



# Proposal for Supporting IISc Quantum Technology Initiative (IQTI)

## **Introduction**

The twentieth century witnessed the understanding of atomic scale phenomena based on the formulation of quantum physics. That led to the first quantum revolution involving semiconductors, superconductors and lasers, paving the way to the present-day electronic gadgets. Towards the end of the twentieth century, the ability to control and manipulate quantum degrees of freedom started the second quantum revolution. It harnesses quantum properties such as superposition, entanglement, squeezing and tunnelling of quantum states to develop novel quantum devices for high-precision measurements, secure communications, efficient computing, and other futuristic technologies. The building blocks of these devices are fundamental physical objects such as spins, atoms and photons.

The ongoing attempts worldwide, focused on construction of customized quantum systems and materials, are directed towards bringing transformative advances in science, economy and society. They envisage orders of magnitude enhancement in the precision of sensors and metrological instruments, strategies for secure communications that would herald the arrival of a quantum internet, quantum computers that can tackle computationally hard problems, and disruptive advances in imaging and energy manipulation techniques.

The Government of India has recognised the immense potential of quantum technologies and has announced the “National Mission on Quantum Technologies and Applications (NM-QTA)” in 2020. The mission aims to lay a solid foundation in the field of quantum technologies by supporting fundamental and translational research, leading to the invention of new products and services, as well as the creation of a skilled human resource. While NM-QTA desires to catapult India to the midst of the second quantum revolution, limitations in the existing expertise and facilities available in India pose significant constraints on its advancement.

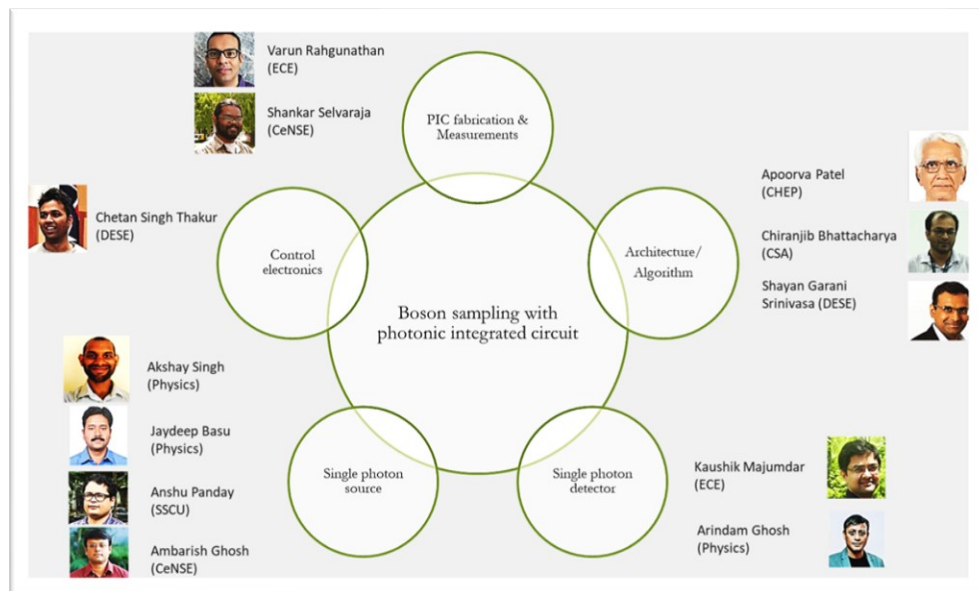
## **Quantum Technology at IISc**

The Indian Institute of Science aspires to deploy a dedicated effort to address these challenges, by establishing a framework to promote collaborations between physicists, material scientists, computer scientists and engineers. IISc, being the key institute instrumental in helping India develop past strategic missions (Indian nuclear technology and space technology programs were conceived and nurtured at IISc), has a multi-disciplinary research faculty with an interest in quantum science and technologies. Prior to the present interest in quantum technologies, IISc has been playing a pioneering role in

the country, for efforts to become self-reliant in the areas of Condensed Matter Physics, Nanoelectronics and Nanoscience.

Ongoing activities:

- With financial support from the Ministry of Electronics and Information Technology (MeitY), IISc has established a multi-disciplinary Center for Excellence in Quantum Technology, in collaboration with the Raman Research Institute (RRI) and the Centre for Development of Advanced Computing (C-DAC), to deliver quantum-enhanced technologies.
- A software simulator for noisy quantum circuits was developed at IISc. MeitY has incorporated it into an educational platform, [Quantum Computer Simulator Toolkit \(Qsim\)](#), that is dedicated to the nation.
- The Government of Karnataka has expressed interest in setting up a Quantum Research Park led by IQTI, with focus on skill development, to foster collaborations between academia and industry/start-ups.
- The picture below represents the multi-disciplinary synergy of faculty members from different departments at IISc to develop a photonic quantum processor.

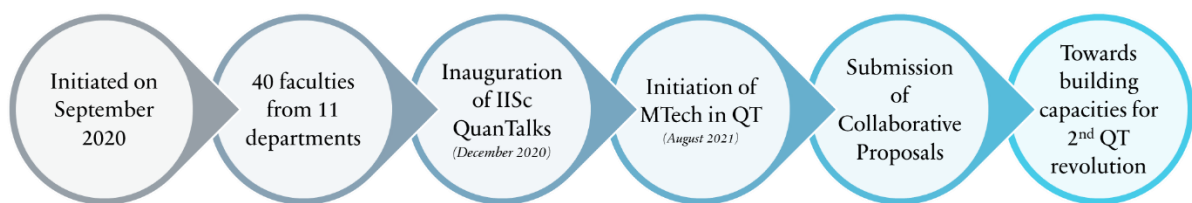


*Caption: The picture depicts the people in synergy for an ongoing MeitY sponsored project 'Photonic Integrated Circuit'.*

## Vision

IISc launched its quantum technologies initiative, IQTI, to participate in and contribute to the national initiative and strategic demands, and to achieve technology readiness at par with international efforts. It will leverage the Institute's research expertise in the area of

quantum technologies, and at the same time form a visionary research and development platform through national and international collaborations. This initiative is envisaged not to be just academic science; it would actively engage with industry and strategic partners to create technology with economic benefits and social impact. IQTI would use the well-established academia-industry interface of IISc to establish a vibrant start-up culture and ecosystem, in order to convert the promises of fundamental research into entrepreneurial activities for product development. The figure below illustrates the journey of this initiative since its inception. The major milestones are organizing national level webinar series called ‘[QuanTalks](#)’, commencement of the M.Tech. program in Quantum Technology (first of its kind in the country) and formulation of a multitude of collaborative research proposals.



*Caption: Milestones of IQTI*

The multi-disciplinary nature of the ongoing R&D at IISc fits seamlessly in the requirement of quantum technology development, from core hardware and backend engineering support to algorithms for cryptography and machine learning. IISc intends to build on-field deployable systems with quantum-enhanced performance, as well as explore new fundamental and engineering routes for disruptive quantum technology applications.

The multifaceted collaborative efforts of IQTI target the following areas:

Core quantum technology	Theoretical and modelling support	Peripheral technology development
<ul style="list-style-type: none"> <li>• Quantum computation</li> <li>• Quantum communication</li> <li>• Quantum sensing and metrology</li> </ul>	<ul style="list-style-type: none"> <li>• Quantum and quantum-inspired algorithms, Software simulators</li> <li>• Quantum information theory and error correction</li> <li>• Quantum cryptography and post-quantum cryptography</li> </ul>	<ul style="list-style-type: none"> <li>• Quantum materials: Discovery, modeling, and design</li> <li>• Quantum materials: Device technology</li> <li>• mK electronics and on-chip quantum control electronics</li> </ul>

## Proposed CSR Activities:

- **Visiting positions:** Funds donated towards these will be utilized to facilitate IQTI collaborations with various international universities. IQTI has established connections with University of Waterloo, Imperial College London, Cambridge University etc., and the process to identify projects of mutual interest is going on. The next step is to promote exchange visits to share and acquire domain specific expertise. Such visits require travel and hospitality support for faculties, students, and post-docs.
- **Fellowships/Internships/Chair professorships:** Fellowships will be awarded to meritorious M.Tech. and research students in the field of Quantum Technology. The support can be for a fixed period or for the complete duration of study. Internships during specified periods will allow the students to obtain valuable industry perspective on QT. Chair professorships would be in the form of incentives for the selected IISc faculty.
- **Directed research projects:** Research projects in QT of mutual interest to industry and IISc faculty members can be supported in collaborative or consultation mode.
- **Schools/Workshops/Outreach activities:** These are intended for both UG and PG/PhD level students in the country. They will have talks/seminars at the pedagogical as well as the advanced level. Apart from the academicians, industries and start-ups in the consortium will have the opportunity to actively participate in the training.
- **Enrichment of the M.Tech. QT Lab:** The M.Tech. in QT program has commenced from August 2021, and it is the first of its kind in India. The program will train students in quantum technology, for both advanced research and advanced industry. The elective part of the program will equip students to acquire training in allied technology areas as well. The program has the following four thrust areas: (i) Quantum Computation and Simulations, (ii) Quantum Communications and Cryptography, (iii) Quantum Sensing and Metrology, (iv) Quantum Materials and devices. Lab courses are an integral part of this program, to provide a hands-on practical training to the students. Experiments to understand the fundamental concepts, and the opportunity to work with cutting-edge technological instruments, would be a great value addition for the students. The following labs are currently being developed.
  - Basic Quantum Technology Lab
  - Advanced Programming Lab
  - Advanced Optics Lab

- Advanced Materials Synthesis and Characterisation Lab
- Advanced Electronics Lab

Kindly visit [our webpage](#) to know about our benefactors.

### **Branding**

IISc will prominently acknowledge the CSR support received from companies. In case a company/industry funds an entire lab, the lab can be named after the company/industry for the duration of the proposal.

### **Tax Information**

- Contributors in India can avail 100% tax exemption under Section 80G (2) (a) (iiif) of the Income Tax Act, 1961.
- IISc is exempted from the provision of the Foreign Contribution Regulation Act 1976.
- Corporates may avail of the **Corporate Social Responsibility** provisions as applicable (CSR Rules, 2014).
- IISc is audited by the C&AG of India.