Deflector and Wienfilter for the Lamb-Shift Polarimeter

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The Wienfilter and the deflector are components of the Lamb-shift polarimeter [1] and have been designed and built [2] as modifications for the measurements at the polarized internal target (PIT) [3] at ANKE. Because of space limitations in the COSY-tunnel, the LSP will be placed in two sections under an angle of 120°. Therefor a 60° deflector is necessary. In the first section, the extracted atomic beam gets ionized and then it is deflected into the Wienfilter.
The electrostatic deflector consists of two spherical segments, the inner and the outer shells have a radius of 6 and 8 cm, respectively. Such a deflector has the advantage that additional to the deflection, the beam gets focussed. These two segments are fixed on a holding plate, which also supports two einzellenses, one in front and the behind the deflector.
All these components are mounted in a vakuum chamber and are carried by an intermediate flange at the upper end of the chamber (Fig.1) for easy handling. Most of the components as well as the chamber were manufactured in the workshop of Fachhochschule Aachen/Jülich.

Fig. 1: Deflector chamber (height about 40 cm) with the spherical deflector and the two lenses (visible is one of the lenses within the teflon insolation with the deflector behind it).

Behind the deflector, the beam is directed into the Wienfilter (Fig.2), which was manufactured in the workshop of the Physics Department of Universität Erlangen. It fulfills two functions. On the one hand, the quantization axis of polarized protons/deuterons along the trajectories in the magnetic field region has to be rotated by about 60°. On the other hand, the Wienfilter is used as a velocity selecting element to seperate ions of different masses, e.g. H_1^+ from H_2^+. For this purpose it contains homogeneous electrical and magnetic fields perpendicular each to the other. In the case of adequate adjustment of these two fields, the protons/deuterons pass the Wienfilter without deflection, while havier ions like N^+ are removed from the beam. Thus it is possible to decrease the underground for the subsequent polarization measuremen. The vertical magnetic dipole field is produced by a coil and a C-shaped pole shoe. With a maximum magnetic flux density of 200 mT and the magnetic length of 21.6 ± 0.2 cm, it is possible to rotate the spinvector in the horizontal plane by about 90° for all LSP-beam energies. For an uniform rotation of the spins of all protons/deuterons within the beam, the homogeneity of the field gets relevant. Field measurements show that the fields on the beam axis and at the beam boundaries at ± 15 mm differ by $1.1 \cdot 10^{-3}$, which is within the requested homogeneity.

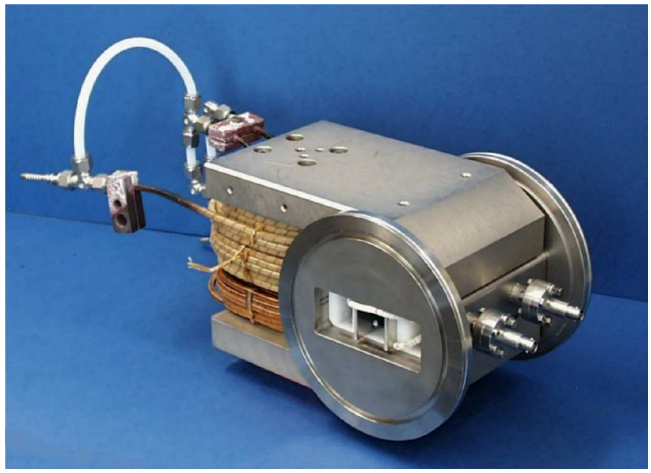

Fig. 2: C-magnet and electrode chamber of the Wienfilter (chamber length 18 cm) with water and current connections for the coil (left) and adapters for the electrodes (right).

For deuterons, the high magnetic flux density and current, needed because of the low magnetic moment, caused high temperature of the air-cooled coils of the old Wienfilter. The tubular coils of the new device are cooled by water, which allows continuous use without temperature problems. The electrical field is produced by two parallel capacitor plates. These and their ambient electrode chamber, manufactured from stainless steel with low permeability, are inserted between the gap of the magnet. The low permeability guarantees a minimal detoriation of the homogeneity of the field. First experiments have shown a transmission of 25%. By optimization of the length of the electric field it should be possible to achieve a much better transmission.

References:

[1] R. Engels et al., Rev. Sci. Instrum., **74** (2003) 4607.
[2] T. Ullrich, Diploma thesis (Fachhochschule Aachen, Abteilung Jülich).
[3] U. Bechstedt et al., contribution to this report.

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