

Performance of JT-60SA Superconducting Magnet Operation in Integrated Commissioning Test

K. Tsuchiya¹, H. Murakami¹, K. Usui¹, Y. Kashiwa¹, M. Sato¹, H. Ichige¹, K. Kawano¹, Y. Onishi¹,
K. Fukui¹, K. Hamada¹, G. Matsunaga¹, K. Takahashi¹ and JT-60SA operation team¹,
S. Davis², M. Wanner², V. Tomarchio², L. Zani², G. Phillips², C. Hoa³, I. Abe³, A. Louzguiti³

QST¹, F4E², ITER Organization³

tsuchiya.katsuhiko@qst.go.jp



ABSTRACT

- In JT-60SA, the 1st plasma was successfully produced, and MA-class plasmas were also successfully operated in 2023.
- Aiming to OP-2 from 2026, several improvements are in progress for the purpose of the safe operation of the magnet system.

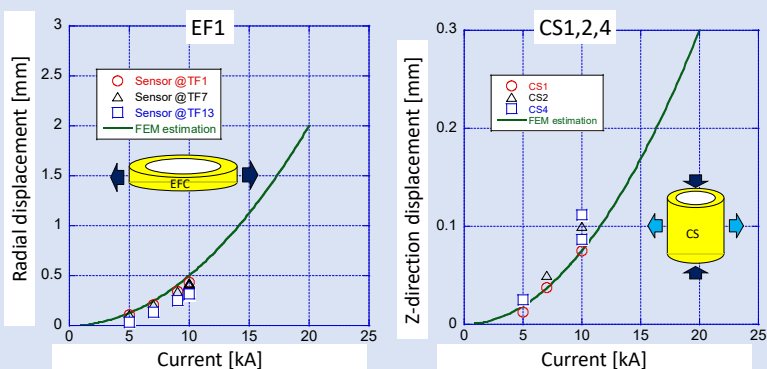
BACKGROUND

- In 2020, 1st cool-down and commissioning was started :
 - TF coil successfully operated with the nominal current (25.7kA).
 - In March 2021, EF1 short-circuit incident occurred.
 - => Insulation reinforcement (mainly terminal part) and HV tests were done.
 - OP-1 from the summer of 2023 :
 - MA-class plasma (maximum $I_p=1.2\text{MA}$) was successfully operated.
 - PF coil current was still limited. (< 5kA)
- In the next series (OP-2), PF coil must be operated with the nominal operation, 20kA.

RESULTS OF COIL ENERGIZATION IN OP-1

COMMISSIONING TEST (SINGLE COIL ENERGIZATION)

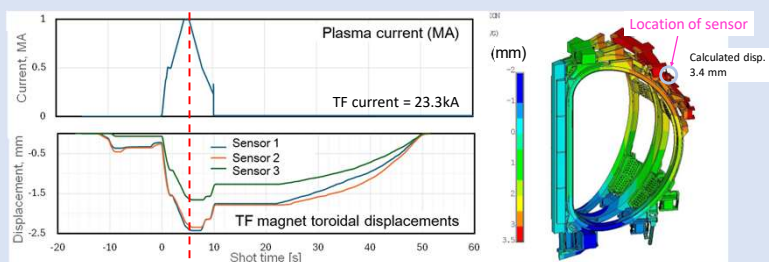
In the single coil energization tests, TF coil was successfully operated with nominal current (25.7kA) [1], and PF coils were operated up to 10kA.



Radial reformation of EF1 and CS module vs. the operation current

PLASMA OPERATION

In the plasma operation, Toroidal (out-of-plane) displacement of TF coils induced by over-turning force was measured due to the mixture energization of TF and PF coils.



Out-of-plane displacement of TF coil measured in a MA-class plasma shot and the evaluated deformation at the timing of EOF (denoted by dotted line).

RESULT ON OP-1

Measured deformations of TF and PF coils were consistent of the design. There were no problems with the mechanical stiffness of the magnet system.

ISSUES TO BE SOLVED FOR OP-2

1. Improvement of magnet withstand voltage capability

- Insulation reinforcement
- reduction of CS dump resistor of fast discharge unit.
- PS spike noise reduction (K. Yamauchi et al. Poster 7 #3043)

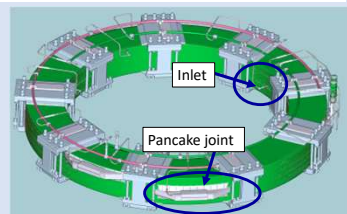
2. Noise reduction on the quench detection system

3. Enhancement of vacuum monitoring system

Installation of vacuum sensor to detect degradation of vacuum to avoid Paschen discharge. (H. Kayano et al. Poster 6 #2835)

1. Insulation reinforcement

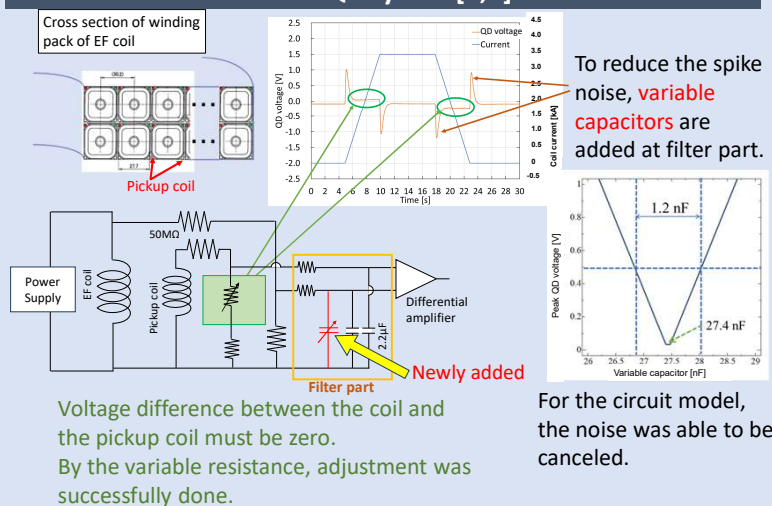
After OP-1, additional insulation enhancement is proceeded. After the work for each location, it was confirmed that the target has enough performance of insulation by the Paschen test in 7kV DC.



Targets of insulation reinforcement on an EF coil and examples of the reinforced parts



2. Noise reduction on the QD system[2,3]



CONCLUSION

- In OP-1, The first plasma in JT-60SA was successfully achieved, and most of PF coils was successfully operated with 10kA in maximum.
- It was confirmed that there were no problem in terms of the mechanical stiffness of TF and PF coils.
- Aiming to the nominal current (20kA) operation for PF coils, the issues were tried to be solved.
- These actions will contribute to the plasma operation in OP-2.

ACKNOWLEDGEMENTS / REFERENCES

JT-60SA was jointly constructed and is jointly funded and exploited under the Broader Approach Agreement between Japan and EURATOM

- [1] TOMARCHIO, V., et al., Magnet Technology (MT29) (Boston, 2025)
- [2] MURAKAMI, H., et al., Journal of Physics: Conference Series 3054 (2025) 01203
- [3] SONODA, S., et al., 17th EUCAS (Porto, 2025)