

CLAIRITY

An Air Quality Network for
MIT's Campus

CO

NO

NO₂

O₃

PM2.5

PM10



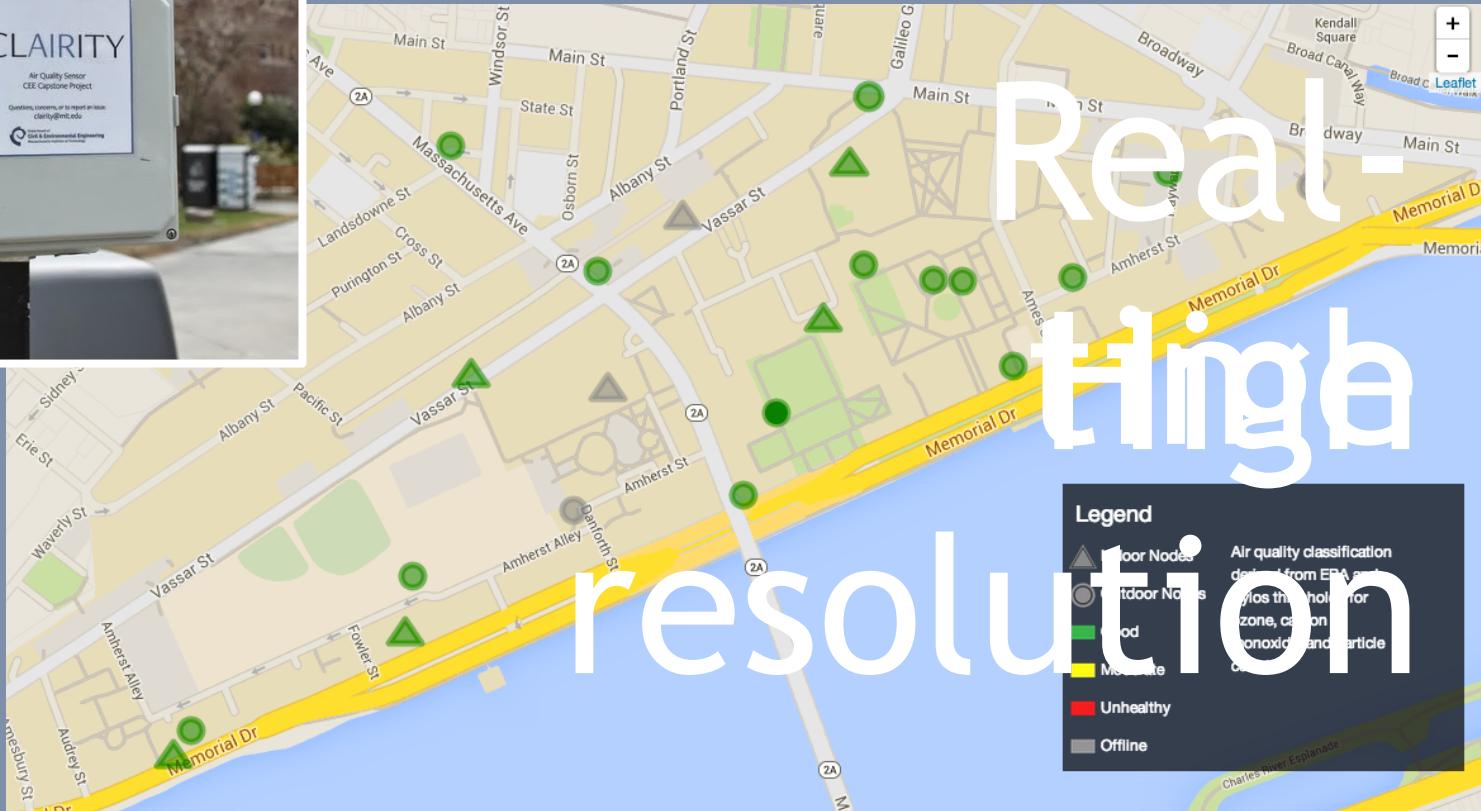
Automobiles

Chemical
Solvents

Power plants

Stoves

Open Fires



CLAIRITY.MIT.EDU

CLAIRITY Locations

Food Service Areas
Parking Areas
Major Intersections
Roofs
Community Cross Section

- ~~Under Building Roefst Alley~~
- ~~Building on Kessag St.~~
- ~~Blacksen Avenue near the parking~~
- ~~Station Building (Wacker~~
- ~~Bleacher Field~~ Parking
- Next House
Courtyard





CONTEXT

HARDWARE

CODING

CALIBRATION

COMMUNICATION

COMPARISON

ANALYSIS

EXPANSION

Project Timeline

Fall 2013

- Chose which pollutants to measure
- Chose sensors to use
- 1st iteration of node design

Spring 2014

- Built & calibrated 25 nodes
- Installed throughout MIT
- Developed software
- Created the CLAIRITY website



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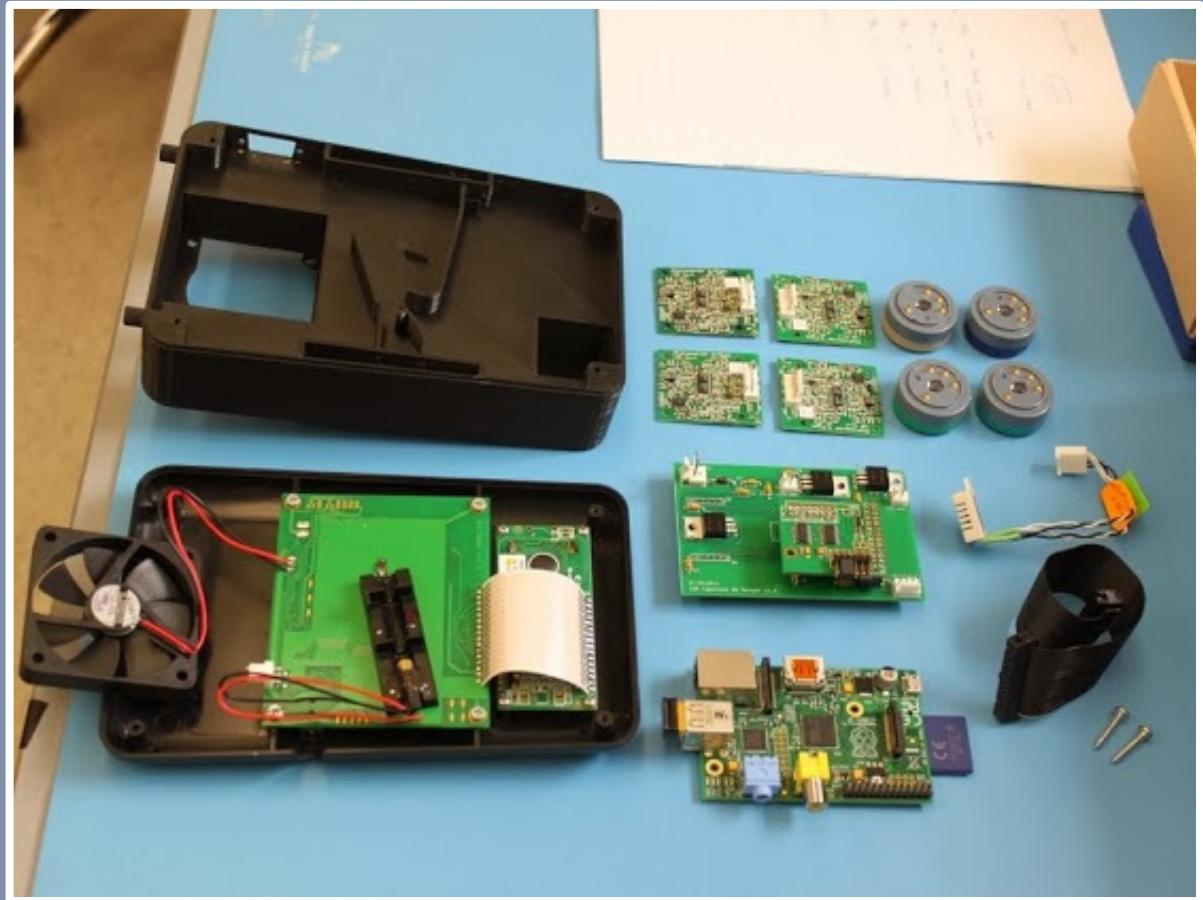
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Node Hardware

- Dylos Particle Counter
- 4 Electrochemical Gaseous Pollutant Sensors
- Raspberry Pi processor

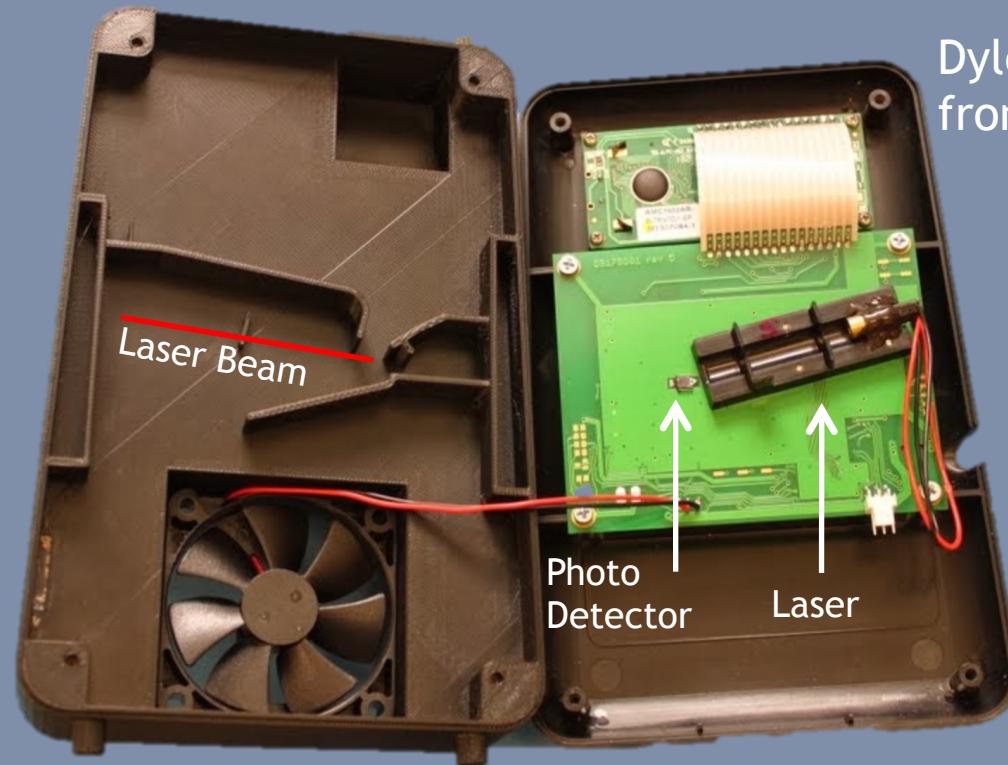


Node Hardware

Electrochemical Sensor



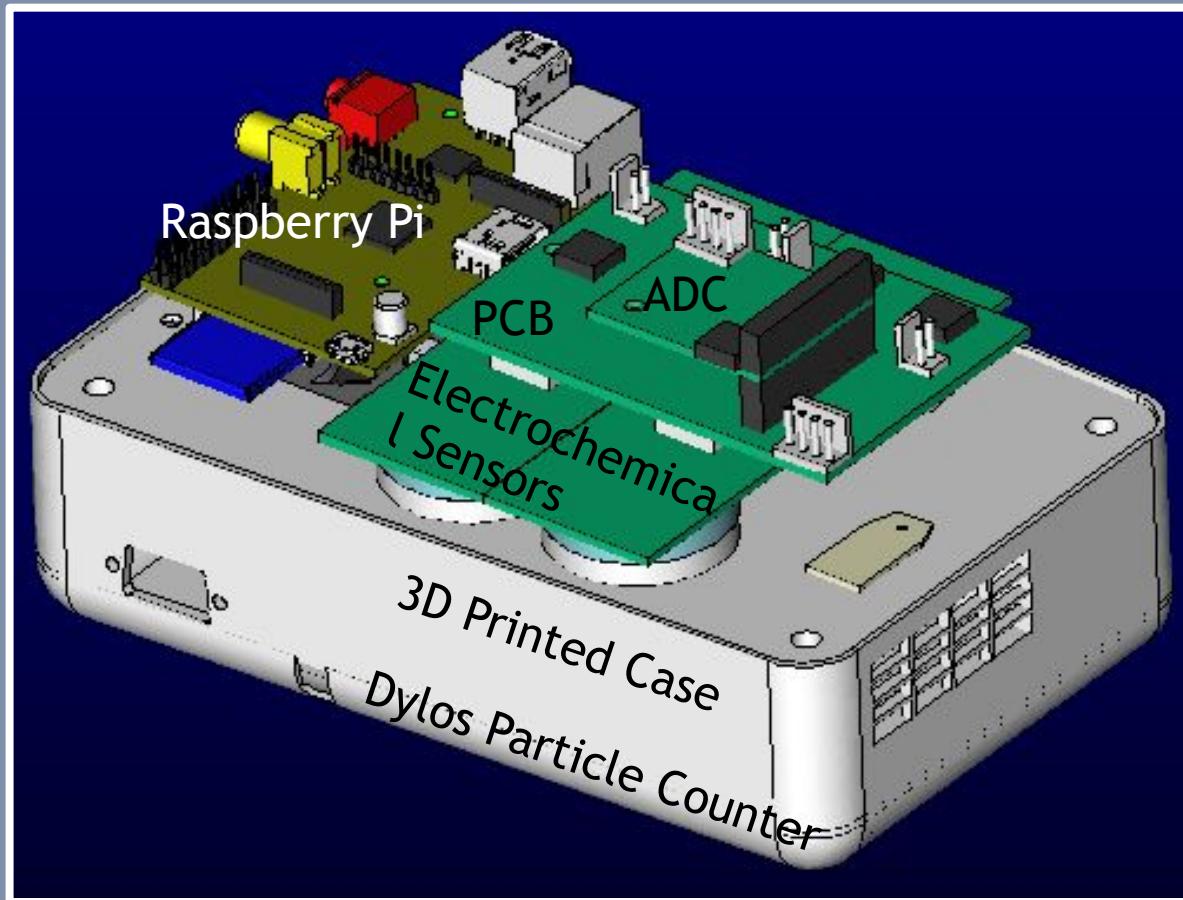
Front of 3D Printed Case



Back of 3D Printed Case

Dylos
front-end

Node Hardware



Data Progression

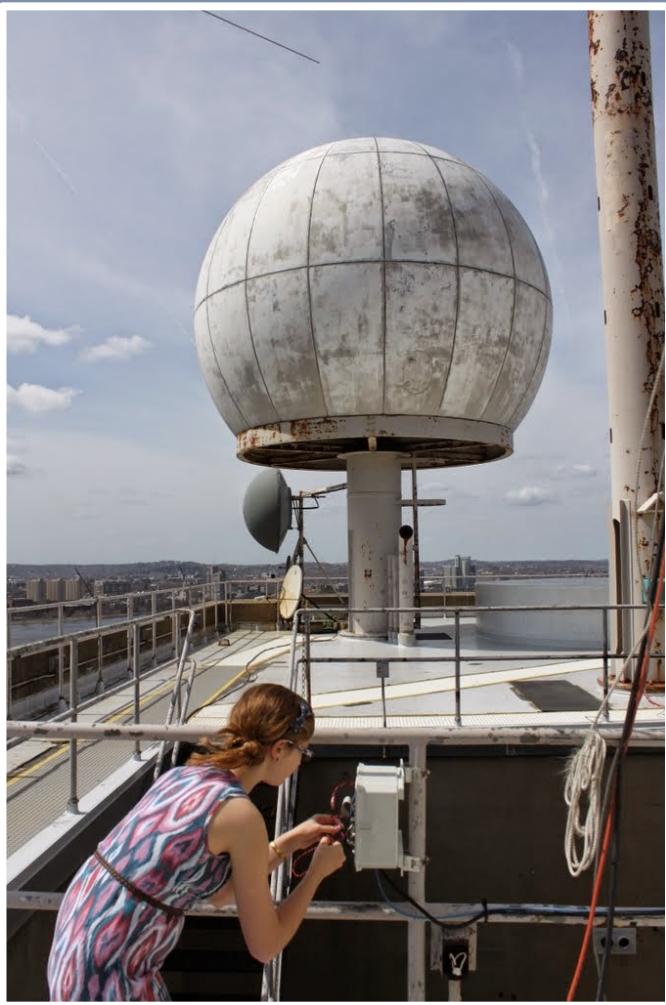


Raw Voltage
from Node

Raw Voltage
Sent to
Database

Voltage
converted
in Database

Data Transmission and Reliability



Transmission

- Compatibility with ethernet
- Multiple email updates

Reliability

- Security
- Averaging function

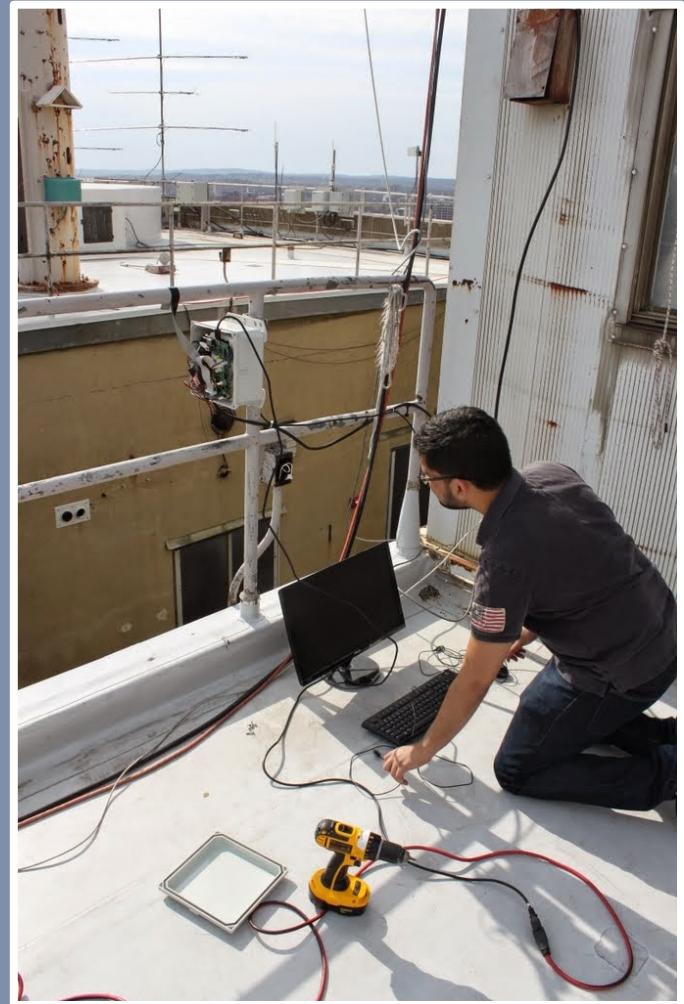
Challenges and Result

Primary Challenge

- Code iterations

Result

- Integrated system
- Organized data storage



Calibration Process

CO

NO

NO₂

O₃

PM 2.5

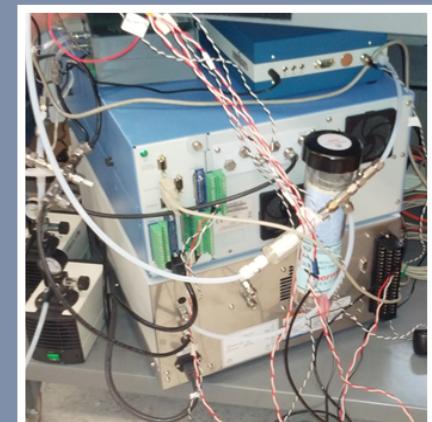
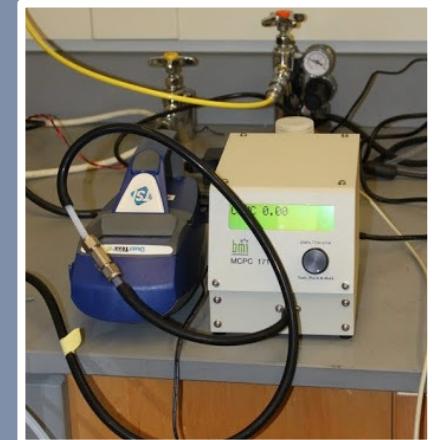
PM 10



Our Node

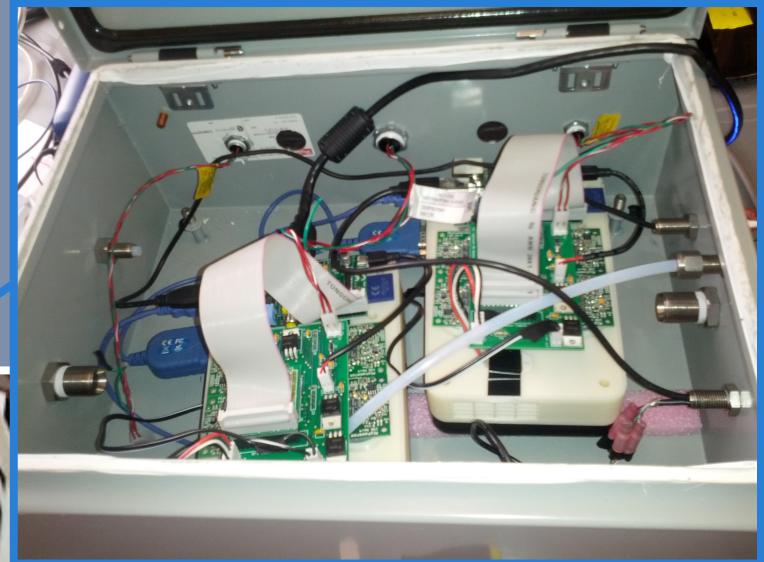
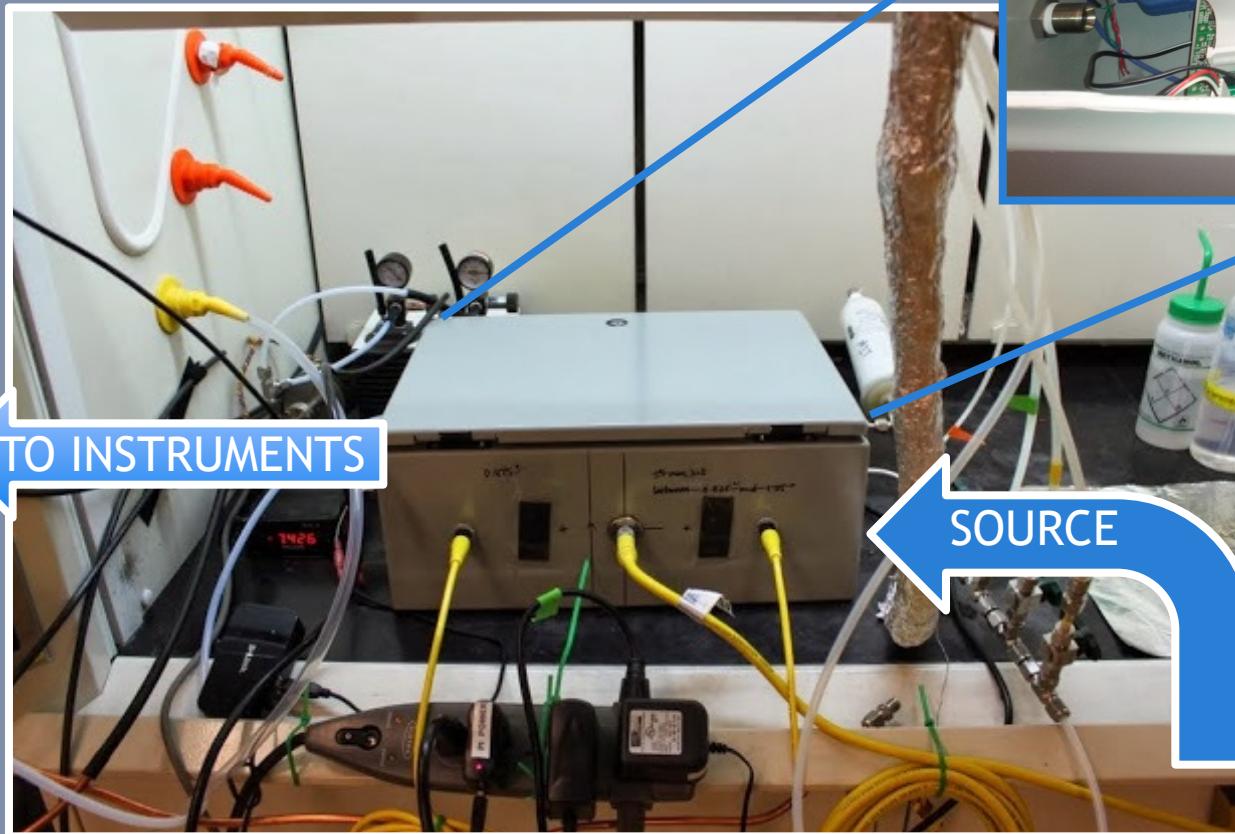


Lab Instruments

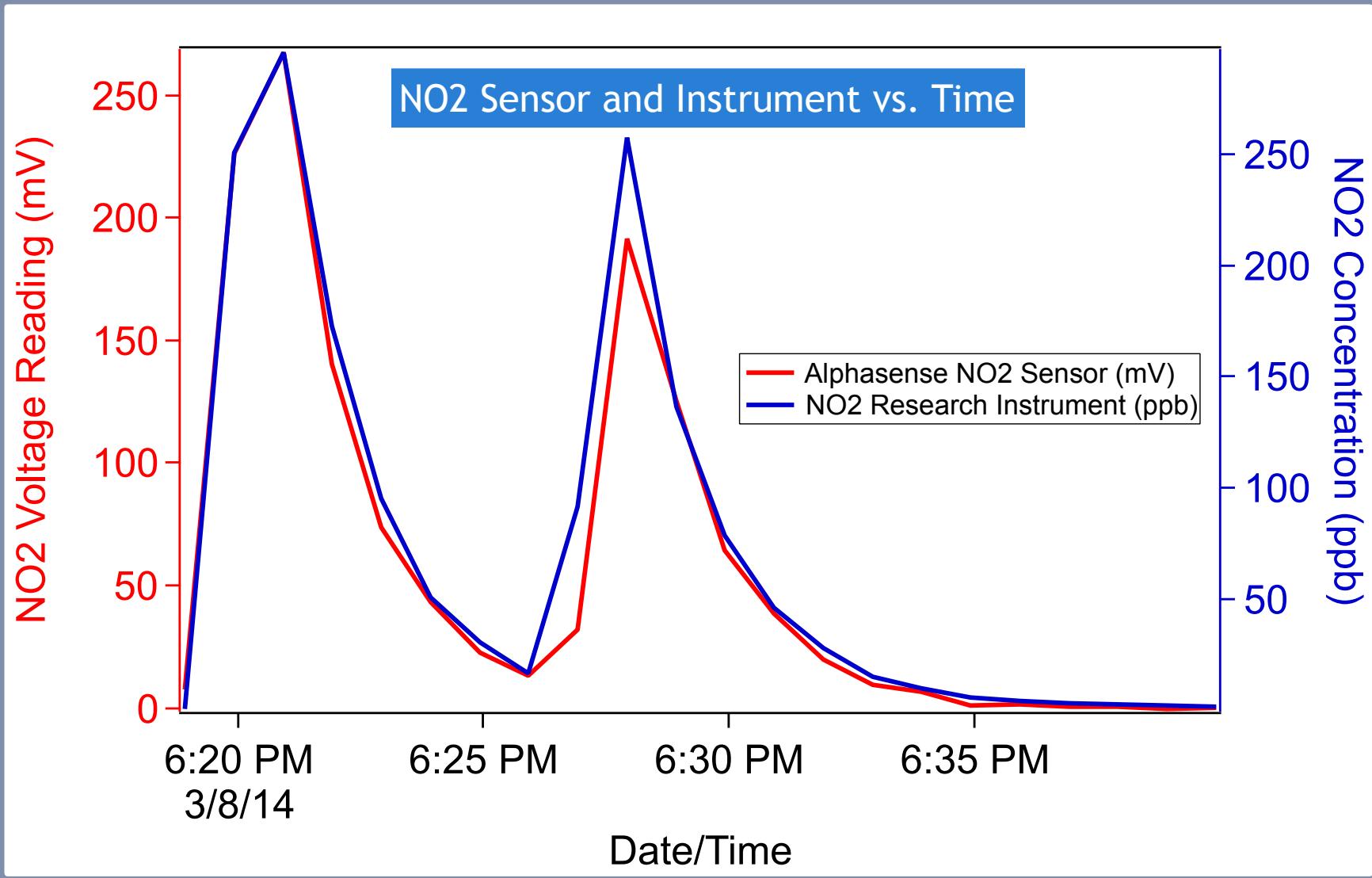


Running Experiments

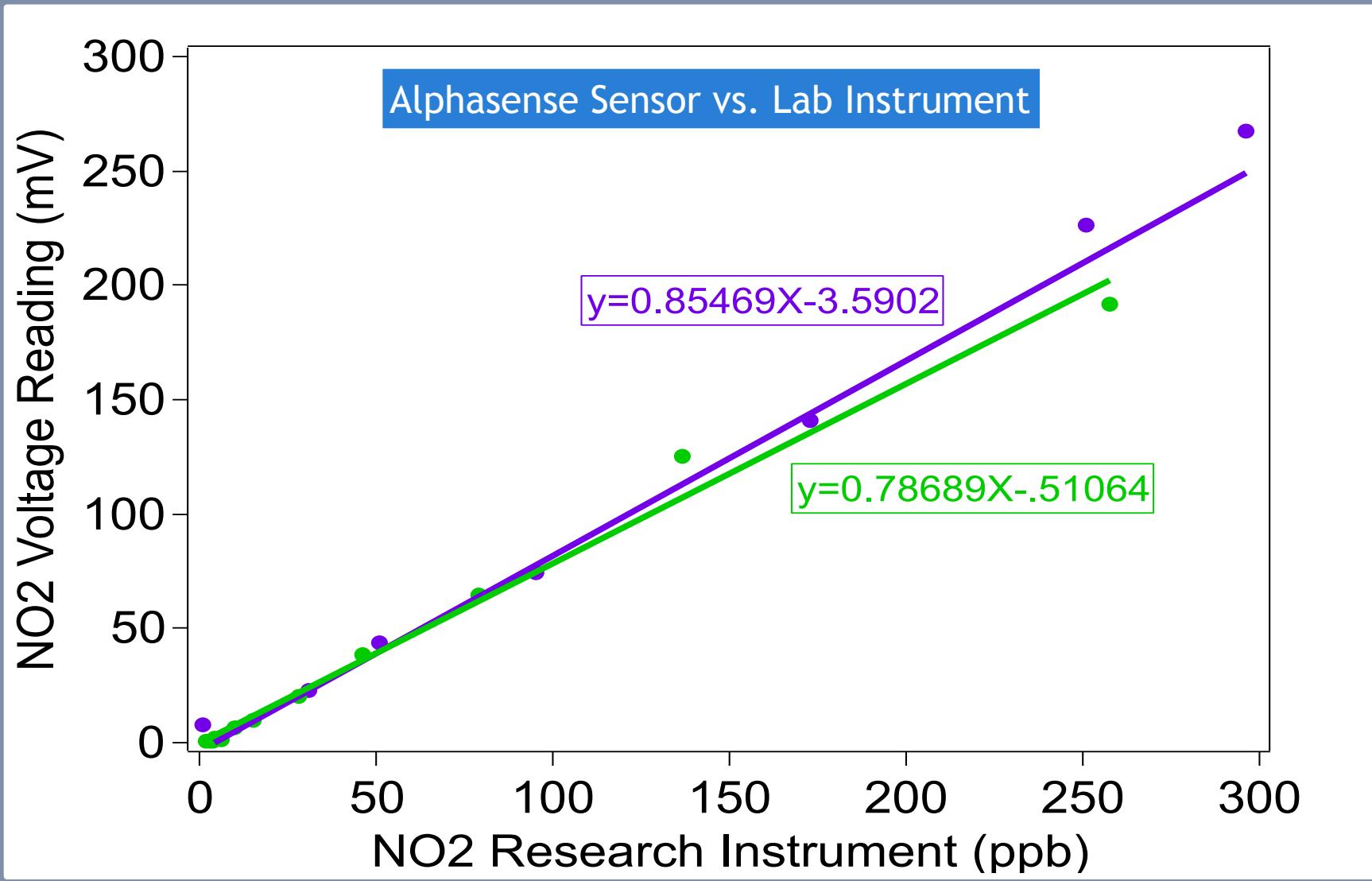
Inside the hood



Calibration Results

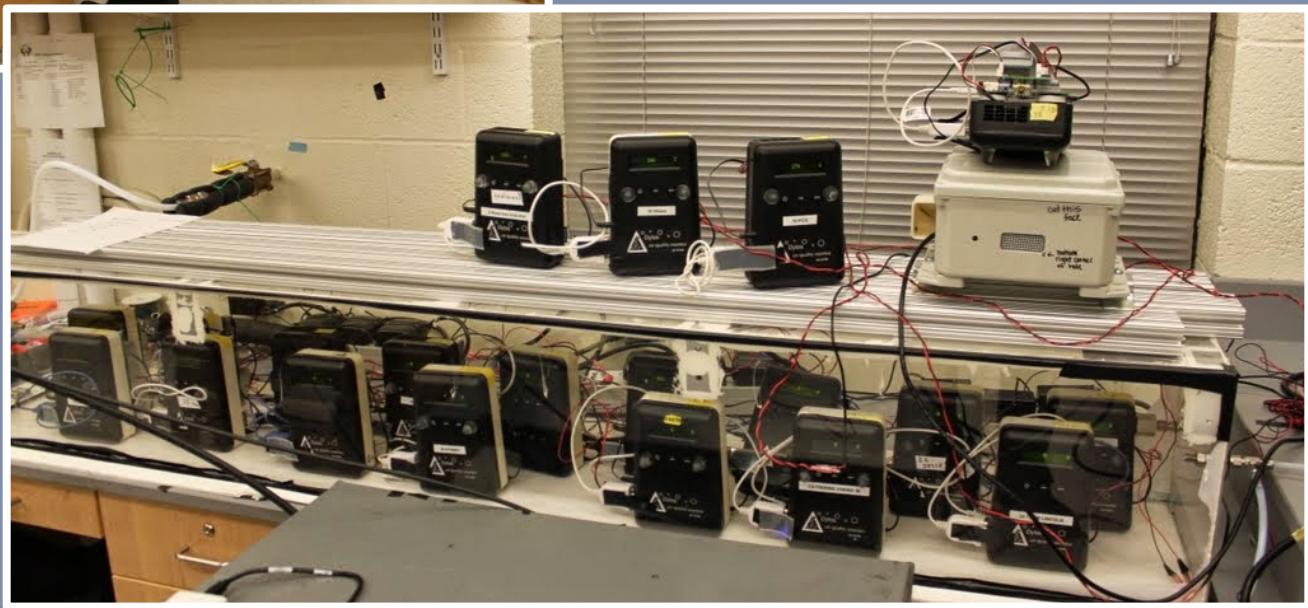


Calibration Results





Ambient chamber



Co-located nodes

Communicating our Data

CLAIRITY

MIT's Air Quality Network

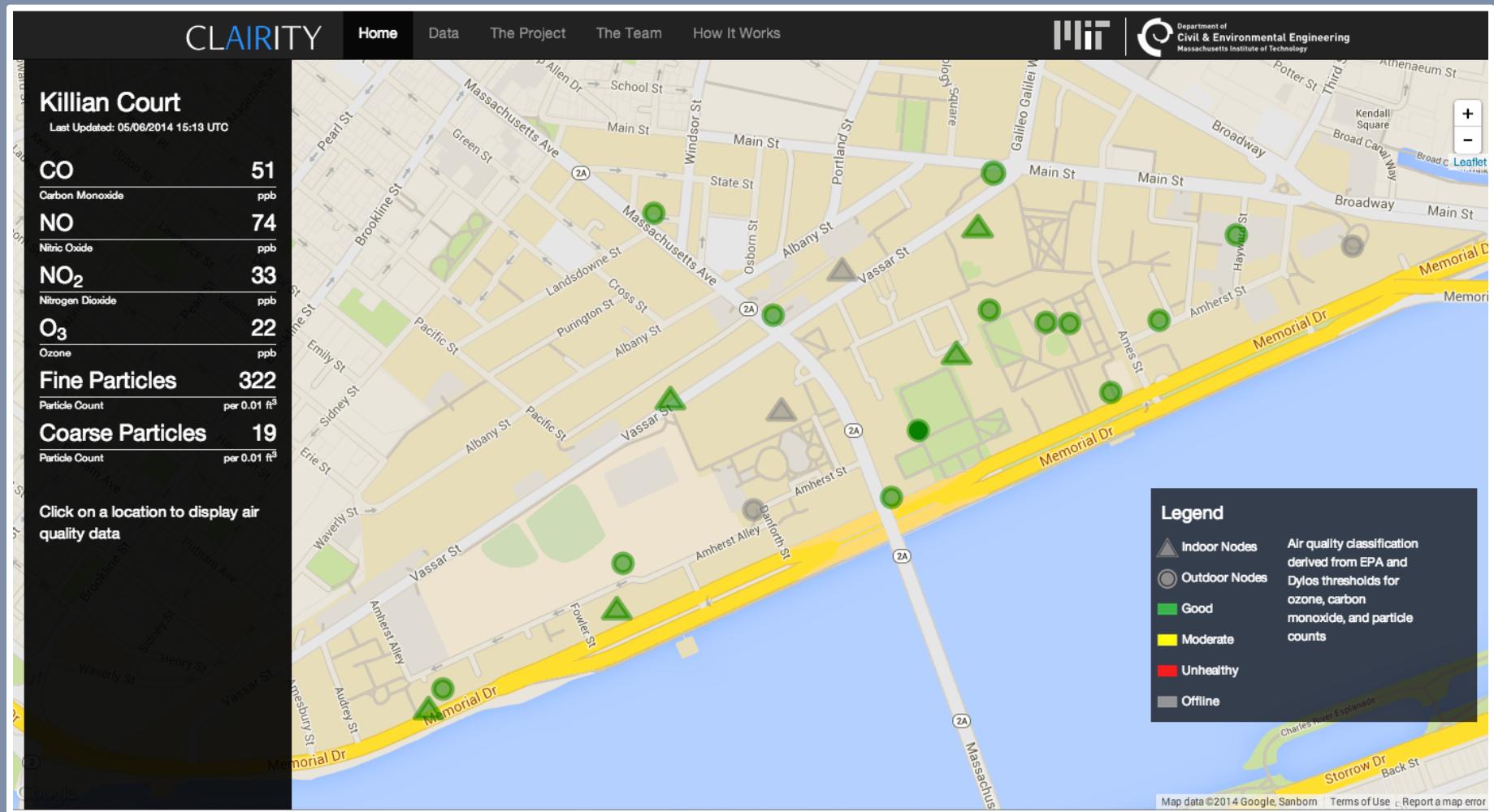
Have you ever wondered what is in the air you breathe?

The MIT Civil and Environmental Engineering Class of 2014 has deployed an air quality sensor network throughout MIT's campus. This website displays real-time data from the network and shows the quality of air around Cambridge.

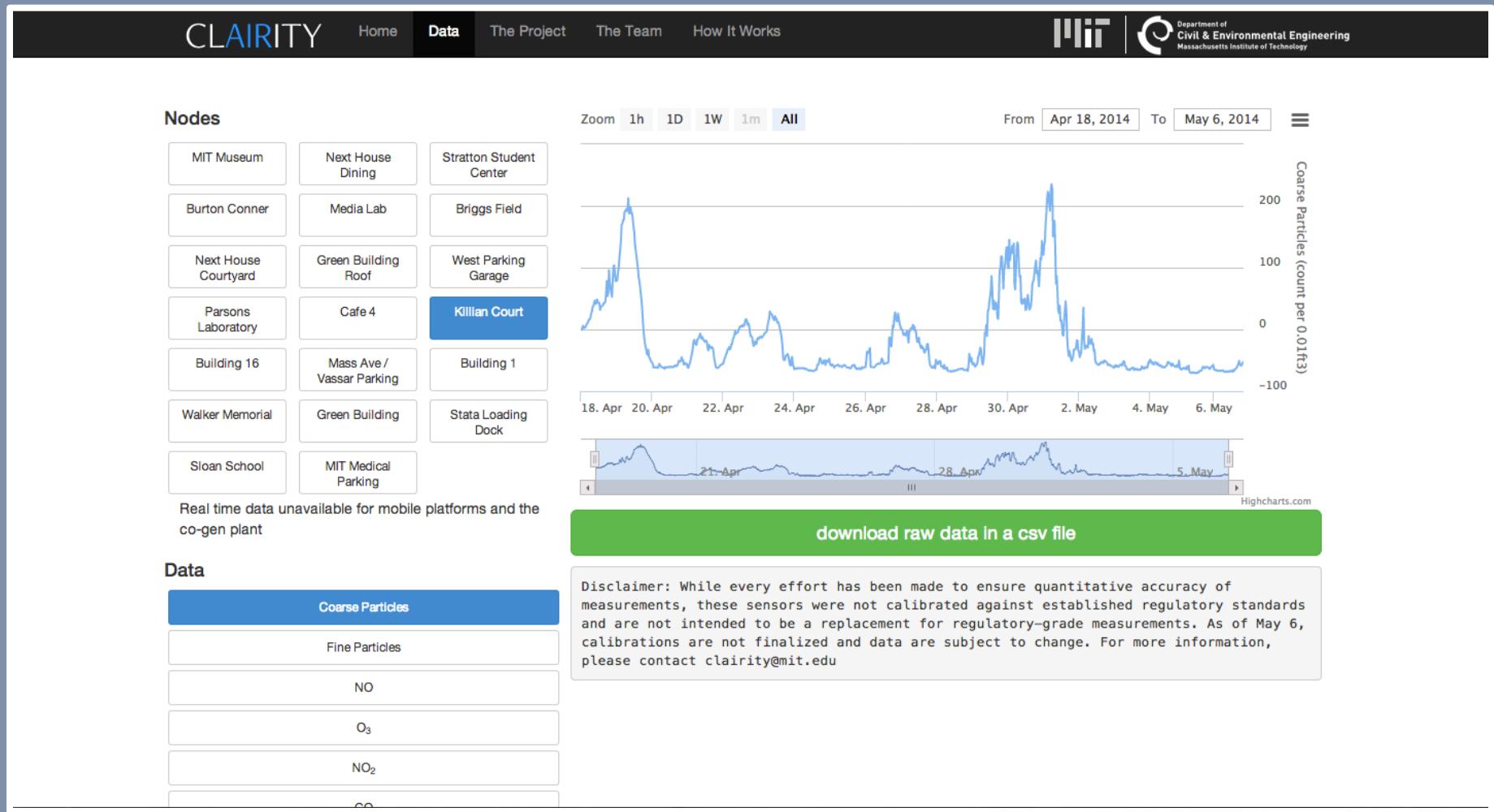
[Enter Site](#)

This project is a product of MIT's Civil and Environmental Engineering Class of 2014.

Communicating our Data



Communicating our Data



Communicating our Data

CLAIRITY

Home Data The Project The Team

How It Works



What are we measuring?

We are measuring five pollutants: nitric oxide, nitrogen dioxide, carbon monoxide, ozone, and particulate matter. The NOx group (nitric oxide and nitrogen dioxide) is emitted from automobiles, power plants, and turbines. Carbon monoxide comes from automobile exhaust and burning fuel. Particulate matter is the result of a wide range of manmade and natural sources, while ozone is the result of reactions between chemicals already in our air. Together, these pollutants paint a comprehensive picture of air quality impacts from the interaction of human activity with natural processes.

CO

Carbon Monoxide

CO is an odorless, colorless gas that is highly toxic when encountered in high concentrations! The main contribution of CO is vehicle exhaust but other sources include fuel combustion, fires, and volcanoes. Harmful health effects of CO occur when it enters the bloodstream through the lungs and binds to hemoglobin, reducing the amount of oxygen that reaches the body's tissues and organs.

[Learn More](#)

NO

Nitric Oxide

Nitric Oxide is colorless and odorless, and of the nitrogen oxides (NOx) emitted, NO is the primary pollutant. While NO is non-toxic by itself, it quickly converts to NO₂ in the air.

[Learn More](#)

NO₂

Nitrogen Dioxide

Nitrogen Dioxide (NO₂) is strongly tied to the presence of O₃ and particulate matter. The largest sources of NO₂ are combustion processes, such as heating and power generation. Long-term exposure to NO₂ has been linked to adverse respiratory effects.

[Learn More](#)

O₃

Ozone

Ozone (O₃), when found in the upper atmosphere, protects

Fine

Fine Particles

Particulate matter (PM) consists of a mixture of solid and liquid

Coarse

Coarse Particles

Particulate matter (PM) consists of a mixture of solid and liquid

CONTEXT

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How Does Our Network Compare?

As compared to current air quality systems, our network:

- shows higher resolution
 - sampling frequency
 - node concentration
- is more cost effective
- has increased public accessibility to data
 - download data
 - real-time data

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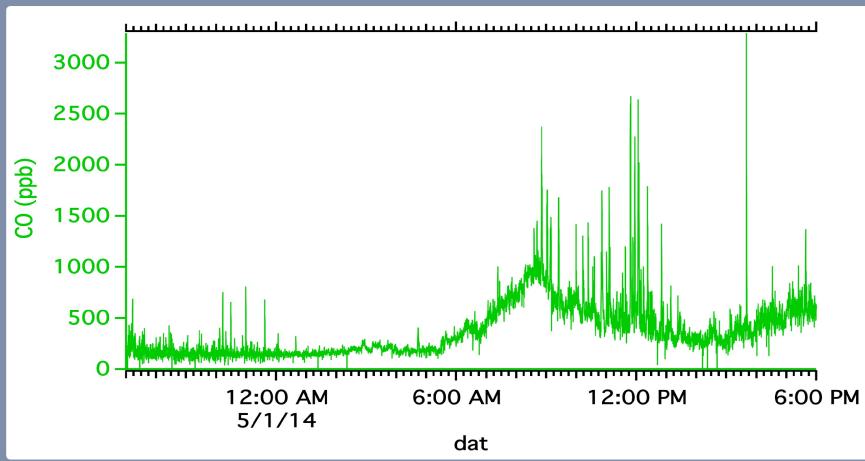
Sampling Frequency

Graph of CO Concentration Over Time



MassDEP Network

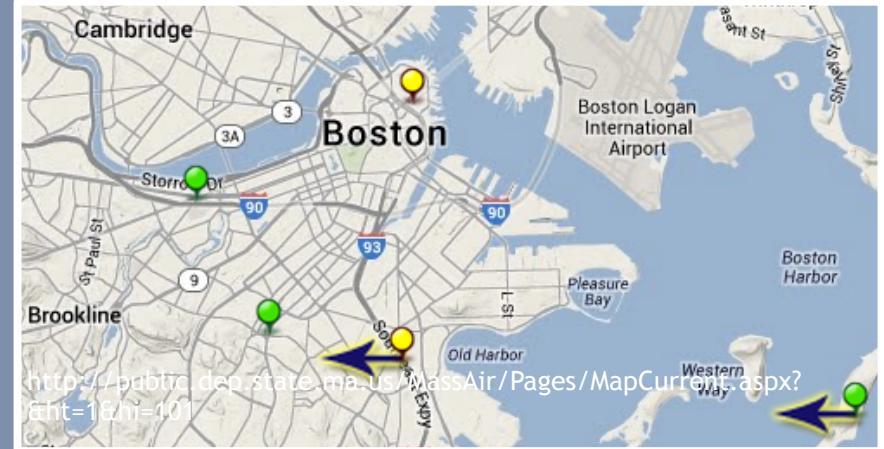
← every hour



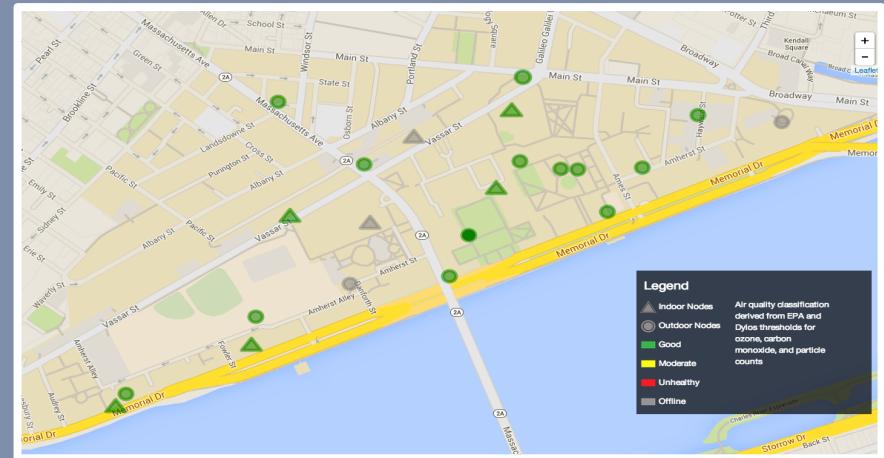
CLAIRITY
Network ← every 10 sec

Node Concentration

MassDEP Network



CLAIRITY Network



Node Concentration

MassDEP

57,344 acres
(Boston)

÷ 5 stations

11,468 acres/station

CLAIRITY

168 acres (MIT
Campus)

÷ 24 nodes

7 acres/node

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Cost Effective

MassDEP

~ \$100,000 per
station 5

~ \$500,000
total

>>

CLAIRITY

~ \$1500 per
node 24

~ \$36,000
total

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Download Data

CLAIRITY

Home

Data

The Project

The Team

How It Works



Department of
Civil & Environmental Engineering
Massachusetts Institute of Technology

Nodes

MIT Museum	Next House Dining	Stratton Student Center
Burton Conner	Media Lab	Briggs Field
Next House Courtyard	Green Building Roof	West Parking Garage
Parsons Laboratory	Cafe 4	Killian Court
Building 16	Mass Ave / Vassar Parking	Building 1
Walker Memorial	Green Building	Stata Loading Dock
Sloan School	MIT Medical Parking	

Real time data unavailable for mobile platforms and the co-gen plant

Data

Coarse Particles

Fine Particles

NO

O₃

NO₂

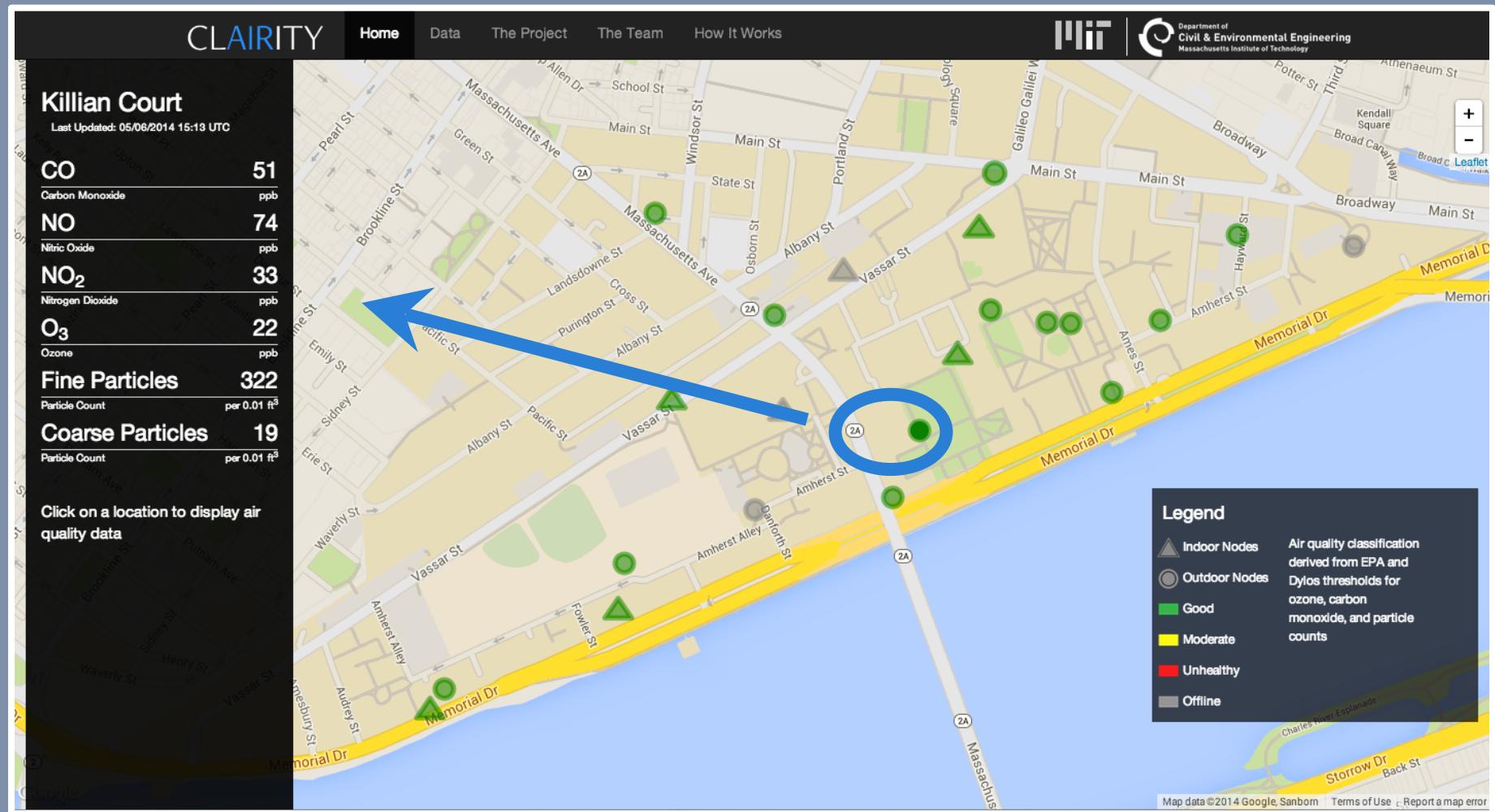
CO



download raw data in a csv file

Disclaimer: While every effort has been made to ensure quantitative accuracy of measurements, these sensors were not calibrated against established regulatory standards and are not intended to be a replacement for regulatory-grade measurements. As of May 6, calibrations are not finalized and data are subject to change. For more information, please contact clarity@mit.edu

Real-Time Data



To Summarize...

24 Nodes

6 Pollutants

10 Second Resolution

Easily Accessible Data &
Graphs

Data Analysis

Air quality
comparison
across
locations

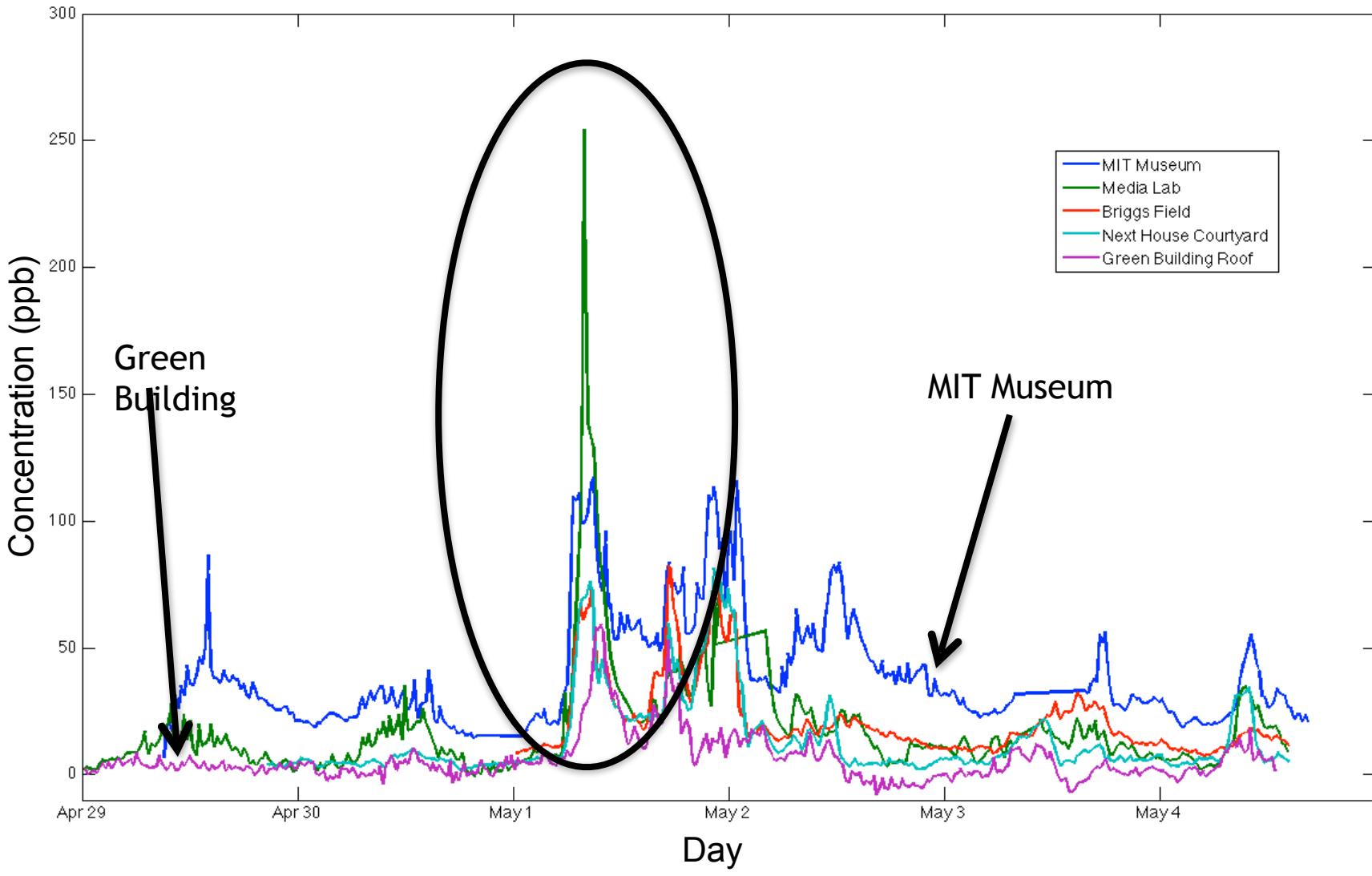


Pinpointing
sources of
pollution

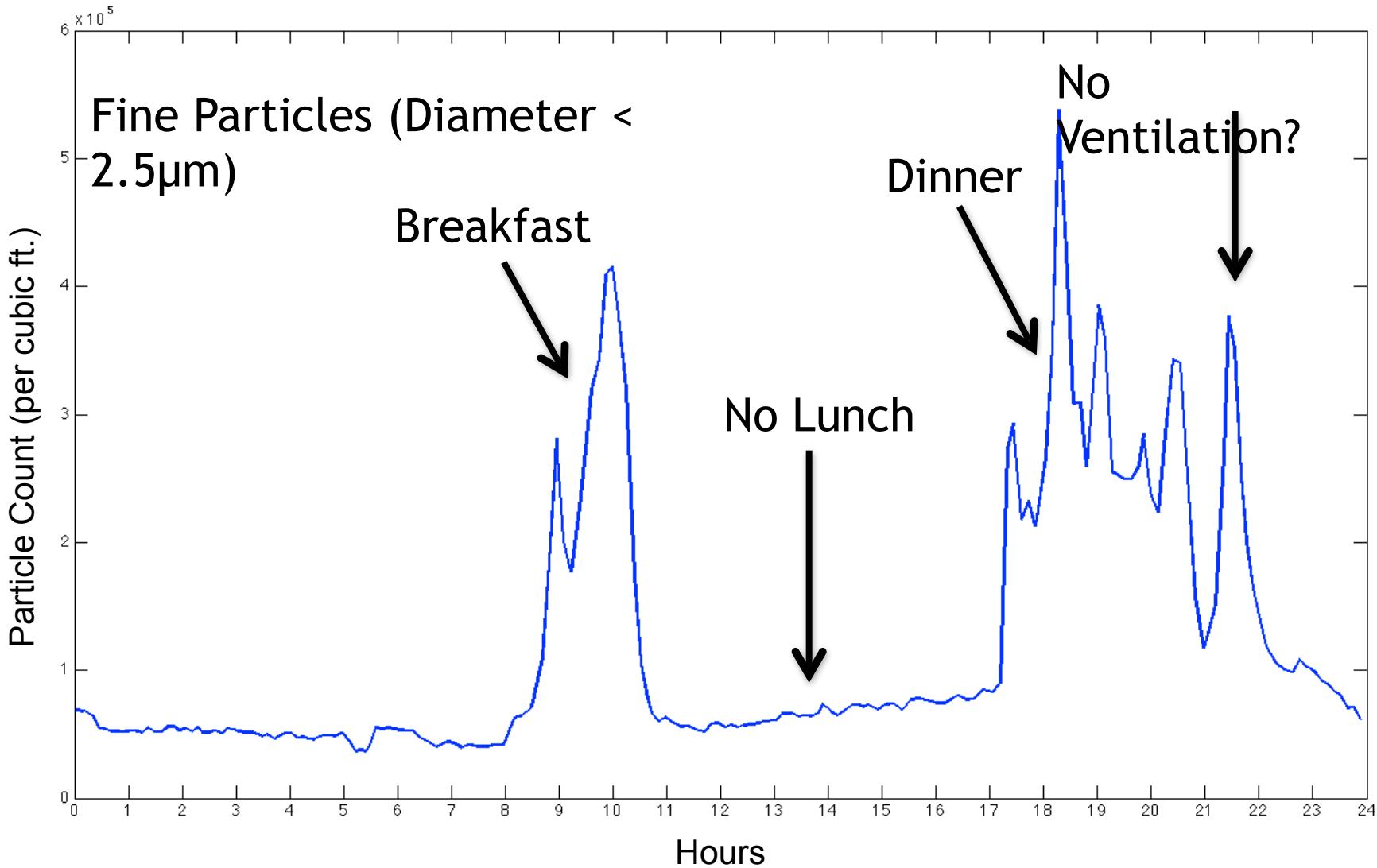


Understandin
g diurnal
trends

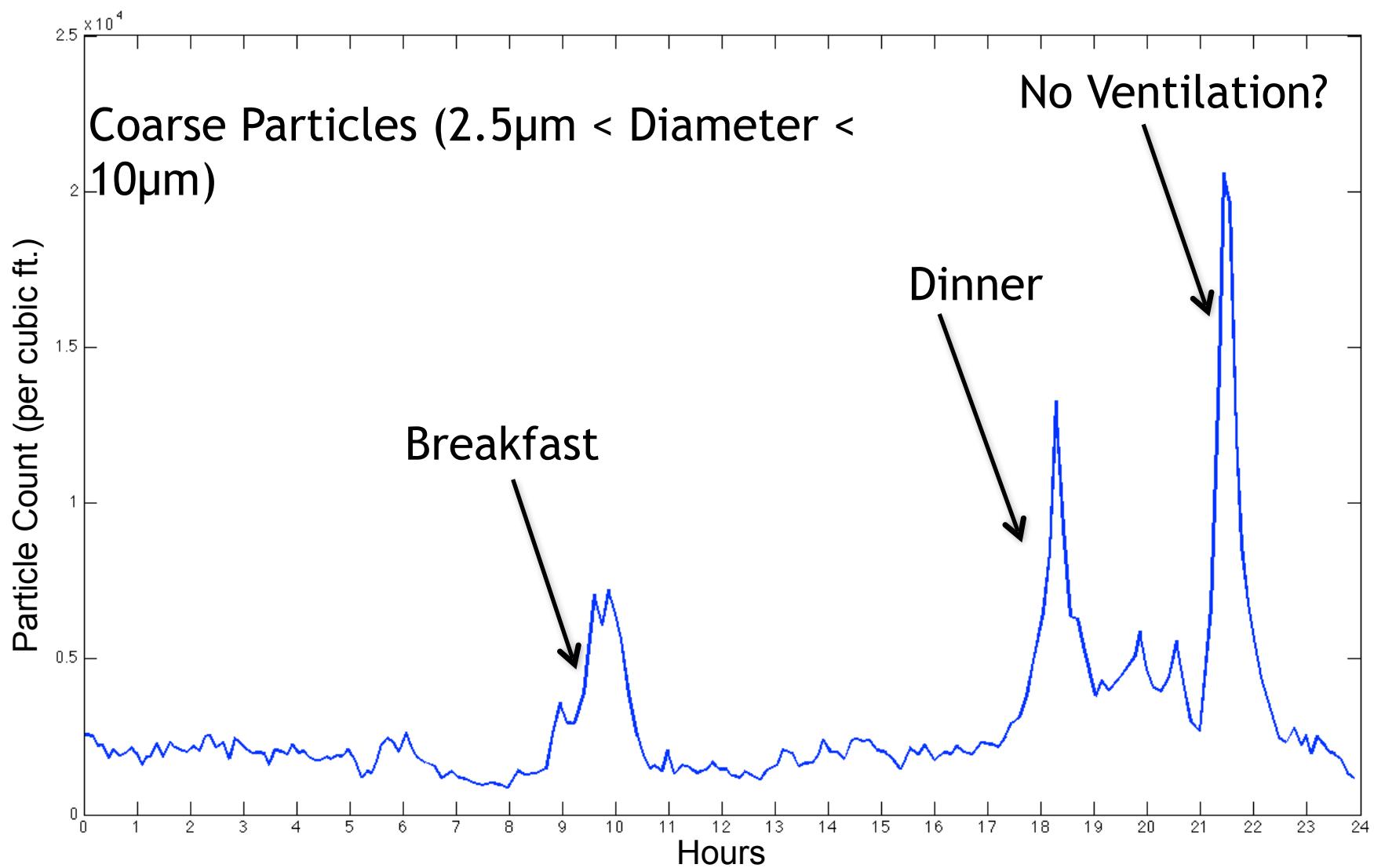
Outdoor NO



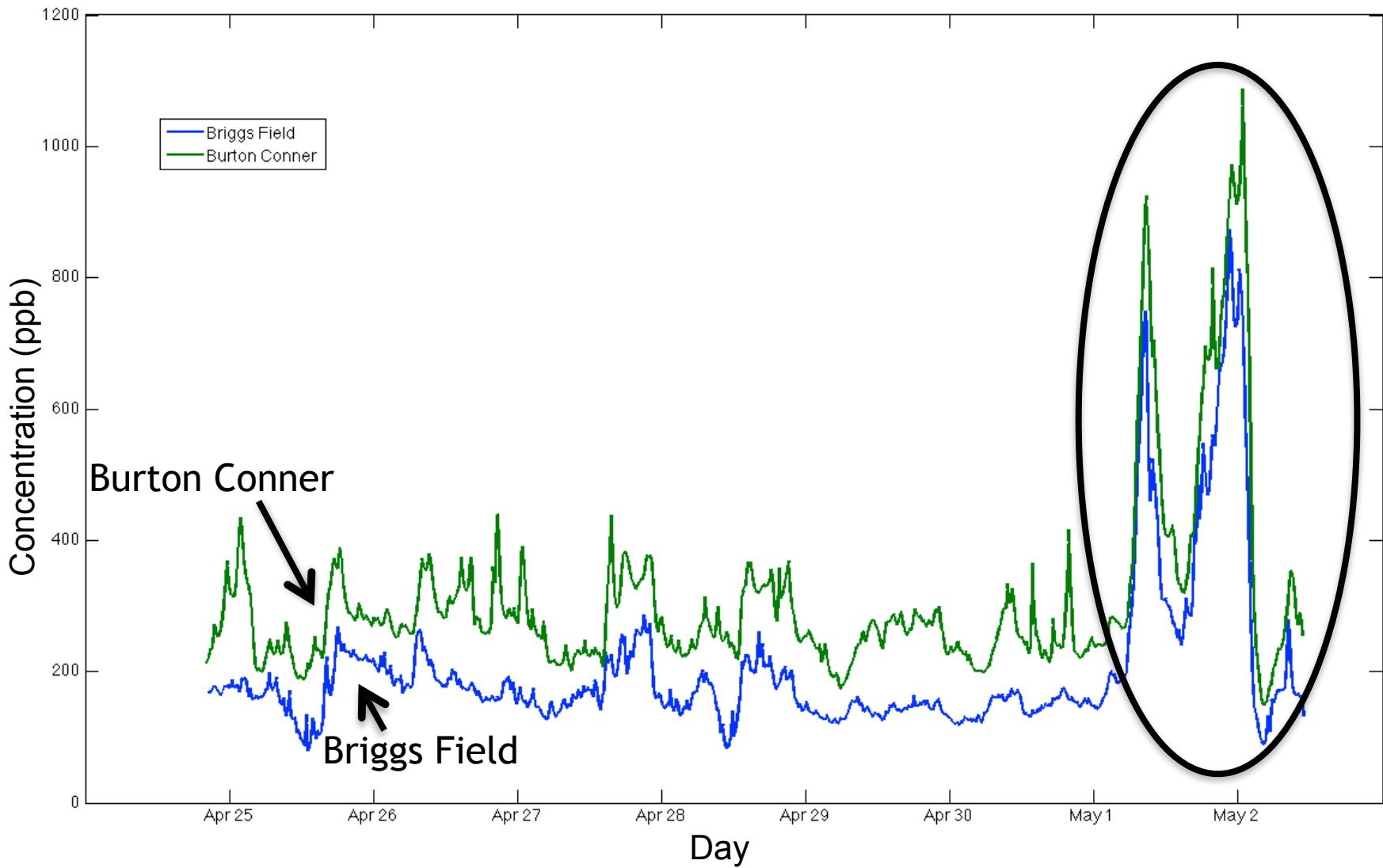
Next House Dining



Next House Dining



Burton Conner vs. Briggs Field - CO



Expanding CLAIRITY

- Pollutant origins
- Pollutant distribution
- Monitor dangerous levels
- Smart Cities

Expanding CLAIRITY

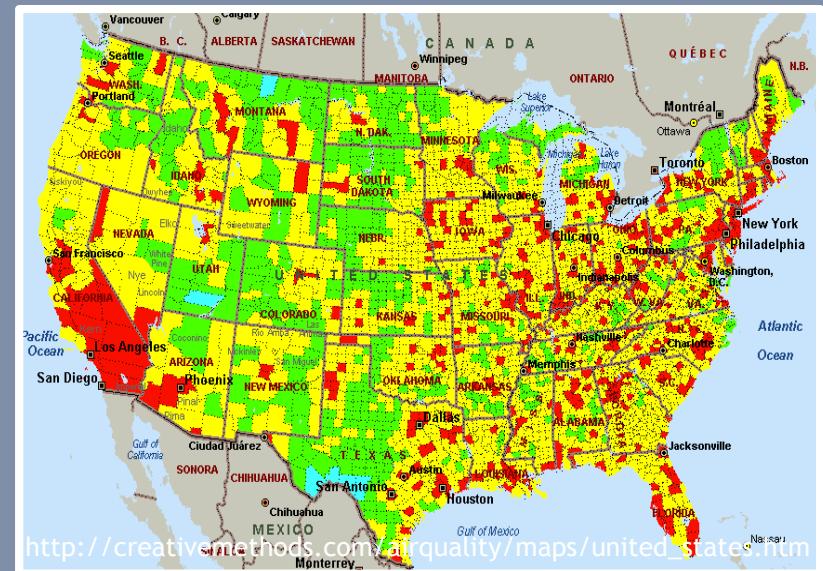
- Pollutant origins

MIT.nano



Expanding CLAIRITY

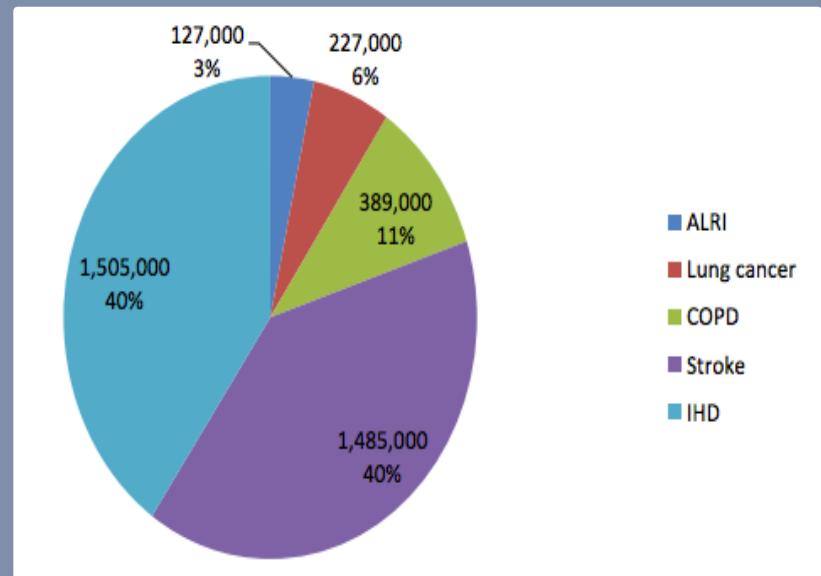
- Pollutant distribution



Expanding CLAIRITY

Deaths Attributable to Ambient Air Pollution (201)

- Monitor dangerous levels



ALRI: Acute Lower Respiratory Disease

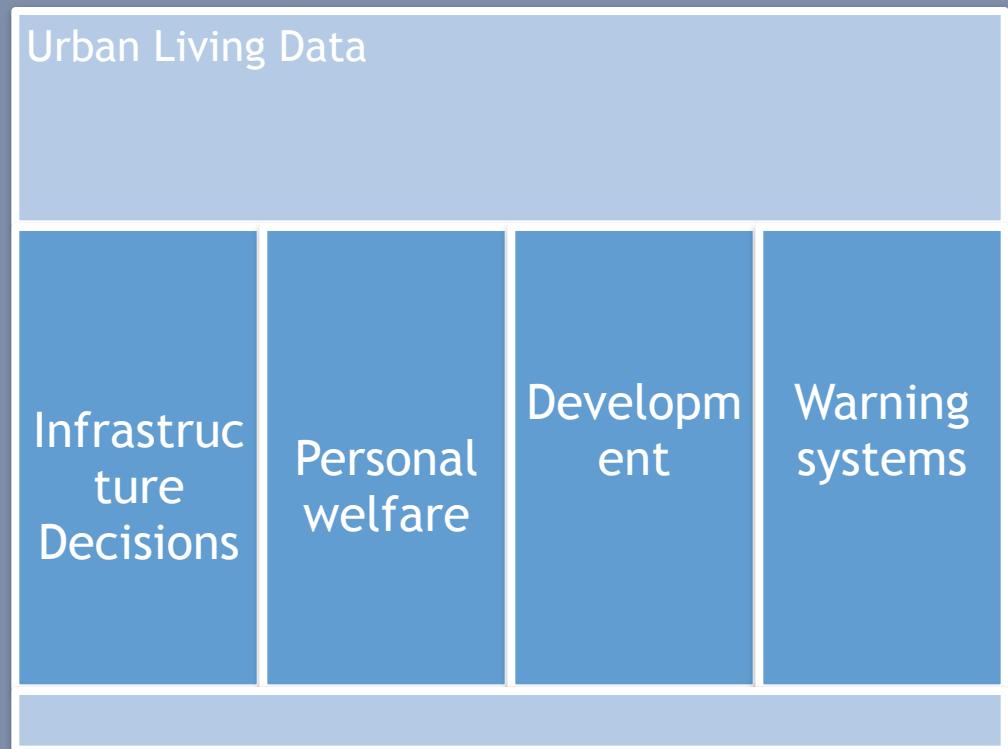
COPD: Chronic Obstructive Pulmonary Disease

IHD: Ischaemic Heart Disease

From: who.int

Expanding CLAIRITY

- Smart Cities





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All photos courtesy of Eben Cross, unless otherwise stated.

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