4 Co-located sensors

Finally got some sense out of 4 different sensors subjected to a squirt of canned smoke.

The sensors used were:-

1. DSM501
2. Sharp gp2y1010 – no fans were used.
3. zph01 (courtesy of Rob Miles) – looks very similar to the Sharp (Identical case)
4. ion Chamber (made it myself using Smoke alarm components)

The DSM datasheet says to use a sample period of 30 seconds but all the other sensors were ok for 1s on and 1s off. So I drove the DSM at the same rate and it appears to work ok.

Each sensor tends to give a different raw output value so I multiplied up the Ion chamber and Sharp outputs just to get them on the same scale and show the trends.

The sensor outputs were subjected to a rolling average but still showed some spiky outputs. The DSM in particular was very spiky so, perhaps, the sample rate was too quick for it. I needed to use the 1 second sample 1 second rest routine to capture the rise and fall of the sensor responses to see how closely they followed each other.

The readings taken were:-

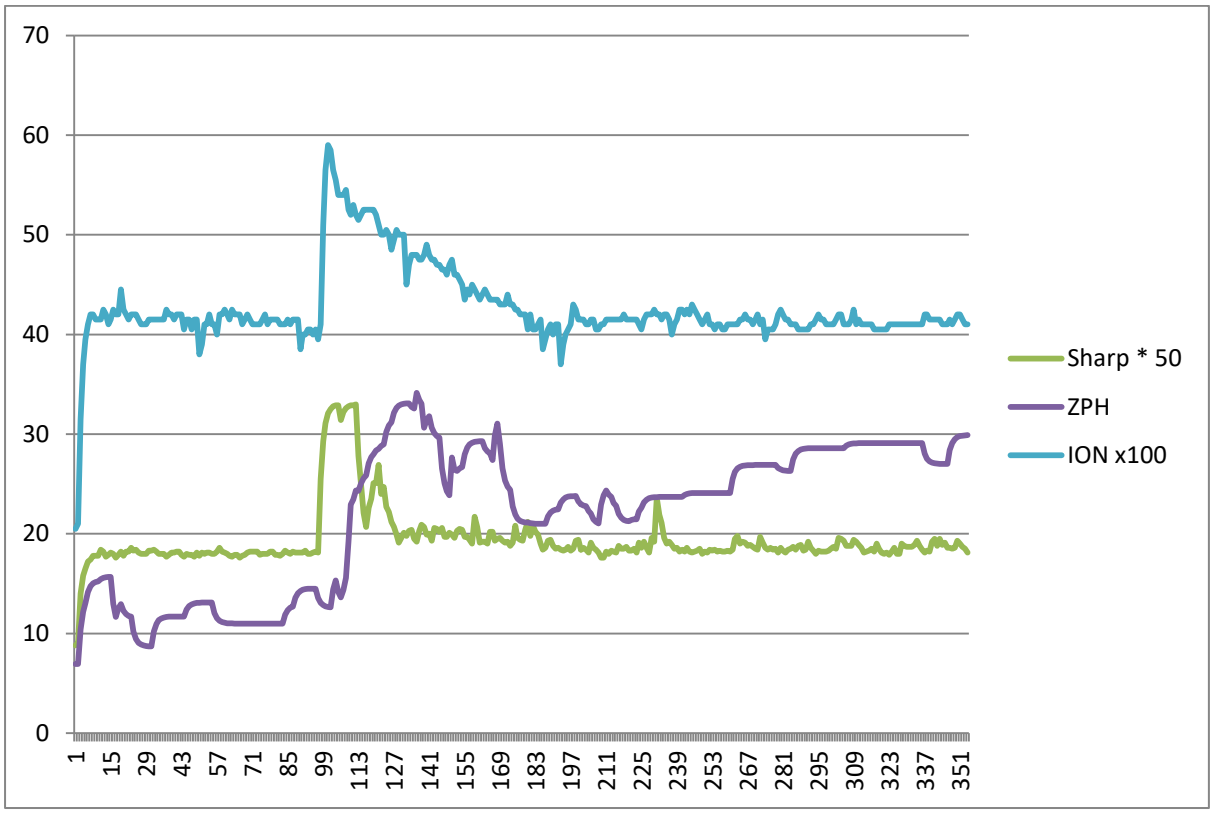
1. DSM pm10 low occupancy ratio (%)
2. DSM pm25 low occupancy ratio (%)
3. Sharp output voltage reading
4. ZPH01 – low occupancy ratio (%)
5. Ion chamber – output voltage (smoothed by a C-R with time constant 0.5s)

The Sharp and Ion chamber readings where low so I scaled them up to emphasise their response. So, for the first few charts please ignore the scales and look, instead, at the shape of the responses. All the devices responded fairly quickly to a squirt of canned smoke. You wouldn't go near anywhere with that much smoke in the air.

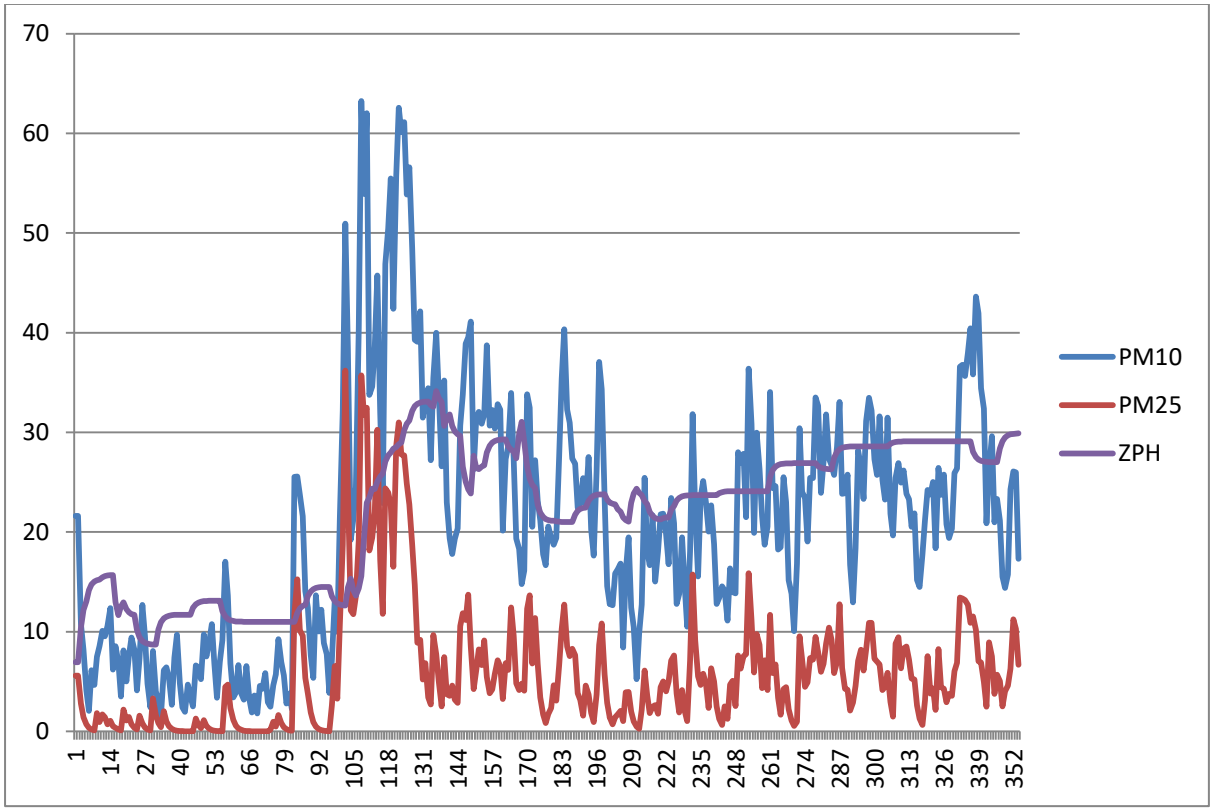
The ZPH01 seemed to be the steady Eddie in this sensor collection, with a nice smoothed response, so I used it as a reference point on both charts that follow. However, notice that the ZPH01 also has a delayed response of several seconds (the horizontal axis readings are at 1 second intervals). I assume this is the device's MCU doing some internal averaging – which might explain why the readings from the sensor tends to be less spiky than the others.

Also, of interest, is the output of the ZPH01 having dipped after a burst of canned smoke then beginning to rise again. This could be eddy currents in my room causing the smoke particles to remain in the air longer than I expected (must open a window – there, just done that! Will take more readings later.)

ZPH01 vs Sharp and Ion chamber



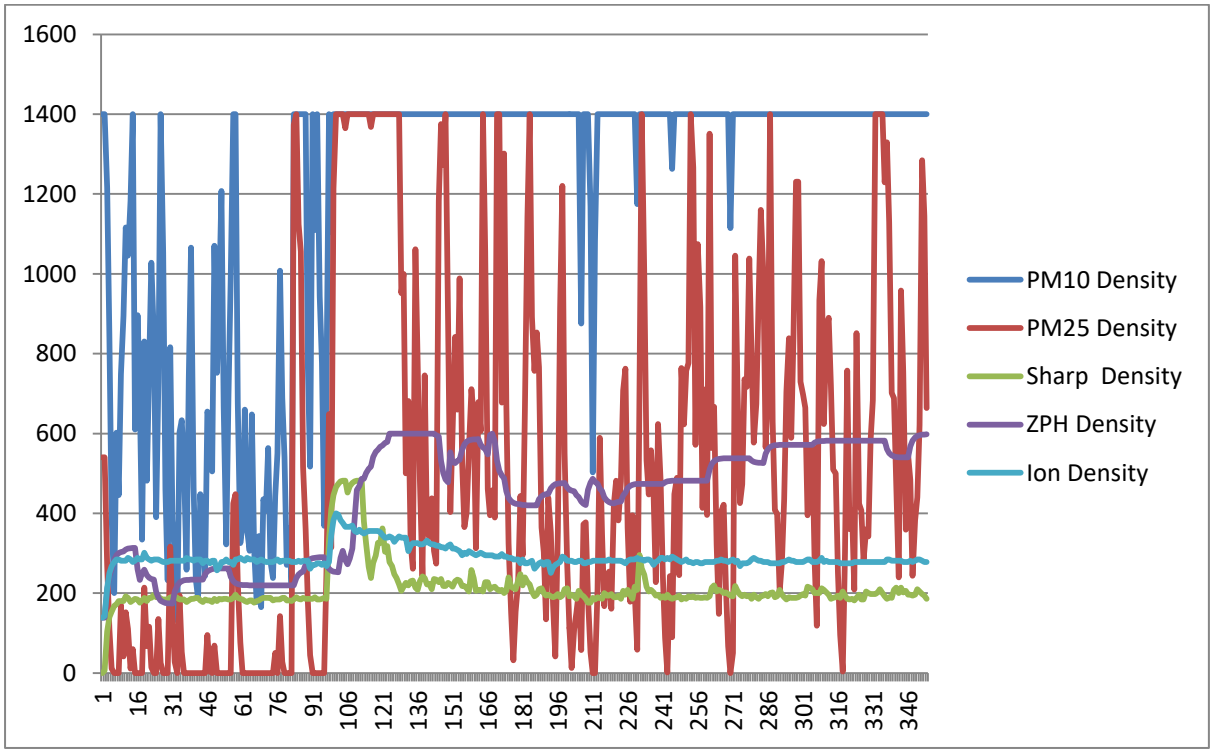
Unsmoothed DSM vs ZPH01



Using Calculated Density

Using the manufacturer's datasheets I computed the particle densities in µg/m^3 and replotted the charts. Since the Ion chamber has no data sheet I used the first two values of the ZPH01 and the ion chamber to estimate a simple ratio which would attempt to fit the ion chamber output to the same range as the ZPH01 , as the ZPH01 seems to be the least noisy.

This chart shows the calculated µg/m^3 for all the sensors. Most sensors have a 30% tolerance so that needs to be considered. The ZPH01 datasheet chart implies a limit of 600µg/m^3 (hence my flattened peak at 600.). The Sharp tops out at 500 µg/m^3 and the DSM charts suggest it measures up to 1400µg/m^3 (I think you would definitely have noticed the smoke at that level).



Smoothing the DSM501

In the next chart I have smoothed the PM10 readings by averaging the past 30 readings – this brings the curve into line with the manufacturer's datasheet which indicates that the low pulse occupancy should be calculated over 30 seconds.

The line starts high because there aren't 30 readings available till we reach the 30th reading. The effect of the smoothing is evident but it also means the sensor's output really cannot be relied on till it has been on for 30 seconds or longer with s/w averaging being used.

Clearly, even with averaging, the DSM501 and ZPH01 still don't compare very well on density.

The NASA AQI index chart below (https://spacemath.gsfc.nasa.gov/earth/10Page105.pdf) shows that PM2.5 below 65.4 is considered healthy yet all the results I have obtained indicate my 'office' is very unhealthy – must be all the canned smoke I've been squirting at the sensors.

AQI	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	Air Quality Descriptor
0–50	0.0–15.4	0–54	Good
51–100	15.5–40.4	55–154	Moderate
101–150	40.5–65.4	155–254	Unhealthy for Sensitive Groups
151–200	65.5–150.4	255–354	Unhealthy
201–300	150.5–250.4	355–424	Very unhealthy

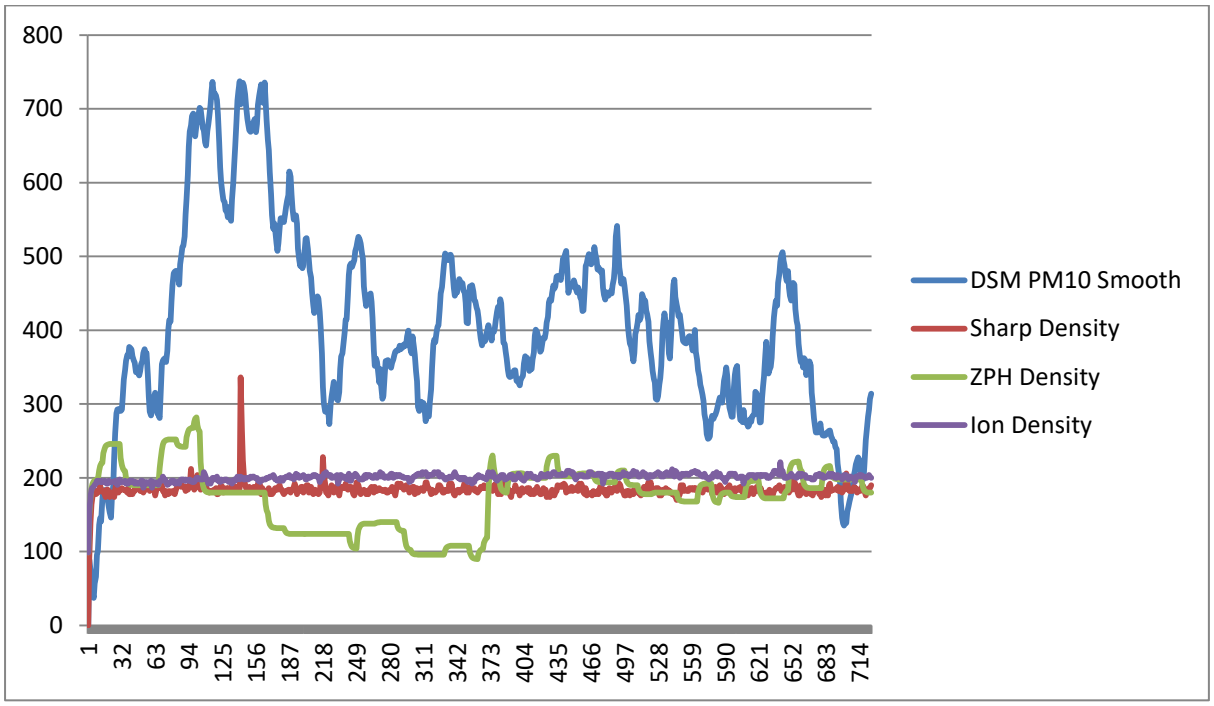
After Opening a Window

Well this is all very interesting. This chart shows the calculated densities ($\mu g/m^3$) for all the sensors but omitting the DSM501 pm25 for clarity.

Apparently it's very unhealthy in my cul-de-sac with the window open. It must be the blokes across the road building a block paved driveway for a neighbour – LOL.

The DSM501 sensor appears to have a different perspective though it looks like it's just taking its time coming down. The ZPH01 exhibits an under-shoot but came back to its senses – don't ask why. I haven't got a clue.

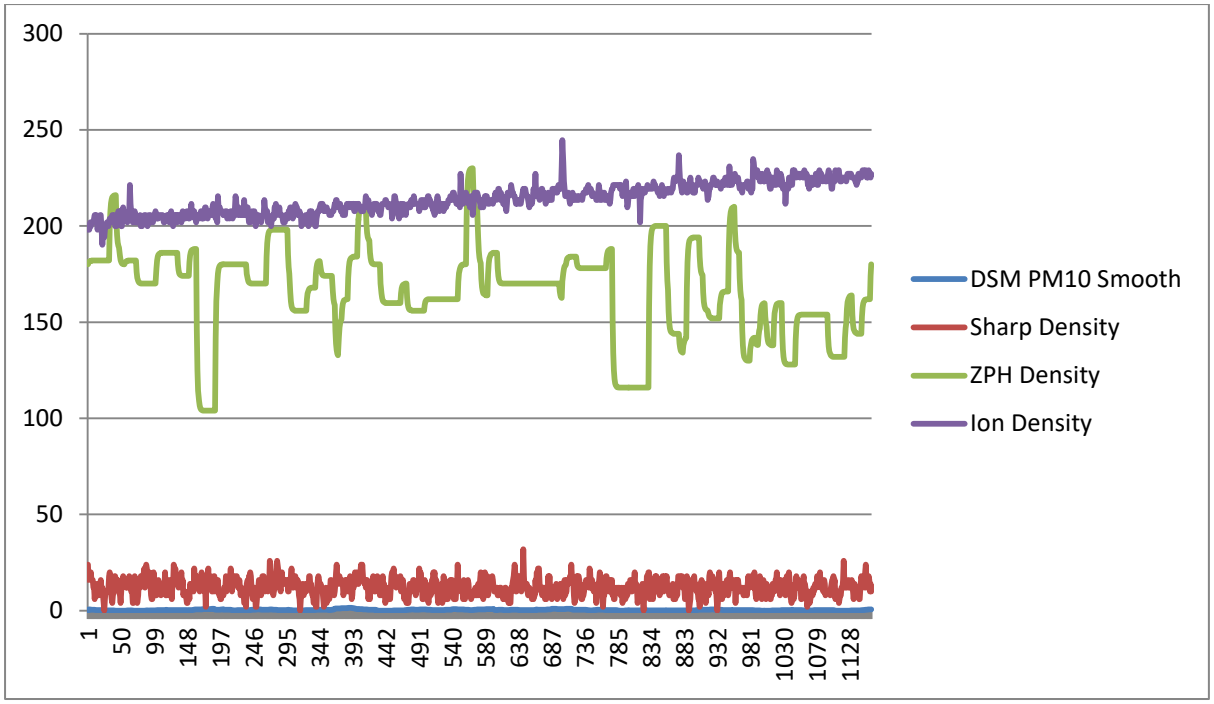
The Sharp and my ion chamber appear to be in broad agreement but they could both be wrong, and I expect they are otherwise I would be dead with those numbers and I'm clearly still typing this.



1128 seconds later.

Odd that the ion chamber trace is gradually increasing. The power source is still holding steady at 9v and other voltage levels are correct so it isn't caused by that.

The Sharp and DSM501 have settled down to a very healthy (how I feel) figure whilst the ZPH01 is indicating a much higher dust level.



Conclusion

As James Earl Jones says in The Hunt for Red-October 'The data supports no conclusions as yet'.

The one worry is the readings I am getting from the ZPH01 with the window open. I will have to put it in a vacuum storage bag and suck the air out to see how low it goes.