

Air Quality Sensor Performance Evaluation Center (AQ-SPEC)

**NACAA Fall Membership Meeting
Denver, CO
October 19-22, 2014**

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Traditional Air Monitoring

- Permanent, large, fixed sites
- Address NAAQS
- Comply with all CFR specs
- Sophisticated and highly accurate
- Expensive
- Limited spatial resolution



Community-Based Air Monitoring

- Local concerns and issues
 - Resident complaints
 - Perceived health impacts
 - Requests from other agencies, elected officials, etc.
- Often source-specific
 - Special monitoring studies
 - Different approaches for different situations
- Non-regulatory
- Technologies deployed
 - Monitoring trailers
 - Deposition plates
 - Portable monitors
 - Grab samples
- Enlist the help of residents
- Risk communication



Monitoring By Community Groups / Others

- Current efforts in South Coast
 - Community based health studies
 - Measurements conducted by
 - *University researchers*
 - *Local agencies*
 - *Consultants*
 - *Single Individuals (DIYers)*
 - *A combination of the above*
- Technology used
 - Portable monitors
 - *Non-FRM/FEM but quite reliable*
 - **“Low-cost” air quality sensors**
 - *Non-FRM/FEM; unknown performance*
 - *Uncertain data quality*



Center for Community
Action and Environmental
Justice



Low Cost Sensor Technology

- Only a few
- Single pollutant measurements
- Non-FRM/FEM

SENSOR
PERFORMANCE

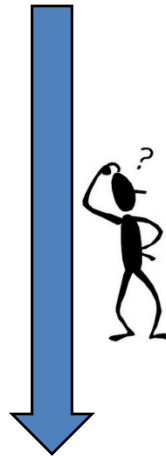
- Many (and more to come)
- Single and multi-pollutant measurements

Decent

Moderate cost
(\$8K - 10K)

Unknown


Lower cost
(\$0.5K - 10K)



Low Cost Sensor Technology

- Air monitoring sensor information and data already available on the web

<http://www.smartcitizen.me/>



WELCOME TO **SMART CITIZEN**

Smart Citizen is a platform to generate participatory processes of the people in the cities. Connecting data, people and knowledge, the objective of the platform is to serve as a rock for building productive open indicators and distributed tools, and thereafter the collective construction of the city for its own inhabitants.

The Smart Citizen project is based on geolocation, internet and free hardware and software for data collection and sharing (Smart Citizen Kit - SKI, [Beetlii app](#), [Mobile App](#) and [Beetlii community](#)).

REGISTER LOGIN

SMART CITIZEN KIT BUY SMART CITIZEN KIT

<http://airqualityegg.com>



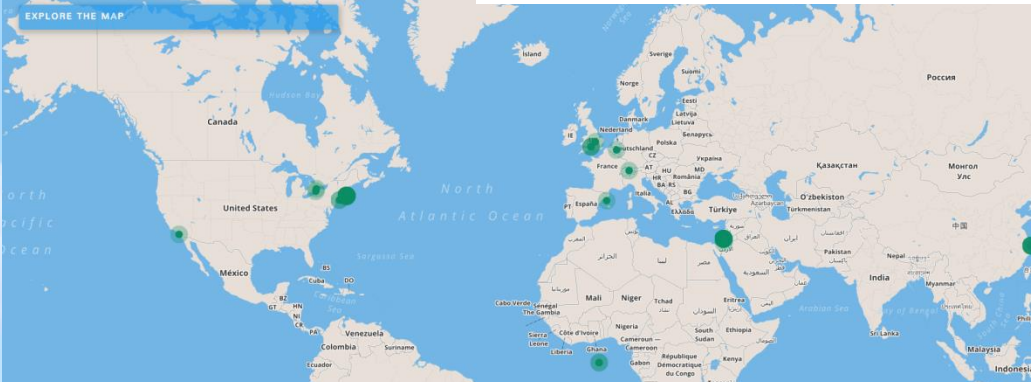
Air Quality Egg community-led sensor

Zoom to location by searching

Map Satellite

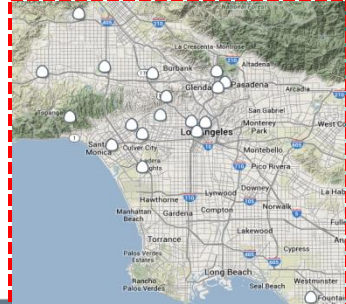
Map data ©2014 Google, INEGI | Terms of Use

<http://elm.perkinelmer.com/map/>



ELM FOR COMMUNITIES ELA

EXPLORE THE MAP



NO2 NITROGEN DIOXIDE	CO CARBON MONOXIDE
258	7839
Temperature	Humidity
21	52

Low Cost Sensor Technology

Potential concerns

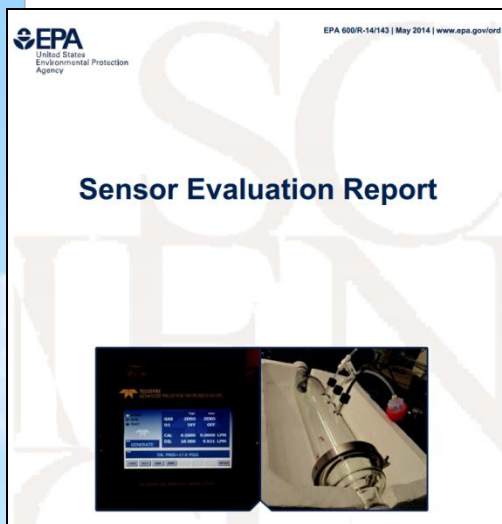
- Rapid proliferation
- Data quality not on par with that of FRM and FEM instruments
- Potential “overload” in the amount of non-agency air monitoring data
- Technical Issues
 - Calibration, accuracy, interferences, time averaging, longevity, expertise of user
- Data interpretation
 - Which pollutant?
 - What levels?
 - False positives: unwarranted alarm
 - False negatives: false sense of security
- Confusion

Opportunities

- Low cost
- Relatively small size
- Ease of operation
- Broader community participation and awareness
- Wider spatial and temporal distribution
 - More refined control strategy
 - Early warning/community alert system
- Data available on web, smart-phones, etc.

Low Cost Sensor Technology

- European and US EPA efforts to gather information, encourage use, and engage the public but...
- ...there is no State/Federal program to systematically evaluate sensor performance



Path Forward

- Engagement, Education and Communication are essential
 - Example: EPA STAR Grant "Air Pollution Monitoring for Communities"
- CAPCOA Conferences:
 - Example: "My Air Quality: Using Sensors to Know What's in Your Air"
 - Northern California (BAAQMD): November 19, 2014
 - Southern California (SCAQMD): November 21, 2014
- What can SCAQMD do?
 - Opportunity to provide leadership
 - Utilize SCAQMD staff experience and expertise
 - Establish **AQ-SPEC** (approved by Governing Board on July 2014)

AQ-SPEC Overview

- Main Goals & Objectives

- Provide guidance & clarity for ever-evolving sensor technology & data interpretation
- Catalyze the successful evolution / use of sensor technology
- Minimize confusion

- Sensor Selection Criteria

- Potential near-term use
- Real- or near-real time
- Criteria pollutants & air toxics
- Turnkey products first
- Price range:
 - < ~\$2,000 (purchase)
 - > ~\$2,000 (lease/borrow)

AQMesh



CairClip



Shinyei



*Dylos
(prototype)*



DC1100 Pro



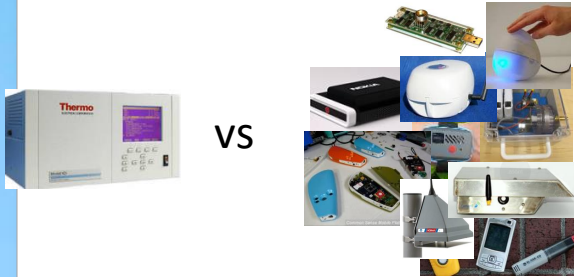
SmartCitizens



AQ-SPEC Overview

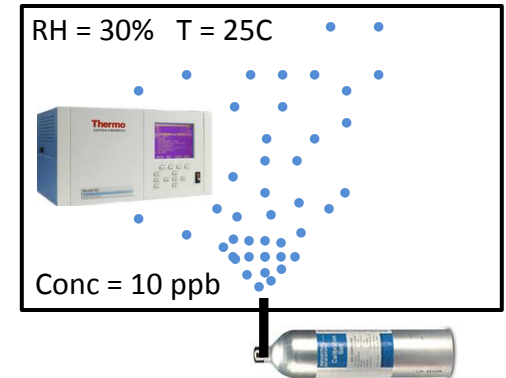
FIELD TESTING

(Side-by-side comparison w/ FRMs)



LAB TESTING

(Controlled conditions)

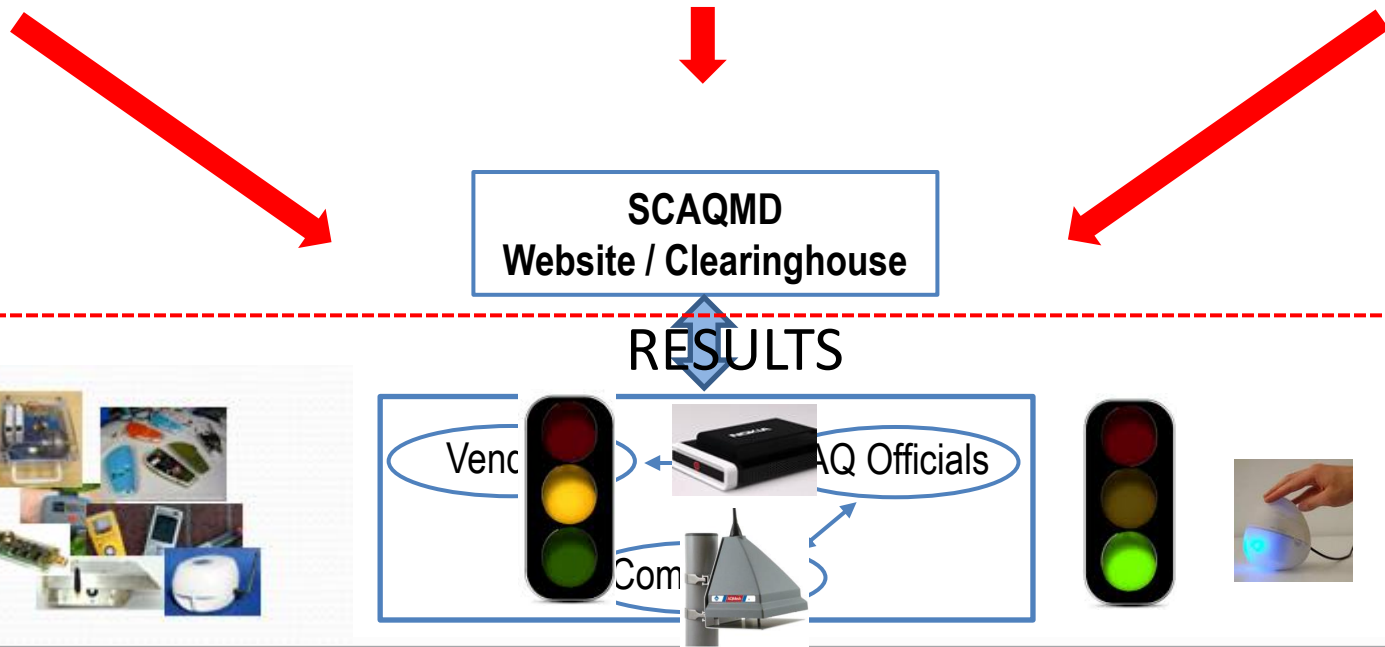


RESULTS

(Categorize sensors based on performance)



AQ-SPEC Overview



AQ-SPEC Field Testing

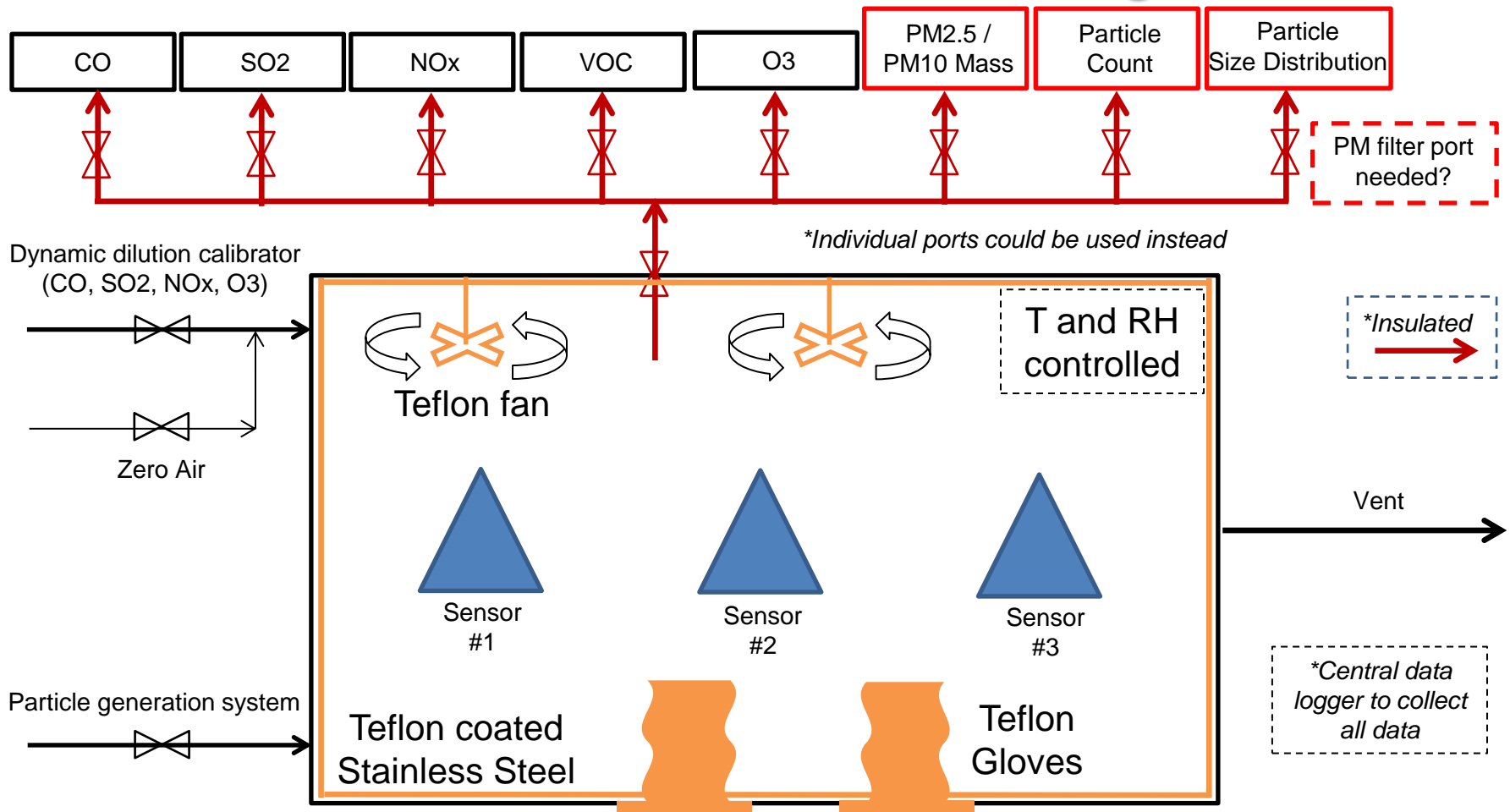
- Started on 09/12/2014
 - Sensor tested in triplicates
 - Two month deployment
 - Locations:
 - Rubidoux station
 - Inland site
 - Fully instrumented
 - I-710 station
 - Near-roadway site
 - Fully instrumented



Sensor / Manufacturer	Pollutant(s) Measured						
	PM	CO	NO2	SO2	O3	VOCs	Other
Dylos particle counter^	X						
MetOne 831^	X						
AQMesh*		X	X	X	X		NO
Cairclip (NO2/O3)^			X		X		
AeroQual Ozone card^					X		
Cairclip VOC^						X	
ELM*	X		X				
SmartCitizen^		X	X				

^Purchased; *Loaned

AQ-SPEC Lab Testing



Design considerations: Dimensions, material

T and RH controlled: T (0-50 °C; +/- 5 °C); RH (5-95%; +/- 5%)

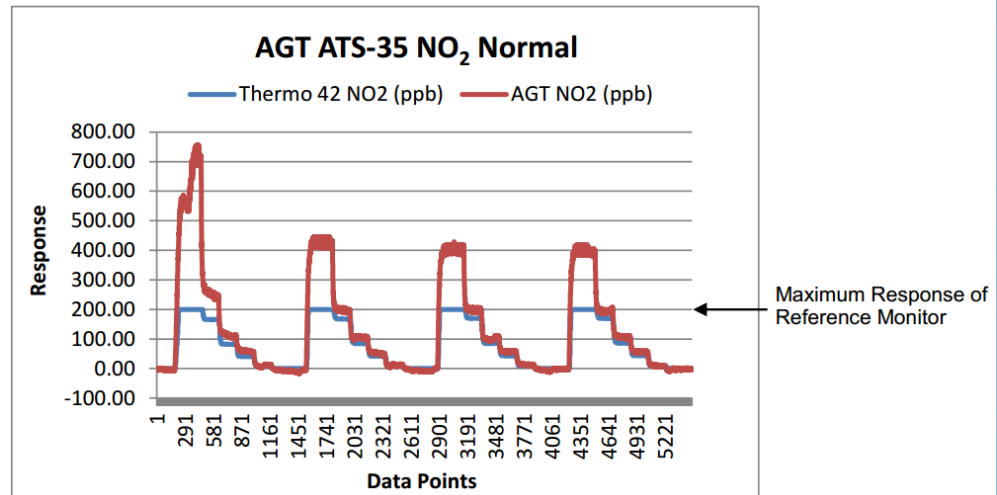
AQ-SPEC Lab Testing Protocol

Based on EPA's:

- Sensor Evaluation Report
- ORD Sensors/Applications Test Bed Challenge: Investigation of Sensor/Application Response under Controlled Laboratory Conditions (by ALION; Air Casting test)

Test for:

- (Conditioning)
- Linearity of response (range)
- Precision of measurement
- Lower detectable limit
- Concentration resolution
- Response time
- Interference equivalents
- RH and T influences



Expected Results and Next Steps

- ✓ Provide the knowledge necessary to appropriately select, use, and maintain sensors and to correctly interpret their data
- ✓ Promote a better and more responsible use of available sensors
- ✓ Discover new and more effective ways to interact with local communities
- ✓ Provide manufacturers with valuable feedback for improving available sensors and for designing the next generation sensor technology
- ✓ Create a “sensor library” to make “low-cost” sensors available to communities, schools, and individuals across California

