COSY Proposal and Beam Request

For Lab. use

Exp. No.: 201.1	Session No. 39

Title of Experiment

Commissioning and initial research with the Polarized Internal deuterium gas Target at ANKE

Collaborators:

ANKE Collaboration

Spokespersons for experiment: Names: **David Chiladze and Kirill Grigoryev**

Address:
David Chiladze and Kirill Grigoryev
Institut für Kernphysik II
Forschungszentrum Jülich
D-52425 Jülich, Germany

Is support from the LSF program of the EC requested?
No

Date: **28.03.2011**

Phone: **+49-2461-616982** Fax: **+49-2461-613930** E-mail: **d.chiladze@fz-juelich.de**
Phone: **+49-2461-612147** Fax: **+49-2461-613930** E-mail: **k.grigoryev@fz-juelich.de**

Total number of particles and type of beam (p,d,polarization)	Momentum range (MeV/c)	Intensity or internal reaction rate (particles per second) minimum needed	Intensity or internal reaction rate (particles per second) maximum useful
unpolarized protons	1219	$1 \cdot 10^{10}$	$1 \cdot 10^{11}$
Type of target	**Safety aspects (if any)**	**Earliest date of installation**	**Total beam time (weeks)**
ANKE PIT D_2 polarized target	-	1^{st}, January 2012	2 weeks

What equipment, floorspace etc. is expected from Forschungszentrum Jülich/IKP?

Summary of experiment (do not exceed this space):

The proposal and beam request concerns the commissioning of the deuterium Polarized Internal Target (PIT) for dedicated experiment of double-polarized $\vec{p}\vec{d}$ charge-exchange reaction study at ANKE. It will include the measurements of vector and tensor polarizations of the deuterium gas target. The dependence of the polarization along the storage cell should be determined as well. The anticipated physics program of single- and double-polarization measurements with the deuterium gas target and unpolarized proton beam is briefly outlined, as well as the results of the commissioning of the polarized hydrogen gas target carried out previously. The status of the different PIT components is discussed, and the time schedule for the commissioning of the polarized deuterium target is presented.

For the activities outlined in the proposal, **two weeks** of beam time are requested.

Attach scientific justification and a description of the experiment providing the following information:

For proposals:
Total beam time (or number of particles) needed; specification of all necessary resources

For beam requests:
Remaining beam time (allocations minus time already taken)

Scientific justification:

What are you trying to learn?
What is the relation to theory?
Why is this experiment unique?

Details of experiment:

Description of apparatus.
What is the status of the apparatus?
What targets will be used and who will supply them?
What parameters are to be measured and how are they measured?
Estimates of solid angle, counting rate, background, etc., and assumptions used to make these estimates.
Details which determine the time requested.
How will the analysis be performed and where?

General information:

Status of data taken in previous studies.
What makes COSY suitable for the experiment?
Other considerations relevant to the review of the proposal by the PAC.

EC-Support:

The European Commission supports access of new users from member and associated states to COSY. Travel and subsistence costs can be granted in the frame of the program Access to Large Scale Facilities (LSF).

COSY Proposal and Beam Request

Commissioning and Initial Research with the Polarised Internal Deuterium Gas Target at ANKE

(COSY Experiment #201)

S. Barsov[1], D. Chiladze[2,3], S. Dymov[4,5], R. Engels[2], R. Gebel[2], K. Grigoryev[1], B. Gou[6], A. Kacharava[2], N. Lomidze[3], B. Lorentz[2], A. Kulikov[4], G. Macharashvili[3,4], D. Mchedlishvili[2,3], M. Mikirtytchiants[1], S. Mikirtytchiants[1], S. Merzliakov[2], M. Nioradze[3], D. Prasuhn[2], F. Rathmann[2], H. Seyfarth[2], R. Schleichert[2], H. Ströher[2], M. Tabidze[3], S. Trusov[2], Yu. Valdau[2], A. Vasilyev[1], Ch. Weidemann[2], and C. Wilkin[7]

[1]High Energy Physics Department, PNPI, 188350 Gatchina, Russia
[2]Institut für Kernphysik, Forschungszentrum Jülich, 52425 Jülich, Germany
[3]High Energy Physics Institute, Tbilisi State University, 0186 Tbilisi, Georgia
[4]Joint Institute for Nuclear Research, LNP, 141980 Dubna, Russia
[5]Physikalisches Institut II, Universität Erlangen–Nürnberg, 91058 Erlangen, Germany
[6]Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou 730000, P.R. China.
[7]Physics and Astronomy Department, UCL, London WC1E 6BT, U.K.

for the **ANKE Collaboration**

Spokespersons: David Chiladze and Kirill Grigoryev

Jülich, March 28, 2011

Abstract

The current proposal and beam request concerns the final commissioning of the Polarised Internal Target (PIT) with deuterium gas and the start-up of the double–polarised research phase of the *pn*–programme at ANKE. It will include measurements of the vector and tensor polarisations of the deuterium gas target by nuclear reactions. The dependence of the polarisation along the storage cell will be measured as well. The anticipated physics programme of single- and double-polarisation measurements with the deuterium gas target and (un)polarised proton beam is briefly outlined, as well as the results of the previous commissioning run (COSY exp. #201.0). The time line for the further commissioning tasks is presented.

For the activities outlined in the proposal, **two weeks** of beam time are requested with unpolarised proton beam with kinetic energy of T_p=600 MeV.

Contents

1 Summary of the first commissioning run

For the commissioning of the deuterium Polarised Internal gas Target (PIT), two weeks were granted by PAC #37 and these were used in November/December 2009. The previous proposal [1] consisted of two phases: the **first phase**, commissioning with the Lamb–shift polarimeter (LSP) without the COSY beam, was **partially completed**. However, the **second phase**, which required a dedicated beam development with the closed storage cell, stacking injection and electron cooling, **failed completely**, due to technical problems at COSY. The results obtained are described in Section 3.

Based on our experience of commissioning and running the PIT with polarised hydrogen and partially with deuterium, we request **two weeks** to finalize the commissioning of the ANKE polarised deuterium source and to make a first production run on the Charge–Exchange study with the polarised deuterium target.

2 Brief summary of the physics case

A key feature of the experiments ongoing and planned at ANKE–COSY is the use of polarised beams and targets, which allows one to perform double–polarisation measurements [2]. Since the summer of 2005, ANKE has been equipped with a Polarised Internal Target (PIT) [3, 5, 6] located between the dipole magnets D1 and D2 (see Fig. 1 in COSY proposal #201.0 [1]). The results obtained during five weeks of a successful production run in October 2009 [7], allocated for the measurement of the Charge–Exchange break–up reaction of polarised deuterons on a polarised hydrogen target $\vec{d}\vec{p} \to \{pp\}n$, have been reported in [8]. Furthermore, we are now preparing for seven weeks of beam time with a polarised 706 MeV deuteron beam and a polarised hydrogen target in order to measure the spin correlation coefficients ($A_{x,x}, A_{y,y}$) of the $\vec{n}\,\vec{p} \to \{pp\}_s\pi^-$ reaction [9].

Given the above successes in the *first* handling of the double–polarised data from the polarised hydrogen target ($\vec{\mathrm{H}}$), we can conclude that ANKE–COSY is ready now to embark on the experimental programme of double–polarisation measurements using the deuterium gas target ($\vec{\mathrm{D}}$). It is expected that this will include:

- The polarised deuteron beam only allows the investigation of the np charge–exchange amplitudes up to a maximum COSY energy of $T_d/2 \approx 1.1$ GeV. It is suggested to extend this range up to about 3 GeV by using a polarised proton beam incident on a polarised deuterium target ($\vec{\mathrm{D}}$) and detecting TWO slow protons in an array of solid state spectator telescopes. The interaction vertex is then very well located within the long target, making it unnecessary to measure the fast neutron in the ANKE facility to identify the $\vec{d}(\vec{p}, pp)n$ reaction. Events of this type have already been identified within the very limited angular acceptance of a single telescope [2]. Eventually this approach might be extended to the production of the $\Delta^0(1232)$ with some of its decay products being detected in ANKE.

- Simultaneously with the charge–exchange investigation, we would measure a fast proton in ANKE in coincidence with one slow (spectator) proton in the silicon telescope array. This would allow measurements of the elastic $\vec{p}\vec{n} \to pn$ polarisation observables in the forward cone below $\theta_{cm} \approx 30^\circ$. The combination of this and the previous item would have a major impact on the isospin–zero nucleon–nucleon phase–shift determinations, for which data are sadly lacking above 800 MeV. As a by–product one will also obtain data on inclusive pion production in polarised proton–neutron collisions, $\vec{p}\vec{n} \to \pi X$.

- We have already investigated the high–momentum–transfer (backward) deuteron charge–exchange breakup reaction, $pd \to (pp)n$, with an unpolarised beam and target and determined the differential cross section [9, 11]. Using a polarised proton beam, we have also obtained the angular distributions of the analysing power at $T_p = 500$ and 800 MeV [12]. Considerable clarification of the dominant reaction mechanism will be obtained through the measurement of a combination of the deuteron tensor analysing power and the transverse $\vec{p}\vec{d}$ spin–correlation parameter [13].

Once the experimental goals of the present request have been achieved, we will submit to next COSY PAC a dedicated proposal for double–polarisation measurements using deuterium gas as an effective neutron target.

3 Status of the deuterium PIT commissioning

3.1 Phase 1: Measurements without the COSY beam

As was described in proposal #201.0 to PAC #37, several items should be addressed during the first scheduled week (November/December 2009) without the use of a COSY beam. It was planned to spend the days for beam development and use the nights to prepare the Atomic Beam Source, its transition units, and to adjust the Lamb–shift polarimeter to work with deuterium. These tasks and the results achieved are described below:

- For any ANKE beam time with a polarised deuterium gas target the measurements of the magnetic field in the ANKE target chamber near the storage–cell region with different settings of the D2 magnet are necessary. This is because we need to operate the source in such a way that also combinations of mixed states are injected into the storage cell. A second reason is because of the different magnitude of the vertical stray field of D2, which is used as a holding field for the polarised deuterium atoms, the nuclear polarisation varies along the cell axis. The results of these measurements are shown on Fig. 1.

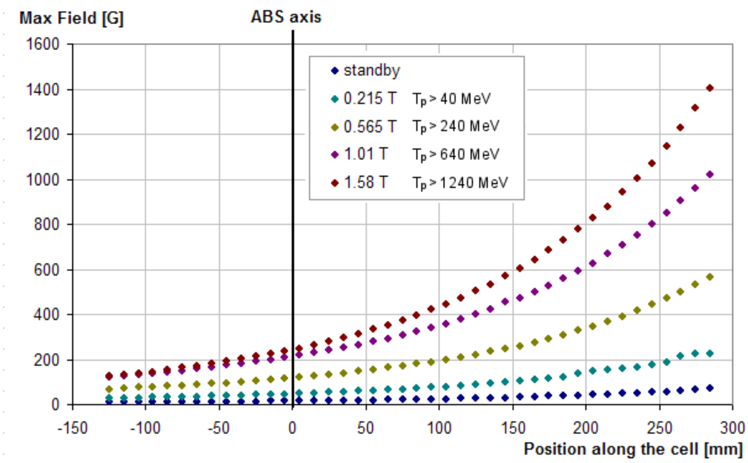

Figure 1: Magnetic field along the storage cell at the ANKE target chamber for different settings of the D2 magnet. Minimum possible proton kinetic energies are also indicated.

- For the asymmetry measurements with the Lamb-shift polarimeter, the atomic beam should not cross a region with zero magnetic field. In such a case, the information about the target polarisation or the atomic polarisation itself will be lost (if this region is located in front of the storage cell). At the various D2 settings, with or without the field of the ionizer (first component of the polarimeter), there are no regions inside the target chamber (see Fig. 2) with zero–field crossing.

- The tuning of the radio–frequency transition units was the next step in the commissioning of the atomic beam source. The results of the first asymmetry measurements with the LSP showed that the final polarisation is much smaller than the one expected. The behaviour of the polarisation suggests that there was at least one zero–field crossing somewhere around the second transition unit. This would make the first transition ineffective and also have some impact on the second transition unit. It was not possible to discover this earlier during the setup of the source at its off-beam position, because it was most probably caused by a magnetization of the shielding–caps of the transition unit, which happened during the previous beam time. It was also not possible to recognize it with the hydrogen target. We are now preparing active shieldings for the second transition unit, which will be installed for the next beam time with the hydrogen PIT in May 2011 [9]. Nevertheless, even with these problems, the tuning of the transition units was still possible and the atomic beam source was ready for the data–taking on time.

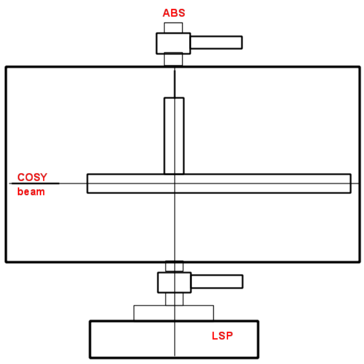

Figure 2: Sketch of a side view of the ANKE target chamber with the PIT main components: storage cell ($\sim$ 400 mm along the beam), ABS, and LSP. The COSY beam comes from the left.

3.2 Phase 2: Measurements with the COSY beam

To complete the deuterium PIT commissioning with the unpolarised proton beam, we asked for two energies to be ready for the Thursday of the first week. It was necessary to schedule two days for the installation of the STT detectors and to start the taking of data on Friday of the first week. However, due to some technical problems in the previous experiment #172.1, we were asked to grant some of our time to this experiment. Unforeseen problems with providing a beam that would pass through the storage cell at zero degrees and with electron cooling at injection energy then extended the beam development into the second week. After the problems of the ANKE magnet system at zero degrees had been overcome, it was found that the D2 magnet and detection system could not be moved to the desired angle of 10.6°, because of the interlock system. At the maximum possible shift of 9.2°, the accelerator crew was not able to prepare the beam and we decided to reduce this angle to 8.5°, where losses in the storage cell at injection were not so dramatically high and some beam could still be accelerated through the cell. When almost everything was ready for the installation of the STT detectors, in the early morning of Tuesday of the second week, almost all COSY electricity was switched off due to work by an external company on the replacement of the power cables in the COSY building. The beam development was continued half a day later from the earlier saved settings. This delayed the installation of the STT from Wednesday night to Thursday night of the second week and the first data were taken on Thursday noon. This left only four incomplete days (plus an extra day granted to us from the following HESR–COSY week) for measurements at a single beam energy.

4 Results of first commissioning

The commissioning of the PIT with deuterium gas at ANKE with the COSY beam was not finished due to:

1. The main problems of COSY performance:
   - **Bad acceleration** at non-zero ANKE angles;
   - Almost **No electron cooling** at injection. This generates high background from the storage–cell walls at the beginning of the cycles. It created great difficulties for the STT detector.

2. ANKE technical problems:
   - ANKE position for 10.6° deflection angle was technically not possible, due to the changes in the COSY interlock system. At the maximum possible angle (9.2°), it was not possible to accelerate the beam through the storage cell and we had to work at the non-optimal deflection angle of 8.5°;
   - Due to the high background and massive hits on the Teflon coating of the storage cell, one layer of the STT detector suffered severe damage.

On the other hand some tasks were completed successfully:

- Settings for transition units were found during the nights of the first week.

- Active shieldings of the weak field transition unit are necessary. Now they have been prepared and will be installed for the next beam time [9].

- Magnetic fields along the COSY and PIT beams at the ANKE target chamber were measured for different D2 field strengths (from stand-by mode to the maximum possible field).

- Lower limits of the ABS polarization were measured with the LSP. Without background corrections, the polarization was $P_z = -0.40$ for states $|3\rangle + |4\rangle$ and $P_z = 0.33$ for $|1\rangle + |6\rangle$. The corresponding laboratory results were $P_z = -0.82 \pm 0.06$ and $P_z = 0.78 \pm 0.05$, respectively.

5 Determination of the polarisation inside the deuterium storage cell target

In this section the principle for the determination of the deuterium target polarisation components, both vector (Q_y) and tensor (Q_{yy}), are presented. For this purpose, we require reactions that have high production rates, with large and well measured analysing powers, which could be detected and well identified at ANKE. We will concentrate mainly on three reactions: (i) quasi–free $p\vec{n} \to d\pi^0$, (ii) $p\vec{d} \to {}^3\text{He}\,\pi^0$, and (iii) $p\vec{d} \to {}^3\text{H}\,\pi^+$. Isospin conservation requires the analysing powers for the latter two reactions to be identical, though the cross section for π^+ production should be a factor of two larger than for π^0.

As was already demonstrated in previous ANKE experiments, the known values of the proton analysing power A_y^p of $p\vec{p} \to d\pi^+$ reaction, available from SAID [14], leads to the determination of the target (or beam) vector polarisation Q_y. The same is true for the second and third reactions for the determination of the tensor polarisation Q_{yy}, since very good measurements of the differential cross sections and tensor analysing powers of $\vec{d}p \to {}^3\text{He}\,\pi^0$ are available in the forward/backward directions over a wide energy interval from SATURNE measurements [15]. We plan to use these data particularly at a proton beam energy of $T_d/2 = 600$ MeV. The monitoring of 'ON-line polarisation' stability will be provided by the measurement of the relative asymmetry by detecting the quasi–free *pp*-elastic scattering in the left and right spectator telescopes (STT), or *pd*-elastic scattering by demanding a coincidence between the STT and the forward detector system.

The possible configurations of the deuterium target polarisations for the ANKE source are presented in Table 1.

Pol #	Transactions	Hyperfine states in the LSP						Ideal polarization	
		$\|1\rangle$	$\|2\rangle$	$\|3\rangle$	$\|4\rangle$	$\|5\rangle$	$\|6\rangle$	P_z	P_{zz}
1	-	•	•	•				0.00	0.00
2	MFT $3 \to 4$	•	•					0.50	-0.50
3	WFT $1 \to 4$ WFT $2 \to 3$		•	•	•			-0.67	0.00
4	MFT $3 \to 4$ WFT $1 \to 4$, $2 \to 3$			•	•			-1.00	1.00
5	SFT $2 \to 6$	•		•			•	0.33	1.00
6	MFT $3 \to 4$ SFT $2 \to 6$	•					•	1.00	1.00
7	SFT $3 \to 5$	•	•			•		0.33	-1.00
8	MFT $3 \to 4$ SFT $3 \to 5$	•	•		•			0.00	0.00
9	MFT $1 \to 4$		•	•				-0.50	-0.50
10	MFT $1 \to 4$ SFT $2 \to 6$			•			•	0.00	1.00
11	MFT $1 \to 4$ SFT $3 \to 5$		•			•		0.00	-2.00

Table 1: Possible configurations of the atomic beam source for feeding the storage cell with deuterium gas. The colour lines apply to vector (green) and tensor (blue) polarisation in the cell.

The variation of the magnetic field along the storage cell means that the polarisation will not be constant inside the cell. Figure 3 shows the distribution of vector and tensor polarisation for a D2 field of 0.841 T. This condition emphasizes the importance of vertex reconstruction to be able to measure the target polarisation in different ranges of the cell. A method to reconstruct vertices inside the extended target has been already developed and tested during the November 2005 beam time. The $pp \to d\pi^+$ process with the detection of both secondaries was chosen for this purpose. The trajectories of both particles, together with their arrival times, allow the reconstruction of coordinates of interaction point with the use of kinematical constraints. The resolution of the reconstructed coordinate was $\sigma_Z = 3.6$ cm longitudinally and $\sigma_X = 0.8$ cm transversely [16].

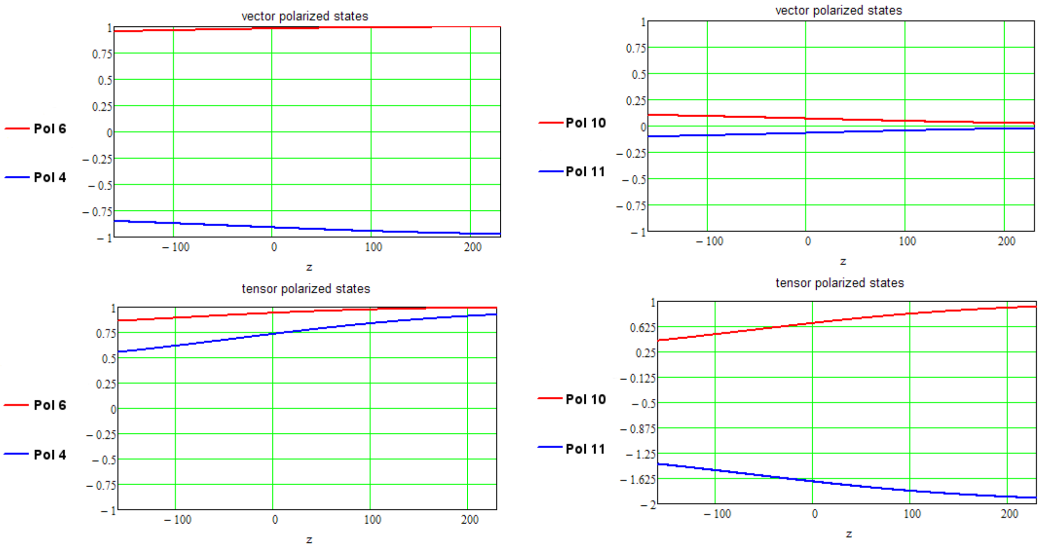

Figure 3: Vector and tensor polarisation distributions along the cell for polarisation states 4, 6, 10, 11 of Table 1. States 4 and 6 are are injected with vector polarisation -1 and +1 respectively and +1 tensor polarisation. States 10 and 11 are considered as pure tensor states (no vector polarisation) with tensor polarisation +1 and -2.

6 Identification of the polarimetry reactions using the PIT

In this section the event identification for the dp–induced reactions are demonstrated when using a long cell target. This is done on the basis of experimental information obtained in dp interactions, especially from the shape of the background from the cell walls, which is imitated through the injection of N_2 gas into the cell [7].

Figure 4 shows events initiated by an incident deuteron beam energy of 1200 MeV (equivalent to 600 MeV protons), where two charged particles were detected in the double–layer forward scintillation hodoscope during the January 2007 beam–time [7]. Polarised $\vec{\mathrm{H}}$ (unpolarised N_2) gas was used in the cell. The figure shows the arrival–time differences for the two particles in the hodoscope (calculated after momentum and trajectory reconstruction under the assumption that both particles were protons) *versus* the measured difference of the two time signals from the scintillators. Thus, the two protons from the $dp \to (pp)n$ reaction should lie along the diagonal, with other particle pairs (such as dp) being found elsewhere. The off–diagonal events, of course, occur in pairs, rotated about the centre by 180°. A similar picture was obtained from the H_2 cluster target measurements [4].

Reactions in the N_2 gas in the cell are expected to show similar smearing of the ejectile momenta due to the Fermi motion of the nucleons as reactions in the aluminium cell–wall material. The comparison of the results presented in the two panels of Fig. 4 shows strong effects for both pp and $dp\pi^0$ events. This should allow one to discriminate between reactions with the $\vec{\mathrm{H}}$ (and later also $\vec{\mathrm{D}}$) gas in the storage cell from wall events due to the

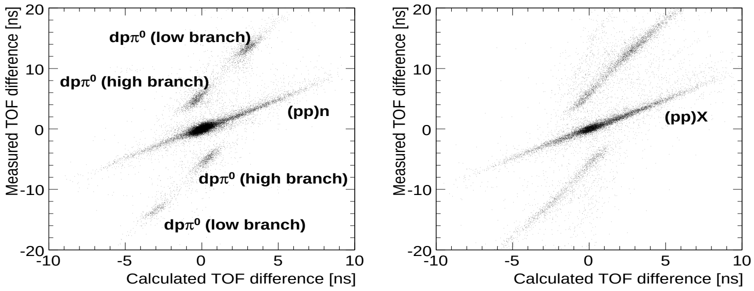

Figure 4: Time difference of the two detected charged particles, calculated under the assumption that both particles are protons *versus* the measured time difference for events from 1200 MeV deuterons and $\vec{\mathrm{H}}$ gas (left panel) and N_2 gas (right panel) in the storage cell. These results were obtained during the January 2007 beam-time.

different widths in the momentum distribution. On the other hand, the narrow band of the *pp* events is very similar for $\vec{\mathrm{H}}$ and N_2 targets (and hence for the cell wall).

6.1 The $\vec{d}\vec{p} \to dp_{sp}\pi^0$ reaction

Time-of-flight cuts applied to the distributions of Fig. 4 allow us to select the *dp* candidates and hence to derive the missing–mass distributions of the $dp \to dp\pi^0$ reactions that are presented in Fig. 5.

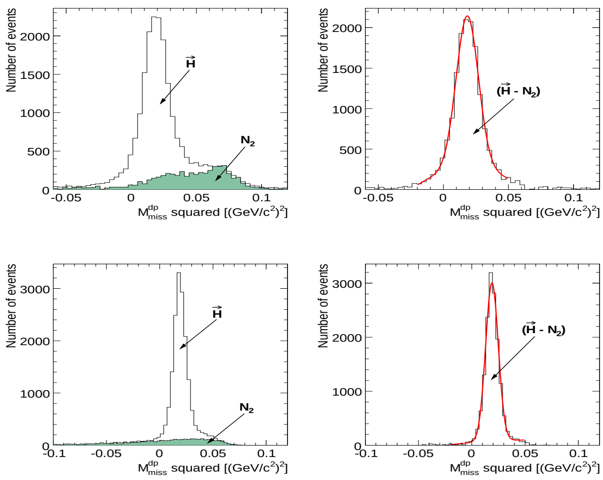

Figure 5: Missing–mass squared distribution for the reaction $\vec{d}\vec{p} \to (dp_{sp})X$ (upper panel corresponds to **High** branch and lower one to **Lower** branch) measured with the storage cell and the 1200 MeV deuteron beam. The open histogram in the left panel represents the result obtained with the hydrogen gas while the shaded areas show the 'background' contributions measured with nitrogen in the cell. These latter distributions have been normalised to the hydrogen data to the right of the peak. In the right panel the data with the hydrogen target is shown after background subtraction. The missing–mass squared corresponding to the unobserved π^0 is clearly seen with a mean value of $0.0184\,(\mathrm{GeV/c^2})^2$ and $\sigma = 8.5\,(\mathrm{MeV/c^2})^2$ (High branch), and a mean value of $0.0189\,(\mathrm{GeV/c^2})^2$ and $\sigma = 6.0\,(\mathrm{MeV/c^2})^2$ for the low branch.

Data with the hydrogen target ($\vec{\mathrm{H}}$) show a prominent peak corresponding to the production of a π^0. The background in both cases is very similar to that measured with the nitrogen target (N_2) and the natural assumption is that in the hydrogen case the background originates from the cell walls.

6.2 The $\vec{d}\vec{p} \to {}^3\mathrm{He}\,\pi^0/{}^3\mathrm{H}\,\pi^+$ reactions

It was also shown in previous measurements with the cluster target at ANKE [4] that there is a large acceptance for the $dp \to {}^3\mathrm{He}\,\pi^0$ reaction when the ^{3}He are emitted very close to the initial beam direction. The high–momentum branch of ^{3}He particles could be selected in an off–line analysis by applying two–dimensional cuts in ΔE *versus* momentum and Δt *versus* momentum for individual layers of the forward hodoscope. The π^0 was then identified through the missing mass derived from the ^{3}He measurement. After background subtraction, the mean value of the missing–mass distribution (Fig. 6) is close to the pion mass.

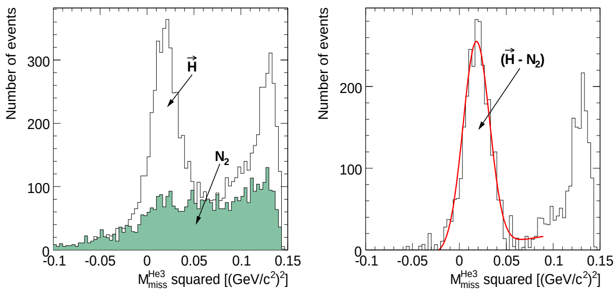

Figure 6: Missing–mass squared distribution for the $\vec{d}\vec{p} \to {}^3\mathrm{He}\,X$ reaction measured with the storage cell and the 1200 MeV deuteron beam. The open histogram in the left panel represents the result obtained with the hydrogen gas, while the shaded areas show the ‘background contributions measured with nitrogen in the cell. The latter distribution has been normalised to the hydrogen data to the right of the peak. In the right panel the data with hydrogen target is shown after background subtraction. The missing–mass squared peak corresponding to the unobserved π^0 is clearly seen with a mean value of $0.0182\,(\mathrm{GeV/c^2})^2$ and $\sigma = 14.0\,(\mathrm{MeV/c^2})^2$.

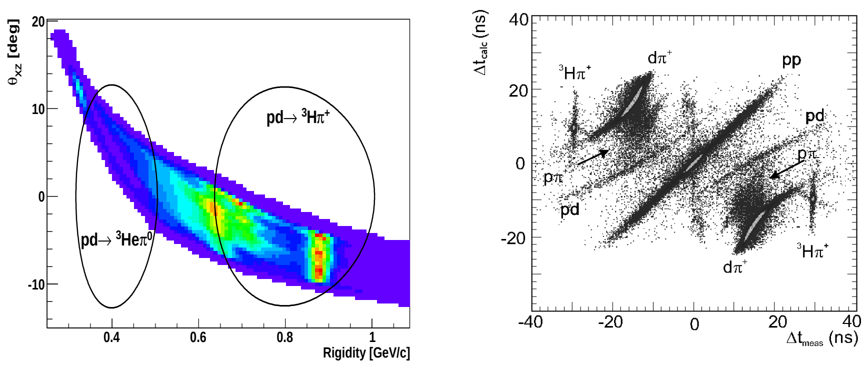

Figure 7: Left panel: Single-particle acceptance of the ANKE forward detector system at $T_p = 500\,\mathrm{MeV}$ showing the polar angle projection θ_{xz} as a function of the particle rigidity. The curves show the kinematical loci for the processes that may be used for the polarimetry study. Right panel: Distribution of two-particle events showing the measured Δt_{meas} versus the calculated difference Δt_{calc} at $T_p = 500\,\mathrm{MeV}$.

Isospin invariance requires that all the analysing powers in the $\vec{p}\vec{d} \to {}^3\mathrm{He}\,\pi^0$ and $\vec{p}\vec{d} \to {}^3\mathrm{H}\,\pi^+$ reactions should be identical. Extra target tensor polarimetry data will be obtained in parallel from the latter reaction, which has the advantage that the two tracks will give further, more precise information on the vertex position ($\sigma_Z \lesssim 2.0$ cm). The ${}^3\mathrm{H}\,\pi^+$ final pairs from proton-deuteron collisions were already detected in an early ANKE experiment at $T_p = 500$ MeV using the deuterium cluster target. The acceptance for a charged particle in ANKE under these conditions is shown in the left panel of Fig. 7 and the reaction identification via the Δt selection in the right panel.

7 Detection system for the new measurements

Once the first part of the commissioning with the Lamb–shift polarimeter is completed, the machine development can be initiated. For safety reasons, the STT–detectors should be installed in the target chamber only after the beam orbit is optimized and the losses on the storage cell walls at injection and during acceleration are small. We plan to use the openable cell for the measurements. For the first time, four telescopes will be mounted on the left and right sides of the ANKE target chamber (as shown in Fig. 8) and installed as close as possible to each other. This means that the first STT should be shifted from its nominal position downstream by by 30 mm and the second one 30 mm upstream with respect to the COSY beam direction.

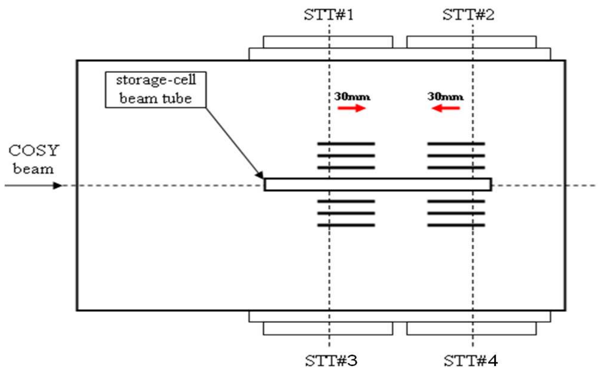

Figure 8: Positioning of four STTs at the ANKE target chamber.

8 Beam-time request and time line

For the measurements outlined above, **two weeks** of beam time are requested with an unpolarised proton beam at a kinetic energy of T_p=600 MeV with the following aims:

1. The **first week** is mainly needed to commission the polarised internal target at ANKE with the LSP. The Lamb–shift polarimeter (LSP) [5] will be used as a tool to adjust the transition units of the polarised atomic beam source (ABS) [6] that are utilised to feed the storage cell.

2. The main goal of the **second week** is to determine the target vector polarisation and the target density using the quasi–free $p\vec{n} \to d\pi^0$ reaction [14] and tensor polarisation

using the $\vec{d}\vec{p} \to {}^3\mathrm{He}\,\pi^0/{}^3\mathrm{H}\,\pi^+$ reactions [15]. Based on the experimental data collected for $p\vec{d} \to \{pp\}n$ breakup reaction, we will submit a dedicated proposal for double–polarisation measurements to the next COSY PAC.

The time-line foreseen (from now) for the activities listed above is as follows:

- ABS ($\vec{H}$) and Lamb–shift polarimeter will be installed in calendar weeks #18 and #19 for the COSY experiment #205.
- The COSY experiment #205 with a polarised deuteron beam and polarised hydrogen target will start data taking in calendar week #20 and last for 7 weeks.
- At the moment it is not clear how long the COSY summer shutdown will be and whether it will be possible to carry out the first part of deuterium commissioning during this time, *i.e.*, during the first week of the summer shutdown.
- It is planned to take out the ABS in calendar weeks #28-29, and to install the ANKE cluster target, in order to allow PAX measurements (see proposal #199.2 from D. Oellers to this PAC) in the second half of 2011.
- In such a scenario, the ANKE ABS could be put back during the winter shutdown and commissioning would take place in early 2012.
- There is a scheduled beam time in May 2011, which plans to use openable cell to reduce the beam losses during injection and acceleration [9]. Based on the outcome of this experiment, the option of openable cell with deuterium gass might be considered in the requested commissioning run.

The main goal is to accomplish a measurement of the target performance, *i.e.* target polarisation and target density. Once the target polarisation has been determined, the data sample obtained can be used to derive the analysing powers of the charge–exchange reaction $p\vec{d} \to (pp)n$. However, experience gained during the previous experiments has shown that the acceptance of ANKE is such that several reactions will be recorded simultaneously.

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