## **Supplementary Materials**

## Calibration data

Tables I–VIII depict calibration metrics for the devices used at the time these devices were used to generate the data depicted in the main text. Calibration metrics affect the precise manner in which circuit gates implemented in QISKIT are translated into microwave pulses used to manipulate the physical qubits.

 $ibmq\_lima$ 

| =====      | T     |                  |                  |             |                     | T                        |
|------------|-------|------------------|------------------|-------------|---------------------|--------------------------|
| Date       | qubit | $T_1$ ( $\mu$ s) | $T_2$ ( $\mu$ s) | freq. (GHz) | Anharmonicity (GHz) | readout assignment error |
| 2022-04-14 | 0     | 93.46            | 118.47           | 5.030       | -0.33574            | $1.78 \times 10^{-2}$    |
| 2022-04-14 | 1     | 122.62           | 131.38           | 5.128       | -0.31835            | $1.67 \times 10^{-2}$    |
| 2022-04-14 | 2     | 117.13           | 131.29           | 5.247       | -0.33360            | $2.22 \times 10^{-2}$    |
| 2022-04-14 | 3     | 135.20           | 106.71           | 5.303       | -0.33124            | $2.68 \times 10^{-2}$    |
| 2022-04-14 | 4     | 21.41            | 21.57            | 5.092       | -0.33447            | $5.10 \times 10^{-2}$    |
| 2022-04-19 | 0     | 71.55            | 97.69            | 5.030       | -0.33574            | $2.27 \times 10^{-2}$    |
| 2022-04-19 | 1     | 123.87           | 107.28           | 5.128       | -0.31835            | $1.50 \times 10^{-2}$    |
| 2022-04-19 | 2     | 123.98           | 134.58           | 5.247       | -0.33360            | $2.30 \times 10^{-2}$    |
| 2022-04-19 | 3     | 96.41            | 96.81            | 5.303       | -0.33124            | $2.92 \times 10^{-2}$    |
| 2022-04-19 | 4     | 22.11            | 22.55            | 5.092       | -0.33447            | $6.20 \times 10^{-2}$    |
| 2022-04-24 | 0     | 169.65           | 188.84           | 5.030       | -0.33574            | $2.30 \times 10^{-2}$    |
| 2022-04-24 | 1     | 125.59           | 117.96           | 5.128       | -0.31835            | $1.47 \times 10^{-2}$    |
| 2022-04-24 | 2     | 78.30            | 96.82            | 5.247       | -0.33360            | $2.22 \times 10^{-2}$    |
| 2022-04-24 | 3     | 101.35           | 69.09            | 5.303       | -0.33124            | $3.31 \times 10^{-2}$    |
| 2022-04-24 | 4     | 23.48            | 22.98            | 5.092       | -0.33447            | $4.82 \times 10^{-2}$    |

TABLE I: Calibration data for qubits in ibmq\_lima.

| Date       | connection | error rate             | gate time (ns) |
|------------|------------|------------------------|----------------|
| 2022-04-14 | 0-1        | $5.290 \times 10^{-3}$ | 305.777        |
| 2022-04-14 | 1-2        | $2.632 \times 10^{-2}$ | 334.222        |
| 2022-04-14 | 1-3        | $1.263 \times 10^{-2}$ | 497.777        |
| 2022-04-14 | 3-4        | $1.680 \times 10^{-2}$ | 519.111        |
| 2022-04-19 | 0-1        | $5.247 \times 10^{-3}$ | 305.777        |
| 2022-04-19 | 1-2        | $7.718 \times 10^{-2}$ | 334.222        |
| 2022-04-19 | 1-3        | $1.171 \times 10^{-2}$ | 497.778        |
| 2022-04-19 | 3-4        | $1.707 \times 10^{-2}$ | 519.111        |
| 2022-04-24 | 0-1        | $4.707 \times 10^{-3}$ | 305.777        |
| 2022-04-24 | 1-2        | $7.186 \times 10^{-2}$ | 334.222        |
| 2022-04-24 | 1-3        | $1.184 \times 10^{-2}$ | 497.777        |
| 2022-04-24 | 3-4        | $1.905 \times 10^{-2}$ | 519.111        |

TABLE II: Calibration data for CNOT gates in ibmq\_lima.

## $ibmq\_manila$

|            | 1.4 | Tr. ( ) | Tr. ( ) | C (CH) | A 1 · · · · · (CII ) |                          |
|------------|-----|---------|---------|--------|----------------------|--------------------------|
| Date       |     |         |         |        |                      | readout assignment error |
| 2022-04-15 | 0   | 107.80  | 66.96   | 4.962  | -0.34335             | $2.70 \times 10^{-2}$    |
| 2022-04-15 | 1   | 135.11  | 74.09   | 4.838  | -0.34621             | $6.37 \times 10^{-2}$    |
| 2022-04-15 | 2   | 157.35  | 22.65   | 5.037  | -0.34366             | $4.16 \times 10^{-2}$    |
| 2022-04-15 | 3   | 197.38  | 65.29   | 4.951  | -0.34355             | $2.50 \times 10^{-2}$    |
| 2022-04-15 | 4   | 138.50  | 45.29   | 5.065  | -0.34211             | $2.97 \times 10^{-2}$    |
| 2022-04-16 | 0   | 118.95  | 81.42   | 4.962  | -0.34335             | $3.0 \times 10^{-2}$     |
| 2022-04-16 | 1   | 124.02  | 65.34   | 4.838  | -0.34621             | $3.41 \times 10^{-2}$    |
| 2022-04-16 | 2   | 165.67  | 25.97   | 5.037  | -0.34366             | $3.37 \times 10^{-2}$    |
| 2022-04-16 | 3   | 179.13  | 52.80   | 4.951  | -0.34355             | $2.24 \times 10^{-2}$    |
| 2022-04-16 | 4   | 178.07  | 49.40   | 5.065  | -0.34211             | $3.72 \times 10^{-2}$    |
| 2022-04-18 | 0   | 104.63  | 69.26   | 4.962  | -0.34335             | $2.91 \times 10^{-2}$    |
| 2022-04-18 | 1   | 170.83  | 53.51   | 4.838  | -0.34621             | $4.80 \times 10^{-2}$    |
| 2022-04-18 | 2   | 207.92  | 25.92   | 5.037  | -0.34366             | $2.79 \times 10^{-2}$    |
| 2022-04-18 | 3   | 147.05  | 53.80   | 4.951  | -0.34355             | $2.17 \times 10^{-2}$    |
| 2022-04-18 | 4   | 156.62  | 43.58   | 5.065  | -0.34211             | $3.07 \times 10^{-2}$    |
| 2022-04-19 | 0   | 131.94  | 70.25   | 4.962  | -0.34335             | $3.38 \times 10^{-2}$    |
| 2022-04-19 | 1   | 130.10  | 76.29   | 4.838  | -0.34621             | $2.92 \times 10^{-2}$    |
| 2022-04-19 | 2   | 142.48  | 25.95   | 5.037  | -0.34366             | $2.44 \times 10^{-2}$    |
| 2022-04-19 | 3   | 157.93  | 60.11   | 4.951  | -0.34355             | $1.90 \times 10^{-2}$    |
| 2022-04-19 | 4   | 170.45  | 41.78   | 5.065  | -0.34211             | $2.59 \times 10^{-2}$    |
| 2022-04-24 | 0   | 199.20  | 99.76   | 4.962  | -0.34335             | $3.2 \times 10^{-2}$     |
| 2022-04-24 | 1   | 195.62  | 72.03   | 4.838  | -0.34621             | $3.18 \times 10^{-2}$    |
| 2022-04-24 | 2   | 158.43  | 24.61   | 5.037  | -0.34366             | $4.64 \times 10^{-2}$    |
| 2022-04-24 | 3   | 159.02  | 40.88   | 4.951  | -0.34355             | $3.23 \times 10^{-2}$    |
| 2022-04-24 | 4   | 130.71  | 40.62   | 5.065  | -0.34211             | $2.29 \times 10^{-2}$    |
| 2022-04-26 | 0   | 157.59  | 104.06  | 4.962  | -0.34335             | $3.55 \times 10^{-2}$    |
| 2022-04-26 | 1   | 226.17  | 77.01   | 4.838  | -0.34621             | $2.82 \times 10^{-2}$    |
| 2022-04-26 | 2   | 188.27  | 25.22   | 5.037  | -0.34366             | $2.66 \times 10^{-2}$    |
| 2022-04-26 | 3   | 228.95  | 64.21   | 4.951  | -0.34355             | $2.28 \times 10^{-2}$    |
| 2022-04-26 | 4   | 124.87  | 45.25   | 5.065  | -0.34211             | $2.97 \times 10^{-2}$    |

TABLE III: Calibration data for qubits in ibmq\_manila.

| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$  |            | I          | ı                      | I              |
|--|------------|------------|------------------------|----------------|
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | Date       | connection | error rate             | gate time (ns) |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2022-04-15 | 0-1        | $8.959 \times 10^{-3}$ | 277.333        |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2022-04-15 | 1-2        | $1.114 \times 10^{-2}$ | 469.333        |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2022-04-15 | 2-3        | $7.623 \times 10^{-3}$ | 355.556        |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2022-04-15 | 3-4        | $5.750 \times 10^{-3}$ | 334.222        |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2022-04-16 | 0-1        | $6.807 \times 10^{-3}$ | 277.333        |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2022-04-16 | 1-2        | $1.049 \times 10^{-2}$ | 469.333        |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2022-04-16 | 2-3        | $6.371 \times 10^{-3}$ | 355.556        |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2022-04-16 | 3-4        | $5.498 \times 10^{-3}$ | 334.222        |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2022-04-18 | 0-1        | $9.176 \times 10^{-3}$ | 277.333        |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2022-04-18 | 1-2        | $1.180 \times 10^{-2}$ | 469.333        |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2022-04-18 | 2-3        | $7.778 \times 10^{-3}$ | 355.556        |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2022-04-18 | 3-4        | $6.451 \times 10^{-3}$ | 334.222        |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2022-04-19 | 0-1        | $7.651 \times 10^{-3}$ | 277.333        |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2022-04-19 | 1-2        | $9.658 \times 10^{-3}$ | 469.333        |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2022-04-19 | 2-3        | $6.794 \times 10^{-3}$ | 355.556        |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2022-04-19 | 3-4        | $6.265 \times 10^{-3}$ | 334.222        |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2022-04-24 | 0-1        | $5.223 \times 10^{-3}$ | 277.333        |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$  | 2022-04-24 | 1-2        | $9.977 \times 10^{-3}$ | 469.333        |
| $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$   | 2022-04-24 | 2-3        | $9.831 \times 10^{-3}$ | 355.556        |
| 2022-04-26 1-2 $1.550 \times 10^{-2}$ 469.333<br>2022-04-26 2-3 $6.702 \times 10^{-3}$ 355.556 | 2022-04-24 | 3-4        | $6.666 \times 10^{-3}$ | 334.222        |
| $2022-04-26 \qquad 2-3 \qquad 6.702 \times 10^{-3} \qquad 355.556$                             | 2022-04-26 | 0-1        | $6.681 \times 10^{-3}$ | 277.333        |
|  | 2022-04-26 | 1-2        | $1.550 \times 10^{-2}$ | 469.333        |
| 2022-04-26   | 2022-04-26 | 2-3        | $6.702 \times 10^{-3}$ | 355.556        |
|  | 2022-04-26 | 3-4        | $5.201 \times 10^{-3}$ | 334.222        |

TABLE IV: Calibration data for CNOT gates in ibmq\_manila.

 $ibm\_lagos$ 

|            |   |        | <u> </u> | I     | I        |                          |
|------------|---|--------|----------|-------|----------|--------------------------|
| Date       |   |        |          |       |          | readout assignment error |
| 2022-04-12 | 0 | 110.77 | 46.41    | 5.235 | -0.33987 | $7.30 \times 10^{-3}$    |
| 2022-04-12 | 1 | 130.34 | 84.81    | 5.100 | -0.34325 | $1.14 \times 10^{-2}$    |
| 2022-04-12 | 2 | 123.18 | 112.70   | 5.188 | -0.34193 | $5.40 \times 10^{-3}$    |
| 2022-04-12 | 3 | 207.35 | 143.35   | 4.987 | -0.34529 | $1.97 \times 10^{-2}$    |
| 2022-04-12 | 4 | 161.92 | 46.82    | 5.285 | -0.33923 | $1.20 \times 10^{-2}$    |
| 2022-04-12 | 5 | 133.28 | 88.03    | 5.176 | -0.34079 | $1.18 \times 10^{-2}$    |
| 2022-04-12 | 6 | 137.78 | 178.13   | 5.064 | -0.34276 | $5.30 \times 10^{-3}$    |
| 2022-04-19 | 0 | 131.57 | 49.25    | 5.235 | -0.33987 | $7.60 \times 10^{-3}$    |
| 2022-04-19 | 1 | 138.38 | 116.49   | 5.100 | -0.34325 | $1.11 \times 10^{-2}$    |
| 2022-04-19 | 2 | 112.36 | 142.46   | 5.188 | -0.34193 | $4.90 \times 10^{-3}$    |
| 2022-04-19 | 3 | 105.22 | 93.65    | 4.987 | -0.34529 | $1.99 \times 10^{-2}$    |
| 2022-04-19 | 4 | 107.02 | 43.79    | 5.285 | -0.33923 | $1.37 \times 10^{-2}$    |
| 2022-04-19 | 5 | 129.64 | 83.89    | 5.176 | -0.34079 | $1.28 \times 10^{-2}$    |
| 2022-04-19 | 6 | 180.21 | 109.66   | 5.064 | -0.34276 | $7.50 \times 10^{-3}$    |
| 2022-04-24 | 0 | 187.41 | 49.35    | 5.235 | -0.33987 | $8.70 \times 10^{-3}$    |
| 2022-04-24 | 1 | 117.38 | 118.40   | 5.100 | -0.34325 | $8.90 \times 10^{-3}$    |
| 2022-04-24 | 2 | 64.03  | 119.95   | 5.188 | -0.34193 | $6.80 \times 10^{-3}$    |
| 2022-04-24 | 3 | 145.37 | 140.26   | 4.987 | -0.34529 | $1.66 \times 10^{-2}$    |
| 2022-04-24 | 4 | 167.96 | 51.35    | 5.285 | -0.33923 | $1.41 \times 10^{-2}$    |
| 2022-04-24 | 5 | 91.06  | 77.16    | 5.176 | -0.34079 | $1.18 \times 10^{-2}$    |
| 2022-04-24 | 6 | 127.67 | 146.32   | 5.064 | -0.34276 | $7.60 \times 10^{-3}$    |
| 2022-09-28 | 0 | 122.09 | 43.23    | 5.235 | -0.33987 | $7.70 \times 10^{-3}$    |
| 2022-09-28 | 1 | 122.50 | 79.85    | 5.100 | -0.34325 | $8.70 \times 10^{-3}$    |
| 2022-09-28 | 2 | 80.70  | 143.44   | 5.188 | -0.34193 | $4.00 \times 10^{-3}$    |
| 2022-09-28 | 3 | 179.06 | 96.01    | 4.987 | -0.34529 | $1.60 \times 10^{-2}$    |
| 2022-09-28 | 4 | 70.89  | 19.19    | 5.285 | -0.33923 | $1.27 \times 10^{-2}$    |
| 2022-09-28 | 5 | 125.56 | 80.26    | 5.176 | -0.34079 | $1.26 \times 10^{-2}$    |
| 2022-09-28 | 6 | 135.57 | 108.60   | 5.064 | -0.34276 | $8.90 \times 10^{-3}$    |
| 2022-10-02 | 0 | 122.09 | 49.23    | 5.235 | -0.33987 | $7.70 \times 10^{-3}$    |
| 2022-10-02 | 1 | 122.5  | 79.85    | 5.100 | -0.34325 | $8.70 \times 10^{-3}$    |
| 2022-10-02 | 2 | 80.70  | 143.33   | 5.188 | -0.34193 | $4.00 \times 10^{-3}$    |
| 2022-10-02 | 3 | 179.06 | 96.01    | 4.987 | -0.34529 | $1.60 \times 10^{-2}$    |
| 2022-10-02 | 4 | 70.89  | 19.19    | 5.285 | -0.33923 | $1.27 \times 10^{-2}$    |
| 2022-10-02 | 5 | 125.55 | 80.26    | 5.176 | -0.34079 | $1.26 \times 10^{-2}$    |
| 2022-10-02 | 6 | 135.57 | 108.60   | 5.064 | -0.34276 | $8.90 \times 10^{-3}$    |
| 2022-10-08 | 0 | 84.09  | 30.77    | 5.235 | -0.33987 | $8.10 \times 10^{-3}$    |
| 2022-10-08 | 1 | 128.29 | 106.63   | 5.100 | -0.34325 | $9.80 \times 10^{-3}$    |
| 2022-10-08 | 2 | 163.44 | 149.43   | 5.188 | -0.34193 | $6.70 \times 10^{-3}$    |
| 2022-10-08 | 3 | 141.19 | 88.05    | 4.987 | -0.34529 | $2.00 \times 10^{-2}$    |
| 2022-10-08 | 4 | 14.20  | 14.23    | 5.285 | -0.33923 | $1.38 \times 10^{-2}$    |
| 2022-10-08 | 5 | 119.10 | 89.16    | 5.176 | -0.34079 | $1.25 \times 10^{-2}$    |
| 2022-10-08 | 6 | 131.13 | 133.12   | 5.064 | -0.34276 | $7.40 \times 10^{-3}$    |
|            |   |        | · -      |       |          | <u> </u>                 |

TABLE V: Calibration data for qubits in ibm\_lagos.

 $ibm\_nairobi$ 

| =          |            |                        |                |
|------------|------------|------------------------|----------------|
| Date       | connection | error rate             | gate time (ns) |
| 2022-04-12 | 0-1        | $6.544 \times 10^{-3}$ | 305.777        |
| 2022-04-12 | 1-2        | $6.707 \times 10^{-3}$ | 327.111        |
| 2022-04-12 | 1-3        | $9.804 \times 10^{-3}$ | 334.222        |
| 2022-04-12 | 3-5        | $1.061 \times 10^{-2}$ | 334.222        |
| 2022-04-12 | 4-5        | $5.090 \times 10^{-3}$ | 362.667        |
| 2022-04-12 | 5-6        | $3.599 \times 10^{-3}$ | 256.000        |
| 2022-04-19 | 0-1        | $7.808 \times 10^{-3}$ | 305.777        |
| 2022-04-19 | 1-2        | $5.743 \times 10^{-3}$ | 327.111        |
| 2022-04-19 | 1-3        | $8.710 \times 10^{-3}$ | 334.222        |
| 2022-04-19 | 3-5        | $1.513 \times 10^{-2}$ | 334.222        |
| 2022-04-19 | 4-5        | $5.895 \times 10^{-3}$ | 362.667        |
| 2022-04-19 | 5-6        | $4.501 \times 10^{-3}$ | 256.000        |
| 2022-04-24 | 0-1        | $7.570 \times 10^{-3}$ | 305.777        |
| 2022-04-24 | 1-2        | $5.387 \times 10^{-3}$ | 327.111        |
| 2022-04-24 | 1-3        | $5.706 \times 10^{-3}$ | 334.222        |
| 2022-04-24 | 3-5        | $8.753 \times 10^{-3}$ | 334.222        |
| 2022-04-24 | 4-5        | $4.983 \times 10^{-3}$ | 362.667        |
| 2022-04-24 | 5-6        | $5.735 \times 10^{-3}$ | 256.000        |
| 2022-09-28 | 0-1        | $6.213 \times 10^{-3}$ | 305.777        |
| 2022-09-28 | 1-2        | $5.485 \times 10^{-3}$ | 327.111        |
| 2022-09-28 | 1-3        | $5.011 \times 10^{-3}$ | 334.222        |
| 2022-09-28 | 3-5        | $9.463 \times 10^{-3}$ | 334.222        |
| 2022-09-28 | 4-5        | $8.606 \times 10^{-3}$ | 362.667        |
| 2022-09-28 | 5-6        | $6.566 \times 10^{-3}$ | 256.000        |
| 2022-10-02 | 0-1        | $6.860 \times 10^{-3}$ | 305.777        |
| 2022-10-02 | 1-2        | $5.756 \times 10^{-3}$ | 327.111        |
| 2022-10-02 | 1-3        | $6.382 \times 10^{-3}$ | 334.222        |
| 2022-10-02 | 3-5        | $1.243 \times 10^{-2}$ | 334.222        |
| 2022-10-02 | 4-5        | $1.116 \times 10^{-2}$ | 362.667        |
| 2022-10-02 | 5-6        | $6.629 \times 10^{-3}$ | 256.000        |
| 2022-10-08 | 0-1        | $6.613 \times 10^{-3}$ | 305.777        |
| 2022-10-08 | 1-2        | $4.230 \times 10^{-3}$ | 327.111        |
| 2022-10-08 | 1-3        | $6.692 \times 10^{-3}$ | 334.222        |
| 2022-10-08 | 3-5        | $9.568 \times 10^{-3}$ | 334.222        |
| 2022-10-08 | 4-5        | $7.202 \times 10^{-3}$ | 362.667        |
| 2022-10-08 | 5-6        | $5.620 \times 10^{-3}$ | 256.000        |

TABLE VI: Calibration data for CNOT gates in ibm\_lagos.

 $ibm\_osaka$ 

ibm\_kyoto

| Date       | qubit | $T_1 (\mu s)$ | $T_2$ ( $\mu$ s) | freq. (GHz) | Anharmonicity (GHz) | readout assignment error |
|------------|-------|---------------|------------------|-------------|---------------------|--------------------------|
| 2022-09-28 | 0     | 160.60        | 36.77            | 5.260       | -0.33983            | $2.41 \times 10^{-2}$    |
| 2022-09-28 | 1     | 159.05        | 84.96            | 5.170       | -0.34058            | $3.74 \times 10^{-2}$    |
| 2022-09-28 | 2     | 106.63        | 81.60            | 5.274       | -0.33890            | $2.47 \times 10^{-2}$    |
| 2022-09-28 | 3     | 162.92        | 33.89            | 5.027       | -0.34253            | $3.41 \times 10^{-2}$    |
| 2022-09-28 | 4     | 92.94         | 69.85            | 5.177       | -0.34059            | $1.92 \times 10^{-2}$    |
| 2022-09-28 | 5     | 156.20        | 19.75            | 5.293       | -0.34053            | $2.61 \times 10^{-2}$    |
| 2022-09-28 | 6     | 130.98        | 60.91            | 5.129       | -0.34044            | $1.55 \times 10^{-1}$    |
| 2022-10-01 | 0     | 142.69        | 35.23            | 5.260       | -0.33983            | $2.20 \times 10^{-2}$    |
| 2022-10-01 | 1     | 135.93        | 101.47           | 5.170       | -0.34058            | $3.14 \times 10^{-2}$    |
| 2022-10-01 | 2     | 92.71         | 101.33           | 5.274       | -0.33890            | $2.29 \times 10^{-2}$    |
| 2022-10-01 | 3     | 150.06        | 71.35            | 5.027       | -0.34253            | $3.18 \times 10^{-2}$    |
| 2022-10-01 | 4     | 126.71        | 74.76            | 5.177       | -0.34059            | $1.76 \times 10^{-2}$    |
| 2022-10-01 | 5     | 152.14        | 20.97            | 5.293       | -0.34053            | $3.22 \times 10^{-2}$    |
| 2022-10-01 | 6     | 165.52        | 106.79           | 5.129       | -0.34044            | $2.85 \times 10^{-2}$    |
| 2022-10-07 | 0     | 151.12        | 30.06            | 5.260       | -0.33983            | $2.75 \times 10^{-2}$    |
| 2022-10-07 | 1     | 112.45        | 94.07            | 5.170       | -0.34058            | $2.53 \times 10^{-2}$    |
| 2022-10-07 | 2     | 132.64        | 205.77           | 5.274       | -0.33890            | $2.32 \times 10^{-2}$    |
| 2022-10-07 | 3     | 166.22        | 69.41            | 5.027       | -0.34253            | $3.94 \times 10^{-2}$    |
| 2022-10-07 | 4     | 77.26         | 75.22            | 5.177       | -0.34059            | $1.97 \times 10^{-2}$    |
| 2022-10-07 | 5     | 121.90        | 21.08            | 5.293       | -0.34053            | $2.82 \times 10^{-2}$    |
| 2022-10-07 | 6     | 152.98        | 96.51            | 5.129       | -0.34044            | $2.48 \times 10^{-2}$    |

TABLE VII: Calibration data for qubits in ibm\_nairobi.

| Date       | connection | error rate             | gate time (ns) |
|------------|------------|------------------------|----------------|
| 2022-09-28 | 0-1        | $1.040 \times 10^{-2}$ | 248.889        |
| 2022-09-28 | 1-2        | $1.668 \times 10^{-2}$ | 426.667        |
| 2022-09-28 | 1-3        | $1.233 \times 10^{-2}$ | 270.222        |
| 2022-09-28 | 3-5        | $1.792 \times 10^{-2}$ | 277.333        |
| 2022-09-28 | 4-5        | $5.119 \times 10^{-3}$ | 312.889        |
| 2022-09-28 | 5-6        | $7.943 \times 10^{-3}$ | 341.333        |
| 2022-10-01 | 0-1        | $1.153 \times 10^{-2}$ | 248.889        |
| 2022-10-01 | 1-2        | $8.893 \times 10^{-3}$ | 426.667        |
| 2022-10-01 | 1-3        | $9.813 \times 10^{-3}$ | 270.222        |
| 2022-10-01 | 3-5        | $1.338 \times 10^{-2}$ | 277.333        |
| 2022-10-01 | 4-5        | $4.588 \times 10^{-3}$ | 312.889        |
| 2022-10-01 | 5-6        | $9.002 \times 10^{-3}$ | 341.333        |
| 2022-10-07 | 0-1        | $9.965 \times 10^{-3}$ | 248.889        |
| 2022-10-07 | 1-2        | $7.843 \times 10^{-3}$ | 426.667        |
| 2022-10-07 | 1-3        | $8.187 \times 10^{-3}$ | 270.222        |
| 2022-10-07 | 3-5        | $1.258 \times 10^{-2}$ | 277.333        |
| 2022-10-07 | 4-5        | $6.003 \times 10^{-3}$ | 312.889        |
| 2022-10-07 | 5-6        | $5.854 \times 10^{-3}$ | 341.333        |

TABLE VIII: Calibration data for CNOT gates in ibm\_nairobi.

 $ibm\_brisbane$ 

| Date       | qubit | $T_1 (\mu s)$ | $T_2 (\mu s)$ | freq. (GHz) | Anharmonicity (GHz) | readout assignment error |
|------------|-------|---------------|---------------|-------------|---------------------|--------------------------|
| 2024-08-12 | 43    | 178.89        | 67.64         | 4.931       | -0.30753            | $1.04 \times 10^{-2}$    |
| 2024-08-12 | 44    | 378.85        | 26.20         | 4.827       | -0.30878            | $1.23 \times 10^{-2}$    |
| 2024-08-12 | 45    | 314.23        | 403.12        | 4.924       | -0.30711            | $2.65 \times 10^{-2}$    |
| 2024-08-12 | 46    | 459.13        | 322.09        | 4.853       | -0.30865            | $4.50 \times 10^{-3}$    |

TABLE IX: Calibration data for qubits in ibm\_osaka.

| Date       | connection | error rate             | gate time (ns) |
|------------|------------|------------------------|----------------|
| 2024-08-12 | 43-44      | $3.972 \times 10^{-3}$ | 660            |
| 2024-08-12 | 44-45      | $4.330 \times 10^{-3}$ | 660            |
| 2024-08-12 | 45-46      | $3.448 \times 10^{-3}$ | 660            |

TABLE X: Calibration data for CNOT gates in ibm\_osaka.

| Date       | qubit | $T_1 (\mu s)$ | $T_2 (\mu s)$ | freq. (GHz) | Anharmonicity (GHz) | readout assignment error |
|------------|-------|---------------|---------------|-------------|---------------------|--------------------------|
| 2024-08-12 | 43    | 452.54        | 461.95        | 4.749       | 0                   | $1.55 \times 10^{-2}$    |
| 2024-08-12 | 44    | 166.53        | 153.02        | 4.936       | -0.30842            | $4.90 \times 10^{-3}$    |
| 2024-08-12 | 45    | 333.59        | 391.58        | 4.716       | -0.31153            | $9.30 \times 10^{-3}$    |
| 2024-08-12 | 54    | 292.48        | 256.60        | 4.830       | 0                   | $1.34 \times 10^{-2}$    |

TABLE XI: Calibration data for qubits in ibm\_kyoto.

| Date       | connection | error rate             | gate time (ns) |
|------------|------------|------------------------|----------------|
| 2024-08-12 | 43-44      | $4.035 \times 10^{-3}$ | 660            |
| 2024-08-12 | 44-45      | $4.482 \times 10^{-3}$ | 660            |
| 2024-08-12 | 45-54      | $4.277 \times 10^{-3}$ | 660            |

TABLE XII: Calibration data for CNOT gates in ibm\_kyoto.

| Date       | qubit | $T_1 (\mu s)$ | $T_2 (\mu s)$ | freq. (GHz) | Anharmonicity (GHz) | readout assignment error |
|------------|-------|---------------|---------------|-------------|---------------------|--------------------------|
| 2024-08-12 | 19    | 406.73        | 81.81         | 4.747       | -0.31072            | $6.79 \times 10^{-2}$    |
| 2024-08-12 | 20    | 218.76        | 101.43        | 4.862       | -0.30910            | $1.15 \times 10^{-2}$    |
| 2024-08-12 | 21    | 289.77        | 125.12        | 4.967       | -0.30695            | $4.90 \times 10^{-3}$    |
| 2024-08-12 | 22    | 220.29        | 213.78        | 5.038       | -0.30655            | $9.50 \times 10^{-3}$    |

TABLE XIII: Calibration data for qubits in ibm\_brisbane.

| Date       | connection | error rate             | gate time (ns) |
|------------|------------|------------------------|----------------|
| 2024-08-12 | 19-20      | $3.955 \times 10^{-3}$ | 660            |
| 2024-08-12 | 20-21      | $4.923 \times 10^{-3}$ | 660            |
| 2024-08-12 | 21-22      | $3.906 \times 10^{-3}$ | 660            |

TABLE XIV: Calibration data for CNOT gates in ibm\_brisbane.

| Date       | qubit | $T_1 (\mu s)$ | $T_2 (\mu s)$ | freq. (GHz) | Anharmonicity (GHz) | readout assignment error |
|------------|-------|---------------|---------------|-------------|---------------------|--------------------------|
| 2024-08-14 | 75    | 232.28        | 158.22        | 4.787       | 0                   | $2.50 \times 10^{-3}$    |
| 2024-08-14 | 76    | 265.63        | 361.35        | 4.683       | 0                   | $2.60 \times 10^{-3}$    |
| 2024-08-14 | 90    | 159.57        | 256.20        | 4.704       | 0                   | $4.20 \times 10^{-3}$    |
| 2024-08-14 | 94    | 254.57        | 158.59        | 4.876       | 0                   | $6.60 \times 10^{-3}$    |

TABLE XV: Calibration data for qubits in ibm\_kyiv.

| Date       | connection | error rate             | gate time (ns) |
|------------|------------|------------------------|----------------|
| 2024-08-14 | 75-76      | $6.240 \times 10^{-3}$ | 561.78         |
| 2024-08-14 | 76-90      | $4.495 \times 10^{-3}$ | 561.78         |
| 2024-08-14 | 90-94      | $5.887 \times 10^{-3}$ | 561.78         |

TABLE XVI: Calibration data for CNOT gates in ibm\_kyiv.

## **Individual scores**

As noted in the main text, several experimental runs were performed during each period of data collection, resulting in at least three scores. Due to device constraints or queue times, it was possible to obtain more than three data points with certain devices. In the event more than three points were obtained, the lowest, largest, and median score were used from the particular run for figures and results presented in the main text. Below we collect the raw (uncorrected) scores, the scores in which basic error mitigation was performed via inversion of the calibration matrix, and error-mitigated scores resulting from a constrained optimization approach. If any difference exists, the latter results in a lower score which was used as the error-corrected score in the main text.

| D .        | 1 .            | . 1         |       |                  |
|------------|----------------|-------------|-------|------------------|
| Date       | device         | uncorrected | _     | matrix inversion |
| 2022-04-15 | ibmq_lima      | 5.844       | 7.631 | 7.681            |
| 2022-04-15 | ibmq_lima      | 5.859       | 7.636 | 7.690            |
| 2022-04-15 | ibmq_lima      | 5.888       | 7.651 | 7.698            |
| 2022-04-19 | ibmq_lima      | 5.906       | 7.743 | 7.819            |
| 2022-04-19 | ibmq_lima      | 5.876       | 7.703 | 7.770            |
| 2022-04-19 | ibmq_lima      | 5.901       | 7.731 | 7.807            |
| 2022-04-24 | ibmq_lima      | 5.860       | 7.651 | 7.717            |
| 2022-04-24 | ibmq_lima      | 5.892       | 7.680 | 7.737            |
| 2022-04-24 | ibmq_lima      | 5.901       | 7.697 | 7.752            |
| 2022-04-15 | 1—             | 6.037       | 7.666 | 7.666            |
|            | ibmq_manila    | 6.051       | 7.683 | 7.683            |
|            | ibmq_manila    | 6.049       | 7.683 | 7.683            |
|            | ibmq_manila    | 6.263       | 7.817 | 7.817            |
|            | ibmq_manila    | 6.252       | 7.815 | 7.815            |
| 2022-04-15 | 1—             | 6.256       | 7.824 | 7.824            |
| 2022-04-16 | ibmq_manila    | 6.271       | 7.701 | 7.701            |
| 2022-04-16 | ibmq_manila    | 6.257       | 7.689 | 7.689            |
| 2022-04-16 | ibmq_manila    | 6.262       | 7.673 | 7.673            |
| 2022-04-18 | ibmq_manila    | 6.200       | 7.735 | 7.735            |
| 2022-04-18 | ibmq_manila    | 6.159       | 7.705 | 7.705            |
| 2022-04-18 | ibmq_manila    | 6.200       | 7.741 | 7.741            |
| 2022-04-19 | ibmq_manila    | 6.500       | 7.946 | 7.946            |
| 2022-04-19 | ibmq_manila    | 6.490       | 7.929 | 7.929            |
| 2022-04-19 | ibmq_manila    | 6.541       | 7.983 | 7.983            |
| 2022-04-24 | $ibmq\_manila$ | 6.390       | 7.761 | 7.761            |
| 2022-04-24 | ibmq_manila    | 6.349       | 7.703 | 7.703            |
| 2022-04-24 | ibmq_manila    | 6.369       | 7.745 | 7.745            |
| 2022-04-26 | $ibmq\_manila$ | 6.037       | 8.029 | 8.031            |
| 2022-04-26 | ibmq_manila    | 6.096       | 8.116 | 8.117            |
| 2022-04-26 | ibmq_manila    | 6.077       | 8.075 | 8.078            |
| 2022-04-12 | ibm_lagos      | 7.178       | 7.984 | 7.984            |
| 2022-04-12 | ibm_lagos      | 7.166       | 7.975 | 7.975            |
| 2022-04-12 | ibm_lagos      | 7.172       | 7.977 | 7.977            |
| 2022-04-12 | ibm_lagos      | 7.175       | 7.986 | 7.986            |
| 2022-04-12 | ibm_lagos      | 7.156       | 7.963 | 7.963            |
| 2022-04-12 | ibm_lagos      | 7.172       | 7.980 | 7.980            |
| 2022-04-12 | ibm_lagos      | 7.166       | 7.970 | 7.970            |
| 2022-04-12 | ibm_lagos      | 7.184       | 7.987 | 7.987            |
| 2022-04-12 | ibm_lagos      | 7.145       | 7.955 | 7.955            |
| 2022-04-12 | ibm_lagos      | 7.183       | 7.995 | 7.995            |
| 2022-04-19 | ibm_lagos      | 7.221       | 8.037 | 8.037            |
| 2022-04-19 | ibm_lagos      | 7.220       | 8.043 | 8.043            |
| 2022-04-19 | ibm_lagos      | 7.225       | 8.050 | 8.050            |
| 2022-04-19 | ibm_lagos      | 7.217       | 8.045 | 8.045            |
| 2022-04-19 | ibm_lagos      | 7.202       | 8.030 | 8.030            |
| 2022-04-19 | ibm_lagos      | 7.211       | 8.022 | 8.022            |
| 2022-04-19 | ibm_lagos      | 7.228       | 8.057 | 8.057            |
| 2022-04-19 | ibm_lagos      | 7.223       | 8.038 | 8.038            |
| 2022-04-19 | ibm_lagos      | 7.221       | 8.036 | 8.036            |
| 2022-04-19 | ibm_lagos      | 7.237       | 8.055 | 8.055            |
| 2022-04-24 | ibm_lagos      | 7.454       | 8.140 | 8.140            |

TABLE XVII: Individual scores.

|            |             | I     |       |                  |
|------------|-------------|-------|-------|------------------|
| Date       | device      |       |       | matrix inversion |
| 2022-04-24 | ibm_lagos   | 7.427 | 8.110 | 8.110            |
| 2022-04-24 | ibm_lagos   | 7.427 | 8.116 | 8.116            |
| 2022-09-28 | ibm_lagos   | 7.284 | 8.158 | 8.158            |
| 2022-09-28 | ibm_lagos   | 7.267 | 8.142 | 8.142            |
| 2022-09-28 | ibm_lagos   | 7.247 | 8.124 | 8.124            |
| 2022-09-28 | ibm_lagos   | 7.292 | 8.179 | 8.179            |
| 2022-10-02 | ibm_lagos   | 6.905 | 8.040 | 8.040            |
| 2022-10-02 | ibm_lagos   | 6.907 | 8.046 | 8.046            |
| 2022-10-02 | ibm_lagos   | 6.935 | 8.081 | 8.081            |
| 2022-10-02 | ibm_lagos   | 6.968 | 8.117 | 8.117            |
| 2022-10-02 | ibm_lagos   | 6.953 | 8.101 | 8.101            |
| 2022-10-02 | ibm_lagos   | 6.912 | 8.057 | 8.057            |
| 2022-10-02 | ibm_lagos   | 6.932 | 8.074 | 8.074            |
| 2022-10-02 | ibm_lagos   | 6.934 | 8.080 | 8.080            |
| 2022-10-09 | ibm_lagos   | 7.326 | 8.132 | 8.132            |
| 2022-10-09 | ibm_lagos   | 7.312 | 8.110 | 8.110            |
| 2022-10-09 | ibm_lagos   | 7.295 | 8.096 | 8.096            |
| 2022-10-09 | ibm_lagos   | 7.290 | 8.087 | 8.087            |
| 2022-10-09 | ibm_lagos   | 7.321 | 8.127 | 8.127            |
| 2022-10-09 | ibm_lagos   | 7.337 | 8.145 | 8.145            |
| 2022-10-09 | ibm_lagos   | 7.289 | 8.092 | 8.092            |
| 2022-10-09 | ibm_lagos   | 7.310 | 8.105 | 8.105            |
| 2022-10-09 | ibm_lagos   | 7.325 | 8.124 | 8.124            |
| 2022-10-09 | ibm_lagos   | 7.325 | 8.136 | 8.136            |
| 2022-09-28 | ibm_nairobi | 6.549 | 8.516 | 8.533            |
| 2022-09-28 | ibm_nairobi | 6.545 | 8.484 | 8.501            |
| 2022-09-28 | ibm_nairobi | 6.547 | 8.497 | 8.509            |
| 2022-09-28 | ibm_nairobi | 6.528 | 8.450 | 8.473            |
| 2022-09-28 | ibm_nairobi | 6.546 | 8.450 | 8.487            |
| 2022-09-28 | ibm_nairobi | 6.530 | 8.451 | 8.476            |
| 2022-09-28 | ibm_nairobi | 6.556 | 8.430 | 8.444            |
| 2022-09-28 | ibm_nairobi | 6.554 | 8.428 | 8.439            |
| 2022-09-28 | ibm_nairobi | 6.550 | 8.420 | 8.434            |
| 2022-09-28 | ibm_nairobi | 6.558 | 8.433 | 8.447            |
| 2022-09-28 | ibm_nairobi | 6.540 | 8.425 | 8.442            |
| 2022-10-01 | ibm_nairobi | 6.652 | 8.281 | 8.283            |
| 2022-10-01 | ibm_nairobi | 6.701 | 8.338 | 8.340            |
| 2022-10-01 | ibm_nairobi | 6.675 | 8.305 | 8.305            |
| 2022-10-01 | ibm_nairobi | 6.682 | 8.322 | 8.323            |
| 2022-10-01 | ibm_nairobi | 6.666 | 8.287 | 8.291            |
| 2022-10-01 | ibm_nairobi | 6.746 | 8.376 | 8.379            |
| 2022-10-01 | ibm_nairobi | 6.748 | 8.373 | 8.374            |
| 2022-10-01 | ibm_nairobi | 6.729 | 8.325 | 8.325            |
| 2022-10-01 | ibm_nairobi | 6.733 | 8.347 | 8.350            |
| 2022-10-01 | ibm_nairobi | 6.742 | 8.353 | 8.353            |
| 2022-10-07 | ibm_nairobi | 6.656 | 8.384 | 8.393            |
| 2022-10-07 | ibm_nairobi | 6.692 | 8.418 | 8.423            |
| 2022-10-07 | ibm_nairobi | 6.685 | 8.409 | 8.416            |
| 2022-10-07 | ibm_nairobi | 6.674 | 8.404 | 8.410            |
| 2022-10-07 | ibm_nairobi | 6.693 | 8.419 | 8.423            |
| 2022-10-07 | ibm_nairobi | 6.687 | 8.408 | 8.412            |
| 2022-10-07 |             | 6.695 | 8.417 | 8.424            |
| 2022-10-07 | ibm_nairobi | 6.692 | 8.432 | 8.439            |
|            |             |       |       | ·                |

TABLE XVIII: Individual scores.

| Date       | device       | resilience level 0 | resilience level 1 |
|------------|--------------|--------------------|--------------------|
| 2024-08-12 | ibm_osaka    | 5.603              | 7.500              |
| 2024-08-12 | ibm_kyoto    | 7.536              | 8.097              |
| 2024-08-12 | ibm_brisbane | 6.492              | 8.054              |
| 2024-08-14 | ibm_kyiv     | 7.840              | 8.028              |

TABLE XIX: Individual scores.