

Dust Sensor Reverse Engineering/Improvement

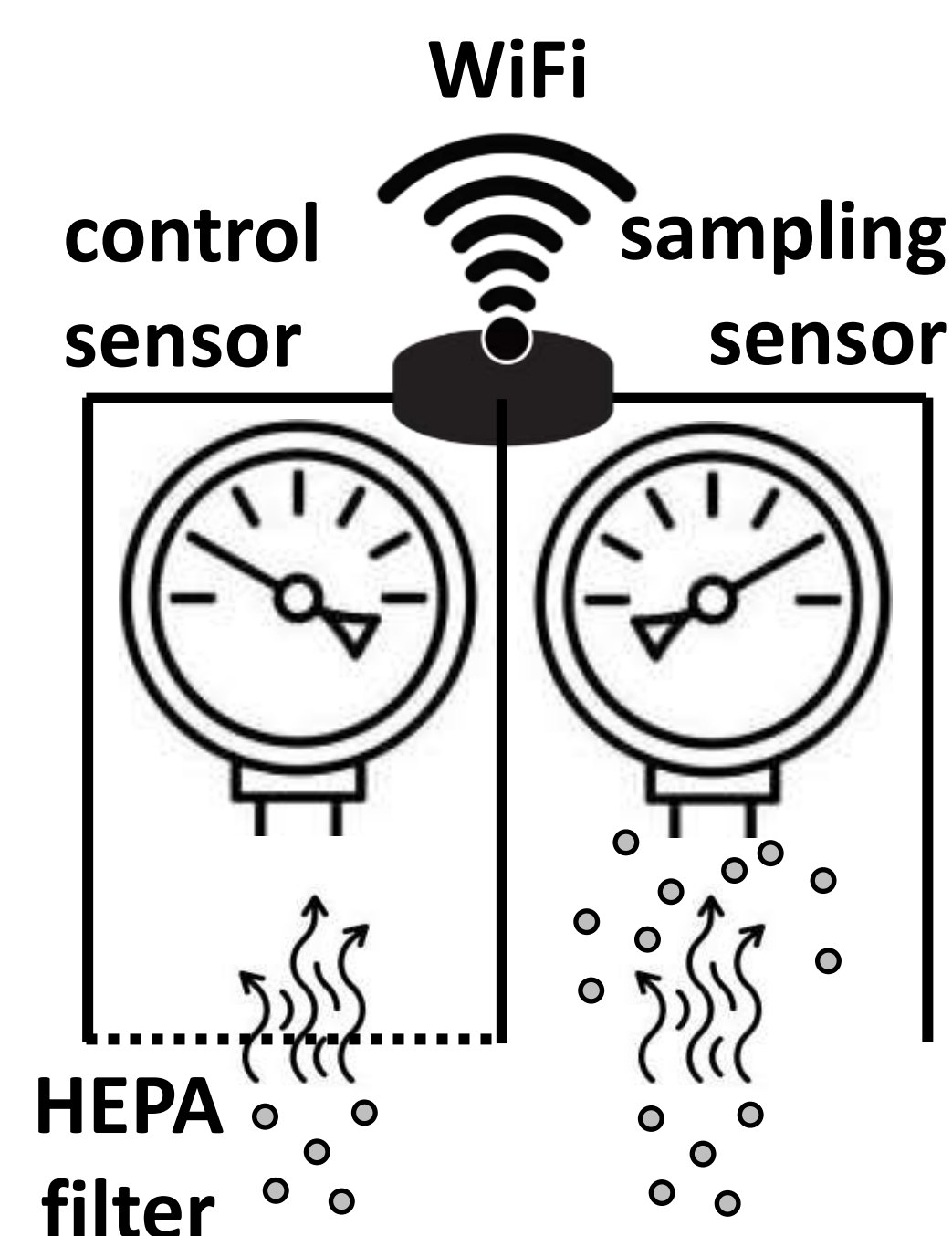
NC OSHERC

PROBLEM STATEMENT

EMS workers, who often work for 24 hours continuously, are commonly exposed to dangerous levels of particulate matter.¹ Portable particulate sensors allow their environments to be monitored for safety. However, the best available value air monitor (“AirBeam3”) lasts less than 12 hours. Additionally, this monitor often misreads high particulate concentrations, likely due to humidity and temperature effects.²

We pursued three Aims:

- 1) Modify the AirBeam3 for a 24+ hour battery.
- 2) Build an apparatus to test sensor performance.
- 3) Build a multi-sensor device to more accurately assess particulate matter. The novel device would feature a particulate-free “control sensor” paired to a particulate-exposed environmental sensor, where the control sensor compensates for measurement corruption by temperature and humidity effects:



#	Design Requirements
1	Portability & durability.
2	Safe design.
3	Minimally 24 hours of battery life.
4	All internal components are protected from debris and moisture.
5	Performance must be better than a stock AirBeam3.

DESIGN, APPROACH, PLAN

Aim 1)

Reverse engineer the AirBeam3 for upgrade to a 56-hour battery:



Aim 2)

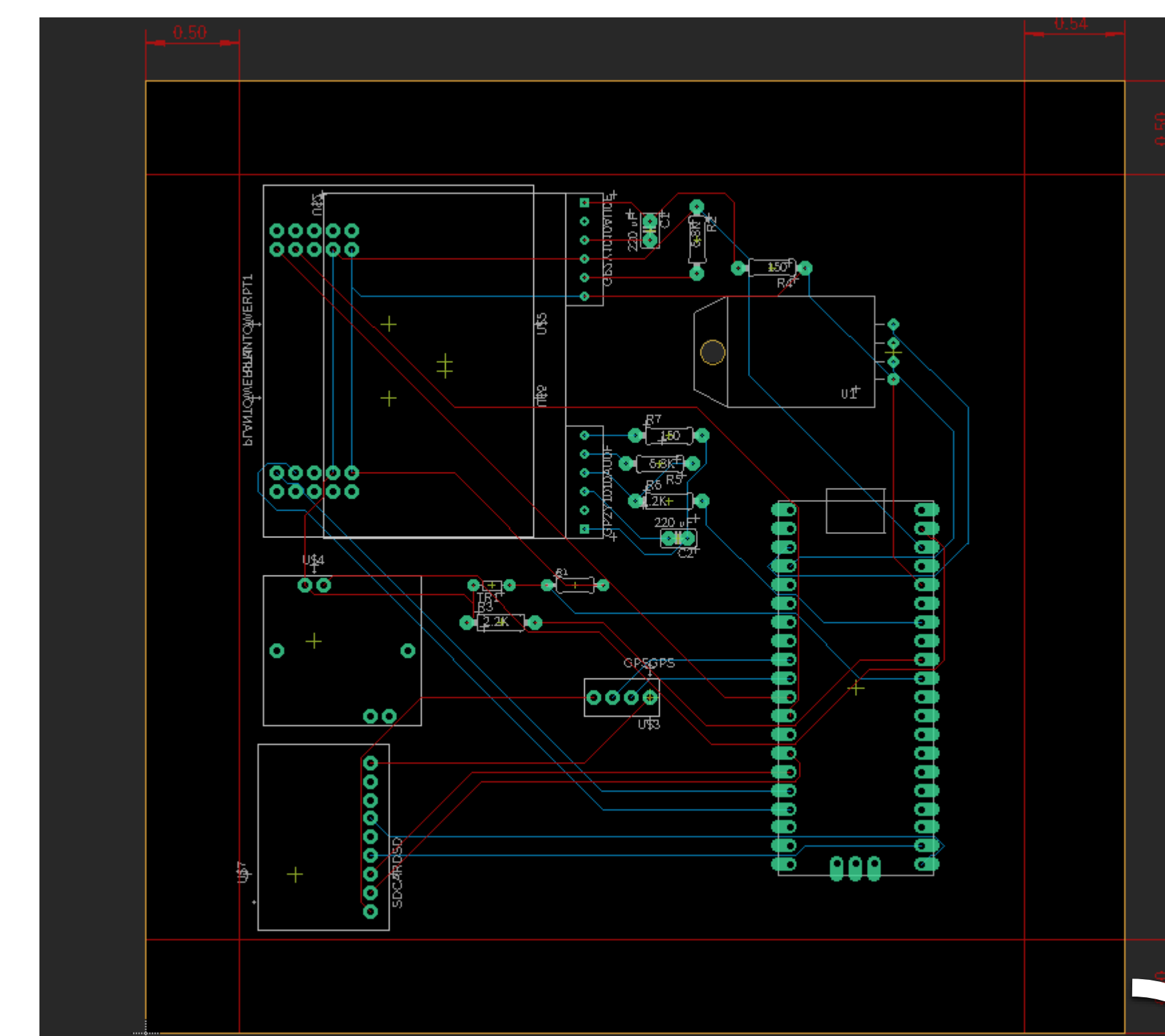
Build an apparatus to baseline particulate measurements and exposures from gas and diesel engine exhaust, wherein the system provides a controlled environment to compare the accuracy of particulate sensors against reference lab equipment.



Aim 3)

Print and program a circuit design for the novel “dual sensor” particulate monitor:

- Raspberry Pi Pico control
- Swappable particulate detectors:
 - PMS7003
 - Sharp GP2Y1010
- Temperature measurement
- Data logging to an SD card
- GPS



Built Spring 2025



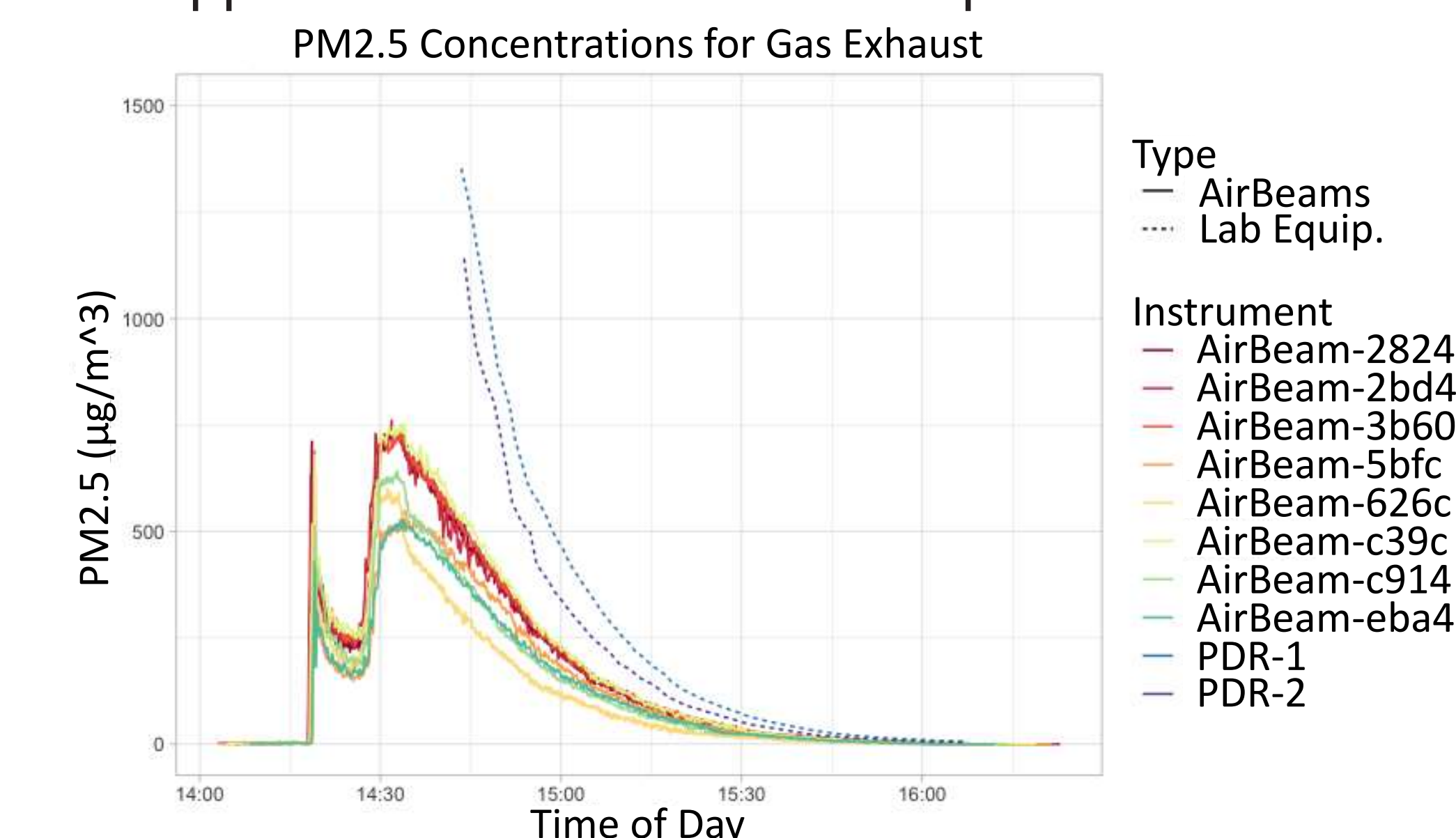
RESULTS

Aim 1)

56-hour battery endurance was confirmed for six AirBeam3 sensors that were upgraded by the team. **These sensors were distributed to Sylva EMS workers to study particulate exposures among emergency personnel.**

Aim 2)

The apparatus for sensor tests is operational:

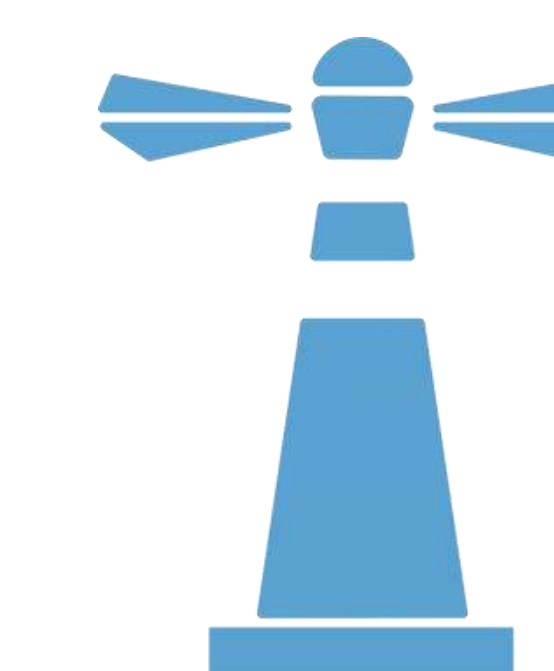


Aim 3)

Novel sensor development is ongoing.

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- Liam Pippert (Electrical Engineering)
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References

1. Dr. Sara Duncan, unpublished.
2. Zou, Y., Clark, J. D., & May, A. A. (2021). A systematic investigation on the effects of temperature and relative humidity on the performance of eight low-cost particle sensors and devices. *Journal of Aerosol Science*, 152, 105715.