JT-60SA International Fusion School (JIFS)

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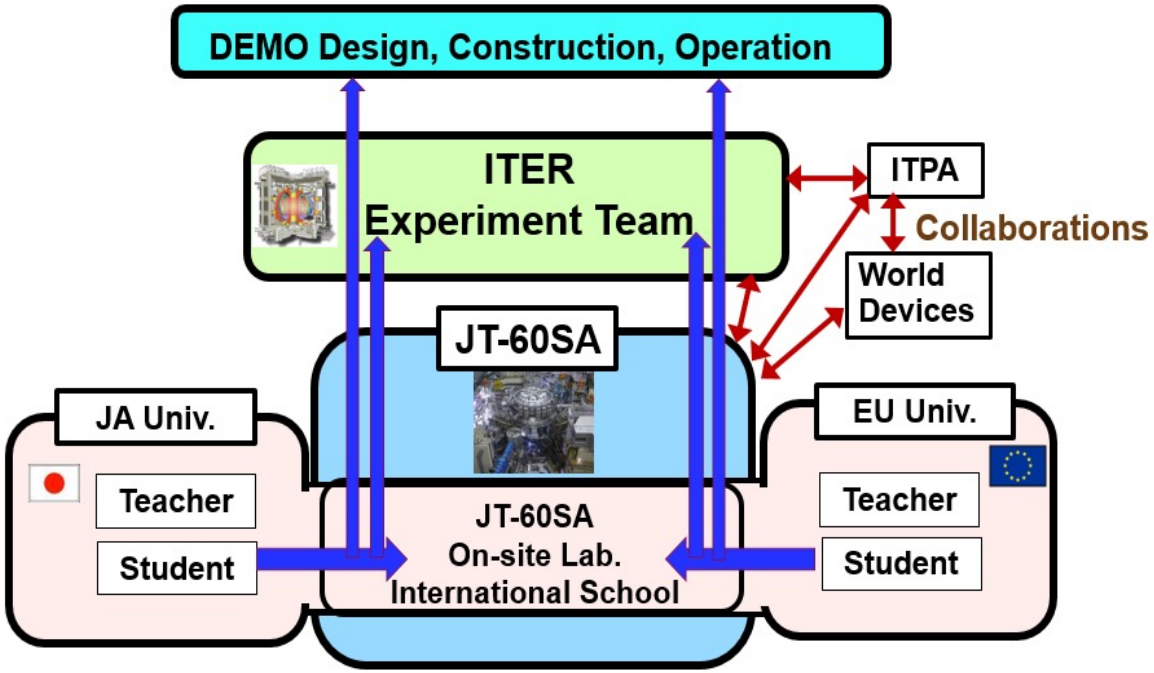
Why another summer school ?

- **JT-60SA missions**:
  - supporting **ITER** exploitation
  - contributing to **DEMO** machine and scenario design
  - fostering **new generations** of fusion physicists and engineers

⇒ **connect the project with training initiatives**



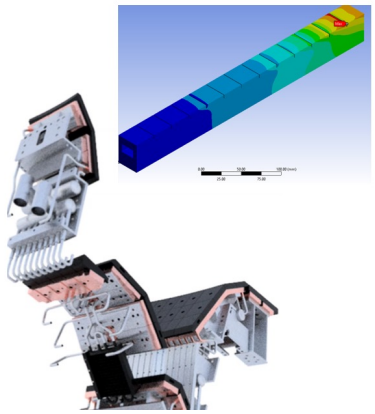
courtesy: Y. Kamada

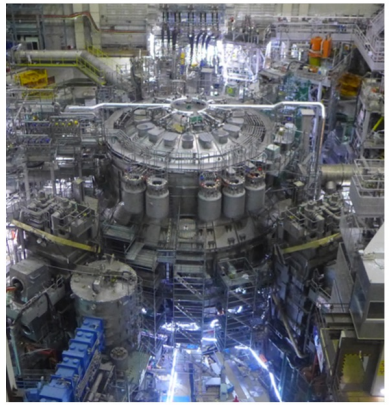
JIFS objectives

- Completing the **training** of selected **students** & **young professionals** by:
  - **lectures** on fusion physics, engineering, operation
  - **group work** using the JT-60SA facility, laboratories, modelling tools and data as an **ideal playground** for practical examples and applications

- **Creating links** between students and young professionals from Japan and Europe*, who could then:
  - participate in **JT-60SA** operation, scientific exploitation and upgrades
  - be involved in Japanese and EU participation in the **ITER** programme.

***Note:** here Europe means EU + countries associated to the EURATOM fusion programme*





Ideas on school main characteristics

- Fusion research involves a **wide range of competences**: theory, computing, experiments, diagnostics, engineering ⇒
- JIFS should be a school addressing this variety of aspects: plasma **physics**, **engineering**, with special attention to **tokamak operation**
- JIFS should include **practical group activities**, using JT-60SA lab facilities, data, codes and analysis tools.
- JIFS should provide a permanent background of **online information**, pre- and post-school time and **favour exchanges** among students
- Involvement of Japanese **Universities**, **QST**, **F4E**, **EUROfusion** and associated **EU University** network
- Not only fusion **PhD students**, but also **young fusion staff** having a Master, in **Physics** or in **Engineering**
- Number of students: **20 (maximum)**: 10 EU and 10 Japanese. Diversity, equality and gender balance promoted.

School organisation structure

- **Two co-directors**, one from Europe and one from Japan, appointed by the JT-60SA Project Leader for three years →

G. Giruzzi
(CEA/EUROfusion)

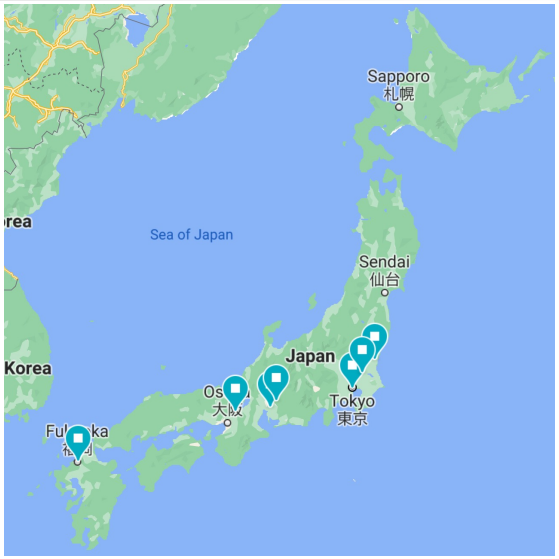
Y. Kamada
(QST)

- **School Advisory Board**: 14 members, appointed by the Directors, from F4E, QST, EUROfusion, European and Japanese academia
- **School Organisation Committee**: appointed by the Directors. In charge of :
  - logistics, administration, IT support (from **QST**)
  - website and social media (from **Europe**)
  - **didactic** aspects (with advice of the Board): programme, contacts with lecturers, organisation of visits and group work, documentation (from **Europe** and **Japan**)

Participating Institutions

- JIFS created under the **auspices** of **Broader Approach** agreement
- It is connected to (but not funded by) the **Satellite Tokamak Programme** and to its two implementing agencies, **QST** and **F4E**.
- It is **jointly funded and operated by QST and EUROfusion**. Funding includes resources for school organisation (staff and logistics) and mission costs for students and lecturers.
- **Participating institutions**: Japanese and European universities and research institutes which provide:
  - school organisers
  - lecturers
  - members of the Advisory Board

School Advisory Board



P. Barabaschi	F4E
P. Bettini	Padova University / RFX
G. De Tommasi	Napoli University / CREATE
A. Fasoli	EPFL
M. Garcia-Muñoz	Seville University
V. Naulin	Technical University of Denmark / EUROfusion
R. Neu	Technical University of Munich / IPP Garching

S. Ide	QST
T. Fujita	Nagoya University
K. Hanada	Kyushu University
Y. Kishimoto	Kyoto University
S. Sakakibara	NIFS
M. Sakamoto	University of Tsukuba
K. Shinohara	The University of Tokyo

1st Advisory Board meeting

1st edition programme elaboration

- Brainstorming via a **survey** among > 100 colleagues, in Japan and Europe
- Extensive discussions within the **preparatory group** (including Japanese Board members)
- Discussion with the JIFS Advisory Board

- Present programme structure:
  - **First week** with **general** lectures on **tokamak** and its **sub-systems**, **basics of plasma physics**, visits
  - **Second week** with **topical** lectures and visits. Then **splitting in groups**, advanced lectures, **practical** exercises, presentations by students

- **1st edition** now scheduled **August-September 2023**

1st edition programme proposal: 1st week

Time	Monday		Tuesday		Wednesday		Thursday		Friday	
Session	plenary		plenary		plenary		plenary		plenary	
8.30 - 10.00	Welcome & Logistics		4) Plasma physics 1	PHY	7) Power Exhaust systems	PWI	10) Tokamak System Optimisation	TOK	14) From JT-60SA to ITER, DEMO & fusion reactors	TOK
10.00-10.30	Break		Break		Break		Break		Break	
10.30-12.00	1) Introduction - tokamak overview	TOK	5) Plasma physics 2	PHY	8) Diagnostics - general	DIA	11) Realising & Assembling a Tokamak	TOK	15) Questions & Discussions	TOK
12.00-13.00	Lunch		Lunch		Lunch		Lunch		Lunch	
13.00-14.30	2) Vacuum Systems and Cryogenics	TOK	Visit - Torus Hall	TOK	Visit - Auxiliary Systems	TOK	12) Operating and Maintaining a Tokamak	OPE	Operation 1	OPE
14.30-15.00	Break		Break		Break		Break		Break	
15.00-16.30	3) Magnets and Thermal Shields	TOK	6) Heating Systems	TOK	9) Loading Conditions, Safety, Standards	TOK	13) Experimental scenarios	SCE	Operation 2	OPE
18.00-20.00	Reception				Social dinner				Career evening	

Topics	Lectures	Practicals	Visits
TOK - Tokamak and sub-systems	9		2
PHY - Plasma physics - general	2		0
DIA - Diagnostics	3		1
SCE - Scenarios	3		0
OPE - Operation	3		1
PWI - Power exhaust and Plasma Wall interaction	3		0
Optional topic - Advanced (5 groups: TOK, DIA, SCE, OPE, PWI)	1	6	0
Totals	24	6	4

Saturday	Sunday
Rest	Joint Student Activities
Lunch	
Sightseeing	

Experienced scientists present their careers to students; Q&A

Self-organised student excursion or activity, considered as a project

1st edition programme proposal: 2nd week

Time	Monday		Tuesday		Wednesday		Thursday		Friday	
Session	plenary		plenary		5 groups		5 groups		plenary	
8.30 - 10.00	Diagnostics 1	DIA	Plasma Wall Interaction 2	PWI	Optional topic: Introduction to Practicals		Optional topic Practicals 4		Presentations by students 1	
10.00- 10.30	Break		Break		Break		Break		Break	
10.30- 12.00	Diagnostics 2	DIA	Scenarios 1	SCE	Optional topic Practicals 1		Optional topic Practicals 5		Presentations by students 2	
12.00- 13.00	Lunch		Lunch		Lunch		Lunch		Lunch	
13.00- 14.30	Visit - Diagnostics	DIA	Visit - control room	OPE	Optional topic Practicals 2		Optional topic Practicals 6		Presentations by students 3	
14.30- 15.00	Break		Break		Break		Break		Break	
15.00- 16.30	Plasma Wall Interaction 1	PWI	Scenarios 2	SCE	Optional topic Practicals 3		Presentations by students: preparation		Closing	
18.00- 20.00	Report on weekend joint activities				Culture evening				Farewell Dinner	

Report on the self-organised weekend activities project

Exchanges on cultural differences and student systems

Topics	Lectures	Practicals	Visits
Optional topic - Advanced (5 groups: TOK, DIA, SCE, OPE, PWI)	1	6	0
Totals	1	6	0

Topics	No.
Opening/closing	2
Lectures	24
Practical work (in groups)	6
Visits	4
Presentations by students	4
Total	40
Evenings	6

Possible split of each topical practical in two modules → students could combine modules of different topics

Detailed structure: an example
Tokamak & sub-systems

Title	Contents	Lecturers / chairs	Comments
1 Introduction - tokamak overview	1.1 Synopsis, how the lectures will flow 1.2 Overview of a Tokamak (e.g. JT-60SA view) 1.2.1 overview description of the entire device 1.2.2 what each sub-systems does 1.2.3 how does a tokamak compare with other fusion devices 1.2.4 how does JT60SA compare with other tokamaks and in particular ITER 1.3 Intro on Fusion reactions 1.3.1 cross sections 1.3.2 reactivity, power balance, nTtau, Ignition 1.4 Introduction on Materials 1.4.1 for structures 1.4.2 for power exhaust		
2 Vacuum Systems and Cryogenics	2.1 vacuum requirements 2.2 vacuum vessel 2.3 cryogenic systems		
3 Magnets and Thermal Shields	3.1 types of magnet systems 3.2 copper magnets 3.3 superconductors 3.4 cable in conduit technology 3.5 magnet structures 3.6 thermal shields 3.7 power supplies		
4 Heating Systems	4.1 Neutral Beam Injection 4.2 EC heating		
…	…		

Programme options

- Split of Practicals in 2 modules. **Just as a possible example**:
  - **Tokamak sub-systems**: "Designing a tokamak" and "Coil connections"
  - **Diagnostics**: "Diagnostic 1" and "Diagnostic 2"
  - **Scenarios**: "Integrated modelling" and "Building a scenario with fast simulator"
  - **Operation**: "Session leading" and "Plasma control"
  - **Plasma-wall**: "Edge modelling" and "PFC materials and design"
- In any case: students will be informed, in both the calls and the interviews, that they can express their preferences, but **they will not have the final choice** →
- It is a strong requirement that students be interested in **learning ALL the subjects**
- They follow a combination of **2 Practicals, in the same or in different topics**, if possible combining different aspects (e.g., modelling and laboratory).
- **Just an example:**

- Group 1 →	SCE-1 & DIA-1	→	Scenario Modelling & Diagnostics
- Group 2 →	OPE-1 & SCE-2	→	Session leading & Simulator
- Group 3 →	TOK-1 & PWI-2	→	Coil connections & Edge modelling
- Group 4 →	PWI-1 & OPE-2	→	PFC materials & Controls
- Group 5 →	TOK-2 & DIA-2	→	Designing a tokamak & Diagnostics

EU-Japan Fusion Energy Training Institute (a proposal)

Motivation

- Long time scale of fusion research and its projects → high importance of **knowledge management** through consolidation/documentation of:
  - **specialist know-how in plasma physics** as well as **design, construction, operation, and maintenance** of fusion research infrastructures
  - **high quality education/training material, programmes, resources**
- Foster in the new generations the collaborative culture best practices developed in the BA activities, **via a genuinely international training**

Legal status

- **TBD, e.g.:**
  - **International institute** with two partners: Japan and EU.
  - Created under the auspices of the European Commission and of the Japanese government
  - Endowed with its own funds

Suitable actions of the Institute

- **JT-60SA EU/JA International Fusion School**
  - Annual 2-week lectures and practical exercises for PhD students and young professionals
  - Production of a **book (or series of books)** with essential knowhow developed in fusion physics and technology.
  - Production of high quality **teaching material** for common use (lecture notes, video lectures, training videos).
  - Promotion of collaborative projects best practices developed in the BA
- **Exchanges and cross-fertilization of academic programmes on fusion energy**
  - Organization of **scientific meetings and events** of special interest for students and young professionals, favouring **cross-field** and **cross-cultural** exchanges.
  - Promoting a homogeneous system of **University credits**
  - **Long-term individual tutoring of selected students** by EU and JA scientists
- **Promotion and funding of :**
  - **Grants for joint EU/JA research projects** conducted by pairs of EU/JA experienced physicists and/or engineers
  - **Scholarships/Exchanges/Internships** for fusion-related Masters and PhD theses in the partner's universities and research institutes
  - **Exchanges of lecturers**, for online or in-person lectures, cycles of seminars etc.

Conclusions

- Escalation of **encouragements** and **interest** on JIFS: BA Steering Committee, Japanese Ministry of Education & Research, EU commission
- We hope that other Europe-Japan **student-related initiatives** will follow

  → EU-Japan Fusion Energy Training Institute (FETI) proposal
- **1st edition** delayed, owing to COVID and to compatibility with machine activities. Cannot be programmed before the end of commissioning. → Now summer 2023 has been chosen → reasonable margin
- JIFS inauguratin together with JT-60SA inauguration ceremony: spring 2023
- PhD **students** and **young professionals**: **apply !** (spring 2023)
- **Expert** physicists and engineers: **volunteer to lecture !** (first and following editions, with different choice of topics)