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8.4 Installation of a new 1 MV Tandem Accelerator at the Giessen Polarization Facility

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The Giessen polarization facility[1] was equipped with a new 1 MV-power supply (General Ionex) including tank, accelerator tubes and terminal. The ion optical properties of the Lambshift source had to be matched to the requirements of the new (longer) tube.

Emittance measurements of the 20 keV-H^--beam were performed by using a double slit system with Faraday cups for the following source conditions:

a) negative ion beam emerging from the Cs-cell, traversing the argon channel without charge exchange (without argon gas),
b) negative ion beam produced by charge exchange of ground state H-atoms in argon gas,
c) negative ion beam produced by charge exchange of metastable and ground state H-atoms in argon gas.

Ohlsen et al.[2] have discussed the emittance degradation of an ion beam, charge exchanged in a magnetic field. For the ideal case of a paraxial beam, (emittance 0) tangential velocity components are generated, which corresponds to a field dependent emittance increase. In a realistic case of an incoming beam of finite emittance tangential components are produced by the $\vec{v}_r \times \vec{B}$-force, opposite to the above components. Therefore the field dependent emittance degradation is a function of the initial beam emittance.

Therefore the measurements for b) and c) were performed as a function of the magnetic field strength superimposed on the argon channel, i.e. 0, 250, 400 Gauss. Table I shows the measured emittance values for the different cases.

Table I: Emittance ε_{50} and ε_{75} for 50% and 75% collected current, respectively, in units of mm·mrad·MeV$^{1/2}$

ε_{50}	ε_{75}	conditions	
7.0	14.6	case a)	
11.6	25.1	case b)	B = 0 Gauss
12.6	24.7		B = 250 Gauss
7.4	17.4	case c)	B = 0 Gauss
9.2	21.0		B = 250 Gauss
8.6	19.1		B = 400 Gauss

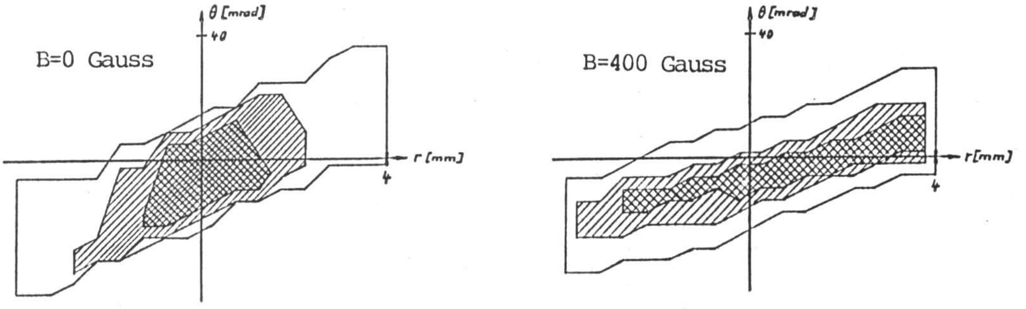

Fig. 1: Emittance area for 50%, 75% and 85% of collected current for B = 0 and B = 400 Gauss.

Fig. 1 shows the emittance area for case c) B = 0 Gauss and B = 400 Gauss as an example.

The geometrical acceptance of the Giessen Cs-Ar-system for 500 eV protons is 4 mm mrad $MeV^{1/2}$. The values given in table I show, that this number cannot be substantiated for the case a) due to the double charge exchange process and its emittance degradation in the Cs-cell. The values in case c) for B = 0 are similar as in case a), indicating that the metastable-negative transition does not introduce an emittance increase. On the other hand one can see from case b) for B = 0 that the ground state-negative transition is in fact connected with a considerable emittance degradation.

The magnetic field dependence of the emittance shows a small, sometimes even reversed effect, so that it is almost negligible for the working conditions of Lambshift sources.

The measured emittance values were used for ion optical calculations of the accelerator tubes and the terminal transmission with the result that transmission losses occur for small terminal voltages. The apertures and the geometry of the stripper canal were enlarged, so that an increased transmission (factor 1.4) could be achieved. The operation of the tandem terminal below 300 kV required a modification in the electronics, which led to a low voltage operation between 80 and 350 kV. For smaller terminal voltages, required for the d-d experiments[3], the terminal is connected to an external 100 kV power supply. Without additional modifications for an optimal ion transport the transmission for deuterons ranges from 30% (100 kV) to 4% (20 kV). The high voltage ripple of the original 1 MV power supply was ± 1 kV. Simple measures allowed the reduction to ± 100 V.

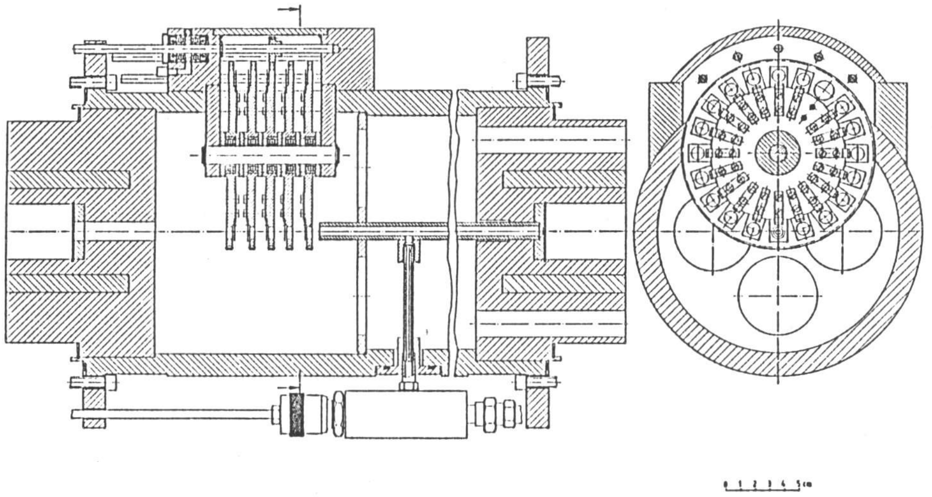

Fig 2: Schematic of the terminal containing a gas canal and a foil stripper

The charge exchange in the stripper gas leads to a reduction of beam polarization. Fig. 2 shows the installation of a new terminal with a foil stripper consisting of 5 wheels each equipped with 19 carbon foils, which can be changed under operational conditions.

References

1) W. Arnold et al., Nucl. Instr. and Meth. 143 (1977) 457
2) G.G. Ohlsen et al., Nucl. Instr. and Meth. 73 (1969) 245
3) E. Pfaff et al., this conference