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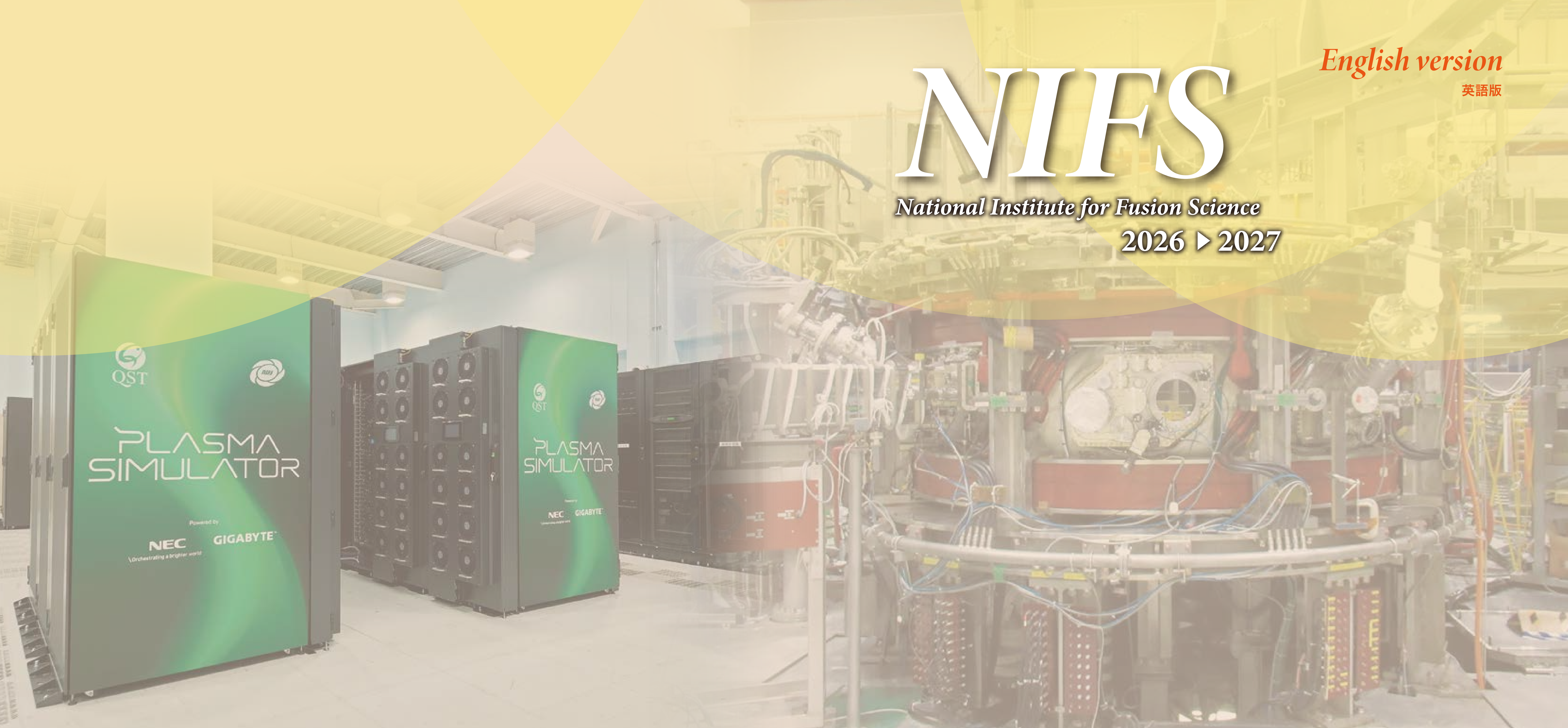
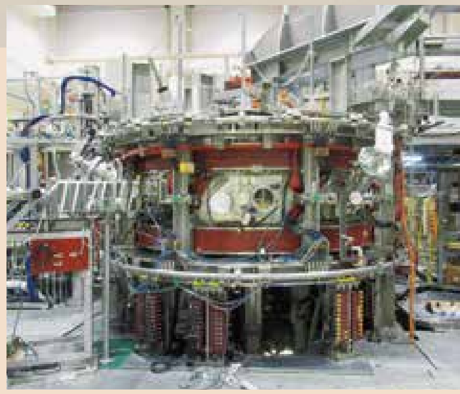
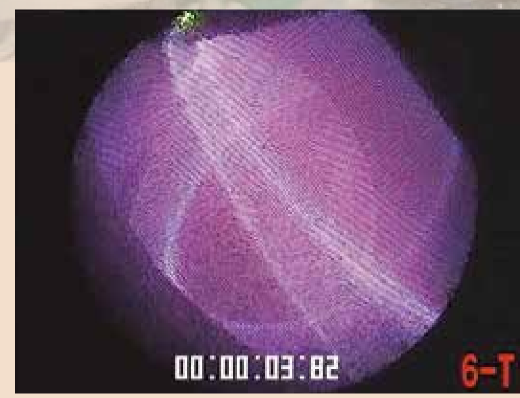
National Institute for Fusion Science

2026 ▶ 2027







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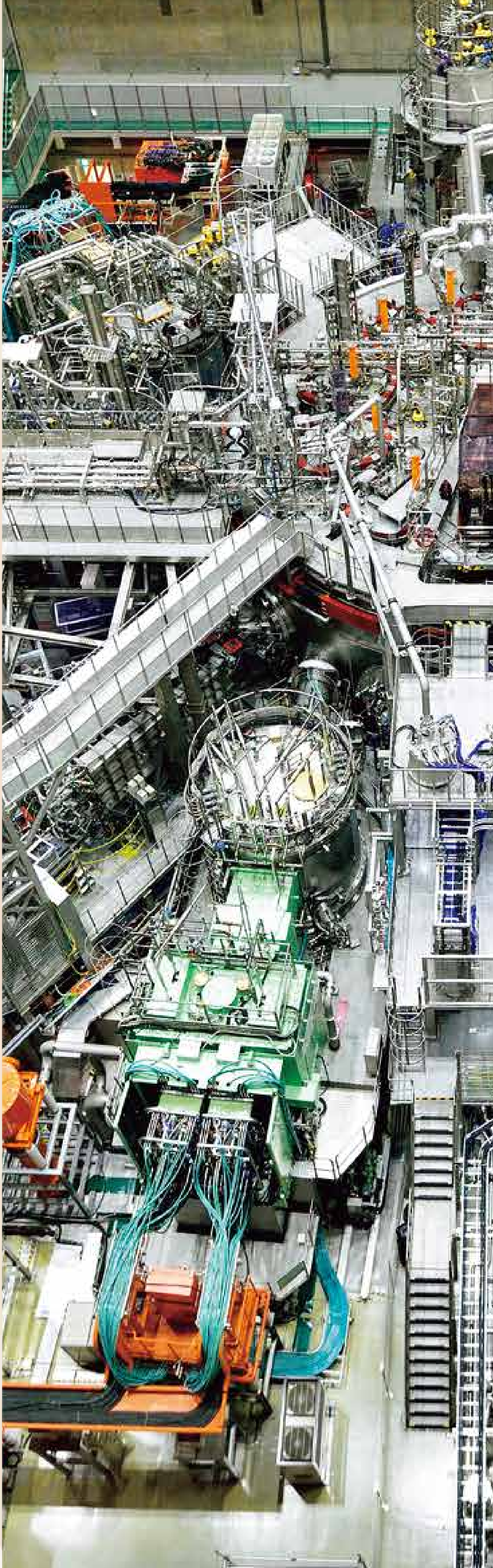
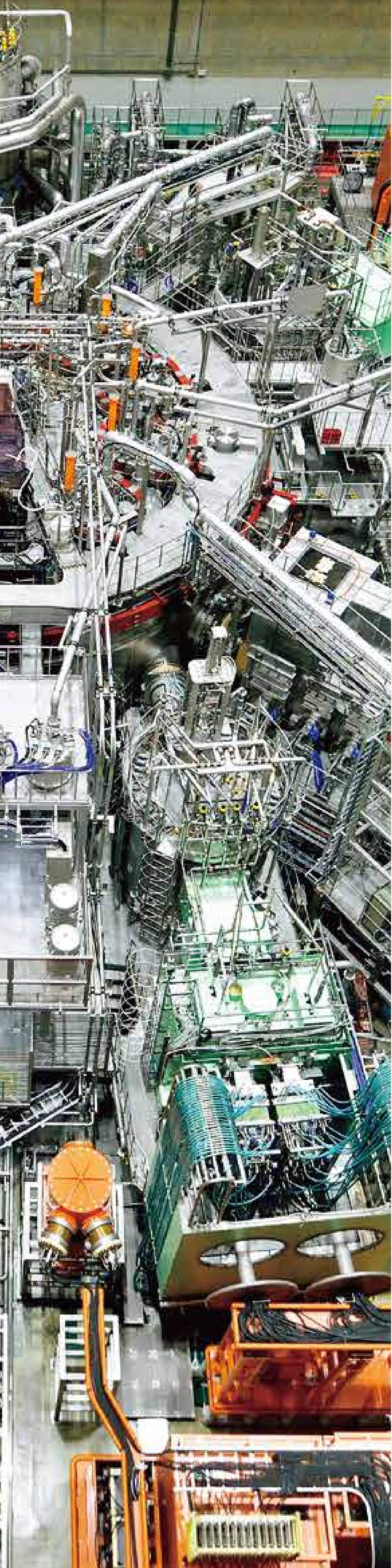




Towards a new era of fusion science

YAMADA Hiroshi
Director General of National Institute for Fusion Science

Fusion science is driven by the aspiration to realize the dream of harnessing fusion energy—the "sun on Earth." This profound motivation stems from both hope for the future and the innate curiosity of humanity, and it is this blend that gives fusion science its remarkable appeal as a transformative scientific and technological endeavor to bring a new era in human history.

The journey toward achieving fusion burning experiments, which now lie within our reach, has been paved with the encounter of numerous formidable challenges—each one overcome through persistent effort. Solving one problem often leads to the emergence of new mysteries, demonstrating the profound depth and expansive reach of fusion science in enhancing our understanding of nature.

While the fusion reaction itself is already well understood, the "system" required to sustain it—the behavior of ultra-high-temperature plasma—remains filled with unanswered questions. In parallel, it is also essential to develop the extraordinarily complex engineering systems that will constitute future fusion reactors.

Viewed from this perspective, fusion science is not only about physical principles—it also touches upon the fundamental principles of the universe, of society, and of life itself. With this grand context in mind, we aim to carve a broad path forward through the landscape of academic research and technological development.

A fusion reaction is, quite literally, a process in which atomic nuclei combine. Since atomic nuclei carry a positive charge, they naturally repel each other. However, if these nuclei can be brought extremely close—within one quadrillionth of a meter (10^{-15} m)—a different force known as the nuclear force overcomes this repulsion, allowing them to fuse. Achieving this requires the fuel to be heated to an extraordinarily high temperature—over 100 million degrees Celsius.

It is well known that matter transitions through three states—solid, liquid, and gas—as temperature increases. As temperatures climb into the tens of thousands of degrees, atoms themselves become ionized, separating into nuclei (ions) and electrons, forming a ionized gas known as plasma. The Sun, too, is a massive ball of hydrogen plasma, within which hydrogen nuclei fuse into helium through nuclear fusion, releasing an enormous amount of energy. In other words, a "star" is a self-sustaining and stable system in which fusion reactions continuously occur within a mass of plasma.

On Earth, however, achieving fusion requires a fundamentally different system from that of a star. Fusion science faces the challenge of creating an artificial mechanism—one that doesn't exist in nature—that can sustain stable fusion reactions. In stars, it is gravity, made possible by their enormous dimension, that confines the plasma. For the much more compact "fusion on Earth," magnetic fields are used to confine the plasma instead.

To realize fusion energy, both advanced plasma physics and groundbreaking engineering must work together like the two wheels of a cart. For example, just one or two meters away from the ultra-high-temperature plasma core where fusion occurs, cryogenic superconducting magnets are installed to create strong magnetic fields. Additionally, facilities designed to divert and filter out the “ash” (helium) produced by fusion must endure heat levels comparable to those experienced by satellites or meteors during atmospheric reentry. These systems must effectively remove the heat while ensuring the stability and safety of the surrounding equipment.

The path toward realizing fusion energy so far has been fraught with challenges—many of which could not have been foreseen when research first began in the mid-20th century. However, encountering unexpected difficulties is not necessarily a misfortune. As many great researchers have testified, “failures often lead to discovery,” because truths that transcend human understanding often lie in the most unexpected places.

In the future, continued academic fusion research will be essential in building a more precise and reliable scientific foundation, which will serve as the basis for improving economic viability and ensuring safety.

Moreover, in the process of overcoming these challenges, we can expect to make unexpected discoveries that lead to deeper understanding of nature and technological innovation.

At the National Institute for Fusion Science (NIFS), we are uniting the efforts of all our staff to serve as a beacon illuminating new directions in fusion science within the broader currents of academic research.

We warmly invite you to take interest in the work of NIFS and to engage with us in a variety of ways as we pursue this exciting endeavor.

Goals of NIFS

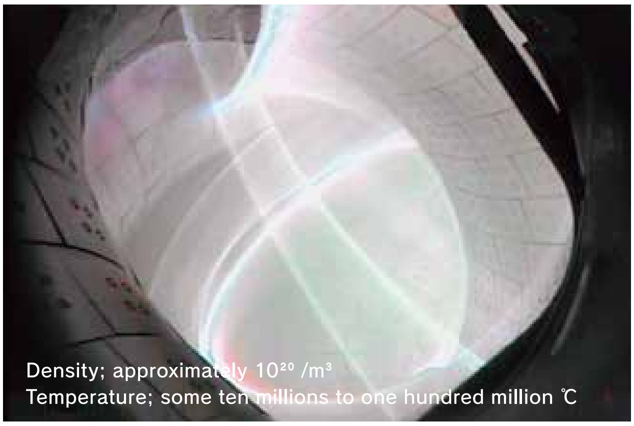
Fusion is a ubiquitous phenomenon in the universe and is the energy source for all activities there. The sun's fusion energy also sustains our Earth’s environment. The National Institute for Fusion Science addresses a wide range of research topics: plasma physics, microscopic quantum processes and materials science, and engineering technology for the components of fusion devices necessary to realize fusion energy in a form we can use.

Human beings have built the current advanced scientific, technological, and industrial society by using fossil fuels such as coal, petroleum, and natural gas as energy sources. However, the consumption of fossil fuels produces large amounts of carbon dioxide and nitrogen oxides, which seriously impact the global environment, and their reserves are limited. Fusion energy has great potential to be a solution to this problem.

As an Inter-University Research Institute, the National Institute for Fusion Science (NIFS) is committed to contributing to the development of fusion science and forming a broad science and technology base by making large research facilities and various research equipment available, and promoting joint research with domestic and foreign universities and research institutes. In addition, NIFS strongly promotes the education of students who will shape the future by establishing laboratories at the Graduate University for Advanced Studies, Nagoya University, Kyushu University, and the University of Tokyo and by providing research guidance to graduate students from universities throughout Japan. NIFS serves as a focal point where the knowledge of the national and global research community is united.

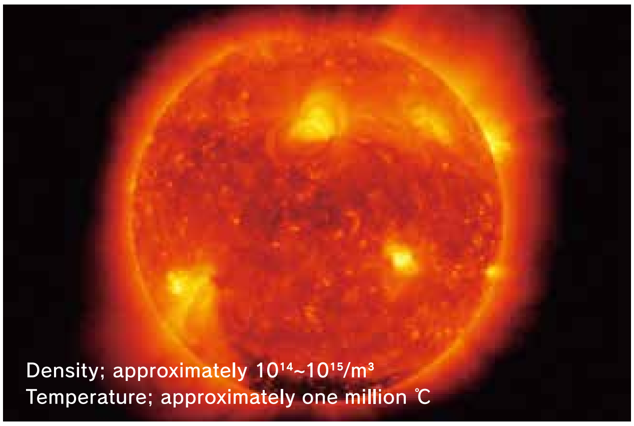
Various Forms of Plasmas

LHD plasmas



Density; approximately 10^{20} /m^3
Temperature; some ten millions to one hundred million ℃

Solar corona



Density; approximately 10^{14}~10^{15}/m^3
Temperature; approximately one million ℃

Photograph: provided by NAOJ/JAXA/MSU

Aurora

Density; approximately 10^{14} /m^3
Temperature; One to two thousand ℃

Photograph: provided by National Institute of Polar Research

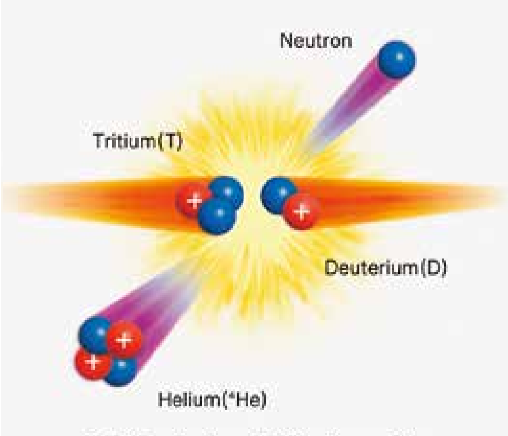
Flame (inside the kiln)

Density; approximately 10^{11} /m^3
Temperature; Less than two thousand ℃

Photograph: provided by the Toki City Junior Chamber

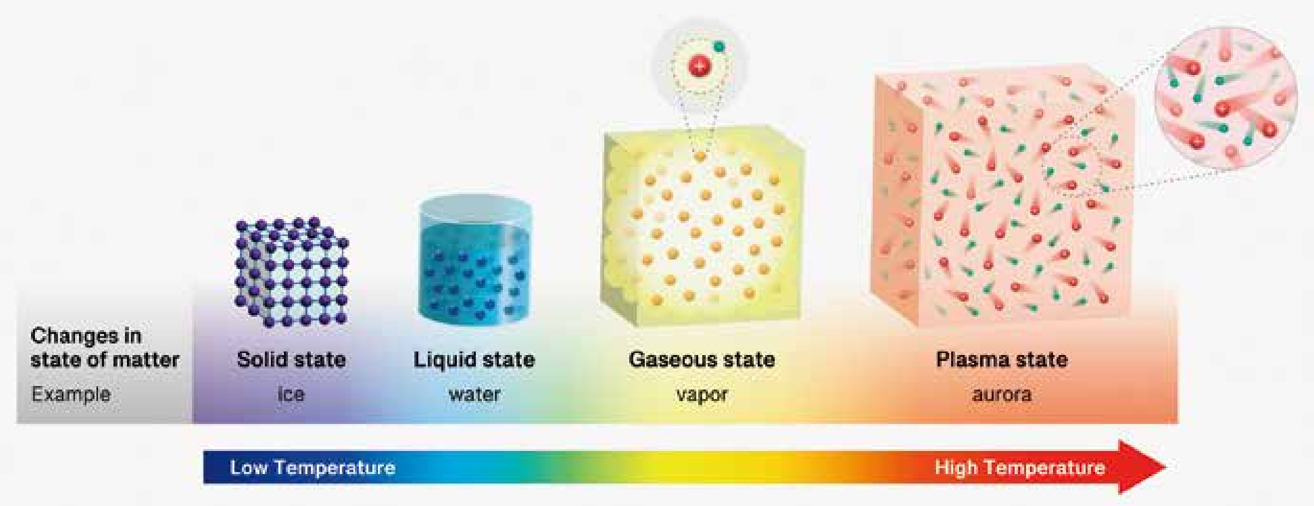
What is FUSION?

In nuclear fusion, two nuclei with small masses collide to form another heavier nucleus, generating enormous energy. Because the total mass after the reaction is slightly lighter than before the fusion reaction, the mass difference is converted into energy ($E=mc^2$). The fusion reaction is the ubiquitous energy source in the universe. Inside stars like the sun, a fusion reaction that produces helium from four hydrogen atoms has generated energy for over 5 billion years. Fusion research is being conducted to use the universe's energy as our power source. To realize a fusion reaction on Earth, deuterium and tritium, isotopes of hydrogen, are used as fuels. Deuterium and lithium, necessary to produce tritium, are found in seawater and can generate a large amount of energy with a tiny amount of hydrogen isotopes.

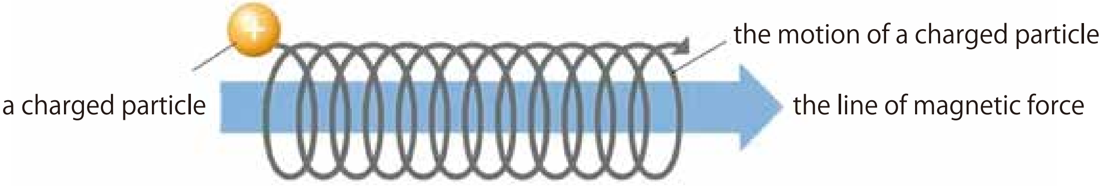


D-T(Deuterium-Tritium)reaction

To initiate a nuclear fusion reaction, deuterium and tritium nuclei (ions) must be brought close together, but Coulomb's repulsive force prevents it. To overcome this repulsive force and bring the nuclei closer together, they must collide at a speed of 1,000 km/s or more. In addition, since the high velocity of the nuclei causes them to escape and energy is lost, it is necessary to confine the fast-moving nuclei within a certain space, and it is also required to increase the density of the nuclei to increase the number of collisions and obtain more fusion energy. Confining many fast-moving nuclei in a certain space is the condition for fusion reactions. Such a state is called a high-temperature plasma.



The sun confines plasma with its enormous gravity, but a magnetic field is used to confine the plasma on Earth. The motion of charged particles, such as nuclei and electrons, which constitute the plasma, can be limited around the magnetic field lines, confining the high-temperature plasma in a certain space. Plasma research, which aims to understand various complex phenomena occurring in plasmas, is of central importance for the development of fusion reactors and provides many subjects for academic research, and plays an essential role as a basis for understanding cosmic and astronomical phenomena.



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April 2026

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Human Resources Development Council
Chairperson ICHIGUCHI, Katsuji

Fusion Outreach Headquarters
Chief TAKAHATA, Kazuya

Deputy Director General
TODO, Yasushi

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Safety and Health Promotion Center
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Public Relations Office
Chief TAKAHATA, Kazuya

Fusion Science Archives Office
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Industry-Academia Collaboration Laboratory
Chief YASUHARA, Ryo

Library
Chief MURAKAMI, Izumi

MCPoP (Micro Collective Phenomena of Plasmas) Project Promotion Headquarters
Division Director YAMADA, Hiroshi

Department of Research
Director SAKAMOTO, Ryuichi

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Meta-hierarchy Dynamics Unit	SEKI, Tetsuo
Structure Formation and Sustainability Unit	OGAWA, Kunihiro
Phase Space Turbulence Unit	NISHIURA, Masaki
Plasma Quantum Processes Unit	MURAKAMI, Izumi
Transports in Plasma Multi-phase Matter System Unit	MORISAKI, Tomohiro
Sensing and Intellectualizing Technology (S&I) Unit	TANAKA, Kenji
Plasma Apparatus Unit	YAMAGISHI, Osamu
Complex Global Simulation Unit	MIURA, Hideaki
Ultrahigh-flux Concerting Materials Unit	TANAKA, Teruya
Applied Superconductivity and Cryogenics Unit	CHIKARAISHI, Hirotaka

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Financial Affairs Division	ARAI, Masanori
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Staff	225
Director General	1
Researchers	107
Engineers	41
Administrative Staff	41
Employees on Annual Salary System	33
Research Administrator Staff	2

New Academic Research Platform Project and Fusion Science Hills Initiative (Platform Renovation)

New Academic Research Platform Projects

Starting in FY2026, the "Academic Research Platform Project on Fusion Science, Centered on 'Micro-collective Phenomena' in Ultra-High-Temperature Plasmas" was launched with support from MEXT.

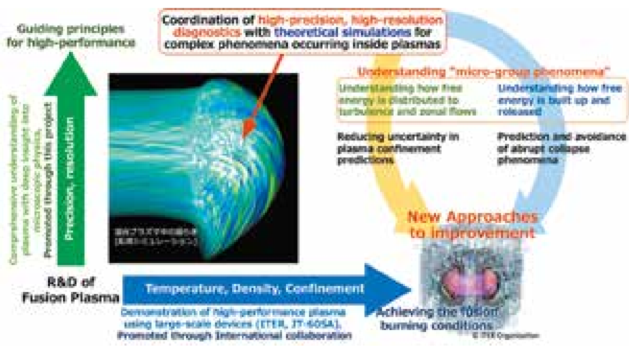
From an academic perspective, plasma physics, which is deeply involved in the realization of fusion energy, deals with collective phenomena caused by that of numerous ions and electrons, and shares a common awareness of the issues to understand the nature of the real world by the sciences of space and astronomy, the atmosphere and oceans, life, and even society.

In collaboration with researchers in these fields, we aim to develop a science that deepens our understanding of nature and society, in which order and complexity coexist.

Looking at that society, we are at a turning point in global expectations for the realization of fusion energy, with growing momentum toward its industrialization. The Japanese government has also adopted the national "Fusion Energy Innovation Strategy". On the other hand, many unresolved issues remain in order to achieve fusion energy, making it important to establish guiding principles that reduce the risks and uncertainties when demonstrating fusion energy.

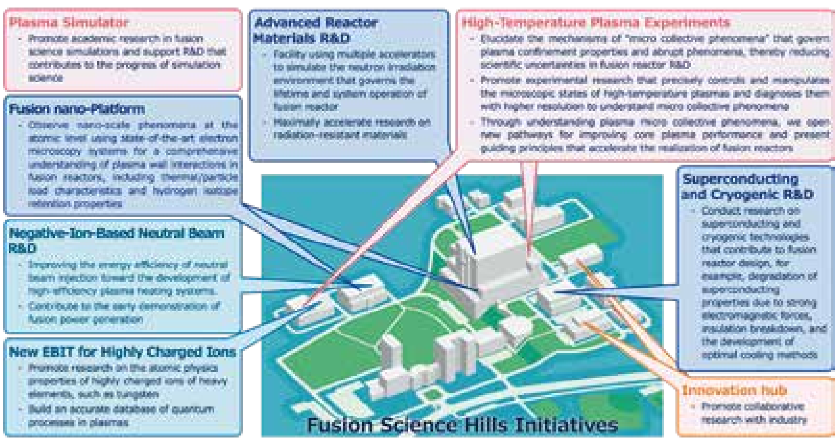
Aiming for broad new research developments that respond to the above academic and social demands, the "Academic Research Platform Project on Fusion Science, Centered on 'Micro-collective Phenomena' in Ultra-High-Temperature Plasmas" aims to elucidate the central scientific risk for realizing fusion energy and to pioneer the frontiers of plasma physics and fusion science by exploring the micro-hierarchies that generate collective phenomena.

To this end, the core of the research is experiments using the existing magnetic confinement plasma device (CHD) and a newly designed and constructed flexible, maneuverable, and variable magnetic confinement plasma device (CHD-U). We will promote joint research, combining supercomputers, plasma and data science to improve predictive performance, and to do experiments on large devices such as JT-60SA and Wendelstein 7-X, as well as on small- and mid-sized devices at universities in Japan.



Fusion Science Hills Initiatives

To accelerate the "Fusion Energy Innovation Strategy," it is important to build a collaborative framework between broadly spread academic research and integrated development research. The National Institute for Fusion Science, an academic research institute, is promoting the "Fusion Science Hills Initiatives". This initiative aims to establish various research facilities (platforms) that will serve as cradles for innovation and to build a core hub that leads interdisciplinary and international collaborative research. The figure below shows the platform currently being developed as part of the "Fusion Science Hills Initiatives".



Overview of the Unit System and Platform Management Office

Unit

Fusion energy, the most important outcome of fusion science, is expected to be a next-generation energy power source that can solve energy and global environmental problems because it is characterized by 1) carbon neutrality, 2) abundant fuel, 3) inherent safety, and 4) environmental conservation. By contrast, fusion science is a comprehensive research field encompassing numerous difficult challenges, and many research issues remain to be solved. Therefore, in addition to developmental research that bundles together various sciences and technologies, academic research is necessary to generate innovation that opens up new possibilities.

The National Institute for Fusion Science (NIFS), an academic research institute, aims to promote the interdisciplinary nature of fusion science by dividing the challenges of fusion energy into several themes and generalizing each problem. Through interdisciplinary development that addresses cutting-edge challenges and fosters awareness of issues across academic fields, we hope to promote the free flow of ideas across an unprecedentedly wide range of disciplines, enabling the sustainable advancement of long-term fusion research.

To promote this interdisciplinary approach, the National Institute for Fusion Science has been reorganized into ten research Units, fostering joint research across a wide range of fields.

Below are the names of the 10 Units. Their respective research themes are described on pages 9 - 13.

Meta-hierarchy Dynamics	Structure Formation and Sustainability
Phase Space Turbulence	Plasma Quantum Processes
Transports in Plasma Multi-phase Matter System	S&I: Sensing and Intellectualization
Plasma Apparatus	Complex Global Simulation
Ultrahigh-flux Concerting Materials	Applied Superconductivity and Cryogenics

Platform

Platforms are various research equipment facilities that form the basis for joint research conducted by the Units. As an inter-university research institute, the National Institute for Fusion Science (NIFS) provides various platforms, including large-scale research facilities, to promote joint research with domestic and international universities and research institutes. The following two sections of the Platform Management Office operate the platform at NIFS.

Experimental Facility Section:	This Section consists of the CHD Device TG, which is responsible for operating the CHD magnetic confinement plasma device and for managing and publishing experimental data, as well as the LHD Asset Utilization TG, Radiation-Controlled Area Equipment TG, Superconducting Magnet System Laboratory TG, Fusion Engineering Research Laboratory TG, R&D Laboratory TG, and Plasma Diagnostics Laboratory TG, which oversee the experimental laboratories within the institute and the platforms installed therein.
Computer Section:	The section consists of numerical experiments, a numerical database of atoms and molecules, and a Virtual Reality (VR) system. As for numerical experiments, the Plasma Simulator "Sousei (binary star)", a supercomputer dedicated to plasma fusion research, has been operating since FY2025 to promote world-class joint research in plasma fusion simulations.

Units

Meta-hierarchy Dynamics Unit

Fusion science covers a very wide range of spatio-temporal scales and physical parameter regions, from the microscopic scales of atoms or electrons to large scales that can be manipulated by human hands, such as fluids, solids, plasma, and actual devices. Furthermore, the collective behavior of charged particles causes a wide variety of phenomena not only in the plasma itself but also in the materials in contact with it. Understanding of these complex phenomena has been pursued by elemental separation into various hierarchical processes and physical models, or by combining the various hierarchical levels with each other. The separation of electrons and ions into their kinetic scales and the coupling of particle and fluid models are good examples. However, with recent remarkable progress toward higher precision and larger scales in experimental and numerical research, phenomena that cannot be well captured by the separation and coupling of hierarchies have become apparent. In such phenomena, what was once a clearly separable hierarchy becomes continuously obscured according to physical parameters, or the scales of hierarchical separation overlap and appear to be a new hierarchy. In this Unit, we will reconsider the static and dynamic characteristics of such hierarchies from a bird's-eye view (meta-perspective). We focus on the hierarchical nature of complex phenomena such as multiscale turbulences, resonance between wave and particle motion, global propagation of fluctuations, plasma-solid interface phenomena, velocity-space structure, anisotropy of distribution functions, and so on, in fusion plasmas, and we are exploring the universality in the hierarchical dynamics.

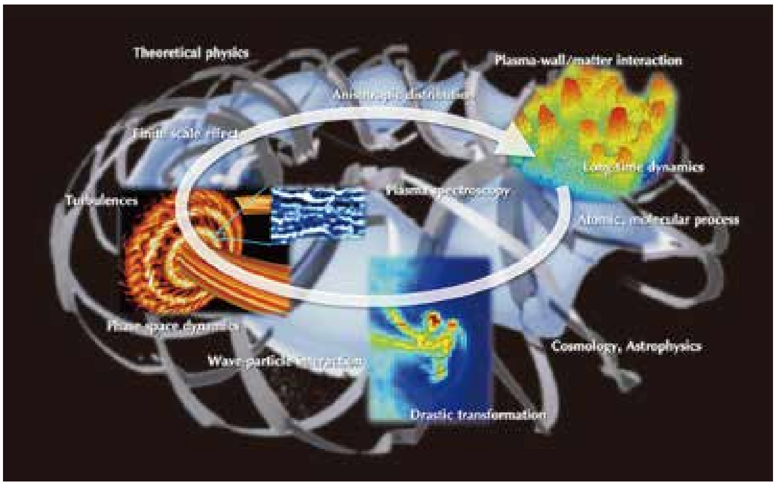


Fig. Meta-hierarchy Dynamics Unit addresses various issues in fusion science.
Hierarchical dynamics with clarity and ambiguity will be explored from a meta perspective.

Structure Formation and Sustainability Unit

Many systems in the real world, such as the Earth, where matter circulates under sunlight, and the organisms that live on it, are placed in a flow of energy. Energy tends to eventually turn into uniform thermal energy. On the other hand, when energy flows through the system, there is room for a non-uniform structure to form and persist. In a magnetic confinement fusion reactor, there is an energy flow starting from the nuclear fusion reaction that occurs in the core plasma. This energy flow creates the confined state of the plasma in magnetic field. Various structures have been observed in experiments to be formed in the plasma, such as organized flows, boundaries where the properties of the plasma change over time and space, exhaust of specific kinds of particles, etc. Some of these structure formations have been found to contribute to the efficiency of fusion reactors. The "Structure Formation and Sustainability Unit" explores the universal principle behind structure formations common to various systems, and develops efficient and sustainable plasma confinement methods.

An important question is how the flow and distribution of energy is determined in a system composed of multiple elements, and what role magnetic fields play in the case of plasmas. Through advanced measurement systems that quantify high-energy particles driving energy flow, experiments using new confinement magnetic fields, and micro-to-macro theory and simulations, we clarify these from both experimental and theoretical perspectives. The findings are fed back to the design and optimization of the confinement magnetic field and the electromagnetic coil that creates it.

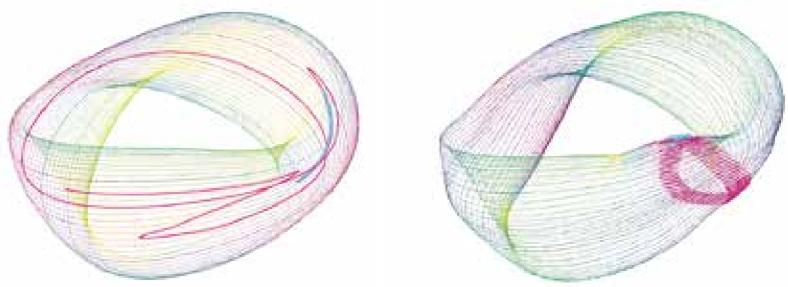


Fig. A toroidal magnetic field structure with different symmetries for high-temperature plasma confinement, derived using the design system developed by the Structure Formation and Sustainability Unit. Thin lines indicate the results of magnetic field line tracing, and the colors represent the magnetic field strength. The thick light-blue and pink lines show the trajectories of high-energy charged particles with different energies, respectively.

Phase Space Turbulence Unit

Magnetically confined fusion plasmas are generally not at all dense so that particle collision rarely occurs. Particles have their electric charges therefore can be trapped or expelled in a phase of electrostatic waves. Those trapped particles travel with the waves while being bounced by the wave potential, like surfing (Fig.1). During this motion, the waves and particles can exchange their energy and momentum, leading to more complicated behaviors. As a result, enhanced plasma transport that makes plasma confinement worse and/or collisionless plasma heating are theoretically predicted to occur. So far, direct observation of those wave-particle interactions has been extremely challenging and therefore experimental knowledge derived from it has been limited. The key quantity is the velocity distribution function, which describes statistical properties of the particle dynamics. In a fluctuation-less situation the velocity distribution function follows Gaussian (normal) distribution.

The Phase-Space Turbulence Unit tries to directly measure the velocity distribution function by cutting-edge diagnostic systems, with unprecedented resolutions in time, real-space, and velocity-space (Fig.2), by which the above-mentioned physics are discussed. This activity contributes not only to nuclear fusion development but also to uncovering far-nonequilibrium plasma dynamics in the universe.

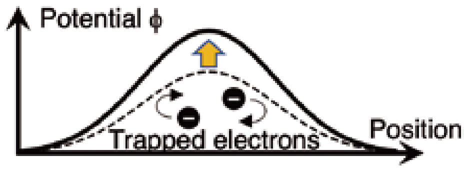


Fig.1 Bounce motion of particles trapped by a potential wave.

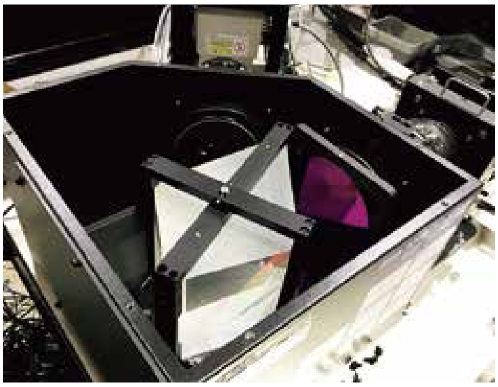


Fig.2 Cutting-edge spectrometer system equipped with grating-prism, CMOS fast-camera, and image-intensifier.

Plasma Quantum Processes Unit

This Unit addresses the question of how collective properties and dynamics are defined and observed as collective phenomena from quantum processes of atoms, molecules, and light in plasmas and materials. Specifically, we measure exotic quantum processes created in the laboratory by highly charged ion sources and intense laser fields, and develop quantitative physical models of non-equilibrium plasmas in fusion reactors, astronomical objects, and the universe, as well as high-density plasmas. Through these studies, we aim to elucidate the universal physics underlying to collective phenomena across a broad range of scales.

We are also conducting highly interdisciplinary collaborative research on development of atomic data and spectroscopic models for various astronomical observations (solar corona, solar wind, supernova explosions, kilonovae, etc.); development of short wavelength light sources using laser pumped plasmas; and the dynamics of muon quantum few-body systems. In addition, we are developing a numerical database of atomic and molecular data and making it open by available (http://dbshino.nifs.ac.jp/) for a wide range of plasma research and applications.

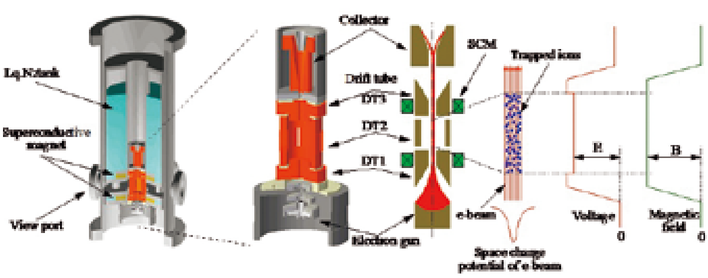


Fig1. Schematic of a compact electron beam ion trap (CoBIT) developed in collaboration with the University of Electro-Communications to generate, trap, and perform precision spectroscopy of highly charged ions of elements observed in fusion reactors and astronomical plasmas.

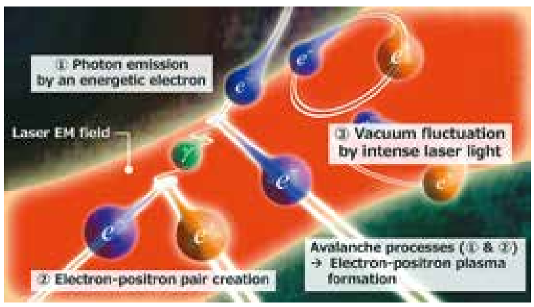
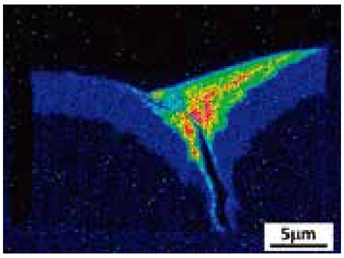
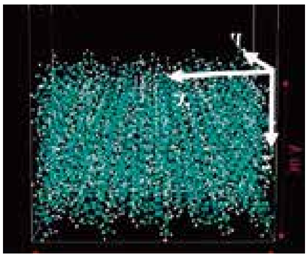


Fig2. Schematic illustration of particle and plasma physics by using high-intensity lasers. Under the intense EM field of a high-intensity laser pulse, various scattering processes between electrons, positrons and photons occur. These avalanche processes are expected to form an electron-positron plasma. We investigate these phenomena for future experiments and understanding cosmic plasmas at extreme EM field intensities.

Transports in Plasma Multi-phase Matter System Unit

The term "multi-phase" refers to the three states of matter: solid, liquid, and gas. At the point where the fourth state of matter, plasma, meets the other three, many interesting phenomena occur. In a fusion reactor, relatively cold plasma around the core plasma, where the fusion reaction is taking place, is connected to the solid or liquid reactor wall. In front of the wall, gas is added to lower the plasma temperature to reduce the heat load on the wall. In the "Transports in Plasma Multi-phase Matter System" Unit, the objective of the research is to investigate how heat and particles are transported in the system where the plasma contacts solids, liquids, and gases in a fusion reactor, to predict what a future fusion reactor will look like, and to control the transport of heat and particles. The Unit also aims to apply the knowledge and techniques gained from fusion research to study various plasma and multi-phase fields other than fusion, such as plasma biotechnology, SDGs, and the formation mechanisms of living materials in space, and to contribute to the advancement of these fields. Our research is conducted through experiments using plasma devices, various material analyses using electron microscopes, etc., and computer simulations.





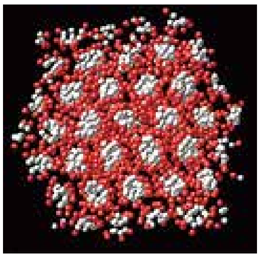


Fig. From left to right: a visible light image of LHD divertor plasma, beryllium distribution on the plasma-facing surface of the tungsten divertor plate in the JET tokamak device, an example of molecular dynamics simulation of hydrogen recycling in an amorphous carbon wall, an example of dissipative particle dynamics simulation of the formation of self-assembled structures in amphiphilic molecular systems.

Sensing and Intellectualizing Technology (S&I) Unit

In this Unit, we aim to conduct "Sensing and Intellectualization (S&I)" of various types of plasma physics. In our definition, S&I is to elucidate the complex structures and relations inside nature and to convert the information into knowledge.

We develop new plasma diagnostics and expand their measurable range. In addition, we maximize the amount of information to extract from the experimental results by utilizing statistical mathematics and data science. Moreover, we reveal hidden correlations inside the obtained data by an interactive method, i.e., converting the data into visual, auditory, and textural information. We collaborate on these research topics with scientists around the world to tackle open issues in fusion science.

The S&I Unit consists of the following three research pillars:

1. Research of plasma dynamics with advanced measurement and analysis

We develop plasma diagnostics such as phase-contrast imaging and laser Thomson scattering measurement, which can pave the way for a deeper understanding of plasma physics. We also work on the development of light sources and detectors that enable new measurements, which can be applied in industry.

2. Sustainable plasma control via predictive/judgment-oriented research using data science

We establish a real-time prediction and judgment method for fusion plasma. In addition, we will investigate the circulation process of stable and radioactive isotopes for the social implementation of fusion reactors.

3. Challenge of understanding data and development of public communication

We study expression methods such as VR display that enables 3D + α analysis, and construction of numerical models for obtaining scientific knowledge. We aim to systematize the intellectual search process that has been conducted empirically so far. In addition, we promote open science and outreach activities for the contribution of our studies to society and the realization of fusion power generation.

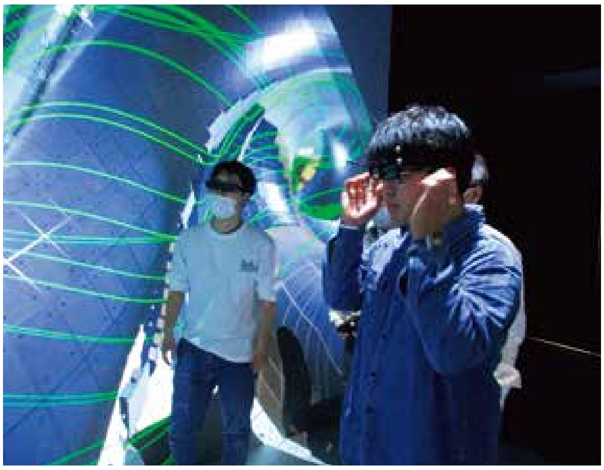


Fig. 360-degree VR display of fusion plasma

Plasma Apparatus Unit

The concept of the Plasma Apparatus Unit is to understand the collective properties of charged particle ensembles possessing diverse energy levels, and to control and apply these properties.

Based on this concept, we aim to further advance a wide range of technologies for controlling charged particle ensembles and to create new device technologies. At the same time, we will introduce new perspectives into the understanding of natural science and deepen that understanding, while also establishing a cross-disciplinary research environment that promotes collaboration and integration among researchers with diverse backgrounds.

We will consolidate the knowledge accumulated to date on the collective properties of charged particle groups—together with advanced instrumentation technologies, including measurement and control techniques cultivated at the National Institute for Fusion Science—along with cutting-edge device engineering, state-of-the-art measurement and control methods, and equipment development technologies. By integrating these with insights and techniques from other disciplines, we will develop new observation and experimental methodologies.

Many natural phenomena can be described as open systems involving external inputs (apparatus), ranging from particle creation and annihilation processes in elementary particle physics, to external heating and particle injection in laboratory plasmas, energy release in space propulsion systems, and further to accretion phenomena and phase formation in neutron stars. This Unit aims to integrate quantum physics, plasma physics, and astrophysics in a cross-disciplinary manner, and to elucidate the mechanisms of nonequilibrium transport phenomena and dissipative processes that are common across different scales.

In addition to NIFS facilities used for fusion science experiments, the Unit will utilize a variety of external plasma devices and promote research conducted by a wide range of researchers from both within and outside the Institute. Target systems include neutral beam injection (NBI) systems, high-beta plasma devices using dipole magnetic fields and their applications to antimatter plasma experiments, muon-catalyzed fusion devices, and plasma space propulsion systems. Except for NBI, these facilities are located outside the Institute. Within the Unit, close information sharing will be fostered, based on common knowledge and technologies across individual research projects. By addressing challenges from multiple perspectives, the Unit aims to deepen the understanding of natural science and generate new developments. Furthermore, to maximize these effects, the Unit will position NIFS as one of the hubs of an academic network that integrates and disseminates knowledge and technologies related to diverse plasma devices.

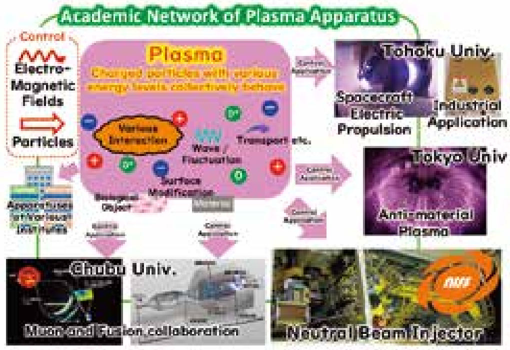


Fig. Academic Network of Plasma Apparatus Unit

Complex Global Simulation Unit

In order to understand the behavior of an entire system composed of multiple hierarchies, individual simulations of each hierarchy are not sufficient. Global simulations that consider the interactions between hierarchies are required. Simulations of magnetic confinement fusion plasma require consideration of the interaction between the microscopic hierarchy of particles in the plasma and the macroscopic hierarchy of magnetohydrodynamic behavior of the entire plasma. Although their realization is not easy, such complex global simulations are important issues that are expected to be actualized not only in the field of nuclear fusion research but also in many other academic fields. The reason for this is that the temporal and spatial scales of the microscopic hierarchy and the entire system are often extremely different, and the capacity and capability of a computer is not sufficient to simulate the entire range of scales based on a single system of fundamental physical equations. The purpose of the Complex Global Simulation Unit is to develop simulation methods to solve this problem and to promote simulation research.

This Unit aims to develop simulation methods that couple different hierarchies and physical models to realize global simulations that predict and elucidate the behavior of entire physical systems that cannot be handled by simulations based on a single system of fundamental physical equations. This Unit will realize global simulations of the whole magnetic confinement fusion plasma including its core and edge, based on kinetic-magnetohydrodynamic hybrid simulation and will elucidate the complex behavior of plasmas. It will also develop a methodology with broad applicability to achieve simulations that more closely reproduce real-world phenomena, beyond the strong limitations imposed by the capacity and capability of the supercomputer. Interdisciplinary research by applying the developed methods to related fields will be promoted.

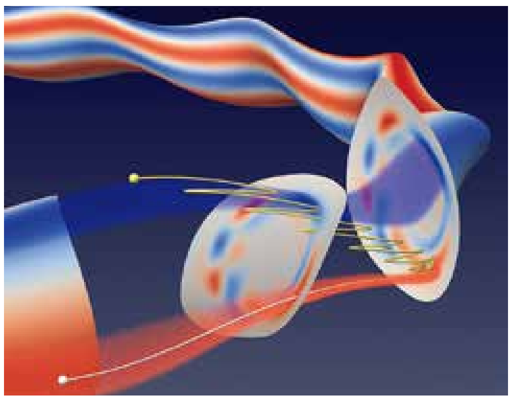


Fig. Pressure perturbation of a magnetohydrodynamic (MHD) instability and orbits of thermal ions in a Large Helical Device plasma simulated with a kinetic-MHD hybrid code. It has been found that trapped ions (shown by the yellow line) suppress the instability and play an important role in maintaining a high pressure plasma. This Unit will extend this simulation model to develop a new method to study interaction between such an MHD instability and micro-instabilities.

Ultrahigh-flux Concerting Materials Unit

Materials for fusion and fission reactors, aerospace craft, chemical plants etc. are used under extreme conditions, which give rise to non-equilibrium states in materials induced by ultrahigh-flux energy and various particles. The non-equilibrium states are expected to bring about the formation of unknown compounds and structural changes in materials such as a self-organization of constituent atoms, including crystal lattice defects. By making good use of these new compounds and structures, The Ultrahigh-flux Concerting Materials (UlCoMat) Unit is to create novel materials that adapt themselves to the extreme conditions and engage with the ultrahigh-flux of energy and various particles.

The target materials are refractory metals, dispersion-strengthened alloys with ceramic nano-particles, ceramics for electrical insulation, hydrogen control, and various sensors, etc. The figure shows fusion reactor grade steel strengthened by ceramic particle dispersion. It is possible to form various oxide nano-particles containing yttrium and titanium under non-equilibrium conditions in an appropriate fabrication process. The UlCoMat targets the identification of stable particles without decomposition under extreme conditions and materials design to enhance the promising particles.

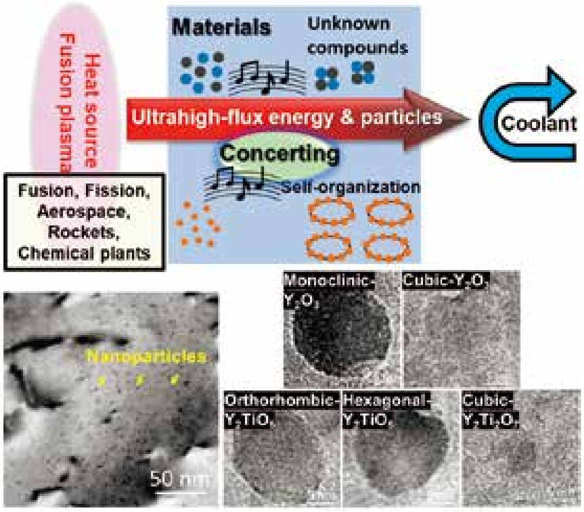


Fig. Schematic illustration of materials concerting with ultrahigh-flux energy and particle environments (top), and electron micrographs of oxide-dispersion-strengthened steel developed for fusion reactors (bottom).

Applied Superconductivity and Cryogenics Unit

The Applied Superconductivity and Cryogenics (ASC) Unit is a restructured body that consolidates the superconducting and cryogenic engineering research conducted by NIFS, aimed at promoting sustainable societal change through new study in these fields. Our Unit aims to clarify an exit strategy for superconducting systems in sustainable society, conduct research and development towards the societal implementation of superconducting technology, and serve as an academic research hub by offering various low-temperature experimental environments using temperature-variable cryogenic systems available in the Superconducting Magnet Research Building to various users through academia-industry collaborations. Furthermore, we will contribute to the realization of a hydrogen society by accumulating experience in the operation of liquid hydrogen as "clean energy," positioned as an achievable aim of Sustainable Development Goals (SDGs), and enhancing the social acceptability of hydrogen, including its safety. To improve the reliability of operating large superconducting magnets and a helium liquefier/refrigerator, we are developing an innovative monitoring system that utilizes AI technology (machine learning) (Fig. 1).

We have developed a device to test the response characteristics of high-temperature superconducting (HTS) wires cooled with liquid hydrogen and have constructed an environment that allows for the liquefaction of a specified amount of hydrogen. Energization tests can be conducted on HTS wires. (Fig. 2)

Fig.1 Image of the LHD helium liquefier/refrigerator incorporating AI technology

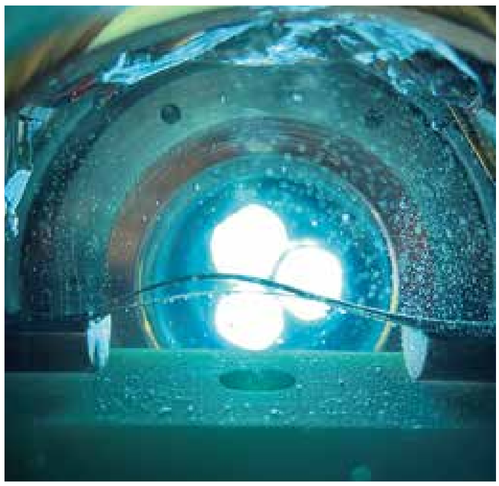


Fig.2 Photograph showing liquid hydrogen being stored in the device for testing HTS wires.

Platform Management Office

Platforms are various research equipment facilities that form the basis for joint research conducted by the Units. The Platform Management Office is responsible for managing, operating, and sharing the use of these platforms within the NIFS. Through the operation of its various charges, the Platform Management Office contributes to the promotion of the NIFS's main project, the "Academic Research Platform Project on Fusion Science, Centered on 'Micro-Collective Phenomena' in Ultra-High-Temperature Plasmas," and improving a research environment for The Units to involve researchers from broad fields and promote cross-disciplinary collaboration in fusion science, while also accelerating the "Fusion Energy Innovation Strategy".

The following two sections of the Platform Management Office operate the NIFS platforms alongside the Department of Engineering and Technical Services to effectively utilize the NIFS platforms for joint research and shared use by researchers both domestically and internationally.

Experimental Facility Section

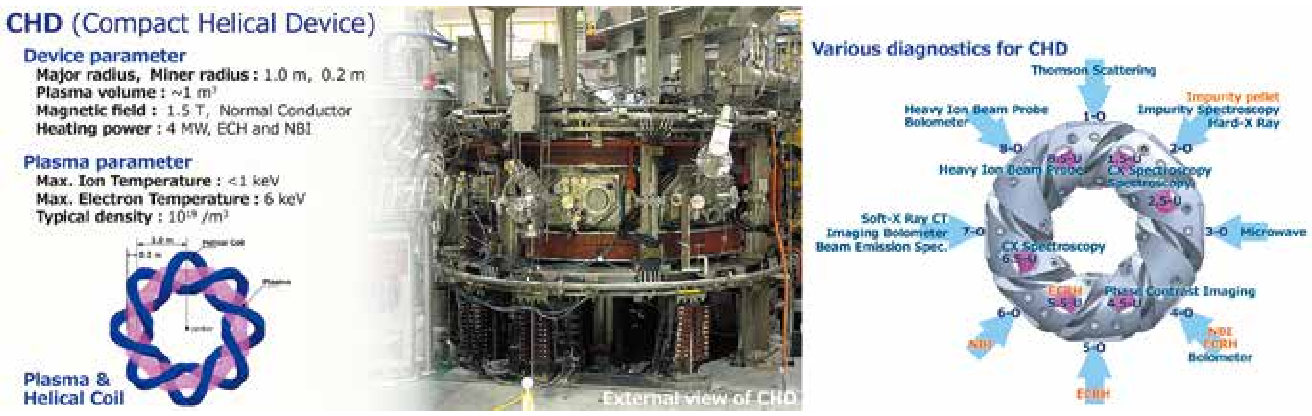
CHD Device Task Group

The CHD Device Task Group is responsible for operating the magnetic confinement plasma device, CHD. The CHD plays a central role in Phase I of a new academic research infrastructure project, the "Academic Research Platform Project on Fusion Science, Centered on 'Micro-Collective Phenomena' in Ultra-High-Temperature Plasmas", which started in FY2026.

The compact plasma device, CHD, enables precise experiments with high maneuverability. It achieves this by combining various high-precision diagnostic systems—further advancing the cutting-edge plasma diagnostics cultivated during the Large Helical Device (LHD) project—with high-power heating devices that utilize LHD assets.

Because this Academic Research Platform Project operates on the principle of open science, data from CHD experiments and the large volume of legacy data* accumulated in the LHD experiment will be made widely available to the public, building a research basis that promotes interdisciplinary collaboration in fusion science.

* LHD experimental data is publicly available at https://doi.org/10.57451/lhd.analyzed-data



LHD Asset Utilization Task Group

The LHD Asset Utilization Task Group plays a role in effectively utilizing assets developed over the 35-year LHD project—such as buildings, facilities, and equipment—for NIFS's future research activities, including the academic research platform project and the establishment of a core hub for fusion research based on the Fusion Science Hills Initiative.

Task Groups for Each Experimental Building

Task groups have been established in each experiment building in the NIFS (the Superconducting Magnet System Laboratory, the Fusion Engineering Research Laboratory, the R&D Laboratory, the Plasma Diagnostics Laboratory, and the controlled area of the Large Helical Experimental Building). These task groups are responsible for managing and operating the platforms installed in their respective buildings, as well as coordinating experiment schedules and implementation frameworks.

The platforms are broadly divided into five categories: (1) Cryogenic Experimental Facilities: used for research on superconducting coils, ranging from small to large, and on cryogenic systems. (2) In-vessel Material Experimental Facilities: used for research on materials capable of withstanding high heat and particle fluxes, functional materials, and liquid blanket systems. (3) Material Analysis Equipment: used for research investigating plasma irradiation effects. (4) Ion Source and Beam Experimental Facilities: includes large-scale facilities capable of generating high-current negative ions and devices that generate and multiply charged ions, utilized for research on ion sources for plasma heating devices and atomic/molecular processes. (5) Basic Plasma and Material Irradiation Experimental Facilities: used for research that involves generating plasma to investigate its fundamental characteristics.

The NIFS broadly utilizes these platforms for collaborative research with universities and private enterprises. Furthermore, it has established a fee-based utilization system to facilitate their widespread use in industry-academia-government collaborative research.

Computer Section

Plasma Simulator Task Group

To promote academic research in fusion science simulations and to support research and development that contributes to the progress of simulation science, we operate the supercomputer system Plasma Simulator “Sousei” (binary star). This new system, jointly introduced with the National Institutes for Quantum Science and Technology (QST) in July 2025, consists of three subsystems. Subsystem A comprises 360 nodes x 2 CPUs, delivering a theoretical peak performance of 5.89 petaflops (1 petaflop corresponds to 1 quadrillion floating-point operations per second) and a total main memory of 270 terabytes. Subsystem B consists of 70 nodes, each equipped with four APU processors that integrate GPUs and CPUs, achieving 34.3 petaflops with a total main memory of 35 terabytes. Together with the auxiliary Subsystem C, the entire system reaches a total theoretical peak performance of 40.4 petaflops. All subsystems are interconnected via a high-speed network, enabling fast data access from any subsystem to a large-scale external storage system with a capacity of 40 petabytes.

Fig. Plasma Simulator “Sousei” (installed at the QST Rokkasho Institute for Fusion Energy)

Database Task Group

We provide the NIFS Atomic and Molecular Numerical Database at http://dbshino.nifs.ac.jp/ for researchers in the world, which contains numerical data, such as cross-sections, for collision processes between electrons, atoms, and molecules in plasmas. The amount of stored data is the largest of all databases on collision cross-sections available around the world, and many researchers access it to use the information in our database. We are also creating other databases, e.g. the Atomic Data and Analysis Structure (ADAS), available for domestic collaborators, which are provided under international collaborations.

VR Task Group

Virtual Reality (VR) is a technology that allows users to step into a virtual space and experience objects as if they truly existed right before their eyes. By freely changing their viewpoint and interacting through intuitive controls, users can explore and even "touch" data—unlocking experiences that are impossible in the real world. Since the introduction of the large-scale immersive VR system CompleXcope in 1997, the National Institute for Fusion Science has been visualizing plasma data obtained from simulations and experiments, as well as designs of future fusion reactors. This enables researchers to "enter" the plasma itself, observing its dynamic behavior from every possible angle, and significantly advancing both understanding and analysis. In recent years, the adoption of head-mounted displays has made VR more accessible than ever. VR technology is now expanding beyond fusion research into a wide range of fields, including medicine, sports science, and the social sciences. VR guides us into the world of data, offering new perspectives and intuitive insights. When the invisible becomes visible, the next scientific discovery begins.

Fig. Large-scale immersive VR system *CompleXcope*

Fusion Science Interdisciplinary Coordination Center

The Fusion Science Interdisciplinary Coordination Center promotes interdisciplinary collaboration in fusion science and development research, and social implementation of fusion technology through industry-academia-government cooperation. As a comprehensive center that leads and supports collaborative research with universities, development research institutes, and industry, the center links three new interdisciplinary fields and a group of Units to develop challenging and interdisciplinary joint research that transcends the boundaries of existing fields. In particular, in order to build an interdisciplinary research network with advanced academic research fields, promote open science, collaborate with international research projects, and implement the technologies cultivated through nuclear fusion in society, the 1) Advanced Academic Research Collaboration Section, 2) Development Research Coordination Section, and 3) Industry-Academia-Government Coordination Section support various joint research in collaboration with the Units.

At our Center we actively promote and support interdisciplinary collaborative projects that bring together multiple research Units. Among these initiatives, we have built a strong foundation through the development of neutron diagnostic systems for the Large Helical Device (LHD). These are then leveraged to advance fusion science and energetic particle confinement research. Drawing on this expertise, we are now pursuing the development of high-performance neutron diagnostics designed to investigate energetic particle dynamics in magnetically confined plasma experiments. These efforts extend to both domestic and international facilities, including JT-60SA and other major experimental devices worldwide (Fig. 2).

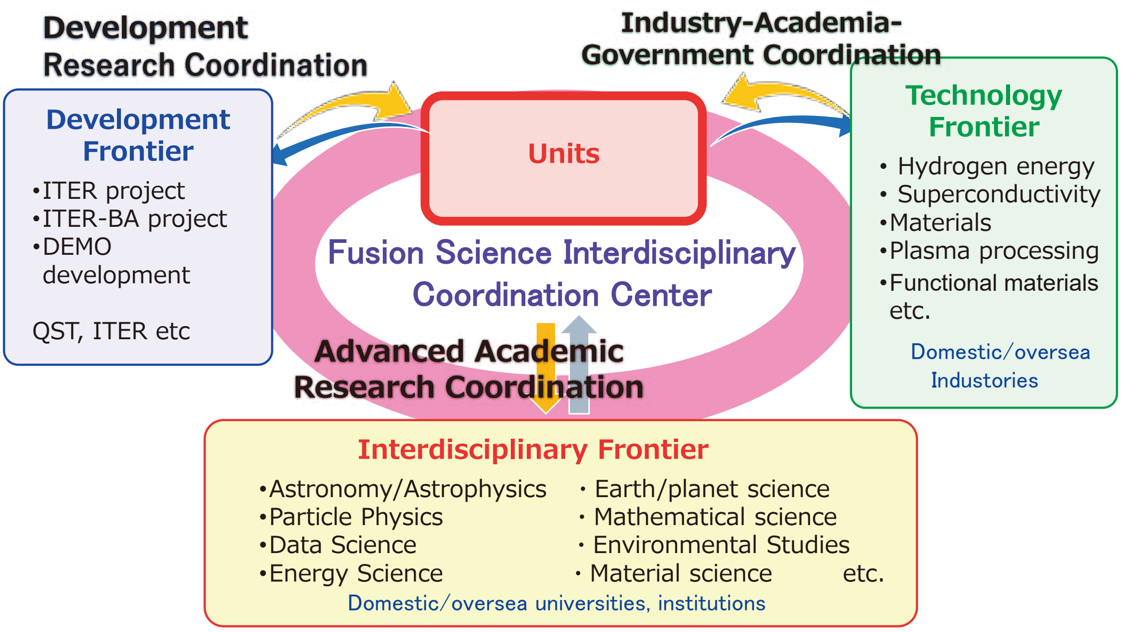


Fig.1 Fusion Science Interdisciplinary Coordination Center

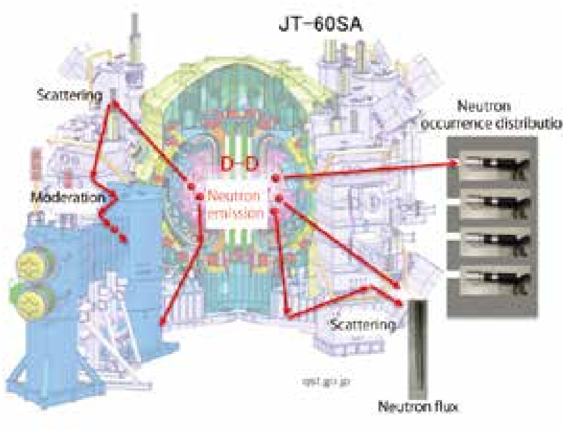


Fig.2 High performance neutron measurement for energetic particle confinement research

Safety and Health Promotion Center

The Safety and Health Promotion Center is devoted to preventing work-related accidents, to ensuring safe and sound operation of machinery and equipment, and to maintaining a safe and healthy environment for all staffs, collaborators, and students. The center is composed of ten offices, as shown in the figure.

Screen shot of the safety training course.

Training lecture held by safety control office leaders and safety management staff.
In 2025, it was held online.

Patrol by members health and safety managers

Safety and health managers regularly patrol the work areas.

Radiation monitoring post at our site boundary

Nine radiation monitoring posts are placed at the site boundary. and five near the laboratory buildings.

Disaster prevention training

All workers attend disaster prevention training held every year.

Through these activities, the Safety and Health Promotion Center conducts environmental safety, which includes radiation safety, safety education, and radiation training. Furthermore, industrial physicians also patrol the work areas. The Committee of Health and Safety discusses and recommends any safety, health, and environmental issues to improve appropriate safety management.

Rokkasho Research Center (RRC)

The Rokkasho Research Center (RRC, established in May 2007) promotes cooperation and joint research with the Broader Approach (BA) activities that are being undertaken in parallel with the ITER project and builds the technical foundation for the development of a prototype fusion reactor, by supporting the participation of collaborators of NIFS and universities based on academic standpoints. Furthermore, to promote the interdisciplinary expansion of issues being tackled in fusion research, we are focusing on disseminating research issues to a range of academic fields, inviting interdisciplinary meetings, and promoting interdisciplinary joint efforts. In addition, we are actively working on contributing to human resource development through establishing and deepening cooperation with neighboring educational institutions.
RRC's Homepage: https://www.nifs.ac.jp/en/about/rrc.html

Highlighted Activities in FY2025

The RRC has served as the fusion research hub for the project of the Research Organization of Information and Systems (ROIS), "Statistical-Mathematical Modeling of Plasma Data Complementary to Plasma Physics." This project concluded as scheduled at the end of the 2024 fiscal year. Subsequently, the project "Creation and Development of Statistical-Mathematical Fusion Science" was selected under the Open Mix Laboratory (OML) program of the National Institutes of Natural Sciences (NINS) for the 2025 fiscal year, followed by the selection of "Evolutional Development of Statistical-Mathematical Fusion Science" for the 2026 fiscal year. Building on achievements to date, the center is further expanding the scope of its activities as a hub for integrating the diverse data found in fusion research with cutting-edge statistical-mathematical thinking.

In March 2026, a public lecture (in Japanese) titled "The Future Society Opened Up by Plasma" was held in Aomori city as part of the NIFS outreach activity support program. While plasma plays a crucial role in nuclear fusion energy research and development, it is also actively utilized across various areas of society—including semiconductor manufacturing, medical applications, plasma agriculture, and environmental solutions—and holds immense potential for realizing a sustainable future society. We invited two experts at the forefront of plasma application research to deliver lectures entitled "What is plasma? The 'fourth state of matter', actively working in our daily lives" and "Controlling lightning to revitalize plants: plasma agriculture for the future" as seen in Fig. 1. The event also featured a Q&A session covering topics such as the relationship with fusion research, plasma applications, and potential collaborations with Aomori Prefecture, fostering interaction between the participants (mostly Aomori citizens) and the speakers.

Fig1
Flyer image for the public lecture (in Japanese), "The Future Society Opened Up by Plasma" (Aomori city, March 2026)

We also continue collaboration with nearby educational institutions. In April 2025, a RRC member gave a lecture entitled "Challenges to the unexplored, towards the realization of fusion energy" at the Engineering Design (ED) I for advanced-course first-year students at the National Institute of Technology (KOSEN), Hachinohe College. The contents are designed so that students can feel that their nearby area (Rokkasho village) has been and will further evolve as the world-leading base for fusion research. A lecture is also planned for 2026.

In addition, as a collaborating organization for the "Aomori Prefectural Citizens' College"—a partnership joined in the 2023 fiscal year—we served as instructors for the "Parents-children hands-on workshop" (held in November 2025) organized by the Rokkasho village board of education, where we built "spinning power-generation crawl robot" together with participating parents and children. Through participation in events like this, we are actively working to foster regional collaboration and spark interest in science for the next generation.

Fig2
"Spinning power-generation crawl robot", created at the Parents-Children hands-on workshop (Rokkasho village, November 2025)

Research Enhancement Strategy Office

The Research Enhancement Strategy Office was established in NIFS in 2013, as a result of a selection by the National Institutes of Natural Sciences (NINS) for a "Research University Enhancement Promotion Project" by the Ministry of Education, Culture, Sports, Science and Technology. This project selects domestic universities and inter-university research institutes that conduct superlative research, and supports their research enhancement policies. Special features of this program are the hiring and placement of Research Administrators (URA: University Research Administration staff) and their resulting performance of related activities. Although the project ended in March 2023, the activities of the office continue to develop.

The Office has two URAs, and promotes activities in five task groups: IR (Institutional Research) / evaluation, enhancement of public relations programs, strengthening of the financial base, enhancement of collaboration activities, and strengthening of human resource development programs. Each task group, headed by the group leader, promotes activities in coordination with other groups and committees in NIFS. These activities are coordinated with the Headquarters for Co-Creation Strategy, established in NINS.

Research Enhancement Strategy Office web page : https://reso.nifs.ac.jp/eng/

Academic Management Meeting

Research Enhancement Strategy Office

Director (1)
Task Group Leader (5)
University Research Administrator (2)
Specially Appointed Research Specialist (1)
Research Administration Staff (2)

Director

Research Enhancement Strategy Office Meeting
Research planning and strategy formulation

IR/Evaluation Task Group
—Analysis of research activities and results
—Research on the field trends
—Examination of evaluation index

link

Public Relations Enhancement Task Group
—Analysis of public relations status, effect, and impact
—Domestic and international media coverage
—Research on public relations activities in related fields

link

Financial Base Strengthening Task Group
—Examination of financial status
—Analysis of status for competitive research funding acquisition and application
—Trend survey of competitive research funds

link

Collaboration Research Enhancement Task Group
—Analysis of joint research satatus and results, and future planning
—Investigation of incentives for international joint research
—Survey on joint research in other institutes

link

Human Resource Development Strengthening Task Group
—Analysis of the status and results of the young, female, and foreigners, development and support
—Analysis of the status and results of education for graduate students
—Investigation of youth career paths

Self-Inspection Committee
—Performance evaluation relating to mid-term plans
—Preparation for external evaluation

Outreach to Society

The National Institute for Fusion Science (NIFS) conducts public relations and outreach activities to promote public understanding of fusion research, NIFS research activities, and research achievements.

Every year we open the Institute and its research facilities to the community, so that people may understand our research activities and become interested in our cutting-edge research. In FY2025, the event was held in October, and In addition to a facility tour (Fig. 1), hands-on activities and exhibits, including virtual reality, experiments with vacuum vessels (Fig. 2), and a superconducting maglev train, were offered to help visitors learn about plasma and fusion in an enjoyable way. About 670 people attended the event.

Moreover, we conduct activities to foster future researchers, such as educational collaboration activities with high schools (tours of the facilities, practical training), internship activities, and other projects.


Fig.1


Fig.2

Public Relations Office

The Public Relations Office, as the core organization responsible for public relations and outreach activities, promotes the disclosure and sharing of research achievements with society, including the local community, through a variety of activities. Since the restructuring of this organization in FY2023, there now are four committees: the Scientific and Public Relations Committee, the Social Engagement Committee, the Archives Committee, and the Educational Collaboration Committee. A summary of the committees is depicted in the following illustration.

Many NIFS research staff are active as members of the office. Principal activities include issuing press releases (Fig.1), publishing public relations magazines (Fig.2), holding scientific events (Fig.3), providing tours of NIFS facilities (Fig.4), scientific classroom activities (Fig.5), organizing and storing historical materials related to fusion science research in Japan, and educational collaboration activities with high schools.

Activities Conducted in FY2025

- Periodic delivery of e-mail newsletters (Research Updates)
- Campus tours (any time)
- Open lectures for the public (online)
- Science classroom activities

Publications and Videos

- NIFS official pamphlet (in Japanese and in English)
- Public relations magazine: *NIFS News*
- Pamphlet Energy Creating the Future: *Fusion*
- NIFS video: *For Our Children's Future*


Fig.1

Scientific and Public Relations Committee
Disseminating R&D achievements widely through press releases, websites, and publications

Social Engagement Committee
Enhancing social engagement through facility tours, scientific classroom, and scientific events

Archives Committee
Investigation, collection, organization, storage, and publication of historical documents related to fusion science research in Japan

Educational Collaboration Committee
Educational collaboration activities with high schools

Fig.2


Fig.3


Fig.4


Fig.5

Library

A library aiming to enrich materials and information provided to fusion researchers around the world

The NIFS Library has 72,000 books and 1,100 title of journals, mainly on physics, natural sciences and engineering, that aim to enrich materials and information to be provided to fusion and plasma researchers around the world. In addition, as an Inter-University Research Institute, we are also responsible for providing information to inter-university researchers nationwide and training students and young researchers.

The library maintains an online library catalog (OPAC), e-journals, e-books, and other online services in an effort to expand its functions as an e-library. We provide access to materials not held by the NIFS Library through pay-per-view services or by obtaining copies from other universities.

In January 2026, the library system was upgraded in collaboration with the Okazaki Library and Information Center and the National Astronomical Observatory of Japan Library, both part of the same organization. (Fig. 1)

In recent years, we have set up an exhibition corner near the library entrance for introducing the collection materials. Exhibitions cover a wide range of themes, not limited to specialized materials. (Fig.2)


Fig.1


Fig.2

Accumulation and Utilization of Research Activities

The Institute has formulated the "National Institute for Fusion Science Open Access Basic Policy", which is based on the principle of disclosing research results such as academic papers of its staff to the public, and is accumulating and disclosing research results. The library also edits and publishes the NIFS series and English annual reports.

■ NIFS Repository

NIFS Repository releases academic results and intellectual products generated by research or educational activities at NIFS. Anyone can access these files free of charge on the Web. NIFS fulfills social responsibility and makes social contributions by releasing research and educational activities through the NIFS Repository.

■ NIFS Series

This preprint publication rapidly disseminates research achievements at NIFS within Japan and abroad. This series consists of five types: NIFS-REPORT, PROC, TECH, DATA, and MEMO. (Fig.3)

■ Annual Report

The Annual Report summarizes all research achievements and activities at NIFS in each fiscal year. The reports are written in English.

Fig.3

Education Council -for Graduate Students-

As an academic center of the fusion community in Japan, NIFS has an important role in developing young researchers who are expected to lead future fusion activity. The education of graduate students is a core part of such human resource development. The Education Council was launched at NIFS in AY2023 and has been comprehensively promoting the education of the students. The education is undertaken within various frameworks in NIFS, such as the Graduate University for Advanced Studies, SOKENDAI, joint programs of graduate courses and special research collaboration programs for education with Japanese universities, internships, and so on.

The Graduate University for Advanced Studies, SOKENDAI

The Graduate University for Advanced Studies, SOKENDAI, was established in 1988 as the first national graduate university which offers only graduate courses (no undergraduate courses). As a unique and flexible education system, its five- and three-year doctoral programs are provided for students who have finished an undergraduate and a master's course. The educational framework of SOKENDAI has been upgraded to Graduate Institute for Advanced Studies since April 2023 to foster researchers in the next generation who can deal with complicated and challenging issues. Graduate Institute for Advanced Studies consists of 20 programs. Each one is supported by a corresponding inter-university research institute. NIFS is the institute in charge of the Fusion Science program.

At present, 18 students are studying in the Fusion Science program. The remarkable point of the program is that students can learn cutting edge scientific and engineering knowledge and skills in a wide range of scientific fields such as plasma physics, atomic physics, electrical and mechanical engineering, superconductivity engineering, material engineering, vacuum engineering, and information engineering. Highly integrated synergy of these fields is required in the fusion development. Therefore, NIFS keeps outstanding researchers specializing in the fields, and they directly teach the students. This is the reason why this remarkable education can be carried out.

Joint Program of Graduate Education and Special Research Collaboration Program for Education

In addition to the SOKENDAI scheme, NIFS provides other educational frameworks for students in various graduate universities. In 2026, NIFS educates 30 students belonging to the Graduate School of Frontier Sciences at the University of Tokyo, the Graduate School of Engineering at Nagoya University, the Graduate School of Science at Nagoya University, and the Interdisciplinary Graduate School of Engineering Science at Kyushu University, based on joint programs with these graduate universities. Furthermore, NIFS has accepted 9 graduate students from other graduate universities nationwide and abroad through the special research collaboration program. NIFS also continually offers educational internship programs.

Research and Education Innovation Office

The Research and Education Innovation Office is composed of the five committees shown in figure. It plans and implements activities to deal with various problems related to research and education at NIFS and to raise the level of research and education.

The Academic Planning Committee, plans and manages seminars and round-table discussions that benefit research institute members and the community. We also plan international conferences and publications hosted by NIFS. We will transmit information to academia based on suggestions from the installed advisory board.

In the Research and Education Improvement Office, along with the Academic Planning Committee mentioned above, four other committees work together to promote the development and improvement of the research and education environment at NIFS.

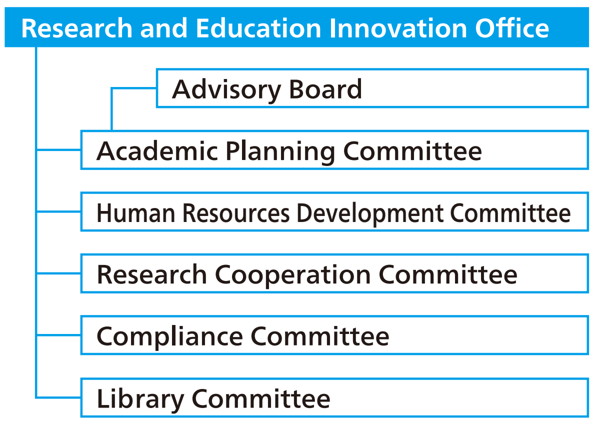


Fig. Composition of the Research and Education Innovation Office and the committees positioned within it.

Information Systems and Cyber Security Center (ISCSC)

Information network, systems and security

At NIFS, research activities generate a large amount of experimental and computational data. A number of results are produced from the data by an information system that is organic ally connected by an information network.

The Information Network Group provides a stable information network environment. Information networks can be regarded as the foundation of research activities, but they are still in their infancy and cannot be a reliable foundation simply by connecting devices. It is important to examine the functions of network devices and consider security.

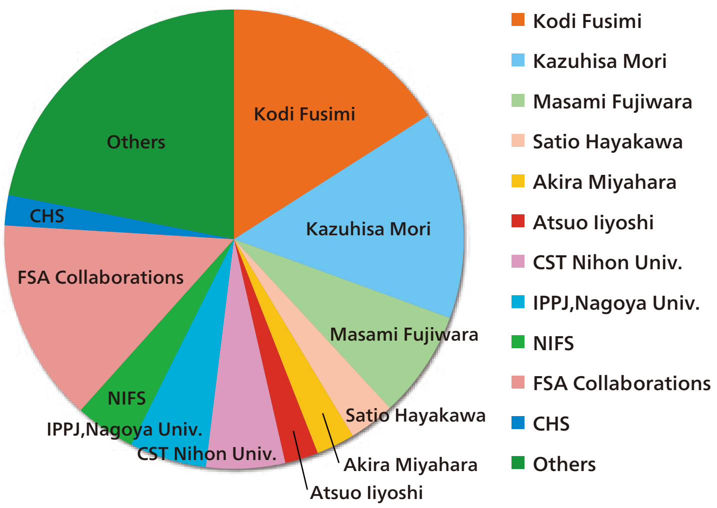
The Information Systems Group develops, operates, and maintains the various information systems that form the foundation of NIFS, as well as information systems related to outreach, evaluation, and research support. The processing capability of an information system is improved by data design and programming methods, and the user interface changes the ease of use. At the stage of developing information systems, we conduct appropriate system development by clarifying requirements through hearings with related parties to facilitate and improve the efficiency of research activities.

The Cyber Security Group works with the Information Network Group and the Information Systems Group to create a strong security structure. This includes user education. In addition, members of the Information Security Group also serve as the Computer Security Incident Response Team (NIFS-CSIRT), and in the event of a security incident, we will investigate the cause and respond to minimize the damage.

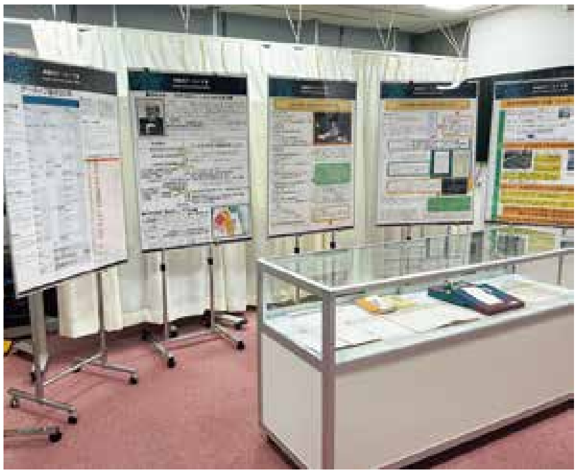
Fusion Science Archives

Taking a Lesson from the Past

Fusion Science Archives preserves and maintains collections of historical documents and materials that are related to fusion research in Japan. These activities are important from the viewpoint of the historical evaluation of fusion research and its social accountability. New items are constantly added through domestic and international collaborations. They are stored in acid-ftee folders and boxes. The total number of registered items is about 36,200 as of April 2026 (See Figure). Part of those catalogues are available to the public through the internet in a hierarchic structure and can be accessed by the use of an electronic retrieval system.
https://www/nifs.ac.jp/archives/



PROVENANCE OF REGISTERED ITEMS
(TOTAL NUMER 36246, AS OF APR. 2026)



A permanent exhibition room is located on the first floor of the Library Building, featuring explanatory panels and select materials from the Fusion Archives.

Industry-Academia Collaboration Research Laboratory for Fusion Energy (IAC Lab)

Overview

The Industry-Academia Collaboration Research Laboratory for Fusion Energy is a premier R&D hub where industry, academia, and government collaborate to realize fusion energy—the world's next-generation energy source. Our mission is not only to advance and enrich the research and education at the National Institute for Fusion Science (NIFS) but also to co-create new social value through strategic partnerships with external organizations.

- NIFS
  - Department of Research
  - Department of Engineering and Technical Service
  - IAC Lab
    - HF Research Group
    - Laser Science and Innovation Group
    - Joint Research Group for Power Generation Demonstration Technology
    - Technology Development Group

Fig1. Organizational Structure

Technology Development Group

We have established the "Technology Development Group" to leverage external funding from private enterprises and other organizations. By utilizing technologies developed in the field of nuclear fusion, this group aims to drive industrial innovation and accelerate the practical implementation of these technologies in society.

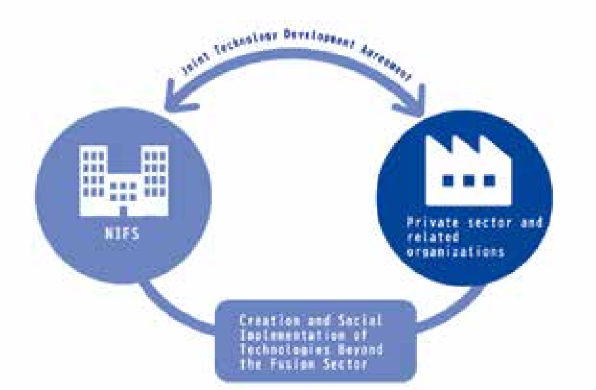


Fig2. Conceptual Image of the Technology Development Group

Technical Support for Fusion Startups

In recent years, startups have played an increasingly vital role in fusion development, intensifying the global race to realize practical fusion reactors. Our laboratory fosters an optimal environment for startups to advance their technological development, providing access to specialized equipment, advanced instruments, and highly experienced researchers and engineers.

Framework for Industry-Academia-Government Collaboration

To facilitate partnerships with external organizations, we offer a variety of collaboration models, including Academic Consultations, Joint Research, Collaborative Technology Development, Commissioned Research, and Commissioned Researchers. We recommend the most appropriate framework based on the specific needs of each partner. Through these initiatives, we support collaborative activities that leverage fusion-derived technologies to help build a future society focused on Society 5.0, SDGs, and Carbon Neutrality.

Coordinated International Research

Nuclear fusion research has been peacefully advanced under international cooperation since its inception, and today a wide range of research is being conducted in many countries. International cooperation will become increasingly important for the realization of fusion energy. NIFS promotes international collaborative research with many universities and research institutes within the following three frameworks:

○ Bilateral Cooperation Based on Intergovernmental Agreements
- Japan-U.S. Cooperation in Research and Development in Energy and Related Fields
- Japan-Korea Cooperation in Fusion Energy Research Area and Related Fields
- Japan-EU Cooperation in Controlled Thermonuclear Fusion Field
- Japan-China Cooperation in Research and Development in Magnetic Fusion Energy and Related Fields

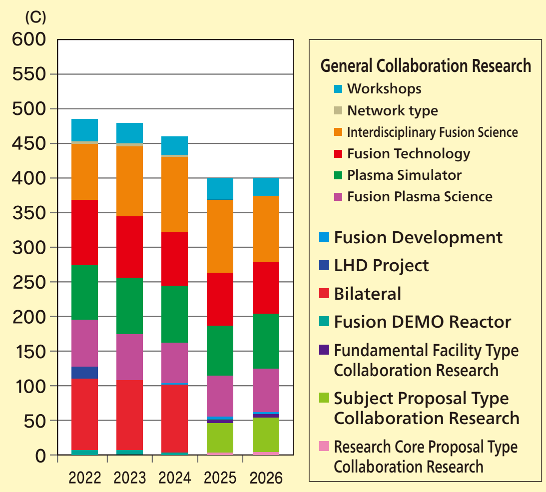
○ Multilateral Cooperation Based on Agreements between the Japanese Government and the International Energy Agency (IEA)

○ Inter-institutional Cooperation Based on Academic Exchange Agreements

Domestic Collaboration Research Programs

In order to satisfy the broad needs for advancing cutting-edge research, NIFS conducts five collaboration research programs. These are : General Collaboration Research which utilizes the facilities of NIFS, Fundamental Facility Type Collaboration Research, Fusion Development Collaboration Research, Subject Proposal Type Collaboration Research, and Core Proposal Type Collaboration Research, which utilize the facilities of other institutes. The joint use and joint research activities are powerfully developed by accepting research proposals from researchers each year.

NIFS collaboration research activities are always reviewed and improved to be compatible with the latest research trends by changing the categories of collaboration. In FY2022, the General Collaboration Research category was reorganized, and in FY2024, Fusion Development Collaboration Research was initiated. In FY2025, in order to support collaboration research that utilizes relevant external research facilities as research platforms, Fundamental Facility Type Collaboration Research, Subject Proposal Type Collaboration Research, and Research Core Proposal Type Collaboration Research were started. The figures show the number of accepted collaboration subjects in each category. LHD Project Collaboration Research, Bilateral Collaboration Research, and Fusion DEMO Reactor Collaboration Research were closed in FY2022, FY2024, and FY2025, respectively.

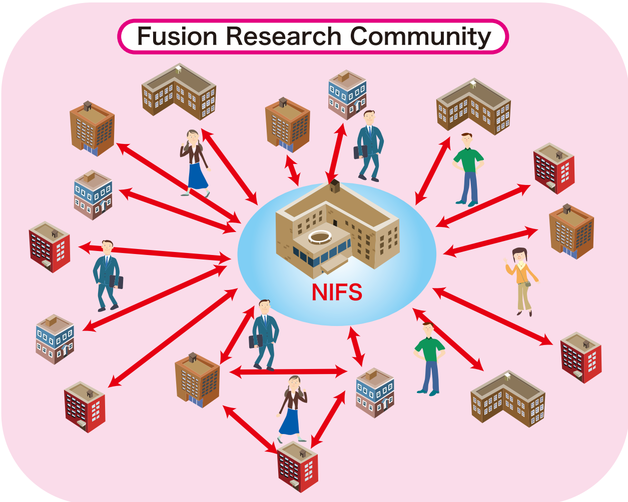


General Collaboration Research

General Collaboration Research is a system for the collaborators to carry out their research by using the facilities or the resources of NIFS, including experimental devices, diagnostics, the supercomputer, databases, and others. Because nuclear fusion includes a wide research area in physics and technology, from fundamental research to application, the system has a variety of categories.

In this collaboration, the collaborators come to NIFS and carry out research at NIFS. However, if it is necessary, NIFS staff can go to the university of a collaborator to perform joint research there. Furthermore, in the "network-type collaboration" category, the collaborators may conduct experiments at other universities involved in a particular project.

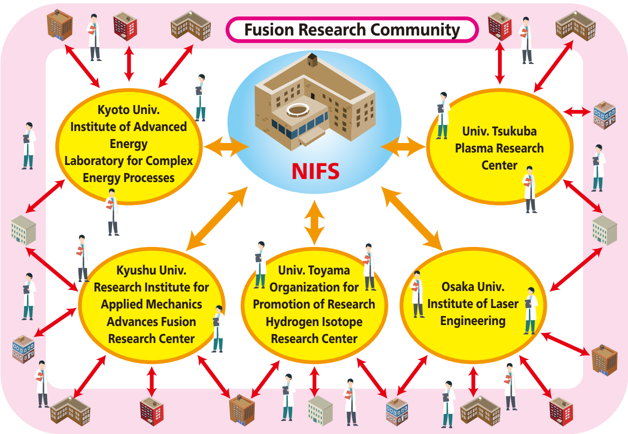
Many exploratory research proposals are adopted in the General Collaboration Research, and since a graduate student can be a collaborator, it is useful for training young researchers.



Collaboration Research Using Facilities Outside NIFS

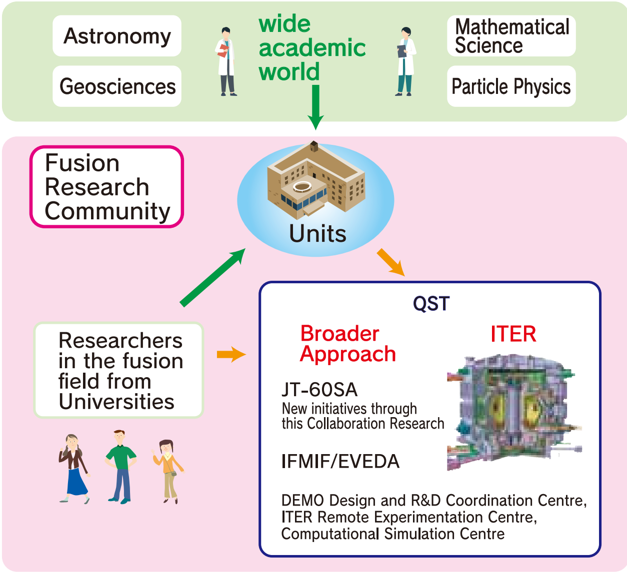
Fundamental Facility Type Collaboration Research

In Fundamental Facility Type Collaboration Research, excellent and original joint research that will contribute to the development of fusion science isconducted between NIFS and five research centers, the Plasma Research Center at the University of Tsukuba, the Laboratory for Complex Energy Processes at Kyoto University, the Institute of Laser Engineering at Osaka University, the Advanced Fusion Research Center at Kyushu University, and the Hydrogen Isotope Research Center, the Organization for Promotion of Research, at the University of Toyama.



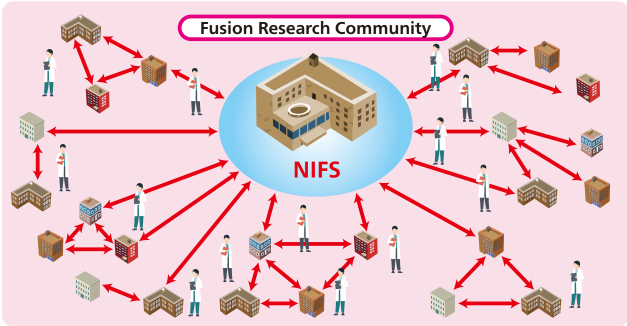
Fusion Development Collaboration Research

Fusion Development Collaboration Research aims to strengthen international competitiveness in the field of fusion science and to strengthen the foundation for human resource development. Fusion Development Collaboration Research promotes academic research using state-of-the-art fusion plasma experiment devices such as JT-60SA led by National Institutes for Quantum Science and Technology (QST) through the joint use program. Fusion Development Collaboration Research strengthens collaboration between academic research and fusion development research through the cooperation of NIFS Units and researchers in the field of fusion science and a wide range of academic circles.



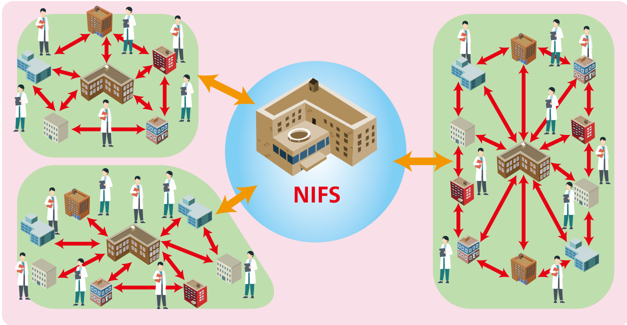
Subject Proposal Type Collaboration Research

In Subject Proposal Type Collaboration Research, joint research using the facilities and equipment of domestic and overseas universities and related research institutions as a research platform, and network-type joint research in which multiple universities collaborate ,is conducted.



Research Core Proposal Type Collaboration Research

In Research Core Proposal Type Collaboration Research, multiple universities and related research institutes collaborate on important issues in the field of fusion science to conduct joint research aimed at creating universal academic and technical knowledge and strengthening the research capabilities of the community through the creation of strong research teams.



Coordinated Research with Domestic Research Institutions

In many domestic universities and research institutions, the experimental and theoretical research which aims at the realization of nuclear fusion energy is advanced, as shown in the figure below. NIFS is promoting four types of collaboration research programs introduced previously to offer a place for research and interaction among researchers all over the country as a center of excellence of nuclear fusion science aiming at broad development of plasma and nuclear fusion research.

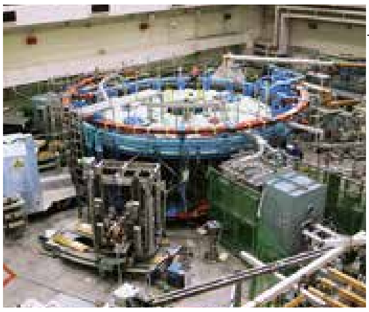
NIFS is also striving for the development of new scientific research fields cooperating with institutions which have excellent specialities through individual academic agreements.

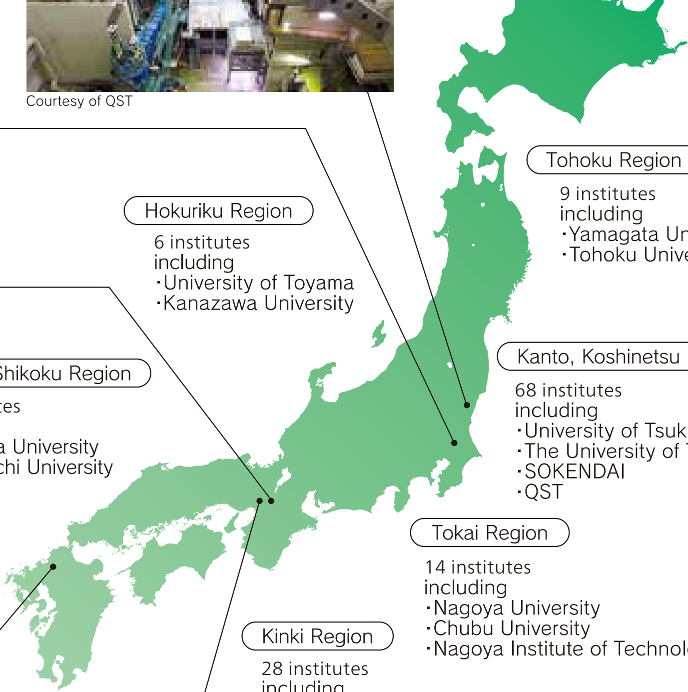
University of Tsukuba
GAMMA 10/PDX

National Institutes for Quantum Science and Technology
JT-60SA

Courtesy of QST

Kyoto University
Heliotron J





Hokkaido Region
8 institutes including
・Hokkaido University
・Kitami Institute of Technology

Tohoku Region
9 institutes including
・Yamagata University
・Tohoku University

Hokuriku Region
6 institutes including
・University of Toyama
・Kanazawa University

Kanto, Koshinetsu Region
68 institutes including
・University of Tsukuba
・The University of Tokyo
・SOKENDAI
・QST

Chugoku, Shikoku Region
17 institutes including
・Okayama University
・Yamaguchi University

Tokai Region
14 institutes including
・Nagoya University
・Chubu University
・Nagoya Institute of Technology

Kinki Region
28 institutes including
・Kyoto University
・Osaka University
・University of Hyogo

Kyushu Region
18 institutes including
・Kyushu University
・University of the Ryukyus

Kyushu University
QUEST

Osaka University
GEKKO-XII

Domestic Academic Agreements 12 institutions

・Hokkaido University
・Tohoku University
・University of Tsukuba
・The University of Tokyo
・University of Toyama
・Shizuoka University
・Nagoya University
・Nagoya Institute of Technology
・Osaka University
・Kyushu University
・National Institutes for Quantum Science and Technology
・Tajimi Technical High School

Department of Engineering and Technical Services

The Department of Engineering and Technical Services is responsible for the development, operation and maintenance of the various research facilities operating in NIFS. It also handles the management and operation of information network systems, as well as safety promotion tasks such as radiation management, high pressure gas management, and hazardous materials management. It makes significant contributions to the advancement of fusion research by providing advanced and specialized technical support.

Mechanical Systems Technology

Using CNC machine tools, conventional machine tools, and welding equipment, we fabricate experimental apparatus and precision components used in experiments.

NC machining center operations

Precision machined products

Design and Development Technology

Using numerical simulation software for structural, thermal, magnetic field, fluid, and electric field analyses, we develop experimental apparatus. In addition, we design and develop experimental apparatus used in vacuum and cryogenic environments.

Structural analysis simulation

Liquid helium transfer operation

Electrical and Electronic Technology

We fabricate electronic circuit boards required for controlling experimental apparatus. In addition, we develop and manage high-frequency power generation systems and large-scale neutral beam injection systems used for plasma production.

Electronic circuit construction

Maintenance of NBI system

Diagnostics and Analysis Technology

We develop and manage plasma diagnostics using lasers, ion beams, and related techniques. In addition, we carry out radiation safety management duties, including environmental radiation monitoring and the management of radiation measurement instruments.

Development for diagnostics

Radioactivity measurement

Control and Information Technology

We develop control systems tailored to specific experimental objectives. In addition, we are responsible for the operation and management of information network infrastructure and managing data acquired from experiments.

Control system development

Management of data storage

Human Resources Development Council

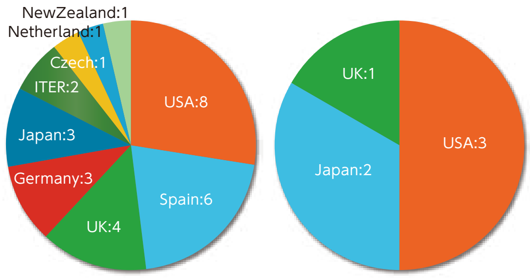
Since fiscal year (FY) 2024, the National Institute for Fusion Science has been promoting a project aimed at establishing a systematic framework for human resource development as well as fostering a diverse fusion workforce. This will be achieved through inter-university and international collaboration, as part of the "Infrastructure Development for DEMO Reactor Realization" under the Advanced Fusion Development Research Grant. Our policy is to promote a new influx of experts from other fields and industry professionals into the fusion sector and to provide educational programs that cultivate both specialized expertise and a broad and holistic perspective. Specifically, the Human Resources Development Council are implementing the following programs under nationwide applications.
(Figures in parentheses represent results for FY 2025)

(1) Schooling and Networking Project
- Fusion Science School (FSS) (5 schools)
- Human Exchange (29 person-exchanges)
- Student Internship (6 person-visits)
- Joint Program with Domestic Academic Societies (tentative to be implemented in FY 2026)

(2) ITER Related Project
- Financial support for ITER International School participation (20 people)
- Financial support for joining ITER Internship (3 people)

スクールテーマ	開催日程	開催場所	参加人数
Women in Fusion and Science (WiFaS) ウイメン・イン・フュージョン・アンド・サイエンス	2025年 12月8日㈪ ～12月10日㈬	水戸 プラザ ホテル	32名
Fusion Design ～電磁解析のハンズオンを通じて、フュージョンデバイス設計の視点を学ぶ～	2025年 12月10日㈬ ～12月12日㈮	御堂筋 本町ビル	9名
核融合について学び・発信するフュージョンエネルギースクール事業	2026年 1月10日㈯ ～1月12日㈪	九州大学 筑紫 キャンパス	40名
未来の原型炉を支える人材を育む多様な若手と核融合の架け橋となるスクール	2026年 2月21日㈯ ～2月24日㈫	つくば 国際 会議場	36名
フュージョン発電所の作り方 ～未来をデザインする三日間～	2026年 1月30日㈮ ～2月1日㈰	慶應義塾 大学 日吉 キャンパス	38名

FSS's implemented in FY2025



Destination countries for Human Exchange (left) and Student Internship (right) implemented in FY 2025

Outreach Headquarters

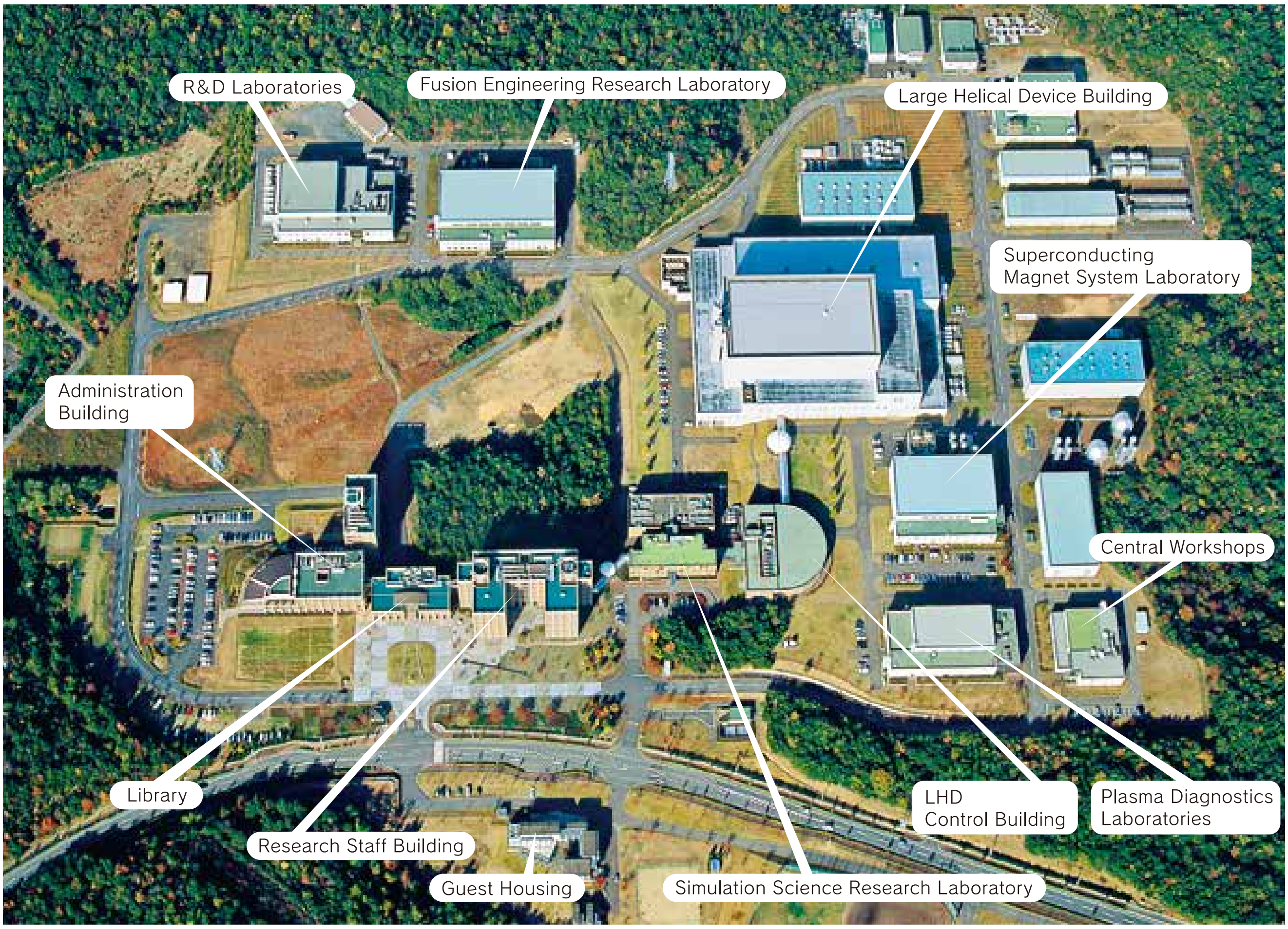
The Cabinet Office's Fusion Energy Innovation Strategy (adopted by the Integrated Innovation Strategy Promotion Council on April 14, 2023) identifies outreach activities to promote public understanding as one of the key industry–academia–government collaborative initiatives supporting the strategy. In response, the National Institute for Fusion Science (NIFS) now serves as the core institution responsible for operating the Outreach Headquarters, a framework established to enable the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and related organizations to work together in carrying out strategic outreach activities.

The Outreach Headquarters brings together representatives from organizations involved in fusion energy, as well as experts and other knowledgeable individuals. Its core membership consists of two NIFS members and nine external members, who plan and promote outreach activities in a flexible and agile manner.

In fiscal year 2025, with support from science communicators and other professionals, the Outreach Headquarters carried out a range of initiatives, including: (1) a public survey to better understand awareness and perceptions of fusion energy; (2) booth exhibits at fusion energy–related events; (3) the development of web-based communication tools; and (4) the creation and publication of educational materials for use in schools. In addition, it actively supported a wide range of outreach activities selected through an open call for proposals from universities, research institutes, academic societies, and other organizations throughout Japan.

Fig. Fusion energy outreach booth at a related event

Site Map



Site 464,445㎡ Total Building Area 39,557㎡ Total Floor Space 71,830㎡

History of NIFS

Nov.	1980	Science Council of the Ministry of Education proposes the "Long Range Plan for Fusion Plasma Research in Universities"
Mar.	1988	The structure of the National Institute for Fusion Science (NIFS) and the new project of the Large Helical Device (LHD) outlined
Apr.	1988	The preparation committee and preparation office for NIFS established
May	1989	NIFS established
Apr.	1992	The Department of Fusion Science established at the School of Mathematical and Physical Science, Graduate University for Advanced Studies
Aug.	1995	The LHD building completed
July.	1997	Headquarters of NIFS moved from Nagoya to Toki
Dec.	1997	Completion of LHD
Apr.	1998	The LHD experiments started
Apr.	2004	Inter-University Research Institute Corporation, "National Institutes of Natural Sciences (NINS)" inaugurated NIFS becomes one of the research institutes which constitute NINS National University Corporation,"The Graduate University of Advanced Studies (SOKENDAI)" was established; The Department of Fusion Science established in the School of Physical Sciences, The Graduate University of Advanced Studies (SOKENDAI)
May	2004	The 15th year anniversary held
Apr.	2010	The research section reorganized, and the Department of Helical Plasma Research established
Feb.	2014	Research Enhancement Strategy Office established
Apr.	2016	Division of External Affairs established
Mar.	2017	The LHD deuterium experiments started
May.	2019	The 30th year anniversary held
Dec.	2022	The LHD deuterium experiments completed
Apr.	2023	The research section reorganized and shifted to the UNIT research system The LHD restarted as an Academic Research Platform for interdisciplinary study
Dec.	2025	The LHD experiments completed

NIFS Location and Access

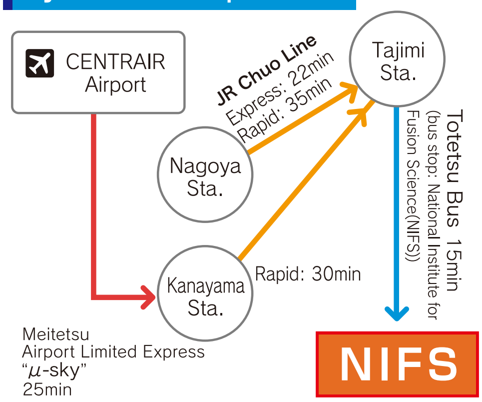
Rokkasho Research Center

Operates inside the building of the Rokkasyo Institute for Fusion Energy, National Institutes for Quantum Science and Technology
2-166 Oaza-Obuchi-Aza-Omotedate, Rokkasho-mura,Kamikita-gun Aomori-ken
039-3212
TEL:0175-73-2151
FAX:0175-73-2199

National Institute for Fusion Science

322-6 Oroshi-cho
Toki-shi, Gifu-ken
509-5292
TEL:0572-58-2222
FAX:0572-58-2601

By Public Transportation



By Automobile

・Toki-Minami Tajimi IC (Tokai-Kanjo Expressway)(5min)
・Tajimi IC/Toki IC (Chuo Expressway)(20min)

NINS National Institutes of Natural Sciences