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IBM's quantum computer. In the future, it is possible such computers will be a security asset that cannot be imported and Israel does not want to be left behind Credit: IBM Research

Tech News

'The Big Money Is Here': The Arms Race to Quantum Computing

A real quantum computer is still far off – but that doesn't bother those engaged in the arms race to develop a quantum processor. Here are the Israelis banking on it

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are skeptical of quantum computers' ability to be beneficial in the foreseeable future, simply because the physical and technological challenges are too great. On the other side, if you ask the entrepreneurs and investors at firms banking on quantum computing, that hasn't been the issue for quite some time. From their standpoint, it's only a matter of time and concerted effort until the major breakthrough and the real revolution in the field is achieved. And they're prepared to gamble a lot of money on that.

For decades, most of the quantum research and development has been carried out by academic institutions and government research institutes, but in recent years, steps to make the transition from the academic lab to the industrial sector have increased. Researchers and scientists have been creating or joining companies developing quantum computing technology, and startups in the field have been cropping up at a dizzying pace. In 2021, $3.2 billion was invested in quantum firms around the world, according to The Quantum Insider – compared to $900 million in 2020.

And in the first quarter of this year, about $700 million was invested – a sum similar to the investments in the field between 2015 and 2019 combined. In addition to the surge in startup activity in the field, tech giants such as IBM, Amazon, Google and Microsoft have been investing major resources in the field and have been recruiting experts as well.

"The quantum computing field was academic for a long time, and everything changed the moment that big money reached industry," said Ayal Itzkovitz, managing partner at the Pitango First fund, which has invested in several

was altogether possible to build such a computer, now we already know that there will be quantum computers that will be able to do something different from classic computers."

'The big money has reached the industry,' says Ayal Itzkovitz of Pitango First, a VC which has invested in several quantum companies
Credit: Yoram Reshef

Quantum computers, which are based on the principles of quantum theory, are aimed at providing vastly greater computing power than regular computers, with the capability to carry out a huge number of computations simultaneously. Theoretically it should take them seconds, minutes or hours to do what it would take today's regular supercomputers thousands of years to perform.

Quantum computers are based not on bits, but on "qubits" produced by a quantum processing unit, which is not limited to the binary of 0 or 1 but is a combination of the two. The idea is that a workable quantum computer, if and when there is such a thing, won't be suitable for use for any task but instead for a set of specific problems that require simultaneous computing, such as simulations, for example. It would be relevant for fields such as chemistry, pharmaceuticals, finance, energy and encoding among others.

It's still all theoretical, and there has yet to be a working quantum computer produced that is capable of performing a task more effectively than a regular computer – but that doesn't bother those engaged in the arms race to develop a

Israel's first quantum computer developed at Weizmann Institute

The quantum computer is about to change the world. Three Israelis are leading the revolution

Israel joins latest arms race: Quantum computing

A million-qubit computer

IBM, which is one of the pioneers in the industry, recently unveiled a particularly large 127-qubit computer, and it's promising to produce a 1,000-qubit one within the next few years. In 2019, Google claimed quantum supremacy with a computer that managed in 3.5 minutes to perform a task that would have taken a regular computer 10,000 years to carry out. And in May of last year, it unveiled a new quantum center in Santa Barbara, California and it intends to build a million-qubit computer by 2029 at an investment of billions of dollars.

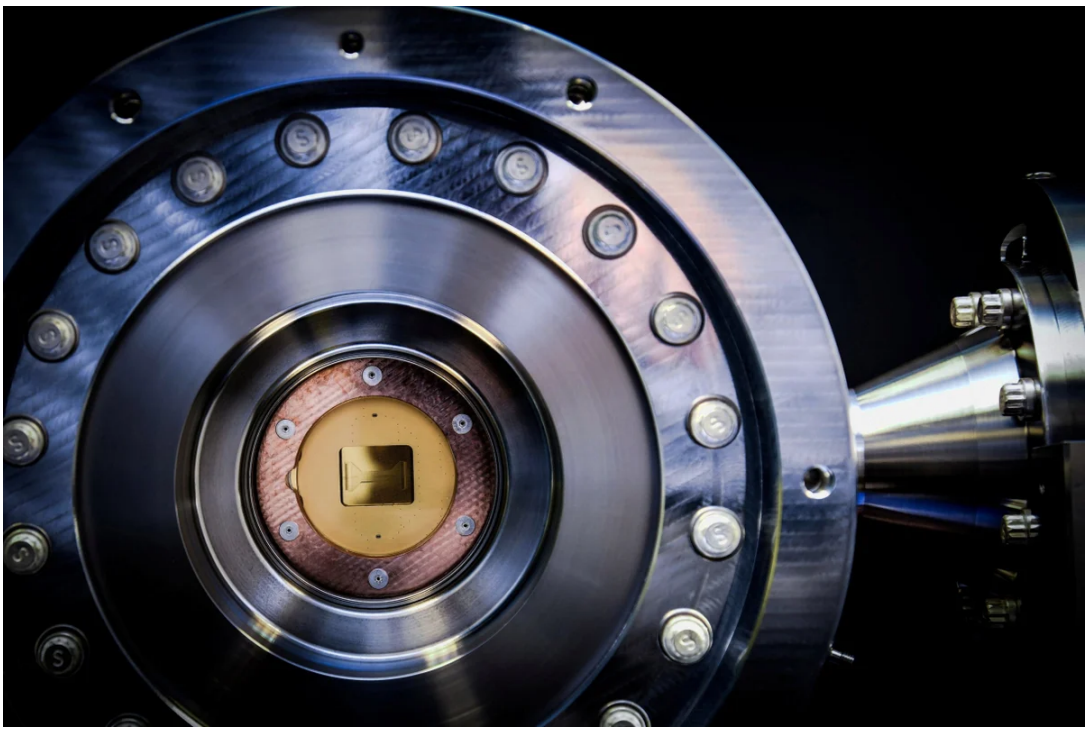
Amazon has gotten into the field, recruiting researchers and recently launching a new quantum center at the California Institute of Technology, and Intel and Microsoft have also gotten into the game. In addition to their own internal development efforts, Amazon, Microsoft and Google have been offering researchers access to active quantum computers via their cloud computing services.

At the same time, there are several firms in the market that specialize in quantum computing that have already raised considerable sums or have even gone public. One of the most prominent of them is the American company IonQ (which in the past attracted investments from Google, Amazon and Samsung) and which last year went public via a SPAC merger. Another such company is the Silicon Valley firm Rigetti Computing, which a[illegible]nt public via a SPAC

a merger between Honeywell Quantum Solutions and Cambridge Quantum.

All that's in addition to a growing startup ecosystem of smaller companies such as Atom Computing and QuEra, which have raised initial funding to develop their own versions of a quantum processor.

In Israel in recent months, the country's first two startups trying to create a quantum processor have been established. They're still in their stealth stage. One is Rehovot-based Quantum Source, which has raised $15 million to develop photonic quantum computing solutions. Its technology is based on research at the Weizmann Institute of Science, and it's headed by leading people in the Israeli processor chip sector. The second is Quantum Art, whose executives came from the Israeli defense sector. Its technology is also based on work at the Weizmann Institute.



A quantum computer. Israel is now working on building a local version - and also laying the groundwork for a local quantum industry Credit: QUANTINUUM/Reuters

There are also other early-stage enterprises that are seeking

company people. Then there is LightSolver, which is seeking to develop a laser technology computer, which is not quantum technology, but it seeks to provide similar performance.

Going for broke

But all of these are at their early stages from a technological standpoint, and the prominent companies overseas have or are building active but small quantum computers – usually of dozens of qubits that are only for R&D use – to demonstrate their capabilities but without actual practical application. That's out of a sense that developing an effective quantum computer that has a real advantage requires millions of qubits. That's a major disparity that will be difficult to bridge from a technological standpoint.

The problem is that sometimes investing in the here-and-now comes at the expense of investments in the future. The quantum companies are still relatively small and have limited staff. If they have an active computer, they also need to maintain it and support its users in the community and among researchers. That requires major efforts and a lot of money, which might be at the expense of next-generation research – and it is already delaying the work of a large number of quantum computer manufacturers who are seeing how smaller startups focusing only on next-generation development are getting ahead of them.

As a result, there are also companies with an entirely different approach, which seeks to skip over the current generation of quantum computers and go for broke – to build an effective computer with millions of qubits capable of error detection and correction – even if it takes many years.


In 2016, it was on that basis that the Palo Alto, California firm PsiQuantum was founded. Last year the company raised $450 million (in part from Microsoft and BlackRock) based on a company valuation of $3 billion, becoming one of the hot and promising names in the field.

Itzkovitz, from the Pitango fund, was one of its early investors. "They said they wouldn't make a small computer with a few qubits because it would delay them but would instead go straight for the real goal," he explained.

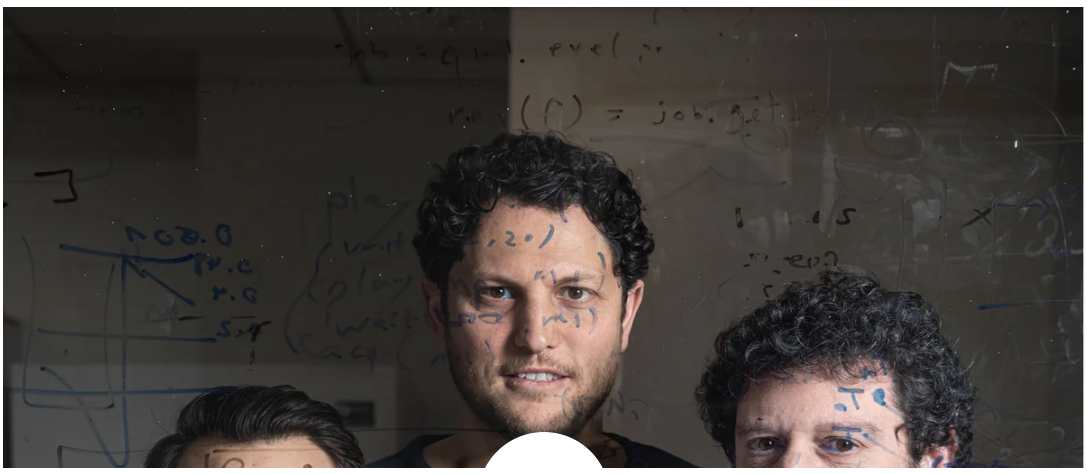
PsiQuantum is gambling on a fundamentally different paradigm: Most of the companies building an active computer, including the tech giants, have chosen technology based on specifical material matters (for example superconductors or trapped ions). In contrast, PsiQuantum is building a photonic quantum computer, based on light and optics – an approach that until recently was considered physically impossible.

Itzkovitz said that he has encountered a large number of startups that are building quantum processors despite the technological risk and the huge difficulty involved. "In the past two weeks, I have spoken with 12 or 13 companies making qubits – from England, Holland, Finland, the United States and Canada – as if this were the most popular thing there was now in the high-tech industry around the world," he said.

As a result, there are also venture capital funds in Israel and overseas that in the past had not entered the field but that are now looking for such companies to invest in – over concern not to be left out of the race, as well as a desire to be exposed to the quantum field.

Similar to the regular computing industry, in quantum computing, it's also not enough to build a processor. A quantum processor is a highly complex system that requires a collection of additional hardware components, as well as software and supporting algorithms, of course – all of which are designed to permit its core to function efficiently and to take advantage of the ability and potential of qubits in the real world. Therefore, at the same time that quantum processor manufacturers have been at work, in recent years there has been a growing industry of startups seeking to provide them and clients with layers of hardware and software in the "tower" that stands on the shoulders of the quantum computer's processor.

A good example of that is the Israeli firm Quantum Machines, which was established in 2018 and has so far raised $75 million. It has developed a monitoring and control system for quantum computers consisting of hardware and software. According to the company, the system constitutes the "brain" of the quantum processor and enables it to perform computing activity well and to fulfill its potential. There are also other companies in the market supplying such components and other components – including even the refrigerators necessary to build the computers.



The Quantum Machines leadership team, from left: Itamar Sivan, Yonatan Cohen and Nissim Ofek. Credit: Ilya Melnikov

Some companies develop software and algorithms in the hope that they will be needed to effectively operate the computers. One of them is Qedma Quantum Computing from Israel, which has developed what it describes as an operating system for quantum computers that is designed to reduce errors and increase quantum computers' reliability.

"Our goal is to provide hardware manufacturers with the tools that will enable them to do something efficient with the quantum computers and to help create a world in which quantum algorithmic advantages can actually be realized," said Asif Sinay, the company's founder-partner and CEO. "It's the Holy Grail of all of the quantum companies in the world."

The big challenge facing these companies is proving that their technology is genuine and that it provides real value to companies developing quantum processors. That's of course in addition to providing a solution that is sufficiently unique that the tech giants won't be able to develop it on their own.

"The big companies don't throw money around just like that," Sinay said. "They want to create cooperation with companies that help them r‘ ‘heir goal and to improve

for example, you can't come and scare a customer into buying your product. Here you're sitting with people at your level, really smart [people] who understand that you need to give them value that assists in the company's performance and to take the computer to a higher level."

'Two concurrent arms races'

What the companies mentioned so far have in common is that they are building technology designed to create an efficient quantum computer, whether it's a processor or the technology surrounding it. At the same time, another type of companies is gaining steam – those that develop the tools to develop quantum software that in the future will make it possible for developers and firms to build applications for the quantum computer.

Classiq is an Israeli company that has developed tools that make it easier for programmers to write software for quantum computers. It raised $33 million at the beginning of the year and has raised $48 million all told. A competitor in Singapore, Horizon Quantum Computing, which just days ago announced that it raised $12 million, is offering a similar solution.

Another prominent player is the U.S. firm Zapata, in which Israel's Pitago fund has also invested, and which is engaged in services involved in building quantum applications for corporations.

"There are two concurrent arms races happening now," says Nir Minerbi, co founder and CEO of Classiq. "One is to build the world's first fully functional quantum computer. And many startups and tech giants are working on that and that market is now peaking. The second race is the one for

and can serve these firms. This is a field that is now only making its first steps - and its hard to know when it will reach its goal."

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