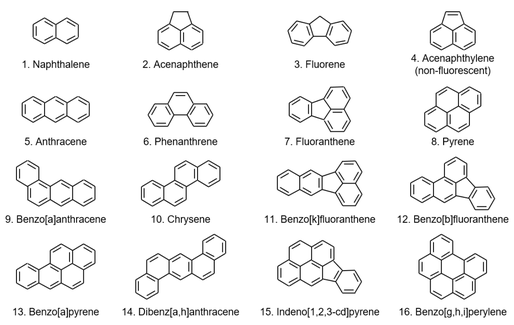
DEVELOPMENT OF ANALYTICAL METHODS FOR THE DETECTION AND QUANTIFICATION OF PAHS IN THE ENVIRONMENT AND THEIR APPLICATION IN THE STUDY OF AIR QUALITY IN STRASBOURG IN FRANCE

Joana Vaz-Ramos[1,2], Anais Becker[1], Farhan Ramadzan Nursanto[1], Mathilde Mascles[3], Damien Bourgain[3], Mathieu Galmiche[1], Olivier Delhomme[1], Maurice Millet[1], Damien Bazin[3], Sylvie Bégin-Colin[2], Stéphane Le Calvé[1]

1 – Institut de Chimie et Procédés pour l'Energie, l'Environnement et la Santé (ICPEES), UMR-7515 CNRS-Université de Strasbourg, 25 Rue Becquerel, 67087 Strasbourg, France
2 – Institut de Physique et Chimie des Matériaux de Strasbourg (IPCMS), UMR-7504 CNRS-Université de Strasbourg, 23 Rue du Loess, 67034 Strasbourg, France
3 – Chromatotec, 15 Rue d'Artiguelongue, 33240 Val-de-Virvée, France

INTRODUCTION

Polycyclic aromatic hydrocarbons (PAHs)



16 US EPA Priority PAHs

- Ubiquous environmental pollutants
- Toxic, carcinogenic, mutagenic and endocrine disruptors

Challenges

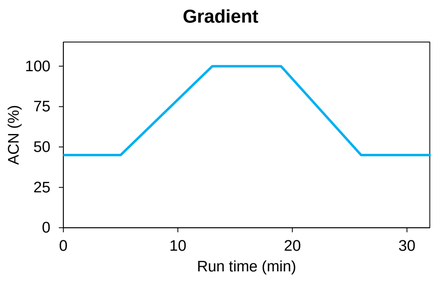
- PAHs present in the environment in low individual concentrations
- Current methods: offline, time consuming and lead to high uncertainties
- Lack of in situ automatic monitoring of PAHs

Objective

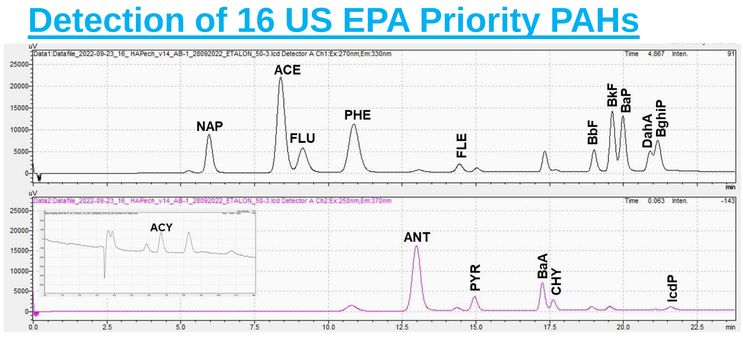
develop different methods to detect very low quantities of PAHs and/or for in situ detection of PAHs in the environment

DEVELOPMENT OF REFERENCE OFFLINE METHOD BY UHPLC-FLD/UV

- **UHPLC system:** Nexera XR (Shimadzu)
- **Column:** Knauer Ultrasep ES PAH-QC, 4 µm, 2 x 60 mm
- **Mobile phase:** Acetonitrile/water
- **Flow:** 0.5 mL/min



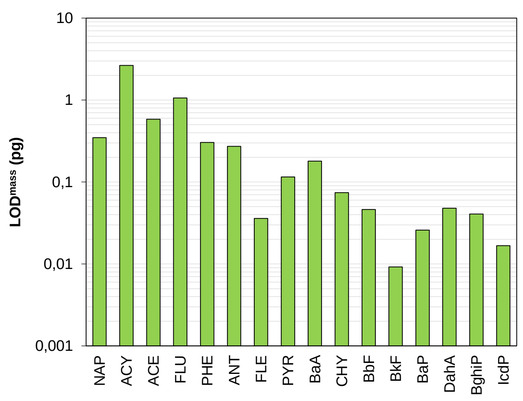
Detection of 16 US EPA Priority PAHs



Fluorescence detection of 15 PAHs in two different detection channels + UV detection of 1 PAH (not fluorescent)

Linear calibration curves in the studied ranges (0.5-100 µg/L for 2-ring and 3-ring PAHs, and 0.05-10 µg/L for 4-ring, 5-ring and 6-ring PAHs) with **$R^2 > 0.998$**

- Good peak resolution with exception of DahA, BghiP and IcdP
- Good repeatability (RSD ≤ 6.74%)
- Good reproducibility (except for FLE, BghiP and IcdP)
- ACY (UV detection) showed the worst sensitivity
- For other PAHs (fluorescence detection):
  LOD^{UPLC} : 0.005 to 0.530 µg/L
  LOD^{mass} : 0.009 to 1.059 pg
  LOD^{air} : 0.03 to 3.53 pg/m³
  (for an air sampling volume of 150 m³)
- Higher sensitivity to HMW-PAHs than to LMW-PAHs



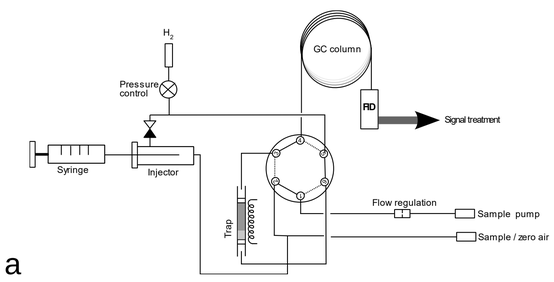
LOD^{mass} determined for comparison with GC-FID method

HMW – high molecular weight
LMW – low molecular weight

DEVELOPMENT OF PORTABLE IN SITU METHOD BY GC-FID

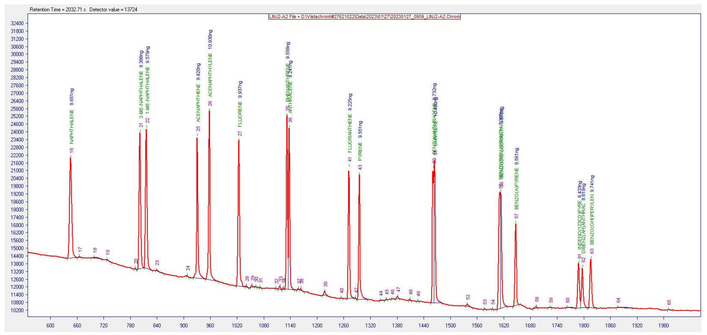
- **Instrument:** airmo C6-C20+ (Chromatotec)
- **Column:** 30 m long MXT-1 GC column, internal diameter: 0.53 mm, film thickness: 0.25 µm
- **FID temperature:** 350°C

The airmoVOC C6-C20+ (Chromatotec) is a **transportable model** that allows in **situ measuring** and **remote monitoring**.



Simplified *schematic diagram of the airmoVOC C6-C20+.*

Detection of 16 US EPA Priority PAHs + 1-Methyl and 2-Methyl Naphthalene



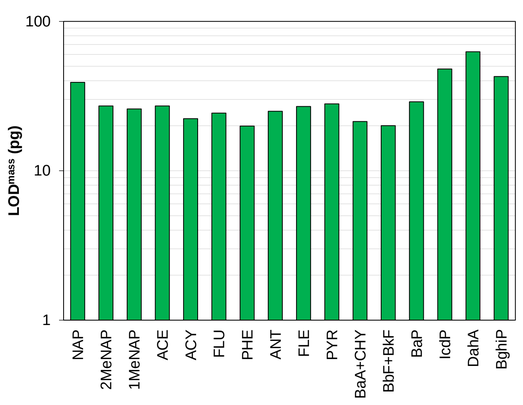
Good separation of 14 of the 18 PAHs

- The isomers BkF and BbF were the most co-eluted, followed by the isomers BaA and CHY.

Linear calibration curves in the studied ranges (0.23-9.91 ng) with **$R^2 > 0.998$** were obtained (the pairs BkF + BbF and BaA + CHY were quantified together)

- LOD^{mass} : 19.9 to 48.0 pg
- LOD^{air} : 0.13 to 0.32 pg/m³

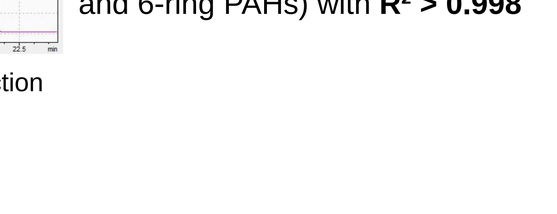
(for an air sampling volume of 150 m3)



STUDY OF AIR QUALITY IN STRASBOURG (FRANCE)

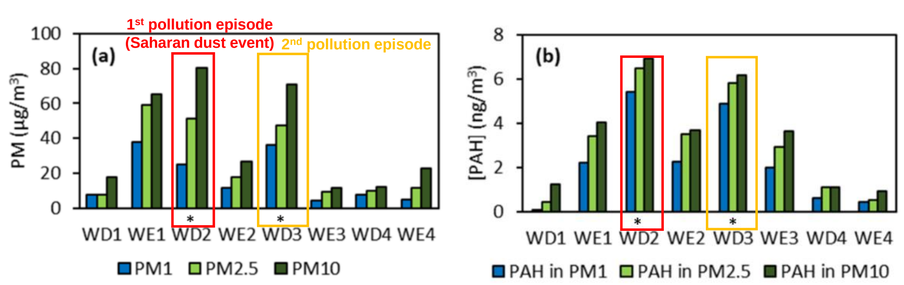
Methodology

Capture of particles in air with filters → Extraction of filters by ASE → **Quantification of PAHs**



Location of sampling sites and different equipment: (**a**) Cronenbourg campus; (**b**) ECPM rooftop; (**c**) ICPEES; (**d**) three-stage cascade impactor; (**e**) weather station; (**f**) particle analyser

Air Quality between February 16th and March 15th 2021[1]



- High PM and PAH concentrations in the pollution episodes.
- Daily PM and PAHs concentrations surpassed EU limits at times.

- **PAHs present in air outside of pollution episodes** (showing the importance of developing in-situ monitoring tools).

CONCLUSIONS

- ❑ The developed reference offline method by UHPLC-FLD/UV showed very good results for the quantification of the 16 US EPA Priority PAHs.
  - ❖ good repeatability and reproducibility were generally obtained.
  - ❖ Very good LOD values were obtained, especially for HMW-PAHs (as low as 0.005 µg/L, equivalent to 0.009 pg in mass).
- ❑ A method for the quantification of 18 PAHs was developed using a transportable airmo C6-C20+ instrument, allowing the in situ monitoring of PAHs.
  - ❖ LOD values between 0.13 and 0.32 pg/m³
  - ❖ Suitable for ambient air analysis
- ❑ Monitoring of PAHs in air in Strasbourg confirmed their presence in the environment, showing the relevancy of developing in situ monitoring tools.

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References:

[1] Nursanto, F.R., et al, *Atmosphere,* **2022,** 13(9).