DESIGN OF AN ECR ION SOURCE FOR POLARIZED IONS

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ABSTRACT

An ECR ion source is being developed in the Research Cneter for Nuclear Physics, to be used as a polarized heavy ion source. As a first step, a small and fairly cheap version of an ECR source has been built to produce $^3He^{2+}$ ions. The operating frequency is 2.45 GHz. The magnetic mirror field is generated by two solenoids and the radial confinement field is produced by six quadratic ferrite magnets.

INTRODUCTION

In recent years, there has been increased use of ECR (electron cyclotron resonance) ion source[1] in terms of producing highly stripped heavy ions. The ECR ion source was found to be effective in producing various kinds of polarized heavy ions[2,3]. As a first step we started constructing an ECR $^3He^{2+}$ source with an rf frequency of 2.45 GHz. The polarized $^3He^+$ beam will be produced by the transfer of polarized electrons from Na to $^3He^{++}$ in an optically pumped Na-cell. The reason for this ECR source is to get some experience in micro-wave techniques, creation and diagnostics of an ECR plasma, and measurement of the charge transfer cross section for He ions. The total system is shown schematicaly in Fig. 1.

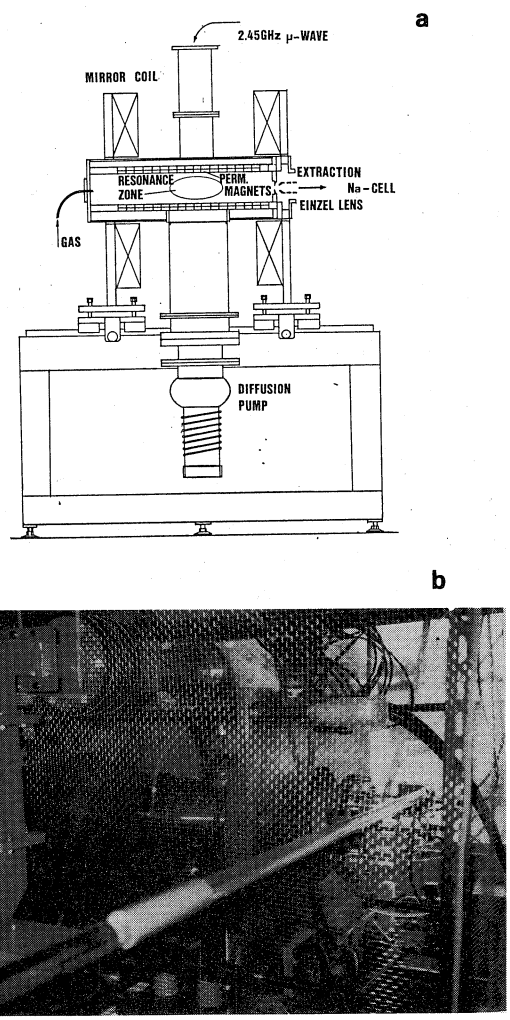

Fig. 1. a) A schematic arrangement of the RCNP 2.45-GHz ECR ion source.
b) Photograph of the RCNP ECR ion source.

MIRROR COIL

Two solenoidal coils are used for an electron spectrometer to the axial mirror coils. Each solenoid consists of a 6-pancakes coils and has a total of 480 turns. The dimensions and electrical specifications are shown in Table 1.

Table 1. Mirror Coil

Approx. mirror ratio	1.4 ~ 2.0
Inner diam.	25.0 cm
Outer diam.	66.5 cm
Axial length	85.0 cm
Electromotive force	52800 AT
Total power	11 KW
Max. current	110 A
Coil material	Cu-hollow conductor

The minimum-B configuration is obtained by superposition of the axial mirror field and the radial field of a ferrite permanent-magnet hexapole assembly. The inner diameter of the assembly is about 10 cm and its length is 60 cm. The maximum field at the pole bars is nearly 1.0 kG. The permanent magnets ($2.0\times4.0\times1.0$ cm^3) are positioned in water-cooled square tubes inside the vacuum chamber.

MICROWAVE POWER

The microwaves are injected through a pyrex glass window protected with teflon plate in a direction perpendicular to the source axis. The microwave frequency is 2.45 GHz, being delivered by a 5kW magnetron, through an E-H tuner and an isolator.

There are three layers choke flanges consisting of ferrite core and teflon plates for the insulation to high voltage.

PLASMA CHAMBER

The plasma chamber is pumped by a 6" oil diffusion pump to some 10^{-6} Torr, while the region near the charge exchange cell following the extraction is pumped by another 6" coil diffusion pump. For ion extraction from the source, more than 10kV can be aplied to the plasma chamber. The extraction system consists of two electrodes with Pierce geometry. The extraction bore is 8 mm in diameter.

In 1987 Oct., we successfully ignited the plasma by introducing helium gas.

REFERENCES

1) Contributed papers of the 7th Workshop on ECR Ion Sources held in Jülich (1986) ed. by H. Beuscher.
2) M. Tanaka and T. Shimoda, RCNP Reports P-68 and T-15 (1984).
3) M. Tanaka and T. Itahashi, RCNP Reports T-21(1985).