Development of a measurement method for health effects of PM-emissions from biomass combustion and evaluation of results achieved

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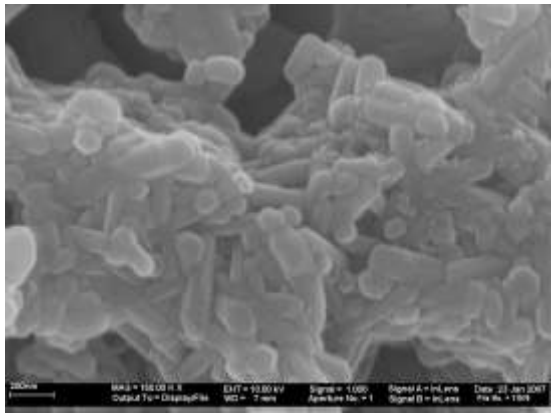


Background

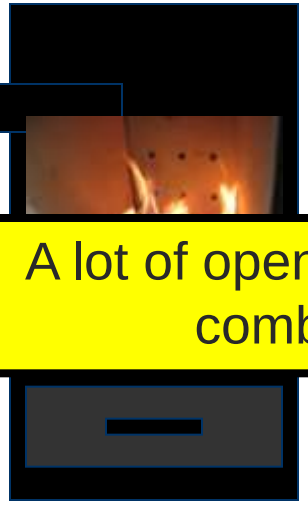
- Particles in the atmosphere effect human health!
- PME from biomass combustion (especially small scale furnaces) have an increasing contingent among the total PM immissions.
- Effect of PME from biomass combustion depends on the quality of combustion – differentiation is necessary!
- Until now no standardized test method for the toxicological relevance of the PME of biomass combustion furnaces is available.

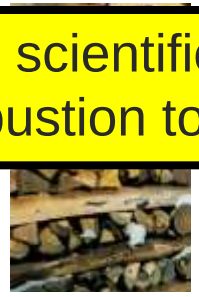
A method for standardized toxicological studies is necessary!

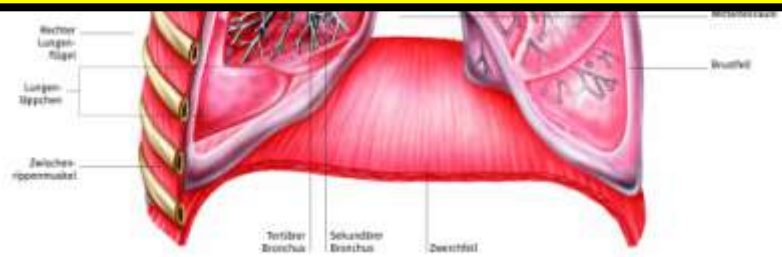
PME and human health


Feinstaub Richtig Heizen, Broschüre vom Amt der Vorarlberger Landesregierung


Graz, Österreich, 2008 kleinezeitung.at







A lot of open scientific questions on the long way from the combustion to the effects on human health.

Status of German research projects LfU Bavaria - Augsburg

- Measurements of particles in the atmosphere of the city of Augsburg were done during heating periods 2006/2007 and 2007/2008.
- Potassium was identified as a good tracer for PME from small scale biomass combustion.
- Significant relations between biomass combustion and PM concentrations and Benzo[a]pyren concentrations were investigated.
- Studies on effects on the human health are missing.

Correlation between biomass combustion and PM and B[a]P concentrations are possible.

Status of German research projects NMI, Reutlingen (FNR)

- Laboratory research (IFK) in 2008 and 2009 on toxicological relevance of particles from a pellet stove and a wood log boiler with an exposition system (KIT).
- Dilution of the flue gas by 1:10 with 80°C hot air and afterwards cooling to 30°C; separation of particles bigger than 1 µm; conditioning in exposition system and collecting the particles on transwells to do toxicological studies.
- Deposition could be proofed. Effects on human cells were only weak – in most cases not significant.
- Experiments with collected particles from the flue gas and submerse contacts showed some significant effects.

In principle the exposition system is working, but the deposition rate as well as the sensitivity of the cell systems has to be increased.

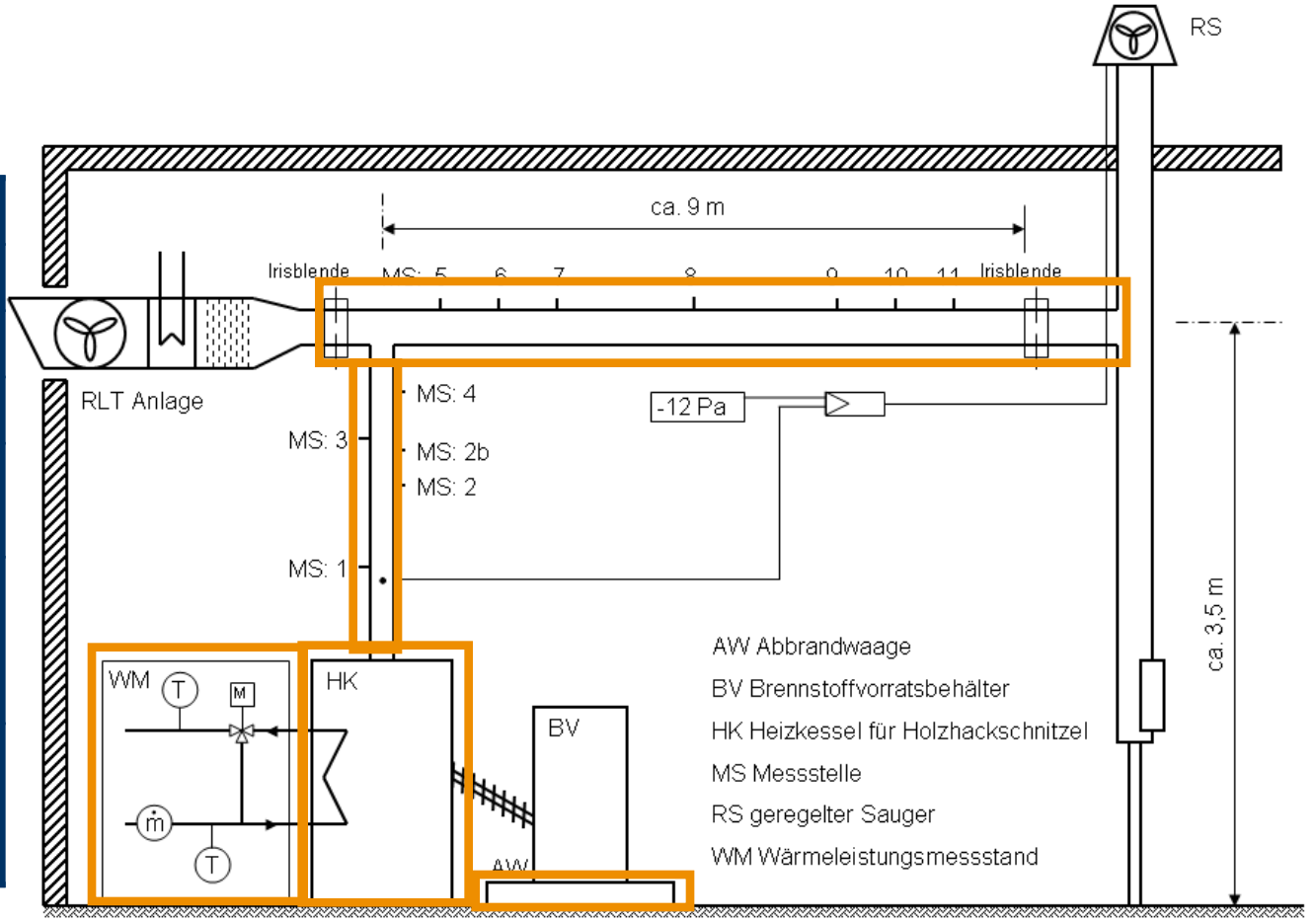
Status of German research projects DBFZ, Leipzig (BMU)

- DBFZ project coordination and measurements on biomass furnaces and precipitators.
- TFZ measurements on stoves.
- KIT construction of an improved exposition chamber.
- IFT doing experiments characterising the emissions and to check the aging of emissions in a climate chamber.
- Uni Konstanz together with TUHH analysing the particles and developing test sets for toxicological research on PME.

Work in progress - first results on the following slides.

Testing facility at the DBFZ

Basic data	
Creation	2010
DR	1:2 – 1:8
Load	20 – 75 kW
Reproducibility of fuel input	100 g
Inaccuracy of efficiency measuring	< 3 %
Number of possible probes	21 + 5



Skizze: DBFZ, T. Schröder

Standardized Measuring Procedures

Gesamtstaubmessung mit Planfilter Ø 45 mm 70 °C

Fotostrecke für die Gravimetrische Gesamtstaubmessung entspr. SOP TK-02

DBFZ Deutsches BiomasseForschungsZentrum gemeinnützige GmbH

Vorbehandlungsschritte

01	Planfilterhalter reinigen	
02	Trocknung 180°C 20 min	
03	Filter in Halter einsetzen	
04	Filter und Planfilterhalter in Wägekabine >2h	

Vorbereiten der Sonde

05	Sonden einbauen	
06	Sonde beblocken	

Durchführung der Messung

09	Noch vor Beginn der Absaugung	

Nachbereitung

09	Messung beenden	
10	10 h Wägekabine	
11	Planfilter verpacken	
12	Sonde spülen	

Redaktion

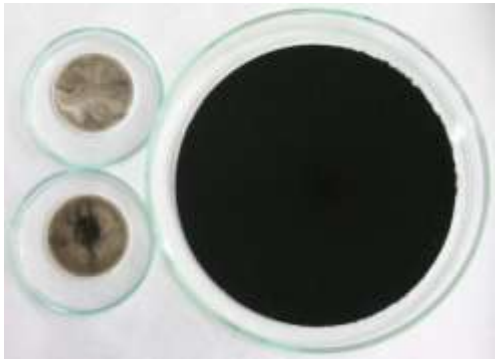
DBFZ Deutsches BiomasseForschungszentrum gemeinnützige GmbH

Stand: 15. Juli 2010

Bearbeitung: Torsten Schröder

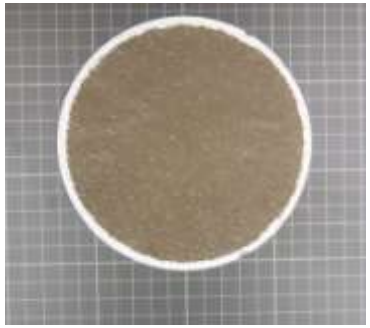
Hinweise: Die hier beschriebenen Schritte ersetzen nicht das studieren der SOP TK-02 „Vereinfachte Bestimmung des Staubgehaltes in Abgas"

150 mm plane filters by TFZ



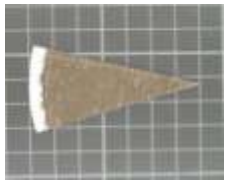
One filter allows all the necessary analysis.

collection equipment



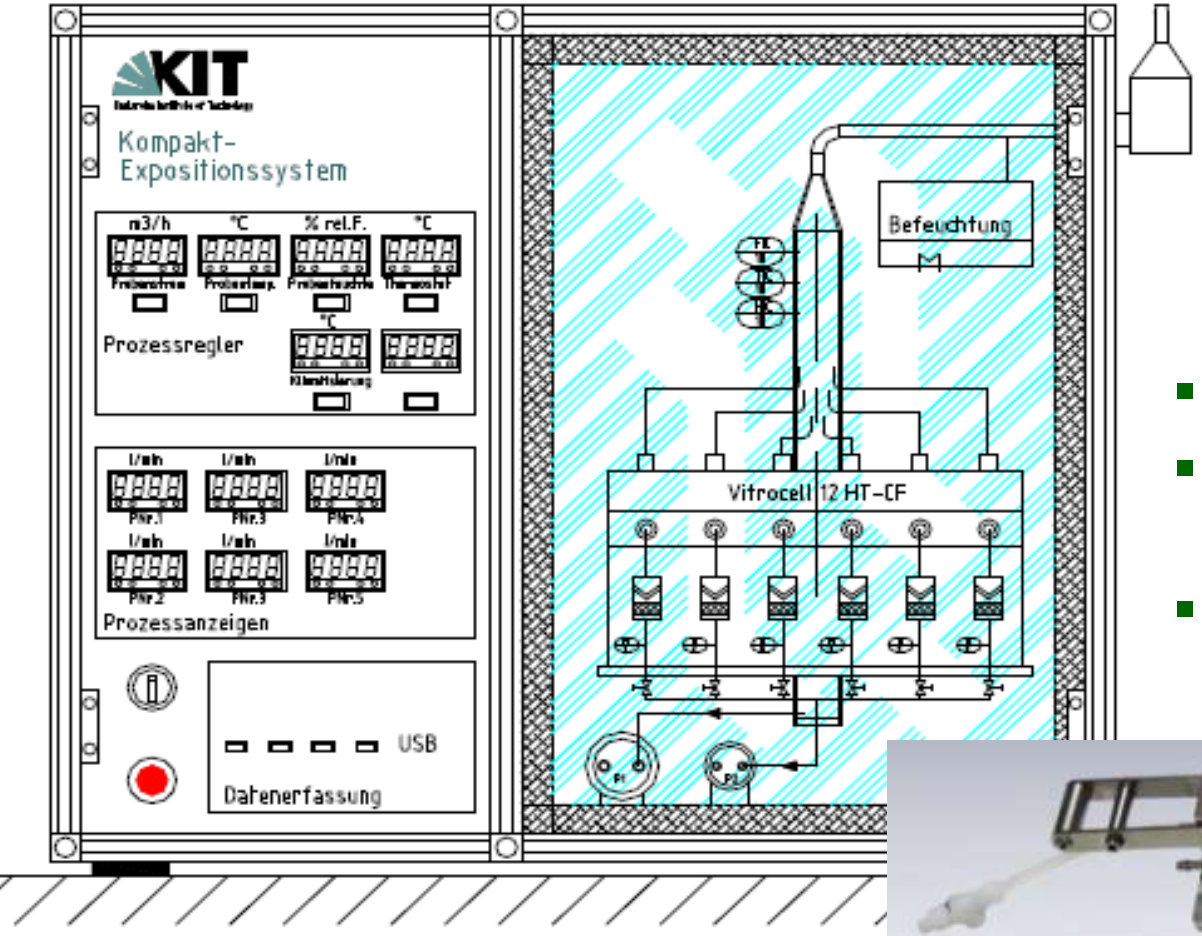
loaded filter

stamping plate with special knive



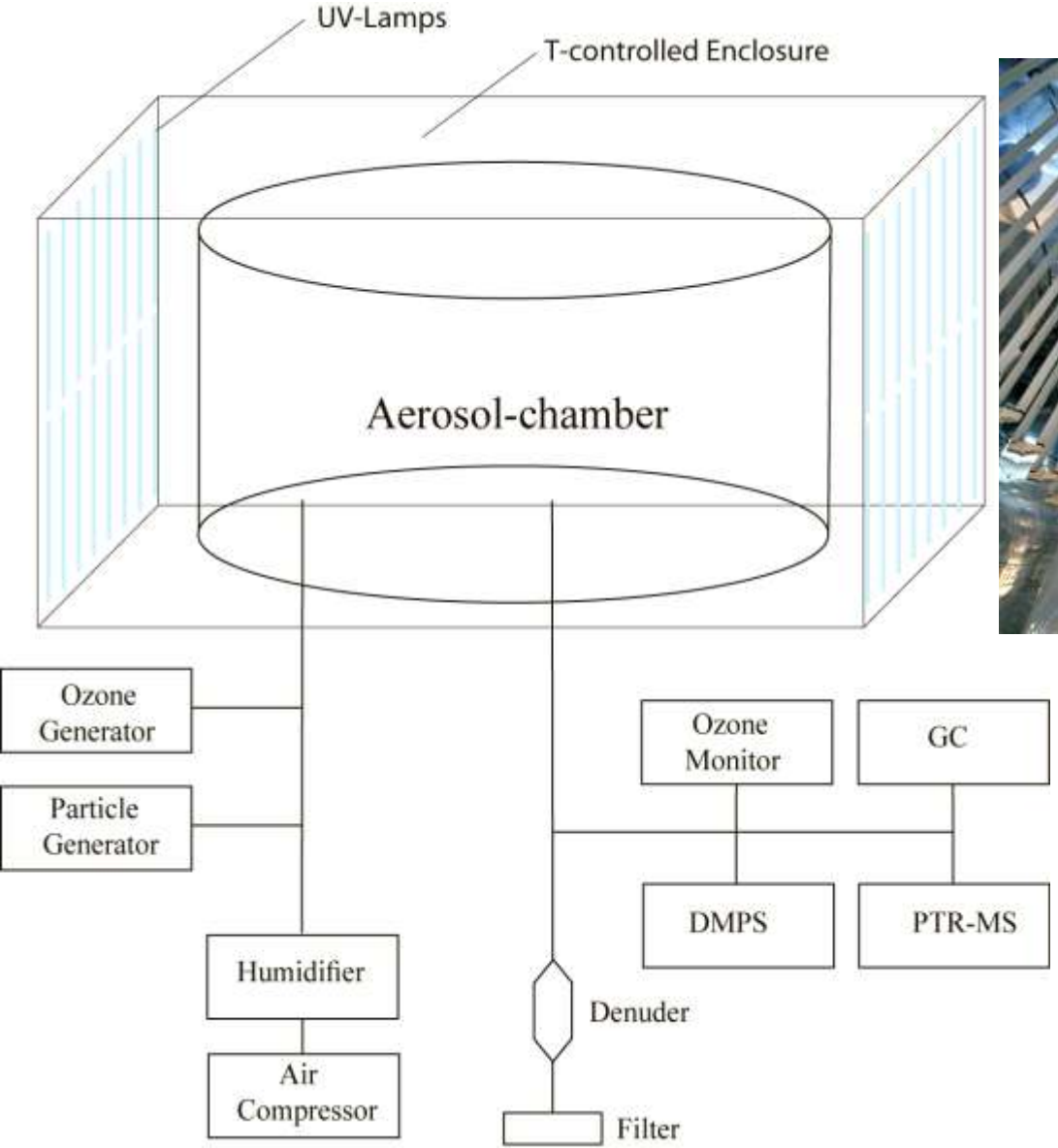
stamped segment

Compact exposition system by KIT

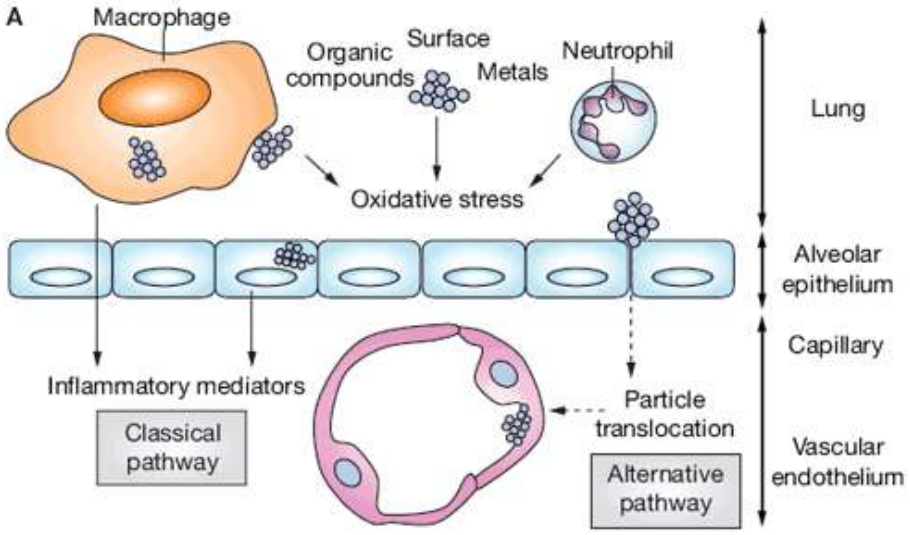


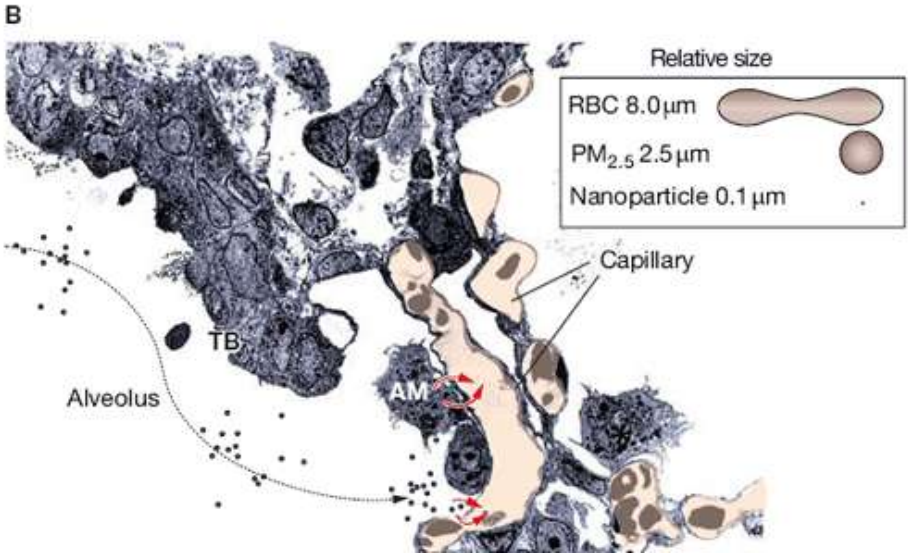
- VITROCELL-Modul 12 HT
- 6 probes with 12 mm cartridges (12 well)
- Micro-balance integrated

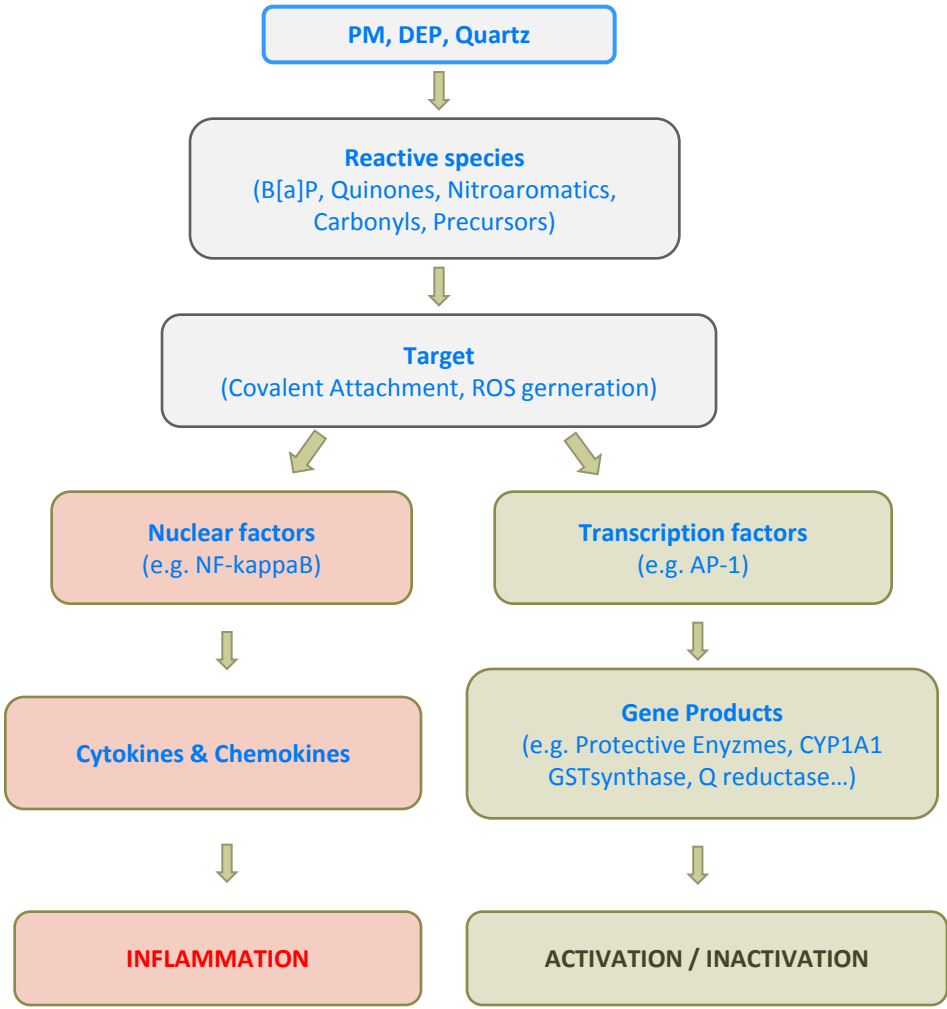
Climate chamber - IfT



Basics of human-toxicological analysis







Verändert nach:
http://cfpub.epa.gov/ncer_abstracts/INDEX.cfm/fuseaction/display.abstractDetail/abstract/8457/report/2001

http://cme.medscape.com/viewarticle/584109_2

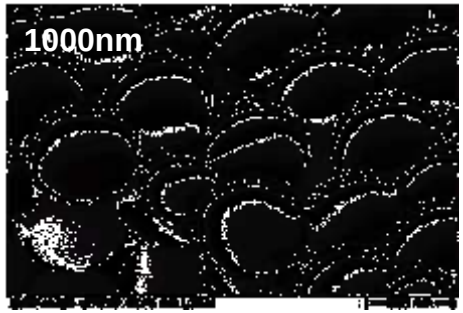
Test set

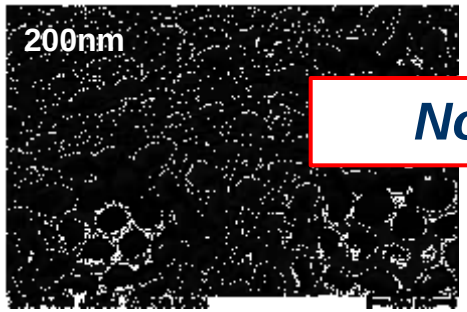
Test System	Exposure	Effect
In vitro cell culture (A549/THP-1) Mono- & co-culture	Suspension; air/liquid interface	Specific parameters of cyto- and genotoxicity, Inflammation, metabolism and signal transduction
Umu-test (ISO 13829)	Suspension; air/liquid interface	Detection of genotoxic effects
Bacteria contact test (DIN 38412-48 ISO/WD 10871)	Suspension; air/liquid interface	Inhibition of dehydro-genase activity; Screening of unspecific effects
C. elegans contact test (ISO/CD 10872)	Invertebrate test at the air/ liquid interface	Interpretation of bio-markers for detection of effect mechanisms

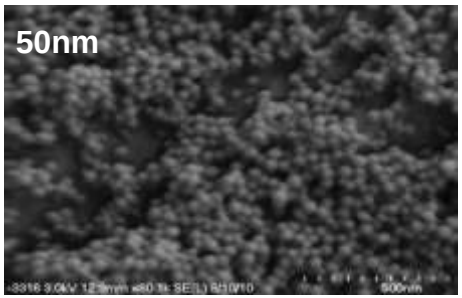
Source: Cooperation partners, current investigation, Poster IAC 2010, Helsinki

Identifing influence of physical properties of the particles

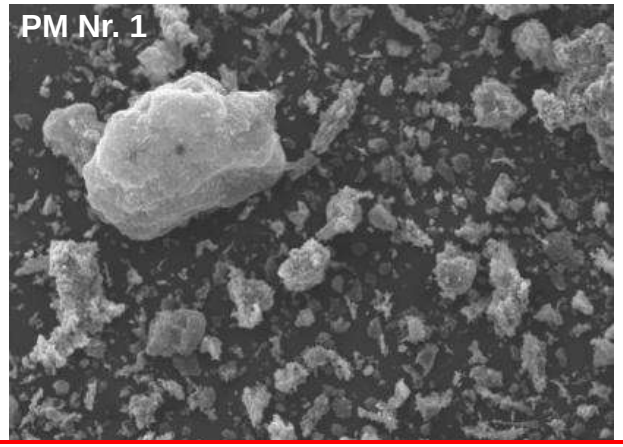
Polystyren-particle

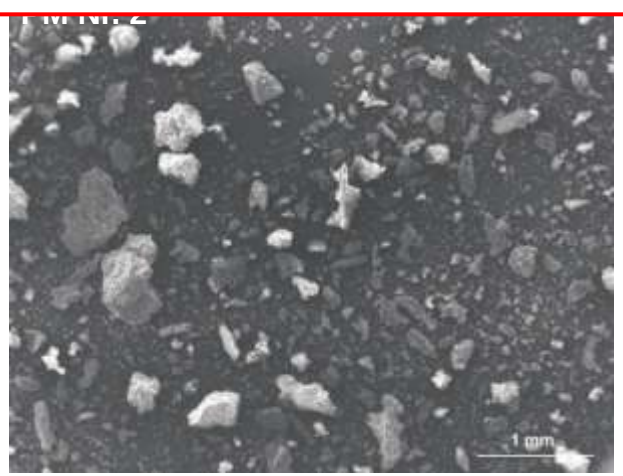




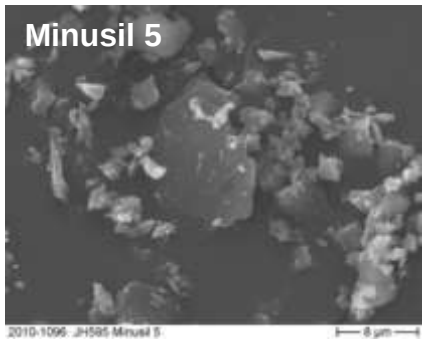


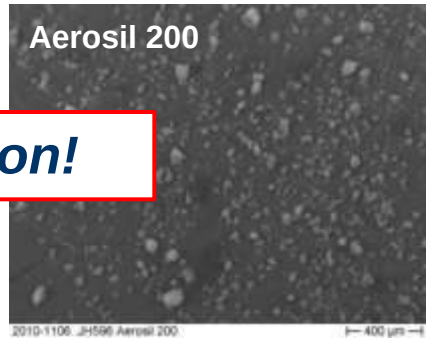
PME

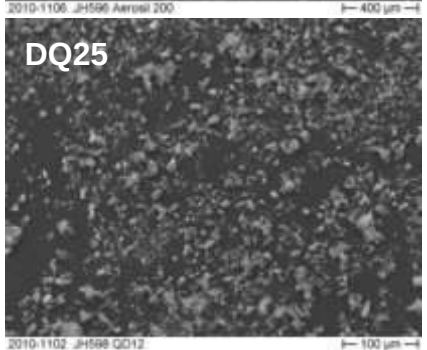




quartz





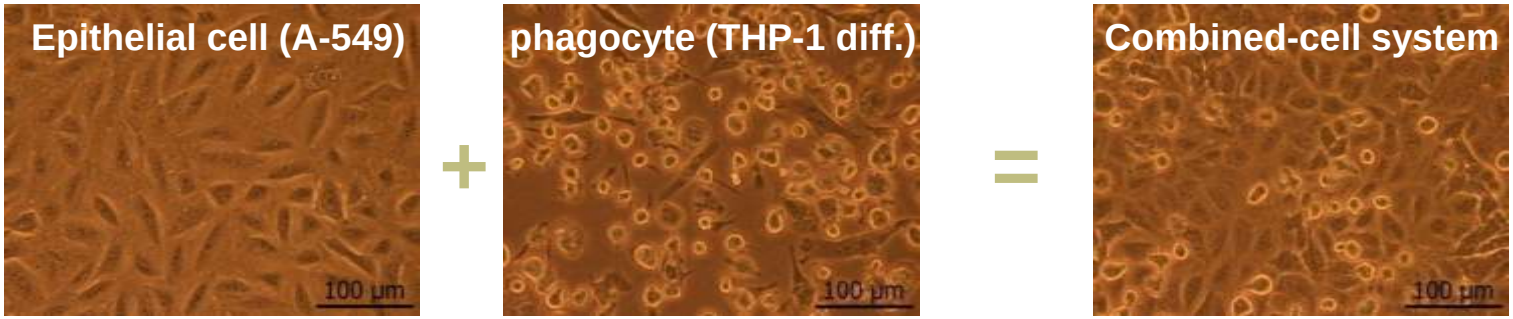


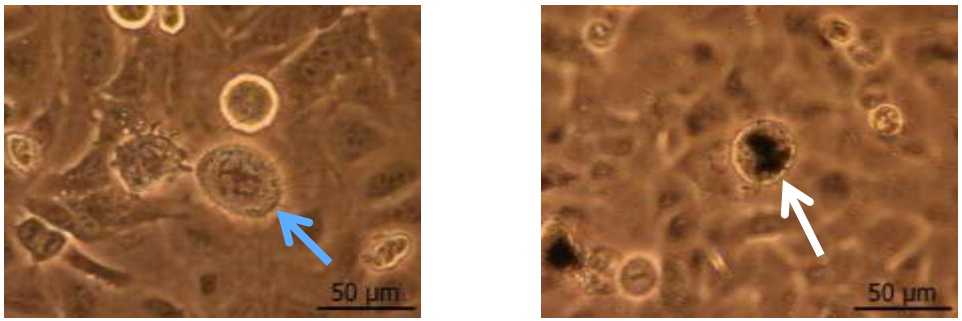
No information about agglomeration!

Research on sensitive cell-systems

Aim: Arranging a combination of different cells

Reason: Try to get nearer to reality. Combined cell systems react differently in comparison to mono-cell-systems.





Source: Cooperation partners, current investigation

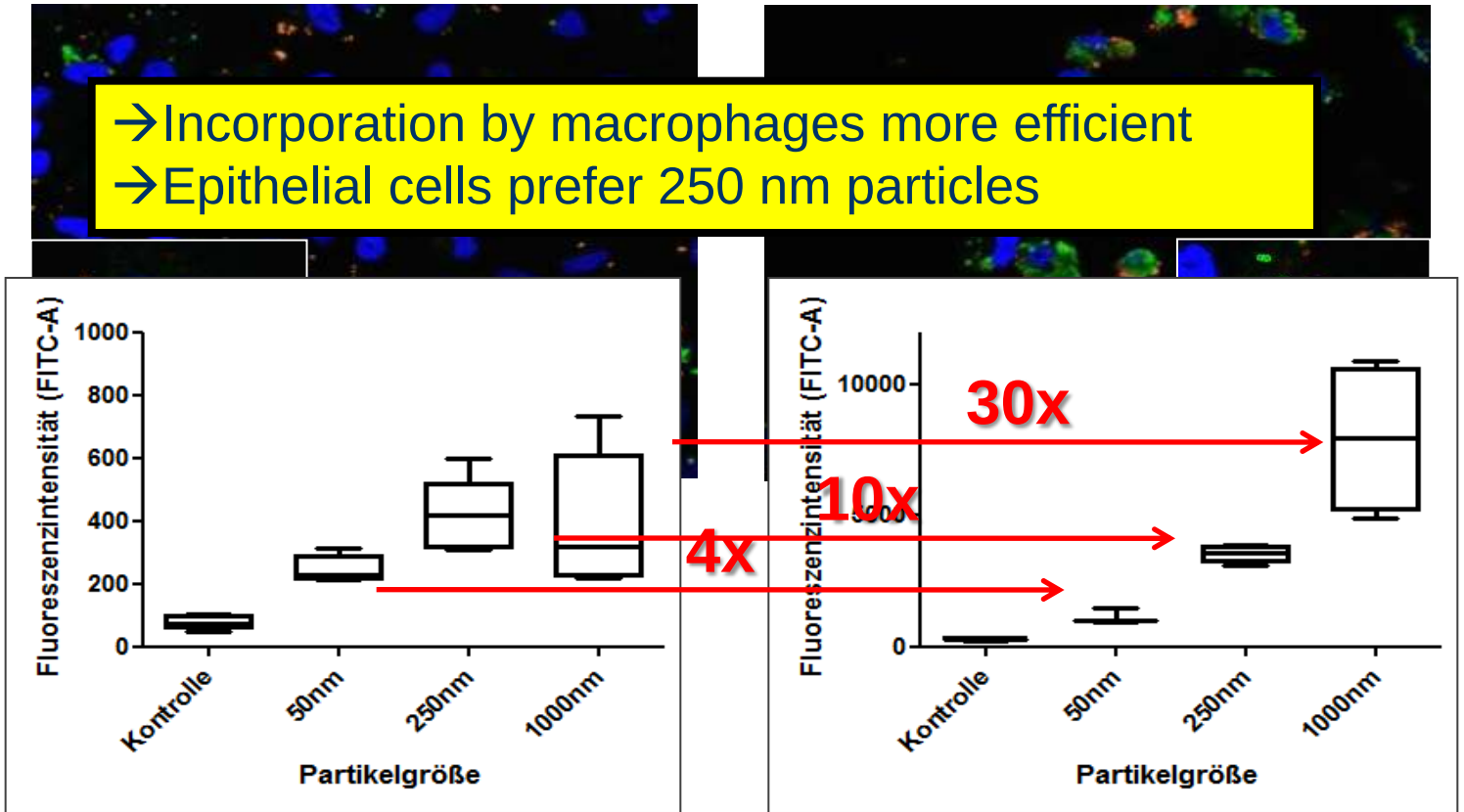
Incorporation tests

Master thesis: „particle size - dependent phagocytosis in A-549 und THP-1 cells *in vitro*“, Cassandra Derreza-Greeven

Aim: Quantifying of incorporation and research on possible incorporation mechanism

1000 nm

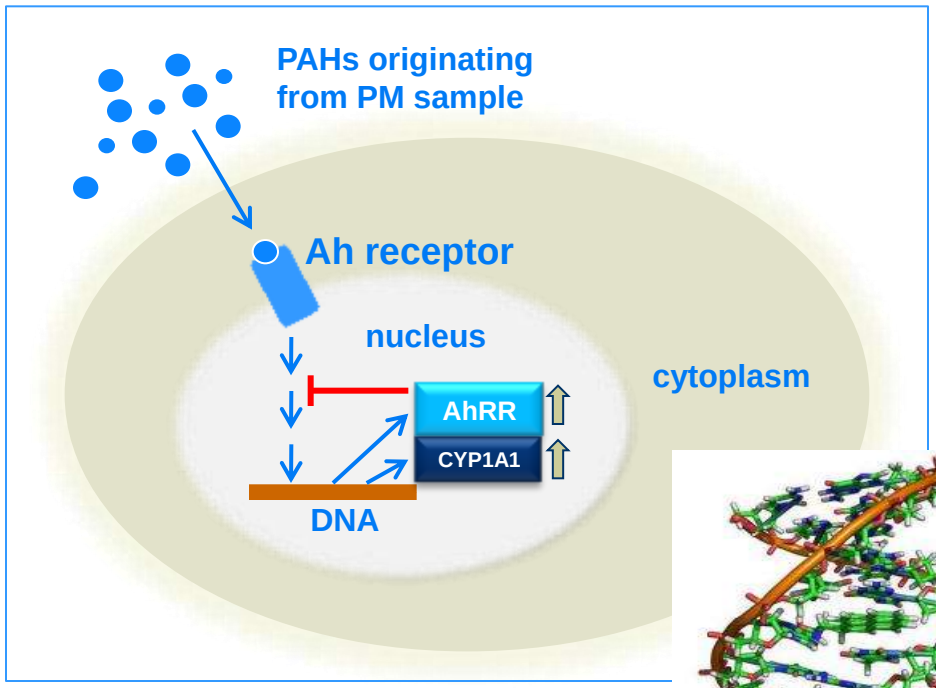
epithelial cell **macrophage**



- 24h exposition with 25 µg/cm²
- median of 10.000 counts

Source: Cooperation partners, current investigation

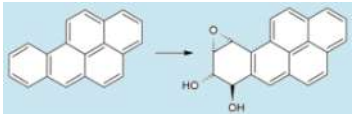
Metabolism of contaminants



PME probe with PAH (e.g. B[a]P)

PAH will be metabolised by Cytochrom P450 syteme, u.a. CYP1A1

Anti-BPDE



creation of DNA adducts

breaks of string & oxidative stress

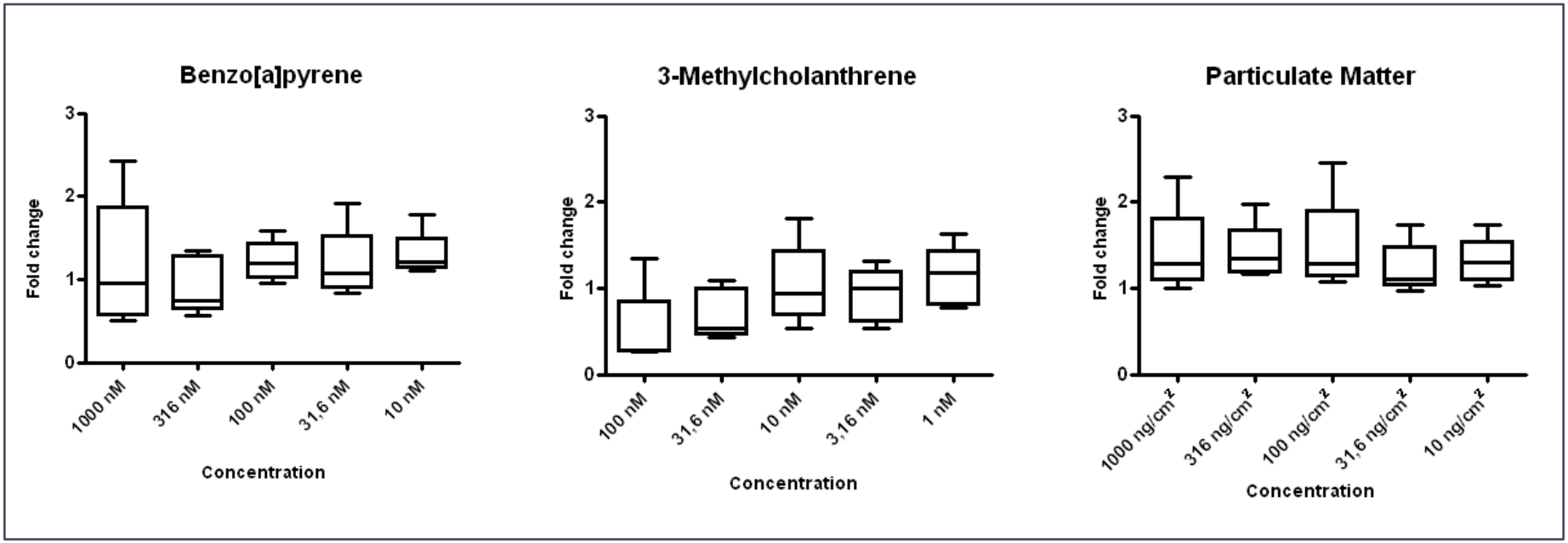
mutations

formation of cancer

www.wikipedia.org
http://www.ust-schadstoff.de/polyzyklische-aromatische-kohlenwasserstoffe-pak.html

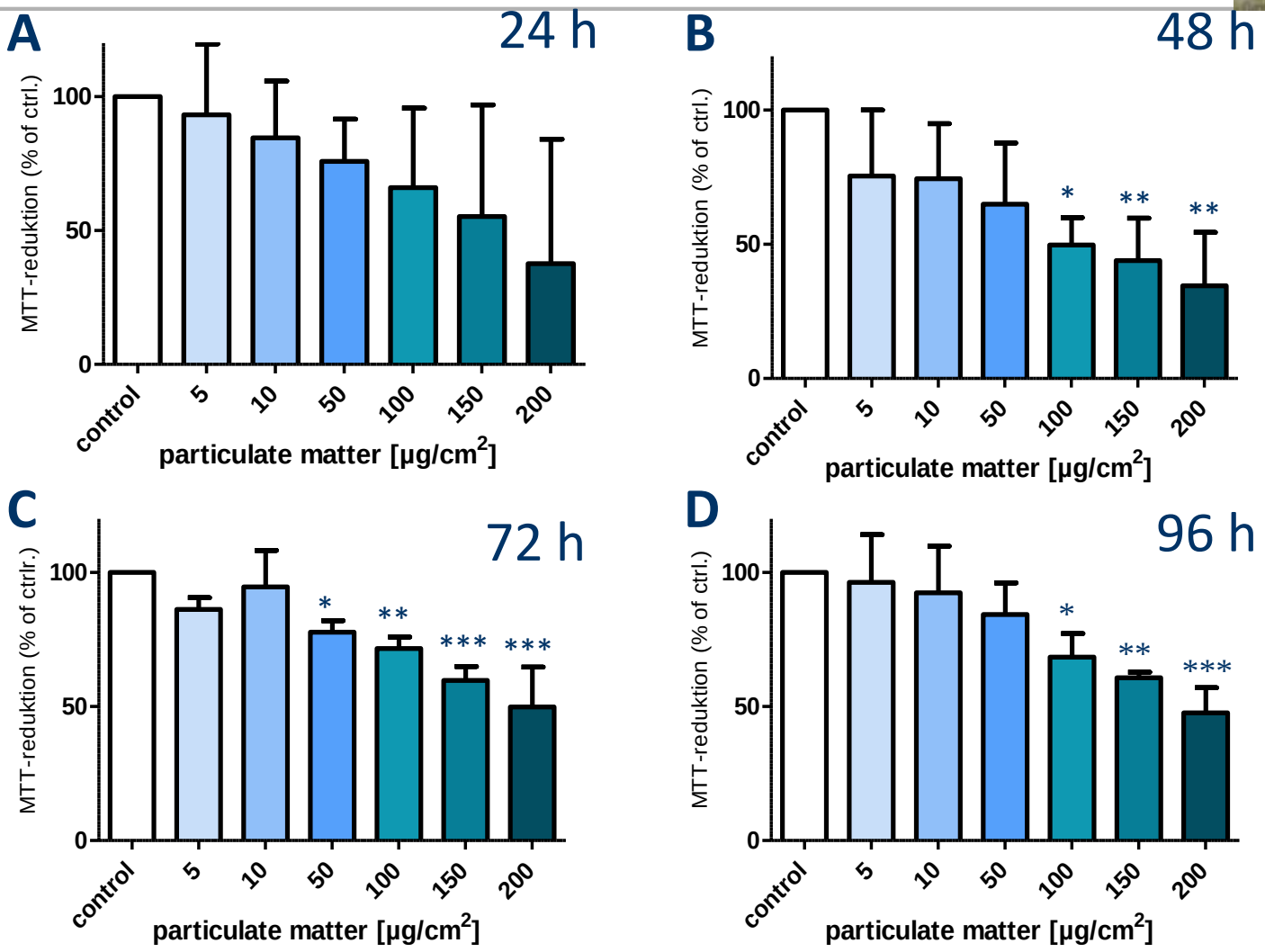
Influence of PME on metabolism

activity of CYP1A1, an important enzyme of metabolism of contaminants



Source: Cooperation partners, current investigation

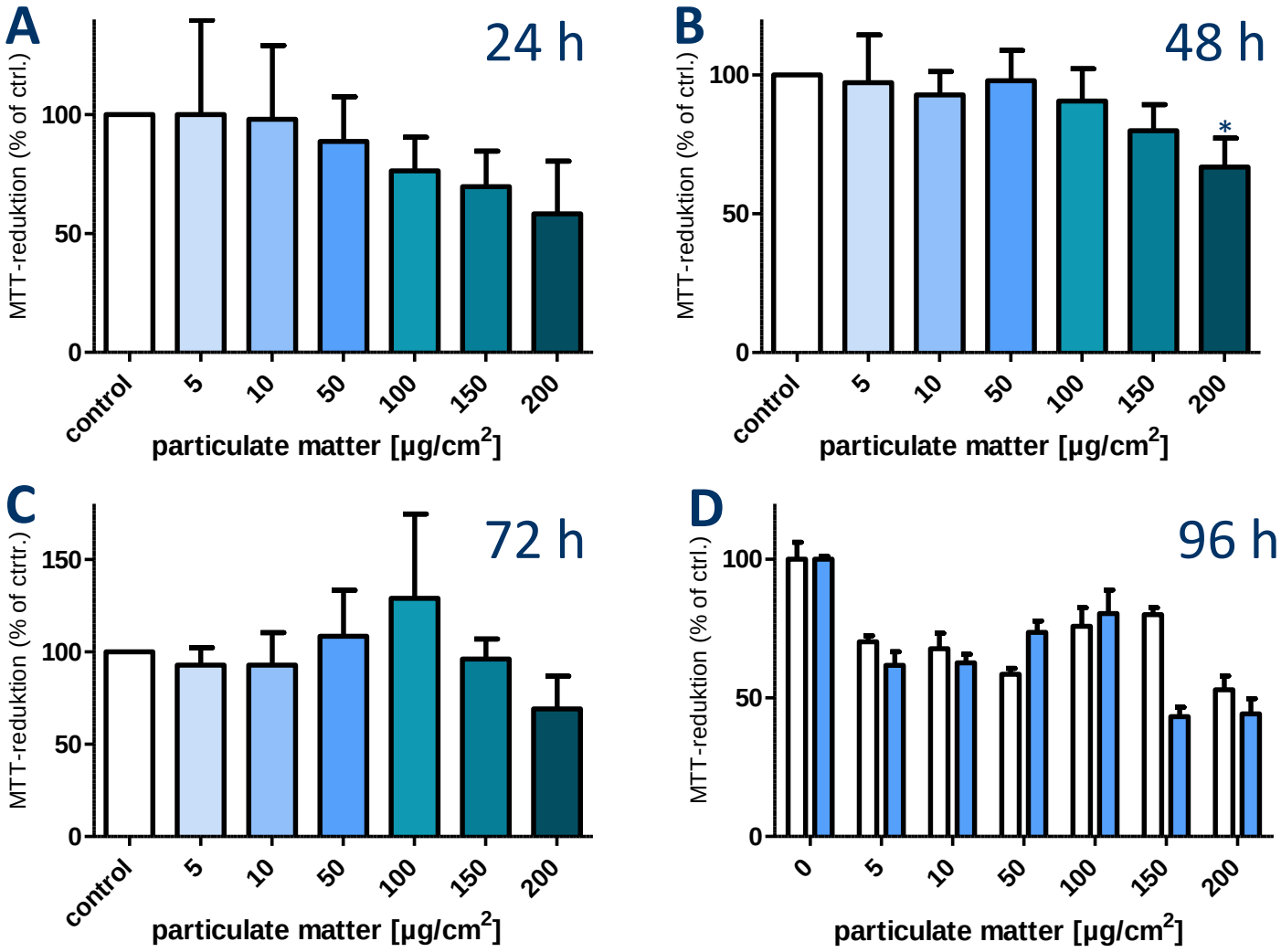
Cell toxicity by PME in A-549 cells



MTT-reduktion in A-549 Zellen nach 24 h (A), 48 h (B), 72 h (C) und 96 h (D) Exposition mit Feinstaub. Vergleich zur Kontrolle. Mittelwert ± Standardfehler. Statistische Analyse mit one-way-ANOVA und Dunnet's test. n=3. ***p-value< 0.001, ** p-value < 0.01; * p-value < 0.05

Source: Cooperation partners, current investigation

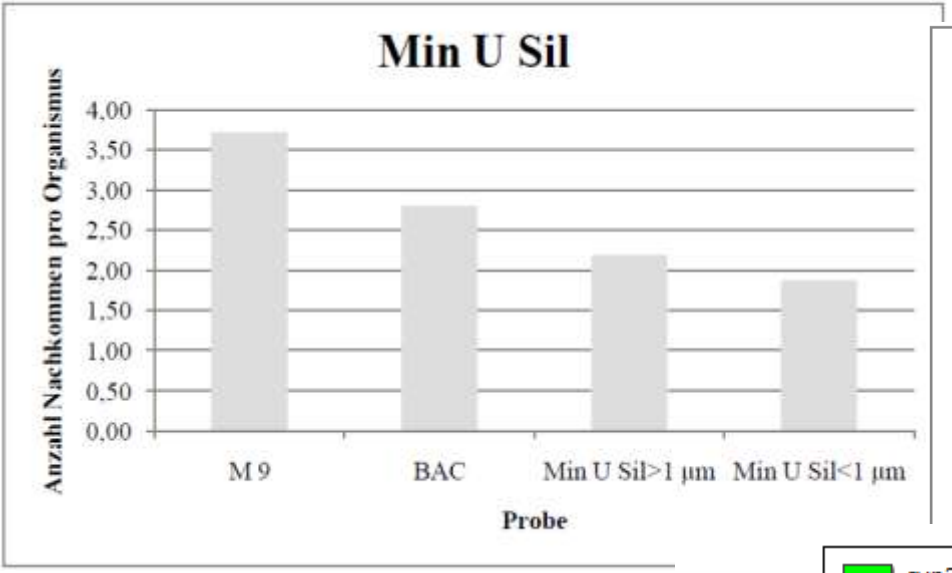
Cell toxicity by PME in THP-1 cells

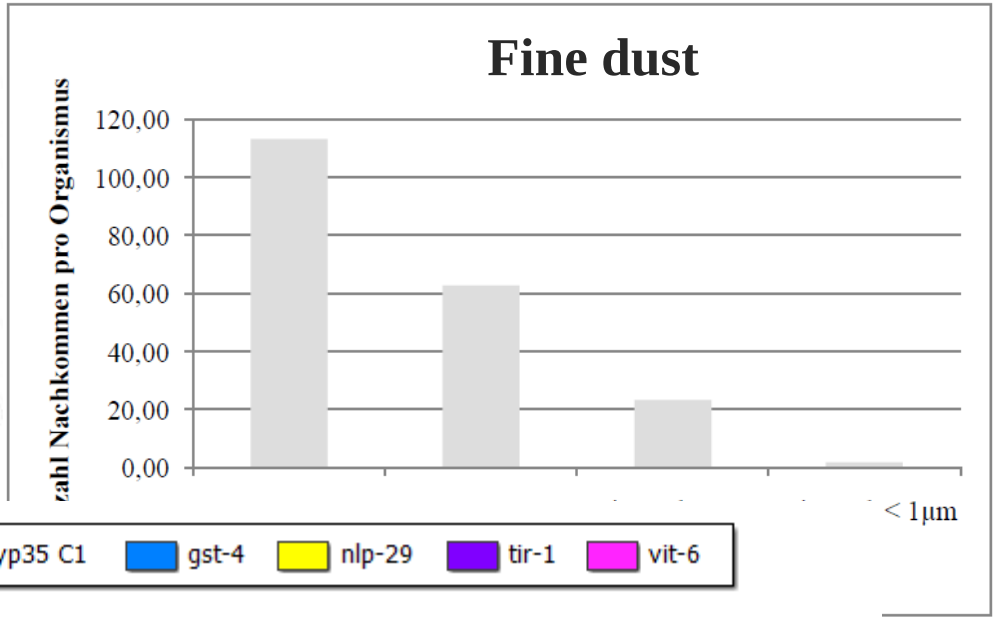


MTT-reduktion in THP-1 Zellen nach 24 h (A), 48 h (B), 72 h (C) und 96 h (D) Exposition mit Feinstaub. Vergleich zur Kontrolle. Mittelwert ± Standardfehler. Statistische Analyse mit one-way-ANOVA und Dunnet's test. n=3 für (A), (B) und (C), n=2 für (D). * p-value < 0.05

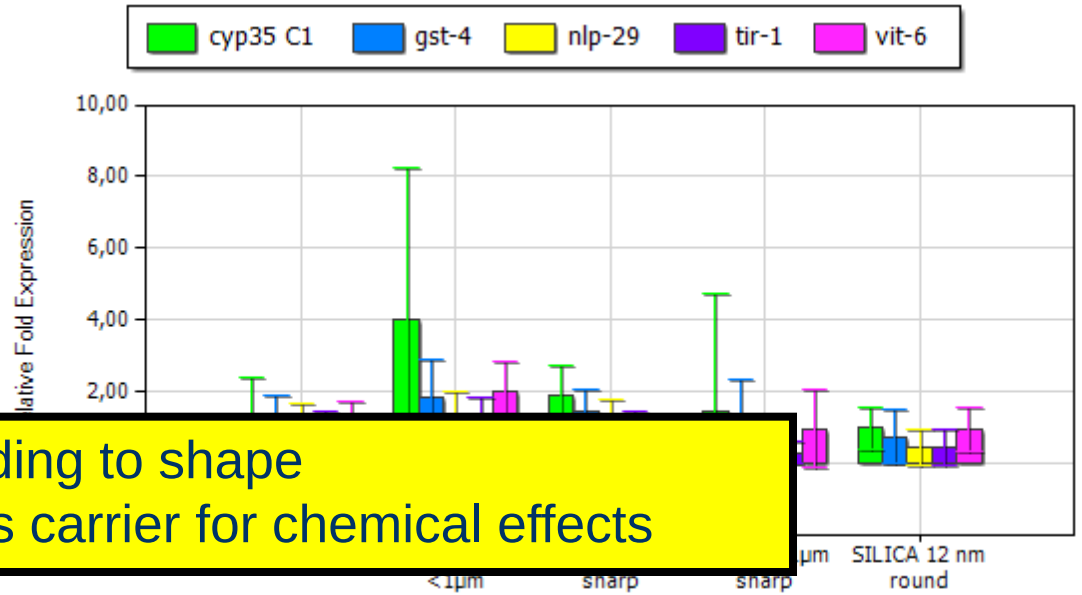
Source: Cooperation partners, current investigation

Nematode-test according to ISO 10872
End point: reproduction





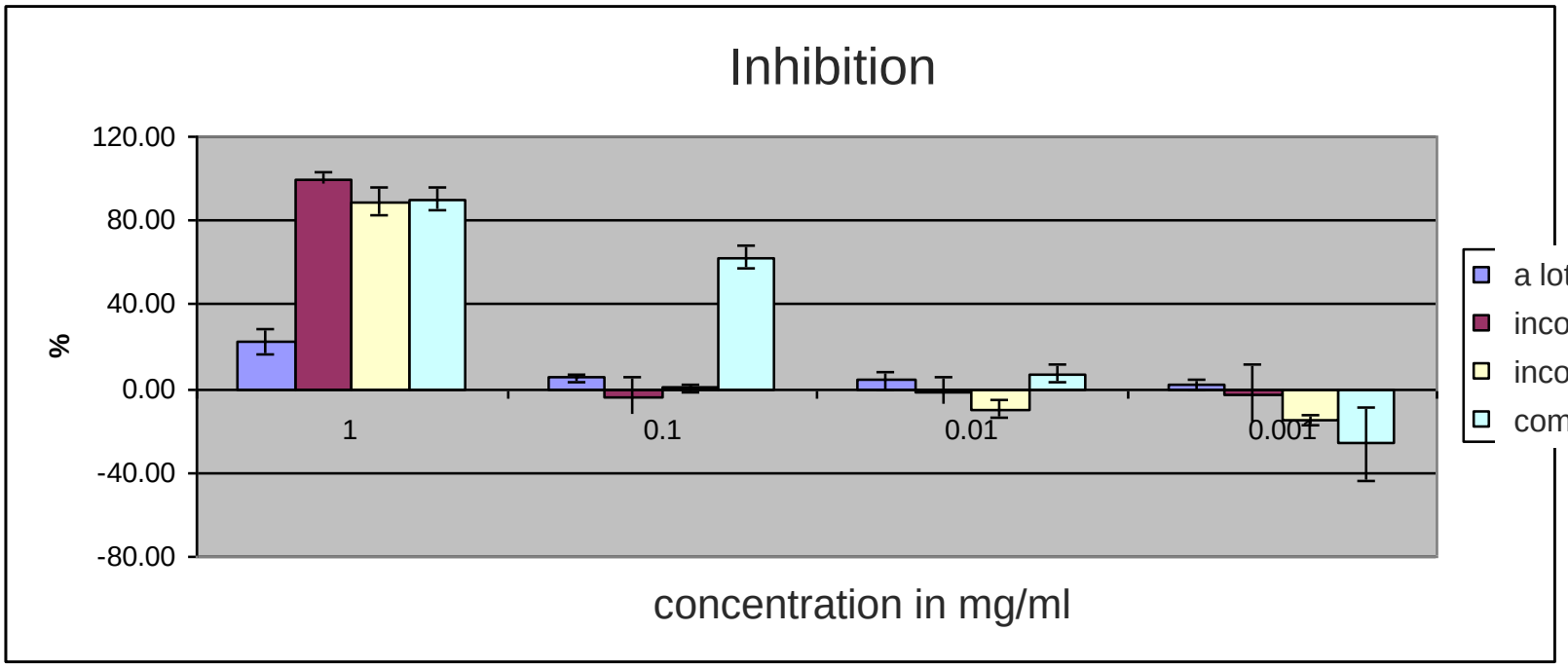
under development:
genetic nematode-test



→ No effect according to shape
→ Fine particles as carrier for chemical effects

Source: Cooperation partners, current investigation

Bacteria contact test (cytotoxicity): first results



→ No correlation with PAH
→ salt concentration?
→ in future also Umu- and YES-test

Source: Cooperation partners, current investigation

Outlook

- Establishing an improved exposition system together with a method of conditioning the flue gas.
- Establishing a biological test system to describe the toxicity of the emissions together with a method to get the probes.
- Development of indicators to get a first idea of the toxicity by chemical and physical characterisation of the particles and than doing measurements with the biological test sets only at important points of development or for type testing.

Final Results will be presented and discussed at different conferences in 2012.

Thank you for your attention.

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