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Hydrogen Carrier Gas in GC-MS: A Sustainable Alternative to Helium for measuring PAHs in the Workplace

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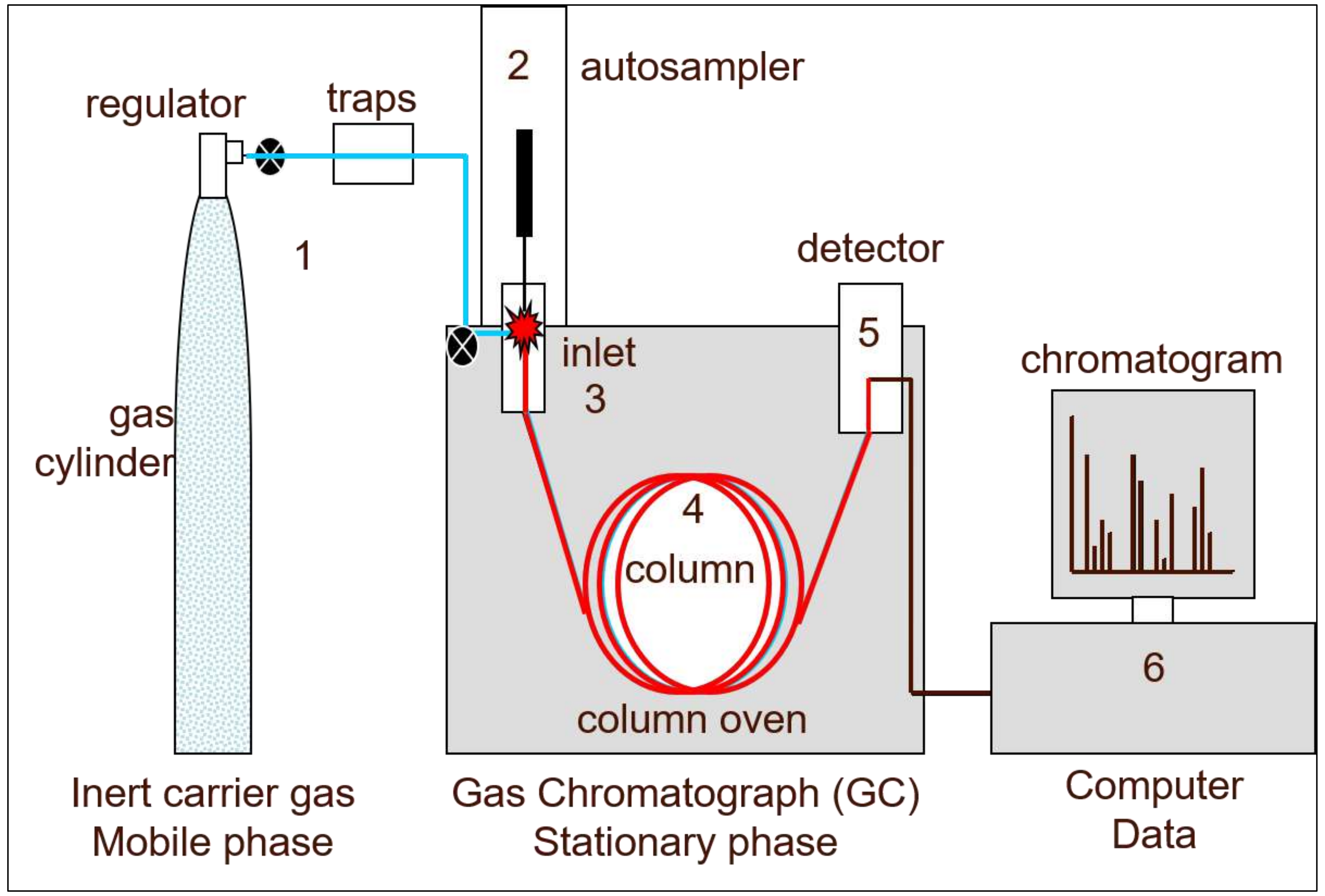
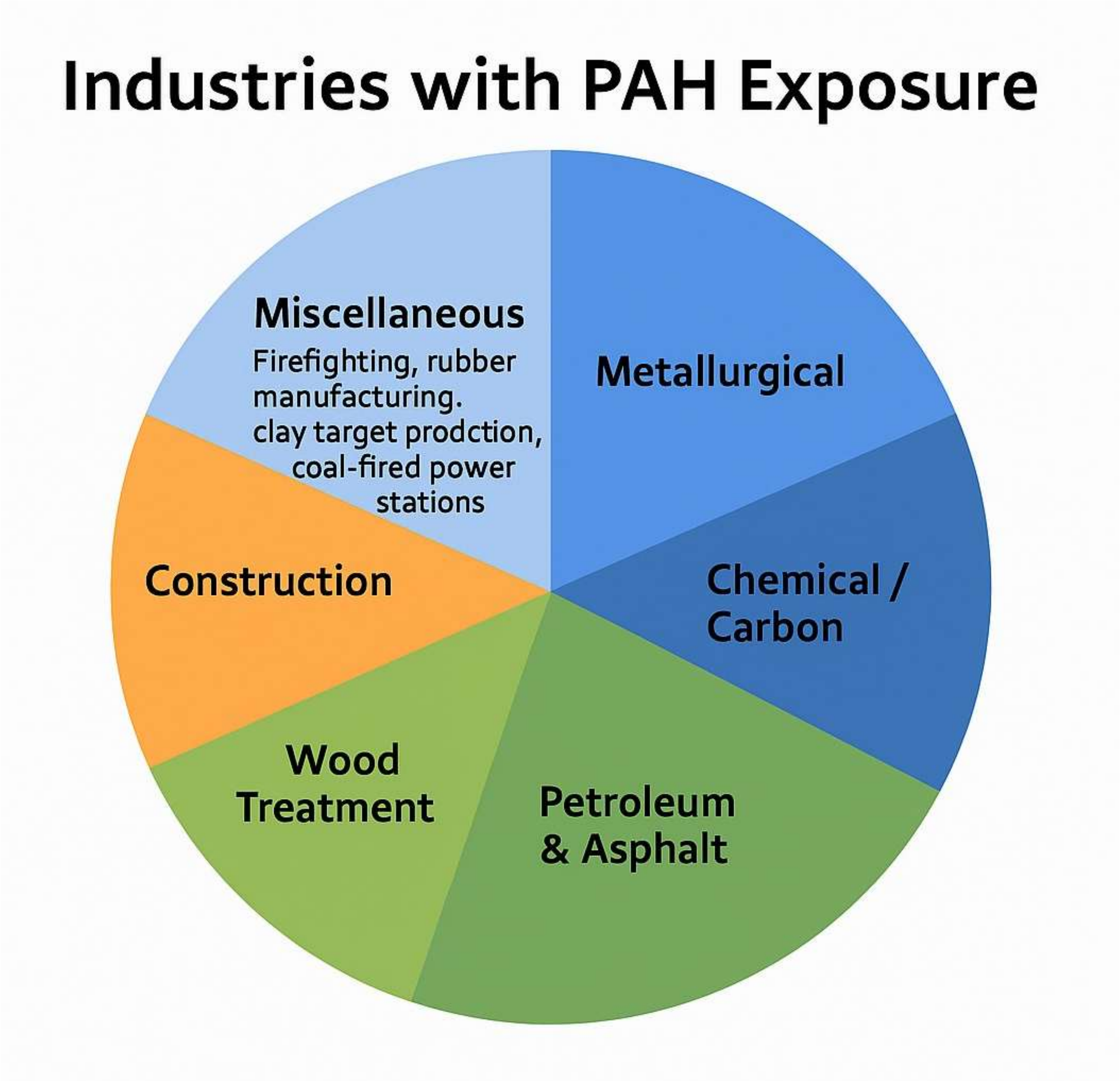
Introduction

- Common Carrier Gases used in GC
  - **Nitrogen**: Cheap, readily available, lower detection limit but **Long run times**
  - **Helium**: Safe, inert, compatible with most detectors, good resolution but **expensive**
  - **Hydrogen**: Better resolution, faster separation, but **explosive**
  - **Argon**: compatible with electron capture detector, but **not easily available**



PAHs in workplace

- PAHs are toxic, semi-volatile organic compounds generated in various industrial processes. mainly produced by incomplete combustion of coal, oil, and organic materials
- They are recognized for their carcinogenic and mutagenic risks, and environmental persistence.
- Humans can be exposed through inhalation, skin contact, or ingestion



Source: recruitment.raf.mod.uk. (August 2025)

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Method

Parameter	Using Hydrogen as a Carrier gas	Using Helium as a Carrier gas
GC-MS System	Agilent 8890/5977C	Agilent 7890/5977
Column	20 m × 180 µm × 0.18 µm HP-5-MS	30 m × 0.25 mm × 0.25 µm DB-EUPAH
Carrier Gas	Hydrogen (1 ml/min)	Helium (1 ml/min)
Injection Volume	2 µl	1.5 µl
Injection Temp	350°C	350°C
Oven Program	60°C (0.5 min), 20°C/min to 320°C (4.5 min), 18 minutes	60°C (0.5 min), 20°C/min to 320°C (36.5 min), 30 minutes
Analytes	16 PAHs + 5 ISTDs	16 PAHs + 1 ISTD
Method File	PAH_SIM40.m (Standard)	EUPAH Test Method 10S.m

Results

Helium Carrier gas

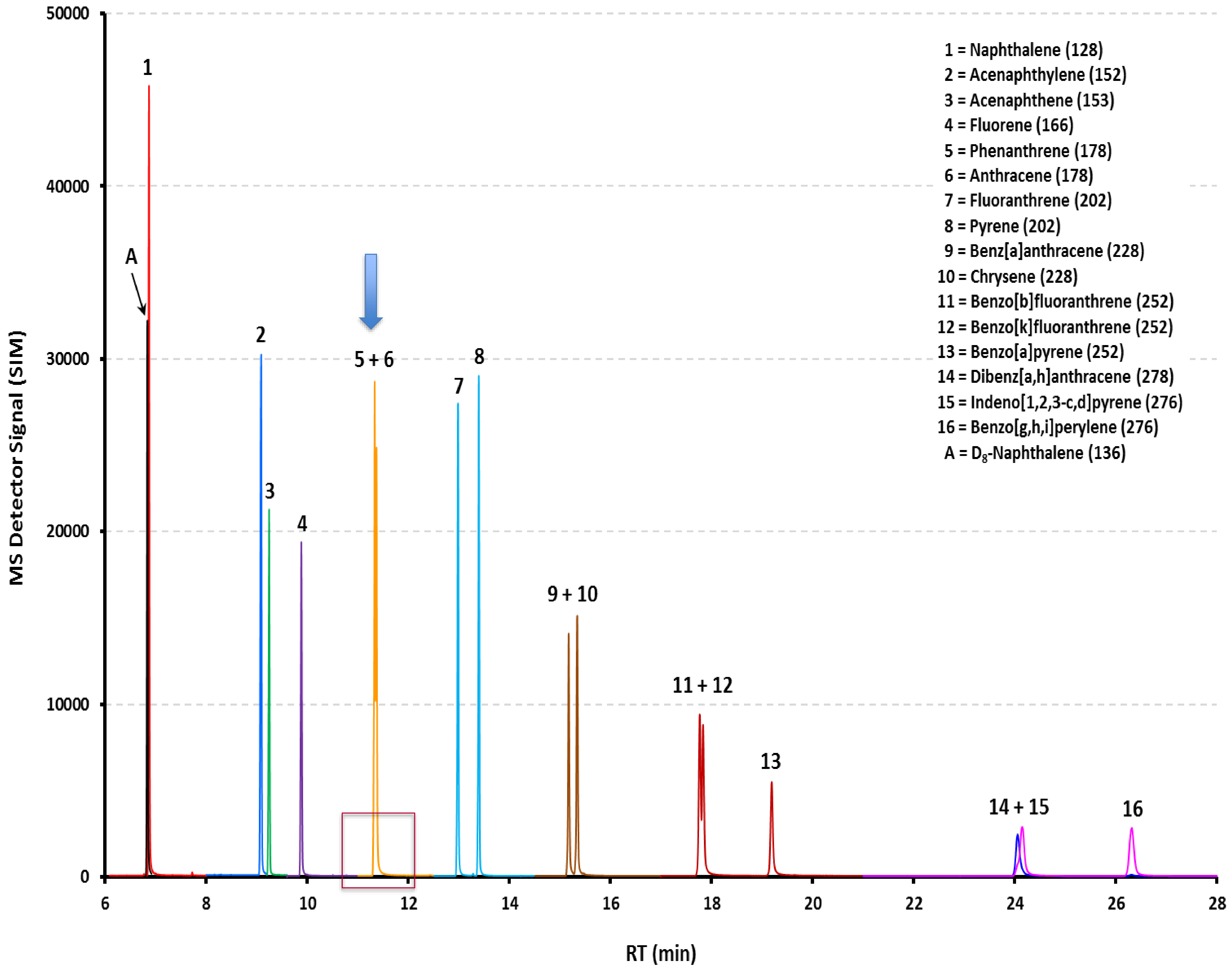

Figure 1. Selected Ion analysis of the EPA16 PAH standards using helium carrier gas

Hydrogen Carrier gas

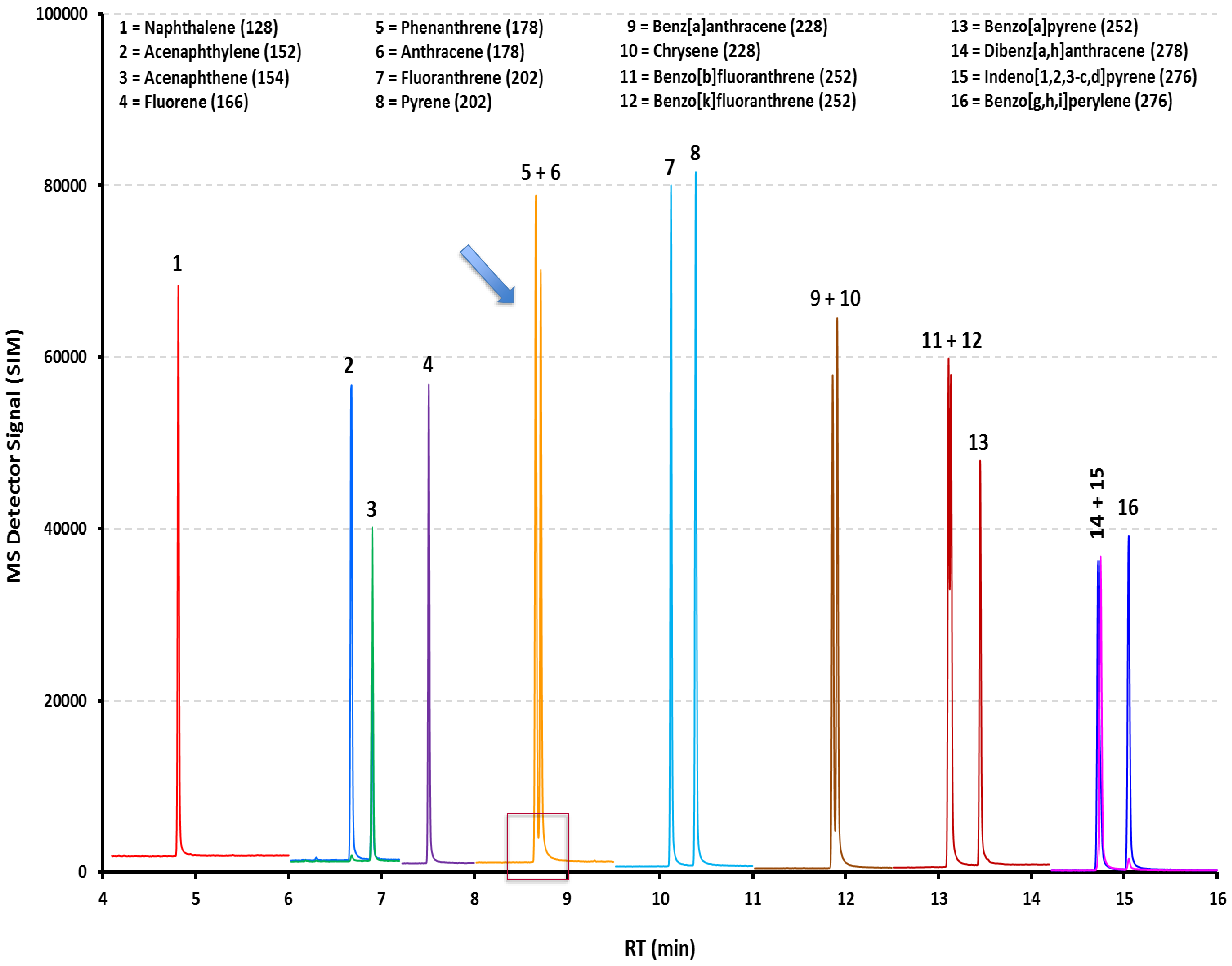

Figure 2. Selected Ion analysis of the EPA16 PAH standards using hydrogen carrier gas

Discussion

- In this study, using hydrogen as carrier gas for PAH determination reduced run times, which could be due to hydrogen having a lower viscosity and higher optimal linear velocity than helium (Pastor et al. 2023).

- It also reduced peak width due to its higher diffusivity, which enhances mass transfer in the column maintaining resolution for closely eluting compounds like Phenanthrene and Anthracene

- Increasing sensitivity for some later eluting compounds, due to improved signal-to-noise ratios (Victor et al., 2024).

Advantages of H_2 as your carrier Gas

- Increased speed
- enhanced sensitivity by improving signal-to-noise ratios, due to narrower peak widths, particularly in later eluting PAH compounds
- Lower temperature separations
- Longer column life with less column bleed and removal of potential acidic sites off the column
- Availability using H_2 Generators

Conclusion

- This comparative evaluation of GC-MS systems using helium and hydrogen as carrier gases highlights the balance between analytical performance, operational cost, and safety.

- Hydrogen offers faster analysis, sharper peaks, and lower operational costs, making it a viable alternative to helium in many applications.

- When Hydrogen carrier gas is generated on-site and on-demand, it is also more sustainable and cost-effective than helium

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