



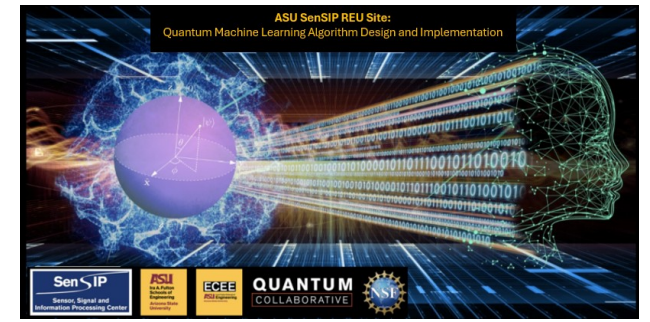
Photovoltaic Fault Detection with Readout-Enhanced Quantum Machine Learning

2026 Quantum Machine Learning REU Program

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RESEARCH BACKGROUND

- PV faults reduce energy yield and can introduce safety risks.
- Large arrays are hard to monitor panel-by-panel.
- Goal: a compact (4–8 qubit) QNN classifier whose feature set and readout design preserve the important PV physics running on AWS Braket.

FEATURE SETS

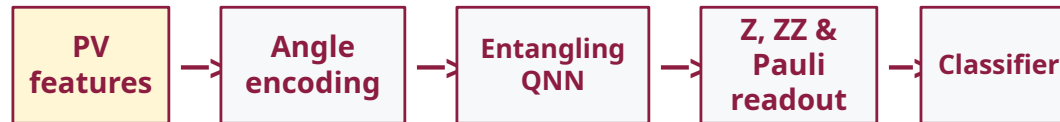
PVWatts includes all but Vmp

Binary QNN

- temperature
- irradiance
- fill_factor
- γ -power / irradiance
- Vmp, Imp, Voc, Isc
- temperature, irradiance
- fill_factor, power
- γ -ratio

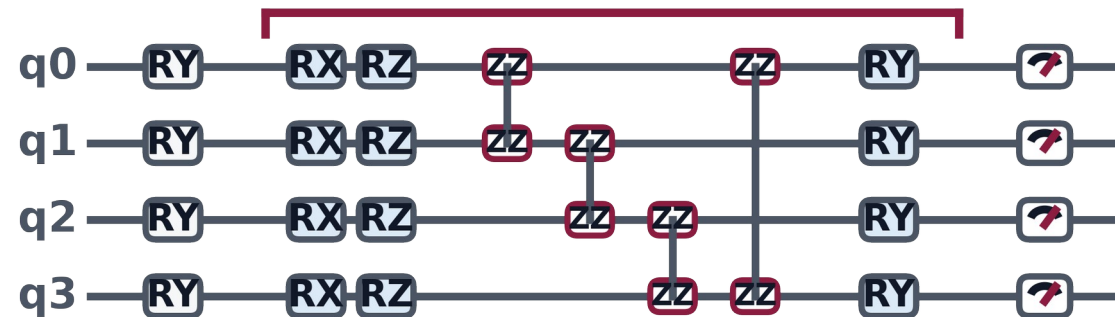


MODEL ARCHITECTURE



Circuit Design Using AWS Braket

4-qubit phase-ring QNN - layer x6



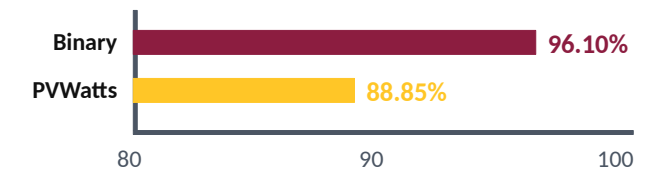
References

- [1] G. Uehara et al., "QNN Parameter Estimation for PV Fault Detection," *IEEE IISA*, 2021.
- [2] S. Rao, A. Spanias, C. Tepedelenioglu, "Solar Array Fault Detection using Neural Networks," *IEEE ICPS*, 2019.

PRELIMINARY RESULTS

Task	Model	Acc.	Takeaway
Binary	Full-Pauli readout	96.10%	richer readout wins
PVWatts 5-class	Z+ZZ + correlations	88.85%	harder 5-class task

Accuracy comparison



CONCLUSIONS / NEXT STEPS

- Versus the published 93.89% QNN reference (different sampling, not a locked comparison) ours hits 96.10% via richer readout of the same circuits
- Optimize quantum circuit, improve and verify results, use more quantum noise simulations