JT-60SA Newsletter

No. 79, 29 July 2016

Headline

CEA SCMPSs arrive at QST Naka site

Figure 1: Voyage of SCMPSs from Bilbao to Yokohama port

Figure 2: Representatives of QST, F4E, CEA and JEMA participated in the box reception at Yokohama port

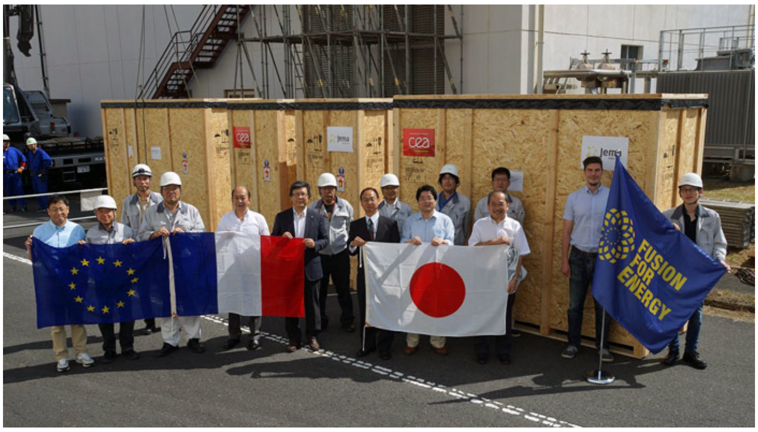

Figure 3: Celebration of the SCMPS arrival at the QST Naka site

On 27 June 2016, the superconducting magnet power supplies (SCMPSs), procured by CEA through a contract with a Spanish supplier, Jema Energy S.A. (JEMA), were delivered to the QST Naka site. These supply power to the superconducting magnets of the JT-60SA device. The delivery included the PS systems for the toroidal field (TF) coils and the equilibrium field (EF) coils 2 - 5.

These 5 converters and 2 transformers, which were packed in 39 wooden boxes and then stored in 7 containers, began their long journey from Bilbao port on 7 May 2016. As a first step, they reached Algeciras port (Spain) where they were transferred to a different ship. Then, after passing through the Suez Canal, they stopped at the ports of Singapore and Hong Kong before reaching the port of Shanghai. Here, they were transferred again to another ship, which finally reached the port of Yokohama on 19 June 2016.

On 23 June 2016, and after customs clearance, the seals of the containers were opened and the status of the 39 boxes was jointly checked at the port of Yokohama by all stakeholders involved: representatives of JEMA, CEA, F4E and QST (Figure 2). They performed an accurate visual check of the boxes and inspected the attached shock detectors to verify if any mishandling had occurred during the transportation. Only 1 shock indicator, out of 95 in total, was found to be tripped, but the further detailed inspection on the questioned box resulted in finding no evident damage, giving reassurance of the good condition of the SCMPS components.

After the check, the responsibility for component transportation was transferred from CEA to QST. Then, the transportation company, Utoc Corporation (UTOC), handled the remaining transport from Yokohama to Naka under a contract with QST.

A simple celebration to welcome the SCMPS components was held at the QST Naka site on 27 June 2016 (Figure 3).

After the celebration, UTOC lifted up and positioned the SCMPS boxes near the final installation place in the rectifier building and the TF PS hall with a movable crane and temporary scaffolding.

Finally, the second joint check of the boxes was performed at the Naka site, proving that no accidents happened during the road transportation from Yokohama to Naka, before returning the responsibility for the components from Japan to Europe.

After this long journey, the installation of the SCMPS components finally started on 4 July 2016. It is foreseen to be completed by the end of September 2016.

Figure 4: Lifting the EF PS boxes into the rectifier building

Figure 5: Group picture taken in front of the SCMPS boxes in the rectifier building

Figure 6: SCMPS reception and box inspection process at the port of entry (clockwise – arrival at Yokohama port, unloading from the containers, inspection, unpacking)

News

VVTS assembly progress with improved jig

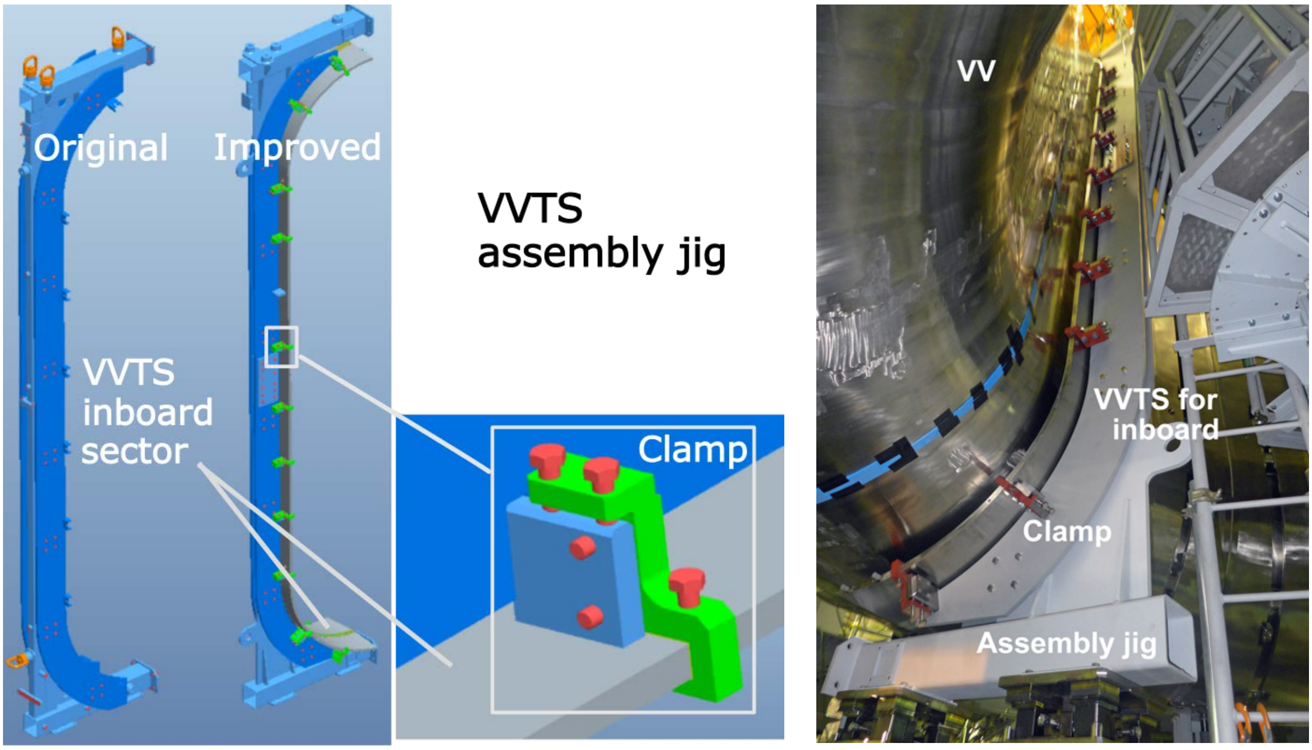

Figure 1: Old and new assembly jigs (left), the clamp (centre), and the inboard VVTS sector #11 assembled with the improved jig (right)

Following the successful mounting of 3 sets of 20° vacuum vessel thermal shield (VVTS) sectors (#14, #13 and #12) around the 340° vacuum vessel (VV), 3 sets of assembly jigs for the inboard VVTS were newly developed in order to proceed with the work more efficiently.

Each jig has a total of 22 clamps (11 pairs) on both sides. The clamps fix the inboard sector tightly onto the jig so that the sector keeps its shape during its installation (Figure 1). The improved jig has been employed since the assembly of the subsequent sector (#11) started in the beginning of June 2016 (Figure 1 right and Figure 2).

A total of 8 VVTS sets (from #14 down to #7) has been mounted so far.

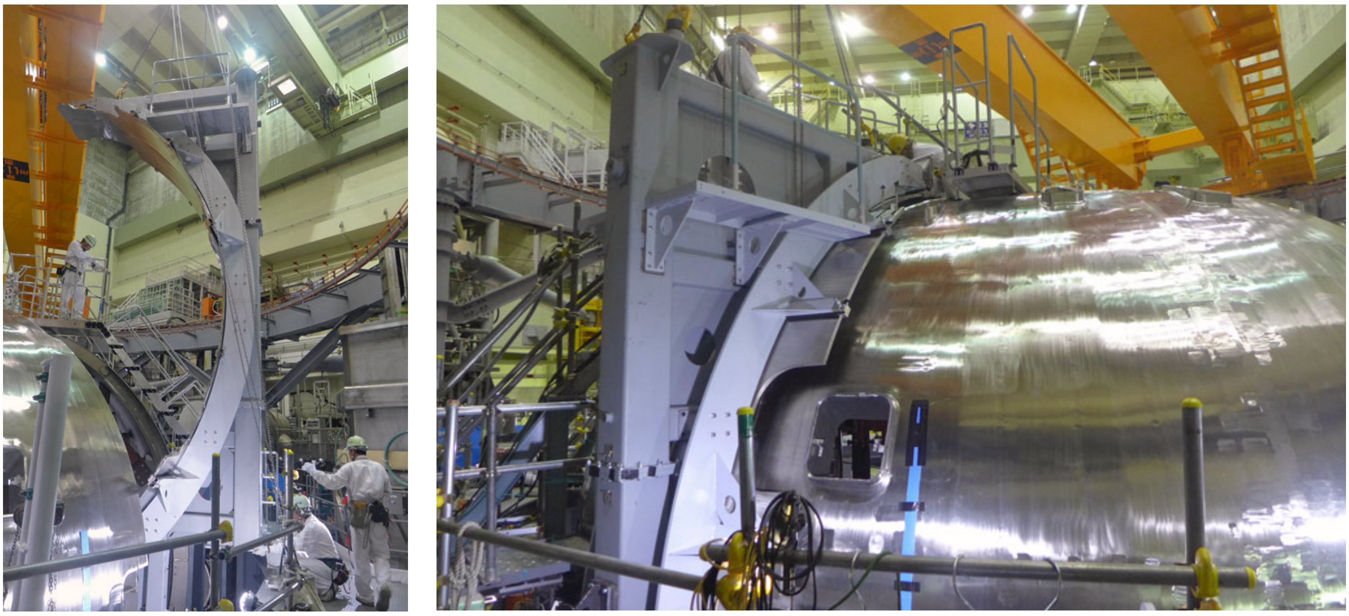

Figure 2: Installing the outboard VVTS sector #11

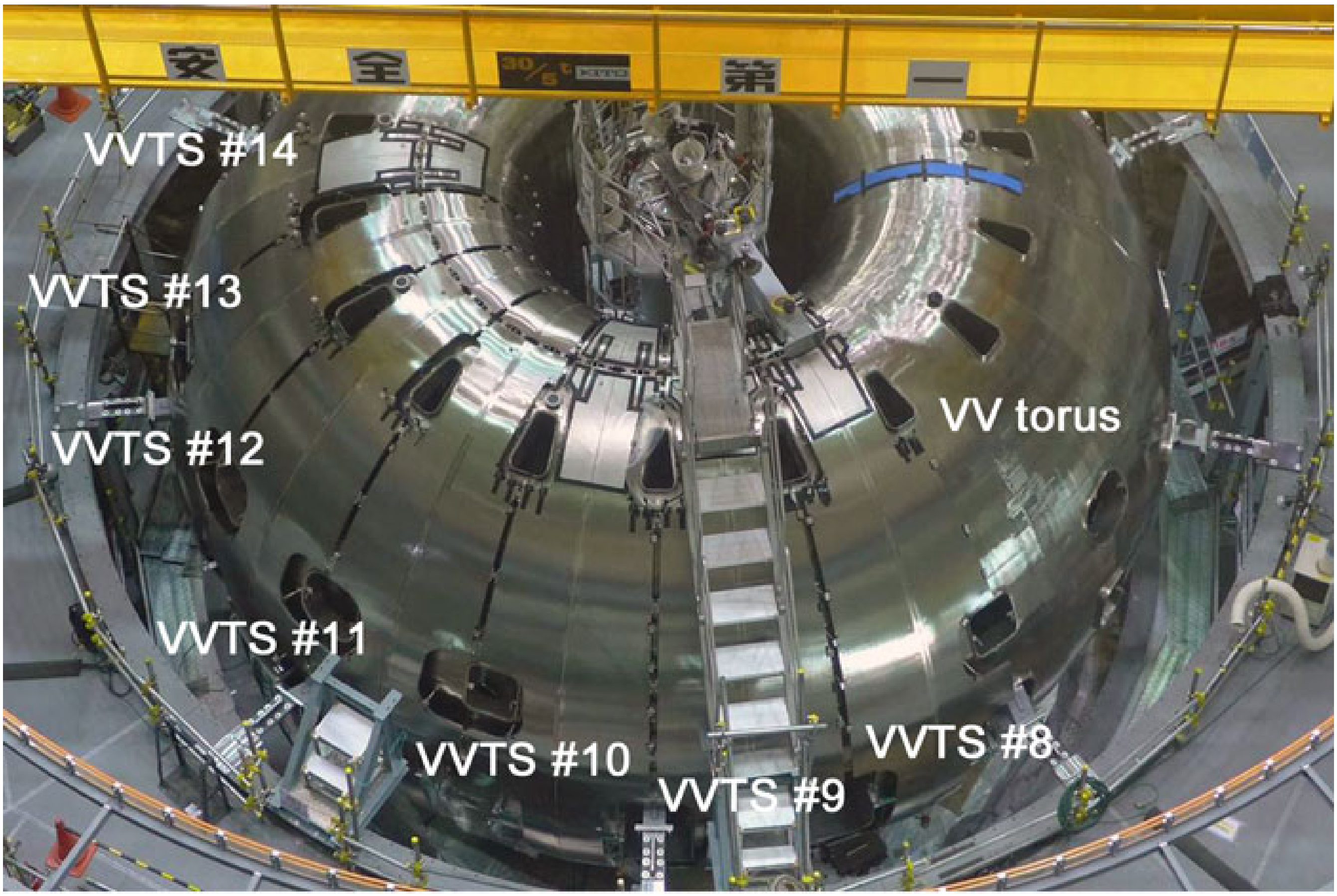

Figure 3: View of the 340° torus after 7 VVTSs (#8 - #14) mounted

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News

Factory acceptance of first GSs for magnet system

Figure 1: First 2 GS sets

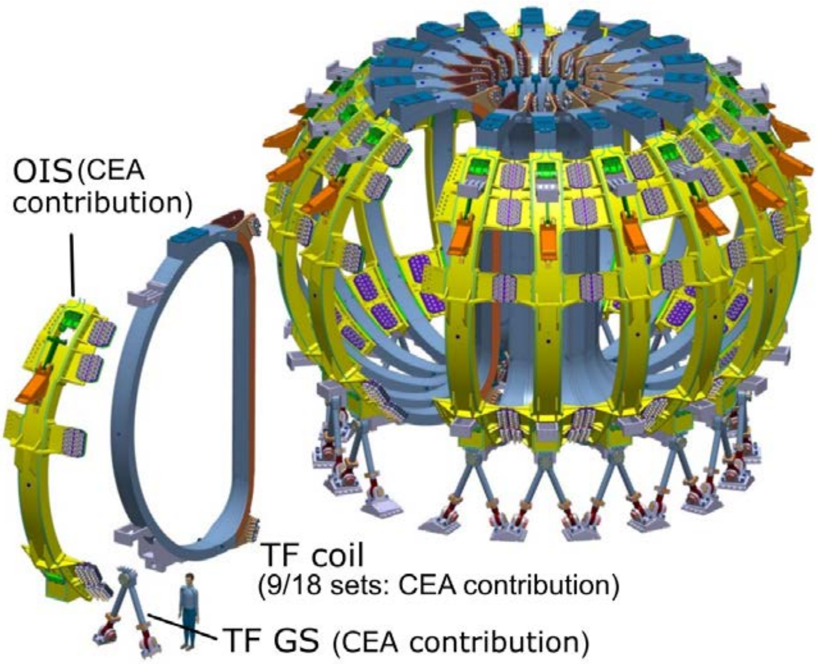


Figure 2: Final assembly of the TF magnet system with 18 sets of TF coil (blue), GS (violet) and OIS (yellow)

On 25 May 2016, CEA and F4E jointly accepted the first 2 sets of gravity supports (GSs) for the superconducting magnet system, manufactured by Alsyom in Tarbes, Hautes-Pyrénées, France (Figure 1). A whole day was devoted to a careful review of the components and associated Acceptance Data Package.

The 18 GSs vertically and toroidally support the complete magnet system, including the toroidal field (TF) coils and their outer intercoil structures (OISs), the equilibrium field coils and the central solenoid (Figure 2). The mechanical loads arising from gravity, seismic events and plasma disruptions have been considered in the component design.

Each GS has 3 bearings to allow the entire magnet system to move slightly in the radial direction during cooldown and magnet energisation. The bearings were designed to work at cryogenic temperature. They were manufactured by a German company, RWG Germany GmbH, and delivered to Alsyom for assembly at the beginning of 2015.

Besides being made from hollow tubes, the GS has a thermal collar, which is made of pure copper and plated with silver, at each GS leg. This is equipped at a given position along the length of each leg to provide 77 K heat extraction to reduce the heat load on the coil. Indeed, the upper part of the GS is at 4.5 K, whereas the lower part is at 240 K approximately.

The welding and weld inspection processes for the 25 mm thick walled stainless steel tubes were carefully developed with the help of well-known, highly skilled companies, such as Probeam (Germany) for the electron beam welding to the lower welds, SEIV (France) for the upper welds, and Institut de Soudure (France) for the development of an accurate ultrasonic control process for the TIG/MAG welds (upper welds).

The final machining of the “V structure” was successfully performed, and it achieved the prescribed mechanical tolerances. Then, the spherical bearings (manufactured by RWG) were assembled with other components machined by Alsyom. Such components included the thermal collar, and the support clevises to anchor the magnet system onto the cryostat base.

Manufacturing of the 16 remaining GSs has recently been completed. The whole set of GSs will be ready for shipment to Japan this summer.

Figure 3: 4 sets of GS already completed

Figure 4: GS being craned and inserted into its package

News

EFCC fabrication status

Figure 1: EFCC after its vacuum impregnation

Figure 2: EFCC in the ground insulation overwrapping

Figure 3: Vacuum chamber for vacuum impregnation

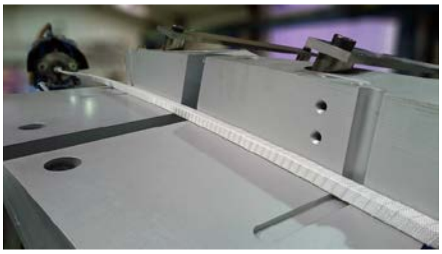


Figure 4: EFCC winding

The error field correction coils (EFCCs) are being manufactured by Tesla Engineer Ltd. in the UK under a contract with QST concluded in November 2014.

Their manufacturing consists of several processes, i.e., winding, ground insulation wrapping, vacuum impregnation and assembly. As of 18 July 2016, 8 coils (out of 18 coils in total) were in production simultaneously; 5 coils had already finished vacuum impregnation (Figure 1), each of the remaining 3 coils was in the vacuum impregnation (Figure 3), ground insulation wrapping (Figure 2), and winding process (Figure 4). QST approved the production and test documents of the assembly process in the middle of July 2016. Accordingly, the coil assembly is starting soon.

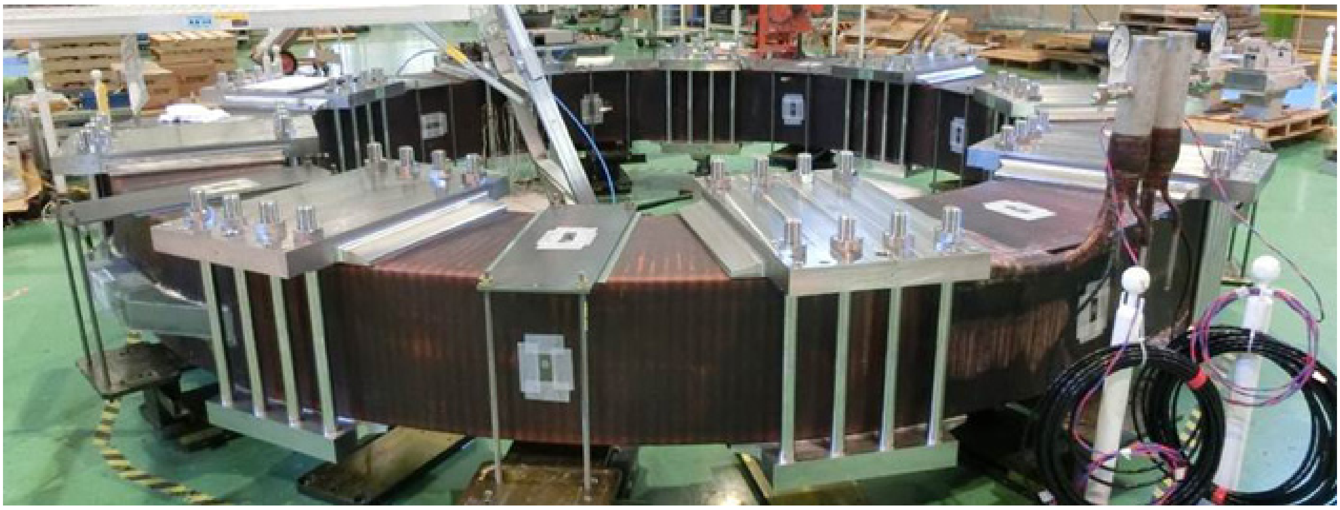
The EFCC fabrication is steadily progressing toward the completion and delivery of all 18 coils, which are planned in December 2016 and early 2017 respectively.

News

EF1 - 3 manufacturing status

EF1 coil

EF2 coil



EF3 coil

The EF1, EF2 and EF3 equilibrium field (EF) coils manufacture is proceeding smoothly. The figures above and the corresponding text below show the latest progress.

- EF1 coil:
  Following the taping for ground insulation, the final curing (resin impregnation) of the winding pack (WP) was finished on 9 June 2016. The support structure (clamps) for the cooling pipes was then installed, and the pipework is now being installed.
- EF2 coil:
  The WP was completed and its pipework finished as well - that is, the EF2 coil has been completed. Currently, the acceptance tests are being performed.
- EF3 coil:
  Following taping of the ground insulation film, the WP curing was finished at the end of June 2016. The installation of its support structure is underway.

News

Development of CO_2 laser interferometer system

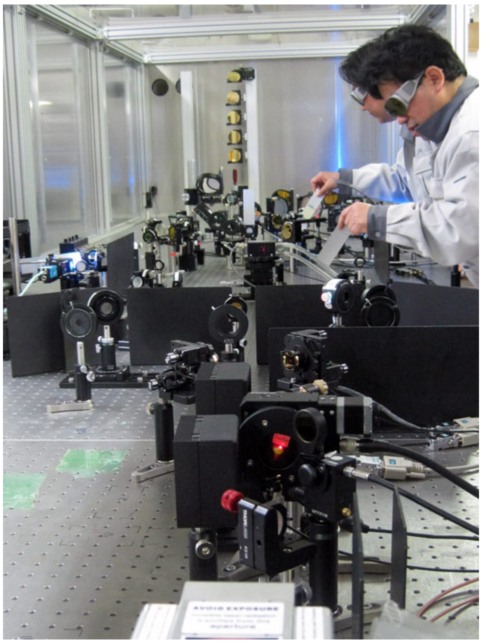


Figure 1: Adjusting the two-colour CO_2 laser interferometer system

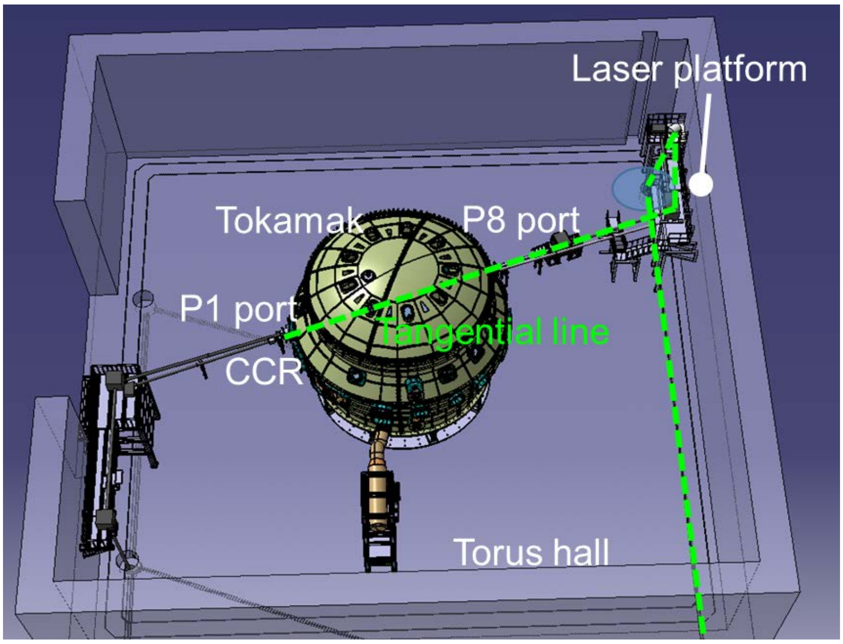


Figure 2: Laser beam path in the torus hall

It is essential for reliable operation of the JT-60SA device to measure line averaged plasma (electron) density. For this purpose, a CO_2 laser interferometer system is being developed (Figure 1). The two-colour configuration (laser wavelength: 10.6 μm and 9.3 μm) is employed for this system to eliminate the noise in the phase measurement, which is produced by mechanical vibration. Major components, including the lasers, frequency shifters, detectors, etc., are located in the dedicated laser diagnostic room, shielded against radiation and magnetic field from the tokamak. 2 laser beams are transmitted to the torus hall, then injected tangentially to the plasma from the P8 port, and reflected at a corner cube reflector (CCR) at the P1 port, and finally returned to the laser diagnostic room (Figure 2). Therefore, the laser beams must be controlled stably in real time and precisely along the long-distance transmission path (about 210 m).

In 2015, the primary CO_2 laser (wavelength: 10.6 μm, power: 50W) was installed and a single-colour interferometer with the laser was set up. It was confirmed with a CO_2 laser spectral profile monitor (Figure 3) that the laser power and wavelength remained stable for more than 3 hours. This monitor can measure the spectral beam image of every wavelength line in order to detect the wavelength hopping and multiple transverse mode of multiline lasers. It was also demonstrated that the beam axis remained stable with an angle resolution of < 20 μrad. The deviation in the phase measurement with the single-colour interferometer was 0.5% of the one expected for the JT-60SA plasma (about ~2200°) for the averaged time of 5 μs. This result is promising for the achievement of the target resolution of 1% for the line averaged electron density measurement with the two-colour interferometer.

In 2016, the secondary laser (wavelength: 9.3 μm) and other optical components will be installed in order to carry out a test as a two-colour interferometer. In 2017, the laser transmission line will be built in the torus hall. In 2018, the CCR and vacuum windows will be installed and the two-colour CO_2 laser interferometer system will be ready for the system commissioning.

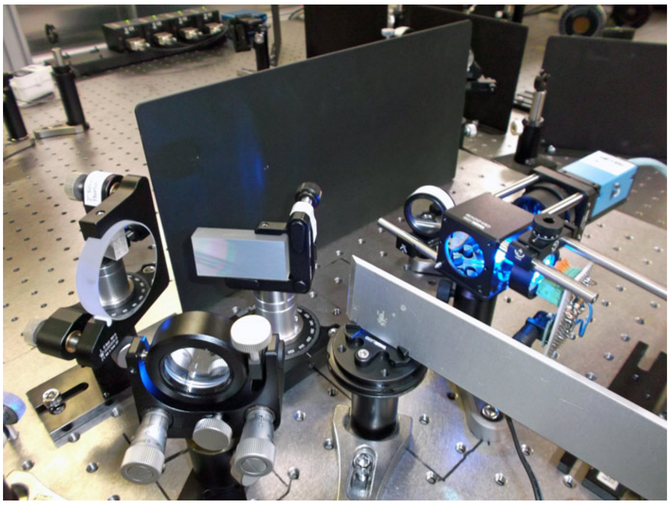


Figure 3: CO_2 laser spectral profile monitor to detect mode hopping of multiline laser (patent pending)

News

Success in repeated gyrotron oscillation for ECR discharge cleaning

Frequency	Power	Pulse length	Interval	Duty cycle	Number of pulses	Total duration	Sum of output energy
110GHz	1 MW	~1 s	60 s	1/60	30	~30 min	30 MJ
		~0.5 s	30 s		60		
		~0.3 s	20 s		90		
82GHz	1 MW	~1 s	100 s	1/100	3	~200 s	3 MJ
		~0.2 s	20 s		12	~220 s	2.4 MJ

In a conventional tokamak like JT-60U, "Taylor discharge cleaning" has been widely utilized, in which a short-pulse tokamak plasma was created by rapidly changing the currents in the central solenoid coils. However, in a superconducting tokamak like JT-60SA, this method is not possible because the change rate of coil currents is very limited. Wall cleaning using millimetre waves is expected to be an alternative method, but this method is not so common in existing tokamaks.

Short-pulse operation at 110 GHz and 82 GHz of a multi-frequency gyrotron and existing power supplies (PSs) of the electron cyclotron range of frequency (ECRF) system was performed to check this capability, as summarized in the above table. Much attention was paid to certain semiconductors in the PS because they heat up quickly during the repeated on/off operations. Attention was also paid to the temperature increase of the components inside the gyrotron caused by "stray power" (millimetre wave power not output from the gyrotron) particularly at 82 GHz output because the stray power is much larger for such operation because this gyrotron is not optimized for millimetre output at this frequency.

The successful results of pulse length, duty cycle, and duration, indicated in the table are promising for wall cleaning using the millimetre waves in JT-60SA. The 110 GHz millimetre waves are suitable for wall cleaning at a toroidal field of 1.7 T, at which the injected millimetre waves are absorbed at the centre of the vacuum vessel. Wall cleaning by 138 GHz waves, which are suitable for 2.3 T, will be available using this gyrotron, considering the previous successful results on 1 MW output for 100 s at this frequency. The result of the 82 GHz output is noteworthy because wall cleaning by first harmonic waves, whose efficiency is reported to be higher than second harmonic waves, will also be possible in JT-60SA.

Calendar

21 – 25 August 2016
22nd Topical Meeting on the Technology of Fusion Energy (TOFE 2016)
Philadelphia, USA

5 – 9 September 2016
29th Symposium on Fusion Technology (SOFT 2016)
Prague, Czech Republic

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

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/.