OQI
Open Quantum
Institute

The Open Quantum Institute, a multilateral governance initiative for quantum computing

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Geneva Science and
Diplomacy Anticipator Foundation

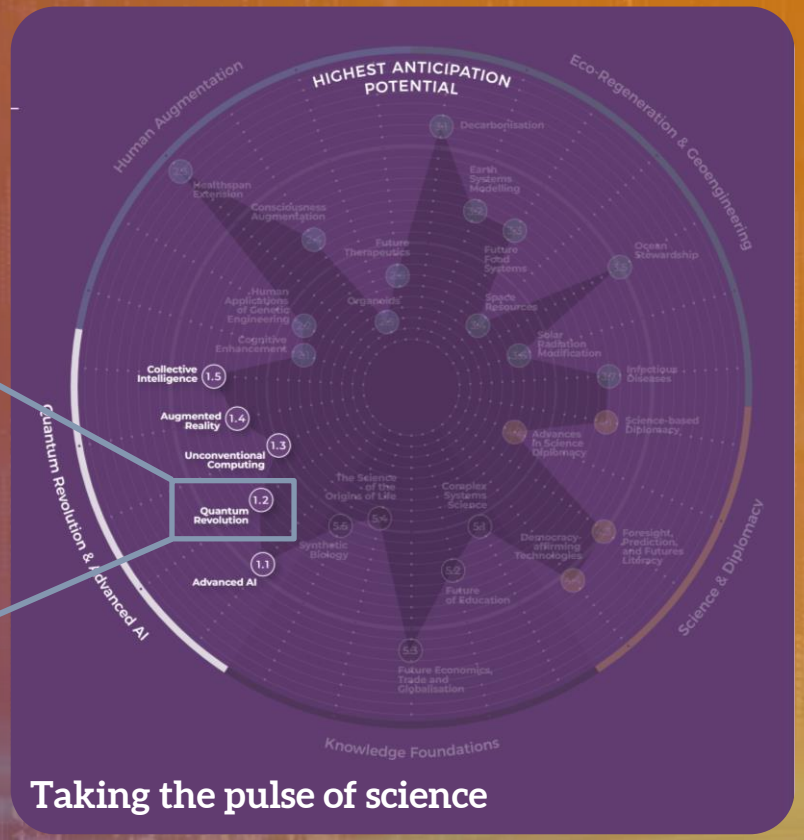
Why the Open Quantum Institute?

1.2 Quantum Computing has *great transformative potential*

Applications that benefit humanity?

Global divides?

How can bring academic, industry, diplomacy and education leaders together?



Taking the pulse of science

The Science Breakthrough Radar

The GESDA Science Breakthrough Radar® aims to identify emerging research and map major science advances at 5, 10 and 25 years. Those advances will potentially have a significant impact on who we are as humans, how we are going to live together and how we can ensure the sustainability of our planet.

The OQI is a **multilateral governance initiative**, bringing together academia, industry, diplomacy and education to promote **global and inclusive access to quantum computing** and the development of **applications for the benefit of humanity**.

OQI
Open Quantum Institute

An initiative hosted by CERN, born at GESDA, supported by UBS

Outline

1 GESDA approach and establishment of the OQI

2 4 "A"s

Accelerate applications

Access

Advancing capacity

Activating governance

Examples

- OQI use case teams
- Industry partnerships
- Education consortiums
- Hackathons
- Diplomacy Game
- Quantum intelligence report

Anticipating scientific breakthroughs

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The GESDA approach: Use the future to build the present

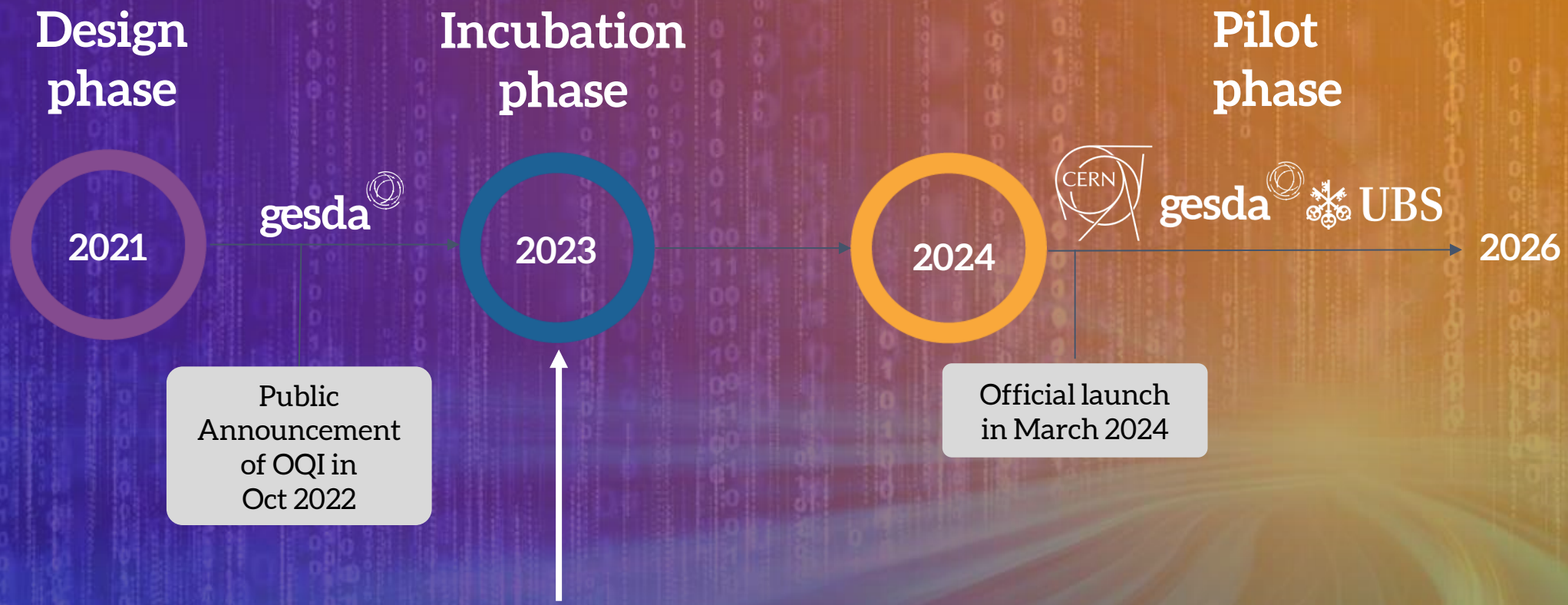
Quantum Computing, a technology with great transformative capability, requiring a science and diplomacy mobilization to ensure global access and benefits.

Ensure equitable access to the technology and progresses for the benefit of humanity

- Science to accelerate sustainable development
- Policymakers to think upstream about the impact of scientific and technological progress on society

Anticipation of future developments › **Acceleration of the dialogue between science, diplomacy, philanthropy and society** › **Translation of opportunities into action**

The OQI Journey



Involvement of **permanent representations in Geneva:** Australia, Austria, Brazil, Chile, Czech Republic, Egypt, France, India, Israel, Italy, Japan, Malta, Mexico, Morocco, the Netherlands, Pakistan, Singapore, Slovenia, Switzerland, UK, US

The OQI Incubation Partners

OQI Open Quantum Institute

Our incubation partners helped us grow OQI from a concept to reality, with many in the process of formalising their engagement to become partners during our pilot phase.

Academia

- Bibliotheca Alexandrina
- Quantum Delta the Netherlands
- University of Copenhagen
- ETH zürich
- RRI
- XPRIZE
- NYU Abu Dhabi
- EPFL
- Imperial College London
- NITheCS
- JÜLICH Forschungszentrum
- CERN
- Université de Genève
- University of Calgary
- University of KwaZulu-Natal / Inyuvesi YaKwaZulu-Natali

Industry

- AQT
- PASQAL
- IQM
- IBM Quantum
- NVIDIA
- aws
- Microsoft
- OQC

Diplomacy

20+ permanent representations in Geneva

- UN Habitat
- Periodic Table of Food Initiative
- UNFCCC
- SDG Lab
- gain
- WIPO
- Comité International Genève
- World Health Organization
- ICRC

Impact

- WHO Foundation
- Fondazione Compagnia di San Paolo
- XPRIZE

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Strategic Pillars of the Open Quantum Institute

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A1 Accelerating applications for humanity

Realising the full potential of quantum computing by **accelerating use cases geared towards achieving the SDGs**, thanks to the combined forces of researchers and developers, entrepreneurs, the United Nations, and large NGOs.

A2 Access for all

Providing **global, inclusive and equitable access to a pool of public and private quantum computers** and simulators available via the cloud

A3 Advancing capacity building

Developing **educational tools to enable everyone around the world** to contribute to the development of quantum computing and make the most of the technology.

A4 Activating multilateral governance for the SDGs

Providing a **neutral forum to help shape multilateral governance of quantum computing** for the SDGs

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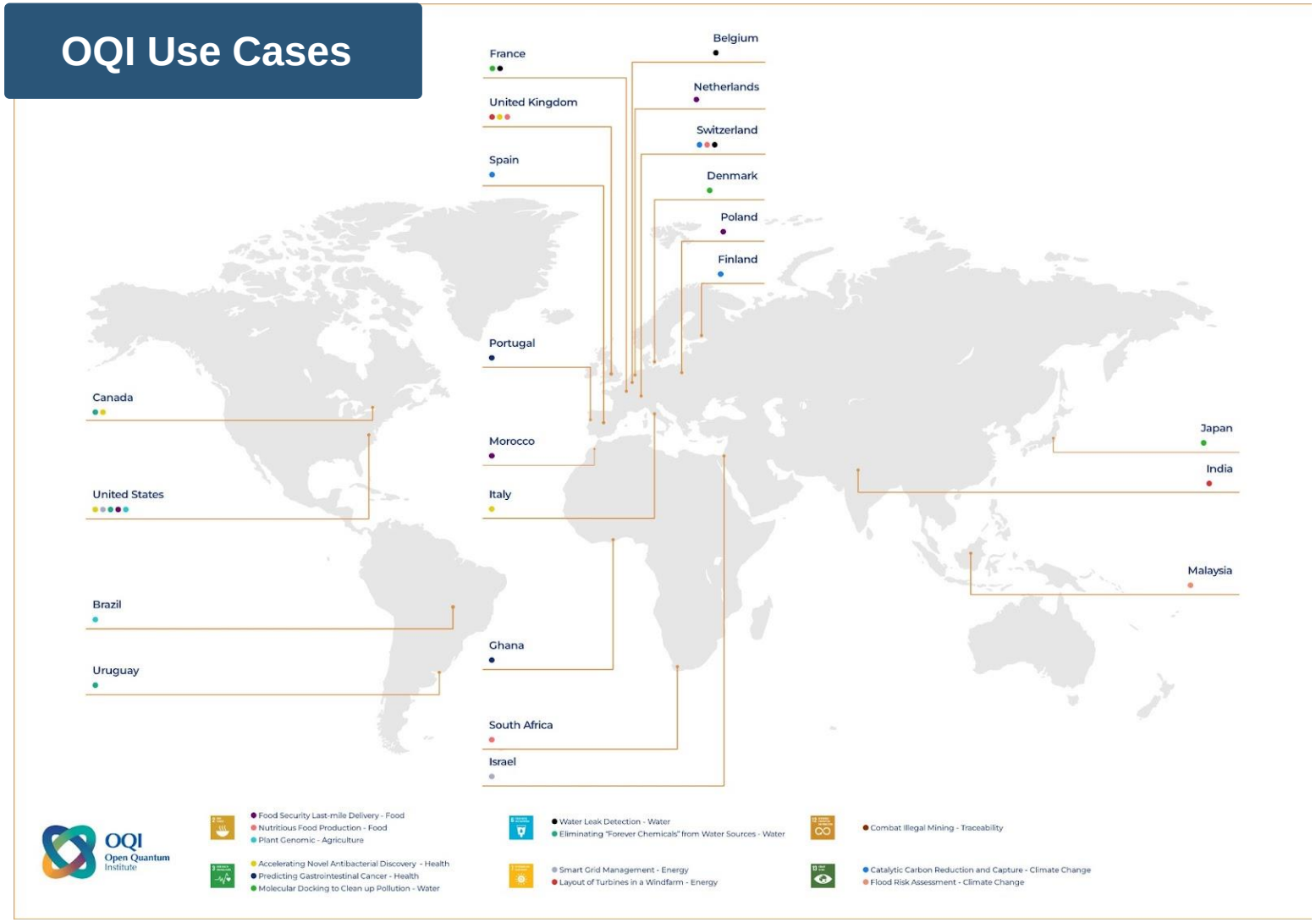
A1 - Accelerating Applications for Humanity

OQI Use Cases



Use case examples:

- Nutritious Food production
- Food Security – Last mile food delivery
- Plant Genomics

- Accelerating Novel Antibacterial Discovery
- Molecular Docking
- Predicting Gastro- intestinal Cancer

- Water Leak Detection
- Eliminating forever chemicals from water sources

- Laying out turbines in a windfarm
- Smart grid management

- Carbon Capture
- Flood risk assessment

Example: Water Leak Detection

Use Case Team: PASQAL, REPLY, QCLAVIS.IO

UN Agency: UN-HABITAT FOR A BETTER URBAN FUTURE

Quantum Approach:
Optimization (Neutral atoms)

Problem: Piping networks loose up to 60% of their freshwater to leaks. Exacerbated by increasing populations and lack of maintenance.

How can the placement of a limited number of expensive sensors be optimized?

Mathematize problem of sensor placement (-> Maximum Independent Set) → Simulate close-to-optimal placement → Improve detection and localization of leakages at lower cost → 6 CLEAN WATER AND SANITATION

A2 - Access for All

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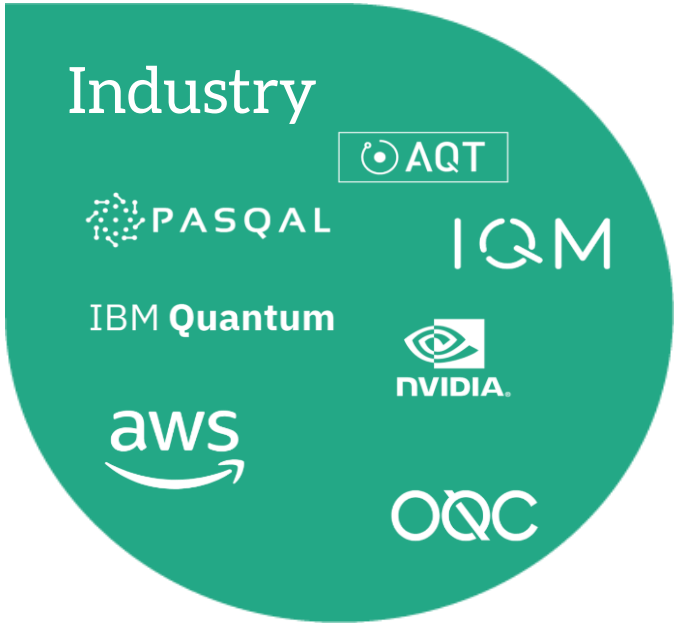
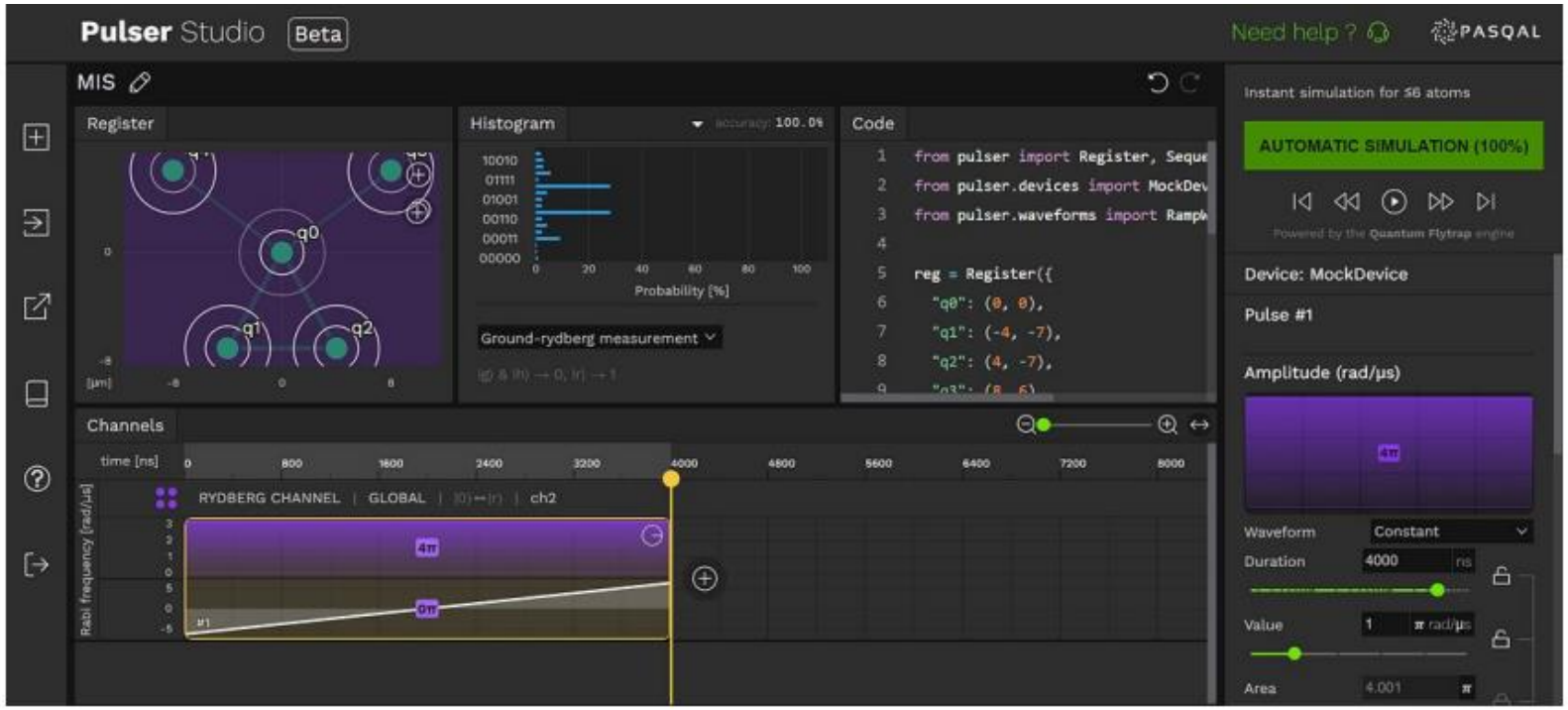
Leverage OQI's industry partnerships to provide QPUs for project teams





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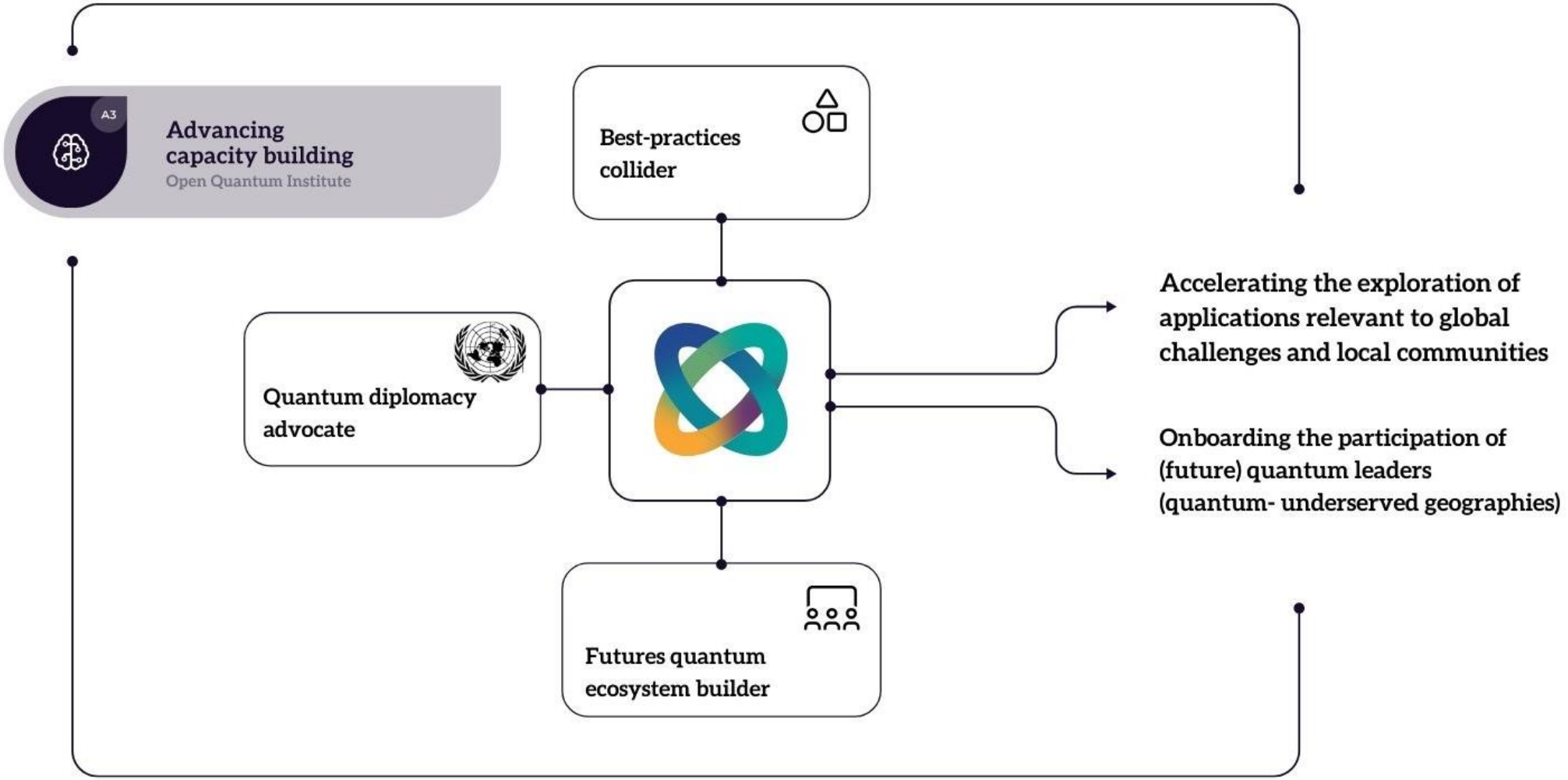
A3 - Advancing capacity building at OQI



A3 - Advancing capacity building - a joint mission

Educational Consortium
55+ institutions contributing, with 17 official member institutions, and 80 experts involved in the Education Consortium

All activities aligned and relayed as part of the UN Year of Quantum Science and Technology

best-practices	• **Educational Consortium Workshops** • Educational Repository • Foundational Trainings
futures quantum ecosystems	• Hackathons • Training for host institutions of OQI supported hackathons • Pre-hackathon training programme for participants • OQI mentorship programme • OQI internship programme • Regional quantum community events • OQI inspired activities
Quantum diplomacy	• Quantum Diplomacy Game • Quantum Diplomacy Game facilitator programme • OQI representation at the UN year of quantum

A3 - Advancing capacity building - a joint mission

For 2025:

OQI educational consortium

- ➔ Share experience and best practices and co-develop tools
- ➔ Feed OQI Edu Repository which will feature e.g. a Paper on Regime of Quantum Advantage

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Example: 2023 Hackathon at NYU Abu Dhabi
Task: Quantum computing to address Sustainable Development Goals

Focus on Affordable & Clean Energy
"Quantum topology and neural networks for blackout response"

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Quantum diplomacy

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- Quantum Diplomacy Game facilitator programme
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A3 - Advancing capacity building - a joint mission

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For 2025:

Quantum hackathons focusing on SDGs

- ➔ Support 6 hackathons in quantum-underserved geographies in all continents
- ➔ Deployment of OQI's Hackathon in a Box

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A3 - Advancing capacity building - a joint mission

Quantum Diplomacy Game
Role play on quantum diplomacy, the game's objective is to raise awareness of the geopolitical implications of quantum computing as an emerging technology.

"The year is 2035. Large-scale quantum computing has been achieved, but the costs are still too high for general commercial use."

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➔ 2025: Deployment of this role play on the geopolitical implications of quantum computing as an emerging technology around the globe

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A3 - Advancing capacity building activities in 2025

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Quantum hackathons focusing on SDGs

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Quantum Diplomacy Game

- ➔ 2025: Deployment of this role play on the geopolitical implications of quantum computing as an emerging technology around the globe

International Year of Quantum Technology and Science (IYQ)

- ➔ OQI representation on the IYQ Steering Committee
- ➔ Contribution to the IYQ global events calendar

INTERNATIONAL YEAR OF Quantum Science and Technology

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A4 - Activating Multilateral Governance for SDGs

Quantum Diplomacy engagement through informal discussions with 20+ permanent representations in Geneva and in country with input from community of practice (industry and science)

- Digital and economic inclusivity
- Technology for the SDGs
- Global Security
- Interoperability
- Trade
- Environment
- Talent
- Human Agency

A4 - Activating Multilateral Governance for SDGs

How quantum and AI will work together

Artificial intelligence (AI) has so far enabled disruptive applications. From efficient analysis and predictive tasks on large datasets to "recommendation" systems and chatbots, AI's rapid adoption across a spectrum of industries is broadening.[4] Combining classical machine learning (ML)[5] - which is a subset of AI - with quantum computing is, unsurprisingly, a field of growing expectations and hype. The intersection of AI and quantum[6] is still a nascent field, and the effort is at the research and development level. Quantum machine learning, for example, accounts for less than 1% of total machine learning research publications.[7]

The interplay of machine learning and quantum computing can be summarized in three categories:

- **Using classical machine learning to develop quantum computers**: Already in use today, classical machine learning can help to improve experimental control of quantum computers and reduce hardware errors,[8] construct quantum circuits,[9] and simulate the result of quantum computations.[10]
- **Quantum-inspired machine learning**: Research on quantum computing has inspired the exploration of new techniques and theoretical insights benefiting classical machine learning.[11]
- **Quantum machine learning**:[12] Industry and academic researchers are exploring ways of using classical machine learning techniques on quantum computers. Currently, much of their research focuses on using existing small-scale quantum computers jointly with classical computers (so called "hybrid computing") to identify potential benefits.[13] Quantum computers also offer some benefits[14] for learning from quantum data (data that itself originates from quantum sensors for instance). **One major challenge is the efficient input and output of classical data to and from quantum data**. It is still too early today to predict if this hybrid approach could realize a quantum advantage for practical applications (i.e. outperforming classical computing),[15] even with future fault-tolerant quantum computing.[16]

In sum, **quantum machine learning will not replace classical machine learning**. One could potentially augment the other by **working in tandem**. Classical machine learning[17] already benefits the development of quantum computers. Despite the early stage of this research field, the intersection of AI and quantum offers exciting avenues that can benefit from more direct collaboration between experts in different disciplines.[18] As the field matures, a transdisciplinary approach should learn from recent AI governance principles and adapted them to this emerging field at the cross-section of AI and quantum computing.

Conclusion: How can we ensure equitable access ?

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Anticipating

Accelerating of the dialogue between science, diplomacy, philanthropy and society

Translating opportunities into action

Identifying opportunities for **SDG use cases** on the global quantum landscape

Identifying access and implementation support needs

Using platforms such as the Quantum Diplomacy Symposium to **debate across sectors** about multilateral efforts required to harness the technology responsibly

Using quantum technologies as tools for equitable innovation rather than instruments of division

Offering support for implementation when providing access to technology

Advocating for **capacity-sharing** initiatives

Offering open-source **educational resources**

Implementing collectively best practices for advancing capacity building

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