

§7. Development and Applications of Ion Source Excited by a DC High-Current Electron Beam

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A dc high-current electron beam gun have been investigated for development of new type of an ion source in these several years. It is found that the plasma produced by the electron beam has a possibility of making a new epoch in ion source history. The aim of our study is to make clear the physical essence of this plasma and to develop a new high-current ion source for the heating of the fusion plasma.

In this year a plasma produced by a dc high-current electron beam was investigated by the Thomson scattering method with YAG laser. Experimental setup of the measurement is shown in Fig.1. A position of the measurement was 7 cm downstream from an anode  $A_2$  in which the electron beam was spouted out.

Examples of scattering profiles are shown in Fig.2(a) and (b). The scattering profile reflects the electron-velocity distribution perpendicular to the direction of the electron beam. When  $P = 6.7$  mTorr the profile shows the sum of a Maxwellian component corresponding to the electron temperature of about 10 eV and high energy electrons up to about the energy of 45 eV ( $\Delta\lambda^2 < 50$ ). On the contrary, when  $P = 0.22$  Torr few amount of high energy electrons appear in the scattering profile. It is considered that the high energy component comes from elastic collisions of the beam electrons with the neutral atoms.

The electron densities and the temperatures obtained from the profiles are listed in Table 1 with experimental conditions. The maximum density observed is  $1.0 \times 10^{14} \text{ cm}^{-3}$  at the beam current of 15 A. The maximum ionization degree reaches about 18 % at  $P = 6.7$  mTorr. It is found that this plasma source can produce even low temperature ( $< 1\text{eV}$ ) plasma with high electron density of about  $10^{14} \text{ cm}^{-3}$ . This plasmas parameter is suited for volume production of negative ion.

P (Torr)	6.7 (-3)	0.22		0.50	
Ib (A)	19	15		15	
Va (V)	100	50	100	50	100
Te (eV)	10	3.0	3.2	0.68	0.85
Ne(/cc)	4.2(13)	1.0(14)	1.0(14)	7.1(13)	9.6(13)

Table 1. Electron densities and temperatures at 7 cm downstream from the anode  $A_2$ .

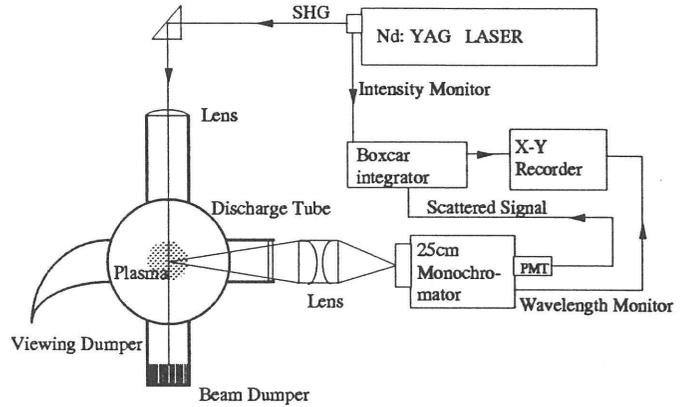


Fig. 1. Schematic diagram of the experimental setup.

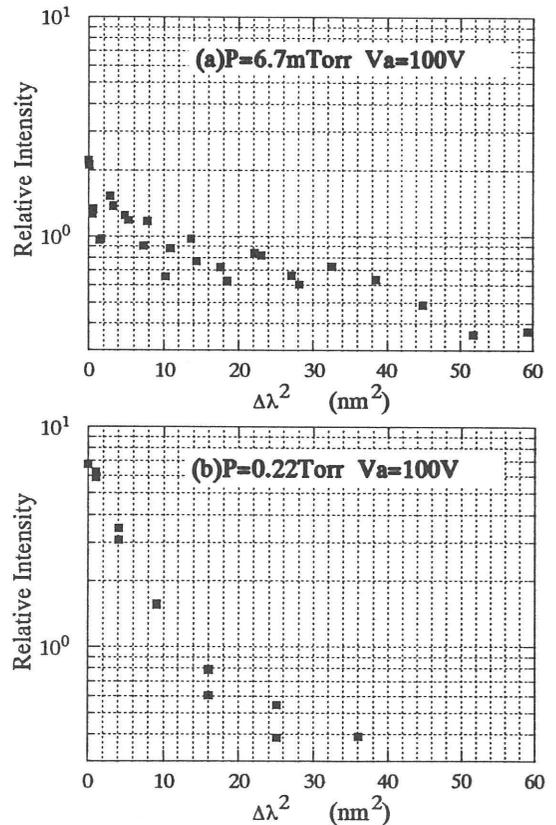


Fig. 2. Examples of the scattering profiles under the condition of (a)  $P=6.7$  mTorr,  $V_a=100\text{V}$  and (b)  $P=0.22$  Torr,  $V_a=100\text{V}$ .