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Chairwoman Murkowski, Ranking Member Cantwell, and members of the committee, thank you for the opportunity to appear before you today to discuss the status of quantum information sciences field, and the role and efforts of the U.S. Department of Energy (DOE) national laboratories in this regard. I am Supratik Guha, a professor at the Institute for Molecular Engineering at the University of Chicago, and director of Argonne National Laboratory's Center for Nanoscale Materials facility, supported by the DOE Office of Science.

Quantum information sciences exploits the unique properties of quantum mechanics to rapidly explore information spaces in a connected manner, rather than the sequential manner of conventional information processing. Building machines and devices that exploit this property, we then expect enormous advantages: in certain types of computing such as codebreaking; in the design of materials and molecules for areas such as drug discovery; and in the secure transmission of data. Advances also extend to the measurement, with unprecedented accuracy, of physical parameters important in areas such as geopositioning as well as in basic science—a field known as quantum sensing. The potential impacts are remarkably broad, from sensing within living cells to single-molecule magnetic resonance imaging. As another example, by using highly precise atomic clocks based upon the principles of quantum mechanics, we can try to answer the fundamental question: Are some of the physical constants we assume in science, really constant?

Every once in a while, a technology appears that offers the potential to change our world, and we should seriously recognize quantum information sciences as such a candidate. However, this is still early stage, and there is a lot to be done in developing the science and creating the technology to make quantum information sciences usable for the public good. But the time is now, with China as well as European nations ramping up their investments in this area. It is also imperative for the U.S. to maintain its edge in this field because this technology will offer critical differentiating advantages to the leader.

In the past, companies such as Bell Labs and IBM carried out the bulk of the pre-competitive research and early development of some landmark technologies. Silicon microelectronics and telecommunications are examples. Today, the costs and complications of current cutting-edge research make it no longer possible for industrial research and development to do it all. This is where the DOE national laboratories come in. They have the size, the massive experimental capabilities and the multi-disciplinary skills from computing systems to physics and materials science under one roof, as well as the professional staff and project management skills to deliver on large, complicated systems and programs. Working in close collaboration with industry and academia, the national labs are ideal places to offer the intellectual and infrastructural breadth that is required to anchor future research in quantum information sciences.

Indeed, the DOE national laboratories have a proven track record in working with industry and academia to convert science into impactful technology. From the 1940s through the 1960s, Argonne National Laboratory played a major role in developing nuclear reactor technology for civilian nuclear power. More recently, the DOE national laboratories, working with computer companies and academic partners anchored the development and scientific utilization of supercomputing. Almost every major drug company has worked with the DOE national laboratories and benefitted enormously from the information on protein structure determined using their advanced X-ray light sources. The science community strongly supports the DOE laboratory system and is well connected historically through the laboratories' various user facilities including the Nanoscale Science Research Centers, the advanced light and neutron sources and computing facilities. The contributions of DOE-sponsored university research is yet another traditional connection between DOE and academia.

Developing quantum information science into a technology will require a new workforce of quantum engineers who are intimately familiar with quantum mechanics. This workforce does not currently exist. Quantum advancements also will require a multi-disciplinary research vision that is purpose driven, with teams drawn from academia, industry and the national labs. This philosophy is behind the newly formed Chicago Quantum Exchange, a collaboration between Argonne, the University of Chicago and Fermi

National Accelerator Laboratory, involving over 60 scientists from these three institutions. The Chicago Quantum Exchange recently has begun research, funded by the DOE, focused on establishing a 30-mile optical fiber link between Argonne and Fermilab as a testbed for studying quantum entanglement and teleportation for secure information transfer. This quantum triangle represents a unique multi Lab-University collaboration, using the science basis of entanglement coupled to the technical and network expertise of the labs. It highlights the unique benefits that DOE's national laboratory network brings: the possibility to immediately respond to a major emerging scientific challenge, to draw from intimate connections between thought leaders both in academia and industry, and to convene the necessary intellectual depth and technological infrastructure to advance the nation's interests.

Aiming to create a workforce, the Chicago Quantum Exchange has begun a program, funded by the National Science Foundation, to match students and their academic advisors across the country with industrial and national laboratory mentors. So far, 21 such students have been matched in less than one year. The nearly 20 university faculty attached to the Chicago Quantum Exchange are some of the world's premier experts in quantum information science and they administer one of the first Ph.D. programs in quantum engineering in the world.

We should keep in mind that while we have clear ideas of some of the benefits that quantum information sciences will bring, it is almost certain there are many applications that are as yet unknown, but which will significantly affect our lives. It is therefore important to have breadth in our activity going forward, and diversity of thought. This is yet another area where the DOE laboratories excel, with their range of scientific skills.

Thank you for your time and attention. I would be happy to respond to any questions that you might have.