Operation of the HERMES Polarised Hydrogen/Deuterium Target in 1997/1998 ◊

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During the HERMES data taking periods 1996 and 1997, the target was operated with polarised hydrogen [1]. The hydrogen target achieved an average target thickness D_T of $D_T = 7.62 \cdot 10^{13}\, nucleons\, cm^{-2}$ with an average target polarisation P_T of $P_T = 0.88 \pm 0.04$ in the 1997 data taking period [2]. The target performance could be improved in 1997 in comparison to 1996, especially the fraction of atoms surviving recombination α_r was close to the maximum in 1997 and reached an average value of $\alpha_r = 0.93 \pm 0.04$. The average proton polarisation was $P_z = 0.92 \pm 0.03$.

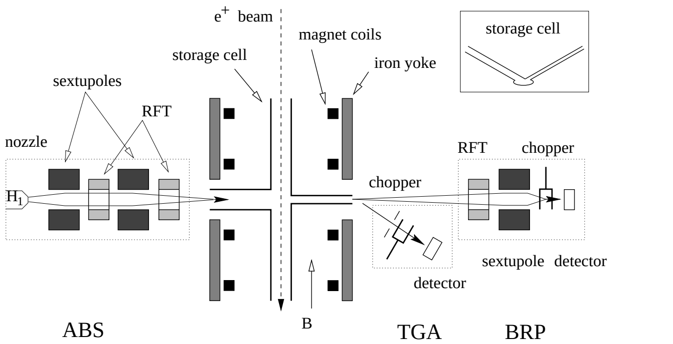

Fig. 1: Scheme of the polarised HERMES deuterium target assembly.

A new calibration method of the Breit-Rabi type target polarimeter (BRP) was developed, which makes use of the possibbility of the HERMES ABS to run up to 7 different injection modes. Using the new method the systematic uncertainty of the BRP could be decreased by a factor of 3 to about ± 0.015 [3]. A new rate equation system based on a combination of the diffusion equation and known theories for wall depolarization and spin exchange collisions was used to model the measured polarisation values [4]. The predictions of the model were compared with bhabha measurements performed at HERMES [5] and agreed within the errors.

Furthermore, the processes leading to recombination could be modelled and quantitatively understood by means of a two layer modell [6]. The left graph of fig. 2 shows the measured atomic fraction vs. the storage cell temperature and the fit based on the two layer model. The extracted recombination probabilities $\gamma_{1,2}$ and layer coverages $\Theta_{1,2}$ are plotted in the right graph. It was found, that water, which is created in the ABS discharge tube and ballistically injected into the target storage cell, helps to reduce recombination.

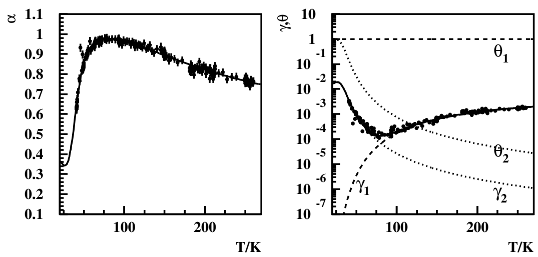

Fig. 2: Measured degree of dissociation α (left) vs. storage cell temperature and fitted recombination probabilities $\gamma_{1,2}$ and layer coverages $\Theta_{1,2}$ of the relevant monolayers (right).

In the winter shutdown 1997/1998, the operation with polarised deuterium was prepared (a schematic is shown in fig. 1) and during the 1998 data taking period, the target was operated with polarised deuterium ($\vec{D}$). The $\vec{D}$ target is operated in the vectorpolarized mode with two hyperfine states. The sextupole system rejects 3 of the 6 hyperfine states. The necessary removal of one more hyperfine state has to be performed by an additional radio frequency transition in between the subdivided sextupole system. The rejection efficiency is in this case known to be imperfect, which reduces the maximal injected polarisation to about 0.92. The typical measured nuclear polarisation during 1998 running was about 0.88 and close to the possible maximum.

References

[1] C. Baumgarten *et al.*, Jahresbericht 1996
[2] C. Baumgarten, Proc. SPIN '98; http://spin.ihep.su/spin98.
[3] M. Henoch, diploma thesis, Universität Münster 1998.
[4] C. Baumgarten, Ph.D. thesis, LMU München, in preparation
[5] T. Benisch, Ph.D. thesis, FAU Erlangen Nürnberg 1998.
[6] H. Kolster, Ph.D. thesis, LMU München, 1998

◊ Work supported by BMBF under 06 LM 363/1 and BL-Munich