Premium

National Quantum Mission: Why India has a lot of catching up to do

In 2023, India launched a mission to rapidly develop quantum technologies but it is far behind China and US in terms of filing patents and publishing research papers. However, the gap can still be bridged

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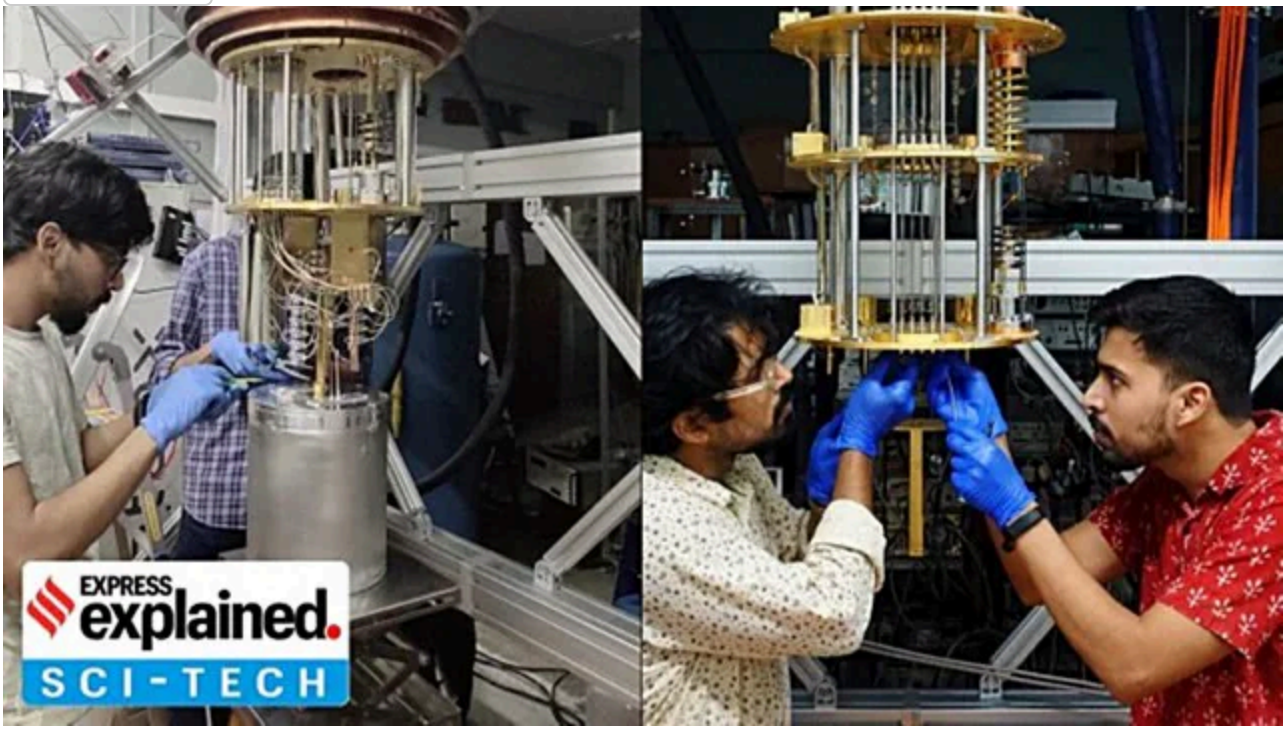


TIFR scientistswire up adilutionrefrigerator used to cool superconducting qubits to –271.14°Cfor buildinga small-scalequantum processor. (TIFR)

India launched the **National Quantum Mission** last year and became one of the few countries in the world to have a dedicated programme to harness the power of quantum technologies. These technologies, which use special properties of the tiniest particles of matter, can yield radical solutions to some of the most intractable problems of our age, such as clean energy and affordable healthcare.

But despite having a fairly strong research base in quantum science, India has a lot of catching up to do. A new report, surveying the existing capabilities of the country in this area, has found that countries like China and the United States have a huge head start over India. These countries have not just invested much more money in funding research, they also have more people working in this sector.

They have been publishing far greater numbers of scientific papers, and register many more patents as well.

But the good thing, as Indian science leaders have been emphasising, is that quantum technologies are still under development, and India is not exactly starting from zero. In fact, in some areas, Indian scientists are very much at the forefront of global research.

The quantum mission

After several years of discussions, India in 2023 announced the setting up of the National Quantum Mission to build capabilities in quantum-related science and technology. The mission focuses on four key domains: computing, communications, sensors, and materials.

Quantum technologies try to make use of the fact that matter behaves in a very unexpected and counter-intuitive manner at its smallest scale. Sub-atomic particles such as electrons seemingly exist at multiple locations at the same time, and can influence the behaviour of a like-particle, with which they have had a prior interaction, over infinitely large distances.

These strange properties have been experimentally verified hundreds of times. However, it is only in recent years that scientists have acquired capabilities to put them to some beneficial uses. Some of these properties, like the ability to exist in multiple states at the same time — a phenomenon called superposition — can be used to perform real-life tasks that conventional technologies are unable to achieve.

Quantum computers are already a reality, though their capabilities are quite limited at this point. More mature quantum computers would be able to do calculations that would be either impossible for normal computers, or would take far too long to perform.

By overcoming the limits of current technologies, a quantum-enabled transformation can build the foundations of a new economy in a decade or two. This is why India wants to try and rapidly build its capabilities in these areas. Partnering in technology development would ensure early fruits of success, which can trigger rapid economic growth. It would also make leading technologies accessible to India.

A lot of ground to cover

The National Quantum Mission, however, is just the first step and there is a lot of ground to cover, according to the Landscape of Indian R&D in Quantum Technologies report. The report has been prepared by itihaasa Research and Digital, a not-for-profit company that seeks to study the evolution of technology and business in India.

The Rs 6,000 crore (around $0.75 billion) earmarked for the mission is impressive by Indian standards but it pales in comparison to what other countries are spending on quantum-related research, the report said. China is estimated to be investing $15 billion in this effort, while the US is pumping in about $3.75 billion. The United Kingdom has put in about $4.3 billion and countries like Germany, South Korea, and France have all committed to spend more than $2 billion (see box alongside).

Researchers in China and the US have been producing the largest number of research papers. Between 2000 and 2018, Indian researchers published 1,711 papers on quantum-related science, according to one publicly available database, while Chinese and American researchers published 12,110 and 13,489 papers respectively. Seven other countries have published more papers than India during this period. Among the 10% most cited papers, the US and China again lead the way, and India ranks 20th, the report said.

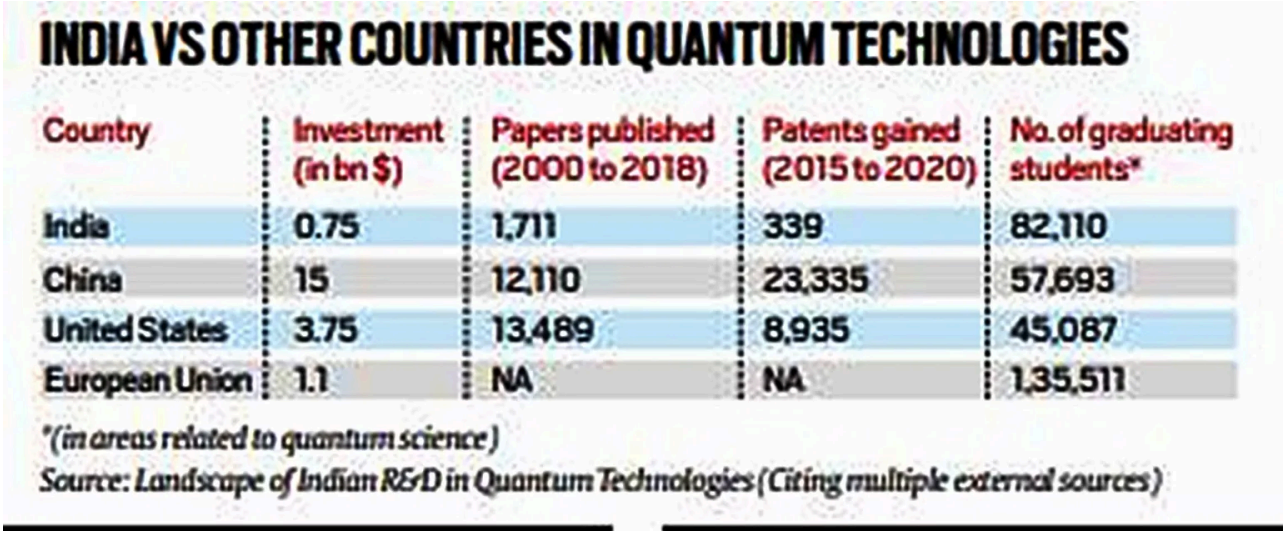
China and the US are also garnering a lion's share of the patents being registered. Between 2015 and 2020, Chinese and American researchers acquired 23,335 and 8,935 quantum-related patents respectively. However, Indian researchers had only 339 such patents in the same period, according to a patent database. India was ranked ninth by the number of patents obtained.

The country was lagging on a few other parameters as well but had a foundation that could be built upon.

Tough race but in competition

The new report pointed out that between 110 and 145 senior scientists were currently leading research groups on quantum-related technologies in India. These groups supported 75-100 post-doctoral fellows, and about 400 PhD students. In addition, about 200 senior scientists were working in the related fields of material sciences, electronics, computer science, and physics.

The report also found that outside the European Union, India had the largest number of graduate students in disciplines aligned to quantum technologies. These include biochemistry, electronics, chemical engineering, statistics, and information and communication technologies. There were more than 82,000 such students enrolled, which is more than in China or the US.



INDIA VS OTHER COUNTRIES IN QUANTUM TECHNOLOGIES

Country	Investment (in bn $)	Papers published (2000 to 2018)	Patents gained (2015 to 2020)	No. of graduating students*
India	0.75	1,711	339	82,110
China	15	12,110	23,335	57,693
United States	3.75	13,489	8,935	45,087
European Union	1.1	NA	NA	1,35,511

*(in areas related to quantum science)

Source: Landscape of Indian R&D in Quantum Technologies (Citing multiple external sources)

India vs other countries in quantum technologies.

The report said the National Quantum Mission needed to identify and promote young talent. The mission could also raise a separate cadre of quantum scientists

like the atomic energy or space science establishments had done, the report added.

Indian scientists are already at the forefront of research into quantum communications and quantum sensing, according to Abhay Karandikar, Secretary in the Department of Science and Technology. Even in areas such as computing and materials, the gap is not such that it cannot be bridged, he said.

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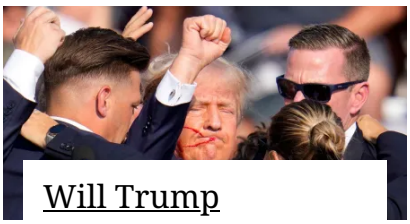

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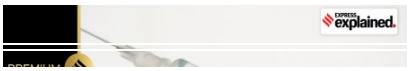

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