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il futuro dei pneumatici fuori uso, oggi

Characterization of Tyre Recycled Rubber and Assessment of the Risks Associated with Dermal and Inhalation Exposure

Florence, October 28, 2016

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- Since 2011 – ELT management under an Extended Producer Responsibility scheme
- Management of 250.000 tonnes ELT/y
- Non for Profit
- (New) Business Development

Besides collecting tires..

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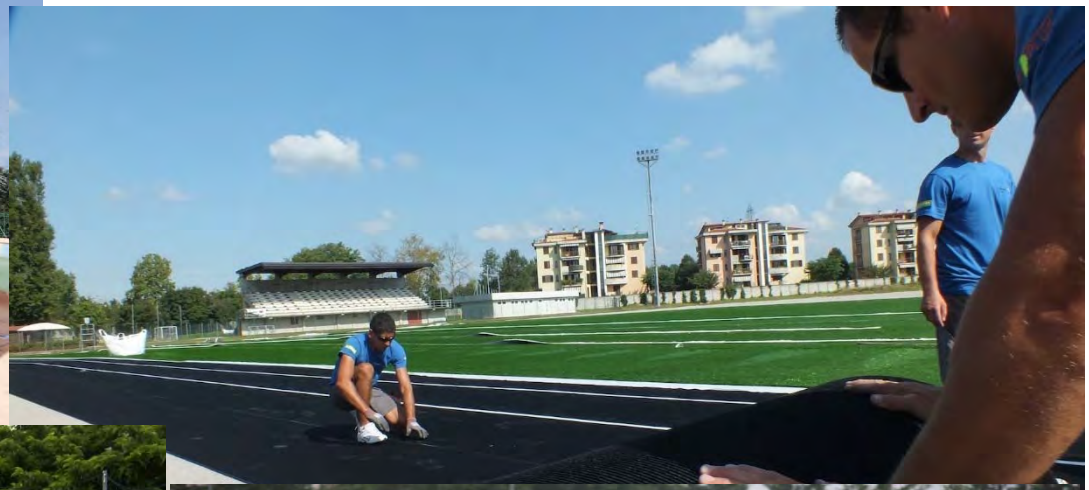

About the safety of rubber

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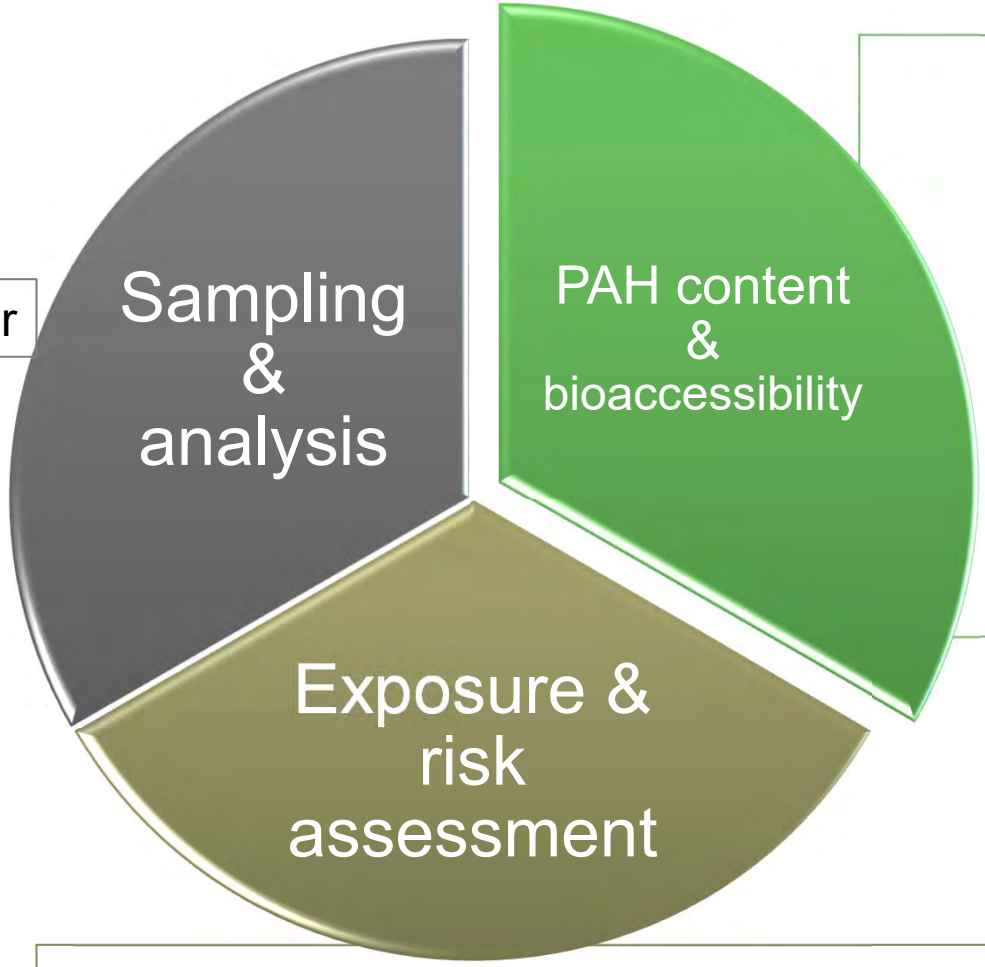
100% tire rubber



Content of 8 PAH:

< 20 ppm

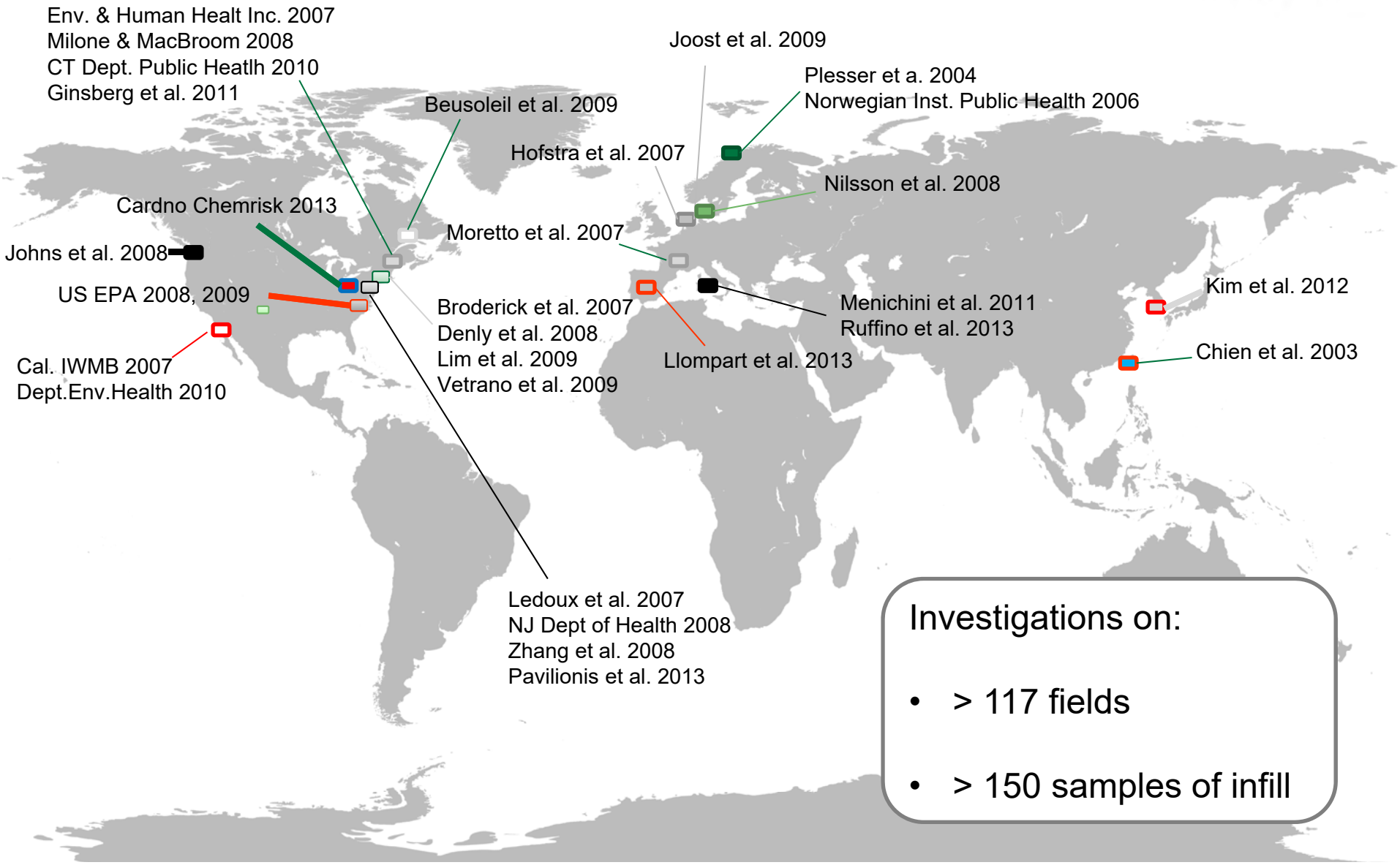
Migration rates:

< 0,007% in sweat

< 4% in pulmonary surfactant

Incremental Carcinogenic Risk << 1 x10^{-6}

Literature review



Investigations on:

- > 117 fields
- > 150 samples of infill

Facts

- Most of the studies generically refer to «Tyre recycled rubber» but the origin of the infill is not thoroughly investigated

- Crumb rubber with high PAHs content was found sometime

- Bioavailability of the PAHs of vulcanized rubber is not fully investigated

- The incremental carcinogenic risk related to the use of ELT recycled rubber is negligible ($< 10^{-6}$)

What is «crumb rubber»?

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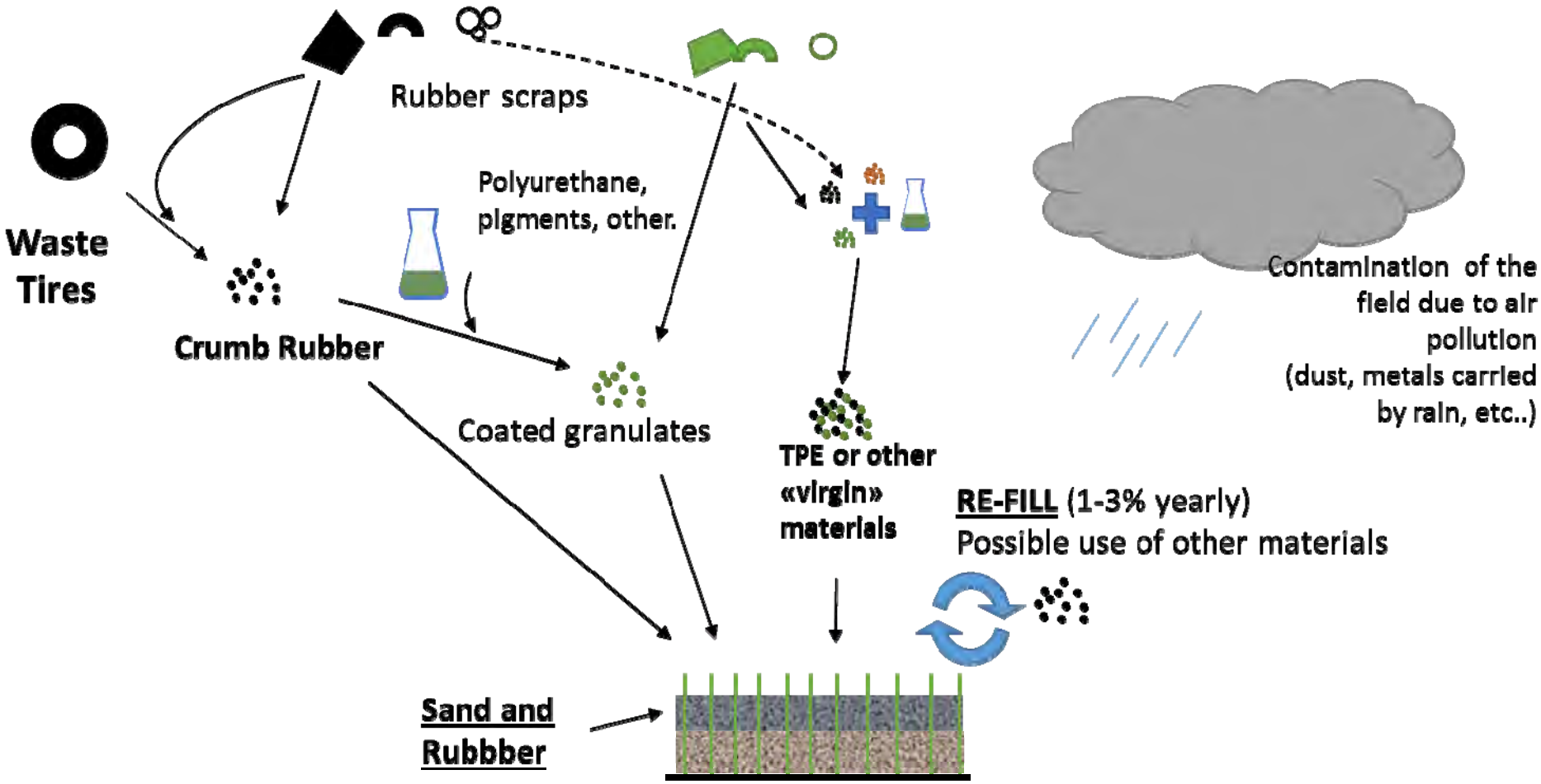

Scientific partners

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Isituto Farmacologico Mario Negri

www.marionegri.it

- *Determination of the PAH content*
- *Migration tests*
- *Risk assessment*

Waste and Chemicals

www.wasteandchemicals.eu

- *Exposure assessment*
- *Risk assessment*

Bureau Veritas

Witnessing - sampling

Cerisie

Characterization of the samples

Tun Abdul Razak Researh Centre

Aromaticity Index (Hbay)

Biochemisches Institut fur Umweltcarcinogene

-PAH content

Project outline

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Sampling and classification

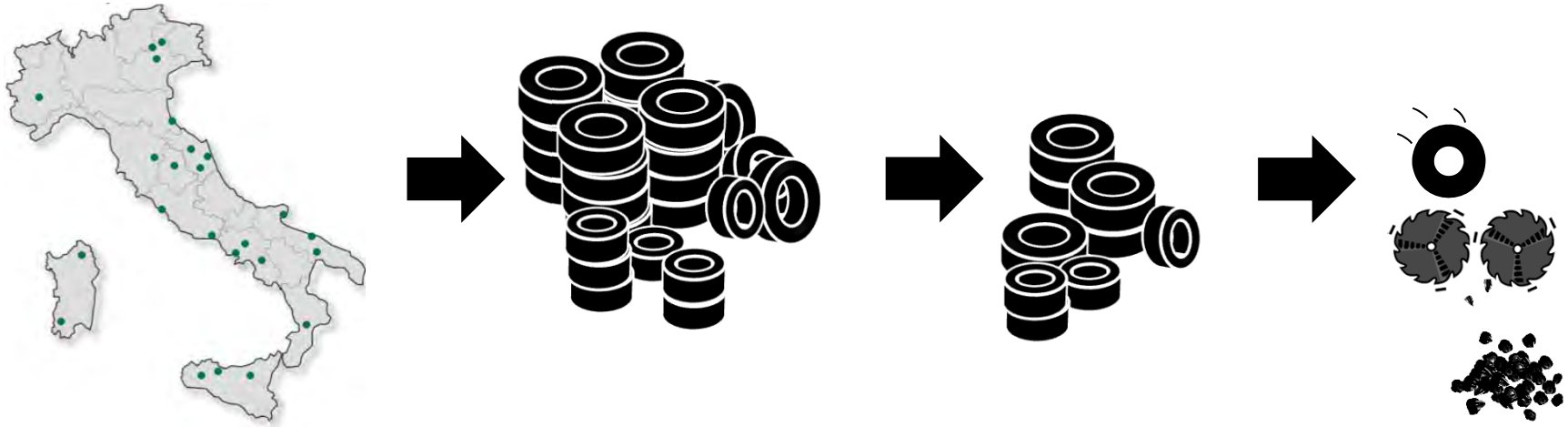
PAH content and other analysis

PAH migration tests

Exposure of workers and athletes

Risk assessment

Representative samples of tire rubber



Waste tires managed by Ecopneus: 250.000 tonnes/y

Primary sample 250 tonnes

Reduced sample 50 tonnes

25 increments (400 g each) to ensure the representativeness of the sample

Sampling and classification

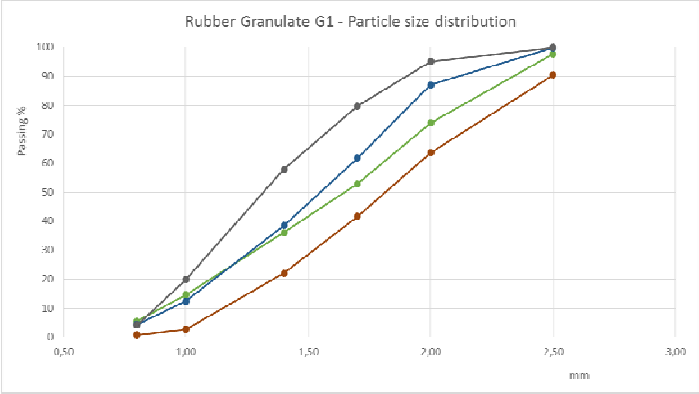
- 5 Facilities involved
- 250 t ELT mixed and reduced to ca. 50 t
- 3.885 ELTs classified by age and origin
- Witnessing and chain of custody by Bureau Veritas
- 5 Laboratories involved (UK, DE, IT)

Sorting by age and «made in»

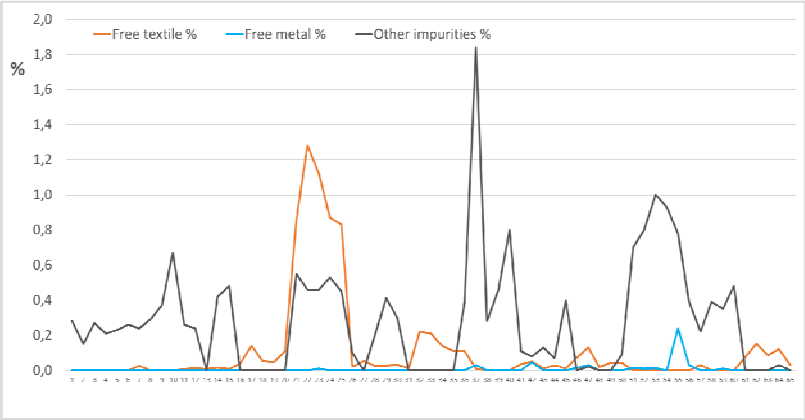
Before2010 Made in EU «Ante-EU»	Before 2010 Non- EU «Ante-nonEU»	After 2010 Made in EU «Post-EU»	After 2010 Non-EU «Post-nonEU»

Characterization of 65 samples

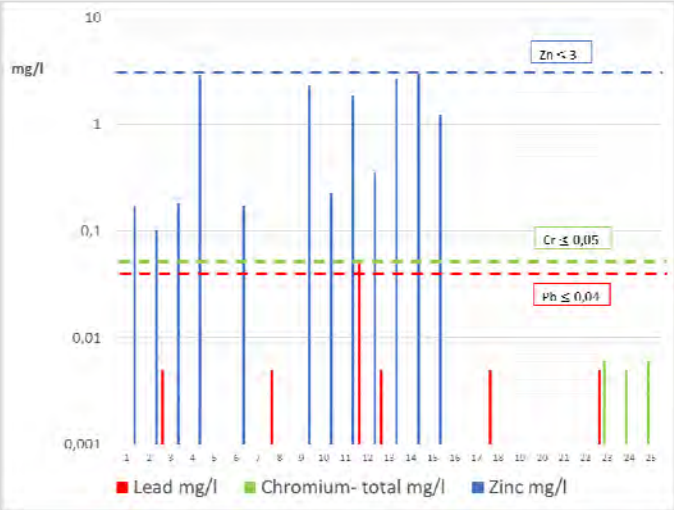
Particle size distribution



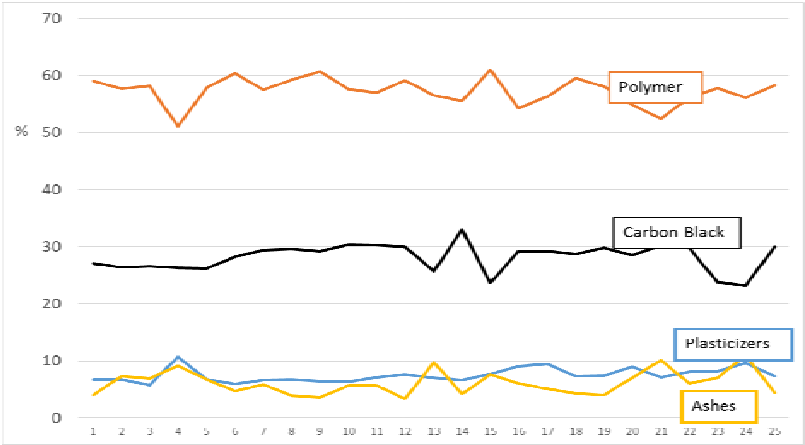
Metal, textile & other impurities



Leaching of metals

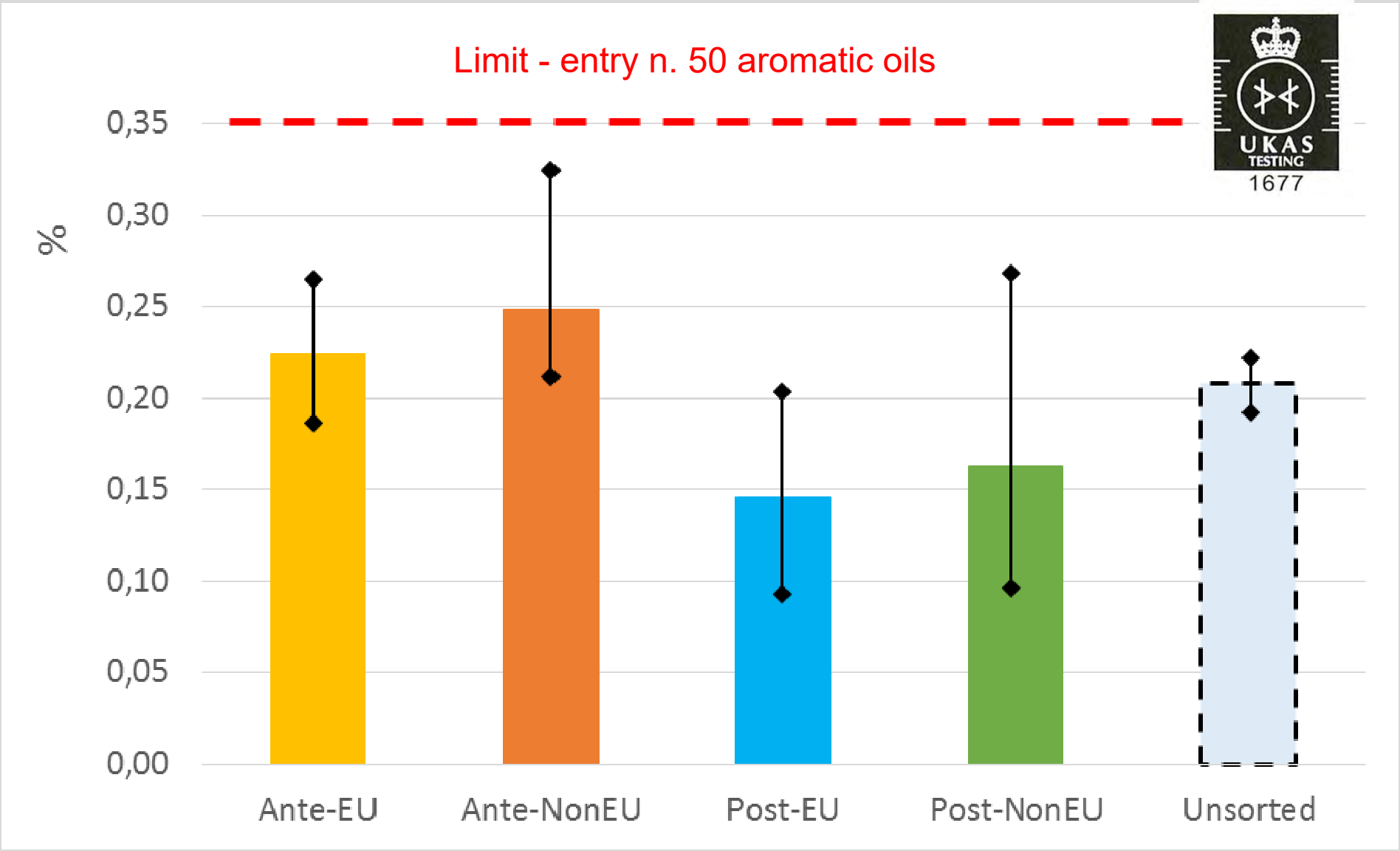


Thermogravimetric Analysis

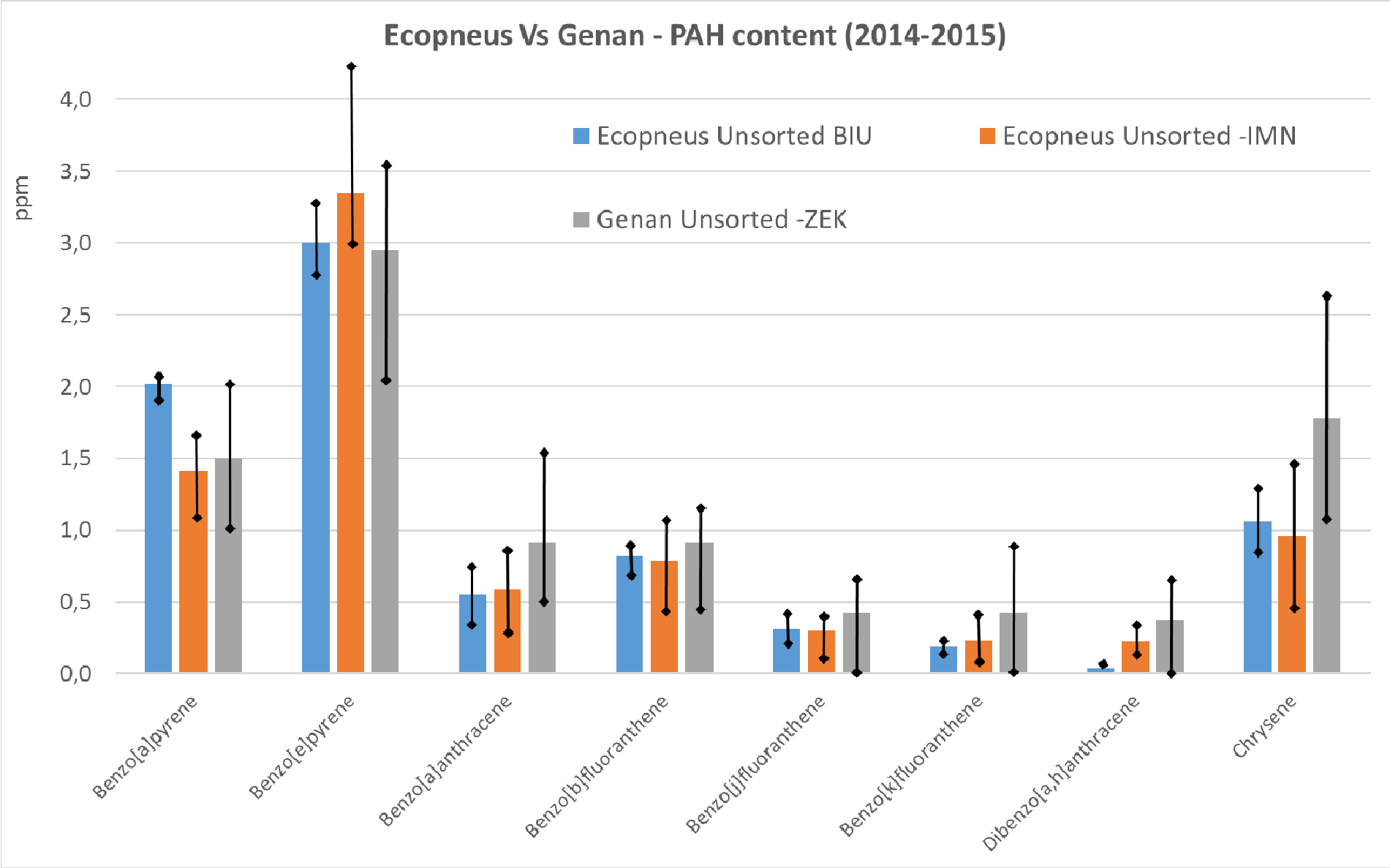


Poly Aromatic Hydrocarbons - PAH

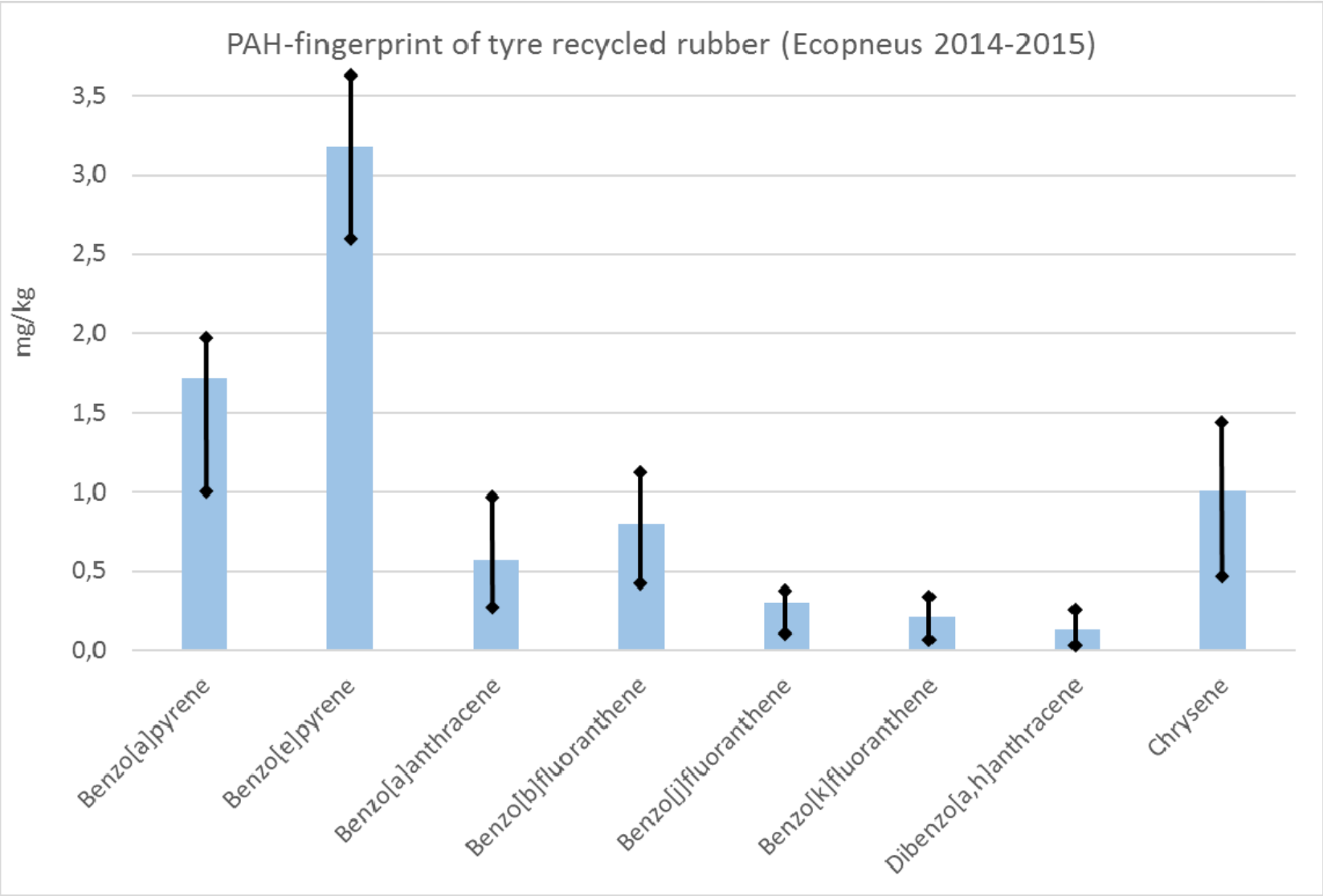
H-Bay – oil aromaticity (ISO-21461)



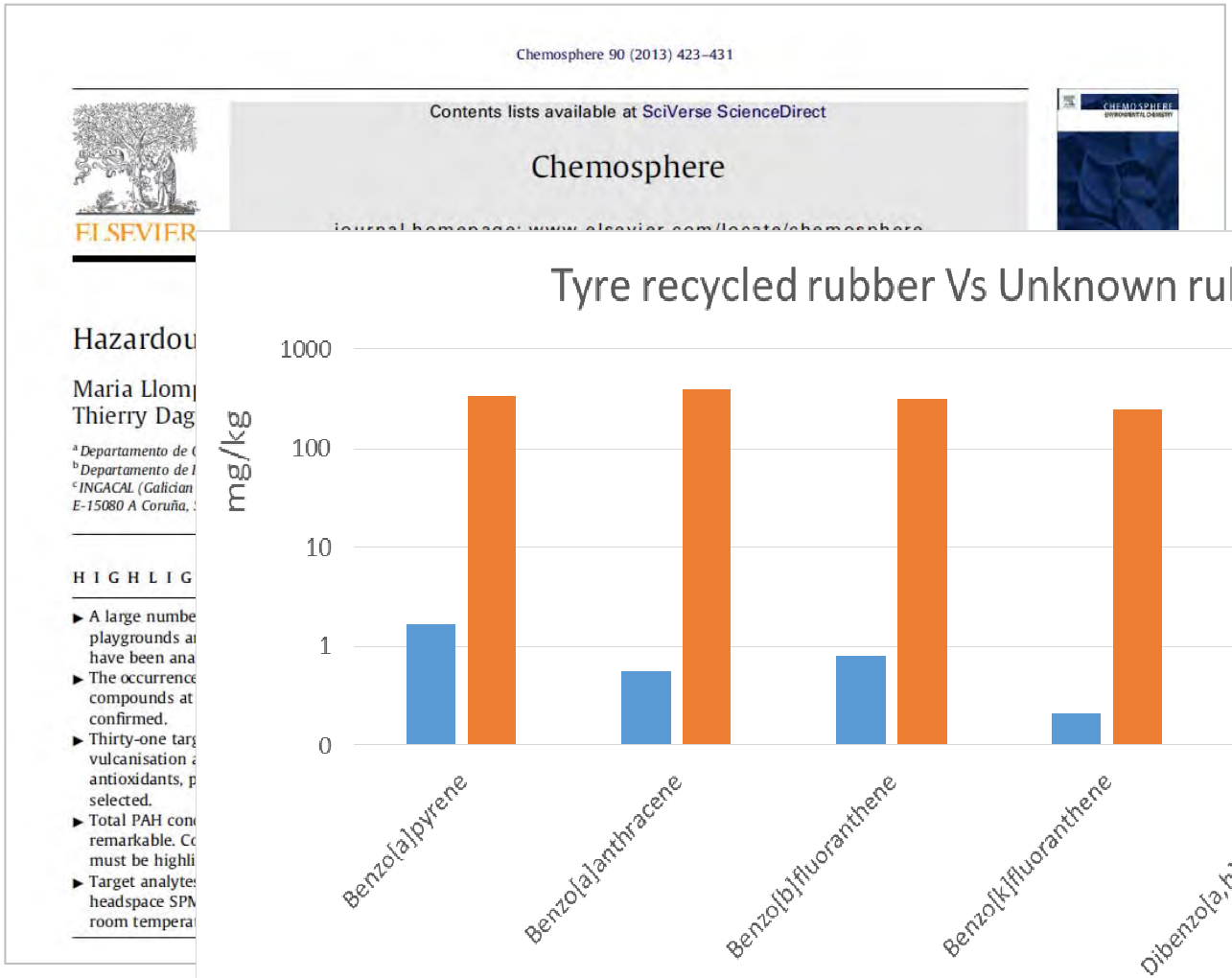
Comparison with central-European ELTs



PAH FINGERPRINT 2014-2015



Was it «tyre recycled rubber»?


Chemosphere 90 (2013) 423–431

Contents lists available at SciVerse ScienceDirect

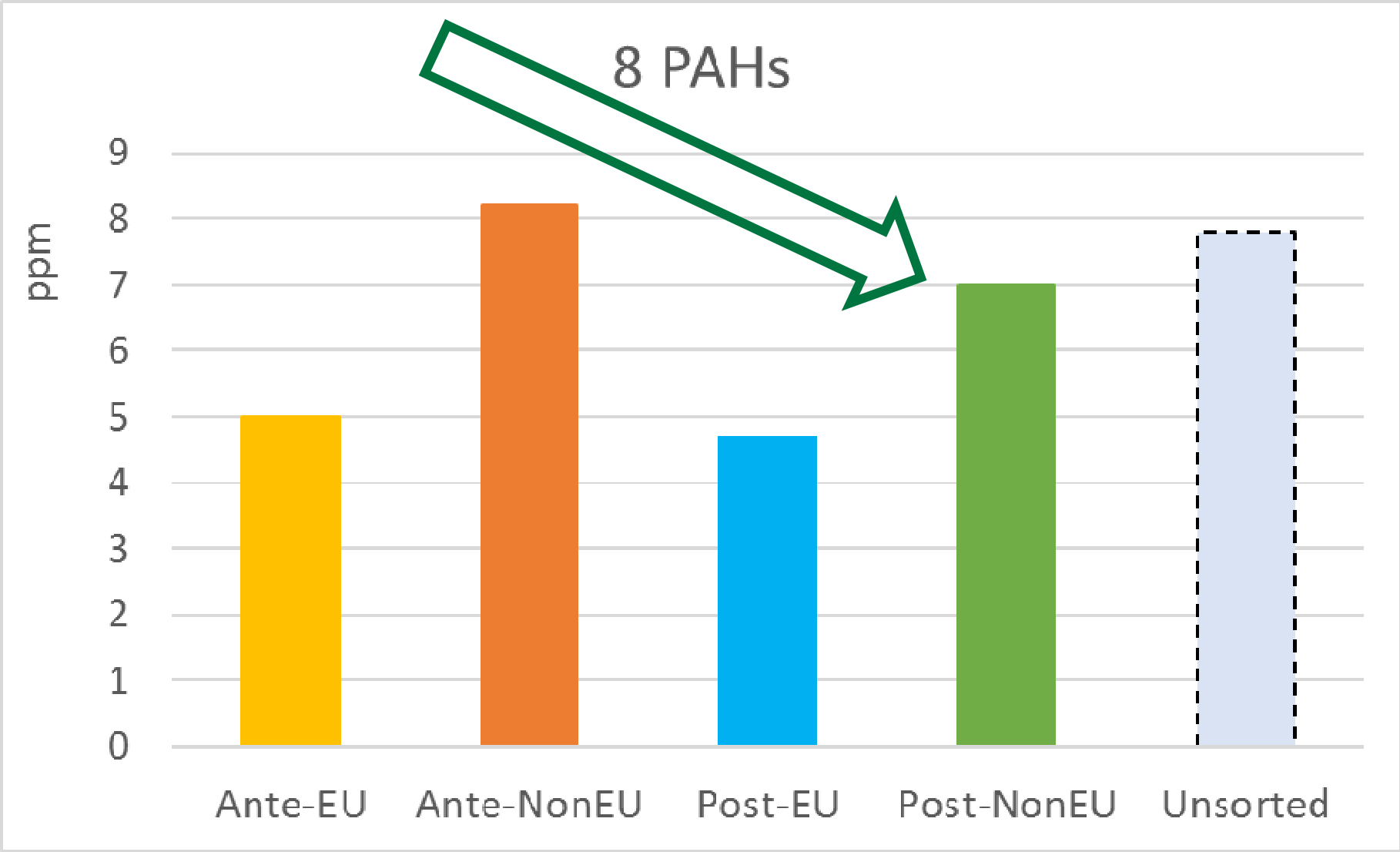
Chemosphere

Hazardou

Maria Llomp
Thierry Dag

HIGHLIG

8 PAHs in ELTs of different age/origin



Migration rate and bio-availability

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Artificial sweat → • Dermal Contact

Pulmonary Surfactant → • Inhalation

Migration in bio-fluids

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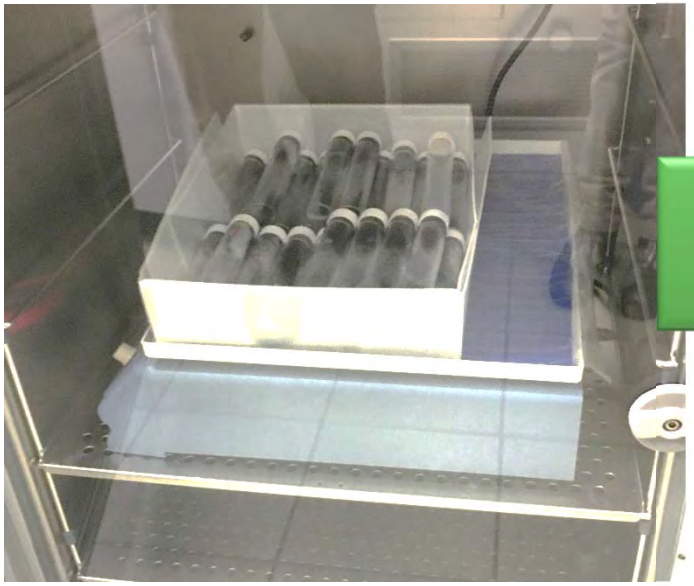


MIGRATION IN ARTIFICIAL SWEAT < 0,007%

MIGRATION IN PULMONARY SURFACTANT < 4%

Migration Test in Artif. Sweat (EN 1810)

-24 h mixing @ 37°C instead of 1h

-5g rubber in 30 ml Artificial Sweat

-PAH in sweat close to the limit of detection <0,05 ng/g B(a)P

Migration < 0,007%

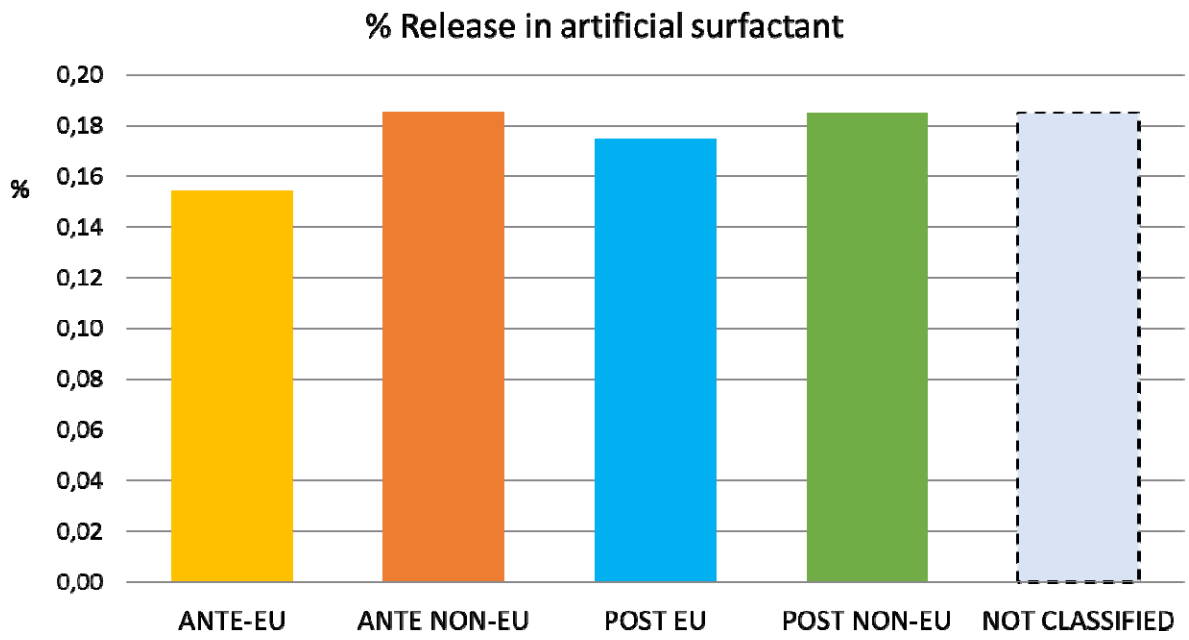
Migration Test in Pulmonary Surfactant

-24 h mixing @ 37°C

-5g rubber in 30 ml Pulmonary Surfactant (3 fluids)

1. 10 mM magnesium chloride, 150 mM sodium chloride, 4 mM potassium chloride, 1mM di-potassium phosphate, 5 mM sodium sulphate, 25 mM calcium chloride, 7 mM sodium acetate, 24 mM sodium bicarbonate, 3 mM sodium citrate) diluted 1:4, and **0.18% (w/v) 1,2-Dipalmitoyl-sn-glycero-3-phosphocholine**.

2. **Natural surfactant** (pig pulmonary surfactant)



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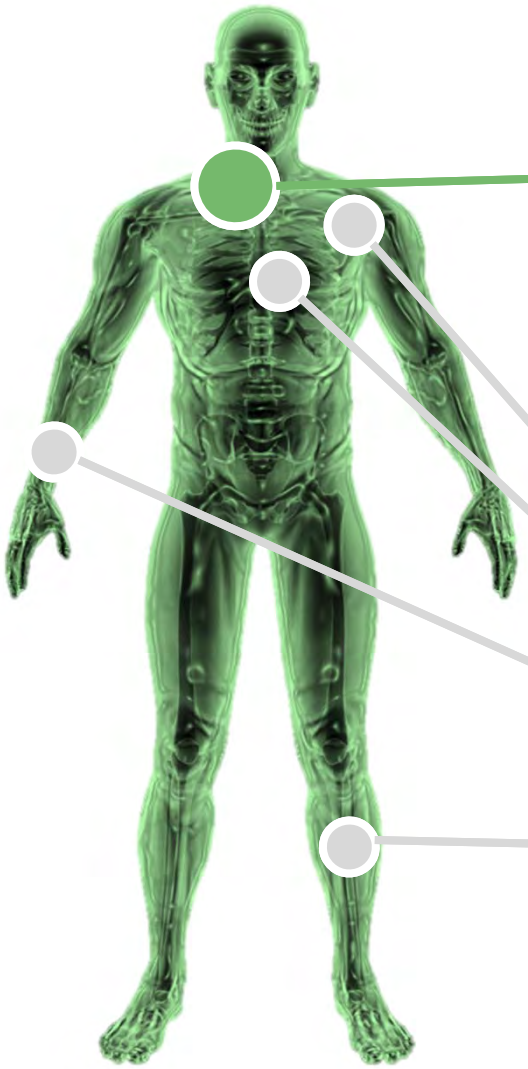
Exposure assessment for workers and athletes.
PAH uptake.
Risk assessment.

Exposure assessment - method



Inhalation exposure

PAH - air

-Breathing zone sampling (NIOSH 5515)
-Quartz filters → 2 l/min

PAH – dust

-Respirable particles (NIOSH 0600)
-Glass filters → 1,7 l/m

Dermal exposure

-Dermal polypropilene patches
-particulate and gaseous PAH adsorption
-chest-shoulder-wrist-calf

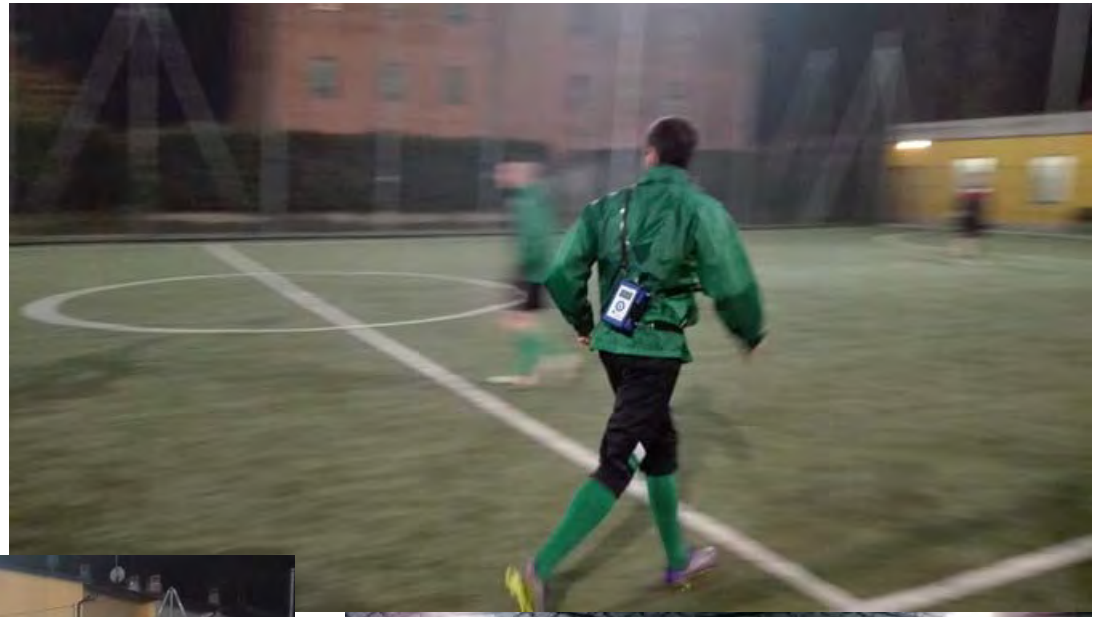
Monitored sites:

#	Field	Date	Type*	Infill
1	Trecella (MI)	07/15	I	SBR
2		11/15	T	SBR
3	Roma	09/15	I	SBR
4		09/15	I	SBR
5	San Salvo (CH)	09/15	I	Cork
6	Milano	10/15	I	SBR
7		10/15	I	SBR
8	Trecella (MI)	05/16	T	SBR
9			T	Erba
10	Trecella (MI)	05/16	T	SBR
11			T	Grass
12	Roma (x2)	06/16	T	SBR
13		06/16	T	Grass

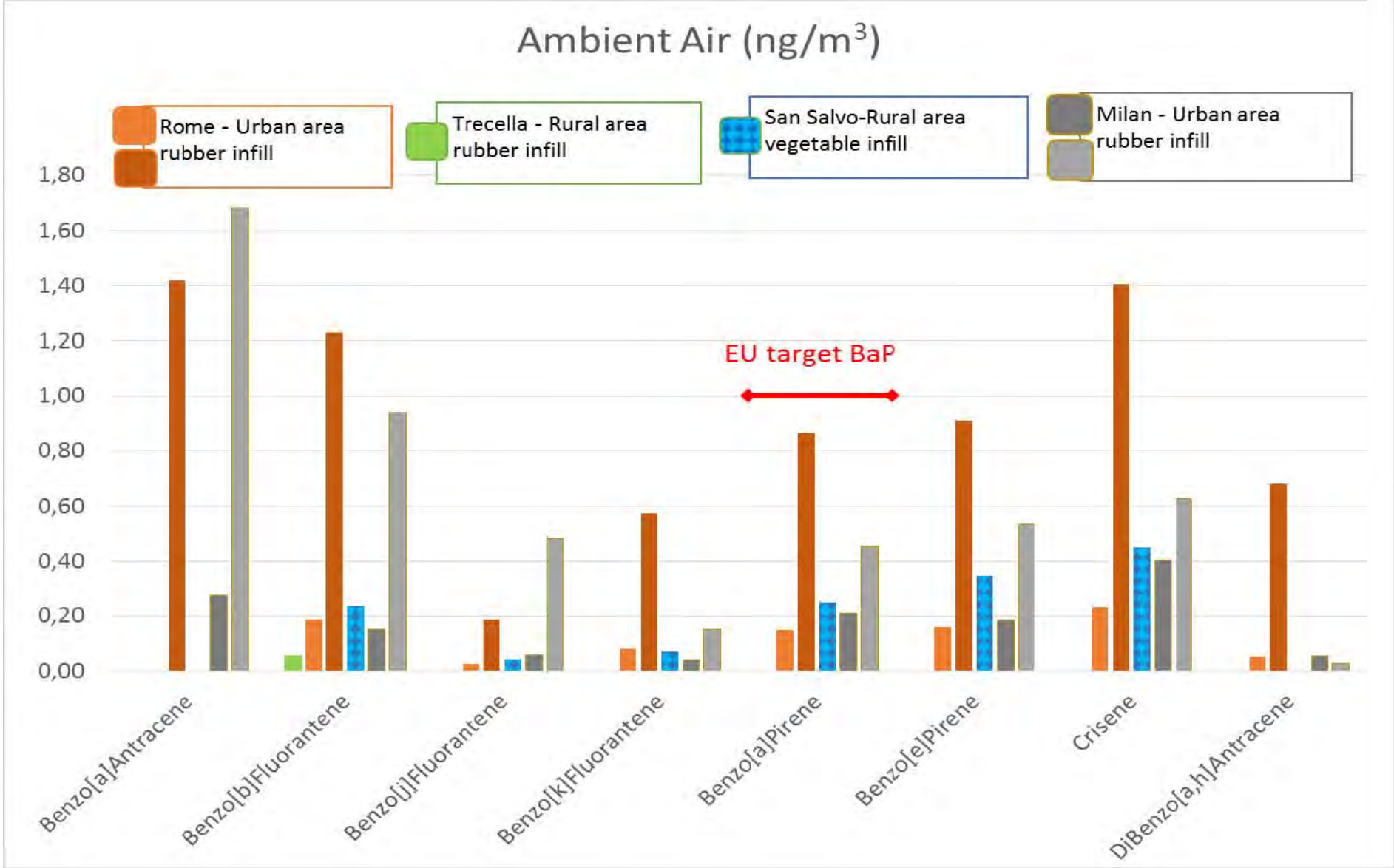
* *I: installation; T: training*

Workers exposure

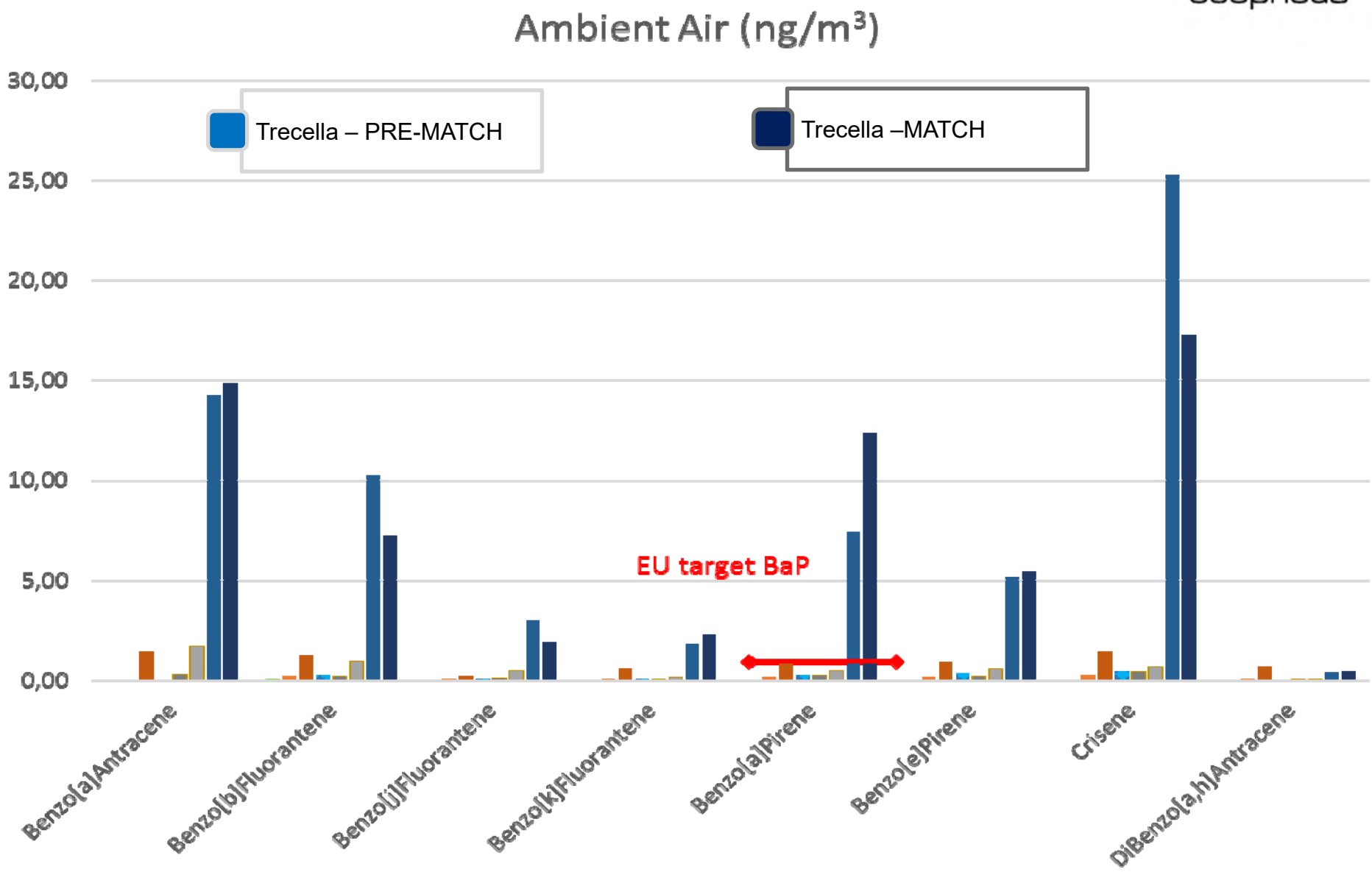
Athletes exposure



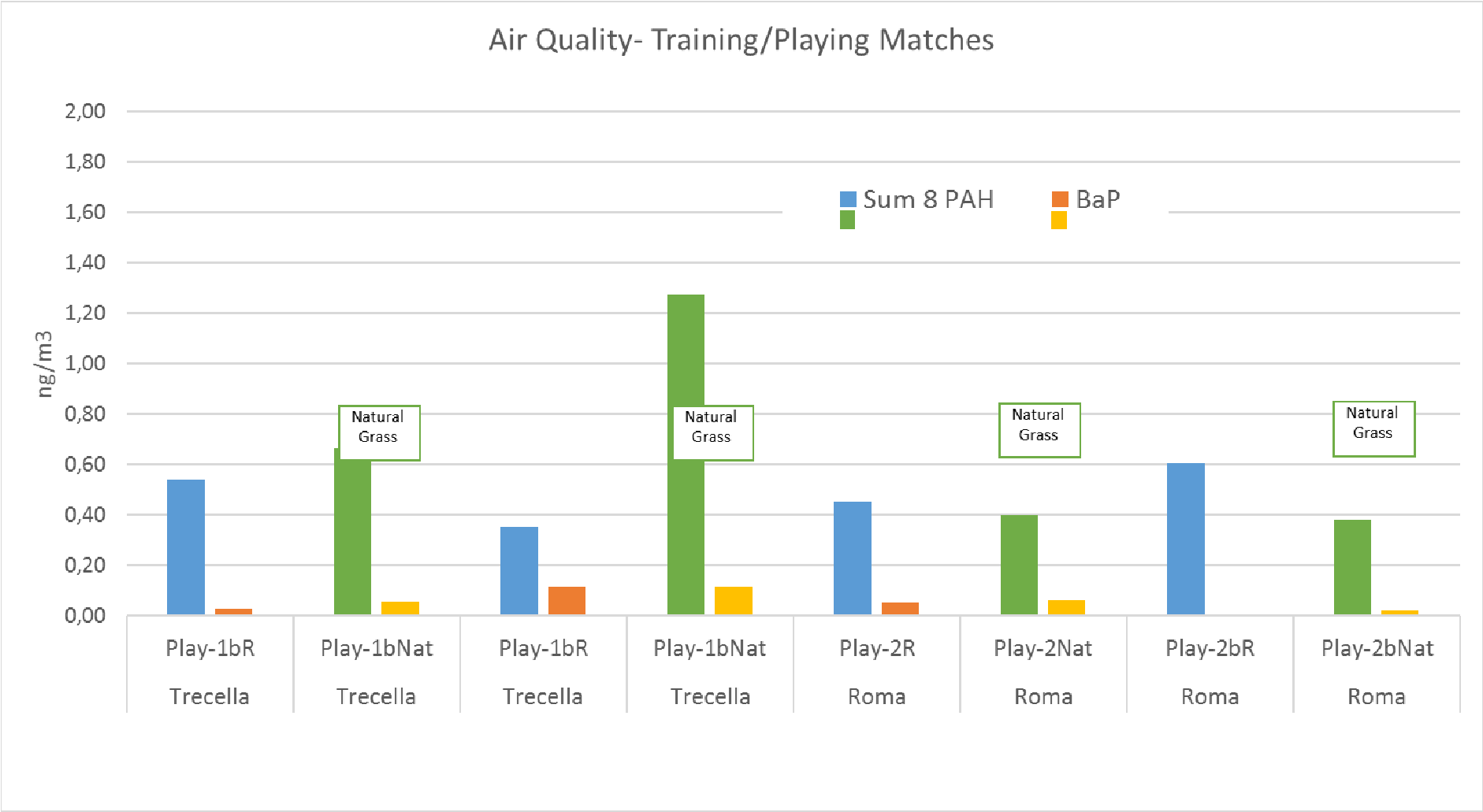
Workers' exposure (Summer- Early Autumn)



Athletes' exposure (December)



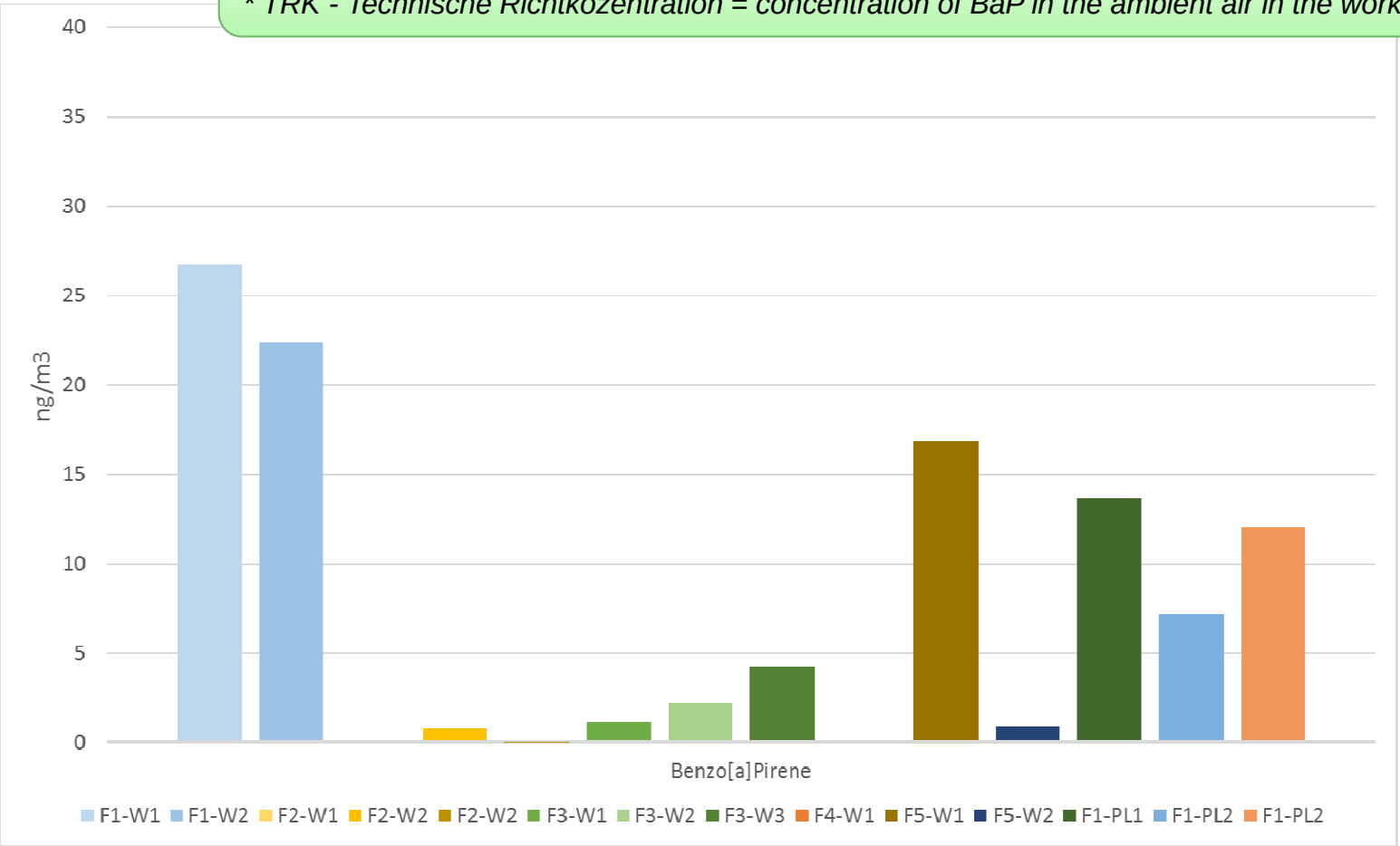
Athletes' exposure (Late spring)



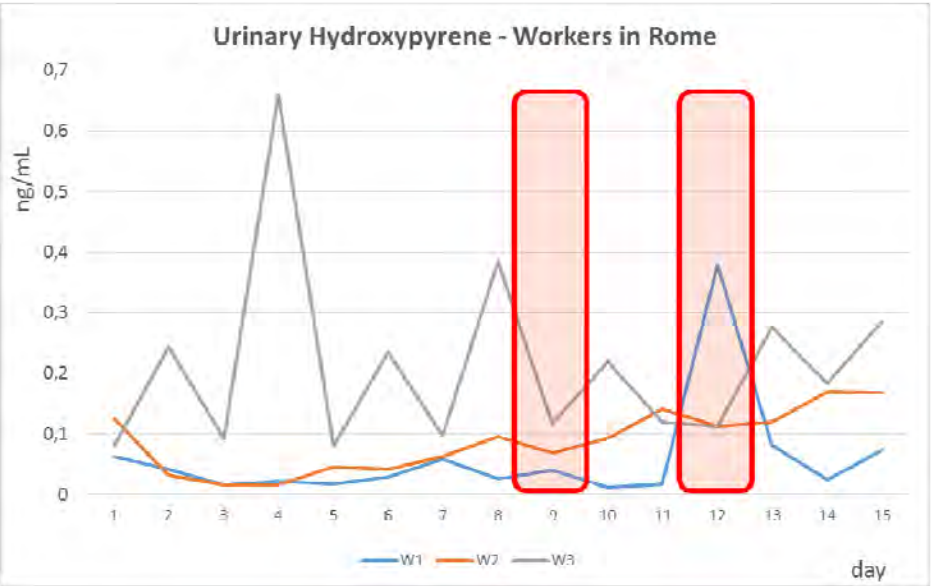
Inhalation exposure (ng/m³ - breathing zone)

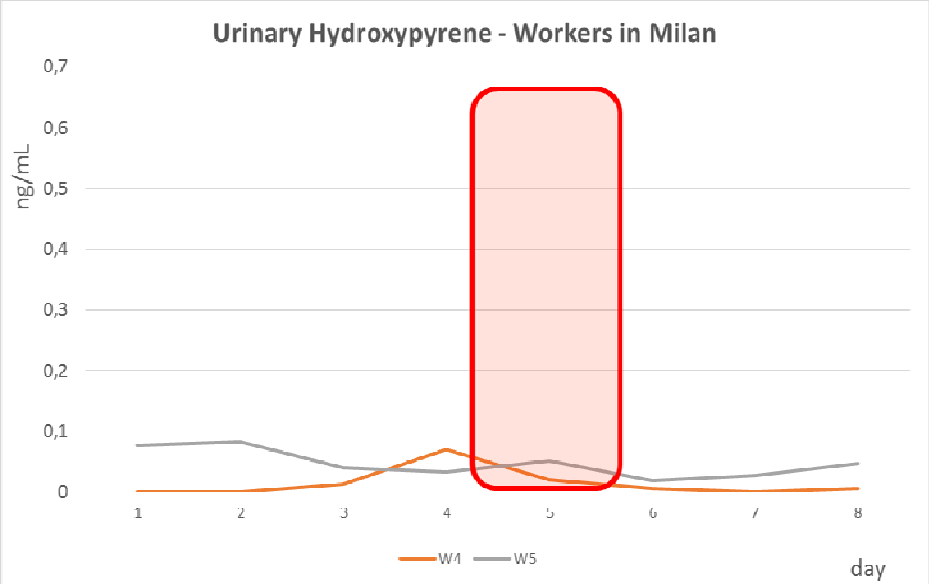
Occupational exposure limit BaP (German TRK*) = 2.000 ng/m³

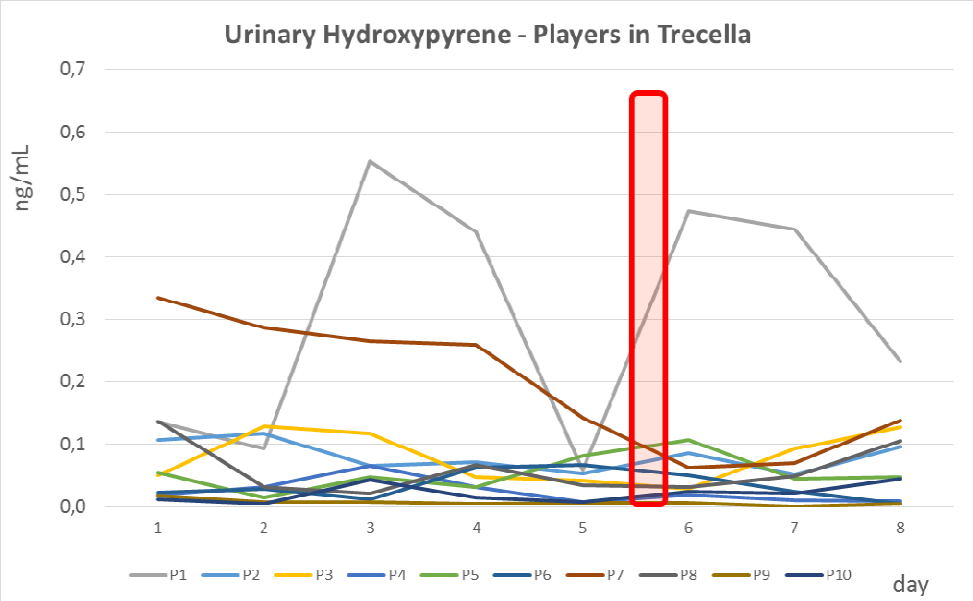
** TRK - Technische Richtkozentration = concentration of BaP in the ambient air in the workplace*



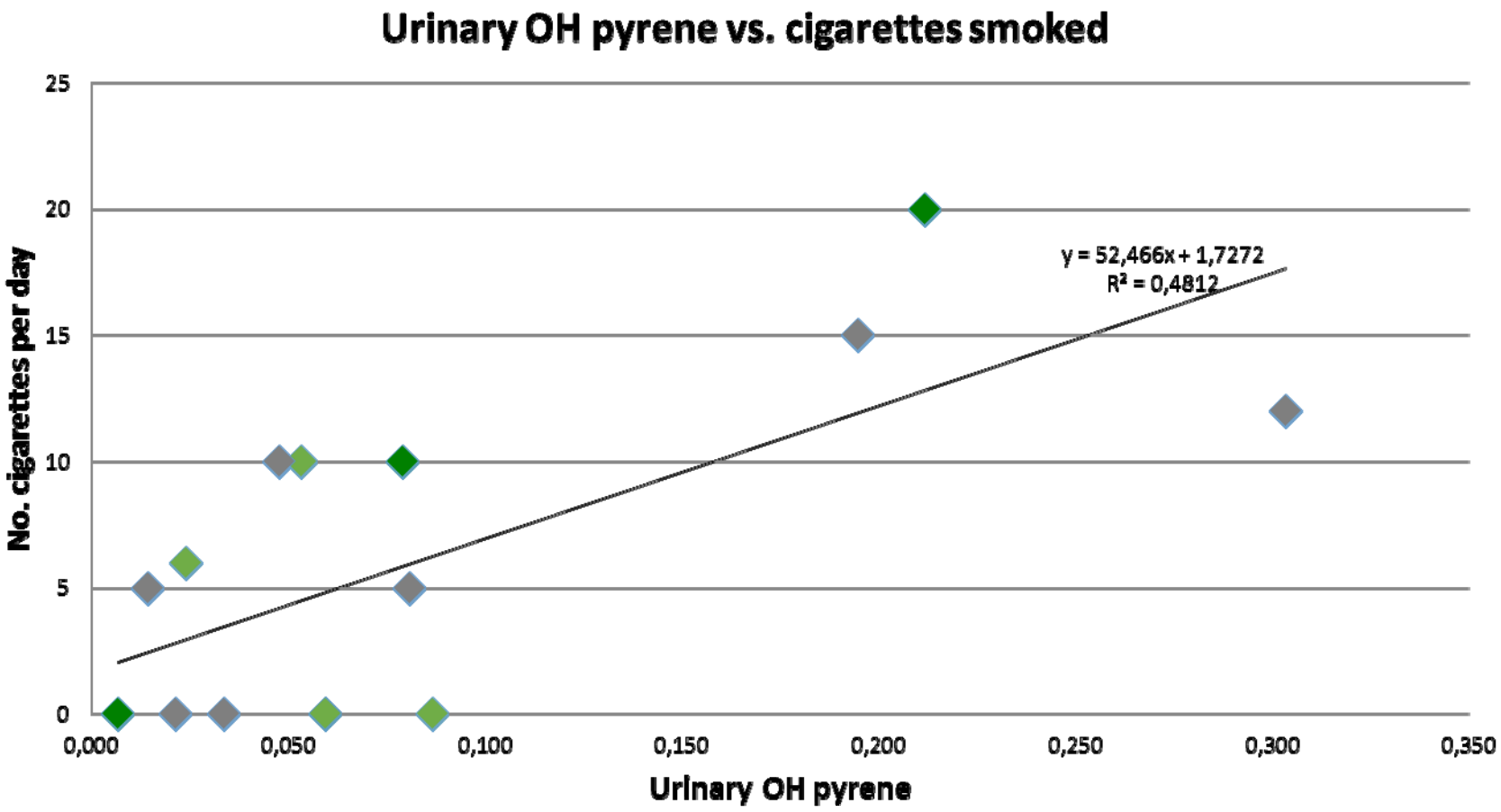
PAH uptake – Urinary Hydroxypyrene







PAH uptake and lifestyle



Resident in rural area

Resident in urban area

Resident in sub-urban area

2 Risk assessments

WASTE AND CHEMICALS

- Based on experimental data
- Exposure values were measured on the fields
- Conservative approach regarding the bioavailability of PAH (1% dermal migration)

ISTITUTO MARIO NEGRI

- Based on average PM10 annual concentration
- 100% PM10 assumed to be ELT-rubber
- 100% bioavailability of PAH in rubber was considered (conservative approach)

Risk assessment

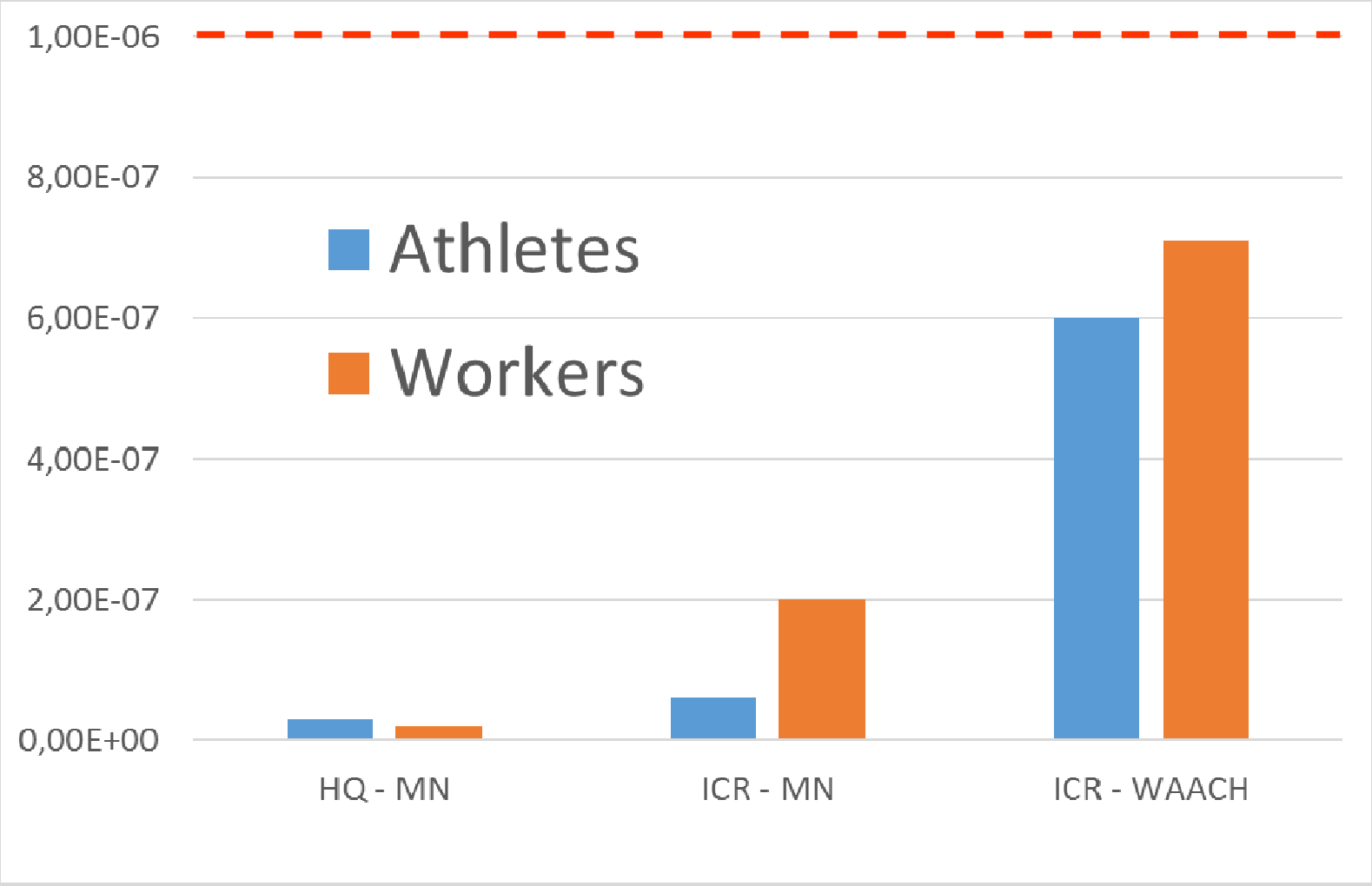
- Equation for inhalatory exposure:

$$R_I = SF_I \frac{(C_p + C_v) \times I_R \times HE \times EF \times ED}{BW \times AT \times 365}$$

- Equation for dermal exposure:

$$R_D = SF_d \frac{C_{pad} \times HE \times BF \times S \times EF \times ED}{ET \times BW \times AT \times 365}$$

Risk assessment



Conclusions

- The risk associated with the PAH exposure is negligible in fields infilled with tire rubber
- The PAH content in tire rubber is limited (< 20 ppm)
- The bioaccessibility of PAH in vulcanized rubber is limited
- The traceability of the infill material should not be given for granted in forthcoming surveys.

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Thank you for your attention.

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