MAGNETRON H^- ION SOURCE AT KEK

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A negative hydrogen ion source of magnetron type has been developed to increase the intensity of accelerated protons in the KEK 12 GeV synchrotron.

The source design is based on the magnetron source at FNAL[1]. H^- ions from the source are directly extracted into a sector focus 90° bending magnet which removes unwanted ions and electrons. The sector focus magnet shapes the H^- ions into a beam suitable for injection into an accelerating column. The source must be capable of producing above 50 mA of the beam with the maximum pulse length of 200 μsec at a repetition rate of 20 Hz.

Fig.1 shows the cross section of our magnetron source with an extraction system. The source anode and cathode parts are made of molybdenum. They are held by two thin insulators. The source body made of stainless steel contains the anode-cathode structure in it , and is covered with a titanium plate anode cover. The anode cover contains an anode aperture (1x10 mm). A thermal insulator is placed between the source body and the base plate. The pulsed gas valve which is popularly used in automobile as a fuel injector is mounted on the base plate. The hydrogen gas is directly introduced from a gas container into the source by this pulsed valve . The H^- ions are extracted from the anode aperture by the extraction electrode and passed through an extraction aperture (1x15 mm). The auxiliary magnet pole produces the source magnet field. Any electrons extracted from the anode aperture are bent by the transverse magnetic field and spiral back to the source.

The cesium vapor is introduced into the source through a heated tube. The tube of about 40 cm long connects with a valve to a cesium oven located outside of the vacuum chamber. To obtain the cesium vapor in the source, the valve and the connecting tube must be heated to 300∿400 °C. The oven temperature is adjusted to 170∿190 °C during the normal operation. The cold box is necessary to trap the cesium vapor from the source.

The arc power is supplied by the arc pulser. Output of a current pulse is regurated within a pulse duration by the negatively feedback circuit. In the hydrogen-cesium mode discharge, arc voltages are 200∿300 V as shown in Fig.2. The arc current can be adjusted up to 150 A. Fig.3 shows a typical waveform of the arc discharge.

A typical result of the H^- beam is shown in Fig.4 together with source parameters. 12∿15 mA of H^- beam is obtained with a shortened extraction gap of 3 mm. Further high intensities could be extracted by increasing the extraction aperture width. The temperature control of the source and the cesium oven must be important for the stable operation of the source. We have continued experiments to obtain a high intensity of the H^- beam in this ion source.

Reference

1) C.W. Schmidt and C.D. Curtis; IEEE Trans. Nucl. Sci.,NS-26, 4120 (1979).

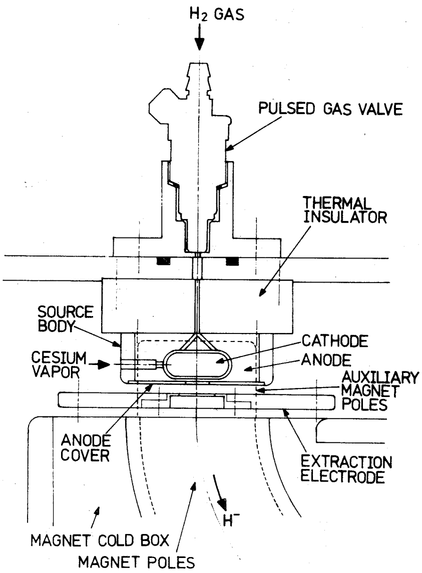


Fig.1 KEK magnetron ion source

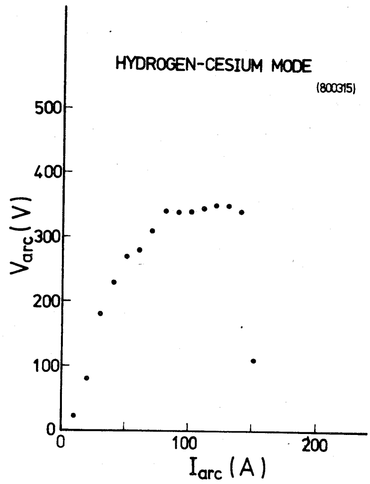
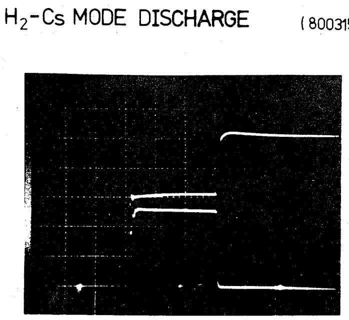


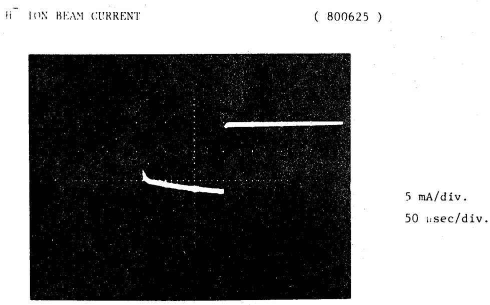
Fig.2 Arc voltage vs arc current.



U: V_{arc}, 100 V/div.
L: I_{arc}, 20 A/div. H: 50 μsec/div.

REPETITION RATE 20 Hz
CATHODE TEMP. ~450 °C
Cs OVEN TEMP. ~190 °C

Fig.3 Arc voltage and current pulses.



PARAMETERS

repetition	:	20 Hz
arc voltage	:	270 V
arc current	:	50 A
arc duration	:	150 μsec
cathode temp.	:	350 °C
anode temp.	:	170 °C
source mag. field	:	920 Gauss
extraction volt.	:	15 kV
acceleration volt.	:	30 kV
extraction gap	:	3 mm
extraction slit	:	1·15 mm
bend. mag. field	:	1470 Gauss
gas flow rate	:	45 cc/min.
Cs oven temp.	:	170 °C
Cs feed tube temp.	:	300-400 °C

Fig.4 12 mA H^- beam after 90° bending magnet.