Q2 2025 EDITION

A newsletter on Indian Quantum Technology Activities

Quantum Vibes

FROM QUANTUM THEORY TO HIGH PRECISION LASERS - A JOURNEY WHICH IS ENABLING TODAY'S QUANTUM TECHNOLOGY BREAKTHROUGHS

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Prenishq and IIT Delhi

Ms. Poonam Yadav
IIT Delhi

ISC

HIGH PERFORMANCE 2025

Looking ahead at the quantum era

QUANTUM INITIATIVES BY MEITY, DOT, DRDO & ISRO

inside the minds

Dr. Santu Sardar, Director, DYSL-QT &
Prof. Dieter Kranzmuller, Chairman of the Board of Directors of the Leibniz Supercomputing Centre

FROM THE EDITOR

Welcome to the second-quarter edition of Quantum Vibes, where we continue our journey through the transformative world of quantum science and technology. This time with a spotlight on India's expanding national quantum landscape.

This quarter's theme honors the groundbreaking initiatives led by India's key mission-driven agencies: MeitY, DRDO, ISRO, and DoT. These organizations are shaping the future of quantum technologies through strategic investments, infrastructure development, and visionary research. Their efforts represent not isolated programs, but a unified momentum toward national quantum self-reliance.

In this edition of Expert Insight, Dr. Bodhaditya Santra and Ms. Poonam Yadav from IIT Delhi take us on an enlightening journey from the fundamentals of quantum theory to the development of high-precision lasers, the very tools driving today's breakthroughs in quantum communication, sensing, and computing. Their narrative seamlessly connects foundational physics with the cutting-edge technologies that are reshaping our future.

Dive deeper into the Qniverse, C-DAC's ambitious unified platform that brings together software, simulators, hybrid integration tools, and a development environment to accelerate quantum exploration, all under one ecosystem!

Our Inside the Minds section features thought-provoking conversations with Dr. Santu Sardar, who gives us an insider's view of DRDO's mission-mode R&D at DYSL-QT for national defense applications, and Prof. Dieter Kranzmüller, who shares a European perspective on hybrid quantum-HPC integration and sustainable supercomputing futures.

We also take you to ISC 2025, where C-DAC made a strong global impression by showcasing India's growing capabilities in HPC and quantum computing alongside trailblazing startups and international collaborations that are defining the global quantum economy.

Finally, don't miss our roundup of quantum career opportunities, notable research publications, major conferences, and key happenings across India's quantum ecosystem curated to keep you informed and inspired.

As quantum continues to shift from the lab to real life, this edition celebrates the vision, collaboration, and relentless innovation driving this transformation across India and around the globe.

Happy Reading !

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Editor

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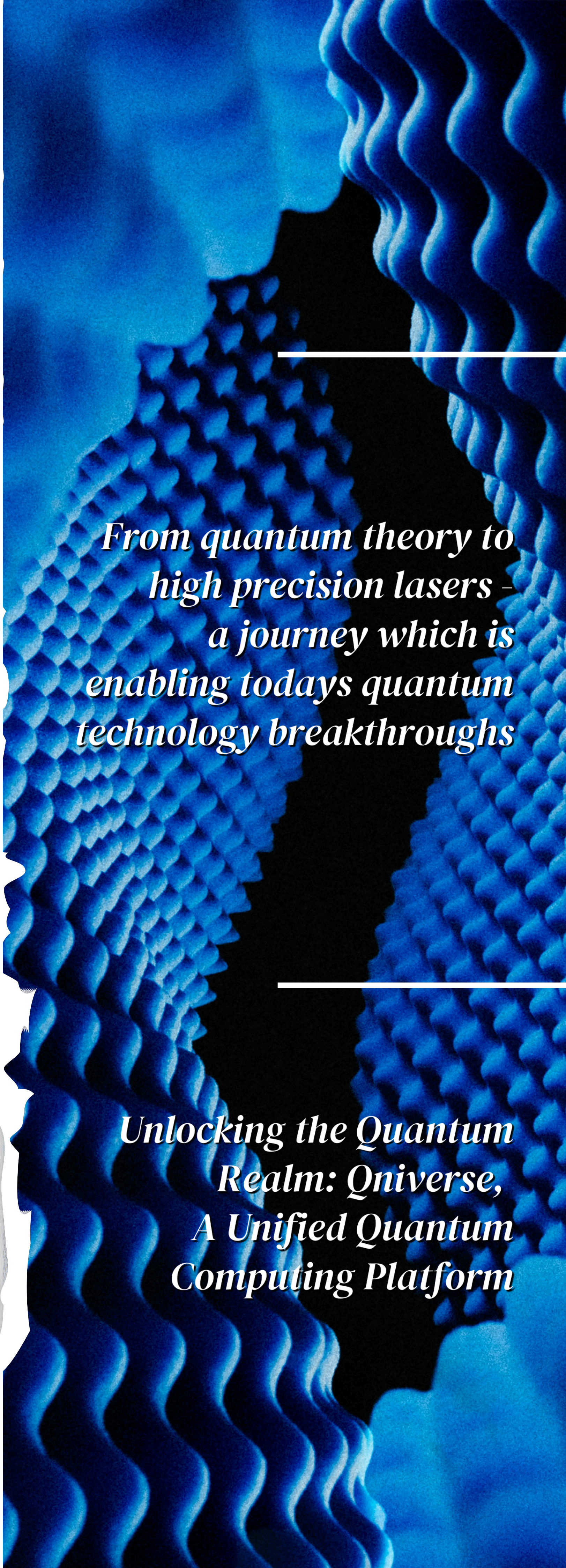

From quantum theory to high precision lasers - a journey which is enabling todays quantum technology breakthroughs

Unlocking the Quantum Realm: Qniverse, A Unified Quantum Computing Platform

From quantum theory to high precision lasers - a journey which is enabling today's quantum technology breakthroughs

DR. BODHADITYA SANTRA

CO-FOUNDER & CTO, PRENISHQ AND ASSISTANT PROFESSOR OF PHYSICS, IIT DELHI

Dr. Bodhaditya Santra is the Co-Founder & CTO, Prenishq, a company focused on developing high precision diode-laser systems for advancing quantum computing through cutting-edge research and technology. A physicist by training, he earned his PhD in Experimental Physics from the University of Groningen and has held research positions at the University of Hamburg, the University of Kaiserslautern, and Leopold-Franzens University Innsbruck. He is also an assistant professor of Physics at IIT Delhi. His expertise spans quantum computing, high precision diode-laser systems, cold atoms, optical tweezer and miniaturized quantum instrumentation relevant for society and industry.

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INSIGHTS & TUTORIALS

From quantum theory to high precision lasers - a journey which is enabling todays quantum technology breakthroughs

Myth

Cold atoms are 'cold' because they are frozen like ice.

Fact

Cold atoms are not cold in the conventional sense. They're cooled using laser light and magnetic traps to temperatures near absolute zero (microkelvin or even nanokelvin), drastically reducing their kinetic energy not freezing them into a solid.

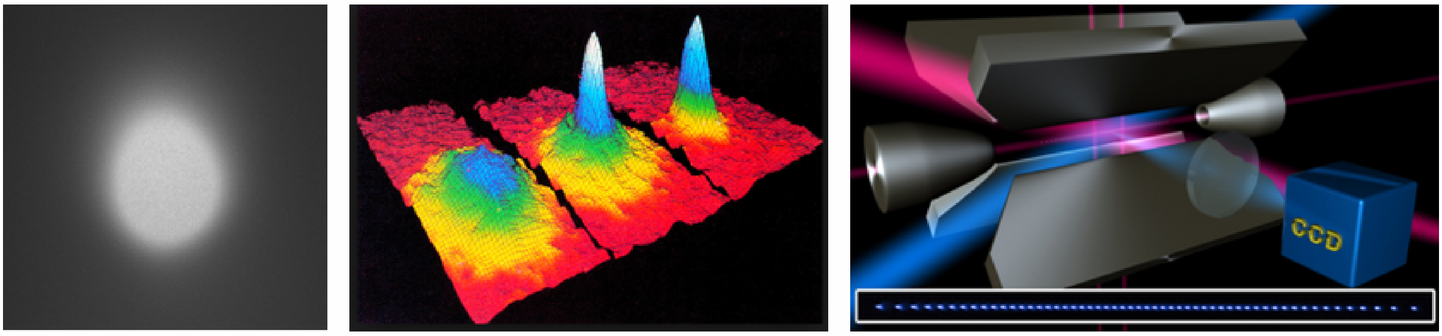
High precision diode lasers are key building block to enable many quantum technologies. These narrow linewidth lasers are ultra-stable in frequency and poses exceptional beam quality which is crucial to maintaining quantum coherence and qubit fidelity.

The story of the diode laser begins with the birth of quantum theory. In 1900, Max Planck proposed that energy is emitted in discrete packets (quanta), introducing the formula E=hv. This marked the beginning of modern quantum physics. In 1917, Albert Einstein introduced stimulated emission, a process where an excited atom, when hit by a matching photon, emits a second photon identical in energy, direction, and phase. This idea became the basis of laser technology.

To make lasers work, two conditions must be fulfilled. First, Population inversion - where more atoms are in excited states than in ground states. Second, Optical feedback and amplification, where emitted photons and defined frequencies are amplified in a resonator which can be as simple as a Fabry-Perot cavity. These conditions are achieved using pumping mechanisms like optical, or electrical excitation. Once the lasing conditions are fulfilled, a stream of photons resulting from the stimulated emissions produces a coherent beam of light.

The early concept of laser was embedded in the postdoctoral work of Isidor I. I. Rabi on molecular beams in the group of O. Stern in the University of Hamburg. Rabi imported the technique to Columbia University in late 1920s when he joined as lecturer in the Physics department of Columbia University. In particular, he used radio-frequency fields to switch population of atoms and molecules from one state to another when the energy of the rf photon matched with the energy difference between the two states of the atoms or molecules.

These experiments were the founding stone of a series of revolutionary technologies building on which, today we are dreaming to build an universal quantum computer. One of the most prominent technologies is magnetic resonance imaging (MRI), which became the unique non-invasive medical imaging technique to monitor various organs inside human body. Rabi had another idea of building precise time standard across the world by detecting hyperfine transitions at few GHz rf frequencies in alkali atoms. Later, one of Rabi's PhD students, Norman Ramsey build such a device using an atomic beam passing through two microwave rf cavities. The method was used for the first realization of atomic clock in 1950s at the National Physical Laboratory, UK by frequency stabilizing a microwave field to the hyperfine ground state transitions of Cesium atoms. Portable version of these clocks are now used in various satellites across the globe to constitute the GPS system which allows the whole world to move from one point to another on the surface of the earth and sometime beyond that. Another machine based on Rabi's molecular beam techniques and built using NH_3 molecules were perhaps the most direct ancestor of laser. As the NH_3 experiment used 24 GHz, Charls Townes and his students named the device MASER – Microwave Amplification by Stimulated Emission of Radiation. Few years later, in 1960, the first light was emitted from LASER – Light Amplification by Stimulated Emission of Radiation. This was



(a) (b) (c)

Fig.1: (a) A cloud of cold Cesium atoms at few micro-Kelvin temperature. The atoms were laser cooled at the intersection volume of three pair of retro-reflected laser beams at the Cold atom quantum technology laboratory, IIT Delhi, India. (b) The creation of first Bose-Einstein condensation of rubidium atoms by cooling atoms to few nano-Kelvin temperature at the JILA laboratory in Boulder, USA. (c) A chain of laser cooled calcium ions at the laboratory of Rainer Blatt in the University of Innsbruck, Austria.

a pulsed laser developed by Maiman using Ruby crystal. Soon after, in 1961, Javen, Bennet and Herriot developed Helium-Neon laser and in 1964, Kumar Patel developed the CO_2 laser. It is an interesting co-incidence that, during 1950s, Kumar Patel, the inventor of CO_2 laser, received a Bachelor degree of Engineering, the University of Pune, India, where almost 70 years later the government of India has setup IHUB – Quantum Technology Foundation to train and develop highly skilled manpower in the area of quantum technologies and translate quantum research into products and services of socio-economic values.

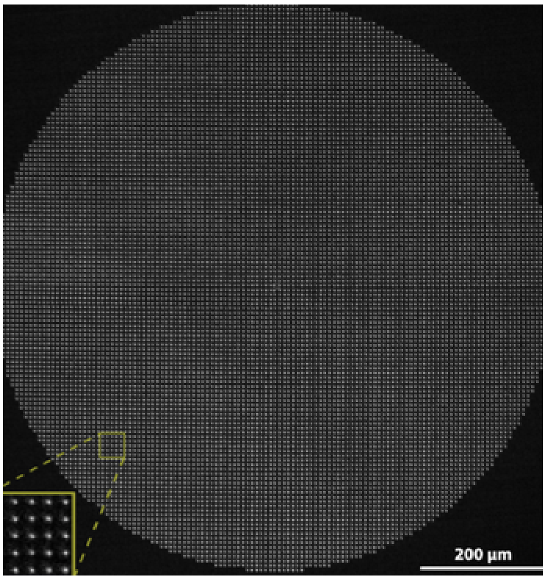
In 2022, Prenishq Pvt. Ltd. was incorporated as a spin-off from the cold atom quantum technology lab at the Indian Institute of Technology Delhi, India. Next year it was selected for incubation and funding for developing prototype of diode lasers for the application of quantum technologies as part of India's National Mission on Interdisciplinary Cyber Physical Systems (NM-ICPS). Next year, Prenishq was selected as one of India's first eight quantum startups by the National Quantum Mission (NQM). Prenishq is dedicated to building large-scale quantum computers using atoms and high-precision lasers. They design, manufacture, and test ultrahigh vacuum chambers, narrow linewidth lasers, and electronics for experimental control and data acquisition systems.

From the time of birth, Lasers and many achievements enabled by Lasers has astonished the whole world. The first of the series is the rejection of the manuscript on first laser by Maiman by Physical Review Letters. As plan A did not work out, Maiman tried plan B – astonishingly – the paper was published in Nature.

Some of the selected milestone experiments in quantum science and technology which have been achieved using high precision lasers are cooling of neutral atoms to few micro-Kelvin temperatures, Bose-Einstein condensation, degenerate Fermi gas, laser cooling of trapped ions, atom interferometry, Rydberg spectroscopy, generation of entangled photon pair and spectroscopy of NV centers in diamond All these achievements are at the core of one or the other quantum devices with applications ranging from quantum computing, quantum sensing, quantum communication and quantum metrology. Among many quantum sensing experiments, in particular LIGO – Laser Interferometer Gravitational-wave Observatory and LISA – Laser Interferometer Space Antenna, extensively uses high precision lasers for gravitational wave detection.

Conclusion

High-precision lasers are a foundational component of a large variety of quantum technologies. The emerging era of Quantum 2.0 is driven by advances in precision measurement, where coherent and stable control and measurement of light is critical. One of the major challenges is the development of compact, ultra-stable lasers that are also suitable for commercialization, particularly to support national initiatives. Given the significant investment in quantum innovation, it is crucial for India to develop domestic laser manufacturing capabilities to ensure technological self-reliance. Laser-based technologies holds great promise for defense and space applications. Indian government agencies are increasingly recognizing this potential and are actively investing in research and development to advance laser enabled quantum technologies systems for projects of national importance.



(a)

(b)

Fig 2: (a) Averaged image of single Cesium atoms trapped across 11,998 site optical tweezer array at the California Institute of Technology, USA. Such array of thousands of qubits with long coherence time are at the heart of building universal quantum computer for practical industry level applications. (b) Frequency and bandwidth conversion of single photons in a room temperature diamond quantum memory at the Institute of Quantum Computing, University of Waterloo. Spectrally pure photons from high precision lasers are necessary for such quantum applications.

Qniverse

UNLOCKING THE QUANTUM REALM: QNIVERSE, A UNIFIED QUANTUM COMPUTING PLATFORM

WWW.QNIVERSE.IN

Unlocking the Quantum Realm: Qniverse, A unified Quantum Computing Platform

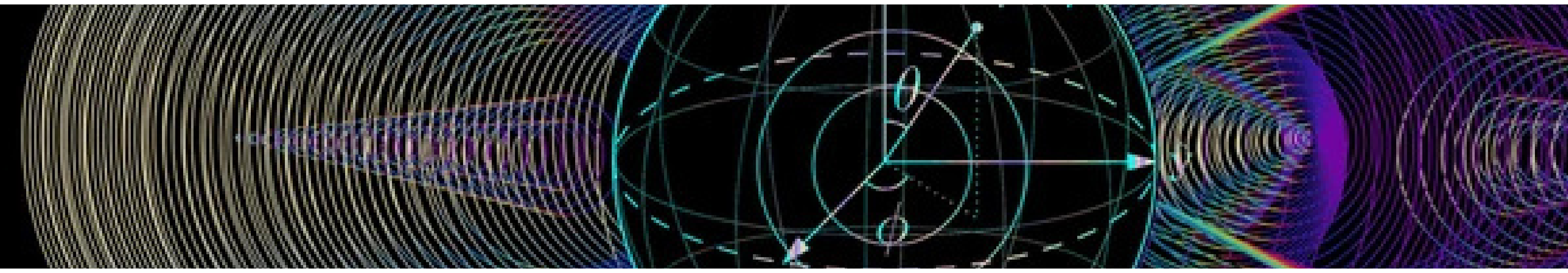
Potential of Quantum Computing

Quantum computing applies the principles of quantum mechanics to tackle computational problems that are either beyond the capabilities of classical computers or can be solved significantly faster than with conventional methods.

From accelerating drug discovery to revolutionizing financial modelling, the potential is vast and with maturing Quantum Computing hardware, but so are the challenges.

Today's ecosystem, however, is highly fragmented:

Leading providers such as IBM, Google, Microsoft, Rigetti, Xanadu, and D-Wave each offer **distinct qubit technologies**, programming languages, SDKs, and execution paradigms. This diversity imposes **steep learning curves** on developers, who must master vendor-specific tool chains, grapple with **non-standardized interfaces**, and engineer bespoke integrations for hybrid quantum–classical workloads. The **lack of interoperability and universal programming models** further complicates efforts to port or scale quantum applications across different backends. Added to that the inherent complexity of quantum mechanics and a scarcity of educational resources, the field becomes daunting for newcomers.



Quantum Computing Use Cases

NOT FULLY ERROR CORRECTED ⟵ ⟶ FULLY ERROR CORRECTED

CURRENT STATE OF DEVELOPMENT

	Early Stage	Late Stage	Fault Tolerant Early Stage	Fault Tolerant Early Stage	Fault Tolerant Early Stage
QUBITS	Logical: NA	Logical: NA	Logical: ~100	Logical: ~1,000	Logical: ~10,000+
Annealing	~10,000	~100,000	~100,000	~1,000,000	~10,000,000+
Gate based QC	~100	~1,000	~100,000	~1,000,000	~10,000,000+
Challenges for Gate Based Quantum Computing		Scalability and Error Correction			Quantum data storage (Quantum RAM) and efficient data input and readout
Challenges for Annealing		Better Qubit Connectivity			
Key Applications	Certified Randomness (Job) Scheduling Optimization Route and Fleet Optimization Clinical-trial site-selection optimization	Synthetic-data Generation Approximate OM Simulation Small-scale Quantum Reinforcement Learning Collateral and Portfolio Optimization Robot Path Optimization Production-process Optimization	Light Risk Simulation (Approximate) MD, MM simulation (eg. Protein Folding) Trading-strategy Optimization Protein Folding	Breaking RSA Cryptography Financial and cyberrisk simulation Large molecule simulation ADME and Toxicity Prediction Complex-mixture Simulation Solid-material Simulation Catalysis or synthesis optimization Finite Element Method Supply-chain Optimization	Supply-chain disruption modelling Self-driving Robots Credit-risk Management Financial-crime Detection Personalized Medicine Automated Drug Recommendations Multiscale Production Optimization

Computational Models:

- Linear Algebra (AI/ML)
- Optimization
- Simulation
- Factoring
- Other

Industries:

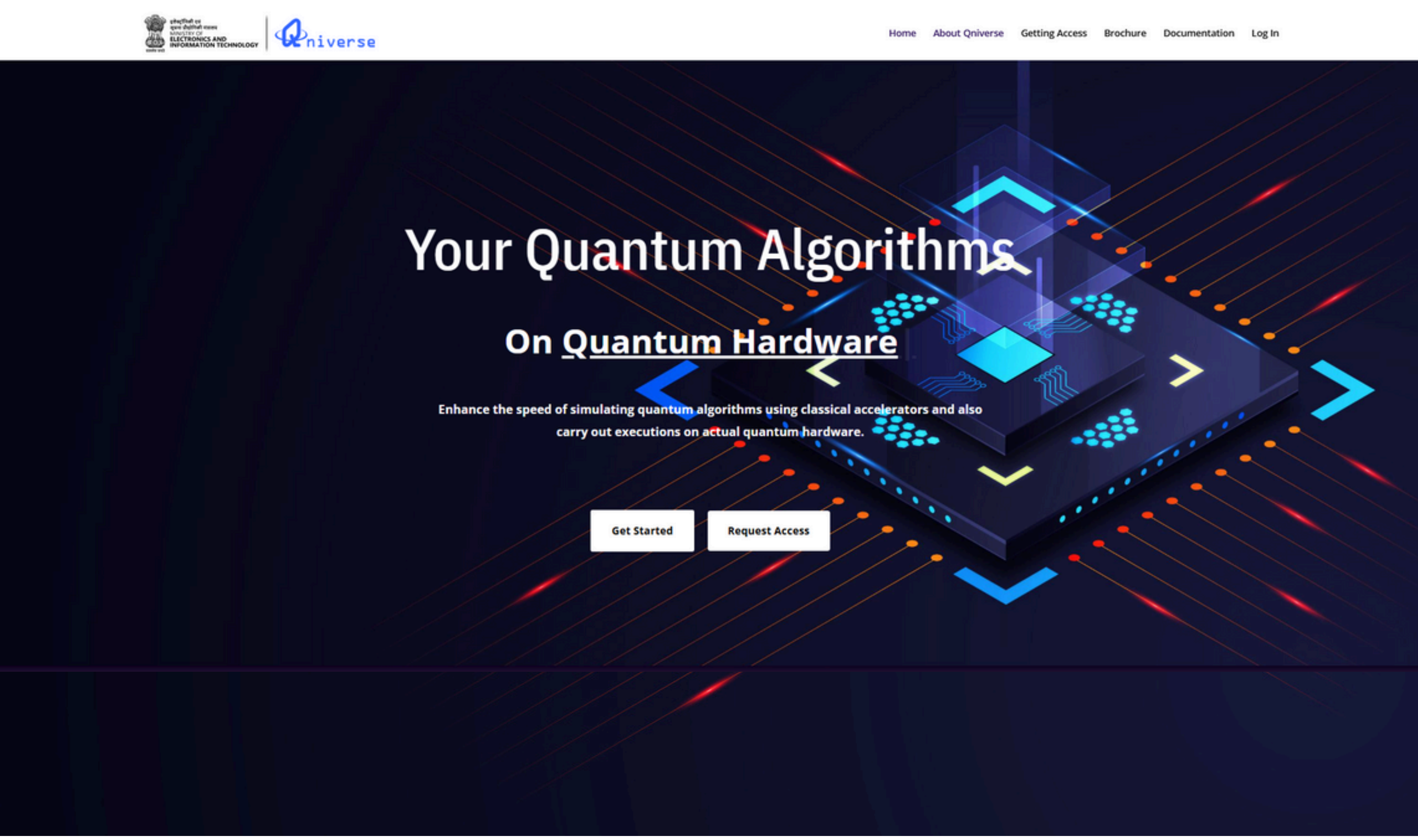
- Pharmaceuticals
- Chemicals
- Automobiles
- Finance
- Logistics

Source: Quantum computing use cases are getting real—what you need to know
McKinsey & Company
December 14, 2021

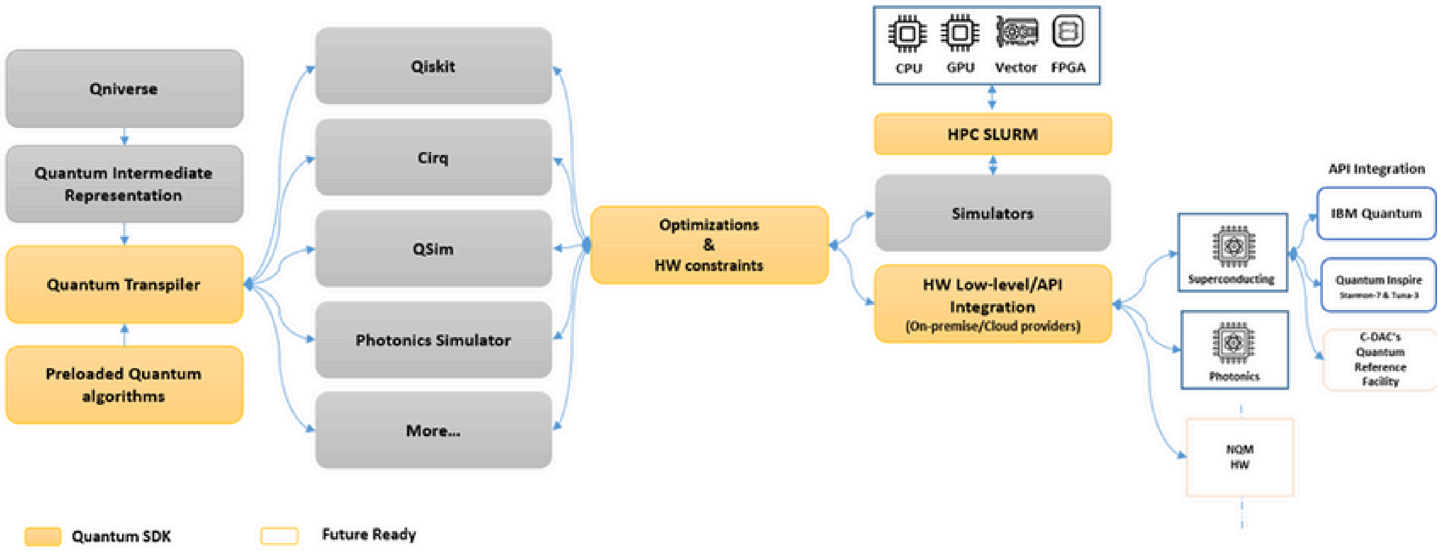
Need for a Comprehensive Quantum Ecosystem

Qniverse aims to tackle these challenges by offering a Unified Quantum Computing Platform that eliminates the complexity of vendor-specific APIs and hardware differences. It offers a consistent environment for designing quantum algorithms, testing and validating simulations using software frameworks on High Performance Computing systems, and executing the same code seamlessly on classical accelerators like GPUs, FPGAs, and vector processors, as well as on actual quantum hardware. Through its hardware-agnostic runtime, developers can prototype and debug quantum algorithms locally, using classical simulators, before seamlessly deploying to physical quantum processors.

Qniverse offers a complete ecosystem built to support users at every stage of their quantum journey. At its core is the Quantum Software Development Kit (QSDK), a robust set of frameworks, libraries, and programming language features that enable seamless interaction with both quantum circuit simulators and hardware.



www.qniverse.in



Qniverse: System flow

Key advantages of Qniverse

Code once & run on multiple platforms: The Qniverse removes the key bottlenecks in quantum software research, fragmented tool chains and poor code portability. Today, developers must rewrite or adapt circuits for each vendor's SDK, juggle multiple dialects (OpenQASM, Quil, Q#, Qiskit etc.) and manually stitch together design, optimization, simulation, and execution steps across superconducting, trapped-ion, neutral-atom, and photonic platforms. Qniverse solves this by offering a truly hardware-agnostic programming model: write your circuits and algorithms once, then execute them unmodified on any supported backend.

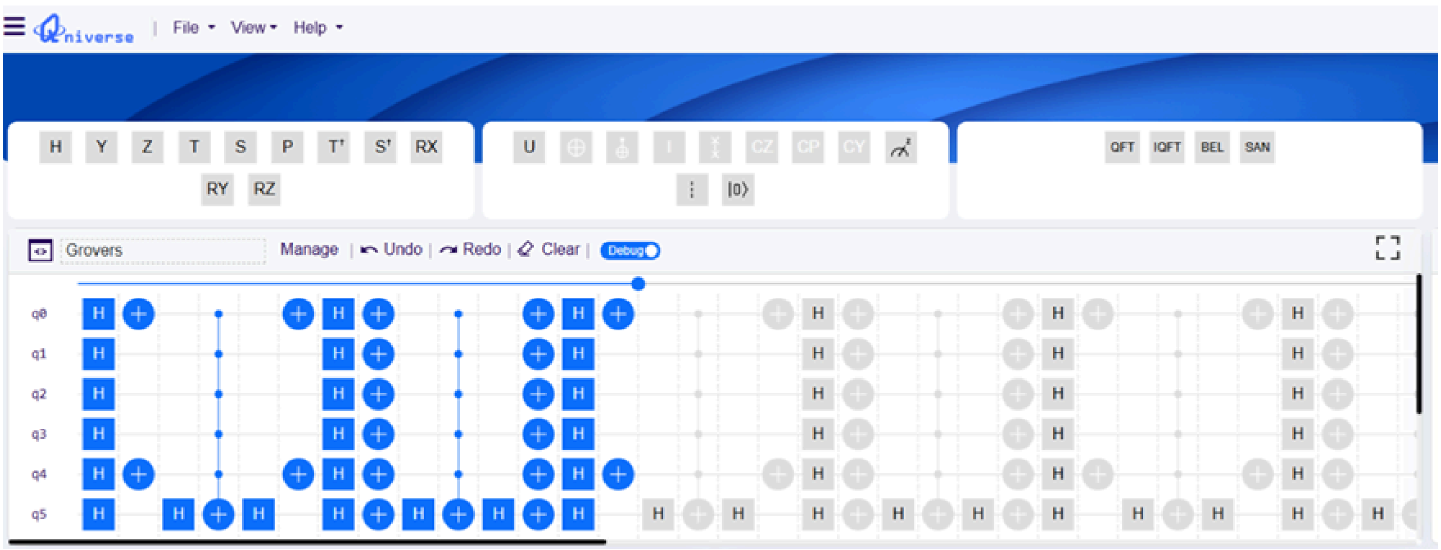


Figure 4 Advanced debugging tools

Reduced development time

Qniverse unifies the entire development lifecycle, circuit design, optimization, simulation execution, and analysis, into a single coherent environment. Its integrated transpiler ingests high-level descriptions applies hardware-aware optimizations (qubit mapping, gate synthesis, pulse scheduling), and returns backend-specific instructions.

Simplified hardware access

Integrated with High-Performance Computing (HPC) systems, the platform enables users to accelerate quantum simulations using classical accelerators such as GPUs, FPGAs, and Vector processors and execute on Quantum Hardware including IBM quantum processors. Currently, Qniverse supports multiple simulator backends including IBM Qiskit [2], Google Cirq [3], Nvidia cuQuantum [4] and Quest [5].

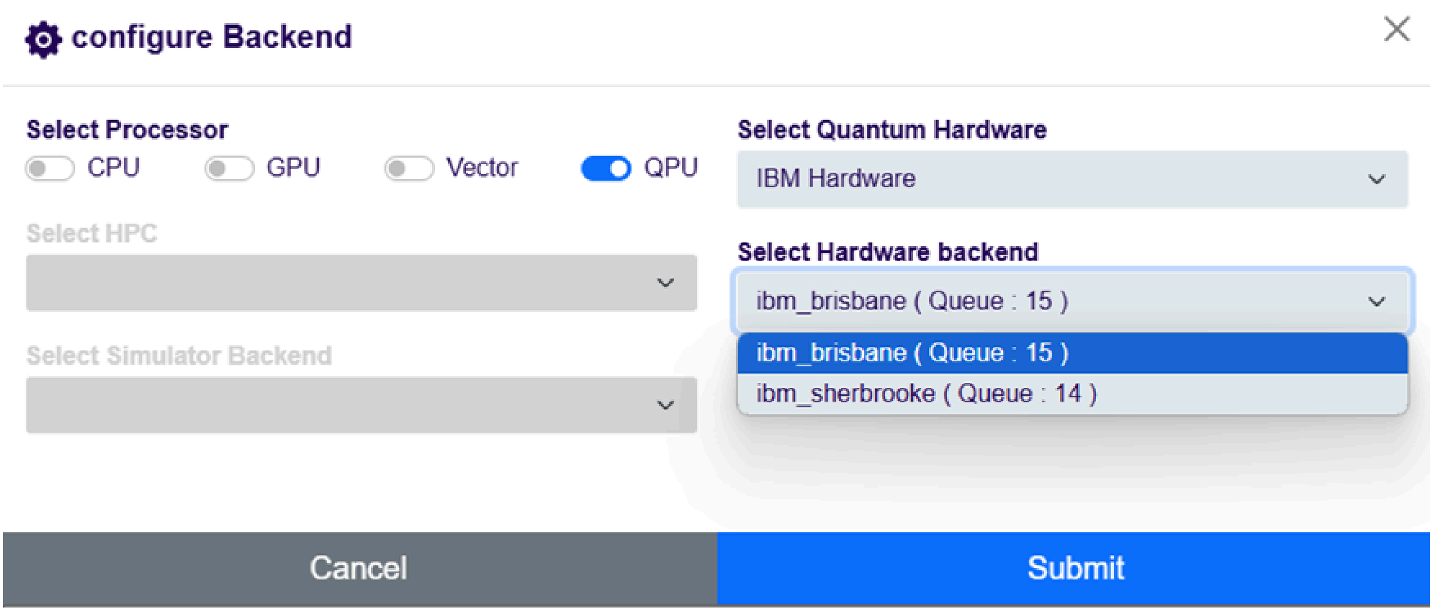


Figure 5 Simulate on Classical Accelerators & Quantum hardware

Modular libraries

The in-built libraries enable users to work with pre-built components and easily integrate them into their workflows, enhancing development efficiency. Whether creating optimization algorithms, machine learning models, or cryptographic protocols, the modular libraries offer the flexibility needed to address a broad spectrum of quantum computing challenges.

Algorithm Implementations

The pre-built quantum algorithms that cater to various needs, from foundational principles like Deutsch-Jozsa to advanced solutions like Shor's factorization algorithm and Grover's search algorithm. These are complemented with Variational Quantum Eigensolver (VQE), QSVM, QKNN, and OKMeans for Quantum machine learning. In terms of real-world applications, Qniverse's pre-built solutions bridge the gap between theoretical concepts and practical implementation solutions for the socialist millionaire problem via QPC and Quantum Veto Algorithm, which utilizes quantum entanglement for secure voting, and the Harrow-Hassidim-Lloyd (HHL) algorithm, which offers exponential speedup for solving linear systems of equations. These applications have far reaching implications across industries such as materials science, manufacturing, and artificial intelligence, where optimization, cryptography, and machine learning are crucial.

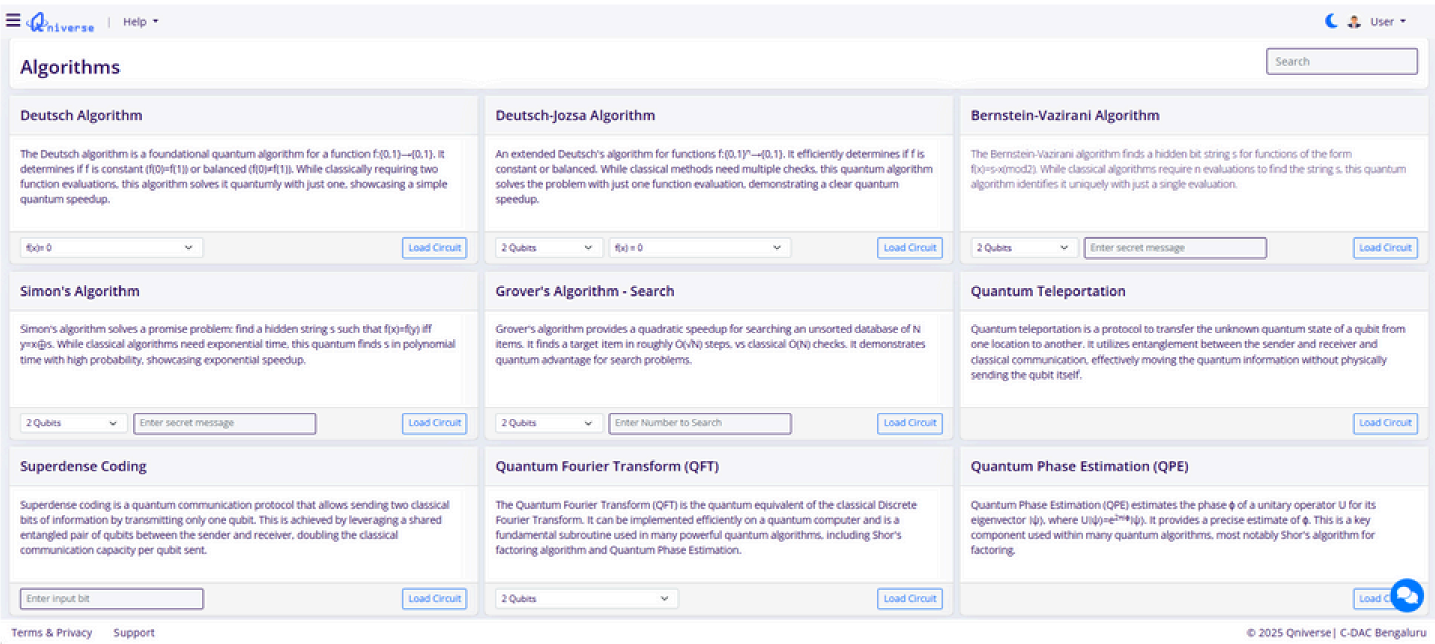


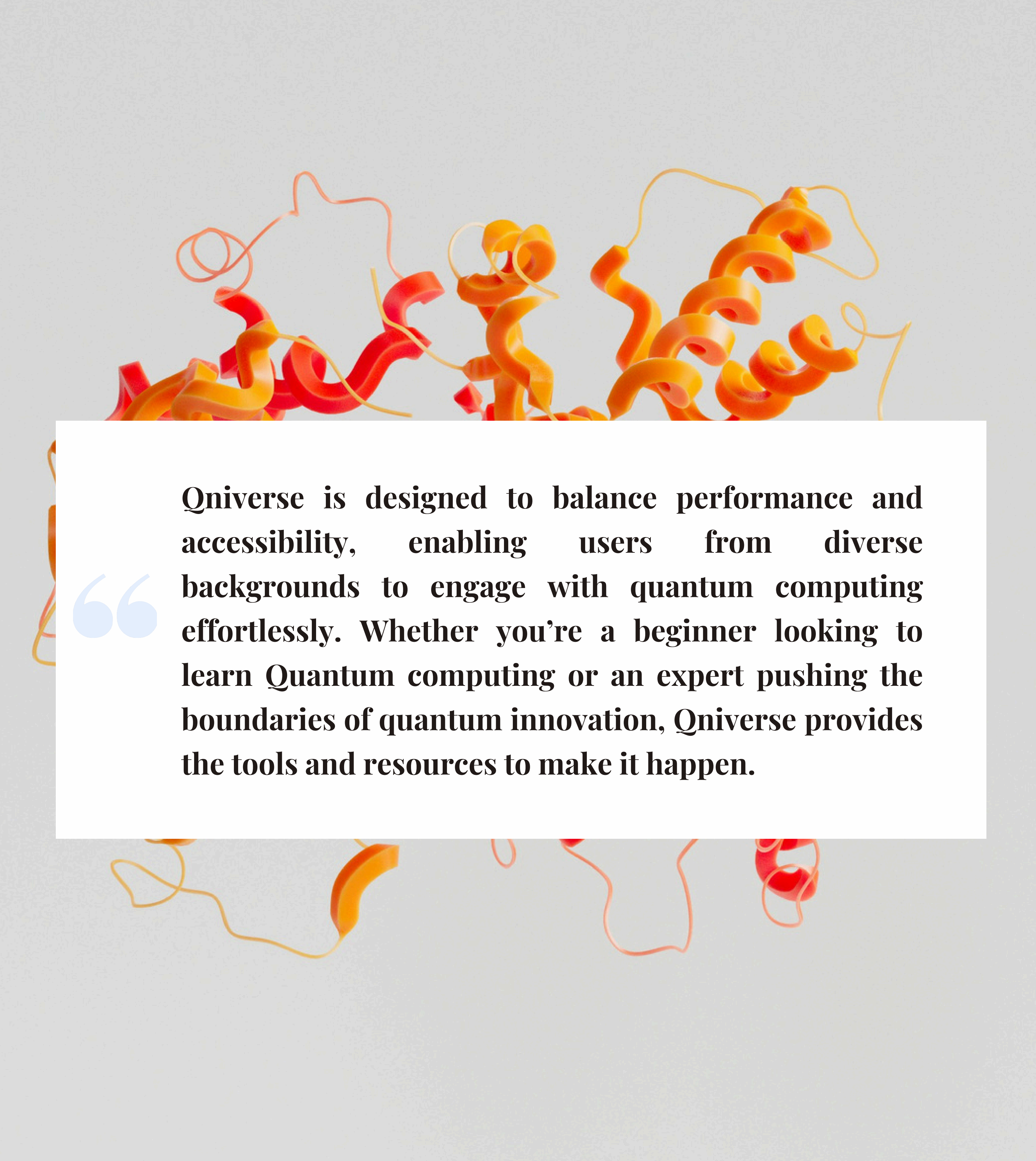
Figure 6 Pre-built Quantum Algorithms & Applications

Comprehensive-learning ecosystem

For learners, the platform combines theoretical quantum mechanics with hands-on programming tutorials, enabling beginners and experts to upskill efficiently.

Future ready

Qniverse is envisioned to provide as a unified quantum computing gateway for accessing the quantum computing hardware developments being carried out as part of the National Quantum Mission. The next version aims to integrate more quantum hardware including Starmon-7 quantum computer from Quantum Inspire, trapped ions, photonics & neutral atoms.



> **Qniverse is designed to balance performance and accessibility, enabling users from diverse backgrounds to engage with quantum computing effortlessly. Whether you're a beginner looking to learn Quantum computing or an expert pushing the boundaries of quantum innovation, Qniverse provides the tools and resources to make it happen.**

Qniverse

WWW.QNIVERSE.IN

Head over to www.qniverse.in to dive into the quantum realm and experience the platform for yourself. The future of computing is here, and Qniverse is leading the charge unlocking discoveries and innovations that will shape the world for years to come.

Acknowledgment

Qniverse is an outcome of the MeitY[6] funded project "HPC-Based Quantum Accelerators for Enabling Quantum Computing on Supercomputers" implemented by Centre for Development of Advanced Computing (C-DAC) [7].

Reference

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Mr. Raja Singh Yadav

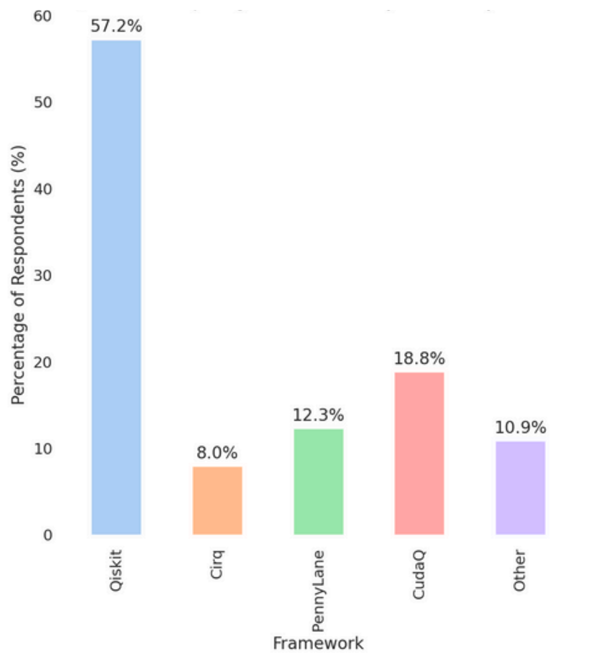
A researcher specialized in Quantum Computing, currently serving as a Knowledge Associate at C-DAC Bangalore.

He holds an M.Tech in Quantum Computing from DIAT Pune, with a strong foundation in quantum algorithms and cryptographic protocols.

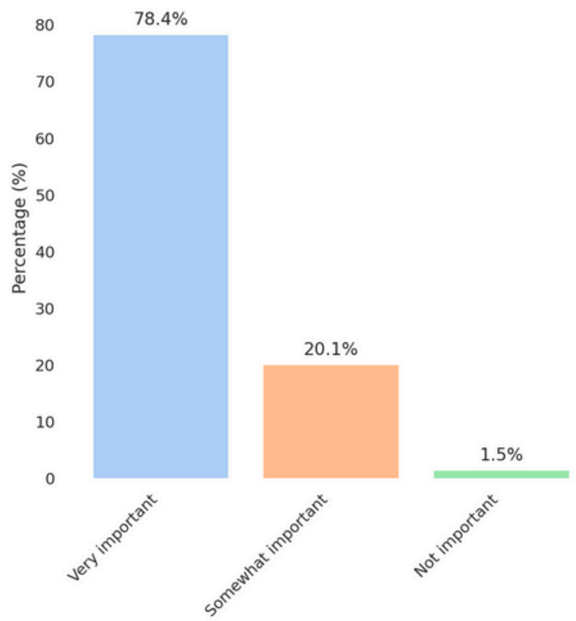
At C-DAC, he is actively involved in cutting-edge research, including the development of an HPC-based quantum accelerator. This initiative focuses on integrating quantum computing with high-performance systems to address complex challenges in optimization, cryptography, and large-scale simulations.

QNIVERSE SURVEY REPORT

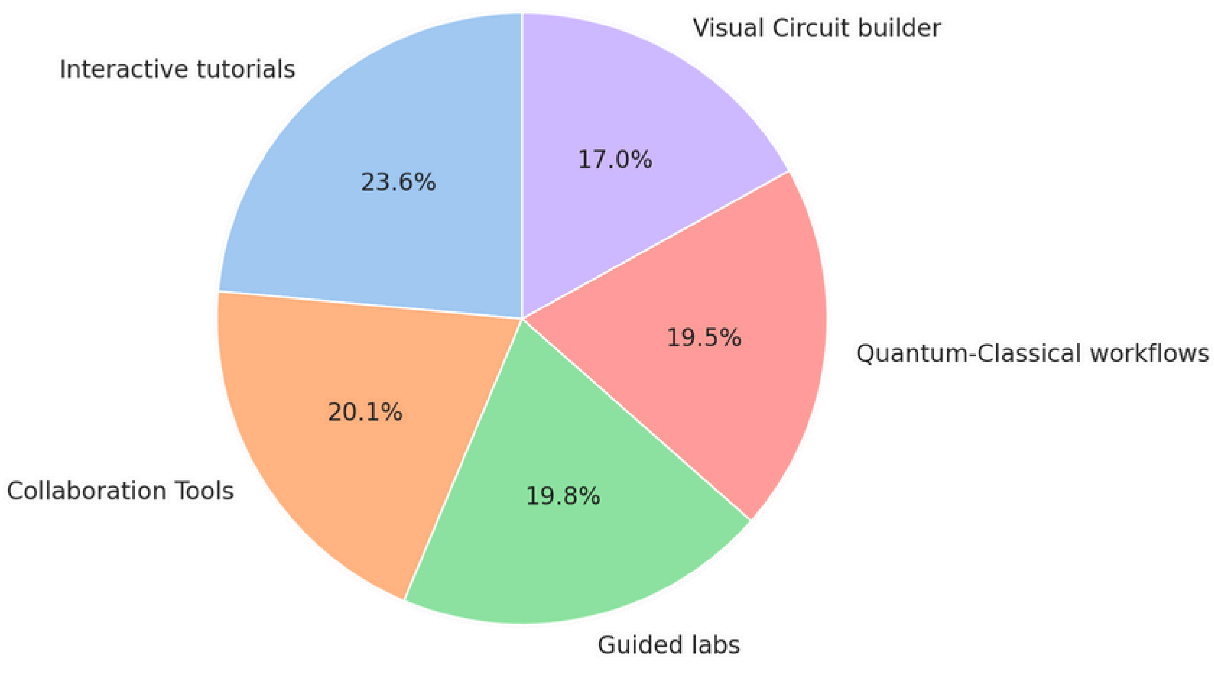
What Quantum Computing frameworks are you currently familiar with?



How important is it for you to have a single unified platform that integrates different Quantum Computing Technologies?

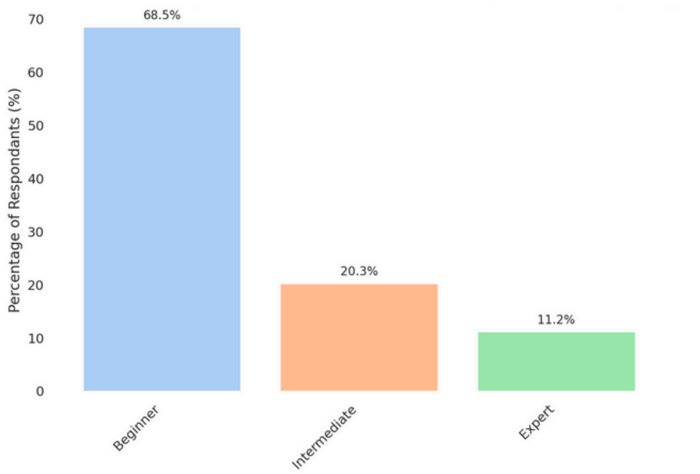


What features would you value most in a Unified Quantum Computing platform?

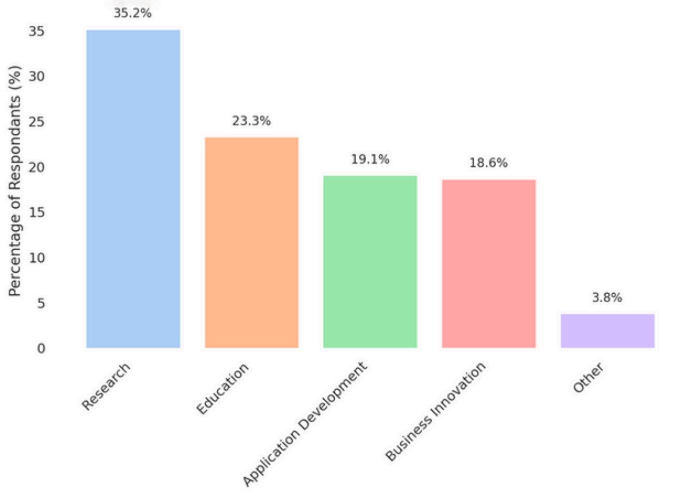


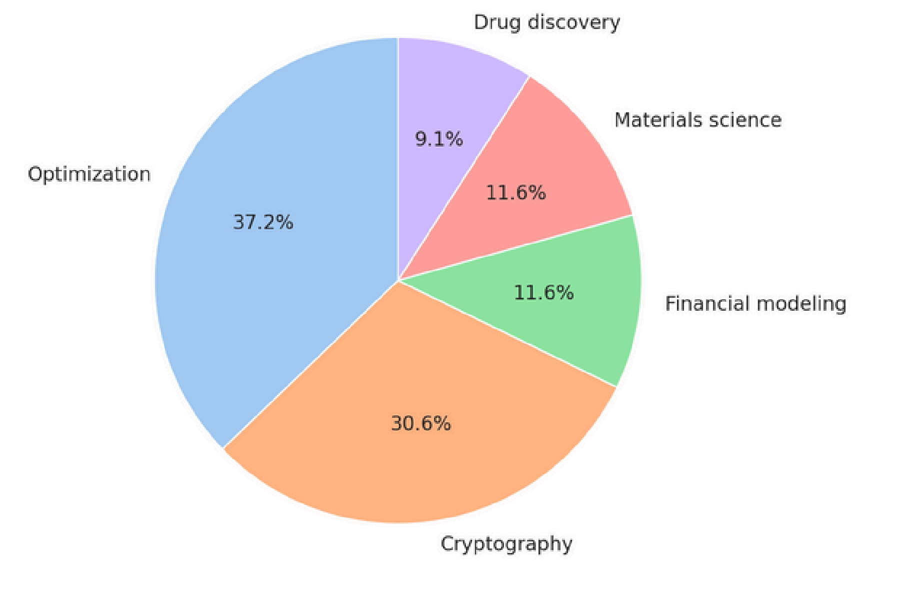
SURVEY SIZE: AROUND 200 PEOPLE

How familiar are you with the fundamentals of Quantum Computing?



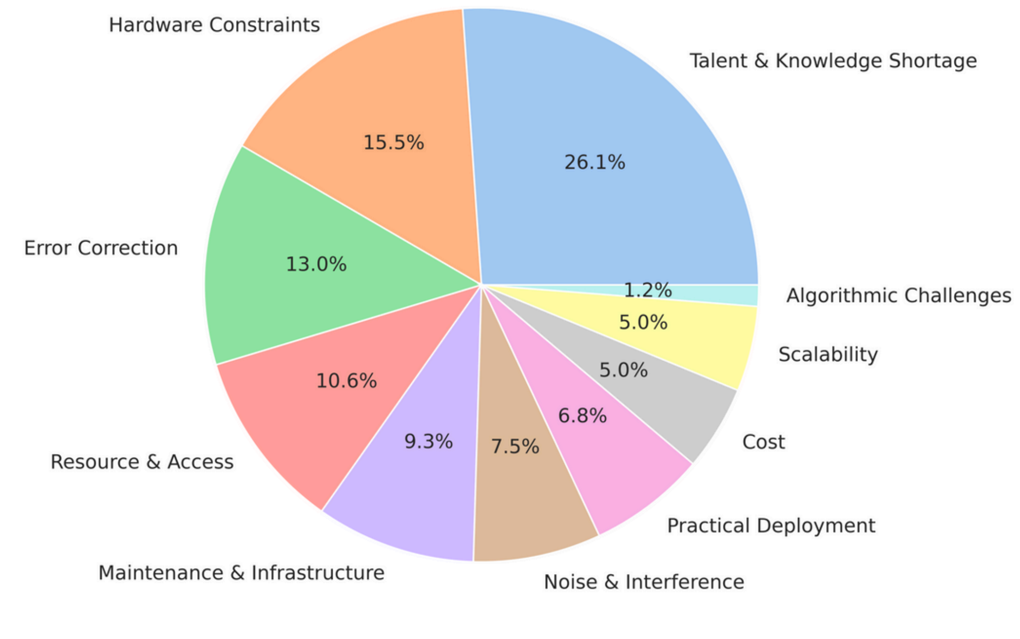
What is your primary interest in Quantum Computing?





Which Quantum Computing applications are you most interested in exploring?

What are some of the biggest challenges you currently face in exploring or implementing Quantum Computing?



Quantum Initiatives by MeitY, DOT, DRDO and ISRO

QSIM TOOLKIT

Launched on August 27, 2021, QSim is India's first indigenous Quantum Computer Simulator Toolkit. developed under MeitY's guidance through a collaboration between IISc Bangalore, IIT Roorkee, and C-DAC. It enables users to build, visualize, and test quantum circuits and algorithms, simulate noise, and is integrated with HPC systems for multi-user access, catering to both academic and research needs.

URL: https://qctoolkit.in/

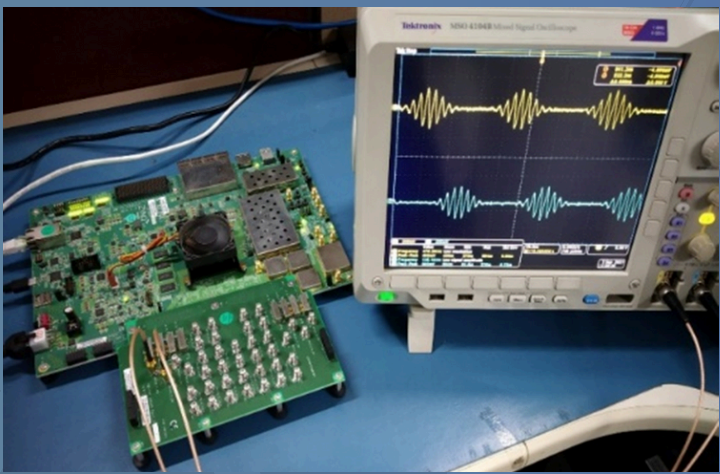
QUANTUM NETWORK SIMULATOR (QNS)

The Indigenous Quantum Network Simulation Framework, developed by C-DAC Bangalore and funded by MeitY under the CC&BT initiative, is designed to simulate quantum communication networks with modular configurations, error models, precise timing, application-layer support, and integration with high-performance computing. It addresses the need to test and validate quantum network protocols before physical implementation.

MAQAN

The Metro Area Quantum Access Network (MAQAN), developed under MeitY and a testbed setup in Chennai, is a key milestone in India's quantum communication efforts. It serves as a metropolitan testbed for indigenous protocols like Coherent One-Way (COW) and Differential Phase Shift (DPS), bringing together IIT Madras, C-DAC Bangalore, ERNET India, and SETS Chennai to deliver a fully indigenous end-to-end quantum communication system—including hardware, firmware, and software.

Quantum Initiatives by MeitY, C-DOT, DRDO and ISRO



CENTER OF EXCELLENCE IN QUANTUM TECHNOLOGIES, IISC BANGALORE

The Center of Excellence in Quantum Technologies at IISc Bangalore, established under MeitY, unites IISc, the Raman Research Institute (RRI), and C-DAC Bengaluru to advance different layers of the quantum stack. IISc has built a 4-qubit superconducting quantum processor with nanofrabrication infrastructure while C-DAC Bangalore develops control electronics using Xilinx hardware and Python APIs for control and measurements.

DRDO'S QTRC, DELHI

On May 27, 2025, DRDO inaugurated the Quantum Technology Research Centre (QTRC) at Metcalfe House, Delhi, under the leadership of Chairman Dr. Samir V. Kamat. Developed by SSPL with support from SAG and MED & CoS, the centre is dedicated to advancing critical defence applications. It houses VCSEL and DFB laser characterization setups, single-photon source test beds, micro-fabricated alkali vapor cells, and experimental QKD systems. Additionally, the centre is pushing the boundaries of ultra-small atomic clocks, femto-Tesla vapor magnetometers, and solid-state quantum devices.

Quantum Initiatives by MeitY, C-DOT, DRDO and ISRO

DYSL- QT, PUNE

Established by DRDO in 2020, DYSL-QT in Pune is driven by a team of researchers under 35, focusing on advancing defence-oriented quantum innovations. The lab specializes in quantum computing, communication, sensing, and randomness. In August 2024, in collaboration with TIFR and TCS, it successfully tested a 6-qubit superconducting processor. Additionally, the lab built a ~150 kbps fiber-based QRNG, validated through global tests, and is advancing MDI-QKD for distances up to 200 km, alongside developing free-space photon sources. It is also working on femto-Tesla atomic magnetometers and quantum algorithms for secure communication, solidifying its crucial role in India's quantum mission.

AGILE AND AD-HOC FREE SPACE-BASED QUANTUM COMMUNICATION USING DRONE

The project titled "Agile and Ad-hoc Free Space-based Quantum Communication using Drone", funded by MeitY and developed by C-DAC Pune, aims to achieve indigenous design, development, and demonstration of an aerial quantum communication payload. This includes the development of an indigenous Pointing Acquisition and Tracking (PAT) system for enabling quantum communication from moving platforms (vehicles/drones). The project focuses on establishing agile free-space quantum links to support both Entanglement Distribution (ED) and Quantum Key Distribution (QKD). Key components include an airborne entanglement source and the PAT unit with control electronics, enabling mobile and secure quantum communication capabilities.

Quantum Initiatives by MeitY, C-DOT, DRDO and ISRO

ISRO-SAC & QNU LABS COLLABORATION

In December 2022, ISRO's Space Applications Centre (SAC) partnered with Bengaluru-based startup QNu Labs under an MoU facilitated by IN-SPACe to boost India's quantum communication capabilities. QNu Labs contributed its advanced QKD technology focused on range and robustness, while ISRO provided expertise in satellite payload design, telemetry, and ground station integration.

SATELLITE-BASED QUANTUM COMMUNICATION

In mid-2023, ISRO, led by SAC and PRL Ahmedabad under Chairman S. Somanath, committed to deploying quantum communication payloads on LEO satellites, moving from campus trials to space-based systems. The plan includes onboard entangled-photon sources, India's first ground-station QKD uplink/downlink systems, and aims for long-distance links. Under the QuEST program, SAC and PRL are refining BBM92 protocols, NavIC-based synchronization, photon sources, and polarization compensation.

QUANTUM COMMUNICATION & QKD INTEGRATIONS

On March 5, 2024, C-DOT and PRL demonstrated India's first hybrid QKD link by integrating C-DOT's fiber-based system, operational since February 2023, with PRL's free-space QKD. Unveiled at the 2nd International Quantum Communication Conclave, the demo was presented to Prof. Ajay Sood and Dr. Neeraj Mittal, showcasing combined fiber and free-space photon-based quantum communication.

Quantum Initiatives by MeitY, C-DOT, DRDO and ISRO

C-DOT'S INDIA QUANTUM ALLIANCE

In April 2023, C-DOT, under DOT, launched the India Quantum Alliance and formed a Technology Advisory Board (TAB) of academic and industry experts to steer quantum communication research, policy, and funding. A tiered funding model supports national consortia, with proposals reviewed by Consortium Panels (up to ₹10 cr), Screening Committees (₹20 cr), and the C-DOT Steering Committee for higher budgets. This structure enables coordinated, mission-driven growth of India's quantum-secure communication ecosystem.

C-DOT, IIT-MADRAS & SAMGNYA TECHNOLOGIES COLLABORATION

In December 2024, under the National Quantum Mission, the IIT-Madras–C-DOT–Samgnya Technologies Foundation was launched as a collaborative platform to build India's quantum backbone. Led by Dr. Anil Prabhakar (QuILA), Dr. Deepak Gaur and Dr. Prashant Chugh (PIPETA), Dr. Bhaskar Kanseri (TAHQEECAT), Dr. Urbasi Sinha (QuEPRAN), and Dr. Senthil Kumar (SBQKD), the initiative focuses on metro-area QKD, post-quantum encryption hardware, entanglement-based repeater networks, quantum memory and hybrid repeaters, and satellite QKD.

Quantum Initiatives by MeitY, C-DOT, DRDO and ISRO

DRDO–IITD QUANTUM TRIALS

DRDO and IIT Delhi have made key strides in secure quantum communication. In February 2022, they demonstrated QKD over 100 km of optical fibre between Prayagraj and Vindhyachal. By November 2024, they tested entanglement-based QKD over 50 km fibre, 8 km campus links, and short-range free-space channels. Most recently, on June 16, 2025, they achieved 1 km free-space QKD using entangled photons, maintaining a secure key rate of ~240 bps and QBER under 7%.

QUANTUM OPTICAL SENSOR SYSTEM FOR TRACE DETECTION OF ARSENIC AND LEAD IN WATER

Funded by MeitY, Government of India, and developed by C-DAC Kolkata in collaboration with Tezpur University, this project aims to build a quantum optical sensor-based system for detecting and categorizing arsenic and lead in water at very low concentrations. It involves developing advanced quantum sensors to enhance detection accuracy, sensitivity, and specificity, and integrating IoT capabilities for real-time data transmission, remote monitoring, and early warning.

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INSIDE THE MINDS

> Quantum technologies will shape the future of secure communication, advanced sensing, and high-performance computing.
>
> India must lead this transformation through bold research and collaborative innovation.

DR. SANTU SARDAR

Dr. Santu Sardar, a leading voice in India's quantum research, has an extensive academic background from BESU, IIT Guwahati, and IIT Hyderabad, and currently serves as Director of DYSL-QT, a DRDO lab advancing quantum technologies. His career spans significant roles at ANURAG, DRDO, multiple research accolades, and contributions to international journals and conferences. With a strong academic foundation and a Visvesvaraya Fellowship during his Ph.D., Dr. Santu Sardar has risen from a Scientist at ANURAG to Director of DYSL-QT, where he spearheads national-level quantum research. His achievements include prestigious awards and over two dozen scholarly publications.

What was the founding vision behind DYSL-QT, and how does it align with India’s strategic goals in quantum tech for defense?

DYSL-QT was established by DRDO to venture into the exciting world of Quantum Technologies. Technological developments in DRDO are guided towards strategic goals by established “Roadmaps” and the same is true for quantum technologies. With the emergence of quantum computing, quantum communication and quantum sensing as potentially disruptive strategic technologies in their respective domains, DYSL-QT has rapidly set course to develop such systems and capability.

Could you also highlight key ongoing projects, focus areas in R&D, and how DYSL-QT collaborates with academia, startups, and industry to drive innovation and defense readiness?

DYSL-QT has under-taken projects like SQC for quantum computing, PPQC & QeKDP for quantum communication and it is also developing an atomic magnetometer. While some of these projects are unprecedented in our country, spin-offs have already emerged and they are being actively pursued for further R&D. Every project has closely involved academia from the very inception, with scientists actively stationed in laboratories across various institutes to imbibe knowledge of promising experimental setups. Technology and product development has been subsequently fostered within DYSL-QT with an atmosphere for innovation via frequent brain-storming and rapid-prototyping. Industry and startup association has been crucial at this stage either as Development cum Production Partner (DcPP) or Production Agency (PA). In many cases ToT has been actively handed over to industries with potential for mass production.

With Dr. Santu Sardar

What are the key advantages and unique challenges of developing cutting-edge quantum technologies within a mission-mode, defense-focused R&D setup like DRDO?

DRDO has various modes for R&D to cater to the strategic needs of the nation.

The novelty of the field of Quantum Technology entails that majority of the initial developmental work taken up by DYSL-QT has been at the S&T stage. The outcome of the S&T activity may be taken up in mission-mode in due course. However, the key advantage has been that **DYSL-QT has been entrusted with the development of this cutting-edge field**. It is the only DRDO lab dedicated for this purpose and many of the administrative and procurement procedures are streamlined to allow rapid R&D progress.

Furthermore, a small dedicated team of scientists is an added bonus. Challenges are present in the development of any technology, however, in the case of quantum technologies, due to its novelty, the quantum community in India is not very large. DYSL-QT maintains an active presence in most of the quantum forums to be in touch with this community. On the quantum technology development front there is substantial reliance on components sourced from over-seas manufacturers. Long term production will only be sustainable if industries in India are able to meet the demand for such components.

> DYSL-QT has been entrusted with developing this cutting-edge field. As the only DRDO lab dedicated to this purpose, many administrative and procurement procedures have been streamlined to enable rapid R&D progress.

What guidance would you offer to students and early-career researchers aspiring to build a career in quantum technologies and contribute meaningfully to this emerging field? Are there any programs or initiatives by DYSL-QT aimed at nurturing young talent in this domain?

Quantum technologies will certainly provide opportunities for very fulfilling careers to physicists as well as engineers in the days to come. Expertise from an eclectic mix of academic background is required to successfully develop products in this technology. Students and early-career researchers, from varied backgrounds, must aspire to gain experience by associating with the plethora of projects that are coming up in India under DRDO, NQM, Meity and many other programmes and organisations.

DYSL-QT hosts such talents via programs such as JRF, SRF and RA. Recently we have started accepting year long internships where final year thesis work for ME, MTech can be undertaken. Every year many students also undertake their summer internship at DYSL-QT where they address short-term developmental goals aligned with project objectives.

Quantum technology is evolving rapidly. How does DYSL-QT balance long-term fundamental research with short-term, mission-aligned deliverables?

DYSL-QT works in close collaboration with academia and industry for R&D in this rapidly evolving field of quantum technology. Long-term fundamental research has been going on in this field in India for quite some time and as was mentioned, scientists from DYSL-QT are stationed at laboratories of institutes to train themselves in the experiments there. Development in DYSL-QT happens in the next phase where the know-how is translated to technology and product with active industry collaboration or via ToT. DYSL-QT at present has been involved in S&T projects and with adequate maturity in these fields will soon take up short-term mission aligned deliverables.

INDIA'S STRATEGIC ROADMAP

As Director of DYSL-QT, how do you envision India's strategic roadmap in quantum technology over the next 5–10 years, especially for defense applications and indigenous technology leadership?

The projects that have so far continued as S&T activities have deepened our understanding of the technology and we are now on the verge of ramping up the pursuit of these goals in a bigger way. This means **building ever powerful quantum computers**, wider **quantum communication networks** and getting **quantum sensors ready for the field**. On the one hand we want to remain relevant in this field so that we are ready when the time demands while on the other, we also want to become pioneers in their defence application.

> The coming decade is crucial, and proper planning and decision-making can propel us to the forefront on the world stage. **Indigenous technology plays a vital role** in this, and thoughtful investment is the need of the hour. Only then can we reap the benefits in the next 5 to 10 years

In Quantum Technology development, we still rely heavily on components sourced from overseas. **For long-term sustainability**, it's essential that **Indian industries rise to meet this demand locally**—only then can we build a truly resilient and self-reliant quantum ecosystem.

Dr. Santu Sardar
Director, DYSL-QT

INSIDE THE MINDS

PROF. DIETER KRANZMULLER

A full professor of computer science at Ludwig-Maximilians-Universität München (LMU) and Chairman of the Board of Directors of the Leibniz Supercomputing Centre (LRZ) of the Bavarian Academy of Sciences and Humanities. He also serves on the board of the German national Gauss Centre for Supercomputing (GCS).

Applies his broad research interests and background in academia as well as industry to emphasise tight integration between IT service operations and progressive R&D.

His support for the advancement of innovation and the broader public-private ecosystem has been evident throughout his professional career and is reflected in his contributions to, among others, the Center for Digital Technology and Management (CDTM), the Münchner Kreis, his role as a founding member of IT:U Linz, and the Scientific Advisory Board at the Heidelberg Institute for Theoretical Studies.

LRZ SuperMUC-NG

Credit - Veronika Hohenegger, LRZ

What do you consider the most transformative milestone in LRZ's supercomputing journey so far, and what future milestone do you most aspire to see?

The most transformative milestone for LRZ was switching to hot-water direct-liquid cooling, which has improved energy efficiency. This allows us to invest more in computing performance at reduced energy costs and a smaller CO_2 footprint.

I am eagerly looking forward to the next milestone:

> **Getting the integration of quantum computing into High Performance Computing (HPC) to production level. This promises significant performance gains for supercomputing.**

With ***Prof. Dieter Kranzmuller***

As a leader and visionary in this space, what personal principles or experiences continue to guide your innovation journey at the helm of LRZ? Are there any current projects that reignite your early passion for computing?

My scientific curiosity about how to best support the resolution of research questions through our IT services drives me and fuels my passion. Each new project is exciting because it leads us into new areas and presents fresh challenges, while each emerging technology offers benefits that we must adapt to serve our users effectively.

With AI, quantum, and neuromorphic computing emerging simultaneously, how is LRZ shaping its computing architecture strategy to stay agile yet sustainable for such a diverse future?

For several years, LRZ has invested substantially in exploring future computing. This has allowed us to evaluate emerging technologies and begin integrating them early on. We strongly believe that several of these solutions will help us continue accelerating supercomputing for the benefit of our users. As the next generation of technologies emerges, we must prepare for a more heterogeneous ecosystem for application developers.

Quantum and classical computing are often seen as complementary. In your view, how can hybrid computing models be effectively designed to maximize the strengths of both paradigms?

We must ensure that quantum computing is applied wherever it can deliver a quantum advantage. To achieve this, we need to develop software tools that can automatically and transparently determine when to execute tasks on a quantum computer and when to use a supercomputer. Success will be achieved when both paradigms operate seamlessly together within a hybrid computing model.

IQM Superconducting Quantum System at LRZ, Munich

Credit - Veronika Hohenegger, LRZ

INSIDE THE MINDS

With ***Prof. Dieter Kranzmuller***

The role of HPC in societal transformation—be it in climate modeling, pandemic prediction, or energy optimization is growing rapidly. How is LRZ aligning itself with global humanitarian or sustainability goals through its research agenda?

“ Today we recognize, more than ever, that our systems, technologies, and our users’ applications leave quite a large CO_2 footprint while at the same time, the results of our users’ research are for the benefit of society. That is why our focus has been on energy-efficient supercomputing for well over a decade, to decrease this footprint. And in terms of domain sciences, we have a focus on environmental computing e.g., in climate research or seismology, to name just a few.

There is a unique plantation within the LRZ campus that visually demonstrates the exponential growth of computational power.

Nobel Prize in Physics - 2005 & 2023

The 2005 Nobel Prize in Physics was awarded in part to Theodor W. Hänsch from the Max Planck Institute of Quantum Optics in Garching, Germany. He shared the prize with John L. Hall (NIST and University of Colorado Boulder) and Roy J. Glauber (Harvard University). They were recognized for their contributions to the development of laser-based precision spectroscopy, specifically Hänsch and Hall's work on the optical frequency comb technique.

In 2023, the Nobel Prize in Physics was awarded to Ferenc Krausz, Pierre Agostini, and Anne L'Huillier for their groundbreaking work in attosecond physics. Ferenc Krausz, a director at the Max Planck Institute of Quantum Optics, was recognized for his contributions to generating and measuring attosecond pulses of light, which are used to study electron dynamics.

LRZ is directly opposite to Max Planck Institute in Munich.

JUNE 10-13 | HAMBURG | 2025

ISC

HIGH PERFORMANCE 2025

QUANTUM EXHIBITION

ISC 2025 OFFERED A DEEP DIVE INTO THE FUSION OF NASCENT COMPUTING PARADIGMS, WITH ARTIFICIAL INTELLIGENCE LEADING THE CHARGE, BUT UNDERPINNED BY POWERFUL HIGH PERFORMANCE COMPUTING INFRASTRUCTURE AND LOOKING AHEAD TO THE QUANTUM ERA.

www.isc-hpc.com

ISC 2025

Hamburg, Germany

ISC 2025 : Shaping the Future of High-Performance Computing

ISC 2025, one of the world's premier events dedicated to high-performance computing (HPC), machine learning, and data analytics, took place in Hamburg, Germany from June 10-13, 2025. Key themes at ISC 2025 included exascale computing, quantum-HPC integration, AI-driven simulations, and next-generation hardware architectures. As quantum computing continued to converge with traditional HPC, the event also highlighted quantum-classical hybrid models and their growing importance in addressing complex real-world problems.

Representing India's leadership in advanced computational research, a delegation from C-DAC attended ISC 2025 and actively participated in technical sessions and collaborative forums. C-DAC members set up a dedicated exhibition stall, where they showcased India's capabilities in HPC, Quantum Computing, and AI infrastructure development. The stall featured PARAM series of supercomputers, Rudra (indigenous server development), quantum platforms like Qniverse, among others. This participation underscored India's strategic progress in self-reliant technology development and its emerging role on the global stage of computational science.

ISC 2025

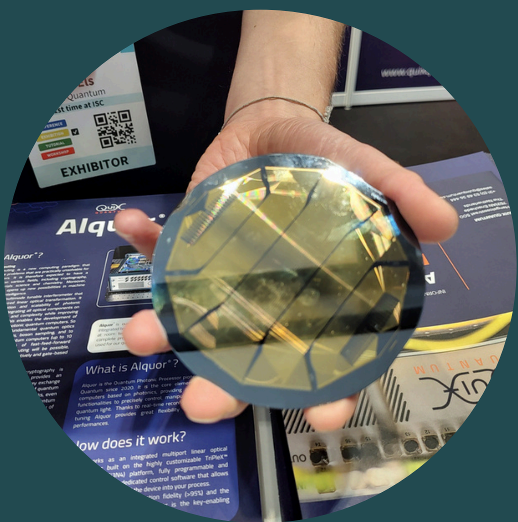
IQM

IQM builds superconducting full-stack quantum computers with up to 150 high-fidelity qubits and the highest connectivity out there, establishing itself as a leading European quantum computing company. The company achieved a significant milestone by reaching 99.9% fidelity with a 2-qubit gate, very close to what's required for fault-tolerant quantum computing. IQM operates a quantum data centre in Munich that opened as part of their European expansion, hosting six state-of-the-art superconducting quantum computers used for research and offered as cloud-based services to scientists globally.

QUANTINUUM

Quantinuum is a quantum computing company formed by the merger of Cambridge Quantum and Honeywell Quantum Solutions, establishing itself as the world's largest integrated quantum company. They achieved a world record in Quantum Volume (QV) with their System Model H2 reaching 8,388,608 (223). They're launching their new quantum system named Helios that supports upto 96 physical qubits with 99.95% fidelity across all qubit pairs and around 50 logical qubits in 2025 and are planning to scale upto 100's logical qubits by 2029.

QUIX



QUIX Quantum is Europe's leading quantum computing company based on photonics, founded in 2019 and is building the first universal photonic quantum computer in Europe, with their first sale to the German Aerospace Center (DLR). In September 2024, QUIX launched Bia™, a near-term quantum cloud computing service designed to solve specific problems in fundamental research and quantum simulations like Boson Sampling, Quantum random walks, and Quantum Monte Carlo simulations. The Bia system is a room temperature photonic quantum processor using state-of-the-art components including single photon generator modules, light detection modules, and advanced quantum control software, starting at 12 channels and scalable up to 20 channels.

ISC 2025

OXFORD IONICS

Oxford Ionics is a UK-based quantum computing company founded in 2019 by Chris Ballance and Dr. Tom Harty, specializing in trapped-ion quantum technology. The company uses a proprietary Electronic Qubit Control (EQC) system instead of lasers. In June 2025, IonQ announced it would acquire Oxford Ionics for $1.08 billion, combining their technologies to advance quantum computing capabilities.The company aims to build systems with 256 physical qubits at 99.99% accuracy by 2026 and scale to over 10,000 physical qubits by 2028. US's DARPA has selected Oxford Ionics to participate in its Quantum benchmarking initiative.

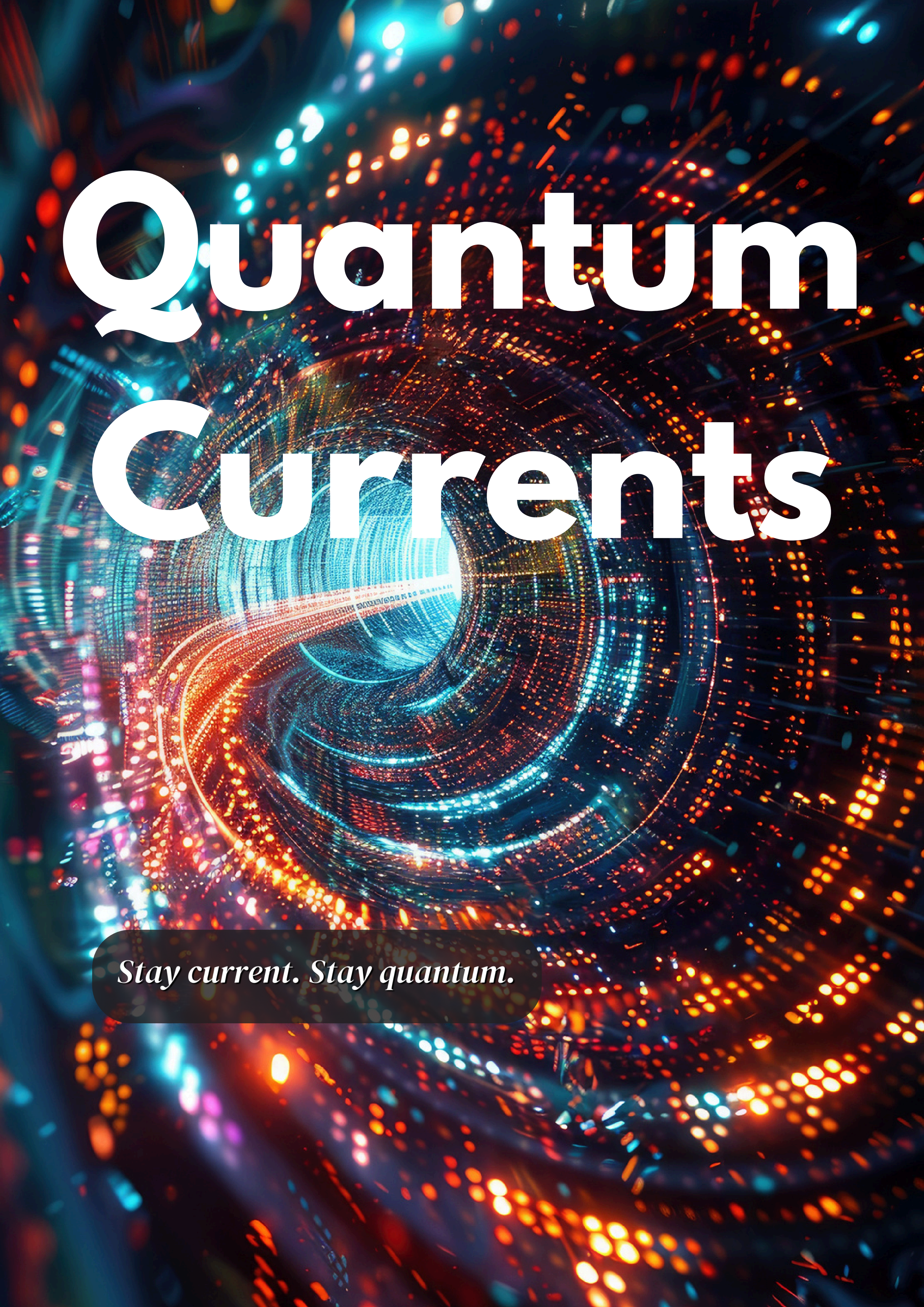
ALPINE QUANTUM TECHNOLOGIES

AQT has developed the first commercial quantum computer designed for standard 19-inch server racks that operates at room temperature, named Marmot. The company focuses on trapped ion quantum computing technology and currently offers a quantum processing unit (QPU) with a quantum volume of 128. AQT was established by distinguished pioneers in quantum computing who made significant contributions to the quantum community (like realization of Cirac-Zoller gate). The company provides cloud-based access to their quantum processors through an intuitive user interface.

QUANDELA

Founded in 2017, Quandela is a pioneer in full-stack photonic quantum computing, developing hardware, middleware, and software for industrial applications including energy, cybersecurity, and finance. In May 2025, Quandela launched Belenos, the world's most powerful photonic quantum computer, offering 4,000 times more computing power than the previous generation and accessible to commercial partners in the cloud. The company's photonic quantum computers and cloud platform are now trusted by 950+ users worldwide, delivering scalable quantum solutions across multiple industries. Quandela has published its 2024-2030 roadmap, aiming to achieve fault-tolerant quantum computing by 2030, with first logical qubits expected by 2025 and industrial-scale quantum computer assembly by 2028.

Quantum Currents



Stay current. Stay quantum.

17 APRIL 2025

C-DOT AND STL ACHIEVE INDIA'S FIRST QUANTUM KEY DISTRIBUTION OVER MULTI-CORE FIBRE

C-DOT and Sterlite Technologies Limited (STL) have successfully demonstrated India's first Quantum Key Distribution (QKD) over a 4-core Multi-Core Fibre (MCF), marking a major milestone in secure quantum communications. The innovation enables quantum signals to transmit through one core while the others carry high-speed data, achieving a stable 100 km QKD link without dedicated dark fibre significantly reducing infrastructure costs.

27 MAY 2025

DRDO LAUNCHES QUANTUM TECHNOLOGY RESEARCH CENTRE TO BOOST INDIGENOUS DEFENCE CAPABILITIES

DRDO inaugurated the Quantum Technology Research Centre (QTRC) at Metcalfe House, Delhi, to advance indigenous quantum technologies for defence. Inaugurated by DRDO Chairman Dr. Samir V. Kamat, the facility includes setups for laser characterisation, quantum key distribution, and single-photon source evaluation.

Led by the Solid State Physics Laboratory and Scientific Analysis Group, QTRC focuses on atomic clocks, magnetometers, and solid-state quantum devices. As part of the National Quantum Mission, DRDO aims to develop sovereign technologies in sensing, secure communication, and post-quantum cryptography.

Source - PIB

14 APRIL 2025

INDIA RELEASES QUANTUM TECH STRATEGY TO ACHIEVE STRATEGIC AUTONOMY IN EMERGING FIELD

The Office of the Principal Scientific Adviser to the Government of India released the country's first International Technology Engagement Strategy for Quantum (ITES-Q) on Monday 14th April 2025, marking a pivotal moment in India's quantum technology ambitions. Principal Scientific Adviser Prof. Ajay Kumar Sood unveiled the strategic document during a special podcast celebrating World Quantum Day 2025, emphasizing the significance of the release during the UN-designated International Year of Quantum Science and Technology. The comprehensive strategy aims to accelerate quantum discovery, foster innovation, and catalyze adoption across critical sectors while supporting India's National Quantum Mission and strengthening the country's position in global quantum technology development.

Prof. Sood highlighted the strategic importance of quantum technology for India's autonomy, stating that no country can afford to be left behind in this critical field. He emphasized the need for substantial investment in quantum hardware to reduce import dependencies, increased funding for startups with risk mitigation measures, and India's active participation in defining global quantum standards. The ITES-Q report provides extensive analysis of global and national quantum ecosystems, covering investments, talent development, research publications, intellectual property, and supply chains.

Source - PIB

06 JUNE 2025

KARNATAKA ALLOCATES ₹48 CRORE FOR QUANTUM RESEARCH PARK EXPANSION AT IISC

The Karnataka State Cabinet has approved Phase 2 of the Quantum Research Park at IISc Bengaluru, allocating ₹48 crore ($5.6 million) to boost India’s quantum tech infrastructure. Announced by IT Minister Priyank Kharge, the initiative will support 55 R&D projects, host 13 startups, and fund research by 15 IISc faculty members to foster innovation and homegrown IP.

Positioned as a global quantum hub, the park will facilitate collaboration between academia, industry, and government in quantum computing, communication, and sensing. It aims to accelerate commercialization through access to specialized equipment and mentorship, reinforcing Karnataka’s role as a leader in next-gen technology and attracting global partnerships.

Source - PIB

30 JUNE 2025

AMARAVATI QUANTUM VALLEY WORKSHOP

The Amaravati Quantum Valley Workshop, held in Vijayawada, Andhra Pradesh, focused on developing the state into a global hub for quantum technology. The workshop, which concluded with the release of the Amaravati Quantum Valley Declaration, brought together stakeholders from various sectors to lay the foundation for the Andhra Pradesh State Quantum Mission. The initiative aims to establish India's first Quantum Computing Valley in Amaravati by January 2026, aligning with the National Quantum Mission.

Key Initiatives:

- **QChipIN**: Launching India's largest open quantum testbed within 12 months.
- **Quantum System Two**: Installing IBM's Quantum System Two by January 2026.
- **Talent Development & Research Infrastructure**: Building a plug-and-play research infrastructure and a dedicated Amaravati Knowledge City.

23 JUNE 2025

INAUGURATION OF PIAST-Q: A LEAP FOR EUROPEAN QUANTUM COMPUTING

On June 23, 2025, under Poland's EU Council Presidency, the EuroHPC Joint Undertaking officially inaugurated PIAST-Q, a 20-qubit laser-based trapped-ion quantum computer in Poznań, Poland. Hosted by the Poznań Supercomputing and Networking Center (PCSS) and supplied by Austrian firm AQT, it marks the first operational deployment of a EuroHPC quantum computer acquired less than a year ago and delivered months ahead of schedule. This milestone underscores Europe's commitment to quantum sovereignty and infrastructure expansion.

17 JUNE 2025

QCI SHIPS 1ST COMMERCIAL ENTANGLED PHOTON SOURCE FOR QUANTUM COMMUNICATION RESEARCH

Quantum Computing Inc. (QCi) has shipped its first commercial-grade entangled photon source to a research institution in South Korea. The device based on spontaneous parametric down-conversion in a bulk lithium niobate crystal generates broadband, C-band-compatible entangled photons that seamlessly integrate with existing fiber-optic systems, aiming to accelerate secure quantum communication and key distribution research.

26 JUNE 2025

IONQ DEMONSTRATES 1ST QUANTUM SIMULATION OF RARE NUCLEAR DECAY PROCESS

In a collaboration with the University of Washington's IQuS team, IonQ has completed the first known quantum simulation of neutrinoless double-beta-decay, an extremely rare nuclear process linked to the universe's matter–antimatter asymmetry. Executed on IonQ's trapped-ion hardware, the simulation marks a major milestone in applying quantum computers to fundamental physics research.

19 JUNE 2025

IONQ COLLABORATES WITH KIPU QUANTUM TO SET RECORDS IN PROTEIN FOLDING AND OPTIMIZATION TASKS

IonQ and Kipu Quantum have harnessed IonQ's Forte trapped-ion system to solve the largest protein-folding problem ever executed on quantum hardware, modeling a 3D structure comprising up to 12 amino acids. Simultaneously, they tackled dense optimization challenges (all-to-all spin-glass QUBO and MAX-4-SAT HUBO) using up to 36 qubits. The breakthrough, achieved via Kipu's BF-DCQO non-variational algorithm, demonstrates significant potential for drug discovery and complex computational applications.

25 JUNE 2025

NORD QUANTIQUE'S ENERGY-EFFICIENT QUANTUM COMPUTER TARGETS 2031 FOR 1,000 LOGICAL QUBITS

A breakthrough quantum computer design from Nord Quantique promises to consume 2,000 times less power than a supercomputer while solving complex problems 200 times faster. The company plans to scale this highly efficient design into a 1,000 logical qubit machine by 2031. This development signifies a major leap towards making quantum computing more accessible and sustainable, addressing two critical challenges: the immense power consumption of current quantum systems and the need for greater computational speed. The focus on logical qubits indicates an emphasis on error correction, a crucial aspect for practical quantum applications. If successful, Nord Quantique's technology could significantly impact fields requiring massive computational power, offering a greener and faster alternative.

10 JUNE 2025

IBM'S ACCELERATED ROADMAP: QUANTUM ADVANTAGE BY 2026

IBM has unveiled an ambitious updated roadmap that accelerates the timeline for achieving key milestones in quantum computing. The company now projects that **quantum advantage**, the point at which a quantum computer can outperform the best classical computers on a specific task, will be reached by **2026**. This is a significant advancement from previous forecasts and is driven by substantial improvements in error correction and the overall quality of their quantum processors. This near-term goal will be achieved on pre-fault-tolerant quantum computers working in conjunction with high-performance classical computers to tackle scientific problems.

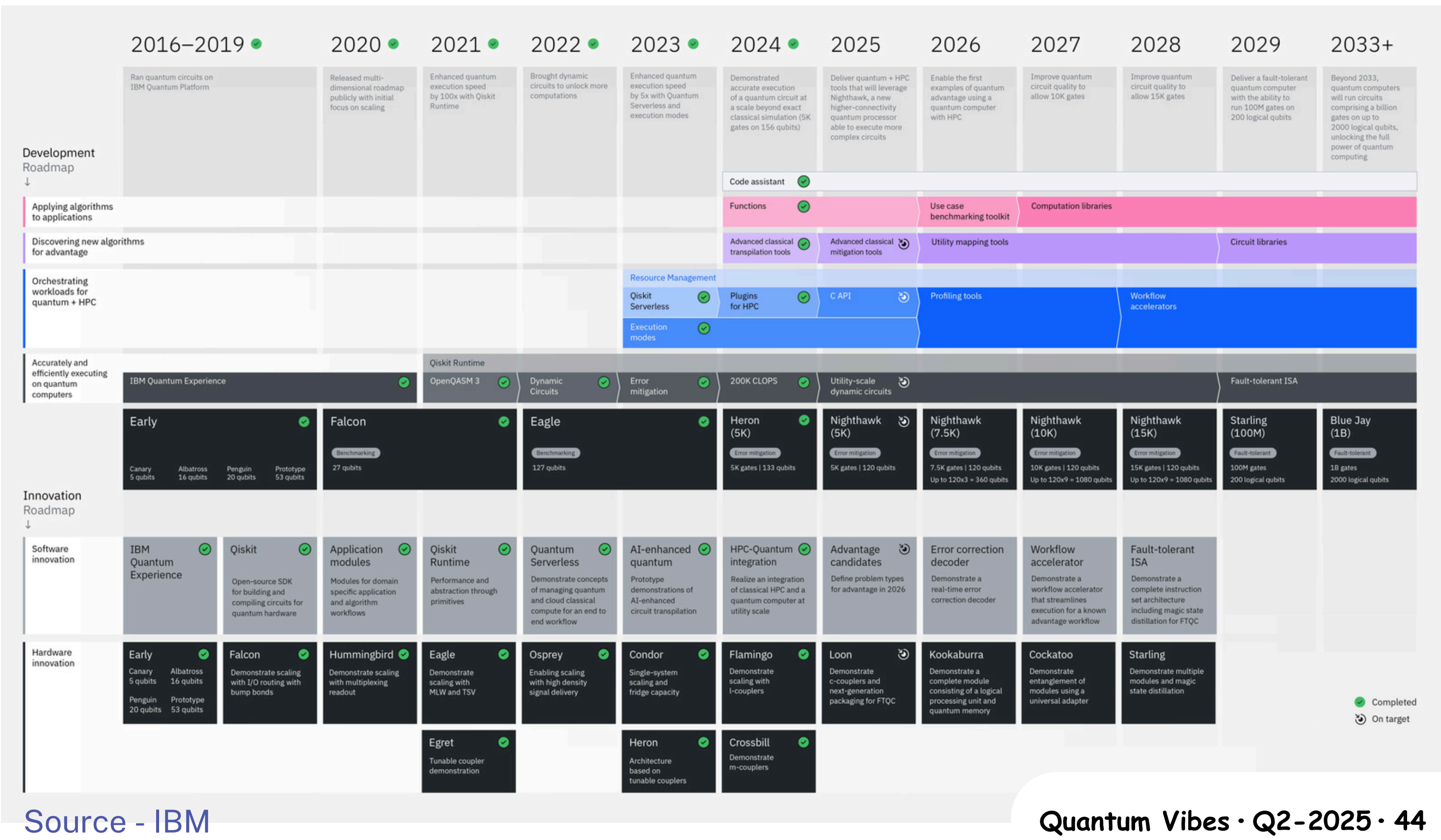
Looking further ahead, IBM has set a target for **2029** to deliver a large-scale, fault-tolerant quantum computer, with the goal of having systems with thousands of logical qubits by **2030 and beyond**. Logical qubits are a crucial concept in fault-tolerant quantum computing, where multiple physical qubits are used to create a single, more robust, and error-resistant logical qubit. IBM's roadmap details a clear and rigorous framework for achieving this, including the development of new processors and modular architectures. This accelerated timeline from a major player like IBM signals a new phase of maturity for the quantum computing industry and brings the promise of quantum-driven breakthroughs in science and technology closer to reality.

17 JUNE 2025

MAGIC STATES UNLOCKED FOR FAULT-TOLERANT QUANTUM COMPUTING

In a landmark achievement two decades in the making, scientists have successfully demonstrated the distillation of "**magic states**." This crucial breakthrough marks a fundamental requirement for building fault-tolerant quantum computers capable of handling system errors. These special states are essential for performing the universal quantum computations needed to solve problems far beyond the reach of today's supercomputers, representing a critical step towards scalable and error-corrected quantum processors.

The process, known as magic state distillation, takes multiple imperfect states and refines them into a single, high-fidelity one. Recent experiments have shown this to be functionally viable, dramatically reducing the resources and overhead previously thought necessary. This success brings the timeline for practical, large-scale quantum computers significantly closer, establishing a key building block for machines that can revolutionize fields like drug discovery and materials science.



Source - IBM

QUANTUM CAREERS

The quantum revolution isn't just a scientific journey —it's a career opportunity waiting to be realized.

Career Opportunities

Quantum Error Correction Scientist

QpiAI
Bengaluru, Karnataka

Quantum Entanglement - (R&D)

Divine Bonding (OPC) Private Limited
Bengaluru, Karnataka

Lead Security Engineer – Quantum Cryptography & AI Security / Associate Director, Software Engineering

HSBC
Pune, Maharashtra

Senior Software Engineer – Quantum Compilers

Atom Computing
Berkeley, CA or Boulder, CO

Computational Scientist

HRL Laboratories
Calabasas, CA

Scientific Software Engineer - Error Correction

QuEra Computing Inc.
Boston, MA USA

Scientific Software Engineer

QuEra Computing Inc.
Toronto, Ontario, Canada

Research Scientist

IBM
Cambridge, Massachusetts, United States

Senior Staff Mechanical Engineer - Quantum Core

IONQ
Bothell, Washington, United States

Product Manager, CUDA-Q Libraries

Nvidia
Remote

Senior Algorithm Researcher

D Wave Quantum
Bengaluru, Karnataka

Process Integration Engineer - Heterogeneous Integration Development

XANADU
Remote

QPU Design Engineer

Oxford Ionics
Oxford, England, United Kingdom

Staff Electrical Engineer - Quantum Control

IONQ
Bothell, Washington, United States; College Park, Maryland, United States

Quantum Computing Pre-Doctoral Researcher

IBM
Dublin, Dublin, Ireland

Scientist, Quantum Sensing (Magnetometry)

Q-CTRL
Sydney

Quantum Software Engineer, Qrisp

IQM
Hybrid

Quantum Computing Scientist - 362

Quantinuum
US Broomfield, CO

Senior Quantum Scientist/Quantum Engineer

RAMAN RESEARCH INSTITUTE
Bangalore, India

CONFERENCES

UPCOMING EVENTS 2025

JUL 15
International Conference and Exposium on Quantum Sensing and Metrology ICEQSM- 2025
TCG CREST, Kolkata, India

JUL 31 - SEP 01
Quantum India
Bengaluru, Karnataka

AUG 06-08
Quantum AI And NLP 2025 Conference
Bloomington, United States of America.

AUG 11-15
QEC25
Yale Quantum Institute in New Haven

SEP 01-05
Infrared and Terahertz Quantum Workshop (ITQW 2025)
Saint-Malo, France

SEP 08-11
Quantum Many-body Physics through the Lens of Quantum Error Correction (BEC 2025)
Santa Barbara, United States of America

SEP 10-13
Centre for Quantum Engineering, Research and Education (CQuERE)
TCG CREST, Kolkata, India

SEP 16-18
Quantum World Congress
Tysons Corner, United States of America

SEP 24-26
6th NIST PQC Standardization Conference
Gaithersburg, Maryland

OCT 07-08
Quantum Effects
Stuttgart, Germany

UPCOMING EVENTS 2025

CONFERENCES

OCT 19-21 — **Uncovering the Coming Wave of Quantum + AI (Q+AI 2025)**
New York, United States of America

OCT 20-24 — **10th Quantum Information in Spain conference (ICE-10)**
Valencia, Spain

NOV 18-21 — **Advanced Quantum Algorithms for Many-body systems (AQAM-2025)**
Montpellier, France

DEC 03-05 — **Quantum Education Summit 2025: Shaping the Future, Empowering Minds**
Barcelona, Spain

OCT 08-10 — **Quantum Computing Expo**
Tokyo, Japan

DEC 01-04 — **Quantum Engineering Sciences & Technologies for Industry & Services (QUEST-IS 2025)**
Paris, France

DEC 08-10 — **Sensing with Quantum Light (SQL25)**
Bad Honnef, Germany

DEC 08-11 — **International Conference on Quantum Information Science and Technology (ICQIST- 2025)**
Kolkata, India

DEC 08-12 — **Quantum field theory with boundaries, impurities, and defects school (BIDW03)**
Cambridge, United Kingdom

DEC 08-12 — **The Australian and New Zealand Conference on Optics and Photonics (ANZCOP)**
Auckland, New Zealand

PUBLICATIONS

List of selected publications in Quantum Technologies during April to June 2025

Coherent control of a superconducting qubit using light *April 2025*	Nature Physics, 1-8 *Warner, H. K., Holzgrafe, J., Yankelevich, B., Barton, D., Poletto, S., Xin, C. J., ... & Lončar, M. (2025)*
Variational quantum eigensolver approach to prime factorization on IBM's noisy intermediate scale quantum computer *April 2025*	Physical Review A, 111(4), 042413 *Sobhani, M., Chai, Y., Hartung, T., & Jansen, K. (2025)*
Direct and efficient detection of quantum superposition *May 2025*	Physical Review A, 111(5), L050402 *Kun, D., Strömberg, T., Spagnolo, M., Dakić, B., Rozema, L. A., & Walther, P. (2025)*
Experimental Single-Photon Quantum Key Distribution Surpassing the Fundamental Weak Coherent-State Rate Limit *May 2025*	Physical Review Letters, 134(21), 210801 *Zhang, Y., Ding, X., Li, Y., Zhang, L., Guo, Y. P., Wang, G. Q., ... & Pan, J. W. (2025)*
Demonstration of algorithmic quantum speedup for an Abelian hidden subgroup problem *June 2025*	Physical Review X, 15(2), 021082 *Singkanipa, P., Kasatkin, V., Zhou, Z., Quiroz, G., & Lidar, D. A. (2025)*
Chemistry beyond the scale of exact diagonalization on a quantum-centric supercomputer *June 2025*	Science Advances, 11(25), eadu9991 *Robledo-Moreno, J., Motta, M., Haas, H., Javadi-Abhari, A., Jurcevic, P., Kirby, W., ... & Mezzacapo, A. (2025)*
Single-qubit gates with errors at the 10-7 level. *June 2025*	Physical Review Letters, 134(23), 230601 *Smith, M. C., Leu, A. D., Miyanishi, K., Gely, M. F., & Lucas, D. M. (2025)*
Ultrabright Entanglement Based Quantum Key Distribution over a 404 km Optical Fiber. *June 2025*	Physical Review Letters, 134(23), 230801 *Zhuang, S. C., Li, B., Zheng, M. Y., Zeng, Y. X., Wu, H. N., Li, G. B., ... & Pan, J. W. (2025)*

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