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FIELD EXPERIENCE WITH PORTABLE SMPS+C SYSTEM ON DIESEL TEST STANDS

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Keywords: Nano Sizer, SMPS+C, Emission, Diesel Soot, PMP, Transient.

ABSTRACT

Due to the carried out results the different working groups of the PMP recommend for the upcoming EURO V and VI type approval for particle measurements a counting system based on a dilution system and a nucleous condensation particle counter CPC. Newer investigations showed that a thermo diluter instead of thermo absorber combinations should give the most reliable results.

The next step will be a comparison of existing CPCs / SMPS systems and definitions for the most reliable system configurations. The portable Grimm CPC 5.403 and Grimm SMPS+C has proven its reliability in different measurement campaigns. Most of the specifications coming from the users are already integrated in the easy to handle measurement system.

- Validation to the existing measurement standard: CPC – Efficiency test to a reference
- Easy setup and low maintenance with different measurement modes (standard and expert)
- Autocontrolling system with integrated intelligence for monitoring and recording of the operation conditions
- Long term stability with automatic condensate drain off between saturator and condenser to avoid uncontrolled efficiency loss
- Range control system to avoid measurements below the detection limit
- Transportability for so called “real life” on road measurements

INCENTIVE

The second part of the PMP, initiated by the GRPE has been finished. The results show that for particle measurements a number concentration measurement technique should be applied to fulfill even low concentrations after particle filters. To guarantee reproducible and repeatable results a stable and well defined

sampling and measurement instrumentation should be available for standard emission measurements.

DEMANDS & EXPERIENCES

Several measurements at engine test rigs and dynamometers showed always the same requirements from the end user.

- 1) Reproducibility / repeatability and stability (more than absolute correctness and sensitivity)
- 2) Robust, easy „plug & play“ handling - low preparation time and reliable during all-day handling
- 3) Defined sampling / measurement method
- 4) Selfchecking / calibration
- 5) Others (mobile application, onboard diagnostic, etc.)

SUMMARY & OUTLOOK

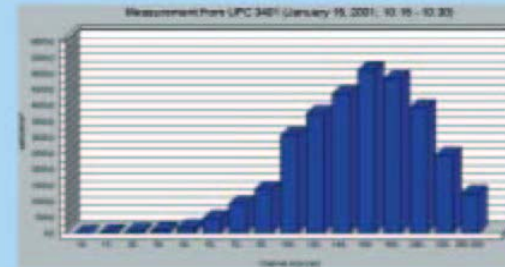
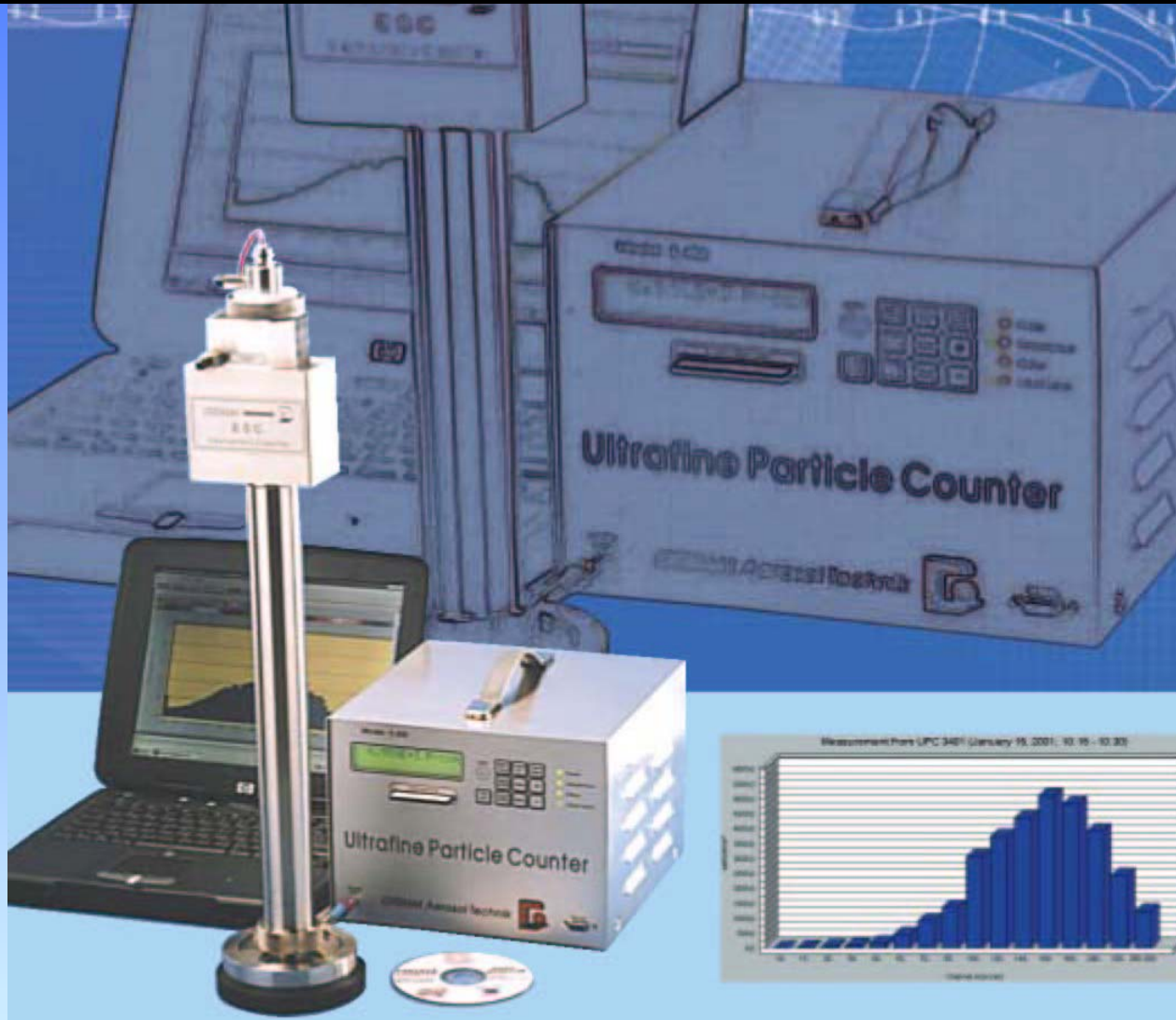
The Grimm CPC and SMPS+C showed in field tests high quality measurements combined with easiest handling.

- Grimm CPC 5.403 is a reliable instrument with comparable results to equal instrument types
- Easiest handling and compact / robust system
- With rot. disk diluter MD19 fast plug and play setup for reproducible AND repeatable results

In future the CPC will be integrated in a complete “PMP” unit with sampling, measurement and a operating software for standard exhaust measurements.

Field Experience with portable SMPS+C system on Diesel Test Stands

(Fast Sequential Mobility Particle Sizer + Classifier)





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1. Incentive
2. Demands & Experiences
3. Summary & Outlook
4. Further Demands



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PMP (GRPE):

Phase II:

Evaluation of particle measurement systems (potential candidates for use in a regulatory role).



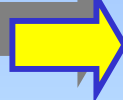
Recommendation:

particle counting with (rotat./thermo) Diluter + CPC

For detailed size information: CPC + DMA

Phase III:

testing programm and validation of candidate systems

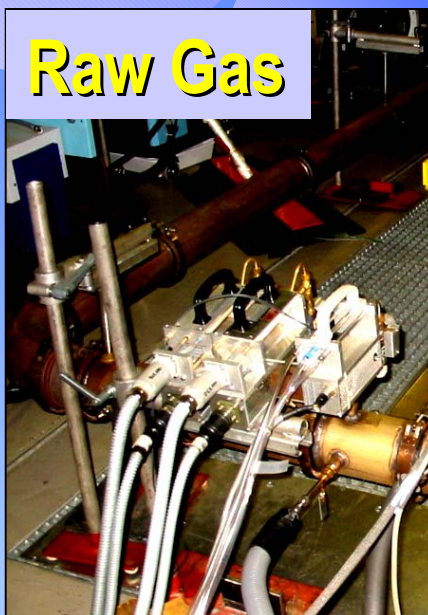


Demands on a standard measurement technique / system

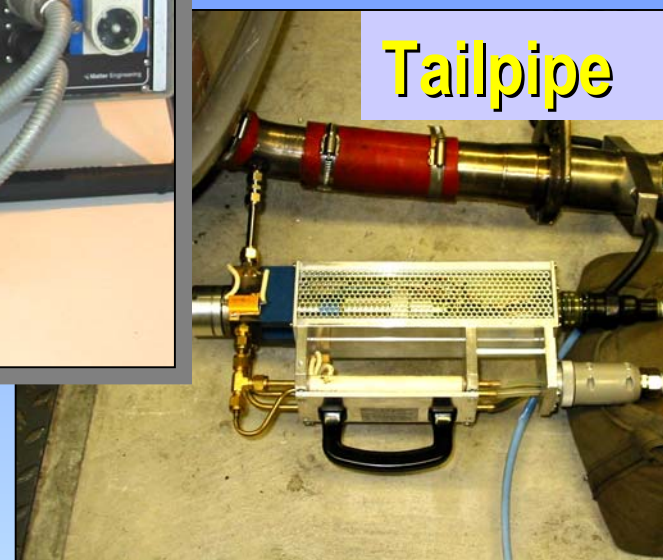
Example for a PMP Nanoparticle Counting system



Raw Gas



Tailpipe





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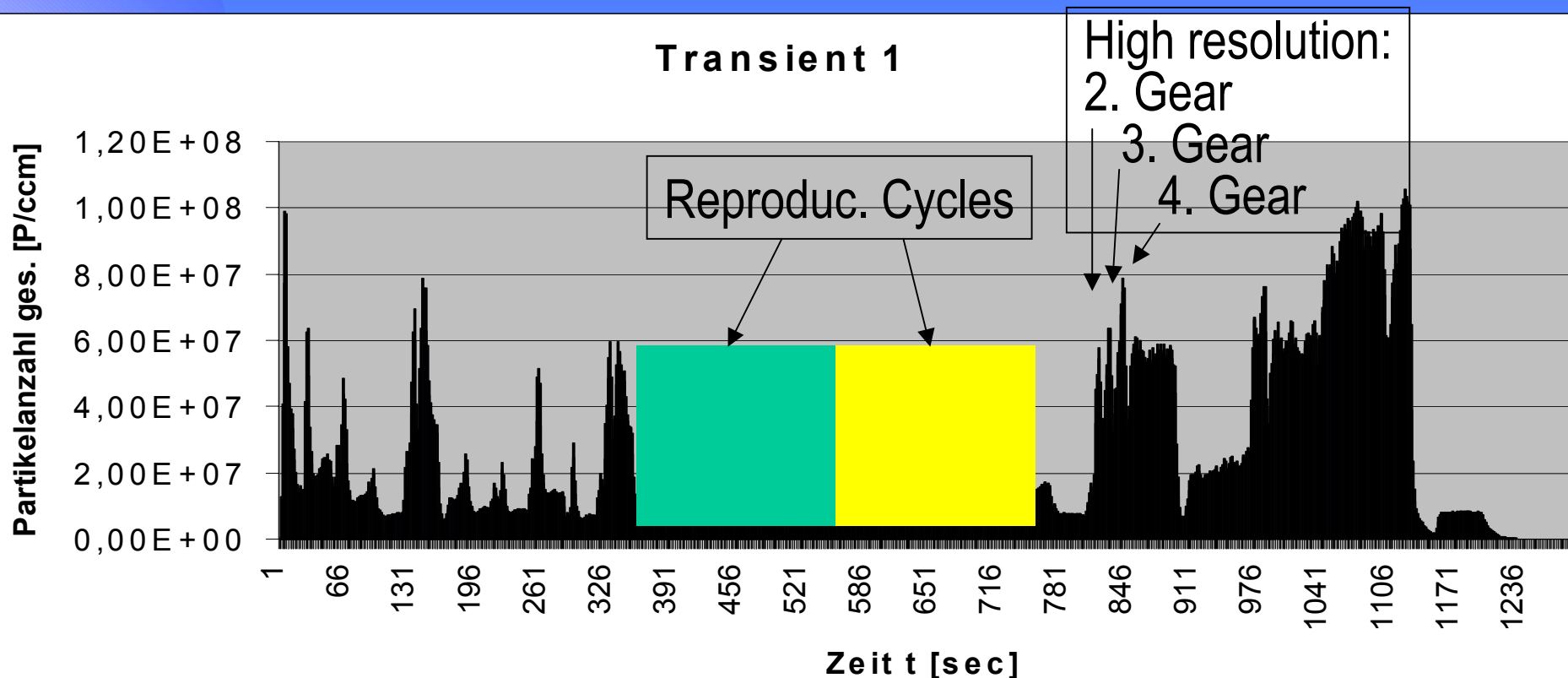
2. Demands & Experiences

Repro. & Stability

- 1) *Reproducibility / repeatability and stability
(more than absolute correctness and sensitivity)*
- 2) *Robust, easy „plug & play“ handling - low preparation time
and reliable during all-day handling*
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- 5) *Others (mobile application, onboard diagnostic, etc.)*

2. Demands & Experiences

Repro. & Stability



2. Demands & Experiences

Repro. & Stability

CPC 5.403: Full Automatic Stand alone System (with internal CPU & PCMCIA interface)

Integrated Alcohol Tank
with automatic supply

Automatic DMA control
for up to 255 channels

Automatic system status
control and recording

Temperature Automatic
(for Saturator / Condenser)

Digital Board +
Slot for Memory Cards



Automatic Condensate
Drain Off

Air-Flow Pumps
with automatic flow control

**External PC: only for start-parameter
and receiving measured data
(from internal counter memory)**

2. Demands & Experiences

robust & reliable

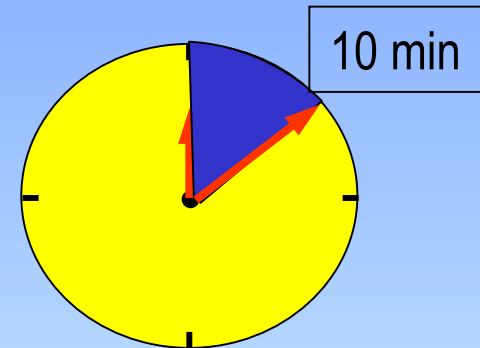
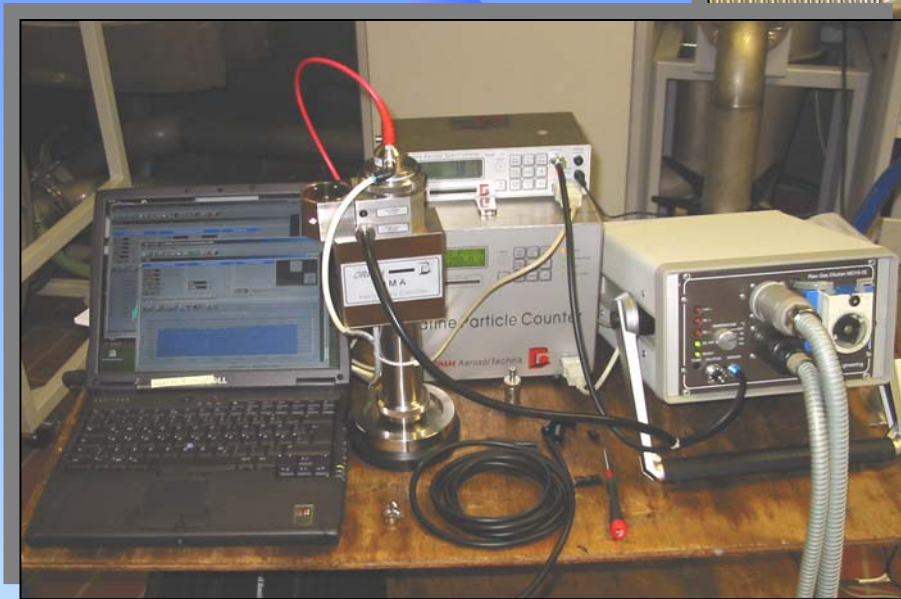
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Field Experience with portable SMPS+C system on Diesel Test Stands

2. Demands & Experiences

robust & reliable

Setup takes in this version less than 10 minutes until the first measurement

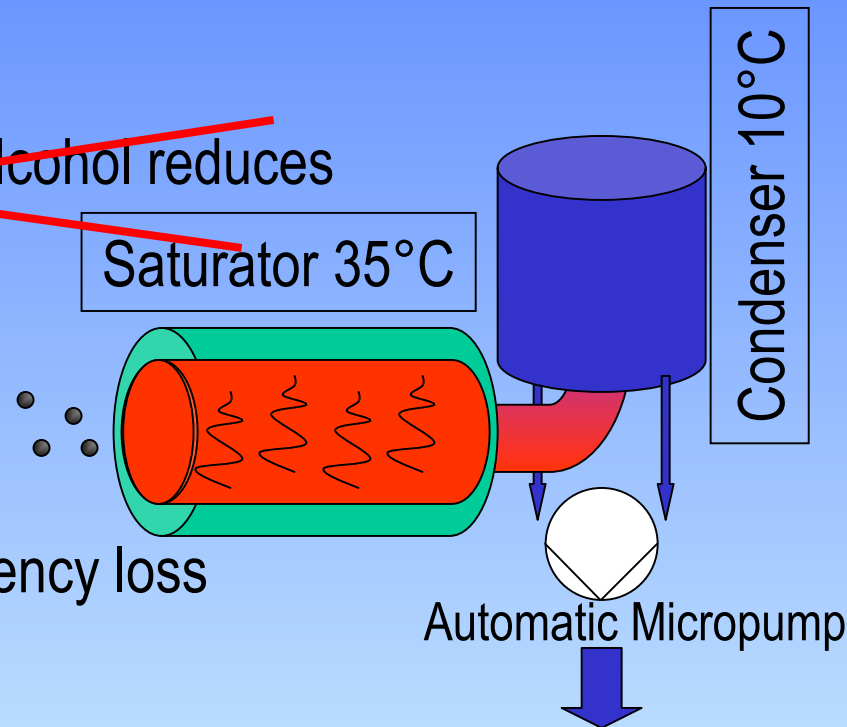


Reliability: Water Condensation Problem:

(condensation of humidity in the CPC condenser)

~~- condensated water in the alcohol reduces count efficiency~~

- long-term measurements without maintenance & efficiency loss



unique

2. Demands & Experiences defined conditions

- 1) *Reproducibility / repeatability and stability
(more than absolute correctness and sensitivity)*
- 2) *Rugged, easy „plug & play“ handling - low preparation
time
and reliable during all-day handling*
- 3) *Defined sampling / measurement method*
- 4) *Selfchecking / calibration*
- 5) *Others (mobile application, onboard diagnostic, etc.)*

2. Demands & Experiences defined conditions



work of the PMP group and the authorities

- 1) sampling and measurement devices*
- 2) measurement procedure*
- 3) sampling locations*
- 4) test cycle*
- 5) etc.*

2. Demands & Experiences measurement quality

- 1) *Reproducibility / repeatability and stability
(more than absolute correctness and sensitivity)*
- 2) *Rugged, easy „plug & play“ handling - low preparation
time
and reliable during all-day handling*
- 3) *Defined sampling / measurement method*
- 4) *Selfchecking / calibration (measurement quality)*
- 5) *Others (mobile application, onboard diagnostic, etc.)*

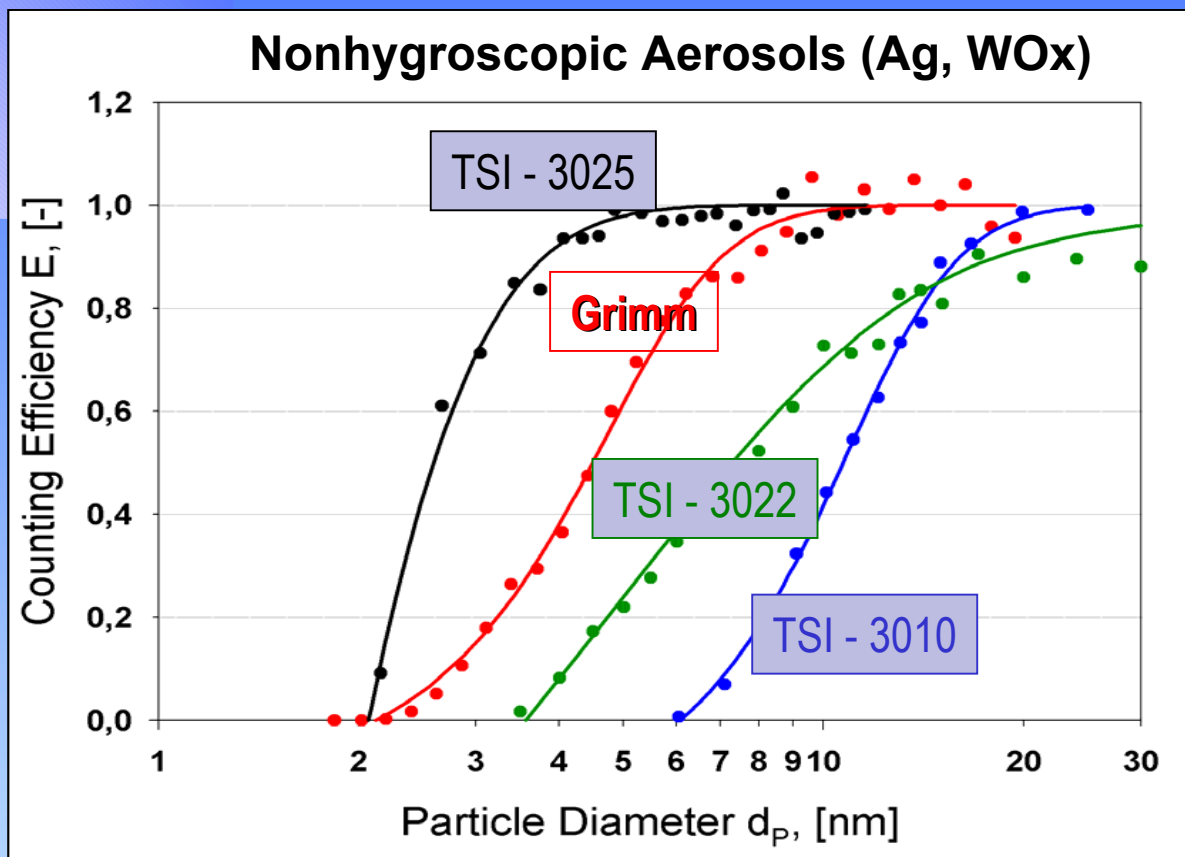
2. Demands & Experiences measurement quality

Selfcheck:

- *Zero count test (with clean air)*
- *Laser test (check of power output)*
- *Clean optic test (no backscattering of dirt in the optic)*
- *Recording of instrument conditions (for a later evaluation of data)*



System Efficiency:



🕒 **TSI 3025 (Kesten 1991)**

$d_{50} = 2.6 \text{ nm}$

(0.1 lpm - Internal Dilution !)

🕒 **Grimm 5.403**

$d_{50} = 4.5 \text{ nm}$

🕒 **TSI 3022 (Ankilov 2002)**

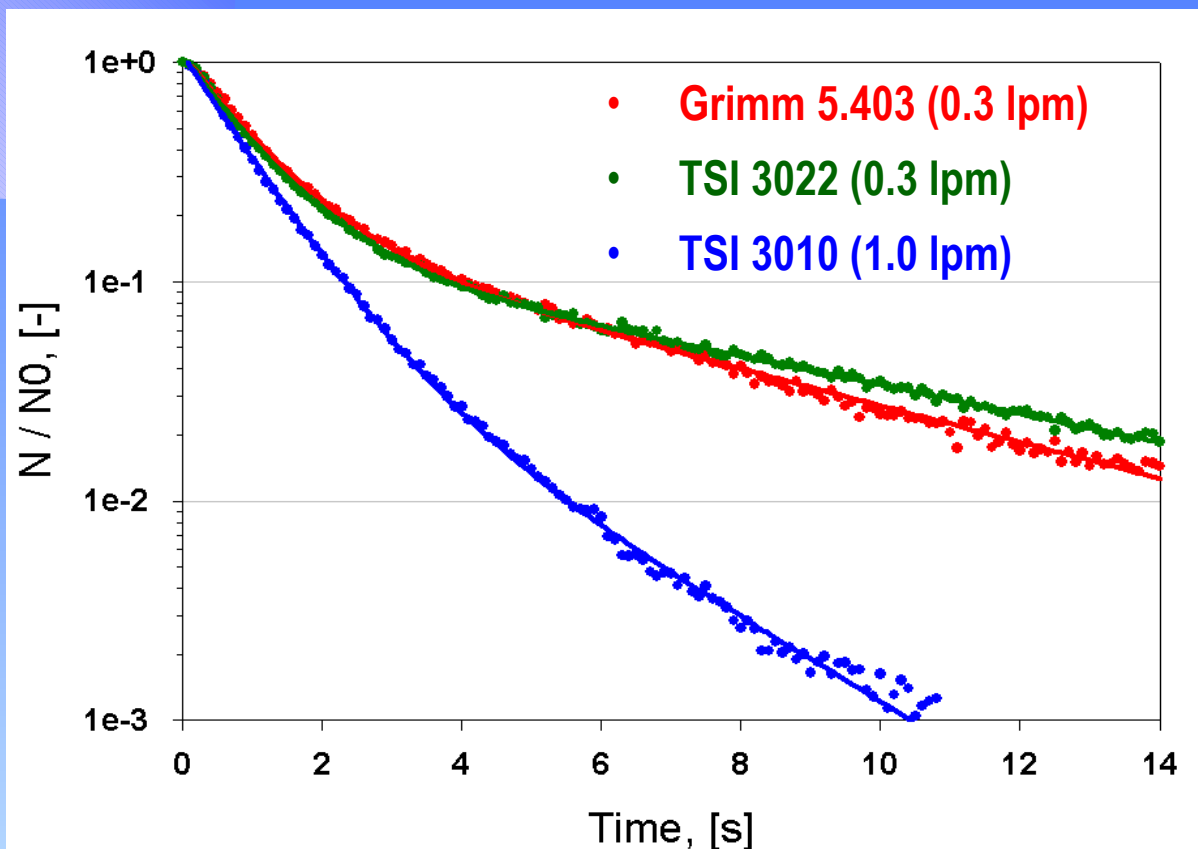
$d_{50} = 6.6 \text{ nm}$

🕒 **TSI 3010 (Ankilov 2002)**

$d_{50} = 10.0 \text{ nm}$

Carried out at Univ. Karlsruhe / Germany; Prof. G. Kasper

Comparison: Step Response



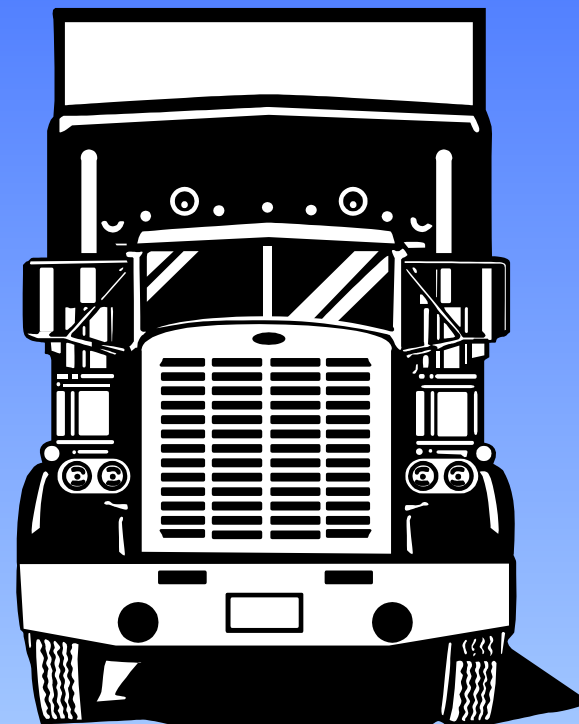
- Nonideal response is also found for other instruments
- Comparable response of Grimm CPC and the TSI 3022 due to same principle technic
- Better performance of TSI 3010 due to higher flowrate and different designed saturator

Carried out at Univ. Karlsruhe / Germany; Prof. G. Kasper

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Transportability:

- Compact System
(Pumps + control integrated)
- Integrated alcohol tank
- Battery operated
- No computer required
(memory cards for data storage)
- Alcohol only in saturated felt



2. Demands & Experiences

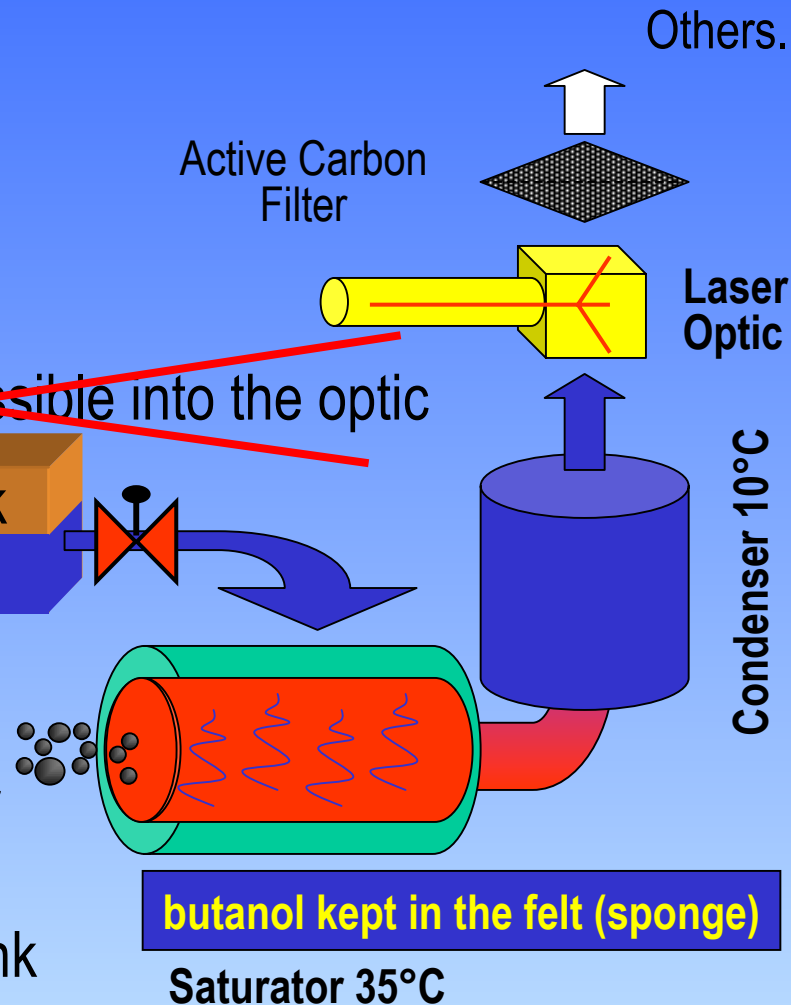
Transportability Problem:

(alcohol spill and odor)

~~- Due to mobility alcohol spill possible into the optic~~

- Integrated alcohol tank with automatic supply of saturator
- controlled by integrated sensor
- Tank level control (min. / max.)
- Optional: refill from external tank

unique



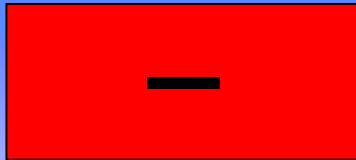


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- + *Grimm CPC 5.403 is a reliable instrument with comparable results to equal instrument types*
- + *Easiest handling and compact / robust system*
- + *With rot. disk diluter MD19 fast plug and play setup for reproducible AND repeatable results*



- *response time of a CPC is limited*
- *for Transient cycles: no size information (without DMA)*
- *sampling and dilution not integrated*



A complete „PMP“ unit
(sampling + measurement) is requested !



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Particle size measurements during
TRANSIENT driving cycles !

! Enormous amount of data acquisition

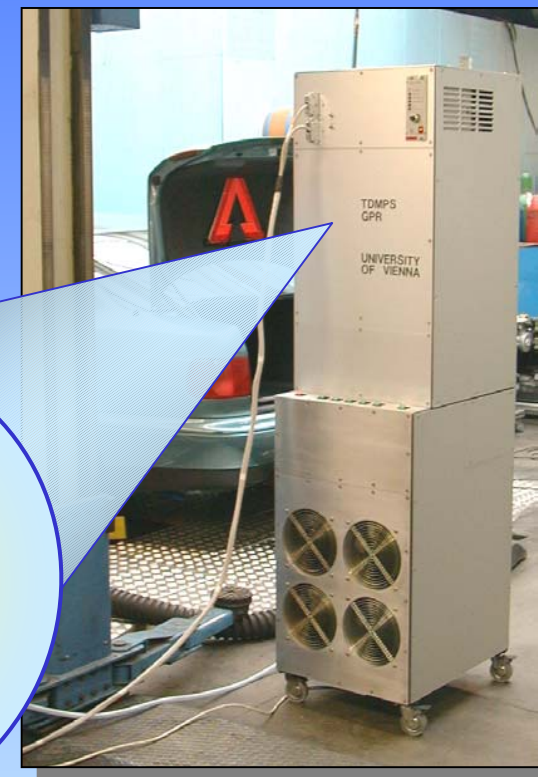
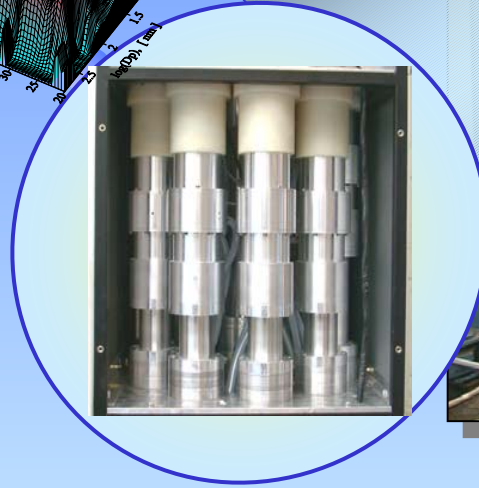
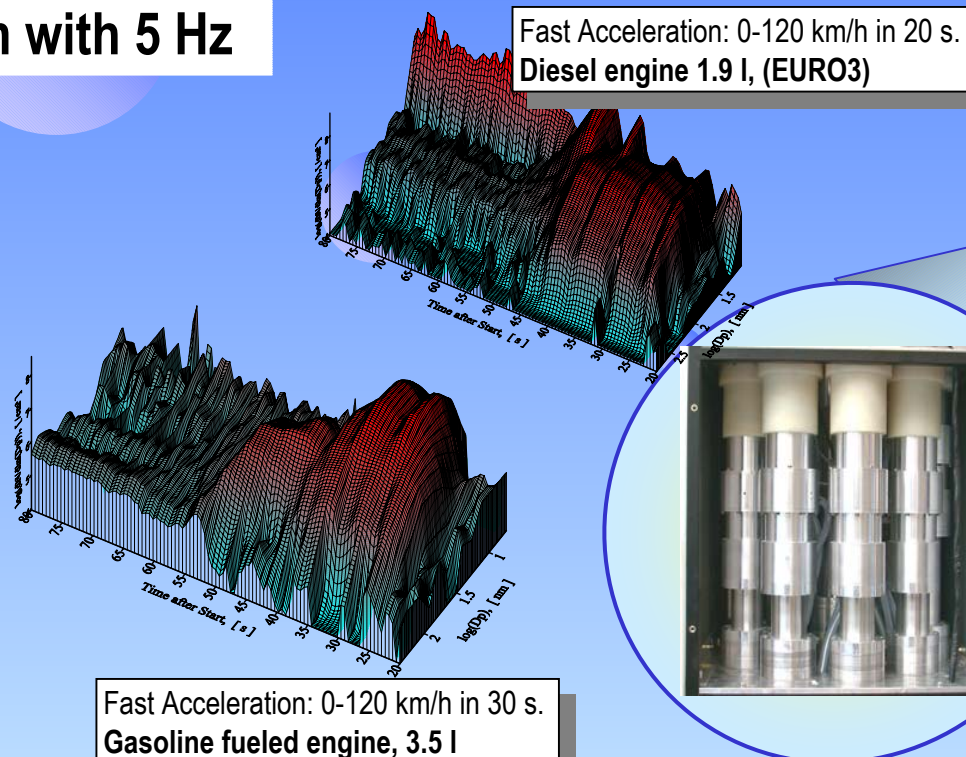
! Analysis and Interpretation of data more complicated

! More technical effort

! Very high price >> EURO 50,000.-

TR-DMPS - System (5.600)

10 channel ultra fast particle spectrometer for number size distributions in the size range of **3 - 600 nm with 5 Hz**



**Thank you for
your attention !**

END