§9. Development of a High Intensity He^- Beam Source for Fusion-Produced Alpha Particle Measurement

Shinto, K., Sasao, M., Kitajima, S., Okamoto, A., Sugawara, H., Takenaga, M., Takeuchi, S., Tanaka, N. (Tohoku Univ.),
Kiyama, S., Sakakita, H., Hirano, Y., Yagi, Y. (AIST),
Wada, M. (Doshisha Univ.),
Kaneko, O., Nishiura, M.

To measure the spatial profile and velocity distribution of fusion-produced alpha particles, an active beam probe system based on double-charge-exchange neutralization of the alphas confined in a reactor core plasma has been being investigated. An energetic He^0 beam produced by the spontaneous electron detachment from He^- ions is considered as the probe beam. The He^- beam is produced by the double-charge-exchange reaction of He^+ ions in the alkali metal vapor cell with the charge-exchange efficiency less than a few per cent. A high-intensity He^+ beam with a good beam quality is required to compensate the low charge-exchange efficiency. Highly convergent beam directed to the double-charge-exchange cell can create an intense He^- beam of enough brightness to diagnose the alphas in the core plasma.

A design of an energetic He^0 beam system for feasibility study of charge-exchange alpha-particle diagnostics in a thermonuclear reactor was studied and reported.[1),2)] Two programs have started to progress the active beam probe system. One is the proof-of-principle (POP) He^0 beam system being constructed at Tohoku University. The system consists of a compact multicusp He^+ beam source[3)], an alkali metal vapor cell, an ion separator with stigmatic focusing, a post-accelerator, a free flight tube and a He^0/He^* fraction diagnostic chamber. The other is the strongly-focused high-intensity He^+ beam source system, being assembled at NIFS. This source can be utilized as the first part of the actual diagnostic system for ITER. A photograph of the He^+ beam source is shown in Fig. 1. The source consists of an arc chamber of 300 mm in diameter and 280 mm in length. Three concave extraction electrodes are made of molybdenum having 100 mm diameter beam forming area. The detailed specifications of the source are listed in Table 1.

The He^+ beam diagnostics have been started at NBI test stand in NIFS in JFY 2006. R&D items of the He^+ beam source for the alpha particle measurement system are;

- He^+ beam energy and beam current density
- He^+ beam emittance and energy distribution, and
- Beam size and profile at the focal point.

The first ion source plasma has been ignited successfully, and the beam extraction experiment will be attempted in this summer. Because of the high power density of the extracted He^+ beam, particularly at the focal point (~300 MW/m^2), some of the beam diagnostic apparatuses should possess unique characteristics and designs.

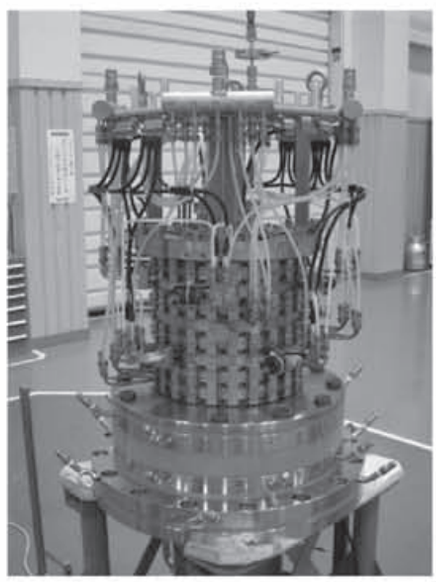

Figure 1: Photograph of a strongly focused He^+ beam source.

Table 1: Specifications of the strongly focused He^+ beam source. (Design parameters)

Arc Power	~ 40 kW
Pulse Duration	< 10 s
Pulse Reputation	< 0.01 Hz (> 120 s)
Beam Energy	< 30 keV
Beam Current	~ 3 A
Extraction Region	ϕ100 mm, Concaved
Extraction Apertures	ϕ 4 mm x 300 apertures
Beam Divergence	< 0.7 deg.
Focal Length	750 mm

References

1) Shinto, K. *et al.*, Proc. PAC05 (2005), 2630.
2) Shinto, K. *et al.*, :NIFS-PROC-63 (2006), 184.
3) Shinto, K. *et al.*, Rev. Sci. Instrum., **77** (2006), 03B512.