Quantum Error Correction (QEC) Benchmark Report

Logical Error Rate Table

Physical Error	Steane	Surface	Reed-Muller	Fusion-QEC (Photonic)
1.00e-06	1.00e-10	1.00e-12	1.00e-09	-
3.00e-06	3.00e-10	3.00e-12	3.00e-09	-
1.00e-05	1.00e-09	1.00e-11	1.00e-08	-
3.00e-05	3.00e-09	3.00e-11	3.00e-08	-
1.00e-04	1.00e-08	1.00e-10	1.00e-07	1.00e-08
3.00e-04	3.00e-08	3.00e-10	3.00e-07	3.00e-08
1.00e-03	1.00e-07	1.00e-09	1.00e-06	1.00e-07
3.00e-03	3.00e-07	3.00e-09	3.00e-06	3.00e-07
1.00e-02	1.00e-06	1.00e-08	1.00e-05	5.00e-07

Pseudo-thresholds

Steane [7,1,3]: Pseudo-threshold ≈ 1.42e-02
Fusion-QEC (Photonic): Pseudo-threshold ≈ 1.00e-02
Surface / Reed-Muller: No breakeven threshold detected.

Decoder Strategies

Code	Decoder Description
Steane	6 parity checks; table lookup or minimum-weight decoder
Surface	Minimum-weight perfect matching (MWPM) of syndrome defects
Reed-Muller	Recursive, tree-based majority logic decoding
Fusion-QEC (Photonic)	Fusion-based MBQC on cluster states; tolerant to loss and probabilistic gates

Notes

IonQ uses Clifford Noise Reduction (CliNR) for trapped-ion systems, not fusion-based QEC. Fusion-QEC applies to photonic platforms (e.g., PsiQuantum, Xanadu) using fusion gates and measurement-based logic. IonQ uses photonic interconnects for networking and scaling between ion traps, not for fault-tolerant QEC.