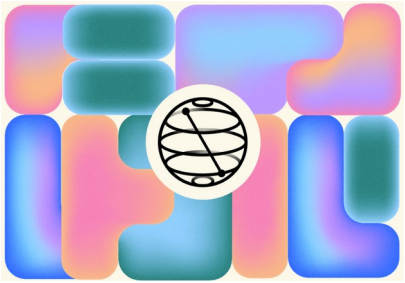
IBM Quantum Composer

Kevin J. Joven

Qiskit Fall Fest

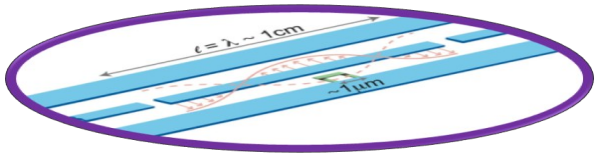


October 23, 2023

What is IBM Quantum Composer?

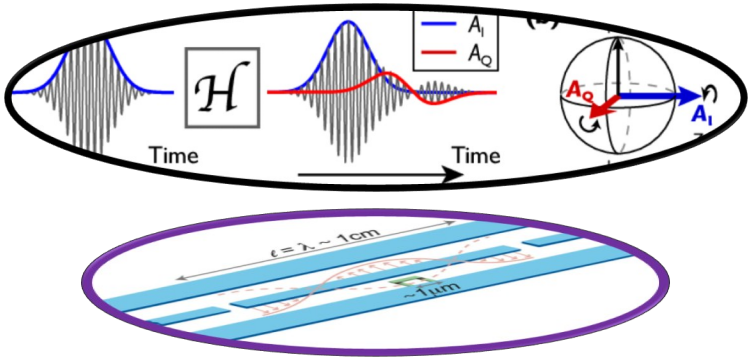
What is IBM Quantum Composer?

Microwave Electronics and cQED



What is IBM Quantum Composer?

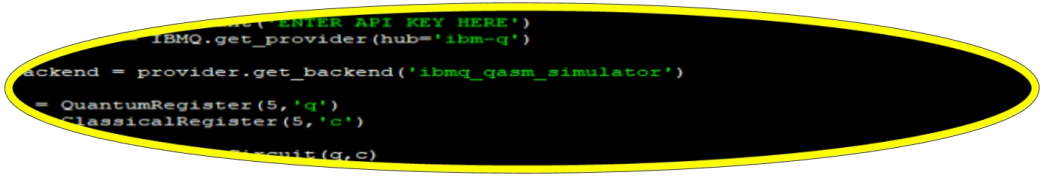
Qiskit Pulse and Transpile



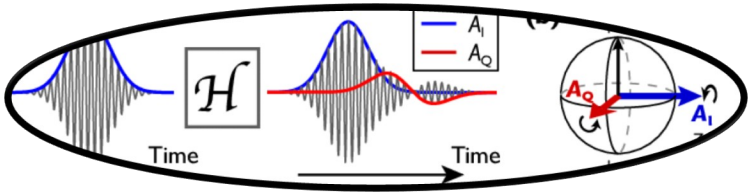
Microwave Electronics and cQED

What is IBM Quantum Composer?

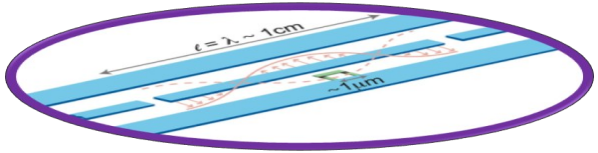
Qiskit Programming



Qiskit Pulse and Transpile



Microwave Electronics and cQED

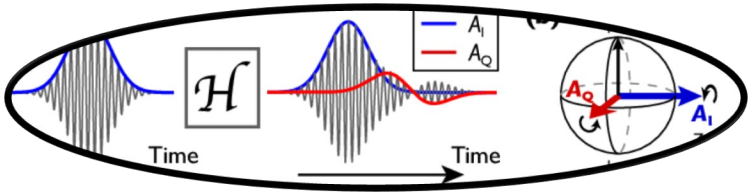


What is IBM Quantum Composer?

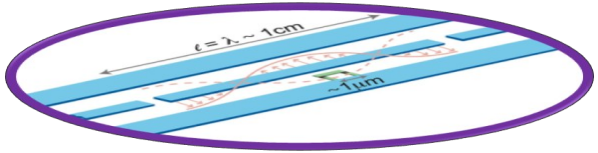
Qiskit Composer

Qiskit Programming

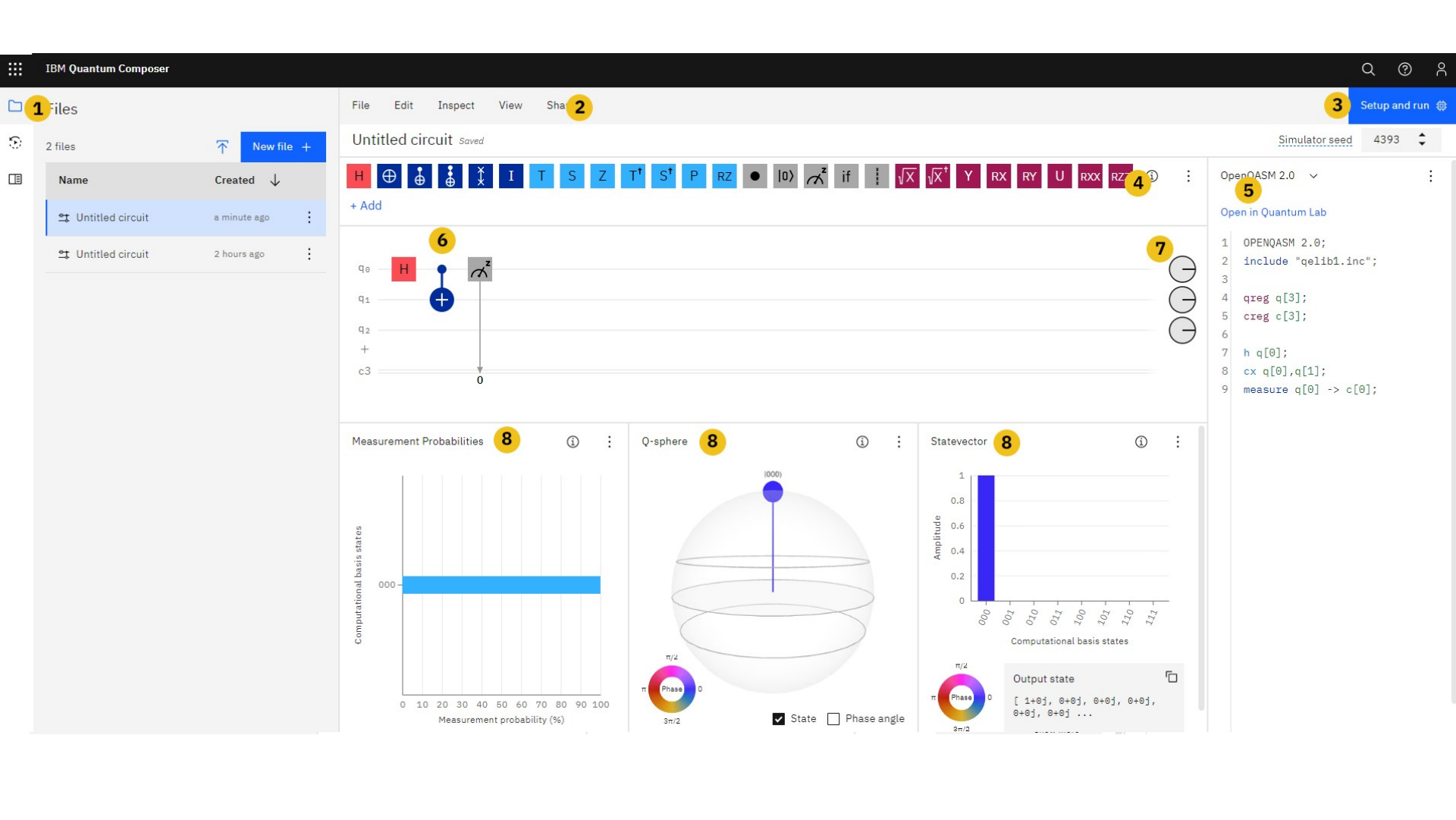
Qiskit Pulse and Transpile



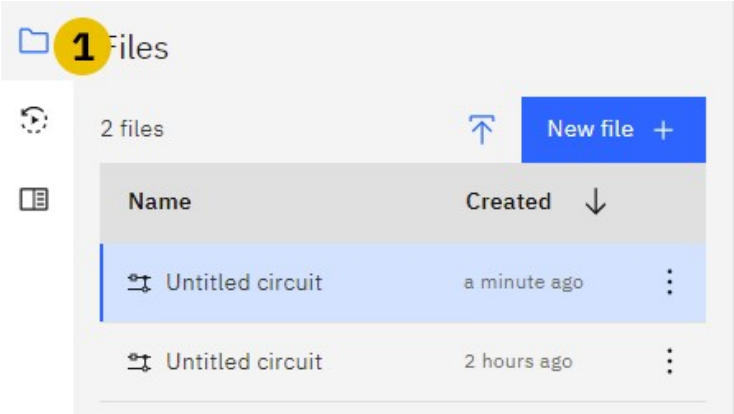
Microwave Electronics and cQED



How It looks like?

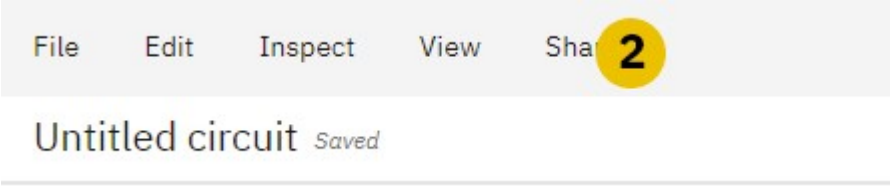

IBM Quantum Composer
1
Files
2 files
New file
Name
Created
Untitled circuit
a minute ago
Untitled circuit
2 hours ago
File
Edit
Inspect
View
Sha
2
3
Setup and run
Untitled circuit
Saved
Simulator seed
4393
H
I
T
S
Z
P
RZ
if
Y
RX
RY
U
RXX
RZZ
4
+ Add
6
7
q0
q1
q2
c3
0
OpenQASM 2.0
5
Open in Quantum Lab
OPENQASM 2.0;
include "qelib1.inc";
qreg q[3];
creg c[3];
h q[0];
cx q[0],q[1];
measure q[0] -> c[0];
Measurement Probabilities
8
Computational basis states
000
0 10 20 30 40 50 60 70 80 90 100
Measurement probability (%)
Q-sphere
8
|000⟩
π/2
Phase
3π/2
State
Phase angle
Statevector
8
Amplitude
1
0.8
0.6
0.4
0.2
0
000 001 010 011 100 101 110 111
Computational basis states
Output state
[1+0j, 0+0j, 0+0j, 0+0j,
0+0j, 0+0j ...

Divide and conquer

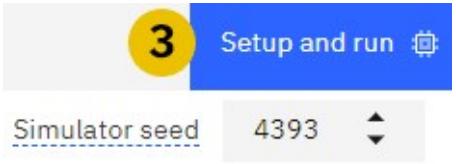


Tools Panel

Menu



Execution



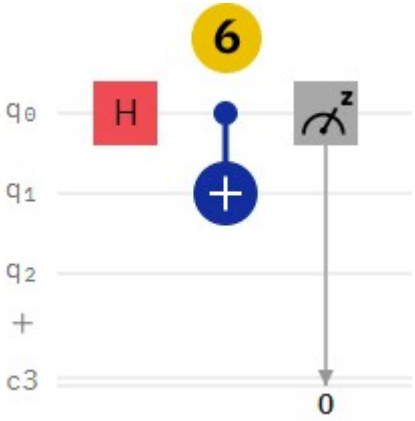
Divide and conquer

+ Add

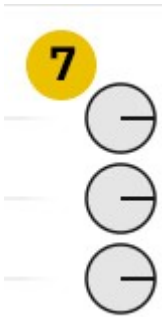
Quantum Gates

Code Output

Quantum Circuit



Final State



OpenQASM 2.0

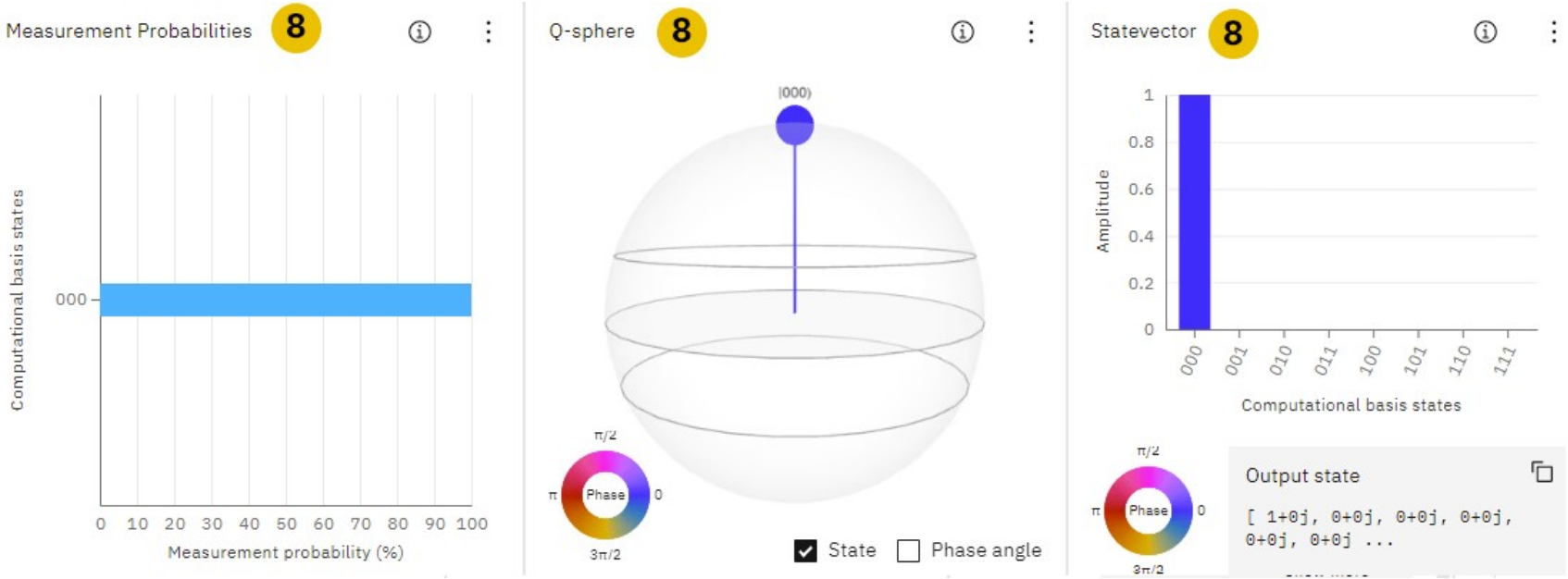
5

Open in Quantum Lab

```
1  OPENQASM 2.0;
2  include "qelib1.inc";
3
4  qreg q[3];
5  creg c[3];
6
7  h q[0];
8  cx q[0],q[1];
9  measure q[0] -> c[0];
```

Divide and conquer

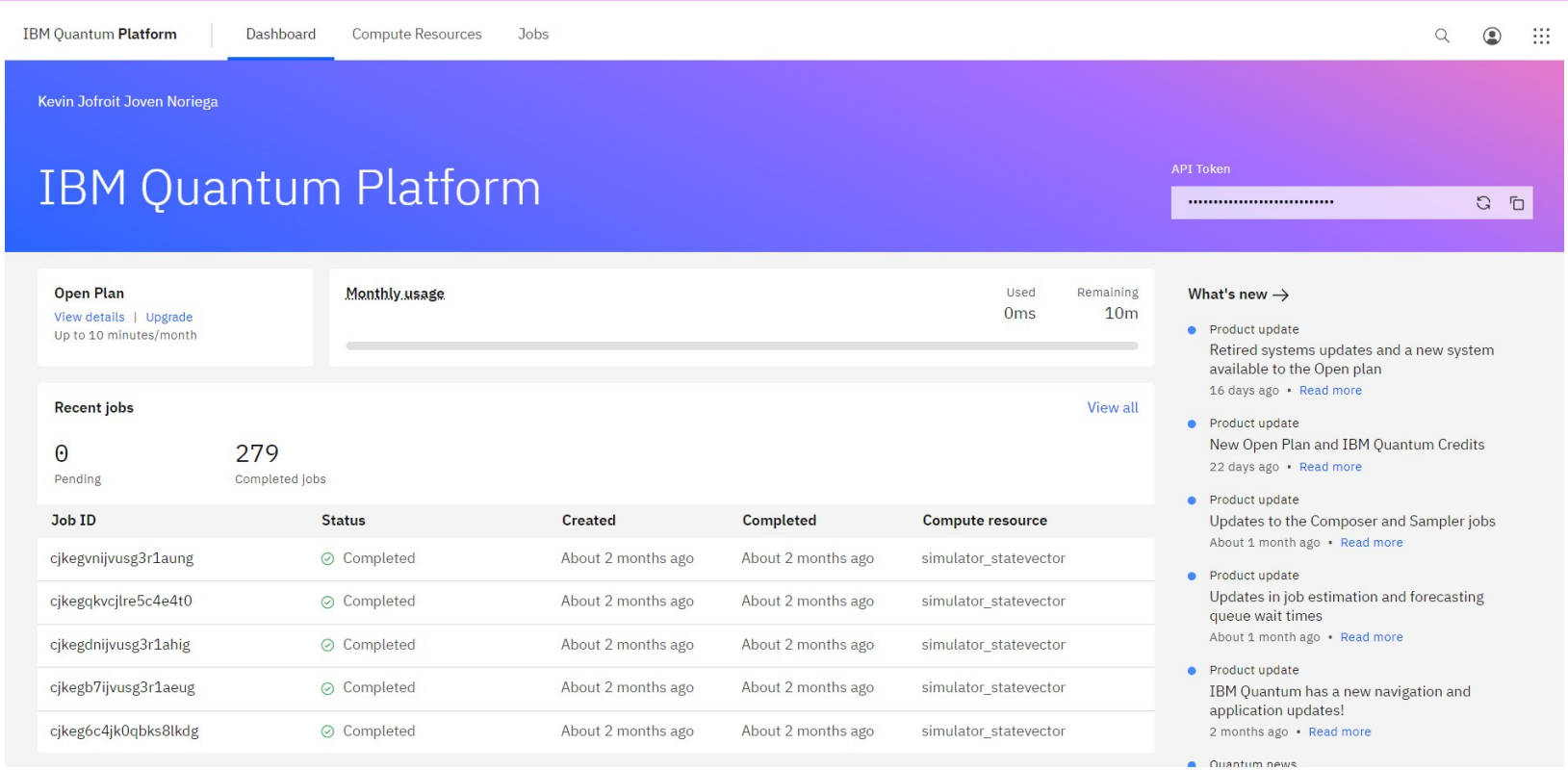
Visualization



What I need?

1. IBM Quantum account: https://quantum-computing.ibm.com/
2. Go to learning resources.
3. Open IBM Quantum Composer.
4. Start programming.

What I need?


IBM Quantum Platform
Dashboard
Compute Resources
Jobs
Kevin Jofroit Joven Noriega
IBM Quantum Platform
API Token
Open Plan
View details | Upgrade
Up to 10 minutes/month
Monthly usage
Used
0ms
Remaining
10m
Recent jobs
View all
0
Pending
279
Completed jobs
Job ID
Status
Created
Completed
Compute resource
cjkegvnijvusg3r1aung
Completed
About 2 months ago
About 2 months ago
simulator_statevector
cjkegqkvcjlre5c4e4t0
Completed
About 2 months ago
About 2 months ago
simulator_statevector
cjkegdnijvusg3r1ahig
Completed
About 2 months ago
About 2 months ago
simulator_statevector
cjkegb7ijvusg3r1aeug
Completed
About 2 months ago
About 2 months ago
simulator_statevector
cjkeg6c4jk0qbks8lkdg
Completed
About 2 months ago
About 2 months ago
simulator_statevector
What's new
Product update
Retired systems updates and a new system available to the Open plan
16 days ago • Read more
Product update
New Open Plan and IBM Quantum Credits
22 days ago • Read more
Product update
Updates to the Composer and Sampler jobs
About 1 month ago • Read more
Product update
Updates in job estimation and forecasting queue wait times
About 1 month ago • Read more
Product update
IBM Quantum has a new navigation and application updates!
2 months ago • Read more
Quantum news

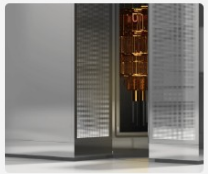
What I need?

IBM Quantum **Platform** | Dashboard | Compute Resources | Jobs

Job ID	Status	Created	Completed	Compute resource
cjkegvnijvusg3r1aung	Completed	About 2 months ago	About 2 months ago	simulator_statevector
cjkegqkvcjlre5c4e4t0	Completed	About 2 months ago	About 2 months ago	simulator_statevector
cjkegdnijvusg3r1ahig	Completed	About 2 months ago	About 2 months ago	simulator_statevector
cjkegb7ijvusg3r1aeug	Completed	About 2 months ago	About 2 months ago	simulator_statevector
cjkeg6c4jk0qbks8lkdg	Completed	About 2 months ago	About 2 months ago	simulator_statevector

Your systems →

4



Simulators →

5

Documentation Open app ↗

Search docs

Hello World

Create a simple quantum program and run it on a quantum system

Qiskit Runtime

Introduction to primitives

Learning Open app ↗

Course New

Fundamentals of quantum algorithms

IBM Quantum Composer

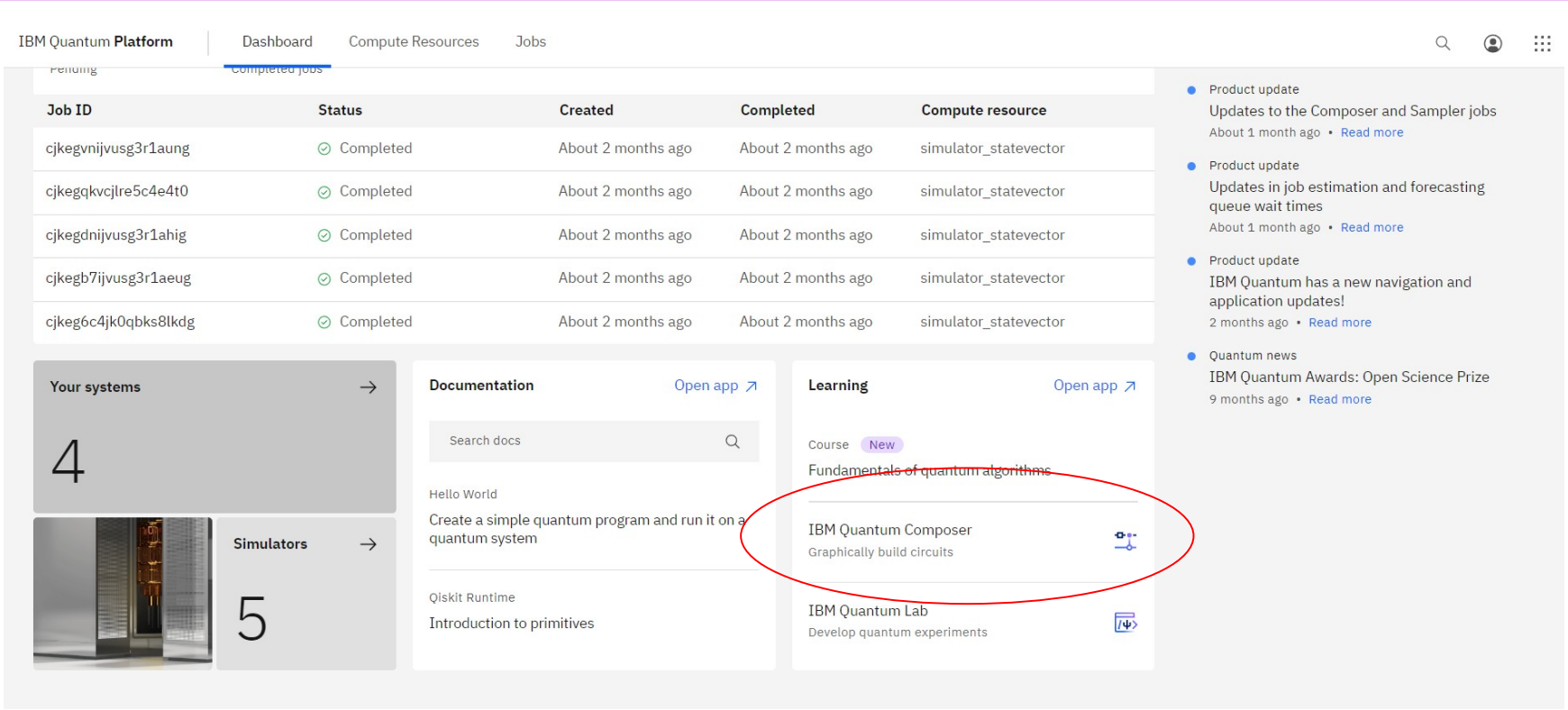
Graphically build circuits

IBM Quantum Lab

Develop quantum experiments

- Product update
  Updates to the Composer and Sampler jobs
  About 1 month ago • Read more
- Product update
  Updates in job estimation and forecasting queue wait times
  About 1 month ago • Read more
- Product update
  IBM Quantum has a new navigation and application updates!
  2 months ago • Read more
- Quantum news
  IBM Quantum Awards: Open Science Prize
  9 months ago • Read more

What I need?


IBM Quantum Platform
Dashboard
Compute Resources
Jobs
Job ID
Status
Created
Completed
Compute resource
cjkegvnijvusg3r1aung
Completed
About 2 months ago
About 2 months ago
simulator_statevector
cjkegqkvcjlre5c4e4t0
Completed
About 2 months ago
About 2 months ago
simulator_statevector
cjkegdnijvusg3r1ahig
Completed
About 2 months ago
About 2 months ago
simulator_statevector
cjkegb7ijvusg3r1aeug
Completed
About 2 months ago
About 2 months ago
simulator_statevector
cjkeg6c4jk0qbks8lkdg
Completed
About 2 months ago
About 2 months ago
simulator_statevector
Your systems
4
Simulators
5
Documentation
Open app
Search docs
Hello World
Create a simple quantum program and run it on a quantum system
Qiskit Runtime
Introduction to primitives
Learning
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Course
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2 months ago • Read more
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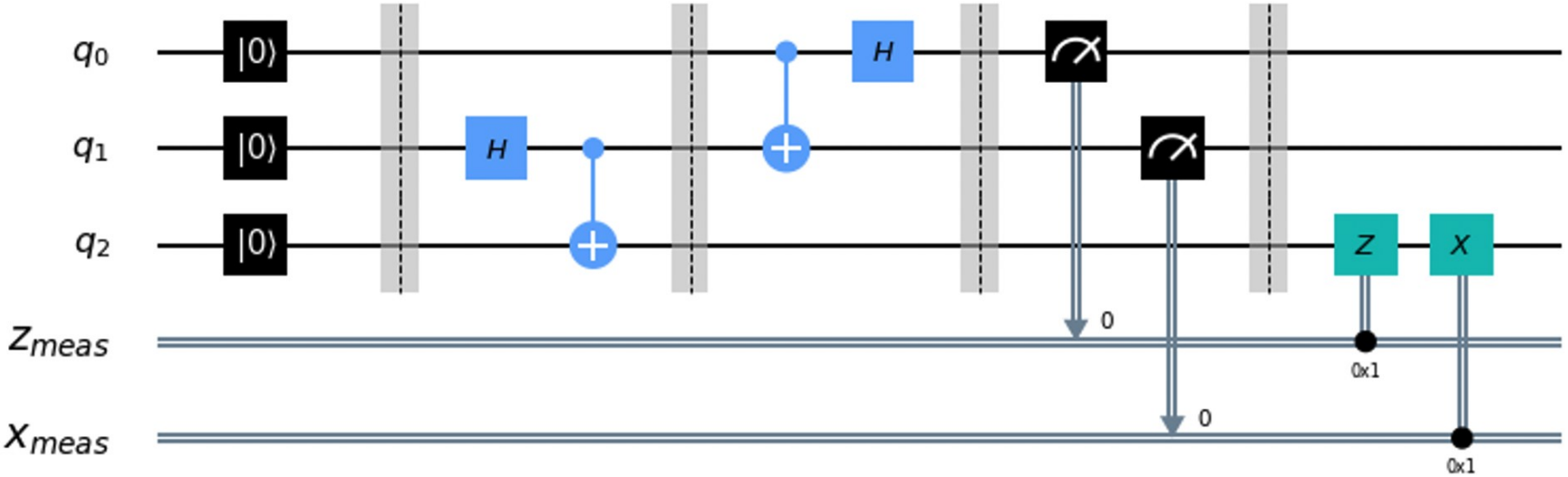
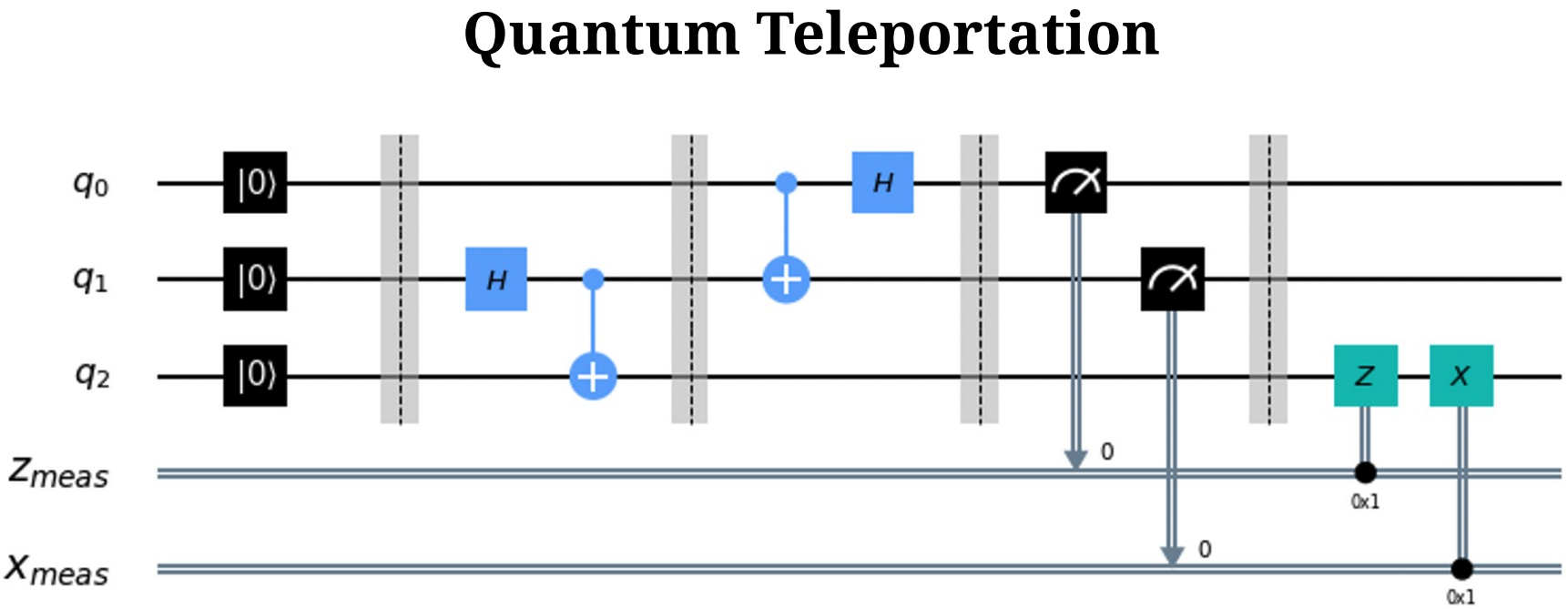
9 months ago • Read more

Let’s test it

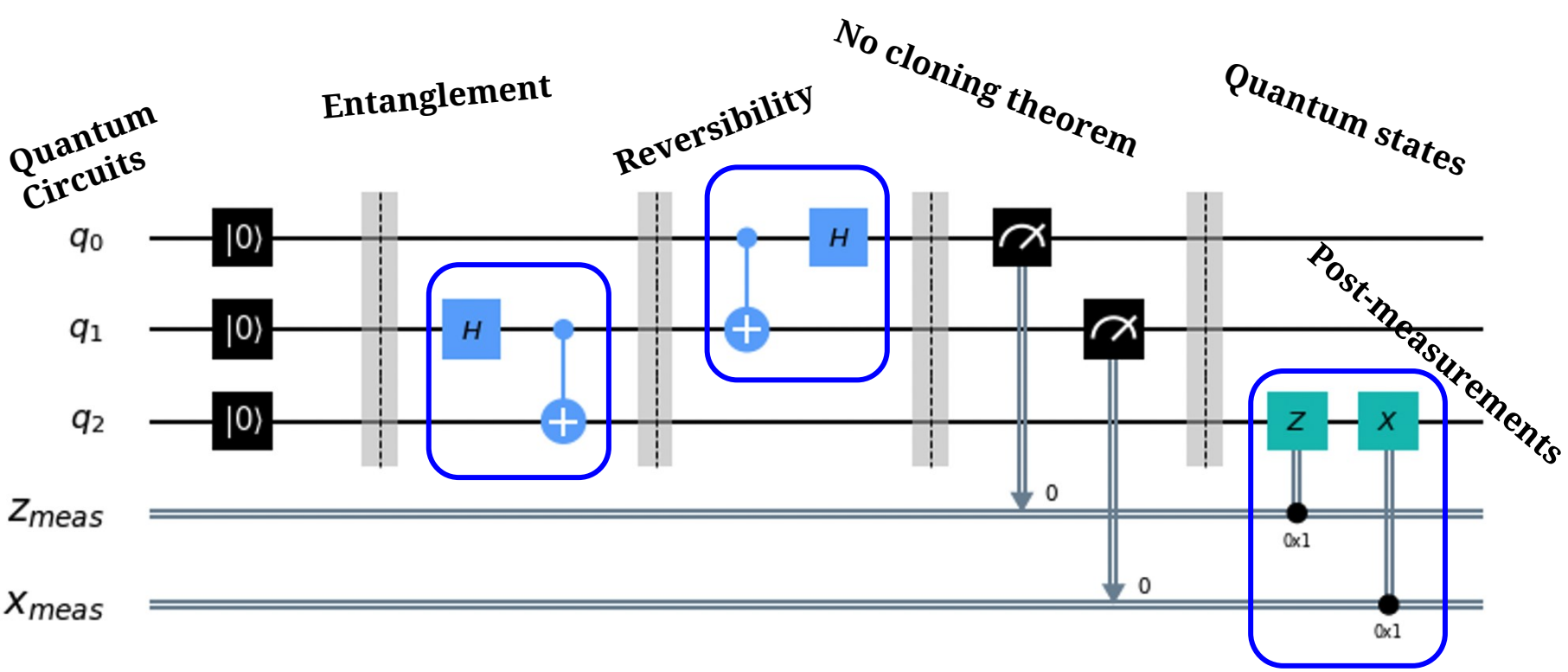
Let’s test it



Let’s test it

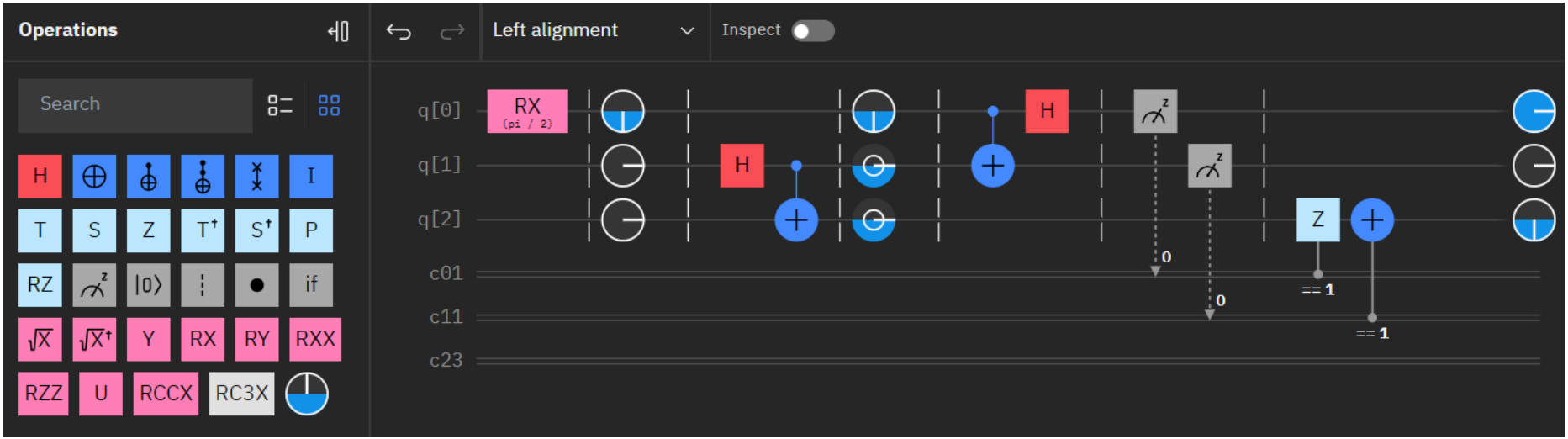

Quantum Teleportation
q_0
q_1
q_2
z_{meas}
x_{meas}
|0⟩
|0⟩
|0⟩
H
H
Z
X
0
0
0x1
0x1

Let’s test it

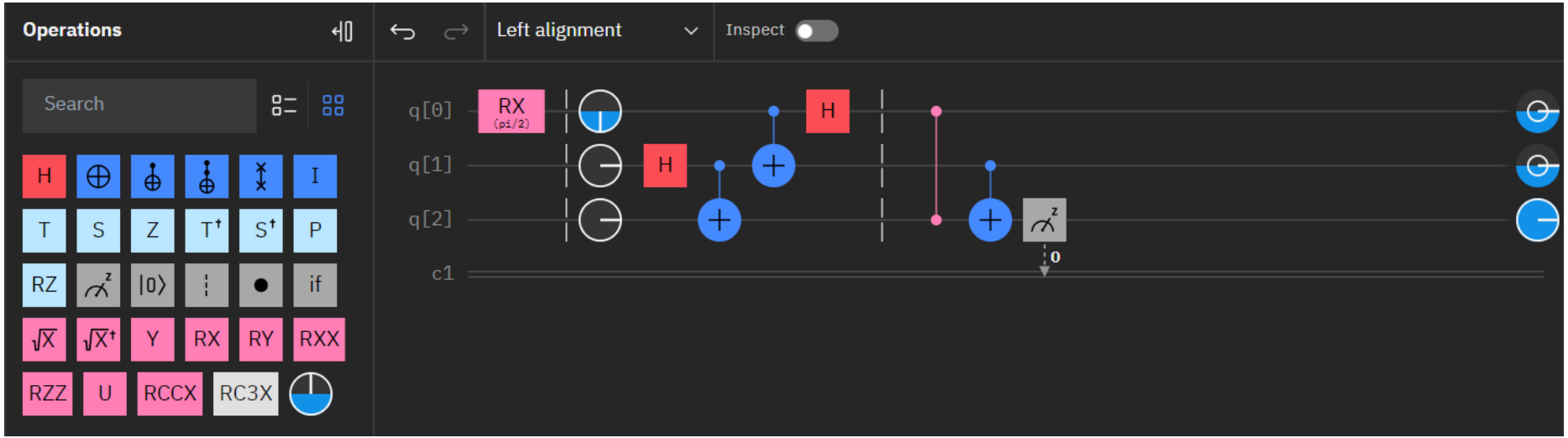

Quantum Circuits
Entanglement
Reversibility
No cloning theorem
Quantum states
Post-measurements
q_0
q_1
q_2
z_{meas}
x_{meas}
|0⟩
|0⟩
|0⟩
H
H
0
0
Z
X
0x1
0x1

Let’s test it

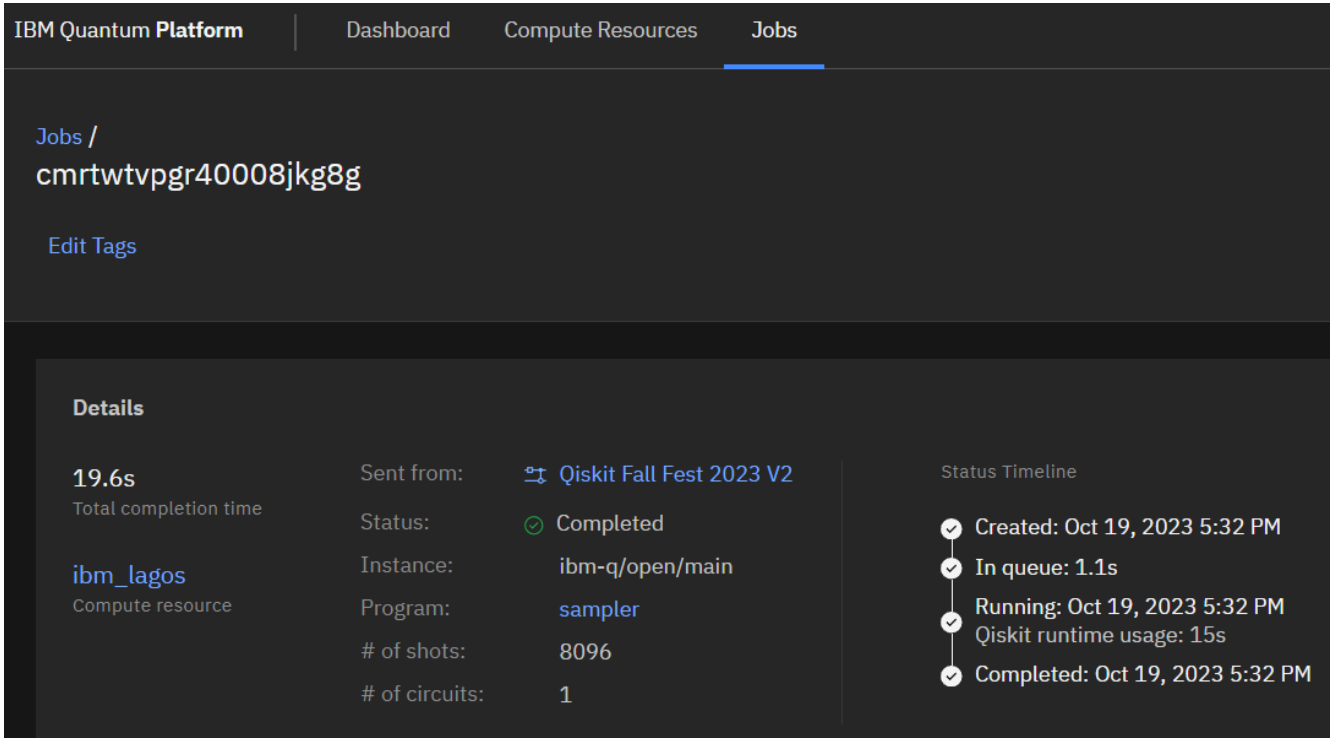
Let’s test it


Operations
Search
H
I
T
S
Z
P
RZ
|0⟩
if
Y
RX
RY
RXX
RZZ
U
RCCX
RC3X
Left alignment
Inspect
q[0]
q[1]
q[2]
c01
c11
c23
RX
(pi / 2)
H
H
Z
0
0
== 1
== 1

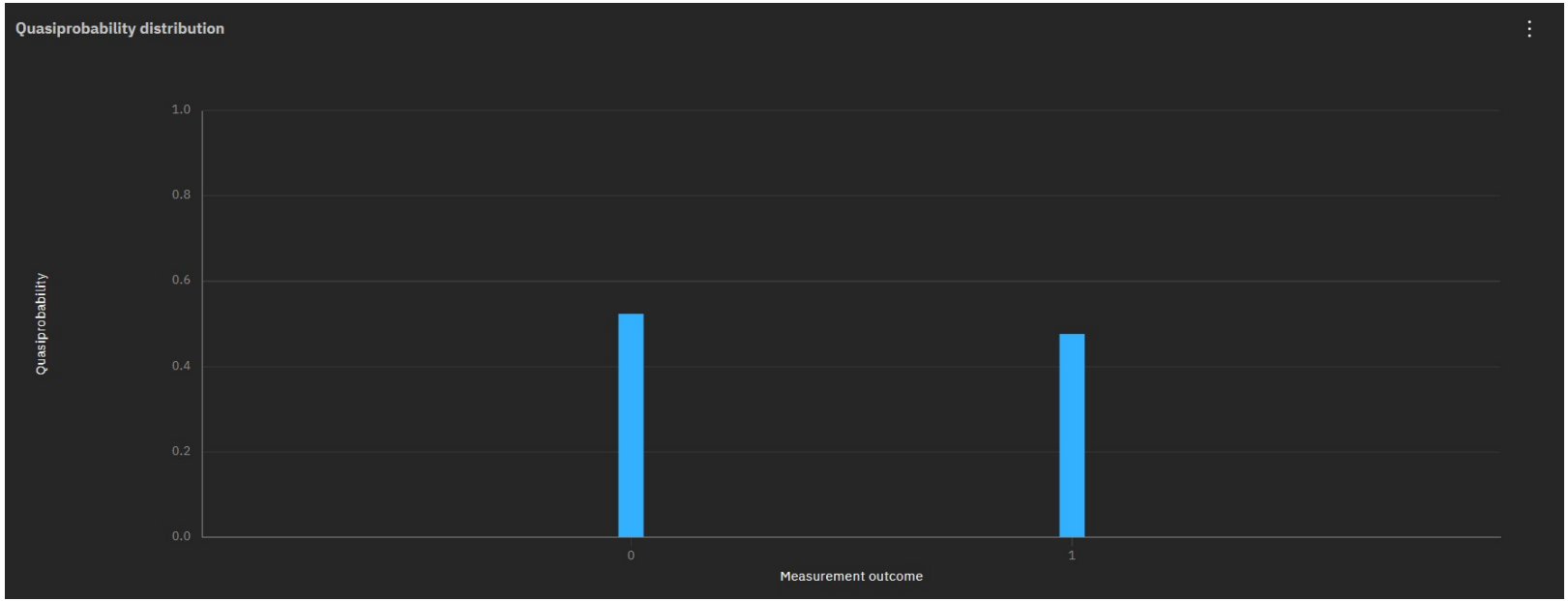
Let’s test it


Operations
Search
H
I
T
S
Z
P
RZ
if
RX
RY
RXX
RZZ
U
RCCX
RC3X
Left alignment
Inspect
q[0]
q[1]
q[2]
c1
RX
(pi/2)
H
H
0

Let’s test it


IBM Quantum Platform
Dashboard
Compute Resources
Jobs
Jobs /
cmrtwtvpgr40008jkg8g
Edit Tags
Details
19.6s
Total completion time
ibm_lagos
Compute resource
Sent from:
Qiskit Fall Fest 2023 V2
Status:
Completed
Instance:
ibm-q/open/main
Program:
sampler
# of shots:
8096
# of circuits:
1
Status Timeline
Created: Oct 19, 2023 5:32 PM
In queue: 1.1s
Running: Oct 19, 2023 5:32 PM
Qiskit runtime usage: 15s
Completed: Oct 19, 2023 5:32 PM

Let’s test it


Quasiprobability distribution
1.0
0.8
0.6
0.4
0.2
0.0
Quasiprobability
0
1
Measurement outcome

Let’s test it

Diagram | Qasm | Qiskit

Original circuit

```
1  OPENQASM 2.0;
2  include "qelib1.inc";
3
4  qreg q[3];
5  creg c[1];
6  rx(pi/2) q[0];
7  barrier q; // @phaseDisk
8  h q[1];
9  cx q[1], q[2];
10 cx q[0], q[1];
11 h q[0];
12 barrier q[0], q[1], q[2];
13 cz q[0], q[2];
14 cx q[1], q[2];
15 measure q[2] -> c[0];
16
```

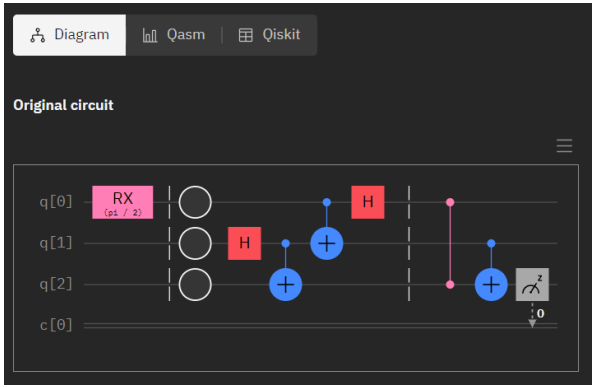
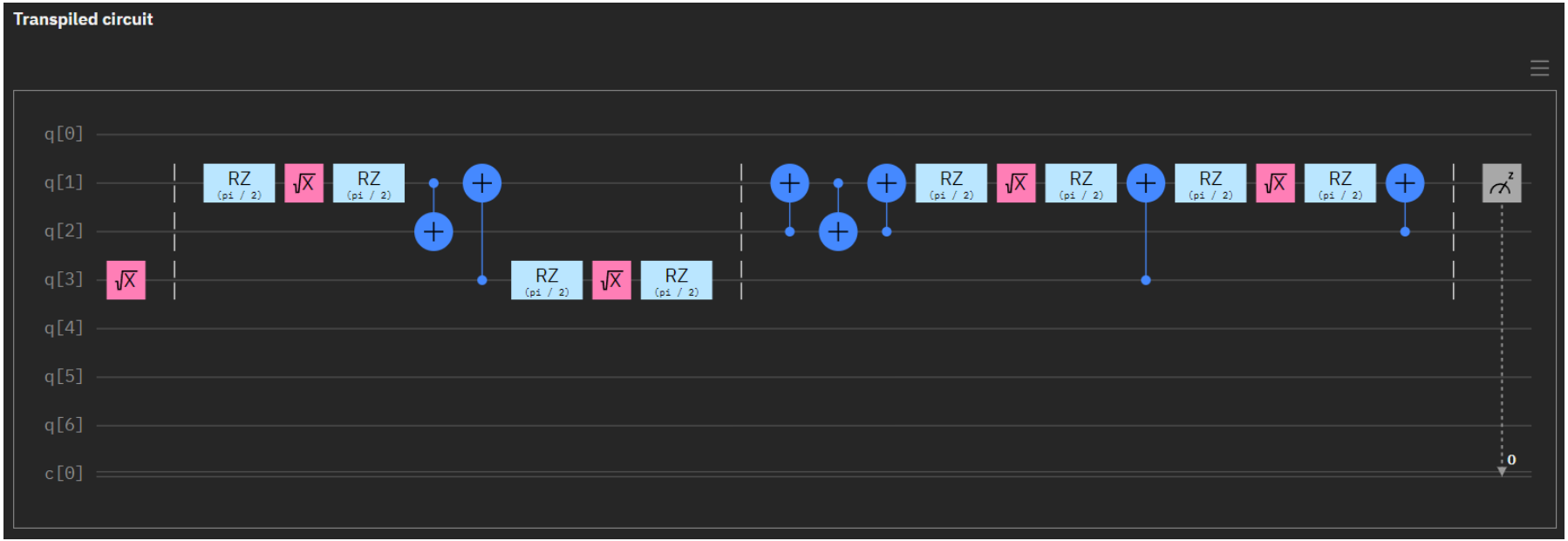


Diagram | Qasm | Qiskit

Original circuit

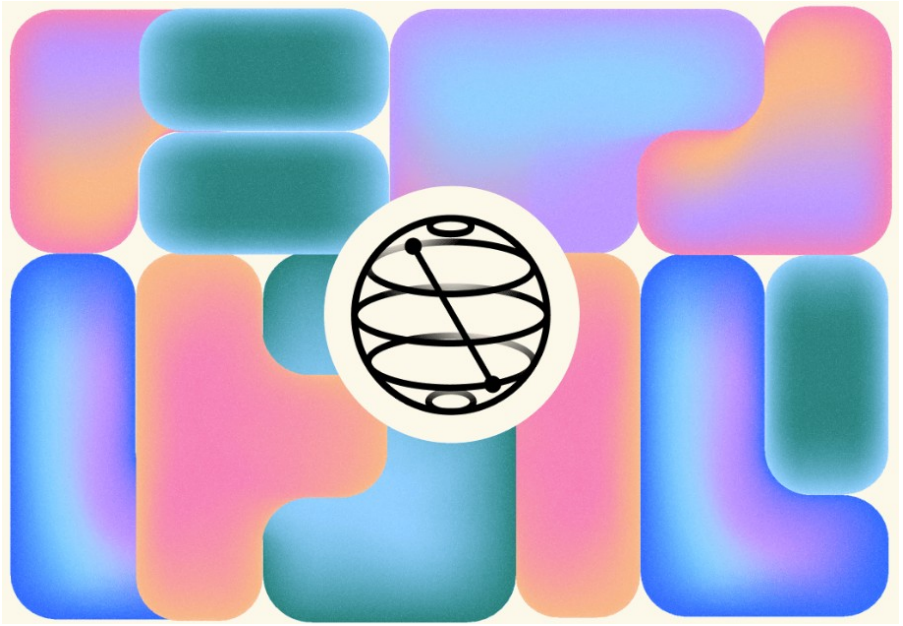
```
1  from qiskit import QuantumRegister, ClassicalRegister,
   QuantumCircuit
2  from numpy import pi
3
4  qreg_q = QuantumRegister(3, 'q')
5  creg_c = ClassicalRegister(1, 'c')
6  circuit = QuantumCircuit(qreg_q, creg_c)
7
8  circuit.rx(pi / 2, qreg_q[0])
9  circuit.barrier(qreg_q)
10 # @phaseDisk
11 circuit.h(qreg_q[1])
12 circuit.cx(qreg_q[1], qreg_q[2])
13 circuit.cx(qreg_q[0], qreg_q[1])
14 circuit.h(qreg_q[0])
15 circuit.barrier(qreg_q[0], qreg_q[1], qreg_q[2])
```

Let’s test it



Thanks!

THANKS!



References

[1] IBM Quantum: https://quantum-computing.ibm.com/
[2] Qiskit Documentation: https://qiskit.org/documentation/stable/0.25/qc_intro.html
[3] Quantum Teleportation with Qiskit: https://www.youtube.com/watch?v=mMwovHK2NrE
[4] Quantum Composer: https://learning.quantum-computing.ibm.com/tutorial/composer-user-guide