JT-60SA Magnet System Status

Sam Davis
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Contents

• What is JT-60SA?

• Magnet system overview

• Coil design and manufacturing

• Electrical testing

• Installation
What is JT-60SA?

- Fully superconducting JET-sized tokamak using existing JT-60U infrastructure at Naka, in particular the beams and the building
- Focused on developing “advanced” plasma scenarios relevant to achieving fusion conditions in a power plant, i.e. operational modes in which
  - plasma current is driven by means other than induction
  - the ratio between plasma pressure and the confining toroidal field is high
  - plasma conditions and plasma-wall interactions are achieved for durations relevant to steady-state operation.

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<tr>
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<th>JET</th>
<th>JT-60SA</th>
<th>ITER</th>
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<tbody>
<tr>
<td>Major radius</td>
<td>2.96 m</td>
<td>2.96 m</td>
<td>6.21 m</td>
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<tr>
<td>Minor radius</td>
<td>1.25 m</td>
<td>1.18 m</td>
<td>2 m</td>
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<tr>
<td>Plasma current</td>
<td>4.8 MA</td>
<td>5.5 MA</td>
<td>15 MA</td>
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<tr>
<td>Plasma volume</td>
<td>100 m³</td>
<td>135 m³</td>
<td>840 m³</td>
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<tr>
<td>Toroidal field</td>
<td>4 T</td>
<td>2.25 T</td>
<td>6 T</td>
</tr>
<tr>
<td>Plasma</td>
<td>Now</td>
<td>2020</td>
<td>2025</td>
</tr>
<tr>
<td>Flat top</td>
<td>20 s</td>
<td>100 s</td>
<td>3000 s</td>
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<tr>
<td>H&amp;CD power</td>
<td>44 MW</td>
<td>41 MW</td>
<td>73 MW</td>
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</table>
A single Toroidal Field (TF) coil
TF coil with Outer Intercoil Structure (OIS)
18 TF coils and OISs
TF magnet with bolts and pins
TF magnet with gravity supports
TF magnet with Equilibrium Field coils and Central Solenoid
Equilibrium Field coils and Central Solenoid
EF coil manufacturing and installation

EF 1, 2, 5 & 6
NbTi, 20kA
Peak field 4.8T

EF 3 & 4
NbTi, 20kA
Peak field 6.2T
CS manufacturing: wind & react

CS modules 1 - 4
Nb₃Sn, 20kA
Peak field 8.9T

27.9mm
CS manufacturing
18 TF coils
NbTi, 25.7kA
Peak field 5.65T
TF coil test facility
TF coil transport and assembly
TF magnet assembly
TF magnet assembly
TF magnet assembly
TF magnet assembly
11 TF coils assembled so far

1st coil: "Annie"
2nd coil: "Brigitte"
3rd coil: "Roberta"
4th coil: "Cécile"
5th coil: "Eleonora"
6th coil: "Danièle"
7th coil: "Emmanuelle"
8th coil: "Sofia"
9th coil: "Giaele"
10th coil: "Fanny"
11th coil: "Valeria"
TF coil positioning
TF coil positioning

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<tr>
<th>Casing tracking point</th>
<th>B</th>
<th>A</th>
<th>G</th>
<th>H</th>
<th>C</th>
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</thead>
</table>
| Coil position 3 
(11th installed, no. 6) | x 0.1 0.1 0.8 -0.4 0.4 0.1 | y -0.2 0.4 -0.9 -0.5 -0.4 0.1 | z 2.3 0.5 1.4 0.7 0.6 0.3 | 1.1 0.6 1.6 0.7 0.5 0.3 |
| Coil position 4 
(9th installed, no. 5) | x -0.1 -1.0 -0.1 -0.4 0.1 -0.3 | y -2.0 -0.3 -0.1 0.0 0.3 0.1 | z 0.0 0.7 0.2 0.3 0.6 0.4 | 0.7 0.5 0.9 0.3 0.3 0.3 |
| Coil position 5 
(7th installed, no. 14) | x 0.4 -0.6 -0.3 -0.6 -0.5 0.3 | y 1.3 1.5 1.8 1.5 1.3 1.5 | z 0.0 0.3 -0.4 0.0 0.4 0.3 | 0.3 1.6 1.2 0.3 0.3 0.3 |
| Coil position 6 
(4th installed, no. 3) | x -0.2 0.8 0.4 0.4 0.2 0.4 | y 0.3 0.7 0.6 0.7 0.3 0.4 | z 0.1 0.5 0.0 0.0 0.5 0.5 | 0.3 1.2 1.3 0.3 0.3 0.3 |
| Coil position 7 
(3rd installed, no. 1) | x 0.0 0.3 0.0 0.0 0.0 0.0 | y -0.1 -0.4 -0.1 -0.4 -0.1 -0.4 | z 0.1 0.5 0.0 0.0 0.5 0.5 | 0.3 0.3 0.3 0.3 0.3 0.3 |
| Coil position 8 
(1st installed, no. 10) | x 0.5 0.5 0.5 0.5 0.5 0.5 | y 2.8 2.8 2.8 2.8 2.8 2.8 | z 1.1 1.1 1.1 1.1 1.1 1.1 | 1.1 1.1 1.1 1.1 1.1 1.1 |
| Coil position 9 
(2nd installed, no. 11) | x 0.2 0.4 0.2 0.2 0.2 0.2 | y 2.0 2.0 2.0 2.0 2.0 2.0 | z 0.6 0.6 0.6 0.6 0.6 0.6 | 0.6 0.6 0.6 0.6 0.6 0.6 |
| Coil position 10 
(5th installed, no. 12) | x 0.3 0.2 0.3 0.2 0.3 0.2 | y 2.1 2.1 2.1 2.1 2.1 2.1 | z 1.2 1.2 1.2 1.2 1.2 1.2 | 0.8 0.8 0.8 0.8 0.8 0.8 |
| Coil position 11 
(6th installed, no. 13) | x 0.3 0.3 0.3 0.3 0.3 0.3 | y 1.0 1.0 1.0 1.0 1.0 1.0 | z 0.4 0.4 0.4 0.4 0.4 0.4 | 1.7 1.7 1.7 1.7 1.7 1.7 |
| Coil position 12 
(8th installed, no. 4) | x 0.3 0.3 0.3 0.3 0.3 0.3 | y 2.1 2.1 2.1 2.1 2.1 2.1 | z 0.6 0.6 0.6 0.6 0.6 0.6 | 0.8 0.8 0.8 0.8 0.8 0.8 |
| Coil position 13 
(10th installed, no. 15) | x -0.1 0.1 -0.1 0.1 0.1 0.1 | y 2.8 2.8 2.8 2.8 2.8 2.8 | z 1.3 1.3 1.3 1.3 1.3 1.3 | 1.4 1.4 1.4 1.4 1.4 1.4 |
Inner Intercoil Structures (IIS)
OIS splice plate installation
Error field correction coils
Conclusion

- Manufacturing of the equilibrium field coils and the error field correction coils is complete.
- Manufacturing of the toroidal field coils and the central solenoid is well advanced.
- Assembly of the TF magnet is underway and will be completed in the first half of 2018.
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<td>On a full 3D thermal structural Finite Element Model of the JT-60SA toroidal field coils</td>
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