

# Switzerland: A Hub for Quantum



Switzerland maintains a world-class quantum ecosystem bolstered by its top-flight universities and research centers, its leading innovation economy, and its deep international connections.

## **World-Class Quantum Science**

Switzerland, despite its small size, produces world-class quantum science, boasting the highest impact factor for quantum research publications of any country in the world. It was an early pioneer in the field, having established four quantum-focused National Centers for Competence in Research (NCCRs) – in nanoscience, quantum photonics, quantum science, and spin qubits – since 2001. This investment in research has helped attract over 30 new professors to top-flight universities like ETH Zurich, EPFL, the University of Basel, and the University of Geneva.

## **Broad Excellence**

Switzerland's research success extends across most major quantum subfields, bringing broad excellence to its quantum technology ecosystem. In addition to well-regarded research into superconducting qubits, trapped ions, ultracold atoms, and spin qubits for computing, Swiss researchers are renowned for their work on quantum communications, sensing, and photonics. Extensive research on quantum theory, simulation, and algorithms round out this broad spectrum of expertise.

## **Pioneering Startups**

Thanks in large part to academic discoveries, Switzerland maintains a robust quantum

innovation sector. Pioneering startups such as ID Quantique and Zurich Instruments have grown into essential suppliers in the global quantum value chain. Many younger Swiss companies, bolstered by Swiss engineering excellence, are emerging with particular strengths in quantum microscopy and measurement, as well as enabling technologies such as photonics and precision nanomanufacturing.

## **International Engagement**

The Swiss quantum ecosystem has always been internationally engaged, featuring among the highest rates of international co-authorship in quantum science. Organizations like CERN and the Geneva Science Diplomacy Anticipator (GESDA) are working to ensure that quantum technologies have broad benefits for the global scientific community and societies at large.

## **National Coordination**

While it has long favored bottom-up energy over top-down strategy, the Swiss quantum ecosystem is gaining more centralized coordination. In 2022, the Federal Council mandated a new Swiss Quantum Initiative to build a framework for research calls, coordinate infrastructure, develop curricula, and strengthen international partnerships. This complements regional clusters such as the Switzerland Innovation network of public-private innovation parks and the uptownBasel innovation campus.

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# Swiss Quantum By Numbers

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- There have been **four** quantum science national research centers founded since 2001 (nanoscience, quantum photonics, quantum science, spin qubits) each funded with approximately **CHF 50M**.
- Swiss research publications in quantum have the **highest relative impact** factor of any country in the world for the 2016–2020 period.
- Switzerland is ranked among the **top 10** countries for venture capital and private equity investments in quantum startups in 2022, and in the **top 15** for the number of quantum startups in 2022.
- From 2016 to 2020, **89% of quantum publications** from Switzerland featured international collaborators.
- In May 2022 the Swiss Federal Council announced new funding measures and the creation of the Swiss Quantum Initiative, with a planned initial investment of **CHF 80M**.
- The private initiative QuantumBasel is investing **\$500M** to create a major European quantum computing hub, and has signed deals with IBM, D-Wave, and IonQ.
- Switzerland has been ranked **#1 in the world in innovation** by the World Intellectual Property Organization for 13 consecutive years.
- QS World University Rankings 2024 ranked ETH Zurich the **7th best university in the world**.

# What's the Hype About Quantum?

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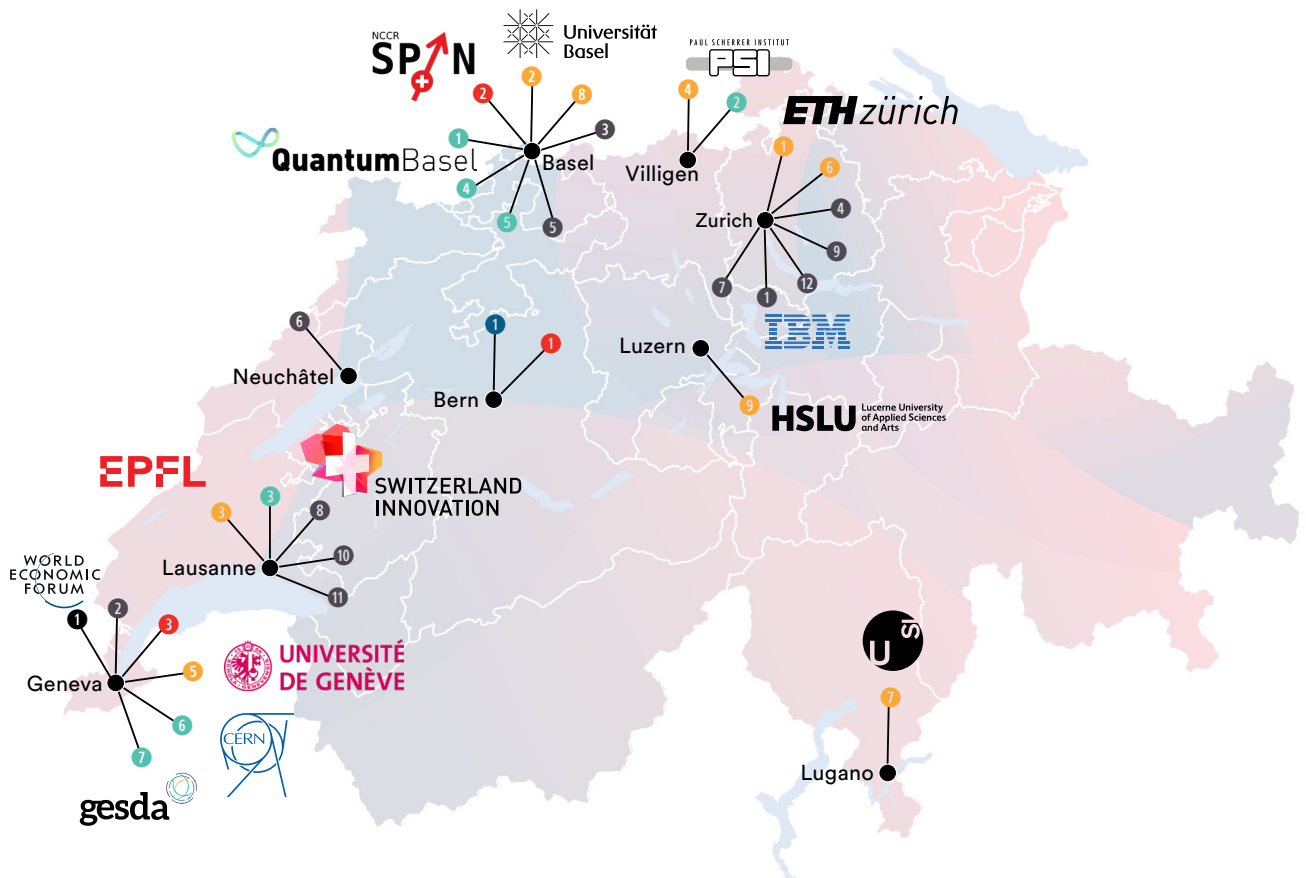
At the smallest scales of the known universe, the laws of classical mechanics break down. Over the last century, physicists have uncovered the mind-boggling principles that define this quantum realm, which has allowed us to develop technologies like lasers, MRI scanners, and GPS. Now we stand at the verge of a second quantum revolution, which seeks to engineer computers, sensors, and other technologies that harness the information conveyed by quantum systems. This revolution could transform both scientific discovery and key technologies just as radically as the classical computing revolution. McKinsey & Company has estimated the quantum technology market could be worth over \$100B by 2040.

But fundamental scientific and engineering hurdles remain. It's still unproven if a universal quantum computer can achieve a useful advantage over classical supercomputers. Even with this uncertain future, technologists, companies, and governments are eager to push for a first-mover advantage. This has created pockets of hype around quantum.

Switzerland is well positioned to persist through any hype cycles and remain a leading ecosystem. Its strengths reside in bottom-up collaboration, long-term commitment to research, world-class universities, and cutting-edge engineering. Switzerland maintains particular strength in quantum sensing, which builds off its rich expertise in precision measurement and is already offering useful real-world advantages.

# Swiss Quantum Ecosystem

While it is impossible to depict the entire Swiss quantum ecosystem, this map highlights some of the major centers, companies, and initiatives that are driving forward quantum research and innovation in Switzerland. Learn more about key centers and initiatives.



## National Initiatives (Headquarters)

- 1 Swiss Quantum Initiative
- 2 NCCR SPIN
- 3 NCCR SwissMAP

## University Centers and Research Hubs

- 1 The Quantum Center at ETH Zurich
- 2 The Basel Quantum Center at University of Basel
- 3 The Center for Quantum Science and Engineering (QSE) at EPFL
- 4 The ETHZ-PSI Quantum Computing Hub
- 5 The Quantum Center at University of Geneva
- 6 Swiss Federal Laboratories for Materials Science and Technology (EMPA)
- 7 Università della Svizzera italiana (USI)
- 8 University of Applied Sciences and Arts Northwestern Switzerland (FHNW)
- 9 Lucerne University of Applied Sciences and Arts (HSLU)

## Ecosystem Builders and Accelerators

- 1 Switzerland Innovation Park Basel
- 2 Switzerland Innovation Park Innovaare
- 3 Switzerland Innovation Park West EPFL
- 4 QuantumBasel

## 5 QAI Ventures

## 6 CERN

## 7 The Geneva Science and Diplomacy Anticipator (GESDA)

## Private Companies and Centers

- 1 IBM Research
- 2 ID Quantique
- 3 Basel Precision Instruments
- 4 Zurich Instruments
- 5 Qnami
- 6 Swiss Center for Electronics and Microtechnology (CSEM)
- 7 Swissphotonics
- 8 Miraex
- 9 QZabre
- 10 Ligentec
- 11 Enlightra
- 12 Sensirion

## Government

- 1 Swissnex HQ

## Other

- 1 World Economic Forum (WEF)

## National Initiatives

### 1. Swiss Quantum Initiative (SQI)

The Swiss Quantum Initiative, which began operations in 2023, works to solidify Switzerland's place among leading nations in quantum information science and technology (QIST) by coordinating activities at a national level. The Initiative is led by the newly formed Swiss Quantum Commission (SQC) composed of experts from the field, and is hosted at the Swiss Academy of Sciences (SCNAT). The Commission is tasked with defining frameworks for research calls, supporting infrastructure developments, promoting curricula, and strengthening international partnerships. The SQC works closely with the Swiss National Science Foundation (SNSF), Innosuisse, and the wider research and innovation communities.

### 2. NCCR SPIN

The National Center for Competence in Research (NCCR) SPIN develops reliable, fast, compact, scalable spin qubits in silicon. The NCCR SPIN team consists of researchers from the University of Basel, IBM Research – Zurich, ETH Zurich, and EPFL. The team members come from several disciplines, including quantum physics, materials science, engineering, and computer science. NCCR SPIN is designed to promote close collaboration between theory and experimentation, and between academia and industry.

### 3. NCCR SwissMAP

SwissMAP is a National Center of Competence in Research in the mathematics of physics. Currently seven universities, CERN, and over 200 researchers are part of SwissMAP. Two of the Center's phase III research directions focus on topics with quantum applications.

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## University Centers and Research Hubs

### 1. The Quantum Center at ETH Zurich

Launched in 2020, the Quantum Center at ETH Zurich encompasses 34 research groups from six departments. It interconnects quantum research and teaching across ETH departments, and serves as a contact point for larger projects, including collaborations with industrial partners and funding through Swiss and international grant agencies, as well as donations. The Center also helps to support ETH Zurich's interdisciplinary Master's Degree in Quantum Engineering.

### 2. The Basel Quantum Center at the University of Basel

The Basel Quantum Center comprises 15 research labs at the University of Basel, focused broadly on condensed matter, atomic, molecular, and optical systems. A subset of these researchers are also involved in the affiliated Center for Quantum Computing and Quantum Coherence (QC2), which is focused on determining if a scalable quantum computer is allowed under realistic conditions by the laws of nature. The Quantum Center also supports a cross-border postdoc cluster in collaboration with the Albert-Ludwigs University in Freiburg, Germany.

### 3. The Center for Quantum Science and Engineering at EPFL

The Center for Quantum Science and Engineering (QSE Center) at the Swiss Federal Institute of Technology in Lausanne (EPFL) serves as the school's research and teaching hub for all quantum efforts. The Center promotes research through collaborative grants, multidisciplinary education, and innovation. Its key focus areas are applied quantum algorithms and data science, along with quantum hardware materials and systems. The Center also helps to support EPFL's new Master's Degree in Quantum Science and Engineering.

### 4. The ETHZ-PSI Quantum Computing Hub

The ETHZ-PSI Quantum Computing Hub was established in May 2021 as a joint center for the development of quantum computers. It brings together the resources of ETH Zurich with the Paul Scherrer Institute (PSI), the largest research institute for natural and engineering sciences in Switzerland. The Hub's central aim is to target the technical and scientific challenges on the way to realizing large-

scale quantum computers based on both superconducting circuits and trapped ions.

### 5. The Geneva Quantum Centre at the University of Geneva

The Geneva Quantum Centre at the University of Geneva brings together around 20 research groups building on a tradition of pioneering research in quantum sciences, most notably in quantum communications, quantum sensing, quantum materials, and in the theoretical foundations of these domains. It targets broad education programs for the general public, schools, and the training of engineers, and has launched new Bachelor and Masters programs. It is also working with industry and other quantum actors in the region to synergize the local quantum ecosystem.

### 6. EMPA

The Swiss Federal Laboratories for Materials Science and Technology (EMPA) is a research institution established in 1880. Today it mainly focuses on interdisciplinary research on materials and technologies, especially those promising a more sustainable future. One of their research focus areas is explicitly targeting quantum devices.

### Other Institutions

The University of Lugano (USI) features a group dedicated to cryptography and quantum information. The University of Applied Sciences and Arts Northwestern Switzerland (FHNW) has a focus on applied quantum computing for the life sciences and photonics. The Lucerne University of Applied Sciences and Arts (HSLU) hosts research on quantum cryptography in practice and on applications for computing in the finance sector. These schools, and many others, are working to train the next generation of quantum-ready engineers, programmers, and technicians.

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## Ecosystem Builders and Accelerators

*Switzerland Innovation is a nationwide public-private initiative dedicated to empowering quantum companies by providing essential resources and support to facilitate their growth. Their Innovation Parks offer state-of-the-art facilities and a comprehensive array of services tailored to nurture quantum enterprises and foster strategic partnerships. Through collaborations with global firms and top Swiss universities, they drive the development of cutting-edge, market-ready solutions poised to transform industries. Three key locations focus on quantum innovation.*

### 1. Switzerland Innovation Park Basel Area

Nestled in a thriving quantum ecosystem, this park is closely connected to the academic excellence of the University of Basel, the leading house behind NCCR SPIN. At the core lies the Basel Quantum Center, a dedicated research hub for quantum technology. Covering a wide spectrum, from condensed matter to atomic, molecular, and optical systems, this center stands at the forefront of advancements in quantum computing, sensing, metrology, communication, and simulation. Additionally, the park offers unrivaled access to the University of Applied Sciences Northwestern Switzerland, renowned for applied quantum computing and hybrid AI algorithms in life sciences. The region is also home to QuantumBasel, a prominent platform to connect industry with the world's best quantum computers, and to QAI Ventures, a quantum incubator with CHF 50M in capital, dedicated to nurturing startups.

### 2. Switzerland Innovation Park Innovaare

Strategically co-located with the Paul Scherrer Institute (PSI), this park is a dynamic epicenter for cutting-edge developments in energy & climate, health innovation, fundamental sciences & future technologies in materials, micro & nanotechnologies, and quantum. PSI's state-of-the-art large research facilities, including the renowned Swiss Light Source and Swiss Free Electron Laser, provide an ideal setting for material characterization and quantum materials research. Within this vibrant ecosystem, you'll find unparalleled expertise in quantum technologies, detector design,

electronics, cryogenics, integrated photonics, and materials characterization. Notably, the ETHZ-PSI Quantum Computing Hub is situated on the PSI campus. It's a place where groundbreaking ideas meet state-of-the-art facilities.

### 3. Switzerland Innovation Park Network West EPFL

Located in western Switzerland, this park thrives on close collaboration with the prestigious EPFL, home to the Center for Quantum Science and Engineering (QSE Center), a hub fostering cross-disciplinary research, education, and innovation in quantum science and engineering. EPFL's quantum education programs attract students and researchers eager to enhance their expertise. Domains of strength include computer and communication sciences, quantum science and technology, data science, learning, photonics, optoelectronics, and quantum optics. The region also hosts the European Organization for Nuclear Research (CERN) and its Quantum Technology Initiative (QTI). The QTI explores quantum's transformative potential in particle physics and beyond, collaborating with member states and stakeholders. Other scientific institutions, such as the University of Geneva and the Swiss Center for Electronics and Microtechnology (CSEM) complete the array of expertise in the field.

### 4. QuantumBasel

QuantumBasel is Switzerland's first commercial quantum center, embedded in the uptownBasel innovation campus and specializing in quantum computing and artificial intelligence. The center of competence provides seamless access to world-leading quantum systems and high-performance computing via a purpose-built platform for enterprises, research institutes, startups, and universities. QuantumBasel's team includes quantum and data scientists that collaborate with organizations in financial services, industrial manufacturing, life sciences, and logistics, enabling them to accelerate their quantum research or take the first steps with the technology. This includes proof-of-concept projects focused on quantum applications as well as education programs.

### 5. QAI Ventures

QAI Ventures is a quantum-focused investor and startup accelerator, based in the innovation ecosystem of uptownBasel. With the overall goal to support building a strong global quantum ecosystem, they build around startups and offer privileged access to state-

of-the-art quantum hardware and services, tailored mentoring, cash grants, and most importantly orchestrated connections to partners in the ecosystem.

### 6. CERN

The CERN Quantum Technology Initiative (QTI) is an international research program exploring how quantum technologies can serve high-energy physics, as well as societies more broadly. Through the QTI, CERN is disseminating enabling technologies such as quantum state sensors and time synchronization protocols. The QTI is also building an academia–industry training programme to accelerate the building of new competencies in quantum technologies, from the high school to senior researcher level. CERN is also a key organizer of World Quantum Day.

### 7. The Geneva Science and Diplomacy Anticipator (GESDA)

The Geneva Science and Diplomacy Anticipator (GESDA) has made quantum technologies into one of its key focus areas. Its radar tracks predicted trends in quantum computing, communication, and sensing on five, ten, and twenty-five year time horizons. Working with leading scientists, GESDA is also anticipating use cases for quantum technologies to reach the UN sustainable development goals (SDGs), and is planning a competition in collaboration with XPRIZE to democratize quantum computing. In October 2023 GESDA launched the Open Quantum Institute to be hosted at CERN.

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# Private Companies and Centers

## 1. IBM Research

Zurich hosts one of IBM's 12 global research labs and represents their European site. While representing many of IBM's research interests, the Zurich hub maintains a strong focus on the manufacturing of silicon spin qubits for quantum computing.

## 2. ID Quantique

Headquartered in Geneva, ID Quantique is a global company with offices and engineering labs across the world. They are a leading company for mature technologies in quantum key distribution (quantum-safe cryptography), random number generation, and photonic sensing.

## 3. Basel Precision Instruments

Basel Precision Instruments is a leading provider of ultra-low noise electronics and cryogenic microwave filters & thermalizers. By unlocking new measurement possibilities, they enable innovators to explore new frontiers of quantum computing and quantum science.

## 4. Zurich Instruments

Zurich Instruments was founded as an ETH Zurich spin-off in 2008 and has since developed into a leading global manufacturer of quantum computing control systems. They provide state-of-the-art laboratory equipment, including lock-in amplifiers, waveform generators, and impedance analyzers.

## 5. QNami

Qnami is a venture capital-backed company working on highly sensitive quantum sensors to measure magnetic fields on an atomic scale. They have created the first scanning nitrogen-vacancy system, which makes possible high precision imaging.

## 6. Swiss Center for Electronics and Microtechnology (CSEM)

The Swiss Center for Electronics and Microtechnology (CSEM) is a public-private, non-profit Swiss microtechnology innovation center. They focus on precision manufacturing, digitalization, ultra-low-power electronics, photonics, AI, and sustainable energy. Their quantum research mainly focuses on vapor cell based atomic clocks, including the fabrication of MEMS cells and PICs for chip-scale atomic clocks, and on other quantum sensors.

## 7. Swissphotonics

Swissphotonics is a non-profit association

promoting the competitiveness of its members through innovation activities and support. Many Swiss photonics companies are active in quantum and provide essential technologies to the quantum research and innovation sectors in Switzerland and globally.

## 8. Miraex

Miraex is a company focused on developing quantum interconnects for distributed quantum computing and quantum communication applications. Miraex quantum interconnects link microwave and optical frequency domains, allowing exponential scale-up of quantum processing units via optical interconnectivity, and quantum entanglement distribution on future quantum networks.

## 9. QZabre

QZabre is an ETH Zurich spin-off working on nitrogen-vacancy technologies. They specialize in high-precision scientific instruments like nitrogen-vacancy scanning tips and quantum scanning microscopes, and have designed quantum confocal scanning microscopes.

## 10. Ligentec

Ligentec is an EPFL spin-off which delivers low-loss photonic integrated circuits, based on a silicon nitride-core technology. Applications include quantum computing, telecommunications, and sensing. In addition to their headquarters in Lausanne, they have a subsidiary close to Paris.

## 11. Enlightra

Enlightra (formerly MicroR Systems) is a startup that emerged out of EPFL and the NCCR Quantum Science and Technology (QSIT). They focus on low-noise microwave generation, satellite up- and downlinks as well as quantum laser sources.

## 12. Sensirion

Sensirion, a global company headquartered in Switzerland, works on smart sensing solutions. They recently acquired IRSweep, an ETH spin-off which developed a semiconductor quantum cascade laser frequency comb in mid-infrared.

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## Government

### 1. Swissnex HQ

Swissnex is the Swiss global network connecting Switzerland and the world in education, research and innovation. Our mission is to support our partners' outreach and active engagement in the international exchange of knowledge, ideas and talent. Swissnex is an initiative of the State Secretariat for Education, Research and Innovation and is part of the Confederation's network abroad managed by the Federal Department of Foreign Affairs. The activities of Swissnex are based on a collaborative approach, relying on public and private partnerships and funding.

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## Other

### 1. World Economic Forum

The World Economic Forum (WEF) has developed the Quantum Economy Network, a global platform for governments, business and academia. Supported by the WEF's Global Future Council on the Future of the Quantum Economy, the network utilizes partners and quantum fellows to leverage the efficiencies of collaboration and shared learning, with the goal of shaping the development of quantum technology and preparing for the quantum economy.

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## Get in Touch

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To understand how the Swiss quantum ecosystem could serve your needs, or to be connected with specific organizations or initiatives, reach out to Swissnex.

Contact Brendan Karch, Swissnex in Boston and New York

### Sources & further reading

1. Bibliometric analysis of scientific publications in Switzerland
2. Targeted measures to further consolidate Switzerland's position as a location for research and innovation
3. McKinsey Quantum Technology Monitor, April 2023
4. The Swiss Quantum Report from 2017 Issued by members of the then active NCCR QSIT.
5. The White Paper on Quantum Technologies in Switzerland issued by the Swiss Science Council in 2020