JT-60SA Newsletter
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Headline

Manufacture of all 26 HTS CLs completed

Group photo of the HTS CL team members involved in manufacturing

On 25 May 2017, R. Heller from Karlsruhe Institute of Technology (KIT) announced that the manufacture of all 26 high temperature superconductor current leads (HTS CLs) had been completed.

The Procurement Arrangement and corresponding Agreement of Collaboration for the delivery of 6 HTS CLs for the toroidal field (TF) coils and 20 HTS CLs for the poloidal field (PF) coils were signed between QST, F4E and KIT in February 2010.

Although the CLs for JT-60SA look quite similar to those also constructed by KIT for the Wendelstein 7-X project, some preparation time was needed before the manufacture and test of the first CL pair for JT-60SA could be commenced. For instance, the CL design had to be modified for the new operating conditions. All interfaces between the HTS CLs and the cold feeders, warm busbars, and cold helium gas supply had to be fixed. The material required a long delivery time, the HTS stacks - high conductivity copper, and very narrow tolerance stainless steel tubes - had to be procured, the prototype components had to be manufactured and tested, and a dedicated test facility had to be set-up.

Once the first HTS CL pair was manufactured and successfully tested, fabrication of the remaining CLs continued smoothly due to the growing expert skill and knowledge. Nevertheless, each manufacturing step had to be executed with great care and precision and checked by stringent quality tests. Thanks to the ambitious and experienced manufacturing team of KIT (see figure), all of the 26 HTS CLs for JT-60SA were finished without any faults and delay. All of them have already passed the acceptance tests at cryogenic temperatures.

A total of 16 HTS CLs have already been delivered to the QST Naka site, and the 6 for the TF coils have already been installed in the coil terminal box. The delivery of the remaining 10 CLs for the PF coils is scheduled in November 2017.

News

TF coil assembly and delivery updates

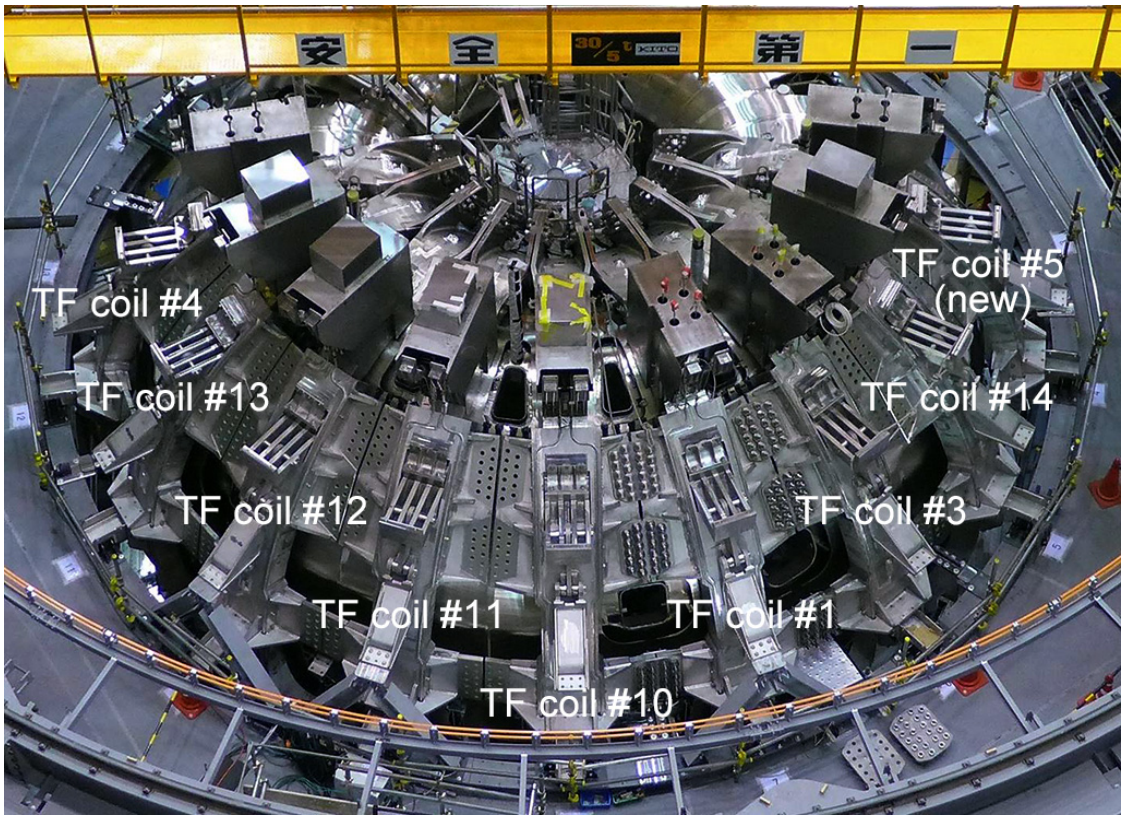


Figure 1: A total of 9 TF coils mounted around 340° torus

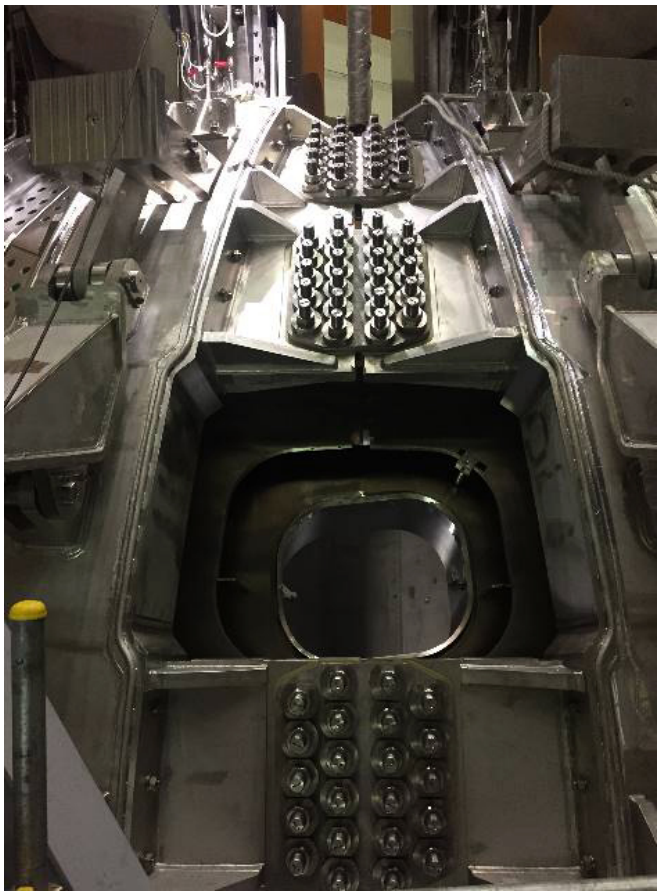


Figure 2: Shear panels joined with splice plates and bolts

Figure 3: Tightening the bolts with the hydraulic tensioners

The toroidal field (TF) coil - “Giaele” (coil #5 in the overall TF coil numbering system of JT-60SA) - was additionally installed after the last report, that is, a total of 9 TF coils have already been mounted in place (Figure 1). This means that the halfway point of the TF coil assembly has been reached.

In parallel, the connection of the adjacent TF coils at their shear panels was started (Figure 2). Each set of shear panels is sandwiched by 2 customised splice plates. The shear panels and splice plates are then joined with 22 bolts making use of the 22 simultaneous hydraulic tensioners (Figure 3). To connect 2 adjacent TF coils, each of 5 shear panel locations must be tightly joined with their corresponding 2 splice plates and 22 bolts, that is, 90 locations for the 18 TF coils composing the 360° torus must be connected with 180 splice plates and 1980 bolts in total.

While this has been going on, the 10th TF coils - “Fanny” (coil #15) - and the 11th - “Valeria” (coil #6) - were delivered to the QST Naka site on 13 and 29 June 2017, respectively. Acceptance tests are being carried out in the engineering experiment building (Figure 4).

Figure 4: TF coils - “Fanny” (front) and “Valeria” (back) - in the engineering experiment building

News

CS3 module production progressing steadily

Figure 1: OP2 and OP3 for the CS3 module after the heat treatment (in the cases)

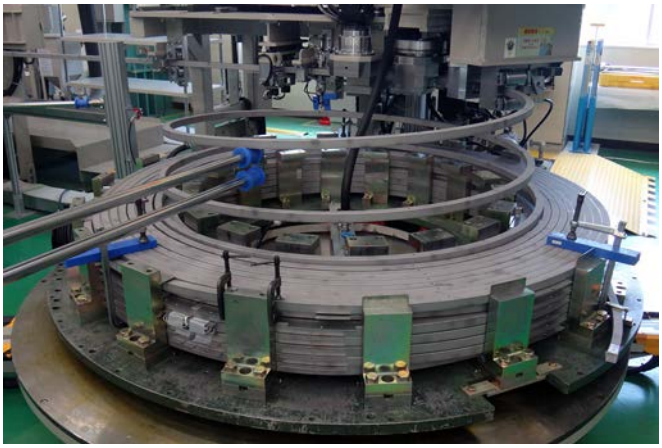


Figure 2: OP5 for the CS3 module during winding

The JT-60SA central solenoid (CS) consists of 4 modules: CS1, CS2, CS3 and CS4. Each module is composed of a four-layer pancake (quadra-pancake (QP)) and 6 eight-layer pancakes (octa-pancakes (OP)).

The CS1, CS2 and CS4 have already been completed.

Regarding the final module, CS3, the winding and heat treatment (which makes niobium tin (Nb_3Sn) conductor superconducting) of the OP1, OP2 and OP3 were completed (Figure 1). The winding of the QP and OP4 were finished as well, and they are in preparation for heat treatment. The OP5 is now in winding (Figure 2).

News

PF coil outdoor DC feeders installed

The installation of the outdoor DC feeders for the poloidal field (PF) coils was completed.

They are composed of the aluminium busbars joined by welding, supplied from the superconducting magnet power supplies installed in the rectifier building to the PF coils (the equilibrium field coils and central solenoid) of the JT-60SA tokamak in the JT-60 main building.

The PF coil feeders leave the rectifier building, cross the passage, climb the wall vertically, and enter the JT-60 main building at the north wall penetration (Figure 1 and 2).

The feeders, frames, cable racks, etc. have already been installed. The safety fences to cover the feeders are being mounted now.

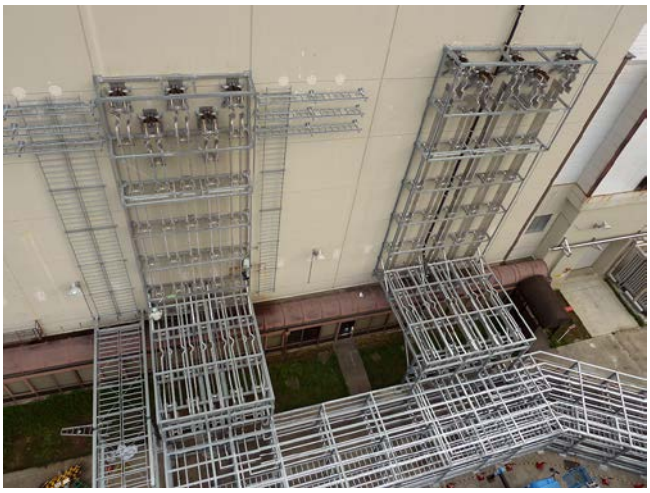
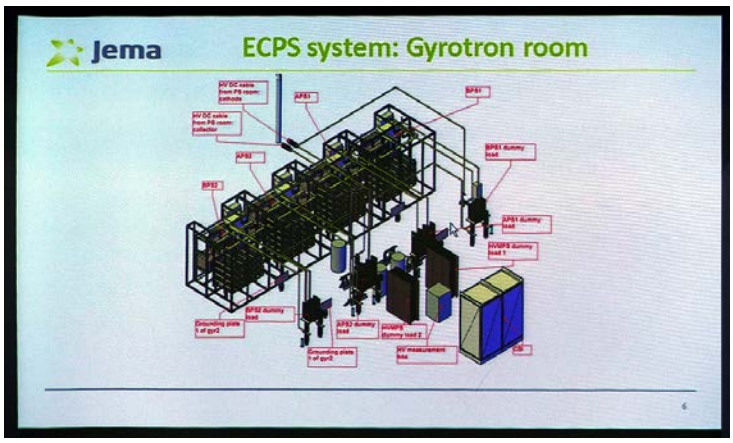


Figure 1: PF coil outdoor DC feeders climbing the north wall of the JT-60 main building to the wall penetration

Figure 2: PF coil outdoor DC feeders crossing the passage between the JT-60 main building (left) and the rectifier building (right)

News

2nd DRM for electron cyclotron range of frequency PS



ECRF PS system presentation by JEMA

JEMA engineers

F4E technical officers

QST technical officers

The power supply (PS) system feeding 2 gyrotrons of the electron cyclotron range of frequency (ECRF) system of JT-60SA is procured by F4E through a contract awarded to the Spanish supplier, Jema Energy S.A. (JEMA) in March 2016.

After a long design phase of about 1 year, the design of the ECRF PS was completed by JEMA in May 2017, and the First Design Report (FDR) describing the details of the system was finally issued.

The ECRF PS system is composed of:

- a high voltage main power supply (HVMPS) feeding, in parallel, 2 gyrotron cathodes with a voltage of 60 kV and a total current of 110 A;
- 2 body power supplies (BPSs) establishing the 35 kV voltage between the body and the collector of each gyrotron;
- 2 anode power supplies (APSs) regulating the 50 kV voltage between the anode and the cathode of each gyrotron.

The key aspects of the proposed design are modularity, redundancy, maintainability and, of course, performance.

The HVMPS system includes 2 cast resin transformers with 8 secondaries each, thus providing a total of 16 HV modules. Each module has a nominal voltage of 4 kV and a nominal current of 110 A. The transformers and the modules will be pre-assembled in 2 containers for the purpose of a quick installation at the site.

The 2 BPSs are composed of 3 HV transformers and 12 HV modules connected in series. Each module is capable of controlling the voltage from 0 to 3.2 kV. Similarly, the 2 APSs are composed of 4 HV transformers and 16 HV modules. The HV modules of the APS and BPS are exactly the same in order to reduce the cost of spare parts.

All of the HVMPS, APSs and BPSs are designed to assure the required performance even in case of failure of one module.

During the design, many computational simulations of the complete system were performed, in order to confirm the fulfilment of demanding requirements under the different operating conditions: fast voltage ramp-up up to the nominal value in 100 microseconds with an overshoot of less than 1 % and errors of less than 0.5 %; fast modulation from 0 to the nominal voltage with a frequency of 5 kHz and a ramp-up time of less than 15 microseconds. In addition, all of the possible faults were simulated, proving that the PS system is capable of protecting the gyrotron even in case of an arc, limiting the energy delivered to the arc to less than 10 J.

The 2nd dedicated design review meeting (DRM) for the ECRF PS was held on 16 May 2016 in Naka, with the participation in person of JEMA, F4E and QST experts to comment and review the FDR. The outcome of the DRM was positive, that is, the proposed design was approved and only minor comments were raised, in such a way that the report was approved soon in June 2017.

The approval of the FDR permits the team to proceed to the next phases of the project - the purchase of the power components and manufacture of the power modules.

News

6th Research Coordination Meeting (RCM-6)

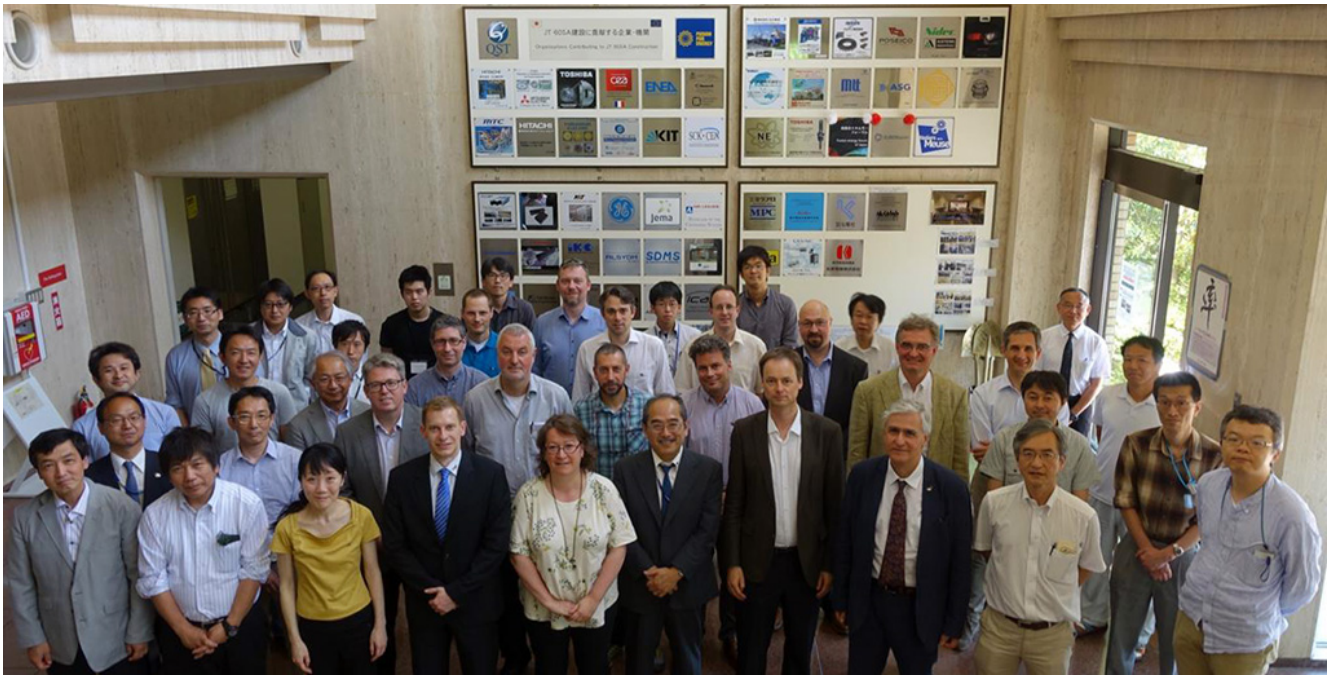


Figure 1: Group photo in front of the JT-60SA key contributor panels including the newly displayed EUROfusion panel

The 6th research coordination meeting (RCM-6) was held at the QST Naka site on 22 - 26 May 2017, in which 51 experts participated - 18 from Europe, 31 from Japan and 2 from the Project Team (Figure 1). They discussed the contents of the JT-60SA Research Plan (SARP) version 4, collaborative work, and the long-term plan taking account of the updated JT-60SA schedule.

Dr. Richard Pitts, the Leader of the Divertor and Plasma-Wall Interaction Section, remotely participated in the meeting, and made a talk entitled "ITER Research Plan and Physics R&D Priorities for JT-60SA". After presenting the overview of the latest ITER Research Plan recently shown at the 22nd ITER Science and Technology Advisory Committee (STAC-22), he mentioned the selected R&D priorities in JT-60SA for ITER, such as disruption mitigation and edge localised mode (ELM) control, emphasising that ITER can learn enormously from JT-60SA both from the commissioning and plasma operation points of view.

In breakout sessions, the research items, such as i) plasma simulation including magnetohydrodynamics (MHD), ii) data and operation, iii) pumping, massive gas injection, pellets, and electron cyclotron wall conditioning, iv) diagnostics, and v) strategy and organisation, were discussed.

During the meeting, the participants visited the torus hall to observe the assembly status of the JT-60SA device (Figure 2).

It was agreed to finalise the SARP version 4.0 within 2017. The next meeting is planned in May 2018.

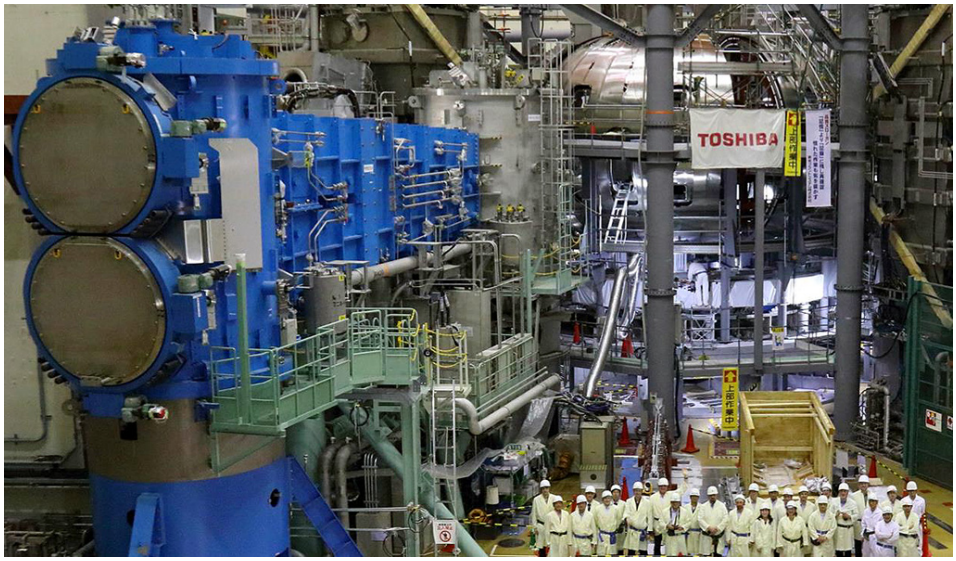


Figure 2: Tour in the JT-60 torus hall where the assembly was ongoing

Meeting

27th IEEE Symposium on Fusion Engineering (SOFE 2017)

The 27th IEEE Symposium on Fusion Engineering (SOFE 2017) was held at the Marriott Shanghai City Centre, in Shanghai, China, from 4 to 7 June 2017.

About 500 participants came together to present and discuss the latest progress in fusion engineering and technology adopted on various devices, for instance, the titles of the presentations included:

- Overall Status of the ITER Project,
- Engineering Challenges in the MAST Upgrade Project,
- Status and Progress of JT-60SA,
- Progress on the EU DEMO Concept,
- Engineering Challenges in Wendelstein 7-X and preparations for the second operation phase,
- Status of the IFMIF project,
- EAST Technical Progress,
- LHD and its deuterium experiments,
- NSTX-U Progress Overview.

Y. Kamada, representing the JT-60SA team, made a plenary presentation focussing on the current status of JT-60SA procurement (Figure 1). He explained that the JT-60SA project was reaching the climax of its full assembly phase leading towards the commissioning, in which assembly of the tokamak body, commissioning of the cryoplant and power supplies, development of the heating and diagnostics systems were rapidly progressing at the

Figure 1: Y. Kamada making the plenary presentation

same time.

He also asserted that the JT-60SA project was producing rich experience in manufacture and assembly of a large superconducting tokamak, which should contribute to ITER and DEMO, emphasising that the excellent team spirit was the key to success for the project. The audience listened with great interest and asked several questions.

4 presentations from the JT-60SA EU and JA Home Teams were given as follows (only presenters and titles are shown):

- Plenary presentations (1)
  1. Y. KAMADA, Status of the JT-60SA Project.

- Oral presentations (1)
  1. A. FERRO, Design and Manufacturing of the SIC-based Power Supply System for Resistive-Wall-Mode Control in JT-60SA.

- Poster presentations (2)
  1. M. ICHIKAWA, Investigation of causes of arcing in an arc-driven multi-cusp negative ion source for JT-60SA;
  2. P. ZITO, Type Tests of JT-60SA Central Solenoid / Equilibrium Field (CS/EF) Super-Conducting Magnet Power Supplies.

Figure 2: A. Ferro making the presentation about the resistive-wall-mode control coil power supply

A. Ferro described his impression of the SOFE 2017 conference, "It was a very fruitful conference, which gave a comprehensive overview of the present status of the research in nuclear fusion engineering. At this conference, Y. Kamada gave a brilliant presentation on the latest assembly advancements of JT-60SA, which were progressing mostly on schedule without any major issues, thanks to the strong and well-addressed cooperation among the involved partners. I presented the status of design and manufacturing of the power supply for resistive-wall-mode control, a very innovative system which was the result of years of joint work among Consorzio RFX, F4E and QST, with strong involvement by the Italian company, Equipaggiamenti Elettronici Industriali S.p.A. (E.E.I.), now in charge of its realisation".

P. ZITO described his impression of the SOFE 2017 conference, “The conference was very interesting because it was a moment of common discussion on the state-of–the-art tokamaks, components, devices, diagnostics and materials, where everybody could learn about their own and other interest areas.”

The next SOFE meeting will be held in Atlanta, GA, USA from 10 to 13 June 2019.

Calendar

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

27 - 29 September 2017
16th International Workshop on Plasma Edge Theory in Fusion Device (PET-16)
Marseille, France

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

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

13 December 2017
21st Meeting of the BA Steering Committee (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/.