5. Fusion Science Interdisciplinary Coordination Center

The Fusion Science Interdisciplinary Coordination Center was established in April 2023 to advance interdisciplinary collaboration in fusion science and development research, and to foster the societal implementation of fusion technologies through close cooperation among industry, academia, and government.

As a comprehensive hub that leads and supports collaborative research with universities, research institutes, and industrial partners, the Center connects three newly defined interdisciplinary domains with a network of specialized Units to pursue ambitious, cross-cutting projects that transcend traditional disciplinary boundaries.

In particular, the Center aims to establish a broad research network integrating cutting-edge academic disciplines, promote open science, strengthen collaborations with international research initiatives, and accelerate the transfer of fusion-related technologies to society. To realize these goals, the Center comprises three dedicated divisions:

- Advanced Academic Research Coordination Section
- Development Research Coordination Section
- Industry–Academia–Government Coordination Section

Each section works in synergy with the Units to facilitate a wide range of joint research activities that bridge science, technology, and innovation.

(R. Yasuhara)

Advanced Academic Research Coordination Section

The Advanced Academic Research Coordination Section supports the promotion of interdisciplinary collaboration between the Units and universities in diverse academic frontier fields. The section facilitates the establishment of a research network with universities and institutes both domestically and internationally. It activates research in fusion science and joint research with those in a wide range of cutting-edge fields by sharing experimental data and promoting open science. In FY2024, the section supported three budding collaborative research proposals for travel expenses and five interdisciplinary mini-projects for their initial and development phases.

(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 wavelength and a liquid crystal filter camera that can observe images of any emission lines were installed at 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. This system has been installed at the KEOPS (Kiruna Esrange Optical Platform Site) of the SSC (Swedish Space Corporation) in Kiruna, Sweden [1,2,3]. HySCAI can provide a monochromatic image at a given wavelength and spectrum at any point in the image with a spectral resolution (FWHM) of 2.1

nm, as seen in Fig. 1. We estimate the precipitating electron energy from a ratio of I(630.0 nm)/I(427.8 nm) to be 1.6 keV at the auroral breakup [4].

Quantitative measurements of aurora emissions during astronomical twilight are difficult using the all-sky camera equipped with a bandpass filter, because of the contamination of background emissions due to sunlight. In contrast, the HySCAI gives the precise aurora emission intensity by subtracting the background of the spectrum. The spectrum of high-altitude blue auroral emissions has been observed with HySCAI during morning astronomical twilight [5,6].
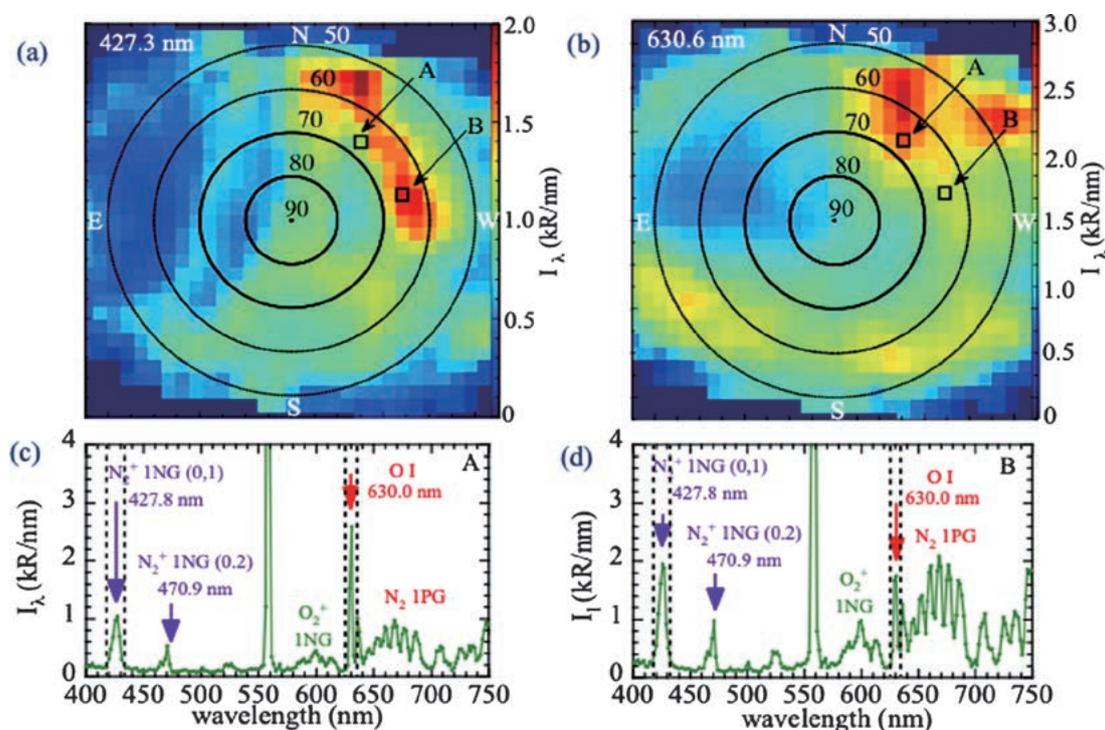

Fig. 1   Monochromatic images at (a) 427 and (b) 630 nm image and spectrum at position A and B. Reproduced from [4]. ©The author(s). Published by Springer Nature. CC By 4.0.

[1] https://projects.nifs.ac.jp/aurora/en/
[2] https://www.eurekalert.org/news-releases/1052684
[3] https://sj.jst.go.jp/news/202410/n1007-01k.html
[4] M.Yoshinuma, K.Ida, Y.Ebihara, Earth, Planets and Space **76**, 96 (2024).
[5] K. Ida, M. Yoshinuma, Y. Ebihara, "Development of hyperspectral camera for auroral imaging (HySCAI) [plenary talk]", 6th European Conference on Plasma Diagnostics, Prague, Czech Republic. 07–10 April, 2025.
[6] K. Ida, M. Yoshinuma, Y. Ebihara, K. Shiokawa, Milan Šimek, Jiří Fujer, "Development of Hyper Spectral Camera for Aurora Imaging (HySCAI) and initial aurora observation result in Kiruna, Sweden, [plenary talk]" 4th International Fusion and Plasma Conference, Daejeon, Convention Center, Daejeon, South Korea. 09–13, June 2025.

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

Development Research Coordination Section

Collaborating with the National Institute for Quantum Science and Technology (QST), EUROfusion and the ITER Organization, four development research ventures were undertaken as a single year project. Nevertheless, they are to be continued.

Fusion Science Interdisciplinary Coordination Center

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

Experimental investigation and development of radiation detector systems are underway for an intensive fusion neutron source. NIFS and QST jointly conducted measurements of fast neutrons and gamma rays at the Linear International Fusion Materials Irradiation Facility Prototype Accelerator (LIPAc), located at the QST Rokkasho Fusion Institute. These measurements were carried out to support the development of a radiation monitoring system for the Advanced Fusion Neutronics Source (A-FNS). Neutron and gamma-ray spectra, as well as neutron flux from the beam target, were measured using detectors developed through domestic/international collaborations between NIFS and universities. Graduate students from SOKENDAI and NIFS technical staff participated in the measurements, contributing to both the research and the development of human resources.

Fig. 1 (left) Radiation detector setups in LIPAc, (right) NIFS technical staff and SOKENDAI student in the LIPAc control room.

[1] Kunihiro OGAWA *et al.*, "Progress in the Development of Radiation Detectors for Fusion Neutronics Source A-FNS", Fusion Engineering and Design **218**, 115214 (2025).

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

A giant radio frequency (RF) negative ion source for a neutral beam injector needs low beamlet divergence, such as a filament-driven arc (FA) source, for application to DEMO because of its long beam transport length. In the RF operation mode of the NIFS-RNIS (Research and development Negative Ion Source) at NIFS with an RF/FA hybrid source, the beamlet divergence in the horizontal direction was found not to be significantly different from that in the FA operation mode.

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

For JT-60SA, we have developed a divertor component that is compatible with a high-power-injection experiment, collaborating with QST and EUROfusion. To accomplish the requirement from the JT-60SA project team, establishing a bonding technique between armor and heat sink is essential. By using the SPS (Spark Plasm Sintering) method, we have obtained quite favorable results in bonding tungsten to copper alloy, that is, tolerable to a heat flux more than 15MW/m^2 for 10s.
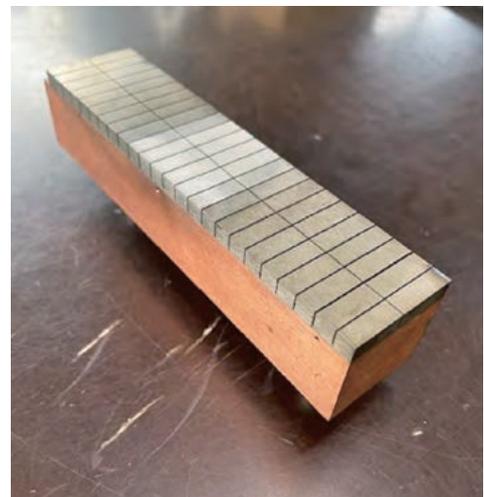

Fig. 2 Divertor test module with the same cross-section as the actual divertor module in JT-60SA.

As the next step, we manufactured a larger test module with the same cross-section as the actual divertor module in JT-60SA, as shown in Fig. 2. We are planning to perform the heat load test with a facility of EUROfusion in France.
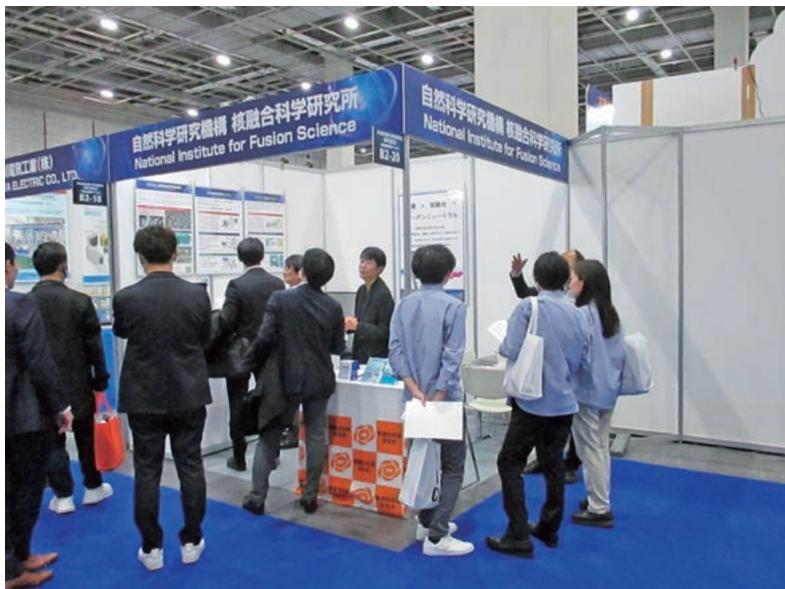
(4) Statistical-mathematics fusion research based on data-driven approach

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 and/or an integrated control simulator 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 QST Rokkasho Fusion Institute, universities and NIFS, has continuously aimed to develop and improve modeling methods towards such goals. Specifically, we have worked on anomaly detection based on plasma images, and dimension reduction of numerical simulation data, such as turbulence and heat transport issues, for realizing real-time (or faster time scale) control compared to the physics integration approach.

<div align="right">(T. Morisaki, K. Ogawa, H. Nakano and M. Yokoyama)</div>

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.

<div align="right">(R. Yasuhara)</div>