# Gather Dust and Get Dusted: Long-Term Drift and Cleaning of Sharp GP2Y1010AU0F Dust Sensor in a Steel Factory

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## 1. Introduction

The Sharp GP2Y1010AU0F is a widely used low-cost dust sensor, but despite its popularity, the manufacturer provides little information on the sensor. Researchers made efforts to characterize the sensor and to find meaningful calibration principles for it [1] . Yet, little information on the sensor's long-term drift is available. Existing analyses often cover only a few devices and relatively short periods [2] [3] . We installed 16 sensing nodes with Sharp dust sensors in a hot rolling mill of a steel factory. In this paper, we analyze the long-term drift of these devices over ten months and the effectiveness of an onsite cleaning of the sensors with compressed air.

## 2. System Description

### 2.1 Sensor and Sensing Node

Sharp's GP2Y1010AU0F dust sensor is based on an optical measurement principle with two diodes: A light detecting diode senses the intensity of pulsed light that is emitted by the other diode. Sharp specifies the measurement range of its sensor with up to 500 µg/m³.

Each sensing node is equipped with one dust sensor, housed in a weather protective casing. A fan is ventilating the system. More information of the sensing node can be found in [4] .

### 2.2 Environment

In April 2021, 16 sensing nodes were set up at the hot rolling mill of the stainless-steel manufacturer Outokumpu in Tornio, Finland. The sensor network covers an area of around 30 times 150 meters (see Fig. 1), in which known dust-releasing processes take place. We published a detailed description of the facility of the measurement environment in [5] .

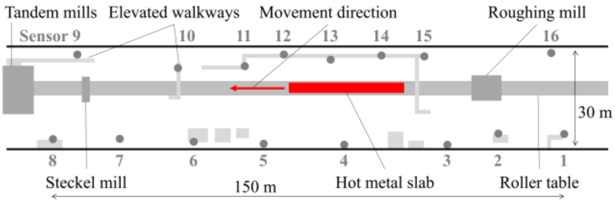

*Fig. 1: Simplified layout of the sensor network environment.*

## 3. Data Description

We analyzed raw sensor data obtained between 1 May 2021 and 28 February 2022. Although the sensors were already set up and exposed to the environment in early April 2021, most devices did not record data before May. Of the theoretically possible 4.864 data points (= 304 days x 16 sensors), we obtained 4.781 unique data points. This is due to temporary outages of some sensing nodes. The sensor signal is interpreted with a 12-bit analog-to-digital converter, which maps the sensor's output voltage to 4096 digital values. While the sensors are sampled every 30 seconds, we resampled the sensors over a window of one calendar day to neglect short-termed effects. Sensor outages were interpolated during resampling.

## 4. Long-Term Drift Analysis

We recognized different drift behaviors for different devices. Most of our 16 dust sensors drifted linearly over time, as displayed in Fig. 2. The drift highly correlates with the accumulated production volume of the facility, which is represented by the black line. The production pause in September lead to a short-term drop of the sensor signals, without any drift. Shortly after the production ramped up, the baseline of the sensors started to increase over time, again.

However, not all sensors drift linearly. Fig. 3 shows sensors whose drift significantly flattens over time. This behavior is generally expected for all sensors but seems to vary in magnitude for each sensor. Curiously, the sensors displayed in Fig. 4 have a negative drift, after a short-term build-up in the first half of May 2021. Although we cannot fully explain this behavior, we assume that it is due to the special location of these sensors in the factory.

In May, June, and November, we compared the sensor signal to gravimetric dust samples. The dust concentrations varied from <0.1 to 8.2 mg/m³ with no clear trend over time for many sensors. Thus, confirming that sensor signals were indeed affected by drift instead of actual concentration differences.

### *4.1 Cleaning in November*

We cleaned the sensors with compressed, canned air on 2021-11-09. This cleaning event is clearly visible in Fig. 4. We sprayed multiple short blows through the sensor’s hole, intending to clean the two diodes, until we recognized a drop in the sensor’s output voltage. This was performed without dismounting the sensors. Looking at the sensor logs, we do not recognize a long-lasting effect of the cleaning. Most sensors quickly went back to their pre-cleaning drift level, and we could not bring back any sensor to the initial factory settings. Only for a few sensors we achieved a stable drift reduction.

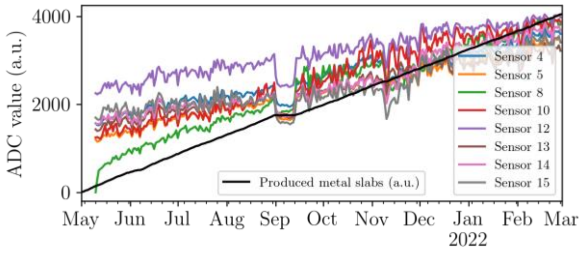

*Fig. 2: Most sensors show a nearly linear drift behavior with the production volume. The sensor labels correspond with the labels in Fig. 1.*

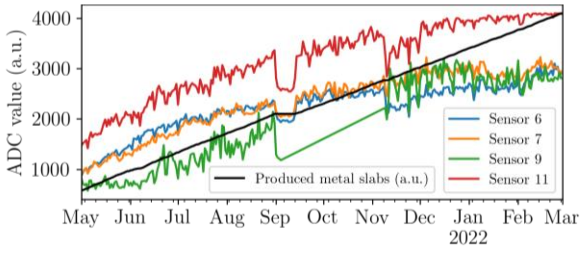

*Fig. 3: Sensor drift slows down over time for some sensors. The power supply for sensor 9 was broken between September and November.*

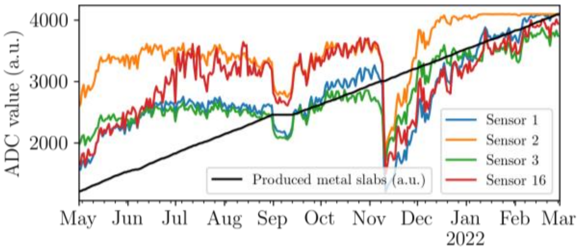

*Fig. 4: Non-linear and negative drift of other sensors, probably caused by their special location. The cleaning in November reset the sensor drift, but the effect vanished quickly.*

## 5. Conclusion

Our analysis shows a clear correlation between sensor drift and accumulated production of the steel factory. An eye should be kept on the long-term drift of the sensors to prevent early saturation. Two of 16 sensors experienced full saturation, each after around eight and ten months of operation.

We do not consider the approach of cleaning the sensors with canned air successful. Although not sustainable, we suggest replacing the whole dust sensor or clean them more extensively in a separate laboratory.

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## References

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