

Figure 5 | Convergence behavior and robustness of the quantum inference pipelines. (a) **Continuous VQE/VQA convergence** shown as the true complex-domain EIS cost (SSE) versus optimization iteration (*mean* \pm *s.e.* over random starts/seeds), demonstrating rapid reduction of the full circuit-model misfit under the bounded-decoding parameterization. (b) Discrete QAOA convergence summarized as the best-so-far expected Ising energy $\langle H \rangle$ versus (γ, β) angle evaluation during the two-stage grid search; the dashed marker indicates the transition from the coarse scan to the refined local window used to select (γ^*, β^*) for final sampling. (c) Noise robustness of recovered parameters quantified by the coefficient of variation (CV%) across refits under controlled complex Gaussian noise levels (scaled by $|Z|$), highlighting which circuit parameters remain stable and which become noise sensitive as perturbations increase. (d) Failure diagnostics versus noise level, reporting the boundary-hit rate (solutions pinned near parameter bounds) and a non-improvement/non-convergence rate, providing practical indicators of solver reliability and identifiability degradation under increasing measurement noise.

