History

1972
- Founded as "Facility of Laser Engineering Research" attached to Faculty of Engineering
- Establishment of Laser Materials Division

1973
- Establishment of Laser Dynamics Division

1976
- Reorganization and name changed to "Institute of Laser Engineering (ILE)" ("*レーザー核融合研究センター*", literally Laser Fusion Research Center)
- Establishment of Laser Simulation Engineering Division

1977
- Establishment of Laser Engineering Division

1979
- Establishment of Laser Fusion Fuel Pellet Engineering Division

1980
- Establishment of Laser Diagnosis Engineering Division

1981
- Establishment of Laser Implosion Engineering Division

1982
- Establishment of Energy Transfer Engineering Division

1989
- Reorganization of Laser Fusion Fuel Pellet Engineering Division to Fusion Target Engineering Division

1990
- Organization of "Research Center for Superconductor Materials and Electronics" (reorganized from "Superconductivity Engineering Laboratory Center" attached to Faculty of Engineering)
- Merged Laser Diagnosis Engineering Division with Laser Implosion Engineering Division and reorganization to Ultra-high Density Plasma Fusion and Measurement Division

1992
- Reorganization of Energy Transfer Engineering Division to Fusion Driver Control Engineering Division
- Establishment of Visiting Foreign Researchers Division

1999
- Reorganization of all research divisions into four new divisions: (1) High-Power Laser Engineering, (2) Implosion Fusion, (3) Laser Plasma Science and Engineering, and (4) High-Intensity Optical Engineering

2000
- Reorganization of "Research Center for Superconductor Materials and Electronics" to "Research Center for Superconductor Photonics (RCSP)"

2004
- Reorganization of all National Universities and establishment of National University Corporation
- Reorganization and name changed to "*レーザーエネルギー学研究センター* (ILE)"(literally Laser Energy Research Center) with the integration of "RCSP"

2006
- Authorized as a National Joint-Use Facility

2010
- Authorized as a Joint Usage/Research Center

2017
- Reorganization and name changed to "*レーザー科学研究所* (ILE)" (literally Laser Science Institute)

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ILE

INSTITUTE OF LASER ENGINEERING
OSAKA UNIVERSITY

INSTITUTE OF LASER ENGINEERING, OSAKA UNIVERSITY

Our goal is to be a global research hub for innovation, exploring the frontiers of our world.

Since lasers were invented in the 1960s, optical technologies have evolved dramatically — for example, high-power lasers have developed to the point where petawatt-order pulses can be generated, which is more than 1,000 times the level of the world's instantaneous power consumption today. We are on the verge of being able to study the interactions between light and vacuum and, furthermore, certain extreme conditions with high energy densities have been realized experimentally using these technologies. This has allowed us to create and control pressures as high as 10 million atmospheres, which have not been demonstrated using conventional equipment. In addition, the evolution of extremely short optical pulse technology has opened up research into the ultrafast world of pico- and femtosecond regimes, which cannot be accessed by any other technique, and the range of laser frequency has been successfully extended to orders of terahertz or exahertz (*e.g.* X-rays), giving us the capabilities to observe and control various material states.

The Osaka University Institute of Laser Engineering aims to become an international research hub with the capability to create novel scientific fields and revolutionary technologies which will lead to innovation. Laser technology is ever developing, evolving, and diversifying, allowing us to explore new fields of sciences that have previously been *terra incognita* to human beings. The Institute also aims to nurture talented personnel who will help us to bring our innovations out into the world.

Ryosuke KODAMA
Director of Institute of Laser Engineering
OSAKA UNIVERSITY

INSTITUTE OF LASER ENGINEERING, OSAKA UNIVERSITY

Towards Co-creation

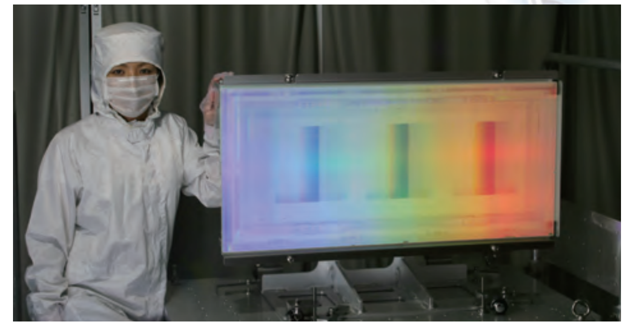
Institute of Laser Engineering Organizational Structure

Photon Beam Science


GEKKO XII: large high-power laser system

The Photon Beam Science Research Division promotes systematic and comprehensive research on the fields of optical science such as laser engineering, optical materials science and engineering, terahertz photonics, and power photonics. In addition, we explore quantum beam science-related researches including plasma photonics and nuclear photonics in Osaka University. We contribute to the creation of new innovations by promoting industry-university partnerships and interdisciplinary collaborations with the High Energy Density Science, Laser Fusion Science, and Theory and Computational Science Research Divisions.

Aside from the GEKKO XII laser, our group has independently developed one of the world's most powerful laser, the LFEX petawatt laser system. We also carry out investigations on laser-related optical elements and devices such as new nonlinear crystals, novel laser materials, large diffraction gratings, and advanced amplification systems. We aim to realize the next generation high-power lasers which are useful not only in research and development but also in the creation of new technologies and innovations for laser damage assessment.


Ultrahigh precision diffraction grating for LFEX - the world's largest high-power laser


Optical experiment with high-power laser

Furthermore, we perform fundamental research based on terahertz radiation leading to the development of metamaterials and new electronic materials. In the long term, we seek to become frontrunners of terahertz nanoscience and terahertz bioscience by engaging in both terahertz and nanoscience researches.

Moreover, we develop plasma photonics in Osaka University with the aim of achieving laser acceleration and high-power laser system miniaturization through the integration of plasma physics and photonics. We also pioneer nuclear photonics which further ties our strength in nuclear science to photonics.

We achieve our goals and realize new innovations through a wide range of university-industry partnerships as well as interdisciplinary collaborations with other research divisions.

High Energy Density Science

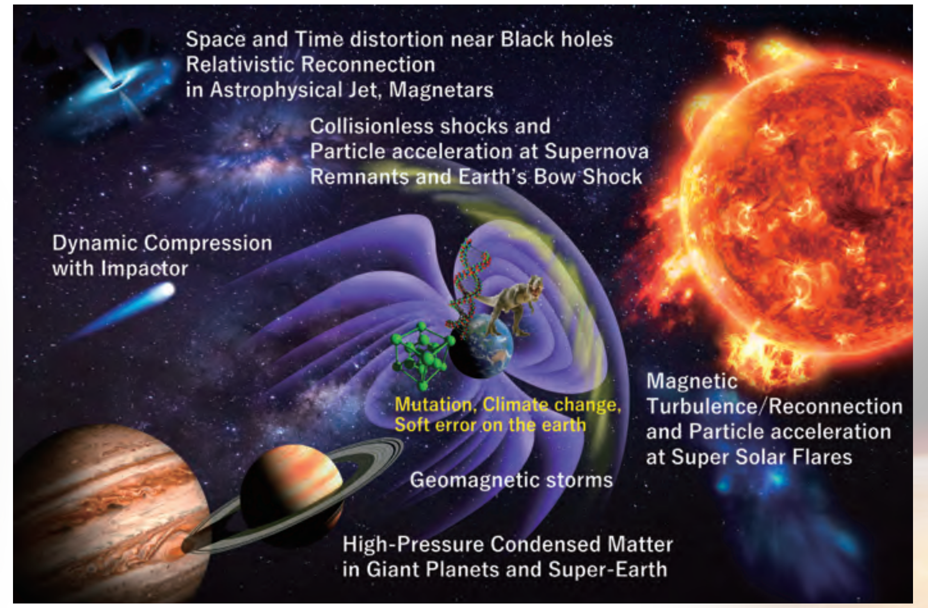

Neutron detector to capture nuclear fusion reaction

The High Energy Density Science Research Division explores interdisciplinary fields from the basic science of the universe to the manufacturing applications by dealing with high energy density states created with high-power lasers. In addition to laser astrophysics initiated at Osaka University, we engage in research on high-pressure materials science and the physics of ultrahigh-intensity fields. We contribute to the understanding of physical processes and to the creation of new innovative ideas through collaborations with the Photon Beam Science and the Laser Fusion Science and Theory and Computational Science Research Divisions, respectively.

Our group explores laser astrophysics as a quest for high energy density states which are created with high-power lasers. Our goal is to shed light on the "mysteries of the universe" by elucidating physical phenomena such as the collisionless shock waves related to supernova explosion, astrophysical jets, and solar flares and the magnetic turbulence or reconnection from spatiotemporal distortion in high acceleration fields corresponding to the wakefield near a black hole.


Large chamber for laser and plasma interaction experiments

Using a high-power laser, we realize a high-pressure state which exceeds 10 million atmospheres (10^{12} Pascal) – the pressure inside the earth's core or at giant planets like Jupiter and other earth-like planets outside the solar system. We perform this research to discover new materials under high pressure and to analyze various laser processes.



Exploring the universe and planets using high-power lasers

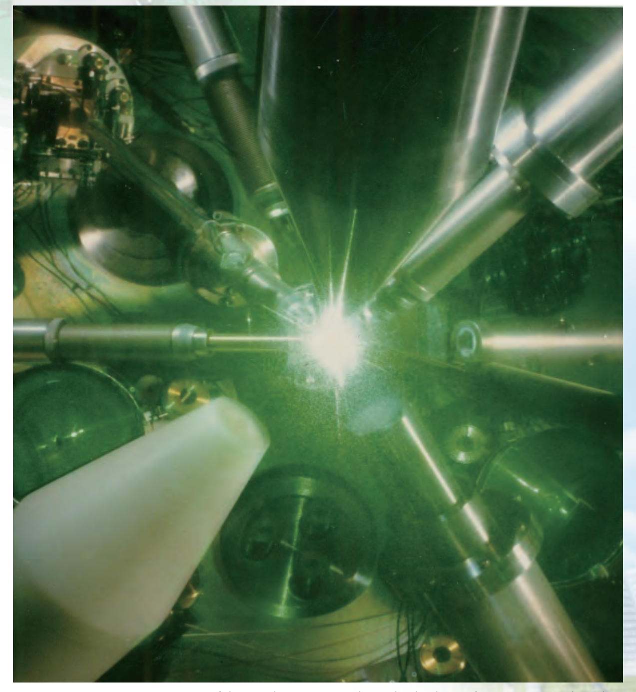
We are also conducting research that leads to the elucidation of the many secrets of the universe such as extremely high plasma and magnetic fields through relativistic particles and magnetic fields above 10 kilotesla. Furthermore, we are devoted to elucidate the state of ultrahigh electromagnetic fields where the interaction between light and vacuum cannot be neglected.

We achieve our goals and realize new innovations through interdisciplinary collaborations in quantum optics, quantum electromagnetism, astrophysics, plasma physics, solid-state physics, and high pressure physics and chemistry with other research divisions.

Laser Fusion Science

The Laser Fusion Science Research Division pursues research on fusion plasma science, laser fusion engineering, and materials science to develop fusion energy using high-power lasers. We contribute to the creation of new fundamental and applied technologies to realize fusion energy by engaging in interdisciplinary collaboration with other research divisions such as the Photon Beam Science.

To realize laser fusion as a sustainable energy source of the future, our group undertakes a wide range of laser nuclear fusion research ranging from materials science to plasma generation and measurements.

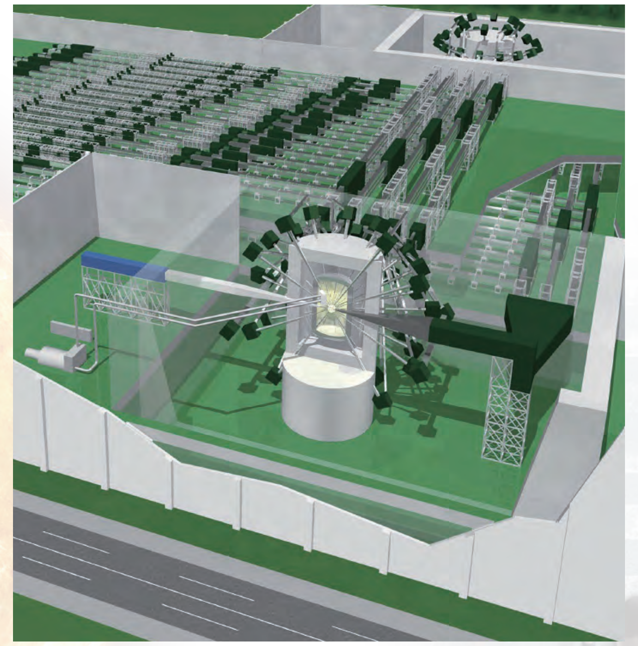

A laser shot captured inside the laser fusion target chamber


A Li6 glass scintillator array for neutron detection

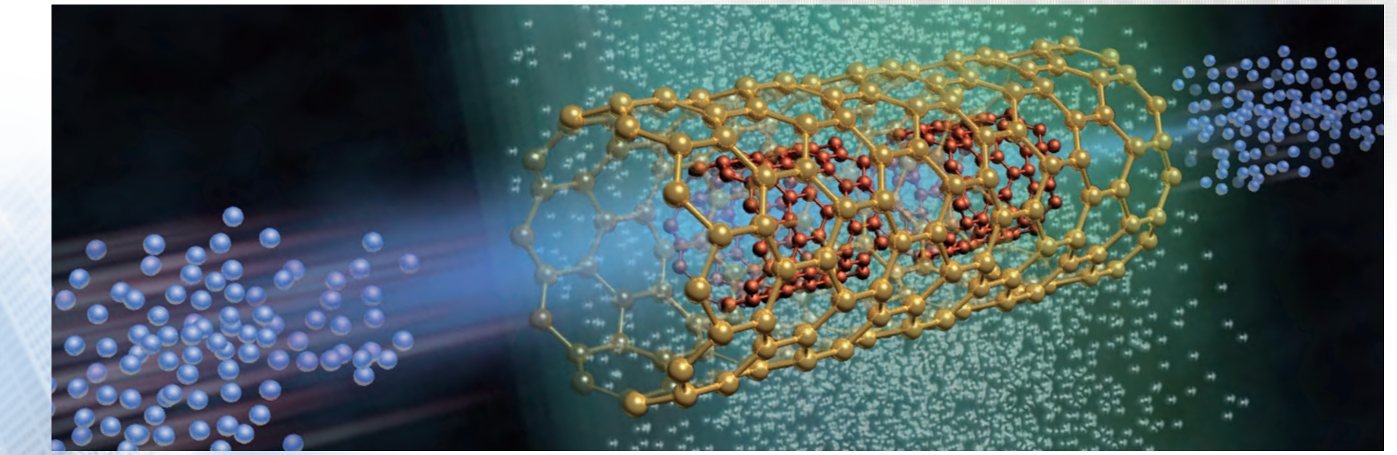
In addition, we investigate the characteristics of materials under extreme conditions such as those inside laser and magnetic fusion reactors as well as materials for synchrotron radiation lasers. We create new knowledge on material structure and optical properties under such extreme conditions and develop new industrial technologies through collaborative research with our industrial partners.

We promote understanding of nuclear fusion science by precise simulations and measurements of high-temperature and high-density plasmas in order to generate and control the fuel target implosion. We independently develop new technologies and innovations to diagnose ultrahigh-density plasmas in extreme conditions that will cause nuclear fusion reactions.

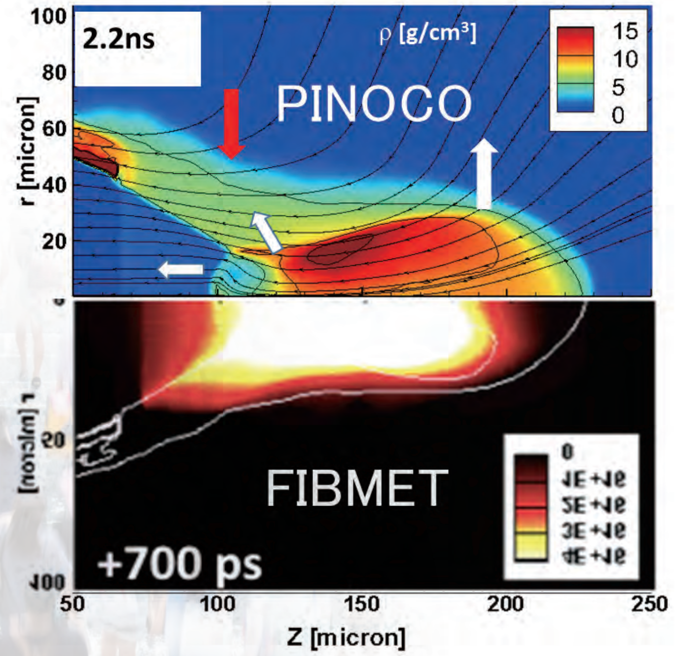
Moreover, we are advancing laser fusion engineering research on fuel targets and elemental technologies of furnace materials, chambers, and systems towards fusion energy development. We aim to create new innovations in fusion technology by widely applying advanced technologies that we develop.


A laser nuclear fusion reactor in the future

Theory and Computational Science


Proton beam emitted from nanotube for future cancer therapy

The Theory and Computational Science Research Division studies various phenomena in high energy density states generated by high-power lasers including vacuum physics with super high electromagnetic fields. In particular, we create new fields of plasma/fluid physics, ultrahigh field physics, and physical informatics through collaboration with other research divisions. We also innovate technologies for large-scale simulations and for massive data processing.

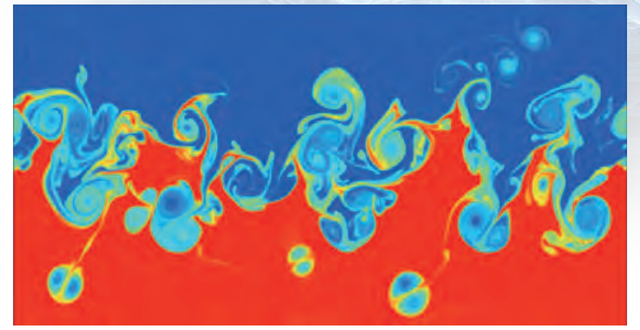


Fast ignition fusion integration simulation

Our group explores various phenomena in high energy density plasmas such as ion acceleration, Coulomb explosion, and collision-less shock formation driven by high intensity lasers. In addition, we study various applications which include proton beam cancer therapy, compact neutron sources, and laser fusion energy development.

We also investigate ultrahigh energy density states generated by high-power sub-picosecond lasers, where quantum electromagnetic phenomena such as gamma-ray radiation and pair production become important. We contribute to the elucidations of the physics of relativistic non-equilibrium radiative plasmas related to astrophysics.

By using a magnetic hydrodynamic code and a kinetic particle codes, we carry out large-scale simulations for implosion and heating processes during laser fusion as well as for the plasma turbulence associated with magnetic fields in the sun. In order to utilize supercomputers efficiently, we work on the development of new algorithms for parallel computing and the information technology of massive data analysis for physics researches.


Two-dimensional fluid simulation of interface instability