PN PTI Focus Event

Why is PTI for modern vehicles needed in addition to OBD, market surveillance and remote control

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Automotive – TÜV Hessen
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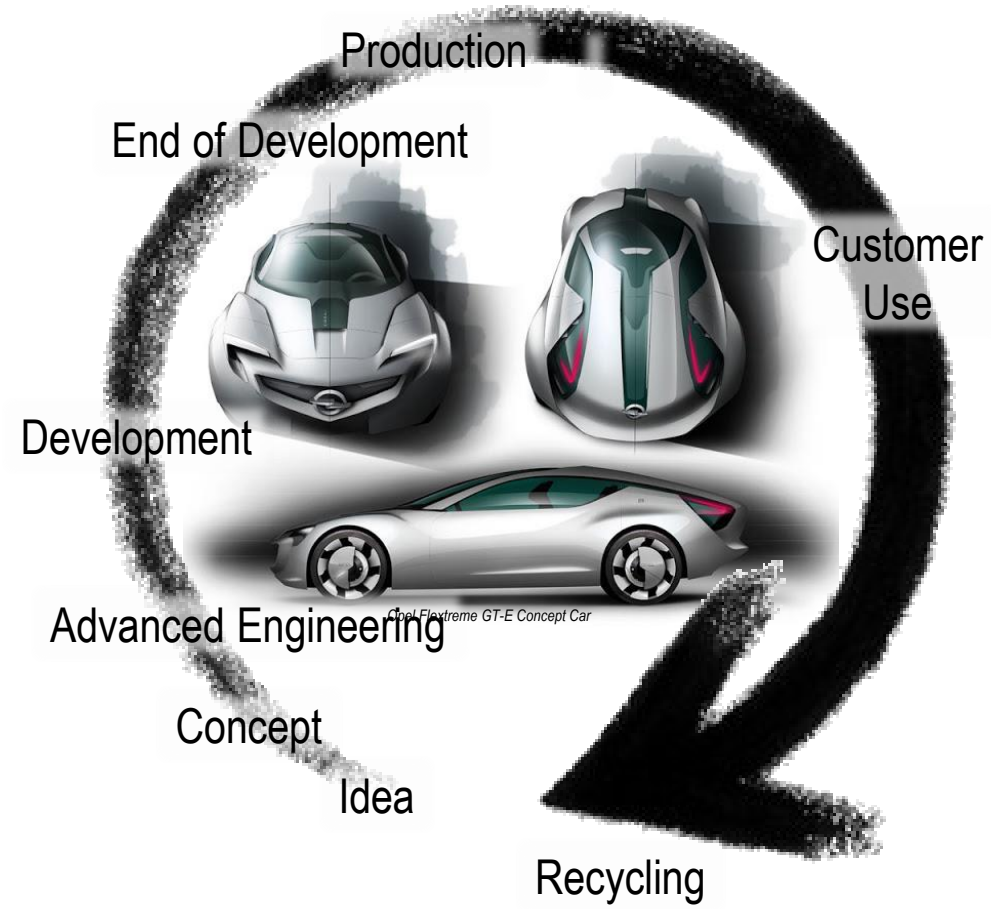
„If you can´t measure it, you can´t control it. Measurement is the first step to control. With measurement you can develop and improve.“

Ronald O.Loveridge, Mayor of Riverside, CA, USA at the 2012 UCR, University of California, PEMS Conference

For years this was my intro for RDE and PEMS, but it is also true for PN and PTI.

Emission control of vehicles during vehicle lifetime

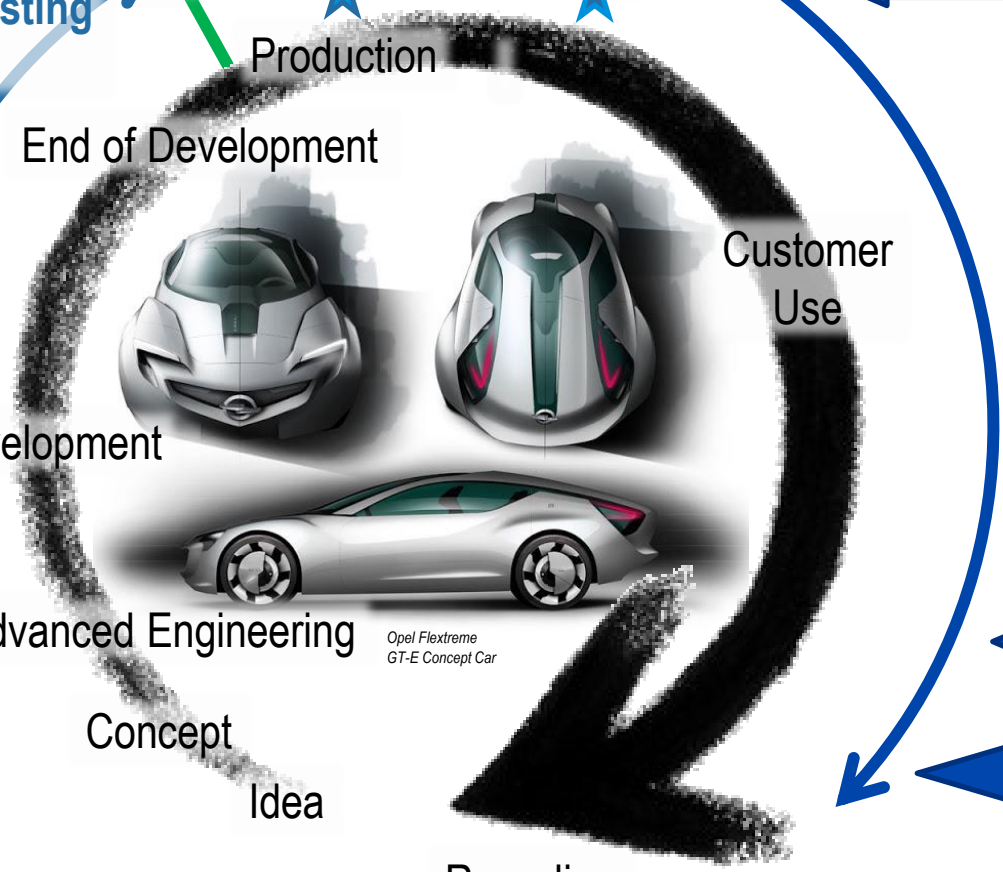


Automotive – TÜV Hessen

Type Approval
with TÜV Technical Service
And Type Approval Authority

Type approval testing
(homologation)

Few cars
Systematic Failures



100% of cars
Random Failures

periodical
technical
inspection – PTI

1
CoP Conformity of Production
By Manufacturer

2
ISC In Service Conformity
MaS Market Surveillance

Emission measurements?

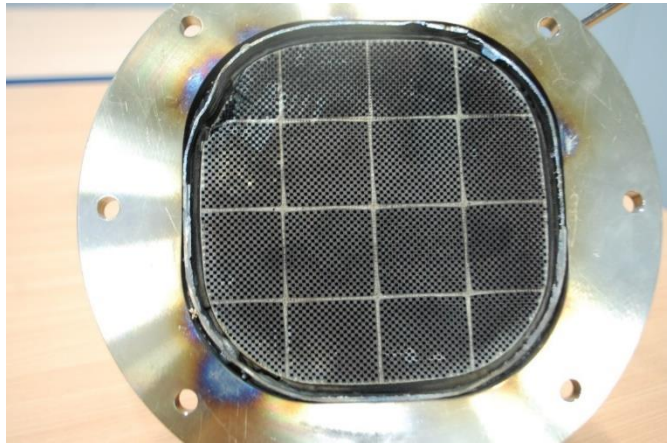
Technical Service

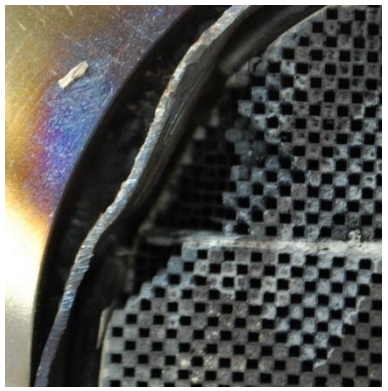
PTI

Emissions: Chassis Dyno and RDE with PEMS

Emission test bench,
gaseous and opacity and new: PN

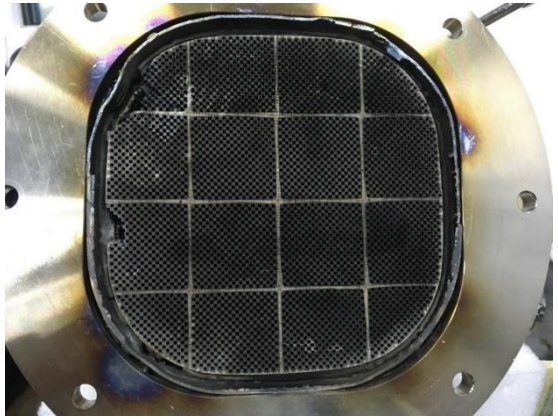
Example: DPF defect in 2 stages





Total 6624 Channels
Damage 1: 0,39%
Damage 2: 0,62%

Tailpipe Measurement Defect	Engine Speed [rpm]	PN [#/ccm]
#1 Average	Idle 780	1,3E5
#2 Average	780	2,2E5
No DPF	780	1,04E7



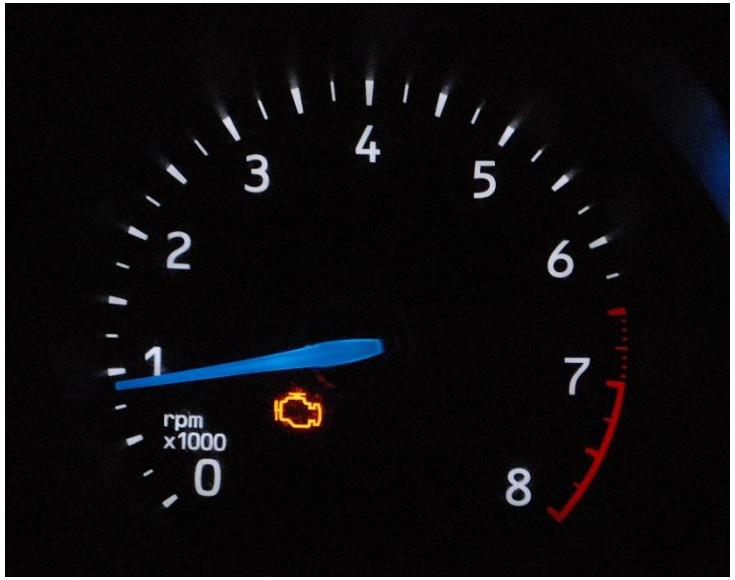
Tailpipe Measurement No defect	Engine Speed [rpm]	PN [#/ccm]
1	Idle 780	3,1E1
2	780	1,5E2
3	780	2,8E2
Average	780	1,5E2

2,0L Diesel DPF
DPF Efficiency

OE: 99,997%
Damage #1: 98,6%
Damage #2: 97,9%

OBD

- OBD is only for single failure, and also always tested like in this mode
- Complete engine system degradation not covered
- High emitters with MIL-off
- PM, PN detection without Sensors: lack of system sensitivity, resolution: not even a readable number
- Good for detection of wiring, shortages, and to identify faults,
- Diagnostics to steer proper repair



EURO 6-2 OBD Limits

PM Emission Limit: 4,5 mg/km
OBD Limit: 2,6 x

Final Euro 6 OBD threshold limits

Category	Class	Reference mass (RM) (kg)	Mass of carbon monoxide (CO) (mg/km)		Mass of non-methane hydro-carbons (NMHC) (mg/km)		Mass of oxides of nitrogen (NO_x) (mg/km)		Mass of particulate matter (1) (PM) (mg/km)		Number of particles (2) (PN) (#/km)	
			PI	CI	PI	CI	PI	CI	CI	PI	CI	PI
M	—	All	1 900	1 750	170	290	90	140	12	12		
N_1	I	RM ≤ 1 305	1 900	1 750	170	290	90	140	12	12		
	II	1 305 < RM ≤ 1 760	3 400	2 200	225	320	110	180	12	12		
	III	1 760 < RM	4 300	2 500	270	350	120	220	12	12		
N_2	—	All	4 300	2 500	270	350	120	220	12	12		

Key: PI = Positive Ignition, CI = Compression Ignition.
(1) Positive ignition particulate mass and particle number limits apply only to vehicles with direct injection engines.
(2) Particle number limits may be introduced at a later date.

Example: Euro 6 OBD:

typical Diesel PM: ~0,3mg/km on Street,
PM Limit: 4,5 mg/km
OBD Limit: 12mg/km (50% EURO 4) ->

Vehicle is a high emittter long
before OBD detection

No measurement of PN and PM with OBD!
(Light Duty)

Future EURO 7 OBD OBM

OBM data transfer: OTA

NOx, NH3 pollutant sensors plus calculation models, EURO 7 Step1

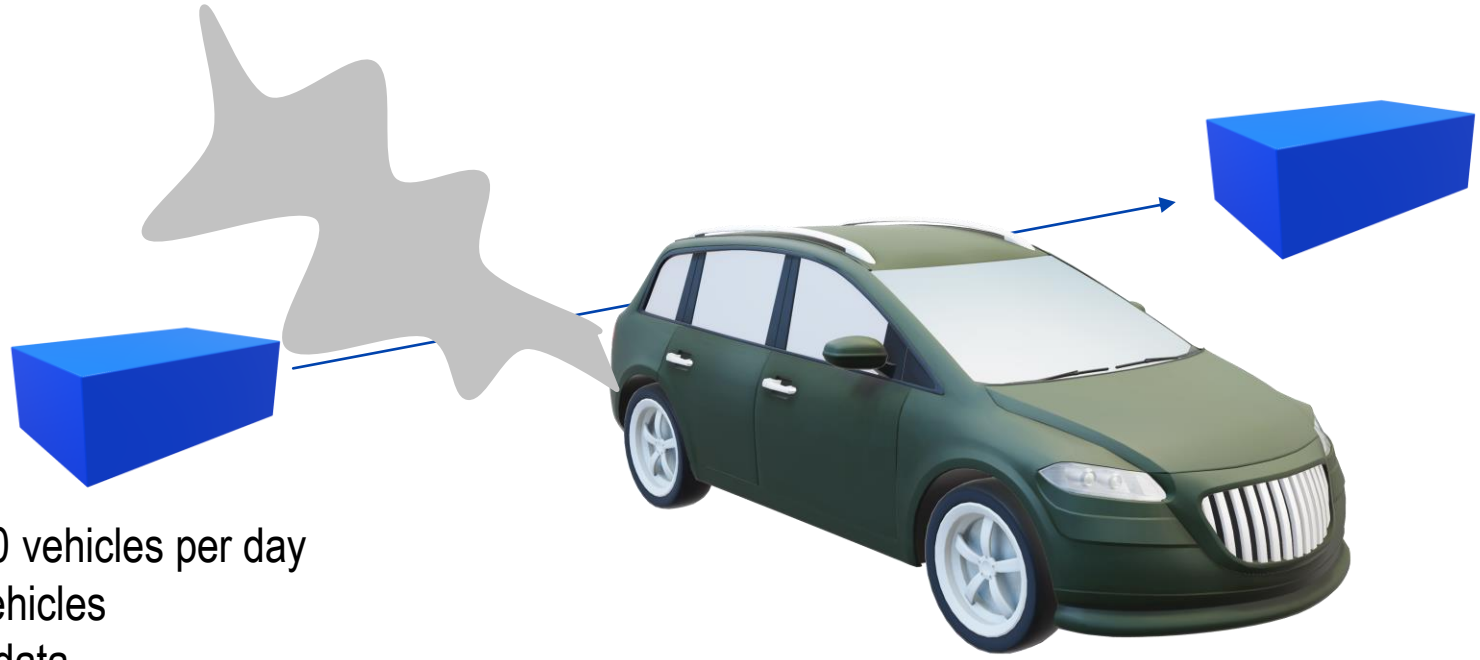
Tracking of emission related data
OBM (big) data analysis

Force high emitters to PTI, no emission testing for low emitters, but OBM check at PTI?

Progress and technology evolving
Hardware / Software / Process Infrastructure has to be deployed

Not feasible for all cars on the road now.

Remote sensing



Sensing of:
Vehicle speed, acceleration, CO2, CO, Nox, Opacity, Ambient conditions, camera to identify vehicle type and license plate

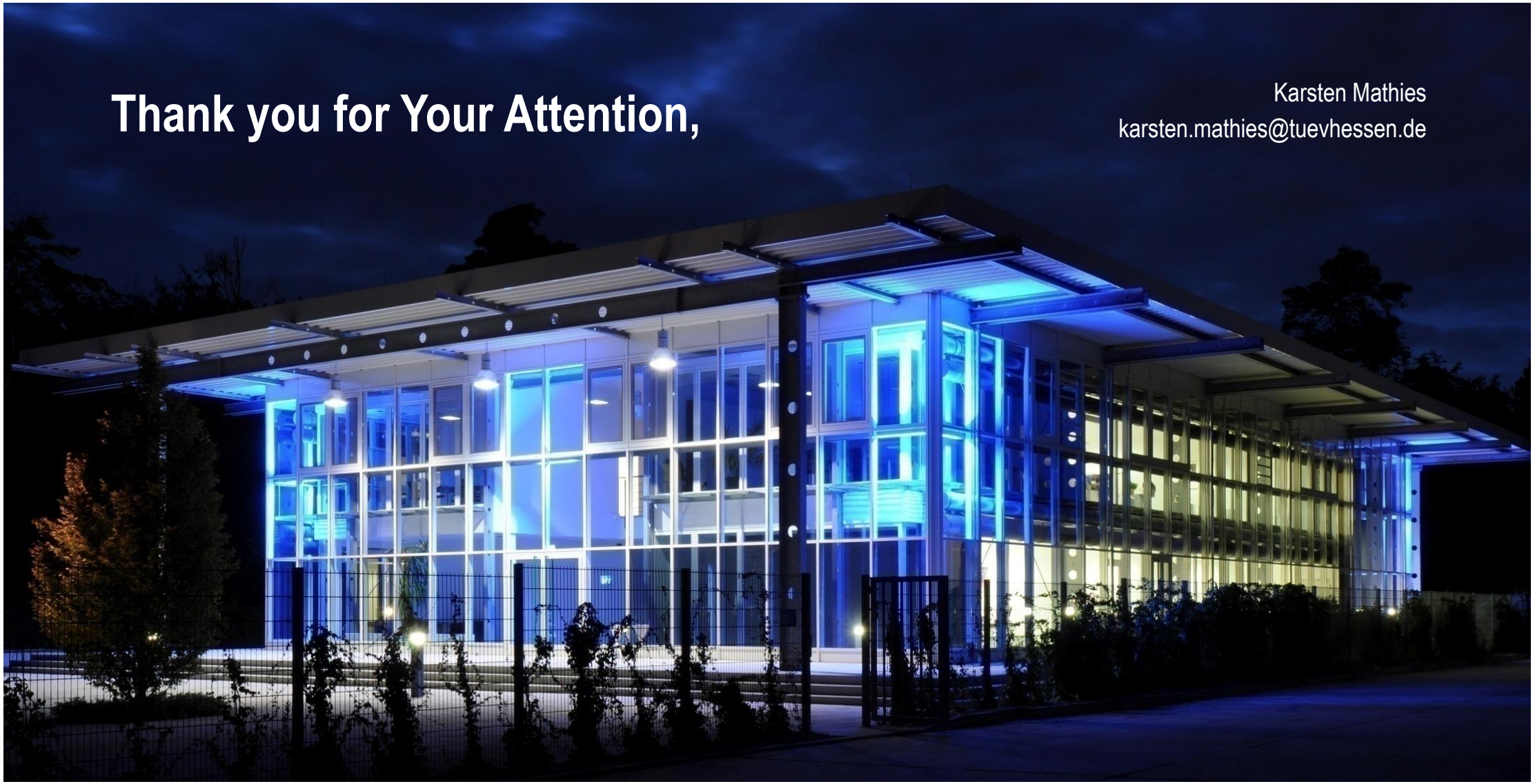
- Can measure up to 6000 vehicles per day
- In real street with real vehicles
- Tool to gather emission data
- Can identify suspect high emitters-> send them to PTI
- For TÜV / workshop use impractical
- Not robust

Summary and Conclusion

- **OBD** does not measure PN, vehicle becomes high emitter long before MIL is activated
- Future EURO 7 **OBM** Onboard Monitoring applies new technologies and new approach, but is far away. Could sent high emitters to repair and PTI.
- **Remote sensing** is a tool to gather valuable emission data locally. Maybe used for surveillance, maybe sent high emitters to PTI. Can not be used in a workshop.

- **A new PN PTI is needed for effective emission control. Only real PN tailpipe measurement is sensitive enough to precisely determine the PN vehicle emission. The PN PTI would hold up in court, is simple and robust and can be performed in workshops and PTI stations.**

- The introduction of the new PN PTI should be supported by measures to promote vehicle maintenance and for cost effective repair solutions.


Thank you for Your Attention,
Karsten Mathies
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Backup: EURO 3-5 OBD Diesel

Emission Limit M1	TA LIMIT PM CI [g/km]	OBD Threschold CI [g/km]
EURO 3	0,050	0,180
EURO 4	0,025	0,180
EURO 5	0,0045	0,050

EURO 3,4 OBD: mostly: detection limit can not be reached without DPF
EURO 5: mandatory DPF removal detection