National Institute for Fusion Science (NIFS)

National Institutes of Natural Sciences (NINS)

Peer Review Reports in FY2010

March, 2011

NIFS Administrative Council External Peer Review Committee

Contents

Chapter 1 Background

National Institute for Fusion Science (NIFS) has promoted joint research and joint use of facilities on a national level since 2004, when it became a member of National Institutes of Natural Sciences (NINS), an inter-university research institute corporation. An inter-university research institute is defined as the “organization that brings together related researchers from national, public and private universities throughout Japan, and carry out joint research as well as joint use of the most advanced facilities and information” and also the “organization that promotes cutting-edge researches while encouraging its researchers to share the experimental or observatory devices that an individual university cannot afford”. Plasma and fusion research is one of those effectively taking advantage of this unique concept, and made a significant progress over the past half century, particularly in a way that such large-scale equipment that a university cannot have is shared through joint researches – an unprecedented and unique system which is unseen in the rest of the world.

At incorporating, inter-university research institutes are required to make a mid-term plan every six years, and implementation of the plan is subject to annual evaluation, which usually targets an administrative performance. However, NIFS considers its scientific performance should be also exposed to external reviewing, and established the External Peer Review Committee under its Administrative Council. The NIFS Administrative Council External Peer Review Committee is constituted by non-NIFS members of the Administrative Council and expert personnel designated from the field related to the year’s target. The target and items to be checked is annually determined by the Administrative Council. Evaluation results are reported to the Administrative Council, who hands it to NIFS, so that it uses the evaluation results to improve performance for the following years. Here a successive cycle of Plan-Do-Check-Act is given to NIFS’s research operation. It is reasonable to see such efforts of the Administrative Council have been rewarded when a high overall rating was given to NIFS’s scientific performance of the first mid-term plan period by National Institute for Academic Degree and University Evaluation.

During the second-midterm plan period NIFS is to improve joint use and joint research based on what it attained to during the last period. Meanwhile, in order to strengthen a centripetal role as a Center of Excellence (COE) in plasma and nuclear fusion research, NIFS has begun to work by organizing three research projects of Large Helical Device (LHD), simulation and fusion engineering, and will integrate the outputs of these to ensure nuclear fusion reactor.

To this end, NIFS had drastically reorganized its research section. A big change is the inauguration of Coordination Research Project. To vitalize collaborative activities is a mission of an inter-university research institute, but activities vary in style and spread out geographically. Domestically, there are joint researches coordinated on an inter-institutional agreement and industrial-academic cooperation, along with the main framework of Domestic Collaboration. Internationally, there are duties as an implementing agency for inter-governmental cooperation. There are inter-institutional collaborations between notable foreign organizations, ITER-related activity of International Tokamak Physics Activity, or ITPA, and other voluntarily efforts. Previously, all these collaborative activities were fully dependent on an individual contribution because NIFS did lack a system to grasp a whole picture and allocate resources. That is why the Coordination Research Project is established. It is expected the Project will undertake the work and provide an organizational support to the activities.

On launching the Project, the Administrative Council decided to give an external view to NIFS's collaboration/coordination activities. The extensively-spread activities need to be reviewed in order to determine a policy in supporting them. The Administrative Council formed NIFS Administrative Council External Peer Review Committee with its nine non-NIFS members as well as four foreign peers, and at the same time established a specialist team of subcommittees with them, inviting other four members in relevant fields.

The committee members first gathered on October 21, 2010, when they discussed this year's evaluation, and made a conclusion on details including what to be checked (see below). At their second meeting, followed by the first meeting of the subcommittees (December 11, 2010), relevant information on activities and results was provided by NIFS using viewgraphs and annual reports (see the references), and then questions were asked and answered. The subcommittee members met on January 27 2011, asked further questions to NIFS and made their own evaluation. After sum-ups were submitted by each subcommittee team, the External Peer Review Committee integrated them and finalized the evaluation at its third meeting (February 23 2011). The attached document No. 3 shows the schedules of the year's evaluation.

This report consists of four chapters – Background (Chapter 1), Summary of Each Section (Chapter 2), Recommendations (Chapter 3) and In Closing (Chapter 4). After being approved by the Administrative Council, the report is going to be submitted by NIFS Director-General to NINS President. Then it will go through NINS sections of Education and Research Council as well as Administrative Council, and then will be a supplementary document for NINS report FY2010, which is to be submitted to Ministry of Education,

Culture, Sports, Science and Technology.

The report is to be released both in print and online.

This year's evaluation perspectives are as follows:

[Domestic collaboration research]

(1) Performances and products after NIFS was reorganized as inter-university research institute in FY2004

・ Are the application categories properly up to date? [*]
・ Has the collaboration research progressed based on the opinions of collaborations? [*]
・ Have the results of collaboration research been published properly? [*]
・ Has the collaboration research progressed based on evaluations over the previous results? [*]
・ Are the results of the collaboration research accumulated properly as an academic resource? [*]
・ Have the circumstances for collaboration been improved? [*]
・ Has the collaboration research helped educating students and young researchers?

[*] Pointed out in the previous external peer reviewing.

(2) Future direction

・ Does the plan in each category suggest a direction based on a long-term vision? Are they satisfactory as a plan of COE of fusion research?
・ Does the collaboration research function as a pivot for advancing new studies, such as a program under the Grants-in-Aid for Scientific Research?

[International collaboration research]

(1) International collaboration research based on inter-governmental agreements

・ Has NIFS fulfilled its responsibility as an implementing agency?
・ Are the policy and plan for future collaboration satisfactory?

(2) International collaboration research based on inter-institutional agreements

・ Does each program take advantage of characteristics of the agreed institutes?
・ Is the strategy that includes ITER and BA appropriate?

(3) International collaboration research under the National institutes of Natural Science

・ Is the program productive?

(4) Voluntary contributions for other International collaboration programs (ITPA, etc.)

・ Are the contributions satisfactory in terms of NIFS's duty?

[Joint research]

(1) Research cooperation within the National Institutes of Natural Science

・ Is the cooperation productive?

(2) Domestic research cooperation based on inter-institutional agreements

・ Does each program take advantage of characteristics of the agreed institutes?

(3) Industry-university cooperation

・ Is the cooperation a productive spin-off of fusion research?

・ Does it contribute to the local community and industries?

Chapter 2　Summary of Each Section

Following the perspectives shown above, this chapter presents main points of remarks by section given by the committee and subcommittee members. The figures in brackets show how many reviewers refer to the same points. Comments by the foreign reviewers are shown with little adjustment.

(1)　Domestic collaboration research

1) Performances and products after NIFS were reorganized as inter-university research institute in FY2004.

①Are the application categories properly up to date?

- Based on advice by the previous External Peer Review Committee, the categories are determined by the Domestic Collaboration committee dominated by external personnel, so the process is highly transparent. In order to contribute to a DEMO reactor, the Bilateral Collaboration has welcomed university centers conducting engineering research, and is now discussing topics to be handled jointly by several centers. In the LHD Project a new category has been established in connection to deuterium experiment, which was requested by the Fusion Network. This movement corresponds well to a scientific trend. Regarding the General Collaboration categories were reviewed in respect for voices of the community. Efforts have been made flexibly enough to fit scientific trend and academic progress. The performance is appropriate and highly commended. (6)
- Now that ITER has entered into a construction phase, Japan is to strengthen academic infrastructure through inter-university affiliation; to support development of ITER and DEMO; and to nurture scientists working there. National Institute for Fusion Science, or NIFS, is expected to strongly promote basic research in an extensive area related to the control of burning plasma. In this sense the approach of the three programs (General, LHD Project and Bilateral) is appropriate. Lines are drawn properly between the three: 1) the General Collaboration focuses on experiments using smaller devices and workshops including ones merely to share information; 2) the LHD Project focuses on experiments related to reactor engineering or fusion plasma such that can contribute to LHD improvement; and 3) the Bilateral Collaboration focuses on experiments on high-temperature plasma using medium-sized devices. Meanwhile, each program has a complementary and multilayered relationship with another, so that one can help others with

differentiated views. The Domestic Collaboration could be a model system for any scientific activities using large devices. So it is highly commended. Those who are studying the space, celestial objects or accelerators have a particular interest in the system of the Bilateral Collaboration. (4)

- For the Bilateral Collaboration, NIFS seems to be well aware of its responsibility not only as a hub care taker but also as a leader to guide all the participants (the Centers). What is highly commended in particular is that with the awareness, NIFS attempts to design a new type of collaboration with the characteristic Centers, which is highly commended. (1)
- Progress has been observed in the following activities of the Bilateral Collaboration: Studies with University of Tsukuba on the effect of electric potential/field structure on the physics of transport improvement and the development of Gyrotron; studies with Kyoto University to enhance advances of helical magnetic field configuration with its high controllability; the advancement of Japan's first steady-state spherical tokamak at Kyushu University; and the development work with Osaka University on fast ignition technologies. The performances are remarkable. The LHD Project and General Collaboration have also been fruitful to LHD and ITER. The 2010 IAEA Fusion Energy Conference (FEC2010) highly approved their output, which probes the adequacy of the application categories. (1)
- The categories have become more corresponding to the new structure of NIFS. It will take some time to determine whether the selection is adequate, but it seems to become more project-oriented. Although it is not clear whether academic progress is reflected well, NIFS's attempt to promote collaborations in reactor designing and engineering is commendable now that demand for a low-carbon society increases and ITER construction is in full operation. (1)
- It seems that the selection of categories follow academic progress properly, and is basically highly commended. The second mid-term plan stresses the promotion of cooperation in fusion engineering with a view to a helical demo reactor. In order to make the plan more effective and more efficient, here I propose following ideas:
  ① Categorize tasks into closed-tasks, tasks in common with tokamak, and tasks to be solved by helical alone, and work harder on the latter two in the Domestic Collaboration.
  ② Japan Atomic Energy Agency (JAEA) is working for the development of solid-breeder blanket while NIFS and universities are working for advanced blanket. Although work is clearly divided, NIFS is expected to lead universities to make academic progress as well as to take part in ITER's project of Test Blanket Module. (1)
- The Bilateral Collaboration handles many subjects that can be shared by the six Centers, so new ideas should be given to the program. For example, a new subject to prompt ties between Centers' can be created like comparison analysis of their devices in a closer relation or a study that requires the use of devices of more than two Centers. They will increase the program's usefulness and significance. The General Collaboration sustains the

foot of fusion research, and at the same time enables researchers in different area to communicate through the program. As it does, I expect NIFS to continuously handle a wide range of basic sciences and broad the horizon of fusion research. (1)

- The categories are basically highly commended. But those of the General Collaboration need further prioritization according to the recent budgetary situation. Expansion of the category is desirable but consideration is necessary to determine what to be emphasized due to financial limitation. (1)
- Bilateral Collaboration: In FY2010, two more large-scale research centers are added to the initial four research center. This expansion made more possibilities of collaboration area, so it resulted in 20 more accepted programs with respected to FY2009. However, the budget limitation in FY2010 collaboration overall, made funding limitation issues that to be resolved.

  LHD Project Collaboration: In this category, two major fields of research, such as "Fusion Engineering Research" and "Fusion Science Research" are maintained.

  General Collaboration: In FY2009, categories of proposal had been increased to 31 from initial FY2004 of 24, including sub-categories. This change is deemed to be reflecting progress of many fields of research interests.

  Therefore, the Domestic Collaboration Program of NIFS is rated very highly by its well-balanced mix of research areas by properly managed and updated categories.
- There is no doubt that application categories are properly chosen.,because they are up to date with current trends of fusion development.

  Moreover, NIFS activities are at the cutting edge of the international fusion research.

  Hence, all of the involved partners ranging from world famous scientific centers and universities to small groups in less renown universities from all over Japan benefit greatly from the collaborations managed by NIFS.

  Indeed, the partners focused on narrow specialized areas of research are provided with the guidance and the coherence needed to achieve the important goal of thermonuclear fusion.

  At the same time, they maintain their excellence in their field of expertise.

  Therefore, the system outlined long back in 2004 has proven to be a powerful mechanism to streamline and coordinate fusion research in Japan.

  The model is now widely recognized and used in different parts of the world.

  It seems that this is the only way to organize a broad interdisciplinary program which requires the synergy of many fields of science focused on a very important goal.

  Therefore, the goal of achieving nuclear fusion vital for the future energy supply has been transformed into the "real target" due to the progress made by the international effort during the period of 2004 – 2010.
- The Domestic Collaborations are divided into three types: Bilateral Collaborations, LHD

Project Collaborations, and General Collaborations. The total number of Domestic Collaborations has increased steadily since 2004, reaching ~450 in 2009, with much of the increase occurring in the category of Large Scale Computer Simulations.

Some changes have occurred in the application categories for the three types of Domestic Collaborations:

① Bilateral Collaborations - During the first mid-term period 2004-2009, NIFS carried out Bilateral Collaborations with four institutions (Kyushu, Osaka, Kyoto, and Tsukuba), with the number of collaboration activities roughly doubling during this period. In 2010, two new Bilateral Collaboration partners (Tohoku and Toyama) were added, to extend the Bilateral Collaboration program into the area of fusion engineering. This extension is appropriate is view of the emphasis on fusion engineering as a crosscutting Research Project of NIFS in the revised organizational structure of the Institute.

② LHD Project Collaborations - Apparently there were no changes in the application categories for this type of Domestic Collaborations. Also, the total number of activities remained unchanged.

③ General Collaborations - The biggest changes in application categories occurred here.

Two new categories were added: DD Experiments Planning (with four collaboration activities) and Fusion Archives (with eight activities). The change is appropriate because NIFS will soon receive final approval for its planned DD experimental campaign and because there is a need to accumulate historical records while the older generation of pioneering scientists in the fusion field are still available.

The subcategories within the category of LHD Project General Collaborations were significantly re-organized. The total number of activities in the LHD Project General Collaboration category was unchanged from 2004 to 2009, but these activities are now spread over the twice the number of subcategories (five in 2004, nine in 2009). This change is appropriate in order to facilitate correspondence to the revised organizational structure of the Department of Helical Research in NIFS.

Several application categories, although unchanged as categories per se, experienced noticeable changes in their respective numbers of activities: e.g., Large Scale Computer Simulations (15 → 59) and Workshops (16 → 24) increased, while CHS/CHS Data Analysis (12 → 4) and Basic Plasma (23 → 13) decreased.

Here are a few other comments:

The list of categories for General Collaborations has major categories called “LHD Project” and “Fusion Engineering,” which correspond to two of the three crosscutting Research Projects of NIFS. It might be helpful to organize the several theory-related categories in the list as subcategories of one major category that would correspond to the third Research Project, namely, Numerical Experiments.

In the list of categories for General Collaborations, it is not clear how the “LHD Theory” subcategory differs from the “LHD Numerical Analysis System” category.

It might be helpful to change the name of the “Coordinate Research” category, in order to distinguish this from the Coordinated Research Collaborations. A similar comment applies to the “LHD Project” category of General Collaborations, in order to distinguish this from the LHD Project Collaborations.

Since Bilateral Collaborations are defined on the basis of the use of large facilities at university research centers (such as Osaka, Kyoto, etc.), it is not clear why Bilateral Collaboration with NIFS itself has existed since 2007 [cf. page 26 of the second presentation].

- In domestic collaboration, NIFS distinguishes between three so-called “frameworks”:

① Bilateral collaboration
② Collaboration with LHD
③ General collaboration

Such a distinction makes sense. There is some overlap between framework 2 and 3, but the work under framework 2 is meant to be more long-term and seems to contribute directly to scientific methods used on LHD. Framework 1 is exclusively devoted to support larger facilities in four universities (Kyushu, Osaka, Kyoto, Tsukuba) and to connect their activities to the research done on LHD.

After 2004, the number of collaboration proposals has increased. This is mainly due to increase in “bilateral collaboration” and “large-scale computer simulation”. The vast majority of proposals is made in the framework 3 “general collaboration”. Here one has a very large variety of collaboration categories with a quite disperse number of proposals. It is remarkable that almost all proposals are accepted. It is reasoned that this is due to the beneficial role of a “caretaker”, who accompanies the proposal process, and due to a conscious promotion of innovative ideas.

My recommendation is to make sure that the quality of the general collaboration proposals is similar for all categories. It is usually a good sign if there is a certain rejection rate. NIFS may consider to adjust the schemes to have more competition and thereby to foster collaboration with the best and most innovative ideas proposed. This is especially important if the budget for collaboration further decreases.

②Has the collaboration research progressed based on the opinions of collaborators?

- A project of QUEST, a spherical tokamak device owned by Kyushu University, was promoted with the involvement of external personnel in application screening and project operating from the beginning of the first mid-term period. Such a system was introduced by all the Centers before the term ended. The Centers adequately exchange views with relevant communities like the Japan Society of Plasma Science and the Nuclear Fusion

Research group by holding symposiums and other meetings. Likewise, the LHD Project and the Domestic Collaboration respect external opinions. The screening process of the LHD Project is undertaken by the Fusion Network Committee, and in the General Collaboration caretakers are constantly in a close contact with participants. Besides, the Domestic Collaboration committee consists largely of non-NIFS members. Considering these factors, the collaboration programs are well connected with the community and adequately operated responding to opinions of collaborators, which is highly commended. (9)

- The cooperative use of diagnostic devices, which started in 2010, is a result of NIFS's eagerness to meet the community's needs. It is a reasonable and useful system in terms of effective use of assets within the community. It is highly commended. (3)
- It is extremely highly appraised that NIFS has been listening to the fusion community so as to develop the General Collaboration, activate joint use and joint research of the LHD Project and the Bilateral Collaboration, and to launch bilaterally-interactive collaborations and network-type collaborations. In order to make the joint systems even more effective, attention should be paid to on-the-spot voices of universities through the Fusion Network and other channels. (1)
- Responding to the community's demand, NIFS has launched joint work in fusion engineering. It also has prepared a new team of researchers within the institute, has secured budget, and has increased participants. It suggests NIFS fulfills its responsibility as an inter-university research institute, which is extremely highly valued. (1)
- Although there is often a confliction between the efforts to expand a program and to maximize its performance, it is expected to increase the pool of human resources in a longer run for expanding the community. (1)
- The advantage of the Bilateral Collaboration is that the lack of personnel on a certain subject at a Center can be covered by other Centers. This is a highly commendable system. Meanwhile, information about the Bilateral Collaboration has to be conveyed more to the community. I expect that an informal meeting, which was highly valued by the External Peer Review Committee years ago, would be continued as it is. (1)
- Among the Centers, Kyoto University is highly commended for its effort toward open and fair operation of its Bilateral Collaboration activity. What is expected there is that it will be more eager to take in the community's opinions. It is expected to add that point to its objectives. The University of Tsukuba is also rated high not only for its H-mode research using the mirror device but also for its attempt to shift it to divertor research, which takes advantage of the end loss out of the H-mode study. Kyushu University is highly commendable for its unprecedented attempt for steady-state operation at the spherical tokamak QUEST using electron Bernstein waves, but it should expand its research theme so as to help tokamak performance as a whole progress. (1)

- Many activities of the joint use and joint research are conducted in coordination with the fusion community, which are highly commended. Meanwhile, it seems necessary to know to what extent NIFS or the community has been benefitting from the General Collaboration or the Joint Research. (1)
- It is appreciated that major issues related to DEMO are set as a common target for the Centers, but it should be clear what makes the Bilateral Collaboration differ from the LHD Project. Consideration is necessary in order to treat magnetic fusion and inertial confinement fusion as one discipline. (1)
- PR effort should be enhanced on middle or smaller workshops as well as lectures held at/by NIFS. There is often a case that a collaborator is inspired to attend such events while working for the Domestic Collaboration. (1)
- The selection and management of NIFS Domestic Collaboration is conducted by "Collaboration Committee" consisted by 44 Members, 25 from outside and 19 from NIFS.

  Also, the "Collaboration Committee" is organized by three sub-committees for three areas of Collaboration. The planning, selection and review processes has been developed to fit each categories of collaboration purpose and needs, with access to the "Fusion Research Community" through "Fusion Network (F-net)" for their feed-back.

  Therefore, the management system of collaboration process is very well organized and balanced, so that fair representation of collaborators' opinion is founded in the system.
- The progress is visible in all aspects of these activities.

  NIFS is adjusting and improving its governing role all the time.

  It shows a great flexibility by introducing new forms of collaborations such as " Fusion Network " bilateral collaborations and etc.

  NIFS also reorganizes itself in order to provide the up to date leadership and guidance to smaller teams participating in the program.

  Thereby it facilitates a broad and profound approach to the most topical and timely issues of fusion research.

  As a result even small groups can make the difference addressing difficult questions.

  Therefore, they become highly competitive and well known.
- The three types of Domestic Collaborations are overseen by the Collaboration Committee, which is set up under the NIFS Administrative Council. Of the 44 members of the Collaboration Committee, 28 members are from outside NIFS.

  The Collaboration Committee appears to be functioning properly.

  NIFS used a questionnaire to solicit comments from collaborators about Domestic Collaborations; this was a useful exercise. Most of the comments were positive. NIFS and the Collaboration Committee will incorporate into future planning the suggestions and requests that were received.
- Of pivotal importance is the collaborative committee that supervises the collaboration

program. There is a balanced number of members from both sides, NIFS and universities. As an external reviewer I cannot say more on this point.

③Have the results of collaboration research been published properly?

- The number of publications from the NIFS's Domestic Collaboration are between 200-400 each year, and about half of them are created by non-NIFS first authors. To IAEA's Fusion Energy Conferences, 30-40 contributions are made each time. Around 10 out of the figures are by non-NIFS first authors. Considering that the Domestic Collaboration annually handles 400-500 activities, quite a high percentage of the activities have come to academic publications. Therefore, it is reasonable to see the Domestic Collaboration is full-fledged work of high quality. At the FEC2010, a lot of results from the Domestic Collaboration were presented, and impressively, many of them were picked up at the summary section on the final day of the event. Therefore, the efforts toward publication as well as the performance are both extremely highly commended. (9)
- The efforts for publication, including the arrangement of the debriefing session, are appropriate and basically highly commended. Particularly the work regarding the Bilateral Collaboration is highly appraisal as members ask for the community's opinions after presenting their results in a meeting like its symposiums at JSPF. (3)
- NIFS is working to cover half of a contribution cost and provide similar support. Such effort is highly commended. (2)
- Although results of the programs are available online, it is not accessible enough. They should be located on an upper directory of the website. Paperback editions are fine as they are now. (1)
- Further effort to disseminate results is expected, such as arranging a session for each program, if possible, in the meetings of society. (1)
- The performance is good in terms of the number of publications. The portion of foreign first authors is expected to increase. University's researchers will have to be encouraged to serve as a theme leader of the LHD Project as they are now. (1)
- The LHD Project is highly commended in that it draws attention from prestigious journals and international conferences, and therefore it leads the mainstream of fusion research. The Bilateral Collaboration has to gain such attention so as to ensure its international competitiveness in a long run, while it is expected to support universities in terms of research and education from a wider standpoint, which gained through its middle-sized experimental activities. More PR effort would be also necessary targeting researchers across a wide range of fields. (1)
- A yearly report of the Domestic Collaboration and the Annual Report often overlap considerably. If the former could be published in English, the latter should be given up.

From a standpoint of saving money, it might be also a good idea to print out an index only and put the rest into a CD. If significant results are released as news on the website, it might have more impact. (1)

- It is better to oblige authors to put a clear acknowledgement if they are supported by the Bilateral Collaboration. Paper contribution to prestigious journals is expected to increase from the program. (1)
- There is no system at NIFS to provide financial support to researchers of the Domestic Collaboration for covering their travel fees abroad. That seemingly discourages them to participate in IAEA-FEC conferences. If such system is prepared, the number of presentations is believed to increase. (1)
- The publication of the Domestic Collaboration results is adequate and highly commended, but further attempt will be necessary in a way of publication, so that outcomes are exposed to various assessments including the assessment from a public standpoint. (1)
- Within collaboration framework, the gradual increase of outside collaborators' contribution to the overall publications is promising trend. It is, however, important to investigate reasons of decreasing number of published papers after 2006 peak.
- Although the number of publications constitutes a very crude criterion of the scientific activity it is impressive and remains within the range of 100 to 200 over the years starting from 2004.

  Some variations are natural and inherent within the scope of an interdisciplinary program.

  Furthermore, the number of presentations from the program constituting highlights of fusion activities is reported at the biannual IAEA Fusion Energy Conference triggering a lot of interest and admiration to the results obtained by the program managed by NIFS.

  The number is a significant part of the total ranging from 30 to 40 on each occasion.
- Many papers based on results from collaboration research have been published each year during the period 2004-2009. The total number of such papers has ranged from a high of ~400 (in 2006) to a low of ~200 (in 2009). I expect that the larger numbers of papers published in the years 2004, 2006, and 2008 are explained by the biennial occurrence of the IAEA Fusion Energy Conference in those years. There appears to be a slight tail-off in the total number of publications, if one compares 2009 to 2007 and 2005; presumably this trend is a temporary anomaly.

  The number of collaboration research papers with NIFS scientists as first authors and the number with non-NIFS scientists as first authors are about equal each year (except in 2008). The number of presentations at the IAEA Fusion Energy Conference with non-NIFS scientists as first authors is actually increasing, which would indicate that the Domestic Collaborations are being successful in strengthening the research activities at universities.
- There is a growing percentage of papers published by non-NIFS scientists based on

results that were obtained within the collaboration with NIFS. This is a very good development that should be further encouraged. Also the percentage of presentations on the IAEA fusion energy conference is increasing. The slight tendency of decrease of the total number of papers is not worrying but should be reversed in the future.

④Has the collaboration research progressed based on evaluations over the previous results?

- All the three programs require participants to present their outcomes and write reports. When an application is made for continuing the research, its latest result is assessed with quantitative measures and a decision is made based on the assessment over the continuation. Adoption and allocation are both done properly. It is considerably demanding work, but it is carried out as it should be. The effort is highly commended. (7)
- The Bilateral Collaboration has been properly improved based on advice by the 2005 External Peer Review Committee as well as by the program's external reviewers for 2007-2008. The composition and election of the Bilateral Collaboration's committee members were reviewed, and the Centers started a steering system of high transparency by including external personnel. The efforts are highly commended. (5)
- The Domestic Collaboration is operated based on the assessment over its previous performance, which is basically appropriate. A problem is that NIFS's argument for the future plan including LHD is a little hard to understand. It will need discussion involving young researchers in particular as well as external personnel, and the discussion should be based upon what NIFS attained so far. (1)
- The LHD Project, which handles NIFS's main subjects and has a large budget, attracts attention among higher levels of research journals and international conferences. It is planned and executed properly. The General Collaboration encompasses a great amount of activities, so an overall evaluation cannot be given to it easily. It could not obtain outcomes of high quality without enhancement of diagnostic devices. Prolonged operation of inefficient work has to be prevented. For the Bilateral Collaboration, it will be important to vigorously discuss a vision from a mid- or long-term standpoint to maximize program performances to the given direction with limited money. A brave decision like changing a direction may be necessary according to circumstances. (1)
- For the Domestic Collaboration a standard screening process is used for its joint-use application, and the process is widely adopted by inter-university research institutes. However, an evaluation method has to differ between for seminal studies and for project-type collaborations which already have a clear objective. The former will need a careful evaluation not to neglect support while the latter will need a different approach, such as mid-term monitoring to judge the degree of attainment for selection and

concentration. (1)

- It is uneasy to evaluate performance and it is challenging to reflect the evaluation on the following operation. Despite such difficulties, the effort is relatively effective. (1)
- The evaluation at the LHD Project debriefing session greatly helps the following year's activities, so it is commendable. Although the LHD Project has the largest budget among the three programs, there is no indication about the program in presentations by participants. It should be mandatory. Meanwhile, when journals oblige authors to do so, which is good because it visualizes the LHD program's performance. Regarding the General Collaboration, it is expected to increase the quality of its activity report. (1)
- It is basically highly commended. Meanwhile, there is an increasing expectation to NIFS for participation and leadership in Japan's TBM of ITER. If such viewpoint is added to evaluation, engineering-related activities will be more effective and efficient. (1)
- As the case of selection process, the evaluation process also followed similar procedure with "committee" with many outside members for transparency and fairness. Therefore it is reasonable to accept that the collaboration has been guided by evaluation process, with effectiveness and fairness.
- The progress is indeed impressive.

  Numerous Japanese fusion communities are strongly encouraged to contribute to the progress of Japanese nuclear fusion research by participating in NIFS activities. NIFS is undoubtedly the fore front leader of the world fusion research. LHD device is the masterpiece of fusion engineering.

  The synergy of the advanced geometry of the magnetic field, the superconductive coils and the enhanced heating provides for the achievement of record parameters highly relevant for fusion. It is obvious that most of results are impossible to achieve on a smaller scale university type facilities. Hence, university groups benefit greatly from their collaborations with NIFS. The system adopted to incorporate research carried out at universities is unique constituting the important Japanese invention. This is also born out by the results obtained on other important yet smaller devices such as GAMMA 10, Heliotron -J, QUEST and FIREX -I and other installations.
- Each university research center involved in a Bilateral Collaboration arrangement with NIFS has established its own local committee, with some of the members from outside that research center, for managing its Bilateral Collaboration activities. This was done in response to a previous recommendation from the External Peer Review Committee. The Bilateral Collaboration Subcommittee of the Collaboration Research Committee reviews the experimental plans from these local committees.

  Safety conditions have been checked during visits to the Bilateral Collaboration university research centers. This, too, was done in response to a suggestion from the External Peer Review Committee.

It would be useful to construct a complete list of the recommendations concerning collaboration research that have been made at previous meetings of the External Peer Review Committee, along with the corresponding response by NIFS to each recommendation. This type of list is often presented at experimental facility program advisory committee meetings in the U.S.

I commend the presentations by Prof. Kaneko and Prof. Mito for presenting many statistics and quantitative data that serve as metrics to indicate how well the various collaborations are proceeding. This had been a previous Review Committee recommendation, and NIFS has responded very well to providing this type of information.

- Yes. Previous recommendations have obviously been carefully considered to improve the collaboration program. In fact, since LHD is operated as an inter-university facility, almost all previous reviews have extensively addressed this issue. Thus, a frequent monitoring is guaranteed and the collaboration is well embedded into the scientific context. Several measures were more recently implemented to improve the collaborative network of NIFS, e.g. collaboration committees, full access to the NIFS network, visitor center etc.

⑤Are the results of the collaboration research accumulated properly as an academic resource?

- Outcomes of the Domestic Collaboration have been accumulated in various forms to lay an academic foundation, such as articles in journals and presentations at international conferences. The Bilateral Collaboration in particular is highly valued in terms of accumulation performance. During the last term, taking advantage of the Centers' devices element research was promoted and many things were found, Results were accumulated as important knowledge, and become what the second mid-term plan is based on. The General Collaboration is very good in that more than half of the publications are by non-NIFS authors and the number of IAEA-FEC presentations by non-NIFS staff are on the increase. (6)
- Along with the accumulation of knowledge like papers and presentations, NIFS is working for real data like QUEST data, using its data acquisition system. It is highly commended in terms of accumulating not only abstract resources but also practical information. (1)
- The Domestic Collaboration is considerably highly appreciated in that it promotes knowledge systematization and increases academic resources in the field that each university is good at. NIFS and partners gain international recognition for their engineering work: NIFS for its work in superconducting engineering; Toyama University in tritium science and technology; University of Tsukuba in gyrotron technologies; NIFS again in advanced structural materials; and Nagoya and Osaka universities in PSI research. Besides,

researchers in a leading position are well renowned and highly praised. Therefore, the Domestic Collaboration has contributed to the enhancement of Japanese intellectual and human resources as a whole. (1)

- Along with the publication of original papers and presentations at international conferences, online disclosure of presentation materials and arrangement of organization repositories are all appropriate. (1)
- I believe outcomes have been well accumulated, but I propose the work should be materialized somehow. It is expected to make it clear how close each research comes to a goal in a bigger picture in terms of the categories like (1) helical confinement, (2) plasma-wall interaction, (3) selection of subjects for designing a demo reactor and so on. (1)
- It has become extremely harder for a national university to develop research on a laboratory by itself since it gained independence. For development and activation of the community, active support to laboratories will be strongly expected. (1)
- When evaluating an activity, reviewers should not only assess a reported outcome, but also its international status and impact level on the relevant studies with an objective scale; such as how much attention it draws from prestigious journals or international conferences, or how many papers list it in their references. (1)
- The Annual Report is downloadable for anybody. Once registered, anyone can use the paper database and the NIFS Article Information System. Maintaining this system itself would be sufficient to contribute to the progress of fusion research. (1)
- The work of accumulation is commendable, but it is a little invisible. New ideas would be necessary about its method. (1)
- In bilateral and LHD project collaborations, the collaboration results are well documented, and these results are indeed very high quality works in academic viewpoint.
- The collaboration research is accumulated properly due to the management structure invented at NIFS.

  Indeed, the administrative council of NIFS promotes the collaboration research vigorously.

  The strategy of the organization of the fusion research in Japan is constantly monitored and examined.

  The decision making is carried out by committees summoned by NIFS.

  This system facilitates the feedback and the effective control of the program as a whole activity focused on the specific goal.

  It broadens the range of issues addressed within the framework of fusion research adjusting to the progress made continuously.
- NIFS is maintaining proper records of the collaboration research activities. Informational lists were provided to the External Peer Review Committee concerning:

- Collaboration programs (354 in number)
- Publications (very extensive)
- Patents (28 during the 2004-2009 period)
- Collaborations by NIFS scientists with companies (34)
- Collaborations between NIFS and companies (105)

On an annual basis, university scientists and research centers report about their collaborative research activities and results at meetings scheduled for this purpose.

- Two flagships of the collaboration program of NIFS are (1) the joint research on LHD and (2) the bilateral collaboration with larger university facilities. The joint results obtained with GAMMA 10, Heliotron-J, QUEST, and FIREX-I are relevant for fusion research and of high quality. The respective four universities also serve as multipliers for the entire university network. The collaboration on LHD is mainly devoted to diagnostics, which is here clearly the best field for university research.

⑥Have the circumstances for collaboration been improved?

- Circumstances are improved such as accommodation, internet environment and safety management system. The Bilateral Collaboration is outstanding in particular. The Centers include external personnel into a steering committee and keep working hard to increase fairness and transparency in steering a program. Conditions for visiting co-researchers, such as houses and network circumstance at the Centers are steadily getting better. All the efforts are highly commended. (4)
- The unification of services into the Visitor Center (the former User's Office) is beneficial for visiting co-researchers of the General Collaboration. The work for improvement is basically highly commended. (4)
- The system of cooperative use diagnostic devices was launched in November 2010. As represented by the effort, support conditions are improved gradually. It is highly commended. (4)
- Support conditions and research surroundings have been considerably improved, which is highly commended. (2)
- In this regard, a continuous effort is desired. While listening to those actually stayed, an adequate level of improvement should be made so as to respond to voices of various co-researchers. (2)
- Laboratory-based researches do not necessarily have sufficient support. Therefore, the introduction of the cooperative use system and the network-based collaboration is appreciated, but these newly-launched attempts should be vitalized, so further support is expected. The accommodation facility of Helicon Club is around ten years old. Although I know it is financially difficult to undergo renovation as frequently as a commercial one

does, I suppose the facility needs some repairing work, particularly to the bathrooms, toilets and air-conditioning systems. (1)

- Conditions has been improved well enough. Especially the massively parallel plasma simulator, which sustains theory and simulation research, is brilliant. The efforts of those working for that are highly commended. (1)
- Challenges have been well addressed, and some of them have been cleared. One of the examples is that a foreign researcher is now allowed to be an applicant now. Such efforts to improve researchers' surroundings are highly commended. (1)
- The effort for the LHD Project is highly commended as NIFS continuously listens to demands regarding peripheral equipment directly related to studies. What is next is how to turn such voices into an actual improvement. The administrative provisions are also subject to improvement, but there are still some voices that the work is bureaucratic. (1)
- Improvement is seen in research-supporting systems and researchers' surroundings. Thoughtful care toward foreign staff is also seen in the attempt of increasing English-written materials. They are highly commended. (1)
- The budget of the Domestic Collaboration now can cover the purchase or the repair of a personal computer. Use of money has become much more flexible and other conditions are getting better. The efforts are highly commended. However, I have a concern that a future budgetary decline could worsen researchers' environments. (1)
- The NIFS's effort to make user-friendly environment for collaboration is progressing, such as "Visitor Center", NIFS Repository, etc. It is also noted that the convenience features such as "network access" and "inside accommodation" has been provided. The safety management for collaborators is also improved by utilizing documents with "lessons learned". It is, however, the circumstance for foreign collaborators has room for further improvement.
- The circumstances for collaborations have been revised and improved significantly.

  User center has been established employing a user friendly interface.

  NIFS Repository has commenced collecting the records, papers, external and internal reports thereby keeping the history of research available and transparent.

  Diagnostics equipment is properly stored and available for rent by collaborations teams and individual researches from the outside of NIFS.

  The collaboration teams are rearranged along the lines of the reorganization of research divisions.

  3 new projects have been launched recently.

  The exchange of personnel with universities has been facilitated by providing mobility both at the " Personal exchange-type " and " Network exchange-type " levels.

  Proposals from foreign researchers may be adopted with exception of "Numerical Analysis System" although the financial support is limited.

- NIFS is commended for having instituted a number of useful improvements in the system for research collaborations.

  The increased availability of information about safety procedures for Japanese and international researchers is consistent with recommendations from the 2009 External Peer Review Committee meeting.

  Previously, foreign researchers could only work on LHD with Japanese scientists. Now, international scientists may submit proposals for collaboration research in all categories except that of Numerical Analysis System, which will allow them to carry out experiments on LHD directly. This, too, is a useful step forward.

  While visiting NIFS before and after this year's External Peer Review Committee meeting, I personally used the new internet network for external users (Extra-Net). It functioned well.

  The Fusion Network that is administered by NIFS will now allow inter-university bilateral collaborations to be carried out. This is an excellent development.

  The NSTX Program at Princeton issues a guidance letter every year to inform outside scientists about topical research priorities and collaboration opportunities. The program letters are posted on the NSTX web site (http://nstx.pppl.gov/DragNDrop/Program_PAC/Program_Letters/). It might be useful for NIFS to do something like this, especially for the LHD Program.
- Yes. NIFS has developed an impressive program to collaborate with a large network of Japanese universities. The university groups very often have a particular strength or expertise in a certain subject/field of plasma physics and engineering. This large network of university research in plasma physics with a strong link to fusion research is probably unparalleled in the world. This huge asset of Japanese plasma science has gained strength and visibility after LHD was introduced as an inter-university facility and NIFS is acting as an agent to stimulate the collaboration with the universities. This is a very remarkable accomplishment.

⑦Has the collaboration research helped educating students and young researchers?

- The Domestic Collaboration seems to function in a way that it takes in young researchers and post-doctoral researchers, proposes research subjects, and then yields specialists of certain fields. The Bilateral Collaboration and the General Collaboration, in particular, take care of a large number of students and young researchers, assist thesis production (1000 over the past five years) and help many acquire a master or doctor degree. Therefore, the Domestic Collaboration makes a considerable contribution to development of young personnel and therefore highly commended. (11)

- A systematic encouragement will be needed to inspire more PhD students to take part in NIFS research for the purpose of educating university-lab students. (1)
- Although the number of scientific exchanges has increased, the participation of young researchers is still low. This should be improved. (1)
- Believing that project-type collaborations could not sufficiently cover fields in training young researchers, NIFS is now preparing a new type of collaboration open to universities in the LHD Project so as to handle an extensive list of subjects. The effort is appropriate. Meanwhile, the General Collaboration needs careful attention not to lose a primary role of the program. If NIFS is willing to take a more serious step for developing young personnel, it needs to introduce some new measures, like introducing a program in which NIFS undertakes postgraduate education commissioned by universities, or activating the exchange of young staff equivalent to assistant professors between universities. (1)
- Although NIFS's educational performance for the Graduate University for Advanced Studies and Nagoya University is limited in number, it will be massive when we include those who joined the Domestic Collaboration. Most fusion energy researchers should have experienced the program during their university days. However, there seem to be only a few cases that NIFS assistant professor or associate professors moved to other universities for stepping up their careers. (1)
- There is cases that the Domestic Collaboration has led to a job offer at NIFS, which therefore seems to be a good system. Interactive activities in the General Collaboration reportedly increase an educational effect, and the Bilateral Collaboration helps develop human resources as well. They are highly commended. (1)
- Further improvement will be expected to the LHD tour and other PR efforts targeting prospective students. (1)
- The contribution is considerably made and highly appreciated. Financial difficulty will be expected, but the effort should be continued as it is now. (1)
- In bilateral collaboration, 25~35 Master Degree and 4~8 Doctoral Degree have been endowed yearly. It is noted that students and young researchers are benefited from collaboration with other university collaborators.
- This activity has made enormous progress lately.

  Many first class students have been brought up to the level of prominent scientists providing the influx of original ideas to both the LHD experimental and fusion theory programs.

  Their presentations have been remarkable and profound addressing a wide variety of timely and topical issues within the framework of NIFS program.

  Many famous universities in Japan contribute by educating excellent students at the Master and Doctoral levels.

NIFS is completing their mission by giving access to the world largest facilities and teaching them to work successfully in a large team.

In summary, this system sustains a classical scheme of bringing the " Big Science " to the university type school of education.

- During 2004-2009, a significant number of students at Kyushu, Kyoto, Osaka, and Tsukuba obtained Masters degrees and Ph.D. degrees based on research performed through Bilateral Collaborations.

  Tsukuba University provided specific information about how the Bilateral Collaborations have enhanced the education and research motivation of students and young researchers, citing an increase in published papers and conference presentations from 120 per annum to 180 per annum, a 50% increase.

  In the General Collaborations, students constitute 20% of the collaborators. The largest absolute number of student collaborators (about 190) work on LHD experiments. Not unexpectedly, students comprise the largest percentage of collaborators for collaborations having to do with Numerical Analysis.
- Yes. The access to all NIFS facilities (LHD, supercomputers, instruments etc.) is clearly an improvement for students and young researchers at Japanese universities. The collaboration research very much improves their mobility and helps to establish new contacts, both on national and international level. It is recommended to advertise the NIFS collaboration to students, who are at the beginning of their career; the outstanding working conditions in connection with the NIFS collaboration should attract more students to choose plasma physics as their research field.

2) Future direction

①Does the plan in each category suggest a direction based on a long-term vision? Are they satisfactory as a plan of COE of fusion research?

- A vision is given to the second mid-term plan and it says that NIFS plans to enlarge engineering-related activities of the Domestic Collaboration for the purpose of realization of a helical DEMO. The direction is appropriate and the planned steps along with the direction are also appropriate. The Bilateral Collaboration particularly has had a big move in this way. It welcomed two new faces of Toyama's Hydrogen Isotope Research Center and Tohoku's International Research Center for Nuclear of Institute for Materials Research (IMR) in 2010. Subjects are selected based on the presumption to be tackled together with major topics like LHD, numerical experiment reactors and fusion engineering. Network-style cooperation connecting the Centers is also under discussion. These movements are appropriate and well correspond to the long-term vision, which is highly

commended. (8)

- It is appropriate as a whole. For the Bilateral Collaboration using middle-sized devices, it is not easy to constantly make a high level of achievement with global impact while assisting university's extensive work including education and personnel development. What is significant there is to create an environment where sufficient discussion can be made over a long-term vision, including analysis of the world's trend, selection and concentration of subjects, or resource allocation between integrative and reductive studies. (2)
- The plan for the LHD Project is highly commended as it is based on a long-term vision. (2)
- The nationwide system of collaboration is unique to Japan, and it has been highly fruitful in terms of activating the research that inevitably depends on larger devices. In this sense, NIFS's Domestic Collaboration is highly commended. An inter-university research institute is to make decisions about a future plan and other issues through discussion with a relevant community, so NIFS is expected to continuously take counsel with the community through various channels including the Fusion Network. (2)
- I deeply hope that NIFS will have a strong resolve to bring about a fusion reactor to Japan and will keep operating the Domestic Collaboration in a long run. It should not go back to mere plasma-confinement research. (1)
- The future direction of the Bilateral Collaboration is basically highly commended, but its long-term vision is a little invisible. It may need to be reviewed based on a budgetary situation. The plan of the General Collaboration and that of the Coordination Research are fine, but the both partly lack the perspectives of a long-term vision. I suppose they also need reviewing. (1)
- The total number of papers and doctor's degree acquisitions has been decreasing at NIFS and the Centers since full-fledge work of ITER Project began. The tendency may be partly due to a budget cut. What NIFS should do then is to give direction to DEMO research for seeing material potential while supporting ITER of course. A scenario should be clearly drawn about how to supplement materials' limitation with system designing, based on latest data. (1)
- What is good about the LHD Project is that it handles basic topics as well as project-related subjects in a bid to activate university research and develop human resources. It is an innovative idea to integrate core plasma research and engineering research in the Bilateral Collaboration and further development is expected in this way. A long-term vision on the General Collaboration is a little invisible from the report but this may be attributed to the nature of the program. (1)
- In order to make activities more effective and efficient, it is expected that NIFS will take an initiative among universities in the way to a helical DEMO reactor. (1)
- In the 2nd mid-term period, the promotion of fusion engineering research and the

contribution to the demo concept, are targeted for two major goals. In this direction, the two newly joined institutes in the bilateral collaboration cover the study of tritium and irradiated materials. Therefore, the plan for collaboration in the 2nd mid-term period well matched two major goal of same period. Also, these 2nd mid-term collaboration plans shared the key issues of NIFS' major research projects such as LHD, Numerical Experiment, and Fusion Engineering, in line with COE function of NIFS.

- The plan is very specific and clearly outlined.

  Two new universities join the bilateral collaboration programs.

  This represents the important extension for issues required for DEMO such as tritium handling technology and irradiation caused by high energy neutrons.

  Of course, key issues faced by LHD, Numerical simulations and Fusion Engineering will be addressed in depth.

  Already approved projects include heating of the Super Dense Core plasma in LHD by Bernstein waves and control of recycling by a novel divertor scheme.

  These improvements may result in the record performance in the near future.

- The numbers of different types of NIFS collaborations, as well as their diversity and breadth, are truly impressive. The management of these collaborations by NIFS as a Center of Excellence for fusion and plasma physics has been outstanding.

  The plan to continue with the present three types of Domestic Collaborations is reasonable. New developments are planned for the Fusion Network (in particular, to enhance collaborations among participating institutions) and for the enhancement of fusion engineering-related collaborations. Both of these developments may require additional budgetary resources.

- The long-term vision of the plan is the joint-effort to solve the remaining issues in physics and technology on the way to fusion as a clean, abundant, safe energy for the next century. In this sense, fusion research is by nature goal-oriented and follows a well-defined plan. Nevertheless, it is scientifically sound to provide room for curiosity-driven research. Here, the bilateral and the general collaboration with the Japanese universities play a particularly important role. The young generation of researchers in the universities approach known problems with a fresh attitude. In this very best sense, the collaboration program acts as a COE for Japanese fusion science.

  The NIFS plans to increase collaboration on engineering can only be applauded. There is an enormous engineering know-how available in Japanese universities, which is absolutely needed for the development of a fusion reactor prototype.

②Does the collaboration research function as a pivot for advancing new studies, such as a program under the Grants-in-Aid for Scientific Research?

- New developments occurs out of the three programs of the Domestic Collaboration in various areas. They are open to younger studies targeting basic sciences. The survey on the Domestic Collaboration shows that as many as 188 studies based on the programs have acquired external funding, which suggests that the program has effectively been a bed for a new research. It is highly commended. (3)
- A new type of network coordination, currently in preparation under the Bilateral Collaboration, is expected to have a high potential of education. Coordination items are subject to budget request, so I look forward to seeing the outcome of the effort. The policy of the LHD Project is highly commended in that the program will serve as a basis in the framework of fusion and plasma science, helping domestic organizations make a breakthrough. The General Collaboration is planned to become more interactive, which meets a demand well and deserves a high mark. (2)
- The next mid-term plan says that all the engineering-related collaborations is to be developed for the realization of a helical DEMO. It is basically commended. (1)
- The Domestic Collaboration is a good place for NIFS and universities to compete each other in a complementary or synergistic manner. From the standpoint, the parallel operation of the comprehensive studies and the well-directed project researches are adequate. The NIFS Project of numerical experiment, for instance, which focuses a numerical test reactor, is meaningful for universities because it motivates them to study theory and simulation. I hope the project researches will make an evolution and increase competitiveness. (1)
- It seems possible for a university researcher to carry out fruitful research while making an self-independent effort such as applying for the Grand-in-Aid for Scientific Research. The distance of the Domestic Collaboration from university researchers is proper and commendable. Because too much dependence on NIFS may impede scientific advancement, it is better that co-researchers are commonly aware of the significance of a self-help effort. (1)
- The Domestic Collaboration is commendable as it is good as a basis for a new attempt. (1)
- Another evolution could be expected if the way of disclosing outcomes is improved and the evaluation process is more systematized. The result of the efforts this time will appear in several years. (1)
- There has not been outstanding output so far, but basically the current method seems proper. I have a little worry as the budget for the Domestic Collaboration, particularly for

the Bilateral Research and the LHD Project, has been declining over the past a few years. (1)

- Amid the increased awareness that the realization of a fusion-power reactor needs cooperation of domestic researchers across many fields, it is commendable to let the Domestic Collaboration be a base for new exploration. The General Collaboration is expected to be more open to many people. The successful internationalization of the Domestic Collaboration is basically valuable. Fair and sensible operation is desired. (1)
- Among the three programs, the LHD Project can be highly assessed in this perspective. But the other two, particularly the General Collaboration, seemingly fail to bring about new developments. It makes me say they are just fine. (1)
- A new system has been introduced to allow co-researchers to use some of NIFS's devices. This is an extremely useful measure for universities, so I hope the system will be expanded as much as possible. (1)
- An considerable effort is expected so that the Bilateral Collaboration will bring out a new development. (1)
- In the summary of questionnaires' response from 136 collaborators, 435 Bachelor degree, 519 Master degree, and 92 Doctor degree have been endowed through participating collaboration program with NIFS. It is also recorded that 188 Grant-in-Aid are received by NIFS collaborators with subjects related to the collaboration program. Therefore, it is demonstrated that NIFS collaboration activities provided many opportunities for new research grants for advancing new studies.
- NIFS program constitutes a powerful vehicle driving the collaboration research forward.
  It is pivotal in achieving the near term and long term goals of fusion research.
  However, the progress is the subject of resources available for financing the program.
  To this end, the budget cannot be cut any further if the results and the output are determined to remain at the current level.
- Responses from 136 of the collaborating institutions reported that 188 Grants-in-Aid for Scientific Research related to the NIFS collaboration program had been obtained during the first mid-term period and that a very large number of students had graduated with Bachelor, Master, and Doctoral degrees after participating in the collaboration program. These are very good indications that the Domestic Collaborations are successfully functioning to advance new studies.

  A significant concern is the recent reduction of the 2010 budget for Bilateral Collaborations (the largest of the three collaboration categories, down by ¥100K = 13% from 2009), with this budget now being folded in with the budget for LHD Project Collaborations (down ~¥50K) and General Collaborations (constant). If this reduction

continues, the Collaboration Committee and the NIFS Coordination Research Project will have to more strongly prioritize research proposals, which will lead to a reduction in the acceptance rate (currently at almost 99%). Establishing reasonable criteria for such prioritization will be important.

- The simple fact that NIFS pools the know-how, which is available in the Japanese university system, makes the collaboration research program pivotal for the field. The access to the NIFS facilities and the huge know-how of the NIFS staff opens up new horizons for university groups. This becomes evident by the large number (188) of grant-in-aid contracts and graduations (about 1000 in total), that are directly related to the collaboration.

  It must be emphasized that further budget cuts would endanger the future of this highly successful collaboration model. Conversely, a due budget increase would have a stabilizing effect and would allow to start new and urgently required activities.

(2) International collaboration research

1）International collaboration research based on inter-governmental agreements

①Has NIFS fulfilled its responsibility as an implementing agency?

- NIFS has sufficiently fulfilled its responsibility as an implement agency of international cooperation like Japan-US, Japan-South Korea, Japan-China and the International Energy Agency (IEA) activities, which is extremely highly commended. (9)
- I extend my sincere gratitude to NIFS's administrative section because university staff have been well cared, particularly in doing his/her administrative work. (1)
- Despite the fact that a governmental treaty is outdated, research cooperation of high quality has been maintained between Japan and the United States thanks to the efforts by relevant bodies including NIFS. The cooperation has significantly promoted research of the two nations. It is strongly desired to keep the level of cooperation continuously. (1)
- NIFS's Japan-US program has greatly advanced fusion research of the two nations. About 200 people are annually exchanged, around 100 papers are created each year, and outcomes have been well accumulated. (1)
- Output of the Japan-US program should not only be presented at the annual reporting session but also be argued at other meetings. Studies of the program are getting mature, so discussion is to be started over new subjects. The Japan-US safety monitoring should be put to end as it has completed its mission. (1)
- According to its strategy, the United States appears to be less enthusiastic about work with Japan, compared to work for South Korea and its device of KSTER (Korea Superconducting Tokamak Advanced Research) or China and its EAST (Experimental Advanced Superconducting Tokamak). A strategy should be designed to activate collaborations in connection with LHD and JT-60SA (JT-60SA is a large tokamak device owned by JAEA, a superconducting version of JT-60U. JT-60SA also refers to a project itself, as one of the BA activities which research steady-state operation of high-performance plasma that ITER cannot deal with). (1)
- The IEA cooperation is basically highly commended. NIFS has chaired the agreement on the development of the Stellarator/Heliotron concept, and has served as a coordinator with the German partner for the Coordinated Working Group activities, which suggests it has exercised leadership. (1)
- Another IEA agreement over steady-state operation is under discussion. Japanese devices like LHD and QUEST are designed to pursue such subject, and Japan has a considerable interest in engineering research. Therefore, it is preferred to extend research to an

international level rather than to focus an individual device. (1)

- The numbers of 25 sent out to China and 50 coming from China show how actively people are exchanged between Japan and China. Besides, NIFS has carried out collaborations with South Korea and with IEA. (1)
- Regarding Japan-South Korea cooperation as well as Japan-China cooperation, a plan should be made based on a fifty-fifty relationship, and rules should be established on publication. It needs to be argued how the programs could contribute to Japan's researches of tokamak, helical and fusion engineering. (1)
- China and South Korea have been working for a three-country framework. It is necessary for Japan to strategically determine its stance toward the movement. (1)
- NIFS does an excellent job of executing the three collaboration exchange programs based on inter-governmental agreements with the U.S., Korea, and China. On behalf of Japan, NIFS also is involved in managing activities related to IEA implementing agreements.
- The number of workshops and the number of exchange scientists for the overall US-Japan collaboration program have declined over the past decade by about 25%, due to budget limitations. However, the number of resulting publications has remained constant, which could be a sign of increased efficiency and which certainly indicates how these joint activities are considered to be valuable. Students have participated in these joint activities (e.g., eight Ph.D. theses resulted from TITAN collaborations during 2007-2008 and five Ph.D. theses from JIFT activities during 2007-2010). In 2010, the 30th anniversary of the US-Japan Fusion Cooperation program was celebrated, and a report will be published to commemorate this milestone. I would like to thank NIFS for its strong support of this bilateral cooperation program, which has led to numerous publications and invited presentations at conferences (e.g., the activities of the Japan-US Joint Institute for Fusion Theory resulted in 120 papers published in journals and 17 invited presentations at IAEA Fusion Energy Conference during the past decade).
- The international collaboration of NIFS has currently four pillars: (1) Japan-US, (2) Japan-South Korea, (3) Japan-China, (4) IEA implementing agreements. The latter are multi-lateral agreements on collaboration. The one on stellarators and heliotrons exists already for 20 years. All four areas of collaborative activity seem to be well implemented and (partially highly) active. Hence, NIFS is very well fulfilling its responsibility as an implementing agency for international collaboration. It will be interesting to see, to what extend the university partners of NIFS will benefit from this role in the future.
- The collaboration activities and its results proved that NIFS fulfilled its responsibility as an implementing agency well and appreciated by counter-part of international collaborations.
- NIFS has fulfilled the responsibility as an implementing agency for International collaboration research based on inter-governmental agreements thoroughly and in depth.

- All of the foreign institutes benefit greatly from the experience gained on the hardware and software development of the LHD which is the world leader in fusion science and engineering. NIFS is also instrumental in training young fusion scientists from all over the world, in particular from the Asian region.

②Are the policy and plan for future collaboration satisfactory?

- Regarding the extensive work of the international programs, the policy gives proposals to individual activities in a way that each takes advantage of parties. The policy is concrete, and therefore, it is extremely highly commended. (4)
- The policy, "The significance of Japan-US cooperation in science and technology is well recognized by the both countries. NIFS will work for reviving the outdated inter-governmental agreement in order to raise the cooperation up to a national level." is appropriate and extremely highly commended. I strongly hope that the effort will become paid off. (2)
- Discussion has begun over new specifications and requirements about ITER's superconducting coils. The work is very important as it is part of efforts to lay an academic foundation and systematize knowledge. What is particularly important for Japan there is to take the initiative in establishing a global standard. Therefore, it is necessary for NIFS to add this viewpoint to its international programs. (1)
- The plans on Japan-US cooperation over ITER, on Japan-South Korea cooperation, on IEA cooperation and on the Asia Core University Program are highly appreciated. But the scale and content of the programs should be reviewed after clarifying what is an objective and what parties will gain through an activity. (1)
- The Japan-US cooperation depends on devices of the United States. It seems better to use devices of the both sides. (1)
- The Japan-US cooperation is highly valued. Travel fees are usually fully covered, but sometimes researchers have to pay for themselves when having additional duties during a trip. I hope the payment will become more flexible as it used to be. (1)
- It is appropriated that the Japan-US Cooperation is going to cover the subjects that ITER cannot deal with . Regarding the TITAN (Tritium, Irradiation and Thermofluid for America and Nippon) Project and the JIFT (Joint Institute of Fusion Theory), the way of calling for application should be more attractive and more understandable. (1)
- Although there are a few things to note, the Japan-South Korea Cooperation and Japan-China Cooperation are basically adequate. (1)
- The current plan is highly appreciated. However, the Japan-US Cooperation and

Japan-China Cooperation will not be subject to budgetary request anymore, so it needs reconsideration from the budgetary planning. (1)

- Considering a recent shift of a research base to Asia from the United States and Europe, the trilateral cooperation of Japan, South Korea and China should gain a definite position. The three nations should join hands in the framework of steady-state operation, and a system for that need to be established. Personnel dispatch with more money is desired. (1)
- It is expected that NIFS's international programs will expedite an interactive flow of findings between parties, will increase intellectual and human resources of Japan, as well as develop young talents. It is also expected to help advancement of Japan's fusion research. (1)
- The policies and plans appear to be satisfactory.
- It has been agreed that the US-Japan Joint Activity will be continued and even strengthened. However, the inter-governmental agreement still remains unsigned after five years, due to legal complications. Fortunately, the cooperation activities have been (and will be) able to continue on the basis of inter-institutional agreements. Some exchange activities have been revised (e.g., the close out of Joint Computational Projects in the JIFT program by mutual agreement). Others will be reviewed (e.g., how to continue after expiration of the TITAN project in 2013).
- In the plan for the future, it is foreseen to strengthen all four existing pillars. This is very much supported since all of them are well working. NIFS is recommended to start with the development of a detailed plan how to collaborate in future with the device Wendelstein 7-X, the large superconducting stellarator under construction by the Max-Planck Institute for Plasma Physics in Germany. After start of plasma operation in 2015, this device will deliver complementary information on the key issues of stellarator physics. Here NIFS should become one of the key players in the international collaboration. This requires an early start of the planning and exchange of personnel beyond the present level.
- The reduction of fund may limit its full potential to maximum utilization. So it is advisable to expand its program further to its full potential.
- The policy and the plan for future collaborations are definitely satisfactory due to the broad range of options offered by NIFS activities. However, it is important to keep in mind that the plan is strongly dependent on the financing of the program in the coming years. To this end, it should not be reduced. On the contrary, it calls for an increase in order to carry out the policy and to realize the plans.

2) International collaboration research based on inter-institutional agreements

① Does each program take advantage of characteristics of the agreed institutes?

- **Collaborations in the framework are actively underway in partne**rship with distinctive world-class institutes, which is highly commended. For instance, NIFS and Princeton Plasma Physics Laboratory carry out an interactive research using the major devices of the both institutes while NIFS and University of Texas at Austin undertake a long-running collaboration taking advantage of strong points of each other, that is, computation simulation and theoretical analysis. NIFS and Max Plank Institute for Plasma Physics send one another around 10 people annually, and let visiting researchers join research at the other site using the helical devices of the two. (9)
- An coordination with other area should be strongly promoted, such as the fields of super large calculations using super computers or reactor engineering related to atomic power. (1)
- The ongoing international collaborations, which use foreign establishments like fusion devices, irradiation facilities, and tritium centers, help us know the world's scientific trend. Japan has only a few bases of irradiation or tritium, so cooperation using such facilities outside Japan is meaningful, which is highly commended. (1)
- There are many joint activities underway using fusion devices overseas, but some are a little unclear in terms of what features are used to make an academic contribution. Considering a budgetary situation, it may be time now to review the activities and sort out what is necessary and what is not. (2)
- Although there are no budgetary provisions on an individual base, collaborations are virtually carried out across many fields based on agreements. The whole activities have been categorized as NIFS's internationally coordination project since April 2010, and which now allows the activities to conduct based on a longer-term vision. The effort is considerably highly commended. (1)
- NIFS participates in inter-institutional agreements with 15 institutions in nine countries. Six of these agreements were established in the mid-1990s, and another nine a decade later during the period 2005-2009. The collaborative research programs for the respective agreements certainly take advantage of institutional strengths (e.g., fusion theory with the University of Texas, materials studies with ORNL, fusion technology with UCLA).
- The involved institutes usually contribute with their specific expertise to the program. This is a working system as the long list of specific activities proves.
- The diversity of collaborators is very wide, from universities, national laboratories, and international organization. It seems that NIFS focused its collaboration with each institution with its strength to take advantage of diverse nature of collaborators. It is also mutually beneficial to focus on mutual interest and strength of collaboration partners.
- Each program benefits strongly from a field of expertise of every institute involved in International collaboration research based on inter-governmental agreements.
- LHD also gives boost to new large experiments in Asia by sharing the experience and

expertise gained during many years of operation of LHD.

②Is the strategy that includes ITER and BA appropriate?

- NIFS plans to conclude an comprehensive agreement with the ITER Organization. It also plans to promote joint activities and human exchanges related to design, construction and experiment-planning of ITER. It has established the Rokkasho Research Center in the Rokkasho village in preparing for coordination with JAEA. Considering all the efforts, the strategy is commendable. (6)
- NIFS will need to internationalize its role as an inter-university research institute while heading for the goal of the realization of a helical DEMO. From this standpoint, the currently planned activities seem appropriate. (2)
- The ITER project and the BA activities are at center of the world's fusion research. Japan is highly expected to make contribution to them and it is a great opportunity for Japan to demonstrate its presence. So collaborations should be conducted with the awareness of that. NIFS has actually been of great assistance in terms of administrative as well as advisory work. It has also helped advancement of physics and science, which is represented by the efforts for ITPA. For engineering and technical cooperation, NIFS has given advice based on its own experiences using the large superconducting device and has provided other practical supports in conducting experiments. The proposal that NIFS will continuously do such work is basically highly commended. What is expected from now on there is that NIFS will join and take an initiative in the TBM Project of ITER. (1)
- The university community including NIFS desires an active involvement in the ITER Project. For that, what steps to take should be decided and systematic provisions should be prepared. I strongly expect them. (1)
- Key to success of fusion power generation is reactor materials. After pursuing the best, material limitation has to be covered by designing. Therefore, it is meaningful that an emphasis is put on the development of DEMO materials. (1)
- Despite a difference in configuration, helical and tokamak could share reactor components and many other issues. It is expected that ITER research is effectively used in designing a helical reactor. (1)
- The strategy is basically appropriate, but it is necessary to increase the involvement in the ITER/BA work, pick up key subjects, and scrutinize the contents. (1)
- LHD's contribution to ITPA is extremely important. There is no other device in the world than LHD that can maintain high-temperature, high-density plasma for as long as 400 seconds. I hope NIFS will increase the LHD contribution, bearing in mind it appeals to the rest of the world. (1)

- The three tasks commissioned by the ITER Organization suggest there is an expectation to a new development by NIFS based on its experiences and skills, which, I hope, will be explicitly shown somehow. (1)
- NIFS has a service contract with the ITER Organization to resolve engineering issues related to construction. NIFS scientists are involved in ITER physics issues through the International Tokamak Physics Activity (ITPA). A NIFS scientist is a member of the ITER Science and Technology Advisory Committee; the NIFS Director General is a member of the ITER Council.
- NIFS plans to carry out joint development with JAEA of central solenoid and error field superconducting magnets (and performance tests) for the JT-60SA facility under construction as part of the Broader Approach. NIFS also provided advice about assembly and quality assurance for JT-60SA. NIFS has an office at the Broader Approach site in Rokkasho-mura, and a NIFS scientist is currently serving as director of operations for the three projects at the International Fusion Energy Research Center at the Broader Approach site. Also, the NIFS Deputy Director General is a member of the Broader Approach Steering Committee, and a NIFS scientist is a member of the Satellite Tokamak Program Board.
- A new player arises with ITER. During the long construction phase, ITER is specifically interested in engineering support. It is not clear to what extend NIFS can handle such a support without hampering operation and upgrade of LHD. Maybe NIFS could act as an agent to establish suitable links to Japanese universities that are strong in engineering sciences.
- NIFS included international collaboration programs including ITER as well as BA, in very appropriated manners. However, it is recommended to expand its contribution and collaboration to ITER and BA, as far as the NIFS' resource could provide.
- NIFS has concluded 3 important tasks contributing to ITER design and performance. This activity should be given the highest priority. BA is a complimenting program vital to Japan. Therefore, it seems mandatory to highlight relevant issues to ITER and BA in making decisions on the priority of different scenario to be realized on the LHD.

3) International collaboration research under the National Institutes of Natural Science

①Is the program productive?

- National Institutes of Natural Sciences (NINS) launched a scheme in 2005 called "Forming Bases for Interdisciplinary and International Research through Cooperation cross Field of Study". Part of the scheme is a project of "Building the International Research Central Network", which was proposed by NIFS. The scheme was continued till 2009, and

during the period, more than 490 people were exchanged as a total supported by the scheme. Now a successor project of “Promotion of the International Research Central Networking” has been underway since 2010. The efforts have led to NIFS’s new agreements between six more institutes include Germany’s Forschungszentrum Karlsruhe GmbH and France’s University of Provence, which are well commended. (3)

- The NIFS-proposed project under the NINS’s inter-disciplinary scheme has helped internationalization of domestic bases including NIFS and Kyoto University (for research of improving confinement in an advanced helical system). It has produced a number of results through international work of the relevant fields, which is highly commended. (1)
- More examples of NINS international coordination in connection with magnetic fusion should have been shown. (2)
- Effectiveness of the NINS-initiated activities is not tangible enough yet, to be honest. (1)
- The inter-NINS-member cooperation basically occurs upon scholarly issues. It should promote tie-ups eagerly in the fields such that fusion research is good at, or that it leads other researches over. (1)
- It may be a little meaningless to limit the argument to the NINS-based activities only, but it is true there are meaningful changes in there. One of them is that the scheme now enables NINS to help its members secure budget to conduct an international collaboration. That led to the new framework of International Coordination Research, which is highly commended. (1)
- There is a tendency that NIFS concludes an agreement between a lot of institutes, which is basically appreciated. However, NIFS’s human resource is limited and there is a little concern whether these agreements could be effective and fruitful in a practical sense. (1)
- It is intangible what differs the international activities initiated by NINS from those by NIFS. A difference should be made clearly. Therefore, I can give it just a passing score. (1)
- Although there is a financial limitation, it contains attractive proposals about research subjects. It is well expendable. (1)
- The collaboration research under NINS is focused on internationalization and the top-level management of the collaborative actions. In that sense, the program appears to be productive.
- In the 2nd mid-term period, NIFS focuses on the topics related to the advanced area of plasma, so that the productiveness of collaboration could be judged with outcome in later period.
- A great experience in networking and spreading of the scientific results gained by NIFS serves well the NINS ambition to form the “ Base for Interdisciplinary and International Research through Cooperation across Field of Study “.
- It appears that these NINS cooperative activities may strongly overlap with the Academic Agreement collaborative activities, since the cooperating international institutions are

identical.

4) Voluntary contributions for other International collaboration programs (ITPA, etc.)

①Are the contributions satisfactory in terms of NIFS's duty?

- Thirteen out of 50 members of ITPA's topical groups are NIFS researchers. Besides, NIFS staff serves as members in the ITER Executive Council, the ITER Science and Technology Advisory Committee, the BA steering committee and other major international groups. Such a voluntary contribution is highly commended. (9)
- Taking advantage of LHD experiences, NIFS is making contribution in the area of 3-D helical physics, where it may take the initiative among the ITPA activities. In this sense it is highly commended. (2)
- It is hoped that financial support will be increased to those, including university members, who are doing voluntary international work (particularly support to travel expenses). (1)
- Contribution basically seems to be well made. However, NIFS should not be satisfied with reporting the participation. I hope it will increase the involvement, pick up key subjects, and share the experiences with LHD researches. (1)
- It is significant to make contribution with LHD under the global attention, appealing to the world that there are issues that do not matter magnetic configurations, or that only LHD can handle. The former will be those related to fluctuation and fast ions while the latter are steady-state operation over 400 seconds. They should be appealed. (1)

- Of the official 49 participants from Japan for the seven ITPA Topical Groups, NIFS provides 12 participants (2 for Diagnostics, 3 for energetic particles, none for Integrated Operational Scenarios, 2 for MHD, 2 for Pedestal, 2 for SOL/Divertor, and 2 for Transport). Of course, scientists other than the official Topical Group participants may also attend the twice-yearly Topical Group meetings. Also, a NIFS scientist is a member of the ITPA Coordinating Committee, which meets once a year.
- NIFS scientists participate regularly in five of the seven ITPA Topical Groups, with 1-3 participants per topical group meeting. During 2009 and 2010, approximately 10 NIFS scientists participated in the annual spring and fall series of ITPA Topical Group meetings—hence the total figure of 20 cited for NIFS attendance at the Topical Group meetings each year. An average of 10 NIFS participants per each series of workshops is respectable.
- Two NIFS scientists who were ITPA Topical Group participants were involved as co-editors of the document "Progress in ITER Physics Basis," which was published by the ITPA in the journal Nuclear Fusion 2007.

- NIFS had contributed actively to the ITPA activities by participants about 20 persons per year. The 3D physics related issues had been contributed by utilizing LHD research, so it is well posed with respect to NIFS' duty and strength. However, it is also recommended that NIFS could expand its participation further to the all major area of ITPA issues, as far as its resource could provide to enhance its role and presence in fusion research world-wide.
- NIFS is very well represented in the ITPA activity. About 20 LHD and other helical plasma researchers have attended the ITPA meetings each year thereby making a significant contribution to ITPA activities. Among the highlights, ELM control problems must be mentioned since it represents the most topical issue for ITER at present.

(3) Joint Research

1） Research cooperation within the National Institutes of Natural Sciences

①Is the cooperation productive?

- Coordinated work has been underway in various forms and its performance is highly commended. As an attempt on the cross-sectional themes of “Imaging Science” and “Hierarchy and Holism in National Science”, a number of joint activities and symposiums have been held, and in 2008 NIFS played a leading role for a NINS-sponsored international symposium. Meanwhile, interdisciplinary work by researchers has also produced some results, like, for example, 20 papers in connection with spectrographic research, which is related to LHD as well as solar studies. (7)
- “Imaging Science” is an interdisciplinary theme encompassing a wide range of fields. Brain science or imaging measurement using microwaves of cosmic plasmas, X-rays and fast-visible cameras may hold the potential to be effective coordination. A system is getting ready for them and an achievement is expectable there. The joint research using the solar observation satellite Hinode is highly commended for performance so far. (1)
- The joint research between IMS (Institute for Molecular Science) on simulation of near-field imaging of nano-particles has been fruitful and is highly commended. (1)
- It is an appropriate approach to join hands upon diagnostic devices like imaging technology. It will have to be strongly promoted as it is. (1)
- What is vital in joint research is for those from different fields to share a common base and bring technologies that each party is good at. Coordination should be strongly encouraged around technologies which fusion research is good at, or with which it takes a lead over other researches. (1)
- The NINS joint research is highly commended as it brings about a fresh scientific approach. (1)
- Although a lot of efforts have been made, it is extremely difficult for those from totally different fields to jointly produce something in nothing. Besides, researchers are usually out of touch each other. In spite of these disadvantages, the inside-NINS cooperation has somehow produced results through activities coordinated between closer fields. It is commendable. (1)
- The “Imaging Science” effort seems to be getting fruitful, but it is still invisible from outside whether it has produced any concrete achievements specific to NIFS or not. If NIFS has more communication with NAOJ (National Astronomical Observatory of Japan) and gives more explanations to cosmic phenomena, the work will be more understandable for

ordinary people. (1)

- The cooperation still remains mere exchange of information for individual researchers. I expect that it will evolve into the one that can make an innovation. What is extremely important in this field in particular is it becomes a catch to the public. A continuous effort to this end is expected. (1)
- NIFS organized the first NINS international symposium, which was held in 2008 on the interdisciplinary theme of "hierarchy and holism," one of two thrusts (both computational) within NINS for which NIFS provides leadership. NIFS also organized six symposia on the interdisciplinary interaction of computer simulation science and signal transduction.
- It is a challenge to conduct really meaningful cross-disciplinary research. The NINS initiative to bring together scientists from neighboring or even far distant science areas is ambitious and deserves support. An outstanding productivity, however, should not be expected. In this light, the achievements made are already very good.
- It has a few potentially productive area of collaborations such as "Imaging science" and materials. However, it is too early to assess its full potential of productivity yet.
- NIFS also contributes to the major research carried out by NINS members NAOJ and Institute for Molecular Science. It is obvious that the expertise of NIFS in fields of " Imaging Science" and " Hierarchy and Holism in Natural Science" is of great value for these 2 institutes.

2) Domestic research cooperation based on inter-institutional agreements

①Does each program take advantage of characteristics of the agreed institutes?

- It is highly commended that the NIFS is in partnership with universities across Japan upon an inter-institutional agreement . Among partners are, for instance, Plasma Research Center of Tsukuba university, Hydrogen Isotope Research Center of Toyama university, Eco Topia Science Institute of Nagoya university, and JAEA. Taking advantage of each collaborator, joint activities have been fruitful. The cooperation with the Tsukuba's Plasma Research Center, in particular, results in the achievement of successful development of the world's most advanced gyrotron, and generates more-than-20keV plasmas. (9)
- The joint research with Shizuoka university to investigate coated boron films has reached actual results including the finding of the influences that are caused by the quantity of impurity contents. It is highly commended. (2)
- Some of the joint activities are effectively taking advantage of participants and are worth of high scores. But others have to be reviewed and reconsidered as to whether an agreement really has a meaning. (3)
- NIFS has concluded agreements with distinguishing universities and conducted joint

researches in the fields that partners are good at. The efforts have promoted knowledge systematization and have enhanced intellectual and personnel resources in Japan's academia community. The joint work as a whole is considerably highly commended. (1)

- While the coordinated activities are productive and commendable, the framework of Joint Research (Coordinated Research) is unclear along with the presence of the General, LHD and Bilateral Collaboration programs. (1)
- Yes—for example, Tsukuba University on high-power gyrotrons, Eco Topia Institute on atomic physics, Nagoya Institute of Technology on materials research, Shizuoka University (and JAEA) on boronization, and Univ.of Toyama on hydrogen isotopes.
- On the basis of the information provided, I got the impression that the collaboration subjects were carefully selected. A more thorough assessment should be made by the internal reviewers.
- Each program has its own purpose of collaboration for taking advantages of each collaborating institutions' strength and interest. Therefore, it should be focused to the goals of each collaboration program as it is initiated.
- Coordinated research based on agreement with domestic universities and institutes bring many advantages to all partners by providing the critical mass to every narrowly focused line of research.

3) Industry-university cooperation

①Is the cooperation a productive spin-off of fusion research?

- Cooperation in the fields of microwaves application, superconducting technology and cryogenic technology have been considerably productive in terms of industrial spin-off. Therefore, they are highly commended. (8)
- Between NIFS and private firms 14-20 coordinated researches are carried out each year, and a total number of 25 patents were obtained during the 2005-2009 period. It suggests industry-university cooperation has been steadily continued, which is highly commended. (1)
- Microwave heating technology has been commendably spun off. The assumption that crystal structures might be affected by coherent electromagnetic fields is very interesting in particular. Industry-university cooperation does not only lead to commercialization but also bring about an academic value. In this sense, it is highly commended. (1)
- Conduction-cooling pulse coils were successfully developed for the emergency system of SMES (Superconducting Magnetic Energy Storage) but unfortunately they failed to be commercialized. But the technology is now being targeted by those working for an indirect-cooling system, as a prospective superconducting coil of a future reactor. Although

it was not a perfect spinoff, what it brings back to the academic is very highly valued. (1)

- The development work in fusion research is actually leading other cutting-edge technologies. Therefore, it is expected that such advanced output will be more progressively applied to industry. (1)
- As the NIFS website says, fusion research has enormous potential for affiliation. It is hoped that university-industry cooperation will focus the things of high value that has an economic potential and bring about a concrete product. (1)
- I believe there are some subjects in the Domestic Collaboration which are struggled by universities despite developing into industry-university cooperation. I expect that NIFS will pick up such activities and serve as a channel to connect those apart in a horizontal relationship. (1)
- Industry-university cooperation is very important and the activities currently ongoing are highly commended. However, there have been few changes and growths in terms of subjects. Simulation research, for instance, may have some subjects that have an industrial potential. New ideas are necessary to the program in order to open the door wider and to organize cooperation that can obtain more funds from the business as well as governmental sectors. (1)
- Each year, about 14-20 such collaborations are carried out. Between 2005 and 2009, 28 patents were obtained, which is a good measure of spin-off productivity. There are three main efforts:
- Microwave ceramic sintering is an excellent example of industry collaboration.
- Low-temperature superconductivity applied for the development of protection against power failure and voltage drop has been productive in terms of publications, conference presentations, and one PhD thesis.
- Real-time simulation of the LHD cryogenic system has received recognition.
- It is notoriously difficult to obtain spin-offs from fusion research, mainly since the needed technologies are highly specialized and tailored to the specific problem. Under these difficult conditions, NIFS is doing a very good job.
- The successful results of industrial cooperation has been provided in areas such as microwave sintering, applied superconductivity and tritium recovery, to name a few.
- The number of collaborations is impressive and grows constantly. The number of patents is also very solid.

②Does it contribute to the local community and industries?

- It is highly commended in that NIFS has developed the microwave technology into a distinguished technology through tie-ups with the local business. (8)
- For the training program for prospective entrepreneurs, or Kenzai-juku, organized by the

Gifu prefecture and its industrial association, NIFS has offered support by letting them use NIFS facilities and assisting workshop arrangement. The total number of collaborations with local firms has reached as many as 40 during the 2004-2009 periods. These efforts are highly commended. (2)

- It is better that evaluation is made here from the perspective whether NIFS has increased understanding of local residents about fusion science". In this sense, the success of the microwave-sintering technology is highly commended. (1)
- NIFS handles technologies such that hold a potential of contribution to the local community like the technology of microwave sintering. Value-added materials is expected to be developed from now on.
- It is limited but I think contribution has been made.
- Those currently underway are making a sufficient contribution and are highly commended. However, NIFS should define *local industry* more extensively and include various businesses in and out of Gifu Prefecture. I suppose NIFS has to seek a contribution to more various businesses across a wide area. (1)
- In particular, microwave technology has proven to be useful in the ceramics industry, which is a major industry in the local community of NIFS. As noted above, a significant number of patents have been obtained. Jointly with local community organizations (such as Cera Techno Toki, the Oroshi Association, et al.), NIFS constructed six microwave hybrid kiln units. These efforts have contributed to local industry and the community.
- NIFS conducted cooperation with local industries, very actively. Especially, the ceramics industrial collaboration in Tokai region is well received and contributed to local industries.
- NIFS contributes to the industrial development of TOKAI region from the start of the Institute. This activity has been amplified lately by launching about 40 collaborations resulting in 38% increase in 5 years.
- Microwave calcinations project is of great importance because the pottery production is a major industrial base of the TOKAI region.

Chapter 3　Recommendation

This chapter provides main points based on the remarks shown in the previous chapter as well as arguments made at the NIFS External Peer Review Committee meetings. It also provides several recommendations which are important to the target activities for future progress.

(1)　Summary

1）Domestic collaboration research

Performances and products after NIFS was reorganized as inter-university research institute in FY2004

1 Are the application categories properly up to date?

Application categories are decided with high transparency by the Collaboration Committee largely consisted of external staff. The categories well reflects research environments and academic advancement thanks to the flexible and complementary relations between the three programs of the General, LHD Project, and Bilateral collaborations. They also reflect adequately the previous advice given by the NIFS External Peer Review Committee. Therefore, the application categories **are highly commended**. Good examples can be seen in the addition of new subjects regarding engineering as well as subjects connecting the Centers to the Bilateral Collaboration.

2 Has the collaboration research progressed based on the opinions of collaborators?

Each of the three Domestic Collaboration programs established a local committee responsible for screening and evaluating filling the majority of members with external staff. They respect opinions from the Fusion Network properly. Besides, the Bilateral Collaboration has plenty of opportunities, where views can be exchanged with the Fusion Community. Therefore, the performance is **highly commended**. The joint research using advanced simulation systems that launched in 2009 and the newly-started system of cooperative use of diagnostic devices are a product from voices of the community. It is a notable movement.

3 Have the results of collaboration research been published properly?

Some hundreds of papers are published each year, and around half of them have non-NIFS first authors. Many results obtained through the Domestic Collaboration have been picked up at summery talks of the IAEA Fusion Energy Conference, which suggests a high level of quality as well as quantity of the activities. Outcomes are also reported properly at the debrief sessions and other meetings. Therefore, the performance of publication is **highly commended**.

4 Has the collaboration research progressed on evaluations over the previous results?

All the three Domestic Collaboration programs require participants to present results and write reports, so that performance of every activity is subject to evaluation. The screening and selection for the following year is made based on the evaluation results and then, resources are allocated properly. Responding to the previous advice given by the NIFS Administrative Council's External Peer Review Committee, the Bilateral Collaboration has now make its activities exposed to the external evaluation, which is made by the sub-committee dominated by external staff. The efforts are **highly commended**.

5 Are the results of the collaboration research accumulated properly as an academic resource?

Outcomes of the NIFS's Domestic Collaboration have been used and stored in various ways to lay an academic foundation. This is shown by a steady increase of presentations by non-NIFS collaborators at the IAEA Fusion Energy Conference as well as many citations by summary talks of the conference. It can be said that the new movements among the Centers starts from the accumulated results. Therefore, the performance is **highly commended**.

6 Have the circumstances for collaboration been improved?

Research conditions surrounding collaborators have been improved in terms of accommodation facilities, internet environments and safety management systems. Systematic improvement is seen in the unification of services for co-researchers into the Visitor Center (the Users Office) and the introduction of the cooperative-use system of diagnostic devices. The efforts are **highly commended**.

7 Has the collaboration research helped educating students and young researchers?

The framework of the Domestic Collaboration provides young researchers with subjects to tackle, and assists the creation of some hundreds dissertations per year. It suggests a great contribution of the program toward development of young personnel. In this sense, the program is **extremely highly commended**.

Future direction

1 Does the plan in each category suggest a direction based on a long-term vision? Are they satisfactory as a plan of COE of fusion research?

It is adequate to implement the plan based on a comprehensive understanding of torus plasmas in the way which heads for a helical DEMO reactor (reactor engineering and numerical test reactor research). The plan says the Bilateral Collaboration will extend its framework to covering engineering issues and the coordination involving more than two Centers is under consideration. The direction is **highly commended**.

2 Does the collaboration research function as a pivot for advancing new studies, such as a program under the Grants-in-Aid for Scientific Research?

New developments out of the Domestic Collaboration are observed in various places. As many as nearly 200 subjects developed from the Domestic Collaboration have won external funds. As represented by the figure, the domestic project has been serving as grounding for new explorations. It is **highly commended**.

2）International collaboration research

International collaboration research based on inter-governmental agreements

1 Has NIFS fulfilled its responsibility as an implementing agency?

NIFS has properly promoted international joint activities of Japan-US, Japan-South Korea, Japan-China/JSPS-CAS, and the IEA. With unparalleled vigor and enthusiasm, NIFS has fulfilled its duty as an implementing agency of international cooperation. Considering these points, the performance is **extremely highly commended**.

2 Are the policy and plan for future collaboration satisfactory?

The proposed future direction is appropriate. It contains concrete proposals which take advantage of features of both parties. It is **highly commended**.

International collaboration research based on inter-institutional agreements

1 Does each program take advantage of characteristics of the agreed institutes?

Based on agreements, NIFS eagerly carries out collaborations with 15 influential foreign institutes respectively. Every activity well utilizes features of the parties involved. The work is **highly commended**.

2 Is the strategy that includes ITER and BA appropriate?

The policy that includes the conclusion of a comprehensive agreement with the ITER Organization is appropriate and **highly commended**.

International collaboration research under the National Institutes for Natural Sciences

1 Is the program productive?

As part of the NINS program, NIFS promoted a sub-program called “Building the International Research Central Network”, and successfully enhanced internationalization of domestic research centers including NIFS itself. Such work is **highly commended**.

Voluntary contributions for other international collaboration programs (ITPA, etc)

1 Are the contributions satisfactory in terms of NIFS’s duty?

NIFS’s staff serves as members of various important groups, such as the ITER Executive Council and the BA steering committee. NIFS also gives an academic support to the ITPA Activity and assists university researchers through the Collaboration framework for their international work. Such voluntary contribution is **highly commended**.

3） Joint research

Research cooperation within the National Institutes of Natural Sciences

1 Is the cooperation productive?

NIFS plays a pivotal role in activities under the cross-cutting themes of “Imaging Science” and “Hierarchy and Holism in Natural Science”. The activities are **highly commended**.

Domestic research cooperation based on inter-institutional agreements

1 Does each program take advantage of characteristics of the agreed institutes?

Joint researches have been conducted based on nine agreements with universities or institutes in the fields of gyrotron development, tritium handling, and superconducting coils. The activities take advantage of the characteristics of NIFS and affiliated partners. Outcomes of the coordinated work are **highly commended**.

Industry-university cooperation

1 Is the cooperation a productive spin-off of fusion research?

A major achievement is the application of microwave heating technologies to industry, which is **highly commended**.

2 Does it contribute to the local community and industries?

NIFS’s contribution to local industries is represented by activities like the support to the *Kenzaijuku* program, which is aimed at the nurturing technical entrepreneurs of next generations, or the involvement in a number of joint activities between private companies in the local area. The contribution is **highly commended**.

(2) Proposal

High marks are given to all the items about the Domestic Collaboration, the International Collaboration as well as the Coordinated Research. This section provides important recommendations to the programs for future activities.

1 In the Bilateral Collaboration, the inclusion of engineering subjects and the attempt to launch multi-Center joint collaborations will enhance the importance of this collaboration research. Further progress on these trials is expected.
2 In order to make engineering studies more useful for development of fusion rector, the collaboration researches toward a helical DEMO reactor in the universities have to be more conducted under the direction of NIFS. The participation of advanced blanket into the TBM project in ITER is expected.
3 The Domestic Collaboration requires disclosure of output, a high transparency in decision-making, and flexibility in operation to respond to the community's voice. It is significant for such efforts to be continued as they are.
4 The project related to numerical test reactors and the cooperative-use system of diagnostic devices will be helpful to promote the university researches. Expansion of these systems is expected.
5 The Japan-US cooperation is highly evaluated. NIFS will work for concluding an inter-governmental agreement and for upgrading the cooperation to a national level of activity. We hope the agreement to be realized.
6 A high mark is given to the policy that NIFS will increase its direct contribution to ITER after concluding a comprehensive contract with the ITER Organization. The policy has to be realized.
7 Under the framework of cooperation like Japan-South Korea, Japan-China as well as the IEA, the study on fusion plasma and reactor engineering was promoted. It may be needed for the contents of such the cooperation to be reconsidered, depending on trends in and out of Japan.

Chapter 4 In closing

The NIFS External Peer Review Committee held its first meeting of the year on October 21, 2010, and determined the year's target and relevant details including check items. At the Committee's second meeting, when subcommittees held their first gatherings (December 11, 2010), they were given explanations by NIFS about activities. Then, reviewers made their evaluation, and a draft report was made by section summing up the individual remarks. At their second gathering (January 27, 2011), subcommittee members exchanged views upon the draft summary, and a final version of the report was completed by the Committee at its third meeting (February 23, 2011).

Regarding the Domestic Collaboration, high marks were given to NIFS's performance since 2004 regarding the given perspectives (*Are the application categories properly up to date?; Has the collaboration research progressed based on the opinions of collaborators? ; Have the results of collaboration research been published properly?; Has the collaboration research progressed based on evaluations over the previous results?; Are the results of the collaboration research accumulated properly as an academic resource?; Have the circumstances for collaboration been improved?; Has the collaboration research helped educating students and young researchers?*). High marks are also given to its future direction (*Does the plan in each category suggest a direction based on a long-term vision? Are they satisfactory as a plan of COE of fusion research?; Does the collaboration research function as a pivot for advancing new studies, such as a program under the Grants-in-Aid for Scientific Research?*).

Regarding the International Collaboration, high marks were given to the activities upon inter-governmental agreements (*Has NIFS fulfilled its responsibility as an implementing agency?; Are the policy and plan for future collaboration satisfactory?*); those upon inter-institutional agreements (*Does each program take advantage of characteristics of the agreed institutes?; Is the strategy that includes ITER and BA appropriate?*); the NINS-initiated programs (*Is the program productive?*); and the voluntary contributions (*Are the contributions satisfactory in terms of NIFS's duty?*).

Regarding the Joint Research, high marks were given to the coordinated activities within the NINS framework (*Is the cooperation productive?*); those based on agreement with individual institutes (*Does each program take advantage of characteristics of the agreed institutes?*); and the industry-university coordinated researches (*Is the cooperation a*

productive spin-off of fusion research?; Does it contribute to the local community and industries?).

NIFS has been making a committed effort for the promotion as well as improvement of such cooperative and coordinated activities. That is believed to be why NIFS could receive high appreciations in all the given perspectives. What is highly valued in particular in the domestic collaborations are the expansion of the Bilateral Collaboration for encompassing engineering challenges, the road of the Domestic Collaboration heading for a DEMO reactor, the introduction of cooperative-use system of diagnostic devices, and the promotion of the numerical experiment project. Further progress is expected to these activities. Regarding the International Collaboration, the ambition for a comprehensive agreement with the ITER Organization as well as that for a government-level agreement between Japan and the United States are highly appraised.

As seen above, NIFS's domestic and international collaboration systems are undoubtedly well-organized. There is no other system in the world that is as excellent as those of NIFS. In concluding, we hope that this report will help NIFS and NIFS will continue its effort to enhance the collaborative and coordinated activities more than ever before.

Reference: Terminology

BA	Broader Approach, or BA, refers to research and development of advanced fusion conducted in parallel with ITER Project. BA is expected to support and supplement ITER Project through its engineering research for DEMO and research of the plasma physics that ITER cannot handle and other issues. BA is based on Japan-EU cooperation, and activities are conducted at an establishment in Naka city of Ibaraki prefecture as well as the one in Rokkasho village of Aomori prefecture; both belonging to Japan Atomic Energy Agency.
DEMO	Before completing a fusion reactor, there are test reactors to be built. The one to demonstrate electric generation is called DEMO, and following DEMO the one to serve as a first electric generator is called PROTO. ITER will demonstrate that fusion can produce energy but not that fusion energy can be changed into electricity, so ITER is a pro-DEMO reactor.
Divertor	Divertor is a device for capturing escaped plasma or unwanted impurities from peripheral areas, and guiding them to a certain place for detainment. To do so, it generates an open magnetic field structure outside the closed main field to confine plasma inside. Challenges are to remove heat from divertor plates as well as to capture neutral particles efficiently.
Electron Bernstein wave(s)	Electron Bernstein wave is one of the electrostatic waves that propagate plasma normal to the magnetic field. Its frequency is almost equal to the integral multiple of cyclotron frequency. The propagation of Electron Bernstein waves do not matter plasma density, so the application to high-density plasma heating is now attempted.
FEC	Fusion Energy Conference, or FEC, is an international conference on fusion research organized by IAEA, where results are reported in a comprehensive way and views are exchanged over the results. The largest and most prestigious conference of the field is held biennially.
Fusion Energy Forum of Japan	Fusion Energy Forum of Japan is a body established to promote research and technical development of fusion energy through ITER and BA efforts. The forum is comprised by those who belong to domestic universities, institutes and private companies, whoever hopes to join the forum.

Fusion Network	Considering fusion is a comprehensive target covering a wide range of disciplines, Fusion Network is established to connect university researchers, in a bid to develop collaborative projects based on information exchanging and joint research. It is divided into two subjects: plasma science and reactor engineering. NIFS takes care of administrative work for the both sections of the network.
H-mode	H-mode is a discharge mode that is very good at confining plasma, which was discovered in a tokamak device. The mode appears when conducting high-power heating to plasma while keeping the amount of neutral particles low in the edge area. The performance of the H-mode is 2-4 times better than that of a normal mode (L-mode).
IAEA	International Atomic Energy Agency
IFERC	International Fusion Energy Research Center, or IFERC, is established in Rokkasho Village, Aomori, as one of three BA activities. IFERC conducts researches to help ITER as well as to realize DEMO Reactor. It contains the following bodies: 1. DEMO Design and R&D Coordination Center 2. ITER Remote Experimentation Center 3. Computational Simulation Center
IFMIF/EVEDA	IFMIF/EVEDA is one of three BA activities expected to do Engineering Validation and Engineering Design Activities (EVEDA) for International Fusion Material Irradiation Facility (IFMIF). Facilities will be built and research will be conducted in Rokkasho Village, Aomori.
Institutional Repository	Institutional Repository is an electric archive system for collecting, preserving and disseminating its intellectual products (research journal articles, digital versions of theses, bulletins and so on) of a research institute.
ITER	International Thermonuclear Experimental Reactor, or ITER, is a tokamak experimental establishment to seek the feasibility of fusion energy under international cooperation. Participants are Japan, EU, Russia, USA, China, South Korea and India. The site is in Cadarache, France. ITER is currently under construction and operation is expected to start in 2019.
ITPA	International Tokamak Physics Activity, or ITPA, is an international gathering to bring findings from across the world and discuss them. ITPA is carried out among the ITER participants, and results of helical plasmas are also respected there as a common physics to the toroidal magnetic confinement.

JAEA	Japan Atomic Energy Agency
JT-60SA	JT-60SA is one of BA activities, a project to study steady-state operation of high-performance plasmas, which ITER cannot demonstrate. It is carried out using a superconducting device of its name, which is an upgraded version of JT-60U, a large tokamak device at the Naka branch of JAEA.
Mirror fusion device	A mirror device confines plasma in a straight-line magnetic field, and curbs loss of plasma by intensifying magnetic field of the both ends. It is represented by Gamma 10 of Plasma Research Center of University of Tsukuba.
PDCA cycle	PDCA cycle is a management process used in business to expedite work like manufacturing control or quality management. Work is improved continuously through the iterated four-step cycle of Plan, Do, Check and Act.
QUEST	It stands for Q-shu Univ. Exp. with Steady-State Spherical Tokamak, an experimental device of Kyushu University's Advanced Fusion Research Center. The operation began in 2009.
TBM	TBM stands for Test Blanket Module. Blanket is expected to play a very important part in a fusion reactor, taking thermal energy out of neutrons, a product after fusion reaction, and at the same time making the neutrons back to be fuel for the reaction, tritium, by combining them with lithium. Although ITER does not demonstrate the process of energy generation, it will have ports to test a blanket using particles produced during the ITER experiments. There are several types of candidate blanket, and each ITER Participant is expected to bring modules to test its original blanket.

Inter-University Research Institute Corporation
National Institutes of Natural Sciences
National Institute for Fusion Science
322-6 Oroshi-cho, Toki, Gifu, 509-5292, Japan
http://www.nifs.ac.jp/