



Introductory notes for the Acta IMEKO third issue in 2026

Francesco Lamonaca^{1,2}

¹ Department of Computer Science, Modeling, Electronics and Systems Engineering (DIMES), University of Calabria, Ponte P. Bucci, 87036, Arcavacata di Rende, Italy

² CNR-NANOTEC, 87036, Rende, Italy

Section: EDITORIAL

Citation: F. Lamonaca, Introductory notes for the Acta IMEKO third issue in 2026, Acta IMEKO, vol. 15 (2026) no. 3, pp. 1-4. DOI: [10.21014/actaimeko.v15i3.2526](https://doi.org/10.21014/actaimeko.v15i3.2526)

Received September 29, 2026; In final form September 30, 2026; Published September 2026

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Corresponding author: Francesco Lamonaca, e-mail: editorinchief.actaimeko@imeko.org

Dear Readers,

The third issue of Acta IMEKO in 2026 presents a collection of research contributions that highlight the fundamental role of measurement science in addressing technological, industrial, environmental, and societal challenges. The papers cover a broad range of topics, including industrial condition monitoring, calibration and measurement uncertainty, quality management, environmental sensing, intelligent measurement systems, assistive technologies, and cultural heritage preservation.

Despite the diversity of the investigated applications, these contributions share a common objective: improving the reliability of information used to understand physical phenomena, evaluate performance, and support informed decisions. In this context, measurement science continues to evolve beyond the traditional acquisition of physical quantities, increasingly integrating advanced signal processing, artificial intelligence, mathematical modelling, and data-driven methodologies.

The research presented in this issue also illustrates how metrology can support the United Nations 2030 Agenda for Sustainable Development. Reliable measurements represent an essential enabling element for several Sustainable Development Goals (SDGs), since technological innovation, environmental protection, industrial efficiency, health, and the preservation of cultural heritage all depend on trustworthy quantitative information.

As Editor in Chief, it is my pleasure to introduce the contributions included in this issue, highlighting their scientific relevance and their potential connections with the UN Sustainable Development Goals.

The reliability of industrial electric motors is essential for ensuring production continuity, improving operational efficiency, and reducing maintenance costs. The study presented in [1] addresses the detection of broken rotor bars in induction motors through the analysis of higher-order stator current harmonics. The proposed approach combines envelope

extraction, continuous wavelet transforms, and convolutional neural networks to identify fault-related signatures under varying operating conditions. An important contribution is the demonstration that a classifier trained at a single operating point can generalise across different supply frequencies and load conditions. The experimental results report an average classification accuracy of 97 % over the investigated operating range. This approach could reduce the need for extensive training datasets and facilitate the application of intelligent fault diagnosis in industrial environments. The work is particularly relevant to SDG 9 – Industry, Innovation and Infrastructure, by supporting reliable industrial equipment and predictive maintenance, and potentially to SDG 12 – Responsible Consumption and Production, through longer equipment lifetimes and more efficient use of resources.

Accurate calibration is another fundamental requirement for reliable industrial measurements. The paper in [2] investigates the use of interpolation methods for reporting accelerometer calibration results, considering polynomial fitting and mathematical models describing accelerometer behaviour. The proposed methodologies allow sensitivity values to be determined at frequencies between experimentally calibrated points, while accounting for the uncertainties associated with model parameters. The research also addresses the practical implementation of model-based calibration in accordance with the developments introduced by ISO 16063-43. By improving the usability and interpretation of calibration information, this contribution supports metrological traceability and the comparability of vibration measurements. Its connection with SDG 9 – Industry, Innovation and Infrastructure lies in strengthening the measurement capabilities required for advanced manufacturing, reliable machinery monitoring, and technological innovation.

Innovation requires not only technological capabilities but also effective organisational processes for managing and evaluating them. The study in [3] proposes a conceptual model for assessing the maturity of innovation management systems in

established companies, based on ISO 56002:2019. The methodology integrates the Analytic Network Process, fuzzy logic, and Importance-Performance Analysis to evaluate organisational maturity, identify critical weaknesses, and establish improvement priorities. The framework is empirically investigated in a Brazilian electricity-sector organisation, demonstrating its potential as a decision-support instrument for innovation management. This research relates to SDG 9 – Industry, Innovation and Infrastructure, by promoting systematic innovation processes, and SDG 8 – Decent Work and Economic Growth, through the potential improvement of organisational effectiveness and innovation capabilities.

The pharmaceutical industry represents a sector in which quality management and regulatory compliance have direct implications for public health. The contribution in [4] presents a multicriteria self-assessment model for pharmaceutical companies, based on Brazilian Good Manufacturing Practices requirements established by Resolution RDC 658/2022 and aligned with international GMP principles. The proposed framework combines the Analytic Hierarchy Process with Importance-Performance Analysis to evaluate compliance capabilities and identify priority areas for improvement. Its application to a pharmaceutical company demonstrates how structured quantitative assessment can support regulatory preparation and quality management decisions. The paper contributes to SDG 3 – Good Health and Well-being, by supporting pharmaceutical quality assurance and safer production practices, while also relating to SDG 9 – Industry, Innovation and Infrastructure, through the development of systematic assessment methodologies for industrial processes.

The competence of testing and calibration laboratories is essential for establishing confidence in measurement results and conformity assessment activities. The research presented in [5] proposes a multicriteria framework for assessing laboratory maturity in accordance with ISO/IEC 17025:2017. The methodology integrates the weighting of standard requirements with importance-performance evaluation, enabling laboratories to quantify their organisational maturity and identify areas requiring improvement. The framework is empirically investigated at the Brazilian Army Evaluation Center, providing evidence of its usefulness for accreditation preparation and quality management planning. This contribution directly supports SDG 9 – Industry, Innovation and Infrastructure, since competent laboratories and reliable measurement services represent essential components of national and international quality infrastructures. It also provides an enabling contribution to SDG 12 – Responsible Consumption and Production, through improved testing, calibration, and quality-assurance capabilities.

The quantitative evaluation of quality is further investigated in [6], which examines the mathematical consequences of normalising the components of composite quality indicators. The authors analyse how transforming individual indicators into dimensionless quantities may modify the extrema of aggregated quality functions. Different mathematical aggregation models are considered, including arithmetic, harmonic, geometric, and quadratic mean formulations. The study highlights an important methodological issue: normalisation is not merely a numerical transformation but may influence optimisation results, and consequently the decisions derived from composite indicators. By improving the mathematical foundations of quality assessment, this research supports SDG 9 – Industry, Innovation and Infrastructure, and potentially SDG 12 –

Responsible Consumption and Production, where transparent and reliable performance indicators can contribute to more informed process optimisation and resource-management decisions.

Environmental monitoring represents one of the most direct applications of metrology to sustainable development. The research in [7] describes the development of an Internet of Things-based environmental monitoring network in Los Ríos, a socially vulnerable urban area of Santo Domingo, Dominican Republic. The system comprises ten compact measurement devices, each integrating seven sensors to monitor air pollutants, environmental conditions, noise, and vibration. The network was conceived with particular attention to the local social, climatic, and urban context, aiming to provide a replicable and energy-efficient infrastructure for environmental data collection. Preliminary measurements identified elevated concentrations of selected atmospheric pollutants, demonstrating the importance of local monitoring for characterising environmental conditions that may not be adequately represented by more general observations. The study is strongly connected with SDG 11 – Sustainable Cities and Communities, through data-supported urban planning and improved understanding of vulnerable urban environments, and SDG 3 – Good Health and Well-being, through the monitoring of environmental factors relevant to public health. It also supports SDG 13 – Climate Action by providing a measurement infrastructure that could contribute to local environmental assessment and adaptation planning.

Optical measurement systems are increasingly used in industrial inspection, automated quality control, and scientific investigations. However, their performance can be significantly affected by unwanted reflections and glare, which reduce image quality and may compromise the reliability of extracted information. The paper in [8] investigates the use of circularly polarised light for reducing these disturbances in vision-based measurement systems. The proposed optical configuration exploits polarisation properties to attenuate specular reflections and improve the visibility of relevant surface features. The approach offers a practical solution for improving image acquisition under challenging illumination and reflection conditions. The contribution is related to SDG 9 – Industry, Innovation and Infrastructure, by improving the measurement capabilities of machine-vision technologies, and potentially to SDG 12 – Responsible Consumption and Production, through more reliable non-contact inspection and industrial quality-control processes.

Reliable positioning is fundamental for maritime navigation and transport safety. The study in [9] addresses the compensation of positioning errors in vessel navigation when measurement errors follow mixed probability distributions. The authors investigate the uncertainties associated with different navigation instruments, and propose a method based on redundant lines of position to improve the estimation of a vessel's location. Analytical developments are complemented by numerical investigations and observations under real operating conditions. The proposed approach demonstrates how measurement redundancy and appropriate error modelling can improve positioning reliability in complex navigation scenarios. This research contributes to SDG 9 – Industry, Innovation and Infrastructure, by supporting the reliability of maritime navigation systems, and SDG 14 – Life Below Water, indirectly, through measurement methods that may support safer maritime operations.

The evaluation of measurement uncertainty remains one of the fundamental pillars of metrology. The paper in [10] presents a simulation-based comparison between the uncertainty propagation approach described in the Guide to the Expression of Uncertainty in Measurement (GUM) and the Monte Carlo method described in its Supplement 1, with particular reference to temperature sensor calibration. The authors investigate different measurement scenarios involving linear and nonlinear models, symmetric and asymmetric probability distributions, and limited sample sizes. The results highlight the limitations of first-order uncertainty propagation when the assumptions of approximate linearity and normality are not satisfied. For the investigated scenarios, Monte Carlo simulation provides a more faithful representation of the output probability distribution under nonlinear or asymmetric conditions. The study offers practical guidance for selecting uncertainty evaluation methods according to the characteristics of the measurement model. This work supports SDG 9 – Industry, Innovation and Infrastructure, by improving calibration reliability, and also provides an enabling contribution to SDG 3 – Good Health and Well-being and SDG 12 – Responsible Consumption and Production, where appropriate uncertainty evaluation can support measurement-based decisions in healthcare-related and industrial processes.

Wearable sensing technologies are creating new opportunities for objective movement analysis outside controlled laboratory environments. The study in [11] introduces a Sensor-in-Glove System for the three-dimensional analysis of wheelchair racing propulsion. The system combines two synchronised inertial measurement units, one integrated into a glove and the other mounted on the wheelchair wheel, to characterise the motion of athletes during outdoor sprinting. Experiments involving six elite athletes demonstrate the possibility of identifying propulsion phases objectively and extracting acceleration-based indicators of individual propulsion characteristics. The reported displacement-estimation error of 0.73 % over a 10-m interval supports the feasibility of the proposed approach for field measurements. The study contributes to SDG 3 – Good Health and Well-being, by advancing quantitative methods for the analysis of physical activity and movement, and to SDG 10 – Reduced Inequalities, by supporting technological research specifically addressing para-athletics and the performance assessment of athletes with disabilities. Although the experimental results concern sports performance, the measurement principles may also inspire future developments in assistive technology and rehabilitation assessment.

The preservation of cultural heritage represents another application domain in which measurement science provides essential information for scientific investigation and conservation decisions. The paper in [12] presents an integrated approach combining laser profilometry and infrared imaging techniques for the study of artworks. The methodology is applied to the panel painting *L'Ebbrezza di Noè*, attributed to Antonio Bazzi, known as *Il Sodoma*, and preserved at Palazzo Barberini in Rome. By combining information about surface morphology and subsurface features, the study demonstrates the complementary value of different non-invasive measurement techniques for investigating artwork structure, execution methods, and conservation-related characteristics. The contribution relates to SDG 11 – Sustainable Cities and Communities, particularly Target 11.4 concerning the protection and safeguarding of cultural heritage, and SDG 9 – Industry, Innovation and Infrastructure, through the development and integration of advanced diagnostic technologies.

The application of measurement science to cultural heritage preservation is further addressed in [13], which investigates the effects of gamma irradiation on early twentieth-century paper materials. Gamma irradiation may be employed for the decontamination of historical documents, but its application requires careful assessment of possible modifications to the treated materials. The authors combine non-destructive and minimally destructive analytical techniques, including Raman spectroscopy, Fourier-transform infrared spectroscopy, electron paramagnetic resonance, and thermogravimetric analysis, to investigate structural and chemical changes following irradiation. The results indicate that, for the examined historical paper samples, irradiation doses below 10 kGy do not produce significant degradation of the investigated physicochemical properties. The study provides relevant experimental information for the development of conservation procedures that balance decontamination effectiveness with material preservation. This contribution supports SDG 11 – Sustainable Cities and Communities, particularly the safeguarding of cultural heritage, and may also relate to SDG 12 – Responsible Consumption and Production, through the development of conservation practices intended to extend the useful life of vulnerable historical materials.

Taken together, the contributions presented in this issue demonstrate the breadth of contemporary measurement science and its relevance to sustainable technological and societal development. From industrial diagnostics and calibration methodologies to environmental monitoring, human movement analysis, and cultural heritage preservation, metrology provides the quantitative foundations required to transform observations into reliable information and informed decisions.

Particularly noteworthy is the increasing integration of measurement technologies with artificial intelligence, mathematical modelling, and distributed sensing systems. Nevertheless, technological sophistication alone is not sufficient to guarantee trustworthy results. The evaluation of uncertainty, the validation of measurement procedures, and the appropriate interpretation of data remain indispensable elements of every reliable measurement system.

The connection between these contributions and the UN Sustainable Development Goals also deserves particular attention. The achievement of sustainability objectives requires not only innovative solutions but also the ability to measure their effectiveness, monitor their evolution, and verify the outcomes of implemented actions. In this respect, metrology should be recognised as an enabling discipline for sustainability, providing the scientific basis for objective assessment, accountability, and continuous improvement.

I hope you will enjoy your reading.

Francesco Lamonaca
Editor-in-Chief

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