Chapter 4 Reinforcing the Fundamental Capability for STI

Section 1 Developing High-quality Human Resources

People drive STI. Despite increasing competition over the recruitment of highly trained personnel around the world, Japan's population of young people continues to decrease. Under these circumstances, improving the quality and exerting the capabilities of STI professionals are becoming even more important. Through various initiatives, in Japan, we are continuously developing and securing diverse and talented pool of professionals, and creating a society in which through their activities, STI professionals can play an active role as knowledge professionals in a variety of sectors, both in academia and in industry.

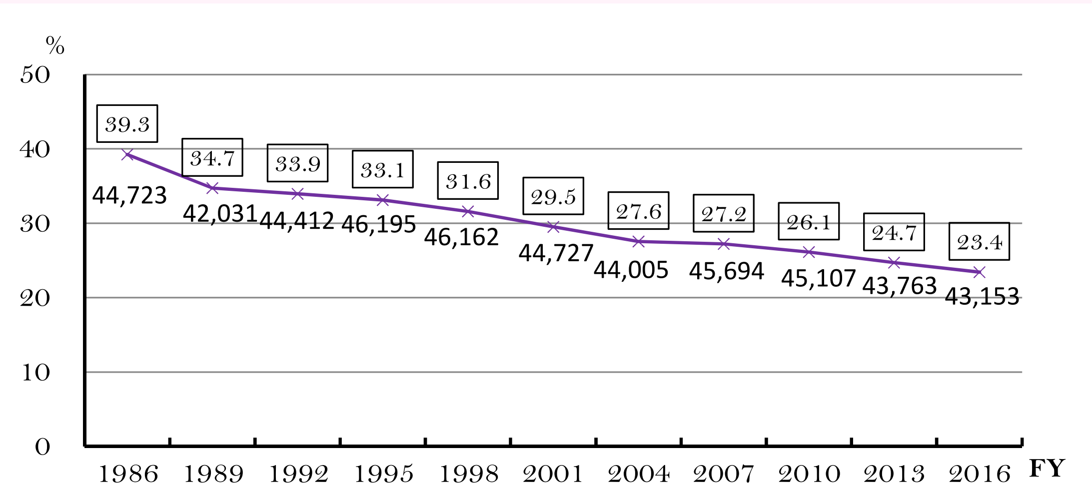
1 Developing, securing and improving career prospects of human resources as intellectual professionals

(1) Developing and improving career prospects of young researchers

It is necessary to develop and secure excellent young researchers who are important players for STI. For this purpose, it is important to increase opportunities of research funding and improve the research environment that ensures both stable employment and mobility to encourage excellent students to take a doctoral course to become the PhDs who are intellectual professionals, focus on their research activities and produce results.

In recent years, however, there have been suggestions of difficult situations of young researchers in Japan, as exemplified by the declining ratio of young full-time university teachers despite the increase of the total number of teachers (Figure 2-4-1).

■Figure 2-4-1/Ratio of full-time teachers aged 40 or younger in universities



Source: MEXT

In this context, the Committee on Human Resources, Council for Science and Technology (CST) compiled the "Important points at issue toward study for the Sixth Science and Technology Basic Plan (interim summary)"in June 2019. In October, a subcommittee on employment of post-doctoral fellows, etc. was set up under the committee. The subcommittee is conducting studies toward formulation of guidelines for institutions which incorporate employment relationship, research environment, and support for career development of post-doctoral fellows, etc., for example.

A. Realization of stable and independent research by young researchers

Ministry of Education, Culture, Sports, Science and Technology (MEXT) launched the Leading Initiative for Excellent Young Researchers in FY2016 to support researchers and research institutions so that excellent young researchers can obtain a stable environment for independent research to devote themselves to voluntary and independent research at research institutions of industry, academia or government. By FY2019 at least 332 young researchers (January 31, 2020) found a stable and independent research environment at positions created under the program.

For the purpose of securing research environments in which young researchers can concentrate on independent research and obtain secure positions, the ministry also has been implementing the Program to Disseminate Tenure Tracking System, which provides support to universities that have newly adopted that system. In FY2019, the program is implemented by19 organizations.

B. Diversification of career options

MEXT has been implementing the "Building of Consortia for the Development of Human Resources in Science and Technology" to secure stable employment for young researchers while increasing their mobility to help their career development, and also to support universities, etc. in constructing a mechanism to diversify their career paths. The support has been provided to 10 organizations in FY2019.

Furthermore, the "Strategic Professional Development Program for Young Researchers" has been implemented since FY2019 and has been supporting two organizations. The program aims to construct a well-organized system to foster researchers beyond the boundary of laboratories, and will include: incorporating knowledge of advanced initiatives in Japan and abroad to improve research productivity in the country; developing programs for fostering of world-class researchers and; a support system for publishing in top journals and acquisition of overseas funds, for example.

The Japan Science and Technology Agency (JST) operates the Japan Research Career Information Network Portal site (JREC-IN Portal[1]) to provide researchers and assistants with information for career development including job information and to support the efficient use of such information.

C. Improvement of research environment

Under the Grants-in-Aid for Scientific Research (KAKENHI), JSPS formulated the "KAKENHI Young Support Plan" and has been working on measures to reinforce support in accordance with the career development of researchers while encouraging friendly competition in an open environment. Toward the aid program in FY2020, a new aid category "Grant-in-Aid for Transformative Research Areas" was

1 https://jrecin.jst.go.jp

established to lead the change and shift of scientific research systems and directions with participation of researchers who will lead scientific research in the future. "Grant-in-Aid for Challenging Research (Pioneering)" that encourages bold challenge based on novel ideas under a wide examination division was greatly expanded and a new fund was established for the aid. In addition, "Grant-in-Aid for Scientific Research (A)/(B)" was expanded in accordance with the alleviation of restrictions on double application to encourage larger-scale research by young researchers.

(2) Developing and improving career prospects of various people in STI

A. Efforts for development of research manager and promotion of their active participation

It is important to develop not only researchers but also diverse human resources and promote their participation. MEXT has been conducting survey and research on support measures for research administrators in order to improve research environments; to encourage more active research, strengthen R&D management at universities and establish diverse career options for scientists/engineers beyond research positions, for example.

In FY2018, with the aim of further strengthening the Research Administration system at universities, etc., the "Study Committee on Strengthening of Research Administrator's Activities" compiled a summary of issues toward introduction of an authorization system that will contribute to improvement of their knowledge/skills and visualization of their executive ability. (September 2018). Based on the summary of issues, survey study has been conducted since FY2019 toward introduction of an authorization system.

With the aim of increasing world-class research universities, support is also provided to 22 universities and other research institutions based on quantitative indicators or evidence. Specifically, the government supports employment of research management personnel, including URA, and intensive reform of research environments so that the research capacity of Japanese universities will increase.

The "Program for development of Program Managers (PM) and promotion of their active participation" is implemented for excellent human resources in Japan to acquire practical knowledge, skill and experience of PM. Its aim is to present and establish this new job category for innovation creation, and to show a career path to work in funds allocation organs.

B. Development of engineers and their capabilities

Industries and engineers that underpin industrial activities assume a pivotal role in the promotion of science, technology and innovation. Increasingly advanced and integrated technologies require engineers to improve their qualifications and abilities. MEXT and related agencies have been making efforts to foster engineers who can keep pace with these changing requirements and to increase their capabilities.

MEXT is promoting efforts for practical education in engineering at universities. Universities are working to achieve qualitative enhancement of education content and method, which include: learning through problem solving using problems at partner companies, and education merging disciplines based on the industrial/social structure. At colleges of technology, integrated professional and practical training in engineering consistent through five years is given to students shortly after they graduate from junior high school. These colleges are strengthening cooperation with other fields, developing human resources who support local industries and developing engineers who are capable playing active roles globally. Engineers who have a high level of applied skill in areas such as S&T and who can engage in planning and designing are qualified as professional engineers under the Professional Engineer Qualification System. The Professional Engineer Examination is divided into the First-Step Examination, which is given to determine whether the examinee has the expertise expected of a university graduate in science or engineering (6,819 successful candidates in FY2019) and the Second-Step Examination, which is given to determine whether the examinee has the high level of applied skill required of a professional engineer (2,819 successful candidates in FY2018). Data on candidates who passed the Second-Step Examination in FY2019 in each technical discipline are shown in Table 2-4-2.

■Table 2-4-2/Breakdown of successful candidates of the Second-Step Professional Engineer Examination by Technical Discipline (FY2019)

Technical Discipline	No. of candidates (people)	No. of successful candidates (people)	Pass rate (%)	Technical Discipline	No. of candidates (people)	No. of successful candidates (people)	Pass rate (%)
Mechanical Engineering	980	190	19.4	Agriculture	796	86	10.8
Marine & Ocean	10	3	30.0	Forest	266	57	21.4
Aerospace	57	8	14.0	Fisheries	126	19	15.1
Electrical & Electronics Engineering	1,229	150	12.2	Industrial Engineering	258	36	14.0
Chemistry	135	29	21.5	Information Engineering	408	30	7.4
Fiber & Textiles	39	8	20.5	Applied Science	576	82	14.2
Metals	76	25	32.9	Biotechnology & Bioengineering	38	10	26.3
Mining	21	5	23.8	Environment	493	78	15.8
Civil Engineering	13,546	1,278	9.4	Nuclear & Radiation	88	17	19.3
Water Supply & Sewerage	1,446	173	12.0	Engineering Management	3,180	490	15.4
Environmental Engineering	558	45	8.1				

Source: MEXT

To aid engineers in acquiring a broader range of basic knowledge about science and technology, the JST provides online self-study materials[1] on common science and technology topics and specific science and technology disciplines.

(3) Promoting reforms of graduate school education

MEXT is working to improve the system of the Graduate Education Reforms to train "Professionals of Knowledge" who think for themselves and act based on sophisticated expertise and a sense of ethics, create new knowledge and values based on their knowledge, work globally and lead the future. In FY2019, the ministry continued enhancement of graduate school education based on the 3rd Platform for the Promotion of Graduate School Education (decision of the Minister of Education, Culture, Sports, Science

1 https://jrecin.jst.go.jp/

and Technology, on March 31, 2016). In the same year, the ministry promoted establishment of graduate education as a diploma program through a system amendment based on "Drastic reform of graduate school education with a view to 2040 – to respond to the demands of society and learners (summary of deliberation)" (Central Council for Education's University Division, January 2019).

The Program for Leading Graduate Schools started in FY2011 to assist radical reform of graduate school education with the participation of industry, academia and government. The program aims to provide interdisciplinary doctoral programs consistently from both terms in order to foster leaders who can play active roles globally in industry, academia and government. As of FY2018, 62 projects have been supported.

Furthermore, in order to cultivate excellent doctoral talents and build excellent centers for sustainable activities for human resource development/exchange and new joint research, the Doctoral Program for World-leading Innovative & Smart Education (WISE Program) started in FY2018. The program supports development of 5-year integrated doctoral programs by universities based on their strengths, utilizing the results of their graduate school reform in organized coordination with other universities, research institutes, private companies, etc. at home and abroad. 15 programs were adopted in FY2018 and 11 programs in FY2019.

The Japan Student Services Organization (JASSO) provides scholarship loan programs to financially support motivated students who excel academically but who have difficulty pursuing their studies due to financial constraints. Interest-free loan recipients who are recognized by JASSO as having achieved particularly outstanding results in their studies may be partially or completely exempt from repaying their loans. Starting from the enrollment in FY2018, JASSO has expanded the system to exempt doctoral students with excellent performance from repaying their loans. The aim is to encourage continued education by reducing financial burden on students of doctoral programs.

To foster top level researchers who will play major roles in future scientific research, the Japan Society for the Promotion of Science (JSPS) offers the Research Fellowship for Young Scientists Program under which fellowships are granted to doctoral students (DC).

At the request of MEXT, the Science Council of Japan (SCJ) has been developing a Guideline for Curriculum Formation that focuses on the basic education given to all graduates for the quality assurance of university education in each academic field and announced the reference standard for 32 academic fields by FY2019.

(4) Development for the next generation of STI professionals

MEXT supports deployment of assistants for science observations and experiments in order to develop a teaching system for further improvement of observations, experiments and teaching in science education. The ministry is also advancing plan-based improvement of facilities and equipment for science and mathematics education including equipment for scientific observations and experiments, pursuant to the Science Education Promotion Act (Act No. 186, 1953).

MEXT designates high schools that provide advanced science and mathematics education as Super Science High School (SSH). This initiative aims to help students develop scientific abilities and thereby develop human resources for science and technology who can play important roles globally in the future. Specifically, schools designated as SSH are promoting project studies in cooperation with universities, research institutes, etc., developing and using curricula focused on science and mathematics to foster highly creative talents. In FY2019, 212 SSHs throughout the country provided such advanced and specialized education.

Under the Global Science Campus (GSC) program, JST selects and supports universities that develop and implement programs to cultivate high-school students who have desire and talent into international human resources in science and technology. In FY2017, JST started the School to Cultivate Junior Doctors for elementary and junior-high school students with outstanding desire and ability in science and mathematics. In this initiative, universities, etc. provide special education programs to further develop their abilities.

The Science Intercollegiate is a venue for undergraduate students from across the country in natural science courses to present their own research in a friendly nationwide competition. They also have opportunities to meet with persons outside academia such as business people. The 9th Intercollegiate was scheduled in Kusatsu City, Shiga, from February 29 to March 1, 2020, but cancelled to prevent COVID-19 infection from spreading.

In addition, the JST has sponsored preliminary domestic contests for international science and technology contents, such as the International Science Olympiads for mathematics, chemistry, biology, physics, informatics, earth science and geography, and the International Science and Engineering Fair (ISEF), as well as supporting Japanese students' participation in competitions abroad and international competitions held in Japan (Figure 2-4-3) In FY2019, the 7th Japan Junior High School Science Championship was held from December 6 to 8, 2019 in Tsukuba City, Ibaraki Prefecture. In this nationwide competition of schools and teams, comprehensive strengths are determined based on paper tests and practical skills in science and mathematics. The Aichi Prefecture team won first place (Figure 2-4-4.) The 9th Japan High School Science Championship scheduled for March 20 to 25, 2020 in Saitama City, Saitama Prefecture was cancelled to prevent COVID-19 from spreading

MEXT, the Japan Patent Office (JPO), the Japan Patent Attorneys Association, and the National Center for Industrial Property Information and Training (INPIT) jointly host the Patent Contests and Design Patent Contest for students at high schools, colleges of technology and universities. The aim is to enhance public understanding and interests in intellectual property. Students participating in these contests are rewarded for inventions and designs and are given support when they apply for a patent or design registration to obtain a patent or design right. MEXT honors the schools of the participating students, which made active efforts for these contests to enhance the Intellectual Property Mind of students or deepen their understanding of the IP system.

Children who will live in Society 5.0 need to effectively use advanced technologies based on ICT in education, but the ICT environment of schools is underdeveloped and there is a big gap among local governments. To address this issue, budgetary steps were made in FY2019 for realization of the GIGA School Program to integrally develop a system for "1 device for 1 student" with high-speed and high-volume networks while at the same time promoting the use of the cloud, establishing a system for procurement of ICT equipment, spreading best practice of utilization and ensuring the PDCA cycle of utilization.

■Figure 2-4-3/Participants in the International Student Contests in Science and Technology (FY2019)

International Mathematical Olympiad (UK) Participants

From left
HAYAKAWA Mutsumi, 3rd grade, Miyazaki Nishi High School (bronze medalist)
SHUKUTA Ayato, 2nd grade, Kaisei High School (silver medalist)
SAKAMOTO Heizo, 3rd grade, Senior High School at Otsuka, University of Tsukuba (gold medalist)
SHIBAYAMA Masahiko, Minister of MEXT
KODAMA Taiyo ,6th grade, Kaiyo Secondary School (gold medalist)
HIRAISHI Yudai, 5th grade, Kaiyo Secondary School (silver medalist)
WATANABE Naoki, 2nd grade, Attached High School of Hiroshima University (bronze medalist)

Source: MEXT

International Chemistry Olympiad (France) Participants

From left
OFUGHI Masahiro, 3rd grade, Yokohama municipal Minami High School (silver medalist)
SUEMATSU Mahiro, 2nd grade, Eiko Gakuen Senior High school (gold medalist)
NISHINO Takumi, 3rd grade, Todaijigakuen Senior High School (gold medalist)
HIRASHIMA Ryoichi, 3rd grade, Nada Senior High School (silver medalist)

Source: Dream Chemistry 21 Committee/The Chemical Society of Japan

International Biology Olympiad (Hungary) Participants

From left
HOSHINO Keita, 2nd grade, Eiko Gauen Senior High School (bronze medalist)
HASEGAWA Shuzo, 2nd grade, Nada Senior High School (bronze medalist)
MUKUNOKI Yuto, 3rd grade, Nada Senior High School (silver medalist)
ONO Shunsuke, 3rd grade, Tottori Prefectural Tottori Nishi High School (silver medalist)

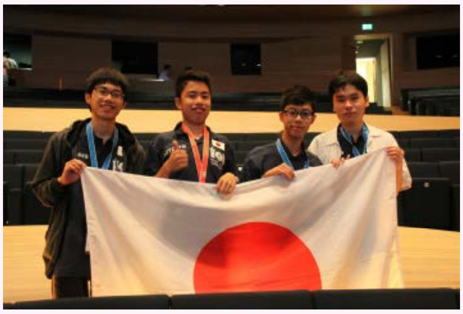
Source: International Biology Olympiad Japan Committee

International Physics Olympiad (Israel) Participants

From left
IKEDA Koki, 3rd grade, Osaka Prefectural Tennoji High School (silver medalist)
SUEHIRO Tamon, 3rd grade, Osaka Seiko Gakuin Senior High School (silver medalist)
CHIBA Ryotaro, 3rd grade, Senior High School at Komaba, University of Tsukuba (gold medalist)
SASAKI Hiroto, 3rd grade, Senior High School at Komaba, University of Tsukuba (silver medalist)
YAMADA Akira, 3rd grade, Senior High School at Komaba, University of Tsukuba (silver medalist)

Source: International Physics Olympiad Japan Committee

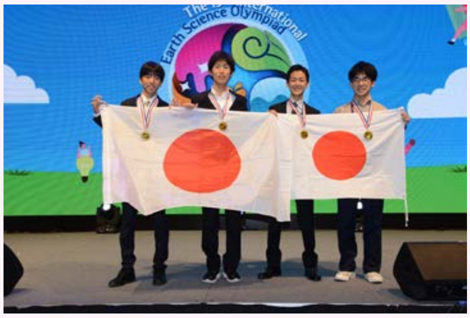
International Olympiad in informatics (Azerbaijan) Participants



From left
TODAKA Sora, 3rd grade, Miyazaki Prefectural Miyazaki Nishi High School (silver medalist)
YONEDA Masataka, 2nd grade, Senior High School at Komaba, University of Tsukuba (gold medalist)
HIRAKI Yasutaka, 2nd grade, Nada Senior High School (silver medalist)
NAMEKATA Koichi, 3rd grade, Senior High School at Komaba, University of Tsukuba (silver medalist)

Source: International Olympiad in Informatics Japan Committee

International Earth Science Olympiad (Republic of Korea) Participants



From left
ONO Koki, 2nd grade, Senior High School at Komaba, University of Tsukuba (gold medalist)
TERANISHI Masaki, 3rd grade, Nada Senior High School (gold medalist)
YAMANO Motoki, 3rd grade, Nada Senior High School (gold medalist)
NAKAO Shunsuke, 3rd grade, Rakusei Senior High School (gold medalist)

Source: International Earth Science Olympiad Japan Committee

International Geography Olympiad (China) Participants

From left
IIDA Nami, 3rd grade, Ibaraki Prefectural Tsuchiura First Senior High School
UEYAMA Ryuto, 3rd grade, Waseda Senior High School
NAKAO Shunsuke, 3rd grade, Rakusei Senior High School (bronze medalist)
TAKANO Hiroumi, 3rd grade, Shibuya Kyoiku Gakuen Makuhari Senior High School

Source: International Geography Olympiad Japan Committee

* Note: The schools and grades are as of when the award was won

■Figure 2-4-4/The 7th Japan Junior High School Science Championship

Winning team: Kaiyo Secondary School team (Aichi Prefectural team)
From left
IWASE Ryosuke, 2nd grade, Kaiyo Secondary School
KANIE Tatsuki, 2nd grade, Kaiyo Secondary School
KAWASHIMA Daiki, 2nd grade, Kaiyo Secondary School
SUZUKI Sena, 2nd grade, Kaiyo Secondary School
TAKIMOTO Kippei, 2nd grade, Kaiyo Secondary School
NAGASAWA Sora, 2nd grade, Kaiyo Secondary School

Source: Japan Science and Technology Agency

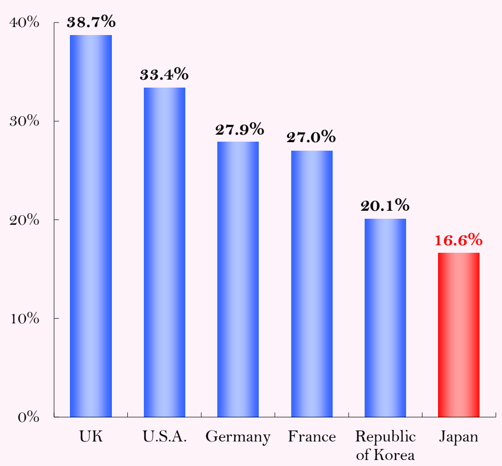
* Note: The grades are as of when the award was won.

2 Promoting diversity and career mobility

(1) Improving women's career prospects in STI

Encouraging female researchers to fulfill their potential promotes economic and social revitalization and gender equality. The 5th Basic Plan aims to promptly achieve the numerical targets of the proportion of female researchers among new hires listed in the 4th Basic Plan (30% of the total in the natural sciences overall, 20% in the physical sciences, 15% in engineering, 30% in agriculture, and 30% in medicine, dentistry and pharmacology combined) during the period of the 5th Basic Plan (28.2% in 2015). In Japan, by supporting employment and increasing the roles of female researchers, the share of female researchers has been increasing every year. However, woman still accounted for only 16.6% of researchers as of March 31, 2019, which is lower than in other advanced countries (Figure 2-4-5).

■Figure 2-4-5/Percentage of female researchers by country



Note: 1. The data are as of 2017 for Germany and Republic of Korea, 2016 for the UK, 2015 for the U.S.A. and France.
2. For the U.S.A. data on scientific professionals (i.e., bachelor's/ master's/ doctoral degree holders in science or engineering who engage in a science-related profession) are used instead of data on researchers. "Science" includes the social sciences.

Source: Adapted by MEXT based on Survey on Research and Development (MIC), Main Science and Technology Indicators (OECD) and Science and Engineering Indicators (NSF)

The Cabinet Office's website Science/Engineering Challenge[1] provides information on efforts by universities and companies to encourage such challenges and provides communications from female workers in science and technology. To encourage female students to choose careers in science and engineering, the Cabinet Office, together with MEXT and the Japan Business Federation, held an event entitled the Summer Science/Engineering Challenge 2019: Encounter Science/Engineering Jobs from July to August 2019. This program gathered a variety of events in universities and businesses to provide female students in lower/upper secondary schools with opportunities including science/engineering workplace visits, work experience and facility tours.

In addition, STEM[2] Girls Ambassadors who have studied science/engineering and are active in various fields are sent to give lectures in 10 cities across the country with cooperation of the local governments. Local companies where women are playing leading roles were introduced to encourage women to live and work in their home town. Hands-on experiment classes were also held to rouse interest in science and engineering fields.

Measures to expand diversity including promotion of active participation by women are decided under the "Comprehensive Package to Strengthen Research Capacity and Support Young Researchers" (decision by The Meeting to Promote Comprehensive Innovation Strategy on January 25, 2020)

MEXT has implemented the Initiative for Realizing Diversity in the Research Environment, to support initiatives for diversity implemented by universities and other institutions. The initiative includes integrated promotion of leader training through support for researchers to allow them to balance their

1 http://www.gender.go.jp/c-challenge/
2 Science, Technology, Engineering and Mathematics

research with maternity, childcare and other life events and support for female researchers in improving their research capabilities. 109 institutions implemented the initiative in FY2019.

The JSPS has implemented the Restart Postdoctoral Fellowship (RPD)[1] Program to provide research incentives to male/female researchers who have temporarily discontinued their research due to maternity/childcare responsibilities.

The National Institute of Advanced Industrial Science and Technology (AIST) organized the Diversity Support Office (DSO), a consortium of 20 universities and research institutions nationwide. The DSO promotes information-sharing and exchanges of opinions on diversity promotion among member institutions. The DSO is also implementing the action plan based on the Act on Promotion of Women's Participation and Advancement in the Workplace in cooperation with universities and companies and working to promote diversity by further expanding the network, supporting work-life balance and career development of researchers and raising awareness.

The G20 Osaka Summit in June 2019 took up women as one of the major topics. Japan hosted the Leaders' Special Event on Women's Empowerment as part of the official program of the summit. At the event, Prime Minister Abe sent a message on the importance of support for female education including STEM (science, technology, engineering and mathematics), which is one of the pillars of discussions on women. Furthermore, the Leaders’ Declaration included a commitment to continue support for girls’ and women’s education including improvement of access to STEM education.

(2) Enhancing the international research network structure

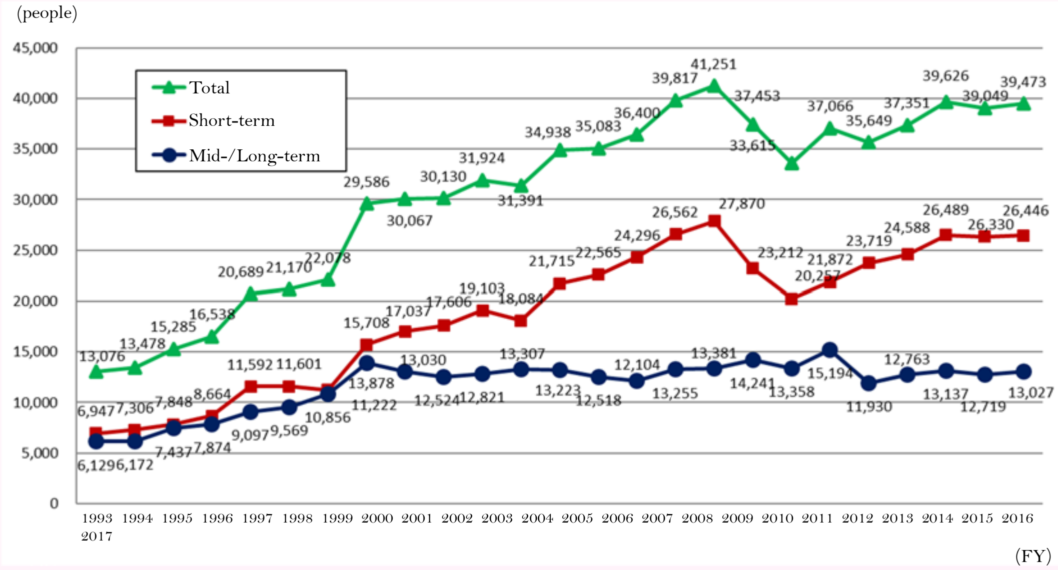
A. The development of international networks of researchers

(A) International mobility of Japanese researchers

According to the Overview of International Research Exchanges published in FY2019, the total number of short-stay foreign researchers accepted by universities and Incorporated Administrative Agencies in Japan showed a tendency to grow until FY2009, while the number decreased in FY2011 as a result of the Great East Japan Earthquake and then rebounded. The number of foreign researchers on mid-length to long stays varied between 12,000 and 15,000 for every year since FY2000 (Figure 2-4-6). The number of Japanese researchers on short stays overseas has tended to grow since the start of the survey. The number of Japanese researchers on mid-length to long stays overseas varied between 4,000 and 5,000 for every year since FY2008 (Figure 2-4-7).

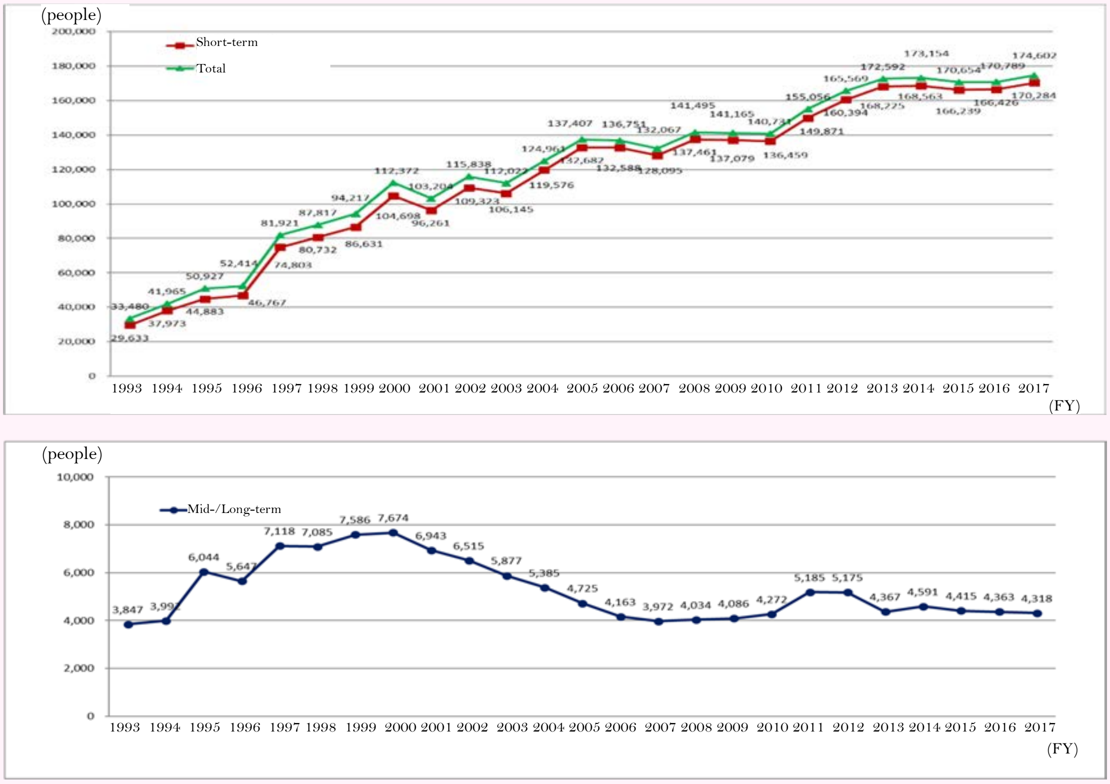
1 Refers to postdoctoral researchers restarting research activities

■Figure 2-4-6/Changes in the number of foreign researchers in Japan (Short or mid-length to long stay)



Note: 1. "Short stay" means 30 days or fewer; "mid-length to long stay" means more than 30 days.
2. Postdocs and research fellows are included in the figures in and after FY2010.
3. The overlap caused by multiple counting of the same foreign researchers accepted at multiple institutions in Japan in the same fiscal year was eliminated from the FY2013 survey.
Source: Overview of International Research Exchanges, MEXT (September 2019)

■Figure 2-4-7/Changes in the number of Japanese researchers overseas (Short or mid-length to long stay)



Note: 1. "Short stay" means 30 days or fewer; "mid-length to long stay" means more than 30 days.
2. Postdocs and research fellows are included in the figures in and after FY2010.
Source: Overview of International Research Exchanges, MEXT (September 2019)

(B) Efforts to promote international exchanges of researchers

In the midst of the globally accelerating brain circulation, Japan is making efforts to ensure that Japanese researchers and research teams can play a central role in networks of international research or researchers.

To foster young Japanese researchers who can play active roles internationally, the JSPS has provided various programs for the purpose of sending young researchers abroad and inviting excellent researchers from other countries to Japan. In the FY2019 Grants-in-Aid (KAKENHI) JSPS introduced a system to temporarily suspend research funds when the recipient is traveling overseas, and expanded "Fostering Joint International Research (B)" for acceleration of international joint research with the requirement of participation of young researchers.

JSPS has also been implementing the "Program for Fostering Globally Talented Researchers" to support universities and other research institutes that send and accept researchers to and from overseas research institutes. In addition, JSPS offers the Overseas Research Fellowships, aiming at fostering and securing highly capable researchers who have broad international perspectives and who will forge future academic activities in Japan. This fellowship program provides excellent young Japanese researchers with an opportunity to conduct long-term research at a university or research institution overseas. The Overseas Challenge Program for Young Researchers is offered to support doctoral students and other travels abroad.

In FY2019, the Cross-border Postdoctoral Fellowship program was established to provide research grant to excellent young researchers who: while tackling ambitious research at a core university/research institution of the international community, are working to form a network with famous researchers and others.

JSPS accepts overseas research fellows under the International Fellowships for Research in Japan to give outstanding foreign researchers opportunities to work at universities in Japan, which will contribute to internationalization of the research environment of Japanese universities, etc. In addition, Bilateral Programs support forming a sustainable network between Japanese and foreign research teams.

To foster young scientists and build collegial networks in the Asia-Pacific and Africa regions, HOPE Meetings have been organized by the JSPS to provide selected graduate students and young researchers from these regions with opportunities to engage in interdisciplinary discussions with Nobel laureates and other distinguished researchers.

The JST started the Japan-Asia Youth Exchange Program in Science (Sakura Science Plan) in FY2014 to invite excellent youths (high school, undergraduate and graduate students and researchers aged under 40) from 41 countries and regions predominantly located in Asia for a short-term visit (one to three weeks) to call in outstanding foreign human resources.

B. International research grant programs

The Human Frontier Science Program (HFSP) is an international research grant program first advocated by Japan at the summit in Venice in June 1987. This program aims at supporting international joint basic research on the complex mechanisms of living organisms and providing the research results for the general interest of mankind. Currently the International Human Frontier Science Program Organization (HFSPO; President: NAGATA Shigekazu) has 15 members (Japan, Australia, Canada, the EU, France, Germany, India, Italy, The Republic of Korea, New Zealand, Norway, Singapore, Switzerland, the UK and the U.S.A.). Japan has been actively supporting the program since its establishment and playing a key role in its operation.

This program provides grants for research expenses of international joint research teams (Research Grants), supports young researchers by covering the cost of overseas research travel and stays (Postdoctoral Fellowships), and holds HFSP awardees' meetings. During the 30 years since the program began in FY1990, HFSPO has given research grants for about 1,100 research tasks of over 4,000 researchers worldwide and provided fellowships to about 3,200 young researchers. Among past winners of the research grant, 28 researchers were awarded with the Nobel Prize, including HONJO Tasku, Distinguished Professor, Kyoto University, who won the Nobel Prize in Physiology or Medicine in 2018. The international cooperation program that supports original, ambitious and inter-disciplinary research is highly regarded throughout the world.

(3) Promoting cross-field, cross-organization, and cross-sector mobility

MEXT and METI recognize the importance of promoting cross appointment to increase the mobility of human resources. In cross appointment, researchers can be employed based on an agreement on secondment between multiple organizations and engage in R&D and education in the organizations according to their role in the respective organization under a certain activity management. The ministries published the "Basic Framework and Notes on Cross-Appointment System" compiling notes and recommended examples in December 2014 and have promoted introduction of the system The Guidelines for Fortifying Joint Research Through Industry-Academia-Government Collaboration formulated in November 2016 also encourages cross appointment. In FY2019, an addendum version of the "Basic Framework and Notes on Cross-Appointment System" was created for further promotion of cross appointment.

MEXT has been implementing the Building of Consortia for the Development of Human Resources in Science and Technology. In this program, consortium is formed in multiple universities to ensure the stable employment of researchers while encouraging mobility for their career progression in cooperation with companies.

Chapter 4

■Table 2-4-8/Major projects for strengthening of human resources (FY2019)

Ministry	Implemented by	Project
MEXT	MEXT	Grant for Science Education Equipment Servicing
		Expenses necessary for Management Expense Grant for National Institute of Technology
		Program to Disseminate Tenure Tracking System
		Building of Consortia for the Development of Human Resources in Science and Technology
		Initiative for Realizing Diversity in the Research Environment
		Leading Initiative for Excellent Young Researchers
		Strategic Professional Development Program for Young Researchers
	JASSO	Scholarship program

Column 2-10 Contributing to development of young talents using marine research platforms

Japan has the world's leading research platforms, including SHINKAI 6500 that is a manned research submersible capable of manned submerging as deep as 6,500m, and the deep-sea scientific drilling ship "CHIKYU." Japan Agency for Marine-Earth Science and Technology (JAMSTEC) that operates these research platforms aims to foster talents who will support the marine science and technology of the future by actively providing young people with opportunities to experience marine science and technology.

In FY2019 JAMSTEC implemented the project "Experience Deep-sea Research!" to provide an opportunity of experience and education in a cutting-edge marine research field. For this project, participants for an underwater research navigation using SHINKAI 6500 were invited from among university students and fourth year students and above of technical college. Under direct tutelage of researchers, as member of a team conducting ambitious cutting-edge research the participants experienced real field activities including preparation for research voyages, boarding a research ship and SHINKAI 6500, and on-board experiments and analysis. Reports by the participants are posted on the website of JAMSTEC (https://www.jamstec.go.jp/j/about/hr_cruise2019/#report.)

In cooperation with Nippon Foundation Ocean Innovation Consortium that was established for the government's objective to foster marine engineers, JAMSTEC holds the CHIKYU boarding seminar for undergraduate and 1st-year graduate students. The popular seminar marked its 4th session in FY2019. Participants stay on CHIKYU and deepen their understanding of the technologies that support scientific drilling and obtained research results through onboard lectures and ship tours that include places not accessible in usual tours.

This human resource development project using the research platform is a prime opportunity for participants to learn about actual research sites, and a unique opportunity to interact with professional researchers, engineers and like-minded people from across Japan. Through these projects JAMSTEC will continue to create interest in pioneering marine science and technology while at the same time contributing to development of talents who will support the marine science and technology of Japan.

Participating undergraduate (right,) a pilot (center) and a researcher (left) in standby in a pressure-resistant shell of SHINKAI 6500 that is about to go underwater
Source: JAMSTEC

Students receiving explanations from an engineer in the drilling control room (Driller's House) of CHIKYU
Source: JAMSTEC

Section 2 Promoting Excellence in Knowledge Creation

Continuous creation of innovations requires flexible thinking and novel ideas not bound by traditions or conventional rules. Through reforms and strengthening of such academic research and basic research as well as development of an environment for researchers to settle down to study, we work to strengthen the foundation of knowledge both in quality and quantity.

1 Promoting academic and basic research as a source of innovation

(1) Reform and enhancements to promote academic research

A. Reform and strengthening of Grant-in-Aid for Scientific Research

MEXT and the JSPS have been implementing the Grants-in-Aid for Scientific Research (KAKENHI). KAKENHI, which are available through MEXT and the JSPS, are the only competitive funds provided for all academic research in any field, from the humanities/social sciences to the natural sciences. KAKENHI grants have been supporting diverse, creative research, broadening the base of various research activities, continually advancing research, and generating profound knowledge. In FY2019, around 29,000 research applications were newly selected by peer review screening (assessment of the research proposals by reviewers selected from the research communities) from over 100,000 applications in major research categories. About 79,000 projects, including those continuing for the several fiscal years, were funded. (The KAKENHI budget for FY2019 is 237.2 billion yen).

The KAKENHI system has been reviewed continuously for improvements, including its introduction of a Multi-year Fund. With the aim of promoting high-quality scientific research and generating excellent knowledge, based on the Policy for Implementing Reforms in the KAKENHI System (formulated in September 2015), MEXT is carrying out radical reform including a review of its screening system.

Specifically, based on "About Reform of the Review System for Grants-in-Aid for Scientific Research–KAKENHI" compiled by the Subdivision on Science, Council for Science and Technology, MEXT, about 400 examination categories were reorganized into an examination category table of a smaller number of categories, and public invitation was made based on the new table starting from FY2018 Grants-in-Aid. Consultative examination is further enhanced through new examination methods including "comprehensive examination".

MEXT will continue to work to improve KAKENHI for further promotion of academic research.

B. Promotion of shared use and joint research at universities and inter-university research institutes

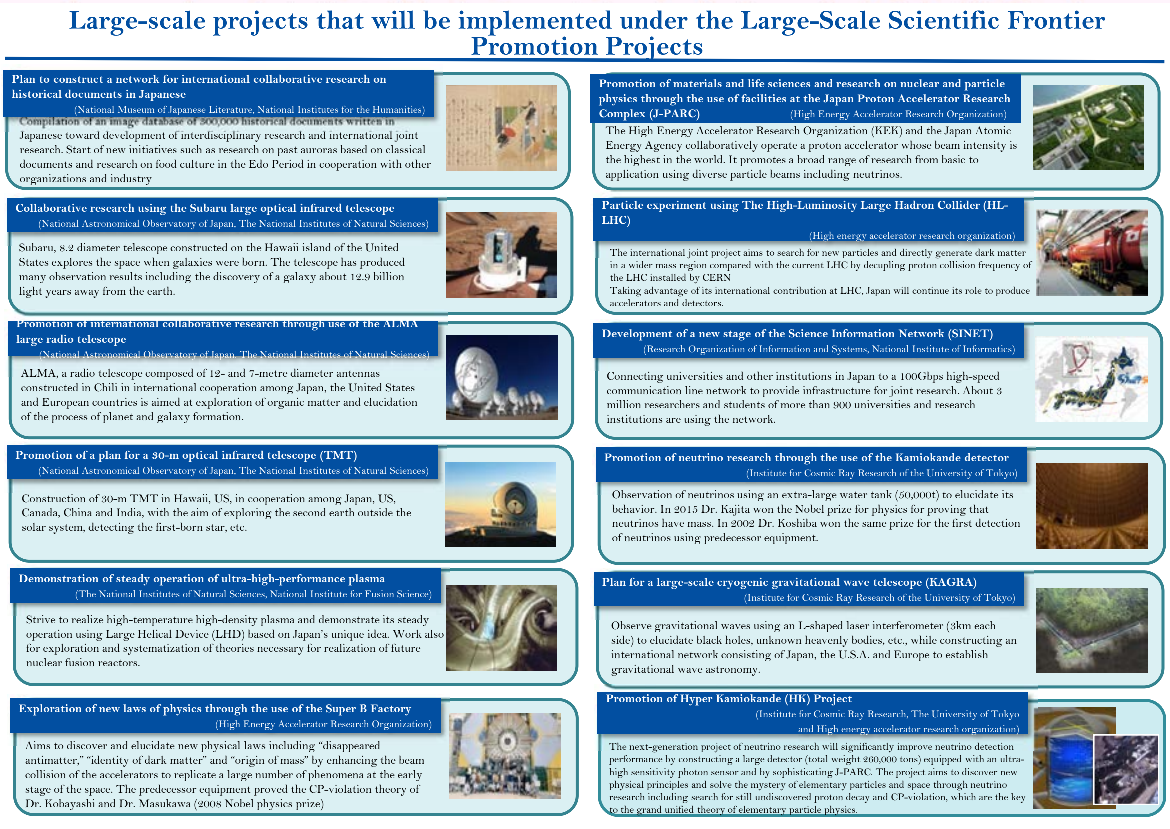
The system for shared use and joint research has made a big contribution to the development of academic research in Japan. Under the system, researchers across the country can use leading edge large equipment and precious materials/data outside the framework of university. The system functions mainly through inter-university research institutes and joint usage / research centers of national, public and private universities certified by the minister of MEXT.[1] and shared use/joint research centers of national, public and private universities certified by the minister of MEXT.

Large-scale scientific research, in particular, leads the world's scientific research by tackling uncharted

1 108 centers of 55 universities (including 7 centers of 5 universities in international joint usage / research centers) have been certified and are active as of October 2019

research subjects using large-scale cutting edge research equipment, and forms a global research center by gathering excellent researchers of Japan and other countries. For this reason, it is important to promote such projects under a shared use/research system. MEXT supports these projects under the "Large-Scale Scientific Frontier Promotion Projects" program (Figure 2-4-9.) Representative examples are Super Kamiokande (SK) that produced research results leading to the awarding of the Nobel Prize in Physics to KAJITA Takaaki, Director of the University of Tokyo's Institute for Cosmic Ray Research in FY2015, and Hyper Kamiokande (HK) that is the next-generation of SK. HK has observation capacity that exponentially exceeds the capacity of SK and aims to discover new physical principles and unlock the mystery of elementary particles and space through neutrino research including proton decay search. Construction of HK started in FY2019. The large radio telescope ALMA project also made a big contribution to the first-ever successful capture of image of a black hole, which was announced by the international joint research team in April 2019. The project has steadily produced results in the study on the formation process of the galaxy and planetary system and origin of life.

■Figure 2-4-9/Large-scale projects that will be implemented under the Large-Scale Scientific Frontier Promotion Projects



Source: MEXT

(2) Reform and enhancements to promote strategic and on-demand basic research

The Strategic Basic Research Programs (Creating the Seeds for New Technology) operated by the JST and the Advanced Research and Development Programs for Medical Innovation launched by the Japan

Agency for Medical Research and Development (AMED) invite applications from researchers at universities and other institutions. These programs are carried under the strategic objectives set by the national government. The research is conducted through a fixed-term consortium that is connected over institutional boundaries. The important results generated by the research are being accelerated and deepened. In order to incite unique and bold ideas of researchers and encourage interdisciplinary research by researchers of diverse fields, the system is reformed by consolidating strategic targets, for example. MEXT set the following seven targets for 2019.

A. Strategic Basic Research Programs (Creating the Seeds for New Technology)

- Elucidation of mechanical property manifestation mechanism based on the understanding of nanoscale dynamic behavior
- Creation of innovative basic technologies taking advantage of leading-edge opto-science and technology
- Creation of quantum computing platform
- Creation and social application of information utilization platforms through coordination and fusion of mathematical science and information science
- Basic technologies that support strategic utilization of the next-generation IoT
- Creation of a technology and analysis platform toward understanding of spatiotemporal interaction of multiple cells

B. Advanced Research and Development Programs for Medical Innovation

- Elucidation of molecular life phenomena at an early life stage toward improvement of the quality of health and medical care

(3) Promotion of emergent research

For Japan to continue to create research results with Nobel-prize-level impact, we need an environment where researchers can concentrate on free and bold research over the long term. Based on this understanding, MEXT created a 50 billion yen fund at JST using the FY2019 supplementary budget for implementation of the "Emergent Research Support Project" that integrally promotes flexible and stable research expense support for up to 10 years and improvement of the research environment.

(4) Promoting joint international research and forming world-class research centers

In order for Japan to be able to occupy an important position in global research networks and exert its presence on the global stage, it is important not only to take a strategic approach to the promotion of international joint research but also to build a research center that can become a hub of international brain circulation for the nation.

A. International joint research with other countries

(A) International Thermonuclear Experimental Reactor (ITER) project, etc.

The ITER project is managed under the international cooperation of seven parties for realization of fusion energy. The construction of ITER began in earnest in Cadarache, France, toward commencement of operations in 2025. Japan is promoting the production of major equipment of ITER including superconductive coils (See Section 1, Chapter 3.) Japan and Europe are also promoting the Broader Approach (BA) that is an advanced fusion R&D supplementing and supporting the ITER project at Rokkasho Village of Aomori prefecture and Naka city of Ibaraki prefecture.

(B) International Space Station (ISS)

Japan operates the Japanese Experiment Module "KIBO" and the uncrewed cargo transfer spacecraft "KONOTORI" (HTV[1]) in the ISS program. (See Section 4 2-(6), Chapter 3.)

(C) International Space Exploration

In October 2019 the Strategic Headquarters for National Space Policy decided "Policy of Japan on the Participation in International Space Exploration under the Proposal of the United States". (See Chapter 3 Section 4-2(7))

(D) International Ocean Discovery Program (IODP)

The IODP is a multilateral international cooperation project led by Japan, the United States and Europe with the aim of elucidating global environmental change, the inner structure of the Earth, and subseafloor biosphere, etc. The program has been implemented since October 2013 to replace the Integrated Ocean Drilling Program (former IODP (2003 to 2013).) A Japanese deep drilling vessel, CHIKYU, that features the world's top level drilling capabilities among science drilling vessels and a U.S. drilling vessel are acting as the principal vessels of the IODP; and Mission-Specific Platforms are provided by the European consortium. These drilling vessels are used to drill deep sea floors worldwide.

(E) Large Hadron Collider (LHC)

In the LHC project[2], the CERN[3] member states, Japan and the U.S.A. have been collaborating in experiments in the energy field at the highest level in the world. The results of the collaboration include discovery of the Higgs Boson. Currently, the upgrade of LHC to increase its luminosity (HL-LHC project) is underway.

(F) Other

An international researcher community is considering the International Linear Collider (ILC) project to investigate the properties of the Higgs Boson in more detail.

Following the opinion of the Science Council of Japan, which was published in December 2018, MEXT expressed "MEXT's view in regard to the ILC project" in March 2019. MEXT has been paying attention to the discussions in the researcher community and implementing this view.

B. Efforts toward Creation of world-leading international research centers

Through the World Premier International Research Center Initiative (WPI) MEXT has been steadily

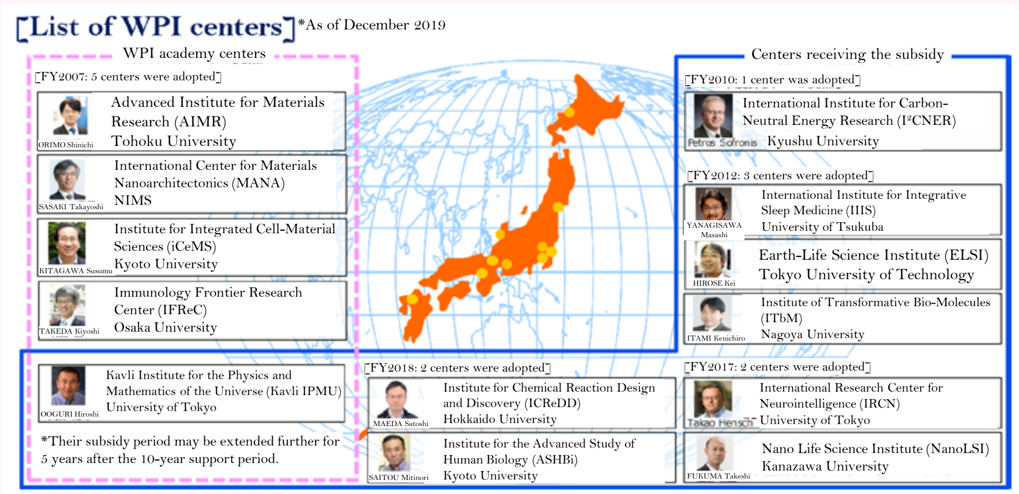
1 H-II Transfer Vehicle
2 In this experimental project, the large circular collider of CERN is used to reproduce extreme conditions similar to those of shortly after the Big Bang, with the aim of discovering unknown particles and the deep internal structure of matter.
3 Conseil Européen pour la Recherche Nucléaire

improving and strengthening the "globally visible brain circulation centers" with highly global research environments and the world's top-level research standards. Specifically, each research center selected for this initiative receives approximately 0.7 billion yen annually for 10 years (up to 1.4 billion yen for the research centers that were selected in FY2010 or earlier). As of the end of FY2019, 13 centers are supported under this initiative (Figure 2-4-10). Under this program, the WPI Program Committee, chaired by NOYORI Ryoji, Director-General of Center for Research and Development Strategy, JST, is playing a central role in careful and meticulous progress management carried out every year.

With the aim of increasing world-class universities and also enhancing universities' research capabilities, the government is implementing the Program for Promoting the Enhancement of Research Universities. Under this program it supports and promotes integrated efforts for securing/utilization of research management personnel, university reform and intensive reform of the research environment, so that the research capacity of the entire country will increase.

Cabinet Office has been supporting activities for expansion of the Okinawa Institute of Science and Technology Graduate University (OIST) toward a global center of science, technology and innovation.

■Figure 2-4-10/List of the World Premier International Research Center Initiative (WPI) centers



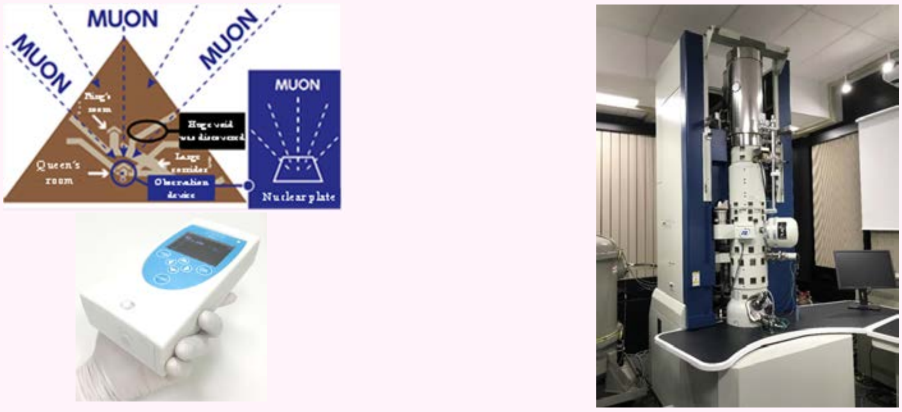
Source: MEXT

2 Strategic enhancement of common-platform technology, facilities, equipment, and information infrastructure supporting research and development activity

(1) Strategic development and use of common-platform technology and research equipment

In line with the MEXT policies, the JST has been implementing the Development of Advanced Measurement and Analysis Systems program to promote the development of the most advanced, unique instruments for measurement and analysis that serve the needs of world-leading researchers and manufacturers (Figure 2-4-11). As of the end of March 2019, 65 prototypes had been developed and put into production.

■Figure 2-4-11/Examples of technologies and instruments for advanced measurement and analysis



Upper left: Development of a nuclear plate that enables high accuracy (under 1μm) observation of cosmic ray muons that have high penetration of physical bodies. Observation using the plate led to the discovery of a huge unknown void at the center of the pyramid of King Khufu, the largest pyramid of Egypt.
Lower left: Development of a mobile genetic testing device that can carry out virus/bacteria test in a short time (about 10 minutes)
Right: developed an electron microscope that enables atomic resolution observation in a magnetic field-free environment which defies conventional wisdom.
Source: JST

(2) Maintenance, sharing, and networking of research facilities, equipment and intellectual infrastructure used by industry, academia, and government

A. Promotion of development/sharing of research facilities/equipment and their networking

As infrastructure to promote S&T, research facilities and equipment support a vast range of R&D; thus, they need to be further advanced and used more efficiently and effectively. The Act on Improving the Capacity, and the Efficient Promotion of Research and Development through Promotion of Research and Development System Reform (Act No. 63, 2008) stipulates that the government shall take necessary measures to promote the shared use of R&D infrastructure facilities and equipment as well as intellectual infrastructure owned by national universities and R&D agencies.

Pursuant to the R&D Enhancement Act, the government has been promoting the effective use of key general facilities and equipment by industrial, academic and government research institutions for diverse R&D on science and technology. The government is also working on networking of these facilities and equipment so that they will be available more conveniently in a mutually complementary manner and will be able to respond to emergencies.

(A) Specified Large-Scale High-Technology Research Facilities

The Act on the Promotion of Shared Use of Specified Large-Scale High-Technology Research Facilities (Act No. 78, 1994) (the Shared Use Act) defines large-scale research facilities of special importance as Specified Large-Scale High-Technology Research Facilities. This act stipulates the need for the systematic development and operation of these facilities, as well as for shared use in a fair, even manner.

(i) Super Photon ring-8 GeV (SPring-8)

SPring-8 is a research infrastructure facility that delivers the top performance in the world in the analysis of atomic or molecular structure/function by using synchrotron radiation, the extremely bright light that is produced when electrons accelerated to near the speed of light are forced to travel in a curved path. For 20 years since the service commencement in 1997, this facility has been contributing to innovative R&D in various fields of research from life science to environment/energy and new materials development which help boost Japan's economic growth.

Super Photon ring-8 GeV (SPring-8) and
an X-ray free-electron laser facility (SACLA)
Source: RIKEN

(ii) X-ray free-electron laser facility (SACLA[1])

SACLA is the most advanced research infrastructure facility in the world with respect to the generation of x-ray laser. The unprecedented light generated there has both laser and synchrotron radiation characteristics and allows instantaneous measurement and analysis of ultra-high speed movements/changes in atomic-level hyperfine structures and chemical reactions. SACLA has been in use since March 2012. In FY2017 simultaneous operation of two hard x-ray free electron laser beam lines by switching the paths of the electric beams[2] started for the first time in the world. Its usage environment has been also steadily improved toward creation of further creation of high-impact results.

(iii) Termination of the operation of the supercomputer "K" and development of "Fugaku"

As a third approach to S&T, following the theoretical and experimental approaches, supercomputer simulations have been crucial for cutting-edge S&T and improvements in industrial competitiveness. The K computer that had been operated by RIKEN since September 2012 underpinned breakthroughs in diverse fields, including upgrading of medical care and drug discovery, manufacturing innovations, the mitigation of earthquake and tsunami damage, and the elucidation of the origin of matter and the universe. Its operation was terminated in August 2019.

Green500 certificate of merit

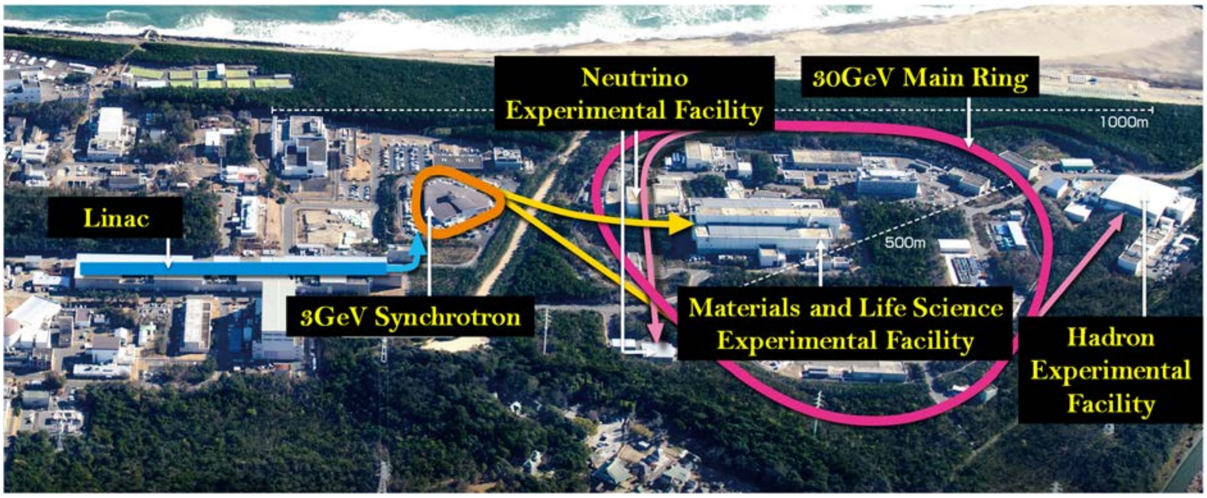
In order to contribute to solutions of Japan's social and science challenges, MEXT has been promoting a project to develop the supercomputer "Fugaku" which succeeds the supercomputer "K" and will become fully operational in FY2021. Through co-design of the system and applications contributing to problem solving, the ministry aims to realize the world's best versatile supercomputer. In the supercomputer ranking in November 2019, the prototype of "Fugaku" took first place in energy efficiency (Green500).

To address COVID-19, MEXT in collaboration with RIKEN decided to deploy "Fugaku" a year in advance of its full operation to combat the pandemic in April 2020.

1 SPring-8 Angstrom Compact Free Electron Laser
2 Multiple beam lines can be used simultaneously by switching the paths of the electric beam from the linear accelerator pulse-by-pulse.

(iv) Japan Proton Accelerator Research Complex (J-PARC)

J-PARC has been contributing to a wide range of R&D, including basic research and industrial applications, by using secondary particle beams of neutrons, muons and neutrinos [1] that are generated by a proton accelerator with the highest beam intensity in the world. The Materials and Life Science Experimental Facility (Specified Neutron Facility) has been used for structural analyses which may spawn innovative materials and new drugs and numerous results have been achieved. The Shared-Use Act is not applicable to the Nuclear and Particle Experimental Facility (Hadron Experimental Facility) or the Neutrino Experimental Facility, but these facilities are used jointly by university researchers in Japan and abroad. At the Neutrino Experimental Facility, Tokai to Kamioka (T2K) experiments have been conducted with the aim of clarifying the characteristics of neutrino oscillations, following the research of neutrino oscillations that won the 2015 Nobel Prize.



Japan Proton Accelerator Research Complex (J-PARC)
Source: J-PARC Center

1 A neutrino is a neutrally charged, elementary subatomic particle. It is extremely difficult to detect neutrinos because they can penetrate ordinary matter without leaving any trace, and little is known about their characteristics or masses.

Column 2-11

Marking the 10th anniversary of the operation of J-PARC Facilities

Japan Proton Accelerator Research Complex J-PARC are multipurpose research facilities that use the world's top-level high-intensity proton beams to create diverse secondary particles for use in a broad range of science activities. Three experimental facilities – the Materials and Life Science Experimental Facility (MLF), Neutrino Experimental Facility and Hadron Experimental Facility – annually attract over 32,000 users in total from Japan and abroad. Here an extremely wide range of research and development are conducted from elementary particle and nuclear physics that explore the origin of universe and matter, material science, chemistry, and life science up to development of batteries and car tires which are familiar in our day-to-day life. In 2019 when J-PARC marked the 10th anniversary of full operation a commemorative ceremony and a symposium were held.

Construction of J-PARC started in 2003 as a joint project of the Japan Atomic Energy Research Institute (current Japan Atomic Energy Agency (JAEA)) and the High Energy Accelerator Research Organization (KEK). Full operation started in 2009 and it accepted a large number of researchers. The Great East Japan Earthquake in 2011 interrupted the facilities' operation but they have been maintaining stably high availability in the last several years. Their research results and plans get newspaper and television coverage. Industrial use proposals account for about 30% of all proposals using the MLF. The results leading to industrial development include: discovery of a new magnetic order in iron-based superconductors; elucidation of materials property that can lead to the development of new car tire material; discovery of a superionic conductor which can lead to the development of all solid ceramic cells, and elucidation of the mechanism of colossal barocaloric effects (CBCEs) of plastic crystals that are expected to become an environmentally friendly solid refrigerant. Evaluation of semiconductor soft error caused by muon is also conducted in recent years. In the field of elementary particle and nuclear physics, the facilities produced pioneering results, which include discovery of transition from muon neutrino to electron neutrino and a hint of CP violation [1] that is a subsequent difference between matter and antimatter.

At J-PARC, human resource development by the Neutron and Muon School and discussions on future plans are also actively pursued. 10 years after starting operation, it entered a new phase. More than ever, the world's cutting-edge research facilities are expected to produce excellent research results in a broad range of fields from basic science to industrial use. MEXT will continue steady operation of J-PARC, support cutting-edge R&D and further develop an attractive research environment.

Participants in the 10th anniversary ceremony of J-PARC

Source: J-PARC Center

1 CP violation means that matter and antimatter are different in property. This is one of the necessary conditions for the universe being composed of matter. Here, C stands for "charge" and P stands for "parity."

(B) The next-generation synchrotron radiation facility (highly brilliant 3GeV-level radiation light source for soft X-ray)

The next-generation synchrotron radiation facility is a research platform that can visualize not only materials structure in the manner performed by existing facilities but also in the electronic state that influences materials function by using highly brilliant intense soft X-rays that can sensitively observe light elements. Beyond academic research, the facility is expected to be used in a broad range of fields including catalyst chemistry, life science and industrial use of magnetic/spintronics materials and high polymer materials. MEXT will promote the facility in a public-private-regional partnership that designates the National Institutes for Quantum and Radiological Science and Technology (QST) as the government body responsible for the development and operation of the facility. Furthermore, the ministry selected five private/regional partners: Photon Science Innovation Center (representative,), Miyagi Prefecture, Sendai City, Tohoku University and Tohoku Economic Federation in July 2018. The next-generation synchrotron radiation facility is now under development toward completion in 2023.

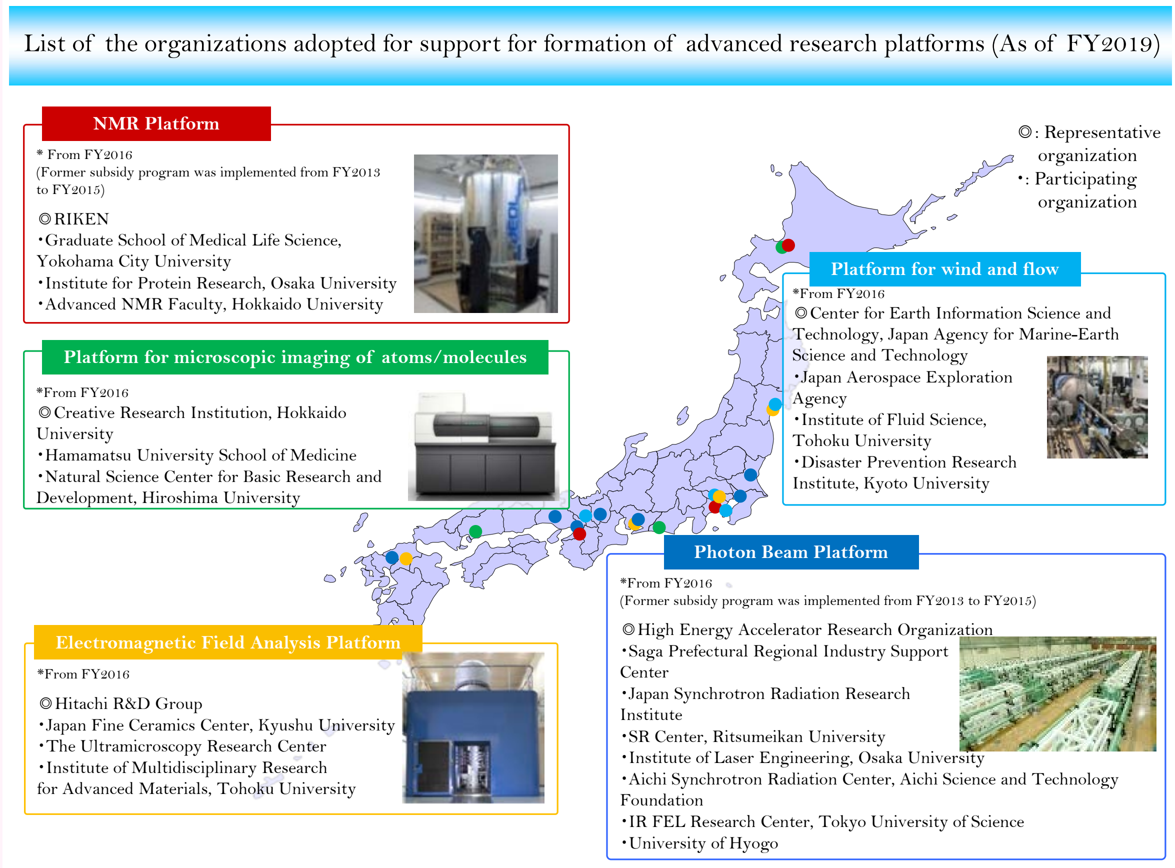
Conceptional Drawing of the next-generation synchrotron radiation facility

(C) Constructing a network of research facilities and equipment

(i) Platforms for shared use

MEXT has been working to maintain and advance the world's leading R&D infrastructure by forming platforms for shared use to construct a network of research facilities/equipment available for sharing by industry, academia and government (Figure 2-4-12).

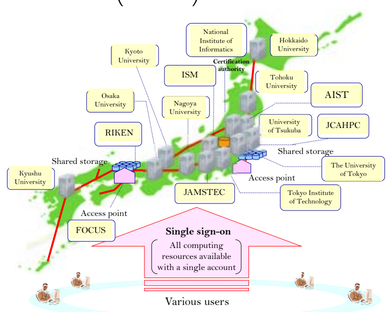
■Figure 2-4-12/Organizations adopted for the Project for Promoting Public Utilization of Advanced Research Infrastructure (support for formation of advanced research platforms)



Source: MEXT

(ii) The development of Innovative, High Performance Computing Infrastructure (HPCI)

To promote scientific research further, MEXT has built an innovative High Performance Computing Infrastructure (HPCI) in which supercomputers and storage sites at universities and research institutes are connected through the Science Information NETwork (SINET). MEXT is also promoting its use in various fields while working for effective and efficient operation of HPCI. In response to COVID-19, HPCI is also being collectively utilized for COVID-19 research.



Source: MEXT

(iii) Nanotechnology Platform

MEXT is providing a nationwide system for the shared use of advanced equipment and technology. Under that platform, research institutions that have cutting-edge nanotechnological research facilities and knowledge work closely to provide opportunities for researchers from industry, academia and government around the nation to use their facilities.

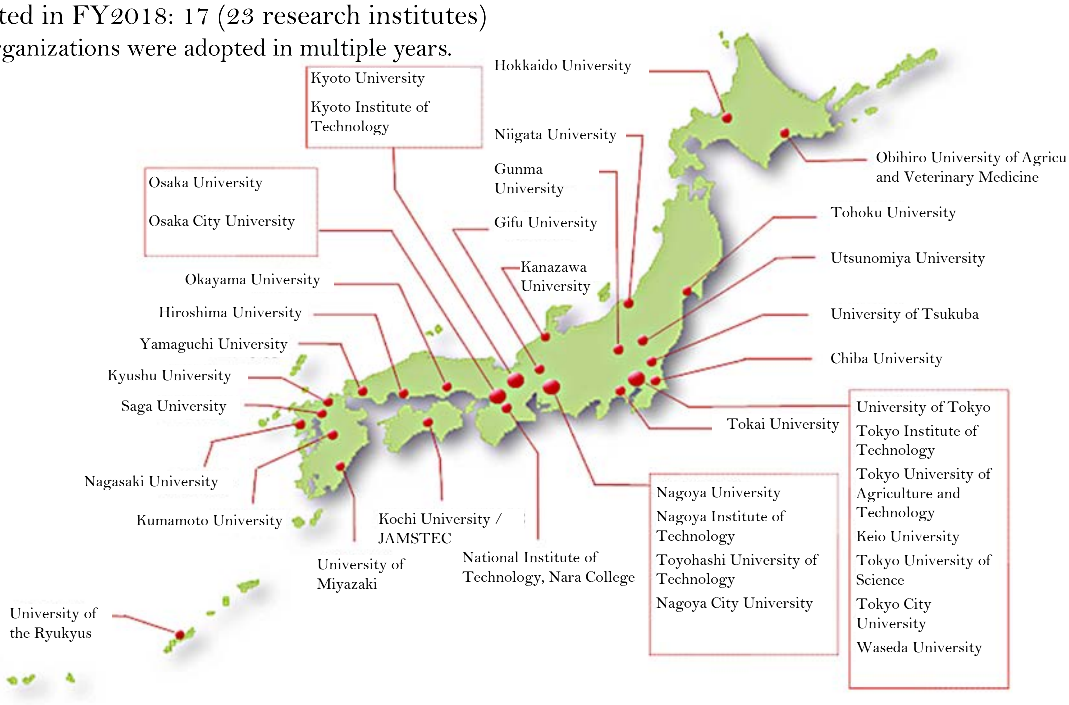
B. Introduction of new sharing system aligned with the competitive fund reform

MEXT is promoting introduction of a new sharing system to realize a virtuous cycle of R&D and sharing in conjunction with the reform of competitive research funds through early establishment of development and operation of research facilities/equipment integrated with the management of research organizations (Figure 2-4-13).

■Figure 2-4-13/Organizations adopted for the Project for Promoting Public Utilization of Advanced Research Infrastructure (support for introduction of the new sharing system)

List of organizations adopted for support for introduction of the new sharing system (As of FY2019)

Number of implementing organizations: 37
Adopted in FY2016: 15 (23 research institutes)
Adopted in FY2017: 16 (24 research institutes)
Adopted in FY2018: 17 (23 research institutes)
*10 organizations were adopted in multiple years.



Source: MEXT

C Introduction of a network for shared use of research equipment

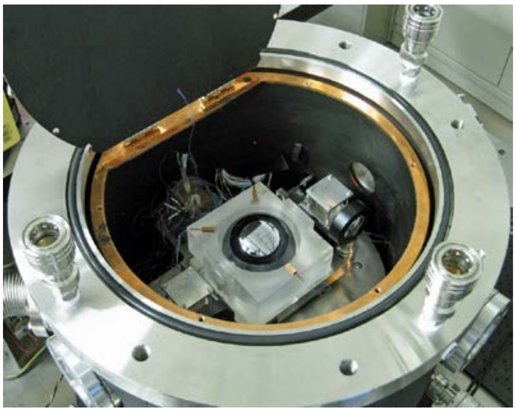
In order to contribute to the improvement of research productivity and regional research capabilities, MEXT conducted a demonstration experiment to build a network for shared use of research equipment among neighboring universities, enterprises and public experimental research institutions (PERI) and is promoting shared use of research facilities and equipment between universities and between universities and enterprises, for example.

D. Promotion of development, sharing and networking of intellectual infrastructure

Under the National BioResource Project, through AMED, MEXT is improving the system so that biological resources, including animals and plants that may become the base of life science and that may be strategically important for the country, can be collected, preserved and distributed in a systematic manner. The ministry is also comprehensively promoting R&D on elucidation and control of the mechanism of aging and implementing "project for elucidation and control of the mechanism underlying aging" with the aim of forming centers of aging research.

METI, based on the understanding that the ministry should formulate a new Intellectual Infrastructure Improvement Plan in order to strengthen the country's R&D capabilities, decided to start detailed analysis. Progress of the second Intellectual Infrastructure Improvement Plan in individual fields is as follows:

Regarding measurement standards, AIST implemented various initiatives. As regards physical standards AIST developed a radiance standard (using standard LED for radiance as calibrator) in response to the increase in the number of radiance calibration service providers registered with the JCSS[1] as the need for LED light source increases. Regarding chemical standard materials, AIST developed standard substances for doping inspection at the request of the World Anti-Doping Agency. AIST also developed Heptaoxyethylene dodecyl ether standard solution corresponding to the standards of nonionic surfactant for quality of drinking water and provided technical support for establishment of an implementation system of JCSS with traceability of measurement. In response to the amendment of the Measurement Units Ordinance following the enforcement of the revised definition of SI (International System of Units) base units (May 20, 2019) AIST made announcements concerning "influence on electrical standard," "change of specified standard instrument for mass" and "operation of calibration certificates based on thermodynamic temperature in standard supply (from 960°C to 2,800°C) of radiation thermometer" on the website of the National Metrology Institute of Japan.



Laser interferometer for high precision measurement of volume of single-crystal silicon sphere (single-crystal silicon sphere is placed at the center)
Source: AIST

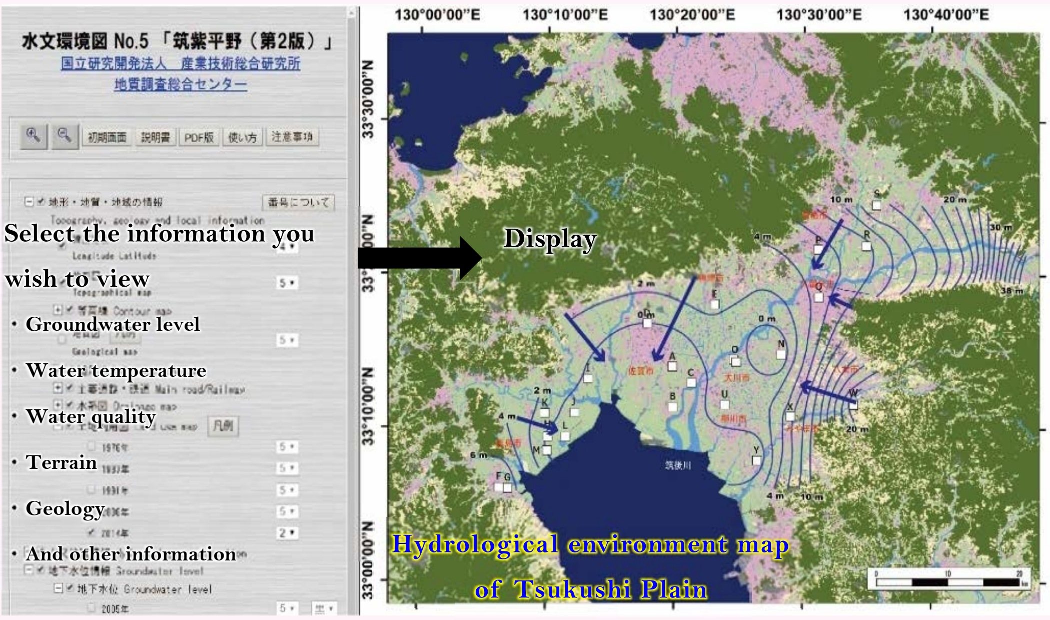
The National Institute of Technology and Evaluation (NITE) has been collecting, preserving and distributing microbial genetic resources and has also been organizing information on these resources in terms of their genes and genetic lineages so as to make the information accessible to researchers and others (6,715 strains of biological genetic resources had been distributed as of the end of January 2020.). It has also constructed cooperative relationships with Asian countries by joining a network of 26 organizations from 15 countries, which aims for the preservation and sustainable use of microbial resources (the Asia Consortium, founded in 2004) and has supported Asian countries in their efforts to use microorganism resources through multilateral interchange programs according to the Convention on Biological Diversity (CBD) and the Nagoya Protocol. In addition to these initiatives, NITE accepted researchers from Taiwan

1 Japan Calibration Service System

for personnel exchange as part of its cooperation with Asian countries regarding genetic resources.

As regards geological information, AIST published geological maps on a scale of 1:50,000 for six blocks (Motoyama, Towadako, Kazusaohara, Akechi, Umaji and Kakunodate) and geological maps on a scale of 1:200,000 for two blocks (Wajima (2nd edition) and Hiroo (2nd edition)). AIST also released the "Geochemical 3D map of Sea and Land" of the Hokuriku region (Figure 2-4-14) and released a nationwide hydrological environment map that can show groundwater quality information on nationwide uniform criteria. This is expected to contribute to groundwater management for sustainable preservation and use of groundwater by local governments as well as promotion of geothermal heat utilization systems together with the release of a geothermal potential map. High-performance optical sensor ASTER (mounted on Terra that is an earth observation satellite of NASA) with 14 bands from visible to thermal infrared was developed for resource exploration and has been in operation for 20 years, which is the world's longest continuous operation on an earth observation satellite. For this achievement, our scientist received the prestigious William T. Group Award in the field of earth observation as a member of the Terra Mission Team.

■Figure 2-4-14/ Released "Map of Groundwater" where ground water information is visible at the first sight



Source: AIST

(3) Development of university facilities and equipment, and enhancement of information infrastructure

A. Facilities and equipment at national universities

Facilities at national universities are places for development of human resources who will play important roles in the future. They are also important infrastructure for education and research activities by serving as centers for regional revitalization and creation of innovations. However, they have major safety and functional problems due to significant aging.

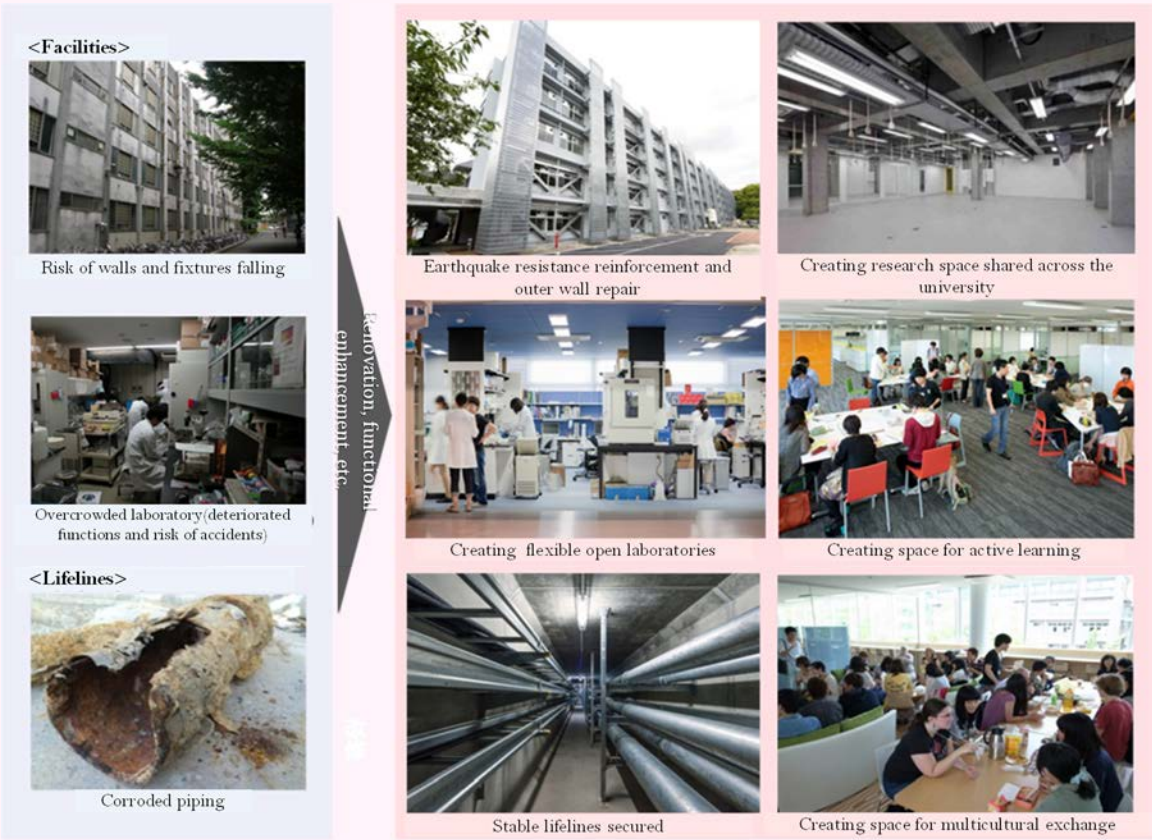
With this in mind, MEXT formulated the 4th Five-Year Program for Facilities of National Universities (FY2016-FY2020) (decision by the Minister of MEXT on March 29, 2016) (Hereinafter: the 4th Five-Year Program) in March 2016, based on the 5th Basic Plan to promote the systematic and prioritized improvement of university facilities. In addition, toward functional enhancement and globalization of national technical colleges for the new age, the ministry is developing international student housing and intensively improving dilapidated student housing and school buildings (Figure 2-4-15).

The 4th Five-Year Program has promoted the following projects as priority: the improvement of infrastructure for safe and secure educational environments; response to changes, which includes the functional enhancement of national universities, and promoting creation of sustainable campuses. Facility functions are enhanced at the timing of renovation of aged building (strategic renovation) in order to respond to changes in education and research activities in universities, etc. For example, active learning spaces for independent learning by students are set up and open laboratories that are shared by multiple research teams are introduced to encourage natural communication.

As the 4th Five-Year Program will end in FY2020, MEXT held the "Council on Facilities of National Universities in the Future" in September 2018. The council started discussions on the next term program and compiled the "Direction of Facilities Development of National Universities in the Future" in June 2019. Based on the discussions, the ministry held the "Research Committee on Campus Development and Facility Improvement of National Universities." The committee has been discussing measures for promotion of facilities development in 2021 and after. Toward systematic maintenance of facilities and based on the Basic Plan for Extending Service Life of Infrastructure (Liaison Conference of Ministries and Agencies Concerned with Promotion of Measures against Aging of Infrastructure in November 2013,) MEXT formulated the "MEXT Plan for Extending Service Life of Infrastructure (Action Plan)" in March 2015 and has been promoting formulation of action plans and individual facility plans at national universities, etc. In addition, the ministry is further promoting initiatives for strategic facility management through effective utilization, appropriate maintenance and creation of sustainable campuses. MEXT is also promoting facility development using diverse funds.

Because facilities of national universities are infrastructure that supports advanced research and quality education, they require plan-based maintenance, management and improvement. In addition to the support for the development of large research equipment by universities, MEXT through its Large-Scale Scientific Frontier Promotion Projects has provided support for the world's most advanced research equipment developed based on the creative ideas of Japanese scientists including the "Hyper Kamiokande (HK) project."

■Figure 2-4-15/Examples of functional enhancement by improvement of aged facilities



Source: MEXT

B. Facilities and equipment at private universities

MEXT supports development of facilities/equipment forming the foundation of high-quality education and research activities of private universities based on their establishment principles and characteristics.

C. Enhancement of Research Information Infrastructure

The National Institute of Information and Communications Technology (NICT) has been promoting technical and social verifications of IoT and a next-generation communications network by using the NICT Comprehensive Test-bed which NICT has developed and has been operating.

The National Institute of Informatics (NII) has been improving and operating the Science Information Network (SINET) as a platform for supporting overall scientific research and education at universities and institutions. SINET is the 100 Gbps[1] network that covers all prefectures. In the light of the recent communication demand, the network was extended by 400 Gbps line between Tokyo and Osaka in December 2019. In order to ensure smooth international circulation of research information: which is required in international cutting-edge research projects, SINET is connected with many research networks in the United States, Europe and other countries. As of the end of FY2019, more than 900 domestic universities and research institutions were connected to SINET, ensuring circulation of academic

1 Giga bit per second (bps) is a unit of data transmission rate and shows the number of bits of data sent in one second. 1Gbps stands for data transmission at the rate of 1 billion bit per second.

information for a large number of academic staffs and researchers. In March 2020, NII in cooperation with the Technical Committee on Data Engineering for Institute of Electronics, Information and Communication Engineers, the Database Society of Japan and the Database Systems, Information Processing Society of Japan, supported holding of online forums and annual meeting of the societies (DEIM2020.) Based on this experience and knowledge, NII has been holding a series of multiple online sessions of "Cyber Symposium on Sharing Information about Remote Classes from April" to share information about how universities and other institutions dealt with remote classes and lectures.

Ministry of Agriculture, Forestry and Fisheries (MAFF) has been developing and operating MAFFIN[1] a research network that connects research institutions related to agriculture, forestry and fisheries. As of the end of Fiscal 2019, 78 institutions are connected in MAFFIN. MAFFIN, which is linked to an institution in the Philippines, is serving as part of a network for the distribution of research information overseas.

Ministry of Environment (MOE) runs the Network of Organizations for Research on Nature Conservation (NORNAC), in which 54 research institutions currently participate. The purpose of this organization is to contribute to the promotion of policymaking for nature conservation based on scientific information. National and local governments and research organizations related to nature conservation exchange and share information through this organization. MOE also serves as the secretariat for the Asia Pacific Biodiversity Observation Network (AP-BON). That network promotes the collection and integration of observation data, including monitoring data, on biodiversity in the Asia Pacific region, towards strengthening the scientific infrastructure that is necessary for the conservation of global-scale biodiversity.

D. Creation and provision of databases

The National Diet Library provides a database (NDL Search[2]) that enables integrated search not only for the materials that are collected and held by the library but also materials, digital contents and the like provided by libraries and academic research institutes nationwide.

To help enhance efficient and effective R&D activities, NII systematically collects scientific information necessary for creating innovations, organizes it into an easy-to-use format and posts it online. For example, NII constructed a database (CiNii[3]) on the whereabouts information regarding bibliographies of academic books and journals kept by university libraries nationwide and on scientific papers including doctoral theses in Japan, to enable to search them at one time. NII jointly with the Japan Consortium for Open Access Repositories is operating a service that provides a cloud-based institutional repository environment (JAIRO Cloud[4]) for universities, etc. to preserve and disseminate their research/educational results.

Japan Science and Technology agency (JST) is offering J-GLOBAL, a public service that anyone can use easily. In this service, a database on basic information is created regarding literature, patent, researchers, and research activities in Japan and overseas, information items are correlated and provided. The JST also provides a bibliographic information service (JDream III) to support specialists. Under this service a database has been created for comprehensive Japanese-language search for bibliography, abstracts,

1 Ministry of Agriculture, Forestry and Fisheries Research Network
2 https://iss.ndl.go.jp
3 Citation Information by NII
4 Japan Institutional Repositories Online Cloud

keywords, etc. of science and technology literature in Japan and abroad, with the added value of analysis and visualization of search sets. "researchmap" is a researcher database that centrally accumulates researcher information in Japan to manage and provide information on research achievements and to support universities in their development of comprehensive researcher lists. In addition to this researchmap JST provides a shared system environment (J-STAGE[1]) for electronic publishing of academic journals and information distribution by academic societies in order to ensure speedy distribution of academic journals, etc. published by various academic societies and strengthen global information dissemination (See 3 of this Section).

MAFF has been creating and providing databases on information regarding literature on agriculture, forestry and fisheries as well as on the whereabouts of literature, including the bibliographic database (Japanese Agricultural Sciences Index (JASI)) on papers published in Japanese science journals related to agriculture, forestry and fisheries. MAFF is also creating and offering databases on digitized full-text information regarding research papers published by independent administrative institutions specializing in R&D, national/public R&D institutions and universities. These cover topics related to agriculture, forestry and fisheries; and topics of ongoing research conducted at R&D institutions.

MOE is collecting, managing and providing information on natural environments and biodiversity throughout Japan by means of the Japan Integrated Biodiversity Information System (J-IBIS).

3 Promotion of open science

(1) Development in Japan

The concept of Open Science which includes open access and open research data is rapidly spreading in the world as a new way of promoting scientific research. In the light of this trend, funding agencies, academic societies, industry, the government and other parties need to accelerate its promotion with appropriate international cooperation. The Integrated Innovation Strategy positions various data including research data as a "source of knowledge" that holds the key to science and technology innovation, and requests the early establishment of a data policy and a data management plan considering open-and-closed strategy and the characteristics of individual research fields to preserve and manage research data securely.

At the Expert Panel on Open Science the Cabinet Office compiled the report "Promoting Open Science in Japan" in 2015. The report suggests the expansion of utilization of research outcomes (papers, research data, etc.) that used public research funds as the basic approach to promotion of open science in Japan. Based on the suggestion, the commission for "follow-up on promoting open science" was set up in fiscal 2015 and 2016 for follow-up of activities for open science in Japan. In FY2017 the Committee on Promotion of Open Science Based on the International Trends" was held to study promotion of open science based on international trends, measures for improvement of international presence and other matters. The committee compiled the "Guidelines for data policy formulation by national research and development agencies" in June 2018, "Guidelines for development and operation of research data repositories" in March 2019 and "Report of Working Group on Research Data Infrastructure Development and International Deployment" in October 2019.

---

1 Japan Science and Technology information Aggregator, Electronic

(2) Efforts concerning sharing and disclosure of research outcomes that use competitive funds

Japan Science and Technology Agency formulated its basic policy on handling of research results in April 2017 with the aim of creating a research environment for promotion of open science. This policy provides open access to all research papers created based on result of a research project in principle, and formulation of a data management plan specifying handling of research data. Disclosure of evidence data is recommended, while disclosure of other research data is desired.

AMED announced a data sharing policy for genomic medicine realization projects toward overcoming diseases and mandated data sharing in research projects in principle.

JSPS presented the direction of efforts pertaining to open access and is promoting open access to papers using KAKENHI etc.

(3) Initiatives for sharing and disclosure of research outcomes

RIKEN, National Institute for Materials Science (NIMS) and National Research Institute for Earth Science and Disaster Resilience (NIED) have been working to create new value by accumulating an enormous quantity of high-quality research data in a manner easy to use in the fields of life science, nanotechnology/materials and disaster prevention: areas where Japan can use its strength, and by sharing and analyzing the data in industry, academia and governments.

NII provides JAIRO Cloud and making use of it, the institute is developing a system (NII-RDC[1]) toward commencement of the system's operation within FY2020. NII-RDC is facilitating management, disclosure and search of research data which is shared and used among universities and research institutions.

To ensure speedy distribution of journals published by various academic societies and strengthen global information dissemination, JST has been providing a shared system environment for academic societies to publish journals (J-STAGE). As of the end of 2019, a total of 3,030 electronic journals of 1,667 academic societies were on J-Stage. The JST Bio Science Database Center is promoting the Life Science Database Integration Program. Under the program, the center is promoting open science through expansion of a joint portal site[2] for centralized reference of life-science data bases held by four ministries (MEXT, MHLW, MAFF and METI), cooperation with the Japan Agency for Medical Research and Development and other efforts.

1 National Institute of Informatics－Research Data Cloud
2 https://integbio.jp/

■Table 2-4-16/Major projects for strengthening of foundation of knowledge (FY2019)

Ministry	Implemented by	Project
MEXT	MEXT	Subsidy for facility expenses of national universities
	MEXT, RIKEN	Development and sharing of large-scale synchrotron radiation facilities (SPring-8) and X-ray free-electron laser facility (SACLA)
	MEXT, Japan Atomic Energy Agency	Development and sharing of a high beam-intensity proton accelerator
	MEXT, National Institutes for Quantum and Radiological Science and Technology	Promotion of the next generation synchrotron radiation facilities in a public-private-community partnership
	MEXT RIKEN	Development of Innovative, High Performance Computing Infrastructure (HPCI)
		Development of supercomputer “Fugaku”

Section 3 Strengthening Funding Reform

Research funds provided by the government are divided into basic research funds for stable and continued support for research and education by universities, etc. and competitive funds to promote excellent research and research contributing to specific purposes.

The government is advancing the reform of research funds considering the appropriate balance of the two types of funds and promoting the reform of research funds and the organizational reform of national universities in an integrated manner to strengthen the foundation of ST innovation activities.

1 Fundamental funds reform

(1) National universities

National university corporations as centers of knowledge and human resources have a role to lead knowledge and create innovations in the knowledge-intensive society. In addition, as regional education and research centers based on their strategic distribution across the country, they are a driving force of social changes by developing the potential of regions in order to contribute to regional revitalization.

Japan has many challenges including the paradigm shift to a knowledge intensive society, globalization of high education and formation of a geographically distributed society. In this context, for national universities to fulfill their roles as the central core of human resource development and innovation creation, they need to develop an environment for solid implementation of university reform with due consideration to continuity and stability of education and research.

In FY2019, 1.0971 trillion yen was allocated as government subsidies for national university corporations. The subsidies are basic funds to ensure their continued and stable research/education activities as centers of human resource development and academic research of Japan. The amount was the same as the previous fiscal year.

As the budgetary allocation system during the period of the third medium-term objectives starting from FY2016, functional enhancement of national universities is promoted through focused support based on evaluation under the “three frameworks for focused support” in accordance with the direction of functional enhancement based on the strengths and unique characteristics of the universities. In FY2019 a new system "allocation based on records with focus on achievement" will be introduced to improve comprehensibility and transparency of evaluation, promote independent activities of universities and improve incentive for reform with due consideration to stability and continuity of education and research.

(2) National Research and Development Agency

The 5th Science and Technology Basic Plan expects National Research and Development (R&D) Agencies to play the role of core organization for STI promotion.

In response to the allocation of the subsidies, National R&D Agencies are expected to reform their organizations and enhance their functions to lead innovation systems. In order to support their functional enhancement so that they can develop into international centers according to their respective missions/roles and effectively fulfill their function for cooperation and bridging with relevant organizations in Japan and abroad, MEXT has been implementing the "Program to Support Innovation Hub Development" since FY2015. In FY2019: the last year of the program, the ministry released the "Knowhow Report" compiling the concrete operation methods of each hub.

2 Reform of public funds

(1) Improvement and enhancement of the competitive fund system

The competitive fund system is a core research-fund system for the establishment of a competitive research environment and for the consistent development of, and ongoing commitment to, researchers in various creative R&D activities. Efforts have been made to reserve budgets and improve the system (436.6 billion yen for FY2019 initial budget, Table 2-4-17). Indirect costs of the competitive fund system are allocated as a proportion of expenses directly used for research (direct costs) to the institution of the researcher to whom competitive funds are granted. The aim of the allocation is to promote competition among research institutions and increase the quality of research. For research funds other than the competitive fund, the entire government has been allocating the amount corresponding to 30% of the direct costs as indirect cost in principle since FY2018.

Based on the Integrated Innovation Strategy 2019 (Cabinet Decision on June 21, 2019) a proportion of the efforts of young researchers employed for implementation of a research project may be appropriated to voluntary research activities, etc. starting from April 2020. The aim is to expand research opportunities for young researchers.

In order to ensure the fair, transparent and high-quality examination and evaluation of research proposals, the government ensures diversity in the age, gender and affiliation of examiners. It also aims to eliminate stakeholders, to develop an examiner-evaluation system, to specify methods and criteria for examination and adoption and to disclose examination results.

For example, the examination of KAKENHI applications is conducted via a process of peer review by more than 7,000 examiners. JSPS selects examiners from the examiner candidate database (about 126,000 researchers as of FY2019) by taking into account the balance among research institutions and the aggressive promotion of young and female researchers. Disclosure of examination results to the applicants has been improved in order. In addition to numerical information such as a rough ranking of all unsuccessful research applications and the average score of each evaluation element, detailed items in each evaluation element that examiners have judged as being inadequate are disclosed through the Electronic

Application System for KAKENHI to give the applicants a more detailed evaluation of the results.

Concerning measures to prevent the inappropriate use of competitive funds and other public research funds, guidelines have been formulated, which include the Measures to Prevent the Inappropriate Use of Research Funds (Council for Science and Technology Policy (CSTP), August 31, 2006) and the Guidelines for Management and Audit of Public Research Funds at Research Institutions (Implementation Standards) (Revised on February 18, 2014, Decision of the Minister of Education, Culture, Sports, Science and Technology). Efforts to prevent the abuse of public research funds include the following: conducting thorough monitoring including investigation of the research institution's system for prevention, guidance and measures for improvement if necessary, and urging them to establish an adequate system for their management and auditing of public research funds.

■Table 2-4-17/List of competitive funds

Ministry	Implemented by	Program	Description	FY2018 Initial Budget (Mill. yen)	FY2019 Initial Budget (Mill. yen)
Cabinet Office	Secretariat, Food Safety Commission	Research Program for Risk Assessment Study on Food Safety	Conducting research to determine guidelines and standards on risk assessments through a "research-area setting type" competitive fund system, which sets out research areas and publicly invites researchers to promote scientific food safety (risk) assessments.	183	193
Subtotal (Cabinet Office):				183	193
MIC	MIC	Strategic Information and Communications R&D Promotion Programme (SCOPE)	Inviting proposals publicly about unique and novel research subjects in the field of information and communications technologies (ITC) widely from research institutions at universities, incorporated administrative agencies, companies and local governments: Research is contracted out to institutions that are selected by external experts, whereby the following are promoted: 1) the fostering of young ICT researchers, 2) regional revitalization through ICT and 3) the international certification of communications technologies	2,106	2,435
	MIC	ICT innovation (the "I-Challenge!" program)	Promoting comprehensive support in order to develop businesses by using commercialization know-how, such as that possessed by venture capitalists, and by using R&D possessed by SMEs and universities, for the practical application of R&D results in ICT fields and for the creation of new businesses	255	101
	MIC	R&D of Technologies for Resolving the Digital Divide	Enhancing communications and broadcasting services for the elderly and disabled by offering political support for R&D to benefit these groups.	50	54
	Fire and Disaster Management Agency (FDMA)	Promotion Program for Fire- and Disaster-Prevention Technologies	The program was established in FY2003 with the aim of inviting R&D that will develop and utilize innovative and practical fire prevention and disaster prevention technologies from a broad range of researchers of industry, academia and government institutions including universities, private companies, research companies and the Fire-defense Headquarters.	126	142
Subtotal (MIC):				2,537	2,732
MEXT	MEXT AMED	R&D Promotion for National Issues	Setting detailed R&D themes for the challenges faced by Japan and selecting outstanding proposals based on the potential achievement of technological targets.	23,571	23,752
	MEXT JSPS	Grants-in-Aid for Scientific Research (KAKENHI)	Targeting the rapid advancement of scientific research according to researchers' own ideas in all scientific fields from the humanities and the social sciences to the natural sciences and funding creative and pioneering research selected by peer review (decided by multiple researchers with the same or similar specialties), supporting the foundation of an affluent society through.	228,550	237,150
	JST AMED	Strategic Basic Research Programs	Forming time-limited consortia beyond institutional boundaries (virtual network institutions) to promote R&D for creating new technologies useful for solving critical issues in Japan under policies determined by a top-down approach based on social and economic needs.	58,884	57,419

MEXT	JST	Future Society Creation Program	Under the program technically challenging goals (high-risk) are set toward clearly defined targets with high economic/social impact (high impact) based on social/industrial needs; R&D is implemented toward a stage where the possibility of practical use can be determined (Proof of Concept: PoC) using diverse research outcomes created under the Strategic Basic Research Programs, Grant-in-Aid for Scientific Research, etc. while prompting private investments.	5,500	6,500
	JST AMED	Industry-Academia Collaborative R&D Programs	Promoting R&D using intellectual property by specific university (researcher) and specific company and R&D using a platform that supports multiple universities (researchers) and industry to promote the practical application of research outcomes at universities through industrial-academia collaboration and create innovation.	26,502	24,634
	JST AMED	International Collaborative Research Program	Promoting international collaborative research with developing countries to address global challenges in environmental and energy fields, disaster-prevention, infectious disease control and bioresources via excellent S&T and ODA in Japan and strategically promoting collaborative research on most advanced technologies with Europe and emerging Asian countries under equal (*50/50*) partnerships based on agreements among ministries and agencies. Also promote together with African countries international joint research for measures against Neglected Tropical Diseases (NTDs) that are stifling development in Africa.	3,521	3,728
Subtotal (MEXT)				346,528	353,184
MHLW	MHLW	Health and Labour Sciences Research Grants	Improving the technological level of health and medical services, welfare, environmental health, and workplace health and safety by fostering a competitive research environment for pioneering research, other original research and solutions eagerly sought by society; promoting research on health, labor and science, in order to ensure the scientific promotion of administrative policies	4,999	5,770
	AMED	Grant Programs of AMED	Enhancing translational R&D and practical application of R&D results in medicine, plus R&D for creating research environments that ensure efficient and effective R&D in medicine.	35,874	35,500
	AMED	Grants for promoting hygiene and medical care surveys	In order to promote health and hygiene measures, promote R&D consistent from basic to practical use in the medical field, and also R&D contributing to development of an environment for smooth application of their outcomes and smooth and effective R&D in the medical field.	7,349	7,766
Subtotal (MHLW):				48,222	49,036
MAFF	Bio-oriented Technology Research Advancement Institution, NARO	Program to promote R&D for innovation creation	In order to create innovation in the field of agriculture, forestry, fisheries and food, implement research based on proposal invitation with focus on R&D that combine diverse knowledge and technologies in various fields. Under this program, seamless support is provided for each stage of R&D, as "basic research stage" for basic R&D, "applied research stage" for application R&D and "development research stage" for practical application R&D, and research topic proposals are publicly invited.	4,132	4,080
Subtotal (MAFF):				4,132	4,080
METI	METI	Project for Strategic Promotion of Advanced Basic Technologies and Collaboration	Supporting R&D and prototyping leading to the improvement of 12 Specific Core Manufacturing Technologies, including design development, precision work and 3D modeling pursuant to the Basic Act for Buildup of Fundamental Monozukuri Technologies to advance fundamental monozukuri technologies of SMEs	10,532	10,904
Subtotal (METI):				10,532	10,904
MLIT	MLIT	Construction Technology Research and Development Subsidy Program	Granting funds for R&D of technologies helping refine and enhance the international competitiveness of construction technologies under MLIT's jurisdiction to promote technological innovation in the construction field.	190	142
	MLIT	Program to Promote the Technological Development of Transportation	Research institutions are invited, through open invitation, to propose research topics contributing to solution of policy issues of MLIT. Prospective topics are selected from these proposals, and the chosen institutions are commissioned to conduct the research related to transport.	102	131
Subtotal (MLIT):				292	273

Chapter 4

Ministry of the Environment (MOE)	MOE Environmental Restoration and Conservation Agency. (ERCA)	Environment Research and Technology Development Fund	Promoting scientific knowledge accumulation and technological development essential for implementing environmental policies to realize a sustainable society by preventing global warming, forming a recycling society, coexisting with the natural environment and managing environmental risk	5,107	5,836
	Nuclear Regulatory Agency	Grants for strategic promotion of research on regulation for radiation safety	The grants are aimed at promotion of research leading to solutions of technical problems identified by NRC, the Radiation Council, etc. while strengthening the research infrastructure of radiation protection through research activities. Outcomes obtained through the program will be used for incorporation of the latest findings into domestic systems as well as improvement of regulations. The aim is that these activities coordinate research and administrative policies to ensure the newest and best safety through continuous, efficient and effective radiation source regulation and radiation protection.	344	316
Subtotal (MOE):				5,451	6,152
Ministry of Defense (MOD)	Acquisition, Technology & Logistics Agency	Innovative Science & Technology Initiative for Security	System to publicly seek and commission basic research on advanced civil technologies that are expected to contribute to future R&D in the field of national defense. The amount is on a contract basis (the total of the fiscal year's expenditure and the amounts to be newly borne in the following year and after)	9,820	10,002
Subtotal (MOD):				9,820	10,002
Total				427,697	436,556

Note: Subtotals and totals may not match due to rounding.
Source: Adapted by MEXT based on data provided by the Cabinet Office

(2) Harmonization of efficiency improvement of execution rules

In order to secure research hours of researchers by reducing their office work and ensure effective and efficient use of research funds, the entire government is working on system improvement with the aim of improving usability of research funds. Harmonized and simplified rules for use of competitive funds will also be applied to other research funds. The government will unify application formats that were designated separately by individual programs and enable application using the unified format through the cross-ministerial R&D management system (e-Rad).

3 Integrated promotion of the national university reform and the research funds reform

The "Research Capacity Reform 2019" announced by MEXT on April 28, 2019 states that reform of "human resources," "funds" and "environment" of research shall be conducted integrally with university reform. Based on the Reform 2019 and on the premise of establishment of a system for appropriate implementation by the research institutions, studies are underway to allow payment of labor cost to the principal investigator from the direct cost of the competitive fund in proportion to his/her efforts for the research activities at the request of the principal investigator. In this way, based on appropriate cost allocation, research institutions can use secured funds to enhance research performance of principal investigators through environmental improvement for focused research and also to strengthen research capacity of the institutions by securing diverse and excellent talents including young researchers. The reform is expected to enhance research capabilities of both researchers and research institutions. Furthermore, in order to increase the hours researchers are able to concentrate on research projects, a reform is under consideration to allow payment for taking care of non-research works for which principal investigators are responsible in their research institution.

Through these efforts, MEXT will work for the continuing creation of research outcomes using competitive research funds, while at the same time encouraging strengthening of the university governance and human resource and payroll management that are the key to university reform.