

BRAKE EMISSION MEASURING @ BMW



EF-701 | 06.05.2021

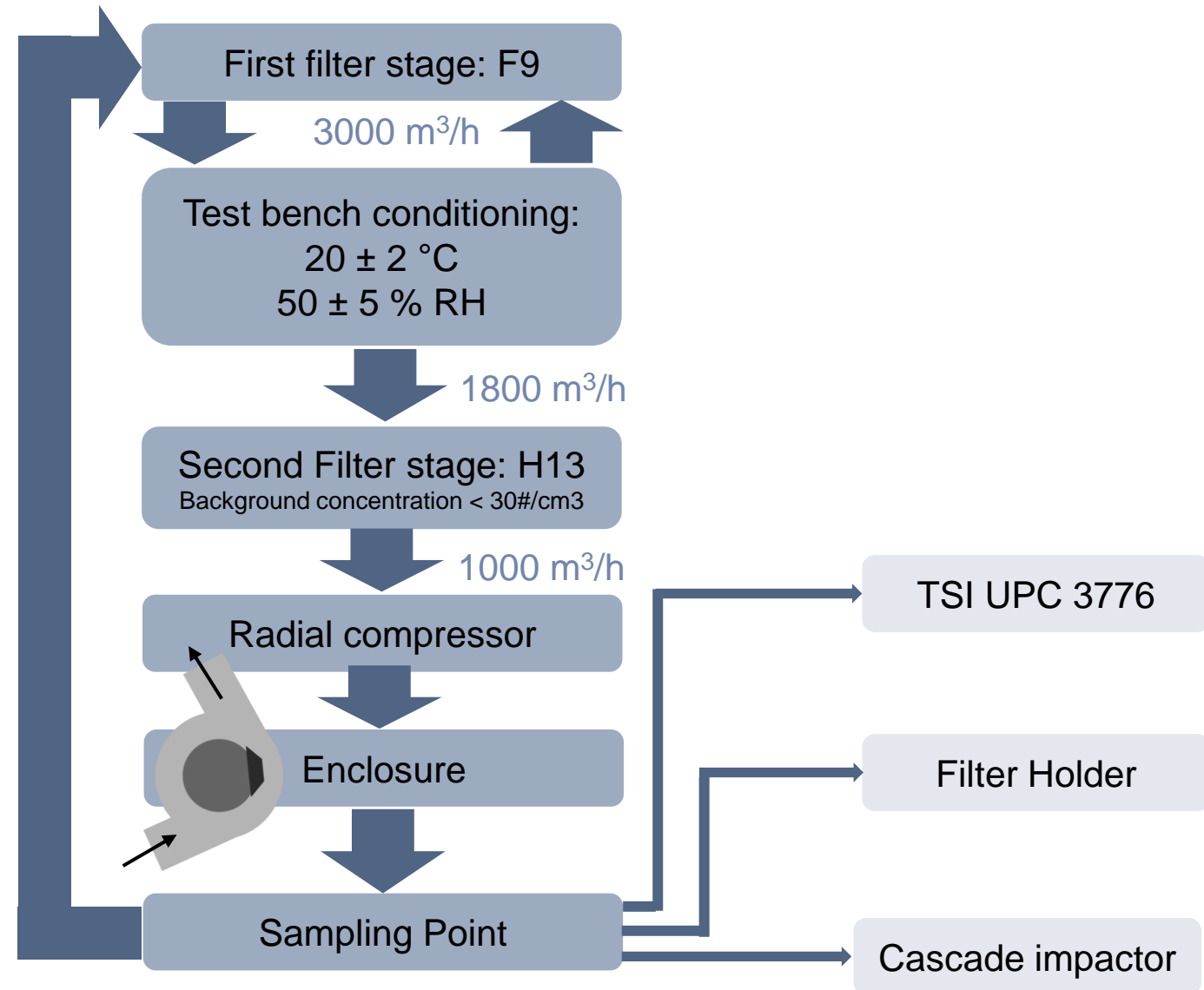
**BMW
GROUP**



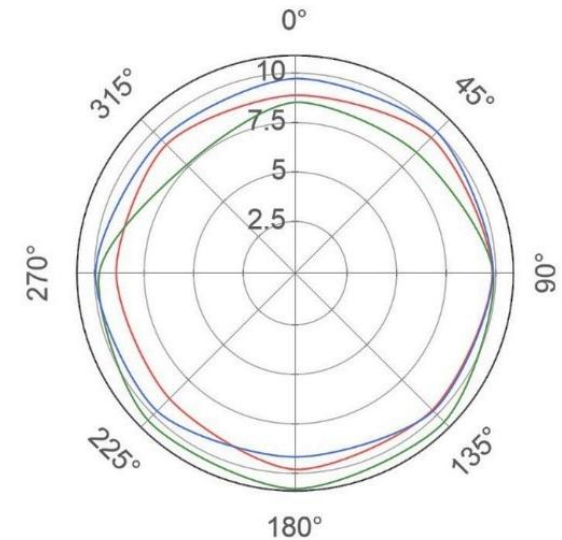
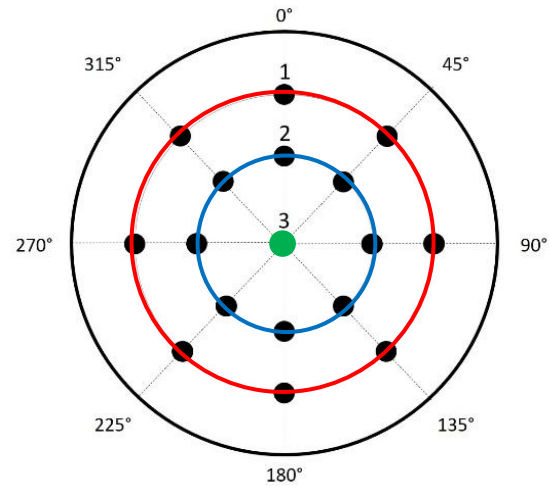
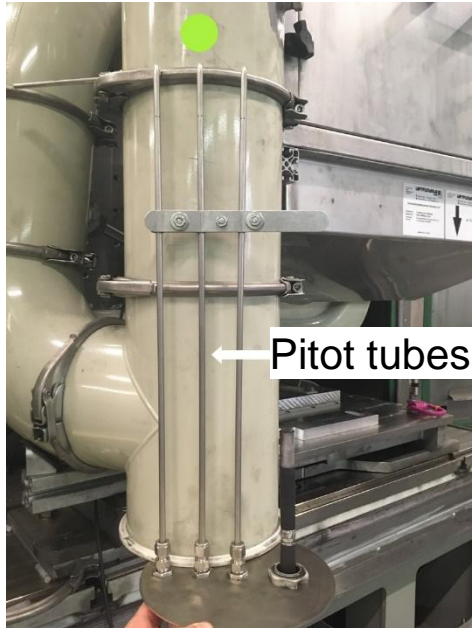
TEST STAND



Electro polished enclosure, in the future also the ducts



FLOW ANALYSIS AT THE SAMPLING POINT



- Measurement of flow velocity at 17 points in the plane of the sampling point
- 3 pitot tubes for measurement on 3 different radii
- Measurement 30s at each point → mean value

→ **Variation of the flow rate is acceptable**

PN MEASUREMENT SET UP

Modell	TSI UPC 3776
Cyclone	TSI CPC Inlet Cyclone
Upper measurement limit	1,5 μm
Lower measurement limit	2,5 nm
Total Inlet Flow	1,5 lpm
Conditions	Isokinetic*

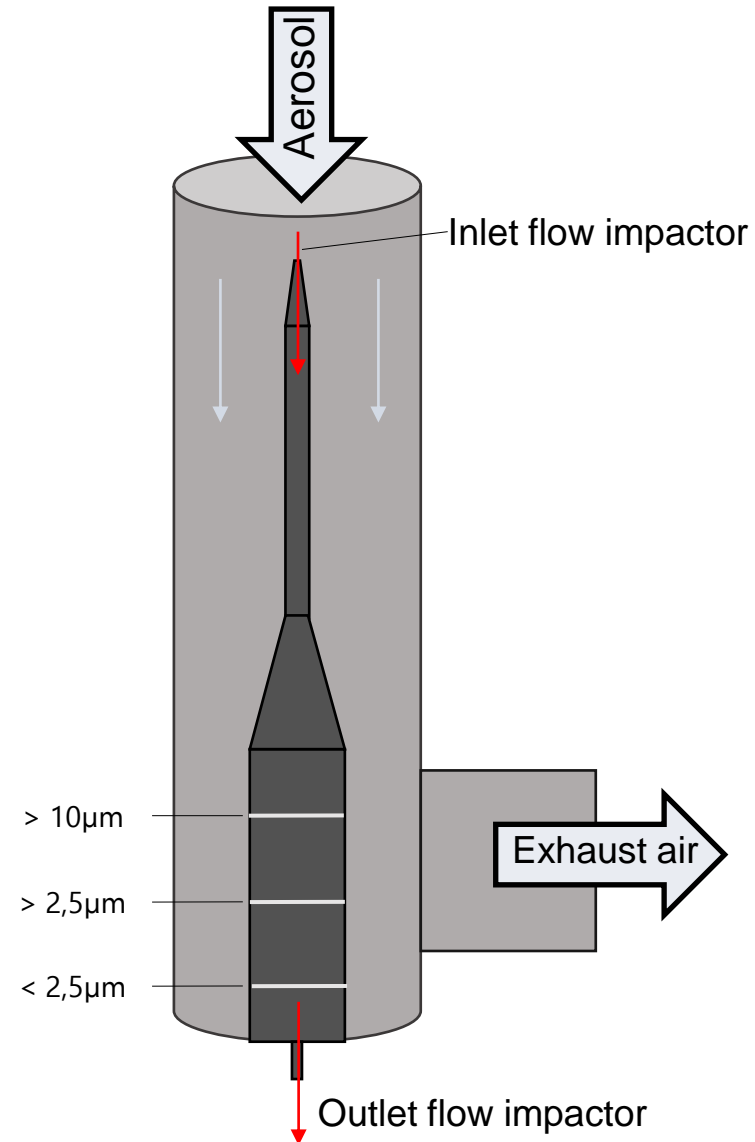
* different nozzles



PM MEASUREMENT SYSTEM 1: CASCADE IMPACTOR

Modell	Paul Gothe Johnas II
Position	Inside the duct
Total Inlet Flow	42 lpm
Conditions	Isokinetic*
D50 Cut Off Size 1	2,5 μm
D50 Cut Off Size 1	10 μm
Filter material	Teflon: Pallflex TX40 HI20WW

* different nozzles



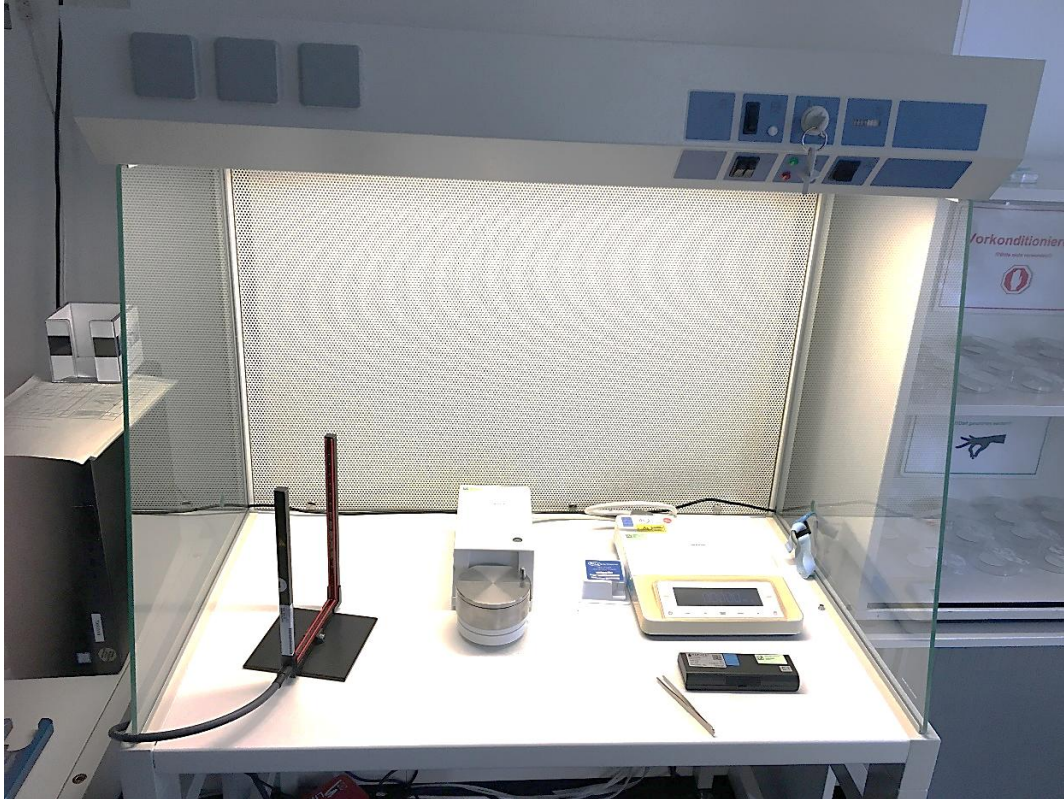
PM MEASUREMENT SYSTEM 2: CYCLONE + FILTER HOLDER

Modell	URG-2000
Filter holder	BGI
Total Inlet Flow	3,07 lpm
Conditions	Isokinetic*
D50 Cut Off Size	10 µm
Filter material	Teflon: Pallflex TX40 HI20WW

* different nozzles



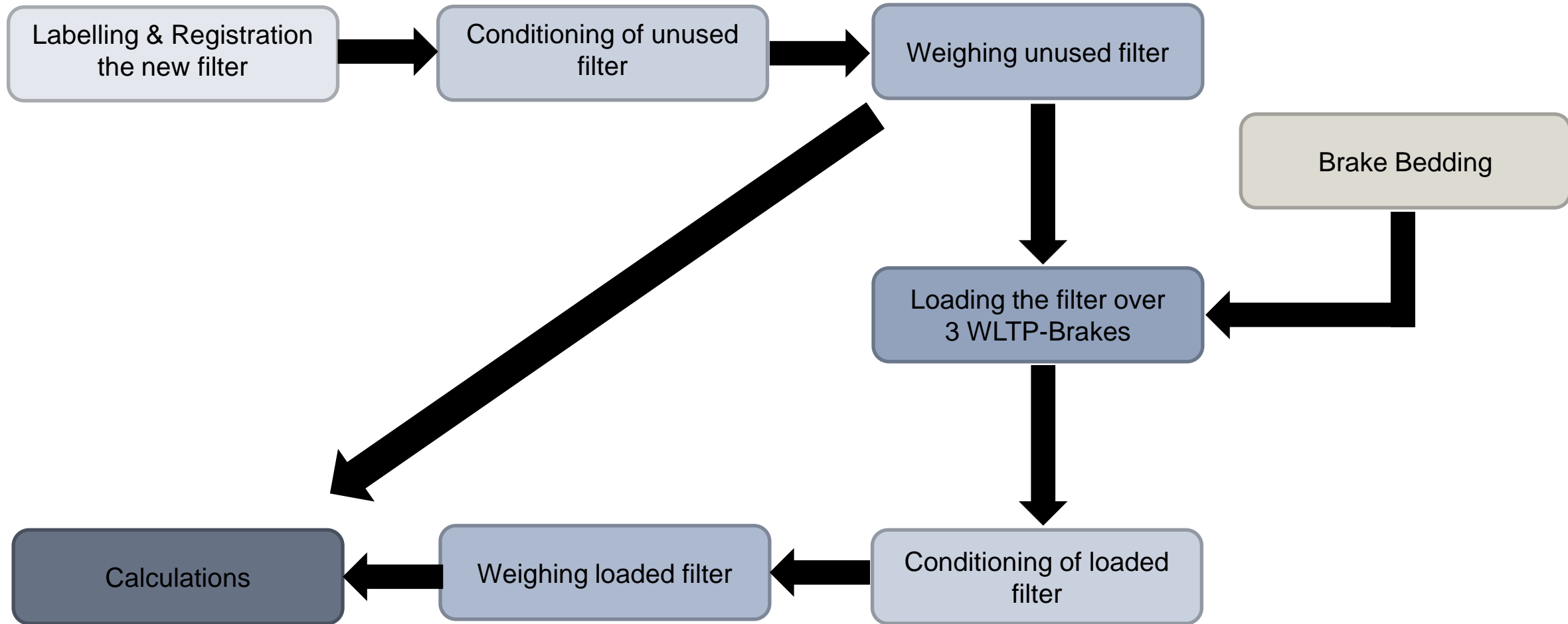
WEIGHTING ROOM



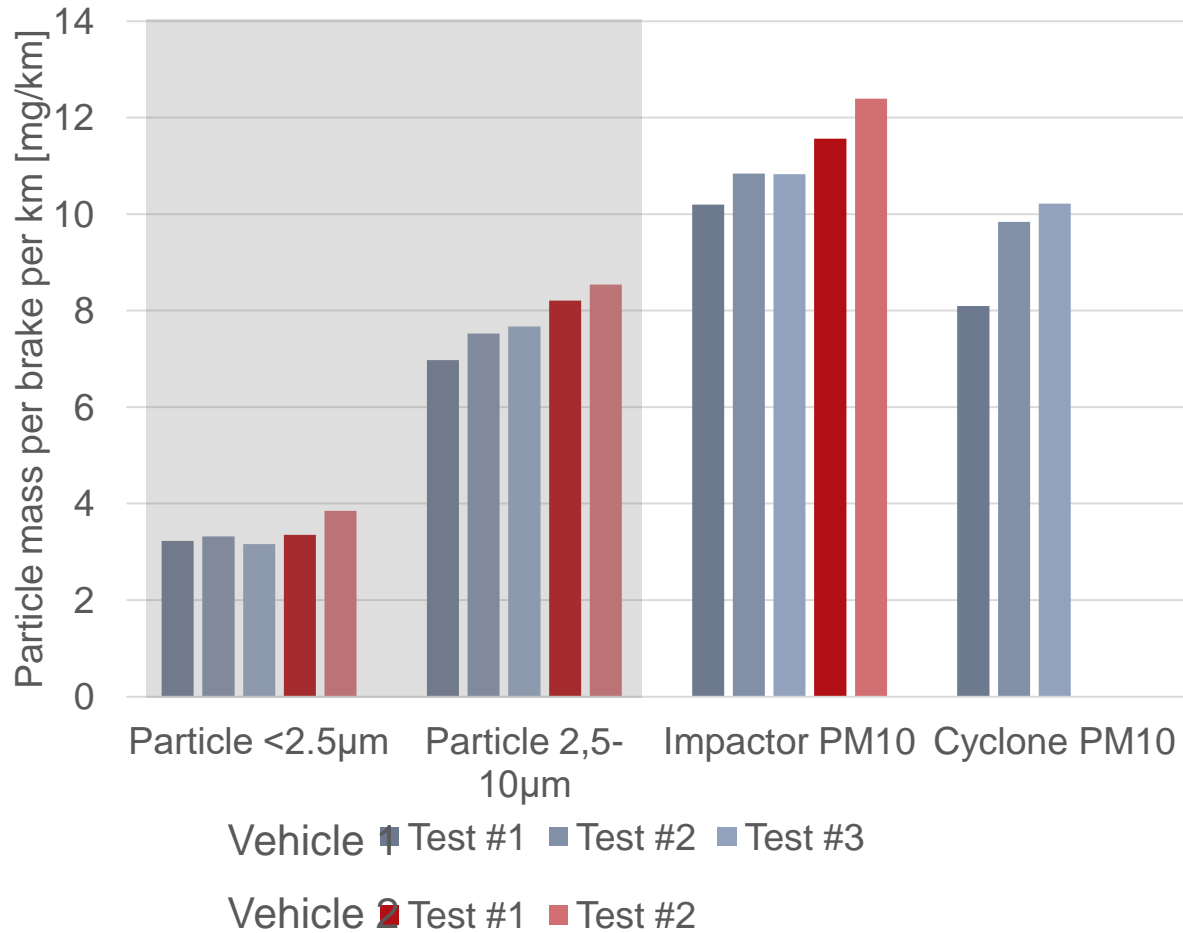
- **Climatic condition:**
 - Temperature $22\pm 1^{\circ}\text{C}$
 - Dew point temperature: $9,5 \pm 1^{\circ}\text{C}$
 - Air flow: $< 0,05 \text{ m/s}$
- **Scale:**
 - Sartorius XAC01 MSE
 - Maximum load: 2100 mg
 - Resolution: 0,0001mg
- **Conditioning:**
 - 24 h

→ Fulfils the specifications of **UNECE Regulations No. 83 2012** (European automotive exhaust regulation)

PM DETERMINATION - WORKFLOW



PM RESULTS PER FRONT BRAKE



- Vehicle 1:
 - standard deviation cascade impactor: 0,37mg
 - standard deviation filter holder: 1,13mg
 - Δ max cascade/filter holder: 2,1mg (test 1)

- Loading of the filters:
 - Cascade filter $\leq 10\mu\text{m}$: ~ 10,23 mg
 - Cascade filter $\leq 2,5\mu\text{m}$: ~ 4,48 mg
 - Filter Holder: ~ 0,99 mg

- Vehicle 2:
 - standard deviation cascade impactor: 0,59mg

OPEN QUESTIONS/PROBLEMS....

- Loading during soak times
- Particle losses (ducts, bends, etc.) vs. limited space inside the test stand
- High influence of the filter handling on the measuring result (low loading)
- Availability of the correct nozzles & cyclones