

QUANTUM TECHNOLOGY RESEARCH CENTRE – SCIENCE & TECHNOLOGY

NEWS: Defence Research and Development Organisation (DRDO) inaugurated the **Quantum Technology Research Centre (QTRC)**.

WHAT'S IN THE NEWS?

Quantum Technology Research Centre (QTRC)

A. Aim and Strategic Focus

- The primary aim of the QTRC is to **strengthen indigenous quantum capabilities**, particularly for **strategic and defence applications**.
- It is designed to act as a **national hub for cutting-edge quantum research**, with applications in secure communication, precision sensing, and defence technologies.

B. Experimental Capabilities and Infrastructure

- QTRC is equipped with **state-of-the-art experimental set-ups** to facilitate advanced **research and development (R&D)** in quantum technologies.
- These include test-beds, characterisation platforms, and experimental systems for foundational and applied quantum science.

C. Key Technical Capabilities

1. Laser Characterisation Facilities:

- Capabilities include precise **characterisation of Vertical-Cavity Surface-Emitting Lasers (VCSELs)** and **Distributed Feedback (DFB) Lasers**, critical for quantum communication systems.

2. Single-Photon Source Evaluation:

- Establishment of **test-beds for evaluating single-photon sources**, essential for secure quantum communication protocols like Quantum Key Distribution (QKD).

3. Alkali Vapor Cell Characterisation:

- Infrastructure for **characterising micro-fabricated alkali vapor cells**, vital components in atomic clocks and quantum sensors.

4. Quantum Key Distribution (QKD) Platforms:

- Development and validation of **QKD techniques** to enable **ultra-secure communication**, ensuring information security in the **post-quantum era**.
- This effort is **spearheaded by the Scientific Analysis Group (SAG)** under the **Defence Research and Development Organisation (DRDO)**.

II. Foundational Quantum Technologies (Led by SSPL)

A. Advanced Timing and Navigation

- Development of **ultra-small atomic clocks** based on **Coherent Population Trapping (CPT)**.
- These are crucial for **precise timekeeping in GNSS-denied environments**, enhancing self-reliant navigation capabilities.

B. Magnetic Field Detection

- Design and fabrication of **atomic magnetometers** using **optically pumped magnetometry**.
- These allow **ultra-sensitive detection of magnetic fields**, with applications in defence, medical imaging, and geology.

C. Solid-State Quantum Devices

- Cutting-edge research is underway in **solid-state quantum devices and materials**.
- Focus areas include **quantum dots, NV centers, superconducting circuits, and topological insulators**.

III. Understanding Quantum Technology

A. Fundamental Basis

- Quantum technology relies on the principles of **quantum mechanics**, which studies **particle behavior at the subatomic level**.
- It leverages **superposition, entanglement, and tunneling** to achieve unprecedented technical capabilities.

B. Four Core Domains

1. Quantum Communication:

- Utilises quantum physics for **highly secure data transmission**, resistant to eavesdropping and interception.

2. Quantum Simulation:

- Employs quantum systems to **simulate complex phenomena** in chemistry, materials science, and high-energy physics.

3. Quantum Computation:

- Involves **quantum processors** to perform tasks that are **intractable for classical computers**, like factoring large numbers or modeling molecules.

4. Quantum Sensing and Metrology:

- Uses quantum systems to achieve **ultra-precise measurements** in fields such as gravimetry, navigation, and timing.

IV. National Quantum Mission (NQM) – 2023 to 2031

A. Objective and Vision

- Launched by the Government of India in **2023**, with a mission period from **2023–24 to 2030–31**.
- Aim: To **seed, nurture, and scale up R&D** in quantum technologies and create a **vibrant, innovation-driven ecosystem** in the country.
- Goal: Position India among the **top nations in quantum technologies and applications (QTA)**.

B. Key Targets and Outcomes

1. Quantum Computing Development:

- Target to develop **intermediate-scale quantum computers** with **50–1000 physical qubits** using platforms such as **superconducting and photonic technologies**.

2. Secure Quantum Communication Infrastructure:

- Establishment of **satellite-based quantum communication links** over a range of **2000 km within India**.
- Development of **inter-city quantum key distribution** and **multi-node quantum networks with quantum memories**.
- Facilitation of **cross-border long-distance secure communications** using quantum technologies.

3. Quantum-Enhanced Timing and Sensing:

- Development of **atomic clocks** for precision **navigation and communication systems**.
- Research into **high-sensitivity magnetometers** using atomic systems.

4. Quantum Materials and Devices:

- Support for the design and synthesis of **novel quantum materials** such as **superconductors, semiconductors, and topological insulators**.
- Fabrication of key components like **single-photon sources, entangled photon sources**, and **high-efficiency detectors** for use in communication, sensing, and metrology.

Implementation: Four **Thematic Hubs (T-Hubs)** have been set up, bringing together 14 Technical Groups across 17 states and 2 Union Territories.

- Indian Institute of Science (IISc) Bengaluru

- Indian Institute of Technology (IIT), Madras in association with the Centre for Development of Telematics, New Delhi
- Indian Institute of Technology (IIT), Bombay
- Indian Institute of Technology (IIT), Delhi.

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