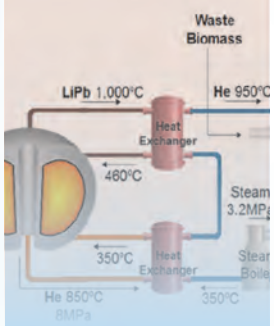
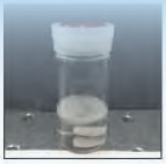
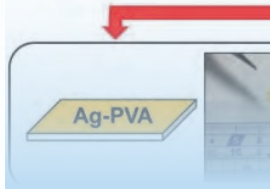


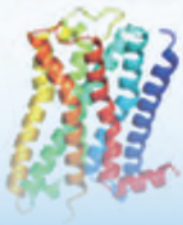


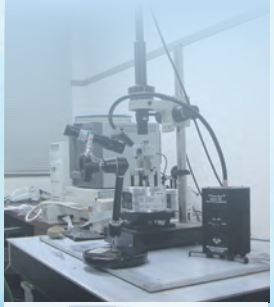


Institute of Advanced Energy

Kyoto University

2019





http://www.iae.kyoto-u.ac.jp/en

Foreword

Director Yasuaki Kishimoto

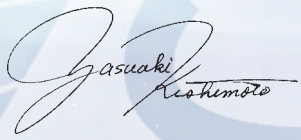
Solar energy, regarded as the origin of life, is produced by nuclear fusion in the extreme conditions at the core of the Sun, and reaches the Earth as light energy, which nurtured terrestrial life over a billion years. In the vast space-time scale of the universe, energy has created the biosphere harmonized with the rich planetary environment, changing the form and shape through nature's ingenious mechanisms. With the various energy-related problems emerging in the current 21st century, a new approach of energy science is desired, which explores next generation energy based on the broader perspectives encompassing the entire coordination of nature.

The Institute of Advanced Energy was established in May 1996 for the purpose of exploring the next-generation energy by probing into the laws and basic principles of nature, and of developing the state-of-the-art technologies to utilize them for practical applications. For this purpose, 14 sections of research areas are organized as three divisions, each dedicated to one of the three basic kinds of energy processes: generation, conversion, and utilization of energy. On top of this, we set up the Laboratory for Complex Energy Processes which also includes 3 sections of research areas. This laboratory organically integrates all the disciplines to enable us to tackle complex energy related issues. Furthermore, we actively promote the internationalization of research and return the fruits of our research back into society incorporating with industry–academia–government collaboration. The institute is also in charge of the Graduate School of Energy Science's Cooperating Chair, which conducts student education and trains researchers in a leading-edge research environment.

The Institute of Advanced Energy focuses on two core research areas: "Plasma and Quantum Energy Science" and "Soft Energy Science". The first topic deals with the generation of energy by nuclear fusion on Earth, which is equivalent to that created in the Sun. The second topic addresses the development of methods for highly efficient energy based on the principles of biology and materials science, which has created the biosphere the Earth's environment. The form and shape of these two energy sources seem different. However, plasma, in which nuclear fusion takes place, has been found to be a highly autonomous medium that spontaneously forms a variety of structures and dynamics similar to those of living organisms.

The Institute has coordinated these phenomena in the wide energy range to create a new energy philosophy incorporated with that referred to as "Zero-Emission Energy". We collaborate with researchers across a broad range of academic fields in Joint Usage/Research Center programs. We hope to develop the breakthrough of energy that will lead the 21st century through the active merging of research in the wide energy range, similar to the creation of beautiful patterns of fabric interwoven from threads of various forms and shapes.

To achieve this end, all of us at the Institute are committed to engaging in extensive discussions, bringing our collective wisdom together, and driving our research and administration under Kyoto University's culture of academic freedom. We look forward to your continued support and cooperation.



Mission and Goal

The Institute of Advanced Energy (IAE) was established to promote researches to sophisticate the generation, conversion, and utilization of energy. Our goals are

(a) to conduct pioneering research on advanced energy science and technology,

(b) to propose solutions to energy and environmental issues associated with rapid global population expansion,

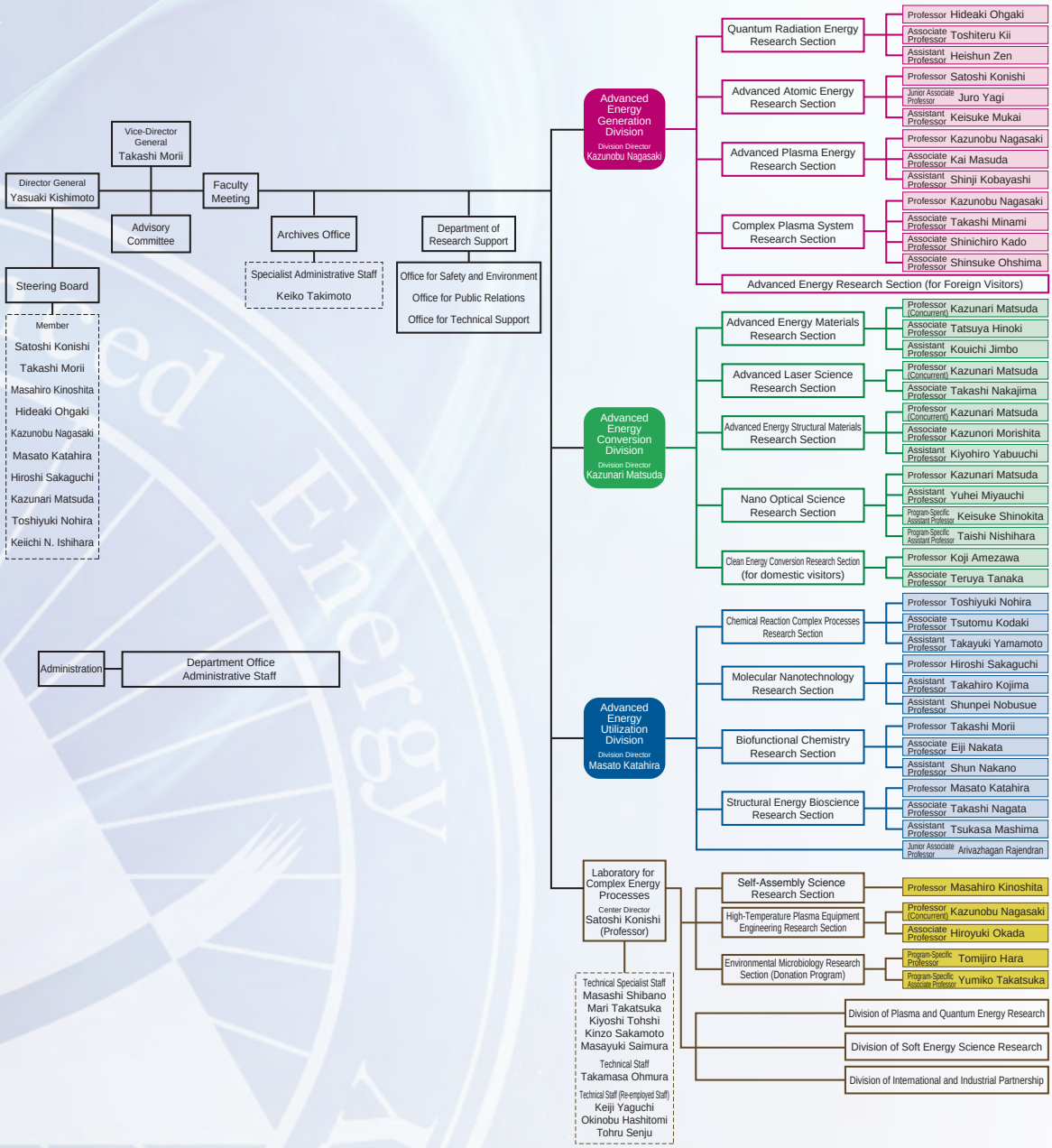
(c) to contribute to the sustainable progress of humankind.

We perform comprehensive approach towards development of next-generation energy systems, which have the potential to replace existing energy systems, with two viewpoints, Quality (harmonization with the environment) and Quantity (social infrastructure). In order to secure sustainable energy resources or systems, our research activities emphasize improving the performance of energy systems, developing new energy resources, and realizing systems for effective use of energy resources, which can be named as Zero-Emission Energy System. Moreover, through these endeavors, we aim to foster scientists and engineers who possess advanced knowledge and skills in energy science and technology.

To meet our objectives, we strive to further develop the research field of Advanced Energy (or Zero-Emission Energy) by building an innovative energy system that has high social receptivity, as well as by developing a system capable of incorporating various sources of energy. Human and research resources at IAE, which are from diverse academic backgrounds, will be strengthened and organically coordinated among different research fields, thereby promoting interdisciplinary and fused research. IAE serves as a hub for advanced energy research in Japan and around the globe.

These activities will further pioneer and develop advanced energy research to bridge us to the next generation and contribute to the growth of society.

Organization Chart



History

Institute of Advanced Energy


Engineering Research Institute


10th Anniversary of Kyoto University Engineering Research Institute

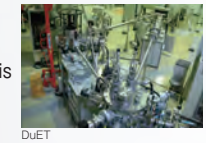

Institute of Atomic Energy


Institute of Advanced Energy Inaugurated


10th Anniversary Ceremony of the Institute of Advanced Energy

Research Center in Faculty of Engineering◀	1914
Engineering Research Institute with 5 Divisions◀	1941
	1959 ▶Heliotron A
	1960 ▶Heliotron B
	1965 ▶Heliotron C
Plasma Physics Laboratory (Faculty of Engineering)◀	1966
Moved from the Main Campus to Uji Campus◀	1968
	1969 ▶Laboratory for Nuclear Reactor Safety Analysis
	1970 ▶Heliotron D
Renamed to Institute of Atomic Energy with 8 Research divisions◀	1971
	1972 ▶Magneto Plasma Research Laboratory
	1975 ▶Heliotron DM
Plasma Physics Laboratory◀	1976
	1980 ▶Heliotron E
	1981 ▶High Temperature Liquid Sodium Heat Transfer Experimental Facility
	1983 ▶Plasma Energy Direct Energy Conversion Laboratory
Institute of Advanced Energy◀	1996
Laboratory for Complex Energy Processes◀	
	1999 ▶Heliotron J
National University Corporation Kyoto University◀	2004 ▶Laboratory for Photon and Charged Particle Research, DuET, KU-FEL
	▶Laboratory for Energy Nano-Science Research
Laboratory for Complex Energy Processes reorganized◀	2006
	2010 ▶NMR
Start of "Joint Usage/Research Program on Zero-Emission Energy" (2011–2015)◀	2011
Start of "Joint Usage/Research Program on Zero-Emission Energy" (2016–2021)◀	2016


Heliotron J


DuET


KU-FEL


NMR

Major Projects

Joint Usage / Research Center (MEXT)

Joint Usage / Research Center for Zero-Emission Energy Research

▶Leader: Director of IAE

▶Project Period (the 2nd Term): FY2016 – FY2021

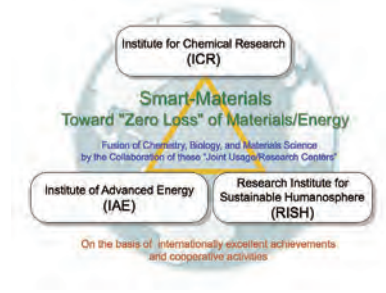
This project promotes inter-university researches for "Zero-emission Energy System", which can give the solution for energy-resource, global-environmental problems and the climate change issue. This project leads the interdisciplinary researches of energy relevant fields, education and training of young students and researchers in the field of advanced energy science. The "A" evaluation has been given at the mid-term evaluation held in 2018 by MEXT.

MEXT Special Budget Project (MEXT)

Joint Research Project "Smart-Materials"

▶Institute for Chemical Research, Institute of Advanced Energy, Research Institute for Sustainablr Humanosphere

▶Project Period: FY2015 – FY2020

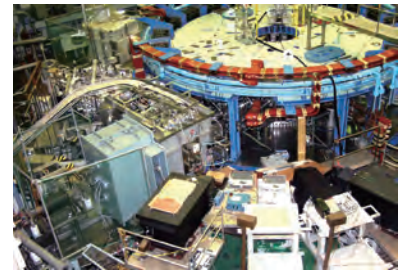


Since April of 2015, the Institute for Chemical Research (ICR), the Institute of Advanced Energy (IAE), and the Research Institute for Sustainable Humanosphere (RISH) have been working in cooperation on the "Smart-Materials" project, supported by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan. The ever-increasing demand for materials and energy by the present social system has almost reached its limit, and the environment is heavily burdened by harmful byproducts and surplus heat from mass production. In order to overcome these issues, this project aims to fabricate smart materials and develop a joint research organization, achieving green innovation through "zero loss" at the production/transportation/usage of materials/energy. The model for the target materials is a biological system with molecular recognition ability, autonomy, and activity. The key to success is interdisciplinary research with flexibility and rapidity. Taking advantage of the three institutes being located at the same campus (Uji campus of Kyoto University), the under-one-roof scheme is expected to deliver internationally excellent results, contributing significantly to this research field.

Bilateral Collaboration Research Program (National Institutes of Natural Sciences)

▶Leader: Prof. Kazunobu Nagasaki

▶Project Period: FY2004 –



Bilateral collaboration research program promotes joint research bilaterally between National Institute for Fusion Science (NIFS), and the research institutes or research centers of universities that have each unique facility for nuclear fusion research. Under this collaboration scheme, the facilities are open to researchers throughout Japan as a joint-use program of NIFS. Our research subject under this program is to investigate experimentally and theoretically the transport and stability control through advanced helical-field control in the Heliotron J device.

Collaboration between industry, academia and government

Cooperation with industries and national institute by using advanced facilities through Collaborative research office: Dual-Beam Facility for Energy Science and Technology (DuET), Multi-Scale Testing and Evaluation Research facility (MUSTER), KU-FEL, and NMR Facilities are open for industries to evaluate materials performance from the viewpoint of multi-scale structure; atomic size, defect size, grain size, etc. to understand the materials behavior in practical applications. Our facilities have supported about 86 companies to contribute in their progress of innovative materials R&D.

Advanced Energy Generation Division

We pro
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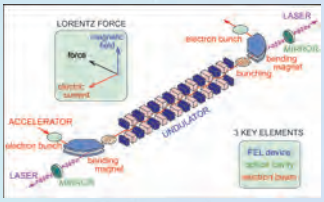
Quantum Radiation Energy Research Section

Research on Generation and Application of New Quantum Radiations, i.e. Compact MIR-Free Electron Laser, Table-Top THz FEL and Laser-Compton Gamma-ray.



Advanced Atomic Energy Research Section

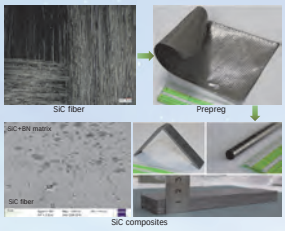
We design and develop the zero-emission energy system powered by fusion, from its generation to utilization, and analyze it from environment, socioeconomics, and sustainability aspects.

Advanced Energy Conversion Division

Aiming at the efficient conversion of energy functions and the generation of new energy functions, this division studies fundamental energy-material interaction and its applications, efficient energy-conversion processes, and the development of functional energy materials.

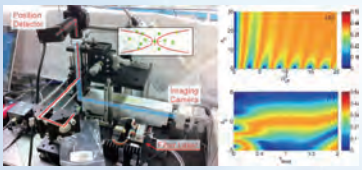
Advanced Energy Materials Research Section

We are investigating the scientific principle and applications of new nano-materials including advanced energy materials, and exploring the physical properties and functionalities of these materials based on nano-science.



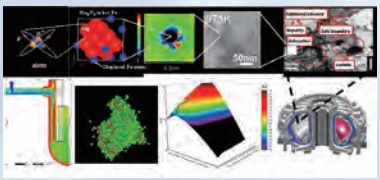
Advanced Laser Science Research Section

Our research interest is to explore, understand, and then control/utilize the various responses of materials, such as atoms/molecules, nanoparticles, and thin films, to the irradiation of lasers.



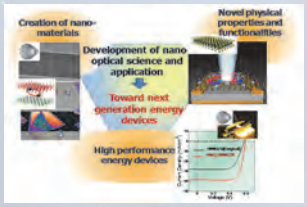
Advanced Energy Structural Materials Research Section

Innovative structural materials R&D with focusing on nano-meso structural control, and basic research for understanding materials performance and behavior.



Nano Optical Science Research Section

We are studying about development of novel optical science and its application for energy based on nano-science from the viewpoint of solid state physics, material science, and device engineering.



Laboratory for Complex Energy Processes

This Laboratory is a core research center for
Research", for fusion and raccelerator studies, (2
national and Industrial Partnership" that promotes
and "High-Temperature Plasma Equipment Engin

Magnetic Confinement Plasma Device, "Heliotron J"

Experiments of Heliotron J are focusing on the optimization studies of "helical-axis heliotron" configuration, which is original to Kyoto University in its design concept with special regard to the realization of the high-performance, steady-state fusion reactor.

DuET

Simultaneous dual ion-beam irradiation is capable by DuET for modification of surface structure and chemical compositions of materials at temperatures between 10 and 1873K.

KU-FEL

The KU-FEL generates tunable laser light in mid-infrared (3.4 ~26 μm) range for advanced researches in energy science.

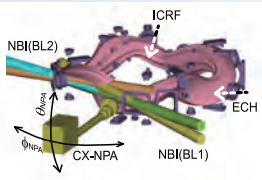
NMR machines

Four NMR machines, including three 600 MHz machines equipped with the super-high sensitivity probe, are operated for the biomass study.

omote the development of socio-friendly and fundamental "zero-emission energy system" that e an inevitable issue sustainable future of humankind, and innovative energy sources with partic-tion including their application technology.

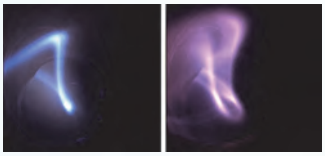
Advanced Particle Beam Energy Research Section

High-power microwave system, compact neutron/proton sources driven by fusion plasmas, plasma diagnostics, highly brilliant relativistic electron beam are being developed by controlling charged particles and electromagnetic field.



Complex Plasma Systems Research Section

Investigating complex properties in high-temperature plasmas in Heliotron J device based on the various plasma diagnostic and analysis techniques.

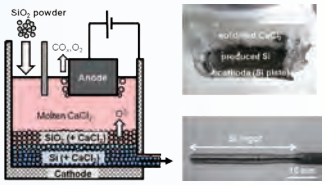


Advanced Energy Utilization Division

The aim of division is the establishment of 'Emergent Materials Science' having a similar concept seen in energy related processes in nature, efficiently converting 'soft energy' into 'electricity' and 'valuable chemicals' without huge consumption. The research projects ongoing cover the researches of energy-related materials sciences, chemistry and biosciences for the development of new technologies for renewable energy conversion and utilization.

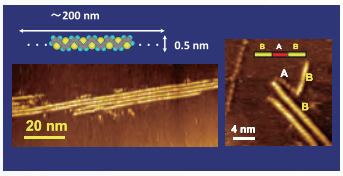
Chemical Reaction Complex Processes Research Section

We are studying materials and systems to realize renewable energies like photovoltaics and bioenergy as the major primary energy source for human beings. We are conducting innovative researches that cover the phases from basic research to applications mainly based on electrochemistry and biochemistry.



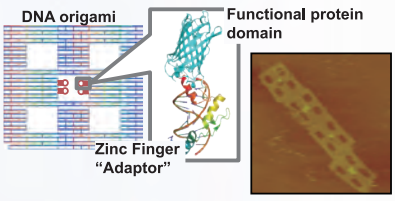
Molecular Nanotechnology Research Section

Nanoscience and technology, ultimate method for producing new materials assembling from single molecules, are studied for energy sector such as organic transistors and solar cells.



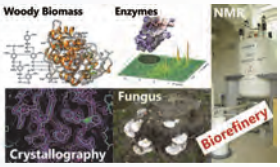
Biofunctional Chemistry Research Section

Our research group is exploring the design and the construction of biomacromolecules "tailored" for pursuing highly efficient energy utilization.



Structural Energy Bioscience Research Section

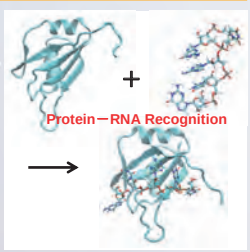
We aim at the establishment of biorefinery through the development of biomass and biomolecules based on structural biology



r strategic and multidisciplinary collaboration studies in IAE, offering cooperative project activities. Three divisions: (1) "Division of Plasma and Quantum Energy 2) "Division of Soft Energy Science Research", that promotes innovative functional materials based on nanotechnology and biotechnology, and (3) "Division of Inter-s collaboration with foreign/domestic, and industry and private sectors. Corresponding to the above two research areas, "Self-Assembly Science Research Section" eering" also belong to the Laboratory. In 2018 fiscal year, "Environmental Microbiology Research Section" was established by a Donation Program here.

Self-Assembly Science Research Section

We elucidate a variety of biological self-assembly and structure-formation processes at molecular levels in a uni-fied manner within the same theoretical framework.

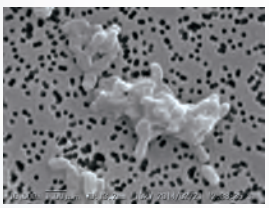


High-Temperature Plasma Equipment Engineering Research Section

To realize the production of core plasma in nuclear fusion, the physical research and development of heating, control, and diagnostics for high-temperature plasmas.

Environmental Microbiology Research Section

As one of the creating methods for sustainable society, we confront the de-velopment of practical applications uti-lizing "enzymes" that are highly energy utilization efficiency in substance catabolism.



Education

The Institute has been established in 1996 upon the start of Graduate School of Energy Science. All research staffs at the Institute have joint appointments with the graduate school. Recently, due to the special efforts by all concerned, such as “Asian CORE (Center Of Research and Education)”, “Global COE Program (Energy Science in the Age of Global Warming)” that started in 2008, and other cooperation programs, more applicants than the quota for the Graduate School have applied for admission.

Accordingly the number of graduate students studying at the Institute steadily increases. Moreover from the characteristic facts such as the increasing number of graduate students studying for the doctorate and high ratio of foreign students with respect to Japanese students, the institute achieves educational and international contributions. There are a lot of students who are attracted by the large and state-of-the-art experimental devices, international exchange programs, a variety of research sections and the research itself at the Institute. An effort has also been made to send graduate students abroad to attend international conferences and do researches at the earliest possible opportunity. This effort indicates that the Institute has a high level for educations and developments of human resources.

International Activities

International Exchange Promotion: ASEAN-JAPAN

▶Leader: Prof. Hideaki Ohgaki

International exchange promotion activities among ASEAN countries by establishing the Asian academic network named SEE Forum has been promoted in IAE with Joint Graduate School of Energy and Environment, Thailand. We also have cooperation with RMUTT, Thailand, to co-organize the Eco-Energy and Materials Science and Engineering Symposium (EMSES) since 2001. In 2015, the Japan ASEAN

Science and Technology Innovation Platform (JASTIP) has been adopted in JST SICORP and we have been promoting the collaboration research platform. In 2017, UNESCO selected Kyoto University as “UNESCO Chair” in the field of water, energy, and disaster prevention to promote international collaboration research and education. From 2019 JSPS Core-to-Core program and JST e-Asia project will be launched to accelerate the international collaboration research and education with ASEAN.

Group photo of EMSES2018 in Uji Campus

Faculty Member

【2018】

Professor	Associate Professor	Lecturer	Assistant Professor	Program-Specific Researcher	Technical Staff/ Administrative Staff	Total
11	13	2	15	2	10	53

Adjunct Member

【2018】

Visiting Professor	Visiting Associate Professor	Visiting Researcher	Lecturer (part-time)	Visiting Research Scholar	Research Support Staff	Research Scientist	Management Staff	Total
1	1	1	3	2	4	13	23	48

Students

【2018】

Under Graduates	Master Course	Doctor Course	Total
8	58	25	91

Budget

【FY2017】[unit: 1 million yen]

Others	Donation	Industry-Academia-Collaboration	Grant-in-Aid for Scientific Research	Cost of equipment	Personal expence	Total
15	53	407	174	483	475	1,607

Research Presentations

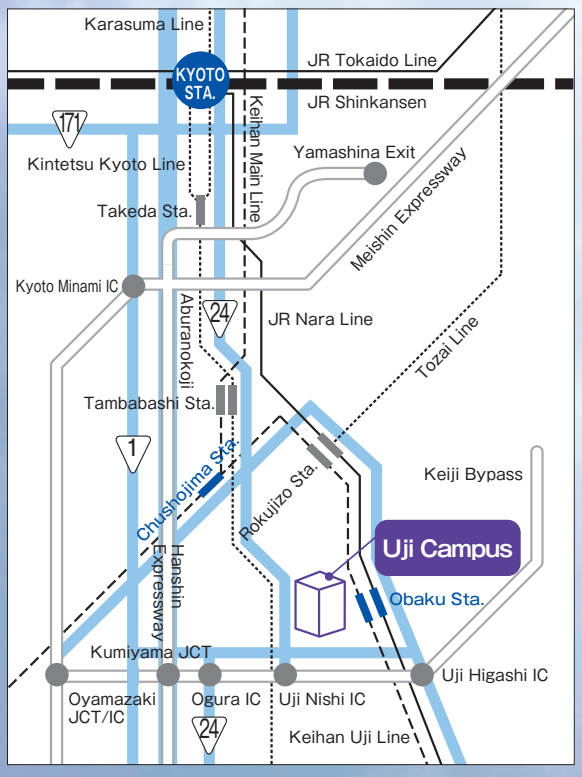
	2015	2016	2017
Original papers	103	115	106
Proceedings	125	105	28
Review papers	12	13	9
Books	3	5	2
Reports	3	2	0
Others	2	3	0
Presentations	432	496	473
Total	680	739	618

The number of applicants to the collaboration program of the Laboratory for Complex Energy Processes

Category	2018
A1: Division of International and Industrial Partnership	5
A2: Division of Soft Energy Science Research	2
A3: Section of promotion for international collaborative research	2
Total	9

The number of applicants to the collaboration program of Joint Usage/Research Center on Zero-Emission Energy

Category	2018
(A) Core research subject	38
(B) Research subject	48
(C) Facility usage	10
(D) Workshop	2
Total	98



▶ACCESS

❶ By JR Line

JR Kyoto Station ····→ JR Obaku Station ····→ Uji Campus

22min JR Nara Line Local　7min Walk

❷ By Keihan Line

Keihan Chushojima Station ····→ Keihan Obaku Station ····→ Uji Campus

9min Uji Line Local　10min Walk

▶INFORMATION

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