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Y. Takeiri, A. Ando, O. Kaneko, Y. Oka, K. Tsumori, R. Akiyama, E. Asano, T. Kawamoto, T. Kuroda, M. Tanaka and H. Kawakami

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RESEARCH REPORT
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Development of an intense negative hydrogen ion source with a wide-range of external magnetic filter field

Y. Takeiri, A. Ando, O. Kaneko, Y. Oka, K. Tsumori, R. Akiyama,
E. Asano, T. Kawamoto, T. Kuroda, M. Tanaka[*1], and H. Kawakami[*2]

National Institute for Fusion Science, Nagoya 464-01, Japan

*1) *Hitachi Research Laboratory, Hitachi 316, Japan*

*2) *Kokubu Works, Hitachi Ltd., Hitachi 316, Japan*

ABSTRACT

An intense negative hydrogen ion source has been developed, which has a strong external magnetic filter field in the wide area of 35 cm x 62 cm produced by a pair of permanent magnet rows located with 35.4 cm separation. The filter strength is 70 G in the center and the line-integrated filter strength is 850 G cm, which keeps the low electron temperature in the extraction region. Strong cusp magnetic field, 1.8 kG on the chamber surface, is generated for improvement of the plasma confinement. These resulted in the high arc efficiency at the low operational gas pressure. A 16.2 A of the H^- ion current with the energy of 47 keV was obtained at the arc efficiency of 0.1 A/kW at the gas pressure of 3.8 mTorr in the cesium-mode operation. The magnetic field in the extraction gap is also strong, 450 G, for the electron suppression. The ratio of the extraction to the negative ion currents was less than 2.2 at the gas pressure of 3 mTorr. The two-stage acceleration was tried, and a 13.6 A of the H^- ion beam was accelerated to 125 keV.

Key Words: negative hydrogen ion source, negative-ion-based NBI,
external magnetic filter, high arc efficiency,
low gas pressure operation, two-stage acceleration

I. INTRODUCTION

In the next step fusion experimental devices such as ITER, the negative-ion-based NBI system is required, because the neutralization efficiency of negative ions is kept high with the injection energy of more than several hundreds of keV. The volume-production negative ion sources have been successfully developed in this decade for this future NBI system[1-10]. Moreover, since the much enhancement of negative ions was confirmed in the cesium-seeded volume-production source[11,12], more than several amperes of negative ions have been obtained in large bucket ion sources[13-16].

In the Large Helical Device project[17], a 125 keV (H) / 250 keV (D) - 20 MW negative-ion-based NBI system is proposed as a main heating device[18]. For this system a 125 keV - 45 A of negative hydrogen ion beam should be produced in a large negative ion source with the grid area of 25 cm x 150 cm. We have already obtained a 16 A of negative ion current in the rod-filter type 1/3-scaled ion source, which has dimensions of 1/3 of the negative ion source required for the LHD-NBI system[19]. However, the arc efficiency is not so high, 0.06 A/kW, and the operational gas pressure is still high, 7 mTorr. The low gas pressure operation is quite important for the reduction of the stripping loss of the H^- ions. In general the rod-filter type source is inferior on the source efficiency such as the arc and the gas efficiencies, because there is a large plasma loss area on the rod surface placed inside the arc chamber and the rod itself makes a shadow on the plasma grid. On the other hand, the external-filter type and the plasma grid (PG)-filter type sources have potential advantages for the efficient negative ion production due to the fact that nothing is immersed in the plasma[9,20]. However, the PG filter-type source requires an additional power supply for the grid current. Although the external-filter type source have produced a 10 A of H^- ions with the relatively narrow grid width of 15 cm[12], it is important to investigate whether the high source efficiency is achieved in an external-filter type source with the strong magnetic filter field generated in wider grid area.

We have developed an external-filter type 1/3-scaled negative ion source in order to produce a high current negative ions with high arc and gas efficiencies. In this ion source a strong external magnetic filter field is generated in large area inside the arc chamber with the cross section of 35 cm x 62 cm. A strong cusp magnetic field for improvement of plasma confinement should also be effective to achieve the high source efficiency[21]. Moreover, the magnetic field for the electron suppression is strong for reduction of the electron current ratio in a beam. In this paper the structure of the ion source and the experimental results are described in detail.

II. STRUCTURE OF ION SOURCE

Construction of a 1/3-scaled external-filter type negative hydrogen ion source is shown schematically in Fig. 1. The ion source has the same width and 1/3 of the vertical length of the ion source designed for the LHD-NBI system. The dimensions of the arc chamber are 35 cm x 62 cm in cross section and 20.6 cm in depth. The strong line cusp magnetic fields for the plasma confinement, more than 1.8 kG, are generated on the arc chamber surface. The wide-range of external magnetic filter field is produced in front of the plasma grid by a pair of permanent magnet rows which face each other at the distance of 35.4 cm. Figure 2 (a) and (b) show the magnetic field strength along the axial direction

(Z-direction in Fig. 1) and the magnetic field direction (X-direction), respectively. It is found that the strong magnetic filter field is distributed in large region. The filter field strength is 70 G in the center and the line-integrated filter field strength is about 850 G cm inside the arc chamber. The external magnetic field is distributed also in the beam extraction and acceleration region, and the integrated field strength along the beam axis is about 540 G cm, which could influence the negative ion beam trajectory.

The negative ion extraction and acceleration system consists of four grids ; plasma, extraction, electron suppression and grounded grids. The plasma grid is made of molybdenum and thermally insulated for keeping the high grid temperature in the cesium-mode operation. There are 522 (18 x 29) apertures of 11.3 mm in diameter in the area of 25 cm x 50 cm on the plasma grid, and the transparency is 42 %. The extraction grid contains permanent magnets generating the strong magnetic field of 450 G at maximum in the Y-direction in Fig. 1, which suppresses and deflects the electrons extracted together with the negative ions. This strong magnetic field is expected to reduce the electron current ratio in the extracted and accelerated beam. The grid gap length for the beam extraction was 5 mm in most of experimental results shown in this paper. The electron suppression grid has the same potential as the extraction grid. The acceleration voltage is applied to the gap between the electron suppression and the grounded grids. The grid gap length for the beam acceleration was 16 mm. The accelerator has a thick insulator for the fifth grid which can be installed for the two-stage acceleration of the negative ion beam. Each beamlet is not focused, that is, a parallel beam.

There are two cesium ovens attached to the side wall of arc chamber. The negative ions are detected by a multi-channel calorimeter array located 2.3 m downstream from the ion source. The calorimeter array has 15 channels in the horizontal direction and 21 channels in the vertical direction. Thus, the horizontal and the vertical profiles are obtained in one shot and the total H^- ion current is estimated using these profiles. The pulse length was 200 to 300 ms.

III. EXPERIMENTAL RESULTS AND DISCUSSION

A. Arc power dependence

The negative ion current is much enhanced by a small amount of cesium supply. The cesium vapor was introduced into the arc chamber at a small rate during the operation, and the valve was closed after the cesium effect, that is, enhancement of the negative ion current was observed. Figure 3 (a) shows the H^- ion current as a function of the arc power in the cesium-mode operation. The gas pressure was 3.8 mTorr. The H^- ion current is increased proportionally to the arc power and reaches 16.2 A, corresponding to 31 mA/cm^2 of the current density, with the energy of 47 keV. The arc efficiency (the ratio of the H^- ion current to the arc power) is around 0.1 A/kW. The extraction and the acceleration drain currents as a function of the arc power are shown in Fig. 3 (b). The extraction and the acceleration currents are also proportional to the arc power. The ratio of the extraction to the H^- ion currents is around 2.2 and the ratio of the acceleration to the H^- ion currents is around 1.7. The strong cusp and filter magnetic fields contribute the high arc efficiency at the low operational gas pressure over the wide-range of arc power. It is important to improve the plasma confinement for achievement of the high source efficiency in the cesium-mode operation. The strong magnetic field in the extraction gap is effective for the reduction of the electron current contained in a beam.

B. Gas pressure dependence

The low operational gas pressure is essential to reduction of the stripping loss of the negative ions. Figure 4 (a) shows the H^- ion current as a function of the gas pressure. The parameter is the arc power. The optimum gas pressure for the H^- ion current increases gradually as the arc power increases. However, even at the gas pressure of about 3 mTorr, a 13 A of the H^- ion current is obtained at the arc power of 130 kW. The ratio of the extraction to the H^- ion currents is shown in Fig. 4 (b), as a function of the gas pressure. At around 3 mTorr of the gas pressure, the ratio of the extraction to the H^- ion currents is about 2. The extracted electron current is suppressed even at this low gas pressure. In the case of 3 mTorr of the gas pressure, the stripping loss of the negative ions is calculated at about 17 %, that is allowable for the NBI system.

C. Bias characteristics

The bias voltage was applied to the plasma grid with respect to the arc chamber throughout the experiments. Figure 5 shows the H^- ion, the extraction and the acceleration currents as a function of the bias voltage at the arc power of 130 kW. The gas pressure is 3.8 mTorr. The extraction current is monotonously decreased with an increase in the bias voltage, while the H^- ion current is nearly constant below 6 V, and then gradually decreased above this bias voltage. The optimum bias voltage, where the H^- ion current is kept high value and the ratio of the extraction to the H^- ion currents shows the minimum, increases as the arc power increases. The plasma potential near the plasma grid is thought to be related to the bias characteristics. The acceleration current is nearly constant below 4 V unlike the extraction current, that indicates the small leakage of the extracted electrons into the acceleration gap. It is thought that the electrons included in the accelerated beam are mainly the secondary electrons generated by the incident H^- ions on the extraction and the electron suppression grids. Therefore, the electron current ratio in the extraction current should be less than 0.5, as supposed from Fig. 4 (b).

D. Dependence on the extraction voltage

The H^- ion current as a function of the extraction voltage is shown in Fig. 6, for the extraction grid gap lengths of 3 and 5 mm. The extractable H^- ion current is increased according to the 3/2-power law of the extraction voltage. The extractable H^- ion current for the extraction grid gap length of 3 mm is about 1.3 times more than that for the extraction grid gap length of 5 mm at the same extraction voltage. The thickness of the plasma grid (3 mm) and the intrusion depth of the electric field (estimated at a third of the aperture radius of the extraction grid, about 2 mm) should be considered for the effective extraction gap length for the H^- ions. The square ratio of the effective extraction gap lengths is 1.57, which is a little larger than the extractable current ratio for the extraction grid gap lengths of 5 mm and 3 mm. The space charge of the electrons contained in the extracted beam is negligible compared with that of the extracted H^- ions. The extractable H^- currents for the grid gap lengths of 5 mm and 3 mm are about 60 % and about 50 %, respectively, of the space-charge limited currents of the H^- ions for the parallel plates. The grid gap length of 3 mm is relatively short compared with the extraction aperture diameter, so that the beam aberration could be larger.

E. Two-stage acceleration

The fifth grid was attached to the accelerator for the trial of the two-stage acceleration of the H^- ion beam. The grid gap length for the second acceleration was 32 mm. In the preliminary experiments, a 13.6 A of the H^- ion beam was successfully accelerated to the beam energy of 125 keV.

It is concluded that the results presented here enable to design the actual LHD-NBI system.

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REFERENCES

1 M. Bacal, G. W. Hamilton, A. M. Brunetean, H. J. Doucet and J. Taillet, Rev. Sci. Instrum. **50**, 719 (1979).

2 K. N. Leung, K. W. Ehlers and M. Bacal, Rev. Sci. Instrum. **54**, 56 (1983).

3 R. L. York, Ralph R. Stevens,Jr., K. N. Leung and K. W. Ehlers, Rev. Sci. Instrum. **55**, 681 (1984).

4 M. Bacal, A. H. Brunetean and M. Nachman, J. Apple. Phys. **55**, 15 (1984)

5 A. J. T. Holmes, G. Dammertz and T. S. Green, Rev. Sci. Instrum. **56**, 1697 (1985).

6 Y. Okumura, H. Horiike, T. Inoue, T. Kurashima, S. Matsuda, Y. Ohara and S. Tanaka, *Proc. of the 4th Int. Symp. on Production and Neutralization of Negative Ions and Beams, Upton, NY, 1986,* AIP Conf. Proc. No. 158, p. 309.

7 A. J. T. Holmes, L. M. Lea, A. F. Newman and M. P. S. Nightingale, Rev. Sci. Instrum. **58**, 223 (1987).

8 K. N. Leung, K. W. Ehlers, C. A. Hauck, W. B. Kunkel and A. F. Lietzke, Rev. Sci. Instrum. **59**, 453 (1988).

9 M. Hanada, T. Inoue, H. Kojima, Y. Matsuda, Y. Ohara, Y. Okumura, K. Watanabe and M. Seki, Rev. Sci. Instrum. **61**, 499 (1990).

10 Y. Takeiri, A. Ando, O. Kaneko, Y. Oka, R. Akiyama, T. Kawamoto, A. Karita, K. Mineo and T. Kuroda, *Proc. of the 16th Symp. on Fusion Technology, London, 1990,* p. 1012.

11 S. R. Walther, K. N. Leung and W. B. Kunkel, J. Appl. Phys. **64**, 3424 (1988).

12 K. N. Leung, C. A. Hauck, W. B. Kunkel and S. R. Walther, Rev. Sci. Instrum. **60**, 531 (1989).

13 Y. Okumura, M. Hanada, T. Inoue, H. Kojima, Y. Matsuda, Y. Ohara, Y. Oohara, M. Seki, Y. Suzuki and K. Watanabe, *Proc. of the 16th Symp. on Fusion Technology, London, 1990,* p. 1026.

14 A. Ando, Y. Takeiri, K. Tsumori, O. Kaneko, Y. Oka, R. Akiyama, T.

Kawamoto, K. Mineo, T. Kurata and T. Kuroda, Rev. Sci. Instrum. **63**, 2683 (1992).

15 Y. Okumura, M. Hanada, T. Inoue, H. Kojima, Y. Matsuda, Y. Ohara, M. Seki and K. Watanabe, *Proc. of the 5th Int. Symp. on the Production and Neutralization of Negative Ions and Beams, Brookhaven, 1990*, AIP Conf. Proc. No. 210, p. 169.

16 A. Ando, K. Tsumori, Y. Takeiri, O. Kaneko, Y. Oka, T. Okuyama, H. Kojima, Y. Yamashita, R. Akiyama, T. Kawamoto, K. Mineo, T. Kurata and T. Kuroda, *Proc. of the 6th Int. Symp. on Production and Neutralization of Negative Ions and Beams, Upton, NY, 1992*, AIP Conf. Proc. No. 287, p. 339.

17 A. Iiyoshi, *Proc. of the 13th Symp. on Fusion Engineering, Knoxville 1989*, p. 1007.

18 Y. Takeiri, O. Kaneko, F. Sano, A. Ando, Y. Oka, K. Hanatani, T. Obiki and T. Kuroda, *Proc. of the first Int. Toki Conf. on Plasma Physics and Controlled Nuclear Fusion, Toki, Japan, 1989*, p. 272.

19 A. Ando, K. Tsumori, Y. Oka, O. Kaneko, Y. Takeiri, E. Asano, T. Kawamoto, R. Akiyama and T. Kuroda, to be published in Phys. of Plasmas.

20 T. Inoue, M. Araki, M. Hanada, T. Kurashima, S. Matsuda, Y. Matsuda, Y. Ohara, Y. Okumura, S. Tanaka and K. Watanabe, Nucl. Instrum. and Meth. **B37/38**, 111 (1989).

21 T. Inoue, M. Hanada, M. Mizuno, Y. Ohara, Y. Okumura, Y. Suzuki, M. Tanaka and K. Watanabe, *Proc. of the 6th Int. Symp. on Production and Neutralization of Negative Ions and Beams, Upton, NY, 1992*, AIP Conf. Proc. No. 287, p. 316.

FIGURE CAPTIONS

Fig. 1 Schematic diagram of the 1/3-scaled external-filter type negative hydrogen ion source.

Fig. 2 Magnetic filter field strength along (a) the axial direction (Z-direction in Fig. 1) and (b) the magnetic field direction (X-direction in Fig. 1). PG, GG and BP indicate the plasma grid, the grounded grid and the back plate of the arc chamber, respectively.

Fig. 3 (a) H^- ion current and (b) the extraction (open circles) and the acceleration (closed triangles) currents as a function of the arc power. The gas pressure is 3.8 mTorr.

Fig. 4 (a) H^- ion current and (b) the ratio of the extraction to the H^- ion currents as a function of the gas pressure for the arc power of 130 kW (closed circles), 100 kW (open squares) and 70 kW (open circles).

Fig. 5 H^- ion (closed circles), the extraction (open circles) and the acceleration (open squares) currents as a function of the bias voltage at the arc power of 130 kW. The gas pressure is 3.8 mTorr.

Fig. 6 H^- ion current as a function of the extraction voltage for the extraction grid gap lengths of 3 mm (open triangles) and 5 mm (open circles).

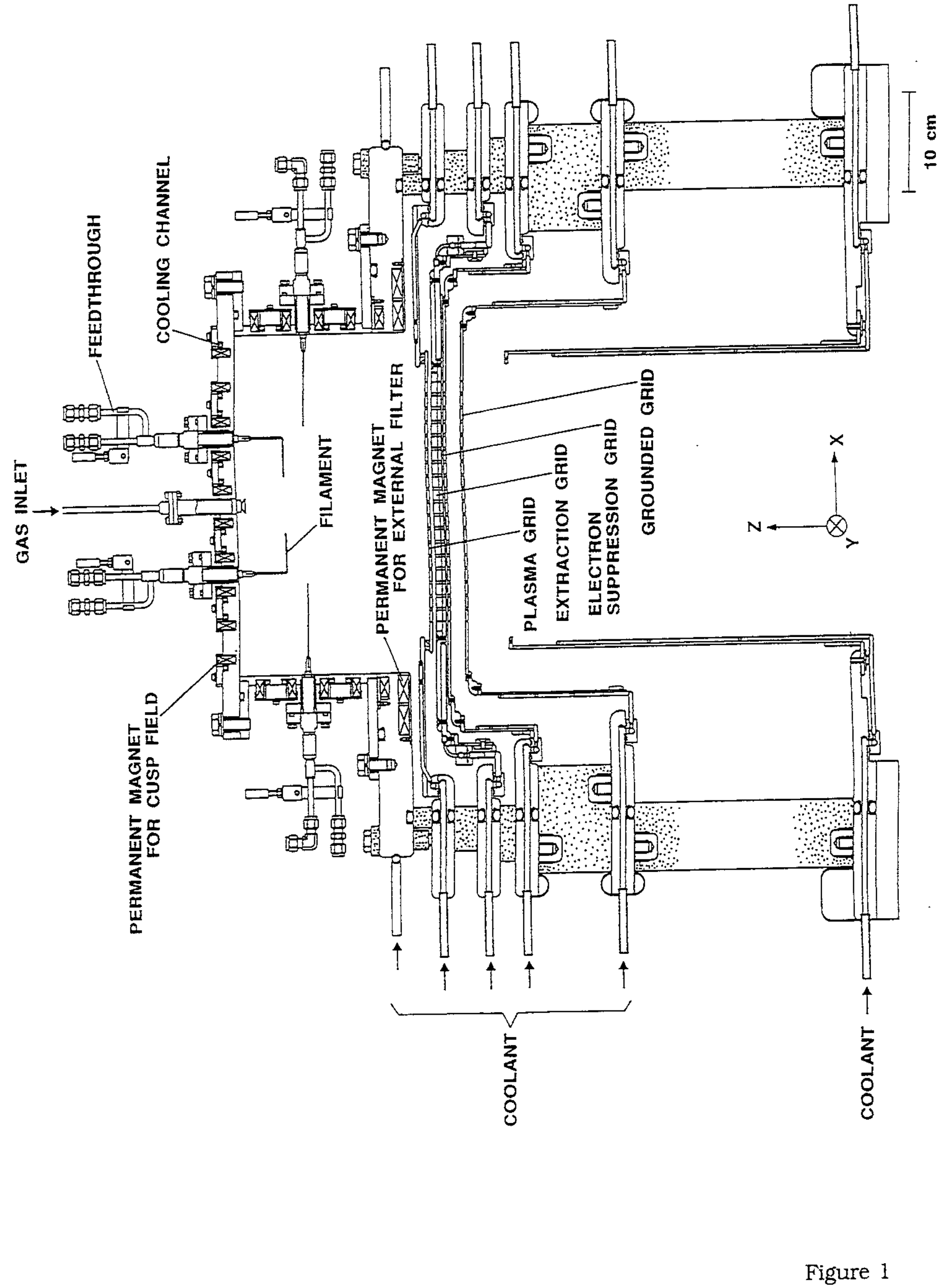

Figure 1

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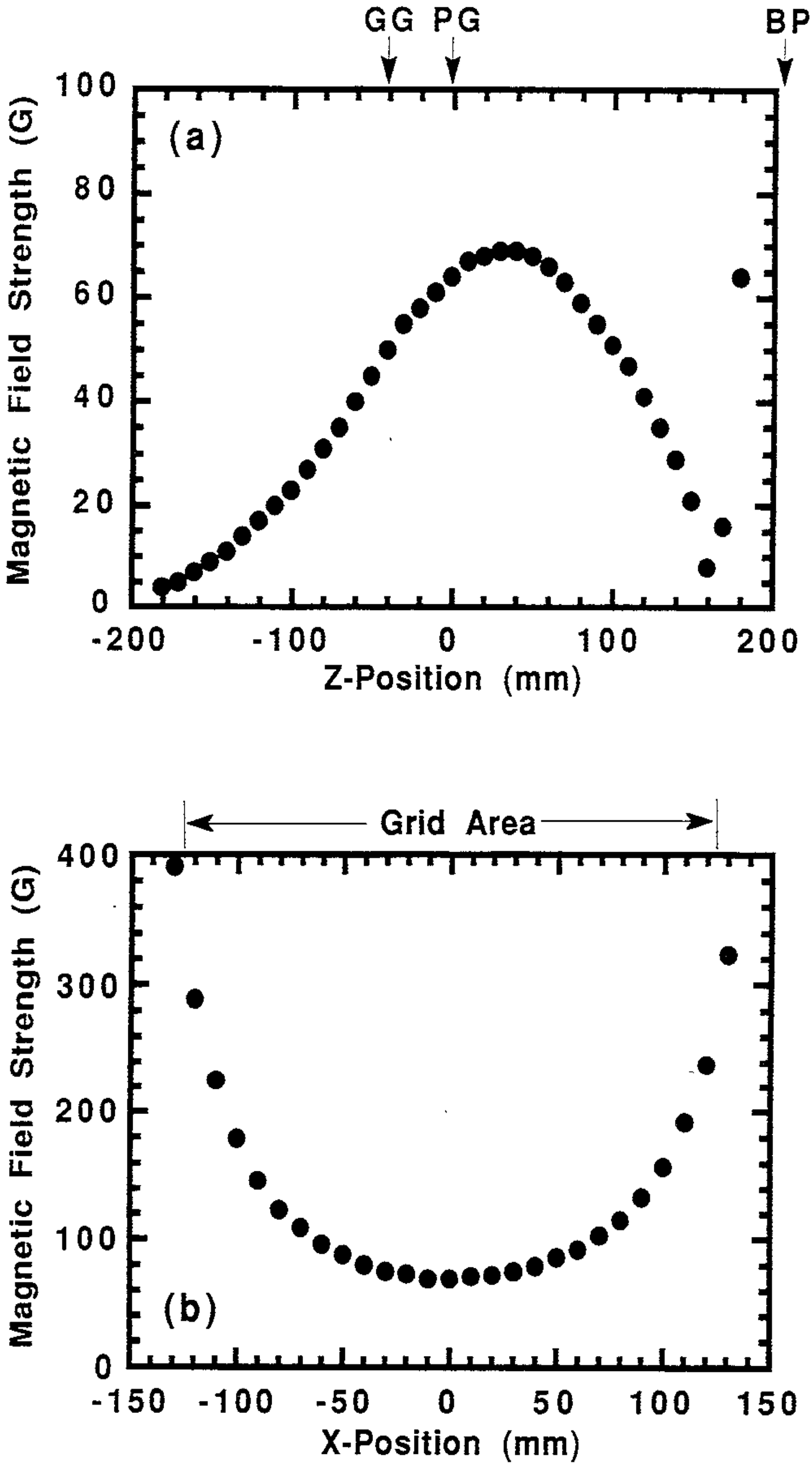

Figure 2
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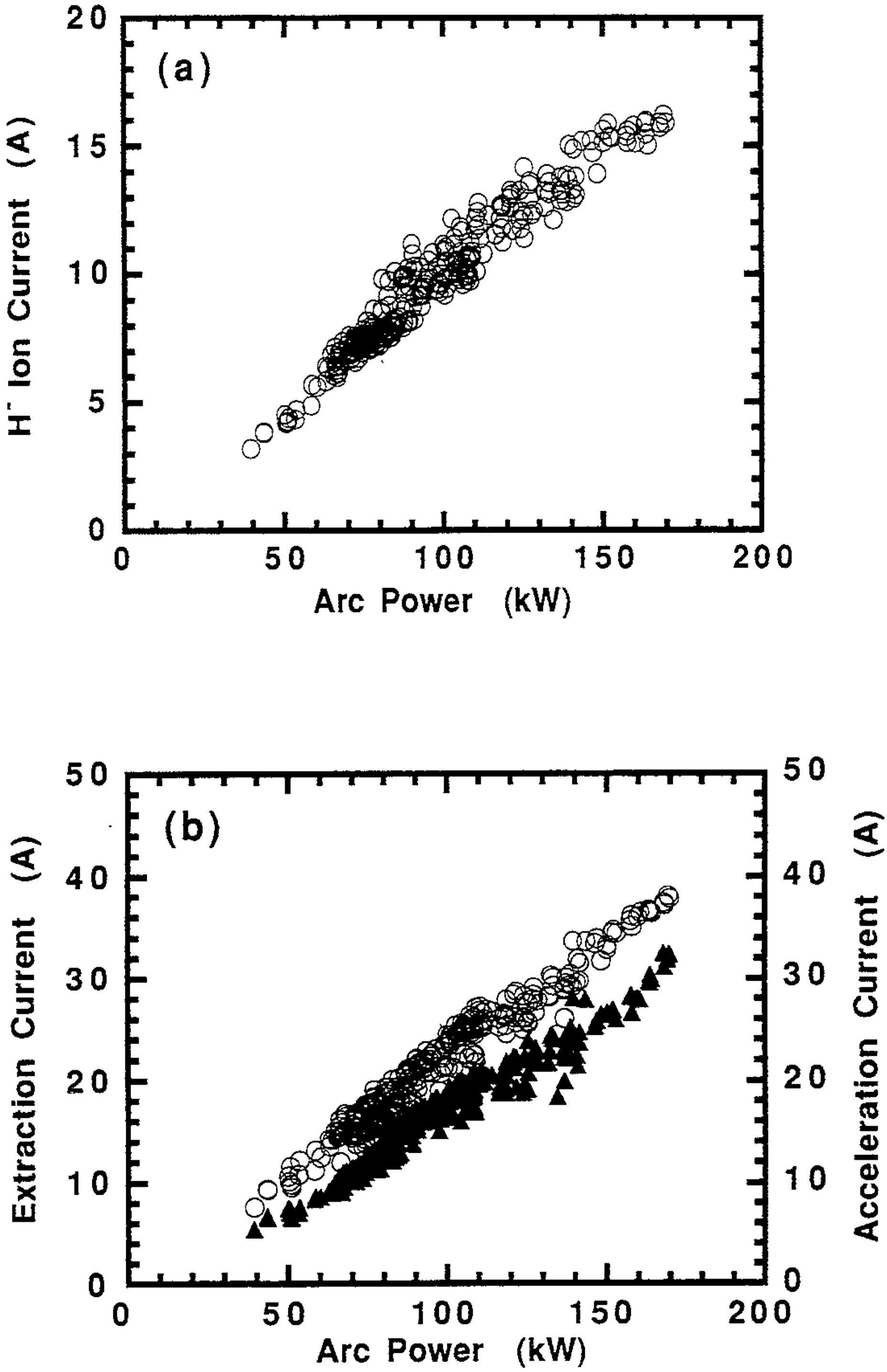

Figure 3
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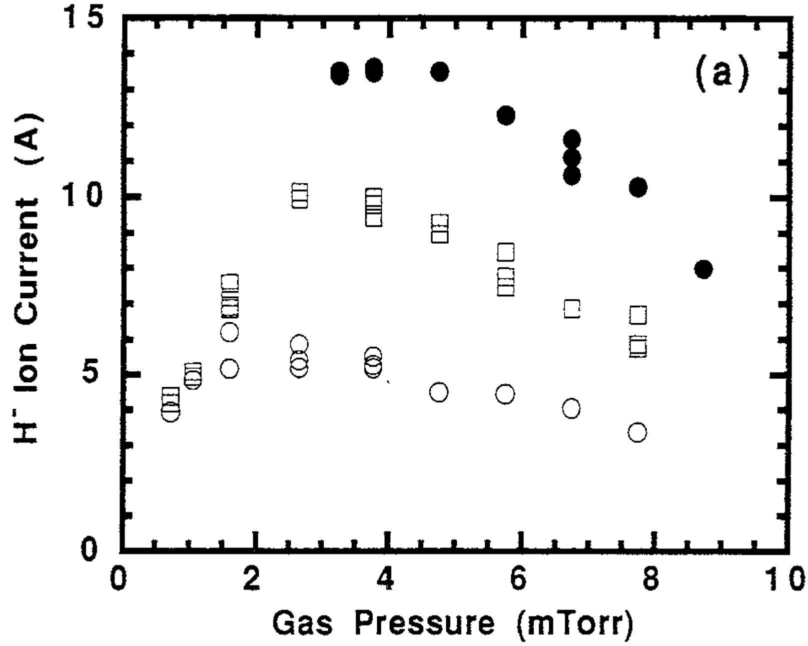

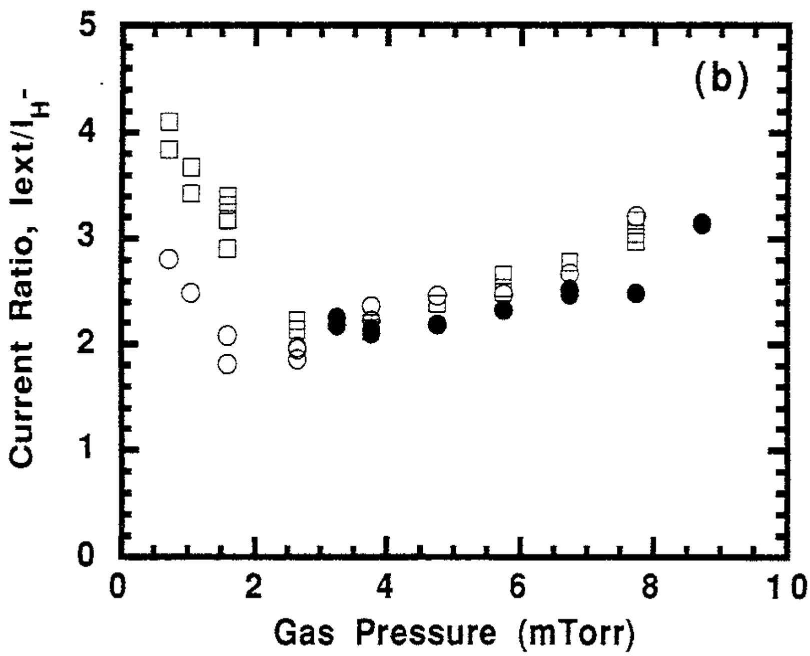

Figure 4
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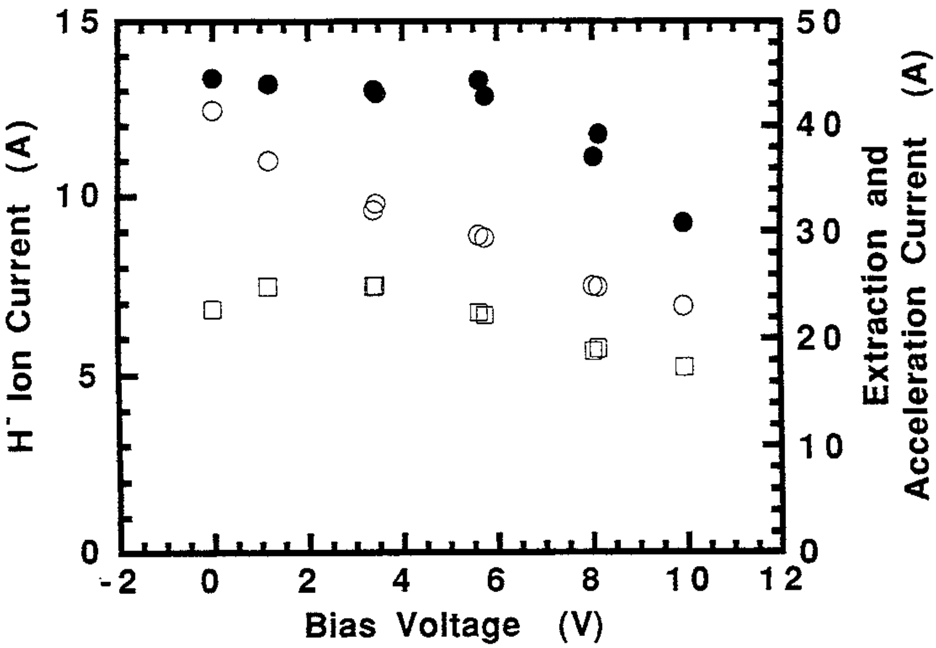

Figure 5
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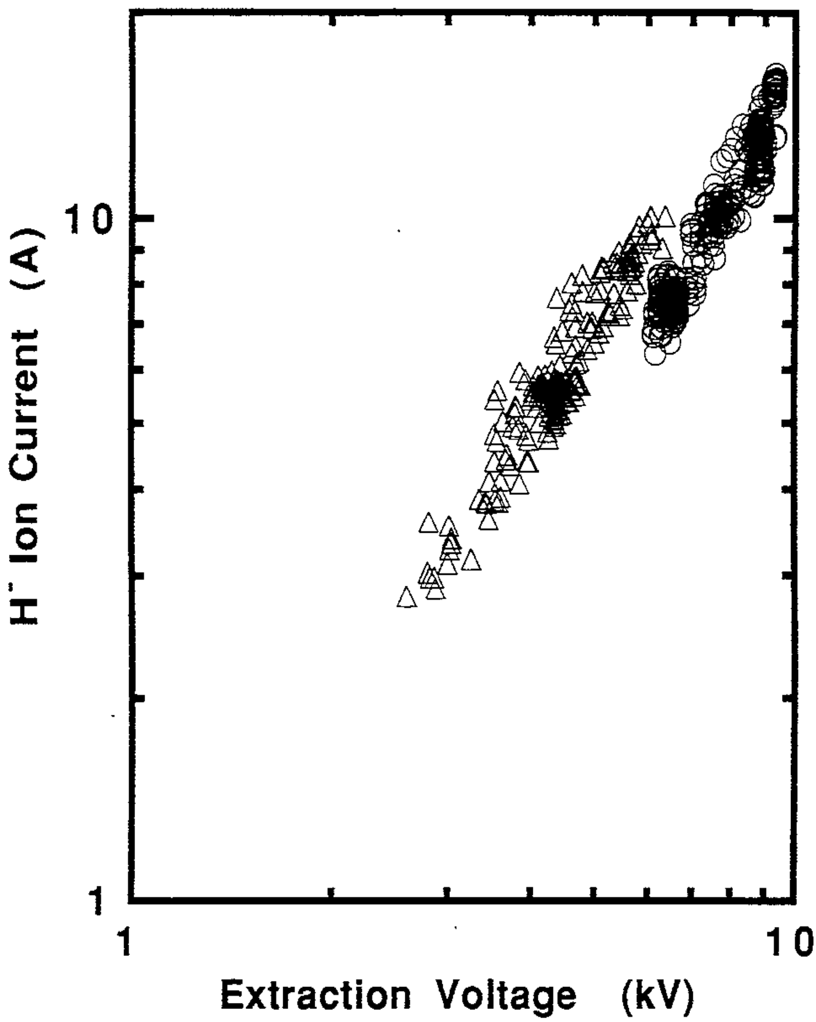

Figure 6
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H. Iguchi, A. Fujisawa, K. Adachi, S. Hidekuma, S. Hirokura, K. Ida, M. Kojima, J. Koog, R. Kumazawa, H. Kuramoto, T. Minami, I. Negi, S. Ohdachi, M. Sasao, T. Tsuzuki, J. Xu, I. Yamada, T. Watari,
Study of Turbulence and Plasma Potential in JIPP T-IIU Tokamak;
Aug. 1994 (IAEA/CN-60/A-2-III-5)

NIFS-302 K. Nishimura, R. Kumazawa, T. Mutoh, T. Watari, T. Seki, A. Ando, S. Masuda, F. Shinpo, S. Murakami, S. Okamura, H. Yamada, K. Matsuoka, S. Morita, T. Ozaki, K. Ida, H. Iguchi, I. Yamada, A. Ejiri, H. Idei, S. Muto, K. Tanaka, J. Xu, R. Akiyama, H. Arimoto, M. Isobe, M. Iwase, O. Kaneko, S. Kubo, T. Kawamoto, A. Lazaros, T. Morisaki, S. Sakakibara, Y. Takita, C. Takahashi and K. Tsumori,
ICRF Heating in CHS; Sep. 1994 (IAEA-CN-60/A-6-I-4)

NIFS-303 S. Okamura, K. Matsuoka, K. Nishimura, K. Tsumori, R. Akiyama, S. Sakakibara, H. Yamada, S. Morita, T. Morisaki, N. Nakajima, K. Tanaka, J. Xu, K. Ida, H. Iguchi, A. Lazaros, T. Ozaki, H. Arimoto, A. Ejiri, M. Fujiwara, H. Idei, A. Iiyoshi, O, Kaneko, K. Kawahata, T. Kawamoto, S. Kubo, T. Kuroda, O. Motojima, V.D. Pustovitov, A. Sagara, C. Takahashi, K. Toi and I. Yamada,
High Beta Experiments in CHS; Sep. 1994 (IAEA-CN-60/A-2-IV-3)

NIFS-304 K. Ida, H. Idei, H. Sanuki, K. Itoh, J. Xu, S. Hidekuma, K. Kondo, A. Sahara, H. Zushi, S.-I. Itoh, A. Fukuyama, K. Adati, R. Akiyama, S. Bessho, A. Ejiri, A. Fujisawa, M. Fujiwara, Y. Hamada, S. Hirokura, H. Iguchi, O. Kaneko, K. Kawahata, Y. Kawasumi, M. Kojima, S. Kubo, H. Kuramoto, A. Lazaros, R. Liang, K. Matsuoka, T. Minami, T. Mizuuchi, T. Morisaki, S. Morita, K. Nagasaki, K. Narihara, K. Nishimura, A. Nishizawa, T. Obiki, H. Okada, S. Okamura, T. Ozaki, S. Sakakibara, H. Sakakita, A. Sagara, F. Sano, M. Sasao, K. Sato, K.N. Sato, T. Saeki, S. Sudo, C. Takahashi, K. Takaka, K. Tsumori, H.Yamada, I. Yamada, Y. Takita, T. Tuzuki, K. Toi and T. Watari,
Control of Radial Electric Field in Torus Plasma; Sep. 1994 (IAEA-CN-60/A-2-IV-2)

NIFS-305 T. Hayashi, T. Sato, N. Nakajima, K. Ichiguchi, P. Merkel, J. Nührenberg, U. Schwenn, H. Gardner, A. Bhattacharjee and C.C.Hegna,
Behavior of Magnetic Islands in 3D MHD Equilibria of Helical Devices;
Sep. 1994 (IAEA-CN-60/D-2-II-4)

NIFS-306 S. Murakami, M. Okamoto, N. Nakajima, K.Y. Watanabe, T. Watari, T. Mutoh, R. Kumazawa and T. Seki,
Monte Carlo Simulation for ICRF Heating in Heliotron/Torsatrons;
Sep. 1994 (IAEA-CN-60/D-P-I-14)