# IBM Quantum

Dr. Sven Peyer
Manager Quantum Hardware

# Bring useful quantum computing to the world

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# Make the world quantum safe

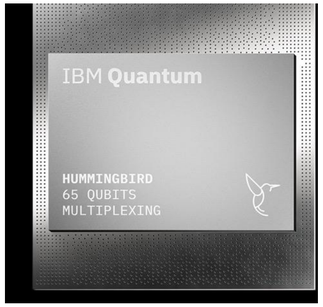
# The path to useful quantum computing

## Run quantum circuits faster on quantum hardware

Chart a path to develop quantum technology (hardware + software) that runs noise-free estimators of quantum circuits faster than can be done using classical hardware alone.

## Map interesting problems to quantum circuits

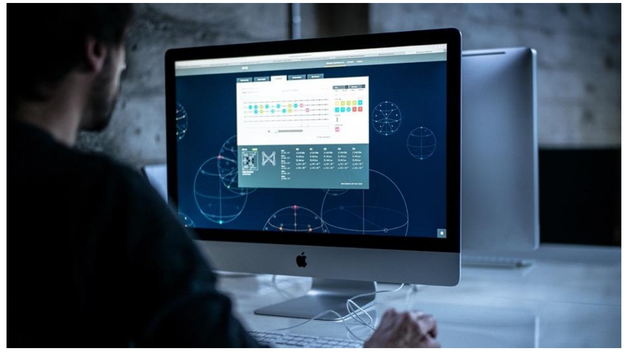
We need applications that can be solved only with quantum circuits that are known to be difficult to simulate. This must be done in partnership with our clients and users.

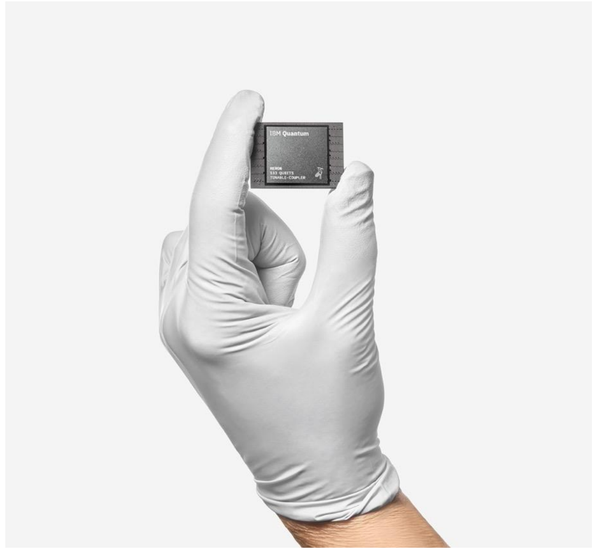

IBM Quantum
HUMMINGBIRD
65 QUBITS
MULTIPLEXING

# 2016 - 2023


IBM Quantum
FALCON
27 QUBITS
HEAVY-HEX


IBM Quantum
EAGLE
127 QUBITS
PACKAGING





# 2023 → Utility

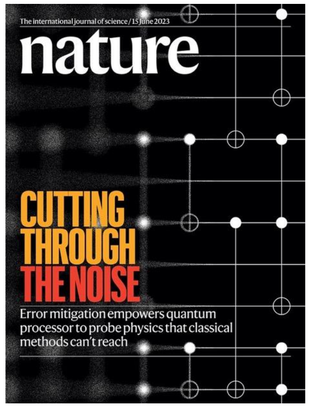
# The era of quantum utility

# Utility vs. Advantage


## Quantum Utility (2023)

Demonstration that a quantum computer can run quantum circuits beyond the ability of a classical computer simulating a quantum computer

Confirmation via research, papers, & theory




IBM's 2023 research paper ("Evidence for the utility of quantum computing before fault tolerance") provided evidence and methods to move the industry into the Utility era

https://www.nature.com/articles/s41586-023-06096-3

## Quantum Advantage (TBD)

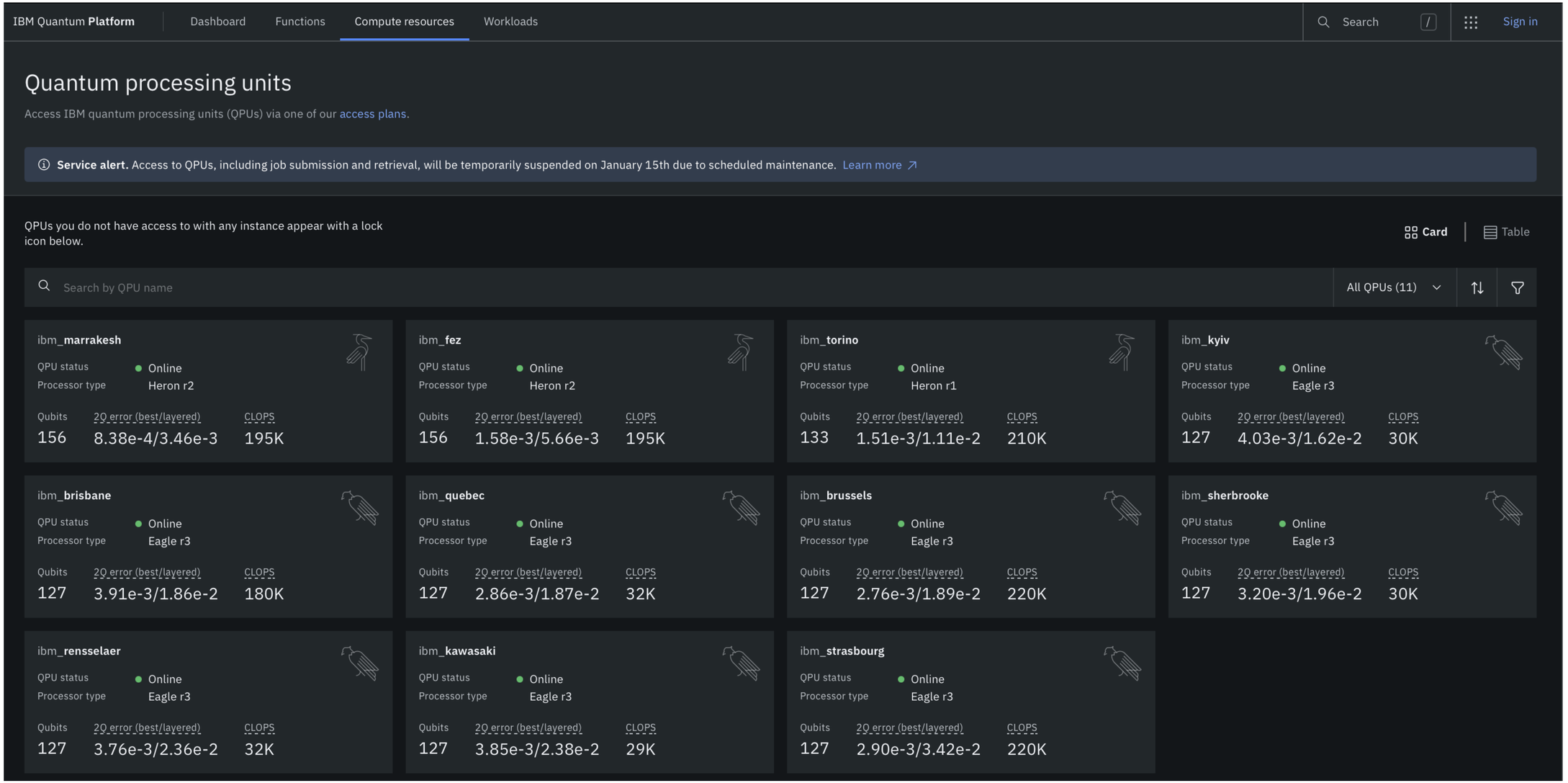
Demonstration that a quantum computer can run quantum circuits beyond the ability of all known classical methods

Confirmation via real-world usage

Advantage will come at different times in different domains and depends on the continued advancement of quantum algorithm implementations across industries

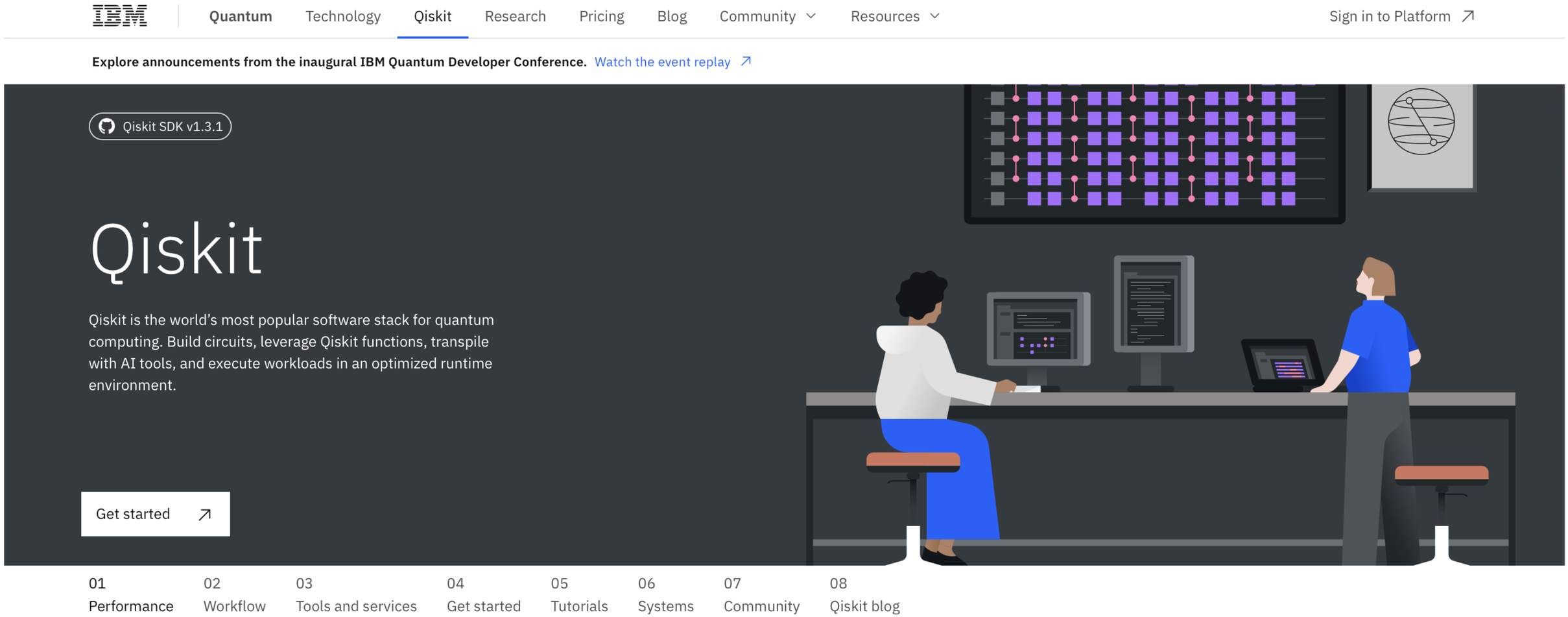
# IBM Quantum Platform

https://quantum.ibm.com



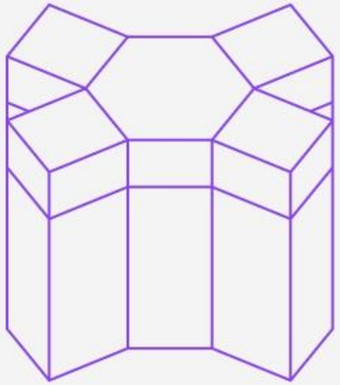
# Qiskit

https://www.ibm.com/quantum/qiskit



Qiskit

+



IBM QPUs

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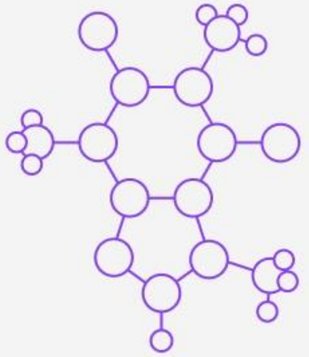


Utility Scale Work

IBM has the strongest quantum ecosystem advancing the field of quantum computing

**3T+**

Circuits run on our systems

**250+**

IBM Quantum Network members

**75+**

Systems deployed worldwide since 2016

**8+**

Quantum systems at IBM Quantum data centers

**2**

Global quantum data centers

**5**

Quantum systems at client-locations
(by end of 2024)

# IBM Quantum Network Use Cases

## E.ON

Providing access to the most advanced quantum computing hardware to accelerate E.ONs aim to drive the transformation of the energy industry with Quantum Computing to implement quantum solutions for their critical workflow.

Arxiv: 2304.10385

## Crédit Mutuel

As the first enterprise in France to join the IBM Quantum Network, Crédit Mutuel identified specific use cases, among many areas of interest in financial services, including: research into customer experience, fraud management and risk management,

## Erste Bank

Erste Digital will gain access to IBM’s premium plan for quantum computer systems, including the recently announced 127-Qubit Eagle processor, as well as to IBM’s quantum expertise. The aim is to investigate, validate and promote concrete quantum application cases relevant to banks.

## Bosch

With its activities in the field of electromobility, Bosch brings in a concrete application in which quantum computers may soon offer a significant advantage over conventional computers in discovering and designing new materials. Fuel cells, batteries, electric engines, or advanced sensors contain strongly correlated electrons.

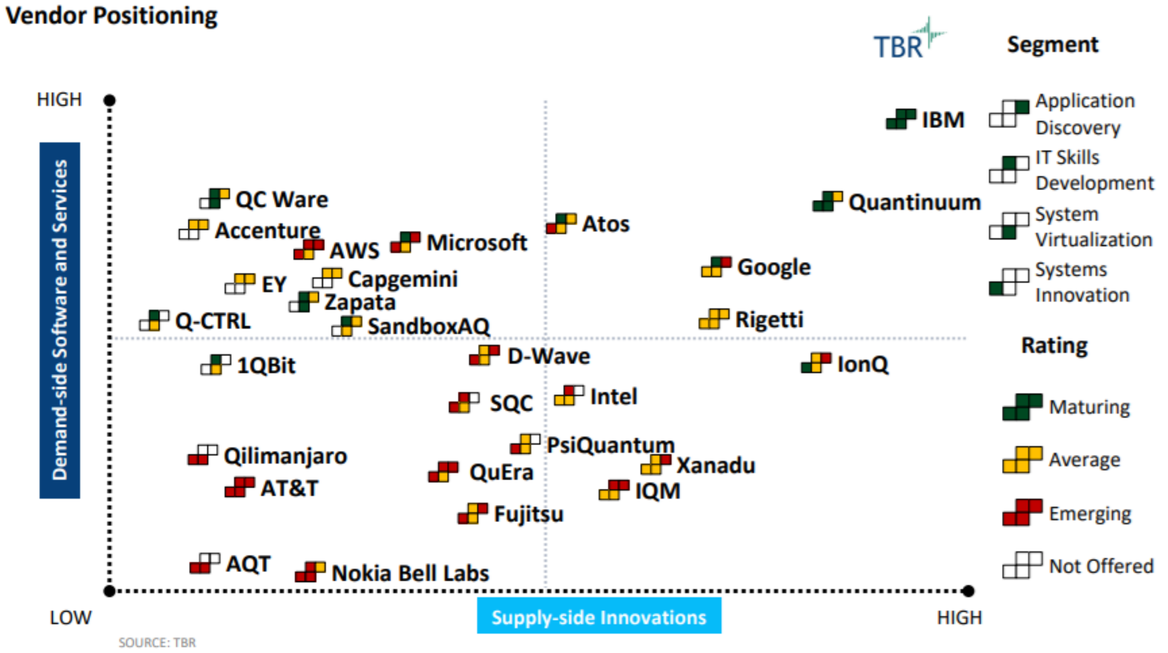
## CERN

The mission of the CERN hub is to explore promising applications of quantum computing for high-energy physics and other sciences together with academia and research institutes in CERN Member States. These also include areas in quantum machine learning.

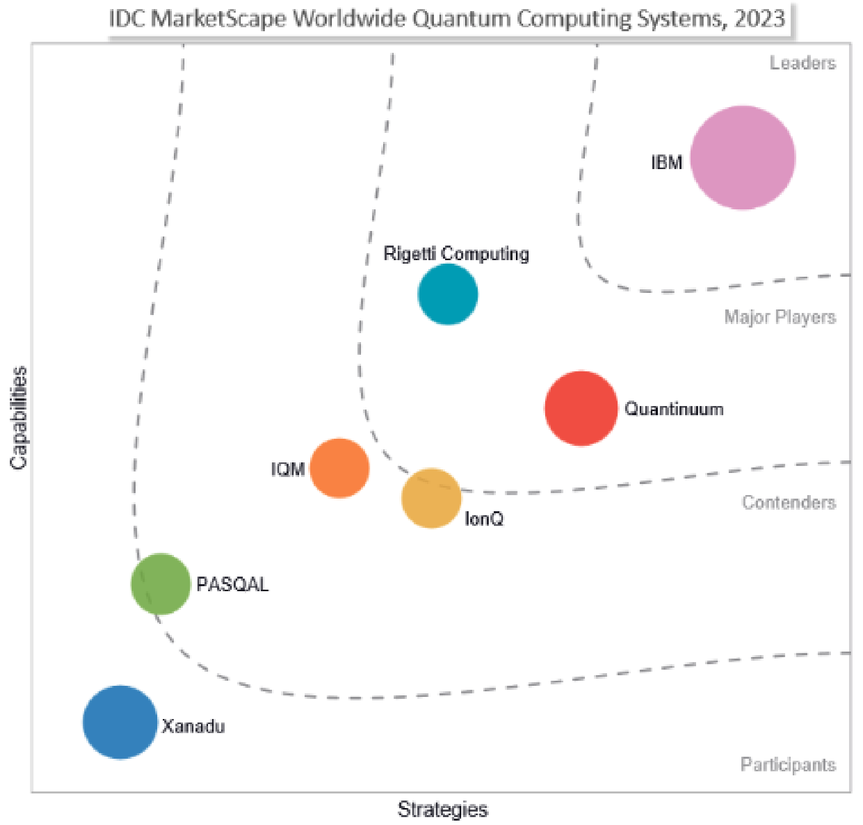
## STFC

Hartree Centre at the UK Research and Innovation's Science and Technology Facilities Council (STFC) will work together over the next five years to apply artificial intelligence and quantum computing to produce innovations in materials, life sciences, climate, agriculture, and manufacturing.

# Named the quantum computing “leader,”
# IBM is your partner to build the future together




Source: Technology Business Research, Inc. – Quantum Computing Market Landscape Q2 2023



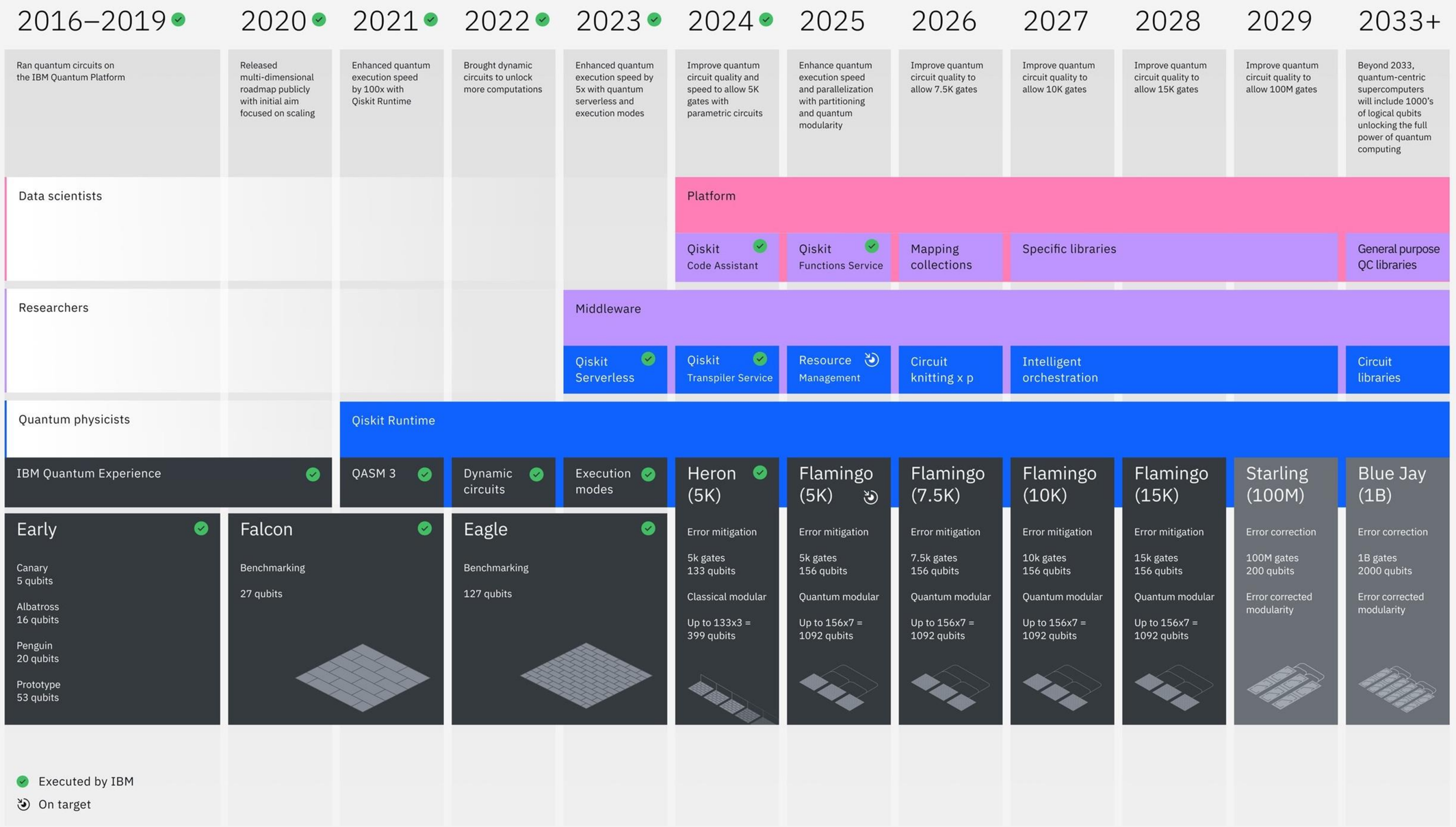

Source: IDC, 2023

Source: IDC MarketScape: Worldwide Quantum Computing Systems 2023 Vendor Assessment (doc #US49607923, August 2023).

IDC MarketScape vendor analysis model is designed to provide an overview of the competitive fitness of ICT suppliers in a given market. The research methodology utilizes a rigorous scoring methodology based on both qualitative and quantitative criteriathat results in a single graphical illustration of each vendor’s position within a given market. The Capabilities score measures vendor product, go-to-market and business execution in the short-term. The Strategy score measures alignment of vendor strategies with customer requirements in a 3-5-year timeframe. Vendor market share is represented by the size of the icons.

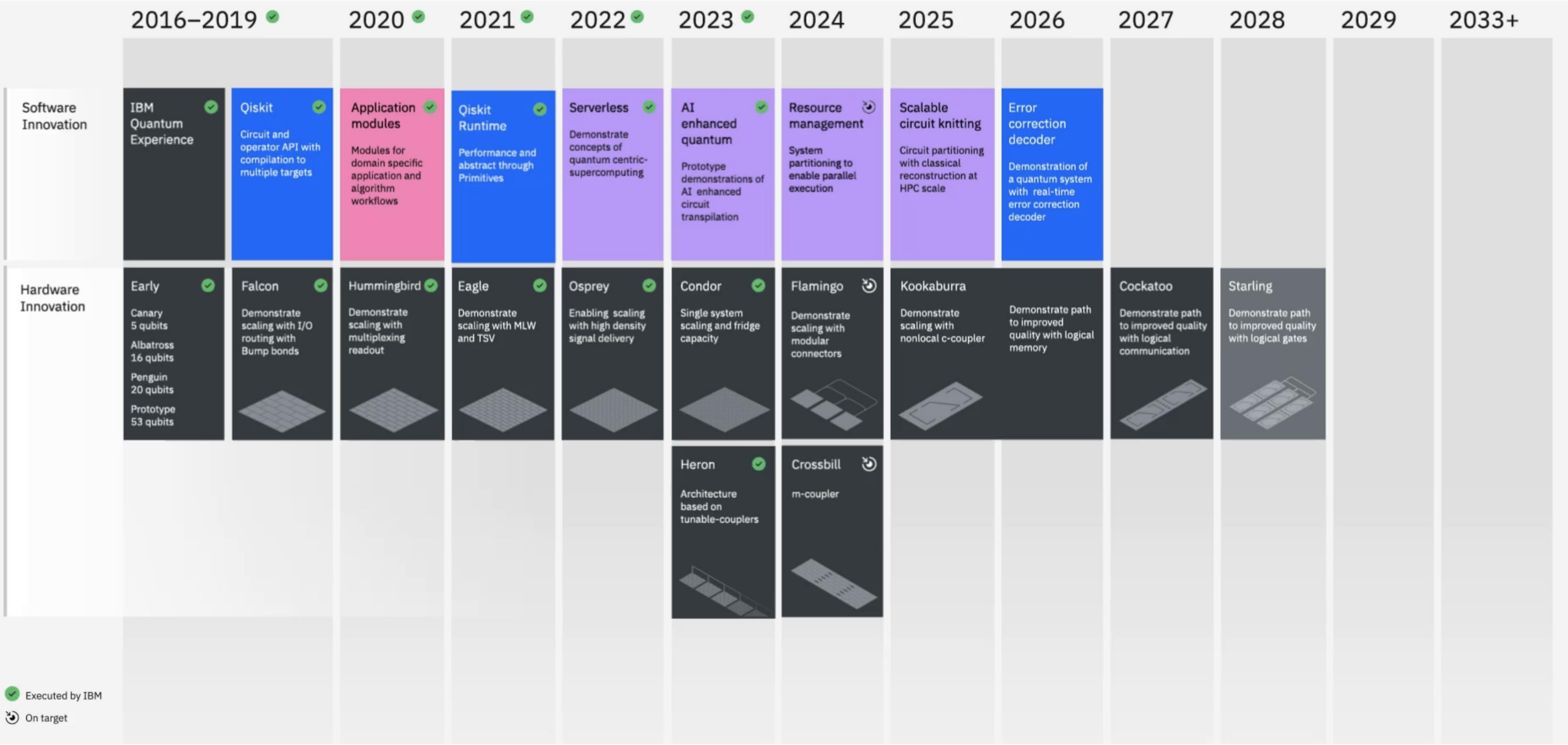
# Development Roadmap





# Innovation Roadmap

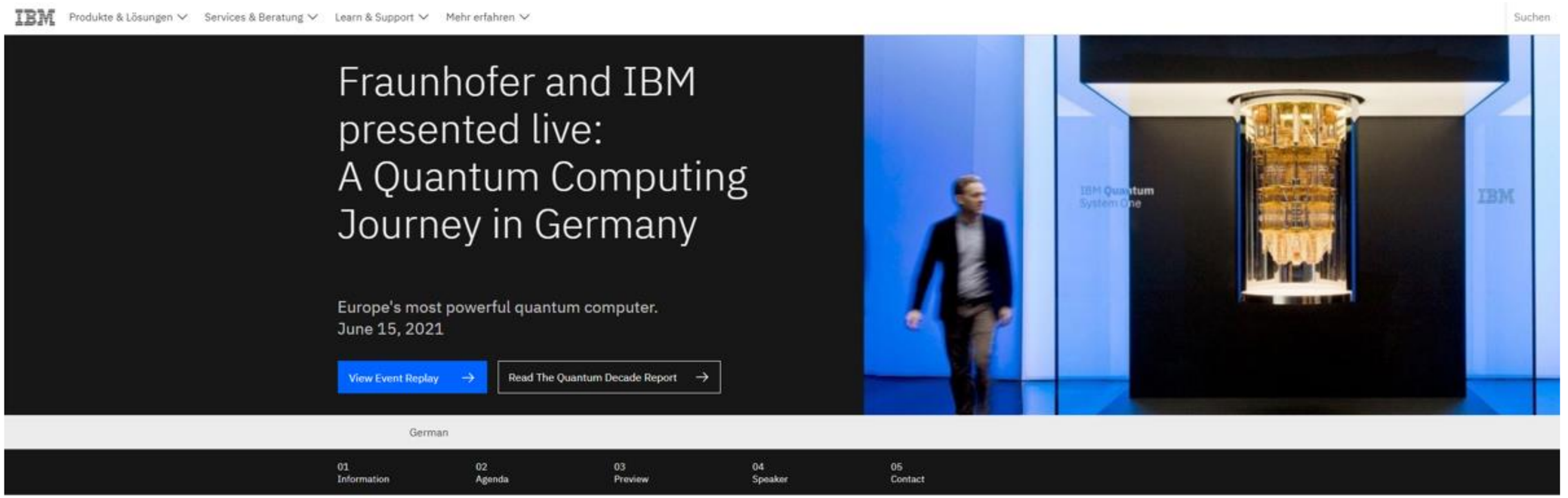




# IBM Quantum in Germany

IBM **Quantum**

# Accelerators in Germany


Fraunhofer and IBM present

**Thank you for your participation!**

With the cooperation between Fraunhofer-Gesellschaft and IBM, the area of quantum computing is taking a big step forward:

We proudly present the joint inauguration of the most powerful production IBM Quantum computer in Europe. In a compact virtual live event on **June 15, 2021, starting at 2 p.m.** under the motto "A Quantum Computing Journey in Germany", we'll give you an exclusive detailed presentation of the system.

We are excited to welcome **German Chancellor Dr. Angela Merkel** as a live broadcasted guest speaker, as well as other high-ranking speakers from politics and science.
Register and ensure your attendance at a piece of computing history with just a few clicks.

We are looking forward to seeing you!

https://www.ibm.com/de-de/events/quantum-opening-en

# IBM Quantum System One in Ehningen

First of its kind in Europe

In cooperation with Fraunhofer

Ehningen, Baden-Württemberg

# IBM to Build its First European Quantum Data Center to Serve Expanding Ecosystem

*The IBM facility in Ehningen, Germany, expected to open in 2024*

*IBM Quantum to allow European cloud region users to provision quantum systems and process data within the EU*

Jun 6, 2023


ARMONK, N.Y. and EHNINGEN, Germany, June 6, 2023 /PRNewswire/ -- Today, IBM (NYSE: IBM) announced plans to open its first Europe-based quantum data center to facilitate access to cutting-edge quantum computing for companies, research institutions and government agencies.

The data center is expected to be operational in 2024, with multiple IBM quantum computing systems, each with utility scale quantum processors, i.e., those of more than 100 qubits.

The data center will be located at IBM's facility in Ehningen, Germany, and will serve as IBM Quantum's European cloud region. Users in Europe and elsewhere in the world will be able to provision services at the data center for their cloud-based quantum computing research and exploratory activity. The data center is being designed to help clients continue to manage their European data regulation requirements, including processing all job data within EU borders. The facility will be IBM's second quantum data

**More Articles**

Crédit Mutuel Alliance Fédérale and Euro-Information Collaborating with IBM to Shape the Bank's Quantum Future

IBM Consulting unveils Center of Excellence for generative AI

IBM Tech Now: IBM Watson Code

# IBM Quantum Europe Data Center

Located in Ehningen, Germany

The Data Center in Europe is part of our long-term worldwide plan. It reflects the growing maturity of our own platform and customer sophistication and demand

## Hardware

*Increasing IBM's global fleet of leading universal quantum computers*

Quantum Data Center with **utility-scale QPUs**:

- **Two Eagle** processors (127 qubits)
- later in 2024: **One Heron** processor (156 qubits)[1]

## Access

*Choose how to consume EU data center resources*

EU-based QPUs are accessible through **various access paths**

- IBM Quantum Platform (Premium Plan)
- Qiskit Runtime on IBM Cloud [Pay-as-you-go] (regional service)
- IBM is collaborating with regional business partners for 3rd party offerings[1] (regional service)

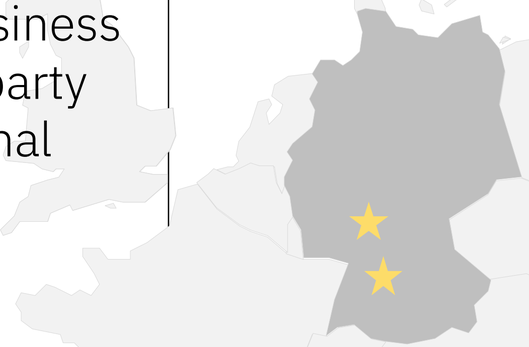
## Data Locality

*Circuit inputs and outputs will stay in the region*[2]

Cloud entry point is in **Frankfurt, Germany**

IBM Quantum Data Center is in **Ehningen, Germany**

Client **user workflow data** (circuit inputs and outputs) **will stay in the EU for regional services**[2]



[1]: Planned

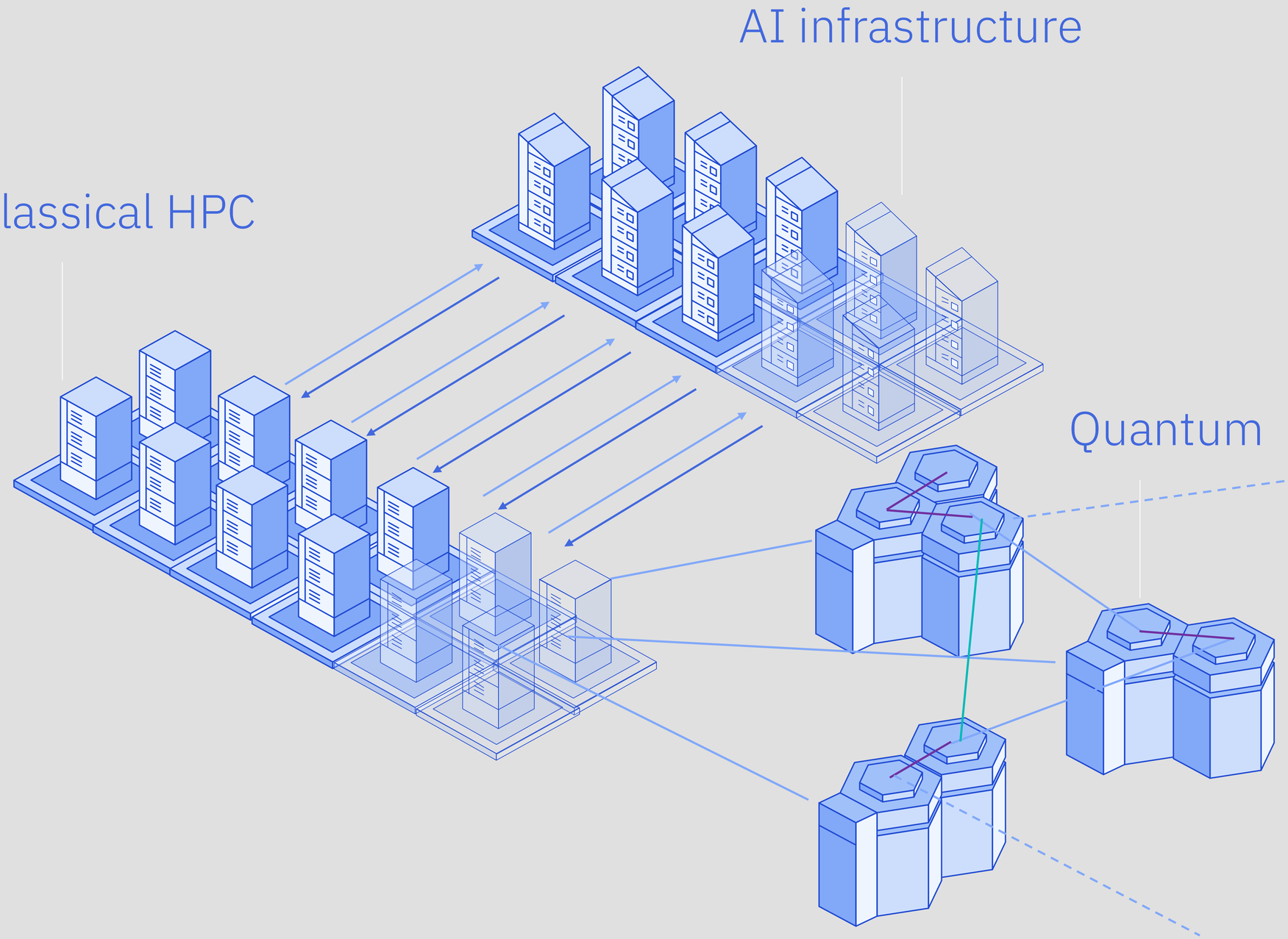
[2]: Given certain constraints

# EU Quantum Data Center Launch on October 1st


Quantum is a component in the future of advanced computing

In the future, quantum will integrate with other components, including AI, to enhance the overall capability of our computational tools.

Each tool is best suited for certain types of tasks, and all will work together to solve the hardest problems that face society today.



# Thank You

IBM **Quantum**