Laboratory Evaluation
Dylos - DC1700 PM Sensor

South Coast AQMD

AQ-SPEC
Air Quality Sensor Performance Evaluation Center

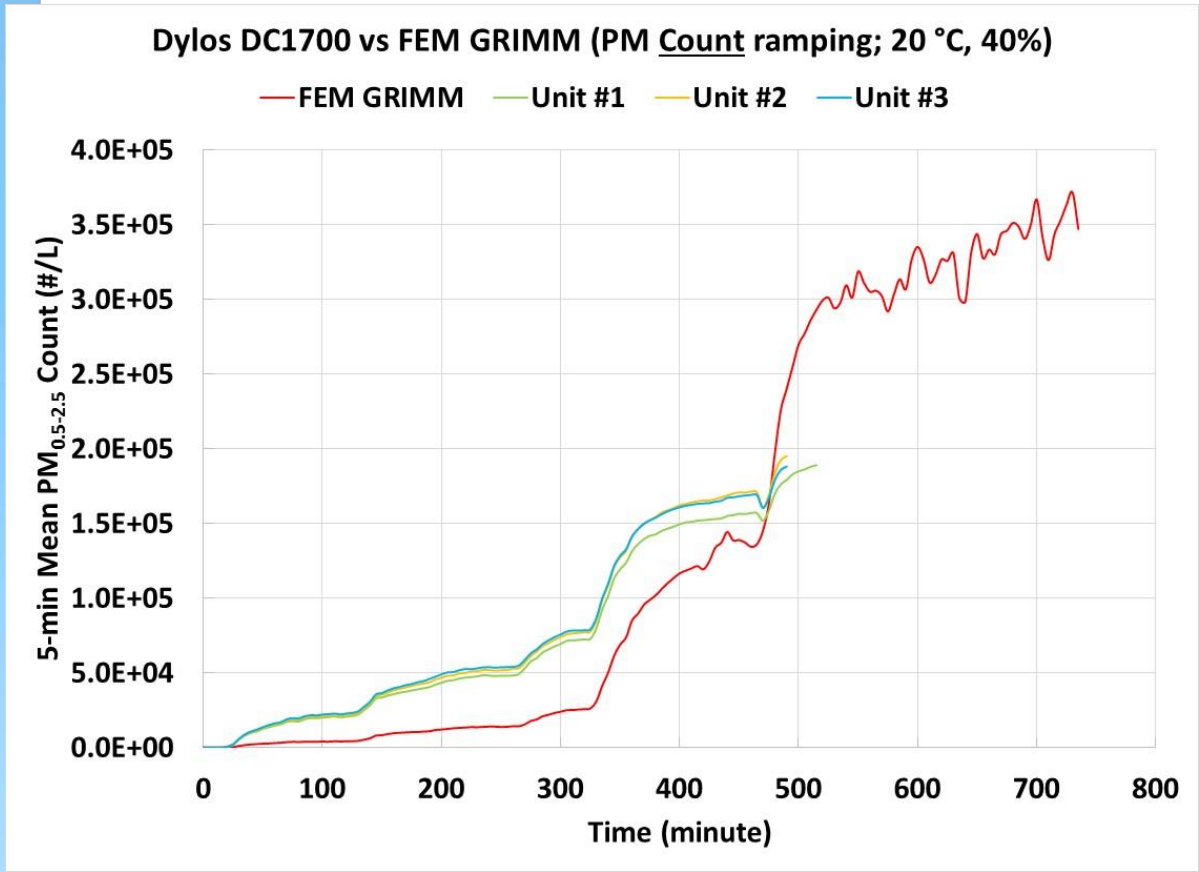
Background

- Three **Dylos DC1700** PM sensors were evaluated in the SCAQMD Chemistry Laboratory under controlled artificial aerosol concentration/size range, temperature, and relative humidity conditions. Previously, three **Dylos DC1100 PRO** PM sensors were tested in the field under ambient conditions. The main difference between the two models was the power supply: DC1100 PRO is powered by battery, whereas DC1700 runs both on battery and power cable.

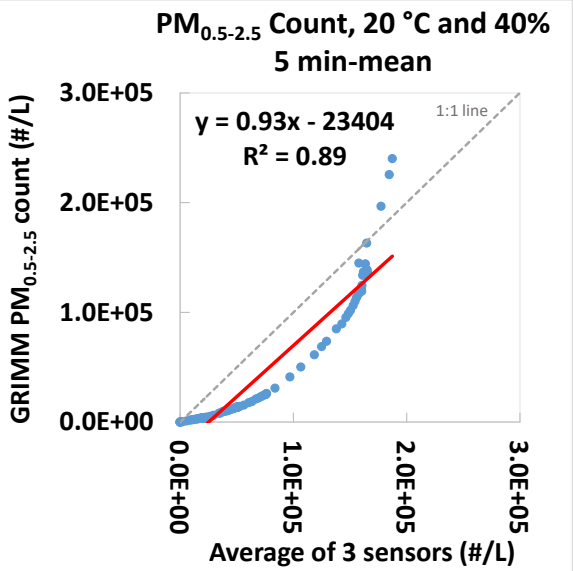
- Dylos (*3 units tested*):
  - Optical particle counter (non-FEM)
  - Measures count of particles larger than 2.5 µm in diameter and particles larger than 0.5 µm in diameter
  - Particle count of $PM_{0.5\text{-}2.5}$ = particle count (D_p > 2.5 µm) – particle count (D_p > 0.5 µm)
  - Cost: ~$500
  - Time resolution: 1-min

- GRIMM (*reference method*):
  - Optical particle counter (FEM)
  - Uses proprietary algorithms to calculate total PM, $PM_{2.5}$, and PM_1 from particle number measurements
  - Cost: ~$25,000
  - Time resolution: 1 min

Dylos DC1700 vs GRIMM ($PM_{0.5\text{-}2.5}$ count; 5-min mean)



Coefficient of Determination



- Dylos sensors showed good correlation with GRIMM $PM_{0.5\text{-}2.5}$ measurement data (R^2 = 0.89) when GRIMM $PM_{0.5\text{-}2.5}$ was lower than $2.0*10^5$ #/L. Dylos sensors overestimated the low $PM_{0.5\text{-}2.5}$ concentration as measured by the GRIMM.

- When GRIMM $PM_{0.5\text{-}2.5}$ count was less than $2.0*10^5$ #/L, the Dylos sensors tracked well the conc. variations (concentration ramping) as recorded by the GRIMM.
- When GRIMM $PM_{0.5\text{-}2.5}$ count was higher than $2.0*10^5$ #/L, the Dylos sensors did not respond properly, reporting invalid count concentrations (not shown in the above figure, only in the raw data files).

Dylos DC1700 vs GRIMM Accuracy

- Accuracy* (20 °C and 40% RH)

Steady State (#)	Sensor mean (#/L)	GRIMM (#/L)	Accuracy (%)
1	22223	4235	-4147
2	52460	14314	-2565
3	76464	26176	-1821
4	165596	136104	-117

- Overall, the three Dylos sensors showed low accuracy compared to GRIMM at 20 °C and 40% RH. The accuracy improved as $PM_{0.5\text{-}2.5}$ count concentration increased.
- Dylos stopped recording valid count numbers when the $PM_{0.5\text{-}2.5}$ surpassed $2*10^5$ #/L as recorded by the GRIMM.

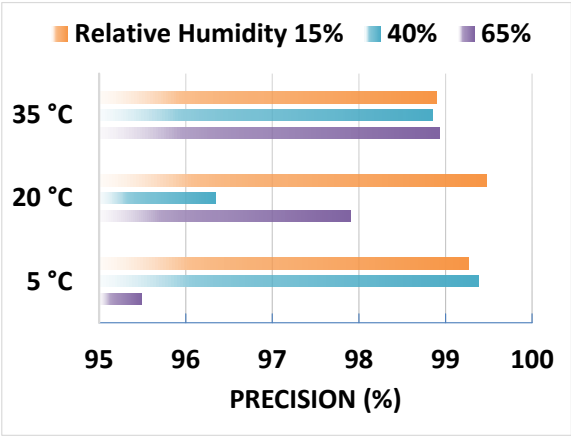
Dylos DC1700 data recovery & intra-model variability

- Data recovery for $PM_{0.5\text{-}2.5}$ count from Unit #1, Unit #2, and Unit #3 was 100%, 97%, and 100% respectively.
- Low $PM_{2.5}$ measurement variations were observed between the three units.

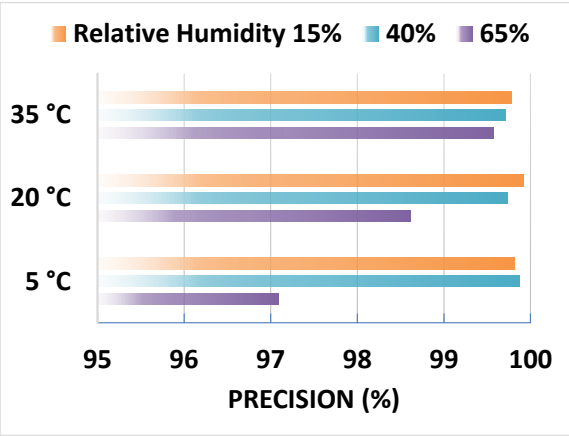
Dylos DC1700 vs GRIMM Precision

- Precision (Effect of $PM_{0.5\text{-}2.5}$ conc.,Temperature and Relative Humidity)

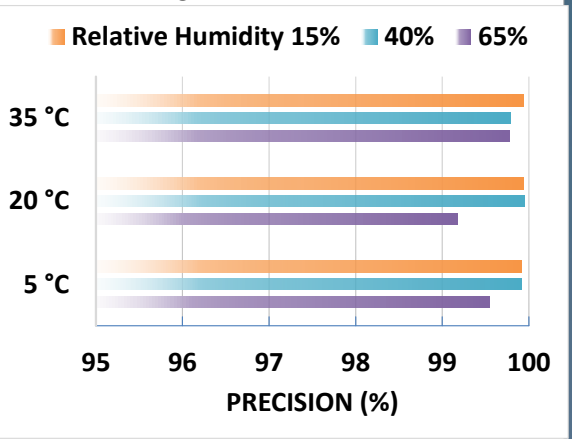
Low PM count



Medium PM count

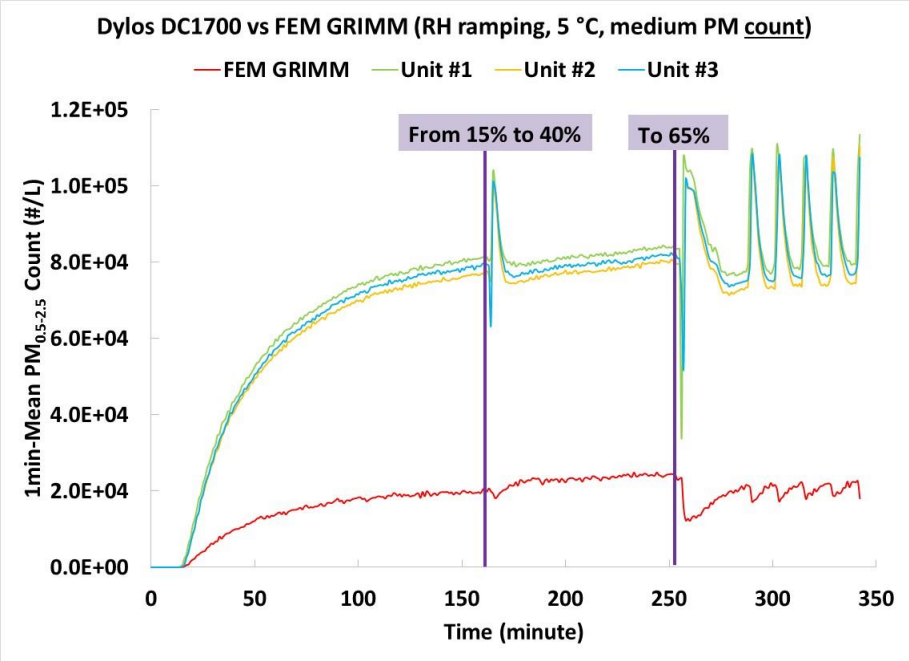


High PM count

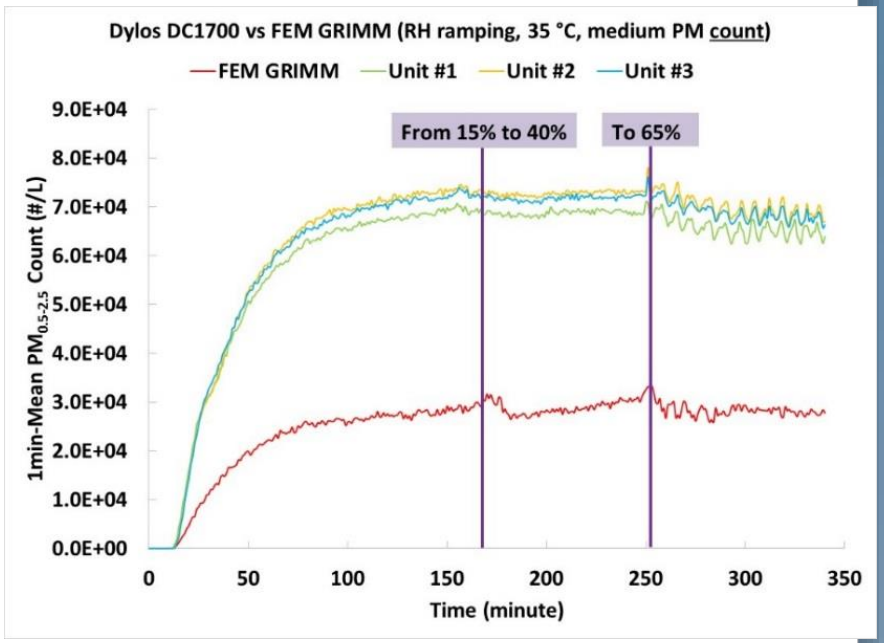


- Dylos sensors showed good precision for most of the test combinations ($PM_{0.5\text{-}2.5}$, T and RH), except at low temperature and high humidity, where the precision was affected by the out-of-scale spikes.

Dylos DC1700 Climate Susceptibility



Low Temp – RH ramping
(medium conc.)



High Temp – RH ramping
(medium conc.)

Discussion

The three **Dylos DC1700** (battery and power cable capabilities) sensors were only tested in the laboratory chamber. The previous version Dylos DC1100 PRO (battery only) was only tested in the field.

- **Accuracy**: Overall, Dylos DC1700 units have low accuracy at low PM concentration, compared to the GRIMM for $PM_{0.5\text{-}2.5}$ ranging 0 to $2*10^5$ #/L (refer to slide 4).
- **Precision**: Dylos sensors have good precision for most of the test combinations ($PM_{0.5\text{-}2.5}$, T, and RH), except at low temperature and high RH (refer to slide 5).
- **Data Recovery:** Data recovery for $PM_{0.5\text{-}2.5}$ count from Unit #1, Unit #2, and Unit #3 was 100%, 97%, and 100% respectively.
- **Linearity of sensor response**: Dylos sensors showed good correlation/linear response with the corresponding GRIMM $PM_{0.5\text{-}2.5}$ measurement data ($R^2 = 0.89$) for count # below $2*10^5$ #/L (refer to slides 3)
- **Concentration range**: 0 to $2*10^5$ #/L $PM_{0.5\text{-}2.5}$ as measured by GRIMM. Dylos sensors largely overestimated the $PM_{0.5\text{-}2.5}$ count. When GRIMM $PM_{0.5\text{-}2.5}$ count was higher than $2*10^5$ #/L, Dylos sensors started to record invalid count numbers.
- **Climate susceptibility**: During the laboratory studies, temperature and relative humidity had some effect on the precision of the sensors. At low temperature-high RH, Dylos sensors' precision was affected. In addition, in order to maintain 40% and 65% RH at 5 °C, the chamber has a fast heating and cooling mechanism, causing a variation around the target RH. Consequently, it also resulted into spiked and invalid values as recorded by the Dylos sensors.