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ITER用中性子束モニタ マイクロフィッションチェンバーの開発の進展

Progress on Development of ITER Neutron Flux Monitor with Microfission Chamber System

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1. Introduction

The absolute measurement of the neutron source strength is one of most important diagnostics in a burning plasma because fusion power can be derived directly from the neutron source strength. This would be accomplished in combination of in-vessel, divertor and in-port neutron flux monitors in ITER. The Microfission chambers (MFC) system will be utilized as in-vessel neutron flux monitor and in ITER are procured by Japan Domestic Agency (JADA). The concept design of the MFC system was finished in 2010 and the detailed design is performing at the present. So, progress on development of the MFC systems is reported.

2. Outline of the Microfision Chamber [1]

The MFC is a pencil size gas counter containing fission material (^{235}U) and will be installed upper and lower outboard behind the blanket module as shown in Fig.1. Triaxial mineral insulated (MI) cables will carry signals from the MFCs to the upper port and will be connected to a soft cable outside the vacuum vessel (VV). The MFC for ITER has been developed on the basis of the in-core monitor for fission reactors. Measurement requirements for ITER MFC system are as follows,

- Total neutron flux range: ~ 10^{17} up to ~ 10^{21} n/s
- Time resolution: 1 ms
- Accuracy: 10 %*

(**This is accomplished by total neutron flux monitors [MFCs, divertor and in-port flux minitors.])*

3. Progress of the MFC system

3.1 Design of in-vessel components

Since installation time of the MFC (with short MI cable) and the MI cable is different, connection procedure of the MI cables is necessary. In this work, compact jig for MI cable connection was designed and also detail procedure of the MI cable connection was designed. Further, in order to fix the MFC detector and the MI cable in the limited space between the blanket module and the VV (< 25 mm), compact support structure of the MFC (~ 20 mm) and clamps for the MI cable (height of ~ 11 mm) were designed together those welding method.

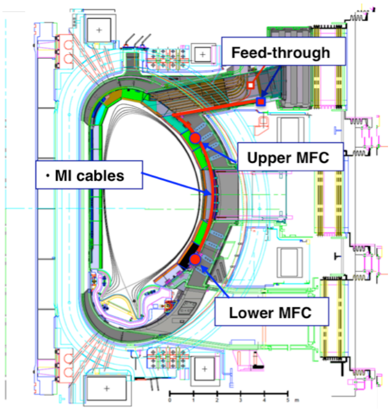

Fig.1 installation position of the MFC

3.2 Tests

a) Signal noise test of the signal transmission system.

Though the signal transmission system of the MFC is affected by effects of various noises, the MFC system has to withstand for those effects. So, electromagnetic noise test for signal transmission system of the MFC was performed. The test was based on procedures standardized by the International Eletcrotechnical Commission (IEC) under the EMC Directive [IEC/EN 61000-4-3]. As a results, it was demonstrated the signal transmission system have enough tolerance for noise standardized by IEC under the EMC Directive

b) Thermal cycle test of the MI cable

MI cable will experience repeated fluctuations in temperature due to nuclear heating from radiation associated with its operation cycle. Since the welds and brazed parts will be subjected to thermal stress, things such as loss of a hermetic seal, insulation resistance degradation, etc., are expected from thermal cycling during actual operation. So, thermal cycle tests for the MI cable was performed. Length and bending structures of the MI cable was simulated for actual installation and more than 10 thermal cycles (50°⇔250°) were exposed to the MI cable. Structural soundness verification test of the MI cable after the thermal cycles showed the MI cable had no damage. Then it is demostrated that the MI cable can withstand for thermal condition in ITER.

4. Summary

During detail design activities, not only designs and tests described above but also various analyses (EM, thermal, fatigue, etc.) have been performed. So, detail results of these detail design activities are presented.

1. Ishikawa, et al., J. Plasma Fusion Res. SERIES, **8**, 334 (2009).

* *The views and opinions expressed herein do not necessarily reflect those of the ITER Organization.*