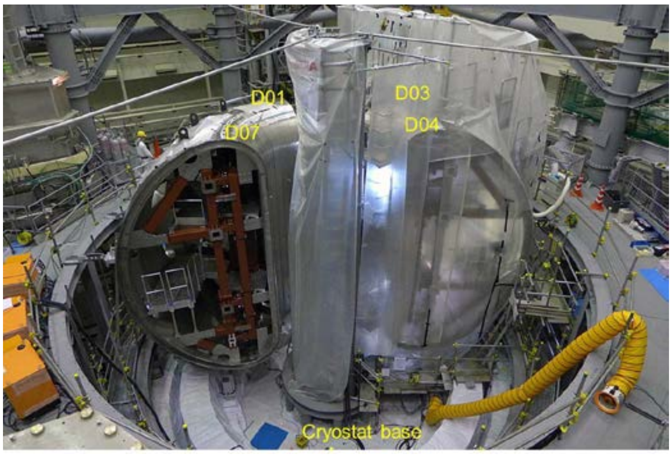
JT-60SA Newsletter

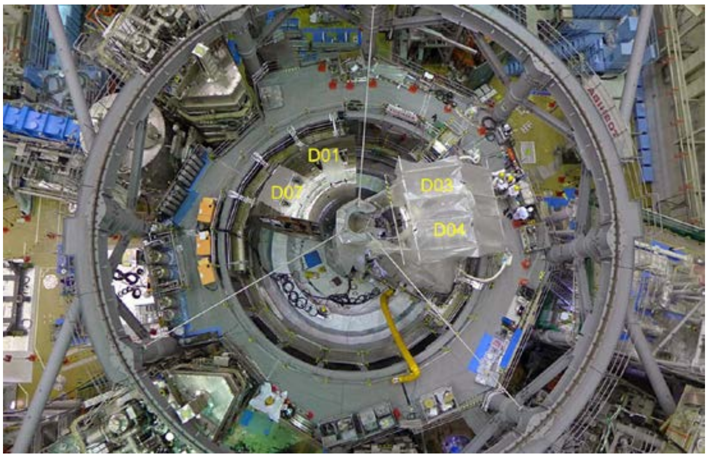
No. 58, 31 October 2014

Headline

Progress of vacuum vessel assembly



VV 40° sectors (D07, D01, D03 and D04) installed on the cryostat base



Top view of VV sectors

This month has seen considerable progress on the welding of vacuum vessel (VV) sectors (see Newsletter No. 57) on the cryostat base (CB). For the welding between the 40° sectors (D03 and D04), the first two layers were welded manually while confirming the procedure of the on-site welding method adopted (multi-layer welding). After that, radiographic testing (RT) was performed to confirm the integrity of the welds. Subsequently, the remaining layers were welded using the automatic welder, in the middle of September. The average shrinkage of all the welds was approximately 4 mm in the toroidal direction, as expected. This important welding step was successfully completed on 15 October 2014.

The third and fourth VV 40° sectors (D01 and D07) were also installed on the CB and their welding started on 6 October 2014. At the same time, the groove alignment of the fifth and sixth VV 40° sectors (D05 and D06) is also being carried out and their welding together on the CB will be completed at the beginning of 2015

News

First CS SNU successfully tested

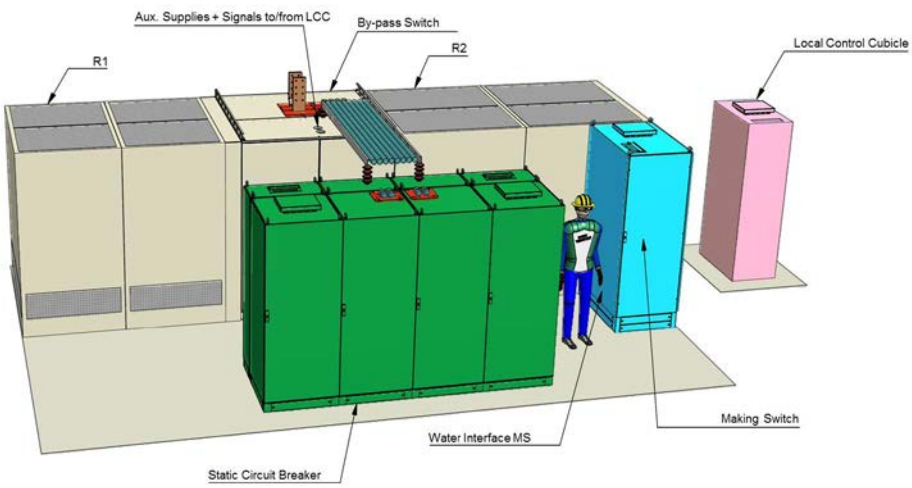


Figure 1: SNU final configuration and layout

Figure 2: The first SNU assembled in the OCEM premises for the preliminary tests

Figure 3: Delivery of all the SNU cubicles to ENEA converter room in August 2014

The first switching network unit (SNU) for the central solenoid (CS) of JT-60SA was successfully tested at nominal current (20 kA) and voltage (5 kV) at ENEA Frascati facilities in September 2014.

The JT-60SA CS is divided into four superconducting modules. Each module is connected to an independent power supply (PS) circuit including a 4-quadrant AC/DC converter and an SNU. SNUs are used in modern tokamaks to induce and sustain the loop voltage needed for plasma initiation.

The four CS SNUs are procured by ENEA through a contract signed in October 2012 with the industrial supplier OCEM Energy Technology. The SNU detailed design was approved in July 2013. The first SNU (full-scale and fully-working prototype) was manufactured throughout 2013 and 2014. As shown in Figures 1 and 2, the components of the developed SNU are enclosed inside six cubicles, containing respectively:

- an electromechanical by-pass switch (BPS) with supercapacitor auxiliary PS, grounding switch and selectors;
- an electronic static circuit breaker (SCB) with water cooling system;
- an electronic make switch (MS) with water cooling system;
- a breakdown resistor bank R1;
- a breakdown resistor bank R2;
- a local control cubicle (LCC).

Due to the novelty of the developed solutions, an exhaustive set of tests was performed to prove the quality of the SNU design both on relevant single devices and on the complete SNU, even at full current, full voltage and full energy. All the critical components of the SNU (BPS, SCB, MS and breakdown resistors) had been already individually tested. To assess the correct operation of the whole SNU, it was necessary to assemble all the components, with a layout identical to the final installation, and to test the complete operation of the SNU at nominal current and voltage.

The pictures in Figures 3 and 4 were taken in the Frascati Tokamak Upgrade (FTU) converter room where the SNU was assembled for functional tests reproducing, as much as possible, the configuration and the conditions for the operations in JT-60SA. The SNU was inserted in the PS circuit of the FTU transformer coil (in practice, a CS), assuring that the circuit current remains constant at the time of SNU operation.

The JT-60SA control scheme and synchronisation method were emulated as far as possible, including input and output alarms. The SNU was controlled by the final LCC. All the tests were performed using a test stand provided by JAEA simulating the future JT-60SA Supervising Computer. The SNU, the LCC, the JAEA Supervising Computer and the FTU PSs were monitored for the type tests from the control room of the FTU converters (Figure 5). In this way, also the correct operation of the interfaces between the SNU control and the central control system of JT-60SA was verified.

Figure 4: JT-60SA partners with the first SNU assembled in ENEA for the official tests

Figure 5: ENEA and OCEM technicians observing the SNU operations in the test control room

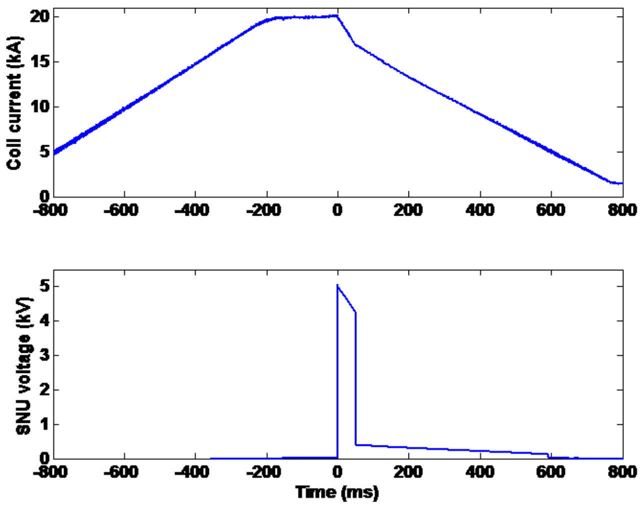


Figure 6: SNU current and voltage measured during a full current and full voltage test in ENEA

Preliminary tests were repeated 10 times at reduced current and reduced voltage values, with the operation of a single SCB parallel branch. In this way, it was possible to validate the correct operation and timing sequence of the current commutation from BPS to SCB and then from the SCB to the R1 resistor. Also the subsequent insertion of the resistor R2 was performed, verifying the correct operation of the MS. Then, tests with reduced current (1,333 A) and nominal voltage (5 kV) were repeated 10 times with the operation of the complete SCB.

Afterwards, the current was increased up to the nominal value of 20 kA, obtaining the nominal voltage of 5 kV, simulating the complete operation sequence of the SNU, as required in the technical specification. To confirm the repeatability of the procedures, 10 tests at 20 kA and 5 kV were successfully repeated, with a repetition time shorter than the JT-60SA repetition time (1,800 s) and without the water cooling available in the final installation. Figure 6 shows the experimental results of a full current and full voltage test performed in ENEA.

Finally, to check the capability of the SNU to protect itself in case of fault, different faults were simulated. The correct protective action was verified for each simulated fault with the actual conduction of current in the SNU.

As the performed tests demonstrated the capabilities of the first SNU to comply with the requirements, the manufacturing of the remaining three CS SNUs can proceed, and is expected to be completed by 2015.

News

Works acceptance of cryogenic system cold boxes

Figure 1: Group photo of CEA, F4E and JAEA colleagues at ALAT workshop

Figure 2: Refrigeration cold boxes (cold end) with insulated cold components

In late September the works acceptance test of the refrigeration cold box (RCB), auxiliary cold box (ACB), and the first of three cryogenic turbines, took place at Air Liquide Advanced Technologies (ALAT) workshop in Sassenage (France). JAEA, CEA and F4E colleagues joined this major milestone on the way to the delivery of the cryogenic system for JT-60SA (Figure 1).

As the cryogenic system is designed for an equivalent refrigeration capacity of 9 kW at 4.5 K (-269°C), the RCB and ACB with 3.2 m diameter and up to 13 m length are quite impressive (Figure 2). Both cold boxes were subjected to pressure and leak tests and checks of the routing and positioning of pipes and instrumentation.

During a full day run the ALAT turbine demonstrated its proven performance at nominal and over-speed while producing about 10 kW of refrigeration at its design temperature of about 30 K.

After a review of the manufacturing documentation, the cold boxes will now be completed and prepared for transport. All components will be shipped together and will arrive at Japan´s Hitachi port by March 2015. In addition, the six 250m^3 helium gas storage vessels are also being manufactured in A. Silva Matos in Portugal. Six vessel heads have been completed and the procurement is on schedule. The storage vessels will be shipped together and will arrive at Japan's Hitachi port between mid-April and mid-June 2015. Documentation required by Ibaraki Prefecture to release the start of installation is being prepared, and the on-site installation work is being organised.

The works acceptance test of the RCB and ACB has been achieved 23 months after signature of the contract exactly on schedule thanks to careful project management by the contractor and an open and constructive cooperation between the contractor, CEA, F4E, and JAEA.

News

Progress in cryogenic system site preparation

Figure 1: WCS building construction status at the end of July

Figure 2: Current construction status of WCS building

Figure 3: Cryogenic hall construction status at the end of July

Figure 4: Current construction status of cryogenic hall

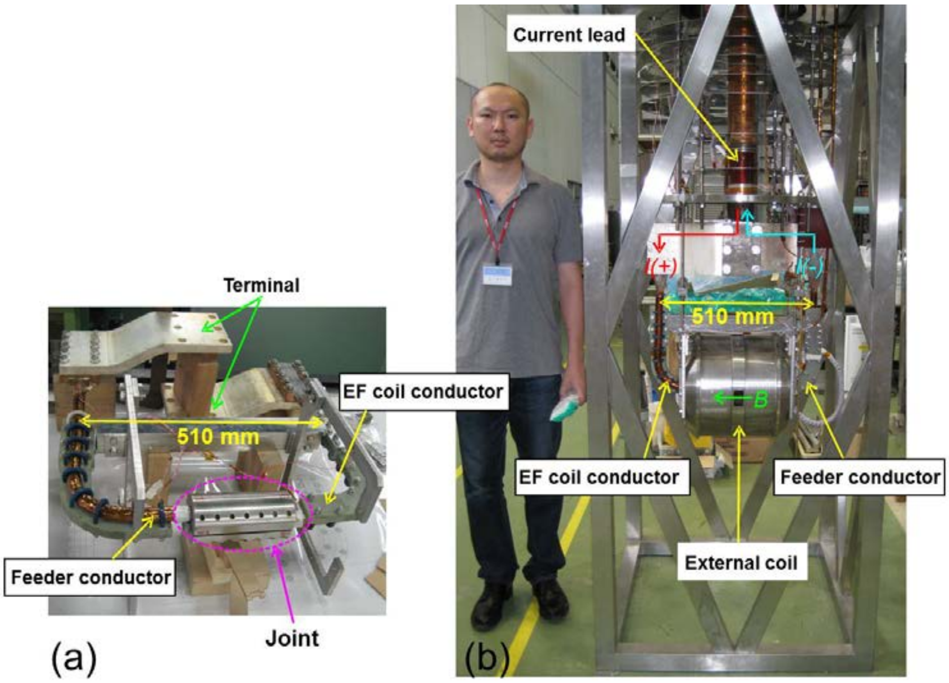
The construction of the warm compressor station (WCS) building, tank yard and cryogenic hall is progressing steadily for the delivery of the cryogenic system components from France scheduled in spring 2015.

For the construction of the WCS building which accommodates the helium compressor, the concrete placement started at the end of July and the building frame assembly is now in progress, as well as the foundation work of the tank yard (Figures 1 and 2). Furthermore, for the construction of the cryogenic hall, which accommodates the cold boxes, the pile foundation work started at the end of July and the installation of reinforcing steel has now been completed for the concrete placement (Figures 3 and 4).

Since a three-phase four-wire system is adopted for the low voltage electrical facilities for the cryogenic system being fabricated in France, which is not commonly used in Japan (a three-phase three-wire system is widely used), the design of local wiring and components was changed from a three-wire system to a four-wire system.

News

Low joint resistance confirmed for EF coil connector



(a) connector prototype of feeder conductor and (b) its installation in the prototype superconducting coil for test

A nominal current test was performed on the connector prototype of the feeder conductor for the equilibrium field (EF) coil by installing it in the prototype of the superconducting coil at the National Institute for Fusion Science (NIFS), with the aim to confirm the joint resistance under the required operating conditions.

In this test, both prototype components were immersed in liquid helium to be cooled down to 4.2 K, and the joint resistance was derived from the current value and the voltage between the taps installed in both joints. As a result, the joint resistance was 1.7 nΩ, which fully satisfied the required value (less than 5 nΩ), and it was confirmed that the solder joint in the feeder conductor connection and assembly would be stable.

Meetings

SOFT-28

A. Cucchiaro presenting the completion of the first TF magnet winding pack

P. Barabaschi presenting the JT-60SA overall construction status

The 28th Symposium on Fusion Technology (SOFT-28) was held in San Sebastián, Spain, from 29 September to 3 October 2014. The symposium is the leading event to exchange information on design, construction and operation of fusion experiments and on the technology for present fusion machines and future power plants. The programme consisted of plenary sessions, oral and poster presentations, and industrial and R&D exhibitions. There were more than 800 presentations including 17 invited presentations, 54 oral presentations and 752 poster presentations. More than 1,000 participants gathered together from more than 30 countries and international organisations.

P. Barabaschi (EU Project Manager) from F4E orally presented the overview of JT-60SA construction, especially the present status of engineering design, manufacturing and assembly of the JT-60SA machine. He remarked on the steady progress of the JT-60SA programme toward the first plasma in March 2019.

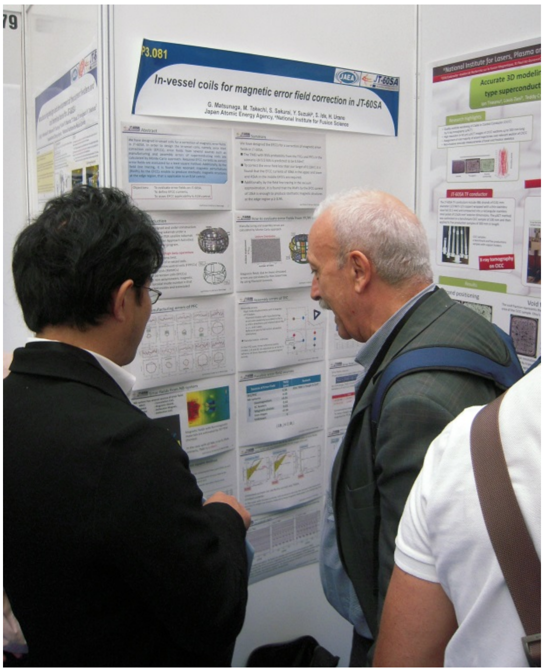
24 contributions from the JT-60SA EU and JA Home Teams were presented as follows (only presenters and titles are shown):

- Oral presentations (2)

- P. Barabaschi from F4E Garching, on the status of JT-60SA construction;
- A. Cucchiaro from ENEA Frascati, on the completion of the first winding pack for the JT-60SA TF magnet system.

- Poster presentations (23)

- W. A. Maksoud from CEA Saclay, on the status of the cold test facility for the JT-60SA tokamak toroidal field coils;
- P. Innocente from Consorzio RFX Padua, on the requirements for tokamak remote operation: application to JT-60SA;
- P. Decool from CEA Cadarache, on the starting the production of the CEA JT-60SA TF coils procurement;
- A. Cardella from F4E Garching, on the computational fluid dynamics analysis of the gaseous helium discharge into the storage vessel following JT-60SA superconductive coil fast discharge computational fluid dynamics;
- P. Bettini from Consorzio RFX Padua, on the three-dimensional electromagnetic analysis of JT-60SA conducting structures in view of RWM control;
- A. Ferro from Consorzio RFX Padua, on the reference design of the power supply system for the resistive-wall-mode control in JT-60SA



A JT-60SA poster session presentation

- A. Maistrello from Consorzio RFX Padua, on the analyses of the impact of connections layout on the coil transient voltage at the quench protection circuit intervention in JT-60SA;
- P. Zito from ENEA Frascati, on the design and realisation of JT-60SA fast plasma position control power supplies;
- A. Lampasi from ENEA Frascati, on the first switching network unit for the JT-60SA superconducting central solenoid;
- G. M. Polli from ENEA Frascati, on the validation of special processes for the manufacturing of the first JT-60SA TF coil;
- D. Tsuru from JAEA Naka, on the development of residual thermal stress-relieving structure of CFC monoblock target for JT-60SA divertor;
- T. Hayashi from JAEA Naka, on the development of remote pipe welding tool for divertor cassettes in JT-60SA;
- Y. Shibama from JAEA Naka, on the welding technology on sector assembly of the JT-60SA vacuum vessel;
- A. Sukegawa from JAEA Naka, on the estimation of the lifetime of resin-insulators against baking temperature for JT-60SA in-vessel coils;
- M. Saigusa from JAEA Naka, on the development of a high power wideband polariser for electron cyclotron current drive system in JT-60SA;
- T. Kobayashi from JAEA Naka, on the mechanical and quasi-optical design of ECH/ECCD launcher for JT-60SA;
- M. Yoshida from JAEA Naka, on the production of uniform negative ion beams in the JT-60 negative ion source;
- M. Takechi from JAEA Naka, on the development of magnetic sensors for JT-60SA;
- L. Novello from F4E Garching, on the present status of the new power supply systems of JT-60SA procured by EU;
- V. Tomarchio F4E Garching, on the progress of the engineering analyses for the JT-60SA toroidal field coils structure;
- K. Kizu from JAEA Naka, on the manufacturing design and development of the current feeders and coil terminal boxes for JT-60SA;
- G. Matsunaga from JAEA Naka, on the in-vessel coils for magnetic error field correction in JT-60SA;
- R. Heller from FZK Karlsruhe, on the high temperature superconductor current leads for the tokamak JT-60SA.

Meetings

15th STP Project Committee Meeting

On 7 October, the 15th Meeting of the Satellite Tokamak Programme (STP) Project Committee (PC-15) was held by videoconference between EU and Japan. 37 participants in total joined the meeting, 5 members from the Project Committee, the Project Leader (PL), 5 experts from the Project Team, and 26 experts from the EU and JA Home Teams.

At the meeting, the PL overviewed the project status and presented the “Work Programme 2015”, to be submitted to the Broader Approach Steering Committee meeting to be held in November 2014. The present status of EU procurement was reported in detail by the EU Deputy Project Manager, while the present status of JA Procurement including assembly activity and site preparation activity at the Naka site was reported in detail by the JA Deputy Project Manager. The SPT-PC expressed satisfaction for the visible and steady progress of procurement and assembly activities by both EU/JA Home Teams, the regular update of the plant integration document, and the enhanced collaboration activities by the research unit involving the fusion communities in EU and JA.

The next STP-PC meeting (PC-16) will be held in March 2015.

Calendar

November 4, 2014
15th Meeting of the BA Steering Committee (SC-15)
Karlsruhe, Germany

November 4-7, 2014
24th International Toki Conference (ITC-24)
Toki, Japan

November 9-13, 2014
21st Topical Meeting on the Technology of Fusion Energy (TOFE-21)
Anaheim, USA

November 12-13, 2014
21st Technical Coordination Meeting (TCM-21)
Saclay, France

March 17, 2015
16th Meeting of the STP Project Committee (PC-16)
Naka, Japan

Contact Us

The JT-60SA Newsletter is released monthly by the JT-60SA Project Team.
Suggestions and comments are welcome and can be sent to newsletter@jt60sa.org.

For more information please visit the website: http://www.jt60sa.org/