

Exploration of the principles of structural changes of material and field in solids and plasmas under extreme conditions with high-power lasers



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Purpose and Significance of the Research

When power laser beams are focused on an area as small as half a hair, it is possible to instantaneously (in about 10^{-9} to 10^{-12} seconds) create extreme conditions on the earth, such as solid states at 100,000 to 10 million atmospheres or plasma states at 10 million to several hundred million atmospheres. Such high energy density (HED) states are useful for understanding the state of matter inside stars and giant planets and the physics in space with relatively small energy. Understanding this HED state is also an important physics issue for applications such as laser processing and for the development of advanced technologies such as ultra-small accelerators and nuclear fusion.

In this project, we will focus on structural changes of " matters" and " fields" in HED states, and challenge the quest for generalities common to various states and the search for universality in the interdisciplinary field. As a result, we will be able to explore the science of a wide range of extreme HED states, from the universe to materials, as well as to efficiently develop applications.

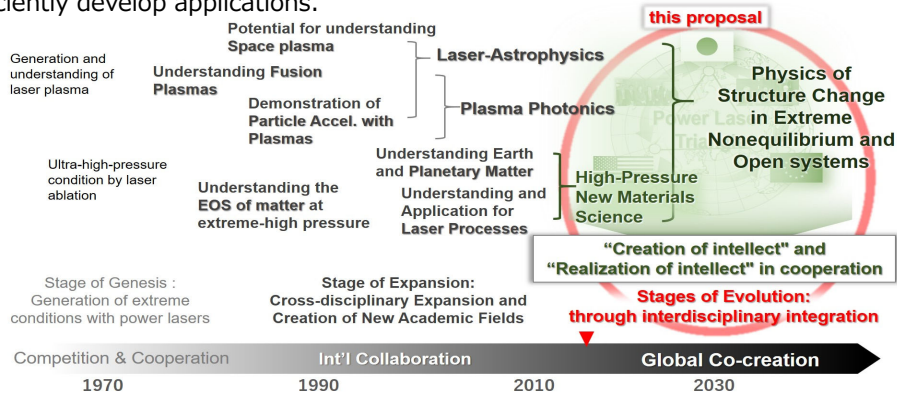


Fig.1 Transformation from interdisciplinary collaboration integration

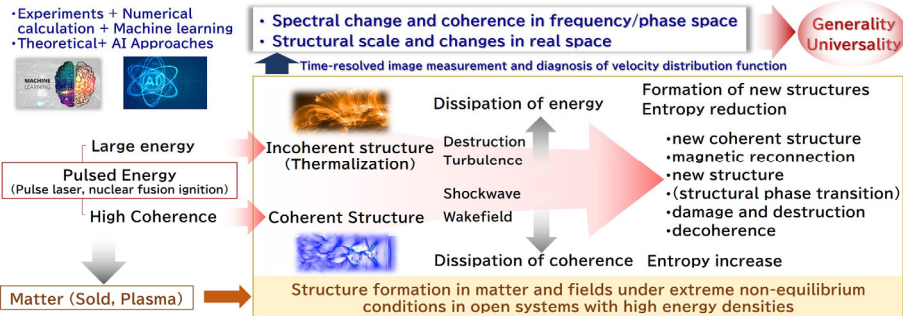


Fig.2 Approach exploring the universality common in a variety of HED conditions

Organization of the Project Team

For each of the three HED research areas, the three core members, who have extensive experience in international joint research, will promote and coordinate collaboration within and among the three areas. Two research subjects are set up in each area, and the core young group leaders will conduct international joint research in collaboration with other young researchers and graduate students. Under the leadership of a PI with a successful and experienced background in the three areas, all participants will discuss the phenomena of various structural changes of matter and fields in HED states and explore the common physics behind such structural changes. Furthermore, for collaboration with power laser facilities and researchers worldwide, three heads of leading facilities in Europe and the United States, who are key persons in the international network in each region, have been selected as international collaborators.

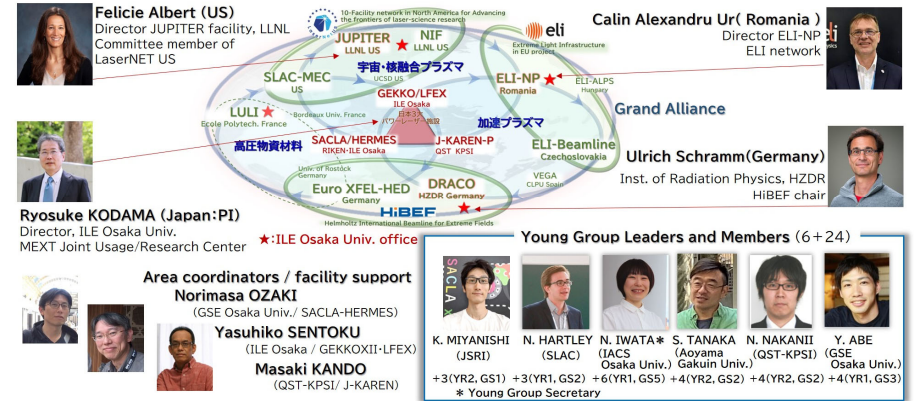


Fig.3 International Network and Research Structure

Plan for Fostering Early-career Researchers

● Outline

A team of young researchers and graduate students will lead international collaborative research toward a larger Grand Alliance, in addition to utilizing the existing international collaboration network and partner offices. The plan for fostering the next generation of human resources will be carried out promoting world-leading academic research to exploring generalities in matter and fields in a variety of high-energy-density states.

- Program for Sending Young Researchers and Graduate Students (Y2024-2029)
- Support the self-reliance of early-career researchers
 - Training Program (T):
 - (a) Practical training for conducting research abroad
 - (b) Support for international joint research proposals
- Academia Startup Program (AS) :
 - (a) Support for international joint research
 - (b) Support for young researchers' network
 - (c) Establish an experimental basement for young researchers
- Frontier Seminar U30 (U) :
 - (a) International joint seminars
 - (b) Summer and/or winter schools
- Other
 - Management and operation using 4 overseas
 - Fostering next-generation network: Grand alliance