Goal 10

Realization of a dynamic society in harmony with the global environment and free from resource constraints, through diverse applications of fusion energy, by 2050.

Here begins our new MIRAI
MOONSHOT
RESEARCH & DEVELOPMENT PROGRAM

Backcasting Digital Systems by Super Dimensional State Engineering

Project manager

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R&D institutions

National Institutes of Natural Sciences

Summary of the project

The project will build a digital platform and virtual laboratory (V-Lab) that will enable, in a digital space, the design and performance test of the fusion energy systems that use fusion reactions for power generation and various other purposes.

To reproduce the state of the plasma (ionized gas) and the complexity and spatiotemporal scales (temporal and spatial extents) of the components in fusion energy systems in the digital space, we will define a new "Super dimensional data space" (Figure 1) that combines time axis, spatial (coordinate) axis, velocity axis, physical quantities, and more. We will establish computational methods that incorporate the unique properties of this space.

Furthermore, to apply these computational methods as "Super dimensional state engineering", we will develop innovative AI/data-driven science techniques that have never been seen before.

By doing so, we will construct a V-Lab where experiments on fusion energy systems can be conducted in a digital space, enabling performance predictions (future forecasts) of elements and the entire system of next-generation fusion energy systems in a digital space (Figure 2). This project aims to drastically reduce the time and cost-intensive trial and error (developing and testing prototypes) processes in the real space. By doing so, we seek to achieve early social implementation and cost reduction of various fusion energy systems, ultimately working towards a society powered by fusion energy.

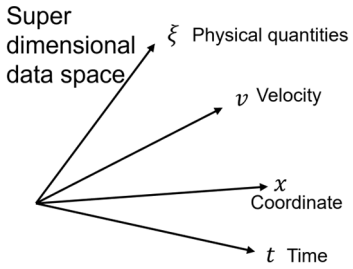

Figure 1. Schematic diagram of "Super dimensional data space".

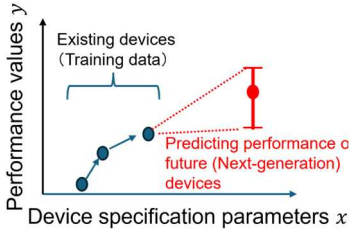

Figure 2. Schematic diagram of future forecasting technology.

Milestone by year 2034

In the three types of V-Labs constructed in digital space (Fusion energy systems for power generation such as ① Magnetic confinement method, ② Inertial confinement method, and ③ Material testing facilities such as neutron irradiation), we will use experimental results from existing devices in real space for benchmarking. We will demonstrate that all three V-Labs can reproduce the experiments of the existing devices in real space. Furthermore, we will demonstrate that the V-Labs possess future forecasting capabilities for fusion energy systems and that these forecasting capabilities are versatile.

Milestone by year 2029

In the three types of V-Labs constructed in digital space, we will use experimental results from existing devices in real space for benchmarking and demonstrate that one of the three V-Labs can reproduce the experiments of the existing devices in real space.

Project structure

We are focusing on the following 4 research and development themes.

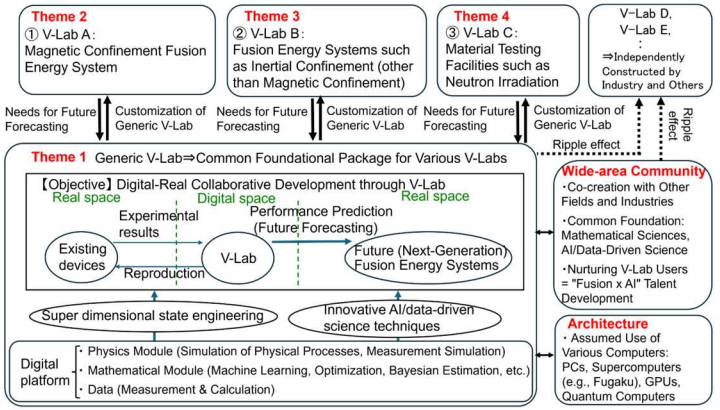

Figure 3. Overall project structure.