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高速度カメラを用いた不純物ガス入射時の GAMMA 10/PDX ダイバータ模擬プラズマの4波長同時観測

Simultaneous 4-wavelength observation of spatio-temporal changes in GAMMA 10/PDX divertor simulated plasmas during impurity gas seeding

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1. Introduction

Reduction of intense heat load on a divertor is one of the critical challenges in magnetic confinement fusion. One promising solution is seeding impurity gases in the divertor region to cause reduction of the particle/heat fluxes. So far, in previous researches conducted on Divertor simulation experimental module (D-module) of GAMMA 10/PDX, we have found that when N_2 is injected in conjunction with H_2, the electron density and the ion flux synergistically decrease while emissions from NH radicals increase, correlated with increased N_2 ratio[1, 2]. These studies suggest the importance of the contribution of N-MAR (Nitrogen Molecular Assisted Recombination), which has higher reaction rate even in relatively higher temperature compared to Hydrogen-MAR (H-MAR). Hence, understanding the spatiotemporal behavior of the N-MAR in the divertor region is important for suitable control of plasma detachment. In this study, we measured emission profiles of H_α, H_β, N-atom, and N_2-1st Pos. in D-module using a high-speed camera with novel 4-branch optical system.

2. Experimental setup

This study uses a high-speed camera ACS-1 with a prism named 'Arbaa prism' [3]. Schematics of the optical system and D-module are shown in Fig. 1(a) and (b), respectively. This new setup allows us to simultaneously obtain spatial profiles of four different wavelengths in the same field of view which enables a more precise evaluation between them.

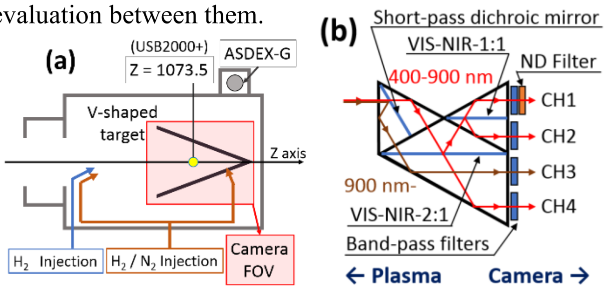

Fig. 1 (a) D-module, (b) Arbaa prism

3. Results

An example of raw data acquired by the system is shown in Fig. 2. The input beam to the Arbaa prism is split into four beams and each of them passes through different band-pass filters then formed on the image sensor of the camera. Each channel's band-pass filters have 10 nm in FWHM. Our new camera setup allowed us a 10-fold enhancement in temporal resolution as well as minor improvement in spatial resolution.

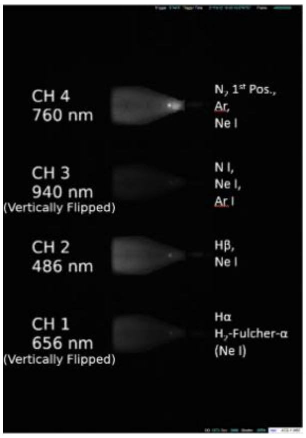

Fig. 2: An example of raw data

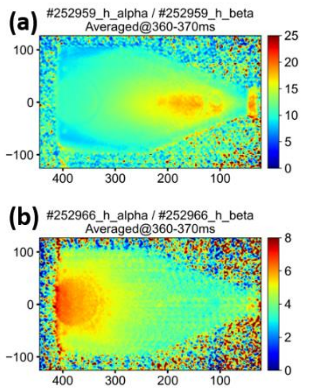

Fig. 3: Change of $I(H_\alpha)/I(H_\beta)$ profiles in seeding gas (a) H_2 only, (b) H_2+N_2

Fig. 3(a) shows an example of the spatial profiles of the ratio of $I(H_\alpha)/I(H_\beta)$, which is an indicator of H-MAR, with H_2 injection. Fig. 3(b) is the result with N_2 injection in addition to H_2. In case of N_2 seeding, it seems like the dominant region of H-MAR shifted toward upstream.

In this presentation, we will discuss the spatiotemporal changes of emissions as well as comparison with other impurities, Neon and Argon.

High-speed camera ACS-1 and Arbaa prism are both provided by nac Image Technology Inc. This work is partly supported by JSPS KAKENHI Grant Number 19K03790, 22H01198 and NIFS Collaboration Research program (NIFS19KUGM137, NIFS19KUGM146 and NIFS20KUGM148).

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