

# Real world PN by METAS-conform PEPA portable instrument

Luis Cachón

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# Introduction



**matter**  
AUTOMOTIVE



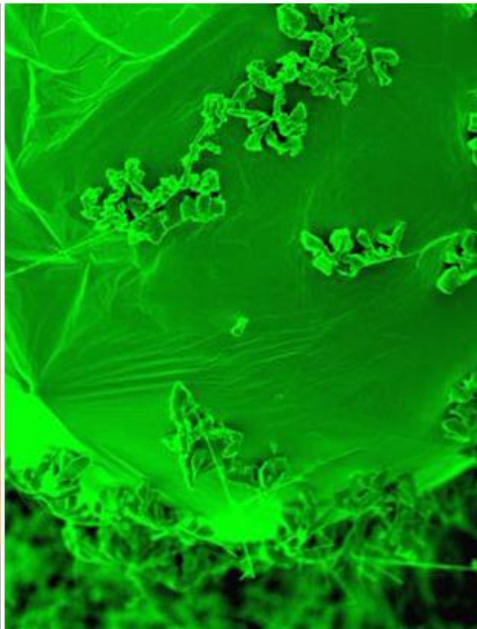
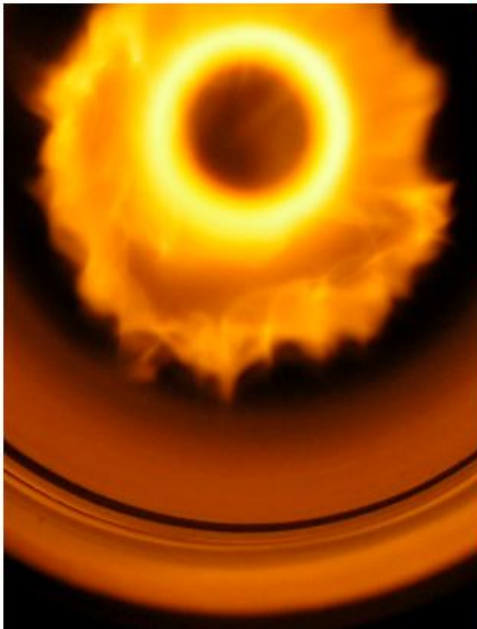
**matter**  
HEALTH&SAFETY



**matter**  
SOOTGENERATORS



**matter**  
SERVICES



# Testo in brief



- **Founded in 1957**
- **Worldwide leading manufacturer of portable and stationary measurement instruments**



## Last 5 years of solid particle counting

2012

2013

2014

2015

2016

2017

- 2012 WHO identified soot diesel as most dangerous pollutant
- 2013 Switzerland periodic control on field for construction machinery, EU requests feasibility study of PEMS-PN for RDE
- 2014 Matter delivers golden instrument for PEMS-PN within RDE Euro 6c  
EU proposal for PN for NRMM; Testo invited to GEME SWG-3 «in-service conformity»
- 2015 VAMV Certification for PEPA
- 2017 RDE Real Driving Emissions within EURO 6c

# 2013 New Swiss legislation on PN for construction machinery



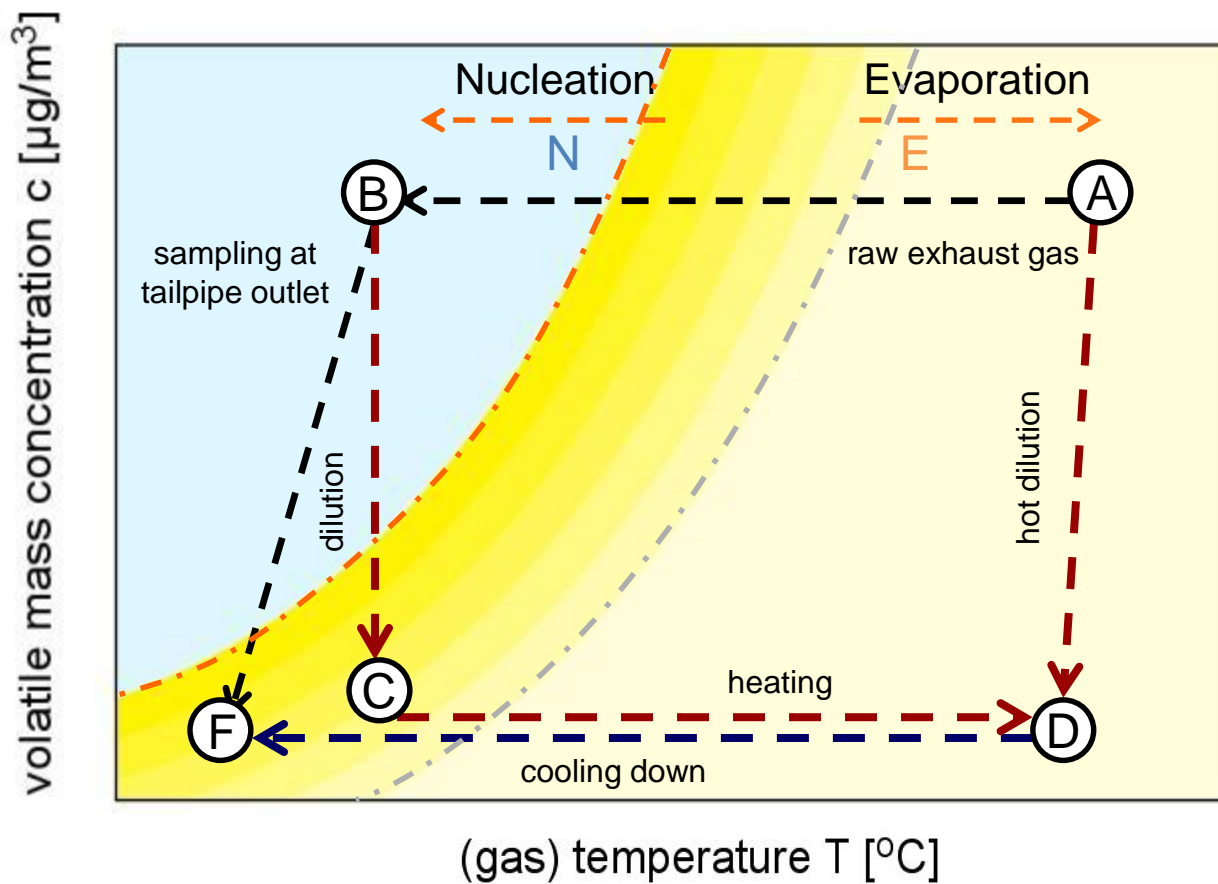
# PEPA – Portable Emission Particle Analyzer

Wir messen es.



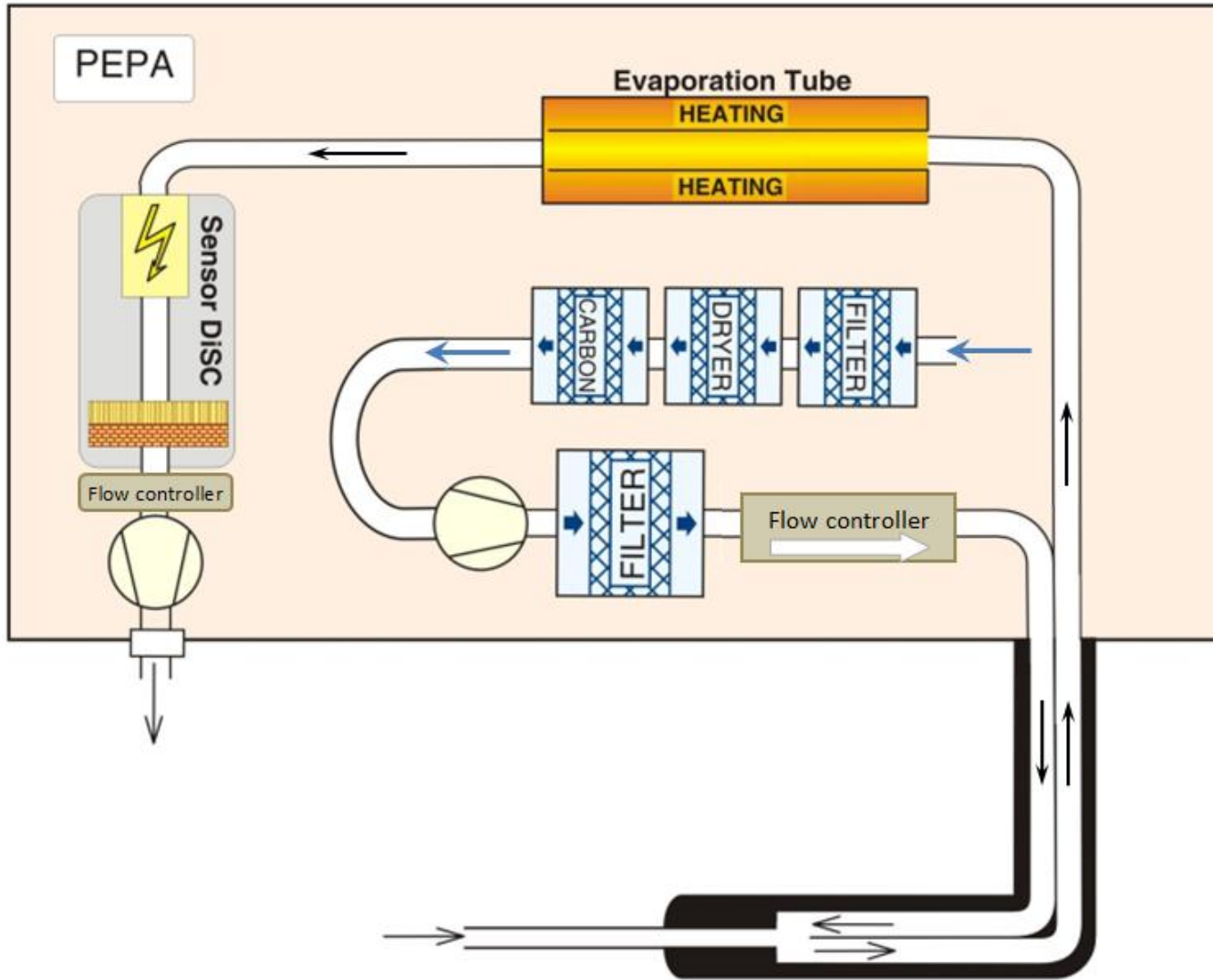
- **Measuring instrument ordinance SR 941.210 appendix 1**
- **Ordinance on exhaust emission measurement instruments SR 941.242 appendix 4**
- **Real time detector for PN determination**
- **Removal of volatiles**
- **Ability to be portable: No safety issue, low mass and power consumption**
- **The candidate PEMS-PN instruments should come along with their calibration data.**

# Post-Dilution ThermoConditioning

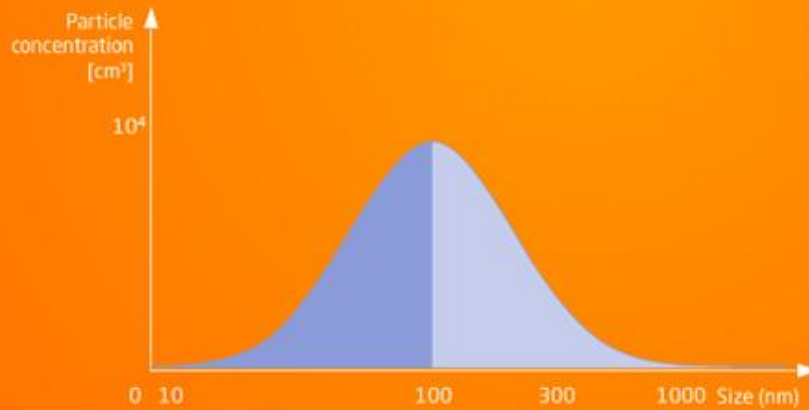
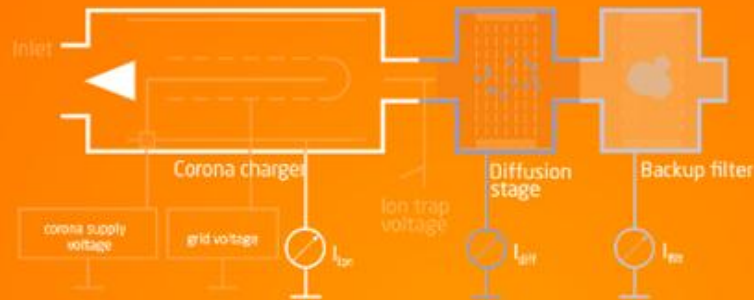




# ViPR Thermo-Dilution

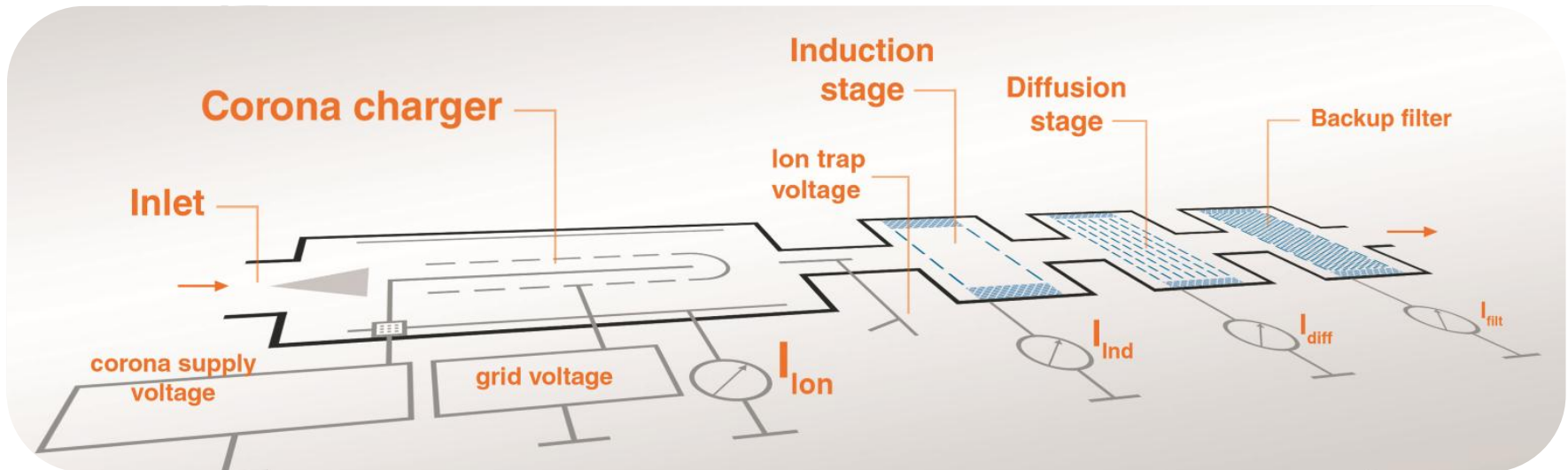
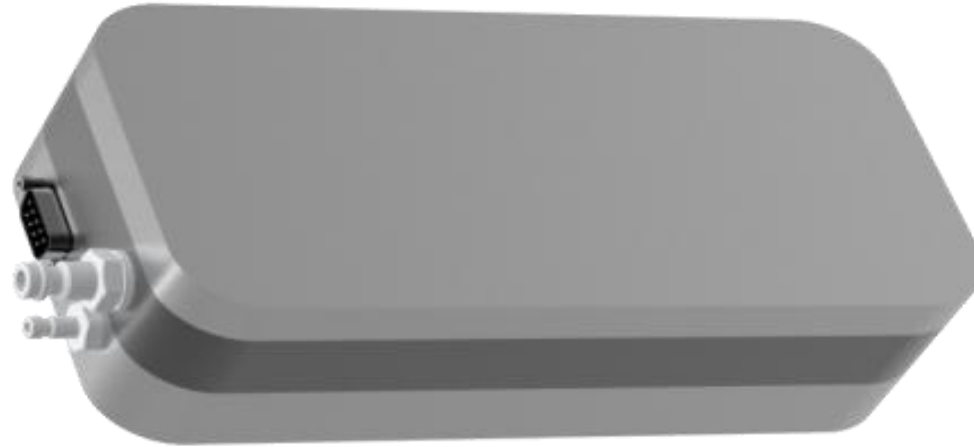


# Particle counting: Diffusion Size Classifier



• matter aerosol  
a testo company

# Particle counting: 2 Generation DiSC



- Particle number concentration [ $\#/cm^3$ ]
- Modal particle diameter [nm]
- Calculated particle mass [ $mg/m^3$ ]
- Lung-deposited surface area [ $\mu m^2/cm^3$ ]
- PMP compliant Volatile Particle Removal



*Raw gas particle concentration*

*1E4 ... 1E7 pt/ccm*

*Particle size*

*10 ... 300 nm*

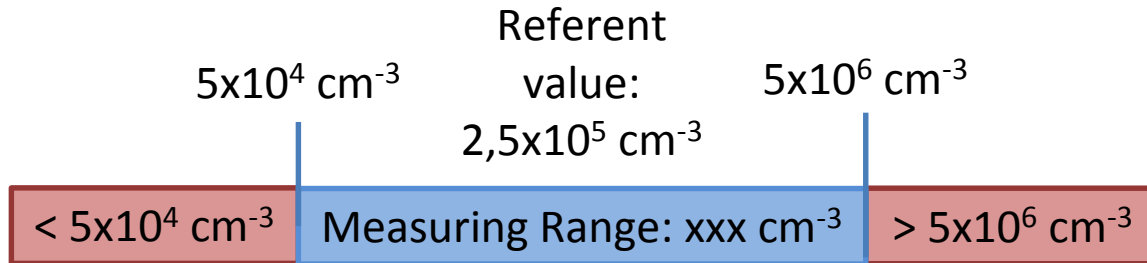
*Power consumption*

*40 W under normal conditions*

*Battery life*

*4 hours under normal conditions*

## ➤ Average particle number concentration at the official measurement

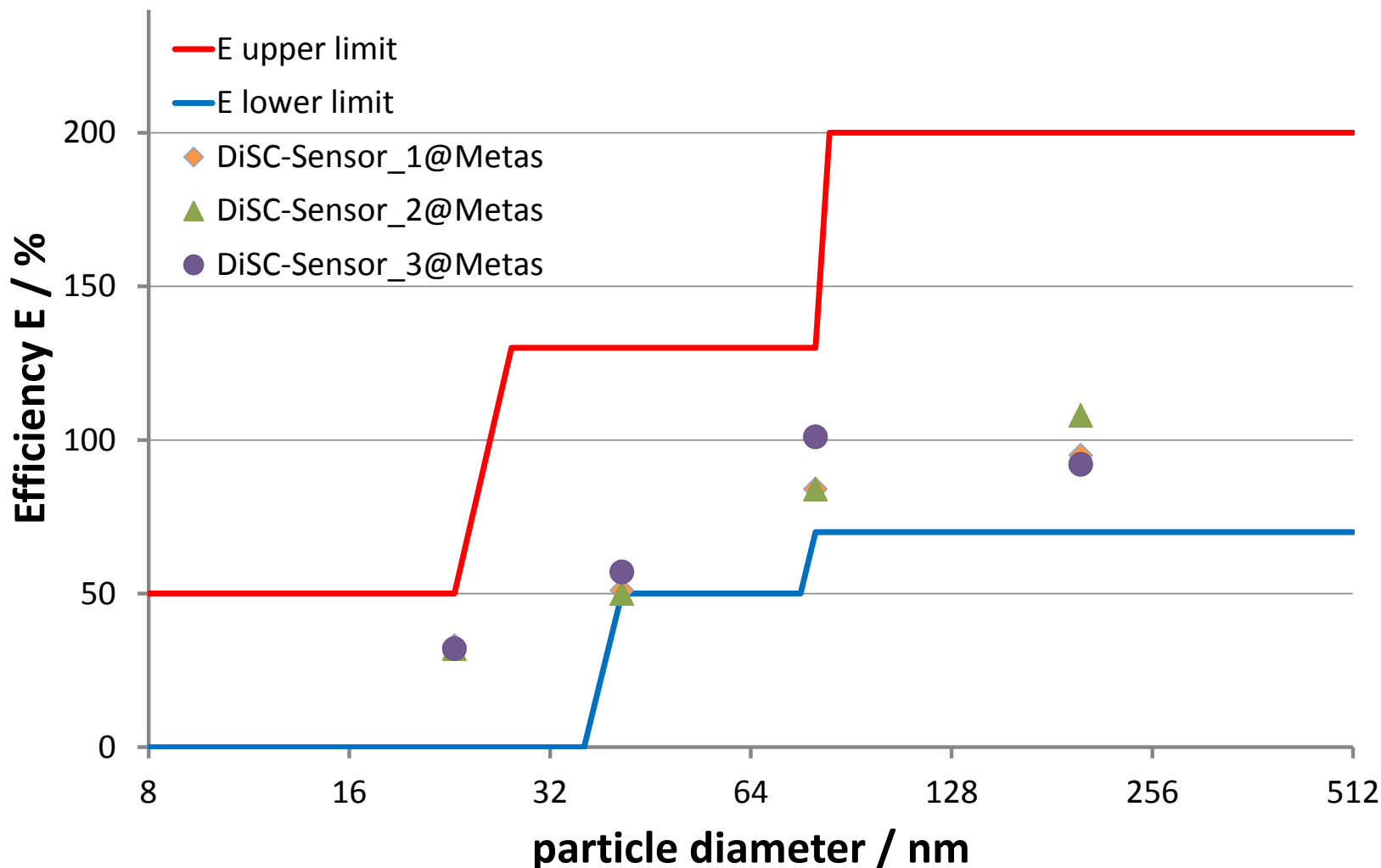


Mobility diameter	Limits of efficiency
23 nm nanoparticles	$E < 50 \%$
41 nm nanoparticles	$50 \% < E$
80 nm nanoparticles	$70 \% < E < 130 \%$
200 nm nanoparticles	$E < 200 \%$
30 nm droplets of tetracontane (number concentration up to $10^5 \text{ cm}^{-3}$ )	$E < 5 \%$

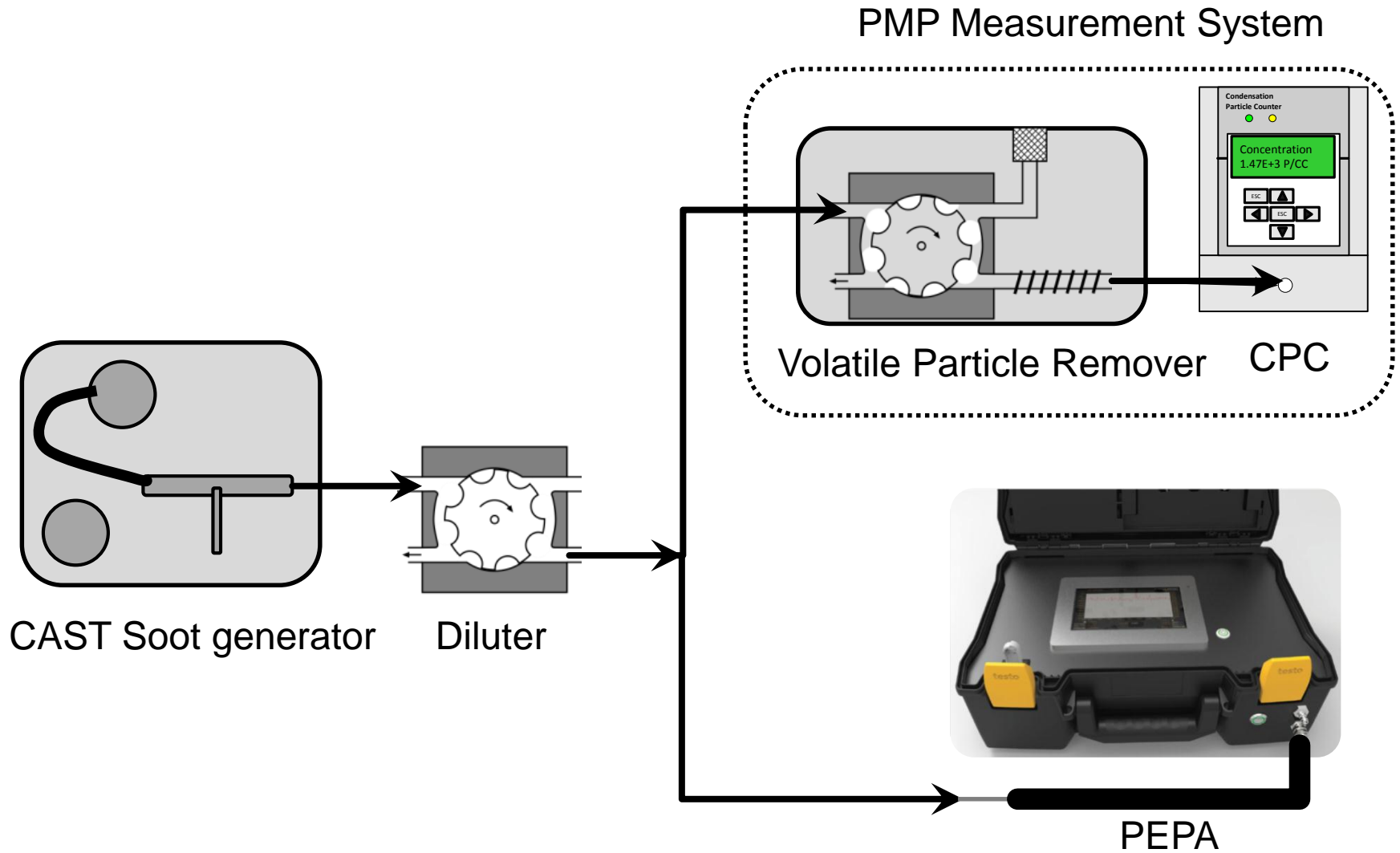


type:Master-Dansil v.1

# Efficiency 2<sup>nd</sup> Generation DiSC-Sensor



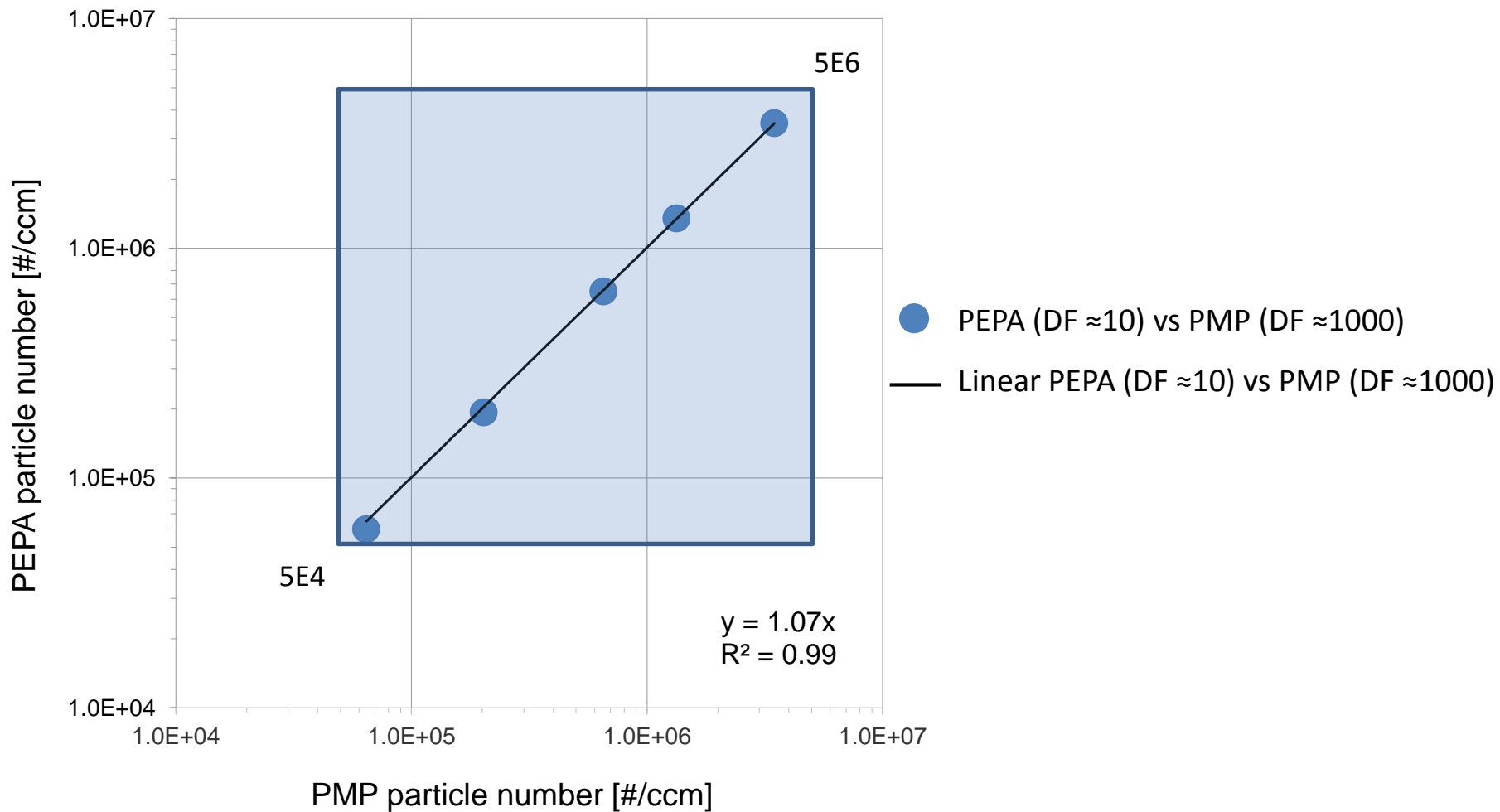
# Validation setup





# PEPA Prototype validation @ 85nm

### Correlation PEPA vs. PMP (GMD 85nm)



- **Testo AG develops PEPA: a Portable Emission Particle Analyzer for field measurements**
- **It is for outdoor application and provides on-line response**
- **Particle counting principle based on Diffusion Size Classifier compliant with LRV efficiency requirements**
- **Thermo-Dilution to remove nanodroplets from exhaust sample**
- **PEPA is candidate for in-use-compliance testing according to Swiss new legislation for construction machinery**



- **BAFU (Umwelttechnologieförderung) for the support to develop portable nanoparticle measurement instrumentation**
- **Simone Krähenbühl (BAFU) and Pierre Comte (AFHB) (Measurement campaign at AVESCO)**
- **Ralf Stich (Testo AG) for the PEPA project management**

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# Thank you for your attention!

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