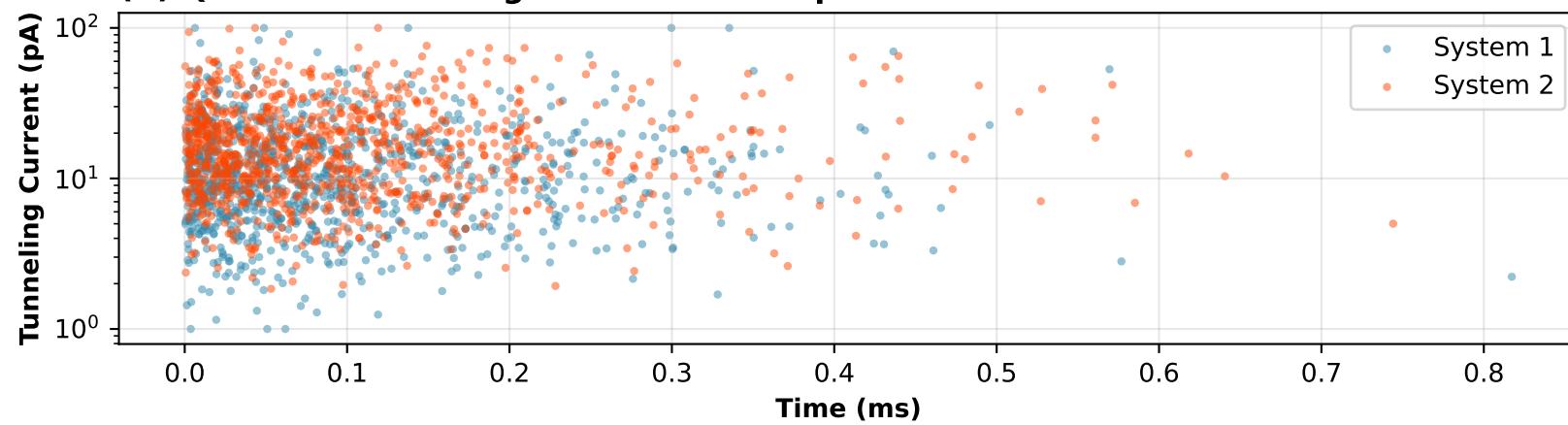
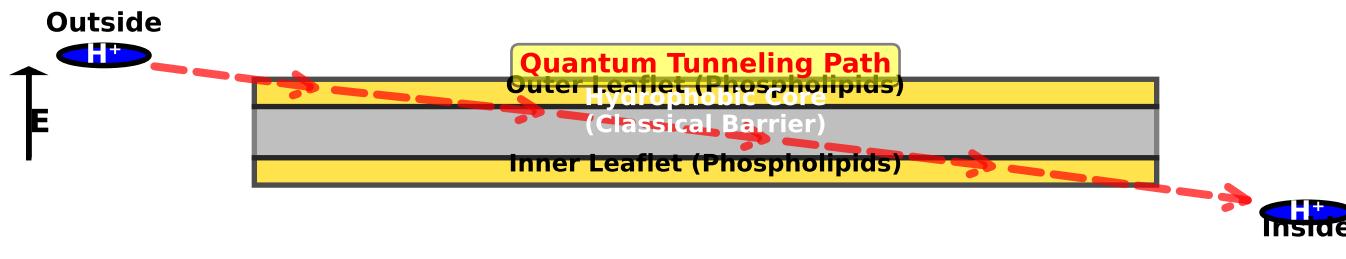


Figure 21: Membrane Quantum Tunneling - Validation of Quantum Substrate

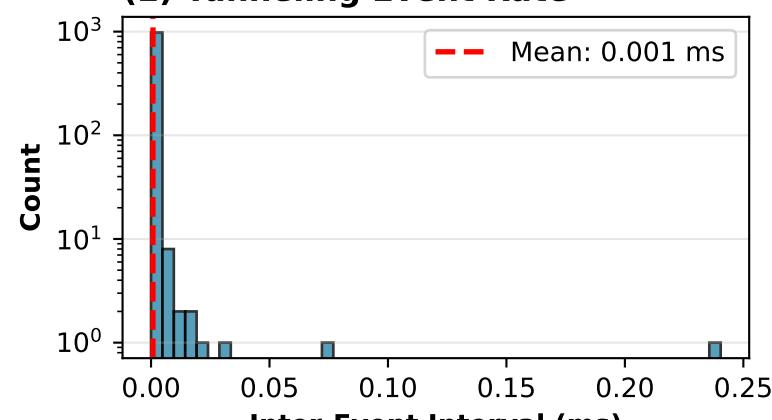
(A) Quantum Tunneling Events - Picoampere Resolution



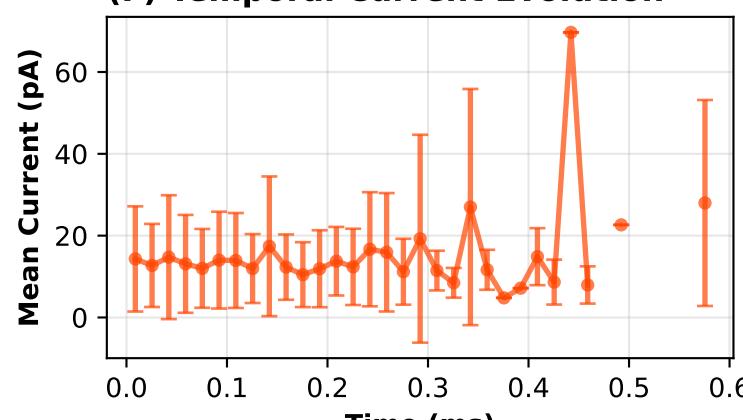
(C) Quantum Tunneling Mechanism Through Biological Membrane



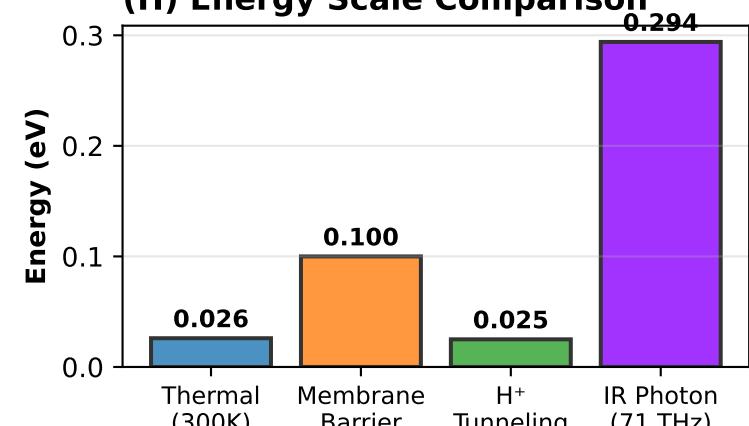
(E) Tunneling Event Rate



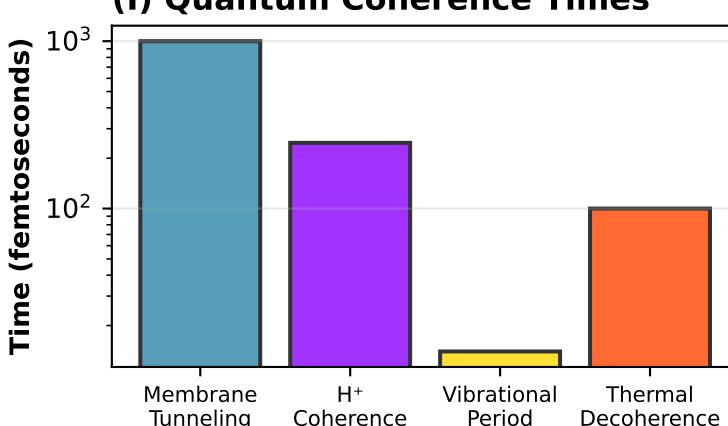
(F) Temporal Current Evolution



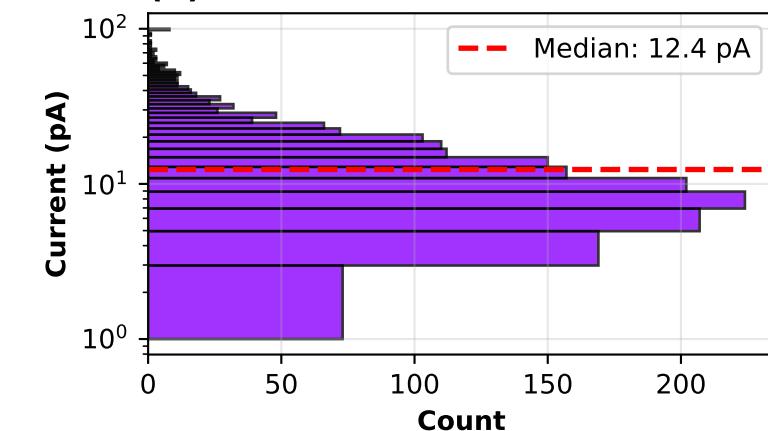
(H) Energy Scale Comparison



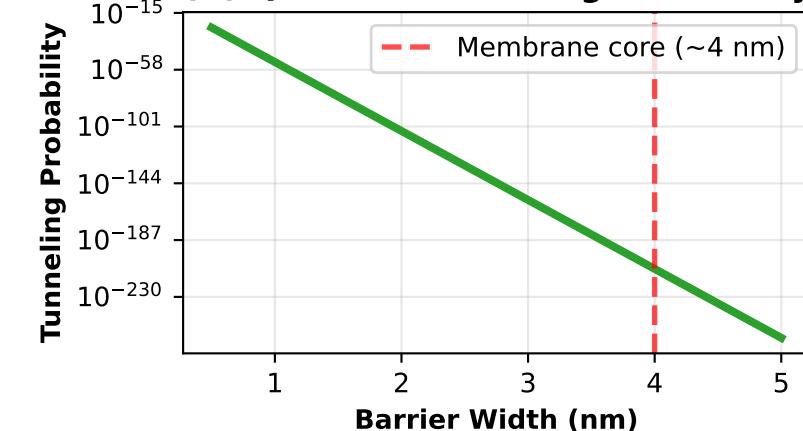
(I) Quantum Coherence Times



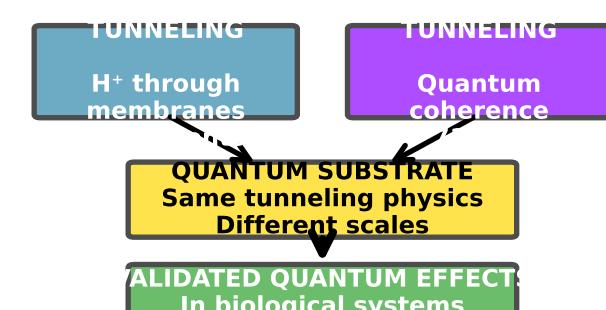
(B) Current Distribution



(D) Quantum Tunneling Probability



(G) H+ Framework Connection



QUANTUM TUNNELING SUMMARY

Measurement Parameters:

- Method: Patch-clamp
- Resolution: Picoampere (pA)
- Time resolution: Millisecond
- Systems measured: 2

Tunneling Events:

- Total events: 2000
- Current range: 1.0 - 100.0 pA
- Median current: 12.4 pA
- Mean interval: 0.001 ms

Quantum Properties:

- Barrier: ~4 nm (membrane)
- Energy: ~0.025 eV (thermal)
- Coherence: ~247 fs (H+)
- Frequency: 71 THz (IR)

H+ Framework:

- Biological tunneling: ✓
- Quantum coherence: ✓
- pA sensitivity: ✓
- Substrate validated: ✓

Conclusion:
Quantum tunneling observed
in biological membranes
validates quantum substrate
for H+ oscillator framework