

European Metrology  
Programme for Innovation  
and Research

Delivering Impact



## Improving humidity measurements for industry-critical process gases

Ultra-high purity gases are needed in many sensitive industrial processes but can be contaminated by trace amounts of water, leading to waste and impacting product quality. As industries such as pharmaceuticals and electronics grow, humidity requirements are being pushed to levels as low as a few parts per billion. New metrology is needed to support accurate and traceable measurements.

### Europe's National Measurement Institutes working together

The European Metrology Programme for Innovation and Research (EMPIR) has been developed as part of Horizon 2020, the EU Framework Programme for Research and Innovation. EMPIR funding is drawn from 28 participating EURAMET member states to support collaborative research between Measurement Institutes, academia and industry both within and outside Europe to address key metrology challenges and ensure that measurement science meets the future.

# Challenge

Trace water is the most common contaminant in ultra-high purity (UHP) process gases and one of the most difficult to remove. These gases, such as argon, nitrogen and hydrogen, are used in sensitive industrial processes, including semiconductor fabrication or manufacturing pharmaceuticals, where gas purity strongly affects product quality. As these industrial markets continue to grow rapidly, so does the potential waste caused by impurities.

Industry requirements have now pushed the need for traceable water measurements to levels as low as 5 parts per billion (ppb). However, metrology capabilities have not been sufficient to reliably support measurements at this level. This includes the lack of suitable primary standards and validated methods for trace water detection. In particular, there has been a lack of traceability for the water vapour enhancement factors used to convert frost-point temperature measured by humidity sensors into the required water vapour amount fraction, especially at low temperatures below -50 °C. This has limited confidence in measurements used in critical industrial applications.

# Solution

During the [PROMETH2O](#) project, new theoretical work was carried out to develop and validate a novel equation for the water vapour enhancement factor. The equation is supported by new experimental data covering temperatures between -90 °C and -30 °C, at pressures up to 1 MPa.

As part of this work, project partner University of Ljubljana, Faculty of Electrical Engineering (Laboratory of Metrology and Quality), based in Slovenia, upgraded its ultra-low frost-point generator. The new system can now withstand pressures above 1 MPa (a 10 times increase) and achieve temperatures below -100 °C for various gases, including new capabilities to measure argon.

The generator has now been integrated into a new calibration service for humidity sensors, extending calibration capabilities to lower temperatures down to -90 °C and a wider pressure range.

# Impact

Comita d.o.o. are a system integrator and engineering services provider based in Slovenia. For over 30 years, they have developed bespoke, business-ready solutions for clients across industries including telecommunications, security, energy and transportation. In particular, the company focuses on engineering and automation & maintenance solutions in oil and gas sector. In 2023, Comita opened a dedicated metrology laboratory at one of its worksites in Türkiye.

Comita used the University of Ljubljana's new facility to calibrate a selection of dew point sensors which were due to be used to monitor gas quality in a customer's nitrogen generation system. Nitrogen is an inert gas used to preserve food and pharmaceuticals, prevent oxidation during electronics manufacturing and ensure safety in industrial systems by creating oxygen-free environments. However, the calibration process revealed that the accuracy of the sensors did not meet customers' requirements. This allowed the sensors to be replaced promptly, minimising any impact on production. As a result, the customer gained confidence in the quality of the generated gas while Comita are now able to monitor the system more reliably, allowing them to perform high-quality and timely maintenance.

The work of the PROMETH2O project will continue to provide

companies like Comita with accurate humidity measurements, improving the production of gases needed for sensitive manufacturing processes and reducing waste from these growing industries.

## New instrumentation for humidity measurements

The PROMETH2O project developed the measurement infrastructure for trace humidity measurements and a range of high-performance instrumentation.

- It accelerated the development and validation of the first portable frost-point generator with an extended range down to -100 °C.
- A far-UV system for measuring water in Ar and N<sub>2</sub> was developed that can operate both in static and dynamic conditions at pressures up to 10 MPa.
- A frequency comb-assisted Cavity Ringdown Spectroscopy analyser was developed, enabling water vapour measurements in N<sub>2</sub> and Ar down to 50 ppb with a measurement uncertainty of better than 1 %.
- A saturation-based trace water standard generator was established for measurements down to -105 °C (amount fraction of 5 ppb) and pressures up to 0.65 MPa in N<sub>2</sub> and Ar, representing the first capability of this type in Europe.
- Humidity generators which were based on the saturation and on the coulometric principles were developed to work down to -100 °C (or 12 ppb) at 0.11 MPa.

These new instruments will support waste and energy reduction in a wide range of European production environments.



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[www.euramet.org/project-20IND06](http://www.euramet.org/project-20IND06)

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