Request of prolongation of the ALPOM-II proposal

(Dated: December 5, 2016)

I. FOREWORD

During the year 2016 the setup ALPOM2 was prepared for data taking and tested with unpolarized deuteron beams in the June run. The results of this run and the concept of using the charge exchange *np* reaction for neutron polarimetry were presented at two international conferences: the report *' Neutron polarimetry in the range 1-6 GeV/c '* devoted to the calculations of the figure of merit was presented by Ying Wang at the plenary session of the XXIII International Baldin Seminar on High Energy Physics Problems "Relativistic Nuclear Physics and Quantum Chromodynamics" (September 19 to 24, 2016, Dubna, Russia), and the report *' np charge exchange polarimetry in the GeV region'* by N. Piskunov at the 22nd International Spin Symposium (September 25 to 30, 2016, Urbana, USA).

In the Nuclotron Run N. 53, in the period November 22-29, 2016, polarized deuteron beams with momenta 6.0, 7.5, and 8.4 GeV/c were used to measure analyzing powers of protons and neutrons with momenta $p_{n,p}$ = 3.0, 3.75, and 4.2 GeV/c. C and CH2 targets were used. In addition, at 3.75 GeV/c momentum an active target (CH scintillator) was used with neutron beam. Two PhD students, Ying Wang (Universit Paris-Saclay, France) and Kieran Hamilton (Glasgow University, Scotland) and the student Kseniya Legostaeva (Dubna University, Russsia) took active participation in the data taking during the November run.

II. RESULTS FROM RUN 53

The current ALPOM-II beam time request was based on the conditions for the primary polarized deuteron beam as reported in Table II.

	expected	obtained
Intensity	$5 \cdot 10^9$	$2 - 5 \cdot 10^8$
Polarization	0.80-0.90	0.25-0.70

The actual beam parameters were far from the expected values. Nevertheless, as we had

the possibility to test the apparatus with unpolarized beams in June 2016, we were ready to take data and could fulfill part of the planned program.

In Fig. 1 we show the azimuthal angle spectra for the two beam polarization states, normalized to the unpolarized one. An asymmetry is definitely observed, and it is also evident that the polarization is not the same in the two beam polarization states. Fig. 1 corresponds to a proton beam on a CH2 target, with detection of a forward emitted proton.

The results for the proton analyzing powers from the $p + CH_2 \rightarrow 1$ charged particle+X reaction, at p_p=3 GeV/c , with a 30 cm thick target, are shown in Fig. 2, for the two beam polarization states, and compared to the existing values from Azhghirey *et al.*, [NIM. A 538 (2005) 431441] at p_p=3.8 GeV/c.

Note that the neutron asymmetry data on a CH and CH2 targets at p_n=3.75 GeV/c are first time measurements and will be especially useful to extending the world data basis.

In general, the data follow the expected trend, but the error bars (shown error bars are statistical only) need to be improved. Moreover the systematic errors related to the beam polarization are difficult to evaluate at this point in time. The beam polarization for each polarization state of the beam, $P_{\pm}$, was obtained with the F3 polarimeter and was monitored during the whole run. The absolute value of the polarization could only be obtained by comparing the measured asymmetry to known values of analyzing power for protons on CH2. It was estimated to be $P_+ = 0.64$ and $P_- = 0.33$.

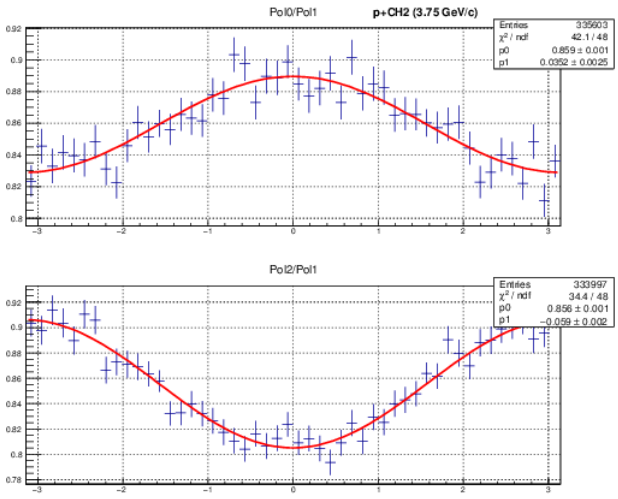

Figure 1: Azimuthal ϕ-distribution for the two polarized states of the deuteron beam polarization (normalized to the unpolarized state) for the $p + CH_2 \rightarrow 1$ charged particle+X reaction, at proton momentum 3.75 GeV/c.

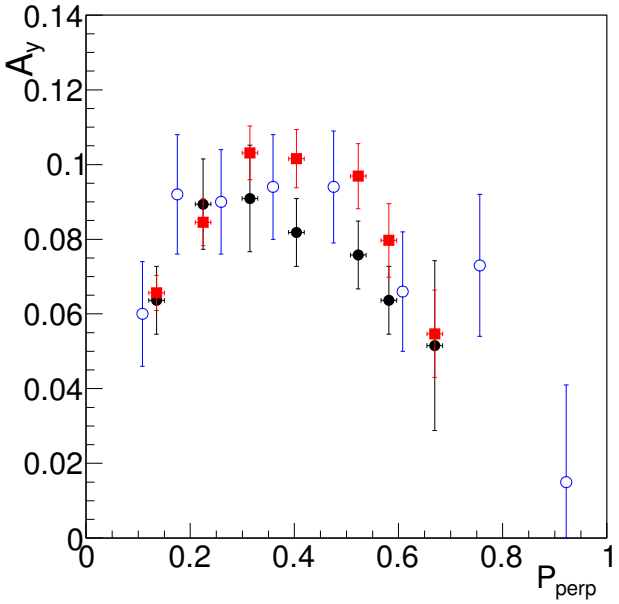

Figure 2: Analyzing powers of the $p+CH_2 \rightarrow$ 1 charged particle+X, at p_p=3 GeV/c, with a 30 cm thick target, for polarization state +1 (red solid squares) and -1 (black solid squares), compared to the existing values from Azhghirey *et al.*, at p_p=3.7 GeV/c [NIM. A 538 (2005) 431441] (blue open circles).

III. CONCLUSION

The goal of the ALPOM-II experiment is to obtain analyzing powers at the highest possible momenta. This will be important in order to optimize the measurements of proton and neutron form factors planned at JLab, following the 12 GeV upgrade. Due to lower beam intensity and polarization, we could not finalize this work according to the original proposal in the given time. The collected statistics is significantly lower than assumed in the original proposal, see Table II.

High priority is to measure the analyzing powers for proton at p_p = 6.5 and 7.5 GeV/c, as well as for neutron at p_n = 4.5 GeV/c, on C and CH2 targets.

Polarimetry requires a secondary scattering, that means very long measurements, and a careful optimization of the figure of merit of the polarimeter is mandatory; this includes the optimization of the analyzing reaction and of the efficiency and acceptance of the apparatus.

Due to the lack of time, we also could not test several planned improvements of the polarimeter that had been suggested in the proposal, as, for example, the comparative use of an active target for the detection of the forward neutrons in $n + CH \rightarrow$ forward n +

recoil p , as well as the study of solutions for a better separation of single and multiple track events.

In the current run, polarized deuteron beam were obtained for the first time after 15 years. The deuteron polarization can be improved, and a better knowledge of the elements of the beam line will be useful. A comparison of the polarizations measured at different momenta for incident protons and neutrons is an important goal of the program.

For all these reasons, and in light of the promising results achieved so far, we require to continue this experiment up to its completion, in the period 2017-2018, according to the originally presented proposal at the PAC meeting in June 2015.

The spokespersons of the ALPOM-II experiment

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