

# Handheld Emission Particle Counter for testing diesel particle filters of off-road engines



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## Introduction

- In Switzerland, construction machines and other off road diesel engines need to have a diesel particulate filter to minimize the exposure of on-site personnel to carcinogenic diesel soot particles.
- To test the correct function of these filters at construction sites and other locations, a mobile diesel soot sensor is needed, which is able to measure the particle number concentration of soot particles directly at the exhaust.
- The Aerosol Group of the Institute for Sensors and Electronics at the University of Applied Science and Arts, Northwestern Switzerland (FHNW) developed such a device, the Handheld Emission Particle Counter (HEPaC).
- The HEPaC is based on the Partector2 by naneos LLC. It has been certified by METAS (VAMV SR 941.242; type certificate CH-K4-21002-00).

## Methodology – Sensor design

The HEPaC is a heated diffusion charging sensor, based on a heavily modified Partector2 (naneos LLC)

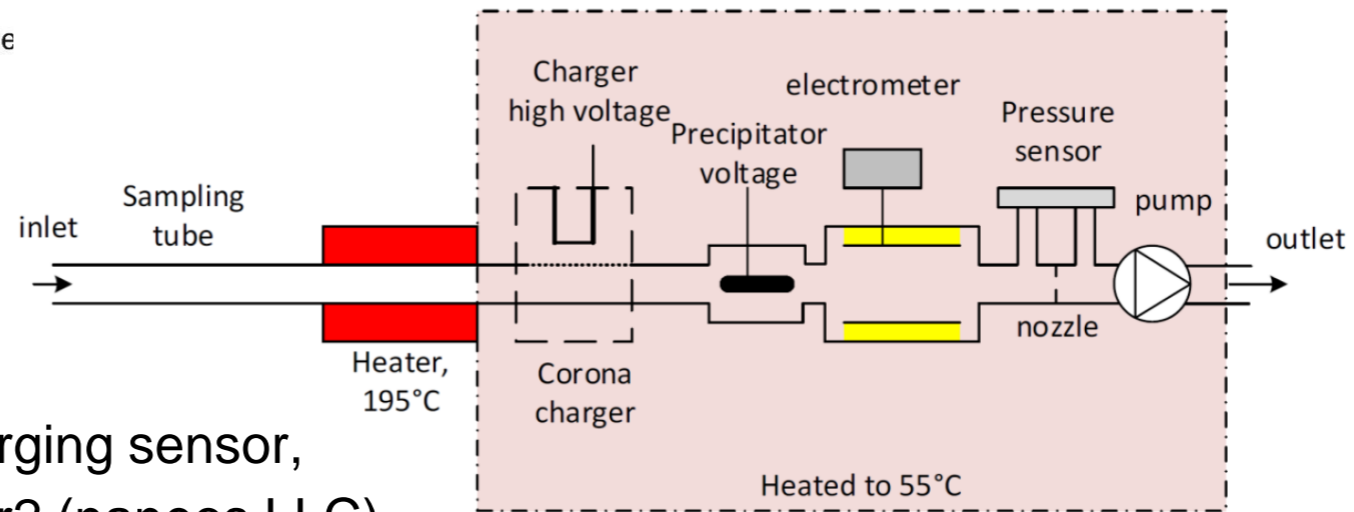


Figure 1: Sensor flow chart

- To avoid condensation and nucleation problems, the aerosol is heated to 195°C by an evaporation tube. The sensor itself is heated to 55°C.
  - After the evaporation tube the aerosol is constantly charged by an unipolar diffusion charger, followed by a pulsed electrostatic precipitator.
  - The resulting periodically changing charge induces a pulsed current (fA) on arrival in a faraday cage, which is measured by an electrometer
- **When all operational parameters like diffusion current, pulsed precipitator voltage and flowrate are correct, the amplitude of the electrometer is directly proportional to the particle number concentration of the aerosol**

## Result – Counting Efficiency measured by METAS

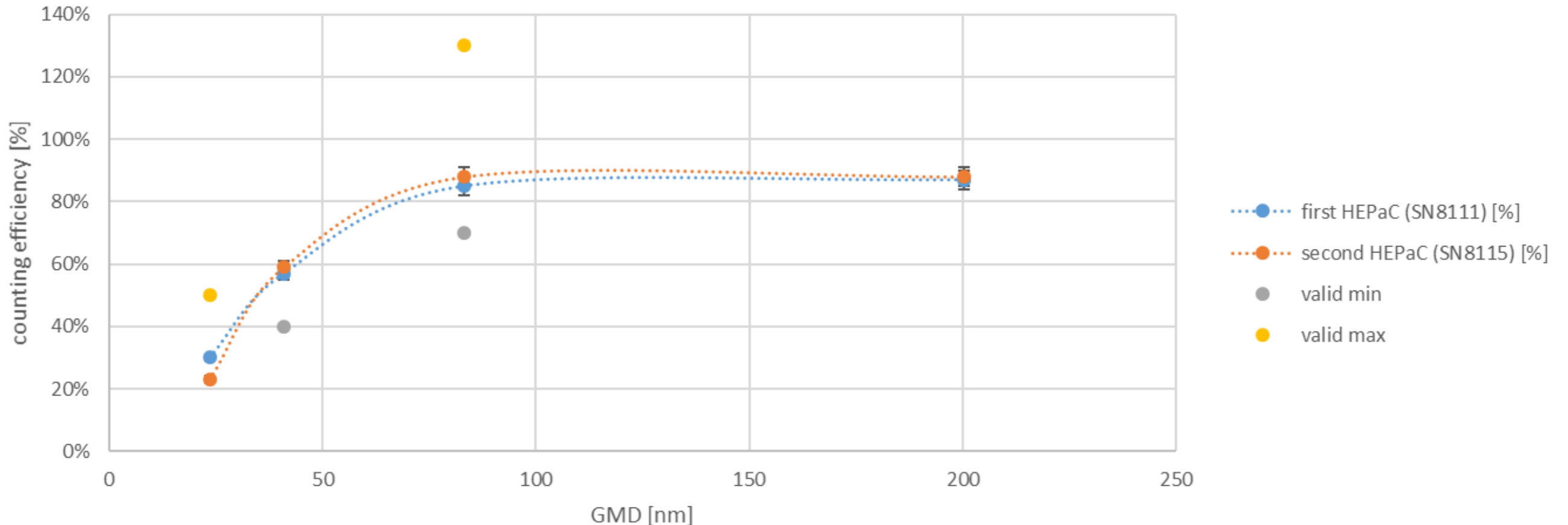


Figure 2: Counting efficiency of the HEPaC with polydisperse CAST soot ( $\sigma = 1.5 \dots 1.6$ ). Gray dots represent the minimum, yellow dots the maximum efficiency according to the VAMV requirement

**→ The counting efficiency (polydisperse soot) of the HEPaC is comparable to a CPC**

## Conclusion

- The HEPaC is a METAS certified lightweight sensor, which allows mobile and simple measurements of particle number concentrations of construction machines directly at the construction site.
- The sensor implementation follows the protocol for Swiss Regulation SR 941.242.
- It works up to a number concentration of 5'000'000 particles/cm<sup>3</sup> with a CPC like counting efficiency curve.
- The efficiency versus particle diameter also fulfills the requirements of the Dutch PTI regulations and the suggestion by PTB for PTI.

## Acknowledgement:

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## Questions?



### HEPaC specifications:

Particle number concentration: 1'000 ... 5'000'000 pt/cm<sup>3</sup>

Time resolution: 1 s

Response Time: 5 s

Inlet flow: 0.5 l/min

Environmental Operating Temperature: 5 – 40°C

Storage Temperature: -10 – 50°C

Sensor temperature: 55°C

Evaporation tube temperature: 195°C

Heat up time: ~ 20min

Relative Humidity: 10 % to 90%, non-condensing

Environmental pressure range: 860 – 1060 hPa

Battery: Rechargeable Li-Ion, 48Wh

Battery lifetime: ~ 3h