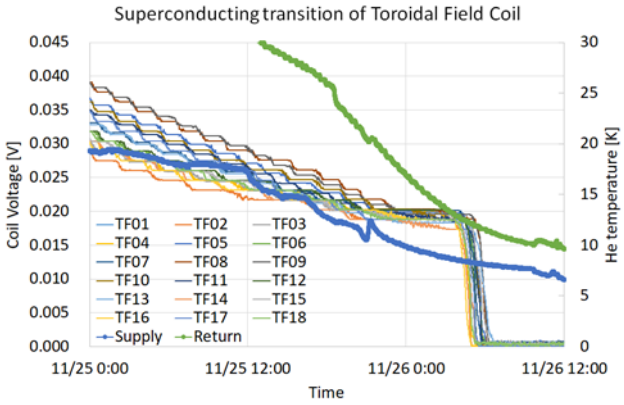
JT-60SA Newsletter
No. 115, March 2021

Headline

All coils reach superconducting state



Superconducting transition of TF coils

Cooling of the superconducting coils started on 10 October 2020. To prevent large stresses in the coils and structures, the refrigerant supply temperature and flow balance were carefully controlled, while paying attention to temperature differences across the device.

From 25 to 26 November 2020, the coils became superconducting and the resistance of all the coils was confirmed to be zero. The toroidal field (TF) coils were energised with a current of 20 A, and the changes of the voltage at both ends of each coil measured (left-hand axis) and the changes of the coolant temperature (right-hand axis) are shown in the figure.

The central solenoid (CS) made of niobium-tin became superconducting at 18 K, and the TF coils and equilibrium field (EF) coils made of niobium-titanium at 8 K. Cooling then proceeded towards about 4 K liquid helium temperature, as required during operation.

Along with the vacuum pumping preparation, and the subsequent baking of the vacuum vessel which was completed at the end of November 2020, integrated commissioning of the main JT-60SA components was successfully completed..

News

Final adjustments for PS with remote support

In parallel to the cool-down of the superconducting magnets, the Power Supply (PS) group is hard at work preparing all the PS systems for the energisation of the coils, which will be the next key phase towards the first plasma.

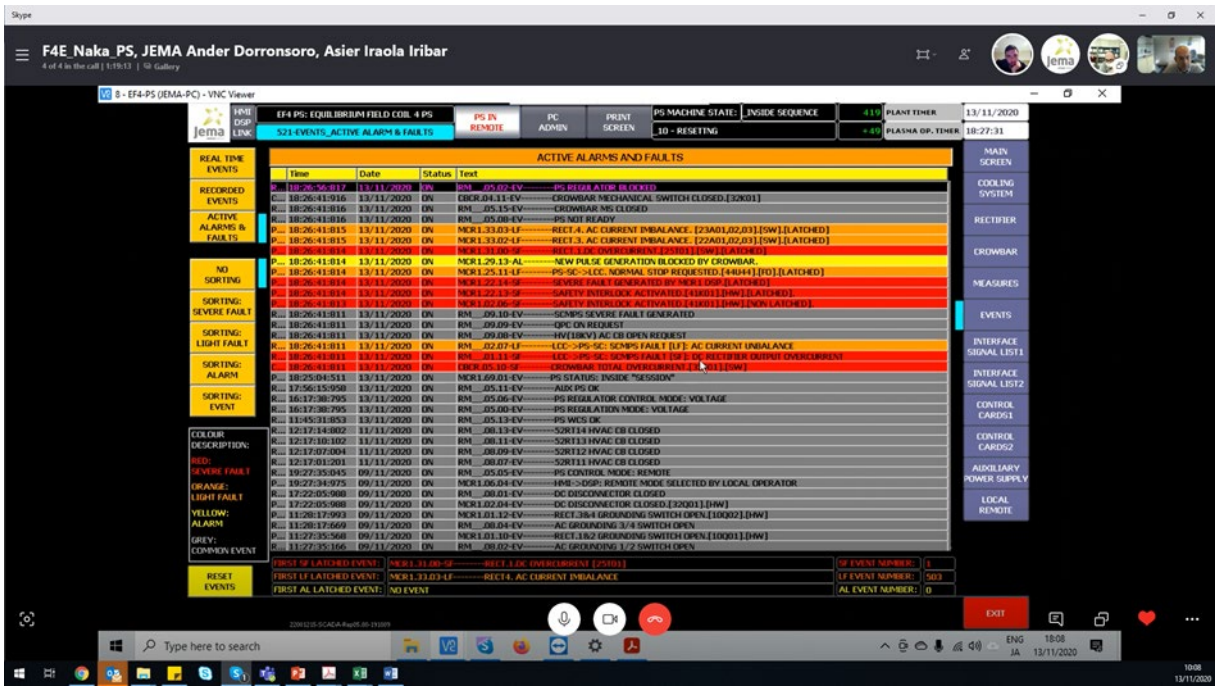
Some small details are still to be adjusted, before having all the PS systems tuned to perfection.

The PS team in Naka is in almost daily contact with the European suppliers and the Fusion for Energy (F4E) personnel in Garching. Due to COVID-19-related travel restrictions, long online sessions have been used to discuss the problems and optimise the systems. Thanks to the screen sharing function of a PC connected to the PS control cubicles, the European experts can follow in real time the operation of the system, contributing to identifying and solving the issues.

Sometimes the problems require a direct check of the hardware… no problem; this is made possible by the use of smart glasses recently procured by F4E. It is sufficient that Giampaolo Frello, one of the F4E experts based in Naka, wears his high-tech smart glasses, and the experts from Europe are virtually with him, seeing what he sees and interacting live with him.

“It is a very hard time”—says Giampaolo— “because there are still a few issues to be solved on the combination tests of the PS. The pressure for having the PS ready for energisation is increasing daily; I would say that this is inversely proportional to the

magnet temperature. The working days start early in the morning and end late in the evening, to allow the overlap with Europe time zone. But it is exciting to be here at this time, collaborating with European and Japanese colleagues, solving one by one all the problems that pop up".



Screen sharing of the equilibrium field (EF) 4 base PS Human Machine Interface (HMI) during a troubleshooting videoconference between QST, F4E and JEMA

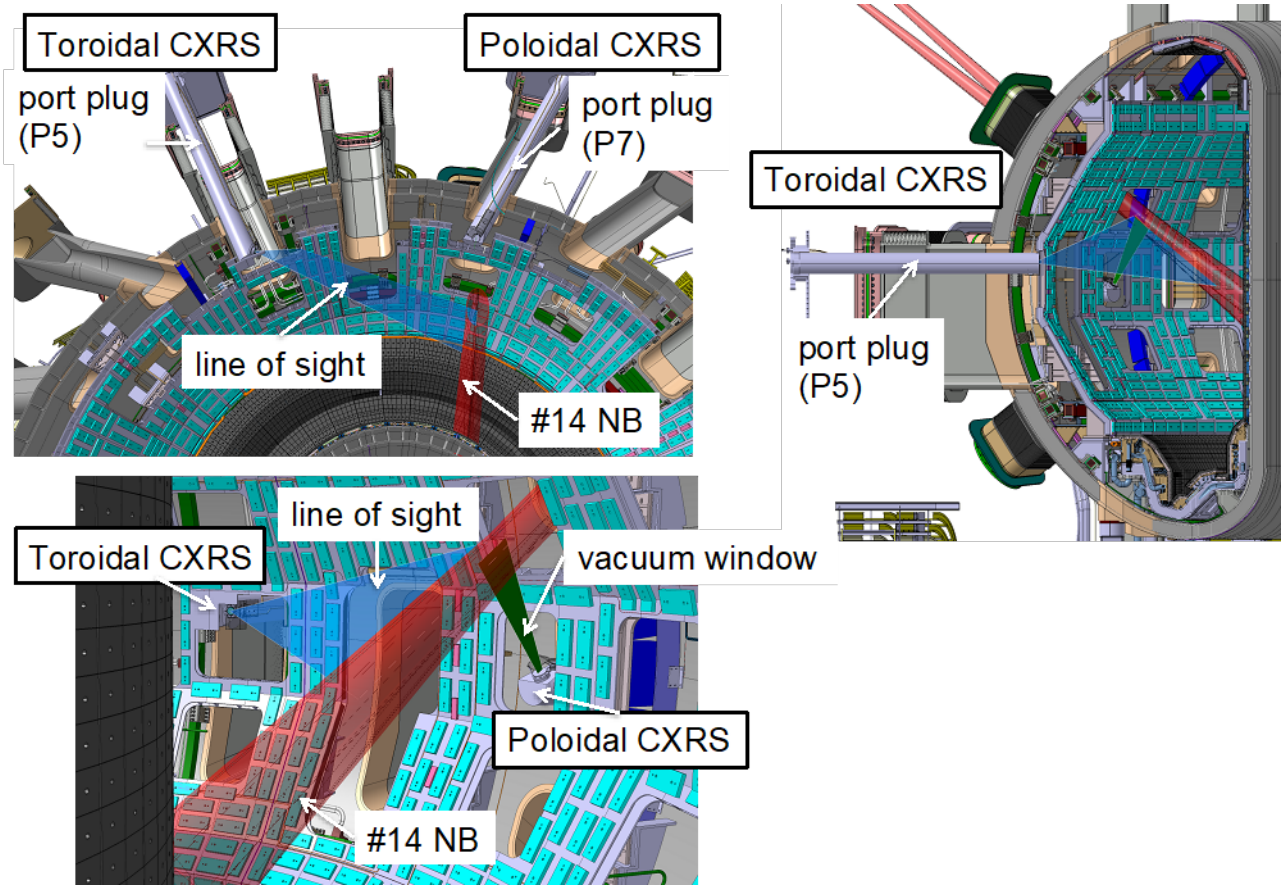
Realtime check from Europe of the EF4 base PS current waveforms with screen-sharing

Getting remote support from Europe while checking the inside of EF3 PS cubicles

Receiving remote support with the use of smart glasses

News

PA signed for Japanese plasma diagnostics



Layout of field of view for toroidal and poloidal CXRS measurements

The "Procurement Arrangement (PA) for the Supply of the Diagnostics System for the Satellite Tokamak Programme" by Japan was signed on 14 September 2020. QST will deliver 16 plasma diagnostic components - a CO_2 polarimeter system, visible TV camera system, infrared TV camera system, electron cyclotron emission diagnostics system, divertor Langmuir probe system, bolometer system, visible spectrometer for divertor & D_α emission monitor system, vacuum ultraviolet (VUV) spectrometer system, Thomson scattering system, charge exchange recombination spectroscopy (CXRS) diagnostics system, soft X-ray

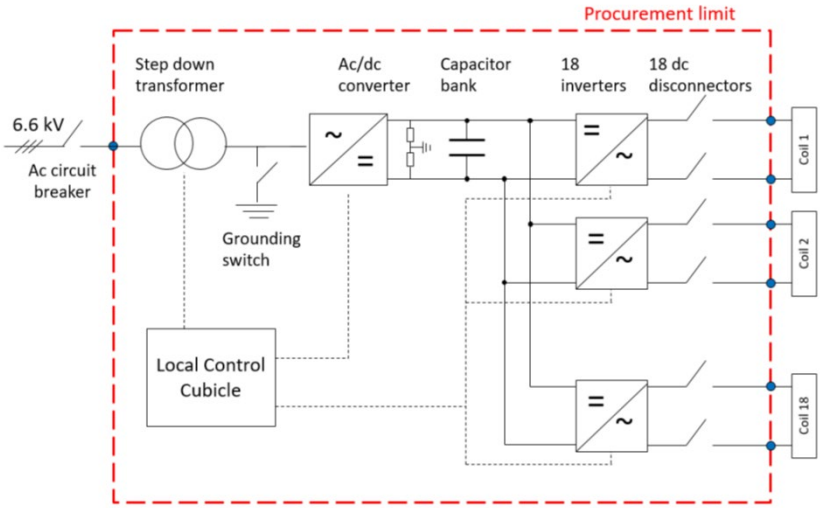
intensity measurement system, motional Stark effect (MSE) polarimeter system, neutron monitor system, neutron profile monitor system, tracer-encapsulated solid pellet (TESPEL) system and a diagnostics common control system.

The PA Annex B has been reviewed and recommended by European experts which have performed analyses of the scope and technical specifications. Based on the PA, the tendering process for some contracts, such as making the port plugs, diagnostics stages and components for each diagnostic system, is now ongoing.

News

PA signed for Error Field Correction Coil Power Supplies

3D model of the 18 error field correction coils of JT-60SA



Simplified scheme of the EFCC PS system

To realise high performance plasma, it is necessary to correct unexpected and unavoidable non-axisymmetric magnetic field components in the plasma region inside the vacuum vessel, which could induce locked modes or degradation of energy confinement.

This non-axisymmetric error field may be the result of deviations within tolerances in the manufacturing and assembly of the superconducting coils, or stray field generated by neutral beam systems, coil feeders, magnetic shields and ferro-magnetic components.

The error field correction coils (EFCCs) system of JT-60SA is designed to produce a magnetic field able to compensate the axisymmetric magnetic error field. It consists of 18 copper coils that will be installed inside the vacuum vessel during the Maintenance & Enhancement period from July 2021 and supplied by independent power supplies (PSs).

The EFCC PS system is composed of a step-down transformer, ac/dc conversion system, 18 independent inverters and a control and protection system.

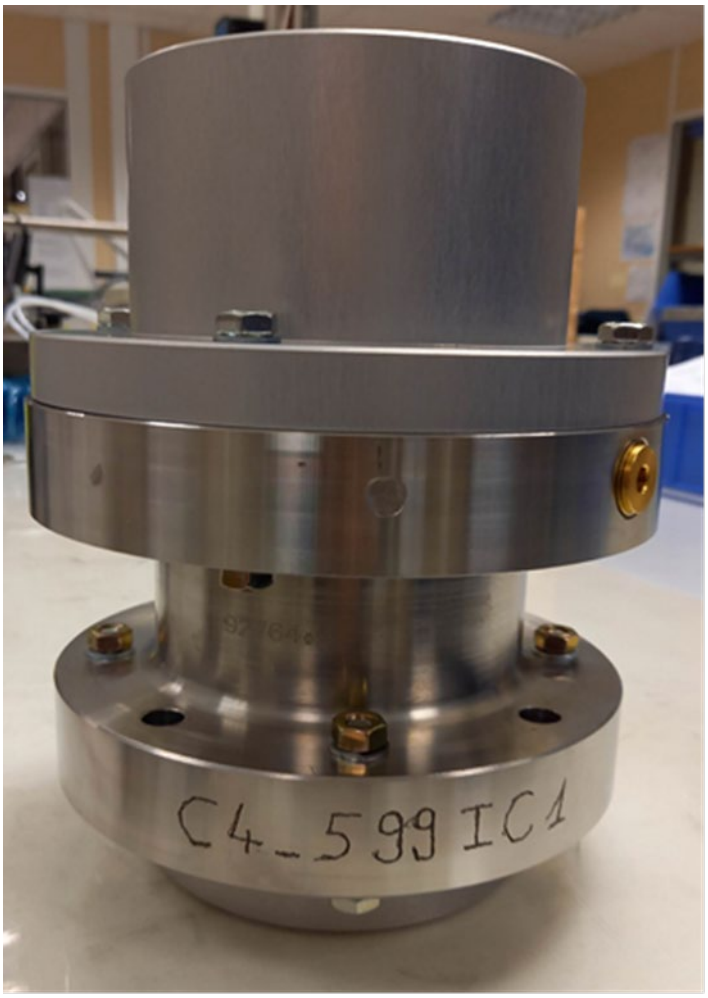
Each inverter shall be able to precisely control the current in the related EFCC up to the nominal value of ± 1500 A, with the capability of performing a full current swing with a frequency up to 7 Hz thanks to the available output voltage of ± 400 V.

The PS system feeding the 18 coils is procured by Fusion for Energy (F4E), and the related Procurement Arrangement (PA) has been signed in December 2020, including design, manufacturing, factory test, transportation to Naka, on-site installation and commissioning.

The related call for tenders is on-going, and the contract is expected to be signed in spring 2021, to deliver the PS system to Naka by the end of 2022.

News

PA signed for additional cryogenic system items



The cartridge of a turbine (courtesy Air Liquide Advanced Technology)

The "Procurement Arrangement (PA) for the Supply of Spare parts and Support for the Cryogenic System for the Satellite Tokamak Programme" was signed on 7 December 2020. Fusion for Energy (F4E) will deliver three spare turbines and one cold machine for the cryogenic system and provide remote support and on-site assistance during integrated commissioning (IC) of JT-60SA.

The turbines are the heart of the cryogenic system, providing up to 10 kW of refrigeration per unit by expansion of pre-cooled, compressed helium. The cold machine can either be configured as a cold pump to drive a flow of up to 1000 g/s of cold, pressurized helium through the superconducting magnets, or operate as a subcooling compressor to lower the temperature of the magnets to -268°C (=4.4 K).

The availability of spare turbines and the cold machine is essential to mitigate the risk of interruptions during the IC. For this reason, F4E started the procurement of these special cryogenic components already in autumn 2019.

Because of the COVID-19 pandemic, European colleagues could not participate in the IC in person, as originally planned. Therefore, the agreed stand-by services and remote support by experts from the European Home Team and from Air Liquide, who built the cryogenic system, became an important tool to assist QST in the operation of the cryogenic system. During cooldown of JT-60SA, daily video meetings allowed information sharing and joint discussions to solve problems arising.

Meeting

27th STP Project Committee Meeting

Discussions during 27th STP Project Committee Meeting

The 27th Meeting of the Satellite Tokamak Programme Project Committee (STP-PC) was held on 26 October 2020. A total of 15 participants joined the meeting by videoconference. There were 5 members from the Project Committee, the Project Leader (PL), 5 experts from the Project Team, and 4 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 “Work Programme 2021”, “Update of Project Plan” and “Update of the Project Team” to be submitted by the PL to the BA Steering Committee (BASC). These were subsequently recommended by the PC for approval at the BASC.

The STP-PC expressed satisfaction with the completion of tokamak assembly and the start of integrated commissioning as well as the achievements and the progress in both European and Japanese procurements since the last STP-PC Meeting. These include the progress of power supplies (PSs) combination tests, the completion of the final layout work of cryolines, the start of vacuum pumping and the completion of the first helium leak test of the vacuum vessel (VV) and cryostat, and the start of cool-down of the magnet system and thermal shields. The STP-PC appreciated the completion of the Toroidal Field Coil (TFC) Displacement and Stresses Monitoring System Procurement Agreement (PA) and the Cryostat Top Lid PA.

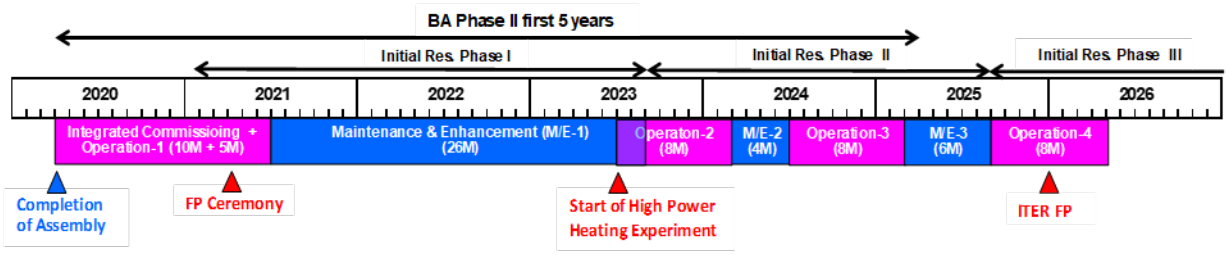
The STP-PC commended the strenuous and continuous efforts of the Japanese HT for the on-site work during the pandemic of COVID-19 to meet the project schedule and the continuous commitment of the European HT in support.

The STP-PC appreciated the support of European experts to integrated commissioning activities, overcoming COVID-19 travel restrictions by use of remote participation, and recommended the further development of tools for effective participation and safe electronic transfer of the necessary data.

The STP-PC decided that the next STP-PC meeting (PC-28) would be held on 17 March 2021.

Meeting

26th BA Steering Committee Meeting



Operation and Maintenance/Enhancement schedule shown in Work Programme 2021

On 2 December 2020, the 26th 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 Work Programme 2021 for the three projects (IFMIF/EVEDA, IFERC and the Satellite Tokamak Programme (STP)).

The BASC welcomed the fact that the objectives of JT-60SA in the BA Phase II (April 2020–March 2025) are (i) completion of integrated commissioning (IC) including the first plasma, (ii) evaluation of the engineering achievements in constructing this large superconducting tokamak device for ITER, and (iii) execution of the experiments satisfying the research targets for the "Initial Research Phase I and II" (ITER scenario development, ITER risk mitigation and steady-state high beta scenario development for DEMO) in parallel to the machine enhancements.

The Project Leader (PL), M. Hanada, reported the progress of IC and the activities for machine enhancement. The BASC commended the Project Team (PT) and both Implementing Agencies (IAs) for the achievements of JT-60SA towards the first plasma. The BASC welcomed the collaboration between JT-60SA and ITER in many fields such as assembly and IC, which will contribute to risk mitigation for ITER.

The next BASC meeting will be held in Naka, Japan in April 2021. The date of the meeting is to be confirmed in line with the date for the JT-60SA Inauguration Ceremony.

Calendar

17 March 2021
28th Meeting of the STP Project Committee (PC-28)
Naka, Japan

April 2021
27th Meeting of the BA Steering Committee (SC-27)
Naka, Japan

23 May–4 June 2021
Pulsed Power Conference & Symposium on Fusion Engineering (2021 PPC & SOFE)
CO, USA

21–25 June 2021
47th European Physical Society Conference on Plasma Physics (EPS2021)
Sitges, Spain

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.