

Quantum computational advantage with a programmable photonic processor

Portability dossier - benchmark

agQSL portability pipeline

2026-06-07

Field	Value
Slug	2026-xanadu-quantum-computational-advantage-programmable-photonic-processor
Source	vendor blog
Link	https://xanadu.ai/qca-paper
Category	benchmark
Triaged	2026-06-07 by port_until_julien_parallel
Bootstrapped	2026-06-07

Paper: fetch failed — see `paper.url`

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1 Capability note

1.1 Claim

Xanadu demonstrated Gaussian boson sampling on 216 squeezed modes with its Borealis photonic processor, detecting events of up to 219 photons (mean photon number 125) and drawing a single sample in 36 μs , a task the authors estimate would take the fastest classical supercomputer roughly 9,000 years by direct simulation (reported 1 June 2022).

1.2 Vendor and machine

Xanadu / Borealis, a time-multiplexed photonic processor with squeezed-light inputs and three-dimensional mode connectivity. Borealis is programmed through Xanadu’s Strawberry Fields software (PennyLane ecosystem) and was made accessible over Xanadu Cloud and Amazon Braket. The result was published in *Nature* (606, 75 to 81) on 1 June 2022, accompanied by a vendor announcement the same day.

1.3 Metrics

Metric	Value	Source
Computational task	Gaussian boson sampling (GBS)	Nature 2022 abstract
System size (squeezed modes)	216	Nature 2022 abstract
Mode connectivity	three-dimensional	Nature 2022 abstract
Max photons detected per event	up to 219	Nature 2022 abstract
Mean photon number	125	Nature 2022 abstract
Time per sample (Borealis)	36 μs	Vendor announcement, 1 June 2022
Classical runtime, single sample	\approx 9,000 years (direct simulation, fastest supercomputer)	Nature 2022 / vendor announcement

Metric	Value	Source
Advantage vs earlier photonic demos	$> 5 \times 10^7 \times$	Nature 2022 abstract
QV / linear XEB	not applicable (photonic GBS, not gate-model)	n/a
1Q gate fidelity	not applicable (no qubit gates)	n/a
2Q gate fidelity	not applicable (no qubit gates)	n/a
Circuit depth sustained	not applicable (sampling, not circuit-model)	n/a
Qubit count used	not applicable (216 photonic modes, not qubits)	n/a

1.4 Context

This is the 2022 Borealis result, which Xanadu positions against earlier photonic GBS demonstrations (USTC’s Jiuzhang series), claiming a runtime advantage more than 5×10^7 times larger. Its stated firsts are full programmability of all implemented gates on a photonic advantage machine, and public cloud access to a quantum-advantage device. It clears a reproducibility threshold (others can submit jobs) but not an error-correction or logical-qubit threshold; the advantage is for a sampling task, not a practical computation.

1.5 Caveats

The dossier’s source is a vendor-blog landing page (xanadu.ai/qca-paper) that failed to fetch, so the figures here are taken from the peer-reviewed *Nature* paper and the 1 June 2022 vendor announcement rather than the blog itself. The underlying claim is peer reviewed, which removes the usual blog-post concern. Two reproducibility caveats remain. First, the $\approx 9,000$ -year figure assumes brute-force direct simulation and does not account for the improved classical and tensor-network algorithms that have since narrowed GBS advantage estimates. Second, classical spoofing of GBS validation statistics has been reported in the literature, so the advantage is task-specific and remains contested; Gaussian boson sampling has no known practical application, and programmability covers Gaussian operations only.