Airviz

Indoor performance testing results, December 2015

To demonstrate the performance of the Speck air quality monitor in a typical home environment, we installed a Grimm EDM 180 federal equivalence monitor (FEM) in a home kitchen along with three Speck units. Excluding a few hours where the monitor was switched off while guests were in the home, the test represents approximately 55 hours of co-located data collection.

The Grimm EDM 180 is an optical FEM that measures PM_1, $PM_{2.5}$, PM_{10}, and particle counts within 31 bins representing particle sizes from .25 to 32 microns. Our EDM 180 is capable of sampling once every 6 seconds, while the Speck is configured in this experiment to measure every second. In order to compare coefficient of determination values, we generate 6-second averages of the Speck readings at each of the EDM 180 timestamps.

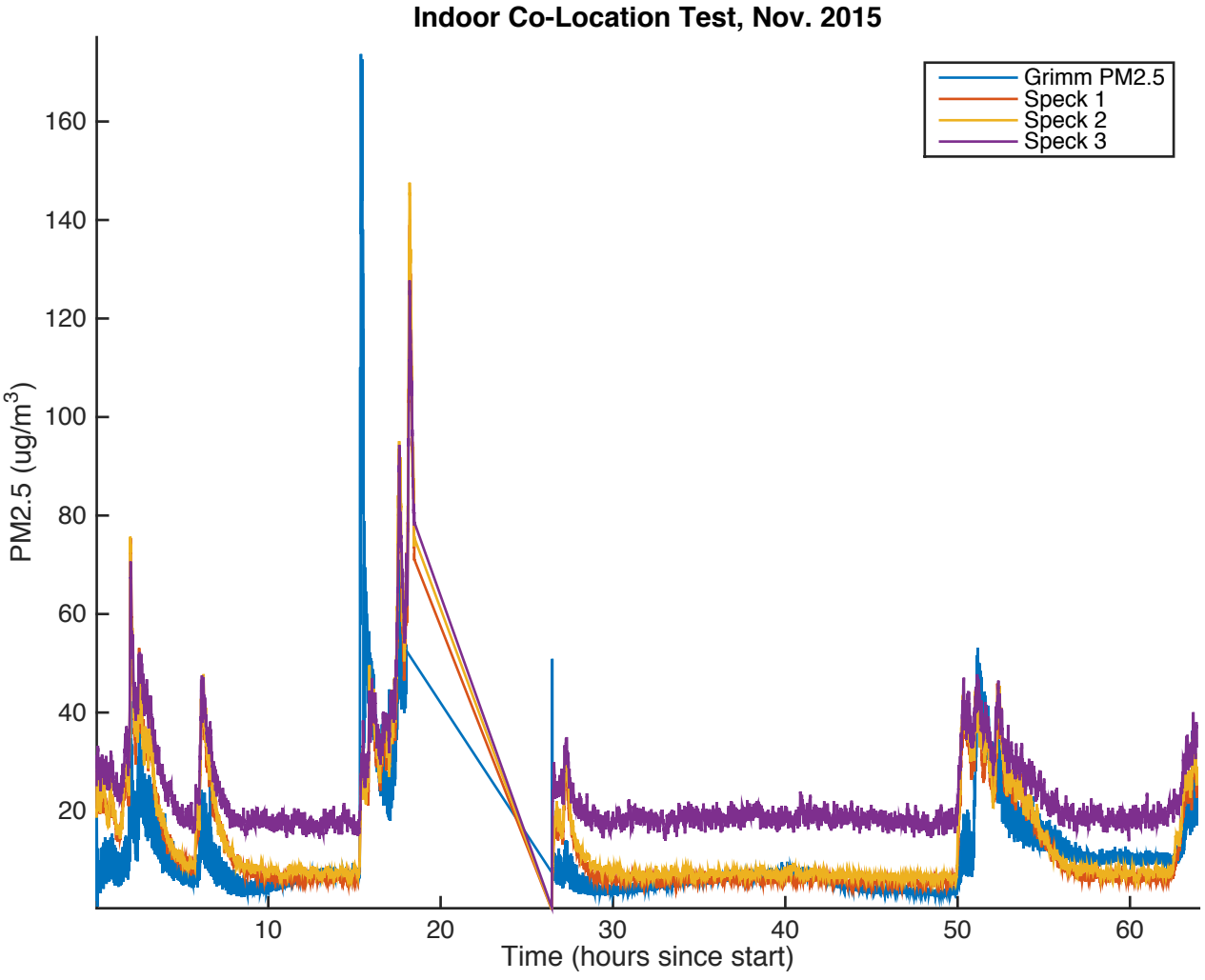

Fig. 1

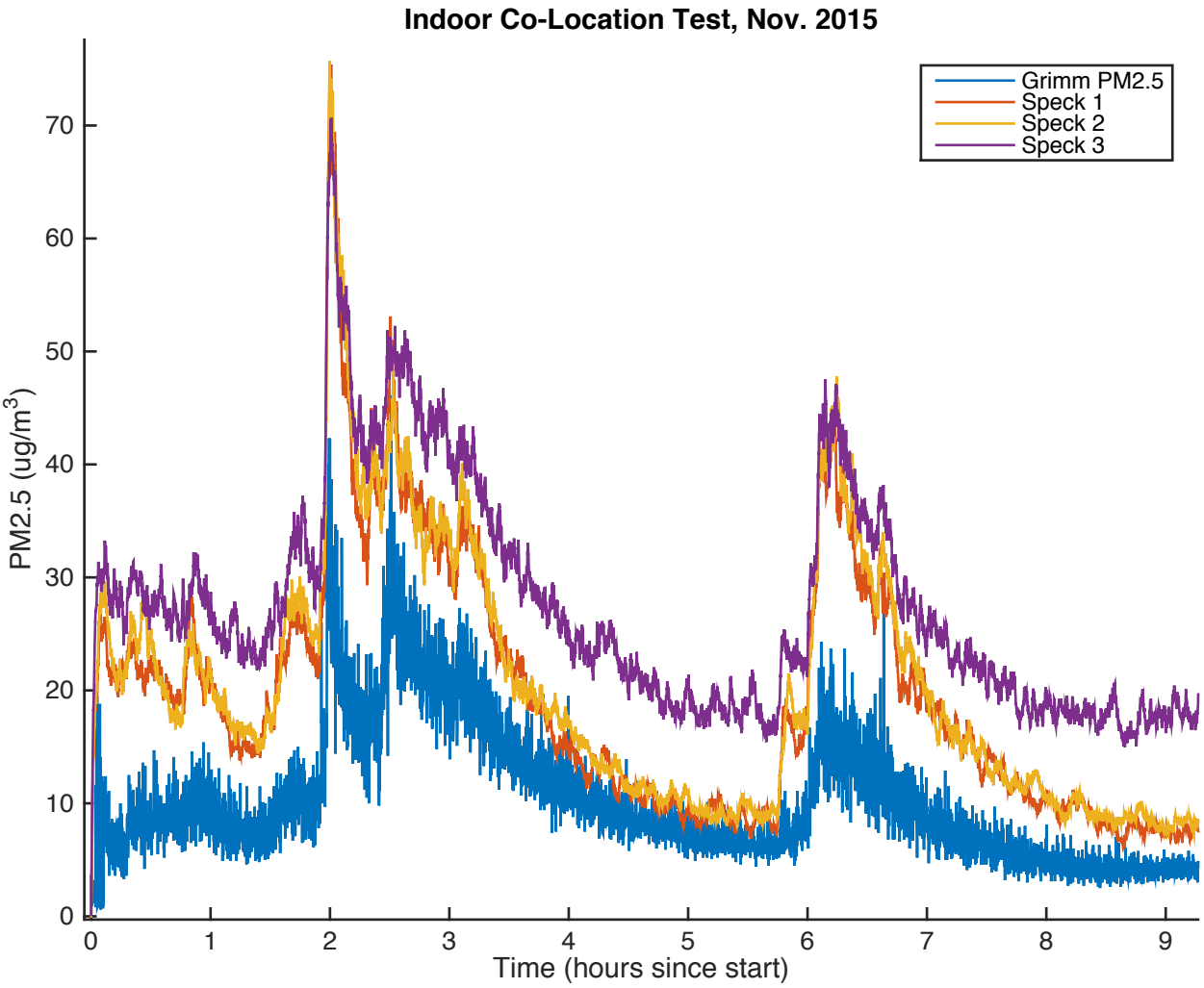

Fig. 2

Figures 1 and 2 shows the estimated $PM_{2.5}$ values for each Speck as well as $PM_{2.5}$ measured by the Grimm EDM 180 FEM. In this test, each of the three Specks slightly overestimates $PM_{2.5}$ as reported by the EDM 180, but the general shape of the air quality events remains preserved. Speck 3 is unusual in that it settles at a much higher minimum value, which may indicate that this unit is in need of cleaning.

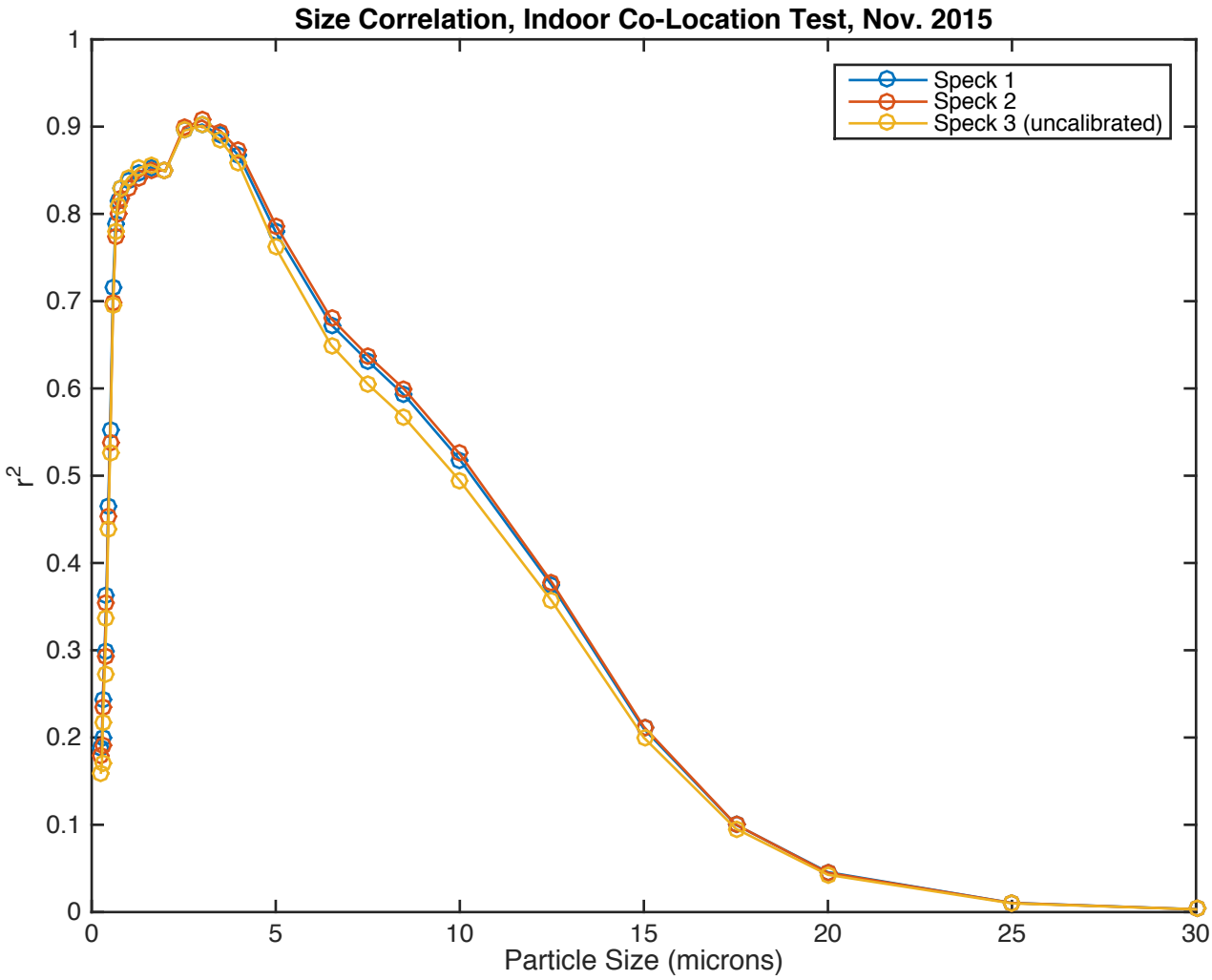

Fig. 3

Figure 3 shows the correlation coefficient (r^2) for each Speck with respect to each of 30 Grimm EDM 180 bins, plot according to size. The 32 micron bin, representing the largest measured particles, is excluded because no particles this large were recorded by the EDM 180 during this experiment.

From this plot, we see that the Speck's correlation coefficient is greater than 0.8 for particles from 0.7 to 4 microns. These values may vary somewhat by location because of different particle size distributions.

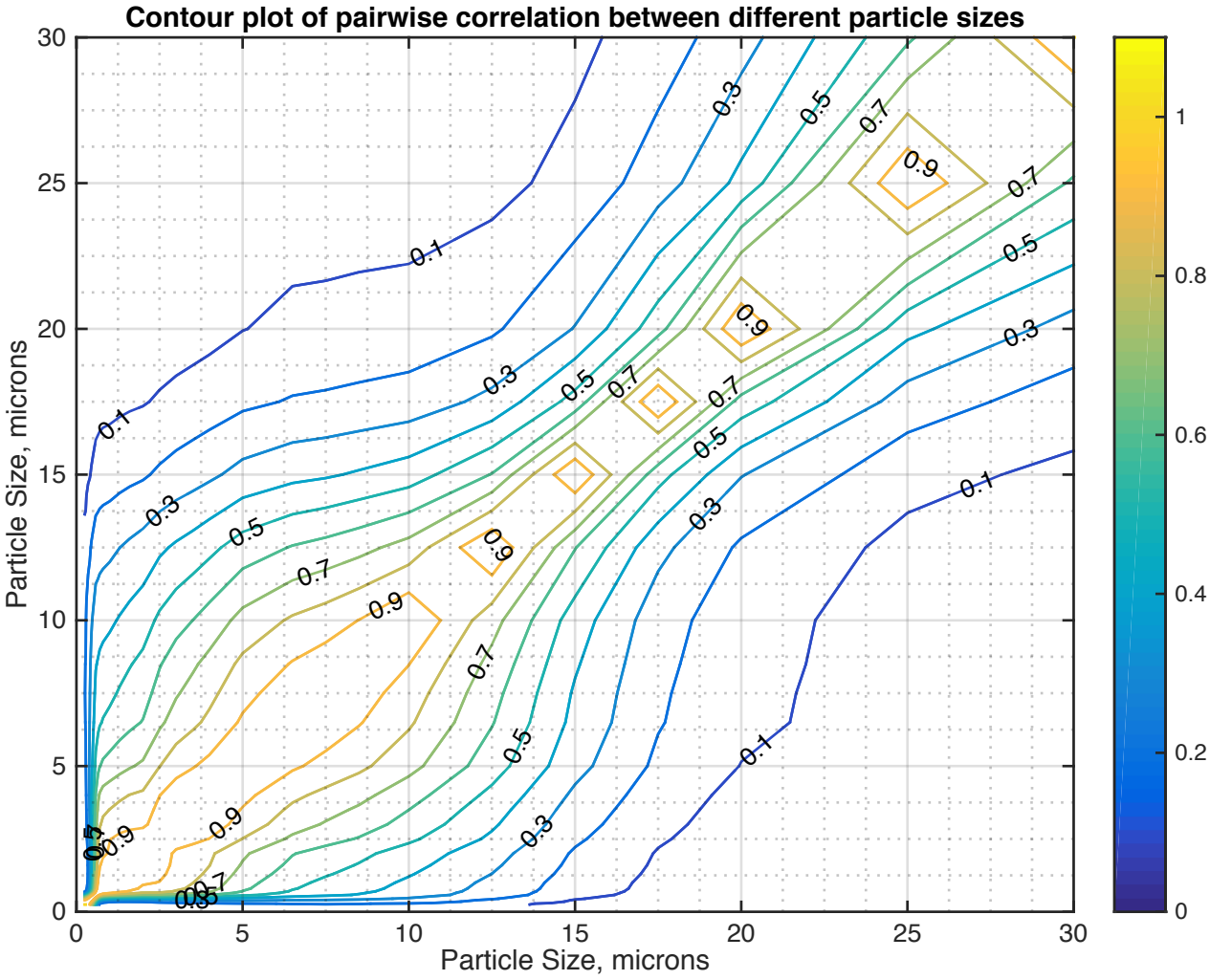

Fig. 4

Figure 4 shows the r^2 values between different size channels of the EDM 180. These values are predictably similar for similar sizes. This figure shows that similarly sized particles tend to appear and dissipate at the same time.

Speck vs. Mass Fraction r^2 coefficients

	Speck 1	Speck 2	Speck 3
PM1	0.20	0.19	0.17
PM2.5	0.46	0.44	0.42
PM10	0.83	0.83	0.81

Table 1

The Grimm EDM 180 also reports mass fractions for PM_1, $PM_{2.5}$, and PM_{10}. These values represent total mass values for all particles below 1, 2.5, and 10 microns respectively. The r^2 coefficients for the three Specks versus these three values are given in Table 1 above. The Speck

exhibits a higher correlation with larger mass size fractions, despite having a highest correlation value with individual particle size bins between .7 and 4 microns in this experiment.

Speck vs. Ranged Mass r^2 coefficients

	Speck 1	Speck 2	Speck 3
PM1	0.20	0.19	0.17
PM2.5-PM1	0.82	0.82	0.83
PM10-PM2.5	0.83	0.84	0.81

Table 2

Table 2 shows r^2 values for each Speck versus mass values from particles smaller than 1 micron, between 1 up to and including 2.5 microns, and 2.5 microns up to and including 10 microns respectively. Here we see that the correlation coefficients are similar for the latter two ranges.

Mass vs. Mass r^2 coefficients

	PM1	PM2.5	PM10
PM1	1.00	0.90	0.40
PM2.5	0.90	1.00	0.66
PM10	0.40	0.66	1.00

Table 3

Table 3 shows r^2 values between each pair of PM_1, $PM_{2.5}$, and PM_{10}values from the Grimm EDM 180. As with individual particle bins, there is a non-zero correlation between each of these three mass fractions, indicating a relationship between the rise and fall of large and small particles. Independent control of smaller particle size ranges will require controlled chamber testing with aerosol size standards.

These results show that the Speck correlates strongly to fine particulates especially in the range of .7 to 4 microns, and exhibits decreasing sensitivity to larger particles. While the correlation is stronger between the Speck reading and PM_{10} with r^2=.83, there is also a nontrivial correlation of r^2=.44 between the Speck and $PM_{2.5}$.