5. Fusion Science Interdisciplinary Coordination Center

The Fusion Science Interdisciplinary Coordination Center was established in April 2023, to promote interdisciplinary collaboration in fusion science and development research, and social implementation of fusion technology through industry-academia-government cooperation. As a comprehensive center that leads and supports collaborative research with universities, development research institutes, and industry, the center links three new interdisciplinary fields and a group of Units to develop challenging and interdisciplinary joint research that transcends the boundaries of existing fields. In particular, in order to build a multidisciplinary research network with advanced academic research fields, promote open science, collaborate with international research projects, and implement the technologies cultivated through nuclear fusion in society, the 1) Advanced Academic Research Coordination Section, 2) Development Research Coordination Section, and 3) Industry-Academia-Government Coordination Section support various joint research in collaboration with the Units.

(I. Murakami)

Advanced Academic Research Coordination Section

The Advanced Academic Research Coordination Section supports the promotion of interdisciplinary collaboration between Units and universities in diverse academic frontier fields. It helps to establish a research network with universities and institutes at home and abroad and activates research in fusion science and joint research with a wide range of cutting-edge fields by sharing experimental data and promoting open science.

(I. Murakami)

Aurora observation project

As one of the interdisciplinary collaborative projects, researchers from the Phase Space Turbulence Unit and the Meta-Hierarchical Dynamics Unit of the National Institute for Fusion Science, the Research Institute for Sustainable Humanosphere of Kyoto University, and Tohoku University have cooperated in launching an aurora observation project. In this project, a hyperspectral camera that can acquire data in two spatial dimensions plus a wavelength and a liquid crystal filter camera that can observe images of any emission lines were installed at

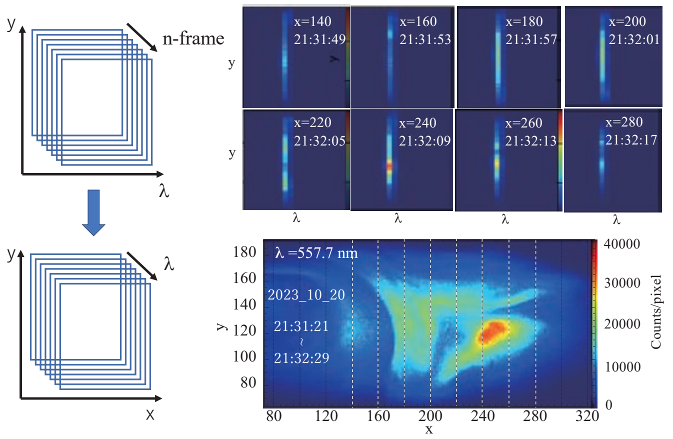

Fig. 1 (top) Original snapshots obtained by HySCAI I (y,l), and (bottom) reconstructed image (x,y) at 557.7 nm.
From Figure 4 in [1], © The Author(s). Published by Springer Open. CC BY 4.0.

the KEOPS (Kiruna Esrange Optical Platform Site) of the SSC (Swedish Space Corporation) in Kiruna, Sweden (67°51′ north latitude).

The hyperspectral camera for auroral imaging (HySCAI), which can provide a two-dimensional (2D) aurora image with full spectrum, was developed to study auroral physics. HySCAI consists of an all-sky lens, monitor camera, galvanometer scanner, grating spectrograph, and electron multiplying charge coupled device (EM-CCD). The galvanometer scanner can scan a slit image of the spectrograph on the all-sky image plane in the direction perpendicular to the slit. As seen in figure 1, the several frames of the spectrum along the slit direction are converted to a two-dimensional image with different wavelength. HySCAI has two gratings; one is 500 grooves/mm for a wide spectral coverage of 400–800 nm with a spectral resolution (FWHM) of 2.1 nm, and the other is 1500 grooves/mm for a higher spectral resolution of 0.73 nm with a narrower spectral coverage of 123 nm.

As the first light results, monochromatic images of N_2^+ 1NG (0, 1) (427.8 nm), N_2^+ 1NG (0, 2) (470.9 nm), H (486.1 nm), N II (500.1 nm), N I (2 D) (520.0 nm), O I (1 S) (557.7 nm,), NaD (589.3 nm), O I (1 D) (630.0 nm), and N_2 1PG (670.5 nm) emission intensity were measured. We estimated the precipitating electron energy from a ratio of I(630.0 nm)/I(427.8 nm) to be 1.6 keV [1].

[1] M. Yoshinuma, K. Ida, Y. Ebihara, Earth, Planets and Space **75**, 96 (2024).

(K. Ida, M. Yoshinuma and Y. Ebihara)

Development Research Coordination Section

Collaborating with the National Institute for Quantum Science and Technology (QST), five types of development research were carried out as a single year project; nevertheless they are to be continued.

(1) Divertor R&D for JA-DEMO

The tungsten (W) monoblock (MB) plasma facing unit (PFU) with a reduced activation ferritic/martensitic (RAFM) steel cooling pipe is one of key components for JA-DEMO divertor design. Small scale PFUs were manufactured by the Hot Isostatic Pressing (HIP) technique in order to investigate thermal and mechanical properties of the joint between W-MBs and a F82H pipe with a thin Cu interlayer. The test facility ACT2 at NIFS provided the environment for evaluating the joining performance by an iterative heat load experiment. The set-up for the experiment is shown in Figure 2. The joint sample has demonstrated its capability to withstand a maximum heat flux of 8 MW/m^2.

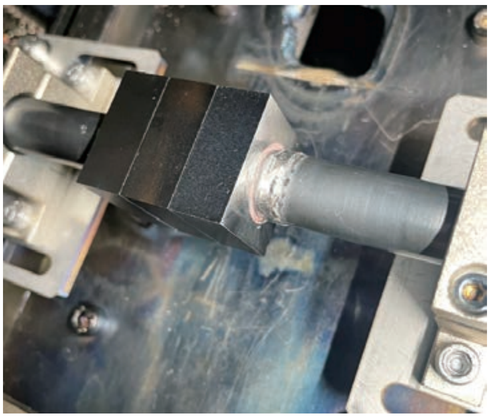

Fig. 2 Experimental set-up for heat loading test in ACT2 facility.

(2) Neutron and Gamma-ray detector development for LiPAC

Fast neutron and gamma-ray diagnostics are important for the characterization and management of an intense fusion neutron source such as the International Fusion Materials Irradiation Facility (IFMIF). The EJ-301 fast neutron scintillation detector, single crystal diamond detector and CeBr3:Ce gamma-ray detector have been used to measure neutron and gamma-ray flux in the IFMIF prototype accelerator (LIPAc).

(3) Upgrading NIFS-RNIS for DEMO NBI R&D

A giant radio frequency (RF) negative ion source for a neutral beam injector needs low beamlet (single beam of multi-beams) divergence, such as a filament-driven arc (FA) source, toward DEMO because of its long beam transport length. A research and development Negative Ion Source at NIFS (NIFS-RNIS) has been upgraded to an RF/FA hybrid source from an FA one. The RF mode operation with beam extraction was successfully performed, and the preliminary result of the beamlet divergence could be obtained with the beamlet monitor in the RF mode.

(4) Development research of bonding technique for JT-60SA divertor

In JT-60SA, the divertor component for a high-power-injection experiment has been developed, establishing a bonding technique between armor and heat sink, which is essential. The Powder Solid Bonding method (PSB) was used to test the bonding of tungsten to copper alloy, bonding tungsten to copper ally, graphite to copper alloy, graphite to molybdenum alloy, and C/C composite to copper alloy using simple test pieces.

(5) "Statistical-Mathematics" Fusion Research based on data-driven approach

It is important to incorporate data science and statistical mathematics methods as research tools to effectively utilize the large amounts of data generated by fusion-related experiments and simulations, and to link this to the development of control methods for future fusion reactors. The "QST Research Collaboration for Fusion DEMO" entitled "development of learning and estimation tools using data science and statistical mathematical methods and their utilization for control-based simulators", among researchers of the QST Rokkasho Fusion Institute, universities and NIFS, aims to develop and improve modeling methods for constructing control logic and predicting performance. Specifically, we have worked on plasma images, measurement data, and numerical simulation data such as that of turbulence and heat transport issues.

(T. Morisaki, M. Tokitani, K. Ogawa, H. Nakano and M. Yokoyama)

Industry Academia Government Coordination Section

The Industry Academia Government Cooperation Section is in charge of supporting the social implementation of fusion technology through industry academia government cooperation. Specifically, this section works on: ①Activities related to joint research with private companies, commissioned research, use of platforms, creation of opportunities for collaboration. ②Accumulation of know-how, collection of information, acquisition of external funding for industry academia government cooperation. ③Establishment of a system for industry-academia-government cooperation activities. ④AManagement and coordination of strategy for the Mission Realization Project.

(R. Yasuhara)