# Citizen Science and Community Based Air Monitoring Network through Micro Sensor Based Integrated Systems

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## Introduction

We demonstrate a micro sensor based air-monitoring system (micro station), developed under the Alberta Environment and Parks *Innovation Fund Project*, for citizen science and community based monitoring programs in the province. The micro stations will allow monitoring of air parameters through custom integration of micro sensors on a shoebox-sized footprint. These systems will allow secure acquisition, transmission and archival of data to support environmental decision making. They can have applications in integration of environmental data from small communities to local, regional and provincial scale.

## The Micro Stations

Two versions of micro stations ***µS 1o1*** and ***µS 2o1*** have been designed and developed by the Environmental Monitoring and Science Division (EMSD) of Alberta Environment and Parks in collaboration with the University of Alberta. Scope and resolution of monitoring of these systems can be customized as per user needs. Additional versions of micro stations with monitoring resolutions of up to the Federal Equivalence Method (FEM) for Air Quality Health Index (AQHI) applications are in progress.

*µS 1o1*

- Two independent Particulate Matter (PM) sensors:
  - -Measures $PM_{1.0}$, $PM_{2.5}$, $PM_{10}$
  - -$PM_{2.5}$ on 1 min and 3 min average
- Calibration option
- Autonomously collects and transmits data, location coordinates and system performance information
- Runs on Battery or Solar Power
- Embedded battery back-up

*µS 2o1*

- Sensors: PM, $O_3$, $NO_2$, $SO_2$, $CO_2$, CO, Temperature, RH
- Calibration option
- Autonomously collects and transmits data
- Runs on Battery or Solar Power
- Embedded battery back-up

**Figure 1.** The micro stations ***µS 1o1*** and ***µS 2o1***.

## What is New?

The micro stations offer low cost, low footprint, energy efficient and convenient method for citizen science and community based air monitoring. The technology can also be adapted for water, biodiversity, ecological systems or climate change studies. The micro stations offer some unique features that are mostly unavailable in the presently available low cost sensor systems:

- Custom selection (suite) of parameters
- Can be quality assured/controlled
- Ease of deployment- device registration and location updates automatically
- Can be used as mobile and/or portable units
- Data security and transparency can be ensured
- Data visualization is independent of vendor specific web portals
- Compatible with provincial data warehouse archiving
- Multi layer GUI platform for networks on community, regional, and provincial scale is possible.

**Table 1:** Comparison of micro stations with commercially available low cost sensor systems (less than $10,000).

| | *µS 101* | *µS 201* | Purple Air | Aeroqual AQY | Vaisala AQT 420 |
|---|---|---|---|---|---|
| Cellular Connectivity | ✓ | ✓ | ✗ | ✓ 1 | ✓ 2 |
| Solar Power | ✓ | ✓ | ✗ 3 | ✗ 3 | ✓ 4 |
| Battery backup | ✓ | ✓ | ✗ | ✗ | ✗ |
| User Data archiving | ✓ | ✓ | ✗ | ✗ | ✗ |
| Compatibility with Alberta data warehouse | ✓ | ✓ | ✗ | ✗ | ✗ |
| Data security & transparency | ✓ | ✓ | ✗ | ✗ | ✗ |
| Data QA/QC | ✓ | ✓ | ✗ | ✗ | ✗ |
| Custom Design | ✓ | ✓ | ✗ | ✗ | ✗ |
| Winter energy management | ✓ | ✓ | ✗ | ✗ | ✗ |
| Parameters | PM | PM, $O_3$, $NO_2$, $SO_2$, CO, $CO_2$ | PM | PM, $O_3$, $NO_2$ | PM, $O_3$, $NO_2$, $SO_2$, CO |
| Cost (approximate CND) | 300 | 1,500 | 450 | 3,500 [5] | 10,000 [5] |

1. Needs annual subscription.
2. Needs annual subscription, fee waived for initial customers.
3. Not offered with sensor package.
4. Under development, cost unknown.
5. Sensor lifecycle 1-2 years, replacement costs not included.

## Can They Do Good Measurements?

The micro station ***µS 1o1*** have been collocated with standard analyzers at the McIntyre Centre. The McIntyre site is equipped with several Federal Reference (FRM) and Federal Equivalence Methods (FEM) of particulate matter analyzers. Initial results show good correlations with the FEM methods deployed at McIntyre centre. All incidents of higher PM episodes during the period of deployment were captured by the system. Similar study for ***µS 2o1*** is in process.

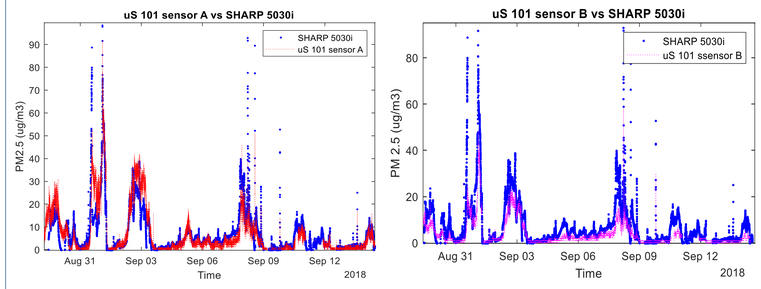


**Figure 2.** Colocation measurement data from ***µS 1o1*** sensor A and B in comparison to an FEM designated analyzer (SHARP 5030i by Thermo Scientific).

## Networking and Real Time Visualization

Micro stations are equipped with GPS and cellular connectivity. They can be located at any locations where cellular signal exists. The stations autonomously collect data and transmit the collected data and station metadata to a base station. The base station has built-in battery backup for 6 hours. Data sent from micro stations placed at remote locations are archived in the base station. The micro station network data can be streamed into a Graphical User Interface (GUI) for visualization in real time. Measurement data and station locations are refreshed every minute on the GUI map.

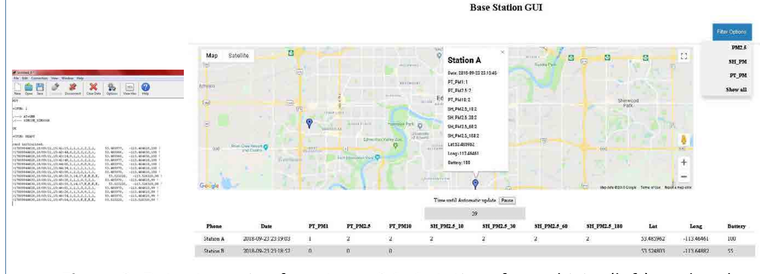


**Figure 3.** Data streaming from two ***µS 1o1*** stations for archiving(left); and real time display of measurement data on a GUI map.

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