CLIMATE SOLUTIONS CONSULTING

TECHNICAL PAPER
HAPEx Nano

This document show a few results of some basics experiments we did during the design of the HAPEx Nano. We look forward to hearing from researchers with access to more advanced testing facilities about the performance of the HAPEx Nano against high end real time PM logger.

DETAIL OF THE INSTRUMENTS USED FOR THESE TESTS

Gravimetric measurement

The gravimetric assessment was made using a SKC 2.5 PMI impactor and a Buck Libra pump running at 3L/min. 37mm quartz filters were used. A semi micro balance (Radwag AS82/220. R2) (precision 0.01 mg, repeatability +-0.05 mg; linearity +-0.07 mg) was used to weigh the filters. The filters were desiccated during 24 hours prior to each measurement.

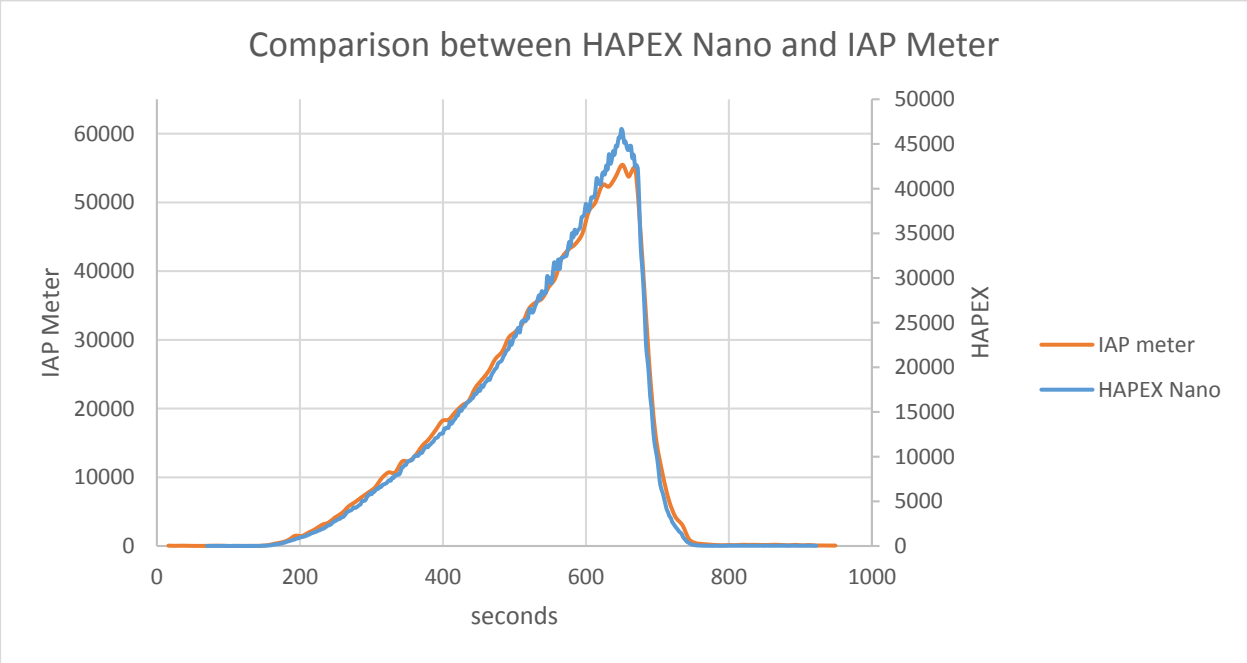
The absolute margin of error on the gravimetric assessment was quite high because of the use of a semi micro balance (+-140ug) but since the change in the filter weight was approximately 1 mg, relative uncertainties are around +-15%.

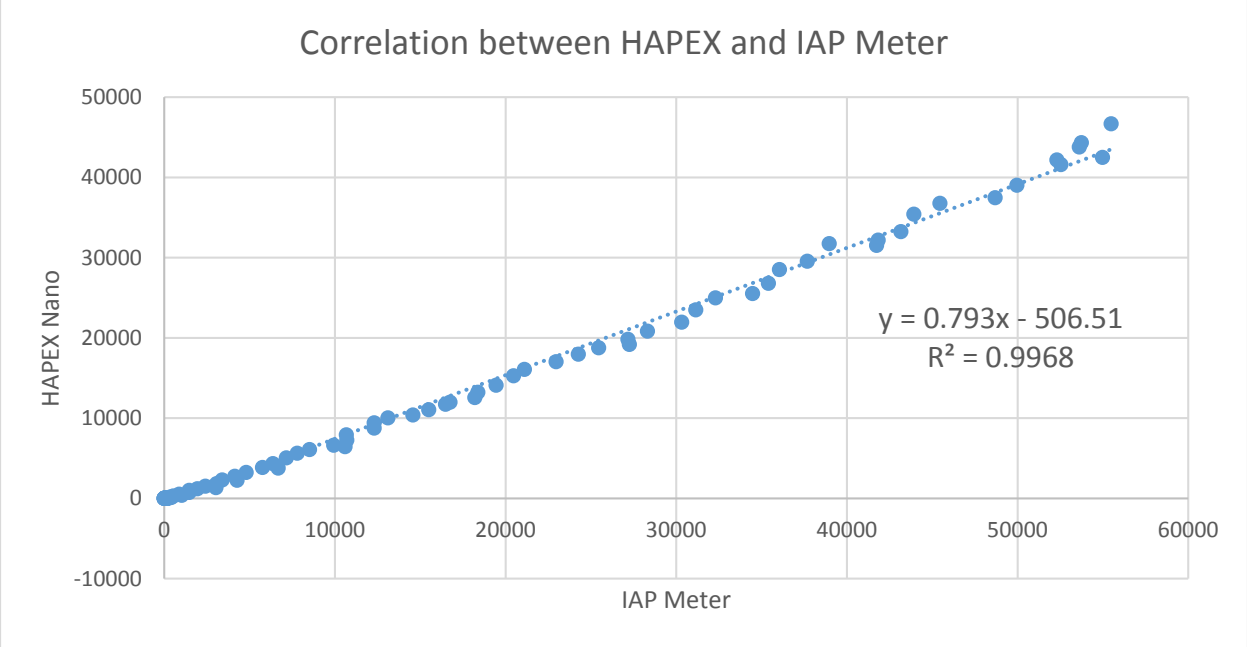
Calibration chamber

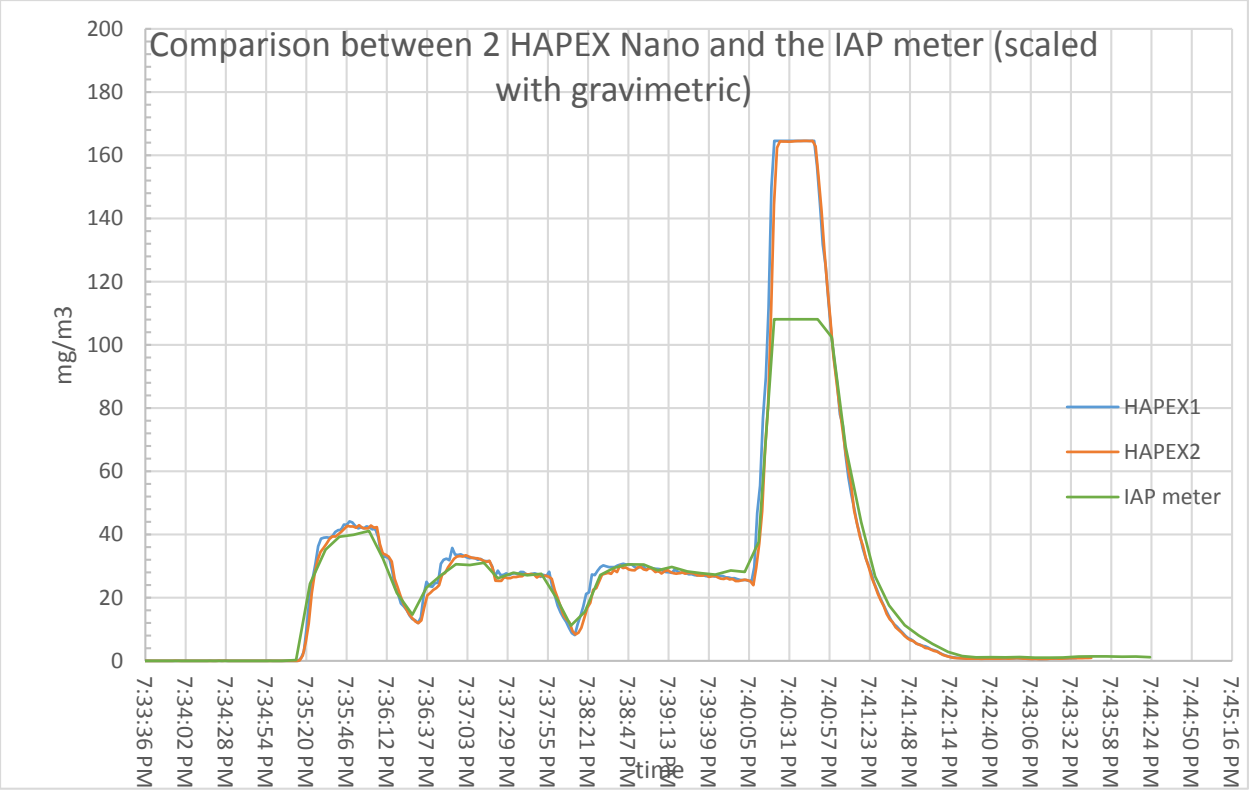
For these tests we used a basic calibration chamber consisting of a sealed container with 4 mixing fans to insure a homogenous concentration of particulates inside the chamber.

Some smoldering wood chips were introduced and the lid promptly sealed to create an increasing concentration of particulate matter.

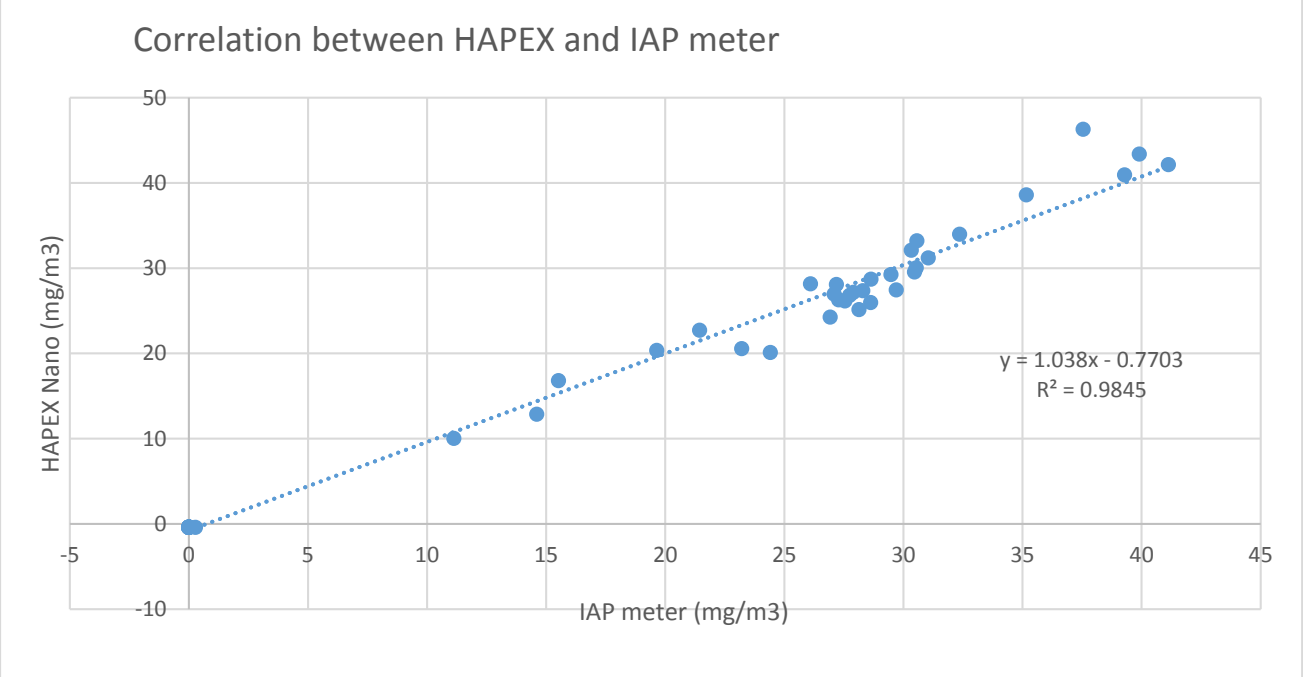
COMPARISON WITH THE “IAP METER” FROM APROVECHO RESEARCH CENTRE







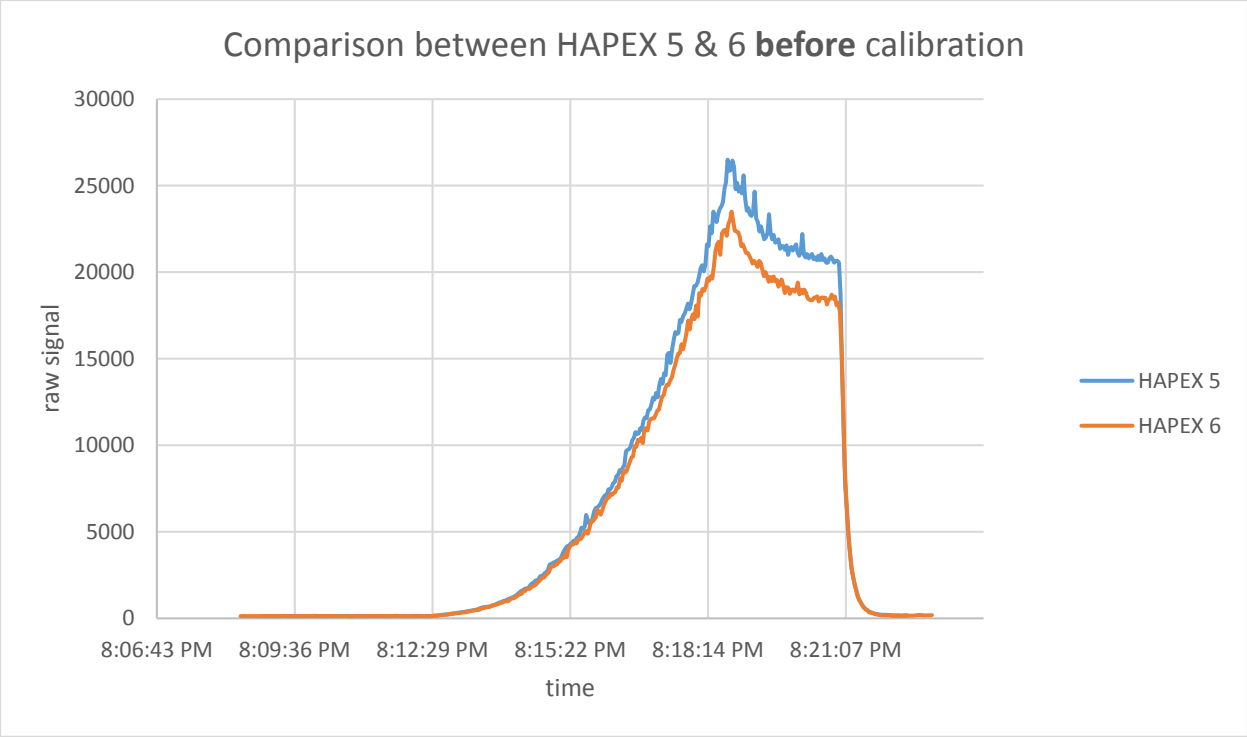
NB: Since the sensor saturated during several seconds the calculation of the scattering coefficient was not very accurate (the concentration above the saturation threshold have been estimated).



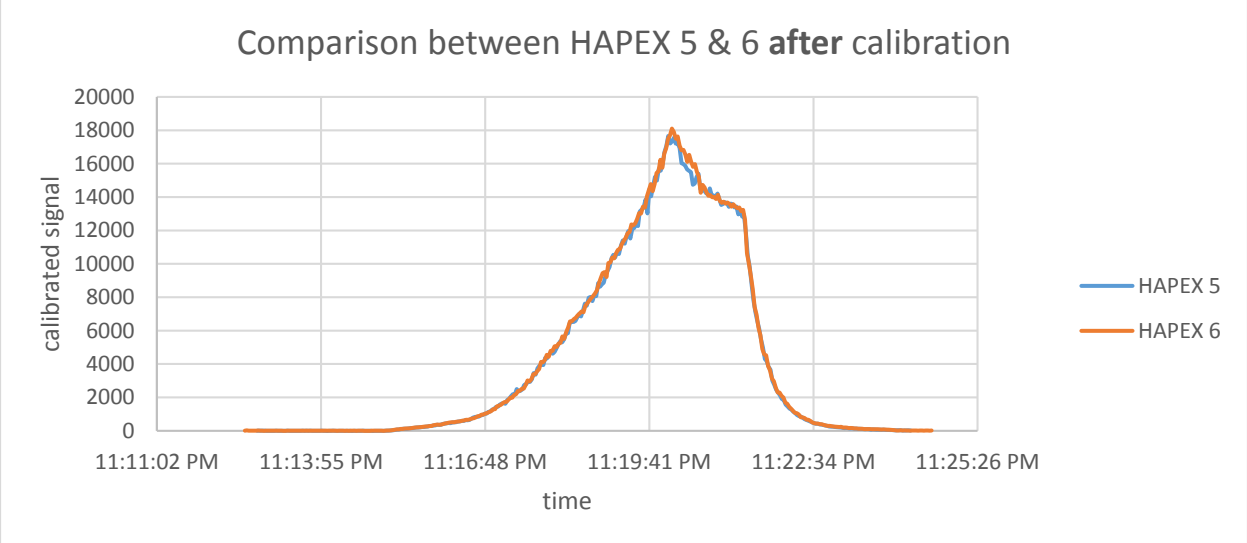
INTER DEVICE VARIABLITY

Before calibration

Before calibration there was a 10% difference in the average measurements done by the 2 devices.

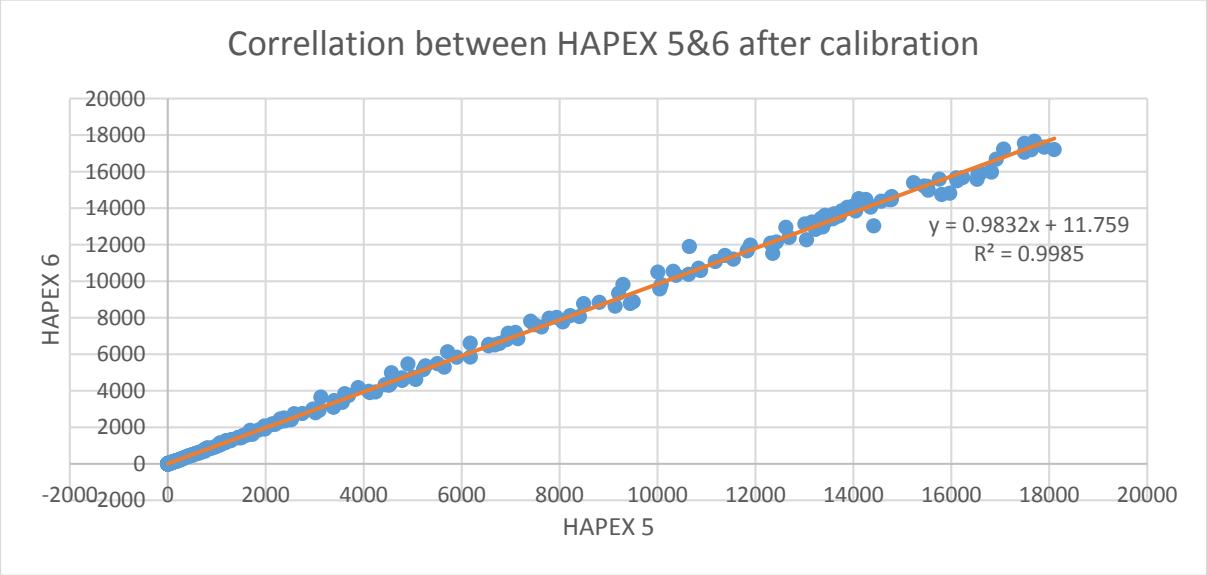


After calibration

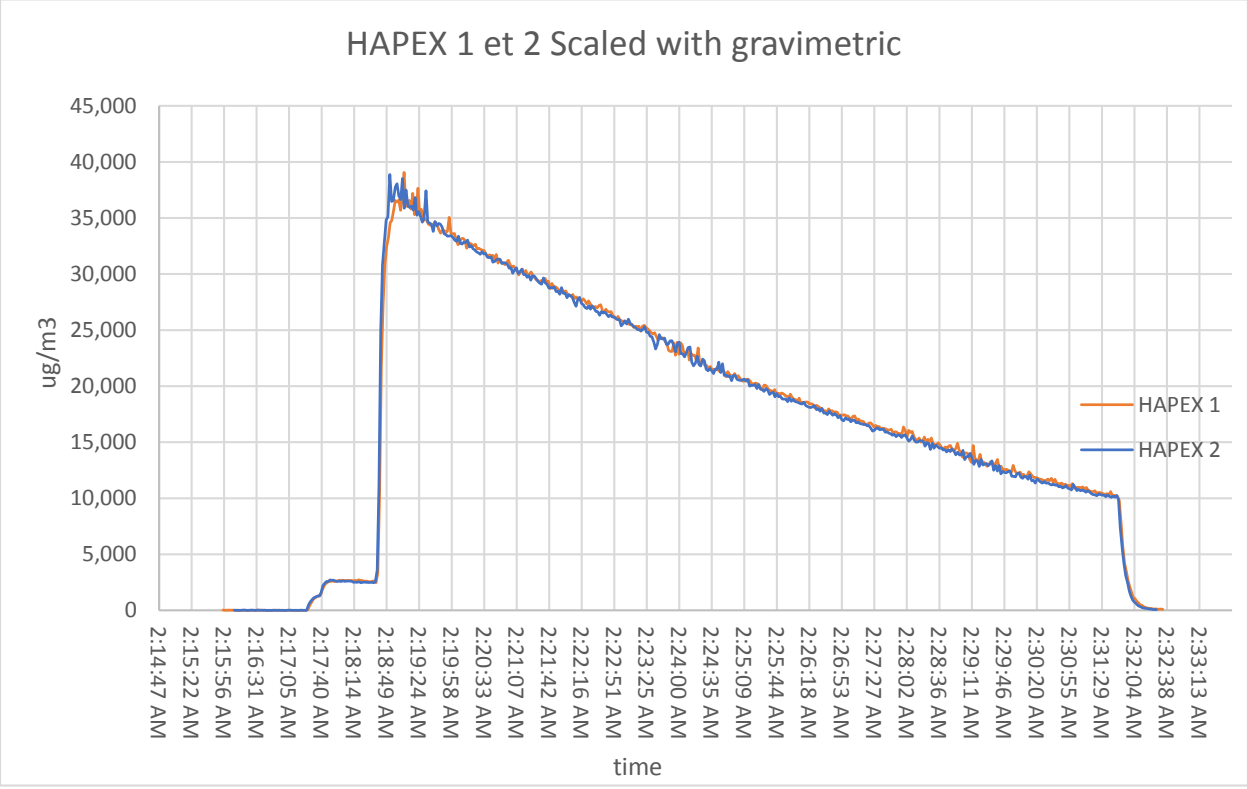


After calibration the difference in the average measured by each device was down to 0.6%.

Correlation between two devices after calibration



Reading from 2 HAPEX Nano calibrated with a co-located gravimetric system.



The use of the gravimetric system allow to convert the signal from the device to actual PM2.5 concentration in ug/m3.

DETERMINATION OF THE LIMIT OF DETECTION

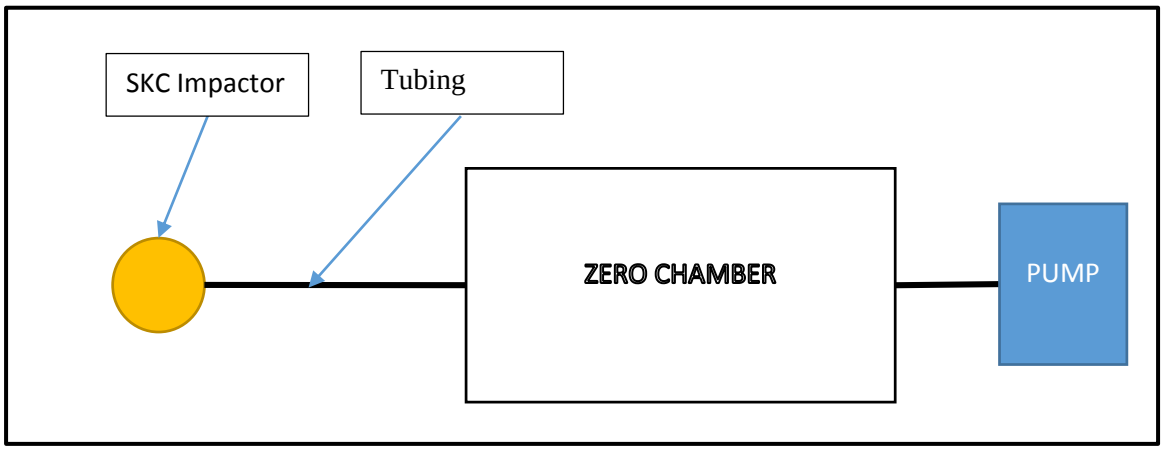
High limit of detection

The sensor saturates at a value of 90,000. This translates into varying PM concentration depending on the light scattering coefficient. With a coefficient of 1.65 (average measurement for smoldering wood smoke) the high limit of detection is around 150 mg/m3. The actual limit of detection will depend on the size distribution of the aerosol being measured.

Low limit of detection

To detect the low limit of detection we looked at the background standard deviation of the device in clean air. We determined the limit of detection as being three standard deviation times the scattering coefficient.

The diagram below show how we exposed the sensors to clean air to assess their lower limit of detection and to zero the sensors. The device were put inside the "zero chamber"



We did this calculation for individual samples and for the average of 4 samples. Because of the averaging the standard deviation is lower and the LOD is better.

	Standard deviation	Scattering coefficient (unit/(µg/m3))	Limit of detection (µg/m3) (3*SD*scattering coef)
Individual sample	2.35	1.65	11.65
4 sample average	1.10	1.65	5.42

In the datasheet we rounded up those values to 15µg/m3 and 8 µg/m3 respectively to give a conservative estimate of the low limit of detection.