

Topical Group #1: Multi-ion Plasma

The topical group: multi-ion plasma for the final two experimental campaigns in the LHD deals with the multi-ion transport, which is one of the crucial issues in a magnetically confined fusion reactor.

Research key phrases

- **Mock test of sustainable burning**
- **Multi-ion transport (circulation) in terms of Core-Edge-Wall coupling**

Questions to be answered in this topical group

Is a sustained nuclear burning achievable?

- Can the controllability of radial profiles of hydrogen isotopes (the mixing ratio) and He ash in a magnetically confined fusion reactor be ensured?
 - In terms of the coupling between edge plasma and plasma facing components (divertor, first wall, etc.)
 - In terms of the coupling between core plasma and edge plasma
- Can the behavior of alpha particles be well-predicted?

High-priority issues in this topical group

1. Estimate τ^*_{He}/τ_E including the effect of a plasma-wall interaction

*The experimental estimation of τ^*_{He}/τ_E as an index of burning condition will be performed by using a He-beam by taking into account the recycling effect of He neutral particles, in deuterium, hydrogen and those-mixed plasmas.*

2. Assess the predictive capability of confinement properties of high-energy helium

The confinement properties of high-energy helium ions, which are originated from the He-beam, will be assessed experimentally with a FICXS-He(FIHE) diagnostic, and those experimental results will be compared with simulation results by a FIHE analysis code.

3. Assess recycling characteristics of multi-particles at plasma facing components

Emissions from each species (hydrogen, deuterium, and helium) at boundary region are measured together with partial pressure in order to assess recycling dynamics at different plasma facing components, divertor plate, first wall etc. The time scales of retention at different components as well as enrichment factor of He will be analyzed.

4. Assess the effect of particle ratio (H/D/He) on transport of each particle and impurities

The fundamental transport properties, such as a confinement time, transport coefficients (diffusivity and convection velocity), of bulk ions and impurity ions will be assessed in deuterium, hydrogen and those-mixed plasmas (the helium will be also added).

5. Assess the controllability of radial profile of each ion in a multi-ion plasma by edge fueling (in terms of mixing and non-mixing)

The radial profiles of each ion, such as hydrogen, deuterium, and impurity ions will be measured precisely with a CXS technique and other profile diagnostics after a variety of edge fueling methods (the pellet injection and the gas puff).

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