NATIONAL INSTITUTE
FOR FUSION SCIENCE

Fusion

THE FUTURE ENERGY

Inter-University Research Institute Corporation
National Institutes of Natural Sciences

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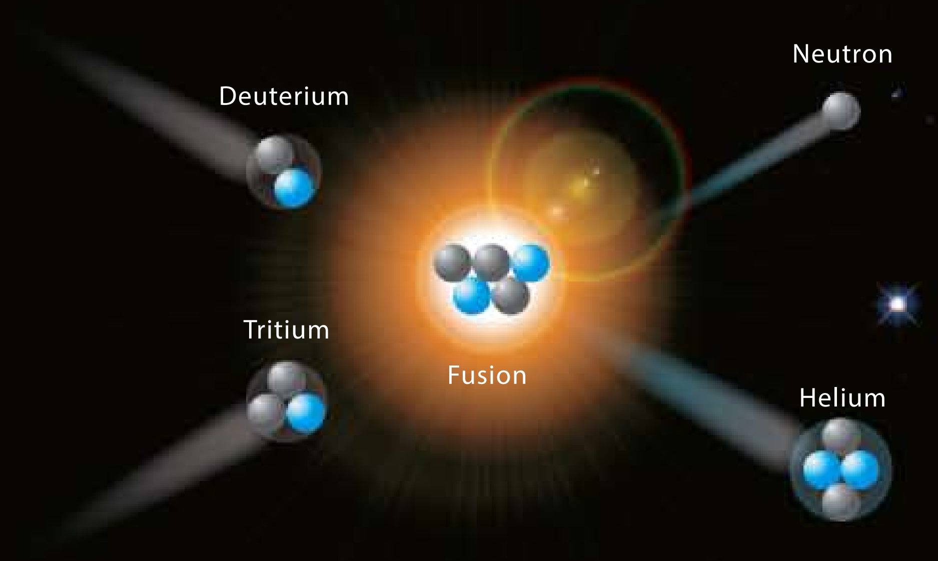
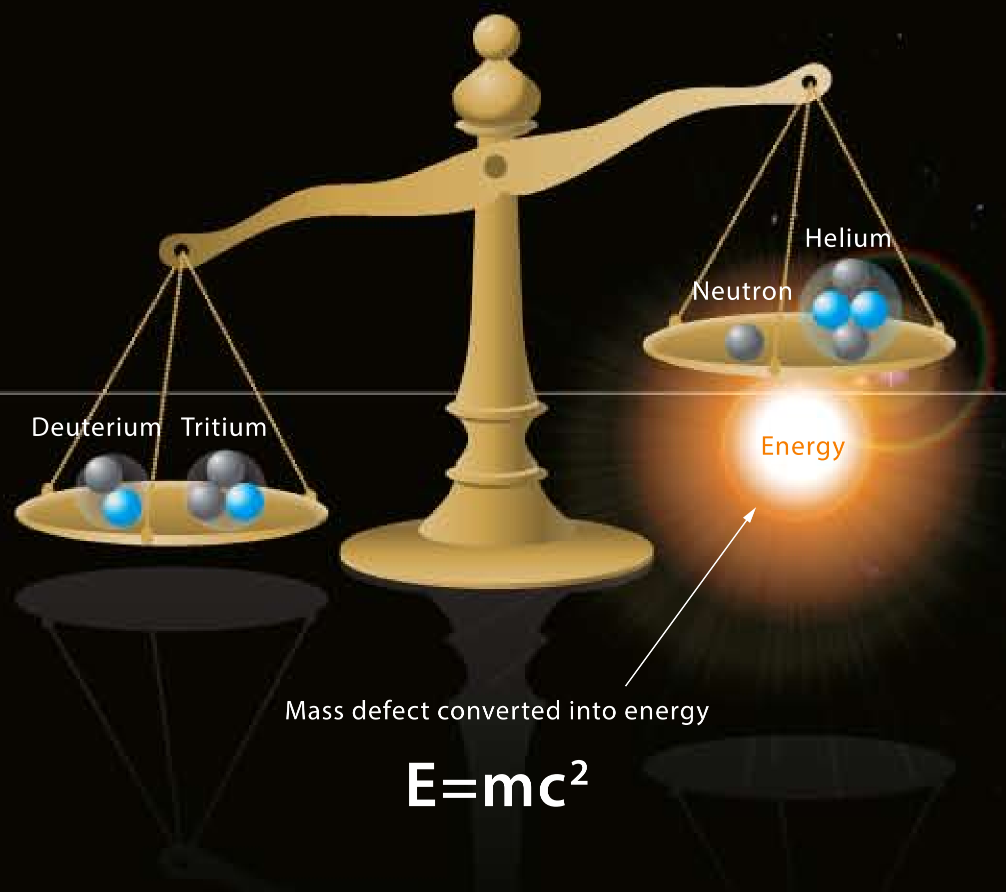
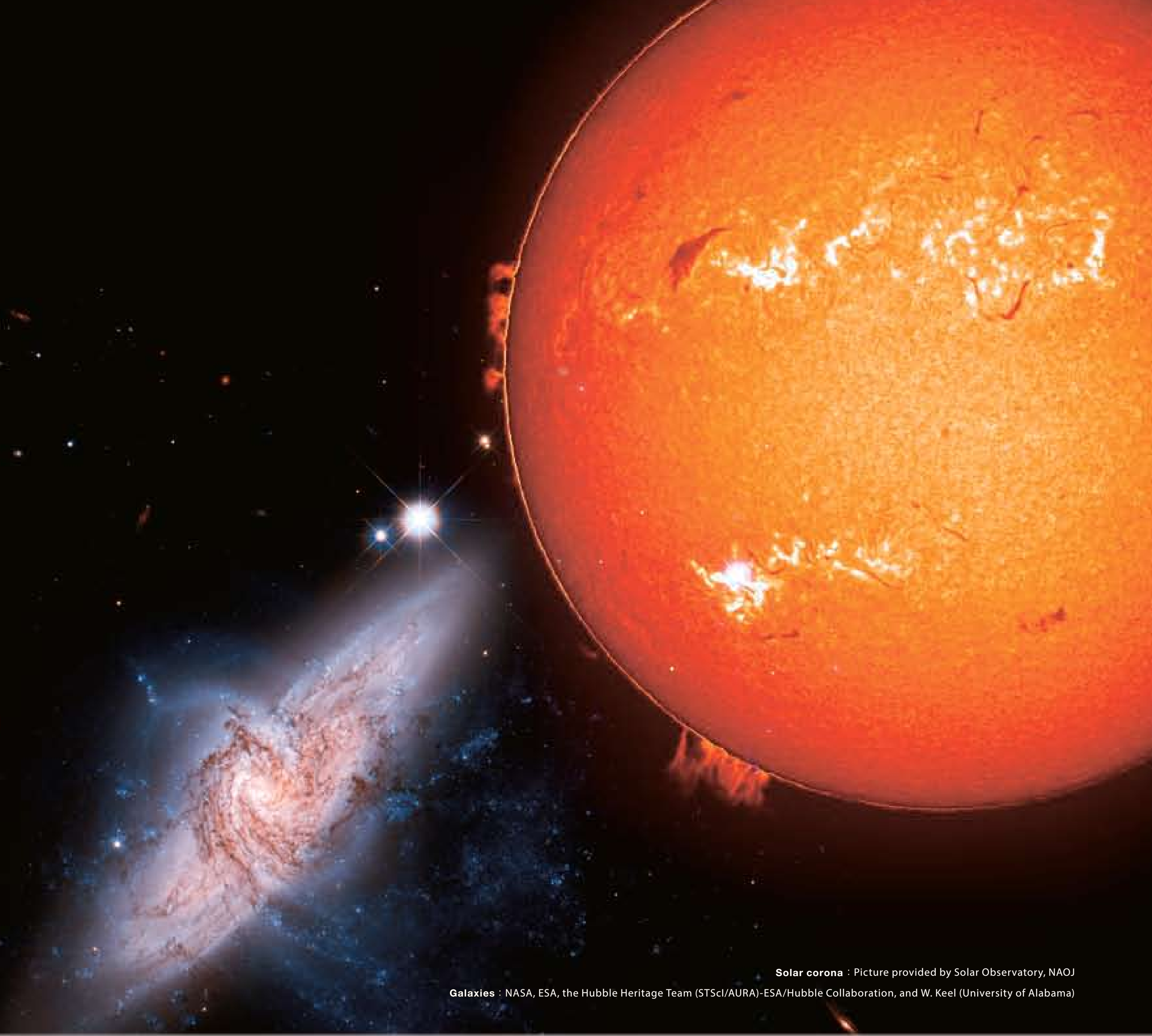
Fusion Energy

Fusion Reaction





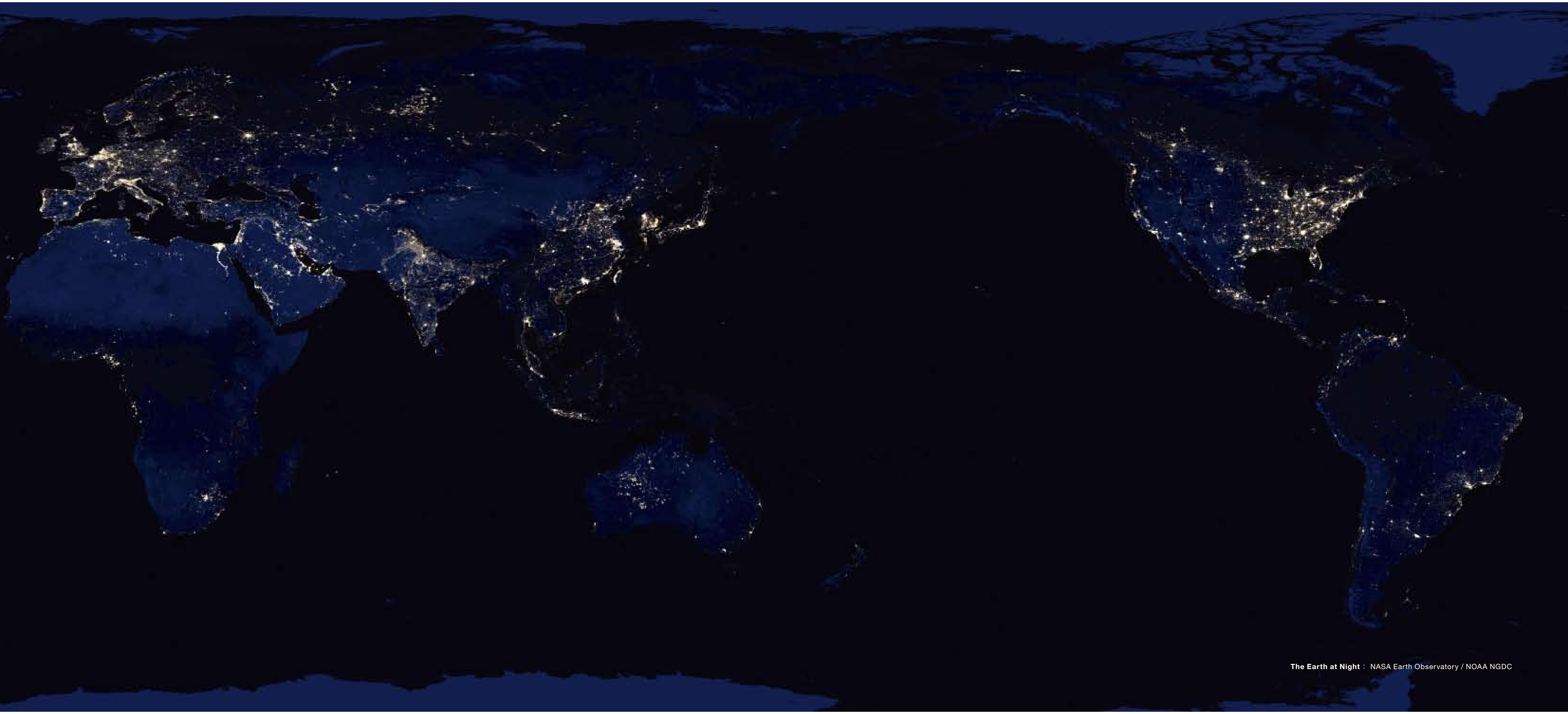


Solar corona: Picture provided by Solar Observatory, NAOJ

Galaxies: NASA, ESA, the Hubble Heritage Team (STScI/AURA)-ESA/Hubble Collaboration, and W. Keel (University of Alabama)

The reaction in which light atomic nuclei collide with another and heavy atomic nuclei are born is called a fusion reaction. The mass after the reaction is smaller than the mass before the reaction, and the reduced mass becomes energy. This energy is expressed as the law of conservation of energy ($E=mc^2$). The energy that brightens the sun and the stars comes from this fusion reaction.

At present, research for generating electricity by using the fusion reaction is advancing. In fusion reactions on Earth, deuterium (D), which has the same isotope as hydrogen, and tritium (T) become fuel. Lithium, which is necessary to produce tritium, and deuterium are found in seawater.



The Need for Fusion Power

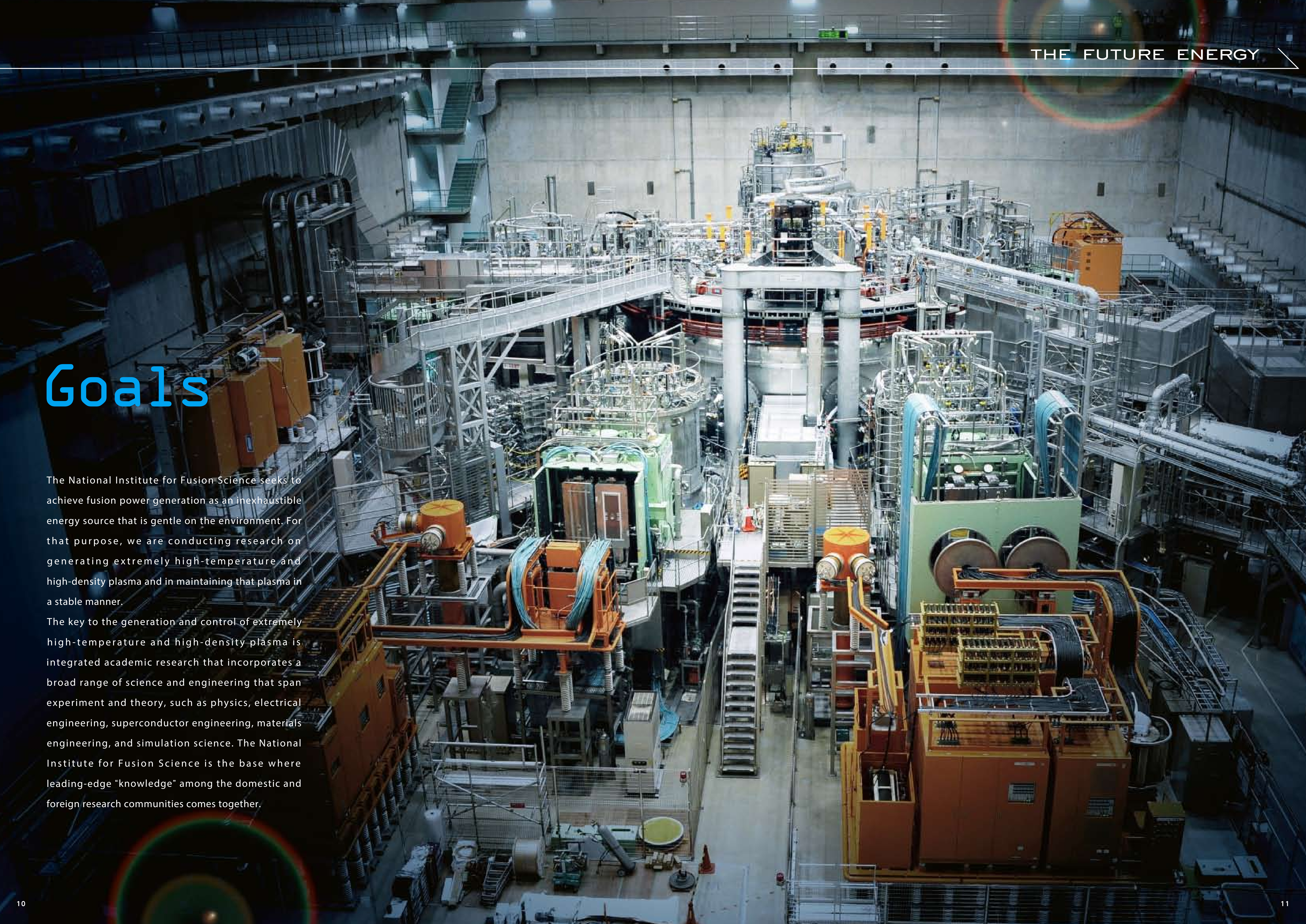
When seen at night from space, the lights that human beings use on Earth are clearly visible. This brightness tells of the great amounts of energy that human beings are consuming. Human beings, using fossil fuels such as coal, oil, and natural gas, built their present high-level scientific, technological, industrial society.

From now, accompanying the population growth and the economic development centered in developing countries, the earth at night will become ever brighter.

Benefits of Fusion Power

The consumption of fossil fuels is producing great amounts of carbon dioxide and nitrogen dioxide, and continues to bring severe influences to the earth's environment. Further, there are limits to the amounts of fossil fuels that are buried, and the exhaustion of energy resources is a concern.

Global warming, air pollution, and exhaustion of energy resources are serious problems that threaten the continued presence of humans. In supporting the advanced civilization that humans have built and passing an affluent society to future generations, the achievement of fusion energy as a new energy source that is inexhaustible and whose environmental burden is small is an important issue shared around the world.



Goals

The National Institute for Fusion Science seeks to achieve fusion power generation as an inexhaustible energy source that is gentle on the environment. For that purpose, we are conducting research on generating extremely high-temperature and high-density plasma and in maintaining that plasma in a stable manner.

The key to the generation and control of extremely high-temperature and high-density plasma is integrated academic research that incorporates a broad range of science and engineering that span experiment and theory, such as physics, electrical engineering, superconductor engineering, materials engineering, and simulation science. The National Institute for Fusion Science is the base where leading-edge "knowledge" among the domestic and foreign research communities comes together.

Research Activities of The National Institute for Fusion Science

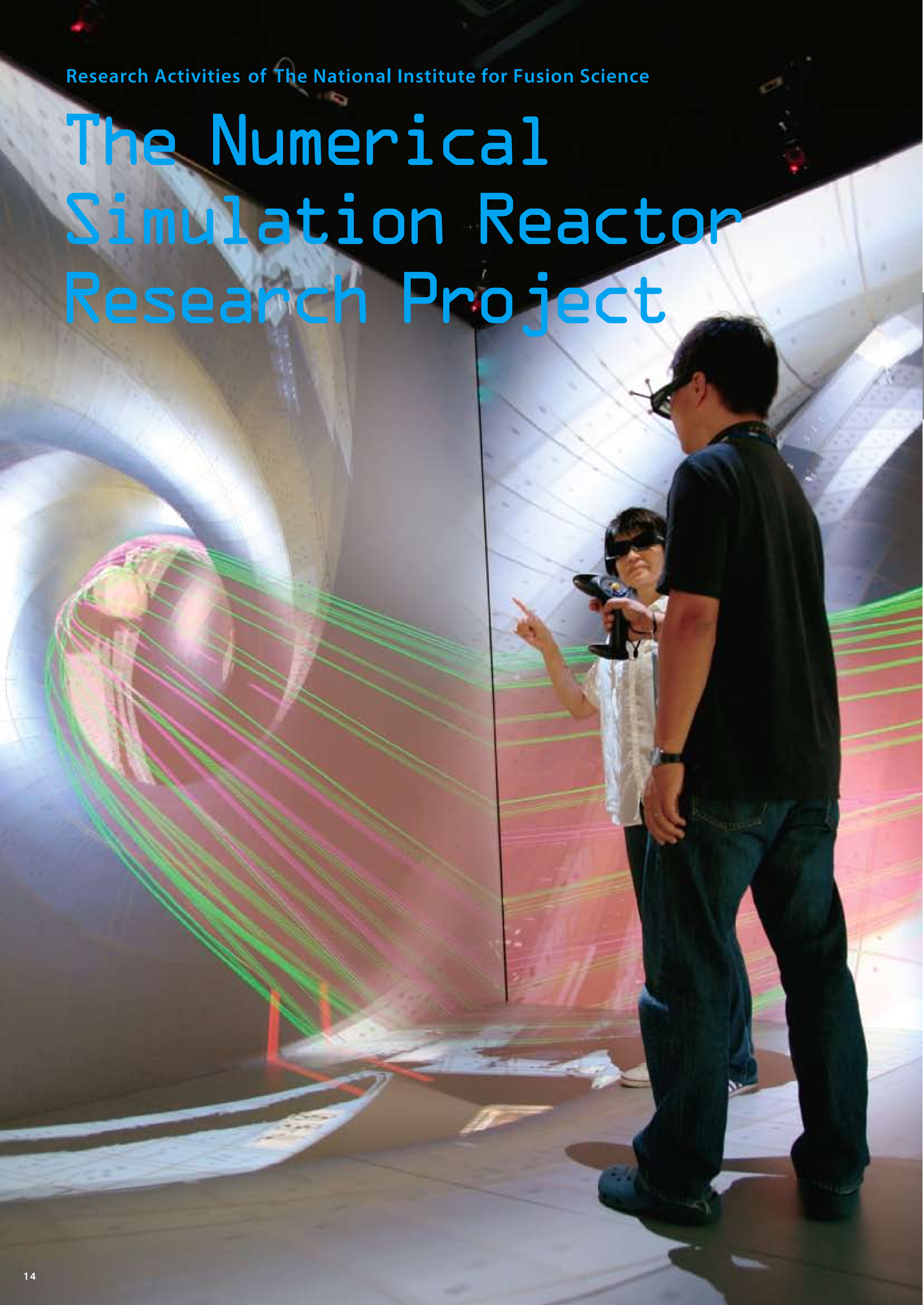
The LHD Project

Utilizing the "Large Helical Device" (LHD), which uses the magnetic field configuration called a "heliotron configuration," and which is an idea unique to Japan, this project conducts research in the generation and the maintenance of extremely high-temperature and high-density plasma.

In order to achieve fusion energy generation, it is necessary to raise the ion temperature of a plasma to more than 120,000,000 degrees Celsius and to reach a density of more than 100,000,000,000,000 per cubic centimeter. In order to satisfy this condition, we are engaging in research on such issues as confinement physics, plasma heating, and the stable maintenance of plasma.

Research Activities of The National Institute for Fusion Science

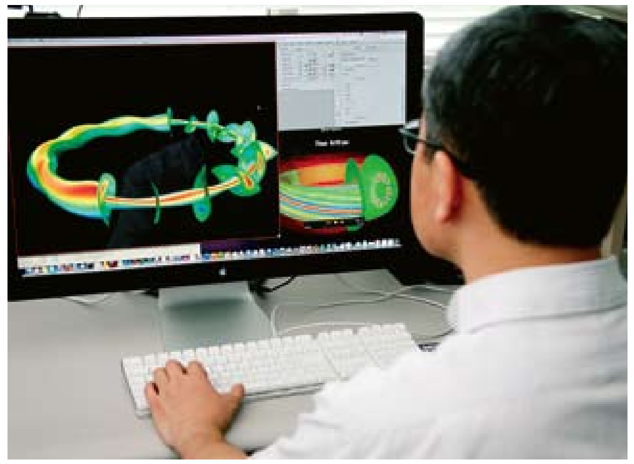
The Numerical Simulation Reactor Research Project



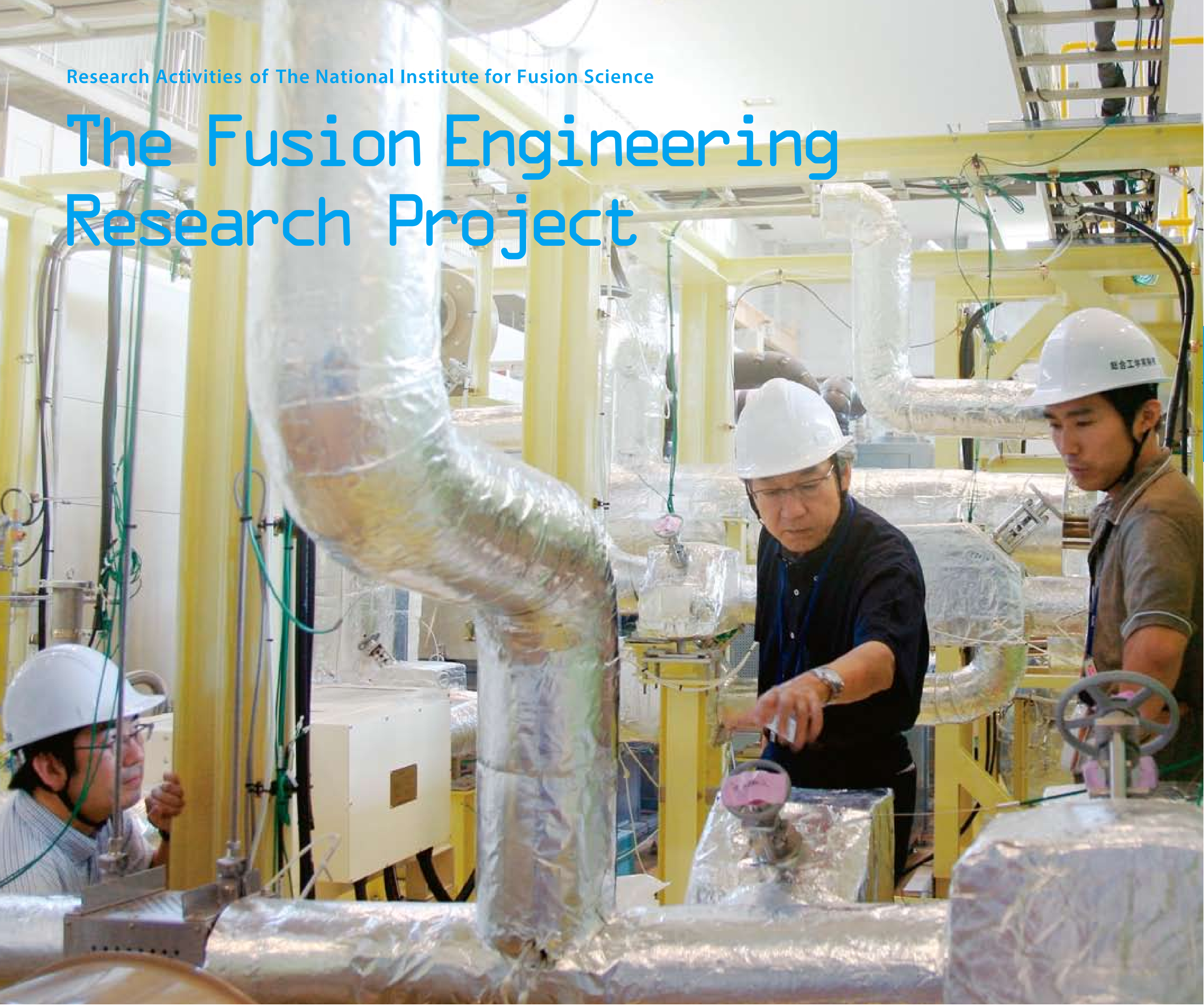
This project engages in numerical experiment reactor research that aims to predict plasma behavior when confined in the fusion device.

In a plasma are micro-scale phenomena that are caused by the movement of electrons and ions. Moreover, there also are macro-scale phenomena at the size of the Large Helical Device that are born from the group movements of electrons and ions. Thus numerous phenomena of differing time scale and spatial scale are mixing.

We recreate these complicated phenomena in a supercomputer, and conduct research that discovers the physics principles that control the phenomena that occur in a plasma.



The Fusion Engineering Research Project



In this project, we are conducting design research in order to clarify what a helical type fusion reactor would be were one to be constructed. In order to realize such a reactor, as the two wheels of a cart, we are engaged in leading-edge engineering research through joint projects with numerous researchers.

We are gaining one after another leading-edge results and important new experiences regarding the "superconducting magnet" that produces a powerful and steady-state magnetic field that confines a fusion plasma, the "reactor instruments" that absorb the energy that emerges from the fusion reaction and self-produce the fuel, and the long-lasting "advanced materials" capable of withstanding a severe environment.

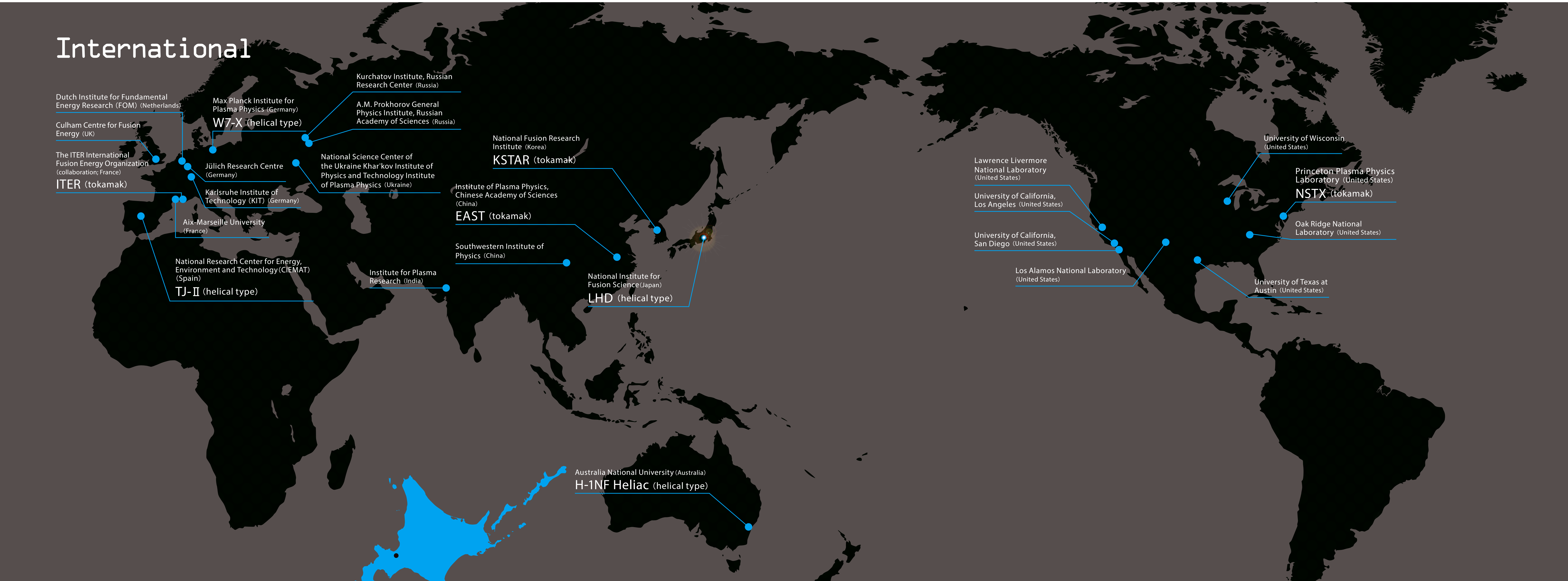
Safety Management

In the LHD, with the goal of producing further extremely high-temperature and extremely high-density plasma, we are planning experiments that will utilize deuterium, which is an isotope of hydrogen. Less than 0.01% of deuterium introduced in an experiment will cause a fusion reaction. The radioactivity level from the LHD to the environment is less than the natural radiation level in nature. And even after commencing with the deuterium experiments, people will be able to go inside the LHD and conduct maintenance work. At NIFS, we have continuously conducted safety management and made information publicly available through continuous measurement of the environmental radiation on our campus, and we make that information available to the public through our homepage. In addition, looking toward the deuterium experiment, we have established the Division of Deuterium Experiments Management, and have strengthened safety management and the sound maintenance of equipment. And we are dealing with those matters in a unified way.

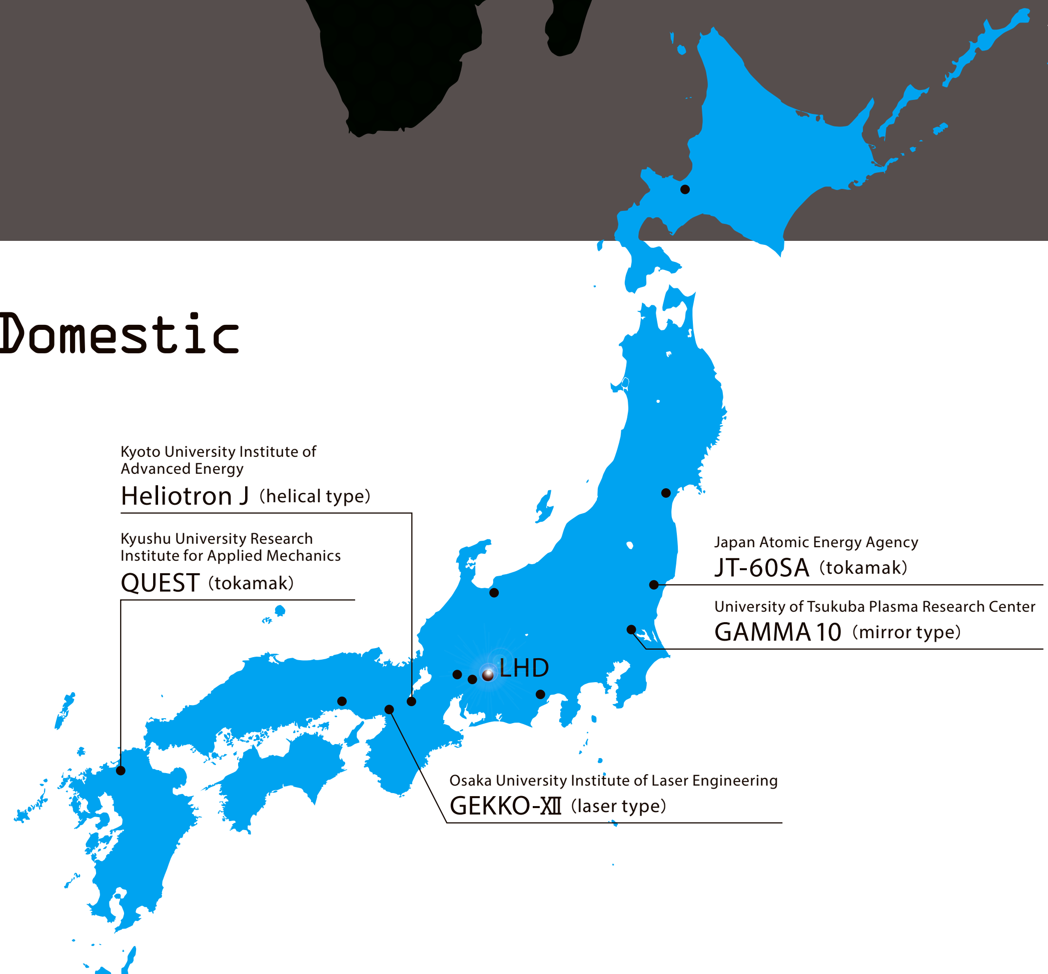
Note : At NIFS, we will not conduct experiments that use tritium.

Joint Research

International



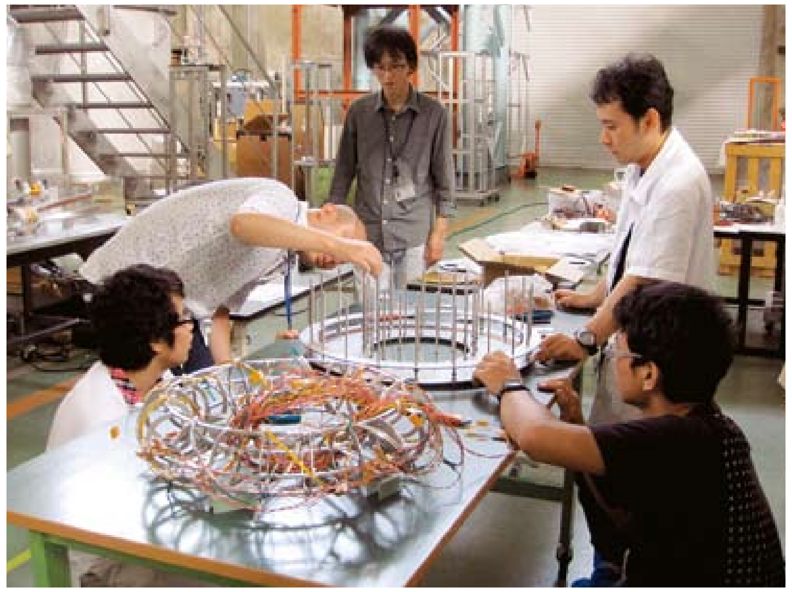
Domestic



In order for research development and the construction of scholarly foundations that aim at the realization of fusion energy generation, it is necessary to gather together the world's knowledge.

NIFS is an Inter-University Research Institute open to researchers at universities throughout Japan. And as Japan's core institution for fusion science research, NIFS has entered into academic cooperation agreements with important universities and research institutes in Japan and abroad. Moreover, NIFS is engaged in active joint research with more than 200 universities and research institutes.

Human Resource Development



NIFS, as the principal institute for academic research in fusion in Japan, is bearing the important role of promoting the growth of young researchers who will carry fusion science in the future. In graduate school education, in addition to the program in fusion science at The Graduate University for Advanced Studies (Sokendai), NIFS is also assisting in cooperative education with universities throughout the country.

Outreach Activities

In order for NIFS and for fusion to be more widely known among the general public, in addition to conducting public relations activities in Japan and in foreign countries, we are engaged in various activities seeking to enhance science education through cooperating with local society and educational institutions.

Lectures

Fusion Festa

Open Campus

Facility Tours

Public Forum

Discovering Science

Internships

Scientific Experiments

Super Science High School

Outline History of NIFS

November	1980	Science Council of the Ministry of Education proposed the "Long Range Plan for Fusion Plasma Research in Universities"
February	1986	The structure of the National Institute for Fusion Science (NIFS) and the new Large Helical Device (LHD) project were outlined
March	1988	The structure of the Fusion Science Research Center (temporary name) and the plan for the next-generation Large Helical Device formulated
April	1988	The preparation committee established and the preparation office for NIFS opened
May	1988	NIFS established in Chikusa Ward, Nagoya
April	1992	The Department of Fusion Science established in the School of Mathematical and Physical Science, Graduate University for Advanced Studies (Sokendai)
August	1995	The Large Helical Device experiment hall completed
July	1997	Move to the Toki area; the home area of NIFS changed to "Gifu Prefecture"
December	1997	Large Helical Device completed
April	1998	Large Helical Device experiments started
April	2004	The Inter-University Research Institute Corporation "National Institutes of Natural Sciences" established; NIFS reorganized as a research institute in the National Institutes of Natural Sciences; National University The Graduate University for Advanced Studies established; Fusion Science course established in the graduate school's School of Physical Sciences Department of Fusion Science
April	2010	Research organization revised and unified; Department of Helical Plasma Research Division established

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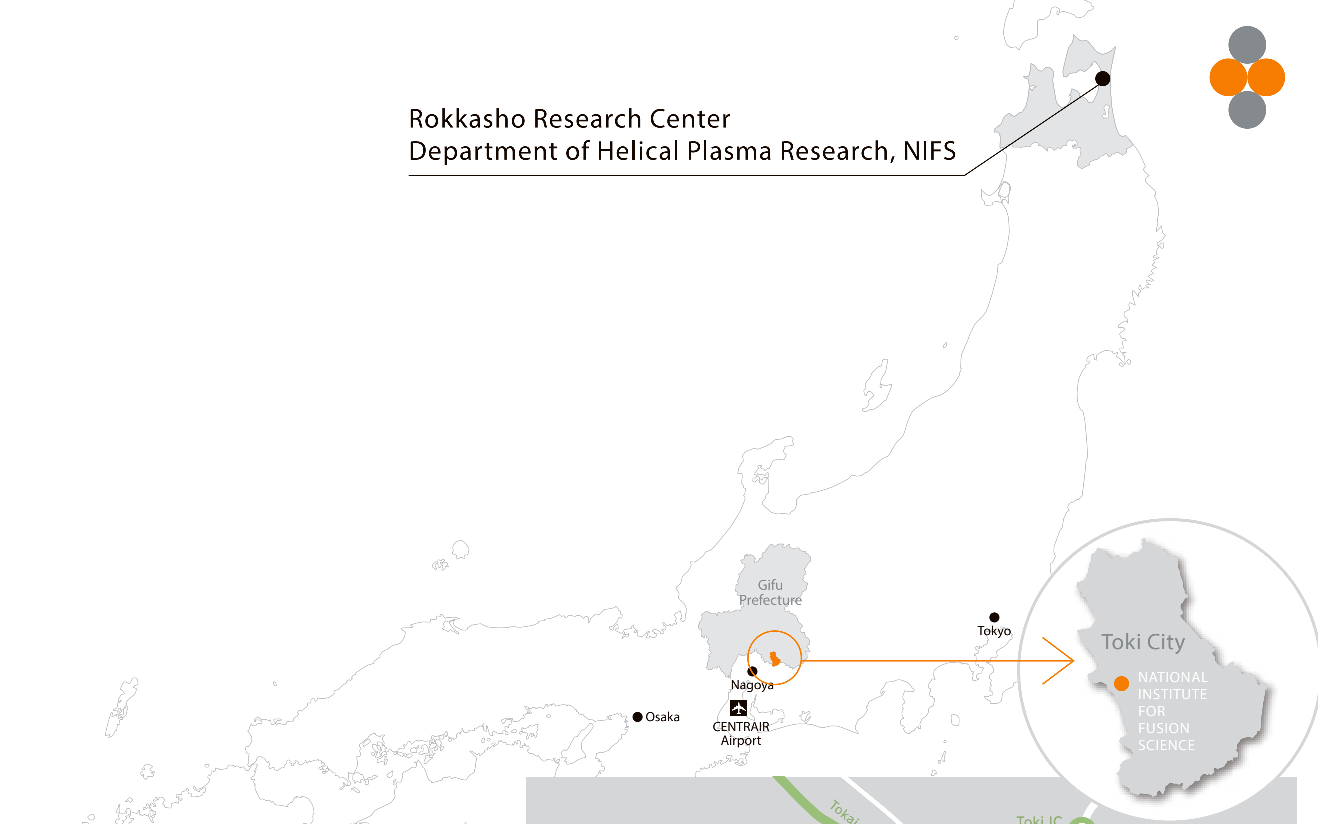

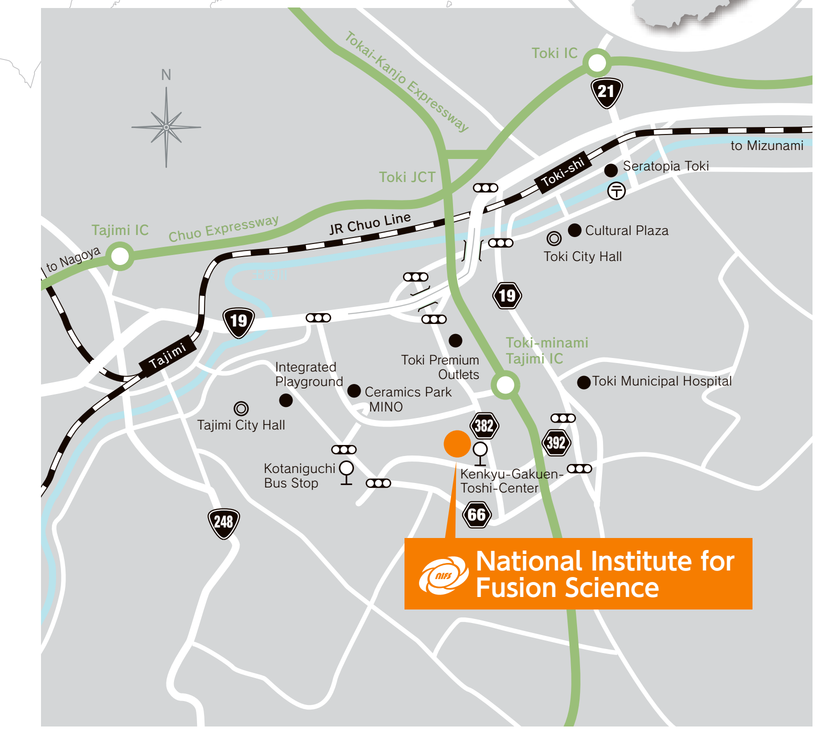

To visit NIFS

>> By car ;
Tokai Kanjo Expressway (Toki-Minami Tajimi Interchange [IC]) ;
5 minutes from the Interchange

>> By public transportation;
From Tajimi Station on the JR Chuo Line,
ride the Totetsu Bus Company bus (Gakuen Toshi bus route) ;
approximately 20 minutes; get off the bus at
"Kenkyu - Gakuen - Toshi - Center"

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