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Lab 1 Report: Introduction to Quantum Computing

Overview

This lab introduces basic quantum operations and measurements using Qiskit. The experiments demonstrate single-qubit gates, superposition, and measurements in different Pauli bases.

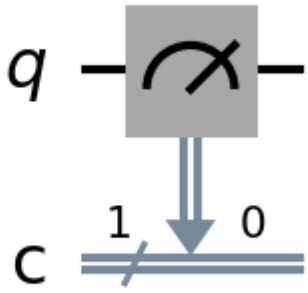
Task 1: Z-type Projection Measurement

Basic measurement of the |0⟩ state in the computational basis.

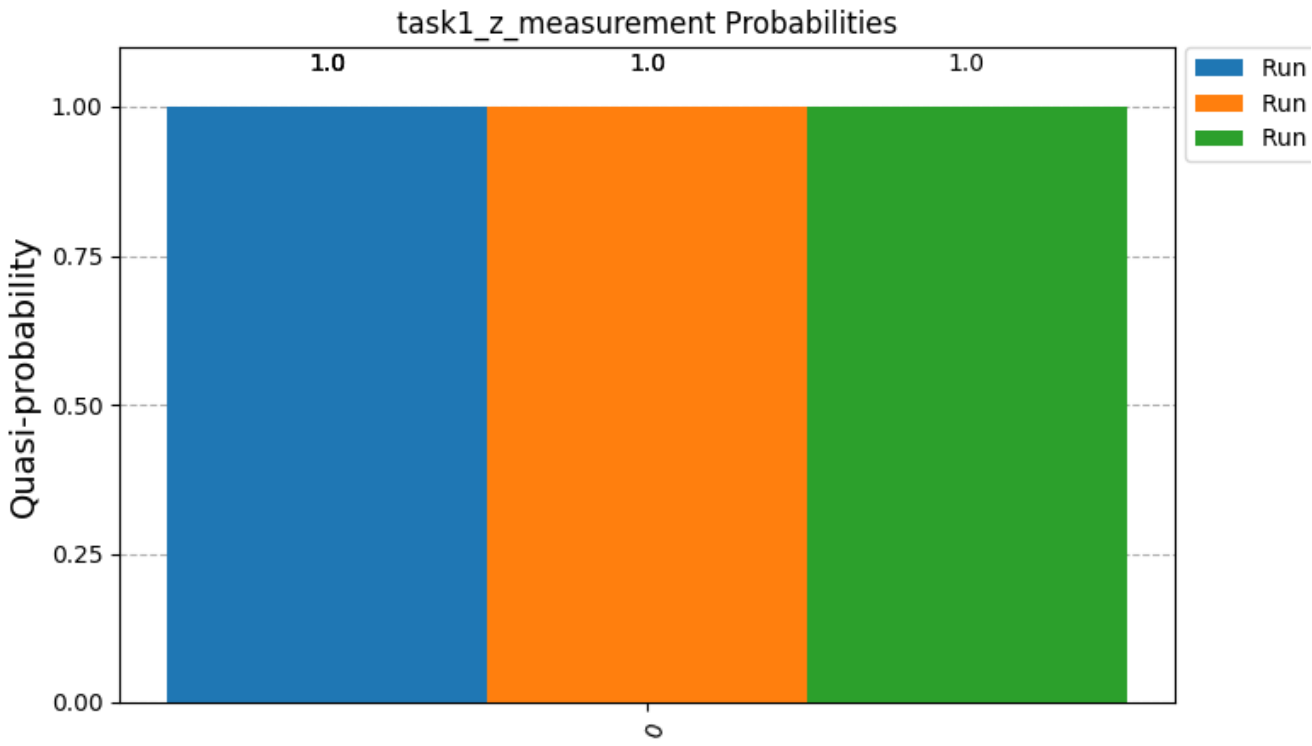
Code Snippet:

```
qreg = QuantumRegister(1, 'q')
creg = ClassicalRegister(1, 'c')
circuit = QuantumCircuit(qreg, creg)
circuit.measure(qreg[0], creg[0])
```

Quantum Circuit:



Probabilities Diagram:



Q-sphere Representation: Q-sphere visualization not available (seaborn library issue).

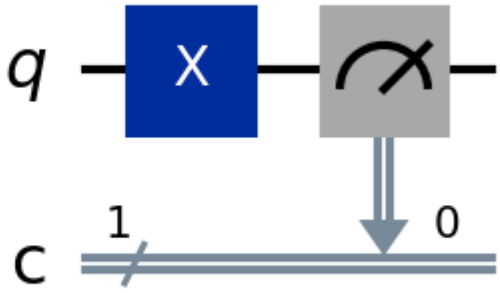
Task 2: X Gate Operation

Application of the X (NOT) gate followed by measurement.

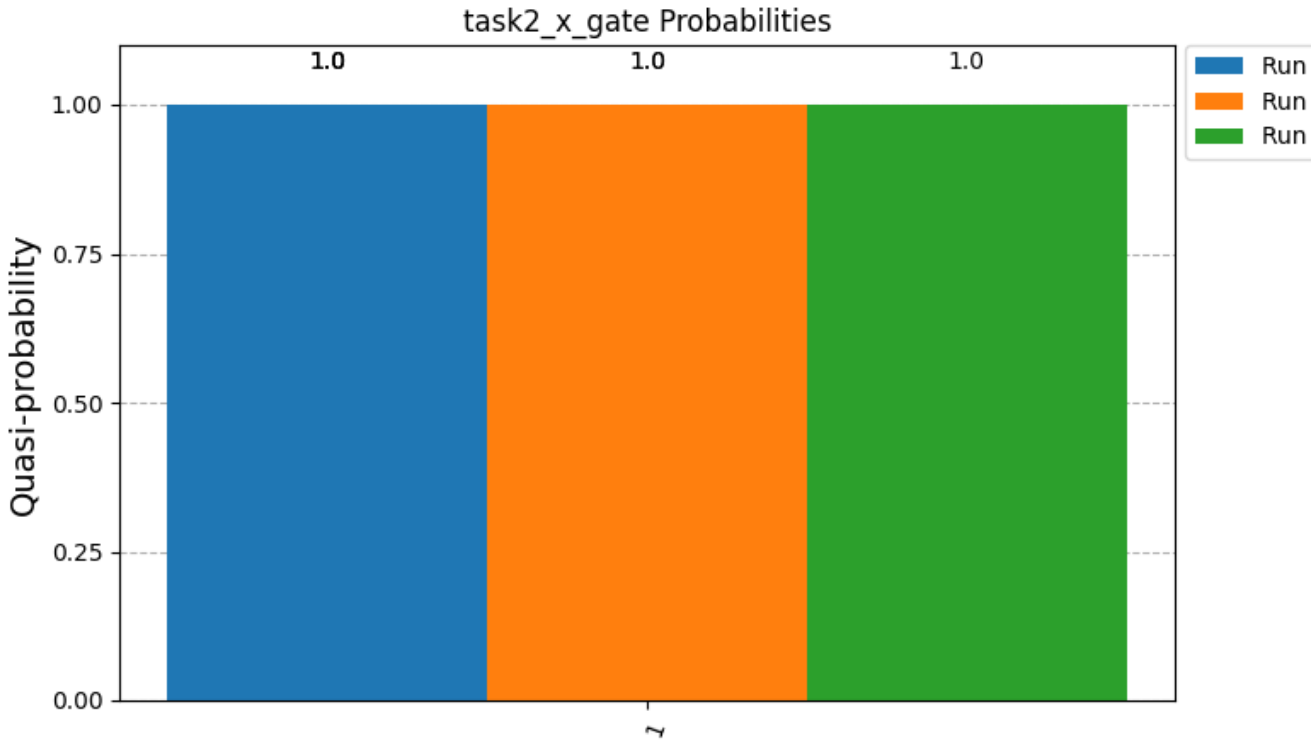
Code Snippet:

```
qreg = QuantumRegister(1, 'q')
creg = ClassicalRegister(1, 'c')
circuit = QuantumCircuit(qreg, creg)
circuit.x(qreg[0])
circuit.measure(qreg[0], creg[0])
```

Quantum Circuit:



Probabilities Diagram:



Q-sphere Representation: Q-sphere visualization not available.

Task 3: Hadamard Gate (Superposition)

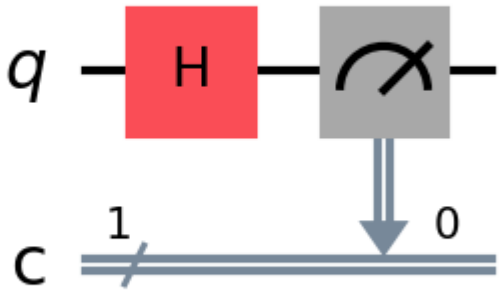
Creation of superposition state using the H gate.

Code Snippet:

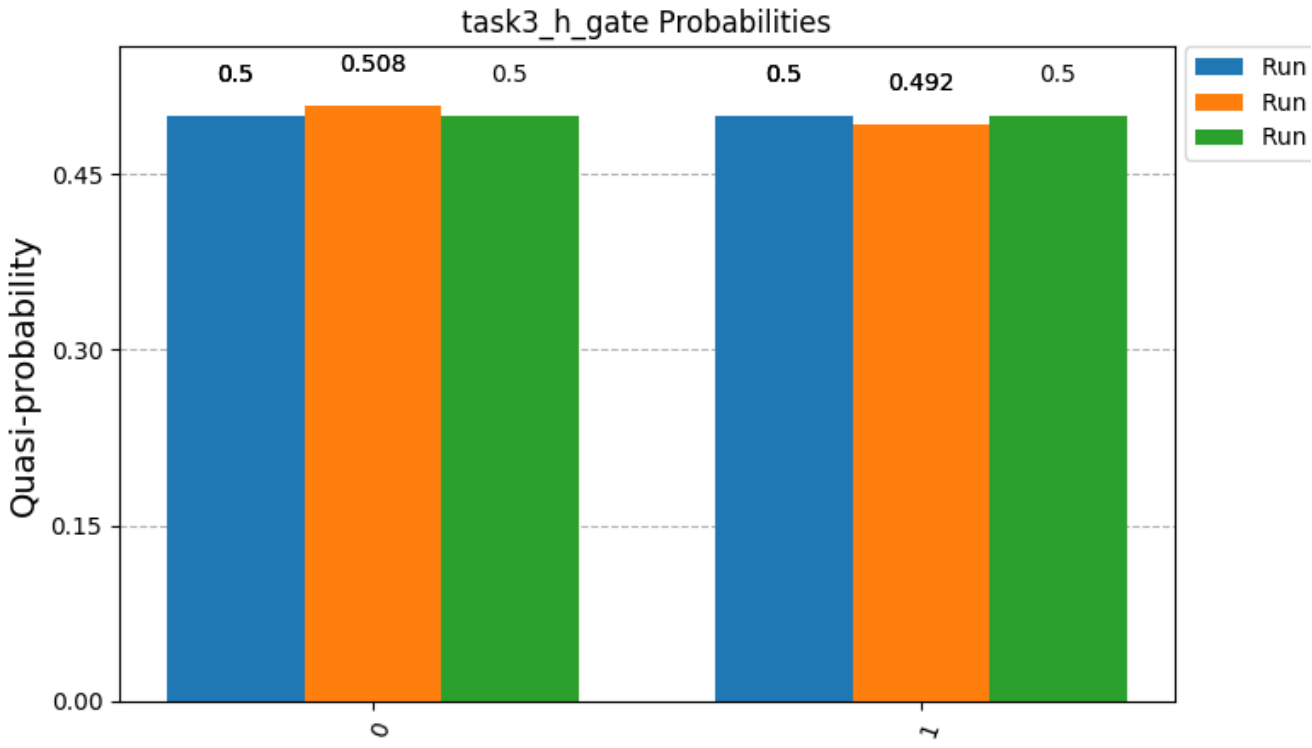
```
qreg = QuantumRegister(1, 'q')
creg = ClassicalRegister(1, 'c')
circuit = QuantumCircuit(qreg, creg)
```

```
circuit.h(qreg[0])
circuit.measure(qreg[0], creg[0])
```

Quantum Circuit:



Probabilities Diagram:



Q-sphere Representation: Q-sphere visualization not available.

Task 4: State Tomography - Measurements in Different Bases

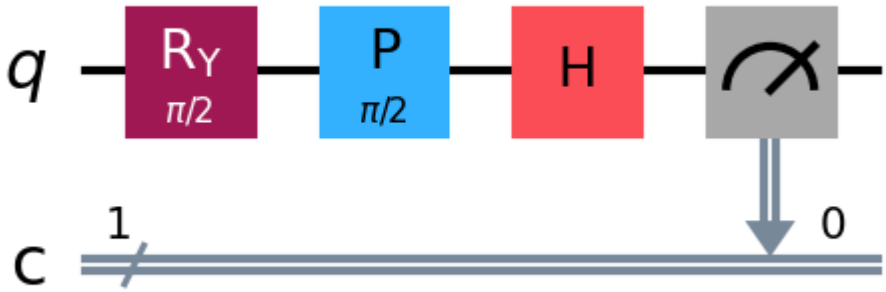
X Basis Measurement

Measurement in the X (σ_1) basis.

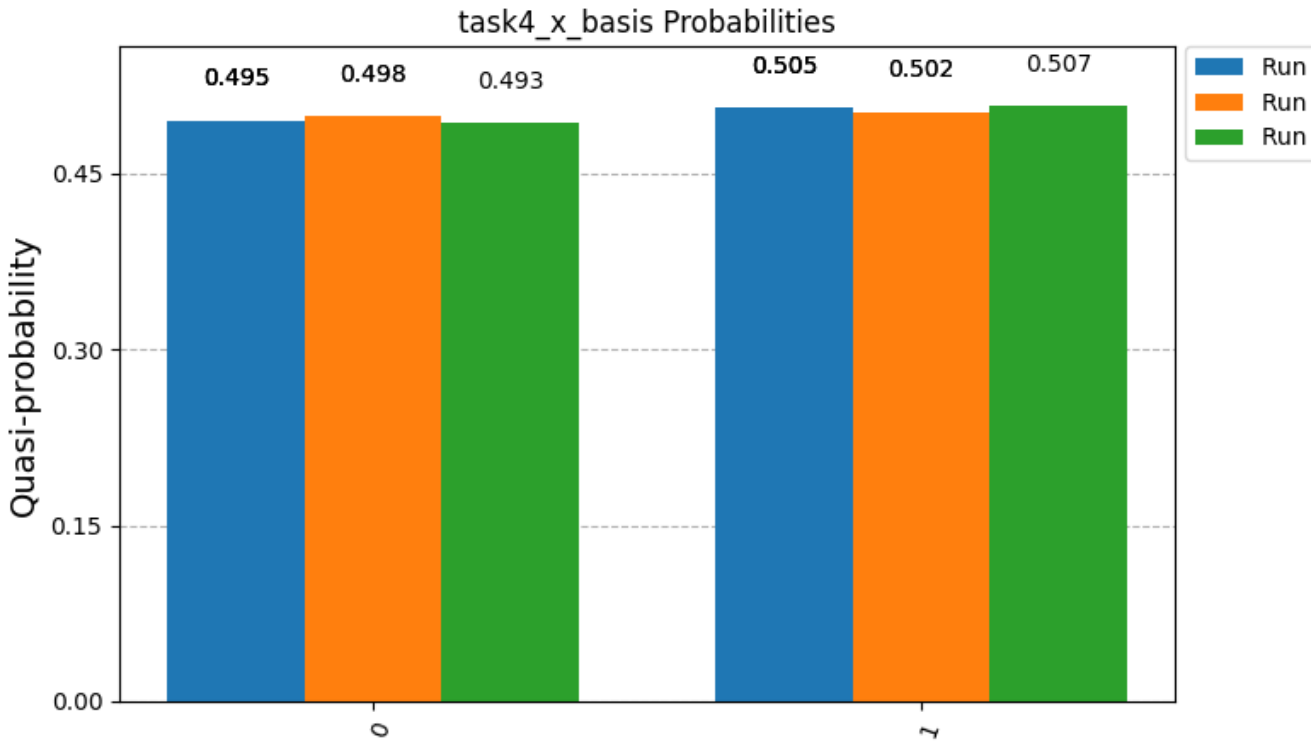
Code Snippet:

```
qreg = QuantumRegister(1, 'q')
creg = ClassicalRegister(1, 'c')
circuit = QuantumCircuit(qreg, creg)
circuit.ry(pi/2, qreg[0])
circuit.p(pi/2, qreg[0])
circuit.h(qreg[0])
circuit.measure(qreg[0], creg[0])
```

Quantum Circuit:



Probabilities Diagram:



Q-sphere Representation: Q-sphere visualization not available.

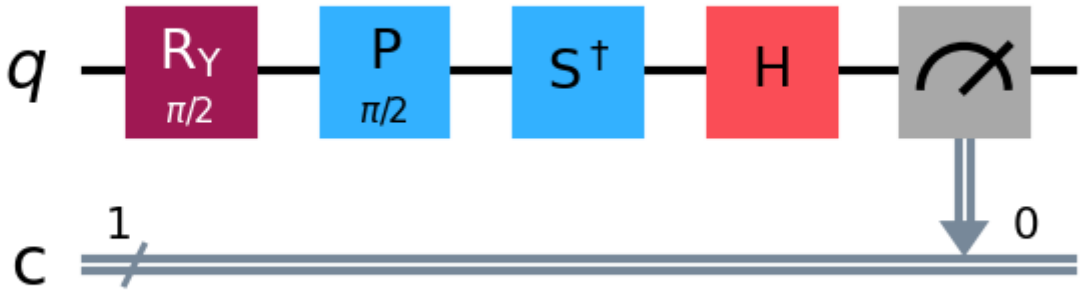
Y Basis Measurement

Measurement in the Y (σ_2) basis.

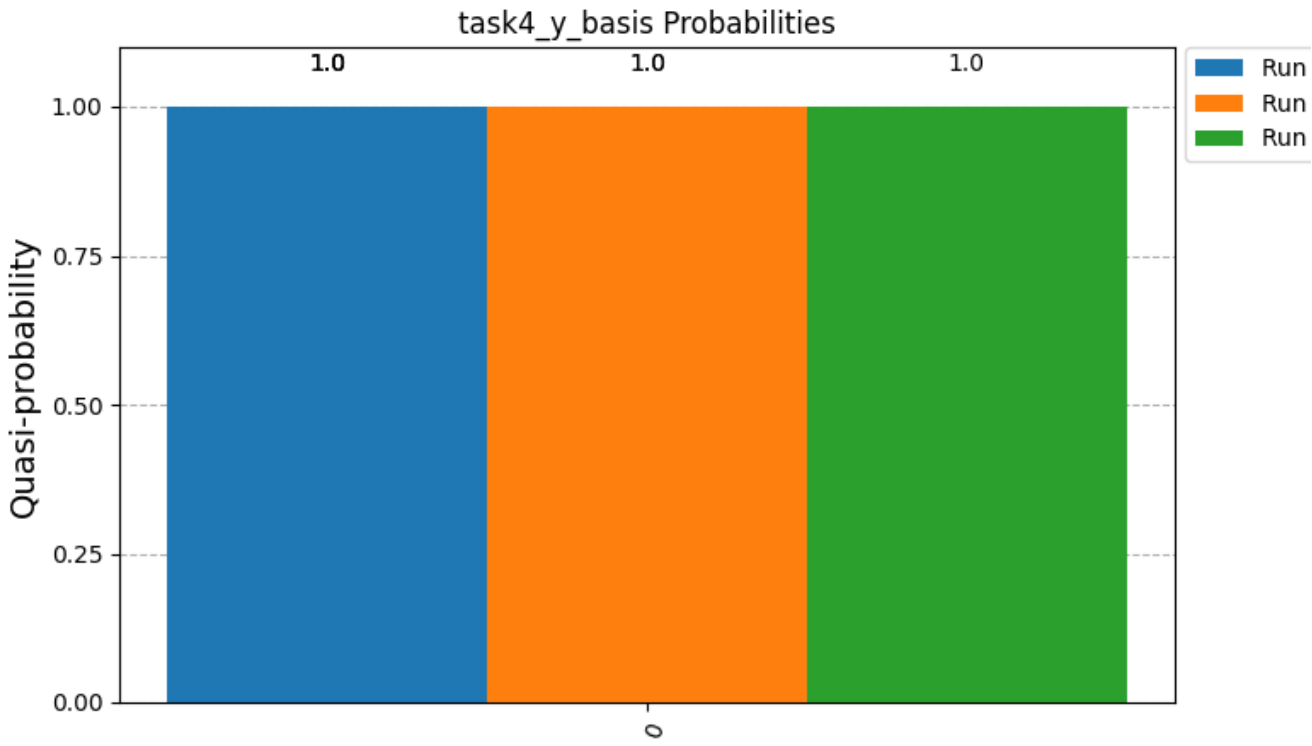
Code Snippet:

```
qreg = QuantumRegister(1, 'q')
creg = ClassicalRegister(1, 'c')
circuit = QuantumCircuit(qreg, creg)
circuit.ry(pi/2, qreg[0])
circuit.p(pi/2, qreg[0])
circuit.sdg(qreg[0])
circuit.h(qreg[0])
circuit.measure(qreg[0], creg[0])
```

Quantum Circuit:



Probabilities Diagram:



Q-sphere Representation: Q-sphere visualization not available.

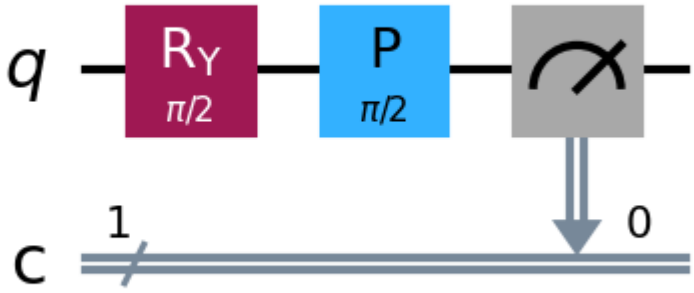
Z Basis Measurement

Measurement in the Z (σ_3) basis.

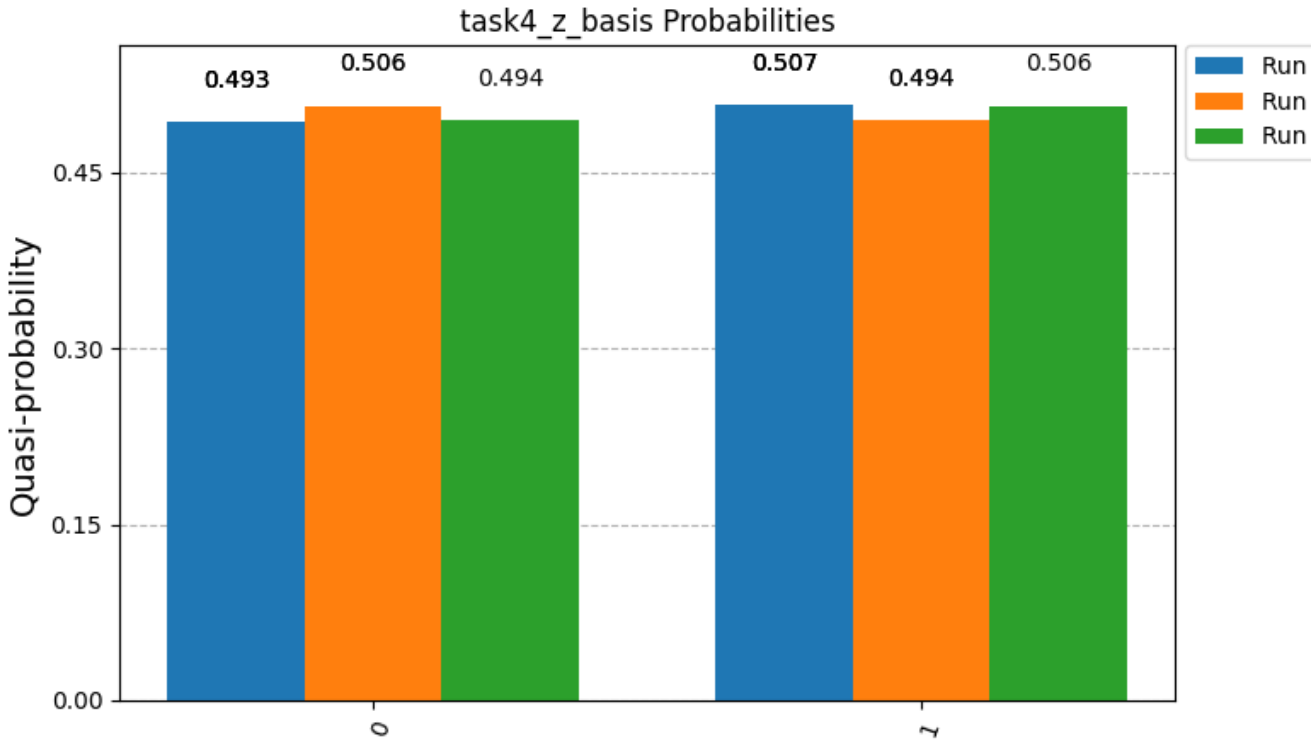
Code Snippet:

```
qreg = QuantumRegister(1, 'q')
creg = ClassicalRegister(1, 'c')
circuit = QuantumCircuit(qreg, creg)
circuit.ry(pi/2, qreg[0])
circuit.p(pi/2, qreg[0])
circuit.measure(qreg[0], creg[0])
```

Quantum Circuit:



Probabilities Diagram:



Q-sphere Representation: Q-sphere visualization not available.