The Lamb-shift Polarimeter for the Polarized Internal Target (PIT) at ANKE

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The Lamb-shift polarimeter [1] (LSP) constitutes an exellent instrument for the determination of the polarisation of an atomic beam produced, e.g. in a polarized atomic beam source ABS [2]. Within a few seconds, the beam polarization can be measured to a high degree of precission. The transition units of the ABS, necessary to provide the desired magnetic substate population for hydrogen and deuterium, could be tuned very efficiently. Typical vector polarization values for hydrogen amount to $p_z = +0.92 \pm 0.01$ and $p_z = -0.97 \pm 0.01$. The adjustments for deuterium were performed within one day.

During the studies of the ABS beam properties, an additional correction factor was identified, required to determine the polarization of the beam from the measured Lyman-α spectrum: The efficiency of the ionizer turns out to depend on the injected hyperfine states of the atoms in the beam, leading to a correction factor ranging from 1 to 1.007.

At ANKE the Lamb-shift polarimeter shall be used to measure the polarization of the atoms in the polarized internal target. In this case only about 1 to 2% of the stored polarized hydrogen or deuterium atoms are extracted, of which about 10^{13} atoms/s reach the LSP. In order to adopt the LSP for use at the PIT at ANKE [3], a number of modifications have to be taken into account:

- A chopper located between storage cell and LSP allows one to reduce effects arising from unpolarized gas that enters the ionizer from the target chamber. Employing a storage oscilloscope or a lock-in amplifier together with a trigger signal from the chopper, the sensitivity of the polarimeter can be substantially increased by at least one order of magnitude.

- In order to separate the LSP from the COSY vacuum system, a fast shut-off valve between target chamber and LSP is neccessary.

- A new ionizer with an internal getter pump was designed and built to reduce the residual gas in the ionization region. Without such a pump, more protons originate from residual gas than from the polarized atoms of the target. In addition, the new ionizer produced about twice the magnetic field than its precursor, whereby the polarization of mixed hyperfine states is preserved more efficiently during ionization.

- With the previous simple Wienfilter the polarization vector of deuterons could not be rotated by 60 ° . For this reason, a new shorter Wienfilter has been developed[1].

- At ANKE there is not sufficient space available to mount all components of the LSP along a straight beam line. In order to provide a solution, a new 60 ° electrostatic deflector is being built as well[2]. In addition, the deflection of the ion beam increases the sensitivity of the polarimeter, because neutral atoms cannot produce a background signal, since they don't reach the quenching region.

- The demineralized cooling water of COSY does not tolerate components made from aluminum in the circuit. Therefore new coils for the magnetic field in the cesium cell are being designed.

- The acceptance of the LSP for Lyman-α photons in the quenching region has been increased by employing a new photomultiplier with a four times larger photocathode in a new small quenching chamber. Improved pumping conditions in the quenching region reduce further the background in the Lyman spectrum.

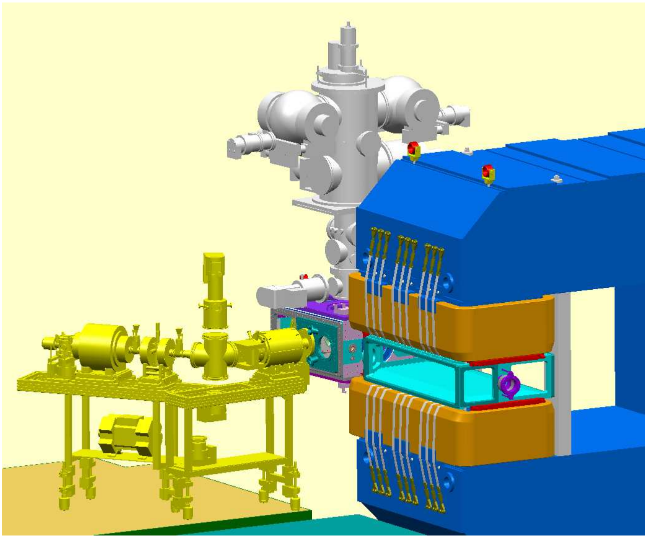

Fig. 1: 3D CAD drawing of the Lamb-shift polarimeter for ANKE together with ABS and new target chamber.

The control system of the LSP will be similar to the one implemented at the ABS. The hardware based on a Siemens S7 PLC to remotely control all components has been assembled and is presently being tested. First measurements of the polarization of atoms extracted from a storage cell test arrangement utilizing the LSP will be carried out in the beginning of 2003.

References:

[1] R. Engels, *Entwicklung eines universellen Lamb-shift Polarimeters für polarisierte Atomstrahl-Targets wie an ANKE/COSY*, PhD-thesis, Universität zu Köln, Jül-3976, ISSN 0944-2952, (2002).

[2] M. Mikirtychiants *et al.*, IKP+COSY Ann. Rep. 2001, Jül-3978 (2002) p.67.

[3] H. Seyfarth *et al.*, contribution to the present IKP Ann. Rep.

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