

ABCI-Q: A Next-Generation Hybrid Platform Integrating AI, HPC, and Quantum Computing

**Global Research and Development Center for Business by Quantum-AI Technology (G-QuAT)
National Institute of Advanced Industrial Science and Technology (AIST)**

Ryousei Takano

26 June 2026 2nd QRUCH workshop in conjunction with ISC26

ABCI-Q: An Open Quantum-AI Testbed for Industrialization

- **ABCI-Q** uniquely combines a **large, dedicated GPU supercomputer** for quantum workloads with **multiple on-premises quantum computers**.
- This unique configuration enables an **open testbed to accelerate the industrialization of quantum computing technologies**.

GPU Supercomputer
(System H, Fujitsu)

Superconducting QC
(System F, Fujitsu)

Neutral Atom QC
(System Q, QuEra)

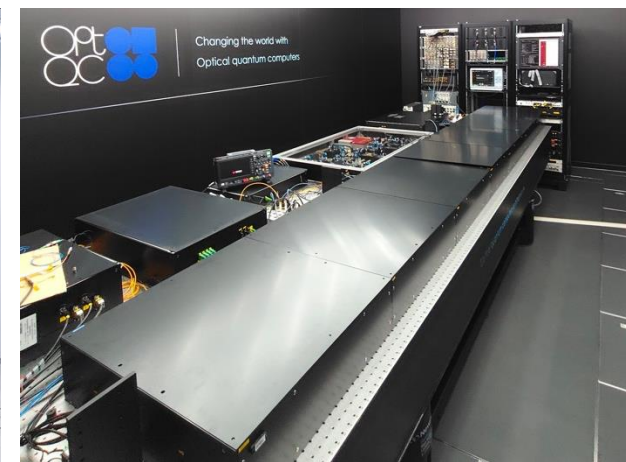
Optical QC
(System O, OptQC)



Available in Oct. 2025

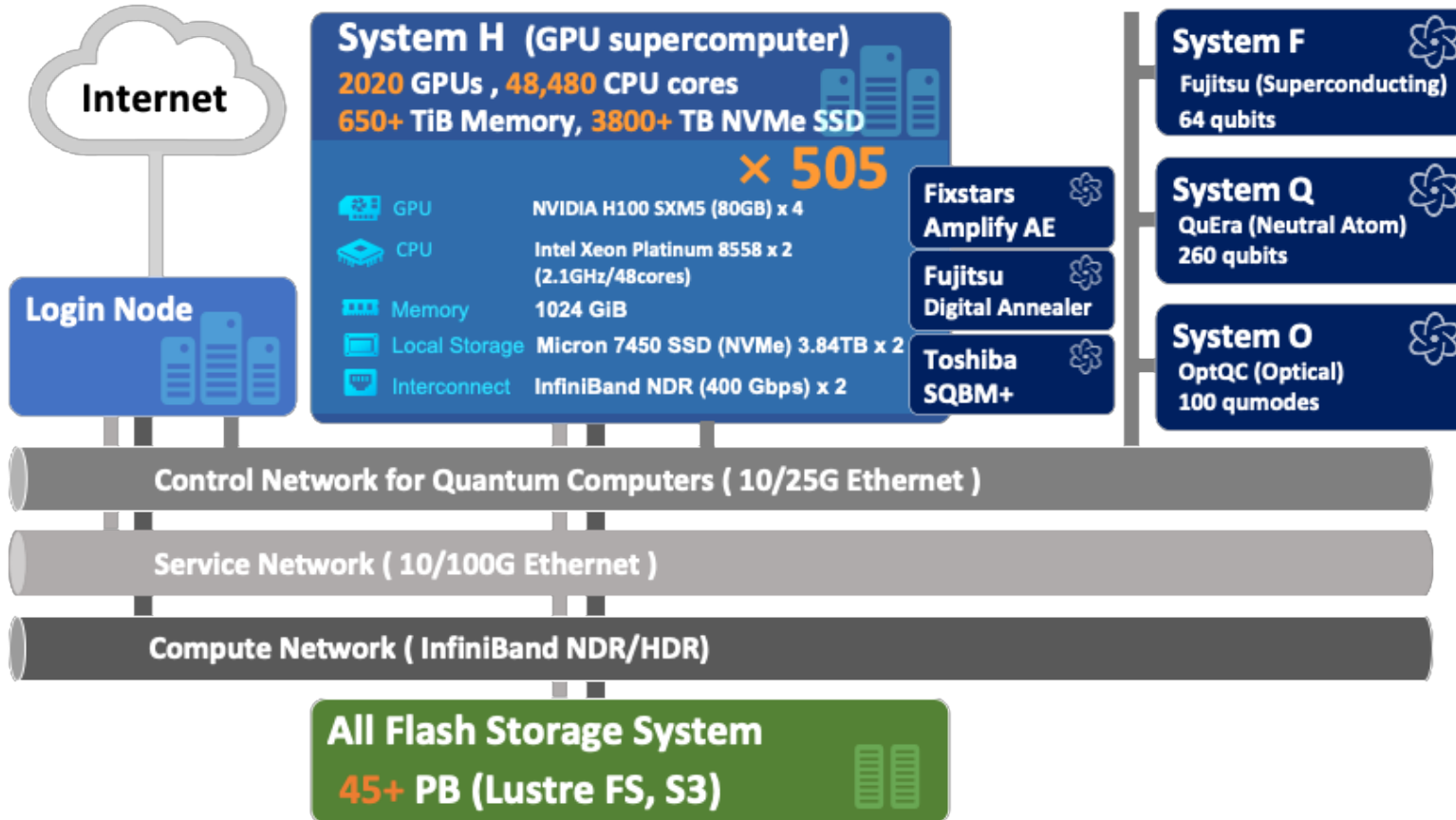


Available in Mar. 2026



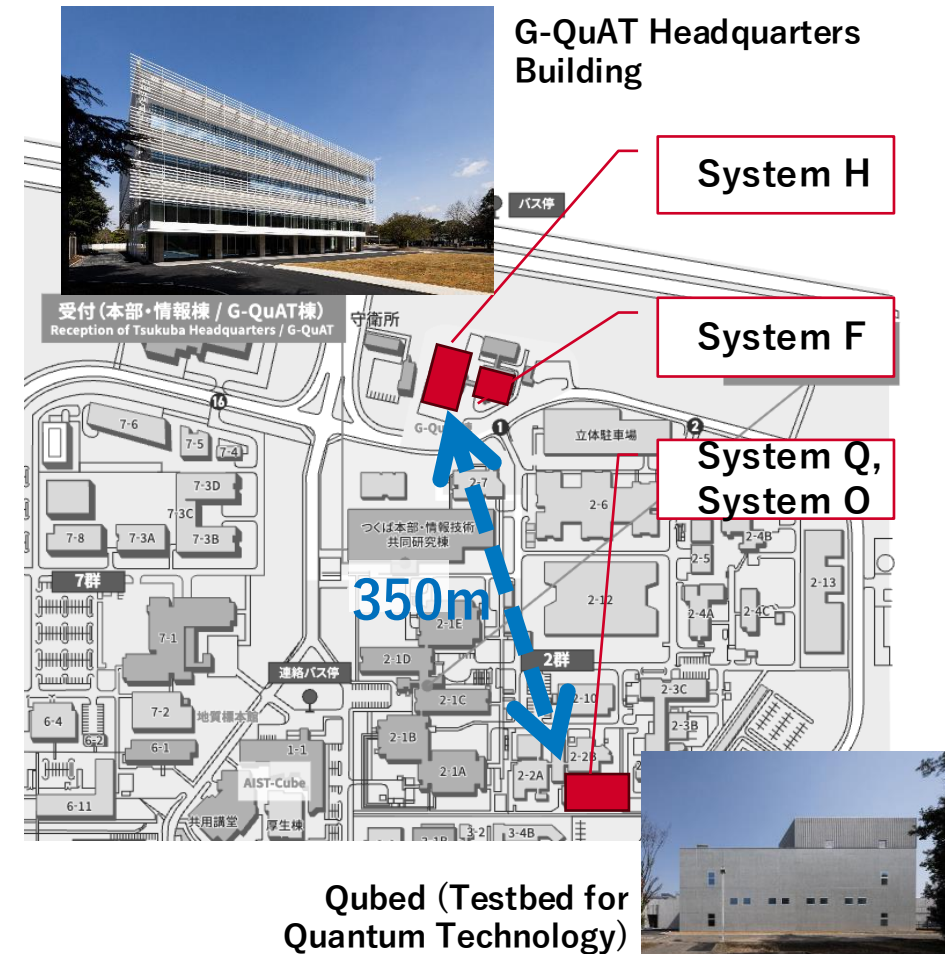
Under Preparation

System Overview



System H is a HPC system ranked 27th on the TOP500 list.

Installation on the AIST Tsukuba campus





Features:

- Developed by **Fujitsu through technology transfer from RIKEN**
- **First deployment of a commercial quantum computer** developed by Japanese vendor

Specifications:

- 64 physical qubits
- Designed to expand to hundreds of qubits
- SDK: QURI Parts OQTOPUS (initial), QUDA-Q (planning)

QURI Parts
OQTOPUS



Features:

- Developed by **QuEra**, utilizing research from Harvard University and MIT
- **The first commercial gate-based neutral atom system “Gemini”.**

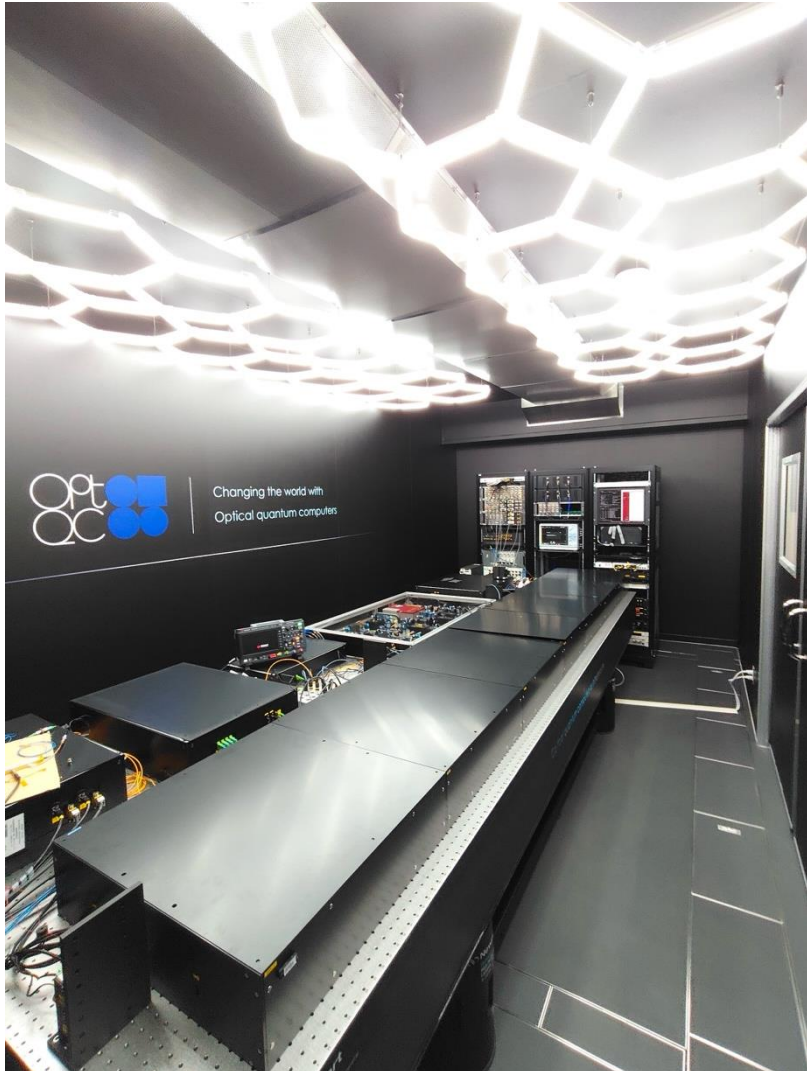
Specifications:

- 260 qubits
- QEC/NISQ/Shuttle modes
- SDK: Bloqade and CUDA-Q (coming soon)
- Simulator (with noise models): Bloqade



Bloqade





Features:

- The **first demonstration machine** developed by **OptQC**, spun off from the Furusawa-Endo Lab at the University of Tokyo
- OptQC aims to achieve the commercialization of an optical quantum computer.
- **Measurement-based Quantum Computer (MBQC)**

Specifications:

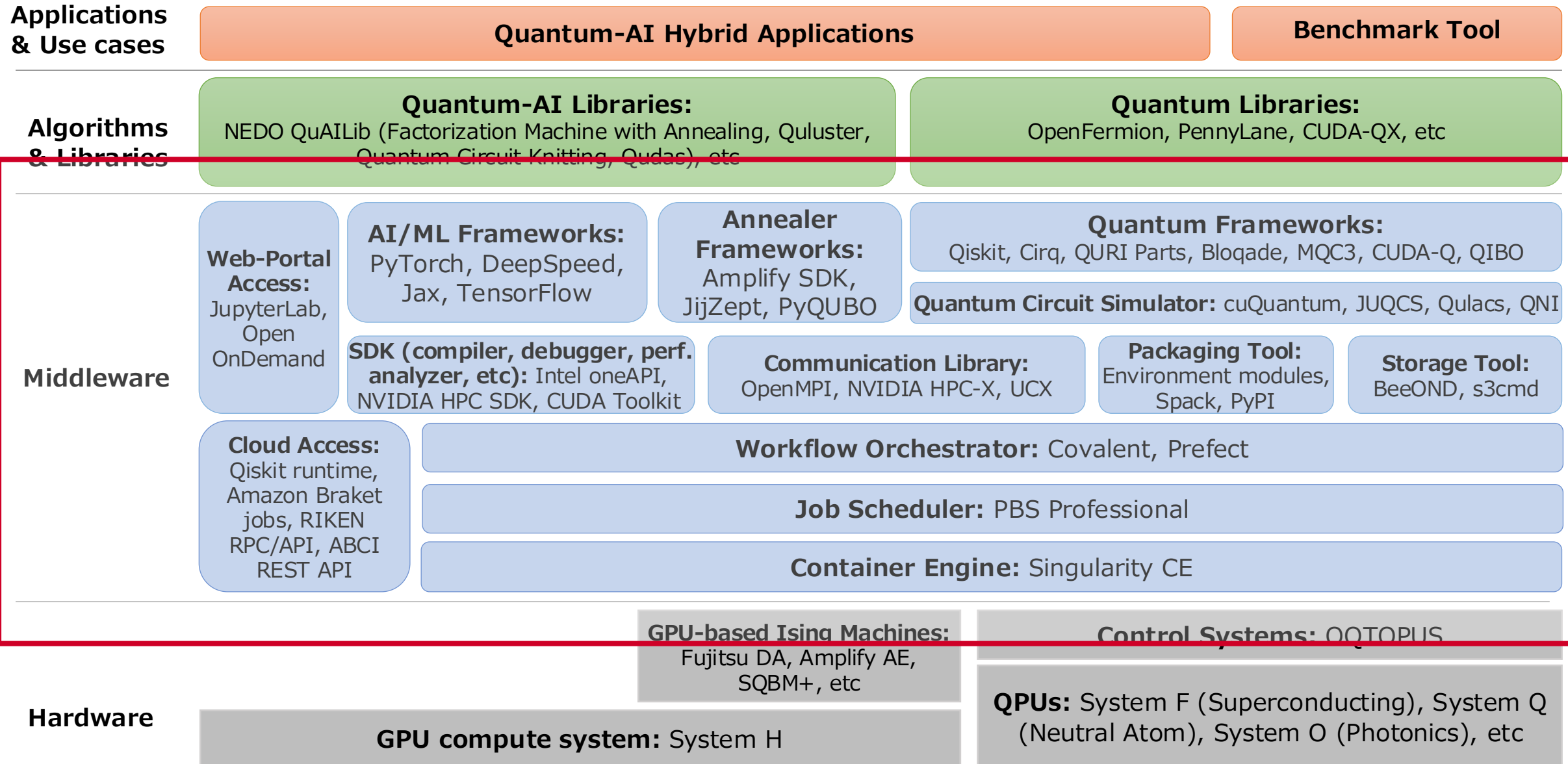
- 129 Qumodes
- Operating frequency: 100MHz
- SDK: MQC3
incl. Strawberry Fields-based simulator

MQC3

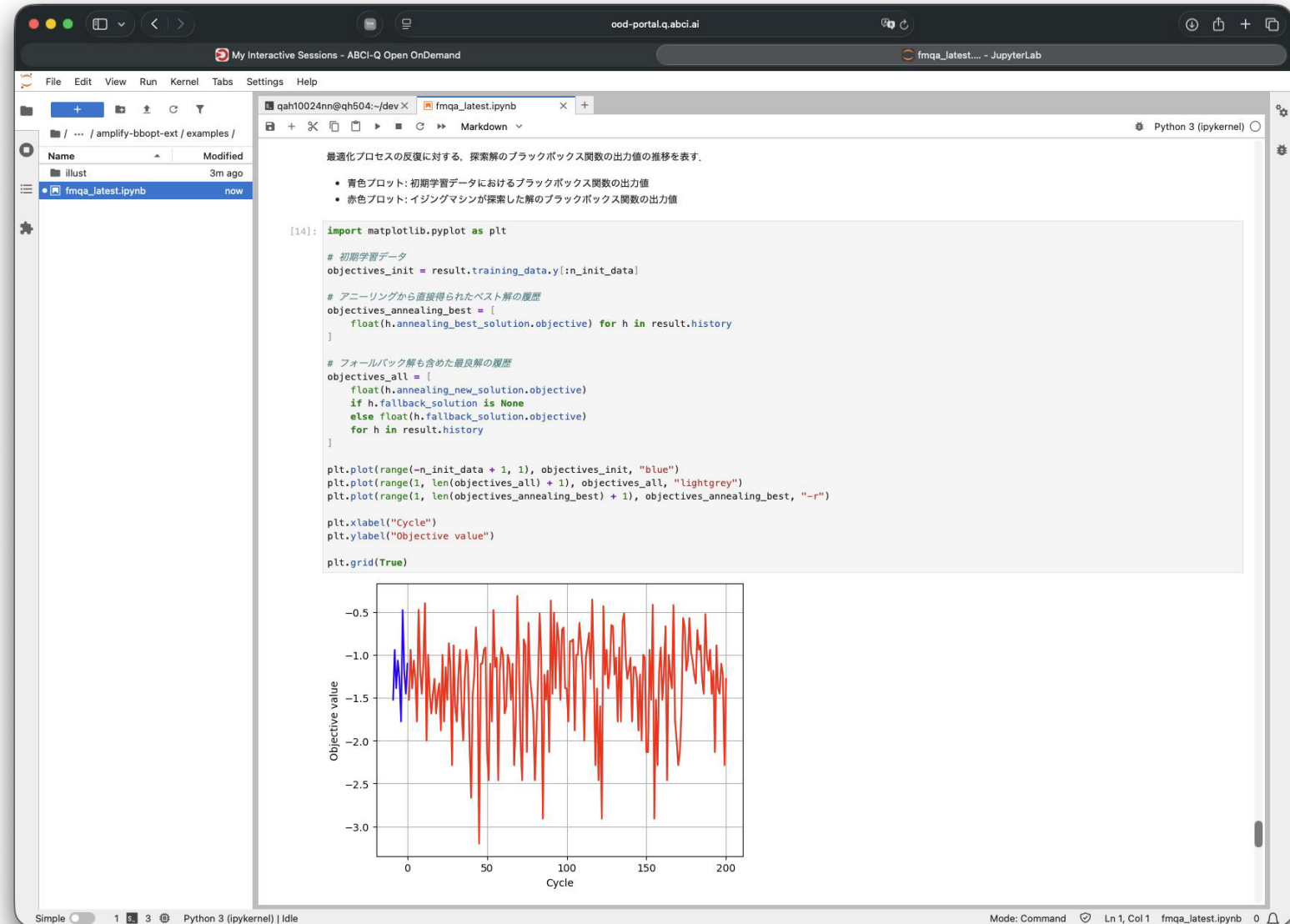
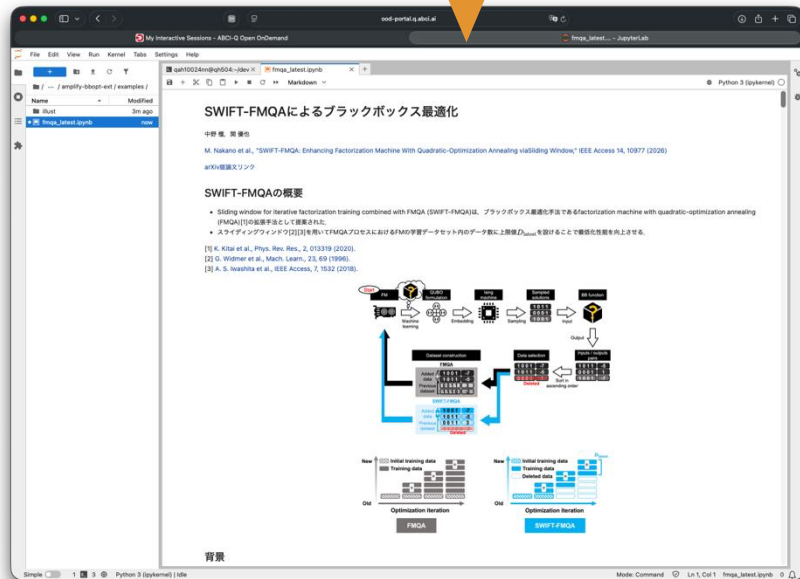
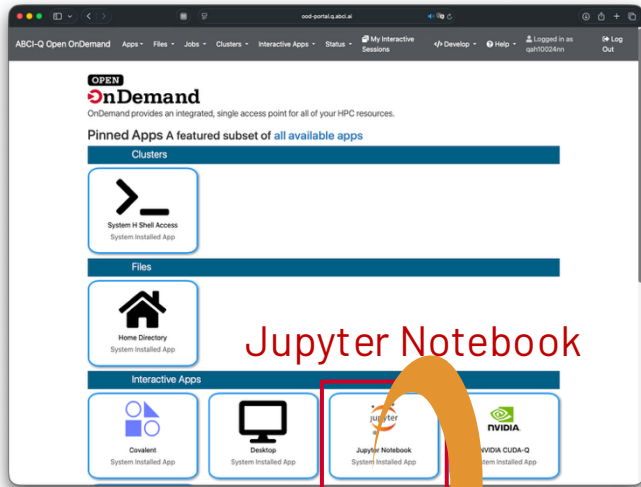


ABCI-Q: Software Stack

Open & Pre-competitive Layer



Open OnDemand: Jupyter Notebook with Fixstars Amplify AE



Example Code of Covalent Workflow Orchestrator

```
import covalent as ct
from quri_parts_oqtopus.backend import OqtopusSamplingJob,
OqtopusSamplingResult
```

```
@ct.electron(executor=systemf)
```

```
def calc():
    program = """OPENQASM 3;
include "stdgates.inc";
qubit[2] q;
bit[2] c;
```

```
h q[0];
cx q[0], q[1];
c[0] = measure q[0];
c[1] = measure q[1];
"""
```

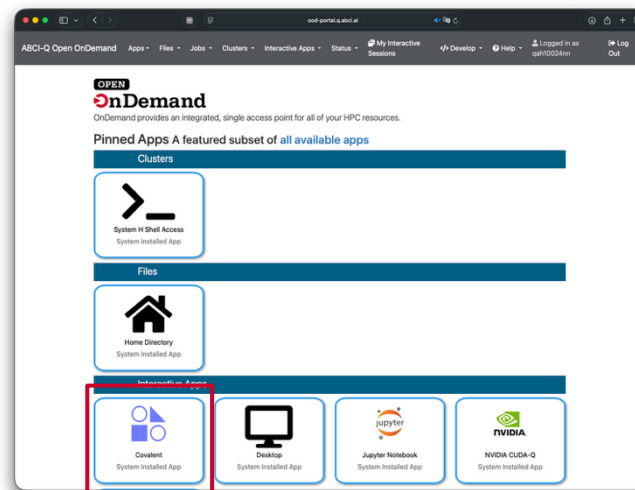
```
param = {
    "program": program,
    "shots": 1000
}
return param
```

```
@ct.lattice
```

```
def workflow():
    output1 = calc()
    output2 = calc()
```

```
return output1,output2
```

```
dispatch_id = ct.dispatch(workflow())
workflow_job = ct.get_result(dispatch_id, wait=True)
print(f'counts={workflow_job.result.counts}')
```

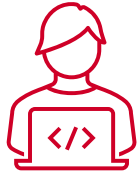


Covalent

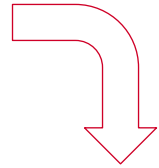


Current Implementation of ABCI System H - System F Integration

Access (SSH, REST API,
Open OnDemand)



User



Admin



System H

System F

Compute node

OQTOPUS Cloud



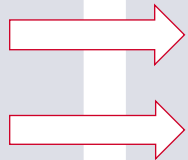
OQTOPUS

Open Quantum Toolchain
for Operators & Users

- User/Job/Data management
- REST API

① *Submit Job*
(HTTP POST)

⑤ *Poll Result*



DB

Control System
(Fujitsu/Keysight)

- Scheduling
- Transpile
- Pulse sequencer

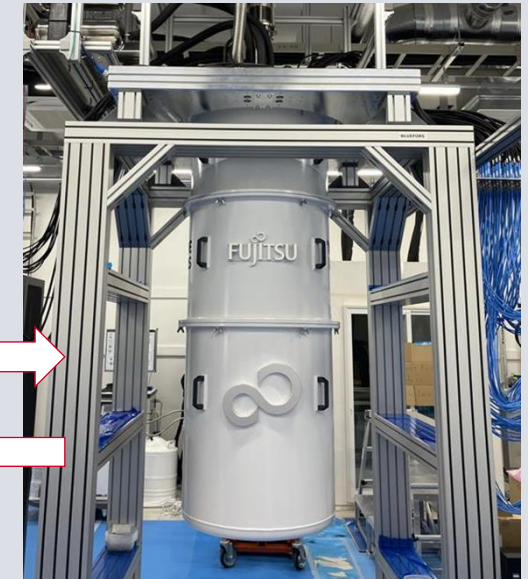
② *Poll Job*
(HTTP GET)

③ *Job Execution*

④ *Send Result*
(HTTP PATCH)



QPU
(Fujitsu)



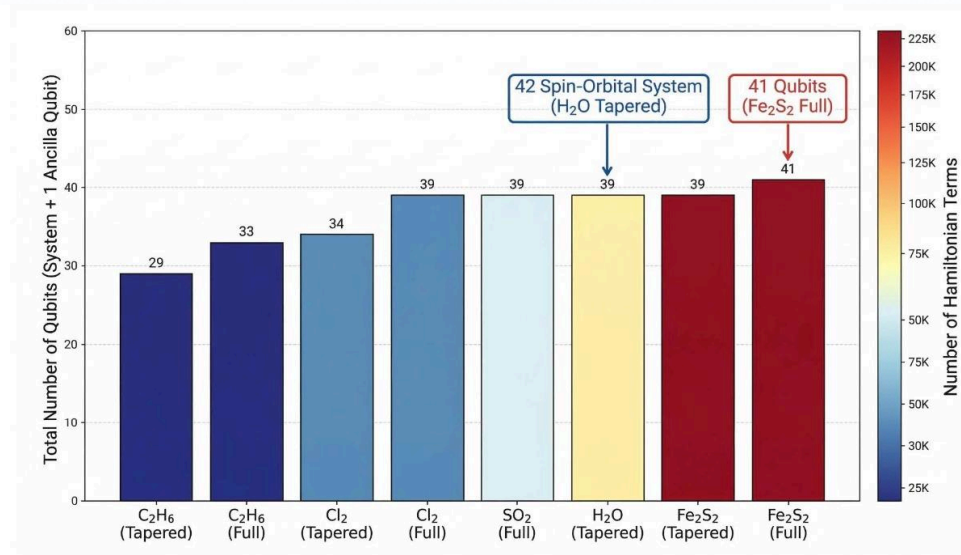
Large-scale quantum circuit simulation (U.Osaka and Fixstars)



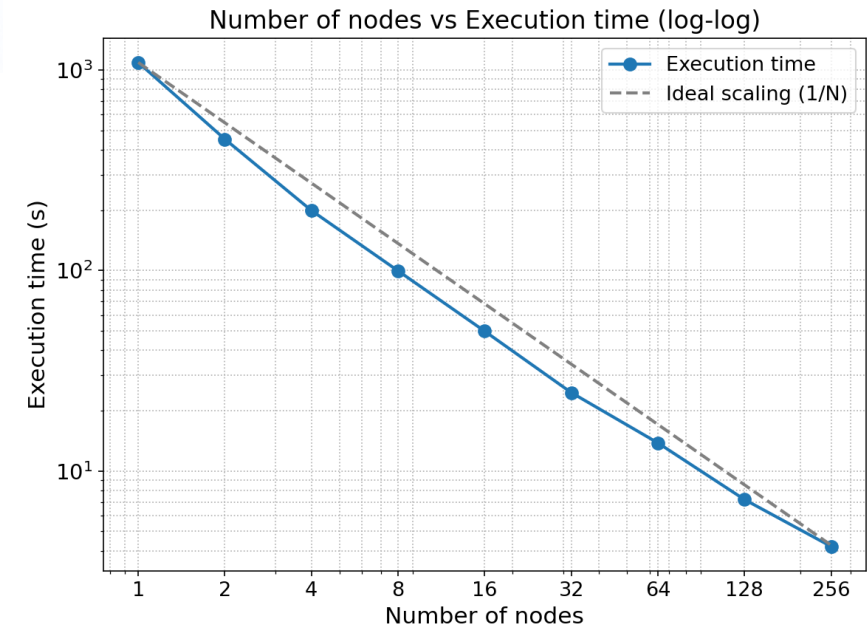
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News Press Release 1 Apr 2026

World's largest quantum circuit simulation for quantum chemistry achieved on 1,024 GPUs: Enabling large-scale benchmarking and validation of quantum algorithms for realistic molecular systems, supporting future industrial applications of quantum computing

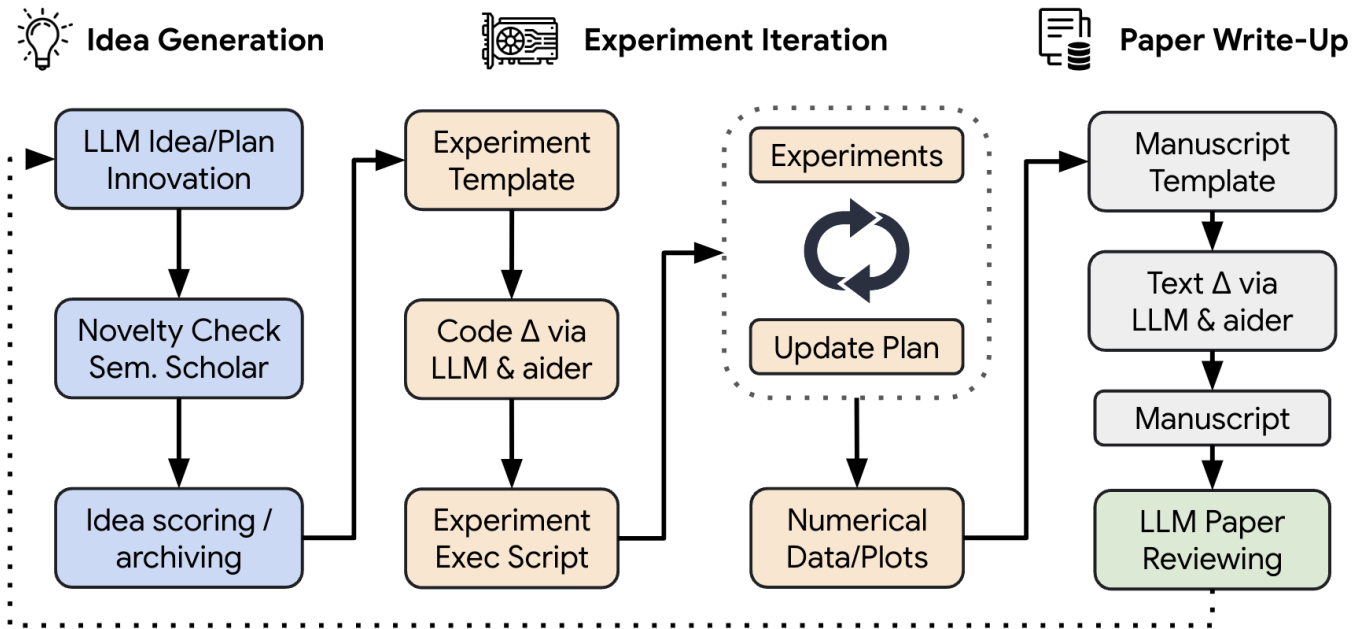


Demonstrates strong scalability



Research Vision: AI Scientist for Quantum Discovery

- FTQC is expected to become a reality in the 2030s.
- AI scientists autonomously drive scientific discovery using quantum computers.



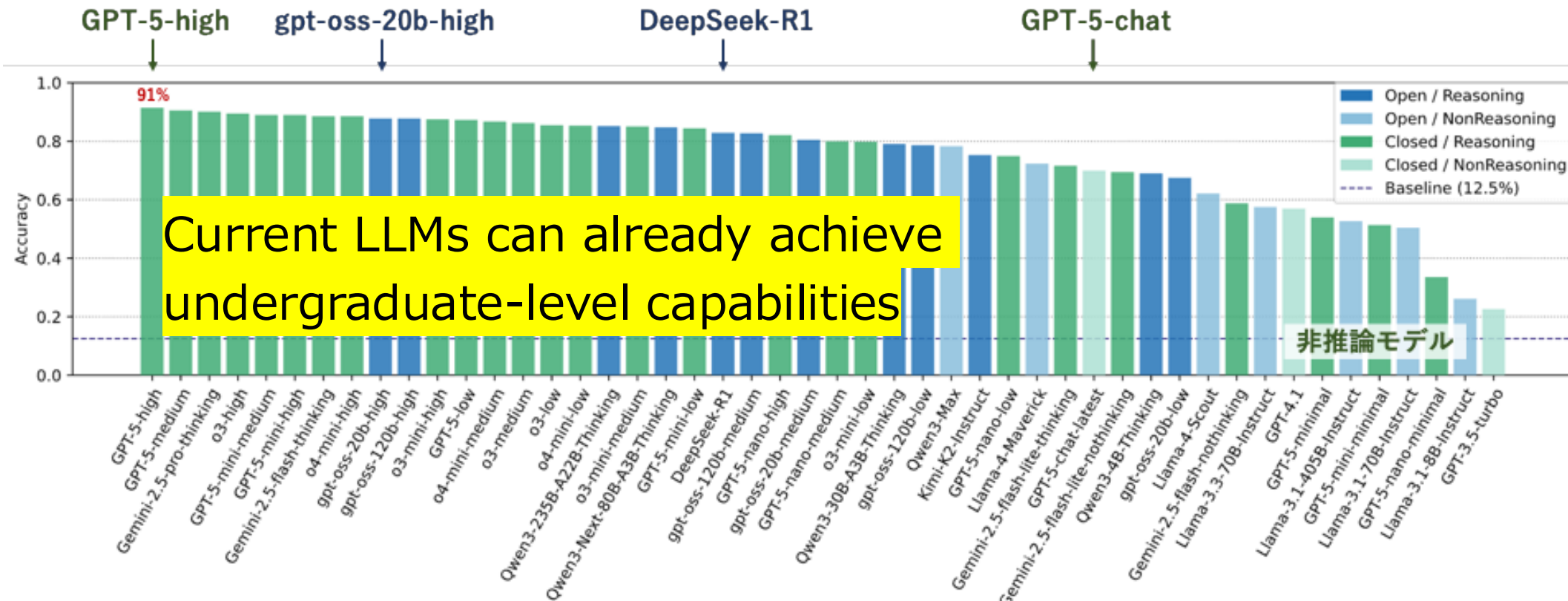
Generated by ChatGPT based on a photo from Wikipedia

Source: Lu et al., "The AI Scientist: Towards Fully Automated Open-Ended Scientific Discovery", Sakana AI (2024). <https://sakana.ai/ai-scientist/>

QuantumBench

- ▶ A benchmark for evaluating LLM performance in the quantum domain
- ▶ Composed of standard undergraduate-level questions

Code



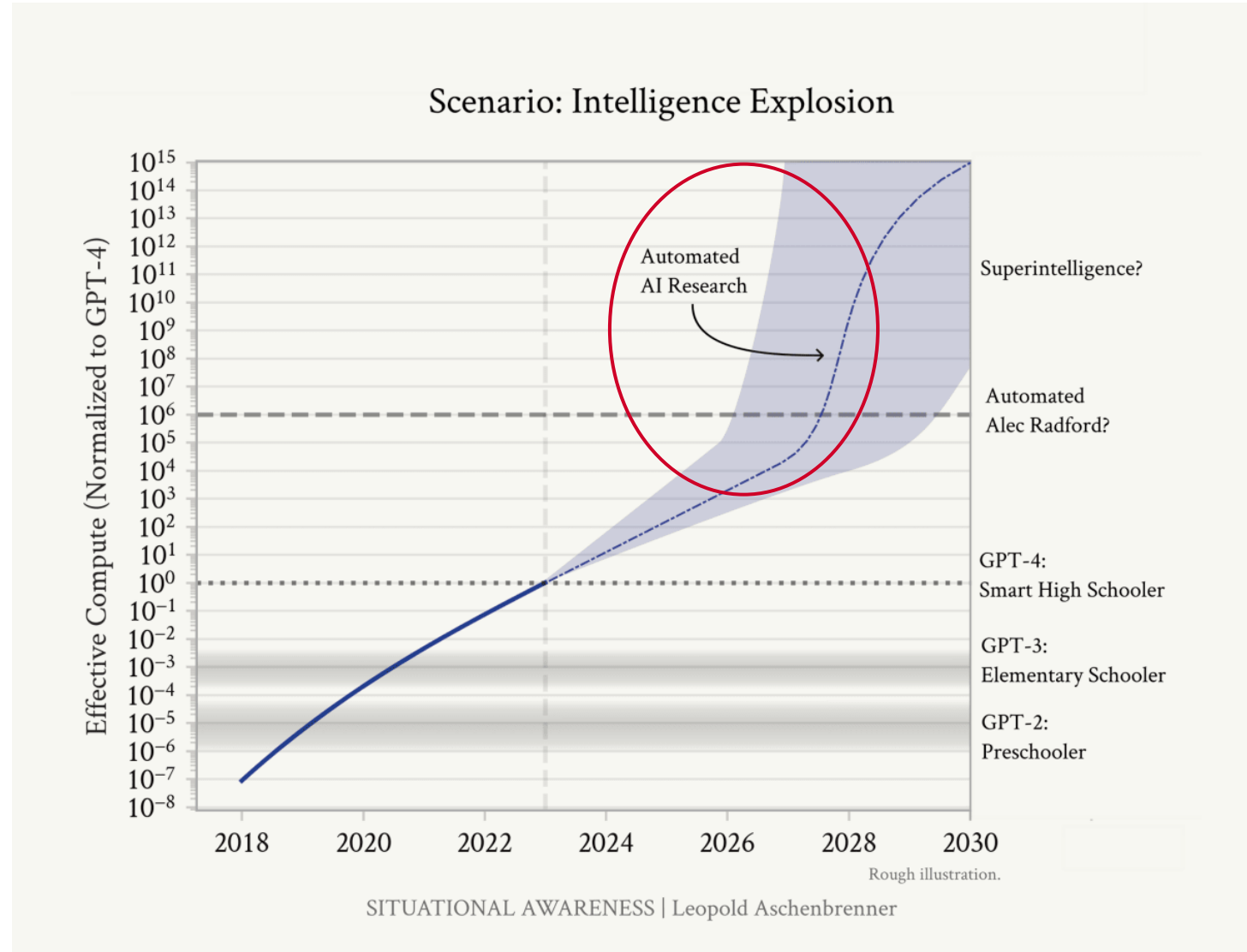
LLMs are advancing rapidly, and **AI research automation** could dramatically accelerate progress—and it's likely to keep advancing.

February 13, 2026 Research Publication

GPT-5.2 derives a new result in theoretical physics

In a new preprint, GPT-5.2 proposed a formula for a gluon amplitude later proved by an internal OpenAI model and verified by the authors.

<https://openai.com/new-result-theoretical-physics/>

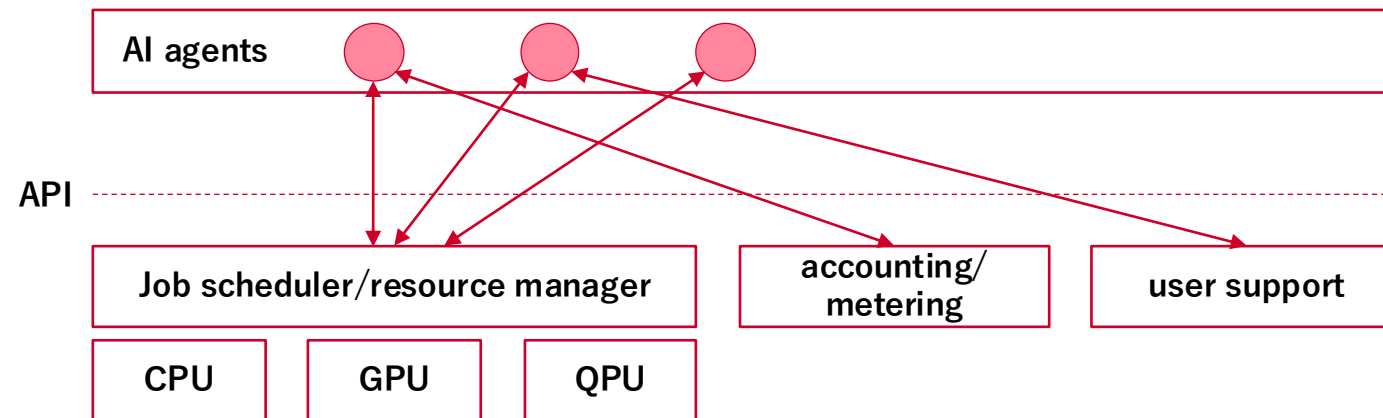


L. Aschenbrenner, "Situational Awareness," June 2024

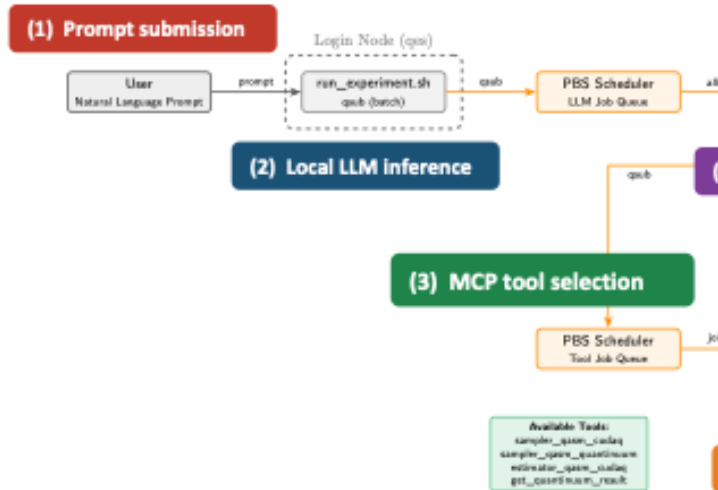
<https://situational-awareness.ai>

Paradigm shift: From human-centric to agent-centric operation

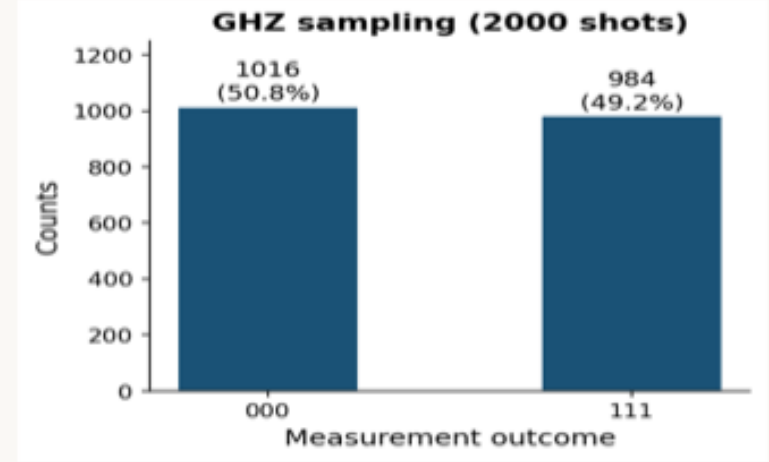
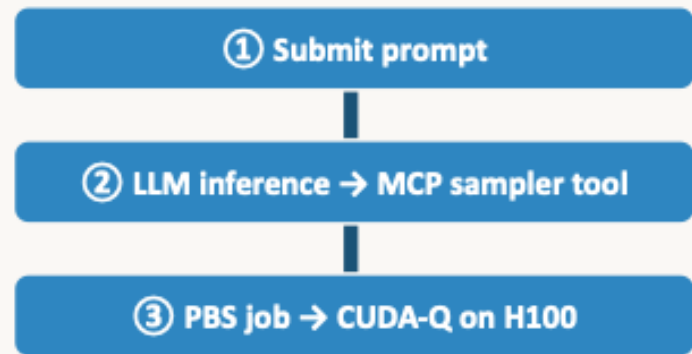
- AI agents autonomously create and execute jobs through continuous interaction with systems.
- APIs, schedulers, security, governance, billing, and user support are redesigned for agent-centric operation.
- Unified automation of operations and monitoring is essential for classical computers as well as quantum computers.



Our system: Local LLM + MCP + hybrid quantum backends



Result 1: Automated GHZ sampling on ABCI-Q Supercomputer (GPU Nodes*)



$|000\rangle \approx 0.50, |111\rangle \approx 0.50$

Input prompt (from paper):
"Prepare a 3-qubit GHZ state in OpenQASM 2.0 and measure it 2000 times using sampler_qasm_cudaq."

* Noise-less simulator (on H100)

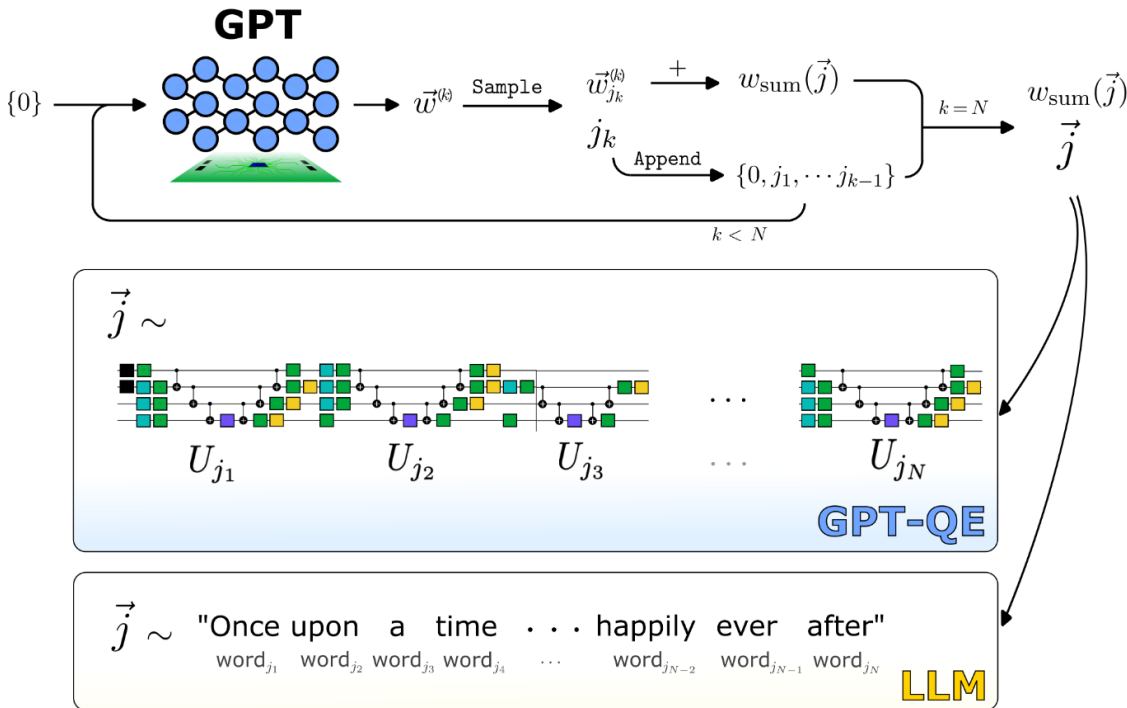
Local deployment keeps execution inside ABCI-Q

QC4C3 @ QCNC 2026 | Masaki Shiraishi

QC4C3 @ QCNC 2026 | Masaki Shiraishi

GQE: Generative Quantum Eigensolver

- Analogous to text generation with language models, a Transformer is used to generate quantum circuit.



GQCO

- A quantum circuit generator based on an encoder-decoder Transformer architecture for solving arbitrary combinatorial optimization problems.

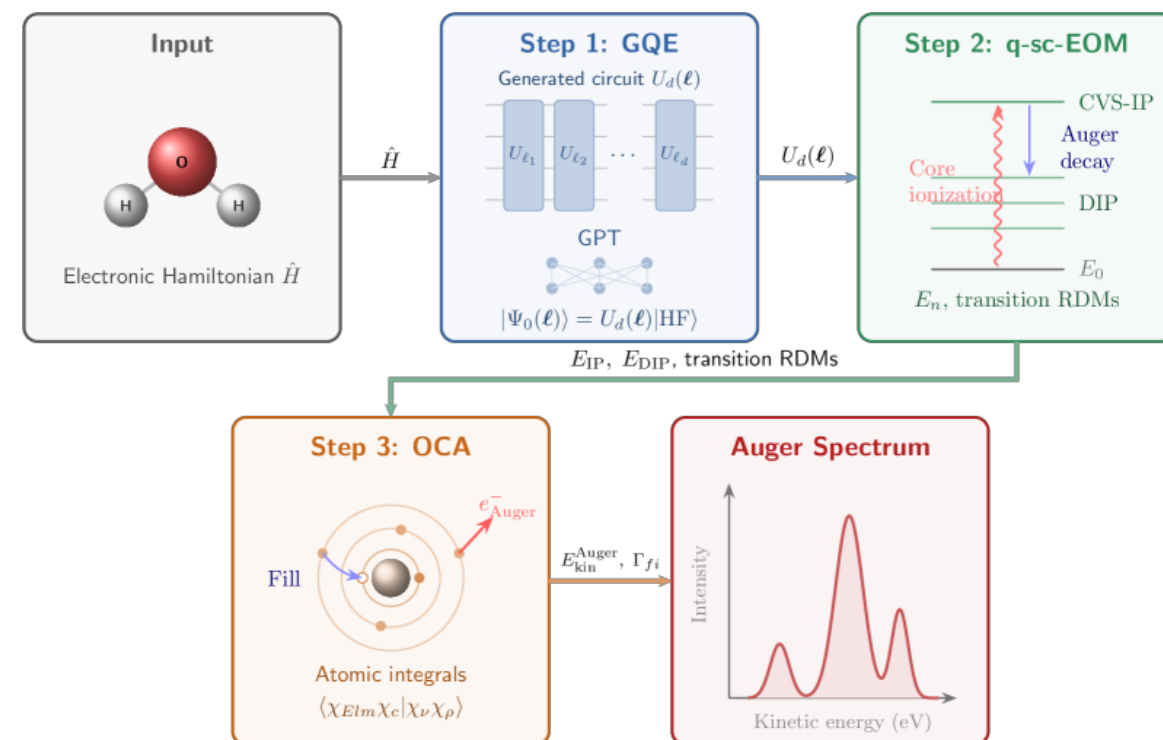
Code



GQCO Web App

Generated circuits match FCI and experiment for H₂O Auger spectra

- Auger spectroscopy needs **many excited states**
- **Hybrid quantum-classical**
— GQE + q-sc-EOM + OCA
- GPU-accelerated via **CUDA-Q**
- Validated on **H₂O** — matches FCI & experiment
- **GQE halves gate count** vs. VQE

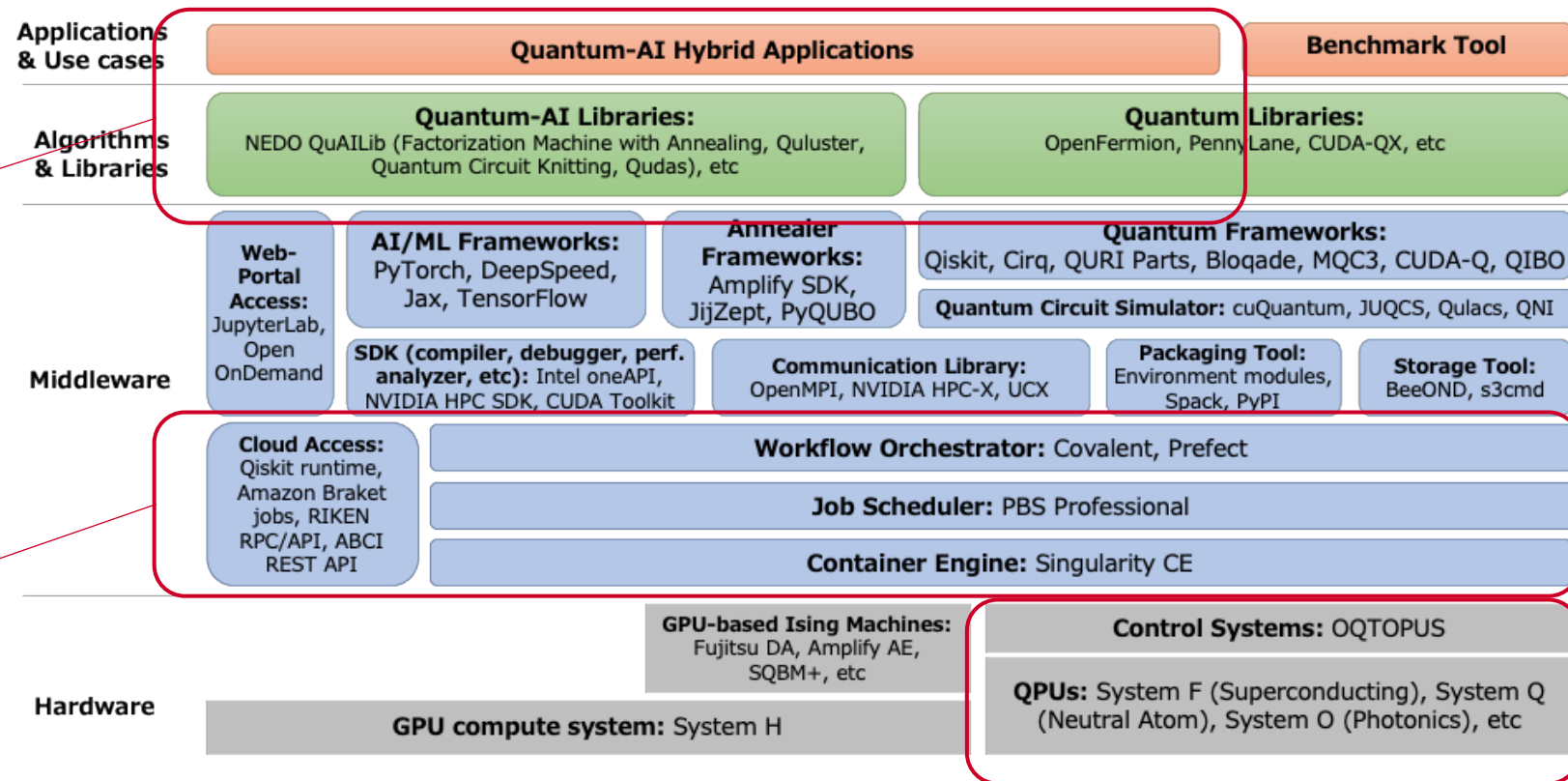


- Quantum computing is becoming more data-driven.
- For example, **NVIDIA Ising**, an open AI mode, introduces AI-powered workflow: calibration, QEC decoder.
- Open data is essential to accelerate data-driven research.
- Challenges toward data-driven Quantum x AI
 - Lack of standard data formats
 - Ensuring reproducibility
 - Limited access to real quantum hardware
- We are working on a common data schema called **Q-DATA** and **open datasets**.



ABCI-Q as an AI-HPC-QC Integration Platform

- ABCI-Q is not just a collection of systems — it is a platform for integrating and co-evolving AI, HPC, and quantum computing.



Quantum-AI hybrid Algorithms & Applications

Agentic workflow

AI-powered QPU control plane

***We are looking for partners to collaborate in building
AI-HPC-QC hybrid platforms.
Thank you for your attention!***



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