Bosonic Quantum Simulation and Device Survey Report

Platform Comparison Overview

Platform / Company	Access Type	DV	CV	Bosonic?	Bosonic Type	Website
Xanadu (Borealis)	Public via Xanadu Cloud, AWS	✗	✓	✓	Gaussian CV (squeezed light, interferometer)	xanadu.ai
PsiQuantum	No public access	✗	✓	✓	Dual-rail photonic qubits (bosonic modes)	psiquantum.com
Quandela	Public via Quandela Cloud 2.0	✓	✗	✗	N/A	quandela.com
QuiX Quantum	Contact for access	✓	✗	✗	N/A	quixquantum.com
ORCA Computing	Custom / partnerships	✓	✗	✗	N/A	orcacomputing.com
Alice & Bob	Limited, partners only	✗	✓	✓	Cat states (microwave cavities)	alice-bob.com
Amazon (Ocelot chip)	Not public (research only)	✗	✓	✓	Gaussian CV (microwave + GKP roadmap)	amazon.science
Nord Quantique	Not public	✗	✓	✓	GKP states (stabilized CV qubits)	nordquantique.ca
Paul Scherrer Institute	Not public (academic research)	✗	✓	✓	GKP and bosonic codes in microwave cavities	psi.ch
QuEra (Aquila)	Public via Amazon Braket	✓	✗	✗	N/A	quera.com
Pasqal	Access via partnerships or Braket	✓	✗	✗	N/A	pasqal.com
IQM (Garnet)	Access through academic/industry	✓	✗	✗	N/A	meetiqm.com

Table 1: Overview of CV/DV Bosonic Quantum Computing Platforms

Goals and Strategy

The goal is to explore CV and DV bosonic systems with a focus on:

- Gate capabilities
- Noise considerations
- Compatibility with QAOA-type circuits

The platforms of interest include bosonic-Qiskit, Xanadu (Strawberry Fields), and Quandela. To move forward efficiently, focus is placed on Xanadu and Quandela due to their superior device access, documentation, and simulation capabilities.

Capabilities of Three Platforms

Platform	Access Type	Type	Website / Tool	Simulation Support	Device Access	QAOA Suitability
Bosonic Qiskit	Open	CV	bosonic-qiskit	Yes	No	Medium
Xanadu	Open + Cloud	CV	Strawberry Fields + PennyLane	Yes + hybrid	Yes (Borealis)	High
Quandela	Open + Cloud	DV (Photonic)	Perceval SDK	Yes	Yes (Cloud)	High

Table 2: Capabilities and Access Comparison of Selected Platforms

Simulating N-choose-K Problems

- **bosonic-qiskit**: Can simulate photon-number states and combinations, but still in development.
- **Xanadu**: Using Fock backends in Strawberry Fields, simulating N-choose-K is efficient and natural.
- **Quandela**: Supports photon number states and combinations using DV logic; can simulate N-choose-K circuits.

Gate Set of Three Platforms

Gate	bosonic-Qiskit	Xanadu (SF)	Quandela (Perceval)	Comments
Displacement	Yes	Yes	No	Not native to DV
Squeezing	Yes	Yes	No	Not native to DV
Beamsplitter	Yes	Yes	Yes	All support
Kerr	Partial	Yes	No	CV-only
CZ (photon)	No	Yes (CV)	Yes	Native to DV in Quandela
Phase-shift	Yes	Yes	Yes	All support
CNOT	No	With encoding	Yes	DV platforms support better

QAOA Simulation Plan

The final plan is to compare the performance and expressivity of a simple QAOA circuit across three platforms:

- **bosonic-qiskit**: CV simulation
- **Xanadu (Strawberry Fields)**: CV real + sim
- **Quandela (Perceval)**: DV real + sim

Each QAOA implementation will include:

- At least 2 qumodes (or qubits for DV)
- Parameter optimization
- Final energy and fidelity metrics

Account Creation and Platform Selection

- Created accounts on Quandela and Xanadu.
- Set up development environments for Strawberry Fields, Perceval, and bosonic-Qiskit.

Examples of VQA Implementation

Quandela:

See the official demo: VQE Tutorial on Perceval

Xanadu:

See the official demo: Xanadu QAOA Tutorial on PennyLane