FY 2009 WPI Project Progress Report
World Premier International Research Center (WPI) Initiative

Host Institution	The University of Tokyo	Host Institution Head	Junichi Hamada
Research Center	Institute for the Physics and Mathematics of the Universe	Center Director	Hitoshi Murayama

Summary of center project progress

Organization Starting September 2009, Hitoshi Murayama resumed teaching at Berkeley. He remains as the IPMU Director and devotes to the directorship duty as hard as ever. He splits his time 30% at Berkeley and 70% for the IPMU duties. Out of 30% at Berkeley, he spends a half of his time at newly launched IPMU Berkeley satellite, so that he spends a total of 85% for IPMU throughout a year. Tsutomu Yanagida became a full time IPMU member. In mathematics, Alexey Bondal is a new principal investigator, while Akihiro Tsuchiya and Michio Jimbo stepped down as PIs. Total number of scientific members is 165 (including joint appointments, students, long-term visitors). Among 60 full time members, 35 are non-Japanese. We have 37 administrative staff, of which 20 are bilingual. The university and UC Berkeley signed a comprehensive academic exchange agreement and, as a result, IPMU Berkeley Satellite was launched in December 2009.

Scientific Activities IPMU held 11 international conferences and 140 seminars. Among 432 visitors, 345 came from abroad. A total of 198 papers were written and 100 were published. Noteworthy is a paper by Hirosi Ooguri with Masahito Yamazaki on decoding quantum states of black holes using crystal melting model in superstring theory, and a paper by Ken'ichi Nomoto and collaborators on observation of most luminous type-Ia supernova. XMASS is getting ready for data taking. Proposal by Hitoshi Murayama on Subaru Measurement of Image and Redshifts "SuMIRe" was approved for 5 years by the Council for Science and Technology Policy. This is a big boost toward our goal to understand dark matter and dark energy.

Honors and Awards Shigeki Sugimoto received the Yukawa-Tomonaga Memorial Prize for his work on holographic QCD approach for understanding hadron physics, an important application of superstring theory to testable phenomena. Hirosi Ooguri received the Nishina Memorial Prize on his contribution to topological superstring theory. Keiichi Maeda received the Astronomical Society of Japan Young Astronomer Award for his work on theoretical and observational work of supernova explosions. Katsuhiko Sato received the Japan Science Academy Prize for developing the famous inflation theory. Takaaki Kajita received the first Yoji Totsuka Prize for discovering the atmospheric neutrino oscillation.

Interdisciplinary Activities Focus Week on new invariants and wall crossing, which was attended by 32 mathematicians and 34 physicists, all leading in the world in this subject, was a symbolic event of IPMU research activities. This subject provides a new insight into the classification of higher dimensional geometry in mathematics, while playing fundamental roles in deriving low energy effective theories from superstring theory, in analyzing quantum states of black holes, and in studying strongly coupled effects in gauge theories. We believe that daily and intensive communication among mathematicians, physicists and astronomers has been firmly established as a selling point of IPMU in the international science community.

Infrastructure Construction of new building in Kashiwa Campus was completed and we moved in January 2010. With this, our staff who used to be scattered in several locations in Kashiwa Campus can stay in one place. It provides a physical setting to pursue an important philosophy in organizing the institute, namely, openness and daily communication beyond traditional barriers.

Outreach and Publicity We organized 10 public lectures, published 3 more editions of IPMU NEWS, and released 3 more short video clips. IPMU was covered 117 times in media.

Response to the Follow-up Committee The 2008 committee specified 1) successful collaboration between mathematics and physics, 2) host institution's support for establishing tenure positions and allowing teaching graduate students, and 3) director's strong leadership for establishing IPMU as a permanent institute, as the issues which need improvement. We are actively addressing these issues.

1. Summary of center project

<Initial plan>
This center aims at establishing a multi-disciplinary research institute with the unifying goal of understanding the universe from the synergistic perspectives of physics, cosmology and mathematics.

The institute brings the world's leading theoretical physicists and mathematicians together to develop new formulations of the fundamental laws of nature, a crucial step toward solving the mysteries of the universe. We will develop infinite analysis, the mathematics for systems with infinite dimensional degrees of freedom, which will be used to build new physical theories and derive their experimental predictions and to invent statistical methods to analyze geometric data.

We will study dark energy, dark matter, neutrinos, and physics beyond the Standard Model of elementary particle physics. The institute builds on the state-of-the-art facilities (Super-Kamiokande, KamLAND, Subaru telescope, and LHC accelerator) that will produce an unprecedented amount of precision data for observational cosmology, astronomy and elementary particles physics. We aim to develop new mathematical tools to analyze the data by taking full advantage of collaboration between mathematicians and physicists, and will develop new experimental strategies to attack the mysteries.

This center is a unique research institute in the world on the forefront of physics, cosmology and mathematics and will lead to a new paradigm of sciences in the 21st century. It will attract highly motivated young researchers, as well as established leading scientists from around the world and will greatly strengthen the foundation of mathematical and physical sciences in Japan.
We will also bring topnotch female researchers as role model to inspire women in Japan and promote Asian diversity.

<Results/progress/alternations from initial plan>

We have been making progress toward our goal. There is no addition to what was described in the Summary of center project progress.

2. Research fields

<Initial plan>

- Describe the importance of the proposed research, including domestic and international R&D trends in the field and Japan's advantages.
- If centers in similar fields already exist in Japan or overseas, please list them.
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Integration of Physics and Mathematics

Science's fundamental and historic search for the fundamental laws of Nature is built on the invention of new mathematics, and it has inspired many important developments in the field. Famous examples include the simultaneous invention of Calculus and Newton's mechanics and the use of Riemannian Geometry in General Relativity. The interface of physics and mathematics is alive and well. Approximately 40% of Fields Medalists in mathematics since 1990 have worked in areas closely related to quantum field theory and string theory. Conformal field theory in two dimensions, whose development was largely motivated by string theory, has been used to explain the remarkable identities about the Monster group (Field Medal to Borcherds) and to describe stochastic geometry (Fields Medal to Werner). Methods of topological string theory have revealed deep connections among the Gromov-Witten invariants, gauge theory instantons, and combinatorics (Fields Medals to Kontsevich and Okounkov). In return, these mathematical developments have provided powerful tools for quantum field theory and string theory.

No other area of science has had such a great impact on mathematics in the past few decades, and the rate of progress in this area suggests that this trend will only accelerate in future. As stressed, for example, in a recent National Research Council report, "Rising Above the Gathering Storm," in the United States, building up strength of mathematical and physical science is a key to lead in a highly competitive world scene of science and technology. Coincidentally, the Science Council of Japan warned recently that Japan's foundation of mathematics is at risk due to not attracting young talented minds into this fundamental field. At the proposed Institute, we will build a community of physicists and mathematicians, redefine the boundaries between them and help nurture future generations of mathematical scientists. Uniquely to this Institute, we anticipate cross-career development between mathematics and physics, such as a statistician moving to experimental physics.

Mathematicians and physicists have very different work styles. Although two

<Results/progress/alternations from initial plan>

In JFY2009, we heard two interesting results from galactic dark matter search experiments. Although not claiming discovery of any sort, these results are exciting and may be suggesting that we are getting near to finding elusive dark matter particles

Pamela project, which has been measuring cosmic antimatter fluxes using a magnetic spectrometer launched by a Russian Soyuz rocket in 2006, reported an observation of anomalous positron abundance. That is a standard signal in astrophysical dark matter observation since a favorite dark matter candidate such as supersymmetric neutralino can annihilate with each other resulting in the production of particles and antiparticles. CDMS collaboration, which has been searching for dark matter in the form of Weakly Interacting Massive Particles (WIMPs) using a cryogenic detector made of germanium and silicon and located at the Soudan mine in Minnesota since 2003, reported that they saw two signal events where they expected no more than one background.

The Pamela experiment is expected to operate for at least three more years. The CDMS group plans to increase the detector volume about three times by summer 2010. Members of particle theory groups at IPMU published a series of papers on interpretations and consequences of the Pamela results. They are well prepared for improved experimental results. At the IPMU Kamioka satellite, Construction of the XMASS detector is nearly completed and soon will join the race for the galactic dark matter search.

PI's for mathematics stay in their current Komaba campus, Tsuchiya will spend time in Kashiwa as a Principal Investigator, and Saito will reside in Kashiwa, who facilitate communication between physicists and mathematicians and maintain activities in this area throughout the year. There will be semi-annual workshops that bring mathematicians and physicists together where they will share their common problems. Once that is established, they will keep communicating over phone and video on individual bases, visiting each other on as-needed basis, as well as organized seminars broadcast over the video to maintain mutual interest. We also plan to have a state-of-art video conference system and internet-blackboards between Kashiwa and Komaba that stay on 24/7 to make impromptu discussions possible.

Japan's Advantages

Our advantage of experimental programs is evident. Japan continues to lead the field of underground physics including dark matter search and study of neutrinos by capitalizing on two major underground detectors (Super-Kamiokande and KamLAND) at Kamioka, where a satellite of the Institute will be established. Some principal investigators of the Institute are now building a new instrument that enables a wide-field, deep survey of galaxies at Subaru telescope. The data from this instrument will most likely dominate the field of observational cosmology and astronomy well into the next decade. Scientists in our Institute will have the first-hand access to high quality, high precision data available from these world premier facilities. LHC, the world highest energy accelerator, will become operational by the end of this year and the data of high energy collisions that mimic Big Bang, the birth of the Universe, will be available to us. By bringing together the world-leading mathematicians, theoretical physicists and experimental physicists and taking advantage of the data available at the Institute, we will take on challenges of solving the mysteries of the Universe. This is another reason why most active world-class scientists should come to work at the Institute.

Centers in Similar Fields

The Institute we will establish is a unique research center in the world that spans pure mathematics, theoretical physics, experimental physics, astronomy, and applied mathematics. This kind of Institute will be truly unique in the world. Kavli Institute for Theoretical Physics is an excellent institution, yet does only theoretical physics. There are many first-rate institutions that combine research in mathematics and theoretical physics, such as Isaac Newton Institute for Mathematical Sciences in Cambridge, Institute for Advanced Study in Princeton, IHES in France, and MSRI in Berkeley, but none of them include experimental physics in their program. There are also great institutions on both theoretical and experimental

physics, such as CERN, Fermilab, SLAC, KEK, but none of them have mathematicians. The combination of science the proposed Institute will include should attract best people from the world because of its uniqueness and potential for major breakthroughs. This project is timely and important in that Japan has currently positioned herself to lead this research field and in that this initiative meets demand for Japan to keep a cutting edge in global and competitive Science and Technology environment.	

3. Research objectives

<Initial plan>	<Results/progress/alternations from initial plan>
- Describe in a clear and easy-to-understand manner the research objectives that the project seeks to achieve by the end of the grant period (in 10 years). In describing the objectives, the following should be articulated in an easily understandable manner: What new domains are expected to be pioneered by fusing the target fields. In the process, what world-level scientific issues are sought to be resolved. What is the expected impact of the scientific advances to be achieved on society in the future. - Describe concretely the research plan to achieve the objectives, and any related past achievements by the host institution. At this Institute we address big questions about the universe, its fundamental laws, its beginning, its fate, and its mysterious components, such as Dark Matter and Dark Energy. For this purpose, we will create new mathematics needed for the unified description of the universe. It will enable new physical theories with testable predictions. Technological innovations follow to make new experiments possible; whose data will further stimulate development in mathematics. This upward spiral will move the science forward, exciting the public at large and motivating students to enter mathematics, science, and engineering to become the next-generation workforce. Even though it is difficult to accurately predict the possible deliverables from this Institute aimed at basic (not applied) research, here are a few examples of new possible domains we may pioneer on the ten-year time scale: - Effort by string theorists to enumerate and classify solutions leads to	Our research objectives remain unchanged from the initial plan. We are proceeding, both theoretically and experimentally, toward our objectives that are to solve the mystery of dark matter and dark energy, or at least make significant step forward toward this goal in a time scale of 10 years. **String Theory, Unified Theory, Mathematics** We hosted a Focus Week “New Invariants and Wall Crossing” which gathered leading mathematicians and physicists working on “quantum invariants” and “wall crossing.” In mathematics this subject provides new insight into the classification of higher dimensional geometry. In physics it plays fundamental roles in deriving low energy effective theories from superstring theory, in analyzing quantum states of black holes, and in studying strongly coupled effects in gauge theories. This area is indeed a forefront with integration of mathematics and physics which IPMU is pushing. (Focus Week is an IPMU-style one-week long international workshop where a group of most active researchers in the field gather and have intense discussion) A mathematics workshop “Quantization, Integrable Systems and Representation System” was held. Mathematicians and physicists discussed

development of new class of geometries.
- New data on dark matter from underground and accelerator experiments of the Institute require new paradigm in particle physics changing the course towards the unified theory in physics, and require new mathematics.
- Mathematical developments in integrable systems allow string theorists to work out new class of solutions that suggest a dynamical behavior of Dark Energy, and prompt new type of observational strategies in spectroscopic galaxy surveys.
- The vast data from the next-generation galaxy surveys nudge the applied mathematicians and statisticians to develop a novel method to extract subtle information from the last data set, uncovering an unanticipated new behavior of Dark Energy.

In all anticipated examples including those above, pure mathematics, theoretical physics, experimental physics underground, astrophysical, and accelerator-based, and instrumentation will motivate each other's efforts in a way not possible in the usual structure of academic institutions where these activities tend to be decoupled from each other. All of these scientific objectives are keenly shared worldwide, and any discoveries at the Institute will have immediate impacts on the global scale.

To ensure this cross-development of this type, we assembled an amazing group of researchers from around the world. They all have a strong track record in working on subjects not confined in their specific research areas, but extend well beyond the boundaries.

The Institute also builds on the strengths of the Japanese science community in many ways. University of Tokyo and Tohoku University lead the world in well-known success in neutrino physics and move to wider scopes of underground experiments such as dark matter searches. The Subaru telescope, the largest field of view among the world 8m class telescopes, will be exploited.
There is a long tradition for physicists and mathematics to work together which was especially true in the 90's and can be revamped in the 21st century. There is close relationship between theoretical and experimental particle physicists working on physics beyond the standard model which is unparalleled in the world.

The research plan is mostly about bringing in superb scientists in the relevant areas as termed professors, postdocs, and visitors. All Principal Investigators have a strong track record in securing and managing

"a classical problem" that remains unresolved for a long time, in which quantum theory with infinite degree of freedom lacks mathematical foundation in spite of its great success in physics. Any new development in this area might lead to unexpected advances in both mathematics and physics.

As a result of daily contacts among mathematicians and theorists (mainly string theorists, they share weekly seminars), connections between mathematics and string theory have been made clearer. We have clearer images about the correspondences of mathematics of string theory to various types of geometries, and about unified view of those geometries in terms of category theory. Until recently those different geometries have been treated independently and thought as unrelated subjects.

Dark Energy, Dark Matter
We hosted an international conference "Dark Energy" and a Focus Week "Non-Gaussianities in the Sky" and conducted a comprehensive survey of recent developments of dark energy. For an attempt to effectively deal with the vast data from telescopes, we hosted a Focus Week "Statistical Frontiers of Astrophysics."

XMASS detector, which tries to make direct detection of dark matter using a 800kg liquid Xenon, is in its final construction stage. The completion is slated for December 2009.
Preparation for the data acquisition has started. Work for identifying SUSY particles, important candidates for the dark matter, in the LHC data has continued. We hosted a Focus Week "QCD in connection with BSM study at LHC". Search for new phenomena Beyond the Standard Model requires deep understanding of QCD.

In August, the Council for Science and Technology Policy approved our 5 year project "SuMIRe" (Subaru Measurement of Image and Redshifts) to build a next generation camera for the Subaru telescope in collaboration with National Astronomical Observatory (NAOJ). This was a big boost toward our goal of understanding dark matter and dark energy. The new device will allow observation of distribution and spectra of more than 30 million distant galaxies within a few years time scale, thus providing unbiased information about the history of expanding universe.

Neutrino
Preparation of a small test experiment (EGADS) for detecting supernova relic neutrinos by enriching the 50,000 ton water tank of Super-Kamiokande with

competitive grants for their research. Focused workshops at the interface of physics, mathematics, and astronomy will bring in worldwide leading scientists to the Institute and breed new directions in the fields and redefine their boundaries. Generous start-up packages and seed money for developing new ideas towards future experiments will bring in competitive grants further. Frequent interactions among the PI's ensure new directions will emerge at the interface of the traditional boundaries of the subfields.

We anticipate big societal impacts of the Institute in the following way. The questions that the proposed Institute addresses are easy to relate to for laypersons. Excitement in the new paradigms in our understanding of the universe spark interest and imagination among young students and more of them enter the fields of mathematics, sciences and engineering to build a stronger future workforce. New experimental initiatives from the Institute will require new technologies in particular in instrumentations, which get transferred to the industry for new purposes. For instance, development in multi-fiber technology needed for future galaxy surveys may well lead to medical applications. It also reverses the tide of brain-drain from Japan not only by bringing back the Japanese researchers who left the country, but also bringing worldwide researchers to Japan because of the attractive research opportunities.

the element gadolinium (GADZOOKS) had started. The project for transforming KamLand into a huge neutrinoless double beta decay experiment by adding Xenon-136 to the detector volume began to receive new fund from Grant-in-Aid for Scientific Research. Purchase of 140 kg Xenon-136 and R&D for liquid scintillator are complete, and testing the container bag for the Xenon-mixed scintillaor and preparation to set up the Xenon purifier are proceeding.

Number of Researchers, Research Activities, Publications

We expanded full time scientific staff to 11 professors, 8 associate professors, 5 assistant professors, and 36 postdoctoral fellows. Total number of scientific staff including principal investigators, full time staff, joint appointments, students and long-term visitors (more than one month) reached 165. We published 100 papers in refereed journals, produced 178 preprints, many of which are being submitted to refereed journals. We held 96 seminars. We were visited by 432 scientists, of which 345 from abroad.

Contribution to Public Interest, Japan's Science and Technology Basis

We have been trying hard to convey the importance and excitement of the science we are pursuing to general public via numerous public lectures and exhibits, often putting very best researchers of the institute including the center director and principal investigators. We organized all of our public lectures with a plenty of discussion time after the lecture so that attendants were able to talk directly with the speakers. Up to now, all of our public lectures have been very successful. We have been noticing that general public is very curious about the universe and anxious to be part of this scientific quest. We also hosted an outreach program which was aimed to attract female junior high-school and high-school students into science.

Our next challenge in this regard is to bring the subject of mathematics into outreach program. Majority of young Japanese today study mathematics just as requirements or a tool for solving problems in other fields, but not as an attractive research subject of its own. We want to play a challenging role to reverse this trend. As a first step, we hosted jointly with JST a science camp of mathematics for high school students in March 2010. We were pleasantly surprised to receive a large number of enthusiastic applicants from all over Japan for the capacity of only 20. The students were really fascinated to learn different geometries in which the three inner angles of the triangle do not add up to 180 degrees, or to "count infinity" using a toy model for Bose particles and Fermi particles.

We view the approval of the SuMIRe proposal by the Council for Science and

	Technology Policy not just as a recognition of its scientific importance, but also as a result of our persistent efforts to convince the government and communities that the high precision astronomical measurements have great potential to strengthen the scientific and technological basis of Japan.

4. Management

<Initial plan>	<Results/progress/alternations from initial plan>
1) Composition of administrative staff The administrative staff is an integral part of the Institute. The administrative organization belongs to Directorate that consists of the Director, Deputy Directors and Administrative director. Because this Institute belongs *directly* to the Office of the President (without any other intervening layers of administration), the University has committed to make administration resource at the University headquarter available to the Institute. The Institute directorate will have direct access to the administration office at the University headquarter and will share its resources. With this direct coupling to the Office of the President, we envision our administrative organization will be streamlined, yet very effective to provide the best possible environment to the researchers in the Institute. On site, we will have, under the administrative director's supervision, offices devoted to 1) general affairs and human resources, 2) financial/budget planning and accounting 3) information and public communication/outreach, and 4) international affairs. Each office consists of a chief officer and a few assistants. These offices will perform day-to-day administrative function and will, whenever necessary, work directly with the directors of the institute. The office of international affairs is particularly important for the institute. It helps our foreign employees and visitors to find houses, international schools for their children, and helps for organizing international conferences and workshops. We hire skilled experts for many sections and plan to fill more than 50% of staff member positions by persons who are bilingual. 2) Decision-making system As shown in the organization chart included in the section of Project Summary, except for personnel decisions regarding the center director and principal investigators (PI's), which will be made by the President, the center Director has a complete authority of making a wide range of decisions, including proposing recruitment of PI's to the President, appointing staff researchers, postdoctoral researchers, research support staff members and administrative employees. The Director will be assisted, whenever needed,	1) Composition of administrative staff The number of administrative staff is 37, of which 25 are in a category of research support staff (hired directly by IPMU as contrast to belonging to the system of University of Tokyo administrative bureau). The Administrative Director supervises entire administrative matters with the help of a deputy administrative director and an administration chief. There are 11 staff in the general affairs and human resources section (including 1 public relation specialist and 4 secretarial staff), 3 staff in the salary and travel expense section, 6 staff in the international affairs section (including 1 conference organizer and 1 Japanese instructors), 2 staff in the finance and budget planning section, 3 staff in the contract and purchasing section, 4 staff in Kamioka Satellite office, 2 staff in computer and network, one each in the library, facilities, and documentation works. Out of 37 administrative division staff, 20 are bilingual (English and Japanese), and 3 are with particle physics background. This team handled all logistics for newly arriving staff and visitors, in particular those from abroad. The team also set up a good English language system of handling various paper works, ranging from hiring contract and visa application all the way to filling grant applications. They published IPMU NEWS (bilingual magazine covering research activities at IPMU as well as other scientific subjects of recent interest, 4 editions a year) and IPMU Annual Report. They updated the bilingual IPMU website and organized all public lectures and outreach program. 2) Decision-making system The Director is making every effort to uplift the Institute by recruiting very best scientists from all over the world, and promoting the science of Institute both in scientific and public communities. For achieving this goal, the Director receives advice at different levels from the Executive Board Meeting (EBM), Scientific Advisory Committee (SAC), and External Advisory Committee (EAC).

by two deputy directors and by the administrative director. The administrative director conducts administrative business and oversees the staff members who take care of visitors from other Japanese institutions and from abroad. His function enables the Director to spend more time to consider the Institute at large and to focus on the direction of the research. The Director will have direct access to the Office of the President and will be able to consult with the President and his assistant staff members. The Scientific Advisory Committee (SAC) reporting to the Director consists of four to five PI's of his choice. They advise the Director on planning of hiring staff members as well as scientific directions. The role is strictly advisory. The Director is solely responsible for making the final decisions. The PI's have a large autonomy in the research they conduct and they are encouraged to fund their research through competitive grants. They can make a proposal to the Director to hire postdocs and termed professors to help their research. The Director's approval on the proposed appointments will reflect the scientific vision and priorities set by the Director, who may consult the SAC as needed. Of particular importance is the External Advisory Board (EAB) who will review annually the scientific achievement and activities of the Institute and advise the Director on the scientific priorities and the research activities to keep the Institute stay on the course of the proposed science. At least half of EAB members consist of scientists from institutes other than the University of Tokyo.	The EBM, consisting of the Director, two Deputy Directors, and the Administrative Director, is held regularly, typically once a week, to ensure smooth operation and swift decision making on daily matters. The members of this meeting also take an important role when the Director makes direct access to the office of the University President. Present SAC members are T. Kohno, H. Ooguri, K. Saito, D. Spergel, and T. Yanagida. They provided frequent advice to the Director on hiring new scientific staff, distributing research fund, and setting research strategies of the Institute. Present EAC members, appointed by the University President, are J. Ellis (CERN), M. Gonokami (U of Tokyo), N. Kaifu (NAOJ), Y.K. Kim (Fermilab/U of Chicago), S. Kojima (Tokyo Tech), D. Morrison (UC Santa Barbara), R. Peccei (UCLA; Chair), S. Kahn (SLAC and Stanford U). S. Kahn is a new member from this year, and this was the last term for N. Kaifu. They met in August 2009 (only M. Gonokami was absent) and reviewd the ongoing activities. As of November 27, only draft of their report is available.
3) Allocation of authority between center director and host institution We have agreement with the Office of the President that except for the appointment of the Director and approval of appointments of PIs, the center Director has the authority to make a wide range of decisions from how to compose and organize the institute to how to operate it.	3) Allocation of authority between center director and host institution The University President negotiated with the University of California and made a final decision regarding the change of Director Hitoshi Murayama's status. The University President also approved the changes of principal investigators. All the rest of decisions regarding IPMU were made by Director Murayama.

5. Researchers and center staffs

i) “Core” to be established within host institution

Principal investigators

	At beginning	Planned for end of FY 2007	Final goal (Date: month, year)	Results at end of FY 2008	Results at the end of FY 2009
Researchers from within host institution	10	10	10 (Mar,2009)	10	9
Foreign researchers invited from abroad	5	5	7 (Mar,2009)	5	6
Researchers invited from other Japanese institutions	5	5	5	5	4
Total principal investigators	20	20	22 (Mar,2009)	20	19

All members

	At beginning	Planned for end of FY 2007	Final goal (Date: month, year)	Results at end of FY 2008	Results at the end of FY 2009
Researchers <Number of foreign researchers among them and their percentage> [Number of female researchers among them and their percentage]	20 <5, 25%>	68 < 14, 21%>	195 (Mar 2011) <69, 35%>	125 < 60, 48%> [6, 5%]	165 < 92, 56%> [10, 6%]
Principal investigators <Number of foreign researchers among them and their percentage> [Number of female researchers among them and their percentage]	20 < 5, 25%>	20 < 5, 25%>	22 (Mar 2009) < 6, 27%>	20 < 3, 15%> [1, 5%]	19 < 4, 21%> [1, 5%]
Other researchers <Number of foreign researchers among them and their percentage> [Number of female researchers among them and their percentage]	0 < , %>	48 < 9, 19%>	173 (Mar 2011) < 63, 36%>	105 < 56, 53%> [5, 5%]	146 < 88, 61%> [9, 6%]
Research support staffs	0	10	20 (Mar 2009)	22	27
Administrative staffs	3	10	10	11	10
Total	23	88	225	158	202

“Other researchers” is the sum of 6 professors (2 foreign, 0 female) excluding principal investigators, 8 associate professors (2 foreign, 0 female), 5 assistant professors (2 foreign, 0 female), 36 postdoctoral fellows (29 foreign, 3 female), 59 joint appointments (22 foreign, 3 female), 2 students (2 foreign, 0 female) and 30 long-term visitors (29 foreign, 3 female).

ii) Satellites

<Initial plan>

Institution (1)

The institute establishes a satellite at Kamioka to promote closer collaboration with the neutrino group. It locates close to the Super-Kamiokande and KamLAND detectors. It gathers researchers who work on the underground experimental activities such as study of neutrino physics and XMASS, a new dark matter search experiment that has recently been funded. Two PI's, Professor Masayuki Nakahata of Kamioka Observatoy, ICRR, University of Tokyo and Professor Kunio Inoue of Research Center of Neutrino Science, Tohoku University, will be stationed at the satellite and we will have researches jointly appointed from neutrino group.

One of the PI'S has already a grant with scientists at NAOJ to pursue the dark energy project. We also gather scientists from the world to conduct an analysis on the data from LHC. We have already a candidate for an associate professor.

-Role

-Personnel composition and structure

-Collaborative framework

Institution (2)

<Results/progress/alternations from initial plan>

As an initial plan, we started "IPMU Kamioka Satellite" and have been strengthening its structure and collaborative frame wok. Since then, a proper definition of "Satellite" was shown to us from the MEXT office in charge of the WPI program. According to the new definition, our Kamioka Satellite, which is closely related to ICRR, a part of the host institution, does not satisfy the criteria of being Satellite. Since, however, we have been frequently using this name in the past, we state its role and collaborative framework below.

Based on a comprehensive academic exchange agreement which was signed by the University of Tokyo and University of California Berkeley, a new IPMU Berkeley Satellite was established on Berkeley campus on December 2009.

"IPMU Kamioka Satellite"

-Role

Two major neutrino experiments, Super-Kamiokande and KamLAND, are running and a dark matter search experiment, XMASS, is in its final stage of construction at Kamioka. IPMU tries to carry out the observation of supernova relic neutrinos using Super-Kamiokande, and the detection of neutrinoless double beta decay using KamLand. IPMU also works on the construction and data analysis at XMASS. The Kamioka Satellite forms a base for the IPMU researchers working on these projects.

-Personnel composition and structure

ICRR team under the principal investigators M. Nakahata and Y. Suzuki consists of 4 associate professors, 1 project associate professor, 7 assistant professors, 4 project assistant professors, and 2 postdocs. RCNS team under the principal investigator K. Inoue consists of 2 associate professors, 3 assistant professors, and 4 postdocs. IPMU team consists of professor M. Vagins (head) and 1 postdoc working on supernova relic neutrino, 1 associate professor (K. Martens) and 1 postdoc working on XMASS, and 1 postdoc working on neutrinoless double beta decay.

-Collaborative framework

All members of "Kamioka Satellite" work closely with collaborators of ongoing Super-Kamiokande and KamLand experiments. IPMU's main goals, however, are the investigation of supernova relic neutrinos and neutrinoless double beta decay at these two neutrino detectors. These

	projects require further R&D, and the IPMU team works closely with the collaborators. IPMU closely works at XMASS construction and preparation for data handling. IPMU Berkeley Satellite -Role The newly founded satellite provides a framework for conducting collaboration between IPMU and Berkeley physics department in a wide range of fields involving particle physics, cosmology and mathematics. Initial activity is taking place in particle theory, both string theory and phenomenology. It is hoped that this place makes the recruitment of IPMU staff easier in the US. -Personnel composition and structure Director Hitoshi Murayama spends a half of his time at the satellite during his stay at Berkeley which is 30% a year, and supervises overall activity with the help of two Research Directors, Tsutomu Yanagida of IPMU and Lawrence Hall of Berkeley. The team consists of 4 other faculty members, 5 postdoctoral fellows and 10 students. -Collaborative framework They collaborate with Yanagida's group and Nojiri's group in particle phenomenology, with Ooguri's group in string theory.
iii) Partner institutions <Initial plan> Institution (1) 1) IHES(Institut des Hautes Etudes Scientifiques) in France (for mathematics), 2) Yukawa Institute for Theoretical Physics, Kyoto University (for mathematics and theoretical physics), 3) Department of Physics, Kyoto University (for neutrino physics), 4) Department of Mathematics, Kyoto University (for mathematicians), 5) High Energy Accelerator Research Organization (KEK) (for neutrino physics), 6) National Astronomical Observatory in Japan (NAOJ) (for dark energy survey and astronomy) and 7) Department of Astrophysical Sciences, Princeton University in USA (for	<Results/progress/alternations from initial plan> Institution (1) National Astronomical Observatory -Role Observations using Subaru telescope have produced many interesting results in recent years. IPMU researchers have been contributing to these astronomical observations in the area of supernova and gravitational lensing. NAOJ is stepping forward and forming collaboration with IPMU for the construction of a next generation camera to investigate dark energy. -Personnel composition and structure NAOJ team consists of professor Hiroshi. Karouji (head), 1 associate professor, 2 assistant professors, and 2 postdocs.

dark energy survey and astronomy). -Role -Personnel composition and structure -Collaborative framework <u>Institution (2)</u>	-Collaborative framework NAOJ and IPMU collaborate on developing a next generation camera, HyperSuprimeCam, and its data acquisition system with a special emphasis on investigation of dark energy. The approval of SuMIRe project is a positive result of this collaboration. <u>Institution (2) High Energy Accelerator Research Organization (KEK)</u> -Role A team of theorists at KEK examines new data of LHC experiments from theoretical perspectives of the standard model (Higgs particle), physics beyond the standard model (SUSY particles and dark matter), and higher dimensional theories (black hole and extra dimensions). -Personnel composition and structure The team lead by principal investigator, M. Nojiri, consists of 1 postdoc and 2 students. -Collaborative framework In analyzing the LHC data, KEK team put emphasis on the standard model and supersymmetric theories, while IPMU team tries to see the data from more cosmological standpoints. The two approaches are complementary and beneficial to both sides. <u>Institution (3)</u> Department of Physics, Kyoto University -Role The team works with the Super-Kamiokande experiment for the measurements of neutrino oscillation. They put main emphasis on T2K experiment. -Personnel composition and structure The team consists of associate professor T. Nakaya (head), 1 assistant professor, and 2 postdocs. -Collaborative framework Kyoto team primarily works on the neutrino beam line at JPARC and the T2K front detector, while IPMU team primarily works on Super-Kamiokande detector itself. Since all three of these elements have to work well for precise neutrino oscillation measurements, their close collaboration is important. <u>Institution (4)</u> Department of Astrophysical Sciences, Princeton University -Role

Princeton team played a leadership role in the historical WMAP project. Their leader and principal investigator, David Spergel, is a world leader of the dark matter search and telescope design. This team is expected to bring various expertise to the construction of HyperSuprimeCam camera and its operation.

-Personnel composition and structure
The team consists of D. Spergel and 3 other professors, one assistant professor, and 3 postdocs.

-Collaborative framework
They collaborate with the teams lead by H. Aihara and K. Nomoto for building HyperSuprimeCam camera and subsequent data analysis for the dark energy investigation.

Institution (5) IHES (Institut des Hautes Etudes Scientifiques)

-Role
IHES is one of the world top-level institutes of mathematics and works closely with physics. At the moment, IPMU is negotiating with IHES to secure postdoc position(s) as joint appointment. We are hoping to strengthen the connection between mathematics and physics through the exchange.

-Personnel composition and structure
Professor Jean Pierre Bourguignon (Director) and professor Maxim Kontsevich (Fields Medalist) collaborate with IPMU scientists.

-Collaborative framework
J.P. Bourguignon collaborates with H. Ooguri and K. Saito on new developments in mathematics which are closely related to physics. M. Kontsevich collaborates with A. Bondal, K. Saito and other IPMU mathematicians.

Institution (6) Yukawa Institute for Theoretical Physics, Kyoto University
-Role
YITP has a long standing tradition as a superior institution of theoretical physics and mathematical physics. Collaboration with them is beneficial to IPMU, particularly in the areas of string theory and quantum field theory.

-Personnel composition and structure
The group consists of professor Tohru Eguchi (Director) and associate

	professor Ken'ichi Izawa. -Collaborative framework A close collaboration between T. Eguchi and H. Ooguri, and between K. Izawa and T. Yanagida, are pursued through their joint appointments and frequent visits to IPMU. <u>Institution (7)</u> Research Center for Neutrino Science, Tohoku University -Role As a member of the IPMU Kamioka Satellite, they continue ongoing study of reactor neutrinos and geo-neutrinos at KamLand. At the same time, they collaborate with IPMU on the detection of neutrinoless double beta decay. -Personnel composition and structure The team lead by principal investigator Kunio Inoue consists of 2 associate professors, 3 assistant professors, and 4 postdocs. -Collaborative framework They collaborate with IPMU and investigate a possible transformation of KamLand into a huge neutrinoless double beta decay detector.

6. Summary of center's research environment

<Initial plan>	<Results/progress/alternations from initial plan>
1) Environment in which researchers can devote themselves to their research The Director will secure the funds to hire administrative staff and research support staffs to assure that researchers of the Institute be exempt from paper works associated with conducing researchers. In addition, for PI's from University of Tokyo, the Office of the President will provide resources that enable PI's to substitute their teaching duties in their original departments.	1) Environment in which researchers can devote themselves to their research Out of 37 administrative division staff, 20 are bilingual and 3 are with particle physics background. They form a strong team to handle a wide range of tasks which relieves scientific staff from paper works.
2) Startup research funding Many of PI's of the Institute have already secured research fund by winning competitive grants. The Director will secure startup funds for young researchers and postdoctolal fellows hired by the Institute.	2) Startup research funding All postdoctoral fellows receive annual research fund of 500,000 yen ($4167 using exchange rate JPY/USD=120) from IPMU. Researcher at or above assistant professor rank receive startup fund according to their needs.

3) Postdoctoral positions through open international solicitations We will post all the job openings on major journals of the community such as Physics Today and will contact proactively via Emails leading scientists of the field, both in Japan and abroad, to solicit outstanding candidates.	3) Postdoctoral positions through open international solicitations We advertised for opening positions in Physics Today, CERN Courier, American Mathematical Society Magazine, American Astronomical Society Magazine, and in English IPMU homepage. We also sent the advertisements to numerous places worldwide via emails.
4) Administrative personnel who can facilitate the use of English in the work process In the fields of particle physics, mathematics and astronomy it has been the standard practice for researchers to speak English for work-related communication. We will assemble administrative staff members as well as research support members who are fluent in English with help from the Office of the President.	4) Administrative personnel who can facilitate the use of English in the work process Among the 37 administrative staff, 20 are bilingual. We set up a system to handle most of daily communications and paper works in both English and Japanese. We made further improvements to the IPMU website which started in 2008. It contains a wide variety of information about contract, living, seminars, publications and various application forms. It is now widely used as a communication tool among the IPMU members and outside research community. We also have been successful to create a friendly atmosphere in the administration office so that foreign researchers come in at any time and freely talk to us.
5) Rigorous system for evaluating research and system of merit-based compensation Salary of the center director will be negotiated through the office of the President. Annual salaries for PI's will be decided by the Director. Salaries of researchers other than PI's will be decided by the Director with consultation to Deputy Directors. Evaluation of researchers will be strictly merit-based and will include citation counts, invited talks at international conferences, cross-disciplinary papers, salaries at competing institutions abroad, and leadership roles at the Institute.	5) Rigorous system for evaluating research and system of merit-based compensation We proceed as stated in the initial plan for setting up the salary scales for all researchers. In order to assist the Director for evaluating the accomplishments of individual researchers, we constructed a comprehensive data base containing all relevant information of individual researchers. We think it is also important to correctly evaluate a type of activities which may not necessarily appear on such record. Our system of "mentor", in which one of the principal investigators closely follows each of young staff's performance, nicely covers this aspect.
6) Equipment and facilities, including laboratory space, appropriate to a top world-level research center The University administration pledges to build a new building on Kashiwa campus for the Institute. The architecture will follow the style of Kavli Institute for Theoretical Physics at UC Santa Barbara and Center for Theoretical Physics at UC Berkeley with a large open area and amenities. It will provide an attractive and competitive environment for researchers from around the world.	6) Equipment and facilities, including laboratory space, appropriate to a top world-level research center New IPMU building in Kashiwa Campus (5,900 square meters) is now complete and we moved in January 2010. IPMU Kamioka Satellite Office (500 square meters) has been functioning as a base for IPMU researchers working at Super-Kamiokande, KamLAND and XMASS since its completion in February 2009. All of the partner institutions are now

We plan to have a state-of-art video conference system and internet-blackboards among Kashiwa, Hongo, Komaba, Kamioka and other collaborating institutions that stay on 24 hours a day, 7days a week to make impromptu discussions possible.	connected via video conference system. They are used daily for seminars and discussion.
7) International research conferences or symposiums held regularly to bring world's leading researchers together Annual international conference at the Institute as well as long-duration workshops à la Kavli Institute for Theoretical Physics and Aspen Center for Physics will be held. They will bring in visitors to further stimulate the intellectual activities and keep the Institute at the forefront of worldwide science.	7) International research conferences or symposiums held regularly to bring world's leading researchers together During the period between April 2009 and March 2010, IPMU hosted 11 international conferences (2 in mathematics, 8 in physics, and 1 in an area involving both).
8) Other measures, if any The University is constructing Kashiwa International Lodge that will be a main residential facility for foreign researchers who have moved to the Institute and short-term visitors. Meanwhile, the University will help the foreign researchers to find housings. The Institute's foreign affairs office will fully conduct the business related to foreign researchers together with the Office of the President.	8) Other measures, if any Kashiwa International Guesthouse opened in March 2010. We continue to organize a group of volunteers who help our foreign staff for registering at the city hall, getting bank account, and looking for housing. We continue to offer free Japanese lessons to newly arriving foreign staff.

7. Criteria and methods used to evaluate center's global standing

<Initial plan>	<Current assessment>
1) We introduce quantitative and objective methods to evaluate the Institute's global standing. The number of refereed journal papers, the number of citations of the papers the Institute researchers published, and the number of presentations our researchers deliver in the major international conferences will be kept monitored and tracked. These "numbers" form a base of evaluation of the center 's global standing.	1) During the period between April 2009 and March 2010, IPMU published 100 papers in refereed journals. We expect the number of publications increases greatly in near future since 178 preprints were written by IPMU members during the same period.
2) The number of visitors and the number of foreign visitors among them are another objective indicator to measure the activity and visibility of the Institute.	2) A total of 432 researchers have visited IPMU during this period, out of which 345 were from abroad.
3) In order to evaluate how effective the Institute is to bring mathematicians and physicists together, we plan to monitor the number of publications co-authored by mathematicians and physicists. It will be a measure of the synergy between the two disciplines.	
The proposed institute has already positioned itself as one of the most cited Institutions in Physics research. This is because all the principal	

investigators we assembled are leading scientists in their own discipline and the number of citations of each investigator is outstanding. Criteria 2 and 3 are, of course, yet to be applied. The goal to meet the criteria 1) is clear. We will maintain the statue of the most cited Institution in Physics and Mathematics. We aim to be one of the most visible research organizations in Physics and Mathematics.	

8. Securing competitive research funding

<Initial plan> Indicate the total amount of research funding (e.g., competitive funding) secured by principal investigators who will join the center project. Itemize by fiscal year (FY2002-2006) taking into account the percentage of time each will devote to research activities at the center vis-à-vis the total time they spend conducting research activities ("Effort ②" in Appendix 2). For example, if this percentage is 70%, then 70% of his/her research funds can be counted in calculating the total amount of research funds. FY2002: $9.7M, FY2003: $10.9M, FY2004: $9.5M, FY2005: $13.2M, FY2006: $13.6M (in units of US dollars, Exchange Rate: JPY/USD=120) Grand total of competitive funding awarded to PI's over past 5 years is $56.9M. ii) Prospects after establishment of the center ・ Based on the past record, describe the concrete prospects for securing resources that match or exceed the project grant. ・ Calculate the total amount of research funding (e.g., competitive funding) based on the percentage of time the researchers devote to research activities at the center vis-à-vis the total time they spend conducting research activities ("Effort ②" in Appendix 2). Be sure the prospects are realistically based on the past record. Principal Investigators of the Institute have already secured competitive funding that amounts to approximately $55M, the same level as that of the past five years. We are, therefore, confident to maintain the same funding profile well into the era of this new Institute.	<Results/progress/alternations from initial plan> We secured $7.22M (using Exchange Rate JPY/USD=120) in FY2009.

9. Other important measures taken to create a world premier international research center

<Initial plan>	<Results/progress/alternations from initial plan>
- Describe activities and initiatives to be taken after project funding ends. We intend to keep the Institute as the advanced institute of the University, a permanent entity that belongs to the University. We plan to work, with the Office of the President, to raise the fund.	- Describe activities and initiatives to be taken after project funding ends. We hope to keep the Institute as a permanent institute of the university. Obviously the most important approach for achieving this goal is to make profound contributions to the field of physics and mathematics of the universe. Also important is to receive recognition from the worldwide scientific community as a place for top level scientists to gather. We are making continuous effort toward this goal. Other important point is to raise funds. For the support of the host institution for converting IPMU into a permanent institute after the project funding ends, we had a strong commitment from the University President, Junichi Hamada. In his February 23, 2010 speech on the occasion of the inauguration ceremony of IPMU's new building, he stated, "The University has actually been discussing an interdisciplinary system of Institute for Advanced Study as its permanent entity, and we are making progress towards its establishment. I express my commitment here that we will integrate IPMU into the University as one of such Institute; sustain IPMU beyond the duration of the WPI funding; and give tenure to a part of the IPMU faculty without sacrificing the traditional University positions." We are extremely encouraged by this statement, and continue to work closely with Hamada's office.
- Describe expected ripple effects（e.g., how the proposed research center project will have trailblazing components that can be referred to by other departments in the host institution and/or other research institutions when attempting to build their own top world-level research centers）. We are confident that our aggressive approach to assemble the world-leading scientists from other institutions from within Japan or from abroad and our ambitious organization will have significant impact to the University. Also the merit-based evaluation system we introduce would be so attractive to young researchers that it could become a model that other institutions would follow.	- Describe expected ripple effects（e.g. how the proposed research center project will have trailblazing components that can be referred to by other departments in the host institution and/or other research institutions when attempting to build their own top world-level research centers）. We continue to recruit a large number of non-Japanese researchers. Our administrative staff is effectively handling their relocation and setting up an excellent research environment. We have been receiving various inquiries about our approaches from other departments.

- Describe other important measures to be taken in creating a world premier international research center, if any.

We will be proactive to raise funding for the Institute. In particular, we engage fundraising from the private sector both in Japan and abroad.

In order to promote competitive atmosphere among PI's and senior researchers, we plan to institute a named distinguished professorship. It will be awarded by the Institute Director to an Institute professor after rigorous evaluation of his/her performance at the Institute.

- If one or more of the projects applying for Global COE program have some connections with this research center project, list the project title(s), outline(s), group leader(s) and the relationship(s) with this project.

Since the call for proposal of Global COE program for the disciplines related to the Institute, which are mathematics and physics, is scheduled for FY2008, there are no Global COE programs to list. Some of PI's, however, will definitely be involved in some of Global COE proposals that are under consideration. We as the Institute will seek close collaboration with such Global COE programs once they have been more developed and its relevance to the Institute has become more evident.

- Describe other important measures to be taken in creating a world premier international research center, if any.

We enforce a policy of requiring all researchers to spend at least 1 month but not more than 3 months abroad as long as the fund allows. We think this is important for all researchers to cross-calibrate their activities with an international standard, and particularly for young staff to stay visible in the international community. We are working hard to secure the fund for this purpose. We had a plan to establish named distinguished professorship. Negotiation with Kavli Foundation to establish such position is still continuing.

- If one or more of the projects applying for Global COE program have some connections with this research center project, list the project title(s), outline(s), group leader(s) and the relationship(s) with this project.

Two proposals for the Global COE Program submitted by the IPMU principal Investigators were approved and the grants started in JFY 2008. They will continue for five years.

Weaving Science Web beyond Particle-Matter Hierarchy
by Kunio Inoue, professor of Tohoku University, as a project leader.

They propose to establish an international research and education center to strengthen the understanding in each of the subjects that form a hierarchy of matter, starting from particles to nucleus, condensed matter, all the way to the universe, and to deepen the connection among them. Through this approach, they try to develop a new frontier of science.

The leader of this project is a Principal Investigator of IPMU, and leading an effort in neutrino experiment at KamLAND. The theme for this program "Hierarchy of matter" can be considered as one aspect of the IPMU's theme "Physics and Mathematics of the Universe", and thus they are closely related to each other.

Quest for Fundamental Principles in the Universe
By Naoshi Sugiyama, professor of Nagoya University, as a project leader.

They propose to establish an international research and education center to study, i) evolution of the universe, ii) space-time structure of the particles and universe, and iii) physics of the cosmological environment. Their research objective "Fundamental Principle in the Universe" constitutes an important

	part of IPMU's objective "Physics and Mathematics of the Universe".

10. Host institution's commitment

<Initial plan>	<Results/progress/alternations from initial plan>
-Provision in host institution's mid-to-long-term plan The University of Tokyo's medium-term research objectives include "investigating exploratory and advanced research and unconventional research areas or actively approaching a new fusion of different academic fields with full respect for research schematization and succession, thereby playing a role to drive forward network-based research with a global perspective." The accompanying medium-term plan states that the university is dedicated to "promoting the establishment of a center for advanced research of excellent creativity and originality in new fields, while fostering the development of new academic areas through interdisciplinary research and collaboration" and "in response to issues newly rising out of academic development and social changes, promoting the establishment of an international research center to deal with such issues in a pioneering, flexible, and practical manner beyond existing academic areas and organizational frameworks." In order to implement the medium-term plan mentioned above, the University of Tokyo has set up the Integrated Research System for Sustainability Science, the Network for Life Science Research, and other inter-departmental organizations under Office of the President to establish a system to promote multi-disciplinary research. Institute for the Physics and Mathematics of the Universe (IPMU), facilitated by the WPI Initiative, most appropriately meets the University's medium-term goals and plans, hence it shall be positioned as the largest and most important organization among those under Office of the President, and enjoy university-wide support under the specific achievement targets.	-Provision in host institution's mid-to-long-term plan In the 2007 Progress Report, following statement was given. "A clear statement was added to the University of Tokyo's medium-term research objectives, saying "We give one of the highest priorities to the setting up of the World Premier International Research Center, Institute for the Physics and Mathematics of the Universe, for investigating the origin and evolution of the universe through close collaboration among mathematics, physics, and astronomy. In order to achieve the goal of the medium-term objectives, the university placed the IPMU directly under the office of the president as the highest priority cross-disciplined research center." There was no change in 2008 and there is no change in 2009.
-Concrete Measures (1) Competitive grants obtained by researchers participating in the project and in-kind contributions, etc. The University of Tokyo will position the IPMU as an organization directly under Office of the President working as a natural facilitator with existing university organizations. The Administration Bureau shall develop an ideal research environment to ensure that chief researchers engaged in	-Concrete Measures (1) Competitive grants obtained by researchers participating in the project and in-kind contributions, etc. The number of administrative staff belonging to the university administrative bureau and work full time at IPMU was increased from 6 to 10 in JFY2008. They worked together with additional 25 administrative staff directly hired by IPMU and handled the need for rapidly increasing

research at the IPMU have minimum possible university duties to allow ample time for them to fully focus on research activities, and that research funding may be more readily secured. As part of developing such an environment, with the aim of securing excellent researchers as well as high-caliber support staff, a new employment scheme has already been implemented whereby it is even possible to recruit exceptionally qualified staff at salaries higher than that of the President. Priority is also given for the use of school research space. Furthermore, the Administration Bureau shall have an organization named the Financial Strategy Office whose task is to develop plans strategically to obtain external funding and to allocate it effectively. This shall allow the maximum financial support for the IPMU, while making full use of university resources including overhead costs for the program.	researchers at IPMU. A strategic management team, which was set up at the university headquarter in JFY2007, continued to support IPMU with a high priority.
(2) System under which the center's director is able to make substantive personnel and budget allocation decisions The University of Tokyo has newly developed an innovative scheme to allow the positioning of the IPMU as an organization directly under Office of the President working in an organic linkage with existing university organizations. Under this scheme, the IPMU may take charge in the operation of the organization under the managerial supervision of the director of IPMU, including for the recruitment of researchers.	(2) System under which the center's director is able to make substantive personnel and budget allocation decisions In the 2007 Progress Report, it was stated that the center's director is able to make all decisions including hiring of scientific staff because the center is placed directly under the university president's office. There was no change in 2008 and there is no change in 2009 to this policy.
(3) Support for the center director in coordinating with other departments at host institution when recruiting researchers, while giving reasonable regard to the educational and research activities of those departments In order to ensure that education and research activities may be implemented smoothly with no disturbance to the university faculties and institutions from which the researchers are gathered for the IPMU, the Administration Bureau shall provide any necessary financial support, such as for personnel expenses of substitute teaching staff, to the concerned university departments and divisions. This shall not only allow such departments and divisions to take measurements including securing substitute teaching staff, but the mobility of researchers within the university may be further improved.	(3) Support for the center director in coordinating with other departments at host institution when recruiting researchers, while giving reasonable regard to the educational and research activities of those departments Based on the university decision of 2008 to provide financial support for hiring substitute teaching staff (assistant professor) per every two IPMU Principal Investigators who are also faculty members at the university, Physics Department, Graduate School of Mathematical Sciences, and ICRR each received the fund for hiring one assistant professor. In addition, the university hired one associate professor in physics department to ease heavy burden of H. Aihara as IPMU's deputy director, and provided one professor position at IPMU to further strengthen its research activity.
(4) Revamping host institution's internal systems to allow introducing of new management methods (e.g., English-language environment, merit-based pay, top-down decision making) unfettered by	(4) Revamping host institution's internal systems to allow introducing of new management methods (e.g., English-language environment, merit-based pay, top-down decision making) unfettered by

conventional modes of operation As described above, the University of Tokyo has developed an innovative scheme to allow positioning of the IPMU as an organization directly under Office of the President working as a natural facilitator with existing university organizations. Under this scheme, the IPMU may take charge in the operation of the organization under the managerial supervision of the director of IPMU, including for the recruitment of researchers, while new special regulations are also to be established designating the IPMU as a special zone in which participating researchers and support staff members may be allowed a limited exemption from some restrictions under the work rules that are generally applied within the university.	conventional modes of operation In the 2007 Progress Report, following statement was given. “Placing the center directly under the office of the university president made it possible for the director’s management to make all decisions including hiring of scientific staffs. We also set up a separate salary scale to attract top class researcher from both Japan and abroad. Specifically, we adopt a system which guarantees the salary level of their previous positions, and can add incentives (for example, salary of the director, who held a professorship in US is sufficiently higher than his previous salary, and as a result, exceeds that of the university president). We adopt English as the official language and include that statement in our hiring advertisements.” There was no change in 2008 and there is no change in 2009 to these policies.
(5) Accommodation of center’s requirements for infrastructural support (facilities, e.g., laboratory space; equipment; land, etc.) The University of Tokyo places great importance on the development of an environment to permit excellent researchers from overseas to steadily concentrate on their research activities. Currently, active initiatives to promote a more international campus are under way under the leadership of the President, and several residential facilities for foreigners are being developed near the campus and are due to open in a few years' time. Priority allocation of such residences for researchers invited to the IPMU from overseas has also been under discussion. The University also develops a number of world-class research facilities and actively promotes sharing the use of such facilities. Measures shall be taken to ensure the priority use of such research facilities. Top priority shall be given to the appropriation of land for a research building for the IPMU and its financing. Until the new research building is constructed in Kashiwa Campus, Chiba Prefecture, rooms and other space of the Kashiwa General Research Building shall be provided in priority for activities of the IPMU.	(5) Accommodation of center’s requirements for infrastructural support (facilities, e.g., laboratory space; equipment; land, etc.) The university continued to secure the required office spaces within the Kashiwa Campus throughout JFY2009. The new building in Kashiwa Campus, which the university was committed to provide from the start of the project, is now complete and we began to occupy in January 2010.This building, together with “Kamioka Satellite” office completed in February 2009, forms a basic infrastructure of IPMU.
(6) Support for other types of assistance With the aim of supporting the establishment of an internationally competitive center through the program, the University of Tokyo has set up	(6) Support for other types of assistance In the 2007 Progress Report, we stated:

a committee headed by the board member in charge of the program. The committee, in addition to ensuring university-wide support for the IPMU, shall work in close cooperation with the Global COE (Centers of Excellence) Program and other schemes, as part of its role to produce maximum synergy. The administrative functions of the Administrative Bureau are to be reorganized in July 2007, where the Research Network Support Group is to be set up to intensively support the IPMU, among other organizations. With these schemes, the University shall provide the maximum possible consistent support for the promotion of the IPMU concept.	"President's Committee chaired by a board member supports creation of internationally competitive research center within the WPI program. This committee provides a university-wide support to IPMU, as well as close coordination with Global COE programs in order to maximize the synergy among various entities within the university. The university administration was restructured in July 2007, and Research Network Support Group was set up directly under the President's office. Using this new structure, the university provides a maximum and stable support to IPMU." This policy stayed the same through 2008 and 2009.

11. FY 2009 funding

i) Overall project funding

(Exchange Rate: JPY/USD=100)

Cost Items	Details	Costs (10,000 dollars)
Personnel	Center director and Administrative director	40
	Principal investigators (no. of persons):10	93
	Other researchers (no. of persons):51	516
	Research support staffs (no. of persons):27 (total)	100
	Administrative staffs (no. of persons):10	76
	Total	825
Project activities	Gratuities and honoraria paid to invited principal investigators	34

Ten thousand dollars (Exchange Rate: JPY/USD=100)

WPI grant for FY 2009	2,342
Costs of establishing and maintaining facilities in FY 2009	1,169
Construction of laboratory building (5,800m²) Costs paid:	1,169
Cost of equipment procured in FY 2009	1,031

	(no. of persons): 34		
	Cost of dispatching scientists (no. of persons): 1	1	
	Research startup cost (no. of persons):36	26	
	Cost of satellite organizations (no. of satellite organizations):1	2	
	Cost of international symposiums (no. of symposiums):11	7	
	Rental fees for facilities	22	
	Cost of utilities	7	
	Other costs	87	
	Total	404	
Travel	Domestic travel costs	11	
	Overseas travel costs	24	
	Travel and accommodations cost for invited scientists (no. of domestic scientists):23 (no. of overseas scientists):165	43	
	Travel cost for scientists on secondment (no. of domestic scientists):1 (no. of overseas scientists):20	10	
	Total	88	
Equipment	Depreciation of buildings	12	
	Depreciation of equipment	105	
	Total	117	
Other research projects	Projects supported by other government subsidies, etc.	646	
	Comissioned research projects, etc.	33	

Construction of super-wide-coverage camera for large telescope
Number of units: 1unit
Costs paid: 462

Ultra-high-purity Spectrometer/purifier
Number of units: 1unit
Costs paid: 405

CCD sensor
Number of units: 3unit
Costs paid: 31

Mass analyzer system
Number of units: 1unit
Costs paid: 9

Audio video system for new building
Number of units: 2unit
Costs paid: 48

Others
Costs paid: 76

	Grants-in-Aid for Scientific Research, etc.	731
	Total	1,410
Total		2,844

ii) Costs of Satellites and Partner institutions

(Exchange Rate: JPY/USD=100)

Cost Items	Details	Costs (10,000 dollars)
Personnel	Principal investigators (no. of persons):0	
	Other researchers (no. of persons):5	
	Research support staffs (no. of persons):0	
	Administrative staffs (no. of persons):0	
	Total	1
Project activities		0
Travel		1
Equipment		
Other research projects		
Total		2

12. Efforts to improve points indicated as requiring improvement in follow-up review and results of such efforts

-Points specified as needing improvement

The 2008 Follow-up review specified following points as needing improvements.

1. Fruitful collaboration between mathematics and physics
2. Support of the host institution for tenured positions and graduate student issues
3. Continuous leadership of center director to establish IPMU as a permanent institute.

1. IPMU already published several papers co-authored by mathematicians and physicists. Newly appointed principal investigator, Alexey Bondal, is a Fields-Medal-class mathematician. At the same time, he has made a significant contribution to physics. Physicist Hirosi Ooguri was awarded American Society of Mathematics medal.
   We hosted a Focus Week “New Invariants and Wall Crossing”. In mathematics this subject provides new insight into the classification of higher dimensional geometry. In physics it plays fundamental roles in deriving low energy effective theories from superstring theory, in analyzing quantum states of black holes, and in studying strongly coupled effects in gauge theories. This area is indeed a forefront with integration of mathematics and physics. We hosted a workshop “Quantization, Integrable Systems and Representation System” where mathematicians and physicists discussed a long-time unresolved

problem on mathematical foundation of quantum theory. Close collaboration between mathematics and physics at IPMU is steadily increasing.

2. For the support of the host institution for tenure, we had a strong commitment from the University President, Junichi Hamada. In his February 23, 2010 speech on the occasion of the inauguration ceremony of IPMU's new building, he stated, "The University has actually been discussing an interdisciplinary system of Institute for Advanced Study as its permanent entity, and we are making progress towards its establishment. I express my commitment here that we will integrate IPMU into the University as one of such Institute; sustain IPMU beyond the duration of the WPI funding; and give tenure to a part of the IPMU faculty without sacrificing the traditional University positions." We are extremely encouraged by this statement, and continue to work closely with his office.

   Teaching graduate students at IPMU has already started. Three mathematicians received permission to take students from Graduate School of Mathematical Sciences. Four physicists received permission from Physics Department and Engineering Department to take students. We expect the numbers of both faculty who get involved in teaching and students to increase in the future. In addition, the university actively provided teaching opportunities to the IPMU faculty who are interested in teaching. S. Hellerman and M. Vagins gave lectures in physics department.

3. The University President's speech of February 23rd covers the subject of converting IPMU into a permanent institute as well. The University has a concrete plan to convert IPMU into a permanent institution within the university system. This encouraging outcome is a result of tireless negotiation under the leadership of Director Murayama, which was made possible since he received an official permission from UC Berkeley management to play this role.
   Dean of Physical Sciences in UC Berkeley has been extremely generous and supportive of IPMU to offer a split appointment for Murayama, in which he stays 70% at IPMU and 30% at Berkeley. Since he can spend a half of his time at the IPMU satellite while in Berkeley, he actually spends 85% of his time for IPMU. This new arrangement secures Murayama's long term and continuing leadership as the IPMU director, and helps realizing the conversion of IPMU into a permanent institute.