

# FY 2022 Follow-up of WPI Program

By Program Committee

# March 2023

(This document reports on progress made under the WPI Program in FY 2021.)

Α.	Highlights in FY 2022	2
Interim Evaluations of ICReDD and ASHBi		2
Launching three new centers		2
В.	WPI Outline	2
C.	WPI Centers	2
D.	Follow-up framework	5
E.	Future plan of the WPI Program	7
F.	Follow up on the 2 Centers launched in 2017	8
I-1. IRCN		8
I	-2. NanoLSI	11
G.	Interim Evaluation of the 2 Centers launched in 2018	
F	H-1. ICReDD	14
F	1-2. ASHBi	17
н.	Follow up on the Centers launched in 2021	20
H-1. QUP		20
I.	New WPI centers launched in 2022	
J.	WPI Academy	
K-1. Aims and members		25
K	K-2. Follow-up of the Academy centers	25
K-3. Change of the Director in ELSI, ITbM, and MANA		25
К.	International mobility of junior researchers with WPI program	
L.	Branding and outreach	

In 2007, the Japanese government launched an ambitious initiative to create globally visible and internationally open research centers. This program, World Premier International Research Center Initiative (abbreviated WPI), has, pursuant to the program's mission stated in 2007, successfully launched 13 centers over the 14-year period from 2007 to 2020. In 2020, a new mission was initiated that advances further the principles of the original WPI mission. The Launching of centers under the New Mission began in 2021. This 2022 followup report describes notable areas of progress in FY 2021 and new developments in FY 2022.

## A. Highlights in FY 2022

#### Interim Evaluations of ICReDD and ASHBi

FY 2022 marked the 5<sup>th</sup> year since the launch of ICReDD and ASHBi, which therefore underwent the Interim Evaluation of the WPI Program. Based on hearings with their directors and the heads of their host institutions, and reports from the Working groups conveyed by the Program officers, the Program Committee concluded that both of the centers deserve a score A. The progress that the two centers are making should enable them to achieve their WPI mission goals by their continuing current efforts.

#### Launching three new centers

In 2022, MEXT announced the launch of three new centers under the WPI's New Mission, which was formulated in 2020. After a vigorous selection process that ran from February to September of 2022, the Program Committee selected as the new centers "Premium Research Institute for Human Metaverse Medicine (PRIMe)" at Osaka University, "International Institute for Sustainability with Knotted Chiral Meta Matter (SKCM<sup>2</sup>)" at Hiroshima University, and "Human Biology-Microbiome-Quantum Research Center (Bio2Q)" at Keio University.

#### Three centers joining WPI Academy

The three centers which were launched in FY 2012 (IIIS, ELSI, ITbM) completed the 10 year WPI funding period. All three centers were judged to have achieved the "world premier" status by the WPI Program Committee in the final evaluation, and have been admitted as members of WPI Academy.

# **B. WPI Outline**

In 2007, Ministry of Education, Culture, Sports, Science and Technology (MEXT) launched the WPI Program aimed at establishing internationally open and globally visible "World Premium Institutes" in Japan. The background was:

 Increasing worldwide competition in generating new research outcomes and in recruiting talented scientists.

- Strong need felt for more efficient forms of funding to advance fundamental and innovative sciences, which are essential to building knowledge-based societies.
- The advent of research excellence initiatives designed to encourage outstanding research by providing large-scale and long-term funding.

To sharply focus the aim of the Program, the following Mission was given to the WPI centers.

- Advancing to the highest pinnacle of globally leading-edge research
- Creating interdisciplinary domains
- Establishing international research environments
- Reforming research organizations

MEXT supports the WPI centers within the following context.

- Up to ¥700 million a year per center in principle
  - (Up to about ¥1.3 billion a year for centers launched in and before 2010)
- Research money is not included.
- Support for 10 years (5-year extension is applicable for centers launched in or before 2012)

In 2020, the New Mission, advancing on the principles of the original mission above, was formulated, namely,

- World-Leading Scientific Excellence and Recognition
  - The Highest Level of Research Impact
  - Expanding Knowledge Frontiers through Interdisciplinarity and Diversity
- Global Research Environment and System Reform
  - Harnessing Talent and Potential through Global Brain Circulation
  - Interdisciplinary and Inter-Organizational Capacity Building
  - Effective, Proactive and Agile Management
- Values for the Future
  - Societal Value of Basic Research
  - Human Resource Building: Higher Education and Career Development
  - Self-Sufficient and Sustainable Center Development

The launching of centers under the New Mission started from 2021. MEXT supports these WPI centers within the following context.

- Up to ¥700 million a year per center in principle
- Research money is not included.
- Support for 10 years

# C. WPI Centers

Nine WPI centers were launched during the first 10 years of the WPI Program.

The first five WPI centers launched in 2007 are now members of the WPI Academy.

- **AIMR** on materialse and mathematics, Tohoku University.
- **Kavli IPMU** on the origin of Universe, The University of Tokyo.
- iCeMS on cell biology and materials, Kyoto University
- IFReC on immunology, Osaka University
- MANA on nanoarchitetonics, National Institute for Materials Science

The sixth WPI center was launched under the "green innovation program" in 2010, and it is now the 6<sup>th</sup> member of the WPI Academy.

- **I<sup>2</sup>CNER** on energy, Kyushu University

Three WPI centers were launched under the new "WPI Focus" program in focused research areas in 2012.

- **IIIS** on sleep, University of Tsukuba
- **ELSI** on the origins of Earth and life, Tokyo Institute of Technology
- **ITbM** on plant/animal biology and chemistry, Nagoya University

In 2017, the 11<sup>th</sup> year of the WPI Program, two WPI centers were added:

- IRCN on origin of intelligence, The University of Tokyo
- NanoLSI on nano life science, Kanazawa University

In 2018, the 12<sup>th</sup> year of the WPI Program, two more centers were launched:

- **ICReDD** on chemistry and information, Hokkaido University
- ASHBi on human biology, Kyoto University

In 2021, the 15<sup>th</sup> year of the WPI Program, one new center was launched under the New Mission:

- **QUP** on measurement science High Energy Accelerator Research Organization (KEK)

In 2022, three new centers were launched under the New Mission:

- PRIMe on human metaverse medicine, Osaka University
- SKCM<sup>2</sup> on knotted chiral metamatter, Hiroshima University
- **Bio2Q** on microbiome and quantum computing, Keio University



As shown above, the sciences explored by the 17 WPI centers extend from Origins of the Universe, Earth-Life, and Intelligence, Life, Materials/ Energy, and Measurement /Information/ Mathematics.

# **D. Follow-up framework**

The WPI Program carries out a robust follow-up system comprising the international Program Committee, program director (PD), deputy program director (DPD), program officers (POs), and working groups (WGs). Since 2017, an academy director (AD), academy officers (AOs), and Academy working groups (AWGs) have been put in place to oversee the follow-up activities of the WPI centers that are members of the WPI Academy.

# **Program Committee**

WPI Program committee continued its operation under Dr. HAMAGUCHI without change of members in FY 2022. The Committee members and their affiliations are listed in the following website:

https://www.jsps.go.jp/english/e-toplevel/07 committee.html

In FY 2022, the Program Committee held meetings on 14-16 September and on 1-2 November. Both meetings were conducted online, the COVID-19 pandemic having made an

in-person gathering difficult. The main items of business on Committee's agenda in its September meeting were (1) selection of three new WPI centers, (2) evaluation of ITbM's Academy membership, (3) report on WPI Academy centers, and (4) the future of the WPI Program. In its November meeting, they were (5) Interim Evaluations of two centers (ICReDD and ASHBi), (6) follow-up reviews of three centers (IRCN, NanoLSI and QUP), and (7) Report on international mobility of junior researchers and WPI.

#### PD, DPD, POs and WGs

PD: Dr. UKAWA Akira has been serving as Program Director since April 2017.

DPD: Dr. KAIBUCHI Kozo was appointed as Deputy Program Director in April 2022. Dr. YOSHIDA Minoru resigned Deputy Program Director at the end of September 2022.

- POs: Being experts in the research areas of each center, they chair site visits and prepare site-visit reports by compiling the comments of the site-visit team members.
- WGs: Assembled for each WPI center, these groups principally consist of 3 domestic and 3 international experts in areas that cover the center's activities.

PD, DPD, POs and WG members and their affiliations are listed in the following website: <u>http://www.jsps.go.jp/english/e-toplevel/08\_followup.html</u>

#### AD, AOs and AWGs

AD: Dr. UKAWA Akira, Program Director, has been in this position since April 2021.

- AOs: Being experts in the research areas of the member centers, they chair site visits and prepare site-visit reports for the Program Committee.
- AWGs: Assembled for each WPI center, these groups principally consist of 2 domestic and 1 international expert in areas that cover the center's activities.

AD and AOs and their affiliations are listed in the following website:

https://www.jsps.go.jp/english/e-toplevel/18 academy.html

#### Site Visits

Site visits to the WPI centers receiving ongoing funding were conducted during the period of June-September 2022. All the site visits were carried out online due to the continuing COVID-19 pandemic. Following the format established in FY 2021, full site visits spanning 2 days were held online. They had full agendas including presentations by the center directors and the heads of the host institutions, presentations by the PIs, and poster sessions by researchers. These full site visits were impactful for the interim evaluations of ICReDD and ASHBi in their 5th year. The full site-visit agenda was also valuable in carrying out the follow-up reviews of IRCN and NanoLSI in their 6th year, and of QUP in its 2<sup>nd</sup> year.

For these five centers, reports on the site visits were submitted to the Program Committee and disclosed to the respective centers.

## **WPI Academy Site Visits**

For the five Academy-member centers (AIMR, iCeMS, IFReC, MANA, and I<sup>2</sup>CNER), site visits were held from December 2021 to January 2022. Attended by AD, AO with PD and DPD, these site visits were carried out online with a duration of about 2 hours. Reports on the site visits were made to the Program Committee in its September meeting by AD.

# E. Future plan of the WPI Program

In this year's January meeting of the Program Committee, Mr. NISHIYAMA Takashi, Director of Basic and Generic Research Division of Research Promotion Bureau of MEXT, presented MEXT's plan for new WPI centers in FY 2023. WPI CORE (Phased growth), a new supporting system will be introduced to promote a stepwise center building with requests of about 70% of the current WPI requirements for the first stage of the center project. For pioneering new domains of basic science via Japan's lead, two new centers in WPI CORE or one new center proposed under the solid alliance of plural host institutions will be adopted.

# F. Follow up on the 2 Centers launched in 2017

# F-1. IRCN

Center director: Takao HENSCH

Program officer: MISHINA Masayoshi, Ritsumeikan University

#### 1. Advancing research of the highest global level

IRCN is tackling challenging questions on how human intelligence (HI) arises by establishing principles of brain development, unraveling the etiology and treatment of mental disorders, and innovating neuro-inspired artificial intelligence (AI).

Researchers in IRCN have discovered new principles in neural communication, critical period shaping, and hierarchical network development, which have been published in high impact journals. Interdisciplinary collaborations stimulated by the center's team-science strategy have produced exciting advances in the understanding of brain functions and mental disorders.

However, it was not clear how far the research has progressed toward innovating neuroinspired AI and answering how human intelligence arises. The center director's report should address the overall status and dynamics of IRCN, not just individual team successes, and what progress has been made toward becoming an international research hub.



**Recent highlight.** Hierarchical layered architecture is a hallmark of both human and artificial deep neural networks. These structures were long thought to develop sequentially from the bottom-up. In 2022, IRCN PI Kenichi Ohki and colleagues revealed that multiple visually-related cortical areas in the mouse brain are constructed in a parallel, modular manner. This groundbreaking discovery revolutionizes both our understanding of early blindness and biologically-inspired generalizable artificial intelligence. The research results were published online in the British scientific journal

#### 2. Implementation as a WPI center

#### Generating fused disciplines:

The center's bottom-up team-science strategy has strongly stimulated interdisciplinary

collaborations among developmental neuroscience, clinical and computation groups. The original 14 research teams were fused down to 5 teams in order to sharpen the center's focus. The work of these 5 teams is advanced by combining them with 3 perpendicular missions to a matrix as 'an AI incubator' for innovating neurodevelopmental AI.

#### **Realizing an international research environment:**

IRCN has established a rich international network with 16 institutes. The center promoted an international environment through online events in English while the pandemic unfortunately limited travel and in-person events. The center held 46 International Science Salon seminars with 24 of 46 speakers being from international locations. IRCN also organized a New Horizons in Computation Workshop and coorganized the 6th Japan-US Science Forum.

#### Making organizational reforms:

Director Hensch governs IRCN via consultation with IRCN's Executive Board and Steering Committee. In April of 2021, a new administrative director (AD), Dr. Nobukazu Toge, and a Special Adviser to the Director (SAD), Dr. Masamitsu Iino, were added to strengthen center management. IRCN enlisted 47 Affiliated Faculty members and 17 Associate Research Fellows to involve PIs from other UTokyo campuses and other institutes in Japan and worldwide. The 5 Core Facilities continue to provide professional and state-of-the-art research services. The impact of IRCN on UTokyo system reform needs to be addressed in more detail.

#### Effort to secure the center's future development over the mid- to long-term:

The center is committed to advancing Team Science as its main engine for achieving a deeper integration of brain development principles with clinical research and for innovating neuro-inspired AI. For funding, IRCN has initiated discussions with a wide range of candidate sponsors and partners. UTokyo has launched a university-wide working group to design the future of IRCN as a permanent entity within the university. However, the plan for a new building is elusive.

#### Center's response to the follow-up results of last year:

IRCN advanced its team science strategy to a matrix by combining 5 selected teams with 3 perpendicular missions so as to sharpen its focus on ensuring excellence and impact. The center employs the matrix as 'an AI incubator' for innovating neurodevelopmental AI. The center's PIs are eligible to give lecture courses in Graduate Schools across UTokyo, and IRCN has continued its membership in the MEXT WISE Graduate Program. UTokyo has launched a university-wide working group to design the future of IRCN as a permanent entity within the university.

# 3. Actions required and recommendations

- 1) IRCN should strengthen the computation group by recruiting more PIs and leading researchers in the field as affiliated faculty or advisors.
- 2) IRCN should present concrete milestones toward unravelling the etiology and treatment of mental disorders and toward innovating neuro-inspired AI based on the principles of brain development. The center should clearly define questions regarding the origin of HI to be solved during the WPI funding period.
- 3) IRCN should overcome significant challenges stemming from the Director being stuck overseas throughout the COVID-19 pandemic. Strong leadership of the Director is needed to innovate neuro-inspired AI and to answer the important question of how human intelligence arises by integrating individual research teams.
- 4) The impact of IRCN on UTokyo reform should be addressed.
- 5) UTokyo should present a concrete plan of a new building to establish IRCN as an autonomous institute at UTokyo. The UTokyo working group on the future of IRCN should present an interim report by next year's site visit. The report should include a plan for an IRCN graduate program to foster young scientists.

#### F-2. NanoLSI

Center director: FUKUMA Takeshi Program officer: NAKANO Akihiko, RIKEN

#### 1. Advancing research of the highest global level

NanoLSI is continuing its excellent activities in science. World top-class Bio-SPM technologies are utilized to visualize nano-scale structures and dynamics of living cells and their inside in vivo and of molecules in vitro. The effects of probe insertion into cells have been carefully examined by calcium ion response. Through collaboration between Bio-SPM and supramolecular chemistry, molecular sensors designed to measure cellular substances have been improved for sensitivity and selectivity. The advantage of AFM in measuring the elasticity of membranes has led to very interesting findings regarding opposite softening and stiffening of the plasma membrane and the nuclear envelope during metastatic cancer progression. Applications to nanoscale particles such as exosomes and viruses also look interesting. Emerging publications of high-impact papers



**Recent highlight** We developed a method to simultaneously measure dynamic changes in topography and mechanical properties of living cells based on our high-speed scanning ion conductance microscopy (HS-SICM) technique. We applied this technique to genotype-defined mouse intestinal tumor-derived cells to investigate the relationships between gene mutations and colon cancer phenotypes. (a) Mapping of topography and inverse elastic modulus in the respective genotype cells. (b) Averaged-inverse elastic modulus (IE) of the representative genotype cells. (c) 3D representation of physical properties, such as IE, surface roughness, and the volume change. (d) The principal component analysis using the gene expression data of organoid cells for the representative genotype cells.

Wang et. al., Biomaterials (2022), vol.280, DOI: 10.1016/j.biomaterials.2021.121256

on proof-of-concept and technology development are impressive. The research activities of NanoLSI and their applicability to many problems are now being observed with keen interests by researchers from a variety of life science fields.

# 2. Implementation as a WPI center

#### Generating fused disciplines:

Various efforts have been made to promote interdisciplinary research. Three priority research themes have been set by the future planning board and will be promoted with incentives. Bottom-up proposals from young researchers are also supported by a promotion grant. T-meetings between pairs of research teams with different disciplines have been quite helpful in promoting the fusion of disciplines at the Center.

#### Realizing an international research environment:

Among the publications over the past five years, 46% were internationally co-authored papers. T-meetings have now been extended to include overseas PI groups. A new overseas PI, Professor Carsten Beta from the University of Potsdam, Germany, has been appointed. Dr. Hanae Sato from Albert Einstein College of Medicine, NY, USA, has been appointed as a new Associate PI at NanoLSI.

#### Making organizational reforms:

NanoLSI is already recognized as an independent research institute within Kanazawa University and has made many successful efforts toward organizational reforms. Tenured and tenure-track positions of PIs and junior PIs have been confirmed and the maintenance of Center's administrative office has been secured.

#### Effort to secure the center's future development over the mid- to long-term:

The new president of Kanazawa University, Takashi Wada, promised to continue strong support for NanoLSI. Kanazawa University will increase its budget for maintenance of the NanoLSI building. NanoLSI continues to acquire increasing amounts of external funds, which will be a strong base for securing the Center's future.

# Center's response to the follow-up results of last year:

NanoLSI has responded to the previous year's follow-up review very sincerely. Among its responses, NanoLSI updated 6 nanotechnology and 7 life science roadmaps and clarified major challenges. To increase female scientists, especially at the PI level, NanoLSI appointed Dr. Hanae Sato from the USA as a new Associate PI. The ratio of female researchers at NanoLSI has been continuously increasing and will exceed 20% in 2023 as planned. Advancing Bio-SPM technology itself has been and will be very seriously pursued and is now explicitly indicated in the project map.

# 3. Actions required and recommendations

Every effort that NanoLSI is currently making appears to be in good shape and is strongly encouraged to continue. It is very good to hear the strong commitment of support from Prof. Wada, the new president of Kanazawa University. Center director Fukuma has slightly changed gears to a more top-down governance so as to support mission-oriented research subjects, which will be important to achieve the Center's final goals. At the same time, bottom-up research activities emerging from young researchers will also be extremely useful in producing unexpected cutting-edges in "Nanoprobe Life Science." The leadership of the director in balancing the top-down and bottom-up trajectories will be very much appreciated. Strategic approaches to involve more early-stage students and female researchers should be continued. In the future, it will also be good to see industry collaborations and perhaps an expansion to nonbiological sciences.

# **G.** Interim Evaluation of the 2 Centers launched in 2018 G-1. ICReDD

Center director: MAEDA Satoshi Program officer: TATSUMI Kazuyuki, Nagoya University

# Interim Evaluation Score: A

The scientific accomplishments made by ICReDD based on multi-disciplinary collaboration across theoretical chemistry, synthetic chemistry, and more recently information science, are evaluated as outstanding. Internationalization is boosted by many researchers from abroad as well as by active participation of eminent foreign PIs, though more proactive effort is needed to increase female scientists. The occurrence of scientific misconduct is serious, lowering the reputation and evaluation of ICReDD. It causes a need for implementing a thorough investigation and robust reforms to establish a healthy research culture.

# A. Advancing the establishment of the center

# 1. Science level

ICReDD has made significant progress in advancing research on chemical reactions in past years. The quality and the volume of its publications are impressive. Collaborative efforts, primarily those of theoretical chemists and synthetic chemists, have been very successful, and they have created a new paradigm for reaction discovery and expanded the scope of designing chemical reactions. The seven Flagship Projects have been set as a powerful driver for research focus, methodological advances and validated reaction discoveries. Bottom-up projects have been proposed and organized by young members, and are nicely complementary to the top-down Flagship Projects.



**Recent highlight** [Left] In silico reaction screening with difluorocarbene for N-difluoroalkylative dearomatization of pyridines (*Nat. Synth.* 2022. DOI: 10.1038/s44160-022-00128-y) [Right] A theory-driven synthesis of symmetric and unsymmetric 1,2-bis(diphenylphosphino)ethane analogues via radical difunctionalization of ethylene (*Nat. Commun.* 2022. DOI:10.1038/s41467-022-34546-5)

# 2. Implementation as a WPI center

# Interdisciplinary research activities:

ICReDD has been conducting research through collaborative efforts across different disciplines in theoretical chemistry, synthetic chemistry, and information science. Following the strong collaboration between theoretical chemists and synthetic chemists, information scientists have accelerated their contribution to ICReDD, strengthening the collaborative capacity of the institute. The fusion of computational and information science has resulted in the AFIR Database, called SCAN.

# Globalization of the institution:

The institute is developing its global plan, and as of July 2022, 42% of researchers are foreign nationals. The active participation of Prof. Benjamin List, a Nobel Prize winner in 2021, who is well aligned with Director Maeda on the vision and objectives of ICReDD, is an advantage not only for the Center's research activity but also for its international reputation as an institute.

# Organizational reform:

The governance of ICReDD has been steadily strengthened with Prof. Ishimori becoming its Administrative Director, who provides significant management help for Director Maeda. Newly appointed President Houkin of Hokkaido University has been very enthusiastic in promoting the activity of ICReDD. Five junior researcher positions, 4 junior PI positions and 1 assistant professor position have recently been provided by the University.

ICReDD continues to have a lamentable paucity of female scientists in the institute (15%). Although significant efforts have been made to change this environment, such as the implementation of additional female-only posts (two out of the five Tenure-Track junior positions), ICReDD may need to be more proactive in directly recruiting from outside rather than focusing on time-consuming internal promotion.

# Future prospects of the centers' project:

It will be particularly important in the Center's second five-year plan to capitalize on existing success but also to reinvent and expand into new areas of potentially high future scientific impact. To achieve this in the second half of its funding period, ICReDD will need to set clear goals/targets and a roadmap.

The occurrence of scientific misconduct at ICReDD is an unfortunate development not only for its reputation but also in terms of the advancement of science. The facts and causes of this incident need to be thoroughly investigated. Robust reforms need to be implemented systematically to ensure a healthy research culture and governance throughout the university. Hokkaido University is asked to submit an official report to the WPI Program Committee on the findings of its investigation and on measures that it takes to prevent reoccurrences.

# **B.** Host institution's concrete action plan toward making its center an autonomous research institute in the second half of the grant period (from the 6th year of the center's operation)

Hokkaido University has presented a strong and concrete support plan for the future of ICReDD, in which the center is envisaged to become a special research organization within the University. The research space will be expanded from 2,600m2 in July 2022 to 8,100m2 in March 2023, including a new building of 5500 m2 which features a "Super Mix-lab".

The initiative to establish the "List DX Catalyst Collaboration Research Platform" is underway within the framework of ICReDD. This is a very welcome boost to the visibility of ICReDD within the world.

# Advice/recommendations

# (Including opinions on host institution's plan toward a sustainable Center)

- ICReDD needs to set explicitly its goals and roadmaps for the Flagship Projects and the bottom-up projects. What has been achieved in the last 5 years and what is expected in the 2nd half of the funding period should be clearly articulated.
- To elucidate the nature of the cancer stem cells that ICReDD has derived from their interactions with hydrogels, closer collaborations with experts in fundamental cancer biology and pathology are needed.
- 3) In its support plan, Hokkaido University should make clear whether the 10 senior PI positions belong to ICReDD.
- 4) ICReDD needs to provide a clear strategy for balancing academic leadership with responsiveness to industry and commercialization opportunities. It is important for the Center to show that it has a strategy for maximizing its impact—both in terms of the academic world and in practical terms.
- 5) Hokkaido University is asked to submit an official report to the WPI Program Committee on the findings of its investigation on the scientific misconduct that occurred at ICReDD and on the reforms that the university will undertake to prevent reoccurrences.

# G-2. ASHBi

Center director: SAITOU Mitinori Program officer: OKANO Hideyuki, Keio University

# Interim Evaluation Score: A

ASHBi's sincere pursuit of what makes us human is overall highly evaluated. The level of science conducted at ASHBi is very high. Its fusion research and ratio of foreign researchers also show that the Center's efforts are yielding very good results. On the other hand, there is serious need for accelerated synthesis and coherence in ASHBi's research aligned with its goal of answering what key biological traits make us human. Also, its contribution to the organizational reform of the university should be addressed.

## A. Advancing the establishment of the center

## 1. Science level

ASHBi is investigating the fundamental concept of human biology focusing on genome regulation and disease modeling, while creating a foundation of knowledge for developing innovative therapies. Over the past four years, ASHBi has produced more than 200 WPI papers with very high impact. The high level of research is well illustrated by Director Saitou's list of representative research results. Looking toward the second half of the WPI funding period, the biggest concern is the need for accelerated synthesis and coherence in ASHBi's research aligned with its goal of answering what key biological traits make us human. Among the critiques of the Center's project are that ASHBi's research is excellent but is a collection of research from different fields and does not seem to be fully addressing the center's fundamental question of what makes us "human," and that, in particular, ASHBi should strengthen a genomic anthropological approach.



**Recent highlight** Reconstituting the human somites in a dish (Alev G, *Nature*, 2022)

# 2. Implementation as a WPI center

# Interdisciplinary research activities:

The fusion of biology and mathematics is making steady progress at ASHBi. Their activities have led to the development of advanced novel algorithms, including RECODE for noise reduction in scRNA-seq analysis and several others relevant to biological data analysis. Regarding the fusion of bioethics and life science, the ASHBi bioethics group is to prioritize ethical considerations regarding "*in vitro* generation of oocytes and embryos" and "human fetal tissue and early postmortem tissue", which will garner much greater attention and interest.

# Globalization of the institution:

Diversity in ASHBi has been advanced by the strategic recruitment of two young foreign PIs and by the promotion of foreign postdocs through the ASHBi Foreign/Female Researcher Employment Support Program. However, it is pointed out that the number of foreign and female researchers is low at the higher levels and high at the lower levels.

## Organizational reform:

The Research Acceleration Unit is functioning very well in providing research support. On the other hand, unfortunately, there is no indication of efforts being made to change the system or culture of the host institution.

# Future prospects of the center's project:

ASHBi needs to align its power toward strategically advancing research with its vision "What makes us human?" The Flagship Project is a crucial vehicle for achieving this purpose, and it should be pushed ahead with the utmost effort by all ASHBi's researchers.

# **B.** Host institution's concrete action plan toward making the center an autonomous research institute in the second half of the grant period (from the 6th year of the center's operation)

The Host institution will give 3 additional tenure positions to ASHBi by 2024. Approximately 90% of ASHBi's minimum required budget will be covered by the host institution. These points are highly commendable. However, the following points need to be clarified. (1) Positions of senior PIs forming the core of ASHBi should be transferred to the Center as an autonomous research institute. (2) Funding support from the host institution should be provided independently of the external funding acquired by ASHBi. (3) The center's administration, including its Research Acceleration Unit, is a crucial component of the ASHBi organization. Kyoto University should guarantee its support after the WPI funding ends.

#### Advice/recommendations

#### (Including opinions on the host institution's plan toward a sustainable Center)

- 1) Accelerating the synthesis and coherence of research that is strategically aligned with ASHBi's founding vision should be the Center's top priority. Utmost effort needs to be made to execute the Flagship Projects from this point of view. The five flagship projects should be more cohesively correlated so that they do not appear to be a collection of research from different fields. Clear goals and milestones need to be set for the successful completion of the project in order to effectively address ASHBi's fundamental question of what makes us "human."
- For ASHBi to become a true international hub for human biology, it would be advisable for it to increase the number of its foreign and female PIs and also its junior researchers including postdocs.
- 3) Kyoto University should clarify the following points in its support plan; (i) Transferring senior PI positions to ASHBi so that its core researchers can be sustainably maintained after the WPI funding ends, (ii) Maintaining the center's administration, including its Research Acceleration Unit, after the WPI funding ends, and (iii) Effort to be made to change the system and culture of the host institution, rather than just maintaining ASHBi after the WPI funding ends.

# H. Follow up on the Centers launched in 2021

# H-1. QUP

Center director: HAZUMI Masashi

Program officer: TSUNETA Saku, National Astronomical Observatory of Japan

# 1. Efforts to improve points indicated as requiring improvement in application review and results of such efforts

The very ambitious goal of creating a world research hub focused on developing novel detection systems relevant for the future of particle physics and cosmology, thereby adding new values to the already well established KEK, was the key to the acceptance of QUP as a WPI center. It is utterly disappointing that there has been nothing to show clear development toward this goal since last year. QUP needs to be far more aggressive in developing specific and clear strategies for achieving the overall WPI goals (world-class science, a global research environment for interdisciplinary research, system reform of the host institution, and the providing of value to society), all of which remain unclear and underdeveloped.

KEK's statement that it needs to review QUP's progress before committing its support for a permanent center is almost counter to the condition for QUP's selection. KEK must make a definitive statement on its policy and plan for making QUP a permanent and sustained institute within KEK.

# 2. Implementation as a WPI center

# (1) World-Leading Scientific Excellence and Recognition

# Advancing research of the highest global level:

Establishing world-visible Flagship Projects is the first and critical step for QUP. Its progress in this regard is very slow and disappointing.

The first Flagship Project is the development of TES (Superconducting Transition Edge Sensor) focal plane detector system for the LiteBIRD mission of JAXA. This is a suitable project for QUP. However, the scope of the project has to be clarified in terms of the delivery of the flight TES detector system to JAXA and the funding to build the flight system.

The second Flagship Project is the forthcoming Project Q. It is worrying that this project is still undefined. It is also disappointing that there were no new ideas about new sensors discussed. Director Hazumi and all the PIs should engage in intense discussions to formulate a project plan so that they all share QUP's vision and actively participate in creating the science aimed at by QUP. Identification of actual projects has to be done

immediately, well before the proposed schedule of FY 2024.

While emphasized as a unique concept of QUP, Systemology continues to be vague in concept and implementation with no demonstrable applicability or new added value.

The problem setting for the proposed "Feeling Beauty in Physics" with neuroaesthetics is very ambiguous. It is unlikely that meaningful research is possible on brain functions behind beauty recognition.

PI-led projects are a mere collection of each PI's research projects. To support them as QUP projects, they will need to be evaluated as to whether they have enough significance and novelty in line with QUP's vision. PI-led projects with sufficient merit for QUP implementation should be promoted to Flagship Projects and be provided with personnel and funding resources.



**Recent highlight** The optical transition edge sensor (TES) can measure the energy of a sub-eV photon. This device can be a new eye for application to dark matter searches. This year, we achieved an energy resolution of 67meV, as shown in the figure. It is the highest absolute energy resolution among TES calorimeters. (K. Hattori et al. *Supercond. Sci. Technol.* 35 (2022) 095002)

#### Generating fused disciplines:

QUP can be a fruitful platform upon which new ideas and efforts for quantum-sensor developments merge and grow through Systemology. To realize this, connecting individual PI-led investigations by QUP leadership will be important. It is also critical that strong interactions continuously take place among the various groups or clusters. The benefit of implementing the Toyota satellite is unclear, as is the application of Casimir force technology.

# (2) Global Research Environment and System Reform Realizing an international research environment:

In order to realize a truly international environment, more than one third of all QUP scientific staffs should be non-Japanese. A more permanent physical presence of PIs from abroad, as well as rotation of staffs (at the working level, not just PIs) among satellites and the Center is required.

For initiating new developments, new additional PIs should be appointed, preferably from abroad, who can always stay at QUP.

Formal establishment of the Berkeley satellite should be done quickly so that young students and postdocs can be dispatched to it from QUP.

# Making organizational reforms:

KEK has instituted changes so that QUP can operate as an autonomous institute within its organization. Specifically, top-down management by Center Director Hazumi allows researcher hiring and funding allocation within QUP to be decided by the Director. However, institutional commitment for making these reforms permanent is lacking.

# (3) Values for the future

# Societal Value of Basic Research:

QUP's plan is very thin on how it creates values for society or how it conveys its research outcomes to society. In this regard, QUP should have had a kickoff symposium. It would have been an ideal arena to advertise the creation of this new institute and its goals, especially regarding the societal values of basic research.

# Human resource building: higher education and career development:

Although the Center is planning to create a program for inviting graduate students starting from FY 2023, its size and contents are still unclear. Marketing of the postdoc training program also seems weak. It will also be important to work out concrete ways in which the postdoc training will synergize with QUP research. It would be good to see a more aggressive approach toward reaching out to graduate students as well as postdocs, perhaps with internship-type programs.

# Self-sufficient and sustainable center development:

Program Committee explicitly pointed out that "KEK should provide a concrete plan for supporting QUP." In response KEK stated that it needs to review how QUP will contribute to KEK's overall value before committing itself beyond the WPI funding period. This attitude of "wait and see how well QUP delivers" is a clear contradiction to the obligation of the

host institution to help develop QUP toward becoming a sustainable institution. KEK must present a plan for sustainability now so as to show its commitment to the successful execution of the QUP grant.

# 3. Actions required and recommendations

QUP must develop specific and clear strategies for achieving the overall WPI goals (worldclass science, a global research environment for interdisciplinary research, system reform of the host institution, and the providing of value to society). KEK must make a definitive statement on its policy and plan for making QUP a permanent and sustained institute within KEK beyond the WPI funding period. If these requirements are not satisfactorily met, QUP is in serious danger of getting stranded before it has really started.

Specific recommendations are as follows:

- Concrete identification of the actual Project Q should be done immediately. This effort should be led by QUP leadership and with the full participation of all the PIs. This will be critically important for interconnecting individual PIs and sharing QUP's vision, while alleviating the danger of devolving into an ongoing development of detectors and sensors.
- 2) PI-led projects are a mere collection of each PI's research projects. To support them as QUP projects, they will need to be evaluated according to their significance and novelty in line with QUP's vision. Those with sufficient merit should be promoted to Flagship Projects and be provided with personnel and funding resources.
- 3) The scope of the Flagship Project to develop a TES detector for the LiteBIRD mission should be clarified in terms of the demarcation point of responsibility between the basic development of the TES detector system and the delivery of the flight TES detector system to JAXA.
- 4) The Systemology project must be concrete in its design and schedule. The buildup of the Systemology Support Section, including the appointment of the section leader and staffs, must be expedited.
- 5) The "Beauty in Physics" project is unlikely to generate the highest quality-level of scientific results in its present form.
- 6) Formal establishment of the Berkeley satellite should be done immediately to attract young students and postdocs.
- 7) Efforts should be made to recruit additional PIs from abroad who can always stay at

QUP.

- 8) An aggressive plan is urgently needed for reaching out to graduate students as well as postdocs.
- 9) KEK Director General should clarify KEK's policy and support plan for making QUP a sustainable institute beyond the WPI funding period. The support plan should include the provision of PI positions and a new building that is well designed for QUP researchers to gather under one roof.

#### I. New WPI centers launched in 2022

In February 2022, MEXT invited proposals for three new WPI center to be launched in 2022. Carrying out a vigorous three steps selection procedure, the WPI Program Committee selected in its September meeting the centers "Premium Research Institute for Human Metaverse Medicine (PRIMe)" at Osaka University, "International Institute for Sustainability with Knotted Chiral Meta Matter (SKCM<sup>2</sup>)" at Hiroshima University, and "Human Biology-Microbiome-Quantum Research Center (Bio2Q)" at Keio University.

Headed by NISHIDA Koji, PRIMe aims to pioneer the field of "Human metaverse medicine" which uses human biodigital twin for understanding and treating human deseases through fusion of human organoid biomedical science and information and mathematical science.

Headed by Ivan Smalyukh, SKCM<sup>2</sup> aims to create a novel paradigm of materials based on knotted chiral meta matter, bringing new understandings on the natural laws on matter and creating novel materials with properties needed for sustainability.

Headed by HONDA Kenya, Bio2Q combines multi-organ analysis data and microbiota data related to various human diseases, development and aging with artificial intelligence and quantum computing to deepen the understanding of the mechanisms involved in maintaining human health.

# J. WPI Academy

# J-1. Aims and members

Concurrent with the end of the 10-year support period for the initially established five WPI centers, a WPI Academy was launched by MEXT in 2017. Its aim is to enhance and amplify the WPI brand and to play a vanguard role in internationalizing and reforming Japan's research environment by leveraging the WPI achievements attained so far.

Academy membership requires certification by the WPI Program Committee that a center has achieved "world premier" status. Centers, then, need to be recertified every 3 to 4 years by the WPI Program Committee, which determines whether they have maintained their "world premier" status.

Currently, the WPI Academy centers are: AIMR, iCeMS, IFReC and MANA from FY 2017 and recertified in FY2020, I<sup>2</sup>CNER from FY 2020, Kavli IPMU from FY 2017 and recertified in FY 2021 at its final evaluation, and IIIS, ELSI and ITbM since FY 2022.

#### J-2. New members of WPI Academy

IIIS and ELSI joined the WPI Academy as of 1 April 2022, having been certified to have

achieved "world premier" status in their final evaluation in FY 2021, and admitted by a meeting of domestic members of the WPI Program Committee in January 2022.

ITbM was also certified to have achieved "world premier" status in FY 2021 in its final evaluation. However, because of the research misconduct that occurred at ITbM, the WPI Program Committee determined that it was necessary to receive another report on efforts to prevent recurrence of research misconduct at Nagoya University and ITbM. As a result of receiving a report again at the Program Committee in September 2022, ITbM was approved as a WPI Academy center from October 1, 2022.

#### J-3. Change of the Director in ELSI and ITbM

Toward their final evaluation in FY 2021, Tokyo Institute of Technology, the host institution of ELSI, proposed a change of the center director from Dr. HIROSE Kei to Dr. SEKINE Yasuhito. Following the procedure for changing WPI center directors, a pre-evaluation by the PD and DPD was conducted on 26 April 2021, a hearing by the Working Group at its site visit on 24 June 2021 and a hearing by the Program Committee on 17 November 2021. The change was approved and Dr. SEKINE started his directorship on 1 April 2022.

Dr. SEKINE is an excellent planetary scientist, well-known for his research on the chemical evolution and material cycle of planets' atmospheres and oceans that nurtures life. Dr. SEKINE is the right person to lead ELSI from the theme of Life on Earth into its next phase of Life on Planets.

Nagoya University, the host institution of ITbM, proposed a change of the center director from Dr. ITAMI Kenichiro to Dr. YOSHIMURA Takashi. A pre-evaluation by PD and DPD was conducted on 28 February 2022, a hearing by the Working Group on 8 March 2022 and a hearing by the Program Committee on 23 March 2022. The change was approved and Dr. YOSHIMURA started his directorship on 1 April 2022.

Dr. YOSHIMURA is a world leading biologist in the field of animal chronobiology. His leadership from the biology side should work well for ITbM to move forward further maximizing the power of chemistry to create transformative bio-molecules.

#### J-4. Follow-up of the Academy centers

Follow-up of 5 WPI Academy centers, AIMR, iCeMS, IFReC, MANA, and I<sup>2</sup>CNER for the period of FY 2020 was conducted from December 2021 to February 2022. The findings were reported at the September meeting of the WPI Program Committee.

#### AIMR

Research activity continued at a high level, with focus on the three Advanced Target

Projects, which resulted in many publications in high impact journals. The ratio of female scientists, which was 5% in 2018, has improved to 15%. The international circulation of junior researchers was kept active even under the COVID-19 pandemic using a new "Remote Funding" scheme implemented by Tohoku University. Outreach to students and industry were made through G-RIPS (Graduate-level Research in Industrial Projects for Students) Program. Tohoku University continued its strong support to AIMR in terms of researcher positions, funding, and infrastructure costs.

#### **iCeMS**

Robust research activity continued including fusion research with emphasis on themes related to human health. The number of publications increased in 2020. The international activity was expanded by adding 2 more On-Site Laboratories (Singapore and New Zealand) in addition to the already existing 4 (Thai, USA, Taiwan, China). Active outreach activities included a web site renewal and a special page for On-Site Laboratories. iCeMS is the founding institute of KUIAS (Kyoto University Institute for Advanced Study), and 2 young researcher positions have been added to iCeMS.

#### **IFReC**

World top-level research was continued with many papers in high impact journals, keeping the world top-rank status of IFReC in immunology. Nurturing of next-generation leaders was made through the "Young Lead Researcher Program", and the "Advanced Postdoc Program" attracted many excellent junior researchers from abroad (12 hired since 2017). The outreach activities include publication of "Imuneco" for general public and "Immunology Map" for children. Funding is in very good shape with the "Inclusive Collaborative Agreement" with Chugai Ltd. and Otsuka Ltd., and collaborative research funding generated from them.

#### MANA

"Quantum Material Project" was established with the change of Director to TANIGUCHI. Fusion research was advanced through funding from Director General of NIMS. Publication record continued to be high in quality and quantity. "MANA Virtual City of Workshops" was held as a new online workshop scheme under COVID-19 pandemic. Active international collaboration continued using 7 satellites. E-bulletin distributed through Kyodo Tsushin successfully reached many audiences. Strong support from NIMS continued as its division for basic research in material science with full support of 90 positions and significant research funding.

#### I<sup>2</sup>CNER

After transitioning to a member of WPI Academy, the research strength was kept at an 80% level in terms of the overall number of personnel; all PIs are kept, and postdocs are increasing after an initial decrease. "International Collaboration Hub" was set up as a platform for international exchange. A number of international symposia including the annual I<sup>2</sup>CNER symposium were held despite COVID-19 pandemic. Support from Kyushu University continued strong in terms of researcher positions (12 tenure positions), research funding, and infrastructure costs.

## K. International mobility of junior researchers with WPI program

In 2021, the WPI Center in JSPS conducted a survey in order to (i) grasp the state of international mobility of junior researchers through the WPI Program, and (ii) grasp the impact of WPI experience on their research and careers.

Junior researchers are defined as postdocs or assistant professors. For those who held the position at WPI centers at any time between 2012 and 2016, web-based search was conducted to collect their affiliations and positions during their 13-year career from 2008 to 2020. An additional web-based search was carried out for their publication records.

The main findings are: (i) WPI centers are functioning well as international hubs of circulation of junior researchers for Japan. (ii) Many junior researchers came from, and went on to, world top-level universities and research institutions via WPI centers. (iii) Junior researchers who came to WPI centers were of high quality in science, and they continued to excel after leaving the WPI centers authoring high quality publications in terms of citation metrics. (iv) Junior researchers steadily elevated their positions through their WPI experience, with about 1/3 securing associate professor or professor position after a decade.

# L. Branding and outreach

Due to the continuing COVID-19 pandemic, online gatherings continue to be the main mechanism for much of the WPI's branding and outreach activities this year.

In December 2022, the 11th WPI Science Symposium was held in Tokyo on the theme "Possibilities opened by science is infinite." IRCN of the University of Tokyo led in organizing the symposium. The symposium was held in a hybrid fashion: 51 attended the symposium in person and 233 through internet.

