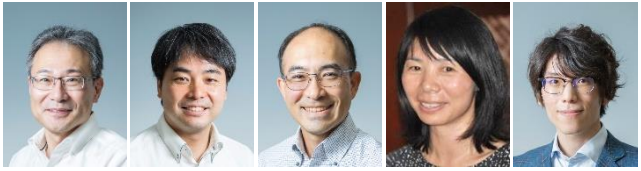
Energy Physics Engineering
Advanced Fusion Reactor Engineering



Prof. HASHIZUME Hidetoshi, Assoc. Prof. ITO Satoshi, Assoc. Prof. EBARA Shinji, Senior Assist. Prof. CHENG Weiying, Assist. Prof. SHISHIDO Hiroki

We are studying on novel technologies for designing advanced fusion reactors, from a viewpoint of integrated energy engineering using fluid dynamics, heat transfer engineering, electromagnetics and structural mechanics.

Official Website : https://web.tohoku.ac.jp/hashizume_fan_club/home/e-home.html
If you need further information, please contact Assist. Prof. Shishido (hiroki.shishido.a7@tohoku.ac.jp).

Designing advanced fusion reactors !

Remountable high-temperature superconducting magnet

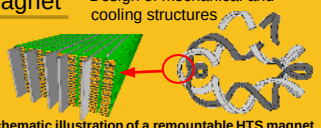
Huge and complex superconducting magnet for a fusion reactor

➡ Remountable high-temperature superconducting (HTS) magnet

Advantage : Easy fabrication, High maintainability

Important features for a commercial fusion reactor !

- Design of mechanical and cooling structures

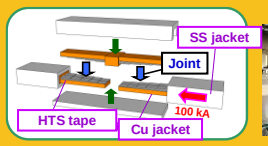


Schematic illustration of a remountable HTS magnet

- R&D in HTS conductors

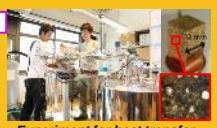
High current HTS conductor (100 kA at 4.2 K for 1 hour)

- R&D in mechanical joints



Mechanical bridge joint

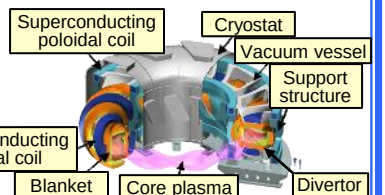
- R&D in porous channel for local heat removal



Experiment for heat transfer enhancement of liquid nitrogen

- Fabrication of a prototype magnet

Prototype of a remountable HTS magnet



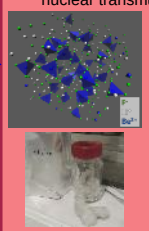
Helical fusion reactor, FFHR-d1 (National Institute for Fusion Science)

Advanced liquid blanket

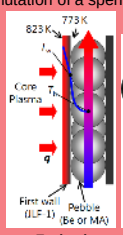
Advantage: Flibe or liquid lithium can play a role as a tritium breeder and coolant

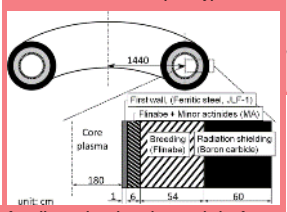
Molten salt Flibe blanket:

- R&D in new molten salt to be suited for heat removal and tritium breeding
- Design of a blanket system having a function of nuclear transmutation of a spent fuel



R&D in new molten salt based on MD



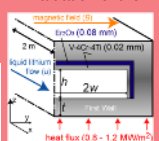


Evaluations of cooling and nuclear characteristics for a Flibe blanket having a function of nuclear transmutation

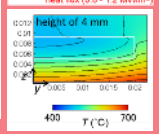
Liquid Lithium / Vanadium alloy channel blanket:

Fabrication of a prototype channel

- Reduction of MHD pressure drop by a three-surface-multi-layered channel
- Evaluation of thermo-fluid characteristic for Li/V blanket



HFLSM, IMR, Tohoku University



MHD simulation

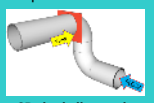
MHD flow experiment by using high field facilities

Divertor cooling technique

Ultra high heat flux at the divertor ➡

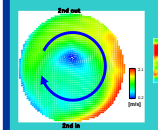
Cooling technique using self-formed flow field

- R&D in divertor cooling technique using self-formed flow field in elbow tube based on flow field visualization and heat removal experiments

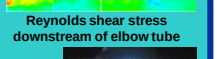


3D dual elbow tube

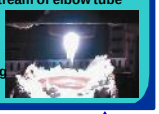
3D dual elbow tube for flow field visualization



Swirling flow at outlet of a dual elbow tube



Reynolds shear stress downstream of elbow tube

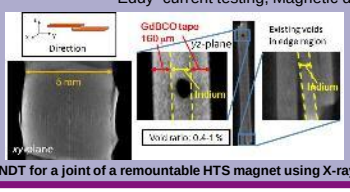


Heat removal experiment using arc plasma with high heat flux

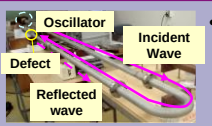
Nondestructive testing/evaluation for component of a fusion reactor

Applying the technique

- R&D in structural inspection techniques using various NDTs
  - Radiation: X-ray CT, X-ray transmission method
  - Ultrasonic wave: Harmonic ultrasonic wave testing
  - Electromagnetics: DC/AC electric potential technique, Eddy current testing, Magnetic detection



NDT for a joint of a remountable HTS magnet using X-ray CT



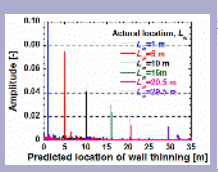
Microwave NDT for a elbow pipe

Microwave NDT for a long pipe

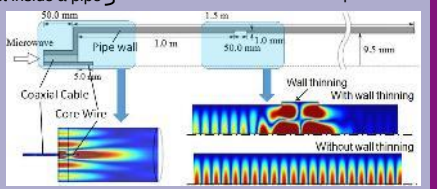
Applying the technique

- R&D in a crack radar (Microwave NDT)

Microwave can propagate rapidly in a pipe
Microwave is reflected at defect inside a pipe ➡ We can scan defects rapidly with the microwave NDT technique!



Experimental data to predict locations of wall thinning



Electromagnetic simulation for microwave NDT (Axial component of electric field)

Research Topics

- **Design and development of a remountable high-temperature superconducting magnet**
- **Design and development of advanced liquid blankets**
- **Development of a divertor cooling technique using self-formed flow field**
- **Development of nondestructive testing/evaluation methods for component of a fusion reactor**
- **Development of a system to transmute radioactive wastes using fusion neutrons**