

# European Metrology Research Project: Automotive combustion particle metrics

Workpackage WP1 in JRP ENV02 PartEmission:  
Emerging requirements for measuring pollutants from automotive exhaust emissions  
<http://www.ptb.de/emrp/partemission-home.html>

Jürg Schlatter, METAS

PMP-Meeting, 6<sup>th</sup> December 2011

## Aerosol metrology



ambient measurements



clean-room monitoring

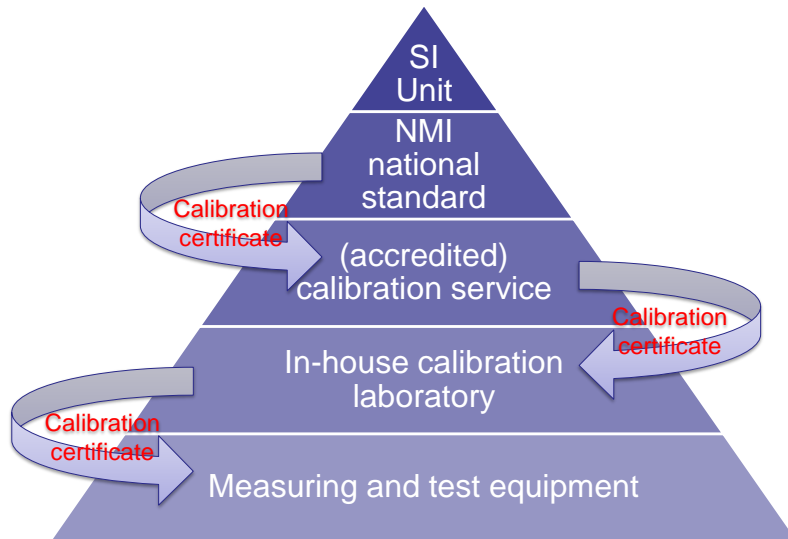


emission measurements



human protection and security

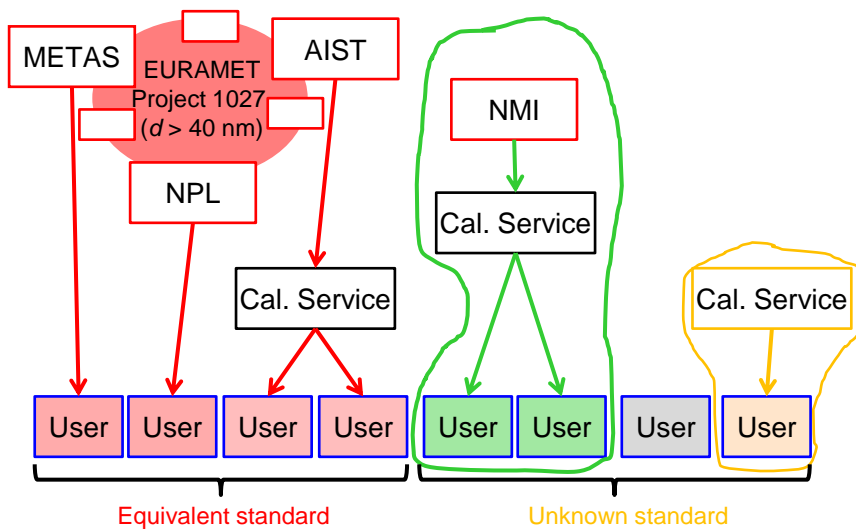
## Traceability concept



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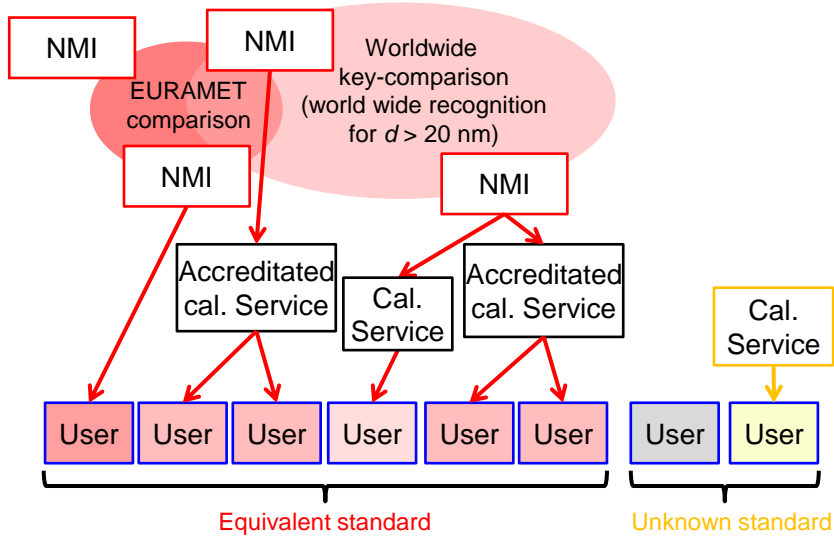
## Traceability for particle number, today



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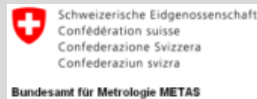
## Traceability for particle number, >2014



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## JRP-ENV02: WP1



REG: Researcher Excellent Grant

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## Goals of WP1

WP1 aims to establish an **international standard** and a calibration service by NMIs **for condensation particle counters** (CPCs) used according to ECE R83 (or Euro 5 and 6) and R49 (or Euro VI).

WP1 aims to develop protocols for the calibration with **thermal stabilized aerosol**. Particle diameters of 30 nm, 50 nm and 100 nm are required for number concentration calibration of the entire measuring system (volatile particle remover at up to 400 °C – aerosol diluter – CPC).

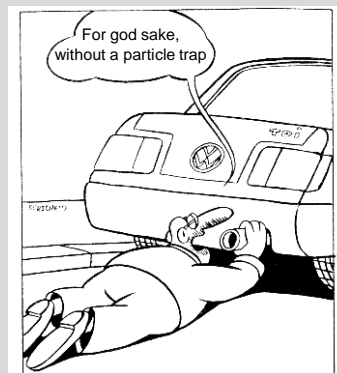
WP1 aims to establish the evaluation and certification of the **cut-off curve of the CPC**. The detection efficiency with soot-like particles of 23 nm and 41 nm diameters a key parameter for the number concentration measurement.

## JRP-ENV02: WP1 Task 1

### Generation of automotive combustion calibration aerosols

Deadline May 2013

Liaison to work package 3 of the iMERA-Plus project T3.J1.1 – Traceable characterization of nanoparticles (Nanoparticles)



Martin quickly found an alternative to harmful cigarettes smoke



## Task 1 – Aerosol generation

The aim of this task is to **generate specific calibration aerosols** with traceable mobility diameters between 23 nm and 100 nm.

- a) Size standard aerosols for calibration service
- b) Aerosol standards with temperature resistance up to 400°C
- c) Aerosol standards “equivalent” to diesel combustion aerosols – “soot-like” aerosol



### a) Size standard aerosol

Calibration service for mobility measurements in aerosols based on reference material with **monodisperse spherical particles** between 23 nm and 100 nm.

Target Date: 05/2012

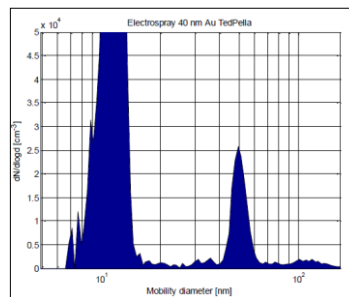
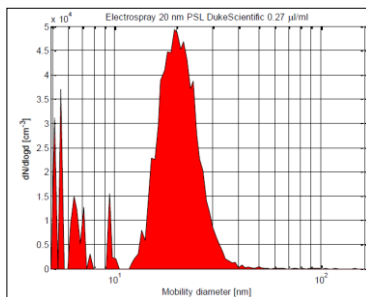
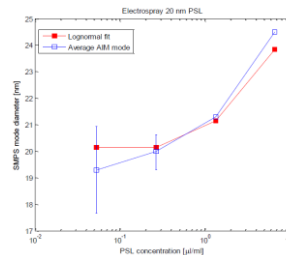
- Evaluation of particle reference materials suitable as a size standard in suspensions (PSL, Au) and generation of aerosols from suspensions ⇒ *ref. material*
- Generation of monodisperse aerosol in the classifier to calibrate (e.g. Ag), extraction of particles for size analysis ⇒ *ref. material for a specific classifier*
- Certification of size distribution of particle reference materials using TEM and AFM ⇒ *report*
- Establishment of calibration services for aerosol mobility analyzers ⇒ *service*



## a) Size standard aerosol – suspension

### Evaluated Size Standards

- 20 nm Au
- 30 nm Au
- 40 nm Au
- 40 nm Ag (only for testing)
- 100 nm Au (only for testing)
- 200 nm PSL



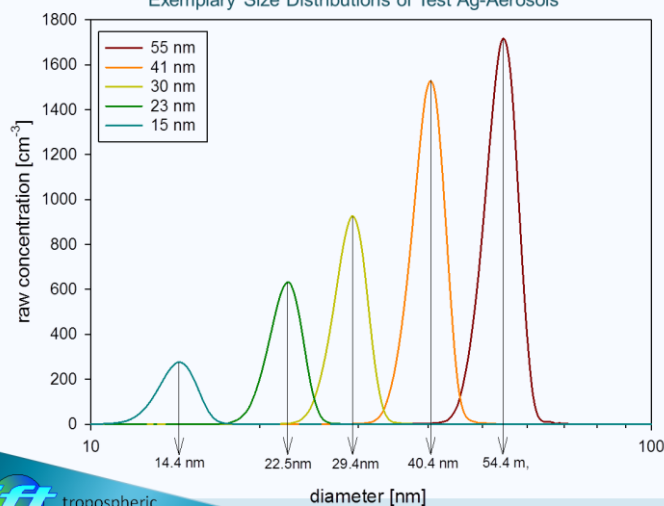
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## a) Size standard aerosol – Ag-Aerosol

### Exemplary Size Distributions of Test Ag-Aerosols



EMRP ENV02 WP1 Meeting Bern 2011

Thomas Tuch

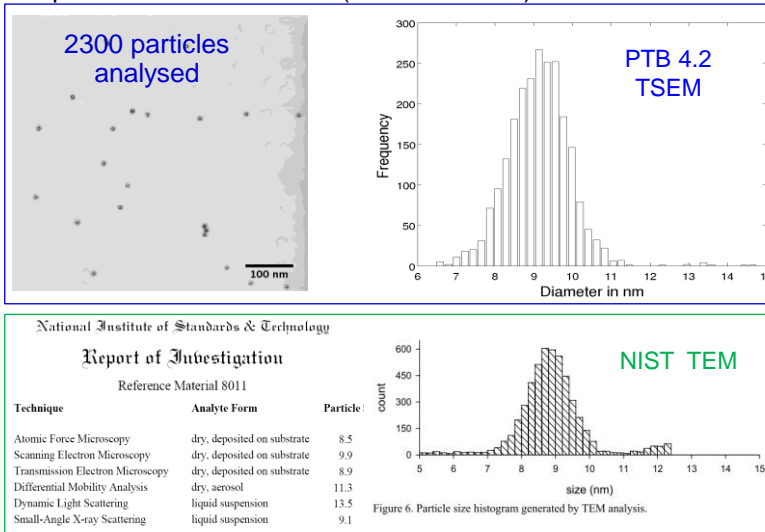
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## a) Size standard aerosol - sizing

Au particles NIST RM 8011 (10 nm nominal)



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## b) Temperature resistant aerosol

Aerosol standards with **temperature resistance up to 400°C** at 30 nm, 50 nm and 100 nm for number concentration calibration.

Target Date: 11/2012

- Generation of aerosol standards: Specified particle materials / unimodal size distribution / particle with single el. charge  
⇒ *procedure*
- Evaluation of characteristics from aerosol standards at temperatures up to 400 °C ⇒ *report*
- Evaluation of the charge distribution from aerosol standards (single/double/triple charged particles, correction strategies)  
⇒ *report*

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## c) “Soot-like” aerosol

Aerosol standards “equivalent” to **diesel combustion aerosols** at 23 nm and 41 nm for evaluation of CPC cut-off curve.

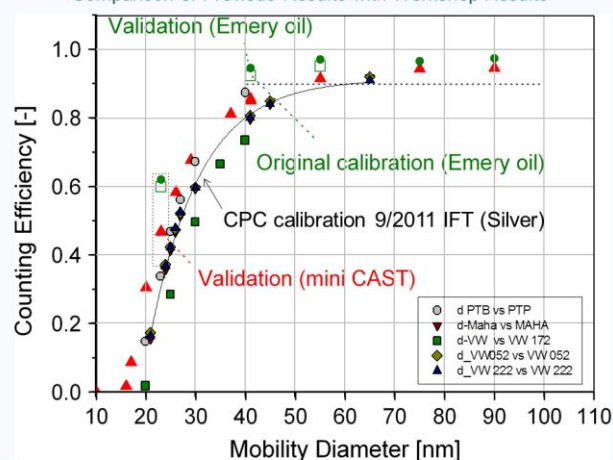
Target Date: 05/2013

- Generation of aerosol standards: particle materials according to PMP definition/ unimodal size distribution / particle with single el. charge  $\Rightarrow$  *procedure*
- Evaluation of similarity of aerosol standards to diesel combustion particles (morphology, size distribution, number concentration, etc.)  $\Rightarrow$  *report*
- Research on the charge distribution of the particles (single/double/triple charged particles, correction strategies)  $\Rightarrow$  *report*



## c) “Soot-like” aerosol

Comparison of Previous Results with Workshop Results



Giechaskiel and Bergmann, J. Aerosol Sci. 42 (2011), 195-203

## JRP-ENV02: WP1 Task 2

### Number concentration traceability for combustion particles

Deadline May 2014

Liaison to the group ISO TC24/SC4/WG12 is close to finishing the draft of the standard ISO 27891 which describes the condensation particle counters (CPC) calibration.



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## Task 2 – Number traceability

The aim of this task is to establish a **standard for combustion particle number concentrations**. The resulting calibration protocol and service cover the measuring range of the CPCs, at least up to  $10^4 \text{ cm}^{-3}$  for mobility diameters between 23 nm and 100 nm.

- a) National particle number concentration standards
- b) Comparison of national standards
- c) Assessment of public services

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## a) National standards

Particle **number concentration standards** by NMIs (national metrology institutes) for automotive particle emission measurements.

Target Date: 11/2013

- NMIs establish independent national number concentration standards for particles with diameters from 20 nm to 100 nm and number concentrations  $< 10^4 \text{ cm}^{-3} \Rightarrow$  *service*
- Comparison, discussion and harmonization of the uncertainty budget of each NMI  $\Rightarrow$  *report*
- Reduction of the uncertainty to  $U_{95\%} < 10 \%$  for number concentration standard  $\Rightarrow$  *report*



## b) Comparison of national standards

International **assessment for national** particle number concentration standards in experimental comparison with aerosols.

Target Date: 11/2013

- Development of a comparison protocol for national number concentration standards (CPC and AE) in international comparison exercises  $\Rightarrow$  *procedure*
- Organization of an international comparison exercise (similar to EURAMET project 1027)  $\Rightarrow$  *report*
- Experimental international validation of national number concentration standards with at least 3 NMIs  $\Rightarrow$  *report*



## c) Assessment of public services

International **assessment for public** and commercial calibration services for automotive particle number instrumentation (CPC and VPR calibration).

Target Date: 05/2014

- Development and publication of a comparison protocol for commercial number concentration services in international comparison exercises  $\Rightarrow$  *procedure*
- Preparation of an instrument in order to execute an evaluation of the cut-off curve and a calibration  $\Rightarrow$  *WG report*
- Organization of an international comparison exercise with a black box instrument  $\Rightarrow$  *initiation round robin test*

## Thank you for your attention

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[www.metas.ch/aerosol](http://www.metas.ch/aerosol)

**EMRP**  
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