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

Explanations to the "Recommendations for the allocation of public funding"

Addendum II – Priorities and proposed financial distribution

January 8, 2024

The purpose of this document is to provide explanations to the "Recommendations for the allocation of public funding" (*recommendations*) by the Swiss Quantum Commission (SQC) from November 29, 2023. Specifically, this document elaborates on the rationale for the recommended priorities in 2025-2028 and the proposed financial distribution.

It has to be noted that the SQC recommendations are the result of a thorough dialogue within the commission[1] and with key representatives from the quantum science research and innovation communities as well as dedicated workshops with industry stakeholders[2], financial investors and ecosystem players[3]. The *recommendations* refer to the best use of *additional and targeted* support in the field of quantum science and technologies.

Four main fields of action are to be prioritized, in line with the mandate and goals of this initiative: (i) scientific research, (ii) innovation, (iii) infrastructures[4], platforms[5], and (iv) education and workforce.

For all fields, the SQI funding is to be considered as *additional* support, as an "add-on", to the established quantum research and innovation landscape. It is important to note that the recommendations for "infrastructures" are focused on *shared* assets or services.

The recommended financial distribution among the four fields of action is based on thirteen key observations as well as ten guiding strategic recommendations[6]. In essence they conclude:

- Given the overall state of scientific and early commercial developments in the field of quantum, the key theme for the SQI in the upcoming years, which is recommended by the SQC, is to enable **curiosity-driven research and innovation** towards scientific breakthroughs and real-world applications. This requires the design and the implementation of specific support

[1] Including individual qualitative and quantitative views on priorities and resources from each SQC member in written form; subsequent aggregation in joint working meetings.
[2] May 26, 2023, SQC meeting including industry representatives.
[3] October 27, 2023, SQC meeting including private investors and ecosystem builders.
[4] Infrastructures for quantum (short: infrastructures) are understood to be facilities, resources and services that are established specifically for technology transfer and innovation purposes, are made available on a medium- or long-term basis, and require specific competencies for their proper establishment, operation and use. They are not used exclusively by individuals or groups, but are open – at a minimum - to a specialist community (academic and industry).
[5] Quantum platforms (short: platforms) are understood to be application-oriented architectures which are based on one or more specific quantum systems such as e.g. superconducting circuits, trapped ions, ultracold atoms or electron spins. Platforms typically contain several technical layers including physical hardware, controls, information processing via dedicated software and user interface.
[6] See "Recommendations for the allocation of public funding" of the SQI, 29 November 2023

instruments in *all four* fields of action (i) to (iv). A selective focus would fail the overall aspirations of the initiative.

- With a view on the enormous potential of quantum technologies and the complexity of the scientific and engineering challenges, this initiative must be set up as a **long-term effort**[7]. To this end and mirroring similar approaches in Switzerland and other nations across various scientific disciplines, investments in infrastructures and education are among the best - if not the best - mode of public support. Given the current scientific and technological developments in the field of quantum technology, this justifies an above average proportion of the budget for the corresponding fields of action.
- Concerning infrastructures, today, individual facilities, assets and services for quantum research and innovation are mainly used by individual research groups or projects. Some longer-term cooperations and respective **sharing of infrastructures and platforms** are emerging, but the present fragmentation of efforts represents a serious gap in the current quantum landscape. Actively addressing this gap in the coming years is particularly important in a relatively small country like Switzerland, that cannot benefit from economies of scale as many other larger nations. Compare: observation (O9).
- Focus on **foundations** in particular infrastructures; not on direct subsidies. This is usually referred to as "setting the table" for research and innovation and, again, can be most effectively achieved in the field of action infrastructures / platforms. Platforms – by their very nature – may also be shared. Compare: recommendation (S5).

Given the different characteristics of the four fields of action and based on thorough discussions with the respective stakeholder groups, minimum amounts for meaningful and effective instruments have been derived. Additional impulses for (iv) education and workforce are partly related to shared infrastructures and platforms and are expected to receive smaller amounts of additional federal funding. This leads to a reasonable financial distribution as outlined below:

(i) **Scientific research** will remain a key element for reaching the SQI goals. Indeed, fundamental and more technology-oriented research are the basis for any meaningful innovation and application. As a complement to the on-going quantum research funding by several cantonal universities and in the ETH-Domain, as well as the general SNSF project funding – also serving the quantum community – the SNSF, on recommendation by the SQC, already launched a new quantum research call in the frame of the SQI (the "Swiss Quantum Call 2024"; total 16 Mio. CHF). Based on previous experience it is the view of the SQC, that roughly 25 to 30 Mio CHF, starting in 2027, will be required for a significant new call for scientific research projects. A new call in 2027/28 seems like the best compromise in terms of implementation speed and availability of funds.

Hence, a third of the total budget is considered optimal for field (i) in this time span, equivalent to an amount of 27.5 Mio. CHF. This is to be understood as additional, specific funding assuming the continuation of quantum research support by the various institutions in Switzerland (universities and ETHs) and by a fair share of SNSF project funding. The fact that a new quantum research call has been launched at the end of 2023, has also been taken into account ("Swiss Quantum Call 2024"; total 16 Mio. CHF with a project duration of 1 to 4 years).

(ii) **Innovation and tech transfer** is an ultimate goal of the SQI and needs essential support. It is the view of the SQC that – in particular in its early stages – innovation can be supported with relatively modest financial support *per case* (per innovation idea, per project or per start-up in the *pre-market* phase). Technology transfer and innovation projects without an

[7] NB: individual research themes will, naturally, continue to vary over time and topics with breakthrough-character are still difficult to predict. Examples: shorter-term quantum computing with "noisy" qubits versus fault-tolerant strategies; specific choices and possible combinations of different physical qubit families; pure quantum versus hybrid quantum-classical approaches for algorithms etc.. Compare: recommendation (S1).

implementation partner may benefit from support starting at meaningful grant sizes of a few hundred thousand CHF. With increasing maturity, the meaningful minimum amounts per innovation project / per case will grow (e.g. in the range of 0.5 to 1.5. Mio. CHF and increasingly larger in a subsequent phase). Given the ERI boundary conditions and, more importantly, the liberal market environment with a "lean state" model and the importance of private venture capital, direct industrial subsidies are not foreseen.

A single digit number of new and relevant startups per year in Switzerland may be expected. Hence, roughly a sixth of the total budget is considered adequate for field (ii), equivalent to an amount of 14.1 Mio. CHF for 2025-2028. Innosuisse has experience in funding promising startups over many areas. This initiative, however, is a new, specific effort for *quantum* technologies and it is clear, that certain subject-specific competencies in orchestrating a call need to be built up first.

(iii, iv) **Infrastructures and platforms** are essential to support the two other fields of action, especially to address the gap, between fundamental research and industrial applications. As can be observed in other scientific fields and industries, infrastructures and platforms usually require substantially higher budgets. This is linked to their long-term aspect and is particularly true for the ambition to consistently handle physical systems on an individual quanta level *at scale* (e.g. involving superconducting setups at low temperatures, systems to control individual atoms, clean room facilities for fabrication or testing, optical fiber networks etc.).

Meaningful minimum sizes for infrastructure support fall into one of the two following categories:

- Enhancing the **utilization and effectiveness of existing infrastructures** towards a stronger sharing model, know-how transfer and exchange. This is foreseen to be addressed by the introduction of a "voucher model" with voucher sizes starting at e.g. 50'000 CHF (or even less). With a few dozen research and innovation groups / alliances active in Switzerland, the setup and roll-out of a voucher model would require, at a minimum, ca. 2 to 4 Mio. CHF.
- A reasonable **extension of infrastructures and the build-up of new facilities**, however, will require much larger investments, typically of the order of 10 Mio. CHF or above per topic area or facility (examples include extensions to low-temperature facilities and control systems for superconducting qubits; efficient materials or qubit testing facilities; upgrades or extensions to clean-room facilities with a substantial impact on innovation processes; high-end metrological or standardization facilities and services).

Last but not least: investments in shared quantum infrastructures and platforms are a valuable impulse for **education and workforce** development e.g. for quantum courses with on-site learning components in real labs. Also, the funding gap for quantum research at Universities of Applied Sciences may be partly "bridged" by fostering infrastructure developments. The SQC assumes that of the order of four to six infrastructure / platform themes can be supported by the SQI in 2025-2028. Hence, roughly half of the total budget will be necessary for fields (iii) and (iv) equivalent to an amount of 41.6 Mio CHF. A smaller part of this volume, to be determined, is specifically earmarked for educational and workforce purposes.

For all categories, it has to be noted that some projects (or funding instruments) might turn out to not fully meet their expectations. It is therefore important to keep flexibility to adapt to the evolving situation. Since Switzerland has already reached a high technological level, any increments have to be substantial to have impact towards the overarching goal of the SQI. Moreover, the Swiss facilities/platforms have to "compete" with other initiatives worldwide in countries with substantial larger central budgets and/or a more top-down approach to drive quick implementations.