Hamed Rasouli Sadabad

Dr Hamed Rasouli Sadabad is a postdoctoral research associate in InToxFIRE project in the FireSERT centre at Ulster University.

Hamed is a senior analytical chemist and materials scientist with education in Polymer Engineering (BSc, MSc) and Environmental Sciences (PhD).

How Effective Are Gears at Blocking Chemical Exposure?
What the Experiments Say

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Why the Chemistry of Fire is Important?

Scope of the Study

Fire generates a wide range of chemicals, some of which are toxic, carcinogenic, irritant, etc.

The content and quantity of generated chemicals are not identical in fire events.

From the type of burning matter (e.g., wood, polymers, synthetic materials, batteries, etc.) to ambient conditions (e.g., availability of O_2, temperature, and relative humidity), and coincidence of various parameters and materials (e.g., presence of electricity), affect the concentration and kind of the generated toxicants.

Exposure to these chemicals is likely to impose loads of acute and long-term health problems to humans and other creatures as well as the whole environment.

Why should we determine the transfer of chemicals through PPE?

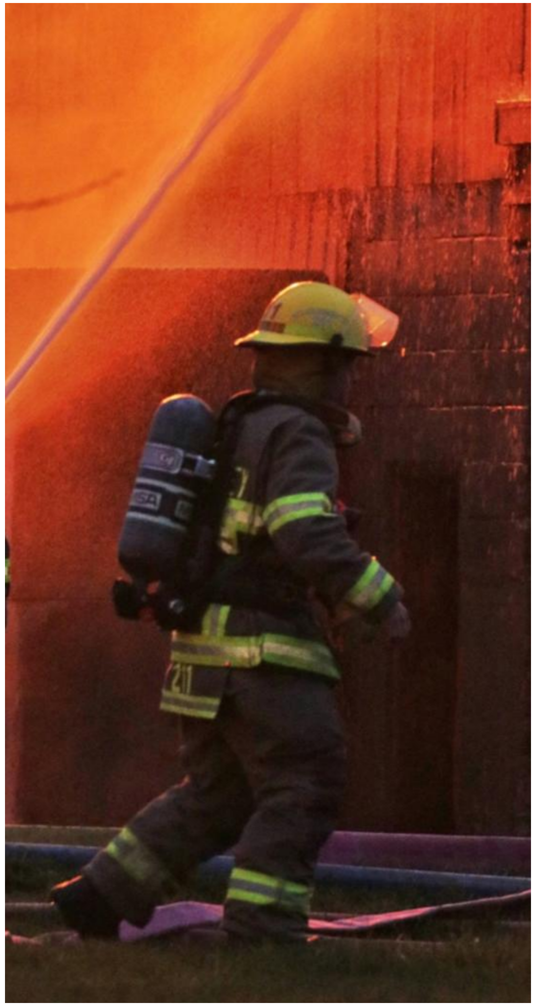
Firefighters and trainers are frequently exposed to these chemicals in different conditions, so they are more prone to the adverse effects of toxicants.

What is the concern? They wear PPEs that protect them to a good level!

What does "a good level" mean? 99%? 95%? Is it durable? Same in various conditions?

Some of those Chemicals such as benzo (α) pyrene, benzene, formaldehyde are categorized as Known Carcinogenic (IARC Group 1)

Scope of the Study



Ref: Occupational Exposure as a Firefighter, 2023, IARC Monographs on the Identification of Carcinogenic Hazards to Humans Volume 132.

What did we aim to investigate experimentally?

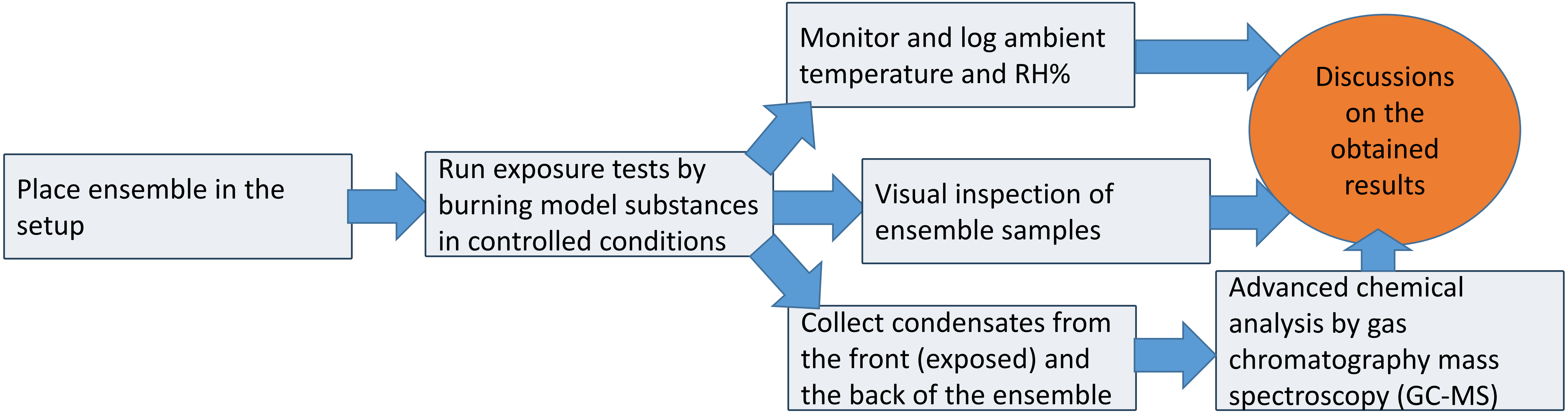
- To simulate the fire event conditions (*in the current presentation: small-scale laboratory setup*)

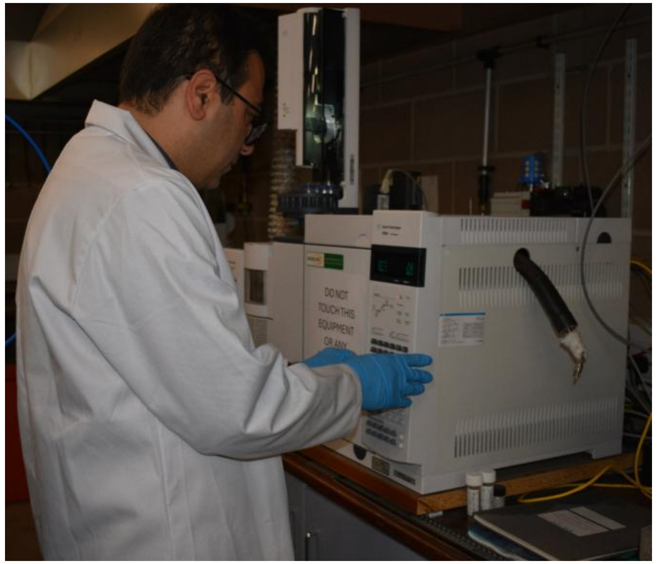
- To determine the nature and types of chemicals generated during fire events (*mainly focused on volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs) in this presentation*)

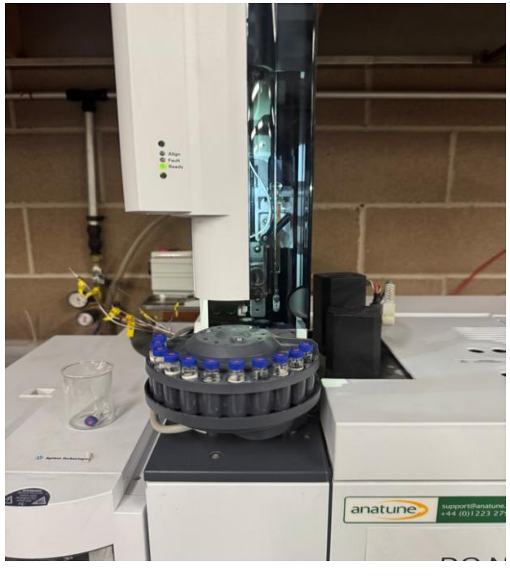
- To evaluate the effectiveness of the studied ensembles in inhibiting different chemicals from passing through the ensemble towards fighter's body

InToxFIRE

Brief Protocol of Experiments







Test Conditions and Initial Results

Ensemble: New,
With PFAS layer on its membrane (PFAS)
No PFAS layer on its membrane, water repellant on final layer

Fuel (10 g solid + 10 mL Hexane)
Wood: 40%, PU foam: 20%; PET: 20%; PS: 10%, PVA: 10%

Air flow rate: 400 L/min

Suction pressure: -25 mbar, immediately drops to 0 when connected, since air is soaked.

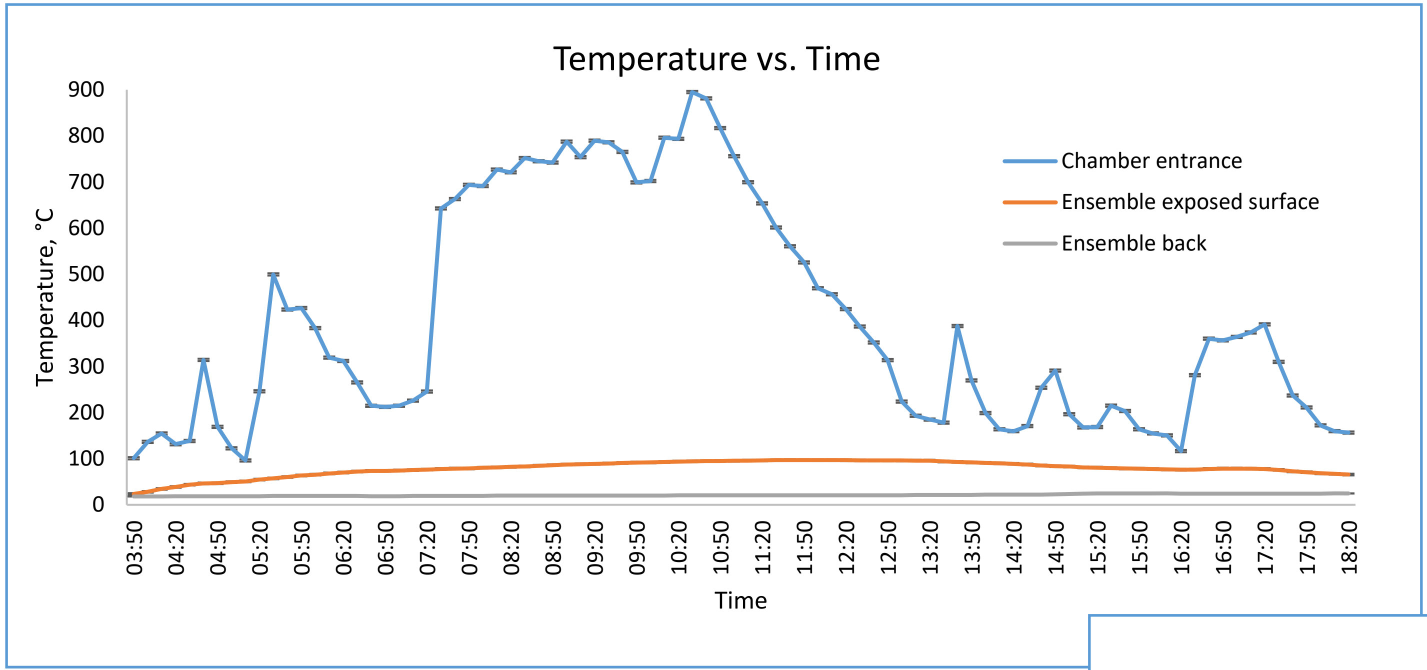
Test time: 3 *15 min

Residue: 39.5±2.5 %

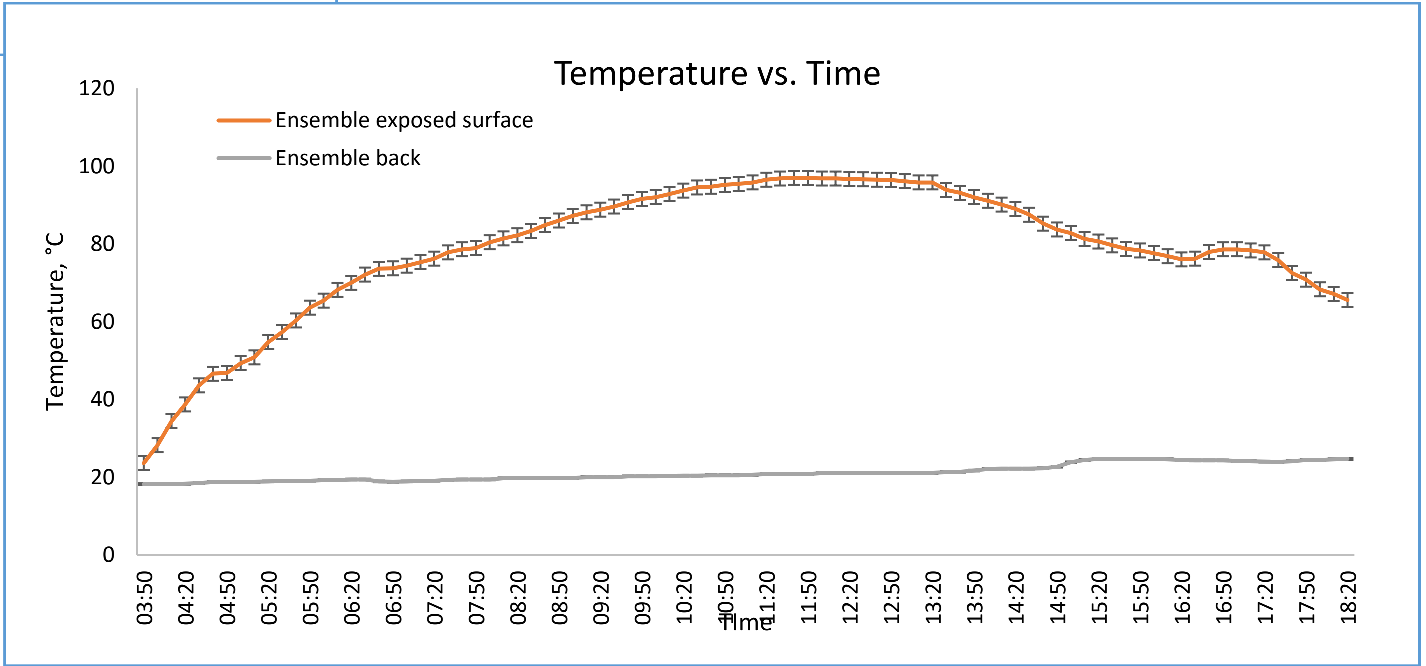
Fire Exposure experiments

Monitored item		PFAS layer on membrane	No PFAS layer on membrane
Released steam pH	Front (exposed)	2-3	2-3
	Back	Similar to reference	Similar to reference
Condensate pH	Front (exposed)	2.5±0.1	2.5±0.1
	Back	Similar to reference (6.0±0.1)	5.0±0.1
Relative humidity change	Back	Similar to reference (55±5%)	From 55 (reference) to 65±5%

Test Conditions and Initial Results



Temperature change regime during the experiment

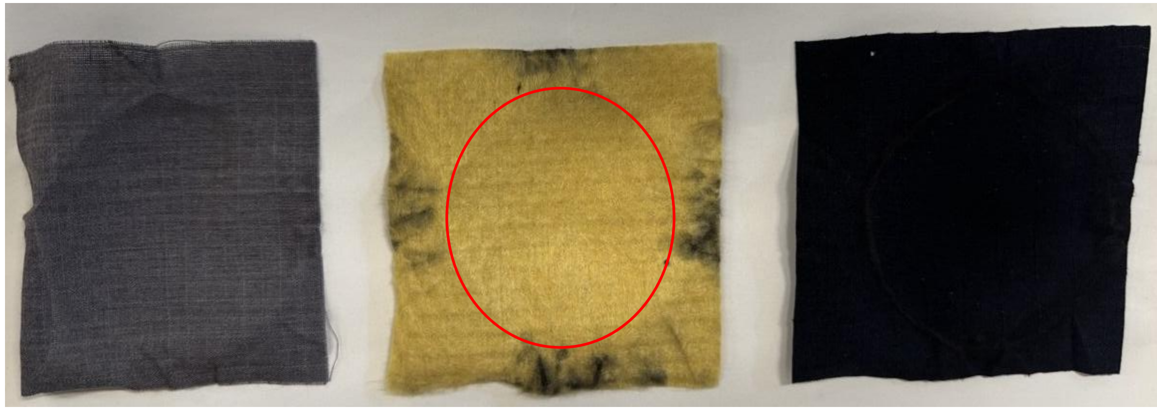


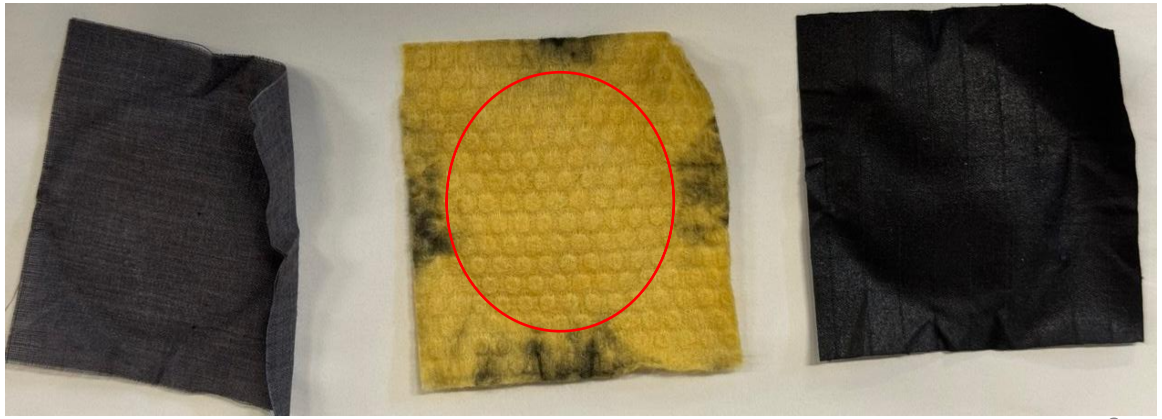
Test Conditions and Initial Results

Visual inspection of the ensembles before and after exposure experiments

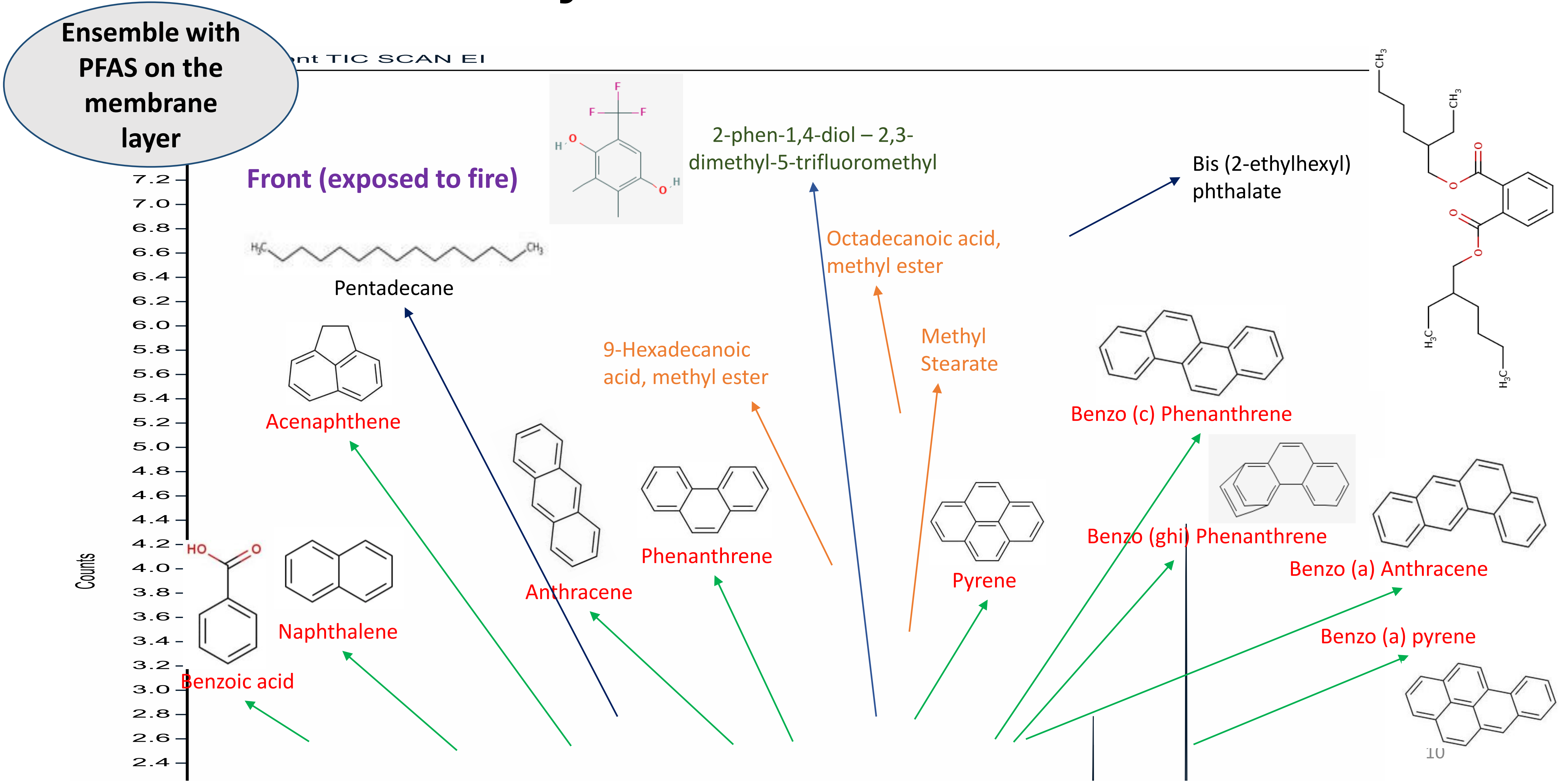
Ensemble: with PFAS

Ensemble: without PFAS





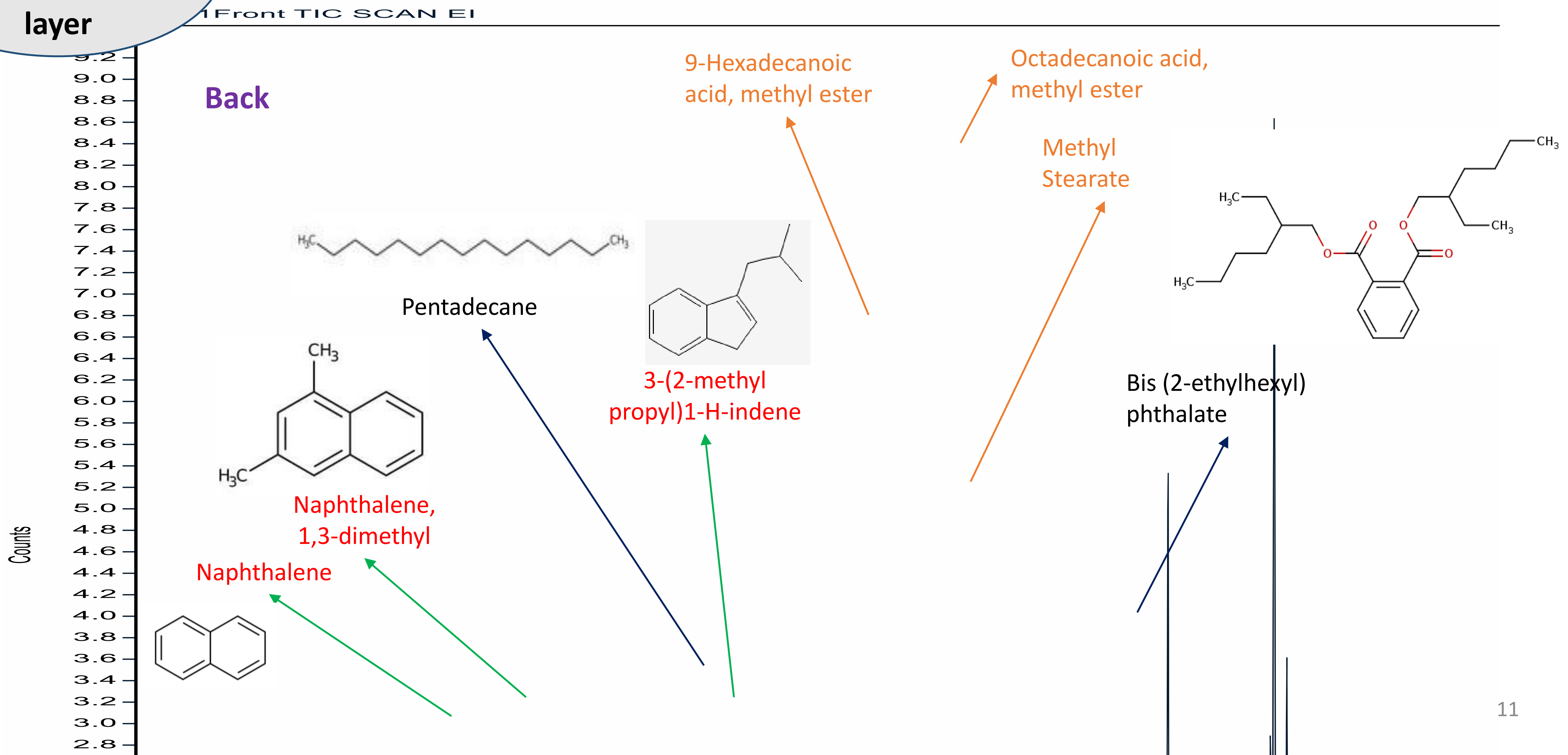
Advanced Analysis: Toxic Chemicals Detection



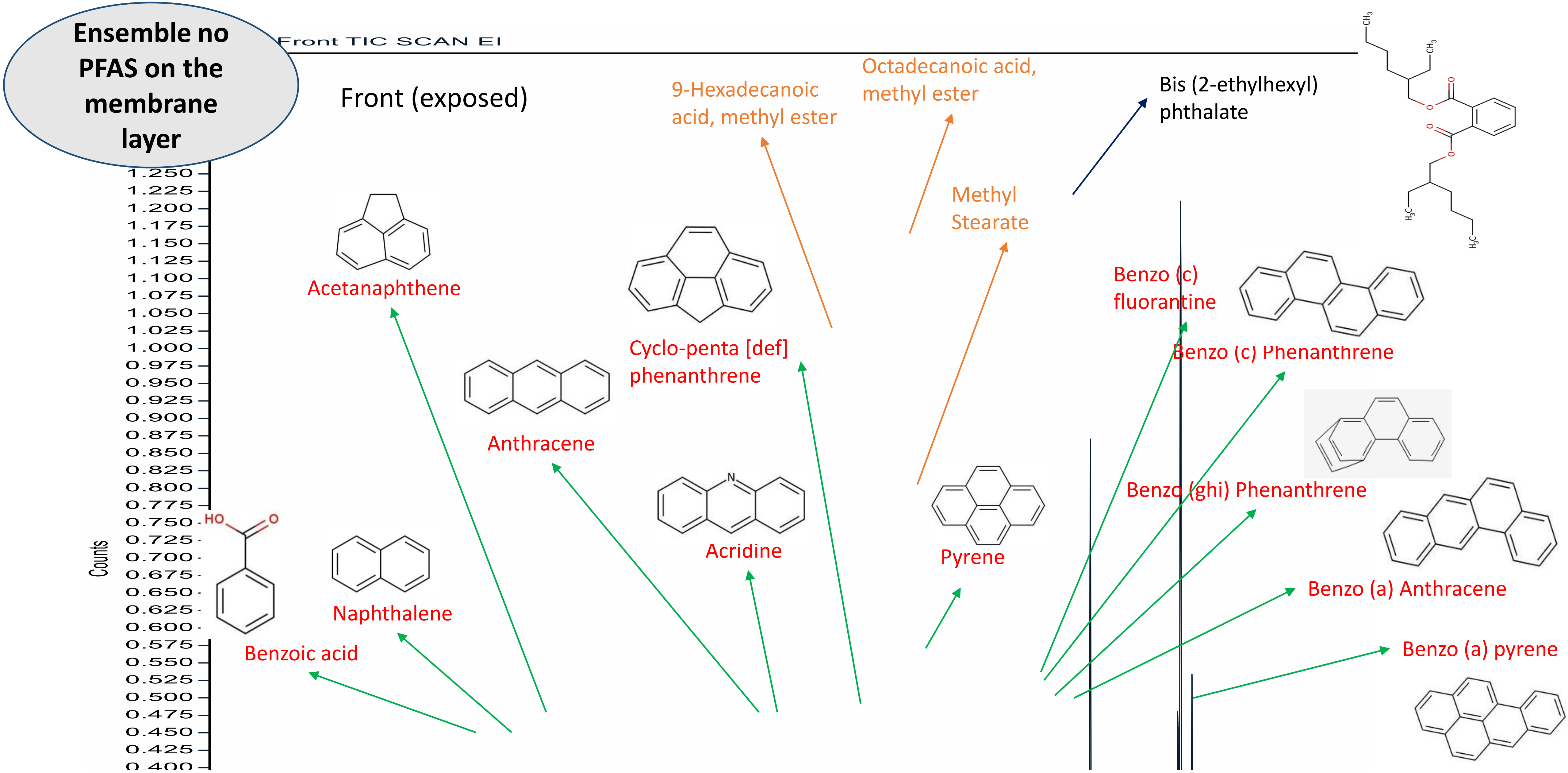
Advanced Analysis: Toxic Chemicals Detection

Ensemble with PFAS on the membrane layer

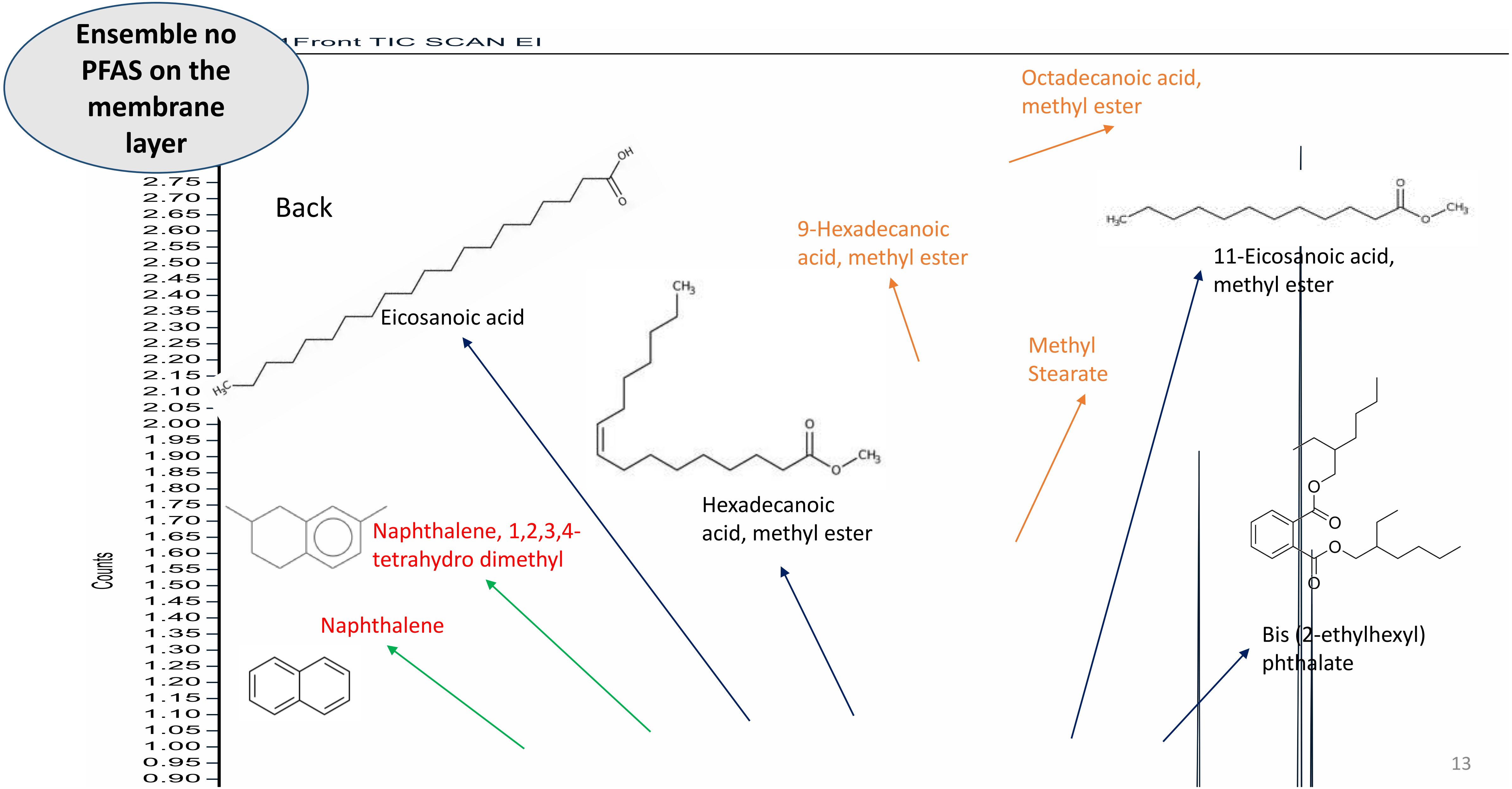
Chemical analysis



Advanced Analysis: Toxic Chemicals Detection



Advanced Analysis: Toxic Chemicals Detection

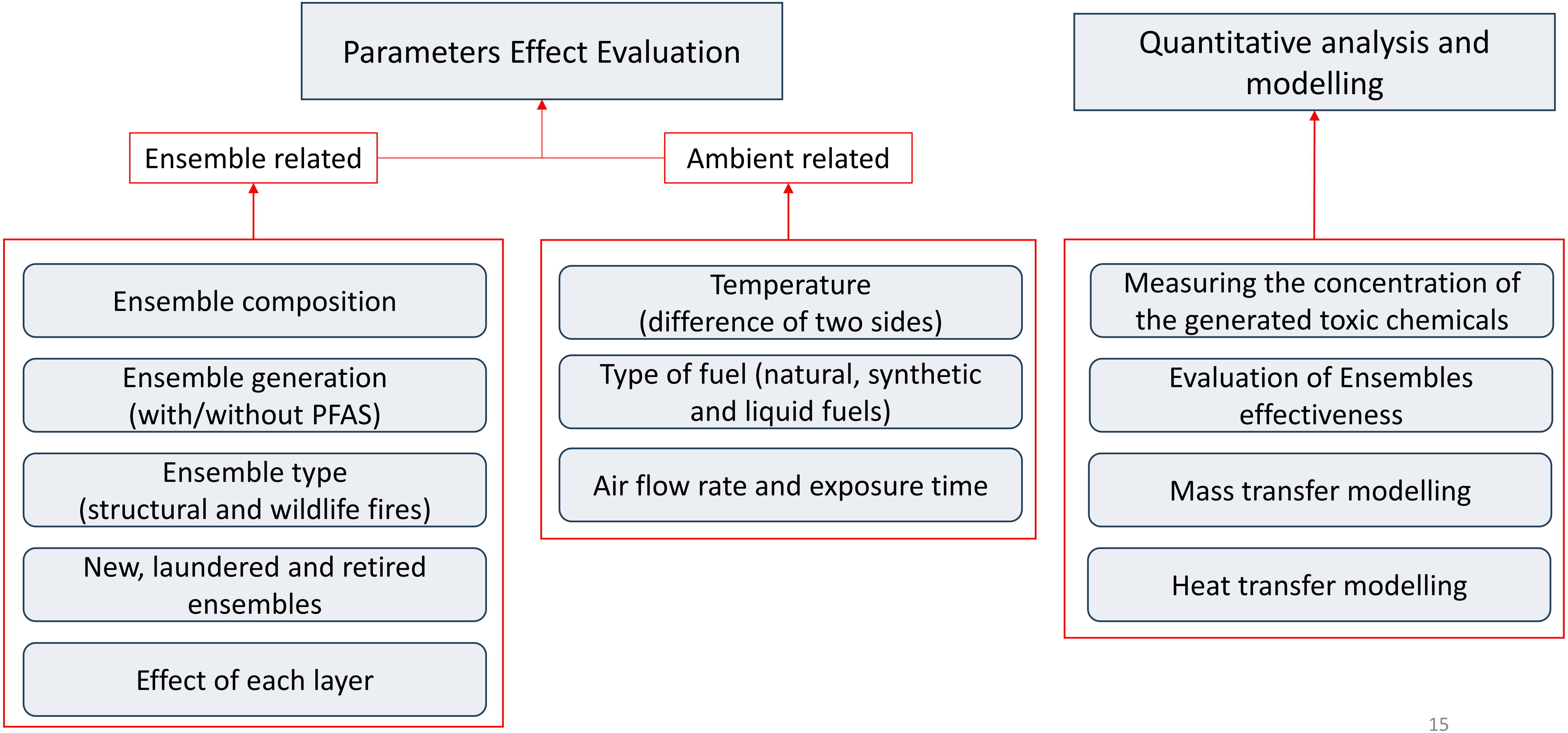


Take Home Message from Experimental Results

Conclusions

- Both ensembles are effective against diffusion of large PAHs.
- Naphthalene and its derivatives are able to diffuse to both ensemble, regardless of presence or absence of PFAS on the membrane layer.
- Linear chemicals are able to pass through the ensembles, even if they have a super-large molecule (eicosanoid acid, hexadecenoic acid methyl ester, etc.)
- Ensemble with PFAS on its membrane showed better barrier effect in stopping linear compounds to pass through it.
- Ensemble with PFAS on its membrane is likely to release fluoride-containing compound(s) to its exposed face to fire (Yet needs to be confirmed by more experiments).

Next in Experimental Studies

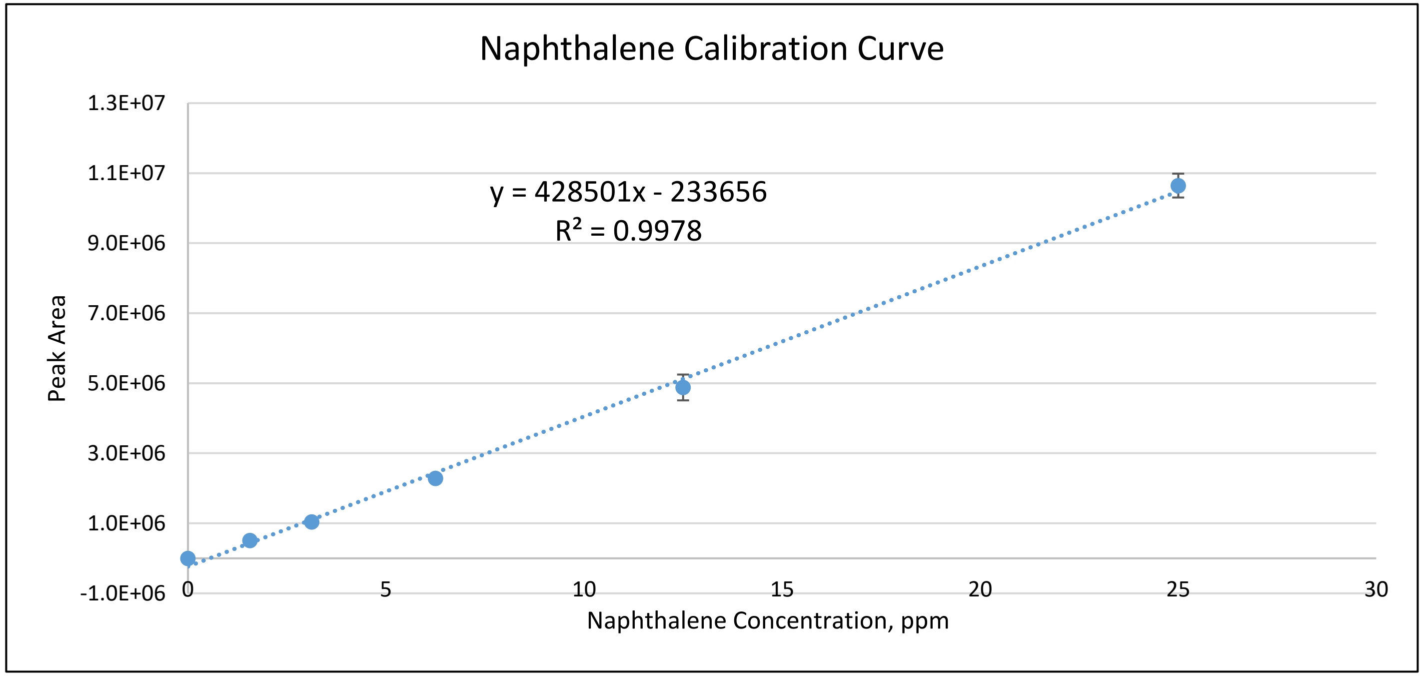


Thanks for your attention

WP2: Small-Scale Experimental Studies

Quantitative analysis

Naphthalene



Item	Value (ppm)
Limit of Quantification (LOQ)	1.5625
Limit of Detection (LOD)	0.3906

WP2: Small-Scale Experimental Studies

Quantitative analysis

Toluene

Item	Value (ppm)
Limit of Quantification (LOQ)	1.5625
Limit of Detection (LOD)	0.1950