FY 2014 Follow-up of WPI Program

By Program Committee

February 2015

(This report deals with progress made under the WPI Program in FY 2013.)

Summary

Outline of WPI program:

The missions of the WPI (World Premier International Research Center Initiative) Program are ambitious; in addition to advancing top-quality science, mandated are internationalization, fusion studies and reform of existing systems, aimed at establishing internationally opened and globally visible research institutions in Japan.

Upon these missions, 9 WPI centers have been launched:

- AIMR on materials science at Tohoku University
- Kavli IPMU on the universe at The University of Tokyo
- iCeMS on cell biology at Kyoto University
- IFReC on immunology at Osaka University
- MANA on nanotechnology at National Institute for Materials Science
- I^2CNER on carbon neutral energy at Kyushu University
- IIIS on sleep at University of Tsukuba
- ELSI on origins of earth and life at Tokyo Institute of Technology
- ITbM on transformative bio-molecules at Nagoya University

Sustainability of WPI centers

A condition upon the host institutions' acceptance to establish a WPI center was that they would sustain the center with their own and other resources after the WPI grant ended. Furthermore, the presidents of the host institutions have repeatedly declared and confirmed their support for their centers.

Follow up of 5 WPI centers launched in 2007

The WPI Program supports the centers for a period of 10 years. A possible extension for another 5 years is applicable to those with outstanding results. Afterwards, these centers are to be sustained under the auspices of their host institutions.

All five of the WPI centers launched in 2007 applied for a possible 5-year extension after their initial supporting period for 10 years. These centers are AIMR, Kavli IPMU, iCeMS, IFReC and MANA.

The WPI Program Committee examined carefully their achievements and concluded that all 5 centers have achieved a "World Premier Status," fully meeting the goal of the WPI program.

After extensive discussion on the definition and implications of "outstanding" as the level of achievement needed to warrant a 5-year extension, the committee members agreed to apply it to only highly exceptional case(s) whose achievements are far beyond the very high WPI standard. As a result, among the five centers under consideration, Kavli IPMU was nominated for a 5-year extension.

It is noted that the other four WPI centers, though not nominated for an extension, are highly regarded as "world premier institutes" in terms of their scientific achievements and WPI mission implementation: For example, the performance in terms of "top 1% papers" percentage of these 4 WPI centers is 4.6% on average, putting them in 3rd place after Rockefeller University and MIT. Accordingly, these supreme institutes should be highly appraised.

Follow up of WPI center launched in 2010 (Interim evaluation of I2CNER)

I^2CNER was subjected to an interim evaluation on its first 4 years of achievements. Under the leadership of Dr. Sofronis, I^2CNER has been making progress toward possible pathways to a carbon-neutral society, but more effort is needed to attain its goals. I^2CNER was rated "A minus."

Future plans of WPI program

The Program Committee has started a discussion on a long-term plan to sustain the WPI program. A tentative future plan as a discussion starter was proposed by the Program Director (PD) at the program committee meeting. The main proposals are:

- Metabolizing the WPI centers through a renewal process is most important for sustaining the activities of the WPI program.
- A system, tentatively called "WPI Academy," will need to be established to ensure the WPI program brand and credibility for on-going and previous WPI centers.
- A future plan will be finalized by the Program Committee following advice of an *ad hoc* international evaluation committee on the WPI program and an international workshop on "Research Excellence Initiative" to be held in October 2015.

The Program Committee's recommendations will be forwarded to MEXT for formulating future policy.

Site visits

Site visits to the nine on-going WPI centers were conducted over a two days period by the PDs, Program Officers (POs), international working group (WG) members, MEXT officials and JSPS secretariats. Detailed reports were submitted to the Program Committee and disclosed to the respective WPI centers. A summary of these site visit reports is given below.

Outreach

All WPI centers are actively engaged in outreach activities such as publishing brochures, delivering lectures to the general public and students, and providing science cafés etc. In February 2014, the 9 WPI centers jointly participated in the "AAAS Annual Meeting" in Chicago, in which Dr. Sofronis director of I^2CNER, delivered a lecture on the aims and activities of the WPI program. The highlight of the WPI outreach activities was a joint workshop for high school

students, held in December 2014 in the center of Tokyo. Seven high schools including five "Super Science High schools (SSH)" presented their research activities, which were of a high level. The students discussed their research with young researchers from the WPI centers.

A. Outline of WPI program

To enhance the level of science and technology in Japan while continuously triggering the kind of innovation that serves as an engine for growth, it will be necessary to boost the nation's basic research capabilities and to strengthen its global competitiveness. As described in its application guideline, MEXT (Ministry of Education, Culture, Sports, Science and Technology) launched the World Premier International Research Center Initiative (WPI) Program as a highly challenging, long-term initiative to support the establishment of world-leading research centers in FY 2007.

The WPI Program aims to ambitiously create globally visible and internationally opened top-world research centers in Japan, centers in which the world's finest brains gather, outstanding research results are generated, and talented young researchers are nurtured. WPI research centers are expected to be highly innovative in both their concepts and practices.

The following four missions are crucial requisites for a WPI center.

- Advancing top-quality of science
- Achieving internationalization
- Making breakthroughs by fusion studies
- Reforming research and administration systems

As indicated in its Guidelines, the implementation period of WPI projects is 10 years with a possible 5-year extension if a project achieves "outstanding" results.

There is now a world trend to create such a research centers by providing large-scale and long-term funding to designate research areas for the purpose of advancing fundamental and innovative science. According to an OECD report published in 2014, over two-thirds of OECD countries are now operating "Research Excellence Initiatives"(REIs), aiming at:

- Providing relatively long-term resources for carrying out ambitious research agendas.
- Leading broad changes in research systems.
- Creating positive externality through REI activities.
- Allowing for greater flexibility in management and hiring researchers.
- Enhancing training programs for future generations of leading scientists.

These REI aims overlap the missions of the WPI program. Indeed, the WPI program is regarded internationally as a REI role model.

B. WPI Centers

Currently, the following 9 WPI centers are on-going:

The first 5 WPI centers from 2007

- Advanced Institute for Materials Research (**AIMR**), Tohoku University
- Kavli Institute for the Physics and Mathematics of the Universe (**Kavli IPMU**), The University of Tokyo
- Institute for Integrated Cell-Material Sciences (**iCeMS**), Kyoto University
- Immunology Frontier Research Center (**IFReC**), Osaka University
- International Center for Materials Nanoarchitectonics (**MANA**), National Institute for Materials Science

The sixth WPI center under the program of green innovation from 2010

- International Institute for Carbon-Neutral Energy Research (**I^{2}CNER**), Kyushu University

The other three WPI centers under the program of "WPI Focus" on focused research areas from 2012

- International Institute for Integrative Sleep Medicine (**IIIS**), University of Tsukuba
- Earth-Life Science Institute (**ELSI**), Tokyo Institute of Technology
- Institute of Transformative Bio-Molecules (**ITbM**), Nagoya University

As shown in this figure, the 9 WPI centers can be categorized into 3 groups: Origins of Universe, Earth, and Life; Materials/Energy; and Life Science. It is pointed out that Kavli IPMU and ELSI cover the origins of the universe, earth, and life, which may stimulate intellectual curiosity among the public, and plant seeds for sprouting future science and scientists.

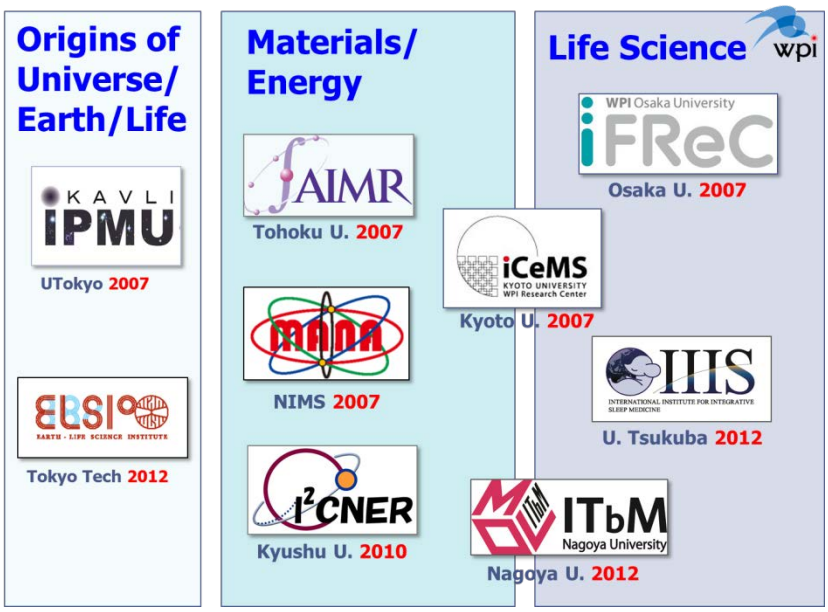

Figure. 9 WPI centers can be classified into the 3 groups.

Sustainability of WPI centers

As stated in the program guidelines, a condition upon the host institutions' acceptance to establish a WPI center was that they would sustain the center with their own and other resources after the WPI grant ended. Furthermore, the presidents of the host institutions have

repeatedly declared and confirmed their support for their centers. For the 5 WPI centers launched in 2007, they have submitted a concrete plan for their center's operation up to FY 2022 to the Program Committee.

C. Follow up

The WPI program carries out a robust follow up system whose members comprise the International Program Committee, PDs, POs and working groups.

Program Committee

The Committee consists of 16 members and is chaired by Dr. Hiroo IMURA, president of the Foundation for Biomedical Research and Innovation. In FY 2014, Drs. Hideo Miyahara and Masatoshi Takeichi left the Committee and Dr. Ryozo Nagai, president of Jichi Medical University, joined it. The members are listed in the following URL:
http://www.jsps.go.jp/english/e-toplevel/data/07_committee/committee_members.pdf
In FY 2014, a Program Committee meeting was held in Tokyo on 18-19 November.

Program directors (PDs) and Program officers (POs)

Dr. Toshio KUROKI, Japan Society for the Promotion of Science, and Dr. Akira Ukawa, RIKEN Advanced Institute for computational Science, serve as the program director (PD) and deputy PD.
The program officers (POs) are indicated in the summaries of each site visit report, shown below. They are also listed in the following URL:
http://www.jsps.go.jp/english/e-toplevel/08_followup.html

Working groups (WG)

Working groups, organized for each WPI center, principally consist of 3 domestic and 3 international experts in the areas covering the center's activities. The working group members are listed in the above URL.

D. Follow-up of 5 WPI centers launched in 2007

The 5 WPI centers launched in 2007 each applied for a possible 5-year extension after their initial 10-year supporting period ends. These centers are AIMR, Kavli IPMU, iCeMS, IFReC and MANA. They submitted the following 2 documents:

1) Progress Report on their achievements from FY 2007 up through FY 2013
2) Progress Plan for the 5-year extension period and a Sustainability Proposal by the host institution.

The WPI Program Committee examined carefully these reports, along with a report by the center directors at its Committee meeting as well as the site visit reports prepared by the POs

and WGs. A discussion was made on the following 3 steps:
Step 1 examined the level of "World Premier Status" achieved by the WPI centers;
Step 2 examined the attainment of "Outstanding" status among the centers that achieved "World Premier Status"; and
Step 3 examined the challenging nature of the center's Progress Plans during extension period.

Step 1: Whether the WPI centers have achieved "World Premier Status" meeting the mission of the WPI program.

The Committee members were all impressed by the extremely high levels of science being advanced by the 5 WPI centers. The Committee also found that all the centers executed successfully the mission of the WPI program, namely, interdisciplinary research, internationalization and system reform. Their excellent performance in advancing science and carrying out the WPI mission is clearly seen as follows:

Science: The average percentage of "top 1% of papers" among the 5 WPI centers during the 2007-2013 period was 4.6 %, putting them in third place after Rockefeller University and MIT (see figure).

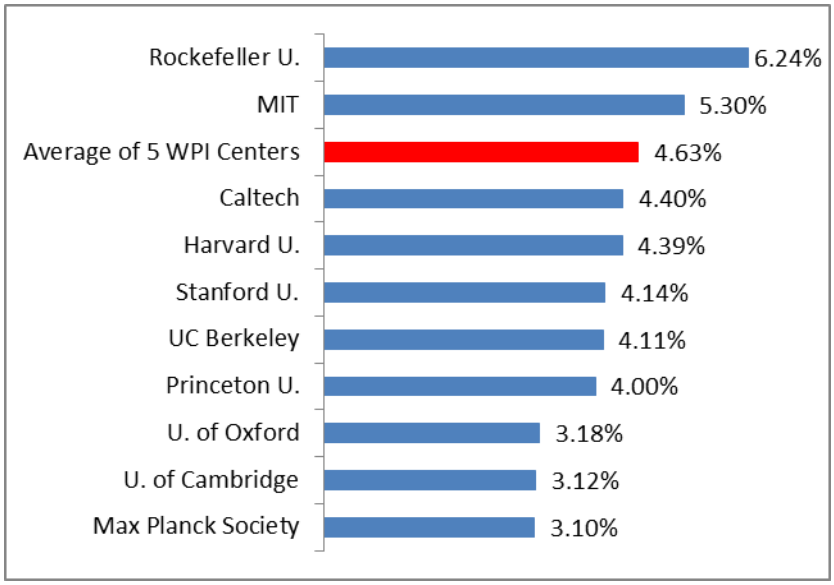

Figure. Top 10 institutions among "Top 1 % papers" percentages. In Japan, the percentages of The University of Tokyo, Kyoto University and RIKEN are 1.61, 1.25, and 2.41%, respectively. Original data was provided by Thomson Reuters.

Internationalization: Foreign researchers at the 5 WPI centers accounted for 40% of their staffs (406/1,006). At MANA, 36% of the PIs, 51% of the staffs, and 93% of postdocs are foreigners. All of the WPI centers organize international symposia, workshops and training courses.

Interdisciplinary studies: All 5 WPI centers carry out vigorous in interdisciplinary studies. Integration of mathematics into materials science (AIMR), fusion of experimental, theoretical physics and mathematics (Kavli IPMU), integration of materials science into cell biology (iCeMS), fusion of immunology, bio-imaging and bio-informatics (IFReC) and interdisciplinary

research under the novel concept of “nanoarchitectonics” (MANA)

System reform: The WPI program emphasizes the importance of system reform in both research and administration. Reforms implemented under the WPI program include the leadership of Center directors, merit-based salary, cross-appointment among national and international institutions, and the use of English, etc. These efforts have spawned ripple effects to the whole host institution, resulting in the change of staff members’ mindsets.

Consequently, the Committee determined that **all 5 centers have achieved “World Premier Status,” fully meeting the goals of the WPI program**. The Program Committee expressed its appreciation for the enthusiastic leadership and collective effort of the center directors in building the WPI centers into world leading institutes.

Steps 2 and 3: Whether any of the “World Premier” WPI centers can be evaluated as “Outstanding” in their performance. And if so, whether their Progress Plan can be evaluated as “Challenging.”

As mentioned above, the WPI guidelines state the WPI program’s period of support to be 10 years, with a 5-year extension possible only for those centers judged to have “outstanding” results. Prior to screening, the Program Committee discussed extensively the definition and implications of “outstanding,” and adopted the following principles for the screening process.

- To assure the quality of the WPI Program and secure its credibility, the standard of “World Premier Status” is to be set very high, and each center must be strictly evaluated in order to determine whether or not it has achieved that standard.
- The Committee recognized that, from the beginning of the WPI program, the regular period of support for each WPI project would be 10 years. The “outstanding results” that merit a 5-year extension are only applied to exceptional case(s) whose demonstrated achievements are far beyond the very high WPI standard.
- The Committee further recognized that it will be important to sustain the “metabolism” of the WPI Program through a renewal process, in which some portion of the program’s budget is to be retained for new centers. Consequently, the number of possible grant extensions had to be limited.
- The Committee pointed out that the Program guidelines have from the beginning required each host institution to sustain its WPI center after the WPI grant end so this means that the centers are to maintain the WPI standard even after termination of Government’s support. The presidents of the host institutions have repeatedly declared that their centers will be sustained with their own support and support from other sources after the current WPI grant ends.

In accordance with the above principles, the Committee decided that only truly exceptional cases can be considered for an extension beyond the 10-year period. The result of stringent evaluations by the Program Committee was to nominate only Kavli IPMU for a 5-year extension among the five centers under consideration. Its proposed research plan for the extension period was evaluated as being sufficiently challenging *(Step 3).*

It is noted that the other 4 centers, though not nominated for an extension, are highly regarded as being "world premier institutes" in terms of their scientific achievements and WPI mission implementation. For example, the performance in terms of "top 1% papers" percentage of these 4 WPI centers is 4.6% on average, putting them in 3rd place after Rockefeller University and MIT (Figure on page 7). Accordingly, their scientific achievements and mission implementations should be highly appraised. Their continued activity is considered to be indispensable to the future of science in Japan.

E. Follow up of WPI center launched in 2010 (Interim evaluation of I^{2}CNER)

I^{2}CNER has been making progress toward creating possible pathways to a carbon-neutral society under robust leadership of Dr. Sofronis. However, it will need to make further effort if it is to attain its goals. I^{2}CNER should critically evaluate its own strengths and weaknesses, and better coordinate and focus its research in line with its mission target. More basic scientists and perhaps social scientists as well should be invited to strengthen the center's interdisciplinary carbon-neutral research. On site PI's of top world level caliber should be secured from abroad, and more junior Japanese researchers should be sent abroad. A tighter collaborative relationship should be established between I^{2}CNER and the University of Illinois at Urbana-Champaign satellite.

Interim evaluation: The Program committee evaluated I^{2}CNER's achievements over its first 4 years as "A minus."

Note: "A" implies that it should be possible for the center to achieve its initial goals by continuing its current efforts, while "B" indicates that more effort will be needed to achieve the center's goals, including consideration given to the Committee's advice.

F. Future plans of WPI program

The committee has started a discussion on a long-term plan for sustaining the WPI program and also for securing the sustainability of the previous WPI centers. A tentative plan as a discussion starter was proposed by PD at the Program Committee meeting. The PD's proposal is outlined as follows:

- After reexamining the achievements of the WPI program over the first 10 years, the program will be given a second phase from FY 2017-2026.

- Metabolizing the WPI centers through a renewal process is most important for sustaining the activities of the WPI program.
- A system, tentatively called "WPI Academy," will need to be established to ensure the WPI program brand and credibility for on-going and previous WPI centers.
- The future plan will be finalized by the Program Committee following the advice of an *ad hoc* international evaluation committee on the WPI program and an international workshop on "Research Excellence Initiative," to be held in October 2015.

The Program Committee's recommendations will be forwarded to MEXT for formulating future policy.

G. Site visits

Site visits to the 9 WPI centers were conducted over 2 days periods during June–September 2014 by the Program Committee members, PD, PO, international WG members, MEXT officials and JSPS secretariats. All 55 WG members except 1 participated in the site visits. Of the Program Committee members, 15 including 5 from abroad participated. The visit schedule included a briefing by the center director, presentations by selected PIs, and poster presentations by young researchers, a guided tour of the facilities and comments/advices by the site-visit team members.

Detailed reports on the site visits were submitted to the Program Committee and disclosed to the respective WPI centers. A summary of these site visit reports is given below.

G-1. AIMR

Program officer: Yoshihito OSADA, RIKEN

Center director: Motoko Kotani

1. Scientific achievement

- Since the Center director Kotani initiated this mathematics and materials science (Math-mate) collaboration with "Three Target Projects," a continual effort has been made to sharpen and focus the Center's activities into the most promising areas. The Math-mate effort has been successful in making remarkable progress beyond initial expectation within a relatively short time.
- The Center has established a unique and convincing identity in Math-mate collaboration. AIMR is now recognized as a globally visible international hub. Its Math-mate collaboration is producing top world-level materials science. AIMR has clearly attained a World Premier Status.
- Proof of the center's excellence in science can be seen in its list of publications, external research funding, world first-rate equipment, and many awards.

2. Implementation as a WPI center

Fusion of research areas

- The center has taken both strategic and bottom-up approaches in carrying out various forms of fusion research toward creating new materials science through Math-mate collaboration. AIMR has provided leadership, resources, and an internal atmosphere that are highly supportive of interdisciplinary research achievement.

Figure. "Interface" group consisting of 7 young theorists and mathematicians, connecting between traditional materials science and mathematics.

- The three Target Projects being tackled through this Math-mate collaboration have been successfully developed, and AIMR is now internationally well recognized as the first institute to promote Math-mate collaboration at an institutional level. It is expected to pioneer new materials science.

Internationalization

- AIMR has made a global effort to establish collaborations with major research centers in materials science including the University of Cambridge and the University of California at Santa Barbara, with which it has set up joint laboratories. The Center has also collaborated with 15 overseas partner organizations through joint research.
- A number of frontline researchers have been assembled in the center from around the world. The creation of an international research environment at AIMR has made notable progress.

System reform

- AIMR has instituted a number of reforms. All the reform efforts made by AIMR have had a positive and strong impact on instituting reforms in Tohoku University, which in turn has given strong support to AIMR. The organization reforms planned by the host institution include an "Organization for Advanced Studies," an "International Administrative Office," and others.

3. Efforts toward sustainability

- President Satomi promised that the host institution will commit to providing AIMR with the

resources sufficient to maintain its activity regardless of whether the WPI funding is extended or not. The host institution will also provide personnel funding in an amount to sustain center activity with an appropriate number of staff.

- The support pledged by Tohoku University to AIMR appears to be very solid in setting up the "Organization for Advanced Studies," in which AIMR is placed as the core organization. A "Graduate School of Spintronics" is also planned to be established, in which AIMR researchers will play a central role.

4. Recommendations

- AIMR is highly expected to create "new materials science capable of predicting new functions based on a mathematics-materials concept."
- Its aspiration of developing new materials with innovative functions can only be realized through an interactive approach between theory and experiment. Good indications in this direction at AIMR are talented young scientists, a new research direction, and new methods for tackling the problems. Mathematicians and materials scientists have begun a dialogue on an equal footing. A two-way cognitive effort, i.e. mathematician learning from materials science and vice versa, is required to accomplish the center's ultimate objectives.
- One effective way for mathematicians to learn from materials science might be to publish a textbook on materials science written by mathematicians themselves. As this would spawn further results, it is recommended that a strategic working group be set up within AIMR to prepare the publication of a math-based materials science textbook.

G-2. Kavli IPMU

Program officer: Ichiro SANDA, Nagoya University
Center director: Hitoshi MURAYAMA

1. Scientific achievements

- Kavli IPMU was created from scratch as a WPI center aiming at elucidating the most fundamental questions in the physics of the universe: 1) How did the universe begin? 2) What is it made of? 3) What is its fate? 4) What are its laws? 5) Why do we exist? In a remarkably short time a highly productive interdisciplinary center has been created, and it has produced top-level results in every one of the three disciplines integral to its mission: mathematics, physics, and cosmology.
- Kavli IPMU research is now being recognized around the world, and its prominence continues to grow. Its accomplishments are competitive with the Institute for Advanced Studies at Princeton, a world-renowned institute.

Experimental Physics

Figure. Subaru Telescope (left) on Mt. Mauna Kea, Hawaii Island

- Kamioka: T2K (neutrino oscillation), XMASS (dark matter search), KamLAND-zen (search for neutrinoless double-beta decay) are running and the first results are being published. EGADS (Supernova search) will be ready next year.
- Celestial observations: HSC (digital camera on Subaru telescope) has had its first light; PFS (Prime focus spectrograph) in SuMIRe project is expected to provide world-class data by the end of the WPI program. MaNGA (Mapping Nearby Galaxies at Apache Point observatory) will soon provide information on the life-cycle of galaxies.

Theoretical Physics

- Kavli IPMU covers quantum field theory, string theory, and particle physics. Its output continues to be of very high quality. More time is needed to see if these results are truly novel, providing key breakthroughs in understanding the origin of the Universe.

Mathematics

- This year some remarkable results, which may turn out to be real breakthroughs, have been published.

2. Implementation as a WPI Center

Fusion

- One of the most prominent features of Kavli IPMU is its interdisciplinary research. Some results have already been published. These are results of fusion between astronomers and mathematicians, mathematicians and physicists, and particle physicists and condense matter physicists.

International visibility

- Kavli IPMU is composed of about 90 scientists, of which 60% are from abroad. More than two thirds of its postdocs have obtained faculty positions at top institutions after finishing their term at Kavli IPMU. This indicates that Kavli IPMU is both an attractive and competitive place in the minds of young researchers, and that its work environment is

completely international. Working at Kavli IPMU is recognized in the worldwide physics community as a significant and proud step in career formation of young researchers.

- Kavli-IPMU has achieved a clear identity and high level of visibility throughout the world. Its special character of “being unique” in its way of approaching problems in fundamental theory is widely acknowledged.

3. Efforts toward sustainability

- Kavli IPMU is a beacon for university reform, both for the University of Tokyo (UTokyo), and for the whole of Japan. Its reforms include merit based salary systems, split appointments, tenured positions with non-traditional external funding. These reforms are now spreading to other universities and stimulating a fluidity of researchers and collaborations among national and international institutions.
- UTokyo transferred 13 FTE (Full Time Equivalent) positions, including 4 FTE positions provided by MEXT, to Kavli IPMU through TODIAS.
- It is gratifying that UTokyo has wise and inspirational leadership that recognizes Kavli IPMU as being a treasure.
- UTokyo has clearly demonstrated its commitment to securing a permanent future for the institute.

4. Recommendations

- Since having students in Kavli IPMU is a necessity especially in its experimental program, it might consider jump-starting a graduate school program by partnering with a foreign university that can supply many good students.
- Incorporating novel statistical procedures in large astronomical data analysis, and paying attention to quality assurance of the data are both absolutely necessary.
- Collaboration with the Institute for The Statistical Mathematics is an excellent first step.

G-3. iCeMS

Program officer: Toru NAKANO, Osaka University.
Center director: Susumu KITAGAWA

1. Quality of Science

- The scientific level of iCeMS is undoubtedly high. Nearly one-thousand of its papers have been published since its inauguration, with about 20% of them in high-impact factor journals (IF>10). These excellent achievements have been backed by the institute’s excellent instrumentation and good atmosphere.
- The acquisition of external grants (more than one billion JPY per year) is extraordinarily good given the size of the institute. This is also indicative of the institute’s excellent scientific level.

- In addition to the research by Prof. Kitagawa on synthetic materials, many other top-class results have been achieved.

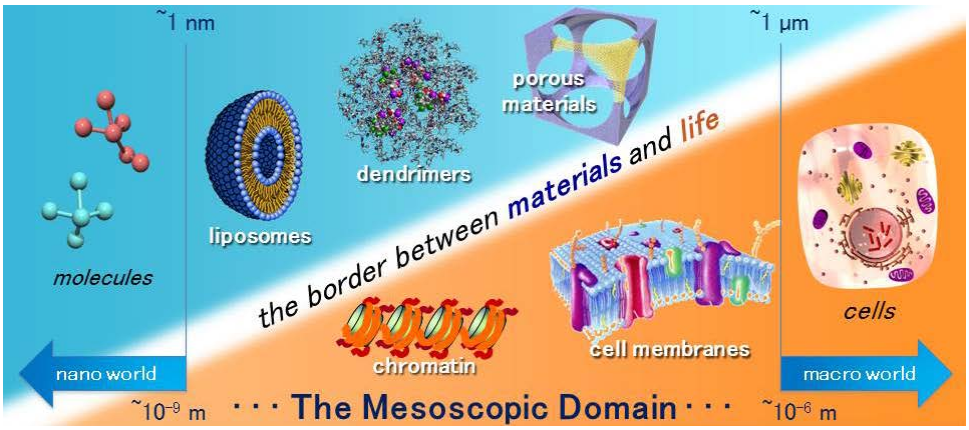

Figure. Research fields of "Meso-scopic" science in materials science and cell biology.

  For example, studies of chemical biology, extracellular matrix, *in vitro* differentiation induction of germ cells, carcinogenesis by reprograming factors, neural stem cells, and so on.
- Taken together with its scientific level, iCeMS is really one of the world's premier class institutes.

2. Implementation as a WPI center

Fusion of research areas

- iCeMS has been making concerted efforts to encourage interdisciplinary research activities. It is highly commended for those efforts having yielded excellent results.
- A lot of innovative interdisciplinary collaborative research has emerged. One outstanding example is a porous gas-releasing material which enables the release of NO gas by light stimulation, providing a novel approach for examining cellular responses.
- It is remarkable that many talented young researchers are involved in such interdisciplinary studies. Although top-down approaches have mainly been conducted from the beginning, recently bottom-up type research has commenced. Many collaborative works between chemists and biologists are on-going and will surely yield excellent results.

Internationalization

- The ratio of overseas researchers is increasing and has exceeded 30%. This high percentage owes to the enormous efforts of iCeMS to recruit and create an atmosphere comfortable for foreign scientists. Although there are a small number of foreign senior PIs, young PIs recruited from abroad are doing impressively well. It is noteworthy that these young PIs praise iCeMS' foreigner-friendly environment.
- iCeMS has 16 partner institutions all over the world, and a substantial number of

publications have come out of collaborative work with them. The launching of the new journal “Biomaterials Science” may elevate the institute’s international reputation.

System reforms

- The top-down approach of iCeMS’ operation functions pretty well and has been successful in bringing about big scientific achievements, interdisciplinary research, globalization, and so on.
- A good atmosphere conducive to frank discussion among iCeMS members has been created through the institute’s excellent organization. At the same time, iCeMS’ interactions with other faculties in Kyoto University do not appear to be particularly strong. iCeMS should let other faculties better know about how excellent its organization is and work to get more substantial support from them.

3. Efforts toward sustainability

- Kyoto University is planning to carry out a rather drastic reform through which the basic structure of the university will be reorganized. The plan includes transforming iCeMS from a singular institute to an institution within the future general scheme.
- Dr. Yamagiwa, the new president of Kyoto University since last October, has eloquently declared that he will continue the past line of iCeMS’ and Kyoto University’s plans. Substantial support from Kyoto University’s headquarter is promised for securing the sustainability of iCeMS.

4. Recommendations

- Although scientific level of iCeMS is very high, including original and interdisciplinary work, the identity of the institute appears to not be firmly settled. This is partially understandable because of its long discussion about “meso-scopic” science, the spin out of CiRA, and the change of directors. Site visit members recommend that iCeMS reconfirms its identity in a realistic and practical way.

G-4. IFReC

Program officer: Takehiko SASAZUKI, Kyushu University
Center director: Shizuo AKIRA

1. Scientific Achievement

- IFReC has successfully achieved top world-level science. Nearly 800 papers with an average number of 29.2 citations have been published from IFReC. According to data on Essential Science Indicators^{TM} for 2003-2013 by Thomson Reuters, Osaka University was identified as the best institute in Immunology in the world. Assessments using criteria such as the impact of its publications, receipt of prestigious prizes and success at

obtaining important grant funding concur with IFReC being identified as a leader of immunology in the world. Thus, IFReC is recognized as a true world-premiere immunology research center.

- The major strengths of IFReC are innate immunity and immune regulation. Prof. Akira uncovered the molecular and cellular mechanisms of innate immune response and its regulation. Regulatory T (Treg) cell research conducted by Prof. Sakaguchi helped to open a new field of immune regulation in acquired immunity. Prof. Kishimoto's IL-6 research is a role-model for molecular and cellular research in immunobiology, leading to the development of a new antibody-based therapy and further elucidation of the etiology of autoimmune diseases. A recent InCites analysis, 5 of the top 10 scientists were from IFReC. There are few immunology institutions with such a high number of world-renowned scientists.
- The contributions of Imaging and Informatics components have steadily grown in importance.

2. Implementation as a WPI center

Fusion Studies

- IFReC's clear strategy has resulted in the creation of an interdisciplinary research environment for fusing immunology, imaging and informatics in order to elucidate the spacio-temporal behaviors of immune cells. Institutional collaboration between IFReC and QBiC/CiNet is being effectively carried out by strong interactive leadership between Profs. Akira and Yanagida.
- The number of papers in fusion studies exceeded 15% of the total publications in 2010, and is now 25% with more to come.

Internationalization and global visibility.

- IFReC has made serious efforts to create a globalized research and academic environment. The contributions of IFReC Kishimoto Foundation and of Osaka University have been of important stimuli for IFReC's continuous globalization efforts.
- Such innovative strategies have increased the number of foreign researchers to a 30% level, including

Figure. Winter school on advanced immunology jointly organized by IFReC and SIgN (Singapore). The 2014 school was held in Awajishima, Japan on January 19-23.

several very good junior PIs and researchers. The IFReC liaison office has been effectively supporting the science and daily life of the center's foreign scientists.

3. Efforts toward sustainability

- The establishment of IFReC and the great support provided it by Osaka University have led to a unique transformation of parts of Osaka University: tight interaction has evolved between IFReC and QBIC, CiNet, and the Research Institute for Microbial Diseases (RIMD) through concurrent appointments of professors and joint research projects and seminars. An impressive, long-term commitment by Osaka University has made this transformation possible while guaranteeing the future sustainability of IFReC.
- It is evident that Osaka University regards IFReC as a role model for its new organization "Institute of Academic Initiatives (IAI)" in terms of internationalization, interdisciplinary research and system reforms. A ripple effect from the WPI program to the whole university is clearly seen. Osaka University's plan for supporting IFReC in the future were well articulated and to be lauded.

4. Recommendations

- Based on its world-leading and highly appreciated scientific achievements in basic immunology, IFReC's new challenge to initiate innovative immunology research for uncured immunological diseases is a logical and reasonable direction for its extension. The center has already accumulated several promising seeds for this new challenge. Through this new endeavor, outstanding basic research on elucidating the dynamism of the immune system, for which IFReC has been most proud, will be further enriched and accelerated, resulting in its continuation as a concrete world-premiere research center.

G-5. MANA

Program officer: Gunji SAITO, Meijo University
Center director: Masakazu AONO

1. Scientific achievement

- The concept of "nanoarchitectonics" in MANA is now recognized as a new paradigm of nanotechnology. It is advancing outstanding work on an atomic switch and its application to neuro-circuits, nano-sheets with a high dielectric constant, sensitivity enhancement of the efficiency of artificial photo-synthesis, and novel ultra-sensitive biomolecule sensing. Concurrently, it is doing theoretical work on topological materials.

- More important is the center's excellent infrastructure with state-of-the-art equipment (including the new development of tools allowing in situ measurements in a TEM or 4-probe STM measurements) and an excellent micro-fabrication facility (MANA Foundry)

Figure. MANA Foundry

2. Implementation as a WPI center

Fusion

- With special top-down programs like "Fusion Research Funds," "Theory-Experiment Fusion Research Program," "Nano-Life Fusion Research Program," and "Grand Challenge Research Program," interdisciplinary domains are being created across MANA's four fields. The fact that young scientists have created their own "great challenges" discussion group demonstrates how "fusion" exists naturally in a bottom-up approach.
- That its atomic switch works as an inorganic synapse and that its sensitive and specific sensors can be applied in life science are typical examples of how interdisciplinary research is being advanced successfully at MANA.

Internationalization and global visibility

- MANA is a role model for the internationalization of WPI centers. Its composition of foreign researchers has reached the level of international institutions, as 36% of its PIs (8/22) and 51% of its total researchers (105/207) are non-Japanese. It is worthwhile to mention that top world level PIs have joined from MANA satellite institutions such as CNRS, UCLA, Georgia Tech and University of Montreal.
- The circulation of young researchers is outstanding. A large number of foreign postdocs have spent time at MANA (238 out of 286 postdocs are foreigners, 83.2%), and many of them (189 postdocs including Japanese) have stepped up their careers with MANA experience.
- There are frequent exchanges of researchers between MANA and its foreign satellites. The large number of foreign visitors (including officials from governments) who come to MANA and its network of MOUs with 44 foreign centers are producing visible results as a successful international program. In FY 2013, 715 visitors came to MANA including 444 from Asia including Japan, 182 from Europe, 68 from America, and 21 from other countries.

System reform

- MANA has changed the scientific culture in Japan and transformed NIMS into a more international government laboratory. Many other research institutes in Japan are also using the MANA model as a guide for their own globalization program.

3. Efforts toward sustainability

- MANA is incorporated within NIMS as its third division. Exchange of positions between MANA and NIMS facilitates their management. NIMS supports MANA by providing more than 1 billion yen in research funding for its foundry operations and supercomputer charges, etc. MANA provides bilingual conditions in all its activities from assistance for daily life of foreign scientists to preparation of documents and announcements. MANA Independent Scientists, who are young and promising researchers, can perform their own research independently. They have benefited from the center's 3D (Double-Mentor, Double-Affiliation, Double-Discipline) system, and many have taken positive next steps in their careers. Thus, MANA has served as a tug boat for NIMS.
- MANA and NIMS aim to proceed as a top world-level institution in Nanoarchitectonics. MANA continues to remain as one of NIMS's research divisions. A large number of tenure positions (approximately 90) are provided and a budget (R&D funding of about 1 billion yen/year) is proposed toward sustaining MANA as a world-leading hub.

4. Recommendations

- The scientists at MANA should continue to do fundamental research at the highest international level and not seek for short-term applications, which may be needed for successful grants after WPI support has ended. New knowledge in Nanoarchitectonics is the best basis for new applications and innovations.

G-6. I^2CNER

Program officer: Kazunari DOMEN, The University of Tokyo (changed from Nobuhide KASAGI, JST on November 2014)

Center Director: Petros Sofronis

1. Scientific achievement

- The scientific level of I^2CNER is generally very good with some selected areas of excellence. Examples of its excellent science are metal oxides for stable and efficient H_2O electrolysis, bio-inspired synthesis of NiFe hydrogenase, and organic LED devices. Its work on a TiFe alloy for hydrogen storage is solid engineering research.
- On the other hand, while top world level scientific issues such as performance and durability are taken into consideration in the center's fuel cells and hydrogen production research, they do not always benchmark well with world-leading ones. Its division for CO_2

capture and utilization has been renewed and the research is expected to be further enhanced.

2. Implementation as a WPI center

Feeding research outcomes back into society

- The center's framework of "Energy Vision," "Scenarios," and "Division Roadmaps" provides a backbone structure for the scientific research conducted at I^2CNER. It should be continuously revised to keep up with the rapid changes in the energy environment, and to help stakeholders and decision-makers in drawing up their strategic energy plan.

Fusion

- Fusion of disciplines has been fostered by several Director's initiatives. The new I^2CNER building has brought researchers under one roof, cultivating collaborations across disciplines. A bottom-up approach has been very successful in producing new interdisciplinary research teams of PIs and young faculty members.

Internationalization and global visibility

- Since the appointment of Dr. Sofronis as Director, the international visibility of I^2CNER has been enhanced continuously. For example, I^2CNER has maintained close contact with the US DOE Office of Energy Efficiency and Renewable Energy.

Figure. US Ambassador Caroline B. Kennedy to Japan with Dr. P. Sofronis at the Tokyo Symposium 2014 on December 12.

System reform

- By the strong leadership of the Director, I^2CNER's processes for promotions, tenure, and merit-based compensation meet the highest international standards. Kyushu University has also made some reforms for enhancing the globalization and sustainability of I^2CNER. The key will be to maintain and continue these efforts. The plan for using University of Illinois as a satellite should be made clearer.

3. Efforts toward sustainability

- The Energy Analysis Division is critically important for keeping the direction of I^2CNER and each of its Division's research theme aligned with the center's strategic roadmaps. The Internal Programs Review Committee assures the quality of I^2CNER policy in each research project. The center's future success hinges on these functional structures working well.

- I^2CNER's future program will need a critical review to be conducted of the strength and weakness of all the projects in its eight Divisions. The deficits should be identified.
- Kyushu University should continue its policy of actively reforming its administrative environment and of working together with I^2CNER members.

4. Recommendations

- The center's current composition of researchers is limited to a few areas of engineering and science. It lacks theorists, mathematicians, environmental specialists and social scientists.
- A particular effort should be made to invite top world-leading scientists who can join the project as foreign PIs residing at I^2CNER.
- Serious effort should always be made to identify the next research focus and research topics with the help of EAD. Much better use should be made of roadmaps, and they should be concretely integrated into the decision-making for future research priorities.
- To ensure the sustainability of I^2CNER after ten years, efforts should be started to design its finances and to seek stable funding resources.
- Program committee members appreciated the excellent leadership and collective efforts of Dr. Sofronis in establishing I^2CNER as a WPI center under not necessarily familiar circumstances. The members wish for his continuous contribution as director of I^2CNER in building a bridge between Kyushu University and the University of Illinois, and even between US, Japan and the rest of the world.

G-7. IIIS

Program officer: Kozo KAIBUCHI, Nagoya University
Center director: Masashi Yanagisawa

1. Scientific achievement

- The science being conducted at IIIS is at the "cutting edge" of the sleep field. Its mouse genetics, systems neuroscience approaches (optogenetics and DREADDs), *in vivo* electrophysiology and imaging are all state-of-the-art approaches. The questions being addressed are fundamental to this field.
- The forward genetics by Drs Yanagisawa and Funato toward isolating sleep mutants has been successful. They have identified at least two mutants and responsible genes named Sleepy and Dreamless. Further molecular and *in vivo* analysis will provide us with fundamental knowledge on the regulation of sleep.
- Dr. Nagase extended his Orexin agonist and made derivatives having high affinity to Orexin receptors. These compounds may be useful not for only the dissection of Orexin pathways *in vivo* but also for clinical studies.

- Some of the research efforts by junior staff seem diffuse, suggesting a lack of mentorship.
- The physiological approaches including cutting-edge imaging, pharmacogenetics and optogenetics are included in several of the projects conducted by young researchers. One year is not sufficient to expect outstanding scientific outcomes; however, we still would like to see someone try to develop a novel technology of their own. That is to conduct a bold project, not just apply existing technology to sleep research. To spawn this kind of idea, IIIS will need to provide interdisciplinary conditions as described below. Also, a senior physiology-based researcher may be needed to mentor younger physiologists.

Figure. Sleep recording chamber by Dr. Y.Urade, PI of IIIS.

2. Implementation as a WPI center

Fusion of research area

- The team consists of quite different types of researchers and is interdisciplinary in basic sleep science. The clinical members, however, do not integrate the basic research findings well into their clinical study.

Internationalization

- Oversea researchers are accounted for 22% at the end of FY 2013 (April 2014), still being behind the target number as a WPI center. This number should be increasing by the time of the center's interim evaluation in FY 2016.
- An international symposium was held in 2014 in which several foreign scientists were invited as participants.

System reform

- The support of U. Tsukuba is very much appreciated: It provided land and supplemental budget for a new building.
- A cross-appointment system has been completed. Dr. Yanagisawa is now cross- appointed with University of Texas Southwestern medical center.
- To improve inter-lab communications, IIIs introduced a 'Science lounge' which promotes sharing research activities and brings members closer together as a team in an informal setting.

3. Recommendations

- PIs should write gene names in full when the center has an evaluation of its progress by reviewers. Otherwise, the reviewers will not be able to evaluate the quality of the center's science appropriately.
- One critical recommendation at this stage is to enhance the success of the junior faculty and researchers in the program. This will provide a strong boost to the overall reputation of IIIS.
- More organized oversight is needed along with strong feedback to junior faculty on their projects. Recruitment of a senior international sleep scientist is needed to back up the director in this arena. Strong support is needed for international travel by researchers and junior faculty so as to give them exposure to broader sleep and neuroscience research communities.
- Regarding the bioinformatics, it is clear that developing new sleep phenotypes and creating a richer database could be very interesting. PIs should try to team up with an engineering school to see whether computer sciences could be applied to their project.
- The unexpectedly lower funding allocation this year is limiting the development of some new and promising areas and will significantly slow hiring of researchers and faculty. We anticipate a significant increase of budget in the next fiscal year so as to further advance IIIS's science.

G-8. ELSI

Program officer: Shoken MIYAMA

Center director: Kei HIROSE

1. Scientific achievement

- The Earth-Life Science Institute (ELSI) at Tokyo Institute of Technology (Tokyo Tech) has been well established as a WPI center within the 2 years since its launching. Dr. Kei Hirose has presented clearly the scope of his approach on the origins of the Earth and life. The revision of the Roadmap has had a positive effect on streamlining the relationship between disciplines, in addressing the 7 problems, and meeting the center's goals.
- In the field of Earth Science, Dr. Hirose published a high-pressure experiment addressing the melting temperature of pyrolite in the journal Science, which has significant implications regarding the dynamics and thermal history of the Earth and provides important information on the existence of water in its core.
- With regard to the origin of life, researchers have nicely launched their projects incorporating interdisciplinary approaches with geoscientists. The best examples are the studies on the serpentine hot spring at Hakuba Happou and the laboratory experiments on the artificial evolution of photosynthetic bacteria.

2. Implementation as a WPI center

Fusion

- The ELSI's research object is itself a fusion study, i.e. understanding the origin of life in close connection with the origin of the Earth. The ONSEN Project (studies on the serpentine hot spring at Hakuba Happou) is a nice outcome of successful communication between biologists and geoscientists. That is, the work by Drs. Kurokawa and Hongoh in describing the relationship between potentially ancient ecosystems with environmental genomics is an outstanding example of that fusion.

Figure. Discussion at tea break

Global visibility and internationalization

- ELSI's visibility is being very rapidly achieved due to the number of its publications in high-standing peer-reviewed journals. And, ELSI's support for and the attendance of its members in international meetings, such as the 2014 Gordon Research Conference on the Origins of Life and the Nara Origins 2014 meeting, has been very good in raising its global visibility.
- ELSI's visibility goes hand in hand with its rapidly growing reputation as a center of high standards and job opportunities for young researchers, who can find in ELSI a place to develop a serious scientific career. Applications from abroad from more than 100 candidates for postdoc positions in ELSI are a good indication for its global visibility.

System Reform

- ELSI is proposing a “joint appointment” system to hire domestic PIs. This system has long been awaited, but has been difficult to institute in Japanese universities. Although it will require strong support from other universities, ELSI is breaking this barrier for future science development in Japan.

3. Recommendations

- Although the revised Roadmap is very clear and easy to understand, it is still important to clarify what is stated in the Roadmap. What is meant by “working model for the origin of life,” “model of early Earth environment,” and “scenario of Earth's formation.”

- ELSI should continue making effort to increase the number of senior-level female scientists.
- For ELSI, it is worth considering more observational studies of protoplanetary disks ALMA, SUBARU, and other telescopes. Also, recent results from the observation of extrasolar planets are very important for ELSI activities. Collaboration with astronomers studying planet formation will be very useful.
- It would be useful to record and report ELSI's “export” as well as its “import” activities in terms of internationalization. In other words, ELSI should put an emphasis not only on hosting researchers from abroad but also on sending its researchers abroad to research centers around the world.

G-9. ITbM

Program officer: Hiroo FUKUDA, The University Tokyo
Center director: Kenichiro ITAMI

1. Scientific achievement

- ITbM, which now consists of 92 researchers including 11 PIs, 45 researchers, 25 supporting staffs and 11 administration staff members, has been successfully established as a WPI center in terms of its scientific achievements and WPI mission implementation. The scientific achievements of the Institute are outstanding, as is evident from the general output of its publications in leading journals, including 17 publications in top-ranked journals, as well as several patents, and prestigious awards and honors given to ITbM members.
- The appointment of Prof. Steve Kay, a world-leading circadian clock expert, and his Co-PI, Dr. Tsuyoshi Hirota was an excellent decision to expand and strengthen this field, and to apply small molecule chemistry to circadian clock biology.
- Research at ITbM is now organized into 4 core projects, 6 seed projects and 6 platforms. Importantly, a number of small molecules as seeds for potential transformative biomolecules have already been synthesized and shown to control plant growth, animal/plant clock, and pollen tube guidance.

Figure. Mix-Lab, where chemists and biologists work together.

2. Implementation as a WPI center

Fusion studies

- Efforts toward fusion of synthetic chemistry and biology are facilitated by mixing researchers from different disciplines in the Mix Lab and supporting innovative ideas by the ITbM Research Award, which is an in-house funding source for young scientists, as well as by ITbM seminars and Mix hours.

Internationalization and global visibility

- ITbM established a partnership with NSF-CCHF (The Center for Selective C-H Functionalization), which is a virtual center of 23 outstanding labs in the USA, and RIKEN Center for Sustainable Resource Science (CSRS). An exchange program for young researchers and collaboration through partnerships has further enhanced the global visibility of ITbM. ITbM is also in an enviable position of hosting three prestigious scientific awards, which surely will provide unique opportunities to further promote its mission and raise its visibility.

System reform

- In good cooperation with Nagoya University, ITbM managed to set up an organization including a decision-driven approach by the director in consultation with his colleagues, use of English as the official language, and backing by a strong administrative and research promotion office, the latter staffed by several PhD holders.
- Nagoya University has already established an internal “mini”-WPI centers following the mission of the WPI program by supporting competitive projects using intramural funds. Thus, ITbM is already having an impact on the entire university by encouraging internationalization and interdisciplinary collaborations.

3. Recommendations

- The Working Group suggests that ITbM hires one or two outstanding foreign junior PIs who will reside in Nagoya. We also encourage ITbM to hire additional female scientists at the senior level.
- ITbM may consider building a strategic international network of outstanding researchers in this new field, for example by hosting a high impact international conference like the Tetrahedron Symposium and by implementing a short-stay program for prominent international researchers.
- ITbM may address environmental/safety issues beyond the scope of current regulations. The Environment and Safety Committee may help prepare criteria on how to assess the “safety” of the transformative biomolecules developed.
- ITbM requires additional expertise in structural biology and computational modeling to

guide the rational design of the most promising small molecule leads. Therefore, a strategic collaboration with CSRS at RIKEN could significantly improve the chance for ITbM to discover small molecule leads that could be ultimately developed into *in vivo* products.

H. Outreach activities

The WPI Program recognizes the importance of outreach activities, aiming at public awareness and understanding of science. All the WPI centers hire scientists/specialists dedicated to outreach activities. These include publishing brochures and pamphlets, providing lectures to the general public, teaching high school students, organizing science cafés, and holding press conferences.

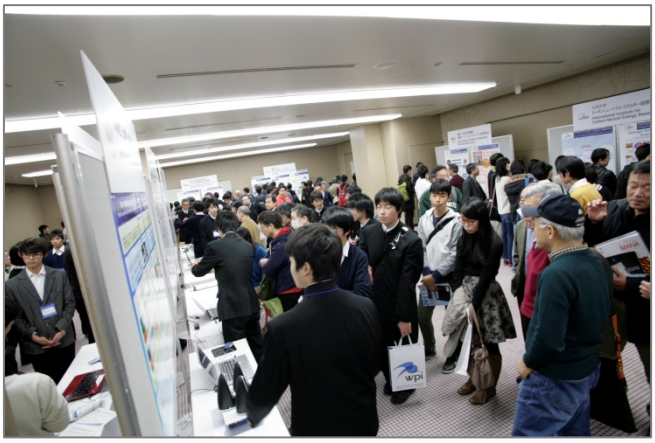

Figure. Crowd at poster presentations of high school students.

In February 2014, nine WPI centers jointly presented their activities at the "AAAS Annual Meeting" in Chicago. Dr. Sofronis, director of I^2CNER, delivered a lecture on the aims and activities of the WPI program. The highlight of the WPI outreach activities was a joint workshop for high school students, held in December 2014 in the center of Tokyo. More than 400 participants, with many high school students, enthusiastically participated in it. Lectures by two young researchers (Drs. D-O, Wang, iCeMS and A.T. Staykov, I^2CNER) and Dr. H. Murayama, Kavli IPMU, attracted the high school students. Seven high schools including five "Super Science High schools (SSH)" presented their research on solar cells, windmills, spinning tops, prime numbers, and other topics.