VIAQ-22-10

STELLANTIS

METHODOLOGY FOR PM MEASUREMENTS IN REAL DRIVING CONDITIONS

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OBJECTIVES

Measure the level of exposition of car passengers to particulate matters in driving conditions

→ **Develop a protocol with a method of reference (DEKATI –INERIS Protocol) / see VIAQ 19-07**)

- Inside and outside the cabin
- In dynamic, meaning in real driving conditions (realized for the 1srt time)
- With the gravimetric method (official method for the environmental French Institute)

→ **Comparison /validation of different measurement devices**:

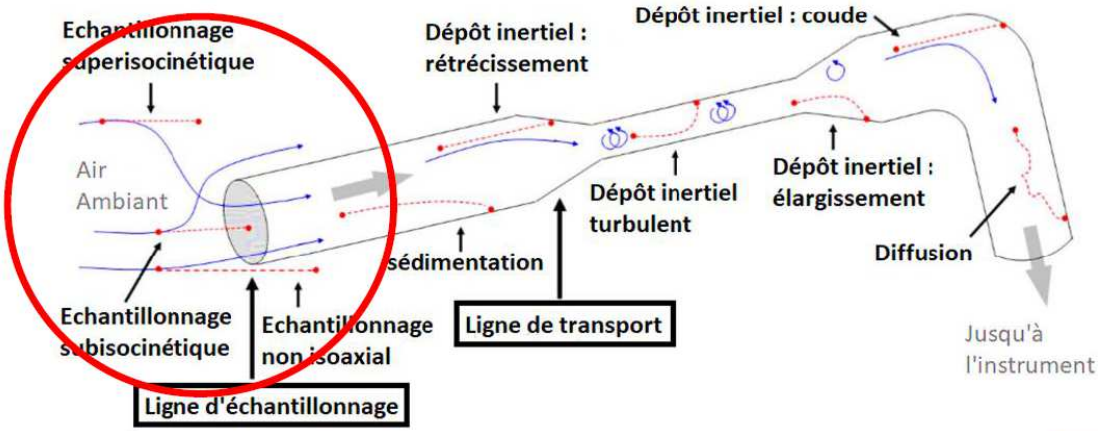
- Gravimetric measurement is complex and require a specific expertise provided by INERIS
- a simple optical indicator (DUSTTRAK device) easy to put in place but need to be validated

ADEME *(French Agency of Ecology transition)*
INERIS *(Institut National de l'EnviRonnement Industriel et des risqueS)*

- **CHALENGES TO SOLVE : ISOKINETIC MEASUREMENTS**

Speed at the sampling point:
In ambient air; in-tube
Need for a STABLE speed in ambient air!

- **Measurement with DEKATI Device**
- **In real Driving Conditions**
- **Sampling outside and inside the vehicle**



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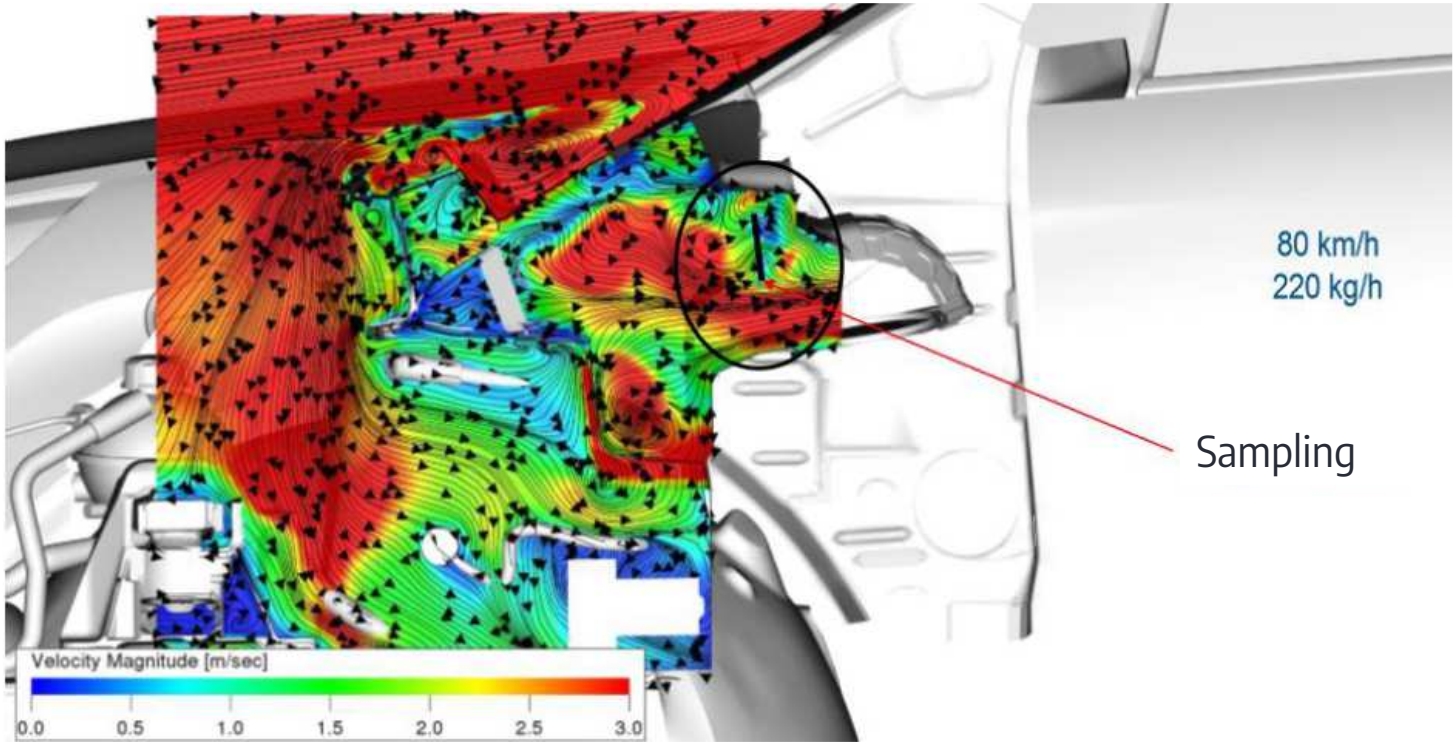
AIR FLOW MODELLING

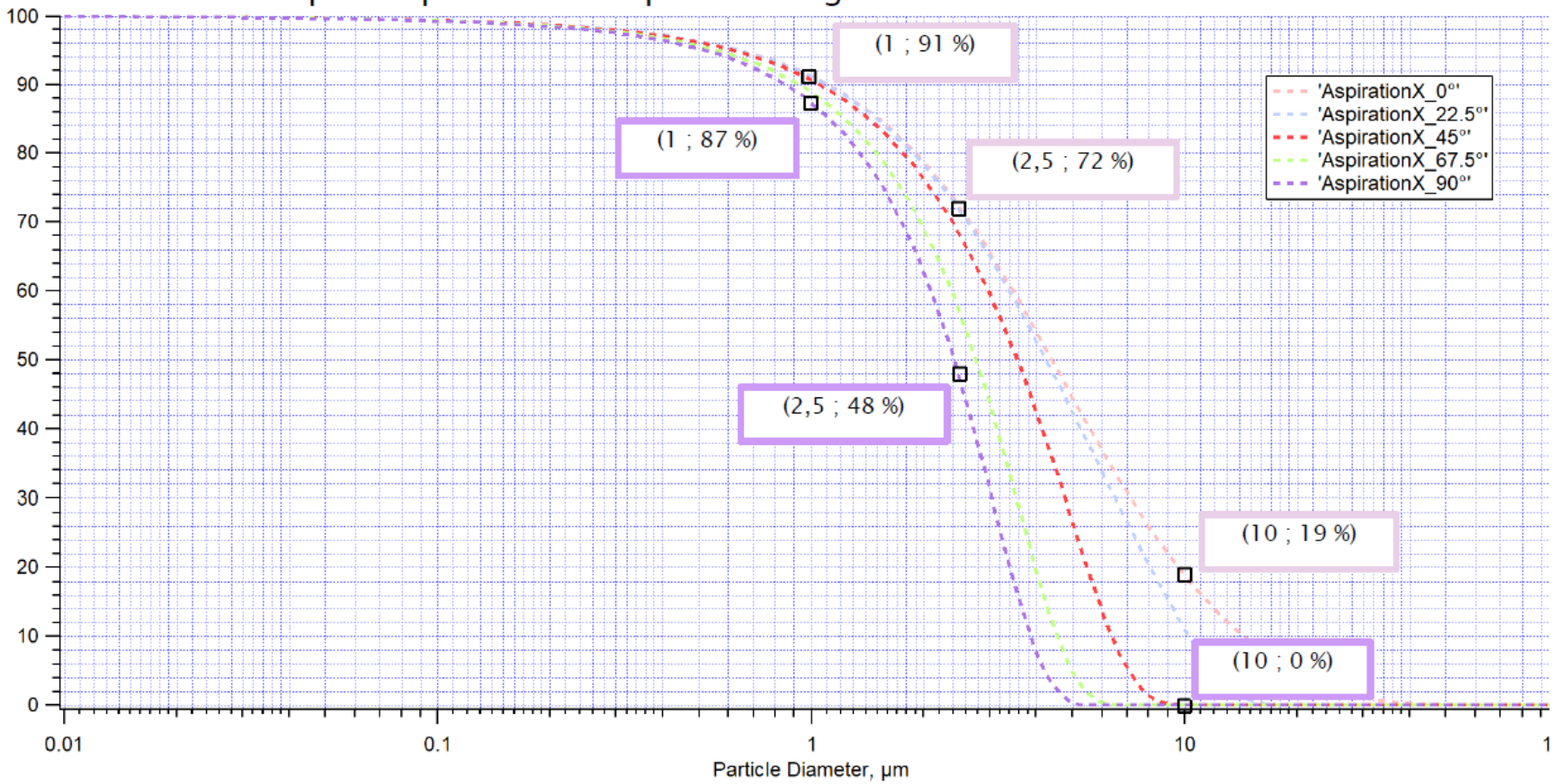


Results: for pale 2, at 80 km/h,

- Same order of magnitude than measured speed
- Confirmation that the upstream wind speed is defined by car ventilation
- Selection of a sampling point out of the recirculation zone
- Sampling direction // to the air flow

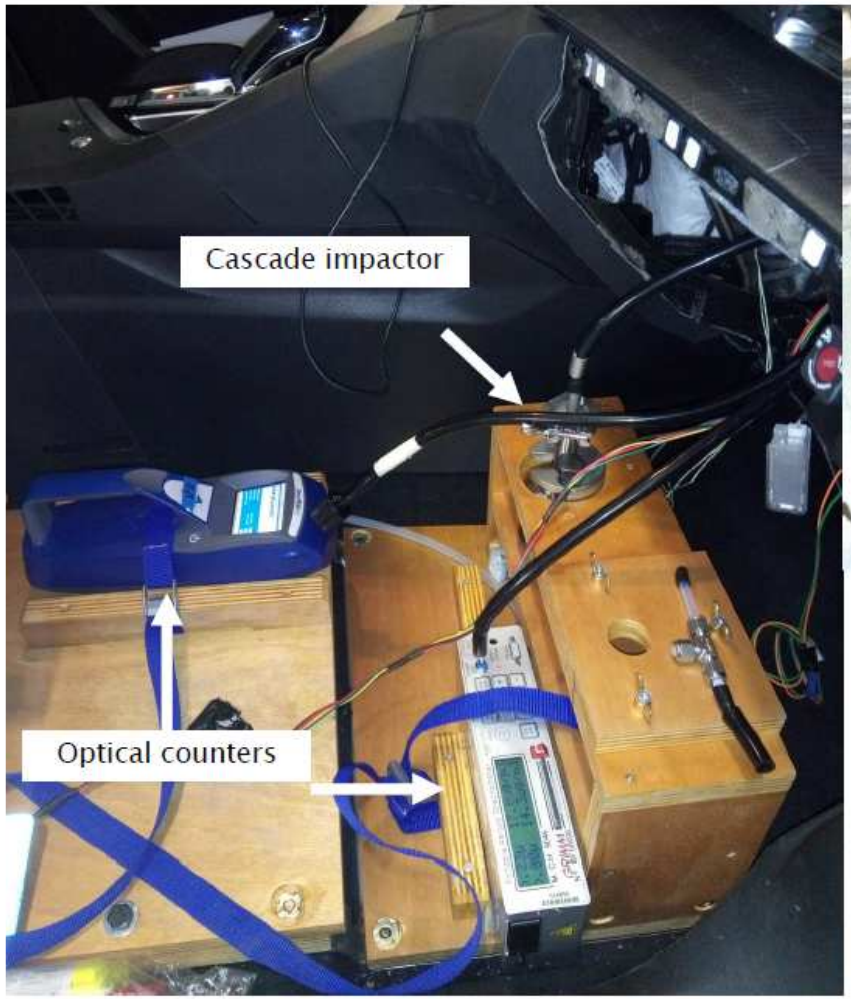
INERIS
maîtriser le risque pour un développement durable

- Example: impact of the aspiration angle



12 Aspiration shall be parallel to the air flow

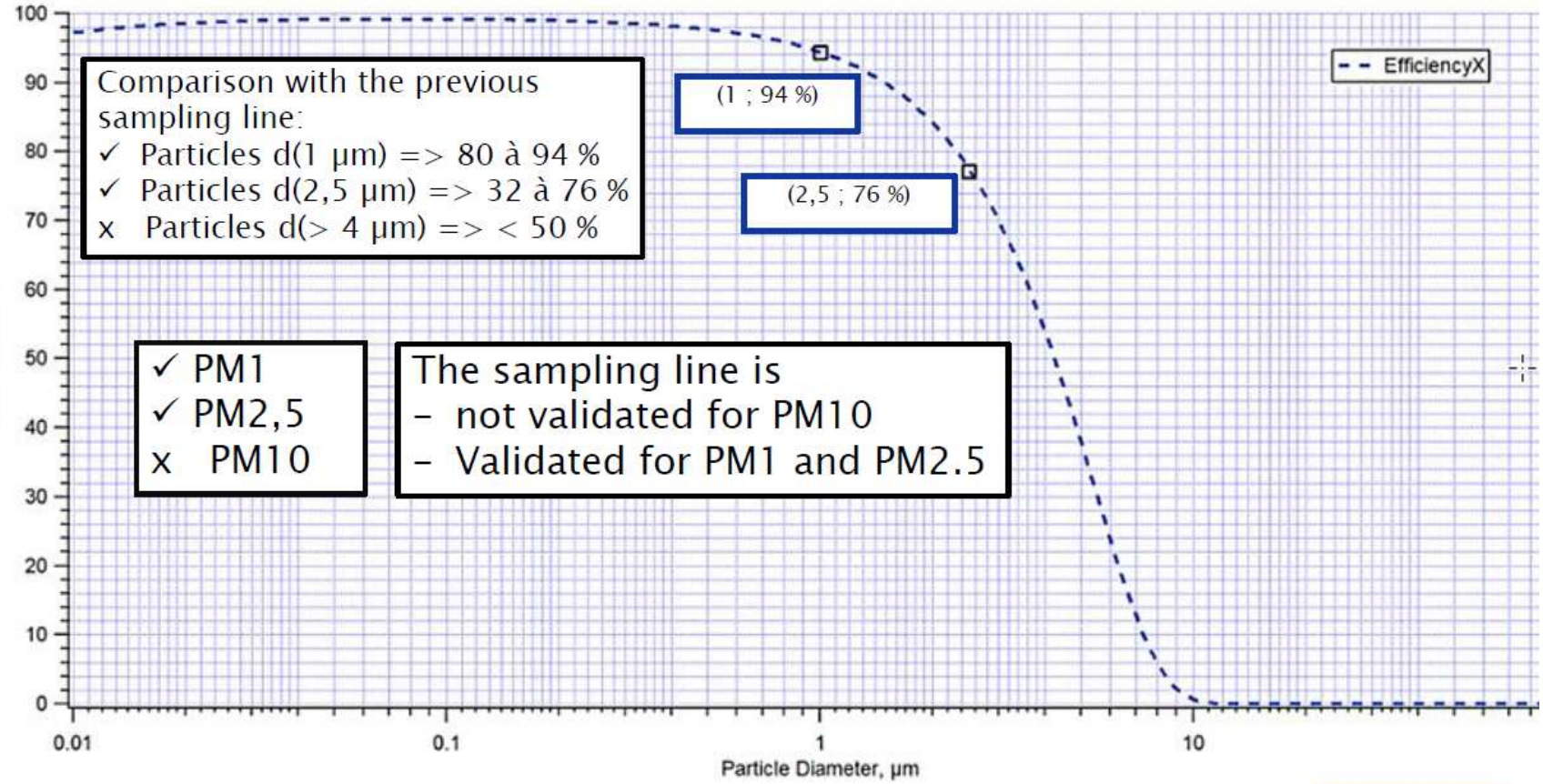
REMENDER: VIAQ19-07



Improvements:

- Shorter tubing (–50%)
- 3 changes of direction => 1 slight
- Larger diameter

Efficiency versus diameter for the optimized sampling line



MAIN RESULTS

Influence of the sampling zone
→ Shall be outsider a recirculation zone
→ Sampling shall be at Same order of magnitude that measured speed –for pale 3, at 80km /h (about 2m/s)

Influence of the Sampling Direction
→ shall be // to the air flow entering in the vehicles

Influence of the Sampling Tube
→ Length and diameter

→ Validation of the Protocol for PM1 and 2,5
Not validated for PM10

COMPARISON OPTICAL AND GRAVIMETRIC METHOD

OPTICAL TECHNIQUES

GRIMM

Easy to use, Mobile, Real time information but need PM1, PM2,5, PM10 can not detect particles < 300 nm

DUSTTRAK II 8532

- PM_1, $PM_{2.5}$, PM_{10} ou respirable
- Mobile, Real time measurement
- Particles > 300 nm
- Fonctions d'enregistrement des données manuelle

Concentration from 0,001 à 150 mg/m^3

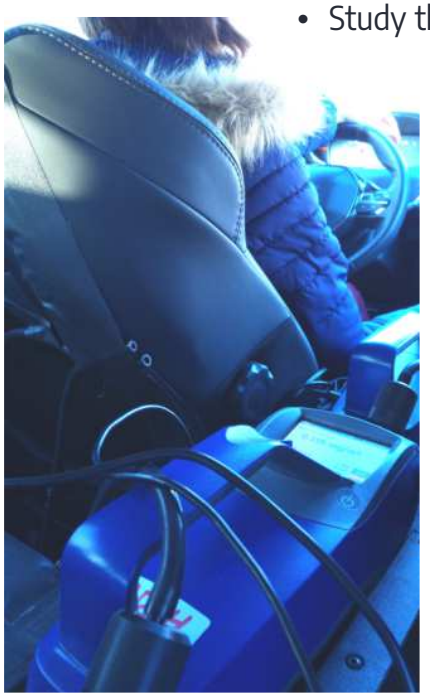
GRAVIMETRIC METHOD

DEKATI
Cascade impactor, PM1, PM2,5, PM10 – particle > 70 nm.

COMPARISON OPTICAL AND GRAVIMETRIC METHOD

Test protocol :

- Realize a blank test with open windows and HVAC on to evacuate particulate matters after a long sleep time of a vehicle
- Specify the robust exterior sampling point (**near the pulser zone**), need to study the sampling point to verify that :
  - It is not placed in a recirculation zone
  - The air speed is constant no matter the car speed (isokinetic principle)
- Study the sampling line to have the best placement to minimize length, bends and optimize diameters



✓

After simulations and tests, we specified the best exterior sampling point for a 3008 vehicle : in the pulser zone
→ Length of interior and exterior sampling line = 0,67m

✓

✓

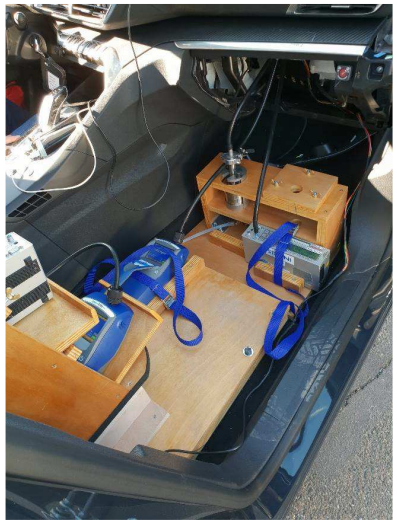
✓

COMPARISON OPTICAL AND GRAVIMETRIC METHOD

Vehicle implementation after simulations and tests :

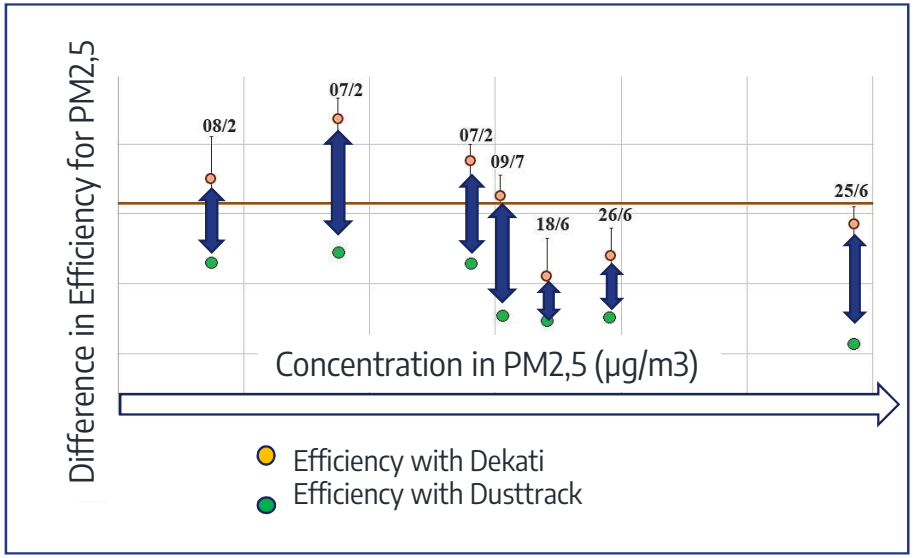
- Exterior sensors in the pulser zone :
  - Not placed in air recirculation zone
  - Constant air speed
- Interior sensors on a wooden support :
  - For security
  - Measures at the head of a passenger

- **Optimized sampling lines :**
  - **Same sampling line lengths (0,65m)**
  - **Minimum bends (1)**
  - **Maximum diameter (8mm)**



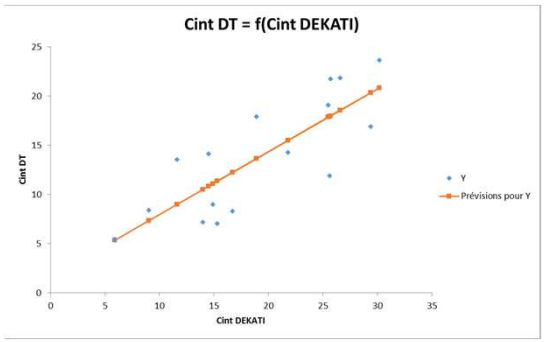
COMPARISON OPTICAL AND GRAVIMETRIC METHOD

Efficiency calculation with Dusttrack and Dekati

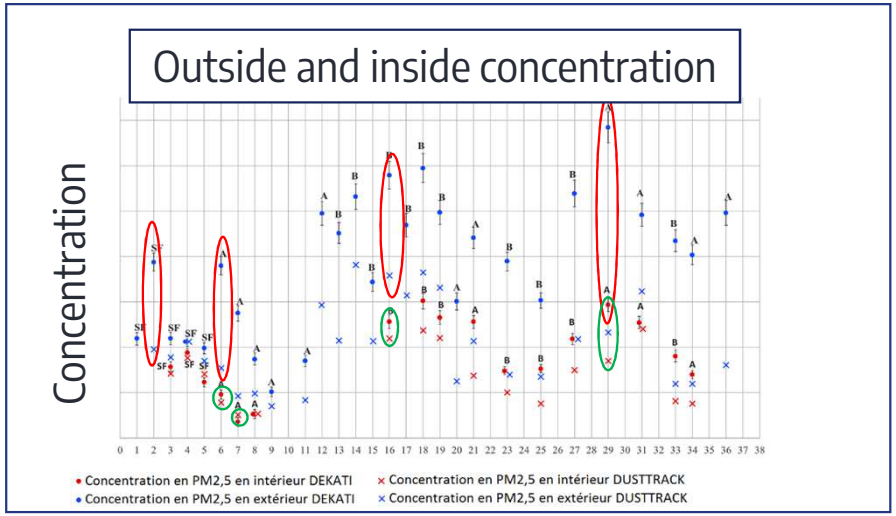


Efficiency < with Dusttrack comparing to Dekati
→ Low level of correlation
→ Due to difference in outside measurement with Dusttrack

Correlation Dust track/ Dekati



	Coefficients
Constante	1,57706375
Coefficient	0,63763737
R^2 =	0,62321962



TAKEAWAY

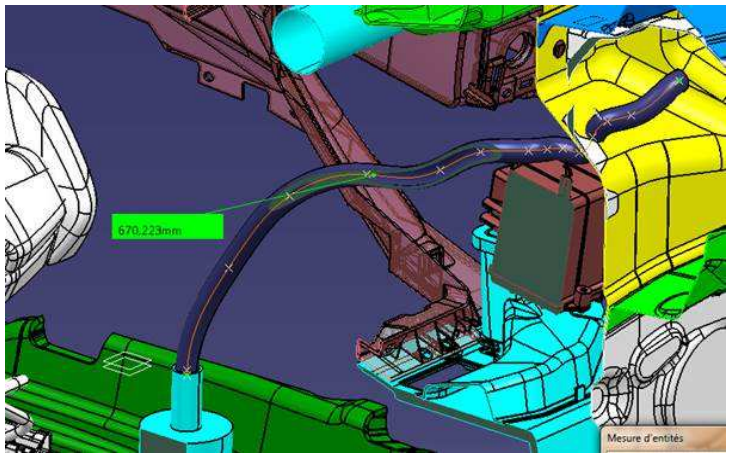
- Methodology still to be improved, specifically for a commonly used device like Dusttrack
- Repeatability is not achieved, due to the difficulties of the dynamic measurement
- High level of dispersion for the outside sampling
- Dusttrack can be use as indicator only

ANNEX

COMPARISON OPTICAL AND GRAVIMETRIC METHOD

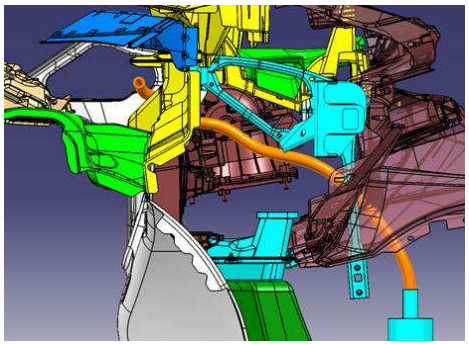
Sampling <u>line</u> requirements :

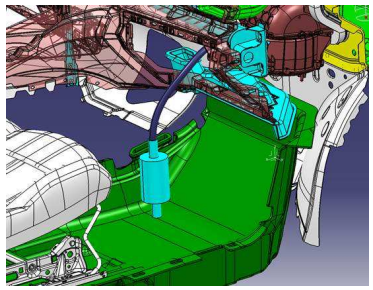
- Minimum length
- Minimum bends
- Large tube diameter



Results of the DEKATI sampling line (INERIS' calculation by their software PowerFLOW) :

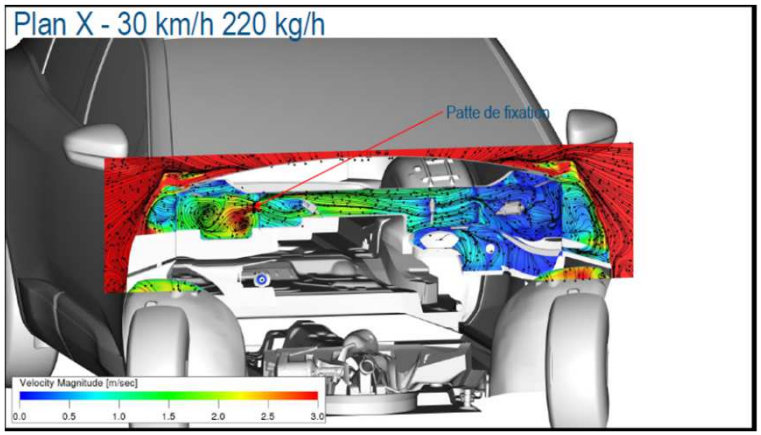
Simulations and tests





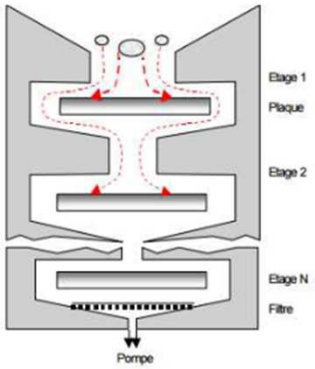
Sampling <u>point</u> requirements :

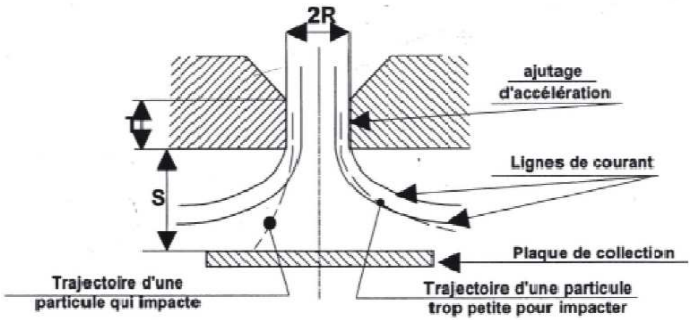
- Constant air speed
- Not placed in a recirculation zone

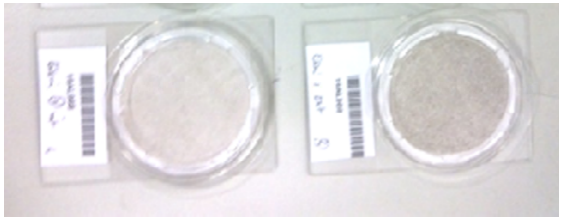


INERIS gravimetric sensor : DEKATI

- Impaction principle : the only reliable technology to measure precisely and officially a particulate matters' concentration in an environment
  - Multiple floors with filters that collect different particles' sizes
  - Weighing of the DEKATI's filters in a laboratory chamber (controlled temperature and humidity)
  - 3 hours of driving tests necessary for PM2.5
  - 6 hours of driving tests necessary for PM1







Interior and exterior
DEKATI filters