KYOTO FUSIONEERING

Kyoto Fusioneering: Company overview, mission & UNITY

(Unique Integrated Testing Facility for Fusion Power Generation)

Mr. Taka Nagao – Co-founder & CEO

Dr. Richard Pearson – Co-founder & Chief Innovator

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FUSION for the FUTURE.

We are **Kyoto Fusioneering**

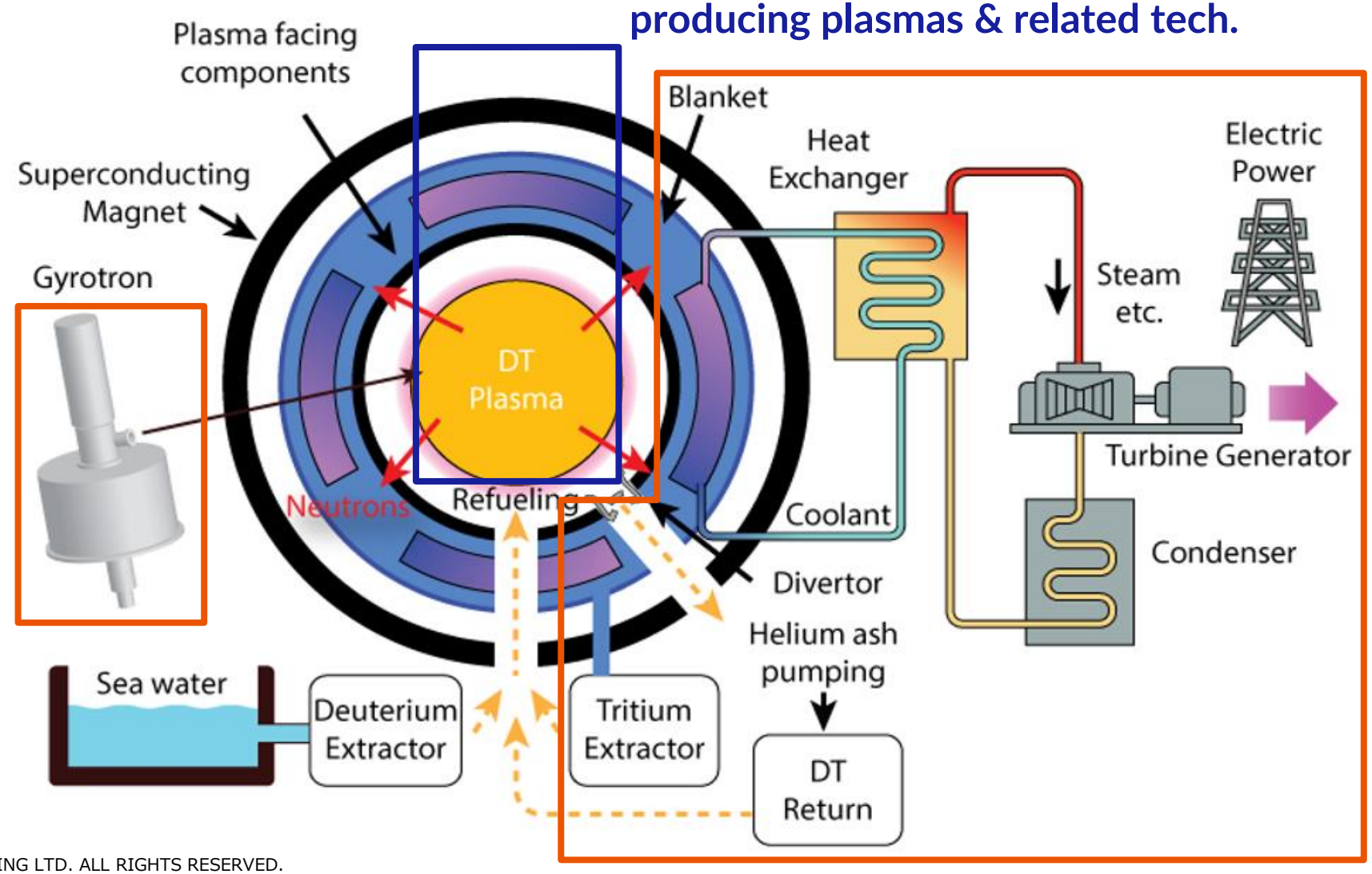
We accelerate the development of **high performance, commercially viable fusion plant components** associated with **power generation and fuel cycle**.

Locations	Tokyo, Japan Kyoto, Japan Reading, UK TBA, US (in 2022)
No. of Staff	50 (full and temporary)
Funding to Date	17 million USD
Foundation	2019

Kyoto Fusioneering's Business Model

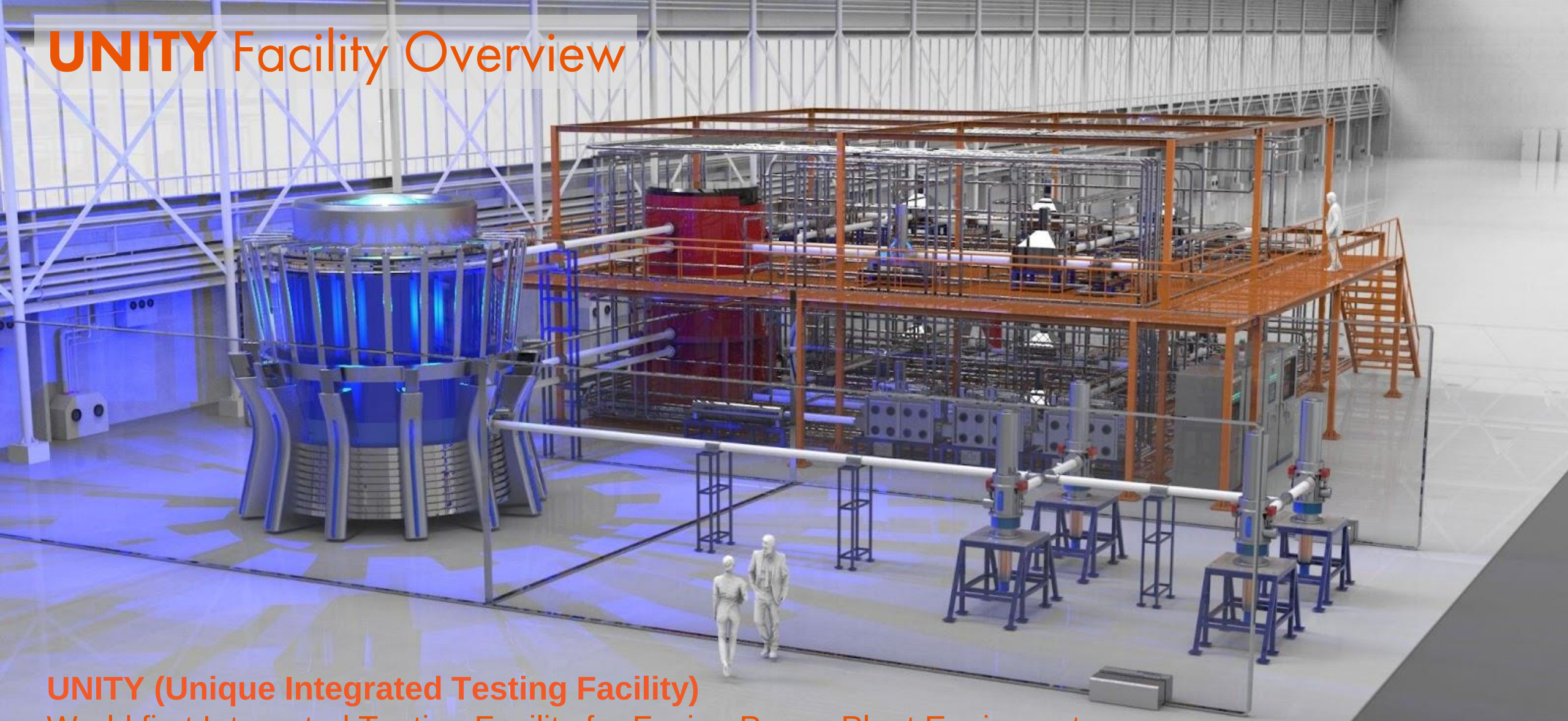
KF is like Levi's during gold rush

Fusion developers are working on power-producing plasmas & related tech.



KF focuses on key reactor technologies and engineering to capture heat from fusion reaction

UNITY Facility Overview



UNITY (Unique Integrated Testing Facility)

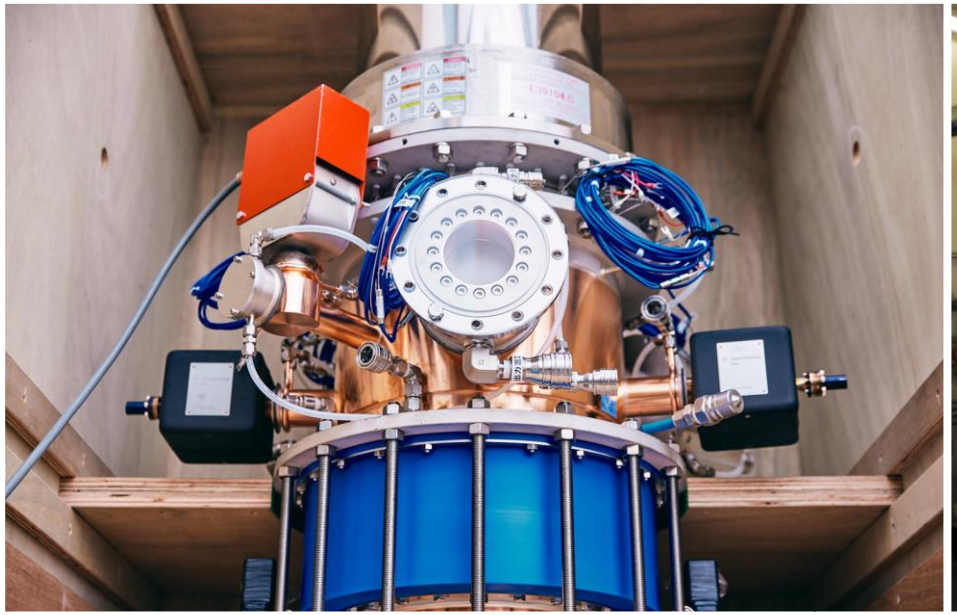
World first Integrated Testing Facility for Fusion Power Plant Equipment

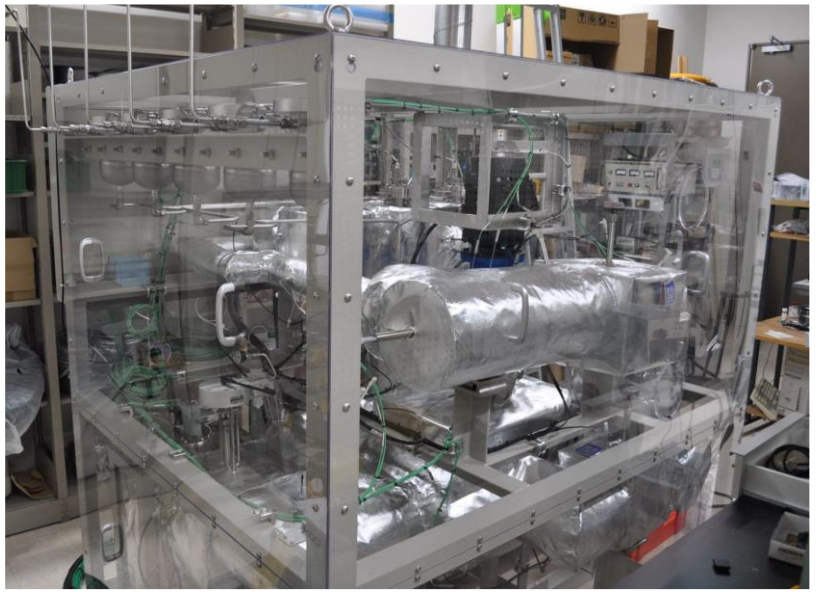
Demonstration of energy extraction from fusion plants, advanced power generation, hydrogen production, carbon fixation and other utilization systems, fuel cycle, and tritium treatment technologies

We specialize in **fusion plant technologies**

We operate **cutting-edge in-house R&D facilities** that develop:

- **Gyrotrons** for plasma heating
- **Tritium fuel cycle technologies** incl. pumps
- **Advanced tritium breeding blankets** (focused on LiPb, Li and FLiBe)
- **Liquid metal & molten salt technologies.**
- **Plasma exhaust systems.**
- **Advanced materials**, including SiCf/SiC.
- **Power cycle engineering**, including non-electricity applications





The next step for the fusion industry

- **Nobody has tested a blanket for a fusion reactor:**
  - Problems around lithium burnup, low conversion efficiency, high Be usage making solid blanket non-commercially viable.
- **Nobody has demonstrated heat extraction from a blanket:**
  - Not planned for ITER, but urgently needed for the private sector and upcoming DEMOs;
  - Material challenge for fusion environment with liquid metal/molten salt are significant.
- **Nobody has demonstrated high-temperature power cycle from liquid metal/molten salt:**
  - High-temp (~1,000 °C) heat extraction from liquid metal/molten not demonstrated;
  - Tritium permeation within the power cycle should not be underestimated.

Beyond lab scale integrated power cycle R&D is urgently needed

UNITY Project Timeline

Stage 1 (2022)

Demonstration of the lithium-lead loop

- Study and verification of materials and components required for a fusion plant.

Stage 2 (2023)

Start of the blanket testing campaign

- Demonstration of advanced blanket performances in experiment + simulation.

Stage 3 (2024)

Start of the power cycle demonstration

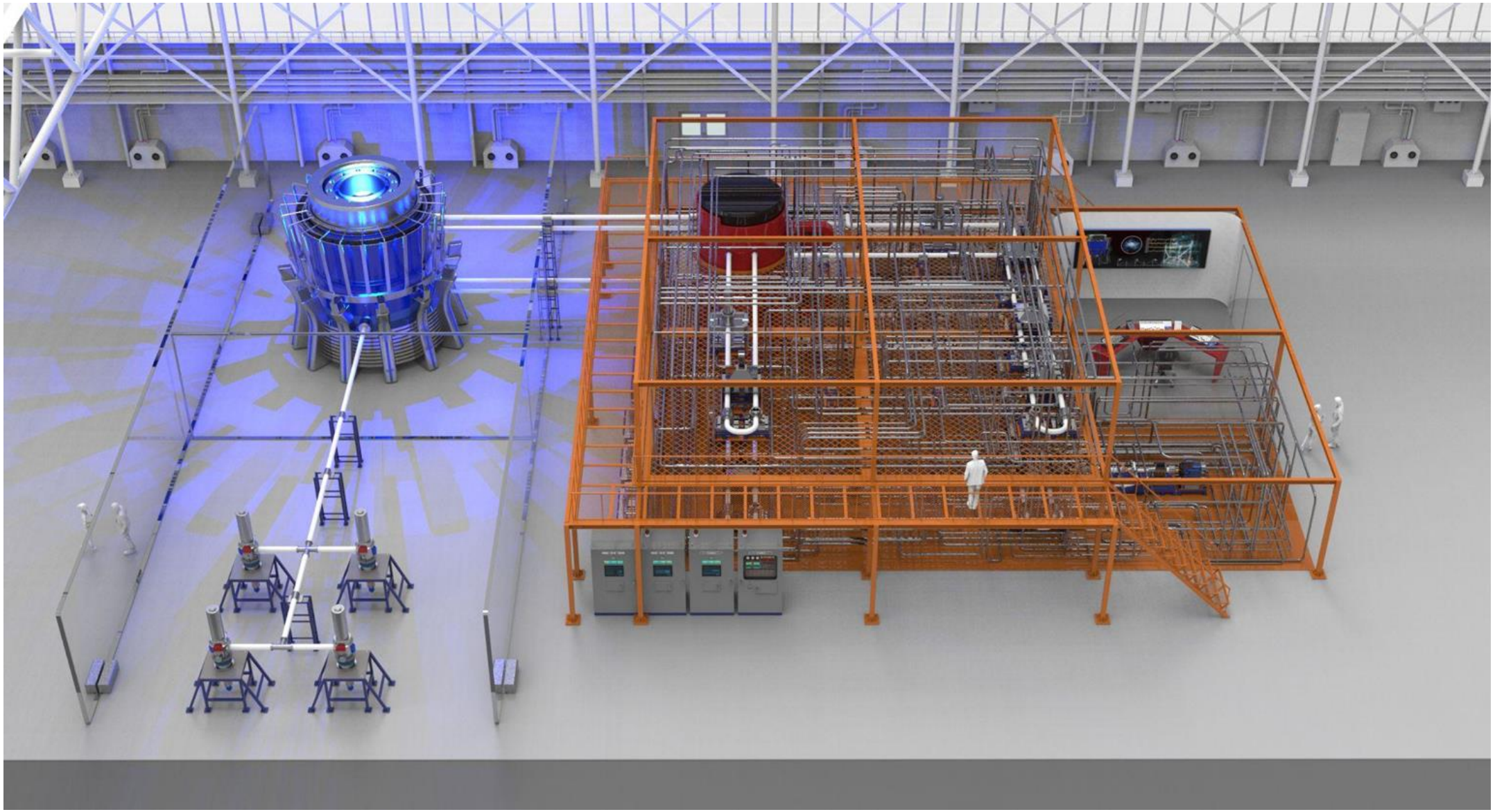
- Demonstration of energy conversion components through electricity generation.

Stage 4 (2025)

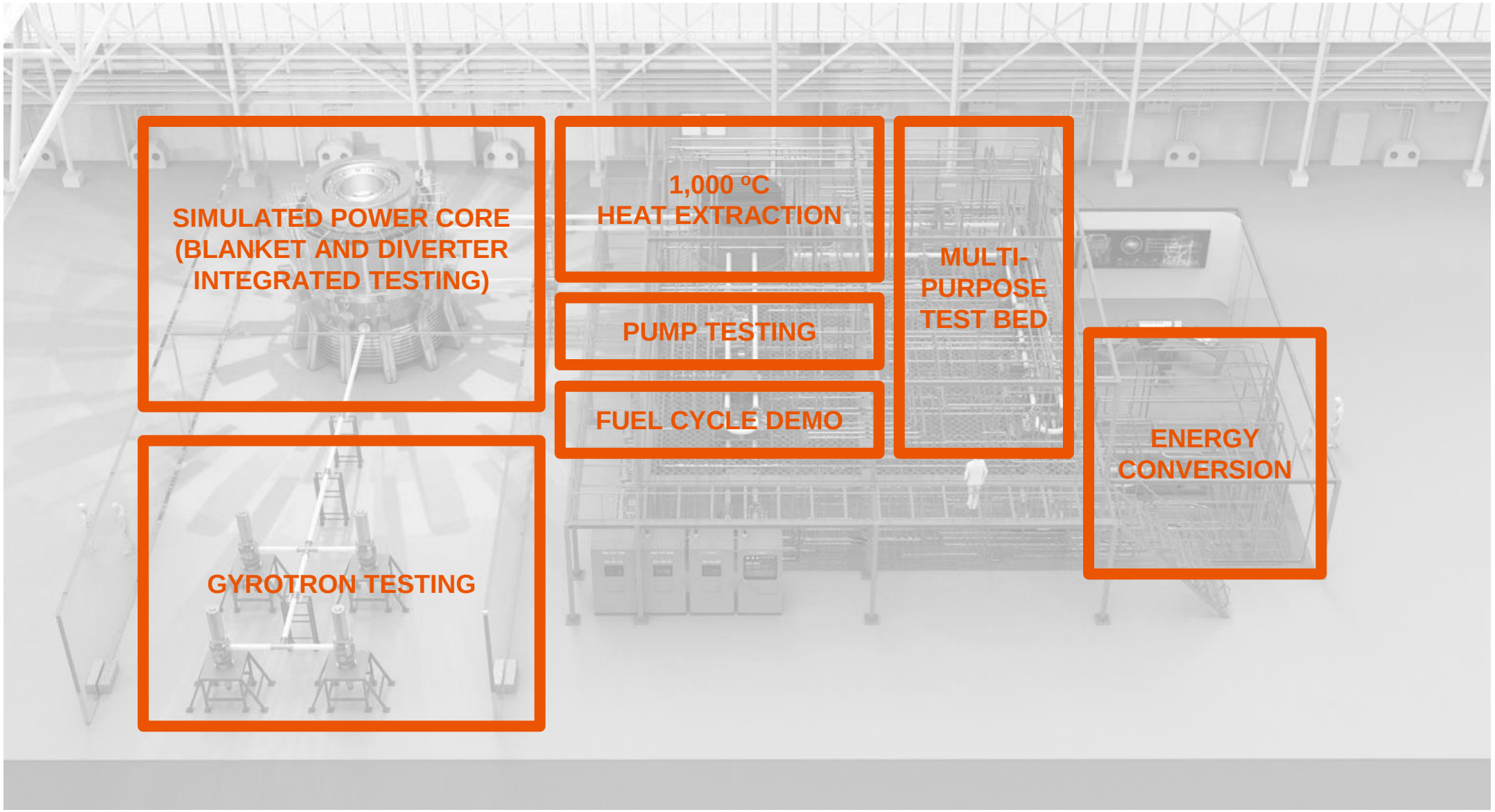
Integrated diverter and gyrotron testing

- Demonstration and R&D of core Kyoto Fusioneering products for the fusion industry.

UNITY Facility Overview



UNITY Facility Overview



Blanket & Diverter Integrated Testing Section: Simulated Power Core

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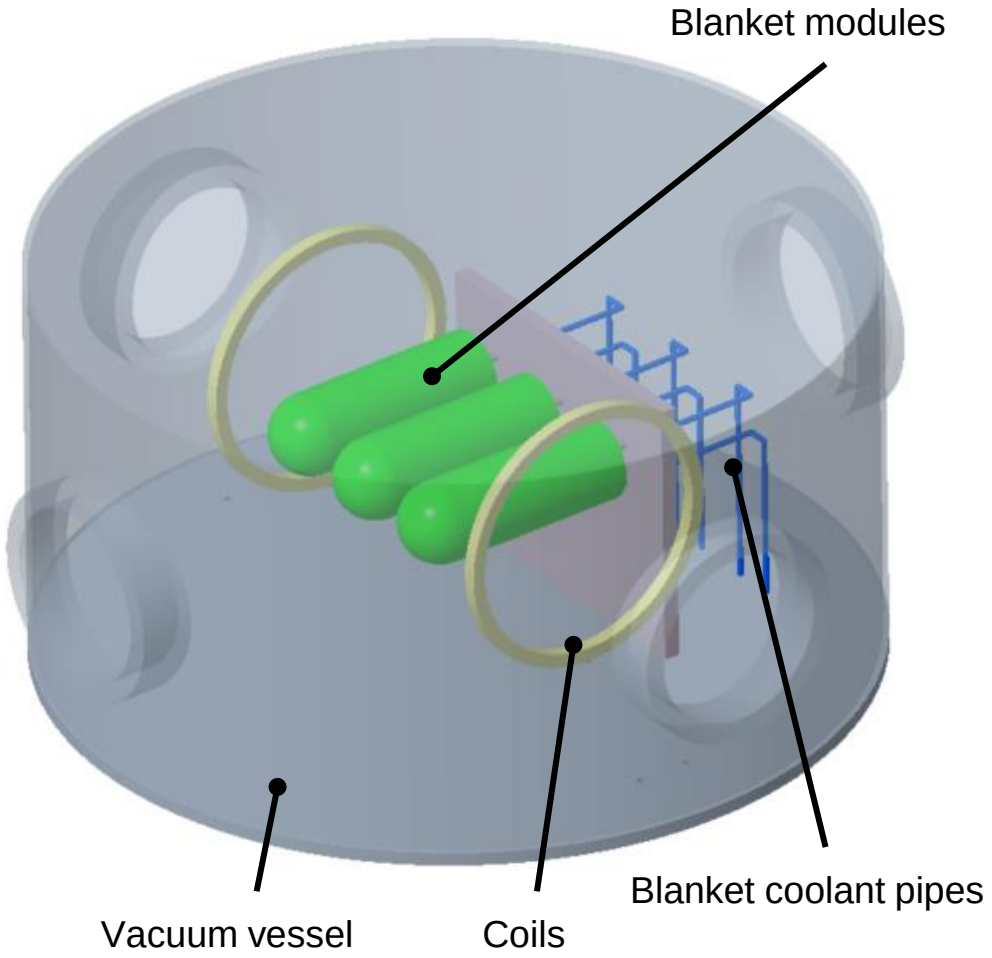
UNITY's blanket testing section features:

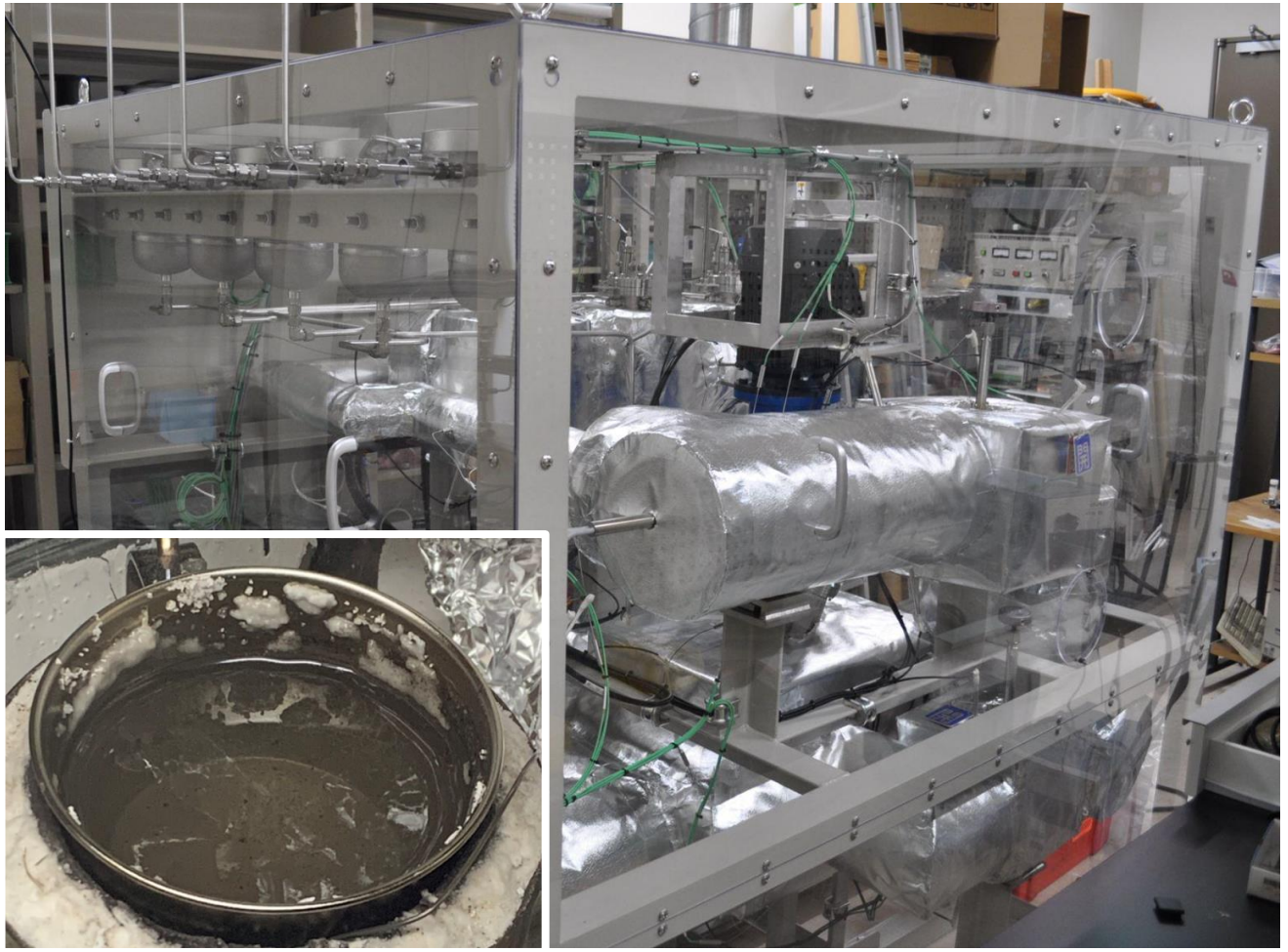
- **Multiple blanket testing capabilities**
  - Experimental capability **with multiple coolants** including LiPb, Li, FLiBe, and water.
- **Testing in 4T magnetic field**
  - Strong magnetic field with gradient to measure MHD effect in blanket module
- **Extraction of high-temperature coolant**
  - External heating to simulate volumetric heating & temperature distribution of **up to 1,000 °C**
  - Vacuum insulation to minimize heat loss



Blanket & Diverter Integrated Testing Section: Simulated Power Core

- Kyoto Fusioneering is currently operating **both a FLiBe and a LiPb loop**, to be scaled-up for a full blanket testing loop.

LiPb Loop



FLiBe

FLiBe Loop

1,000 °C Heat Extraction Demonstration Unit

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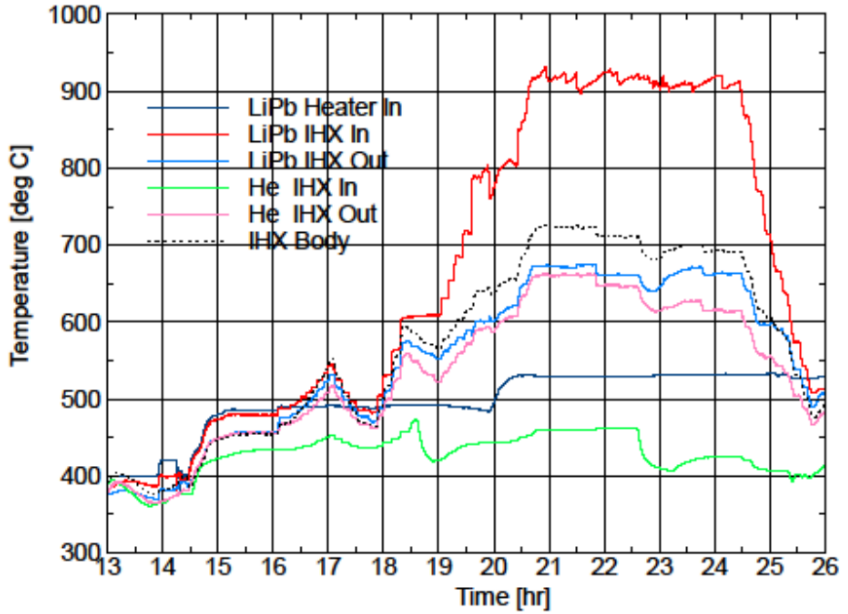
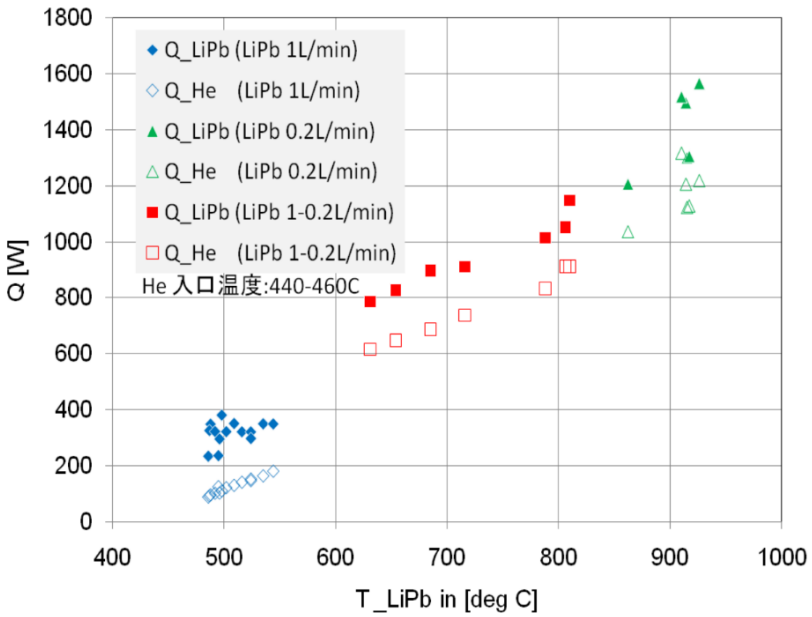
- Kyoto Fusioneering is developing novel fusion-grade SiCf/SiC.
- Previously tested in heat transfer experiment with LiPb and He with heat exchanger at 900°C using Kyoto University LiPb-He loop (Noborio et al., 2011). See Fig. top RHS.
- Successful heat transfer across SiCf/SiC from LiPb to helium secondary coolant.
    - Heat transfer from LiPb increases with temperature (see Fig. bottom RHS)
    - Rate limiting factor is helium heat transfer in secondary loop.
- SiCf/SiC heat exchanger has been designed with helium gas turbine for high-efficiency power generation by JAEA(see Ihli et al., 2008)





Fusion Fuel Cycle Demonstration Section

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* UNITY will use deuterium as an analogue of tritium.

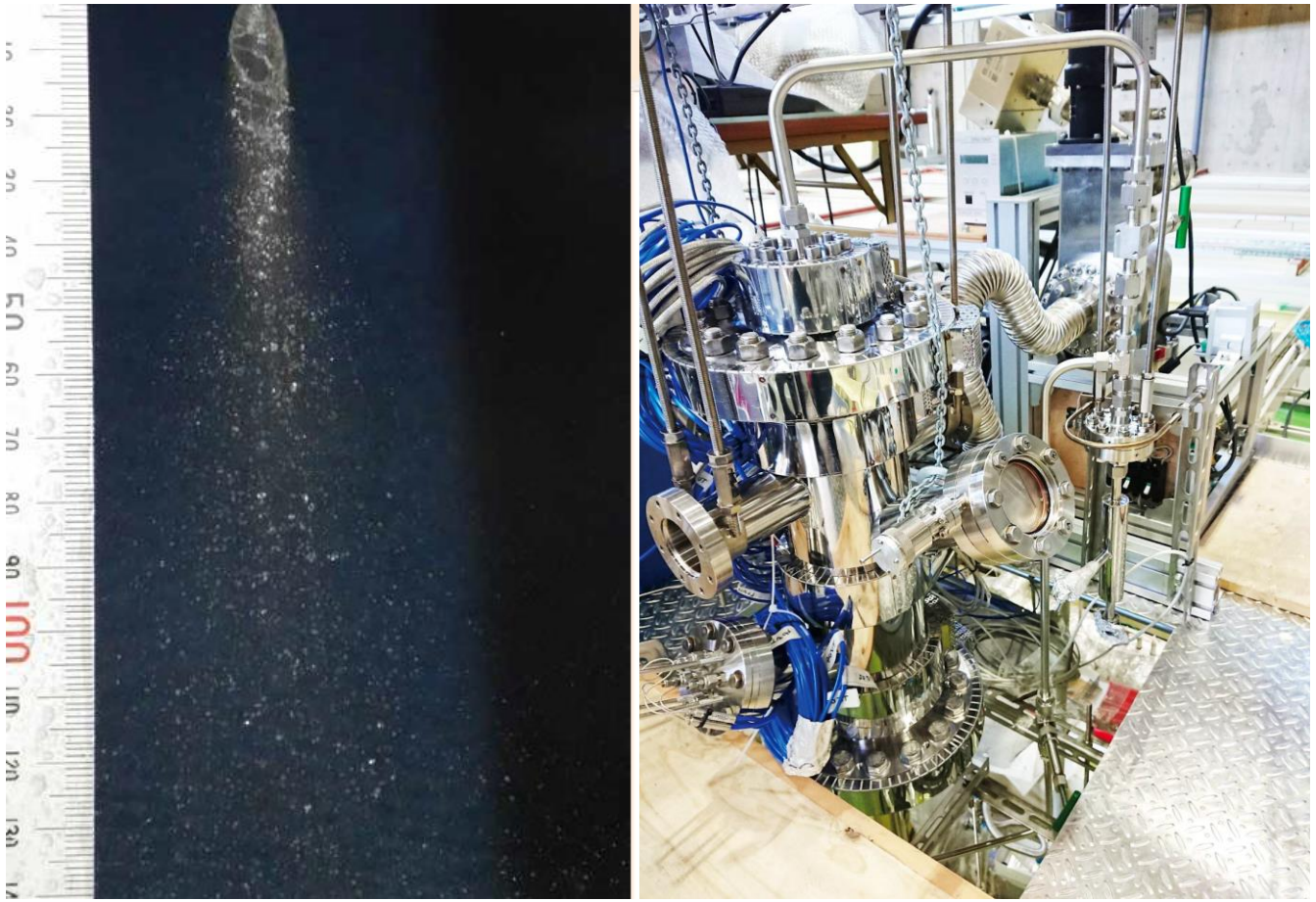
Tritium Extraction

- R&D and demonstration of tritium recovery:
  - UNITY will demonstrate **tritium recovery from the blanket for the two primary coolants** (FLiBe and LiPb)

Tritium Handling and Storage

- R&D and demonstration of tritium handlings, **including the pumps for tritiated gas**.
- Assessment of detritiation and isotope separation technologies.

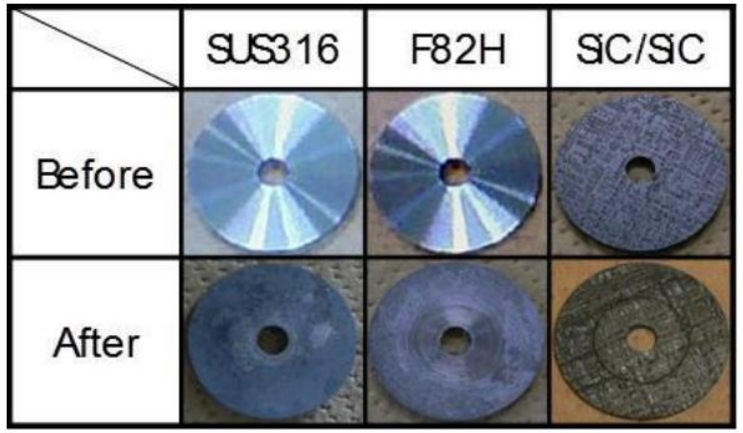
Tritium extraction demonstration from LiPb Loop via Vacuum Sieve Tray



Multi-Purpose Testing Section

SiCf/SiC corrosion by FLiBe/LiPb

- SiCf/SiC samples with LiPb in experiments at Kyoto University (Park et al., 2011; Park et al., 2018)
- Tested SiCf/SiC - and also SS316 & F82H - in form of rotating disc sample in flowing LiPb @ 900°C for 3000 hours (see Figure)
  - No significant corrosion of SiCf/SiC (see Figure)
  - Mechanical properties largely unchanged
  - Suggests that corrosion-resistant coating is not required for SiCf/SiC in LiPb

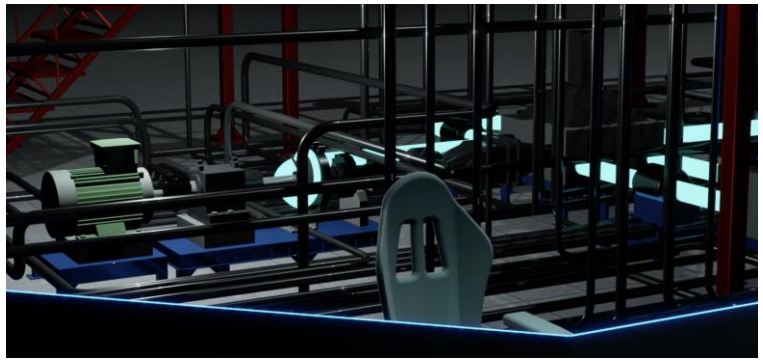


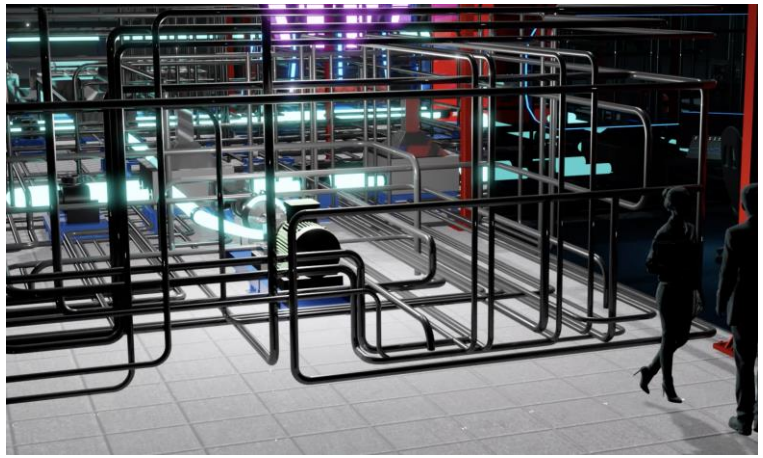
Park et al., 2011

Energy Conversion Demonstration Section

UNITY will demonstrate electricity generation from blanket in 2024

- UNITY will examine a number of potential electricity generating cycles, **including Brayton and Rankine cycles**, in fusion-relevant conditions.
  - 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.
- It will also demonstrate alternative applications of high-grade heat, **including hydrogen production**.





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R&D + Demonstration of the full fusion power system completed

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