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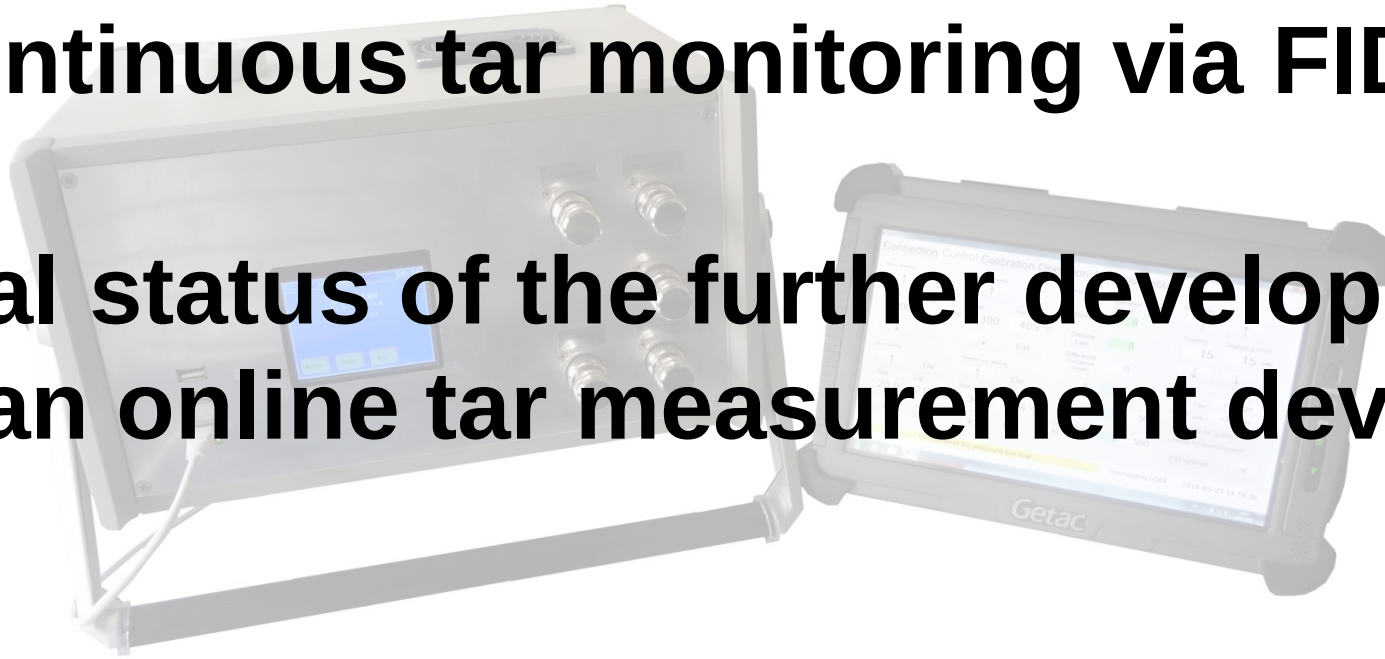
ifk

Continuous tar monitoring via FID –

Actual status of the further development of an online tar measurement device



Andreas Gredinger

Gas Analysis Workshop, Hamburg 2014

Tar analyzer history

~ 1994
- Idea of tar measurement with an FID based online device at IFK
- Development of 1st prototype at IFK lab for the verification of the general measurement system

1998
- 2nd (improved) prototype

1999
- 3rd and final IFK prototype available

2000
- License agreement to “Ratfisch Analysensysteme GmbH”
- 1st Ratfisch prototype available
- Start commercialization 1st generation measurement device

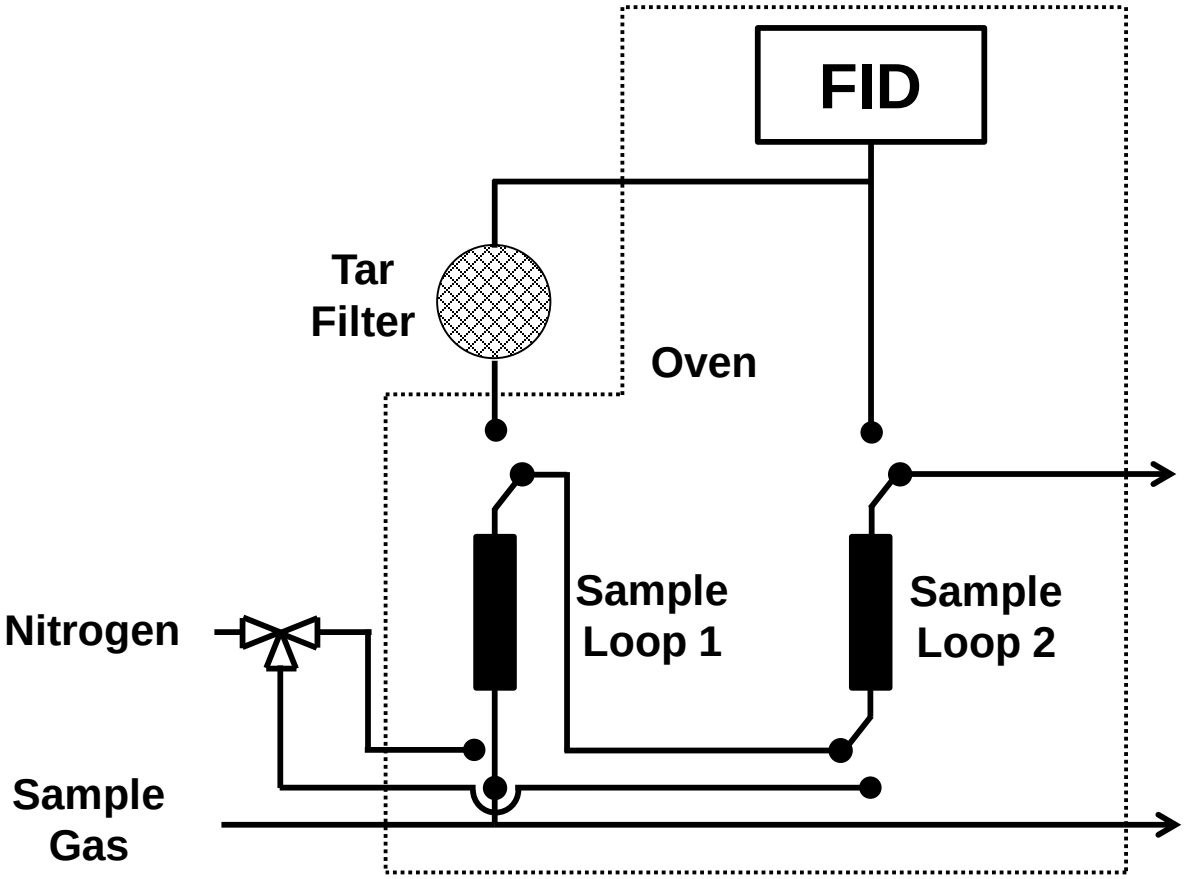
2001
- Different research projects in the field of gasification and (online) tar measurement at IFK with Ratfisch prototype

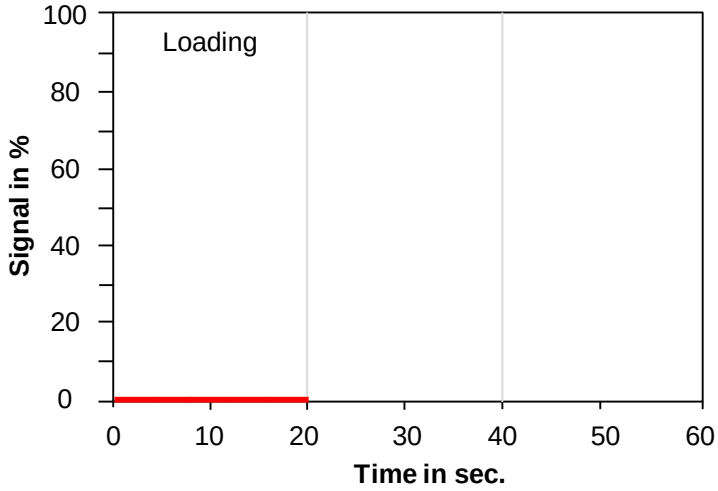
2011
- Start KIC DEMITAR project
  - Development of 2nd generation FID based online tar analyzer
  - Tests in laboratory environment and at pilot and industrial gasifiers

2014
- Commercialization of 2nd generation measurement device

future
- Further lab and field testing…

Measurement principle

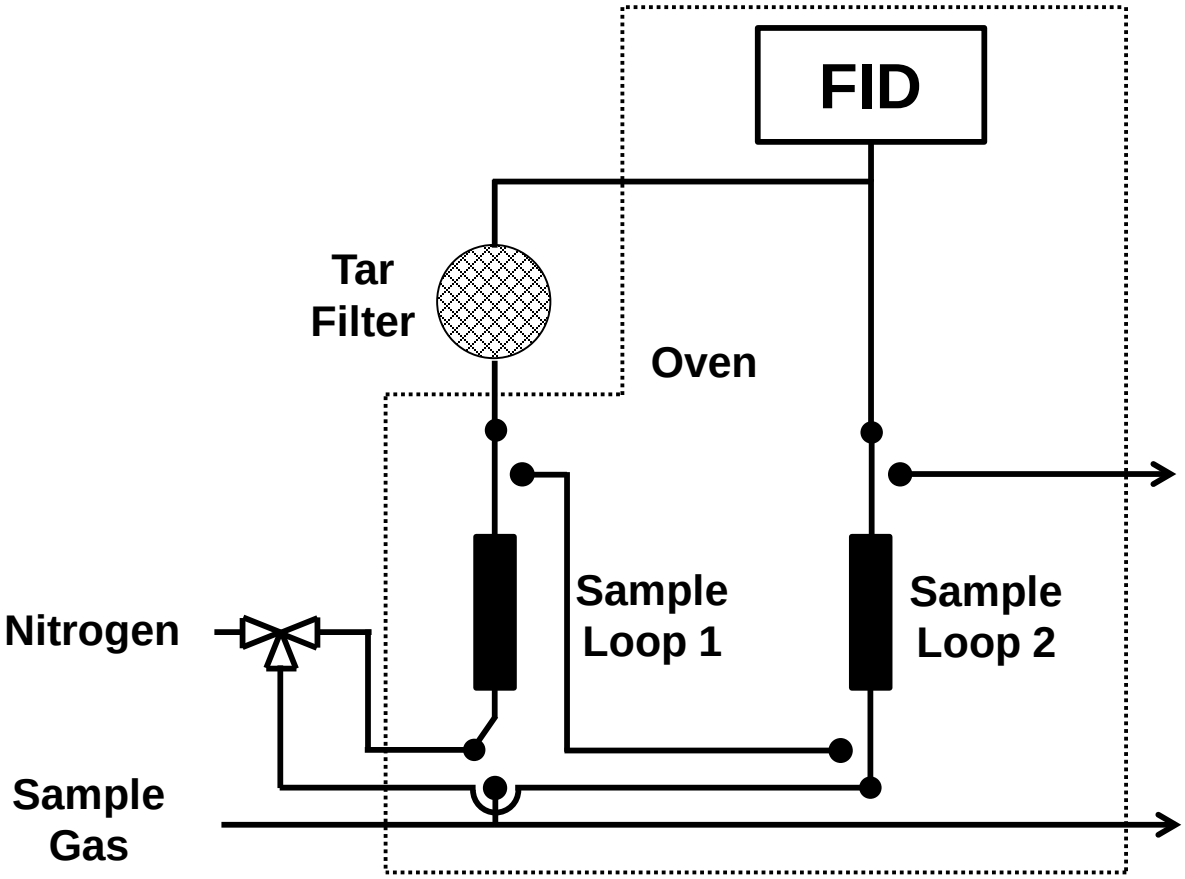




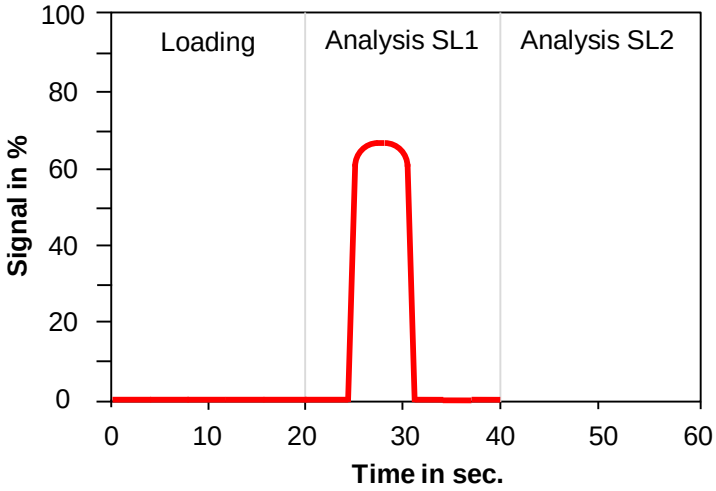
- Sample gas is sucked into the analyzer by venturi nozzles
- Both sample loops are loaded consecutively
- Measurement signal is zero

Loading phase

Measurement principle

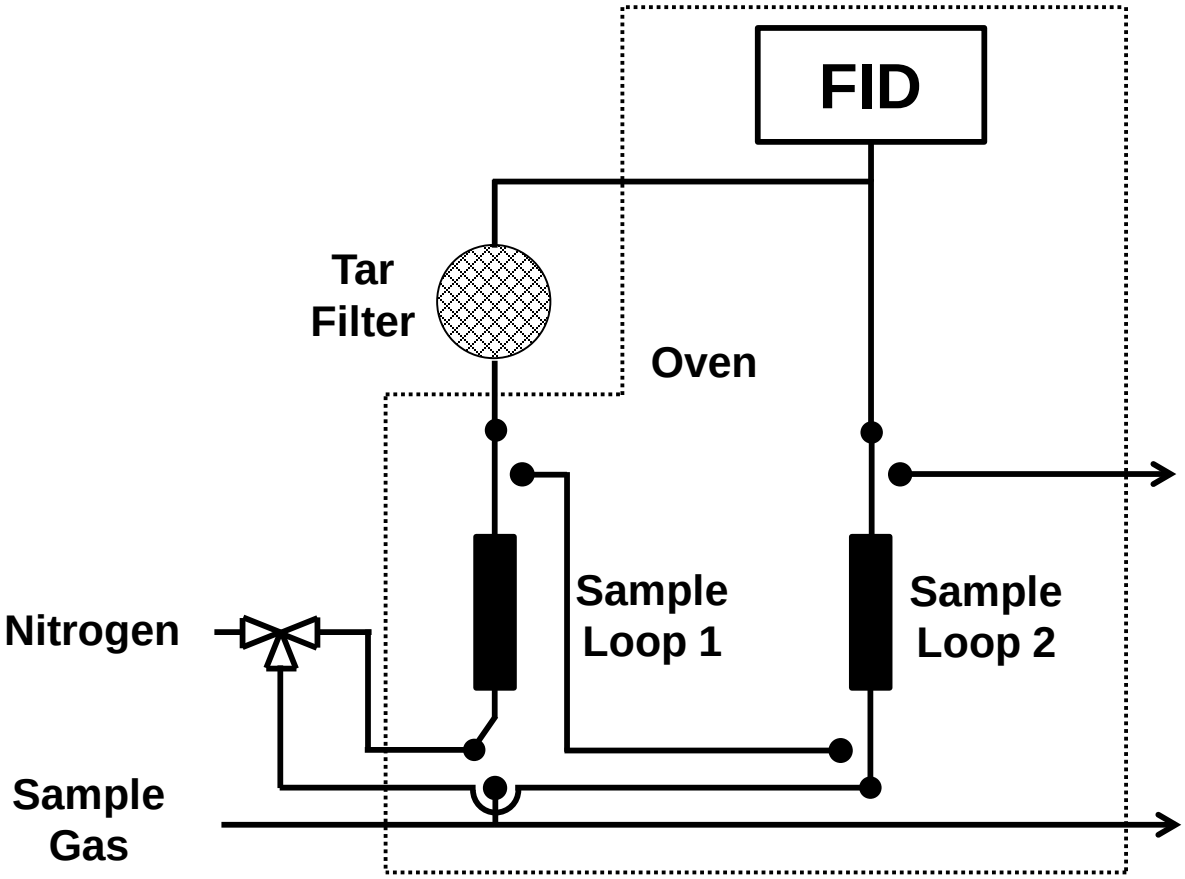


Analyzing phase

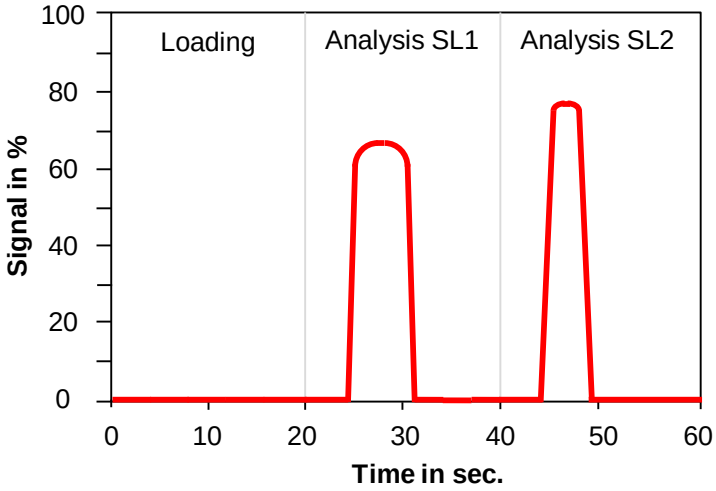


- Sample loops are flushed subsequently to the FID
- Difference between loop 2 and 1 determines the tar content
- Measurable values:
  - Total hydrocarbon content
  - Total non-condensable hydrocarbons
  - Total condensable hydrocarbons

Measurement principle



Analyzing phase



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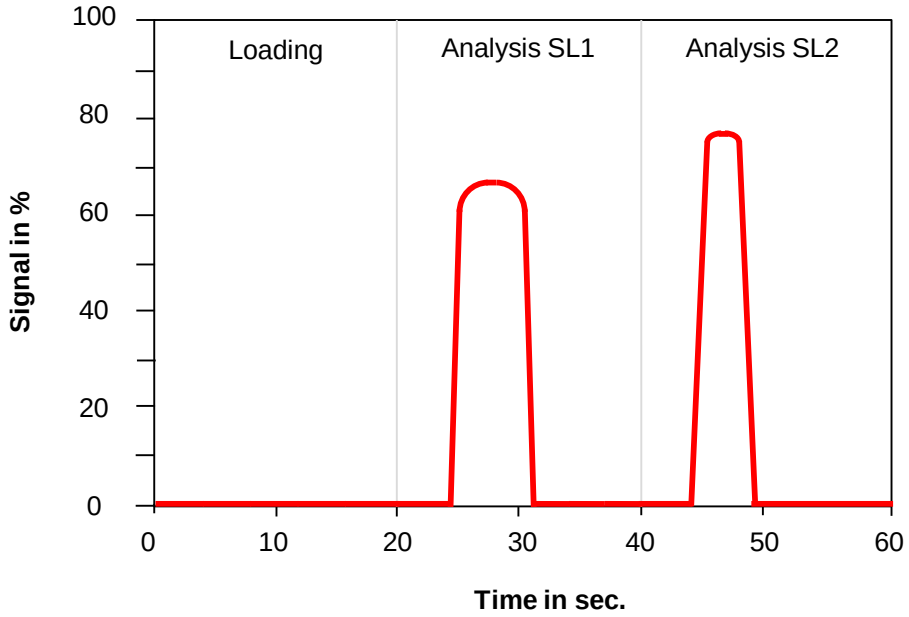
Analyzer specifications

- Measurement principle: Differential measurement of sample gas with and without tars (tars = hydrocarbon condensate on filter!)
- Oven temperature: 300°C
- Tar filter temperature: Adjustable between 20 and 99°C
- Tar filter material: Sintered bronze
- Effective measurement range: 3 zones up to 120g_{Carbon}/m^3_{stp} (0-12, 0-60, 0-120)
- Measurement limit: Around 200mg_{Carbon} (Still to be validated!)
- Reproducibility: < 0.5% of the measured value
- Time for sampling and analysis: Minimum 50-60 seconds (per measurement)
- Sample gas flow rate: ~1l/min
- Ambient temperature: 0 to 50°C
- Heating time: Minimum 60 minutes
- Sample gas pressure: -10 to 50mbar

Calculation of tar concentration



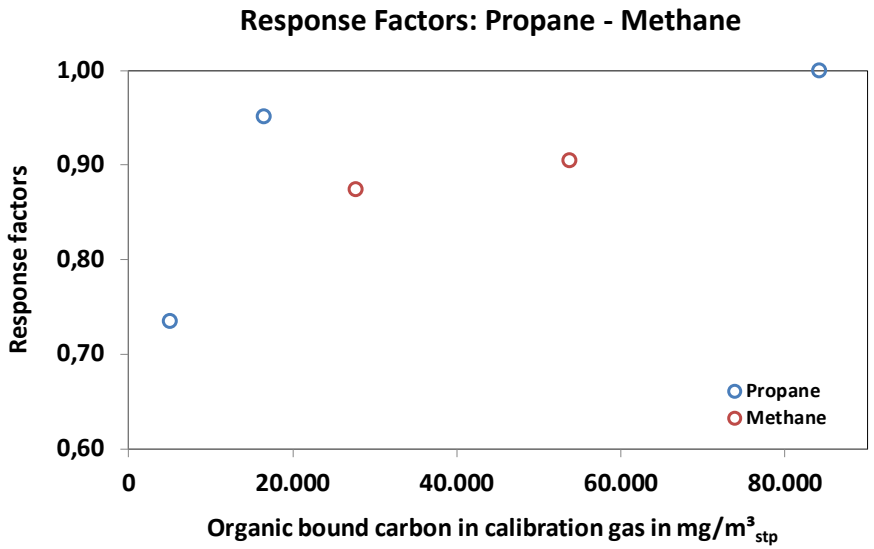
$$Concentration_{tar} = Peakarea_{Sample\ Loop\ 2} \cdot Calibration\ factor_2 - Peakarea_{Sample\ Loop\ 1} \cdot Calibration\ factor_1$$

- $Peakarea_{Sample\ Loop\ 1/2}$ = Accumulated FID Signal of respective peak area (integral)
- $Calibration\ factor_{1/2} = \frac{C\text{–}concentration\ of\ calibration\ gas\left(\frac{mg_{Carbon}}{m^3 stp}\right)}{Peakarea_{Sample\ Loop\ 1/2}}$

Calibration and response factors

From theory:

- The signal of an FID is almost directly proportional to the amount of organically bound carbon.
- Propane is commonly used as calibration gas for FIDs because of the linear detection of different concentrations.



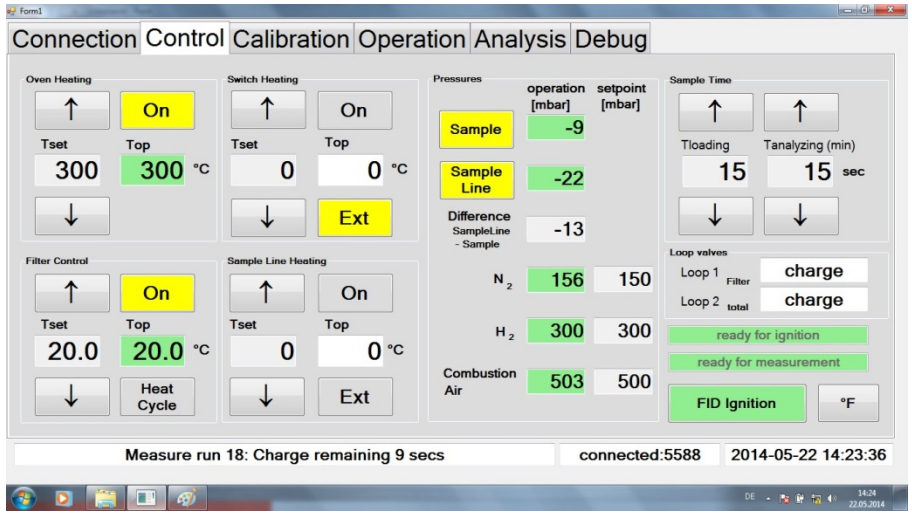
Substance	*Gredinger*	*Dobson*	*Wandinger*
Propane	1.00	1.00	1.00
Methane	*~0.90*	1.00	1.26
Butane		0.95	1.01
Benzene		0.97	1.14
Toluene		1.00	1.08
Xylene		0.93	1.08
Phenol	expected to be < 0.8		

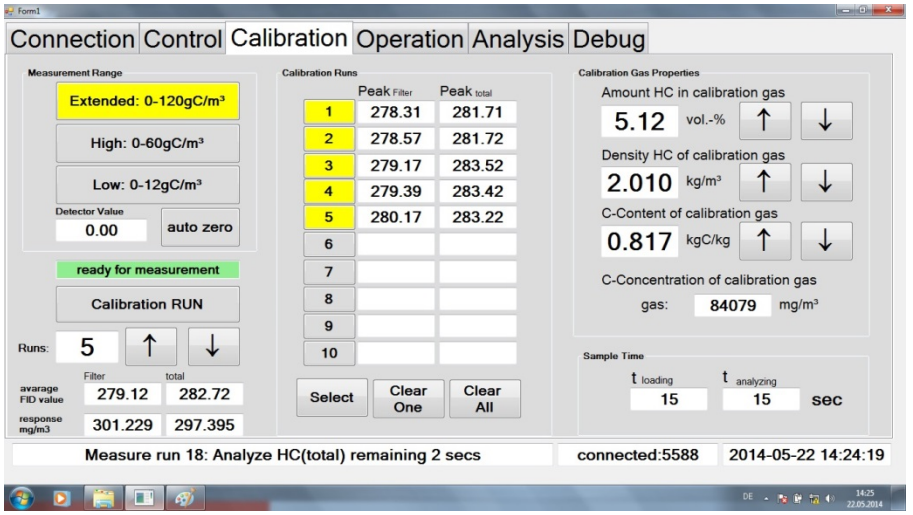
Use of 5.12% propane in N_2 as reference gas.

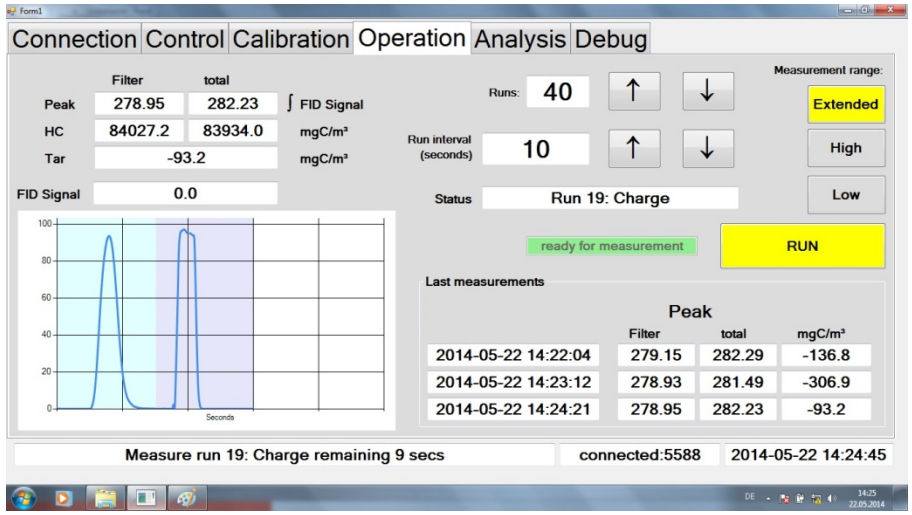
Decreasing response factors for propane with decreasing concentrations → Choice of measurement range!

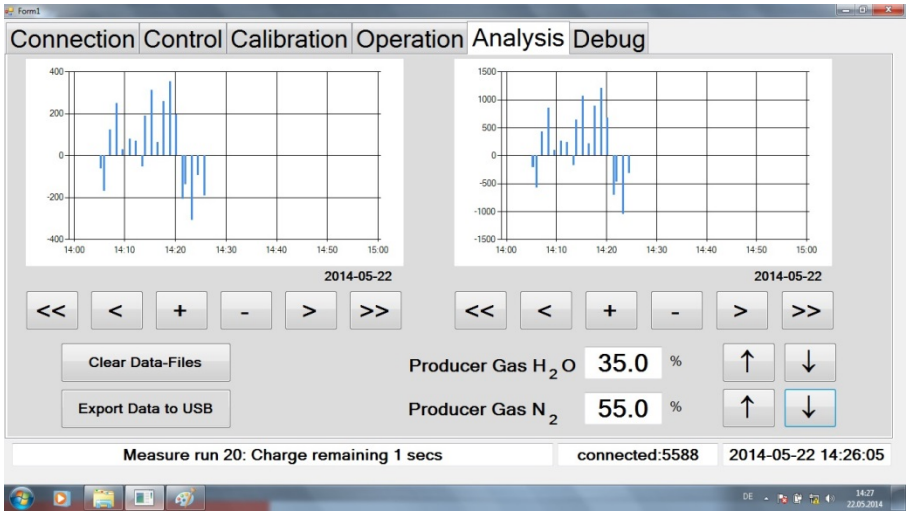
Response factors for methane ~0.9 compared to propane

Operation and control software

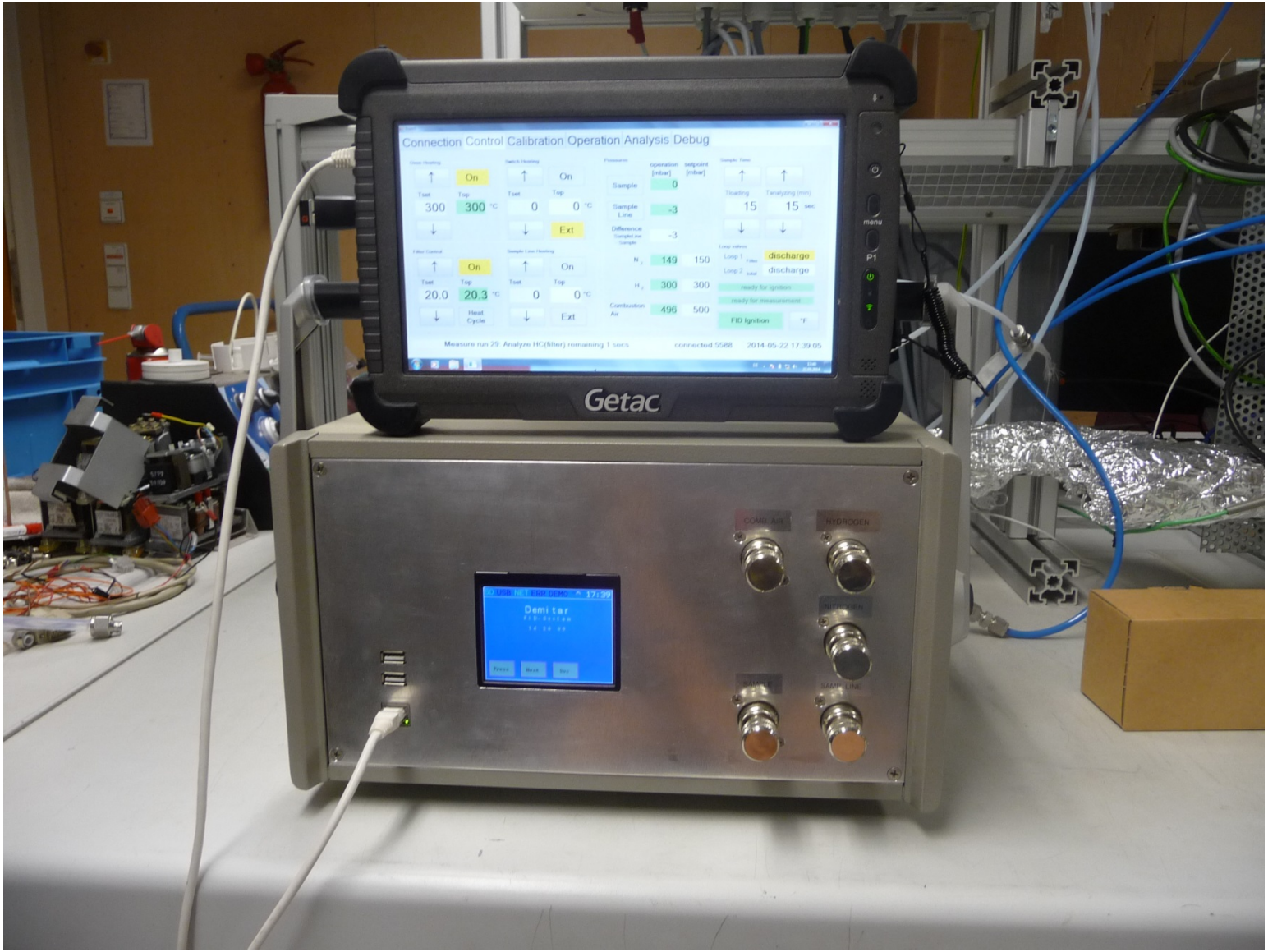




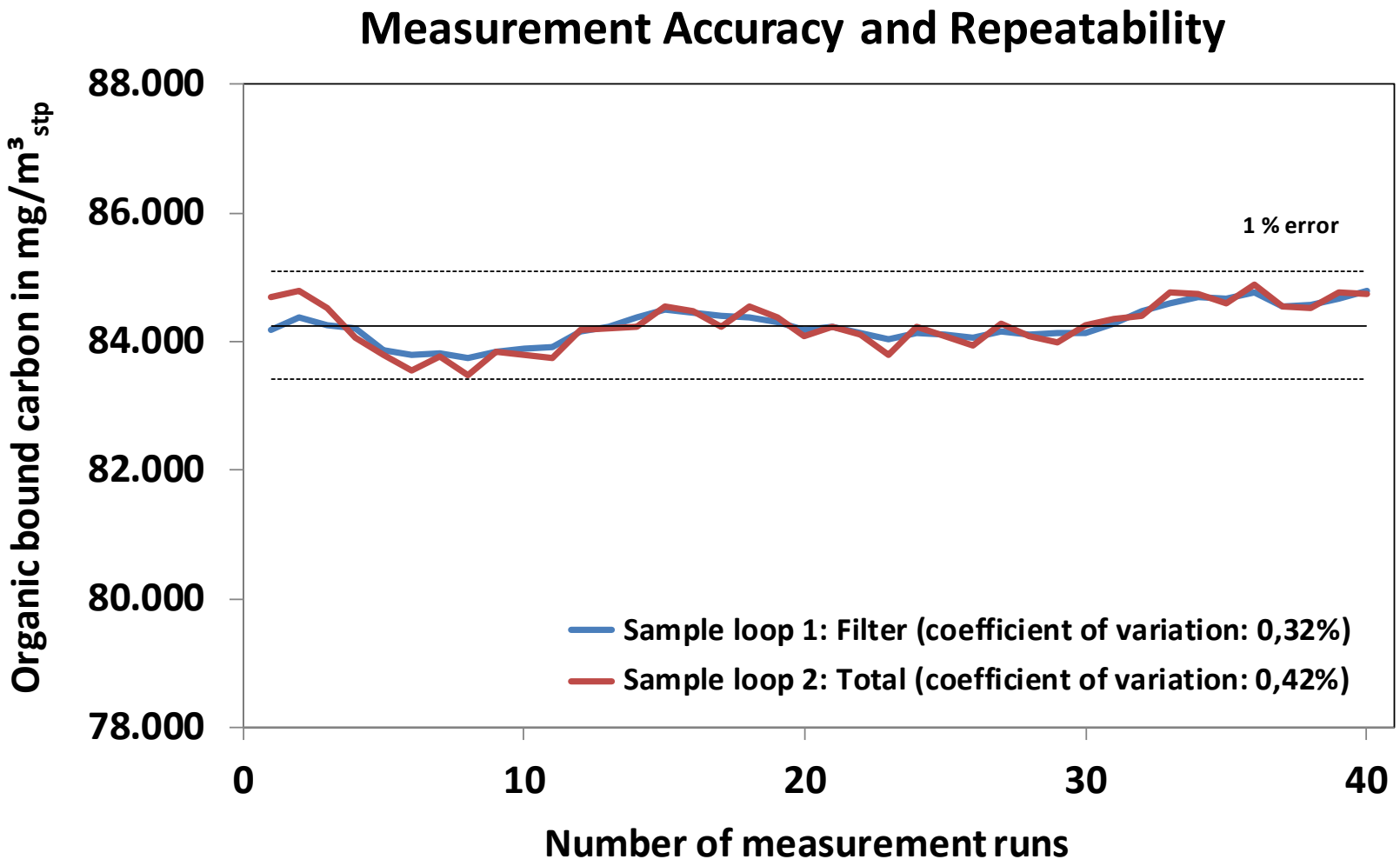




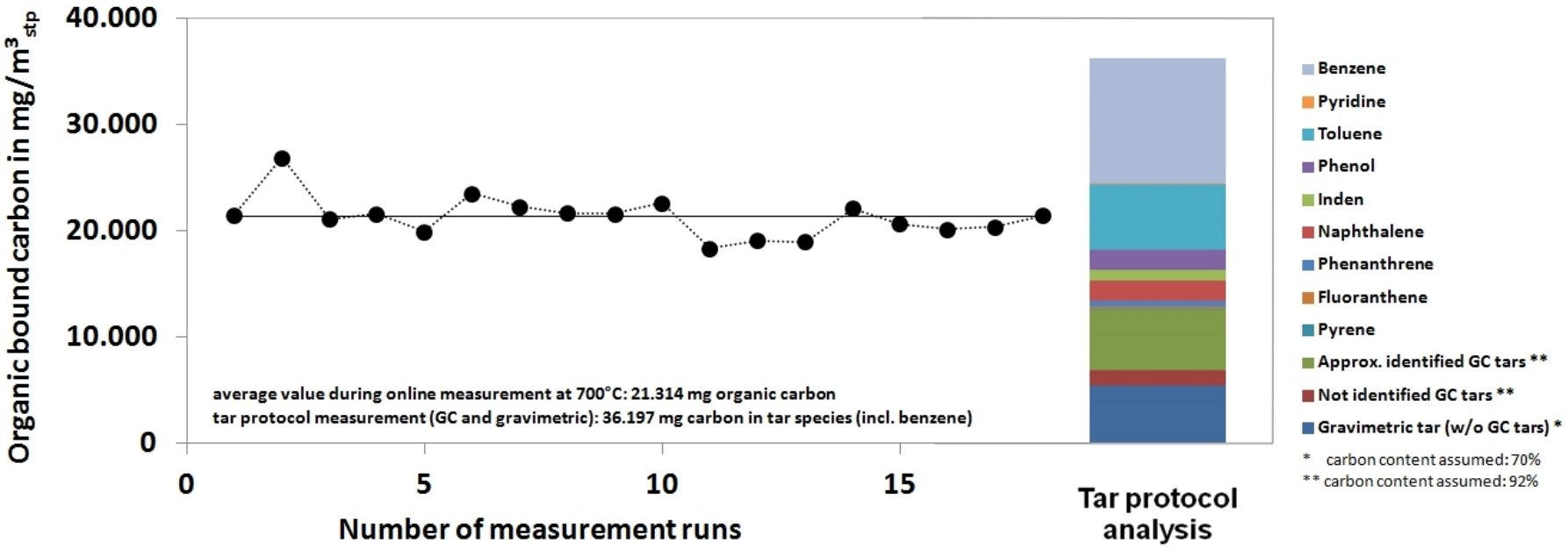
2nd gen. online tar measurement device



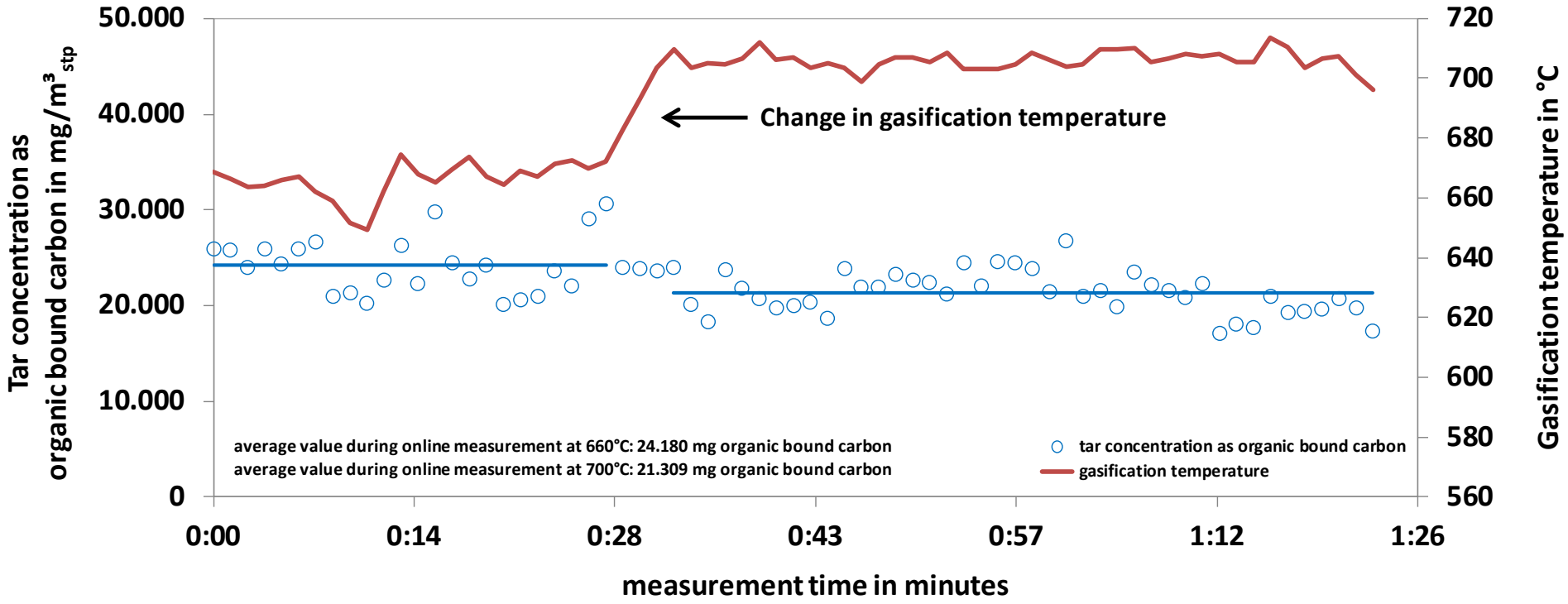
Results of calibration gas tests



Comparison with results from tar protocol



Tar monitoring - Change in gasification temp.



Possible applications

- General (industrial) gasifier monitoring
- Surveillance / Monitoring of gas cleaning / gasifier downstream equipment
- Simplified detection of optimal gasifier / gas cleaning equipment operation point

Future experiments and analyzer validation

- Further tests with calibration gas for general analyzer validation
  - Influence of general analyzer settings to measurement signal
- Tests with single tar species (generated with own „tar generator“):
  - Identification of single response factors
  - Identification of filter breakthrough at different concentrations
- Tests with hydrogen in sample gas to detect influence on analyzer signal
- Tests with steam in sample gas to detect influence on analyzer signal and filter behavior
- Long term tests at IFK pilot plant to see time of filter breakthrough
- Tests at IFK pilot plants to compare measurements with tar protocol and SPA at different gasification processes
- Tests at CIUDEN gasifier (Ponferrada/Spain) in September

Interested parties are always welcome to visit IFK during test time!

Thank you for your attention !

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