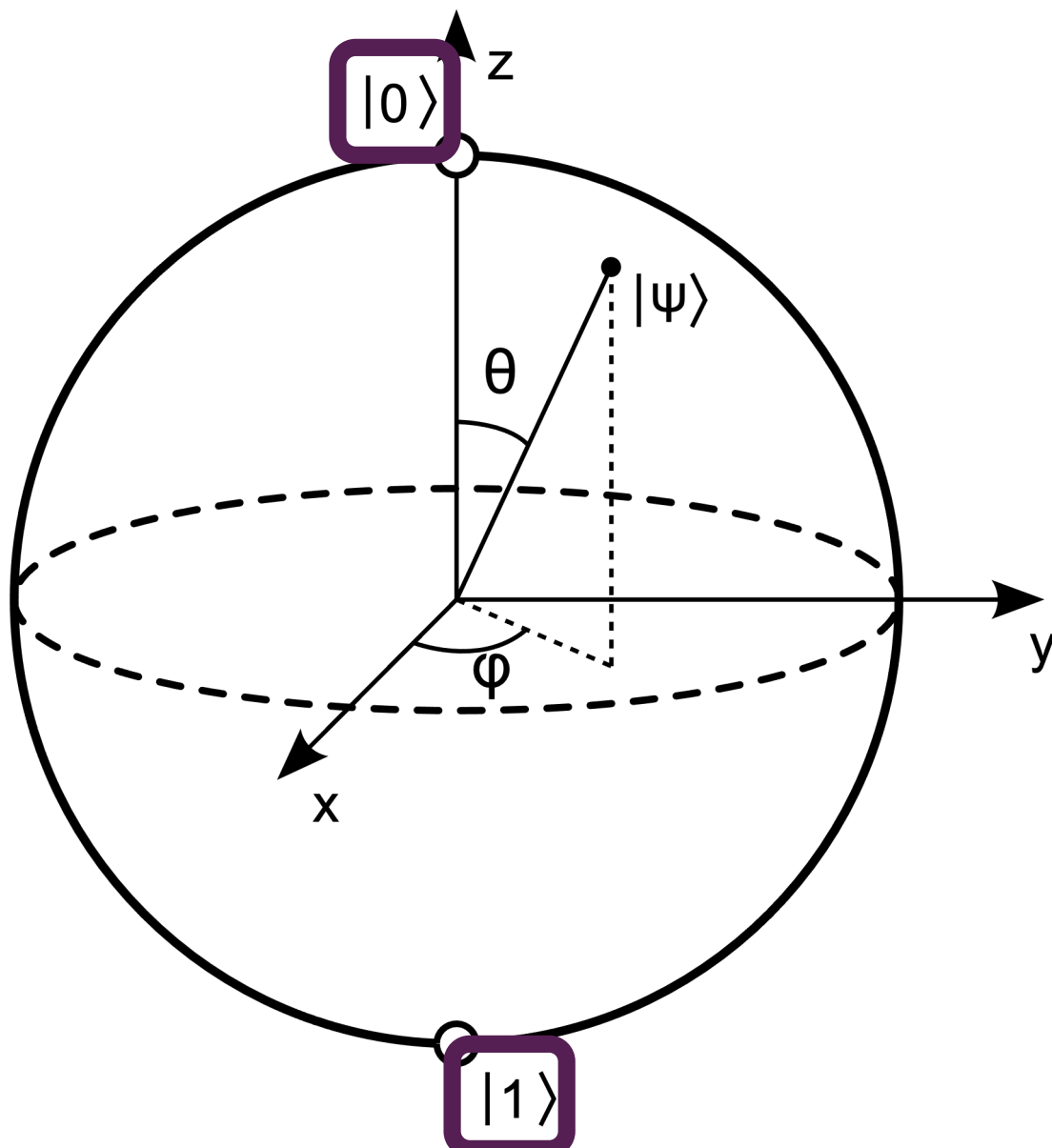Quantum
Circuits
Fundamentals

UNIVERSITÀ
degli studi
di BARI
ALDO MORO

Maggio
2024

BLOCH SPHERE

$$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$$

$$\alpha^2 + \beta^2 = 1$$

LET'S
SIMULATE

https://algassert.com/quirk

LET'S SIMULATE

https://algassert.com/quirk
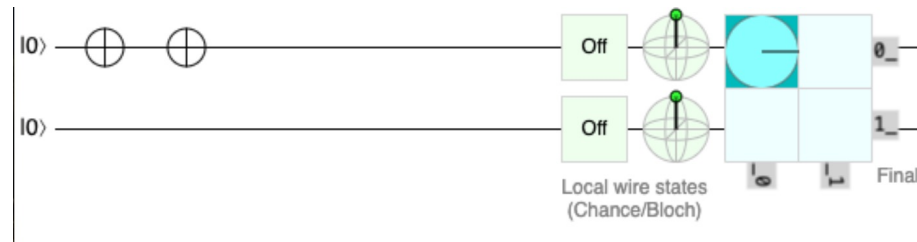
Scenario 1: Pauli Gates
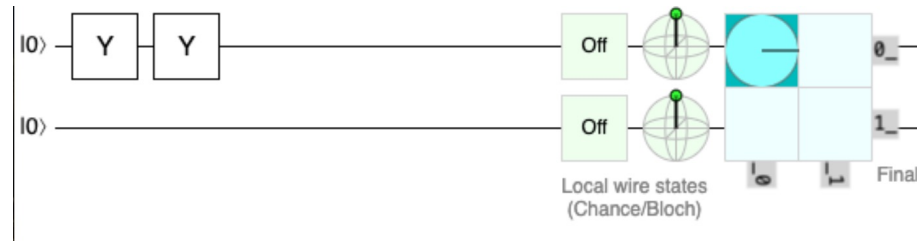
Pauli X
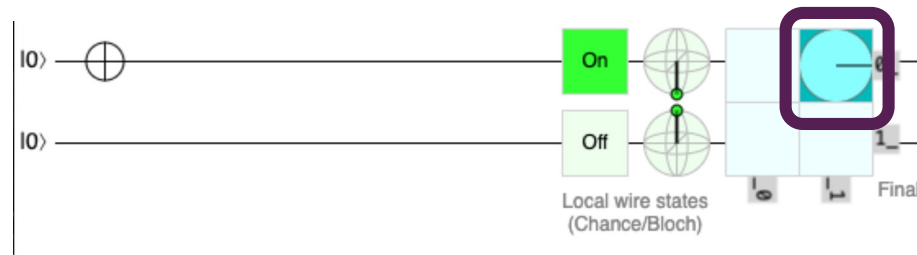
0->1

Pauli Y
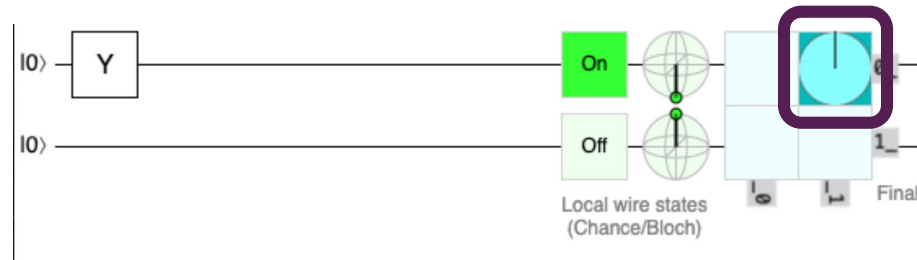
0->1

Pauli Z
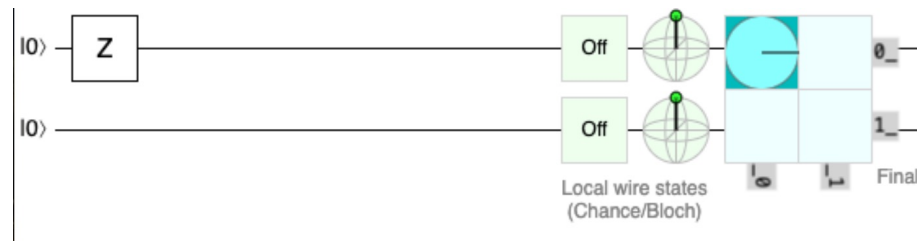
0->0

Scenario 1b: Reversibility

Pauli X

Pauli Y

Pauli Z

Scenario 2: Hadamard Gate

LSB (q_0)

MSB (q_1)

Local wire states
(Chance/Bloch)

Final

q_1q_0 00 (50%) 01 (50%)
10 (0%) 11 (0%)
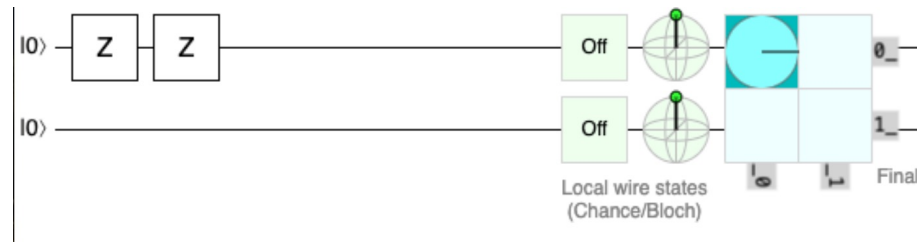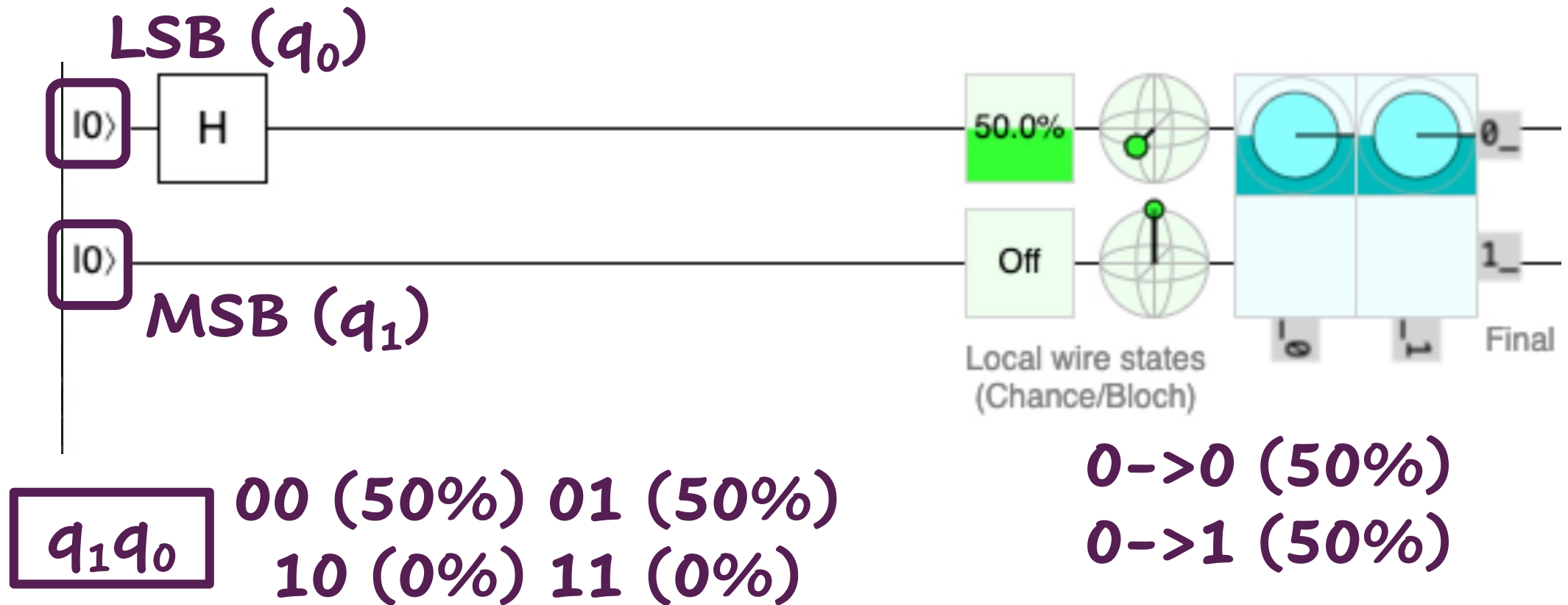
0->0 (50%)
0->1 (50%)

Scenario 2: Hadamard Gate
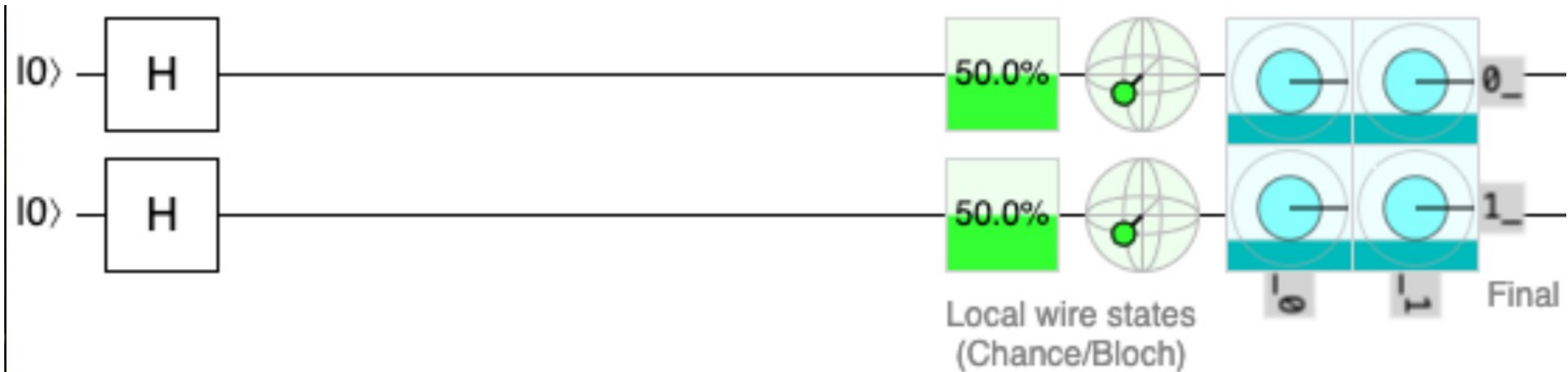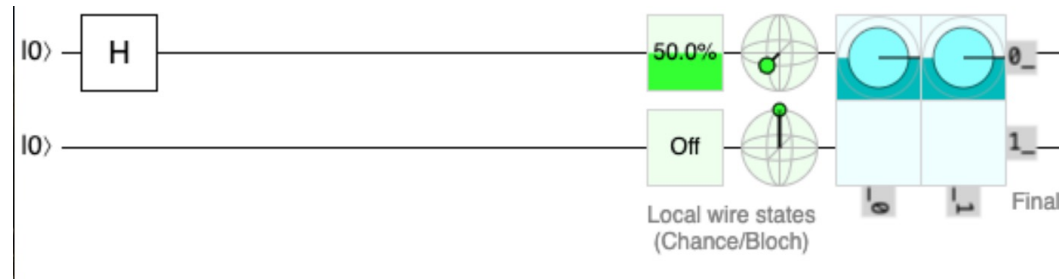
0->0 (50%)
0->1 (50%)

x2 qubits!

00 (25%) 01 (25%)
10 (25%) 11 (25%)

Scenario 3: Controlled Gates

control

target

control + NOT -> CNOT

|0⟩

|0⟩

Off

Off

Local wire states
(Chance/Bloch)

0_

1_

Final

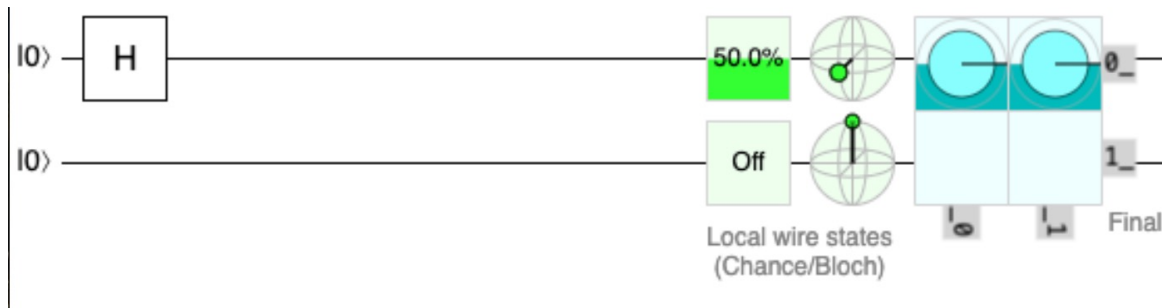# Scenario 3: Controlled Gates

control

target
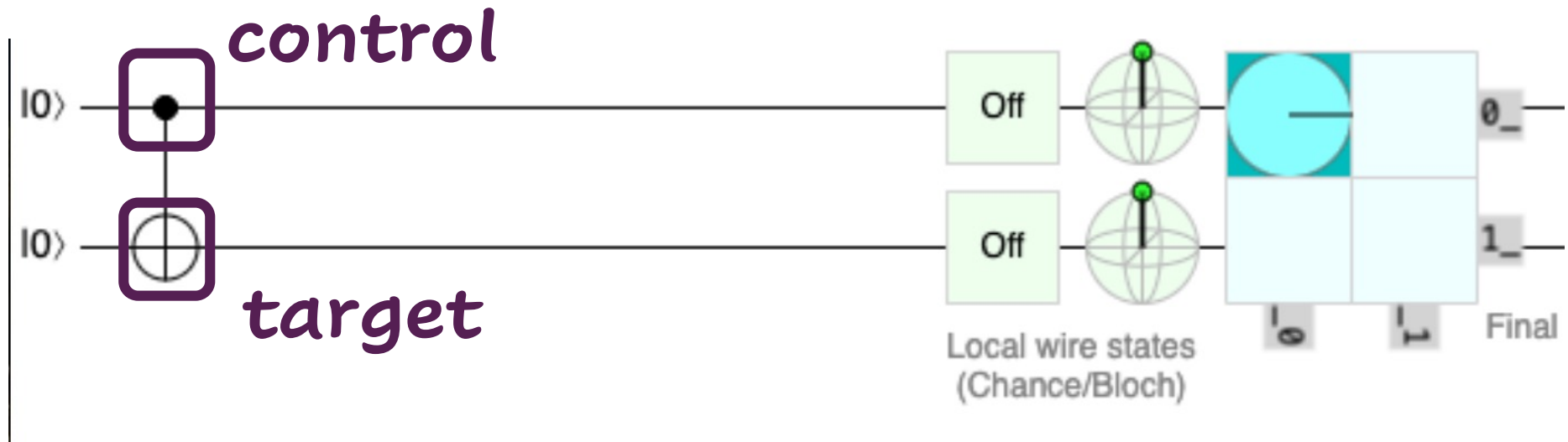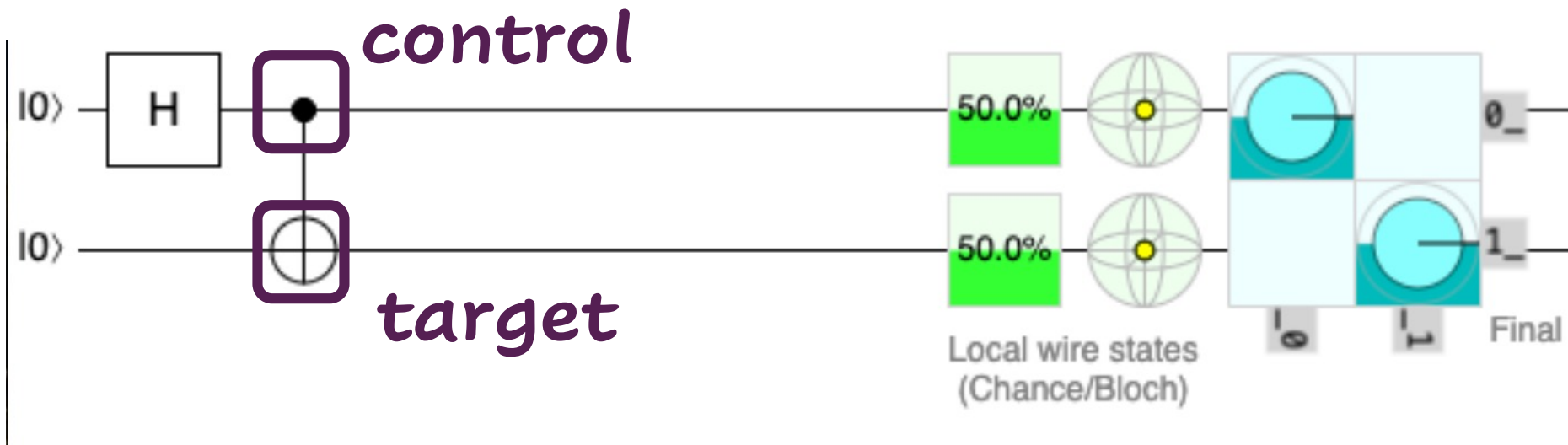
q_0 AND q_1

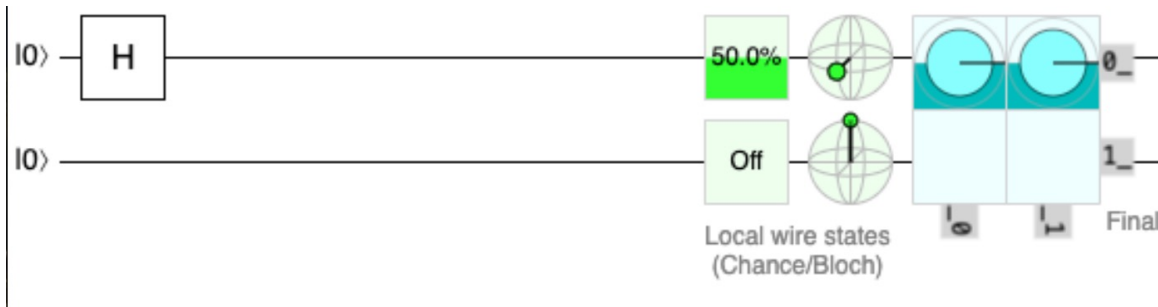00 (50%) 01 (0%)
10 (0%) 11 (50%)

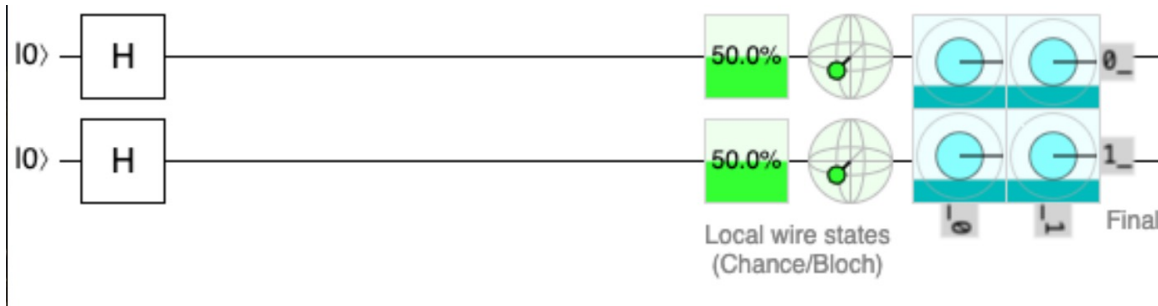# Let's play!!

Let's play!!

00 (50%) 01 (50%)
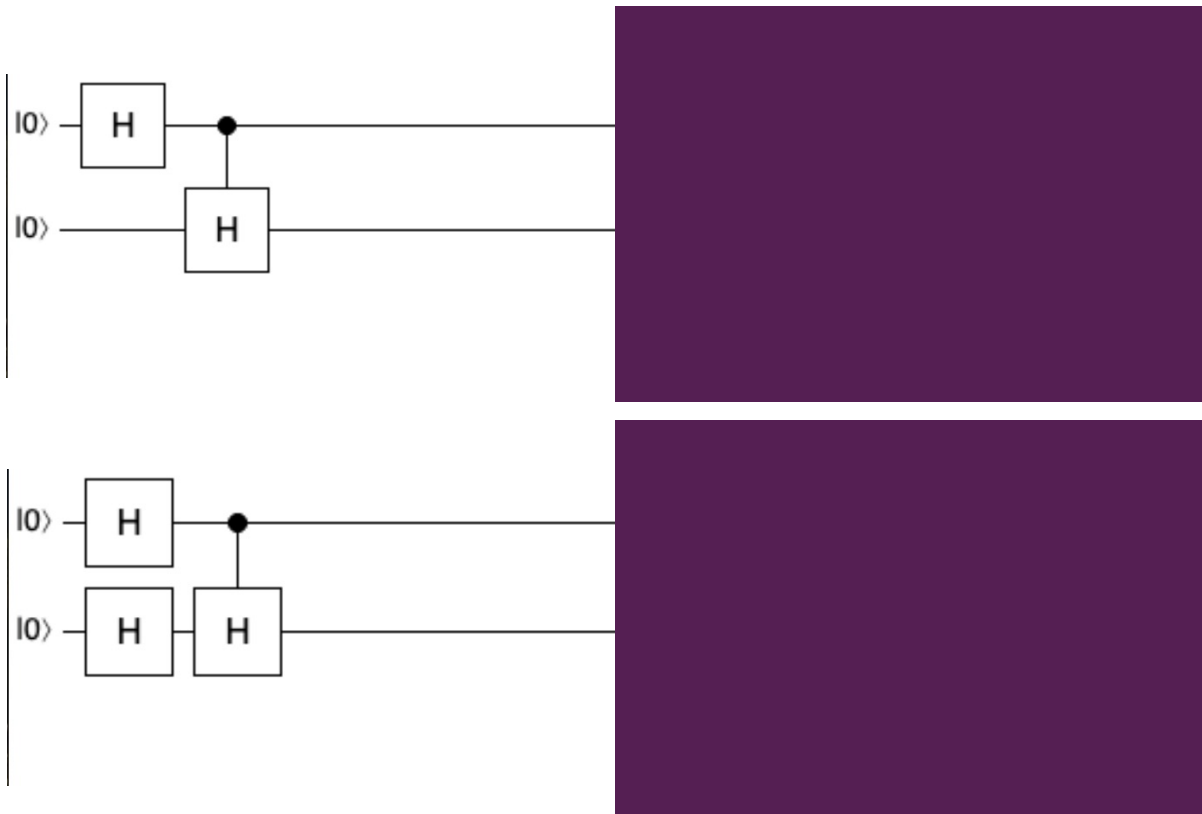10 (0%) 11 (0%)

Let's play!!
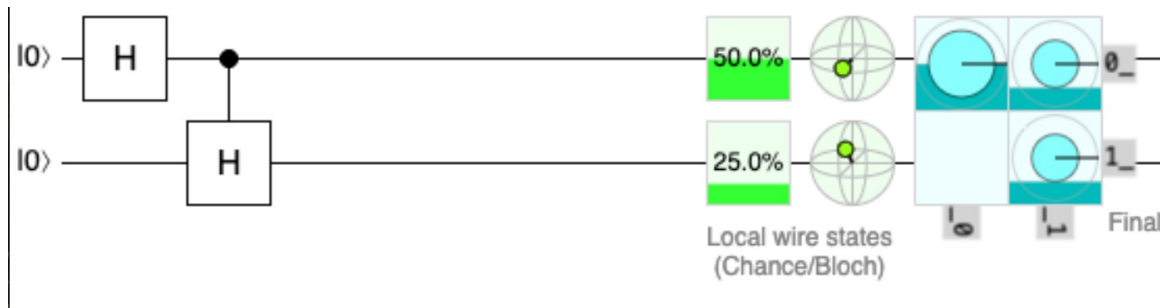

00 (50%) 01 (50%)
10 (0%) 11 (0%)

00 (25%) 01 (25%)
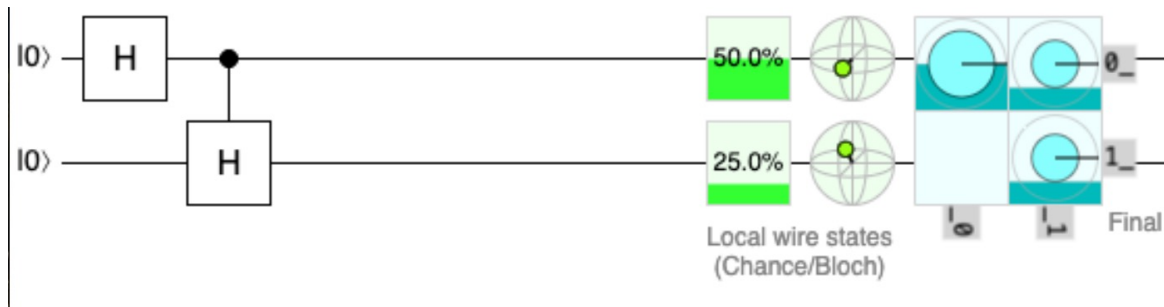10 (25%) 11 (25%)
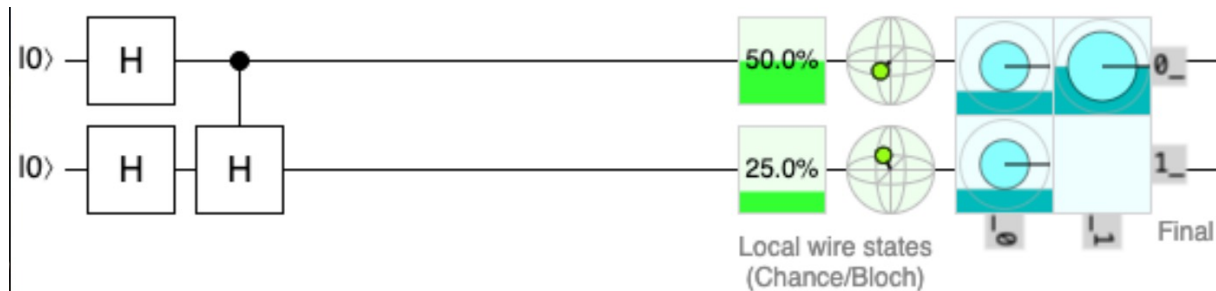
Let's play (2)!!

Let's play (2)!!

00 (50%) 01 (25%)
10 (0%) 11 (25%)

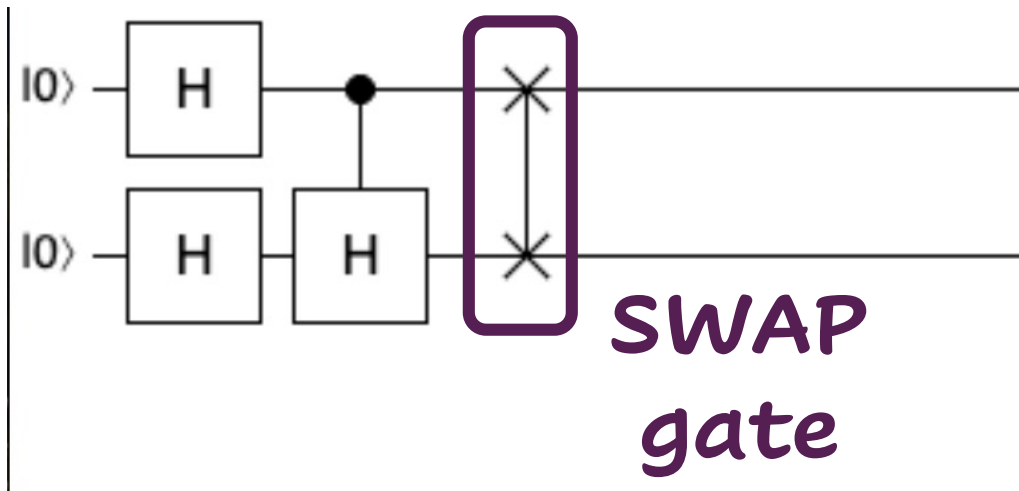# Let's play (2)!!

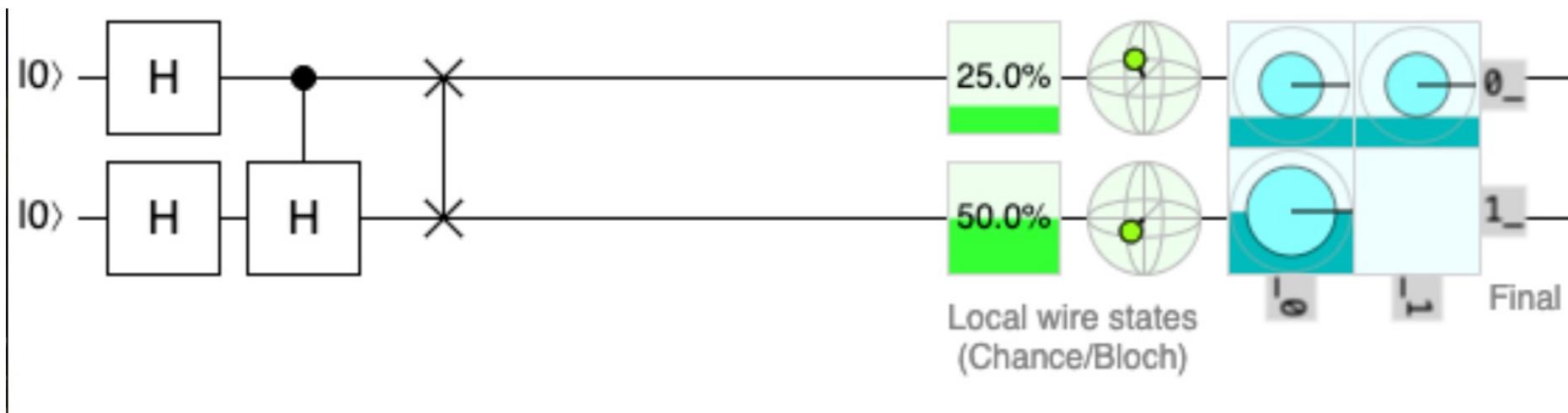00 (50%) 01 (25%)
10 (0%) 11 (25%)

00 (25%) 01 (50%)
10 (25%) 11 (0%)

Let's play (3)!!

SWAP gate

Let's play (3)!!

00 (25%) 01 (25%)
10 (50%) 11 (0%)

Grazie!!!

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@jjoselemuss