

2023 Microsensors Challenge results: how reliable are these new air quality monitoring tools?

On November 23rd, 2023, Airparif, AIRLAB and their partners announced the winners of the 4th AIRLAB Microsensor Challenge during an international event held simultaneously in Bangkok and Paris. As part of the French-Thai Year of Innovation, an international and independent evaluation of the performance of air quality microsensors was carried out for the first time concurrently in France and Thailand, to assess the impact of different meteorological conditions, and pollution levels and sources, on microsensor performance.

59 microsensors were submitted to the Challenge, by 33 companies from 13 different countries. Monitoring sites were deployed in Tourcoing (France), in Bangkok (Thailand) on the roof of the Alliance Française, and in a new area dedicated to the evaluation of innovative measurement systems in Airparif's metrology laboratory in Paris (France). 255 million data points were processed during the test phases. The microsensors were evaluated in several usage categories, both in outdoor and indoor air.

The 2023 edition of the AIRLAB Microsensors Challenge was organized with the support of the Clean Air Fund, Agence Française de Développement (AFD), Agence de la Transition Ecologique (ADEME), Bloomberg Philanthropies, the French Embassy in Thailand and the Alliance Française Bangkok. It was carried out with the technical collaboration of the Asian Institute of Technology, Atmo Hauts-de-France, the Bangkok Metropolitan Administration, the Centre scientifique et technique du bâtiment / Observatoire de la qualité de l'air intérieur, EMPA, FIMEA, the National Institute of Metrology Thailand, and the World Meteorological Organization.

What is a microsensor? In contrast to the reference devices used by national or local regulatory air quality observatories to monitor air pollution, microsensors are small, compact and inexpensive. These characteristics make them relatively easy to handle. Each microsensor measures one or more air pollutants, including fine particles, nitrogen dioxide and volatile organic compounds. As they are not regulated, the characteristics and reliability of microsensors vary greatly depending on the pollutant, type of environment, and application.

Key learnings of this new edition: Performance varies greatly depending on pollutants and weather conditions

Once again, the results of the Challenge showed that, from one microsensor to the next, monitoring reliability varies widely between manufacturers, pollutants, and applications. Overall, the performance of microsensors for particulate matter (PM) measurement is better in more polluted PM with larger particles: the microsensors tested performed better in Bangkok, where particle concentrations are higher than in France. From this point of view, these devices are better adapted to the pollution levels and sources in this geographical area.

Microsensors capable of assessing individual exposure to fine particles on the move also performed better than in previous editions, although measurements are limited by the inability to quantify the presence of ultra-fine particles, which are very small in size.

While, overall, most of the microsensors tested remain unreliable when it comes to measuring gaseous pollutants such as ozone and nitrogen dioxide, some particular microsensors have, for the first time, demonstrated a particularly accurate measurement capability for ozone and black carbon in outdoor air.

The microsensors used to measure gaseous pollutants showed little adaptability to the variation in meteorological conditions between Thailand and France, and experienced a deterioration in accuracy when moving from one measurement site to another. The measurement correction algorithms used encountered difficulties in handling variations in temperature and humidity, which have a strong influence on the performance of the microsensors.

In contrast to previous editions, the technical performance of the microsensors tested showed little overall improvement compared with the 2021 Challenge, reflecting the more limited capacity for innovation on the part of microsensor manufacturers due to the consequences of the COVID epidemic and the resulting strain on supply chains. The cost of the microsensors tested has generally stagnated since the last edition, at between €100 and €12,000 per micro-sensor.

For the first time, an analysis of the environmental impact of the microsensors tested was carried out, using life-cycle analyses. Almost all participants made the effort to provide the data requested, with varying degrees of completeness. The data showed that most of the environmental impact of microsensors is linked to their use (maintenance, electricity consumption) and depends on their duration of use.

2023 Challenge laureates

International Microsensors Challenge

*AIRLAB



• Most accurate multi-pollutant sensor:

- Outdoor: **Bettair Static Node** - Spain  (Overall)
- Indoor: **Ethera Mini XT basic** - France  (France)
- Indoor under €500: **AirGradient ONE** - Thailand  (France)

• Outdoor Air:

- Monitoring: **Magnasci SMOGGIE** - Romania  (France)
- Ethera NEMo** - France  (Thailand & Overall)
- Awareness: **Magnasci SMOGGIE** - Romania  (France & Overall)
- AirGradient Outdoor** - Thailand  (Thailand)

• Indoor Air (Monitoring & Awareness & Piloting):

- Atmotech Atmotube** - United States  (France)

• Best accuracy:

- PM_{2.5} - Outdoor: **Airly PM-NO2-O3** - United States  (Overall)
- PM_{2.5} - Indoor: **Kunak Air Lite** - Spain  (France)
- PM_{2.5} - Indoor under €500: **AirGradient ONE** - Thailand  (France)
- O₃: **Bettair Static Node** - Spain  (Overall)
- CO₂ - Indoor: **Zaack QAI®** - France  (France)
- CO₂ - Indoor under €500: **Envira NANOENVI IAQ** - Spain  (France)
- VOCs - Indoor: **IQ-Air AirVisual Flex** - Switzerland  (France)
- VOCs - Indoor under €500: **Atmotech Atmotube** - United States  (France)

• Special Jury Prize:

- ACOEM C-12 Carbon Sensor** - France 

All the results for each microsensors are made available on the AIRLAB website via [an interactive platform](#), so that potential users can make their choice of microsensors according to their specific needs. These evaluations are available in English and French.

A rigorous, independent assessment of microsensors performance

Air quality is a health, economic and societal issue. Air pollution, outdoor and indoor, is responsible for 7 million premature deaths each year worldwide, according to the latest WHO report published in 2018. In this context, there is an increasing demand from authorities (but also private companies and citizens) to produce and have access to air quality data. The issue of data quality and reliability is

therefore crucial, in order to inform public policy, and implement effective actions to improve air quality.

With the increasing development of microsensors technology, Airparif (the independent, state-approved regional air quality observatory for the greater Paris region) and AIRLAB (its open innovation laboratory) periodically organise the AIRLAB Microsensors Challenge since 2018. This event aims to provide a robust and independent evaluation of the performance of microsensors, thanks to an international expert panel and under real conditions of use. The objective is to enlighten potential users on the individual performance of sensors according to various parameters (measurement reliability, ease of use, simplified information and cost) and for manufacturers to benefit from an evaluation of their products and a positioning in relation to others. The various editions every two years also allow us to keep pace with technological developments in these devices. A new international edition of the Challenge is scheduled for 2025.

To find out more about case studies and recommendations for use, see [Airparif Dossier: micro-sensors](#) and a [brochure listing the results of the 2023 Microsensors Challenge](#).

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Microsensors tested on the roof of Alliance Française in Bangkok. Credit: Airparif

About Airparif: Airparif is the independent air quality observatory for the greater Paris region. Airparif is a non-profit association approved by the French Ministry of the Environment to carry out the following missions: monitor the air breathed by the inhabitants of the greater Paris region, thanks to a robust and reliable monitoring network; understand air pollution, its impacts and its evolution, by contributing the enhancement of knowledge; support citizens, and all stakeholders, in improving air quality in relation to energy and climate, by informing and providing the Observatory's expertise in drawing up and assessing action plans; and innovate by facilitating the emergence of new solutions to improve air pollution more rapidly, and assessing the performance of these innovations.

For more information: www.airparif.fr

About AIRLAB: launched by Airparif and its partners, AIRLAB brings together a community committed to improving air quality. Large companies, SMEs and start-ups, research institutes, local authorities, citizens: everyone contributes ideas, skills, resources and means. AIRLAB contributes to protecting public health, supporting innovative companies and boosting employment by promoting the development and implementation of solutions to air pollution in Paris and the greater Paris region. It also encourages the promotion of these solutions at national and international level.

For more information: www.airlab.solutions