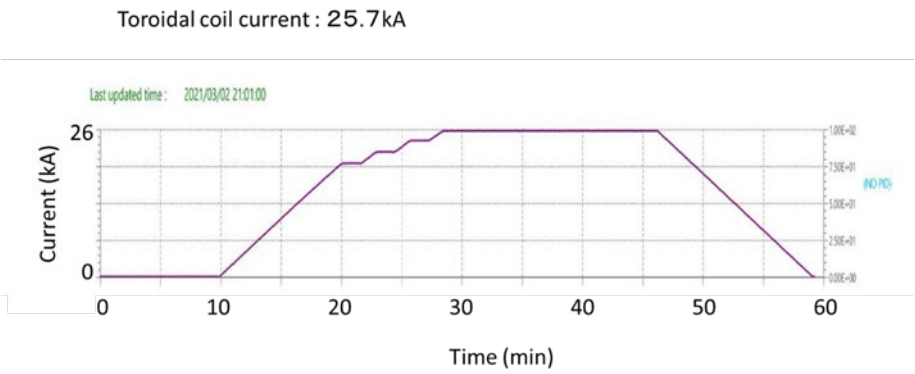
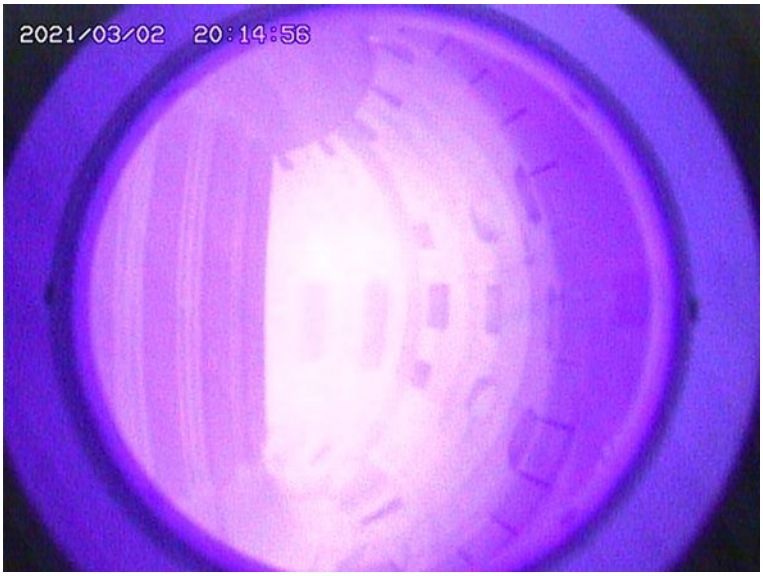
JT-60SA Newsletter
No. 116, June 2021

Headline

TF coil successfully energized with full design current



Energisation of TF coil with full design current



Generated ECR plasma

JT-60SA integrated commissioning is proceeding in cooperation between Europe and Japan, with Europe providing remote support at the Naka Fusion Institute due to the COVID-19 pandemic. For the energisation test of each superconducting coil, the test was aimed at energising the toroidal field (TF) coil power supply (PS) up to 100% of its rating, and energisation of the equilibrium field (EF) coil power supply up to 50% of its rating. In the energisation test of the TF coils, the current was increased step by step (1 kA, 3 kA, 5 kA, 10 kA, 15kA), a fast demagnetisation test was conducted after maintaining each current value, and the action of each device was checked. On 2 March 2021, the complete TF coil magnet was successfully energised with its full design current of 25.7 kA. At this time, using the electron cyclotron resonance (ECR) heating system, 82 GHz and 760 kW millimeter waves were injected for a pulse duration of 200 ms to 400 ms, and plasma was also successfully generated in the JT-60SA vacuum vessel. For the EF coil tests, all coils functioned correctly up to 25% of their rating. However an anomaly occurred at that point, which is now under further investigation.

News

PA signed for Thomson scattering system

Many diagnostics will be installed in the JT-60SA tokamak to provide information about the key characteristics of the plasma. One such diagnostic is the Thomson scattering system (TSS), which will measure the electron temperature and density profiles of the plasma. The system, comprising both a core TSS and an edge TSS, must be designed to provide high spatial resolution, which will be used to identify the temperture pedestal parameters and other small structures in the plasma.

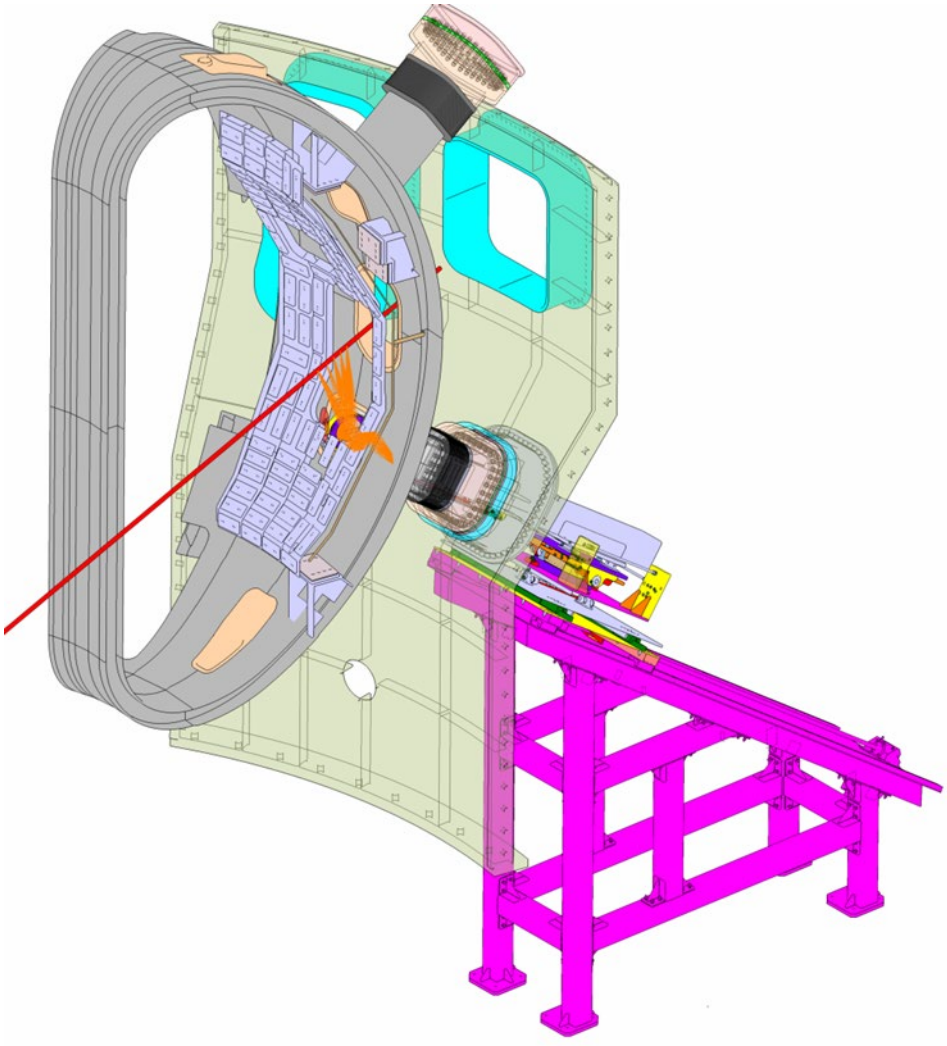
The Procurement Arrangement (PA) for the supply of the Edge Thomson Scattering System includes not only the edge collection optics, but also the laser, polychromators and optical fibres for both TSSs. The PA was signed in March 2021, and the associated design and procurement activities are now progressing rapidly within Europe. Fusion for Energy (F4E) is responsible for management of the overall procurement, while RFX (Italy), supported by ICSI (Romania), is responsible for the design, manufacturing and supply of many of the hardware items.

The RFX procurement of the Nd: YAG laser, the beam of which will be injected on the equatorial plane of the tokamak, is in an advanced stage of preparation, with procurement contract signature expected within the next couple of months. The agreement also makes RFX responsible for the manufacturing of the optics, for which the final design review with the manufacturer, Officina Stellare (Italy), was held at the beginning of April 2021.

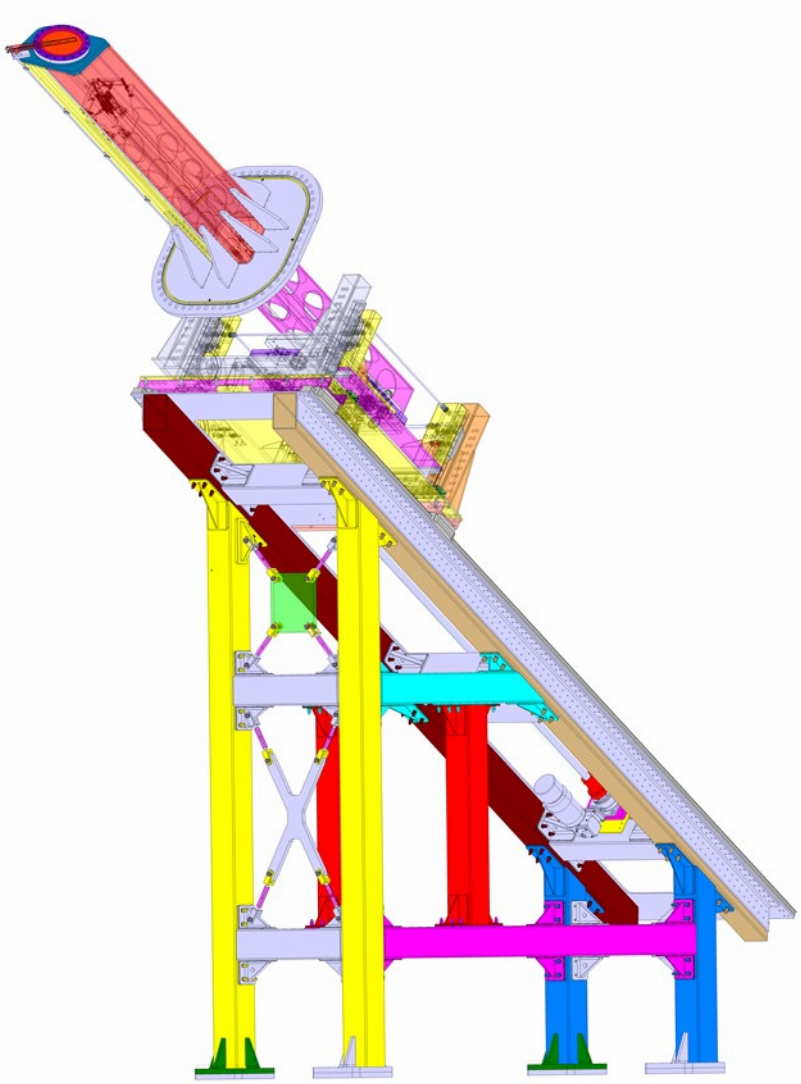
The design of the support structures is also developing fast, with manufacturing drawings nearing completion at ICSI.

F4E has the responsibility to supply the optical fibres and polychromators, for which procurement contracts have been placed with Molex Interconnect GmbH (Netherlands) and G.N.R. srl (Italy), respectively. The first 300 km of optical fibre has been manufactured in the USA and arrived in Japan for bundling activities to commence at the beginning of April 2021.

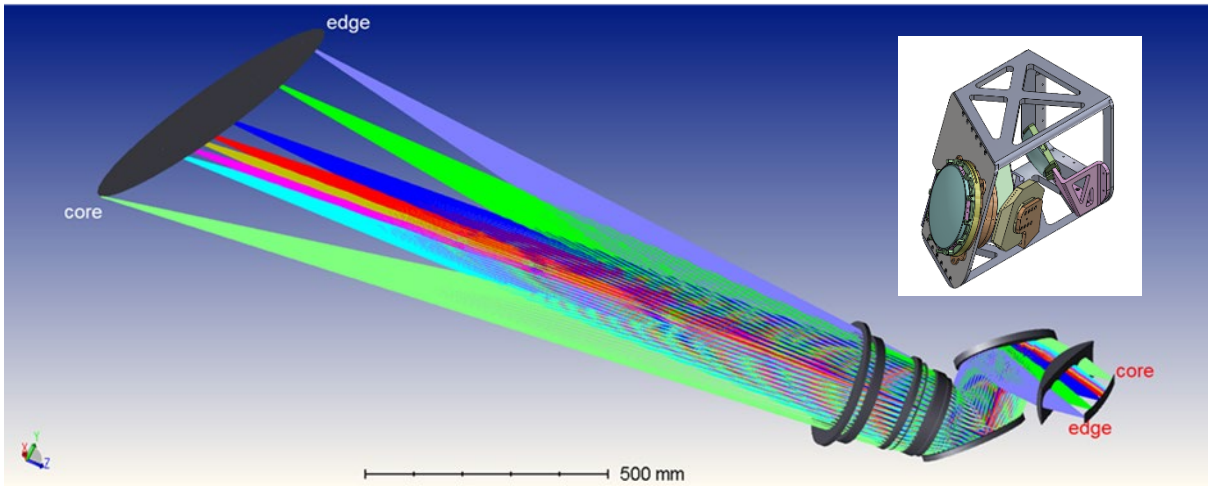
It is expected that all of the hardware will be delivered to QST in the second half of 2022 for integration on the tokamak.



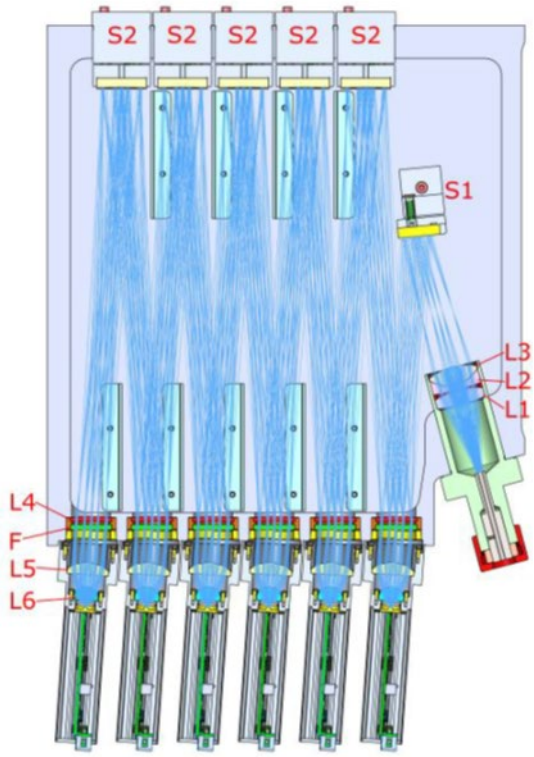
Edge Thomson scattering collection optics layout, also showing the laser injection path on the equatorial plane of the tokamak



Edge Thomson scattering collection optics inside the cryostat port plug



Edge Thomson scattering collection optics



Edge Thomson scattering polychromator design

First batch of optical fibres (300 km) delivered to QST

News

PAs signed to enhance ECRF system for initial research phase

Electron cyclotron range of frequency (ECRF) heating and current drive are necessary for reliable plasma start-up, localized heating and current drive for stabilizing the plasma, and also for EC wall cleaning. In order to enhance the capability of the ECRF system for high-power long-pulse heating in the initial research phase, three procurement arrangements (PAs) have been signed.

(a) Supply of the Electron Cyclotron Range of Frequency Gyrotrons for the Satellite Tokamak Programme (STP-PA-JA-ECRF-GY01).

In addition to the two units of the gyrotron system already ready for the integrated commissioning, two additional multi-frequency gyrotron systems, which provide high-power/long-pulse millimetre wave output of 1 MW/100 s each at two frequencies of 110 GHz and 138 GHz, will be procured by Japan under this PA. The gyrotron auxiliaries such as superconducting magnets, matching optics units, gyrotron stages and oil tanks etc. are also included in this PA.

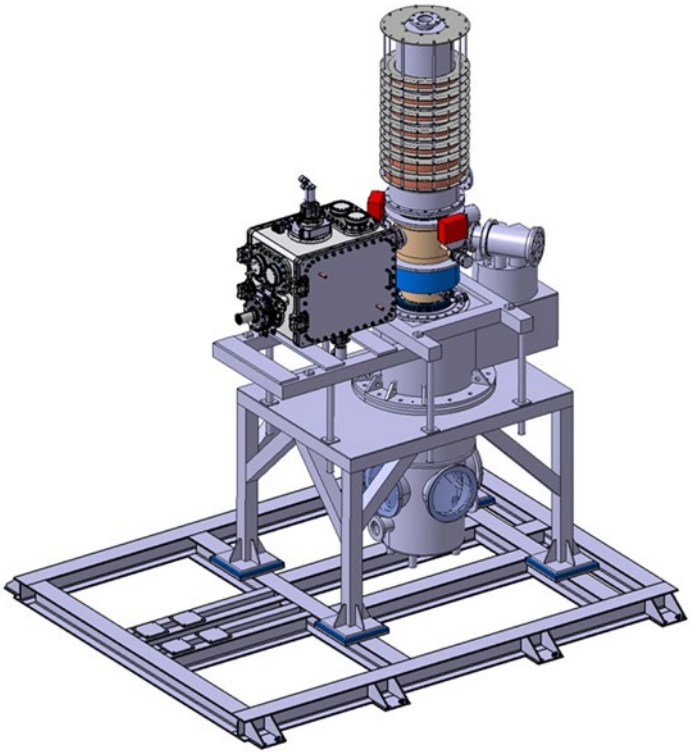


Figure 1: Main part of the multi-frequency gyrotron system of JT-60SA

(b) Installation of the Electron Cyclotron Range of Frequency Transmission Lines and Supply of the Auxiliary Systems for the Satellite Tokamak Programme (STP-PA-JA-ECRF-TL01)

In the initial research phase, four units of the gyrotron systems (indicated as #2, #3, #5 and #6 in Figure 2) will be connected to two units of the launchers to be installed into the upper oblique ports P8UO and P11UO by four sets of waveguide transmission lines (Figure 2). This PA includes the installation of transmission lines (TLs) as well as the cooling system, vacuum pumping systems and related parts of the EC main control system. The procurement of the TL components such as waveguides, mitre-bends and diamond windows, and the pumping system components, will be procured by F4E, but some components such as the TLs support and vacuum pumping line are procured by QST, and all items will be installed by QST under this PA. This PA also includes a partial control system upgrade.

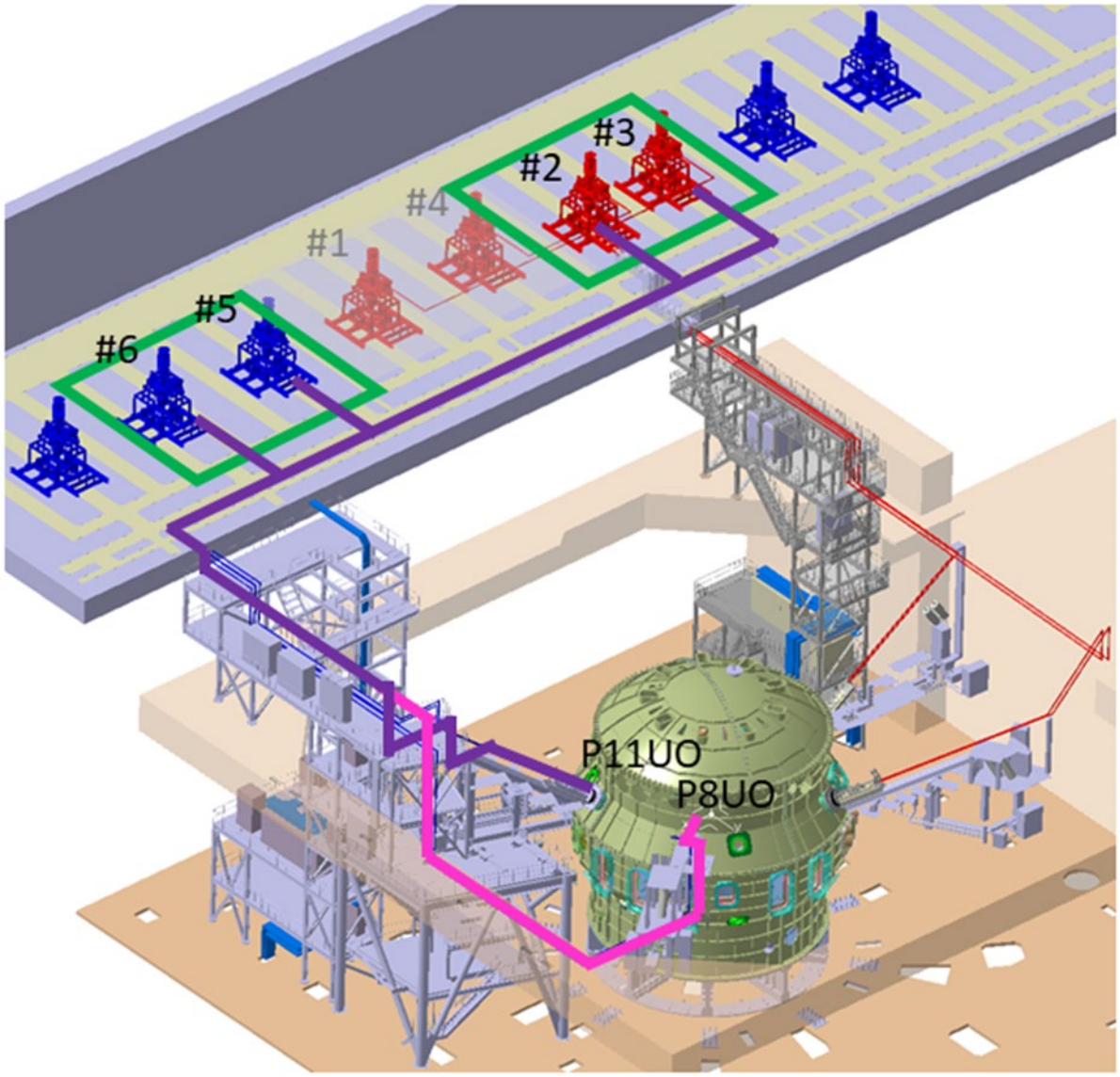


Figure 2: Routes of the ECRF transmission line to be installed in the gyrotron room and torus hall

(c) Supply of the Electron Cyclotron Range of Frequency Control System for the Satellite Tokamak Programme (STP-PA-JA-ECRF-CS01)

The layered structure of the ECRF control system (Figure 3) was developed for the integrated commissioning phase with two units of the gyrotron systems and high-voltage power supplies, two sets of TLs and the waveguide launcher without beam steering functions. It is mainly composed of three sub-systems, i.e., EC-Supervisory Control system (EC-SC), EC-Injection Control system (EC-IC) and EC-Main Control system (EC-MC). These three sub-systems should be upgraded for four sets of gyrotron systems, TL systems and two set of two-axis steering launchers. This PA will upgrade the EC-SC and the EC-IC but the EC-MC is upgraded by the STP-PA-JA-ECRF-TL01 (see (b)).

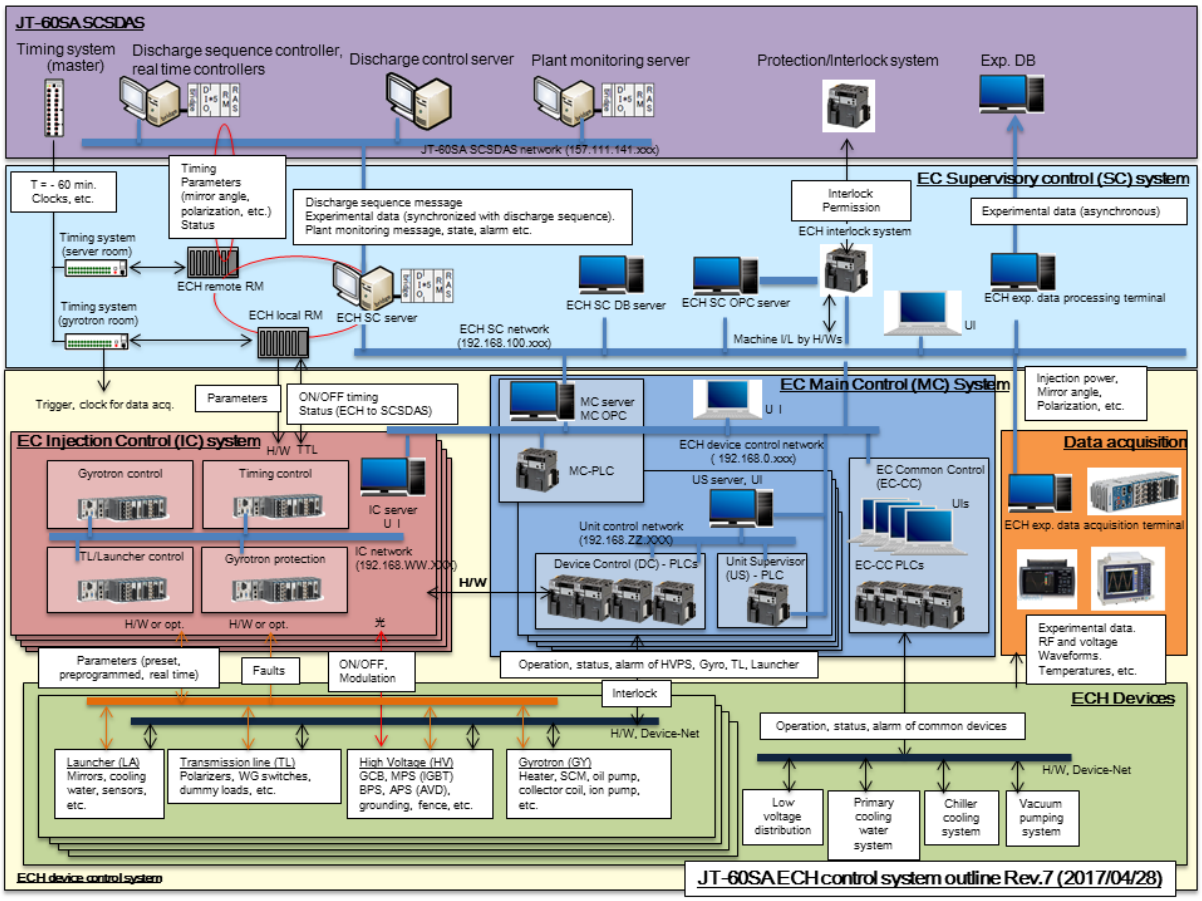


Figure 3: Layered ECRF Control System structure.

Design review meetings (DRM) for STP-PA-JA-ECRF-GY01, STP-PA-JA-ECRF-TL01 and STP-PA-JA-ECRF-CS01 were held on 16 September 2020, 4 November 2020 and 19 January 2021, respectively, via video conference, and the PA documents were agreed by all of the participants from QST, F4E and PT.

After the formal review processes in both QST and F4E, the PAs were signed on 25 December 2020 (STP-PA-JA-ECRF-GY01), 17 February 2021 (STP-PA-JA-ECRF-TL01), and 29 March 2021 (STP-PA-JA-ECRF-CS01).

The call for tenders related to the above PAs have been started and the process for the upgrade of the ECRF system has been started as scheduled.

Meeting

28th STP Project Committee Meeting

Participants in the 28th STP Project Committee Meeting

The 28th Meeting of the Satellite Tokamak Programme Project Committee (STP-PC) was held on 17 March 2021. A total of 22 participants joined the meeting by videoconference. There were 6 members from the Project Committee, the Project Leader (PL), 7 experts from the Project Team, and 8 experts from the European and Japanese Home Teams (HTs).

In this meeting, the PL, the European Project Manager and the Japanese Deputy Project Manager reported on the progress of the STP project, and recommendations on the "Annual Report 2020", "Project Plan" and "Update of Work Programme 2021" to be submitted by the PL to the Broader Approach Steering Committee (BASC).

The STP-PC expressed satisfaction with the progress of integrated commissioning (IC) as well as the achievements and the progress in both European and Japanese procurements since the last STP-PC Meeting. These include the completion of power supplies (PSs) combination tests, the completion of vacuum vessel (VV) baking with circulating nitrogen gas of 200°C, the

completion of cool-down operation of magnet system with the superconducting transition state and the progress of coil energisation tests.

In particular, the STP-PC commended the major achievements of commissioning on the toroidal field (TF) coils to 100% current (25.7 kA) and all individual equilibrium field (EF) coils and central solenoids (CSs) up to 25% current (5 kA) which was achieved by 9 March 2021. The STP-PC also recognised the commissioning of the error field correction coils (EFCCs) system and successful achievement of ECRF assisted technical discharges as an important milestone towards the first plasma.

The STP-PC appreciated the completion of Main Components Assembly Procurement Agreement（PA）and EDICAM PA, and the conclusions of new PAs for IC, Preparation for Scientific Exploitation, Diagnostics, ECRF, Power Supply and Cryoplant. The STP-PC commended the strenuous and continuous efforts of the Japanese HT for the on-site work in order to meet the project schedule and the continuous commitment of the European HT in support.

The STP-PC took note of the report by the PL on the incident of the unexpected increase of current in a poloidal field (PF) coil circuit during high voltage commissioning on 9 March 2021, and also took note of the investigation in the cryostat to clarify a root cause of the incident, to be started in early April 2021, as soon as the cryostat would be accessible.

The STP-PC recommended the “Annual Report 2020” for approval by the BASC. The STP-PC, notwithstanding its positive assessment of the overall “Project Plan”, recognised that the Project Plan would require to be amended on the basis of the ongoing analysis of the above reported incident. The STP-PC recommended the “Update of Work Programme 2021” for approval by the SC under the understanding that an additional amendment might be submitted to take into account the needs deriving from the incident.

Meeting

29th STP Project Committee Meeting

The 29th Meeting of the Satellite Tokamak Programme Project Committee (STP-PC) was held on 21 May 2021 specifically to discuss the above-mentioned equilibrium field (EF) coil 1 incident of 9 March. A total of 21 participants joined the meeting by videoconference. There were 5 members from the Project Committee, the Project Leader (PL), 7 experts from the Project Team, and 8 experts from the European and Japanese Home Teams (HTs).

In this meeting, the Japanese Deputy Project Manager reported on the incident at the EF1 feeder joint, including timelines and what happened, root causes, counter-measures, and recovery plans.

The STP-PC expressed satisfaction with the progress of careful analyses and observations in the cryostat to clarify the root causes of the EF1 incident. The STP-PC commended this report for its clarity and factual, synthetic format.

The STP-PC recognised the effort made by the Integrated Project Team to develop the Project Plan based on careful analyses of the EF1 incident. The STP-PC asked the PL, in close collaboration with both Implementing Agencies, to consider the possibility

of recovery from the delayed overall schedule of the STP Project, and make the best use of the time e.g. by starting activities already planned for the Maintenance & Enhancement (M/E-1) stage.

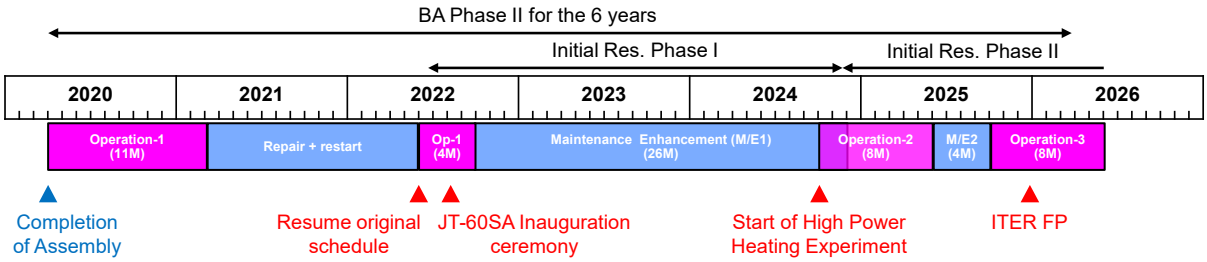
The STP-PC took note of the updated schedule on the Integrated Commissioning to be continued up to the end of September 2022. The necessary repairs to prevent reoccurrence of a similar incident will be completed by the end of January 2022. Then the preparatory works for restart, such as vacuum pumping, coil cooling and baking, and the remaining coil energisation test and plasma operation will be performed. The STP-PC considered this schedule adequate.

The STP-PC recommended the "Update of Project Plan" and the "Update of Work Programme 2021" amended from the document submitted to PC-28 for approval by the Steering Committee.

The STP-PC decided that the next STP-PC meeting (PC-30) would be held on 15 October 2021. The STP-PC expressed hope that this meeting could be held in person.

Meeting

27th BA Steering Committee Meeting



Operation and Maintenance/Enhancement schedule shown in the update of the Project Plan

On 3 June 2021, the 27th Broader Approach Steering Committee (BASC) meeting was held via videoconference with representatives and experts from Europe and Japan in attendance. They confirmed the progress of all the activities and approved the Annual Report 2020 for the three projects (IFMIF/EVEDA, IFERC and the Satellite Tokamak Programme (STP)).

Concerning the STP Project, the Project Leader (PL), M. Hanada, outlined the progress of commissioning activities at JT-60SA, including the completion of cool-down of the magnet system with the superconducting transition state and the progress of coil energisation tests, until the incident with the equilibrium field (EF) 1 coil. The BASC praised the project team (PT) and both the implementing agencies (IAs) for their efforts to clarify the root causes of the EF1 coil incident, with the continuous remote support of the European Home Team, and for their transparent communication. The BASC noted the estimated 15-month impact of the EF1 incident on the JT-60SA schedule and asked the PT and both the IAs to consider the possible actions to recover the overall schedule of the STP Project

The next BASC meeting will be held in Padua, Italy on 16 December 2021.

News

Thank you, Marco

In normal time, Naka site would have been the destination of many European technical experts on power supplies (PSs) in the last several months, helping Japanese colleagues side by side with the difficult task of getting JT-60SA PS up and running towards the operational phase.

However, the world is no longer what it used to be, since the COVID-19 pandemic began in February 2020. Hence, the travel between Europe and Japan is currently restricted.

Still, an adventurer from Europe, Mr. Marco Tamburrino from the Industrial Supplier Nidec ASI, supplier of the quench protection circuits (QPCs) and of two poloidal switching networks units (SNUs) of the equilibrium field (EF) coils, managed to enter into Japan at the beginning of 2021, just one day before its border closed.

Mr. Tamburrino came to Japan for the first time in 2016, and has come to Japan several times during the project. However, this is the first time he is spending a long period in the country, the country he really loves.

Mr. Tamburrino's initial goals were to clear a couple of minor issues on the QPCs identified during the initial test performed before the connection of the superconducting coils, and to be ready to support in case of need during the integrated tests with the superconducting coils. In the last period, with the kind approval of his company Nidec ASI, he has been available to support the general activities on the PSs together with QST and F4E colleagues.

JT 60SA project members deeply appreciate Mr. Tamburrino's help in this difficult period.

本当にありがとうございました。(Meaning "Thank you very much indeed!" in Japanese.)

"YUM!" Big smiles of Marco and Giampaolo Frello with delicacies of the sea

Calendar

15 October 2021
30th Meeting of the STP Project Committee (PC-30)
Naka, Japan

12−16 December 2021
Pulsed Power Conference & Symposium on Fusion Engineering (2021 PPC & SOFE)
CO, USA

16 December 2021
28th Meeting of the BA Steering Committee (SC-28)
Padua, Italy

17–22 April 2022
15th International Symposium on Fusion Nuclear Technology (ISFNT-15)
Hefei, China

Contact Us

The JT-60 Newsletter is released by the JT-60SA Project Team.

Suggestions and comments are welcome and can be sent to newsletter@jt60sa.org.