

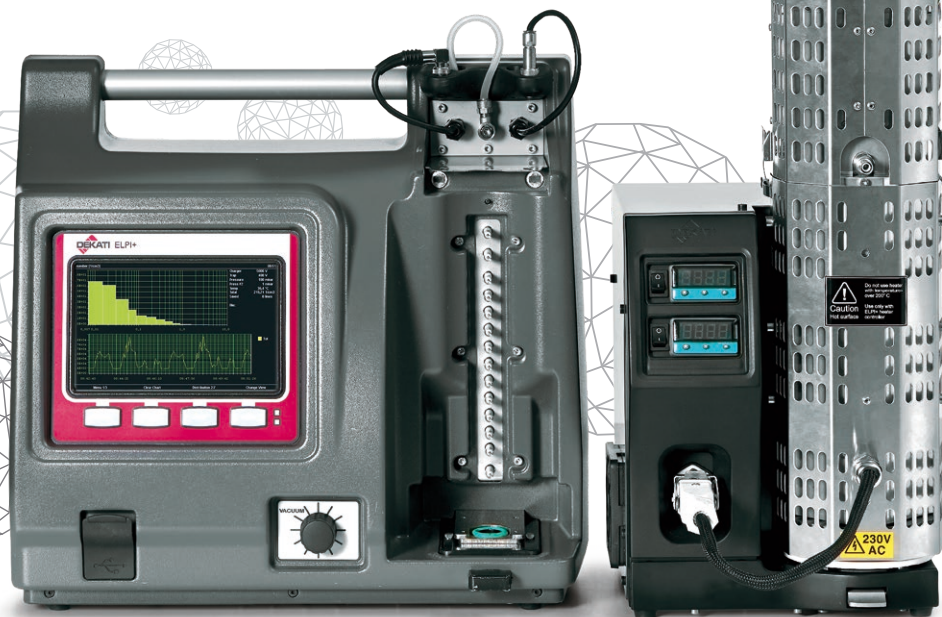
Dekati[®] High Temperature ELPI[®]+

- ▶ Real-time particle size distribution
- ▶ Wide particle size range with one measurement method
- ▶ High temperature aerosol measurements



Excellence in Particle Measurements

Dekati® High Temperature ELPI®+



Description

The **Dekati® High Temperature ELPI®+** (Electrical Low Pressure Impactor, HT-ELPI®+) is a unique version of the Dekati® ELPI®+ that enables real-time measurement of particle size distribution from 6 nm up to 10 µm with 10 Hz sampling rate. The High Temperature ELPI®+ allows direct measurement of up to 180 °C aerosol samples without the need to cool the sample, which makes the HT-ELPI®+ a one of a kind tool to characterize high temperature aerosols. Additionally, the HT-ELPI®+ has all the benefits of the Dekati® ELPI®+ system including real-time standalone operation, wide sample concentration range, wide particle size range and robust structure for operation even in harsh conditions. The use of impactor technology enables post-measurement chemical analysis of the size classified particles. In addition, the HT-ELPI®+ can be used for real-time particle charge distribution and gravimetric measurements. All these features make the HT-ELPI®+ an ideal choice for characterization of high temperature aerosols.

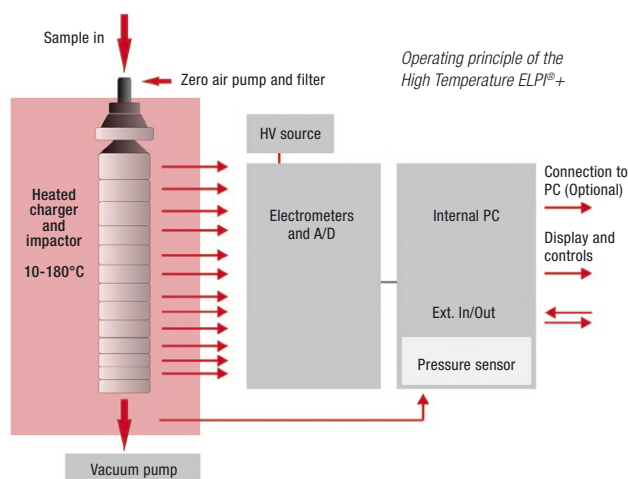
The operating principle of the High Temperature ELPI®+ is the same as that of the ELPI®+. In the High Temperature ELPI®+, the impactor and charger unit is separated from the ELPI®+ main unit and placed inside a heating element. The heating element can be heated up to 180 °C allowing direct sampling of hot aerosols without the risk of condensation or sample transformations. The impactor support and heater controller are all integrated into one easy-to-use unit, which also allows control of an additional heater such as a heated sampling line that is also provided with the unit.

Operating principle*

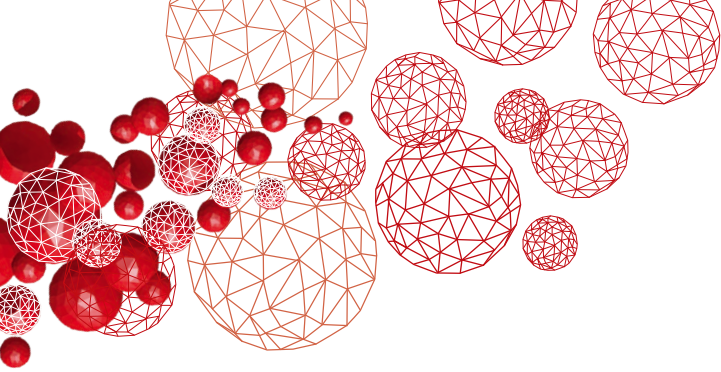
ELPI®+ operating principle can be divided into three stages:
1) particle charging, 2) inertial size classification of the particles in a cascade impactor, and 3) electrical detection of particle charge with sensitive electrometers.

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 from each other and each of the impactor stages is connected to an electrometer. As the charged particles get collected in the different impactor stages, the charge carried by them is detected by the electrometers. This measured current signal is directly related to the number of particles, thus enabling the ELPI®+ to measure particle number size distribution and concentration in real-time. If the ELPI®+ charger is switched off, the electrometers are measuring the charge size distribution of the particles in the sample.



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



Measurement Applications

High Temperature ELPI[®]+ is a unique instrument capable of measuring properties of high temperature aerosols without dilution or a sample conditioning unit. This enables accurate measurements without the risk of sample transformations and even when sample particle concentrations are very low.

Typical applications for the HT-ELPI[®]+ include:

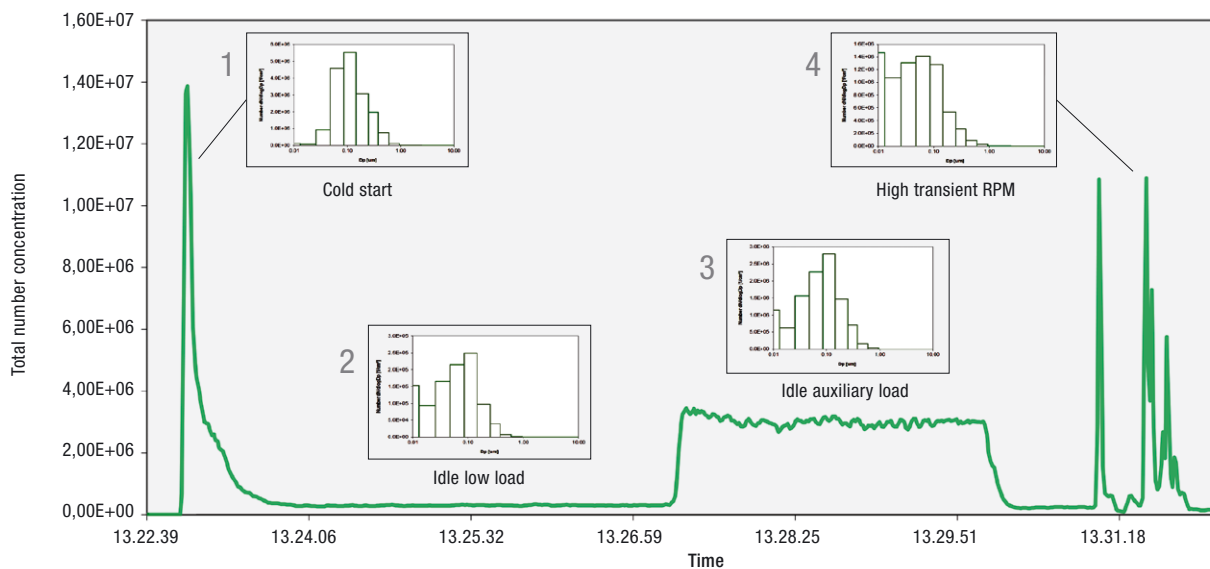
- Combustion process studies and emission measurements
- Development and optimization of stationary source emission cleaning devices
- Development of engine emission after-treatment devices
- On-board engine emission measurements
- Blow-by gas emission measurements
- Particle transformation studies and general particle research

Accessories

- Aluminium (max 300 °C) and polycarbonate (max 140 °C) impactor collection foils, 25 mm
- Sintered collection plate sets for long-term, maintenance free operation
- Vacuum pumps
- Spare impactors and collection plate sets
- High Resolution ELPI[®]+ software for improved particle size resolution. Calculation in the software is based on the actual, measured impactor stage collection efficiency curves (Järvinen et al), no curve fits used.
- Different length heated stainless-steel sampling lines for sample transfer
- Dekati[®] Sample Conditioning Systems for specific applications and sampling from up to 1200 °C

Features and benefits

- Real-time particle size distribution and total concentration measurements with one measurement method and one instrument throughout the complete size range
- Wide particle size range; 6 nm-10 µm
- 14 particle size fractions standard, up to 500 size classes with the High Resolution ELPI[®]+ upgrade
- Temperature range 10-180 °C allowing direct measurement of high temperature aerosols
- Real-time (10 Hz) data on particle number, active surface and mass concentration
- Possibility for post-measurement chemical characterization of size classified impactor samples
- Automated particle charge size distribution measurements
- Wide operational concentration range
- Impactor and charger units heated and temperature controlled with an integrated digital control unit
- 1.5 m heated sampling line provided with the unit and temperature controlled with the secondary integrated digital control unit
- Can be connected directly to high temperature aerosol source
- Improved sensitivity as no dilution systems are needed
- Insensitivity to variations in sample pressure
- Sophisticated calibration made for each manufactured unit
- Impactor calibration values provided for 20, 60, 120 and 180 °C
- Integrated flow control and pressure adjustment
- Independent stand-alone operation or control via laptop using ELPI[®]+VI software
- Large 7" display with graphic user interface



Solid particle emissions from a GDI engine under different engine conditions

Dekati® High Temperature ELPI®+



HT-ELPI®+ Specifications

Particle size range	0.006 - 10 µm
Number of size classes	14 standard, 100/500 with High Resolution ELPI®+ upgrade
Sample flow rate	10 lpm
ELPI®+ dimensions	H407 x W454 x D242 mm
External heating unit	H350 x W240 x D240 mm without impactor
Collection plate diameter	25 mm
Unit weight	15 kg without impactor 22 kg with impactor in its place
Heating unit:	8.6 kg without impactor 16.3 kg with impactor and heater
Pump requirements*	20 m³/h @ 40 mbars
Operating temperature	10-35 °C
Sample temperature	10-180 °C Up to 1200 °C when combined with Dekati® Sample Conditioning Instruments
Pre-set calibration temperatures	20, 60, 120 and 180 °C
Sample humidity	0-90 % RH Non-condensing
Sampling rate	10 Hz
Power	100-250 V, 50-60 Hz, 200 W for ELPI®+ Impactor heater: 500 W for 110/230 V 1.5 m heated sampling line: 500 W for 110/230 V Alternative external heater to the provided heated sampling line: Max 500 W for 110 V Max 1000 W for 230 V
Computer requirements	MS-Windows 8™, MS-Windows 10™
Connection to PC	RS-232 or Ethernet
6 analogue inputs	0-5 V
3 analogue outputs	0-10 V

* Suitable pumps available at Dekati Ltd.

Stage	D50% [µm]	Di [µm]	Number min [1/cm³]	Number max [1/cm³]	Mass min [µg/m³]	Mass max [mg/m³]
15	10					
14	5,3	7,3	0,1	1,7E+04	11	3400
13	3,6	4,4	0,1	3,0E+04	4	1300
12	2,5	3,0	0,16	5,2E+04	2,3	730
11	1,6	2,0	0,3	9,7E+04	1,3	400
10	0,94	1,2	0,6	2,0E+05	0,6	195
9	0,60	0,75	1,2	3,9E+05	0,3	85
8	0,38	0,48	2	6,8E+05	0,12	38
7	0,25	0,31	4	1,2E+06	0,06	17
6	0,15	0,19	6	2,0E+06	0,03	7,7
5	0,094	0,12	12	3,7E+06	0,01	3,2
4	0,054	0,071	21	7,0E+06	0,004	1,3
3	0,030	0,040	42	1,4E+07	0,0015	0,47
2	0,016	0,022	90	3,0E+07	0,0005	0,16
1	0,006	0,010	240	7,9E+07	0,0002	0,03

Each 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.



► **Dekati Ltd.** is a world leader in designing and manufacturing innovative fine particle measurement solutions. We have over 25 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.



Heating unit of the High Temperature ELPI®+

Acknowledgements

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