

Proposal Number: PR12-13-011 **Hall: C**

Title: The Deuteron Tensor Structure Function b_1

Contact person: K. Slifer (UNH)

Beam time request:

Days requested for approval:	30
Tune up included in beam request:	No

Beam characteristics:

Energy:	11.0 GeV
Current:	115nA
Polarization:	No

Targets:

Nuclei:	C, polarized ND ₃
Rastering:	Yes (special pol tgt raster)
Polarized:	Yes

Spectrometers:

HMS:	Yes
SHMS:	Yes
Other (SOS, BigCal, etc.):	No

Special requirements/requests:

A major installation class experiment requiring the UVA/JLab 5T polarized ND₃ target system. and the special polarized target raster system Extensive rework of target area to accommodate the superconducting solenoid, ND₃ target and associated vacuum and cooling systems will be required.

Technical Comments:

This is a major installation class experiment technically similar to previous UVa/JLab ND₃ polarized target experiments at JLab. Basically the proposal plans to significantly improve on measurements taken previously by the HERMES experiment.

The observable of interest is the normalized difference of two cross sections, $A_{zz} = 2(\sigma_{\text{tgtpol}} - \sigma_{\text{tgtunpol}})/\sigma_{\text{unpol}}$. The experiment seeks to measure this quantity with an error of roughly ± 0.01 . The experimentally observed quantity, which we will refer to as the asymmetry, is $f P_{zz} A_{zz}$, the physics asymmetry scaled down by the dilution factor (essentially the fraction of the target that is deuterium) and the tensor polarization of the target. With a dilution about 6/20 and a target tensor polarization of about 20%, the required error on the experimental asymmetry is less than ± 0.001 (0.0006)

Typical drifts in Hall C in the factors used to normalize the scattering rate will create relatively large false asymmetries of $\pm O(0.01)$ so need to be mitigated. We believe this is possible with a combination of upgrades to Hall C infrastructure *and sufficient commitment by the collaboration to control the unusual systematic issues of this experiment*. The latter presents a challenge since a significant team is always needed simply to install and operate this polarized target.

The error propagation presented in the proposal is definitely on point but neglected a few contributions to false asymmetries such a beam position drifts which are easily be removed by regression. The table below summarizes our estimates for drifts in some important parameters used for normalization (and how to mitigate them).

This experiment requires effectively unpolarized beam to cancel large effects from A1 and, at the highest x and Q2 settings, not-insignificant effects from parity violating asymmetries. Although JLab's beam is always polarized, this experiment can construct unpolarized beam in software by adding matched numbers of + and – helicity states.

The proposal assumes an average tensor polarization of 20%. Under normal polarizing conditions this value corresponds to a vector polarization of approximately 50%. While this polarization has been achieved in irradiated ND₃ under optimal circumstances, experience in previous experiments at JLab and elsewhere indicates that an average vector polarization of approximately 40% is more likely during beam conditions, with a corresponding tensor polarization of 12%. The tensor polarization can be dramatically increased using RF techniques such as hole-burning. However, these techniques upset the direct relationship between the vector and tensor polarization (see the equation under Eqn 33) and make an accurate determination of the latter quantity difficult. It is possible that the tensor polarization can be extracted from a lineshape analysis of the NMR curve, but this will require a significant research effort. However an uncertainty in target polarization will scale the asymmetry, so is less of a concern than systematic errors which can lead to false asymmetries.

Normalization Parameter	Expected Magnitude of Unmitigated Drift	Mitigation
Charge	0.1%-1%/12 hrs (setup dependent)	1. Significant modification to present BCM setup to make it more temperature stable.

		(Then monitor and correct for remaining temperature dependence.) 2. New low power Faraday Cup. (contact person: D. Mack)
Trigger/Cuts/Tracking Efficiency	1%/12 hours	1. Set detector thresholds conservatively. 2. Use loose PID cuts. 3. Carefully measure relative changes in tracking efficiency between slugs.
Dilution f and the related pt (“length”)	0.1%? (WAG) (there may be occasional step-like changes from target beads shifting)	1. Reverse target polarization as frequently as dead-time permits. 2. Depolarize using a technique that won’t jostle the target beads. Eg, emptying He from the nose sounds suspicious. (And will change the dilution.) 3. Develop a luminosity monitor based on $e^+e^- \rightarrow e^+e^-$ coincidences or target radiometry. (contact persons: D. Mack and C. Keith)
$\Delta\Omega$	0.1%/12 hours (assuming O(1)%/mm sensitivity and 0.1mm drift in beam position)	1. Always have the MCC restore to a golden orbit with fixed position and angle on target. 2. Correct for dependence of yield on beam position. 3. Correct for dependence of yield on various magnet currents.