In [63]:

```
import numpy as np
import time
import qiskit
from qiskit import QuantumRegister, QuantumCircuit, ClassicalRegister, Aer
from qiskit.providers.aer import noise
from qiskit.tools.visualization import plot_histogram
from qiskit.ignis.mitigation.measurement import (complete_meas_cal, tensored_mea
                                                 CompleteMeasFitter, TensoredMea
```

In [64]:

```
qr = qiskit.QuantumRegister(3)
qubit_list = [0, 1, 2]
meas_calibs, state_labels = complete_meas_cal(qubit_list=qubit_list, qr=qr, circ
```

In [65]:

```
state_labels
```

Out[65]:

```
['000', '001', '010', '011', '100', '101', '110', '111']
```

In [66]:

```
backend = qiskit.Aer.get_backend('qasm_simulator')
job = qiskit.execute(meas_calibs, backend=backend, shots=1000)
cal_results = job.result()
```

In [67]:

```
meas_fitter = CompleteMeasFitter(cal_results, state_labels, circlabel='mcal')
print(meas_fitter.cal_matrix)
```

```
[[1. 0. 0. 0. 0. 0. 0. 0.]
 [0. 1. 0. 0. 0. 0. 0. 0.]
 [0. 0. 1. 0. 0. 0. 0. 0.]
 [0. 0. 0. 1. 0. 0. 0. 0.]
 [0. 0. 0. 0. 1. 0. 0. 0.]
 [0. 0. 0. 0. 0. 1. 0. 0.]
 [0. 0. 0. 0. 0. 0. 1. 0.]
 [0. 0. 0. 0. 0. 0. 0. 1.]]
```

In [68]:

```
noise_model = noise.NoiseModel()
for qi in range(5):
    read_err = noise.errors.readout_error.ReadoutError([[0.9, 0.1],[0.25,0.75]])
    noise_model.add_readout_error(read_err, [qi])
```

In [69]:

```
backend = qiskit.Aer.get_backend('qasm_simulator')
job = qiskit.execute(meas_calibs, backend=backend, shots=1000, noise_model=noise
cal_results = job.result()
```

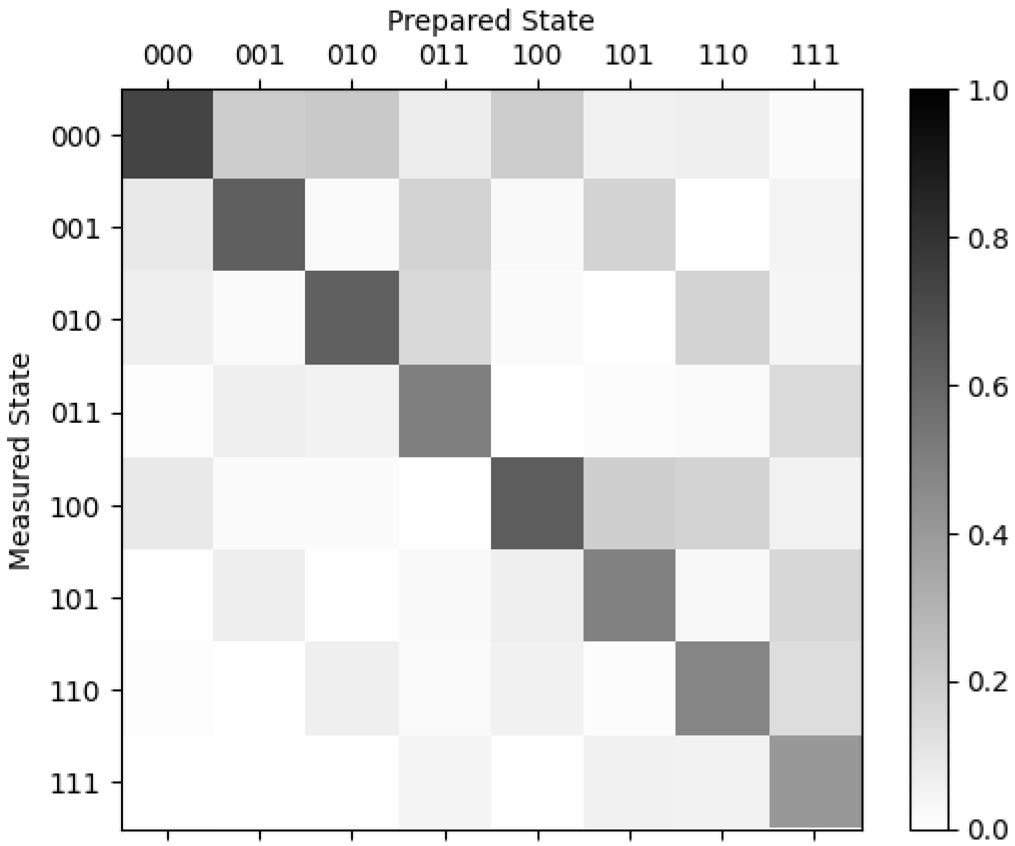
In [70]:

```
meas_fitter = CompleteMeasFitter(cal_results, state_labels, qubit_list=qubit_lis
print(meas_fitter.cal_matrix)
```

```
[[0.733 0.199 0.211 0.072 0.199 0.058 0.065 0.017]
 [0.089 0.627 0.022 0.173 0.024 0.175 0.006 0.044]
 [0.066 0.02  0.622 0.151 0.016 0.004 0.175 0.041]
 [0.009 0.061 0.053 0.507 0.001 0.013 0.021 0.144]
 [0.087 0.019 0.018 0.004 0.635 0.189 0.174 0.052]
 [0.007 0.067 0.002 0.024 0.066 0.491 0.029 0.16 ]
 [0.008 0.003 0.065 0.023 0.056 0.014 0.477 0.136]
 [0.001 0.004 0.007 0.046 0.003 0.056 0.053 0.406]]
```

In [71]:

```
meas_fitter.plot_calibration()
```



In [72]:
```
print("Average Measurement Fidelity: %f" % meas_fitter.readout_fidelity())

print("Average Measurement Fidelity of Q0: %f" % meas_fitter.readout_fidelity(
    label_list = [['000','001','010','011'],['100','101','110','111']]))
```

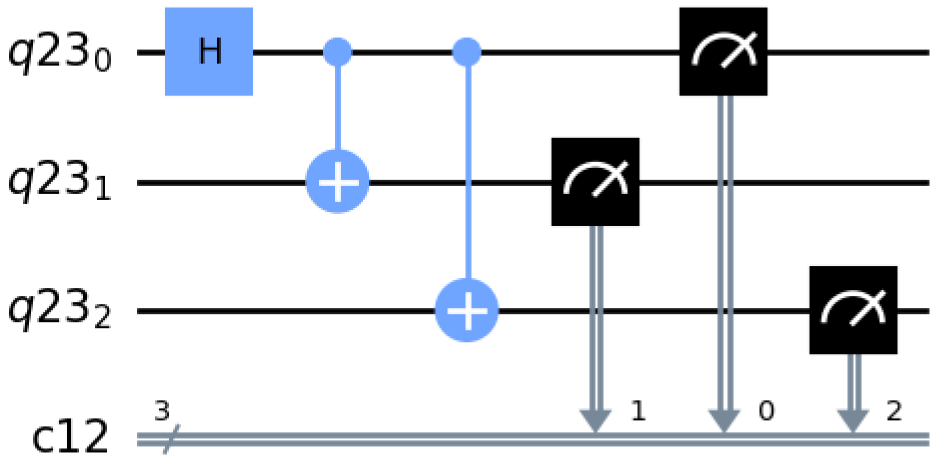
```
Average Measurement Fidelity: 0.562250
Average Measurement Fidelity of Q0: 0.826500
```

In [73]:
```
cr = ClassicalRegister(3)
ghz = QuantumCircuit(qr, cr)
ghz.h(qr[0])
ghz.cx(qr[0], qr[1])
ghz.cx(qr[0], qr[2])
ghz.measure([0,1,2], [0, 1, 2])
```

Out[73]:
```
<qiskit.circuit.instructionset.InstructionSet at 0x7f039478bbb0>
```

In [74]:
```
ghz.draw()
```

Out[74]:



In [75]:
```
job = qiskit.execute([ghz], backend=backend, shots=5000, noise_model=noise_model
results = job.result()
```

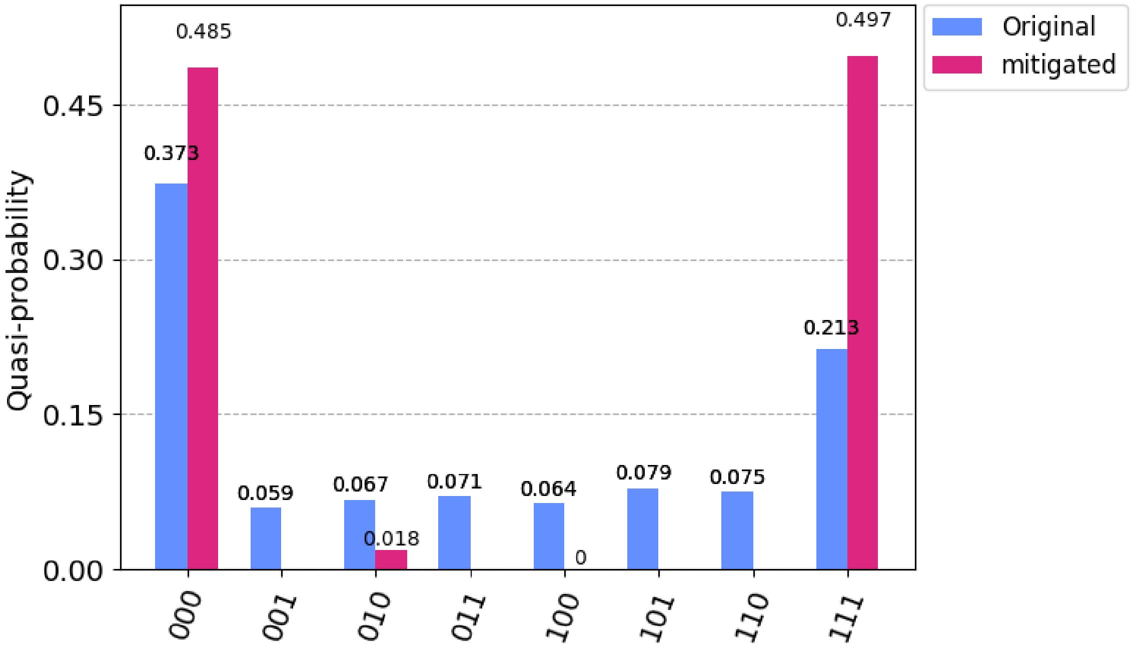
In [76]:
```
# Results without mitigation
raw_counts = results.get_counts()
meas_filter = meas_fitter.filter
# Results with mitigation
mitigated_results = meas_filter.apply(results)
mitigated_counts = mitigated_results.get_counts(0)
```

In [77]:
```
print("Original Counts: ", raw_counts)
print("Mitigated Counts: ", mitigated_counts)
```

```
Original Counts:  {'001': 294, '111': 1067, '011': 353, '100': 320, '101': 393,
'010': 335, '000': 1864, '110': 374}
Mitigated Counts:  {'000': 2425.4448138430485, '010': 89.49065598702185, '100':
5.43350737666759e-12, '111': 2485.0645301701056}
```

In [78]:
```
from qiskit.tools.visualization import *
plot_histogram([raw_counts, mitigated_counts], legend=['Original', 'mitigated'])
```

Out[78]:


Quasi-probability
0.00
0.15
0.30
0.45
Original
mitigated
0.373
0.485
0.059
0.067
0.018
0.071
0.064
0
0.079
0.075
0.213
0.497
000
001
010
011
100
101
110
111