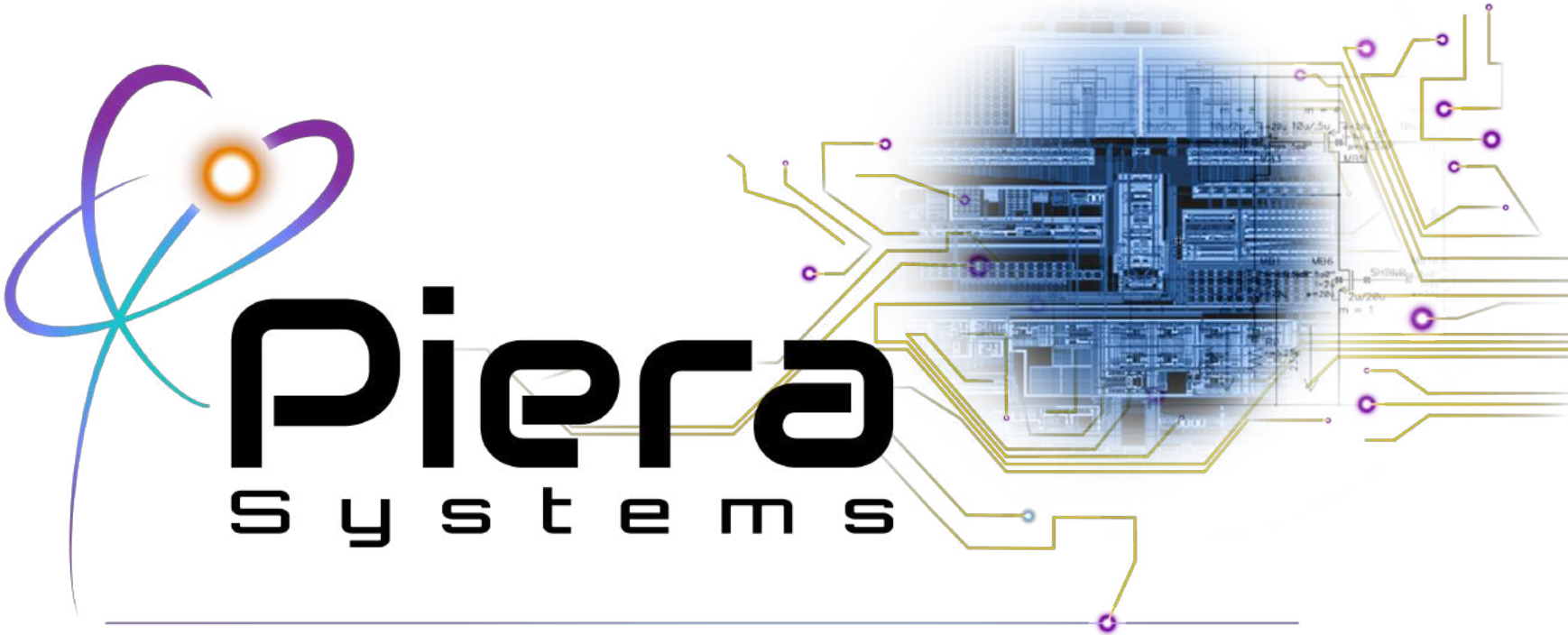


What's in your Air?

CLIMATE CHANGE IS THE DEFINING PROBLEM OF THIS CENTURY

"AIR POLLUTION IS A PANDEMIC IN SLOW MOTION"

8 million deaths/year[1]

$5 trillion in welfare costs[2]

Untold damage to human health

Reality is Even Worse

We focus on what we see

AQI only reports PM10 and PM2.5
Tells you it's bad but not why

What we don't see is even more dangerous

"Fine particles, less than PM2.5, pose the greatest risk to health." – EPA

"Ultrafine particles, less than PM1, can penetrate into tissues and organs, posing an even greater risk of systemic health impacts." - WHO

PM10 PM2.5 PM1 & below

Let’s Talk About Air

Clearly, bad air for many

Bad air locally

What about this one?

Simple answer is, we don’t know …
… not until we measure it

Here’s why …

Let’s Talk About Air

PM10

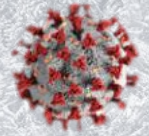
Vehicles
Industries
Construction
Sandstorms
Pollen

PM2.5

Fires, Wild and Controlled
Vehicles
Industries
Bacteria & Fungi
Biomass

PM1.0 – PM0.1

Cigarette & Vape Smoke
Wood Burning
Allergens
Cooking
Viruses
Humans



Why not measure it all?

What Are We Measuring?

PM10

PM2.5

PM1.0 – PM0.1

EPA uses gravimetric and reference instruments co-located to report only PM2.5 & 10.0
Hundreds of miles apart, expensive, labor-intensive, and not real-time

PLANTOWER 攀藤科技
SENSIRION
OMRON
BreezoMeter
武汉四方光电科技有限公司 Wuhan Cubic Optoelectronics Co.,Ltd.
PurpleAir

Ubiquitous low-cost sensors used indoors & outdoors in air purifiers and AQMs
Precision and accuracy susceptible to temp, humidity, drift, variance, etc; cannot measure below PM1.0; mass concentrations are only estimates

Measurement Blackhole

Current Sensors Estimate

No EPA Guidelines

Piera Systems

“What’s In Your Air?”

PM10 PM2.5 PM1.0 – PM0.1

Only way to get the whole picture

1. Accurately measure mass concentration
2. Measure coarse, fine, and ultrafine particles
3. Count individual particles, not just mass

A highly accurate, affordable, easy-to-use particulate sensor did not exist … until now

Indoor Air Quality Critical to Health

Indoor air quality has a much bigger health impact than outdoors

Air quality indoors is subject to drastic, and rapid, changes

Ventilation, Filtration systems optimized for energy conservation

Many air-cleaning products are ineffective

Each buildings is different; continuous monitoring is essential

Indoor Pollutants

- Diesel particulates
- Human behavior
- Viruses
- Cooking and fuel use
- Outdoor air infiltration
- Construction/machinery dust
- …


The Economist

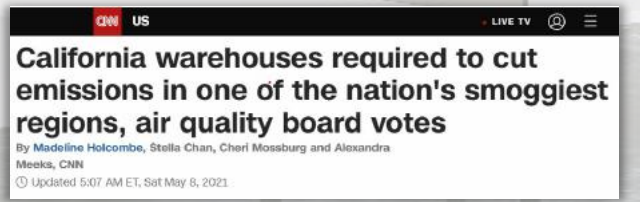
Leaders

May 29th 2021 edition ›

Ventilation and public health

It is time to clean up the air in buildings

Fresh thinking about fresh air


CNN US LIVE TV

California warehouses required to cut emissions in one of the nation's smoggiest regions, air quality board votes

By Madeline Holcombe, Stella Chan, Cheri Mossburg and Alexandra Meeks, CNN

Updated 5:07 AM ET, Sat May 8, 2021

Ways to Partner With Us

Integrate our Sensors

Build our easy-to-use, highly accurate, affordable sensor into your product

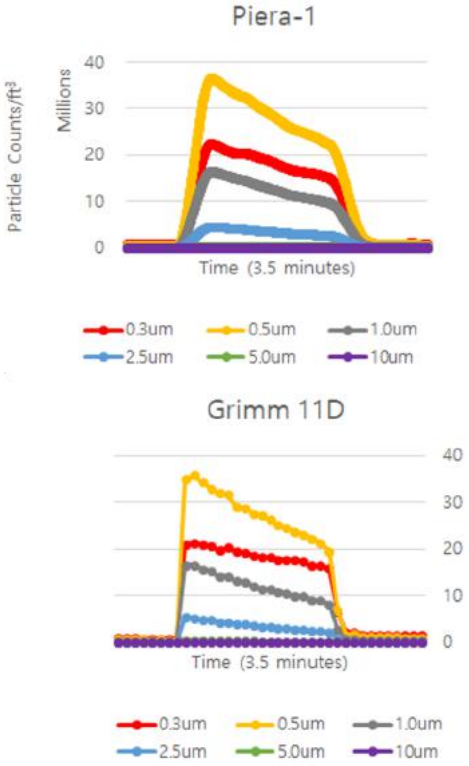
Deploy our AQMs

Ready-for-deployment, fully integrated with the cloud and a powerful UI; lease, buy, or resell

Piera Systems

Break-through Family of Sensors

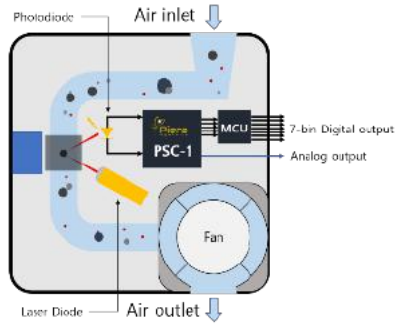
- Highly Accurate
- PM10 to PM0.1
- Particle counts and size, not just mass
- Software Defined
- >6000 ug/m^3
- <$30-$95



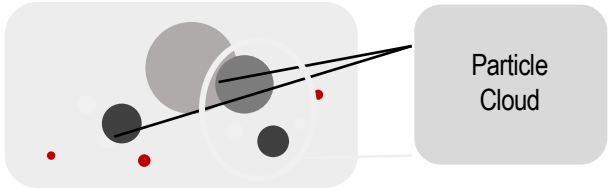
World's <u>only</u> certified sensor that accurately counts every particle from 0.1 um - 10 um in real-time

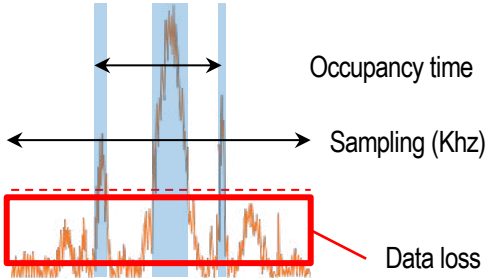
Piera Systems

Custom Photon Counting Processor



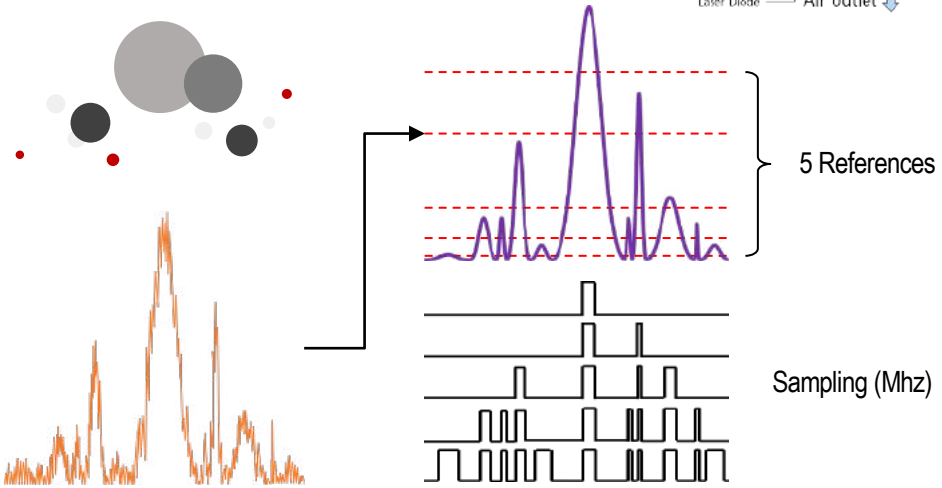
Competition





Estimated Concentration
PM2.5 only

Piera



Software–Defined bin sizes
count every particle

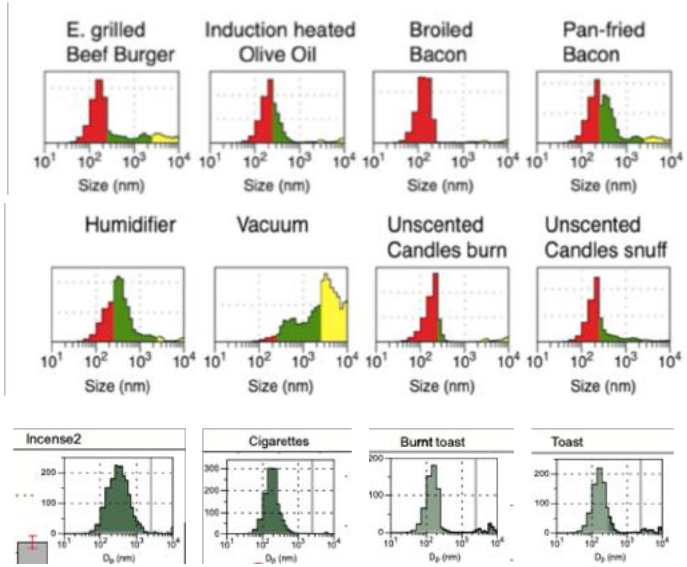
Piera Systems

Nothing Else Comes Close

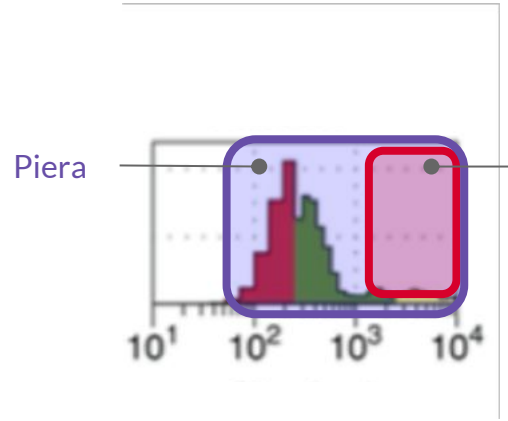
	Detection Capability	Response Time	Accuracy	Particle Classification	Cost Effectiveness
Piera Systems	🟢	🟢	🟢	🟢	🟢
OMRON	🔴	🔴	🔴	🔴	🟡
PLANTOWER 攀藤科技	🟡	🟡	🔴	🟡	🟡
武汉四方光电科技有限公司 Wuhan Cubic Optoelectronics Co.,Ltd.	🔴	🟡	🟡	🔴	🔴
SENSIRION	🟡	🟢	🟡	🟡	🟡
Winsen 炜盛科技	🔴	🔴	🔴	🔴	🔴
SHARP	🟠	🔴	🔴	🔴	🟠

Classification is the New Frontier

Particle Count + Particle Size + Number of Bins = Particle Classification



Pollutant signatures from Lawrence Berkeley National Laboratory



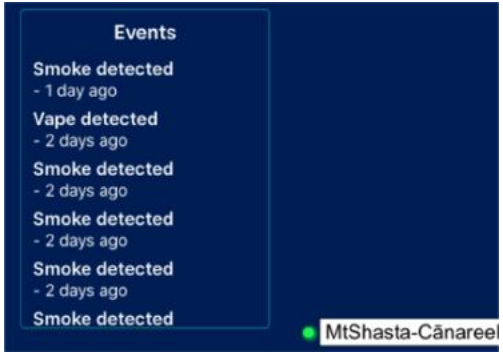
Only Piera can measure PM0.1-1.0

Competition cannot classify particles

Piera Systems

Vape/Smoke Detection

- Highly accurate event detection; within 30 seconds
- Distinguishes smoke from vape with proprietary algorithms
- SenseiAQ displays events as they happen and logs them
- LED on Canaree flashes red for smoke and purple for vape



SenseiAQ Cloud Dashboard enables event detection from remote sensors

Piera Systems

Canāree: Next Generation Air Quality Monitor

Canãree A1 for Aruba access points

7cm x 5cm x 1.4cm (2.75” x 2” x 0.5”)

35 grams (~1.2 ounces)

- Highly accurate indoor air quality monitor
- Leverages existing wireless access
- SenseiAQ™ real-time dashboard for alerts and insights
- Vape/smoke detection in real-time
- Secure cloud-based storage and analytics
- Flexible pricing models

I1 - Expand coverage to non-AP areas with WiFi
I5- Particulates + temp/press/RH/VOC/CO2

Piera Systems

Complete Solution for AQM

Connect to wireless access points, PC's, mobile devices, or integrate into your product

Data aggregated in the cloud, yours or ours

SenseiAQ Dashboard

PM data analyzed and displayed on intuitive tools

Piera Systems

SenseiAQ Software and Dashboard

- Browser application for Windows/Mac
  - iOS, Android apps (Q2 ‘21)
- Standalone or connected to cloud
  - Our cloud or yours
- Dashboard: EPA AQI, vape/smoke, alerts
- Detailed analytics tab and logging capabilities
- Manage Canãree installation, setup, control
  - Maintenance, OTA updates, cleaning, monitoring
- API for integration with other applications

sensei.pierasystems.com

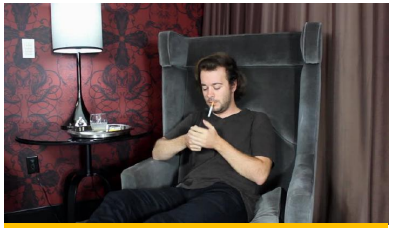
Piera Systems

Markets/Applications/Use Cases

Smart Buildings

Data Centers

Construction Dust



Hotels /Casinos/AirBnb

Wildfires

Smart Cities

Healthy Home

Transportation

Piera Systems

Smart Cities

Challenge

Urban areas are some of the most polluted environments on the planet

Causes numerous ailments to residents and measurably decreases life expectancy

Solution

Only Piera has the accuracy & range for outdoor AQM

- Highly accurate PM10 & PM2.5 measurements
- Industry's highest mass concentration limit (>6000 ug/m^3) means low maintenance costs
- Build accurate city- and region-wide maps, identify hotspots, and trends; generate alerts

For smart, healthy cities you need Piera

Healthy Indoor Spaces

Challenge

Indoor air quality impacts health more than outdoors

Current PM measurement methods based on outdoor

Indoor impacted by human behavior, infiltration

Solution

Accurately detect and mitigate indoor pollutants

- Particle Count, Size to classify sources
- Vape and smoke detection in real-time
- Wide range of pollutants; viruses, mold, pet allergens, cooking, smoke, pollen, mold
- Ensure efficiency and efficacy of mitigation techniques including air purifiers/cleaners, HVAC Filters, ventilation

Intelligent and healthy Spaces need Piera

Piera Systems

Wildfire Smoke

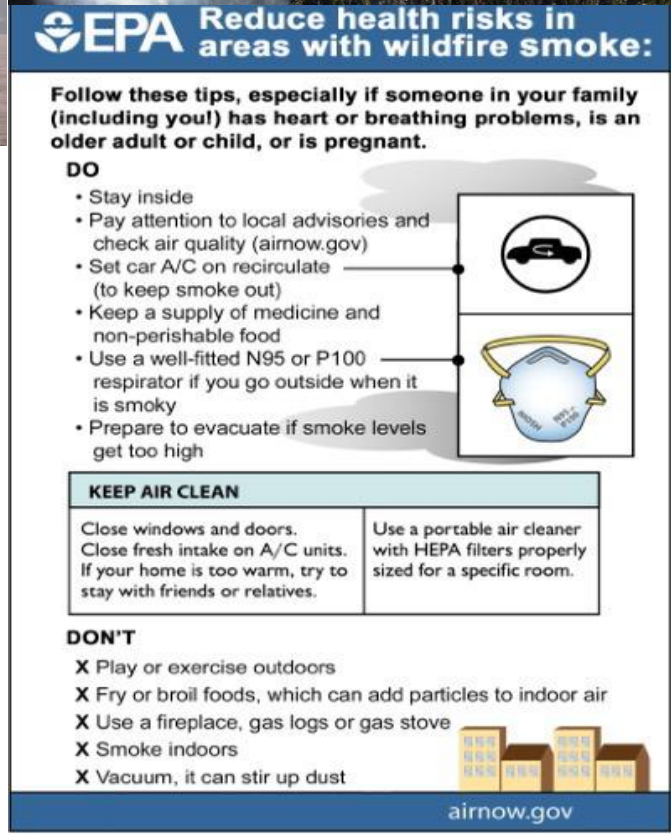
Challenge

EPA reports PM2.5, 10 hourly, not locally
Smoke finds its way indoors, travels thousands of miles
Wildfires dominated by PM <1.0
Peaks may coincide with other 'events' (Vehicle Pollution, Cooking)

Solution

Piera sensors, Canāree detect particle size and count <1.0 um
Can classify particles <1.0 micron (smoke vs vape vs cooking)
EPA Guidelines: Monitor and Mitigate
Monitor overall effectiveness of mitigation steps
Replace Filters based on effectiveness not time.

During wildfire season you need Piera



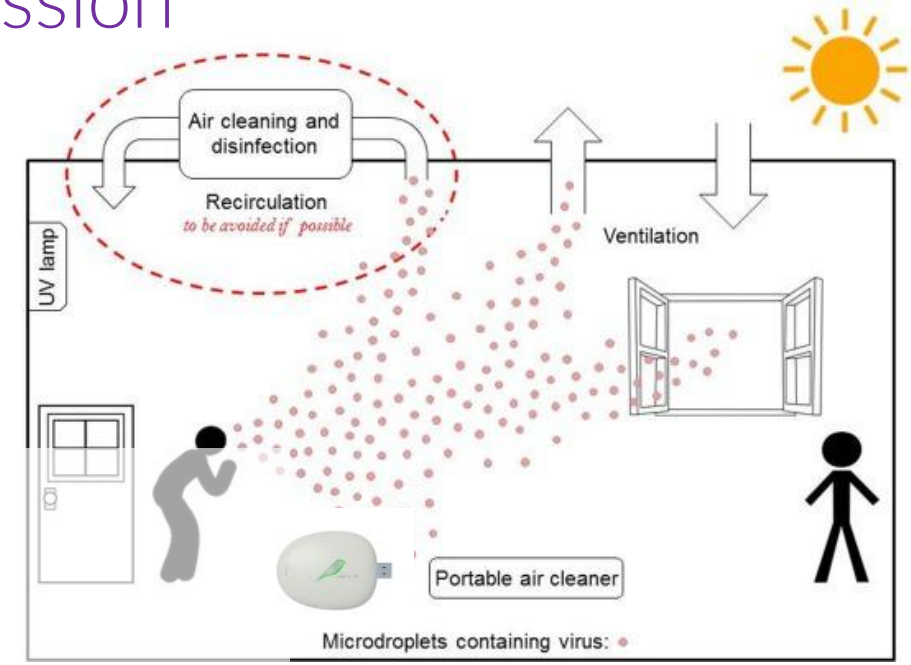
Reduce Covid-19 Transmission

Challenge

Reduce Covid-19 Transmission Indoors by up to 50 %[1]

Aerosol Transmission highest PM 0..2-2.5 um

Monitor effectiveness of Mitigation Steps



Solution

Only Piera can accurately detect and classify 'aerosol' PM

Accurate at low concentrations establishes 'good' air

Real-time monitoring detects elevated particulate levels, mitigation effectiveness

To reduce Indoor Covid-19 transmission you need Piera

[1] EPA Webinar: June 18, 2021

Get to the Source

28% of high school students vape creating
hazardous environments at home and in school

Existing vape sensors are rendered ineffective by
tampering with contaminants such as body spray

Only Piera sensors can measure below PM1.0 which you need to accurately classify smoke vs vape vs body spray

Deploy our sensors and classification algorithms in
schools, hospitals, hotels, rental cars, homes …
… wherever you need to deter smoking or vaping

Pollen

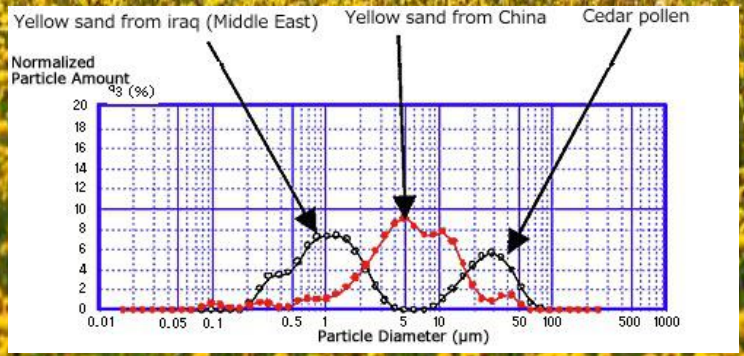
Challenge

EPA reports pollen but not locally
Pollen finds its way indoors
Wide range of particle size
Pollen peaks coincide with other ‘events’ (Yellow Sand)

Solution

Piera sensors detect pollen particle size and count
IPS-7XU is programmable from 0.5u to 100 u
Pollen count ‘events’ vs others

During pollen season you need Piera



Rental Cars / Hotels

Challenge

Patrons smoke and vape inside rental cars and hotel rooms leaving toxic emissions for next customers

Enforcement of no-smoking/no-vaping rules is difficult and so is measuring effectiveness of cleanup efforts

Solution

Only Piera has the algorithms and accuracy to classify vape vs cigarette smoke vs contaminants

- Precisely time-stamp vape/smoke events
- Measure efficiency of cleanup efforts
- Provide deterrent against events occurring at all
- Assurance of a safe environment for future customers

For clean cars and hotels, you need Piera

Industrial, Construction

Challenge

Keep employees safe, healthy by monitoring air quality and eliminating pollutants

Size, Weight, Cost, Reliability

Measure at High Concentration levels

Solution

Only Piera can accurately detect and classify ‘aerosols’ PM < 5.0 microns

Meet OSHA and other requirements on workplace safety

UL Compliance, Safety and other certifications

For healthy industrial sites you need Piera

Mold Mitigation

Challenge

Monitor Spaces during Remediation, Mitigation

Compare workspace mold levels to ‘nominal’

Measure particle count across range of PM sizes continuously during remediation

Solution

Only Piera can count particles across the size of Mold

Continue remediation until particle counts reach ‘nominal’

Final Testing ensures Mitigation successful

For Mold Mitigation and Remediation, you need Piera

Piera Systems

Smart Buildings

Challenge

Keep employees safe and healthy by monitoring air quality and eliminating pollutants

Studies show poor air hinders employee productivity; concerns significantly heightened due to pandemic

Solution

Only Piera can detect ultrafine particles

- classify vape and cigarette smoke in real-time
- accurately monitor and improve indoor air quality
- seamlessly integrate into HVAC systems, air purifiers, and building management software

For healthy spaces you need Piera

HVAC Systems need the Accuracy

"… we found very strong correlation of submicron particulates with occupancy, unlike larger particles (>1micron) that did not correlate with occupancy."

"Some fraction of these small particulates are respiratory, and our experiment showed that we could reduce their concentration through both increased fresh air ventilation and improved filtration (MERV13)."

"… we think today's standards are half of what they should be …"

"Air cleaning products require in-situ monitoring and control"

LEED, WELL, RESET

Challenge

Certification Standards for Green, Healthy Buildings

LEED – Building and its services not health of occupants

WELL - is for People, not prescriptive, audits,

RESET – Focused on Air: A, B, C Grade Monitors

Solution

Indoor Air Quality Metrics based on EPA PM 2.5, 10 MC

Most sources of indoor emissions are PM <1.0

Canāree meets WELL, RESET Grade A specs at low cost

To monitor and create healthy indoor spaces you need Piera

Piera Systems

ROI for Improving Air Quality

- Improved IAQ for healthier, more productive employees
- Improved Employee Health = $34 per sq. m
- Improved Staff productivity => $410 per sq. m
- Possible ROI = 120 %

Source: 75F

Useful links

Our home: www.pierasystems.com

Canaree : https://www.pierasystems.com/canaree/

Canaree for Aruba APs brochure

IPS-7100 sensor datasheet

Vape / smoke detection video

Questions?

vin.ratford@pierasystems.com
raj.seelam@pierasystems.com

No more guessing, know exactly ‘What’s in your Air’

- Most accurate, scalable particle sensor in the world

Future-proof your products

- Fine, Very-Fine and Ultrafine particle detection is the future, be ready

Let’s partner on new possibilities

- Our disruptive technology empowers new markets and applications

Additional Information

ASHRAE Report on Schools

- 4k schools, 2.5 M students, 24 states
- 6 IAQ Strategies: increase fresh air, filtration
- Array of Guidance from multiple sources
- “Many vendors selling snake oil”
- IAQ Monitoring was basic: not real-time; CO2 not PM
- “Investments in school infrastructure needed to address indoor air quality”

We found that school districts relied heavily on their mechanical systems to implement air quality measures. Using mechanical ventilation to increase fresh air was most commonly adopted by schools, followed by filtration measures to remove airborne contaminants from recirculated air. The most frequently cited challenge to implementing protective air quality measures at schools was that school buildings were not designed to support the strategies that were being recommended.

Preparation in the Pandemic:
How Schools Implemented Air Quality Measures to Protect Occupants from COVID-19

ANNIE HOANG
Research Associate, The Center for Green Schools
MPH Candidate, Harvard TH Chan School of Public Health
MD Candidate, University of California – San Francisco School of Medicine (UCSF)

ANISA HEMING
Director, The Center for Green Schools

ASHRAE

THE CENTER FOR GREEN SCHOOLS

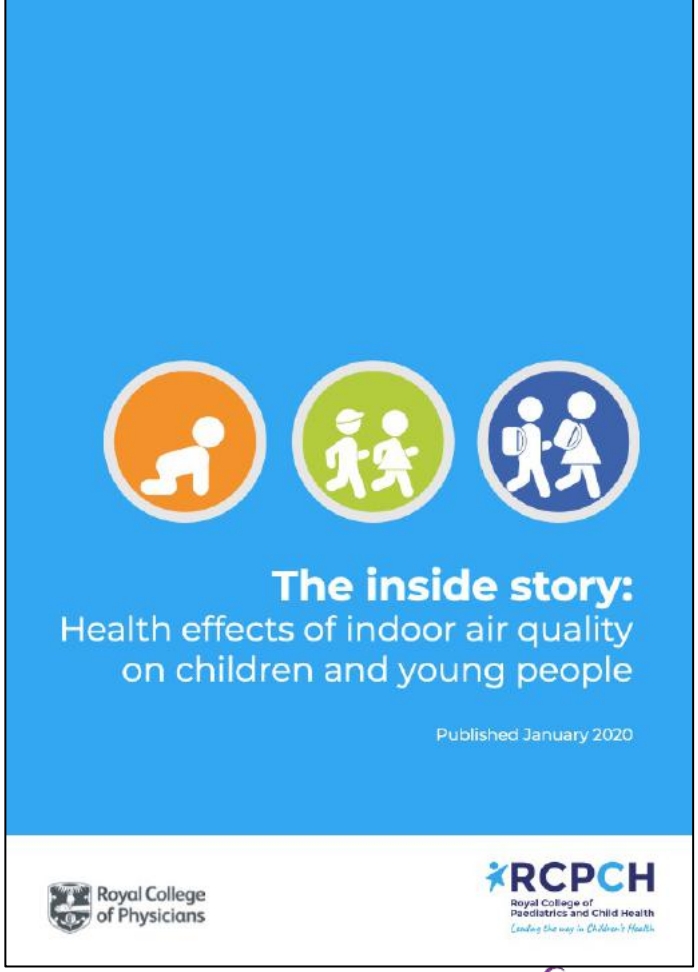
Piera Systems

RCPCH Report on Children

- Indoor Air 2-5 times worse than outdoor
- Air Pollution Mortality 30-65k lives each year

RECOMMENDATIONS

- Establish national strategy and regulations
- Advise the public and professionals
- Increase Local Authority oversight and powers
- Reduce the potential for inequality
- Performance-based building design, construction and mgmnt.
- Protect school children
- Provide high-quality research and evidence



ELI Report on Cooking

- Protect residents from unhealthy levels of cooking pollution
- Kitchen Ventilation reduces exposure
- Policies and Programs for New Homes and Existing ones
- Building Codes, Green Buildings, Housing Codes
- DOE Project: Smart Range Hood with sensors
- Financial Assistance
- Information and Outreach are Vital to Reducing Exposure

Campaigns might also incorporate low-cost air qualify sensors… which can be a powerful tool for residents to assess the effectiveness of their kitchen ventilation systems, as well as to increase awareness of the problem.”

Environmental Law Institute
April 2021, Washington, D.C.

AQM –Access Points

Challenge

Keep employees safe and healthy by monitoring air quality and eliminating pollutants

Studies show poor air hinders employee productivity; concerns significantly heightened due to pandemic

Leverage existing wireless access points

Solution

Canāree and Aruba deliver secure, affordable AQM solution

- accurately monitor and improve indoor air quality
- classify vape and cigarette smoke in real-time
- seamlessly integrate into HVAC systems, air purifiers, and building management software

For healthy spaces you need Piera

aruba
a Hewlett Packard Enterprise company

PARTNER SOLUTION OVERVIEW

ARUBA & Piera Systems

Indoor Air Quality Monitoring and Reporting

THE NEED FOR INDOOR AIR QUALITY MONITORING

Employees, customers and the general public are now aware of the need to Monitor, Measure and Improve indoor Air Quality. Wildfires, Climate Change, Covid-19 and the increasing amount of time spent indoors has created a 'tipping point' for companies to take action. The source of most poor Air Quality is due to Particulate Matter (PM) a mixture of airborne solid particles and liquid droplets that can be inhaled and causes serious health problems. The World Health Organization (WHO) reports airborne particulate matter (particulate from 0.1-10 micrometer in size) as a Group 1 carcinogen and as the biggest environmental risk to health, with responsibility for about one in every nine deaths annually.

The EPA monitors and reports Outdoor Air Quality but not Indoors and their monitoring stations are quite far apart, expensive and do not update in real-time. The EPA's Air Quality Index (AQI) is a simple, easy to follow metric for classifying Air Quality and can be applied indoors. However, it doesn't classify sources of poor Air Quality. To do so requires more detailed information about particle size and count. A new class of Air Quality Monitors based on more accurate, higher resolution, real-time data about particle size and count has been developed by Piera Systems leveraging existing wireless access points from Aruba to quickly and cost effectively allow monitoring of Indoor Air Quality.

A BREAKTHROUGH IN AIR QUALITY MONITORING: CANĀREE

Canāree™ is a low cost, Air Quality Monitor that when connected to Aruba Access Points operates as an IOT device that measures Air Quality instantly, calculating EPA's AQI and can leverage MS Azure cloud services for secure data storage and remote access to data. Piera's **SenseiAQ™** software application running on Azure is a Real-time dashboard that reports AQI together with additional analytics and alerts about indoor Air Quality. Canāree installs by simply plugging into an existing Access Points side USB connector without the need to remove the AP to install. Power and secure IoT communications are provided by the AP and Mobility Manager. Data is logged and stored on Azure IoT Hub for easy integration with existing Building Management Systems. Canāree is easy to install, configure, maintain and update and a network of Canāree sensors monitored by SenseiAQ can be easily reconfigured as needed.

WHY ARUBA AND Piera Systems

- Highly accurate Indoor Air quality monitoring & management
- Leverage existing wireless access points to reduce costs, simplify installation and deliver real-time analytics
- SensieAQ™ application provides real-time dashboard, alerts and Insight to take action and improve indoor air quality
- Vape/Smoke detection in real-time
- Secure, Cloud-based storage and analytics integrates with existing IT and Facilities Management applications
- Flexible business models allow own/ rent/lease for short or long-term business requirements

Figure 1 Canāree

Canāree utilizes Piera Systems **Intelligent Particle Sensor (IPS)**, an optoelectrical sensor based on laser scattering. IPS utilizes Piera's proprietary **Particle Counting Integrated Circuit**, **(PCIC)** a custom ASIC specifically developed for photon-counting and processing (3 granted US patents). PCIC can identify different sized particles and their concentration by directly counting pulses of different levels of photon energy, featuring superior accuracy, resolution and true real-time data acquisition compared to other sensors using a less accurate, slower LPO technique that 'estimates' overall Air Quality.

Canāree's real-time data on PM is stored on Microsoft's Azure IOT hub and SenseiAQ can classify its components and take actions to improve it. Canāree can identify uniquely vape and cigarette smoke using proprietary ML/AI algorithms. Alerts identify it's presence, concentration and persistence (how long it remains in the air). Knowing the source of PM, its location and severity provides insight and mitigation including changing HVAC systems, adding air purifiers, removal of the source or limiting access to areas with poor Air Quality.