Brake Wear Emission Measurement Solutions

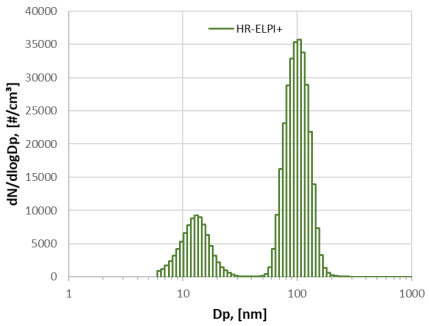
Particle emissions from brakes not only affect air quality and human health but can also have effect on operation and safety of the brakes themselves. Braking is a very dynamic and fast process with many contributing factors such as duration and force of the braking which both have effect on heat generation and therefore temperature of the brakes. All these factors influence the size and concentration of the emitted particles. Mechanical abrasion generates mostly micron-sized (typically > 1µm) particles but emissions typically also include nucleation particles from volatile matter, typically 10 - 200 nm. Since the particle emissions from the brake wear are formed through different mechanisms and contain particles of various sizes, an instrument with a very wide particle size range is needed to accurately characterize these emissions.

Dekati has over 25 year of experience in providing high quality instrumentation for fine particle measurements. Our brake emission measurement solutions include both particle detection and dilution systems, and today we have solutions for both for research and routine monitoring of brake emissions from 6 nm up to 10 µm.

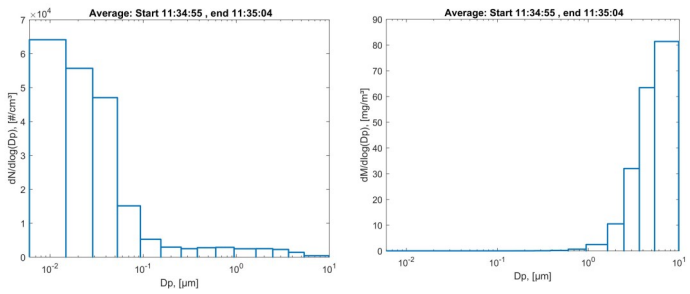
ELPI®+ and HR-ELPI®+
One measurement method and one instrument 6nm-10µm in real-time

- Particle concentration and size distribution measurement
- Size range 6 nm – 10 µm with one measurement method
- 14 - 500 size classes
- 10 Hz time resolution
- Particles are collected for further analysis
- Long term measurements with minimum downtime

Dekati® ELPI®+ (Electrical Low Pressure Impactor) and Dekati® High Resolution ELPI®+ are unique instruments ideal for brake wear emission measurements. Both instruments can measure particle size distribution between 6 nm and 10 µm in real-time covering the complete size range needed to characterize brake wear emissions. The ELPI®+ systems use one measurement method and one instrument throughout the complete size range eliminating the need for complicated calculation routines needed to combine data from several different instruments into one size distribution result. The ELPI®+ instruments additionally collect the particles in 14 size fractions during the real-time measurement; these collected particles can be analyzed after the real-time measurement with different chemical or physical analysis methods to gain further understanding on the composition and source of the particles in different size fractions.



Particle size distribution measured with the High Resolution ELPI®+ with 500 size fractions



Particle number size (left) and mass size (right) distribution of brake wear emission measurements using ELPI®+ with 14 size fractions.

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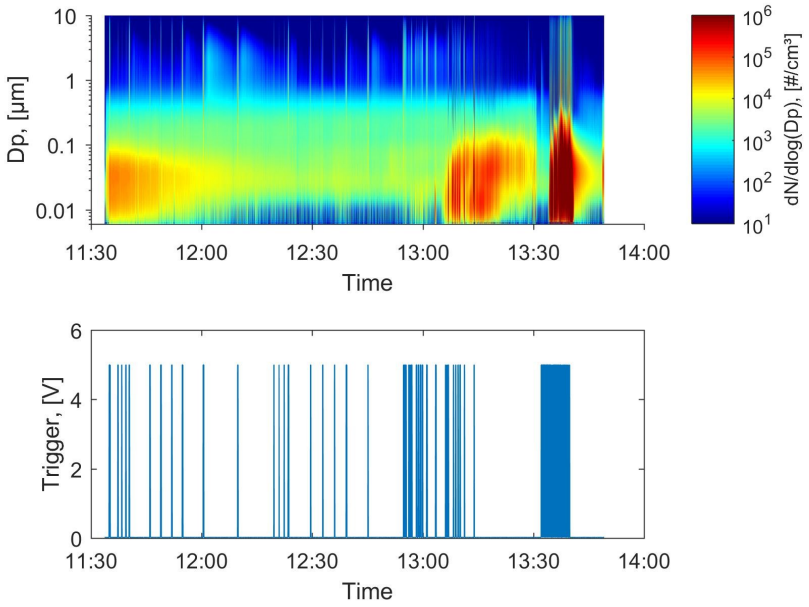
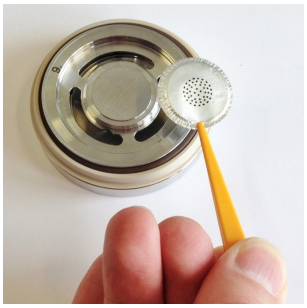
Real-time particle size and concentration measured with High Resolution ELPI®+ 6 nm—10 µm with one measurement method



Particle size and concentration measured with High Resolution ELPI®+ above and braking pattern

As illustrated in the figure left both large and small particles are generated during braking. However, when there are several braking episodes or high energy deceleration, temperature increases in the disc and pads and most of the formed particles are small nucleation particles (6 - 200 nm). Particles with different size can have different origin and particle composition analysis gives valuable information on the origin and formation mechanisms of the particles.



Particles in 14 size fractions can be analysed after the real-time measurement

Gravimetric PM size distribution with Dekati® Low Pressure Impactor (DLPI+)

- PM size distribution in 14 size fractions 16 nm - 10 µm
- Gravimetric or chemical analysis of size classified particles
- Sample flow rate 10 lpm
- Particle collection area Ø25 mm
- Integrated low pressure measurement and control, no additional flow control device needed
- Can be upgraded into an ELPI®+

Real-time LDSA and total PM mass with Dekati® eFilter™

- Combined gravimetric PM and real-time LDSA, PM and PN measurement
- Standard gravimetric filter holder with 47 mm filter for gravimetric PM
- Real-time measurement in a miniature diffusion charger - electrometer module
- Replaceable real-time detection module
- Battery operated with internal pump for the real-time measurement
- Fully automated operation with a touch screen user interface

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Brake Wear Emission Measurement Solutions

Dekati® Solutions for Sample Dilution and Conditioning

The wide particle size range of brake wear emissions can also be a challenge to sample conditioning systems. The sample dilution and conditioning system needs to be designed so that particle losses through diffusion, impaction, gravitation and electrostatic phenomena are minimized. Dekati provides several suitable dilution systems for brake wear emission measurements including customized solutions that fulfill specific requirements of different measurement locations. Combined with the particle measurement products, we're able to provide a complete and accurate measurement solution for brake-wear emission characterization.

Dekati® eDiluter™ & eDiluter™ Pro
For sample dilution with adjustable dilution temperature and dilution factor

The Dekati® eDiluter™ and eDiluter™ Pro are portable dilution systems that allow easy sample conditioning for brake emission measurements. The compact structure includes a two-stage dilution system with a dilution factor ranging from 1:25 to 1:225, the dilution factor is also adjustable in the Pro-version.

- Two-stage dilution system for particle measurement applications
- Adjustable dilution temperature up to 400 °C
- Adjustable dilution factor (Pro-version)
- High output sample flow, up to 80 lpm
- Stable dilution factor even in variable sample pressure conditions (Pro-version)
- Option for remote control and monitoring of dilution parameters
- Sophisticated dilution stage design, optimized for minimal particle losses
- Two additional, integrated temperature controllers for regulating the temperature of external heaters such as a heated sampling line

Dekati® eDiluter™ & eDiluter™ Pro

Dekati® Diluter

Dekati® Diluter is a robust and reliable choice for aerosol dilution. This diluter comes with a fixed dilution factor of 1:8 and it can be heated up to 400 °C.

- Robust and simple to operate
- No moving parts and all stainless-steel construction
- Fixed dilution factor ~1:8
- Suitable for sampling high temperature aerosols up to 450 °C
- High output sample flow – up to 45 lpm

Dekati® Diluter

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Brake Wear Emission Measurement Solutions

Complete Instrument Set for both Detailed Analysis and Routine Testing

Using the ELPI®+ in combination with the Dekati® Low Pressure Impactor (DLPI®+) and Dekati® eFilter™ allows measurement of various aspects of aerosols with the same particle measurement principles. This instrument set allows both detailed analysis of the characteristics of the particles as well as routine testing for quality assurance purposes. When combined with Dekati® Dilution systems, you can take the sample reliably from any sample conditions into the measurement instruments.

- Real-time particle number, LDSA, mass for different sized particles
- Real-time particle size distribution
- Total gravimetric mass
- Gravimetric particle size distribution
- Chemical/elemental analysis for size classified particles
- Single measurement principle both for advanced studies and routine testing
- Aerodynamic diameter measurement
- Field condition instruments provided with up to 5 year warranty
- Open data processing

Dekati® ELPI®+

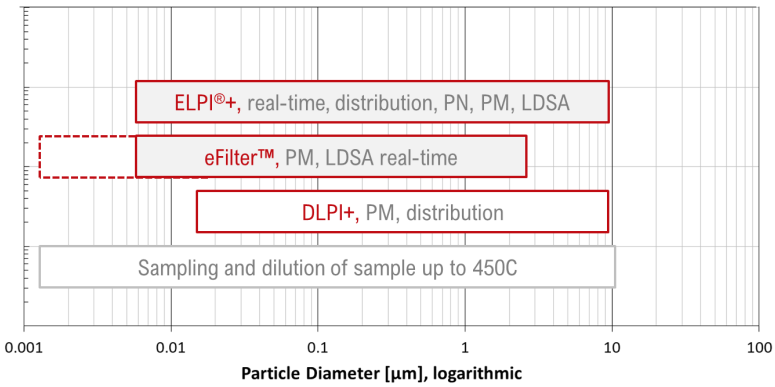
- Real-time number/LDSA/mass
- Particle concentration and size distribution measurement
- Chemical/elemental analysis

Dekati® eFilter™

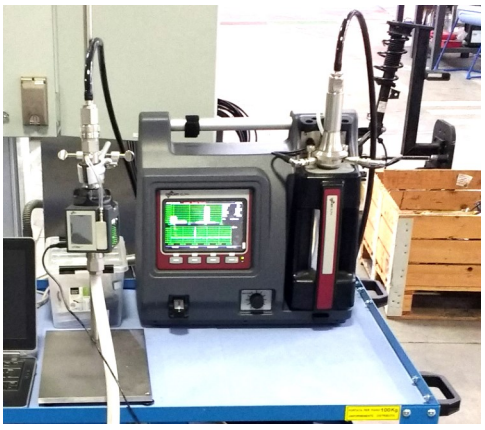
- Real-time LDSA
- Total gravimetric PM

DLPI+

- PM10, PM2.5 and PM1.0
- Detailed gravimetric mass size distribution
- Chemical/elemental analysis



Particle size measurement range of Dekati® Products



ELPI®+ and eFilter™ Setup

Contact us for details and we can recommend the best solution for your measurements!

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