



# Reduction of PAH by the Use of Electrostatic Precipitators at different Positions in the Exhaust Gas Stream of Logwood Stoves

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Gefördert durch:



aufgrund eines Beschlusses  
des Deutschen Bundestages



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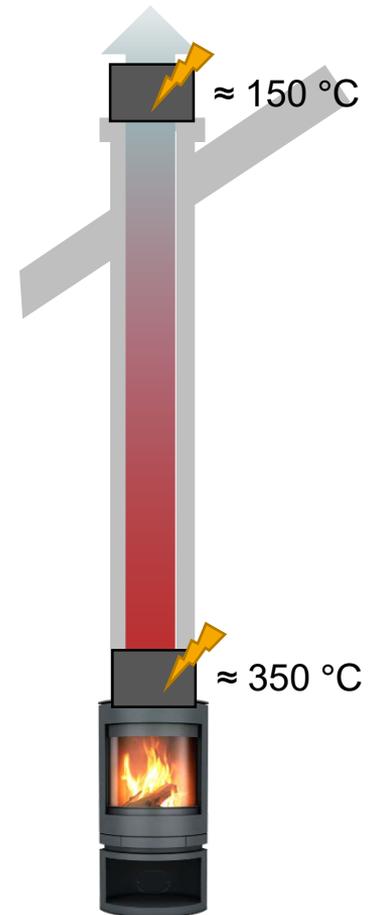
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# Motivation

## Research Focus: PAH Emission from Domestic Wood Burning

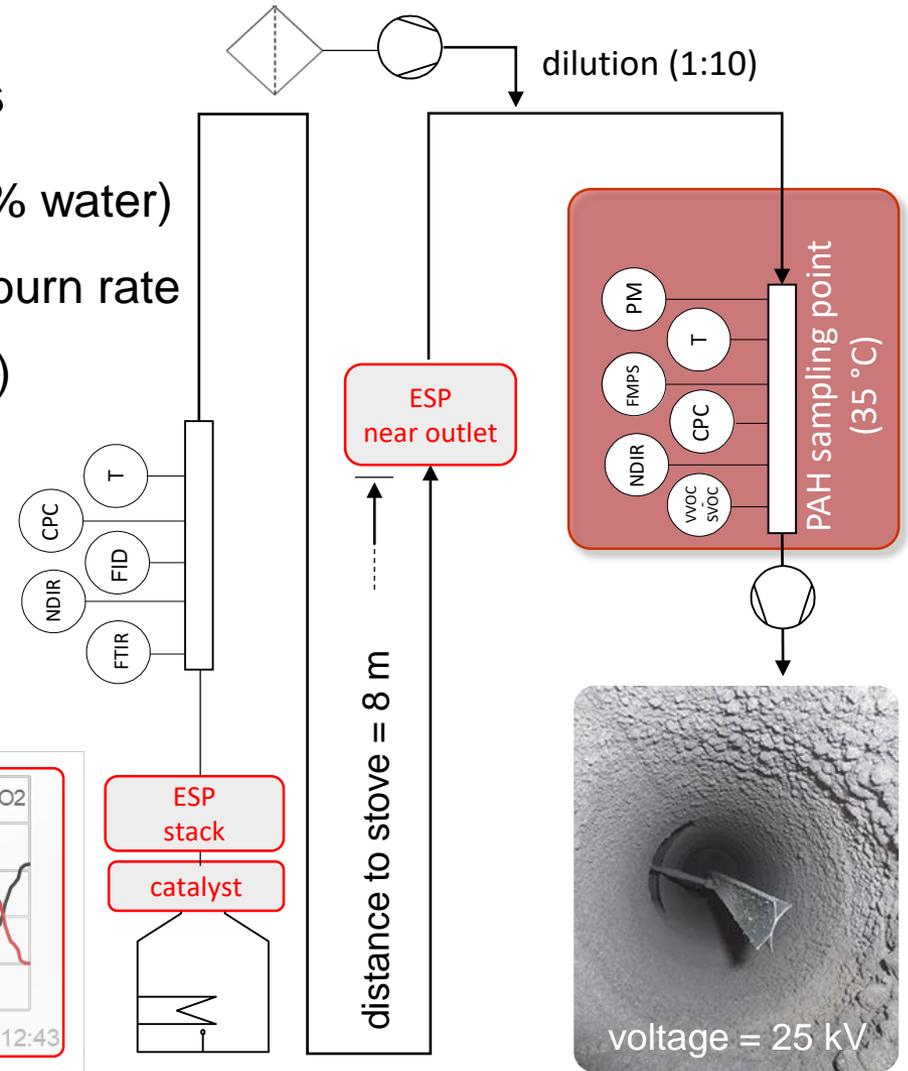
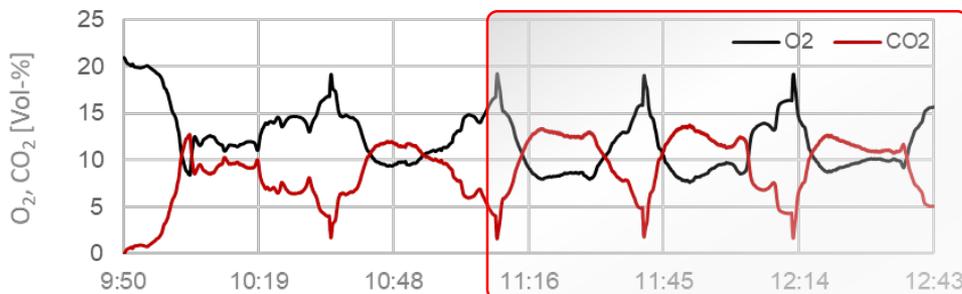
- domestic wood burning responsible for large share of PAH emissions in Germany (>> 50 %)
- PAH not directly addressed by any emission limits
  - 1. BImSchV: only limits for total PM and CO
  - ecolabel „Blue Angel“: additional limits for particle number and OGC
- research questions
  - PAH reduction potential of ESP and catalyst
  - **most favorable position of ESP** regarding PAH reduction
  - stack of the stove versus top of the chimney (outlet)
- starting hypothesis
  - PAH rather particle bound at low temperature position
  - chimney/position near outlet = favorable position



# Method and Material

## Test Bench, Sampling and Analysis

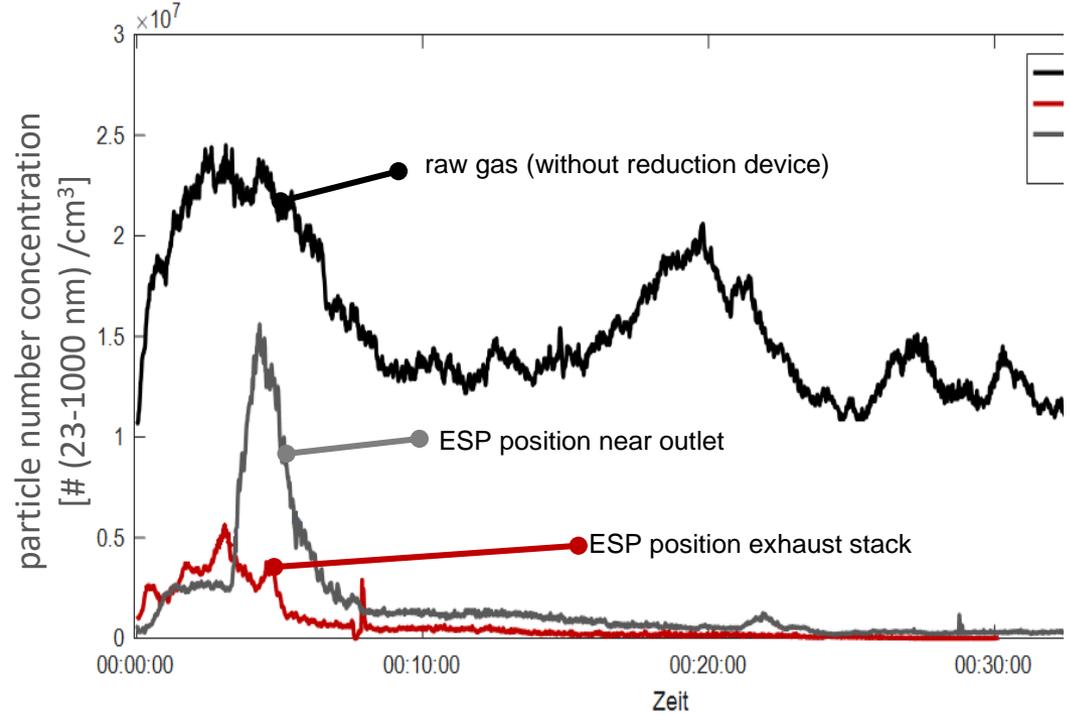
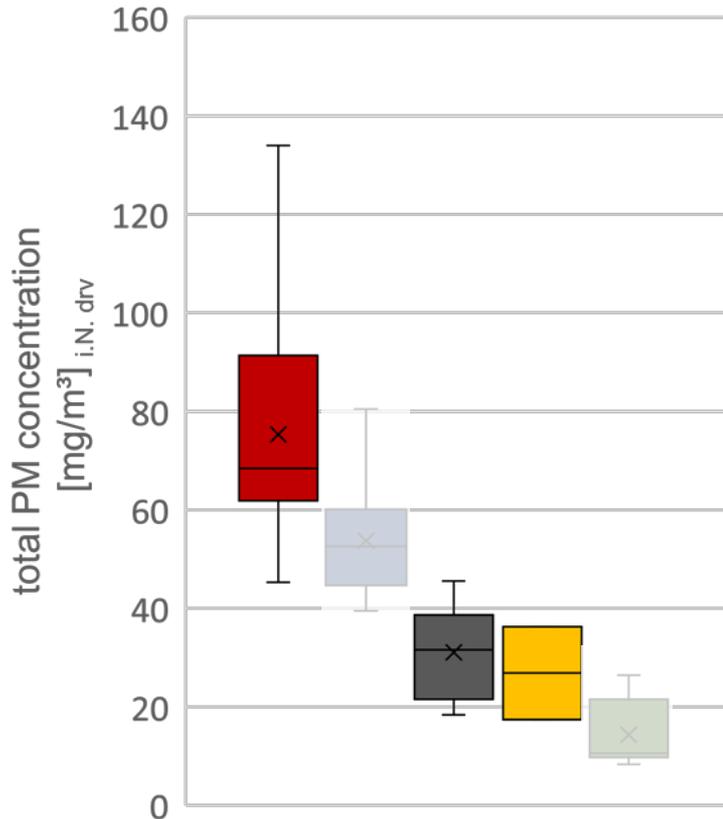
- stove: 6 kW, logwood, beech (12 +/- 2 % water)
- sampling period: 3 batches at nominal burn rate
- sampling point: full dilution tunnel (1:10)
- sampling and analysis method:
  - filter and XAD-4
  - PLE (DCM/MeOH) + GC-MS
  - 16 EPA PAH + o-PAH



# Results

- raw gas (without reduction device)
- ESP position exhaust stack
- ESP position near outlet

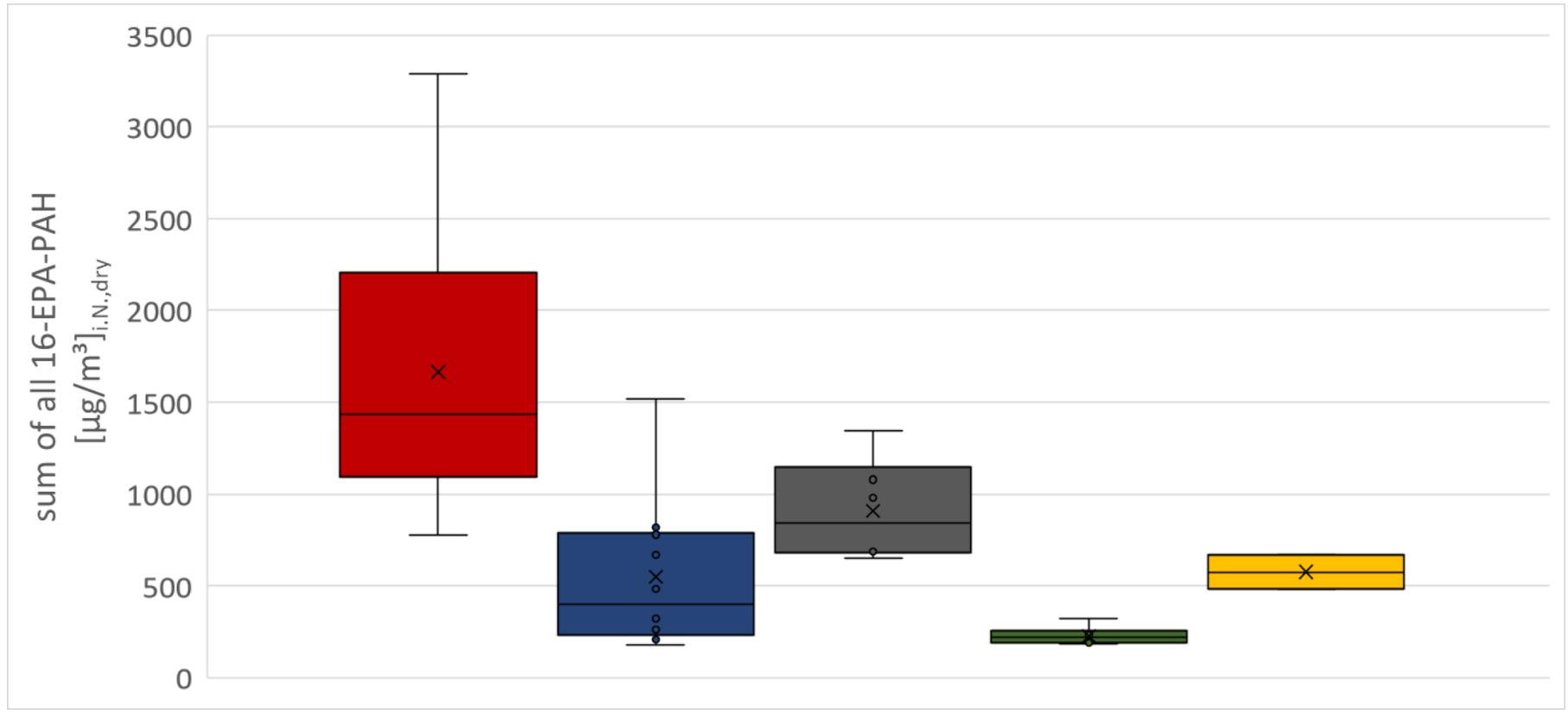
## Performance of the ESP (total PM and particle number concentration)



# Results

- raw gas (without reduction device)
- ESP position exhaust stack
- ESP position near outlet

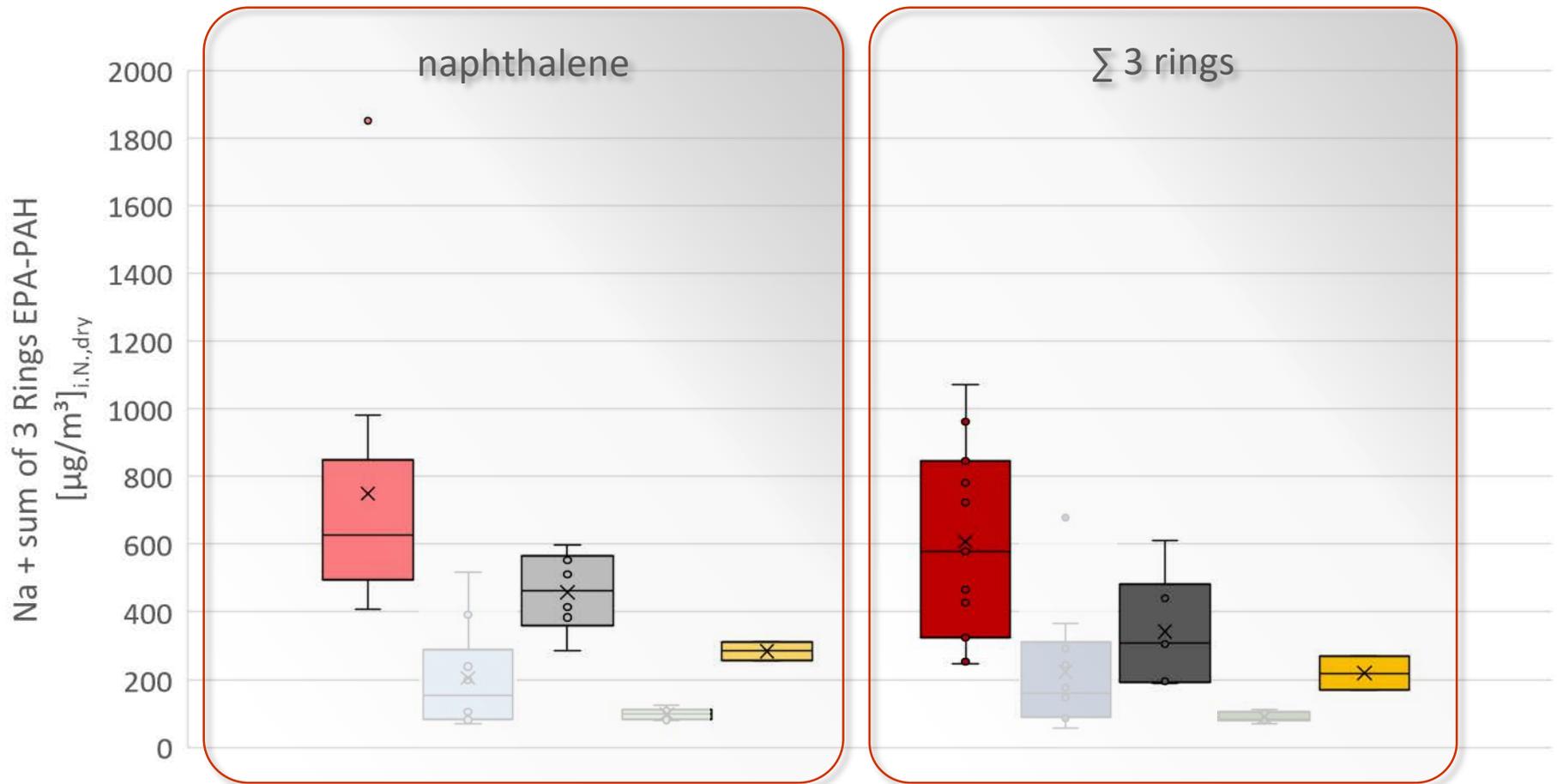
## Sum of all 16 EPA-PAH



# Results

- raw gas (without reduction device)
- ESP position exhaust stack
- catalyst + ESP stack
- ESP position near outlet

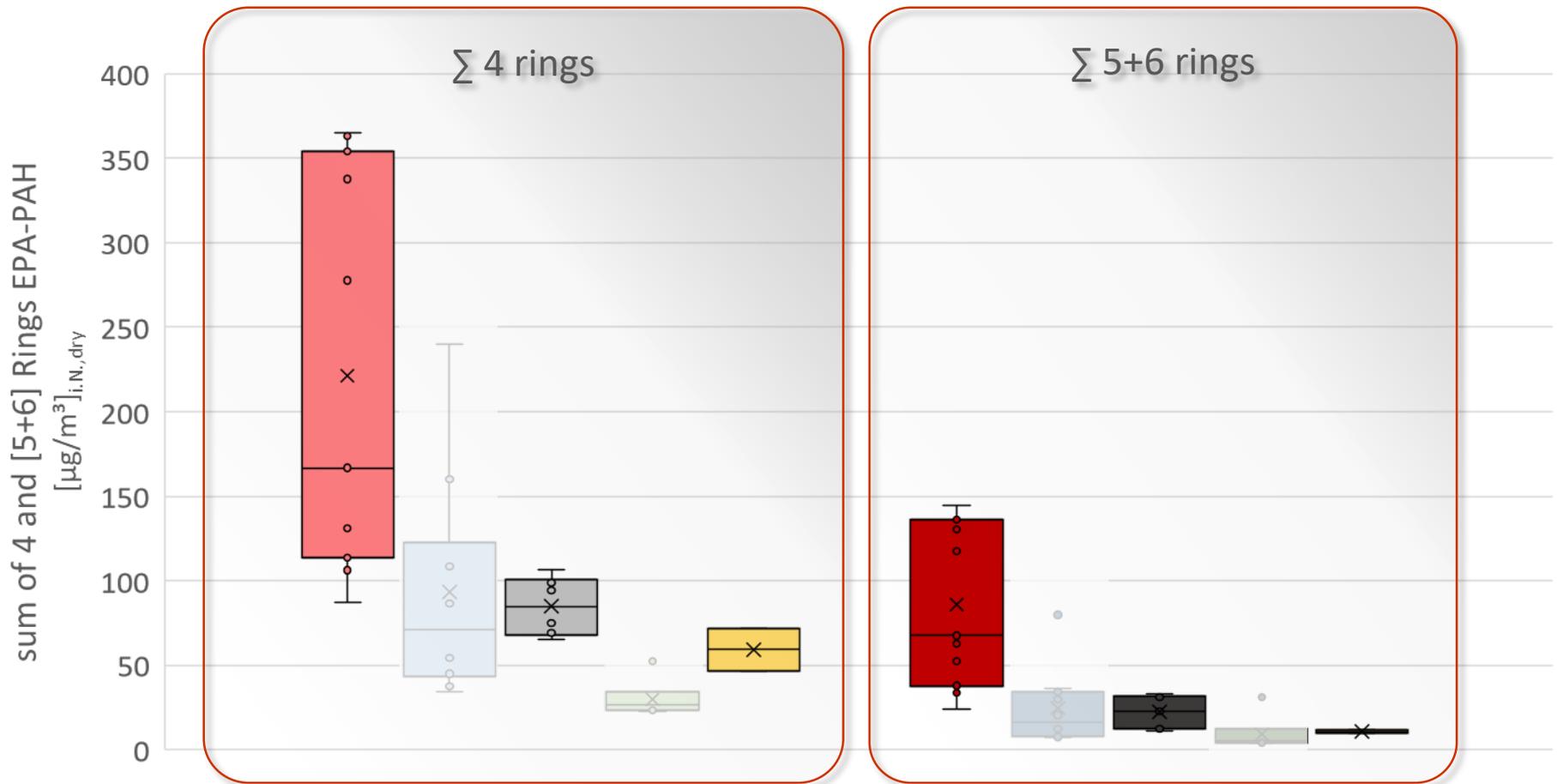
## Sum of EPA PAH (naphthalene and $\Sigma$ 3 rings)



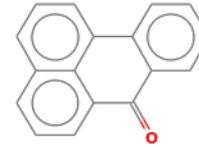
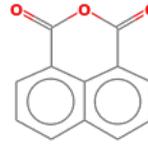
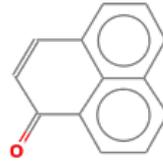
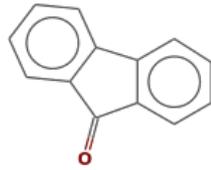
# Results

- raw gas (without reduction device)
- ESP position exhaust stack
- catalyst + ESP stack
- ESP position near outlet

## Sum of EPA PAH ( $\Sigma$ 4 rings and $\Sigma$ 5 + 6 rings)

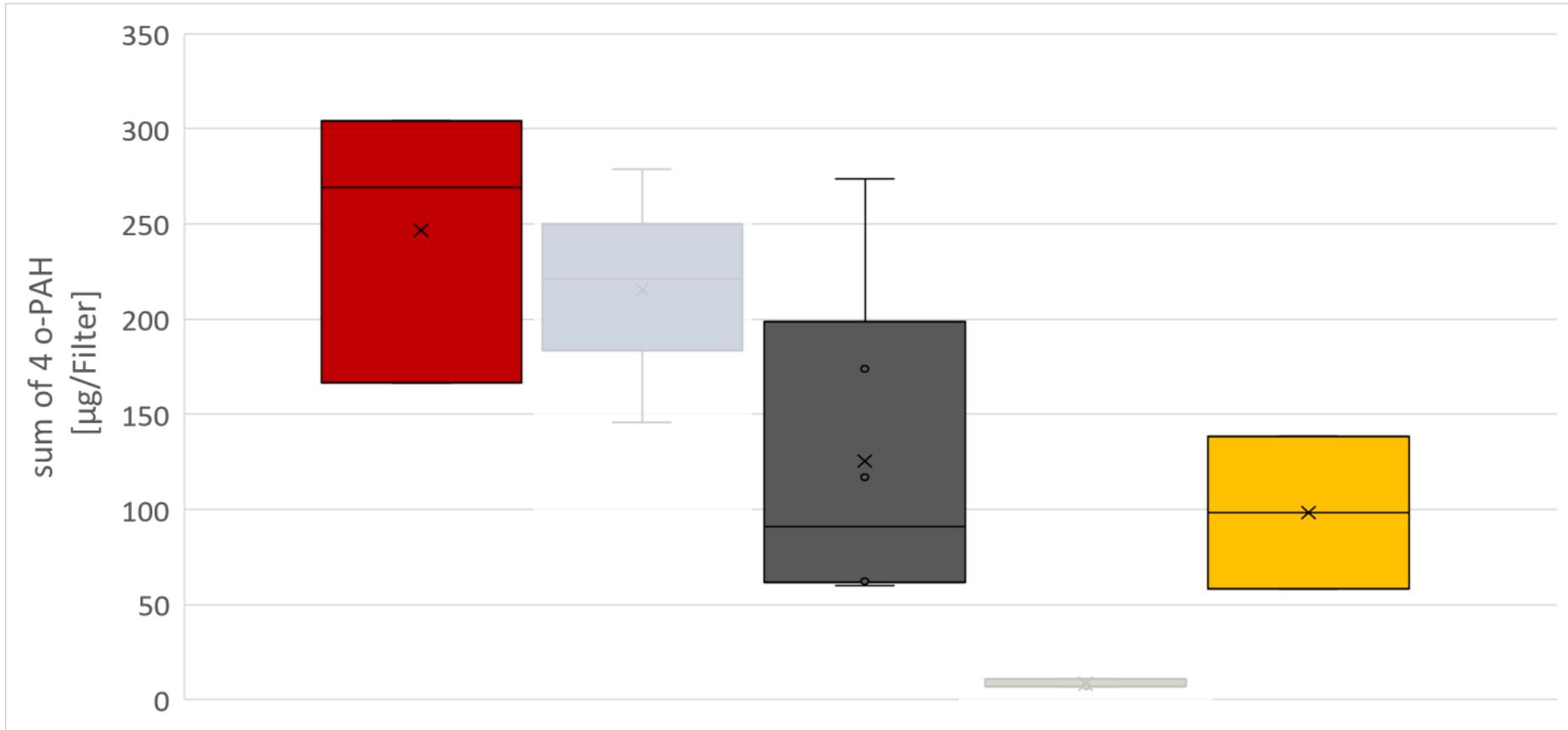


# Results



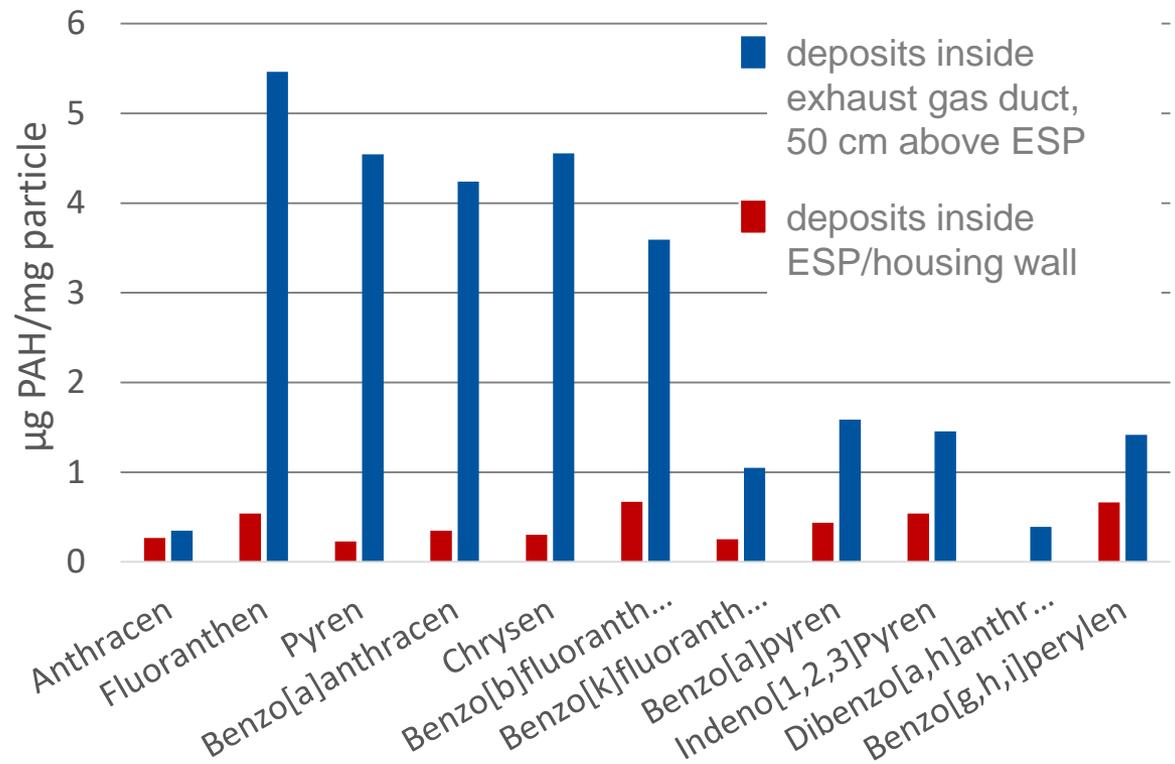
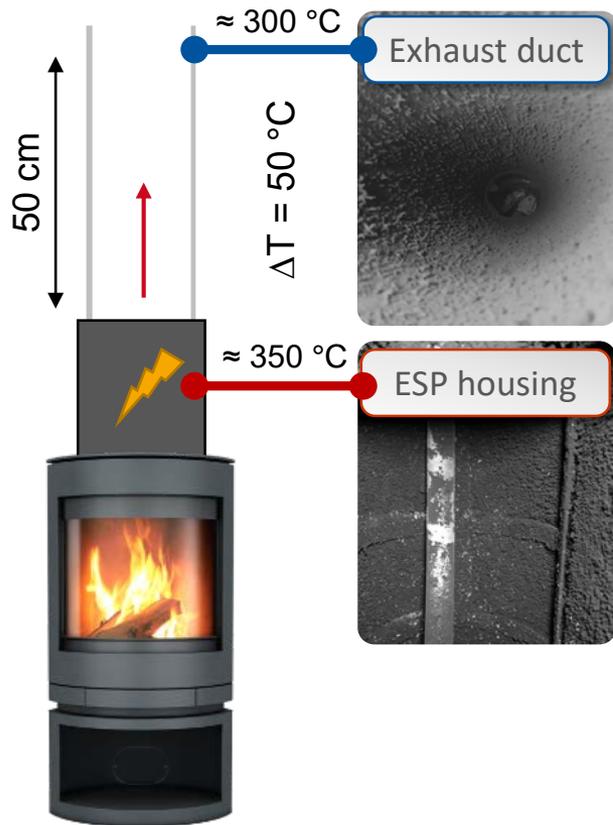
- raw gas (without reduction device)
- ESP position exhaust stack
- catalyst + ESP stack
- ESP position near outlet

## Sum of 4 o-PAH [9H-Fluorene-9-one, 1H-Phenalene-1-one, Naphthalic anhydride, 7H-Benz[d,e]anthracen-7-one]



# Results

## Adsorption Pathway of PAH - Particle Deposits at the Exhaust Duct

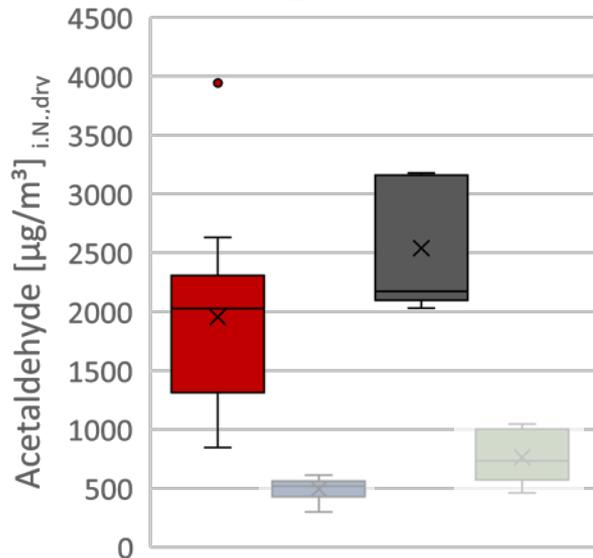
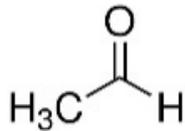


# Results

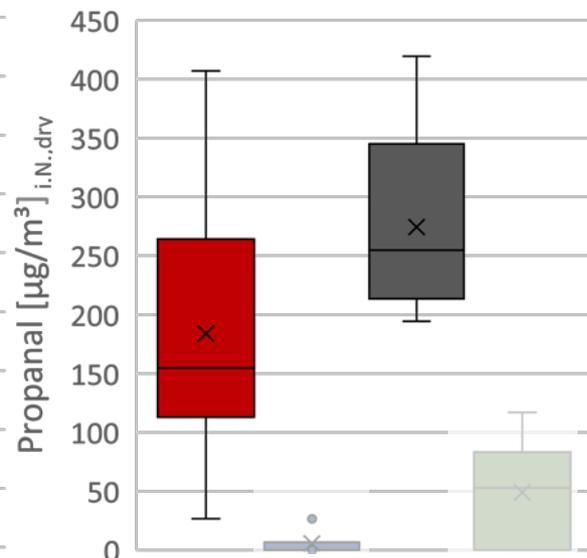
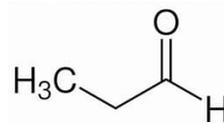
- raw gas (without reduction device)
- ESP position exhaust stack
- catalyst + ESP stack
- ESP position near outlet

## Degradation of PAH – Potential Fragments and Reaction Products

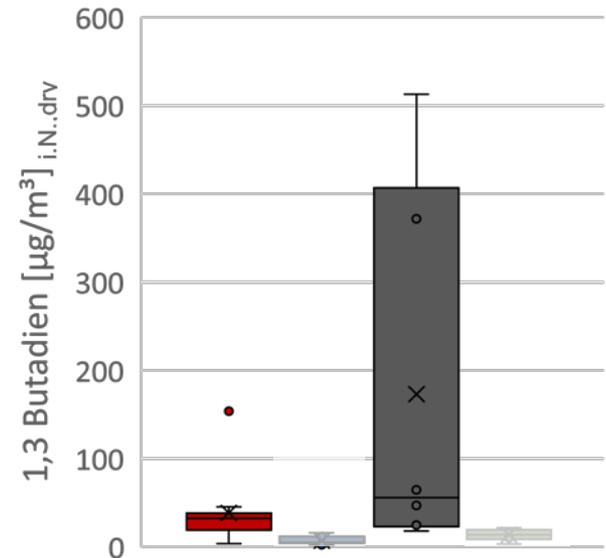
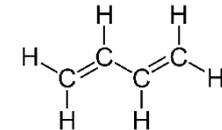
### Acetaldehyde



### Propanal



### 1,3-Butadiene



Method: sampling on DNPH, carbosieves and tenax sorbents tubes

# Conclusion and Outlook

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## PAH Reduction of the ESP

- high reduction potential of ESP
- similar reduction performance for both positions
  - slightly better performance of the ESP position near outlet
- different mechanism are involved in reduction
  - adsorption processes and a superimposition of ...
  - degradation due to energy input by corona discharge and radical formation
- further work
  - determine dominating mechanism for 4, 5 and 6 ring PAH
  - enhance operation condition of ESP
  - gain long-term reduction of PAH from wood fired stoves