

# Hands-on-exercise: Measurement of personal exposure to air pollution

**Dr. Kalpana Balakrishnan**  
**Dean (Research)**

Professor and Director

ICMR Center for Advanced Research

Air Quality, Climate and Health

Sri Ramachandra Institute for Higher Education and

Research (SRIHER)

Chennai, India

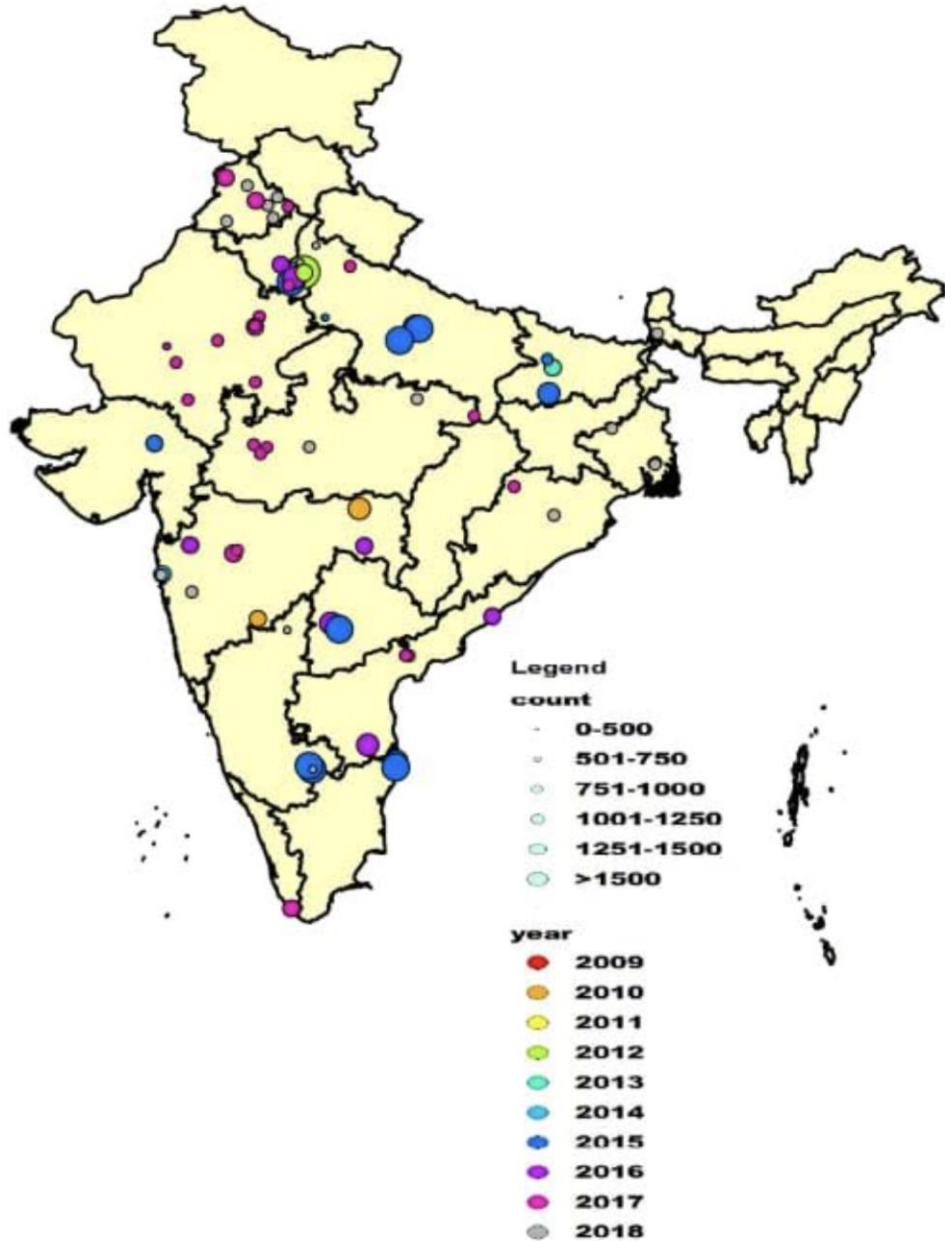
**ICIMOD HEI Early Career Training**  
**August 2024**



# Why is measurement of personal exposure important?

- Ambient monitor coverage is very sparse
- Exposures are heterogeneous, ubiquitous and seamless across rural-urban environments
- Exposures for vulnerable populations can be unique
- Time resolved personal exposures lend themselves to exposure attributions with greater precision
- Global models require representative sets of empirical measurements for accurate estimation of population exposures from LMICs

# Ambient monitoring is sparse



- Disproportionately distributed ground (reference-grade) monitors [Martin et al., 2019]
  - 804 manual monitors
  - 342 CAAQMS
  - All urban sites
- Mean distance to the nearest monitor = 80 km
- 1 Billion USD required to create an adequate network [Brauer et al., 2019]



# Exposure heterogeneity can be overwhelming



*“You get what you inspect and not what you expect”  
(Late) Professor. Kirk Smith*

# Developing, validating and deploying field instrumentation to capture exposure heterogeneity in rural and urban micro-environments



PC- XR8  
Active PM Sampler



Casella  
Active PM Sampler



Air-check Touch  
Active PM Sampler



Air-check XR 5000  
Active PM Sampler



PATS+  
Passive PM Sampler



UPAS  
Active PM Sampler



ECM  
Active PM Sampler



Purple Air  
Passive PM Sampler



Dräger  
Passive CO Sampler



LASCAR  
Passive CO Sampler



Beacon Logger  
Time Location monitor



Beacon Unit  
Time Location monitor



I button & Dots  
Stove use monitors





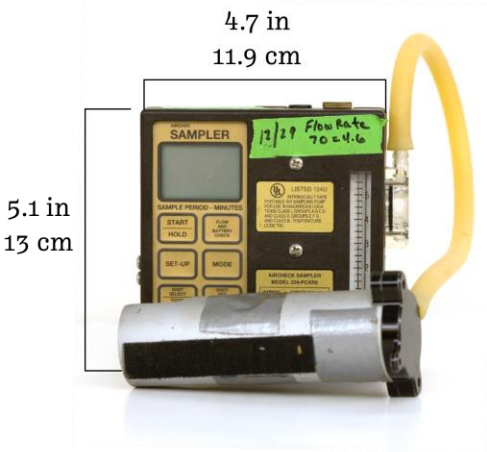
Photo Credit: SRIHER







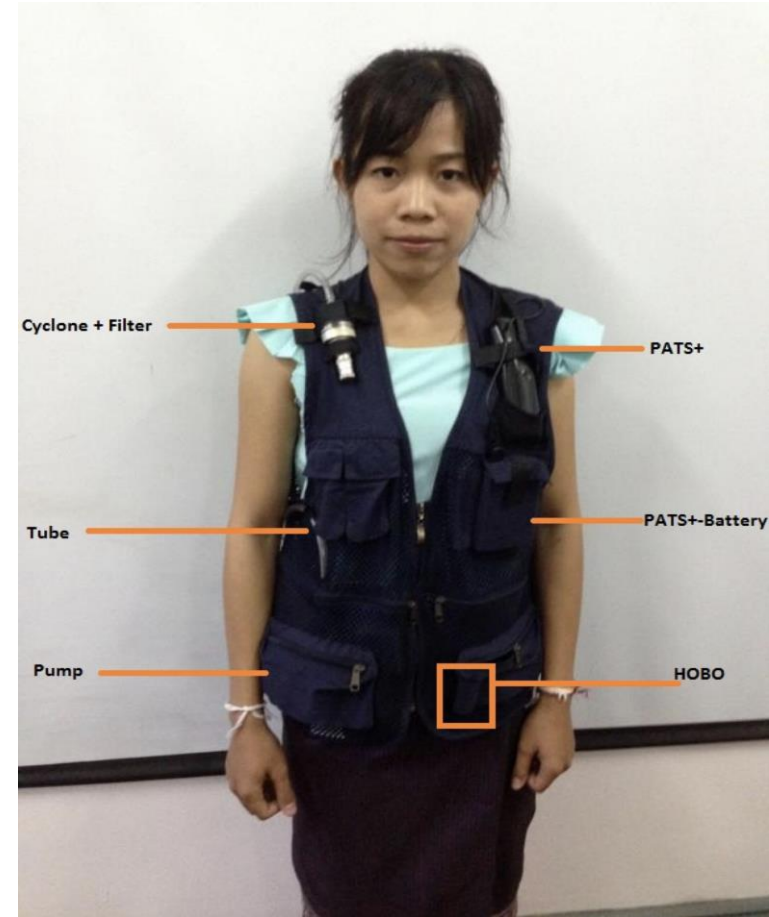
# From carrying to wearing PEM devices...



Heavy, loud, poor battery life  
Bulky and obtrusive  
Low compliance



# Multi-pollutant monitoring across population sub-groups



# Exposure and source heterogeneity in urban, peri-urban and rural micro-environments is now well characterised

HOW?

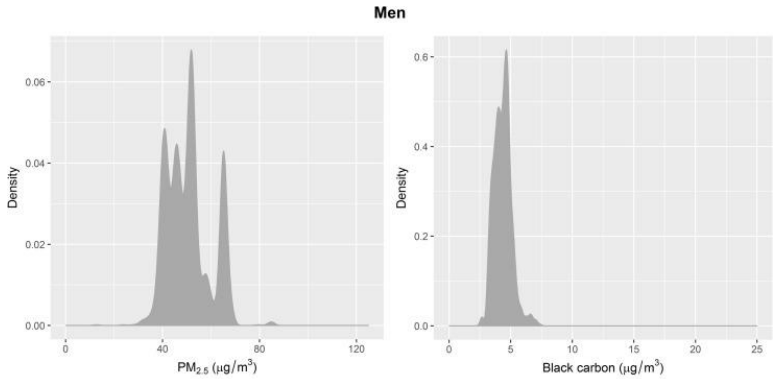
Ambient monitoring  
LUR estimates

GPS  
Wearable camera  
Questionnaires

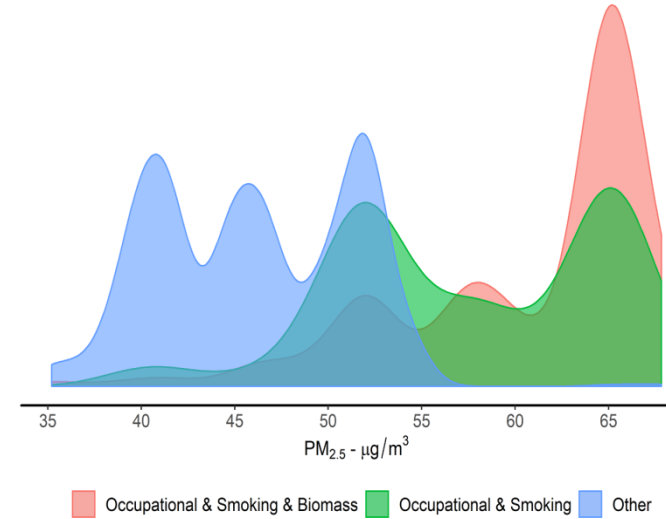
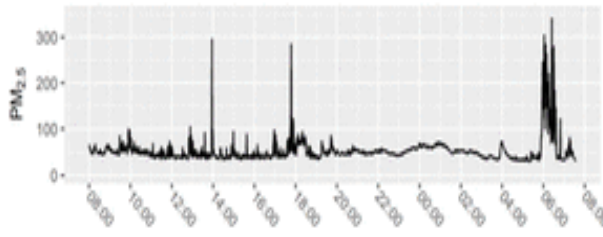
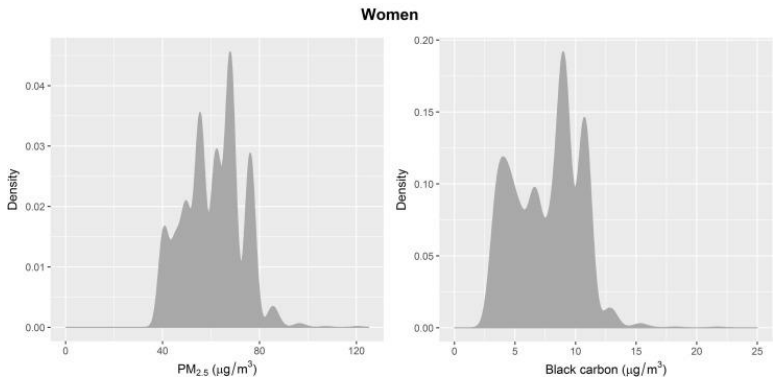
PM<sub>2.5</sub>  
personal  
exposure

When?

Where?

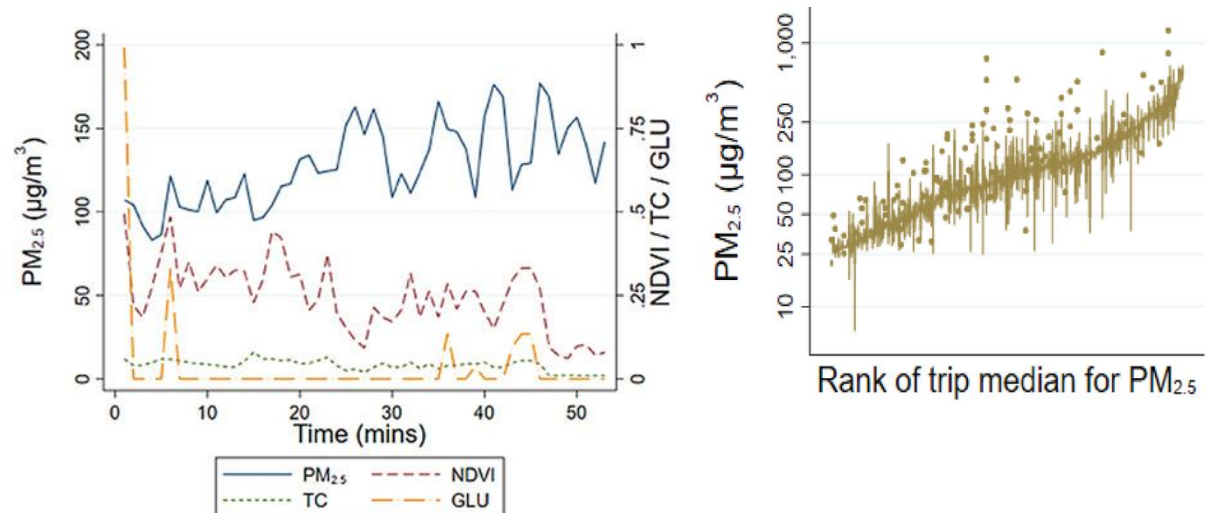
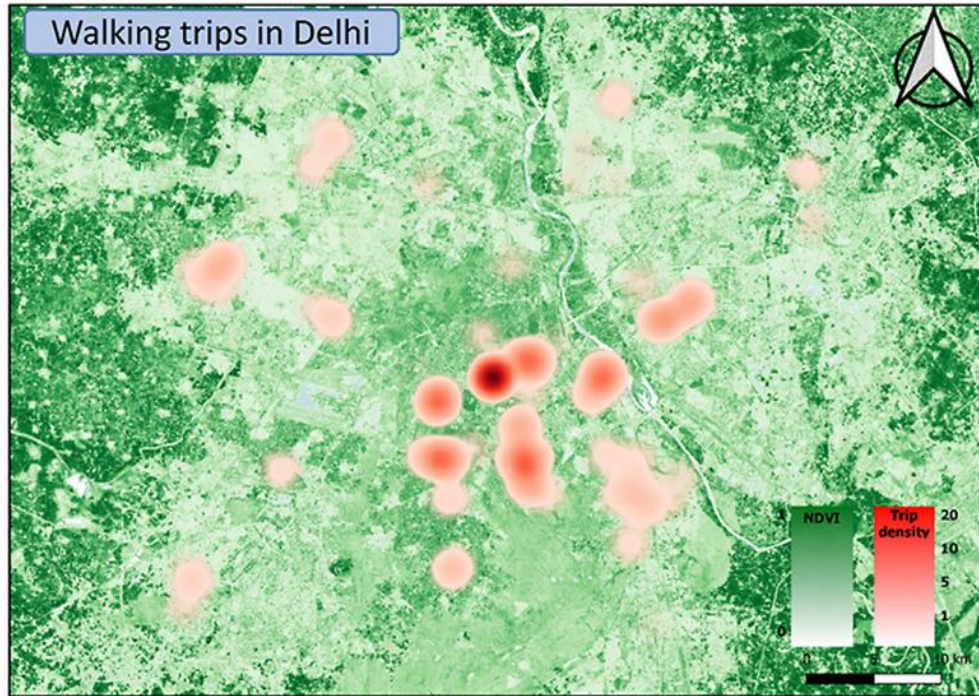


What?





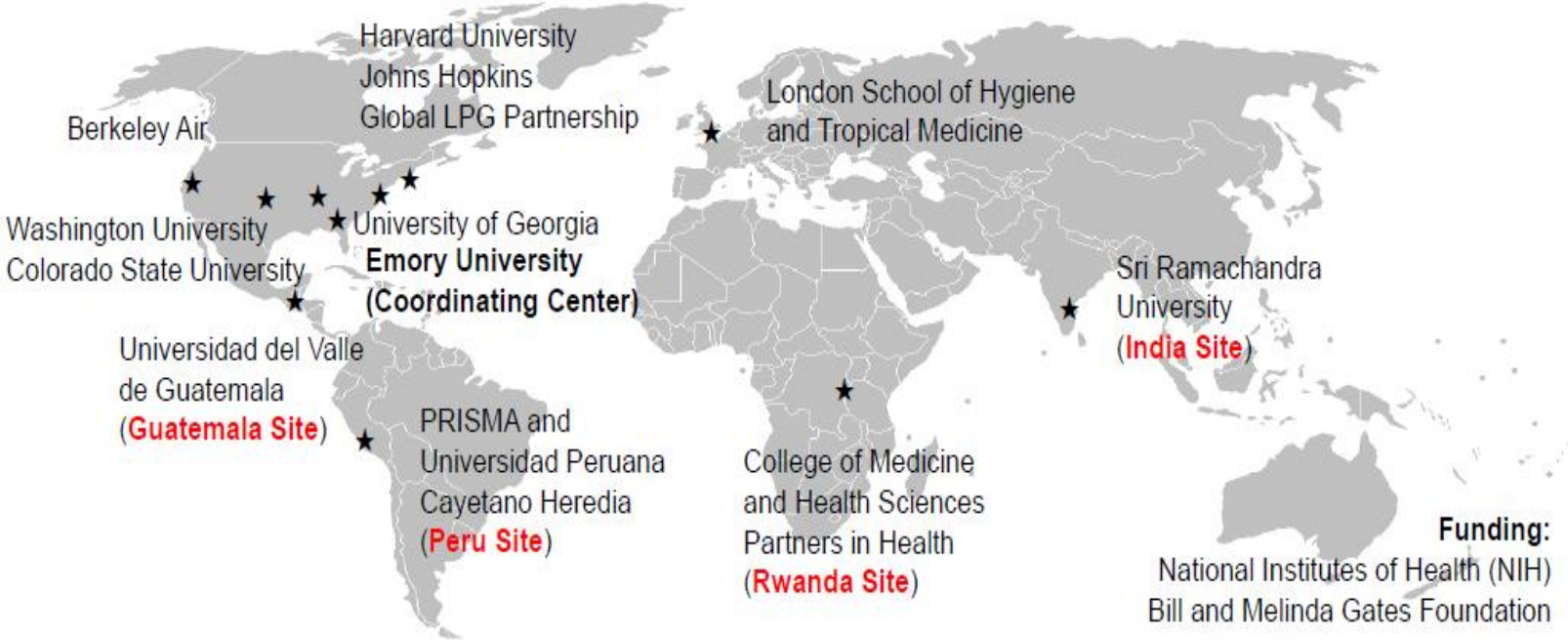
# Exposure and source heterogeneity in urban, peri-urban and rural micro-environments is now well characterised



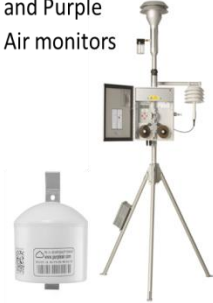


# HAPIN: Scaling multi-pollutant, longitudinal HAP and stove-use monitoring within multi-country RCTs

The Household Air Pollution Intervention Network (HAPIN) 



Ambient PM: E-Sampler and Purple Air monitors



LPG intervention



Birth weight  
Child severe pneumonia  
Child linear growth/stunting  
Adult blood pressure



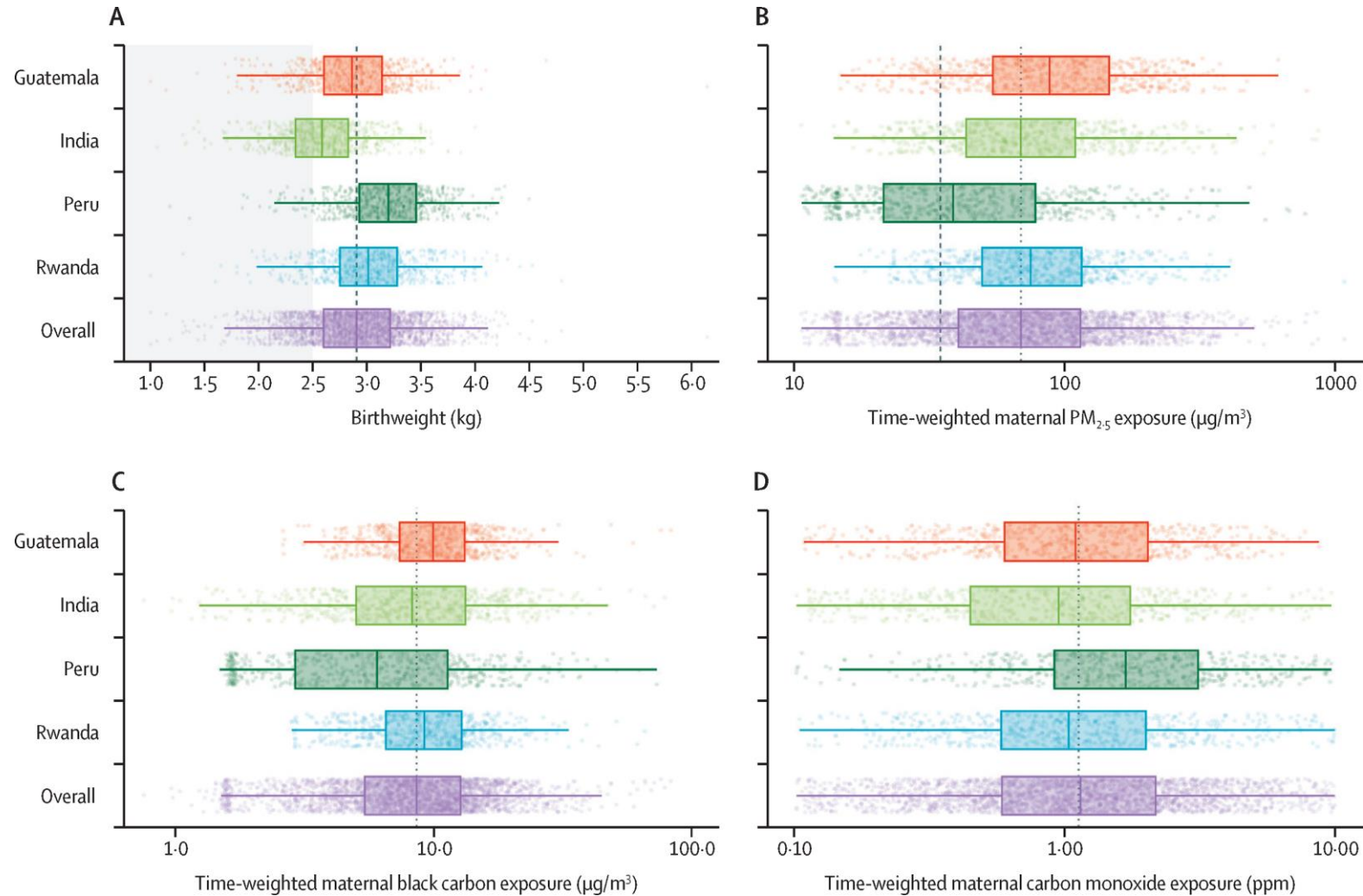
Logger



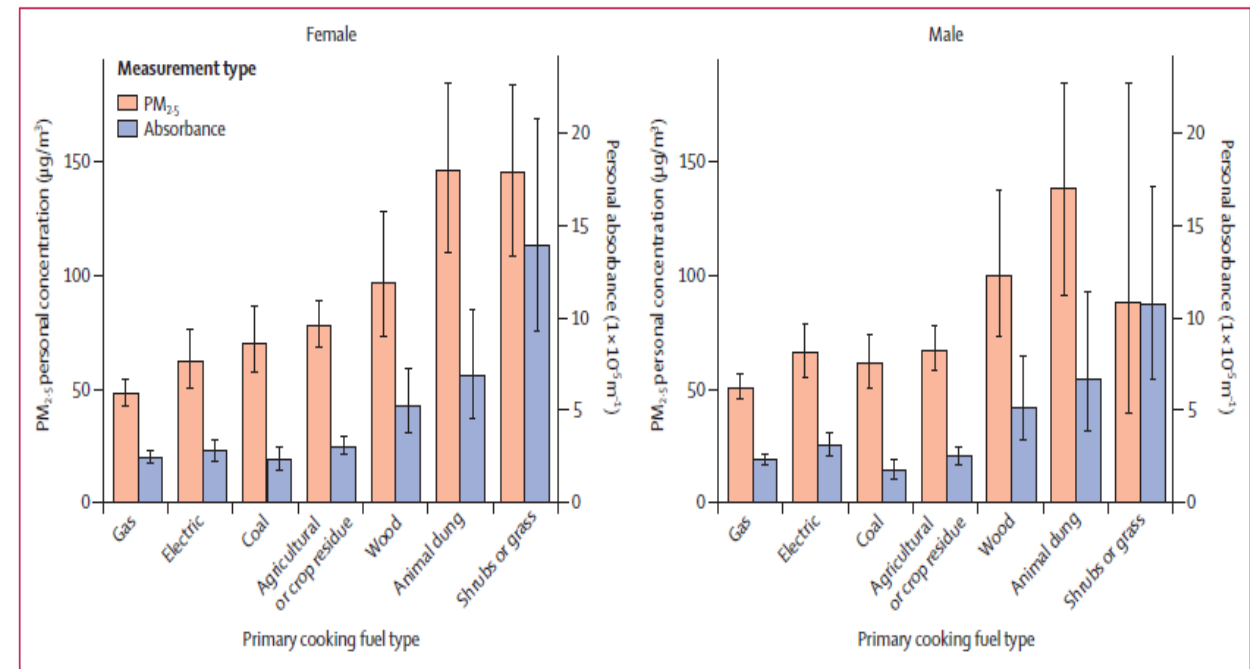
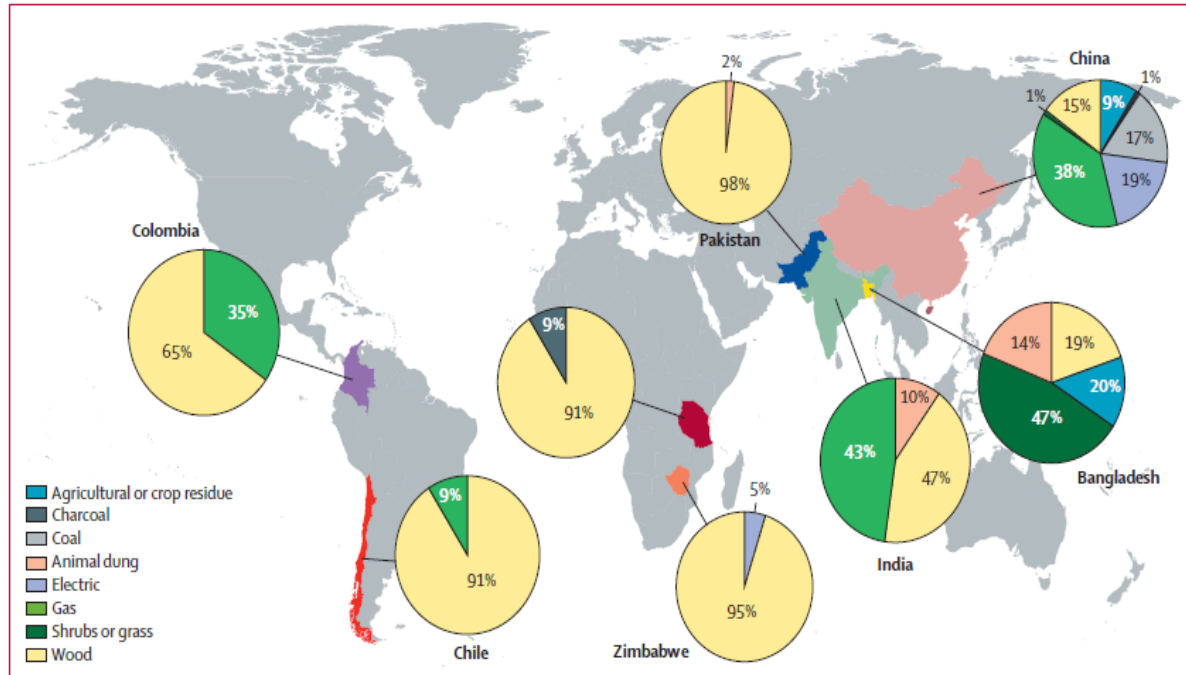
Thermocouple



# Exposure and source heterogeneity in rural, peri-urban and urban micro-environments is now well characterised



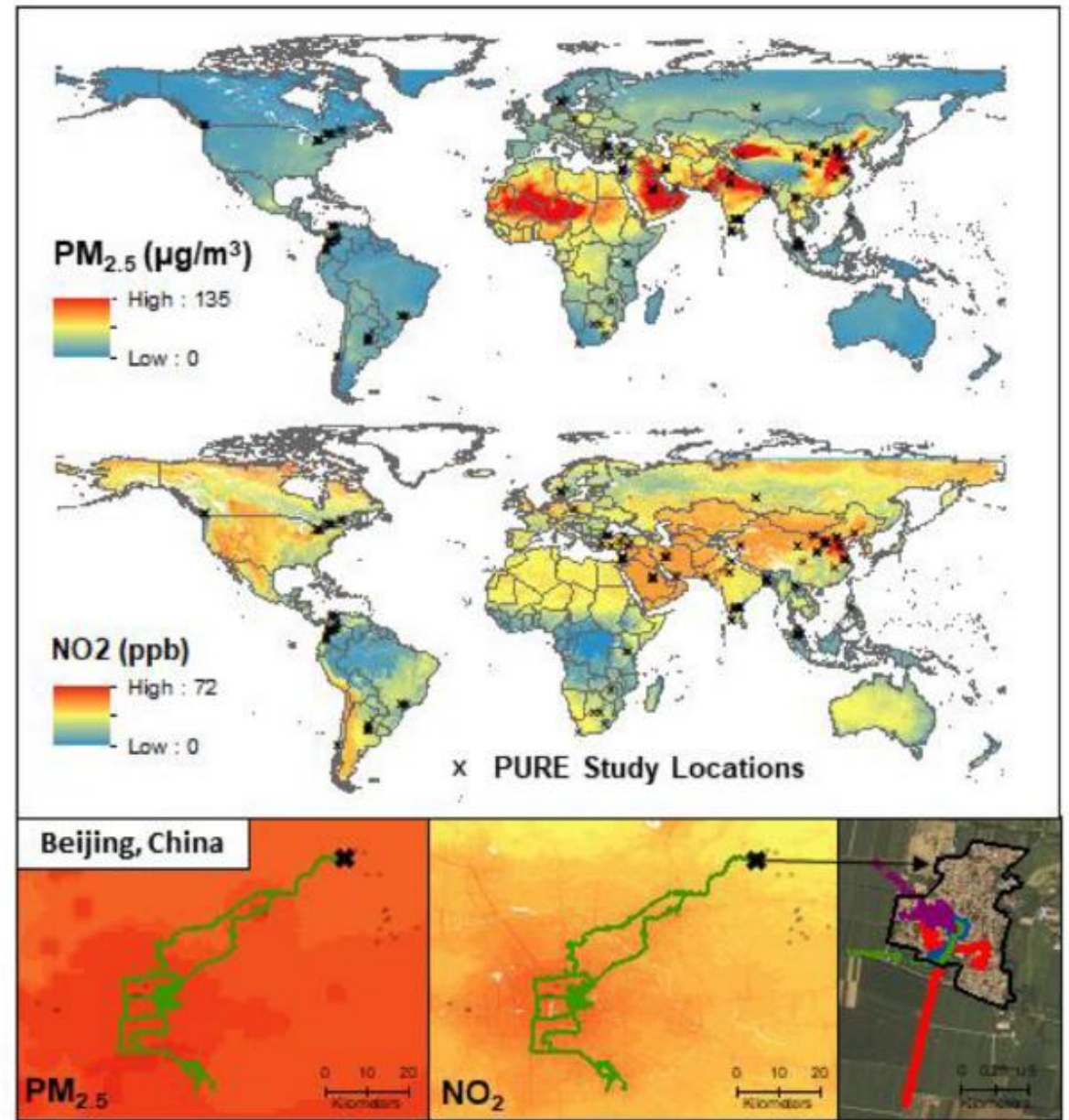
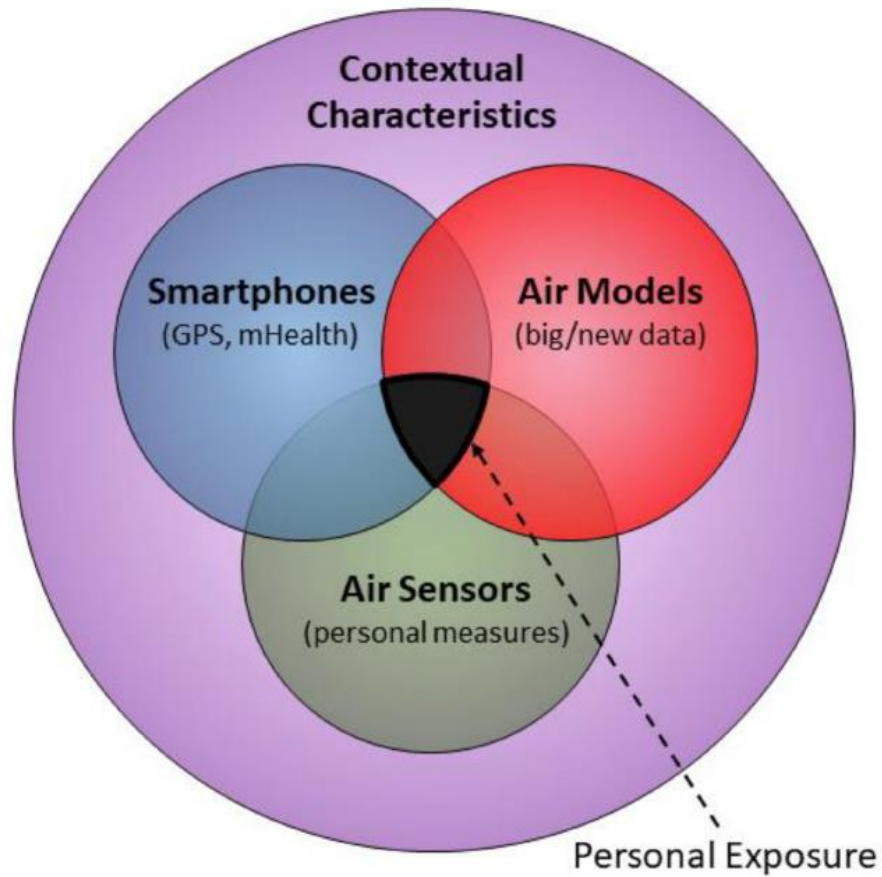
# PURE- Air: Scaling cross-sectional HAP Exposure Measurements across 8 countries



Shupler et al 2020



# Where are we headed?



# DEMONSTRATION



# OVERVIEW OF AN EXPOSURE ASSESSEMENT MONITORING DEVICES

## Indoor monitoring: Air quality monitors



SKC Air Sampler



UPAS



ECM



PATs+



LASCAR CO monitors



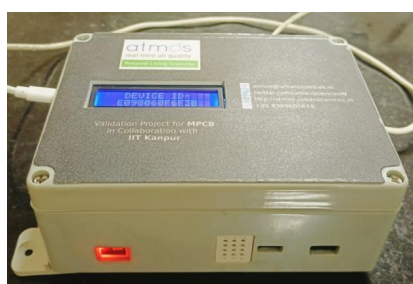
Beacon Unit and Beacon Logger



## Low cost sensors (LCS) : Air quality monitors



LCS-Atmos Ver.1



LCS-Atmos Ver.2



LCS-Aerogram Ver.1



LCS-Aerogram Ver.2



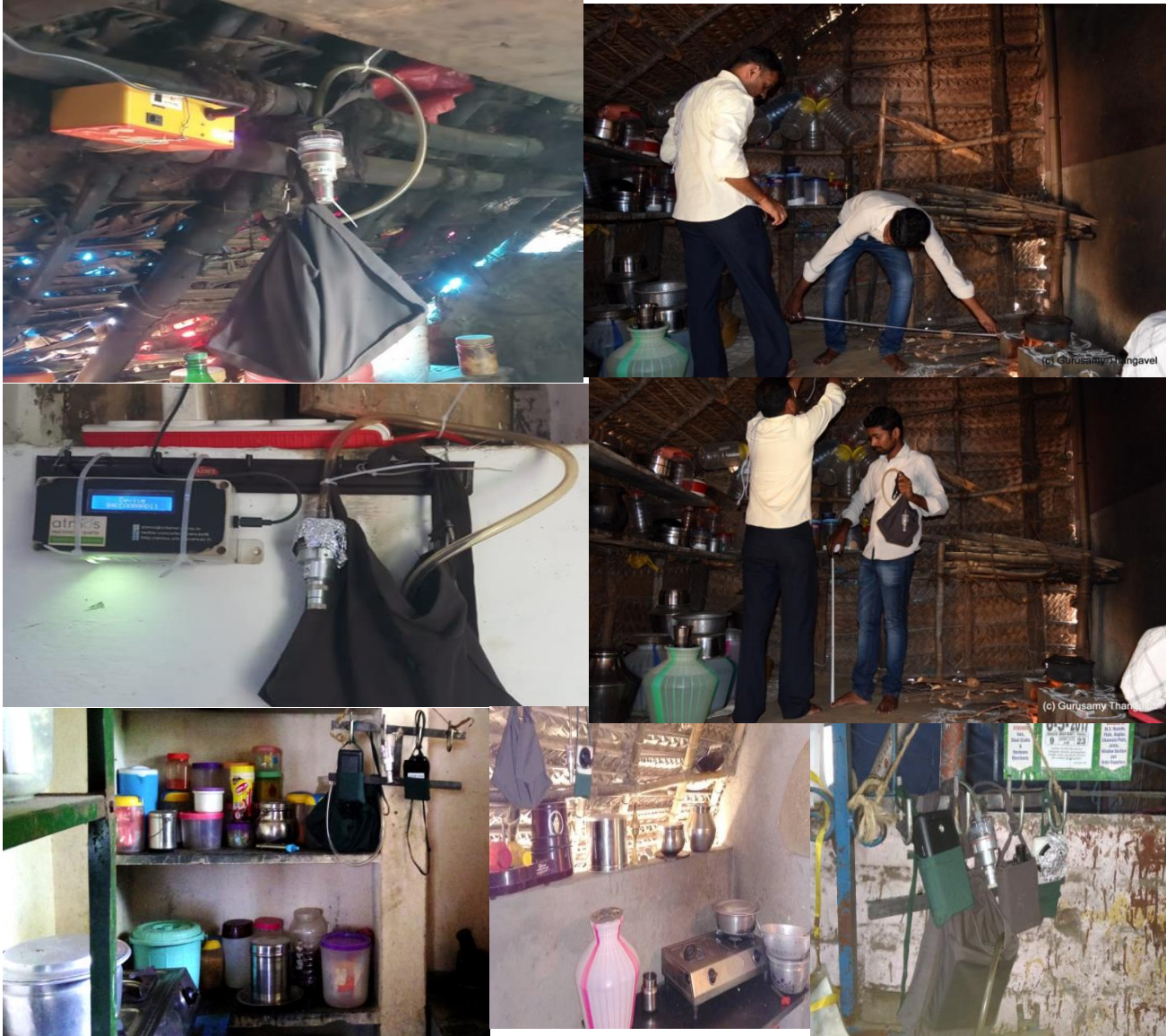
Purple Air



# Household Air Pollution/Personal Assessments - Pictures

Microenvironment placement

Personal placement





# Household Air Pollution/Personal Assessments - Pictures

Near Outdoor placement



Ambient placement





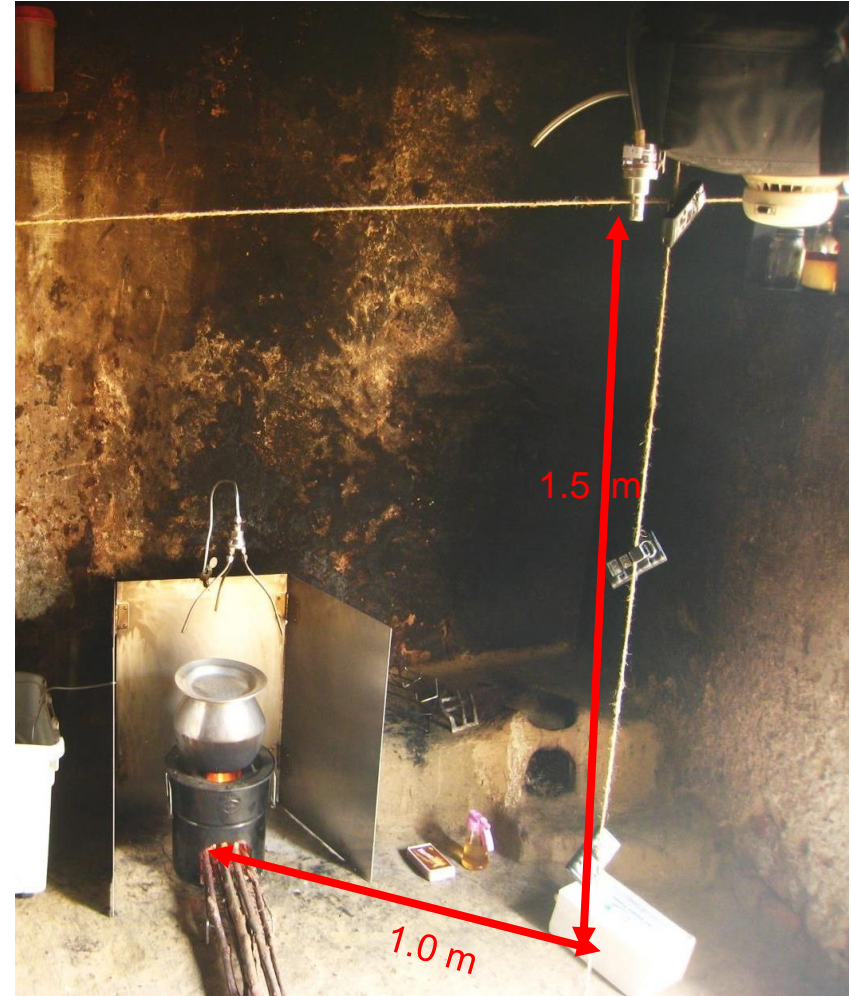
# HAP Instrument Placement – Indoor Kitchen Area

Should be placed:

- **1.0 m** from edge of combustion zone of the main cook stove
- **1.5 m** above the floor (related to approximate breathing height of cook)
- **1.5 m** away (horizontally) from open doors and windows
- Place markers with labels below equipment in order to replicate placement

***Always record actual distance from combustion source and doors/windows!***

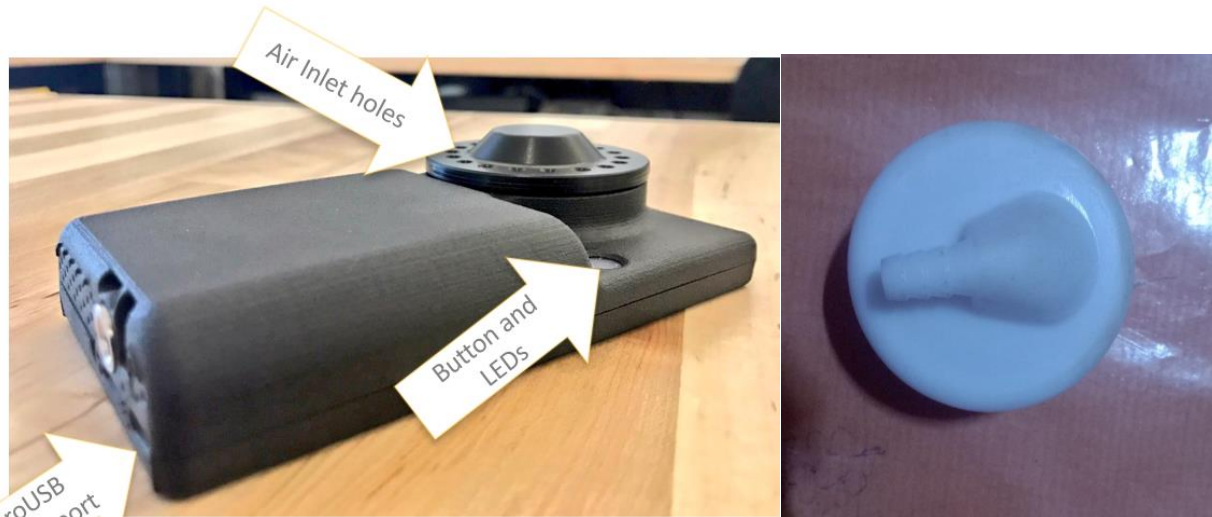
- A hook or nail can be used to keep placement **secure and consistent**





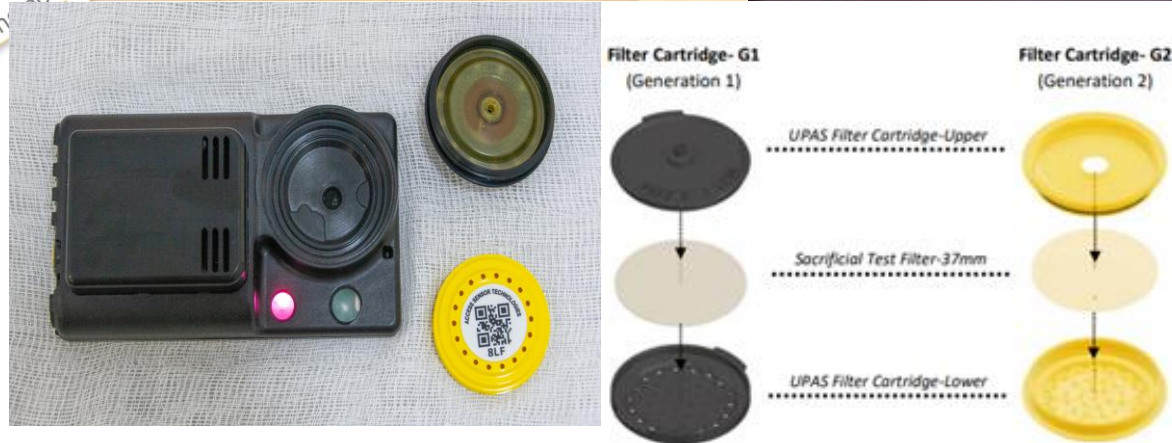
# Air quality Sampler- UPAS Demonstration

## Ultrasonic Personal Aerosol Sampler (UPAS)



## Steps to follow UPAS for Sampling

- Download the mobile device application for IOS or Android (AST UPAS or CSU UPAS)
- Setting Up UPAS
- Calibrating Flow Rate(Pre sampling)
- Installation and Removal of sampler
- Data Downloading
- Removing and storing Filter
- Cleaning



# Air quality Sampler- ECM Demonstration

RTI's Enhanced Children's MicroPEM (ECM)



## Steps to follow ECM for Sampling

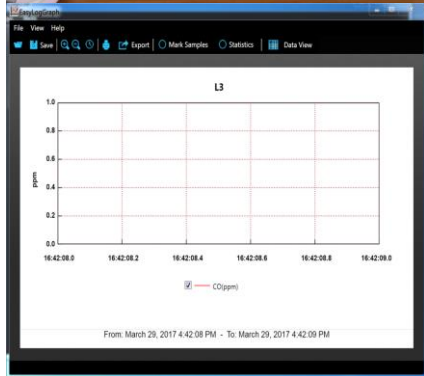
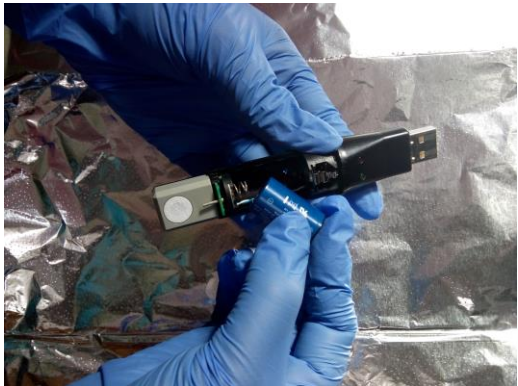
- Software install
- Setting Up ECM
- Calibrating Flow Rate(Pre sampling)
- Installation and Removal of sampler
- Data Downloading
- Removing and storing Filter
- Cleaning





# Air quality Sampler- Lascar CO Logger Demonstration

## Lascar CO Logger



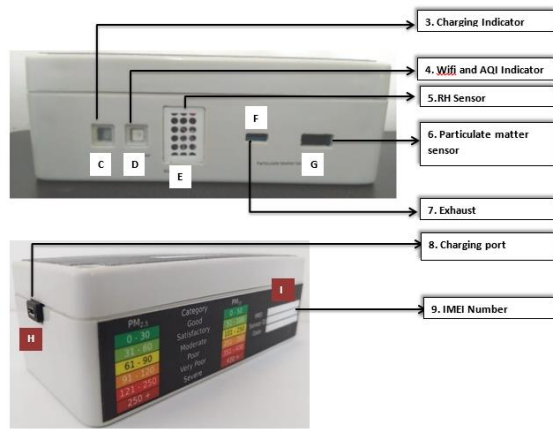
## Steps to follow CO Logger for Sampling

- Software install
- Setting Up CO logger
- Installation and Removal of Logger
- Data Downloading

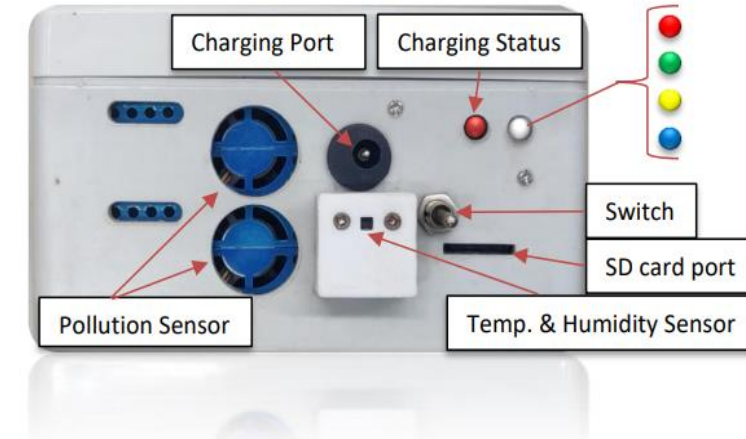


# Low Cost Sensor(LCS) Demonstration

## ATMOS:



## AEROGRAM:







**Thank you from SRIHER!**

Shot on OnePlus  
By Isaac willson 11

(c) Gurusamy Thangavel