4. Basic, Applied, and Innovative Research

As an inter-university research institute, NIFS activates collaborations with researchers in universities, as well as conducting worldwide top-level research. It is important to establish an academic research base for various scientific fields related to fusion science and to maintain a powerful scientific community to support the research. Programmatic and financial support to researchers in universities who work on small collaboration projects are important.

For basic plasma science, NIFS operates several experimental devices and offers opportunities to utilize them in a collaboration program for university researchers. A middle-size plasma experimental device the HYPER-I is available for basic plasma research. The compact electron beam ion trap (CoBIT) for spectroscopic study of highly charged ions, atmospheric-pressure plasma jet devices for basic study on plasma applications, and other equipment are all used for collaborations.

(I. Murakami)

Improvement of energy conversion fraction towards electrons in high guide field magnetic reconnection

The macroscopic behavior of magnetic reconnection is drastically affected by a guide magnetic field, which is involved in the spherical tokamak formation process by use of a plasma merging technique. A self-generated in-plane electric field is essential to sustain steady plasma outflow from the reconnection region under the presence of a large guide field. Fig. 1 shows spatiotemporal evolutions of (a) reconnection electric field E_t, (b) current density j_t, (c) in-plane electric field E_z, and (d) parallel electric field $E_{//}$ along the current layer formed on the mid-plane of the UTST plasma merging experiment, with limiter plates equipped on the center stack [1]. It was found that E_z was largely suppressed in the region where magnetic field lines were connected to the conducting limiter plates (shown by the hatched area in Fig. 1 (c)) due to the electric short-circuit effect. This suppression of E_z lead to maintaining large $E_{//}$, as shown in Fig. 1 (d), resulting in electron acceleration along the field lines in the inboard-side downstream region. This result suggests that boundary condition modification could change the energy conversion fraction towards electrons in high guide field magnetic reconnection.

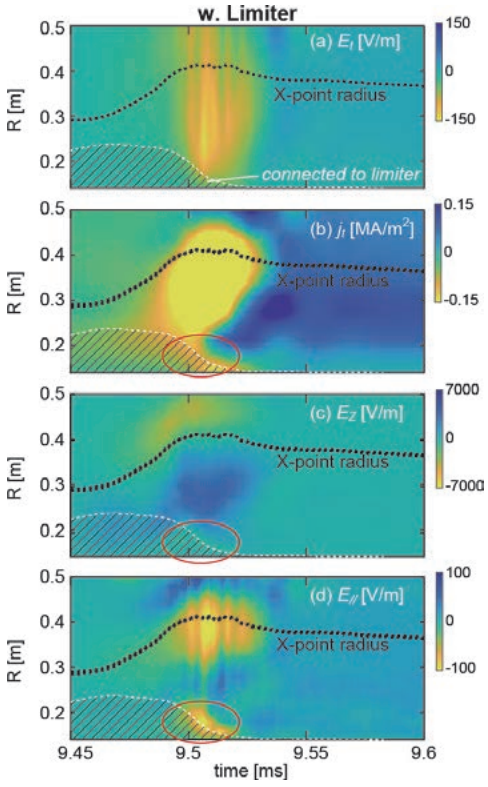

Fig. 1 Time evolutions of radial profiles of (a) toroidal electric field E_t, (b) toroidal current density j_t, (c) axial electric field E_Z, and (d) parallel electric field $E_{//}$ measured on the midplane ($Z = 0$) in the ST merging start-up with limiter plates [1].

(M. Inomoto, Univ. of Tokyo)

Development of a compact negative ion source towards improving beam focusing based on velocity distribution functions

A strict requirement is placed on beam divergence lower than 7 mrad for ITER relevant negative ion beams [2]. A single negative ion beam extracted from a research and development negative ion source at the National Insti-

tute for Fusion Science (NIFS-RNIS) has been observed with multiple velocity distribution functions, as shown in Fig. 2, and their abundance ratio has been quantified with an emittance meter [3]. This experimental result indicates that several production and extraction processes of negative ions, due to a cesium seeded negative ion source, may affect such velocity distributions and the resultant superimposed beam divergence.

In order to investigate the correlation between the production and extraction mechanism of negative ions and their velocity distributions, a compact negative ion source, including beam diagnostics to measure transverse velocity distributions, is being developed at Nihon University.

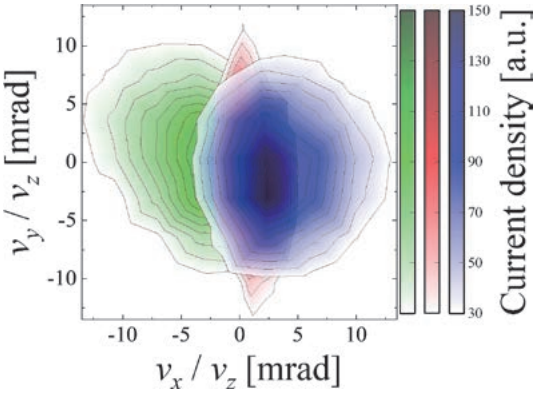

Fig. 2 The velocity distributions for the single negative ion beam produced by the NIFS-RNIS.

(Y. Haba, Nihon Univ.)

Application study of data analysis technology to medical data in nuclear fusion towards a medical-engineering cooperation

Aiming to apply data analysis techniques in the field of nuclear fusion, this study is conducting data analysis of Kawasaki disease. This pediatric disease is unique to children, and the cause of its onset is still unknown. Possible causes of pathogenesis include infections, autoimmune abnormalities, and environmental factors. In 2020, the incidence of Pediatric Infectious Diseases (PIDs) decreased dramatically due to the COVID-19 pandemic. Therefore, this study investigated the impact of the pandemic on the incidence of Kawasaki disease using infection surveillance data collected by Jichi Medical University. Figure 3 shows percentage changes in the weekly numbers of patients with Kawasaki disease (red) and PIDs (others) in 2020, compared with 2017–2019 [4]. The average number of incidences between 2017 and 2019 was used to calculate the percentage change. It was found that the issuance of the emergency declaration led to a rapid decrease in PIDs and a subsequent decrease in the incidence of Kawasaki disease. A decrease of up to 60% was observed, and the results suggest that PIDs are involved in the development of the disease. This research is a good example of medical-engineering collaboration in data analysis and an application of data analysis techniques developed in the nuclear fusion field.

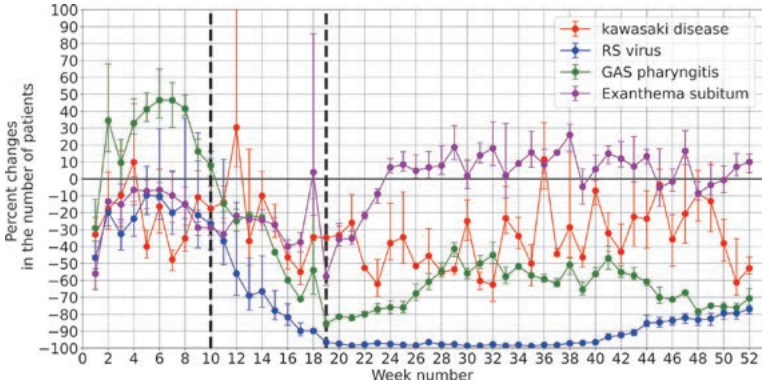

Fig. 3 Percentage changes in the weekly numbers of patients with Kawasaki disease and PIDs in 2020, compared with 2017–2019. The mean and range of weekly percentage changes in the numbers of patients who developed Kawasaki disease and PIDs are compared between 2020 and 2017–2019, shown using error bars in the charts. The school closure period (weeks 10–19) is highlighted using dashed lines. [4]

(Y. Shibata, National Inst. Tech., Gifu)

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[2] A. Hurlbatt *et al.*, AIP Adv. **11**, 025330 (2021).
[3] Y. Haba *et al.*, AIP Adv. **12**, 035223 (2022).
[4] R. Ae, Y. Shibata *et al.*, J. Pediatrics **239**, 50-8 (2021).