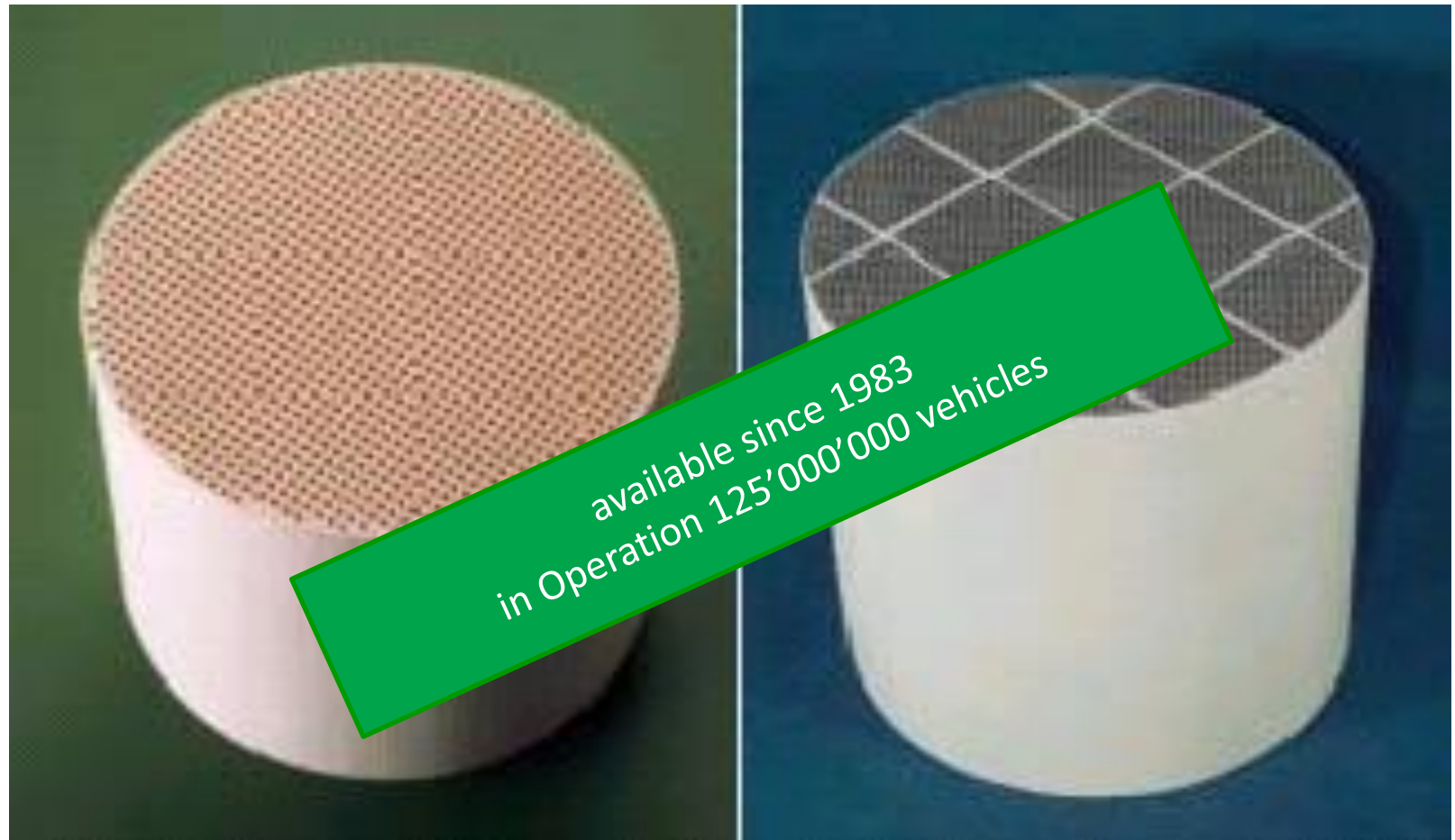


AQM 2018 and VERT workshop, Tehran, January 23rd

DPF-Safety and Quality by systematic Inspection & Maintenance

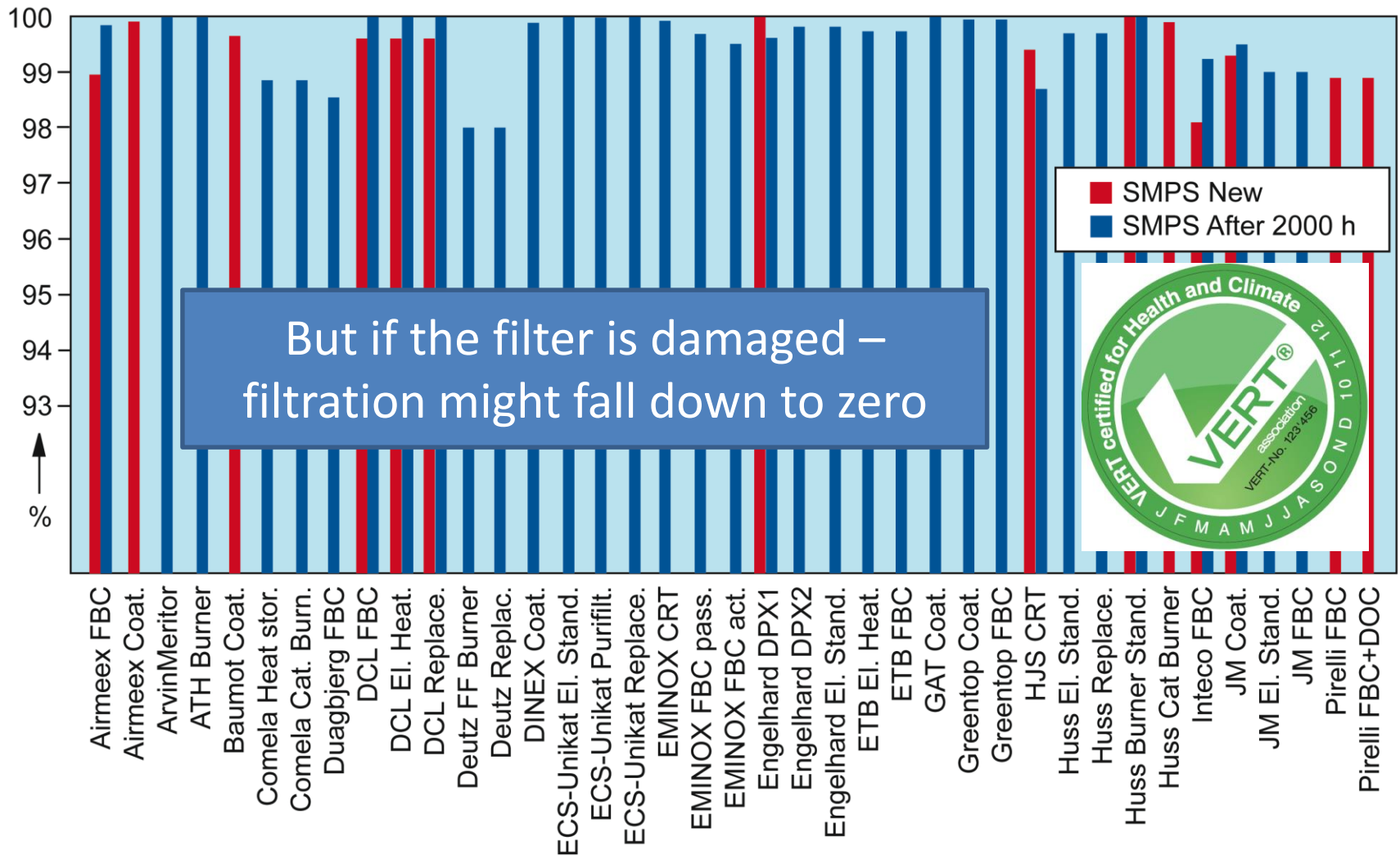
A.Mayer , Th.Lutz

DPF are made by porous ceramics and operate in a hostile environment at High Temperatures and Vibrations

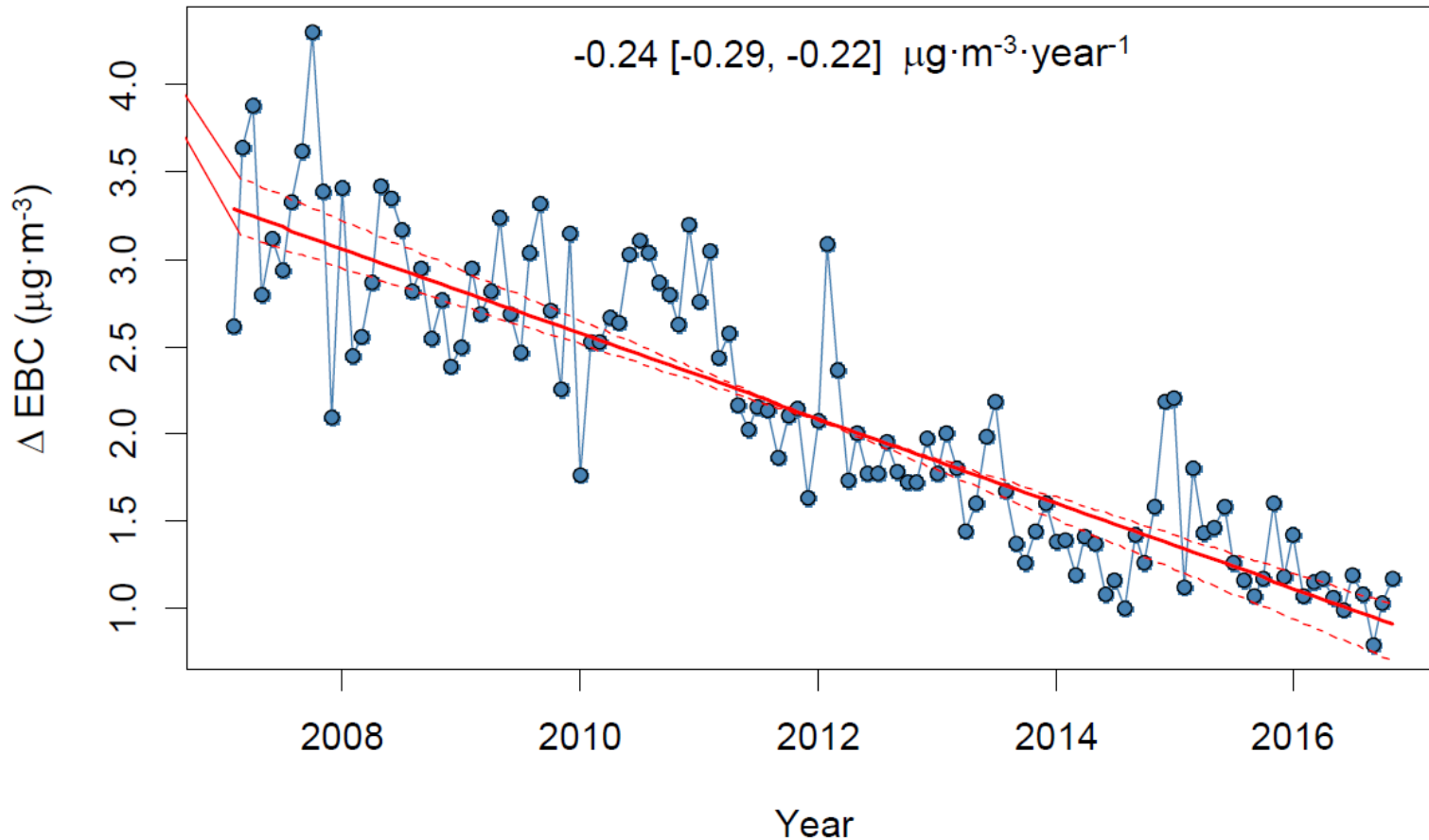



Filtration is brilliant - 65 DPF VERT tested

25 % > 99.8 % within size range 20-300 nm



Success is proven: PN and BC monitoring at a very busy motorway crossing in Switzerland although traffic increased by 30 %

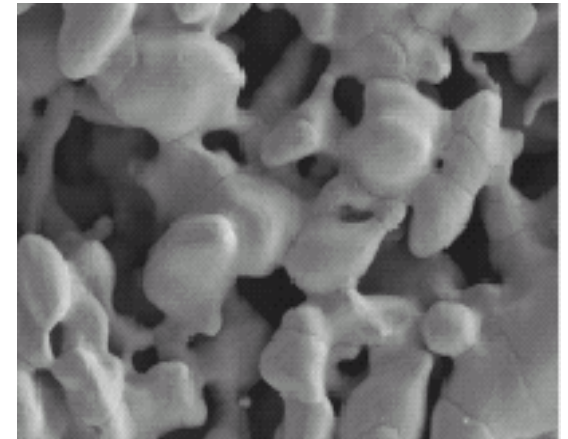
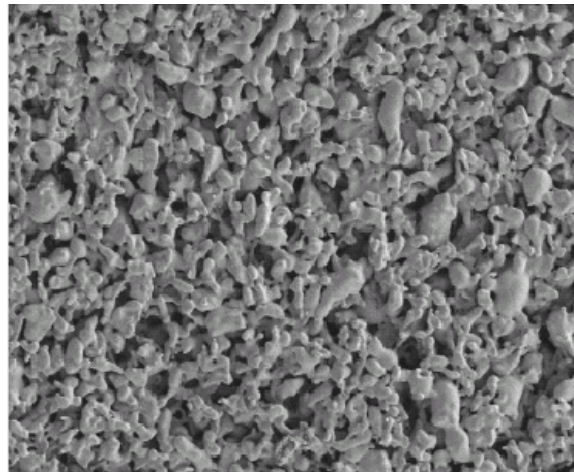
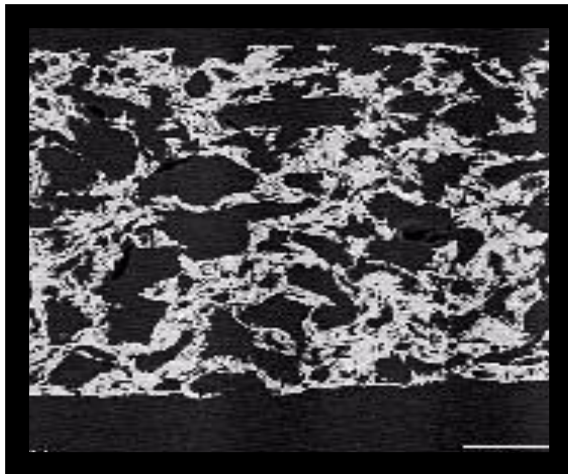
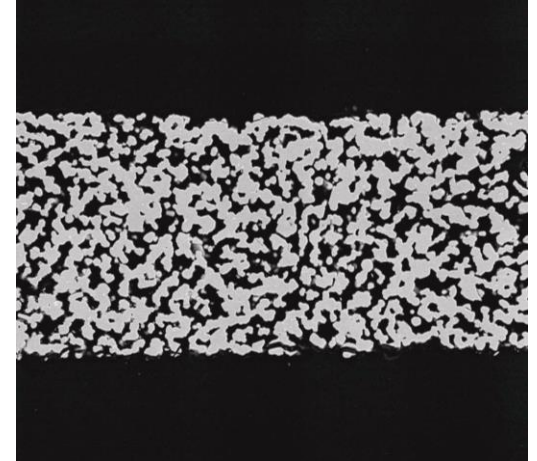
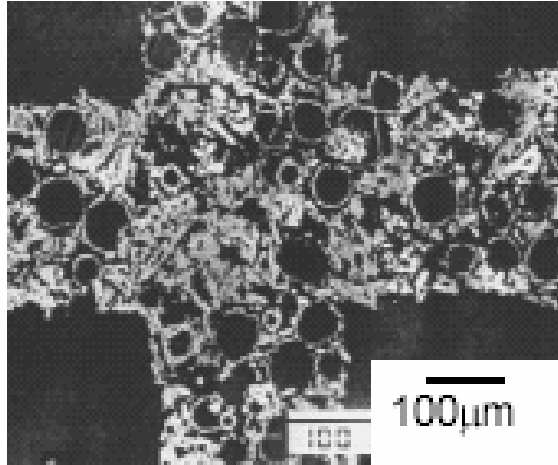
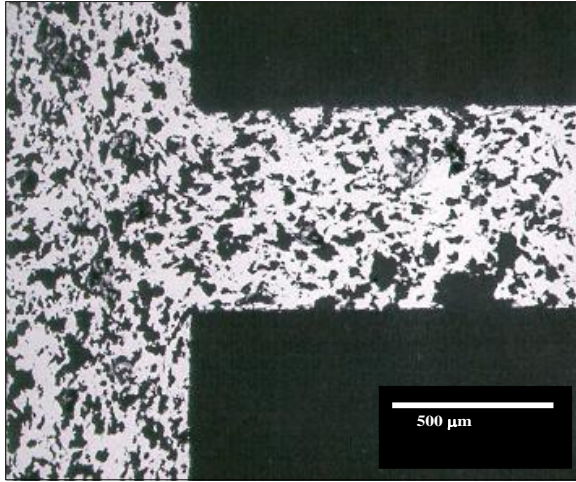




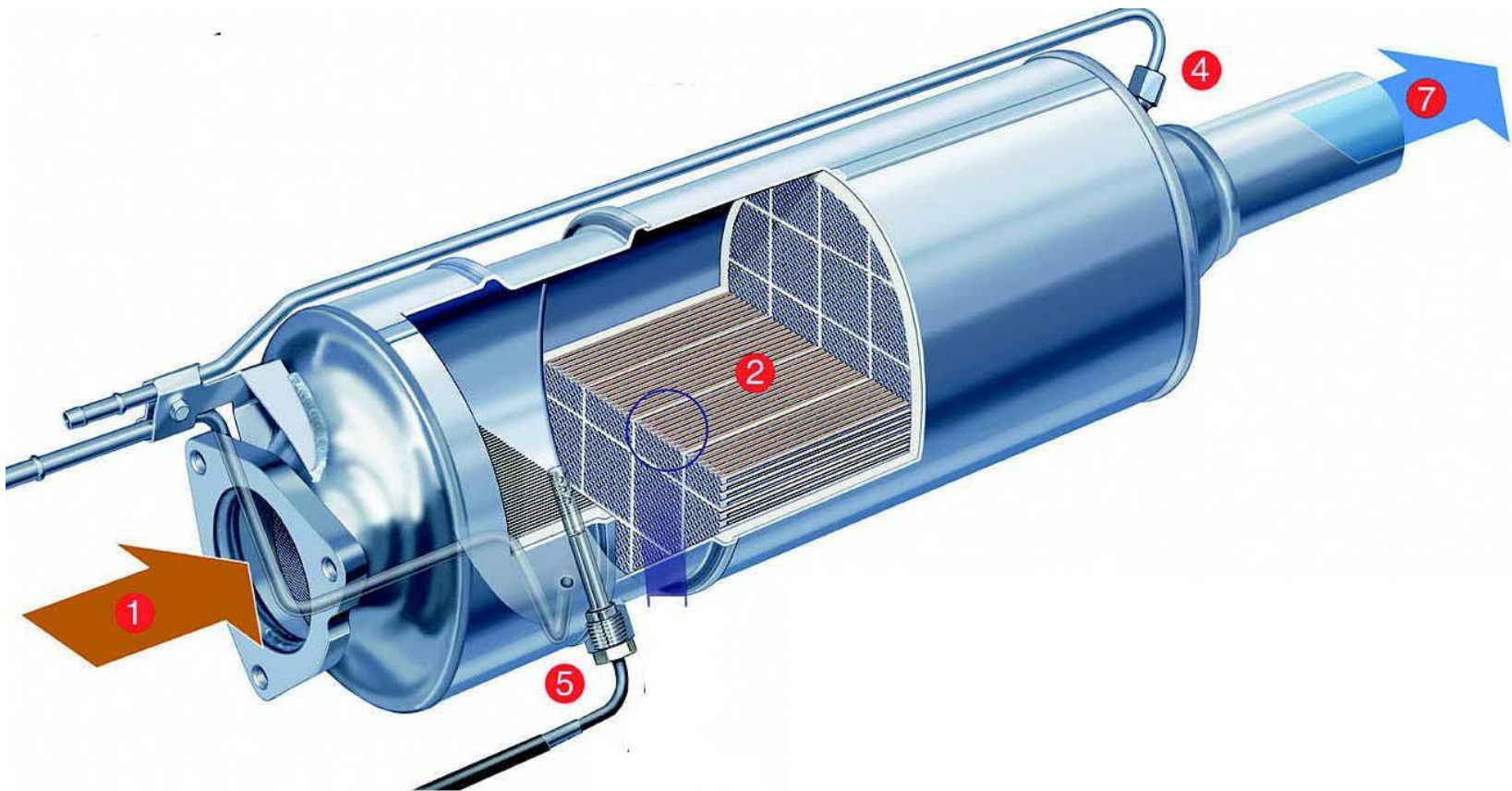
**But for IRAN this is New Technology
and contains
Risk Elements**

*and hence the need for
Inspection, Maintenance and Control*

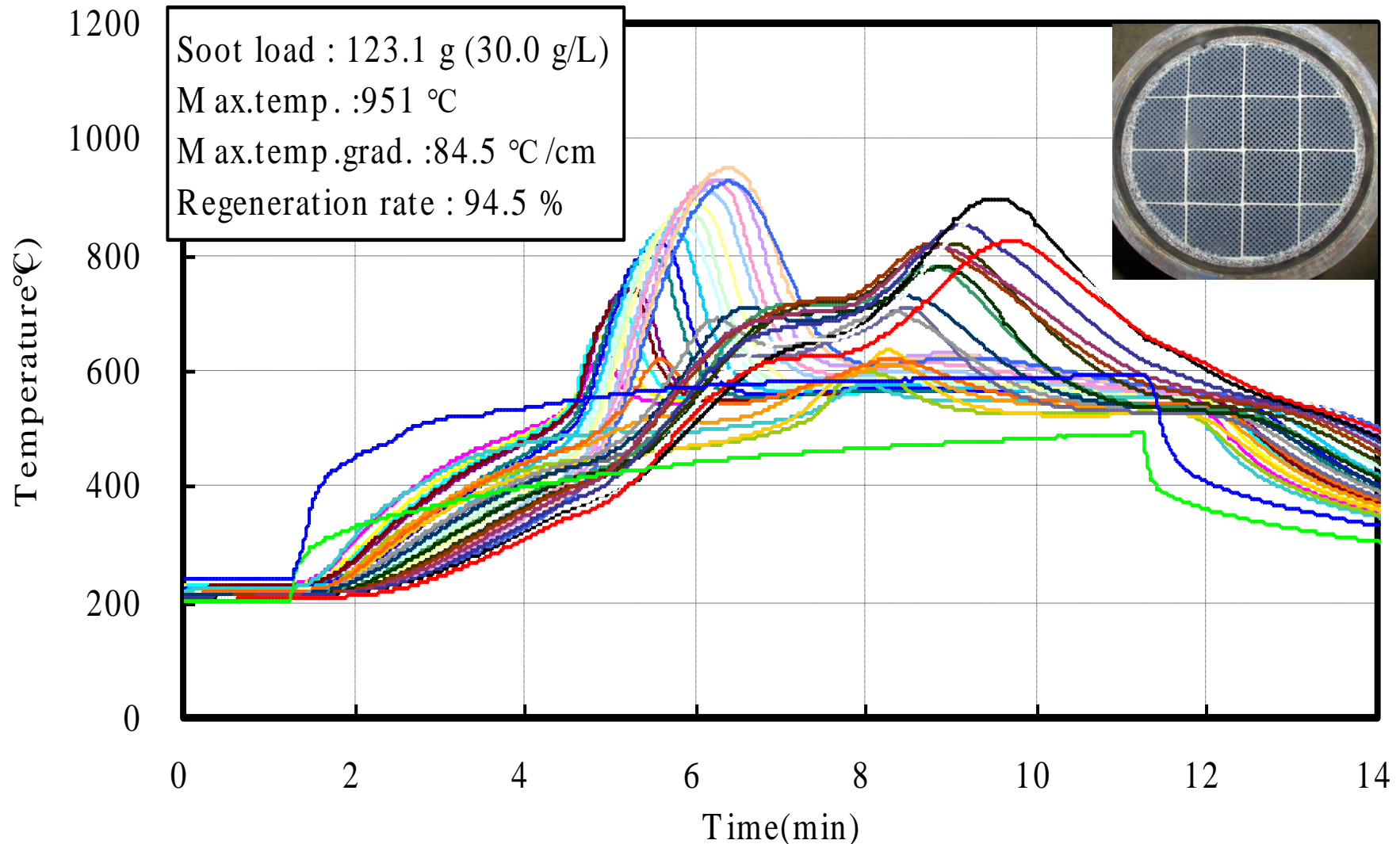
Filter-materials need to be porous
→ necessarily weak and brittle



Ceramic Particle Filter Systems require careful shock absorbing canning and insulation

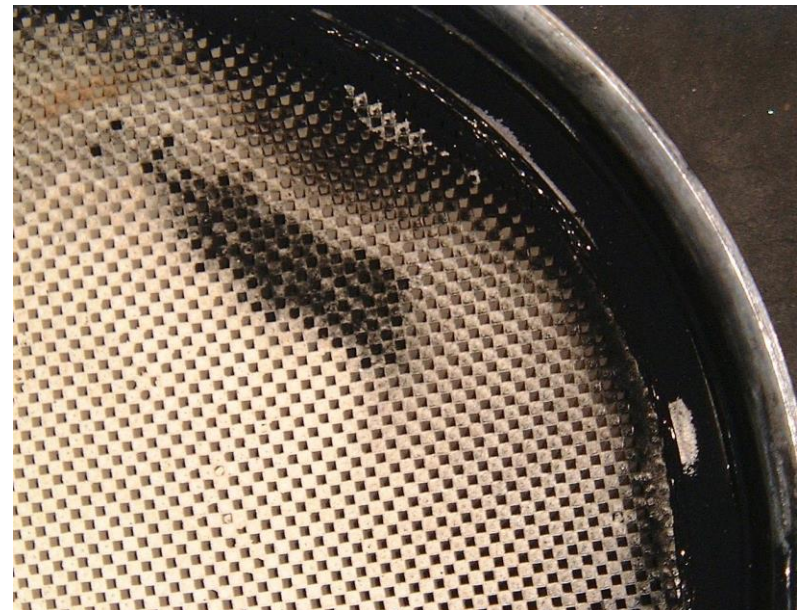
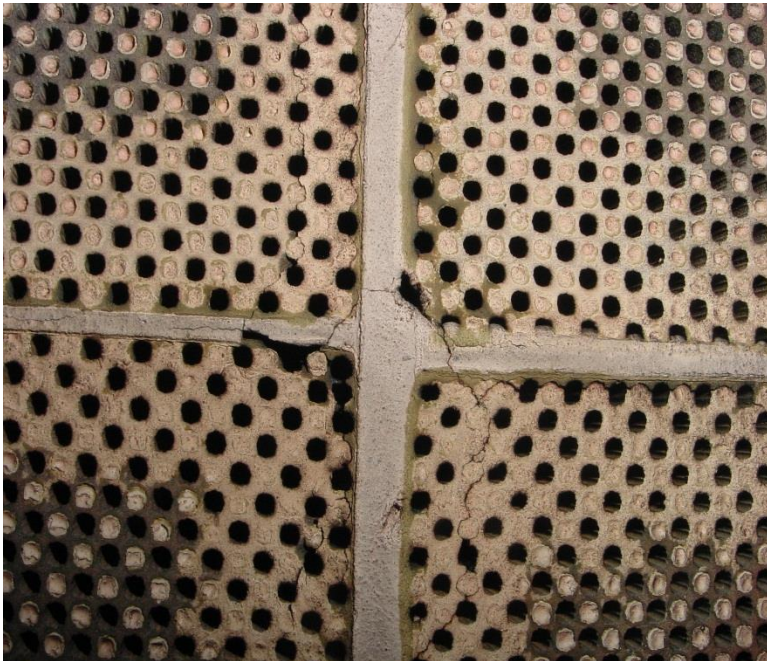


Origin of Failures: Local Temperature Peaks during Regenerations (source IBIDEN)



Small failures can be repaired

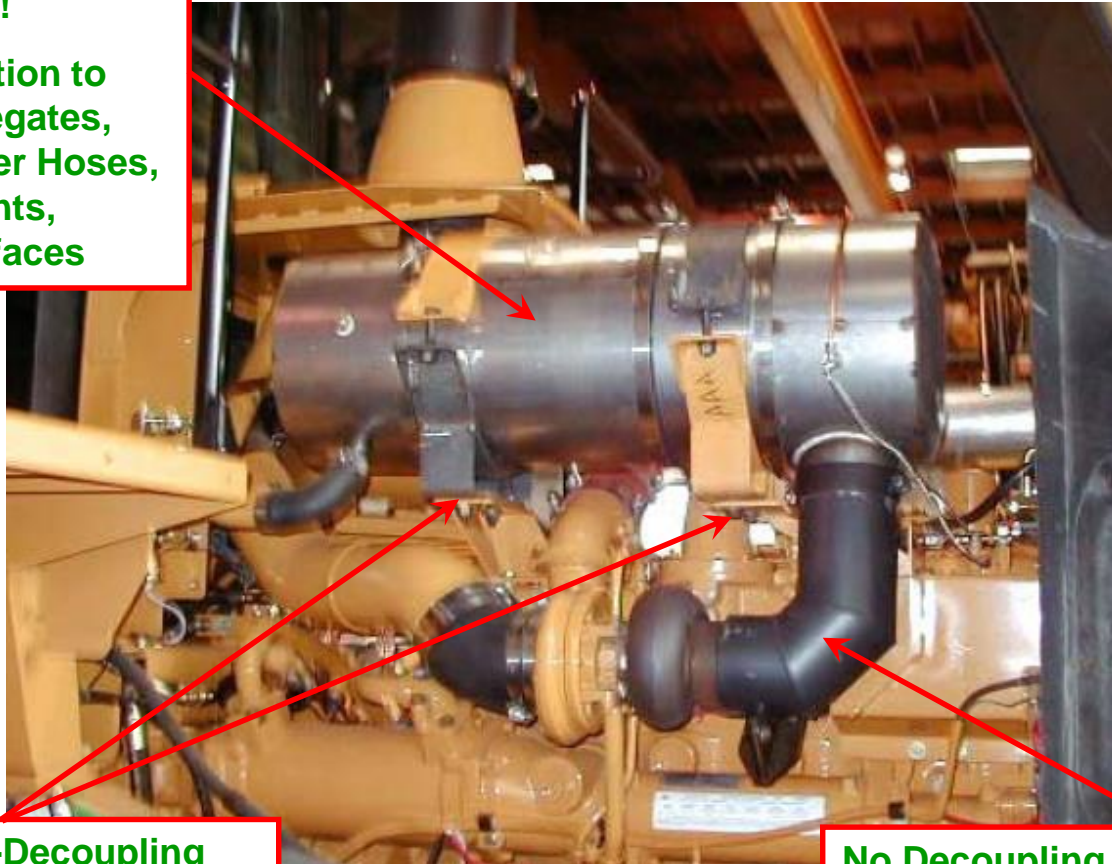
filtration efficiency is deteriorating even with small cracks



Mechanical Problems to be Expected ?

No Insulation !

→ Heat Radiation to
Engine, Aggregates,
Cables, Rubber Hoses,
Plastic elements,
Coloured Surfaces

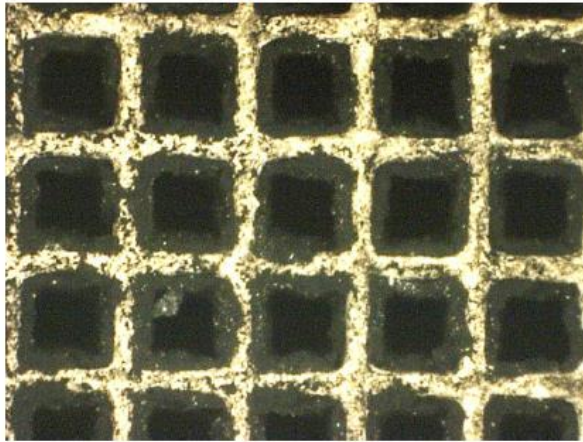


**No Vibration-Decoupling
angainst an Engine Aerea
where 30- 50 g is a normal
Vibration Level**

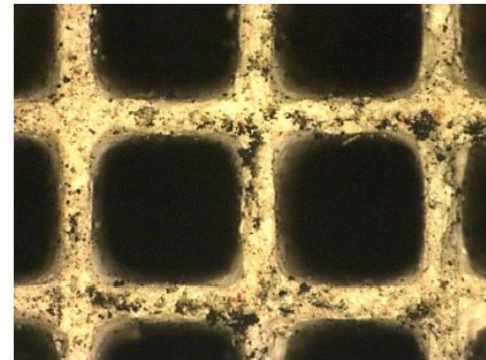
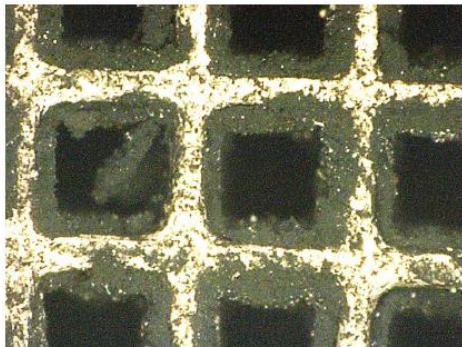
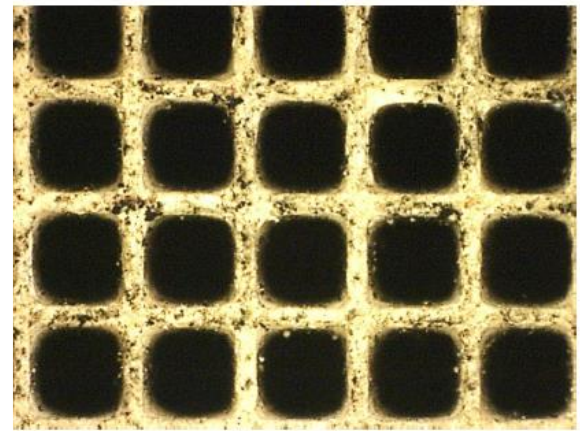
**No Decoupling against Vibration
and Thermal Expansion**

DOC might be covered by soot or poisoned which inhibits regeneration

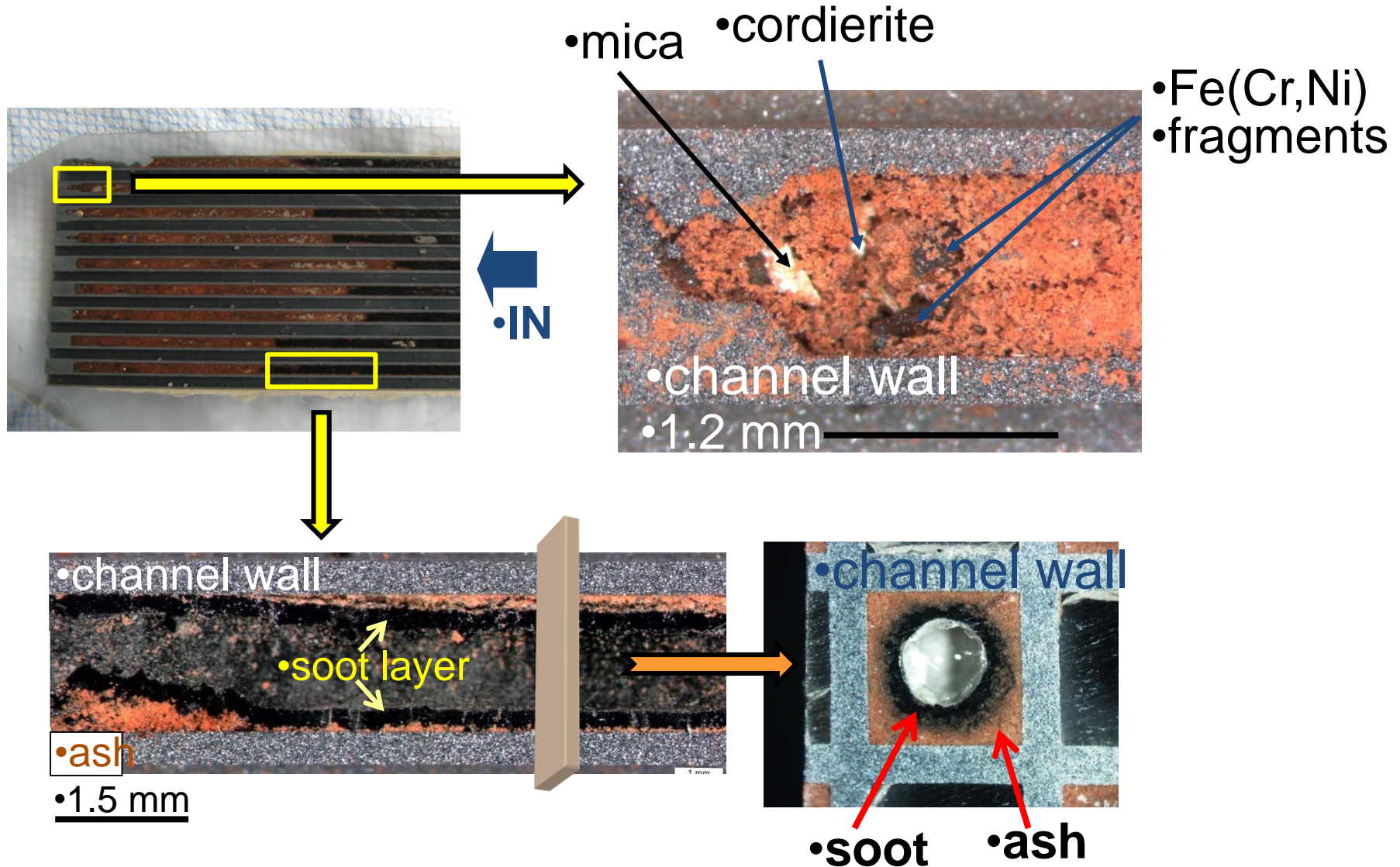
Inlet



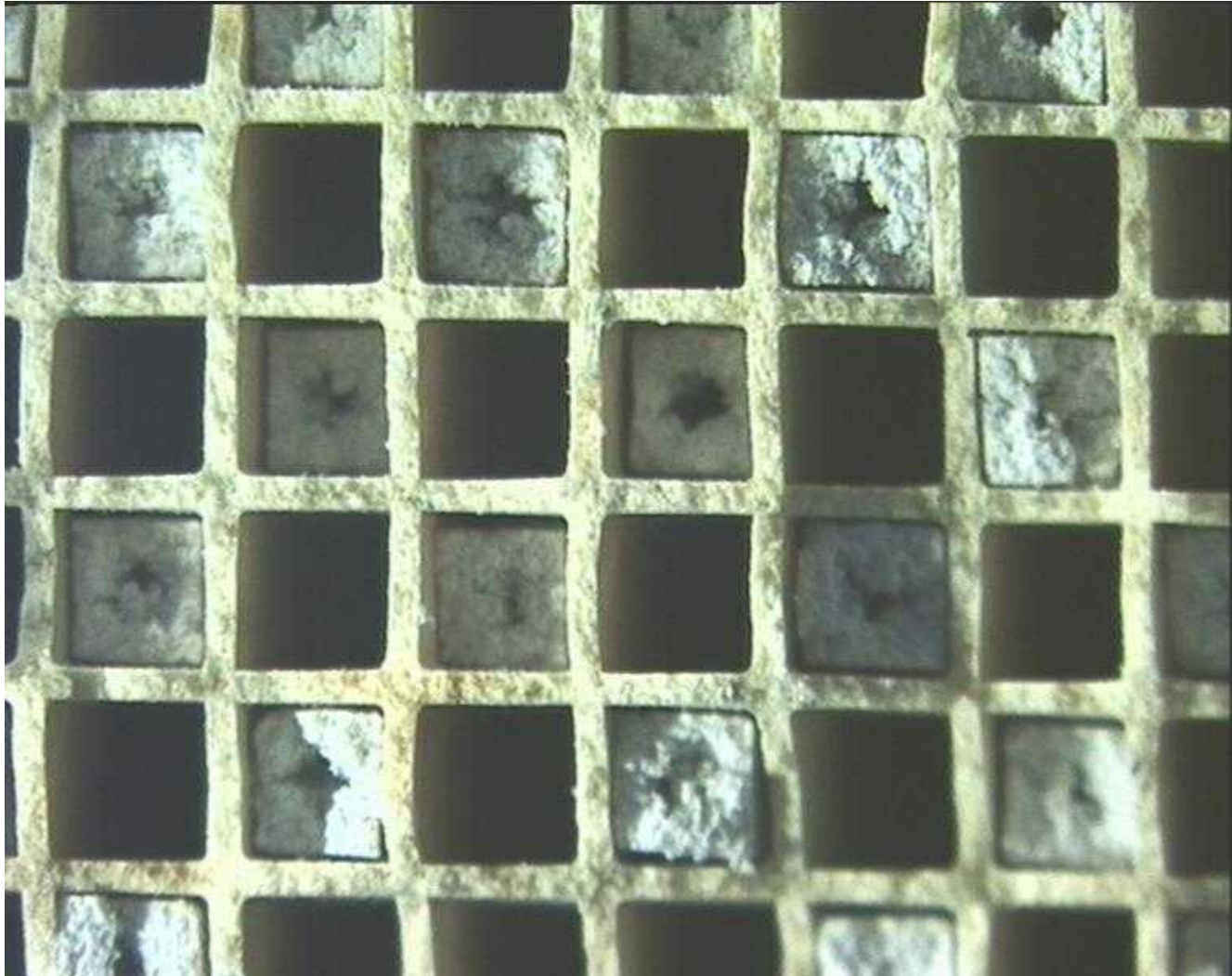
Outlet



Ash is perfectly filtered but Ash Deposits can plug Particle Filter Cells



Too late - No Cleaning possible anymore !



Engine Problems e.g. by Nozzle-Deposits

can lead to production of much more soot
and thereby become a risk for the DPF

light



strong



middle

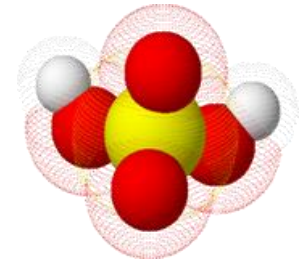


very strong



Sulfur in Iranian Diesel Fuels can produce acids and inhibit regeneration

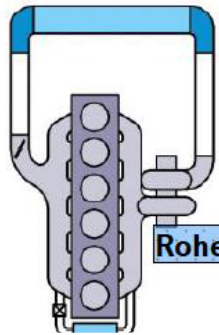
These Reactions are accelerated if Pt is used as catalyst



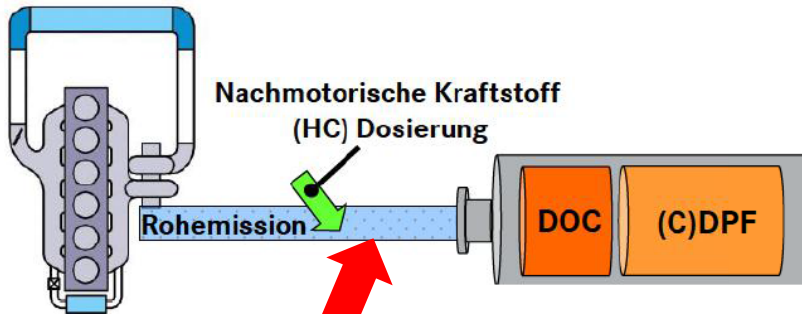
Fuel sulfur influence has been thoroughly investigated for Iran and in Iran by AQCC / Sharif and only Sulfur tolerant DPF should be used

Aftertreatment masks the Engine

→ tailpipe control alone might be misleading



Old engine: raw emission permits engine-diagnosis by noise, smoke, smell, colour
Free acceleration revealed all problems



DPF and DOC mask smell and smoke, change noise and colour → engine diagnosis impossible

→ *Engine-Out emission control is important for Engine protection and preventive maintenance*

Trouble Shooting List available



Indication of Malfunction	Diagnosis	Cause	Remedy
Back-pressure indication frozen	DLA	Sensor connection or pipes are blocked, iced or leaking	Clean pipes and connections; rectify leaks
		Pressure sensor defective	Sensor test with compressed air at 500 mbar
Back-pressure high, does not return to zero when inoperative	DLA	Connection or pipes are blocked, ev. condensation	Clean pipes and connections; rectify leaks Fit condensate trap
		Pressure sensor defective	Sensor test with compressed air at 500 mbar
- Ignition frequency		Exhaust pipe leakage	Repair flange leakage
- Whistling		Inlet and/or exhaust system leakage	Repair leakage or cracked inlet/exhaust pipe
- Rattling, more when idling		Loose parts (filter element)	Repair loose filter element
- Low frequency dropping noise		Engine/exhaust connection not dammed (vibration not decoupled)	Improve filter vibration isolation from engine; insert bellows

- See also by ASA

Lesson learned in Tehran DPF retrofit project

Dec 2016 , Inspection Workshop, Hossein Izanloo

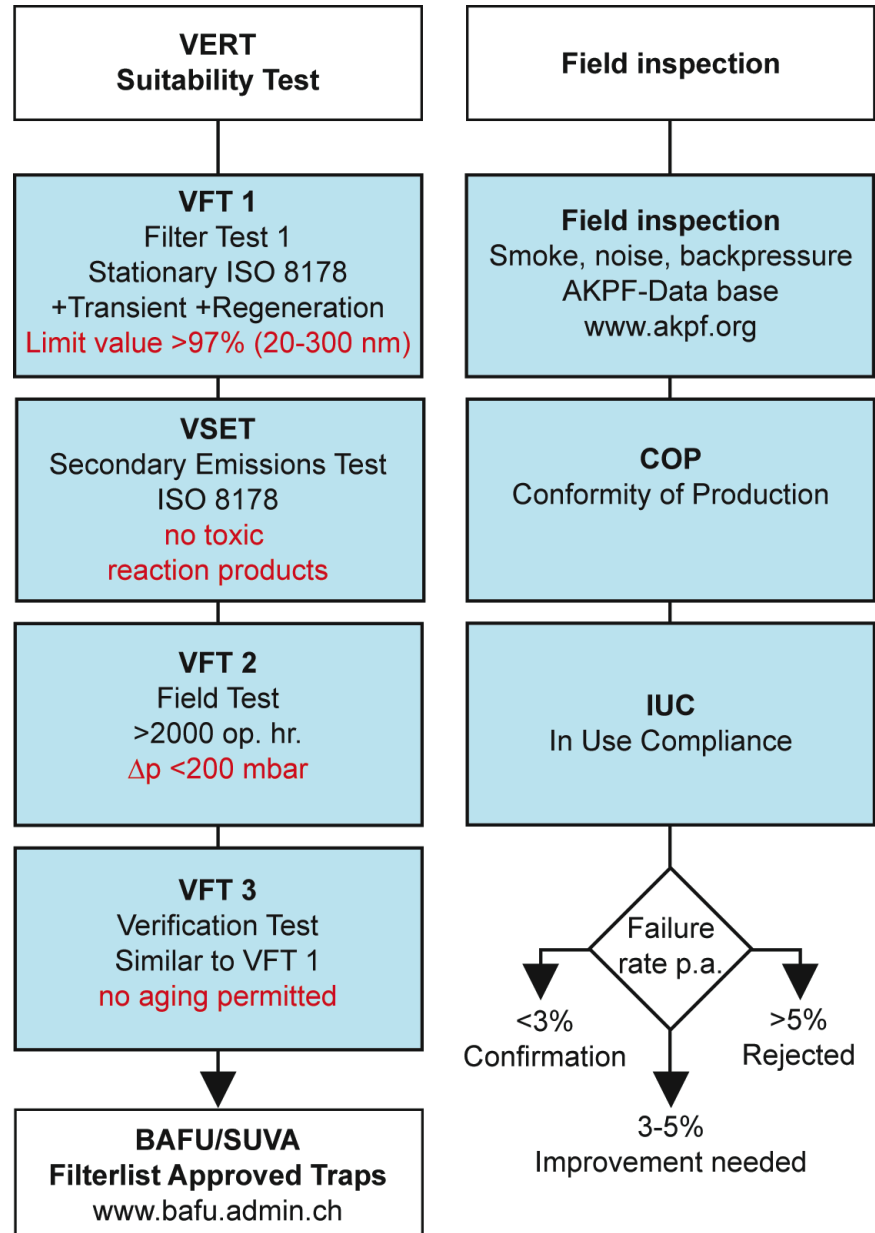
How to avoid failures ?

1.

Respect existing experience:

- DPF Specification VERT
- Testing Standard SN 277206
- Installation acc. to VERT rules

VERT Approval is a Must never accept non-certified DPF



How to avoid failures ?

2.

Respect safety in operation

- design elements for safety
- build-in on-board control OBD
(electronic remote control)
- respect visibility, surface temperature

Each DPF must have a certified Control

Electronic Datalogging



Sensors for Backpressure and Temperatures



Anzeige von Messwerten der ECU, z. B.

- Gegendruck
- Temperaturen
- Betriebsspannung
- Drehzahl
- Kraftstofftankinhalt
- Additivtankentnahmemenge

Auslesemöglichkeit aktive Fehlerliste

Warnung des Fahrers bei

- Zu hohem Gegendruck (VERT)
- Additivreserve ...

Alarm Indicator
at the Drivers
Seat

or remotely
controlled



How to avoid failures ?

3.

Perform Regular Maintenance
of all emission relevant elements and
functions of the engine
and the emission control system
must become a routine

Automatic Cleaning Machines available

- hermetically closed
- 2-stage process
- success control



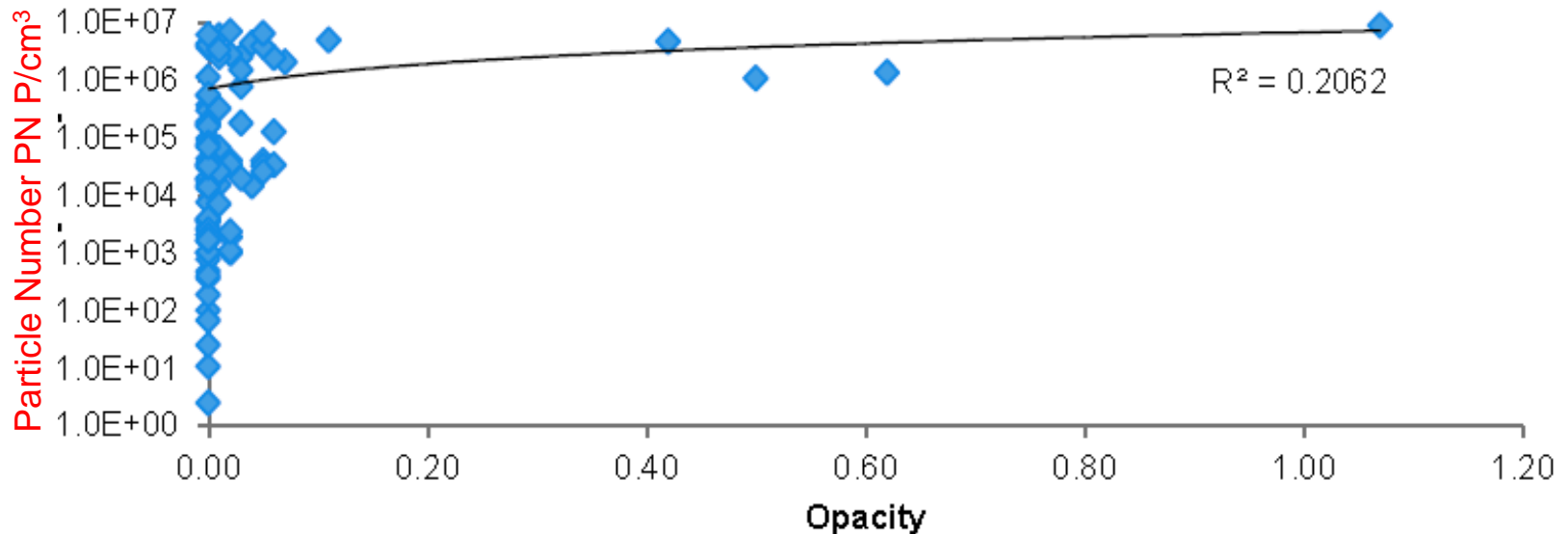


How to avoid failures ?

4.

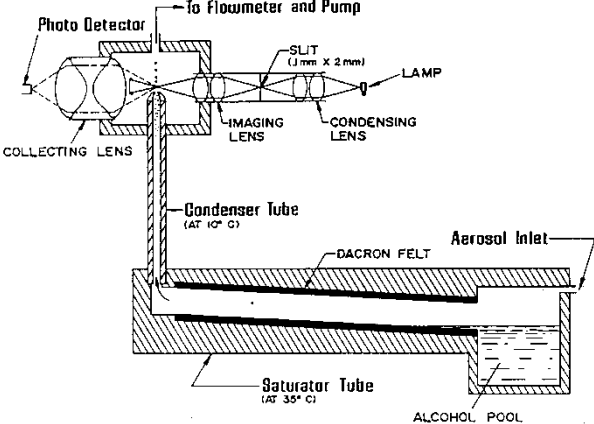
**Emission Measurement must
become part of maintenance**

Opacity-Measurement is outdated
“blind” for ultrafine particles < 400 nm
→ Particle counting is needed

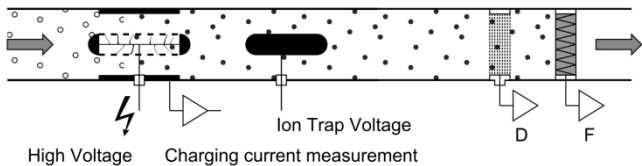


Handheld Instruments are available

Classic CPC condensation nucleus counter

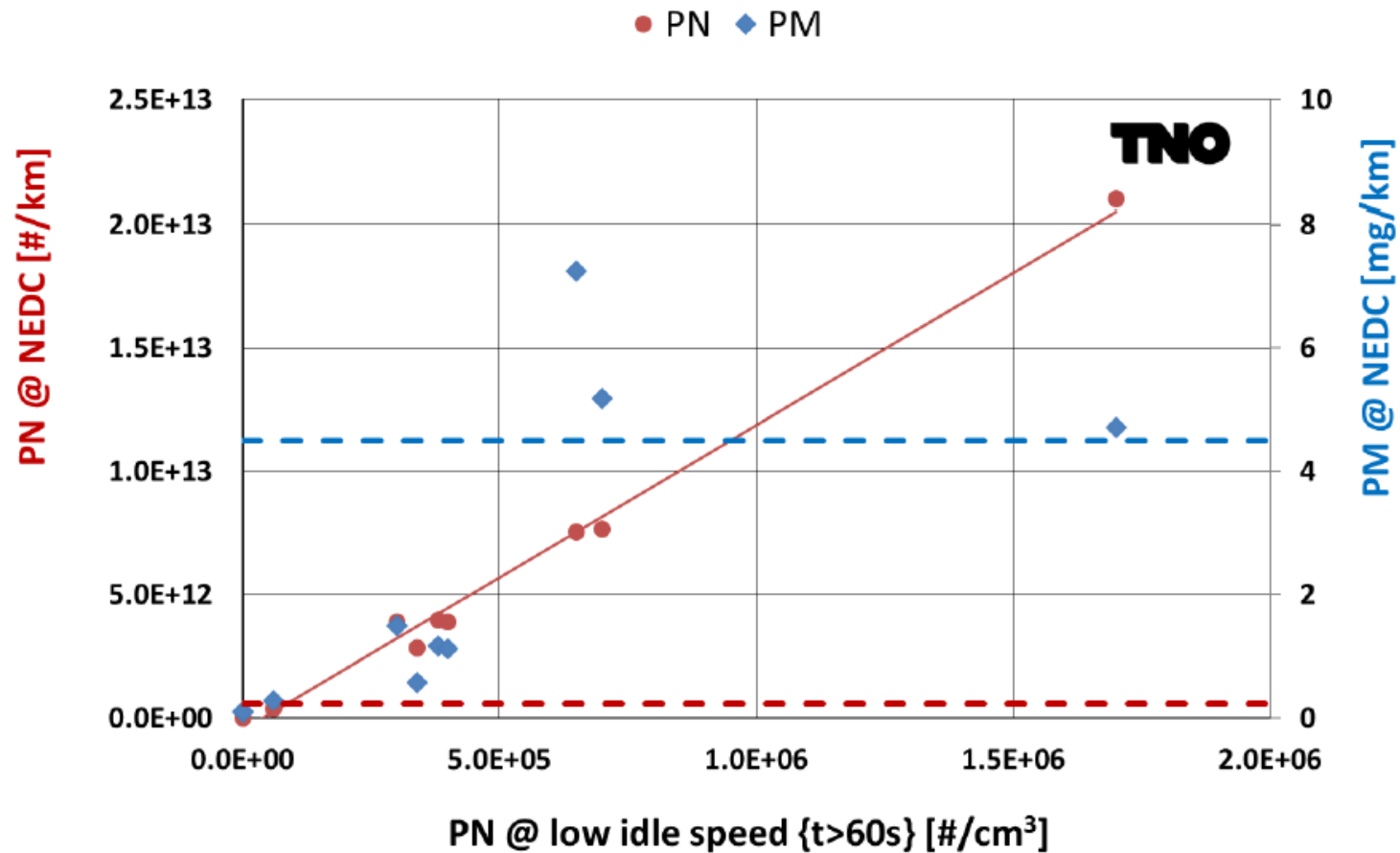


Diffusion Charging

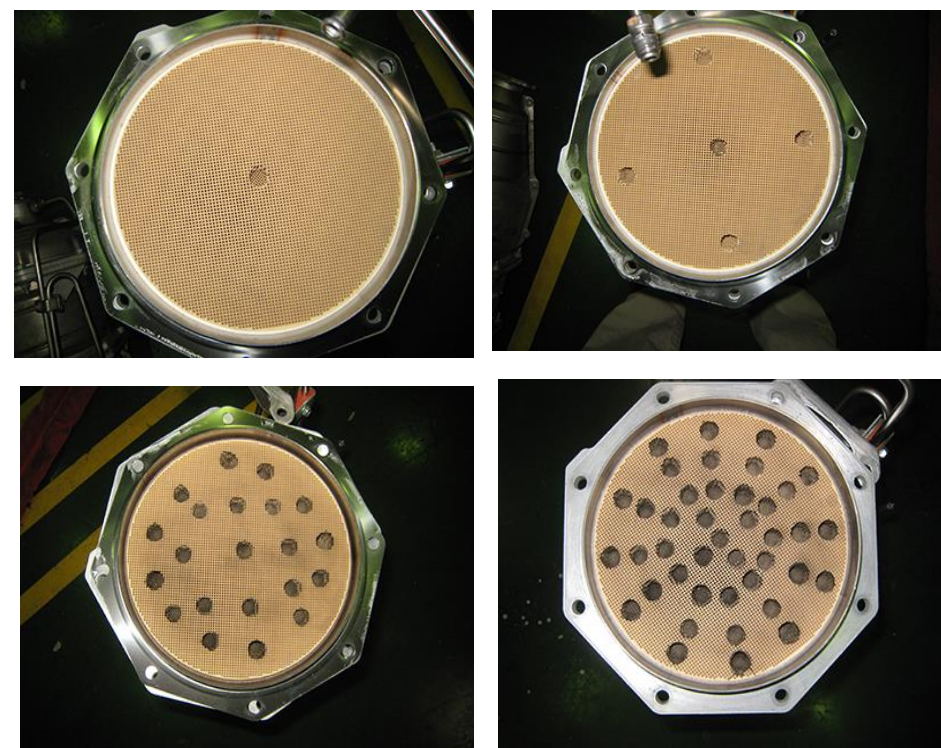


Measurement at low idle – simple, fast

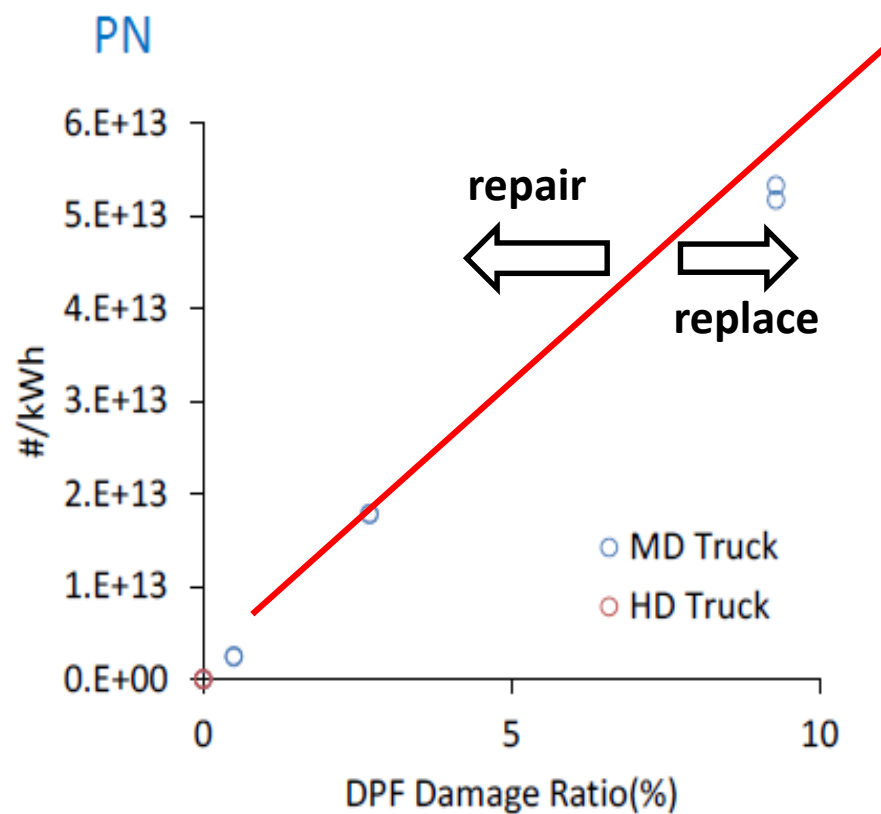
Correlates perfectly to test cycle



Even small failures can be detected by PN at low idle and repaired



Source: Yamada, ETH-NPC 2015





How to avoid failures ?

5.

and the authority:

**Perform Periodic Inspection
and random Control by Police**

Supervision Test – On-road / On-site (road police)

- Identification of the vehicle
- Measurement of PN
at **low idle**
- If the limit of e.g. $250'000 \text{ \#/cm}^3$
is exceeded:
 - ▶ operator of the vehicle is obliged to a regular engine and DPF system maintenance and retest by a PTI station



Maintenance and Inspection must be documented

Document at the vehicle

Example Switzerland

ABGAS-WARTUNGSDOKUMENT
FICHE D'ENTRETIEN DU SYSTÈME ANTIPOLLUTION
DOCUMENTO SULLA MANUTENZIONE RELATIVA AI GAS DI SCARICO
Diesel
Muss stets im Fahrzeug mitgeführt werden Doit toujours rester dans le véhicule Il presente documento deve sempre accompagnare il veicolo

Gesetzliche Vorschriften auf Seite 6 und 7 Voir prescriptions légales aux pages 6 et 7 Prescrizioni legali, vedere pagine 6 e 7

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 © Editée par l'Association des Fabricants et Négociants suisses de machines pour entrepreneurs
 VSBM-Sekretariat, c/o VSIQ, Postfach 656, CH-4010 Basel

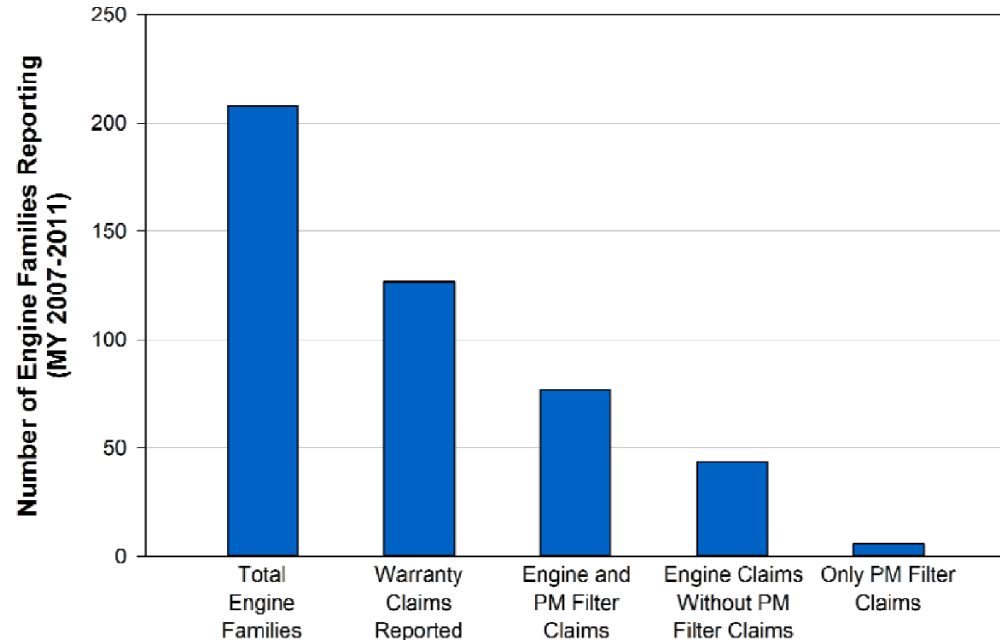
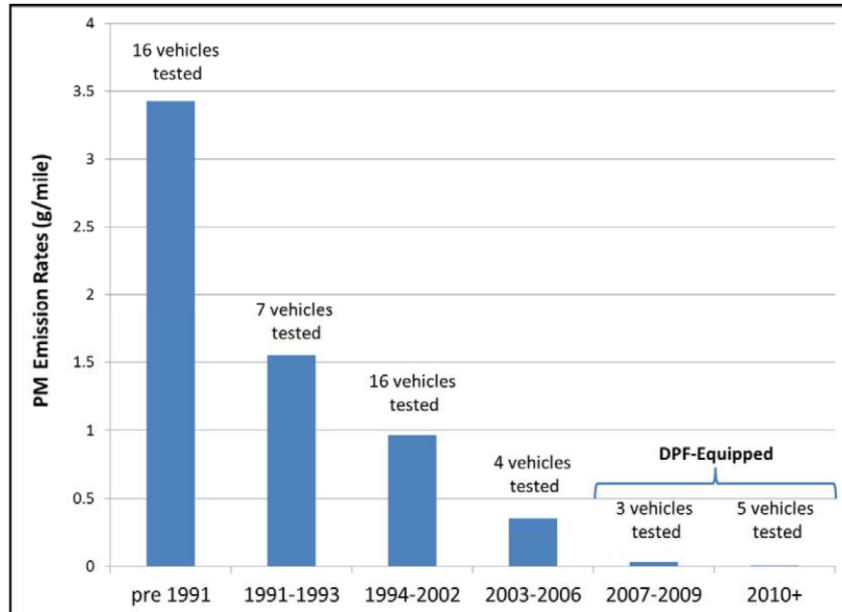
1
① Fahrzeugdaten / Données du véhicule / Dati del veicolo <ul style="list-style-type: none"> • Marke Marque Marca • Fahrzeugtyp Type du véhicule Tipo veicolo • Fahrgestell-Nr. No du châssis Telajo no • Motor-Kennzeichen Identification du moteur Identificazione motore
② Messbedingungen / Conditions de mesure / Condizioni di misurazione <ul style="list-style-type: none"> • Motor auf Betriebstemperatur bringen. - Alle elektrischen Verbraucher ausschalten. - Erfolgt die Messung in grösseren Höhen als 600 m ü. M., so sind bei Fahrzeugen ohne Druckkorrektur zur Berücksichtigung des Höheninflusses vom gemessenen Wert, je 0,25 m⁻¹ bzw. 0,5 Bacharach pro 400 m grössere Höhe abzuziehen. Es ist der korrigierte Wert einzutragen. - Weitere Angaben des Herstellers beachten. • Chauffer le moteur à sa température de marche. - Déclencher tous les consommateurs électriques. - Pour tenir compte de l'influence de l'altitude sur les véhicules sans correction de pression, lorsque des mesures sont effectuées à des altitudes excédant 600 m, on déduira respectivement 0,25 m⁻¹ ou 0,5 indice de barométrisme Bacharach par tranche de 400 m au-dessus. Il y a lieu d'inscrire la valeur corrigée sur la fiche d'entretien. - Consulter attentivement les indications du constructeur. • Portare il motore a temperatura di marcia. - Staccare tutti i consumatori di elettricità. - Per poter tener conto dell'influenza barometrica esercitata sui veicoli senza correttore di pressione, nel caso di misurazioni effettuate ad altitudini superiori a m. 600, si dedurrà rispettivamente 0,25 m⁻¹ o 0,5 indice di barizzazione Bacharach per fasce supplementari di 400 m. Solo il valore corretto viene registrato sul foglio di manutenzione. - Attenersi alle indicazioni del costruttore.

2		
Sollwerte des Herstellers	Valeurs du constructeur	Dati del costruttore
③ Kontrollwerte / Indications de réglage / Indicazioni di regolazione		
<ul style="list-style-type: none"> • Leerlaufdrehzahl Régime de ralenti Regime del minimo 		min ⁻¹
<ul style="list-style-type: none"> • Obere Leerlaufdrehzahl Régime maximal à vide Regime massimo, a vuoto 		min ⁻¹
<ul style="list-style-type: none"> • Förderbeginn Commencement du débit Inizio mandata 	<ul style="list-style-type: none"> - statisch statique - dynamisch dynamique 	mm ² mm ⁻¹
<ul style="list-style-type: none"> • Plomben und/oder Versiegelungen Plombs et/ou sceaux Piombe e/o sigilli 		
④ Rauchemissionswerte / Valeurs des émissions de fumées / Valori delle emissioni di fumo		
<ul style="list-style-type: none"> • Trübungskoeffizient Coefficient d'opacité coefficiente d'opacità 	<ul style="list-style-type: none"> maximal maximum massimo 	m ⁻¹
<ul style="list-style-type: none"> • Schwärzungszahl Degré de noircissement grado di annerimento 	<ul style="list-style-type: none"> maximal maximum massimo 	Bacharach
⑤ Bestätigung / Attestation / Attestazione		
		Datum Sgr.
<ul style="list-style-type: none"> • Der Interzeckhende bestätigt, dass die Abgaswartung nach Herstellerschrift und unter Verwendung der vorgeschriebenen Messgeräte ausgeführt wurde. • Le assagné atteste que le service d'entretien du système antipollution a été exécuté conformément aux indications du constructeur et en utilisant les appareils de mesure prescrits. • Il firmatario attesta che il servizio di manutenzione del sistema anti inquinamento è stato eseguito conformemente alle indicazioni del costruttore e utilizzando gli apparecchi di misura prescritti. 		Stempel / Timbre / Timbro

CARB investigated 587 trucks (OE and Retrofit) for engine and DPF problems (report May 2015)

As discussed in Section 3, staff conducted 621 roadside truck inspections, 587 of which were trucks equipped with PM filters. The resulting sample of paired truck inspections and operator surveys was representative of the California fleet. Appendix V provides a table showing the number of trucks inspected by body type relative to statistical sample targets.

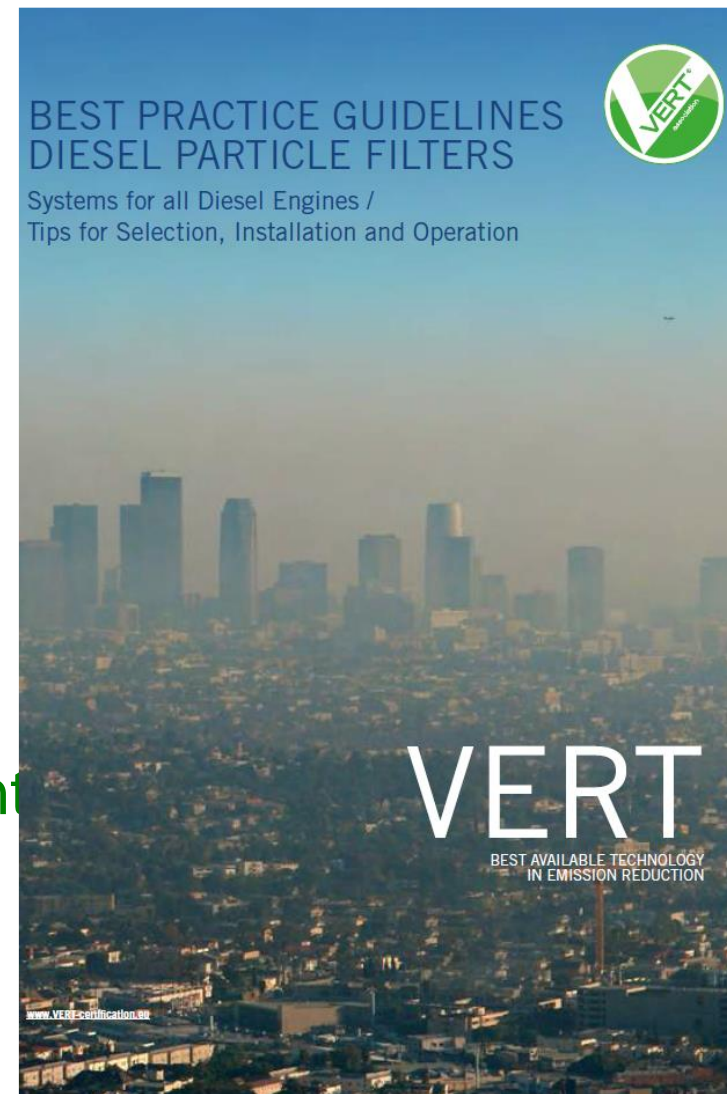
Based on responses from truck operators, about 2 percent (11 of 587 trucks) reported a past problem with the PM filter on their truck that required service to resolve the



Summary:

How to avoid Failures

- Use only VERT-certified filters
- Evaluate vehicle operation
- Design installation carefully
- Install datalogger and alarms
- prefer remote download
- Set alarms to max 200 mbar
- Training (mechanics & management)
- Acceptance test of each retrofit
- Control emission once a Year
- **Maintenance (engine + DPF)**
- **Inspection at PTI and road controls**
- ***be proud cleaning the air of your environment***



The Bus Fleet of Berlin (1200 vehicles) respecting these rules has 1-2 failures per year – 0.1 %