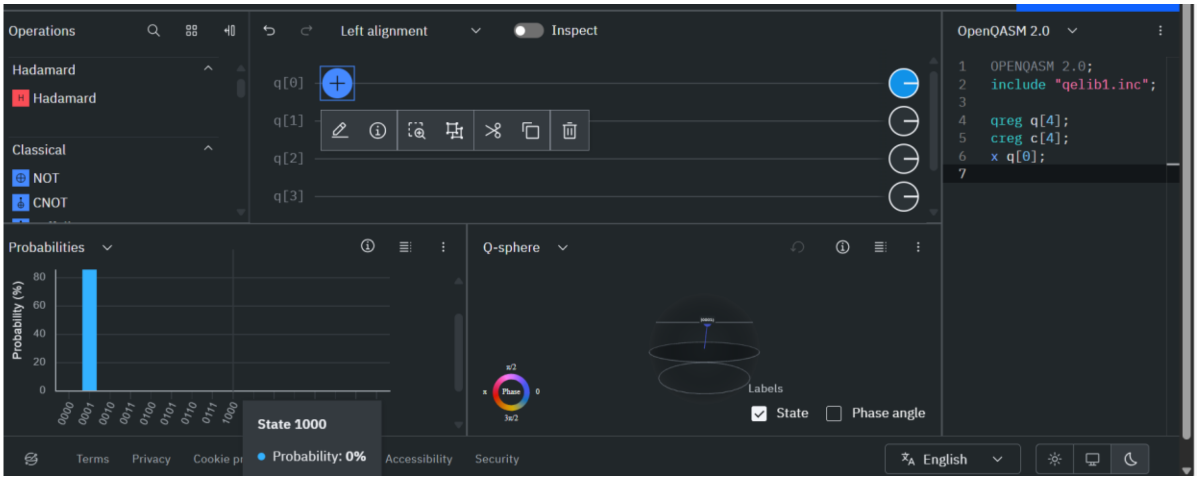
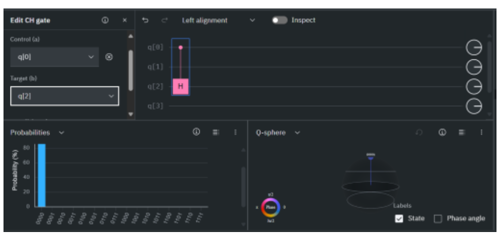
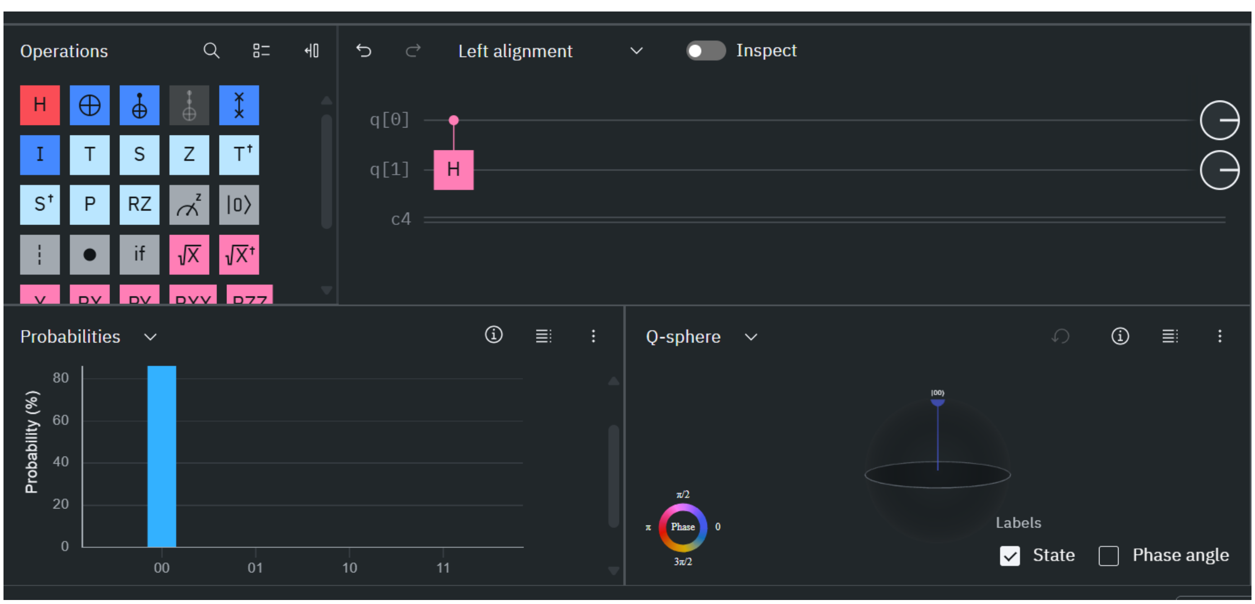
Part 1; State Preparation

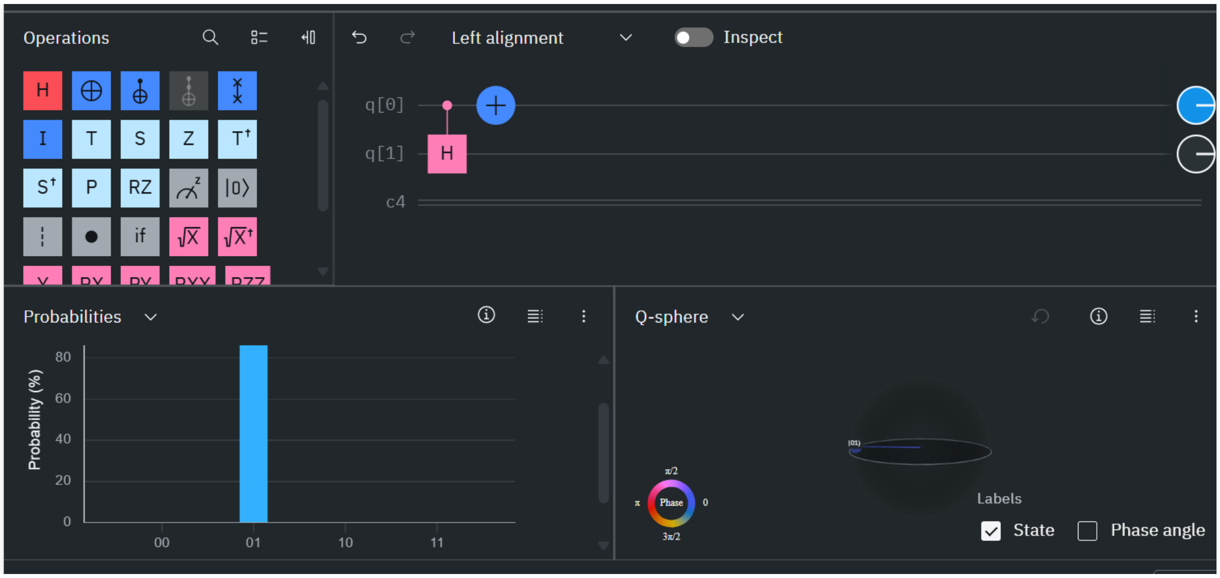


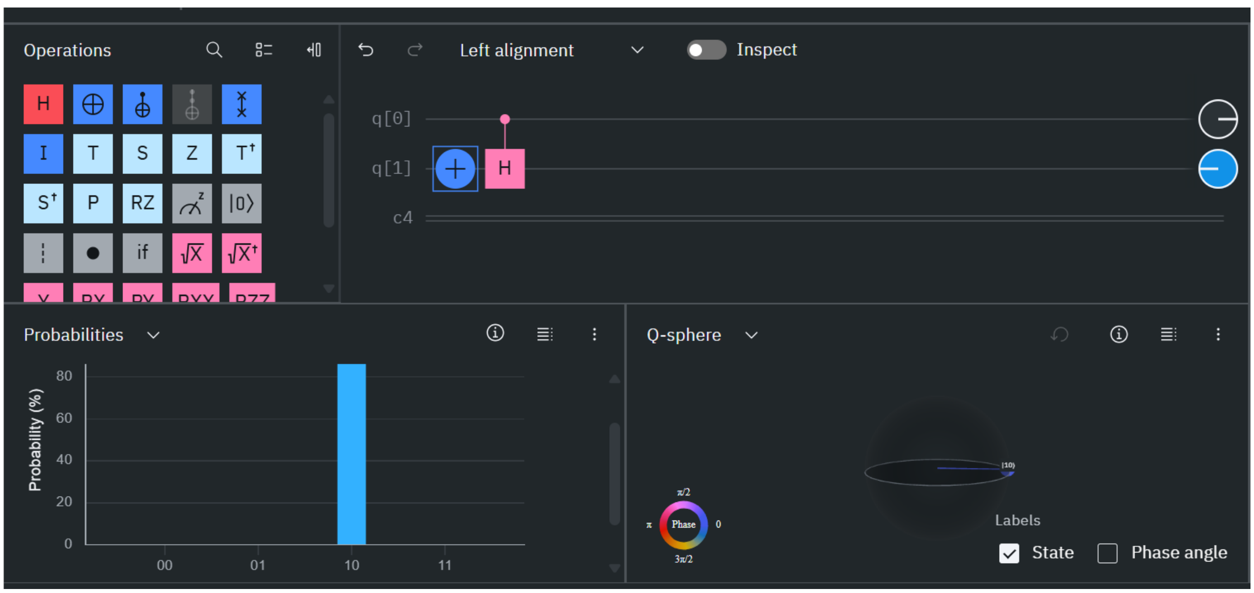
Part 2; A Control Hadamard gate

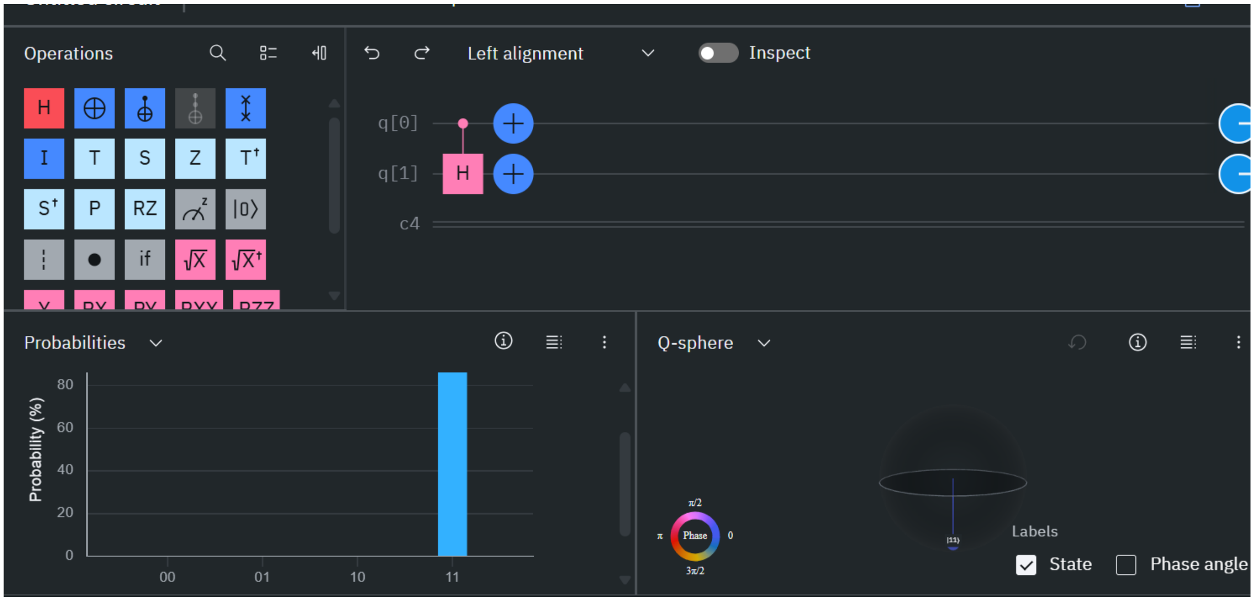


Part 3; Testing all possible inputs |00| |01| |10| |11|

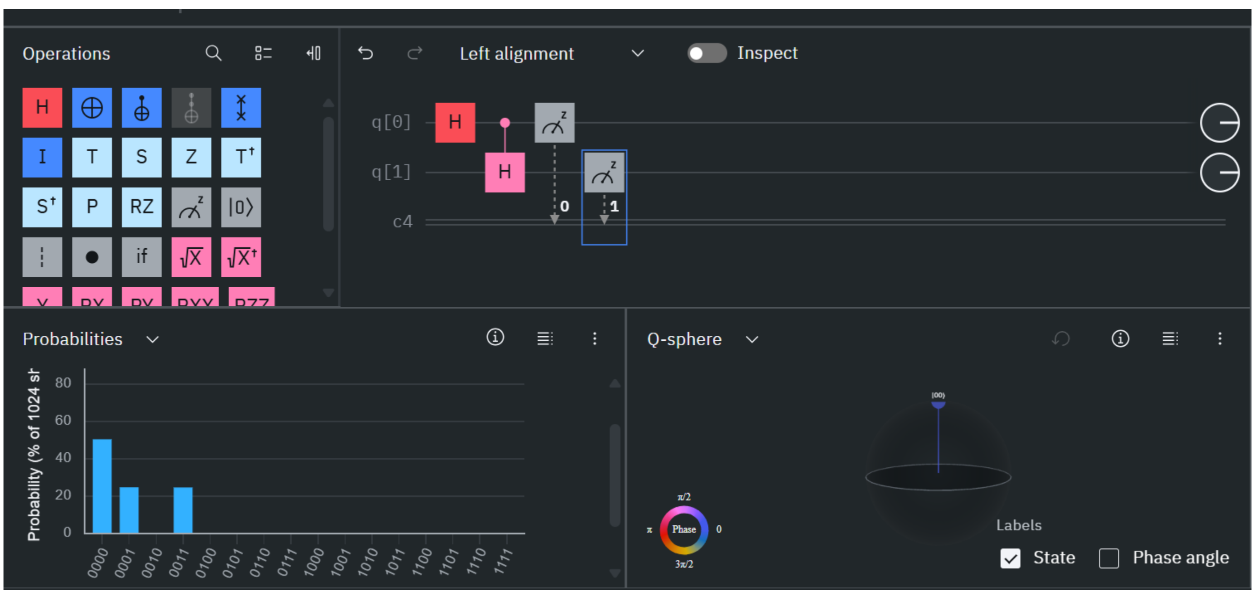



Operations
Left alignment
Inspect
H
I
T
S
Z
S†
P
RZ
|0⟩
if
√X
√X†
q[0]
q[1]
c4
Probabilities
Probability (%)
80
60
40
20
0
00
01
10
11
Q-sphere
|01⟩
Phase
π/2
π
0
3π/2
Labels
State
Phase angle


Operations
Left alignment
Inspect
H
I
T
S
Z
S†
P
RZ
|0⟩
if
√X
√X†
q[0]
q[1]
c4
Probabilities
Probability (%)
80
60
40
20
0
00
01
10
11
Q-sphere
|10⟩
Phase
π/2
π
0
3π/2
Labels
State
Phase angle



Part 4; Measuring and Simulation

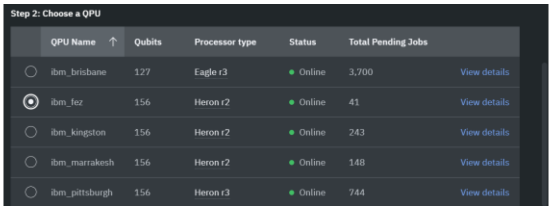


Usually, when the control qubit (q[0]) is in the |0⟩ state, (i.e 100% probability of |0⟩), the target qubit remains unchanged. When the control qubit q[0], is in the |1⟩ state (i.e 100% probability of |1⟩), the target qubit undergoes a Hadamard operation determistically.

However, in this case, since we have set our control qubit (q[0]) to a superposition state |+⟩, the result is no longer deterministic but probabilistic. The control qubit has a 50% probability of being in |0⟩ and a 50% probability of being in |1⟩. If the control qubit is measured in the |1⟩state, the target qubit will undergo the Hadamard operation, giving the target qubit a 50% chance of being affected by the Hadamard operation.

Part 5; Running on a real computer

Which backend did you use? Ibm_fez

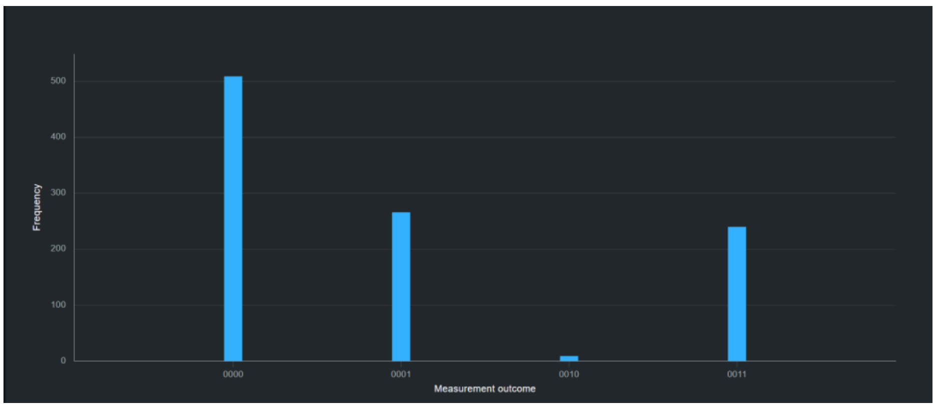


Step 2: Choose a QPU

QPU Name	Qubits	Processor type	Status	Total Pending Jobs	
ibm_brisbane	127	Eagle r3	Online	3,700	View details
ibm_fez	156	Heron r2	Online	41	View details
ibm_kingston	156	Heron r2	Online	243	View details
ibm_marrakesh	156	Heron r2	Online	148	View details
ibm_pittsburgh	156	Heron r3	Online	744	View details

How did the results of the real quantum computer differ from the simulator?

Using the simulator, the state |0010⟩ appeared to have zero probability. However, on the real quantum computer, the same state had a frequency of 9, indicating a non-zero probability.



List how many times each measurement appeared

State 0000; 509

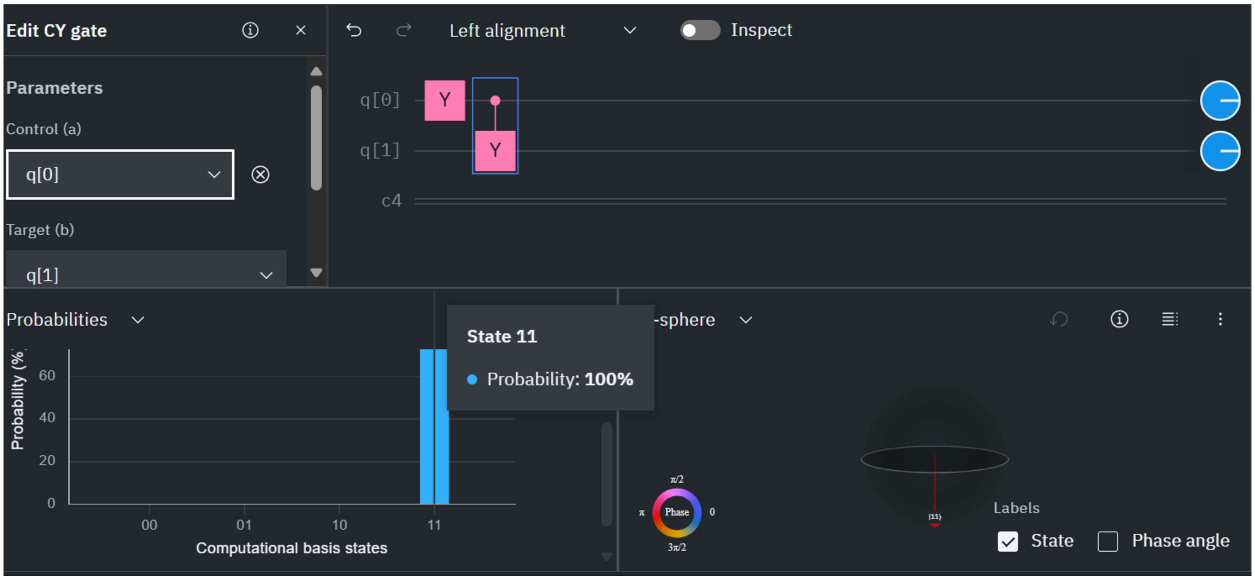
State 0001; 266

State 0010; 9

State 0011; 240

Part 6; Exploration

Gate; Control Z gate (CZ)



I applied the Y gate to q[0], flipping it to the i|1⟩ state. Next, I applied the control Y gate with q[0] as the control and q[1] as the target. Since q[0] has already been flipped by the initial Y gate, this causes the Y gate operation to be applied to q[1], flipping it to the i|1⟩ state as well. This results in a computational basis state of |11⟩ with 100% probability.