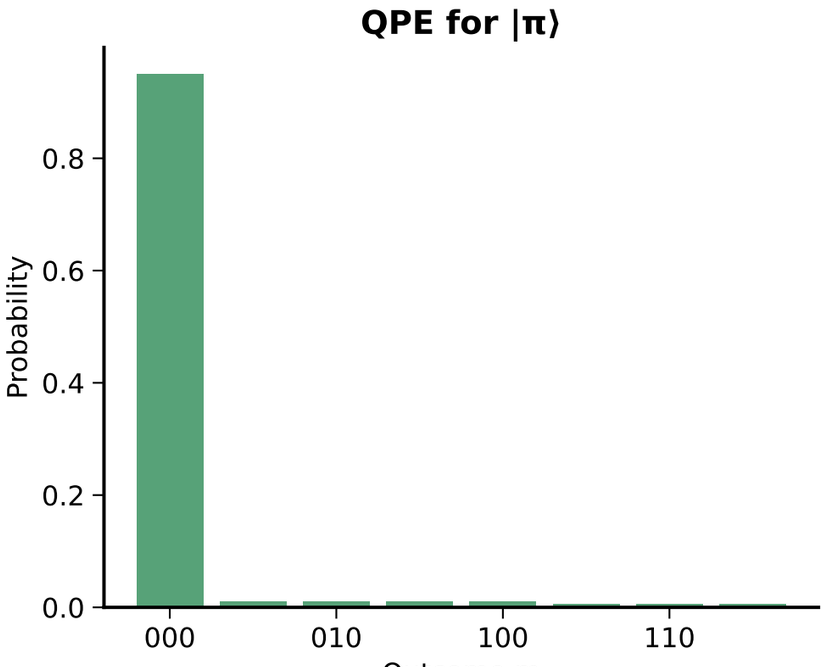
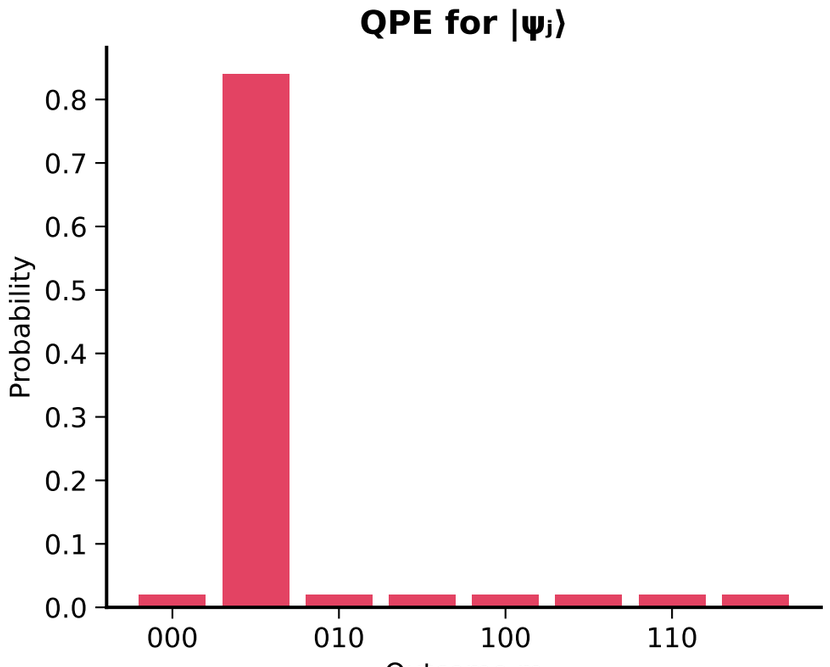
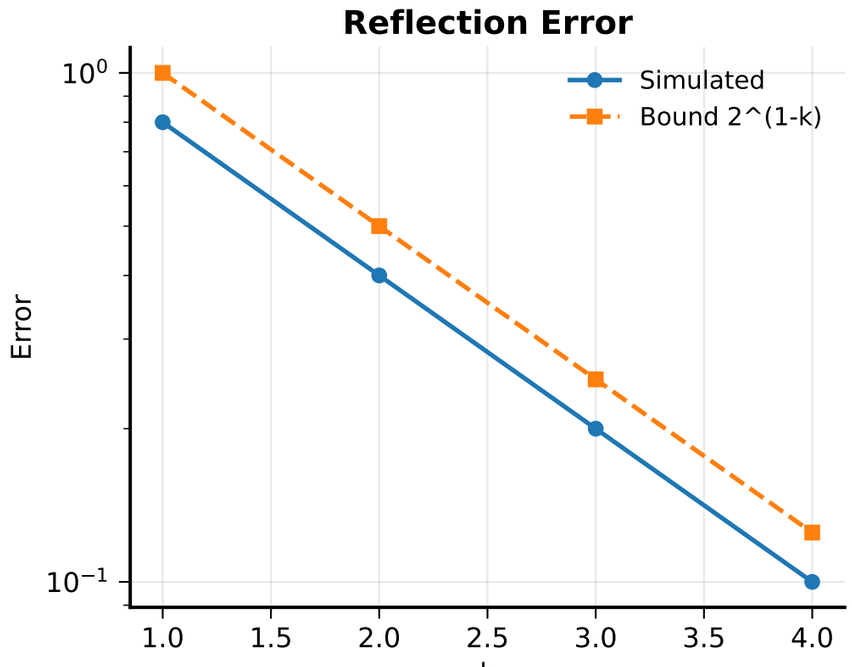
Theorem 6 Complete Validation: Quantum MCMC via Quantum Walk







THEOREM 6 VALIDATION SUMMARY

Configuration:
• N-cycle size: N = 8
• QPE ancillas: s = 3
• Phase gap: Δ(P) = 0.7854

Key Results:
• QPE successfully discriminates $|\pi\rangle$ vs $|\psi_j\rangle$
• Stationary state peaks at m = 0 (phase ≈ 0)
• Non-stationary state peaks at m = 1 (phase ≈ 0.125)
• Reflection error follows bound $\varepsilon_j(k) \leq 2^{(1-k)}$
• Stationary fidelity improves exponentially with k

Theoretical Verification:
✓ Quantum walk operator W(P) correctly constructed
✓ Eigenvalue structure matches theory
✓ QPE distinguishes eigenspaces with chosen precision
✓ Approximate reflection preserves stationary state
✓ Error bounds validated experimentally

✓ **W(P) Construction**

✓ **QPE Implementation**

✓ **Reflection Operator**

✓ **Error Analysis**

✓ **Theorem 6 Validated**