DEPARTMENT OF NUCLEAR ENGINEERING AND MANAGEMENT

School of Engineering
The University of Tokyo

Department Guidance Book

October 2015

Challenging Global Issues

Mission of Our Department

Creating Sustainable Society Through International Cooperation

The mission of the department is to contribute to the creation of sustainable societies in harmony with the natural environment. This involves multi-layered and complex approaches that include trade-offs between economic activities and environmental protection concerns, such as global warming. Rapid globalization requires our economic activities and environmental policies to be compatible with the realities and policies of other countries. Therefore, finding comprehensive solutions to these challenges is crucial. The department is involved in science and engineering education and research that focus on nuclear energy and radiation to contribute to the development of realistic solutions to our current global challenges. A need exists for global leaders who are skillfully equipped to facilitate efficient international cooperation, including global power plant management. Therefore, the department incorporates social science education and research with traditional disciplines in this field, such as nuclear energy and radiation. These programs are collaborations among international organizations and the world's leading universities.

Education and Research Policies

The curriculum and research policies of the department have been reviewed to address the critical challenges resulting from the accident at the Tokyo Electric Power Company's Fukushima Daiichi nuclear power plant (Fukushima NPP accident) in 2011.

(1) Incorporating Social Science Knowledge in the Engineering Framework

Despite our strong historic focus on accident prevention, our planning for the post-accident phase has proven to be insufficient. A crucial problem reaching beyond science and technology that has been identified includes the gap between the level of safety the public and engineers expect. It is therefore necessary to enhance our knowledge of people, society, and cultural contexts by incorporating and adapting advanced liberal arts courses, such as ethics, risk management, and communication.

(2) Balance between Conceptual Skills and Holistic Perspectives

The Fukushima NPP accident highlighted that despite prioritizing and intensely focusing on the details of specific problems, substantial system defects concerning vital tsunami related system safety checks were overlooked. Therefore, conceptual skills based on systematically acquired, as well as a holistic perspective that transcends borders between disciplines are crucial.

To fulfill our mission, the department aims to foster human resources with the following qualities:

1. Human resources who have acquired in-breadth engineering and social sciences knowledge
2. Human resources who have developed systematic nuclear safety, energy, and radiation science knowledge and applications based on their social science and engineering knowledge basis
3. Human resources who can responsibly lead research, development, planning, design, production, management, and policy proposal efforts with an international perspective
4. Human resources who can contribute to the sustainability and development of our society by conducting pioneering research in emerging fields or accelerate technological innovation

Welcoming Students from Diverse Backgrounds

Brief Introduction

1 Excellent Environment for Research and Education

- We pride ourselves on our research excellence in various fields, including nuclear engineering, physics, chemistry, electrical and electronic engineering, medical engineering, mechanical engineering, bioengineering, and disaster engineering.
- The university has several campuses in the Tokyo area, including the Hongo (main), Asano, and Tokai campuses.
- Our students and faculty participate in domestic and international joint research programs.
- We support opportunities for students to take internships and attend international conferences.

2 Welcoming Students from Diverse Backgrounds

- Our domestic students come from diverse academic backgrounds such as engineering, science, and social sciences.
- About 40% of the student population is foreign.
- Fluent Japanese language skills are not mandatory, and lectures and research supervision are generally provided in English.
- Numerous career paths exist after graduation.

3 Global Networks and International Collaboration

- Additional degree programs can be taken at partner universities such as the Ecole des Mines de Nantes in France.
- Domestic and international internship programs with financial support (e.g., IAEA, AREVA, UC Berkeley) are available.

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Curriculum

Lecture courses of the department are categorized into (1) Nuclear Engineering Core Courses, (2) Specialized Basic Courses, and (3) Advanced Courses. All courses are taught in English. In addition to the classroom courses, there are: (4) Course Seminars/Practical Classes/Laboratory Sessions to provide students with hands-on learning experience. In addition, special omnibus-format lectures are presented by external lecturers from time to time.

The first year of Masters program starts with taking "(1) Nuclear engineering core courses" which introduce a wide range of engineering and social science topics. "(2) Specialized basic courses" provide students with a systematic knowledge about nuclear safety, energy, and radiation science, applications. Students have the opportunities to develop advanced knowledge related to nuclear engineering by "(3) Advanced courses".

In addition to classroom lecture, students participate in "(4) Course Seminars/Practical Classes/Laboratory Sessions" to learn how to manage a research project responsibly. At course seminars, all students are required to give a research presentation once a year about the progress of your masters or doctoral thesis.

The department participates in management of Resilience Engineering Research Center established in April 2013 (http://rerc.t.u-tokyo.ac.jp/). Students have the opportunity to take an optional educational program "(5) Transdisciplinary Education Program on Resilience Engineering" in addition to the standard program.

	Masters course		Doctoral course		
	1st year	2nd year	1st year	2nd year	3rd year
Nuclear engineering core	■				
Specialized basic	■	■ (part)			
Advanced	■	■	■	■	■
Master course exercise	■	■ (part)			
Practical/labs	■	■	■	■	■
Seminars	■	■	■	■	■
Resilience engineering	■	■	■	■	■
Masters thesis	■	■			
Doctoral thesis			■	■	■

1 Nuclear Engineering Core Courses

For understanding a wide range of engineering knowledge and social sciences. These courses are offered annually, designed for first year students on the Master's program. (Open to all students including Doctoral students)

原子力物理E Nuclear Reactor Theory and Radiation Physics	原子炉工学E Nuclear Thermal-hydraulics and Structural Mechanics	エネルギーシステム概論E Overview of Energy Systems
社会科学基礎E § Social Science Essentials	原子力化学E Chemistry in Nuclear Engineering	放射線生物E Radiation Biology
原子核基礎E Fundamentals in Nuclear Physics	Introduction to Nuclear Engineering	

2 Specialized Basic Courses

To learn a systematic knowledge about nuclear safety/energy, and radiation science/applications. These courses are offered annually, designed for students on the Master's program. (Open to all students including Doctoral students)

原子力安全学E Nuclear Safety Engineering	システム保全学E § Maintenance Engineering in Complex Systems	放射線安全学E Radiation Safety
原子炉燃料工学E Nuclear Fuel Engineering	核不拡散･核セキュリティE Nuclear Nonproliferation and Security	原子力国際プロジェクト論E International Nuclear Project and Cooperation
原子力プラント学E Nuclear Plant Engineering	放射線応用工学E Applied Radiation Engineering	放射線廃棄物工学E Management of Spent Fuel and Radioactive Waste

3 Advanced Courses

Comprehensive theme-based courses designed to give specialized knowledge on nuclear energy. These courses are offered bi-annually.

先進放射線リスク特論E Radiation and Risks	放射線計測学特論E Advanced Radiation Measurements	プラズマ･レーザー特論E Advanced Plasma and Laser Science
量子ビーム発生工学特論E Quantum Beam Engineering	放射線利用特論E Advanced Radiation Application	科学技術社会特論1E ＊ § Social Issues on Science and Technology 1
原子力政策特論E International Nuclear Policy	エネルギーシステム特論E Energy Systems Analysis	次世代核エネルギーシステム特論E Advanced Lecture on Next Generation Nuclear Energy Systems
シビアアクシデント特論E Severe Accident (Advanced)	シミュレーション科学特論E § Advanced Lecture on Simulation Science	核燃料リサイクル特論E Advanced Lecture on Nuclear Fuel Cycle
科学技術社会特論2 ＊ § Technology and Social Science 2	廃止措置特論E Special Lecture on Decommissioning and Dismantling	

4 Course Seminars/Practical Classes/Laboratory Sessions

Designed to give a in-breath, interdisciplinary perspective and extensive experience through course seminars (research presentations and Q&A) and Master's course exercises (project-based exercises at several laboratories).

原子力工学修士輪講I~IV E Nuclear Engineering Master's Course Seminar 1~4	原子力工学博士輪講I~VI E Nuclear Engineering Doctor's Course Seminar 1~6	原子力工学修士演習I~III Nuclear Engineering Master's Course Exercise 1~3
量子ビーム実習 Quantum Beam Laboratory	原子力工学特別実施演習第一･第二 Nuclear Engineering Internship I, II	原子力工学特別演習第一･第二 Nuclear Engineering Workshop I, II

5 Transdisciplinary Education Program on Resilience Engineering

Optional program in addition to the standard program to learn transdisciplinary viewpoint and specialty on complex issues in the real world.

レジリエンス工学特論E Advanced Lecture on Resilience Engineering	レジリエンス工学特別演習J/E Resilience Engineering Project	システム安全学E Systems Safety
レジリエントシステムのためのセンシングE Sensing for Resilient Systems	(Detail: http://www.rerc.t.u-tokyo.ac.jp/)	

＊ Cooperative lecture with Graduate School of Public Policy
§ Cooperative lecture with Transdisciplinary Education Program on Resilience Engineering

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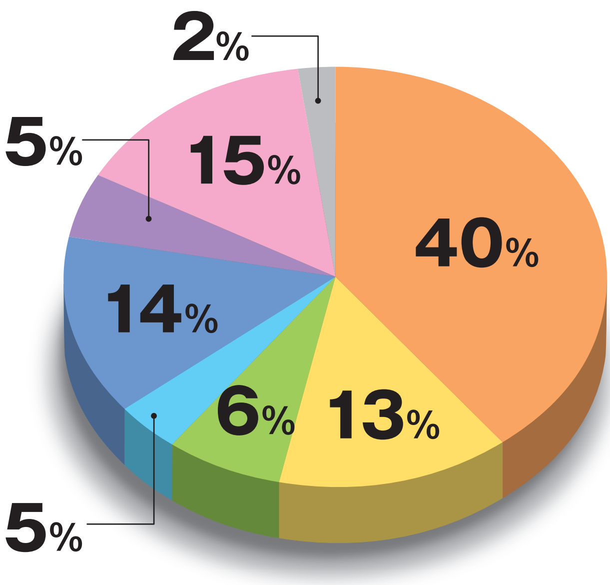
Students’ Backgrounds

We welcome students from diverse backgrounds and encourage students with undergraduate degrees in fields other than nuclear engineering to apply. The department actively accepts international students.

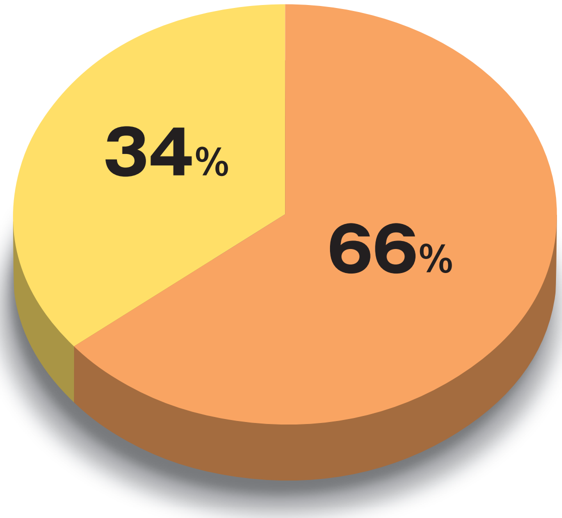
Undergraduate backgrounds of our student population



Over the past four years

- Energy & environment
- Computer engineering
- Electric engineering
- Mechanical and material engineering
- Physics
- Chemistry
- Other engineering
- Social science

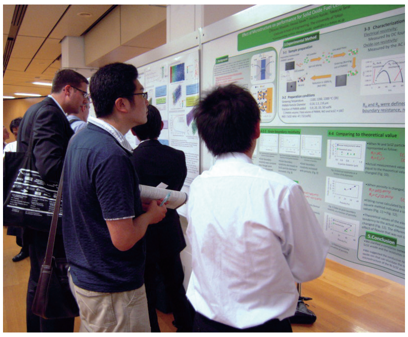
Nationalities



Over the past three years

- Domestic
- International

Nationality:
Indonesia, China, France, Jordan, Panama, Spain, Thailand, United States



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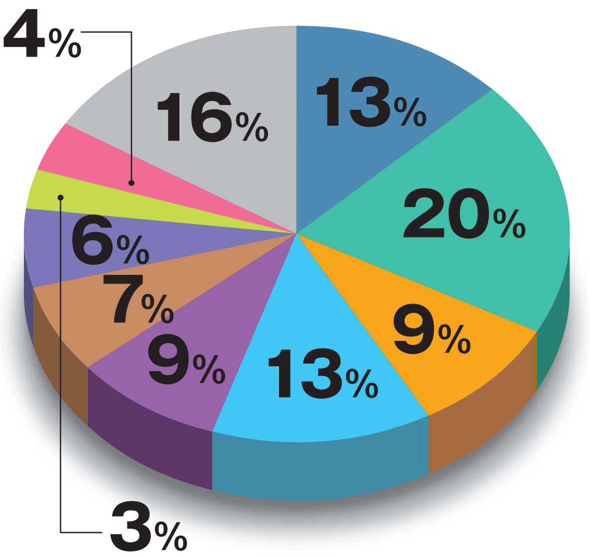
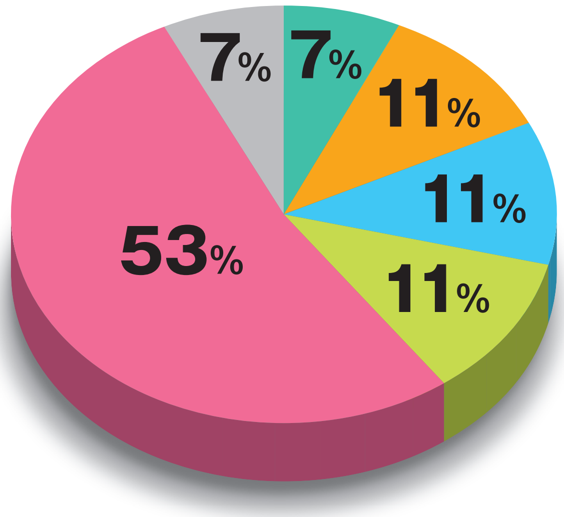
Career Paths

The following statistics indicate career paths our students followed after graduation. Individual cases are provided on the next page.

After Masters program



After Doctoral Program



2011 - 2014
(Including domestic students)

- Doctoral Program
- Manufacturing (Heavy industry)
- Manufacturing (Others)
- Utilities
- Information Technology
- Finance & Insurance
- Consulting
- Public Sector
- University & R&D Organization
- Others

Examples of career paths followed by our international students:
・China National Nuclear Corporation
・Mitsubishi Heavy Industries
・RIKEN
・Thailand Institute of Nuclear Technology
・University of the Philippines

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Message from Students and Graduates

MIZUNO Kazue

Kazue MIZUNO

Project Researcher, School of Medicine, the University of Tokyo, PhD

I studied physics during my undergraduate years and completed the Master's and Doctoral programs in the Department of Nuclear Engineering and Management. My main research topic is the use of chemoradiotherapy to treat cancer. Medical treatments using radiation are related to various fields, and my research was not only conducted in collaboration with the University of Tokyo Hospital, but also with other departments, laboratories and corporations. One major characteristic of this Department is that one can meet and exchange opinions with many researchers. It is also a very international environment with many foreign staff and students. Students also actively utilize the study abroad program available here.

Shota UEDA

Doctoral student

I gained a broad knowledge about fundamental mechanics, design and production, starting with the four dynamics, as I majored mechanical engineering. I enrolled in this program of study starting from the master's degree program at the graduate school and I am currently engaged in a research on severe accidents at nuclear power plants. In my case, I selected the topic relating to nuclear power plants for my research, as I wanted to utilize what I had learned from majoring in mechanical engineering in my own research.
Nuclear engineering is very relevant to the society and is made up of numerous industrial technologies and as such, one is required to have knowledge not only about the nuclear power but also the knowledge from a broad range of fields, such as mechanics and chemistry, as well as biosciences and sociology. The diverse range of lecture topics and research topics that are available in this major of study reflects that. Having numerous options for topics to select from in deciding on one's specialization is indeed an attractive feature and I believe that the availability of opportunities to gain fundamental knowledge from fields other than one's own specialization is an advantage of this department. It is also possible to choose topics from fields that are different from those one had been exposed to during undergraduate years to make use of the knowledge one has gained from the undergraduate studies. Such environment of this department, I believe, not only allows students to dig further into their own specialization but also nurture the ability to address problems in a multifaceted manner, armed with a wide spectrum of knowledge.
Many foreign students are studying with us at the research group I am assigned to. I am therefore given ample opportunity to communicate in English and to gain insight into and learn about different cultures. This is not something that is limited to the particular research group I belong to, but is indicative of the department as whole, which has markedly international in nature. There is a full complement of internship available overseas and there is also an abundant support for study abroad, which also lend to this privileged environment, where there are many opportunities for nurturing international perspectives.
I recommend this department for people who desire to engage in cutting edge researches with a bird's eye perspective and be active on an international scale.

UEDA Shota

Andrew Ballard

Andrew BALLARD

Tractebel Engineering

I graduated from the University of Tokyo with a PhD in Nuclear Engineering in autumn 2009. Using a variety of computer simulations I studied radiation-influenced material changes that take place in an important reactor component during the lifetime of a nuclear power plant. Participating in this research field revealed to me the painstaking process that national nuclear regulators apply when granting licenses for nuclear components, and since this is a very important part in the process for building a new nuclear power plant, it has been useful to me in my further career managing nuclear new build projects in Finland, Turkey and UK.

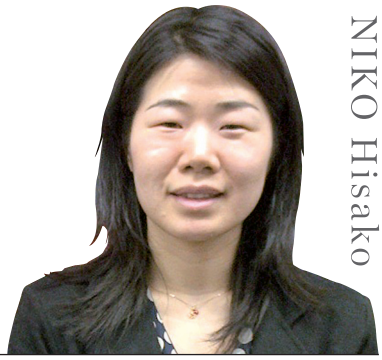
WATANABE Rin

Rin WATANABE Masters student

Nuclear power is a distinctive field of study, even as a student. We are often struck by the circumstances we find ourselves in, when for instance a question is raised during lectures regarding a problem in the field, which even an expert is unable to understand. On the other hand we are also blessed with opportunities to learn from actual issues, and by meeting "amazing individuals" who are engaged in such issues. It is valuable to watch how they engage knowledge in the actual field.
Nuclear power is also a field that encompasses a broad range of disciplines. It may be an interesting challenge for those who enjoy acquiring an overview of several fields, while solidifying their own specialization. Please note, being capable of helping yourself is a requirement. I look forward to meeting people who find such substantial and interdisciplinary issues appealing.

Hisako NIKO Springer, Tokyo Office, PhD

As an undergraduate student at the Department of Applied Physics, Faculty of Engineering, I studied superconductivity. I followed this by developing radiation detectors on a satellite as a master's student at the Department of Physics, Graduate School of Science, and then spent three years studying gas proportional counters as a doctoral student at the Department of Nuclear Engineering and Management. I changed schools upon starting the master's and doctoral courses, and I felt that the boundaries of schools and departments are meaningless when pursuing my goals. This Department is true to its name: very international and open to the world. There are also many older research groups that have continued to carry out important research in Japan, and so there is definitely a research topic to interest everyone.
There were many opportunities to stay abroad and do research. I carried out research at the Institut Laue-Langevin in France after I earned my degree. A PhD is highly evaluated globally, paving the way to many career paths not only in research but also in many other fields, such as public relations and publishing. I am now working as an editor at a publisher of scientific and academic books that was established in the 1840s. I repeatedly have discussions with many researchers, and am helping to publicize research achievements to the world.



NIKO Hisako

Novriana Dewi

Novriana DEWI Doctoral student

My background in undergraduate years (in Indonesia) was Medical Physics and I focused on radiotherapy. After that I got more interested in a specific type of radiotherapy and found the possibility of working research about it at The University of Tokyo, which is one of the top universities in the world as everyone knows.
I am very lucky to have the chance to work under supervision of great professors in The University of Tokyo, where the research facility, the environment, and every other thing really support your work. I even get to perform experiment with a medical doctor, which gives me a new experience as a student from outside of medical school.
My life in Tokyo, especially in The University of Tokyo has been very great as well. As I am a foreign student, I got to know that getting involved in Student Association's activities has been the solution for my homesick. Learning Japanese and the culture has also been very interesting for me during my years in Japan until now.

Faculty

(Alphabetic order)

The academic scope of our department is not limited to nuclear engineering, and includes physics, chemistry, mechanical engineering, electrical and electronic engineering, computational science, civil engineering and the social sciences.

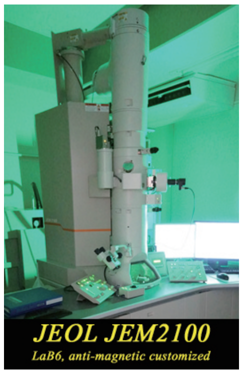
Professor

Hiroaki ABE

阿部 弘亨

Nuclear Materials Engineering

As one of the expected solutions for the safe design and operation of nuclear power plants, the further improvements of nuclear materials and fuels are indispensable. We deal with research and development of materials for fusion reactors, advanced fission reactors (Generation IV), and current light water reactors (LWR). The main aspects are to reveal fundamental mechanism of the degradation process under extreme environments, such as irradiation, corrosion and hydrogenation, in Fe-based and Zr-based alloys. Developments of high-performance materials and testing methods are also of our interest. The following techniques are currently applied: microscopy like TEM, HVEM, TEM-accelerator, SEM/EBSD etc.; mechanical tests like advanced expansion-due-to-compression (A-EDC) test, tensile, creep and nano-hardness etc.; and computer simulations like FEM and MD.



Keywords Fission, Fusion, Nuclear materials, Nuclear fuels, Extreme environment, Degradation mechanism, Radiation effects

Associate Professor

Kazuyuki DEMACHI

出町 和之

Diagnosis Technology for Medicine and Nuclear Plants

I am engaged on Research and Development of Safety Assessment and Security of Assessment of Nuclear Power Plant. I am also engaged on Research and Development of Imaging Technology for Medical Radiation Therapy.

Recent Research Theme are,

(1) Interface of Nuclear Security and Safety

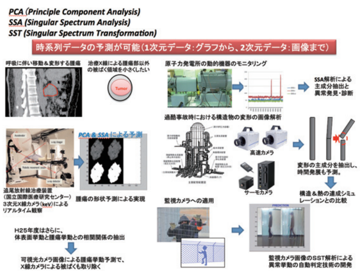
(2) Nuclear Plant Security Assessment based on Resilience,

(3) Nuclear Plant Safety Assessment based on Resilience,

(4) Diagnosis and Detection of Abnormal Signals of Condition Based Maintenance (CBM),

(5) Prediction of Lung Tumor Motion for Chasing Radiation Therapy,

(6) Radiation Therapy Planning Calculation.



Keywords Applied electromagnetics, Nuclear maintenance engineering, Applied medical engineering, technology, Medical image analysis

Professor

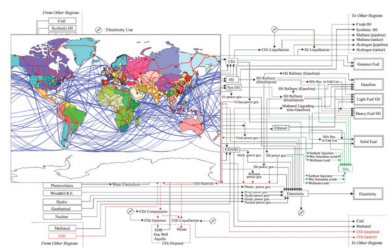
Yasumasa FUJII

藤井 康正

Energy Systems Analysis for Policy and Technology Assessment

Fujii laboratory has been working on the research topics of the feasibility analysis of various alternative energy supply technologies, and policy evaluation for international energy security and environmental issues using a global energy system model built with large-scale mathematical programming on the computers. Moreover, research topics of energy management, such as institutional design of deregulated electricity markets and optimal strategy planning of energy procurement under uncertainty, have also been investigated using variety of analytical techniques of stochastic dynamic programming, financial engineering, and multi-agent simulation with reinforcement learning.

In Fujii laboratory, since we try to find the solutions for the energy problems of 100 years and for the social system which is not realized yet, we welcome students who have the interest to learn various fields, and those who have strong imagination to consider the future of foreign countries.



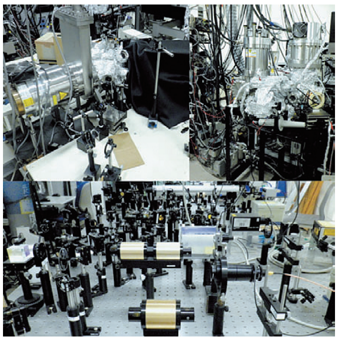
Keywords Energy economic systems, Technology and policy assessment, Optimization, Stochastic programming

Professor

Shuichi HASEGAWA
長谷川 秀一

Development of Novel Advanced Systems Based on Quantum Engineering

Recent progresses in Quantum Engineering such as laser technologies, ion beam optics, and quantum electronics, have made possible photo-nuclear reaction, precise ion delivery, and laser cooling, respectively. We are interested in developing a novel advanced system utilizing such single atom control technologies, which are based on atomic, molecular and optical physics. For instance, isotope separations and nuclear reprocessing systems in the nuclear fuel cycle require such technologies in order to propel the reduction of environmental load, the management of radioactive wastes and the strengthening of non-proliferation. Isotope separation for nuclear fusion becomes important for future energy resources. Isotope engineering for medicine, tracer technique, forensic science, and so on is also of interest to apply our technology.



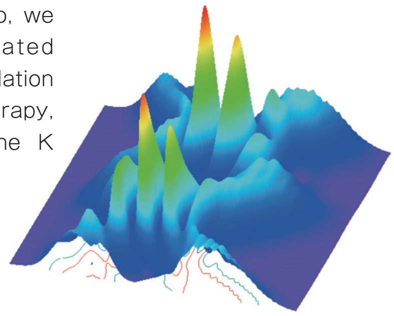
Keywords Advanced quantum engineering, Nuclear fuel cycle, Isotope engineering, Atomic, molecular and optical physics

Professor

Kenichi ISHIKAWA
石川 顕一

Attosecond Science and Particle Cancer Therapy

We study the interaction of a laser pulse and an ion beam with matter through theory and simulations. Our research interest is a new field called high-field phenomena and attosecond science, which studies the quantum dynamics in an ultrashort intense laser field. Especially, we investigate highly nonlinear processes such as high-harmonic generation and tunneling ionization as well as attosecond electron dynamics in atoms and molecules, based on atomic and plasma physics as well as quantum chemistry. Also, we develop a sophisticated method of dose calculation for heavy-ion cancer therapy, which also runs on the K supercomputer.



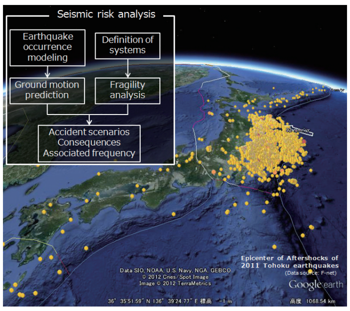
Keywords High-field physics, Multi-electron dynamics, Ab-initio simulations, Monte-Carlo method

Associate Professor

Tatsuya ITOI
糸井 達哉

Seismic Safety and Resilience of Nuclear Facility

Our research focuses on modeling of risk due to natural hazards (earthquake, strong wind, etc.) from the standpoint of disaster prevention and mitigation of nuclear facilities, buildings and infrastructures; (1) Risk analysis of spatially-distributed systems, (2) Ground motion prediction and probabilistic seismic hazard analysis, (3) Real-time earthquake disaster mitigation, (4) Risk governance framework of important facilities against natural hazards



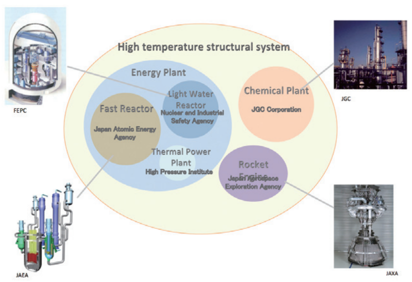
Keywords Natural disaster modeling, Earthquake engineering, Risk governance

Professor

Naoto KASAHARA
笠原 直人

Design by Analysis for High Temperature Structural Systems

Energy plants are complex systems based on thermal, fluid and structural fields. Understanding of essential mechanism of multi-physics phenomena and their synthesis will lead to development of superior design methods which can satisfy both plant safety and reliability. Our laboratory studies plant structure design and analysis methods though both simulation and experimental works. Typical applications are fast reactors, light water reactors, chemical plants and rocket engines. Mechanical students are welcome as well as nuclear students.



Keywords Nuclear structural engineering, High temperature Structural design, Fast reactor

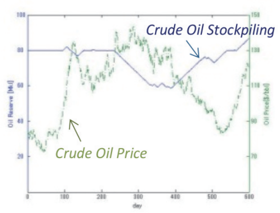
Associate Professor

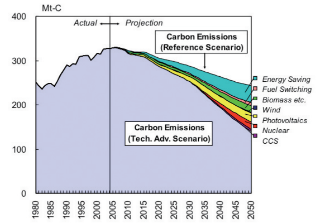
Ryoichi KOMIYAMA

小宮山 涼一

Quantitative Analysis of Energy Security

Energy security is a key agenda to address for sustaining socioeconomic activities under various structural and contingency risks such as the depletion of fossil fuel and energy supply disruption. In order to formulate effective technical and political measures for enhancing energy security under those risks and constraints, we need to comprehensively understand economics and international energy market as well as the engineering aspect of energy technology. The research theme in our group is to develop a mathematical and computational energy-economic model to analyze the optimal strategy for the deployment of energy technologies and to discuss energy policy firmly based on the simulated results derived from the model.





Keywords Energy security, Energy-economic model, Mathematical optimization, Econometrics

Associate Professor

Hisaaki KUDO

工藤 久明

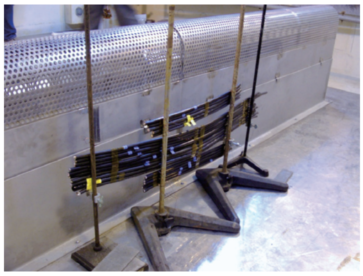
Radiation Chemistry and Application of Polymer Materials

I am working on radiation chemistry, reaction mechanism and irradiation effects of polymer materials by using ion and electron beam accelerators. Also I am working on durability and aging mechanism of polymer materials used around radiation or nuclear facilities.

Radiation chemistry and radiation application have potential to change our life, and create industry.

Moreover, radiation chemistry contributes to nuclear safety and space exploration.

I expect those who have interest in elucidation of the phenomena induced by radiation and quantum beam, and its practical application.



Keywords Radiation chemistry, Radiation application, Radiation degradation, Polymer material

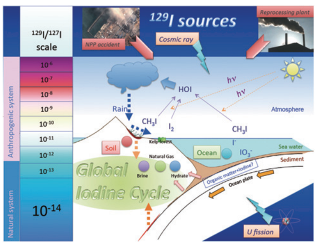
Professor

Hiroyuki MATSUZAKI

松崎 浩之

AMS, Isotope System, Earth Environmental System

Accelerator Mass Spectrometry (AMS) can analyze extremely rare long-lived radio isotopes such as ^{10}Be(half life = 1.36x10^{6} yr), ^{14}C(5,730 yr), ^{26}Al(7.2x10^{5} yr), ^{36}Cl(3.01x10^{5} yr), ^{129}I(1.57x10^{7} yr). These rare isotopes form special isotope systems with their stable isotopes which have precise information about earth environment system. Most famous isotope system is the ^{14}C/^{12}C system well known to be used for dating. Our laboratory has a 5MV tandem accelerator and developed multi-nuclide AMS system of which the performance retains world's top level. While we are applying AMS to various interdisciplinary research fields from archaeological to earth environmental sciences, recently we especially focus on the ^{129}I/^{127}I system. As iodine has a close relation with organic matter and is often found with important carbon reservoir such as methane hydrates and soils, we consider ^{129}I/^{127}I system is an important clue to elucidate the total carbon dynamics.



Keywords Ion beam, AMS, Isotope geochemistry, Radioisotope environment assessment

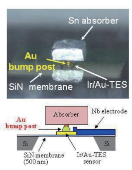
Associate Professor

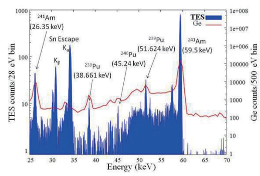
Masashi OHNO

大野 雅史

Innovative analysis of nuclear material using superconducting radiation sensors

Our academic objective is to realize a new innovative high-energy-resolution spectroscopy for nuclear structure investigations, radioactive or non-radioactive nuclide identifications, material analyses, and radiotherapy. For example, non-destructive analysis of nuclear materials for safeguards and nuclear forensic requires improvement in accuracy and sensitivity. The precision spectroscopy of hard X-ray and gamma ray from the nuclear materials is powerful tool for the identification of the plutonium, uranium, actinide and their decay products. However it needs to resolve their X-ray or gamma ray peaks in the complex spectrum of around 100keV region, which cannot be resolved by the conventional detectors. Therefore, we have developed the superconducting radiation sensor with the ultra-high energy resolution. Now our research group has already obtained the world top energy resolution in high-energy gamma-ray region and also, tried to measure gamma-rays from fission products with this superconducting detector.





Keywords Superconductivity, Nanotechnology, Gamma-ray spectroscopy, Charge particle therapy

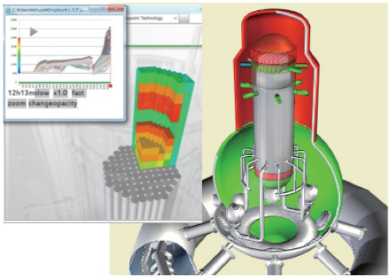
Professor

Koji OKAMOTO

岡本 孝司

Severe Accident Analysis and Nuclear Safety

Fukushima-Daiichi NPP Accident was the Severe Accident. Understanding the severe accident is the key to develop the Safety Nuclear Systems. Severe accident is highly non-linear and complicated phenomena, combining the heat transfer, fission, decay heat, phase change and chemical reaction. Experimental and numerical approach on these phenomena reveal the physics of severe accident. Also, the safety decommissioning of nuclear reactors is most important issue in Japan. Many challenges on the Nuclear Safety is waiting your contributions. Our research topics include Severe accident simulation code development, Very high-temperature buckling, PCV Spray cooling, Molten Corium Concrete Interaction, Thermal stratification at Suppression Pool, Physical evaluation of Fukushima-Daiichi Accident and so on.



Keywords Visualization, Nuclear safety, Severe accident

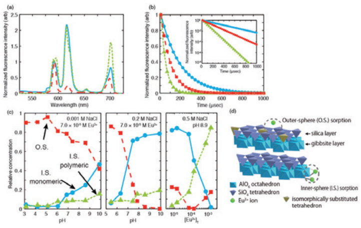
Associate Professor

Takumi SAITO

斉藤 拓巳

Chemistry for nuclear waste disposal and environmental behaviors of radionuclides

It is the duty of our generation to settle the issue of nuclear waste disposal. Geological disposal is the only feasible option for high-level wastes or spent fuels, where various basic research and R&D are still needed. Chemistry of radionuclides is a key foundation to realize a well-accepted disposal project. Thus, we are pursuing understanding and modeling of the chemistry that governs the migration of relevant radionuclides in subsurface environments, which is often called “natural barrier”, using sophisticated spectroscopy, chromatographic techniques, and computer simulation. Knowledge obtained through the research has been applied to the modeling of chemodynamics of radionuclides released from the accident of the Fukushima Daiichi nuclear power plant in soils. Any students who has an interest in the issue of nuclear waste disposal are welcomed, no matter what academic backgrounds they have.



Keywords Nuclear waste disposal, Geochemistry, Environmental chemistry, Actinide chemistry

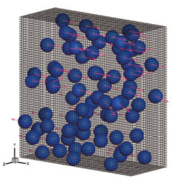
Associate Professor

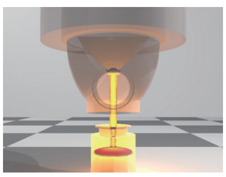
Mikio SAKAI

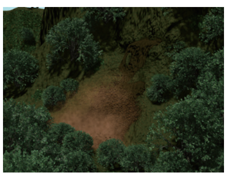
酒井 幹夫

Multiphysics Modeling for Computational Granular Dynamics

We study multiphysics modeling for computational granular dynamics, namely, numerical simulations of solid-fluid and solid particle-elastic body interaction problems. We encounter these problems in various fields including nuclear engineering, chemical engineering, mechanical engineering, civil engineering, pharmaceutical, etc. Numerical studies on the problems were challenging since these were hardly simulated because of the complicated phenomena and excessive calculation cost. Accordingly, our research topics becomes wide ranging, for example, slurry suspension, magneto-rheological fluids, fluidized beds, debris flows, slope failure. At present, we develop new models to perform the simulations by using Lagrangian-Lagrangian or Eulerian-Lagrangian approaches. Our original technologies become important in engineering and science.







Keywords Multi-physics simulation, Physics based computer graphics, Computational Fluid Dynamics

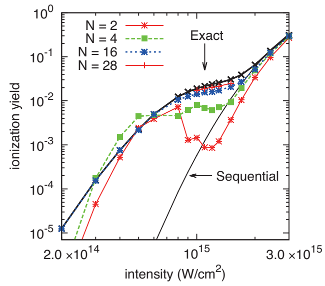
Project Lecturer

Takeshi SATO

佐藤 健

Multielectron dynamics in intense laser fields

High field physics and attosecond science are rapidly progressing, in which dynamics of electrons in matters are directly measured and even controlled, using ultra-short high-intensity laser pulses. We are developing state-of-the-art theoretical and computational methods to solve time-dependent Schrödinger equation of multielectron systems interacting with intense laser fields, aiming at ab initio study of nonlinearly nonperturbative phenomena such as tunneling ionization, high harmonic generation, and nonsequential multiple ionization.



Double ionization probability of one-dimensional helium atom as a function of applied laser intensity (wavelength 750 nm). Fully correlated simulation (Exact) gives higher probability than that without correlation (Sequential) by two orders of magnitude, around 10^{15}W/cm^2 (nonsequential double ionization). TD-CASSCF method (colored) can systematically improves the accuracy.

Keywords High field physics, Attosecond science, Wave function theory, Density functional theory, Quantum chemistry

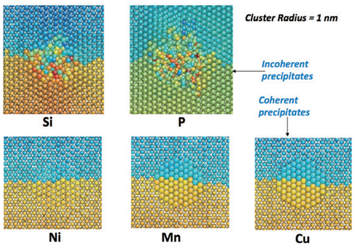
Professor

Naoto SEKIMURA

関村 直人

Systems Safety, Maintenance Engineering of Complex Systems, Radiation Damage in Nuclear Materials

Multi-scale simulation and experimental studies on microscopic and macroscopic behaviors of nuclear materials under very severe conditions including energetic neutron irradiation are the major topics. I have been leading national projects for ageing management of nuclear reactors components and materials with other universities, national laboratories and industries. Our group is also working on international collaboration on safe long term operation of nuclear systems and seismic safety through intensive collaboration with IAEA and OECD/NEA .



Keywords Safety and knowledge management for nuclear systems, Multiscale modeling of materials

Project Professor

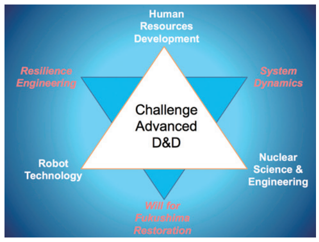
Shunichi SUZUKI

鈴木 俊一

Decommissioning of Fukushima Dai-ichi NPP and project management

In order to complete the decommissioning of Fukushima Dai-ichi NPP, we need to challenge and overcome the difficulties which no one has ever experienced. The key technology for decommissioning of the accident plants is how to solve the unsteady state problems caused by remarkable changes of environment, circumstances and the states of the plant condition with the lapse of time.

Main theme of this course is finding the tasks and their solutions for decommissioning through evaluation of phenomena which may occur in the future and also though making the scenario with experiments such as material and thermal-hydraulic tests. This course will not only deepen your skill & knowledge on decommissioning, but also give you an opportunity to understand the importance of the project management and the way of System Thinking for a complex world which you will face in the future.



Keywords Decommissioning, System dynamics, Risk assessment, Resilience engineering

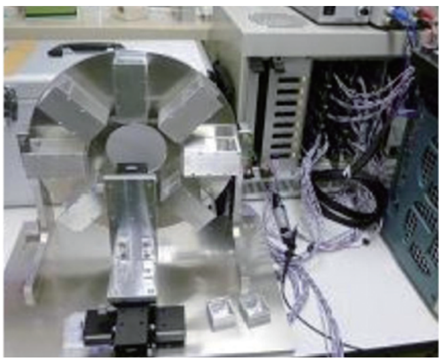
Professor

Hiroyuki TAKAHASHI

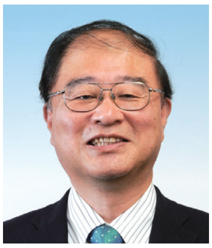
高橋 浩之

Radiation Measurements and Instrumentation

Radiation measurements are very important in many science and technology areas. We develop quantum radiation detectors for various applications in many areas such as medical imaging, industrial imaging, basic science, etc. Microfabrication techniques, microelectronics and computer hardware techniques, and simulation calculations are effectively used in our research.



Keywords Radiation measurements, Gamma-ray imaging, Environmental radiation, Neutron detectors, Signal processing



Professor

Takayuki TERAI

寺井 隆幸

Materials Science and Elemental Technology for Advanced Energy and Environment Systems

We study material science and chemical engineering for advanced energy systems including the next-generation fission reactor, fusion reactor and nuclear fuel reprocessing systems. Elemental techniques for hydrogen energy system including fuel cell, hydrogen storage, etc. are also investigated. In addition, material processing with high-energy particles such as neutrons, ions, electrons and plasma particles for advanced material preparation and property modification are our research targets.

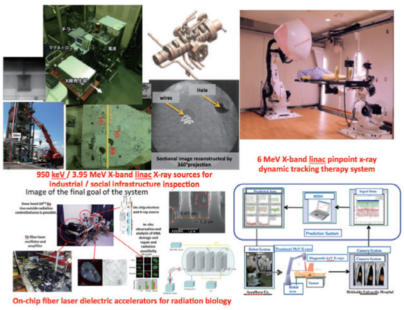
Keywords Reactor materials, Hydrogen energy,High-energy particles

Professor

Mitsuru UESAKA
上坂 充

Advanced and Compact Accelerators and Medical Physics

We are developing advanced and compact accelerator, such as S-Band (2.856 GHz) electron photocathode injector and linear accelerator (linac) for radiation chemistry, 950 keV / 3.95 MeV X-band (9.3 GHz) linac X-ray sources for industrial/social infrastructure inspection, 6 MeV X-band linac for pinpoint X-ray dynamic tracking cancer therapy. Advanced treatment planning works for the therapy are also under way. On-site industrial/social infrastructure inspection by the 950 keV / 3.95 MeV X-band linac X-ray sources have started. Moreover, we are developing compact and mobile X-band linac neutron sources for precise nuclear data study after the research reactor "Yayoi". We are promoting the synergy of compact accelerators and high sensitivity sensors, too.



Keywords Portable linear accelerator, Fiber laser, Radiation biology

Professor

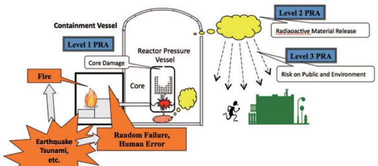
Akira YAMAGUCHI
山口 彰

Trans-Science and Nuclear Risk

Science and technologies promise better life and more wealthy society in the future. Eventually, we gain benefits from the fruits. The idea does not adapt to the contemporary society. The societal value of the science and technology is closely concerned with the rational relationship of the technology and the society. Key words of science and technologies in the light of societal view are uncertainties, imaginary skill, unknowns, questioning attitude, rational decision making and so on.

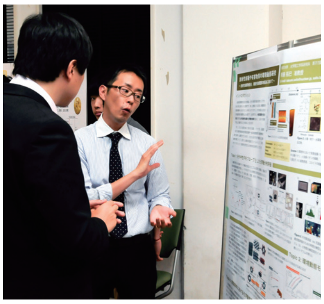
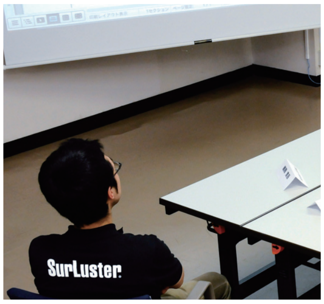
Contemporary science and technologies need to be established putting more emphasis on the societal acceptance in terms of risk and benefit, i.e. welfare of the society. Researches necessary to respond to the expectations are for: (1) simulating the technology (to understand phenomena), (2) perceiving the technology (to understand risk), and (3) assessing the technology (to make a decision rationally). Common baseline idea is to be developed by an academic field that deals with the lack of knowledge and unknowns, e.g. uncertainties.

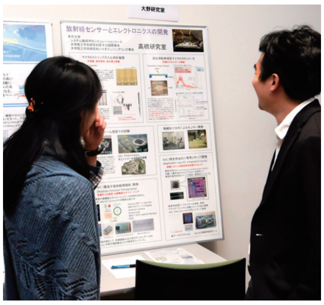
Energy is the source and foundation of social infrastructures. The dual aspect, light and shadow (safety and uncertainty), of the energy should be quantitatively understood in whole the society for a good and rational decision-making. Last but not least are, needless to say, the next generation researchers. It is a challenge for those living in Japan that have engraved the experience of nuclear disaster deeply in heart. Please join us for opening the door of risk and safety research.

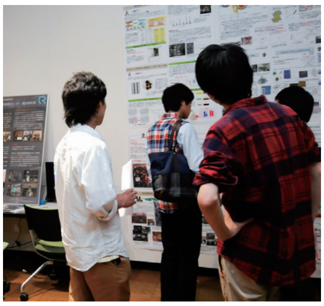


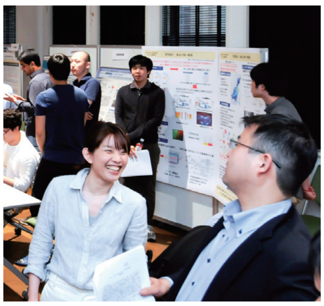
Full Scope Probabilistic Risk Assessment (PRA)

Keywords Risk assessment, Simulation, Unknown, Uncertainty, Decision making, Nuclear safety







Message from the Department Head

Head of the Department of
Nuclear Engineering and Management

Kenichi Ishikawa

The scope of nuclear power is widening to include not only the technologies that employ the release of nuclear energy, such as nuclear power generation and nuclear fusion, but also the application of the radiation generated by nuclear disintegration and accelerators in the fields of industry, medicine, and life sciences. Even after the accident at the Fukushima Daiichi Nuclear Power Plant in March 2011, the introduction of nuclear energy and the building of nuclear power stations still continue in the world, especially in developing nations. Furthermore, the large number of foreign students who study at the Department of Nuclear Engineering and Management also shows us the magnitude of the expectations from our nuclear technology, since we are a country that has learnt lessons from the accident.

The birth and development of nuclear technology has gone hand in hand with Nobel Prize winning research and discoveries such as the discovery of X-rays and radioactivity and nuclear fission, and the theory of relativity and quantum mechanics. Recently, we have learnt how to image debris inside the Fukushima Daiichi reactors using muons, which are elementary particles coming in from space. When faced with a new problem, science is the light that dispels darkness. New reliable technologies originate from solid science infrastructure and are applied to the areas that appear unconnected at the first glance. In other words, nuclear technology can be said to be a sphere in which people from many fundamental branches of science, such as physics, chemistry, biology, and computer science, can participate successfully.

Further, technological innovation is necessary to make use of scientific results. Whether it is in nuclear power plants, applications of radiation in industry or medicine, or dealing with decommissioned nuclear reactors and radioactive waste, things that are "possible in principle" or "can be made safely and well when enough money is spent on it" are not helpful. It is important that we develop the technologies that can be realized within reasonable timeframes and at justified levels of costs and risk. In this sense, nuclear technology is a driving force that is supported by various fields of engineering, including mechanical and materials engineering, electrical and electronic engineering, and chemical engineering, and also leads to further development in these fields of engineering.

However, not everything can be solved by science and technology alone. Even if the accuracy of weather forecasting increases (=scientific progress) and we have light and strong umbrellas (=technological progress), we decide whether to go out with an umbrella or not and which umbrella to take after considering factors such as the day's schedule, our clothes, and luggage. Similarly, for making decisions on how to use nuclear power and radiation technologies, the leaders of our society must have the capacity to consider all aspects, including energy problems, environmental issues, climate change, economic efficiency, and security, from an international, comprehensive, and all-inclusive perspective. Furthermore, it is also important to consider things from the perspective of a resilient society and technologies that lose as little functionality as possible under unforeseen circumstances and that recover quickly.

Nuclear power is a cross-disciplinary branch of science that brings together a wide range of subjects from science and technology to the social sciences. I hope that young talented people from a wide variety of backgrounds will get together at the Department of Nuclear Engineering and Management, collaborate with people from other fields while perfecting their own area of specialization, and grow into leaders, who equipped with an international and comprehensive perspective, will be the pioneers of a prosperous future.

Campus Map

Hongo / Asano Campus

Micro Analysis Laboratory, Tandem Accelerator

Tokai Campus (Nuclear Professional School)

High Fluence Irradiation Facility

Reactor Building

Experimental Facilities

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Nuclear Engineering and Management

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