

**Figure S6 | QAOA angle selection via coarse-to-refined  $\gamma$ - $\beta$  landscape search ( $p = 1$ ).** (a) **Coarse**  $(\gamma, \beta)$  grid evaluation of the expected Ising energy  $\langle H \rangle$  for the 21-qubit QAOA surrogate (3-bit  $\times$  7-parameter encoding), used to locate the basin of low cost. (b) Refined  $(\gamma, \beta)$  scan in a tight window centered on the best coarse cell to sharpen the optimum. In both panels, the star marks the selected angles  $(\gamma^*, \beta^*)$  that minimize the evaluated  $\langle H \rangle$ . These final angles are then used for shots = 4096 QAOA sampling, followed by best-shot bitstring decoding (with trust-region  $\Delta=0.08$  and bounds in Table S1) to obtain the discrete parameter vector  $\theta$  used in the final EIS overlays.

