PMP Meeting

May 16th 2018

Presented on behalf of PEMS4NANO
by Les Hill
HORIBA Europe
May 2018

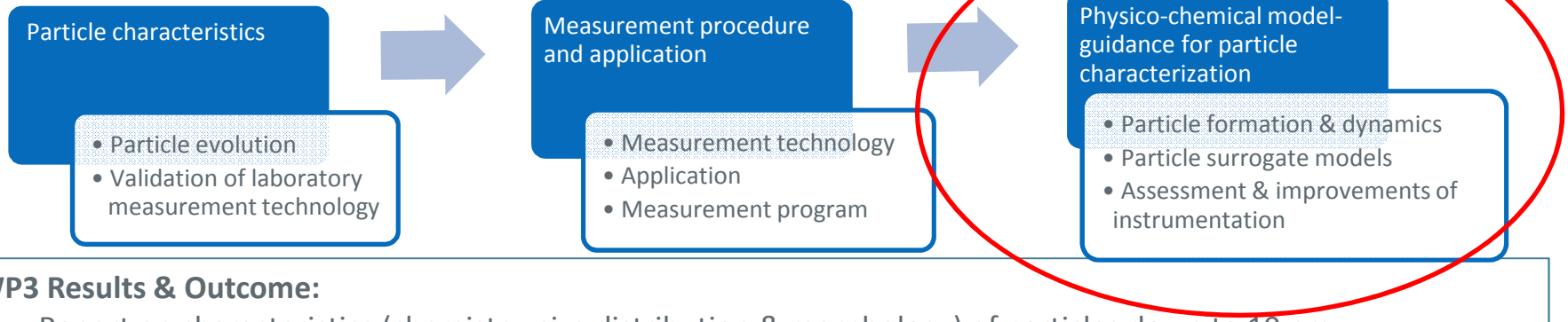
www.pems4nano.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 724145

WP3 – Measurement integration into system development

WP3 Aim & Objectives:

1. Particle characterization in exhaust line & validation of laboratory measurement technology
2. Development of a PN >10 nm measurement procedure for the application on a MCE test bench
3. Development of surrogate models for particle size distribution and composition
4. Assessment/improvements of instrumentation models associated with measurement technologies/procedures



WP3 Results & Outcome:

1. Report on characteristics (chemistry, size distribution & morphology) of particles down to 10 nm
2. Recommendation for a reliable & robust PN > 10 nm measurement procedure for the application in the engine development process
3. More robust instrumentation models associated with measurement technologies & procedures

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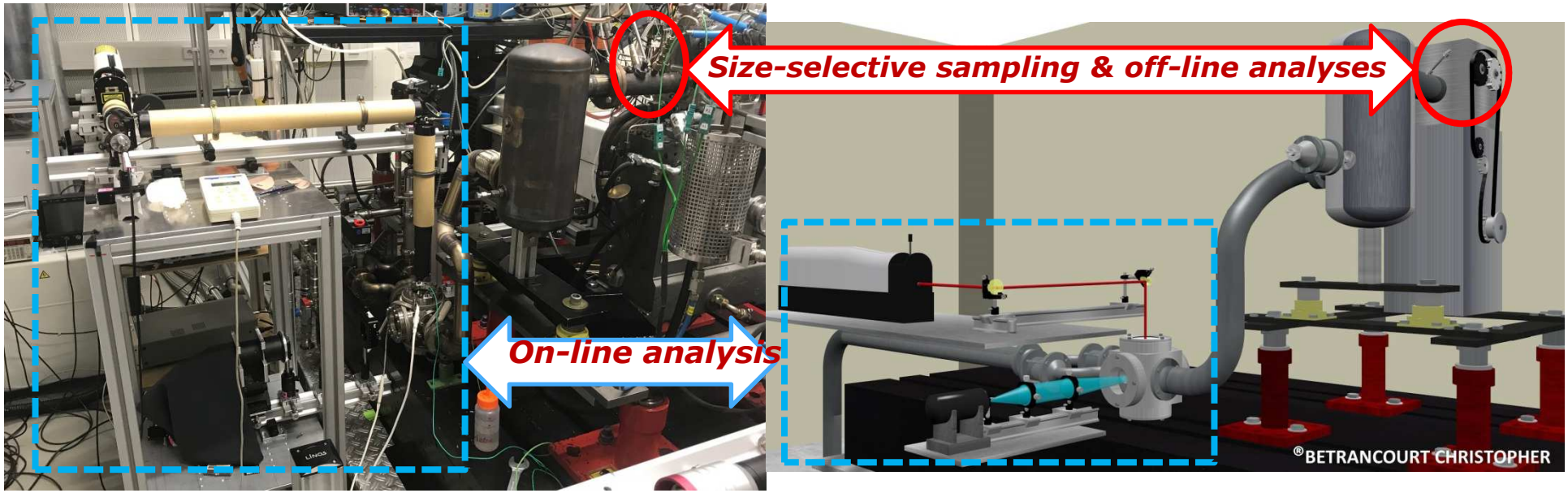
Experimental Setup
Single Cylinder Engine @ Bosch, Renningen



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Physico-chemical characterization of the smallest particles emitted by internal combustion engines

Results & importance

Extensive database on size-dependent particle structure, morphology, chemical composition … for various working regimes of the single cylinder engine (engine setpoint) – used as particle generator

	Engine setpoint	RPM	pmi	Lambda	soi	fuel
Increase load	1	2000	5	1.02	-270	Gasoline
	2		8			
	3		10			
Injection delay	4		10		-305	EURO5
	5		10		-311	

PMI : in cylinder pressure (bar)
SOI : start of injection

PEMS4Nano prototype optimization & Possible use in other projects for engine optimization

Input for the complex model developed by CMCL & Univ. Cambridge

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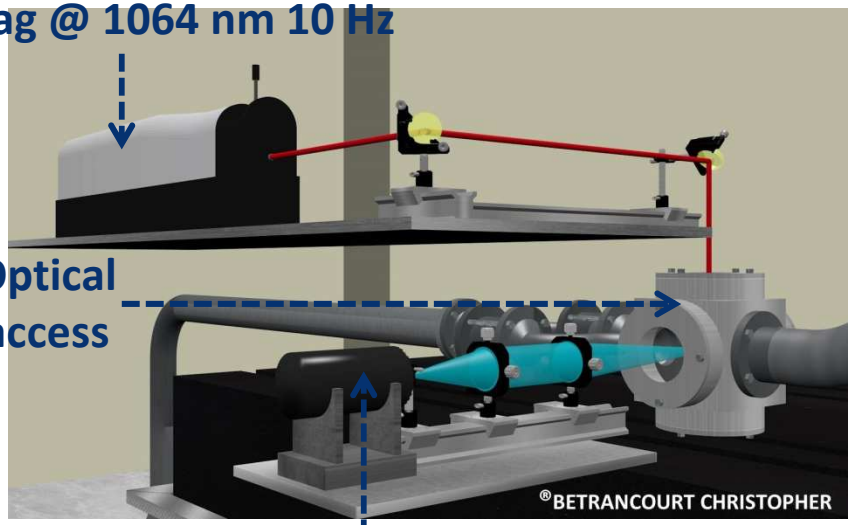
Experimental Setup

- ***On-line analysis by*** ***Laser-Induced Incandescence***



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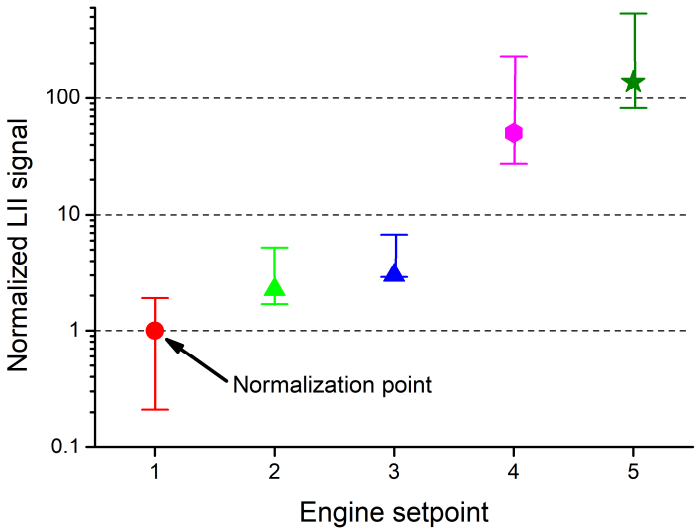
Physico-chemical characterization of the smallest particles emitted by internal combustion engines

PEMs 4Nano

On-line analysis by Laser-Induced Incandescence

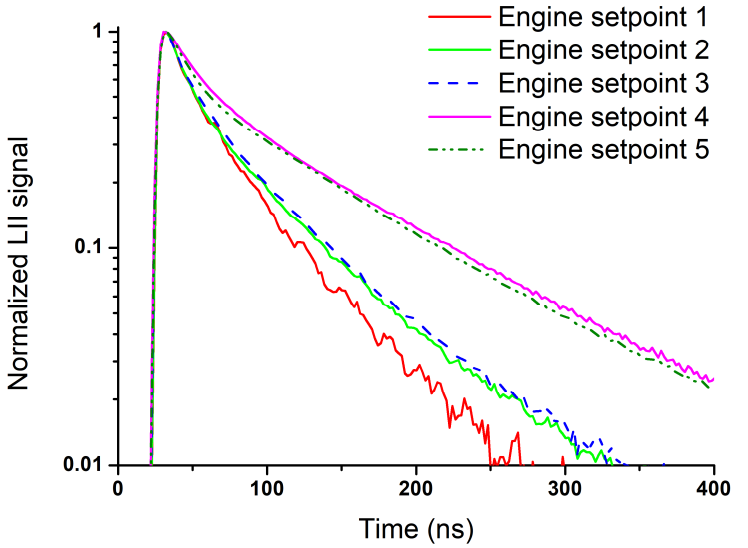
Variation of LII intensity: soot volume fraction



Increase of the soot volume fraction

Variation of LII decay-time:

« mean soot diameter » indicator



Increase of mean soot diameter

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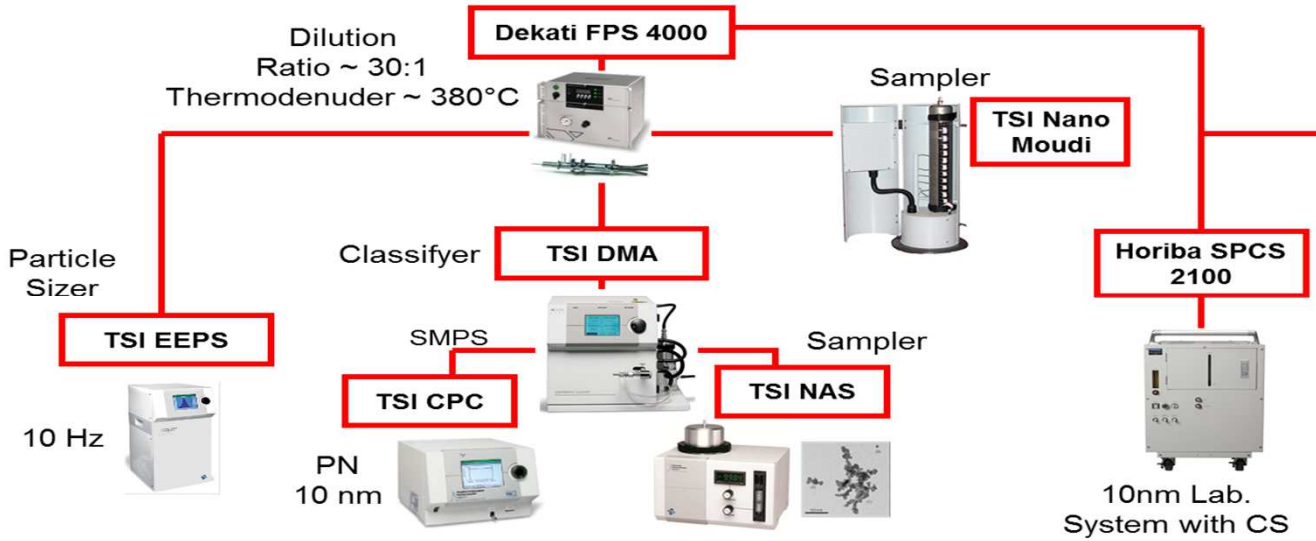
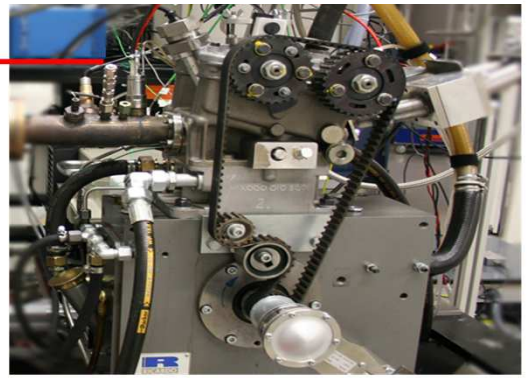
Experimental Setup

***Size-selective sampling & off-line analyses** by laser ionisation mass spectrometry, electron and atomic force microscopy, Raman spectroscopy*





- Single cylinder engine
- Displacement: 449 cm³, ε=12.5
- GDI and PFI mode possible

EEPS = Engine Exhaust Particle Sizer
FPS = Fine Particle Sampler
NAS = Nanometer Aerosol Sampler 3089

PFI = Port Fuel Injection
GDI = Gasoline Direct Injection

DMA = Differential Mobility Analyser
SMPS = Scanning Mobility Particle Sizer

Real time LII data can be compared to SMPS/EEPS/SPCS

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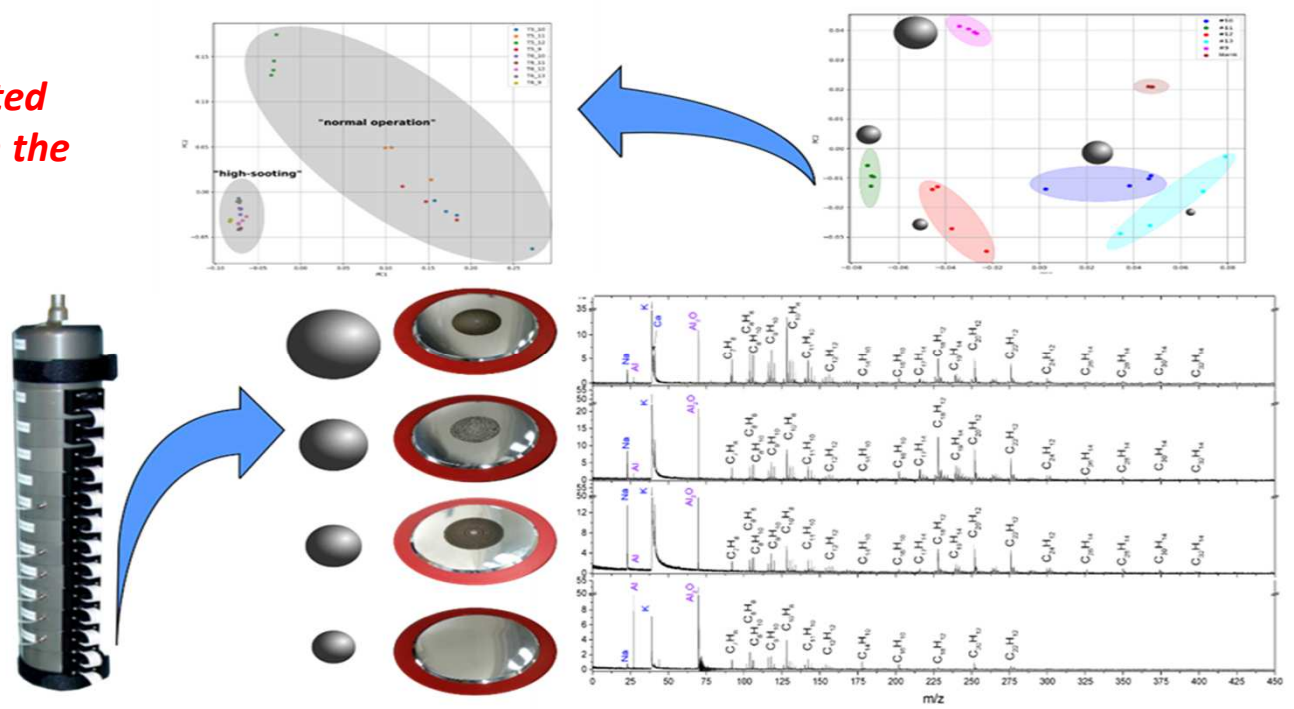
Physico-chemical characterization of the smallest particles emitted by internal combustion engines

Size-selective sampling and off-line analyses
laser ionisation mass spectrometry + advanced statistical analysis

Determining the size related particle morphology from the Nano MOUDI samples



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Physico-chemical characterization of the smallest particles emitted by internal combustion engines

Size-selective sampling and off-line analyses

Further analysis of particles by

- Electron microscopy (Scanning Electron Microscope / Transmission Electron Microscope)

- Atomic force microscopy

- Tip Enhanced Raman Spectroscopy (TERS)

Work In Progress . . . .

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Model Guided Application (MGA)

- MGA combines physico-chemical and statistical algorithms to simulate the formation and evolution of the particulate emissions in IC engine driven vehicles.
  MGA development offers :
  - ✓ Sensitivity of PM and PN to operating conditions in IC engines and vehicles
  - ✓ particle size distribution, PM, PN, aggregate composition and morphology as a function of fuel characteristics, engine operating mode, after-treatment and RDE attributes
  - ✓ Thermodynamic boundary conditions at various sampling points to reduce the need for measuring “everything“
  - ✓ Improvement of the robustness of measurements procedure(s)

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MGA interfaces with measurements

- **MGA development:**
  - Detailed particle population balance model within the SRM Engine Suite™ extended beyond soot to include ash, sulphates and volatiles
  - *k*inetics™ reactor network simulation to account for dilution and sampling

- **Direct benefits to MGA from the Single Cylinder Engine measurements campaign:**
  - Validation of engine-out particle size distributions at load-speed points

- **Results, recommendations and next steps:**
  - Dilution and temperature thresholds recommended by MGA based on the number density of solids and SOF
  - Size-resolved chemical characterisation of particles to be used to assess the MGA

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Workshop on particle measurement

The coordinators of the three particle measurement projects DownToTen, PEMs4Nano and SUREAL-23 are in the progress of organizing a two day event on the ***Measurement and Characterization of nanoparticles from powertrains.***

Proposed Date: ***Tuesday, October 9th 2:00 PM – Wednesday, October 10th 2:00 PM***
Location: ***Aristotle University 54124 Thessaloniki, Greece***

It will cover presentations from different stakeholders with the following topics:

Current EU/US/Japanese regulation trends,
Results from the green vehicle projects (Upgrade, Dieper, Paregen, Eagle…)
…

Please block the date – more information will be available shortly

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End of presentation

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