Field Evaluation
Samyoung S&C – SY-DS-DK3 PM
Sensor Evaluation Kit
From 03/07/2019 to 05/14/2019, three Samyoung S&C – SY-DS-DK3 PM Sensor Evaluation Kit (hereinafter Samyoung S&C) sensors were deployed at the South Coast AQMD stationary ambient monitoring site in Rubidoux and were run side-by-side with three reference instruments measuring the same pollutants.

- **Samyoung S&C (3 units tested):**
  - Particle sensor (optical; non-FEM)
  - PM sensor: PSMU2.5
  - Each unit reports: PM$_{2.5}$ ($\mu$g/m$^3$)
  - Unit cost: $100
  - Time resolution: ~1 second
  - Units IDs: 1, 2, 3

- **MetOne BAM (reference instrument):**
  - Beta-attenuation monitor (FEM PM$_{2.5}$ & PM$_{10}$)
  - Measures PM$_{2.5}$ & PM$_{10}$ ($\mu$g/m$^3$)
  - Unit cost: ~$20,000
  - Time resolution: 1-hr

- **GRIMM (reference instrument):**
  - Optical particle counter (FEM PM$_{2.5}$)
  - Measures PM$_{1.0}$, PM$_{2.5}$, and PM$_{10}$ ($\mu$g/m$^3$)
  - Cost: ~$25,000 and up
  - Time resolution: 1-min

- **Teledyne API T640 (reference instrument):**
  - Optical particle counter (FEM PM$_{2.5}$)
  - Measures PM$_{2.5}$ & PM$_{10}$ ($\mu$g/m$^3$)
  - Unit cost: ~$21,000
  - Time resolution: 1-min
Data validation & recovery

- Basic QA/QC procedures were used to validate the collected data (i.e. obvious outliers, negative values and invalid data-points were eliminated from the data-set)
- Data recovery for PM$_{2.5}$ mass conc. measurements from all units was ~ 85%.

Samyoung S&C; intra-model variability

- Moderate measurement variability (~26%) was observed between the three Samyoung S&C units for PM$_{2.5}$ mass concentration measurements
Data recovery for PM$_{2.5}$ from FEM GRIMM, FEM BAM and FEM T640 is 99.4 %, 94.5 % and ~100 %, respectively.

Good correlations between the three reference instruments for PM$_{2.5}$ measurements (0.65 < $R^2$ < 0.84) were observed.

$y = 0.6589x + 1.8652$

$R^2 = 0.6538$

$y = 0.6362x - 0.0236$

$R^2 = 0.8317$

$y = 0.9742x + 3.5274$

$R^2 = 0.7093$
Samyoung S&C vs FEM GRIMM (PM$_{2.5}$; 5-min mean)

- Samyoung S&C sensors showed moderate correlations with the corresponding FEM GRIMM data ($R^2 \approx 0.62$).
- Overall, the Samyoung S&C sensors overestimated the PM$_{2.5}$ mass concentrations measured by FEM GRIMM.
- The Samyoung S&C sensors seemed to moderately track the PM$_{2.5}$ diurnal variations as recorded by FEM GRIMM.
Samyoung S&C vs FEM GRIMM (PM\textsubscript{2.5}; 1-hr mean)

- Samyoung S&C sensors showed good correlations with the corresponding FEM GRIMM data ($R^2 \sim 0.65$)
- Overall, the Samyoung S&C sensors overestimated the PM\textsubscript{2.5} mass concentrations measured by FEM GRIMM
- The Samyoung S&C sensors seemed to track the PM\textsubscript{2.5} diurnal variations as recorded by FEM GRIMM

\begin{align*}
\text{Unit 1} & : y = 0.3558x + 2.3581, \quad R^2 = 0.6377 \\
\text{Unit 2} & : y = 0.3054x + 2.5161, \quad R^2 = 0.657 \\
\text{Unit 3} & : y = 0.2696x + 2.4649, \quad R^2 = 0.6558
\end{align*}
Samyoung S&C vs FEM GRIMM (PM$_{2.5}$; 24-hr mean)

- Samyoung S&C sensors showed good correlations with the corresponding FEM GRIMM data ($R^2 \sim 0.69$)
- Overall, the Samyoung S&C sensors overestimated the PM$_{2.5}$ mass concentrations measured by FEM GRIMM
- The Samyoung S&C sensors seemed to track the PM$_{2.5}$ diurnal variations as recorded by FEM GRIMM

$$y = 0.386x + 1.9914$$
$$R^2 = 0.6707$$

$$y = 0.3354x + 2.1007$$
$$R^2 = 0.6962$$

$$y = 0.293x + 2.0985$$
$$R^2 = 0.6902$$
Samyoung S&C sensors showed moderate correlations with the corresponding FEM BAM data ($R^2 \sim 0.55$).

Overall, the Samyoung S&C sensors overestimated the PM$_{2.5}$ mass concentrations measured by FEM BAM.

The Samyoung S&C sensors seemed to moderately track the PM$_{2.5}$ diurnal variations as recorded by FEM BAM.
Samyoung S&C vs FEM BAM (PM$_{2.5}$; 24-hr mean)

- Samyoung S&C sensors showed good correlations with the corresponding FEM BAM data ($R^2 \sim 0.65$)
- Overall, the Samyoung S&C sensors overestimated the PM$_{2.5}$ mass concentrations measured by FEM BAM
- The Samyoung S&C sensors seemed to track the PM$_{2.5}$ diurnal variations as recorded by FEM BAM
Samyoung S&C vs FEM T640 (PM$_{2.5}$; 5-min mean)

- Samyoung S&C sensors showed good correlations with the corresponding FEM T640 data ($R^2 \approx 0.69$)
- Overall, the Samyoung S&C sensors overestimated the PM$_{2.5}$ mass concentrations measured by FEM T640
- The Samyoung S&C sensors seemed to moderately track the PM$_{2.5}$ diurnal variations as recorded by FEM T640

![Graph showing comparison of PM$_{2.5}$ concentrations between Samyoung S&C and FEM T640 sensors for three units over the period from 4/8/19 to 4/20/19.](image)
Samyoung S&C vs FEM T640 (PM$_{2.5}$; 1-hr mean)

- Samyoung S&C sensors showed good correlations with the corresponding FEM T640 data ($R^2 \approx 0.72$)

- Overall, the Samyoung S&C sensors overestimated the PM$_{2.5}$ mass concentrations measured by FEM T640

- The Samyoung S&C sensors seemed to track the PM$_{2.5}$ diurnal variations as recorded by FEM T640
Samyoung S&C vs FEM T640 (PM\textsubscript{2.5}; 24-hr mean)

- Samyoung S&C sensors showed good correlations with the corresponding FEM T640 data ($R^2 \sim 0.78$)
- Overall, the Samyoung S&C sensors overestimated the PM\textsubscript{2.5} mass concentrations measured by FEM T640
- The Samyoung S&C sensors seemed to track the PM\textsubscript{2.5} diurnal variations as recorded by FEM T640
Discussion

- The three Samyoung S&C sensors’ data recovery for PM$_{2.5}$ mass conc. measurements from all units was ~ 85%.
- The three sensors showed moderate intra-model variability (~ 26%)
- The reference instruments (GRIMM, BAM and T640) showed good correlations with each other for PM$_{2.5}$ ($R^2$ ~ 0.73) mass concentration measurements (1-hr mean)
- PM$_{2.5}$ mass concentration measurements measured by Samyoung S&C sensors showed moderate to good correlations with the corresponding FEM GRIMM, FEM BAM and FEM T640 ($R^2$ ~ 0.65, 0.55 and 0.72, respectively, 1-hr mean) and overestimated PM$_{2.5}$ mass concentration measured by the FEM GRIMM, FEM BAM and FEM T640
- No sensor calibration was performed by South Coast AQMD Staff prior to the beginning of this test
- Laboratory chamber testing is necessary to fully evaluate the performance of these sensors under known aerosol concentrations and controlled temperature and relative humidity conditions
- All results are still preliminary