

# TO SEE INVISSIBLE

## air dust sensor workshops



**GREEN ALLIANCE**



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**Erasmus+ Short-term exchange of groups of pupils**  
**Zespół Szkolno-Przedszkolny w Dębem, POLAND**  
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## What is PM, and how does it get into the air?

PM stands for particulate matter (also called particle pollution): the term for a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope.

Particle pollution includes:

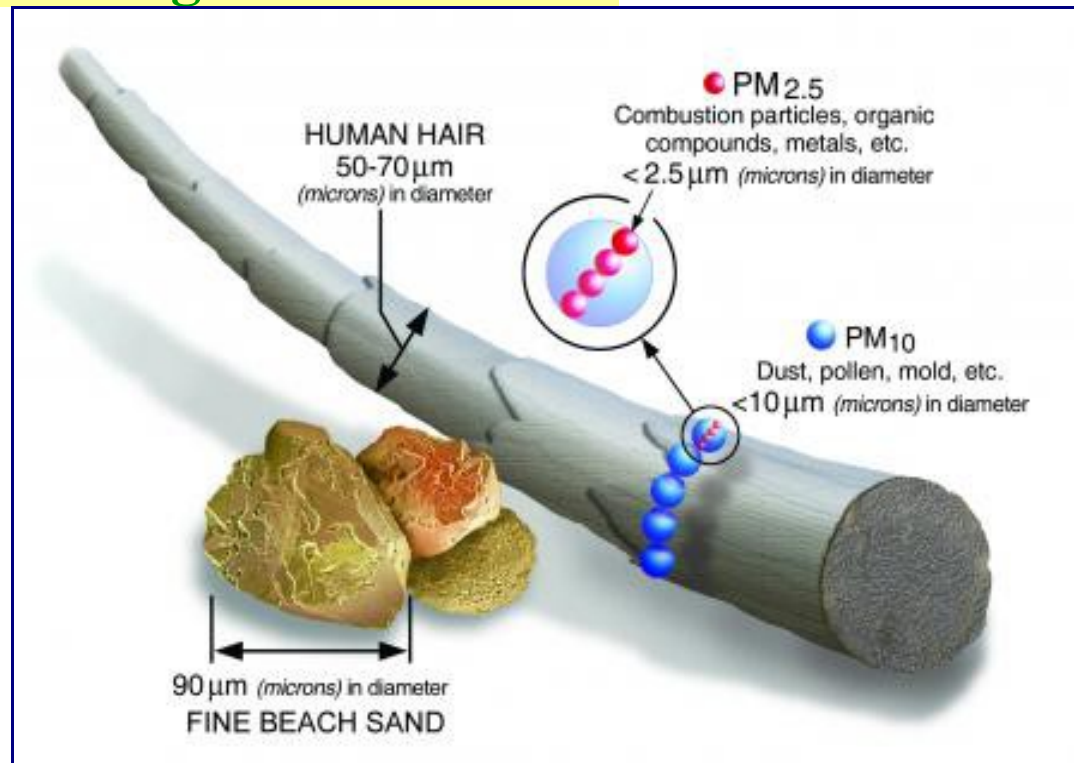
**PM<sub>10</sub>**: inhalable particles, with diameters that are generally 10 micrometers and smaller; and

**PM<sub>2.5</sub>**: fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller.

How small is 2.5 micrometers? Think about a single hair from your head. The average human hair is about 70 micrometers in diameter – making it 30 times larger than the largest fine particle.

### Sources of PM

These particles come in many sizes and shapes and can be made up of hundreds of different chemicals. Some are emitted directly from a source, such as construction sites, unpaved roads, fields, smokestacks or fires. Most particles form in the atmosphere as a result of complex reactions of chemicals such as sulfur dioxide and nitrogen oxides, which are pollutants emitted from power plants, industries and automobiles.



## What are the Harmful Effects of PM?

Particulate matter contains microscopic solids or liquid droplets that are so small that they can be inhaled and cause serious health problems. Some particles less than 10 micrometers in diameter can get deep into your lungs and some may even get into your bloodstream. Of these, particles less than 2.5 micrometers in diameter, also known as fine particles or PM<sub>2.5</sub>, pose the greatest risk to health.

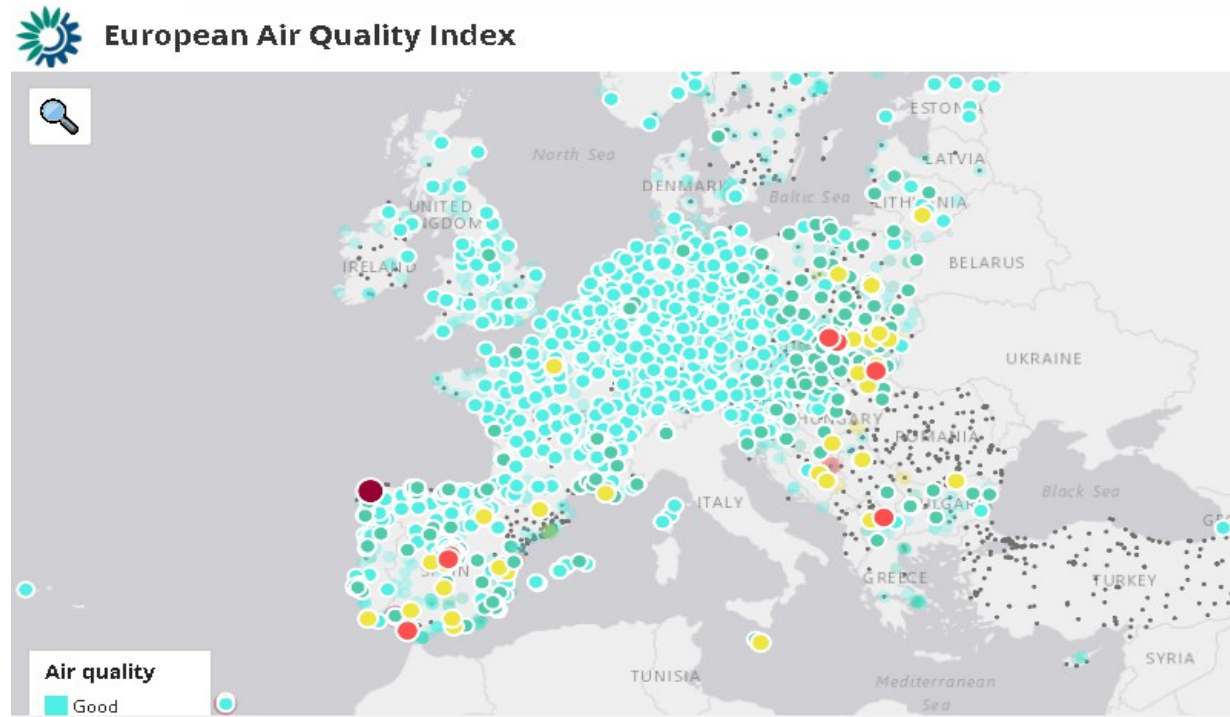
**Bad air kills almost a million Europeans a year. According to recent estimates, it shortens our lives by almost three years.**

# How Can I Reduce My Exposure to PM?

You can use air quality alerts to protect yourself and others when PM reaches harmful levels: <https://airindex.eea.europa.eu/>

## How many air quality meter station is next to me?

<https://airindex.eea.europa.eu/>



## What can I do if there is no air quality station next to me?

**You can measure air quality Yourself. Build a sensor and become part of the worldwide civic tech network**

## What is Luftdaten air quality sensor?

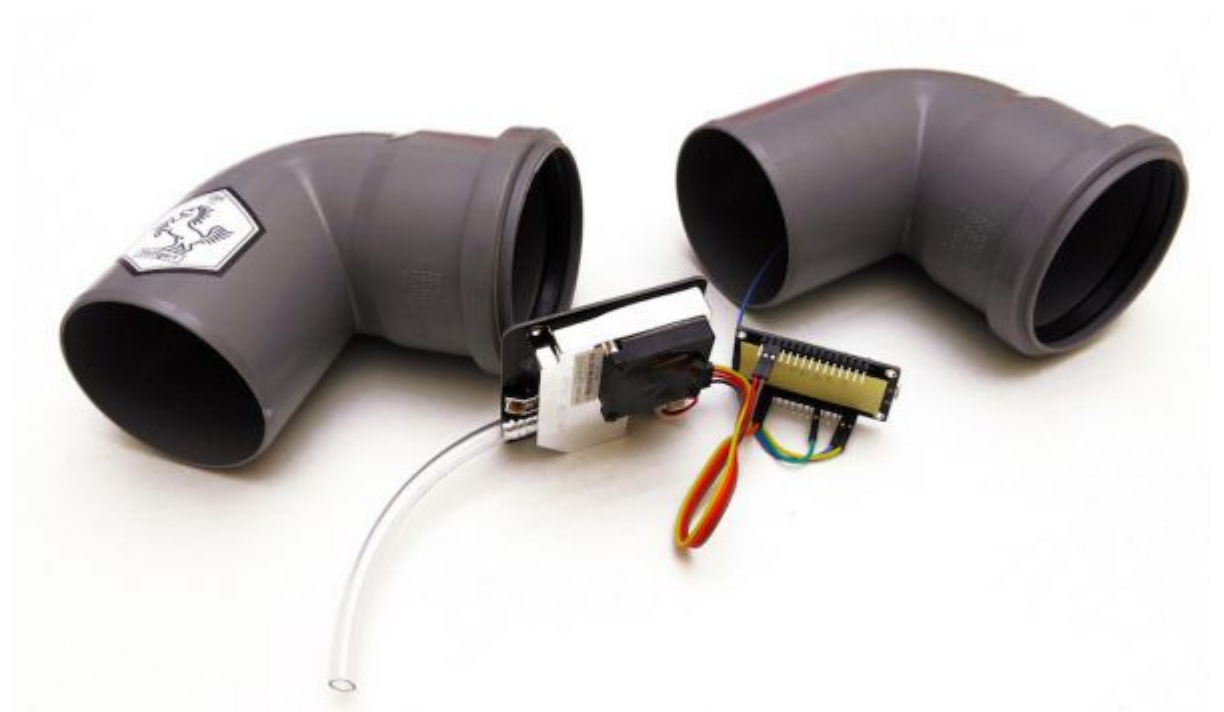
The fine dust measurement with the Citizen Science project luftdaten.info. You and thousands of others around the world install self-built sensors on the outside their home. Luftdaten.info generates a continuously updated particular matter map from the transmitted data. **Fine dust becomes visible. It can measure the smallest PM.**

Air Quality Index	SO <sub>2</sub>	NO <sub>2</sub>	CO	PM <sub>10</sub>	PM <sub>2,5</sub>	O <sub>3</sub>	C <sub>6</sub> H <sub>6</sub>	Meaning
<b>Good</b>	0–50	0–40	0–2 499	<b>0–20</b>	<b>0–12</b>	0–30	0–5	The air quality is satisfactory, air pollution is not a threat, ideal conditions for outdoor activities
<b>Satisfactory</b>	51–100	41–100	2 500–6 499	<b>21–60</b>	<b>13–36</b>	31–70	6–10	Air quality is still satisfactory, air pollution is a minimal threat to those at risk *, very good conditions for outdoor activities
<b>Moderately polluted</b>	101–200	101–150	6 500–10 499	<b>61–100</b>	<b>37–60</b>	71–120	11–15	Air quality is acceptable, air pollution can pose a risk to people at risk *, good conditions for outdoor activities
<b>Poor</b>	201–350	151–200	10 500–14 499	<b>101–140</b>	<b>61–84</b>	121–160	16–20	Air quality is average, air pollution is a threat to those at risk * who may experience health effects, others should limit spending time outside, especially when they experience symptoms such as coughing or sore throat
<b>Very poor</b>	351–500	201–400	14 500–20 499	<b>141–200</b>	<b>85–120</b>	161–240	21–50	The air quality is bad, people at risk * should avoid going outside, the rest of the population should limit it, outdoor activities are not recommended
<b>Hazardous</b>	>500	>400	>20 499	<b>&gt;200</b>	<b>&gt;120</b>	>240	>50	Air quality is dangerously bad, people at risk * should absolutely avoid going outside, the remaining population should limit the exit to a minimum, all outdoor activities are discouraged

# Fine dust sensor construction

## Shopping list

- NodeMCU ESP8266, CPU/WLAN
- SDS011 Fine dust sensor (formerly PPD42NS)
- BME280, temperature & humidity (optional)
- Cable
- USB cable e.g.: flat 2m Micro-USB
- Power supply USB
- Cable straps
- Flexible tube, if possible not transparent, diameter 6 mm, length approx. 20cm (DIY store)
- Weather protection, Marley Silent HT Arc (DN 75 87°)



## Assemble

The assembly is designed in such a way that everyone can take part. With only 7 discs and 2 cable ties, the kit becomes a measuring station. Really simple!

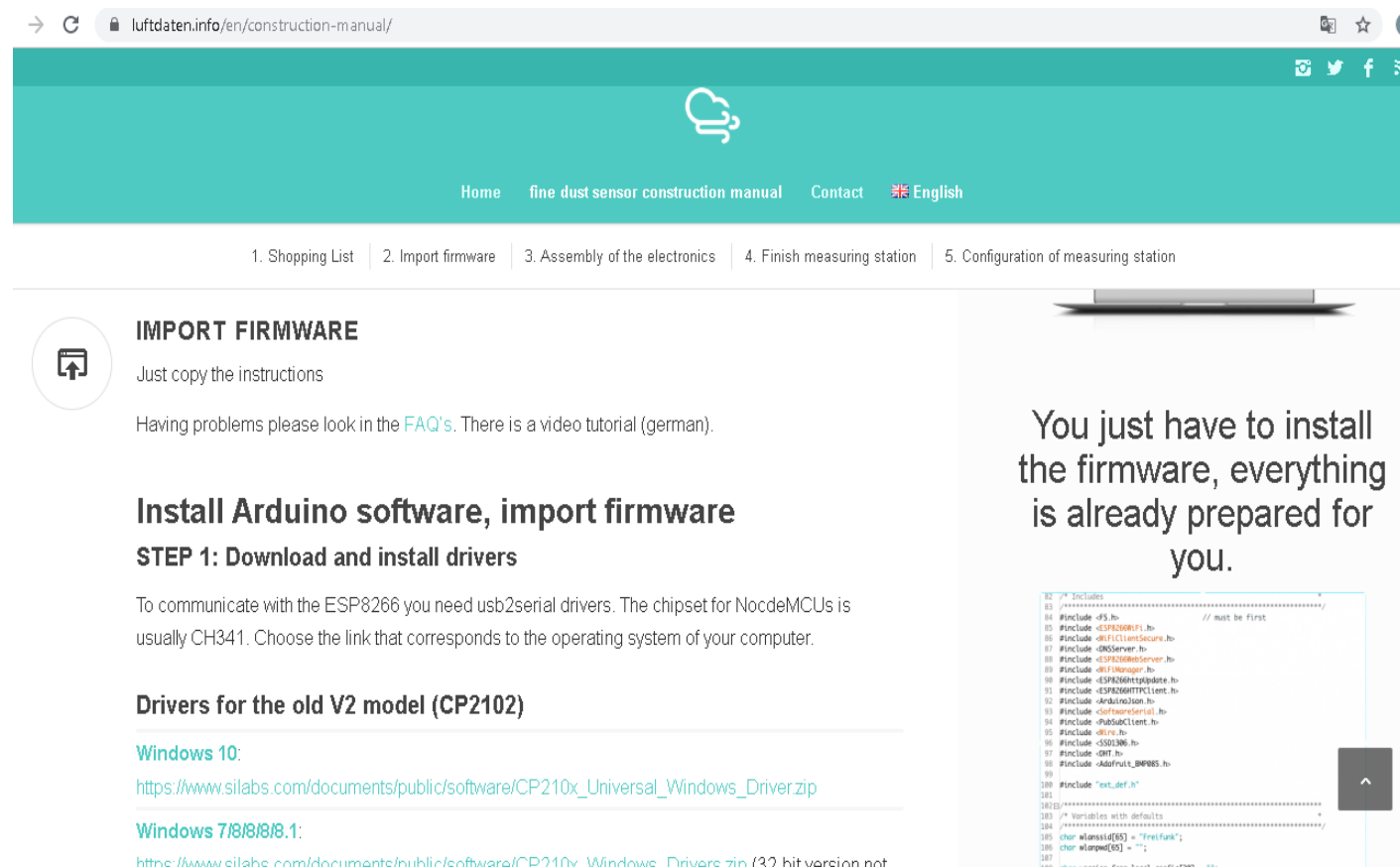
# Import and install software on computer, download and program firmware, register on luftdaten.info etc.

You do not have to program, don't worry!

We already programmed the firmware and do everything for you.

If you need more informations, just visit:

[www.luftdaten.info](http://www.luftdaten.info)



luftdaten.info/en/construction-manual/

Home fine dust sensor construction manual Contact English

1. Shopping List | 2. Import firmware | 3. Assembly of the electronics | 4. Finish measuring station | 5. Configuration of measuring station

## IMPORT FIRMWARE

Just copy the instructions

Having problems please look in the [FAQ's](#). There is a video tutorial (german).

### Install Arduino software, import firmware

#### STEP 1: Download and install drivers

To communicate with the ESP8266 you need usb2serial drivers. The chipset for NodemCUs is usually CH341. Choose the link that corresponds to the operating system of your computer.

#### Drivers for the old V2 model (CP2102)

**Windows 10:**  
[https://www.silabs.com/documents/public/software/CP210x\\_Universal\\_Windows\\_Driver.zip](https://www.silabs.com/documents/public/software/CP210x_Universal_Windows_Driver.zip)

**Windows 7/8/8.1:**  
[https://www.silabs.com/documents/public/software/CP210x\\_Windows\\_Drivers.zip](https://www.silabs.com/documents/public/software/CP210x_Windows_Drivers.zip) (32 bit version not)

```
82 /* Includes
83 .....
84 #include <FS.h> // must be first
85 #include <ESP8266WiFi.h>
86 #include <WiFiClientSecure.h>
87 #include <DNSServer.h>
88 #include <ESP8266WebServer.h>
89 #include <WiFiManager.h>
90 #include <ESP8266HTTPUpdate.h>
91 #include <ESP8266HTTPClient.h>
92 #include <ArduinoJson.h>
93 #include <SoftwareSerial.h>
94 #include <PubSubClient.h>
95 #include <IR.h>
96 #include <SSD1306.h>
97 #include <GHT.h>
98 #include <Adafruit_BMP085.h>
99
100 #include "ext_def.h"
101
102 .....
103 /* Variables with defaults
104 .....
105 char *language[5] = {"en","de","fr","it","pt"};
106 char *language[5] = "";
107
108 .....
```

# Assembly of the electronics

## Interconnect the electronic parts together

### Connection SDS011

Pins are numbered from RIGHT to LEFT, make sure when connecting that the cables are sitting on the pins, as most Dupont cables also fit inbetween the pins.

SDS011 Pin 1 -> Pin D1 / GPIO5

SDS011 Pin 2 -> Pin D2 / GPIO4

SDS011 Pin 3 -> GND

SDS011 Pin 4 -> unused

SDS011 Pin 5 -> VU (NodeMCU v3) / VIN (NodeMCU v1,v2)

SDS011 Pin 6 -> unused

SDS011 Pin 7 -> unused

### Connecting BME280

Pins are numbered from LEFT to RIGHT.

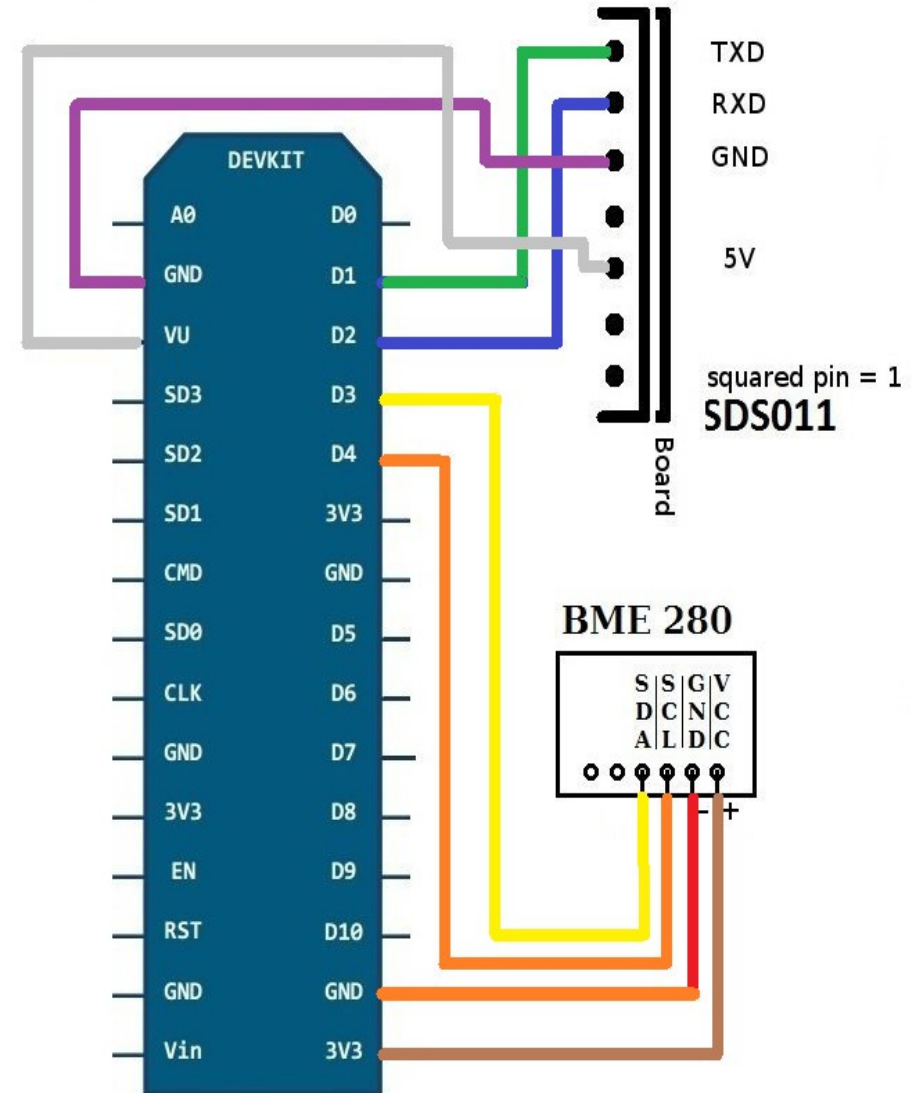
VCC (Pin1) <-> 3V3

GND (Pin2) <-> G

SCL (Pin3) <-> D4

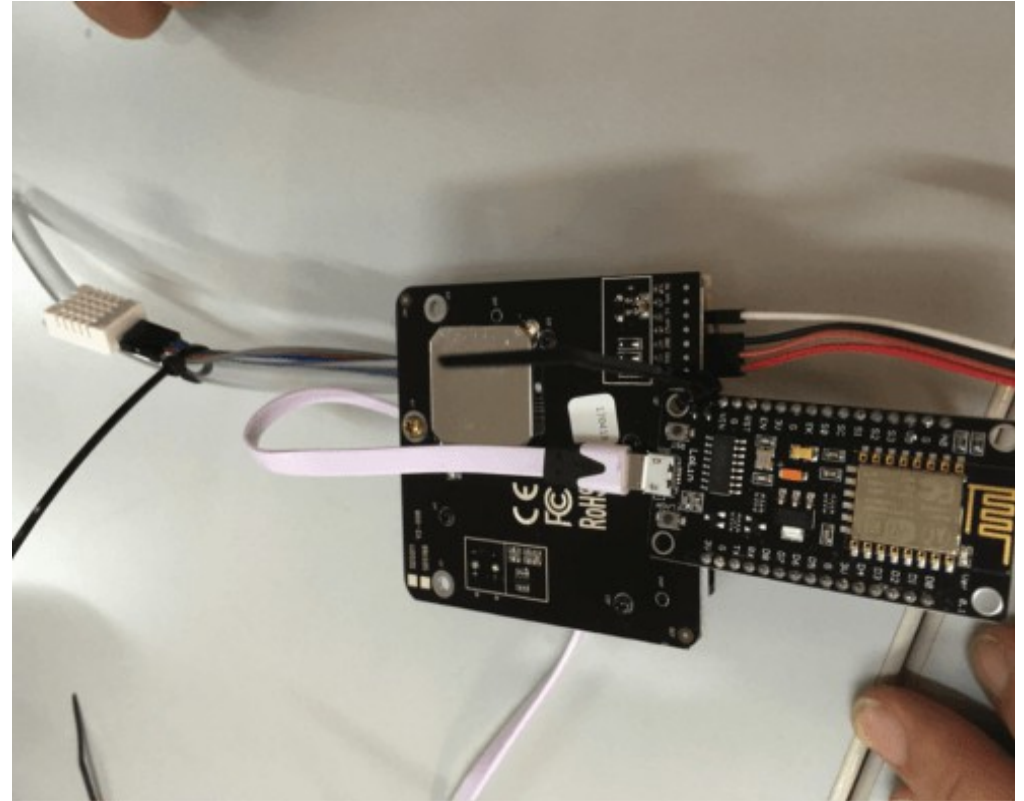
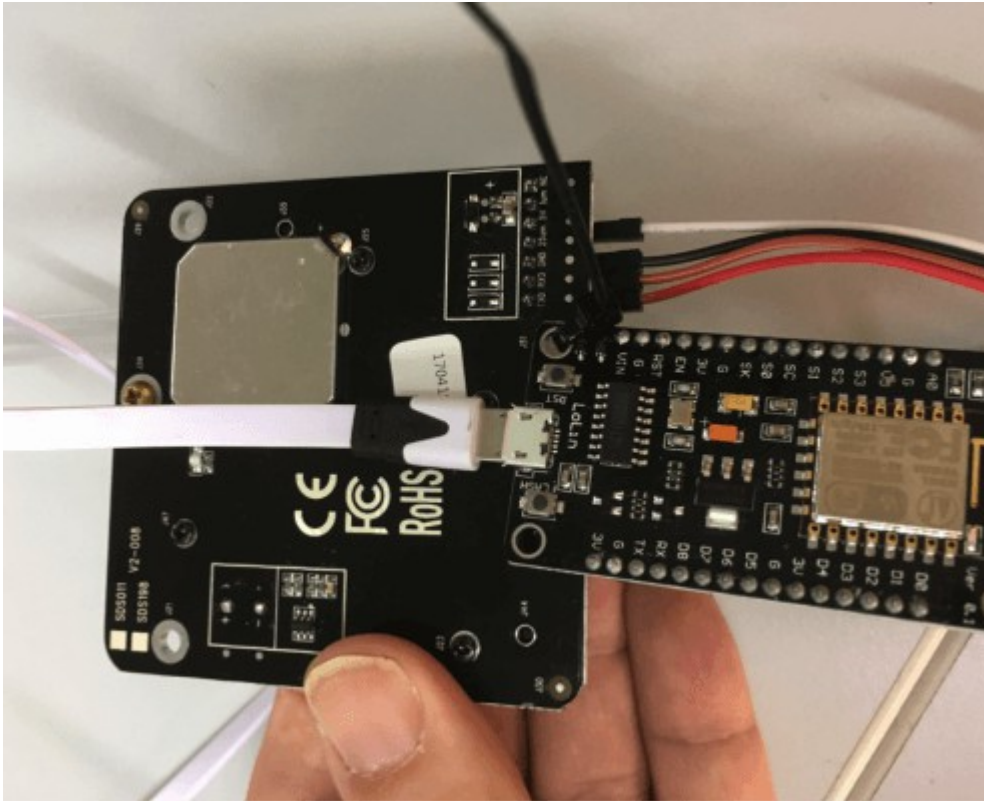
SDA (Pin4) <-> D3

## NodeMCU+SDS011+ BME 280



## Finish the measuring station

### Assemble the components



### Tie together

- Tie NodeMCU (ESP8266) and SDS011 fine dust sensor together with a cable tie. Point the Wifi antenna away from the sensor.
- Tie the temperature sensor BME280 to the tube with another cable tie (see picture).





- Pull the USB cable through the pipe.
- Install the SDS011 particulate matter board. **The fan is pointing down.**
- Push parts into the pipe, so that the sensor fixates in the pipe.
- Tube and USB cable should be looking out of the pipe.
- Connect the second Pipe. Make sure that no cables are pinched.
- Position the temperature sensor at the end, so it still sits inside the pipe.
- Cut the transparent tube
- Close the open ends of the pipes with a net or similar, so that the air can circulate but insects stay outside.

# Configuration of the measuring station

The sensor connects to the Wifi

- Mount the sensor outside in a good range of your wireless network
- Connect the station with the power cable
- The station tries to connect to the configured WLAN access point. If this does not work, the sensor opens an access point with the name Particulate matter . The ID refers to the ChipID (in the example 6997200. Please note that number down, as we need it later
- Connect to this access point. Wait a moment until the connection is made. Sometimes it take multiple attempts.
- Open your browser and type in <http://192.168.4.1/>. You see the menu site, choose Your WiFi SSID (name of the Wifi) and Wifi password
- For sensors according to this manual, nothing needs to be changed
- After saving, the sensor will restart and is no longer accessible. **If you want to access configuration, switch of your wifi network**

If everything is setup correctly, visit following sites. Search for your ChipID

Italy 10305926, Spain 6997200, Turkey 3844675, Romania 6996669

Sensor data: <http://www.madavi.de/sensor/graph.php>

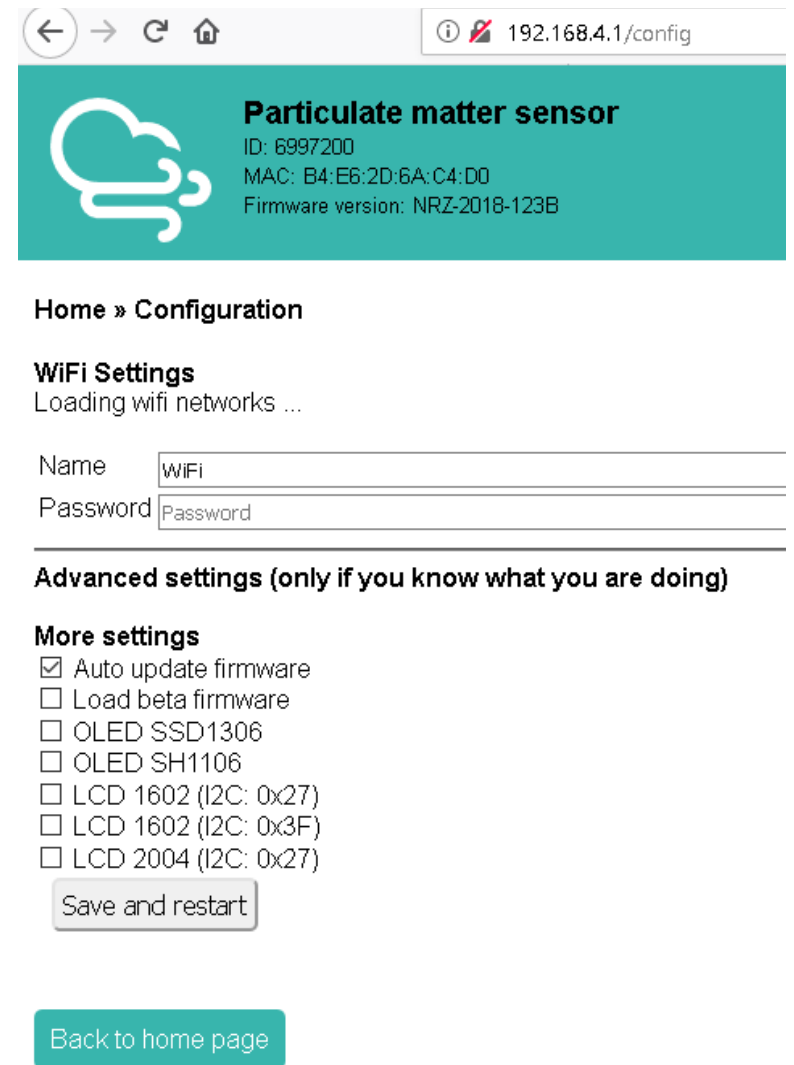
Wifi signal: <http://www.madavi.de/sensor/signal.php>

Find your sensor on maps:

<https://maps.luftdaten.info>

<https://opensensemap.org/>

**Last steps - install Particulate Matter APP on Your mobile phone.  
Almost done! Soon you can measure fine dust.**



The screenshot shows a web browser interface for configuring a particulate matter sensor. The address bar shows the URL [192.168.4.1/config](http://192.168.4.1/config). The page title is "Particulate matter sensor" and includes the following information: ID: 6997200, MAC: B4:E6:2D:6A:C4:D0, and Firmware version: NRZ-2018-123B. The navigation menu shows "Home » Configuration". Under "WiFi Settings", there is a "Loading wifi networks ..." section with two input fields: "Name" containing "WiFi" and "Password" containing "Password". Below this is a section for "Advanced settings (only if you know what you are doing)" and "More settings" with several checkboxes: "Auto update firmware" (checked), "Load beta firmware", "OLED SSD1306", "OLED SH1106", "LCD 1602 (I2C: 0x27)", "LCD 1602 (I2C: 0x3F)", and "LCD 2004 (I2C: 0x27)". A "Save and restart" button is located below the checkboxes. At the bottom, there is a "Back to home page" button.