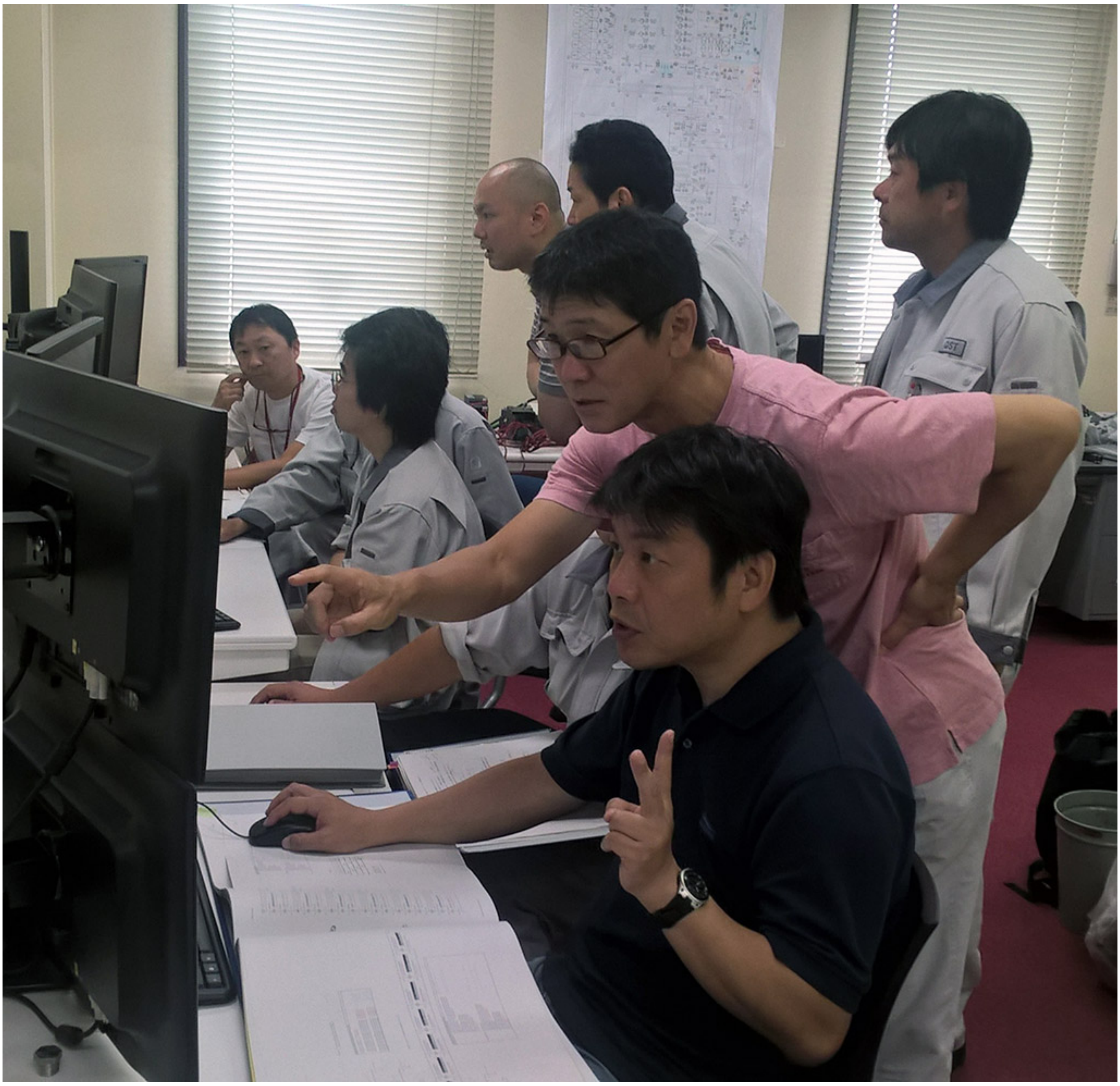
JT-60SA Newsletter

No. 94, 31 October 2017

Headline

First operation of cryogenic system by QST operation team



QST cryogenic operation team actively engaging in the plant operation

Following the acceptance tests of the cryogenic system by the supplier, Air Liquide Advanced Technologies S.A. (ALAT), and the transfer of ownership from ALAT to CEA, then to F4E, and finally to QST on the 12 December 2016, the first operation campaign to be performed by the QST cryogenic operation team took place from the end of August to the beginning of September 2017. The aim of this campaign was to train the QST team members to get them familiar with this powerful new plant, at the same time to validate some improvements which were agreed to be implemented during the acceptance tests, and further to identify possible defects within the warranty period.

Before the plant was cooled down, ALAT and QST re-installed the cold compressor, which had been removed for inspection, replaced some instrumentation, and updated the control system software. On 28 August 2017, the cooldown was begun by the QST team supported by a commissioning engineer from ALAT and a process control system expert from an ALAT subcontractor, with attendance of CEA and F4E responsible officers for the cryogenic system.

Within a tight schedule, over 12 days, the plant was cooled down and switched to the nominal operation mode where cold circulators were running to force some 1700 g/s of helium through the toroidal and poloidal field coil by-pass loops in the auxiliary cold box. The liquid helium reservoirs were sub-cooled to 3.6 K and 4.3 K as a result of nominal operation of the very low pressure compressors and cold compressor, respectively. The cryoplant was finally warmed up to ambient temperatures. During the whole testing programme, the performance of all sub-systems was checked and evaluated.

The QST team, which was reorganised in this April, had thoroughly prepared themselves for this campaign, with even a “Japanese Manual” which was translated from the original English version and also included many details recorded during the acceptance tests in 2016. As a consequence, the QST team members were able to operate the complex plant with many interacting control loops almost completely on their own. The ALAT expert was available during the first week and helped them in particularly tricky situations. When several alarms, off-normal situations, and even a sudden trip of the compressor system and the refrigerator cold box occurred, the QST team members were able to recover normal operation by themselves, after thorough consultation.

When the plant successfully returned to ambient temperature, the QST team members could be happy and proud of their own achievement. After the hard work of 2 weeks, with several night shifts, it became apparent that such hands-on training to acquire practical experience was essential for the operators to understand more about the plant's “character” and to be able to react quickly and properly in any unforeseen situations. The QST team members were eager to perform the next campaign to improve their skills and to increase their experience. It was exciting and rewarding for all the people involved in the project to participate in the operation of such a complex system.

News

Cryoline installation begins

Figure 1: Torus hall overview and cryoline layout

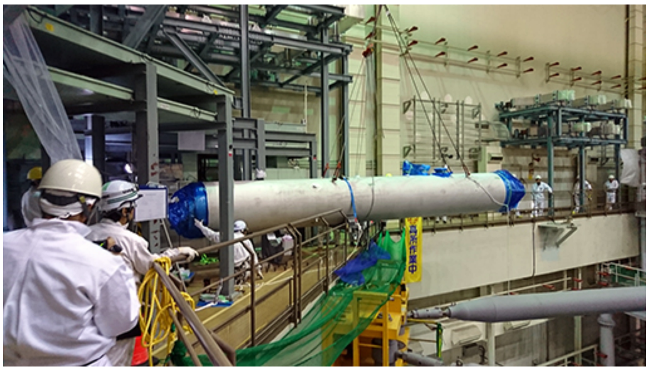


Figure 2: Transporting the CryoL-A sector in the torus hall

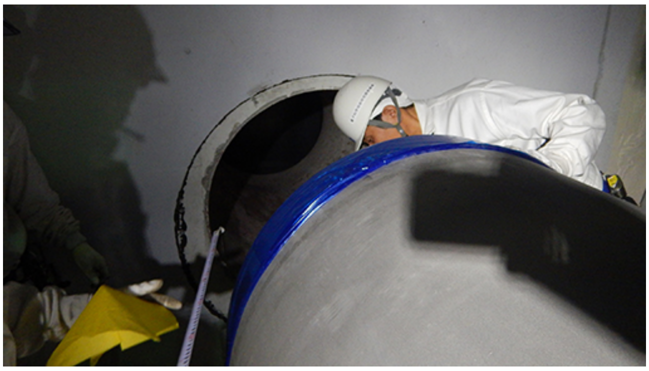


Figure 3: Jointing the CryoL-A end with the wall penetration

Figure 4: The CryoL-A sector installed in the torus hall

The cryoline (CryoL) is a multiple vacuum insulated pipe connecting the auxiliary cold box of the cryogenic system (helium refrigerator) and the cryostat of the JT-60SA tokamak device (Figure 1). It is composed of 10 sectors and has a barrier in the middle to separate the insulation vacuum, which is located in the torus hall. The 5 sectors on the cryogenic system side of the vacuum interface are referred to as CryoL-A, while the 5 sectors on the tokamak side are referred to as CryoL-B.

All of the 5 CryoL-A sectors were produced by Taiyo Nippon Sanso Corporation and delivered to the QST Naka site by the end of September 2017. Subsequently, the installation of one of them began in the torus hall. On 6 October 2017, the foremost sector of CryoL-A was successfully installed in the torus hall, joining its one end to the wall penetration, (Figure 2 - 4).

News

Valve boxes completed and delivered to Naka

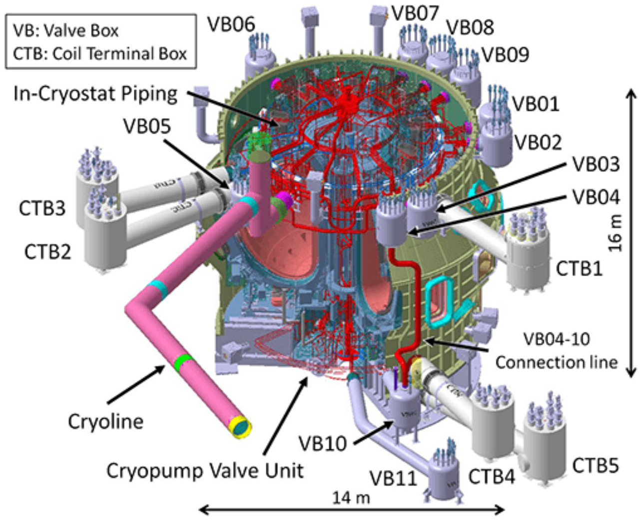


Figure 1: JT-60SA tokamak device and VB layout

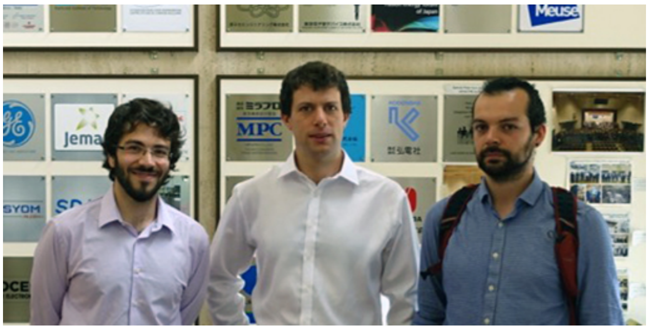
Figure 2: 5 VBs delivered in September 2017

The valve boxes (VBs) will be installed around the cryostat of the JT-60SA tokamak device, as shown in Figure 1. They enclose the cryogenic valves to control supercritical helium flow for the cryopump, thermal shields, high temperature superconductor current leads, superconducting coils and their structure. Each weighs about 2 - 3 t and is made of stainless steel.

Taiyo Nippon Sanso Corporation produced all 11 VBs under contract to QST. At the end of September 2017, 5 VB units (VB03, VB04, VB06, VB08, and VB09) were delivered to the superconducting coil winding building at the QST Naka site (Figure 2). Together with 6 units already delivered in March 2017, all 11 VBs are now present and waiting for the later integration with the cryostat planned in 2019.

News

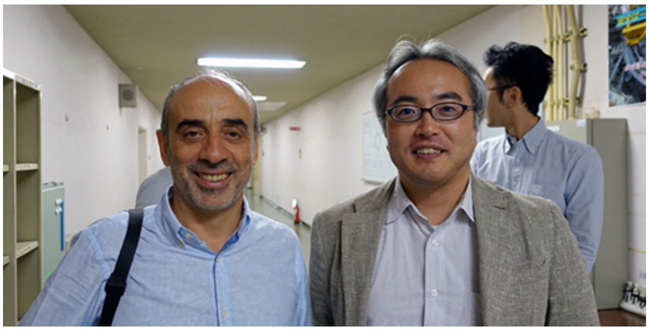
VIPs visit QST Naka site



Mr. Tiago Romella Lobo (left), Mr. De. Simon Kierk (centre), and Mr. Keelan Keogh (right)

Mr. Bernd Heinemann (left) and Ms. Ursel Fantz (right)

Mr. Dieter Leichtle



Mr. Carlo Damiani (left)

Mr. Fabien Josseaume

In October 2017 the following people visited the QST Naka site to see the progress of JT-60SA construction and to discuss fusion research and development.

On 2 October:

- Mr. Tiago Romella Lobo (Fellow, Eindhoven University of Technology), Mr. De. Simon Kierk (Engineering Fellow, EUROfusion), and Mr. Keelan Keogh (Mechanical Engineer, UK Atomic Energy Authority);
- Mr. Bernd Heinemann and Ms. Ursel Fantz (Max Planck Institute);
- Mr. Dieter Leichtle (F4E);
- Mr. Carlo Damiani (F4E).

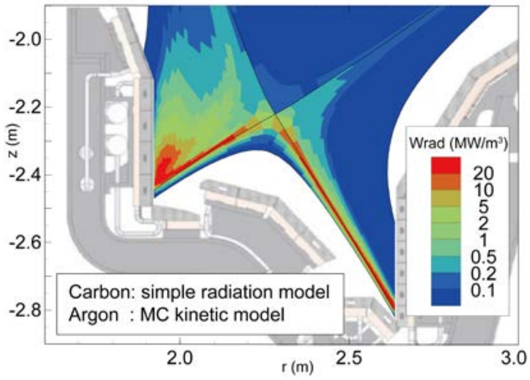
On 3 October:

- Mr. Fabien Josseaume (ITER International Fusion Energy Organization).

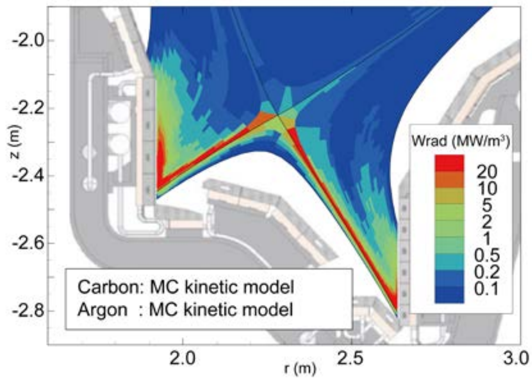
Representatives of QST welcomed and guided them on a tour of the JT-60SA device, including the toroidal field coils being assembled in the torus hall, the equilibrium field coils 1 - 3, error field correction coils, high temperature superconductor current leads, coil terminal box 01, and valve boxes in the superconducting coil winding building, the cryogenic system in the cryogenic hall, and the superconducting magnet power supplies in the rectifier building.

News

SOL/Divertor Integrated Codes - "SONIC" - extended for multi-impurity simulation



Previous simulation (a simple radiation model for carbon and a MC kinetic model for argon)



Extended SONIC simulation (a MC kinetic model for both carbon and argon)

Spatial profiles of impurity radiation power including carbon and argon

QST is developing a suite of integrated divertor codes - "SONIC (Scrape-Off Layer (SOL)/Divertor Integrated Codes)". One of the SONIC code features is the capability of impurity treatment by a Monte-Carlo (MC) kinetic model, which has advantages in transport modelling, such as the thermal force, plasma wall interactions, etc.

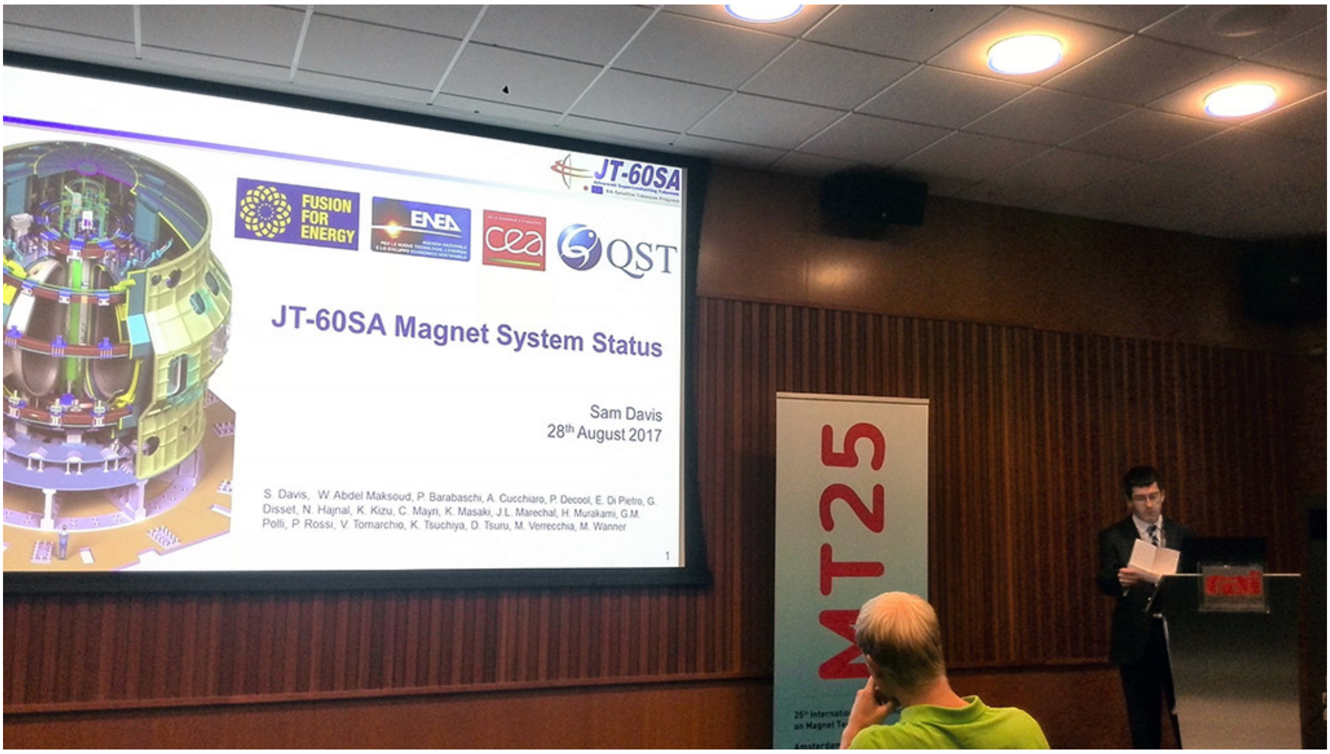
In order to predict the radiative divertor plasma more precisely, the SONIC code has now been extended to cover simulation of multiple impurity species, such as intrinsic impurities generated from the wall/divertor plate (W, Be, C) and seeded impurities (Ne, Ar, etc.). In order to extend the SONIC code, a new integrated modelling framework, using an MPMD (Multiple Programme Multiple Data) approach and an MPI (Message Passing Interface) data exchange, has been developed. By introducing the new framework, more than 2 impurities (for instance, C and Ar) can be treated simultaneously with a kinetic model.

The extended SONIC code was applied to re-assess the target heat load for the JT-60SA steady-state high-β scenario, which was previously analysed with a simple radiation model for carbon. To understand the impact, the same input parameters as the previous analysis were used except for the carbon impurity model. In the re-assessment, the carbon impurity was treated by the MC kinetic model, and the carbon generation and its transport were held consistent with the background plasma and seeded Ar impurity. The results show that the carbon density is now increased by the chemical sputtering at the dome and the outer flux region far from the separatrix, and the carbon radiation power is increased and localised close to the target and separatrix due to temperature dependence on the electron cooling rate (see figures). As a result, target heat load is decreased from 10 MW/m^2 to 6.2 MW/m^2. However, mainly due to the increase of electrons due to carbon ionisation, the SOL electron density exceeds the limit allowable for the operational scenario. To decrease the SOL density, a parameter survey of the gas puffing rate of D_2 and Ar was performed. With an optimised gas puffing rate, the SONIC simulation showed that a radiative divertor plasma scenario, compatible with the steady-state high-β plasma, could be achieved. This confirms with greater confidence the same conclusion as the previous analysis.

Future work will include studies of the balance between D_2 and the seeding impurity gas puff, the location of the gas puff, etc. on the divertor plasma performance, and the radiative divertor scenario for a full metal wall, in addition to the analyses of the effects of the choice of impurity species for seeding.

Meeting

25th International Conference on Magnet Technology



S. Davis delivering his invited talk

The 25th International Conference on Magnet Technology (MT25) was held in Amsterdam, the Netherlands from 27 August to 1 September 2017. Over 900 participants attended the conference.

The subject of the conference was the technology associated with the construction of coils and magnets. Large, powerful magnets are fundamental for confining the plasma in a tokamak such as JT-60SA to achieve fusion-relevant conditions. Until the completion of ITER, JT-60SA will be the largest superconducting tokamak in the world, so the design, manufacturing, installation, and performance of its magnets is of interest to other magnet engineers.

The conference programme included a dedicated oral session for JT-60SA for the first time. S. Davis from F4E presented an invited talk entitled “JT-60SA Magnet System Status”, explaining that the equilibrium field coils and error field correction coils for JT-60SA had already been completed and that the manufacturing of the toroidal field (TF) coils and the central solenoid were well advanced. The talk included many photos showing the completed components and illustrating the assembly of the TF magnet which is currently underway at the QST Naka site. The talk was well received by the audience, as were the following presentations on more specific aspects of the JT-60SA magnets. The excellent collaboration on technical matters between the many contributors to the magnet system was highlighted during the time for questions.

In total, 12 contributions from the JT-60SA EU and JA Home Teams were presented as follows (only presenters and titles are shown):

- Invited presentation (1)
    1. S. Davis, JT-60SA Magnet System Status.

- Oral presentations (3)
    1. H. Murakami, Vacuum Pressure Impregnation for Central Solenoid of JT-60SA;
    2. G. M. Polli, Completion of ENEA’s Procurement for 9 TF Coils of JT-60SA Tokamak;
    3. W. Abdel-Maksoud, Progress of the JT-60SA Toroidal Field Coils Tests in the Cold Test Facility.

- Poster presentations (8)
    1. F. Bonne, Dynamical Cryodistribution Model of the JT-60SA Toroidal Field Coil in Cold Test Facility;
    2. D. Ciazynski, Analyses of Early Quench Development in JT-60SA Toroidal Field Coils Tested in the Cold Test Facility;

3. R. Heller, Overview of JT-60SA HTS Current Lead Manufacture and Testing;
4. S. Fujiyama, Evaluation of Voltage between Conductors for Resonance Phenomenon and Transient Response in JT-60SA Central Solenoid;
5. P. Decool, Completion of the French JT-60SA Toroidal Field Magnet Contribution;
6. S. Nicollet, Parametric Analyses of JT-60SA TF Coil in Cold Test Facility with SUPERMAGNET Code;
7. V. Tomarchio, On a Full 3D Thermal Structural Finite Element Model of the JT-60SA Toroidal Field Coils;
8. Y, Huang, Numerical Modelling of the Quench Propagation Phase in the JT-60SA TF Coils Tested in CTF.

Conference venue - RAI Amsterdam

“I amsterdam” sign in the Museum Square

Meeting

13th European Conference on Applied Superconductivity

Figure 1: International Conference Centre of Geneva

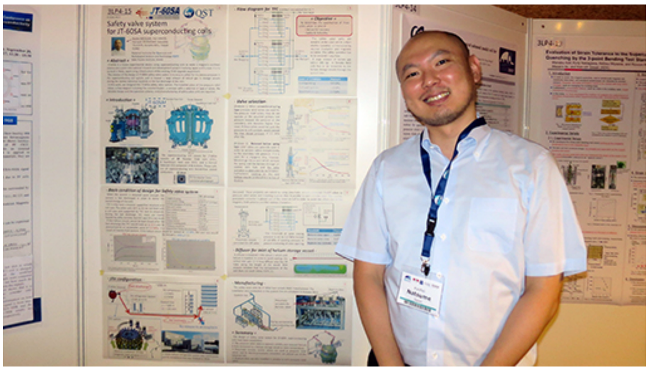


Figure 2: K. Natsume with his poster presentation

Figure 3: Conference programme underway

Figure 4: Participants viewing the poster presentations

The 13th European Conference on Applied Superconductivity (EUCAS 2017) was held at the International Conference Centre in Geneva, Switzerland from 17 to 21 September 2017. A total of 1194 participants attended the conference.

The EUCAS is a worldwide forum which provides scientists and engineers with an ideal platform to share their knowledge and the most recent advancement in all areas of applied superconductivity from large-scale applications to micro-electronics devices, traditionally focussing on advanced materials and conductors. Because of its broad scope, it is, at the same time, a challenging opportunity to foster novel, inter-disciplinary approaches in the research and to promote cross-fertilization among the various fields of applied superconductivity.

K. Natsume from QST presented "Safety valve system for JT-60SA superconducting coils" on a poster (Figure 2). He explained the design of the pressure relief system and the helium recovery scheme of the cryogenic and cryodistribution systems of JT-60SA. Even if resistive transitions (quenches) of the 18 toroidal field coils should occur on the JT-60SA device, evaporated helium gas with a weight of about 200 kg will be fully retrieved in the helium storage vessels through the dedicated pressure relief valves and pipes. Pneumatic remote control valves were adopted as the pressure relief valves (activation pressure is 1.8 MPa). In order to secure more safety and reliability, rupture discs (2.0 MPa) were installed in parallel with those valves.

This presentation attracted many participants and was well received.

Calendar

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 BA Steering Committee (SC-21)
Mol, Belgium

17 - 18 January 2018
29th Technical Coordination Meeting (TCM-29)
Saclay, France

13 March 2018
22nd Meeting of the STP Project Committee (PC-22)
Naka, Japan

26 April 2018
22nd Meeting of the BA Steering Committee (SC-22)
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/.