JLab Program Advisory Committee Eleven Proposal Cover Sheet

This document must be received by close of business on Wednesday, December 18, 1996 at:

Jefferson Lab
User Liaison Office, Mail Stop 12 B
12000 Jefferson Avenue
Newport News, VA 23606

(Choose one)

☐ **New Proposal Title:**

☒ **Update Experiment Number:** E93-038

☐ **Letter-of-Intent Title:**

Contact Person

Name: RICHARD MADEY
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E-Mail › Internet: MADEY @ CEBAF.GOV

Experimental Hall: C **Days Requested for Approval:** 60
Days Approved by PAC 6: 60

Jefferson Lab Use Only

Receipt Date: 16 DEC 96

By: G. Smith

PR 96-004

LAB RESOURCES REQUIREMENTS LIST

CEBAF Proposal No.: ______________ Date: ______________
(For CEBAF User Liaison Office use only.)

List below significant resources — both equipment and human — that you are requesting *from CEBAF* in support of mounting and executing the proposed experiment. Do not include items that will be routinely supplied to all running experiments, such as the base equipment for the hall and technical support for routine operation, installation, and maintenance.

***Major Installations** (either your equip. or new equip. requested from CEBAF)*

- Neutron Polarimeter [NPOL]
- Dipole Magnet [CHARYBDIS] to precess neutron spin
- steel shadow shield

New Support Structures:
- Shield House & Collimator for NPOL
- Support structure for Shadow Shield

Data Acquisition/Reduction

Computing Resources:

New Software:

Major Equipment

Magnets: HMS

Power Supplies: HMS
SOS [for CHARYBDIS]

Targets: LD_2, LH_2, Empty
solid

Detectors: G_M^n Detector
(from Hampton U)

Electronics:

Computer Hardware:

Other:

Other

HAZARD IDENTIFICATION CHECKLIST

CEBAF Experiment: E93-038 Date: 12/16/96

Check all items for which there is an anticipated need—do not check items that are part of the CEBAF standard experiment (HRSE, HRSH, CLAS, HMS, SOS in standard configurations).

Cryogenics ___ beamline magnets ___ analysis magnets ✓ target ___ drift chambers ___ other	**Electrical Equipment** ___ cryo/electrical devices ___ capacitor banks ___ high voltage ___ exposed equipment	**Radioactive/Hazardous Materials** List any radioactive or hazadorous/ toxic materials planned for use: ___ ___
Pressure Vessels ___ inside diameter ___ operating pressure ___ window material ___ window thickness	**Flammable Gas or Liquids** (incl. target) type: ___ flow rate: ___ capacity: ___	**Other Target Materials** ___ Beryllium (Be) ___ Lithium (Li) ___ Mercury (Hg) ___ Lead (Pb) ___ Tungsten (W) ___ Uranium (U) ___ Other (list below) ___ ___
Vacuum Vessels ___ inside diameter ___ operating pressure ___ window material ___ window thickness	**Radioactive Sources** ___ permanent installation ✓ temporary use type: 228 Th strength: ~10 μC	**Large Mech. Structure/System** ___ lifting devices ___ motion controllers ✓ scaffolding or elevated platforms ___ other
Lasers type: ___ wattage: ___ class: ___ **Installation** ___ permanent ___ temporary **Use** ___ calibration ___ alignment	**Hazardous Materials** ___ cyanide plating materials ___ scintillation oil (from) ___ PCBs ___ methane ___ TMAE ___ TEA ___ photographic developers ___ other (list below) ___ ___ ___	**Notes:** ___ ___ ___ ___ ___ ___

BEAM REQUIREMENTS LIST

Lab Proposal No.: E93-038 Date: 16 dec 1996

Hall: C Anticipated Run Date: Fall 1998 PAC Approved Days: 60

Spokesperson: R. Madey Hall Liaison:
Phone: 757 269 7323
E-mail: MADEY @ CEBAF. GOV

List all combinations of anticipated targets and beam conditions required to execute the experiment. (This list will form the primary basis for the Radiation Safety Assesment Document (RSAD) calculations that must be performed for each experiment.)

Condition No.	Beam Energy (MeV)	Mean Beam Current (μA)	Polarization and Other Special Requirements (e.g., time structure)	Target Material (use multiple rows for complex targets — e.g., w/windows)	Material Thickness (mg/cm²)	Est. Beam-On Time for Cond. No. (hours)
G_E^n						
1	800	35	80% Polarized	LD_2	2520	180
2	800	35	"	LH_2	1060	36
3	800	35	"	Empty	700	18
4	800	10	"	Fe	7.9	18
5	1600	35	"	LD_2	2520	210
6	1600	35	"	LH_2	1060	42
7	1600	35	"	Empty	700	21
8	1600	10	"	Fe	7.9	21
9	3200	35	"	LD_2	2520	300
10	3200	35	"	LH_2	1060	60
11	3200	35	"	Empty	700	30
12	3200	10	"	Fe	7.9	30

The beam energies, E_{Beam}, available are: $E_{Beam} = N \times E_{Linac}$ where N = 1, 2, 3, 4, or 5. E_{Linac} = 800 MeV, i.e., available E_{Beam} are 800, 1600, 2400, 3200, and 4000 MeV. Other energies should be arranged with the Hall Leader before listing.

BEAM REQUIREMENTS LIST

JLab Proposal No.: E93-038 Date: 16 dec. 1996

Hall: C Anticipated Run Date: Fall 1998 PAC Approved Days: 60

Spokesperson: R. Madey Hall Liaison:

Phone: 757 269 7323

E-mail: Madey@CEBAF.GOV

List all combinations of anticipated targets and beam conditions required to execute the experiment. (This list will form the primary basis for the Radiation Safety Assesment Document (RSAD) calculations that must be performed for each experiment.)

Condition No.	Beam Energy (MeV)	Mean Beam Current (μA)	Polarization and Other Special Requirements (e.g., time structure)	Target Material (use multiple rows for complex targets — e.g., w/windows)	Material Thickness (mg/cm²)	Est. Beam-On Time for Cond. No. (hours)
G_H^n						
13	800	35		LD_2	2520	20
14	800	35		LH_2	1060	38
15	1600	35		LD_2	2520	20
16	1600	35		LH_2	1060	38
17	3200	35		LD_2	2520	40
18	3200	35		LH_2	1060	60

The beam energies, E_{Beam}, available are: $E_{Beam} = N \times E_{Linac}$ where N = 1, 2, 3, 4, or 5. E_{Linac} = 800 MeV, i.e., available E_{Beam} are 800, 1600, 2400, 3200, and 4000 MeV. Other energies should be arranged with the Hall Leader before listing.

E93–038 COLLABORATION

1. *Kent State University*

   R. Madey (spokesman), A. Ahmidouch, B. Anderson, A. Baldwin, D. Keane, D.M. Manley, G. Petratos, D. Prout, R. Suleiman, J.W. Watson, W. Zhang

2. *Hampton University*

   R. Madey (spokesman), A. Ahmidouch, K. Assamagan, S. Avery, K. Baker, W. Buck, J. Cha, T. Eden, R. Ent, P. Gueye, M. Harvey, W. Hinton, C. Keppel, G. Niculescu, I. Niculescu, G. Savage, L. Tang, Graduate Students

3. *Thomas Jefferson National Accelerator Facility*

   R. Carlini, J. Dunne, R. Ent, D. Mack, J. Mitchell, W. Vulcan, R. Whitney, S. Wood, C. Yan

4. *Massachusetts Institute of Technology*

   G. Dodson, M. Farkhondeh, S. Kowalski, W. Turchinetz, S. Wells, Graduate Students

5. *Duke University*

   A. Crowell, C. Howell, W. Tornow, R. Walter

6. *University of Maryland*

   C. C. Chang, J. J. Kelly, PDF, Graduate Students

7. *Indiana University Cyclotron Facility*

   J. M. Cameron, D. Prout

8. *The College of William and Mary*

   J. M. Finn, C. Armstrong, D. Armstrong, K. Griffioen, Graduate Students

9. *Old Dominion University*

   P. Ulmer, L. M. Weinstein

10. *North Carolina A&T University*

    S. Beedoe, S. Danagoulian, R. Sawafta

11. *University of Virginia*

    R. Lourie

12. *Florida International University*

    H. Anklin, W. Boeglin, L. Kramer, P. Markowitz, Graduate Students

13. *Gettysburg College*

    P. J. Pella

14. *Yerevan Physics Institute*

    H. G. Mkrtchyan

15. *Kyungpook National University*

    W-Y. Kim

16. *Rutgers University*

    P. Rutt

17. *University of Mainz*

    H. Arenhövel

UPDATE OF TJNAF E93-038

THE ELECTRIC FORM FACTOR OF THE NEUTRON FROM THE d($\vec{\mathrm{e}}$, e'$\vec{\mathrm{n}}$)p REACTION

1. Purposes of This Update

This update of E93-38 has three purposes:

1. To request PAC 11 to endorse the physics validity of a timely independent measurement of the electric form factor of the neutron, G_E^n. Currently the polarized target version, experiment E93–026, is scheduled to run in early 1998. Comparisons of the polarimeter experiment E93–038 with the polarized target experiment E93–026 are made in section 3 to permit an evaluation of the scientific potential of each experiment.
2. To request PAC 11 to confirm the physics need for measurements of G_E^n with smaller uncertainties than those projected for the polarized target experiment E93-026. Parity experiments at Jefferson Lab desire uncertainties in G_E^n that are small enough to eliminate G_E^n as an effective contributor to a precision measurement of parity-violating asymmetries. Experimental values of G_E^n with the smallest possible uncertainties will survive in the literature and will be available to challenge theorists.
3. To request PAC 11 to endorse an updated run plan. PAC 6 approved 60 days to measure G_E^n and G_M^n at two values of Q^2. Experimental advances since that time permits measuring G_E^n and G_M^n at three values of Q^2 in the same 60 days approved by PAC 6. These advances include a new polarimeter, 80% beam polarization, and the introduction of a neutron spin rotator magnet ahead of the polarimeter.

2. Brief Description of the Experiment

The experimental arrangement is shown in Fig. 1. A neutron polarimeter detects the recoil neutron from the quasielastic $^2\mathrm{H}(\vec{e}, e'\vec{n})^1\mathrm{H}$ reaction and measures up-down scattering asymmetries $\xi_{S'}$ and $\xi_{L'}$ related to $P_{S'}$ and $P_{L'}$, the sideways and longitudinal polarization components of the neutron, respectively. The scattered electron from the $^2\mathrm{H}(\vec{e}, e'\vec{n})^1\mathrm{H}$ reaction is detected with the high-momentum spectrometer (HMS) in coincidence with the recoil neutron. A dipole magnet placed in front of the neutron polarimeter with sufficient magnetic field strength to precess the neutron longitudinal polarization $P_{L'}$ into the sideways direction permits measuring the neutron scattering asymmetry $\xi_{L'}$. With another measurement of $\xi_{S'}$ (with the dipole magnet turned off) for the same kinematics as that of the measurement of $\xi_{L'}$, the ratio of G_E^n and G_M^n is simply the ratio of the scattering asymmetries scaled by a kinematic function K_R:

$$g \equiv \frac{G_E^n}{G_M^n} = -K_R \frac{\xi_{S'}}{\xi_{L'}}$$

The kinematic function K_R is determined by the electron scattering angle θ_e in the $^2\mathrm{H}(\vec{e}, e'\vec{n})^1\mathrm{H}$ reaction. For a total data-acquisition time T, the time fractions for measuring

$\xi_{S'}$ and $\xi_{L'}$ are optimized to minimize the statistical uncertainty in g.

A significant advantage of this technique for measuring the ratio of the two scattering asymmetries is that the scale and systematic uncertainties are minimal because the relative uncertainty in the analyzing power of the polarimeter does not enter in the ratio. The same is true for the beam polarization provided P_L does not change during sequential measurement of $\xi_{S'}$ and $\xi_{L'}$. In contrast, the systematic uncertainties are larger in the analogous polarized-target experiment [E93-026] because the uncertainties in the target and the beam polarization must be included; also, the polarized target experiment has to make subtractions for the scattering asymmetry from the nitrogen in the $^{15}ND_3$ target.

In the cross-ratio method of analysis of the scattering asymmetry measured in the polarimeter, Ohlsen and Keaton [OH73] showed that false asymmetries cancel to all orders from helicity-dependent errors in charge integration or system dead-times, or from errors in detection efficiency and acceptances; and that false asymmetries cancel to first order from misalignments with respect to $\vec{q}$, or from a difference in the beam polarization for the two helicity states. The cross ratio is the ratio of two geometric means $(N_U^+ N_D^-)^{1/2}$ and $(N_U^- N_D^+)^{1/2}$, where $N_U^+(N_D^-)$ is the yield in the peak for scattering neutrons up (down) when the helicity is positive (negative).

We plan to use the CHARYBDIS dipole magnet to precess the longitudinal component of the neutron polarization through 90°. This magnet has a 10-inch gap, which is large enough to illuminate fully the front detector of our neutron polarimeter (20-in high by 40-in wide). The CHARYBDIS magnet will permit measurements at four values of Q^2 [*viz.*, Q^2 = 0.49, 1.00. 1.41, and 1.73 $(\text{GeV}/c)^2$] with the neutron polarimeter and its shielding fixed at 42.3°. Table 1 lists the kinematic conditions, the $\int Bdl$ required to precess the neutron polarization through 90°, and the neutron energy resolution at a mean flight path of 7.0 m. The neutron energy resolution is sufficient to discriminate against neutrons associated with pion production.

Table 1. Kinematics at $\theta_n = 42.3°$

Q^2 $(\text{GeV}/c)^2$	E $(\text{GeV})^{(i)}$	θ_e (deg)	$P_{e'}$ (MeV/c)	T_n (MeV)	P_n (MeV/c)	$\int Bdl_n$ $(\text{Tm})^{(ii)}$	ΔT_{hwhm} (MeV)
0.49	0.845	60.0	581	261	748	1.604	9
1.00	1.645	43.5	1109	533	1135	1.984	30
1.41	2.445	33.9	1693	749	1404	2.141	55
1.73	3.245	27.7	2323	919	1605	2.223	80

(*i*) Injection energy is 45 MeV.

(*ii*) Maximum central $\int Bdl_n = 2.39$ Tm for CHARYBDIS.

3. Comparison of Polarimeter and Polarized Target Techniques

The polarimeter experiment [E93-038] has the scientific potential of achieving significantly smaller uncertainties than measurements of G_E^n by other techniques at this time. A comparison of the projected statistical uncertainties $\Delta g/g$ from E93-038 and the polarized target experiment [E93-026] is given in Table 2. For the same data acquisition time, statistical uncertainties in the ratio $g \equiv G_E^n/G_M^n$ projected for E93-038 are *one-half* or less of those for the polarized-target experiment [E93-026]. Because the systematic uncertainties in the polarimeter experiment are smaller, E93-038 can run longer and obtain smaller statistical uncertainties. Also, note that the polarimeter experiment can achieve the same or comparable statistical uncertainties as the polarized target experiment in a small fraction of the data-acquisition time. [See columns 7 and 8 in Table 2].

Table 2. Projected Statistical Uncertainties (%) in $g = G_E^n/G_M^n$ from E93–026 and E93–038

	Comparative Uncertainties for Same Run Time			Uncertainties with Reasonable Run Times		Run Time for Same (Comparable) Uncertainties	
Q^2 $(\mathrm{GeV}/c)^2$	$t^{(i)}$ (hr)	E93–026$^{(ii)}$ $\Delta g/g$	E93–038$^{(iii)}$ $\Delta g/g$	t (hr)	E93–038$^{(iii)}$ $\Delta g/g$	t (hr)	E93–038$^{(iii)}$ $\Delta g/g$
0.50	100	7.4	3.6	144	3.0	24	7.4
1.00	100	12.8	4.8	168	3.7	14	12.8
1.41	–	–	–	192	6.8	(40)	(14.9)
1.50	235	16.0	–	–	–		
1.73	–	–	–	240	9.2	(60)	(18.3)
2.00	400	21.7	–	–	–		

$^{(i)}$ From proposal for E93-026.

$^{(ii)}$ For $P_L = 80\%$, $P_T = 40\%$, $I = 40$ nA and $x = 2.5$ cm $^{15}ND_3$, giving a luminosity of $\mathcal{L} = 4 \times 10^{34}$ cm^{-2}s^{-1}.

$^{(iii)}$ For $P_L = 80\%$ and $I = 35\ \mu$A, with analyzing powers and efficiencies obtained from polarimeter calibration measurements at Saturne in May 1996.

The E93-038 projections are based on values of the efficiency ϵ and the analyzing power $\langle A_y \rangle$ of the polarimeter that were measured in May 1996 at Saturne; preliminary results for A_y, ϵ, and the figure-of-merit $A_y^2\epsilon$ are presented in Table 3. For three values of Q^2 [*viz.*, Q^2 = 0.49, 1.00 and 1.73 (GeV/c)^2] in E93–038, the projected uncertainty $\Delta g/g$ is plotted in Fig. 2 as a function of the data acquisition time on a liquid deuterium target.

Table 3. Measured [LNS 276] A_y, ϵ and $A_y^2\ \epsilon$

Q^2 (GeV/c)^2	T_n (MeV)	A_y (%)	ϵ (%)	$A_y^2\epsilon$ ($\times 10^4$)
0.49	261	21.6	0.50	2.4
1.00	533	15.2	2.1	4.8
1.41	752	15.3	1.4	3.4
1.73	922	12.7	2.0	3.3

The use of a spin rotator magnet ahead of the neutron polarimeter results in a significant reduction in the scale and systematic uncertainties. With the spin rotator, our projections of the scale and systematic uncertainties in g are about 2.6%, which is less than *one-half* of the ~6.5% projected for the polarized target experiment for the combined uncertainties in the beam polarization, the target polarization, and the dilution factor. Our estimate for systematic uncertainties are typically $\pm$ 1.3% for the precession uncertainty [$\Delta g/g = 1 - \cos\Delta\chi$, where $\Delta\chi$ is the uncertainty in the precession angle χ], $\leq \pm$ 1% for the uncertainty from variations in detector thresholds, $\sim \pm$ 2% for the uncertainty from variations in P_L and $\pm$ 0.33% for the traceback uncertainty; the quadrature sum of the these four uncertainties is 2.6%. As in Bates E85-05, a measurement in E93-038 with an LH_2 target will permit a correction for a possible false asymmetry from the ^{2}H$(\vec{e}, e'\vec{p})n$ reaction followed by a Pb$(\vec{p}, \vec{n})$ reaction in the lead wall ahead of the polarimeter. A relatively short measurement with an LH_2 target in Bates E85-05 at $Q^2 = 0.255$ (GeV/c)^2 showed that the contamination of the quasielastic $e - n$ coincidence signal was less than 1%. At $Q^2 = 1.73$ (GeV/c)^2, we estimate a negligible false asymmetry from the two-step [$d(\vec{e}, e'\vec{p})$ + Pb$(\vec{p}, \vec{n})$] background reaction because the polarization-transfer coefficient $D_{SS'}$ is close to zero. Our measurements with an LH_2 target will permit us to correct for a dilution of the asymmetry; the error in the correction would be small.

4. Projected Uncertainties in G_E^n for Reasonable Run Times in Table 2

Listed in Table 4 (for the reasonable run times given in column five of Table 2) are the relative statistical uncertainties $\Delta G_E^n/G_E^n$ and ΔG_E^n unfolded from the measured $\Delta g/g$ for $\Delta G_M^n/G_M^n$ = 0.050 and 0.030. Note that for Q^2 = 1.00 and 1.73 (GeV/c)^2, $\Delta G_E^n \sim 2.2 \times 10^{-3}$ with $\Delta G_M^n/G_M^n$ = 0.050 and $\Delta G_E^n \sim$ 1.7 to 2.0×10^{-3} for $\Delta G_M^n/G_M^n$ = 0.030. Experiments at Mainz and Jefferson Lab are seeking $\Delta G_M^n/G_M^n$ = 0.030.

Plotted in Fig. 3 for the Galster parameterization of G_E^n are statistical uncertainties expected in E93-038 (black circles) and also from E93-026 (open squares). These statistical uncertainties in G_E^n are obtained after including a relative uncertainty of 3% in G_M^n.

Table 4. Statistical Uncertainties* ΔG_E^n with $\Delta G_M^n/G_M^n$ = 0.050 or 0.030

			$\Delta G_M^n/G_M^n$ = 0.050		$\Delta G_M^n/G_M^n$ =0.030	
Q^2 (GeV/c)^2	t (hr)	$\Delta g/g$ (%)	$\Delta G_E^n/G_E^n$ (%)	ΔG_E^n (10^{-3})	$\Delta G_E^n/G_E^n$ (%)	ΔG_E^n ($\times 10^{-3}$)
0.49	144	3.0	5.8	3.1	4.2	2.2
1.00	168	3.7	6.2	2.2	4.7	1.7
1.73	240	9.2	10.4	2.2	9.6	2.0

* For the Galster parameterization of G_E^n.

5. Allocation of Beam Time for Measuring G_E^n at Three Values of Q^2

With a total of 46 days of beam time to measure G_E^n, we project that E93-038 can extract G_E^n for three Q^2 points with the statistical uncertainties listed in Table 4; the remaining 14 days will be used to measure G_M^n at these three Q^2 points. Shown in Table 5 is the allocation of the 60 days of beam time for measuring G_E^n and G_M^n at three values of Q^2.

We request PAC 11 to endorse this updated run plan.

Table 5. Allocation of beam time on target for E93–038 to achieve G_E^n statistical uncertainties in Table 4 for three Q^2 points

	G_E^n						
Q^2 (GeV/c)^2	LD_2 (hr)	LH_2 (hr)	P_L (hr)	Shadow-Shield (hr)	Dummy (hr)	Other$^{(i)}$ (hr)	Total (hr)
0.49	144	36	18	36	18	48	300
1.00	168	42	21	42	21	45	339
1.73	240	60	30	60	30	45	465
Total	552	138	69	138	69	138	1104

	G_M^n				G_E^n	$G_E^n + G_M^n$
Q^2 (GeV/c)^2	σ_3 (hr)	ϵ_n (hr)	Other$^{(i)}$ (hr)	Total (hr)	Total (hr)	Total (hr)
0.49	20	38	36	94	300	394
1.00	20	38	36	94	339	433
1.73	40	60	48	148	465	613
Total	80	136	120	336	1104	1440

$^{(i)}$ Includes checkout.

6. Timely Scientific Opportunity for Jefferson Lab

Recent preliminary results from Mainz [KL96] at $Q^2 = 0.35$ (GeV/c)^2 reveal that the value of G_E^n from a liquid deuterium [LD_2] target is more than twice that from a polarized helium-3 target. The preliminary data are shown in Fig. 4. Statistical errors are typically 10%. The $^3\overrightarrow{\mathrm{He}}$ point is averaged over the Q^2 interval from 0.27 to 0.47 (GeV/c)^2. The LD_2 results were obtained with a polarimeter technique. Both measurements used a lead-glass array for the electron detector. The energy resolution was insufficient to exclude neutrons associated with pion production. A new measurement at $Q^2 \sim 0.6$ (GeV/c)^2 is planned with a $^3\overrightarrow{\mathrm{He}}$ target of higher density and with a magnetic electron spectrometer. The diamond point is the result of an exploratory run [ME94] at $Q^2 = 0.31$ (GeV/c)^2 from the exclusive $^3\overrightarrow{\mathrm{He}}(\vec{e}, e'n)$ reaction.

The scientific community cannot believe either result until this discrepancy is resolved. If Mainz had carried out only one of these two experiments, the world might have been misled for some time. Jefferson Lab is in the enviable position of having two A-rated experiments to probe the charge structure of the neutron by different techniques. By obtaining agreement in the results from both the polarimeter and the polarized-target techniques, the scientific community will have confidence in the results, and Jefferson Lab will make a broad impact on particle and nuclear physics. The polarized target experiment [E93-026] is scheduled for 1998; The polarimeter experiment [E93-038] seeks to run in the latter part of 1998.

We request PAC 11 to endorse the physics validity of a timely independent measurement of G_E^n.

7. Small $\mathbf{G_E^n}$ Uncertainties Required for Parity Experiments

Small uncertainties in G_E^n are needed for the A-rated experiments at Jefferson Lab that seek to measure parity-violating (PV) asymmetries. Donnelly, Dubach, and Sick [DO88] claim that the contribution of G_E^n to the proton parity asymmetry varies from 20% at low Q^2 [~ 0.20 (GeV/c)^2] to 10% at $Q^2 = 1.7$ (GeV/c)^2. The Hall A program at TJNAF wants to reach $Q^2 = 1.3$ (GeV/c)^2; the point approved at $Q^2 = 0.71$ (GeV/c)^2 projects a 5% statistical error and a total error of 8%. Ultimately, the proponents of the PV experiments would like to push the precision to 3% because even a small 10% strange–quark effect would be very important. A relative uncertainty $\Delta G_E^n/G_E^n$ of 7% will eliminate G_E^n as an effective contributor to a precision measurement of the PV asymmetry. The polarimeter experiment has the potential for delivering the small uncertainties required in G_E^n so that the uncertainty in G_E^n does not limit the quality of the parity experiments.

We request PAC 11 to confirm the physics need for measurements of G_E^n with the small uncertainties projected for the polarimeter experiment E93–038.

8. E93 – 038 Collaboration

The TJNAF E93-038 collaboration is a strong, experienced, and large collaboration over 65 scientists from 17 institutions, as shown in the attached list collaborators. This collaboration is an expansion of the Bates E85–05 collaboration of 39 scientists. The Bates E85–05 collaboration pioneered the polarization transfer measurement of G_E^n.

Kent State University (KSU) is making significant contributions of equipment and personnel to this project. KSU is providing detectors and associated electronics; in addition, KSU Research Engineer, Alan Baldwin, will assist with the preparation of the electronics and be present during the experiments to help insure the success of the experiment. KSU Research Fellow, W. M. Zhang will write and checkout the data acquisition software; he carried out this function for Bates E85-05. KSU experimentalists [Professors B. D. Anderson, J.W Watson and D.M. Manley; and Drs. A. Ahmidouch, D. Prout, and W. Zhang] will be responsible for the proper operation of the neutron polarimeter during their shifts. Anderson has been added as a co-spokesperson.

The Nuclear and High Energy Research Center of Excellence (NuHEP) at Hampton University has made substantial financial commitments for equipment for these G_E^n and G_M^n experiments. Major equipment purchases include 5-in diameter photomultiplier tubes for the neutron polarimeter, FastBus electronic equipment, high-voltage power supplies, neutron scintillation detectors and photomultiplier tubes for G_M^n measurements, and an HP 9000/735/125 computer and three X-window terminals.

The University of Maryland plans to construct and test new Pb-glass Čerenkov detectors for the Møller polarimeter at Bates; Florida International University plans to construct new veto counters for the G_M^n detector; the College of William and Mary plans Monte Carlo simulations of particle trajectories in the neutron arm with the dipole magnet as well as in the electron arm; and Duke University will oversee the dipole magnet to be used ahead of the neutron polarimeter. MIT-Bates has refurbished the CHARYBDIS dipole magnet to be placed ahead of the neutron polarimeter at Jefferson Lab.

References

DO88 W. Donnelly, J. Dubach, and I. Sick, Physical Review C37, 2320 (1988).

KL96 F. Klein, Proceedings of the PANIC 96 International Conference held at Williamsburg, VA, in May 1996.

ME94 M. Meyerhoff *et al.*, Phys. Lett. B327, 201 (1994).

OH73 G.G. Ohlsen and P.W. Keaton, Jr., Nucl. Instrum. & Meth. 109, 41 (1973).

PL90 S. Platchkov *et al.*, Nucl. Phys. A508, 343c (1990); A510, 740 (1990).

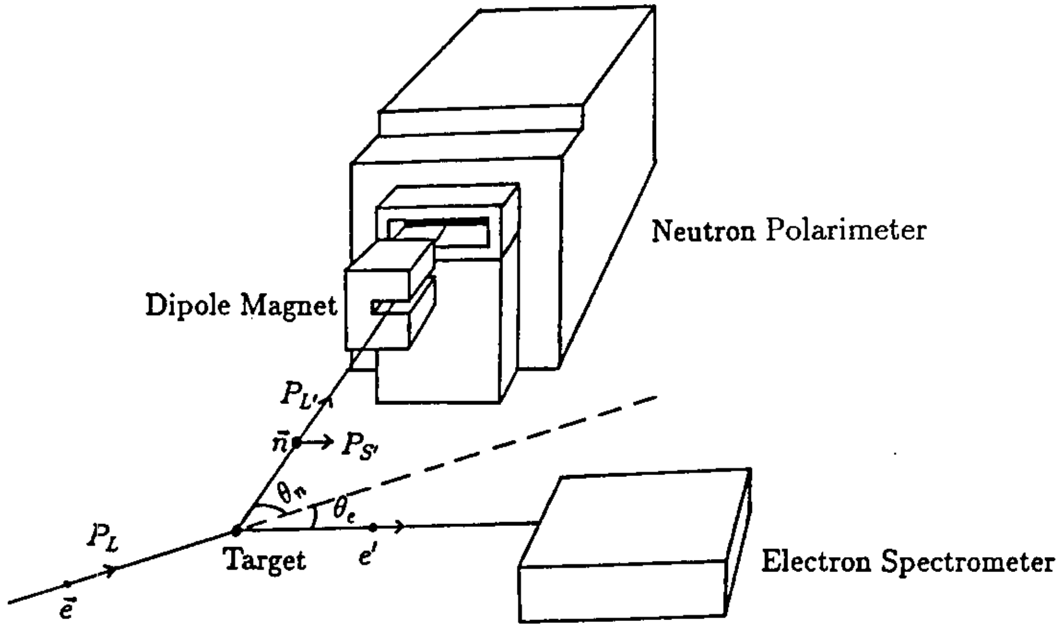

Fig. 1 Experimental arrangement for the G_E^n measurement. A dipole magnet is placed ahead of the neutron polarimeter (NPOL) to precess $P_{L'}$ into the sideways direction. For the G_M^n measurement, the NPOL is replaced by a single neutron detector and the magnet is not used.

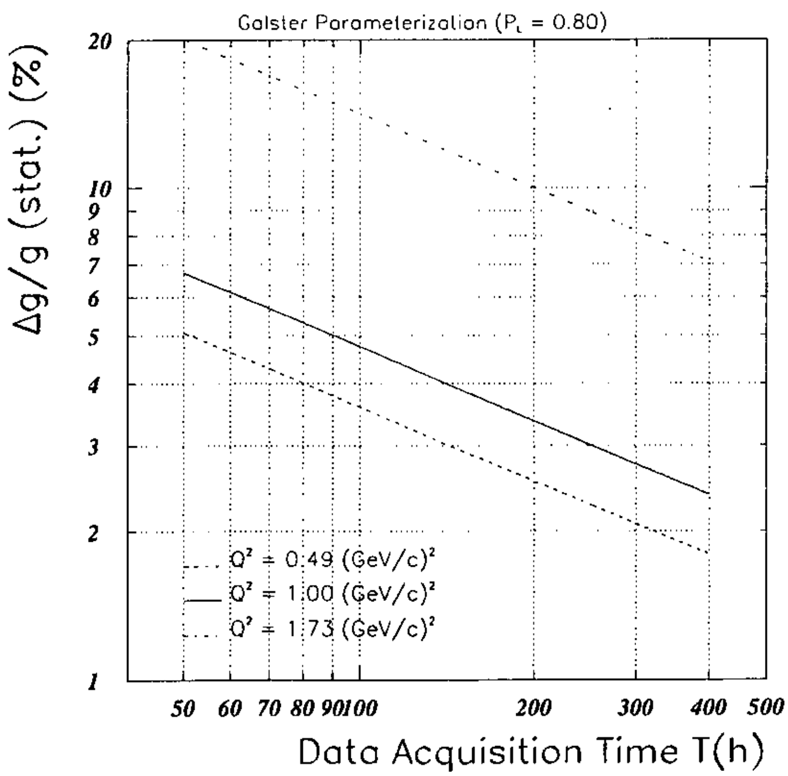

Fig. 2 Relative statistical uncertainty $\Delta g/g$ as a function of data acquisition time on a liquid deuterium target.

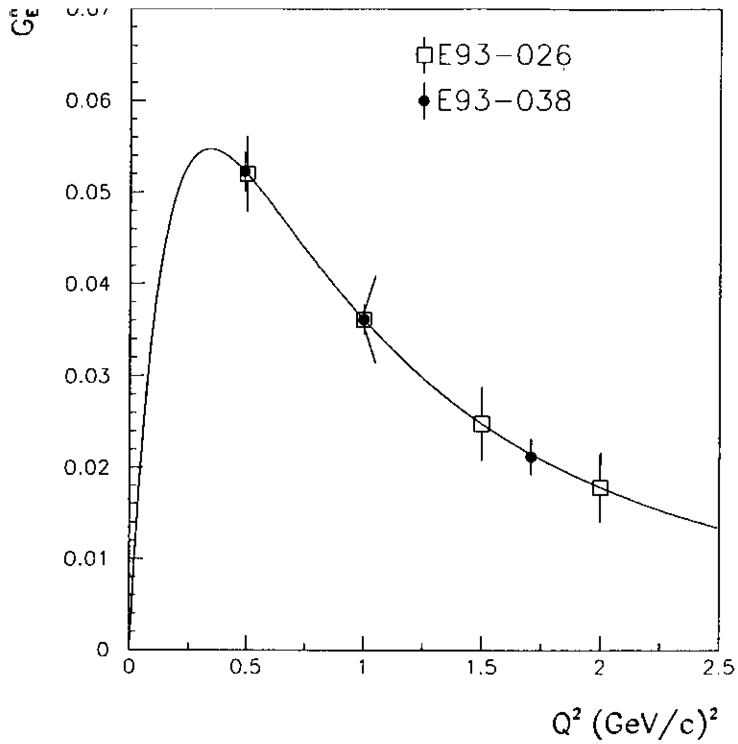

Fig. 3 Projected results for G_E^n measurements from E93–038 (black circles) and E93–026 (open squares). Shown are statistical uncertainties after including a relative uncertainty of 3% in G_M^n.

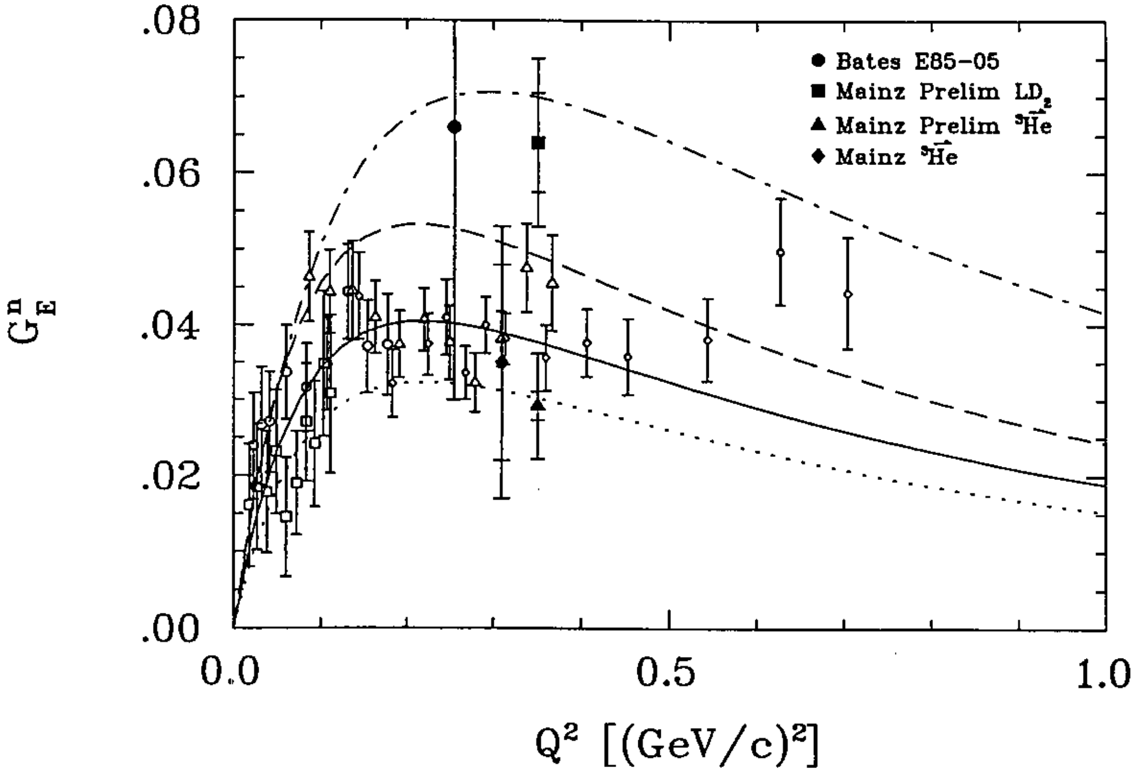

Fig. 4 The value of G_E^n from various experiments (closed symbols). The open symbols are from Platchkov *et al.*[PL90] unfolded with the Paris potential (solid line). The broken lines show other $N-N$ potentials: Nijmegen (dash-dotted), Argonne V14 (dashed), and Reid soft core (dotted).