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Nuclear Fusion Research Activities at KAERI

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1. Introduction

Nuclear fusion is considered to be a next generation clean and sustainable energy due to its inherent safety and abundant fuel resource. In this context, ITER has been built to resolve the scientific and technological issues remained for the ignition at Cadarache in France since 2006 [1, 2]. Korea has joined the ITER project and contributed to ITER construction and understanding of plasma physics through KSTAR (Korea Super Conducting Tokamak Advanced Research) [3].

KAERI has much experience on fusion plasmas through KT-1 development and KT-2 planning since 1983. After that we have participated the KSTAR and ITER projects in various fields. In the present paper, these activities at KAERI, especially for Fusion Nuclear Engineering Development Division were introduced.

2. KT-1 construction and KT-2 planning

KT-1 had been built since 1983 and it is operated until 1996. It is a first tokamak controlled in Korea. The major radius is 0.27m, and mirnor radius is 0.05m. The toroidal magnetic field 2.6 T and 15 kA plasma current is achieved. The plasma current of 4 kA is maintained during about 20 msec by using feed back current control as shown in Fig. 1.

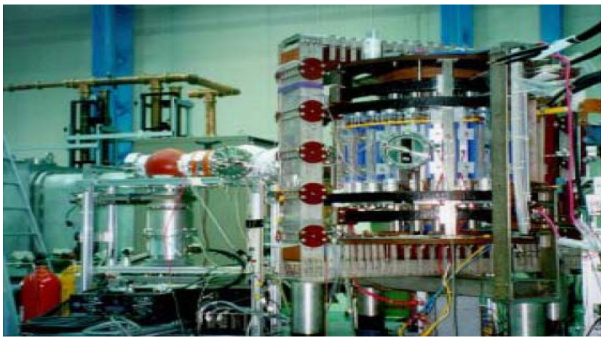

Fig. 1 Constructed KT-1

The experiment and experience becomes the basis of KT-2 planning and it also has contributed the KSTAR construction. KT-2 was planned to provide the technical baseline necessary to maintain fusion as a realistic option for future energy sources and have a means to contribute to the international fusion research.

The main features of KT-2 are as follow;

Normal conductor(B0=3T)

Medium-szied(R =1.4m)

Large aspect ratio (5.6)

High bootstrap current (≥50%)

Intensive RF heating and current drive (5 MW)

3. Research & Development on KSTAR heating system

We have participated in KSTAR construction and operation using the lessons from the former tokamaks [4-6] with focus on tokamak heating and current drive devices such as ICRF and NB since 1996. It provided KSTAR heating power up to 6MW at present time. Especially, NB contributed to achievement of long-pulse stable H-mode during 40 sec at KSTAR [7]. It will enable KSTAR to achieve high beta long pulse advanced operation with power upgrade up to 10 MW in near future.

The NBTS(neutral beam test facility) had been constructed. (110kV, 70A acceleration p/s, 3MW cooling capability, CW) as shown in Fig. 2. Three KSTAR NBI ion sources have been developed. (100keV, 50A D+ beam, 2MW neutral deuterium beam power). It contributed the long pulse operation of more than 40 seconds in KSTAR 2014 campaign.

Fig. 2 NB test facility at KAERI

ICRF heating and current drive system has been developed to provide 2MW power for KSTAR high beta long pulse operation. (Frequency= 20~60 MHz at Bt =2~3). Installation was completed in 2007 and it was upgraded continuously to increase the coupled power together with fast particle diagnostics to confirm the RF ion heating as shown in Fig. 3. 1 MW power was coupled to plasmas in 2014 KSTAR campaign

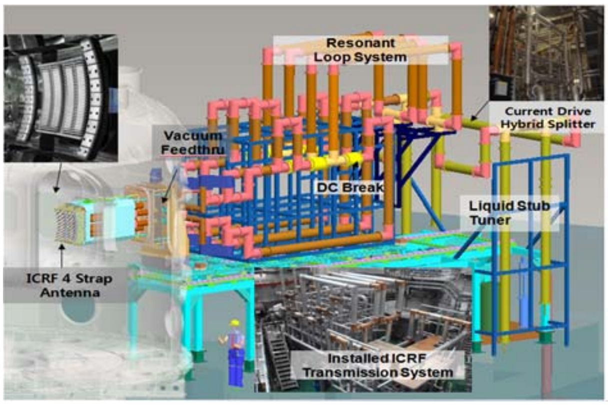

Fig. 3 Perspective of ICRF system for KSTAR

4. NB and RF H & CD for advanced tokamak study

Spherical Torus has been researched as a commercial advanced fusion reactor around world [8] and VEST(Vesatile Experiment Spherical Torus) has been built and researched at SNU(Seoul National University) since 2008 [9]. KAERI is cooperating with SNU for the high beta steady-state operation of VEST by developing 600 kW NB power and novel RF current drive concept based on the utilities and technologies accumulated through ICRF and NB development through KSTAR construction.

5. Research & Development on ITER Test Blanket Module

To extract heat from fusion neutron and generate electricity, breeding blanket should be developed. KAERI has much infrastructure and experience to handle neutrons and generate electricity through the R&D of several types of commercial nuclear fission reactor and next generation reactor for last six decades. Based on the high technology for neutrons and electric generation, KAERI is participating in ITER project by providing TBM(Test Blanket Module) since 2006 as shown in Fig 4. At present time, TBM is focusing on the development of high heat-flux endurable structure material and fabrication technology, tritium breeding and extraction for tritium self-sufficiency, and heat transport system for electricity generation [10].

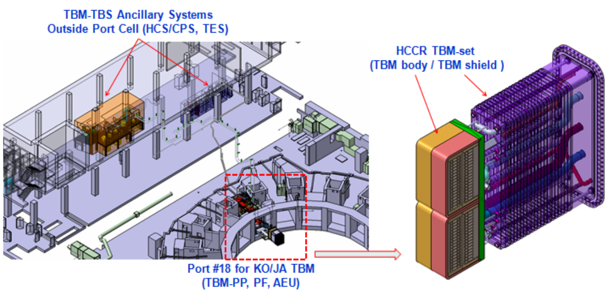

Fig. 4 Port # 18 in ITER and TBM-set

6. Conclusions

KAERI has contributed to the development of fusion energy during last three decades and will continue core R&Ds for the clean and sustainable future fusion energy.

Acknowledgments

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