



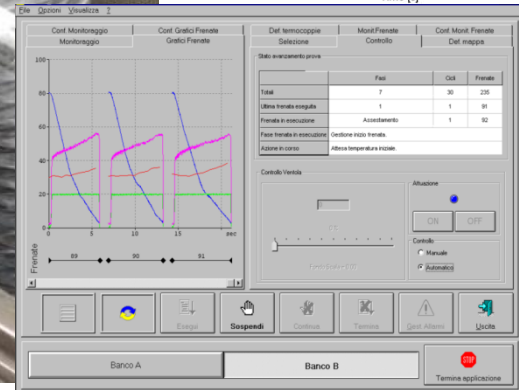
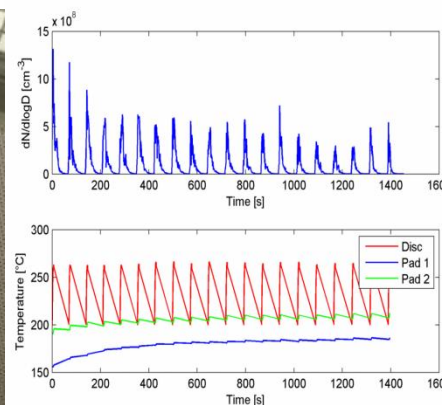
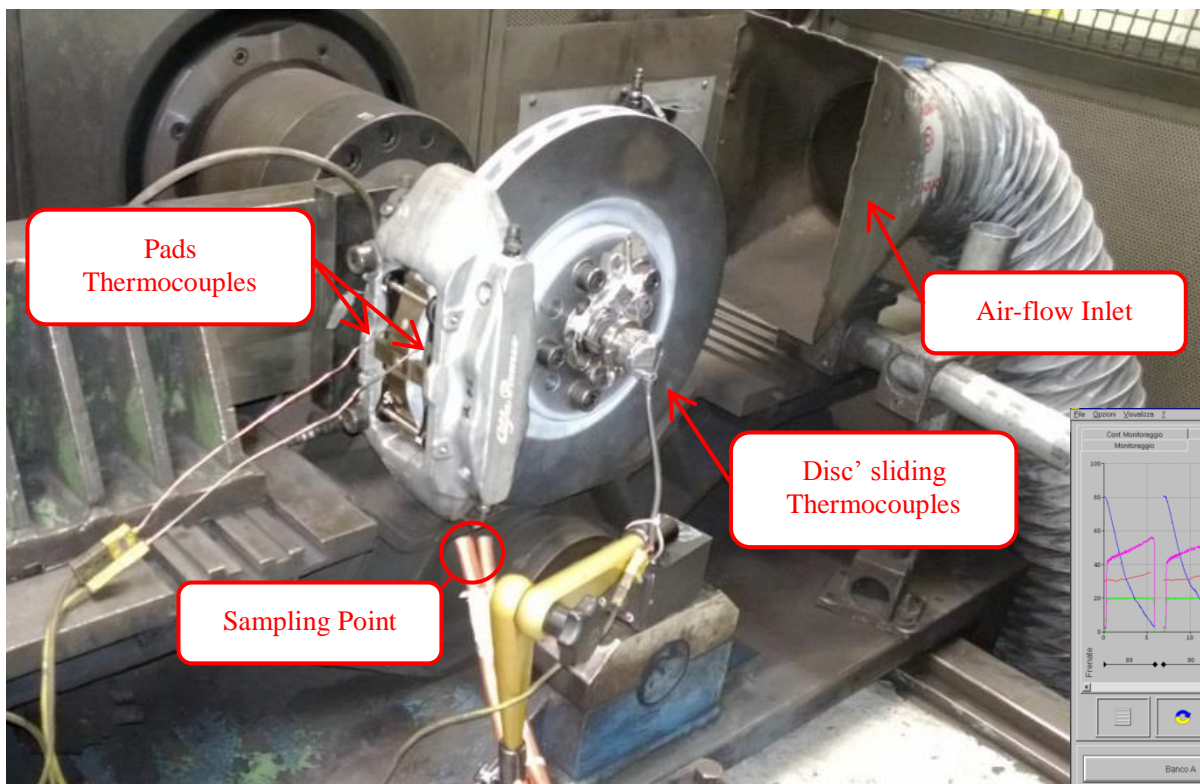
A brake test stand for particles measurement and collection

PmP Meeting
10-02-2016

Outlines

- Introduction
- New design
- Working principle
- Sampling
- Results example

Where were we the last time?



*Mattia Alemani, Ulf Olofsson, Guido Perricone, Jens Wahlström, Anders Söderberg, Alessandro Ciotti, "A proposed dyno bench test cycle to study particle emissions from disc brakes", Eurobrake 2014 proceedings

Dynamic Bench tests helps to understand the particle behavior under real working conditions. Recent updates includes a clean chamber and Isokinetic sampling.

Why to improve?

- To avoid sample contamination due to external sources
- To have a representative sample through iso-kinetic sampling
- To have a controlled volume with well mixed particles

How to improve?

SAMPLING VOLUME

Clean Chamber: A well defined and controlled volume, with an HEPA H13 filtered air inlet

Well-mixed airflow: inside the clean chamber will provide an homogeneous aerosol

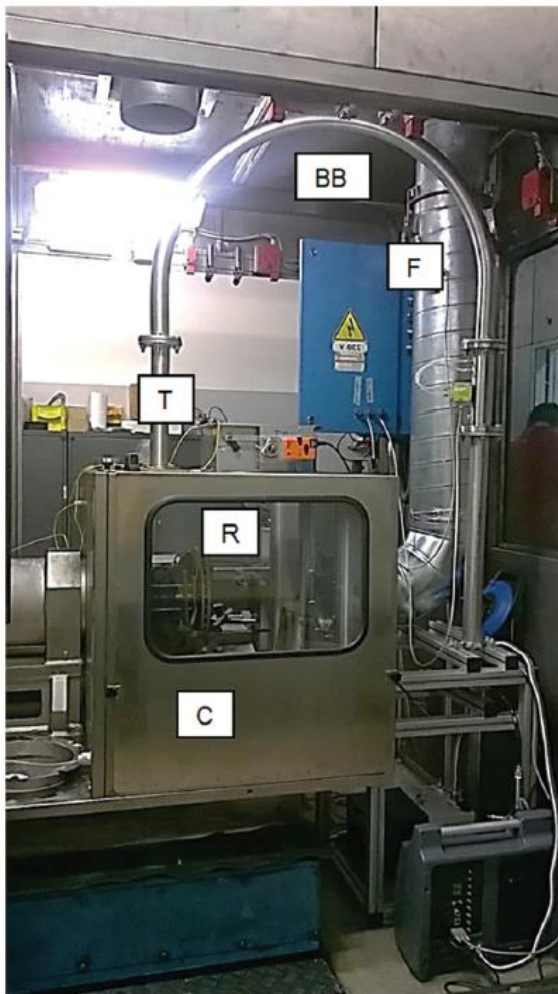
SAMPLING LINE

Isokinetic Sampling: outlet speed equals the sampling probe inlet speed avoiding particle losses

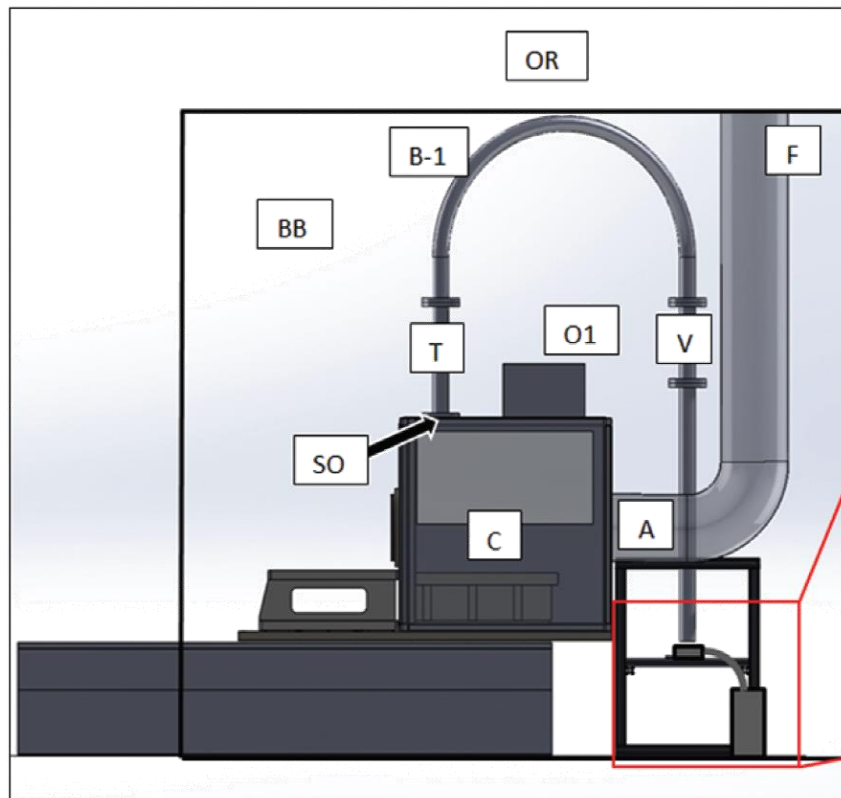
Sampling efficiency: to reduce particles settling or sticking along the sampling line

The final target is to have a sampling chain as much representative of the system emissions and reliable, as possible

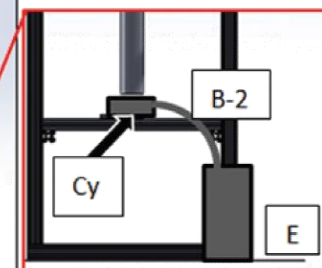
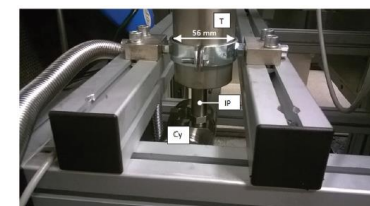
Final design



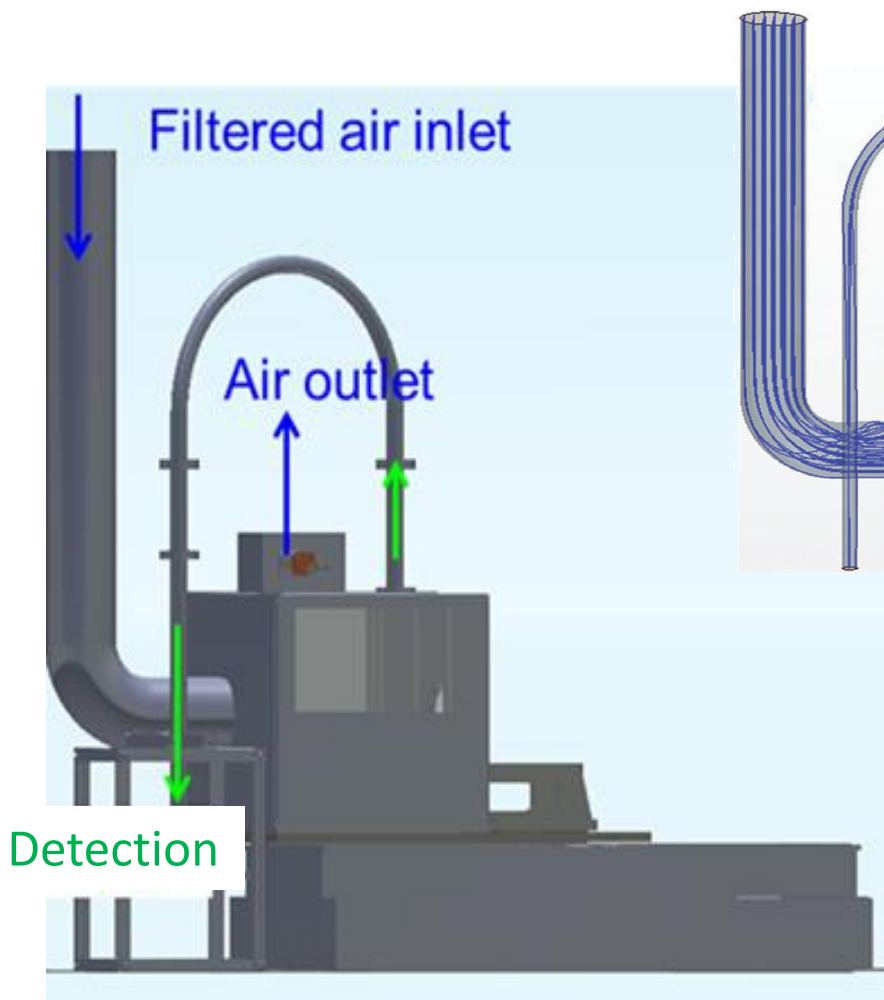
A photograph of the novel bench design. BB: bigger box (door open); F: inlet tube from which clean air enter; T: outlet tube; R: rotor; C: dust-box chamber



Schematic diagram of the test stand. OR: outdoor room; B-1: 0.4m bend tube; F: flow measurement point and filter; BB: bigger box; T: tube; O1: first outlet gap; V: Venturi flow measurement tube; SO: sampling outlet; C: dust-box chamber; A: Air inlet opening; Cy: Cyclone; B-2: 90°, 0.1m bend tube; E: ELPI+® cascade impactor



Chamber working principle



Source: 2015, Proc IMechE Part D: J Automobile Engineering, p. 1-8

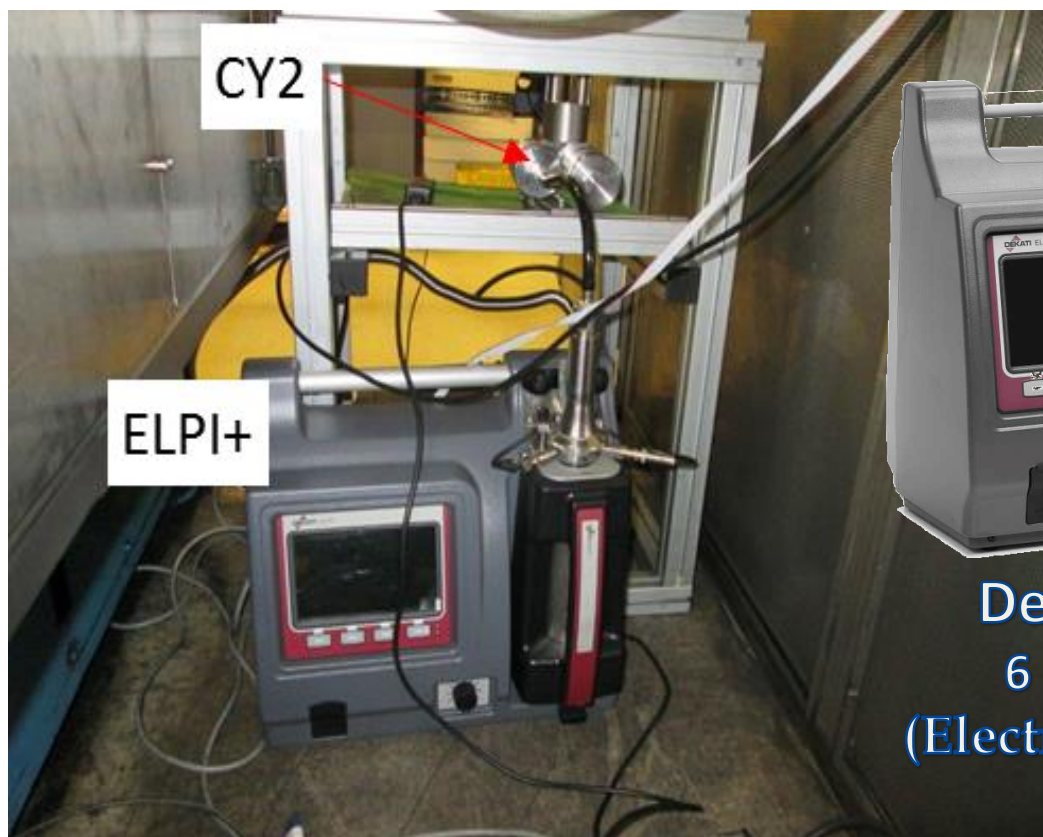
Features	Characteristics
Chamber dimensions [mm]	1296 x 3793x795 (WxLxH)
Chamber volume [m ³]	0.817
Airflow [m ³ /h]	1175 (adj. 500-2500)
Air-exchange [# /min]	19.5
Sampling speed [m/s]	3.47

Controlled parameters

Parameter	Dyno Bench
Wear	<i>Measured after test (weights/thickness)</i>
Pressure	<i>Applied</i>
Torque	<i>Torque transducer</i>
Friction	<i>calculated</i>
Disc Temperature	<i>1 k-type thermocouple</i>
Pin Temperature	<i>2 k-type thermocouples (one for each pad)</i>
Sliding velocity	<i>Imposed/measured</i>
Flow rate	<i>Imposed</i>
PM/PN	<i>Elpi+ (with collection)</i>

Sampling

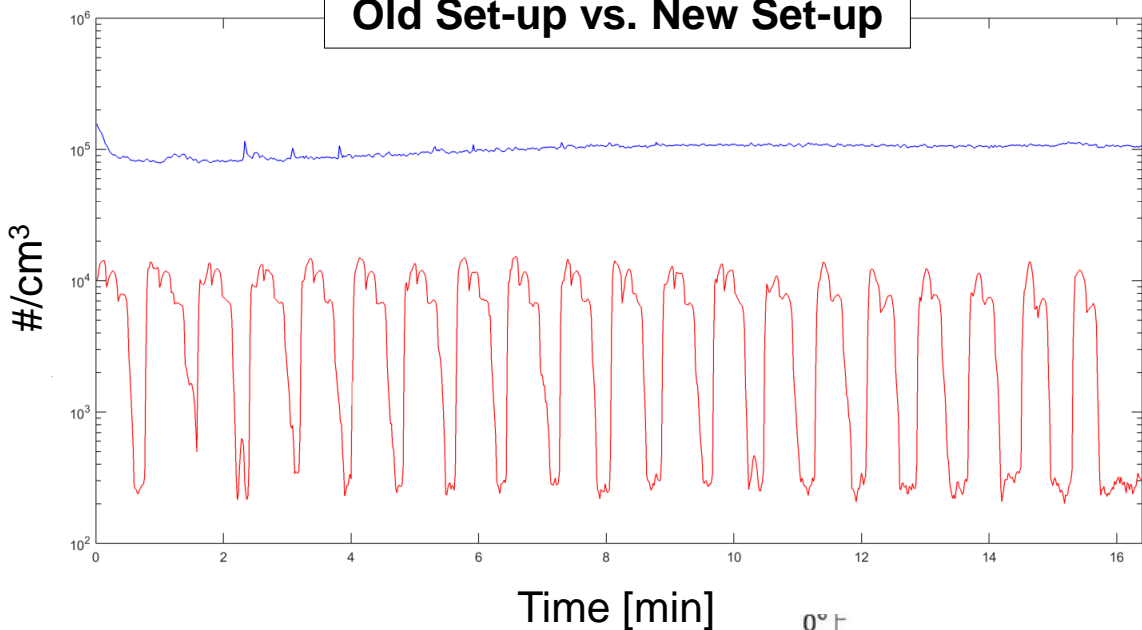
An Electrical Low Pressure Impactor (ELPI+[®]) measures and collect particles. A cyclone filters all the particles bigger than 10 μ m



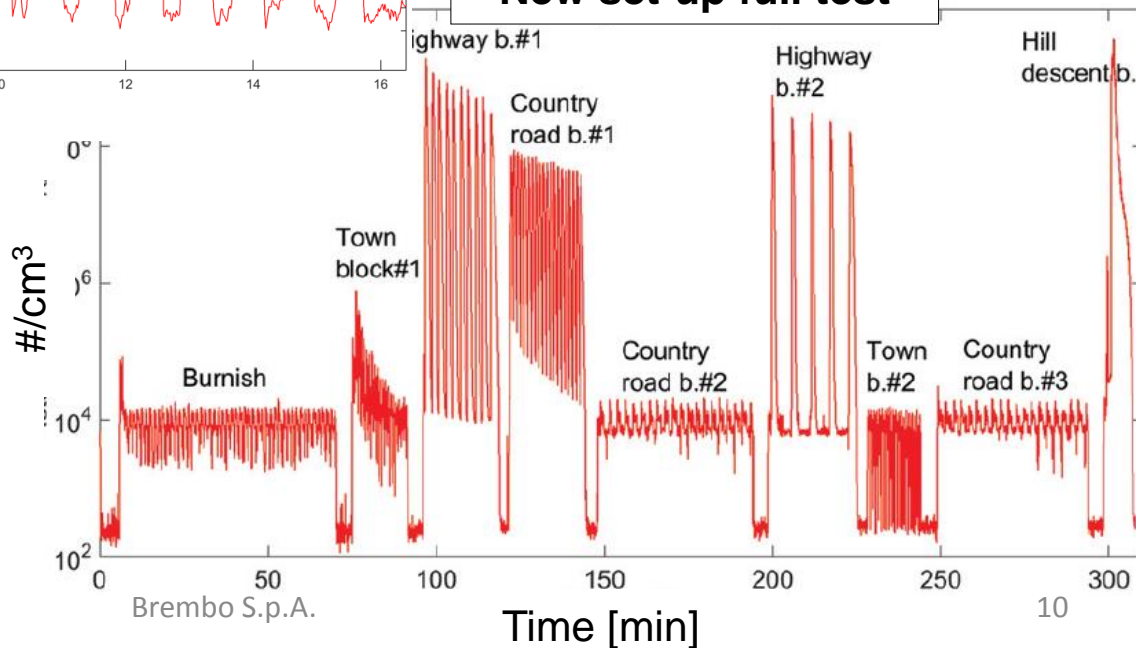
Dekati[®] ELPI+
6 nm – 10 μ m
(Electrical/ Impactor)

A result example

Old Set-up vs. New Set-up



New set-up full test



— Old Set-up
— New Set-up

Reference




Original Article

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**MECHANICAL
ENGINEERS**



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J Automobile Engineering*
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Thank
you

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