

National Institutes of Natural Sciences
National Institute for Fusion Science

Peer Review Reports for FY2016

March, 2017



National Institute for Fusion Science
Advisory Committee External Peer Review Committee

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Chapter 1 Background

The National Institute for Fusion Science (below as NIFS), in order to advance fusion energy research as an Inter-University Research Institute Corporation, was established in 1989 as the Large Helical Device (below as LHD) being the principal device. The LHD, which bears the consensus and the expectations of the fusion energy research community, and having the unique characteristic of generating a heliotron-type magnetic field by superconducting magnets, together with generating high-performance plasma in a helical magnetic field through high-power heating, is advancing experiment-based research that aims to clarify physical and engineering issues which focus upon realizing a fusion reactor based on the toroidal magnetic field configuration. On the other hand, parallel to this goal, in the analysis of fusion plasma bearing essential complexities theoretical research that utilizes large-scale simulations is necessary. For that reason, at NIFS we have installed a supercomputer for exclusive use, and by making this supercomputer available to fusion theory researchers throughout Japan we have advanced with cutting edge research. Further, from 2010, in order to strengthen further our centripetal force as a Center of Excellence (below as COE) in the field of plasma-fusion research, we have organized research projects in the three fields of LHD, theory and simulation, and fusion engineering. Further, looking toward achieving the fusion reactor, we have initiated research project that will integrate these research results. In addition to having revised the research structure within NIFS and having placed all research staff in one research department, by establishing a research system that enables participation by free will in research projects, and has enabled easier cooperation in the three projects of LHD, theory and simulation, and fusion engineering than in the past we are increasingly able to respond resourcefully to new topics.

In this period there have been changes in the academic research system in Japan. Since 2004, NIFS has advanced further its collaborative research and its collaborative use as a research institute belonging to the Inter-University Research Institute Corporation National Institutes of Natural Sciences (below as NINS). Upon becoming an inter-university research institute corporation, a system for mid-term goals and mid-term planning was introduced, and a system of annual evaluations regarding the advancement, too, was introduced. This annual evaluation focuses primarily on administrative management. At NIFS, it also was judged important that research results be evaluated by professional researchers outside of NIFS. As a result, each year an external peer review committee organized and placed under the NIFS Advisory Committee undertakes a research evaluation. The items for evaluation are decided at the Advisory Committee meeting, and the evaluation is undertaken by the External Peer Review Committee, which is composed of individuals who are external members of the Advisory Committee and external experts who are appropriate for evaluating the topics of evaluation. The External Peer Review Committee reports its evaluation

results to the Advisory Committee. NIFS, in addition to making those results available on the NIFS homepage, utilizes the results for improving research activity in following years.

The items for evaluation for the External Peer Review Committee are deliberated and decided upon, and change each year. Most recently, the Fusion Engineering Research Project in 2013, the LHD's Deuterium Experiment Implementation Planning in 2014, and the Numerical Simulation Reactor Research Project in 2015 each underwent external evaluation. Further, in this current year of 2016, taking "Collaboration Research" as the topic, an external evaluation was conducted. The external evaluators were ten external members of the Advisory Committee and three foreign members. Further, there were three experts from outside NIFS. These members composed the External Peer Review Committee, and they conducted the evaluation.

First, at the first External Peer Review Committee and Experts Committee Meeting held on October 12, 2016, there was discussion regarding how this year's External Peer Review would move forward, and the issues for evaluation and the specific items for evaluation were decided. Those contents will be introduced at the end of this chapter. At the second External Peer Review Committee and Experts Committee Meeting, which were held on December 10, 2016, a detailed explanation was provided by persons in charge at NIFS by utilizing viewgraphs, activity report documents, and other materials (please see the appended documents) that touched upon the points of evaluation. A question and answer session followed. Subsequently, on February 1, 2017, the third External Peer Review Committee and Experts Committee Meeting was held. Additional discussion with NIFS was conducted, including a question and answer session with NIFS staff. The evaluation was conducted according to the issues for evaluation and the specific items for evaluation decided upon by the External Peer Review Committee and the Experts Committee, and the evaluations were compiled. As a result, regarding the fundamental conclusion of the evaluation results because a general agreement was reached, subsequently, deliberation was undertaken through an email discussion, and the final report was completed. The dates of this year's External Peer Review Committee and Experts Committee Meetings may be found in Document 4.

The issues for evaluation for the "Collaboration Research," which is the topic of this year's evaluation, in the mid-term planning to be decided by NINS, are indispensable for the evaluation of "Collaboration Research," which NIFS has promoted. These are the basis of the evaluation of achievements and the evaluation of the level of research.

Further, based upon the "Proposal" in the "Domestic Collaborative Use and Collaborative Research" and the "International Collaborative Research" which were implemented in 2010, we will

also consult evaluations of the following points.

1. Is the expansion of Bilateral Collaboration Research to engineering topics being further promoted?
2. Anticipating the helical-type fusion reactor, is academic collaborative research that leads universities developing?
3. Regarding the numerical simulation reactor research project and the system of joint use of measuring instruments, is expansion advancing?
4. Has there been a review of the contents of the Japan-Republic of Korea, the Japan-People's Republic of China, and the IEA cooperative activities in response to the respective conditions in Japan and abroad?

The evaluation topics for “Collaboration Research” conducted this year are as below.

(Domestic Collaborative Research)

1. Do the recruitment contents for collaborative research reflect trends in research developments and in the respective fields?
2. Regarding the screening of collaborative research topics, has a mechanism for reflecting the opinions of the fusion community been constructed?
3. Together with engaging in the evaluation of research results, is summarizing the results and then sharing those results among the collaborating researchers occurring?
4. Is improvement of the research environment improving through the expansion of equipment advancing, and is the research environment also contributing to collaborative research and collaborative use including industry-university collaboration?
5. Is this collaboration contributing to the strengthening of the functions of universities and to the research enhancement of universities?
6. Is this collaboration contributing to the development of human resources?
7. Is this collaboration advancing academic research in wide-ranging plasma and fusion fields, including cooperation with different fields?

(International Collaborative Research)

8. Is the collaboration being prepared soundly for collaborative research bases and systems with foreign organizations?
9. Is the collaboration advancing cooperation with ITER-BA project? Further, is the collaboration contributing to voluntary activities such as ITPA and others?
10. As an implementing body involved in advancing international collaborative research, is that role

being sufficiently carried out? Further, are those contents being revised appropriately?

11. Is this international collaborative research contributing to the development of human resources in Japan and abroad?

Chapter 2 Summation of the Evaluation and Proposals

In this chapter, regarding the activities and results of collaborative research, we summarize the main points of the evaluation based upon evaluation results and discussions that were raised by the External Peer Review Committee members.

[1] Summation of the Evaluation

(Domestic Collaboration Research)

1. Do the recruitment contents for collaborative research reflect trends in research developments and in the respective fields?

The recruitment contents were categorized appropriately based upon the three categories of General Collaboration Research, LHD Project Collaboration Research, and Bilateral Collaboration Research. We respond to the broad range of requests from researchers, and revisions and modifications that respond to activities and developments in fusion research are being undertaken. In LHD Project Collaboration Research, we are strongly supporting graduate school-level laboratory group research in fusion science and reactor engineering fields. In Bilateral Collaboration Research, expansion of university facilities is advanced strategically as seen in the well-modulated budget distribution, and we are able to broadly construct a system that supports plasma and fusion research. In General Collaboration Research, research topics promoted by NIFS in response to research projects and research topics deriving from the ideas of individual researchers are advancing broadly. Based upon the information above, these activities can be highly evaluated.

On the other hand, in LHD Project Collaboration Research and Bilateral Collaboration Research, whose budgets are comparatively large, based upon the future plan at NIFS and how fusion research at universities proceeds, still further careful investigation is anticipated, and it may be thought that a rather more flexible discussion would have been beneficial, such as regarding changes in the budgets provided for each Collaboration Research and the concentrated budget distribution in the General Collaboration Research. In the future, because the creation of new academic areas through links within fields and links across fields is being sought, the roles of universities as a place for interaction among varied academic fields will become extremely important. For that reason, not only the personnel contributions from NIFS to universities, but also contributions and support to university research from both the hardware and the software facets are anticipated.

2. Regarding the screening of collaborative research topics, has a mechanism for reflecting the opinions of the fusion community been constructed?

For the screening of collaborative research proposals, a committee for each Collaboration Research is formed. The members of those committees are not limited only to NIFS researchers. The cooperation of researchers from around the country is sought by utilizing the fusion community network. An external member serves as a committee chair, and several researchers from the fusion community are added, and a structure with great transparency that can reflect their opinions is formed. Further, the selection process is clearly expressed in the recruitment announcement, and this will be made publicly available. And that a structure that permits a representative from each community to participate in the selection process will be constructed is extremely highly evaluated.

On the other hand, regarding the method for selecting the external members and the research field of the present members, it is necessary to more clearly clarify the concrete method for guaranteeing fairness. Further, regarding General Collaboration Research, compared to the size of the budget the number of selected projects is many, thus the burden of work relating to screening is heavy. It may be necessary to consider this point. In the future, because the strengthening of broad links with academia and industry is growing widely, it may be a good idea to add committee members from research fields in NINS but outside NIFS and to actively create opportunities to hear the opinions of industry.

3. Together with engaging in the evaluation of research results, are summarizing the results and then sharing them among the collaborating researchers occurring?

Through the introduction of the collaborative research database Nicollas, to which researchers throughout Japan apply and which can screen applications, improvements in the structure regarding the screening of the numerous application documents are implemented, and unified management of information related to collaborative research by the system and screening based upon whether a collaborative research report was submitted or not in the past are also implemented. That a joint base of consolidated collaborative research results by collaborative researchers is being appropriately constructed, and, further, the NAIS system for article information regarding research results has been improved, and that support for submitting articles is being provided is highly evaluated. Further, regarding all collaborative research, as research reports are being compiled and distributed to collaborative researchers, we can highly evaluate the database introduced by utilizing the above-mentioned registration system with regard to the sharing and the consolidation of results.

On the other hand, regarding the system above, there also are matters under development.

In particular, regarding NAIS, the relationship between research results (articles) and recruitment subjects is unclear. The familiarity of university researchers with this system is thin, and because the system's convenience is thin, improvement of management and of the system is sought.

4. Is improvement of the research environment improving through the expansion of equipment advancing, and is it also contributing to collaborative research and collaborative use including industry-university collaboration?

In the reactor engineering field, that preparation of the high-performance experimental devices is being undertaken, the preparation for installation of the plasma-irradiation device in LHD, and preparations for collaborative research are being advanced, that the performance of the large-scale parallel computer "Plasma Simulator" has been increased by eight times and is being utilized in large-scale simulation collaborative research in the plasma and fusion fields is highly evaluated. Further, "Collaborative Use of Diagnostic Devices," too, has begun. The opinions of the community continue to be reflected, and are being organized. Research is advancing not only with universities, but also with private enterprises, and the expansion year after year of instruments in common use can be highly evaluated.

On the other hand, because the operation days of some devices are few, analysis of causes, and including the possibility of cooperation between industry and universities, ideas to increase the effectiveness of operation are sought. The "Plasma Simulator" is greatly increasing the time available for CPU. However, in order to increase the number of users, we hope there will be plans to increase the fields that take advantage of simulation. In industry-university collaboration, it may be necessary to initiate systematic planning for developing researchers who can be bridges with companies, and developing systems for this with a thorough knowledge of the uniqueness and the innovativeness of fusion research.

5. Is this collaboration contributing to the strengthening of the functions of universities and to the research enhancement of universities?

Research which cannot be realized in the structure of research laboratories at universities such as with high-performing experimental equipment, diagnostic equipment (devices), plasma physics which utilize large-scale computer environments, and research in fusion engineering contributes greatly to enhancing research at each university. In particular, General Collaboration Research and LHD Project Collaboration Research are performing roles broadly in supporting fundamental research at universities. Further, regarding the number of published research papers in Bilateral Collaboration Research and LHD Project Collaboration Research, 90 % of those articles

were written by researchers outside NIFS, and because the amount of contributions to university-led research results is large the contributions to the function and the research enhancement by NIFS can be highly evaluated.

The standpoint of the enhancement of the function and research of universities-refers to the evaluation points that were newly added in the third mid-term planning from the 2016 academic year, as there also are unfamiliar parts in the question of how to determine the standard for the evaluation of the degree of contribution in the contents of this report there may be found opinions that data analysis in this report remains insufficient. We anticipate the promotion of research that brews new connections across fields and creates new fields based on the precise examination of the statistics and of the degree of collaborative activities in the papers.

In the future, in examining what NIFS should undertake in order to contribute to strengthening the functions and to enhance research at universities together with making clear the evaluation items, while effectively utilizing the broad collaborative research system and further placing the URA system in perspective it is important to promote research that creates new fields without being limited to the traditional form of linkages across fields. For that purpose, we should promote the strengthening of links with NIFS and universities, which are contact points for broad academic fields. It is necessary to construct structures and system designs for collaborative research for new collaborative research that has not yet existed and looks hard at supporting the hardware and software, and the human resources aspects of universities. As a measure of research enhancement at universities, it is important to consider whether NIFS's contributions are linked not only to publishing research articles, but also to the development of projects within the university, the acquisition of external funding, and the construction of a research hub.

6. Is this collaboration contributing to the development of human sources?

NIFS, as an Inter-University Research Institute Corporation, advertises for collaborative research projects. For graduate students and undergraduate students who are members of those research groups, they are provided the opportunity to undertake collaborative research with NIFS researchers using NIFS' experimental instruments. Seen from the perspective of nourishing human resources, this is highly evaluated. Regarding devices and instruments utilized in collaborative research, there also are large-size high-function instruments that are not possessed at universities. From being provided a place to discuss with expert researchers at NIFS, this contributes greatly to opening their abilities of students participating in collaborative research. In particular, conducting collaborative research at NIFS that maintains a distance from universities and is a research institution with a mission to conduct large-scale research, this becomes an opportunity for students to consider their career path as a researcher in the future, and this can be highly evaluated from the

perspective of obtaining researchers.

Regarding students who participate in collaborative research, as an important influence, as a place for collaborative research NIFS can be considered as a place for “plasma engineering studies” and “fusion studies.” And we wish to see the development of human resources holding global perspectives through interactions with students and researchers from foreign countries who are present at NIFS.

7. Is this collaboration advancing academic research in wide-ranging plasma and fusion fields, including cooperation with different fields?

In the meaning in which basic academics is considered to be extended, “Fusion Studies” is connected with various fields. And collaborative research, too, which is being developed at NIFS, is receiving various suggestions from a broad range of fields, and this is highly evaluated. Among experimental facilities for collaborative use, there are many with high operation rates, and at the same time, as the fundamental processes of plasma physics, atoms and molecules processes, plasma measurement and other research are continuously advancing, the development is advancing into new fields such as high pressure plasma as well as plasma biology and applied life sciences. Further, that NIFS, by displaying a positive posture for engaging in cross-disciplinary collaborative activities within NINS, is fulfilling a role as a compass that indicates direction to collaborative research participating institutions also is evaluated. In actuality, within General Collaboration Research long-living basic research topics, and also research topics opening new fields, are included. Further, academic research that links to plasma in broad ways is advancing, particularly in the fields of astronomy, general fusion, light science, biology, atoms and molecules, receives a fixed evaluation.

As NIFS is the core of the plasma and the fusion communities, it has established itself as the “hub of plasma research.” And through holding numerous research meetings each year it is involved in outreach, and this is highly evaluated. However, regarding the research results of individual researchers, while their research is appropriately disclosed being published in academic journals, disclosure about the resources and management system for the promotion of academic research at NIFS is insufficient. Distribution of information to society in easy to understand formats is requested.

(International Collaboration Research)

8. Is the collaboration being prepared soundly for collaborative research bases and systems with foreign research organizations?

By concluding academic exchange agreements with many research institutions abroad and by adjusting the categories and the systems for broad international collaborative research such as Japan-United States cooperation, Japan-People's Republic of China cooperation, Japan-Republic of Korea cooperation, and IEA cooperation, NIFS is constructing a base for implementing the foundations of international collaborative research. In each international collaborative research project, numerous Japanese researchers are being sent abroad, and foreign researchers are being invited to Japan. As the management system for this, the formats that are beneficial in improving research content such as establishment of Coordination Research Committee and the Research Enhancement Strategy Office are being composed. Further, the efforts are being made for achieving sufficient research progress, and these can be evaluated. Regarding the progress in projects currently underway and the implementing framework, even in the fusion community, information sharing is not being conducted in some instances. A system for dealing in the future with the transmission of information is sought.

Regarding NIFS as seen from universities, there also are opinions which request integration of international collaborative research in plasma and fusion fields in Japan. Further, regarding the construction of a strategy for international collaborative research that incorporates all of NIFS and the Japanese plasma and fusion communities, opinions from universities regarding taking initiative are gathering.

9. Is the collaboration advancing cooperation with the ITER-BA project? Further, is the collaboration contributing to voluntary activities such as ITPA and others?

NIFS and ITER have completed a memo of understanding regarding technology cooperation, and NIFS is contributing actively to ITER project and BA activities in many fields such as superconducting technology, plasma diagnostics technology, heating equipment development, wall material, fundamental research, DEMO design. This is highly evaluated. NIFS staff have taken leadership and are participating actively in technological support and evaluation activities and are contributing greatly with universities. Together with the National Institutes for Quantum and Radiological Science and Technology, NIFS is fulfilling the role as window for research collaboration in Japan. And in the future, as well, NIFS is expected to function as a core institute in constructing opinion in Japan.

Because these expectations are great, the requests of universities with regard to "further contributions" too are great. Aiming for "the strengthening of functions" and "research enhancement" of universities NIFS is asked loudly to design strategies as community coordinators of Japan's research so that universities can deepen further their links to ITER Project/BA Activities.

10. As an implementing body involved in advancing international collaborative research, is that role being sufficiently carried out? Further, are those contents being revised appropriately?

The Japan-United States cooperation, the Japan-People's Republic of China cooperation, and the Japan-Republic of Korea bilateral collaborative research are making steady progress. The IEA and ST, Stellarator/Heliotron collaborative research projects, and various international collaborative research are being managed smoothly. These are highly evaluated. As the institution that coordinates international collaborative research projects for the fusion field NIFS is appropriately fulfilling its duty to coordinate international collaboration projects by managing international academic project formation enterprises for the fusion field at NINS, also undertakes the dispatch of NIFS and university researchers and the inviting of foreign researchers. In the future, coordination of opinions regarding strategic decisions relating to international collaboration projects will be sought. And the framework for international categories will change, and projects taking a combinatory strategy that integrates intersecting projects will be sought.

11. Is this international collaborative research contributing to the development of human resources in Japan and abroad?

In international collaborative research that will be implemented by NIFS, that on the two sides of dispatch and acceptance the exchange of young researchers, including students, will be undertaken, and that this will contribute to raising global human resources is highly evaluated. Further, in the case in which veteran fusion researchers at NIFS, when visiting abroad for international collaborative research, or when foreign young researchers are accepted into collaborative research at NIFS, this is beneficial in raising young researchers who will participate in collaborative research. Together with international collaborative research, integrating plans for internships and international schools is a point that may be evaluated with regard to opportunities for raising international human resources.

As the first mission of international collaborative research is not said to be the raising of human resources, the dissemination of raising young research as a research result is not being fully undertaken. If the strategic dispatch and acceptance of young researchers is being undertaken, while periodically confirming results, constructing a system that enables the delivery of research information and system maintenance is necessary.

[2] Proposals

In this year's evaluation we discussed collaborative research at NIFS. Considering those comments, we have summarized proposals regarding future collaborative research.

- (1) Together with evaluating the point that NIFS has managed organically three different types of collaborative research in budget size and research subject, that is, General, LHD Project, and Bilateral Collaborative Research, in the future, too, we anticipate still further development of collaborative research systems that have considered the complete image of the plasma fusion field. While working to expand the research base of the fusion physics by augmenting collaborative research actively, academic comments towards other fields and promotion of cross-discipline connections, we wish to advance the construction of a broad, cooperative system.
- (2) In order to vitalize collaborative research, we anticipate the inclusion of still more active various opinions and wishes of researchers by grasping the research trends of the fusion community. In addition, in computerization of management business such as application of collaboration research and research report submission we anticipate efforts that aim at improving further convenience from expectations that the progress in information technology will improve.
- (3) The inclusion of the strengthening of the functions and research enhancement of universities in the third mid-term planning can be highly evaluated. By enhancing linkages between universities that are involved in coordination across wide-ranging academic fields and NIFS, we anticipate endeavors aimed at reforms of collaborative research that link new constructions of wide-ranging cooperation and support relationships that lead to strengthening of the research base of universities and to more active human interactions.
- (4) We highly evaluate that broad-ranging development of international collaborative research around the world is energetically advancing. In the future, too, as the core institution advancing academic research in the fusion field in Japan, regarding the active involvement in ITER Project/BA Activities as well as participation in broad international collaborative research, we seek still further functional development while integrating linkages with universities and opinions of universities.
- (5) Through academic research with fusion as the key, NIFS is contributing to the development of young researchers, including graduate students and young researchers in Japan as well as young researchers from Asia-centered foreign countries. We anticipate their further enrichment. In

addition, while using opportunities for actively training human resources and utilizing broad training systems for young researchers, we anticipate measures that will link to the strategic raising of human resources and the strengthening of the system.

Collaborative research and collaborative use in which inter-university research institutes play a major role is a system unique to our country, and contributes greatly to the advancement of our country's academic research centered in universities. In particular, because we can highly evaluate the designing of various efforts and improvements relating to collaborative research for the fusion community at NIFS, we anticipate still further expansion of collaborative research so that NIFS will develop further as a core of academic research in the fusion field.

Chapter 3 In Closing

At NIFS, since the beginning of the second midterm objective period from 2010 in order to further strengthen the centripetal force of plasma and the fusion field as COE, NIFS has organized research projects in the three fields of LHD, theory and simulation, and fusion engineering, and started research planning for integrating these results aiming toward realization of the fusion reactor. For this reason, in 2010 a restructuring of the research organization also was undertaken. All research education staff were combined into one research department, and a system which permits free participation in the three projects was composed. Links among the three fields of LHD, theory and simulation, and fusion engineering were forwarded, and regarding the research topics, being able to respond according to circumstances is anticipated.

At the External Peer Review Committee at NIFS, evaluations of the Fusion Engineering Research Project which was initiated in 2013, the Deuterium Experiment Implementation Planning in 2014, and the Numerical Simulation Reactor Research Project in 2015 were undertaken. Then, this current year (2016) at the Advisory Committee it was decided to conduct an external evaluation of “Collaboration Research.” The External Peer Review Committee was composed of ten external members of the Advisory Committee and three foreign members. Further, in addition, three specialist researchers in Japan who are not affiliated with NIFS were added to the committee. They undertook an evaluation of the points below.

(Domestic Collaborative Research)

1. Do the recruitment contents for collaborative research reflect trends in research developments and in the respective fields?
2. Regarding the screening of collaborative research topics, has a mechanism for reflecting the opinions of the fusion community been constructed?
3. Together with engaging in the evaluation of research results, are summarizing the results and then sharing them among the collaborating researchers occurring?
4. Is improvement of the research environment improving through the expansion of equipment advancing, and is it also contributing to collaborative research and collaborative use including industry-university collaboration?
5. Is this collaboration contributing to the strengthening of the functions of universities and to the research enhancement of universities?
6. Is this collaboration contributing to the development of human resources?
7. Is this collaboration advancing academic research in wide-ranging plasma and fusion fields, including cooperation with different fields?

(International Collaborative Research)

8. Is the collaboration being prepared soundly for collaborative research bases and systems with foreign research organizations?
9. Is the collaboration advancing cooperation with the ITER-BA project? Further, is the collaboration contributing to voluntary activities such as ITPA and others?
10. As an implementing body involved in advancing international collaborative research, is that role being sufficiently carried out? Further, are those contents being revised appropriately?
11. Is this international collaborative research contributing to the development of human resources in Japan and abroad?

The External Peer Review Committee met three times from October 2016 through February 2017, and detailed explanations along the evaluation points from NIFS as well as question and answer sessions were held. The evaluation results of the Peer Review Committee members have been compiled with all results present, and the External Peer Review report was completed.

As the results of the External Peer Review conducted this year regarding “Collaboration Research,” with regard to domestic collaborative research and international collaborative research, our conclusion is, in general, a high evaluation. Through this evaluation, the three categories of collaborative research systems, General, LHD Project, and Bilateral Collaborative Research were highly evaluated. Together with anticipating still further development, efforts toward additional improvement and reforms are anticipated. For example, from the perspective of the strengthening of the functions of universities and research enhancement of universities, the necessity of planning to strengthen linkages with universities further is being extolled and the need for educating human resources in the fusion field is continually being noted, and it is noted that the significance of the necessity of raising human resources can be raised. Further, in the evaluation of research projects, because, in general, the goals that should generally be achieved are frequently expressed as numbers the standards for evaluation are comparatively clear. However, regarding collaborative research, through continuous effort there is continuous development, and because there are no clear indicators for evaluation, it cannot be helped that the bases of evaluation used by the evaluators vary somewhat. Perhaps for that reason, in the evaluations in this current collaborative research, it seems that compared to evaluations of past projects, the evaluations were somewhat lower. However, when reading individual opinions, inferring that many wish to receive good collaborative research is a common message, reviewers are highly evaluating collaborative research. Rather, this is the flip side of their having high expectations for collaborative research. Further, it goes without saying that not

only NIFS but also the plasma fusion community should design together a still better collaborative research system.

Finally, we have collected below proposals for advancing NIFS' collaborative research in the future.

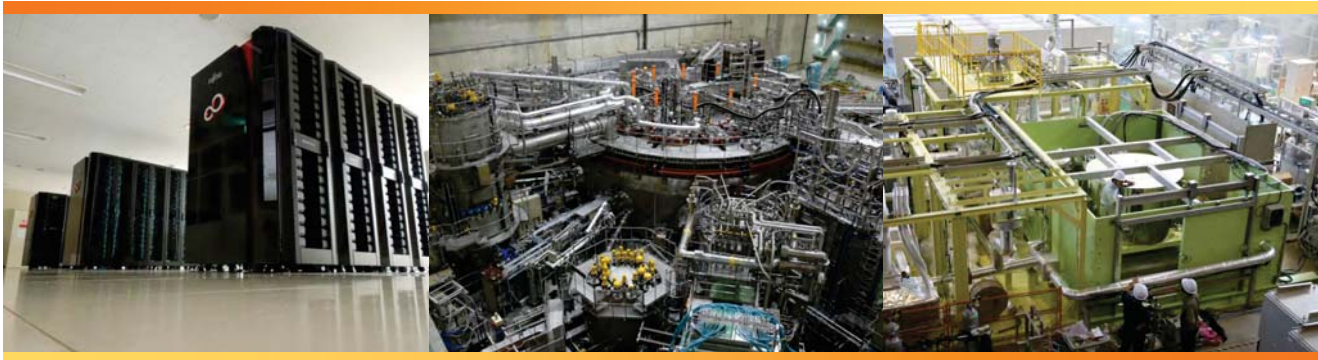
- (1) Together with evaluating the point that NIFS has managed organically three different types of collaborative research in budget size and research subject, that is, General, LHD Project, and Bilateral Collaborative Research, in the future, too, we anticipate still further development of collaborative research systems that have considered the complete image of the plasma fusion field. While working to expand the research base of the fusion physics by augmenting collaborative research actively, academic comments towards other fields and promotion of cross-discipline connections, we wish to advance the construction of a broad, cooperative system.
- (2) In order to vitalize collaborative research, we anticipate the inclusion of still more active various opinions and wishes of researchers by grasping the research trends of the fusion community. In addition, in computerization of management business such as application of collaboration research and research report submission we anticipate efforts that aim at improving further convenience from expectations that the progress in information technology will improve.
- (3) The inclusion of the strengthening of the functions and research enhancement of universities in the third mid-term planning can be highly evaluated. By enhancing linkages between universities that are involved in coordination across wide-ranging academic fields and NIFS, we anticipate endeavors aimed at reforms of collaborative research that link new constructions of wide-ranging cooperation and support relationships that lead to strengthening of the research base of universities and to more active human interactions.
- (4) We highly evaluate that broad-ranging development of international collaborative research around the world is energetically advancing. In the future, too, as the core institution advancing academic research in the fusion field in Japan, regarding the active involvement in ITER Project/BA Activities as well as participation in broad international collaborative research, we seek still further functional development while integrating linkages with universities and opinions of universities.
- (5) Through academic research with fusion as the key, NIFS is contributing to the development of young researchers, including graduate students and young researchers in Japan as well as young

researchers from Asia-centered foreign countries. We anticipate their further enrichment. In addition, while using opportunities for actively training human resources and utilizing broad training systems for young researchers, we anticipate measures that will link to the strategic raising of human resources and the strengthening of the system.

Collaborative research and collaborative use in which inter-university research institutes play a major role is a system unique to our country, and contributes greatly to the advancement of our country's academic research centered in universities. In particular, because we can highly evaluate the designing of various efforts and improvements relating to collaborative research for the fusion community at NIFS, we anticipate still further expansion of collaborative research so that NIFS will develop further as a core of academic research in the fusion field.

Documents

1. 2016 External Peer Review Presentation Materials



Collaboration Research Activities in NIFS

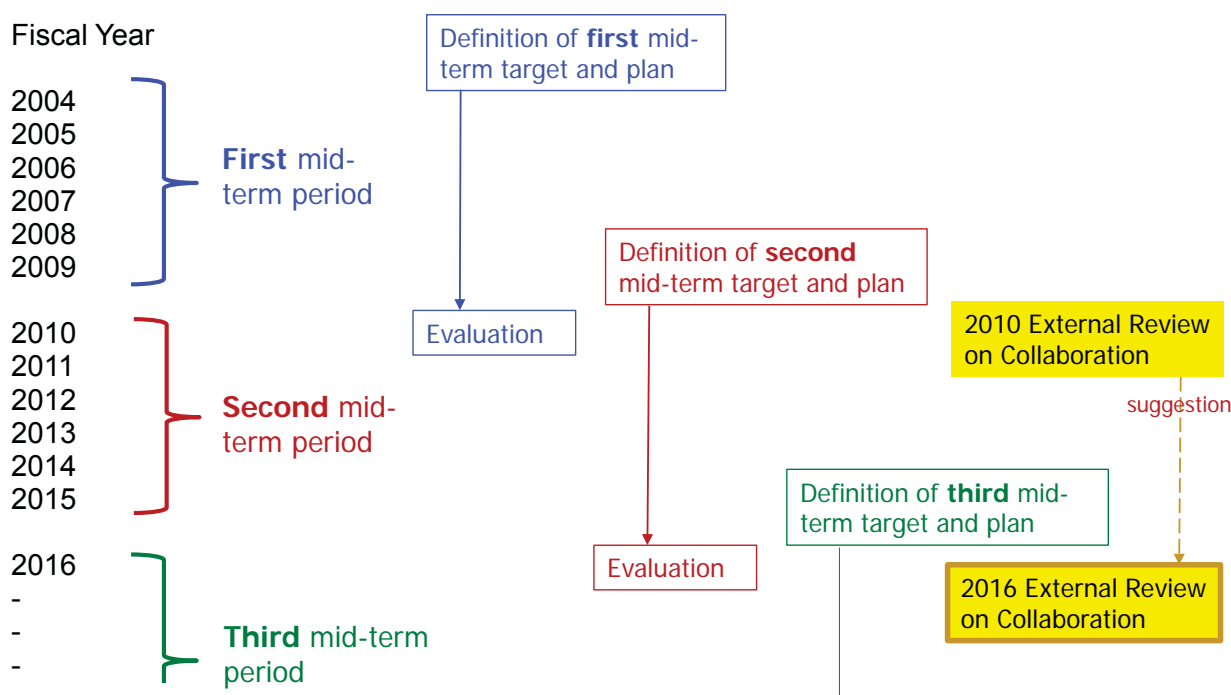


Presented in
NIFS external peer review committee meeting
10th Dec. 2016

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Scope of 2016 External Review on "Collaboration"



2016 External Review will be based on **Second Midterm Target/Plan** and **suggestions from 2010 External Review**, and also consider **Third Midterm Target/Plan**.

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2010 External Review on “Collaboration Research” – Overview

Last external peer review on “Collaboration Research” was carried out in 2010 after the first mid-term period (2004-2009)

2010 external review report suggested

1. Further **extension of the Bilateral Collaboration research including fusion engineering subjects.** (双方向型共同研究において、工学課題へ拡張を一層推進すべきである。)
2. Promoting **academic collaboration with Universities targeting mainly Helical DEMO reactors** for the purpose of enhancing effectiveness of the fusion engineering research. Participation to **ITER-TBM is encouraged.** (工学関連活動をより一層効果的なものにするために、主としてヘリカル原型炉を見据えて、より一層大学を牽引した学術的な共同研究を展開すること、ITER-TBMへの参加を期待する。)
3. **Incorporating the Community’s opinion** in the collaboration, publicizing of the results, and judgement of the applications with high transparency. (共同研究について、コミュニティの意見を反映するとともに、成果の公表と透明性の高い審査が求められる。)
4. Enhancing the collaboration by **Numerical Simulation Reactor Research Project and joint use system of the diagnostics instruments**, because they are quite valuable for the research of Universities. (数値実験炉に関する研究プロジェクト及び計測器を共同利用に供する制度について、大学の研究の推進に役立つものであり、このような制度の拡充を期待する。)
5. Exploring **re-conclusion of the governmental agreement for J/US collaboration.** (日米科学技術協力に関して、政府間協定の再締結を行い、国レベルの協力活動として推進することを期待する。)
6. Enhancing cooperation with **ITER Organization by concluding a comprehensive agreement.** (ITER機構との包括協定を締結して、ITERへの直接貢献を強めることを期待する。)
7. Possible **redirection of J/Korea, J/China and IEA-based collaborations.** (日韓協力、日中協力、IEA協力において、今後、国内外の状況に応じて内容を見直すことも必要。)

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Mid-term Target for Collaboration

Second Mid-term Target for collaboration

1. **Academic systematization** of fusion and relevant science and engineering cooperating with Universities and Research Institutes. (大学や研究機関と共に核融合科学及び関連理工学の学術的体系化と発展を図る。)
2. Promote Japanese fusion research including collaboration **using large facilities and computers and by international cooperation programs including support of ITER burning experiment.** (大型の実験装置や計算機を用いた共同研究から、国際協力による核融合燃焼実験への支援までを含む日本全体の当該研究を推進する。)
3. As **COE of fusion research**, promote further the collaboration with domestic/international partners producing excellent outcomes. (専門分野を先導する中核拠点として、国内外の研究者との共同利用・共同研究を一層推進し、優れた研究成果を上げる。)
4. Progress the collaboration system **representing the users’ opinion and evaluation of the results.** (共同利用・共同研究の実績評価や利用者の意見を反映して改善できる体制を構築する。)
5. Enhance **self-assessment and external review** for reexamining and reinforcing the research and collaboration system. (研究体制、共同利用・共同研究体制や業務運営体制を適宜、見直し、改善・強化するために自己点検、外部評価等を充実する。)

Second Mid-term Plan describes more details and items specific to NIFS

New key-phrases in Third Mid-term Target and Plan for collaboration

Functional enhancement of Universities (大学の機能強化)

Cross-field partnership (異分野連携)

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Evaluation Items of 2016 External Review-1

Domestic Collaboration Research

1. Do the recruitment contents for collaborative research **reflect trends in research developments** and in the respective fields? (共同研究の公募内容は、研究の進展と関連分野の動向を踏まえたものになっているか。)
2. Regarding the screening of collaborative research topics, has a mechanism for **reflecting the opinions of the fusion community** been constructed? (共同研究課題の審査において、核融合コミュニティと連携し意見を反映する仕組みが構築されているか。)
3. Together with engaging in the evaluation of research results, **are summarizing the results and then sharing them among the collaborating researchers occurring**? (成果に対する評価を行うとともに成果の集約及び共同研究者間の共有がなされているか。)
4. Is **improvement of the research environment improving** through the expansion of equipment advancing, and is it also contributing to collaborative research and collaborative use including industry-university collaboration? (設備の拡充など研究環境の整備を進め、産学共同も含めた共同研究・共同利用に供しているか。)
5. Is this collaboration contributing to the **strengthening of the functions of universities and to the research enhancement of universities**? (大学の機能強化、研究力強化に貢献しているか。)
6. Is this collaboration contributing to the **development of human resources**? (人材育成に貢献しているか。)
7. Is this collaboration advancing **academic research in wide-ranging plasma and fusion fields, including cooperation with different fields**? (異分野連携を含む、幅広いプラズマ・核融合分野の学術研究を推進しているか。)

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Evaluation Items of 2016 External Review-2

International Collaboration Research

1. Is the collaboration being prepared **soundly for collaborative research bases and systems with foreign research organizations**? (海外研究機関との共同研究基盤・体制を整えているか。)
2. Is the collaboration **advancing cooperation with the ITER-BA project**? Further, is the collaboration contributing to **voluntary activities such as ITPA and others**? (ITER-BA計画との連携を進めているか。また、ITPAなどボランティアな貢献をしているか。)
3. As an **implementing body** involved in advancing international collaborative research, is that **role being sufficiently carried out**? Further, are those contents being **revised appropriately**? (実施機関として進めている国際共同研究において、その役割を十分果たしているか。また、その内容が適宜見直されているか。)
4. Is this international collaborative research contributing to the development of **human resources in Japan and abroad**? (国際共同研究を通して、国内外の人材の育成に貢献しているか。)

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Domestic Collaboration Researches in NIFS

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(1) What have we done to reflect trends in research developments and in respective fields?

「共同研究の公募内容は、研究の進展と関連分野の動向を踏まえたものになっているか。」

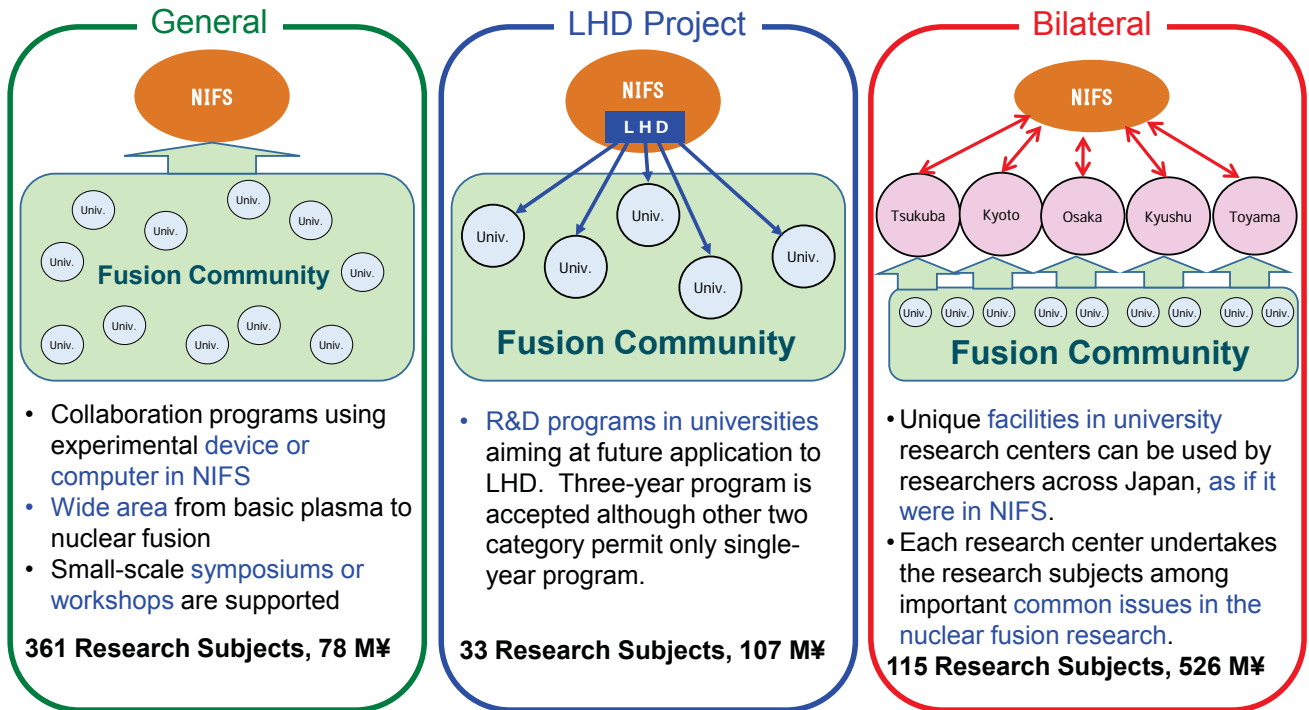
(2) What have we done to reflect the opinion and requirement of the fusion community?

「共同研究課題の審査において、核融合コミュニティと連携し意見を反映する仕組みが構築されているか。」

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Three frameworks of domestic collaboration research are established



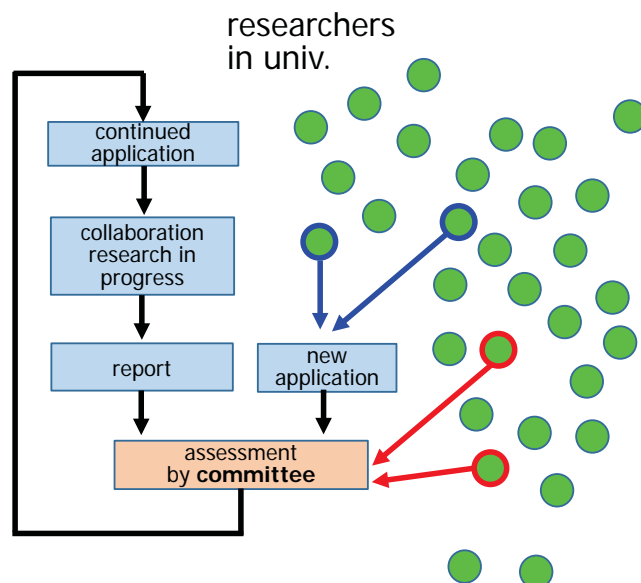
General Collaboration Research

- Process from application to execution -

Each collaborator can study various kind of **subjects** from **fundamental to application**, collaborating with NIFS

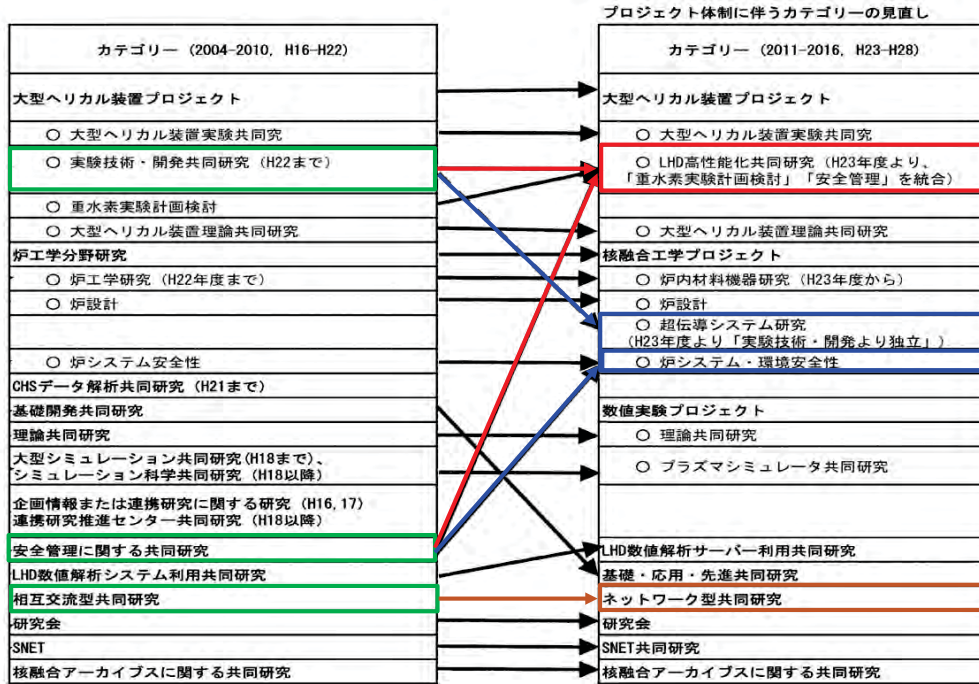
Trends in research development and respective fields can rapidly be involved in the collaboration research

Reviewers consist of NIFS staff and **researchers from fusion community**





Categories in General Collaboration Research

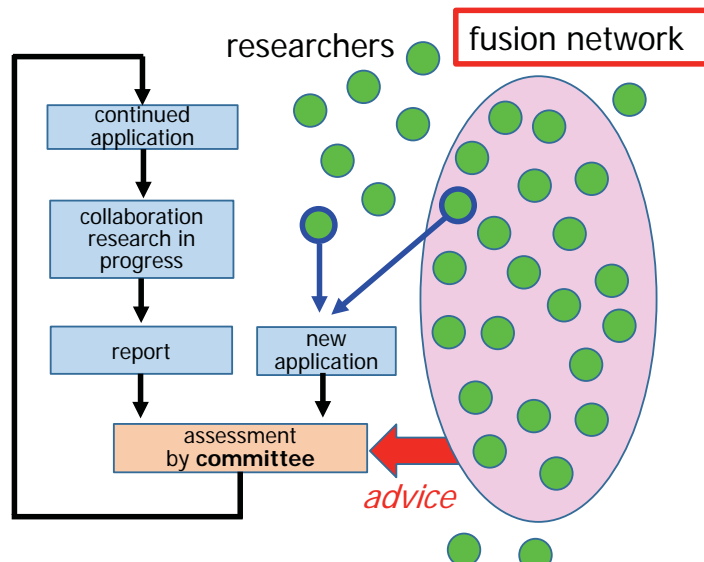


Modification of categories in general collaboration, resulting from the establishment of three research projects in NIFS



LHD Project Collaboration Research

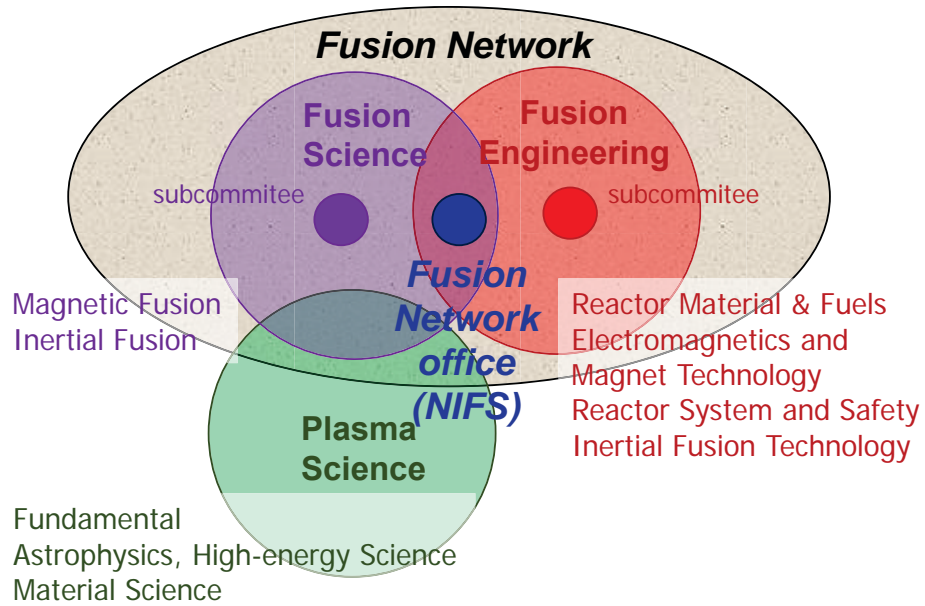
Opinion and requirement from the fusion community are included in the reviewing process via Fusion Network (F-net)



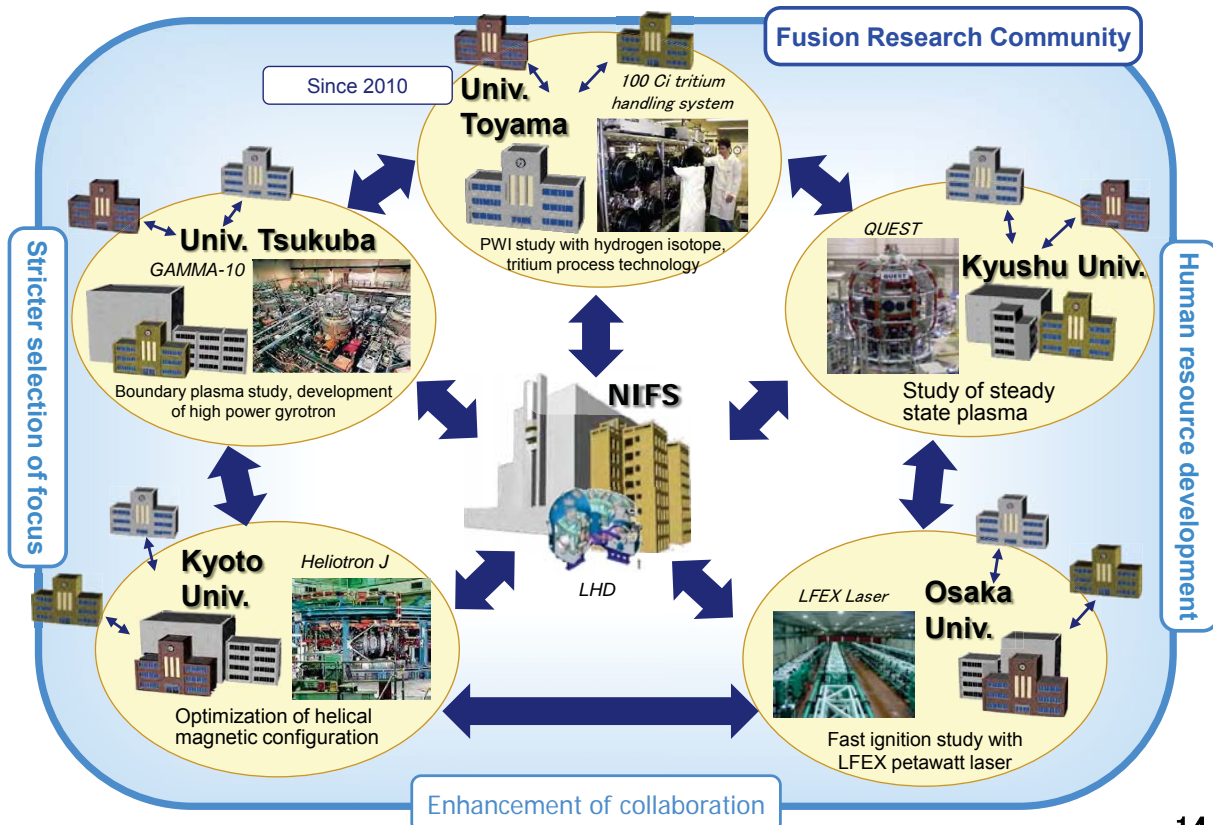


Structure of the Fusion Network <F-net>

F-net consists of fusion community in Japanese Universities



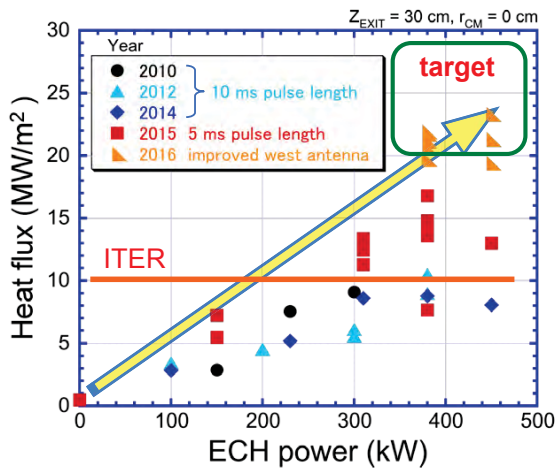
Bilateral collaboration research



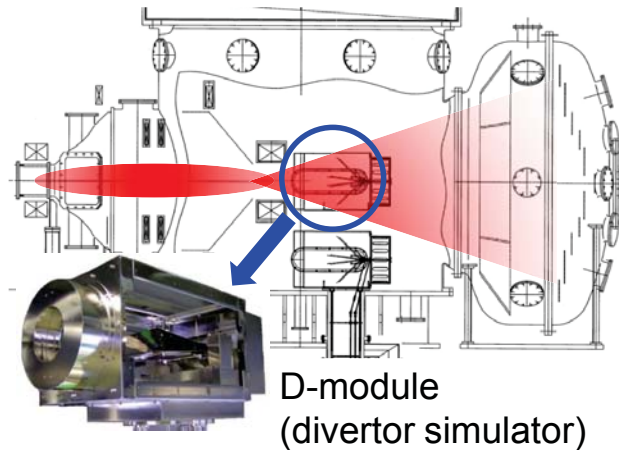
Budget was concentrated in U. Tsukuba to promote "boundary plasma study" in 2nd mid-term period

High heat flux plasma was generated in GAMMA10/PDX

- * Achievement of 23MW/m²
- * Realization of divertor detachment



Number of applied subject and collaborator has increased since 2011



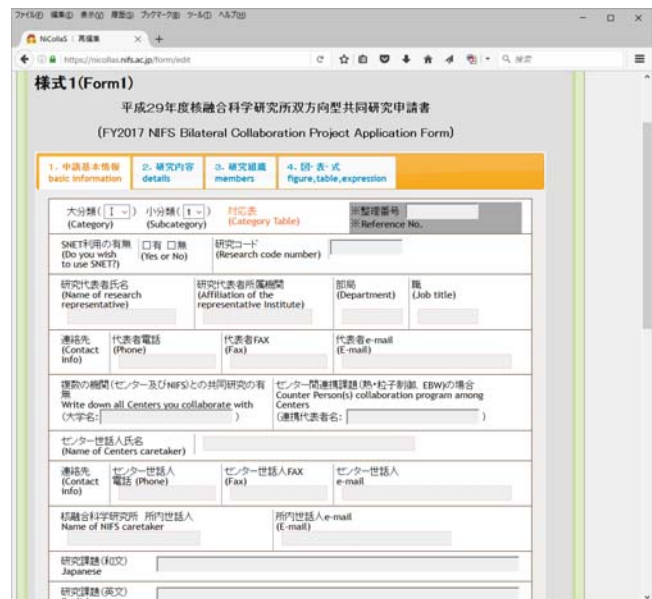
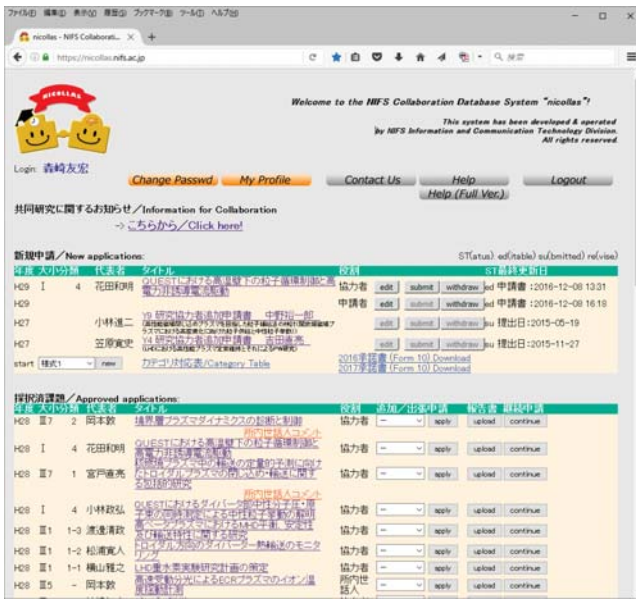
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(3) What have we done to evaluate, summarize and share the research results among the collaborating researchers?

「成果に対する評価を行うとともに成果の集約及び共同研究者間の共有がなされているか」



Online application system "NiCollaS" (2013~)



With web-base system, application and submission of report by collaborators, and judgement by reviewers are available



Online article information system "NAIS"

Database for collaboration research achievements is accessible via web-base system



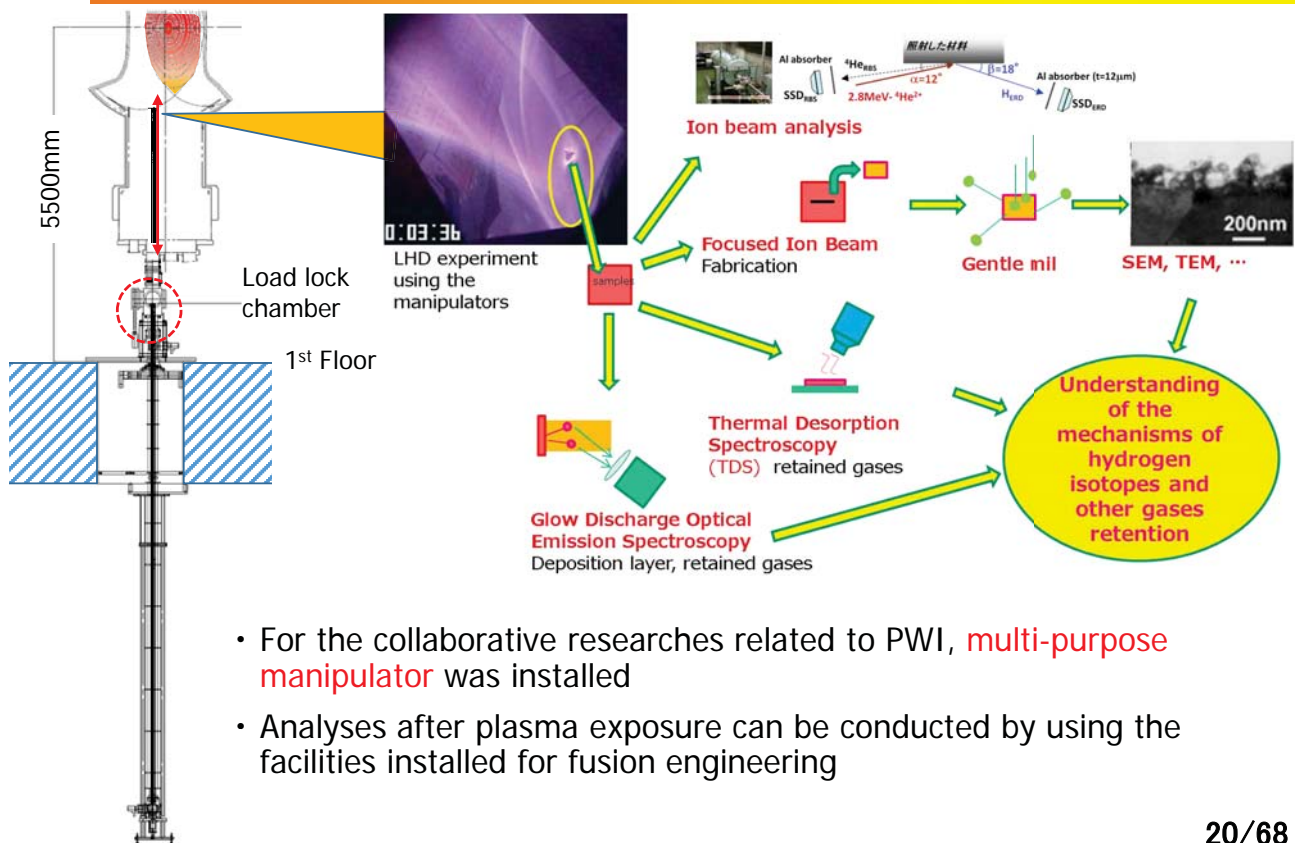
- Operated by RESO (Research Enhancement Strategy Office)
- Collect information of published paper, books and presentations in the conferences.
- Collect information of research achievements by NIFS scientists and collaborators.
- Collect information of research achievements using NIFS utilities and devices for the collaborations.

(4) What have we done to improve research environment for collaborative research not only with universities but also with industry ?

「設備の拡充など研究環境の整備を進め、産学共同も含めた共同研究・共同利用に供しているか。」



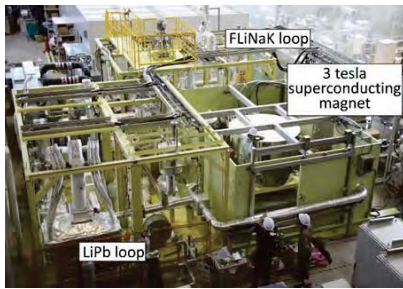
Installation and Setup of Facilities in LHD between 2012-2015



- For the collaborative researches related to PWI, **multi-purpose manipulator** was installed
- Analyses after plasma exposure can be conducted by using the facilities installed for fusion engineering



Installation and Setup of Facilities for Fusion Engineering R&D between 2012-2015 (1)



FLiNaK/Li-Pb twin loop with 3T magnet for liquid blanket research



Thermal creep test facilities



Hot Isostatic Press (HIP) facility



Divertor heat load test facility



Ion beam accelerator for analysis



Installation and Setup of Facilities for Fusion Engineering R&D between 2012-2015 (2)



Transmission Electron Microscope (TEM) with X-ray Energy Dispersive Spectroscopy (EDS)



Focused Ion Beam (FIB) and Electron Back Scatter Diffraction (EBSD)

Installed in Radiation Controlled Area



High Field and Large-Bore Superconducting Magnet



Variable temperature cryogenic test stand

These facilities are also used for industrial research



Installation and Setup of Facilities for Numerical Simulation Project between 2012-2015

	Machine	Performance	Main memory	External storage device
2009.3~2012.8	SR16000-L2 128 nodes	77 TFlops	16 TB	0.5 PB
2012.10~2015.3	SR16000-M1 322 nodes	315 TFlops	40 TB	2.0 PB
2015.6~2019.5	PRIMEHPC FX100 2592 nodes	2.62 PFlops	81 TB	10.0 PB



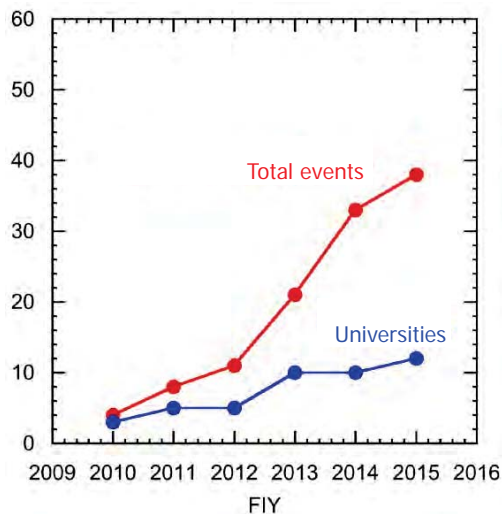
Various kinds of numerical simulations were performed with "Plasma Simulator"

PRIMEHPC FX100



Circulation of diagnostic instruments from NIFS

NIFS has lent some multi-purpose instruments to universities



Fast camera

Data acquisition



- Administration system was improved to provide efficient service to collaborators
- Number of circulation of diagnostic instruments increases year by year, owing to wide-spread information



(5) What have we done to improve and enhance functions for research in universities ?

「大学の機能強化、研究力強化に貢献しているか。」

(6) What have we done to contribute the development of human resources ?

「人材育成に貢献しているか。」

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Functional and Research Enhancement of Universities -1

This is the new key-phrase in Third Mid-term Target and Plan

Relevant sentences in Third Mid-term Plan

1. Contribution of the collaboration products on **functional enhancement of Universities** will be evaluated.
(成果を把握し、大学の機能強化への貢献度を明らかにする)
2. The cooperation of Universities by each Institute will be combined for **research enhancement of Universities**.
(各機関における大学間連携を集約し、大学の研究力強化を推進する)
3. Contribute to **functional enhancement of Universities** by educating and exchanging young scientists.
(若手研究者の育成と人材交流を通して、大学の機能強化に貢献する)

In this report, contribution to functional and research enhancement of Universities was investigated according to **the research products (publications) by non-NIFS first authors, and academic degrees conferred based on the collaborations.**

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Functional and Research Enhancement of Universities - 2 (Research Products)

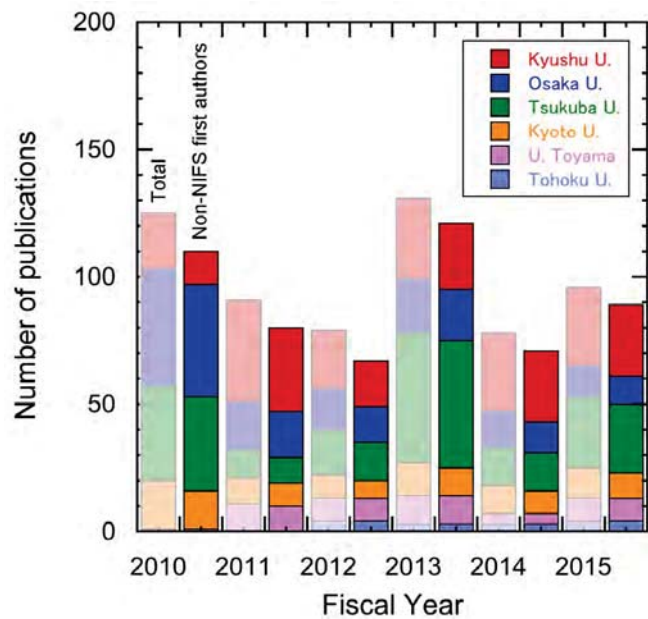
Number of publications based on **Bilateral Collaboration** par year varies 80 to 130.

~90% of the publications were made by non-NIFS first authors.

In 2010-2015, 662 papers were published based on **LHD Project Collaboration**.

~13 papers were published par adopted subject.

~90% of the publications were made by non-NIFS first authors.



Number of publications based on the **Bilateral Collaboration** Program

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Functional and Research Enhancement of Universities - 3 (Education of Young Scientists)

~400 students participated in NIFS collaborations every year

(13-15% of the total participants)

Number of academic degrees conferred based on **Bilateral Collaboration** in FY2010-2015

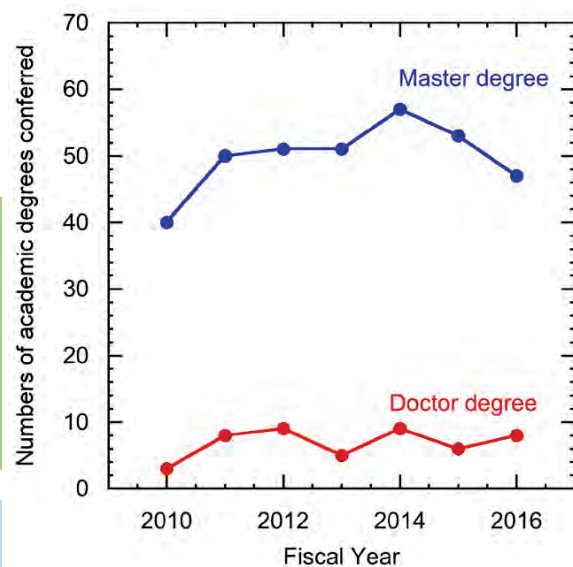
Master : 302 (50.3 par group)

Doctor : 40 (6.7 par group)

Number of academic degrees conferred based on **LHD project collaborations** in FY2010-2015

Master : 268 (5.2 par adopted subject)

Doctor : 31 (0.6 par adopted subject)



Number of academic degrees conferred based on the **Bilateral Collaboration** Program

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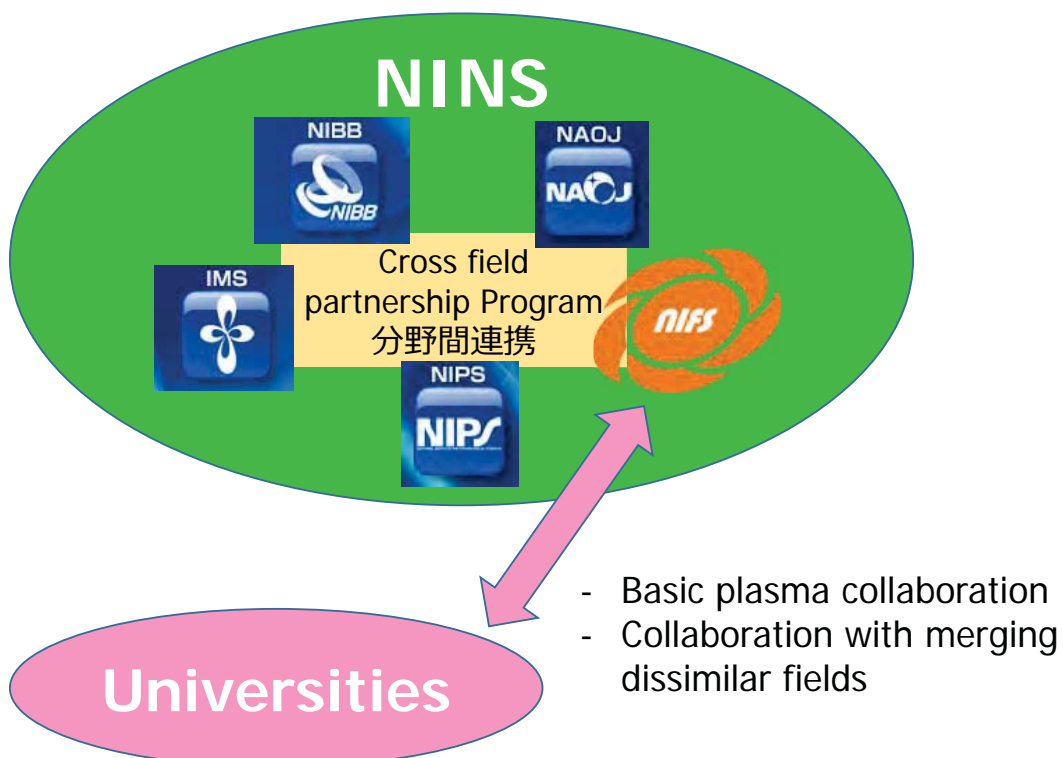


(7) What have we done to drive and advance wide range of research for plasma and fusion science, including cooperation with different fields ?

「異分野連携を含む、幅広いプラズマ・核融合分野の学術研究を推進しているか。」



Basis for Promoting Wide-Ranging Plasma and Fusion Research





Basic Plasma Collaboration Research (HYPER-I Experiment)

HYPER-I -- *small ECR linear device* --

can conduct various kinds of studies, from basic plasma physics to applications



Research Themes

- flows in plasma
- spontaneous structure formation in plasma

Collaborating Universities:

Kyushu, Tohoku, Nagoya, Kyoto, Yokohama Natl., Utsunomiya, Oita, Nihon

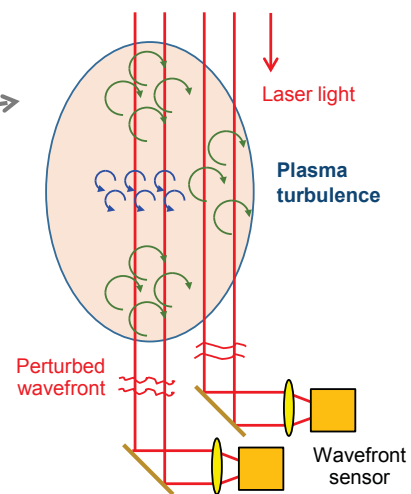
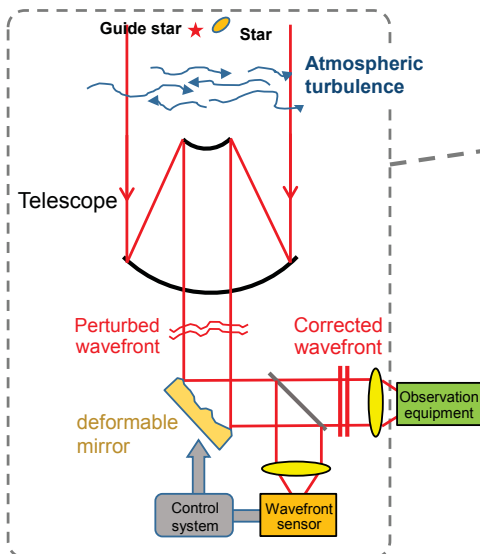
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New diagnostic technique for plasma turbulence using telescope optics technique

A telescope with adoptive optics
- *atmospheric fluctuation canceller* -

Plasma turbulence measurement with wavefront sensor

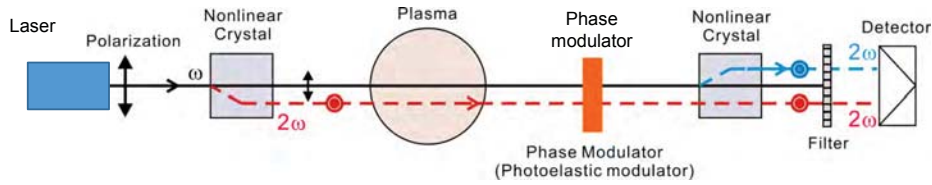


Wavefront sensor has been developed in collaboration with National Astronomical Observatory of Japan, National Institute for Basic Biology (Adoptive optics in microscope) and NIFS

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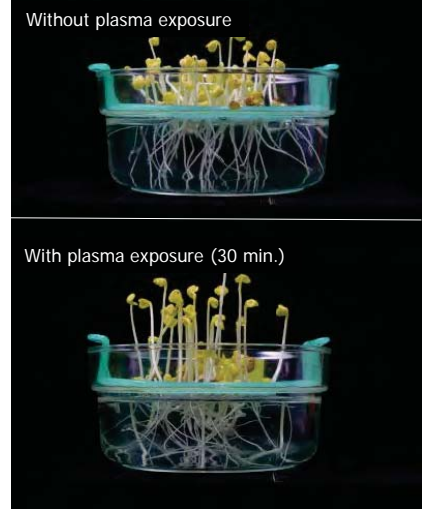
Fusion plasma diagnostics are applied on biological research with atmospheric pressure plasma



- “A dispersion interferometer” is intrinsically free from mechanical vibrations.
- Designed for ITER, based on LHD results
- Suppressing perturbations by air, **electron density of atmospheric pressure plasma can be measured**



Application to plasma diagnostics in industrial, agricultural, medical purposes



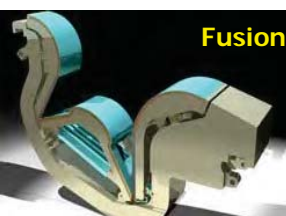
Growth enhancement by plasma irradiation to seeds of radish sprouts



Basic research on atomic and molecular physics

Astrophysics

EUV Lithography



Spectroscopy for various highly charged ions of high Z elements using LHD and Tokyo-EBIT in the University of Electro-Communications





Summary - 1

Collaborations between NIFS and universities in three categories were carried out successfully in the second mid-term period.

- (1) In order to lead the current fusion research,
 - “boundary plasma study” with Gamma10/PDX started, concentrating the budget of the bilateral collaboration program
- (2) In order to reflect the requirement of the fusion community,
 - chairs of each program committee are from universities
 - application guidebook was revised annually
- (3) In order to collect and share the research achievements,
 - web base system was established, which is used from application to review
 - web base database system for publication was established

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Summary - 2

- (4) In order to provide better environment to enhance the collaboration,
 - large scale fusion engineering R&D facility was constructed in NIFS
 - plasma simulator (super computer) was replaced to apply for larger numerical simulations
- (5) In the contribution to university research to be improved,
 - many papers were published in the NIFS collaboration program
 - efficient education for graduate students were provided
- (6) Related research was developed by fusion study
 - basic plasma physics
 - application of high temperature plasma diagnostics to ultra low temperature plasma
 - application from astronomical research to plasma diagnostics was tried

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International Collaboration Researches in NIFS

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Points of Evaluation for the 2016 “Collaborative Research” External Peer Review

- Is the collaboration being prepared soundly for collaborative research bases and systems with foreign research organizations?
(海外研究機関との共同研究基盤・体制を整えているか。)
- Is the collaboration advancing cooperation with the ITER-BA project? Further, is the collaboration contributing to voluntary activities such as ITPA and others?
(ITER-BA計画との連携を進めているか。また、ITPAなどボランティアな貢献をしているか。)
- As an implementing body involved in advancing international collaborative research, is that role being sufficiently carried out? Further, are those contents being revised appropriately?
(実施機関として進めている国際共同研究において、その役割を十分果たしているか。また、その内容が適宜見直されているか。)
- Is this international collaborative research contributing to the development of human resources in Japan and abroad?
(国際共同研究を通して、国内外の人材の育成に貢献しているか。)

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Is the collaboration being prepared soundly for collaborative research bases and systems with foreign research organizations?

(海外研究機関との共同研究基盤・体制を整えているか。)

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International Collaboration Researches

Bilateral Coordination with intergovernmental agreements

US-Japan Collaborative Program,
Korea-Japan Nuclear Fusion Cooperation Project
China-Japan Collaborative Program

Multilateral Coordination under IEA

Stellartor-Heliotron Concept
Plasma Wall Interaction in TEXTOR → PWI
Spherical Tori
Steady State Operation

Coordination with Other Institutes

25 International Academic Exchange Agreements

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Coordinating of the International Collaborations

Section of the coordinating of collaboration researches

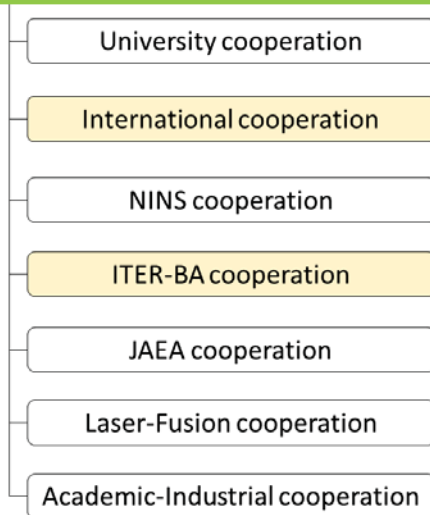
Coordination Research Project (2010-2013)



Research Enhancement Strategy Office (2013-)



Collaborative Research Enhancement Committee

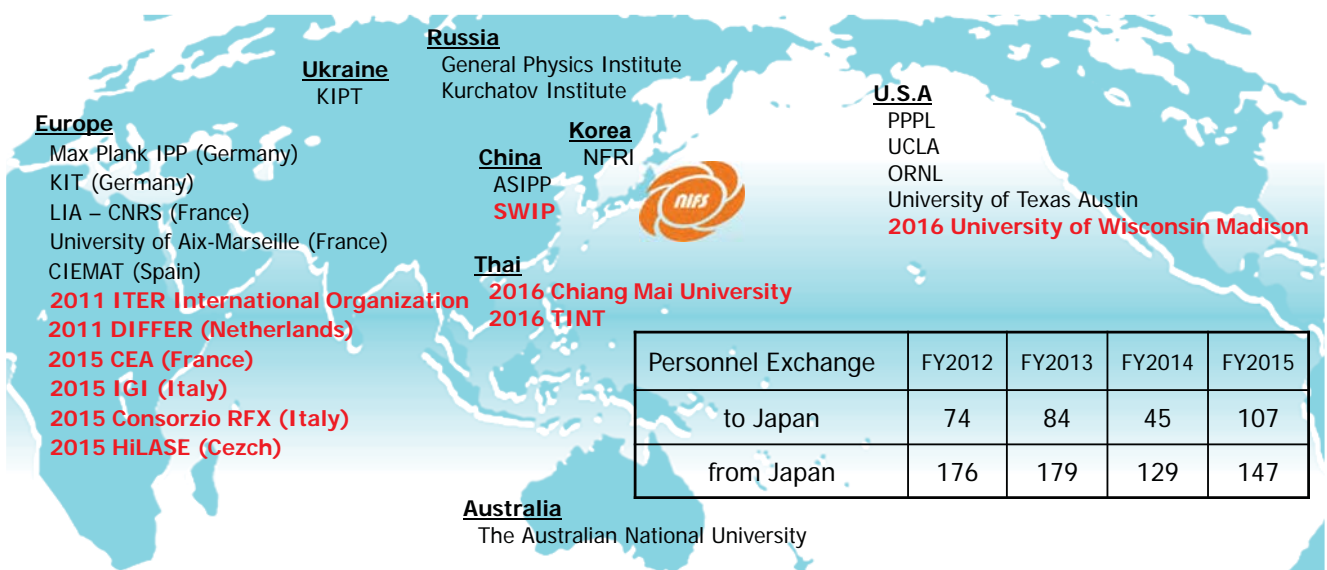


- The coordination research project aimed at a smooth accomplishment of a wide range of coordinated research activities in NIFS.
- It plans, establishes and supports the framework of coordinated.
- In order to accomplish the above-mentioned purpose, the coordination research committee with the sub-committees was set up and corresponds to a variety of coordinated researches.
- Research Enhance Strategy Office (RESO) has taken the roles of the coordination research project since 2013.

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10 New Coordination with Foreign Institutes were concluded after 2010



Personnel Exchange	FY2012	FY2013	FY2014	FY2015
to Japan	74	84	45	107
from Japan	176	179	129	147

- To conclude the 7 new coordination after 2013, RESO played the leading role.

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International Cooperative Activity via NINS initiative

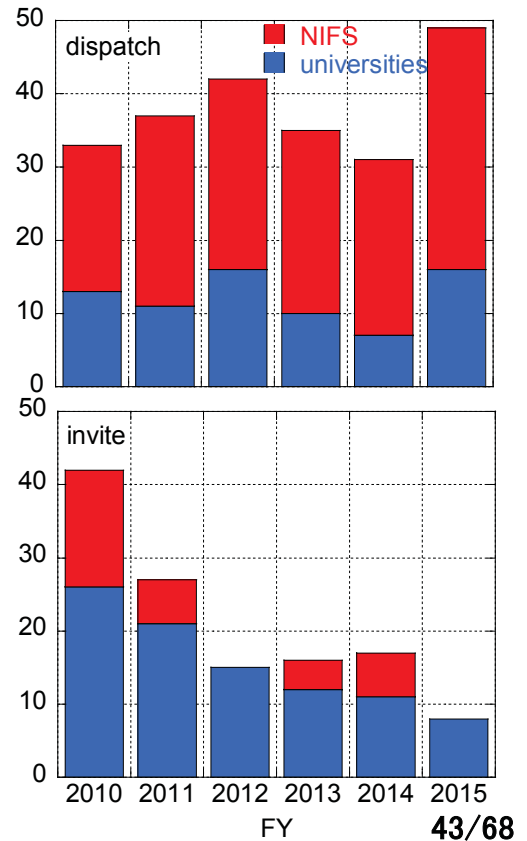
National Institute of Natural Science

budgeted for the program of “Formation of international scientific bases in natural sciences” from 2010 to 2015.

In the program, NIFS focused on “Study on turbulence, magnetic islands and magnetic field lines in plasmas”

This program was consists of 12 groups, and 3 of them were led by universities.

Some international collaboration frameworks, which were not budgeted by NIFS, were supported by this budget.



Is the collaboration advancing cooperation with the ITER-BA project?

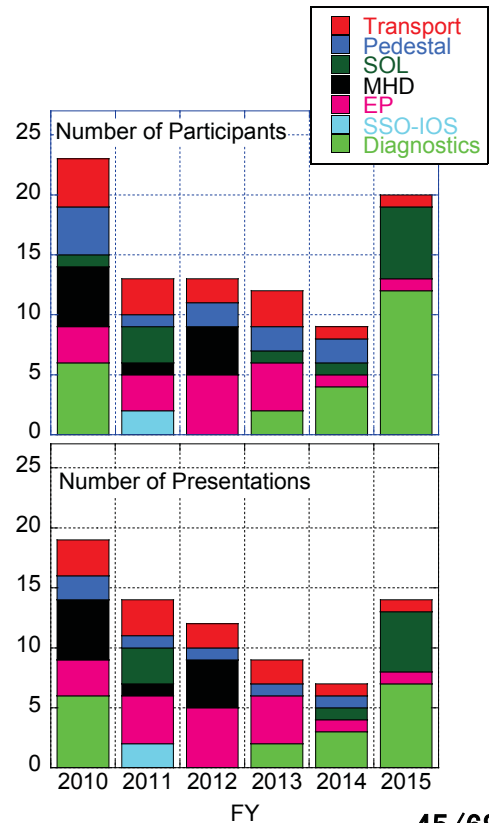
Further, is the collaboration contributing to voluntary activities such as ITPA and others?

(ITER-BA計画との連携を進めているか。また、ITPAなどボランティアな貢献をしているか。)



Contributions to ITPA

- Contributions to ITPA from NIFS have been conducted by ~15 participants/year with ~12 presentations/year.
- NIFS supports the travel fee for the participants.
- Some NIFS researchers have important roles in their topical groups, such as sub-group leader.
- Recently, importance of 3-D effects on plasma transport in tokamaks with RMP has been recognized, and the research in LHD contributes to the understanding of the effects.
- The simulation codes, which have been developed in NIFS, are applied to tokamak modeling.



Contributions to ITER

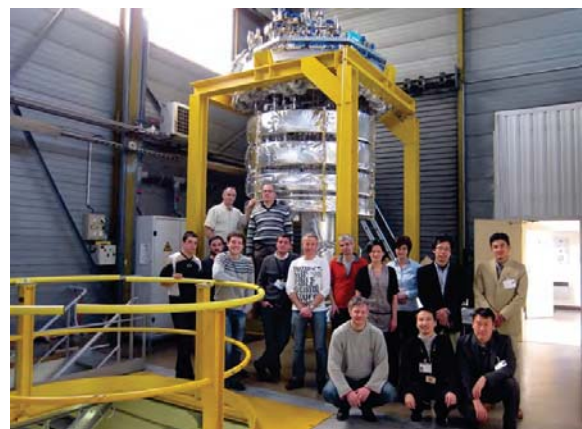
- NIFS has the bases of the super-conducting R&D, plasma heating, and plasma diagnostics, and they have been applied to the ITER construction.

Contract with JA-DA

- **Performance examination of the ITER-TF coil connection**

Contract with ITER-IO

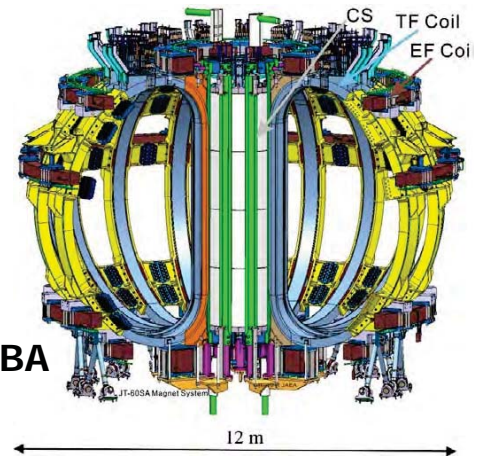
- **High power tube test for ITER ICH system**
 - 1.3MW/10s, 1MW/100s with frequency of 65 MHz using 4CM2500KG.
- **ITER Cryo-plant Process Study**
 - Dynamic simulation for the supercritical helium test loop experiment
 - Full-scale TF structure modelling with simulation under two base line scenarios, 15 & 17 MA, with Plasma disruption followed by the slow ramp down and the fast discharge
- **Engineering Support to ITER Diagnostics Interferometer**
 - Design of the dispersion-interferometer for ITER





Contributions to BA

- NIFS contributes to Broader Approach through the collaboration researches
 - **BA collaborations**
 - DEMO design collaboration
 - DEMO R&D collaboration
 - Reduced-activation ferritic steel
 - SiC/SiC composit
 - JET ILW PWI research
 - IFMIF/EVEDA collaboration
 - NIFS also contributes to the **management of BA**
 - NIFS researchers take the posts of:
 - Steering committee member
 - IFERC project leader
 - Contributions to **JT-60SA**
 - Collaboration between NIFS and QST (former JAEA)
 - Joint development of the super-conducting magnets of JT-60SA
 - Making the JT-60SA Research Plan



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As an implementing body involved in advancing international collaborative research, is that role being sufficiently carried out?

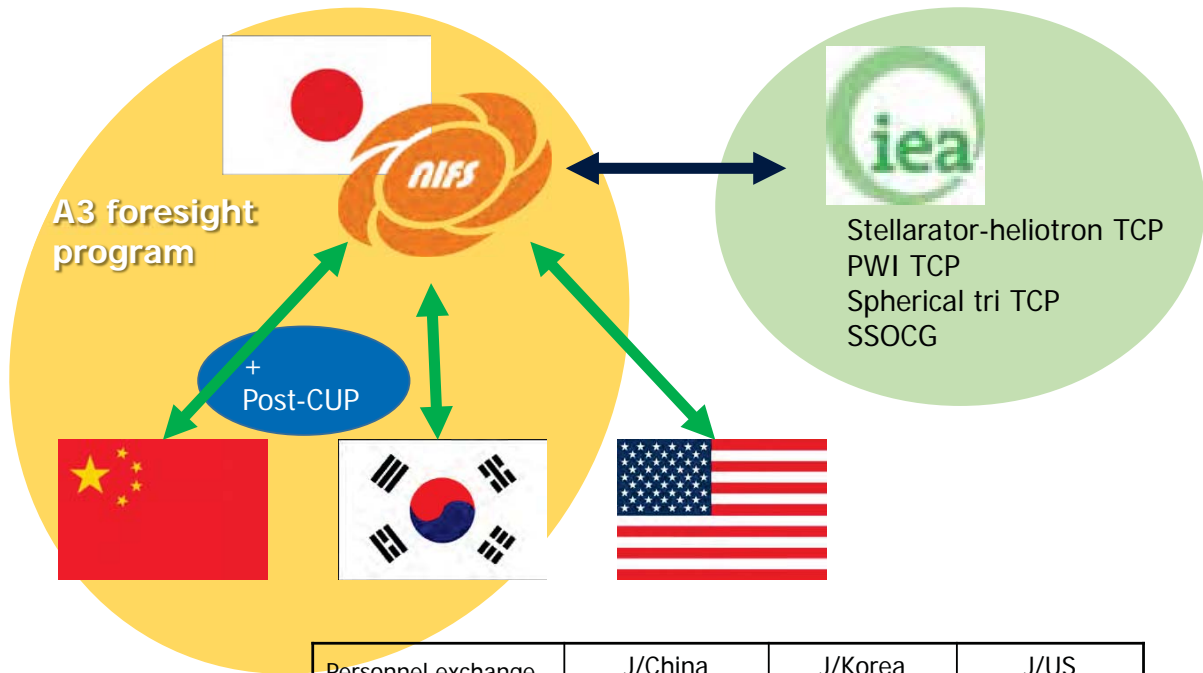
Further, are those contents being revised appropriately?

(実施機関として進めている国際共同研究において、その役割を十分果たしているか。また、その内容が適宜見直されているか。)

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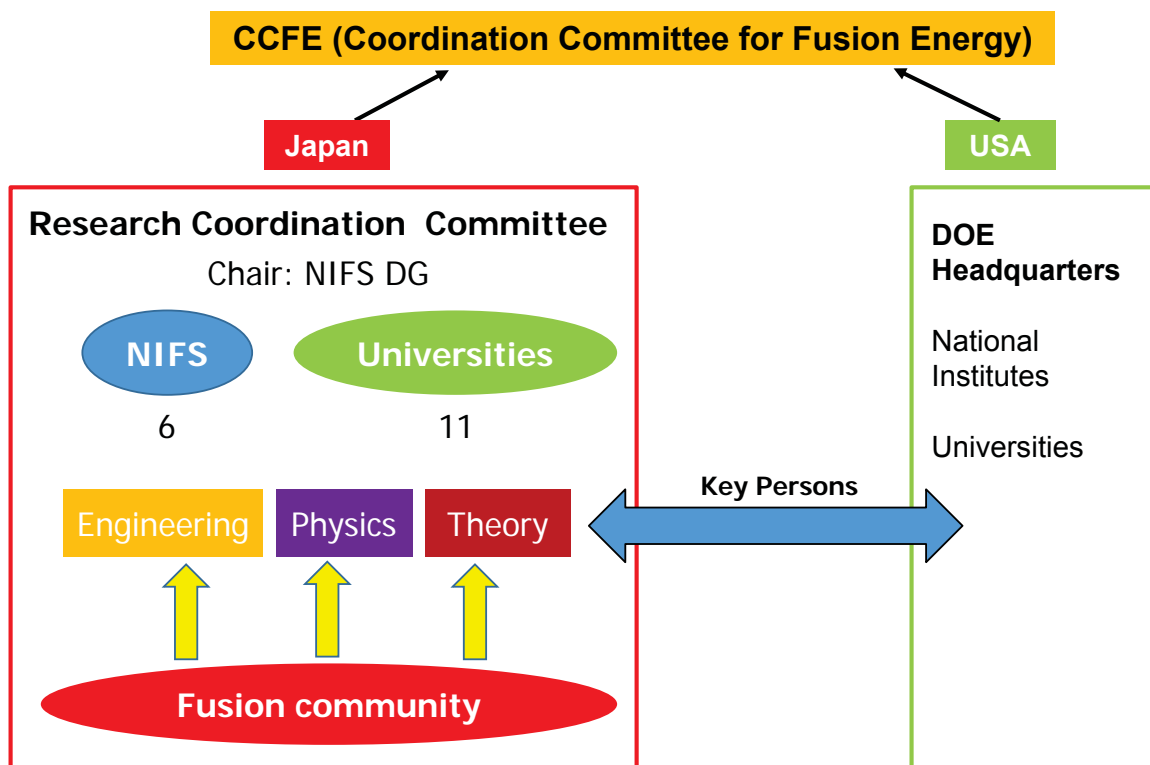
Bilateral and Multilateral Coordination with intergovernmental agreements



Personnel exchange in FY2015	J/China		J/Korea		J/US	
	man	day	man	day	man	day
to NIFS/Japan	14	138	36	116	63	374
from NIFS/Japan	23	147	33	172	76	860



US-Japan Collaboration Program Structure of the program





US-Japan Collaboration Program Structure of the program

1. Joint Planning Programs

- (1) Fusion Technology
- (2) Fusion Physics
 - Steady state
 - MHD and high beta
 - Confinement
 - Diagnostics
 - High energy-density science

2. **Joint Institute of Fusion Theory**  Steering committee

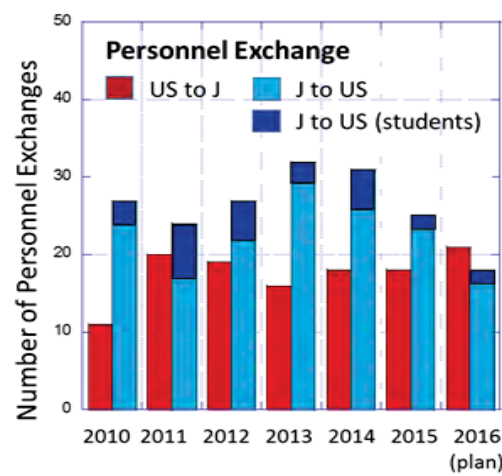
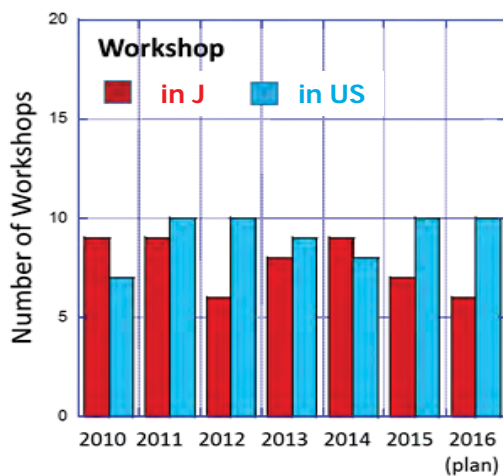
3. **Joint Research Projects**  Steering committee

○ TITAN Project (2007 – 2012)

○ PHENIX Project (2013 – 2018)
(Technological Assessment of Plasma Facing Components for DEMO Reactors)



US-Japan Collaboration Program Statistics of the program

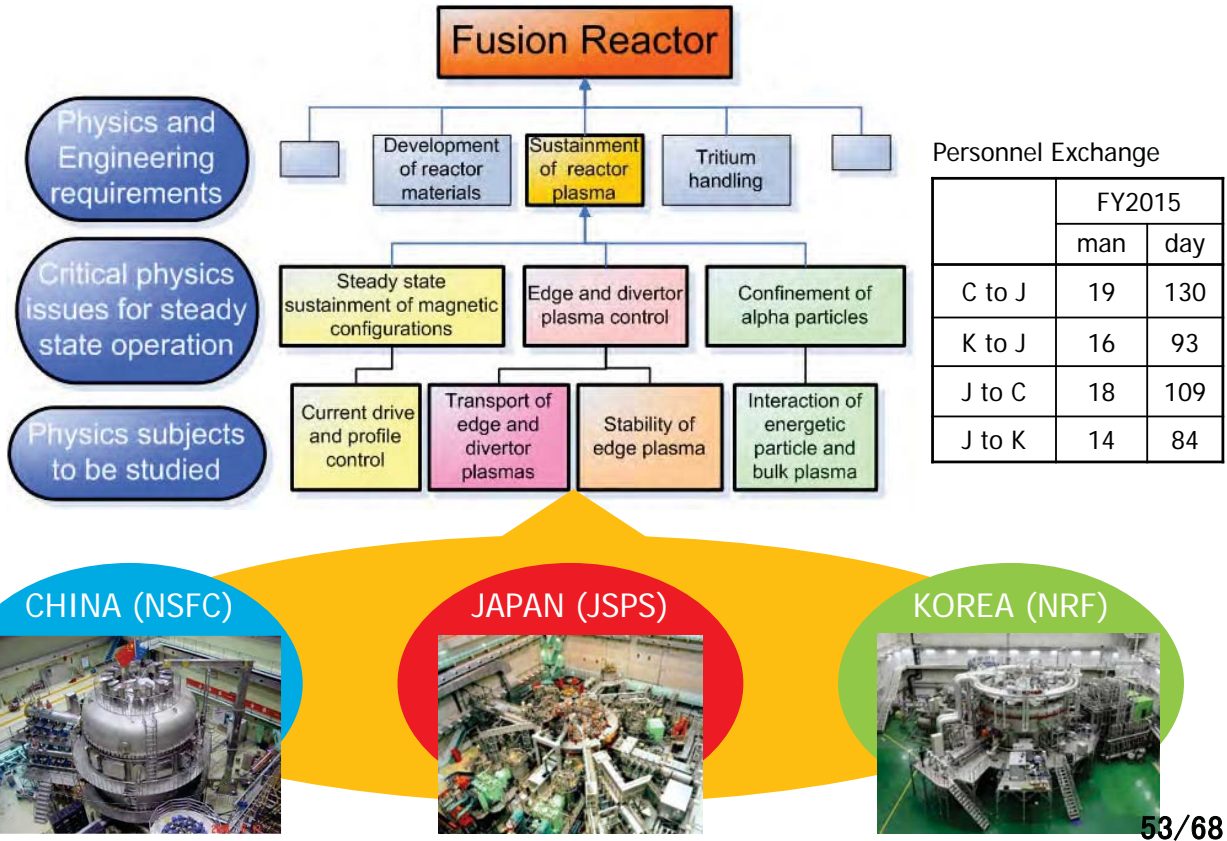


Participation to workshops is Not included

- More than 10 workshops have been held every year.
- More than 30 personnel exchanges including students have been conducted.



J-C-K A3-Foresight Program FY2012(H24)-2017(H29) "Study on Critical Physics Issues Specific to Steady State Sustainment of High-Performance Plasmas"



China-Japan Collaborative Program Structure of the program

JFY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
	JSPS-CAS Core University Program (Plasma, Engineering, Simulation)										post-CUP (NIFS internal program)						
												JSPS/NSFC/NRF-A3 Foresight Program (Fusion Physics)					
									MEXT/MOST Agreement Program (Plasma, Engineering, Simulation)								

JSPS-CAS Core University Program (CUP) started April 2001 and ended March 2011
 Many collaboration researches were carried out on fusion materials, tritium/blanket, magnet, plasma-wall interactions and reactor design

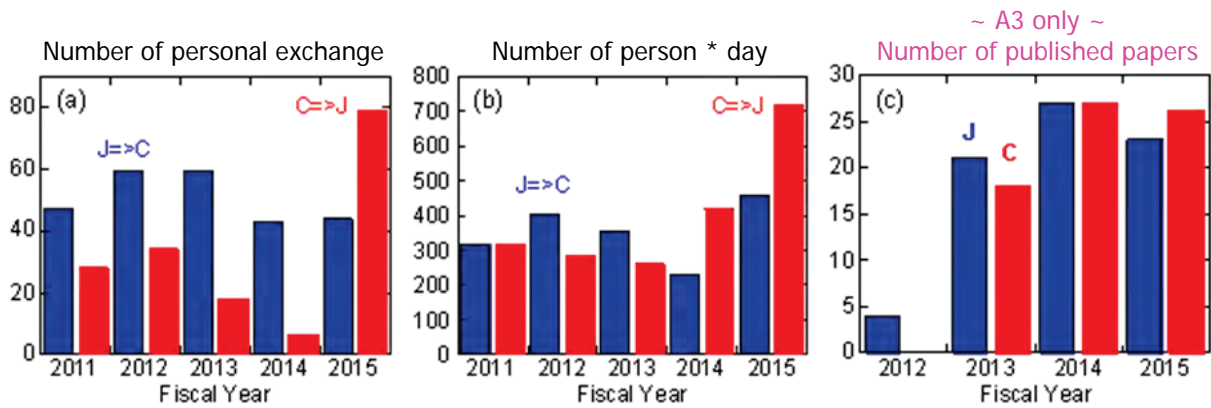
MEXT/MOST agreement program started in 2008 including fusion engineering (JWG).
 However this is NIFS&JAEA - ASIPP&SWIP exclusive program (LHD/JT-60SA/EAST/HL2A, reactor design etc)

J/C/K/ A3-Foresight Program started in 2012 for 5 years
 Only physics but includes plasma-wall interactions

"Post-CUP" continued based on NIFS internal budget with smaller size than CUP
 Major platform for fusion engineering collaboration between Japanese and Chinese Institutes and Universities (JCS Symposium etc)



China-Japan Collaborative Program Statistics of the program



- Number of personnel J→C has been more than 40/year.
- Number of person*day has been more than ~300/year.
- Number of published paper in A3 has been 20-25/year.
- C-J collaborative program contributes to education of young researchers. 30-40% of the personnel exchanges has been young researchers.

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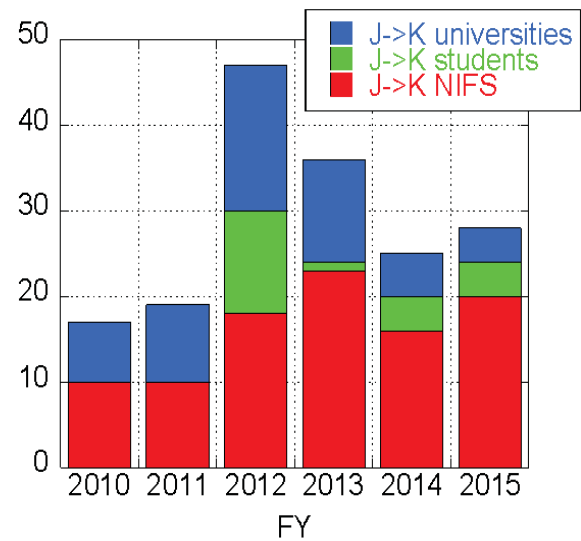
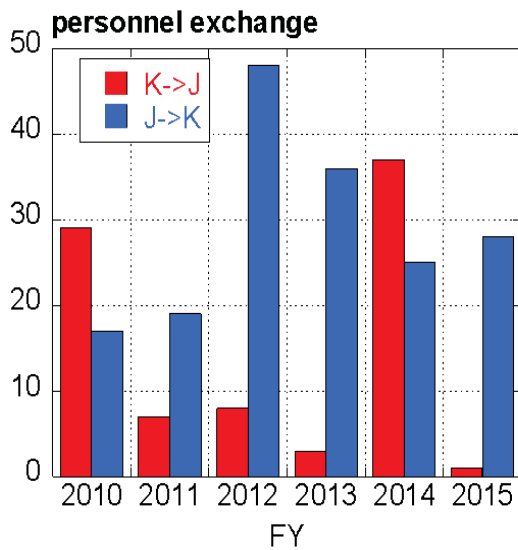
Korea-Japan Nuclear Fusion Cooperation Project Structure of the program

- Agreement has been concluded in 2004
- Content of joint researches are
 - ITER Cooperation
 - KSTAR Cooperation
 - Young researcher's promotion and education
 - Workshop, Researcher exchange
- NFRI(Korea, KSTAR) and NIFS(Japan, LHD) cooperate in fields of plasma diagnostics, plasma heating, etc.

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Korea-Japan Nuclear Fusion Cooperation Project Statistics of the program



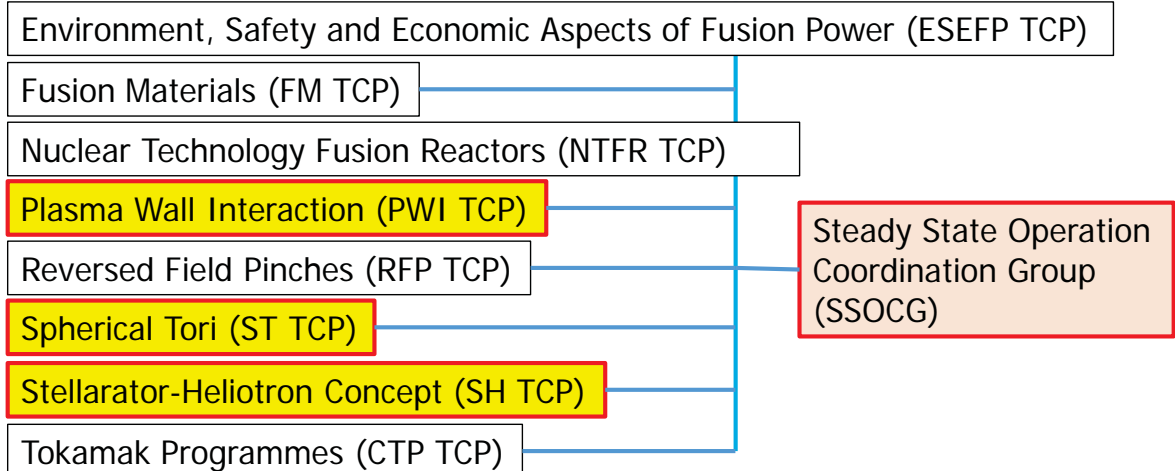
- More than 10 persons, including universities researchers and students have been dispatched to Korea every year.



Multilateral Coordination under IEA

- 2015 Implementing agreement
- 2015 - Technology Collaboration Programmes, TCP

IEA Fusion Power TCPs



- NIFS is the representative institute of Japan for the three TCPs.
- The chair of the SSOCG was NIFS researcher from 2010 to 2015.



Stellartor-Heliotron Concept TCP Objective and Scope

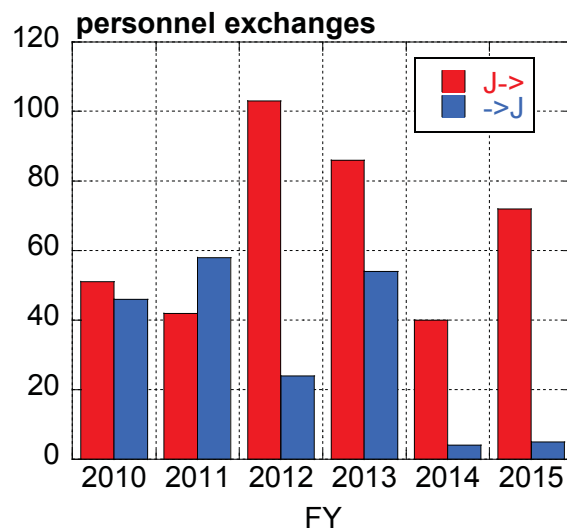
- **Objective:** The objective of the co-operation is to improve the physics base of the Stellarator-Heliotron concept and to enhance the effectiveness and productivity of research and development efforts related to the Stellarator-Heliotron concept by strengthening co-operation among Agency member countries.
- Under auspices of IEA-IA, **Coordinated Working Group** has been evolving dramatically, and NIFS is a major player in this activity.



Stellartor-Heliotron Concept TCP Statistics of the programme

- NIFS was the chair institute from 2006 to 2015.
- NIFS has played the leading role of the extension of S-H IA to June 2016

- The budget for the personnel exchanges was via NINS initiative international activity, and the budget which researchers got by themselves.
- More than 40 dispatches/year have been conducted.
- Under the Collaborative Research Enhancement Committee in NIFS, Stellarator-Heliotron Cooperation sub-committee was been launched in FY2016,

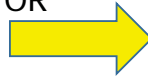




TEXTOR IA, PWI TCP



TEXTOR

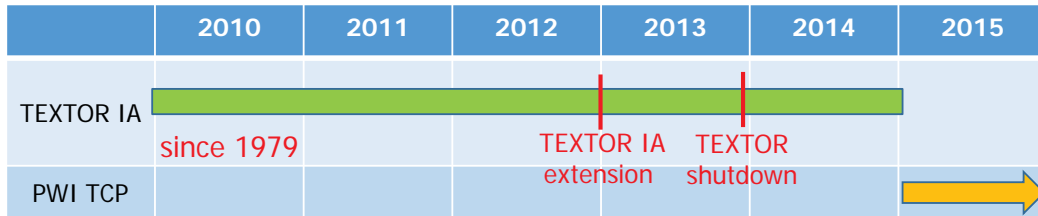


Linear devices



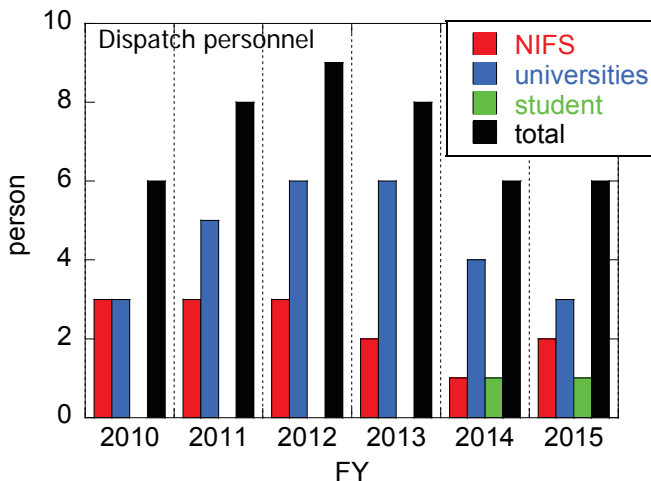
- PWI
- Toroidal plasma control
- Dynamic Ergodic Divertor
- Plasma diagnostics

-PWI in reactor relevant conditions



TEXTOR IA, PWI TCP Domestic technical committee

- NIFS has budgeted for the TEXTOR IA, and PWI TCP.
- Every year, the domestic technical committee for this program collects the research proposals from the Japanese fusion community, evaluates them, approves, and decides the budget for each proposals.
- The domestic technical committee consists of the researchers in NIFS (1-2), QST (1), universities (6-9).



- Every year, 6-9 researchers, conducted collaborative researches at the institutes in Europe and USA.
- This program has been opened to students since 2014.



Spherical Tori TCP

QUEST

All-Japan ST research program

MAST(EU)

NSTX-U(US)

TST-2

NIFS

NIFS has budgeted for the travel fee for the domestic meetings of the all-Japan ST research program, and for the dispatch related to the collaboration with NSTX and MAST.



Steady State Operation Coordination Group (SSOCG)

- Fusion Power Coordinating Committee (FPCC) decided to establish SSOCG in 2012 to accelerate knowledge transfer between fusion devices and experiments by highlighting and addressing cross-cutting issues.
- A NIFS researcher has been one of the co-chair of the SSOCG.
- 7 work packages, shown below, were decided in the first meeting of the SSOCG.

	Area	Contact
SSOCG-1	The use of IR cameras to detect hot spots with real-time event handling	X. Litaudon
SSOCG-2	The documentation of vacuum conditions required for steady state operation	G. Sips
SSOCG-3	The use of MIMO control of plasma shapes with SC coils, including error field compensation	Y.S. Bae, X. Gong
SSOCG-4	The control of wall particle content and sudden influxes (flakes)	K. Hanada, T. Mutoh
SSOCG-5	The documentation of irradiation damage on superconducting coils	IPR, India
SSOCG-6	The evaluation of gaps in the H&CD developments for steady state operation	D. Bora
SSOCG-7	Draft a roadmap for developing steady state operation	Chairs to ask for participation

Is this international collaborative research contributing to the development of human resources in Japan and abroad?

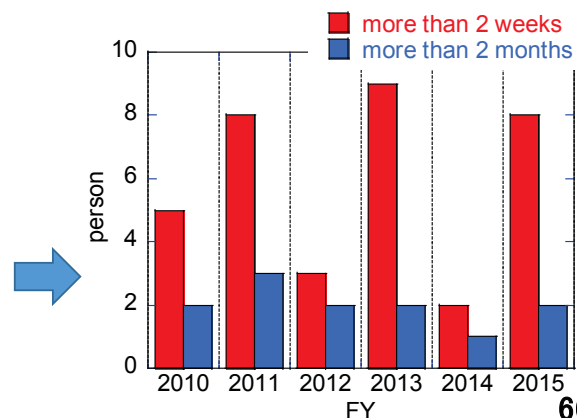
(国際共同研究を通して、国内外の人材の育成に貢献しているか。)

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Development of human resources through the international collaborations

- To develop human resources for fusion research is essential, because the research will continue several tens years.
- For Japanese young researchers, long-term dispatches to the institutes, which have the academic exchange agreement with NIFS, such as IPP.
 - via SOKENDAI program
 - via Research Enhancement Strategy Office program
- For foreign young researchers, NIFS accepts internship from foreign institutes, and universities.



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Examples of Active Young Scientists in Foreign Countries

Plasma measurement



Dr. Zhenying Cui
Research Professor
VUV Research Leader
SWIP



Fusion Engineering



Dr. Masa Shimada
Senior Staff Scientist
STAR Experiment Leader
Idaho National Lab.



3D plasma physics



Dr. Wonha Ko
3D Task Force Leader
NFRI



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Summary

- NIFS has been improving the international collaboration basis and system.
- NIFS has contributed to ITER-BA, and also ITPA.
- As the hub of the international collaboration between Japanese universities and foreign institutes, NIFS has carried out the role of the implementing body of the bilateral Coordination with intergovernmental agreements and multilateral Coordination under IEA.
- NIFS has dispatched young researchers and students to the institutes, which have agreements between NIFS, for their training and experience. And, NIFS has accepted foreign young researchers and students, as internship and so on, to train them in the framework of collaborations

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References

Table of Evaluation Results for the 2016 External Peer Review

“Collaborative Research”

Table of Evaluation Results for the 2016 External Peer Review "Collaborative Research"

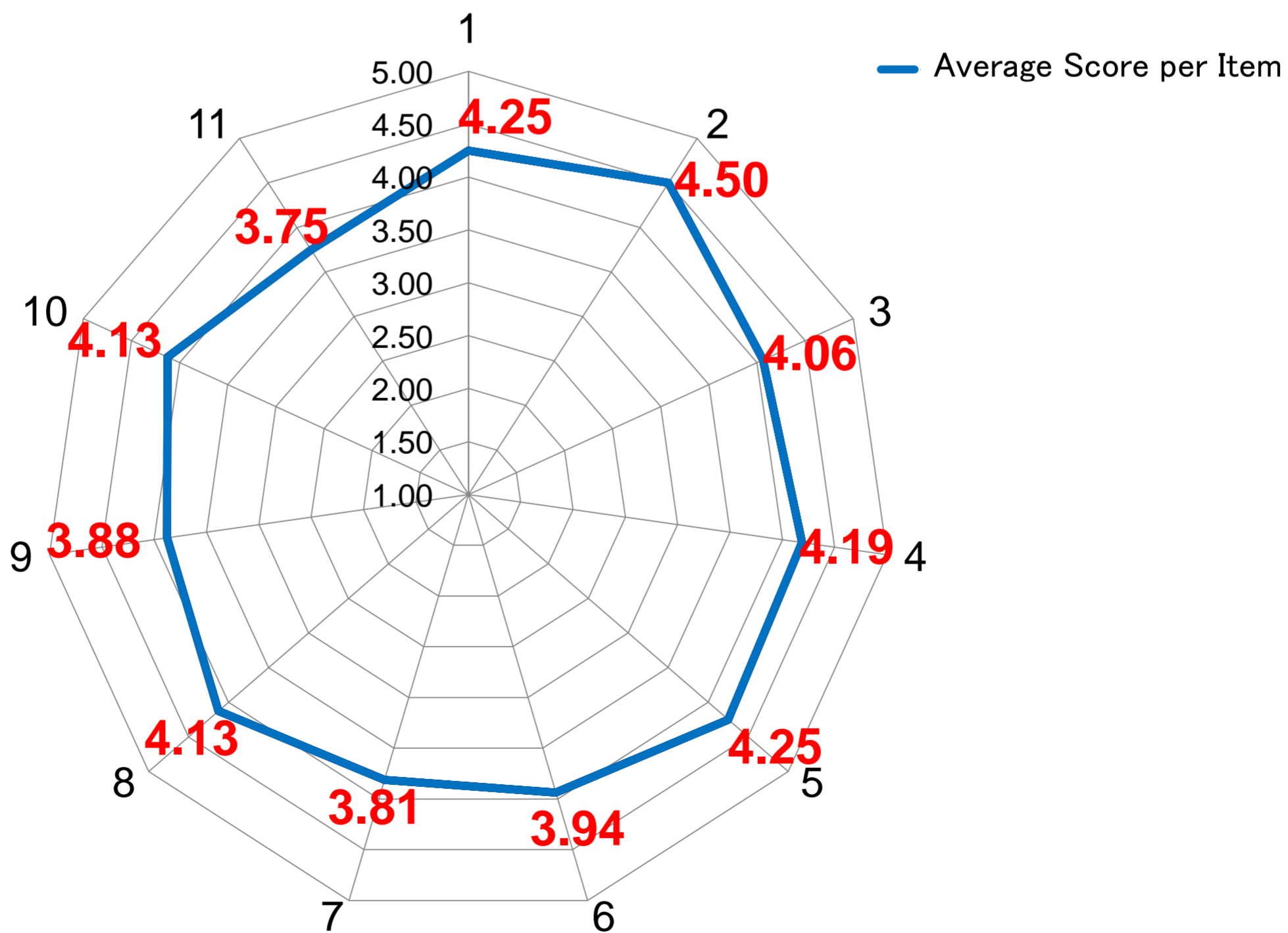
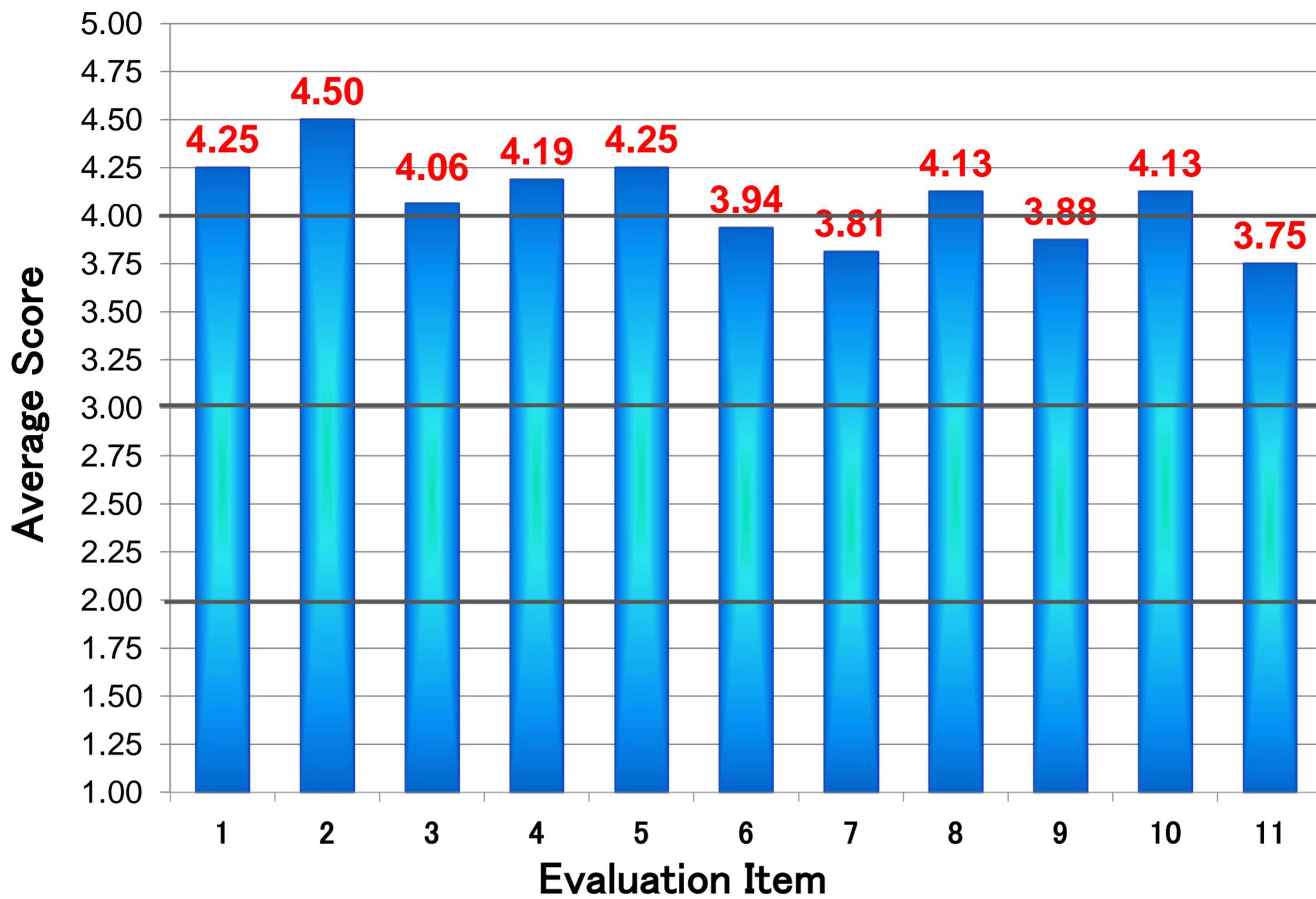
項目	Number of persons										
	1	2	3	4	5	6	7	8	9	10	11
Extremely highly commendable	6	8	3	5	7	1	4	6	2	5	1
Highly commendable	8	8	12	9	6	13	6	6	10	8	10
Commendable	2	0	0	2	3	2	5	4	4	3	5
Adequate	0	0	1	0	0	0	1	0	0	0	0
Inadequate	0	0	0	0	0	0	0	0	0	0	0
Average Score	4.25	4.50	4.06	4.19	4.25	3.94	3.81	4.13	3.88	4.13	3.75

Evaluation Response Table	
Extremely highly commendable	5
Highly commendable	4
Commendable	3
Adequate	2
Inadequate	1

※ The evaluation result is a combination of the results of domestic committee members and foreign committee members.

Items	Points for Evaluation
[1]	Domestic Collaborative Research
1	Do the recruitment contents for collaborative research reflect trends in research developments and in the respective fields?
2	Regarding the screening of collaborative research topics, has a mechanism for reflecting the opinions of the fusion community been constructed?
3	Together with engaging in the evaluation of research results, are summarizing the results and then sharing them among the collaborating researchers occurring?
4	Is improvement of the research environment improving through the expansion of equipment advancing, and is it also contributing to collaborative research and collaborative use including industry–university
5	Is this collaboration contributing to the strengthening of the functions of universities and to the research enhancement of universities?
6	Is this collaboration contributing to the development of human resources?
7	Is this collaboration advancing academic research in wide-ranging plasma and fusion fields, including cooperation with different fields?
[2]	International Collaborative Research
8	Is the collaboration being prepared soundly for collaborative research bases and systems with foreign research organizations?
9	Is the collaboration advancing cooperation with the ITER–BA project? Further, is the collaboration contributing to voluntary activities such as ITPA and others?
10	As an implementing body involved in advancing international collaborative research, is that role being sufficiently carried out? Further, are those contents being revised appropriately?
11	Is this international collaborative research contributing to the development of human resources in Japan and abroad?

Average Score by Evaluation Item





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