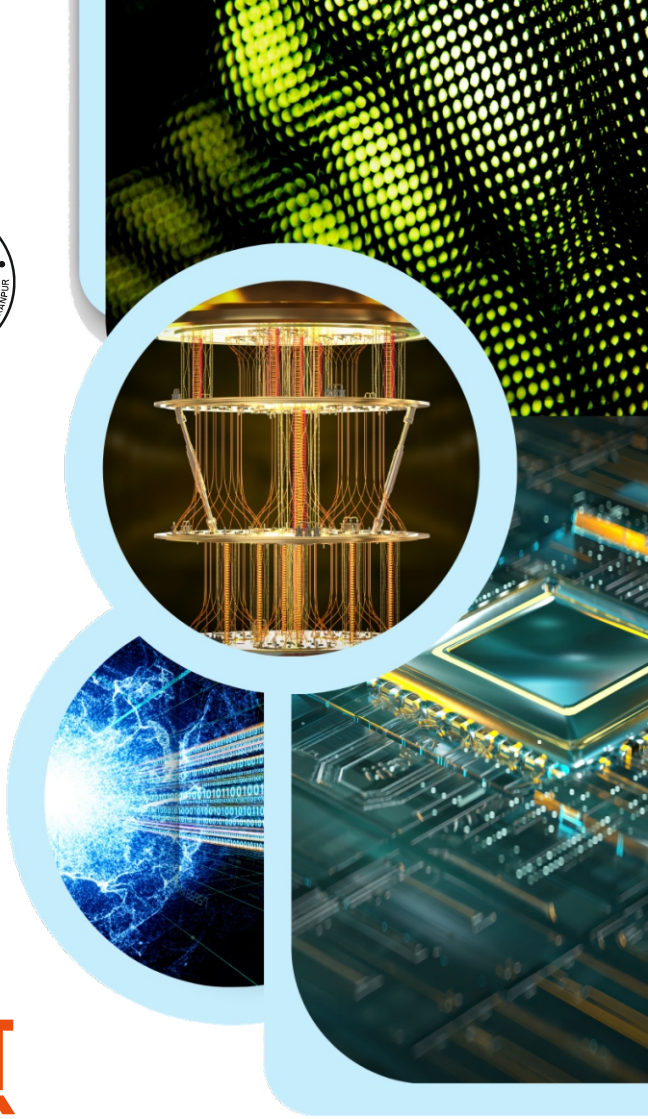
National Quantum Mission

विज्ञान और प्रौद्योगिकी विभाग
Department of
SCIENCE & TECHNOLOGY

IIT KANPUR



QUANTUM प्रबोधनम्

Newsletter | NATIONAL QUANTUM MISSION

Inaugural Edition

February 2025

Message from Secretary, DST

सत्यमेव जयते
प्रो. अभय करंदीकर
Prof. Abhay Karandikar

सचिव
भारत सरकार
विज्ञान एवं प्रौद्योगिकी मंत्रालय
विज्ञान एवं प्रौद्योगिकी विभाग
Secretary
Government of India
Ministry of Science and Technology
Department of Science and Technology

20th March, 2025

Message

I am glad to launch the 1st Edition of the National Quantum Mission Newsletter – Quantum प्रबोधनम्.

India stands at the threshold of a quantum revolution, and the National Quantum Mission (NQM) is our decisive step toward global leadership in this transformative domain. Quantum technologies are no longer a futuristic vision-they are rapidly reshaping computing, communication, sensing, metrology and landscape. All countries are in a race to harness this potential, and India is here to lead.

With an outlay of ₹6003.65 crore, NQM is India's most ambitious quantum initiative, driving cutting-edge research, industry collaboration, and global partnerships. The establishment of four Thematic Hubs (T-Hubs) will create a strong foundation for indigenous quantum technology development, ensuring we do not just adopt but innovate, productize commercialize, and dominate this sector.

This is a national mission with global aspirations. We are mobilizing academia, industry, startups, and government agencies to make quantum breakthroughs that will secure India's technological sovereignty. Quantum computing will redefine computing and optimization; quantum communication will set new standards for cybersecurity; quantum sensing and materials will power next-generation innovations. Every sector—defence, healthcare, finance, space-stands to benefit, and we are determined to make this vision a reality.

This is not the time for hesitation. We need disruptive thinking, audacious goals, and relentless execution. Our success will not be measured by research papers alone, but by the impact we create-breakthroughs in quantum computing, unbreakable quantum-secure networks, cutting-edge sensors, and real-world applications that power our economy and national security.

The challenge is huge, but our resolve is stronger. The National Quantum Mission is not just about keeping pace-it's about setting the pace. India will lead the quantum era. Let's get to work.

(Abhay Karandikar)

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MESSAGE

The National Quantum Mission (NQM) is a transformative step toward establishing India as a global leader in quantum technologies. With the successful establishment of four Thematic Hubs (T-Hubs) across key quantum verticals—Quantum Computing, Quantum Communication, Quantum Sensing & Metrology, and Quantum Materials & Devices—NQM is creating a strong foundation for cutting-edge research, innovation, and technology development.

To foster innovation and commercialization, we have developed comprehensive guidelines for supporting quantum startups, and eight pioneering startups have already been onboarded. This initiative is catalyzing breakthrough developments and accelerating India's journey toward quantum-enabled solutions. Building a skilled workforce is equally critical. NQM is investing in capacity building through dedicated skill development initiatives, including the launch of an undergraduate course on quantum technologies in collaboration with AICTE.

NQM is bringing together academia, industry, startups, and government agencies to create a dynamic quantum innovation ecosystem to translate cutting-edge research into real-world applications that will drive national security, economic growth, and technological leadership.

The momentum has begun, and the opportunities ahead are vast. Through a collective and coordinated effort, we are not just laying the groundwork for quantum advancements but positioning India as a frontrunner in this technological revolution.

Dr. J B V Reddy
(Head, QTC)

Message from
Head, Mission Coordination Cell, NQM

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प्रो. मणीन्द्र अग्रवाल
निदेशक

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Directorate

Prof. Manindra Agrawal
Director

Date: March 20, 2025

MESSAGE

I am happy that the first edition of National Quantum Mission (NQM) Newsletter, 'Quantum प्रबोधनम्' is getting launched from Mission Coordination Cell (MCC) at Quantum Quest-Flagship Awareness Event.

The last six months have been pivotal for our country in the field of quantum technology, as we have taken a momentous leap. It is not that we did not have quantum technologies research and innovations in India earlier. But that was confined to individuals' laboratories, often restricting the translation and tangible outcomes. The National Quantum Mission has filled this gap. Substantial funding and resources have been provided to leading research groups in India in form of Technical Group consortiums, and to synergize them and ensure the mission's success and tangible outcomes from the projects, Thematic Hubs have been set up.

Not only has the National Quantum Mission set deliverables that are vital for India, like quantum processors for education and commercial applications, 2000 km secure communication network, quantum memories, novel quantum sensors and imaging tools for diagnostic applications, etc., but the mission is also working on facilitating industry connections and start-up ecosystem establishment for the commercialization of technologies developed.

MCC is serving as the backbone of coordination for the mission, ensuring seamless integration of various activities & initiatives. MCC, in alignment with the mission, is also actively conducting specialized training programs, faculty development programs (FDPs), and quantum awareness initiatives like Quantum Quest, so that a strong foundation for quantum technologies is created in our country to drive the research and innovations in future.

I am glad to see significant achievements of National Quantum Mission so far being featured in the inaugural edition of the Newsletter. I am highly optimistic, in the next edition, we will see more achievements.

(Manindra Agrawal)

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Brief on Quantum Science & Technology

Quantum Technology (QT) is based on the principle of Quantum Mechanics which describes the nature at the scale of atoms and elementary particles. It is concerned with the control of these elementary particles with the goal of achieving information processing faster than their best classical counterparts.

Quantum Technologies have critical application potential in various sectors such as communication sector, health sector, drug design, financial sector, energy sector, space applications, defence, transportation and giga factories. Rapid improvements in design and control of quantum hardware are roughly doubling the capabilities of quantum devices every year, faster than the Moore's law that has characterized the growth of electronics industry for several decades. Sensors and metrological instruments are increasing their precision and orders of magnitude enhancements. New types of secure communications have been demonstrated over hundreds of kilometres, heralding the arrival of a quantum Internet. Prototype quantum computers and simulators are on the threshold of attaining quantum supremacy, i.e. perform calculations faster than their best classical counterparts. Highly disruptive advances are possible in imaging and energy manipulation techniques. All this is arising from the development of exquisite methods to control quantum systems and to protect fragile quantum dynamics from the environmental disturbances. The outstanding and practical challenge is the largescale integration of elementary quantum components. Quantum Technologies have the potential to provide information processing capabilities much beyond the limits of the classical technology. QT is manifested through various applications including solving computational problems exponentially faster than any available classical computer. QT will be used for networking quantum computers to ensure the authenticity of documents more securely than existing digital signatures. QT will also lead to development of quantum sensors and measurement devices to perform less invasive, more localized, ultra-high-resolution measurements (e.g. in Brain mapping), better and faster imaging techniques (e.g. in MRI diagnostics). Quantum computing will increase the speed of discovering new drugs for faster treatment of diseases. Quantum evolution techniques can produce new financial models to enhance security and detect fraudulent activities. Brief on Quantum Science & Technology Quantum Technology (QT) is based on the principle of Quantum Mechanics which describes the nature at the scale of atoms and elementary particles. It is concerned with the control of these elementary particles with the goal of achieving information processing faster than their best classical counterparts.

About National Quantum Mission (NQM)

The National Quantum Mission (NQM) is India's flagship initiative to propel the nation to the forefront of quantum science and technology. The Mission being driven by the Prime Minister's Science Technology Innovation Advisory Council (PM-STIAC) for leveraging cutting edge scientific research.

The Union Cabinet approved the National Quantum Mission on April 19, 2023, with a budget of ₹6003.65 crore for eight years, aiming to seed, nurture, and scale up India's quantum ecosystem, fostering cutting-edge R&D and industrial advancements.

The Mission is implemented by the Department of Science and Technology along with other key Ministries/Departments such Department of Space (DoS), Department of Research and Development Organisation (DRDO), and Department of Atomic Energy.

Mission Objectives

- Develop intermediate-scale quantum computers with 20-50 physical qubits (3 years), 50-100 physical qubits (5 years) and 50-1000 physical qubits (8 years).
- Develop secure quantum communication across 2000 km within India (both satellite- and fibre-based), long-distance secure quantum communication with other countries
- Develop a multi-node quantum network with quantum memories and synchronized quantum repeaters
- Achieve ultra-sensitive magnetometers, precision atomic clocks, and high-resolution gravity measurements for navigation and timing applications
- Design next-gen quantum materials such as superconductors, semiconductors, and topological materials for quantum computing, communication, and sensing

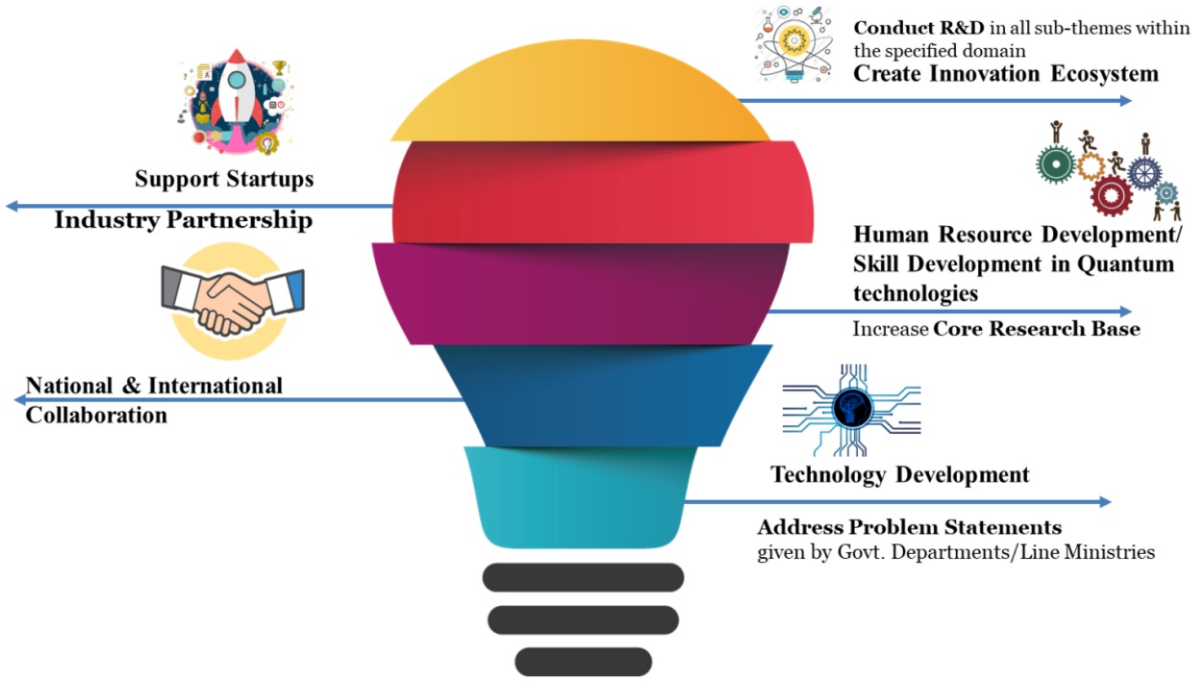
Mission Implementation Strategy

The **Hub-Spoke-Spike Model** anchors the strategy of the **National Quantum Mission,** where Thematic Hubs (T-Hubs) serve as central research and innovation hubs, driving India's quantum advancements. Spokes connect academia and industry through collaborative, cluster-based projects through T-Hubs. At the cutting edge, Spikes focus on specialized projects, accelerating quantum breakthroughs. Together, they form a dynamic ecosystem shaping India's quantum future.

Mission Mandates

The **National Quantum Mission** is strategically advancing India's quantum ecosystem through four mandates:

- **Technology Development:** Driving progress in quantum science through basic and applied research, translational research, directed research, and the development of cutting-edge R&D infrastructure
- **Entrepreneurship Development & Industry Partnership:** Encouraging indigenous innovation by supporting start-ups and fostering industry participation to accelerate quantum technology commercialization
- **Human Resource Development:** Strengthening India's quantum workforce by investing in capacity building, skill development, and expanding the core research base
- **International Collaboration:** Facilitating global partnerships and networking opportunities to position India as a key player in the global quantum landscape



Mandate of T-Hubs

Mission Coordination Cell

The Mission Coordination Cell (MCC) is set up as a coordinating body for the Mission which works in coordination with the Mission Secretariat, DST. It is set up at the Noida Outreach Centre of IIT Kanpur to facilitate the Mission Secretariat for implementing the NQM. MCC aims to foster close collaboration with various Ministries, National Agencies, and Industry by connecting them with the Thematic Hubs (T-Hubs) to undertake directed research on specific challenges. Additionally, it seeks to explore the market landscape for quantum technologies and provide strategic guidance to the T-Hubs. Furthermore, MCC will serve as a key interface for technology transfer, facilitating the adoption of quantum advancements by industry and government agencies while ensuring NQM alignment with other National initiatives, Missions, and potential beneficiaries.

Activities under the National Quantum Mission

The National Quantum Mission has achieved a significant milestone by establishing four Thematic Hubs in key quantum technology verticals, marking a major step forward in advancing research, innovation, and ecosystem development in the field of quantum technologies. These hubs will serve as centers of excellence, fostering collaboration among academia, industry, and startups to accelerate breakthroughs in quantum computing, quantum communication, quantum sensing & metrology, and quantum materials & devices.

Other key initiatives undertaken under the National Quantum Mission include the unveiling of the official NQM logo, the development of guidelines to support startups in quantum technologies, and the announcement of pioneering startups that are turning innovative ideas into reality. Additionally, efforts in human resource and skill development have led to the creation of an undergraduate course on quantum technologies in collaboration with AICTE. Furthermore, a concept paper on establishing a Quantum Safe Ecosystem in India has been introduced to strengthen cybersecurity in the quantum era.

Launch of National Quantum Mission Logo: A Symbol of India's Quantum Future

The **National Quantum Mission** launched its official logo on **September 30, 2024,** during the **Announcement Ceremony of the Thematic Hubs,** a landmark event that marked a major milestone in India's quantum journey. The logo embodies the essence of quantum technologies while reflecting India's vision to become a global leader in this cutting-edge field.

- At the heart of the logo is a stylized **'Q',** symbolizing **Quantum,** forming the focal point of the design.
- Encircling it are multiple **overlapping rings,** representing the **atomic structure,** orbiting **electrons** and the phenomenon of **quantum entanglement**—the fundamental building blocks of quantum mechanics. This intricate design signifies the interconnected and transformative nature of quantum technologies.
- Emphasizing **India's national identity,** the logo incorporates the **tricolour,** inspired by the Indian flag.
- It also features four feather-like extensions, representing the four key **quantum domains** under NQM — **Quantum Computing, Quantum Communication, Quantum Sensing & Metrology, and Quantum Materials & devices.** Each of these domains is instrumental in revolutionizing scientific advancements and industrial applications.

Launch of National Quantum Mission Logo

Establishment of Thematic Hubs (T-Hubs) and Technical Groups (TGs)

In a landmark move for India's National Quantum Mission, premier institutions have been selected to establish Thematic Hubs (T-Hubs). The announcement was made by Dr. Jitendra Singh, Honorable Union Minister of State (Independent Charge) for Science and Technology on September 30, 2024.

'These T-Hubs aim to accelerate research and innovation in quantum technologies, positioning India as a global leader in this transformative field', said Dr. Jitendra Singh at the event. He also highlighted critical role of T-Hubs in advancing quantum computing, communication, sensing, and materials.

He emphasized the multidisciplinary nature of the T-Hubs, which bring together experts from physics, computer science, engineering, and material science to foster holistic advancements.

The T-Hubs will drive progress in technology development, human resource capacity building, entrepreneurship, industry collaboration, and strengthening international partnerships. Each T-Hub will operate under the Hub-Spoke-Spike model, supporting a network of research projects (Spokes) and individual research groups (Spikes). This framework enhances coordination among institutions, enabling pooled resources and expertise and ensuring research translates into tangible advancements in telecommunications, defence, finance, and healthcare.

Announcement of four Thematic-Hubs under National Quantum Mission

The event was graced by Dr. Ajai Chowdhry, Chairman Mission Governing Board, National Quantum Mission; Prof. Ajay K Sood, Principal Scientific Advisor to Government of India; Prof. Abhay Karandikar, Secretary, DST; Dr. Samir V Kamat, Secretary, Department of Defence R&D and Chairman, DRDO; Dr. Neeraj Mittal, Secretary, DoT.

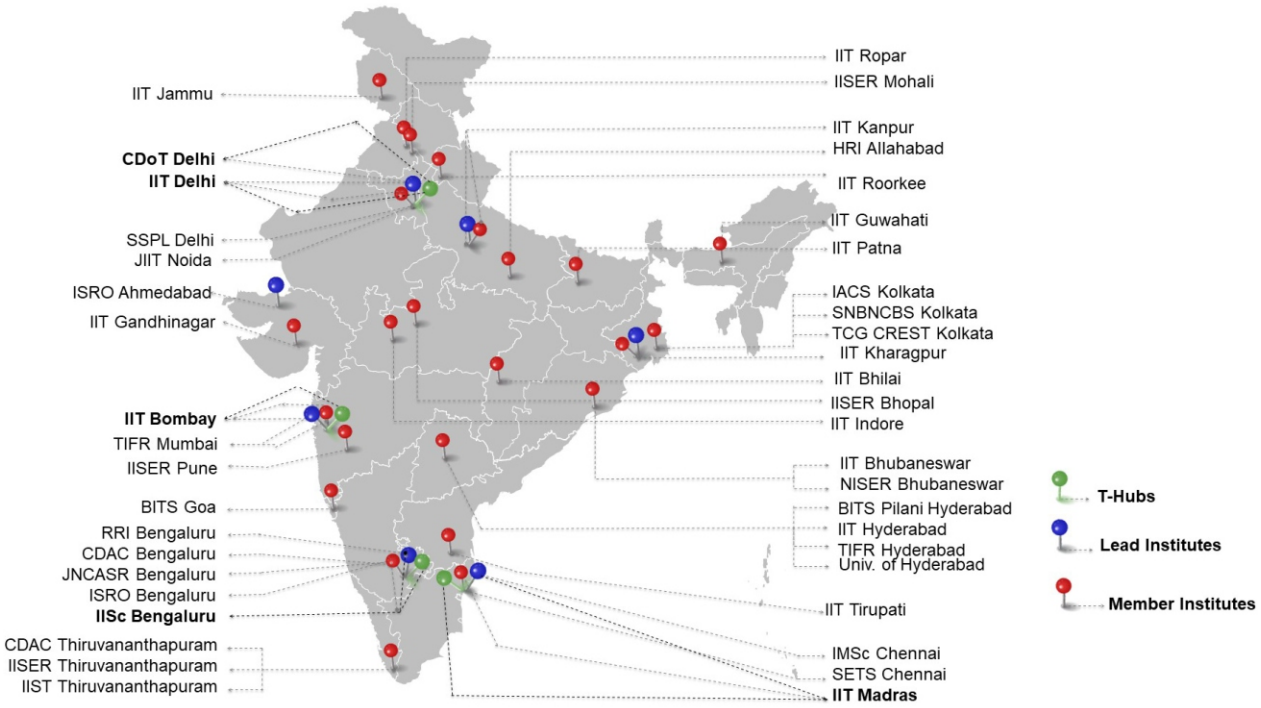
The T-Hubs are strategically located at premier institutions of the country:

- **Quantum Computing:** Indian Institute of Science, Bengaluru
- **Quantum Communication:** Indian Institute of Technology, Madras, in association with CDOT, New Delhi
- **Quantum Sensing & Metrology:** Indian Institute of Technology, Bombay
- **Quantum Materials & Devices:** Indian Institute of Technology, Delhi

These T-Hubs comprise of **14 Technical Groups** having **17 Project Teams** across **17 states** and **2 Union Territories.** The hubs bring together a total of **152 researchers** from **43 institutions** across the country.

It marks a pivotal step in India's journey to becoming a global leader in quantum technology, aligning with national initiatives such as **'Make in India'** and **'Digital India'.**

Mapping of Institutions under National Quantum Mission



43 Institutions (Lead & Member) from 17 states and 2 UTs are involved

Quantum Computing T-Hub

Host Institution: Indian Institute of Science, Bengaluru

Vision: This T-Hub aims to develop scalable and fault-tolerant quantum computing platforms, accelerating India's capabilities in high-performance quantum computing research and applications.

Establishment of Quantum Computing T-Hub at IISc Bengaluru with supporting Technical Groups

Technical Focus and supporting Technical groups (TGs) from premier institutions:

- **(i)** **Scaling quantum computing capabilities using semiconducting qubits:** IIT Delhi, IIT Kanpur, IIT Roorkee, IIT Ropar, IIIT Delhi, BITS Pilani-Hyderabad Campus
- **(ii)** **Programmable photonic quantum computing:** IMSc Chennai/IISc Bengaluru, JIIT Noida, SETS Chennai, C-DAC Bengaluru
- **(iii)** **Photonic quantum processors:** IISc Bengaluru, IIT Indore, IISER Thiruvananthapuram, C-DAC Bengaluru, IIT Delhi
- **(iv)** **Neutral atom qubits:** RRI Bengaluru, IIT Roorkee, IISER Pune, IIT Guwahati, IIT Patna, IIT Kanpur, NISER Bhubaneswar
- **(v)** **Superconducting qubits:** TIFR Mumbai, TIFR Hyderabad, IISc Bengaluru, IIT Bombay, IIT Madras
- **(vi)** **Spin Qubits:** IIT Bombay, IISER Thiruvananthapuram, IIT Delhi, IIT Bombay, JNCASR Bengaluru

Quantum Communication T-Hub

Host Institution: Indian Institute of Technology, Madras in Association with CDOT, New Delhi

Vision: The hub is dedicated to securing communication networks using quantum cryptography, including Quantum Key Distribution (QKD) and post-quantum cryptographic techniques.

Establishment of Quantum Communication T-Hub at IIT Madras in association with CDOT and supporting Technical Groups

Technical Focus and supporting Technical groups (TGs) from premier institutions:

(i) **Quantum Internet with Local Access QuILA:** IIT Madras, IISc Bengaluru, IIT Indore, C-DAC Bengaluru, IIT Hyderabad, SETS Chennai, C-DAC Thiruvananthapuram

(ii) **Advancing trusted-node-free quantum secure networks:** IIT Delhi, IIT Roorkee, IISc Bengaluru, IIT Jammu, IISER Bhopal

(iii) **Multi-node Quantum repeater network:** RRI Bengaluru, HRI Prayagraj, IIT Tirupati, IIT Patna, IISER Mohali

(iv) **Satellite-based quantum key distribution systems:** ISRO Ahmedabad, ISRO Satellite Centre, IIST DOS, Thiruvananthapuram

(v) **Pioneering post-quantum cryptography:** CDOT New Delhi, IIT Kanpur, IIT Bhilai, IIT Kharagpur

Quantum Sensing & Metrology T-Hub

Host Institution: Indian Institute of Technology, Bombay

Vision: This hub focuses on advancing quantum-enhanced sensing technologies for applications in precision measurements, medical diagnostics, and geophysical explorations.

Establishment of Quantum Sensing & Metrology T-Hub at IIT Bombay with supporting Technical Groups

Technical Focus and supporting Technical groups (TGs) from premier institutions:

(i) **Diamond NV center-based sensors:** IIT Bombay, IISc Bengaluru, IIT Madras, IISER Bhopal, TCG CREST Chennai, TIFR Bombay

(ii) **Quantum-enhanced sensors on integrated hybrid platform:** IIT Kanpur, IISc Bengaluru, TIFR Mumbai, TIFR Hyderabad, IISER Bhopal, IIT Gandhinagar, HRI Prayagraj, IACS Kolkata, IIT Bombay, BITS Pilani - Goa Campus, University of Hyderabad

(iii) **Quantum entanglement-enhanced imaging technologies:** IIT Kanpur, IIT Ropar, SNBNCBS Kolkata, IIT Delhi

Quantum Materials & Devices T-Hub

Host Institution: Indian Institute of Technology, Delhi

Vision: This T-Hub aims to innovate in quantum materials, superconducting technologies, and nanofabrication for quantum computing and sensing applications.

Establishment of Quantum Materials & Devices T-Hub at IIT Delhi with supporting Technical Groups

Technical Focus and supporting Technical groups (TGs) from premier institutions:

(i) **Development of single-photon emitters, quantum dots:** IIT Delhi, IIT Bombay, IIT Roorkee, IIT Kharagpur, SSPL - DRDO Delhi, IIT Madras

(ii) **2D spintronic materials:** IIT Bombay, IACS Kolkata, IIT Kharagpur, IISER Pune, IIT Kanpur, IIT Delhi

(iii) **2D materials based photonic qubits:** IIT Kharagpur, IIT Bhubaneswar, IIT Bombay, IIT Roorkee

Start-up Ecosystem Support

Guidelines evolved for supporting start-ups under NQM

In a major push to accelerate India's quantum technology ecosystem, guidelines for supporting start-ups under the National Quantum Mission were evolved. The guidelines will pave the way for providing start-ups in Quantum technologies with structured support in funding, mentorship, and access to advanced infrastructure.
Following this, the I-Hub Quantum Technology Foundation (QTF), the Technology Innovation Hub (TIH) at the Indian Institute of Science Education and Research (IISER) Pune, established under the National Mission on Interdisciplinary Cyber Physical Systems (NM-ICPS), launched Call for Proposals aimed at fostering innovation and entrepreneurship in quantum technologies. The initiative sought to nurture start-ups engaged in quantum computing, quantum communication, quantum sensing, and quantum materials.

This collaborative effort marked a pivotal step in harnessing quantum technologies for national development. By fostering an ecosystem of innovation, these initiatives aimed to propel India towards the forefront of the global quantum revolution.

Quantum Start-up Announcement: Transforming Ideas into Reality

In a significant stride towards establishing India as a global leader in quantum technology, **Honorable Union Minister Dr. Jitendra Singh** announced the selection of **eight pioneering start-ups** for support under the **National Quantum Mission** and the **National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS).**

The selected start-ups i.e. QNu Labs, QPiAI India Private Ltd., Dimira Technologies Pvt. Ltd., PrenishQ Pvt. Ltd., QuPrayog Pvt. Ltd., Quanastra Pvt. Ltd., Pristine Diamonds Pvt. Ltd., and Quan2D Technologies Pvt. Ltd., will drive innovation in quantum technologies.

Domains of selected quantum start-ups:

- **QNu Labs (Bengaluru):** Advancing quantum communication by developing end-to-end quantum-safe heterogeneous networks
- **QPiAI India Private Ltd. (Bengaluru):** Building a superconducting quantum computer, marking a milestone in quantum computing
- **Dimira Technologies Pvt. Ltd. (IIT Bombay):** Focusing on indigenous cryogenic cables essential for quantum computing
- **PrenishQ Pvt. Ltd. (IIT Delhi):** Developing precision diode-laser systems vital for the sector's growth.
- **QuPrayog Pvt. Ltd. (Pune):** Innovating optical atomic clocks and related technologies in quantum sensing and metrology
- **Quanastra Pvt. Ltd. (Delhi):** Developing advanced cryogenics and superconducting detectors
- **Pristine Diamonds Pvt. Ltd. (Ahmedabad):** Creating diamond materials for quantum sensing
- **Quan2D Technologies Pvt. Ltd. (Bengaluru):** Advancing superconducting nanowire single-photon detectors

These start-ups were meticulously chosen after a rigorous evaluation process, reflecting their alignment with NQM's vision of fostering cutting-edge research, innovation, and industrial applications to place India at the forefront of quantum technology on the global stage.

Dr. Singh emphasized India's commitment to leading the global quantum revolution and highlighted the role of these start-ups in shaping the nation's technological future.

Announcement of eight quantum start-ups by Dr. Jitendra Singh

Human Resource & Skill Development

Launch of Undergraduate Courses in Quantum Technologies by DST and AICTE

The Department of Science and Technology and the All India Council for Technical Education (AICTE) have announced the launch of undergraduate minor courses in quantum technologies under the National Quantum Mission. Faculty development programs and lab infrastructure support have been planned and are in progress. The initiative aims to align education with cutting-edge research, accelerating India's leadership in quantum technology development.

Release of UG minor curriculum in Quantum Technologies by AICTE and DST

Showcase: Quantum Advantage Summit

The team from the National Quantum Mission (NQM) participated in the **India Mobile Congress (IMC) in October 2024,** held at Bharat Mandapam, New Delhi. As part of IMC, **The Quantum Advantage Summit** was hosted by the **Department of Science & Technology (DST),** bringing together key stakeholders driving India's advancements in quantum technology.

The summit witnessed the presence of eminent dignitaries, including Dr. Ajai Chowdhry**,** Chairman, Mission Governing Board, NQM; Prof. Ajay K Sood, PSA to GoI; Prof. Abhay Karandikar, Secretary, DST; Dr. Jay Gambetta, Vice President, IBM – Quantum and other thought leaders from industry and academia.

Discussions focused on **India's quantum roadmap,** the role of **Thematic Hubs (T-Hubs)** under NQM, and **industry-academia collaborations** in quantum computing, communication, and materials research. The event reaffirmed **India's commitment to accelerating its quantum ecosystem,** fostering innovation, and strengthening global partnerships.

Quantum Advantage Summit during India Mobile Congress 2024 highlighting the role of India in the global quantum landscape

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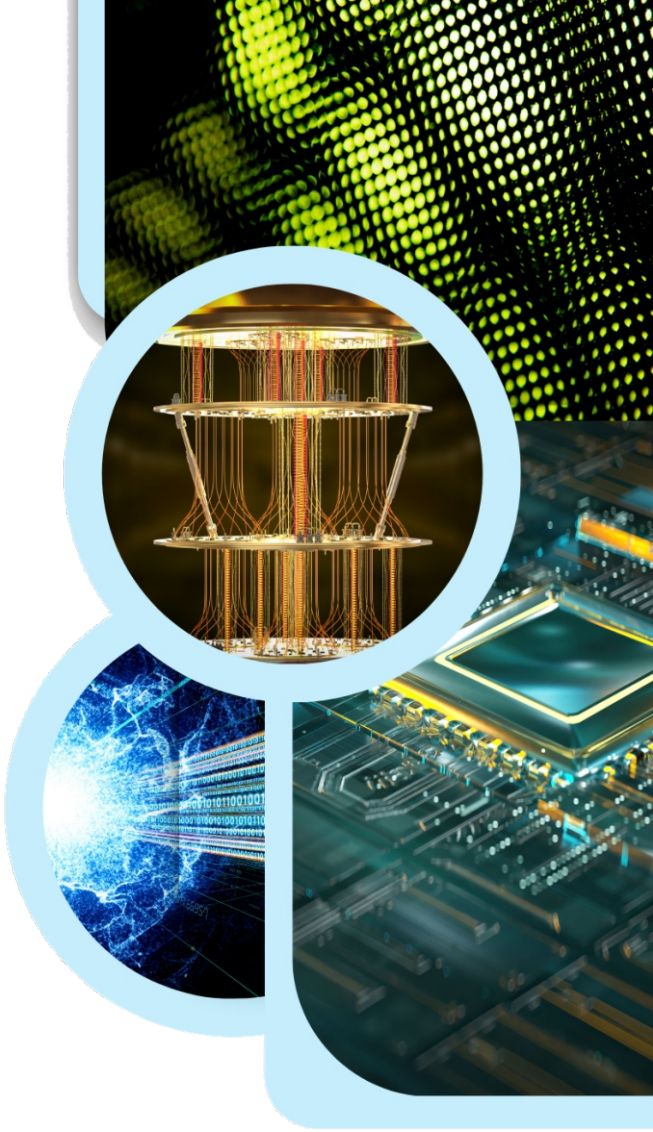

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