

Meet Aurora: the smart weather station

TinyML Challenge 2022

Jonathan Reymond
Robin Berguerand
Ayman Manzoor
Jona Beysens





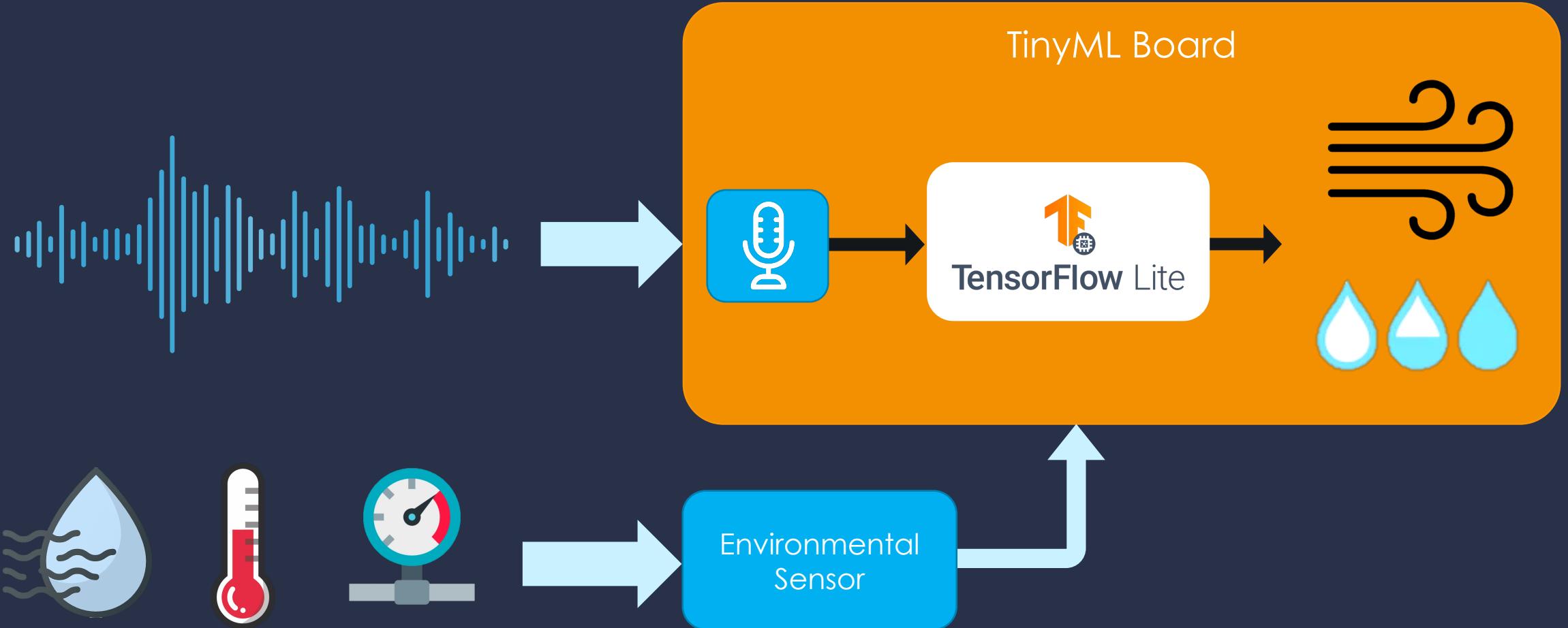
Aurora

- Detects wind and rain
- Maintenance-free
- Works in real-world conditions
- ML fully embedded
- Easy to install

2

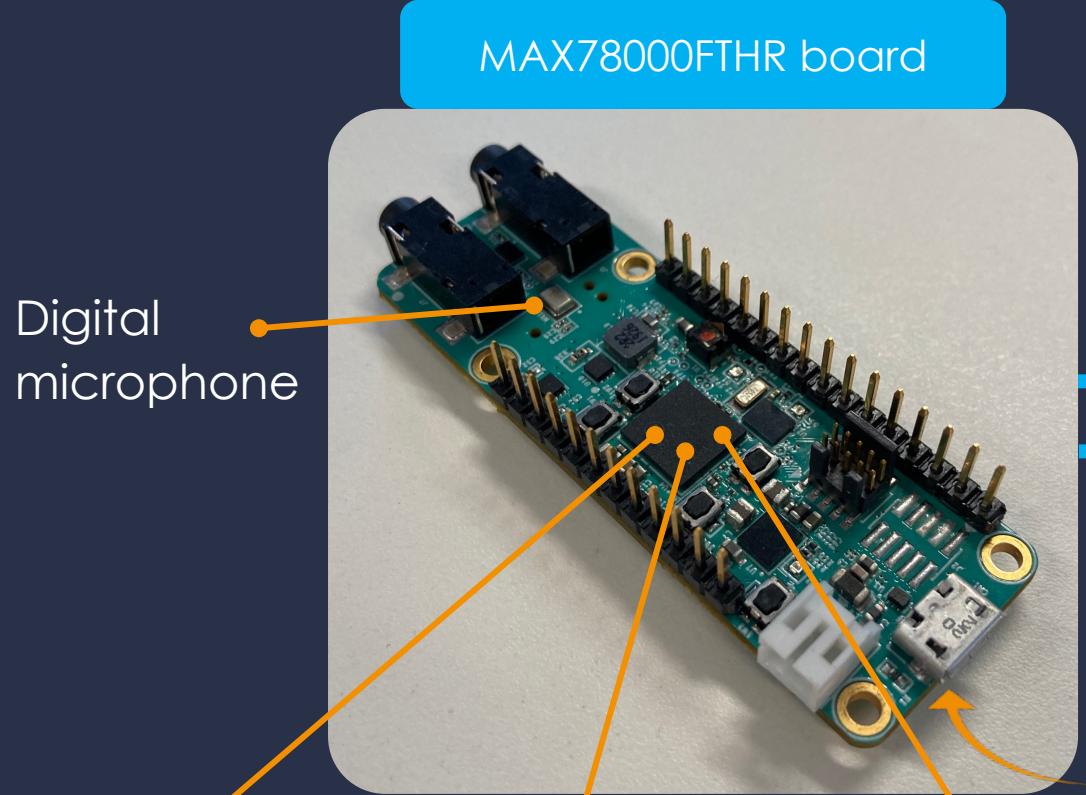
How does she work?

Aurora: the big picture



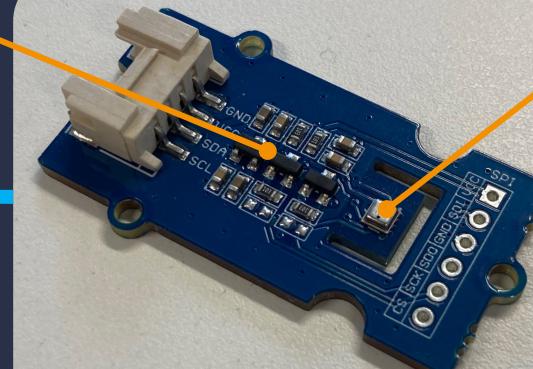
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Aurora's components



Sleep mode

Bosch BME280

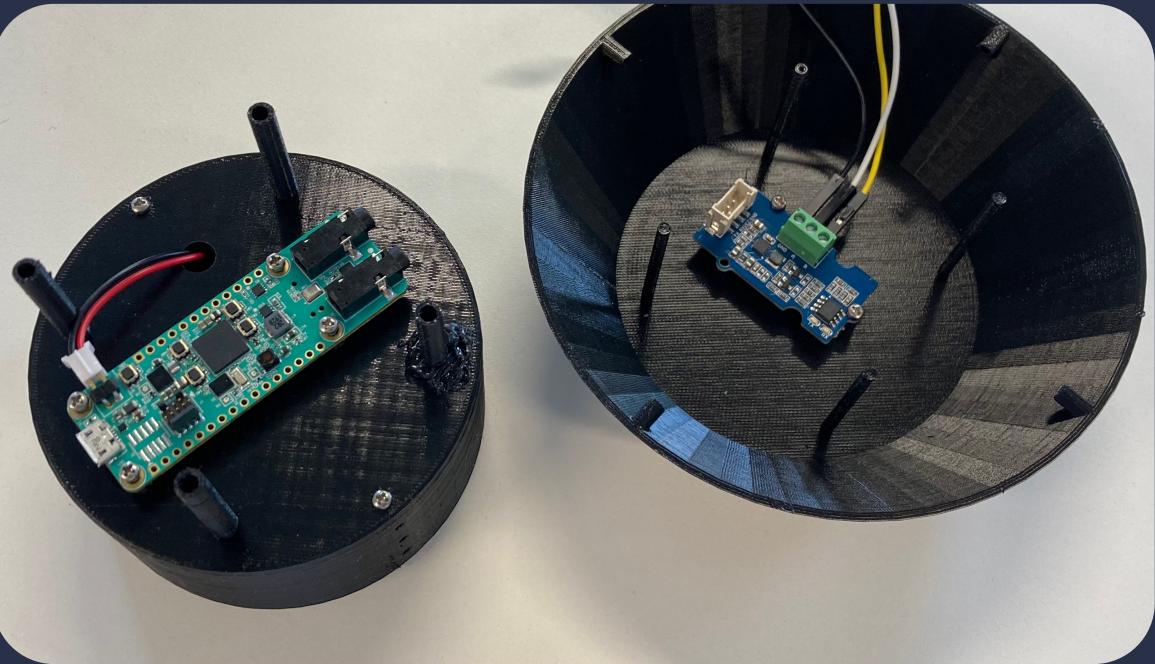


Humidity
Temperature
Pressure

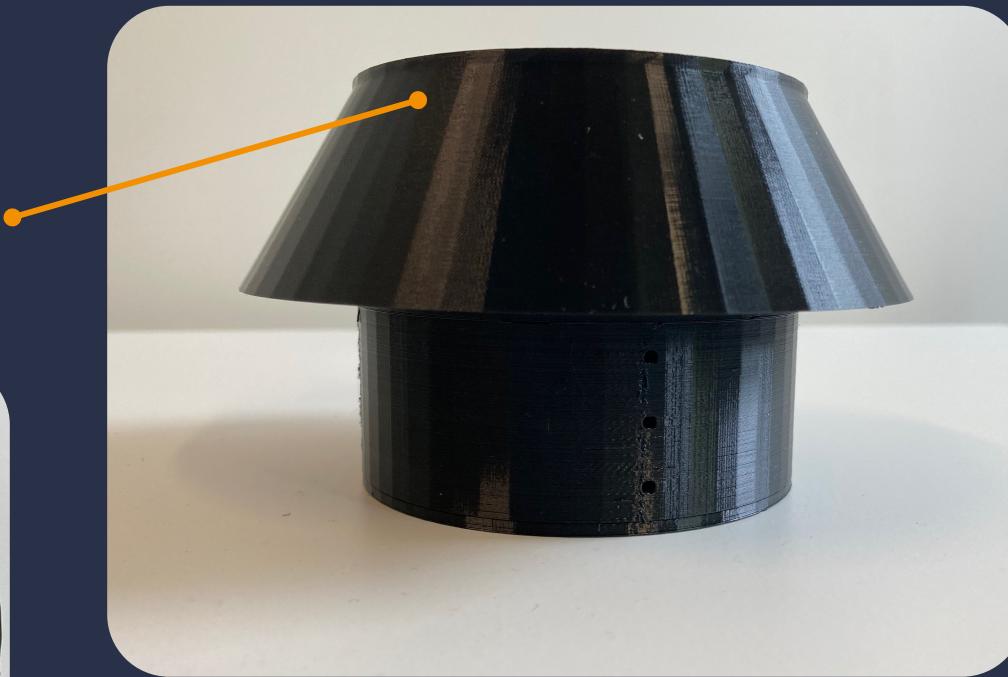
Lithium-ion battery



The final product



3D printed design



5

Component	Cost estimation*
MAX78000FTHR	€ 31
BME280 sensor	€ 13
Battery	€ 20
3D filament	€ 7
Wires	€ 2
Total	€ 75

* For single prototype, without economies of scale

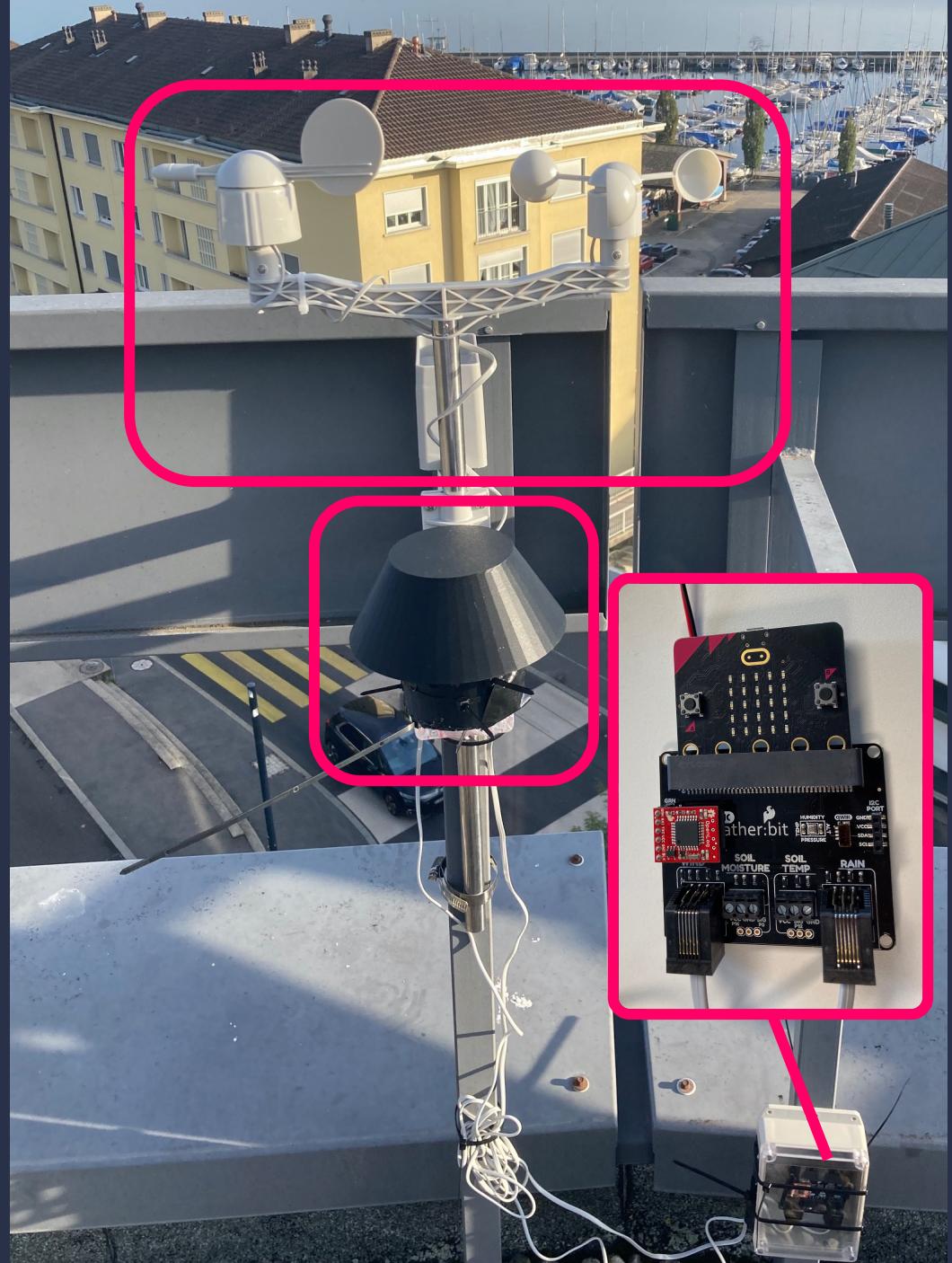
Real-world dataset acquisition

Neuchatel, Switzerland

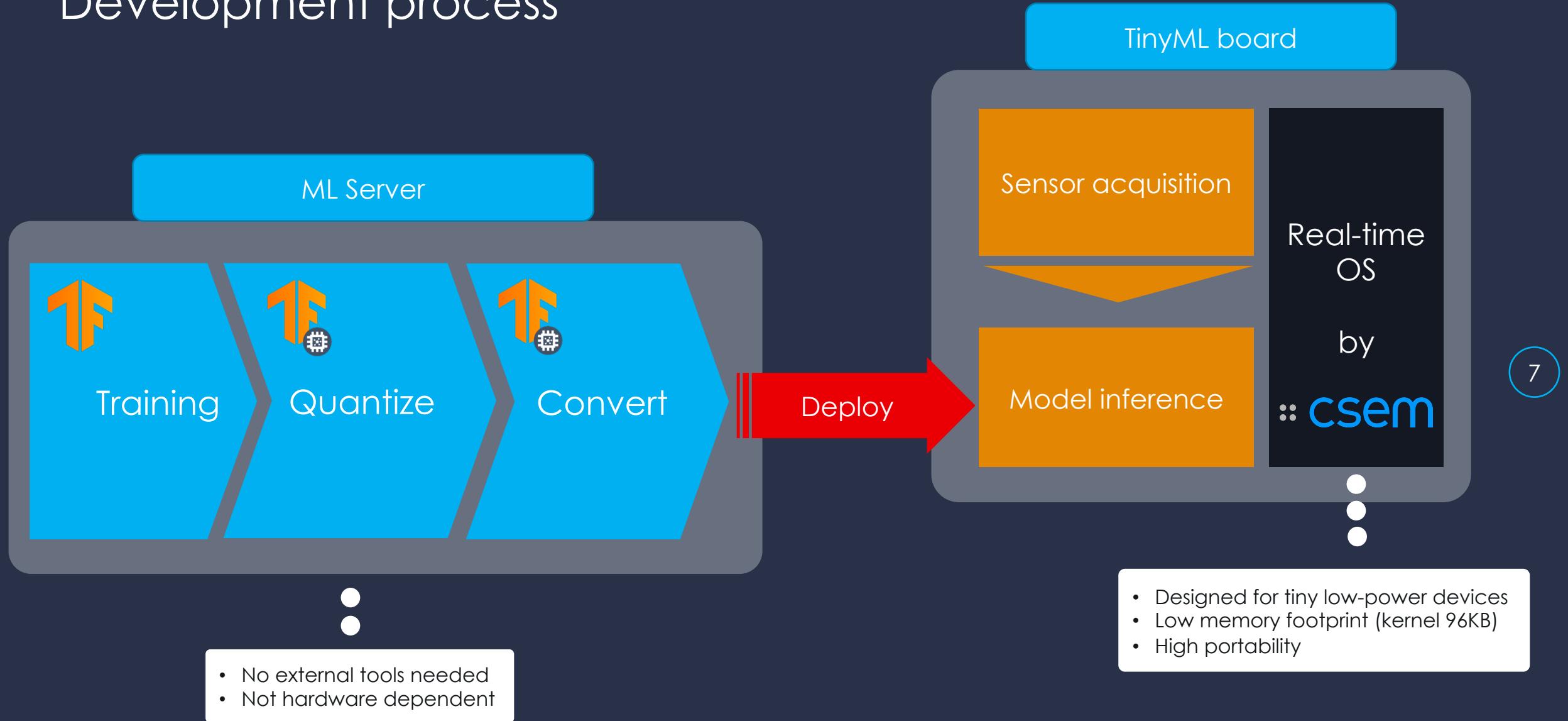
- MAX78000
 - Mic: 1s audio at 16 kHz
 - Env. sensor: temp, pressure, humidity
 - Storage: SD card
- Sparkfun weather station kit
 - Rain + wind measurements every 2s
→ fine granularity
 - Used as reference for data labelling



Over 160 hours of recordings



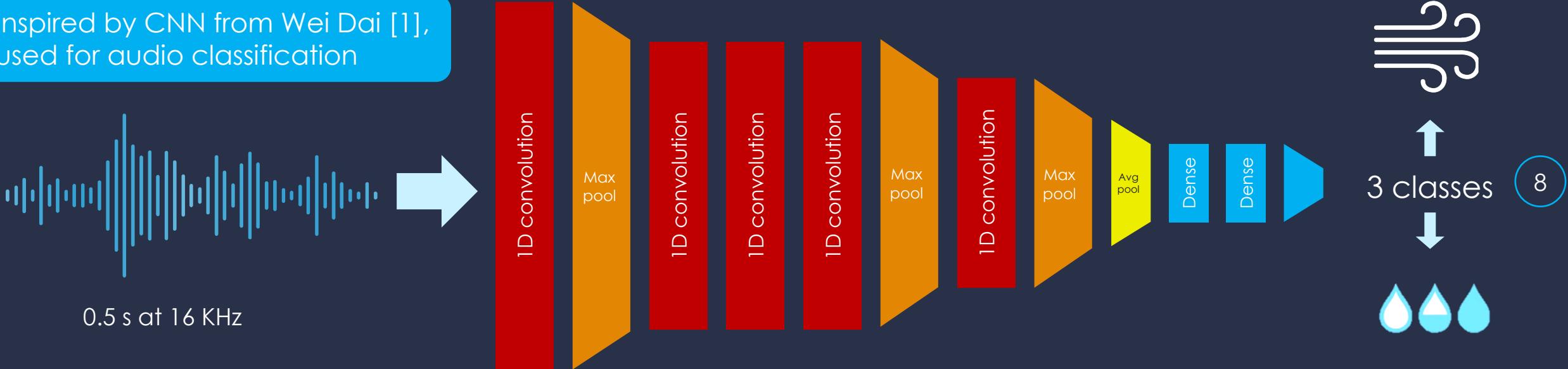
Development process



ML model

- Process directly raw waveforms
 - No MFCC implementation needed on embedded device
 - Used for SoTA audio tasks (ex. ACDNet)

Inspired by CNN from Wei Dai [1],
used for audio classification



- Class imbalance mitigation
 - Down/up sampling classes (SMOTE)
 - Class reweighting

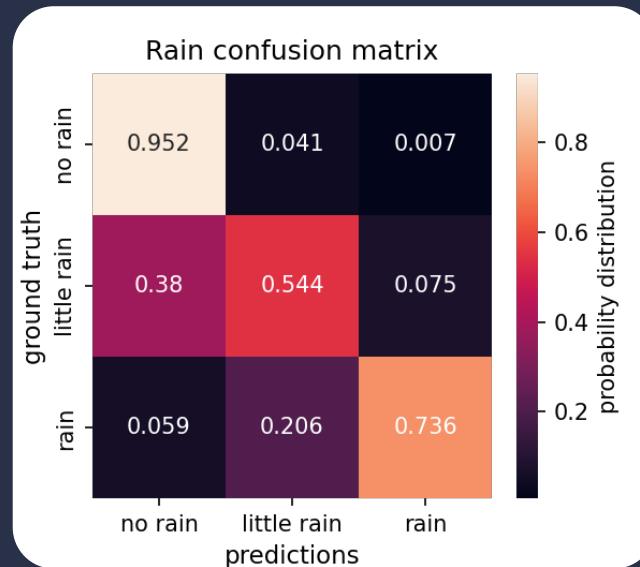
Hyperparameters optimization with
OPTUNA
Size: < 125K parameters
Flash: ~150KB / RAM: ~87KB

[1] Wei Dai, Chia Dai, Shuhui Qu, Juncheng Li, and Samarjit Das. Very Deep Convolutional Neural Networks for Raw Waveforms. (2016).

Performance evaluation

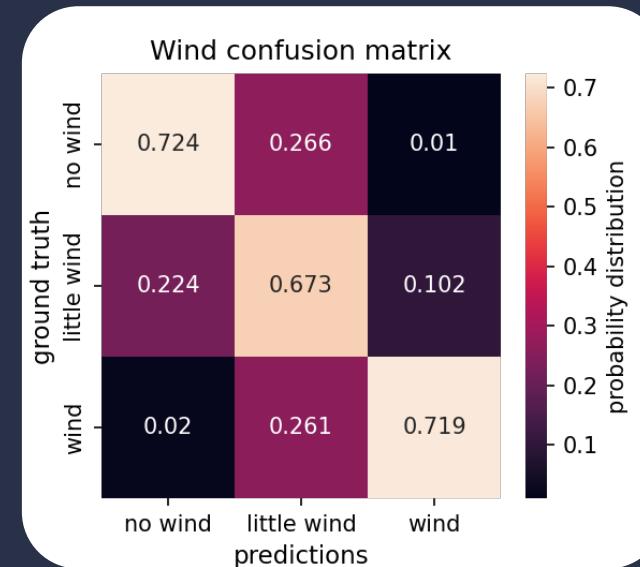
- Rain

- 3 classes : 74.4%*
- 2 classes (no+little rain, rain) : 85.7%*



- Wind

- 3 classes : 70.5%*
- 2 classes (no+little wind, wind): 83.1%*



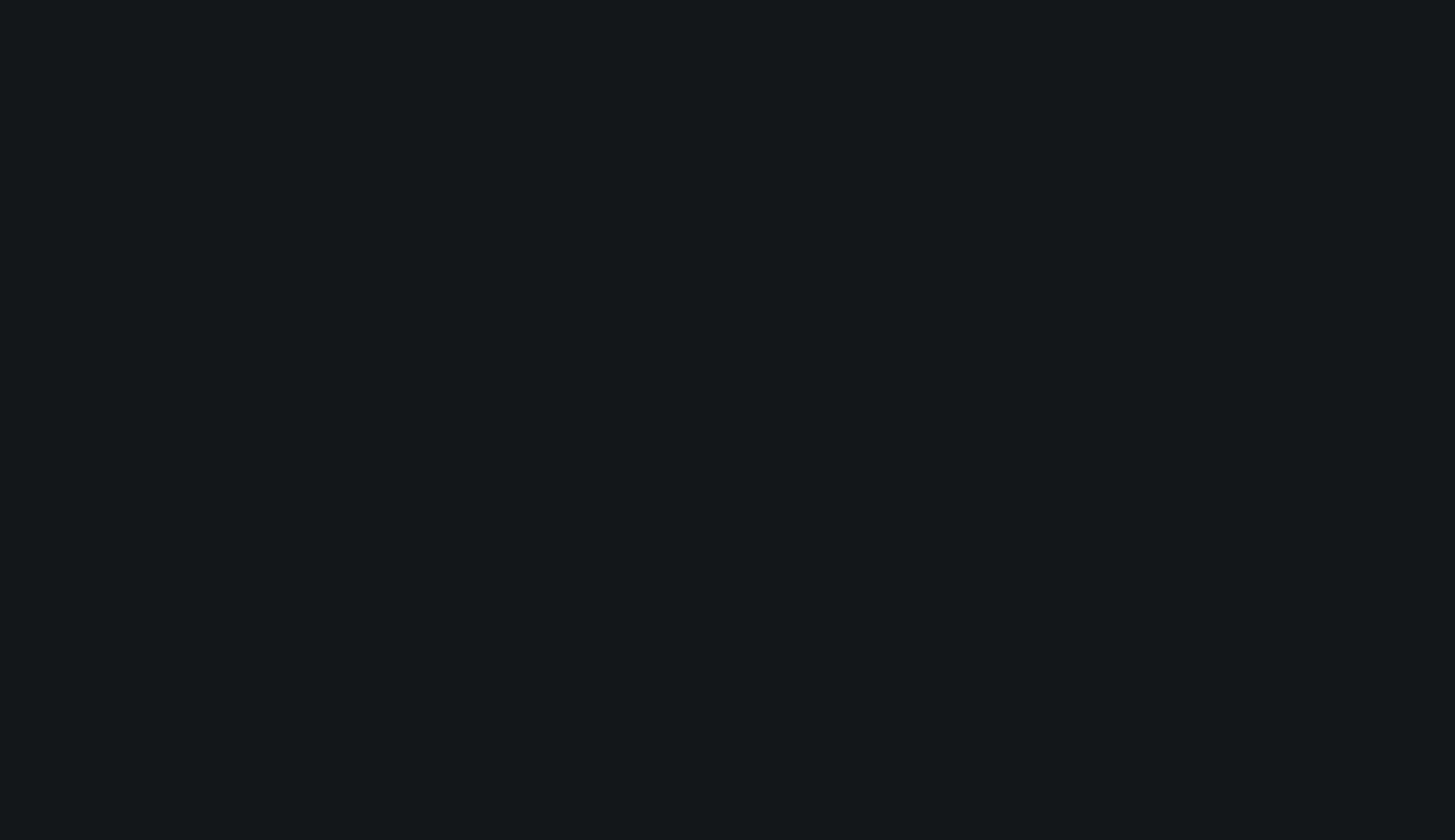
9

- Energy for one measure per minute

- Evaluation kit: ~12.5 mA at 3.7V supply voltage

- Dedicated PCB: ~5.7 mAh estimated per day → 770 days autonomy

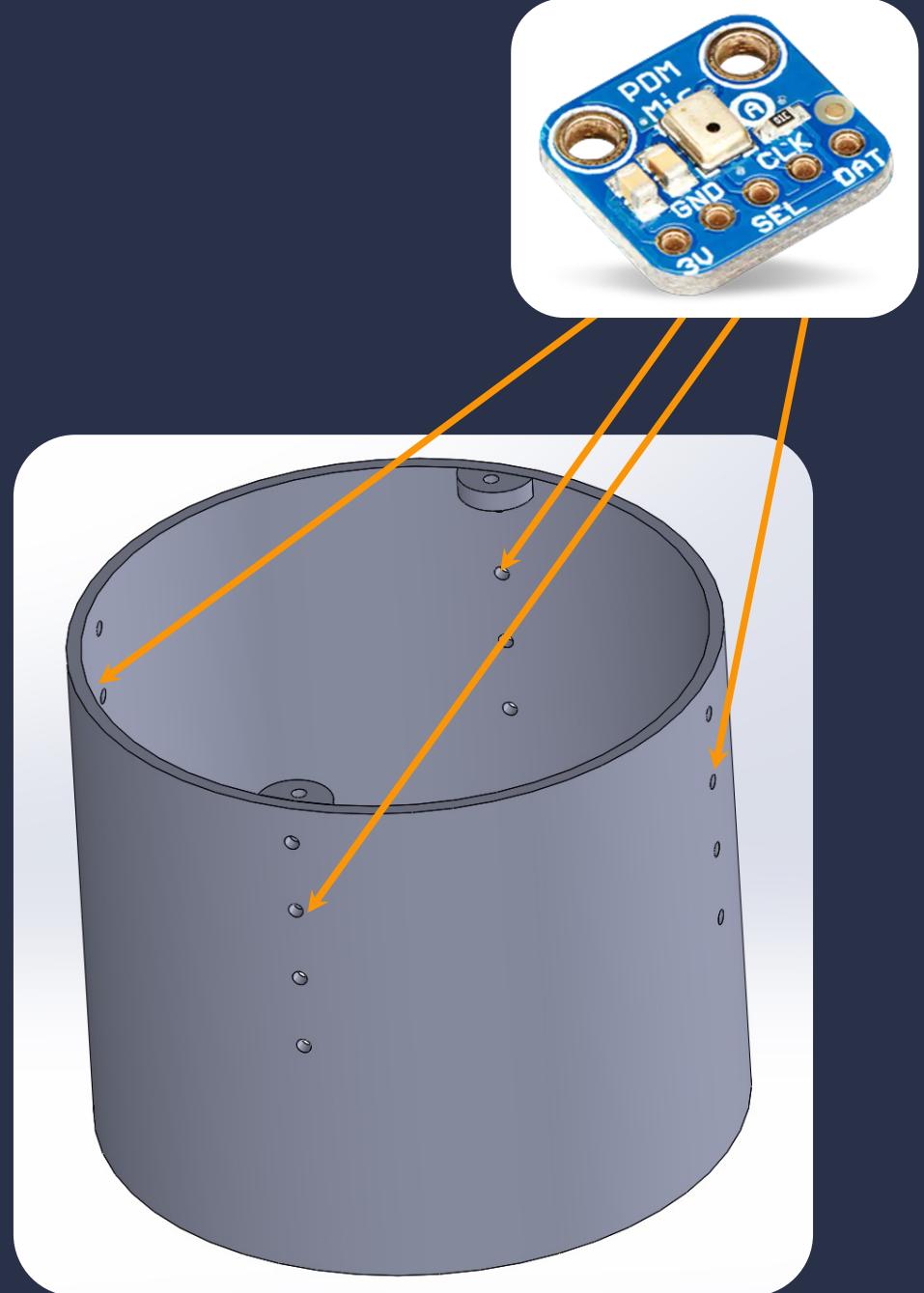
Demo



10

The future of Aurora

- Assess wind direction with 4 MEMS microphones (cost ~€ 14)
- Fully autonomous operation with solar panel (cost ~€ 20)
- Remote wireless connection via cloud (e.g., LoRa)



Aurora

The smart weather station

for anyone
at anytime
and anywhere

