Dali Dust Box

Open-Source PM2.5 Mapping

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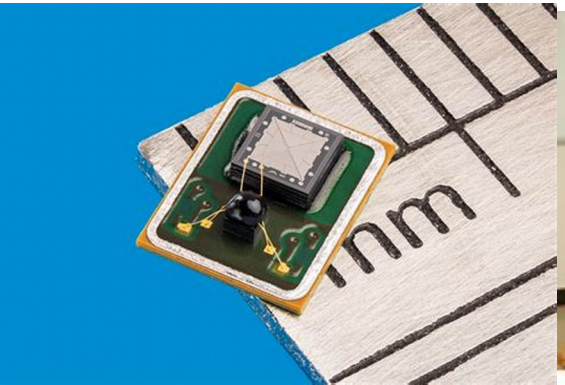
Introduction: Me!

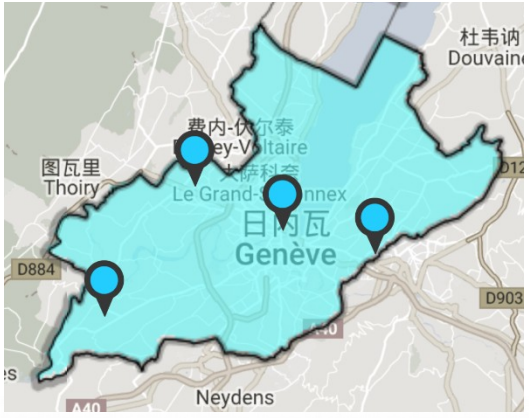
- Kellner Emmanuel – 柯埃渺
- Studied micro-engineering
- Now, Sustainable development & Innovation
- At University of Geneva & Tsinghua

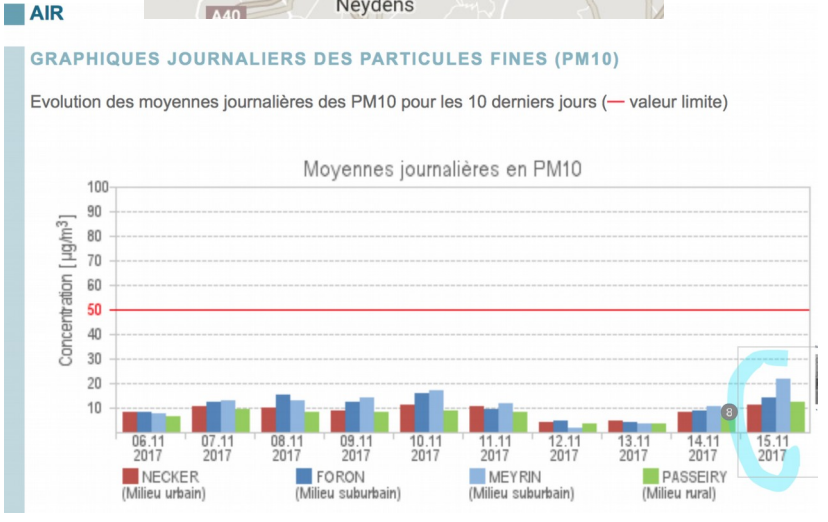


Introduction: You!

- Short introduction!
  - Name
  - Major
  - Hometown
  - Any air quality issue there? What is the cause?
  - Any experience with environment monitoring?
  - Any experience with sensors / electronics?

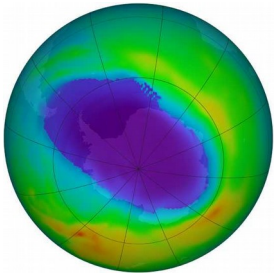
Why mapping air pollution?

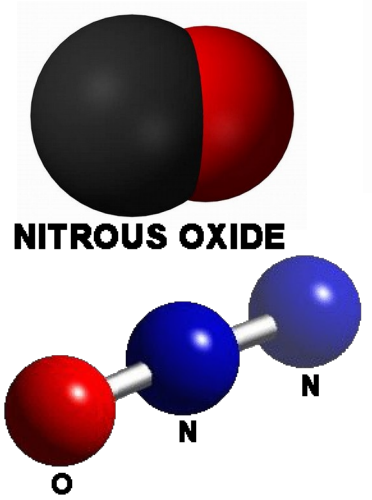


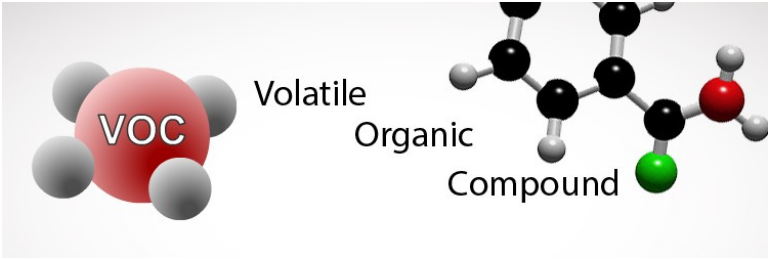


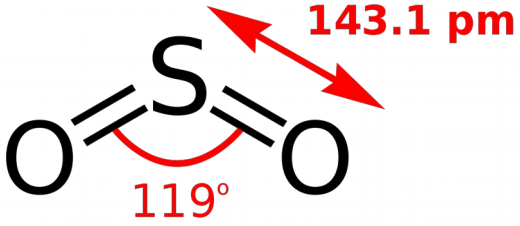
What is air pollution?

- PM2.5 & PM10
- Carbon Monoxyde (CO)
- Ozone (O3)
- Nitrous oxides (NOx)
- Sulfur Oxides (SOx)
- VOCs (benzene, formaldehyde…)
- …

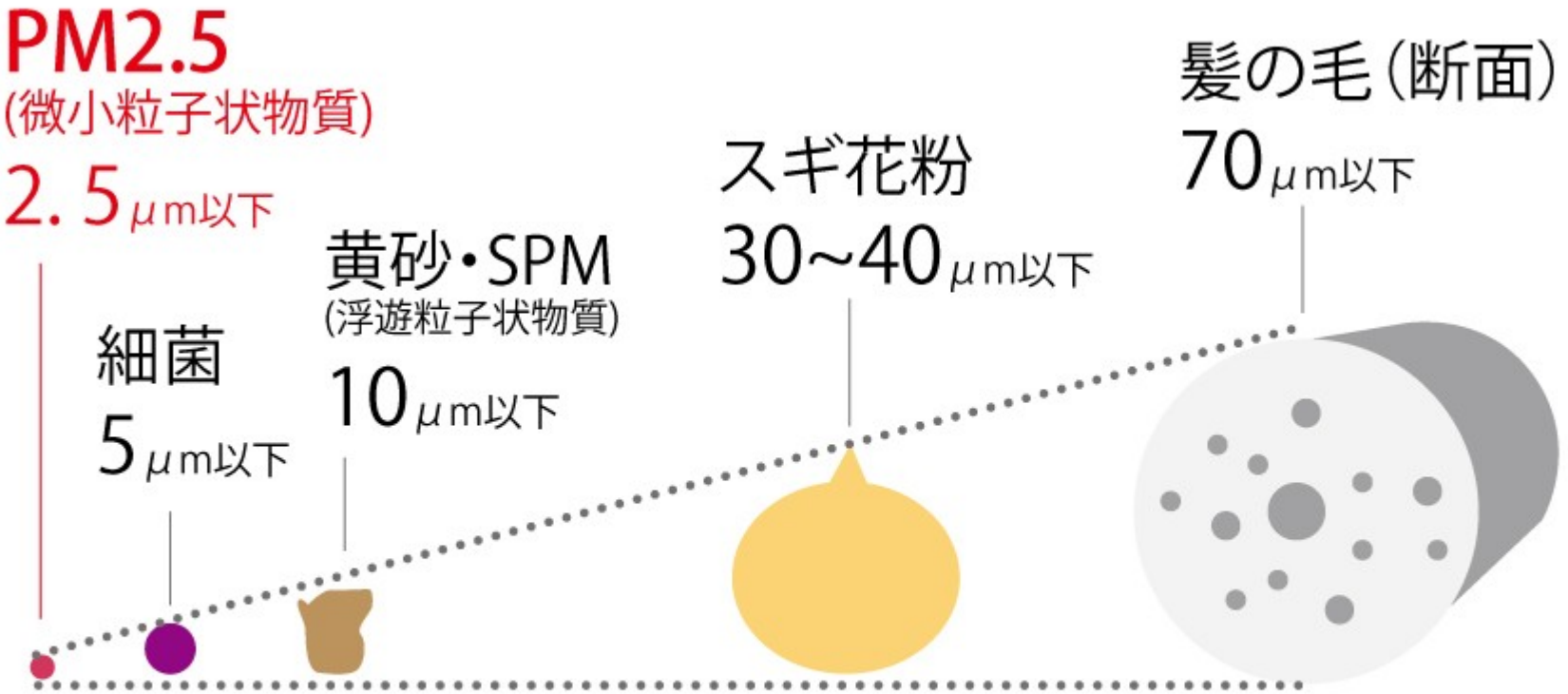








PM2.5 & PM10



出典：米国EPA・大阪府環境農林水産業
「微小粒子状物質（PM 2.5）」に関する資料より

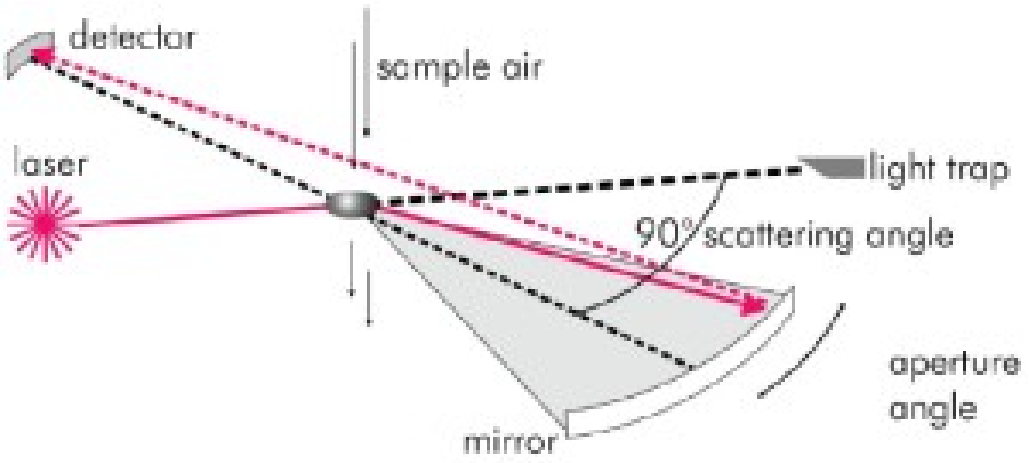
What causes PM2.5 & PM10?

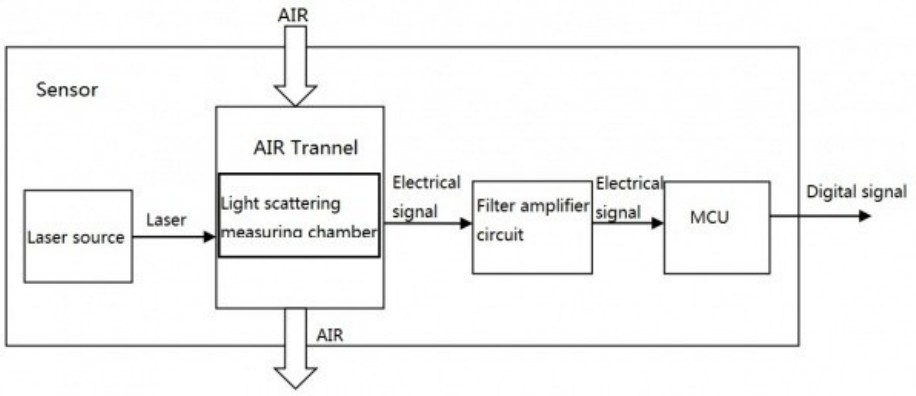
Why measure PM2.5 & PM10?

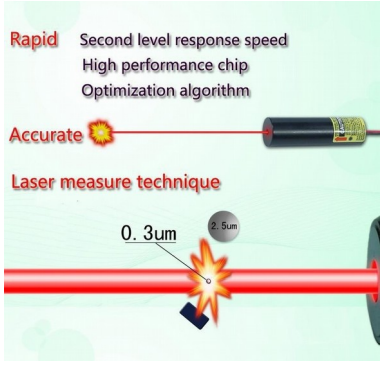
- Dangerous!
  - Responsible for 1 over 7 premature death In Switzerland!
- Everyone know them
  - But not that well
- We can measure them

How to measure PM2.5 & PM10

- LASERS! IR laser scattering







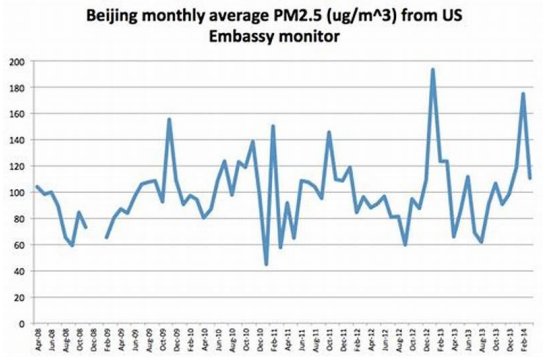
Okay, but… how to do that?

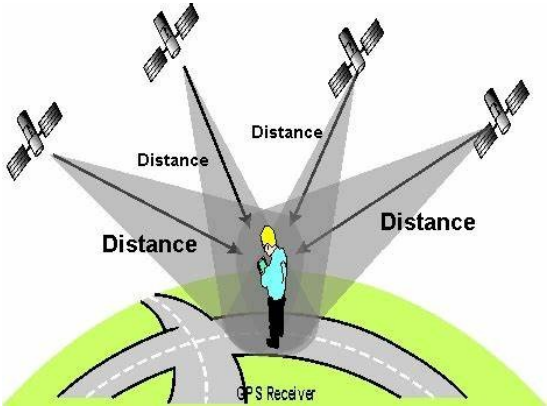
- No need to know how it works to use it!
  but better to understand a bit, to trust the data
- Many products exists. Find one that works for you.
  If you cannot find one, **make it**!

How to map air pollution

Simple!

- Get PM2.5 & PM10 value
- Get GPS position
- Write all that to a file!





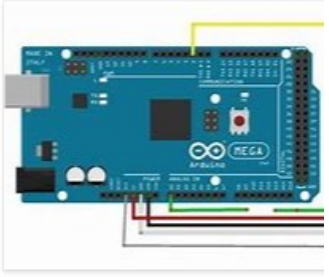
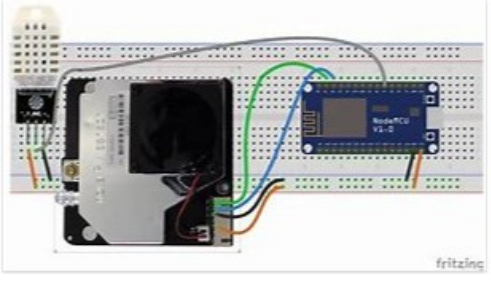
- How to measure PM2.5? Ask internet?
- How to get position? Ask internet…
- How to log that to a file? Ask internet!

Building on what is already there

- Find people already using what you need:

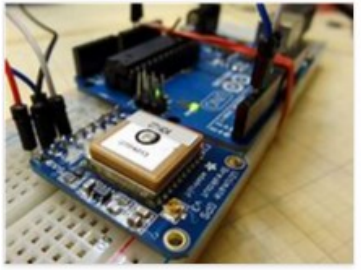
国内版 国际版

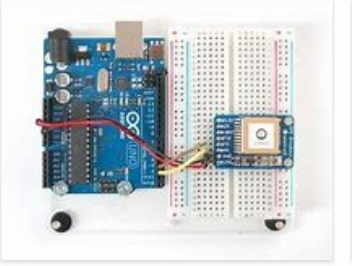
pm2.5 arduino


国内版 国际版

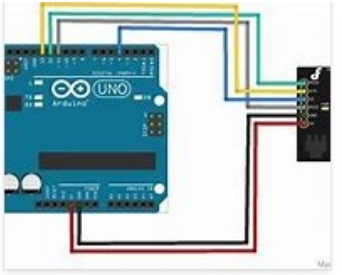
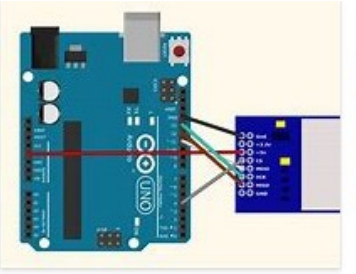
gps arduino

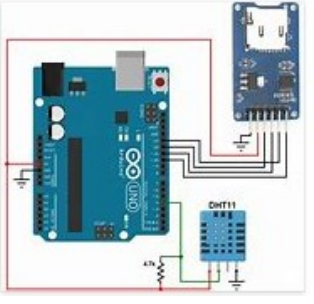
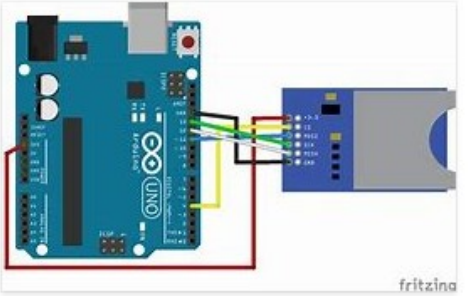


国内版 国际版

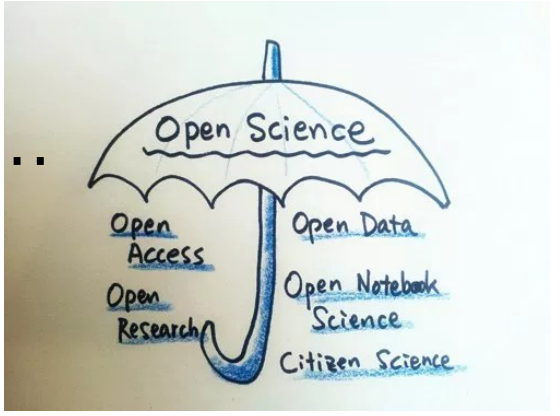
sd card arduino

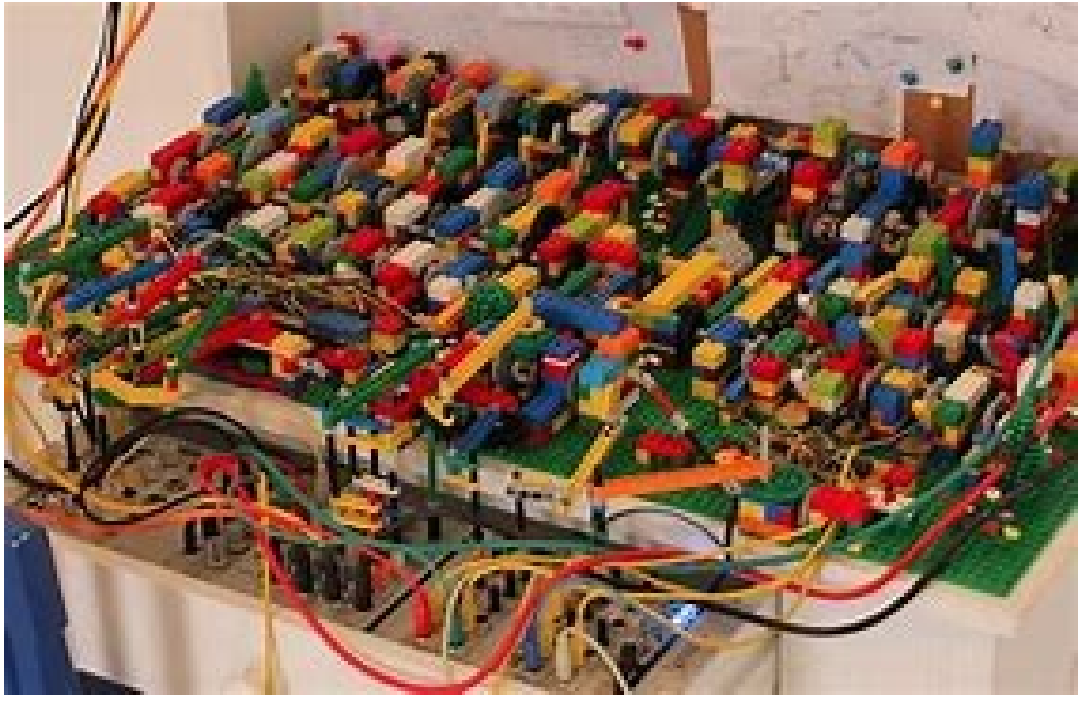



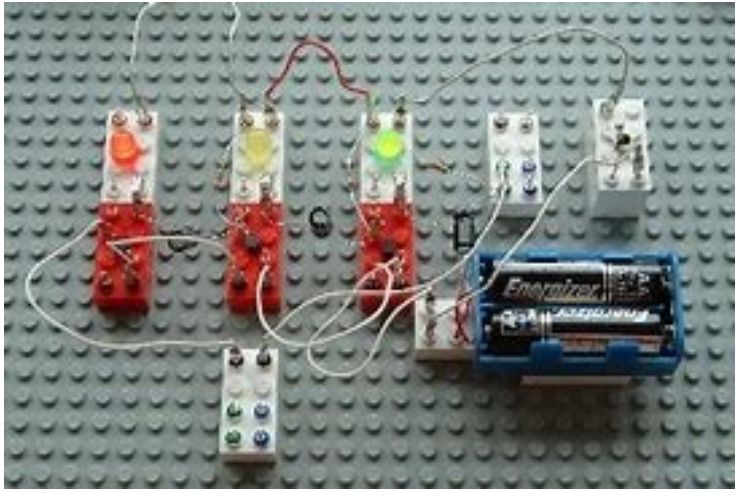
Open source community

- Many people have similar issue
  Many people try things, similar, different…
  - Find out what others use, why, and how
- Documentation!
  - Like scientific papers: hypothesis, methodology, result
- Open source, Open Hardware, Open Science
  - Share so others can improve and share back!



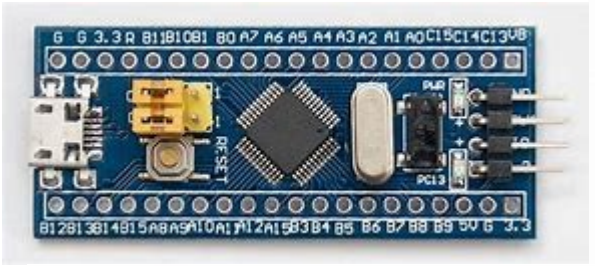
Prototype (原型) = LEGO / IKEA





Components

- Microcontroller
- PM2.5/PM10 sensor
- Temperature/Humidity
- GPS
- SD-Card
- Lots of wires!



Microcontroller - 单片机

- Bluepill – STM32
- Cheap! 10RMB
- Powerful
  - lots of input/outputs, fast
- Compatible Arduino (but cheaper ;))
  - Do you know Arduino?

PM2.5/PM10 sensor – PM 传感器

- SDS018
- (not so) cheap! 110RMB
- Good quality

  cheaper sensors = random output

  more expensive sensors = too expensive!
- Arduino Libraries available!

Temperature & Humidity – 温度 & 湿度

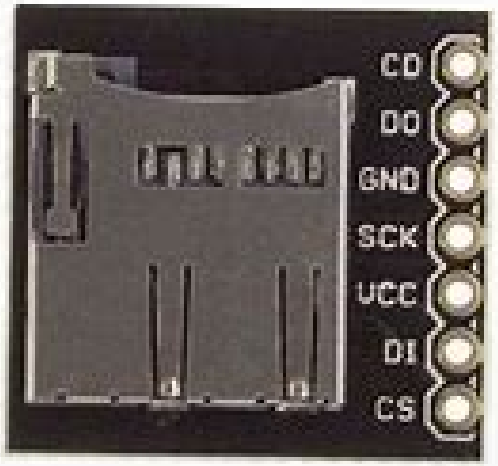
- Why? Humidity change particle apparent size...
- BME280
- Cheap: 16RMB
- Good
- Not much to say…
- Arduino Libraries available!

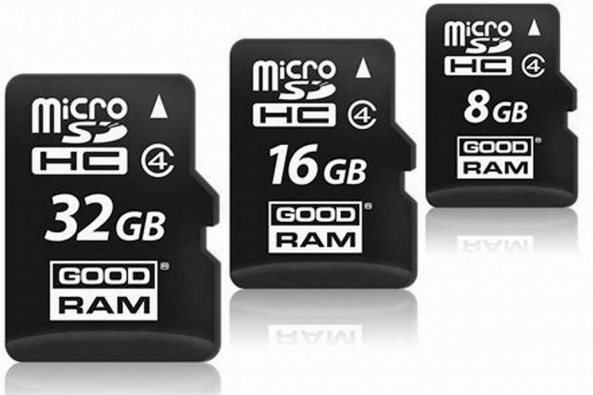
GPS receiver

- MT3339
- Expensive: 130RMB
- But good signal!
  - Mapping need correct position
  - GPS signal is sometimes hard to get
- Arduino Libraries available!

SD card reader

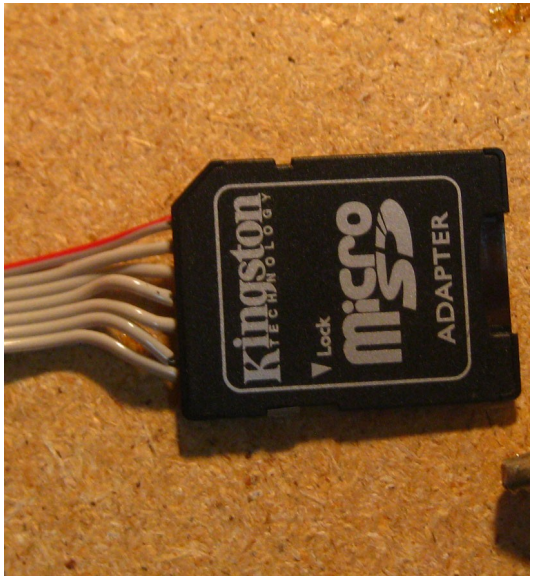
- Simple connection
- Cheap: 5RMB
- But…
- We didn’t receive those… Hack!

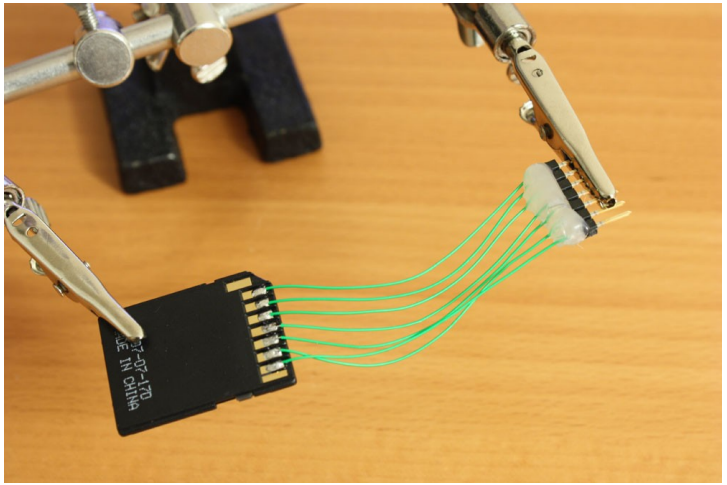




SD card reader hack

- Simple connection
- Cheaper: 1RMB
- But… a bit messy





To summarize

	Component	Price
Microcontroller	Bluepill	10 RMB
PM2.5/PM10 sensor	SDS018	120 RMB
GPS	MT3339	130 RMB
Humidity & Temperature	BME280	15 RMB
SD card + breakout	No Name	20 RMB
Total		**300 RMB**
Professional Solution		**2100 RMB**
+ pencil & paper		

Assembling

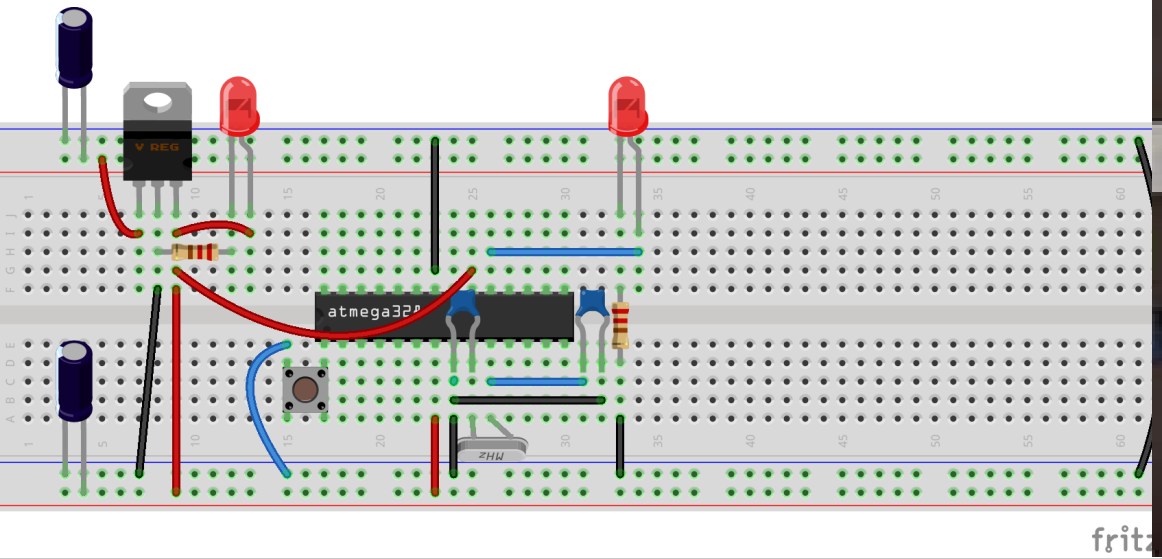
- How to wire things
- Breadboard prototype
- Soldering workshop

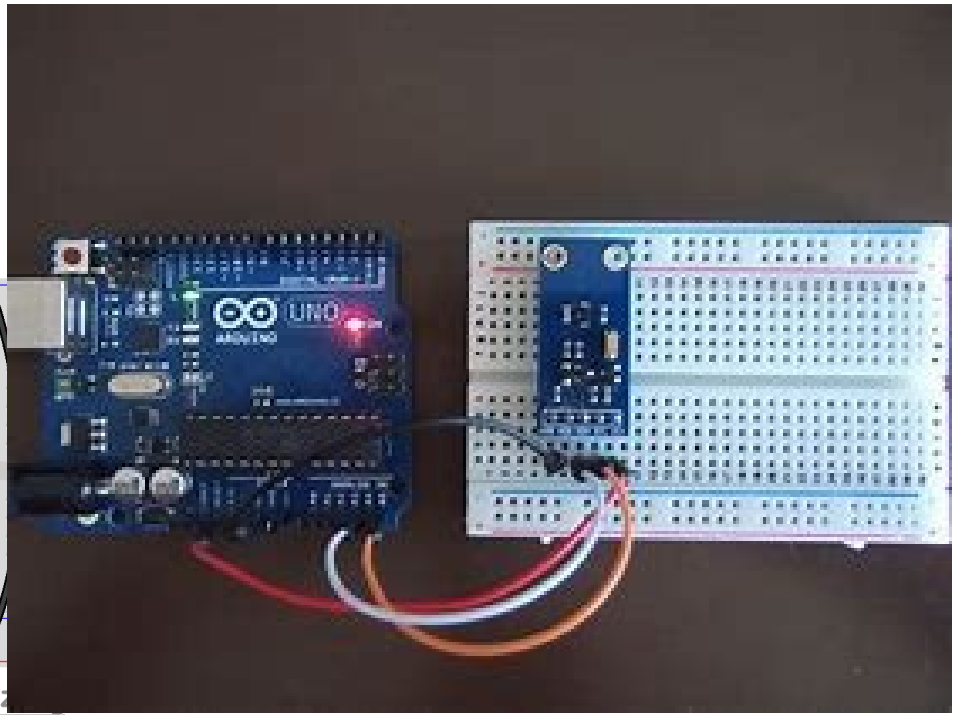
Wiring

- Available online: follow instructions

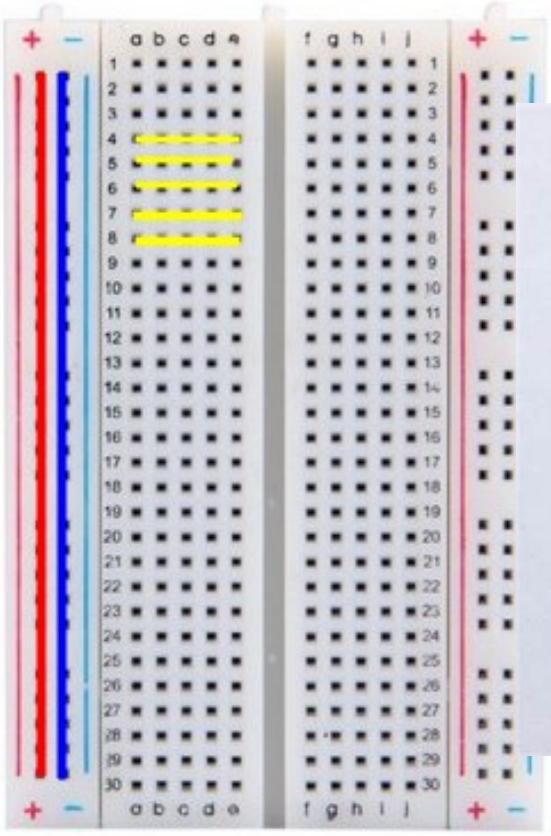
Breadboard - 面包板

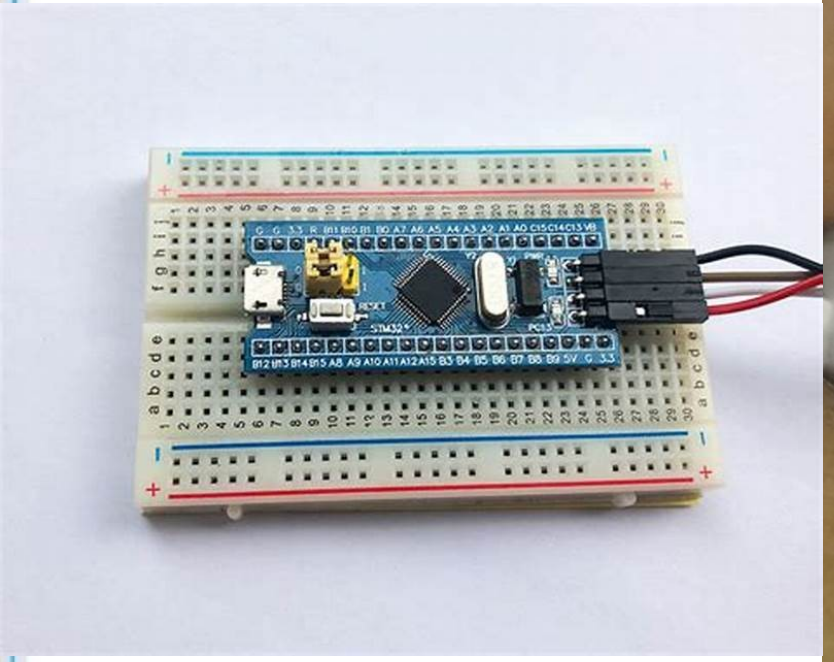
- Used to assemble without soldering
- To see if it works

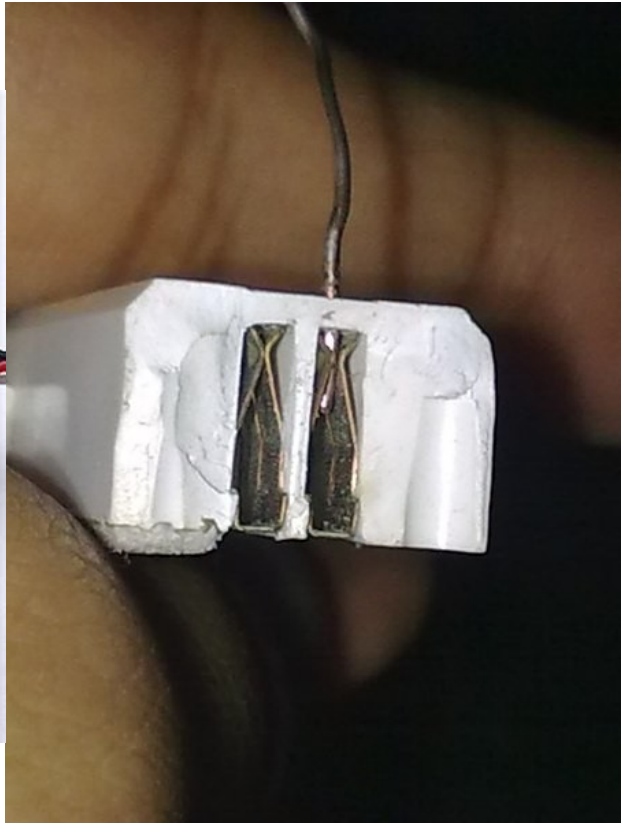




Breadboard - 面包板

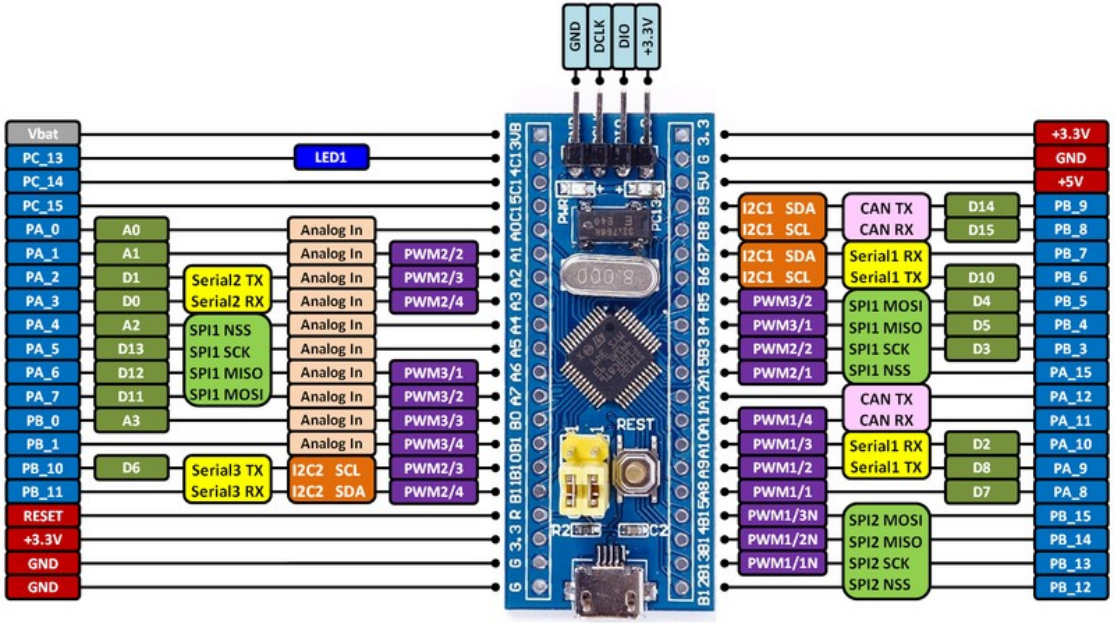






Microcontroller - 单片机

- Pins have names and numbers
- They do different things: read signal, blink LED..



PM2.5/PM10 sensor – PM 传感器

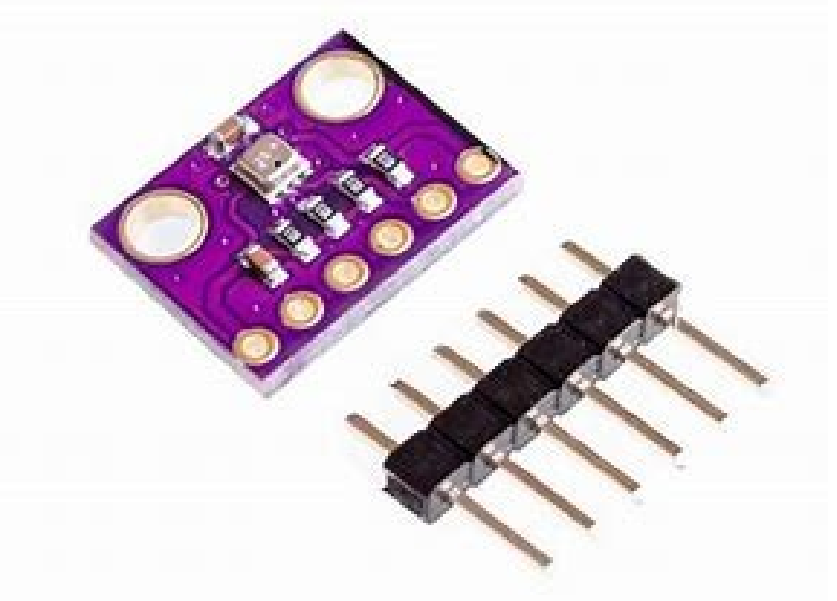
- Input: Electricity (5V, GND)
- Output: PM2.5, PM10 (TX, RX)

SDS018	BluePill
5V	5V
GND	GND
RX	B10
TX	B11

Temperature & Humidity – 温度 & 湿度

- Input: Electricity (VCC, GND)
- Output: Temperature, Humidity, Pressure

BME280	BluePill
VCC	3.3V
GND	GND (G)
SCL	A5
SDA	A7
CSB	A4
SDO	A6



GPS receiver

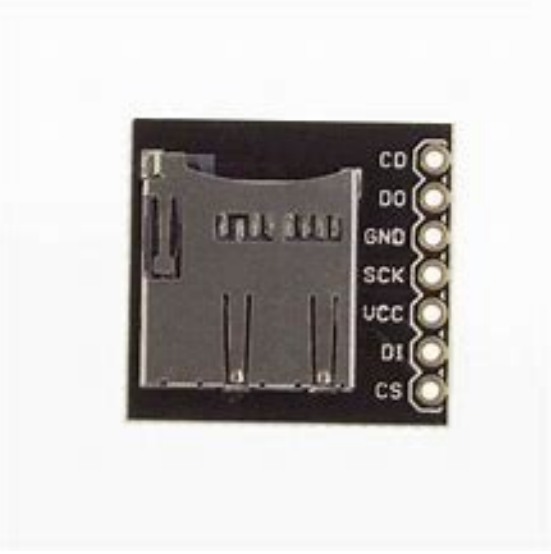
- Input: Electricity (VCC, GND)
- Output: Date/Time, Latitude, Longitude

GPS	BluePill
GND	GND (G)
VCC	5V
TXD	A3
RXD	A2

SD card

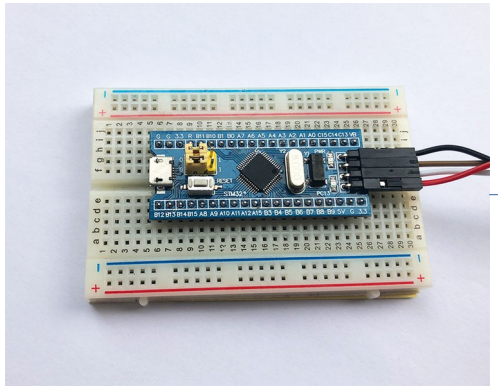
- Input: Electricity (VCC, GND), Data
- Output: … writing logfile

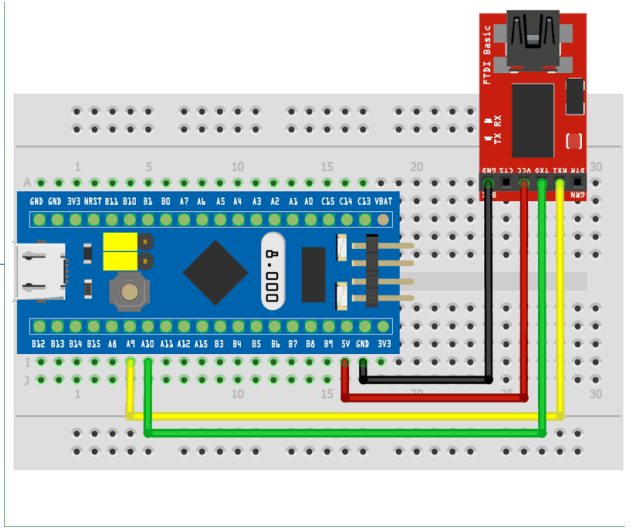
SD breakout	BluePill
3V3	3.3V
CS	B0
MOSI	A7
CLK	A5
MISO	A6
GND	GND (G)



Wiring

SDS018	BluePill
5V	5V
GND	GND
RX	B10
TX	B11

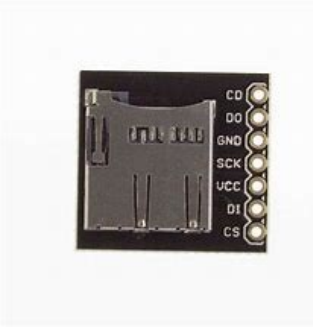




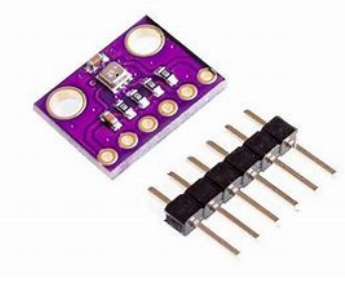
Wiring

SDS018	BluePill
5V	5V
GND	GND
RX	B10
TX	B11

GPS	BluePill
GND	GND (G)
VCC	5V
TXD	A3
RXD	A2



SD breakout	BluePill
3V3	3.3V
CS	B0
MOSI	A7
CLK	A5
MISO	A6
GND	GND (G)



BME280	BluePill
VCC	3.3V
GND	GND (G)
SCL	A5
SDA	A7
CSB	A4
SDO	A6

Soldering