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The New Munich Polarized Ion Source

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An improved Lambshift polarized ion source (LS) Fig. 1 was developed and installed at the MP tandem accelerator. It replaced the old polarized ion source[1] and is used routinely since October 1984. Main components are an improved focussing system, a combination of spin filter (SF) and diabatic field reversal method (Sona), a cryo pumped argon gas target and a Wien filter (WF) Fig. 2 for spin rotation. The system is controlled and operated from the tandem control room by a table computer through an optic cable.

We have four polarized modes and run the source with the following performances (at WF cup, polarizations from quench ratio):

Mode	$\vec{J}$[μA]	P_3	P_{33}
SF, m = +1	1.0	0.68	0.68
SF, m = 0	1.0	0	-1.36
SF, m = -1	1.0	-0.68	0.68
Sona	2.6	-0.58	0

For protons $\vec{J}$ = 0.45 μA with P = 0.83 was obtained in the SF mode.

The transmission from the source is 50% to the scattering chamber. (82% to the tandem and 65% to the analyzing magnet behind the tandem). Measurements of the beam polarization using the ${}^4He(\vec{d},d_o)$ reaction at E_d = 11.88[2] and 14.0 MeV[3] resulted in P_3=0.650, P_{33} = 0.647 for SF (m=+1) and P_3 = -0.560, P_{33} = 0.03 for Sona operation at the above quench ratios. For protons using ${}^4He(\vec{p},p_o)$ at E_p = 12.3 MeV[4] we obtained P_3 = 0.835.

A few details of the components are described in the following context (see also [5]).

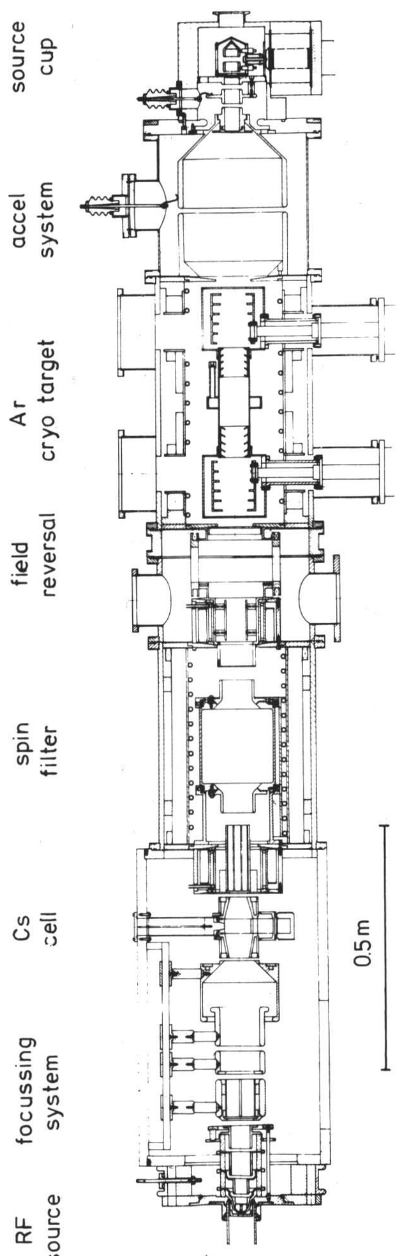

Fig.1 Lambshift source

The RF source has a one winding inductive coupling which is operated with 300 Watts RF power at a frequency of 28 MHz. A 2.8 mA D^+ beam is extracted at an energy of 3.4 keV. The emittance is $\varepsilon = rr' E^{1/2}$ = 0.4 cm rad $eV^{1/2}$ and the energy spread is about 25 eV.

In the focussing system the D^+ beam is prepared to have a waist in the spin filter at an energy of 1.2 keV. In principle the multi electrode arrangement consists of an Einzel lens which is movable along the beam axis by electrical means and a subsequent decel lens with a free electrode for adjustment of the focussing power. An integrated steerer allows transmission of the beam through a 4 mm diameter aperture in the accel system behind the argon cryo target.

In the cesium cell cesium is evaporated from the oven below (T = 147°C) to the charge exchange canal (T = 30°C) in a way that it can not leave the apertures directly. It flows back after it is condensed. The consumption is 1 gram/day and has a strong contribution from Cs^+ being extracted into the focussing system. The emittance of the metastable beam leaving the cesium cell seems to be considerably larger than that of the incoming D^+ beam.

The spin filter is based on the Los Alamos design. The cavity has a Q of 5000 and the temperature walk of the resonance frequency is -30 kHz/K. It is driven by a fixed frequency oscillator which has a frequency of 1609 MHz ±5 ppm using about 30 mW of power. Resonance tuning is done via the temperature of the solenoid cooling. The longitudinal B-field raises from zero to 180 G with 16 G/cm and from 180 G to 575 G with 75 G/cm to minimize quenching of the α-states. The homogenity in the cavity region is $\Delta B/B = \pm 3 \cdot 10^{-4}$.

The argon cryotarget consists of two T = 80 K heat shields with the gas canal having the same temperature. On both sides T = 14 K baffles pump the argon with a measured pumping speed of 10^5 l/sec which corresponds to the solid angle ratio. The 60 G B-field having a homogenity of $\Delta B/B = \pm 1.5\%$ can be switched parallel or antiparallel to the spin filter B-field depending on SF or Sona mode operation. An emittance of 0.7 cm rad $eV^{1/2}$ can be accepted by the argon target and is enlarged by the charge exchange to 1 cm rad $eV^{1/2}$.

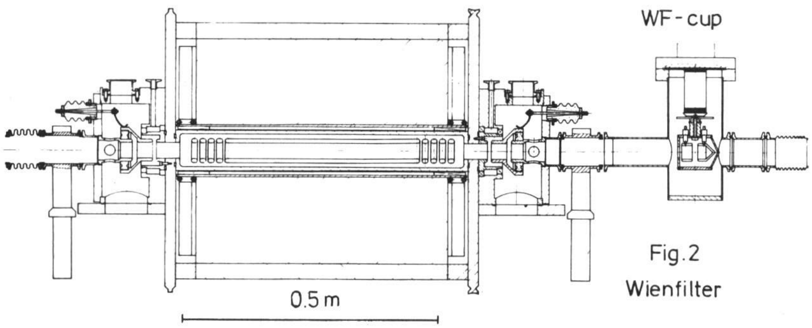

Fig. 2
Wienfilter

The Wien filter has an effective length of 50 cm. It can rotate the spin of the 20 keV D^- beam, which is parallel or antiparallel to the beam axis, through 100 degrees around the B-field. The device itself is rotatable around the beam axis so that any spin orientation of the polarized beam can be achieved. The magnetic and electric dipol fields are carefully matched at both ends to prevent a parallel shift of the beam. A magnetic quadrupole field is superimposed by integrated coils so that the focussing has no astigmatism. Symmetric beam transportation with a waist in the middle of the device is achieved independent of the spin rotation angle by additional Einzel lenses on both sides (not rotated). The transmission of the polarized beam through the WF is 100%.

References

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