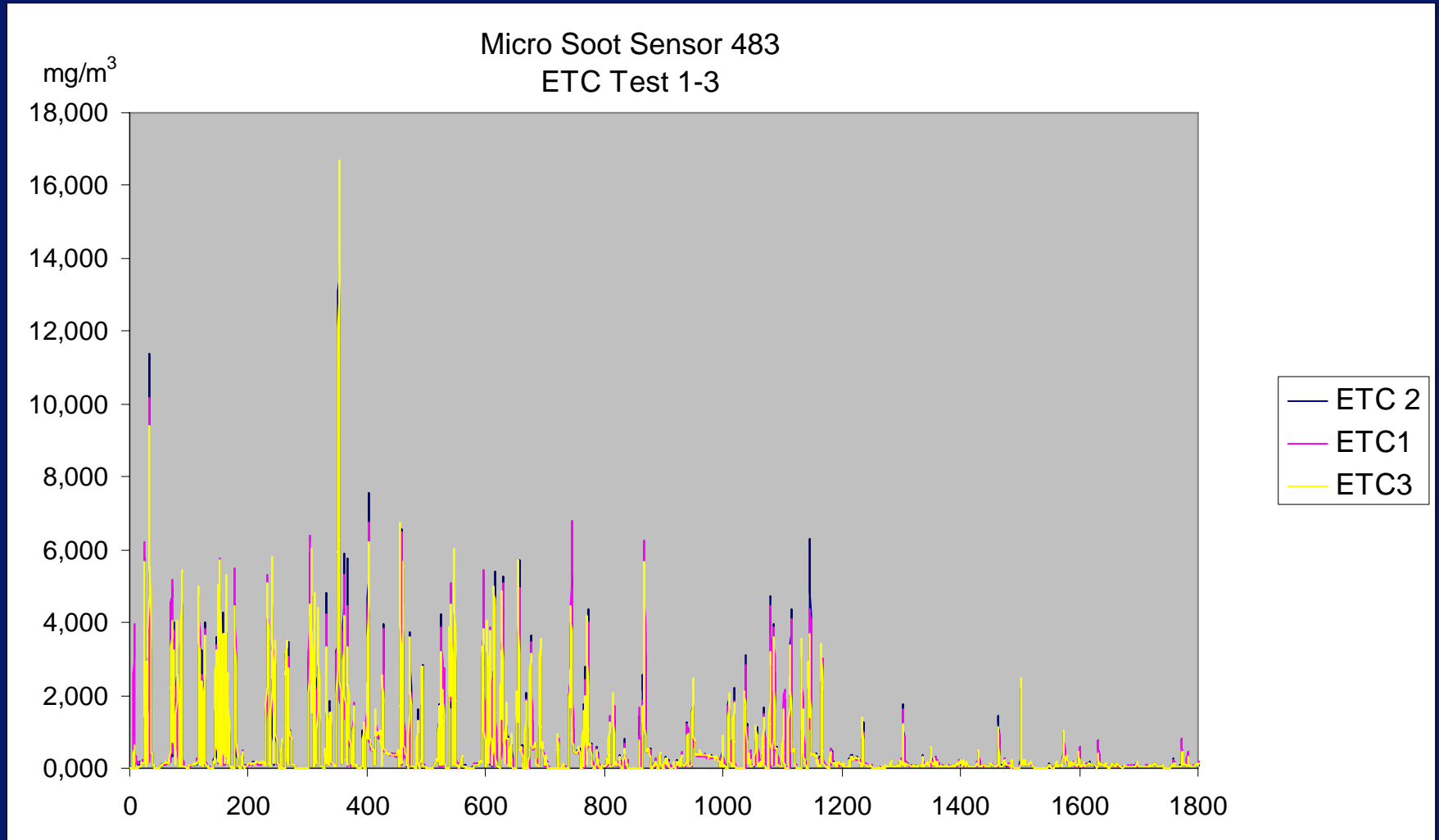
- For diesel and gasoline engines
- Diluted measurements at engine- and vehicle test beds
- Research & Development
- Production
- On-Board application
- In verification for future legislation

Application Exhaust Aftertreatment

- Efficiency of Diesel Particle Filter (DPF)
Measurement upstream and downstream DPF

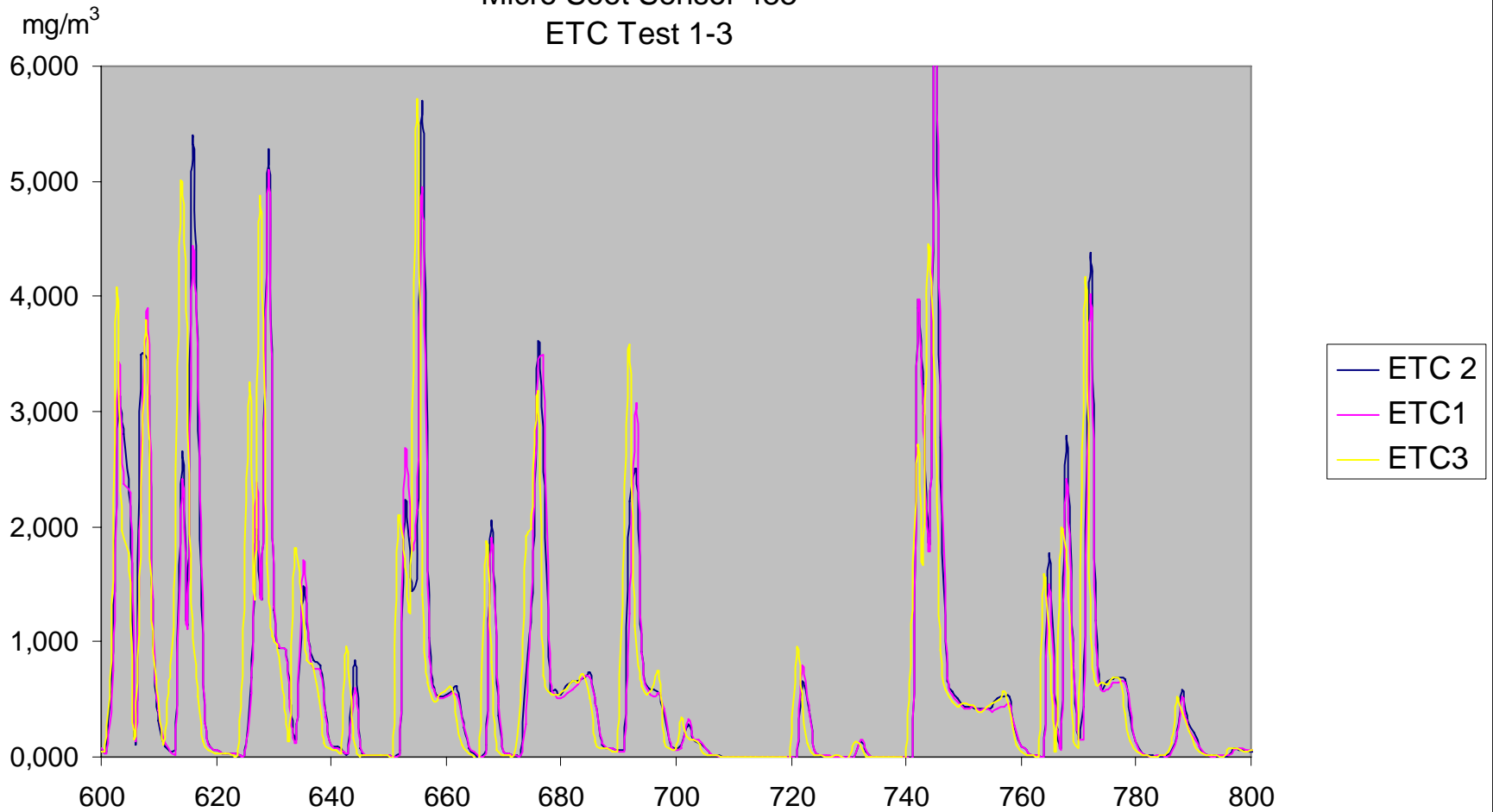


Test Results



Test Results

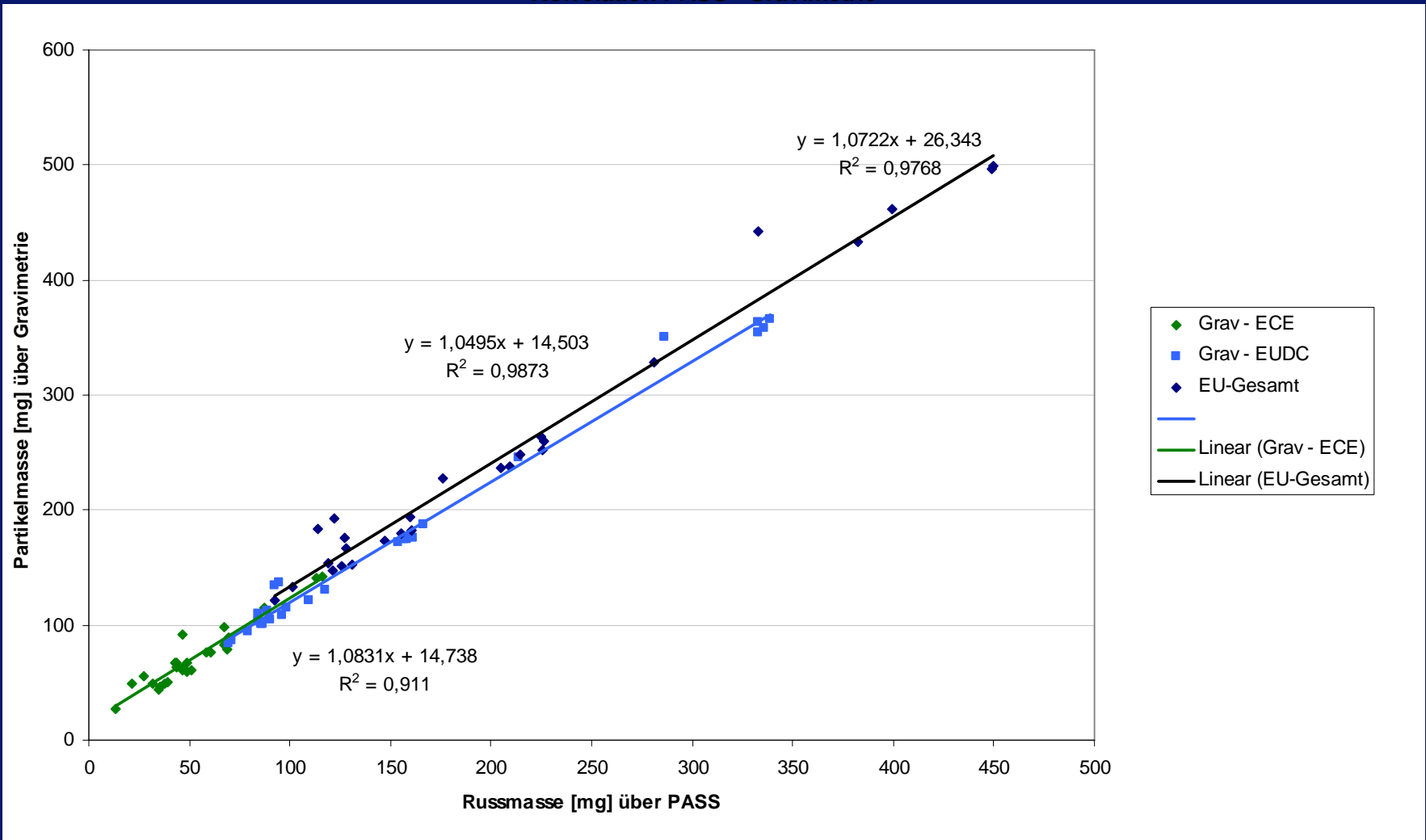
Micro Soot Sensor 483
ETC Test 1-3



Correlation AVL 483 vs. Gravimetry



Korrelation PASS - Gravimetrie





- **Transient measurement of soot concentration**
Data rate: 10Hz digital, 100Hz analog
Phys. Signal rise time: ≤ 1 s
- **High sensitivity and wide measuring range**
(5 $\mu\text{g}/\text{m}^3$ - 50 mg/m^3)
- **Measurement upstream and downstream DPF**
Back pressure up to 2000 mbar
Temperature up to 1000°C
- **In-Use Measurement**
Real-time On-Board Soot measurement



- High repeatability and reproducibility
- Easy calibration
 - Calibration with soot generator at checkout
 - Calibration Check with Absorber Window
 - Automatic internal calibration for sensitivity
- Low maintenance
 - Weekly cleaning of windows and filter change
 - Monthly cleaning of measuring chamber and pump
- Easy integration into test bed
 - e.g. AK-Protocol, TCP-IP, DIO..



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