TO: Executive Secretaries of the US-Japan Fusion Research Collaboration

FROM: Steering Committee, US-Japan Joint Institute for Fusion Theory (JIFT)

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SUBJECT: JIFT Annual Report of Activities for 2025-2026

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Annual Report of JIFT Activities

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Annual Report of Activities

US-Japan Joint Institute for Fusion Theory

April 1, 2025–March 31, 2026

JIFT Steering Committee

Co-Chairmen: H. Sugama and J. Varela Rodriguez

Co-Executive Secretaries: Y. Todo and A. Arefiev

February 25, 2026

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1. *INTRODUCTION*

The Joint Institute for Fusion Theory (JIFT) is one of the four programs through which the US-Japan Fusion Research Collaboration is organized. The other three programs are the Fusion Physics Planning Committee (FPPC) and the Fusion Technology Planning Committee (FTPC).

The distinctive objectives of the JIFT program are (1) to advance the theoretical understanding of plasmas, with special emphasis on stability, equilibrium, heating, and transport in magnetic fusion systems; and (2) to develop fundamental theoretical and computational tools and concepts for understanding nonlinear plasma phenomena. Both objectives are pursued through collaborations between U.S. and Japanese scientists by means of two types of exchange program activities—namely, workshops and exchange visitors.

Each year the JIFT program usually consists of four topical workshops (two in each country), six exchange scientists (three from each country). So far, during its 45years of successful operation, JIFT has sponsored 259 long-term visits by exchange scientists and 145 topical workshops.

- The *workshops* typically have an attendance of 15–30 participants, of whom usually three to seven scientists (depending on the particular workshop) travel to the workshop from the non-host country. Scientists from countries other than the U.S. and Japan are also often invited to participate in JIFT workshops, either as observers or multi-laterals.
- Of the approximately three *exchange visitors* in each direction every year, one (called the "JIFT Visiting Professor") is supported by the host country, while the others (called "Exchange Scientists") are supported by the sending country. The visits of the Exchange Scientists usually last from one to several weeks in duration, whereas the Visiting Professors normally stay for one month.

The topics and also the participating scientists for the JIFT exchange visits, and workshops are selected so as to have a balanced representation of critical issues in magnetic fusion research, including both fundamental problems as well as questions of near-term significance, and also to take into account the specific capabilities and interests of both countries. The Japanese and US members of the JIFT Steering Committee agree together on the appropriateness of proposed topics before recommending them.

2. *SUMMARY OF COMPLETED ACTIVITIES (2025-2026 PROGRAM)*

Most of the activities in the two categories—workshops and personal exchanges—that had been scheduled for the 2025-2026 JIFT program were carried out during the past year. Two workshops were successfully held. In the category of personal exchanges, one Visiting Professor and four Visiting Scientists made exchange visits. The JIFT Steering Committee meeting was held by email for discussing schedules for the 2025-2026 and 2026-2027 JIFT programs.

Summary reports about JIFT activities for 2024-2025 are given below.

A 2025-2026 Workshops

Japan to US:

JF-1 Understanding non-diffusive phenomena in fusion plasmas
Organizers: P.H. Diamond (UCSD) and Y. Kosuga (Kyushu Univ.)
Location: University of California San Diego, San Diego, CA, USA
Dates: August 18-19, 2025
Summary:

The purpose of this workshop was to exchange recent developments in transport theory related to non-diffusive phenomena. A particular emphasis is placed on the edge region of fusion devices, where strong turbulence activity is observed. In this workshop, we had 23 presentations, including 6 from Japan and 17 from US. The topics covered are; Fundamentals, Structures in Turbulence,

Avalanches, Multi-scale Interaction, Jets and Staircases, Transport events, and Turbulence. While a main focus was on theory and modeling, we had several presentations from experimentalists to discuss validation of theory. Also covered is a basic physics related to turbulence phenomena, such as transition via a directed percolation. We had a fruitful interaction and future collaboration on a validation study was discussed.

US to Japan:

JF-6 Self-organized structure formation and functional emergence driven by intense lasers
Organizers: Yasuhiko Sentoku (ILE, UOsaka) and Alexey Arefiev (UCSD)
Location: PACIFICO Yokohama Room 311, Kanagawa, Japan
Dates: April 21, 2025
Summary:

The purpose of this workshop was to promote research collaboration between Japanese and U.S. researchers in high energy density science by deepening understanding and discussion of the physics. The workshop had 15 participants (5 from US, 1 from EU, and 9 from Japan) and 8 oral presentations, which covered subjects in relation to acceleration mechanisms of fast electrons and fast ions, magnetized laser-plasma interactions, heating and energy transport in high density plasmas, and laser fusion. This workshop has stimulated young scientists and had established very fruitful US-Japan collaborations using both the ILE UOsaka and LLNL laser systems. The collaboration results had been published in several journals last a few years including one in Physical Review Letters.
The workshop website is https://www.ile.osaka-u.ac.jp/jift/ .

B. 2025-2026 Exchange Visits

Japan to US:

JF-2 Collaboration on tokamak boundary plasma turbulence simulations for divertor heat flux width
Visiting Scientist: Haruki Seto (QST)
Location: Xueqiao Xu (LLNL)
Dates: Apr. 14 – 18, 2025; paid by JA
Summary:

This exchange visit was canceled.

JF-3 Kinetic turbulence simulation of helical confinement plasmas using graphics processors
Visiting Scientist: Tomoya Tatsuno (Univ. Electro-Communications)
Location: IREAP, University of Maryland, College Park, Maryland, USA
Dates: Aug. 24 - Sep. 7, 2025 (15 days); paid by Japan
Summary:

In general, helical devices are computationally more difficult to analyze than tokamaks due to their complicated geometry. Thus, turbulence calculations, which require a large amount of computational resources, are not as advanced as those in tokamaks. In particular, in Heleotron J, turbulence analysis using gyrokinetic theory has been rarely performed except by Ishizawa et al. [1]. However, even in helical systems, anomalous transport due to turbulence is considered to be larger than neoclassical transport due to inter-particle collisions [2], so more analyses are expected. [1] B.D. Dudson et al., Comput Phys. Commun. 180 (2009) 1467

Since the use of graphics processors is now widely spread due to the effort of NVIDIA, the group at Univ. Maryland (UMD) started developing gyrokinetic simulation code GX around 2015 in the hope that it can be used for turbulence simulations of helical systems [3]. Last year, I learned and started to run GX for Heliotron J to perform turbulence simulations in helical systems. I performed linear and nonlinear calculations of Ion-Temperature-Gradient (ITG) instability and confirmed that turbulence actually develops in the typical plasma equilibrium of Heliotron J.

In 2025, I first confirmed that GX works well in the newly installed Plasma Simulator of the Computational Simulation Centre at the International Fusion Energy Research Centre. Next, in the collaboration with the UMD group, I learned the way to include the electron dynamics and electromagnetic effects in order to investigate the stability of Trapped-Electron-Mode (TEM) and Electron-Temperature-Gradient (ETG) modes. We found that GX needs to be upgraded to include a new term in order to correctly simulate the small scale dynamics as those of ETGs.

We are currently conducting turbulence analysis in collaboration with the Heliotron Group in order to compare the experiments in Heliotron J.

[1] A. Ishizawa, Y. Kishimoto, T.-H. Watanabe et al., Nucl. Fusion 57, 066010 (2017).
[2] S. Nagasaki, T. Mizuuchi, H. Okada et al., J. Plasma Fusion Res. 96,475 (2020) [in Japanese].
[3] N. R. Mandell, W. Dorland, I. Abel et al., J. Plasma Phys. 90, 905900402 (2024).

JF-4 Hamiltonian Theory of Collision Operators in Noncanonical Phase Space

Visiting Scientist: Naoki Sato (NIFS)
Host Scientist: Philip J. Morrison (University of Texas at Austin)
Location: The University of Texas at Austin, Austin, Texas, USA
Dates: May 18 - June 12, 2025; paid by US
Summary:

During this visit, we advanced a Hamiltonian framework for collision operators in noncanonical phase space, motivated by weakly collisional, long-wavelength/low-frequency regimes relevant to plasma turbulence and transport. Building a general "grazing-collision" scattering theory determined by the Poisson tensor and interaction potential, we identified conditions ensuring conservation laws (particle number, momentum, energy, and internal Casimirs) together with an H-theorem. We then applied the general formulation to guiding-center dynamics and derived an explicit 5D drift-kinetic (guiding-center) collision operator possessing a metriplectic structure (noncanonical Poisson bracket plus symmetric dissipative bracket), which guarantees conservation of total magnetic moment and monotonic relaxation toward thermodynamic equilibrium with respect to an appropriate invariant measure. The theory clarifies structural links to the 6D Landau operator and its gyro/drift-kinetic variants, and indicates a practical pathway toward implementation via linearization in existing gyro/drift-kinetic simulation codes.

Related publications:

[1] N. Sato and P. J. Morrison, "Scattering Theory in Noncanonical Phase Space: A Drift-Kinetic Collision Operator for Weakly Collisional Plasmas," Physics of Plasmas 32, 102306 (2025).

JF-5 Multi-scale turbulence interactions and transport modeling

Visiting Scientist: Shinya Maeyama (NIFS)
Location: Cole Stephens (University of Texas at Austin)
Dates: July 27 – Aug. 23, 2025; paid by US
Summary:

This exchange visit was canceled.

US to Japan:

JF-7 Validation study on avalanche transport in fusion plasmas

Visiting Scientist: P.H. Diamond (UCSD)
Location: Kyoto University, Uji, Japan
Dates: Sep. 22-27, 2025; paid by US
Summary:

This exchange visit was canceled.

JF-8 Collaboration on Tokamak boundary plasma turbulence simulations for divertor heat flux width
Visiting Scientist: Ben Zhu (LLNL)
Location: Rokkasho Institute for Fusion Energy, QST, Aomori, Japan
Dates: August 6-9, 2015 (4 days); paid by U.S.
Summary:

Dr. Zhu visited QST Rokkasho to discuss the code extensions required for simulating ELM control by RMP using BOUT++. Since existing codes such as JOREK and MIPS have difficulty simulating short wavelength ELMs, extending BOUT++ to handle short wavelength ELMs and their RMP control is one of important issues for ITER and DEMO reactors. Although BOUT++ can calculate short wavelength ELMs with reasonable computation cost, full torus simulations suffer from numerical instabilities. QST and LLNL have been jointly developing methods to resolve this issue under the JIFT framework.

During the visit, the LLNL side reported progress on developing the interface for coupling BOUT++ with the three-dimensional perturbed magnetic equilibrium code GPEC, as well as on modeling RMP fields calculated by GPEC for use in BOUT++. The QST side reported advancements in numerical techniques for full torus simulations and updates to the grid generation code—originally developed in the FY2025 JIFT collaboration—to handle long wavelength perturbation fields more self-consistently. Based on these reports, we discussed a future development plan of BOUT++ to integrate their code extensions and enable ELM control simulations using RMP. They agreed to continue the collaboration in FY2026 and proceed with functional enhancements of BOUT++. We also agreed to change the project title to "Collaboration on Tokamak boundary plasma turbulence simulations in BOUT++ framework" to clarify the focus on ELM control simulations. Furthermore, due to Dr. ZHU's transfer to Columbia University in January 2026, both LLNL and Columbia University will serve as U.S. host institutions for the collaboration.

JF-9 Effect of EP on Pressure driven MHD instabilities in the helical plasmas
Visiting Scientist: Jacobo Varela-Rodrigues (University of Texas at Austin)
Location: National Institutes for Fusion Science (NIFS), Toki, Japan
Dates: Apr. 15 – May 15, Sep. 16 – Nov. 13, 2025
Summary:

Dr. Varela performed analysis of the stability of AEs and pressure gradient driven modes in LHD, CHS and VAST configurations using the code FAR3d. Numerical analysis and dedicated experiments in the 26th LHD campaign are performed dedicated to identifying techniques to avoid or minimize core density collapses by extending the destabilization threshold of ballooning modes considering different heating patterns and magnetic configurations. In addition, operation scenarios coupling NBI and ICRH heating are explored experimentally. Nonlinear simulations are also performed to study the effect of the Landau damping in the saturation phase of MHD burst. The effect of multiple TAEs on ITG turbulence is also explored in LHD experiments with intense AE activity.

JF-10 Analysis on driving mechanism of Core density collapse phenomena in helical plasmas
Visiting Scientist: Jacobo Varela-Rodrigues (University of Texas at Austin)
Location: National Institutes for Fusion Science (NIFS), Toki, Japan
Dates: Mar. 12 – 27, 2026

Summary:

Dr. Varela performs numerical analysis of the ballooning mode stability in LHD discharges performed in the 26th campaign dedicated to avoid or minimize CDC activity. Using the FAR3d code, a set of experimental and theoretical configurations are explored, identifying optimization trends leading to an incrment of the ballooning modes destabilization threshold by tailoring the elge pressure profile and magnetic field configuration.

3. *PROGRAM ADMINISTRATION*

JIFT has a Steering Committee consisting of eight members, four from each country. Two of these members are the Japanese and US co-chairmen. Two other members of the Steering Committee, the US and Japanese co-executive secretaries, are responsible for the ongoing daily oversight of the progress of JIFT activities. The co-chairman and co-executive secretary on the US side are, respectively, the director of the Institute for Fusion Studies (IFS) of The University of Texas at Austin and the Professor of the University of California San Diego. The Japanese co-chairman is the Professor of the Complex Global Simulation Unit at the National Institute for Fusion Science, and the Japanese co-executive secretary is the Deputy Director General of the National Institute for Fusion Science. Furthermore, on the Japanese side there is an Advisory Committee comprised of three members representing a spectrum of Japanese universities and the National Institutes for Quantum and Radiological Science and Technology; and on the US side there is an Advisory Committee comprised of four members representing a spectrum of US universities and national laboratories. The names of the persons on the Steering Committee and the names of the Advisors are listed below.

JIFT Steering Committee

US Members	*Japanese Members*
J. Varela Rodriguez (IFS)—Co-Chairman	H. Sugama (NIFS)—Co-Chairman
A. Arefiev (UCSD)—Co-Exec. Secretary	Y. Todo (NIFS)—Co-Exec. Secretary
D. Spong (ORNL)	S. Murakami (Kyoto)
F. Parra (PPPL)	Y. Sentoku (Osaka)

JIFT Advisors

Japanese Advisory Committee: Y. Kishimoto (Kyoto), T.-H. Watanabe (Nagoya), M. Yagi (QST)

*US Advisory Committee***:** J. Palastro (LLE/Univ. of Rochester), F. Graziani (LLNL), Adelle Wright (Wisconsin University) and Michael Halfmoon (DoE)

The JIFT Steering Committee attempts to schedule workshops in such a way as to dovetail with other meetings. It also encourages participation at workshops by interested experimentalists and invites relevant available scientists from other countries to attend workshops.

As the principal program for fundamental theoretical exchanges in the US-Japan Fusion Research Collaboration, JIFT operates alongside the Fusion Physics Planning Committee (FPPC) and the Fusion Technology Planning Committee (FTPC). In particular, the JIFT activities are coordinated with the four FPPC areas of activity, viz., core plasma phenomena, edge behavior and control, heating and current drive, and new approaches and diagnostics.

4. *PLANS FOR FUTURE ACTIVITIES (PROPOSED 2026-2027 PROGRAM)*

The topics and themes of the exchange activities that have been proposed for the next year (April 1, 2026–March 31, 2027) are consistent with the traditional emphasis of JIFT on fundamental theoretical plasma physics issues. At the same time the proposed activities have direct relevance to the fusion science programmatic interests of both countries. The schedule of proposed activities for the coming year (2026-2027) is listed below.

A. 2026-2027 Proposed Workshops

Japan to US:

JWU1 Workshop on Theory-Experiment Integrated Approaches to Diagnostics, Control of Magnetically-Confined Plasmas and AI applications
Organizers: Adelle Wright (University of Wisconsin–Madison) and Hiroyuki Yamaguchi (NIFS)
Proposed Place/Time: University of Wisconsin–Madison Aug. 3-7, 2026

JWU2 Self-organized structure formation and functional emergence driven by intense lasers
Organizers: Alexey Arefiev (UCSD) and Yasuhiko Sentoku (ILE, UOsaka)
Proposed Place/Time: Chicago Nov. 6, 2026

US to Japan:

JWJ1 Mesoscopic turbulence and transport in fusion plasmas
Organizers: Y. Kosuga (Kyushu Univ.) and P.H. Diamond (UCSD)
Proposed Place/Time: Yokohama Sep. 8-10, 2026

B. 2026-2027 Proposed Exchange Visits

Japan to US:

JPU1 Noncanonical Hamiltonian Fluid Closures
Visiting Scientist: Naoki Sato (NIFS)
Location: The University of Texas at Austin
Dates: July 1-10, 2026

JPU2 Simulation Study of MHD Stability Characteristics in QA/QI-like Configurations of Variable Symmetry Torus
Visiting Scientist: Yuki Takemura (NIFS)
Location: Institute for Fusion Studies (IFS), The University of Texas at Austin
Dates: May 17-June 6, 2026

JPU3 Collaboration on Tokamak boundary plasma turbulence simulations in BOUT++ framework
Visiting Scientist: Haruki Seto (QST)
Location: LLNL
Dates: Aug. 2-16, 2026

US to Japan: