

# Charter of the JT-60SA International Fusion School (JIFS)

## Foreword

JT-60SA is the largest tokamak in operation. It has been designed and built jointly by Japan and Europe, and has started operation in 2021. Peculiar properties of JT-60SA are its capability to produce long-pulse, high- $\beta$  and highly shaped plasmas. Its main missions are to support ITER exploitation and to contribute to DEMO machine and scenario design, while fostering the new generations of fusion physicists and engineers. For this third mission, the JT-60SA machine, laboratories, experimental programme and its associated modelling activity constitute an ideal playground for the training of Japanese and European students and young professionals, provided suitable specific initiatives in this direction are carried out. The JT-60SA International Fusion School has been created as the first initiative in this direction.

## 1. Objectives and Scope of the school

The main purpose of this education programme is to contribute to the preparation of a next generation of fusion physicists and engineers from Japan and Europe (i.e., EU + countries associated to the EURATOM fusion programme), mainly focusing on:

- The completion of their training by lectures, group works and visits, taking advantage of the JT-60SA facility, environment, experiments and data for practical examples and applications.
- The establishment and consolidation of connections between Japanese and European students and young professionals, who could ideally be involved together in the future JT-60SA and ITER operation, scientific exploitation and upgrades.

Experience shows that professional success in fusion research is not only based on excellence in specific subjects (plasma theory, computing, experiments, diagnostics, engineering etc.) but also on a broad knowledge of the different ingredients that contribute to the realization and scientific exploitation of fusion experiments. Moreover, for decades, international collaboration across cultures and nations has been the natural environment of fusion research and a decisive factor for its progress.

Therefore, JIFS addresses the main aspects of fusion research, from plasma physics to engineering, with special attention to their combination into tokamak operation, at the same time with the aim of strengthening the links between the Japanese and European fusion communities.

A key characteristic of the school is that it includes practical activities, using experimental facilities in the JT-60SA laboratories, JT-60SA data, analysis and computational tools. The school also aims to provide a permanent background of online information, as well as means to prepare and continue exchanges among students and between students and lecturers.

## 2. Participating Institutions

JIFS has been created under the auspices of the Broader Approach agreement between Japan and Europe for fusion energy research and of EUROfusion. It is connected to the Satellite Tokamak Programme and to its two implementing agencies, namely the National Institutes for Quantum and Radiological Science and Technology (QST) and Fusion for Energy (F4E).

It is jointly funded and operated by QST and EUROfusion, with the participation of organisers, lecturers and advisors from Japanese and European universities and research institutes, which are then

considered as participating institutions. A present-day list of these institutions (open to future extensions) is given in the Annex.

### **3. Funding**

The costs for the school are jointly sustained by Japan and Europe as in-kind contributions from QST and EUROfusion, without attribution of formal Broader Approach credits and separately from the JT-60SA project costs and credits. They include resources for school organisation (staff and logistics) and mission costs for students and lecturers.

### **4. School Organisation Structure**

The main bodies of the JIFS organisation structure are the following:

Directors: two Co-directors, one from Japan and one from Europe, belonging to the participating institutions. They are appointed for three years by the JT-60SA Project Leader, upon proposal of the funding institutions. They are responsible for promoting the school, approving the school programme, formally appointing the lecturers, selecting the students, appointing and coordinating the School Advisory Board, supervising the practical organisation.

School Advisory Board: it is composed by representatives of the participating institutions, in particular from the academia, in charge for three years. The members have the role of advising and supporting the Directors for the definition of the school programme and timetable, choice of lecturers and selection of students. They ensure proper connections with the academic world and promotion of the school in their institutes.

School Organization Committee: appointed by the Directors upon proposals of the funding institutes, it is led by a Chair and composed by:

- QST staff in charge of administrative and logistics aspects of the school;
- a website manager, in charge of the school website and of additional communication channels, such as social media;
- a pool of Japanese and European professionals in charge of the coordination of the didactic aspects, with the advice of the School Advisory Board: coherence and level of lectures and exercises, preparation of the programme, contacts with the lecturers, documentation for students.

Members of these three bodies could also have a more direct participation in the school as lecturers or students.

### **5. Format**

At present, the school is hosted, on an annual basis, by the QST Naka Fusion Institute and is scheduled on two consecutive weeks on site, preferentially in the summer period.

The programme is a combination of lectures, practical (individual and group) exercises and in-depth visits of the JT-60SA device, control room, diagnostic hall, annexed experimental facilities and laboratories.

A final evaluation of the students (through individual or group presentations) is foreseen. Whenever possible and useful, academic credits could be associated to participation in the school.

Creating lasting links between European and Japanese students is one of the main objectives of the school. To this aim, a number of initiatives are implemented, for instance: a common students' accommodation structure is chosen, groups for practical work and visits always combine Japanese and European students, common social activities are encouraged. Self-organization of these activities by students during the weekend, starting by proposals and exchanges before the school, is considered as

an objective, on which students should report at the end. Dedicated social media pages and communication tools are implemented via the school website in order to favour contacts before and after the school.

## **6. Remote participation**

The lectures are broadcast online and, whenever possible, recorded for use by a wider audience of students and professionals. Masters students are particularly encouraged to follow the lectures online as a preparation to future participation in the school. Although the full educational offer (lectures, exercises and visits) can be attended only once, online lectures could be used by previous participants to complete their training.

In case in-person organisation of the school would be impossible, the school will be held online, with a schedule adapted to participation from both Japan and Europe. However, the selected students will be entitled, at a later date, to an extra week of visits and practical exercises at the QST Naka site, in which they will have the possibility to get acquainted with the lecturers and the other students, via group work and social activities.

## **7. Subjects and Activities**

Typical topics addressed by the school are: tokamak operations, plasma diagnostics, transport and confinement, scenario design, heating and current drive, numerical simulation, plasma turbulence, MHD instabilities, plasma-wall interaction, energetic particles, disruption prediction and mitigation, magnetic equilibrium, plasma control, fuelling and pumping, integrated performance, IT for fusion facilities, data-driven science, cryomagnetic system, remote handling technology, DEMO design, fusion research strategy, etc.

Every year, a subset of topics is selected. Ideally, the subset covers physics, engineering and tokamak operation aspects, encompassing theory, experiments and technology. The final programme is elaborated with the aim of attaining a fair balance of these fundamental aspects.

## **8. Lecturers**

The lecturers are chosen as a well-balanced combination of Japanese and Europeans, as well as theoretical and experimental physicists, engineers and tokamak operation experts. They are selected primarily among members of the JT-60SA Integrated Project Team and regular JT-60SA collaborators, experts and academics with recognised competences in the field of plasma physics, operations and engineering. Furthermore, some external lecturers can also be invited, in particular from ITER, DEMO related R&D projects or universities.

The aim is to appoint every year a restricted team of lecturers, available to spend time and interact with the students (also pre- and post-school time). They are expected to contribute on a voluntary basis, with their mission expenses covered by the school budget.

Having the school programme as a reference, lecturers are appointed by the Directors, advised by the School Advisory Board, typically 5 months prior to the start of the school.

## **9. Selection of students**

For the sake of efficiency, in particular as far as visits, supervised exercises, group work and interaction with lecturers are concerned, the school attendance is limited to a selected number of students (typically 20), equally distributed between Japan and Europe and not necessarily belonging to the participating institutions. Their mission expenses are covered by the school budget. Students from other countries collaborating with the JT-60SA project could be exceptionally admitted, provided that their institutes cover the mission expenses. The selection procedure is organised as follows:

Call for participation: a Call for Participation will be published on the school website and widely disseminated (typically 5 months prior to the start of the school). The call aims in particular to PhD students, post-docs and young professionals.

The candidates will have to submit:

- application form, CV, publication list, motivation letter;
- one or two recommendation letters, describing the candidate's background, level, motivation and what he/she could gain from participation in the school programme;
- an endorsement letter of their institution, stating that the institution supports their application and their attendance for all aspects not explicitly covered by the school funding and the logistics support (e.g. insurance for medical costs).

Selection criteria and procedure:

The main selection criteria are the following (not in priority order):

- academic record (courses followed and marks obtained)
- background in fusion-relevant physics or engineering
- motivation to continue a career in fusion research
- motivation for international activities and curiosity for other cultures

In addition to these criteria for individual student selection, the aim is to set up a student group with a well-balanced combination of Japanese and Europeans, as well as theoretical and experimental physicists and engineers. Furthermore, diversity and equality in the selected candidates will be promoted, with particular attention to gender balance.

After a first screening, a shortlist is established. The Directors and members of the School Advisory Board may decide that the shortlisted candidates will be interviewed to confirm CV and motivation. If this is the case, for equality, a video conference system will be used for all the interviews.

## **10. Website & document management**

Website: an official JIFS website is used to post key information for advertisement of the school, school programme, call for participation, School Annual Report, useful logistic information, lectures material etc. Links to the JIFS website appear on the JT-60SA website as well as on the F4E and EUROfusion websites.

Document management: all the relevant organisation documents (minutes of meetings, timeline, programme, etc.) are stored in a dedicated area of the JT-60SA website, accessible to the personnel of the school organisation structure.

School Alumni: school will ask permission to maintain a record of the relevant data of the school participants, with the purpose of promoting continuing professional and personal relationships.

## **11. Logistics**

On the basis of the School Programme and schedule, lecturers and student lists, the School Organization Committee is in charge of, typically:

- a) Organising the venue for the lectures, visits and practical exercises
- b) Organising accommodation for lecturers and students, transport to the venue, social events
- c) Preparing a set of documents, providing useful logistic information. Organising means to create connections between the students
- d) Preparing educational material for students and lecturers
- e) Preparing IT access for students and lecturers, as well as IT infrastructure with the pre-installed software necessary for numerical simulations and access to JT-60SA data, as needed for practical exercises.

## 12. Certificate of completion

At the end of the school, after some form of evaluation (tests or presentations by students), a certificate of completion will be delivered, assessing participation and achievement of training objectives.

## 13. Feedback process

At the end of the school (if needed, also during the school period), the students will have the possibility to give feedbacks and express their opinions on the organization of lectures, infrastructures, level of communication, etc.

## 14. Approvals and reporting

The school schedule and programme are submitted by the Directors for approval to the JT-60SA Project Leader, who ensures compatibility with other project activities, such as experiments, maintenance, hardware upgrades, as well as availability of project staff.

Elements affecting resources and budget, such as school duration and venue, logistics, mission expenses for students and lecturers, should be approved by the funding institutes.

The School Directors issue every year a report on the actual achievements of the school including the School Annual Programme, courses, list of lecturers and students, social events. The report is sent to all the participating institutions.

### Annex

List of participating Institutions, contributing to JIFS with organisers, lecturers and Advisory Board members (Feb. 2021).

| Japan  |
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| QST  |
| The University of Tokyo  |
| Kyushu University  |
| Nagoya University  |
| University of Tsukuba  |
| Kyoto University   |
| NIFS – National Institute for Fusion Science                                 |
| Europe   |
| Fusion for Energy  |
| EUROfusion   |
| CEA (France)   |
| CCFE (UK)  |
| Max-Planck Gesellschaft / IPP Garching (Germany)                             |
| Consorzio RFX (Italy)  |
| Ecole Polytechnique Fédérale de Lausanne / Swiss Plasma Center (Switzerland) |
| University of Napoli Federico II (Italy)                                     |
| University of Padova (Italy)   |
| Technical University of Denmark  |
| Technical University of Munich (Germany)                                     |
| University of Seville (Spain)  |
| ...  |