bqp

The Quantum-Ready Handbook

Get more out of your GPUs today while preparing for tomorrow's quantum advantage – a Practical Guide to quantum-inspired engineering workflows

Featuring examples and workflows built on BQPhy® QuantumNOW™

Table of Contents

Chapter 01

Why wait for Quantum Computing Hardware?

Traditional simulation algorithms, often developed decades ago, may not be optimized for current generation of HPCs and GPUs.

BQP's Quantum powered stack BQPhy®QauntumNOW™, helps engineering teams extract significantly more performance from classical HPC clusters. Improve GPU utilization and computational efficiency—without waiting for quantum hardware, with QauntumNOW™ solutions

Get multiple X speedups on existing infrastructure today, and position your workflows for exponential acceleration as quantum hardware matures

> Traditional simulation algorithms, often developed decades ago, may not be optimized for the intricate challenges of modern engineering.

The Bottleneck

Legacy solvers assume a different compute architecture. Never designed for solving present day, complex engineering problems

The Result

- Adding more hardware yields diminishing returns.
- Optimizing the engine around an algorithm designed decades ago.
- Simulation time, compute cost, and design precision all plateau together.

The Opportunity with QuantumNOW™

"QuantumNOW" means optimizing current algorithms in the simulation workflow and extracting more from existing hardware.

BQPhy®QuantumNOW™ harnesses quantum computing principles to unlock the full compute power of today's existing HPC infrastructure, giving you more output with the same resources.

DID YOU KNOW?

10x 10x Faster Results on Current HPC

BQPhy® QauntumNOW™ delivers 10x faster simulation results compared to legacy methods - without new hardware.

Chapter 02

Quantum-Inspired vs. Pure Quantum

A Quick Reality Check

- Quantum Inspired Algorithms Run on classical hardware (GPUs/CPUs) today – no quantum processors, or error correction required. True Quantum requires specialized, scarce, and error-prone hardware.
- True quantum promises exponential speedups, but only at hardware maturity (5–10+ years away)
- Quantum Inspired Algorithms Integrate into existing HPC workflows with minimal code changes. They are drop-in compatible providing high-performance metaheuristic search speedups (typically 2–10x).

Drive higher throughputs on GPUs and HPC infrastructure with QuantumNOW™

The Technology

BQP operates on two tracks:

Track	What It Means	Where It Runs
BQPhy QuantumNOW™	Solving intractable Optimization problems in conjunction with CFD, ML outcomes	Existing classical infrastructure
BQPhy QuantumMAX	Quantum Native Algorithms for solving large scale Partial Differential Equations(PDE) in CFD	Quantum Hardware

Quantum-Inspired Evolutionary Optimization (QIEO) emulates quantum effects on classical GPUs and HPC environments - solving complex, non-convex problems faster than traditional methods, without physical quantum processors.

Research access extends this to hybrid quantum-classical configurations via platforms like NVIDIA CUDA-Q.

The "NOW" Factor

BQP supercharges current HPC infrastructure with quantum-inspired solvers to accelerate complex system optimization, simulations and AI/ML optimization.

It enables companies to achieve 10x-1000x faster performance today without waiting for fault-tolerant quantum hardware

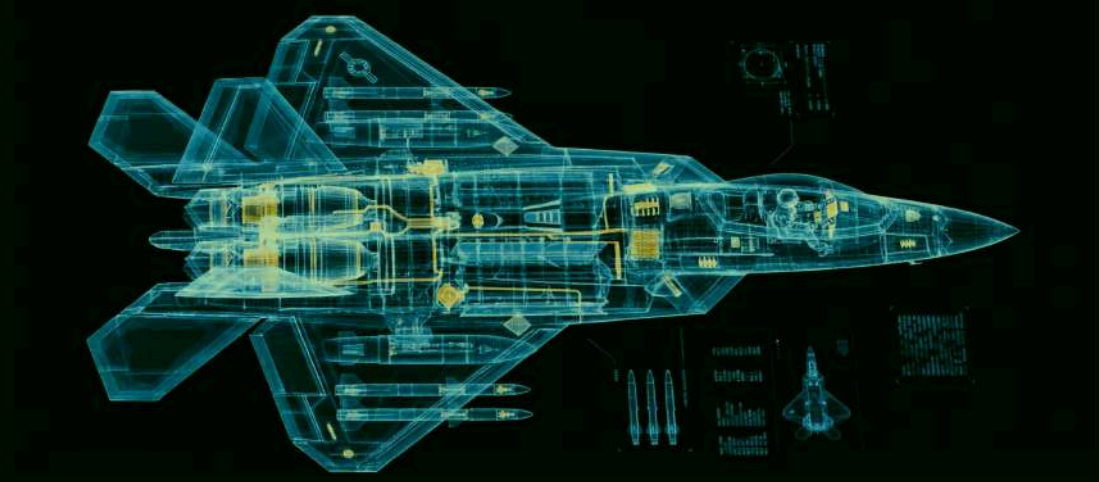
Access BQPhy® QuantumNOW™ from Your Stack

Use BQPhy® QuantumNOW right inside MATLAB, Python, or your own platforms and start running high-performance simulations with minimal setup.

- Toolbox for MATLAB: Call BQPhy® solvers directly from MATLAB with an auto-configured toolbox
- Python SDK: Plug BQPhy® into Python workflows using a native SDK for quick experiments and batch runs.
- BQPhy APIs (BQPhy®): Integrate BQPhy® via secure REST APIs with bearer tokens for reliable system-to-system access

Access BQPhy® QuantumNOW

The runway is NOW.



Chapter 03

The 3 Pillars of Speed

BQPhy® QuantumNOW™ accelerates engineering workflows across three distinct dimensions. Each pillar addresses a specific bottleneck - and all three work together.

PILLAR 1 **Faster Convergence**

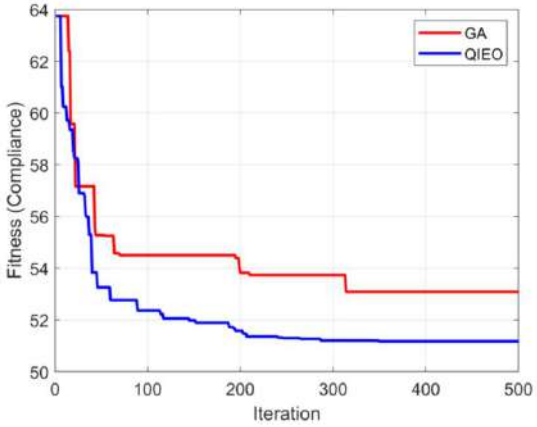
Technology : QIEO explained

At the core of the BQPhy QuantumNOW™ platform is its proprietary Quantum-Inspired Evolutionary Optimization (QIEO) algorithm. This approach uses a probabilistic framework to balance global exploration and local exploitation, allowing it to navigate complex problem spaces more smoothly and converge more reliably to a high-quality solution

Application in the Real World:

The algorithm's ability to converge efficiently unlocks solutions to real-world problems that were previously impractical to solve :

- An airfoil optimization problem for the aerospace industry, the QIEO solver was shown to converge to a solution using up to **90% fewer iterations** compared to a Genetic Algorithm (GA).
- **3x Faster Convergence:** For airline gate scheduling, BQP's Quantum-Inspired Optimization solver delivered up to **3x faster convergence** to a conflict-free schedule
- Achieved **6% more weight reduction** than those found by classical methods, without compromising structural strength



DID YOU KNOW?

4x

4x Faster Convergence

QIEO reaches optimal solutions in one-fourth the iterations of classical genetic algorithms on non-convex, non-separable design problems.

PILLAR 2 **Global Optimization**

Technology: QIEO (Quantum-Inspired Evolutionary Optimization)

Classical genetic algorithms find a solution. QIEO finds the best solution.

QIEO encodes design candidates into a quantum register, then manipulates quantum parameters to generate and evaluate additional candidates - continuing until true optimization criteria are satisfied.

Test Function	QIEO Iterations	GA Iterations	Improvement
Ackley	100	2,000	**20x fewer**
Rosenbrock	200	1,000	**5x fewer**
Rastrigin	100	200	**2x fewer**

PILLAR 3 **Reduced Compute**

Technology: Quantum-Inspired Solvers

The most expensive part of CFD and FEA isn't the physics - its the number of Iterations, and time taken per iteration that slows the processing. This is where BQPhy® makes a massive difference massive difference

BQP's quantum-inspired solvers accelerate these systems significantly compared to classical approaches.

10x
faster overall simulation results on current HPC

Up to 20x
speedup on complex iterative solver tasks

20%
parameter reduction with QA-PINN (less compute per training cycle)

Chapter 04

Sector Proof Points

Aerospace & Defense

CFD acceleration • Flight path optimization • Turbomachinery flows

Use Case	Outcome
CFD linear system acceleration	**Up to 20x faster**
Flight path fuel savings	4% reduction
Emission reduction	6% decrease
Flight time saved per route	6.5 hours less

Automotive

Lightweighting • Aerodynamic optimization • Cost reduction

Use Case	Outcome
Control arm topology optimization	3.2x greater weight reduction
Compute resources used	8x less vs. classical
Racecar airfoil shape optimization	18% performance improvement
Racecar airfoil weight reduction for cost saving	40% reduction

Manufacturing & Logistics

Supply chain optimization • Combinatorial routing

Supply chain scheduling is a combinatorial explosion. Classical solvers approximate. They don't optimize.

- Quantum-inspired solvers handle multi-variable logistics routing at scale
- 30% reduction in total shipping costs through optimized routing
- Timely delivery performance improved through cost-efficient scheduling

Chapter 05

The "Quantum-Ready" Checklist

Three steps. No rip-and-replace. No new infrastructure

Step - 1

Identify the Bottleneck

Ask the right diagnostic question first. Where is your engineering workflow losing time or money?

- Simulation time - CFD/FEA runs taking days instead of hours?
- Compute cost - HPC bills scaling faster than output quality?
- Design precision - settling for 'local best' instead of global optimum?

Your bottleneck determines the customization of BQP's QIEO Algorithms

Step - 2

BQPhy® QuantumNOW™ integrates into your existing stack.

Ask the right diagnostic question first. Where is your engineering workflow losing time or money?

Integration Method	Details
MATLAB	Built-in BQPhy® package
Python	Native API integration
Deployment	Browser-based · Cloud · On-premise

No rearchitecting. No migration. No downtime.

Step - 3

Don't buy the outcome. Benchmark it.

BQP offers a commitment-free Proof of Concept (POC) - run BQPhy® QuantumNOW™ against your existing classical baseline on a real problem from your current workflow.

Ask the right diagnostic question first. Where is your engineering workflow losing time or money?

- Define your target problem (CFD, Optimization, Machine Learning)
- Run identical inputs through classical baseline and BQPhy®
- Compare: speed, solution quality, compute cost
- Decision backed by your own data

Conclusion and Next Steps

Don't Wait for the Future. Build It.

The classical ceiling is real. The hardware-scaling plateau is documented. The algorithms running your simulations were not designed for what you're asking them to do today.

Quantum-inspired solvers run on your current HPC. They integrate with your existing tools. And they have been benchmarked against real engineering problems.

How Quantum-Inspired Solvers Perform compared to Classical Solvers

Metric	Result
QA-PINN CFD Training	25x faster (Reduces training parameters)
Quantum CFD Circuit Compression	100x compression
QIEO vs Genetic Algorithm	4x better convergence
Complex Mission Scheduling	2-10x Faster
Airfoil Weight reduction	6% better reduction
Hybrid Quantum Classical Finite Element Methods for structural Impact	Better accuracy at scale (Error rate of 10^{-3})

Take the Next Steps

BQPhy QuantumNOW™works the way you do. Use it in the cloud, inside MATLAB, with Python, or via secure enterprise APIs.

Schedule a Proof of Concept

See verified performance data across aerospace, automotive, and logistics applications.

Explore Results & Benchmarks

Not Convinced yet ?

Explore how BQphy® QuantumNow™ solutions drive efficiency, reduce costs, and unlock new possibilities. **Download** our detailed case studies that cover our approach, methodology and results

Approach
How quantum-inspired solvers are applied

Methodology
Implementation on GPU/ HPC clusters

Results
Measured speedups and accuracy gains

Our methodology is grounded in rigorous, peer-reviewed research. Download our IEEE papers on the links below

Scalability & Performance:
Investigates how QIEO leverages GPU parallelization to solve complex, large-scale industrial problems.

Functional Benchmarking:
Provides mathematical proof that GPU-optimized QIEO consistently outperforms traditional classical solvers in speed and accuracy.

Paper -1

Investigation of Performance and Scalability of a Quantum-Inspired Evolutionary Optimizer (QIEO) on NVIDIA GPU

Paper -2

Benchmarking of GPU-optimized Quantum-Inspired Evolutionary Optimization Algorithm using Functional Analysis:

Paper -3

Design of magnetic lattices with a quantum-inspired evolutionary optimization algorithm