



**FY 2013 Follow-up of WPI Program**

**By Program Committee**

January 2014

(This report deals with progress made under the WPI Program in FY 2012.)

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**Summary**

Research systems face increasing worldwide competition in creating new research outcomes and recruiting talented scientists. Governments are searching for more efficient forms of funding to advance fundamental and innovative science, which is essential for a knowledge-based society.

According to OECD, over two-thirds of OECD countries are now operating “Research Excellence Initiatives” (REIs), which are designed to encourage outstanding research by providing large-scale and long-term funding to designated research units. REI aims correspond to the missions of the WPI Program, shown below. Indeed, the WPI Program is regarded internationally as a REI role model.

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.

Under these missions, 5 WPI centers were launched in October 2007. They are:

- AIMR on materials science at Tohoku University
- Kavli IPMU on universe at 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.

In December 2010, the sixth WPI center was established:

- I<sup>2</sup>CNER on carbon neutral energy at Kyushu University.

In 2012, WPI centers are expanded by adding 3 more centers were added under the program “WPI Focus”:

- 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

The WPI centers’ Programs are followed up closely every year by site visit teams and the Program Committee with focus on their scientific achievements and implementation of the WPI missions. These efforts are guided by the program director (PD) and program officers (POs).

The following WPI research centers aim to create new frontiers of science by advancing interdisciplinary studies:

- AIMR: Creation of new materials science in collaboration with mathematics
- Kavli IPMU: Understanding of universe by fusion of physics and mathematics
- iCeMS: Integration of cell biology into materials science
- IFReC: Emerging of immunology, bio-imaging and bio-informatics
- MANA: Creation of nanoarchitectonics

- I<sup>2</sup>CNER: Towards carbon-neutral society with emphasis of the use of hydrogen
- IIIS: Elucidation of fundamental mechanisms of sleep
- ELSI: Elucidation of origins of the earth and life
- ITbM: Creation of transformative bio-molecules

All WPI centers are actively engaging outreach activities such as publishing brochures, delivering lectures to general publics, and students, providing science café etc. In FY2013, 9 WPI centers jointly participated in “Science Agora” in Tokyo and “AAAS Annual Meeting” in Boston. Following our tradition, “Science Talk Live 2013” was held in Sendai in December for high school students. For the first time, presentations were given by students from 3 super science high schools in Miyagi Prefecture and one from the USA (Eleanor Roosevelt High School in MD).

The WPI Program supports the centers basically for a period of 10 years. 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. As there is a need to discuss more concretely the center’s future development over the mid-to-long term, including their activities and initiatives after project funding ends, the Program Committee has initiated dialogues with the centers and their host institutions.

#### **A. Global Trend toward Research Excellence Initiatives**

Research systems face increasing worldwide competition in creating new research outcomes and recruiting talented scientists. Governments are searching for more efficient forms of funding to advance fundamental and innovative science, which is essential for a knowledge-based society.

According to OECD, over two-thirds of OECD countries are now operating “Research Excellence Initiatives” (REIs), designed to encourage outstanding research by providing large-scale and long-term funding to designated research units, 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 aims overlapped the missions of the WPI Program. Indeed, this program is regarded

internationally as a REI role model.

On May 2013, an international workshop was held in Jerusalem to discuss the current status of the REI program, in which the WPI PD and deputy PD participated. In September 2013, a delegation from MEXT and JSPS visited German agencies and universities to learn about the German Excellence Initiative, especially their procedures and measures for extending support.

## **B. Outline of WPI Program**

In FY 2007, MEXT (Ministry of Education, Culture, Sports, Science and Technology) initiated the WPI (World Premier International Research Center Initiative) Program, a highly challenging, long-term program to support the establishment of world-leading research centers in Japan.

The WPI Program aims ambitiously at creating globally visible and internationally opened top-world research centers in Japan, 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.

Basically, the WPI Program covers fundamental research of a kind that will strengthen future growth and global competitiveness.

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

- Top-quality of science
- Internationalization
- Making breakthroughs by fusion studies
- Reforming research and administration systems

## **C. Nine WPI Centers**

In FY 2012, 3 more WPI centers were added to preceding 6 WPI centers. Consequently, 9 WPI centers are currently operating under the WPI Program.

The first 5 WPI centers were selected in FY 2007. They are:

- 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 (NIMS)

These WPI centers started their research activities in October 2007.

In FY 2010, the Program Committee selected the sixth WPI center under a program to advance Green innovation:

- International Institute for Carbon-Neutral Energy Research (**I<sup>2</sup>CNER**), Kyushu University

I<sup>2</sup>CNER started its activity in December 2010.

In FY 2012, the WPI program was expanded by adding three more centers under the program "WPI Focus", in which the research areas and center sizes are more focused. The new centers are expected to develop sharper strategies, implement agile but bold management schemes, and gain international recognition for their distinct characters. Among four missions shown above, fusion studies are important in principle but less emphasized in the WPI Focus Program. Furthermore, the centers are encouraged to build upon previous center-building initiatives. Research areas are not specified.

Of the 15 applications submitted, six were given a hearing by the Program Committee and finally three were selected. They are:

- International Institute for Integrative Sleep Medicine (**IIS**); Director, Dr. Masashi Yanagisawa, University of Tsukuba
- Earth-Life Science Institute (**ELSI**); Director, Dr. Kei Hirose; Tokyo Institute of Technology.
- Institute of Transformative Bio-Molecules (**ITbM**); Director, Dr. Kenichiro Itami; Nagoya University.

These WPI centers were launched in December 2012.

As shown in the figure (see next page), these 9 WPI centers can be categorized into 3 groups, i.e. Origins of Universe, Earth and Life; Materials/Energy; Life science. We are in particular pleased that WPI Program covers three origins i.e. universe, earth and life by Kavli IPMU and ELSI. These areas of research may stimulate and evoke intellectual curiosity among the public, planting seeds for future science and scientists.

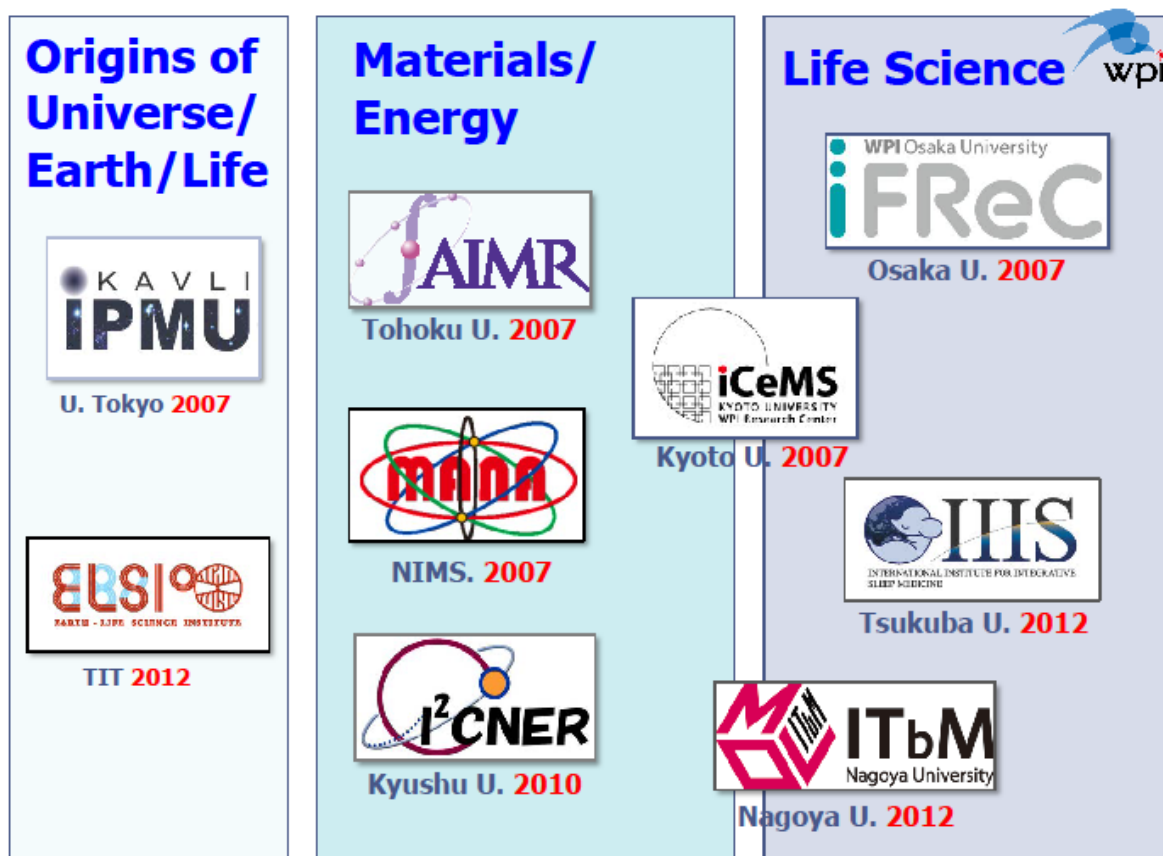


Figure 9 WPI centers can be classified into the 3 groups

## D. Members

### D-1. Program committee

In FY2013, Program committee consists of the following 17 members.

Hiroo IMURA (Chairperson), President, Foundation for Biomedical Research and Innovation

Toshiaki IKOMA, Representative Director, Executive Vice President & CTO, Canon Inc.

Hiroto ISHIDA, President Emeritus, Kanazawa Gakuin University

Tsutomu KIMURA, Chairman, Tokyo Metropolitan Government Board of Education

Kiyoshi KUROKAWA, Academic Fellow, National Graduate Institute for Policy Studies

Makoto KOBAYASHI, Director, Research Center for Science Systems, Japan Society for the Promotion of Science (JSPS) Nobel Laureate in Physics (2008)

Hideo MIYAHARA, Former President, National Institute of Information and communication Technology (NICT)

Michiharu NAKAMURA, President, Japan Science and Technology Agency (JST)

Ryoji NOYORI, President, RIKEN, Nobel Laureate in Chemistry (2001)

Shinichiro OHGAKI, Former President, National Institute for Environmental Studies (NIES)

Masatoshi TAKEICHI, Director, RIKEN, Kobe Institute

Robert AYMAR, Senior Counsellor to the "Administrateur Général" (CEO), French Atomic

Energy Authority (CEA), France  
Rita COLWELL, Professor, University of Maryland, USA  
Richard DASHER, Professor, Stanford University, USA  
Ian HALLIDAY, Professor Emeritus, University of Edinburgh, UK  
Chuan Poh LIM, Chairman, Agency for Science, Technology and Research, Singapore  
Matthew MASON, Director, Robotics Institute, Carnegie Mellon University, USA  
(Dr. Yuko HARAYAMA left the committee due to her appointment to chairperson of Council for Science and Technology Policy)

#### **D-2. Program directors (PD) and Program officers (PO)**

Toshio KUROKI, *JSPS*, Program director  
Akira UKAWA, *Tsukuba University*, Deputy program director (appointed on April 1, 2013)  
Yoshihito OSADA, *RIKEN*, Program officer for AIMR  
Ichiro SANDA, *Kanagawa University*, Program officer for Kavli IPMU  
Toru NAKANO, *Osaka University*, Program officer for iCeMS  
Takehiko SASAZUKI, *Kyushu University*, Program officer for IFRcC  
Gunji SAITO, *Meijo University*, Program officer for MANA  
Nobuhide KASAGI, *JST*, Program officer for I<sup>2</sup>CNER  
Kozo KAIBUCHI, *Nagoya University*, Program officer for IIIS  
Shoken MIYAMA, *Hiroshima University*, Program officer for ELSI  
Hiroo FUKUDA, *University Tokyo*, Program officer for ITbM

#### **D-3. Change of Center director and Administration directors**

Susumu KITAGAWA, Director of iCeMS since January 1, 2013  
Tomiyoshi HARUYAMA, Administration director of Kavli IPMU since April 1, 2013  
Kazuo FUNAKI, Administration director of I<sup>2</sup>CNER since April 1, 2013  
Toshio KOKUBO, Administration director of IIIS since July 1, 2013  
Motonori HOSHI, Administration director of ELSI since October 20, 2013  
Tsuyoshi MATSUMOTO, Administration director of ITbM since January 1, 2014

#### **D-4. Working groups (WG)**

Working groups consist of 3 domestic and 3 international experts of the areas covering the activities of the WPI centers. For members see the following URL:  
[http://www.jsps.go.jp/english/e-toplevel/data/08\\_followup/FY2013WGMembers.pdf](http://www.jsps.go.jp/english/e-toplevel/data/08_followup/FY2013WGMembers.pdf)

## **E. Follow-up**

WPI centers are followed up for their scientific achievement and implementation of the WPI missions by site visits and the Program Committee.

The annual Program Committee meeting was held on October 29 and 30, 2013 with the participation of PD, POs and MEXT officers and the JSPS secretariat. Hearing was conducted on the 9 WPI Centers regarding their scientific achievements and mission implementation as WPI Centers. Presidents of host institutions from the 5 WPI centers established in 2007 reported their plans to sustain the centers after the WPI program.

Site visits to the nine WPI centers were conducted over two days during June–September period in 2013 by PD, PO, international WG members, MEXT officials and JSPS secretariats. In 2013, 14 program committee members, including 5 from abroad, participated in the site visits following their interests. The schedule included a briefing by the center director, presentations by selected PIs, and poster presentations by young researchers, guided tour to facilities and comments/advices by site-visit team members.

Reports on the site visits were submitted to the Program Committee and disclosed to corresponding WPI centers.

Summary of these reports are shown below:

### **E-1. AIMR**

#### **1. Scientific achievements**

- Following the interim evaluation, AIMR proposed change of Director and introduction of mathematics into materials science, which was approved by Program committee with the condition of careful watch for 2 years. This condition is cleared by the site visit team and the committee due to remarkable progress as shown below.
- After a dramatic turn-around last year, AIMR under the strong leadership of the Center Director, Dr. Kotani, is moving forward at an excellent pace to establish world-class mathematics-oriented materials science.
- The math-mate collaboration is yielding results in the three target projects: spintronics where AIMR is becoming a world leading center, bulk metallic glasses where persistent homology theory has provided new insights in their structure, and nano-porous gold for which graph theory has been successfully used to analyze the structure.
- There is no doubt that AIMR is keeping world top-quality activity in materials science. This is apparent from the long list of publications in high impact journal, of prestigious awards, many invitations to international conferences, and an amount of external funds



totaling 6% of the whole Tohoku University research budget.

## 2. Implementation as a WPI center

### *Fusion of research areas*

- Math-mate collaboration is a truly challenging subject. Nonetheless AIMR has made a substantial progress. Instrumental in this progress has been the “Interface Unit” and efforts by young investigators through Math-Mate Seminar, TP-IU (Target Project-Interface Unit) joint seminar and others. Recent recruitment of materials scientists and mathematicians has further enhanced the collaboration.

### *Internationalization*

- AIMR is ambitiously trying to construct a world-wide network with major institutions. It is now recognized as a globally visible international hub in research excellence of mathematics and materials science. Collaborations between University of Cambridge and with the Fraunhofer Institute are highly appreciated.



*Young mathematicians of “Interface Unit”  
discussing with materials scientists*

### *System Reform*

- The administration has become truly distinct from traditional operations of Japanese institutions in a way that administrators communicate actively with researchers.
- “Research Support Center” is another good feature, in particular the “Common Equipment Unit” is functioning well to get newly arriving junior researchers to start work smoothly.

## 3. Efforts toward sustainability

- President Satomi’s vision for Tohoku University places AIMR as a role model to reform the entire university. A Task Force was set up and has been drawing plans on the sustainable organizational framework after the end of the WPI Program. It is desirable to make clear how the future new organization is ranked relative to the other existing research centers and how these organizations share the roles in the research on materials science.
- The math-mate collaboration seems to be inducing some changes of the local research culture giving an impact to the traditional materials community in Tohoku University.

These efforts have created a more open-minded attitude among investigators. Expectation is held in the University's continued efforts to secure the WPI center's sustainability.

#### 4. Recommendations

- A discussion of the long-term future strategy of materials science at AIMR is recommended. It is important for AIMR to hold the current strategy with full confidence. Also short- and medium-time strategy should be carefully prepared in parallel.
- AIMR was asked to consider possible limitations of the math-mate collaboration and to consider on which area their efforts should be concentrated. That limitations and difficulties may be encountered when pursuing further should be recognized and, therefore, an additional discussion might be necessary on what fields in the materials science should be challenged by the math-mate collaboration.

#### E-2. Kavli IPMU

##### 1. Scientific achievement

###### *Experimental Physics*

- Experimental programs have made considerable progress over the past year.
- The origin of the accelerating expansion of the universe is one of the greatest questions in all of the physical sciences. The combination of Subaru deep wide-field imaging and spectroscopy (SuMIRe), for which Kavli IPMU is making significant contributions, represents a unique capability for probing this issue. The Hyper Suprime-Cam (HSC) digital camera has been completed, and the HSC survey will start in 2014. The Prime Focus Spectrograph (PFS) has successfully passed the Conceptual Design Review and Preliminary Design Review.
- In Kamioka underground experiments, KamLAND-Zen and GADZOOKS! are exploring the properties of neutrinos, and XMASS is looking for dark matter particles. All three



*Prof. Murayama (second from right) and his colleagues at Piazza Fujiwara in Kavli IPMU Bldg.*

experiments made significant progress. While they have a large number of outside collaborators, all three have been originated by Kavli IPMU staff.

### ***Theoretical Physics***

- The science output in theoretical physics continues to be of very good quality. The ultimate success will come once the institute creates some trademark topics and research fields that are universally accepted to be “made in Kavli IPMU”.
- In string theory there are a number of accomplishments showing concrete examples of fusion between mathematics and particle physics.

### ***Mathematics***

- We have been much impressed by the presentations of Milanov and Toda. They are certainly at the world’s top class level, especially among fields related to theoretical physics. It is no surprise that Toda was invited to International Congress of Mathematicians 2014, the most prestigious meeting in mathematics held every 4 years where the Fields Medal is awarded.

## **2. Implementation as a WPI Center**

### ***Fusion***

- The cross-fertilization at Kavli IPMU is definitely working. The atmosphere of the institute is becoming very interactive between mathematicians and theoretical physicists, as evidenced by 11 papers produced between 2011 and 2013 which explicitly acknowledged the role of interdisciplinary discussions.

### ***International visibility***

- The reputation and visibility of the Kavli IPMU is very high throughout the global community of mathematicians, physicists and astronomers. It is appropriate to compare Kavli IPMU with other leading institutes throughout the world including those in Princeton, Stanford and Santa Barbara.

## **3. Efforts toward sustainability**

- There is a clear demonstration of the willingness and commitment of the University of Tokyo to take the steps necessary to secure the future of the institute. The concrete measures already in place include the establishment of TODIAS (Todai Institutes for Advanced Study), and a number of reforms on flexible appointments.

- In addition University of Tokyo presented its vision that (i) it aspires to be a World Premier University in research and education, and (ii) it will lead the system reform of Japanese universities. Expectation is held in the University's continued efforts to secure the WPI center's sustainability.

#### 4. Recommendations

- Kavli IPMU should look beyond the 10-15 year period, and seriously consider what it will do in science and organization to evolve from a world top level institute to a world leading institute in the physics and mathematics of the Universe.
- Particularly at this crucial time in the history of Kavli IPMU, it is important to focus resources on a few areas of unique scientific promise to guarantee Kavli IPMU status.
- Focusing is especially important for SuMIRe beyond data pipeline software in the areas of software for cosmology data analysis and cosmological simulations. Full collaboration with other similar efforts already underway should be pursued. Kavli IPMU could leverage advances in data mining and informatics by collaborating with computer scientists and statisticians outside Kavli IPMU jointly with National Astronomical Observatory of Japan.
- The number of on-site PI's should be increased. Especially we hope to see more progress on making joint appointments for mathematics and theoretical physics PI's at other Japanese institutions.

### E-3. iCeMS

#### 1. Quality of Science

- The director of iCeMS was changed from Dr. Nakatsuji, a biologist, to Dr. Kitagawa, a chemist, after last year's site visit. Based on the switch, the aim of the institute has been changed. Although the institute will continuously concentrates on the fusion of cell biology and material science, its main emphasis is shifted from biology to chemistry. A cell-inspired materials approach was added to the initial aim.
- New director revived the concept of "mesoscopic" science, as an inherently dynamic regime, in which biology, chemistry and physics are integrated. The application of mesoscale pore material to gas biology will make the importance of meso-science in the fusion area



*Prof. S. Kitagawa,  
iCeMS director since 2013*

much clearer.

- In addition, some other key improvements, such as recruitment of new PIs and establishment of new interdisciplinary groups will further strengthen the scientific achievement.
- All the site visit members were impressed by iCeMS's scientific quality and achievements, through its presentations and publications. They are waiting for visible papers representing mesoscopic science, following the new direction of the institute. Such publications will surely help to clarify the identity of the institute.

## **2. Implementation as a WPI center**

- Both the quality and number of fusion researches have been significantly improved. It is especially impressive that young researchers are engaged in various aspects of the fusion research area between biological science and material science.
- Steady efforts to attain global visibility have been made and have made iCeMS more visible in the scientific society. Those efforts include the Kyoto Fellow program, a program for young researchers to visit world-class institutions for international collaboration, organization of international symposia, publication of a new journal "Biomaterials Science" and opening of satellite laboratories in Bangalore.
- An excellent administration system has encouraged young researchers including Kyoto Fellows to pursue independent interdisciplinary studies and has attracted many young foreign researchers.

## **3. Efforts toward sustainability**

- According to the President Matsumoto's presentation, iCeMS is regarded as a prototype of the plan for Kyoto University, which aims to establish a new institute(s) in interdisciplinary and exploratory research areas under the plan for "International Center for Emerging Sciences" (ICeMS (tentative name)).
- As for the relationship between iCeMS and CiRA, a long-standing problem, the mission of iCeMS was clarified as being different from that of CiRA, translational research and application for regeneration medicine. Expectation is held in the University's continued efforts to secure the WPI center's sustainability.

## 4. Recommendations

- Directorship has been smoothly shifted to Dr. Kitagawa, who presented the second mission of iCeMS, cell-inspired materials. Although the new director emphasized the significance of mesoscopic science, the terminology and the line of thinking did not create a commonly shared impression among the site visit members.
- Based on this, our biggest concern is that identity of iCeMS has not been clearly defined yet. We understand the significance of cell-inspired materials but are afraid that the incorporation of the new theme will broaden the topics more diffusively. In other words, research topics appear to be a little too diversified in areas related to cell biology, stem cells, membrane structures, chemistry and physics.
- In addition, as for the administration, a robust and concrete future plan for the institute by Kyoto University headquarters is keenly required.

### E-4. IFRcC

#### 1. Scientific achievement

- Based on the progress report and presentations during the site visit meeting, all members of the working group have recognized that the overall scientific quality of IFRcC is outstanding and reflective of the critical mass of highly productive and talented scientists in the fields of immunology, imaging science and informatics.
- In addition to world-leading research outcomes in fields of innate immunity (Dr. Akira), regulatory Tcells (Dr. Sakaguchi) and IL-6 stories (Dr. Kishimoto), several exciting and provocative findings are being generated that will open up new and dynamic aspects of the immune system relative to physiological and pathological conditions.

#### 2. Implementation as a WPI center

##### *Fusion studies*

- Fusion of immunology with imaging science and informatics is becoming a reality and producing many interesting results in both fundamental and clinical immunology. QBiC and CiNET, the recently opened imaging science centers of Osaka University, are exerting big impacts on IFRcC, and these three independent research organizations are creating a new field of bioscience, which will certainly attract excellent young researchers from the world.
- It is advisable that young investigators to be given the opportunity to propose new

projects in fusion research using their own ideas. In this respect, new fusion research units, such as a quantitative immunology research unit and a next generation immune-imaging research unit, are highly evaluated. There may be an underlying issue of strategy in projecting future programs within this interface.

### *Internationalization and global visibility*

- IFRcC is clearly on the global map as one of the best places for conducting cutting edge research and obtaining top-notch scientific training in immunology in the world. As a result, the numbers of foreign PIs and trainees have increased. The center's renowned researchers in the areas of immunology and imaging science and its well-equipped laboratories are highly recognized and appreciated by the bioscience and medical science communities all over the world. Organizing international symposia and holding a winter school on advanced immunology have contributed much to IFRcC's global recognition.
- IFRcC has established scientific and social-support systems for researchers and students from abroad in conjunction with Osaka University's administration. Every effort made by the administrative staffs to enhance research administration was highly appreciated. They provide a role model for URA (University Research Administrator) within Osaka University. PhD holders in the administration office advise foreign researchers on how to apply for Kakenhi (Grants-in-Aid of MEXT), not only those in IFRcC but also in Osaka University. These efforts should be continuously improved and advanced.
- Career paths established for young researchers are also impressive, helping them to obtain good positions worldwide to becoming an independent researcher and/or initiating new research career development in highly recognized research institutions and universities.



*Dr. Coban (center) and her colleagues in Laboratory of Malaria Immunology*

### **3. Efforts toward sustainability**

- IFRcC has already organized a future planning committee together with Osaka University's central administration office and other related research institutes including RIMD, QBIC and CiNET. It will be important to continuously discuss and plan ways to

create the best and most sustainable conditions for the further advancement of IFReC as one of the core health science programs at Osaka University.

- Osaka University has newly established the “Institute for Academic Initiatives (IAI)”. Its mission is to promote world premier research and create new global academic disciplines, both of which clearly fit IFReC’s mission. This should be a reinforcing factor for the continuous growth and sustainability of IFReC in Osaka University.
- Osaka University proposed the concrete provision of resources to sustain IFReC after the termination of the WPI budget from MEXT. Expectation is held in the University’s continued efforts to secure the WPI center’s sustainability.

#### 4. Recommendations

- It is highly recommended to establish junior positions for excellent young researchers with scientific independence and a possible tenure track. These young researchers should be selected based on their scientific vision, originality, excellence and project proposal. They will not only bring fresh ideas into the institute but also change the science culture in Japan.
- Clinical immunology is becoming an important future goal of IFReC during extended period. As a matter of fact, Japan is behind in this field and no research center for clinical/medical immunology is available. Therefore, movement of IFReC, a world leading institute in basic immunology, to this direction is most welcome. Progress report claimed about two-thirds of the groups are now involved in clinical immunology. However, their researches still remain at the level of translational research of individual PIs. IFReC should propose a general principle, institutional strategy and their future perspectives.

#### E-5. MANA

##### 1. Scientific achievements

- MANA’s science has evolved to become very high quality for the majority of its projects. A good fraction of the work is done at an internationally best level. High activities in scientific achievement, publication, funding, and award are steadily progressing and there is no question that MANA is ranked as a leading world institute in materials science.



*Young researchers gathered in the new cafeteria with eco system.*



- Impressive materials science achieved at MANA includes neuromorphic computation (artificial brain) with atomic switches developed at MANA, nanosheets having unexpected properties like the amazing swelling and shrinkage behavior, topological quantum devices based on Majorana fermions.
- Core facilities are remarkably well prepared including an assortment of first-class equipment and techniques. The world-leading work on multiple scanning proximal probes and multi-capability transmission electron micrograph (TEM) are offering important complements in surface characterization at the atomic level.

## **2. Implementation as a WPI center**

### *Fusion*

- MANA has been making a major effort to promote fusion research. Especially the “camp” type Grand Challenge Meetings trigger new innovative research activities. Theory is becoming well fused into experiments and further use of theory is highly encouraged.

### *Internationalization and global visibility*

- MANA is one of the best institutes in Japan for internationalization (foreign researchers 54%, foreign PIs 38%, bilingual support for families as well as for researchers, the average TOEIC score of the NIMS administrative staff is 507, up from 381 in 4 years).
- Publications of MANA-dedicated special issues are counted as four in FY 2013 i.e. “Langmuir” and “J. of Nanoscience and Nanotechnology” in addition to “Advanced Materials” and “STAM”, which evidently contribute to the global visibility of MANA.

### *System Reform*

- The proportion of female researchers is now at 23%, although there are no Japanese female PIs.

## **3. Efforts toward sustainability**

- NIMS’s third five-year plan includes a strategy to maintain MANA as a permanent organization as one of three research divisions named Nano-scale Materials Division.
- NIMS has assigned 88 permanent staffs (as of April 1, 2013) to MANA. NIMS continues to support to MANA.
- The task force for MANA’s mid-to-long-term vision is actively studying its research directions, research strategies, and research group reform with an eye to extending the

program. Expectation is held in the University's continued efforts to secure the WPI center's sustainability.

#### 4. Recommendations

- MANA should take the attitude "Make invisible ENEMY (competitors) visible" in highly competitive fields of research.
- Provision of a platform to facilitate communication between theorists and experimentalists is needed.
- MANA can and should play a substantial role in the exploration and development of basic materials to detect and remove radioactive species caused by nuclear disasters. This is a very urgent but brand-new issue to be addressed by materials science and technology. We are pleased that MANA is showing an interest in this direction while demonstrating a capability.
- Challenging and long-term research such as development of room temperature superconductors will need more open discussions, brainstorming and collaborations with diverse scientists from outside of MANA and NIMS. We would like to recommend the holding of collaborative and brainstorming workshops.
- MANA should continue to work on evolving the Nanolife area into projects built coherently around a solid core of fundamental science. There should be a path for taking what we know from fundamental interface chemistry and physics and developing a step-by-step connection to biological interfaces. There should be a leap of knowledge in MANA programs, not just incremental steps along well-traveled paths.

#### E-6. I<sup>2</sup>CNER

##### 1. Scientific achievement

- After the 2012 site visit, I<sup>2</sup>CNER has achieved a favorable turn-around in general. The personnel of the center has been much enriched with 24 PIs redefined, newly appointed professors, PDs and PhD candidates. The leadership of the Director has been much



*I<sup>2</sup>CNER researchers are now working under one roof.*

enhanced with two Associate Directors and Administrative Director. A new building, laboratories and newly acquired state-of-the art instrumentation have been provided for further enhancing the quality of science. Mindsets of I<sup>2</sup>CNER researchers seem to be improving. The overall strategy of I<sup>2</sup>CNER has become much clearer than before with the future vision and roadmaps. However, there is still room for improvement in the quality of science toward the WPI level of outstanding research base.

- The numbers of publications in 2012 are remarkable, counting more than 200 papers with WPI affiliation and more than 600 WPI related papers. Improvement is evident in the quality of publications, with contributions in Nature, Science, Advanced Materials, Energy and Env. Science, and Angew. Chem., all of which have impact factors higher than 10.
- The roadmap presented in the progress report, which clearly indicates the direction of research effort and long term target of each Division, is a distinct progress at I<sup>2</sup>CNER. However, the roadmaps are in their infancy and need to further evolve before reaching maturity. I<sup>2</sup>CNER needs to be clear on the target percent reduction/year in carbon and proactively develop scenarios for reaching the targets versus electing “a portfolio.” Some of the technologies in the roadmap will be transferred to industry and commercialized before 2050, while some others may still remain in the R&D phase. These differences should be recognized and reflected to respective roadmaps. A key to the success is a successful and proactive maturation of the roadmap being updated annually.

## **2. Implementation as a WPI Center**

### ***Fusion studies***

- Interdisciplinary work coming from interactions of PIs from different areas is taking place as seen in joint publications. Some collaborative work has been promoted by I<sup>2</sup>CNER's own funding system. The scheduled seminars and invited talks also help toward fusion. Thus, the fusion seems to be gradually expanding in several areas, although inter-division research activities are still encouraged.
- The *ad hoc* Internal Programs Review Committee and the planning for I<sup>2</sup>CNER's new building have undoubtedly contributed to the spirit of furthering fusion. The shared building is expected to cultivate more spontaneous collaborating activities.

### ***Internationalization and global visibility***

- Thanks to the continuous efforts by the Director and Members, I<sup>2</sup>CNER is certainly moving toward a globally visible research center. The US-Japan Joint Symposium in December 2012, where Ambassador John Roos was present, demonstrated that I<sup>2</sup>CNER

has become a symbolic collaborative activity of the US and Japan in energy issues.

### ***System reforms***

- The major system reform has been made under the leadership of the President of Kyushu University (KU). Nine professor lines were transferred to I<sup>2</sup>CNER from the Faculty of Engineering and additional four tenure position track lines to the center for young people. In addition, teaching integration programs are on the way in the college of engineering.

### **3. Recommendations**

- In 2012, Director Sofronis made 10 trips to Japan, spending 103 days or 46% of his time. Although this is clearly good improvement, it is important to maintain his physical presence at more than 50%.
- A particular effort should be made to appoint world-leading top scientists as PIs residing at I<sup>2</sup>CNER. The Faculty Recruiting Committee should move much more proactively to identify and invite such scientists. Administrative Division should also work to help in close cooperation with its counterpart in Illinois.
- The mutual exchange of researchers between KU and University of Illinois (UI) is not enough in numbers and in their lengths of stay. In FY2012, five researchers visited UI from KU and only two of them stayed for more than one month, while from UI twenty visited KU but stayed for less than one week.
- The efforts to increase the number of post-docs are ongoing straightforward. One post-doc line has been allocated to each Kyushu PI, but clearly this appointment procedure needs rigorous evaluation of each candidate.
- Fuel Cell Division should seek for some high-risk research themes. Thermo physical Properties Division needs to reconsider their short-term and long-term research themes in relevance to carbon neutral concept. The research project on electro-fuel utilizing captured CO<sub>2</sub> should be carefully examined if it is a central issue for realizing a carbon neutral society.
- It should be noted that some of the research work carried out by young faculties do not seem to be at top-levels in the relevant fields. They should discuss on their research subjects more extensively with senior researchers or Lead PI's in their fields.

## E-7. IIIS

### 1. Scientific achievement

- International Institute for Integrative Sleep Medicine (IIIS) has been successfully launched as a WPI center under the program of WPI Focus. The center director Yanagisawa and administrative director Kokubo understand well the aims and missions of the WPI program and have made every effort in establishing IIIS.
- The director is to be commended for providing a challenging vision and bringing together such a strong multi-disciplinary team to tackle critical issues related to the neurobiology and genetics of sleep science. The Yanagisawa/Funato forward genetics screen is poised to make major contributions to the understanding of sleep mechanisms, and their unbiased approach will unlock doors not likely to be opened by traditional approaches. The other PIs, including Sakurai, Urade, Greene, Nagase, and Lazarus, show a high quality of science based on their strong backgrounds.

### 2. Implementation as a WPI center

#### *Fusion studies*

- IIIS's strategy is to integrate chemistry, pharmacology and clinical medicine into sleep science, rather than fusing different disciplines. This approach is acceptable for WPI Focus.

#### *Internationalization and global visibility*

- The director Yanagisawa's scientific prominence and the team he has assembled ensure that IIIS has the potential to achieve the goal of becoming a "globally visible research center." IIIS will quickly establish itself as a leading Center.

#### *System reforms*

- University of Tsukuba supports IIIS by providing necessary facilities until its new building is constructed. The land for the new building is provided by changing the campus plan. The administration, headed by Dr. Kokubo, is well organized and provides efficient support to the researchers.



*Dr. Yanagisawa (left), IIIS director, in an animal room.*

- As part of its system reform, IIS should make recruitment of female scientists in the core research group a high priority.

### **3. Recommendations**

- Program committee expressed deep concern about intellectual property in association with the position of Dr. Yanagisawa at Howard Hughes Medical Institute (HHMI). Prompt action on these issues by the host institution is expected.
- Dr. Yanagisawa needs to establish a bioinformatic on sequencing analysis (genomics and others) and other matters as soon as possible, which seems to be strikingly missing in IIS.
- IIS can create a program to bring scientists of all career levels to IIS for "short-term stays" of 3 weeks to 6 months. This would allow students, postdoctoral fellows and junior faculty to visit IIS and learn of its new techniques, start collaborative projects, gain experience in international implementation of scientific research, and expand the personal network that they will carry with them throughout their careers. For more senior researchers, IIS can play a role in helping PIs from other countries to formulate new research projects and collaboration. IIS can greatly expand its influence in advancing sleep science worldwide.
- Integration of clinical and animal models is a core issue of IIS. Stronger systems in neuroscience would benefit the translation of discoveries to clinical use and could also provide important insights into how to best engage the multiple drug targets.
- The members of IIS should try to collaborate with clinical and human research teams in translating animal studies into humans. If they want to use human genetics to elucidate the mechanism of sleep/wake regulation in humans based on their basic research findings, they should collaborate with human genetic researchers that have sufficient sample sizes of the genome for sleep disorders or bipolar disorder.
- Recruitment of one or two other senior neuroscientists, especially with a systems neuroscience focus, would likely enhance the center's development.

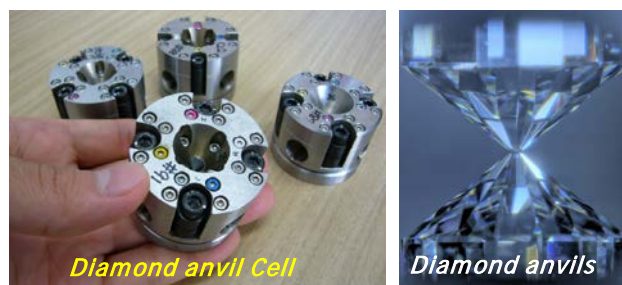
## **E-8. ELSI**

### **1. Scientific achievement**

- The Earth-Life Science Institute (ELSI) has been successfully launched within the short period of 10 months. Under the strong leadership of the Director Hirose, ELSI's direction and energy hold promise for its future success. The quality of the scientific research

presented by the PIs is for the most part extremely high and quite impressive. It is at a level appropriate to meet the WPI program's aspiration to create world-leading research centers.

- The research program proposed by the director is an integrative framework that sees the origin and evolution of the Earth and of the biosphere not only as parallel issues but also resulting in deep interactions. An advantage of this approach would be that the individual groups of ELSI are not pursuing individual agendas, but have a coordinated perspective. An important case is the site of the first life on earth for which there are three major hypotheses advanced by the three PI's of ELSI.



*High P-T Experimental Constraints*

## 2. Implementation as a WPI center

### *Fusion*

- It is apparent that the potential for scientific fusion is very high in ELSI. The Director Hirose is implementing a number of incentives, including renovation and construction of ELSI building so that all people can work under one roof, weekly seminars and lunch meetings, and planned financial support for interdisciplinary research.

### *Global visibility and internationalization*

- ELSI is successful in establishing an internationally open institute by hiring PIs such as the well-known Professors Hut and Kirschvink from abroad. Recruiting more foreign PIs and young researchers will enhance ELSI's international reputation. Exchange programs for junior and senior researchers with overseas universities and institutes will also be important.

### *System Reform*

- The host institute is providing strong support to ELSI in terms of tenured positions, research buildings, research funds, and amenities for international members of ELSI.

- In addition to these offers, the host institute emphasizes that the WPI program will exert ripple effects on the university reforms toward renovating the traditional system and culture of science and reforming administration, which is a mission of the WPI program.

### **3. Recommendations**

- The road map of ELSI is an important guideline for all ELSI researchers as well as for visitors. It is recommended to make a simplified map that clearly indicates the present location and future direction.
- Recruiting the first “class” of young foreign scientists should be considered one of the most important goals of ELSI over the next 6 months or so, and it should be explicitly raised to this level of priority by ELSI management.
- Activities of female scientists are not apparent in the leadership roles at ELSI. It also appears that female scientists who are actually active on a routine level are restricted to junior ranks. Vigorous efforts are needed to promote activities of female scientists.
- In describing ELSI’s participation within a larger collaboration, for example, the JUICE space mission or advanced computing hardware development, ELSI needs to state clearly what its contribution would be.
- ELSI has, as a whole, impressive expertise in deep earth science, planetary research, genomics and phylogenetics, but needs to reinforce its research in prebiotic chemistry and evolutionary biochemistry, which are a major component in current discussions on the origins of life.

## **E-9. ITbM**

### **1. Scientific achievement**

- Dr. Itami, Director of ITbM, enthusiastically announced its scope and roles in producing “transformative bio-molecules” by fusion of chemistry and biology. These “transformative bio-molecules”, which the scientists expect will contribute to transforming society in many ways, is a visionary concept. However, ITbM should remain realistic and not become overambitious in terms of transforming society.
- The current 10 PIs are all at the ages of 40s and outstanding leaders of their respective disciplines. Although inaugurated only recently, ITbM has already assembled a group of world-class young chemists and biologists who focus on exciting and innovative synthetic chemistry and cutting edge biological problems.



- Several collaborative projects that have already been initiated are well organized and are expected to produce novel molecules that will significantly contribute to basic science as well as applied science.



*Prof. Itami (front, most right), ITbM director and his colleagues in director's room*

- Three core facilities (Live Imaging Center, Molecular Structure Center and Chemical Library Center) will facilitate further research activities of ITbM, especially by appointing chief coordinators in these centers to effectively support the scientists.

## **2. Implementation as a WPI center**

### ***Fusion studies***

- Merging chemistry and biology to focus on new research directions is challenging. The Mixed-Lab concept, joint seminars and projects proposed by the ITbM scientists will greatly increase their communication and build synergies between biological and chemical experimentation. The Mixed-Lab is therefore an important strategy beyond discussions at tea time, sharing work space and everyday research life.
- A new building is under construction and soon most laboratories will be under one roof, which should greatly facilitate the interactions between biology and chemistry.

### ***Internationalization and global visibility***

- Although ITbM was established only recently, it has already gained significant global visibility through (i) the excellent publications from its PIs, (ii) the successful 1st International Symposium on Transformative Bio-Molecules, (iii) the recruitment of 9 overseas postdocs, and (iv) the establishment of partnerships with other leading research centers.

### *System reforms*

- Nagoya University is giving the ITbM high priority and strong support, and will provide a new building in which an existing building will be integrated.
- The administrative office is already well established under the strong leadership of an Administrative Director and the staff is proficient in English. The number of staff in the Research Promotion Section with PhDs and background in biology and chemistry is impressive.

### **3. Recommendations**

- Although the Program Committee has suggested increasing the number of animal/pharmaceutical researchers, the Working Group advises that achieving a balance between plant and animal researchers is not a high priority but that ITbM focuses plant biology as an institutional strategy.
- The mission of ITbM states that it should become a novel institute for the discovery, development and production of transformative bio-molecules. Although ITbM presented a roadmap towards reaching this mission, it needs clarity and refinement. ITbM should continue to focus on groundbreaking fundamental research and the identification of opportunities to benefit society, including collaboration with pharmaceutical and agricultural researchers.
- The Working Group recommends hiring computer and/or theoretical scientists to complement and advance research on transformative bio-molecules.
- ITbM is recommended to make good use of a unique opportunity to train a new generation of national and international researchers in synthetic chemistry, biology and computational science.

### **F. 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 general publics, teaching to primary, secondary and high school students, organizing science café, holding press conferences etc. In FY 2013, nine WPI centers organized jointly the following three events:

- **“Science Talk Live 2013” for high school students in Sendai**

Since 2011, the WPI Program has been organizing special public symposia, specially targeting high school students. In 2013, AIMR held “Science Talk Live”, in which the center directors of IIS, ELSI and ITbM spoke about the significance of their research activities. Further, Dr. A. Takayama, who just finished her PhD thesis, talked vividly about how she enjoys science. These talks were followed by presentations in English by students from 3 “Super Science High School (SSHs)” in Miyagi Prefecture and from Eleanor Roosevelt High School in Maryland, USA. More than 500 participants, mostly high school students, enthusiastically participated and joined the booth session with the lecturers from the 9 WPI centers.



*Presentations of high school students*



*High school students in WPI booth session*

- **“Science AGORA 2013”**

Science AGORA has been organized by JST since 2006 as a plaza (agora) for communication between scientists and the public especially children and students. Nine WPI centers participated for the second time in the 2013 Science Agora held in November 9-10 at the National Museum of Emerging Science and Innovation, Tokyo.

- **“2013 AAAS Annual Meeting”**

The 9 WPI centers presented their activities at the 2013 American Association for the Advancement of Science (AAAS) Annual Meeting held in Boston on February 14-18, 2013. A WPI booth was opened in the Japan Pavilion (organized by JST), to which 1,143 audience members visited.



*WPI booth in Japan pavilion*

## **G. Sustainability of the WPI centers**

As clearly described in the “Application Guideline” in 2007, the implementation period of the WPI program is 10 years, with a possible 5-year extension for projects with outstanding

results. The Guideline also envisioned the sustainability of the WPI centers after the end of program funding.

Host institutions are primarily responsible for sustaining their center. However, considerable efforts will be required by host institutions to provide the resources needed to support the WPI centers under the present financial circumstances.

The Program Committee has initiated dialogues with the centers and their host institutions to discuss more concretely the center's future development over the mid-to-long-term, including activities and initiatives after project funding ends. In parallel, the Committee discussed the evaluation procedures, criteria, etc.