Measurement of the Neutron Magnetic Form Factor G_M^n at High Q^2 Using the Ratio Method on Deuterium

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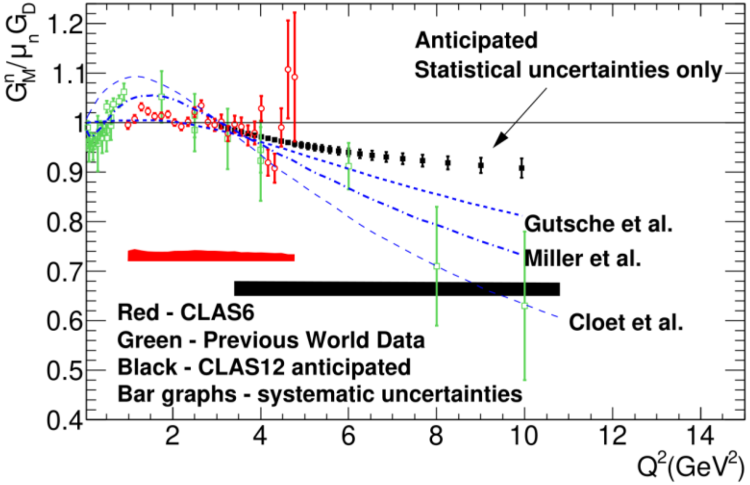
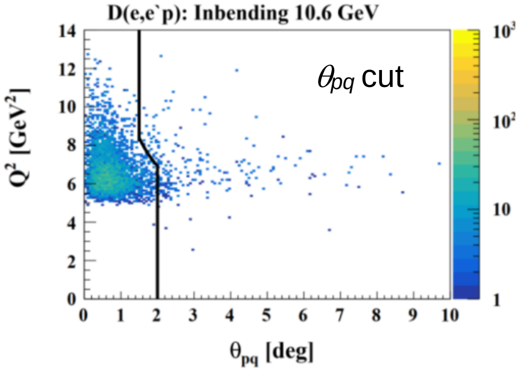
Goal: Extract G_M^nat high Q^2 using the ratio of quasi-elastic e-n and quasi-elastic e-p events on deuterium: $R = \frac{d(e,e'n)p}{d(e,e'p)n}$



1. The neutron magnetic form factor is a fundamental observable related to the distribution of magnetization in the neutron.
2. Figure to the left shows world's data for G_M^n including anticipated results.
3. Curves show recent theoretical calculations from Gutsche et al. (PRD 97, 054011, 2018))and Miller et al. (arXiv 1912.07797 [nucl-th], 2020).
4. Considerable progress has been made. The Pass 1 extraction of G_M^n is complete and was the topic of L.Baashen's doctoral thesis at Florida International University.
5. The group is now analyzing the Pass 2 data which has increased statistics and improved resolution.
6. Additional RGB run time will extend the reach in Q^2 and improve the statistical precision.

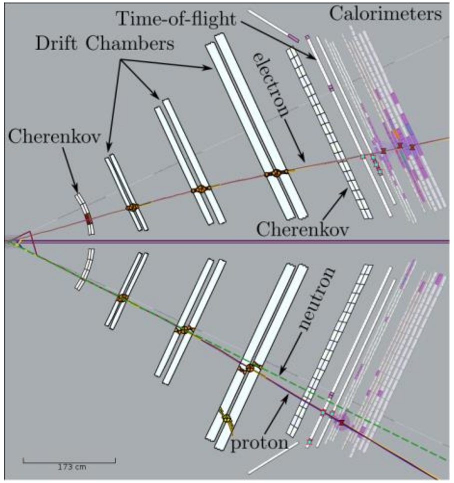
Quasi-Elastic e-n and e-p Event Selection

1. Use *e-n* and *e-p* scattering angles for electron and nucleon to calculate beam energy. Require 1σ cut on result.
2. Require reaction products to lie in the same plane: $|\Delta\phi| < 1.7$ deg.
3. Require θ_{pq} < 2-3 deg where θ_{pq} is the angle of the nucleon relative to the 3-momentum transfer.



Acceptance Matching

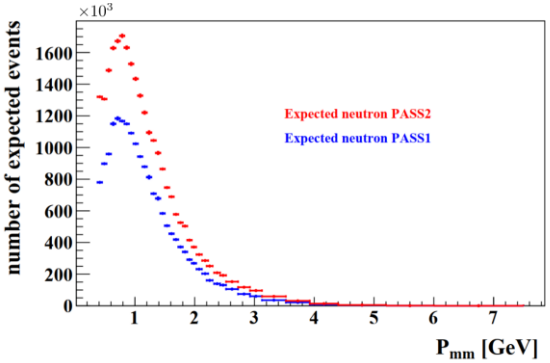
1. Need to have the same solid angle Ω for *e-n* and *e-p* events.
2. Start with a good electron. Assume elastic scattering and a stationary nucleon.
3.Swim a proton and a neutron through CLAS12 and require both to hit the PCAL/ECAL.
4. Complete the analysis of the event.

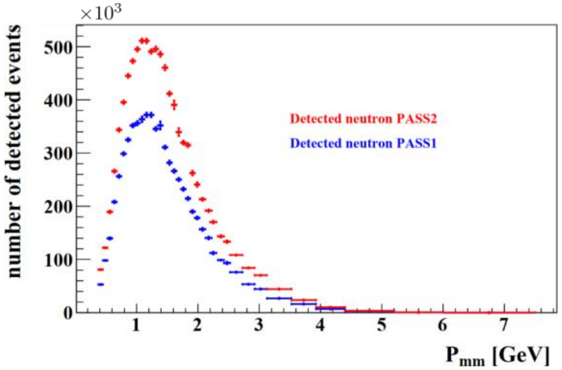


Corrections to the e-n/e-p Ratio

Measuring the neutron detection efficiency (NDE) for quasi-elastic e-n

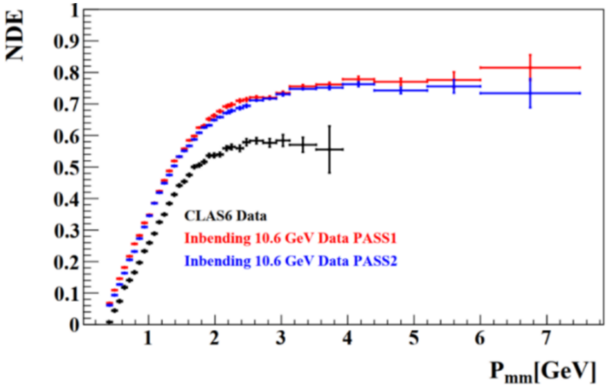
1. Use $ep \rightarrow e'\pi^+n$ from Run Group A on LH_2 target to obtain tagged neutrons.
2. In each event require a good electron and π^+ and then predict the neutron trajectory.
3. If the trajectory intersects the PCAL/ECAL this is an expected event. See below.
4. Search for a neutral hit near the intersection. If found, this is a detected event.
5. Note the increase in the number of Pass 2 events below compared with Pass 1.
6. The NDE is the ratio of detected events to expected ones.





Comparison of Pass 1 and Pass 2 NDE

The NDE extracted as described above for both Pass 1 and Pass 2 is shown. They agree within 2-3%. Plot shows the CLAS6 results too.



Other Corrections

1. Proton Detection Efficiency (PDE)
2. Fermi Correction
3. Radiative Correction
4. Nuclear Correction

Corrections 1-3 above have been completed for Pass 1 and are ongoing for Pass 2. Radiative corrections are very close to one. We are working with two theorists on the nuclear correction.