

Latest Approaches and Science behind Air Quality Monitoring

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Air Quality Monitoring

Joint presentation by Nick Browne and Rob Murray. Both working in the field of occupational hygiene and environmental science.

- Key steps required for monitoring
- New Technology
- What drives the need for monitoring
- Issues and challenges

Key Steps Required for Monitoring



Initial assessment

Risk profile of job

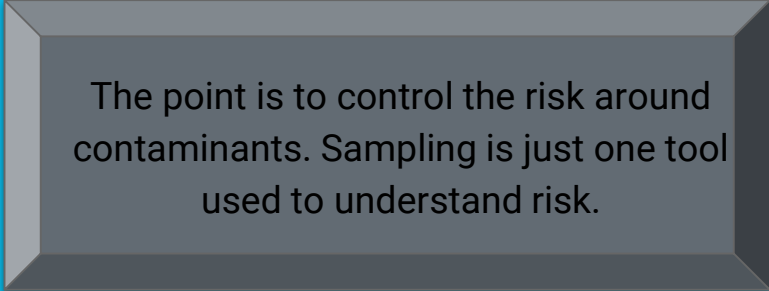
Identification of those affected

Material safety data sheet review

Dose

Length of exposure

Real time screening measurements



The point is to control the risk around contaminants. Sampling is just one tool used to understand risk.

Accuracy

What will the results tell you about an exposure?

Can the results be compared against a regulatory limit?

Repeatability

Limits of detection

Interferences

Practicality

Can the monitor work in the situation?

For example:

- Intrinsically safe
- Physical size
- Battery life
- Data log capability

Latest Technology



Drones

Process Optimisation

Emergency Response

Radiation

Confined Spaces

Large Scale Noise



AgCon Aerial Group

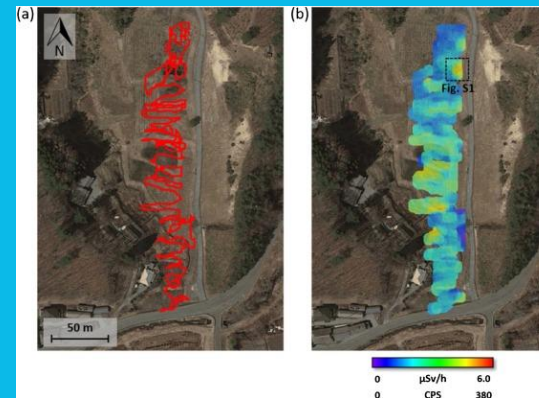


Image courtesy Martin et al, <https://www.sciencedirect.com/science/journal/03032434>

Drones

Re-entry into a site after a serious incident

Drone used to enter and measure gas levels before human entry

Combination of land and air based drones

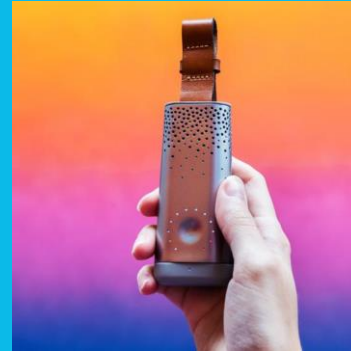


Low Cost Sensors

Measure range of contaminants -
 $PM_{2.5}$, PM_{10} , NO_2 , VOC

Real-time data with mobile apps

Designed for citizen science but may
soon be available to workplace
environments



Flow



Egg

Video Exposure Monitoring

Not a new concept

Synchronises real-time concentrations with video images of worker activities or workplace processes

Real-time monitoring of dust, organic compounds, noise, temperature

Assess peak exposures and identify sources

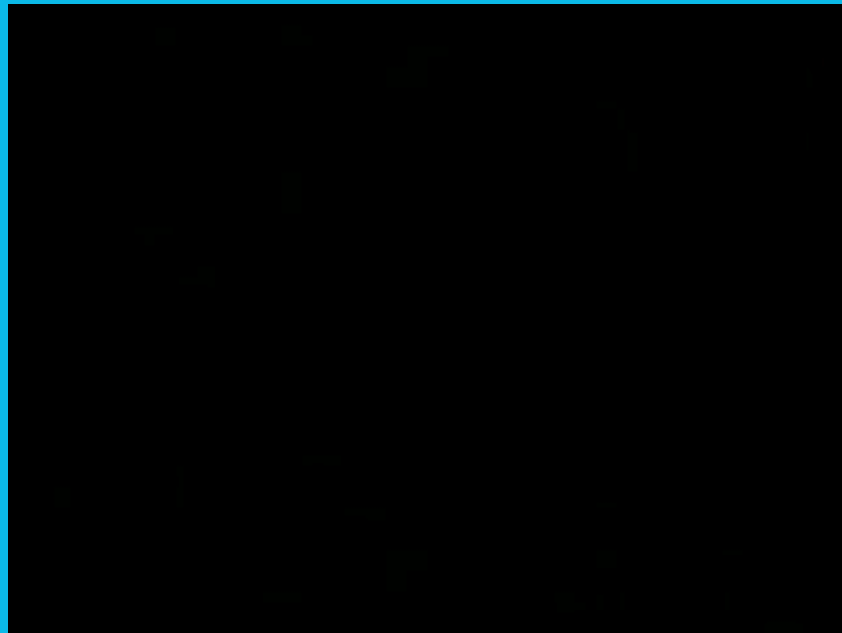
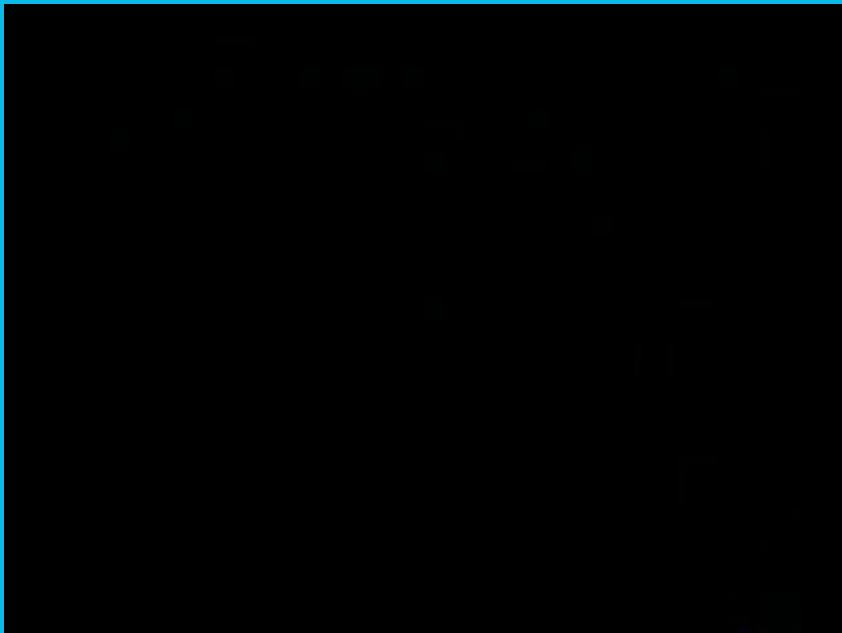
Compare the effectiveness of controls

Communication of results with affected parties



Image courtesy of Dr Jim McGlothlin

Video Exposure Monitoring



Video Exposure Monitoring



Mobile Phone Apps

NIOSH SLM App

Uses built in microphone or external microphone to measure A, C or Z weighted decibels.

Based around occupational noise measurements;

1. Run time
2. A-weighted Sound Level (LAeq)
3. C-weighted Peak Sound Pressure Level (LCpeak)
4. Time Weighted Average (TWA)
5. Dose



Tracking and Logging Capabilities

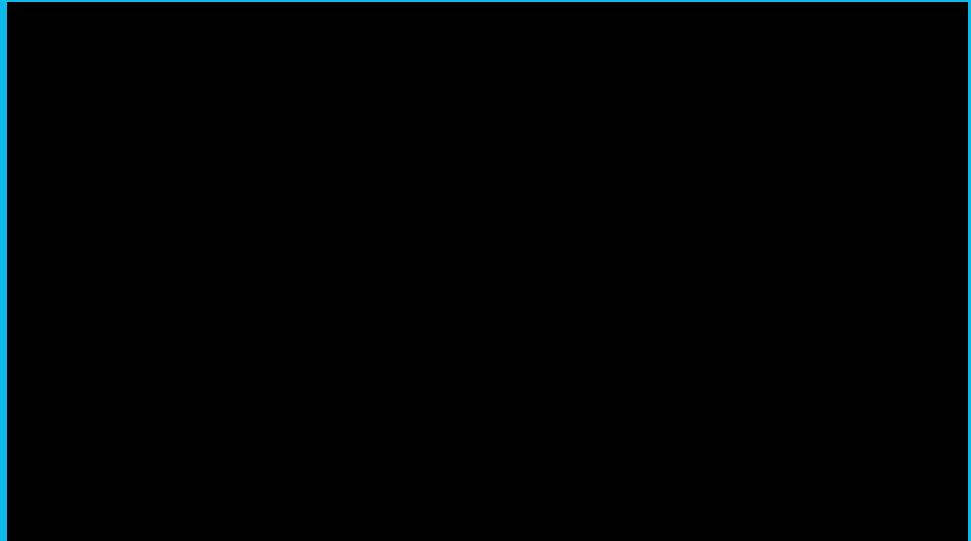
Real-time analysers

Assign instrument to a user by scanning a tag

Assign locations to an instrument by using beacons located around the worksite

Assign alarms to areas with restricted entry

Connectivity - wireless realtime data sent to central PC



Video from Industrial Scientific

Portable Labs

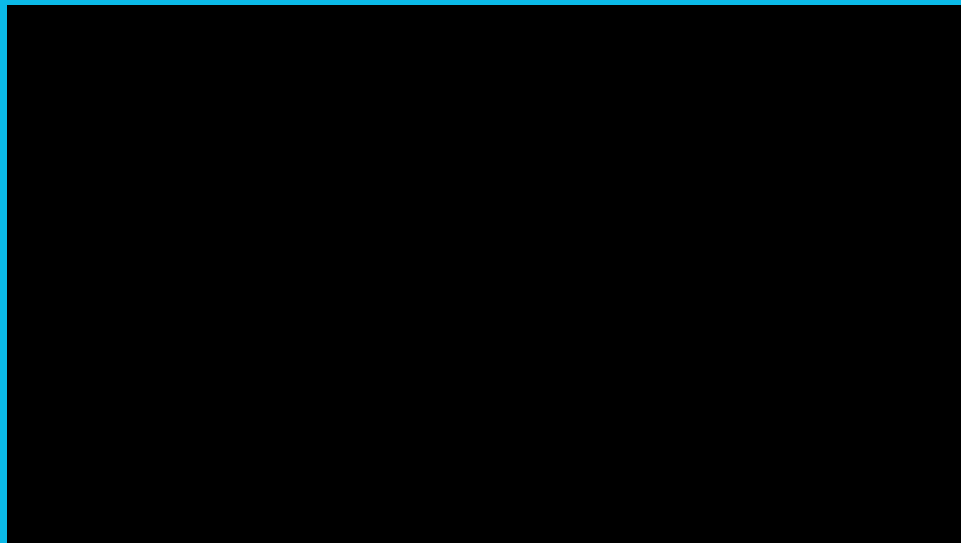
Portable GCMS

Light, battery powered, on site sampling and analysis (results in 4 minutes)

No transport to lab or delay with results

Forensics, terrorism, environmental;

Organic, pesticides, chemical warfare agents



Video from FLIR

What drives the need for
improvements in monitoring?



Compliance with regulation

New contaminant limits:

Respirable crystalline silica - was 0.2 mg/m³ and now 0.1 mg/m³ (from 2016 onwards) and potentially lower.

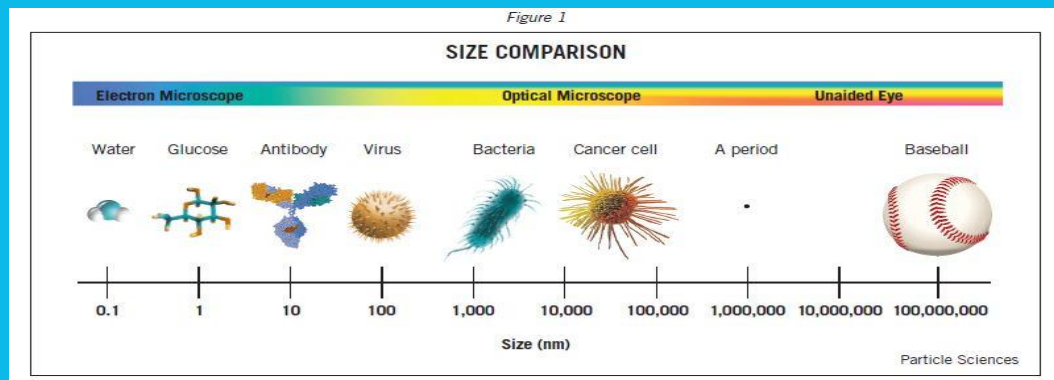
Diesel - was not present in WES and now 0.1 mg/m³ (from 2016 onwards)

Others?

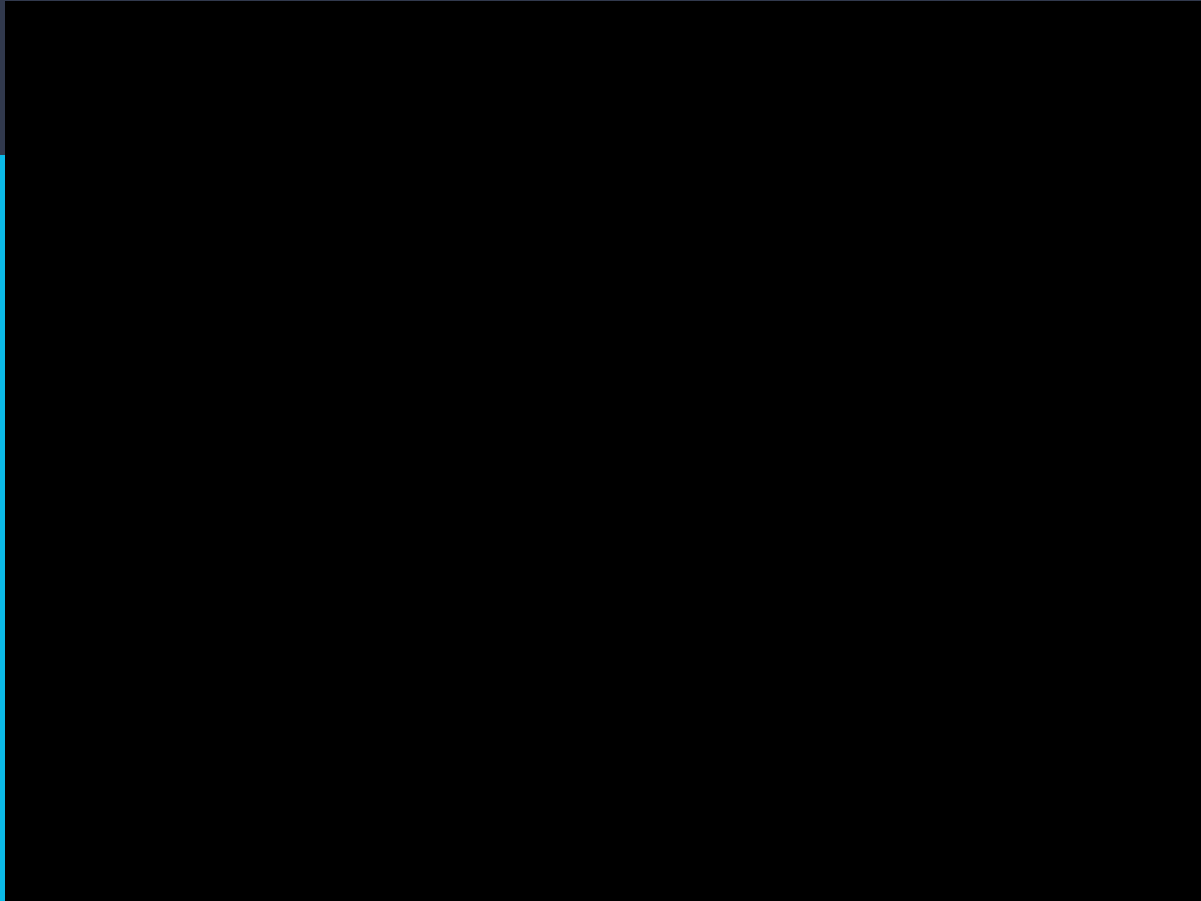
Nanoparticles - not in NZ WES

but within international regulation guidelines

and limits are being included.



How small is a nanoparticle?

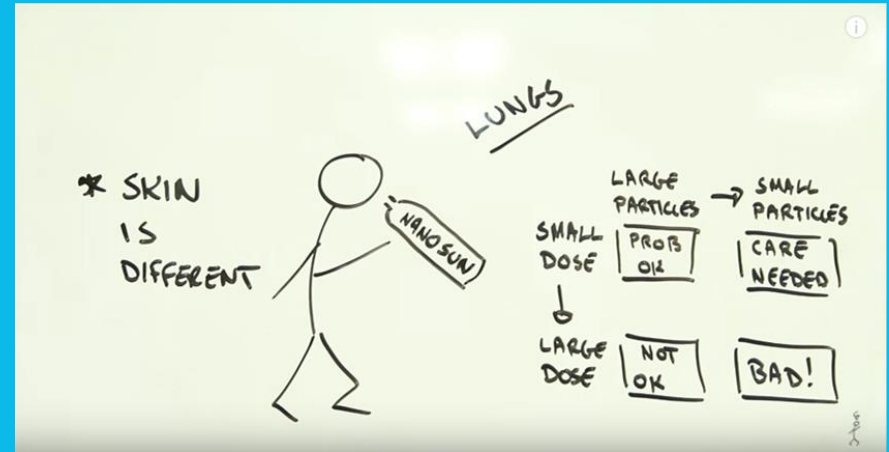


Source: <http://www.centerfornanomedicine.org> (taken from YouTube)

Engineered Nanoparticles

British Standards Institution (BSI) - benchmark guidelines

- Insoluble nanoparticles =
 - 0.066 x OEL of relative microsize material (based off titanium dioxide)
- Fibrous nanoparticles =
 - 0.01 fibres/mL (based on current asbestos clearance level)
- Highly soluble nanoparticles =
 - 0.5 x OEL of relative microsize material
- CMAR nanoparticles =
 - 0.1 x OEL of relative microsize material



Source: Risk Bites Youtube channel (supported by University of Michigan)

Sampling Engineered Nanoparticles

Traditional sampling not necessarily the best for nanoparticles.

- Difficult measuring particles less than 1 micron.
- Mass not the only factor of importance

Three factors in the sampling device:

- Number concentration
- Mass concentration
- Surface concentration

Sampling Engineered Nanoparticles

Need to measure down to the ultrafine fraction (yet to be defined)

Functional unit for transport and use in a industrial setting for personal and static sampling.

Separate out background nanoparticles (naturally/normally occurring from engineered)



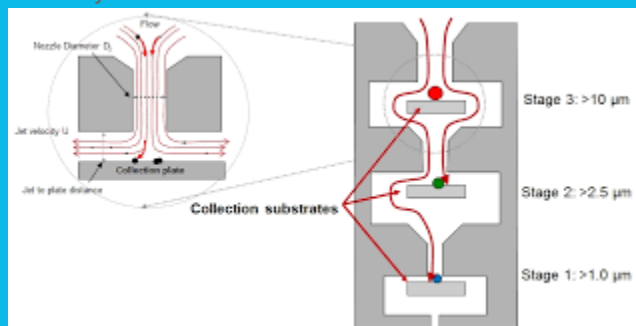
Source: TSI Incorporated (www.tsi.com)

NANODEVICE is a european funded project with the following purpose:

The idea of NANODEVICE is to develop Novel Concepts, Methods, and Technologies for the Production of Portable, Easy-to-Use Devices for the Measurement and Analysis of Airborne Engineered Nanoparticles in Workplace Air.

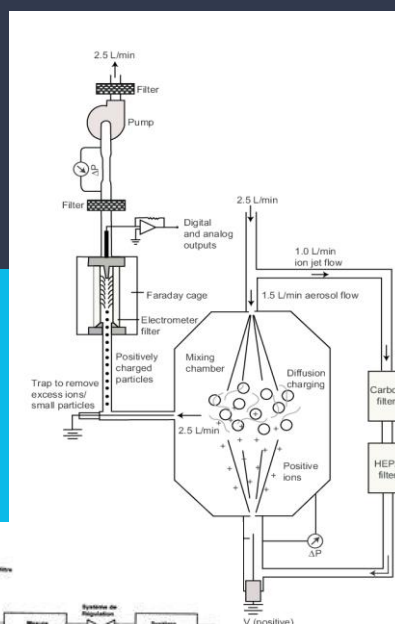
Current sampling techniques for nanoparticles

Cascade impactor - mass of different aerodynamic diameter

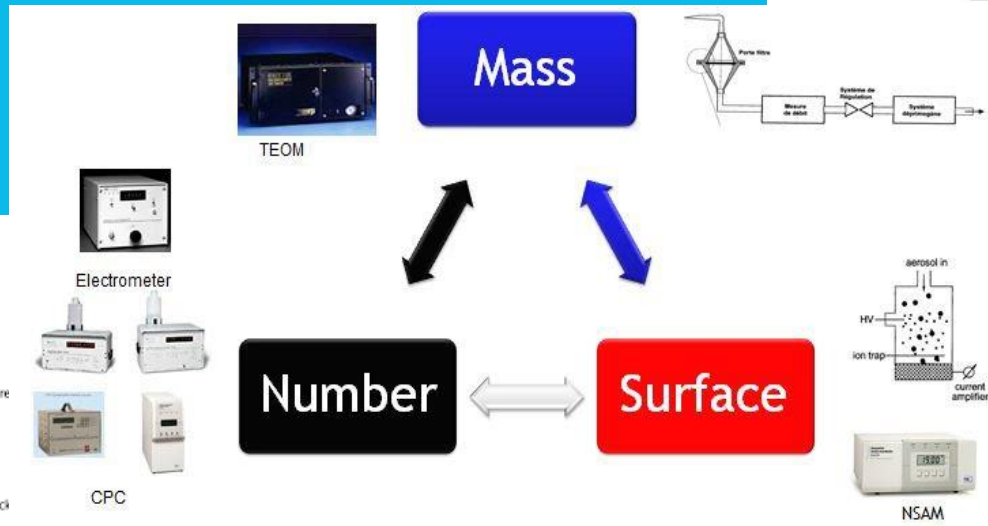
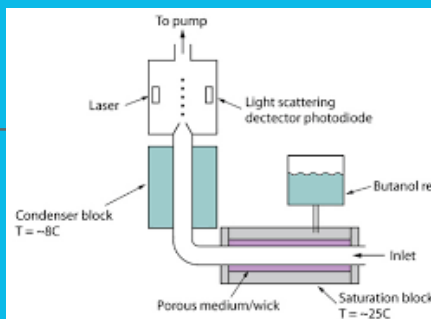


Nanoparticle surface aerosol monitor
- surface area of measured particles

Overall



Condensation particle counter - particle counts



Efficiency

Ease of use

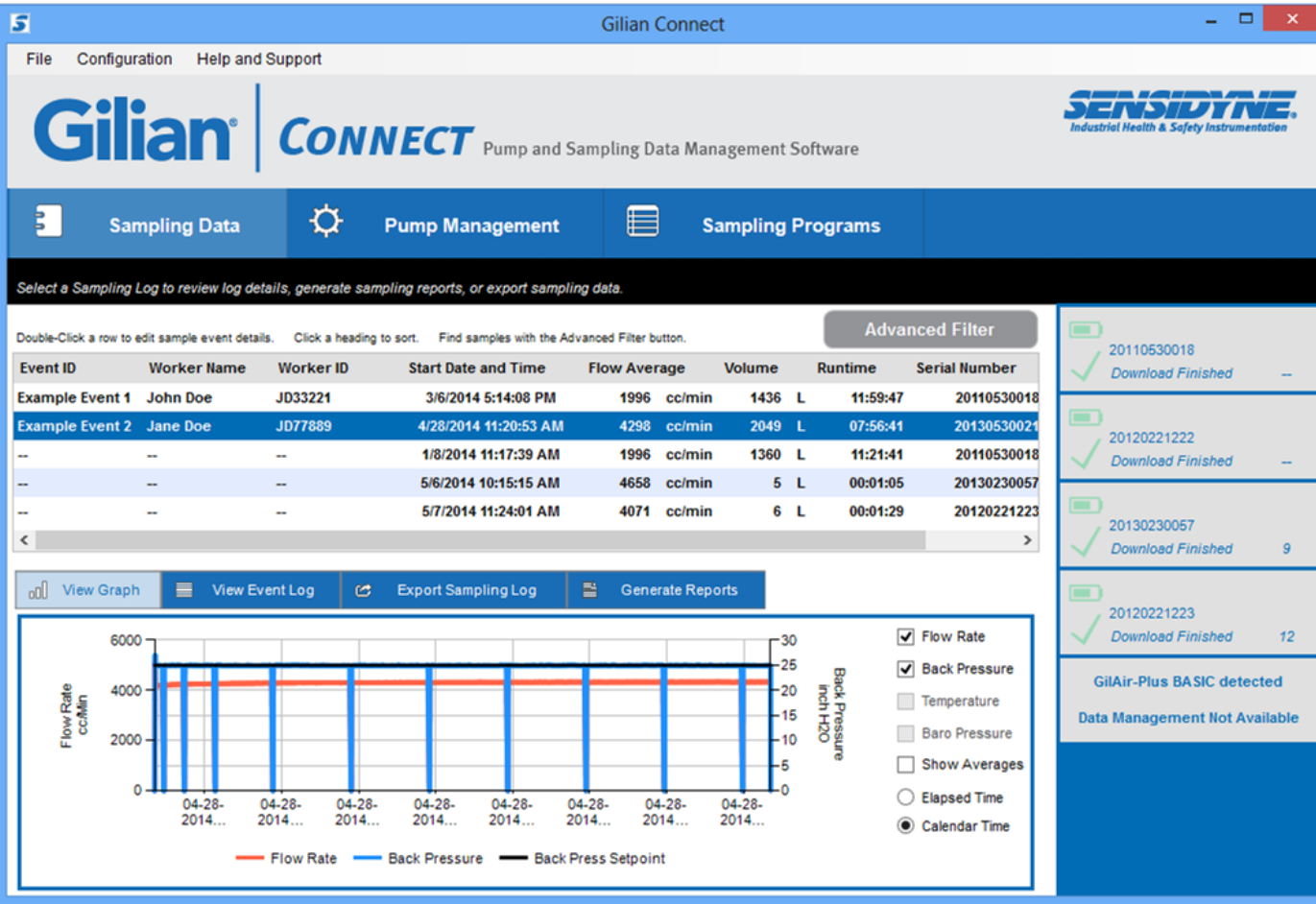
Comfort of user

Increased accuracy versus traditional methods

A basic but everyday type of example that Air Matters experiences each day is the improvements in something as simple as a sampling pump.



Source: Sensidyne, LP (www.sensidyne.com)



Issues & Challenges



Verification of Sensors

The quality of the devices:

Air Quality Sensor Performance Evaluation Centre (EPA a part of group to assess technology)








PM Sensors							
Sensor Image	Manufacturer (Model)	Type	Pollutant(s)	Approx. Cost (USD)	*Field R ²	*Lab R ²	Summary Report
	AethLabs (microAeth)	Optical	BC (Black Carbon)	~\$6,500	R ² ~ 0.79 to 0.94		
	Air Quality Egg (Version 1)	Optical	PM	~\$200	R ² ~ 0.0		
	Air Quality Egg (Version 2)	Optical	PM	~\$240	PM _{2.5} : R ² ~ 0.79 to 0.85 PM ₁₀ : R ² ~ 0.31 to 0.40		
	Alphasense (OPC-N2)	Optical	PM _{1.0} , PM _{2.5} & PM ₁₀	~\$450	PM _{1.0} : R ² ~ 0.63 to 0.82 PM _{2.5} : R ² ~ 0.38 to 0.80 PM ₁₀ : R ² ~ 0.41 to 0.60	R ² ~ 0.99	PDF (1,291 KB)
	Cair	Optical	PM(1-2um), PM(3-10um)	~\$200	PM _{2.5} : R ² ~ 0.43 to 0.51 PM ₁₀ : R ² ~ 0.39 to 0.51		
	Dylos (DC1100)	Optical	PM _(0.5-2.5)	~\$300	R ² ~ 0.65 to 0.85	R ² ~ 0.89	PDF (1,384 KB)
	Foobot	Optical	PM _{2.5}	~\$200	R ² ~ 0.55		



Image: Ecotech - Met One



Image: TOZA wearable air quality tracker

Compliance with Standards

NIOSH SLM app non compliant with
National Standards

*'No smartphone or smartphone
based-app has met the acoustical and
electrical tests required by national or
international standards'*

Interpretation of Data

Large amounts of data to is generated and needs to be analysed.

Real-time data misinterpreted by users, esp when compared with public health standards based on longer term exposure.

E.G. a low cost sensor measuring dust will be realtime and the WES is a time weighted average.

EPA Air Sensor Citizen Science Toolbox

How to Use Air Sensors



- [Uses for Air Sensors](#)
- [Air Sensor Guidebook](#)
- [Air Sensor Performance Evaluations](#)
- [Plot Air Data on a Map](#)
- [Evaluate and Interpret Your Air Sensor Data](#)

What is EPA Doing?



- [Overview](#)
- [Research and Development](#)
- [E-ENTERPRISE for the environment](#)
- [E-ENTERPRISE Projects](#)
- [Wildland Fire Sensors Challenge](#)

What Do My Sensor Readings Mean?



- [Sensor Scale Pilot and FAQs](#)
- [AirNow – Current Air Quality](#)
- [Minute-by-minute Data from Village Green Stations](#)

Resources and Funding



- [Resources](#)
- [Funding Opportunities](#)

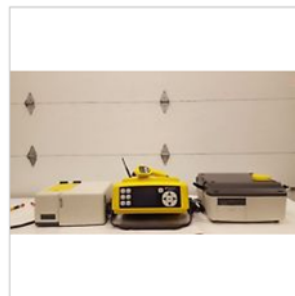
Other Issues

Portable GCMS very expensive

Intrinsically safe

Battery life

Synchronisation for VEM



INFICON Hapsite Smart ER Chemical Identification System Portable GC-MS

\$35,000.00

Buy It Now
or Best Offer

Very nice set-up in great working order. HAPSITE ER has the capability to identify analytes in the PPM (parts per million) - PPT (parts per trillion) range. The GC column provides sharp chromatography...

Image: EBAY

Summary

- Smaller
 - More widely available
 - More data
 - And quite exciting?
- New contaminants to consider
 - Developments in equipment to accurately measure
 - Technological improvements being incorporated

Thanks!



Auckland and Mount Maunganui

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