

UNIQUE INTEGRATED TESTING FACILITY

UNITY-1

INTEGRATING THE FUSION THERMAL CYCLE

Beyond lab-scale integrated power cycle R&D is needed before we can build a commercial fusion power plant

UNITY for Fusion Power Generation

No test facility for fusion power generation systems exists = No demonstration of the feasibility of power generation by fusion.

- Engineering R&D for plant components (indispensable for the commercialization of fusion power generation) still in its infancy.

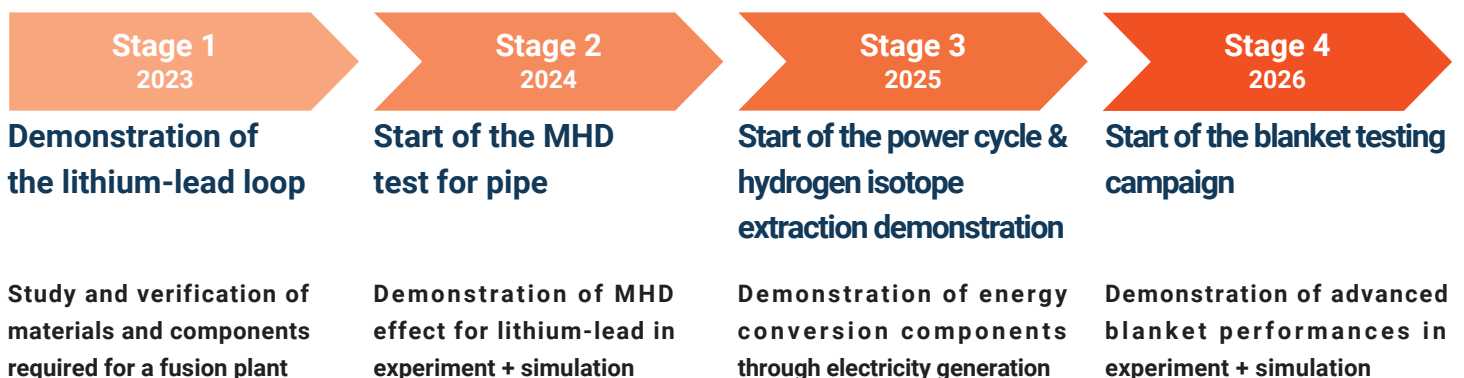
No heat extraction and energy utilization from the breeding blanket has been demonstrated.

- These tests are not even planned for ITER, yet they must be demonstrated to achieve fusion energy.

No high-temperature energy utilization system using liquid metal or molten salt has been demonstrated.

- A high temperature (1,000°C) energy cycle using liquid metal/molten salt must be demonstrated.
- Challenges, such as tritium migration from the breeder into the high-temperature power cycle, must be resolved through experimental verification.

UNITY-1 Project Timeline



Blanket and Divertor Integrated Testing Section

Testing Capability for Multiple Blanket Types

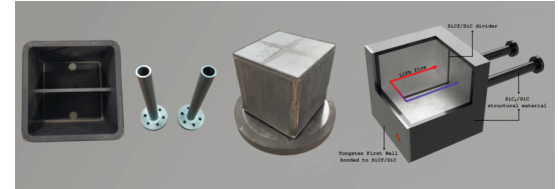
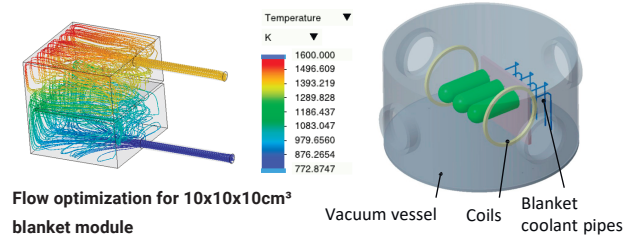
- Experimental capability with multiple coolants including LiPb, Li, FLiBe, and H₂O).

Testing in 4 T Magnetic Field

- Strong magnetic field with gradient to measure MHD effect in blanket module

Extraction of High-Temperature Coolant

- External heating to simulate volumetric heating & temperature distribution of up to 1,000°C
- Vacuum insulation to minimize heat loss



High-Temperature Heat Exchange and Extraction Testing Section

Developing for >50% thermal efficiency

- capable of performing heat exchange up to 1,000°C in a simulated fusion plant environment
- enables compatibility tests of liquid metal/molten salt with various materials
- Measurement of tritium permeation for complex geometries
- R&D on advanced manufacturing methods for SiC_f/SiC components based on the technology developed at Kyoto University

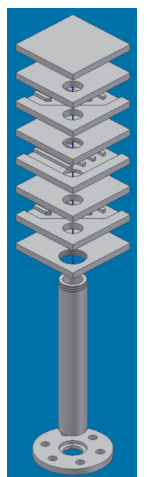
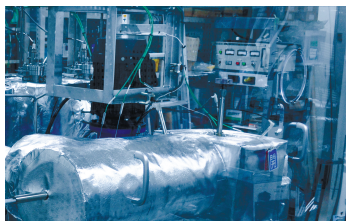


Plate heat exchanger design



FLiBe loop



LiPb loop

Energy Utilization Testing Section

UNITY-1 will conduct the world's first power generation demonstration test in 2025

- Various power generation cycles from heat extraction from the blanket (Brayton cycle, Rankine cycle) under power plant conditions
 - World's first demonstration of power generation from a blanket
 - This experiment will yield critical understandings of fusion power systems and key parameters required for designing a power plant
 - High-temp heat exchange and tritium permeation to the generation system should not be underestimated
- UNITY-1 will demonstrate alternative applications of high-grade heat, including hydrogen production

