Development of Novel Quantum Algorithms

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Hamiltonian simulation using Classiq platform

Article

Evidence for the utility of quantum computing before fault tolerance

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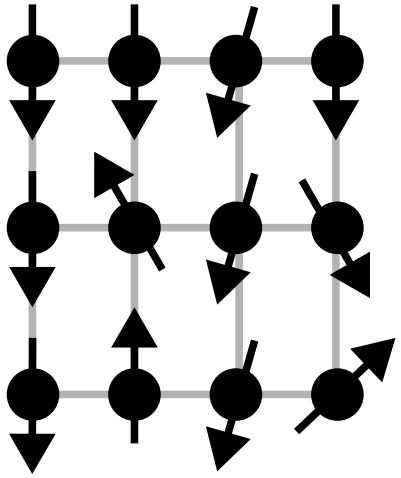
2D transverse-field Ising model

$$H = -J \sum_{\langle i,j \rangle} \sigma_i^z \sigma_j^z + h \sum_j^N \sigma_j^x$$

interaction term external field



2D transverse-field Ising model

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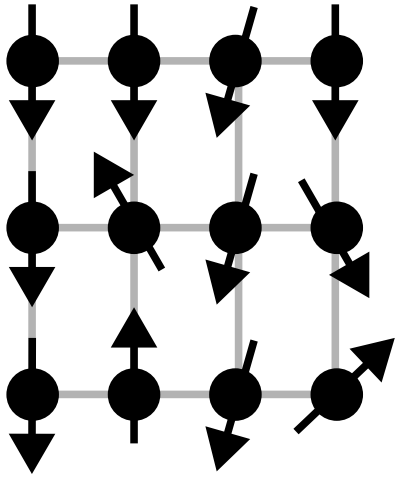
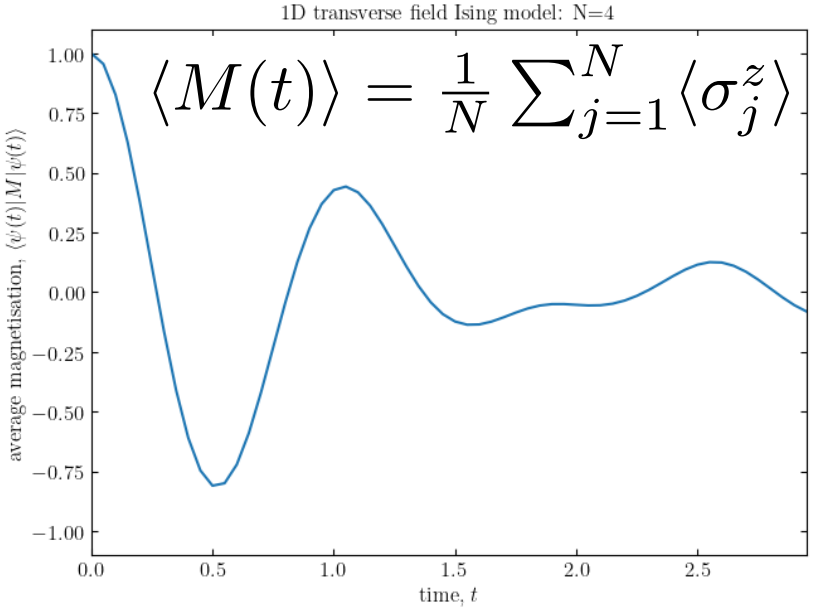
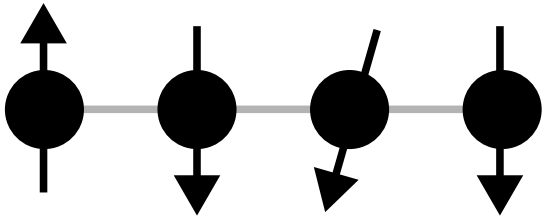
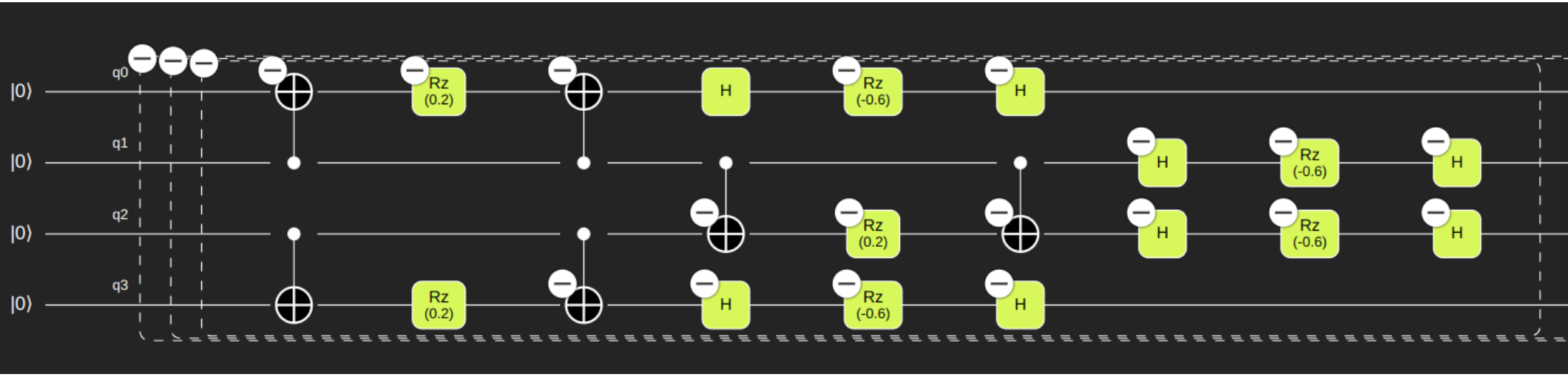




Toy model: 1D transverse-field Ising model

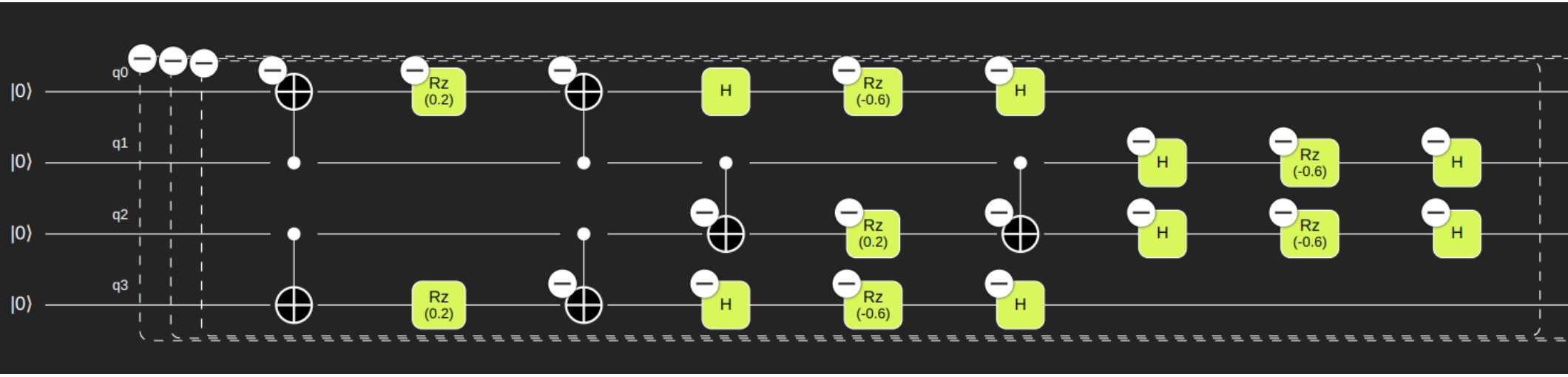


Trotter-Suzuki decomposition (Classiq platform)



Quantum circuit:
Rz: 7, H: 8, CX: 8
depth: 9, width: 4

Trotter-Suzuki decomposition (Classiq platform)



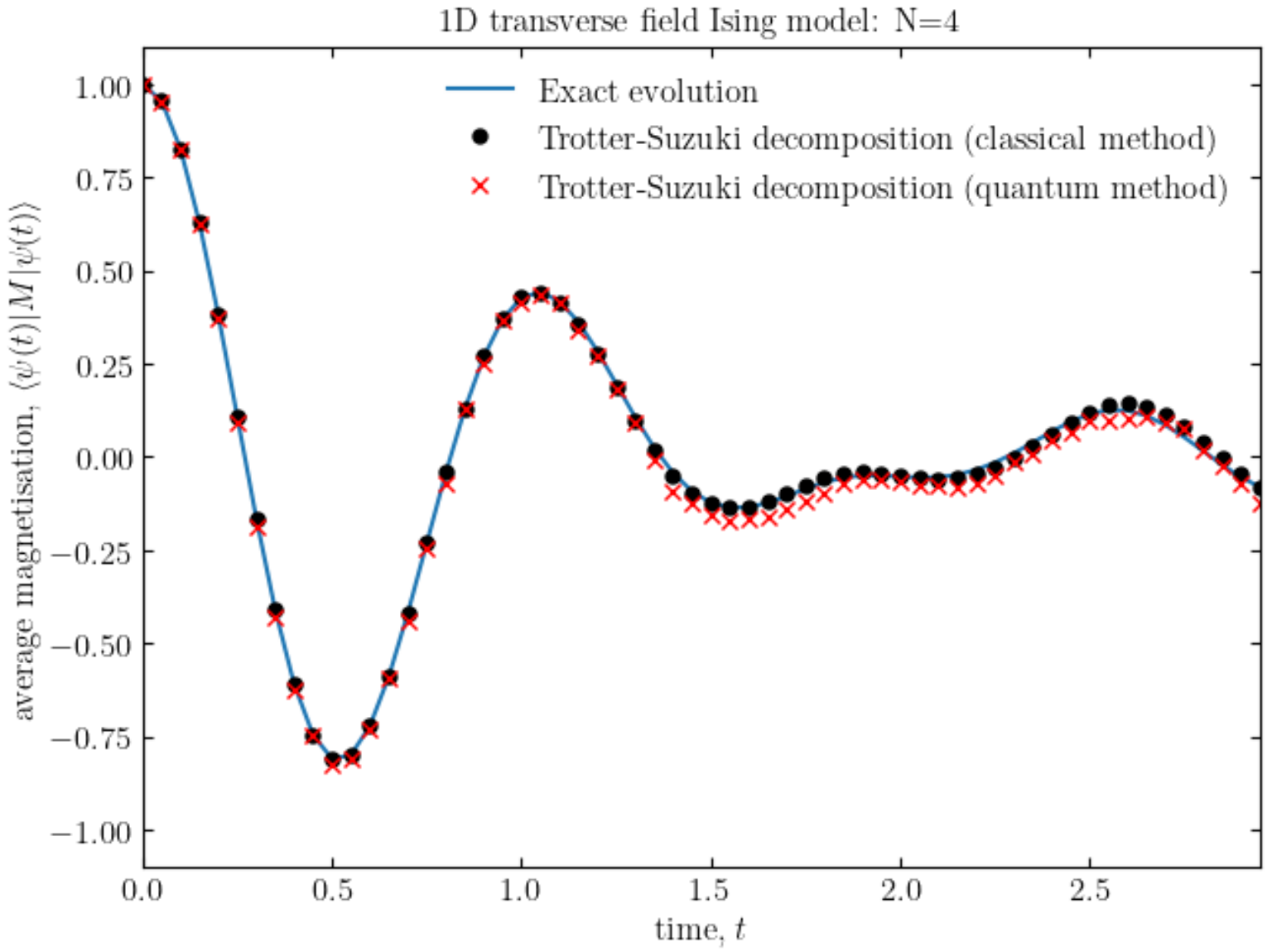
Quantum circuit:
Rz: 7, H: 8, CX: 8
depth: 9, width: 4

Initial state: $|0\rangle^{\otimes N}$

Output: state after time t

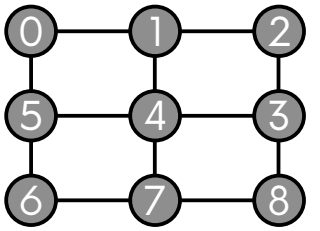
Post-processing: extract magnetization

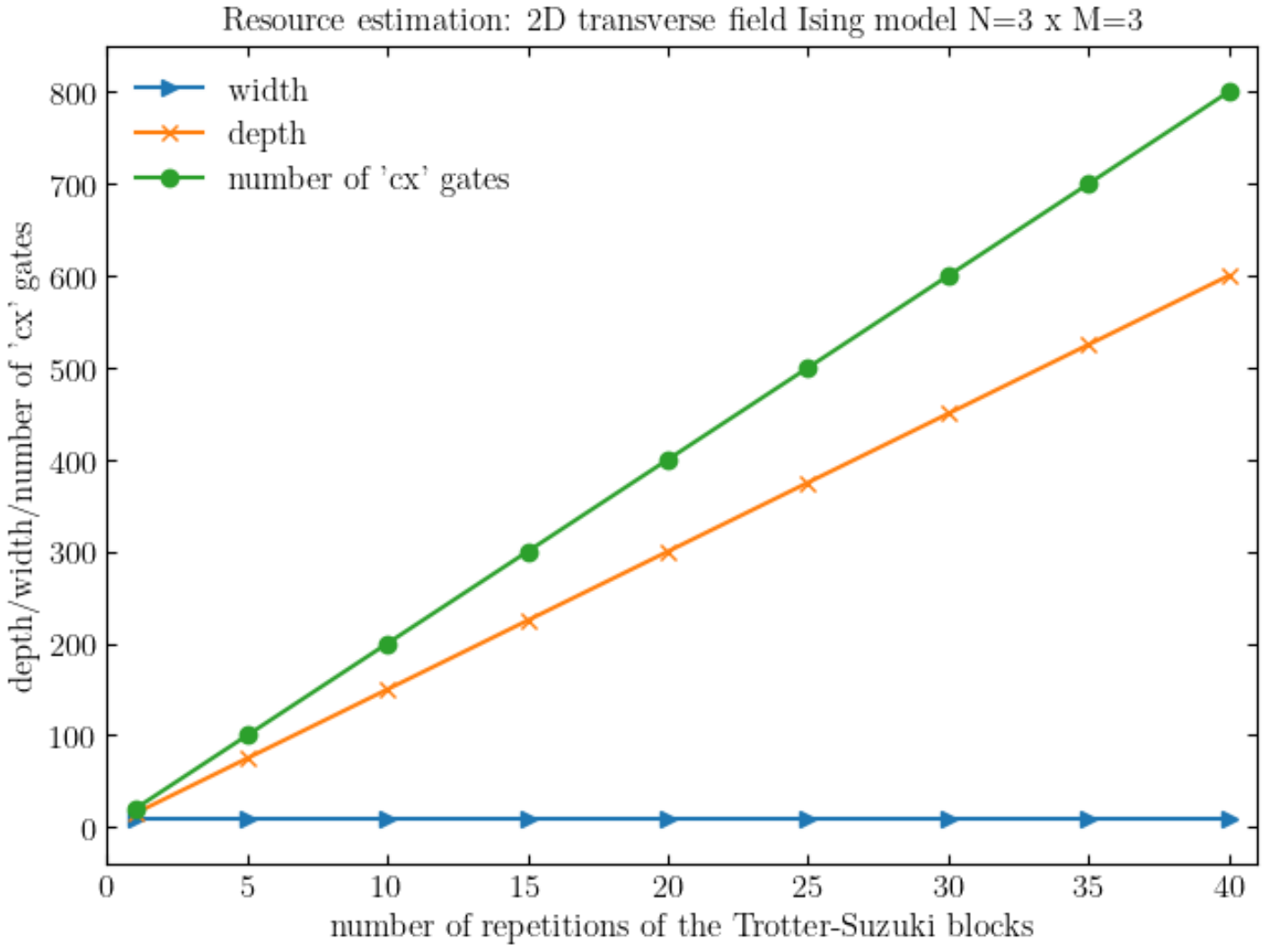
Magnetization vs. time



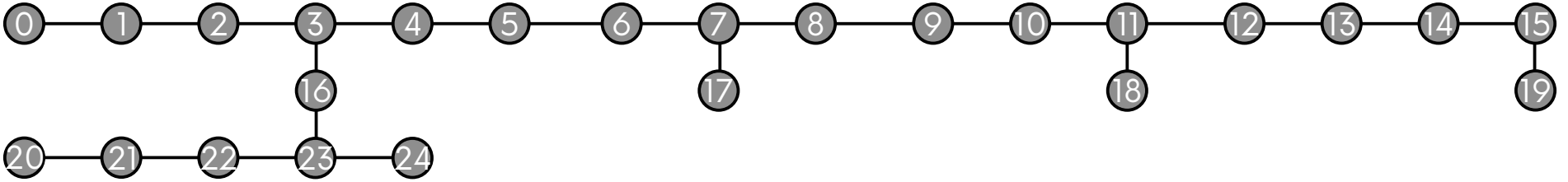
Enlarged model: 2D transverse-field Ising model

resource estimation





Optimize the solution according to the hardware (ibm_fez)



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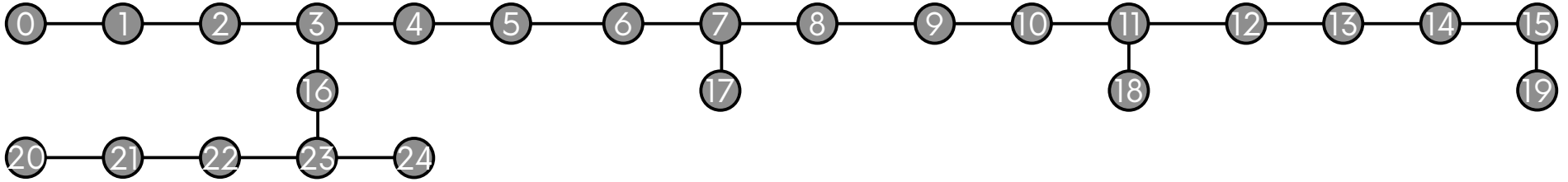
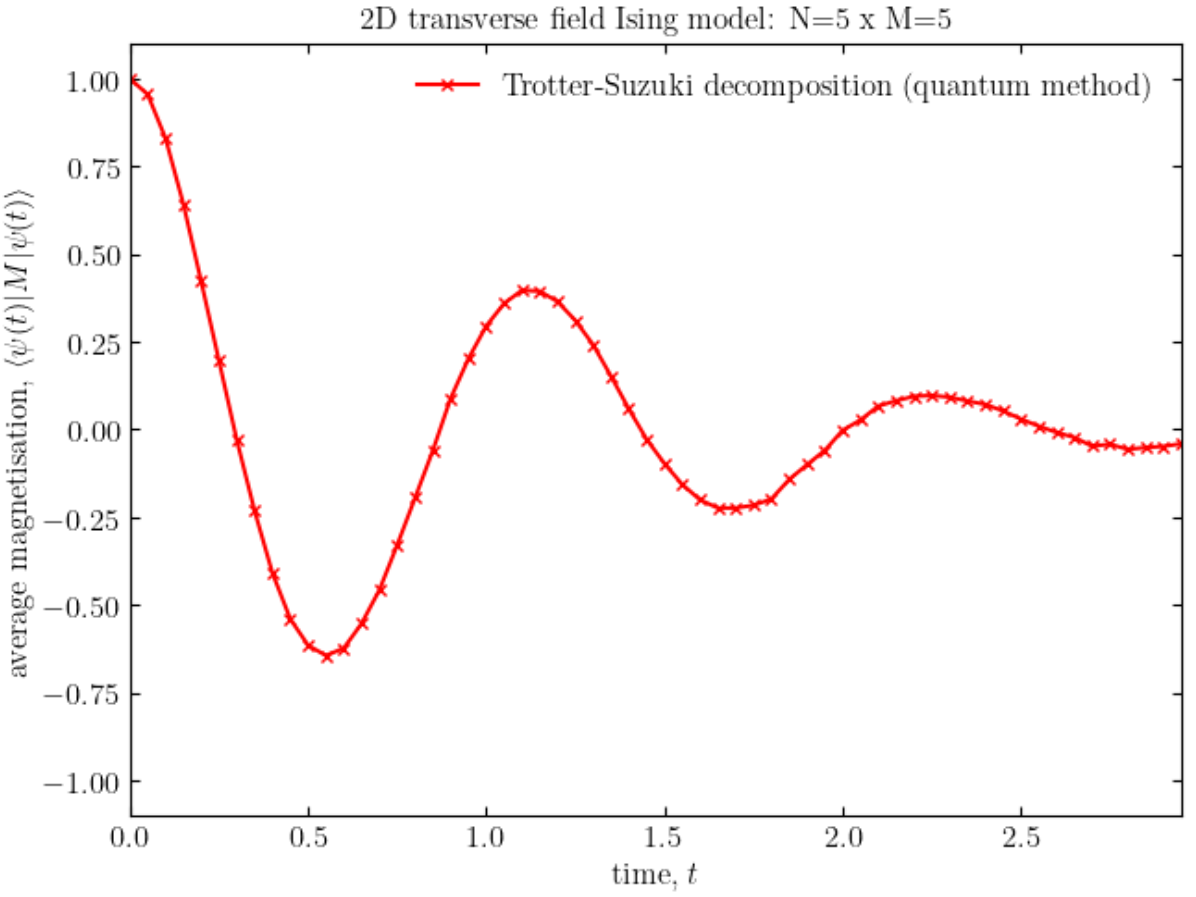
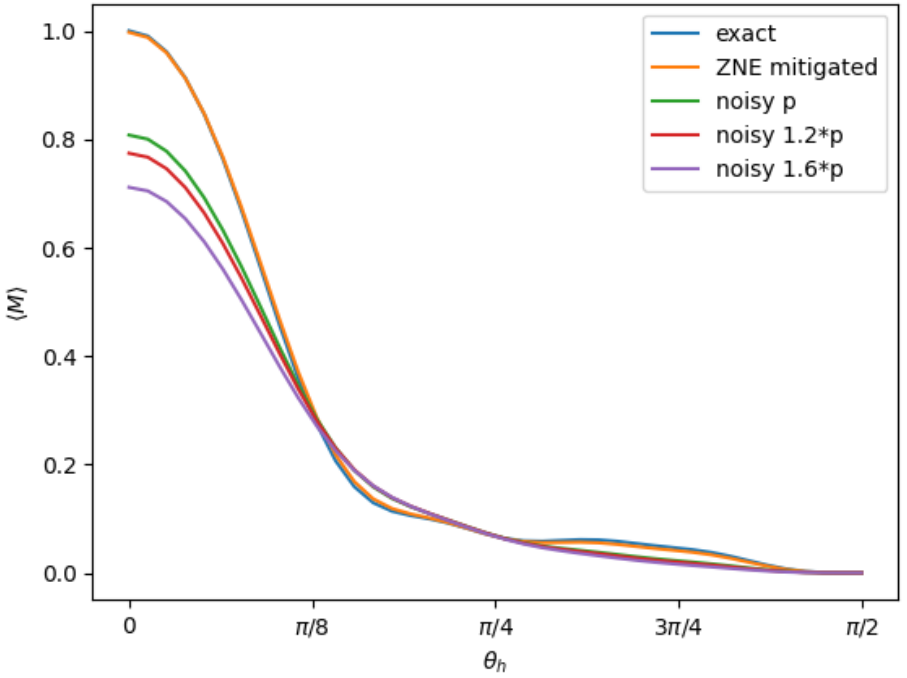


Depth: 180
Gates:
{'h': 750, 'rz': 735, 'cx': 720}
Width: 25



Future scope

1. Implement noisy hardware on the Classiq platform (depolarizing Kraus gates)



2. Implement noise gain for zero-noise extrapolation

3. Run that model on a real quantum processor

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