# **JT-60SA Newsletter**



No. 92, 31 August 2017

## Headline

#### Manufacturing and pre-assembly of cryostat vessel body cylindrical section completed



Figure 1: Group photo in front of the pre-assembled CVBCS with

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- A. Cardella (F4E), K. Masaki (QST), M. Medrano (CIEMAT),
- A. Gonzalez Rodriguez (ASTURFEITO),
- A. Rodriguez Herrero (ASTURFEITO), and
- A. M. Jordi (F4E) from left to right

The cryostat vessel body cylindrical section (CVBCS) is the large outer containment vessel structure enclosing the core JT-60SA components. It is composed of 12 large sectors which will be assembled with a high precision and capped by the cryostat top lid (QST procurement) at the QST Naka site. The CVBCS is procured by Europe, through the Spanish Voluntary Contributor, CIEMAT, from the manufacturer, Asturfeito S.A. (ASTURFEITO) in Aviles, Spain.

All of the sectors were successfully manufactured and tested. They were then pre-assembled at ASTURFEITO in order to assure that the sectors can be integrated within the required tolerance. This process is very important so that all of the vacuum vessel ports, auxiliary devices, cryolines, and supply tubes can be fitted precisely to a total of 83 flanges and openings of the CVBCS in the later assembly at the QST Naka site.

The pre-assembly was performed in 3 phases. In the first phase, the 8 lower sectors (with a height of ~7 m) were, one by one, positioned onto the supporting system precisely reproducing the cryostat base already installed at the Naka site. They were then adjusted and bolted to the supporting system. Afterwards, their vertical flanges were bolted to each other. Prior to the positioning and fitting of the last octant, some of the adjacent sectors had to be re-adjusted in order to achieve a close-to-perfect integration.

In the second phase, the 4 upper sectors (with a height of ~4 m) were assembled on another precise temporary supporting system using similar procedures to those for the lower sectors. The vertical flanges of the upper sectors are structurally different from those of the lower sectors (Figure 1). Therefore, a different bolting system was used for the upper sectors to join those vertical flanges.

In the third phase, the pre-assembled upper sector ring was lifted, positioned, and adjusted on the lower sectors, completing the entire CVBCS (Figure 1 and 2). The flanges at the bottom of the upper sectors and the top of the lower sectors were joined using the same method as applied to the lateral flanges of the upper sectors.

The pre-assembly was successfully completed on 28 July 2017, and the long and accurate metrology of the entire CVBCS (Figure 3) was completed on 10 August. After the final evaluation, it was decided that several bronze positioning pins would be additionally installed in order to make the final assembly at the Naka site easier.

Afterwards, the sectors will be dismantled and will undergo a final fine refurbishment to eliminate some small scratches on the surfaces and other minor damage during the handling and pre-assembly. ASTURFEITO's contract will be completed by final cleaning, wrapping in plastic foil, packing inside large dedicated frames, and finalising the documentation. This is planned to be on 29 September 2017 (the delivery date of ex-works (EXW) ASTURFEITO). With the transfer of all CVBCS component ownership to F4E, the Spanish government acting through CIEMAT will successfully complete procurement of all its in-kind contributions to JT-60SA.

F4E will directly manage the transport to Japan. The packages will be protected from damage during the sea and land transport with thick tarpaulin covers. In addition to the sectors, a 11 m long lifting beam, a specially manufactured lifting frame (for handling of the lower sectors at the Naka site), all of the auxiliary parts (e.g. removable lifting hooks, assembly devices, bolts, spacer sleeves, nuts), and the material left over from manufacturing, will be transported to Japan.

The arrival of those components in Japan is expected to be sometime in December 2017 or January 2018, depending on the availability and route of the ship. In any case, they will be delivered to the Naka site more than one year ahead of the required final assembly date.



Figure 2: The vast size of the CVBCS is finally apparent



Figure 3: Precisely measuring the port position and dimensions with a laser tracker

\*) Watch a movie introducing the "<u>Pre-assembly of cryostat vessel body cylindrical section in CIEMAT/ASTURFEIT</u>" on the JT-60SA project website.



## <u>News</u>

## In-cryostat feeders for lower PF coils delivered





Figure 1: Schematic layout of the coil terminal boxes, current leads, and feeders inside the cryostat

Figure 2: Delivered in-cryostat feeder for the lower PF coils

The in-cryostat current feeders for the <u>poloidal field (PF) coils</u> are made of niobium titanium (NbTi) superconductor. They were procured by Japan.

The current feeders for the upper PF coils: central solenoid (CS) module 1, 2, and equilibrium field (EF) coil 1, 2, 3, (manufactured by Mitsubishi Electric Corporation) were delivered to the QST Naka site in February 2017 (Figure 1). Recently, the current feeders for the lower PF coils: CS module 3, 4, and EF coil 4, 5, 6, were completed by Fuji Electric Co. Ltd. and delivered to the Naka site on 31 July 2017 (Figure 2).

Those feeders will be installed on the JT-60SA tokamak in the second half of 2019 after all of the superconducting coils (toroidal field coils, EF coils, and CS) and the cryostat vessel body cylindrical section have been assembled.

### <u>News</u>

## Piping and cabling work for power supplies progressing



Figure 1: Main cooling water pipes for the PF coil PSs



Figure 4: 11 kV power cables for the TF transformer



Figure 2: Main cooling water pipes for the TF coil PS



Figure 5: Auxiliary power cables for the SNU-CS



Figure 3: Cooling water pipes for the EF2 - 5 coil PSs



Figure 6: Cooling water pipes for the SNU-CS

The <u>switching network units</u> for the <u>central solenoid</u> (SNU-CS) and superconducting magnet power supplies (SCMPSs) are components procured by Europe. The <u>commissioning and site acceptance tests of the SNU-CS</u> procured by ENEA were finished on 31 March 2017, and <u>those of the SCMPSs for the equilibrium field (EF) 2 - 5 coil PSs and toroidal field (TF) coil PS</u>, procured by CEA, are just now coming to completion.

Piping and cabling work at the QST Naka site was begun prior to those commissioning and tests, and is being continued by QST. Installation of the following items has been completed so far:

- main cooling water pipes for the poloidal field (PF) coil PSs in the rectifier room and vacuum circuit breaker (VCB) room of the rectifier building (Figure 1),
- main cooling water pipes for the TF coil PS in the TF PS room and on the roof of the JT-60 main building extension (Figure 2),
- branch cooling water pipes for the EF 2 5 coil PSs (Figure 3), and auxiliary power cable,
- 11 kV power cables of the TF PS transformer primary side (Figure 4),
- auxiliary power cables, grounding conductors and cooling water pipes of the SNU-CS (Figure 5 and 6).

The remaining piping and cabling work by QST is scheduled to be performed in advance of the site acceptance tests for the <u>SCMPSs procured by ENEA</u> (CS module 1 - 4 PSs, EF1, 6 coil PSs, and the <u>fast plasma position control coil</u> PSs).

#### Meeting

### **3**rd design review meeting for assembly



The design review meeting (DRM) for the assembly of the main components (DRM-AS03) was held at the QST Naka site on 3 July 2017. A total of 12 experts: 4 from the EU Home Team, 7 from the JA Home Team, and 1 from the Project Team, participated in the meeting.

The main objective of the DRM was to review the assembly procedures of the main components and the draft of the Procurement Arrangement (PA).

Overall, the assembly procedures were acceptable. The PA draft was reviewed with no issue as well. Therefore, it was agreed by F4E and QST to go on to the PA approval process.

#### **Meeting**

## **2**8th Technical Coordination Meeting held in Naka

The 28th Technical Coordination Meeting (TCM-28) took place on 5 and 6 July 2017 at the QST Naka Fusion Institute in Japan. A total of 81 experts attended the meeting in person or via videoconference: 34 from the EU Home Team (France, Germany, Italy, and Spain), 40 from the JA Home Team, 5 from the Project Team, and 2 invited from EUROfusion.



Figure 1: Group photo taken in front of the sequence graphic panel in the JT-60 control room



Figure 2: Technical tour in the torus hall where the JT-60SA tokamak assembly was progressing

At the beginning of the meeting, H. Shirai, the Project Leader (PL) of the Satellite Tokamak Programme (STP), made an opening presentation including the results of the latest meeting of the Broader Approach Steering Committee (BASC-20) held

in April 2017. He explained that the SC expressed its satisfaction with the achievements and progress in both EU and JA procurements as well as the assembly, installation, and commissioning. He also explained that the SC approved the updated Project Plan, in which the extension of the STP Project until the end of March 2020 was clarified. In addition, as a reference, he showed the schedule beyond March 2020 compiled based on the technical assessment.

After the secretariat introduced the agenda and Action List from the last TCM-27 as usual, the updates of the Plant Integration Document were reviewed. Then, the EU and JA Project Managers respectively explained the overall status of the procurement, assembly, research and development of their teams.

During the meeting on the first day, the status and actions in the following areas were reported and discussed: manufacturing of the thermal shields, high temperature superconductor current leads, coil terminal (CT) boxes and cryostat top lid, manufacturing and pre-assembly of the cryostat vessel body cylindrical section, manufacturing, cold test, pre-assembly and delivery of the toroidal field (TF) coils, structural design of the cryostat and vacuum vessel port connection, and basic design of the control system for the cryogenic system. In addition, a technical tour was organised by QST to see the tokamak assembly in the torus hall and the <u>completed CT-01</u> in the superconducting coil winding building (Figure 2).

On the second day, the following items were reported and discussed: development of the fast wide-angle video diagnostics and laser welding technique for the divertor cassettes, manufacturing of the central solenoid modules, manufacturing and commissioning of the power supply systems, assembly of the TF coils in the torus hall, commissioning and operation of the overall JT-60SA device including the linkage test with the supervisory control system. The configuration control models and updates of the Action List were summarised as well.

During the second day's meeting, the group photo of the participants was taken in front of the newly developed sequence graphic panel of JT-60SA (Figure 1). In addition, a certificate of appreciation for the <u>completion of switching network units</u> (SNUs) was presented to J.-C. Vallet of CEA, representing the SNU team, by the Director General of Naka Fusion Institute (Figure 3). Furthermore, the JT-60SA Newsletter awards and special prizes were given by the PL to the top 3 contributors in January 2016 - June 2017 (1st: K. Masaki of QST, 2nd: L. Novello of F4E, and 3rd: S. Sakurai of QST) and 2 families of the resident F4E experts (A. Jokinen and G. Frello families, who also contributed their introduction to Japan) (Figure 4).

Finally, the PL announced that the next meeting, TCM-29, would be held in Saclay, France on 17 and 18 January 2018, and that the TCM-30 would be held in Naka, Japan on 4 and 5 July 2018.



Figure 3: A certificate of appreciation for SNU completion given to the SNU team



Figure 4: Winners of the JT-60SA Newsletter awards and special prizes

## Meeting

## **C**ryogenic Engineering Conference and International Cryogenic Materials Conference 2017

The 21st Cryogenic Engineering Conference and International Cryogenic Materials Conference (CEC/ICMC 2017) were held in Madison, Wisconsin, U.S.A. from 9 to 13 July 2017. The conference scope was research and development on cryogenic materials, superconducting materials, wires and tapes, magnets, power devices and systems, and superconducting electronics. The programmes consisted of plenary, oral and poster sessions. A total of 600 participants attended the conference.

There was 1 oral and 2 poster presentations by members of the JT-60SA EU and JA Home Teams as follows:

- Oral presentation (1)
  - 1. C. Hoa, on "Performance of the JT-60SA cryogenic system under pulsed heat loads during acceptance tests".
- Poster presentations (2)
  - 1. K. Kamiya, on "Superconducting Magnet Control System of the JT-60SA".
  - 2. F. Bonne, on "Model-based PI tuning for the JT-60SA cryogenic system: experimental results".



Figure 1: C. Hoa making her oral presentation





Figure 2: Guide plate at the entrance of conference venue - "Monona terrace"

Figure 3: Wisconsin State Capitol in Madison, Wisconsin

C. Hoa showed the results of the JT-60SA <u>refrigerator</u> commissioning <u>performed in 2016</u> (Figure 1). In her presentation, she emphasised the way that the JT-60SA cryogenic system team conquered the heat load variation expected in JT-60SA pulse operation, which will be the largest among other tokamak fusion devices such as ITER and KSTAR.

K. Kamiya explained the <u>superconducting magnet</u> control system of JT-60SA, focussing on the cryogenic mass flow control in the toroidal field coil winding packs during the cool down, and the temperature control of the <u>high temperature superconductor</u> <u>current leads</u>.

F. Bonne showed the comparison between the model-based proportional integral (PI) tuning and experimental data acquired in the commissioning of the JT-60SA cryogenic system.

Researchers on large-scale magnets and cryogenic systems listened to the explanations with interest, and the presentations were well received.

The next CEC/ICMC will be held in Hartford, Connecticut, U.S.A. from 21 to 25 July 2019.

#### **Local**

## Rice field art



Figure 1: Panoramic view of the Tanbo Art from the lookout (centre), its ground plan (right bottom), and Oarai-Kashima Line train (left bottom)







Figure 2: Various coloured rice leaves

There is an expanse of paddy fields about 15 km to the south of the QST Naka site, where the Oarai-Kashima Line of Kashima Seaside Railway (Figure 1 left bottom) runs. Tanbo Art ("Tanbo" means rice field in Japanese) - involving the drawing of huge illustrations and patterns (Figure 1 centre) with rice of various coloured leaves (Figure 2) - is performed alongside the railway.

Mito city holds this event every year with the aim of promoting friendship between the urban and rural communities and vitalizing the local agricultural industry.

This year, the figure shows Iba-lucky (yellow-faced mascot of the 2019 National/Handicapped Sports Festival to be held in Ibaraki) and Mito-chan (community mascot of Mito city, right side of Iba-lucky) happily singing "run, run, run" and running on the street. The rice was planted according to the skillful ground plan (Figure 1 right bottom) accurately drawn taking account of the viewing angle. It can be seen in 3-D perspective representation from the train running on its viaduct and from a nearby lookout with a height of about 4 m.

This presentation is seen from the rice planting season in June through to the harvesting season in October. It is interesting also to see the figure changing along with the rice growth.

## **Calendar**

25 - 29 September 2017 <u>13th International Symposium on Fusion Nuclear Technology</u> (ISFNT-13) Kyoto, Japan

27 - 29 September 2017 <u>16th International Workshop on Plasma Edge Theory in Fusion Devices</u> (PET-16) Marseille, France

17 October 2017 21st Meeting of the <u>STP Project Committee</u> (PC-21) Naka, Japan

5 - 8 December 2017 Joint meeting of the 26th International Toki Conference and the 11th Asia Plasma and Fusion Association Conference (ITC-26 & APFA-11) Toki, Japan

13 December 2017 21st Meeting of the <u>BA Steering Committee</u> (SC-21) Mol, Belgium

## **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/.