# Laboratory Evaluation: Aeroqual S500 Particulate Matter Head



South Coast AQMD

AQ-SPEC
Air Quality Sensor Performance Evaluation Center

# Background

Three **Aeroqual S500 Particulate Matter Head (hereinafter Aeroqual S500-PM)** sensors (units IDs: 1, 2, 3) were field-tested at the South Coast AQMD Rubidoux fixed ambient monitoring station (04/17/2020 to 06/24/2020) under ambient environmental conditions and have been evaluated in the South Coast AQMD Chemistry Laboratory under controlled artificial aerosol concentration/size range, temperature, and relative humidity. The same three Aeroqual S500-PM units were tested both in the field (1st stage of testing) and in the laboratory (2nd stage of testing).

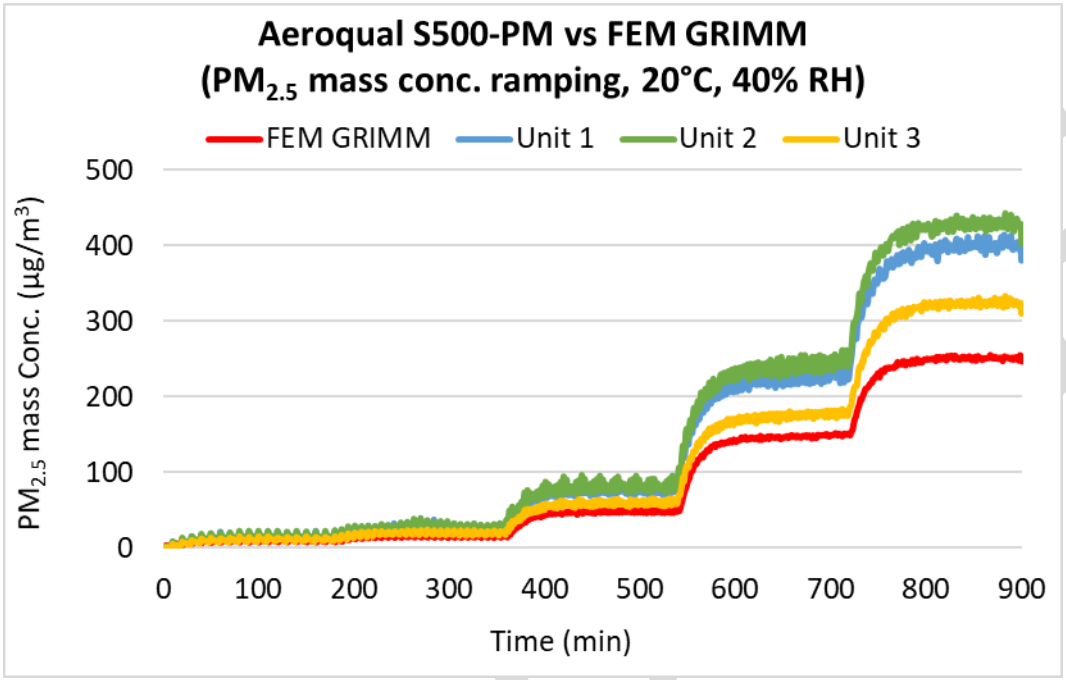
**Aeroqual S500-PM (*3 units tested*):**

- PM Sensor – Laser Particle Counter (non-FEM)
- Each unit measures: $PM_{2.5}$ and $PM_{10}$ ($\mu g/m^3$)
- Unit cost: $1490 (Series 500 base + PM head)
- Time resolution: 1-min
- Units IDs: 1, 2, 3

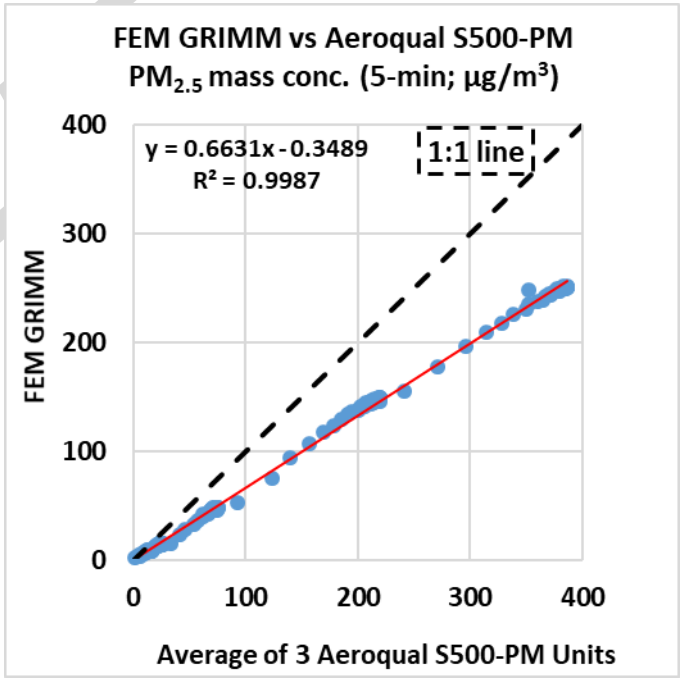
**GRIMM (*reference method*):**

- Optical particle counter
- FEM $PM_{2.5}$
- Uses proprietary algorithms to calculate $PM_{1.0}$, $PM_{2.5}$, and $PM_{10}$ mass conc. from particle number measurements
- Cost: ~$25,000
- Time resolution: 1-min

# Aeroqual S500-PM vs FEM GRIMM ($PM_{2.5}$ mass conc.)




## Coefficient of Determination




- The Aeroqual S500-PM sensors tracked well with the concentration variation as recorded by the FEM GRIMM in the concentration range of 0 - ~250 µg/m$^3$.

- The Aeroqual S500-PM sensors showed very strong correlations with the FEM GRIMM $PM_{2.5}$ mass conc. ($R^2$ > 0.99)

# Aeroqual S500-PM vs FEM GRIMM $PM_{2.5}$ Accuracy

- Accuracy (20°C and 40% RH)

| Steady state # | Sensor Mean (µg/m³) | FEM GRIMM (µg/m³) | Accuracy (%) |
|---|---|---|---|
| 1 | 14.4 | 8.7 | 34.6 |
| 2 | 25.2 | 14.8 | 30.2 |
| 3 | 73.9 | 48.1 | 46.3 |
| 4 | 219.3 | 149.4 | 53.2 |
| 5 | 384.2 | 250.3 | 46.5 |

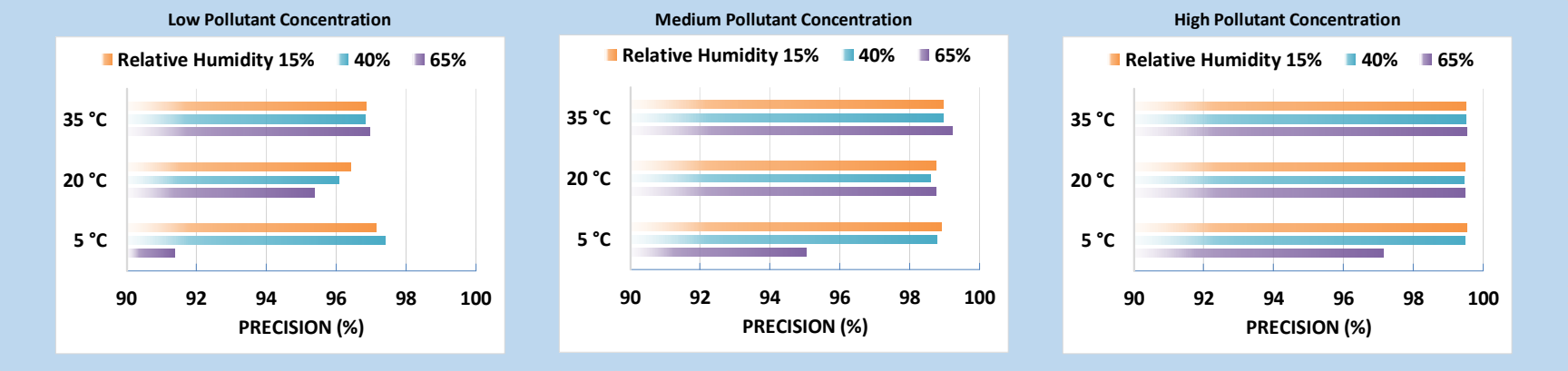
- The Aeroqual S500-PM sensors overestimated FEM GRIMM $PM_{2.5}$ mass concentration at 20 °C and 40% RH. The accuracy of the Aeroqual S500-PM sensors was fairly constant (~30% to 53%) over the $PM_{2.5}$ mass concentration range tested.

# Aeroqual S500-PM: Data Recovery and Intra-model Variability

- Data recovery for $PM_{2.5}$ mass concentration from all units was 100%
- Moderate $PM_{2.5}$ measurement variations were observed between the Aeroqual S500-PM sensors

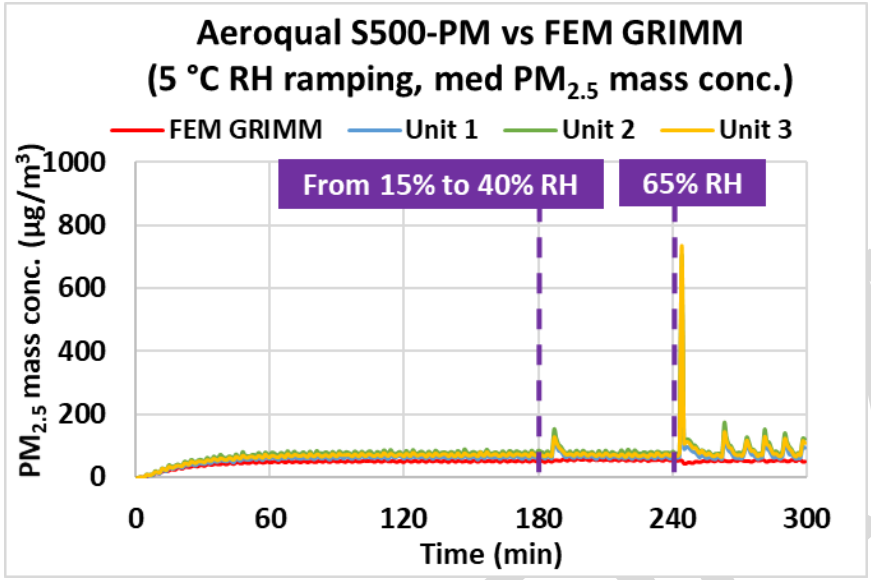
# Aeroqual S500-PM $PM_{2.5}$: Precision

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



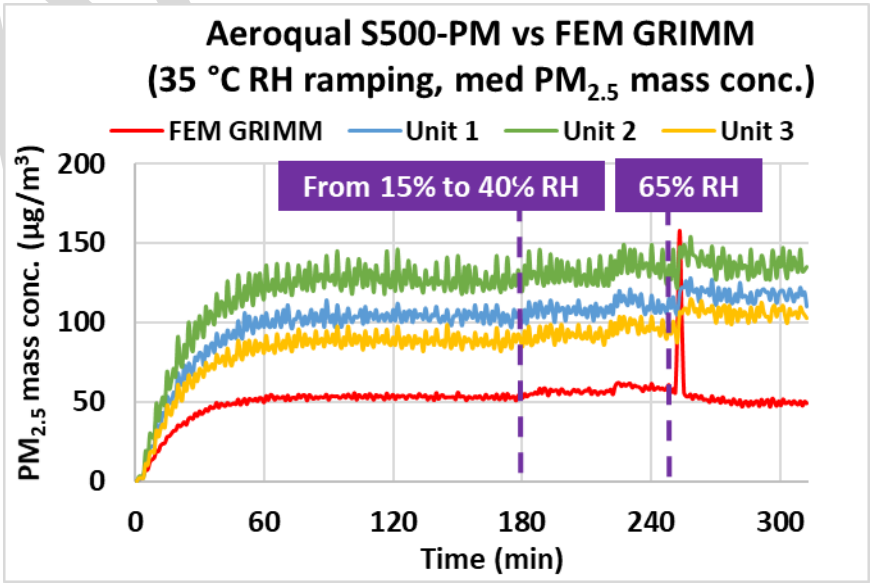

- Overall, the Aeroqual S500-PM sensors showed high precision for all combinations of low, medium and high $PM_{2.5}$ conc., T, and RH.
- Precision was relatively higher at higher $PM_{2.5}$ mass concentrations.

# Aeroqual S500-PM $PM_{2.5}$: Climate Susceptibility




**Low Temp – RH ramping (medium conc.)**

**High Temp – RH ramping (medium conc.)**



# Discussion

- **Accuracy**: Overall, the accuracy of the Aeroqual S500-PM sensors was fairly constant (~ 30 to 53%) over the $PM_{2.5}$ mass concentration range tested. The Aeroqual S500-PM sensors overestimated $PM_{2.5}$ measurements from FEM GRIMM in the laboratory experiments at 20 °C and 40% RH.
- **Precision**: The Aeroqual S500-PM sensors showed high precision for all test combinations (PM concentrations, T and RH) for $PM_{2.5}$ mass concentrations
- **Intra-model variability**: Moderate intra-model variability was observed among the Aeroqual S500-PM sensors.
- **Data Recovery:** Data recovery for $PM_{2.5}$ mass concentration was 100% from all Aeroqual S500-PM units
- **Coefficient of Determination**: The Aeroqual S500-PM sensors showed very strong correlation/linear response with the corresponding FEM GRIMM $PM_{2.5}$ measurement data ($R^2 > 0.99$).
- **Climate susceptibility**: For most of the temperature and relative humidity combination, the climate condition had minimal effect on the Aeroqual S500-PM sensors' precision; the sensors showed spiked conc. change at the RH change points at 5 °C and showed significant concentration variation at 5 °C/65% RH.