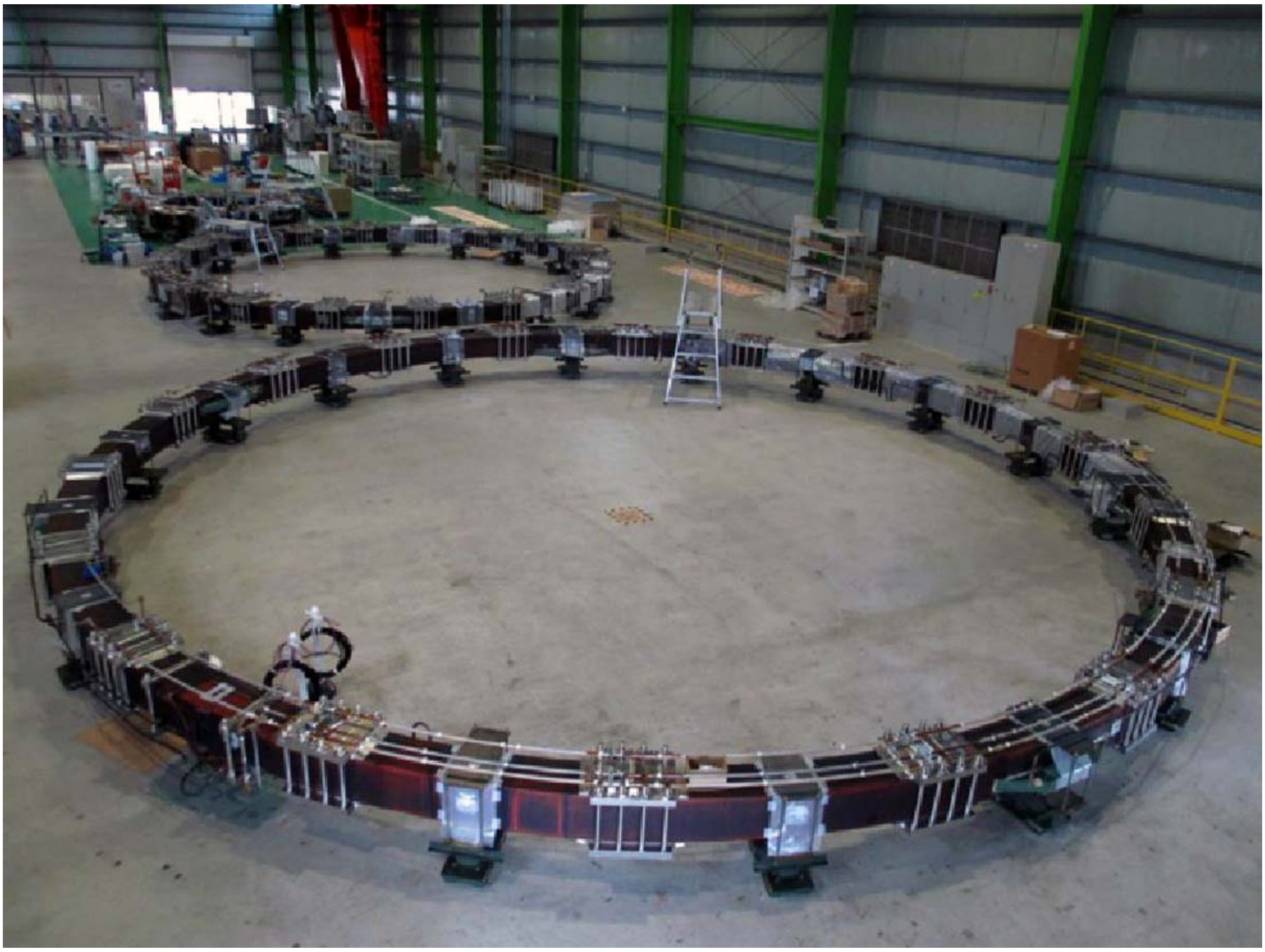
JT-60SA Newsletter

No. 81, 30 September 2016

Headline

All equilibrium field coils completed



The equilibrium field (EF) coils 1 - 3 were completed early in August 2016. This means that the manufacturing of all 6 EF coils, including the coil EF4 - 6 temporarily installed on the cryostat base, was finished as scheduled.

One of the key achievements is that the coils attained much higher circularity than the requirement. In other words, the superconducting coils have a smaller error magnetic field. For instance, the coil EF1 (at the front in the figure), with an outer diameter of about 12 m, achieved a circularity (i.e. maximum diameter deviation) of 0.3 mm (requirement: ≤ 8 mm).

This remarkable feat was accomplished as the result of several improvements, such as an enhancement of the calender (the winding head with a series of rollers used to form the conductor), the distributed arrangement of the pancake junctions in the circumferential direction, an optimisation of the relative positions among the pancakes, and so forth.

The error magnetic field can be one of the causes of plasma instability. Therefore, this achievement will benefit steady plasma operation.

The EF coils now stand ready for their installation on the tokamak after the completion of the toroidal field coil installation, expected in 2018.

News

Progress in cryogenic system commissioning

Figure 1: Venting of gaseous nitrogen above the cryogenic hall during the baking test

The cryogenic system for JT-60SA, with a total capacity equivalent to about 9 kW at 4.5 K, is one of the most powerful refrigerators in Asia. It provides refrigeration at different temperatures for the superconducting magnets and their structure, the current leads, the thermal shields (TSs), and the divertor cryo-pumps. During plasma experiments on JT-60SA, the cryogenic system will have to cope with approximately 800 s long heat pulses at 4.4 K with loads of up to 7.4 kW at 4.4 K in 2 magnet loops. This far exceeds the stationary capacity of the plant, so the buffers absorb the heat by partial vaporisation and a temperature and pressure increase of the liquid helium. After the heat pulse the buffer is re-cooled to its initial temperature and pressure. At night and during the short term stand-by mode when the magnets are not energized, the refrigeration is less demanding. However, when the vacuum vessel of JT-60SA is baked at 473 K, the radiation to the 80 K TS increases to 135 kW, which again has to be absorbed by the refrigerator. During this mode, the magnets are allowed to warm to about 12 K.

CEA contracted with Air Liquide Advanced Technology (ALAT) for the construction of the cryogenic system as a part of the French contribution to the Broader Approach activities. ALAT started commissioning of the system and liquefied some helium in March 2016. During this first commissioning phase, the main subsystems underwent functional checks. The work then focussed on automatic operation and validation of the various refrigeration modes specified. So far, the following modes have been tested and partly validated:

- A general capacity test. The heat loads of 6.6 kW were injected into the liquid helium while the TS loop was heated with 43 kW. This first test demonstrated overall refrigeration capacity of the plant.
- An automatic cool down. The mass flow rates and temperatures in the TS and magnet loops were controlled, while maintaining the temperature of the magnets 40 K lower than that of the TSs all the time, in order to trap gas impurities on the colder surfaces and maintain the good heat reflecting quality of the polished TS.
- A continuous 36 hour baking mode test. This test demonstrated that the heat exchangers were capable of vaporising and warming up liquid nitrogen at about 2.7 t/h. It generated a huge vapour cloud above the cryogenic hall (Figure 1)! This test was also a logistical challenge. The liquid nitrogen, with a total weight of 120 t, had to be delivered by trucks in batches every 2 to 3 hours.
- Another continuous 36 hour test. The short term stand-by mode with reduced refrigeration power could be demonstrated.
- Normal operation mode. For the plant, this is the most demanding operation where heat pulses are repeatedly injected at 4.4 K. It requires the maximum refrigeration with 3 turbines plus 2 cryogenic pumps, to circulate about 1 kg/s of supercritical helium through each of the magnet loops. A cryogenic compressor reduces the helium bath pressure in order for the helium again to achieve 4.4 K at the next pulse start. The results of the first tests looked quite promising. After injection of a single heat pulse with 75 % of the nominal heat loads into the 2 magnet loops, the increased temperature, liquid level and vapour pressure in the helium buffer were recovered to the initial level within 30 minutes. To generate 3.7

K helium for the later operation of the divertor cryo-pumps, the vapour pressure above the liquid helium must be low enough. This was achieved by a set of vacuum pumps at ambient temperature.

The execution of transient operations as well as recovery from cryogenic machine trips required frequent night shifts by ALAT engineers and involved staff of CEA, F4E and QST in conformity with Japanese safety requirements. Thanks to the efficient execution of the tests, the consumption of electricity and liquid nitrogen could be kept well below the amount originally estimated. Plant performance has been steady and stable. Therefore, unattended operation will be certainly achieved after some modification of the operation sequences and adjustment of the loop control parameters. Since the beginning of September, the final cool down and commissioning have been carried out, in preparation for validation of normal operation mode with several dynamic scenarios. With that, the cryogenic system can then be accepted and transferred to QST.

News

More thermal shields delivered

L-PTSs completely delivered to the QST Naka site

The 18 lower port thermal shields (L-PTSs), 9 each for the odd- and even-numbered sectors (see figure), together with the final vacuum vessel thermal shields (VVTSs), were delivered to the QST Naka site at the end of May 2016.

The VVTSs and PTSs consist of double 3 mm thick stainless steel (SS316L) panels with a coolant channel, located in between, to distribute gaseous helium at 80 K. Their surfaces are polished to reduce thermal radiation.

The VVTS assembly is underway. As of 23 September 2016, a total of 11 VVTSs have been mounted onto the vacuum vessel. Each L-PTS will be mounted one by one onto the VVTS when the respective toroidal field coil is positioned.

News

Young scientist from the Netherlands joins JT-60SA research in Naka

Mr. J. van den Berg, a young, 23-year-old, scientist from the Netherlands, joined the JT-60SA research at QST Naka Fusion Institute as a trainee from 20 June to 31 August 2016. We asked him about it:

- What is your background?

I grew up in Amsterdam and moved to Delft for the bachelor of applied physics at Delft University of Technology (TU Delft) in the Netherlands. After this, I decided to go into the nuclear fusion field and studied for the dedicated masters degree of "Science and Technology of Nuclear Fusion", where the students with bachelors in physics, mechanical engineering and electrical engineering came together.

- Why did you join the JT-60SA research?

When completed, JT-60SA will be the largest tokamak in the world. The size matters indeed, but more important things to achieve are the actual research goals being pursued here in the JT-60SA project. I was keen to learn them and to experience the Japanese working environment as well!

- How were your internship at Naka Institute, and life in Japan?

It was good to realize that the research in JT-60SA, as a part of the Broader Approach, was being carried out in collaboration, instead of competition, with the experts from various institutes and countries. Thanks to it, I had an opportunity to be here to study plasma diagnostics and physics. I spent a good time studying Thomson scattering diagnostics, which are essential to measure the electron temperature and density.

It was also good to know that, for example, the flat or reversed shear profiles in a large tokamak were important for the development of future tokamaks like DEMO, whose development is, of course, the big challenge we are all working towards.

QST was very kind to offer me an apartment to stay in the Minouchi Housing of QST Naka. The room had real “shoji” windows (inner windows made of wood and paper in traditional Japanese style)! They also took care of transportation. I commuted by awesome ”QST bike”, a typical Japanese granny bike that QST lends to visitors.

After a long week of work, you well deserve some leisure time, especially when you are 8000 km away from home! Therefore, I spent many weekends exploring Japan. Of course, I visited Tokyo several times, as it is not so far from Naka. In addition, the places I also put on my itineraries were: Nikko, beaches in Ibaraki, the Large Helical Device in Toki, and Takayama. To round off, at the end of my stay in Japan, I spent 7 days on the road with an open and unlimited ride pass for Japan Rail! Between those travels, I went on some nice hikes to Mt. Nantai in Nikko, Mt. Hakkoda in Aomori, Mt. Misen in Miyajima (Hiroshima), and, of course, beloved Mt. Fuji.

Altogether, my stay in Japan, especially at QST, was a wonderful experience, and I would love to come back one day in the future!

Mr. J. van den Berg from the Netherlands at his desk at Naka Fusion Institute

News

Recent progress at Rokkasho IFERC site

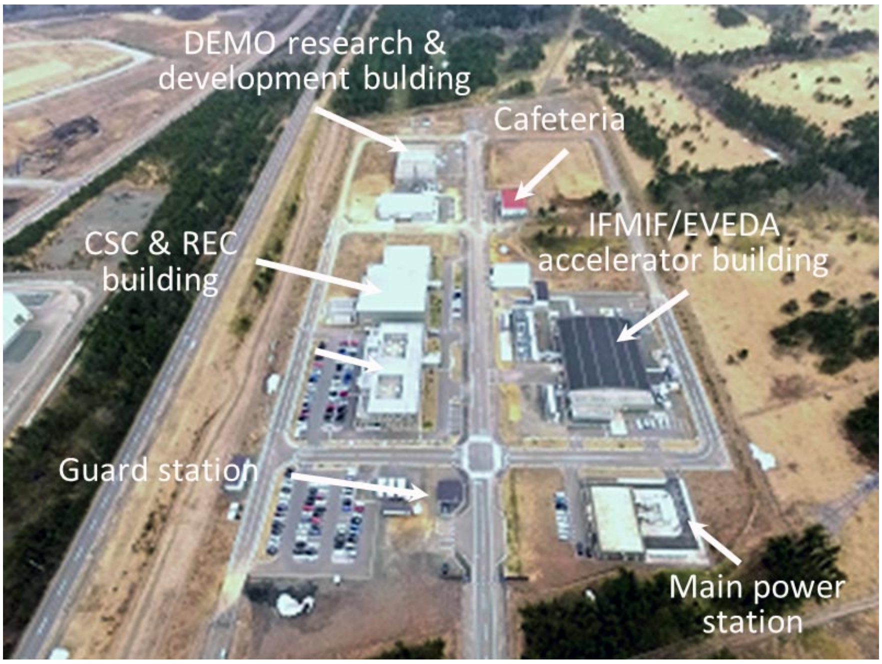


Figure 1: Current view of the BA site at the IFERC in Rokkasho

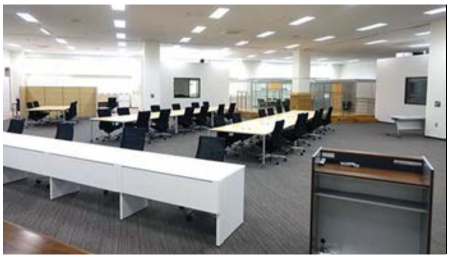


Figure 2: REC room (the main partitioning completed)

Figure 3: DEMO joint research building and DEMO research & development building

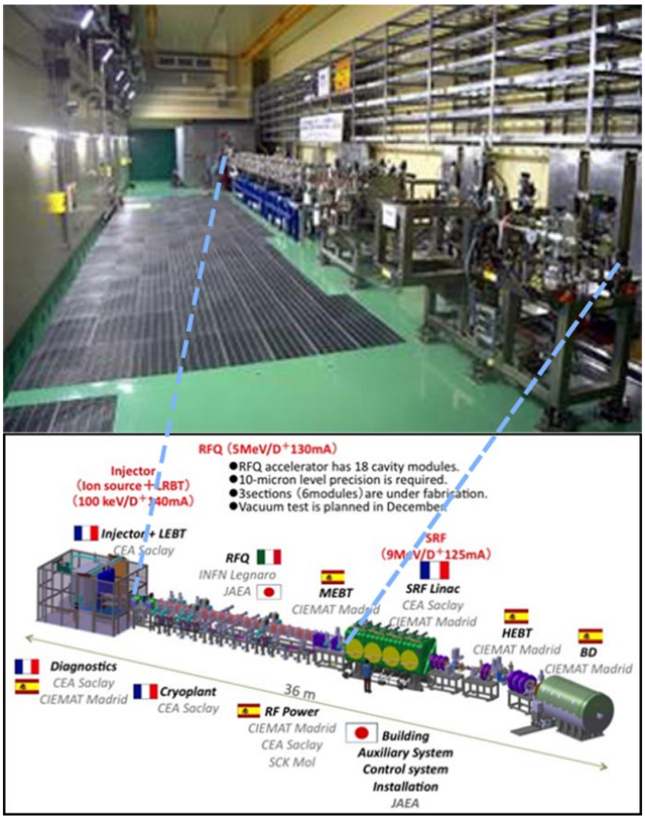


Figure 4: Present view of the Linear IFMIF Prototype Accelerator

Figure 5: Lunchtime in the cafeteria

Figure 6: Yagen hot spring

The JT-60SA Newsletter No.41 issued in May 2013 introduced the International Fusion Energy Research Centre (IFERC) in Rokkasho, Aomori in Japan (Figure 1). The facility construction, as well as the research activities, have been progressing well.

At the ITER remote experimentation centre (REC), the REC room (Figure 2) is being constructed for remote experimentation on ITER and on other fusion related devices. There are several meeting rooms, where TV conference systems will be introduced for intensive discussion among scientists joining the remote experiments. The construction has made significant progress, and the data transfer between the ITER site and the REC was demonstrated from 30 August to 5 September 2016.

At the computational simulation centre (CSC), the IFERC-CSC supercomputer, Helios, has been used by European and Japanese researchers very frequently. Its operation rate reaches almost 90% on weekly average, and 512 peer reviewed papers have been published using Helios. The CSC activity will be finished at the end of December 2016 according to the initial project plan.

The DEMO joint research building and the DEMO research & development building (Figure 3) have been completed. The buildings were constructed to enhance research activities for the remaining Broader Approach (BA) period, based on the agreement between Europe and Japan. In the DEMO design activity, the intermediate report of the joint design research of DEMO was published in 2015, which included analysis of key design issues and R&D needs implemented by both Europe and Japan.

In the IFMIF/EVEDA accelerator building, the commissioning of the injector and the installation of the radio frequency quadrupole (RFQ), RF power generator, medium energy beam transport (MEBT) line and diagnostics have been progressing successfully (Figure 4). A celebration of the success of the injector commissioning and the start of installation of the RFQ and RF power generator for the Linear IFMIF Prototype Accelerator was held at the site on 21 April 2016. More than 150 members from Europe and Japan, including the Ambassador of Spain to Japan, the Administrator General of CEA et.al, attended.

The residential environment has been developed and maintained smoothly. At the cafeteria (Figure 5), people enjoy various good quality made-to-order lunches. Aomori is famous for its beautiful hot springs (Figure 6) and many people are enjoying quality hot spring resorts.

Meeting

22nd Topical Meeting on the Technology of Fusion Energy (TOFE-22)

TOFE 2016

Philadelphia city area

The 22nd American Nuclear Society Topical Meeting on the Technology of Fusion Energy (TOFE 2016) was held at Sheraton Philadelphia Society Hill Hotel in Philadelphia, PA, U.S.A, on 21 - 25 August 2016. More than 200 participants joined to present and discuss the latest progress on the technologies of fusion energy. During this meeting, a total of 203 presentations (12 plenary talks, 31 invited talks, 68 orals and 92 posters) were given.

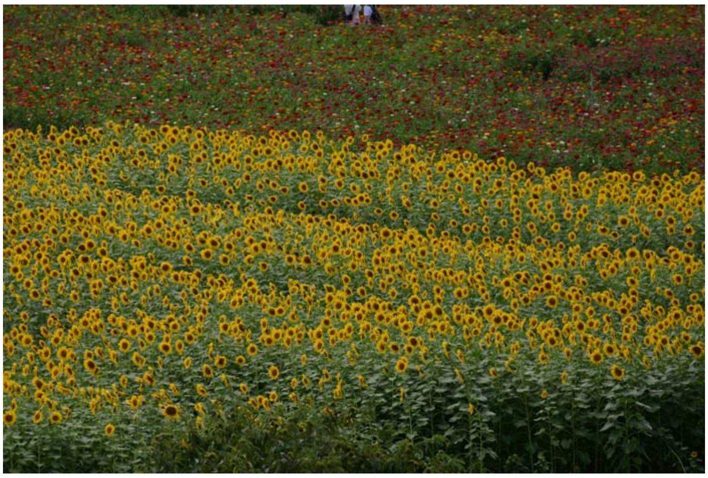
A. Sakasai, Director of the Tokamak System Technology Department, QST Naka Fusion Institute, gave an invited plenary talk entitled “Progress of JT-60SA Construction and Research Planning”, presenting an overview of the JT-60SA construction including manufacturing and assembly of components which were shared by Europe and Japan. He remarked that the JT-60SA project was progressing steadily towards the achievement of “first plasma” in 2019. He also reported that the research collaboration in JT-60SA between Europe and Japan had been strongly promoted and the latest JT-60SA Research Plan (ver. 3.3), released in March 2016, was written by 378 researchers from Europe and Japan. The audience listened with interest, and the presentation was well received.

The next TOFE meeting will be held on Orlando, FL, USA in 2018.

<u>**Local**</u>

Summer flowers in Hitachi Seaside Park


Zinnias ("Hyakunichi-sou" in Japanese)




Sunflowers ("Himawari" in Japanese)

Kochias ("Houkigi" in Japanese)


Port of Hitachinaka and beach

Hitachi Seaside Park, an urban park featuring seasonal flowers, is located approximately 9 km to the southeast of the QST Naka site. With various flower gardens covering an extensive area of about 200 ha open to the public, it is one of the most popular tourist spots in Ibaraki, Japan.

In August, zinnias and sunflowers, showcasing Japanese summer, are in full blossom in Miharashi (“lookout” in Japanese) village, and round bushes of kochia (bassia scoparia) cover Miharashi hill in light green, on the northeast side of the park (see figures). Roughly 350000 flowers of zinnia decorate Miharashi village fields with 6 colours like a pointillism picture. About 30000 sunflowers, the most typical summer flower in Japan, are in their full glory. Approximately 32000 kochia bushes are at the peak of their growing season, and preparing for turning red in October. The flower relay here is led by narcissuses, notifying the arrival of spring. The baton is then passed to tulips, nemophilas (baby blue eyes), roses, zinnias, sunflowers, kochias and cosmoses from season to season.

The park faces the Pacific Ocean. You can look out over the ocean and the port of Hitachinaka from the top of Miharashi hill.

Calendar

11 October 2016
19th Meeting of the STP Project Committee (PC-19)
Naka, Japan

17 – 22 October 2016
26th IAEA Fusion Energy Conference (FEC 2016)
Kyoto, Japan

9 – 10 November 2016
26th Technical Coordination Meeting (TCM-26)
Naka, Japan

14 December 2016
19th Meeting of the BA Steering Committee (SC-19)
Madrid, Spain

22 – 23 February 2017
27th Technical Coordination Meeting (TCM-27)
Karlsruhe, Germany

Contact Us

The JT-60 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/.