Swiss Quantum Initiative (SQI) – Strategy for 2025-2028

Recommendations for the allocation of public funding

By the Swiss Quantum Commission (SQC)

November 29, 2023

1. Preface

This document is part of a continuous strategy process and community dialogue in the field of quantum science and technology for Switzerland, led by the SQC as an ongoing effort.

The *absolute* amounts of federal public funding for research and innovation are governed by the established processes of the Swiss Confederation and are rooted in democracy. The thematic analysis and recommendations on *relative* financial distributions in this paper are rooted in science and considerations on science-based innovation with an impact on society. The recommendations are formulated with a view along the quantum value chain, from basic scientific research to societal and industrial applications.

In this paper the SQC has formulated recommendations for the use of 83.2 MCHF over the time period of 2025 to 2028 as given in the current ERI dispatch. It should be noted that, with a view on international developments in the field of quantum, the SQC considers the currently planned level and timing of funding for this initiative as insufficient to fulfill its goals; in particular to effectively strengthen the position of Switzerland along the entire value chain and to remain competitive at an international level.

2. Summary: Enabling curiosity-driven research and innovation towards scientific breakthroughs and real-world applications

The broad field of quantum science and technology holds tremendous potential for science, the economy and society. Overall, the development of practical applications is still in an early phase and further significant advancements are expected to evolve over the next years. The groundbreaking innovations in quantum information processing, communication and sensing – along with further scientific breakthroughs - are expected to continue over multiple years if not decades.

A critical driver for further advancement of the field and a top priority for Switzerland is *curiosity driven research and innovation*, which has been a stronghold of the country over decades. Several organizations and private companies have – for good reasons – chosen to pursue "mission-oriented" technology roadmaps for their respective businesses. The SQC believes that, for Switzerland overall, additional public funds via the SQI should be mainly used towards scientific and technological breakthroughs, leading to novel and scalable applications in a broad range of quantum topic areas. The breath of research and innovation topics pursued and the associated skill base is one of the key strengths of Switzerland.

In this spirit, the SQC recommends directing significant additional resources[1] in 2025-2028 towards:

(i) Scientific research, including a substantial new research call (33% of total funding i.e. 27.5 Mio. CHF).

(ii) Targeted support for promising innovation projects, in particular driven by emerging and young enterprises in Switzerland (17% of total funding i.e. 14.1 Mio. CHF).

(iii) Shared infrastructures and platforms, in particular for applied quantum research and development, which lead to industrial innovations[2]; complementing an increasing level of private funding in Switzerland (up to 45% of total funding i.e. 37.4 Mio. CHF).

(iv) In parallel and as a foundation, outreach and education on all levels including high schools, universities of applied sciences and universities; fostering the awareness and collaboration between academic efforts and industries (resources included in (iii) in this document).

As part of this high-level plan, ca. 5% of total funding i.e. 4.2 Mio. CHF are foreseen to be used for the continuous SQI strategy process, steering of the initiative as well as national and international community dialogue including conferences and events.

In shaping corresponding support instruments, the SQC will take the increasing maturity levels of technologies and the market readiness of solutions from private companies into account, in order to direct additional public support on meaningful topic areas with a particularly high mid- to longer-term potential for Switzerland.

In all these efforts, it is vital that Switzerland stays closely connected internationally, in particular with other leading national quantum programs, efforts from world-class research institutions and high-caliber individual research and innovation groups around the globe. While the global field is evolving towards more practical applications, it is essential the Switzerland maintains a leading position as one of the most attractive countries in the world to pursue quantum research and to bring emerging innovations to life and to industrial scale.

3. Goals

The overarching goals of this national initiative have been formulated in accordance with the decision of the Federal Council of May 4, 2022 on supplementary measures in the area of research and innovation and it is assumed that these goals for 2023-2024, as stated within the Additional Protocol of September 12, 2023, shall continue to apply for 2025-2028.

(G1) This initiative serves to strengthen Switzerland's leading position in the field of quantum science and technology across the entire value chain (from fundamentals to application), to remain competitive and connectable at the international level, and to maintain a good position for international collaborations.

(G2) This overall goal shall be pursued with a view on: (i) enabling *breakthroughs in scientific discoveries* and (ii) supporting the development and implementation of *real-world applications* with significant benefits for society and a positive impact on the Swiss economy.

[1] Percentage numbers represent fractions of 83.2 Mio. CHF for 2025-2028. An overhead of 5% for the initiative is assumed within this document.
[2] Supported infrastructures need to address industry needs, in alignment and collaboration with academia (not pure scientific research infrastructures).

4. Observations and current state analysis

The following observations within past and current developments in the field of quantum form the basis for the recommendations by the SQC in this document:

(O1) Significant parts of quantum science and technology are still fields in development, with low to medium Technology Readiness Levels (TRLs). Associated with this is a medium to high degree of uncertainty regarding the technological and commercial success of *specific* solutions.

(O2) The current landscape of the so-called "quantum industry" is, as of today, still mainly focused on developing and building hardware, software and systems. There are early adopters of quantum solutions in certain sub-fields (most notably in quantum communications and quantum sensing) and companies are increasingly investing in their readiness toward applying emerging and future quantum computing applications.

(O3) Overall, global developments are mainly publicly funded, either directly via public institutions or indirectly e.g. via public-private research collaborations or supply chains. However, over the past years, private investments have been playing an increasingly larger role and are important to take into consideration for the SQI planning.

(O4) Switzerland currently holds a strong position internationally in scientific and applied research in the field, mainly funded via the Swiss National Science Foundation (SNSF). National Centers of Competence in Research (NCCRs) have been making important contributions and scientific advancements in this field go hand in hand with excellent fundamental and high-precision engineering capabilities.

(O5) In recent years, several education programs dedicated to quantum science and technology have been established, with benefits within and beyond the field of quantum.

(O6) In addition, Switzerland is home to several internationally leading (small and mid-sized) companies e.g. in quantum communication, sensing and instrumentation.

(O7) Furthermore, in mature markets there is a strong Swiss innovation landscape with high relative levels of funding, both private and public. A set of instruments to promote science-based innovation in the interest of the economy and society is available – at the forefront via Innosuisse (not a quantum-specific observation).

(O8) However, current public innovation funding instruments are not specifically targeted at requirements for deep tech innovations, including quantum technologies.

(O9) Infrastructures and platforms for quantum science and innovation are mainly organized and maintained at a local level, within individual workgroups and institutions. Examples of shared physical infrastructures and infrastructure services at larger institutions in Switzerland and through cooperations with institutions are emerging[3].

(O10) Challenging Swiss / EU relations have led to an exclusion of Swiss researchers from quantum topics of Horizon Europe. Swiss companies are facing challenges to participate in international programs and markets involving "strategic technologies" (such as quantum technologies).

(O11) In the context of global tendencies towards economic and technological self-sufficiency, several countries are prioritizing the expansion of their respective national quantum industries and are reducing dependence on global supply chains. Some Swiss companies, which are active in the field of quantum, have been taken over or have partly relocated their businesses abroad.

(O12) Investments in Deep Tech, including but not limited to quantum, play a significant role within the Swiss venture capital landscape. In several countries, government agencies and public

[3] For example: EPFL Center of MicroNano Technology (CMI), ETH Quantum Engineering Unit, EMPA, PSI Park Innovaare Cleanroom for Optics and innovation (PICO), Federal Institute of Metrology (METAS), Centre Suisse d'Electronique et de Microtechnique (CSEM)

institutions utilize public procurement for early adoption of products based on quantum technologies. So far, Switzerland does not pursue such an approach.

(O13) Currently, the SQI is weakly funded in an international comparison; other developed countries are implementing significantly larger programs (both, in terms of absolute amounts of funding and in terms of normalized (relative) funding with respect to the size of the respective economic strength, GDP).

5. Principles

(P1) Free scientific research
Free scientific research encompasses the right and responsibility of researchers to freely define research questions, choose and develop theories, gather empirical material and employ sound academic research methods, to question accepted wisdom and bring forward new ideas. While the SQI (and other thematic initiatives) is directing additional resources specifically to the field of quantum, this undisputed principle for Switzerland and the global research community shall not be interfered with.

(P2) Curiosity-driven innovation
Curiosity-driven innovation is the pursuit of scientific-based discovery driven by natural curiosity rather than strict top-down goals. It encourages researchers, entrepreneurs and companies to explore diverse ideas, make unexpected connections, and follow self-defined interests, often leading to breakthroughs. However, from a public funding perspective, not all topics and sub-fields within quantum require the same support mechanisms.

(P3) Open and liberal market environment
The private sector is the home of results-oriented development and implementation of industrial, scalable products and services. Correspondingly, investments in the competitive landscape of emerging quantum industries are led by entrepreneurs, private companies, investors and deep tech venture capitalists. As a publicly funded initiative, the SQI supports meaningful foundations e.g. in the form of infrastructures and specific support via competitive calls but it should not interfere excessively in market processes or distort private competition. In particular, the SQI does not intend to "bet on winners" in the corporate race for economic gains, neither in terms of specific products or individual companies.

(P4) Responsible innovation
Responsible innovation involves a conscientious and ethical approach to the development and deployment of new technologies. It emphasizes considering the societal, environmental, and ethical implications of innovations throughout the entire process, from conception to implementation. The goal is to ensure that technological advancements align with shared values, minimize risks, and contribute positively to society while addressing potential concerns and consequences.

6.1 Strategic recommendations

(S1) Position this initiative as a long-term effort: beyond typical policy cycles and elections and beyond short- to mid-term views of profit-oriented companies. Foster continued and increasing impact on science, society and the economy - over decades rather than years.

(S2) Focus on substantial and real developments in all parts of the value chain. Work with clear, honest and enthusiastic communication, but not contributing to some of the current "hype" regarding the field of quantum.

(S3) Support a broad range of quantum topic areas: quantum communication, quantum computation, quantum simulation and quantum sensing and metrology. Further, support work that

cuts across the above topic areas including but not limited to: materials for quantum devices, quantum control hardware, quantum theory and computer sciences.

(S4) Overall focus of additional thematic efforts and funds on the «middle ground» in the value chain (typically from TRL 2-3 to TRL 6-7): applied research and fundamental engineering to *bridge the gap* between scientific research efforts and real-world applications.

(S5) Further strengthen the research and innovation *foundations and conditions* in Switzerland ("setting the table"). Direct subsidies for individual companies are not the preferred direction. Swiss Universities of Applied Sciences (UAS) and Research & Technology Organizations (RTOs) can play important roles in building out capabilities and increasing the impact of quantum applications.

(S6) Foster shared infrastructures and platforms to strengthen shareable assets, services and skills across multiple stakeholders, both in academia and towards industrial applications.

(S7) Support the development and implementation of infrastructures and use cases for quantum technologies in science, e.g. in high energy physics: "quantum applications for science" – not just "science for quantum applications".

(S8) Foster the early adoption of solutions in the Swiss public sector and with large Swiss-based companies.

(S9) Strengthen education and workforce - from high schools, UAS to industrial PhD programs. Specific focus shall be given to application-oriented efforts such as industry PhD programs and UAS and RTO programs. With increasing size of the field and technology maturity levels, education initiatives need to be broad and inclusive, including but not limited to selected "elite" university programs.

(S10) Pursue an open Swiss Quantum Strategy Framework: encourage partnerships and guests from around the world and foster international exchange; not limited to an exclusive short-list of defined partner countries. Leverage the unique international position of Switzerland to build bridges between countries and regions, including strategic partnerships with leading high-tech nations, institutions and companies. Strengthen multilateral international processes via multiple channels[4].

These strategic recommendations (S1) to (S10) lead to distinct areas of importance for 2025-2028 for the SQI and, hence, to a high-level distribution of funding as outlined in Figures 1, 2 and in the next section.

[4] including but not limited to: Swissnex, Multilateral Dialogue on Quantum, GESDA / Open Quantum Institute (OQI), CERN, UNESCO / UN (e.g. proposed International Year of Quantum Science and Technology 2025), Swissphotonics, the World Economic Forum and Präsenz Schweiz.

Figure 1: Anticipated relative importance of *additional* public and private resources along the value chain, 2025-2028 (illustrative):

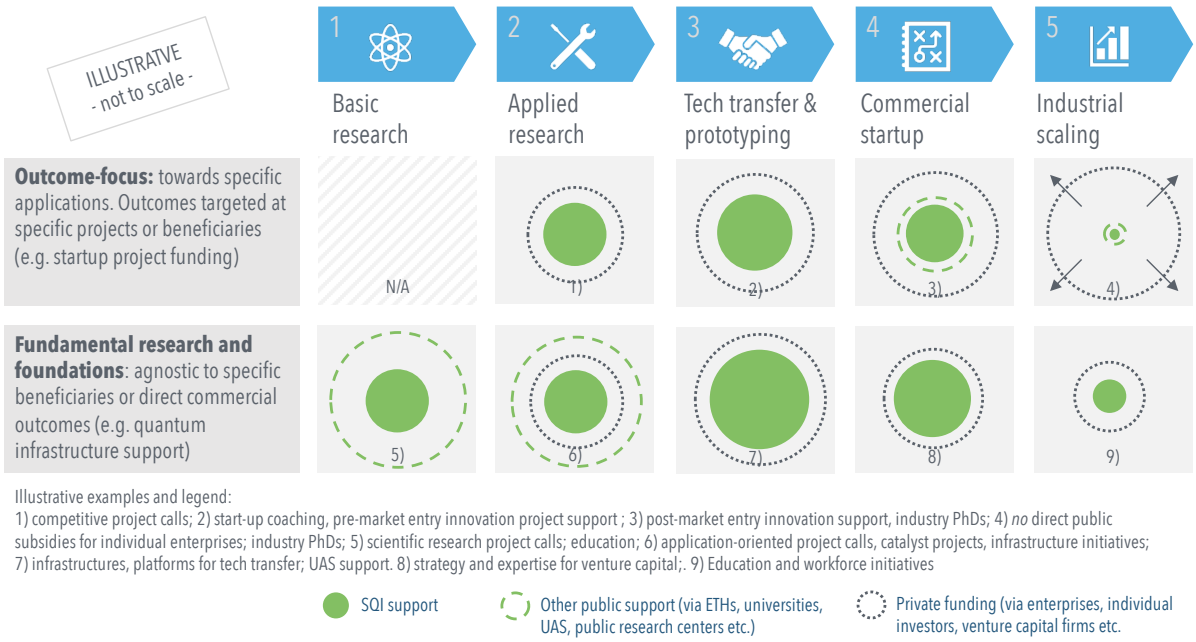
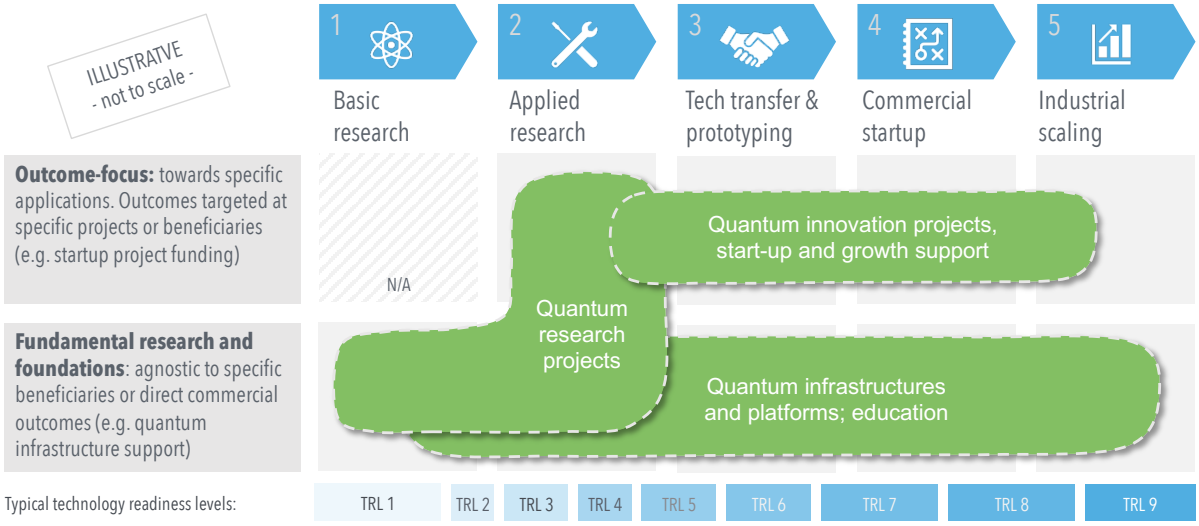


Figure 2: Scope of SQI support instruments (simplified):



6.2 Financial recommendations

(F1) Mainly regarding the implementation of measures via the SNSF.
The current Swiss Quantum Call 2024, launched in November 2023, will provide grants for a duration of 1 to 4 years. A significant new scientific research call shall be launched in 2027/28 using up to **ca. 33 %** of SQI resources for 2025-2028 (27.5 Mio. CHF). This call is foreseen to be targeted at selected quantum topic areas with high relevance for Switzerland and foster projects to stimulate further breakthroughs and national as well as international partnerships.

(F2) Mainly regarding the implementation of measures via Innosuisse.
Targeted innovations instruments in the field of quantum shall be deployed including e.g.

innovation projects (early stage without implementation partner and later stage between companies and research institutes) as well as start-up innovation projects (pre- and post-market entry) using up to **ca. 17 %** of SQI resources for 2025-2028 (14.1 Mio. CHF).

(F3) Mainly regarding the implementation of measures via SCNAT.
A significant portion of SQI funding shall be dedicated to the support of shared infrastructures and platforms at the intersection of applied research and industries. Up to **ca. 45 %** of SQI resources for 2025-2028 (41.6. Mio. CHF) are foreseen for these activities. Also included in this line item are cross-sectional tasks including but not limited to outreach, education and workforce initiatives, thematic events and conferences.

(F4) A financial overhead target of maximum 5% is foreseen for this initiative in 2025-2028 including SQI strategy work, initiative steering and communications.

Table 1: Recommended high-level SQI resource distribution for 2025-2028 (in Mio. CHF):

	2025	2026	2027	2028	**TOTAL**	%
SNSF	-	-	13.7 [2)]	13.8 [2)]	**27.5**	33%
Innosuisse	2.0 [3)]	2.0	6.0 [4)]	4.1	**14.1**	17%
SCNAT	4.0	14.0	9.1	14.5	**41.6**	50% [5)]
SQI TOTAL[1)]	**6.0**	**16.0**	**28.8**	**32.4**	**83.2**	100%

1) Given as a boundary condition for the SQI in 2025-2028 (see: ERI dispatch); basis for this document.
2) *One* SQI research project call foreseen in 2027 to combine volumes for 2027 and 2028: 27.5 Mio. CHF.
3) First SQI innovation instrument launch foreseen for 2025: 5.0 Mio. CHF (with 2.0 Mio. CHF in 2025; 2.0 Mio. CHF in 2026 and 1 Mio. CHF in 2027).
4) Second SQI innovation instrument launch foreseen for 2027: 9.1 Mio. CHF (with 5 Mio. CHF in 2027 and 4.1 Mio. CHF in 2028).
5) Mainly for quantum infrastructures and platforms; also including SQI strategy, steering and support for events and conferences.

7 Requirements for the way forward

(R1) Unified SQI effort with all stakeholders from basic scientific research to industries; not a central top-down effort.

(R2) Partnership between SCNAT, SNSF and Innosuisse with a common SQI strategy process, led by the SQC, and closely aligned communications.

(R3) Decentral operationalization of the initiative with strong regional and local players including quantum centers / hubs and a growing field of private organizations.

(R4) Financial resources from the SQI are provided *in addition to* existing research and innovation efforts (via universities, SNSF, Innosuisse etc.).

(R5) Continuous strategic reviews – based on updated observations - and possible adjustment of strategic recommendations (not a fixed one-time strategy)

(R6) Possibility for justified adjustments and shifts of financial resources between above categories (i) – (iii) along the timeline (maintaining total budgets).