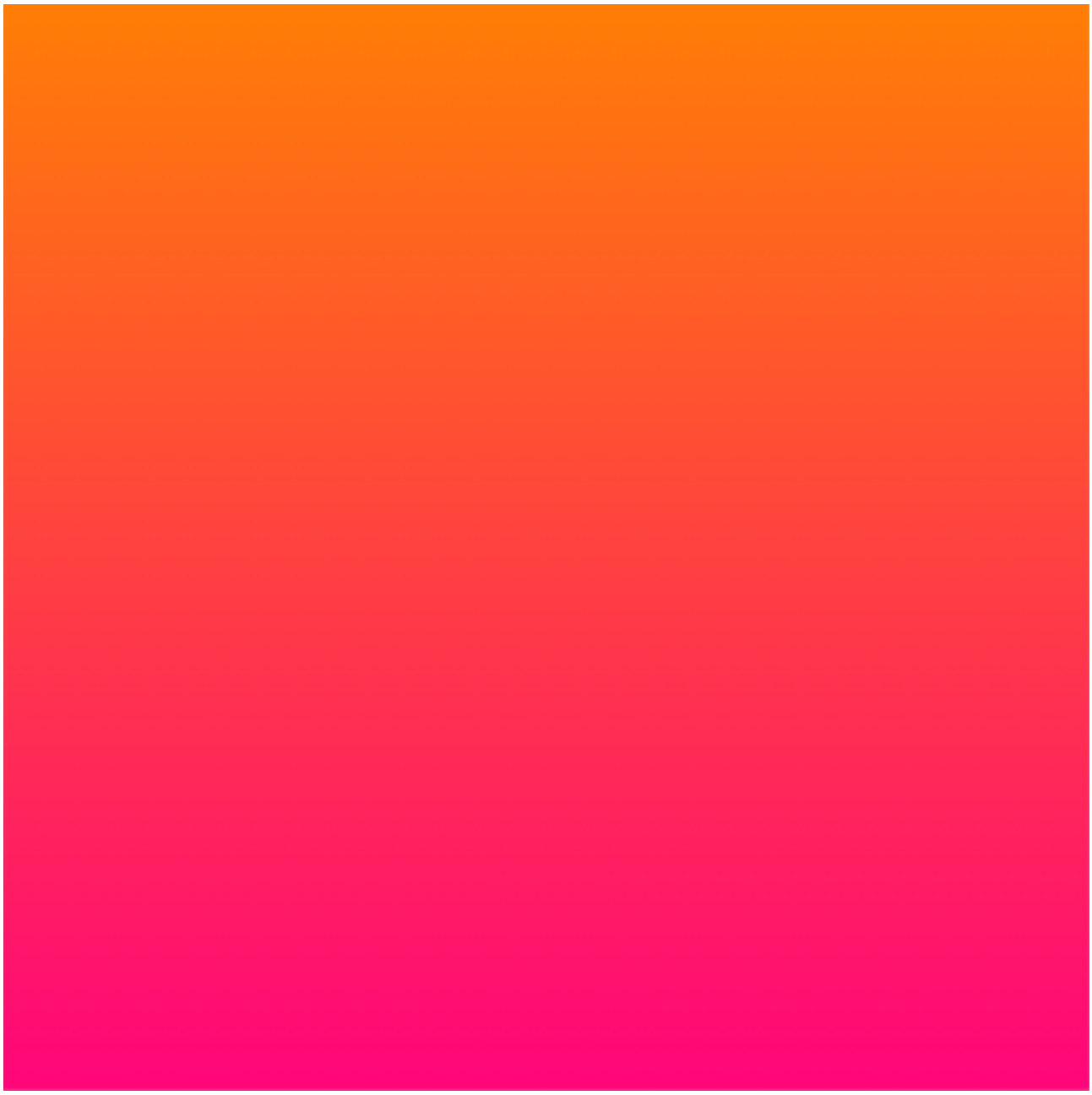
Main orientations and recommendations for

SHAPING A EUROPEAN STRATEGY IN QUANTUM TECHNOLOGY



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INTRODUCTION

The Quantum Technology Coordination Group (QTCG), uniting all 27 EU Member States with coordination from the European Commission, was created in the wake of the Quantum Declaration. Following the kick-off QTCG in 2024, designated representatives from EU Member States were invited to serve in three different Work Groups: Research, Talent and Impact (WG1), Infrastructure (WG2), and Industrialization & Standardization (WG3). Representatives were additionally invited to provide inputs on current activities and programmes in their Member State along the axes of all three Work Groups[1].

This document presents the combined efforts of all three Work Groups whose comprehensive memoranda (reported below) provide the main orientations and a set of recommendations for a robust, interconnected strategy designed to advance Europe's global leadership in Quantum Technology (QT). Underpinning the strategy is the prerogative to foster inclusivity in all its forms, in particular by promoting gender balance and the participation of Widening Countries, to fully leverage the pool of talent existing in the EU

- ✓ **WG1 (Research, Talent, and Impact),** forms one of the three core pillars by promoting actions aimed at strengthening research collaboration, attracting, nurturing and retaining talent, as well as ensuring impactful innovation across Europe. It spotlights the importance of supporting coordinated education and training initiatives across the Union to build a skilled quantum workforce and suggests expanding QT applications into various scientific domains. It furthermore highlights the need for strategic international partnerships on quantum. By aligning Europe's research and innovation landscape and fostering excellence, WG1 lays the groundwork for future commercial breakthroughs and the industrial uptake of quantum technologies.
- ✓ **WG2 (Quantum Infrastructure),** constitutes a second core pillar, addressing critical infrastructure needed to both ensure that Europe maintains technological sovereignty and global competitiveness, and that excellent European quantum research gets efficiently translated into practical and accessible applications and/or devices. This can be realistically achieved by strengthening and scaling up the existing European quantum infrastructures: quantum computing and simulation facilities in collaboration with the EuroHPC Joint Undertaking; secure communication networks under EuroQCI, advanced quantum sensor networks; quantum chip manufacturing pilot lines established under the Chips Act. Expanding infrastructure – and ensuring broad access – will provide an essential basis for researchers and industry across Europe to develop, test, scale, and deploy quantum technologies.
- ✓ Completing this triad, **WG3 (Industrialisation and Standardisation)**, emphasizes the need for strong industry engagement, intellectual property strategies, and clear regulatory frameworks, to make sure that Europe's quantum sector is both globally competitive and resilient. To this end, it provides recommendations to fill existing gaps in the quantum supply chain, enhance the commercialization environment, promote private investments, and facilitate the "lab-to-fab" transition. The necessity of actively shaping international standards to align with European technological strengths and safeguard economic security interests, is also stressed.

The working basis of all three WGs was that a vibrant European ecosystem – essential for sustainable advancements in quantum science, technology and innovation, as well as future commercial applications – can only be built by implementing measures that integrate academia, industry, and policy frameworks.

The unified and cohesive strategy emerging from the presented WGs memoranda will ultimately empower Europe to leverage quantum technologies fully, contributing significantly to its economic growth and competitiveness, technological autonomy, and global scientific leadership.

[1] A preliminary assessment of the collective status quo across Member States has been realised by WG3 (Industry & Standardisation)

WG1 – RESEARCH, TALENT and IMPACT

The mandate of WG1 was to develop a concrete set of proposals that would contribute to the plan of actions that the Member States and the Commission have agreed to develop for implementing the following activities of the Quantum Declaration:

> *[Activity 1] Align and/or coordinate major European, national, and regional R&D programmes and initiatives in quantum technologies and launch cooperation activities to intensify European efforts to be a leading quantum player globally, from research to applications.*
>
> *[Activity 3] Support a coordinated network of quantum competence clusters. The mission of these competence clusters would be to promote quantum-focused, basic and industry-oriented research, innovation and support activities in Member States, and to help network them at EU level. They would address combinations of different activities of the quantum technology ecosystem, in accordance with the preferences and objectives of each Member State.*
>
> *[Activity 7] Identify the skills development and training measures necessary to support and grow the EU quantum ecosystem and take coordinated action to implement them.*
>
> *[Activity 8] Undertake activities to gain a deeper understanding of the social and economic impact of quantum technologies and of the challenges that quantum computing is likely to raise for current encryption techniques.*
>
> *[Activity 9] Monitor the global quantum technologies outlook, align internationally focused measures to strengthen the EU's economic security, identify key developments, opportunities, and threats, and actively engage in the identification and development of prospective EU-level agreements and collaboration opportunities in quantum with third countries and international organisations.*

Therefore, Working Group 1 (WG1) is proposing activities that would focus on the European Union efforts needed in order to address critical challenges in quantum research and innovation, aligned with the activities of the Quantum Pact. Such WG1 proposals thus aim to:

- ✓ Strengthen collaboration between academia, industry, and quantum competence clusters, while promoting coordinated education and training, talent management, and outreach initiatives to support a robust, skilled quantum workforce across the EU.
- ✓ Target activities that would need to be undertaken in order to reinforce Europe's leadership in quantum research, expand basic and industry-focused, collaborative projects, and foster alignment and coordination between national and EU-level research programmes.
- ✓ Enhance Europe's talent pipeline by fostering the development of dedicated educational programs, supporting workforce upskilling, and facilitating mobility across Member States and EU quantum clusters.
- ✓ Cultivate international research and innovation (R&I) collaborations with like-minded countries. Proposed activities for the EU international cooperation dimension should also consider the following: identifying and advancing partnerships and networks that not only contribute to scientific and technological advancements but also protect the EU's economic and security interests in the global quantum landscape.

In the context of its mandate, WG1 has also developed ambitious concrete targets to reach.

SCOPE

WG1 covered specific activities related to enhancing research, fostering talent, and supporting innovation within quantum technologies leveraging excellence in the European research and innovation area.

The overarching aim is for Europe to be the world's leading region in quantum technology: a place to which the best researchers are drawn, and where their work constantly feeds innovation within a thriving quantum ecosystem that includes every Member State. This 'Quantum Valley of the world' will host European quantum computers finding new solutions to problems, accessible to science and industry; secure quantum communication networks on earth and in space; and a quantum internet linking all kinds of quantum devices across Europe. Its education and training institutions build a skilled and inclusive quantum workforce. It is home to many quantum companies, large and small, which can access financial support from targeted funds and from public and private investors committed to making the quantum revolution happen in the EU.

The following activity lines from the Quantum Pact are included in the scope of WG1.

Research and Innovation Cooperation Programmes

Objective: foster collaboration among Member States and the Commission in quantum research and development, develop a joint roadmap based on the Flagship SRIA (Strategic Research and Innovation Agenda), and streamline national priorities with EU goals. The goal is to secure Europe's continued leadership in quantum technologies, emphasizing basic research, collaborative projects, and industry-academia partnerships, leveraging excellence in the European research and innovation area, including in Widening Countries.

Proposals for actions within this activity line include:

- ✓ Identify new ways to support basic research in Quantum Science and Technology to strengthen Europe's position in computing, simulation, communication, and sensing.
- ✓ Elaborate strategies to foster collaborative research programmes to sustain ongoing and new partnerships and networks that would maximally capitalise on resources for ambitious quantum research initiatives, while considering also the interdisciplinary approach dimension.
- ✓ Recommend the development of national quantum strategies in all EU member states to facilitate a clear focus on how each country wants to work with Quantum Science and Technology.
- ✓ Suggest new means for expanding Quantum Science and Technology applications, e.g., by extending quantum information tools into disciplines such as condensed matter, high-energy physics, and quantum chemistry, among others.
- ✓ Recommend strategies to develop and mature quantum technologies, addressing open scientific challenges – both experimental and theoretical – to expand applications, and to ensure flexibility and scalability in the development as well as long-term impact and EU leadership in all application areas.

A coordinated network of Quantum Competence Clusters

Objective: establish and support a network of quantum competence clusters within and/or across Member States, aiming to consolidate expertise, drive industrial applications, and foster knowledge exchange within the quantum technology ecosystem at the EU level.

Quantum Competence Clusters (QCCs) should seek to utilize competences already existing in the EU, and facilitate access for relevant EU stakeholders to competences, resources and infrastructures.

The QCCs will elevate quantum competencies across all of the EU Member States by supporting and promoting basic and industry-oriented research, innovation, access to research and technology infrastructure, and industrialization. The mission of the QCCs will be to:

- ✓ Boost cooperation of topically connected research;
- ✓ Create widely accessible entry points to quantum infrastructure. Ideally, dedicated entry points should be established for specific areas, such as pilot manufacturing, to support stakeholders entering the field. These entry points should provide clear, transparent pathways for interaction and services, along with professional, standardised procedures to access existing infrastructures and R&I resources.

- ✓ Involve SMEs, startups, and other relevant quantum stakeholders to guide and promote the research and infrastructure development, and bring those developments towards high technological readiness (e.g. supporting standardization).

The QCCs will support national activities across Member States and help intertwine them in an interconnected EU-level network. An adaptable approach would need to be implemented taking into account Member States' existing assets and future needs, linking existing activities on the same topic happening in different places or bringing together initiatives on different topics in the same place. Members States shall determine autonomously in which structures and priorities they will participate.

Proposals for actions within this activity line include:

- ✓ Facilitate the establishment of focused quantum competence clusters, promoting specialized research and application fields (e.g., quantum computing, quantum simulation, quantum communications, quantum sensing, quantum materials, basic science and enabling technologies).
- ✓ Share methods and protocols across clusters to ensure interoperability and the harmonization of research and training methodologies.
- ✓ Initiate regular exchanges and relevant, demand-driven collaborative thematic-oriented activities between clusters across all of the EU, enabling sharing and access to resources, expertise, and infrastructures for cross-European innovation.
- ✓ Support each cluster in building partnerships with local industry players to pilot quantum technology implementations and scale practical applications, linking these efforts to EU-wide industrial strategies.

Talent and Skills Development

Objective: nurturing, attracting and retaining quantum expertise across Member States through coordinated education and training efforts. This includes fostering academic programs, upskilling professionals, and promoting collaboration across quantum competence clusters.

Proposals for actions within this activity line include:

- ✓ Propose ways to establishing Quantum Technology (QT) Master Programmes within and across Member States with an application focus while addressing also basic science, and upskill professionals through industry-oriented programs.
- ✓ Suggest strategies facilitating collaboration and exchange within the European QT Ecosystem, including student mobility, internships, and the alignment of competencies with EU frameworks.
- ✓ Propose activities to raise QT awareness in society and among decision-makers, e.g. by keeping regularly informed key industry and policy leaders about QT applications and promoting public outreach initiatives.

Social and Economic Impact Assessment of Quantum Technologies

Objective: deepen understanding of the social, economic, and ethical implications of quantum technologies, with a particular focus on the potential disruptions posed by quantum computing to existing encryption methods and data privacy frameworks.

Proposals for actions within this activity line include:

- ✓ Propose studies to conduct and support R&D initiatives aimed at understanding the challenges that quantum computing could introduce to current encryption standards and secure communications. Such studies should involve collaborating with cybersecurity experts, policymakers, and industry stakeholders to develop new cryptographic standards that are resilient to quantum attacks.
- ✓ Investigate how the introduction of quantum technologies may affect societal structures, including data privacy, digital rights, and equality of access to technology. Proposed activities could for example include setting up public consultations and expert panels to

explore and address potential ethical and societal concerns, ensuring that quantum advancements align with EU values and citizens' rights.

- ✓ Propose to put in place outreach initiatives aiming to inform the public, industry, and policymakers about the benefits and risks associated with quantum technologies. Such initiatives would also have to include the necessary resources and hosting workshops required that explain the implications of quantum advancements in accessible language, fostering informed dialogue and public trust.
- ✓ Identify comprehensive frameworks to evaluate the potential economic impact of quantum technologies on various sectors, including finance, healthcare, energy, and transportation. This could include forecasting models to understand how quantum advancements might reshape industry practices, job markets, and value chains across the EU.
- ✓ (Optional) Elaborate a set of policy recommendations aiming to support the responsible development and deployment of quantum technologies. This includes addressing regulatory needs, proposing ethical guidelines, and suggesting frameworks for monitoring the broader impacts of quantum applications as they evolve.

Identification and development of prospective EU-level agreements and collaboration opportunities with strategic third country partners

Objective: align with international quantum research efforts and create strategic collaborations that bolster the EU's position in the global quantum landscape, while securing economic and technological interests.

Proposals for actions within this activity line include:

- ✓ Propose studies or other activities aiming at a continuous analysis of global quantum technology advancements for identifying emerging opportunities and potential challenges, including economic security risks.
- ✓ Elaborate measures to forge collaborations with international partner countries that share the EU's values and ambitions in quantum technology, focusing on research, industrial applications, and workforce development.
- ✓ Suggest means to facilitate information exchange on scientific findings, technological advancements, and policy frameworks with international partners to strengthen collective progress in quantum fields.
- ✓ Propose initiatives that aim to develop policy frameworks that safeguard the EU's strategic interests in quantum technology and critical infrastructure, while encouraging mutually beneficial exchanges.

WG2 – INFRASTRUCTURE

The mandate of WG2 was to come up with a concrete set of proposals that would contribute to the plan of actions that the Member States and the Commission have agreed to develop for implementing the following activities of the Quantum Pact Declaration:

> *[Activity 4] Engage in activities to build collectively the pan-European quantum infrastructures of the future, both on Earth and in space, in quantum computing and simulation, secure communications, and quantum sensing and metrology.*

The remit of WG2 was therefore to explore and propose activities that would focus on how Europe can further develop and deploy quantum infrastructure in key areas such as quantum computing, communications, sensing, and metrology integrating emerging and cutting-edge European quantum technologies. Underpinning all quantum technologies is the capacity to support pilot lines enabling chip manufacturing.

WG2 provides recommendations for the best and most feasible approaches and activities to support the development of robust infrastructures. The group acknowledges the pivotal role such infrastructures play as a bridge between research and industrialization. Building, maintaining and scaling quantum infrastructures provides the essential physical and organizational foundation upon which efforts in both WG1 and WG3 critically depend. On the one hand, this helps translating research and talent development into practical applications with societal impact by providing the testbeds, facilities, and networks needed to test, validate and scale research breakthroughs. On the other hand, industrialization and standardization rely on infrastructure availability to enable companies to perform the “lab to fab” transition and prepare the ground for wide market access. These dependencies lead to a virtuous cycle that will be essential for ensuring the overall European quantum ecosystem evolves coordinated and effectively, thereby strengthening European sovereignty.

In this context, WG2 proposes measures that aim to build, maintain and scale quantum infrastructures, including quantum computing centres, quantum communication and metrology networks, and pilot lines for sensors, QPUs and other quantum devices. It fosters collaboration between academia, RTOs and industry and proposes tools and instruments to align national efforts with EU-wide strengths in quantum technologies.

SCOPE

WG2 covers specific activities that are essential for building, maintaining, and scaling quantum infrastructures within Europe. The following activity lines are included in the scope of WG2:

European Quantum Computing and Simulation Infrastructure (EuroHPC-QCS)

Objective: develop the European Quantum Computing Infrastructure, aiming to establish a pan-European quantum computing network by building on EuroHPC and national/regional initiatives. The goal is to place Europe at the global forefront in quantum computing.

Proposals for actions for this infrastructure include:

- ✓ Suggest ways for a sustained integration between EuroHPC and national or regional initiatives and infrastructures, e.g., by identifying and compiling existing resources, access points, and services.
- ✓ Develop effective strategies for the development of Quantum Computing Excellence Centres (QCEC) in the context of EuroHPC, thereby supporting collaborative research, involving industry, and developing a quantum software ecosystem, while also ensuring broad geographic coverage and adoption.
- ✓ Propose to elaborate plans to facilitate access for industry, especially SMEs, to quantum computing infrastructure, encouraging practical use cases and business models.

- ✓ Sustain the development of European quantum computers and simulators, which are installed on a number of HPC machines, for wide accessibility for researchers and industry/ SMEs.
- ✓ Sustain the further integration and hybridisation of HPC and quantum technologies (CPUs, GPUs, quantum computers, as well as FPGAs and more) to the maximum benefit of the users.

European Quantum Communication Infrastructure (EuroQCI)

Objective: facilitate and coordinate the implementation of a secure quantum communication infrastructure spanning the entire EU, connecting operational national quantum communication networks. The goal is a fully connected Europe with quantum-enhanced security.

Proposals for actions for this infrastructure include:

- ✓ Recommend the deployment of Proof-of-Concept (PoC) for Quantum Key Distribution (QKD) applications in each Member State, supporting real-world QKD applications, in both terrestrial and satellite links.
- ✓ Establish a realistic roadmap and timeline for the operational deployment of National QCI (NatQCI) networks, including aspects from technology validation and standardization to supply chains, also fostering the development of cross-border links between Member States to ensure harmonized operation ensuring an end-to-end service across the EU.
- ✓ Encourage the expansion of National Quantum Communication Infrastructures (NatQCI), with a particular focus on increasing the number and diversity of public sector and national security end-users.
- ✓ Introduce targeted measures to ensure the long-term sustainability, maintenance, and upgrading of deployed NatQCI infrastructures under EuroQCI, enabling them to transition from pilot to operational phase and deliver tangible value in real-world environments.
- ✓ Recommend ways to appropriately engage service providers and network operators to ensure that they meet end-user requirements for EuroQCI.
- ✓ Develop benchmarks for verification and authentication of QCI technology to ensure interoperability and security in operational use.

Quantum Sensing and Metrology Infrastructures

Objective: deploy and operate quantum sensor networks for industrial and societal applications.

Proposals for actions for this infrastructure include:

- ✓ Propose developing strategies to facilitate the transfer of quantum sensors from applied science to industry, e.g., by fostering academia-industry collaboration and supporting the entire supply chain from basic ideas to prototypes.
- ✓ Identify activities aiming to strengthen European industrial capabilities in quantum sensor technologies by recommending actions to ensure independence of supply chains and promoting commercialisation through innovative public procurement.
- ✓ Propose to launch actions that would elaborate concrete plans to engage pilot lines in the development and testing of quantum sensors, thereby bridging the gap between research and practical applications.
- ✓ Recommend creating quantum sensor networks across Europe.

Quantum Chip Manufacturing Infrastructure

Objective: develop and consolidate the European quantum pilot lines planned under the Chips for Europe Initiative (Pillar 1 of the Chips Act), aiming to establish a network of quantum device and component fabrication infrastructures, in synergy with standard chip production facilities. The goal is to ensure European strategic autonomy and competitiveness in quantum device manufacturing.

Proposals for actions for this infrastructure (additional to the implementation of quantum pilot lines under the Chips Joint Undertaking) include:

- ✓ Facilitate initiation of collaboration between national infrastructures and the European quantum pilot lines to support national R&D programs and innovation throughout the EU.
- ✓ Propose to closely engage industry, especially SMEs, in quantum pilot lines, encouraging practical use cases and business models.
- ✓ Evaluate the need, as well as launch actions, for quantum testing and evaluation facilities, including dedicated quantum test laboratories with cryostats and testing equipment for external industrial users, for supporting quantum chip, device and system experimentation, as a way to speed up quantum chip and system development. Establish these pilot lines as entry points for end users across Europe.

Acknowledging the pivotal role of quantum infrastructures as a bridge between scientific research advances and industrialization efforts, WG2 recommends the creation of a dedicated Quantum Infrastructure Point of Contact Group. This group, working in synergy with the Quantum Competence Clusters, will have the mandate to coordinate the activities related to quantum infrastructures within the Member States and the EU ensuring a smooth integration with research and industrialization actions. Its overarching objective will be to enable a coherent strategy for effectively building, maintaining and scaling infrastructure capabilities across the Union.

WG3 – INDUSTRIALISATION & STANDARDISATION

The mandate of WG3 was to propose solutions to ensure the competitiveness and resilience of Europe's quantum industry, a sector identified as critical for the economic security of the European Union [U. von der Leyen, 3 October 2023]. Areas of focus include the following Actions from the European Quantum Declaration:

[Activity 1] Align and/or coordinate major European, national, and regional R&D programmes and initiatives in quantum technologies and launch cooperation activities to intensify European efforts to be a leading quantum player globally, from research to applications.

[Activity 2] Coordinate efforts to accelerate the transition from the "lab" to the "fab", fill the gaps in the European supply chain and facilitate the transformation of high-quality European quantum research into marketable devices and applications with substantial economic and societal value.

[Activity 5] Further develop all areas of the European quantum ecosystem, especially via support for start-ups and scale-ups, as well as actions to encourage private funding, including encouraging large companies in many industrial sectors to invest in quantum.

[Activity 6] Support more public investments in European innovation in quantum, boosting the EU's economic security and technological autonomy

[Activity 7] Identify the skills development and training measures necessary to support and grow the EU quantum ecosystem and take coordinated action to implement them.

[Activity 9] Monitor the global quantum technologies outlook, align internationally focused measures to strengthen the EU's economic security, identify key developments, opportunities, and threats, and actively engage in the identification and development of prospective EU-level agreements and collaboration opportunities in quantum with third countries and international organisations.

The outcome of WG3 should lay the foundations for an EU-wide quantum strategy harmonized with national quantum plans.

SCOPE

WG3 covers specific activities aimed at promoting the industrial adoption of quantum technologies, featuring both hardware and software, improving the investment environment for European quantum SMEs, especially scale-ups, and driving the development of standards. This includes societal resilience and quantum security and exploring advancements with potential dual-use applications such as in defence or national security.

The following activity lines were also included in the scope of WG3: Most countries report barriers such as the absence of a commercially viable market, lack of risk capital, or insufficient dedicated funding, with some mentioning government involvement in venture capital, no indication of a joint EU Capital Market, and one country noting state acquisition programs and IP monetization strategies.

Sustained Growth and Standardisation of Quantum Technologies

Objective A: Ensure that global standards incorporate the interest of European quantum companies and support the adoption of quantum solutions by industrial users through known standards.

Possible actions within this activity line include:

- ✓ Develop a unified European standardisation strategy under CEN-CENELEC JTC22, providing financial incentives for quantum industry involvement in global standardisation activities. This includes developing standards for benchmarking HPC/QC hardware and software, as well as standards for the quantum interface with other emerging technologies.
- ✓ Promote awareness and active engagement in European and international standardisation bodies by educating industry stakeholders about global developments, incentivising active participation by European companies, and establishing certification processes.
- ✓ Proactively engage with international bodies to ensure European interests are represented and foster international alignment on European technical specifications, protocols, and quality standards.

Objective B: Facilitate the adoption of early-generation EU-developed & -fabricated quantum technologies by governments and encourage their industrial use.

Possible actions within this activity line include:

- ✓ Position Member States as first-buyers and users of EU-made quantum technologies, both hardware and software, and provide financial inducements to reduce costs for selected industrial projects.
- ✓ Engage large companies across various sectors to invest in and apply quantum technologies, thereby creating demand and fostering growth in Europe's quantum start-up ecosystem. Engagement to be possibly promoted via positive examples from peers or companies in adjacent industries.
- ✓ Expand Europe's intellectual property portfolio and ensure its commercial use by:
  - Incentivising the creation and "valorisation" (i.e. monetization) of patents by RTOs and academic institutions.
  - Financially supporting the submission and maintenance of IP rights for quantum SMEs.
  - Leveraging a healthy investments environment in Europe for quantum tech.

"From Lab to Fab": establish a resilient quantum value chain

Objective: Ensure quantum companies have access to key components and can find outlets for their solutions across the world (within the bounds of export control regulations).

Possible actions within this activity line include:

- ✓ Identify and, if needed, establish specialized manufacturing hubs in collaboration with leading quantum research institutions and industry players, including industrial engineering capabilities, to create a scalable infrastructure for quantum device production. These hubs could stem from the quantum pilot lines (QT-Test / Qu-Pilot, Chips Pilot Lines).
- ✓ Identify and address critical weaknesses in the European quantum supply chain, investing in essential components and materials to reduce dependencies on non-European sources and lead-times.
- ✓ Fund pilot manufacturing programs that transform lab-scale quantum devices into commercially viable products, leveraging the strengths of existing research institutions and industry partnerships. This ambition should build on successful European initiatives such as the Chips JU and support the development of a European Quantum Chips Plan (statement from EVP Virkkunen).
- ✓ Anticipatory study: investigate both the regulatory needs and challenges that quantum technologies will raise so as to balance support to European economic and security considerations.

Investments: Improve the Investment Environment for the European Quantum Industry Ecosystem

Objective: Mobilise investments from sovereign wealth funds, pension funds and investment firms (private equity firms, VC groups, others) to provide sustainable financial support and enhance coordination between existing funds and EU instruments.

Possible actions within this activity line:

- ✓ Establish specific and bold goals for investments from EU-level and national-level sovereign funds by 2025, including equity and venture debt.
- ✓ Identify obstacles and propose incentives to significantly expand lead investments in quantum companies by private funds (incl. VC, CVC), pension funds and sovereign wealth funds, with a focus on timely but long-term patient capital and leveraging public-private funding synergies to de-risk investments.
- ✓ Anticipate roadblocks to intra-EU mergers and acquisitions of quantum companies.

Skills retention and attraction

Objective: Europe has one of the world's largest pools of quantum talents today, and yet that pool is too shallow to sustain the growth of a competitive quantum industry. In addition, European quantum companies are challenged by peers abroad (notably USA) with extensive marketing and attractive salaries to obtain talents. WG to propose solutions to remedy Europe's talent shortage.

Possible actions within this activity line include:

- ✓ Identify best practices by EU Member States to attract and retain talent for industrial R&D in quantum tech, while considering relevant scientific challenges and including for example tax incentives for industrial R&D staff and industrial fellowships.
- ✓ Government programmes to re-train / re-skill workers for the needs of the quantum industry (broader workforce in quantum tech), in conjunction with the network of Quantum Competence Clusters.
- ✓ Identify and encourage fast-track work visa system for talents with skills adapted to quantum workforce across EU Member States (e.g. point system similar to immigration strategies in Canada and Australia)

Setting the EU on the global stage

Objective: Evaluate options to monitor the global quantum technologies and propose measures to strengthen the EU's economic security, identify key developments, opportunities, and threats, and actively engage in the identification and development of prospective EU-level agreements and collaboration opportunities in quantum with third countries and international organisations.

Possible actions within this activity line include:

- ✓ Examine possible trade promotion measures with select like-minded countries, especially countries having a digital partnership with the EU and/or nations aligned in common European networks (e.g. Eureka Network).
- ✓ Awareness of knowledge security, and streamlined rules, regarding Export Control and IP-sharing for strategic collaborations with third countries.
- ✓ Leverage official EU communication channels, campaigns, and events (e.g. EQTC, EuroHPC Summit) to showcase the strengths and achievements of the EU quantum ecosystem on the global stage.

Aims and Means

Starting from the extended activity lines the following key proposals for actions have been identified:

- ✓ Identify obstacles and propose incentives to increase private funding in quantum technologies.
- ✓ Mobilise investments from sovereign wealth funds, VC groups, and pension funds.
- ✓ Facilitate public-private funding synergies to de-risk the uptake of quantum solutions.
- ✓ Ensure EU MS representation, including industry stakeholders, in European (JTC22) and international (JTC3) standardisation bodies to promote and protect European interests.

In addition, the following three goals have been identified as most important for the EU and its MS:

- ✓ EU and MS to maximize the elaboration and adoption of EU quantum methods and approaches, and minimise exposure to potential export control restrictions on non-EU quantum tech.
- ✓ EU and its MS to maximise portfolio of quantum IP owned in the EU.
- ✓ EU and its MS to steer the emergence of one or several European fault-tolerant quantum computing (FTQC) champions on global stage.

MAIN STRATEGIC RECOMMENDATIONS

As a result of the discussions within the Working Groups, including a survey about prioritization of the most urgent and important actions outlined in the previous sections, a set of main strategic recommendations have emerged, which provide concrete measures to enhance research and innovation, reinforce essential infrastructures, accelerate commercialisation and industrial uptake, and engage in international standardization. Collectively, these activities lay out an ambitious implementation of the European Declaration on Quantum Technologies, by effectively leveraging Europe's strengths, addressing current gaps, and anticipating future challenges and opportunities in the global quantum landscape.

SUMMARY OF MAIN RECOMMENDATIONS FOR RESEARCH, TALENT AND IMPACT

Recommendation RTI-1	**Establish a European Quantum Research Coordination Platform** *to ensure the alignment and coordination of R&D initiatives; assist Europe's quantum ecosystem global competitiveness and reinforce links between the quantum competence clusters*

Description: create a European-wide initiative funding collaborative projects among all European quantum stakeholders (research institutes, national quantum programmes, industry partners).

Recommendation RTI-2	**Launch a Cross-European Quantum Competence Cluster Network** *to address fragmentation in the Union's quantum research ecosystems and improve the industrial take-up of research outcomes*

Description: Quantum Competence Clusters (QCCs) are intended to be adaptable platforms that unify research, infrastructure, and industry stakeholders. These clusters will become the backbone of "go-to places" of the EU quantum ecosystem by consolidating and providing access to quantum expertise, resources, and state-of-the-art infrastructures across Europe. A flexible, "variable geometry" approach envisaged for the QCCs accommodates Member States' existing assets and future needs, by linking activities on similar topics across regions, while also serving as localized centers uniting distinct initiatives. The QCCs will elevate quantum competencies by boosting cooperation in relevant research, creating widely accessible and transparent infrastructure entry points, and involving SMEs, startups, and other stakeholders to guide research and infrastructure development towards technological readiness. The QCCs could serve as a means of integrating the strategic threads identified by the Working Groups, depending on how the framework for their implementation evolves.

Recommendation RTI-3	**Implement a European Quantum Education and Talent Mobility Program** *to prepare a quantum-ready workforce for both academia and industry*

Description: nurture, train, attract, and retain quantum talent and professionals across Europe through a dedicated EU-wide program targeting secondary and tertiary education, master's degrees, internships, industrial placements, and exchange opportunities.

Recommendation RTI-4	**Launch a European Quantum Awareness and Outreach Initiative** *to foster informed dialogue about quantum technologies, facilitate societal readiness, promote public trust, and enabling informed policymaking and industry adaptation to quantum developments*

Description: Establish a comprehensive EU-wide Quantum Awareness and Outreach Initiative targeting industry stakeholders, policymakers, students, and the broader public.

SUMMARY OF MAIN RECOMMENDATIONS FOR INFRASTRUCTURES

Recommendation I-1	**Establish a Quantum Infrastructure Point of Contact Group** *to coordinate and align quantum infrastructures and related activities across Member States*

Description: Create a dedicated Quantum Infrastructure Point of Contact group, synchronized with the Quantum Competence Cluster network, to coordinate the Member States and EU efforts for building, maintaining, and scaling European infrastructure capabilities for quantum technologies and chip manufacturing.

Recommendation I-2	**Facilitate Broad Access to Quantum Infrastructures for Industry and Research** *to enhance innovation, interoperability, and practical industrial applications*

Description: Develop and implement ad-hoc strategies to provide extensive access for researchers and industry users (especially SMEs) to the different quantum infrastructures (EuroHPC-QCS, EuroQCI, sensing and metrology, chips). The goal is to: foster innovation through practical use cases; enable the development of collaborative ecosystems (e.g., quantum software platforms); and support common interoperability benchmarks, stimulating commercial uptake and business development. The Quantum Competence Clusters will play an important role in this respect.

Recommendation I-3	**Develop and implement a living Roadmap for European Quantum Infrastructures** *to ensure long-term operational sustainability and continuous integration of technological advancements*

Description: Create and maintain an evolving, realistic roadmap accompanied by clear timelines for developing, consolidating, and operationalizing European quantum infrastructures. This roadmap will dynamically integrate emerging technological advancements, such as the convergence of Quantum Processing Units (QPUs) with High-Performance Computing (HPC) and quantum simulators, and will adapt infrastructure services to evolving end-user demands.

SUMMARY OF MAIN RECOMMENDATIONS FOR INDUSTRIALIZATION AND STANDARDIZATION

Recommendation IS-1	**Launch a Competitive Procurement Challenge for FTQC** *to accelerate the uptake and commercial traction of fault-tolerant quantum computing (FTQC) solutions, consistently with the recommendations of the EuroHPC JU multi-annual strategic plan (MASP) for 2025-2027*

Description: Establish a substantially funded competitive (procurement) initiative specifically targeting European quantum processor companies and consortia developing FTQC technologies. The Procurement Challenge should target FTQC solutions able to address real-world applications from several industrial sectors, such as materials and life sciences. Ultimately, the Procurement Challenge should generate robust purchase interest from both private companies and public entities.

Recommendation IS-2	**Enable and Financially Support Direct EU MS Participation in Quantum Standardisation Bodies (JTC-22 and JTC-3)** *to strategically promote and safeguard European quantum interests on global standards.*

Description: Facilitate and financially support the direct participation of quantum experts from all EU Member States in European (JTC-22) and international (JTC-3) standardisation committees. Aim for a minimum of 50, ideally up to 100 participants, ensuring full representation and pre-alignment among EU MS positions. Complement this aim with EC- and JTC22-driven awareness actions targeting policymakers and industry stakeholders.

Recommendation IS-3	**Leverage National and EU Financial Institutions to Catalyse Quantum Investments** *to significantly enhance private-sector quantum investment capabilities and capacities within Europe.*

Description: Mobilize and leverage investments from national sovereign wealth funds, pension firms, national development banks, venture capital groups, and EU-level financial institutions (EIB, EIC, EIF) to significantly increase private-sector investment into quantum technologies. Provide, in collaboration with the network of quantum competence clusters, targeted quantum education and awareness programmes for lenders, capital fund providers, and equity analysts to effectively evaluate quantum opportunities, supporting informed investment decisions and maximizing the quantum IP portfolio owned within the EU.