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8.48 A Polarized Ion Source for HI-13 Tandem Accelerator At Beijing

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At the Tandem Accelerator Laboratory of Atomic Energy Institute ,Beijing,China, a Lamb-shift (spin filter) polarized ion source is being developed. The main body of the source has been assembled as shown in Fig.1. Most of the source part have been tested and We hope to get moderate intensity polarized ion beam in near future.

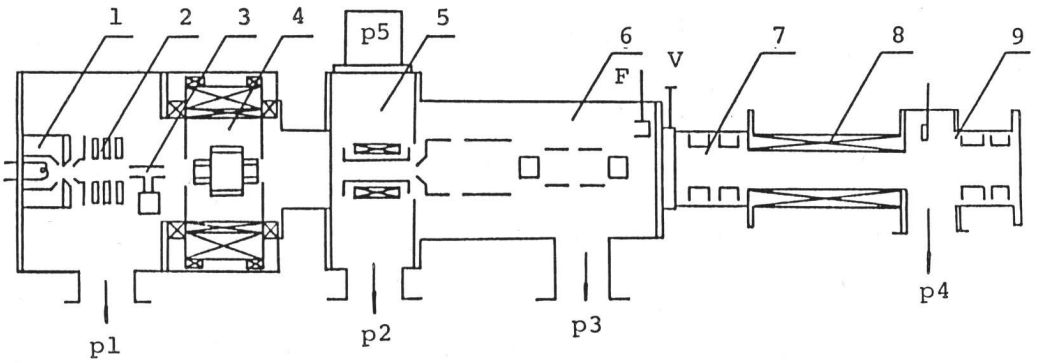

Fig.1.The polarized ion source configuration
p1--p5 pumps F--Faraday cup K--Valves
1. Duoplasmatron 2. Accel-decel electrodes 3. Cs cell
4. Spin filter 5. Ar exchanger 6. Focussing lenses
7,9. E.S.quadrupoles 8. Wien filter

1. Testing of 500 ev proton beam

Many tests indicated that $\vec{H}^-$ ion beam intensity limitations in Lamb-shift polarized ion sources result from large divergence in the 500 ev H^+ ion beam. For getting greater polarized ion beam, We have payed attention to the extraction geometry of the duoplasmatron, as opposed the Los Alamos style close-coupled geometry, We have an extended extraction geometry which similar with " Giessen " source. From the proton source , 4mA proton beam extracted out at 9kv voltage, passed through an einzellens, then went through the decel electrode and the cesium charge exchange canal. At first the Cs-cell was cool, 400μa proton beam was measured at the Farady cup which located at 30 cm from the Cs canal, as the distance increased to 65 cm, beam intensity dropped to 30μa. At the same location, then the Cs-cell was warmed up to raise the cesium vapor density, the beam intensity increased with the Cs-cell temperature rise, it reached the maxium value 70μa. based on above results, near three hundred nA polarized ion beam might be produced, if each part of the source works well.

2. Spin filter

A spin filter is used to polarize the metastable hydrogen or deuterium atomic beams.The cavity of spin filter which is mounted in a uniform axial magnetic field is divided into quadrant where the static and rf field are applied. our spin filter is a copper cylinder , 7 cm long and 15 cm dia., with silver plated. Our spin filter is closely followed that of LASL 1). The cavity operates in a TM010 mode. By slightly adjusting the cavity diameter, it's easy to tune resonance frequency at 1609 MHz.

The solenoid coils for uniform axial magnetic field is composed of a main coil, two correction coils, two end coils and a modulation coil with which the magnetic field can be modulated by 50G. A Hall component has been used to measure the magnetic field, the fluctuation of magnetic field in the effective region of the cavity is approximately ±0.5G.

When the solenoid coils work, the temperature of the cavity increases to about 70°C by the heat of the coils. The change of the resonance frequency caused by thermal expansion should be considered. We have measured the resonance frequency shift Δf, the shift Δf is about 15kHz/°C for our cavity.

A rf power-leveling system used PIN diode modulators has been set up. The system can feed the rf power into the cavity at two levels; low level (8-200 mw)for ordinary operation, and high power level (0.2-2 w) for full quenching of the metastable atoms. In order to improve the stability of rf field amplitude in an active cavity, an automatic amplitude control circuit is employed. The power level in the rf cavity is easily regulated by direct current from the amplitude control circuit to intrinsic terminal of input PIN modulator.

3. Spin precession and injection system

Spin-quantization axis of polarized beam from argon canal is along beam direction, an external spin-precession system is being designed to provide full spin orientation requirement. We chose to use a crossed electric and magnetic field device, known as " Wien filter ", but the optical quality of which is highly astigmatic, two electrostatic quadrupole doublets are to be inserted into beam line. With these quadrupole doublets, the optical quality of transported beam will be improved. The contour of cross section of the quadrupoles is intended to be hyperbolical,so as to reach a pretty linear field distribution in large enough aperture of the quadrupoles.

The beam will be brought to focus at the middle of the spin precessor by means of an electrostatic quadrupole doublet. By means of another electrostatic quadrupole doublet,which will be downstream from the precessor, the beam will be brought to focus at the entrance of 150 kv pre-accelerator, then directly injected to low energy accelerating tube of HI-13 tandem.

Reference

1) G.G.Ohlsen, J.L.McKibben, R.R.Stevens, G.P.Lawrence and N.A.Lindsay, Los Alamos Scientific Laboratory Report LA-4112 (1969).