Proceedings of the International Conference on Isochronous Cyclotrons, Gatlinburg, Tennessee, 1966

THE POLARIZED PROTONS AND DEUTONS SOURCE FOR AXIAL INJECTION INTO THE GRENOBLE ISOCHRONOUS CYCLOTRON

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A 50 kV polarized protons and deutons source for axial injection into the Grenoble isochronous cyclotron is being constructed. We use a Keller (1) dissociator, a Stern-Gerlach sextupole giving about 10^{16} atoms/s, a Abragam (2) RF transition system which are now classical; but the axial ionizer is new with a 30 mA oscillating electron beam which would give (3), 40cm along, about 1 % efficiency. The full size prototype would be operating in a few months, and the polarized ion source (fig.1) will be put together with the axial injection system (4) into the cyclotron now in progress.

The Keller dissociator -

The atoms are produced by dissociation of molecules in a electrodeless discharge. The plasma is formed by a RF field (27Mc/s) to which it is capacitively coupled ; the matching is accurately done by two cylindrical silver electrodes, using (fig.2) capacity C_1. The optimum gas pressure into the discharge tube (fig.3) is about 0.4mmHg($\simeq$ 5mmHg at 40cm from the bulbs). The high intensity beam (fig.8) is produced by using a specially shaped (5) nozzle ($\varnothing \simeq$ 2,1mm), associated with a $\varnothing 2 \simeq$ 3mm peeler and a $\varnothing 3$ 4mm hole just before the sextupole magnet.

The Stern-Gerlach magnet -

The sextupole (fig.4) magnet (L$\simeq$ 50 cm) built (6) for focusing atoms with different speeds has roughly the same field configuration as that of Beurtey (7). The pole tip radius tapers (fig.3) from 3 mm to 7,5 mm at the middle, which is the beginning of the straight part of the gap. A 8kG pole tip field and a 26 kG/cm field gradient is obtained. The optimum atomic beam intensity (fig.8), measured with a compression tube is about $0.8.10^{16}$ atoms/s behind the sextupole (no variation was observed until to 50 cm) ; the beam size varied from $\varnothing \simeq$ 5 mm at 10 cm to $\varnothing \simeq$ 7mm at 50 cm. When the gas flow is greater (fig.8) than 4 torr.l.s^{-1}, there is a saturation of the pumping system (tank 2). The sextupole terminated in a 2-pole magnet giving a magnetic field parallel with the field into the RF transition system.

The Abragam RF system -

Now we are preparing the deuton beam using the transitions (fig.6) between the hpf levels of the deuterium ground state. These transitions will be induced by two RF field switched on and off alternatively.

The axial ionizer -

- In 1962, when Professor R. Bouchez takes the decision to build at the laboratory a polarized ion source with high intensity using Abragam method, we immediately realize the main difficulty concerns the very small efficiency of the ionizer. On the suggestion of Dr. Renucci (8) to use an axial electron beam, a first model (3) is built : a 250 mA, 1200 eV electron beam was confined by an 800 G axial magnetic field, but as the electrons were produced from a Pierce (10) cathode on a large radius ($\simeq$ 3,5 cm) the electron beam was annular and did not fill the whole area (2cm^2) of the atomic beam.

- After stimulating discussions with Dr. W. B. Powell, B.L. Reece and S. W. Oh at University of Birmingham, where an axial ionizer was independently realized, we built a second model but with an 30 mA oscillating (9) electron beam between (fig.7) R_1 and R_2, and with a Pierce cathode using a smaller (2.5cm) radius.

- Now the electron beam fills the area near the axis of the atomic beam. The theoretical efficiency (3), after the characteristics of the electron beam (L$\simeq$ 40 cm, V$\simeq$ 600 volts) is about 1 %. The measurements are in progress.

References -

1 - R. Keller - CERN 57-30 - R. Keller, L. Dick, M.Fidecaro - CERN 60-02.

2 - A. Abragam, J.M. Winter, Phys. Rev. Letters 1958 1 374, C.R. Acad. Sc. 1962, 255, 1099.

3 - J.F. Arvieux, Thèse Grenoble 1963.

4 - J. Fermé, J. L. Belmont - This conference.

5 - E.W. Becker, K. Bier, Z. Naturf, 1954 9a 975.

6 - L. Ghazarossian - Internal report (Laboratoire de Physique Nucléaire 1964).

7 - R. Beurtey - Thèse Paris 1965.

8 - Private communication - Dr. Renucci is now at University of Nice.

9- S.W. OH, 1965 ANL 7118.

10 - J.R. Pierce - Theory and design of electron beams - Van Nostrand 1954.

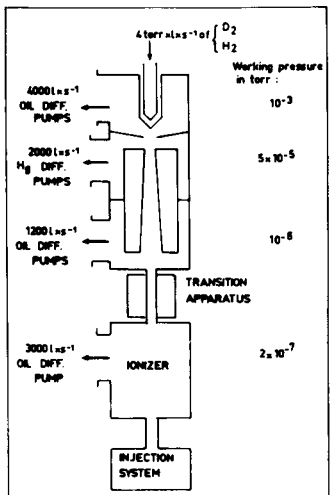

Figure 1.

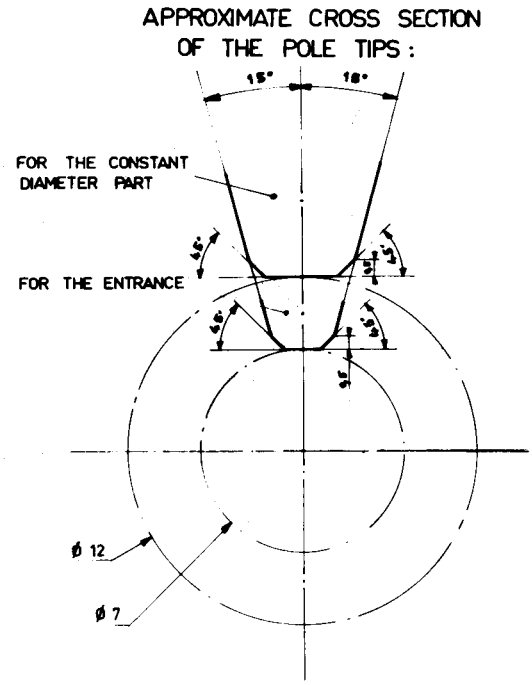

Figure 4.

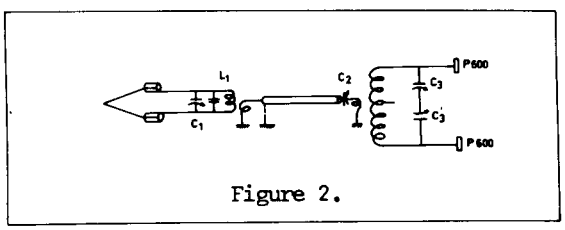

Figure 2.

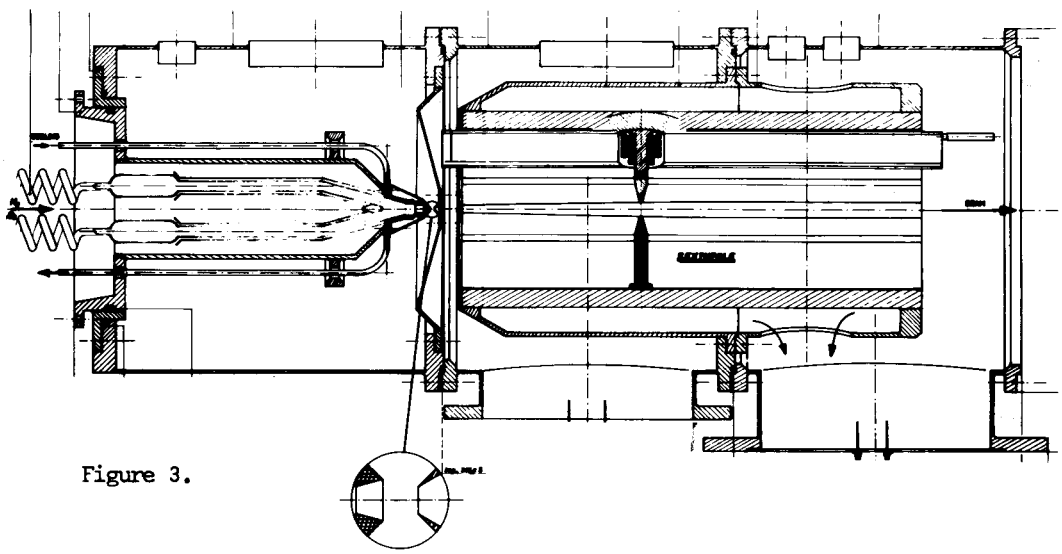

Figure 3.

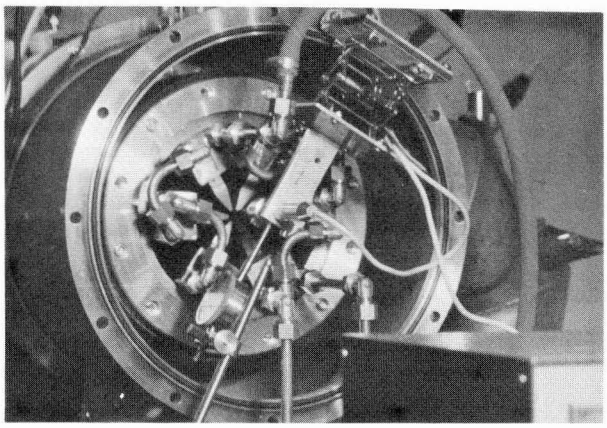

Figure 5.

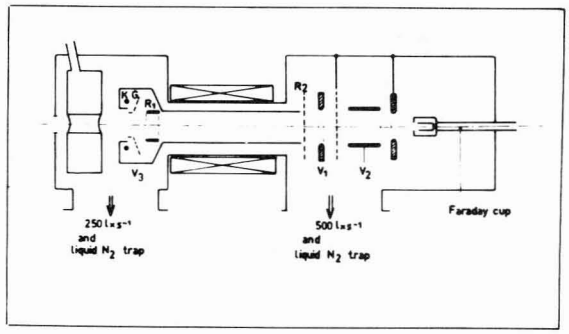

Figure 7.

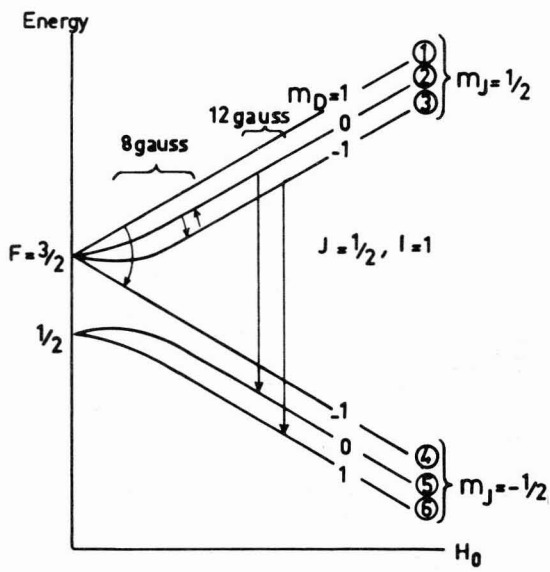

Figure 6. Energy level diagram of the atomic deuterium in a magnetic field.

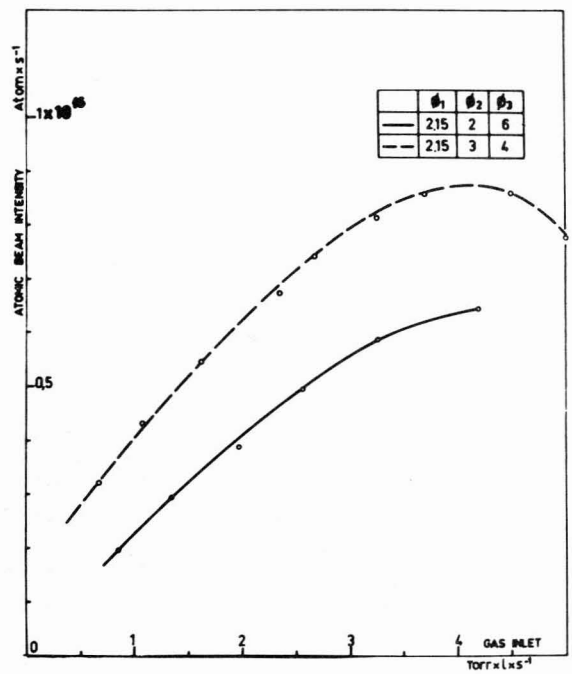

Figure 8.

