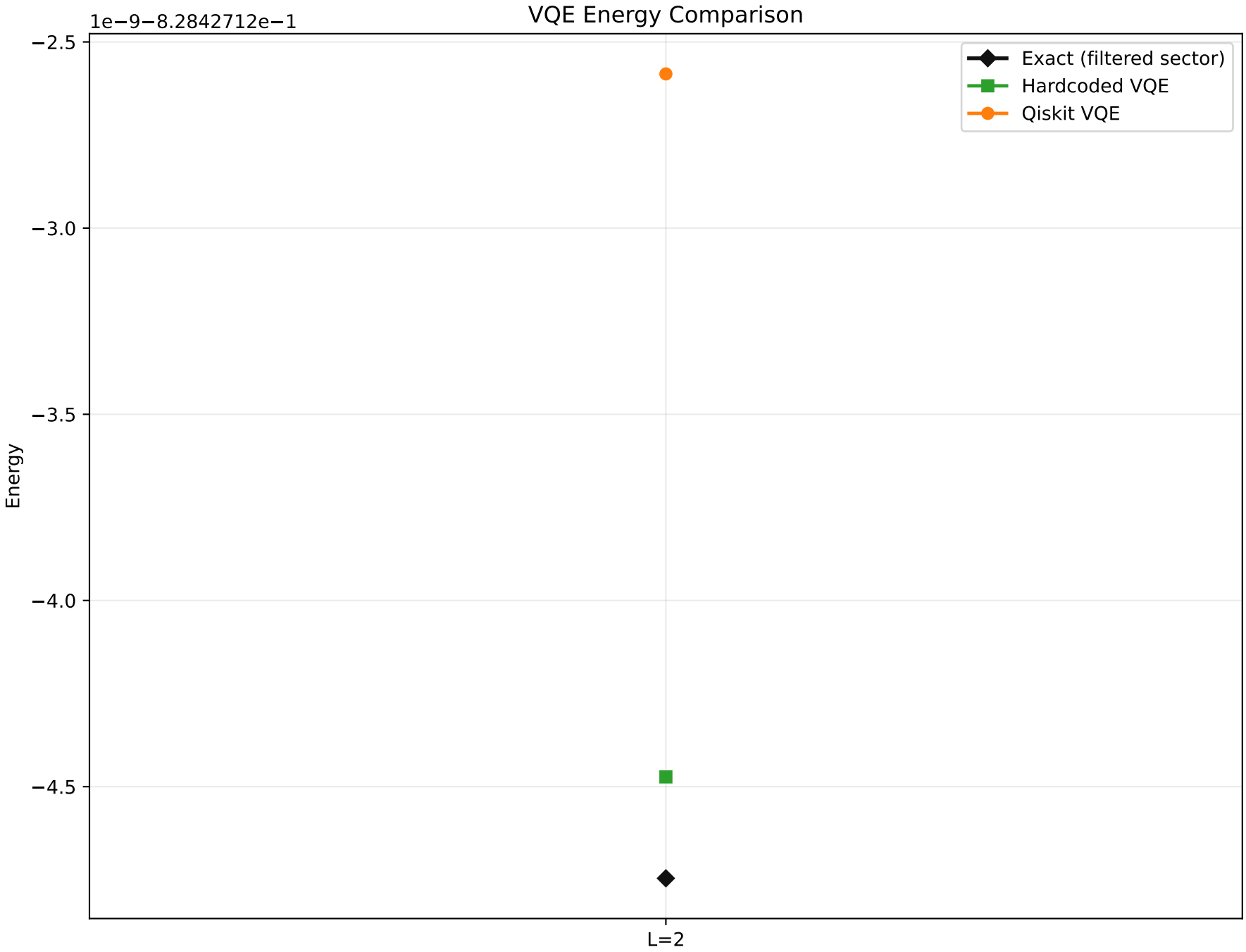
Executed Command

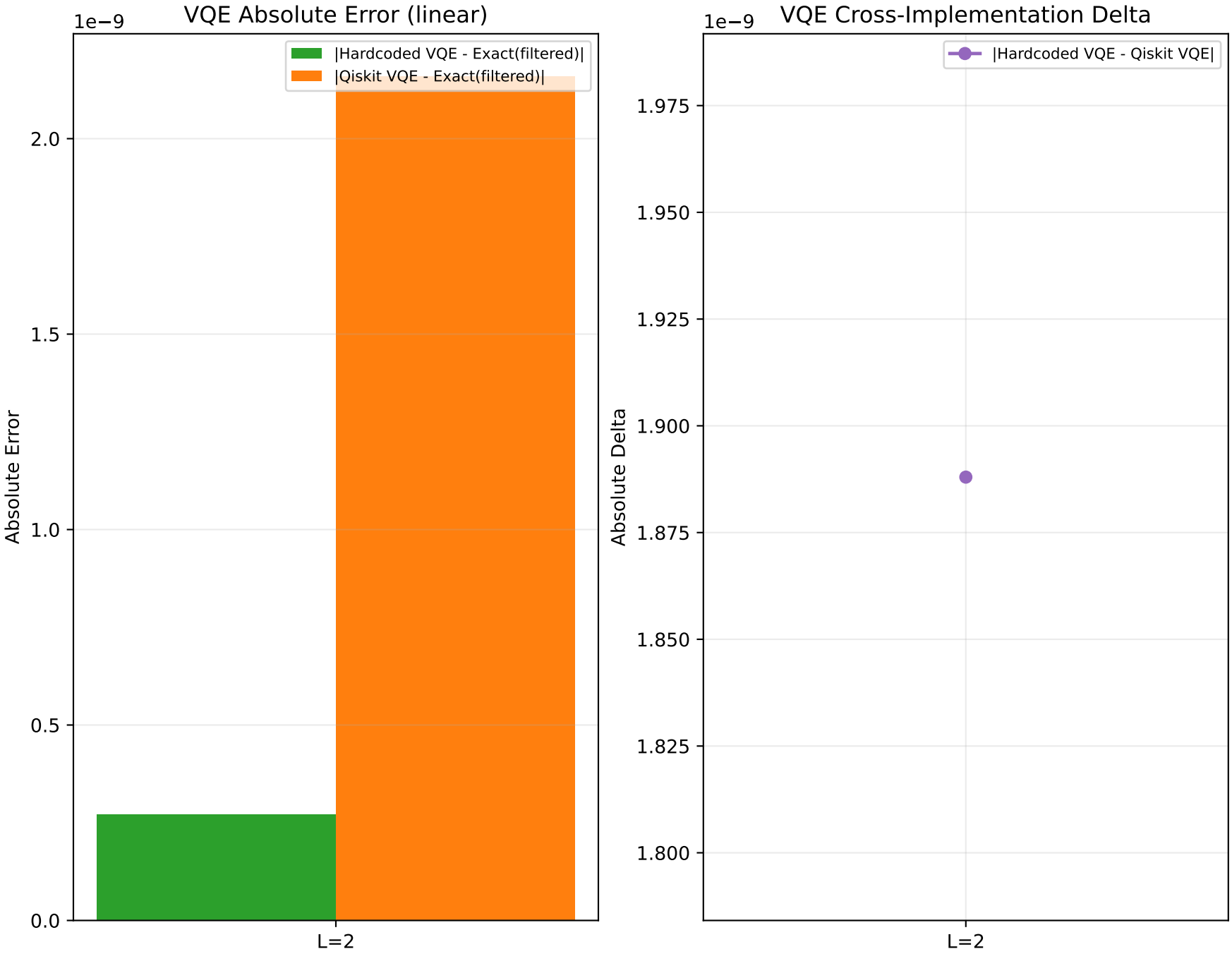
Reference: pipelines/PIPELINE_RUN_GUIDE.md
Script: pipelines/compare_hardcoded_vs_qiskit_pipeline.py

```
/opt/anaconda3/bin/python3 Fermi-Hamil-JW-VQE-TROTTER-
    PIPELINE/pipelines/compare_hardcoded_vs_qiskit_pipeline.py --l-values 2 --run-pipelines --enable-drive
    --drive-pattern dimer_bias --drive-omega 2.0 --drive-tbar 2.0 --t-final 2.0 --num-times 21 --trotter-steps
    32 --drive-amplitudes 0.0,0.2 --with-drive-amplitude-comparison-pdf --artifacts-dir
    artifacts/amp_compare_smoke --skip-qpe
```

```
Hardcoded vs Qiskit Pipeline Comparison Summary

generated_utc: 2026-02-21T00:10:16.463575+00:00
all_pass: True
l_values: [2]
trajectory_comparison_basis: trotter trajectories start from
  each pipeline's selected initial_state_source (default: vqe)
exact_trajectory_labels: Exact_Hardcode, Exact_Qiskit
exact_trajectory_method: python_matrix_eigendecomposition

thresholds:
{'doublon_trotter_max_abs_delta': 0.001,
 'energy_trotter_max_abs_delta': 0.001,
 'fidelity_max_abs_delta': 0.0001,
 'ground_state_energy_abs_delta': 1e-08,
 'n_dn_site0_trotter_max_abs_delta': 0.005,
 'n_up_site0_trotter_max_abs_delta': 0.005}

hardcoded_qiskit_import_isolation:
{'offending_imports': [],
 'pass': True,
 'qiskit_imports': [{'line': 497, 'module': 'qiskit'},
                    {'line': 498, 'module': 'qiskit.circuit.library'},
                    {'line': 499, 'module': 'qiskit.primitives'},
                    {'line': 500, 'module': 'qiskit.quantum_info'},
                    {'line': 501, 'module': 'qiskit.synthesis'},
                    {'line': 502, 'module': 'qiskit_algorithms'},
                    {'line': 503, 'module': 'qiskit_algorithms.minimum_eigensolvers'}],
 'qpe_adapter_range': {'end_line': 599, 'start_line': 463}}

Delta metric definitions:
ΔF(t)      = |F_hc(t) - F_qk(t)|
ΔE_trot(t) = |E_trot_hc(t) - E_trot_qk(t)|
Δn_up0(t)  = |n_up0_hc(t) - n_up0_qk(t)|
```

```
Δn_dn0(t)  = |n_dn0_hc(t) - n_dn0_qk(t)|
ΔD(t)      = |D_hc(t) - D_qk(t)|
F_pipeline(t) is the pipeline's stored trajectory fidelity value (as computed internally vs that pipeline's exact
    evolution).

Per-L pass flags:
L=2 pass=True metrics_json=/Users/jakestrobel/Documents/Holstein_implementation/Holstein_test/artifacts/amp_compare
    _smoke/hardcoded_vs_qiskit_pipeline_L2_metrics.json
```


VQE Energy Comparison
1e−9−8.2842712e−1
−2.5
−3.0
−3.5
−4.0
−4.5
Energy
L=2
Exact (filtered sector)
Hardcoded VQE
Qiskit VQE

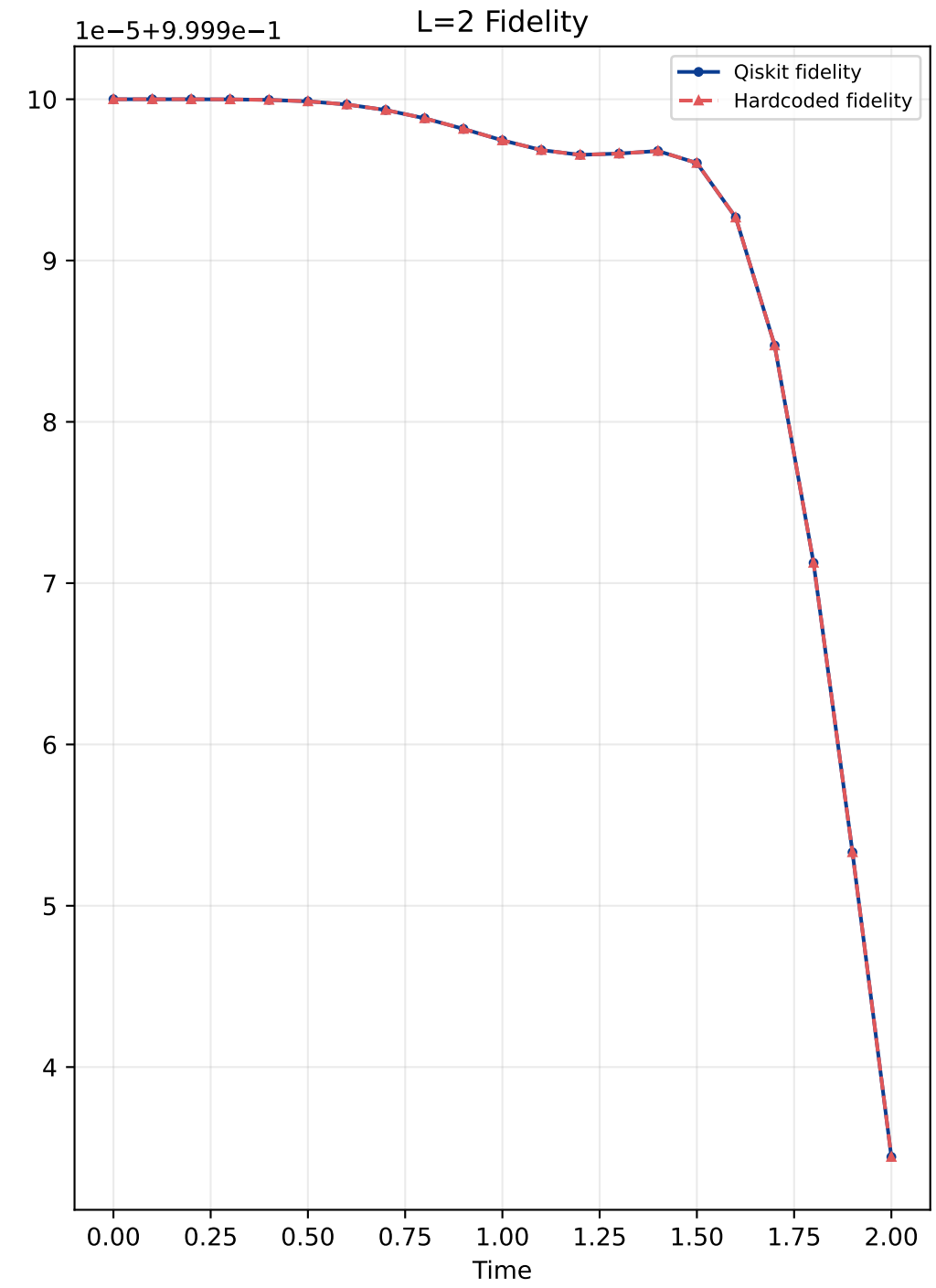

VQE Absolute Error (linear)
1e−9
|Hardcoded VQE - Exact(filtered)|
|Qiskit VQE - Exact(filtered)|
Absolute Error
2.0
1.5
1.0
0.5
0.0
L=2
VQE Cross-Implementation Delta
1e−9
|Hardcoded VQE - Qiskit VQE|
Absolute Delta
1.975
1.950
1.925
1.900
1.875
1.850
1.825
1.800
L=2

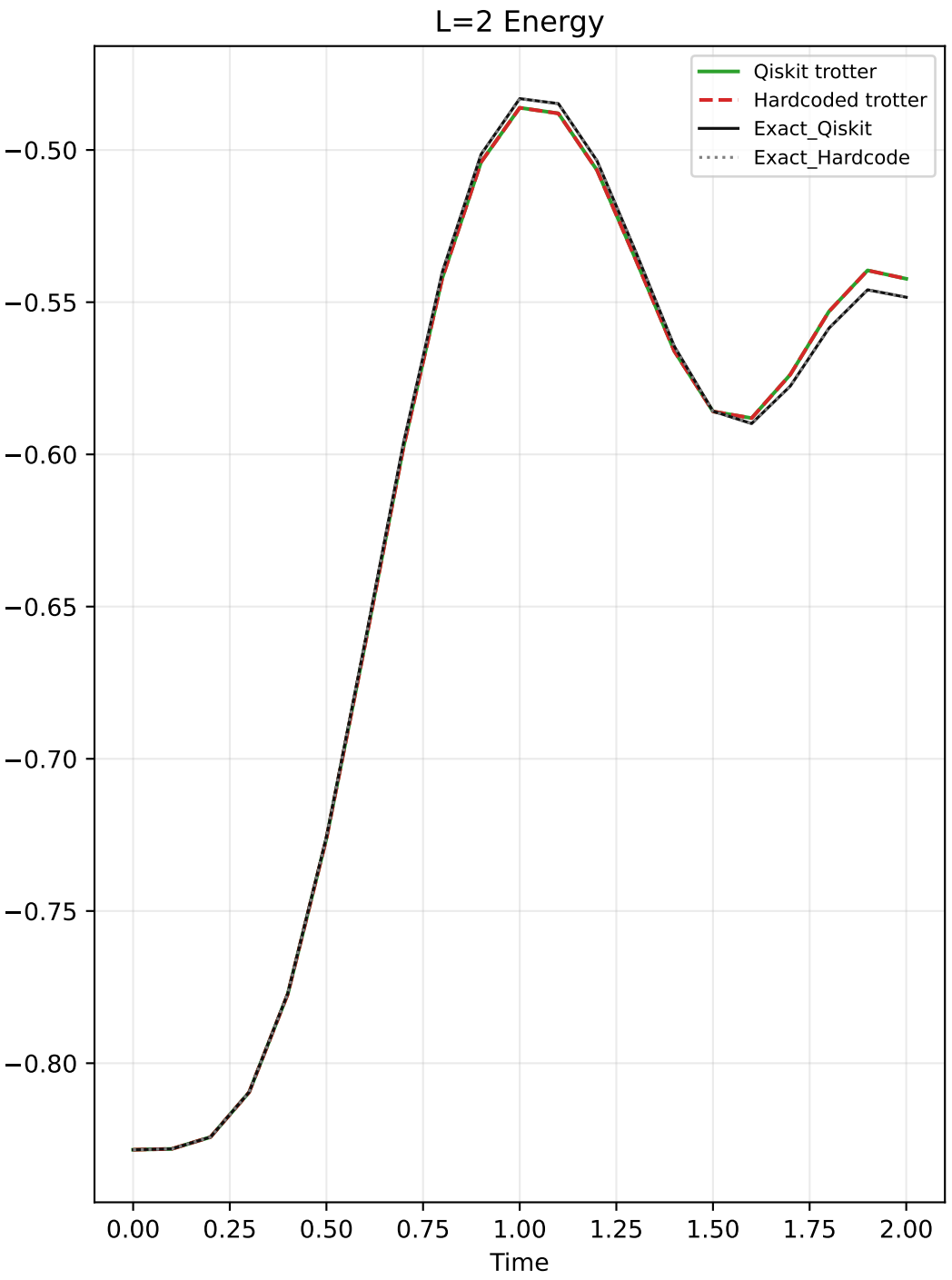
QPE comparison skipped: no finite QPE energy estimates were found in per-L payloads.

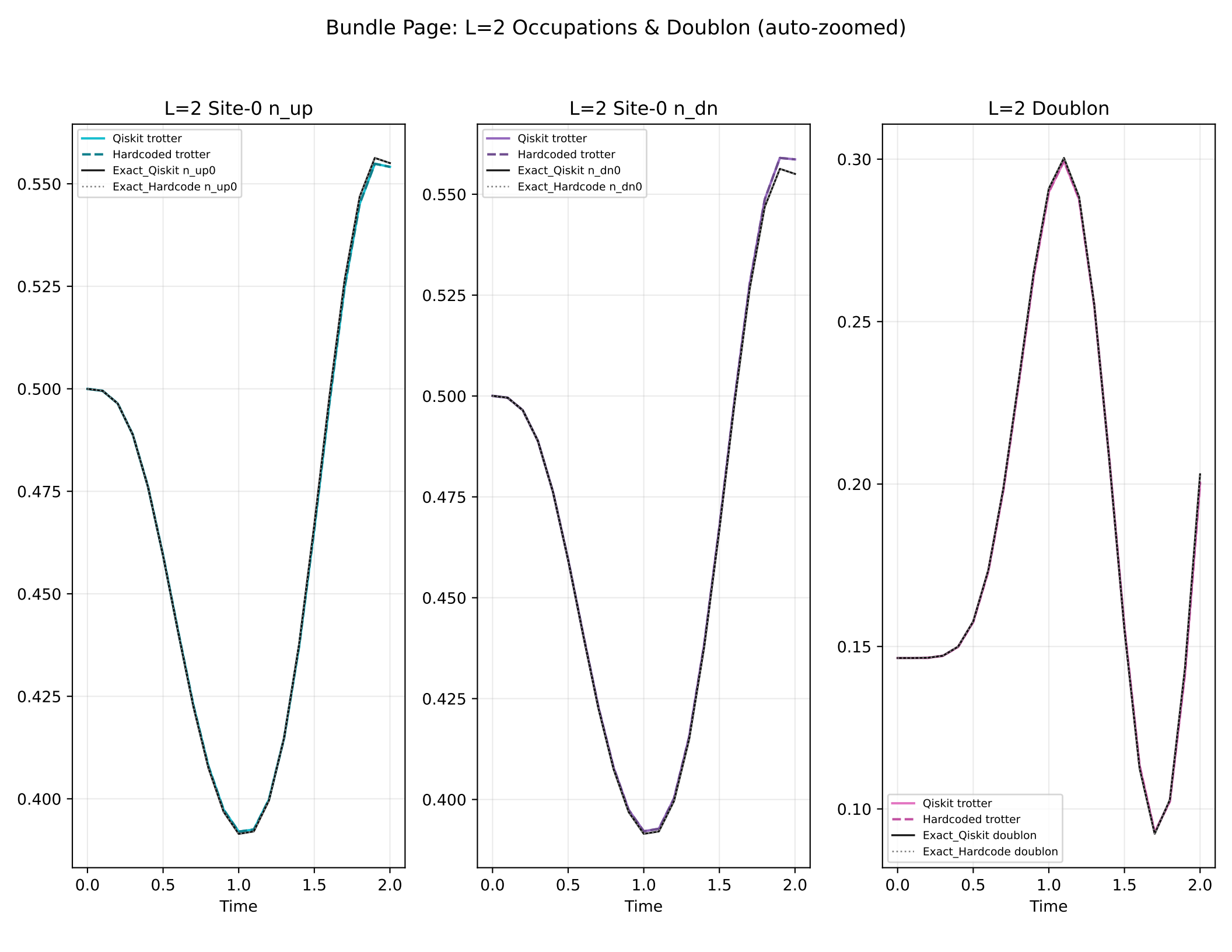
Bundle L=2: Run Settings & Metrics Summary

```
L=2  t=1.0  u=4.0  dv=0.0  boundary=periodic  ordering=blocked  initial_state_source=vqe  t_final=2.0  num_times=21  suzuk

thresholds:
  doublon_trotter_max_abs_delta: 1.00e-03
  energy_trotter_max_abs_delta: 1.00e-03
  fidelity_max_abs_delta: 1.00e-04
  ground_state_energy_abs_delta: 1.00e-08
  n_dn_site0_trotter_max_abs_delta: 5.00e-03
  n_up_site0_trotter_max_abs_delta: 5.00e-03

max |Δ|:
  gs_energy: 0.00e+00
  doublon_trotter: 1.32e-05
  energy_trotter: 2.86e-05
  fidelity: 1.05e-09
  n_dn_site0_trotter: 2.79e-05
  n_up_site0_trotter: 2.45e-05
result: PASS
```

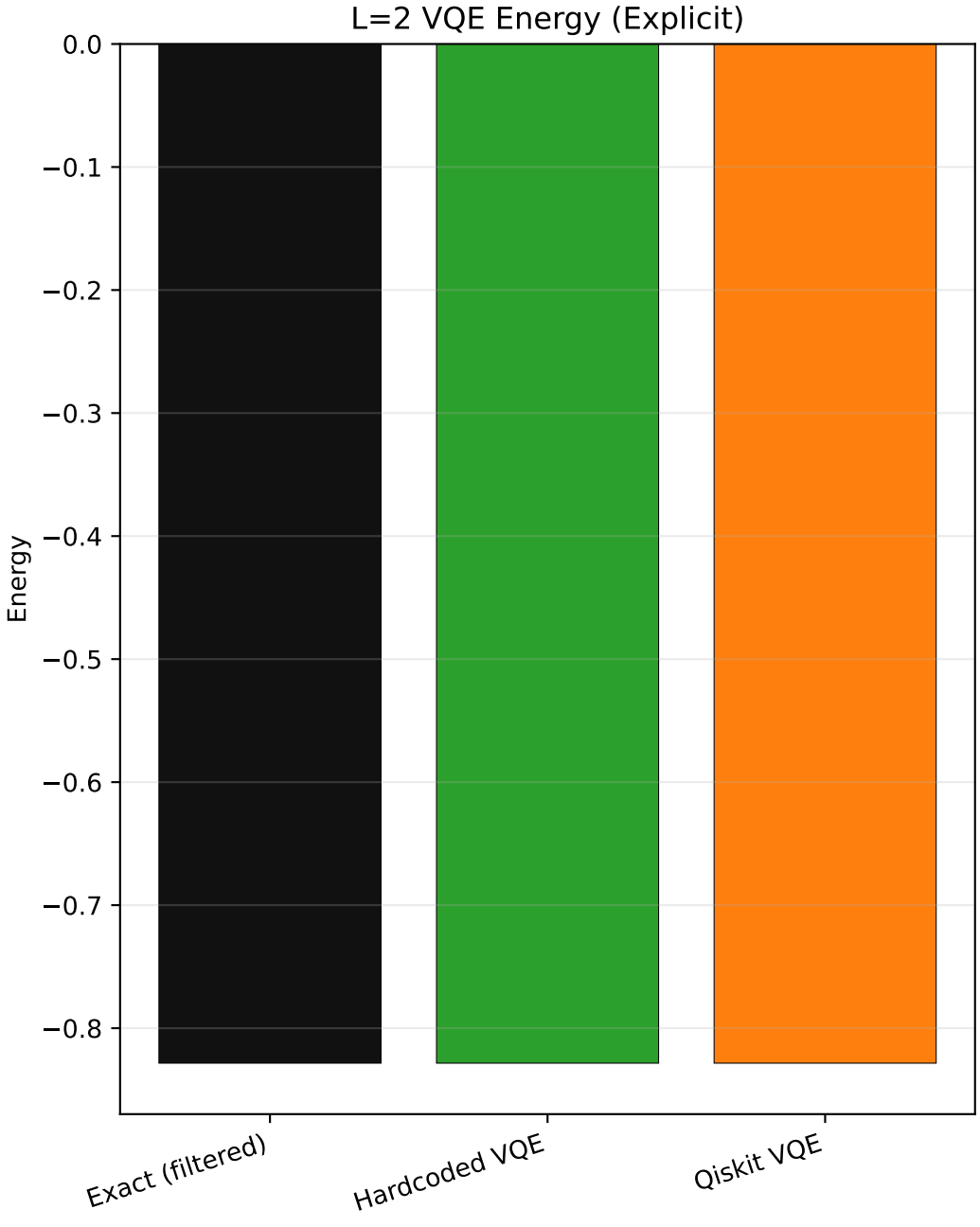
Bundle Page: L=2 Fidelity & Energy

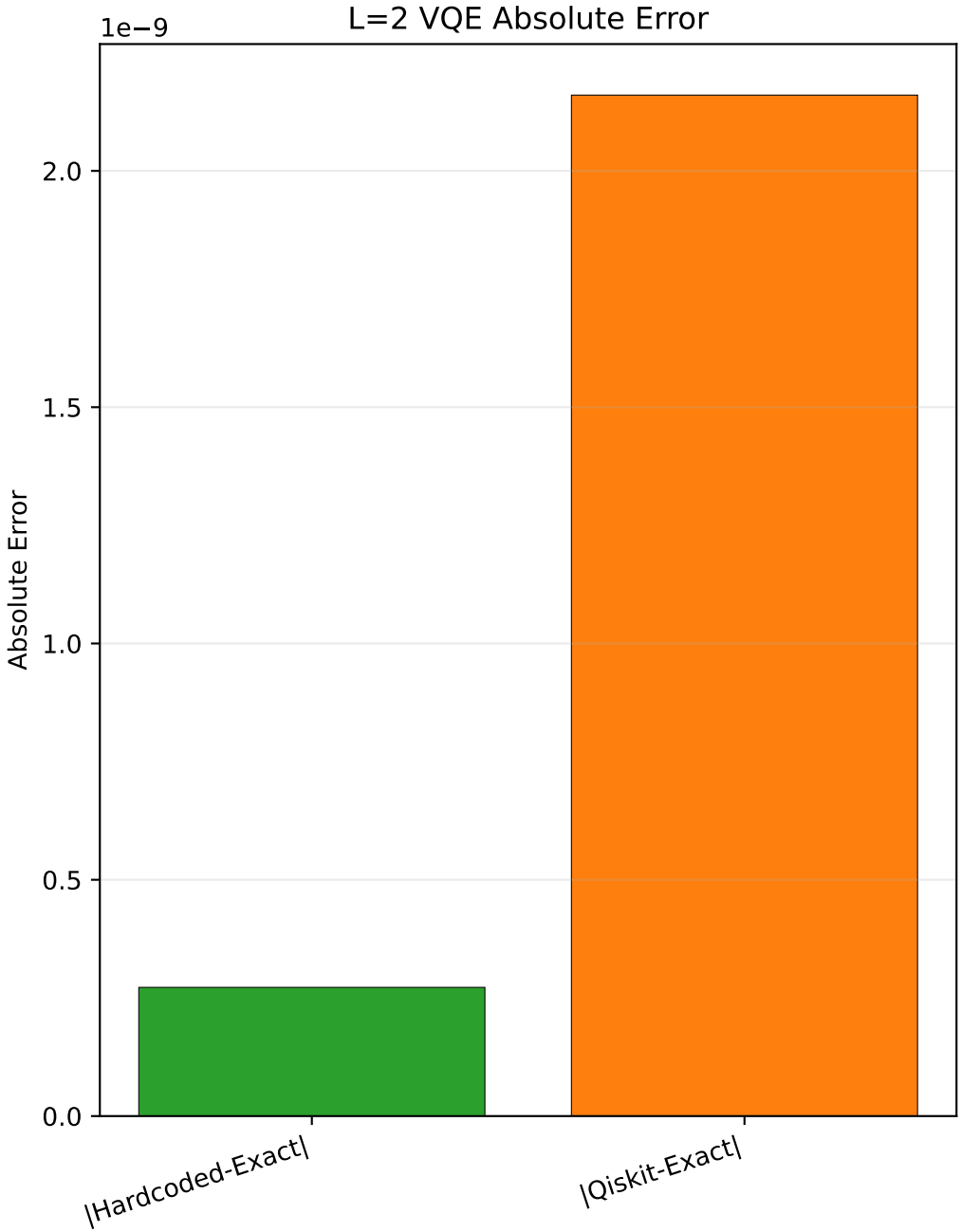





Bundle Page: L=2 Occupations & Doublon (auto-zoomed)
L=2 Site-0 n_up
Qiskit trotter
Hardcoded trotter
Exact_Qiskit n_up0
Exact_Hardcode n_up0
0.550
0.525
0.500
0.475
0.450
0.425
0.400
0.0
0.5
1.0
1.5
2.0
Time
L=2 Site-0 n_dn
Qiskit trotter
Hardcoded trotter
Exact_Qiskit n_dn0
Exact_Hardcode n_dn0
0.550
0.525
0.500
0.475
0.450
0.425
0.400
0.0
0.5
1.0
1.5
2.0
Time
L=2 Doublon
0.30
0.25
0.20
0.15
0.10
Qiskit trotter
Hardcoded trotter
Exact_Qiskit doublon
Exact_Hardcode doublon
0.0
0.5
1.0
1.5
2.0
Time

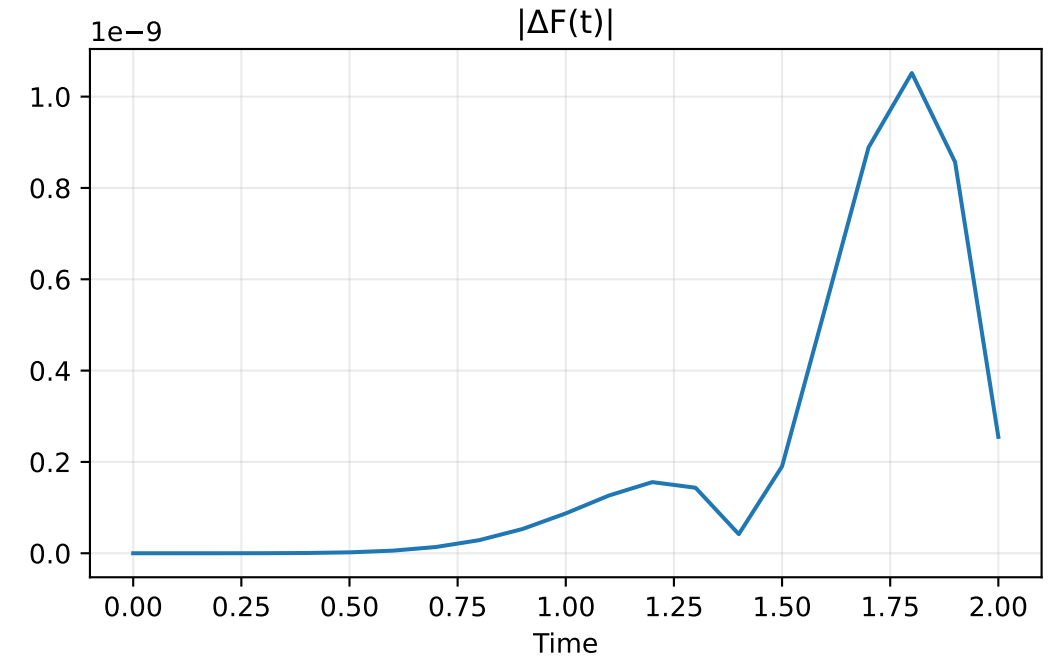
When initial_state_source=vqe, Trotter E(t=0) = ⟨ψ_vqe|H|ψ_vqe⟩ = VQE energy.
VQE energy ≠ exact ground state energy unless VQE fully converged.

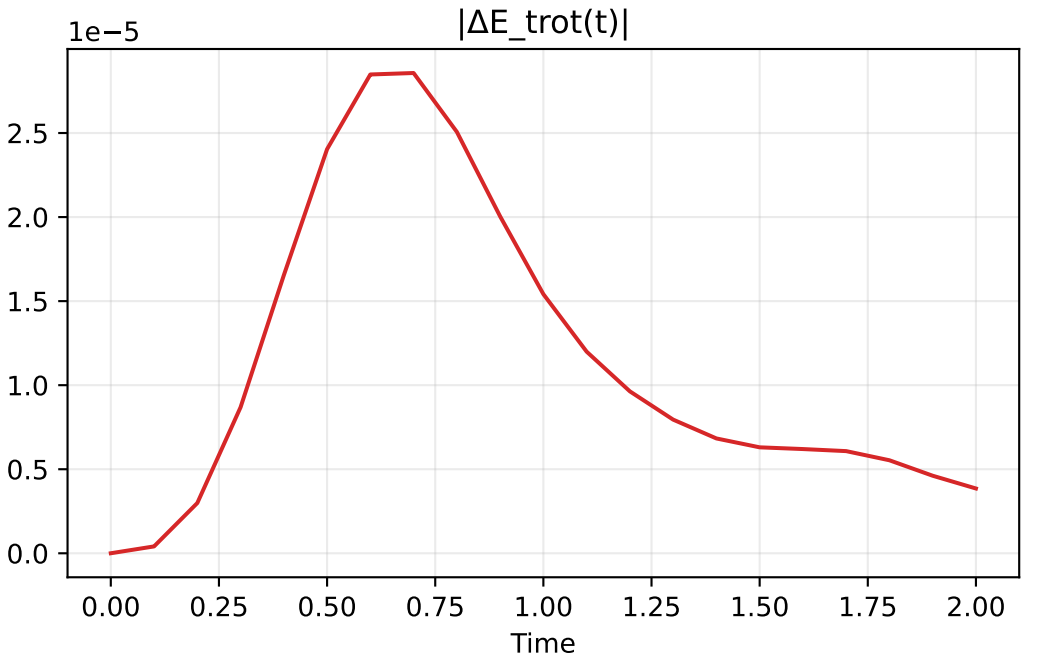


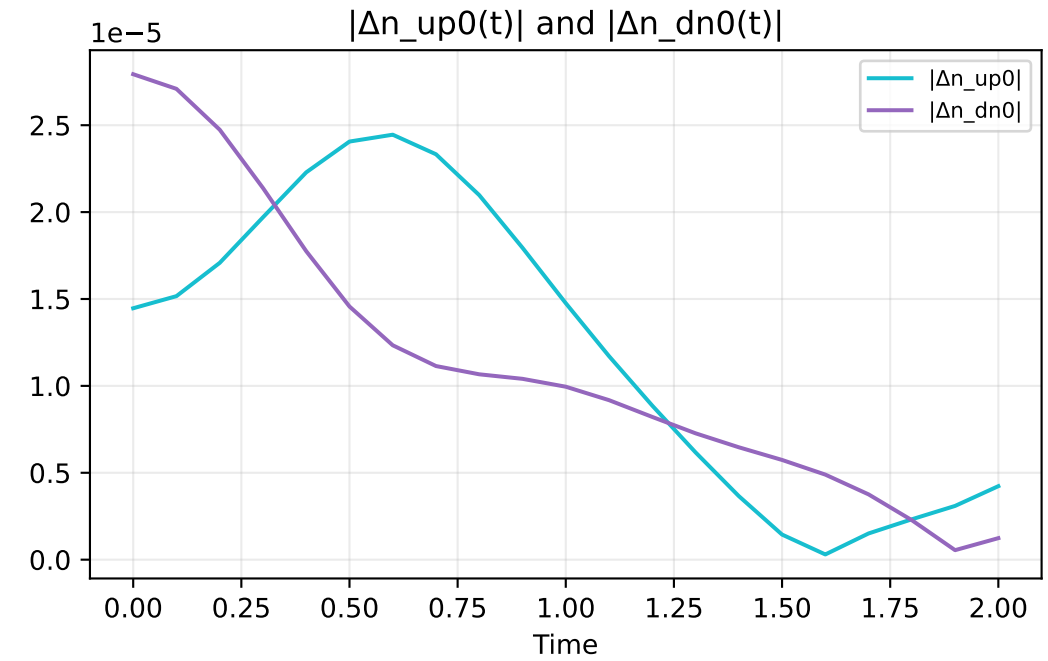


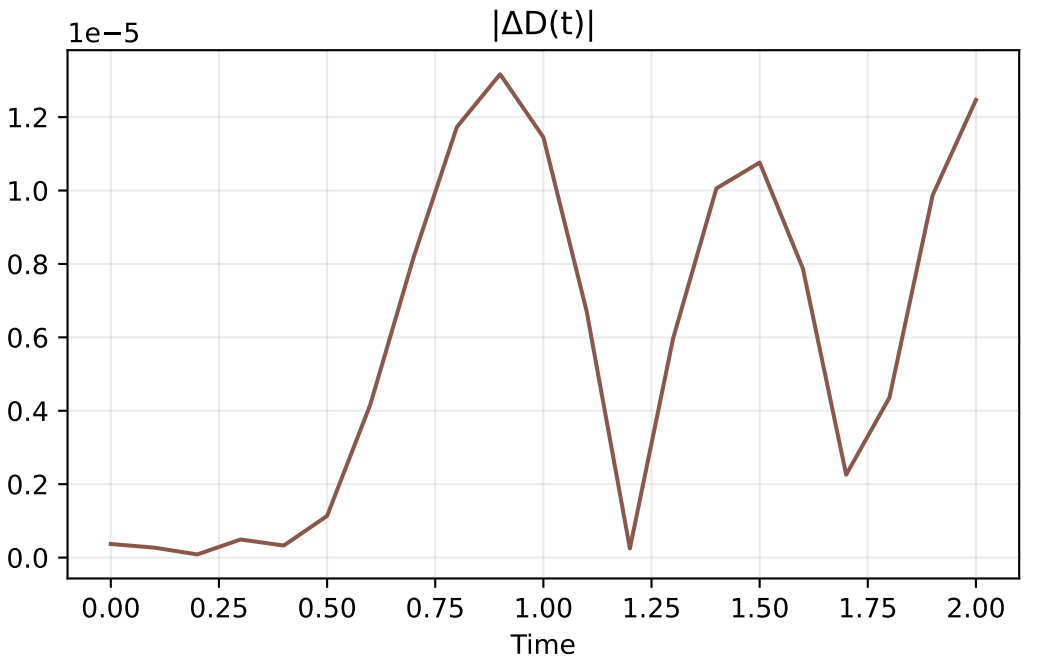
Bundle Delta Diagnostics L=2

ΔX(t) = |X_hc(t) − X_qk(t)|, where X_pipeline(t) is that pipeline's stored trajectory value.









```
Bundle metrics page L=2

Trotterization comparison uses each path's configured initial state.
Trajectory labels: Exact_Hardcode and Exact_Qiskit.
Exact trajectory method: python_matrix_eigendecomposition.
For VQE-init runs, both exact(t) and trotter(t) start from the VQE ansatz state.

Delta metric definitions:
ΔF(t)      = |F_hc(t) - F_qk(t)|
ΔE_trot(t) = |E_trot_hc(t) - E_trot_qk(t)|
Δn_up0(t)  = |n_up0_hc(t) - n_up0_qk(t)|
Δn_dn0(t)  = |n_dn0_hc(t) - n_dn0_qk(t)|
ΔD(t)      = |D_hc(t) - D_qk(t)|
F_pipeline(t) is the pipeline's stored trajectory fidelity value (as computed internally vs that pipeline's exact
    evolution).

ground_state_energy_abs_delta = 0.0
fidelity max/mean/final = 1.051727371859l014e-09 / 2.1139742337591575e-10 / 2.5473967379952e-10
energy_trotter max/mean/final = 2.8569770569086828e-05 / 1.1392085824032025e-05 / 3.854281204862531e-06
n_up_site0_trotter max/mean/final = 2.4453936811663635e-05 / 1.2263117297871604e-05 / 4.229340619166244e-06
n_dn_site0_trotter max/mean/final = 2.7934482115687942e-05 / 1.1312123054409349e-05 / 1.2385115255586499e-06
doublon_trotter max/mean/final = 1.3169303991367176e-05 / 5.808441969007691e-06 / 1.246908090368759e-05

checks:
{'doublon_trotter_max_abs_delta': True,
 'energy_trotter_max_abs_delta': True,
 'fidelity_max_abs_delta': True,
 'ground_state_energy_abs_delta': True,
 'n_dn_site0_trotter_max_abs_delta': True,
 'n_up_site0_trotter_max_abs_delta': True}

PASS = True
```