

Quality Assurance Infrastructure for Quantum Technologies – From Metrology to Market

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**QUANTUM
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Authorship and Imprint

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Quality Assurance Infrastructure for Quantum Technologies – From Metrology to Market

This document proposes a quality assurance infrastructure for quantum technologies. It outlines the key elements of a quality assurance infrastructure for quantum technologies, spanning the pathway from metrology and standardisation to regulation, accreditation, certification and market adoption. The framework highlights the need for coordinated action among National Metrology Institutes (NMIs) -coordinated by the EURAMET European Metrology Network in Quantum Technologies (EMN Quantum), Research and Technology Organisations (RTOs), industry, academia, standardisation bodies, regulators and conformity assessment organisations to build trust, support innovation and strengthen Europe's leadership in quantum technologies.

I. Requirements for a quality assurance infrastructure to support and stimulate the European leadership:

Maintaining and strengthening European leadership in quantum technologies requires the establishment of a comprehensive and future-oriented quality assurance infrastructure that evolves alongside technological advances. Such an infrastructure should be built on a strong metrological foundation provided by NMIs, coordinated by the EURAMET EMN Quantum, enabling internationally recognised measurement capabilities, traceability and reference standards for emerging quantum technologies. These metrological capabilities must be closely linked with standardisation activities, conformity assessment frameworks and, where appropriate, accreditation and certification mechanisms that are proportionate to the maturity, application area and associated risks of quantum technologies.

A successful quality assurance infrastructure further requires effective collaboration across the European quantum ecosystem, bringing together EMN Quantum members, RTOs, industry, academia, standardisation bodies, regulators and accreditation organisations. While RTOs support technology development, validation and industrial deployment, EMN Quantum members provide the independent measurement science necessary to ensure reliability, comparability and trust. Early integration of quality assurance considerations into research, development and innovation activities will accelerate technology transfer and market adoption, reduce barriers to commercialisation and facilitate interoperability across national and sectoral boundaries.

To stimulate European leadership, investments should also focus on developing shared testing and benchmarking capabilities, internationally harmonised standards and regulatory frameworks that foster innovation while ensuring market confidence. By establishing a coordinated and risk-based quality assurance infrastructure, Europe can strengthen its strategic autonomy, support the competitiveness of its quantum industry and position itself as a global leader in trustworthy and market-ready quantum technologies.

II. Implementation of the quality assurance infrastructure

The implementation of a quality assurance infrastructure for quantum technologies should follow the established quality infrastructure chain from metrology to market adoption, with clearly defined roles and strong collaboration among all stakeholders.

Metrology: National Metrology Institutes (NMIs), coordinated through organisations such as EURAMET EMN Quantum, provide the foundation through internationally recognised measurement capabilities, reference standards and traceability. In collaboration with RTOs, academia and industry, NMIs also support the development of testing methods and benchmarking approaches for emerging quantum technologies.

Standardisation: European and international standardisation organisations, including CEN-CENELEC JTC 22, ETSI TC-QT, ETSI ISG-QKS, ISO JTC3, develop harmonised standards for terminology, interoperability, performance evaluation and testing methodologies. These activities are already started with close involvement of EMN Quantum members, RTOs, industry and academia to ensure technical relevance and broad acceptance.

Regulation: The European Commission, together with relevant national competent authorities, establishes regulatory frameworks that promote innovation while ensuring safety, reliability and market confidence. Regulatory requirements should be proportionate to the maturity and risk profile of the respective quantum technologies.

Accreditation: National accreditation bodies, operating within the framework of the European co-operation for Accreditation (EA), assess and formally recognise the competence and impartiality of testing laboratories, inspection bodies and certification organisations involved in conformity assessment activities.

Certification: Certification bodies, among them some NMIs, can provide independent verification of compliance with applicable standards and requirements. Certification schemes should be introduced where they provide clear added value and should be proportionate to the intended application and associated risks, avoiding unnecessary barriers to innovation and market entry.

Market Uptake: Industry, investors, public procurers and end users ultimately drive the adoption of quantum technologies. A coherent quality assurance infrastructure strengthens trust, facilitates market access and interoperability, and supports the development of a competitive European quantum ecosystem.

Effective collaboration across all stages of this chain is essential to ensure that quality assurance enables innovation, accelerates commercialisation and reinforces European leadership in quantum technologies.

III. Recommendation for the Quantum Act

To strengthen European leadership in quantum technologies, the European Quantum Act should establish a coordinated framework that integrates quality assurance across the entire innovation cycle, from research and development to market deployment. This challenge cannot be fully addressed by individual industrial actors, as it requires globally accepted reference standards, rigorous uncertainty evaluation, and metrological traceability. NMIs are uniquely positioned to provide these capabilities, enabling reliable performance validation and supporting the development of standardised testing and certification schemes. A systematic integration of metrology into the quantum innovation cycle is therefore essential to reduce technological and investment risk, accelerate standardisation, and facilitate the transition from laboratory-scale demonstrations to scalable, market-ready systems. A robust quality infrastructure will enhance trust, support interoperability, facilitate market access and strengthen Europe's strategic autonomy and global competitiveness in quantum technologies.

Recognise metrology as the foundation of the quantum technology quality infrastructure. Support NMIs, coordinated by the EURAMET EMN Quantum, in developing measurement capabilities, reference standards and traceability for quantum technologies.

Promote coordinated standardisation activities. Foster collaboration between NMIs, RTOs, industry, academia and standardisation bodies, including CEN-CENELEC, ETSI, ISO and IEC, to develop harmonised standards for terminology, performance evaluation, interoperability and benchmarking. Establish a risk-based regulatory and conformity assessment framework. Ensure that regulatory requirements, accreditation and conformity assessment mechanisms are proportionate to the maturity, intended application and associated risks of quantum technologies, avoiding unnecessary barriers to innovation and market entry.

Apply a proportionate approach to certification. Mandatory certification should be limited to cases where it is clearly justified by safety, security, interoperability or other critical regulatory needs. For other applications, voluntary conformity assessment mechanisms should be encouraged to support market confidence and transparency without hindering innovation and competitiveness. Support European testing and benchmarking infrastructures. Invest in shared facilities and capabilities that enable independent performance validation, comparison of technologies and demonstration of compliance with agreed standards. Support access to these facilities by industry and academia.

Strengthen collaboration across the European quantum ecosystem. Encourage coordinated actions among NMIs, RTOs, industry, academia, regulators and quality infrastructure organisations to accelerate technology transfer and market uptake.

Invest in skills development and international cooperation. Build expertise in quantum metrology, standardisation and conformity assessment, while promoting international alignment of standards and measurement approaches to facilitate global market access.

Integrate quality assurance considerations early in innovation programmes. Ensure that European funding initiatives and technology roadmaps address quality assurance needs from the outset, enabling a smoother transition from research to commercialisation. By embedding these elements within the European Quantum Act, Europe can establish a trusted and innovation-friendly framework that accelerates commercialisation and reinforces its position as a global leader in quantum technologies.

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