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.

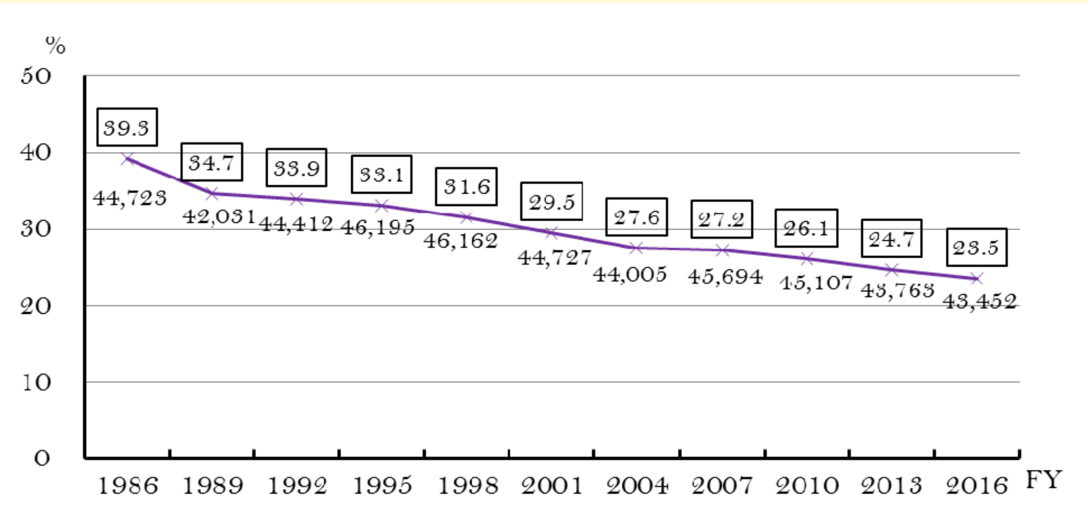
1 Developing, securing and improving career prospects of human resources as intellectual professionals

(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 (Figure 2-4-1).

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



Source: MEXT

A. Realization of stable and independent research by young researchers

Ministry of Education, Culture, Sports, Science and Technology (MEXT) launched the Excellent Young Researchers Program in FY2016 to create an environment for stable and independent research by excellent young researchers exploring new research areas. The program also presents new career paths in research institutions of industry, academia and government across Japan. By FY2017 at least 212 young researchers (as of April 1, 2018) found an environment for stable and independent research 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 the Tenure Tracking System, which provides support to universities that have newly adopt that system. As of FY 2017 this program is supporting 39 organizations.

In order to expand employment of excellent young researchers by national universities, support using the subsidy for stepping up of the reform of national universities (National University Young Researcher Support Project (specified support)) started in FY2014. As of FY2017, 53 organizations have been supported by the program.

Furthermore, the Act for the Amendment of the Act on Improving the Capacity, and the Efficient Promotion of Research and Development through Promotion of Research and Development System Reform and of the Act on Term of Office of University Teachers, etc. (Act No. 99 of 2013), enforced in December 2015, is expected to make it easier for researchers to achieve research results during the employment contract period and to receive fair evaluations of their achievements so that they can obtain stable positions.

B. Diversification of career options

For promotion of science and technology innovation, it is important that postdoctoral fellows not only work as researchers in universities, etc. but that they also actively participate in various activities of society, so that they can clearly see their career paths.

The Council for Science and Technology (CST)'s Committee on Human Resources set up by MEXT discussed the direction of efforts in the future with focus on contact points with society that will be the "activity area" of postdoctoral fellows, while keeping in mind trends of doctoral courses that are their "training place". Based on the discussions the committee compiled "Encouraging Doctorate Holders to Play an Active Role in a Variety of Sectors."

The "Building of Consortia for the Development of Human Resources in Science and Technology" has been implemented to secure stable employment for young researchers while increasing their mobility to help their career development, and also to support universities, etc. constructing a mechanism to diversify their career paths. The support has been provided to 10 organizations as of FY2017.

Furthermore, under a program provided by the Japan Science and Technology Agency (JST) for supporting the use of career information, the Japan Research Career Information Network Portal site (JREC-IN Portal) is operated, through industry-university-government cooperation, to provide useful information for career development 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. In FY2018 Grants-in-Aid (applications were received in September 2017), enhancement of support was pursued through the "Grant-in-Aid for Young Scientists" that provides broad support for the development of the foundation for young researchers. Furthermore, JSPS worked to enhance support for larger-scale "Basic Research (B)" indispensable for sophistication of research under international competition, and also made efforts to relax the application limit to promote the step up from the "KAKENHI Young Support Plan" to "Basic Research" categories that are the core of KAKENHI.

Column 2-9

What kind of R&D evaluation will promote development and support for young researchers? -FY2017 MEXT R&D Evaluation Symposium-

Based on the National Guideline on the Method of Evaluation for Government R&D, MEXT formulated the "Guidelines for Evaluation of Research and Development in MEXT," in which the ministry identified "promotion of development of and support for young researchers who will lead the next generation" as one of the tasks that require special attention.

In recent years young researchers are facing a difficult situation including fewer stable positions and severe competition to obtain external funds such as competitive funding. The Special Committee on R&D Evaluation of experts set up under Director-General of Science and Technology Policy Bureau held discussions that better operation of R&D evaluation should promote development of and support for young researchers in this situation. Based on the discussion, the FY2017 MEXT R&D Evaluation Symposium[1] was held under the theme of "What kind of R&D evaluation will promote development and support for young researchers?" on March 22.

The symposium discussed a broad range of issues beyond individual performance evaluation for employment and promotion of young researchers. Examples are: constructive evaluation that supports research tasks of young researchers to help them develop into independent researchers (mainly evaluation of R&D tasks) and evaluations that include evaluation of efforts to develop and support young researchers employed by R&D institutions (evaluation of R&D tasks and R&D institutions).

Part 1 introduced the following initiatives: from Kyoto University, its development and support program for young researchers and evaluation/comments under the program to help development of young researchers (e.g. mutual evaluation of research presentations by young researchers of different disciplines with long-term goals and views in mind); from Hiroshima University, its system for teacher activity indicators such as its unique achievement-motivated key performance indicators (AKPI®), recognition/certification system for young teachers, portfolio aimed at capacity building for development of young researchers and other initiatives to develop young researchers, and; from Japan Science and Technology Agency, ACT-I that supports "confirmation of identity" of creative young researchers under the Strategic Basic Research Programs, evaluation items with young researchers in mind in task selection and initiatives to support young researchers.

Part 2 was a panel discussion based on the lectures and with the inclusion of questions from participants. The discussion was made on the background of the system design of the introduced examples, unexpected effects of the initiatives and unanticipated problems and points of attention for application by other institutions, for example. Because many R&D institutions are not progressing in R&D evaluation that promotes young researchers, participants made remarks that introduction of concrete initiatives was informative.

Source: MEXT

---

1 MEXT has been holding R&D evaluation symposiums with the aim of further utilization and efficiency improvement of R&D evaluation, awareness raising about evaluation among persons involved in evaluation and promotion of their cooperation.
http://www.mext.go.jp/a_menu/kagaku/hyouka/1296586.htm

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

A. Efforts for development of management personnel 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.

With the aim of increasing world-class universities, support is also provided to prospective world-class universities based on quantitative indicators or evidence. Specifically, the government promotes intensive reform of research environments by helping these universities to employ research management personnel, including research administrators, so that the research capacity of Japanese universities will increase. In FY2017, 22 universities and inter-university research institutes selected in FY 2013 were supported.

The "Program for development of Program Managers 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 and universities that are improving their educational content and methodologies. For example, students are provided opportunities to learn through hands-on experience, group exercises, presentations, debates and problem-solving. At national 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, 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. In FY2017, 8,658 candidates passed the First-Step Examination and 3,501 candidates passed the Second-Step Examination. Data on candidates who passed the Second-Step Examination 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 (FY 2017)

Technical Discipline	No. of candidates (people)	No. of successful candidates (people)	Pass rate (%)
Mechanical Engineering	1,178	243	20.6
Marine & Ocean	15	6	40.0
Aerospace	61	13	21.3
Electrical & Electronics Engineering	1,546	222	14.4
Chemistry	133	37	27.8
Fiber & Textiles	47	14	29.8
Metals	115	50	43.5
Mining	18	4	22.2
Civil Engineering	14,248	1,817	12.8
Water Supply & Sewerage	1,510	180	11.9
Environmental Engineering	635	42	6.6

Technical Discipline	No. of candidates (people)	No. of successful candidates (people)	Pass rate (%)
Agriculture	881	123	14.0
Forest	303	66	21.8
Fisheries	161	22	13.7
Industrial Engineering	226	66	29.2
Information Engineering	540	39	7.2
Applied Science	607	67	11.0
Biotechnology & Bioengineering	53	21	39.6
Environment	536	131	22.6
Nuclear & Radiation	97	22	22.7
Engineering Management	3,343	326	9.8

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 promoting the Graduate Education Reforms to train "Knowledge Professionals" who think for themselves and act based on their sophisticated expertise and sense of ethics, create new knowledge and values based on their knowledge, work globally and lead the future. For example, the ministry is enhancing graduate school education based on the Graduate Education Reforms Leading the Future (*Central Council for Education' University* Division, September 15, 2015) and the 3rd Platform for the Promotion of Graduate School Education (decision of the Minister of Education, Culture, Sports, Science and Technology, on March 31, 2016).

Specifically, 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 FY 2016, 62 projects have been supported.

The Japan Revitalization Strategy as revised in 2015 (Cabinet Decision in June 2015) stated "establish TAKUETSUDAIGAKUIN PROGRAM (tentative) systems formed through cooperation of multiple universities, research institutions, companies, overseas organizations, etc. to enable integral education of

1　https://jrecin.jst.go.jp/

multiple disciplines (e.g. humanities & science) and leading-edge education in the fields where Japan is strong." Based on the strategy, "Experts Meeting on TAKUETSUDAIGAKUIN PROGRAM (tentative)" consisting of industry, academia and government members compiled "basic approach to the TAKUETSUDAIGAKUIN PROGRAM (tentative) plan" in April 2016. The plan shows the basic direction of the selection of the fields forming a TAKUETSUDAIGAKUIN PROGRAM and the system for collaboration of multiple organizations. Toward its full-fledged implementation in FY2018, universities will conduct studies for realization of the plan. MEXT accelerates the study through the "commissioned project to promote the TAKUETSUDAIGAKUIN PROGRAM (tentative)" for study on policies of public invitations, examinations, etc. in FY2017.

The Japan Student Services Organization (JASSO) provides scholarship loan programs to financially support to 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 will expand 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 program.

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 Special Fellowship (DC) Program under which fellowships are granted to doctoral students.

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 31 academic fields by FY 2017.

(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 Schools (SSH), to which support is provided through the JST. This initiative aims to help students develop scientific abilities and thinking and thereby develop human resources for science and technology who will play important roles globally in the future. Specifically, efforts are made to promote the development and use of curricula that are not based on the National Curriculum Standards, to promote project studies, to foster human resources for science and technology in the future and to share the results of these efforts among multiple schools. In FY 2017, 203 high schools throughout the country provide such advanced and specialized education.

Under the Global Science Campus (GSC) program, Japan Science and Technology Agency 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, JSTA 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.

Furthermore, the JST is promoting the Program for Promoting the Science Club Activities of Junior/Senior High-Schoolers, which helps students to identify issues by themselves and to conduct activities constantly and independently while applying scientific methods. This is done in collaboration with schools, boards of education and universities.

In addition, MEXT sponsored the 7th Science Intercollegiate (March 3 and 4, 2018) in Toshima city, Tokyo, as 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 business people, etc. Of a total of 263 applications, 169 who had passed a documentary examination were presented (Figure2-4-3).

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 Intel International Science and Engineering Fair (Intel ISEF), as well as supporting Japanese students' participation in competitions abroad and international competitions held in Japan (Figure 2-4-4). In FY 2017, the 7th Japan High School Science Championship was held from March 16 to 19, 2018 in Saitama City, Saitama 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 Kanagawa Prefecture team won first place (Figure 2-4-5). The 5th Japan Junior High School Science Championship was held on December 1 to 3 2017 in Tsukuba City, Ibaraki Prefecture. Tokyo Metropolitan team won first place in this nationwide competition of schools and teams (Figure 2-4-6).

MEXT, the Japan Patent Office (JPO), the Japan Patent Attorneys Association, and the National Center for Industrial Property Information and Training (INPIT) jointly host patent contests and patent design contests 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. Director-General, Science and Technology Policy Bureau Award is given to the schools of the participating students, which made active efforts for the contest to enhance the Intellectual Property Mind of students or deepen their understanding of the IP system.

Figure 2-4-3 The 7th Science Intercollegiate opening ceremony

Source: MEXT

Figure 2-4-4 Participants in the International Student Contests in Science and Technology (FY 2017)

International Mathematical Olympiad (Brazil) Participants

From left
Shuho KANDA, 6th grade, Kaiyo Academy (silver medalist)
Daishi KIYOHARA, 2nd grade, Senior High School at Komaba, University of Tsukuba (bronze medalist)
Naoki KURODA, 2nd grade, Nada Senior High School (gold medalist)
Toshiei MIZUOCHI, State Minister of METI
Yuta TAKAYA, 3rd grade, Kaisei High School (gold medalist)
Nobuyuki OKADA, 3rd grade, Fukuyama Senior High School Attached to Hiroshima University (bronze medalist)
Soji KUBOTA, 3rd grade, Senior High School at Komaba, University of Tsukuba (silver medalist)
By courtesy of the Mathematical Olympiad Foundation of Japan

International Chemistry Olympiad (Thailand) Participants

From left
Kensei YAGIU, 3rd grade, Aichi Prefectural Okazaki Senior High School (silver medalist)
Yuki AMABE, 3rd grade, Nada Senior High School (silver medalist)
Keiya SAKABE, 6th grade, Kaiyo Academy (gold medalist)
Shuku MORITA, 3rd grade, Okayama Prefectural Okayama Asahi Senior High School (silver medalist)
By courtesy of Dream Chemistry 21 Committee/The Chemical Society of Japan

International Biology Olympiad (UK) Participants

From left
Shogo TSUSHIMA, 2nd grade, Musashi High School (silver medalist)
Genki SATO, 3rd grade, Shiga Prefectural Zeze High School (silver medalist)
Ayaka EGUCHI, 2nd grade, Oin Senior High School (silver medalist)
Nobutaka IKEDA, 3rd grade, Senior High School at Komaba, University of Tsukuba (silver medalist)
By courtesy of the International Biology Olympiad Japan Committee

International Physics Olympiad (Indonesia) Participants

From left
Michito UJINO, 2nd grade, Osaka Seiko Gakuin Senior High School (silver medalist)
Kosuke YOSHIMI, 2nd grade, Nada Senior High School (gold medalist)
Akihiro WATANABE, 3rd grade, Todaijigakuen Senior High School (gold medalist)
Tomohiro KOMIYAMA, 3rd grade, Saitama Prefectural Omiya Senior High School (silver medalist)
Yusuke NAKAE, 3rd grade, Osaka Prefectural Kitano Senior High School (silver medalist)
By courtesy of the International Physics Olympiad Japan Committee

International Olympiad in informatics (Iran) Participants

From left
Keiya SAKABE, 6th grade, Kaiyo Academy (silver medalist)
Satoru KAWAHARAI, 3rd grade, Senior High School at Komaba, University of Tsukuba (gold medalist)
Yoshimasa HAYASHI, Minister of MEXT
Riku KAWASAKI, 3rd grade, Senior High School at Komaba, University of Tsukuba (gold medalist)
Yuta TAKAYA, 3rd grade, Kaisei High School (gold medalist)
By courtesy of the International Olympiad in Informatics Japan Committee

International Earth Science Olympiad (France) Participants

From left
Yuki KOSHIDA, 3rd grade, Kaijo Senior High School (silver medalist)
Shota OSHIMI, 6th grade, Tokyo Metropolitan Koishikawa Secondary School (gold medalist)
Shunsuke TSUCHIYA, 3rd grade, Seiko Gakuin High School (gold medalist)
Yuichiro NAKAGIRI, 3rd grade, Ritsumeikan Keisho Senior High School (silver medalist)
By courtesy of the International Earth Science Olympiad Japan Committee

International Geography Olympiad (Serbia) Participants

From left
Keito AONUMA, 2nd grade, Senior High School at Komaba, University of Tsukuba (silver medalist)
Koichiro HINAGO, 3rd grade, Fukuyama Senior High School Attached to Hiroshima University (bronze medalist)
Shutaro SHINOHARA, 3rd grade, Kyoto Municipal Horikawa Senior High School
Yasuyuki TAGUCHI, 3rd grade, Tokyo Metropolitan Musashi Senior High School
By courtesy of the International Geography Olympiad Japan Committee

Figure 2-4-5 The 7th Japan High School Science Championship

Winning team: Eiko Gakuen Senior High School team (Kanagawa Prefecture team)
From left of the front row
Ryo TAKENAKA (1st grade)
Toshiyuki OSHIMA (2nd grade)
Yosuke CHIGIRA (2nd grade)
Yasuhiro YOSHIKAI (2nd grade)
From left of the back row
Keigo OSHIMA (2nd grade)
Tomohiro KARINO (2nd grade)
Kan NAGANO (1st grade)
Takumi TANAKA (2nd grade)
By courtesy of the Japan Science and Technology Agency

Figure 2-4-6 The 5th Japan Junior High School Science Championship

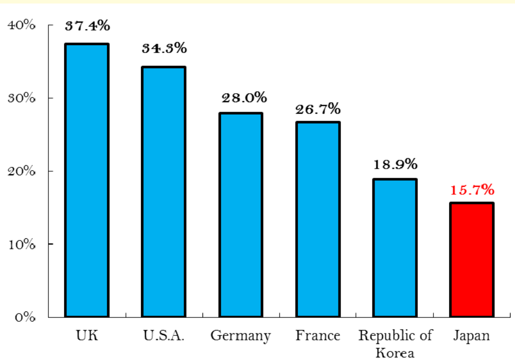
Winning team: Tokyo Metropolitan team
From left
Ryoya AWANO, 2nd grade, Junior High School at Komaba, University of Tsukuba
Taiken MATSUZAWA, 2nd grade, Junior High School at Komaba, University of Tsukuba
Yuki AKIYOSHI, 2nd grade, Junior High School at Komaba, University of Tsukuba
Ami ARIYAMA, 1st grade, Toshimagaoka-Joshigakuen Junior High School
Sae KANO, 1st grade, Toshimagaoka-Joshigakuen Junior High School
Aika UCHIDA, 1st grade, Toshimagaoka-Joshigakuen Junior High School
By courtesy of the 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. In Japan, by promoting 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% of researchers as of March 2017, which is lower than in other advanced countries (Figure 2-4-7).

Figure 2-4-7 Percentage of female researchers by country



Note: 1. The data are as of 2013 for the U.S.A., 2014 for the UK and France, 2015 for the Republic of Korea and Germany and 2017 for Japan.
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: The choice by female junior and senior high-school and university students to major in science[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

1 http://www.gender.go.jp/c-challenge/

Office, together with MEXT and the Japan Business Federation, held an event entitled the Summer Science/Engineering Challenge 2017: Encounter Science/Engineering Jobs in universities and businesses from July to August 2017. Under this program, female students in lower/upper secondary schools are given opportunities to participate in a variety of events including science/engineering workplace visits, work experience and facility tours.

MEXT has implemented the Initiative for Realizing Diversity in the Research Environment, under which universities set targets and plans for such diversity through promotion of participation by female researchers. The initiative includes integrated promotion of leader training through support for researchers to allow them to balance their research with maternity, childcare and nursing care and support for female researchers in improving their research capabilities. MEXT is supporting 69 universities as of FY 2017.

The JST has implemented the "project to encourage female students of lower/upper secondary schools to follow scientific career paths." Under this program, female students in lower/upper secondary schools are given opportunities to communicate with female science and technology researchers, engineers and university students, as well as to take part in experimental classes and school visit programs.

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

In order to promote participation of female scientists and engineers, Ministry of Economy, Trade and Industry (METI) has been implementing the "program to support the success of female scientists and engineers." The program supports visualization of their skills and the skills sought by industry to help them understand what skills they need to develop. In September 2017, the ministry held a symposium to promote the success of female scientists and engineers for students, university teachers and personnel management officers of companies.

The National Institute of Advanced Industrial Science and Technology (AIST) organized the Diversity Support Office (DSO), a consortium of 18 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 G7 Ise-Shima Summit held in May 2016 chose women's empowerment as one of its agenda items and the G7 leaders agreed on the launch of the *Women's Initiative* in Developing STEM Career (WINDS). In November 2016, Ministry of Foreign Affairs (MOFA) appointed three WINDS ambassadors. They have actively participated in various conferences and events for promotion of women's success in STEM fields. In January 2018, one WINDS ambassador was reappointed.

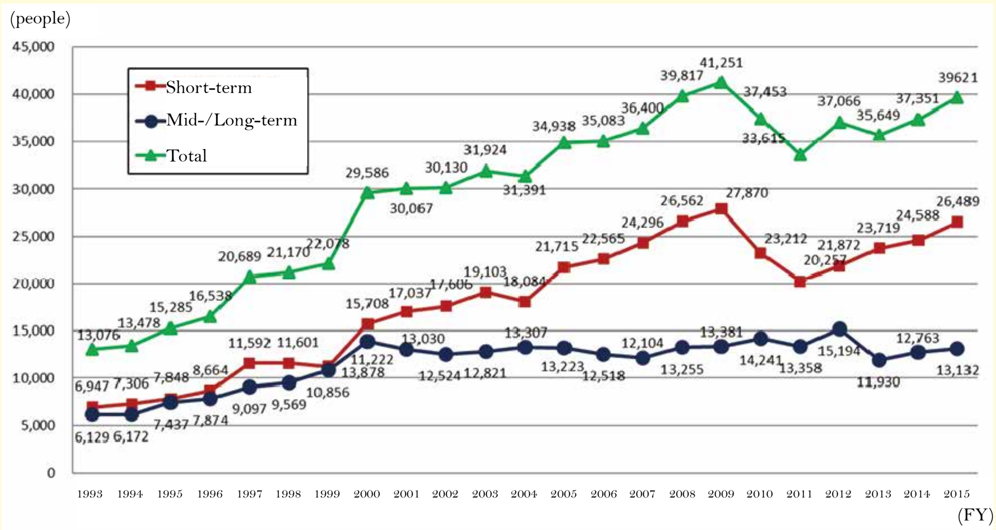
(2) Enhancing the international research network structure

A. The development of international networks of researchers

(A) International mobility of Japanese researchers

According to the Survey on International Research Exchanges published in FY 2017, the total number of short-stay foreign researchers accepted by universities and independent administrative institutions in Japan showed a tendency to grow until FY 2009, while the number decreased in FY 2011 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 FY 2000 (Figure 2-4-8). 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 FY 2008 (Figure 2-4-9).

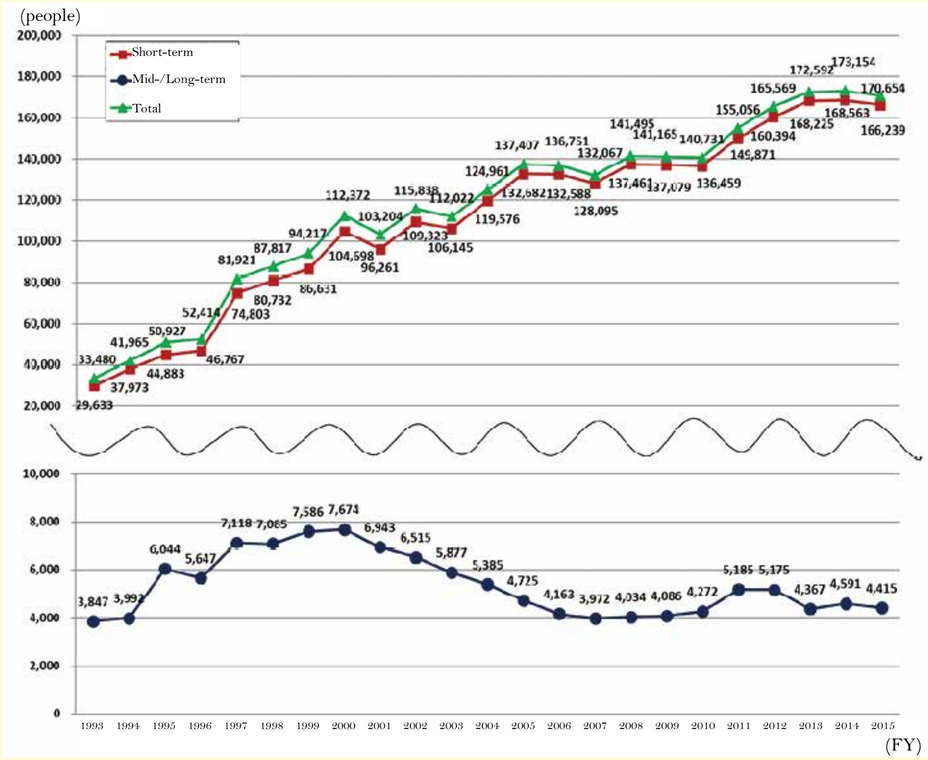
Figure 2-4-8 **Changes in the number of foreign researchers in Japan (Short or mid-length to long stay)**



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 FY 2013 survey.

Source: Survey on International Research Exchanges, MEXT, June 2017

Figure 2-4-9 **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: Survey on International Research Exchanges, MEXT, June, 2017

(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 sending young researchers abroad and inviting excellent researchers from other countries to Japan. Starting from the FY2018 Grants-in-Aid (applications were accepted in September 2017) JSPS will expansively review the Fund for the Promotion of Joint International Research in KAKENHI grant programs to establish "International Joint Research (B)" for construction and further enhancement of the foundation of international joint research.

In addition, JSPS has been implementing the Program for Advancing Strategic International Networks to Accelerate the Circulation of Talented Researchers to support universities and other research institutions that exchange young researchers with leading overseas research institutions and enable domestic research groups with high potential to strategically formulate research networks in their specialties. JSPS also offers the Postdoctoral Fellowship for Research Abroad. 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 Program for Young Researchers is offered to support traveling abroad by doctoral students and others.

Invitation programs such as the JSPS Postdoctoral Fellowships for Research in Japan are provided to give outstanding foreign researchers opportunities to work at universities in Japan according to their various career stages and objectives, which will contribute to internationalization of the research environment of Japanese Universities, etc. In addition, Bilateral Programs supports a sustainable network between Japanese and foreign research teams.

To foster young scientists and build 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 discussions with Nobel laureates and other distinguished researchers.

The JST started the Japan-Asia Youth Exchange Program in Science in FY 2014 to invite excellent youths (high school, undergraduate and graduate students and researchers aged under 40) from 35 Asia-Pacific countries and regions for a short-term visit (one to three weeks) to acquire 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 at Venice in June 1987. This program aims at supporting international joint basic research on the complex mechanisms of living organisms. The HFSP is now operated by 15 parties (Japan, the U.S.A., France, Germany, the EU, the UK, Switzerland, Canada, Italy, Australia, the Republic of Korea, New Zealand, India, Norway and Singapore). Japan has been actively supporting the program since its establishment. This program provides grants for research expenses of international joint research teams, supports young researchers by covering the cost of overseas research travel and stays, and holds HFSP awardees' meetings.

(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, teachers work full time at multiple organizations while ensuring the necessary engagement ratio. The ministries published the "*Basic Framework* and Notes on *Cross-Appointment* System" compiling notes and recommended examples in December *2014 and has promoted introduction of the system.* The Guidelines for Fortifying Joint Research Through Industry-Academia-Government Collaboration formulated in November 2016 also encourages 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.

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 FY 2017, around 25,000 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 76,000 projects, including those continuing for the several fiscal years, were funded. (The KAKENHI budget for FY 2017 is 228.4 billion yen)

The KAKENHI system has been reviewed continuously for improvements including its introduction of a foundation. 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) and the 5th Basic Plan that reflects the content of the policy, MEXT is carrying out radical reform ((1) review of screening system, (2) review of research categories and frameworks, and (3) promotion of flexible and proper use of research funds) and sets the quantitative policy goal of a new adoption rate at 30%.

For (1), 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 a new examination category table of a smaller number of categories after a fundamental review, and new examination methods including "comprehensive examination" with more stress on consultative examination were introduced starting from FY2018 Grants-in-Aid (applications were received starting from September 2017).

For (2), based on "On the Strengthening of Support for Challenging Research through KAKENHI" compiled by Subdivision on Grants-in-Aid for Research of the Subdivision above, the "Challenging Research" category was established to support research for reform and shift of academic research, and a program to support independence of young researchers started in FY2017.

MEXT will continue to carry out reform based on the 5th Basic Plan and 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[1] and shared use/joint research centers of national, public and private universities certified by the minister of MEXT.

Because large academic research projects, in particular, require many physical and human resources, such projects are difficult to implement by individual universities and therefore implemented mostly under a shared use/research system. MEXT has been promoting these initiatives under Promoting Large Scientific Frontier Projects.

In FY 2017, 10 projects (Figure 2-4-10) were promoted from which world-leading research results are expected. For example, results from the Super-Kamiokande neutrino detector directly contributed to research by a winner of the Nobel Prize in Physics: Takaaki Kajita, Director of the University of Tokyo's Institute for Cosmic Ray Research in 2015. The plan to construct a network for international joint research of Japanese classic books aims to advance new international joint research by developing digital images of about 300,000 classic books. In October 2017 the "new comprehensive database of Japanese classics" was published based on the plan enabling everyone to access digital images of early Japanese books. Under these initiatives, research has been advanced through fusion of different disciplines. For example, a replication based on *Seikai*, a book published during the Edo Period, and modern calculation discovered that one of the biggest magnetic storms in the history of the sun occurred in 1770.

1 105 centers of 53 universities have been certified and are active as of April 2017.

Figure 2-4-10 **Large-scale projects that will be implemented under the Large-Scale Academic Frontier Promotion Project**

Source: MEXT

Column 2-10

Current state of scientific research in Japan as featured by the international science journal *Nature*

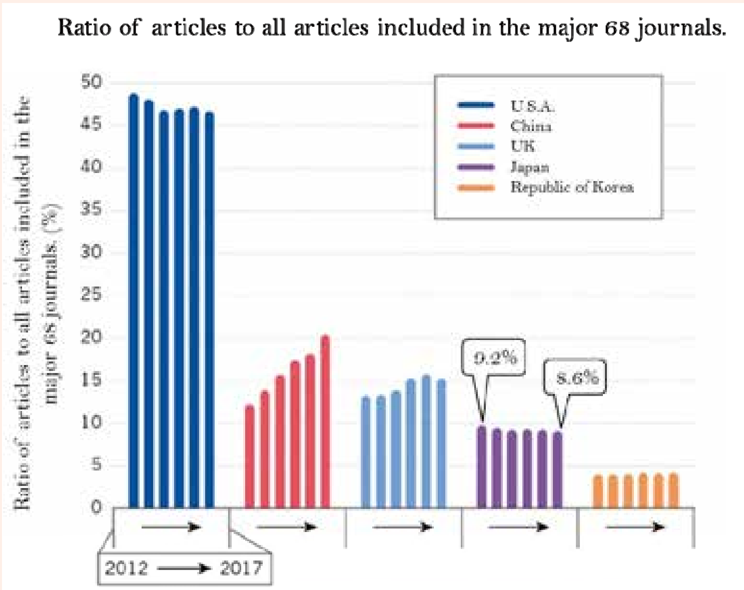
In March 2017, *Nature*, an international science journal, issued the "*Nature Index 2017 Japan*", which was a separate printing featuring concerns about scientific research in Japan.

According to the special issue, comparative analysis of the number of papers included in major 68 academic journals handling high-quality science results in the world found that from 2012 to 2016 the number of papers from China and that from UK increased 47.7% and 17.3% respectively, while at the same time those from Japan decreased by 8.3%. While the total number of articles in the database of papers appearing in a broader range of academic journals increased by approximately 80% between 2005 and 2015 and the output of China and the United States grew greatly, Japan's output grew by only 14% and its share of global output fell from about 7.4% to 4.7%. According to *Nature*: "Japan is one of the world's top research-producing nations. But, over the past decade its scholarly output has not kept pace with the average growth in publications around the world."

The causes suggested by the journal include: the government R&D spending has remained essentially flat in Japan since 2001, while other nations – such as Germany, China and South Korea – have significantly increased their spending and; the operating support funds used for personnel expenses in national universities have been reduced, leading to fewer opportunities for early-career researchers to obtain full-time research positions. The special issue raised an alarm for Japanese science research: "Japanese research is at a tipping point. If it cannot boost its output in the next decade, the country risks losing its status as one the world's top research nations.

According to "*Nature Index 2018 Japan*" published in March 2018, Japan's share of the world's high-quality research articles included in 68 major academic journals further declined from 9.2% in 2012 to 8.6% in 2017 against the background of the growth of China.

Similarly, a report of the National Institute of Science and Technology Policy (NISTEP), MEXT, shows data that the number and share of articles produced by Japanese researchers are on a declining trend. One of the causes may be the relatively low growth of Japan's multiple authorship articles while international multiple authorship articles are greatly increasing in the world. To address this challenge, Japan is working to foster young researchers who will lead the next generation and to strengthen international networks including formation of the world's top-level research centers, while at the same time working to increase the ratio of the government's R&D investments to GDP to 1%, which is a target of the 5th Basic Plan.



Material: Created by MEXT based on the data included in NATURE INDEX 2018 JAPAN (Nature 555, S54-S55 (2018) https://www.natureindex.com/supplements/nature-index-2018-japan/index)

(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.

MEXT established the following six objectives for FY 2017.

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

- Development of innovative materials and device technologies based on understanding and manipulation of nanoscale thermodynamics
- Construction of revolutionary material development methods through fusion among experiments and theory/data science
- Advanced Interaction Technologies within the Networked Environment
- Innovation of Bio-Sensing, Elucidation of Dynamics and Interactions between Biomolecules by Using Quantum Technology
- Elucidation of biological mechanism of extracellular fine particles and the control system.

(Advanced Research and Development Programs for Medical Innovation)

- Clarification of the mechanism of individual's functional impairment over the entire life course

(3) 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 intellectual circulation for the nation.

A. International joint research with other countries

(A) International Thermonuclear Experimental Reactor (ITER)

The ITER project is managed under the international cooperation of seven parties, and the construction of ITER began in earnest in Cadarache, France, toward commencement of operations in 2025. Japan is promoting the production of superconductive coils, etc. (See Section 1, Chapter 3.)

(B) International Space Station (ISS)

Japan operates the Japanese Experiment Module KIBO and the automated cargo spacecraft KONOTORI (HTV) in the ISS program. (See Section 4, Chapter 3.)

(C) International Ocean Discovery Program (IODP)

The International Ocean Discovery Program (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 Subsurface Geobiology, etc. The program has been implemented since October 2013 to replace the Integrated Ocean Drilling Program (IODP (2003 to 2013).) Drilling vessels work in groups to drill deep sea floors worldwide. 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. In FY2017 CHIKYU was used for drilling at the Kumano-nada Sea off the Kii Peninsula that is an assumed hypocentral region of the anticipated Tonankai earthquake.

(D) Large Hadron Collider (LHC)

In the Large Hadron Collider (LHC) project[1], the CERN[2] member states, Japan and the U.S.A. collaborated to complete an accelerator in 2008, and now experiments are being performed in the energy field at the highest level in the world.

(E) International Linear Collider (ILC)

A group of international researchers is planning to construct an International Linear Collider (ILC) to investigate the properties of the Higgs Boson particle in more detail, and an ILC Technical Design Report was published in June 2013.

In light of the response from the Science Council of Japan in September 2013, MEXT has been holding meetings of external experts since May 2014 and compiled a summary of the discussions on the scientific significance of ILC in June of 2015, those on policy for securing and development of human resources in July 2016, and those on ideal system and management in July 2017. MEXT continues study of issues regarding the ILC plan by again setting up a committee to examine its scientific significance and costs based on the revised plan published in November 2017 and by promoting discussions.

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

MEXT has been promoting the World Premier International Research Center Initiative (WPI) Toward construction of research centers with excellent research environments and the world's top-level research standards. The program provides focused support for schemes that aim to form the world's top-level centers led by excellent researchers. 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 FY 2017, eleven centers are supported under this initiative (Figure 2-4-11). Under this program, the WPI Program Committee, chaired by Ryoji Noyori, 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 to ensure that these centers develop into globally visible

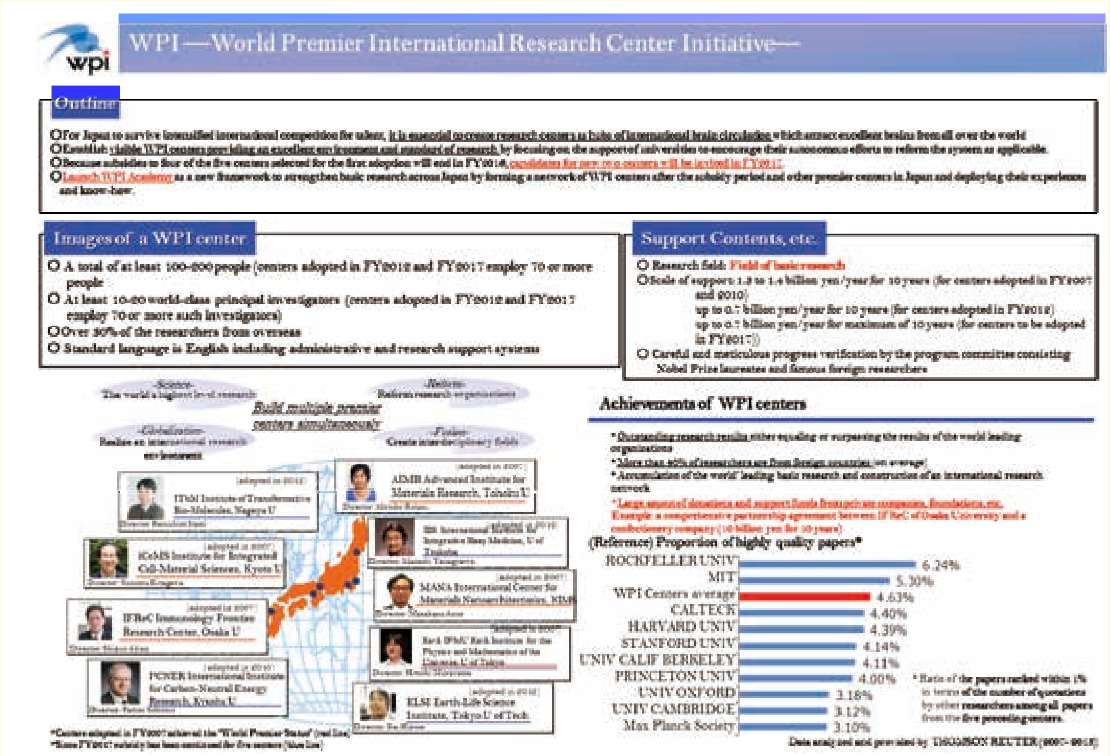
1 In this experimental project, the large circular collider of CERN is used to reproduce extreme conditions similar to those of shortly after the Big Bang, with the aim of discovering unknown particles and the deep internal structure of matter.

2 Conseil Européen pour la Recherche Nucléaire

research centers.

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.

Figure 2-4-11 World Premier International Research Center Initiative (WPI)



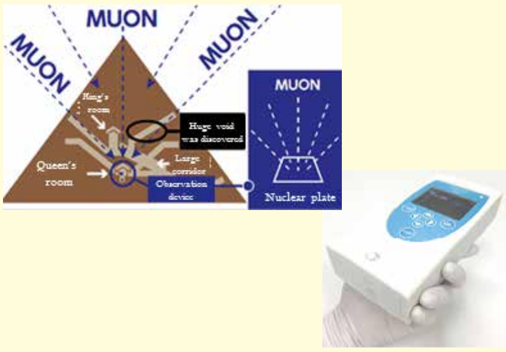
Source: MEXT

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 (Figure2-4-12). As of March FY 2018, 57 prototypes had been developed and put into production.

Figure 2-4-12 Examples of technologies and instruments for advanced measurement and analysis



Upper: 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: Development of a mobile genetic testing device that can carry out virus/bacteria test in a short time (about 10 minutes)
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 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 research facilities and equipment owned by universities and national 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 these facilities and equipment such 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 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

Super Photon ring-8 GeV (Spring-8) (Right) and An X-ray free-electron laser facility (SACLA) (left)
Source: RIKEN

Chapter 4

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.

(ii) X-ray free-electron laser facility (SACLA)

SACLA is the most advanced research facility in the world with respect to the generation of light. 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. MEXT also launched the Priority Strategic Research Issues Using X-ray Free-Electron Lasers program in the same year to promote pioneering research using the facility. Epoch-making achievements in FY2017 include success in video filming of the moment when material is destroyed at an ultrafast speed, which could not be observed with conventional technologies. Usage environment has been also steadily improved by simultaneous operation of two hard x-ray FEL[1] beam lines by dividing electric beams[2] for the first time in the world.

1 Hard x-ray FEL is a free electron laser in the region of short hard x-rays at 0.3nm or shorter

2 By dividing electron beams from a linear accelerator pulse-by-pulse to multiple beam lines multiple beam lines can be used simultaneously.

Column 2-11

20 years after the commencement of the service of SPring-8

SPring-8 is a large synchrotron radiation facility that is a large research infrastructure for use of the most-advanced radiation light. Its construction started under the collaboration of RIKEN and the former Japan Atomic Energy Research Institute (current Japan Atomic Energy Agency (JAEA)) in November 1991. In October 1997, after about six years, it was placed in service for researchers in a broad range of disciplines in Japan and abroad.

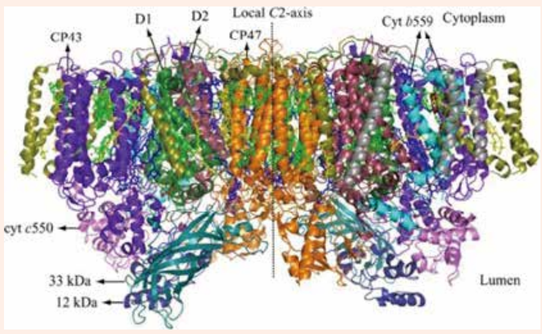
For the period of 20 years SPring-8 realized a high operation rate by keeping down time (hours where the facility was not available due to failure, etc.) under 1% and has maintained an environment for use of radiation light of high brightness and stable high quality. Thanks to this environment, the facility has been used widely not only for academic research but also for industrial purposes. It has served 16,000 users annually, or 220,000 users in total, and helped the creation of 1,000 papers annually, or over 10,000 papers in total. The facility has been used by researchers of a broad range of disciplines including nanotechnology, biotechnology, life science, environment/energy and materials development, and has helped epoch-making achievements of R&D in diverse fields.

Examples of academic research include determination of the three-dimensional structure of rhodopsin and calcium pumps, and analysis of fine particles of the asteroid Itokawa under the asteroid probe Hayabusa Project. R&Ds by private companies are also actively pursued. The facility has been used by about 400 companies for development of high-performance, high-quality and high mileage tires through precise structural analysis of the interior of rubber, and; elucidation of thin film transistor (TFT) characteristics of transparent amorphous oxide semiconductors (IGZO), for example. An array of research achievements using Spring-8 has been conductive to productization.

In March 2012, the world's second x-ray free electron laser SACLA started service adjacent to Spring-8. This has created facilities unique in the world, where radiation light and x-ray laser are simultaneously available and R&Ds using both radiation light and x-ray free electron laser have been actively conducted. Here, the world's most advanced achievements have been produced. For example, Photosystem II Complex is a protein that plays an important role in the photosynthesis of plants. The structure of the entire protein was analyzed using radiation light and its catalytic center atomic structure was elucidated by the x-ray free electron laser for the first time in the world.

In October 2017, SPring-8 reached the 20th year after its commencement of service. In addition to people from the industry, academia and local governments, heads of major synchrotron radiation facilities from around the world gathered to participate in the 20th anniversary ceremony of SPring-8 held in Himeji Castle that is a national treasure. Through these 20 years, SPring-8 as a leading-edge research facility has contributed to Japan's science and technology innovations and strengthening of industrial competitiveness. It is also expected to continue to support the leading-edge R&D of Japan in the coming 20 years.

Ceremony commemorating the 20th anniversary of SPring-8
Source: RIKEN



Crystal structure of photosystem II protein complex
Provided by Professor SHIN Kenjin of Okayama University

(iii) The "K computer" supercomputer

The "K computer" supercomputer

Source: RIKEN

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 was officially made available for use as of the end of September 2012 is operated by the RIKEN, in cooperation with the Research Organization for Information Science and Technology (RIST), which is a registration organization supporting users of the K computer; and the HPCI[1] Consortium, which consists of organizations that represent user communities. K has 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.

In order to contribute to solutions of Japan's social and science challenges, MEXT has been promoting a project to develop Post-K succeeding K toward commencement of operation in 2022. Through coordinated development of a system and applications contributing to problem solving, the ministry aims to realize the world's best versatile super computer. In FY2017 MEXT conducted detailed design of the system and worked on R&D of applications related to nine priority subjects including health and longevity, disaster prevention/mitigation, energy and manufacturing, and four emerging subjects in the field of social/economic phenomena and the neural circuit of the brain, etc.

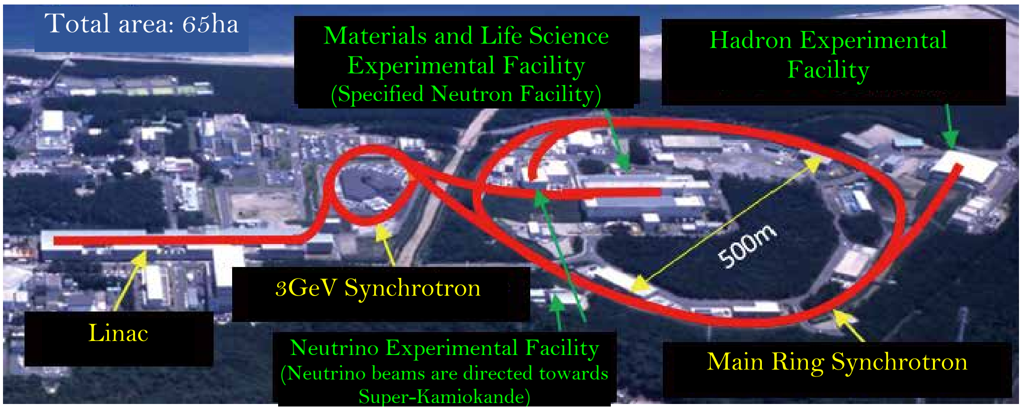
(iv) Japan Proton Accelerator Research Complex (J-PARC)

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[2] 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.

---

1 High Performance Computing Infrastructure

2 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.



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

(B) New high-intensity 3GeV-level radiation light source for soft x-ray

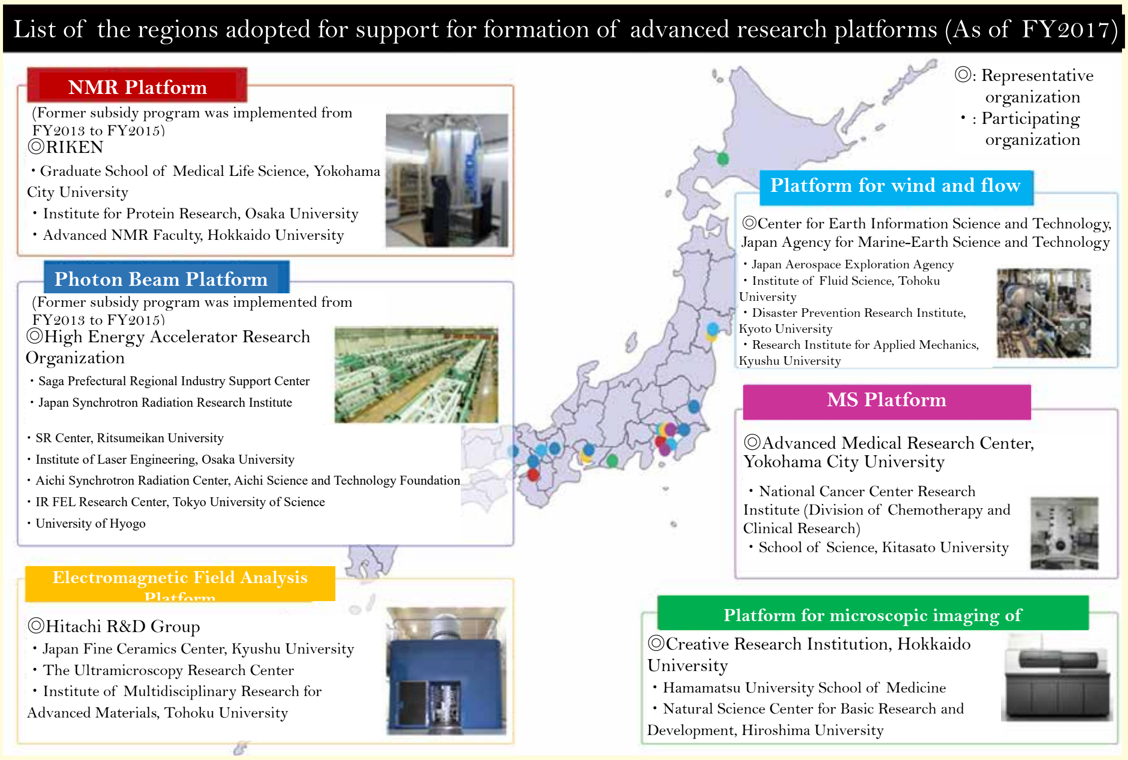
Concerning the High-intensity 3GeV-level radiation light source (next generation synchrotron radiation facility) that has strengths in soft x-ray, since the November 2018 MEXT at the Subcommittee on Quantum Science and Technology, the Subdivision on R&D Planning and Evaluation, CST, has been promoting deliberation and investigation on its significance for the science and technology innovation policy, its required performance, basic approach to development and operation, and concrete measures. In January 2018 the subcommittee compiled the result: "it is necessary to develop the next generation synchrotron radiation facility that is expected to be intensively used for both academic and industrial research early in a public-private-community partnership and it is appropriate to proceed with the plan, where the National Institutes for Quantum and Radiological Science and Technology will serve as the development and operating body of the state" in a report titled "Development of new High-intensity 3GeV-level radiation light source for soft x-ray.

(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 2-4-13).

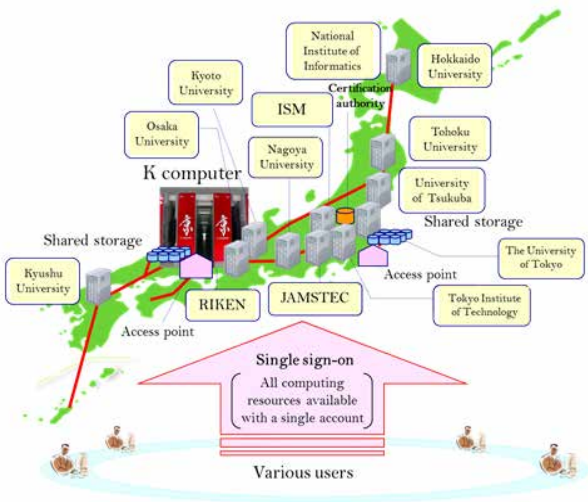
Figure 2-4-13 Organizations adopted for the Project for Promoting Public Utilization of Advanced Research Infrastructure (support for formation of advanced research platforms)



Source: MEXT

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

MEXT has been advancing the development of an innovative High Performance Computing Infrastructure (HPCI) that provides a computing environment meeting the diverse needs of users. The HPCI is based on the K computer, one of the world's most powerful supercomputers, which is connected via high-speed networks with other supercomputers and storages at universities and research institutions in Japan. MEXT is also promoting its use in various fields while working for effective and efficient operation of HPCI.



Source: MEXT

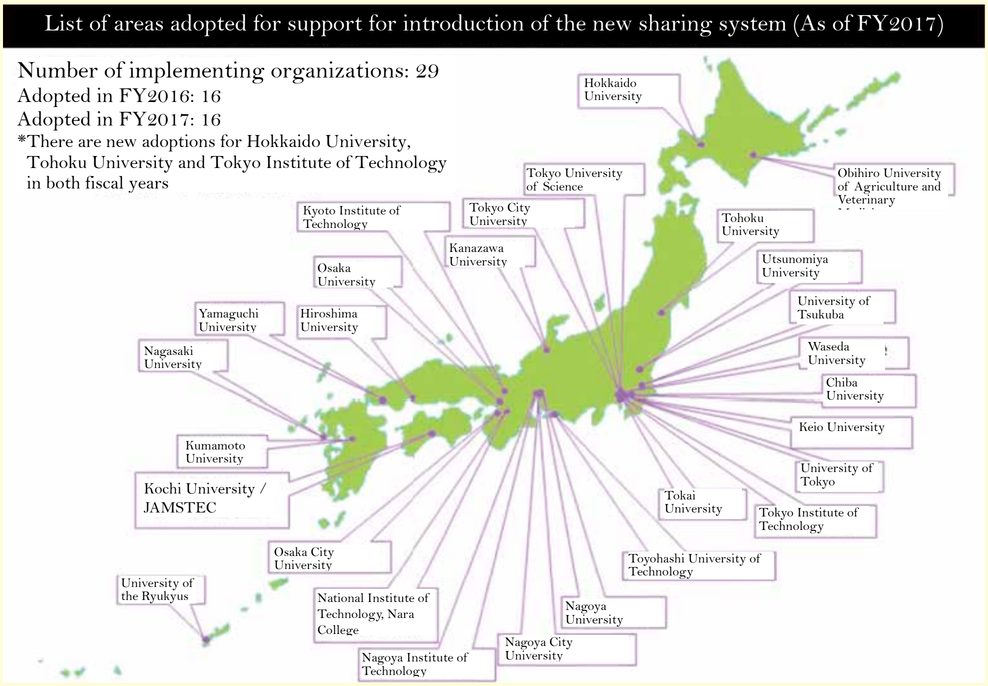
(iii) Nanotechnology Platform

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 2-4-14).

Figure 2-4-14 Organizations adopted for the Project for Promoting Public Utilization of Advanced Research Infrastructure (support for introduction of the new sharing system)



Source: MEXT

C. 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.

In February 2018, METI checked the progress of a plan for the development of intellectual infrastructure in three areas (measurement standards, microbial genetic resources and geological information), checked specific measures for promoting the use of intellectual infrastructure and reviewed the plan.

Regarding measurement standards, AIST developed physical standards for the medium flow rate of

Chapter 4

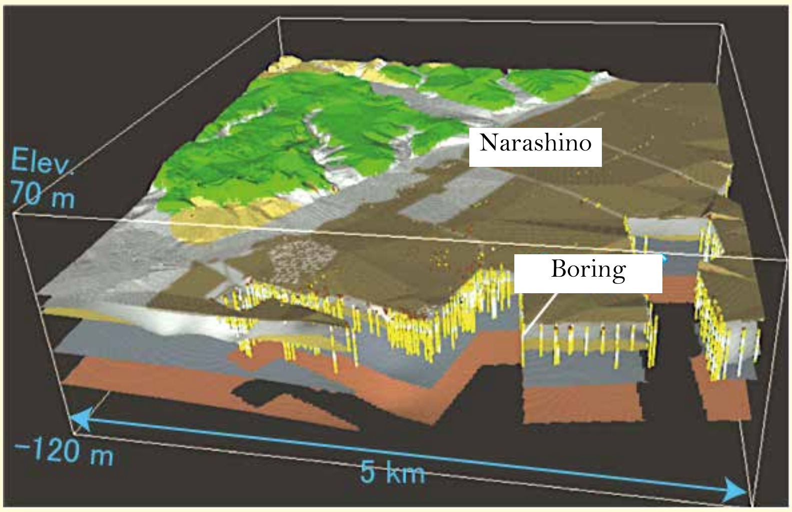
petroleum. The standards are expected to be used for fuel measurement in oil and automobile industries. For chemical standard materials, AIST developed a metal standard solution for ICP-MS[1] and a water-soluble polymer standard material for static light scattering for the purpose of proper management of advanced materials to establish a system for implementation of requested tests with ensured traceability to 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. (6,339 strains of biological genetic resources had been distributed as of the end of January 2018.) It has also constructed cooperative relationships with Asian countries by joining a network of 27 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 is also supporting an exploration of microbial resources useful in industry and their transfer to Japan that is being conducted by Japanese business operators in Myanmar.

Regarding geological information, AIST published four 1:50,000 geological maps and one marine geological map. With the aim of reducing the risk in the ground environment of urban areas, the institute produced 3D geological maps that accurately visualize the distribution of underground strata (geological subground map of urban area) for the northern part of Chiba Prefecture (Figure 2-4-15). Furthermore, AIST officially published the 1:200,000 seamless geological map of Japan V2 as the next generation seamless geological map. In the V2 edition the number of legends increased more than 6 times from 386 in the past to over 2,400, which enabled expression of more detailed geological information and flexible display according to the purpose and use. In response to volcanic eruptions, AIST carried out emergency survey at the time of the eruption of Shinmoedake of Mt. Kirishima in October 2017 and the eruption of Kusatsu-Shirane volcano in January 2018. The results were promptly published on its website and reported to the Coordinating Committee for Prediction of Volcanic Eruption. For secondary use of geological information, AIST regularly updates Geological Map Navi, and has developed and published applications. To Geological Map Navi, AIST added the significantly revised Seamless Geological Map of Japan V2, and functions to display geothermal resource data and plate surface contour line data. Cooperation with other organizations enabled display of red 3D maps and soil maps (with cooperation of the National Agriculture and Food Research Organization) and population density data (with cooperation of the Statistics Bureau, MIC). In terms of applications, AIST produced a new viewer for 3D display of geological maps and published the display as open source.

1 Inductively coupled plasma-mass spectrometry

Figure 2-4-15 3D geological model of the northern region of Chiba prefecture



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 lead the next generation, and also foundations of knowledge that contribute to realization of Society 5.0 by serving as centers for regional revitalization and creation of innovations. Now, about 60% of the facilities of universities are older than 25 years, while aging of water feed/drainage and gas pipes is also progressing.

With this in mind, MEXT formulated the 4th Five-Year Program for Facilities at National Universities (FY 2016-FY 2020) (approved 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 (Figure 2-4-16).

The 4th Five-Year Program prioritizes the following projects: 1) the improvement of infrastructure for safe and secure educational environments (approx. 4.75 million m^2), 2) responding to changes such as the functional enhancement of national universities through the construction of new buildings and extension (approx. 400,000 m^2) and improvement of university hospital facilities (approx. 700,000 m^2) (a total of approx. 5.85 million m^2) and 3) promoting lowering energy consumption and initiatives to serve as leading models for society towards creating sustainable campuses. In FY2017, the second year of the plan, the areas developed during the two years are expected to be approx. 540,000 m^2 combining: 1) approx. 250,000m^2 for the improvement of infrastructure for safe and secure educational environments, and 2) approx. 80,000m^2 responding to changes such as the functional enhancement of national universities through the construction of new buildings, and approx. 210,000 m^2 for extension and improvement of university hospital facilities. MEXT will continue the plan-based and focused improvement of facilities.

The plan asks national universities to create and improve their campus master plan based on their long-term vision, and strive to implement systematic, more effective and efficient facility development based on this plan in accordance with their basic principles, academic plan and management strategy. Furthermore, strategic facility management and facility development utilizing diverse sources of finance will be further promoted. Regarding facility management, in order to achieve university visions and academic plans, MEXT started to hold expert meetings[1] in November 2013 to promote the facility management of all university facilities from a management perspective. The expert meeting published a report[2] in March 2015 targeting the administration of national universities. This report introduces the basics and detailed procedures for facility management, and examples of advanced practices. In October 2015 and March 2017, MEXT compiled a collection of examples for reference for facilities management based on the report.

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 Academic Frontier Promotion Program has provided support for the world's most advanced research equipment developed based on the creative ideas of Japanese scientists including the "Thirty Meter Telescope (TMT) project."

Figure 2-4-16 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

1 Examination Committee for the Comprehensive Management of Facilities at National Universities

2 Strategies for the Management of University Facilities: Facility Management Strengthens Educational and Research Infrastructure

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 operating the Science Information Network (SINET) as a platform for supporting overall scientific research and education at universities. As of the end of Fiscal 2017, more than 850 Japanese universities and research institutions were connected to SINET. Through SINET, the distribution of academic information is secured for many people at institutions of education and research. The international distribution of research information is necessary for internationally advanced research projects. To promote such information distribution, SINET is connected with academic and research networks overseas, including those in the U.S.A. and Europe.

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 2017, 82 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 53 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 keeps a database on the publications, materials and the like. It collects and provides information on the database via its website[2].

To help enhance the efficiency and effectiveness of R&D activities, the NII systematically collects information on science and technology necessary for the creation of innovations, organizes the information into an easy-to-use format and posts it online. For example, the NII has been creating and providing a database on the whereabouts of information regarding bibliographies of academic books and journals kept by university libraries nationwide and on doctoral and other scientific papers in Japan (CiNii[3]). A common repository system is provided by NII to research institutions and universities to help them to develop their

1 Ministry of Agriculture, Forestry and Fisheries Research Network
2 http://iss.ndl.go.jp/
3 Citation Information by NII

own institutional repository for preserving and disseminating their research/educational results. NII is operating JAIRO[1].

The JST is offering an information service, J-GLOBAL. In this service, a database on basic information is created regarding literature, patent, researchers, and research activities and in Japan and overseas and information is provided by linking a specific researcher, for example, to the relevant information. The JST has also been creating a database on abstracts in Japanese available online via the paid bibliographic information retrieval service (JDreamIII[2]). "researchmap" is a researcher database that centrally accumulates researcher information in Japan to manage and provide information on research achievements and support universities in their development of comprehensive researcher lists. In response to this initiative and the progress of open science, in addition to assisting in the development of open-access journals published by various academic societies, the JST has been providing a common-use system environment (J-STAGE[3]) (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 includes open access and open research data. It is rapidly spreading in the world and attracting attention as an important foundation for open innovation. In light of this trend, funds allocation organs, academic society, industry, the government and other parties involved need to accelerate its promotion in appropriate international cooperation.

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 set up to study promotion of open science based on the international trends, measures for improvement of international presence and other matters.

MEXT at the Science Information Committee, Subdivision on Science, Council for Science and

1 Japan Institutional Repositories Online
2 JST Document Retrieval system for Academic and Medical fields III
3 Japan Science and Technology information Aggregator, Electronic

Technology, compiled “Promotion of open science information (summary of deliberation)” in February 2016. In the summary, MEXT announced a policy that research papers written using public research funds and research data as their evidence shall be made public in principle and proposed matters to be worked on by relevant organizations. Based on this, MEXT compiled the “Summary of deliberation on follow-up of the implementation status of the 5th Science and Technology Basic Plan at the Comprehensive Policy Special Committee” at the Committee in January 2017. Considering the international trends surrounding open science and the situation in Japan, the summary suggested the direction and points of attention for concrete measures with focus on promotion of data sharing/disclosure concerning competitive funds, data disclosure/non-disclosure according to the characteristics of the research field and development of infrastructure pertaining to research data storage.

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

The JST showed its data management policy in its Strategic Basic Research Programs to store, manage and disclose data in the research area where effective generation of research outcomes is expected through active sharing and use of data.

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 Prevention (NIED) have been developing data platform centers to create new values by accumulating an enormous quantity of high-quality research data in a manner easy to use in the field of nanotechnology/materials, life science and disaster prevention where Japan can use its strength, and share and analyze the data in industry, academia and governments.

NII supports research institutions and universities in developing their own institutional repository for preserving and disseminating their research/educational results, and also is working for cooperation of the institutional repositories (JAIRO).

To assist in the development of open-access journals published by various academic societies, the JST has been providing 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[1] 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 http://integbio.jp/

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.

In order to ensure the vitality and persistence of our society, expectations are greatly rising regarding the role of national universities in creating knowledge as the foundation of new values and developing human resources who support the creation. It is necessary to maximize their "function to create knowledge" as an "engine for social change."

It is important for national universities, by taking greater advantage of corporatization, to boldly change their way of thinking with a view toward the new economic society, to develop new research fields including fields of fusion and human resources that are playing important roles in industry of the new age, to respond to changes in industrial structure and employment needs and solve economic and social problems facing the communities, Japan and the world. At the same time, national universities need to change themselves into organizations that can make maximum contributions to advancement in knowledge and creation of innovations. For further advancement of reform, they must make further efforts to strengthen their financial bases and functions.

In FY2017, 1.0971 trillion yen was allocated as government subsidies for national university corporations. The subsidies are basic research funds to ensure their continued and stable research/education activities as centers of human resource development and academic research of Japan. The amount was increased by 2.5 billion yen from the previous fiscal year. This is the first increase since the incorporation of national universities in FY2004.

During the period of the third medium-term objectives starting from FY2016, in order to ensure fine-tuned support for universities in accordance with the direction of functional enhancement based on their strengths and unique characteristics, focused support based on evaluation is provided under the "three frameworks for focused support" of the government subsidies for national university corporations. Functional enhancement of national universities is also promoted under the framework in FY2017.

(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. The government subsidies for the eight National R&D Agencies under the jurisdiction of MEXT had been generally on a declining trend from FY2010 to FY2018. In the FY2017 budget, however, 468.9 billion yen (a 3.0% increase from the previous fiscal year) was allocated in consideration of their important missions. Starting from FY2017, the government subsidies are used for the budget necessary for development of data platform centers to create new values by accumulating an enormous quantity of high-quality research data in a manner easy to use in the field of nanotechnology/materials, life science and disaster prevention where Japan can use its strengths and share and analyze the data in industry, academia and governments

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 is implementing the "Program to Support Innovation Hub Development".

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 (427.9 billion yen for FY 2017 budget, Table 2-4-17). Indirect costs, a feature of the competitive fund system, are allocated as a proportion of research funds (direct expenses) 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.

Regarding R&D management works, including the publication of information on public invitations and acceptance of applications for competitive funds, the Cross-ministerial R&D Management System (e-Rad[1]) is used. The system improves the efficiency of applications and management pertaining to requests for research funds for both researcher/research institutions and funds allocation agencies.

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 92,000 researchers as of FY 2016) by taking into account the balance among research institutions and the aggressive promotion of young and female researchers. Disclosure of examination results 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. Furthermore, for research categories ("Basic Research A" and "Challenging Research") where "comprehensive examination" is introduced in FY2018 Grants-in-Aid (applications were received in September 2017) "opinions on the

1　The "E" of electronic is added to Rad, and abbreviation for research and development examination results" were disclosed based on the opinions of each examiner.

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	FY 2017 Budget (Mill. yen)	FY 2018 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.	177	183
Subtotal (Cabinet Office):				177	183
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	2,166	2,106
	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	291	255
	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.	39	50
	Fire and Disaster Management Agency (FDMA)	Promotion Program for Fire- and Disaster-Prevention Technologies	With the aim of fostering and using innovative and practical technologies to solve problems of fire-fighting and disaster prevention activities, R&D on firefighting and disaster prevention is promoted through commissioning (based on request for proposal) to industry, academia and public research institutions that propose research content of great significance.	126	126
Subtotal (MIC):				2,622	2,537
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.	22,898	23,571
	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.	228,350	228,550
	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.	3,000	5,500

MEXT	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.	61,127	58,884
	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.	27,448	26,502
	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.	3,627	3,521
Subtotal (MEXT):				346,450	346,528
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	4,603	4,999
	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.	38,725	35,874
	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.	5,274	7,349
Subtotal (MHLW):				48,602	48,222
MAFF	MAFF	Promotion of research on S&T for agriculture, forestry, fisheries and the food industry	To foster innovation that promotes the growth of the agriculture, forestry, fishery and food industries, there is the need for a system that ensures the practical use, at production sites, of basic research results that are achieved by public research institutions. Such practical use is done in collaboration with private companies so that the investment benefits producers in the agriculture, forestry and fisheries industries and benefits society. This program aims to integrate domestic research capabilities and to activate exchanges of human resources by optimally exploiting Japan's high R&D capabilities in the agriculture, fishery, forestry and food industries, by enlisting the interdisciplinary research capabilities of private companies and by supporting industry-academia collaborative research to solve technological issues and improve industrial competitiveness. Under this program, seamless support is provided for each stage of R&D, as "seeds creation stage" for basic R&D, "development fusion stage" for application R&D and "practical technology development stage" for practical application R&D and research topic proposals are publicly invited.	3,070	4,132
Subtotal (MAFF):				3,070	4,132
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	10,253	10,532
Subtotal (METI):				10,253	10,532

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.	240	190
	MLIT	Program to Promote the Technological Development of Transportation	Research institutions are invited, through open annual invitation, to propose research topics related to policy issues of MLIT. Prospective topics are selected from these proposals, and the chosen institutions are commissioned to conduct the research under R&D projects.	146	102
Subtotal (MLIT):				386	292
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	5,293	5,107
	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.	273	344
Subtotal (MOE):				5,566	5,451
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.	10,780	9,820
Subtotal (MOD):				10,780	9,820
Total				427,906	427,697

Note: Subtotals and totals may not match due to rounding.

Source: Adapted by MEXT based on data provided by the Cabinet Office

(2) Reform of competitive research funds for supporting the continuous production of research results

MEXT is advancing improvement of the competitive research fund system. For example, based on the interim report "Reform of competitive research funds for supporting the continuous production of research results (interim summary)" submitted by the Investigative Commission on Reform of Competitive Research Funding (Chaired by Michinari Hamaguchi, president of the JST) on June 24, 2015, MEXT decided to allocate indirect expenses equivalent to 30% of the direct expenses to each research project that is newly qualified to receive competitive research funds in FY2916 and after. Government ministries are investigating reforms for research funding other than competitive funding in view of the progress of university reform. The reform of research funding under consideration includes the addition of indirect expenses to research funds and the improvement of the usability of research funds.

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

In order to construct the foundation for Japan to become "the world's most innovation-friendly country" MEXT has been integrally promoting university reform and research funds reform.

Specifically, indirect expenses equivalent to 30% of the direct expenses have been allocated for competitive funding[1] of MEXT. The same measure has also been applied to competitive research funds[2] for research projects that are newly qualified to receive competitive research funds in FY2016 and after.

Indirect expenses of other ministries/agencies are under review by "the liaison meeting of related offices and ministries on research funds" set up at the Cabinet Office. Currently the meeting is sorting projects to be covered. MEXT also conducted analysis about the needs for appropriate allocation of indirect expenses, etc. and explained the results at the meeting.

MEXT is also conducting review toward flexible direct cost expenditure to enable paying of labor costs to the principal researcher on the premise of reform of the human resource and payroll system at national universities. Through these efforts, MEXT will work for continuing creation of research outcomes using competitive research funds, while at the same time encouraging strengthening of university governance and management that are key to university reform.

1 Resource allocation bodies broadly solicit R&D issues, adopt issues to implement based on evaluation by multiple evaluators including experts with a focus on scientific and technical aspects, and allocate R&D funds to researchers, etc. Practically, the term refers to the system registered with the Cabinet Office by individual ministries based on this definition.

2 Competitive funding pertaining to "research" and obtained by research institutions through public solicitation