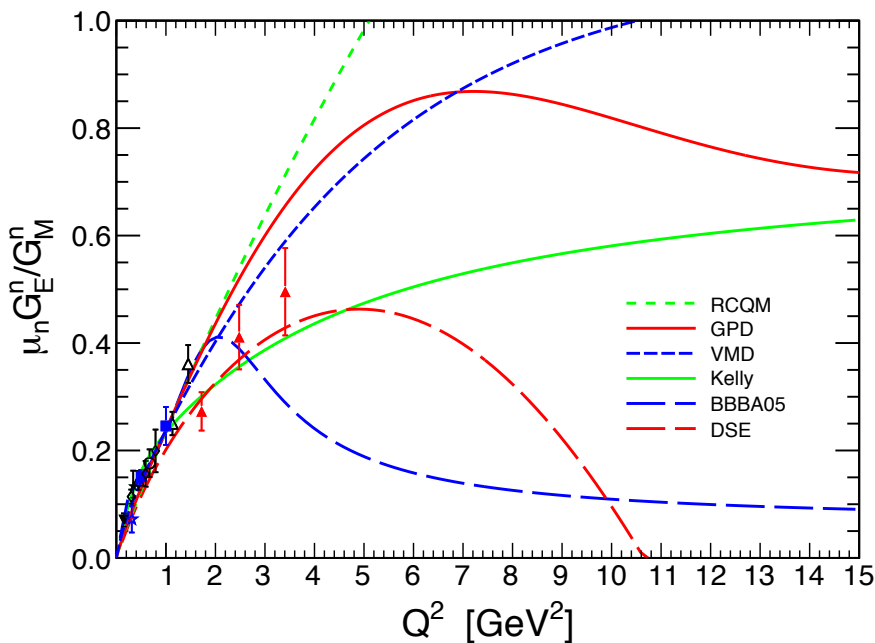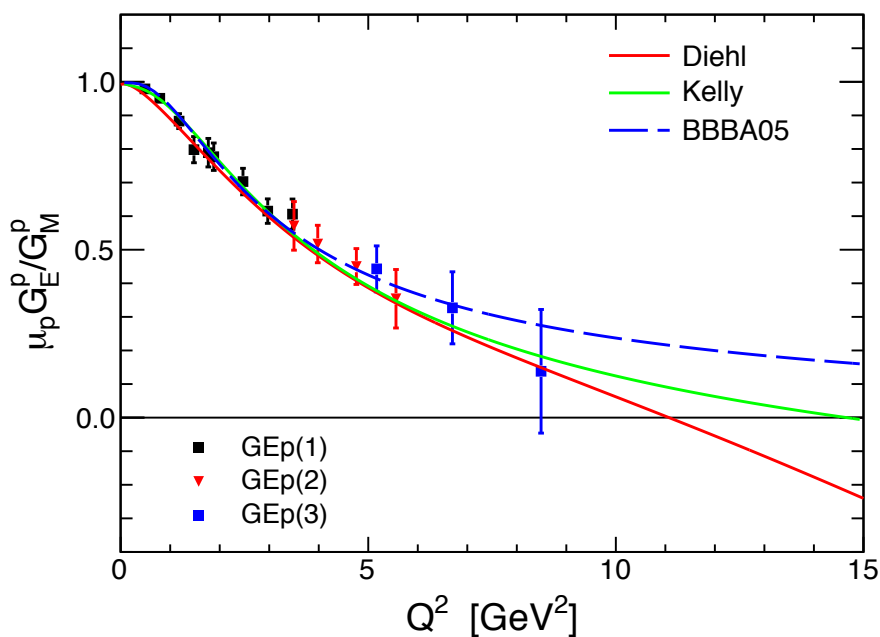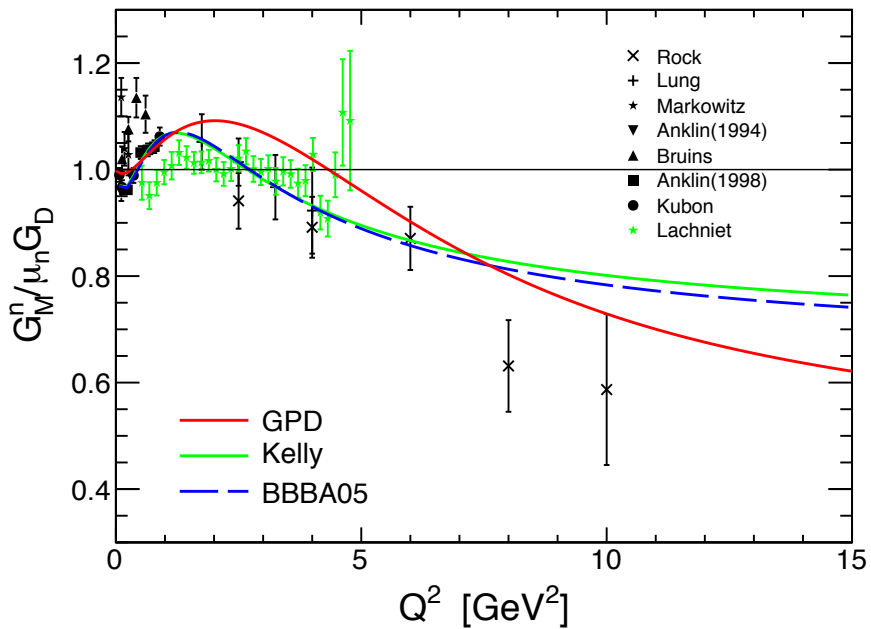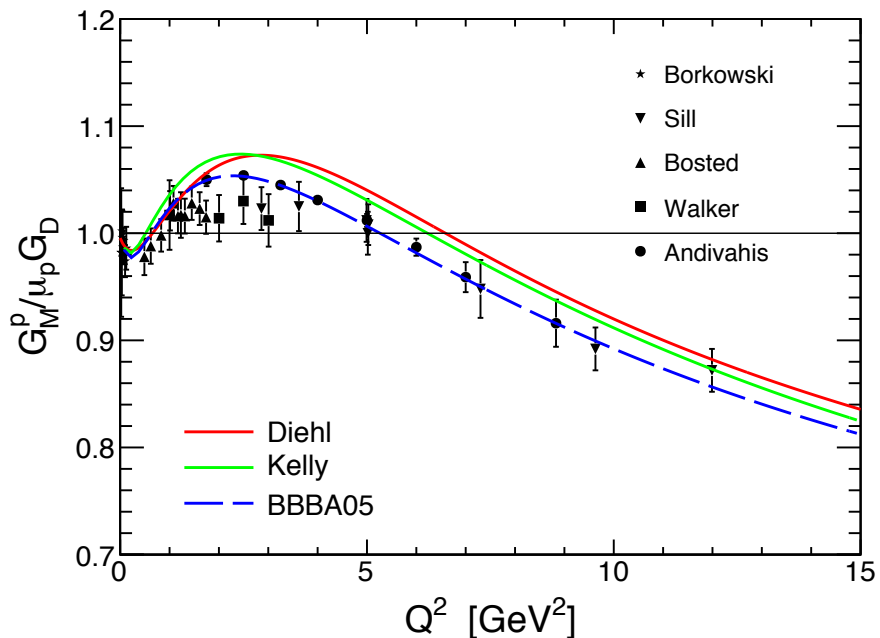# Neutron magnetic form factor E12-09-019

Bogdan Wojtsekhowski, Jefferson Lab

Sachs Form Factors of the nucleon

The cross section ratio method for the neutron magnetic FF
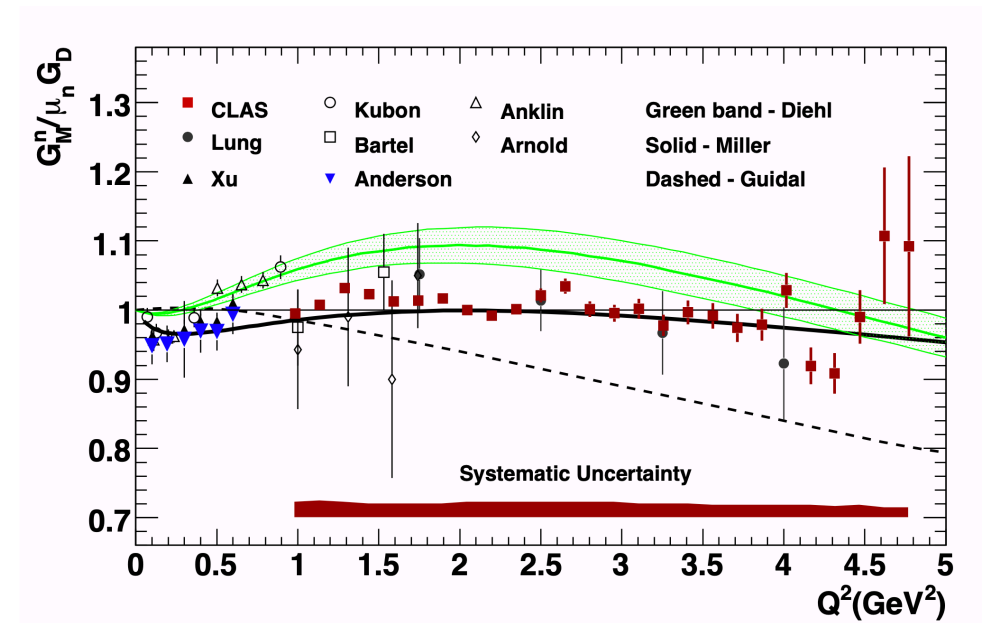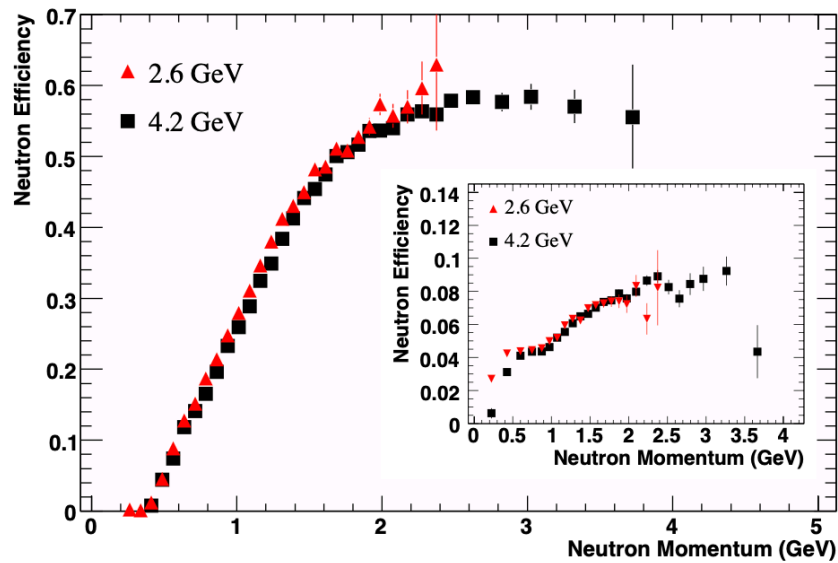
Durand, 1959

$$R'' = \frac{\left(\frac{d\sigma}{d\Omega}\right)_{d(e,e'n)}}{\left(\frac{d\sigma}{d\Omega}\right)_{d(e,e'p)}} \xrightarrow[\substack{\text{nucl.}\\\text{corr.}}]{} \frac{\left(\frac{d\sigma}{d\Omega}\right)_{n(e,e')}}{\left(\frac{d\sigma}{d\Omega}\right)_{p(e,e')}} \xrightarrow[1\gamma]{} \frac{\eta \frac{\sigma_{\text{Mott}}}{1+\tau}\left(\left(G_E^n\right)^2 + \frac{\tau}{\varepsilon}\left(G_M^n\right)^2\right)}{\left(\frac{d\sigma}{d\Omega}\right)_{p(e,e')}}$$

$$\xrightarrow[\substack{\text{neutron}\\\text{Electric}}]{} \quad \boxed{R = \frac{\eta\sigma_{\text{Mott}}\frac{\tau/\varepsilon}{1+\tau}\left(G_M^n\right)^2}{\left(\frac{d\sigma}{d\Omega}\right)_{p(e,e')}}}$$
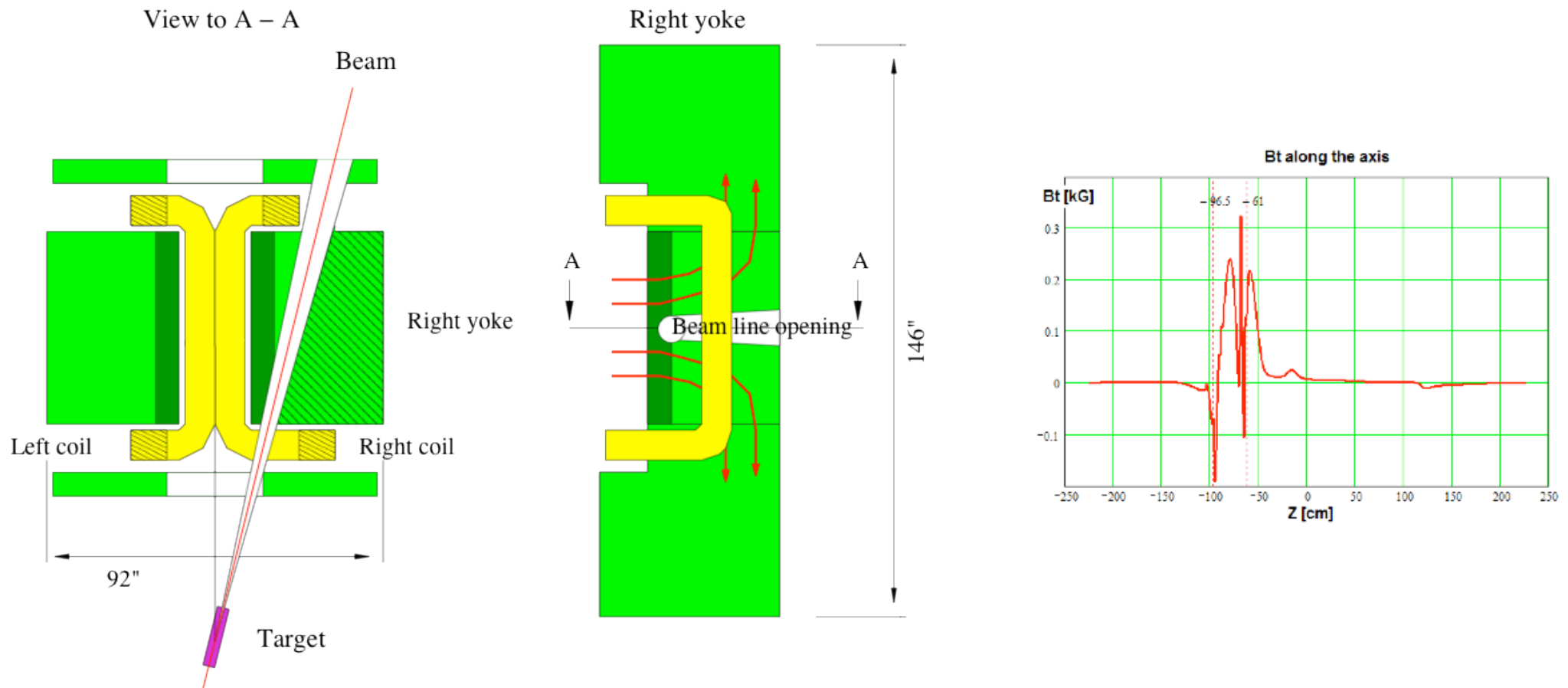
This method requires a c.w. electron beam.
Experiment could be very accurate,
especially at $Q^2 > 1$ GeV^2

CLAS6 experiment

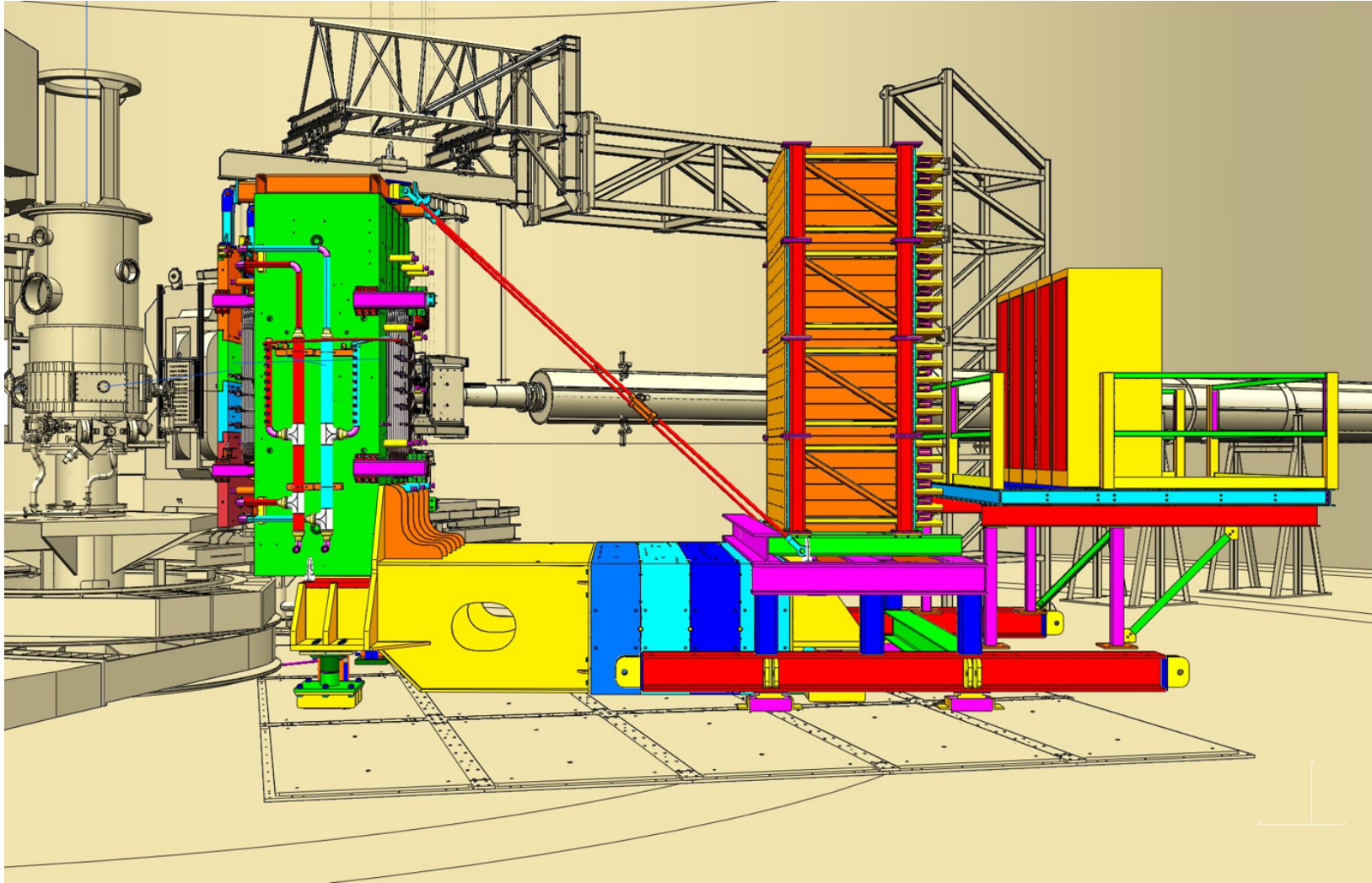
using tagged neutrons from the $^1H(e, e'\pi^+)n$

Super Bigbite Spectrometer

48D48 – 46 x 155 cm² aperture and 1.6-2 Tesla*m

GEM chambers with 100 μm resolution

CAD model

Hadron Calorimeter
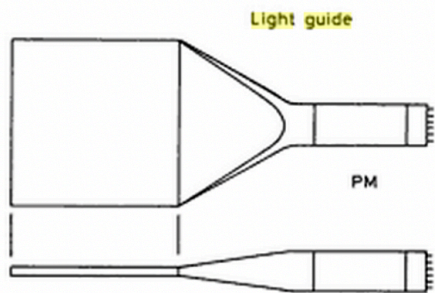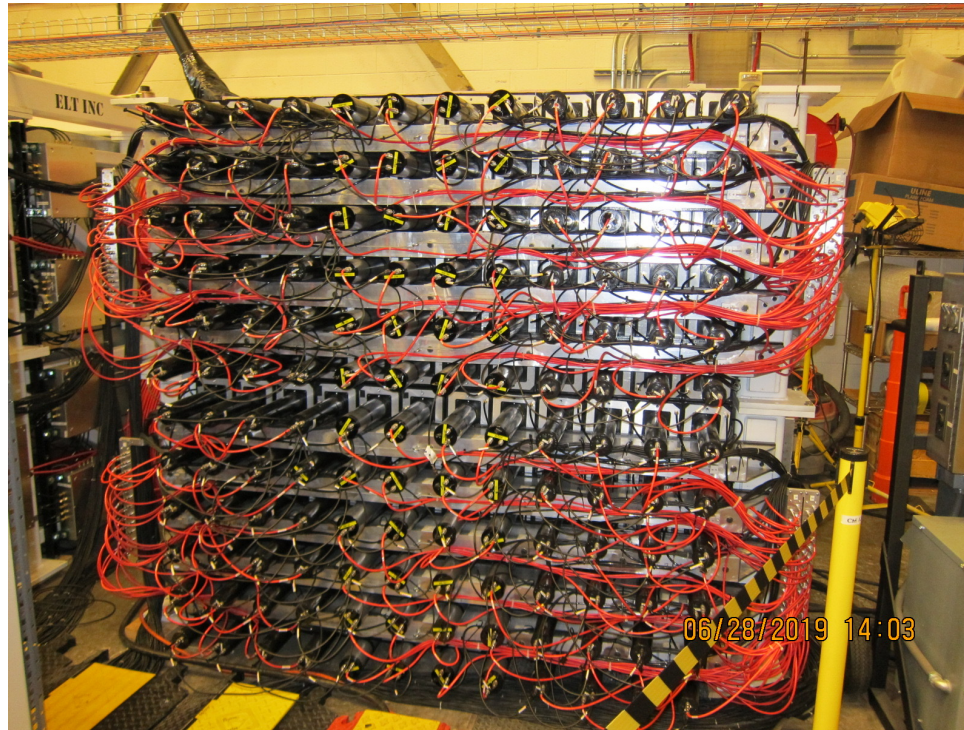
Traditional LG shapes

Novel topology LG

Hall A form factor experiments

Proton magnetic form factor: E12-07-108
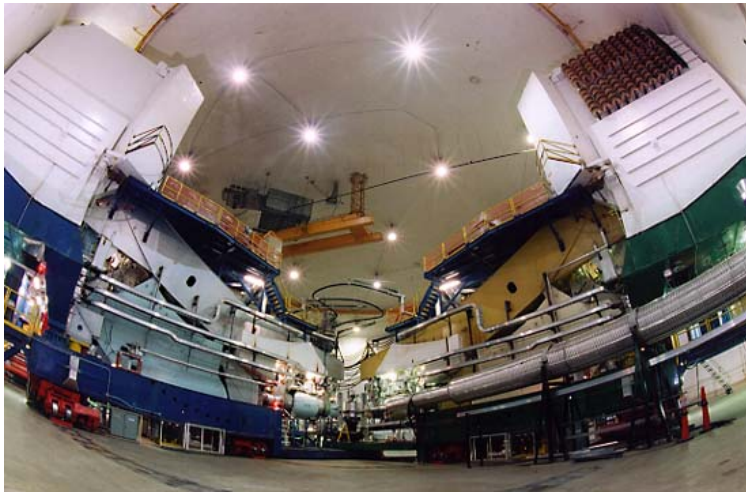
Neutron/proton form factors ratio: E12-09-019
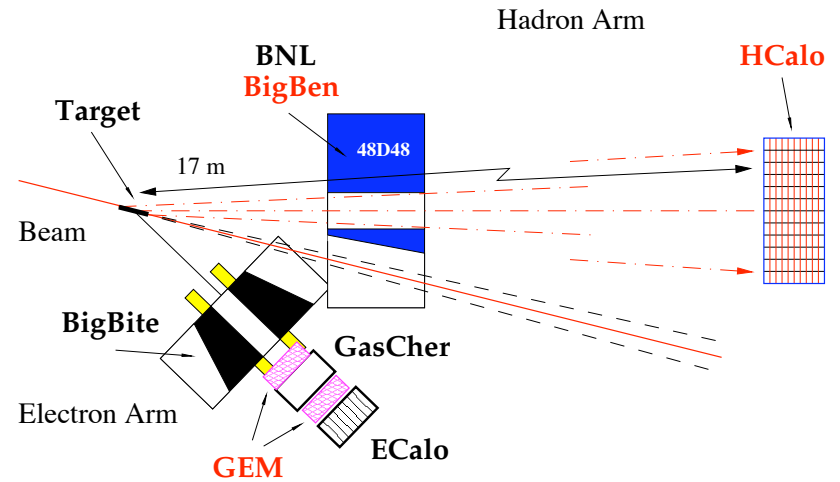
Proton form factors ratio, GEp(5): E12-07-109
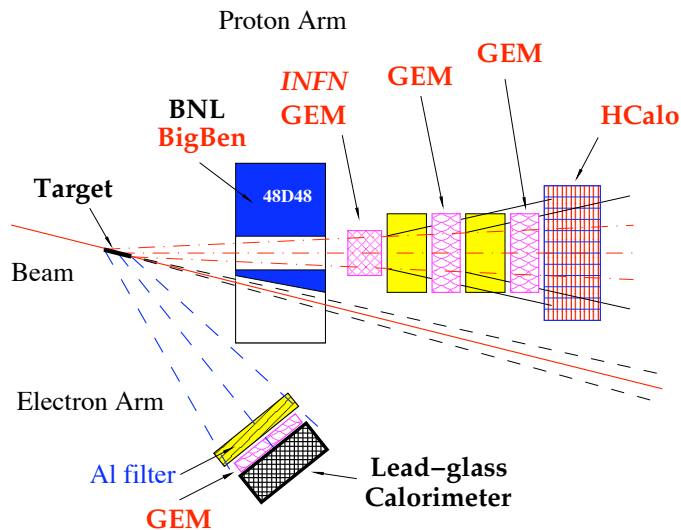
Neutron form factors ratio, GEn(2):E12-09-016
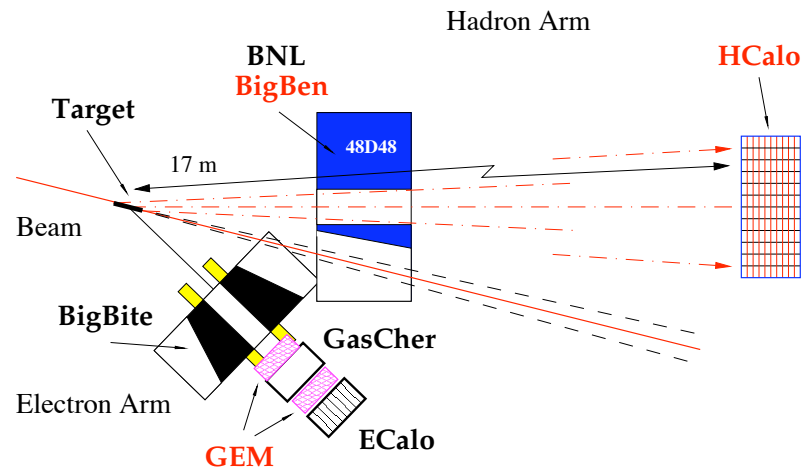
Sachs Form Factors with SBS plans
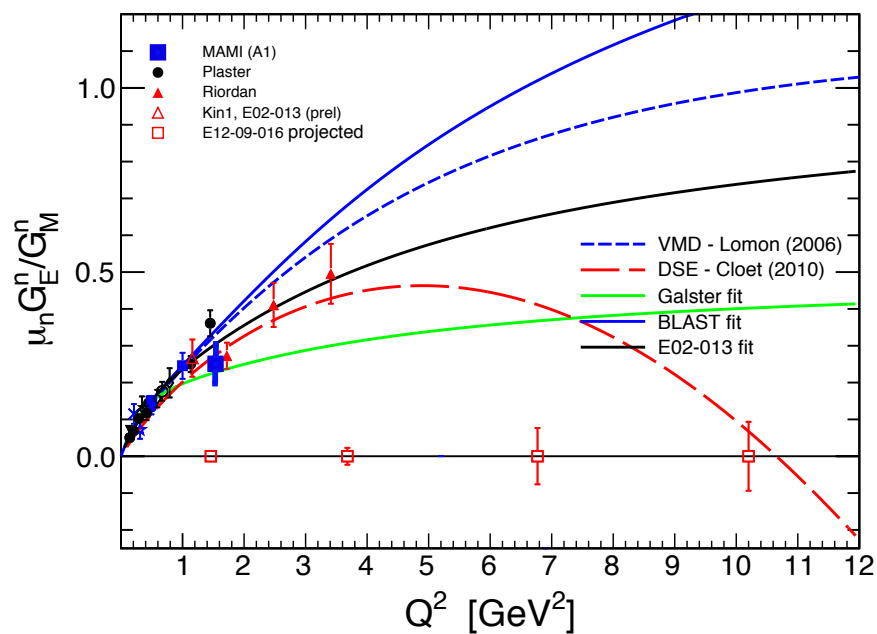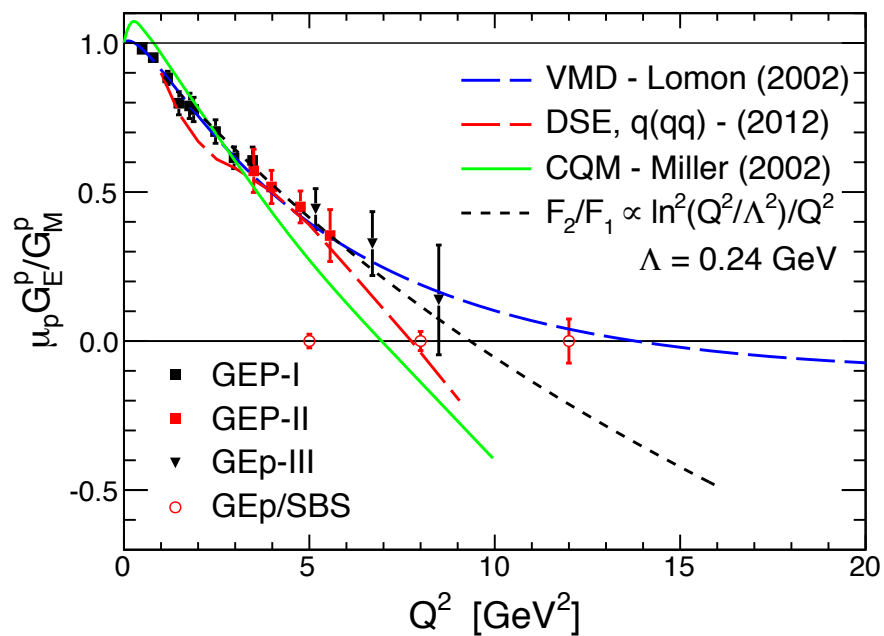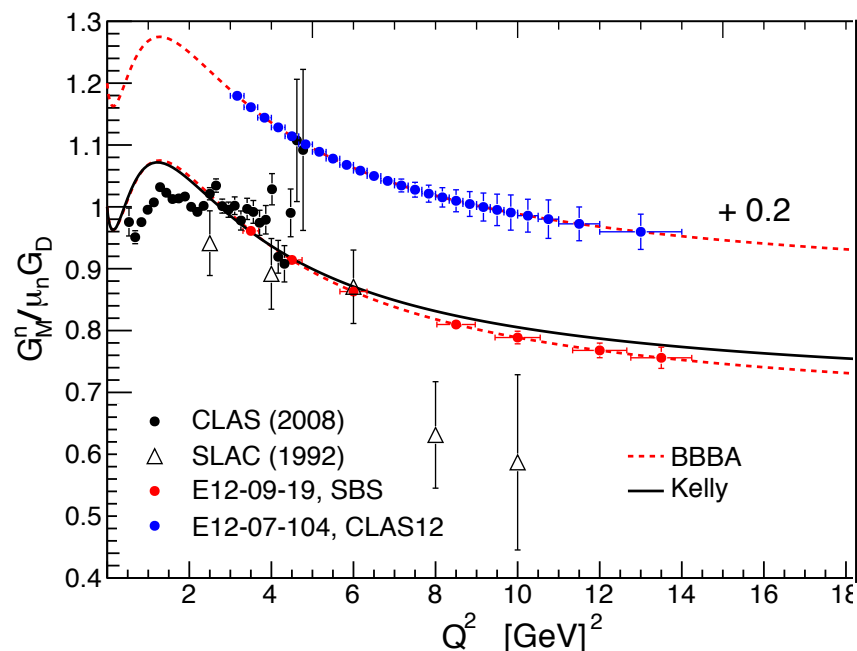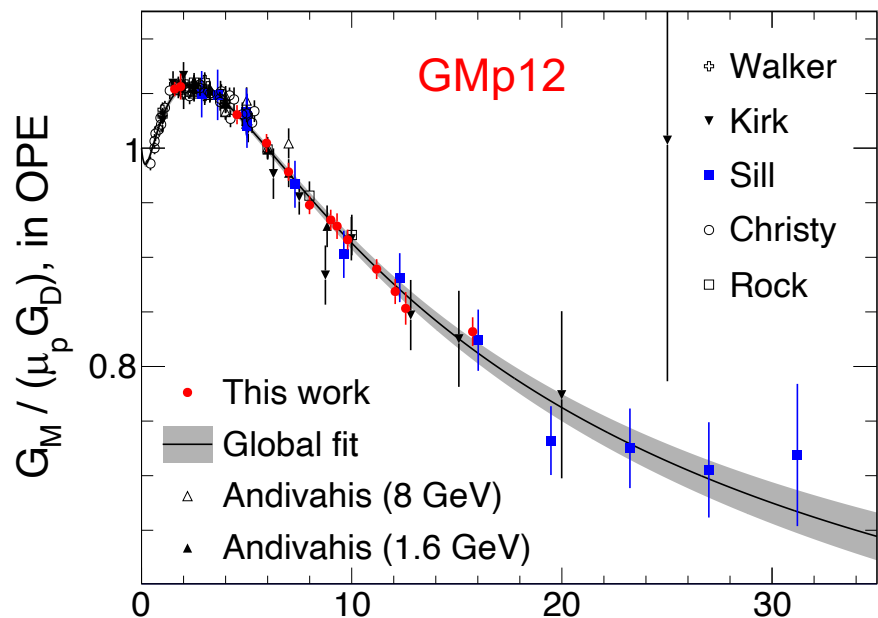
The flavor disparity in the nucleon

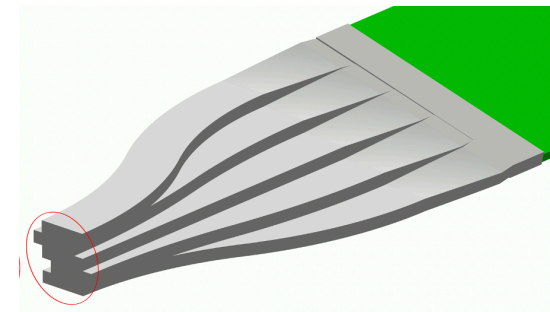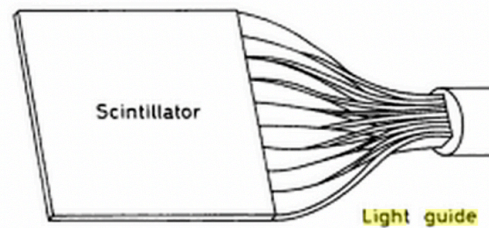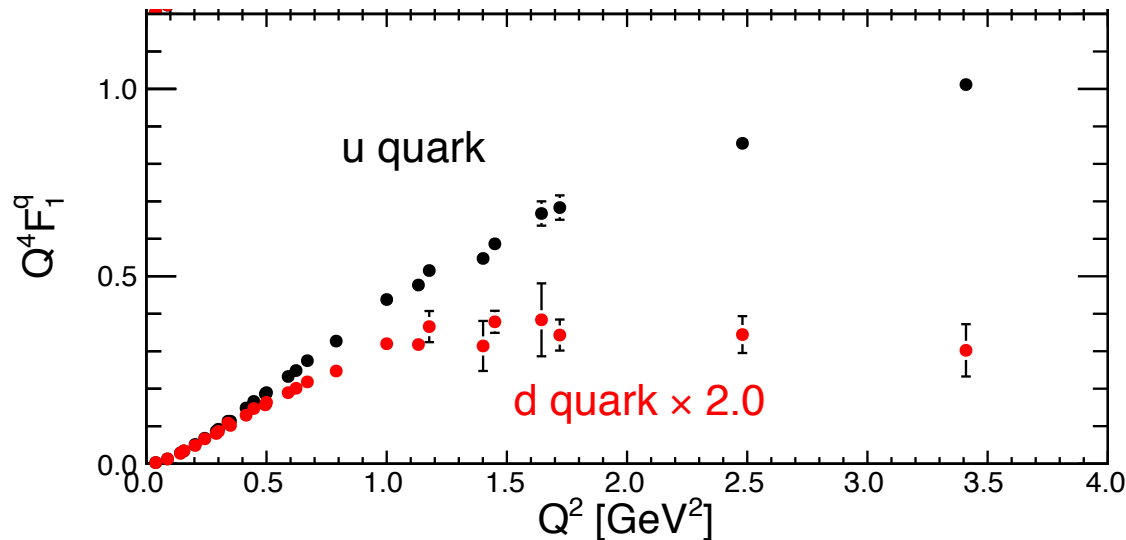The experiment suggests that the probability of proton survival after absorption of a massive virtual photon is much higher when the photon interacts with an up quark, which is doubly represented in the proton.

This may be interpreted as an indication of the up-up correlation. At high Q^2 a correlation usually enhances the high momentum component and the interaction cross section.

The relatively weak down quark contribution to the F_{1p} indicates a suppression of the up-down correlation or a mutual cancellation of different types of up-down correlations.

F_1 decomposition at very large Q^2

$$F_1 = \frac{G_E + \tau G_M}{1+\tau} \qquad F_2 = -\frac{G_E - G_M}{1+\tau}$$
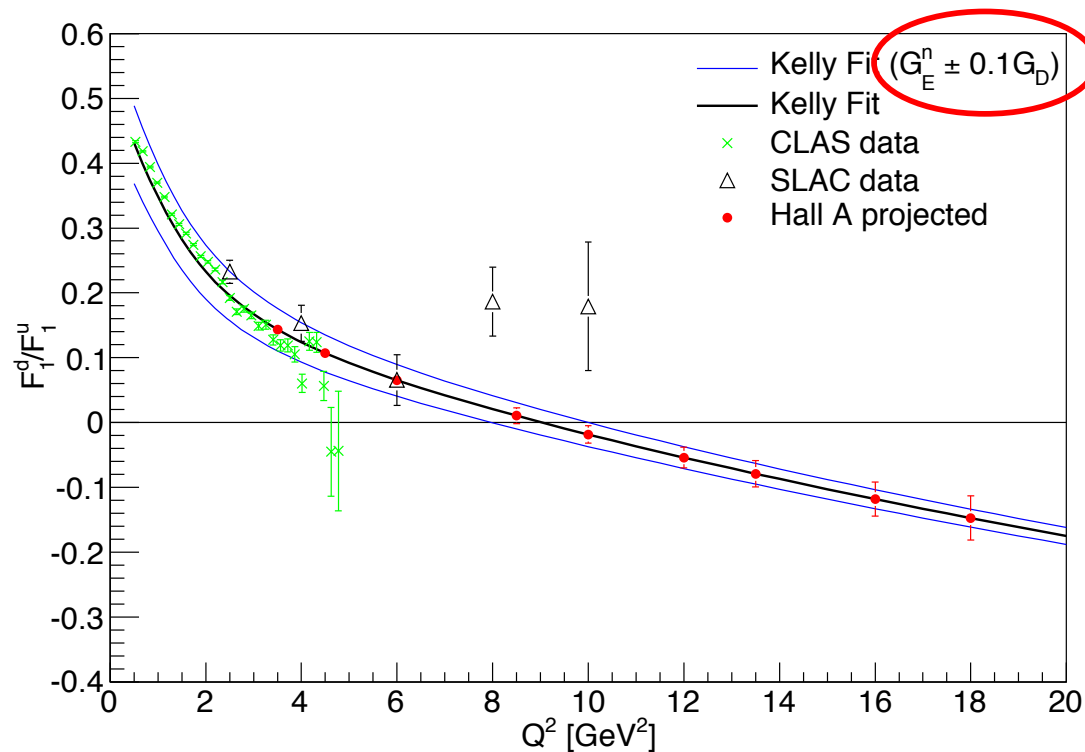
GMn events and HCAL efficiency
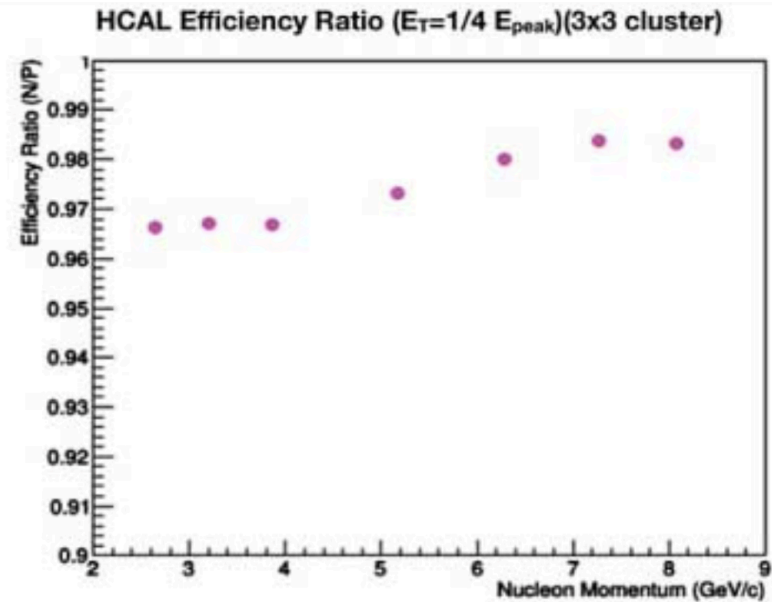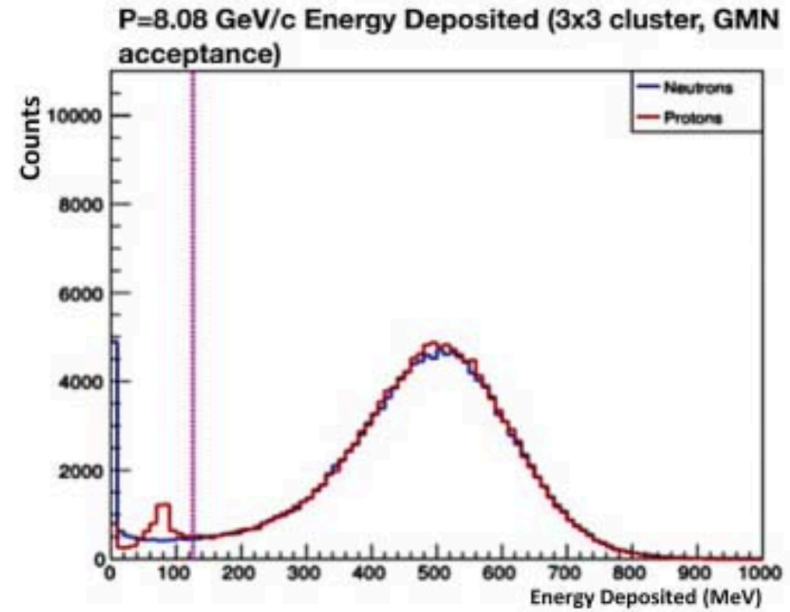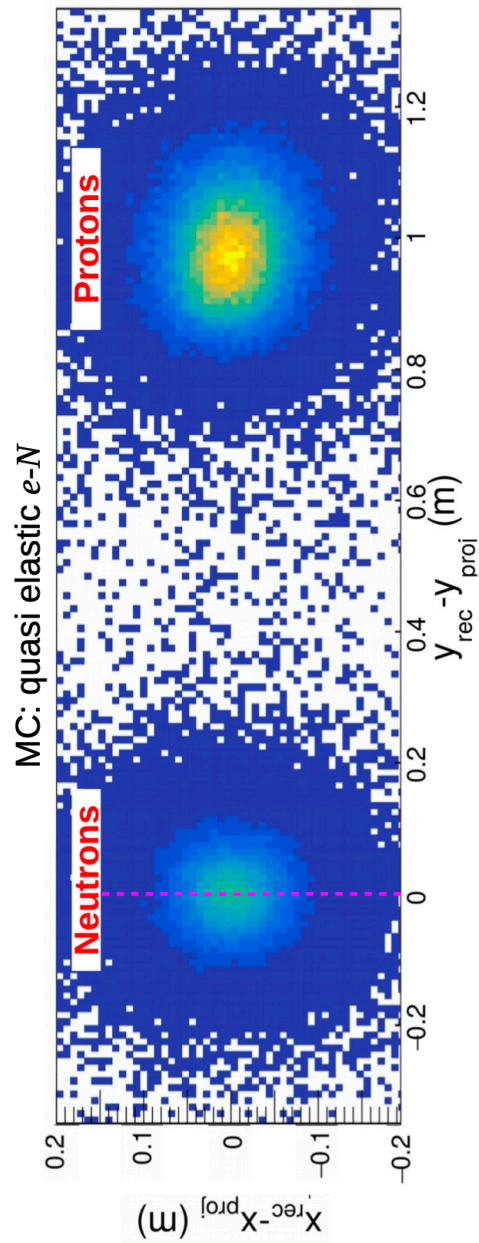
GMn projected results
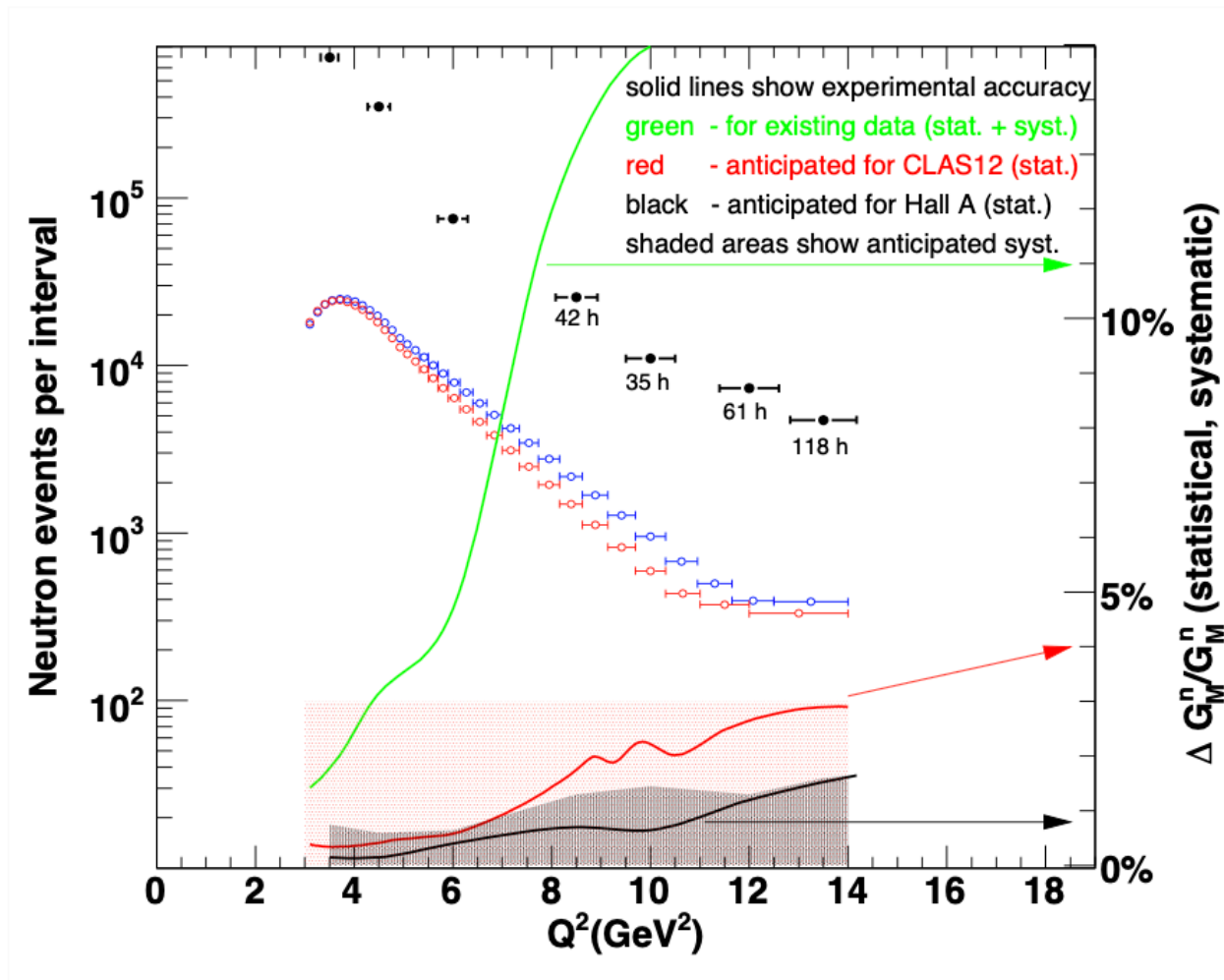
Initial GMn kinematics

Q^2 (GeV/c)^2	E_{beam} (GeV)	θ_e	θ_N	E' (GeV)	P_N (GeV/c)	R_{HCal} (m)	$\int B\,dl$ (T-m)	Equiv. p_{Kick} (MeV/c)	$\mathcal{L}(\times 10^{38}/A)$ (/cm^2/s)
3.5	4.4	32.5°	31.1°	2.5	2.6	6.2	1.4	270	0.7
4.5	4.4	41.9°	24.7°	2.0	3.2	6.2	1.7	350	1.4
6.	4.4	64.3°	15.6°	1.2	4.0	11	0.7	250	2.8
8.5	6.6	46.5°	16.2°	2.1	5.4	11	1.2	250	2.8
10.	8.8	33.3°	17.9°	3.5	6.2	13	1.3	340	1.4
12.	8.8	44.2°	13.3°	2.4	7.3	14	1.2	350	2.8
13.5	8.8	58.5°	9.8°	1.6	8.1	17	0.9	330	2.8

cut due to
one week delay

Current request for GMn run plan

Date	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	
Sept. 27	-/3.7/9.2	-/3.7/9.2	-/3.7/9.2	-/3.7/9.2	-/3.7/9.2	-/3.7/9.2	-/3.7/9.2	
program for ^	beam line	beam line	beam line	beam line	beam line	beam line	beam line	
Oct. 4	2.0/3.7/9.2	2.0/3.7/9.2	2.0/3.7/9.2	2.0/3.7/9.2	- /3.7/9.2	5.56/3.7/9.2	5.56/3.7/9.2	
program for ^	move SBS/BB	HCAL + BB	HCAL + BB	HCAL + BB	move SBS/BB	Q2= 5.0	Q2= 5.0	
Oct. 11	5.56/3.7/9.2	- /3.7/9.2	3.7/ - /9.2	3.7/ - /9.2	3.7/ - /9.2	- /3.7/9.2	7.38/3.7/9.2	
program for ^	Q2= 5.0	move SBS/BB	Q2= 3.0	Q2= 3.0	Q2= 3.0	move SBS/BB	Q2= 6.5	
Oct. 18	7.38/3.7/9.2	7.38/3.7/9.2	- /3.7/9.2	7.38/3.7/9.2	7.38/3.7/9.2	7.38/3.7/9.2	7.38/3.7/9.2	
program for ^	Q2= 6.5	Q2= 6.5	move SBS/BB	Q2= 8.0	Q2= 8.0	Q2= 8.0	Q2= 8.0	
Oct. 25	7.38/3.7/9.2	7.38/3.7/9.2	- /3.7/9.2	7.38/3.7/9.2	7.38/3.7/9.2	7.38/3.7/9.2	7.38/3.7/9.2	
program for ^	Q2= 8.0	Q2= 8.0	move SBS/BB	Q2= 10.0	Q2= 10.0	Q2= 10.0	Q2= 10.0	
Nov. 1	7.38/3.7/9.2	energy adjust	energy adjust	energy adjust	9.91/6.0/8.0	9.91/6.0/8.0	9.91/6.0/8.0	
program for ^	Q2= 10.0	move SBS/BB	move SBS/BB	ready	Q2= 10.0	Q2= 10.0	Q2= 10.0	
Nov. 8	- /6.0/8.0	6.0 / - /8.0	6.0 / - /8.0	6.0 / - /8.0	6.0 / - /8.0	- /6.0/8.0	4.03/6.0/8.0	
program for ^	move SBS/BB	nTPEQ2= 4.0	nTPEQ2= 4.0	nTPEQ2= 4.0	nTPEQ2= 4.0	move SBS/BB	Q2= 4.0	
Nov. 15	4.03/6.0/8.0	4.03/6.0/8.0	4.03/6.0/8.0	4.03/6.0/8.0	- /6.0/8.0	9.91/6.0/8.0	9.91/6.0/8.0	
program for ^	Q2= 4.0	Q2= 4.0	Q2= 4.0	Q2= 4.0	move SBS/BB	Q2= 13.6	Q2= 13.6	
Nov. 22	9.91/6.0/8.0	9.91/6.0/8.0	9.91/6.0/8.0	9.91/6.0/8.0	9.91/6.0/8.0	9.91/6.0/8.0	9.91/6.0/8.0	
program for ^	Q2= 13.6	Q2= 13.6	Q2= 13.6	Q2= 13.6	Q2= 13.6	Q2= 13.6	Q2= 13.6	
Nov. 29	/6.0/8.0	/6.0/8.0	/6.0/8.0	/6.0/8.0	/6.0/8.0	/6.0/8.0	/6.0/8.0	Crane Nov. 29
program for ^	move SBS/BB	move SBS/BB	move SBS/BB	move SBS/BB	SBS trackers	SBS trackers	SBS trackers	
Dec. 6	/6.0/8.0	/6.0/8.0	/6.0/8.0	/6.0/8.0	4.03/6.0/8.0	4.03/6.0/8.0	4.03/6.0/8.0	
program for ^	SBS trackers	SBS trackers	SBS trackers	SBS trackers	SBS trackers	SBS trackers	SBS trackers	
Dec. 13	4.03/6.0/8.0	4.03/6.0/8.0	4.03/6.0/8.0	4.03/6.0/8.0	4.03/6.0/8.0	4.03/6.0/8.0	4.03/6.0/8.0	
program for ^	GEn Q2=4.1	GEn Q2=4.1	GEn Q2=4.1	GEn Q2=4.1	GEn Q2=4.1	GEn Q2=4.1	GEn Q2=4.1	
Dec. 20	4.03/6.0/8.0	4.03/6.0/8.0	4.03/6.0/8.0	4.03/6.0/8.0	no beam	no beam	no beam	
program for ^	GEn Q2=4.1	GEn Q2=4.1	GEn Q2=4.1	GEn Q2=4.1	holiday	holiday	holiday	
Dec. 27	no beam	no beam	no beam	no beam	no beam	no beam	no beam	
program for ^	holiday	holiday	holiday	holiday	holiday	holiday	holiday	
Jan. 3	/6.0/8.0	6.0/ - /9.9	6.0/ - /9.9	6.0/ - /9.9	6.0/ - /9.9	6.0/ - /9.9	6.0/ - /9.9	
program for ^	move BB	PionKLL	PionKLL	PionKLL	PionKLL	PionKLL	PionKLL	
Jan. 10	/6.0/9.9	/6.0/9.9	/6.0/9.9	/6.0/9.9	/6.0/9.9	6.0 /2.1/9.9	6.0 /2.1/9.9	Crane Jan. 10
program for ^	remove BB	remove BB	remove BB	remove BB	move HRS/SBS	HCAL calibr.	HCAL calibr.	
Jan. 17	6.0 /2.1/9.9	6.0 /2.1/9.9	- /2.1/9.9	4.03/6.0/9.9	4.03/6.0/9.9	4.03/6.0/9.9	End of Run	
program for ^	HCAL calibr.	HCAL calibr.	move HRS/SBS	HCAL calibr.	HCAL calibr.	HCAL calibr.	HCAL calibr.	
Jan. 24	no beam							
program for ^	cosmic run							

SBS weekly meeting, Bogdan Wojtsekhowski