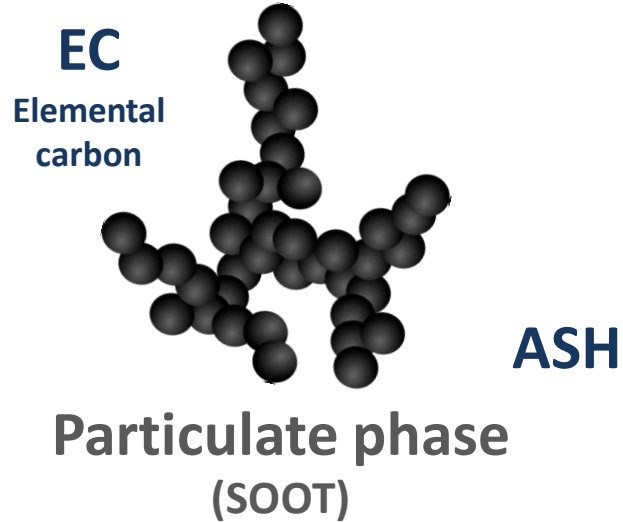
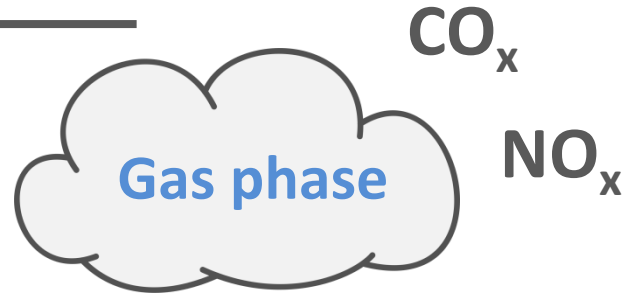


A novel methodology for the analysis of the particulate/gas phase partitioning in combustion emissions

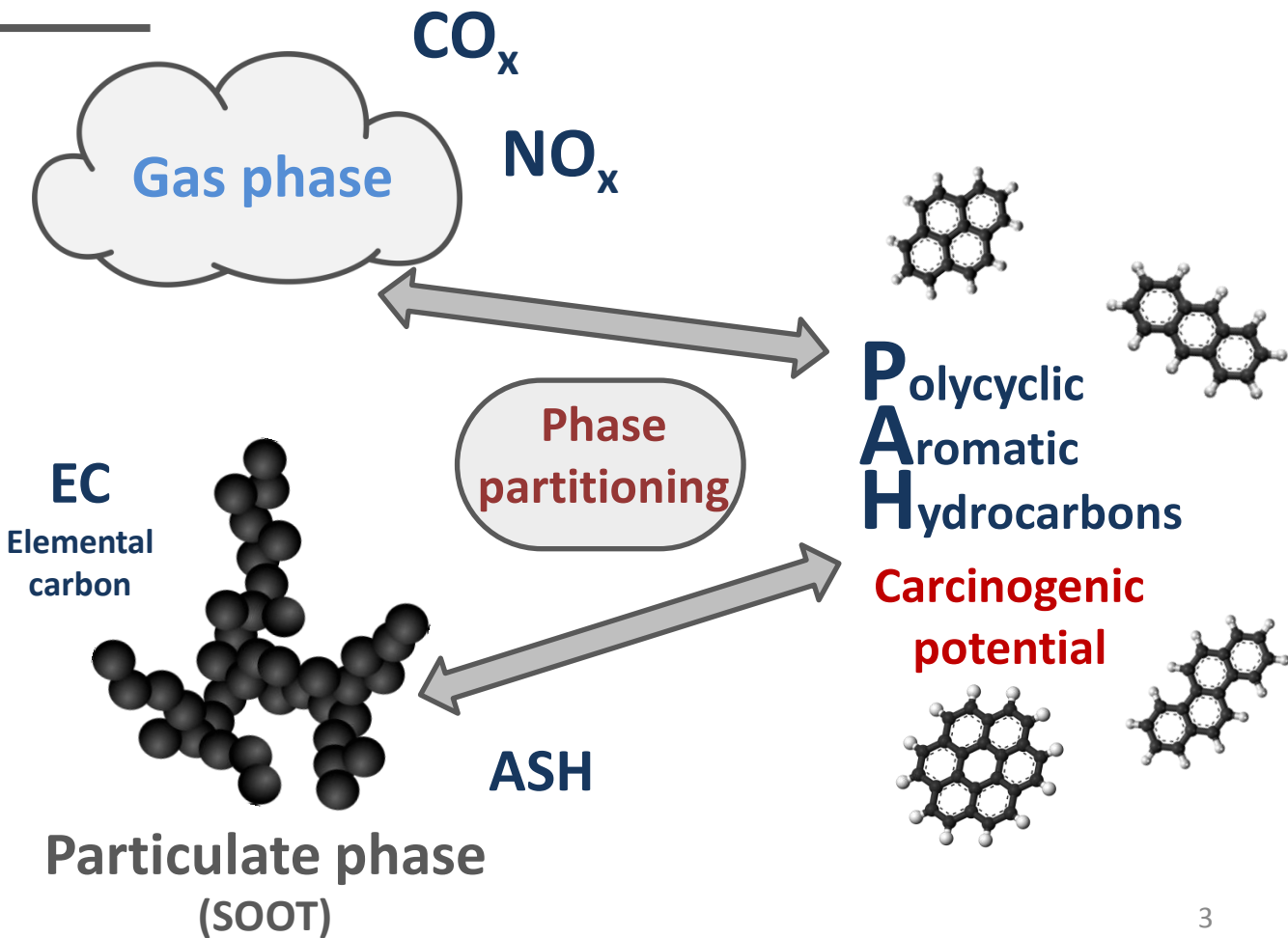
D. Duca, Y. Carpentier, M. Vojkovic, C. Pirim and C. Focsa

Univ. Lille, CNRS, UMR 8523 - PhLAM - Physique des Lasers, Atomes et Molécules, Lille F-59000, France

Motivation



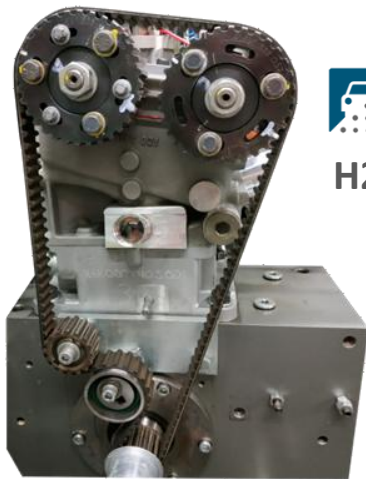
Motivation



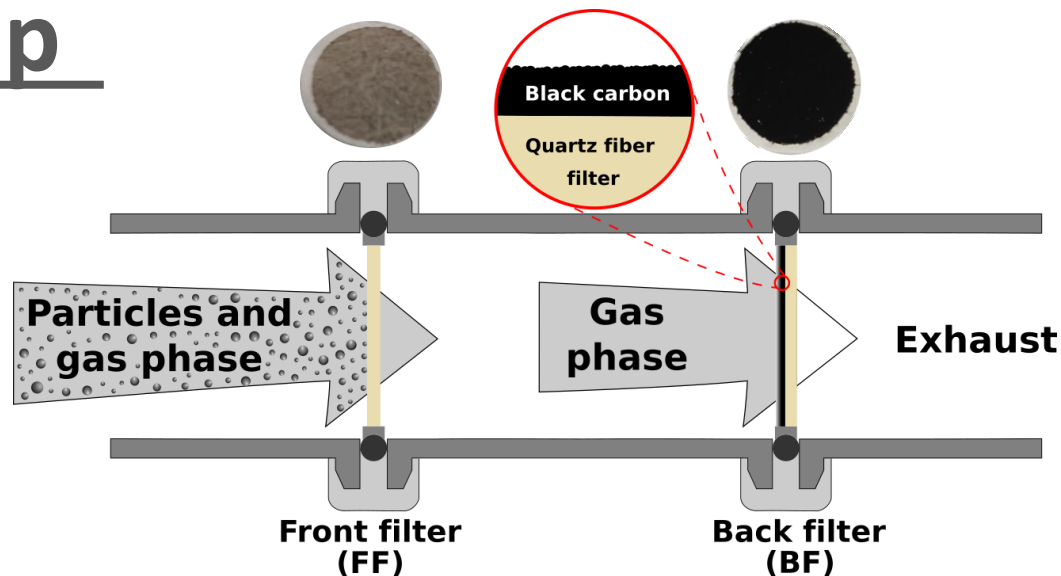
Sampling setup



miniCAST (propane)



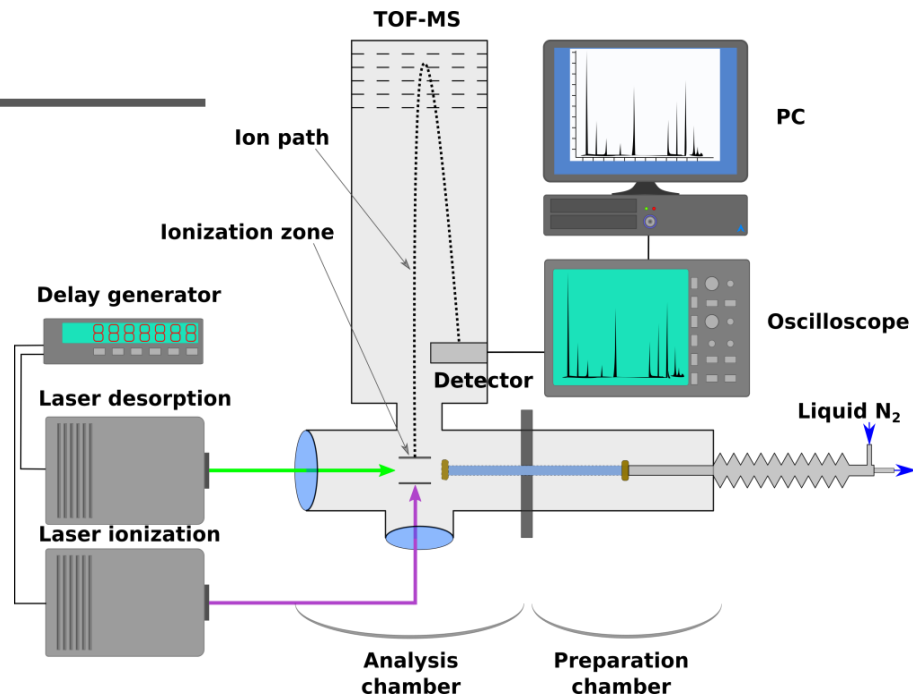
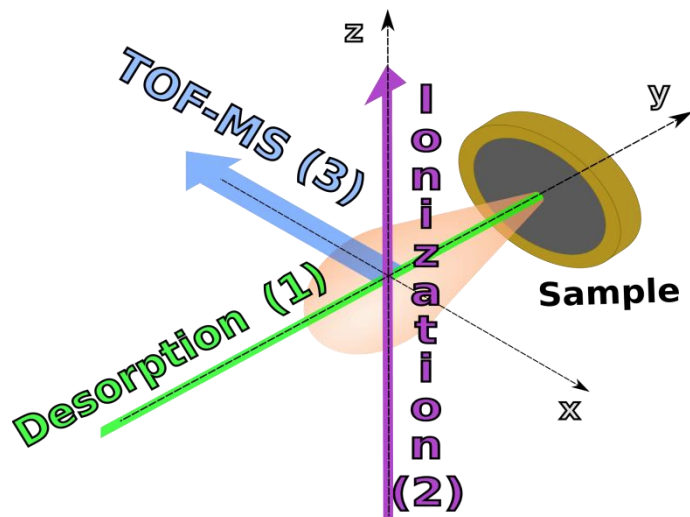
Single cylinder engine
(EURO5 gasoline)



New double-filter sampling system:

- First (front) filter collects the **particulate phase**;
- Second (back) filter captures the **gas phase**;

Experimental setup

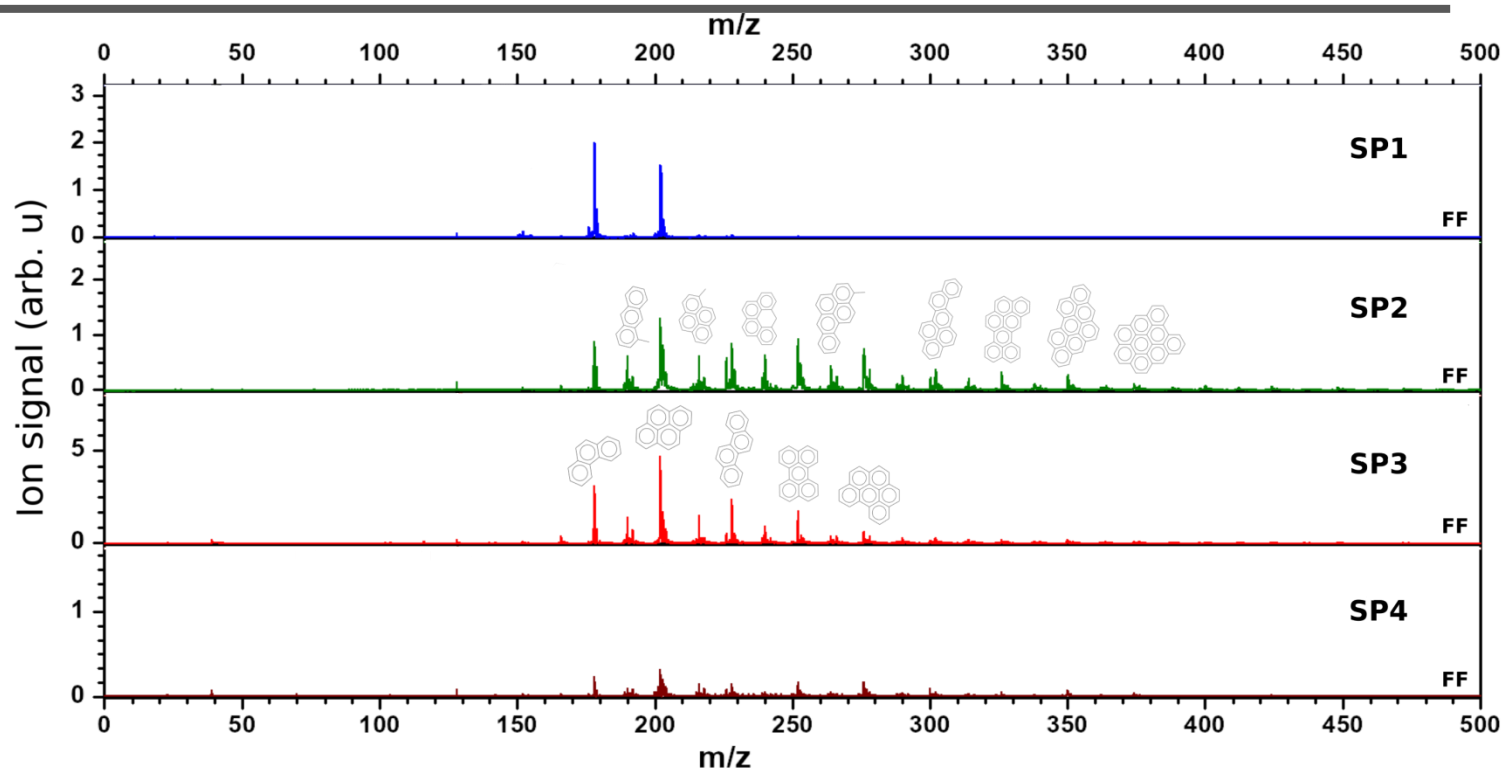


Two step laser mass spectrometry (L2MS) can be divided into three key stages:

- (1) Laser desorption ($\lambda=532\text{nm}$)
- (2) Laser ionization (multiple wavelengths: 266nm, 157nm, 118 nm)
- (3) Detection: Time-of-flight mass spectrometer

- Controlled fragmentation
- Ultra-sensitive to PAHs [1]
- Selective (laser ionization)

Front filter (FF) – particulate phase



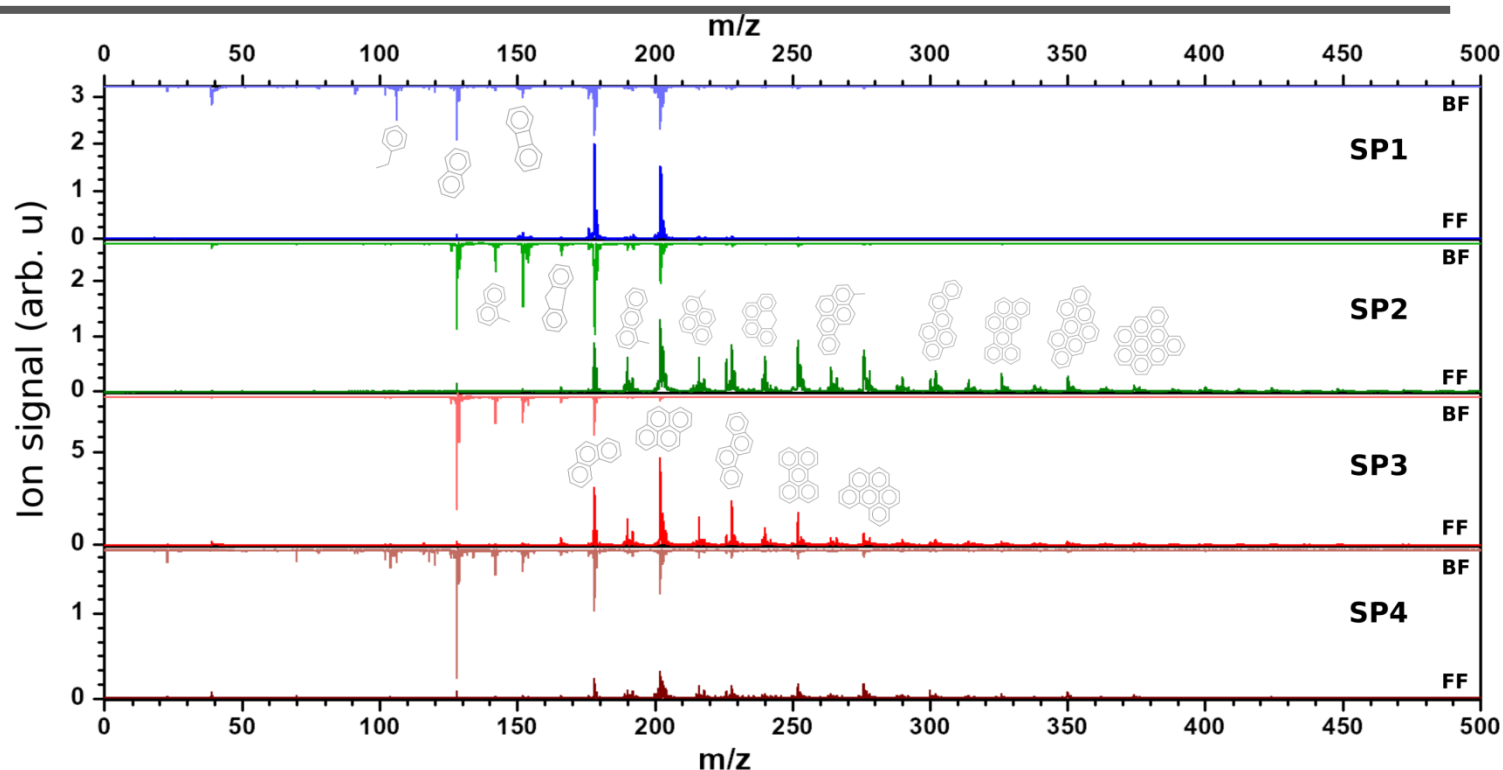
L2MS
266 nm ionization



PAH distribution depends on the CAST set point

Front Filter (FF) – Back Filter (BF):

separation between particulate and gas phases



L2MS

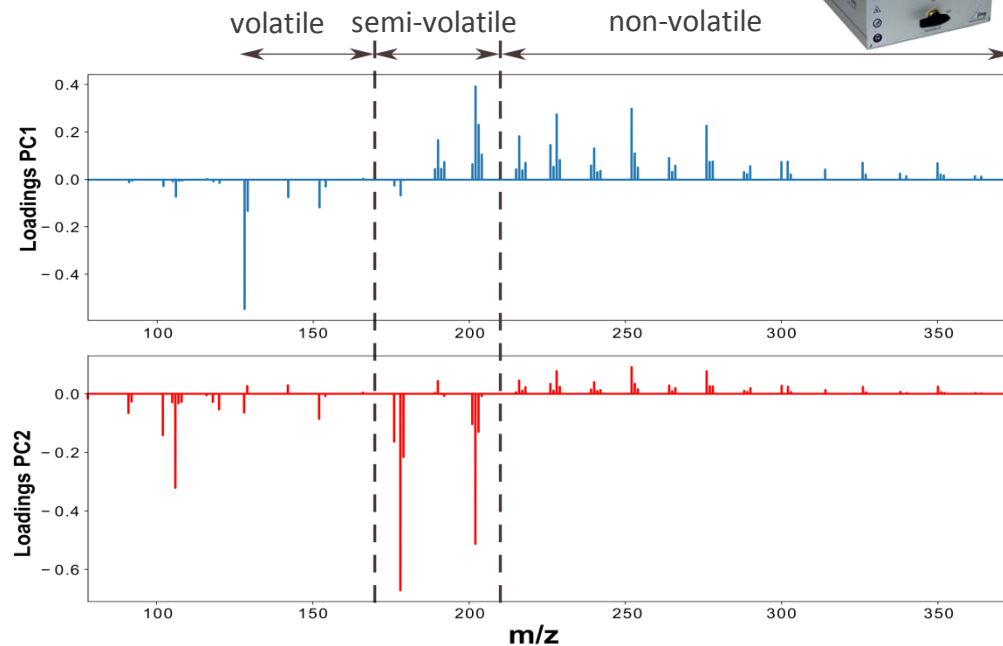
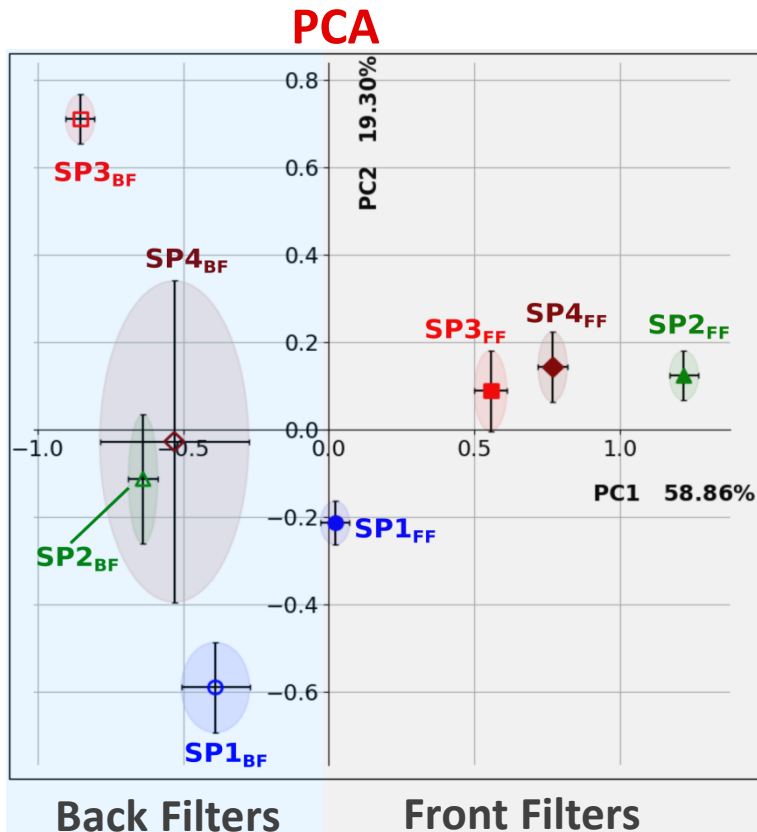
266 nm ionization



- **2-ring PAHs** are only in the gas phase (Back Filters)
- Species with **m/z > 202** are only on Front Filters

Front Filter (FF) – Back Filter (BF):

Principal component analysis (PCA)

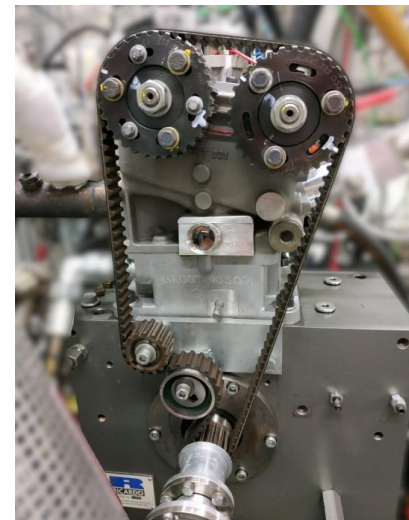
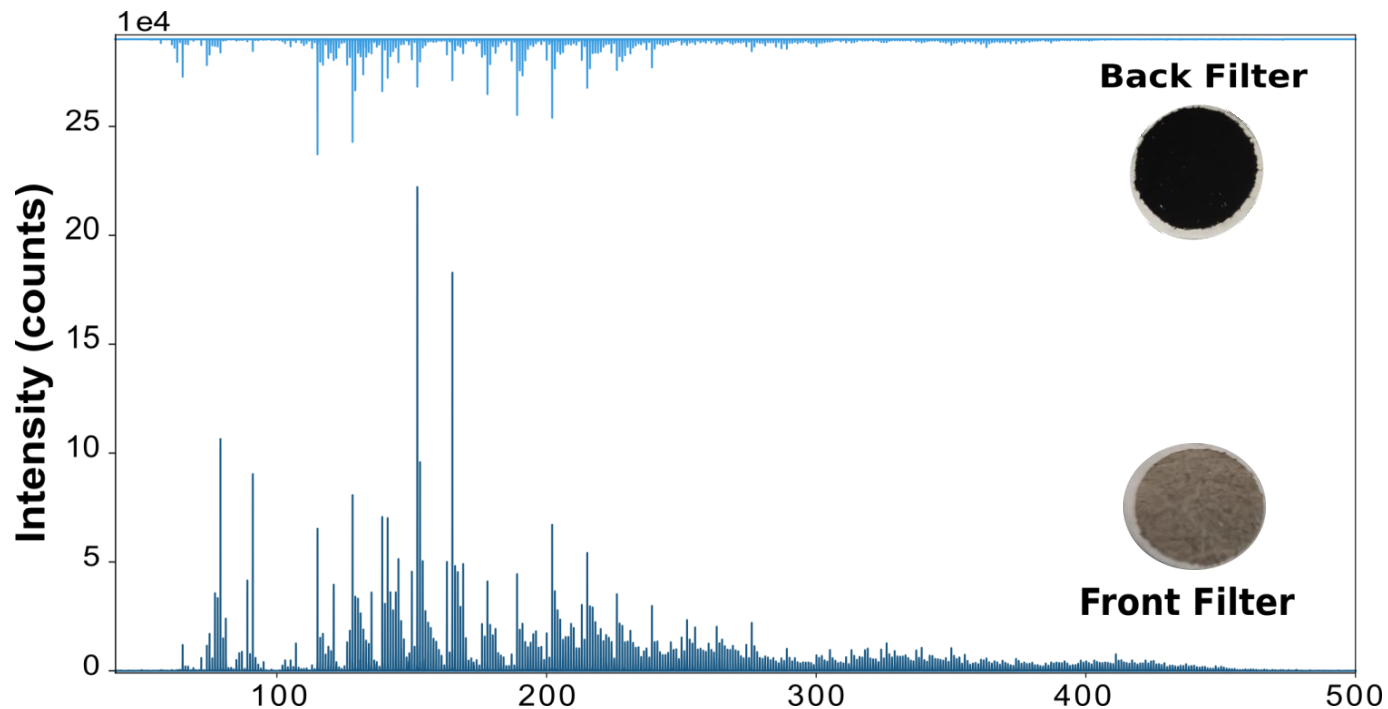


3 classes of PAHs:

- Volatile
- Semi-volatile
- Non-volatile

Front Filter (FF) – Back Filter (BF):

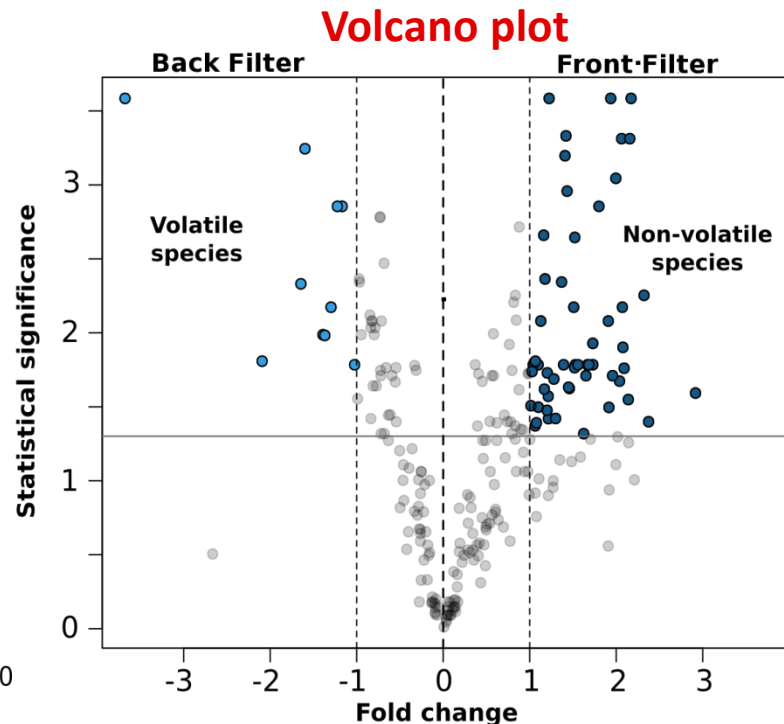
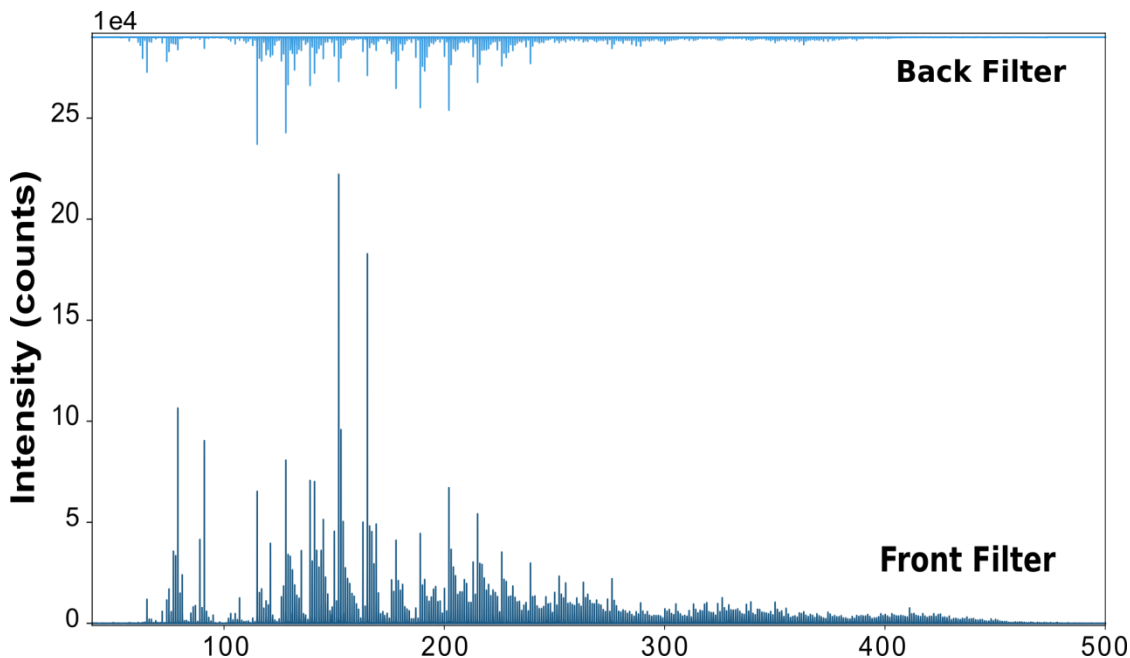
separation between particulate and gas phases



Single cylinder engine
(EURO5 gasoline)
2000 RPM, high load

Front Filter (FF) – Back Filter (BF):

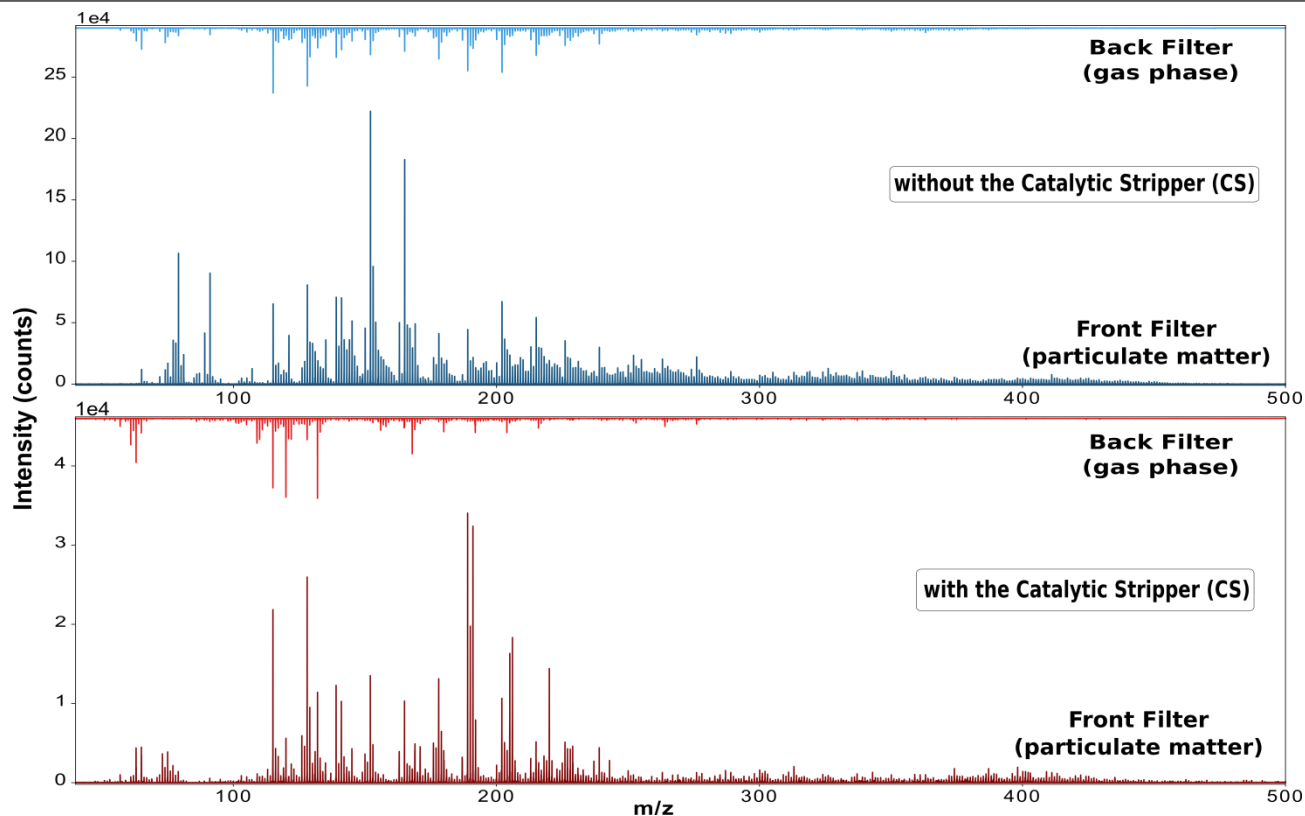
separation between particulate and gas phases



- **Volatile** species (m/z 128 – 178) are present on the Back Filter
- **Semi-volatile** (m/z 178 – 242) compounds detected on both filters
- **Non-volatile** species (m/z > 242) are present on the Front Filter

Front Filter (FF) – Back Filter (BF):

impact of the Catalytic Stripper



The catalytic stripper removed a significant part of organic compounds from the particulate and gas phases

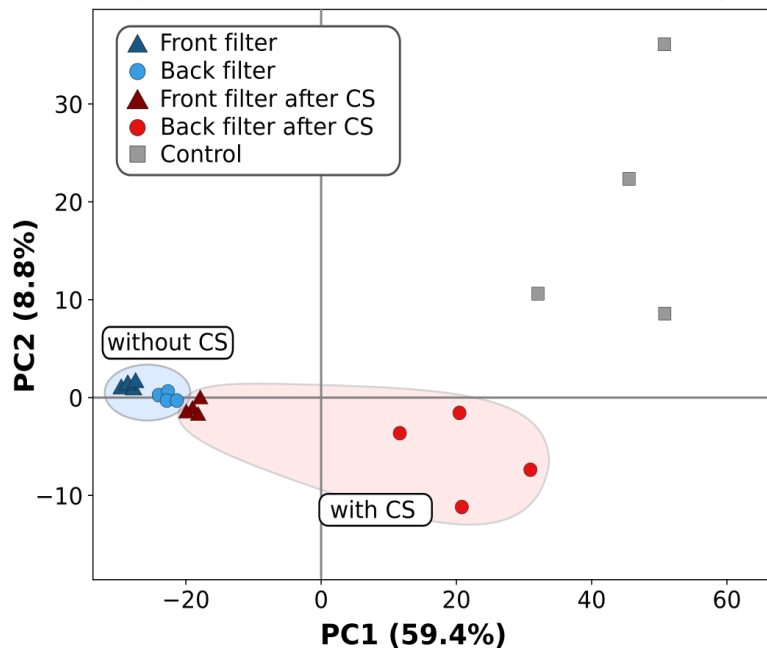
Front Filter (FF) – Back Filter (BF):

impact of the Catalytic Stripper

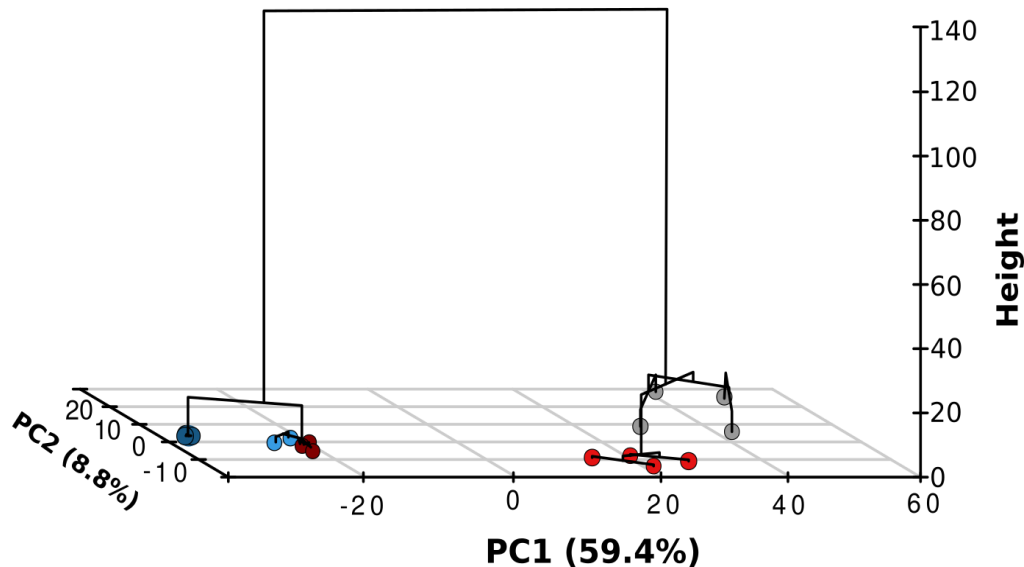
Principal Component Analysis (PCA)

Aromatic species (OC)

C_n (EC)



Hierarchical Clustering Analysis (HCA)

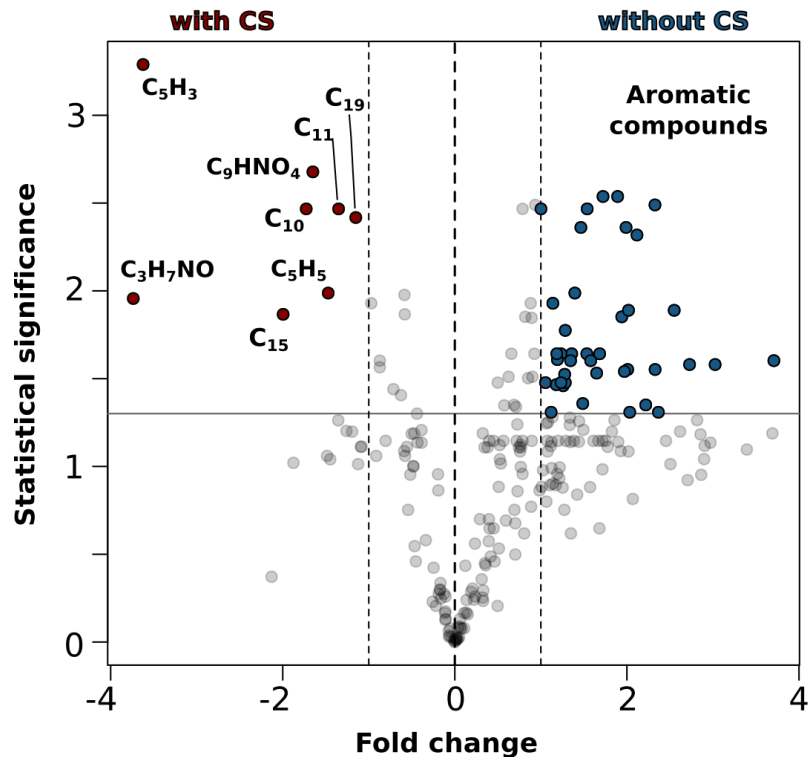


The catalytic stripper removed the organic fraction from both the **particulate** and **gas phase**

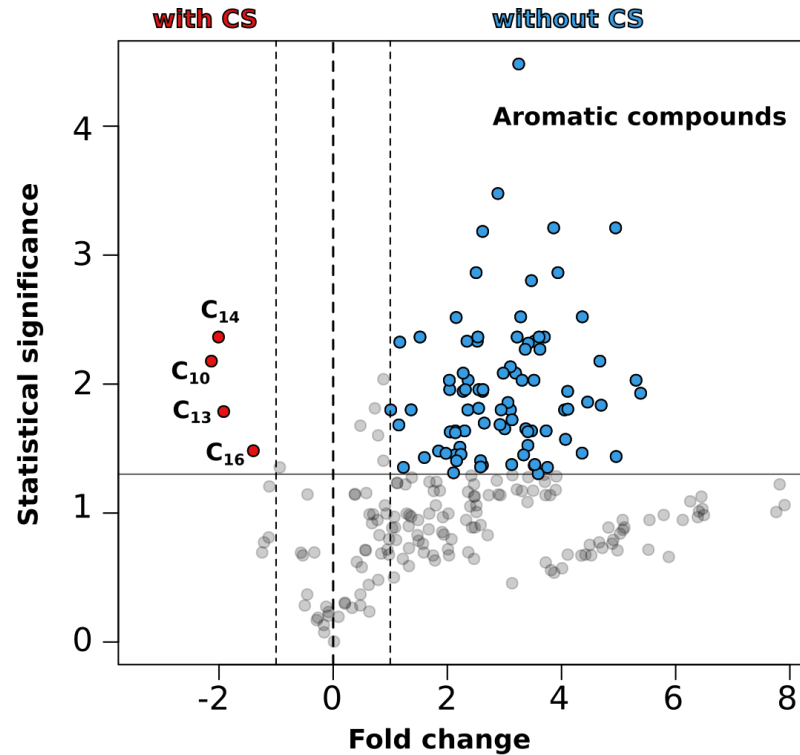
Front Filter (FF) – Back Filter (BF):

impact of the Catalytic Stripper

Front Filter



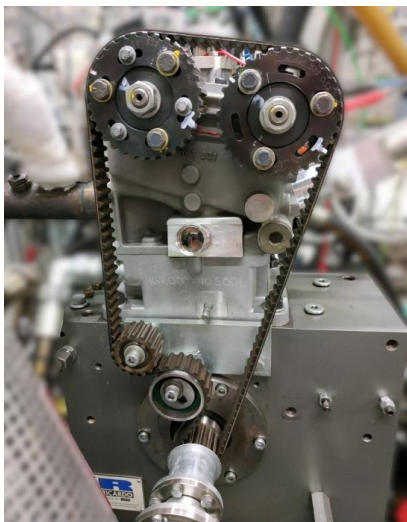
Back Filter



The catalytic stripper removed the organic fraction from both the **particulate** and **gas phase**

Front Filter (FF) – Back Filter (BF):

impact of the Catalytic Stripper

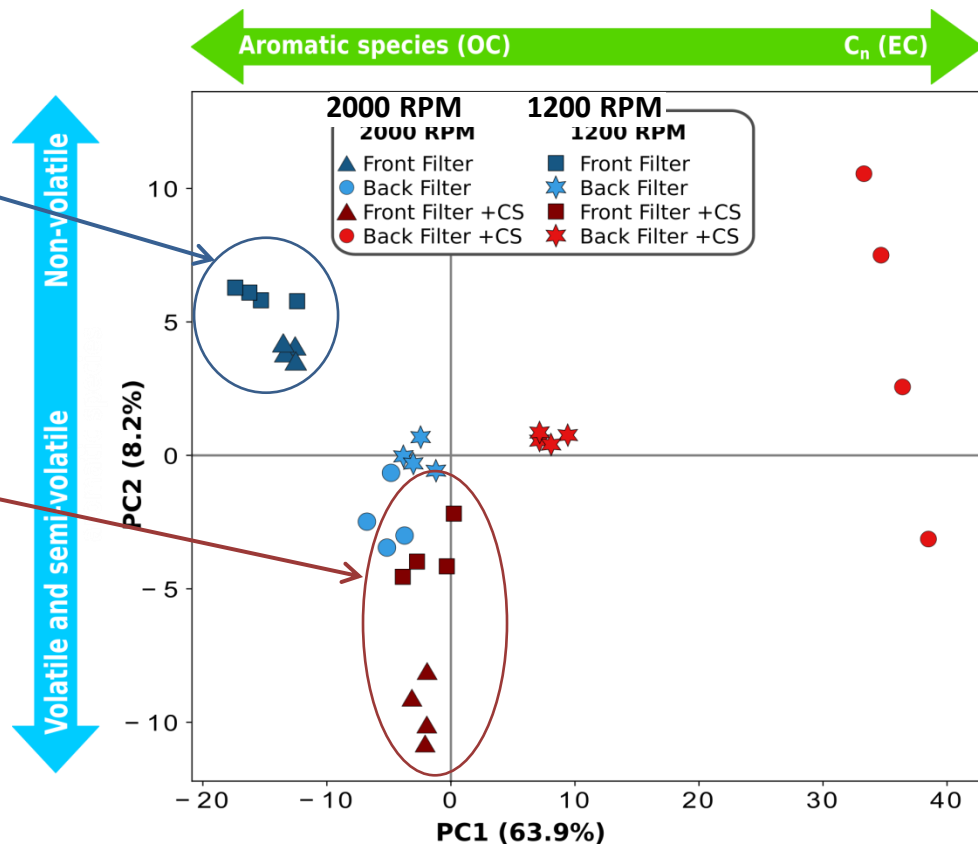


Soot particles sampled **without** the catalytic stripper

Soot particles sampled **with** the catalytic stripper

Two different regimes:

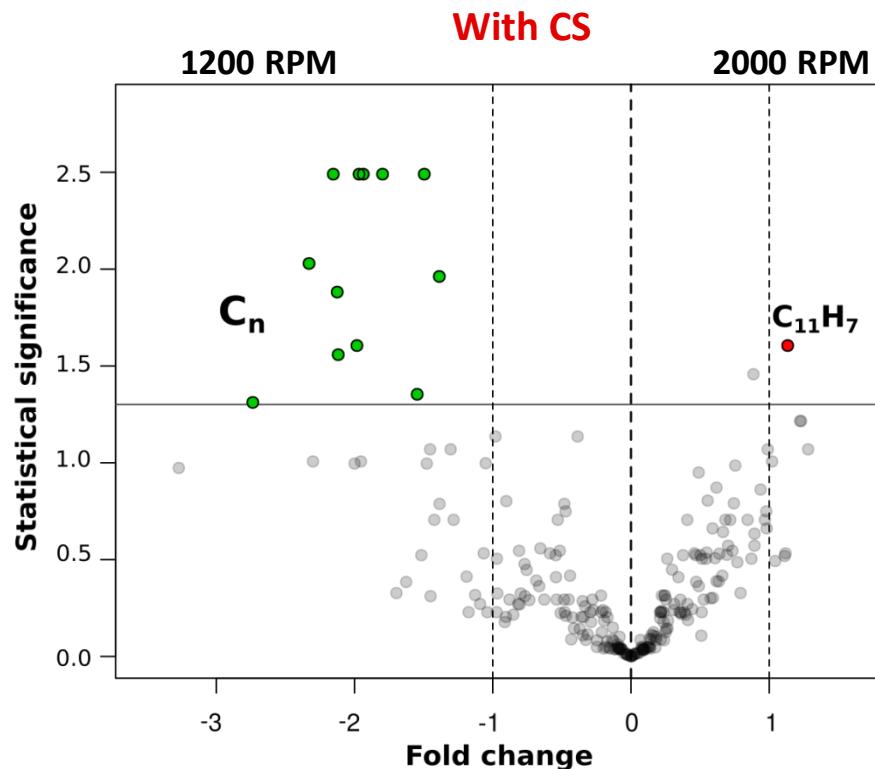
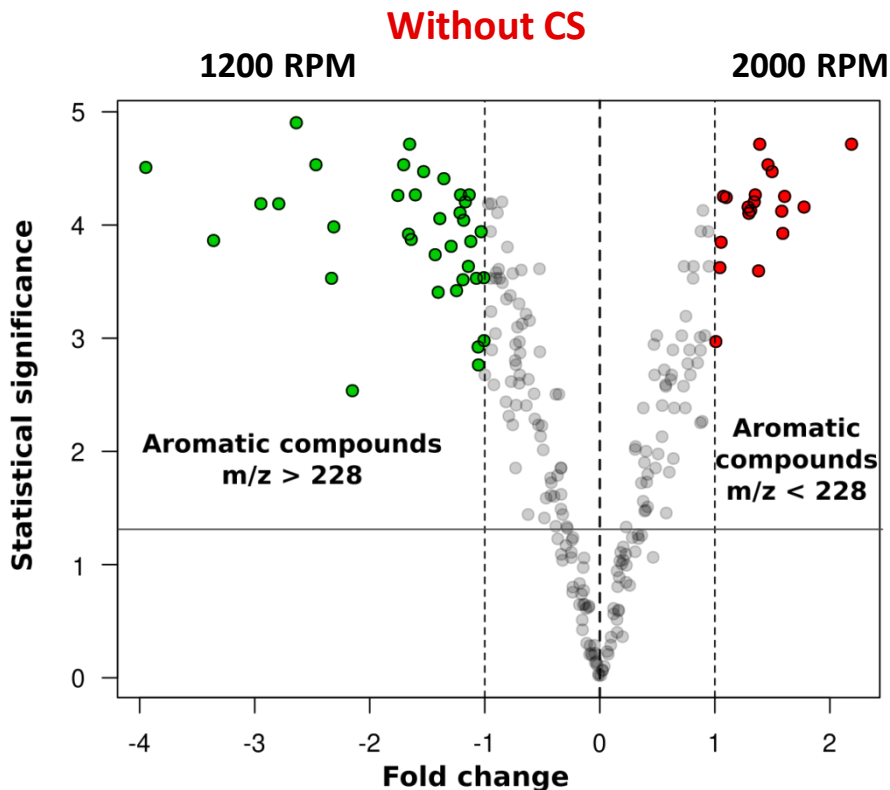
- 2000 RPM, high load
- 1200 RPM, high load



Front Filter (FF) – Back Filter (BF):

impact of the Catalytic Stripper

Front Filters



The majority of organic species removed from the **particulate** phase.
Different before and similar after the catalytic stripper

Conclusions

- A method to probe separately the chemical composition of the condensed phase and the gas phase was developed.
- The particulate and gas phases were chemically characterised for the exhaust of a miniCAST soot generator and a single cylinder engine.
- Three classes of PAHs have different contribution to the condensed and gas phase.
- The impact of the catalytic stripper on both phases was studied.

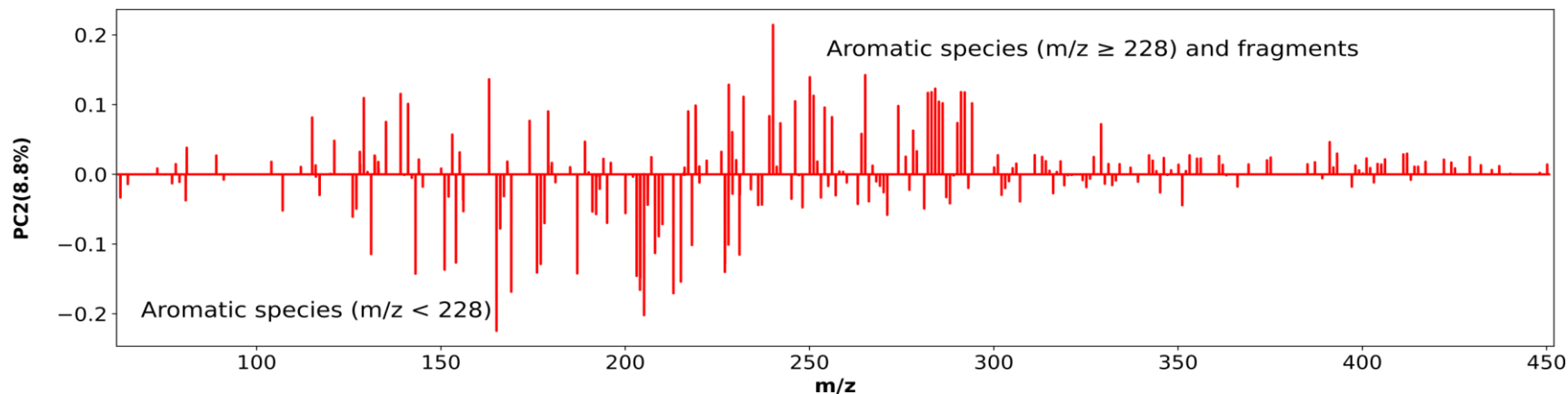
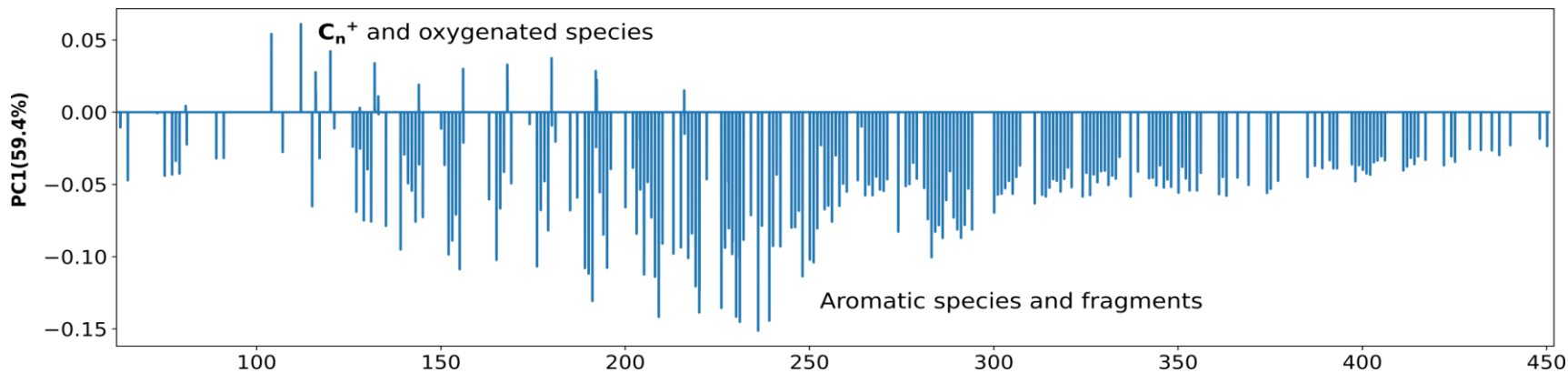
Conclusions

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- The particulate and gas phases were chemically characterised for the exhaust of a miniCAST soot generator and a single cylinder engine.
- Three classes of PAHs have different contribution to the condensed and gas phase.
- The impact of the catalytic stripper on both phases was studied.

Thank you !

Loadings

(with and without the catalytic stripper)



Loadings

(different regimes with and without the catalytic stripper)

