

# Laboratory Evaluation

## Davis Instruments - AirLink



# Background

Three **Davis Instruments AirLink** (hereinafter **AirLink**) sensors were field-tested at the South Coast AQMD Rubidoux fixed ambient monitoring station (04/02/2021 to 06/01/2021) under ambient environmental conditions. Following field-testing, the same three units were evaluated in the South Coast AQMD Sensor Environmental Testing Chamber 2 (SENTEC-2) under controlled artificial aerosol concentration/size range, temperature, and relative humidity.

## AirLink (3 units tested):

- Particle sensor: **optical; non-FEM (PMSA003, Plantower)**
- Each unit reports:  $PM_{1.0}$ ,  $PM_{2.5}$ , and  $PM_{10}$  ( $\mu\text{g}/\text{m}^3$ ), Temperature ( $^{\circ}\text{F}$ ), RH (%)
- **Unit cost: ~\$179**
- Time resolution: 1-min
- Unit IDs: 023B, 023F, 0206



## Reference instruments:

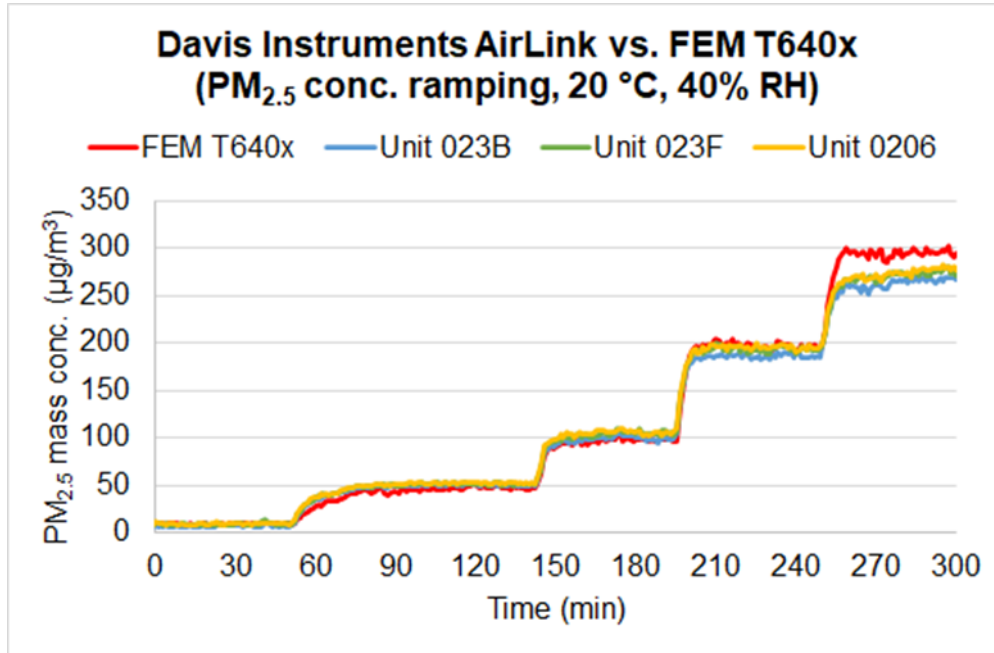
- $PM_{2.5}$  instrument (**Teledyne T640x, San Diego, CA; hereinafter FEM T640x**); **cost: ~\$37,000**
- Time resolution: 1-min



# PM<sub>2.5</sub>

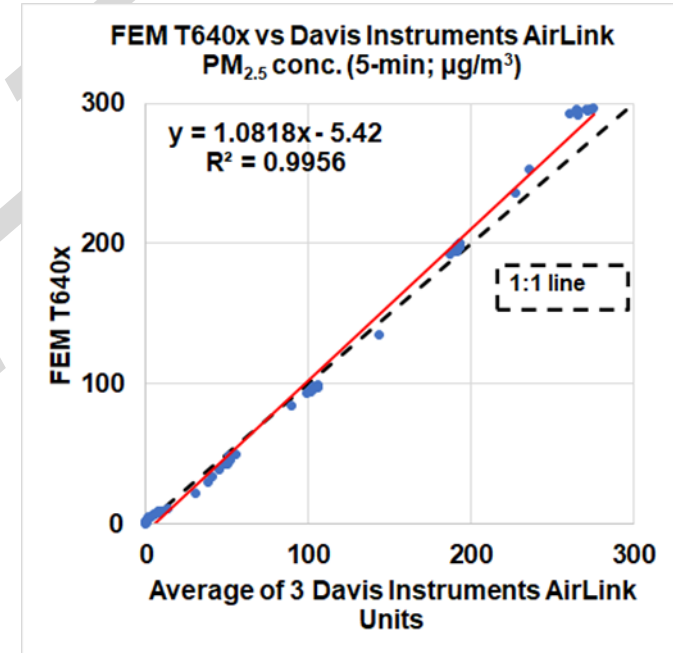
1. **FEM T640x vs AirLink**
2. **Accuracy, data recovery, and intra-model variability**
3. **Precision**
4. **Climate susceptibility**
5. **Discussion**

# AirLink vs FEM T640x (PM<sub>2.5</sub>)



- The AirLink sensors tracked well with the concentration variation but tended to overestimate PM<sub>2.5</sub> concentration values at lower levels, while underestimating at higher levels, compared to the FEM T640x in the concentration range of 0 - 300 µg/m<sup>3</sup>.

## Coefficient of Determination



- The AirLink sensors showed very strong correlations with the FEM T640x PM<sub>2.5</sub> mass conc. ( $R^2 > 0.99$ )

# AirLink vs FEM T640x PM<sub>2.5</sub> Accuracy

- Accuracy (20 °C and 40% RH)

Steady State #	Sensor Mean (µg/m <sup>3</sup> )	FEM T640x (µg/m <sup>3</sup> )	Accuracy (%)
1	8.74	9.05	96.5%
2	51.14	47.50	92.3%
3	103.57	97.71	94.0%
4	192.09	196.31	97.8%
5	273.76	296.41	92.4%

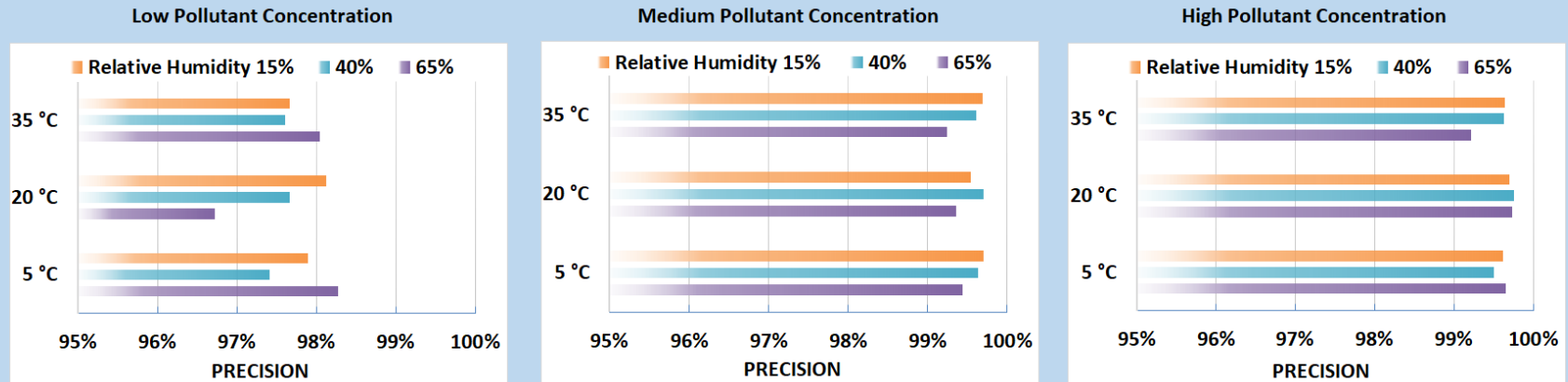
- The AirLink sensors tended to overestimate PM<sub>2.5</sub> concentration values at lower levels, while underestimating at higher levels compared to the FEM T640x PM<sub>2.5</sub> mass concentration at 20 °C and 40% RH. The AirLink sensors showed high accuracy (92.3% to 97.8%) for all tested PM<sub>2.5</sub> concentrations compared to the reference FEM T640x for the entirety of test.

## AirLink Data Recovery and Intra-model Variability

- Data recovery for PM<sub>2.5</sub> measurements was 100% for all units.
- Low to moderate PM<sub>2.5</sub> concentration variations were observed between the three units at 20 °C and 40% RH, at 10, 50, and 150 µg/m<sup>3</sup> PM<sub>2.5</sub> as measured by the FEM T640x.

# Precision: AirLink (PM<sub>2.5</sub>)

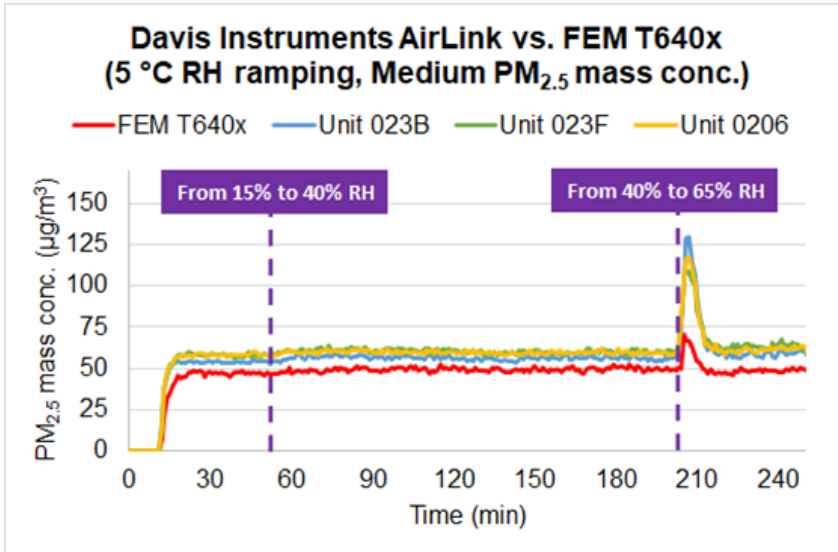
- Precision (effect of PM<sub>2.5</sub> conc., temperature and relative humidity)



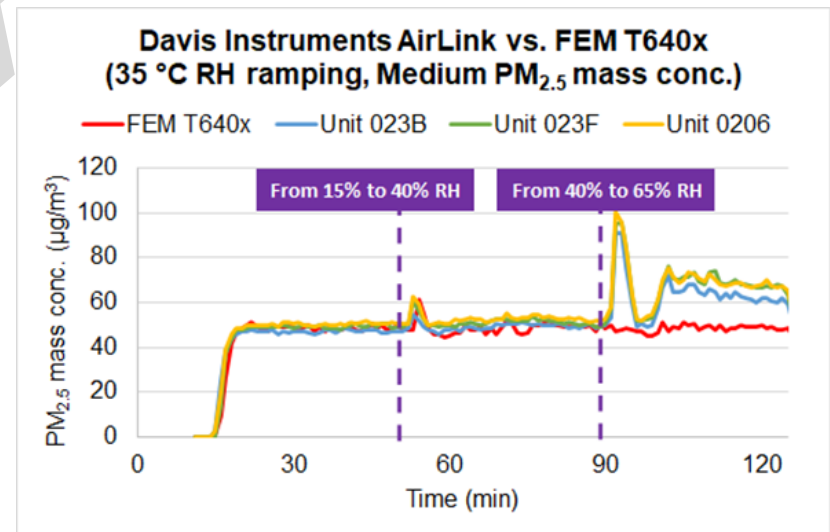
- Overall, the three AirLink sensors showed high precision for all combinations of PM<sub>2.5</sub> conc., T, and RH.

# Climate Susceptibility: AirLink (PM<sub>2.5</sub>)

Low Temp - RH ramping  
(medium conc.)



High Temp – RH ramping  
(medium conc.)



# Discussion: PM<sub>2.5</sub>

- **Accuracy:** The three AirLink sensors showed accuracy ranged from 92.3% to 97.8%. (refer to slide 5)
- **Precision:** The three AirLink sensors exhibited high precision during all tested PM<sub>2.5</sub> conc., T, and RH conditions. (refer to slide 6)
- **Intra-model variability:** Low to moderate PM<sub>2.5</sub> measurement variations were observed among the three AirLink sensors at 20 °C and 40% RH. (refer to slide 5)
- **Data Recovery:** Data recovery for PM<sub>2.5</sub> measurements was 100% for all units. (refer to slide 5)
- **Bias:** N/A
- **Detection limit:** The detection limit cannot be estimated due to limitations in the chamber system design.
- **Response time:** Response time could not be studied due to the design of the chamber system. With a 1.6 m<sup>3</sup> chamber volume, it was not possible to reach a high pollutant concentration within a short time.
- **Linear Correlation:** The three AirLink sensors showed very strong correlation/linear response with the corresponding FEM T640x PM<sub>2.5</sub> measurement data ( $R^2 > 0.99$ ). (refer to slide 4)
- **Selectivity:** N/A for PM sensors test
- **Interferences:** N/A for PM sensors test
- **Note about PM<sub>1.0</sub>:** The field evaluation compared the PM<sub>1.0</sub> values reported from the AirLink sensors against the field GRIMM and T640 that reported PM<sub>1.0</sub>. However, PM<sub>1.0</sub> was not compared in this lab evaluation because at the time of lab testing (before March 2022) the lab T640x firmware upgrade to report PM<sub>1.0</sub> was not finalized yet.



# Discussion: PM<sub>2.5</sub>

- **Measurement duration:** AirLink sensors report 1-minute averaged values.
- **Measurement frequency:** AirLink sensors report 1-minute averaged values. The obtained data was used as-is for calculation of statistics (e.g. data recovery, intra-model variability, mean, accuracy, precision), but condensed into 5-minute averages for linear correlation studies against the FEM T640x.
- **Sensor contamination and expiration:** Prior to the laboratory evaluation, the AirLink sensors were tested in the field for two months. The PM<sub>2.5</sub> laboratory studies lasted for about 9 days with intermittent non-operating periods and a storage period of ~ 6 months. For PM<sub>2.5</sub> measurements, all of the AirLink sensors maintained their functionalities and operated normally throughout the duration of the testing.
- **Concentration range:** PM<sub>2.5</sub> concentration range was not listed by the manufacturer. During the laboratory evaluation, the AirLink sensors were challenged with PM<sub>2.5</sub> concentrations up to 300 µg/m<sup>3</sup>. (refer to slide 4)
- **Drift:** N/A
- **Climate susceptibility:** During the lab studies, climate did not significantly impact precision. Increasing temperatures led to more underestimation by the sensors, at RH levels below 65%. Above 65% RH, increasing temperatures resulted in sustained overestimation by the sensors compared to the FEM T640x. (refer to slides 6 and 7)
- **Response to loss of power:** AirLink sensors were powered through the entirety of the lab tests.