

**Calendar No. 676**115<sup>TH</sup> CONGRESS  
2<sup>D</sup> SESSION**S. 3143****[Report No. 115–389]**

To provide for a coordinated Federal program to accelerate quantum research and development for the economic and national security of the United States.

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## IN THE SENATE OF THE UNITED STATES

JUNE 26, 2018

Mr. THUNE (for himself, Mr. NELSON, Mr. GARDNER, Ms. HARRIS, Mr. DAINES, and Mr. RUBIO) introduced the following bill; which was read twice and referred to the Committee on Commerce, Science, and Transportation

NOVEMBER 27, 2018

Reported by Mr. THUNE, with an amendment

[Strike out all after the enacting clause and insert the part printed in *italic*]

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**A BILL**

To provide for a coordinated Federal program to accelerate quantum research and development for the economic and national security of the United States.

1       *Be it enacted by the Senate and House of Representa-*  
2       *tives of the United States of America in Congress assembled,*

1 **SECTION 1. SHORT TITLE; TABLE OF CONTENTS.**

2 (a) **SHORT TITLE.**—This Act may be cited as the  
3 “National Quantum Initiative Act”.

4 (b) **TABLE OF CONTENTS.**—

Sec. 1. Short title; table of contents.

Sec. 2. Definitions.

Sec. 3. Purposes.

**TITLE I—NATIONAL QUANTUM INITIATIVE**

Sec. 101. National Quantum Initiative Program.

Sec. 102. National Quantum Coordination Office.

Sec. 103. Subcommittee on Quantum Information Science.

Sec. 104. National Quantum Initiative Advisory Committee.

Sec. 105. Sunset.

**TITLE II—NATIONAL INSTITUTE OF STANDARDS AND  
TECHNOLOGY QUANTUM ACTIVITIES**

Sec. 201. National Institute of Standards and Technology Activities and Quantum Workshop.

**TITLE III—NATIONAL SCIENCE FOUNDATION AND MULTIDISCIPLINARY CENTERS FOR QUANTUM RESEARCH AND EDUCATION**

Sec. 301. Quantum Information Science Research and Education Program.

Sec. 302. Multidisciplinary Centers for Quantum Research and Education.

Sec. 303. Spending limitation.

5 **SEC. 2. DEFINITIONS.**

6 In this Act:

7 (1) **ADVISORY COMMITTEE.**—The term “Advisory  
8 Committee” means the National Quantum Initiative  
9 Advisory Committee established under section  
10 104(a).

11 (2) **COORDINATION OFFICE.**—The term “Co-  
12 ordination Office” means the National Quantum Co-  
13 ordination Office established under section 102(a).

14 (3) **INSTITUTION OF HIGHER EDUCATION.**—The  
15 term “institution of higher education” has the

1 meaning given the term in section 101(a) of the  
2 Higher Education Act of 1965 (20 U.S.C. 1001(a)).

3 (4) PROGRAM.—The term “Program” means  
4 the National Quantum Initiative Program imple-  
5 mented under section 101(a).

6 (5) QUANTUM INFORMATION SCIENCE.—The  
7 term “quantum information science” means the  
8 storage, transmission, manipulation, or measurement  
9 of information that is encoded in systems that can  
10 only be described by the laws of quantum physics.

11 (6) SUBCOMMITTEE.—The term “Sub-  
12 committee” means the Subcommittee on Quantum  
13 Information Science of the National Science and  
14 Technology Council established under section  
15 103(a).

16 **SEC. 3. PURPOSES.**

17 The purposes of this Act are to ensure the continued  
18 leadership of the United States in quantum information  
19 science and its technology applications by—

20 (1) supporting research, development, dem-  
21 onstration, and application of quantum information  
22 science and technology in order to—

23 (A) expand the number of researchers,  
24 educators, and students with training in quan-

1           tum information science and technology to de-  
2           velop a workforce pipeline;

3           (B) promote the development and inclusion  
4           of multidisciplinary curriculum and research op-  
5           portunities for quantum information science at  
6           the undergraduate, graduate, and postdoctoral  
7           level;

8           (C) address basic research knowledge gaps;

9           (D) promote the further development of fa-  
10          cilities and centers available for quantum infor-  
11          mation science and technology research, testing  
12          and education; and

13          (E) stimulate research on and promote  
14          more rapid development of quantum-based tech-  
15          nologies;

16          (2) improving the interagency planning and co-  
17          ordination of Federal research and development of  
18          quantum information science and technology and  
19          maximizing the effectiveness of the Federal Govern-  
20          ment's quantum information science and technology  
21          research and development programs;

22          (3) promoting collaboration among government,  
23          Federal laboratories, industry, and universities; and

1           (4) promoting the development of standards for  
2           quantum information science and technology secu-  
3           rity.

4           **TITLE I—NATIONAL QUANTUM**  
5           **INITIATIVE**

6           **SEC. 101. NATIONAL QUANTUM INITIATIVE PROGRAM.**

7           The President shall implement a 10-year National  
8           Quantum Initiative Program. In carrying out the Pro-  
9           gram, the President shall, acting through appropriate  
10          Federal agencies, councils, working groups, subcommit-  
11          tees, and the Coordination Office—

12           (1) establish the goals, priorities, and metrics  
13           for a 10-year plan to accelerate development of  
14           quantum information science and technology applica-  
15           tions in the United States;

16           (2) invest in fundamental Federal quantum in-  
17           formation science and technology research, develop-  
18           ment, demonstration, and other activities to achieve  
19           the goals established in paragraph (1);

20           (3) invest in activities to develop a quantum in-  
21           formation science and technology workforce pipeline;

22           (4) provide for interagency coordination of Fed-  
23           eral quantum information science and technology re-  
24           search, development, demonstration, and other ac-  
25           tivities undertaken pursuant to the Program;

1           (5) partner with industry and academia to le-  
2           verage knowledge and resources; and

3           (6) leverage existing Federal investments effi-  
4           ciently to advance Program goals and objectives.

5 **SEC. 102. NATIONAL QUANTUM COORDINATION OFFICE.**

6           (a) **ESTABLISHMENT.**—The President shall establish  
7 a National Quantum Coordination Office, which shall  
8 have—

9           (1) a Director appointed by the Director of the  
10 Office of Science and Technology Policy, in consulta-  
11 tion with the Secretary of Commerce, the Director  
12 of the National Science Foundation, and the Sec-  
13 retary of Energy; and

14           (2) staff that shall be comprised of employees  
15 detailed from the Federal agencies that are members  
16 of the Subcommittee.

17           (b) **RESPONSIBILITIES.**—The Coordination Office  
18 shall—

19           (1) provide technical and administrative support  
20 to—

21                   (A) the Subcommittee; and

22                   (B) the Advisory Committee;

23           (2) oversee interagency coordination of the Pro-  
24 gram, including encouraging and supporting joint

1 agency solicitation and selection of applications for  
2 funding of projects under the Program;

3 ~~(3)~~ serve as the point of contact on Federal ci-  
4 vilian quantum information science and technology  
5 activities for Government organizations, academia,  
6 industry, professional societies, State governments,  
7 and others to exchange technical and programmatic  
8 information;

9 ~~(4)~~ ensure coordination between the Multidisci-  
10 plinary Centers for Quantum Research and Edu-  
11 cation established under section 302(a) and the Na-  
12 tional Quantum Information Science Research Cen-  
13 ters established under section 402(a);

14 ~~(5)~~ conduct public outreach, including dissemi-  
15 nation of findings and recommendations of the Advi-  
16 sory Committee, as appropriate; and

17 ~~(6)~~ promote access to and early application of  
18 the technologies, innovations, and expertise derived  
19 from Program activities to agency missions and sys-  
20 tems across the Federal Government, and to United  
21 States industry, including startup companies.

22 ~~(c) FUNDING.~~—Funds necessary to carry out the ac-  
23 tivities of the Coordination Office shall be made available  
24 each fiscal year by the participating agencies of the Sub-

1 committee, as determined by the Director of the Office  
2 of Science and Technology Policy.

3 **SEC. 103. SUBCOMMITTEE ON QUANTUM INFORMATION**  
4 **SCIENCE.**

5 (a) **ESTABLISHMENT.**—The President shall establish,  
6 through the National Science and Technology Council, a  
7 Subcommittee on Quantum Information Science.

8 (b) **MEMBERSHIP.**—The Subcommittee shall in-  
9 clude—

10 (1) the National Institute of Standards and  
11 Technology;

12 (2) the National Science Foundation;

13 (3) the Department of Energy;

14 (4) the National Aeronautics and Space Admin-  
15 istration;

16 (5) the Department of Defense;

17 (6) the Office of the Director of National Intel-  
18 ligence;

19 (7) the Office of Management and Budget;

20 (8) the Office of Science and Technology Policy;  
21 and

22 (9) any other Federal agency as considered ap-  
23 propriate by the President.

24 (c) **CHAIRS.**—The Subcommittee shall be jointly  
25 chaired by the Director of the National Institute of Stand-



1 ards and Technology, the Director of the National Science  
2 Foundation, and the Secretary of Energy.

3 (d) RESPONSIBILITIES.—The Subcommittee shall—

4 (1) coordinate the quantum information science  
5 and technology research and education activities and  
6 programs of the Federal agencies;

7 (2) establish goals and priorities of the Pro-  
8 gram, based on identified knowledge and workforce  
9 gaps and other national needs;

10 (3) assess and recommend Federal infrastruc-  
11 ture needs to support the Program; and

12 (4) evaluate opportunities for international co-  
13 operation with strategic allies on research and devel-  
14 opment in quantum information science and tech-  
15 nology.

16 (e) STRATEGIC PLAN.—Not later than 1 year after  
17 the date of enactment of this Act, the Subcommittee shall  
18 develop a 5-year strategic plan, and 6 years after enact-  
19 ment of the Act develop an additional 5-year strategic  
20 plan, with periodic updates as appropriate to guide the  
21 activities of the Program, meet the goals, priorities, and  
22 anticipated outcomes of the participating agencies.

23 (f) REPORTS.—The Chairs of the Subcommittee shall  
24 submit to the President, the Advisory Committee, the  
25 Committee on Science, Space, and Technology of the

1 House of Representatives, the Committee on Commerce,  
2 Science, and Transportation and the Committee on En-  
3 ergy and Natural Resources of the Senate, and other ap-  
4 propriate committees of Congress the strategic plans de-  
5 veloped under subsection (e) and any updates to such  
6 plans.

7 **SEC. 104. NATIONAL QUANTUM INITIATIVE ADVISORY COM-**  
8 **MITTEE.**

9 (a) **IN GENERAL.**—The President shall establish a  
10 National Quantum Initiative Advisory Committee.

11 (b) **QUALIFICATIONS.**—The Advisory Committee es-  
12 tablished by the President under subsection (a) shall con-  
13 sist of members from industry, academic institutions, and  
14 Federal laboratories. The President shall appoint mem-  
15 bers to the Advisory Committee who are qualified to pro-  
16 vide advice and information on quantum information  
17 science and technology research, development, demonstra-  
18 tions, education, technology transfer, commercial applica-  
19 tion, or national security and economic concerns.

20 (c) **MEMBERSHIP CONSIDERATION.**—In selecting an  
21 Advisory Committee, the President may seek and give con-  
22 sideration to recommendations from the Congress, indus-  
23 try, the scientific community (including the National  
24 Academy of Sciences, scientific professional societies, and

1 academia), the defense community, and other appropriate  
2 organizations.

3 (d) DUTIES.—The Advisory Committee shall advise  
4 the President and the Subcommittee and make rec-  
5 ommendations that shall be considered in reviewing and  
6 revising the Program. The Advisory Committee shall pro-  
7 vide the President and the Subcommittee with an inde-  
8 pendent assessment of—

9 (1) trends and developments in quantum infor-  
10 mation science and technology;

11 (2) progress made in implementing the Pro-  
12 gram;

13 (3) whether the Program activities, priorities,  
14 and technical goals developed by the Subcommittee  
15 are helping to maintain United States leadership in  
16 quantum information science and technology;

17 (4) the management, coordination, implementa-  
18 tion, and activities of the Program;

19 (5) the need to revise the Program;

20 (6) whether or not there are opportunities for  
21 international cooperation with strategic allies on re-  
22 search and development in quantum information  
23 science and technology; and

1           (7) whether national security, societal, eco-  
2           nomic, legal, and workforce concerns are adequately  
3           addressed by the Program.

4           (e) ~~REPORTS.~~—The Advisory Committee shall report,  
5           not less frequently than once every 2 years, to the Presi-  
6           dent on the assessments required under subsection (d) and  
7           any recommendations to improve the Program. The first  
8           report under this subsection shall be submitted not later  
9           than 6 months after the date of enactment of this Act.  
10          The Director of the Office of Science and Technology Pol-  
11          icy shall transmit a copy of each report under this sub-  
12          section to the Committee on Science, Space, and Tech-  
13          nology of the House of Representatives, the Committee on  
14          Commerce, Science, and Transportation of the Senate, the  
15          Committee on Energy and Natural Resources of the Sen-  
16          ate, and other appropriate committees of the Congress.

17          (f) ~~TRAVEL EXPENSES OF NON-FEDERAL MEM-~~  
18          ~~BERS.~~—Non-Federal members of the Advisory Committee,  
19          while attending meetings of the Advisory Committee or  
20          while otherwise serving at the request of the head of the  
21          Advisory Committee away from their homes or regular  
22          places of business, may be allowed travel expenses, includ-  
23          ing per diem in lieu of subsistence, as authorized by sec-  
24          tion 5703 of title 5, United States Code, for individuals  
25          in the Government serving without pay. Nothing in this

1 subsection shall be construed to prohibit members of the  
2 Advisory Committee who are officers or employees of the  
3 United States from being allowed travel expenses, includ-  
4 ing per diem in lieu of subsistence, in accordance with ex-  
5 isting law.

6 (g) EXEMPTION.—The Advisory Committee shall be  
7 exempt from section 14 of the Federal Advisory Com-  
8 mittee Act (5 U.S.C. App.).

9 **SEC. 105. SUNSET.**

10 (a) IN GENERAL.—Except as provided for in sub-  
11 section (b), the authority to carry out sections 101, 102,  
12 103, and 104 shall terminate on the date that is 11 years  
13 after the date of enactment of this Act.

14 (b) EXTENSION.—The President may continue the  
15 activities under such sections if the President determines  
16 that such activities are necessary to meet national eco-  
17 nomic or national security needs.

1 **TITLE II—NATIONAL INSTITUTE**  
2 **OF STANDARDS AND TECH-**  
3 **NOLOGY QUANTUM ACTIVI-**  
4 **TIES**

5 **SEC. 201. NATIONAL INSTITUTE OF STANDARDS AND TECH-**  
6 **NOLOGY ACTIVITIES AND QUANTUM WORK-**  
7 **SHOP.**

8 (a) NATIONAL INSTITUTE OF STANDARDS AND  
9 TECHNOLOGY ACTIVITIES.—As part of the Program de-  
10 scribed in title I, the Director of the National Institute  
11 of Standards and Technology shall—

12 (1) continue to support and expand basic quan-  
13 tum information science and technology research  
14 and development of measurement and standards in-  
15 frastructure necessary to advance commercial devel-  
16 opment of quantum applications;

17 (2) use its existing programs, in collaboration  
18 with other agencies, as appropriate, to train sci-  
19 entists in quantum information science and tech-  
20 nology to increase participation in the quantum  
21 fields;

22 (3) establish or expand collaborative ventures or  
23 consortia with other public or private sector entities,  
24 including academia, National Laboratories, and in-

1       dustry for the purpose of advancing the field of  
2       quantum information science and engineering; and

3           (4) have the authority to enter into and per-  
4       form such contracts, including cooperative research  
5       and development arrangements and grants and coop-  
6       erative agreements or other transactions, as may be  
7       necessary in the conduct of the work of the Institute  
8       and on such terms as the Director considers appro-  
9       priate, in furtherance of the purposes of this Act.

10       (b) QUANTUM WORKSHOP.—

11           (1) IN GENERAL.—Not later than 1 year after  
12       the date of enactment of this Act, the Director of  
13       the National Institute of Standards and Technology  
14       shall convene a workshop of stakeholders to discuss  
15       the future measurement, standards, cybersecurity,  
16       and other appropriate needs for supporting the de-  
17       velopment of a robust quantum information science  
18       and technology industry in the United States. The  
19       goals of the workshop shall be to—

20           (A) assess the current research on the  
21       issues described in this paragraph;

22           (B) evaluate the research gaps relating to  
23       such issues; and

24           (C) provide recommendations on how the  
25       National Institute of Standards and Technology

1           and the Program can address the research  
2           needs identified.

3           ~~(2) REPORT TO CONGRESS.~~—Not later than 2  
4           years after the date of enactment of this Act, the  
5           Director of the National Institute of Standards and  
6           Technology shall transmit to the Committee on  
7           Science, Space, and Technology of the House of  
8           Representatives and the Committee on Commerce,  
9           Science, and Transportation of the Senate a sum-  
10          mary report containing the findings of the workshop  
11          convened under this section.

12          ~~(c) FUNDING.~~—The Secretary of Commerce shall de-  
13          vote \$400,000,000 to carry out this section, which shall  
14          include \$80,000,000 for each of fiscal years 2019 through  
15          2023, subject to the availability of appropriations, to come  
16          from amounts made available for the National Institute  
17          of Standards and Technology. This section shall be carried  
18          out using funds otherwise appropriated by law after the  
19          date of enactment of this Act.



1 **TITLE III—NATIONAL SCIENCE**  
2 **FOUNDATION AND MULTI-**  
3 **DISCIPLINARY CENTERS FOR**  
4 **QUANTUM RESEARCH AND**  
5 **EDUCATION**

6 **SEC. 301. QUANTUM INFORMATION SCIENCE RESEARCH**  
7 **AND EDUCATION PROGRAM.**

8 (a) IN GENERAL.—The Director of the National  
9 Science Foundation shall carry out a basic research and  
10 education program on quantum information science and  
11 engineering.

12 (b) PROGRAM COMPONENTS.—In carrying out the  
13 program required under subsection (a), the Director of the  
14 National Science Foundation shall carry out activities that  
15 continue to support basic interdisciplinary quantum infor-  
16 mation science and engineering research, and support  
17 human resources development in all aspects of quantum  
18 information science and engineering. Such activities shall  
19 include—

20 (1) using the existing programs of the National  
21 Science Foundation, in collaboration with other Fed-  
22 eral agencies, as appropriate, to—

23 (A) improve the teaching and learning of  
24 quantum information science and engineering

1 at the undergraduate, graduate, and post-  
2 graduate levels; and

3 (B) increase participation in the quantum  
4 fields, including by individuals identified in sec-  
5 tions 33 and 34 of the Science and Engineering  
6 Equal Opportunities Act (42 U.S.C. 1885a; 42  
7 U.S.C. 1885b);

8 (2) formulating goals for quantum information  
9 science and engineering research and education ac-  
10 tivities to be supported by the National Science  
11 Foundation;

12 (3) leveraging the collective body of knowledge  
13 from existing quantum information science and engi-  
14 neering research and education activities;

15 (4) coordinating research efforts funded  
16 through existing programs across the directorates of  
17 the National Science Foundation; and

18 (5) engaging with other Federal agencies, re-  
19 search communities, and potential users of informa-  
20 tion produced under this section.

21 **SEC. 302. MULTIDISCIPLINARY CENTERS FOR QUANTUM**  
22 **RESEARCH AND EDUCATION.**

23 (a) **MULTIDISCIPLINARY CENTERS FOR QUANTUM**  
24 **RESEARCH AND EDUCATION.—**

1           (1) IN GENERAL.—The Director of the National  
2           Science Foundation, in consultation with other Fed-  
3           eral agencies as appropriate, shall award grants to  
4           institutions of higher education or eligible nonprofit  
5           organizations (or consortia thereof) to establish up  
6           to 5 Multidisciplinary Centers for Quantum Re-  
7           search and Education.

8           (2) COLLABORATIONS.—A collaboration receiv-  
9           ing an award under this subsection may include in-  
10          stitutions of higher education, eligible nonprofit or-  
11          ganizations, and private sector entities.

12          (3) PURPOSE.—The purpose of the Centers  
13          shall be to conduct basic research and education ac-  
14          tivities in support of the goals and priorities of the  
15          Program as determined in title I, to—

16                (A) continue to advance quantum informa-  
17                tion science and engineering;

18                (B) support curriculum and workforce de-  
19                velopment in quantum information science and  
20                engineering; and

21                (C) foster innovation by bringing industry  
22                perspectives to quantum research and workforce  
23                development, including by leveraging industry  
24                resources and research capacity.

1           (4) REQUIREMENTS.—An institution of higher  
2 education or an eligible nonprofit organization (or a  
3 consortium thereof) seeking funding under this sec-  
4 tion shall submit an application to the Director at  
5 such time, in such manner, and containing such in-  
6 formation as the Director may require. The applica-  
7 tion shall include, at a minimum, a description of—

8           (A) how the Center will work with other  
9 research institutions and industry partners to  
10 leverage expertise in quantum science, edu-  
11 cation and curriculum development, and tech-  
12 nology transfer;

13           (B) how the Center will promote active col-  
14 laboration among researchers in multiple dis-  
15 ciplines involved in quantum research including  
16 physics, engineering, mathematics, computer  
17 science, chemistry, and material science;

18           (C) how the Center will support long-term  
19 and short-term workforce development in the  
20 quantum field;

21           (D) how the Center can support an innova-  
22 tion ecosystem to work with industry to trans-  
23 late Center research into applications; and

1           (E) a long-term plan to become self-sus-  
2           taining after the expiration of Foundation sup-  
3           port.

4           (5) SELECTION AND DURATION.—

5           (A) IN GENERAL.—The Centers selected  
6           and established under this section are author-  
7           ized to carry out activities for a period of 5  
8           years.

9           (B) REAPPLICATION.—An awardee may  
10          reapply for an additional, subsequent period of  
11          5 years on a competitive, merit-reviewed basis.

12          (C) TERMINATION.—Consistent with the  
13          existing authorities of the Foundation, the Di-  
14          rector of the National Science Foundation may  
15          terminate an underperforming Center for cause  
16          during the performance period.

17          (6) FUNDING.—The Director of the National  
18          Science Foundation shall devote \$250,000,000 to  
19          carry out this section, which shall include  
20          \$50,000,000 for each of fiscal years 2019 through  
21          2023, subject to the availability of appropriations, to  
22          come from amounts made available for Research and  
23          Related Activities and Education and Human Re-  
24          sources. This section shall be carried out using

1 funds otherwise appropriated by law after the date  
2 of enactment of this Act.

3 (b) GRADUATE TRAINEESHIPS.—The Director of the  
4 National Science Foundation may establish a program to  
5 provide traineeships to graduate students at institutions  
6 of higher education within the United States who are citi-  
7 zens of the United States and who choose to pursue mas-  
8 ters or doctoral degrees in quantum information science.

9 **SEC. 303. SPENDING LIMITATION.**

10 No additional funds are authorized to be appro-  
11 priated to carry out this Act and the amendments made  
12 by this Act, and this Act and such amendments shall be  
13 carried out using amounts otherwise available for such  
14 purpose.

15 **SECTION 1. SHORT TITLE; TABLE OF CONTENTS.**

16 (a) *SHORT TITLE.*—This Act may be cited as the “Na-  
17 tional Quantum Initiative Act”.

18 (b) *TABLE OF CONTENTS.*—

*Sec. 1. Short title; table of contents.*

*Sec. 2. Definitions.*

*Sec. 3. Purposes.*

*TITLE I—NATIONAL QUANTUM INITIATIVE*

*Sec. 101. National Quantum Initiative Program.*

*Sec. 102. National Quantum Coordination Office.*

*Sec. 103. Subcommittee on Quantum Information Science.*

*Sec. 104. National Quantum Initiative Advisory Committee.*

*Sec. 105. Sunset.*

*TITLE II—NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY  
QUANTUM ACTIVITIES*

*Sec. 201. Quantum standards and measurement activities.*

## TITLE III—NATIONAL SCIENCE FOUNDATION QUANTUM ACTIVITIES

Sec. 301. Quantum Information Science Research and Education Program.

Sec. 302. Multidisciplinary Centers for Quantum Research and Education.

1 **SEC. 2. DEFINITIONS.**

2 *In this Act:*

3 (1) *ADVISORY COMMITTEE.*—The term “Advisory  
4 *Committee*” means the National Quantum Initiative  
5 *Advisory Committee established under section 104(a).*

6 (2) *COORDINATION OFFICE.*—The term “Coordi-  
7 *nation Office*” means the National Quantum Coordi-  
8 *nation Office established under section 102(a).*

9 (3) *INSTITUTION OF HIGHER EDUCATION.*—The  
10 *term “institution of higher education” has the mean-*  
11 *ing given the term in section 101(a) of the Higher*  
12 *Education Act of 1965 (20 U.S.C. 1001(a)).*

13 (4) *PROGRAM.*—The term “Program” means the  
14 *National Quantum Initiative Program implemented*  
15 *under section 101(a).*

16 (5) *QUANTUM INFORMATION SCIENCE.*—The term  
17 *“quantum information science” means the utilization*  
18 *of quantum physics for the storage, transmission, ma-*  
19 *nipulation, computing, or measurement of informa-*  
20 *tion in ways that offer advantages to classical capa-*  
21 *bilities.*

22 (6) *SUBCOMMITTEE.*—The term “Subcommittee”  
23 *means the Subcommittee on Quantum Information*

1        *Science of the National Science and Technology Council*  
2        *cil established under section 103(a).*

3    **SEC. 3. PURPOSES.**

4        *The purposes of this Act are to ensure the continued*  
5        *leadership of the United States in quantum information*  
6        *science and its technology applications by—*

7            (1) *supporting research, development, demonstra-*  
8            *tion, and application of quantum information science*  
9            *and technology in order to—*

10            (A) *expand the number of researchers, edu-*  
11            *cators, and students with training in quantum*  
12            *information science and technology to develop a*  
13            *workforce pipeline;*

14            (B) *promote the development and inclusion*  
15            *of multidisciplinary curriculum and research op-*  
16            *portunities for quantum information science at*  
17            *the undergraduate, graduate, and postdoctoral*  
18            *level;*

19            (C) *address basic research knowledge gaps,*  
20            *including computational research gaps;*

21            (D) *promote the further development of fa-*  
22            *ilities and centers available for quantum infor-*  
23            *mation science and technology research, testing*  
24            *and education; and*



1                   (E) stimulate research on and promote more  
2                   rapid development of quantum-based tech-  
3                   nologies;

4                   (2) improving the interagency planning and co-  
5                   ordination of Federal research and development of  
6                   quantum information science and technology and  
7                   maximizing the effectiveness of the Federal Govern-  
8                   ment's quantum information science and technology  
9                   research and development programs;

10                  (3) promoting collaboration among government,  
11                  Federal laboratories, industry, and universities; and

12                  (4) promoting the development of international  
13                  standards for quantum information science and tech-  
14                  nology—

15                         (A) to facilitate technology innovation and  
16                         commercialization; and

17                         (B) to meet economic and national security  
18                         goals.

19                   **TITLE I—NATIONAL QUANTUM**  
20                   **INITIATIVE**

21                   **SEC. 101. NATIONAL QUANTUM INITIATIVE PROGRAM.**

22                   *The President shall implement a 10-year National*  
23                   *Quantum Initiative Program. In carrying out the Pro-*  
24                   *gram, the President shall, acting through appropriate Fed-*

1 eral agencies, councils, working groups, subcommittees, and  
2 the Coordination Office—

3 (1) establish the goals, priorities, and metrics for  
4 a 10-year plan to accelerate development of quantum  
5 information science and technology applications in  
6 the United States;

7 (2) invest in fundamental Federal quantum in-  
8 formation science and technology research, develop-  
9 ment, demonstration, standards development, and  
10 other activities to achieve the goals established in  
11 paragraph (1);

12 (3) invest in activities to develop a quantum in-  
13 formation science and technology workforce pipeline;

14 (4) provide for interagency coordination of Fed-  
15 eral quantum information science and technology re-  
16 search, development, demonstration, standards en-  
17 gagement, and other activities undertaken pursuant  
18 to the Program;

19 (5) partner with industry and academia to le-  
20 verage knowledge and resources; and

21 (6) leverage existing Federal investments effi-  
22 ciently to advance Program goals and objectives.

23 **SEC. 102. NATIONAL QUANTUM COORDINATION OFFICE.**

24 (a) *ESTABLISHMENT.*—The President shall establish a  
25 National Quantum Coordination Office, which shall have—

1           (1) *a Director appointed by the Director of the*  
2           *Office of Science and Technology Policy, in consulta-*  
3           *tion with the Secretary of Commerce, the Director of*  
4           *the National Science Foundation, and the Secretary*  
5           *of Energy; and*

6           (2) *staff that shall be comprised of employees de-*  
7           *tailed from the Federal agencies that are members of*  
8           *the Subcommittee.*

9           (b) *RESPONSIBILITIES.—The Coordination Office*  
10 *shall—*

11           (1) *provide technical and administrative support*  
12 *to—*

13                   (A) *the Subcommittee; and*

14                   (B) *the Advisory Committee;*

15           (2) *oversee interagency coordination of the Pro-*  
16           *gram, including encouraging and supporting joint*  
17           *agency solicitation and selection of applications for*  
18           *funding of projects under the Program;*

19           (3) *serve as the point of contact on Federal*  
20           *quantum information science and technology activi-*  
21           *ties for Government organizations, academia, indus-*  
22           *try, professional societies, State governments, and oth-*  
23           *ers to exchange technical and programmatic informa-*  
24           *tion;*

1           (4) *ensure coordination between the Multidisci-*  
2           *plinary Centers for Quantum Research and Edu-*  
3           *cation established under section 302(a), the collabo-*  
4           *rative ventures or consortia established under section*  
5           *201(a), and centers or consortia established by other*  
6           *agencies participating in the Program;*

7           (5) *conduct public outreach, including dissemi-*  
8           *nation of findings and recommendations of the Advi-*  
9           *sory Committee, as appropriate;*

10          (6) *promote access to and early application of*  
11          *the technologies, innovations, and expertise derived*  
12          *from Program activities to agency missions and sys-*  
13          *tems across the Federal Government, and to United*  
14          *States industry, including startup companies; and*

15          (7) *promote access, through the appropriate gov-*  
16          *ernment agencies and an open and competitive merit-*  
17          *reviewed process, to existing quantum computing and*  
18          *communication systems developed by industry, uni-*  
19          *versities, and national laboratories to the general user*  
20          *community, in pursuit of discovery of the new appli-*  
21          *cations of such systems.*

22          (c) *FUNDING.*—*Funds necessary to carry out the ac-*  
23          *tivities of the Coordination Office shall be made available*  
24          *each fiscal year by the participating agencies of the Sub-*

1 *committee, as determined by the Director of the Office of*  
2 *Science and Technology Policy.*

3 **SEC. 103. SUBCOMMITTEE ON QUANTUM INFORMATION**  
4 **SCIENCE.**

5 (a) *ESTABLISHMENT.*—*The President shall establish,*  
6 *through the National Science and Technology Council, a*  
7 *Subcommittee on Quantum Information Science.*

8 (b) *MEMBERSHIP.*—*The Subcommittee shall include—*

9 (1) *the National Institute of Standards and*  
10 *Technology;*

11 (2) *the National Science Foundation;*

12 (3) *the Department of Energy;*

13 (4) *the National Aeronautics and Space Admin-*  
14 *istration;*

15 (5) *the Department of Defense;*

16 (6) *the Office of the Director of National Intel-*  
17 *ligence;*

18 (7) *the Office of Management and Budget;*

19 (8) *the Office of Science and Technology Policy;*  
20 *and*

21 (9) *any other Federal agency as considered ap-*  
22 *propriate by the President.*

23 (c) *CHAIRS.*—*The Subcommittee shall be jointly*  
24 *chaired by the Director of the National Institute of Stand-*

1 *ards and Technology, the Director of the National Science*  
2 *Foundation, and the Secretary of Energy.*

3 *(d) RESPONSIBILITIES.—The Subcommittee shall—*

4 *(1) coordinate the quantum information science*  
5 *and technology research, information sharing about*  
6 *international standards development and use, and*  
7 *education activities and programs of the Federal*  
8 *agencies;*

9 *(2) establish goals and priorities of the Program,*  
10 *based on identified knowledge and workforce gaps and*  
11 *other national needs;*

12 *(3) assess and recommend Federal infrastructure*  
13 *needs to support the Program;*

14 *(4) evaluate opportunities for international co-*  
15 *operation with strategic allies on research and devel-*  
16 *opment in quantum information science and tech-*  
17 *nology; and*

18 *(5) propose a coordinated interagency budget for*  
19 *the Program to the Office of Management and Budget*  
20 *to ensure the maintenance of a balanced quantum in-*  
21 *formation science research portfolio and an appro-*  
22 *priate level of research effort.*

23 *(e) STRATEGIC PLAN.—Not later than 1 year after the*  
24 *date of enactment of this Act, the Subcommittee shall de-*  
25 *velop a 5-year strategic plan, and 6 years after enactment*

1 *of the Act develop an additional 5-year strategic plan, with*  
2 *periodic updates as appropriate to guide the activities of*  
3 *the Program, meet the goals, priorities, and anticipated*  
4 *outcomes of the participating agencies.*

5       *(f) SUBMITTAL OF STRATEGIC PLANS.—The Chairs of*  
6 *the Subcommittee shall submit to the President, the Advi-*  
7 *sory Committee, the Committee on Science, Space, and*  
8 *Technology of the House of Representatives, the Committee*  
9 *on Commerce, Science, and Transportation and the Com-*  
10 *mittee on Energy and Natural Resources of the Senate, and*  
11 *other appropriate committees of Congress the strategic*  
12 *plans developed under subsection (e) and any updates to*  
13 *such plans.*

14       *(g) ANNUAL PROGRAM BUDGET REPORT.—*

15           *(1) IN GENERAL.—Each year, concurrent with*  
16 *the annual budget request submitted by the President*  
17 *to Congress under section 1105 of title 31, United*  
18 *States Code, the Chairs of the Subcommittee shall sub-*  
19 *mit to the Committee on Commerce, Science, and*  
20 *Transportation of the Senate, the Committee on*  
21 *Science, Space, and Technology of the House of Rep-*  
22 *resentatives, and such other committees of Congress as*  
23 *may be appropriate a report on the budget for the*  
24 *Program.*

1           (2) *CONTENTS.*—*Each report submitted under*  
2           *paragraph (1) shall include the following:*

3                   (A) *The budget of the Program for the cur-*  
4                   *rent fiscal year, for each agency that partici-*  
5                   *pates in the Program.*

6                   (B) *The budget proposed for the Program*  
7                   *for the next fiscal year, for each agency that par-*  
8                   *ticipates in the Program.*

9                   (C) *An analysis of the progress made to-*  
10                   *ward achieving the goals and priorities estab-*  
11                   *lished for the Program.*

12 **SEC. 104. NATIONAL QUANTUM INITIATIVE ADVISORY COM-**  
13 **MITTEE.**

14           (a) *IN GENERAL.*—*The President shall establish a Na-*  
15 *tional Quantum Initiative Advisory Committee.*

16           (b) *QUALIFICATIONS.*—*The Advisory Committee estab-*  
17 *lished by the President under subsection (a) shall consist*  
18 *of members from industry, academic institutions, and Fed-*  
19 *eral laboratories. The President shall appoint members to*  
20 *the Advisory Committee who are qualified to provide advice*  
21 *and information on quantum information science and tech-*  
22 *nology research, development, demonstrations, standards,*  
23 *education, technology transfer, commercial application, or*  
24 *national security and economic concerns.*



1       (c) *MEMBERSHIP CONSIDERATION.*—*In selecting an*  
2 *Advisory Committee, the President may seek and give con-*  
3 *sideration to recommendations from the Congress, industry,*  
4 *the scientific community (including the National Academy*  
5 *of Sciences, scientific professional societies, and academia),*  
6 *the defense community, and other appropriate organiza-*  
7 *tions.*

8       (d) *DUTIES.*—*The Advisory Committee shall advise the*  
9 *President and the Subcommittee and make recommenda-*  
10 *tions that shall be considered in reviewing and revising the*  
11 *Program. The Advisory Committee shall provide the Presi-*  
12 *dent and the Subcommittee with an independent assessment*  
13 *of—*

14               (1) *trends and developments in quantum infor-*  
15 *mation science and technology;*

16               (2) *progress made in implementing the Program;*

17               (3) *whether the Program activities, priorities,*  
18 *and technical goals developed by the Subcommittee*  
19 *are helping to maintain United States leadership in*  
20 *quantum information science and technology;*

21               (4) *the management, coordination, implementa-*  
22 *tion, and activities of the Program;*

23               (5) *the need to revise the Program;*

24               (6) *whether or not there are opportunities for*  
25 *international cooperation with strategic allies on re-*

1 search and development in, and the development of  
2 open standards for, quantum information science and  
3 technology; and

4 (7) whether national security, societal, economic,  
5 legal, and workforce concerns are adequately ad-  
6 dressed by the Program.

7 (e) *REPORTS.*—The Advisory Committee shall report,  
8 not less frequently than once every 2 years, to the President  
9 on the assessments required under subsection (d) and any  
10 recommendations to improve the Program. The first report  
11 under this subsection shall be submitted not later than 6  
12 months after the date of enactment of this Act. The Director  
13 of the Office of Science and Technology Policy shall trans-  
14 mit a copy of each report under this subsection to the Com-  
15 mittee on Science, Space, and Technology of the House of  
16 Representatives, the Committee on Commerce, Science, and  
17 Transportation of the Senate, the Committee on Energy and  
18 Natural Resources of the Senate, and other appropriate  
19 committees of the Congress.

20 (f) *TRAVEL EXPENSES OF NON-FEDERAL MEMBERS.*—  
21 Non-Federal members of the Advisory Committee, while at-  
22 tending meetings of the Advisory Committee or while other-  
23 wise serving at the request of the head of the Advisory Com-  
24 mittee away from their homes or regular places of business,  
25 may be allowed travel expenses, including per diem in lieu

1 of subsistence, as authorized by section 5703 of title 5,  
2 United States Code, for individuals in the Government serv-  
3 ing without pay. Nothing in this subsection shall be con-  
4 strued to prohibit members of the Advisory Committee who  
5 are officers or employees of the United States from being  
6 allowed travel expenses, including per diem in lieu of sub-  
7 sistence, in accordance with existing law.

8 (g) *EXEMPTION.*—The Advisory Committee shall be ex-  
9 empt from section 14 of the Federal Advisory Committee  
10 Act (5 U.S.C. App.).

11 **SEC. 105. SUNSET.**

12 (a) *IN GENERAL.*—Except as provided for in sub-  
13 section (b), the authority to carry out sections 101, 102,  
14 103, and 104 shall terminate on the date that is 11 years  
15 after the date of enactment of this Act.

16 (b) *EXTENSION.*—The President may continue the ac-  
17 tivities under such sections if the President determines that  
18 such activities are necessary to meet national economic or  
19 national security needs.

1 **TITLE II—NATIONAL INSTITUTE**  
2 **OF STANDARDS AND TECH-**  
3 **NOLOGY QUANTUM ACTIVI-**  
4 **TIES**

5 **SEC. 201. QUANTUM STANDARDS AND MEASUREMENT AC-**  
6 **TIVITIES.**

7 (a) NATIONAL INSTITUTE OF STANDARDS AND TECH-  
8 NOLOGY ACTIVITIES.—As part of the Program described in  
9 title I, the Director of the National Institute of Standards  
10 and Technology shall—

11 (1) continue to support and expand basic and  
12 applied quantum information science and technology  
13 research and development of measurement and stand-  
14 ards infrastructure necessary to advance commercial  
15 development of quantum applications;

16 (2) use its existing programs, in collaboration  
17 with other agencies, as appropriate, to train scientists  
18 in quantum information science and technology to in-  
19 crease participation in the quantum fields;

20 (3) establish or expand collaborative ventures or  
21 consortia with other public or private sector entities,  
22 including academia, National Laboratories, and in-  
23 dustry for the purpose of advancing the field of quan-  
24 tum information science and engineering; and

1           (4) *have the authority to enter into and perform*  
2 *such contracts, including cooperative research and de-*  
3 *velopment arrangements and grants and cooperative*  
4 *agreements or other transactions, as may be necessary*  
5 *in the conduct of the work of the Institute and on*  
6 *such terms as the Director considers appropriate, in*  
7 *furtherance of the purposes of this Act.*

8           (b) *QUANTUM CONSORTIUM.—*

9           (1) *IN GENERAL.—Not later than 1 year after*  
10 *the date of enactment of this Act, the Director of the*  
11 *National Institute of Standards and Technology shall*  
12 *convene a consortium of stakeholders to discuss the fu-*  
13 *ture measurement, standards, cybersecurity, and other*  
14 *appropriate needs for supporting the development of*  
15 *a robust quantum information science and technology*  
16 *industry in the United States. The goals of the con-*  
17 *sortium shall be to—*

18                   (A) *assess the current research on the issues*  
19 *described in this paragraph;*

20                   (B) *evaluate the research gaps relating to*  
21 *such issues; and*

22                   (C) *provide recommendations on how the*  
23 *National Institute of Standards and Technology*  
24 *and the Program can address the research needs*  
25 *identified.*

1           (2) *REPORT TO CONGRESS.*—Not later than 2  
 2           years after the date of enactment of this Act, the Di-  
 3           rector of the National Institute of Standards and  
 4           Technology shall transmit to the Committee on  
 5           Science, Space, and Technology of the House of Rep-  
 6           resentatives and the Committee on Commerce,  
 7           Science, and Transportation of the Senate a sum-  
 8           mary report containing the findings of the consortium  
 9           convened under this section.

10          (c) *FUNDING.*—There is authorized to be appropriated  
 11         to the National Institute of Standards and Technology to  
 12         carry out the activities under this section \$60,000,000 for  
 13         each of fiscal years 2019 through 2023.

14         **TITLE III—NATIONAL SCIENCE**  
 15                 **FOUNDATION QUANTUM AC-**  
 16                 **TIVITIES**

17         **SEC. 301. QUANTUM INFORMATION SCIENCE RESEARCH**  
 18                 **AND EDUCATION PROGRAM.**

19          (a) *IN GENERAL.*—The Director of the National  
 20         Science Foundation shall carry out a basic research and  
 21         education program on quantum information science and  
 22         engineering, including the competitive award of grants to  
 23         institutions of higher education or eligible nonprofit organi-  
 24         zations (or consortia thereof), which may support Multi-

1 *disciplinary Centers for Quantum Research and Education*  
2 *established under section 302(a)(1).*

3 (b) *PROGRAM COMPONENTS.*—*In carrying out the pro-*  
4 *gram required under subsection (a), the Director of the Na-*  
5 *tional Science Foundation shall carry out activities that*  
6 *continue to support basic interdisciplinary quantum infor-*  
7 *mation science and engineering research, and support*  
8 *human resources development in all aspects of quantum in-*  
9 *formation science and engineering. Such activities shall in-*  
10 *clude, at a minimum—*

11 (1) *using the existing programs of the National*  
12 *Science Foundation, in collaboration with other Fed-*  
13 *eral agencies, as appropriate, to—*

14 (A) *improve the teaching and learning of*  
15 *quantum information science and engineering at*  
16 *the undergraduate, graduate, and postgraduate*  
17 *levels; and*

18 (B) *increase participation in the quantum*  
19 *fields, including by individuals identified in sec-*  
20 *tions 33 and 34 of the Science and Engineering*  
21 *Equal Opportunities Act (42 U.S.C. 1885a; 42*  
22 *U.S.C. 1885b);*

23 (2) *formulating goals for quantum information*  
24 *science and engineering research and education ac-*

1 *tivities to be supported by the National Science Foun-*  
2 *ation;*

3 (3) *leveraging the collective body of knowledge*  
4 *from existing quantum information science and engi-*  
5 *neering research and education activities;*

6 (4) *coordinating research efforts funded through*  
7 *existing programs across the directorates of the Na-*  
8 *tional Science Foundation; and*

9 (5) *engaging with other Federal agencies, re-*  
10 *search communities, and potential users of informa-*  
11 *tion produced under this section.*

12 **SEC. 302. MULTIDISCIPLINARY CENTERS FOR QUANTUM RE-**  
13 **SEARCH AND EDUCATION.**

14 (a) *MULTIDISCIPLINARY CENTERS FOR QUANTUM RE-*  
15 *SEARCH AND EDUCATION.—*

16 (1) *IN GENERAL.—The Director of the National*  
17 *Science Foundation, in consultation with other Fed-*  
18 *eral agencies as appropriate, shall award grants to*  
19 *institutions of higher education or eligible nonprofit*  
20 *organizations (or consortia thereof) to establish up to*  
21 *5 Multidisciplinary Centers for Quantum Research*  
22 *and Education.*

23 (2) *COLLABORATIONS.—A collaboration receiving*  
24 *an award under this subsection may include institu-*



1        *tions of higher education, eligible nonprofit organiza-*  
2        *tions, and private sector entities.*

3            (3) *PURPOSE.*—*The purpose of the Centers shall*  
4        *be to conduct basic research and education activities*  
5        *in support of the goals and priorities of the Program*  
6        *as determined in title I, to—*

7            (A) *continue to advance quantum informa-*  
8        *tion science and engineering;*

9            (B) *support curriculum and workforce de-*  
10       *velopment in quantum information science and*  
11       *engineering; and*

12          (C) *foster innovation by bringing industry*  
13       *perspectives to quantum research and workforce*  
14       *development, including by leveraging industry*  
15       *resources and research capacity.*

16          (4) *REQUIREMENTS.*—*An institution of higher*  
17       *education or an eligible nonprofit organization (or a*  
18       *consortium thereof) seeking funding under this section*  
19       *shall submit an application to the Director at such*  
20       *time, in such manner, and containing such informa-*  
21       *tion as the Director may require. The application*  
22       *shall include, at a minimum, a description of—*

23          (A) *how the Center will work with other re-*  
24       *search institutions and industry partners to le-*  
25       *verage expertise in quantum science, education*

1           *and curriculum development, and technology*  
 2           *transfer;*

3           *(B) how the Center will promote active col-*  
 4           *laboration among researchers in multiple dis-*  
 5           *ciplines involved in quantum research including*  
 6           *physics, engineering, mathematics, computer*  
 7           *science, chemistry, and material science;*

8           *(C) how the Center will support long-term*  
 9           *and short-term workforce development in the*  
 10          *quantum field;*

11          *(D) how the Center can support an innova-*  
 12          *tion ecosystem to work with industry to translate*  
 13          *Center research into applications; and*

14          *(E) a long-term plan to become self-sus-*  
 15          *taining after the expiration of Foundation sup-*  
 16          *port.*

17          (5) *SELECTION AND DURATION.—*

18          *(A) IN GENERAL.—The Centers selected and*  
 19          *established under this section are authorized to*  
 20          *carry out activities for a period of 5 years.*

21          *(B) REAPPLICATION.—An awardee may re-*  
 22          *apply for an additional, subsequent period of 5*  
 23          *years on a competitive, merit-reviewed basis.*

24          *(C) TERMINATION.—Consistent with the ex-*  
 25          *isting authorities of the Foundation, the Director*

1           *of the National Science Foundation may termi-*  
2           *nate an underperforming Center for cause dur-*  
3           *ing the performance period.*

4           (6) *FUNDING.*—*There is authorized to be appro-*  
5           *priated to the National Science Foundation to carry*  
6           *out this section for each of fiscal years 2019 through*  
7           *2023 an amount equal to the number of Multidisci-*  
8           *plinary Centers for Quantum Research and Edu-*  
9           *cation (as provided in the National Science Founda-*  
10          *tion budget request for the fiscal year) multiplied by*  
11          *\$10,000,000.*

12          (b) *GRADUATE TRAINEESHIPS.*—*The Director of the*  
13          *National Science Foundation may establish a program to*  
14          *provide traineeships to graduate students at institutions of*  
15          *higher education within the United States who are citizens*  
16          *of the United States and who choose to pursue masters or*  
17          *doctoral degrees in quantum information science.*

Calendar No. 676

115<sup>TH</sup> CONGRESS  
2<sup>D</sup> SESSION

**S. 3143**

[Report No. 115-389]

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## **A BILL**

To provide for a coordinated Federal program to accelerate quantum research and development for the economic and national security of the United States.

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NOVEMBER 27, 2018

Reported with an amendment