On-line tar analysis by application of a Photo-Ionization Detector - PID

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Objectives

Overall objective: Development of a ‘low-cost’ on-line tar measurement system based on a Photo-Ionization.

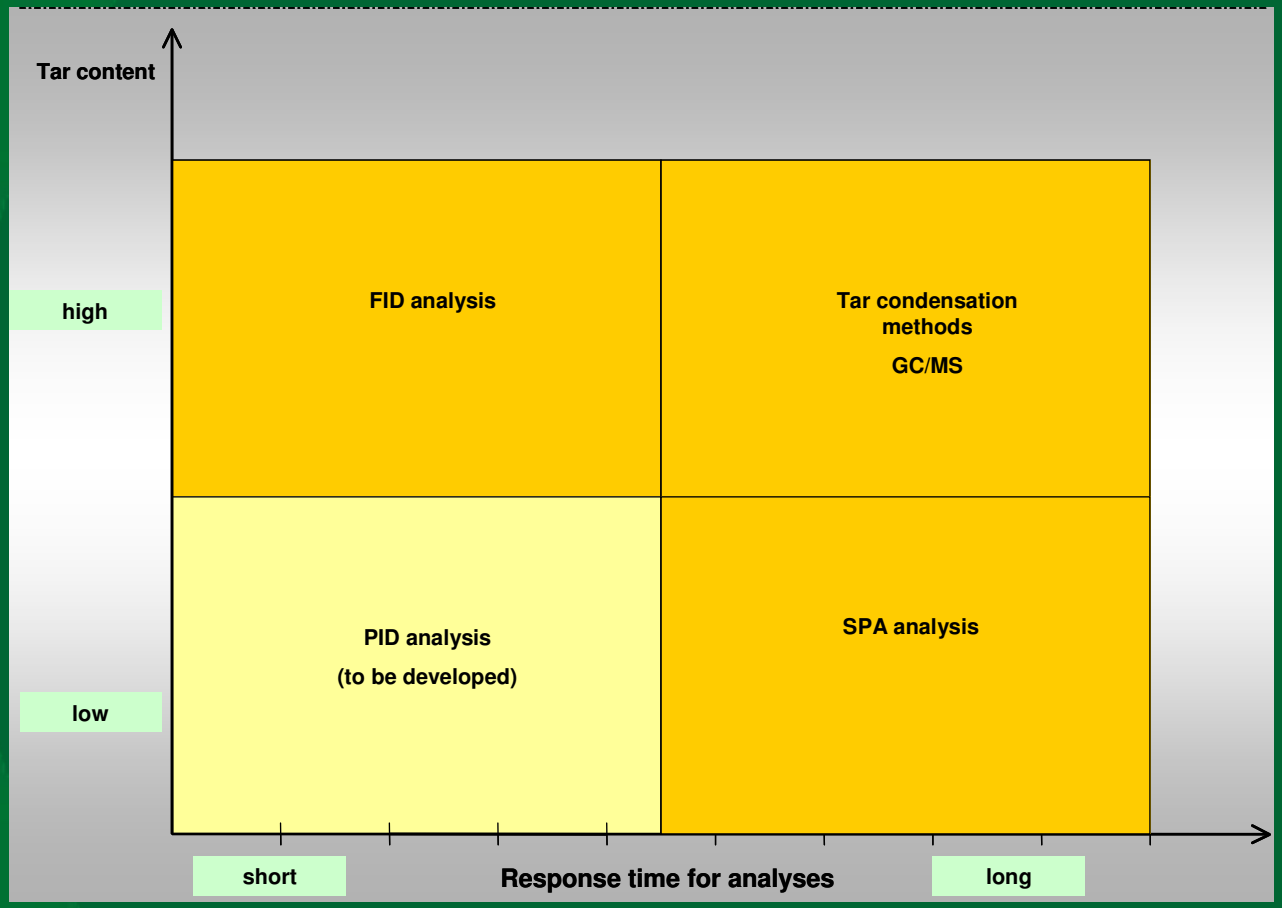


Photo-ionization detection - PID

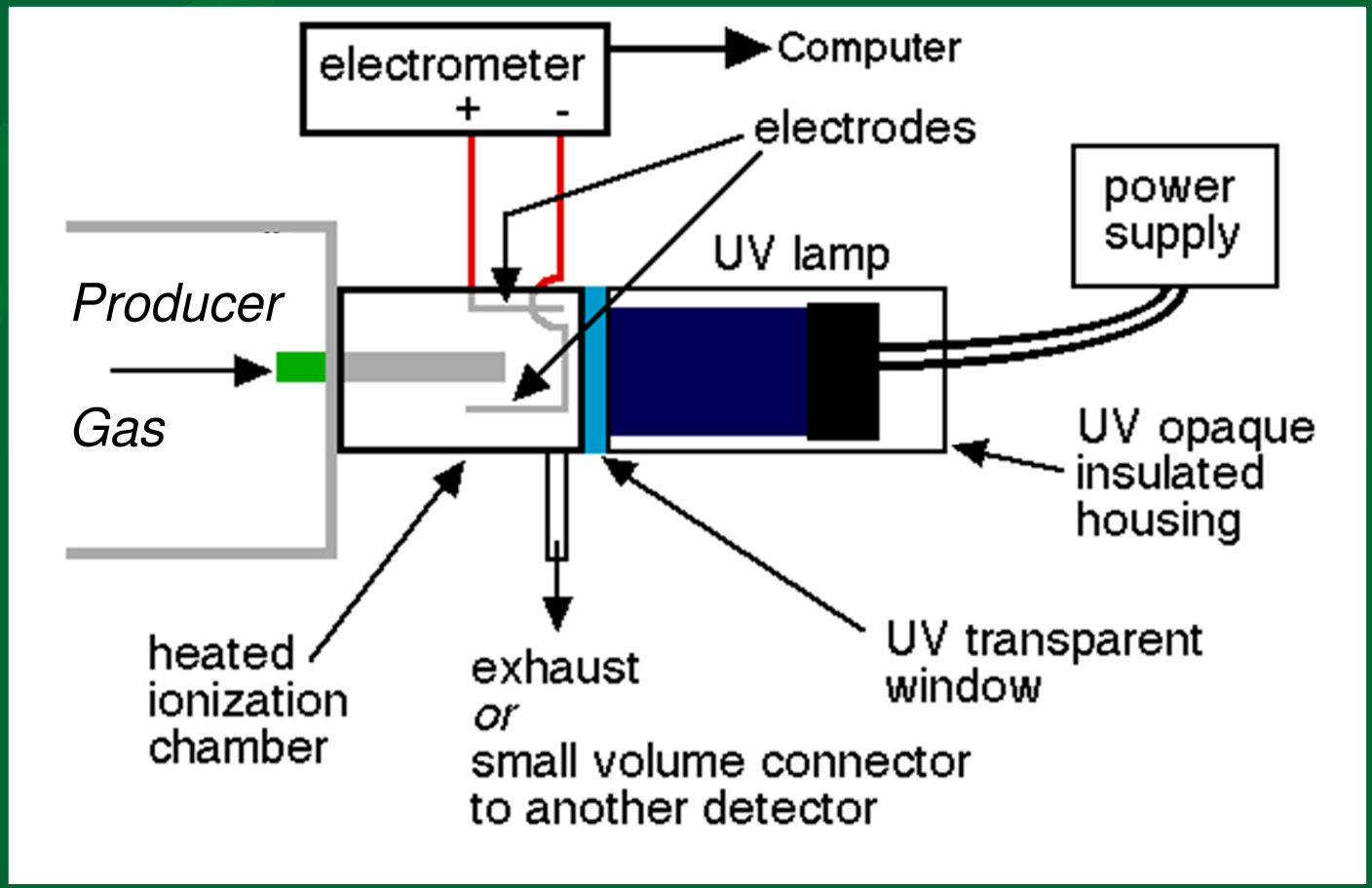
- *Principle:* If energy of an incoming photon is high enough photo-excitation can occur; an electron can be completely removed from its molecule.

$$R + h\nu \longrightarrow R^{+} + e^{-}$$

- *Tar selectivity:* The energy required to remove an electron from a specific molecule is different for different species; Typical tar compounds require a relative low energy, and possibly a high selectivity can be achieved.

PID versus Ionization Potential

PID lay-out



Typical lay-out of a PID detector

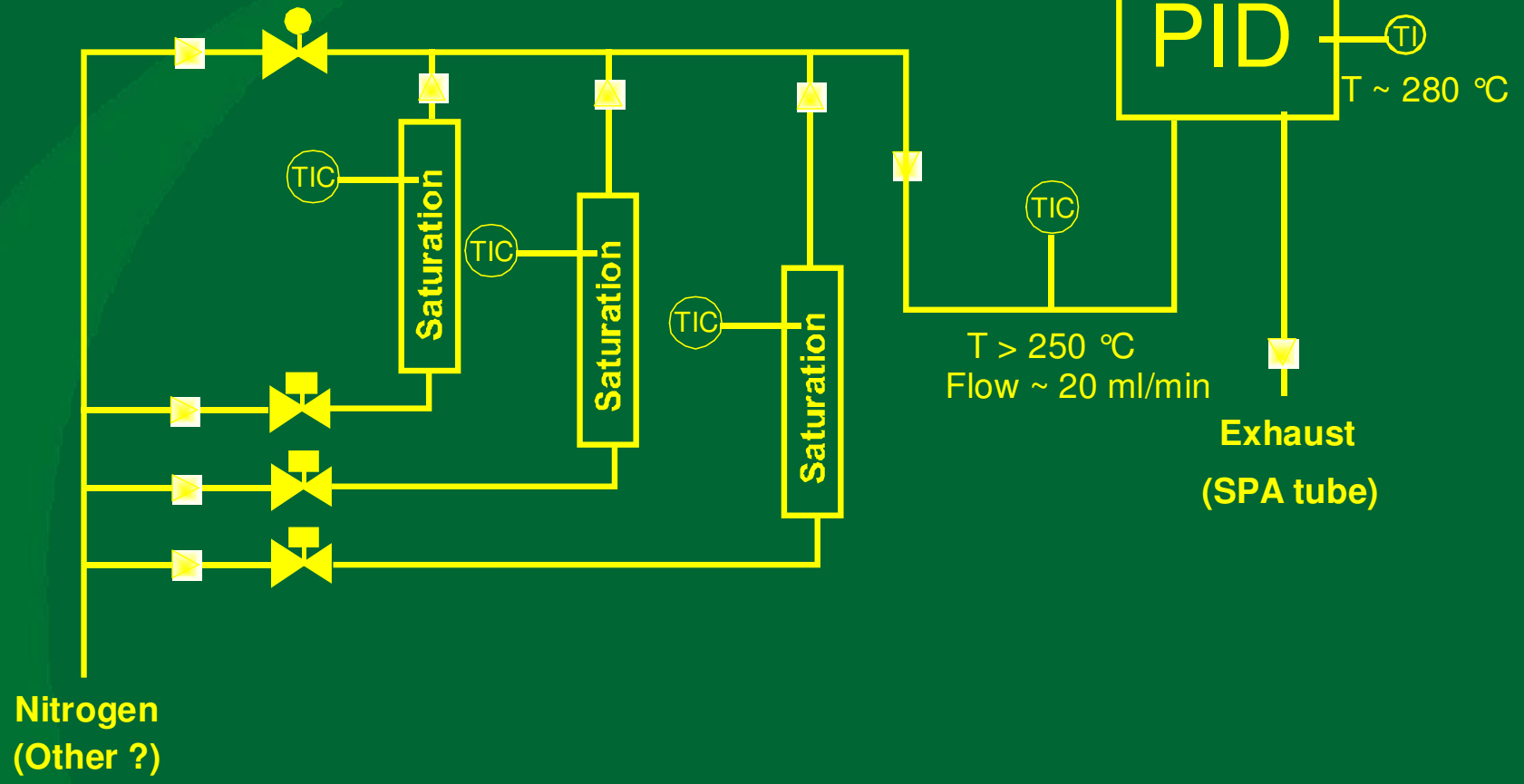
Research issues

- *Proof-of-principle with few typical components (e.g. phenol, naphtalene, ..).*
- *Influence of type of component, flow, detector temperature, light source intensity, type of lamp, influence carrier gas, …… on signal.*
- *Selectivity of PID (benzene vs toluene ?)*
- *Development of calculation method (~ e.g. naphtalene equivalents). Response factors for different components*
- *Desired accuracy of method ?*

Practical issues

- *Temperature detector/feed line above tar dewpoint. ECN indicates that for a wide range of gasifier conditions, high/low tar contents, etc the tar dewpoint is below 220-250 C.*
- *How to guarantee complete saturation ? How to check – SPA ? (PID detector not required !)*
- *Concentration range, components ?*
- *Contamination of the UV lamp*

Experimental set-up

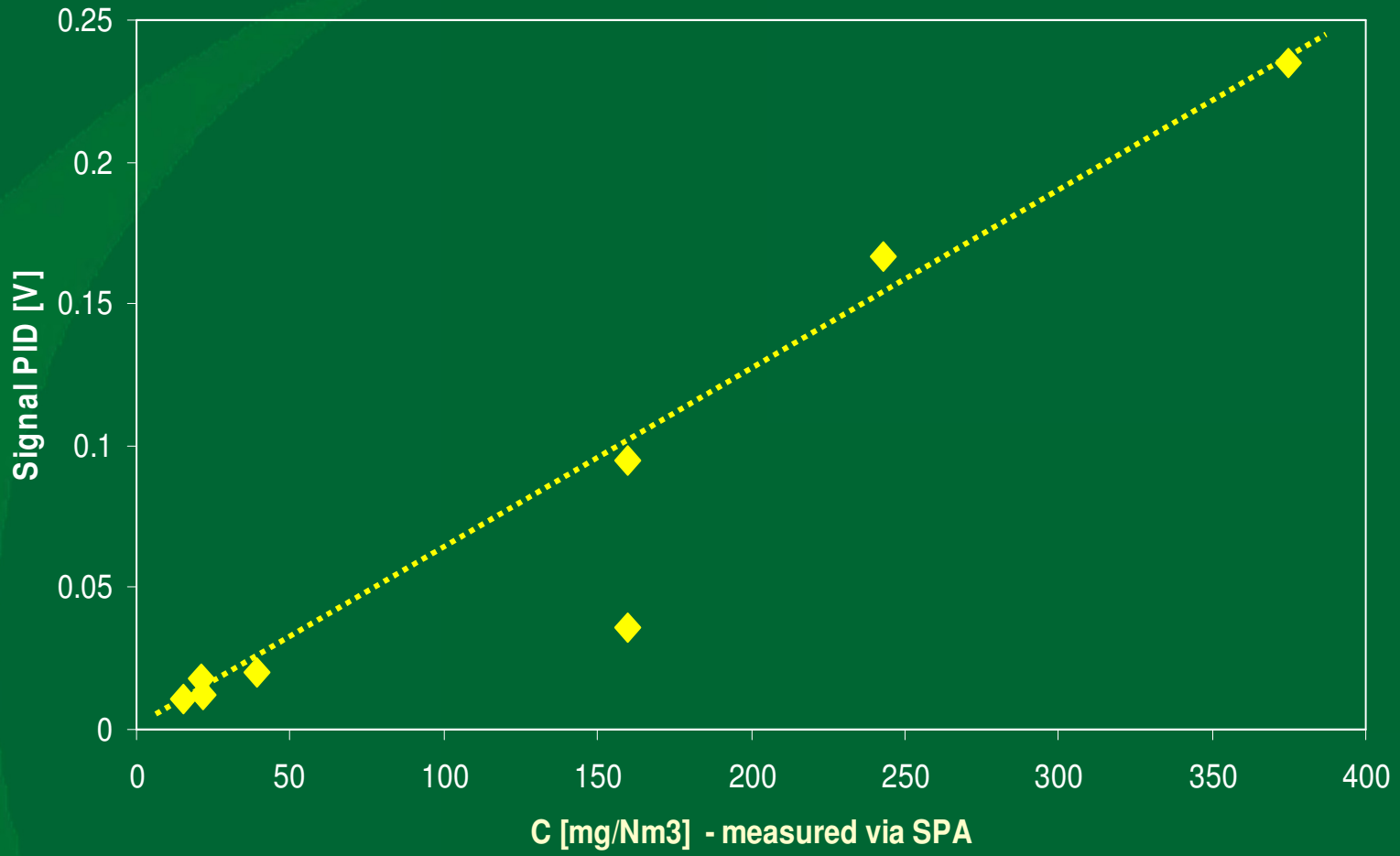


Schematic drawing of experimental set-up

Experimental set-up at BTG

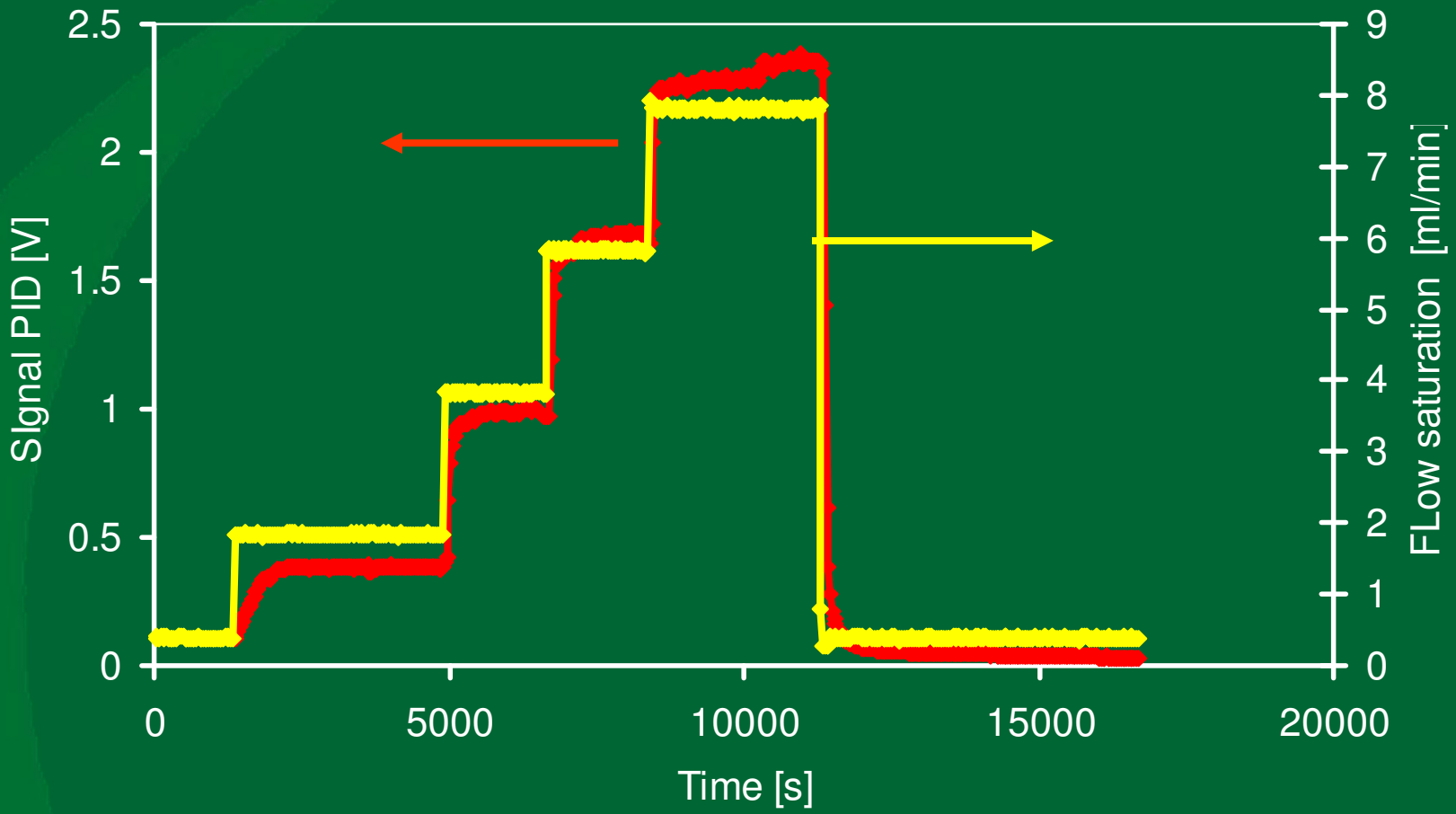
Photo's of current experimental set-up

Results (2)



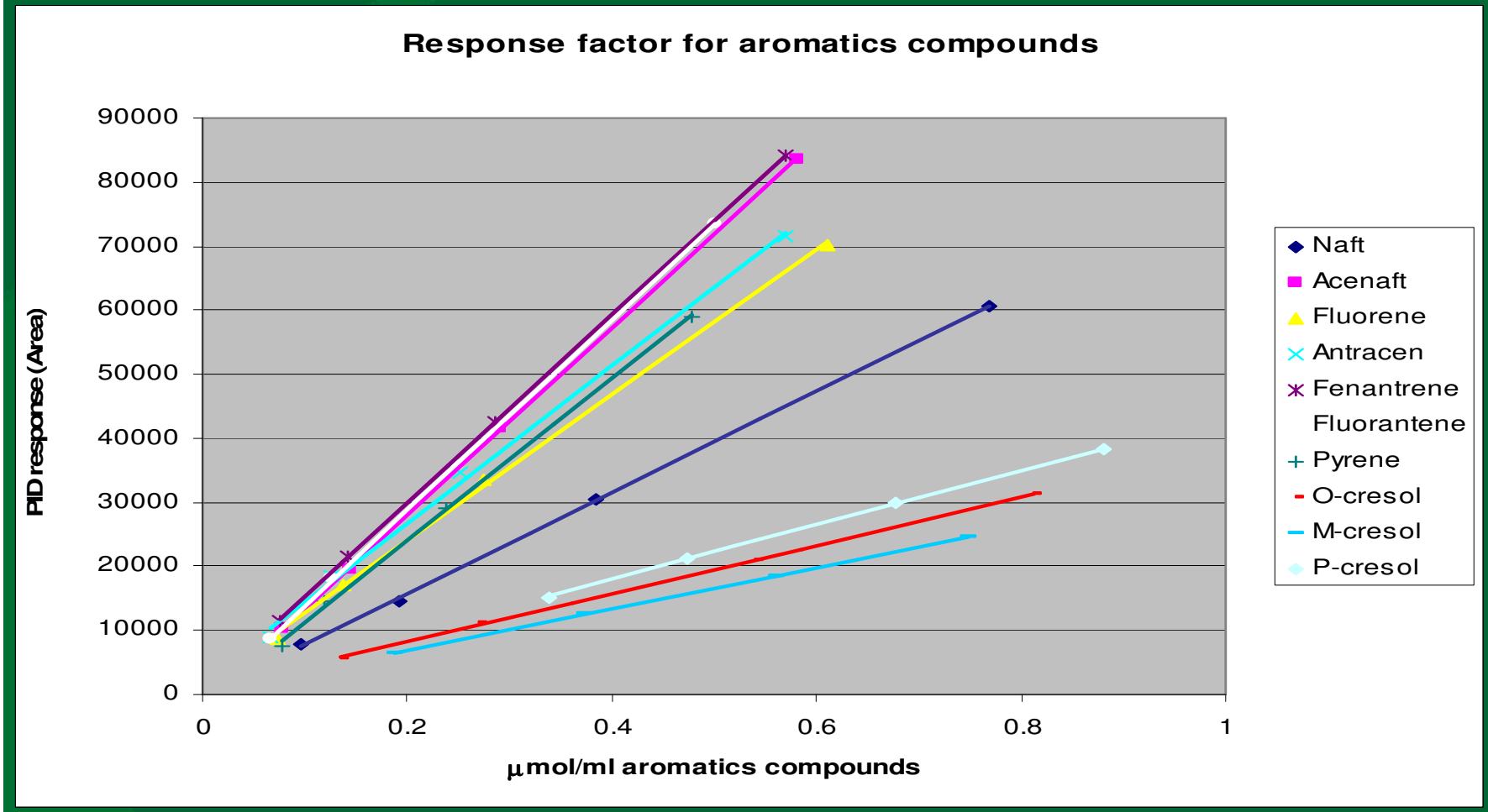
PID signal as a function of naphtalene concentration (SPA)

Results (3)

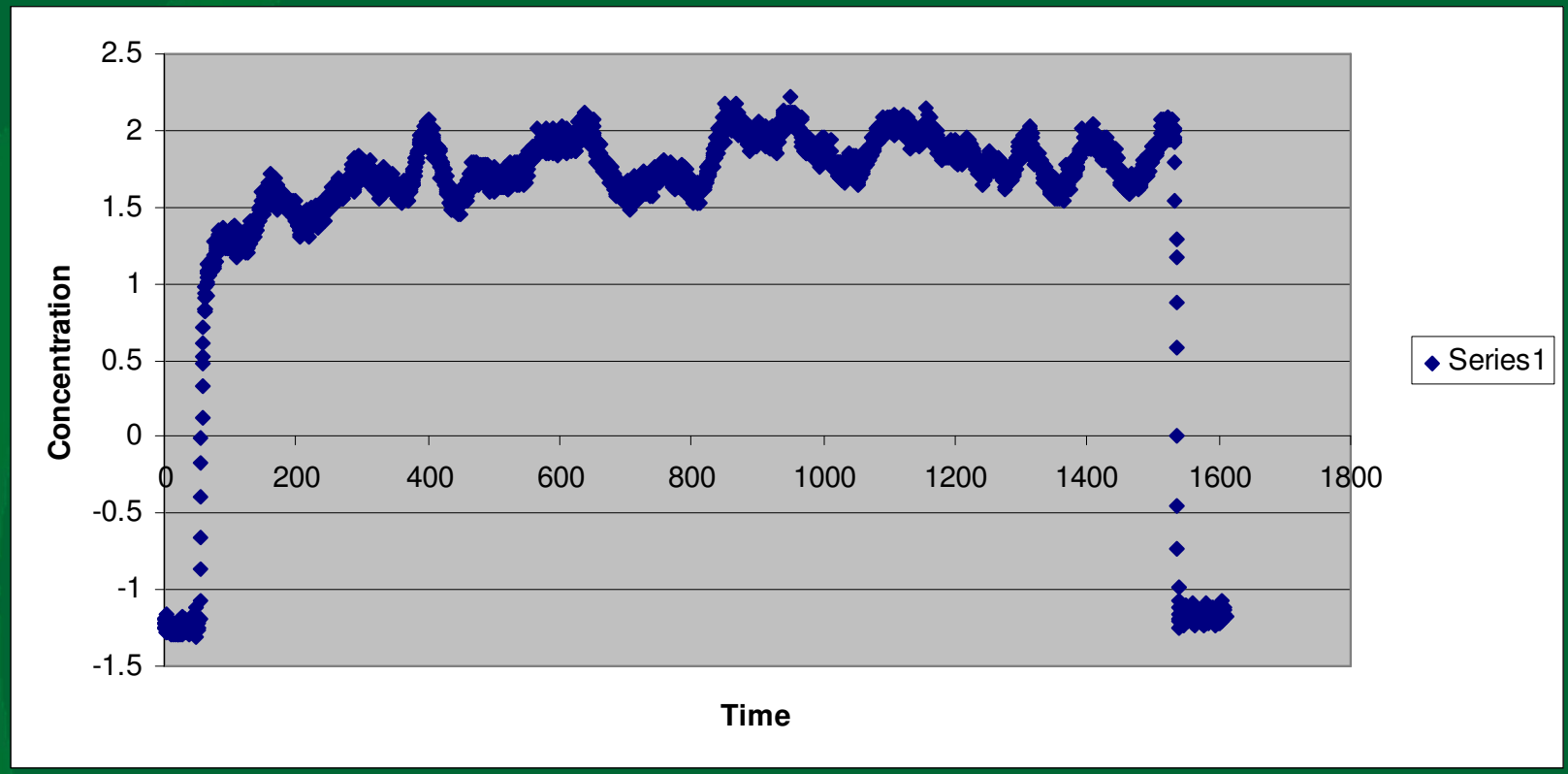


Exploratory tests with Napthalene; Concentration changed by changing flow through naphtalene saturation vessel

Results (4)


Response factor for aromatics compounds
PID response (Area)
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
0
0.2
0.4
0.6
0.8
1
µmol/ml aromatics compounds
Naft
Acenaft
Fluorene
Antracen
Fenantrene
Fluorantene
Pyrene
O-cresol
M-cresol
P-cresol

Results (5)



PID signal of tar at real gasifier at KTH

Future work – next steps

- Determination of individual response factors
- Measuring mixture of model compounds
- Development of calculation method to link tar content to PID signal
- Development of complete analysis system
- Validation with real gasifiers
- Test the 9,6 eV lamp

Thank you for your attention

Tar is only then your friend

When there is nothing to see of it

In the end