Referee Report

Manuscript No.: PLB-D-14-01723.
Authors: D.S. Parno *et al.*
Title: "Precision Measurements of A_1^n in the Deep Inelastic Regime".

The paper reports a measurement of A_1^n, the double-spin virtual-photon asymmetry at medium x, $0.3 \lesssim x \lesssim 0.6$ and at an average Q^2 of about 3 $(\mathrm{GeV}/c)^2$, doubling the available high-precision data in this kinematic range. Results were obtained with an open-geometry spectrometer operating at a large scattering angles; a gas Čerenkov counter limited the charged-pion background.

The aim of the measurement was to check a behaviour of the A_1^n asymmetry and to extract the leading order u- and d-quark polarised-to-unpolarised distribution ratios (when combined with the world data on proton targets) in the range where theoretical predictions begin to diverge. A previously observed sign changing of A_1^n at $x \approx 0.5$, was confirmed while in case of the quark distribution ratios it is not yet possible to distinguish between models; this is especially true for d-quarks where distributions suffer from large statistical errors, except at highest x where systematics dominates.

The results reported in this paper are useful albeit not groundbreaking; their analysis is sound and its description adequate.

Just a few minor comments (numbers are line numbers):

4-6: it does not look correct to quote a phenomenological paper [3] only; a reference to RHIC experimental results is also needed.

138: please add an example of a numerical value of the dilution factor f, in the region of measured x.

138-141: a figure with definition of all angles would help.

190: "The DSSV model [37] was used...". A model of what?

Figure 2: HERMES points quoted here come from 1999; surely there are more recent results from their SIDIS analysis. Also COMPASS has published results at similar Q^2. Please update that plot.

References:

[1] The EMC results on the proton spin were first published in Phys. Lett. B206 (1988) 364; you may add this to the long Nucl.Phys. paper you mention.

[53] I guess it has already been published in Phys.Lett. B740 (2015) 168-171.

The authors mention that two dedicated measurements of A_1^n will be performed at JLab in the future, extending measurements to $x \approx 0.8$. A comment is needed whether systematic uncertainties at that high values of x, are expected to be substantially decreased/eliminated in those experiments. Otherwise, if a trend visible in Fig 2 continues, the new measurements may not bring any new information, especially for d-quark distributions.

To summarize: The results reported in this paper qualify for publication in The Phys. Lett. B, with a few changes suggested above.