

## Planning and Progress on the Fusion Neutron Sources Development at KAERI for Fusion and Fission Application

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### 1. Introduction

Fusion energy in Korea has been developed based on the “Fusion Energy Development Promotion Law” since March 2007. According to the Law, National Fusion R&D Master Plan was modified every 5 years and new Master Plan was established on 2016 and 3rd 5-yr plan started from 2017, as shown in Fig. 1. The following 3 major R&Ds are on-going with each objective;

- ✓ KSTAR for plasma physics and advanced scenario development
- ✓ ITER for burning plasma, fusion engineering, and international collaboration
- ✓ DEMO construction by the 2041 for Fusion Power Plant

However, large scale volumetric fusion neutron source (temporarily called, V-FNS) are newly proposed for complimenting the plan & gap between ITER and DEMO, for the integral tritium breeding/handling (beyond ITER TBM), and for component test which will be used in DEMO engineering, as shown in Fig. 2; Fusion Nuclear Science Facility (FNSF) in USA, Component Test Facility (CTF) in EU, and Chinese Fusion Engineering Test Reactor (CFETR) in China are introduced from a few years ago in the world.

In order to cope with the needs, Korea Atomic Energy Research Institute (KAERI) established the own plan and started projects for implementing the V-FNS development. In this paper, the plan and the current activities for developing the FNS are introduced.

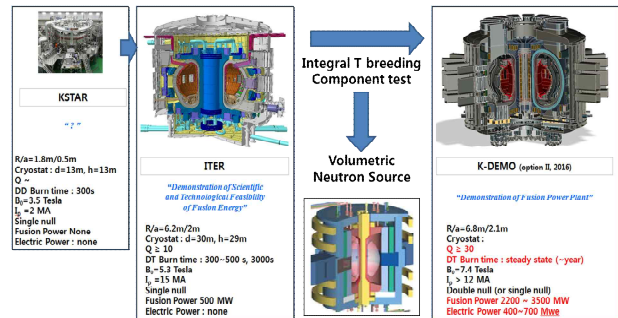


Fig. 2. Main design changes of the TBM-set in the PD phase

### 2. FNS Development Plan

We established the long- and short-term plan on the FNS for satisfying the fusion/fission needs, as shown in Fig. 3;

- (1) V-FNS for long-term needs,
- (2) Compact Fusion Neutron Source (temporarily called, C-FNS) for short-term needs, and
- (3) their application to the fission and industrial fields, which can be applied with both C- and V-FNSs

V-FNS are planned especially for considering the design, requirement for component testing, and tritium breeding and so on. Currently, spherical tokamak (ST) is one of candidate for neutron source. This tokamak heating, RF ion sources will be used for heating and its small scale one can be used in C-FNS. So, one of C-FNS, “on site compact fusion neutron source” is being developed with the RF ion source which was developed through the KSTAR heating system development by KAERI. The summarized developing procedure and results are introduced in the following section;

### 3. Current Work for developing the C-FNS

Development plan and status in the project are as follows and shown in Fig 4 for (1) to (4);

- (1) RF driver was developed: slanted-slit and water-cooled type Faraday shield was developed
- (2) RF generator fabrication and control test
- (3) Plasma generator development

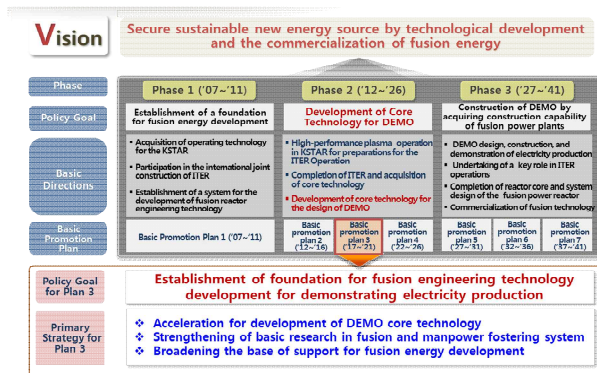


Fig. 1. National Fusion R&D Master Plan in Korea

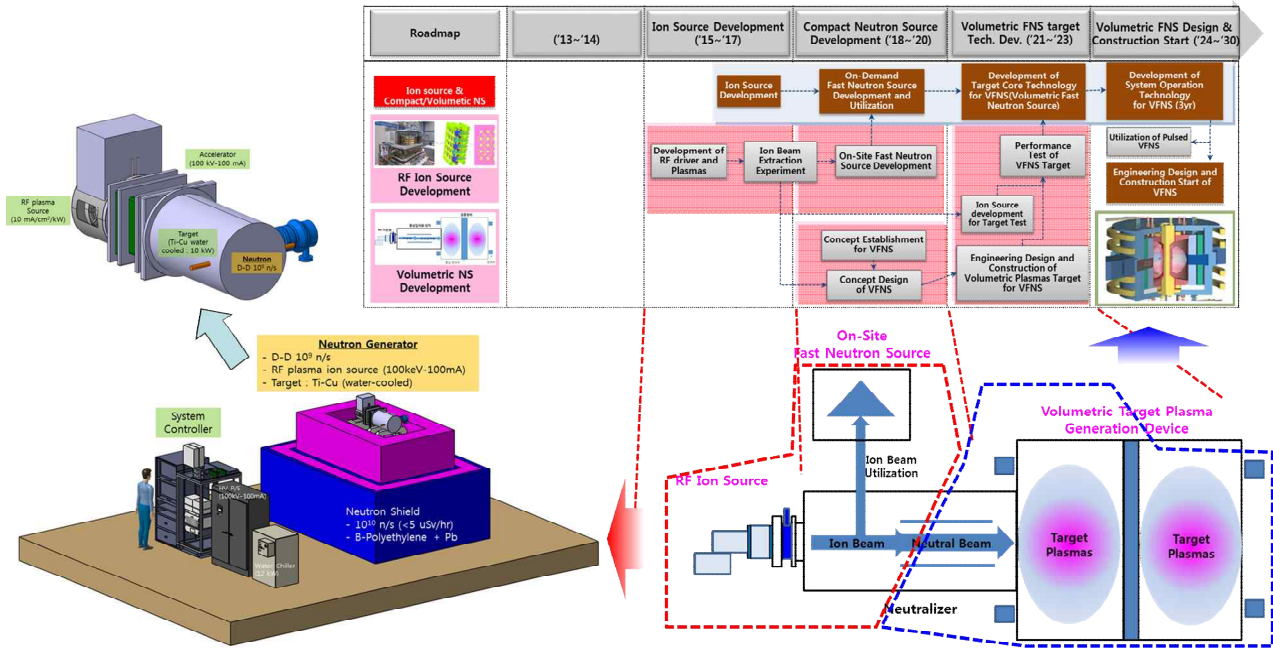


Fig. 3. Plan for C- and V-FNS

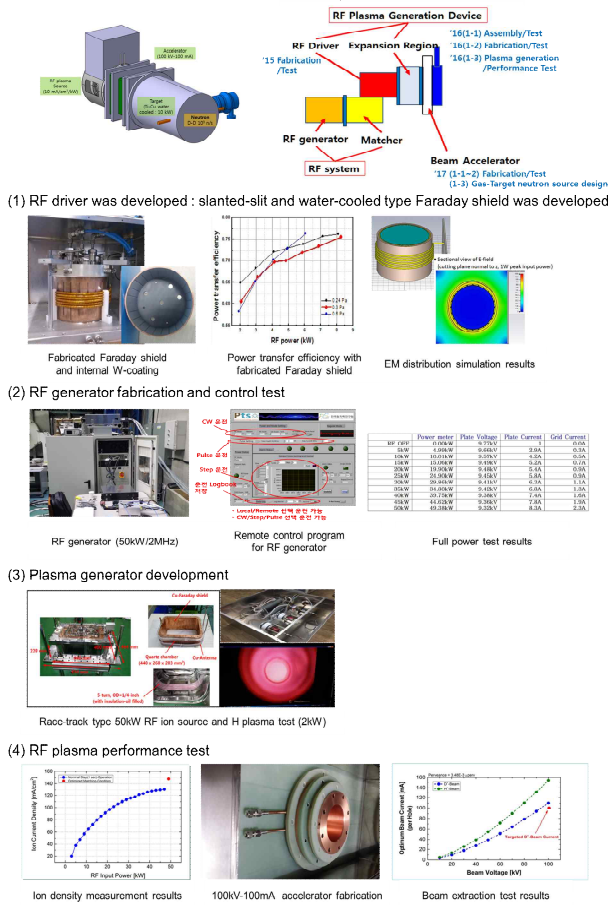


Fig. 4. RF ion source development for C-FNS

For (5), various targets were designed and first candidate was fabricated and tested with high heat flux facility. Among them, cone type target was fabricated with pure Cu including Ti coating as the first candidate, as shown in Fig. 5. Cooling scheme was evaluated and selected with slit-type one. For the high heat flux test for confirming its integrity and also the cooling capability with high heat flux test facility (KoHLT-EB at KAERI), preliminary analysis were performed and the test conditions were selected, as shown in Fig. 6; the maximum target temperatures were obtained and they were not exceeded to 200 C, which is the required temperature to absorbed Deuterium in Ti target. To compare with the experimental results were also estimated.

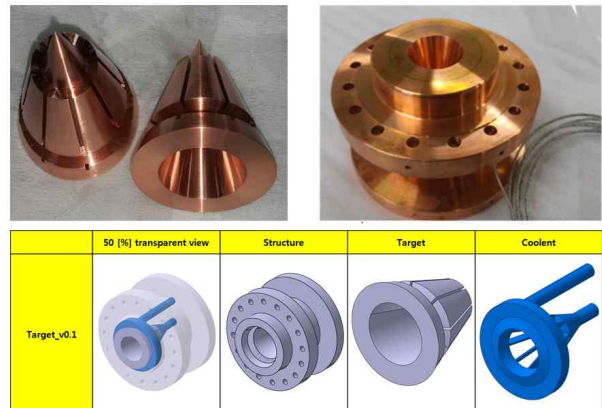


Fig. 5. Cone-shape target design, fabrication

- (4) RF plasma performance test
- (5) Various targets were designed and first candidate was fabricated and tested with high heat flux facility

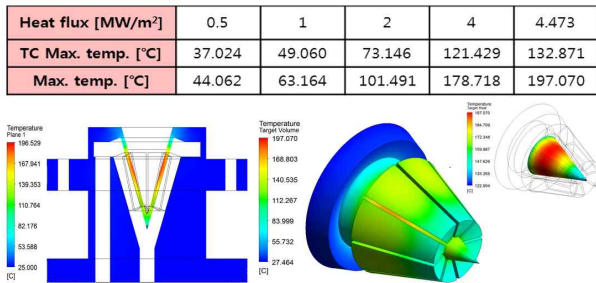


Fig. 6. Preliminary analysis results for high heat flux test of the fabricated target

#### 4. Conclusions and future works

The fusion energy road map has been updated especially to reduce the gap between ITER and DEMO in Korea; to develop the V-FNS for integral components test. KAERI have prepared the plan for developing the V-FNS and C-FNS as the base facilities for using fusion neutron in the fusion and also the fission/industrial application. For developing the C-FNS, RF ion source including RF driver/generator was developed and target has been designed, fabricated, and tested with the high heat flux test facility, KoHLT-EB at KAERI. Both components were successfully tested and on-site FNS and further V-FNS design will be prepared in detail.