AirPen: A Wearable Monitor for Characterizing Exposures to Particulate Matter and Volatile Organic Compounds

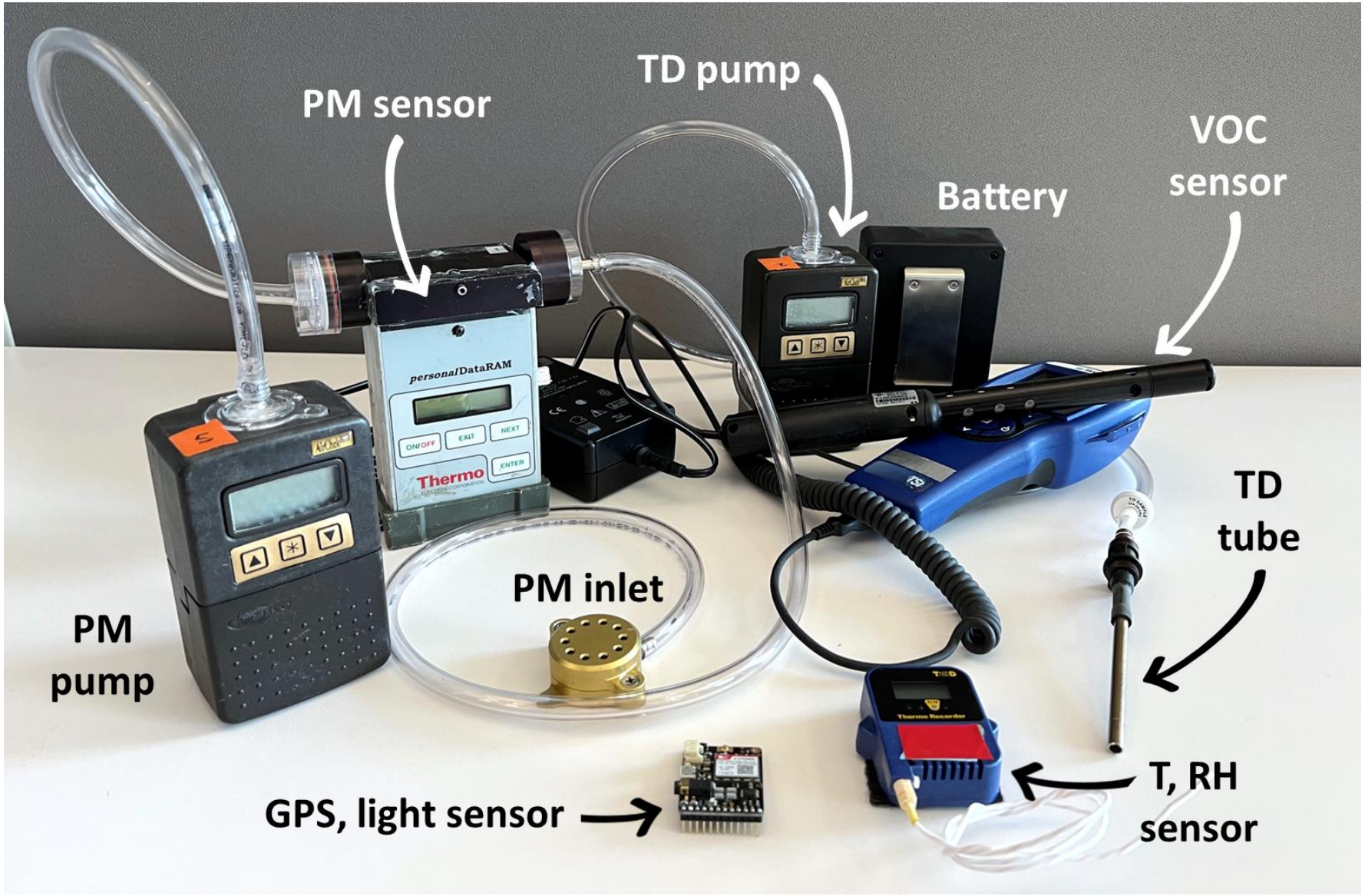
Emilio Molina Rueda, Jessica Tryner, Casey Quinn, Marie J. Andales, Christian L'Orange, Ellison Carter, and John Volckens

ASIC 2024 California Conference
Apr 30 – May 3, 2024

Colorado State University

Technologies for assessing personal exposure to particulate and gaseous air pollutants have limitations.

The Status Quo



Traditional Technology:

- Loud & heavy
- Burdensome
- Requires expertise (in field)
- Time-consuming QA/QC

Small Sample Sizes

Can technologic innovation increase sample size for personal exposure assessment?

A new paradigm: let’s measure ever

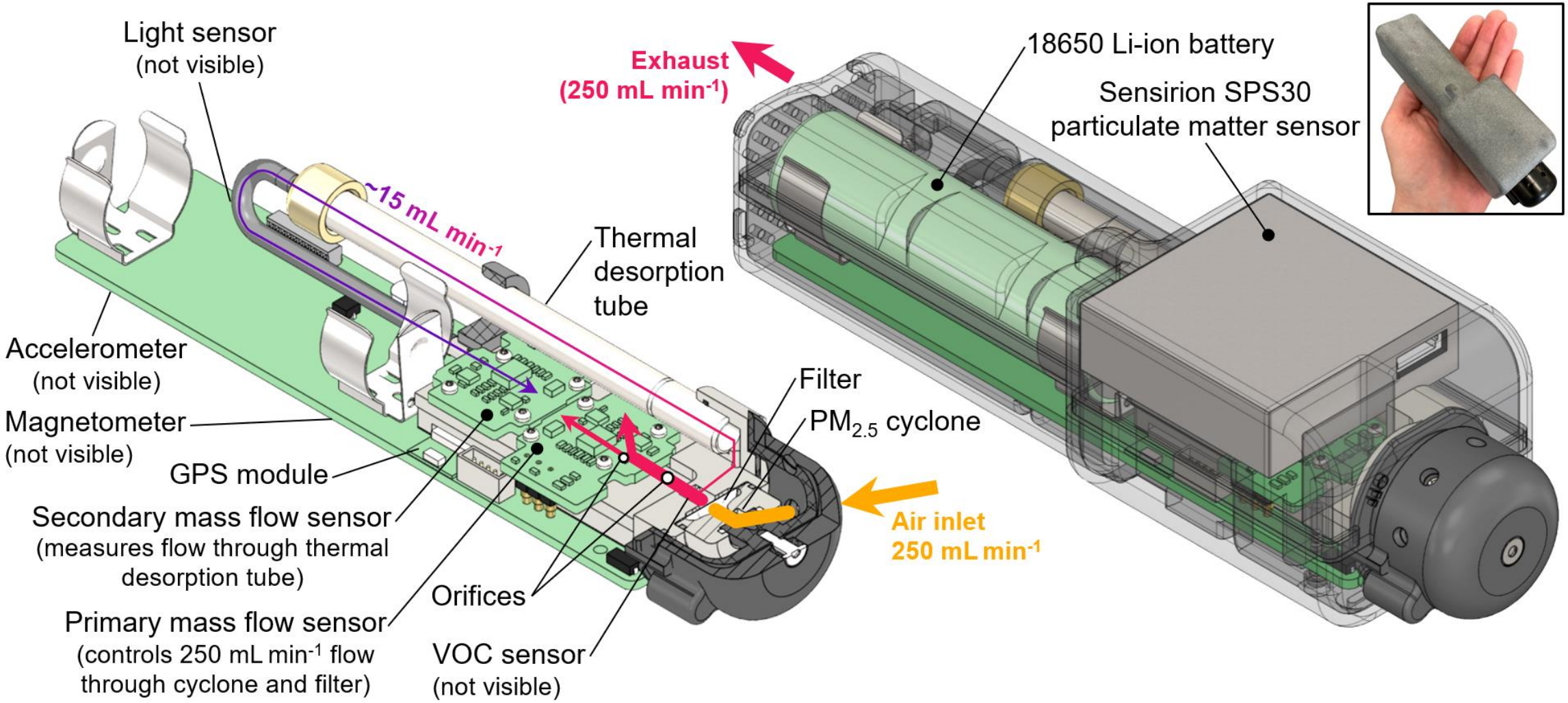
Happier practitioners, happier participants

AirPen is a wearable sampler for air pollution exposure assessment:

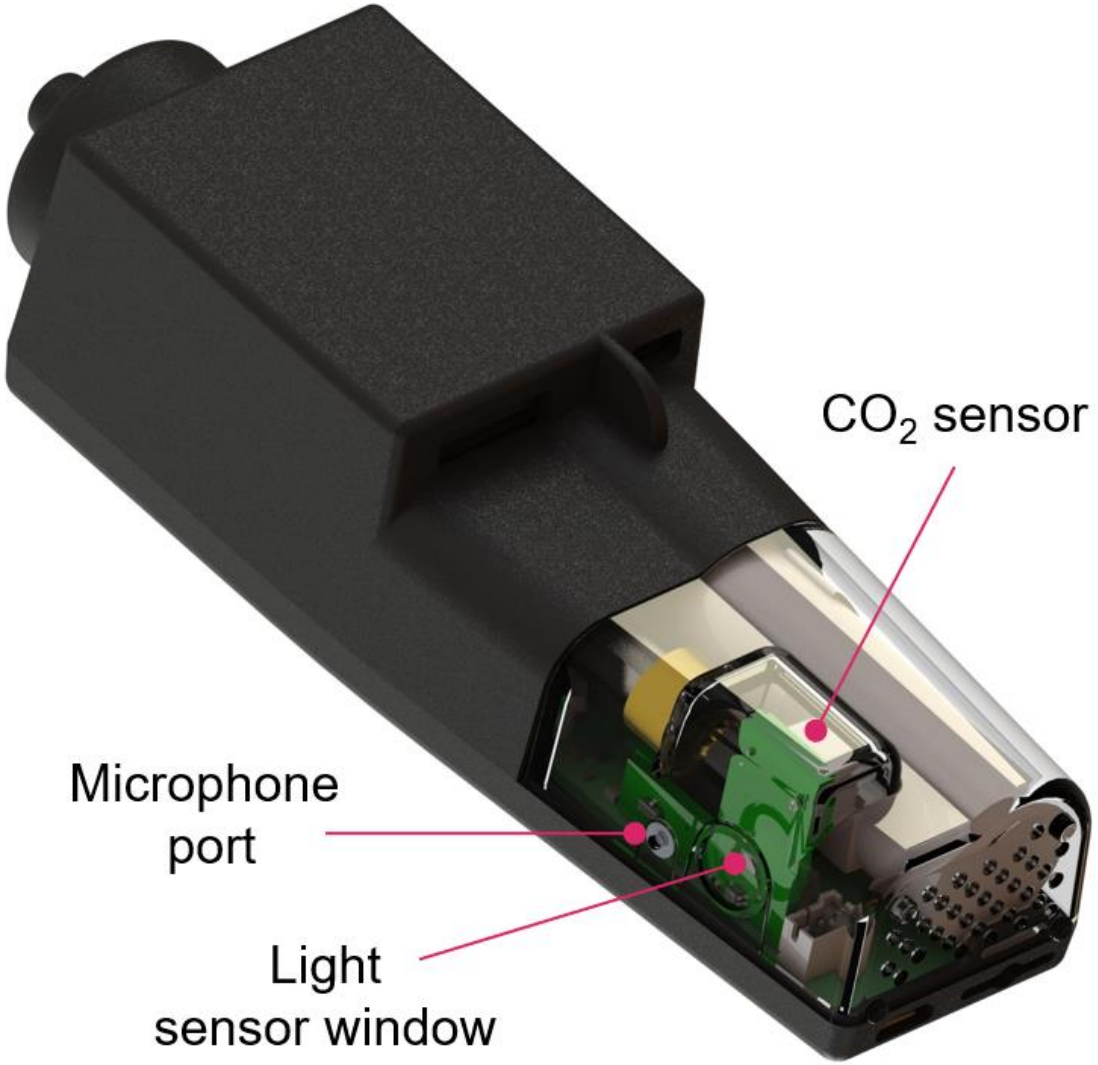
- Lightweight (~200 g) and compact (150 x 42 x 38 mm)
- Quiet (~55 dB)
- Includes filter + sorbent tube + PM & gas sensors
- Lower total cost of deployment

One AirPen for every person in your study

The AirPen in detail

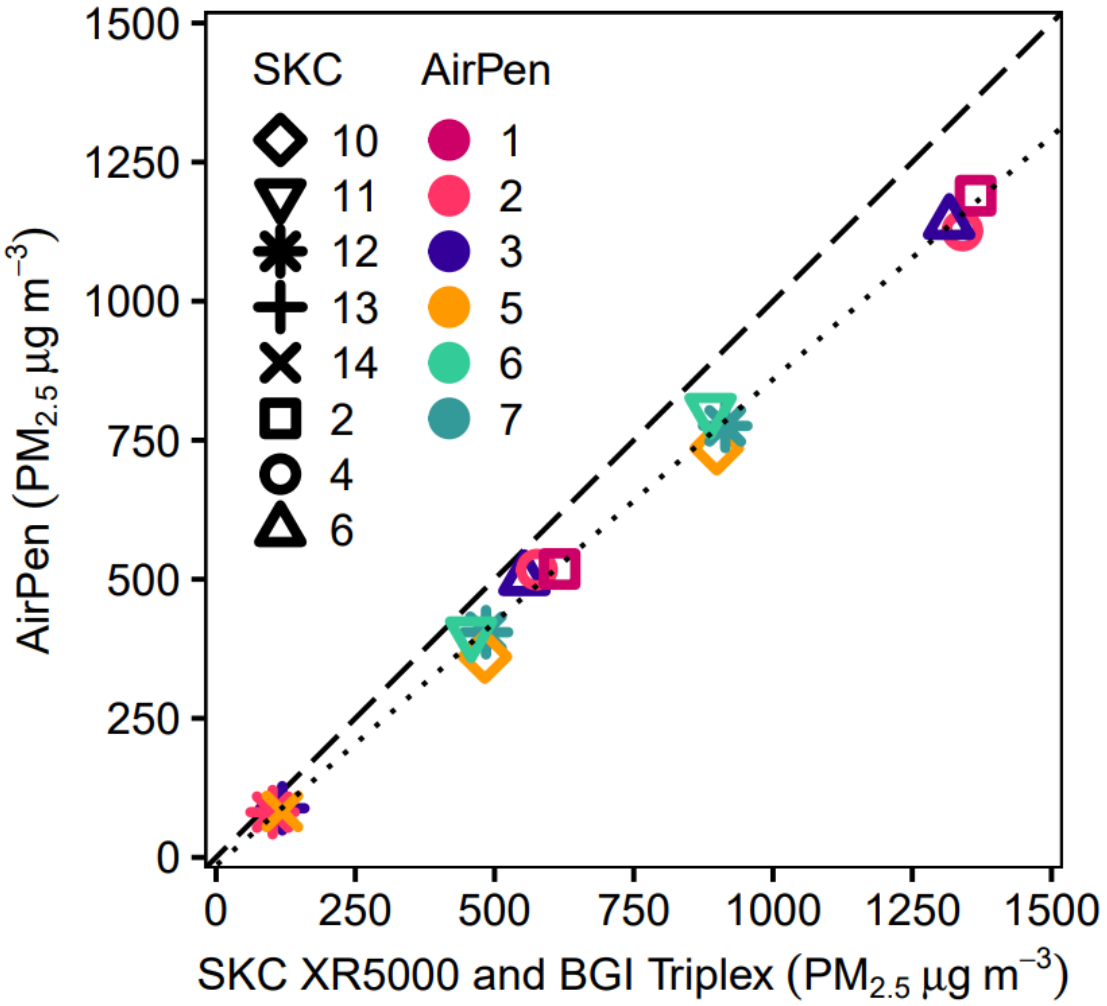


The AirPen in detail

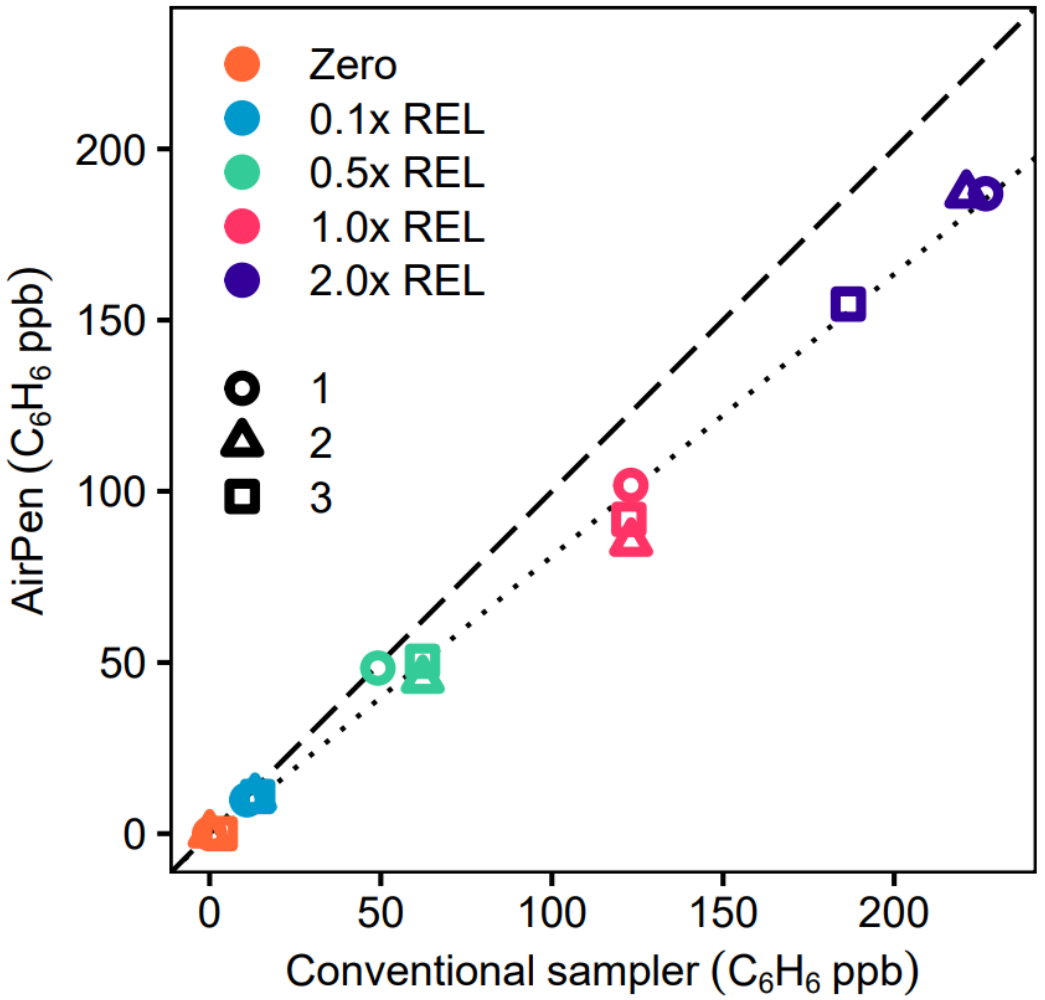


Our miniaturized technology provides quality data

Laboratory validation



$PM_{2.5}$

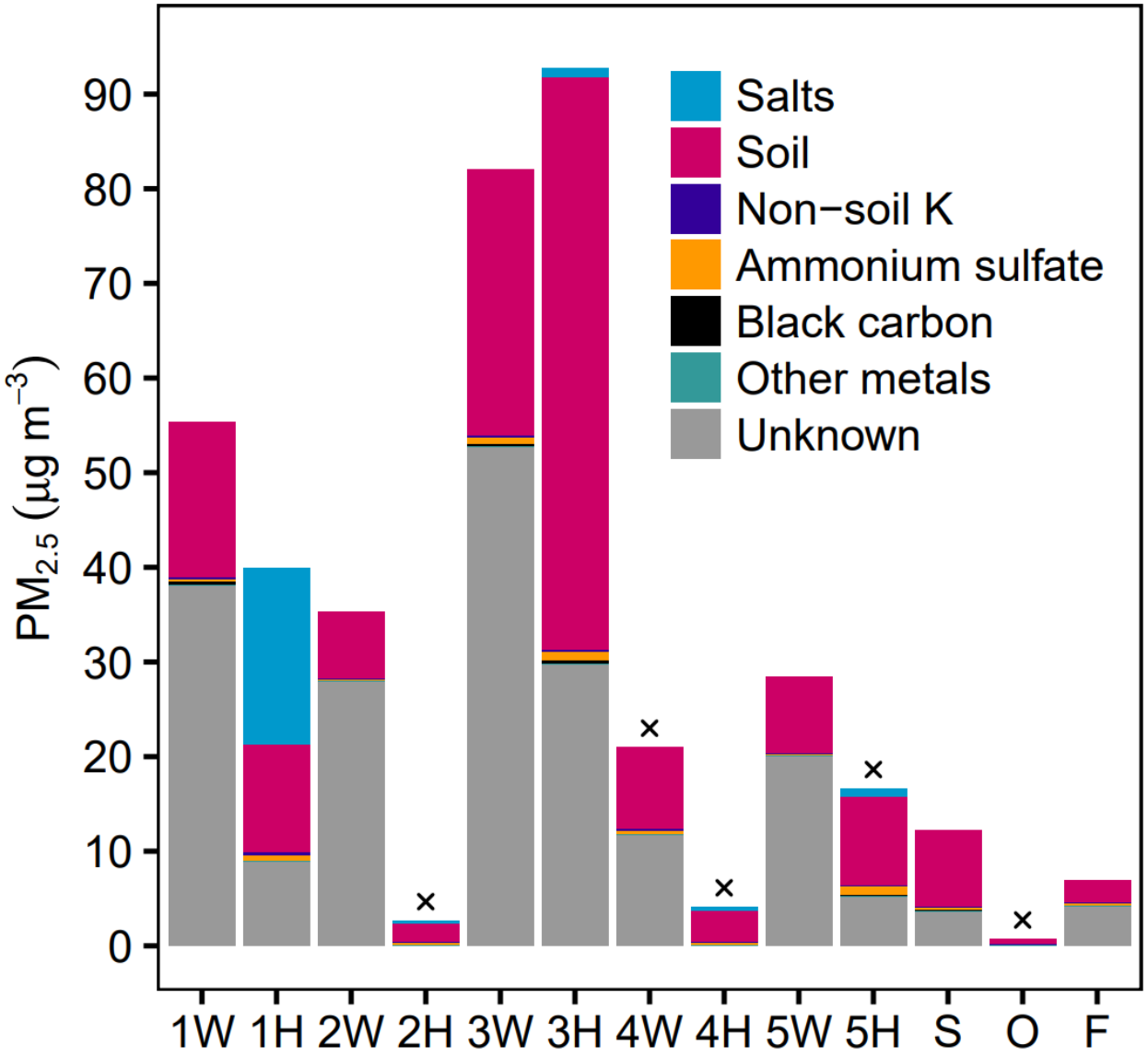


Benzene

Pilot Study

- Personal sampling campaign with five participants.
- At CSU's agricultural research center.
- One full work week.
- $PM_{2.5}$ and VOCs sampled with AirPens and traditional instruments.
- At work and away-from-work samples.

PM composition from filter analysis

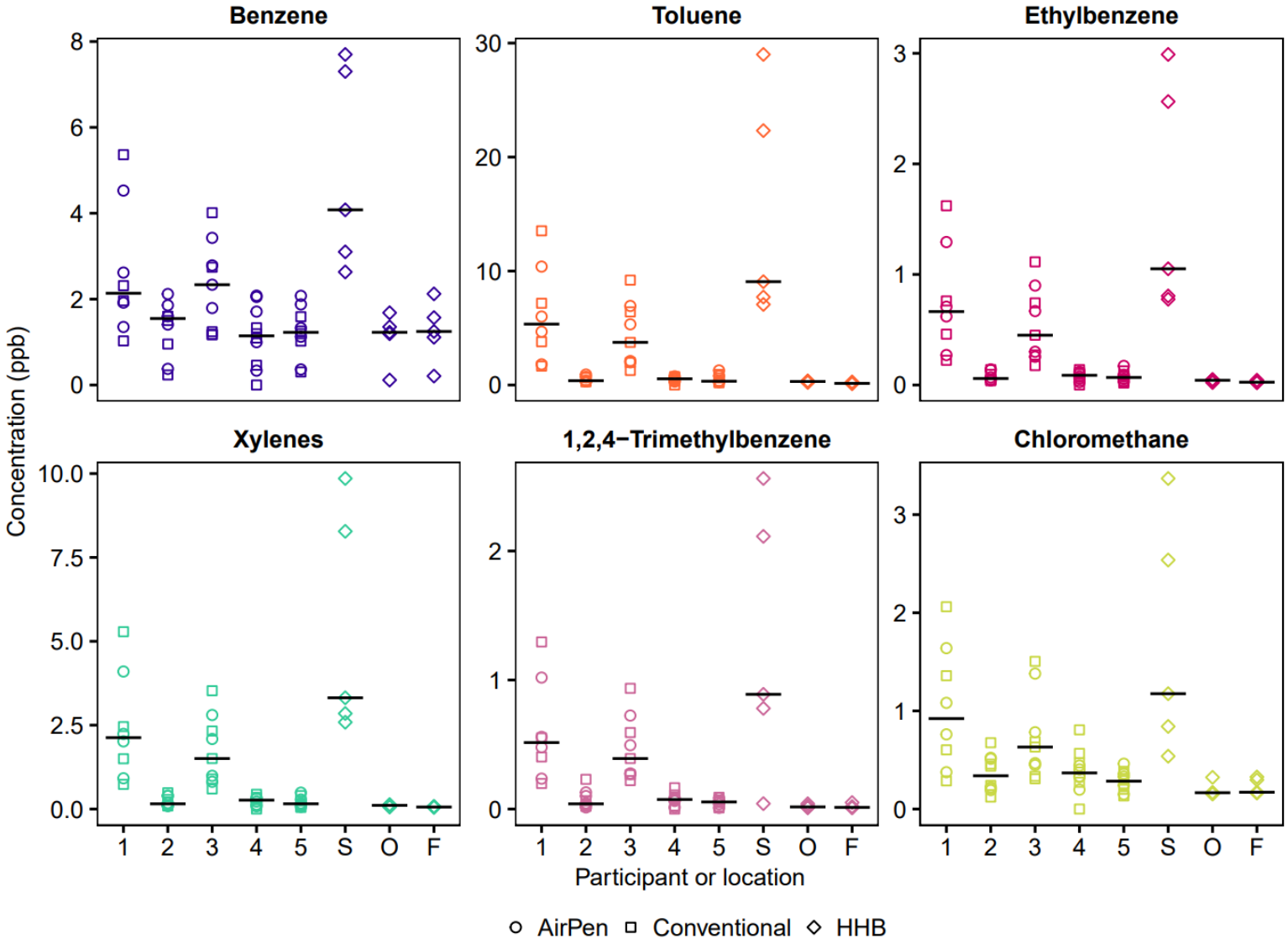


- Gravimetric (total mass)
- Organic carbon
- Elemental carbon
- Elemental composition
  - Salts
  - Metals

Samples legend

AirPen	Stationary
1 – 5: participant ID	**O:** office
H: at-home	**S:** shop
W: at-work	**F:** field

VOC composition from sorbent tube analysis



- Dozens of VOC's can be quantified by using calibration gases.
- We developed 39 calibration curves using EPA TO-14 mix.

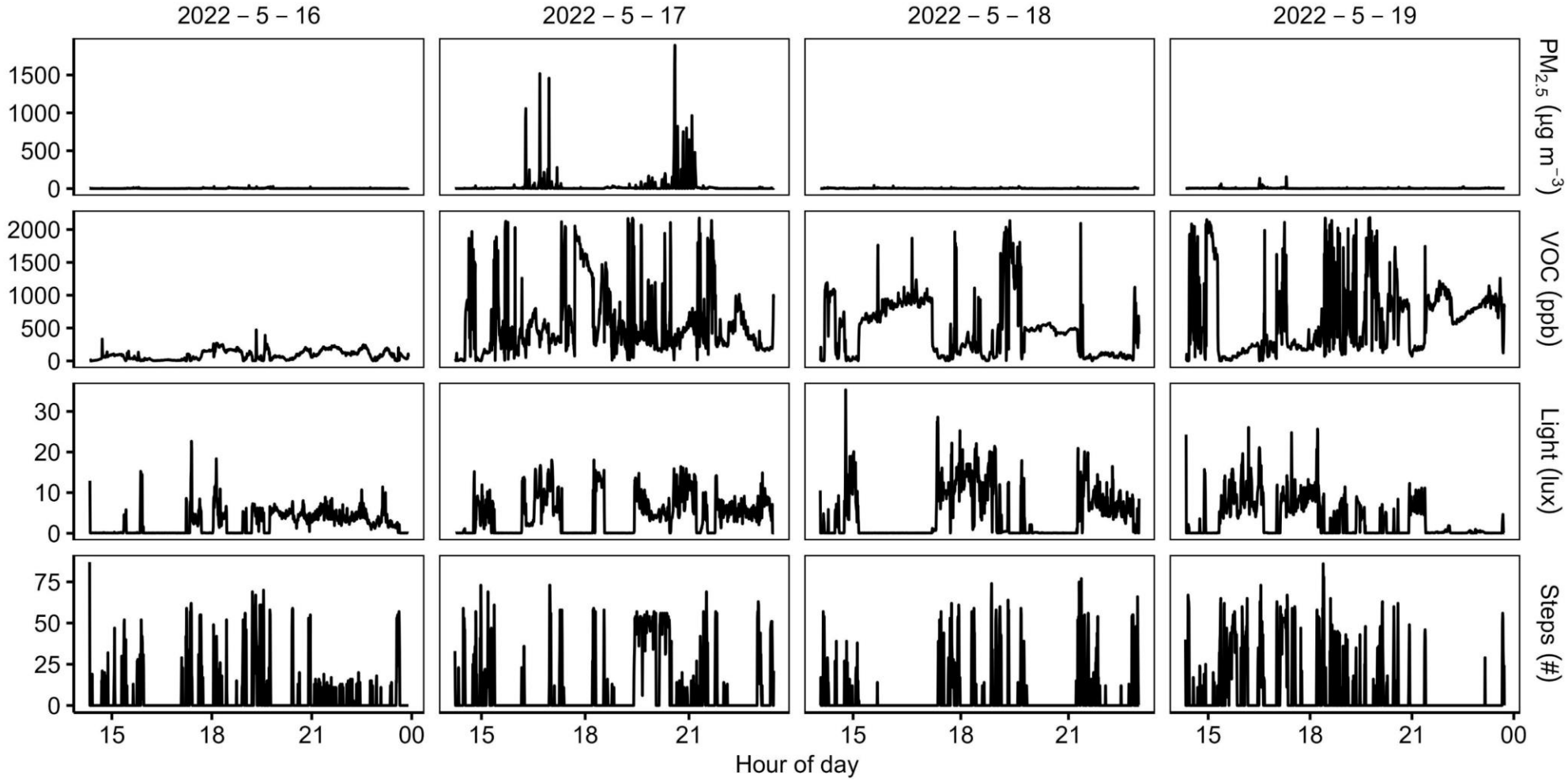
Sensor data give us context

$PM_{2.5}$

TVOC

Light

Steps



Larger sample sizes reveal the variability within and across different groups

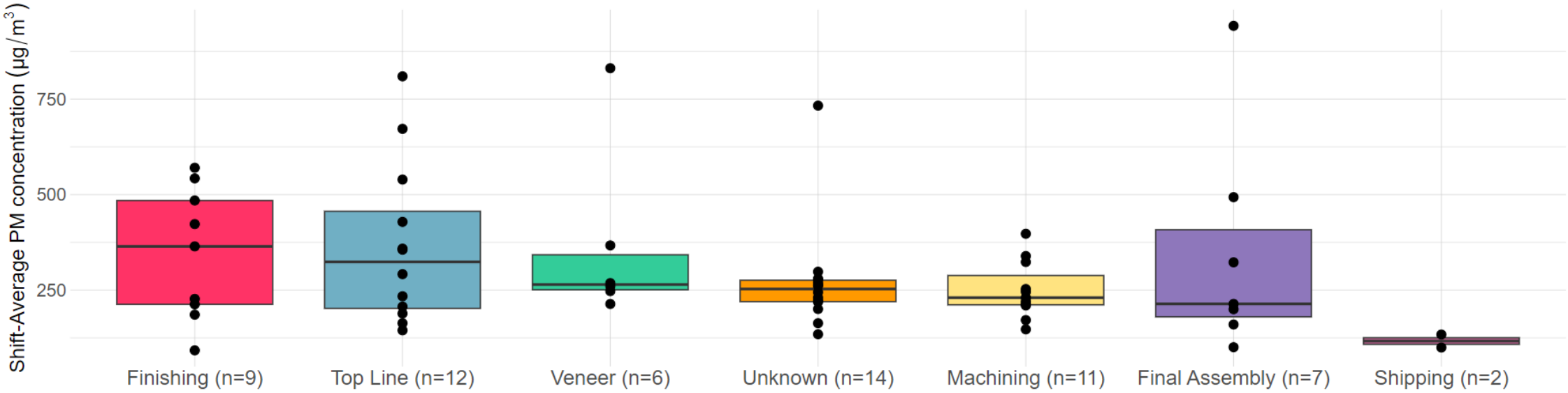
Full-Scale Study

- Personal sampling campaign with **84 participants in a single day.**
- One full work shift (~8 hours).
- At a furniture manufacturing facility in Georgia.
- Hazards quantified:
  - Total dust (µg/m3)
  - Formaldehyde (ppb)
  - Noise (A-weighted dB)

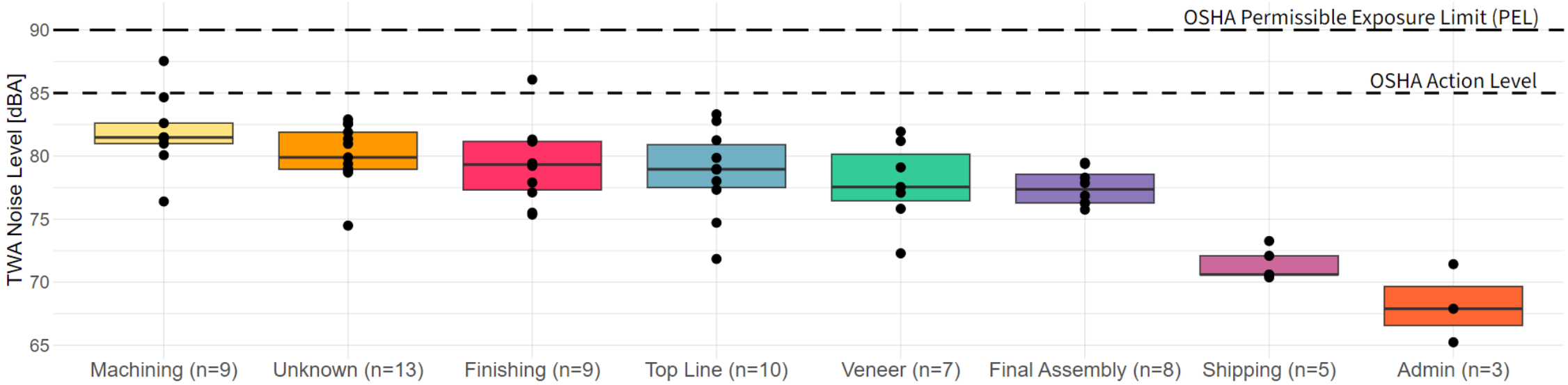
Full-Scale Study

Exposure distributions by job/task

Dust



Noise



Article Citation

AirPen: A Wearable Monitor for Characterizing Exposures to Particulate Matter and Volatile Organic Compounds

Jessica Tryner, *et al.* Environmental Science & Technology 2023 57 (29), 10604-10614

DOI: 10.1021/acs.est.3c02238

Acknowledgments

This project is funded by NIOSH R01OH011660 grant

Thank you

MECHANICAL ENGINEERING
COLORADO STATE UNIVERSITY

Contact Information

john.volckens@colostate.edu

ellison.carter@colostate.edu

emilio.molina_rueda@colostate.edu