EFFECTIVE PM MEASUREMENT FOR I/M PROGRAMS

The economic and social costs of PM emissions around the world have been well documented and cost/benefit analysis strongly supports action. PM is produced by both diesel and petrol engines and action needs to be taken to reduce both sources.

Emission regulators around the world have appropriately tightened certification standards for diesel engines, and some future regulations will also address spark-ignition vehicles. The challenge is to reliably identify and rectify the high PM emitting diesel and petrol engines, and use our public and private funds for PM-reduction technologies and devices in the most effective way possible.

Currently, PM is not measured in petrol I/M testing, and traditional opacity instruments are generally not capable of reliably identifying and measuring excessive PM emission levels from diesel engines certified to modern regulations. In many cases, modern engines with faults producing emission levels many times the certification limit have barely registered (if at all) on a traditional opacimeter.

The On Board Diagnosis in new vehicles introduces an electronic system capable of self-diagnosing exhaust emission deviations. However meaningful this feature, it is not able to amend the limit values, nor can it introduce an efficient tangible measuring method to test compliance with limit values.

Although proposals have been advanced to extend the capabilities of On Board Diagnostic (OBD) systems to include monitoring of PM emission levels, the technologies to do this have not yet been developed, and the European Commission does not expect them to be available on new vehicles for at least 4 or 5 years. It is therefore unlikely that even 50% of vehicles will have a PM OBD capability before 2025 and we will need to continue tailpipe testing for at least two or even three decades.

The test and the tester must be capable of producing reliable data that reflects on-road emissions performance, at an acceptably low total cost per test. The benefits of an I/M program is early detection of problems with engines and OEM installed or retrofitted emission control systems.
An example of a successful program is the report in October 2007 of several PM filters failing to perform in testing by the German UBA (EPA). The result of this testing was swift and effective, and the defective units or even entire product lines were replaced.

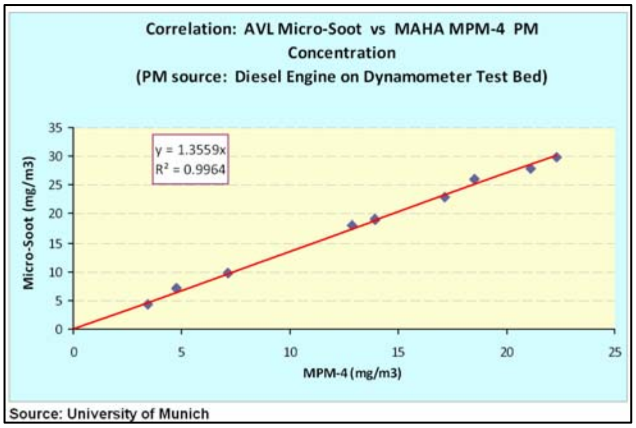
Several I/M tests already exist which are both simple and fast, with a long history of success. In regions where a testing program already exists and is using loaded dynamometer testing such as ASM, IM240 or truck “Lug Down” then these will continue to deliver good results, provided the instrumentation can measure the necessary range of PM concentrations.

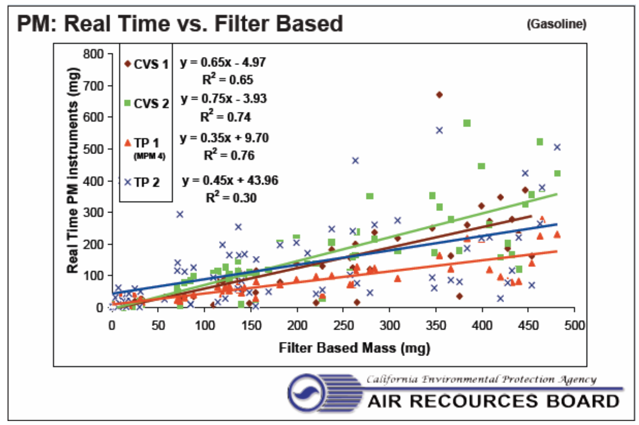
Two-speed (free acceleration or snap-idle) tests, while less discriminating than the loaded tests, can also do a good job provided the measuring range of the instrumentation matches the emission levels likely to be encountered.

Instruments are now available in the market which meet all of the necessary criteria to measure PM:

- sensitivity to distinguish between correct and incorrect functioning of engines equipped with a diesel particle filter or equivalent technologies;
- sufficient range to measure gross PM emissions from older technology engines;
- rugged and easy to use; and
- low cost.

Pilot projects are now in-progress in California, Australia and Germany to gain experience before the instruments are introduced for widespread use.

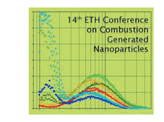




Short CV: Antonio Multari

Antonio Multari is the Director Project Management for Maschinenbau Haldenwang & Co. KG. (MAHA), in Haldenwang, Germany. Over the past 10 years, he has worked in several international emission programmes. Antonio has worked in several working groups, to realize emission projects. Currently he is working in the German project "Emission Check 2010", CITA Working Group Emission and in the Californian pilot program with CARB, SCAQMD and FCCC.

Effective PM Measurement for I/M Programs



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Presenters:
Antonio Multari, Elmar Tschinkel
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Peter Anyon, Antonio Multari, Elmar Tschinkel

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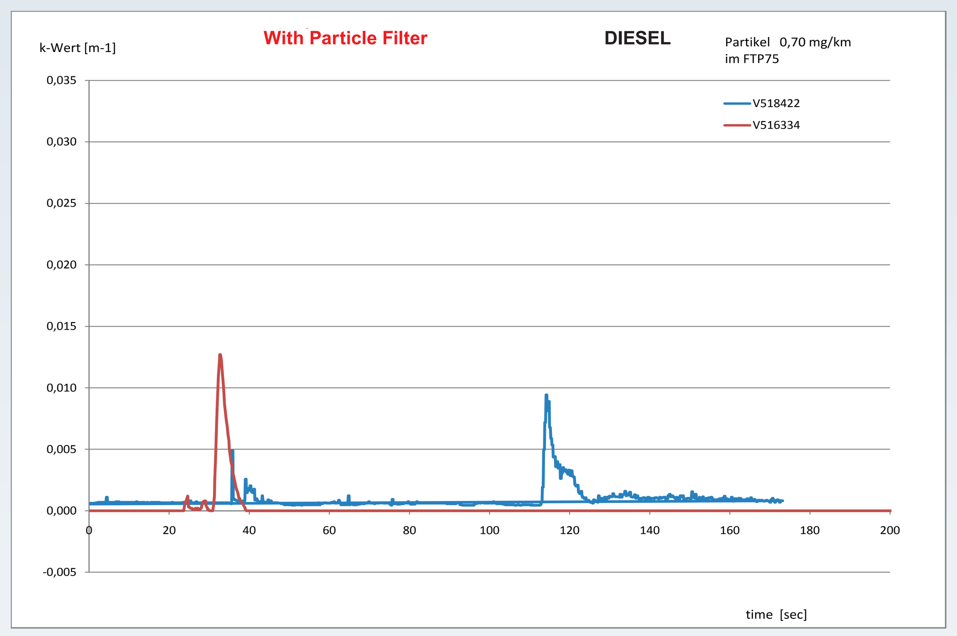
German Emission Project "Emission 2010"

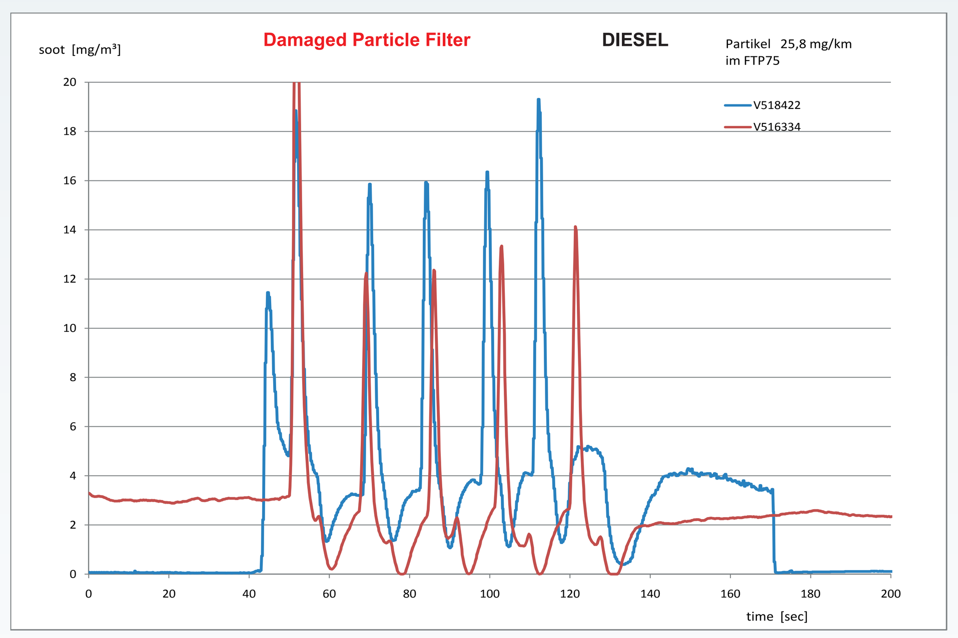
The project joint venture consisting of ASA, DEKRA, VdTÜV and ZDK has performed in two phases research into the further development of the vehicle emissions test with DIESEL engines.

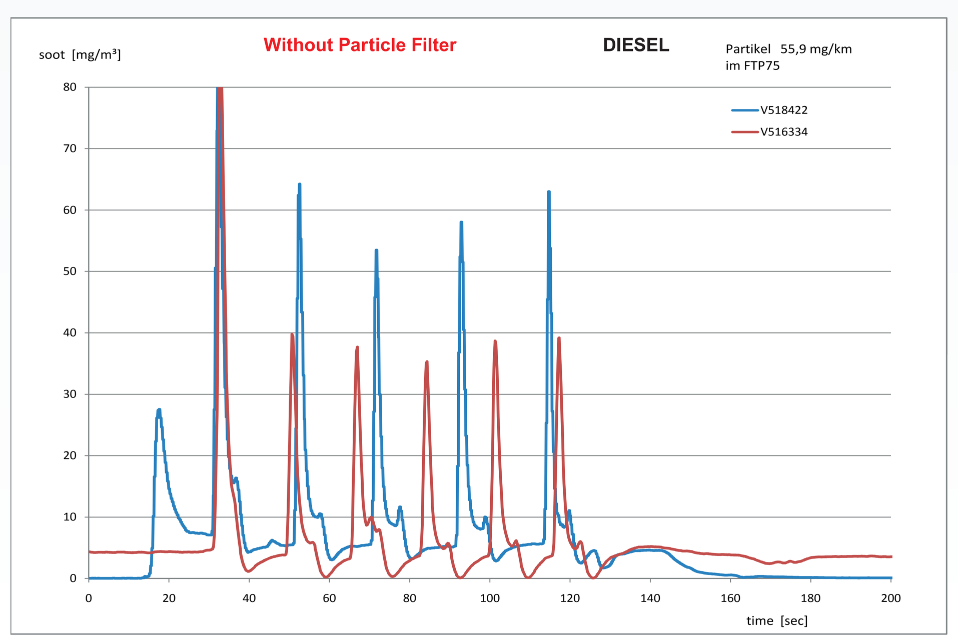
Based on the experience from the CITA study in which vehicles with PETROL engines were checked by way of fault simulations as to the informational value of the OBD, investigations on vehicles with DIESEL engines were run. As for the investigations on the vehicles with PETROL engines, here too in the case of vehicles with DIESEL engines not all faults were detected by the OBD systems.

In Phase 1, turbidity measurements were performed using different particle analysers. It was found that particle analysers are capable of measuring the turbidity emissions of vehicles with DIESEL engines.

In Phase 2 the investigations were continued with the most capable analyser found during project phase 1. In the investigations also the operational capability of the analyser was to be checked under practical vehicle emission testing conditions. In order to be able to arrive at a statement regarding the correlation with the present measurement method, approximately 3000 measurements were performed in the course of a field test involving the whole of Germany.



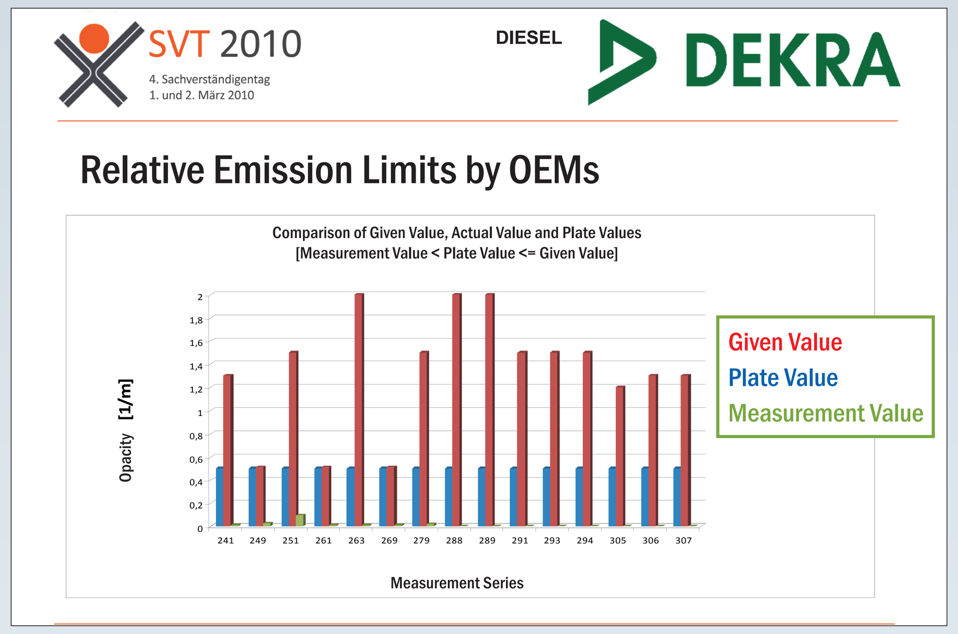


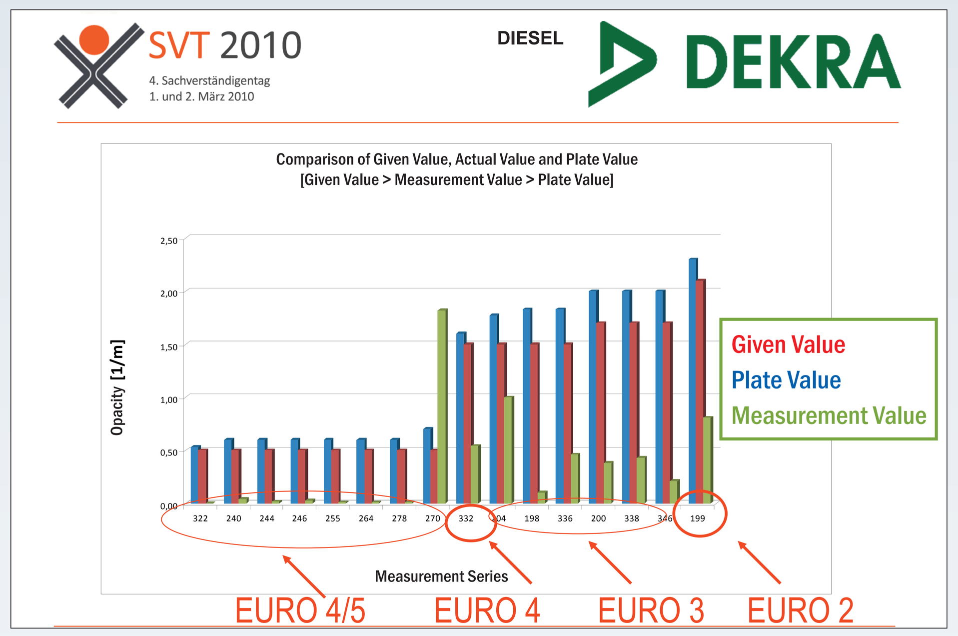


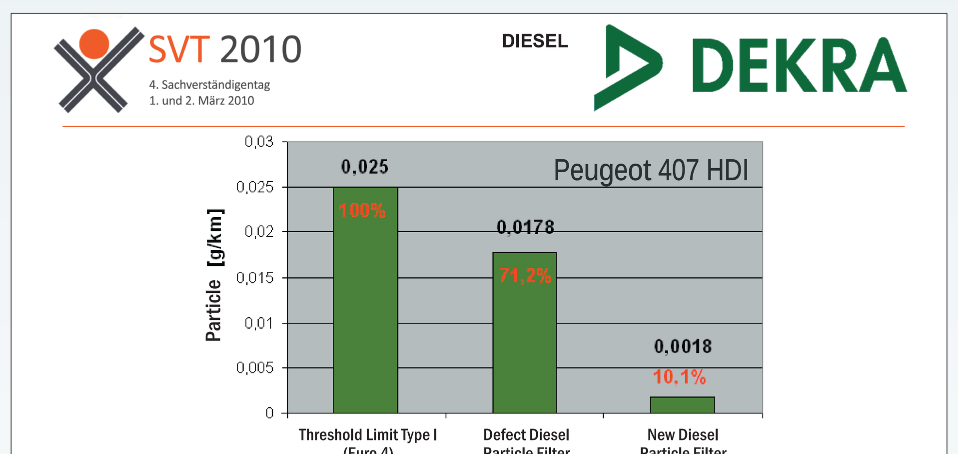
Field Tests "Emission 2010"

Based on the total of approximately 3000 individual measurements in which simultaneously the opacimeter as well as the new scattered light analyser were used, the following statements can be derived:

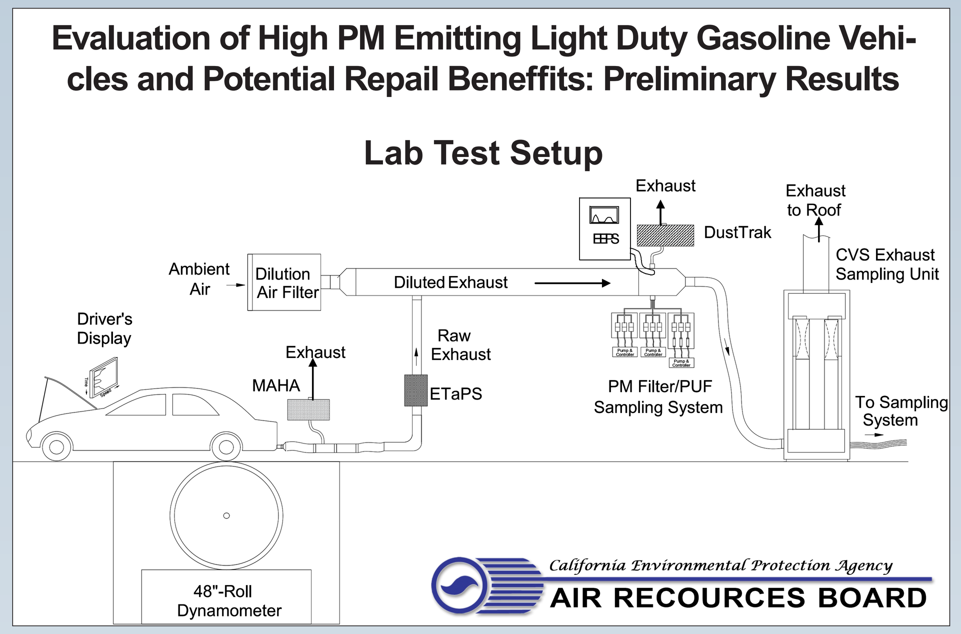
1. Suitability under practical conditions as the successor generation for opacimeters has been proven in the field; the vehicle emissions test could be performed under real-world conditions with this analyser.
2. The measurement data could be logged within the scope of existing operator guidance.
3. The field measurements were not targeted at assessing the maintenance, repair or calibration methods.
4. An analysis of the existing vehicle stock regarding the relative position of the P-value with respect to the vehicle emissions test nominal data as well as the actual values/measured values could be produced.
5. A significant potential for improvement is apparent when projecting, respectively estimating a reduction of the limit values to the level of the emissions test sticker value.

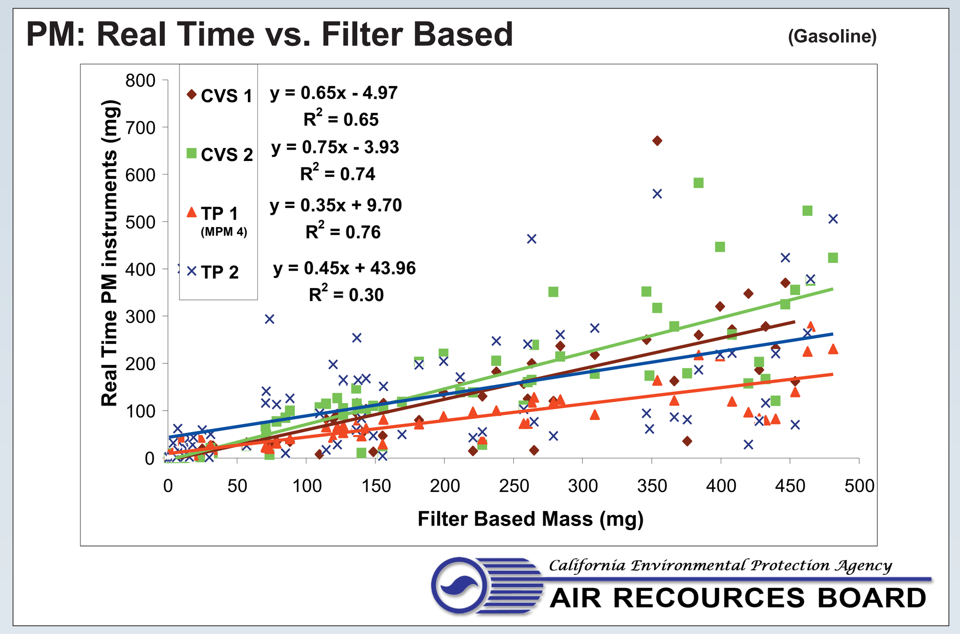


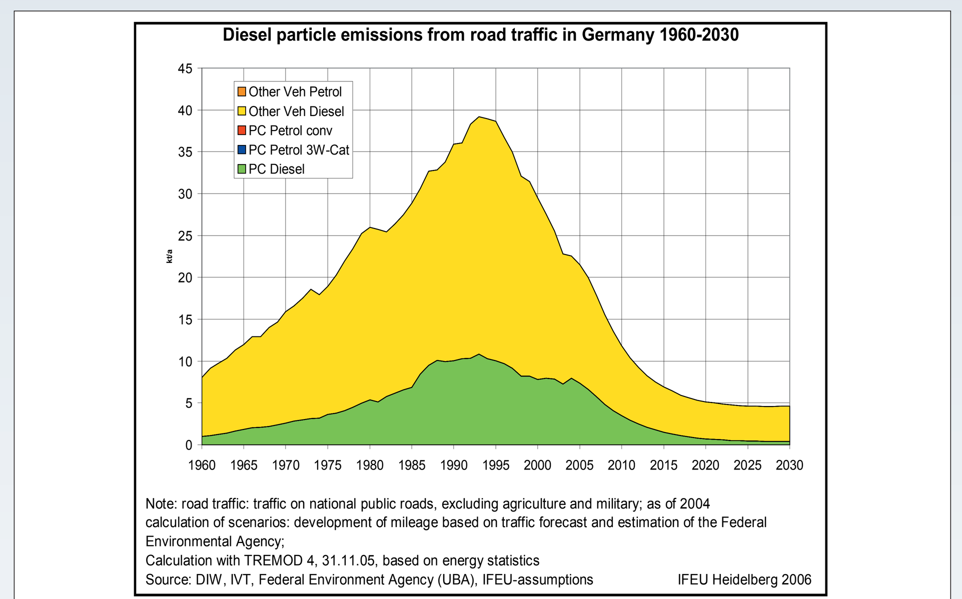




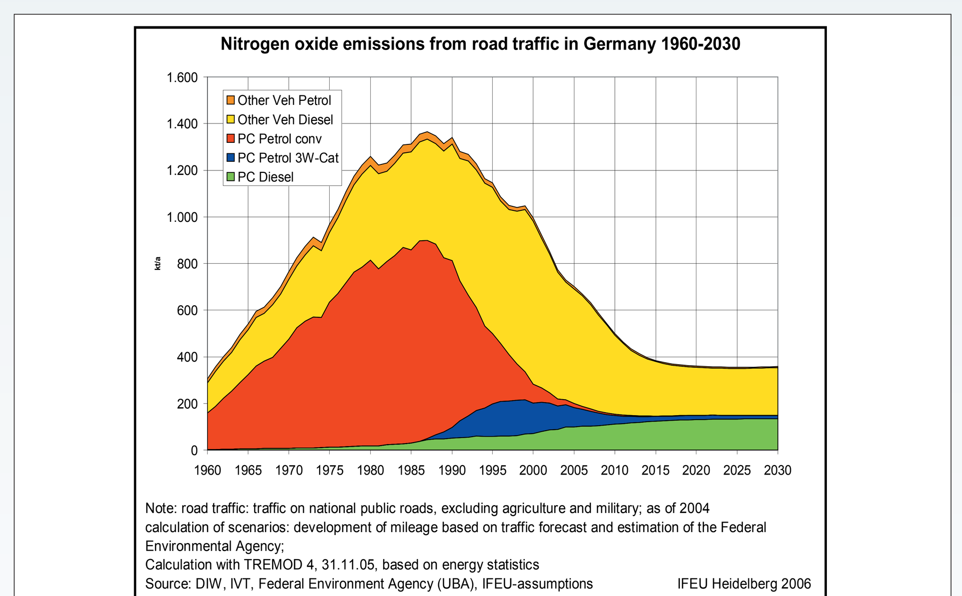
Diesel Particle Filter	Threshold Limit g/km	Measurement Value g/km	% of Threshold Limit	OBD-MIL	OBD-Readiness Codes	Result
Defect Diesel Particle Filter	0,025	0,0178	71,4	Off	OK	OK
Diesel Particle Filter Replaced	0,025	0,0018	7,2	Off	OK	OK







TREMOD = Transport Emission Model by University of Heidelberg (Germany)



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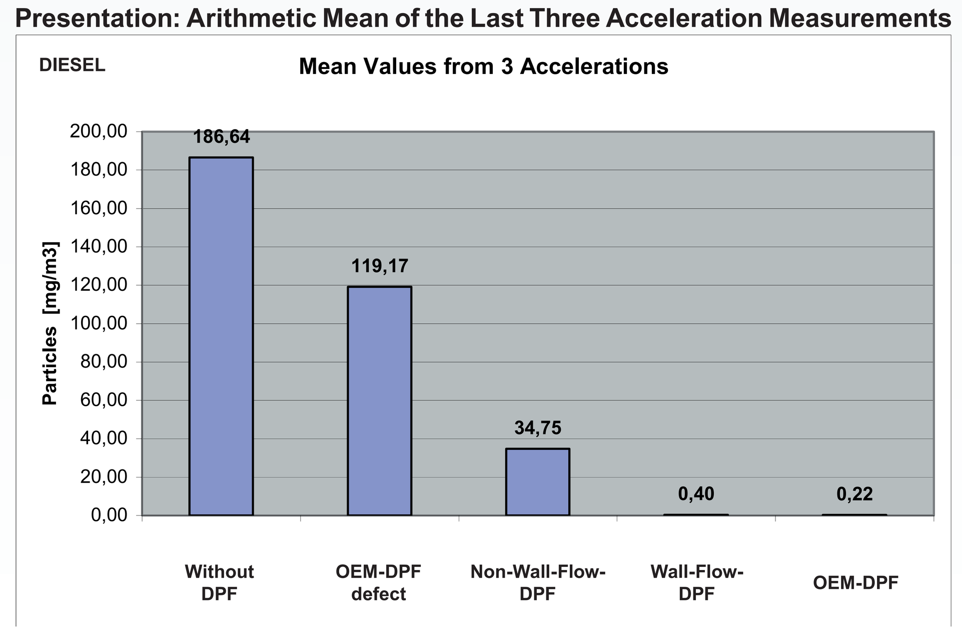
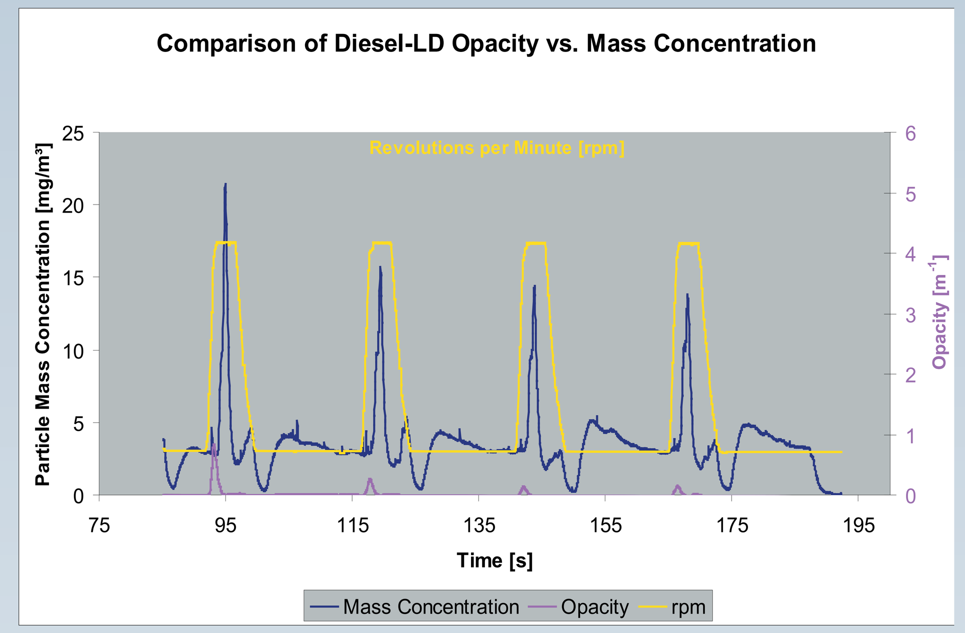
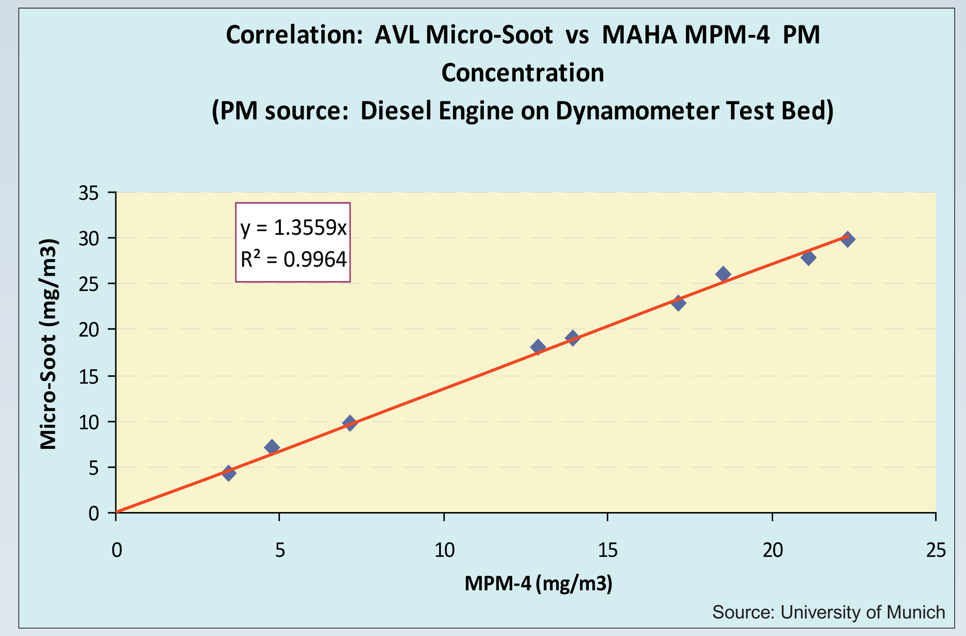
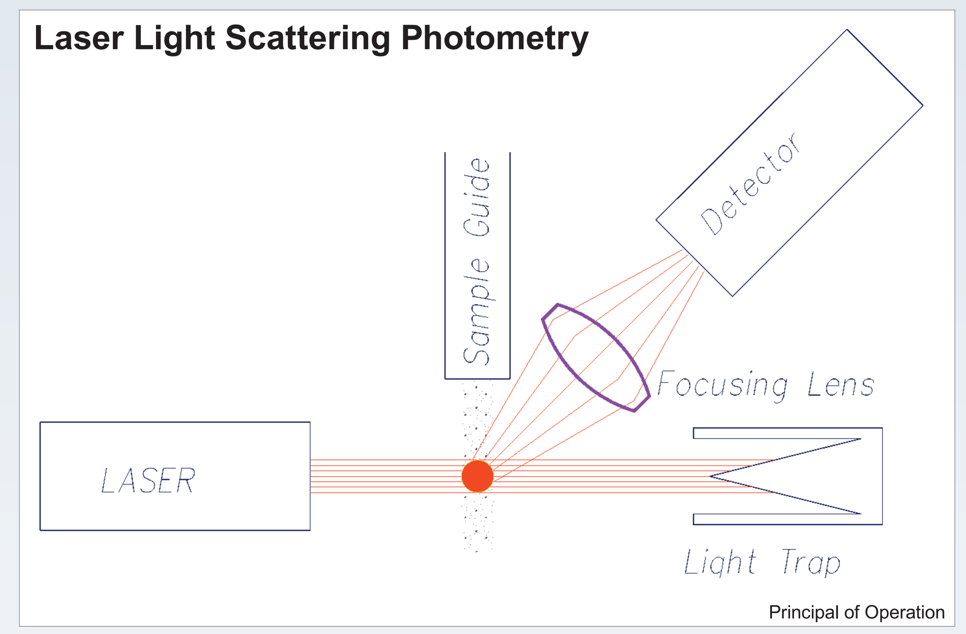
Presentation: Arithmetic Mean of the Last Three Acceleration Measurements



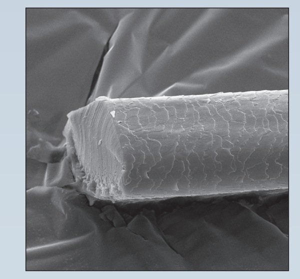




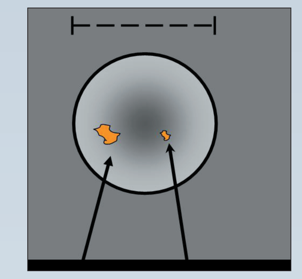


Diesel Particle

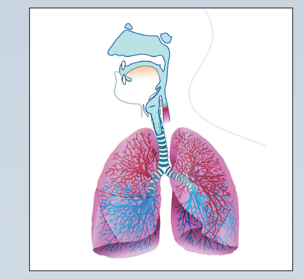
In order to understand the depth of danger that the smallest particles in diesel engine emission represent, we need to try to think in the tiniest dimensions. The most common measure of comparison is the human hair. It measures 70,000 nm in diameter. A typical diesel particle measures only 250 nm diameter. More than a million of these particles can be found in a volume of cm3 which corresponds with a normal concentration. When inhaling, particles in the range of 5,000 to 10,000 nm get into the nose and throat with smaller particles between 3,000 and 5,000 nm reaching into the air pipe. Even smaller particles with a diameter of 2,000 to 3,000 nm can advance forward into the bronchial tubes. Particles with a diameter of 1,000 to 2,000 nm can reach the bronchiole area. And the smallest diesel particles with a diameter of only 100 to 1,000 nm attack the pulmonary alveoli in the lungs. This then opens the path for particles to enter the bloodstream. It does not take all too much fantasy to imagine the damage that they can cause there. For this reason it is of paramount importance that vehicles with heavy particle emission be identified in the framework of the official emission inspection using state-of-the-art measurement technology. Our health also depends on this.



Human hair has a diameter of 70,000 nm.

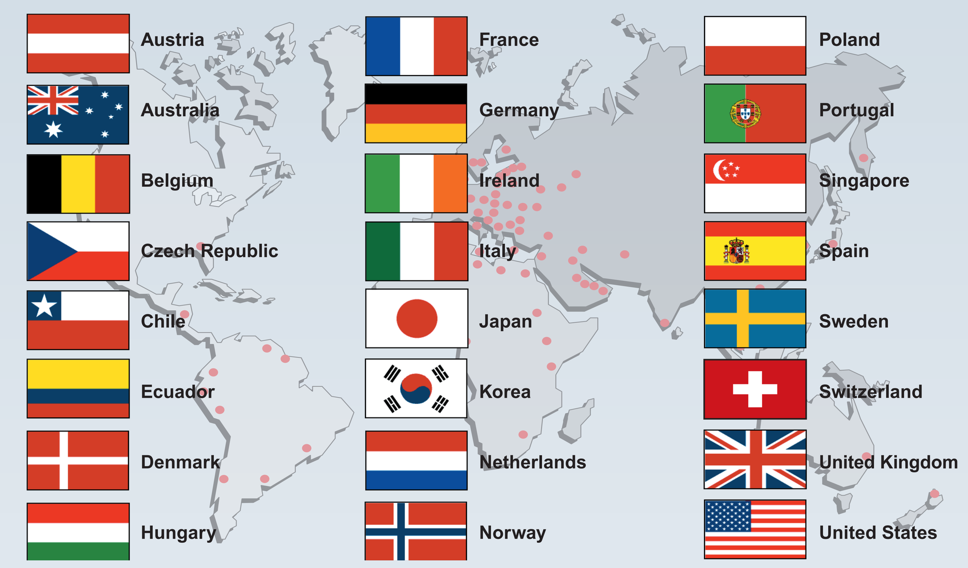


Typical diesel particles are much smaller than the diameter of a human hair.



Extremely fine diesel particles can enter the bloodstream through the lungs.

Some Pilot Programs Worldwide



MET 6.2

Technical Data

Weight	5 kg (11 lbs.)
Power Supply	10-30 V (DC) / 110-240 V (AC) / 50-60 Hz
Measurement Range	0.01 - 700.00 mg/m³
Measurement Method	Laser Light-Scattering Photometry (LLSP)
Precision of Measurement (Display)	0.01 mg/m³
Particle Size Range	70 nm - 10.000 nm
Two Analogue Outputs (continuous)	0 - 5 V
Interfaces	RS 232, LAN (optional: W-LAN, Bluetooth)
Measurement Range at the Analogue Output	0.00 - 40 mg/m³ (Low Range) 0.00 - 700.00 mg/m³ (High Range)
Pump	1.6 l / min