India has large gap to bridge in quantum capabilities

India was far behind of the United States and China in terms of patents obtained in quantum technologies till now, and in publications in top journals.

Written by Amitabh Sinha Follow
New Delhi | Updated: July 4, 2024 08:04 IST

Principal Scientific Advisor Ajay Sood (centre) and DST Secretary Abhay Karandikar (second from left) among others releasing a report on the current landscape Indian R&D in quantum technologies at an event at India International Centre in New Delhi on Tuesday. (Express Photo)

India may have done the right thing by launching a Rs 6,000 crore-worth National Quantum Mission to develop some of the most sought-after technologies for the future, but it would have to overcome a significantly large gap that currently exists between its capabilities and those of other leading countries in these areas like the United States and China, a new assessment of India's potential in quantum technologies has revealed.

The assessment by Itihaasa, a non-profit that studies the evolution of technology and business domains in the country, shows that India was just one among 17 countries to have a dedicated government programme to back research in quantum technologies, and one of the 12 to have committed separate investments for the purpose. But several countries were much ahead of India, not just in terms of committed funding for research and development but also in their current capabilities.

India's Rs 6,000 crore translates to about USD 0.75 billion over five years. China, on the other hand, was estimated to be spending USD 15 billion for developing quantum technologies. The United Kingdom (USD 4.3 billion), the United States (USD 3.75 billion), Germany (USD 3.3 billion) and South Korea (USD 2.35 billion).

India was far behind of the United States and China in terms of patents obtained in quantum technologies till now, and in publications in top journals.

“It is commendable that India is among the 17 countries with formal national quantum missions, and is among the top 12 countries in terms of committed investments. At the same time, we must recognise that India is lagging the global leaders in quantum technologies, and needs to ramp-up both R&D and translational aspects to catch up with them,” the assessment said.

Quantum technologies exploit the extremely weird and counter-intuitive — but very special nonetheless — properties of sub-atomic particles like an electron to develop processes and devices with capabilities and efficiencies that are impossible to achieve with classical, non-quantum, systems. A quantum computer, for example, can perform certain tasks that a normal computer, however fast or powerful it may be, might not be able to finish in any useful amount of time.

Quantum technologies, once they mature, will probably cause a disruption in almost every field, but some of the areas that are expected to be impacted first, and gain the most, happen to be computing, communications, cryptography, cybersecurity, and healthcare. Most of the technologies are still under development, with scientists still to gain full control over the quantum behaviour of the sub-atomic particles in a way that could be used to extract useful work.

India's National Quantum Mission, launched last year, aims to develop capabilities in four areas – quantum computing, communications, sensors and metrology (the science of measurements), and materials.

Abhay Karandikar, Secretary in Department of Science and Technology which is executing the quantum mission, said in at least two of these areas, communications and sensing, India had a very realistic chance of joining the global leaders in about five years' time.

"We already have fairly advanced capabilities in these areas (quantum communications, and sensing). We even have a few start-ups doing very good work. With a little push, we should be in the global lead. With other technologies, including quantum computing, we would have to work a lot more harder. But we are not starting at zero in any of these areas. We would be among the top-five, top ten or top 15 everywhere," he said.

Principal Scientific Advisor Ajay Sood said the gap between India and other leading countries was not such that it could not be bridged.

"In some areas we are may be one year behind. In some others, we might be four to five years behind. In some areas we are at par with the best in the world. We have to work hard for the next few years, because the fruits of these technologies are going to be transformational," Sood said.

The assessment report found about 110-145 Indian researchers, at the principal investigator level, already working on quantum technologies at major laboratories and institutions. About 75-100 Post-docs and 300-400 PhD students were working with them. In addition, there were about 50-100 MTech students in different areas related to quantum technologies.

biochemistry, chemistry, physics, electronics and chemical engineering, mathematics and statistics. More than 82,000 students were graduating in these subjects every year. Only European Union, taken as a whole, had higher number of students in these areas.

“These graduates will still need focused training on different aspects of quantum technologies to make them a relevant workforce in the field,” the assessment said.

It said that the government should explore the possibility of facilitating a dedicated science and technology cadre in each of the four areas identified for National Quantum Mission, similar to the dedicated cadres in India’s space and nuclear sectors.