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Committee on Science, Space, and Technology
Hearing on
"From Policy to Progress: How the National Quantum Initiative Shapes U.S. Quantum Technology Leadership"
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Chairman Babin, Ranking Member Lofgren, and distinguished members of the Committee, thank you for this opportunity to offer testimony on the state of the American quantum computing industry and to support the National Quantum Initiative Act Reauthorization.

My name is Pete Shadbolt. I am co-founder and Chief Scientific Officer at PsiQuantum. Prior to co-founding the company in 2016, I was a researcher in the UK, where I worked on photonic quantum computing for about a decade.

Eight years ago, together with three of my former professors, I quit my academic job and moved to the United States with a singular mission — to build and deploy the first large-scale, commercially useful quantum computers.

We established our headquarters in the United States because there is no better place to build world-changing technologies.

Our advanced society is built on a microscopic foundation of chemistry, physics and math. Leadership in many of our critical industries is contingent on drug molecules, fuels, materials, catalysts, fertilizers, and semiconductor manufacturing processes where today, despite great progress in high performance computing and artificial intelligence, we often lack the tools to rapidly design new capabilities without enormously expensive trial and error.

These are exactly the problems where quantum computers promise to give answers, which will remain forever out of reach for any conventional computer.

Our company was founded with a vigorous determination to drag quantum computing out of the research lab and into the mature semiconductor manufacturing industry. We believed that through leverage of this existing ecosystem — which builds millions of chips for cellphones and GPUs every year — we could unlock a fast path to the million-qubit machines required for all useful applications.

Since then, we have raised over $700M in private capital, created jobs for hundreds of the best technical people on the planet, and have already invested hundreds of millions of dollars to advance American semiconductor manufacturing. Today we make thousands of wafers of quantum chips at GlobalFoundries FAB8 in upstate New York. We are now scaling up towards mass production of the three-ton steel refrigerators which cool our chips. And later this year, we will break ground on a datacenter-sized quantum computer on American soil.

The United States currently enjoys an unequivocal leadership position in quantum computing and advanced technology more broadly. However, that status is under perpetual and escalating threat from both benign competitors and hostile adversaries. They want tech superiority just as much as we do — and will stop at nothing to get it.

Now is the time for governments to take bold steps and secure the future of this critical technology. PsiQuantum has already benefited tremendously from our partnerships with DARPA, the Air Force, and the National Labs, and I am grateful to have these organizations by my side as we launch this sovereign, strategic capability into the world.

This Committee now has the opportunity to make policy choices that will shape the next ten years of investment and incentives, and which will impact the rest of the century. The path forward is clear. The U.S. has the industrial base, the scientific talent, and the strategic allies, but it must move decisively to pull these threads together. We hope that PsiQuantum can be a trusted partner in shaping those outcomes so that the U.S. and its allies can win this race.

The State of U.S. Quantum Computing and Global Competition

The United States currently maintains a leadership position in quantum computing research, development, and commercialization, but this advantage is increasingly under threat from competitors that see an opportunity to overtake us and lead the world in this critical capability. The quantum computing landscape has evolved and grown rapidly since the passage of the original National Quantum Initiative Act (NQIA) in 2018, with significant advances in hardware, algorithms, and potential applications. The prospect of a large, powerful quantum computer capability has shifted from possible to increasingly imminent.

Intensifying global competition is coming from China, which has made quantum technology a national priority. There are clear signals of their commitment: public statements of state-led investments exceeding $15 billion[1], showcasing milestones to include the world's first quantum satellite and a 2,000-kilometer quantum network,[2] and notable achievements in quantum computing hardware.[3] At PsiQuantum, we are laser-focused on our own mission,

[1] "Betting Big on Quantum," McKinsey and Company, September 13, 2022, https://www.mckinsey.com/featured-insights/sustainable-inclusive-growth/chart-of-the-day/betting-bigon-quantum.
[2] Hodam Omaar and Martin Makaryan, "How Innovative is China in Quantum," Information Technology & Innovation Foundation, September 2024, www2.itif.org/2024-chinese-quantum-innovation.pdf.
[3] Matt Swayne, "China Introduces 504-Qubit Superconducting Chip," Quantum Insider, December 6, 2024, https://thequantuminsider.com/2024/12/06/china-introduces-504-qubit-superconducting-chip/; Brian Hart, Bonny Lin, Samantha Lu, Hannah Price, Yu-jie (Grace) Liao, Matthew Slade, "Is China a Leader in Quantum Technologies," Center for Strategic and International Studies, January 31, 2024, https://chinapower.csis.org/china-quantum-technology.

but we are acutely aware that a determined CCP can scale investment, impose its own strategic vision for technology development, and coordinate across academia and state-owned industry. This determination and allocation of resources poses a substantial challenge to U.S. leadership in quantum computing.

In recent years, governments have become increasingly aware that frontier technologies — such as semiconductor fabs, AI supercomputers, and datacenters — will have sovereign strategic implications. These are multi-hundred-million-dollar systems, rooted into the ground, so complex and technically challenging as to be nearly impossible to replicate — and their location and stewardship can have significant geopolitical implications. The world's dependence on southeast Asia for the vast majority of advanced semiconductor capability is a destabilizing strategic vulnerability, one that the U.S. is actively working to mitigate. We emphasize that as far as we understand, quantum computers are likely to exhibit similar practical constraints and geographic trends, implying the same strategic considerations. The few countries that today understand the quantum computing race is not merely academic, will generate profound outcomes for national security, economic competitiveness, and technological sovereignty.

Our Allies share our vision for harnessing this game-changing technology. In 2024, the Australian Federal and State of Queensland Governments announced an investment of nearly $650 million to build the world's first utility-scale quantum computer in Brisbane. The Government of Australia recognized early that quantum computing is a sovereign capability that could transform their commercial industry and national security capabilities. Other countries or regional blocs have invested resources into basic research in quantum computing and quantum technology, but the bold decisions made by Australia and the United States to build utility-scale systems remain unequalled.

Quantum computing is one of a few technologies — including AI, autonomous vehicles, photonics, and semiconductor manufacturing — that are rightly and routinely described as defining the frontier of advanced technology. All of these technologies have endured a multi-decade journey out of the research lab, assisted tremendously by government engagement. And despite understandable skepticism and impatience, none of these technologies are fundamentally out of reach. The basic question for nations is: do you want to possess and master the most advanced technology, or not?

PsiQuantum's Approach to Utility-Scale Quantum Computing

Quantum computing is fundamentally a "zero-to-one" technology. Contrary to some other familiar technologies, small quantum computers are ***not*** marginally commercially useful. While academically interesting, such systems cannot solve any real problems of any commercial or strategic value. Large quantum computers – on the order of a million physical qubits – are widely anticipated to solve valuable problems, which will never be solved by any conventional computer we could ever build. This intrinsic "step function" is a challenge for the funding and development of the technology that, while well-understood by academia, has so far not been fully internalized by industry and governments.

By the time PsiQuantum was founded nine years ago, my cofounders had already spent more than a decade each in the university system, making basic scientific demonstrations of qubits, gates, and algorithms, which were published in various high-profile academic journals. In some cases, this work was funded in part by IARPA, DARPA, AFRL and various other U.S. agencies. My colleagues were successful professors, running large research groups.

When we founded the company, we deliberately made an abrupt departure from this academic mode of operation. We largely stopped publishing papers and going to conferences and built a company that is singularly and urgently focused on delivering large-scale, commercially useful systems as fast as humanly possible.

Above all, we were emboldened by the prospect of leveraging the incredible volume and density that is routinely achieved in the semiconductor industry. We believed that this existing capability could become the key to unlock a fast path to million-qubit machines, without prohibitively costly and slow re-invention or re-implementation of the mature manufacturing processes required at scale.

Since 2019, we have been embedded with one of the world's leading semiconductor manufacturers, GlobalFoundries in Upstate New York, where we are fabricating quantum computing chips using the same processes that produce today's most sophisticated electronics. GlobalFoundries is rare in that it is a true tier-one semiconductor foundry in the same category as TSMC, Samsung, and Intel. We have directly witnessed the capability of the fab as applied to our quantum chips — thanks to our collaboration with GlobalFoundries we are now able to produce thousands of wafers of quantum chips, with beyond-state-of-the-art performance.

Our engagement with GlobalFoundries is characteristic of our interactions with our supply chain more broadly, in that it is far from a hands-off transactional relationship. PsiQuantum has a team of ten people collocated at the Albany location, and we have installed ten shipping-container-sized semiconductor manufacturing tools into the fab to enable the production of nonstandard materials such as superconducting thin films and an advanced optical switch. These interventions, though our collaboration, extend the boundary of what GlobalFoundries can offer to their customers in industry and government, and are designed from the outset to be mutually, strategically beneficial, even outside the scope of quantum computing — to photonics, computing, networking, sensing, imaging, and beyond.

The U.S. quantum supply chain doesn't end there. We are cutting steel in Minnesota for our refrigerators, using the growing photonics industry in Montana, working with fiber optics suppliers in Virginia and Colorado, and partnering with growing quantum tech industries in California and Texas. Overall, in 2024 PsiQuantum worked with over 500 suppliers and vendors in the United States, spanning 39 different states. We value international partners that are important for stability and growth, but identifying domestic manufacturing of state-of-the-art components is a strategic benefit for the company.

When we build the first useful quantum computer in the United States, we believe that the implications for commercial competitiveness and national security will be profound. A utility-scale quantum computer is a tool that will transform the microscopic foundations of our largest industries, delivering a new agency over biology and chemistry.

- In pharmaceuticals, quantum computing is expected to dramatically accelerate drug discovery by enabling precise simulation of complex molecular interactions.

- In materials science, it will revolutionize the design of novel materials with engineered properties — from ultra-light, high-strength alloys to the next generation of semiconductors — with applications spanning aerospace, defense, and advanced manufacturing.

- In energy, it will drive new chemistries for the next-generation batteries and ultra-efficient catalysts for carbon capture, directly impacting the global energy transition.

The potential impact on national security is equally, if not more, important. We know that there is a technological path for quantum computers to break today's most widely used encryption protocols. It is perhaps notable that one of the earliest applications of conventional computers was for codebreaking during the Second World War. Shortly afterwards, brute-force codebreaking was rendered practically impossible by the invention of protocols such as Diffie-Hellman, RSA, and elliptic curve cryptography, which are in widespread use today. Security professionals have become very used to the idea that the cryptography is the strongest part of any computer security system, but a sufficiently large quantum computer would completely break this deeply held assumption — shaking the foundations which protect government communications, critical infrastructure, defense systems, and global financial networks. Disrupting the fundamentals of encryption has the potential to undercut global commerce and communications. Governments have been preparing for that moment by developing more sophisticated defense measures and protections, but we must also invest to ensure that the U.S. and its allies win that technological sprint.

Our team at PsiQuantum has published the most advanced and efficient algorithms for breaking elliptic curve cryptography, setting the benchmark for the power and size of quantum computer needed to enter into cryptographic territory. These machines are no longer decades away.

Public-Private Partnerships: The DARPA Model

While PsiQuantum is a commercial company, we have been the beneficiaries of government partnerships in the U.S. and with allied governments. These relationships mix private and public resources, expertise, and ideas. We believe that our experiences highlight the role of governments in support of critical emerging technologies.

PsiQuantum is a longtime partner with the Department of Energy and its national laboratories focused on quantum science. We have collaborated for some time with the Stanford Linear Accelerator (SLAC), where we are using the LCLS-II cryoplant – one of the largest in the United States – to produce liquid helium for our prototype cryostats. We contract with Los Alamos to advance applications for the National Security Mission. PsiQuantum will also collaborate with Argonne and Fermilab as the Illinois Quantum and Microelectronics Park (IQMP) builds out in Chicago. We hope to continue expanding our work across the National Labs and in recent months we have formed partnerships with Lawrence Berkeley Lab (NERSC Integration), Brookhaven National Lab (Quantum and High Energy Physics), and Pacific Northwest National Lab (Quantum Chemistry and Biology).

In addition to these relationships across the Department of Energy, our collaboration with the Defense Advanced Research Projects Agency (DARPA) exemplifies the power of strategic public-private partnerships to advance cutting-edge technologies. DARPA's Quantum Benchmarking Initiative (QBI) has helped accelerate our development of quantum computing hardware and software while subjecting our technology architecture to rigorous government verification and validation. We are pleased that DARPA has selected PsiQuantum to advance to the final round in their evaluation of quantum technologies.

Quantum computing is a technology that is unfortunately associated with considerable hype and confusion. One of the most welcome characteristics of the DARPA program has been skepticism — the original DARPA Unexplored Systems for Utility-Scale Quantum Computing (US2QC) program started from the intentionally negative assumption that (i) quantum computers are not commercially useful and (ii) nobody knows how to build one any time soon. The program was explicitly designed to rule out indefensible claims of utility or viability of particular approaches, and has had a welcome focus on underexplored aspects of building a real technology, such as manufacturability, yield, reliability etc. PsiQuantum is proud to have survived this in-depth “red team” evaluation, and we offer that surviving evaluation by determined skeptics represents greater value and more significance than receiving endorsement from uncritical quantum enthusiasts.

This partnership has yielded mutual benefits. For PsiQuantum, it has provided not only funding but also access to domain expertise from across the national lab ecosystem and defense enterprise. For DARPA, the broader U.S. government, and most importantly the taxpayer, it has accelerated progress toward quantum capabilities that address critical national security challenges while establishing a model for responsible innovation in dual-use technologies. The outcomes of our work with DARPA, to include the agency’s evaluations of our technology, will also be shared with the Department of Energy per a formal agreement between the two organizations.

The success of this collaboration demonstrates how federal agencies can effectively engage with the private sector to advance strategic technologies without duplicating efforts or competing with commercial investment. DARPA's focus on cutting edge research, combined with its willingness to establish ambitious but achievable technical milestones, has proven particularly effective in the quantum computing domain.

This model could be replicated across other agencies, with appropriate adaptations for their specific missions and requirements. The Department of Energy, National Science Foundation, National Institute of Standards and Technology, and other agencies all have important roles to play in advancing different aspects of the quantum computing ecosystem.

NQIA Reauthorization and Achieving American Quantum Dominance

The race for useful quantum computing is one that the United States and its allies must lead. To do so, the federal government should be bold in the support of quantum computing capabilities. The commercial sector is investing billions in quantum computing, but the U.S. government can augment the quantum computing ecosystem by serving as 1) an accelerator of critical capabilities; 2) a validator of different quantum modalities to provide confidence in the value of quantum computing; and 3) a facilitator of collaboration across allies.

- <u>Accelerator</u>: In PsiQuantum's experience, government resources or policies have accelerated some capabilities in areas where the private market could not. These include evolutionary development of advanced semiconductor chips in coordination with national laboratories and the Department of Defense, identification of quantum applications that would be useful for government sponsors, and incentives to build the first useful quantum computers in Chicago and Brisbane.

- <u>Validator:</u> Partnering with government agencies to rigorously evaluate the state of the technology will provide confidence in quantum computing to commercial customers and other government agencies. PsiQuantum's collaboration with DARPA has broadly highlighted our efforts to develop a utility-scale quantum computer, confirmed with the investor community that our technological roadmap has merit, and showcased to other government agencies that potential applications of quantum computing are no longer opportunities for the distant future. There is no substitute for the technology proving itself in the commercial market, but government evaluation can enhance the acceptance of quantum computing as a solution.

- <u>Facilitator:</u> U.S. export controls, particularly under the AUKUS security agreement between the U.S., Australia and the United Kingdom, have allowed for greater collaboration to meet national security requirements. Its "Pillar II" focuses on facilitating technology sharing on critical technologies like quantum computing will allow companies like PsiQuantum to more easily work across the three countries.

The reauthorization of the National Quantum Initiative Act (NQIA) provides this Committee and Congress an opportunity to bolster American competitiveness in quantum computing. The original NQIA established landmark coordinated federal approaches to quantum information science and technology, spanning fundamental research, workforce development, technology transfer, and international cooperation. This framework has proven effective but requires renewal and additional bold measures:

Specifically, I humbly recommend that the reauthorized NQIA:

1. **Compete and secure access to a useful quantum computer of a million qubits in size that will be a dedicated resource for U.S. government science, research, and applications.** The federal investments in supercomputers decades ago continue to pay dividends in scientific exploration, commercial applications, and military requirements. The Department of Energy should take action toward a public-private collaboration to secure access to and utilize a national quantum computing asset to address the government's most pressing problems. This is not a low-risk or inexpensive endeavor, but if successful, could ensure quantum computing dominance.

2. **Augment the quantum supply chain through strategic capital investments in critical manufacturing.** Like the Department of Defense's Office of Strategic Capital (OSC), the Department of Energy should create a program to leverage U.S.-backed loans and loan guarantees for quantum industry manufacturing. For example, there are limited U.S. suppliers for cryostat manufacturing – a capability that nearly all quantum computing companies will need – but low-risk investments in these capabilities could pay huge dividends for the industry. A robust quantum computing supply chain benefits the entire nation.

3. **Increase funding for fundamental quantum research, with particular emphasis on error correction, fault tolerance, and algorithm development.**

4. **Expand support for workforce development programs, addressing the critical shortage of talent needed.** This includes more than just quantum physicists – a robust utility-scale quantum computing ecosystem requires semiconductor engineers, software programmers, and highly skilled tradespeople like welders.

5. **Strengthen Department of Energy public-private partnerships** through expanded use of cooperative research agreements, consortia, and other collaborative mechanisms.

Conclusion

The quantum computing revolution is no longer theoretical—it is unfolding now, with profound implications for America's future prosperity and security. At PsiQuantum, we are proud to be at the forefront of this transformation, working to build the world's first useful quantum computers right here in the United States and in partnership with our closest allies.

However, we know that success will be shared with the government with the right public policy and resources that accelerate, validate and facilitate the quantum computing industry. Sustained federal leadership, investment, and coordination are essential to maintain America's quantum advantage. The reauthorization of the National Quantum Initiative Act represents a critical opportunity to recommit to U.S. leadership in this transformative technology.

The economic and strategic stakes are too high for hesitation or half-measures. Other nations are moving aggressively to establish quantum capabilities, and the U.S. must respond with commensurate ambition and commitment.

I urge this Committee and Congress to consider these recommendations, and to act expeditiously to reauthorize and strengthen the NQIA, ensuring that the United States remains at the vanguard of the quantum revolution. The future of our technological leadership, economic competitiveness, and national security depends on it.

Thank you for your consideration, and I look forward to answering any questions you may have.