



NORMA
Utilizing Quantum Algorithms
with Q Platform



The Next Q Platform

Norma leads in quantum innovation, providing a unique platform for superior computing and robust Post-Quantum Cryptography (PQC) security. As pioneers, we accelerate the quantum era's growth with our expertise in computing and security.

Norma Quantum Services

Q Platform | Operating System

Provides quantum simulators and SDKs

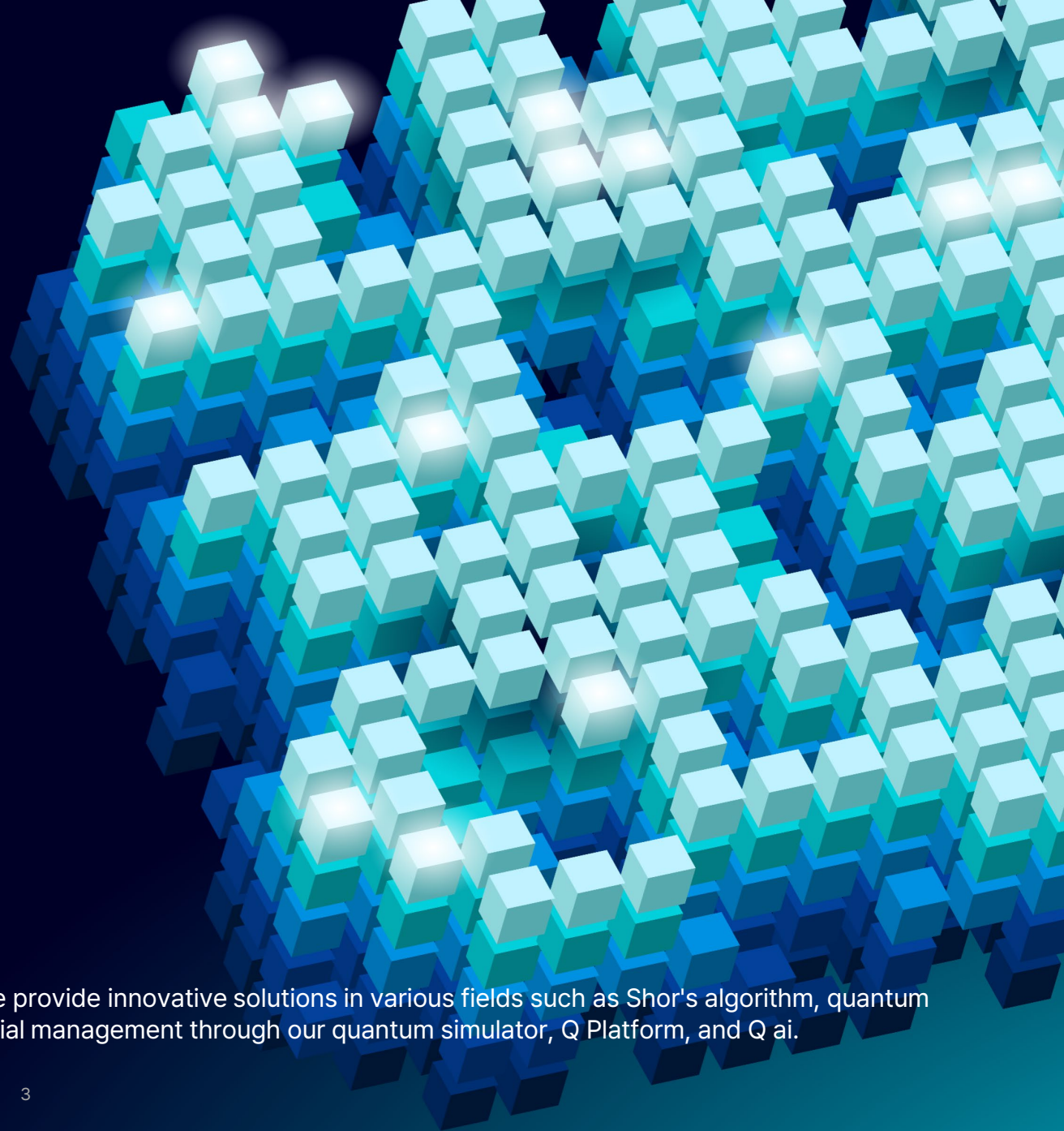
Q AI | Application

Supports quantum AI solutions for technological innovation

Q Computing | Hardware

R&Ds, Consults for quantum computers

- As the only company in Korea developing quantum supremacy applications, we provide innovative solutions in various fields such as Shor's algorithm, quantum traffic management systems, quantum drug development, and quantum financial management through our quantum simulator, Q Platform, and Q ai.



Norma Quantum Services

Q AI

Pharmaceuticals/Biotechnology

Finance

INPUT: processed past payment data

OUTPUT: Probability of delinquency for the payment

New Materials

$$\rho = \{ \dots \}$$

$$E = \sum_{i=1}^N E_i(\rho_i)$$

Aerospace/Space Exploration

Q Platform

Simulator

SDK

Q Computing

R&D

Consulting

Q Platform

NORMA

Q Platform

The Q Platform is an innovative platform that leverages the principles of quantum mechanics to enable complex computations. It provides a user-friendly development environment and powerful simulation tools, significantly enhancing the accessibility and efficiency of quantum computing.

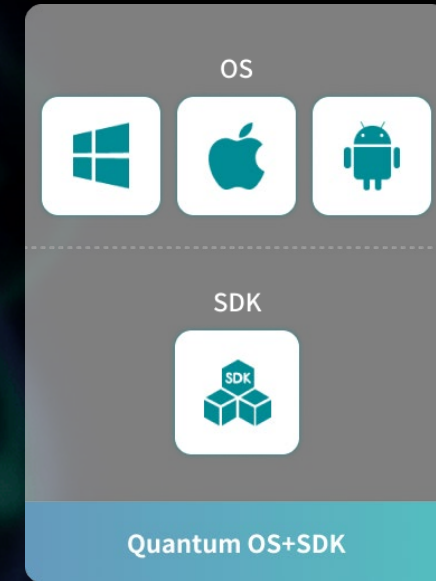
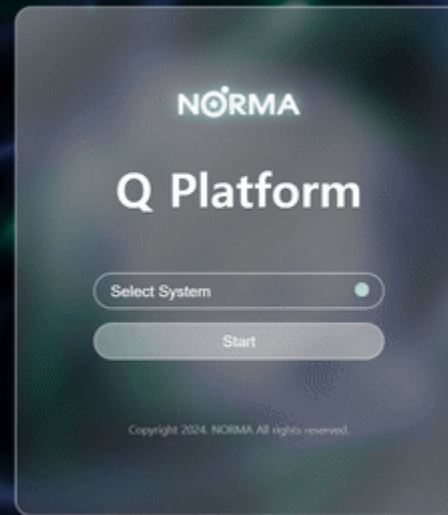


Features

- Innovative quantum computing platform based on the principles of quantum mechanics.
- Utilizes interference and entanglement to perform complex calculations.
- Applicable to various tasks including factorization and quantum simulation.

Main Components

- Quantum Portal: Supports access to various quantum computing resources and tools.
- Quantum SDK: Provides a comprehensive environment from quantum circuit design to execution.
- Quantum Simulator: Supports quantum circuit simulation on classical computers.



Functionality

- Provides a user-friendly environment to enhance accessibility to quantum computing.
- Supports compatibility with various operating systems and third-party platforms.

Q Platform

The Q Platform enables users to explore new solutions through quantum technology, solve tangible problems, and lead future-oriented innovations. It is an essential tool for realizing the potential of quantum computing and driving industry-wide changes.

Norma Quantum Portal

- An intuitive web-based interface that allows developers and researchers easy access to quantum computing resources and tools.

Norma Quantum SDK

- A comprehensive development kit that makes it easy to design, compile, and execute quantum circuits.

Norma Quantum Simulator

- A powerful simulation tool that allows for testing and optimizing quantum algorithms on classical computers before actual quantum hardware.

Key Features - Education

We offer education on fundamental technologies such as quantum theory and circuits, as well as a variety of quantum development examples and tutorials, including quantum algorithms, machine learning, optimization, and simulation.

The screenshot shows the QPlatform website interface. At the top, there is a navigation bar with the QPlatform logo and links for 'Compute resources', 'Jobs', 'Docs', 'Education', and 'Select System'. The main heading is 'Norma Quantum Education' with a subtext 'Learn the basics of quantum computing, and how to use Quantum services and systems.' Below this, there is a 'Tutorials' section with the text 'Learn how to apply Quantum technology to your workflow and explore utility-scale examples.' Two tutorial cards are visible: 'Quantum Computing Guide with Qiskit' and 'Quantum AI Guide with PennyLane', each with a 'Start' button. At the bottom, there is a 'Quantum experience' section with the text 'Quantum circuit design and testing experience tool.' and three buttons: 'Norma Quantum Circuit', 'Circuit playground', and 'Circuit tutorials'.

The screenshot shows the Norma Quantum Education interface. On the left, there is a sidebar with the 'NORMA' logo and links for 'Introducing Qjs', 'Circuit playground' (highlighted), 'Circuit tutorials', and 'API documentation'. The main area displays a quantum circuit playground with a grid of qubits (0-6) and gates (H, X). Below the circuit, there is a 'Result probabilities' section showing a list of binary strings and their corresponding probabilities (all 0% chance).

The screenshot shows the Norma Quantum Education interface in a code editor. The top bar includes 'NORMA' and various menu options like 'File', 'Edit', 'View', 'Run', 'Kernel', 'Tabs', 'Settings', and 'Help'. The main area displays a quantum circuit diagram with four qubits (0-3) and four 'ApproxTimeEvolution' gates. Below the circuit, there is a code block with the following content:

```
[1] if Qiskit: parameters
weights = 0.5*np.ones((2, num_layers), requires_grad = True)
opt = optim.Adam(parameters)
for i in range(10):
```

Key Features - User Guide and Application

We provide comprehensive documentation, including a user guide on how to use and apply the Norma Quantum Platform and an API reference for backend integration with simulators and quantum computers.

The screenshot shows the 'Quick Start' page of the Norma Quantum Platform documentation. The page has a blue header with the 'norma provider' logo and a search bar. The main content area is titled 'Quick Start' and includes a sub-header 'Quick example of how to run a Qiskit circuit using the Norma SDK:'. Below this is a code block with Python code for running a Qiskit circuit. The code imports 'qiskit' and 'norma_provider', sets up a provider and backend, creates a quantum circuit with 3 qubits, and runs it. Below the Qiskit code is another sub-header 'An example of how to run a PennyLane circuit using the SDK:' followed by a code block for a PennyLane circuit. The page also features 'Previous' and 'Next' navigation buttons and a copyright notice for 2024.

```
from qiskit import *
from norma_provider import Norma

Norma.save_account('<token>')
Norma.load_account()

provider = Norma.get_provider()
backend = provider.get_backend("<simulator>")

circ = QuantumCircuit(3)
circ.h(0)
circ.cx(0, 1)
circ.cx(0, 2)

job = backend.run(circ)
result = job.result()
```

```
import pennylane as qml
from pennylane import numpy as np

dev = qml.device('qiskit.norma', wires=1, backend="<simulator>", token="<token>")

@qml.qnode(dev)
def circuit(angle):
    qml.RY(angle, wires=0)
    return qml.probs(wires=0)

probabilities = circuit(np.pi / 4)
```

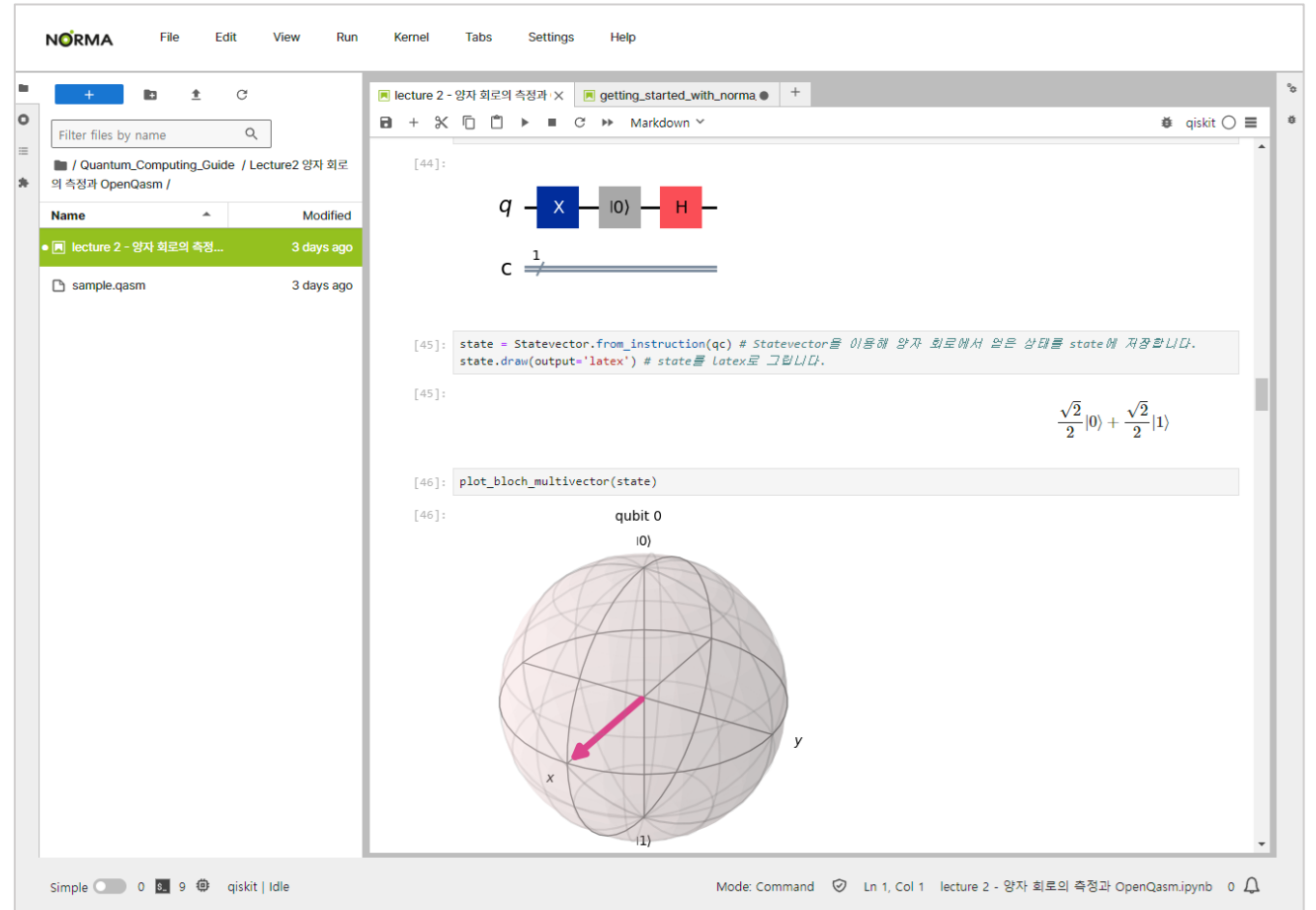
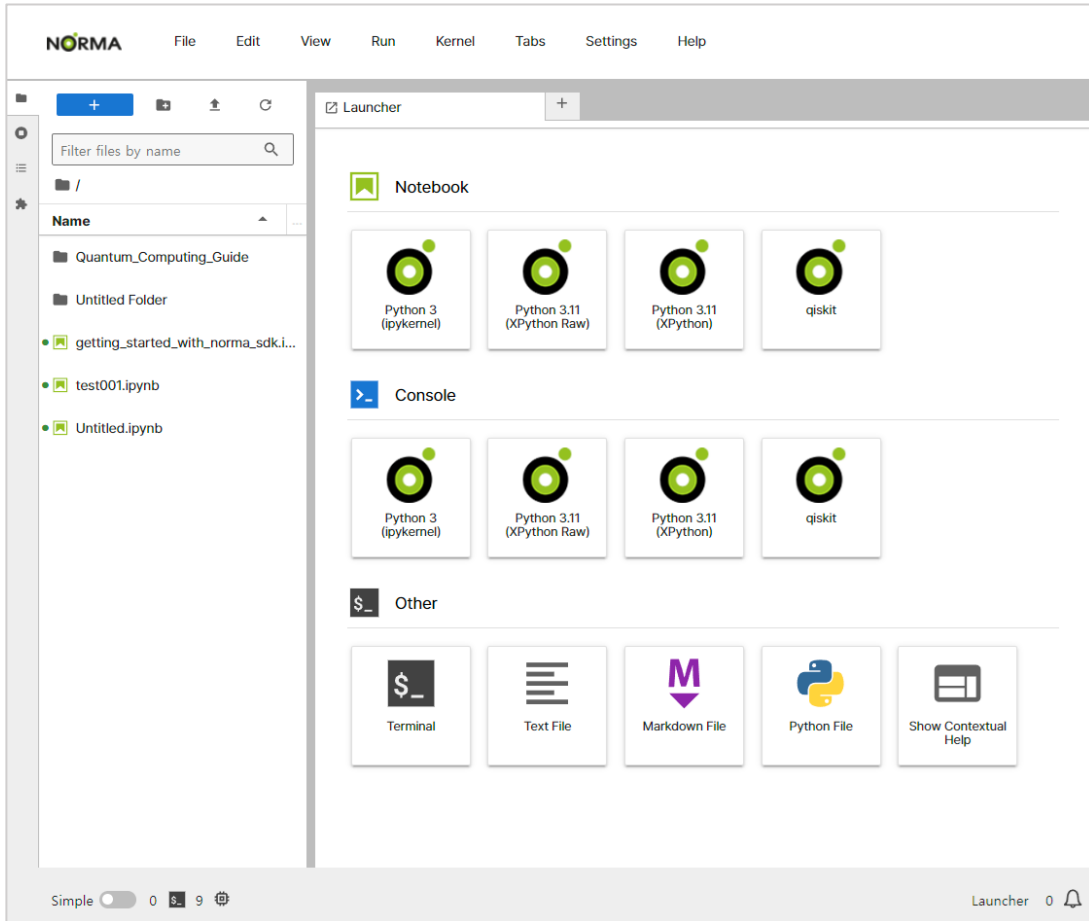
The screenshot shows the 'norma_provider package' API reference page. The page has a blue header with the 'norma provider' logo and a search bar. The main content area is titled 'norma_provider package' and lists several classes and methods. The 'NormaAccount' class is highlighted, showing its base class as 'object' and a method 'save_account(api_token)'. The 'NormaProvider' class is also highlighted, showing its base class as 'object' and methods 'load_account()', 'get_provider()', and 'get_token()'. The 'NormaProvider' class is further detailed, showing its base class as 'object' and methods 'backends()' and 'get_backend(backend_name=None)'. The page also features a 'View page source' link and a copyright notice for 2024.

```
class norma_provider.norma_provider.NormaAccount
    Bases: object
    save_account(api_token)
        Save the API key to access the Norma simulator.
        Parameters:
            api_token (str) - API token of the user.
    load_account()
        Authenticate your API key to access the Norma simulator.
    get_provider()
        Returns NormaProvider instance to access the Norma simulator.
        Return type: NormaProvider
    get_token()
        Returns the saved Norma token.
        Return type: str

class norma_provider.norma_provider.NormaProvider(api_token, response)
    Bases: object
    backends()
        Returns available backend names.
        Return type: list[str]
    get_backend(backend_name=None)
```

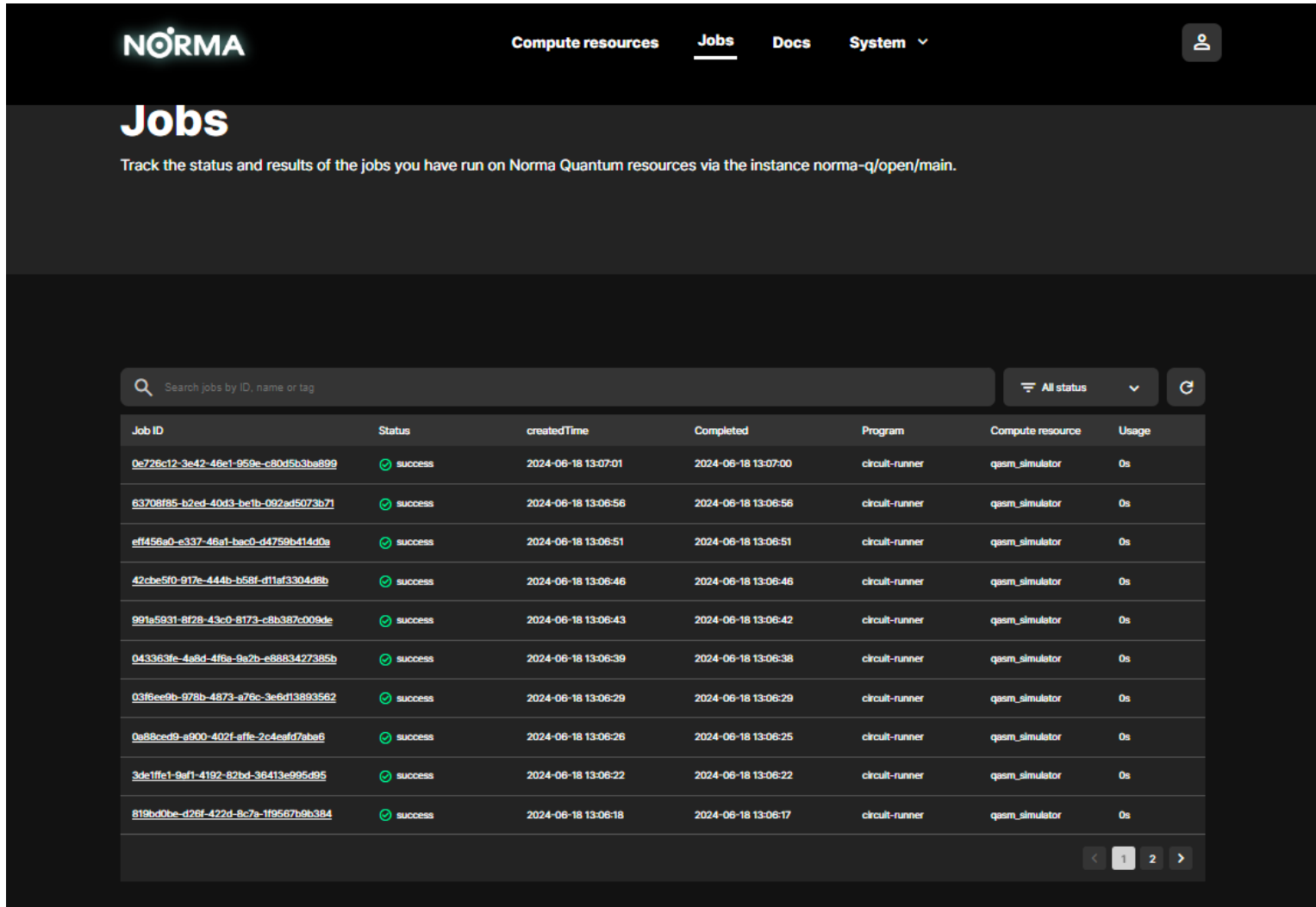
Key Features - SDK

The Norma Quantum SDK supports languages and libraries for programming quantum algorithms. It provides tools to develop complex quantum logic as modules and includes tools to integrate with Qubit backends.



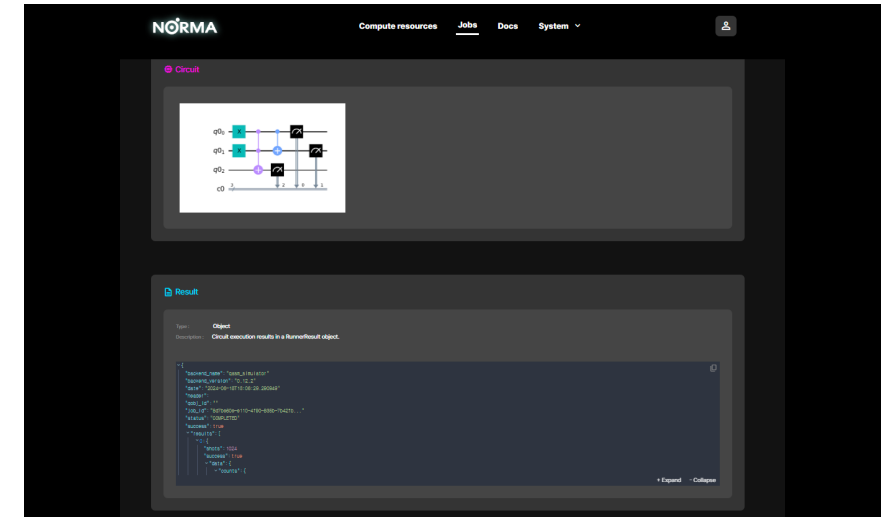
Key Features - Job History

Track, analyze, and reuse the execution history of quantum programming tasks to enhance job efficiency and achieve cost savings.



The screenshot shows the NORMA Jobs page. At the top, there are navigation links for "Compute resources", "Jobs", "Docs", and "System". Below the navigation is a search bar with the text "Search jobs by ID, name or tag". To the right of the search bar is a filter dropdown set to "All status" and a refresh icon. The main content is a table with the following columns: Job ID, Status, createTime, Completed, Program, Compute resource, and Usage. The table contains 10 rows of job history data, all with a status of "success".

Job ID	Status	createTime	Completed	Program	Compute resource	Usage
0e726c12-3e42-46e1-959e-c80d5b3ba899	success	2024-06-18 13:07:01	2024-06-18 13:07:00	circuit-runner	qasm_simulator	0s
63708f85-b2ed-40d3-be1b-092ad5073b71	success	2024-06-18 13:06:56	2024-06-18 13:06:56	circuit-runner	qasm_simulator	0s
eff456a0-e337-46a1-bac0-d4759b4140a0	success	2024-06-18 13:06:51	2024-06-18 13:06:51	circuit-runner	qasm_simulator	0s
42cbe9f0-917e-444b-b58f-d11af3304dbb	success	2024-06-18 13:06:46	2024-06-18 13:06:46	circuit-runner	qasm_simulator	0s
991a5931-8f28-43c0-8173-c8b387c009de	success	2024-06-18 13:06:43	2024-06-18 13:06:42	circuit-runner	qasm_simulator	0s
043363fe-4a6d-4f6a-9a2b-e8883427385b	success	2024-06-18 13:06:39	2024-06-18 13:06:38	circuit-runner	qasm_simulator	0s
03f6ee9b-978b-4873-a76c-3e6df3893562	success	2024-06-18 13:06:29	2024-06-18 13:06:29	circuit-runner	qasm_simulator	0s
0a88ced9-a900-402f-affe-2c4eafd7aba6	success	2024-06-18 13:06:26	2024-06-18 13:06:25	circuit-runner	qasm_simulator	0s
3de1fe1-9af1-4192-82bd-36413e995d95	success	2024-06-18 13:06:22	2024-06-18 13:06:22	circuit-runner	qasm_simulator	0s
819bd0be-d26f-422d-8c7a-1f9567b9b384	success	2024-06-18 13:06:18	2024-06-18 13:06:17	circuit-runner	qasm_simulator	0s



The screenshot shows the NORMA interface for a specific job. At the top, there are navigation links for "Compute resources", "Jobs", "Docs", and "System". Below the navigation is a search bar. The main content is divided into two sections: "Circuit" and "Result". The "Circuit" section displays a quantum circuit diagram with qubits and gates. The "Result" section displays the execution results in a code editor, showing a JSON object representing the circuit execution results.



The screenshot shows the NORMA interface for a specific job. At the top, there are navigation links for "Compute resources", "Jobs", "Docs", and "System". Below the navigation is a search bar. The main content is divided into two sections: "Histogram" and "Circuit". The "Histogram" section displays a bar chart showing the frequency of measurement outcomes. The "Circuit" section displays a quantum circuit diagram with qubits and gates.

Q Platform Use Cases - RSA Key Cracking

The Q Platform has a practical use case where it demonstrated an attack using a quantum computer to crack RSA keys.

```
edit View Run Kernel Tabs Settings Help
Python 3 (ipykernel)

if flag == 0:
    print("Algorithm failed. Try again.")

if __name__ == '__main__':
    ### Change here ###
    N = 12319
    #####

    ### DO NOT CHANGE HERE ###
    n = math.ceil(math.log(N, 2))
    print("<<< RSA-{} attack process >>>".format(n))
    print("Factoring target N = {}".format(N))
    print(' ')
    print("*****")
    print("*** Shor's algorithm started ***")
    print("*****")
    print(' ')

    while True:
        a = randint(1, N - 1)
        print("Random a = {}".format(a))
        g = gcd(a, N)
        if g != 1:
            print("No quantum period-finding subroutine.")
            print('Factorization done successfully.')
            print('{} = {} * {}'.format(N, g, N // g))
            break
        else:
            print("Quantum period-finding subroutine required.")
            quantum_period_finding_subroutine(a, N)
            break

<<< RSA-14 attack process >>>
Factoring target N = 12319

*****
*** Shor's algorithm started ***
*****

Random a = 9985
Quantum period-finding subroutine required.
Quantum circuit compiled successfully.
JobStatus.VALIDATING
-----
Quantum simulation done successfully.
-----
*****
12319 = 97 * 127
```

1h 54m 59.4s
Total completion time

Takes 1 hour and 54 minutes

simulator_mps
Compute resource

- Created: Jan 27, 2023 12:07 PM
- Transpiling
- Validating: 10.9s
- In queue: 977ms
- Running: 1h 54m 40.3s
time in system 1h 54m 38.4s
- Completed: Jan 27, 2023 2:02 PM

Sent from: Quantum lab
Created on: Jan 27, 2023 12:07 PM
Sent to queue: Jan 27, 2023 12:07 PM
Provider: ibm-q/open/main
Run mode: fairshare
of shots: 100
of circuits: 1

Histogram

97, argument of 12319, outputs 127

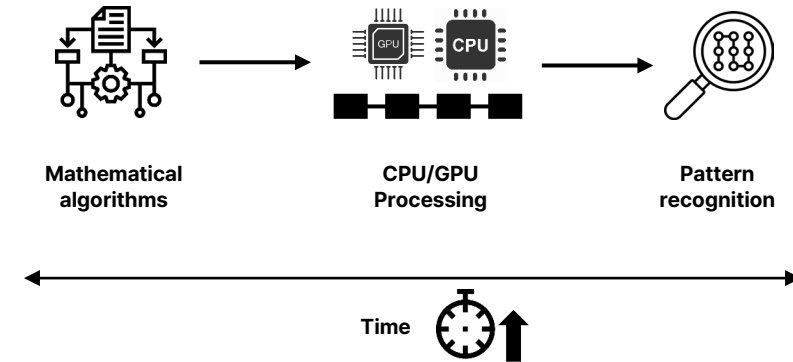
Q AI

NORMA

Advantages of Q AI

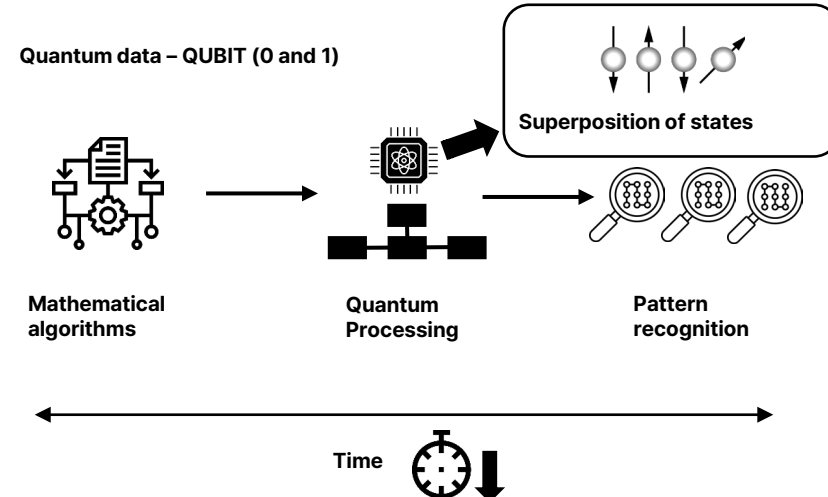
Classical Machine Learning - CML

Classical data – BIT (0 or 1)



Quantum Machine Learning - QML

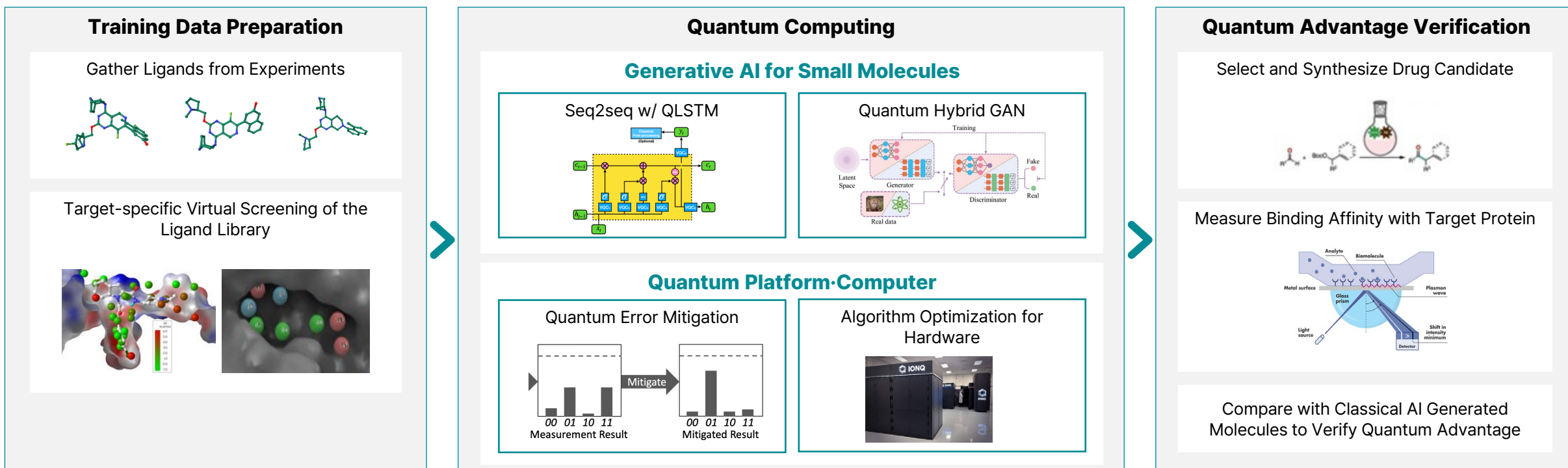
Quantum data – QUBIT (0 and 1)



Advantages of using Quantum Computers for AI

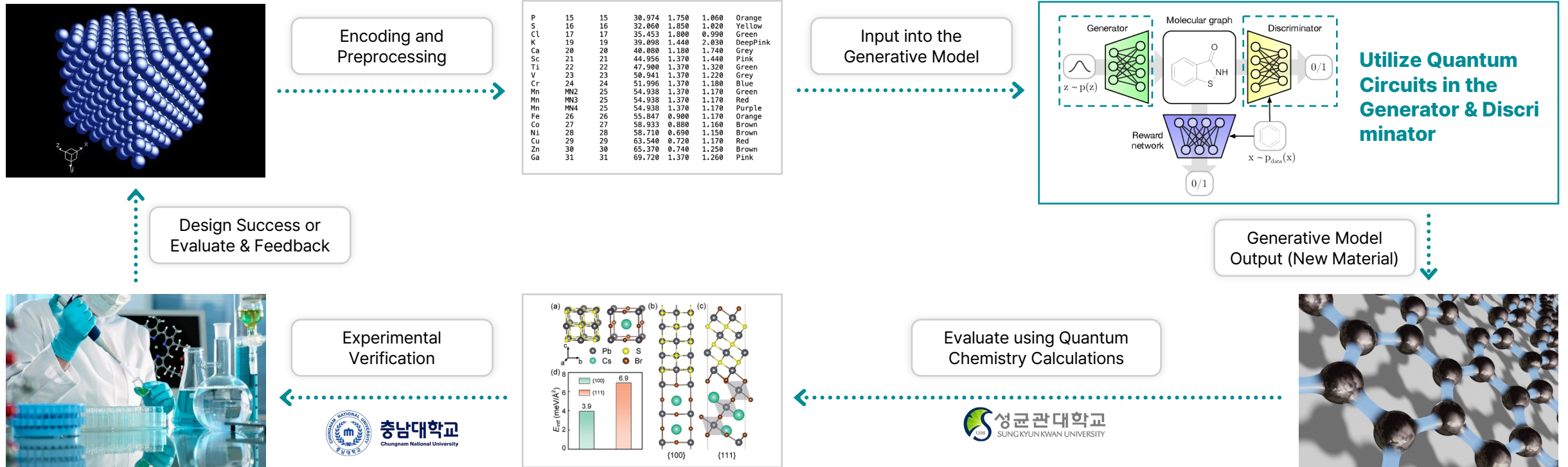
- Useful when large computational resources are needed for training high dimensional data
- Utilizes superposition and entanglement
- **Speed-up over conventional methods in certain cases**

Q AI Use Case – inCerebro Drug Design Project



- Generate ligands that act as inhibitors of a target protein
- Train AI using available ligand datasets → Generate ligands using the trained model → Verification with in vitro experiments
- Potentially achieve quantum advantage using quantum machine learning models (QLSTM, QGAN)
- **Received research grant from the National Research Foundation of Korea**

Q AI Use Case- CO2 Reduction Reaction Catalyst Design



- The electrochemical CO2 reduction reaction (CO2RR) decreases CO2 emissions and creates useful byproducts
- Discovering promising CO2RR catalysts has become a meaningful task, with machine learning being applied to accelerate discovery
- This project aims to create new catalysts using generative quantum machine learning

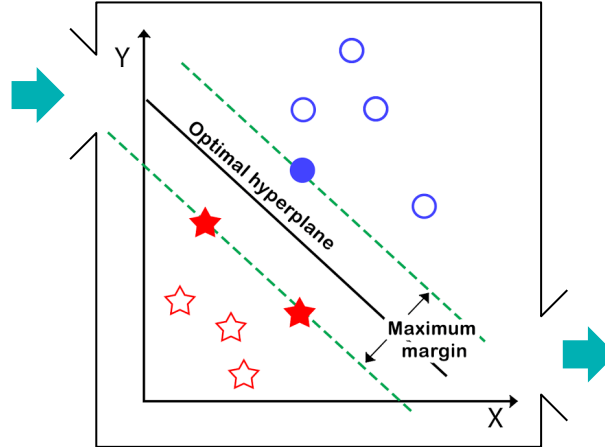
Q AI Use Case - HectoFinancial Quantum Credit Scoring System (CSS)

Input

Historical payment data

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	...	V22	V23	V24
0	-1.359807	-0.072781	2.536347	1.378155	-0.338321	0.462388	0.239599	0.098698	0.363787	0.090794	...	0.277838	-0.110474	0.066928
1	1.191857	0.266151	0.166480	0.448154	0.060018	-0.082361	-0.078803	0.085102	-0.255425	-0.166974	...	-0.639672	0.101288	-0.339846
2	-1.358354	-1.340163	1.773209	0.379780	-0.503198	1.800499	0.791461	0.247676	-1.514654	0.207643	...	0.771679	0.909412	-0.689281
3	-0.966272	-0.185226	1.792993	-0.863291	-0.010309	1.247203	0.237609	0.377436	-1.387024	-0.054952	...	0.005274	-0.190321	-1.175575
4	-1.158233	0.877737	1.548718	0.403034	-0.407193	0.095921	0.592941	-0.270533	0.817739	0.753074	...	0.798278	-0.137458	0.141267
5	-0.425966	0.960523	1.141109	-0.168252	0.420987	-0.029728	0.476201	0.280314	-0.588671	-0.371407	...	-0.559825	-0.026398	-0.371427
6	1.229658	0.141004	0.045371	1.202613	0.191881	0.272708	-0.005159	0.081213	0.464960	-0.099254	...	-0.270710	-0.154104	-0.780055
7	-0.644269	1.417964	1.074380	-0.492199	0.948934	0.428118	1.120631	-3.807864	0.615375	1.249376	...	-1.015455	0.057504	-0.649709
8	-0.894286	0.286157	-0.113192	-0.271526	2.669599	3.721818	0.370145	0.851084	-0.392048	-0.410430	...	-0.268092	-0.204233	1.011592
9	-0.338262	1.119593	1.044367	-0.222187	0.499361	-0.246761	0.651583	0.069539	-0.736727	-0.366846	...	-0.633753	-0.120794	-0.385050
10	1.449044	-1.176339	0.913860	-1.375667	-1.971383	-0.629152	-1.423236	0.048456	-1.720408	1.626459	...	0.313894	0.027740	5.00512
11	0.384978	0.616109	-0.874300	-0.094019	2.924584	3.317027	0.470455	0.538247	-0.558895	0.309755	...	0.238422	0.009130	0.996710
12	1.249999	-1.221637	0.383930	-1.234899	-1.485419	-0.753230	-0.689405	-0.227487	-2.094011	1.323729	...	-0.483285	0.084668	0.392831
13	1.069374	0.287722	0.828613	2.712520	-0.178398	0.337544	-0.096717	0.115982	-0.221083	0.460230	...	0.074412	-0.071407	0.104744
14	-2.791855	-0.327771	1.641750	1.767473	-0.136588	0.807596	-0.422911	-1.907107	0.755713	1.151087	...	0.222182	1.020586	0.028317

including transaction dates, transaction amounts, and the number of delinquencies



Quantum machine learning-based credit evaluation models (QSVM, VQC)

Output

Probability of delinquency for the given payment

79%

- HectoFinancial utilizes past mobile payment histories of its users to develop a credit evaluation model.
- This model estimates future financial risk based on the past data of the individual being assessed.
- By applying quantum machine learning models (QSVM, VQC) to the traditional credit scoring system, the performance of the credit evaluation model is enhanced, resulting in improved predictions of delinquency probabilities for payments.



Quantum Computer Development/Service

Strategy for In-House Quantum Computer Development

Norma is committed to developing its own quantum computer by building a CUDA Quantum-based simulation infrastructure, incorporating global technologies, and promoting the commercialization of quantum technologies through Quantum AI.

Objectives

Advance quantum computer technology and foster an ecosystem through the development of applications utilizing Quantum AI

- ✓ Establish a development platform for the creation and application of AI algorithms based on quantum computing.
- ✓ Upgrade existing AI technologies with quantum computing and develop new Quantum AI applications.
- ✓ Promote industrial innovation and the commercialization of quantum technology.

Phase 1

Initial Infrastructure Research

- Goal: Establish a quantum development platform.
- Details: Create a user-friendly development environment to improve accessibility.
- Expected Outcomes: Activate quantum computing technology and validate initial technologies.

Phase 2

Development of GPU-Based High-Performance Quantum Simulator

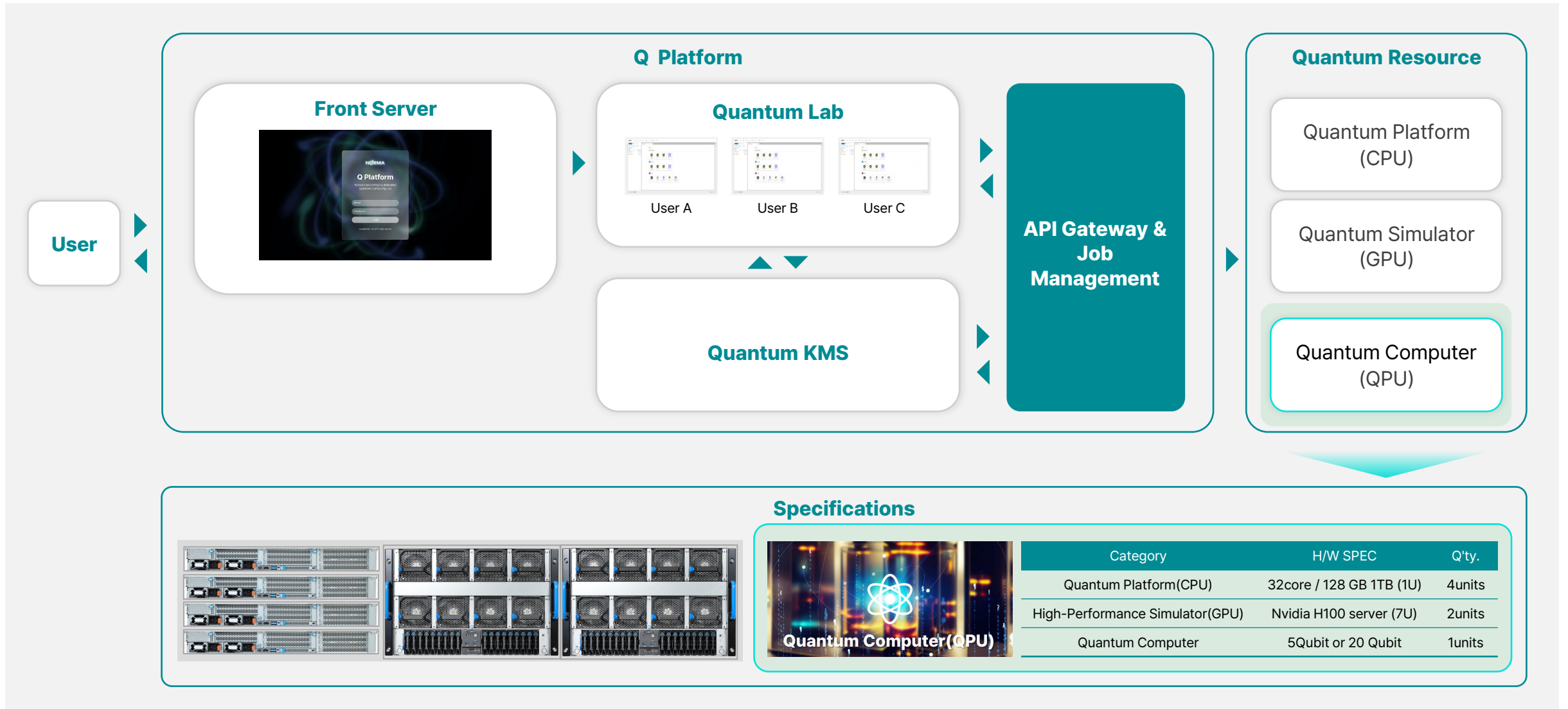
- Goal: Utilize the Nvidia CUDA Quantum platform to build a high-performance quantum simulator.
- Details: Provide a simulation environment for testing and validating complex quantum algorithms.
- Expected Outcomes: Accelerate research and development and develop demonstrable technologies.

Phase 3

Supply of Quantum Computers

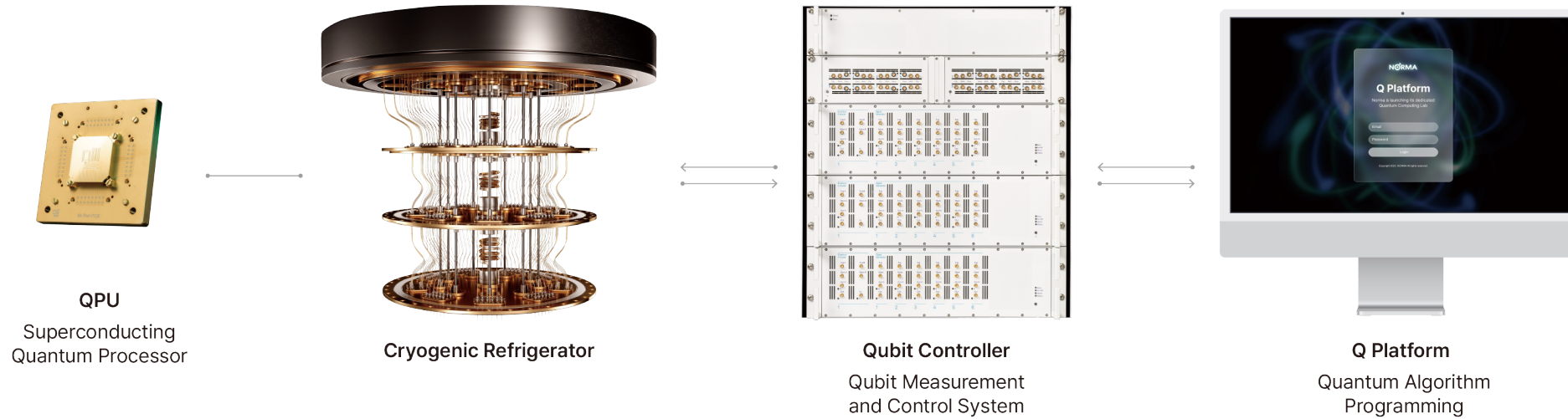
- Goal: Secure actual quantum computers through collaboration with domestic or global partners.
- Details: Enhance research capabilities by introducing leading technologies from around the world.
- Expected Outcomes: Commence practical quantum computing research and expand international collaboration networks.

Strategy for In-House Quantum Computer Development



In-House Quantum Computer Development

Q Computing is a quantum computer that operates with the Q Platform (OS), developed in collaboration with multiple companies, including VTT and BLUEFORS.



Joint Development



Norma Quantum Computer Development Roadmap





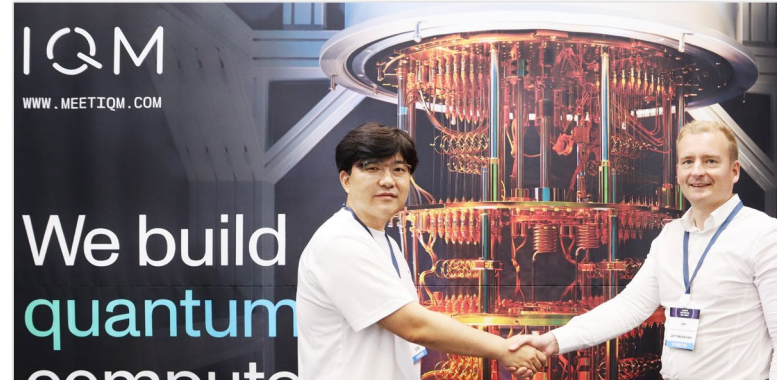
Business Strategy and Vision

Partnerships

Collaboration with leading quantum security and computing firms worldwide for joint solutions and technology exchange.



Established a PQC VPN with U.S. company IONQ and collaborated on quantum resources.



Partnered with Finland's IQM for quantum computing research and utilization in Europe.



Collaborated with IBM on utilizing quantum computing and PQC encryption.



Partnered with Entrust for PQC encryption standards in Europe.



Engaged in talks with France's Quandela for photonics-based quantum computing cooperation.



Signed an MOU with Saudi Arabia's ITB for exporting quantum security solutions.

Norma's European Tour for Quantum Computer Companies and Collaboration Discussions



NORMA Utilizing Quantum Algorithms with Q Platform Business Strategy and Vision

Norma's European Tour for Quantum Computer Companies and Collaboration Discussions



Pioneering in HPC Integration

Finland opens quantum computer for research purposes – the fusion of quantum computing and supercomputing enables completely new science

2022-11-01 · 6 minute read

Demonstration in Slush 18.11.2022

Task	Time	Success Rate
Q1	17:048	0% 121
Q2	17:112	0% 183
Q3	17:176	0% 183
Q4	17:240	0% 113
Q5	17:304	0% 203

Fast Lane to Quantum Advantage

IQM

Norma's Visit and Residency Discussions at Quantum Basel, Switzerland



NORMA Utilizing Quantum Algorithms with Q Platform Business Strategy and Vision



Global Quantum Alliance with IQM, VTT, BLUEFORS, NVIDIA, and More

Norma is forging a global quantum alliance with leading quantum companies through these strategic technological collaborations, we aim to create a superior quantum world



Norma's Global Partnerships





NORMA

Quantum Momentum

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