

DEKATI® eFILTER™, A GRAVIMETRIC FILTER HOLDER WITH AN INTEGRATED DIFFUSION CHARGER

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World's best fine particle measurement solutions
from Finland

Dekati Ltd.



- Sales, manufacturing and development of fine particle measurement solutions
- Core competence: Real-time fine particle size & concentration measurement and sample conditioning technologies
- Privately owned technology spin-off company from TUT Aerosol Physics Lab
- Distributors in ~35 countries worldwide
- Located in Kangasala Finland



Background

- Gravimetric PM measurement is and will be required by several regulations
- Measurement setups and sampling systems for gravimetric measurement exist already
- Real-time particle concentration information is essential
- Active surface area measurement is one possible metrics to complement or replace traditional particle number or mass concentrations *

*Kuuluvainen et al. "Lung deposited surface area size distributions of particulate matter in different urban areas", Atmospheric env. V.136 2016

Levin et al. "Can We Trust Real Time Measurements of Lung Deposited Surface Area Concentrations in Dust from Powder Nanomaterials?" Aerosol and Air Quality Research Volume 16, No. 5, 2016



Dekati[®] eFilter[™]

- **Target:** add real-time information to normal gravimetric particle measurement without weakening usability
- **Implementation:** Parallel gravimetric and diffusion charger particle measurement, battery operation with internal pump for electrical measurement
- **Design:** 47mm filter holder with integrated real-time module
- **Usability:** Fully automated operation. No cables, hoses, no additional work required compared to standard gravimetric measurement



Design principle

Battery operation:
No cables or hoses

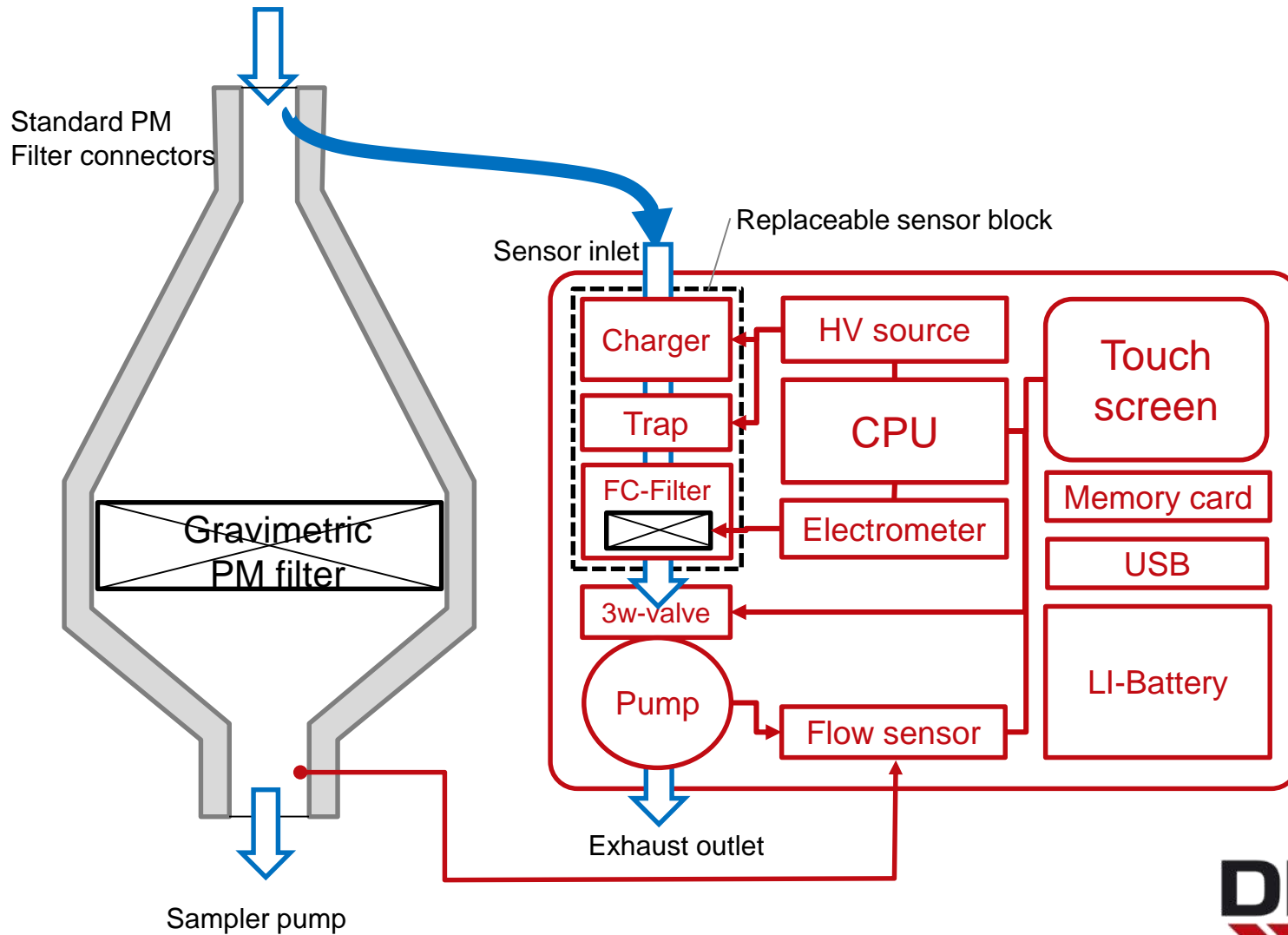
Tolerates 47C temperature

Gravimetric PM filter holder
meets US EPA ambient
sampling requirements

Fully automated operation,
start / stop based on
gravimetric PM filter flow



Details



eFilter™ design

Inlet / Outlet with G1/2”
thread or quick connectors

PM Filter holder,
geometry according to
US EPA requirements

Flow divider

Minor flow tube

Replacable diffusion
charger and faraday cup
filter

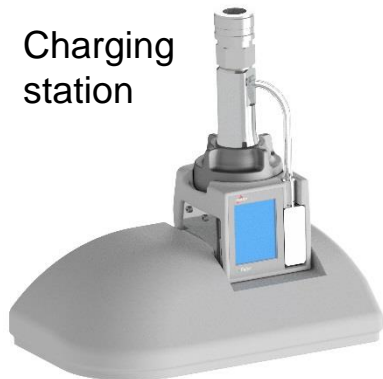
Minor flow out

Touch screen
user interface

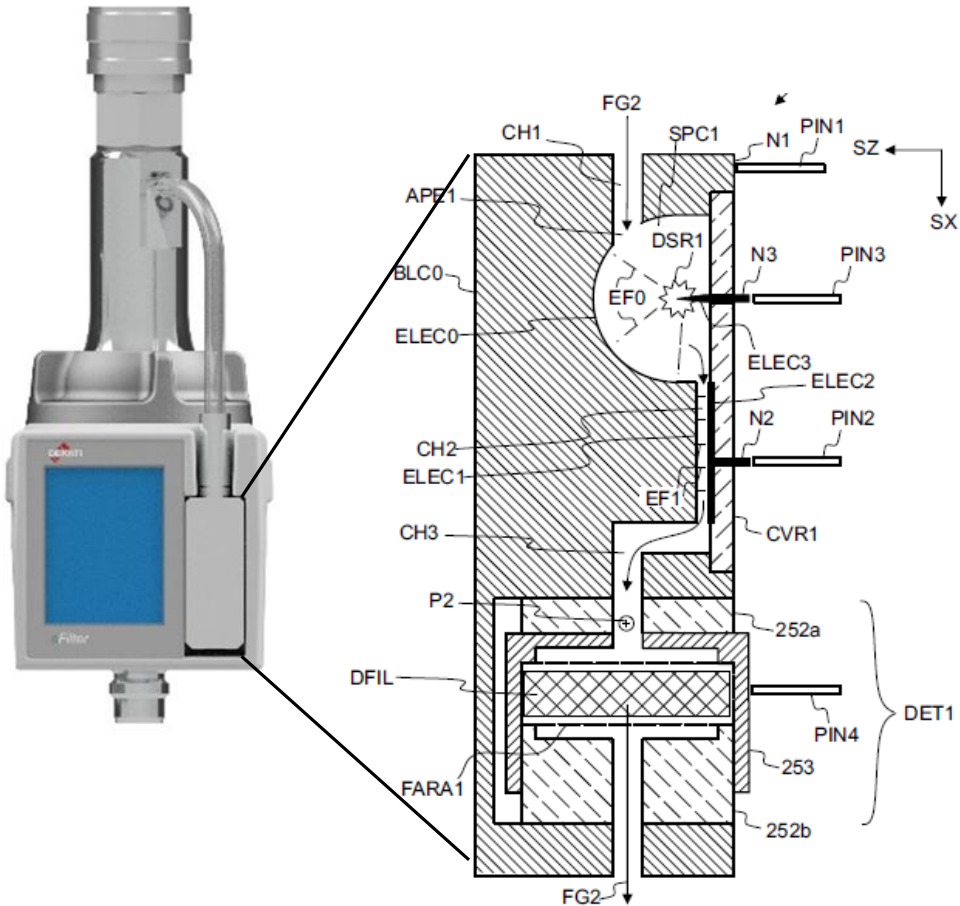
Data storage to
SD card

RS-232 / USB
interface

Charging
station

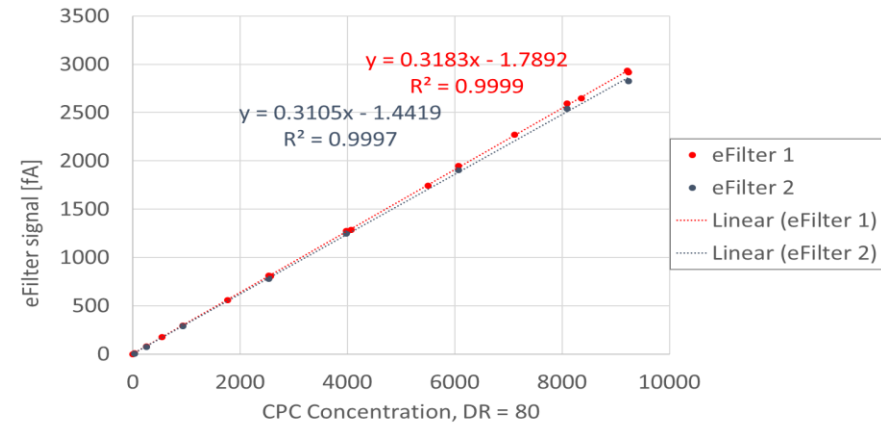


Miniature Diffusion charger: construction, linearity and calibration

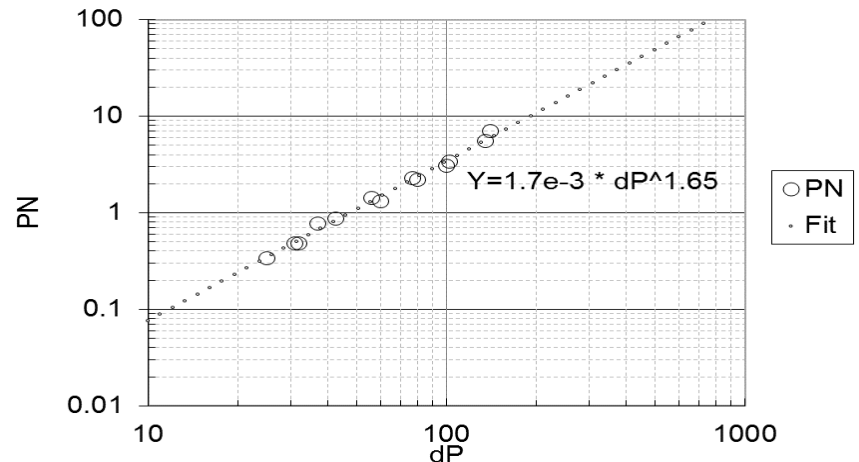


Patens pending

eFilter Linearity, repeatability, sensitivity
70nm DEHS particles



eFilter DC charging efficiency

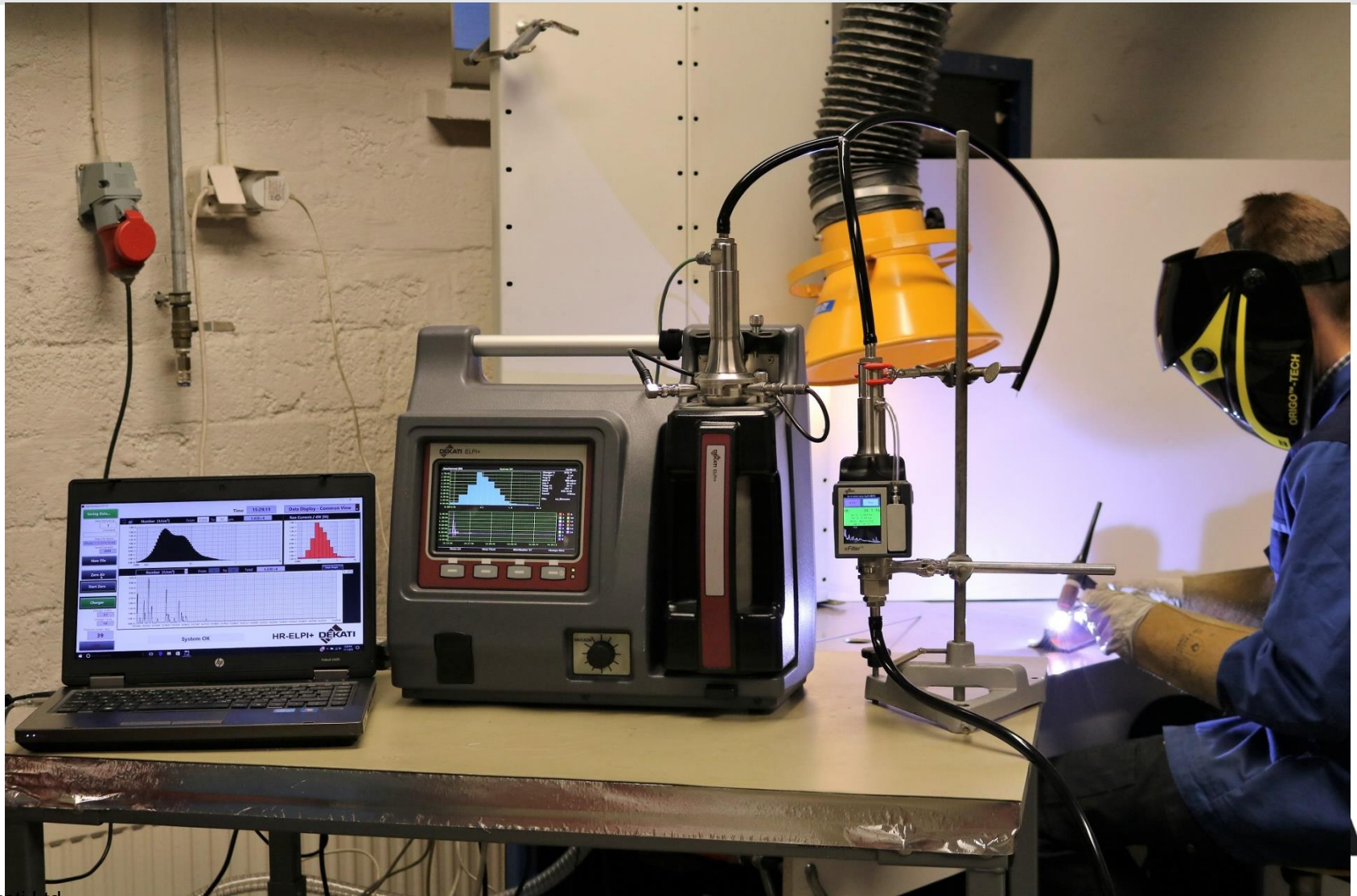


Application example results

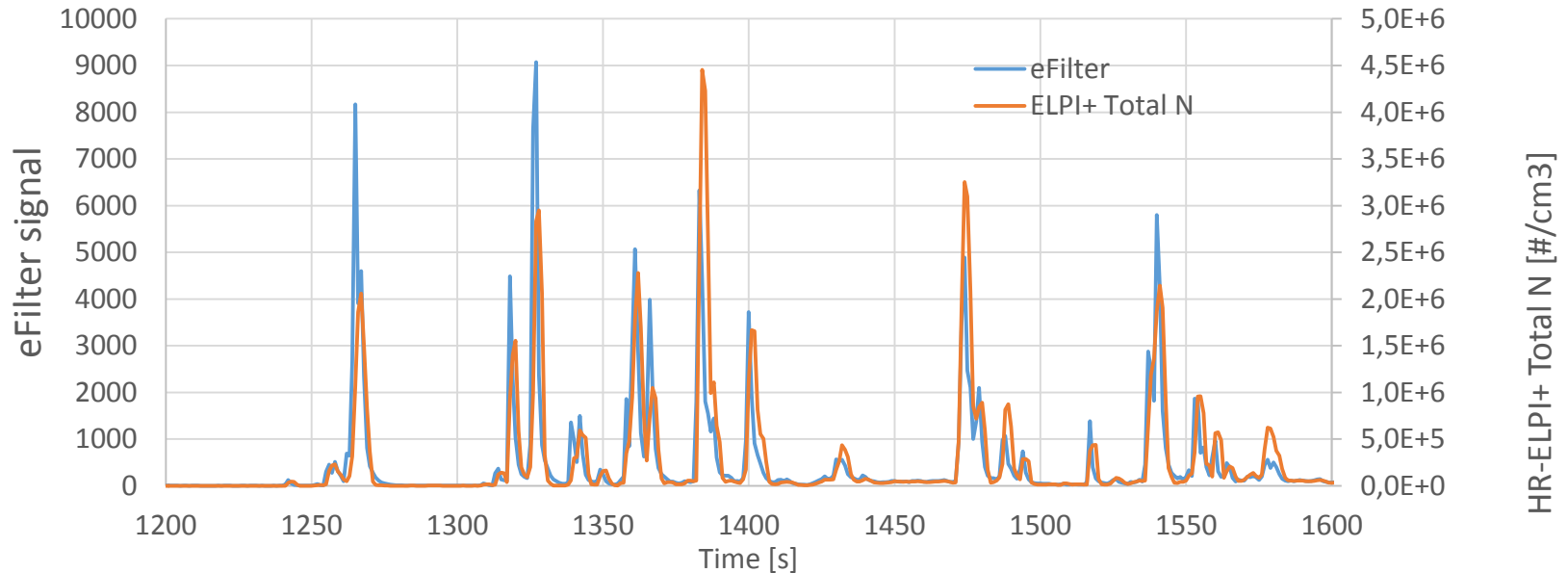
- Welding fume (eFilter vs. HR-ELPI+)
- Indoor (office environment) air quality (eFilter vs. ELPI+/CPC)
- Outdoor air quality (eFilter vs. HR-ELPI+/CPC)
 - Nafion dryer+PM2.5 preseparator
- Diesel emissions (eFilter vs. gravimetric mass)
 - CVS-tunnel



Workplace measurement: welding fumes



Welding measurements: eFilter™ & HR-ELPI®+



eFilter™ & ELPI®+ are giving correlated real-time information (current/LDSA/N)

- Flow of eFilter™'s real time detector 0.5 lpm
- Flow of the HR-ELPI®+ 9.89 lpm
- To compare the results, different flows are taken account
- $I_{eFilter} = measured I_{eFilter} \frac{9.98 \text{ lpm}}{0.5 \text{ lpm}}$



Welding measurements: eFilter™ & HR-ELPI®+

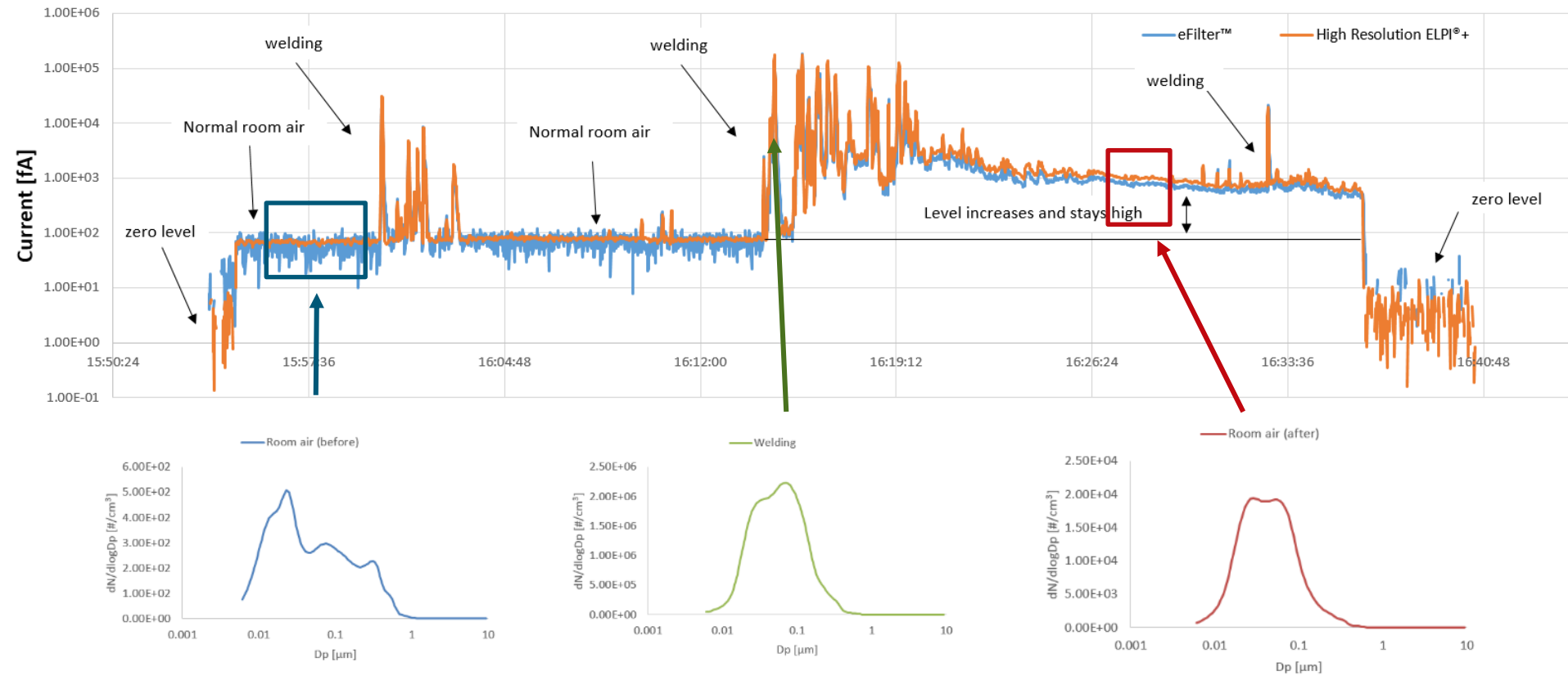


Current (y-axis) is logarithmic

- 2nd welding: shielding gas blew the air in the room
- → particle concentration increases in room even the local exhaust ventilation is used
- Most of particles and mass are collected after 2nd welding



Welding measurements: eFilter™ & HR-ELPI®+

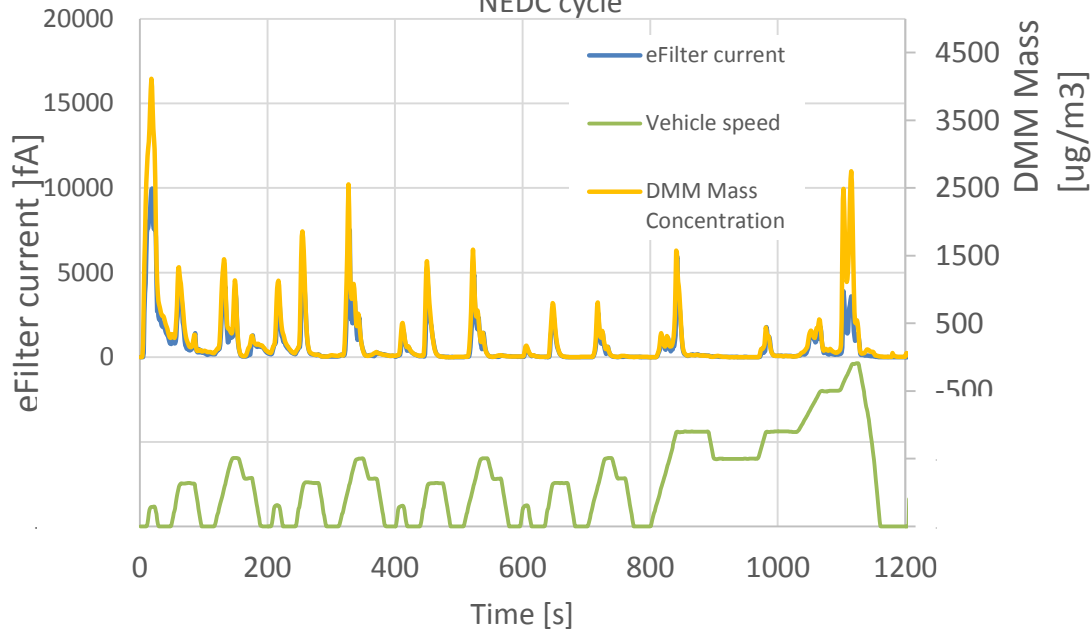


Number concentration measurements from different measurement point using HR-ELPI®+

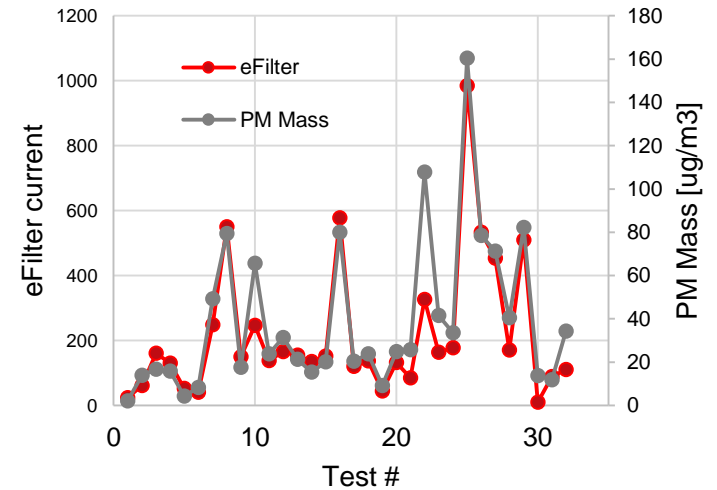


Engine exhaust particles: eFilter vs. gravimetric mass

GDI Vehicle, 3 mg/mile
NEDC cycle

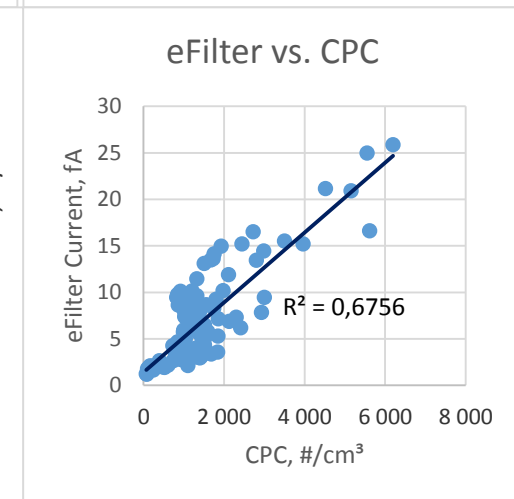
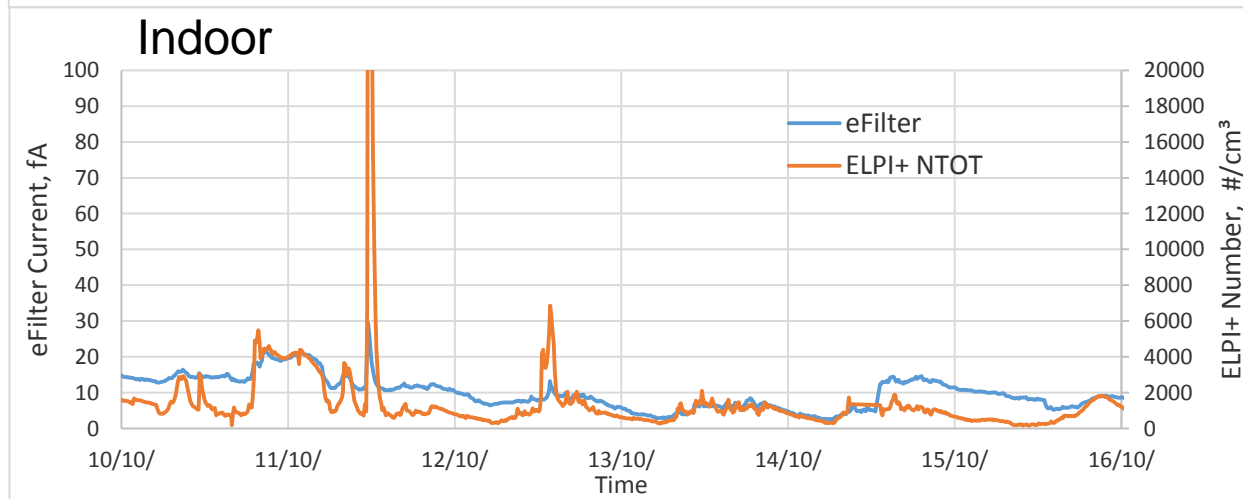
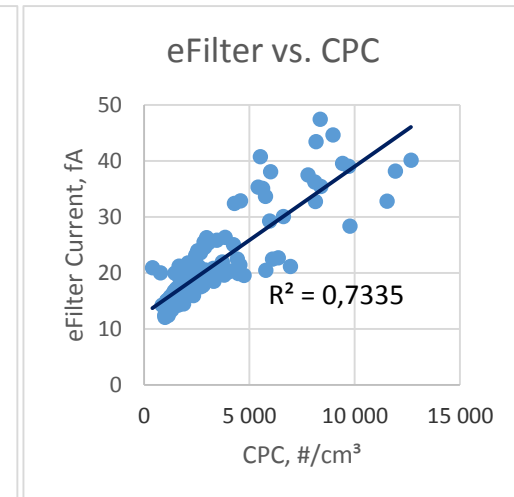
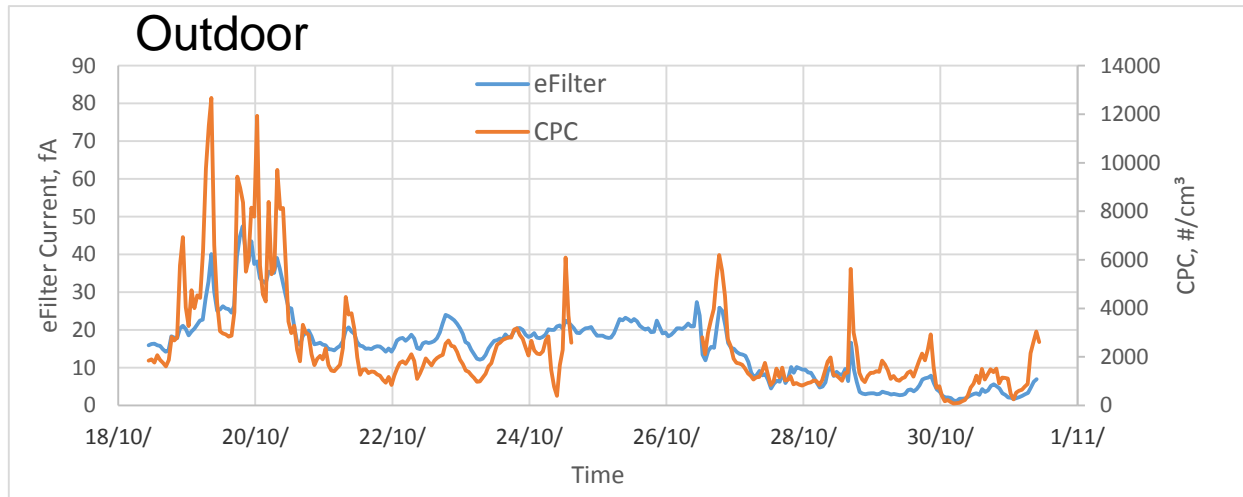


eFilter and gravimetric PM



Niemelä et al. 26th CRC Real World Emissions Workshop
Data courtesy by Ford Motor Company

Outdoor&indoors air quality: eFilter vs. CPC/ELPI+



eFilter measurement result

- Unaffected gravimetric PM measurement result
 - Total particle mass
- Electrical current from the diffusion charger electrometer
 - Fast response second-by-second data
 - Active Surface Area measurement
 - Correlation and conversion to LDSA
- Real-time data benefits:
 - Repeatable
 - Sensitive
 - Real-time signal can also be used for PM measurement quality assurance
 - Can be also a trigger for PM/analysis sampling or collection



Specifications

(subject to change)

Electrical detection sensitivity	About 3 fA electrical current With 70nm particles this corresponds to about 1000 #/cm ³ , 1 ug/m ³
Particle material	Total PM (Solid / semivolatile / liquid)
Battery life	About 7 hours
Minor flow rate	0.50 lpm, automatically adjusted in docking station
Major flow rate	20 -100 lpm
Operating conditions	10-50°C
Filter holder specifications	US EPA 40 CFR part 1065/1066
Data transfer	SD card, USB port



What affects the eFilter signal comparisons (Ratio between eFilter signal and total M, N)

- Changes in particle size
- Nucleation mode and particle size
- Filter artefact - gas phase HC adsorption to PM filter
- Volatile PM evaporation from filter paper



Conclusions

- A new gravimetric PM filter holder provides both standard gravimetric PM result and real-time information about PM accumulation to a filter
- Filter holder integrated miniature diffusion charger provides repeatable, fast and sensitive signal about particle concentration changes
- Diffusion charger response remains stable over long periods of time



Acknowledgements

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Thank you for your attention!

www.dekati.com

