Machine learning for Quantum Control
Quantum Cartpole

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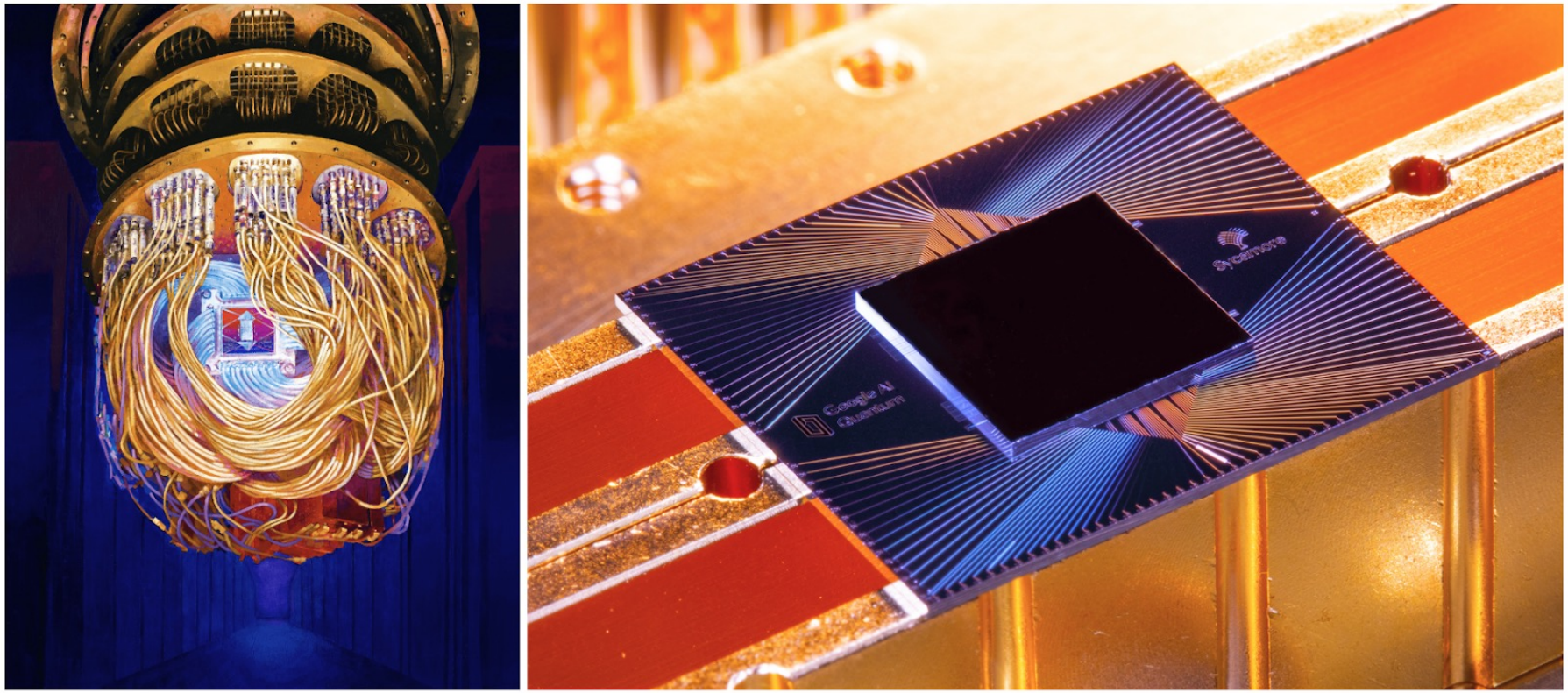
Quantum Control

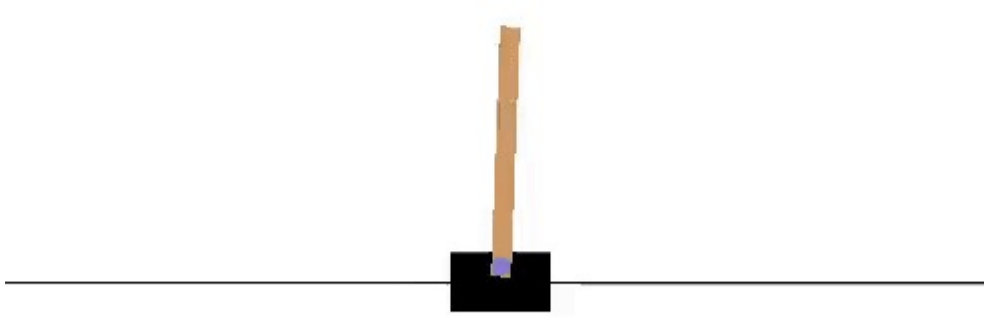
Quantum Control is necessary for Quantum computing, NISQ, Quantum memory!



Google AI Blog

Cartpole

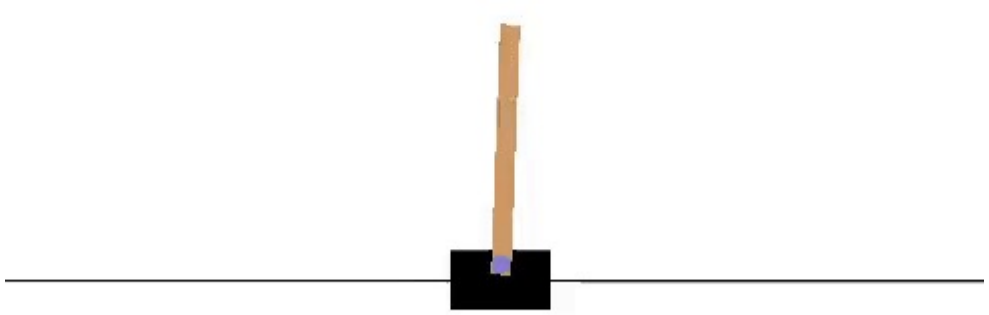
Classical



OpenAI

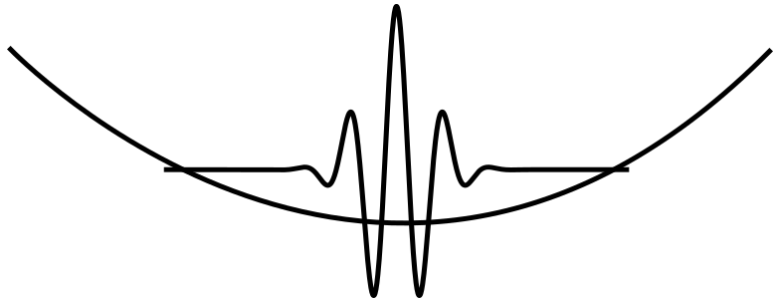
Quantum Cartpole

Classical



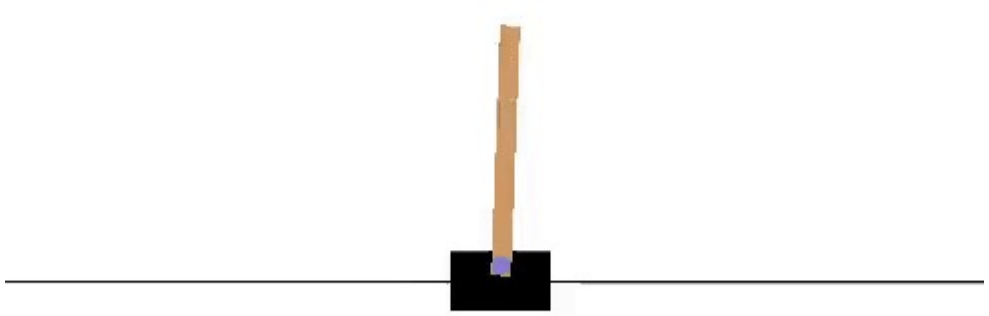
OpenAI

Quantum



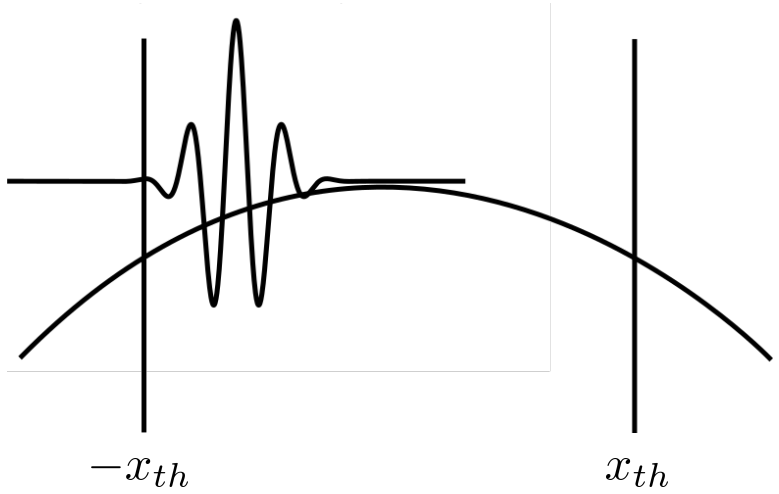
Quantum Cartpole

Classical



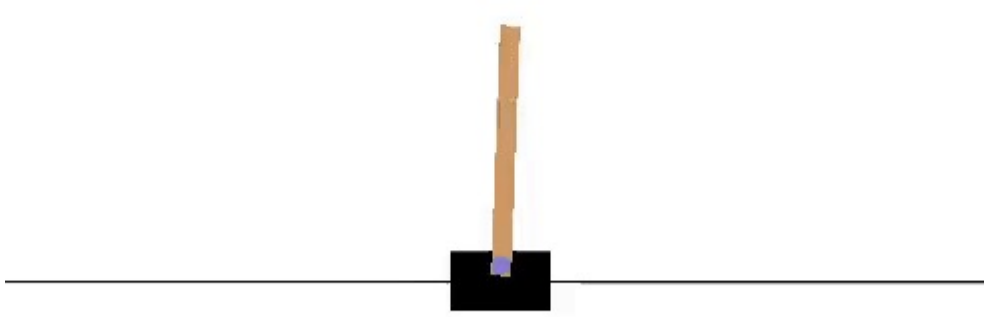
OpenAI

Quantum



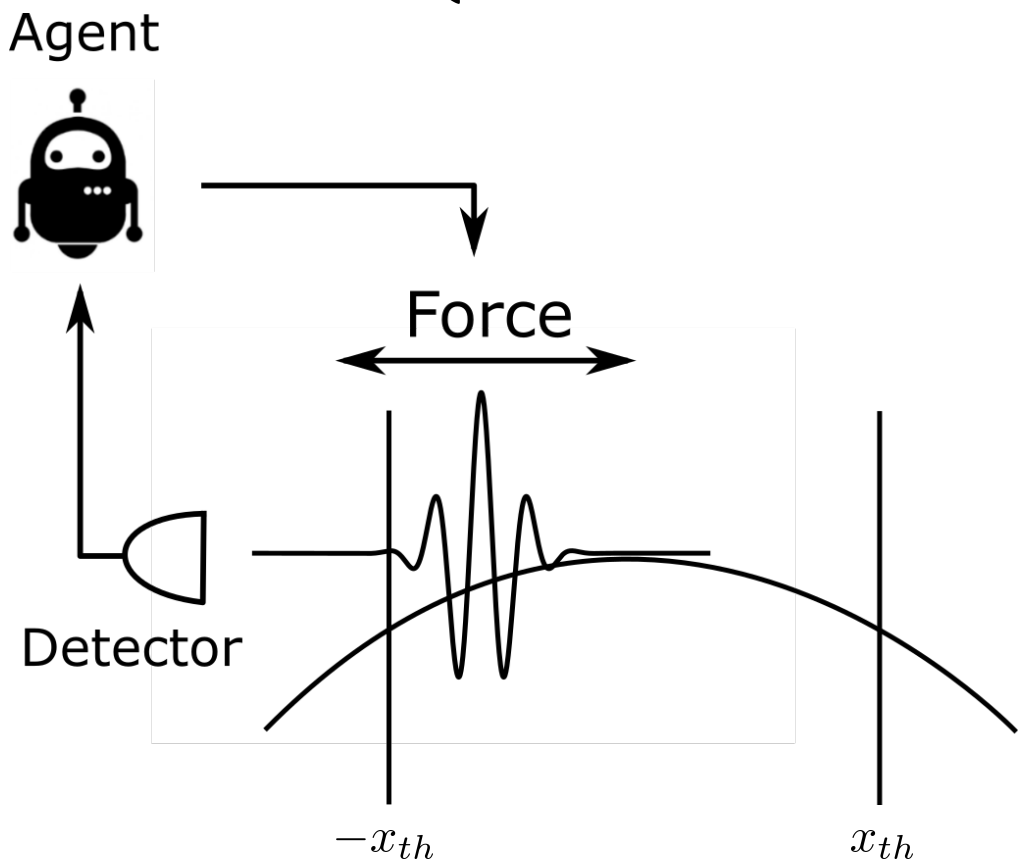
Quantum Cartpole

Classical



OpenAI

Quantum



Quantum Measurement

Heisenberg Uncertainty Principle

$$\sigma_x \sigma_p \geq \frac{\hbar}{2}$$

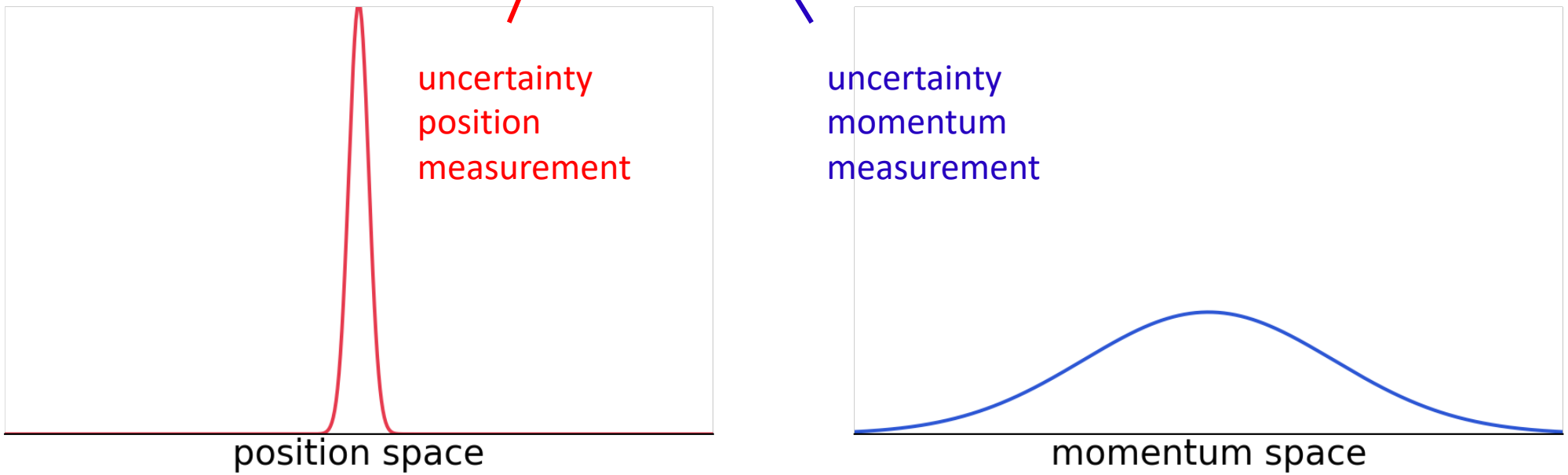
uncertainty position measurement

uncertainty momentum measurement

Quantum Measurement

Heisenberg Uncertainty Principle

$$\sigma_x \sigma_p \geq \frac{\hbar}{2}$$



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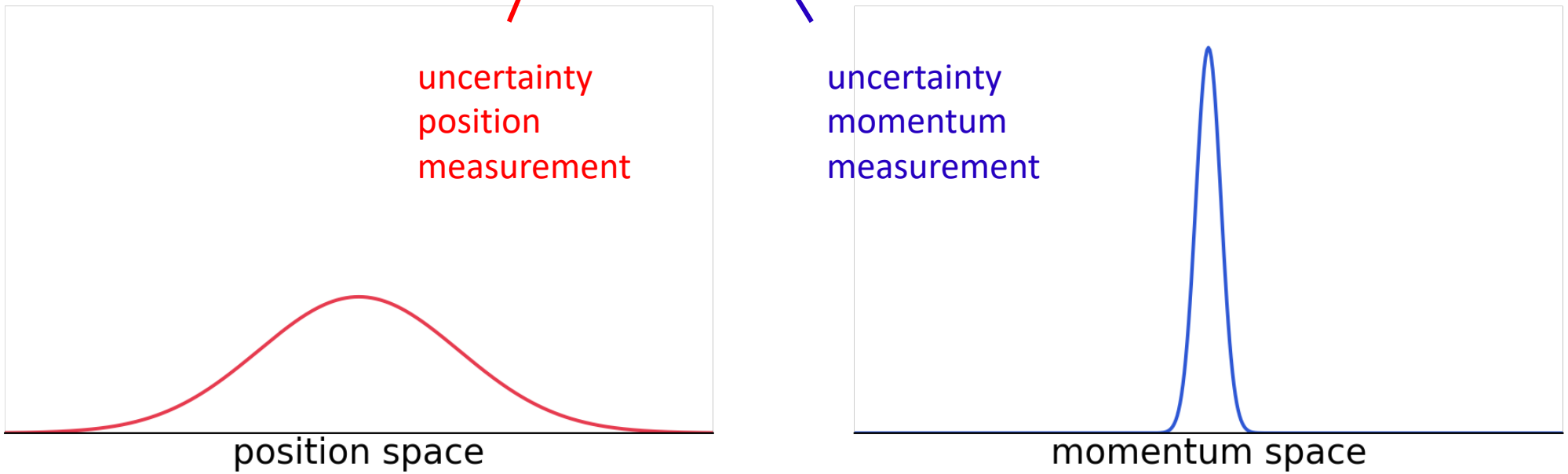

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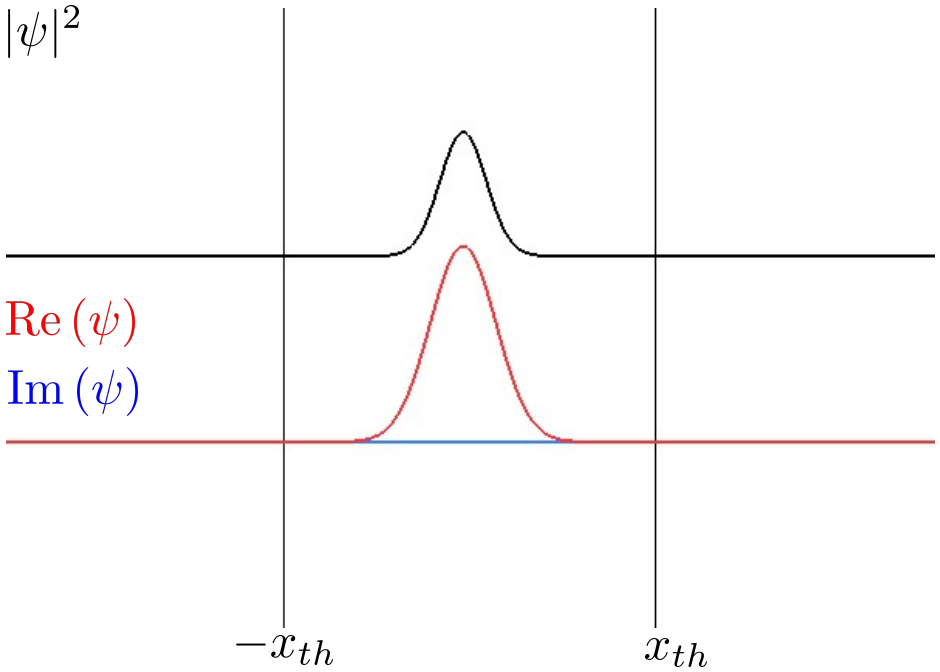
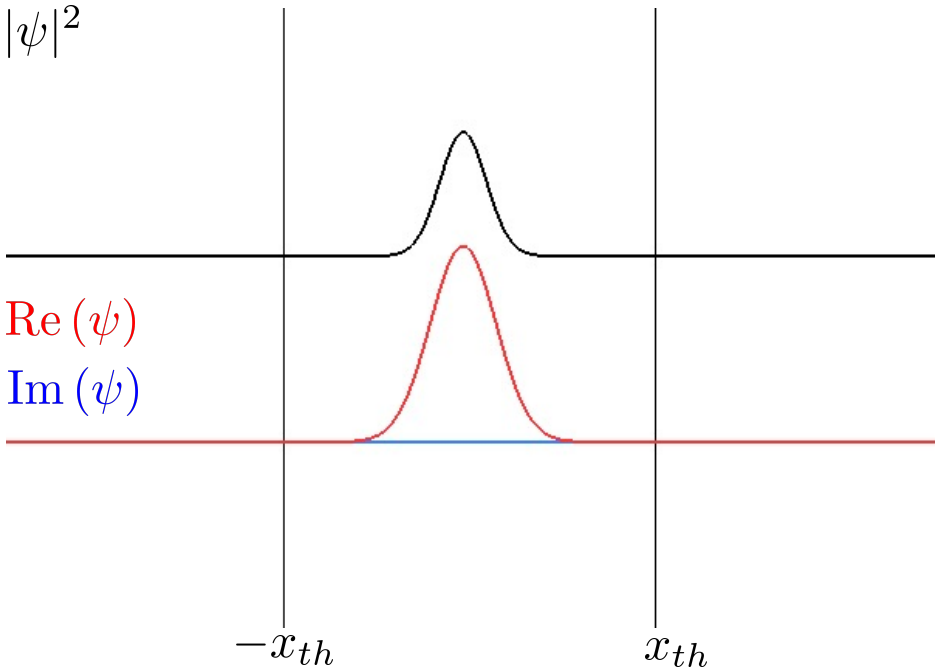
Weak Measurements



delocalizes with time

Weak Measurements



delocalizes with time

Weak measurement:

$$|\Psi\rangle = |\psi\rangle_{system} \otimes |\phi\rangle_{ancilla}$$

$$U = e^{-i\lambda x_{system} \otimes p_{ancilla} dt}$$

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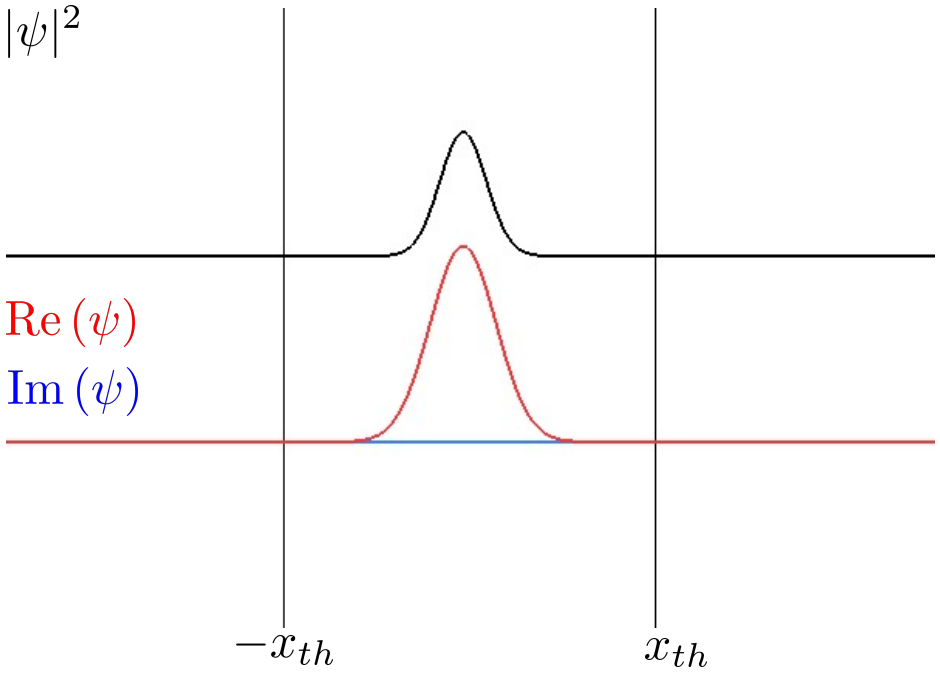
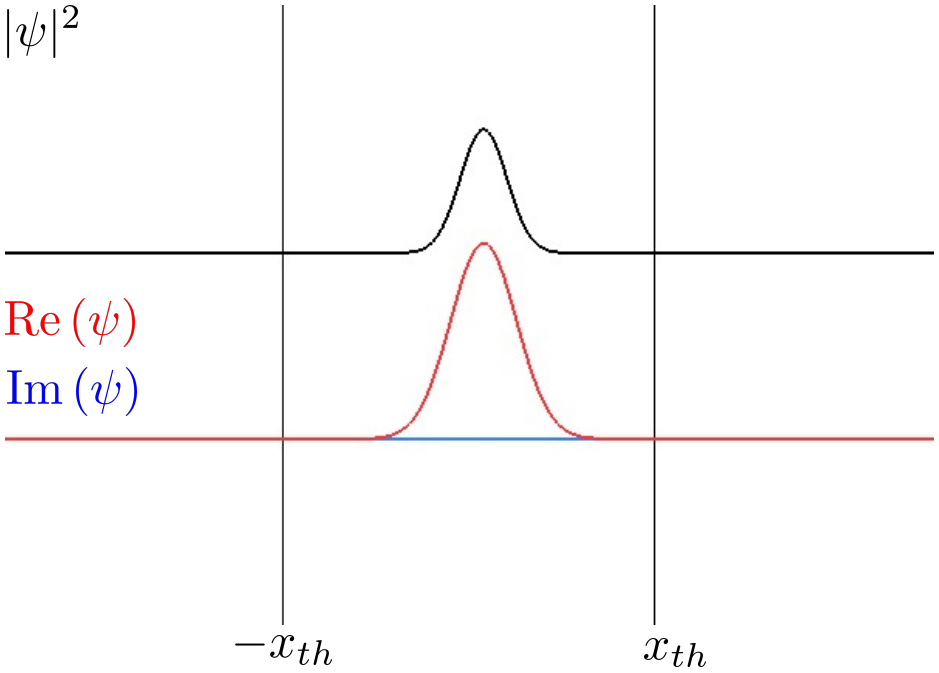
Weak Measurements

No measurement



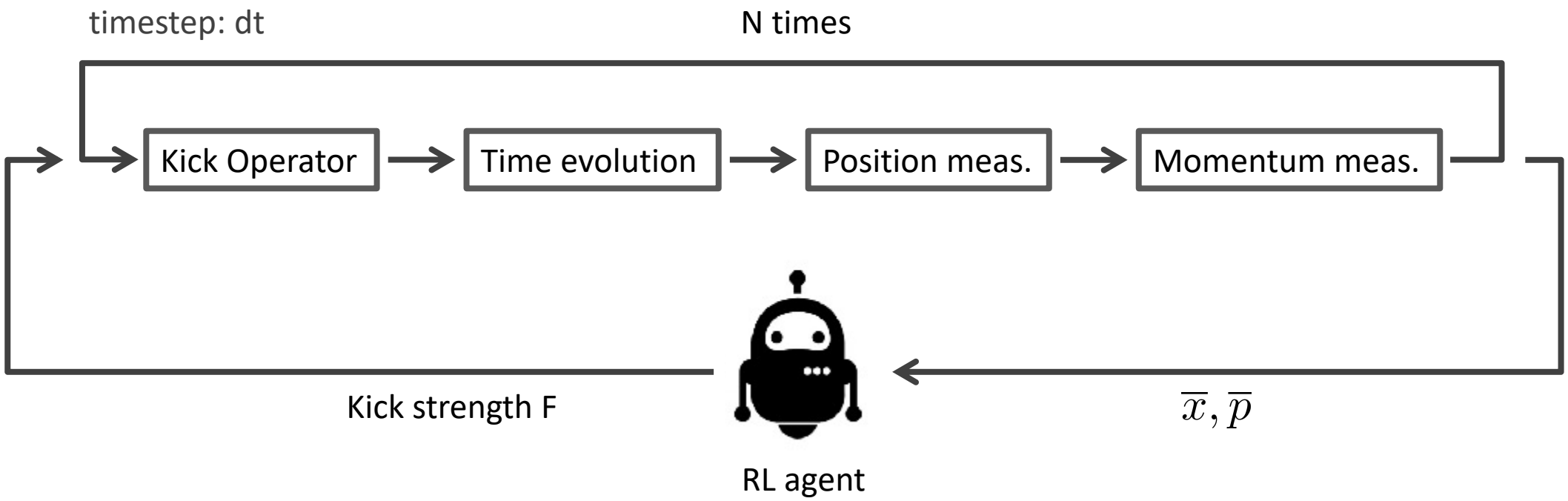
delocalizes with time

Weak measurement

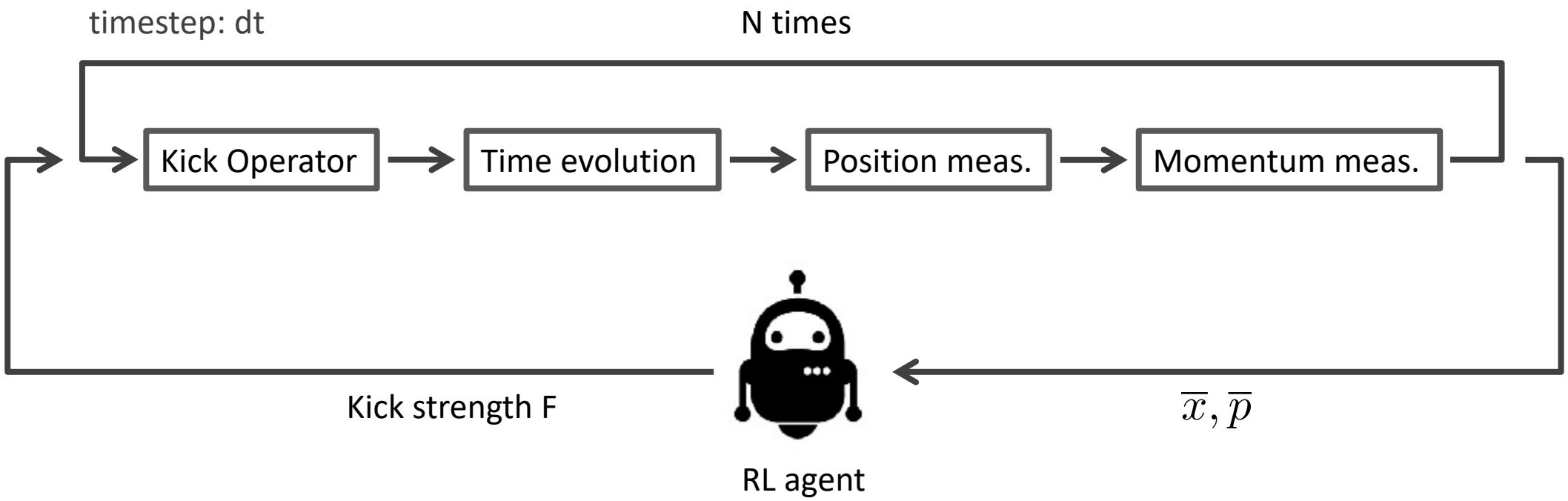


keeps a constant width
drops out of bounds

Quantum Cartpole environment

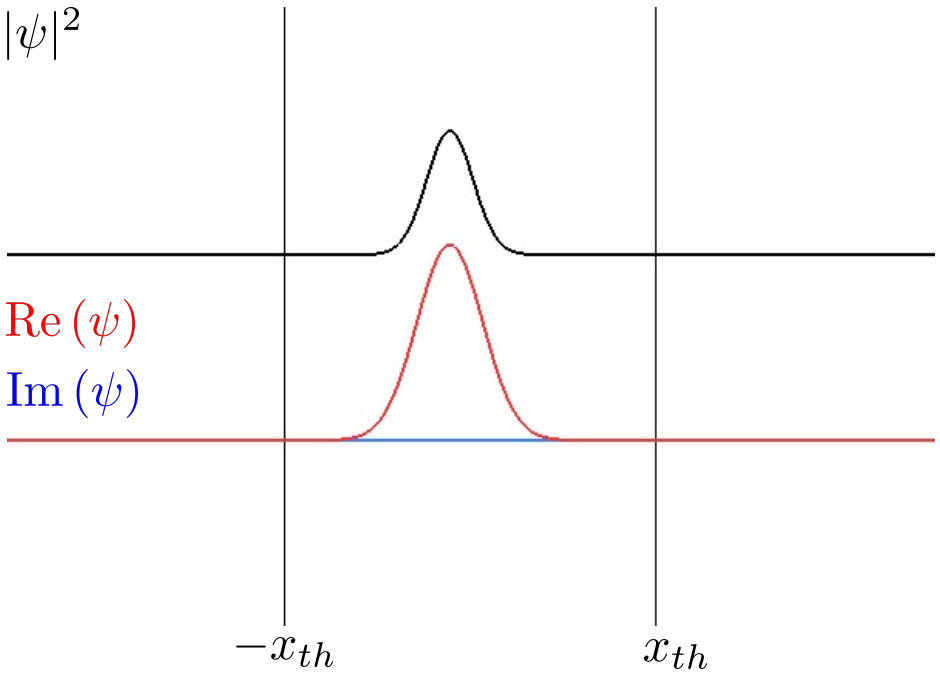


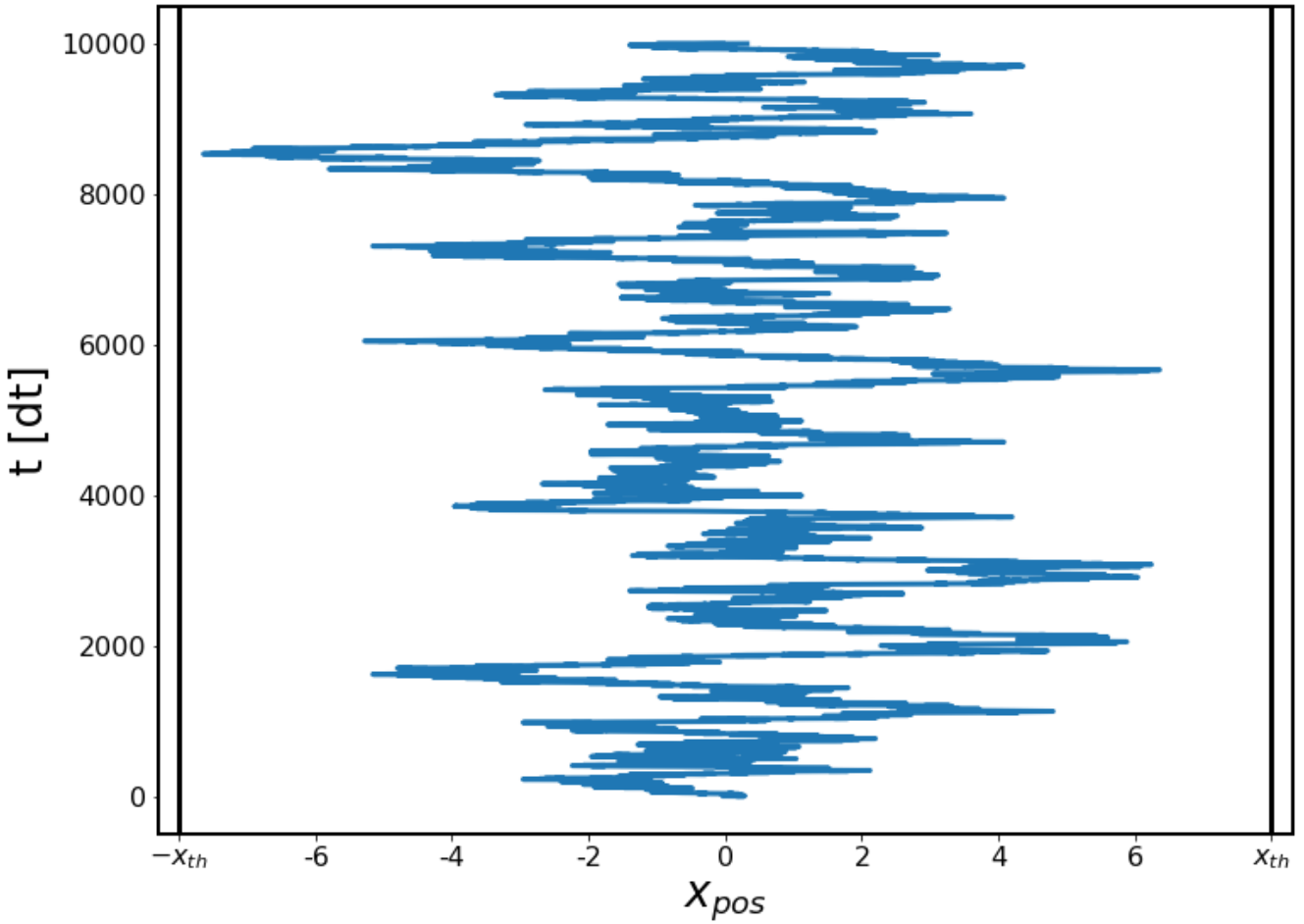
Quantum Cartpole environment



Quantum ⟵ Number of Measurements ⟶ Classical

Applied controls





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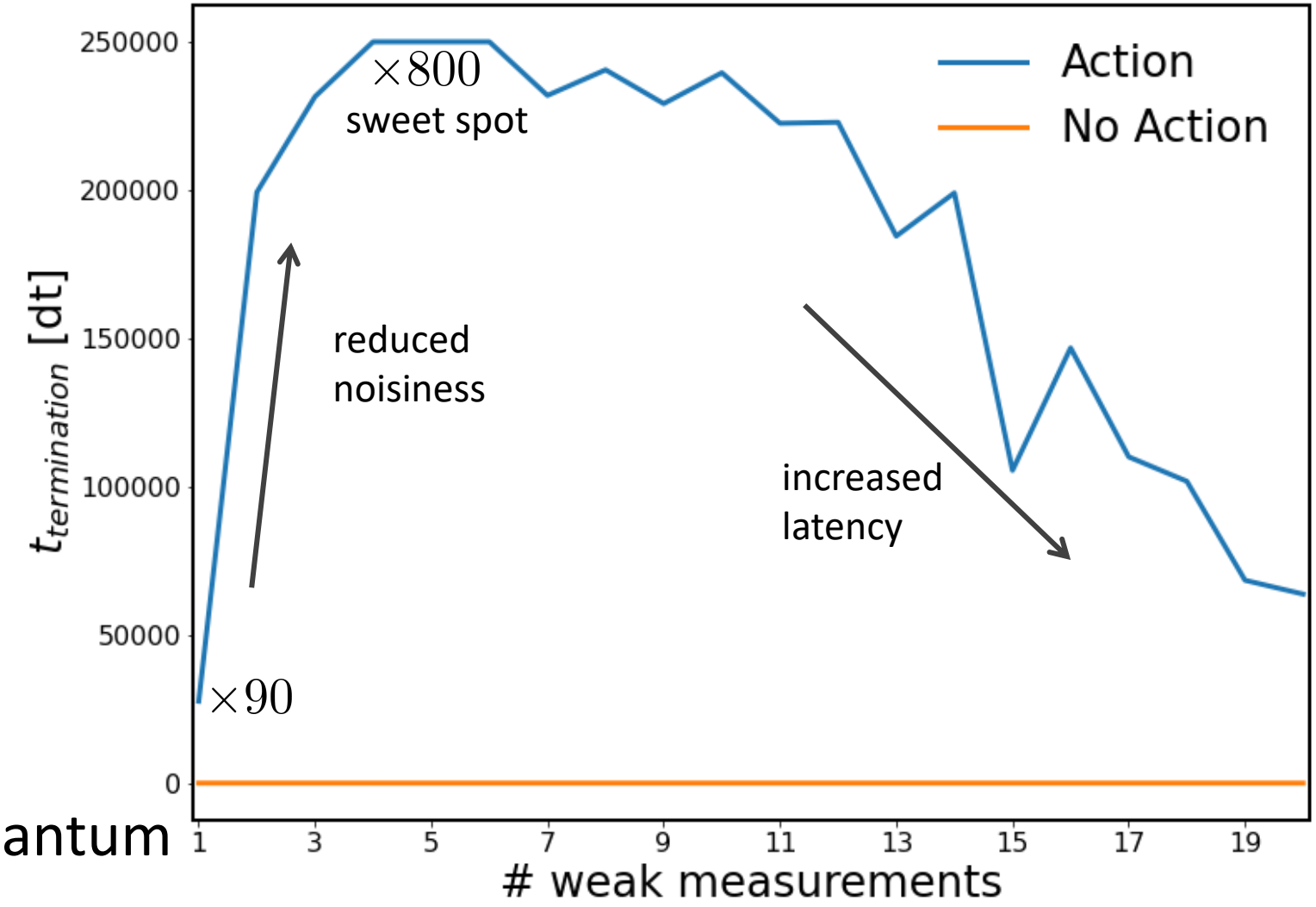
Applied controls



Quantum

Classical

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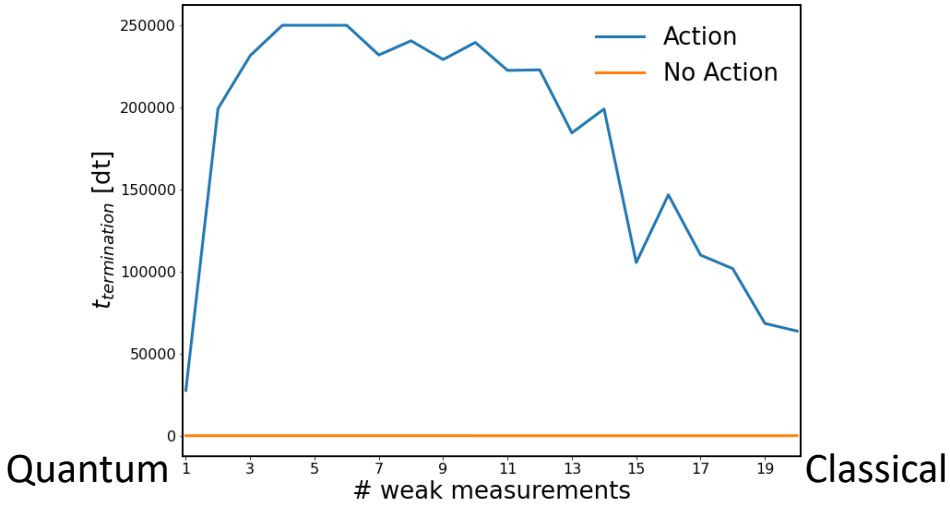
Conclusion

- Connect RL with quantum control



- Build a quantum benchmark environment for RL

- Stabilized the wavefunction in the quantum and classical regime

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Thank you for your attention!