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Synergistic Effect of Impurity and Hydrogen Gas Puffs on Plasma Detachment in the GAMMA 10/PDX Tandem Mirror

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In Plasma Research Center, University of Tsukuba, divertor simulation experiments have been conducted at the end region of GAMMA 10/PDX. The high temperature end loss plasmas of GAMMA10/PDX are a functional tool for simulating edge and divertor plasmas and contribute to developing a deeper understanding of the physics involved in plasma detachment. Our aim is to study detachment phenomena under equivalent conditions for ITER SOL and divertor plasma under high temperature and strong magnetic field. So far, we have performed characterization of plasma detachment from high temperature plasma (ion temperature has achieved a few hundred eV) produced by a large tandem mirror device for various radiator gases.

For ideal detached plasma operation, the amount of impurities is expected to be as low as possible. In this study, we have investigated the synergistic effect of a combination of various impurity gases and hydrogen gas on plasma detachment of high temperature plasma, equivalent to SOL plasma of tokamaks in the GAMMA 10/PDX end region, utilizing an open magnetic field configuration. A small puff of an impurity gas (N2, Ne, Ar, Kr, Xe) in combination with a puff of H2 gas is examined to evaluate their synergistic effect on the formation of detached plasma; the following results are obtained: (i) A combination of N2 and H2 puffs showed clear decrease of electron density and ion flux, (ii) N2 and H2 puffs form a strong density gradient along the axial direction and (iii) other noble impurity gases showed insufficient synergistic effect. The new results indicate the possibility of achieving a reliable divertor operation scheme and the importance of investigating molecular processes in further detail. We can contribute to the optimization of detached plasma formation through a deeper understanding of the H2 and N2 assisted recombination process.

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Primary author: Dr EZUMI, Naomichi (University of Tsukuba)

Presenter: Dr EZUMI, Naomichi (University of Tsukuba)

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