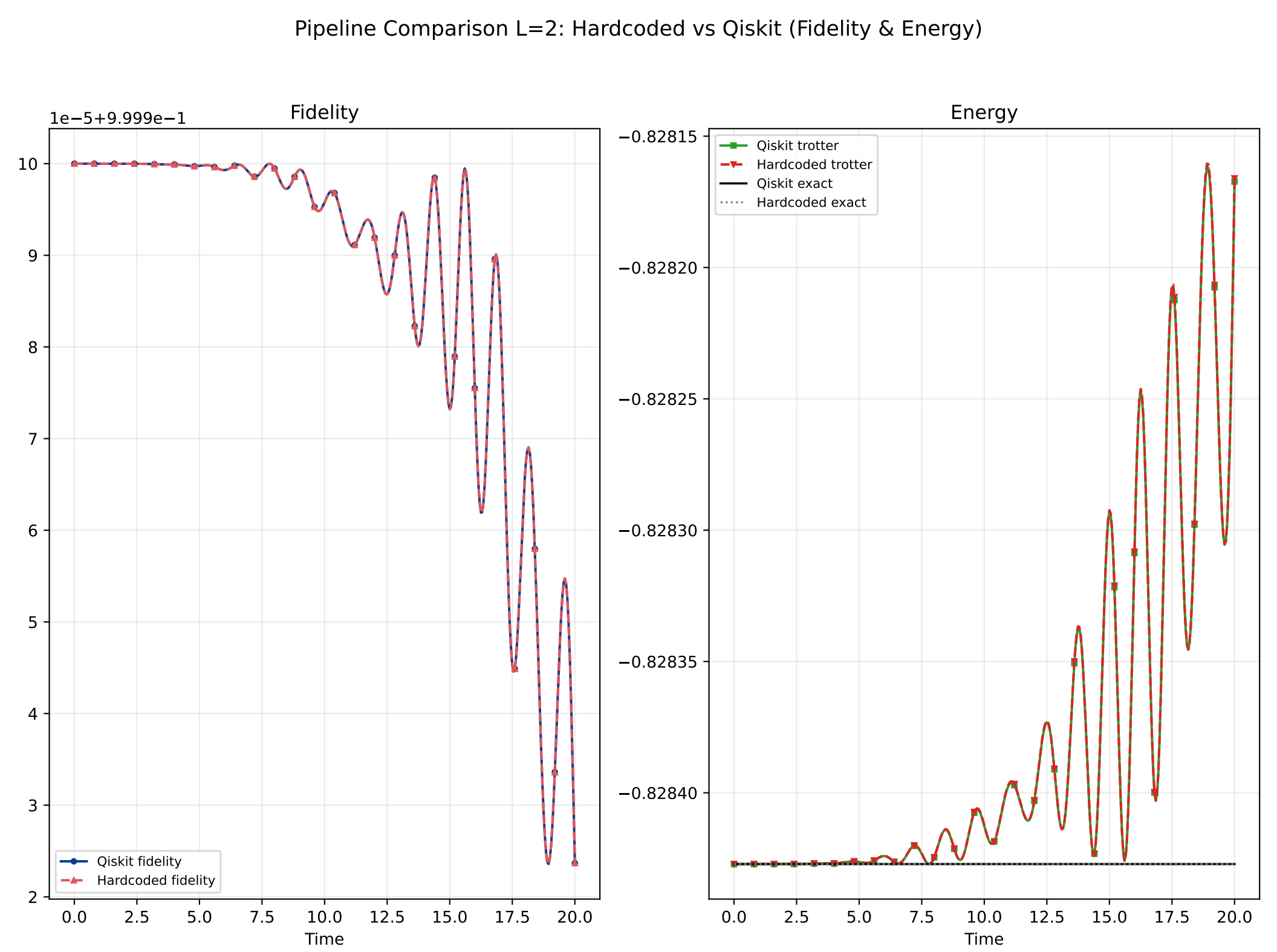
Executed Command

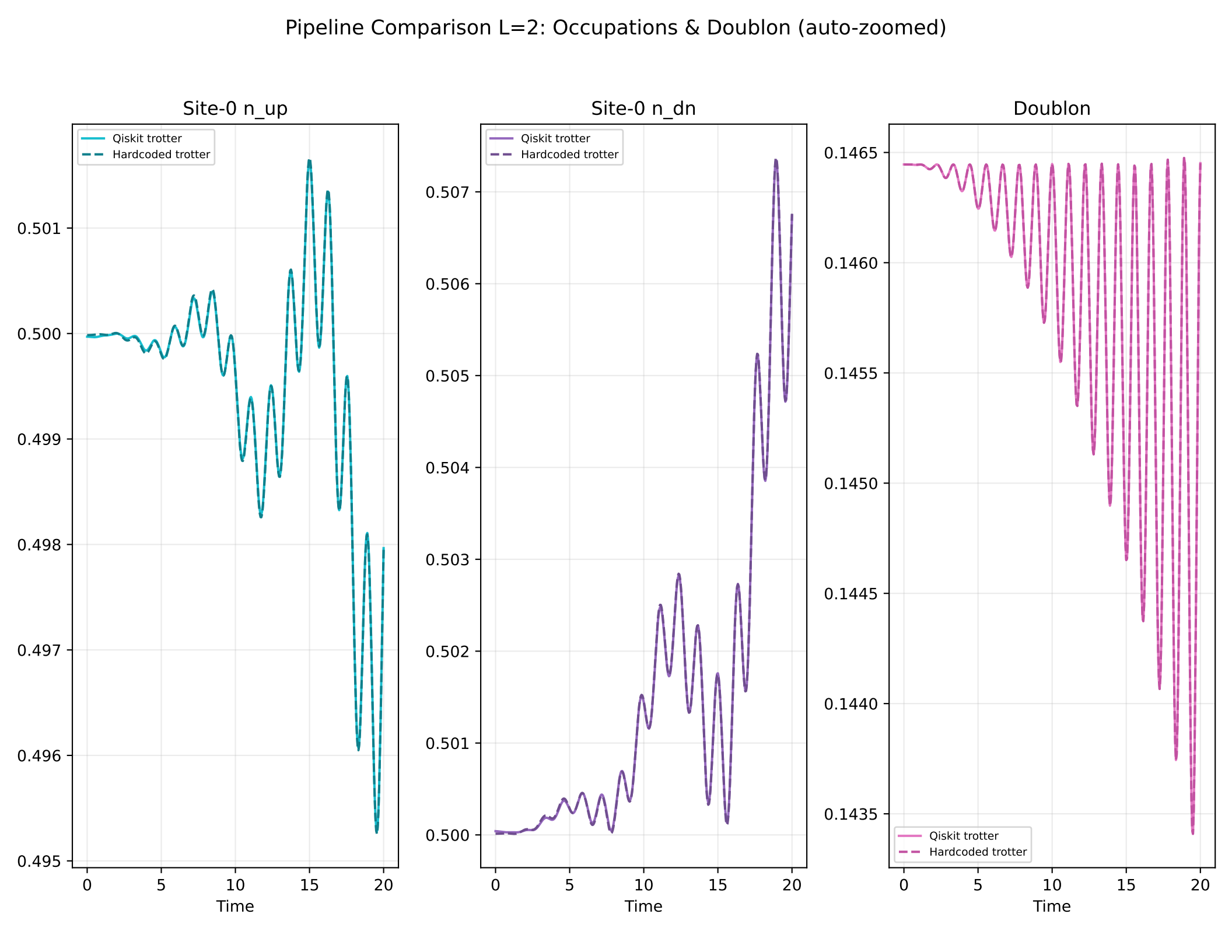
Reference: pipelines/PIPELINE_RUN_GUIDE.md
Script: pipelines/compare_hardcoded_vs_qiskit_pipeline.py

```
/opt/anaconda3/bin/python3 pipelines/compare_hardcoded_vs_qiskit_pipeline.py --l-values 2 --with-per-l-pdfs
    --initial-state-source vqe --num-times 401 --trotter-steps 256 --hardcoded-vqe-reps 2 --hardcoded-vqe-
    restarts 5 --hardcoded-vqe-maxiter 1800 --qiskit-vqe-reps 2 --qiskit-vqe-restarts 5 --qiskit-vqe-maxiter
    1800 --skip-qpe
```

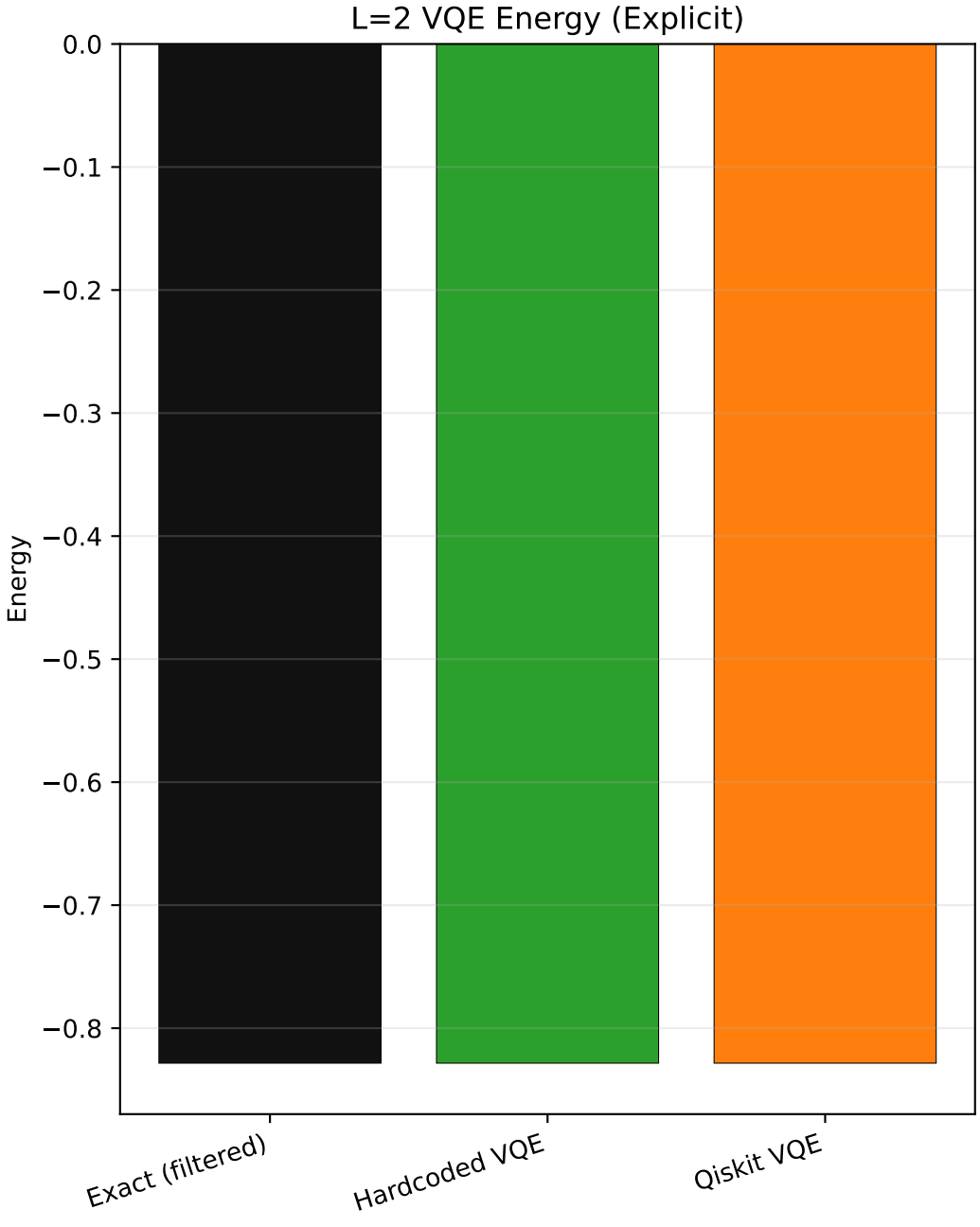
L=2 Run Settings & Metrics Summary

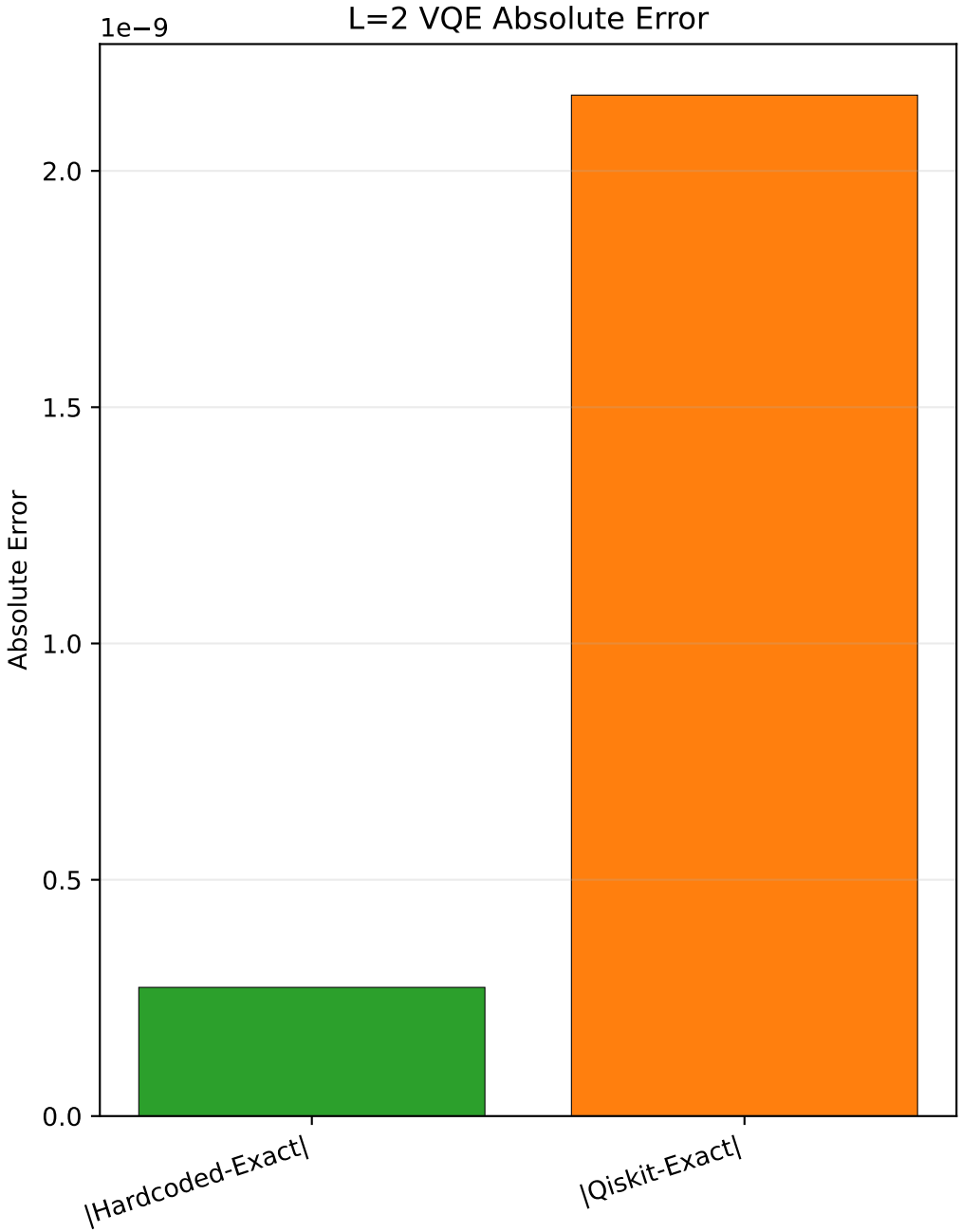
```
L=2  t=1.0  u=4.0  dv=0.0  boundary=periodic  ordering=blocked  initial_state_source=vqe  t_final=20.0  num_times=401  suzu

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: 4.84e-07
  energy_trotter: 1.40e-06
  fidelity: 2.26e-08
  n_dn_site0_trotter: 2.79e-05
  n_up_site0_trotter: 2.78e-05
result: PASS
```


Pipeline Comparison L=2: Hardcoded vs Qiskit (Fidelity & Energy)
Fidelity
1e−5+9.999e−1
10
9
8
7
6
5
4
3
2
Qiskit fidelity
Hardcoded fidelity
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
Time
Energy
−0.82815
−0.82820
−0.82825
−0.82830
−0.82835
−0.82840
Qiskit trotter
Hardcoded trotter
Qiskit exact
Hardcoded exact
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
Time


Pipeline Comparison L=2: Occupations & Doublon (auto-zoomed)
Site-0 n_up
Site-0 n_dn
Doublon
Qiskit trotter
Hardcoded trotter
Time
0.501
0.500
0.499
0.498
0.497
0.496
0.495
0.507
0.506
0.505
0.504
0.503
0.502
0.501
0.500
0.1465
0.1460
0.1455
0.1450
0.1445
0.1440
0.1435
0
5
10
15
20

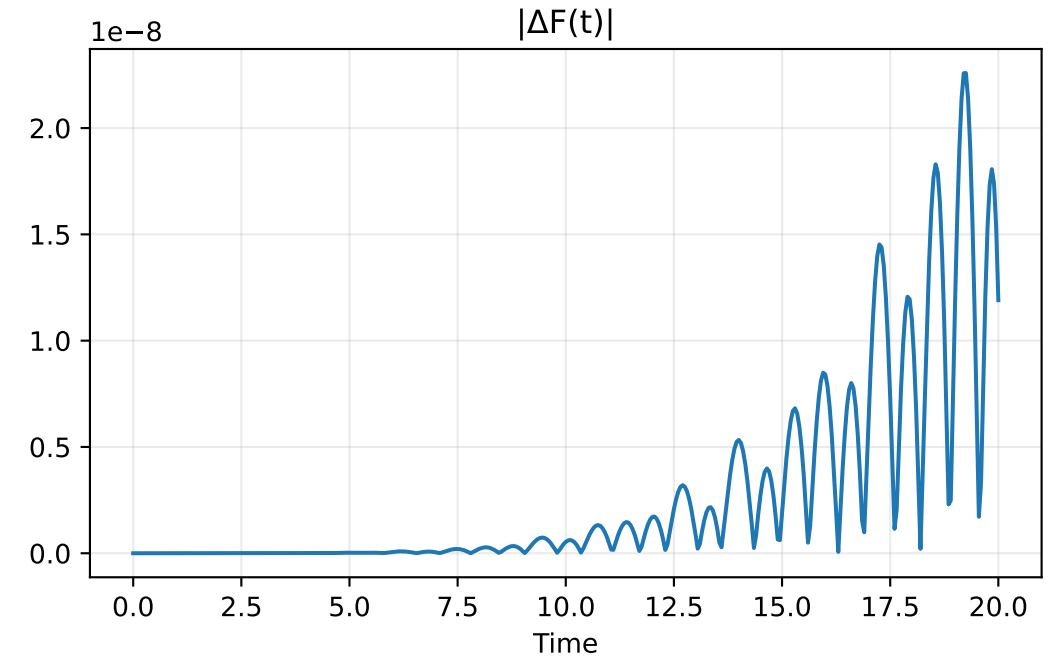
When initial_state_source=vqe, Trotter E(t=0) = ⟨ψ_vqe|H|ψ_vqe⟩ = VQE energy.
VQE energy ≠ exact ground state energy unless VQE fully converged.

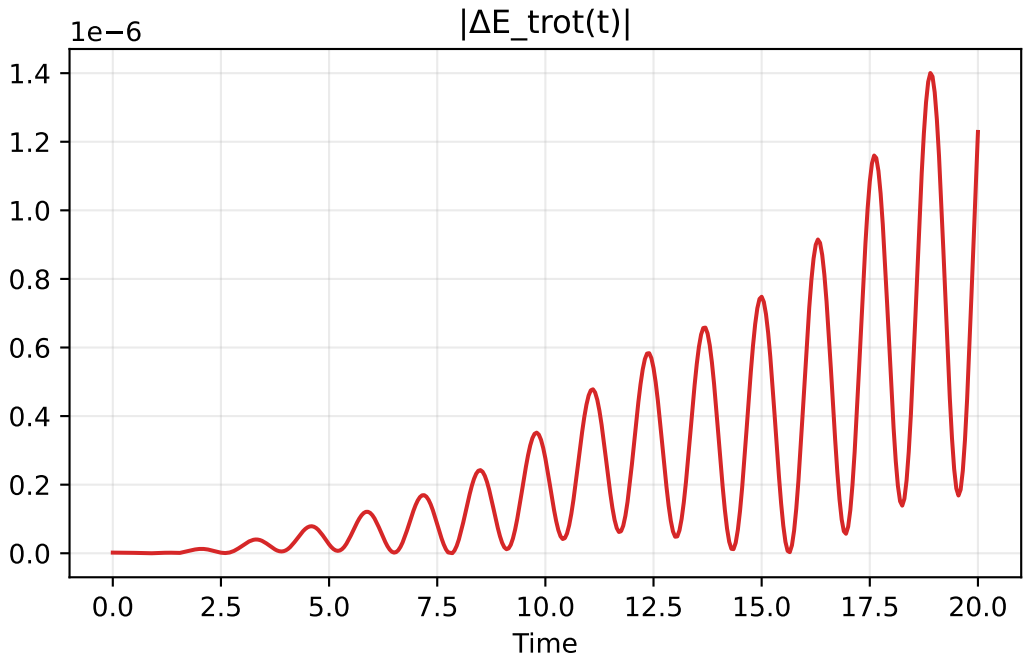


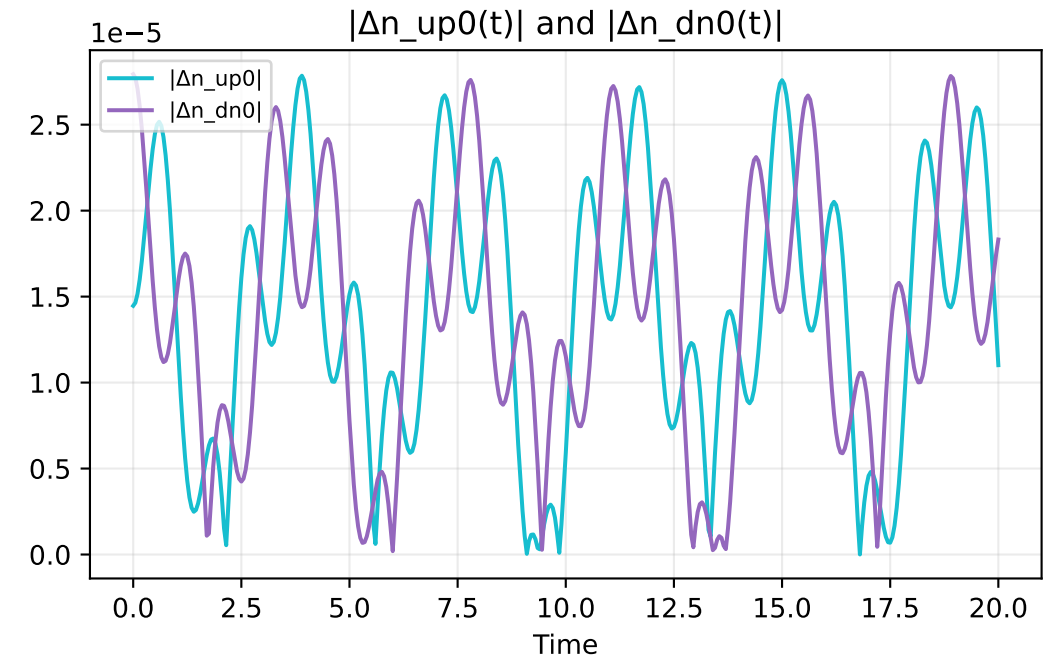


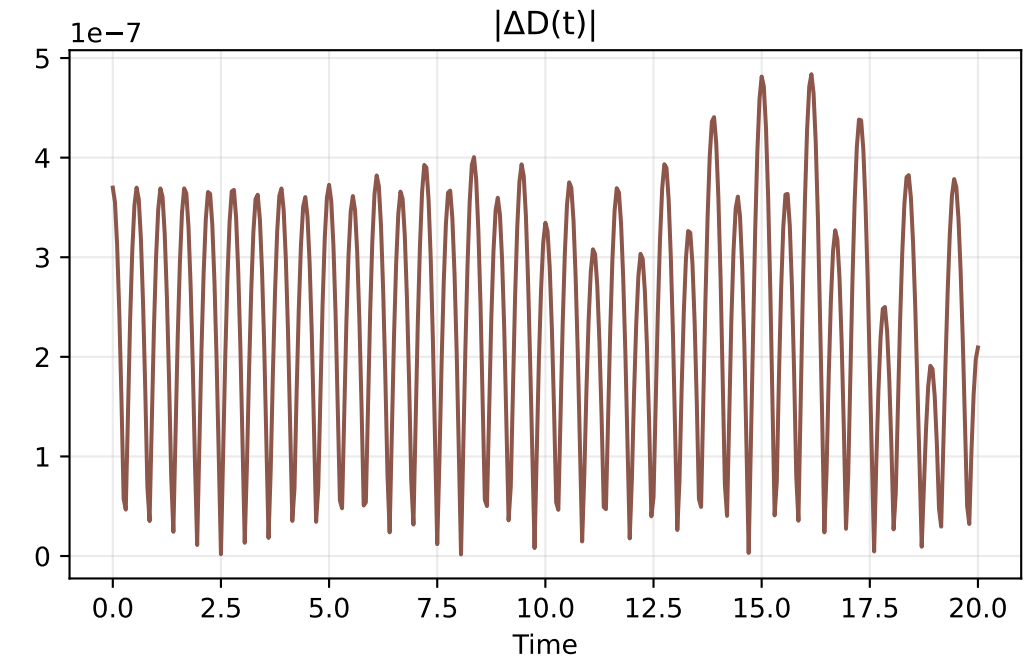
Delta Diagnostics L=2

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









```
L=2 metrics summary

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 = 2.2590508352848815e-08 / 2.6804744024278294e-09 / 1.190507825654663e-08
energy_trotter max/mean/final = 1.400460892919675e-06 / 2.561722049860173e-07 / 1.228592043989174e-06
n_up_site0_trotter max/mean/final = 2.7846824668553705e-05 / 1.4103046424698389e-05 / 1.1012572472712812e-05
n_dn_site0_trotter max/mean/final = 2.7934482115687942e-05 / 1.406226762311699e-05 / 1.8319372432129555e-05
doublon_trotter max/mean/final = 4.837666837398391e-07 / 2.3529349619561587e-07 / 2.0937875369608783e-07

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
```