



Excellence in Particle Measurements



Dekati® **High-Resolution ELPI®+**

Real-time particle size distribution

Wide particle size range with
a single measurement method

High size resolution

Particle number, mass and LDSA concentration

Direct high-temperature aerosol measurements



Dekati®

High Resolution ELPI®+

Description

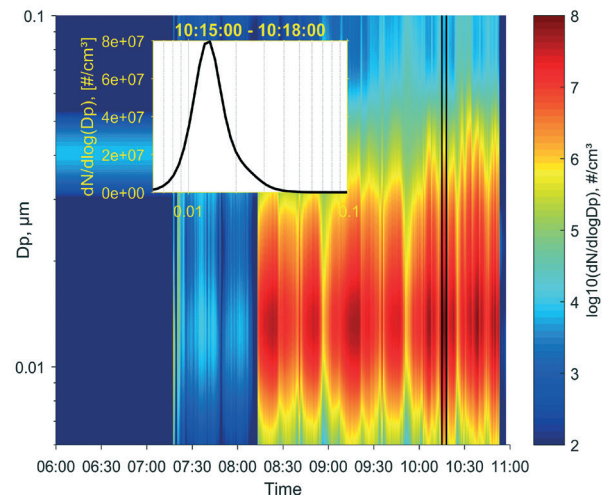
The Dekati® High Resolution ELPI®+ (Electrical Low Pressure Impactor, HR-ELPI®+) is an improved version of the widely used ELPI®+ instrument. The High Resolution ELPI®+ utilizes a data inversion algorithm that gives real-time particle size distribution in up to 500 size classes 6 nm – 10 µm. Other High Resolution ELPI®+ features include wide particle sample concentration range, robust structure and possibility to characterize chemical composition of size classified particles after the real-time measurement. The latest addition to the HR-ELPI®+ features is a new Data Analysis Tool software that makes data analysis and visualization fast and easy for the instrument operator. This new tool comes with particle number, LDSA and mass concentration (6nm-2.5 µm) calculations for the HR-ELPI®+.



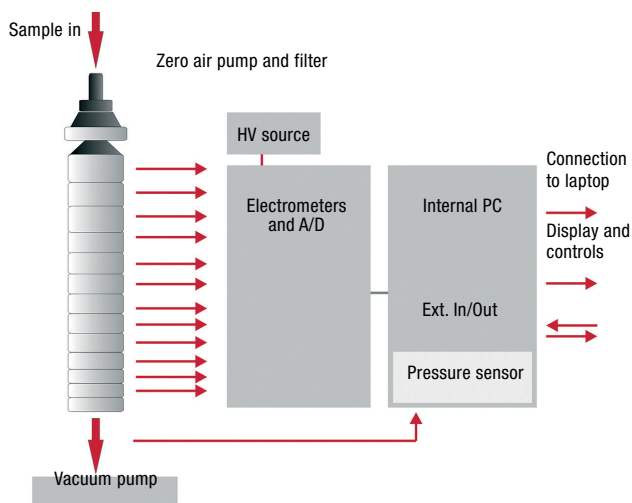
Operating principle

First, the particles pass through a unipolar corona charger where they are charged up to a known positive charge level. Second, the particles are size classified in a cascade impactor into 14 size classes depending on their aerodynamic size. The classification of particles is based on the inertia of the particles, with larger particles getting collected on the upper impactor stages and smaller particles getting collected on the lower stages.

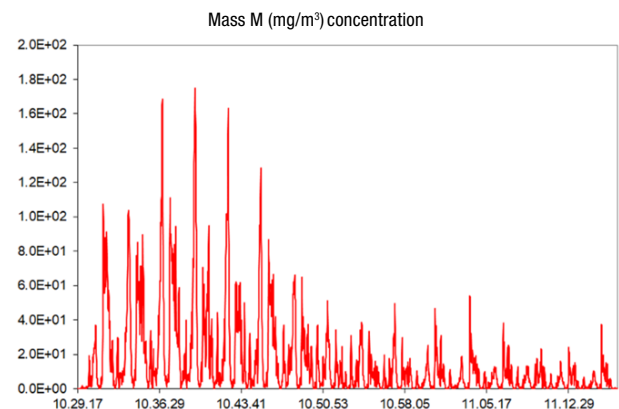
All the impactor stages are electrically insulated, and each impactor stage is connected to an electrometer. The primary particle collection efficiencies have been determined for each impactor stage allowing determination of impactor Kernel functions. The data inversion calculation method used in the HR-ELPI®+ is based on these Kernel functions and iterative calculation routines, resulting in an accurate and reliable determination of particle size distribution with high size resolution. The inversion calculation runs in real-time and does not use any initial assumptions on the size distribution.



3D printer emissions measured with the HR-ELPI®+



Operating principle of the High Resolution ELPI®+



On-board real time tyre wear mass concentration

Accessories



The High-Temperature ELPI®+ allows direct measurements from up to 180 °C samples

- Dekati® Dilution Systems for measurement from high temperature/pressure sources
- Spare impactor and charger units
- Sample inlets and dryer setups for air quality measurements
- Aluminium and polycarbonate impactor collection foils, 25 mm
- Collection substrate spray (DS-515) with a stencil (DS-125)

Dekati® High Temperature HR-ELPI®+

The High Temperature HR-ELPI®+ is a unique instrument capable of measuring high temperature and humid aerosols without dilution. This allows measurements without the risk of sample transformations even when sample particle concentrations are very low.

Dekati® Oxidation Flow Reactor DOFR™

Dekati® Oxidation Flow Reactor, DOFR™, is a unique, all-in-one solution for secondary aerosol (SA) formation studies, combining a sample conditioning unit and an oxidation flow reactor. The formation and aging of secondary aerosols can take several days in the atmosphere and the purpose of the oxidation flow reactor is to speed up these processes. In the Dekati® DOFR™, UVC radiation together with water molecules and ozone in the sample create highly oxidative conditions inside the reactor to achieve days of atmospheric aging in less than a minute.



The Dekati® Oxidation Flow Reactor DOFR™ and its conditioning unit, connected to the HR-ELPI®



Dekati® eDiluter™ Pro

The Dekati® eDiluter™ Pro is a portable dilution system that allows easy sample conditioning for a wide range of particle measurement applications. Its compact structure includes a two-stage dilution system with an adjustable total dilution factor ranging from 1:25 to 1:900. Diluted sample can also be extracted directly after the first dilution stage.



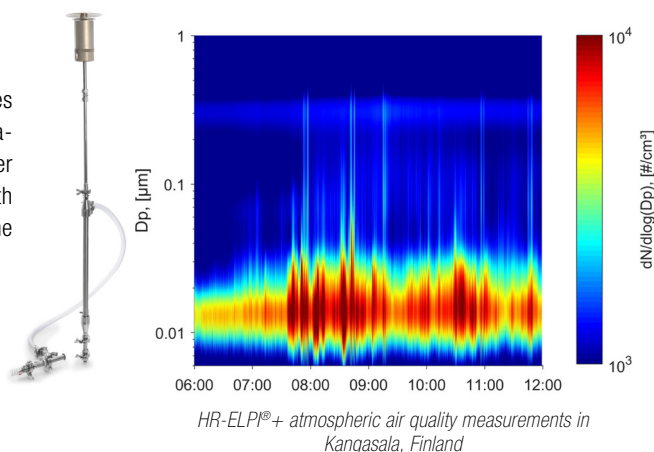
Impactor analysis plates

Analysis plates allow collection of samples onto 25mm collection substrates such as aluminium foils or polycarbonate foils. Collected samples can be analyzed gravimetrically, chemically or through microscopy methods including SEM/TEM.



Dekati® DD-603

Dekati® Dryer is a particle dryer designed to remove water in real-time from an aerosol sample. Since most ambient air particles are hygroscopic, they grow as the ambient humidity increases. Traditionally this water has been removed from the particle sample after gravimetric collection by equilibration or heating of the sample. Both methods may also result in loss of other volatile components from the sample, whereas the Dekati® Dryer only removes the water.



Notes



Stage [μm]	D50% [μm]	Dp [μm]	Size range of Collected Particles [μm]	Number Concentration Min [#/cm ³]	Number Concentration Max [#/cm ³]	Mass Concentration Min [μg/m ³]	Mass Concentration Max [mg/m ³]
15	9,88		> 10				
14	5,4	7,3	5,3 < 10	0,05	2,4E+04	10	4,9E+03
13	3,7	4,4	3,6 < 5,3	0,11	4,1E+04	4,8	1,8E+03
12	2,5	3,0	2,5 < 3,6	0,20	7,3E+04	2,8	1,0E+03
11	1,6	2,0	1,6 < 2,5	0,34	1,4E+05	1,5	5,7E+02
10	0,91	1,22	0,94 < 1,6	0,65	2,9E+05	0,6	2,7E+02
9	0,59	0,73	0,6 < 0,94	1,4	5,6E+05	0,3	1,2E+02
8	0,32	0,43	0,38 < 0,60	3,2	1,1E+06	0,13	4,5E+01
7	0,17	0,23	0,25 < 0,38	10	2,3E+06	0,07	1,5E+01
6	0,099	0,130	0,15 < 0,25	30	4,7E+06	0,035	5,3E+00
5	0,051	0,071	0,094 < 0,15	81	9,7E+06	0,015	1,9E+00
4	0,034	0,042	0,054 < 0,094	203	1,9E+07	0,0077	7,1E-01
3	0,019	0,025	0,030 < 0,054	371	3,5E+07	0,0031	2,9E-01
2	0,014	0,016	0,016 < 0,030	791	6,1E+07	0,0017	1,3E-01
1	0,006	0,009	0,006 < 0,016	1693	1,2E+08	0,0006	4,7E-02

Main characteristics of the HR-ELPI®+ impactor stages. Each HR-ELPI®+ unit is individually calibrated before delivery; the calibration includes detailed determination of the exact sample flow rate and D50% values. The values presented in this table are nominal values.

Measurement Applications

The robust structure of the HR-ELPI®+, and its ability to measure in real-time over a wide size range, make the HR-ELPI®+ the ideal choice for various measurement applications. In combination with Dekati® Sample Conditioning Instruments, Dekati can provide complete HR-ELPI®+ measurement solutions for a very broad range of applications and even demanding measurement conditions. Typical applications for the HR-ELPI®+ include:

- Brake and tyre wear measurements
- Nanoparticle measurements
- Nuclear safety research
- Outdoor and indoor air quality measurements
- Occupational health studies
- Inhalation toxicology
- Engine exhaust measurements
- Blow-by gas measurements
- Combustion process studies and emission measurements (incl. carbon capture research)
- Filtration efficiency measurements
- ENDS measurements

Features and benefits

- Wide particle size range 6 nm - 10 μm with one instrument
- Up to 6 months continuous use without maintenance
- Real-time (10 Hz) particle size distribution in up to 500 size classes
- Particle number, LDSA and mass concentration calculation
- Long-term, maintenance free operation
- Wide operational concentration range
- Sampling from up to 180 °C with the High Temperature ELPI®+ upgrade
- ELPI®+ Data Analysis Tool software for easy data processing and visualization
- Simple and robust construction
- Insensitivity to variations in sample pressure and humidity
- Possibility of post-measurement chemical characterization of size classified impactor samples
- Each unit individually characterized
- Integrated flow control and pressure adjustment
- ISO16000-34 compliant measurement method for real-time determination of PM indoors

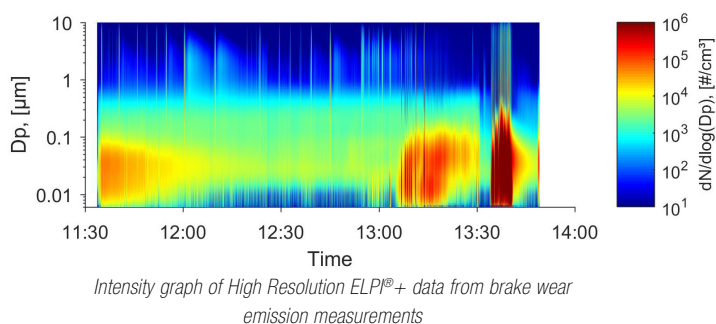


Specifications

Particle size range	0.006 - 10 µm
Number of size classes	100 or 500 (30 or 150 per decade)
Sample flow rate	10 lpm
Sensitivity	250 #/cm ³ for 10 nm particles 20 #/cm ³ for 100 nm particles 1.0 #/cm ³ for 1 µm particles 0.1 #/cm ³ for 5 µm particles
Dimensions	H407 x W454 x D242 mm
Collection plate diameter	25 mm
Unit weight	22 kg
Pump requirements	20 m ³ /h @ 40 mbars
Sample temperature	10-50 °C 10-180 °C with the High Temperature ELPI®+ upgrade Up to 1200 °C when combined with Dekati® Sample Conditioning Instruments
Sample humidity	0-90 % RH Non-condensing
Sampling rate	10 Hz
Power	100-250 V, 50-60 Hz, 200 W
Computer requirements	MS-Windows 8™, MS-Windows 10™, MS-Windows 11™
Connection to PC	RS-232 or Ethernet
Digital output	As ASCII stream
6 analogue inputs	0-5 V
3 analogue outputs	0-10 V



HR-ELPI®+ impactor and charger unit



Publications

Järvinen, A., Aitoma, M., Rostedt, A., Keskinen, J. Yli-Ojanperä, J., Calibration of the new electrical low pressure impactor (ELPI+). J. Aerosol Sci. , 69, 150-159, 2014

Lepistö, T., Kuuluvainen, H., Juuti, P., Järvinen, A., Arffman, A. & Rönkkö, T. Measurement of the human respiratory tract deposited surface area of particles with an electrical low pressure impactor. Aerosol Science and Technology, vol 54, pp. 958-971.

Saari, S., Arffman, A., Harra, J., Rönkkö, T. & Keskinen, J. 2018. Performance evaluation of the HR-ELPI+ inversion. Aerosol Science and Technology, vol 52, pp. 1037-1047.

Acknowledgements

The ELPI® instrument originated through work carried out at the Aerosol Research Group at the Tampere University of Technology, Tampere, Finland.



Dekati Ltd. is a world leader in designing and manufacturing innovative fine particle measurement solutions. We have more than 30 years of experience in providing measurement instruments and complete measurement solutions to a wide variety of environments and sample conditions. All Dekati® Products are developed and manufactured in Finland and are available with up to five-year warranty.

