

# Measurement of PM10 and PM2.5 using SAW sensors-based Rayleigh wave and Love wave.

Fatima-Ezzahraa Dbibih <sup>1</sup>, Meddy Vanotti, Valerie Soumann, Jean-Marc Cote, Lyes Djoumi, Virginie Blondeau-Pâtissier

## Introduction

Surface Acoustic Wave (SAW) sensors are used as impaction plate in cascade impactor for real time measurements of particulates matter (PM) [1]. An innovative system with SAW sensors combined to 3 Lpm cascade impactor was developed in our team for real time mass concentration measurements. In this study, we compare the PM sensitivity of two types of SAW sensors. The first one consists of delay lines based on Rayleigh waves propagating on a Lithium Niobate LiNbO<sub>3</sub> Y-X 128° substrate and the second one is a based-on Love waves on AT-Quartz.

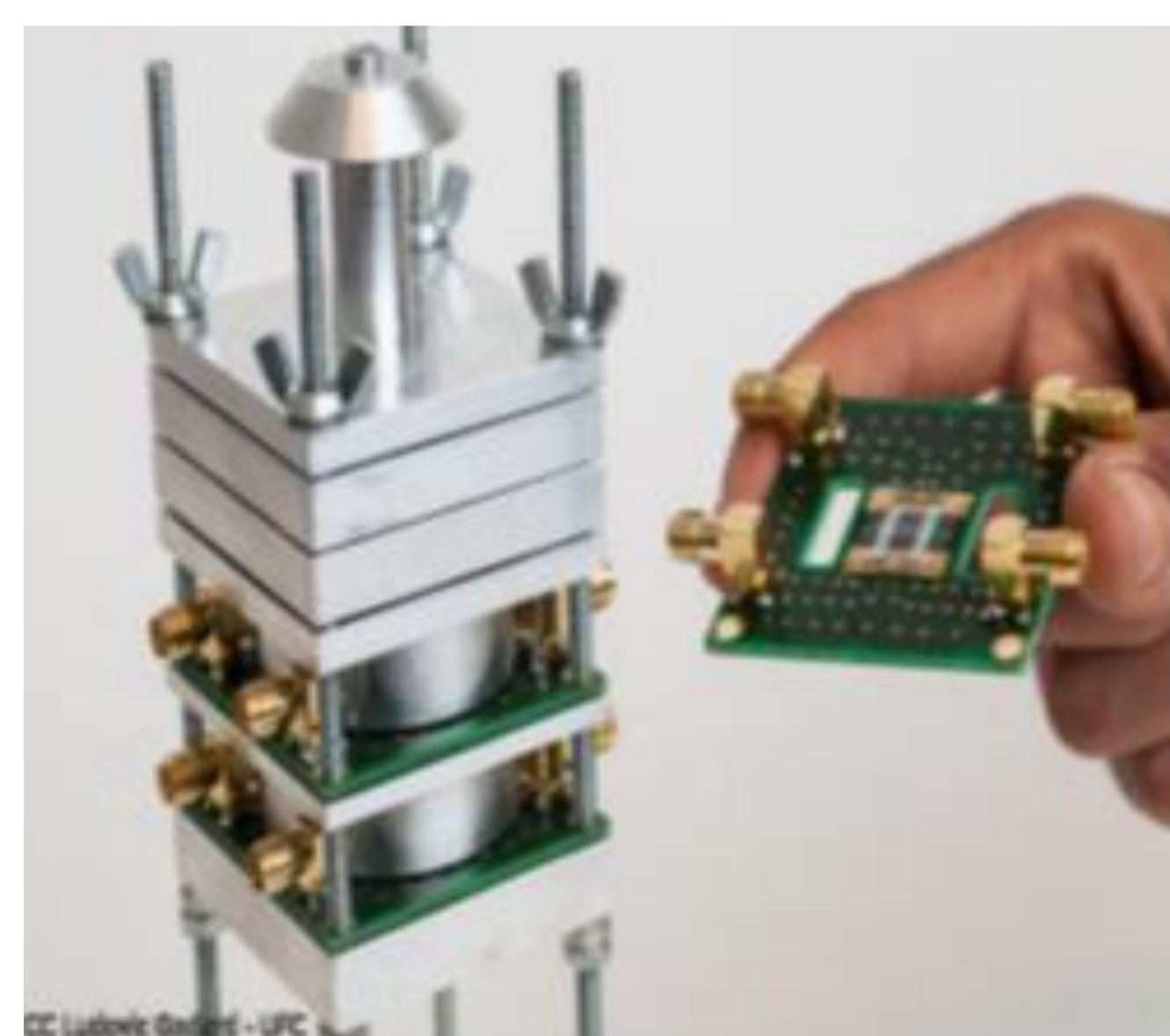


Fig. 1. Real Time Cascade Impactor prototype with SAW sensors [1]

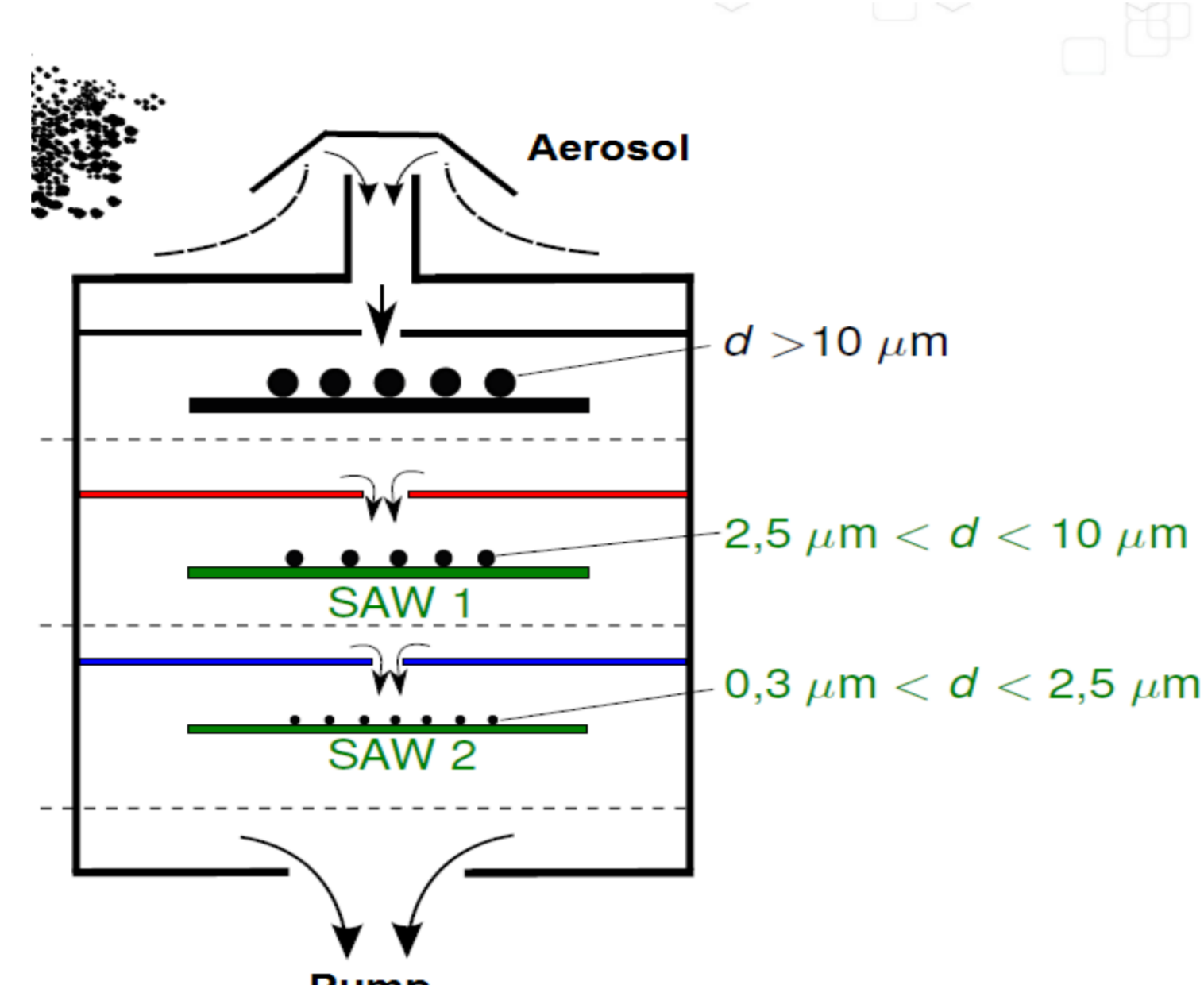


Fig. 2. Schematic of cascade impactor containing SAW sensors [1]

## Experimental results

The sensitivity of the Rayleigh wave sensor based on LiNbO<sub>3</sub> is lower than the Love wave sensor based on AT-Quartz for both PM10 and PM2.5. The response of the SAW based PM 10 and PM 2.5 sensor is linear, and in accordance with the response of the reference system monitor.

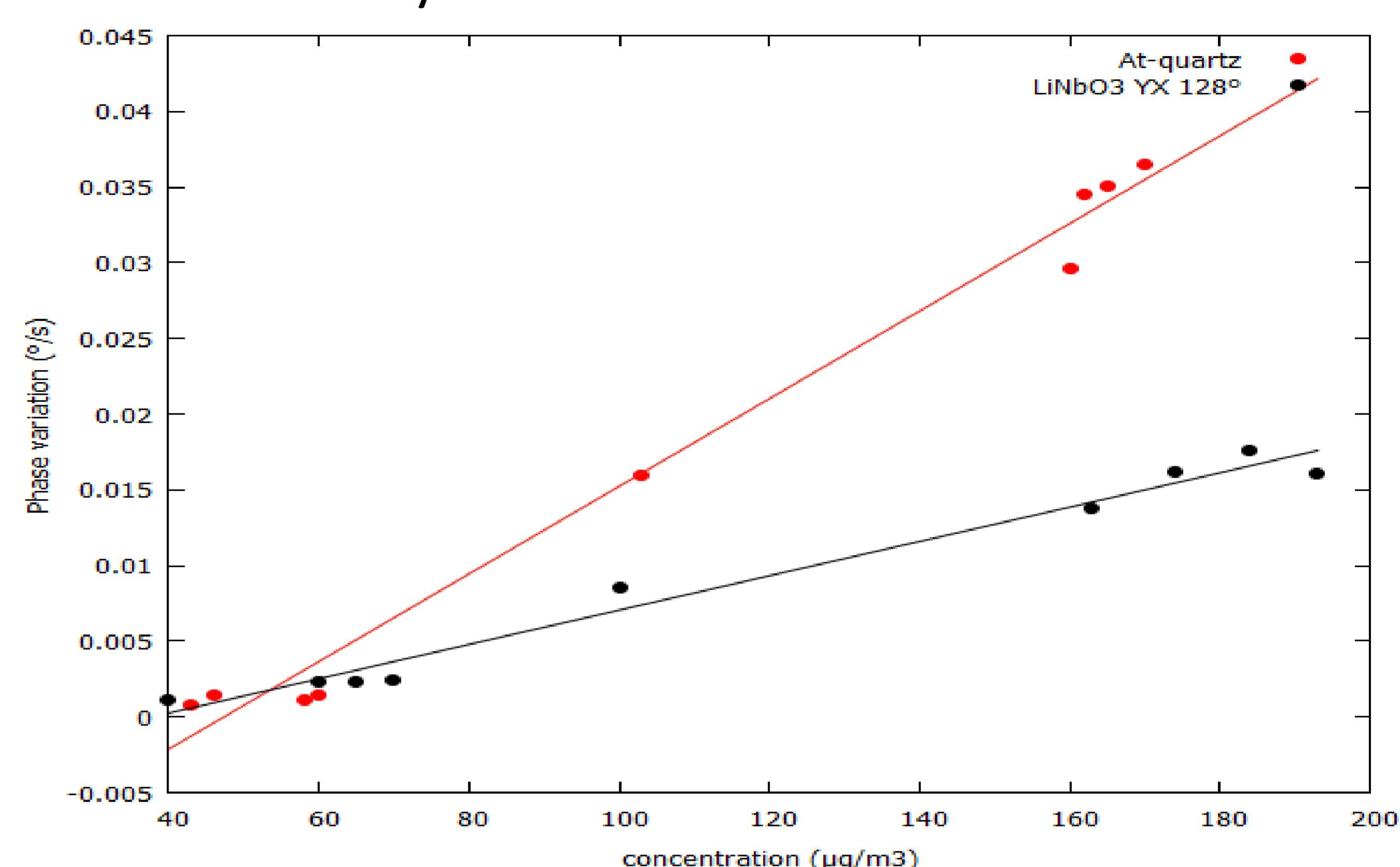


Fig. 4. SAW sensors based response changes with PM 2.5 mass concentration measured by Fidas 100.

The sensor's sensitivity is estimated by applying a linear fit. The sensitivity of sensors based on AT-Quartz is  $3.10^{-4}$  (°/s)/(μg/m<sup>3</sup>) for PM 2.5 and  $5.10^{-5}$  (°/s)/(μg/m<sup>3</sup>) for PM 10. For sensors based on LiNbO<sub>3</sub>, the sensitivity is  $1.10^{-4}$  (°/s)/(μg/m<sup>3</sup>) for PM 2.5 and  $1.10^{-5}$  (°/s)/(μg/m<sup>3</sup>) for PM 10.

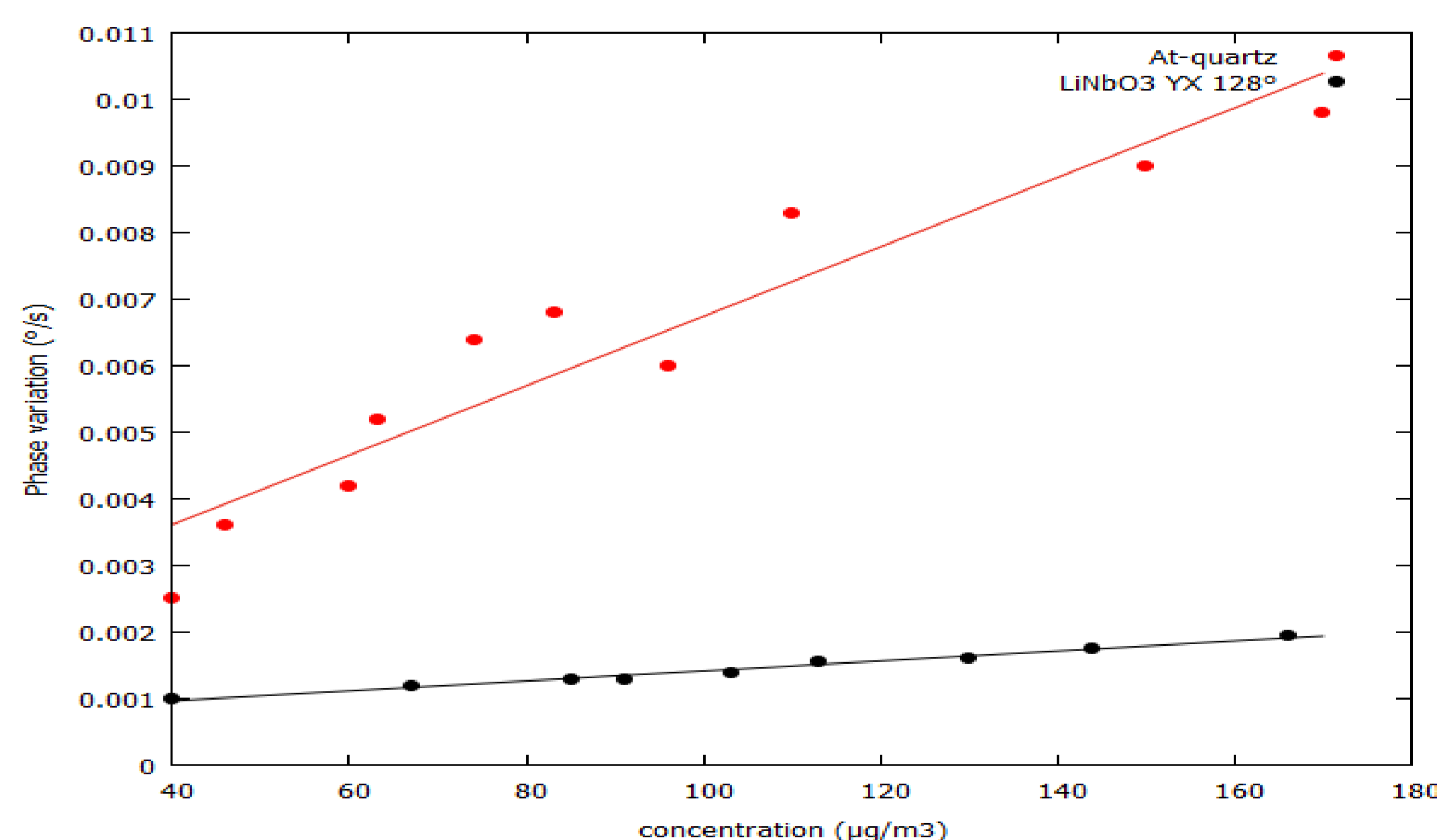


Fig. 5. SAW sensors based response changes with PM 10 mass concentration measured by Fidas 100.

## Experimental setup

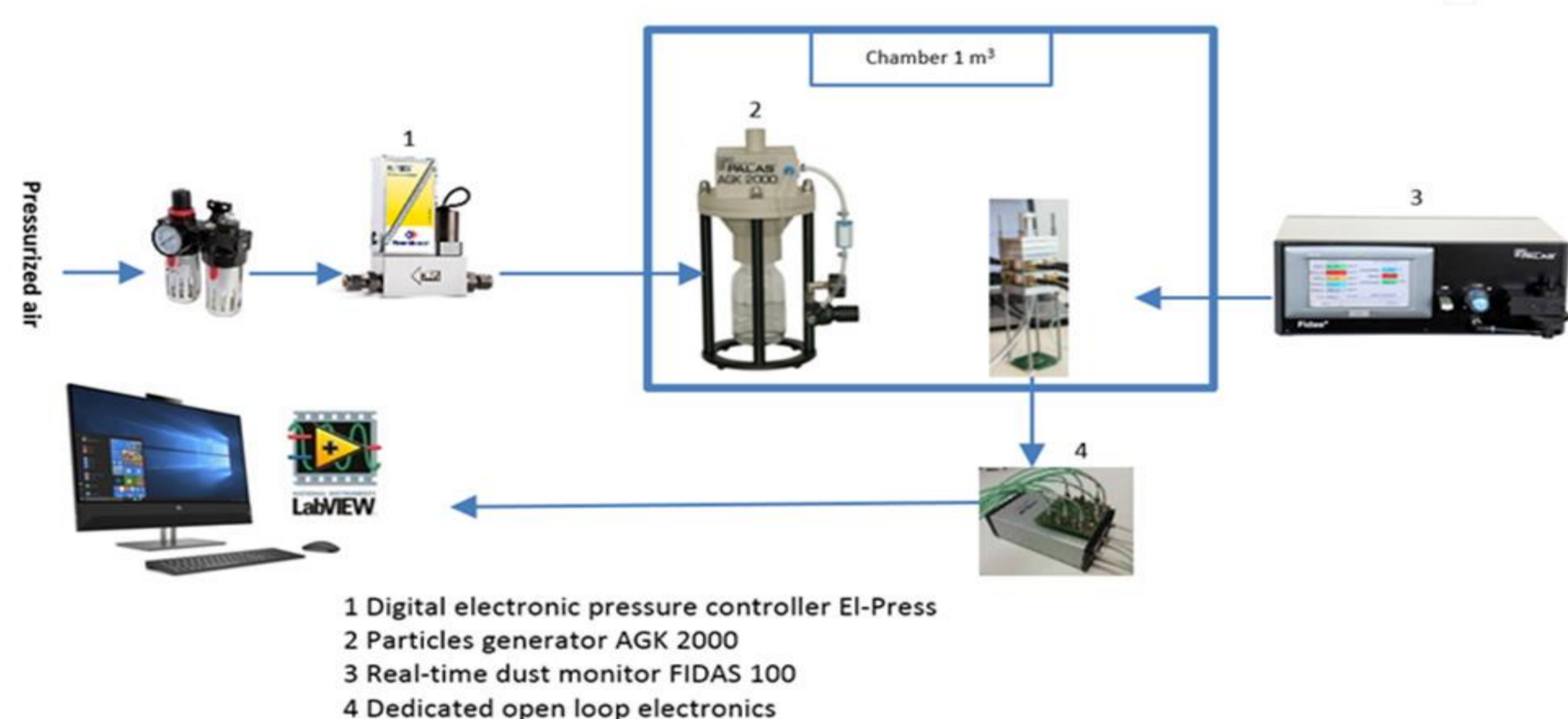


Fig.3. Schematic of the experimental setup for sensitivity test of SAW sensors to aerosol.

To perform the sensitivity tests of SAW sensors, we developed a bench test with reproducible conditions of particle size distribution and concentration

## Conclusion and perspectives

- An experimental bench test was developed to perform sensitivity tests reproductively.
- The Love wave sensor show a higher sensitivity to PM than Rayleigh wave.
- The sensitivity of both sensor to PM 2.5 is higher than PM 10. This can be explained by the rebound effect .
- An anti-rebound developed layer is under test currently.
- The developed system has a great potential for the application of airborne particle detection.

## Acknowledgement

This work was partly supported by the French RENATECH network and its FEMTO-ST technological facility. The authors are grateful to the French National Research Agency (ANR CO3SENS project).

### References :

[1] ] L. Djoumi, M. Vanotti, V. Blondeau-Patissier, "Real time cascade impactor based on surface acoustic wave delay lines for PM10 and PM2.5 mass concentration measurement", Sensors, 18(1), (2018), pp. 255