Fundamental concepts for promoting large scientific research projects
Formulation of a roadmap

Roadmap 2020

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Working Group on Large Scientific Research Projects
Research Environment Infrastructure Subcommittee, Science Committee, Council for Science and Technology

Contents

Introduction

Large scientific research projects (referred to below as "Large Projects") have taken the lead in scientific research worldwide, by aggregating cutting-edge technology and knowledge to tackle research issues that have yet to be explored by anyone and bringing about dramatic development in those fields, and it is necessary for Japan as well to promote these projects through a long-term outlook, while garnering the support and understanding of the general public and society overall.

The "Fifth Science and Technology Basic Plan" (Cabinet decision in January 2016) indicated the necessity of striving to strategically and systematically promote Large Projects, which will contribute to the building of a nationwide joint usage and research system in Japan, with the aim of strengthening the fundamental abilities of science and technology innovation, and also indicated the necessity of strategically promoting large research facilities that will lead the world's scientific frontiers in the "Basic Policy on Economic and Fiscal Management and Reform2020" (Cabinet decision in July 2020) and the "Integrated Innovation Strategy 2020" (Cabinet decision in July 2020)).

On the other hand, the Large Projects require large amounts of expenses, and it is particularly important to promote them after conducting sufficient matching between the national science policies and projects in the scientist community based on scientific objectives and thorough preparations.

Based on such a viewpoint and in light of the "24th Master Plan on Large Scientific Research Projects (Master Plan 2020)" (January 2020) formulated by the Science Council of Japan, the Working Group on Large Scientific Research Projects (referred to below as "Working Group") recently drafted "Formulation of a Basic Concept Roadmap for Promotion of Large Scientific Research Projects – Roadmap 2020", from the perspective of clarifying the priorities for promoting the Large Projects.

This Working Group has formulated four roadmaps[1] thus far, and Large Projects through national support projects have been promoted and based on these. Previously, national support was mainly focused on fields that required large experimental facilities, but since the formulation of the roadmaps, database-building and network-forming research projects have been added, moving in the direction of covering a wide range of scientific fields, and this effect is becoming clearly apparent.[2] Based on the Roadmap, etc., the government has been working to promote the Large Projects, and we continue

[1] The Working Group has formulated the following four roadmaps thus far.
- Formulated a "Roadmap" (October 2010) based on the "Master Plan" (March 2010) of the Science Council of Japan.
- Formulated "Roadmap 2012" (May 2012) based on "Master Plan 2011" (September 2011) of the Science Council of Japan.
- Formulated "Roadmap 2014" (August 2014) based on "Master Plan 2014" (February 2014) of the Science Council of Japan.
- Formulated "Roadmap 2017" (July 2017) based on "Master Plan 2017" (February 2017) of the Science Council of Japan.

[2] In Japan, we have been promoting Large Projects through various support projects. Among them are "Exploration of new physical laws by upgrading B factory accelerators", "Promotion of neutrino research using 'Super Kamiokande'" and "Joint research of the large optical infrared telescope 'Subaru'". In addition to conducting research using large experiments and observation facilities, research is being promoted through a project for database building, such as the "Project to Build an International Collaborative Research Network for Pre-modern Japanese Texts" and research is being promoted to build a nationwide scientific information network infrastructure, such as the "Construction of a Scientific Information Network for a New Stage" (SINET)".

to expect that the government will make the utmost efforts to secure the required budgets.

Furthermore, we ask that the researcher community engage in lively discussions based on the evaluation results and organization of tasks shown in the Roadmap, and hope that these will contribute not only to progress in individual Large Projects, but also to the promotion of scientific research in general by the positioning of the researcher's research based on trends in the global researcher community through the formulation of projects applying to be listed in the Roadmap, and confirmation of the direction the research should take.

1. Large Scientific Research Projects

(1) The Significance and Necessity of Promoting Large Projects

In recent years, Japan's fundamental scientific capabilities have tended to see a relative decline when compared to other countries, as can be seen in the stagnant growth in the number of scientific papers and the decline in the international share of the top 10% scientific papers. As international competition intensifies, it has been pointed out that there has been slow progress in building an international research network in Japan's research environment where young researchers, female researchers and engineers are able to fully demonstrate their abilities. There is a need to improve the environment, and in order to tackle these issues, it is important to build an appealing research environment that is open to the world through the promotion of Large Projects.

In addition, such projects have expanded places for cutting-edge research in a broad scientist community that is centered on universities, and played a definitive role in the development of Japan's scientific research. For example, the Kobayashi-Maskawa Theory, which explains the breaking of CP symmetry, was proven through B Factory experiments, and neutrino vibration, which proves that neutrinos have mass, was discovered in Super-Kamiokande, and these things led to the two physicists being awarded the Nobel Prize in physics.

In this way, the Large Projects showcase Japan's scientific research to the world, attract outstanding researchers from around the world and contribute to human resource development in the fields, and moreover, increase interest in science of the general public, including children who will lead the next generation, provide dreams and hopes, and have great significance for Japan. Promotion of the Large Projects is an extremely effective initiative in strengthening the joint usage and research system, as well as aggregating the knowledge of researchers beyond the framework of the organization and contributing to the development of scientific research in Japan.

On the other hand, because large investment amounts are required for the Large Projects, smooth promotion has been difficult in the austere financial situation of recent years. A similar situation is occurring in the advanced nations of the world, and Large Projects with significance for the history of humankind are increasingly being promoted through international cooperation. From the perspective of Japan's sustainable development and contribution to the world, it is essential to promote the Large Projects with a view to international competition and international cooperation in

the various fields of fundamental science, which are Japan's strengths. For that reason, from now on, it will be necessary for Japan to clearly position as the basis of the nation's science policies the stable and continuous investment of fixed resources into the Large Projects, while obtaining support from all segments of society and the public.

(2) Fundamental Outlook for Large Projects

① Fundamental Attributes of the Large Projects

Up to now, the Large Projects have generally been considered to have the fundamental attributes listed below, and they have been promoted as important tasks for scientific policies. It will be necessary to maintain this outlook from now on as well.

- Projects that are carefully conceptualized and prepared for thorough independent evaluation based on intellectual curiosity and inquiring minds of researchers, and through formation of agreement within the scientist community, with the objective of aiming for the pursuit of truth to contribute to the development of humanity.
- Projects that are expected to produce groundbreaking results and that have taken the lead in scientific research worldwide, by aggregating cutting-edge technology and knowledge to tackle research issues that had yet to be explored by anyone.
- Projects that can support research and education at universities from a broad position and strengthen the foundation of science, while also increasing the public's interest in science, allowing Japan to exhibit leadership amid international competition and cooperation, and contributing to the world.
- Nationwide projects in which multiple research facilities form an organic network, many researchers participate under a clear promotion system, and all of the participants take on the challenges of large themes

The "Large Scientific Research Projects", which are the Large Projects published in the Master Plan of the Science Council of Japan, are planned and implemented based on the vision and system of each scientific field following careful discussion, preparation, and agreement by the scientific community, and "have a long-term implementation period (5-10 years or more) and a total budget of more than several billion yen (no upper limit set)" and "consist of a large facility plan and a large research plan".

② Implementing institutes

In order to continue to the strengthening of the foundation for Japan's scientific research as a whole, it is appropriate for the Large Projects to be promoted using a joint usage and research system, and from such a perspective it is conceivable that interuniversity research institutes and joint usage and research centers will become the main implementing institutes. These institutes are required to

proactively take on a wide range of roles and fulfill their responsibilities, such as coordinating the consensus-building of the research community in each field regarding promotion of the Large Projects.

Meanwhile, even with the Large Projects carried out using a top-down decision-making approach, for example, by the National Research and Development Agency as the implementing institution, on account of the scientific attributes of the relevant projects and the expected results, some of them will be difficult to promote smoothly unless a large number of researchers voluntarily and proactively participate. For such projects as well, it is desirable to position the projects as Large Projects based on the bottom-up proposals and discussions of the scientist communities through the process of the formulation of a master plan by the Science Council of Japan.

In the Roadmap, regarding the Large Projects carried out by the various implementing institutes, the advantages, tasks and points to bear in mind with regard to the projects recognized to take priority are being compiled so that wide-ranging cooperation can be obtained in the future. It is expected that there will be proactive consideration by the Council for Science and Technology's other subcommittees in terms of measures to promote these projects.

(3) Significance and Effects of Formulating the Roadmap

① Significance of formulating the roadmap

Large Projects require large amounts of expenses over long periods due to their characteristics such as aggregating cutting-edge technology and knowledge to tackle research issues that have yet to be explored by anyone, and in the promotion of these projects, it is necessary to keep in mind the overall circumstances of research in Japan, as well as such matters as the current situation and future prospects for public and government spending, and to conduct promotion strategically and systematically with a long-term outlook, while obtaining wide-ranging support from society and the general public. Based on these points, the Working Group conducts multifaceted studies, and formulates and publishes a Roadmap from the perspective of clarifying the priorities.

The Science Council of Japan's Master Plan, which serves as a base for the Roadmap, emphasizes scientific judgment in its formulation, and states that, "in addition to including large research projects that are required by each scientific field, it is aimed at providing certain policies for how Japan's large research projects should proceed, and is not directly involved in things such as budget allocation for resource allocated organizations".

Meanwhile, although the Working Group's Roadmap does not guarantee budget measures, as a document that should be sufficiently considered in the promotion of related policies, it clarifies the priority of the Large Projects. In this Working Group, after further examination of the large scientific research projects of the Master Plan that have been recognized as particularly having certain priority, the Large Projects that should be posted on the Roadmap are selected and the main advantages, tasks and points to keep in mind are indicated.

Since the situation affecting scientific research changes significantly due to such factors as academic trends, social demands and international affairs, the priorities of the Large Projects

indicated by "Roadmap 2020" shall be maintained until the next roadmap is formulated, and these priorities will be reviewed approximately every three years.

While bearing in mind the above, the roles played by the Roadmap can be organized as follows:

- By formulating a roadmap, it becomes possible to make strategic and systematic policy decisions based on thorough scientific evaluation.
- It becomes possible to promote projects while obtaining the support of society and the general public.
- It becomes possible to promptly and appropriately handle international competition and cooperation.
- It becomes possible to provide the opportunity for scientist communities to voluntarily consider, from broad perspectives, future objectives and required conditions for the accomplishment of such objectives.
- It becomes possible to promote interaction between different scientist communities and promote cross-sectoral efforts for complicated scientific challenges.
- By having the opinions of scientist communities organized in advance in the form of the Roadmap.

From these things, the following effects are mainly expected.

- Even for projects that follow top-down decision-making, it becomes easy to reflect bottom-up opinions in some ways.
- Even when new support scheme for the Large Projects are created through supplementary budget, etc., it becomes possible for scientist communities to promptly and effectively utilize it.
- For government agencies related to research and development other than the Ministry of Education, Culture, Sports, Science and Technology (MEXT), it becomes easy to ascertain the trends and specific needs of each field.
- Depending on the scientific field, in circumstances in which international cooperation is essential due to the increased scale of research, the Roadmap contributes to promotion of international cooperation, as something that indicates the outlook about promotion of the Large Projects in Japan.

In Europe and the United States, promotion plans (roadmaps) for the Large Projects are being formulated and promoted through such agencies as Europe's "European Strategy Forum on Research Infrastructure (ESFRI)", the UK's "Research Council", and the United States' "Department of Energy (DOE)". In promoting Large Projects in Japan, what is needed is for these European and US promotion plans to be utilized to clarify the division of roles with overseas research institutes and researchers and to build a collaborative/cooperative system, where necessary, and to utilize the Roadmap and promote it while becoming more aware of the importance of international collaboration and international cooperation.

② Effects of formulating the Roadmap

In terms of the "Projects to Promote Large Scientific Frontiers (referred to below as "Frontier

Projects"), which aim to strategically and systematically promote the Large Projects, the following projects will be launched and promoted from among the projects positioned in the Roadmap so far.

- Large-Scale Cryogenic Gravitational Wave Telescope (KAGRA) Project (published in "Roadmap 2010")
- "Search for new physics by making more advanced B Factory accelerators" (published in "Roadmap 2010")
- "Japan Proton Accelerator Research Complex (J-PARC)" (published in "Roadmap 2012")
- "Promotion of the 30-Meter Optical Infrared Telescope (TMT) Project" (published in "Roadmap 2012")
- "International Collaborative Research Network for Pre-modern Japanese Texts" (published in "Roadmap 2012")
- "Construction of the Scientific Information Network (SINET) for a New Stage" (published in "Roadmap 2014")
- "Particle physics with the High-Luminosity Large Hadron Collider (HL-LHC))" (published in "Roadmap 2017")
- "Promotion of neutrino research through 'Super-Kamiokande" ("Roadmap 2017")

In addition, the recipients of support for the projects published in the Roadmap are not limited to the Frontier Projects, and there are many projects that were supported through being published in the Roadmap which have been able to procure funds other than from the Frontier Projects. For example,

- "LiteBIRD - A satellite for exploring the universe before the hot big bang with measurements of cosmic microwave background polarization" (published in "Roadmap 2014"): Project partially launched with a grant from the National Research and Development Agency.
- "Project of a low emittance synchrotron radiation facility for the establishment of a coming world leader in science and technology" (published in "Roadmap 2017"): Project launched with a subsidy for research and development of common infrastructure technology for low-emittance radiation.

As described above, cooperation with national policies has been strengthened through various funds and the implementation of the Large Projects described in the Roadmap is steadily progressing with further development expected in the future.

2. Formulation of "Roadmap 2020"

(1) The Science Council of Japan's "Master Plan 2020"

In January 2020, the Science Council of Japan formulated "Master Plan 2020" consisting of 161 "large scientific research projects" in 32 fields that are necessary for each scientific field "for the purpose of providing certain guidelines for Japan's large scientific research projects through broadly covering and systematizing large-scale research plans with great scientific significance". In the

"Master Plan 2020", as in previous years, the method of soliciting proposals from the scientist communities was adopted, and from among the proposed projects, 31 "Important Large Research Projects" (16 new projects, 15 continuing projects) that should be implemented particularly promptly were selected.

(2) Policies for Roadmap Formulation

Based on the announcement of the "Policy for Formulating the 24th Master Plan for the Large-Scientific Facility Projects / Large Research Projects" by the Science Council of Japan in December 2018 and upon the start of the formulation of the new master plan, "Master Plan 2020", discussions began on the formulation of a new Roadmap.

In the discussions, in order to proceed with work based on the policies unique to the Working Group and regardless of the contents of "Master Plan 2020", the "Formulation Policy for a Fundamental Concept Roadmap to Promote Large Scientific Research Projects" was formulated in December 2020 prior to the formulation and publication of "Master Plan 2020" (January 2020).

In the formulation policy for "Roadmap 2020", based on the formulation policies of previous roadmaps, the acceptance of screenings for (1) the projects published in the "Important Large Research Projects" in "Master Plan 2020" and (2) the projects that were the subject of the important large research project hearings in the formulation of "Master Plan 2020" commenced, and those projects that were rated above a certain level through the document screenings and hearings were published in the Roadmap.

In addition, since most of the current projects supported by the Frontier Projects will reach the end of the project period for the Frontier Projects within a few years following the formulation of "Roadmap 2020", the following policies were indicated in the current formulation policy.

- Of the current projects, with regard to successor projects that wish to receive continuous, developing support, the direction of support (period, scale, etc.) after the end of the current project will be indicated based on the contents of "Master Plan 2020".
- For those whose successor project is not listed in the Roadmap after the end of the period, we propose to shift to a framework other than the Frontier Projects (for example, the Scientific Research Infrastructure Projects (tentative name)) based on the results of joint usage.

(3) Screening of Research Projects to Be Published in "Roadmap 2020"

Based on the formulation policy of "Roadmap 2020" following the formulation of "Master Plan 2020", the Working Group accepted screening applications for a total of 74 projects comprising ① the 31 projects selected in the "Important Large Research Projects" of "Master Plan 2020" and ② 43 additional projects subject to important large research project hearings posted in the "Important Large Research Projects", and screenings were conducted for 60 projects.

The screenings were carried out based on the "Roadmap 2020 Screening Guidelines" decided by

the Working Group.

- As a result of the document screening of 60 projects, the Working Group decided to conduct hearings for 17 projects (① 15 projects of the "Important Large Research Projects" of the Master Plan, and ② two projects other than the "Important Large Research Projects").
- As a result of the hearings for the 17 projects, a decision was made to post 15 projects on the roadmap. Of the 15 projects, eight were successor projects of the current Frontier Projects, and seven were other projects.

The main process of the screenings was as follows.

- The perspectives of the screenings were the seven perspectives in the evaluation at the time of the formulation of "Roadmap 2017" and the additional perspective of the "scientific significance of the project", and the evaluation was made from the following eight perspectives.

(Perspectives that are the basic requirements to be met in promoting the project)
① Scientific significance of the project, ② Agreement within the research community,
③ Implementing institute of the project, ④ Joint usage system, and ⑤ Legitimacy of the project.

(From the perspective of clarifying priority in promoting the project)
⑥ Urgency, ⑦ Strategic value, ⑧ Support from society and the general public

- In the document screenings and hearings, each member of the Working Group evaluated each of the above eight items for each research project. However, members who had a conflict of interest or who did not have a conflict of interest but had expressed that they were in an equivalent position did not participate in the document screenings or hearings for the project.
- As a result of the document screenings, the 17 projects that were subjects to the hearings were classified according to the following 1) and 2).
  1) Regarding the perspectives (① to ⑤ above) that are the basic requirements to be met in promoting the project, the evaluations were rated comprehensively as "a", "b" or "c".
  2) From the viewpoint of clarifying priority in promoting the project (⑥ to ⑧ above), the evaluations were rated comprehensively as "a", "b" or "c".
- Of the projects that received a certain level of rating in 1) and 2) above, a careful review was conducted from a comprehensive perspective of the responsibility structure for promoting the project, the status of the organizational decision-making, the legitimacy of the budget and staffing plans, the status of research or facility preparation, and an international competitive edge through implementation at an early stage, while also taking into account the characteristics of the field, and those projects that were considered to be highly urgent and of strategic value, especially for the launch and implementation of the project were carefully selected.
- As a result of the above screenings, a decision was made that 15 projects (8 projects to succeed the current Frontier Projects and 7 other projects), which had the basic attributes of a Large

Project, the basic design relating to the implementing institute, equipment, etc. and the formation of an agreement within the researcher community were clear, and where the construction costs etc. had been sufficiently examined were to be published in "Roadmap 2020".

- Aside from being classified into 1) and 2) above, the outstanding points, tasks, and points to note were compiled for all of the 17 projects that were subject to a hearing, including the two projects that were not posted in "Roadmap 2020", and the applicants were notified of these points after the completion of the screening.

(4) Public Comments

When formulating "Roadmap 2020", public comments were solicited on the draft. There were 357 submissions for the solicitation of comments, and various opinions were received regarding the promotion of Large Projects and the selection of Roadmap published projects. The Working Group finalized the Roadmap based on these opinions.

(5) Future Treatment of Large Projects Being Promoted as Current Frontier Projects

Eight of the 15 plans posted in "Roadmap 2020" were proposed as successors to the projects supported by the current Frontier Projects, but high-level scientific goals have been newly set for these, and therefore, we would like to request the government for continued support of these projects for which further achievements are expected.

Meanwhile, with regard to projects for which, as a result of the screening, a successor project was not posted in "Roadmap 2020" even though support was received as a current Frontier Project, there is a need to ask the implementing institute to consider an exit strategy for the entire project by the end of the business period of the Frontier Project for the project, and for the Working Group to further consider the project's future direction.

3. Aiming for Promotion of the Large Projects

(1) Points to Bear in Mind When Implementing Large Projects

① Proactive transmission of information and interactive communication with society and the general public

Obtaining the support of all segments of society and the general public is a wholly reasonable obligation since the research is being promoted using the nation's limited financial resources. Furthermore, in order to reliably promote the Large Projects, which require large amounts of investment, it is now more important than ever to proceed through consideration together with society and the general public. In the future, we expect that the implementing institutes of each research project will share with society at large and the general public, the importance and appeal of the project,

and implement proactive and strategic initiatives such as transmitting information, in order to appropriately promote their Large Project. In the formulation of this Roadmap, the initiatives of each implementing institute to transmit information were evaluated in the evaluation perspective of "the support of the general public and society", but even more proactive evaluations may be conducted in the future with regard to this vital point.

The formulation and publication of the Roadmap itself is an important step in order to disclose to the general public the direction of Japan's cutting-edge science and to inspire public interest in it, and it is necessary for the national government and the implementing institutes to make efforts to communicate the Roadmap to all segments of society and the general public.

A Large Project is a highly specialized initiative that requires advanced knowledge and technology, and at the same time, is also an initiative where it is possible for the dream of the achievement of a research challenge that has not yet been explored by anyone, reached through aggregating technology and knowledge, to be shared widely with the general public. Based on this, it is essential that the implementing institute of a Large Project conveys the goals and content of its project clearly and in a way which is easy to understand not only for researchers but also for society and the general public by setting up and operating an appealing website that transmits the progress and results of the project.

In order to steadily promote Large Projects, it is important for a full explanation to be given not only of the significance of each project as well as the attributes of fundamental science as shown below, but also to proactively discuss the significance of investing in fundamental science, and to raise the level of shared understanding among researchers and society and the general public.

- In order to obtain new knowledge in fundamental science, extremely long-term research is necessary.
- Investment in fundamental science has the meaning of making an international contribution to humanity's shared "knowledge" base.
- Although fundamental science itself does not aim for direct application, it has played a major role in opening new paths for humanity by obtaining new and deep understanding about nature.

Large Projects handling cutting-edge themes have the potential to stimulate broad public interest and intellectual curiosity, including those of researchers in other fields. Since the promotion of Large Projects and the transmission and exchange of information related to them leads to the development of diverse human resources in science, there is a need to maintain the perspective of developing wide-ranging researcher communities and supporters through transmissions and exchanges which appeal to the general public, including researchers, faculty members, and students in the surrounding areas. Therefore, when implementing a Large Project, it is conceivable, for example, to promote efforts such as the following measures.

- Researchers themselves communicate the contents and results of Large Projects and the appeal of science in an easy-to-understand manner by using various opportunities such as giving lectures at schools or through public lectures.
- Use of the Internet, etc. to communicate not only the progress and results of the research, but also precise details about the activities, such as the state of the facility's construction or reflections when results were not achieved, and efforts to sufficiently listen to the opinions of the general

public and society.

- The implementing institutes of Large Projects should strive to improve the support system such as assigning staff with specialized knowledge and creating specialized departments with regard to efforts on interactive communication, etc.
- Encourage researchers, etc. to proactively conduct communication activities and give consideration so that such activities lead to the personal evaluation of the researcher.
- Provide chances for researchers to have dialogues with the general public during opportunities such as open forums, etc. organized by the implementing institute of the Large Project.
- Build mutual trust, such as by putting a system in place to effectively provide the information, etc. required by the media, and appealingly transmit information through collaboration with the media.

② Ensuring the fairness and safety of research activities

The support of society and the general public is indispensable for the promotion of Large Projects, and for that purpose, one major premise if ensuring the fairness and safety of the research activities.

Particularly for Large Projects, which require large amounts of expenses and a large number of people, it is essential to strive to the utmost so as to cultivate a high level of research ethics among the related individual researchers, groups, and research institutes, promote fair research activities, and make sufficient efforts to ensure safety in the research activities.

③ Promotion of leading initiatives that will serve as a model for future research activities

As a leading player in Japanese scientific research, the implementing institutes of the Large Projects are required to serve the role of pioneering new models in the various aspects of the research activities such as strengthening the joint usage and research system, creating new fields and deepening interdisciplinary fusion, establishing new research methods, facilitating international collaboration and transforming and expanding the researcher base (human resources development).

In particular, at present, scientific research activities are suffering stagnation throughout the world due to the spread of COVID-19. Large Projects are largely promoted through international cooperation, and it is expected that they will be more susceptible to the impact of COVID-19, but while keeping an eye on this situation, we are expected to lead the transition to a new research style in this post-COVID society such as promoting remote and automated joint usage and research.

(2) National Support and Proper Evaluation

① Reliable support through the national budget

In order to obtain new knowledge in basic science, extremely long-term research is needed. We

would like to request the national government for utmost efforts based on the priorities indicated in the Roadmap to ensure a stable and continuous budget from a long-term perspective towards reliable promotion of the outstanding Large Projects.

In particular, it was announced that after the establishment of the Frontier Projects in 2012, the promotion of Large Projects through these Frontier Projects would be based on the Roadmap, but the budget for Large Projects is not simply limited to the Frontier Projects alone, and Large Projects are being promoted using various public funds such as national subsidies and operating cost subsidies. We would like to request that the government continues to strategically and systematically proceed with budgetary measures for Large Projects while utilizing various methods.

In addition, the implementing institute of each Large Project that receives support is further being asked to try and reduce maintenance costs by utilizing existing facilities and equipment and introducing new technologies, and while taking into account the nature and content of the project, to make further self-reliant efforts for the promotion of stable and continuous projects, such as promotion of international cooperation including the sharing of costs, and support from third parties including cooperation with industry.

② Implementation of appropriate evaluation of the Large Projects conducted through the Frontier Projects

When promoting a Large Project listed in the "Roadmap" through a Frontier Project, including cases where the project is a successor project to the current project, a preliminary evaluation shall be carried out anew by the Working Group, etc. In the preliminary evaluation, it is necessary to carry out an appropriate follow-up on the status of responses to the tasks and points to be noted indicated in the Roadmap.

In addition, when budgeting the project as a Frontier Project, a project period (in principle, within 10 years; provided, however, that for large facility projects, the initial operation period following the preparation of the facility may be taken into consideration) shall be set as an annual project, and progress may be evaluated at any time by the Working Group or others during the period.

Furthermore, with regard to each project, the positioning of subsequent projects (succession as a Frontier Project, transition to a new framework, termination of the projects, etc.) will be examined and decided before the end of the period of the annual project. After the end of an annual project, an evaluation will be conducted at the end of the term, which will serve to explain whether the objectives and goals of the projects that have been implemented so far have been achieved and the results will be announced, and the significance, outcomes, and knock-on effects of the project will be reported to society and the general public.

In carrying out these evaluations, the evaluation shall be objective and highly transparent, while paying attention to the opinions of the general public and stakeholders, and appropriate feedback shall be provided such as giving advice to the implementing institute based on the evaluation results. In particular, it is important to "select" and "concentrate" resource allocation by making recommendations such as improvements, and by setting out a policy to end support for projects that,

according to the evaluation, are not expected to achieve their goals.

In this Working Group, efforts have been made to improve the evaluation methods by refining the perspectives of the evaluations, introducing field surveys and hearings, and utilizing external experts (evaluation advisors) in order to carry out rigorous evaluations. In particular, the fact that the evaluator visits the site of the project enables the discovery of new issues and ascertaining of the motivation of researchers, including the young researchers, leading to a more realistic evaluation. In the future, we would like to continue to carry out these visits as much as possible while paying sufficient attention to preventing the spread of COVID-19.

(3) Formulation of the Roadmap and Promotion of Large Projects in the Future

Due to the nature of independent and emerging scientific research based, the Science Council of Japan formulate a master plan mainly the research plans proposed by wide-ranging researcher communities mainly from a scientific perspective. Therefore, this Working Group has endeavored to contribute to the strategic and systematic promotion of Large Projects by formulating a Roadmap that takes into account the priorities for promotion based on the master plan. The Large Projects listed in the Roadmap so far are being steadily promoted with the support of the government.

It is important to deepen cooperation between the researcher communities, the scientific field and the government through continuous review and further development while basically maintaining the existing framework.

The Science Council of Japan has begun to follow up on the Master Plan, and it is necessary to continue to search for effective measures for the promotion of Large Projects such as through this Working Group, etc. also collaborating with the follow-up and considering how to verify the effectiveness of the formulation of the Roadmap.

It is hoped that wide-ranging opinions will be exchanged among those involved in the field of science and technology such as the Science Council of Japan, the Council for Science and Technology, and the related ministries and agencies in relation to the direction of the Master Plan and Roadmap, progress in the projects and other matters so that the cycle of proposal, do, check and act in future Large Projects will function even more effectively. We expect that even more proactive discussions will be held even among the researcher communities in each field on the planning and promotion of the Large Projects, and that these discussions will lead to exchange and fusion with different fields and the creation of new academic fields.

We sincerely hope that these efforts will lead to strategic promotion of various Large Projects in Japan, the expansion of an attractive research environment open to the world, and the strengthening of the foundation of Japan’s knowledge.

Appended

Roadmap 2020 — Fundamental Concepts for Promoting Large-Scale Scientific Research Projects

The Roadmap is organized according to the concepts explained below, based on the Master Plan of the Science Council of Japan and the results of the evaluation by the Working Group.

1. "Fields," "Categories*," Project name," Project summary," "Implementing organization," "Financial requirements," "National budget, self-financing," "Project period" are defined in the Roadmap 2020 application

※ Concerning "Categories"

"Large-scale Facilities Projects" are large-scale research projects that aim at opening up cutting-edge research through the construction, maintenance, and operation of large-scale facilities and related equipment and facilities, with Inter-University Research Institute Corporations and other organizations serving as the main implementing bodies, based on agreement of the scientific community.

"Large-scale Research Projects" are large research projects that create new knowledge through the promotion of large-scale systematic research. This entails gathering and organizing many researchers and promoting their research and observations over a long period of important research issues, the significance of which there is consensus agreement among the researchers in the field. This may also involve promoting the organization of

- The order of the projects is based on Master Plan 2020.

2. "Project period": : ■ shows period for construction and initial investment, strengthening of functions, etc. ■ shows the period for operation and maintenance

3. Criteria for "Evaluations" in Roadmap 2020

- Basic criteria/requirements that must be fulfilled for pursuing the project: 1) scientific significance of the project, 2) consensus within scientific community, 3) project implementing organizations, 4) system for joint utilization, 5) appropriateness of the project. Criteria for clarifying the priority of the project: 6) urgency, 7) strategic value, 8) understanding/support from the general public and society.

Specific points of criteria	
Basic criteria that must be fulfilled for pursuing the project	Criteria for clarifying the priority of the project
1) Scientific significance of the project ・Can new knowledge be created through original exploration based on the capability and knowledge of researchers? (Challengingness) ・Is the project being undertaken from a comprehensive perspective that takes an overview of subdivided knowledge and places importance on diversity of academic research? (Comprehensiveness) ・Can the project create new disciplines of knowledge through collaboration and cooperation among researchers in different fields and various stakeholders inside and outside Japan? (Fusion) ・Will the project contribute to the world by achieving world-class excellence that establishes the position of the project's research through discussion and verification in the world scientific community? (Internationality)	6) Urgency ・How important is the prompt implementation of the project, what kind of merits and dominance can Japan obtain in international competition and cooperation? ・What kind of concerning impact would there be on Japan if the project is delayed? 7) Strategic value ・Will the project produce worldclass outcomes in the particular field and will it further enhance the strengths of Japan? ・What kind of spillover effects will the project have on other fields? ・Will the project lead to international contributions and international ″brain circulation″? ・Will the project lead to the future growth and development of Japan? ・What will Japan lose if the project is not implemented?
2) Consensus within scientific community ・Is there clear consensus-building within the scientist/researcher community on the value of the project?	8) Understanding/support from the general public and society ・Can the significance and necessirty of the project be persuasively explained to citizens and society? ・Will citizens and society support the investment of large sums of national funds over a long period? ・Will a relationship of trust be built with local governments and residents?
3) Project implementing organizations ・Does the project implementing organization have a clear system for implementing the project? ・If several organizations are to participate, are the division of roles and allotment of responsibilty clear?	
4) System for joint utilization ・Has a system for joint utilization and joint research been established? Can a broad range of university researchers participate?	
5) Appropriateness of the project ・Are the project's schedules for preparation and implementation clear? Are the schedules feasible? ・Are the construction and operation costs appropriate? Has enough study been done? ・Are the budget planning and manpower planning appropriate? Has enough study been done? ・Is the preparation of the project (preliminary research, technical development, system preparation) being	

- For the written evaluations, each member of the Working Group evaluates each research plan into one of three levels (A, B, C) for each criterion (1 to 8), and appraises whether an evaluation interview should be conducted with the planners.
- The evaluation results of all the written evaluations by the WG members are collated, and for those project plans recognized as excellent, a further interview evaluation is conducted. At the interview evaluation, each WG member evaluates each of the eight criteria into three levels （◎、○、△）.
- Based on the results of the interview evaluations by the WG members, a comptrehensive Evaluation 1 — "Basic criteria that must be fulfilled for pursuring the project" — and a comprehensive Evaluation 2 — "Criteria for clarifying the priority of the project" — are conducted.

Evaluation 1: A project is evaluated into one of the following three levels (a, b, c) based on the the percentage of triangle (△) evaluations for the evaluations （◎、○、△） of criteria 1 to 5 by the WG members.
Percentage of △ evaluations less than 20%: "a" ／ Percentage of △ evaluations 20% or more but less than 40%: "b" ／ Percentage of △ evaluations 40% or more: "c"

Evaluation 2: The evaluation results of criteria 6 to 8 by each WG member are collated and scored, and the project is evaluated into one of the following three levels (a, b, c).
50% or more of the possible full score: "a" ／ 25% or more but less than 50% of the possible full score: "b" ／ less than 25% of the possible full score: "c"

- Based on the results of Evaluation 1 and Evaluation 2, the WG conducts a comprehensive deliberation and decides whether the project should be included in the Roadmap.

Field	Category	Project name	Project overview	Implementing organization: Core organization	Implementing organization: Collaborating Organization	Financial cost ※Costs from 1st to 10th year of project	Project period	Evaluation 1	Evaluation 2	Main outstanding points	Main issues, considerations, etc.	Remarks
Human Sciences, Social	Large-scale research project	Model Building in the Humanities through Data-Driven Problem Solving	By building data infrastructure in the humanities fields in order to reshape humanities research into data-driven-type research and achieve a sustainable society, the Project aims at producing problem-solving-type humanities research that can collaborate with other fields through the effective utilization of this infrastructure.	National Institute of Japanese Literature, National Institutes for the Humanities	National Institute of Japanese Literature , National Institutes of Informatics, National Institutes of Japanese Language and Linguistics, National Institute of Polar Reseach, National Diet Library, Tokyo University Faculty of Letters, Future University Hakodate, Freer Gallery of Art (U.S.) and more.	Total cost: 5.42 billion yen Facility, equipment costs: 300 million yen Personnel costs: 3.64 billion yen Operating costs: 80 million yen Others: 1.4 billion yen	**Construction, initial investment; strengthening of project functions** 1st to 3rd year: Preparation of basic data infrastructure, development of analytical technology **Operation** 4th to 10th year: Implementation of analytical technology, development of data-driven humanities research	a	a	●By building data infrastructure enabling anyone to utilize the wide range of classic books and documents that have been handed down in Japan, the project is expected to improve scholarship and culture in Japan and elevate Japan's cultural presence in the world. ●By bringing technical innovation to the humanities through the introduction of informatics technology and creating pioneering cases making a paradigm shift in the humanities through the utilization of methodologies from the natural sciences, the project is expected to create new value in the humanities.	●The number of classic documents has exceeded the 300,000 number targeted under the original plan. The project has begun uncovering and designating the vast amounts of classic materials kept by individuals, shrines and temples, etc., but further consideration is necessary to decide what methods should be employed to proceed with the project and what kinds of classic materials should be specifically digitalized. ●This is a pioneering plan to make a shift from conventional humanities studies to data-driven humanities, but regarding the fostering of human resources, efforts must be made not only to utilize persons from the field of informatics but also to foster people who are familiar with the humanities and both information science and the natural sciences.	Successor to the Large-Scale Scientific Frontiers Project
Basic medicine science	Large-scale facilities project	Establishment of world-leading research and training center for infectious diseases with a high containment laboratory (BSL-4)	By setting up BSL-4 facilities for research and HRD, and establishing a world-leading research and training center for studying certain kinds of pathogens, the Project aims to contribute to ensuring global safety and peace of mind.	Nagasaki University	Infectious Disease Research Consortium(Hokkaido University, Tohoku University, The University of Tokyo, Tokyo Medical and Dental University, Keio University, Osaka University, Kobe University, Kyushu University, Nagasaki University)	Total cost: 16.782 billion yen Facilities, equipment costs: 8.540 billion yen Personnel costs: 1.872 billion yen Operating costs: 6.370 billion yen Others: 0	**Construction, initial investment; strengthening of project functions** 1st to 3rd year: Construction of facilities, procurement, installation of equipment, testing of safety management of facilities, operations systems **Operation** 3rd to 5th year: Test operations, ensuring safety management of facilties, testing operations systems From 6th year: Operation of facilities, conducting of research, training	a	a	●Since Nagasaki University has a strong track record in infectious diseases research up to now, by preparing and operating the infectious diseases research hub with the core BSL -4 laboratories at Nagasaki University, the project can be expected to produce greater research results. ●This is an important plan from the perspective of strengthening responses against COVID-19 and other new and variant infectious diseases. Direct outcomes for the development of vaccines against BSL-4 viruses and spillover effects for the development of vaccines against other viruses can be expected.	●Further study will be necessary regarding the positioning and operation of this project's facilities in the government's measures against infectious diseases. ●Even after the construction of the facilities and the project moves into the operational stage, efforts must be made to get the continuous support of society and citizens, including local governments and residents. ●To advance the infectious diseases research through collaboration with other universities with Nagasaki University as the core, it will be desirable to clarify further the systems for collaboration and joint use of facilities, based on the roles of each organization.	
Basic medical science	Large-scale research project	Human Glycome Project	The Project aims at elucidating the structure of the sugar chain, one of the three major life chains of living organisms together with genomes and proteins. By obtaining information on the glycome complement, researchers will be able to understand the pathology of diseases. Moreover, by taking the lead on sugar analysis technology, the Project will promote the development of innovative new medical care, disease prevention and pre-emptive medicine.	Tokai National Higher Education and Research System (Nagoya University, Gifu University)	Tokai National Higher Education and Research System(Institute for Glyco-core Research, Brain & Mind Research Center), National Institutes of Natural Sciences Exploratory Research Center on Life and Living Systems, Soka University Glycan & Life System Integration Center, National Center for Geriatrics and Gerontology, Tokyo Metropolitan Geriatric Hospital and Institute of Gerontology, University of Lille, Academia Sinica, Griffith University, University of Alberta, and more	Total cost: 15.4 billion yen Facilities, equipment costs:2.4 billion yen Personnel costs: 6.02 billion yen Operating costs: 980 million yen Others: 6 billion yen	**Construction, initial investment; strengthening of project functions** 1st to 5th year: Installation of equipment 1st to 5th year: Acquiring blood sugar chain information on aging, dementia 1st to 5th year: Compilation of cell glycan atlas (mechanism of synthesis) 3rd year: Expansion of data base **Operation** 6th to 10th year: Glycan analysis of several diseases 6th to 7th year: Elucidation of mechansims of cell localization of glycan synthesis 8th to 10th year: Establishment of sugar chain rewriting cells 6th year: Collaboration with Omics data	a	a	●Glycan chain research is a research field that Japan is strong in. This project has the possibility of further advancing life sciences that cannot be understood by genome analysis. ●This will be very challenging research that aims at promoting bioinformatics for accumulating and analyzing "sugar chain information."	●Since at the present stage the building of joint-use systems has not necessarily been adequate, it will be necessary to study the preparation of a system that will make it easier for researchers in the same fields to participate. It will also be desirable for the Project to consider international collaboration to promote cohort research of Asian and African races. ●From the aspect of medical applications, the elucidation of the mechanism of sugar chains and issues related to the methodologies for sugar chain modification technology remain.	

Field	Category	Project name	Project overview	Implementing organization: Core organization	Implementing organization: Collaborating Organization	Financial cost ※Costs from 1st to 10th year of project	Project period	Evaluation 1	Evaluation 2	Main outstanding points	Main issues, considerations, etc.	Remarks
Clinical medicine	Large-scale research project	Establishment of strategic center for elucidating basis of human diseases and their prevention	Targeting lifestyle-related diseases with modeling of integrated information analysis of rare disease genomes and cancer genomes, the Project aims to establish an information-intensive academic core that will enable integrated analysis utilizing state-of-the-art information analysis technology and the accumulation of lifestyle Big Data.	The University of Tokyo Medical Genomics Research Initiative	National Institutes of Genetics, Yokohama City University, Internatonal University of Health and Welfare, National Cancer Center, National Center for Child Health and Development, National Center for Global Health and Medicine	Total cost: 43.93 billion yen Facilities, equipment costs: 9.5 billion yen Personnel costs: 4.6 billion yen Operating costs: 7.4 billion yen Others: 22.43 billion yen	**Construction, initial investment; strengthening of project functions** 1st to 3rd year: Preparation of measuring equipment 1st to 4th year: Preparation of computational infrastructure **Operation** 2nd year: Production of advanced large-scale data 2nd year: Advancement of research on normal state through genotype-phenotype matching, including obtaining of genome information and clinical information, and grasping molecular mechanism of disease state 2nd year: Collection of resources, preparation of management system 5th to 7th year: Preparation, maintenance of base network 8th to 10th year: Expansion to nationwide network 10th year: Commercialization of industry-academia-government collaboration 1st year: Start of training human resources for genome medical science data human resources training 4th year: Return of human resources to medical, industrial sites 7th year: Creation of new occupational fields	a	a	●By preparation of medical and information networks and measurement and analysis networks based on vast databases on information on mutations/polymorphisms obtained through large-scale human genome analysis, and by the conducting of applied research through mutual collaboration, the project is expected to produce results that can be utilized for next-generation medicine, biology, and drug discovery. ●The genome research on the onset of diseases arising differently among human races will be very significant. The analysis of data on Asian people, including Japanese people, in Japan will be important, and it can be expected that Japan will gain an advantage in international competition in this field.	●To further clarify the significance of conducting research targeting Asian people, including Japanese people, it is necessary to confirm whether the project will enable making use of those special characteristics. ●The purpose of the project is not just the preparation of information infrastructure; it is necessary to clarify how the data from this project will be utilized from the perspective of Japan overall and also how the fostering of human resources will proceed.	
Physics	Large-scale facilities project	High Magnetic Field Collaboratory-Formation of Unified Next Generation All Japan Facility	So that the MegaGauss Science Laboratory, which plays a leading role in materials science research can be developed into a world-class, next-generation facility, the integrated research institute (High Magnetic Field Collaboratory) was established based on a cooperation agreement among three centers for high magnetic field research signed in March 2019.	The University of Tokyo The Institute for Solid State Physics	Core Collaboration Organization：Tohoku University The Institute for Materials Research, Osaka University Graduate School of Science, Collaboration Organization：Kobe University Molecular Photoscience Research Center, University of Fukui Research Center for Development of Far-Infrared Region, Osaka Prefecture University Organization for Research Promotion Research center for utilization of high magnetic field	Total cost: 6.96 billion yen Facilities, equipment costs: 3.9 billion yen Personnel costs: 300 million yen Operational cost: 2.76 billion yen Others: 0	**Construction, initial investment; strengthening of project functions** 33 tesla superconducting magnet and quasi-steady magnetic fields 1st to 2nd year: Introduction, adjustment 3rd year: Adjustment operation 100 tesla non-destructive magnet and shared strong magnetic field 1st to 3rd year: manufacture, introduction 4th year: Adjustment operation **Operations** 4th to 10th year: Joint utilization operation 11th to 20th year: Ugrading, joint utilization operation	a	a	●This project will build a high magnetic field collaboratory-formation as a new research hub based on the past research achievements in the field of high magnetic fields and materials science, which are fields that Japan plays a leading role in, and it is expected to be an important project that will enable Japan to strategically compete in competition with the United States and Europe. ●Since the project is receiving financing from the industrial sector and is also endeavoring to secure self-financing, it is expected that the project will be very likely to be realized, and that a foundation for effective joint research and utilization will be established.	●Although Japan has achieved unique success in this field, for the advancement of the project, it will be necessary to promote the research while conducting multifaceted studies that incorporate the advantages of other research projects, for example, carrying out comparative studies with research advanced at overseas high current research facilities. ●For the more stable advancement of the research, it will be desirable to continue to consider ways so that further cooperation can be obtained from the industrial and other sectors.	
Physics	Large-scale facilities project	Super B-Factory Project at KEK	The Project will further advance the research results in the field of particle physics/Hadron physics and promote international collaboration utilizing the SuperKEK-B accelerator and the Belle II detector, which started colliding-beam experiments in 2018, receiving support as a Large-scale Academic Project.	High Energy Accelerator Research Organization	120 institutions in 26 countries and regions around the world(As of September 2020. Including Japan, KEK.)	Total cost: 117.765 billion yen Facilities, equipment costs: 5.135 billion yen Personnel costs: 1.115 billion yen Operational costs: 111.515 billion yen Others: 0	**Construction, initial investment; strengthening of project functions** 1st to 6th year: Reinforcement of injectors 7th to 9th year: Reinforcement of main link 1st to 10th year: Reinforcement of Belle II measurement instrument **Operation** From 1st year: Full-scale operation (accumulating data while improving performance)	a	a	●This is challenging research that aims to gain hints for formulating new theories that go beyond the Standard Model of particle physics, and it is expected that new research outcomes will be achieved. ●This is a research project in a field that has marked collaboration and competition around the world. Through the previous research projects, Japan's international influence in this field has grown. This project will be indispensable for maintaining Japan's continued strong presence.	●While this is a project in a field where Japan has its own unique advantage and Japan has a leading position internationally with high expectations placed on it, from the perspective of international cooperation, attention must be paid to carrying out its role as the host country. ●Since the scale of the overall budget for the project itself is huge, further efforts must be made for the efficient operation of the project, including saving on operational costs, such as electricity costs.	Successor to the Large-Scale Scientific Frontiers Project

Field	Category	Project name	Project overview	Implementing organization: Core organization	Implementing organization: Collaborating Organization	Financial cost ※Costs from 1st to 10th year of project	Project period	Evaluation 1	Evaluation 2	Main outstanding points	Main issues, considerations, etc.	Remarks
Physics	Large-scale facilities project	Quest for the origin and evolution of universe and matter with highintensity proton beams	Producing high-intensity secondary-particle proton beams, J-PARC conducts experiments in a wide range of fields, from basic research to applied research, leading to the development of new industrial products. Operating for nine months out of the year, the Project aims at elucidating the origin and evolution of the universe and materials.	High Energy Accelerator Research Organization	Japan Atomic Energy Agency, The University of Tokyo Institute for Cosmic Ray Research(and 20 domestic and 47 international institutes.)	Total cost: 143.833 billion yen Facilities, equipment costs: 43.153 billion Personnel costs: 880 million yen Operational costs: 97.8 billion yen Others: 2 billion yen	**Construction, initial investment; strengthening of project functions** 2nd to 7th year: Increasing accelerator beam intensity 2nd to 5th year: Preparation of Muon g-2/EDM experiments 4th to 9th year: Preparation and augmenting of Hadron Experimental Facility 5th to 7th year: Augumenting ofμ-e converson experiment (COMET) **Operation** From 1st year: Hadron, Muon particle experiment; neutrino oscillation experiment; neutron, muon MLF experiment	a	a	●From an international perspective, the high-intensity proton beam facility is a research facility that researchers from various fields will utilize. This project is positioned highly in the international scientific community. ●Japan has a dominant position in field of particle physics, and the main facility of this project has achieved significant achievements in various joint utilization and joint research activities up to now. Particularly in the field of neutrino research, the project is expected to be an internationally advanced and competitive project that will make significant scientific contributions.	●In order to maintain the project's future competitiveness in various directions, high priority must be given to the intensification of the proton beam. ●Since J-PARC, the facility for this project, is used not only for particle physics research but is owned by various users, it will be necessary to further enhance and upgrade the management of the facility's operations. In particular, attention must be paid to countering the aging of the facility in future operations.	Successor to the Large-Scale Scientific Frontiers Project
Physics	Large-scale facilities project	ALMA2: A Giant Millimeter/submillimeter Telescope in Search of our Cosmic Origins	The Project aims to significantly upgrade the ALMA telescope array jointly built on the Atacama Plateau in Chile by the United States, Japan, and Europe, provide to the international scientific community the results of the telescope's unmatched radio observation performance, and elucidate the evolution of cosmic matter, including the "seeds" of the birth of planets and signs of life beyond Earth.	National Institutes of Natural Sciences National Astronomical Observatory of Japan	National Science Foundation, National Radio Astronomy Observatory, European Southern Observatory	Total cost: 132 billion yen (Japan's share: 30 billion yen) Facilities, equipment costs: 18 billion yen (Japan's share: 1.5 billion yen) Personnel costs: 16 billion yen (Japan's share: 4 billion yen) Operational cost: 98 billion yen (Japan's share: 24.5 billion yen) Others: 0	**Construction, initial investment; strengthening of project functions** 1st to 12th year: Steady enhancement of functions of the ALMA telescope array **Operations** 1st to 12th year: Operation of ALMA telescope array, producing of results	a	a	●The successor to the ALMA project, which produced outstanding research results, this project is expected to lead research in astronomy and new research fields like astrobiology, including regarding research on planet formation. ●A framework for international cooperation has already been established, and based on the achievements in the project's development and operation through this joint international framework, Japan's own unique contributions, beginning with technological development, are expected in the execution of the project from now.	●Attention should be paid to the fact that in this international cooperation project, each country's contribution such as cost sharing will be reflected in the amount of time for observations. Based on this and under this international cooperation framework, Japan will need to make efforts for risk management in the advancement of this international project. ●From now, since it is possible that the project will be greatly impacted by changes in the international situation and economic conditions, risks should be considered beforehand, including country risks, assuming these possible impacts.	Successor to the Large-Scale Scientific Frontiers Project
Physics	Large-scale research Project	Large-scale Cryogenic Gravitational-wave Telescope KAGRA	KAGRA is a gravitational wave telescope that measures the coalescence of binary black holes and binary neutron stars. Joining the international gravitational wave observation network with LIGO and VIRGO, the Project will contribute to gravitational-wave astronomy and multi-messenger astronomy.	The University of Tokyo Institute for Cosmic Ray Research	National Institutes of Natural Sciences National Astronomical Observatory of Japan, High Energy Accelerator Research Organization, University of Toyama	Total cost: 5.748 billion yen Facilities, equipment costs: 95 million yen Personnel costs: 300 million yen Operational costs: 4.2 billion yen Others: 1.153 billion yen	**Construction, initial investment; strengthening of project functions** 1st to 5th year: Repair, retrofitting of equipment 8th to 9th year: Repair, retrofitting of equipment From 11th year: Repair, retrofitting of equipment when needed **Operations** 1st to 3rd year: Phase 1 operation From 4th year: Implementation of project plan (successor plan)	a	a	●The project will contribute to the development of multi-messenger astronomy, a new field of astronomy, and to other fields. ●The project will enable the building of an observation system under an international framework in collaboration with the US and European detector equipment. It is an important project for maintaining Japan's international presence in this field.	●It will be necessary to strengthen the research system as an international collaborative project, including the acceptance of human resources, and to maintain Japan's influence as a hub for international gravity wave detection. ●It will be desirable to continue observations through collaboration with other similar facilities under the international collaborative system and, at the same time, to strive for effective management to show further Japan's presence.	Successor to the Large-Scale Scientific Frontiers Project
Physics	Large-scale facilities project	Subaru 2 – Super Wide Field Large Optical-Infrared Telescope	The Project aims at strengthening the functions and performance of the Subaru Telescope, a large optical-infrared telescope at the summit of Maunakea, Hawaii. Centering on its large-scale survey observations by ultra–wide-field imaging spectroscopy, Subaru 2 will provide invaluable data to the international scientific community and investigate the structural evolution of the universe and the origin of elements.	National Institutes of Natural Sciences National Astronomical Observatory of Japan		Total cost: 21 billion yen Facilities, equipment costs: 4 billion yen Personnel costs: 7 billion yen Operational costs: 5 billion yen Others: 5 billion yen	**Construction, initial investment; strengthening of project functions** 1st to 5th year: Development of ULTIMATE (Ultra-wide Laser Tomographic Imager and MOS with AO for Transcendent Exploration) project **Operations** 1st to 10th year: Operation of Prime Focus Spectrograph (PFS) From 6th year: Operation of ULTIMATE	a	a	●Its 8-meter-class telescope with super-wide field capability makes the Subaru highly unique in the world, and it is expected both domestically and internationally to play a leading role in solving new problems and challenges in astronomy. ●Through the development of new observation equipment, Subaru 2 is expected to produce original research results in the field of astronomy.	●Since the Subaru is expected to be put into integrated operation with the 30-meter optical infrared telescope (TMT), if obstacles arise in the TMT's construction, it will be necessary to clarify future operations. ●To continue the research activities in the future, It will be important to maintain dialogue with local residents to get their continuous support.	Successor to the Large-Scale Scientific Frontiers Project

Field	Category	Project name	Project overview	Implementing organization: Core organization	Implementing organization: Collaborating Organization	Financial cost ※Costs from 1st to 10th year of project	Project period	Evaluation 1	Evaluation 2	Main outstanding points	Main issues, considerations, etc.	Remarks
Physics	Large-scale research project	LiteBIRD - A Satellite for Exploring the Universe before the Hot Big Bang with Measurements of Cosmic Microwave Background Polarization	JAXA selected LiteBIRD as a strategic large-scale mission #2, with the aim of launching it in fiscal 2027. Its main aim is the verification of the inflationary space theory through mapping of the degree of polarization of cosmic background radiation.	Japan Aerospace Exploration Agency	High Energy Accelerator Research Organization(KEK), The University of Tokyo, Okayama University, CNES, ASI, NASA, University of California, University of Colorado, NIST, CSA, McGill University, and 39 institutes	Total cost: 29.707 billion yen Facilities, equipment costs: 29.540 billion yen Personnel costs: 167 million yen Operational cost: 0 Others: 0	**Construction, initial investment; strengthening of project functions** 1st to 5th year: Preparation, design 6th to 8th year: Manufacture, testing **Operations** 8th year: Launch 8th to 11th year: Operation 9th to 14th year: Data analysis	a	a	●This is a research project in a field that Japan, which will conduct a minute examination of the creation of the universe and standard cosmic inflationary theory, is strong in. The project has great scientific significance and could produce revolutionary scientific results. ●Since an international cooperation framework has been built over many years, as a project that Japan is leading based on international collaboration, strategic advancement is likely, and as an international project, it should be highly effective.	●Since huge efforts will be needed, including technology development, for analysis after the observation data are obtained, efforts must be made for elaborating theories and filling in the gaps of equipment development. ●Effective management will be important so that Japan's contributions are made clear while the international cooperation system is being established.	
Physics	Large-scale facilities project	New developments in neutrino physics at Super-Kamiokande	By simultaneous measurement of neutrinos with the introduction of Gd into the Super-Kamiokande detector, the Project will significantly improve the sensitivity of anti-electron neutrino observations. By doing so, the Project aims at improving the observation of supernova relic neutrinos and the accuracy of the directional detection of galactic supernovae.	The University of Tokyo Institute for Cosmic Ray Research	16 universities and research institutes in Japan(High Energy Accelerator Research Organization, Kyoto University, Nagoya University, Kobe University, Okayama University and more), 32 universities and research institutes in foreign countries(University of California, Boston University, University of Warsaw, Seoul National University, Tsinghua University, Autonomous University of Madrid, TRIUMF, University of Oxford, INFN, École polytechnique and more)	Total cost: 5.797 billion yen Facilities, equipment costs: 0 Personnel costs: 794 million yen Operational cost: 4.923 billion yen Others: 80 million yen	**Construction, initial investment; strengthening of project functions** 1st to 3rd year: Introductio of Gd **Operations** 1st to 8th year: Operation of Super-Kamiokande dector, data analysis	a	b	●The project has international advantages that will enable Japan to continue to maintain its position as a leader in neutrino research.	●Since 20 years have passed since the completion of the facilities, care must continue to be taken in the safe operation and management of the facilities, and efforts must be made to provide further careful and clear explanations to local residents to continue to get their adequate support for the project. ●In regards to the possibility of integrated operations with the Hyper-Kamiokande project, study on this must be continued, including regarding the budget plan.	Successor to the Large-Scale Scientific Frontiers Project
Informatics	Large-scale research project	Next-generation academic research platform for promoting research data utilization, circulation, and management	The Project will prepare and operate a next-generation academic research platform for promoting "data-driven research" that will be useful for the analysis in cyberspace of data obtained from various activities in the real world and for improving efficiency in society and effecting change.	Research Organization of Information and Systems National Institute of Informatics	Hokkaido University, Tohoku University, The University of Tokyo, Nagoya University, Kyoto University, Osaka University, Kyushu University, Otaru University of Commerce, University of Tsukuba, Chiba University, Gunma University, Tokyo Institute of Technology, Sizuoka University, Kanazawa University, Hiroshima University, National Institute of Fitness and Sports in KANOYA, Keio University, Hosei University, High Energy Accelerator Research Organization, National Astronomical Observatory of Japan, National Institute for Fusion Science, National Institutes of Genetics, RIKEN, Research Organization for Information Science and Technology, National Institute of Information and Communications Technology, JAXA, Japan Agency for Marine-Earth Science and Technology, National Institute for Environmental Studies, and more	Total cost: 57.5 billion yen Facilities, equipment costs: 0 Personnel costs: 1.4 billion yen 0 Operation costs: 54.1 billion yen Others: 2 billion yen	**Construction, initial investment; strengthening of project functions** Network infrastructure 1st year: Building, transition to next network infrastructure 7th year: Building, transition to next-next network infrastructure Research data infrastructure 1st to 7th year: Strenthening of research data infrastructure functions, development of next infrastructure **Operations** Network infrastructure 1st year: Operation of SINET-5 2nd to 7th year: Operation of next network infrastructure Research data infrastructure 1st to 7th year: Operation of research data infrastructure	a	a	●Building an information infrastructure that can deal with the demands of science is an urgent task, and because the project is proceeding comprehensively with the preparation and operation of SINET, the building of an information security system, and so on up to now at the implementing entities, the spillover effects to universities and other institutions have been great, and the enhancement of SINET and the preparation of a research data infrastructure is very important. ●SINET is important as highly versatile information platform that can be jointly used by a wide range of researchers, and it is expected that SINET's enhancement and diffusion will lead to the development of various academic fields.	●Although the preparation of new networks and research data infrastructure is important, with each institution now preparing its own individual information infrastructure, it is desirable to show a vision and strategy for the future to avoid overlapping or duplicate overall investment. ●It is necessary to make efforts to build a flexible system for advancing the project that keeps within view responses to the rapidly changing social situation as information infrastructure that comprehensively supports Japan's research capabilities and can withstand international competition.	Successor to the Large-Scale Scientific Frontiers Project

Field	Category	Project name	Project overview	Implementing organization: Core organization	Implementing organization: Collaborating Organization	Financial cost ※Costs from 1st to 10th year of project	Project period	Evaluation 1	Evaluation 2	Main outstanding points	Main issues, considerations, etc.	Remarks
Chemistry	Large-scale facilities project	Attosecond Laser Facility (ALFA)	The Project is establishing a joint-use facility equipped with attosecond soft X-ray beamline and measurement devices that will provide state-of-the-art light sources to researchers in a wide range of fields, including physics, chemistry, biology, and medicine as well as develop next-generation attosecond light source technology.	The University of Tokyo	RIKEN, High Energy Accelerator Research Organization(KEK), National Institutes of Natural Sciences Institute for Molecular Science(IMS), Keio University, The University of Electro-Communications	Total cost: 11.105 billion yen Facilities, equipment costs: 8.8 billion yen Personnel costs: 800 million yen Operational costs: 1.505 billion yen Others: 0	**Construction, initial investment; strengthening of project functions** 1st to 4th year: Construction of experiment building, research building, accelerator building, preparation of beamline facility 2nd to 8th year: Preparation of next-generation light source devices **Operations** From 4th year: Operation of general-use beamline, high repetition beamline From 5th year: Operation of high intensity beamline From 8th year: Operation of next-generation beamline	a	a	●In addition to augmenting Japan's own original research achievements, the project will develop next-generation laser technology, and the attosecond laser facility is expected to be utilized for experiments and measurements in materials science and other fields and to contribute to the development of these fields. ●Attosecond laser technology is expected to be utilized by many users around the world and to produce great spillover effect through international collaboration.	●The research in the relevant fields will be planned and conducted at a high level, but at present, the relevant researcher community in Japan is not necessarily large, and it will be essential to enlarge this community in the promotion of the project. ●It will be necessary to develop future measures for expanding the support of citizens and to consider how to expand the range of users of the attosecond laser facility, such as researchers and others from many fields, including industry.	
Engineering	Comprehensive Large-scale research Project	Building and Developing Spintronics Research Infrastructure and Network	Building a spintronics research infrastructure, the Project will build interdisciplinary networks and networks among institutions in the areas of materials science, physics, storage, memory and logic for quantum information technology, and so on, as well as foster human resources who will be engaged in future research and development in these fields.	The University of Tokyo	Tohoku University, Osaka University, Keio University, Kyoto University and more	Total cost: 4.95 billion yen Facilities, equipment costs: 3.4 billion yen Personnel costs: 500 million yen Operational costs: 550 million yen Others: 500 million yen	**Construction, initial investment; strengthening of project functions** 1st to 2nd year: Preparation for full-fledged operation of the "Spintronics Research Infrastructure and Network" **Operations** From 3rd year: Full-fledged operation of "Spintronics Research Infrastructure and Network" Implementation concentrated at the Center for Spintronics Research Network	a	a	●By advancing research based on the world-leading record Japan has achieved in the development of spintronics materials and devices, the project is expected to bring technological innovations in the field of quantum information. ●The Center for Spintronics Research Network has already been launched, and a joint-utilization system is being prepared.	●A network-type research system appears to be flexible, but care must be taken so that flexibility is not lost due to the circumstances of the respective participating organizations. ●It will be necessary to consider original indicators to evaluate the results that will become possible for the first time through the building of the network.	