Elastic Cross Section for H(e,e'p)

From our 6 kinematics runs (2009, 2033, 2037, 1257, 1243, 1256), our kinematic coverage are from 0.1<Q2<0.6 GeV^2 which translate to 0.3<|q3m|<0.8 GeV/c.

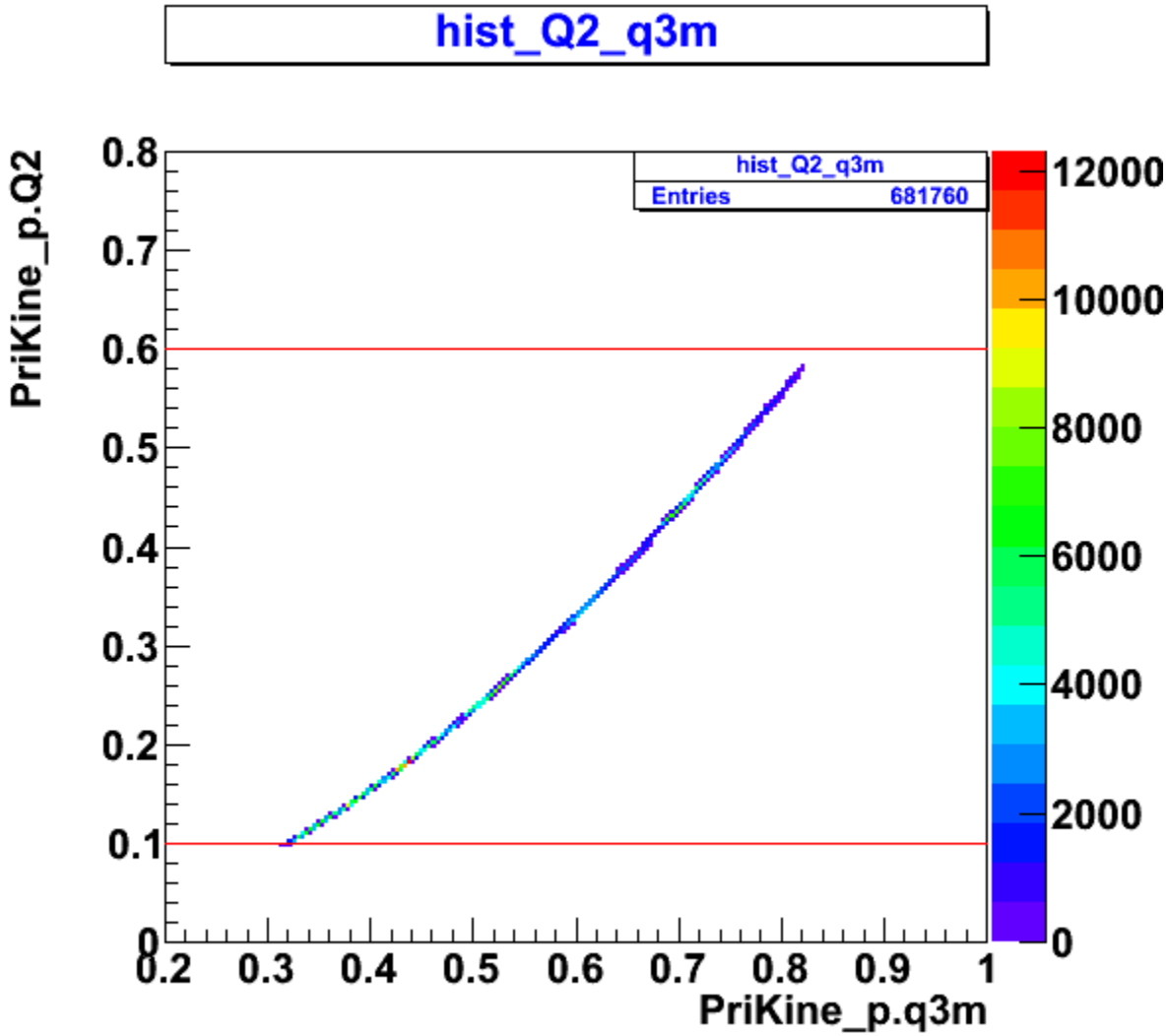


Figure 1. Elastic H(e,e'p) coverage in term of Q^2 and |q3m| with [GeV^2] and [GeV/c] unit respectively.

Each individual run information are as follow.

Run	2009	2033	2037	1257	1243	1256
E_beam [GeV]	1.15976	1.15976	1.15976	2.257	2.257	2.257
Scattering Theta (e') [degree]	17.45	20.5	23.0	14	16.489	19
(e') center momentum [GeV/c]	1.05	1.05	1.05	2.1	2.02	2.02
Main Peak momentum	+4%	+2%	0%			
BigBite.theta [degree]	68	68	68	64.4	64.4	64.4
Q2 [GeV]^2	0.1 to 0.14	0.13 to 0.19	0.17 to 0.23	0.22 to 0.36	0.32 to 0.47	0.42 to 0.58
|q3m|	0.32 to 0.38	0.37 to 0.44	0.42 to 0.49	0.49 to 0.64	0.58 to 0.72	0.68 to 0.82

Table 1: Individual initial data

The Calculated theoretical cross section are follow the following equation:
“Theory cross section”

$$\frac{d\sigma}{d\Omega} = \frac{\alpha^2}{4E^2\sin^4(\theta/2)} \frac{E'}{E} \left\{ \frac{G_E^2+\tau G_M^2}{(1+\tau)} \cos^2(\theta/2) + 2\tau G_M^2 \sin^2(\theta/2) \right\}$$

with
tau = Q2/(4*Mp^2)
alpha = 1/137
(h_bar*c)^2 = 0.389 GeV^2*mbarn

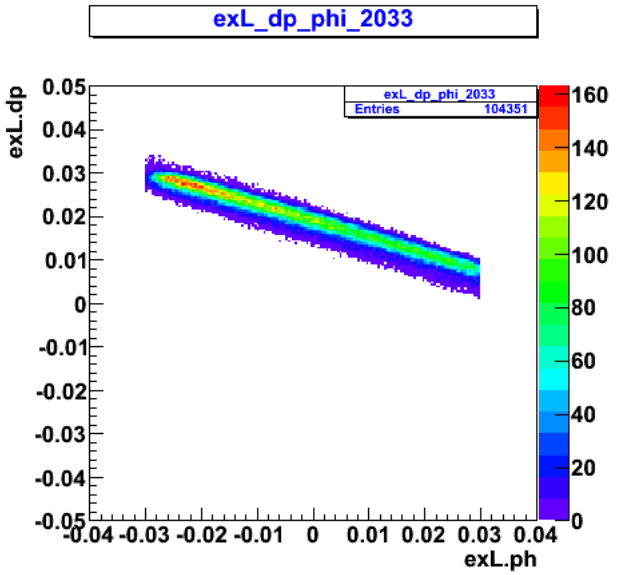
dipole fit for Ge and Gm:
Ge = 1/(1+Q^2/0.71GeV^2)^2 and
Gm = 2.79*Ge.

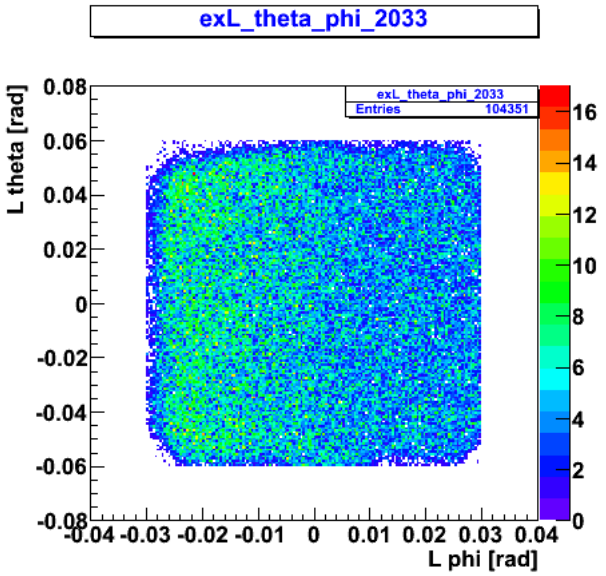
Table 2: Cross section Calculation

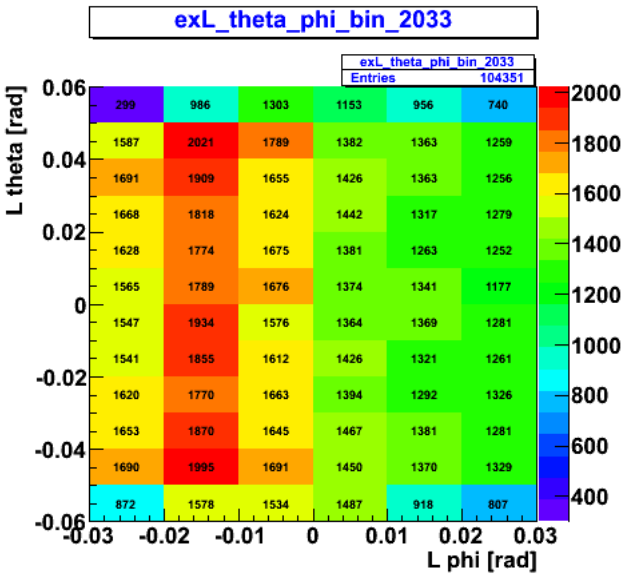
run		2009	2033	2037	1257	1243	1256
E	GeV	1.1598	1.1598	1.1598	2.26	2.26	2.26
scattered theta	degree	17.45	20.5	23	14	16.5	19
scattered theta	radian	0.3046	0.3578	0.4014	0.2443	0.2880	0.3316
E'	GeV	1.0973	1.0756	1.0560	2.1065	2.0536	1.9955
Q2	GeV^2	0.1171	0.1580	0.1947	0.2824	0.3817	0.4907
Ge	1/(1+Q^2/0.71 GeV^2)^2	0.7368	0.6691	0.6159	0.5118	0.4229	0.3496
Gm	2.79*Ge	2.0557	1.8668	1.7183	1.4279	1.1800	0.9755
tau	Q2/(4*Mp^2)	0.0333	0.0449	0.0553	0.0802	0.1084	0.1394
alpha		0.00730	0.00730	0.00730	0.00730	0.00730	0.00730
sin(theta/2)		0.1517	0.1779	0.1994	0.1219	0.1435	0.1650
cos(theta/2)		0.9884	0.9840	0.9799	0.9925	0.9897	0.9863
alpha^2/(4*E^2*sin^4(theta/2) (GeV^-2)		0.0187	0.0099	0.0063	0.0119	0.0062	0.0035
E'/E		0.9462	0.9274	0.9105	0.9333	0.9099	0.8841
(Ge^2+tau*Gm^2)/(1+tau)*cos^2(theta/2)		0.6463	0.5598	0.4937	0.3880	0.2914	0.2176
2*tau*Gm^2*sin^2(theta/2)		0.0065	0.0099	0.0130	0.0049	0.0062	0.0072
cross section	(GeV^-2)	0.01155	0.00522	0.00289	0.00435	0.00167	0.00070
(h_bar*c)^2	GeV^2* ubarn	389.379	389.379	389.379	389.379	389.379	389.379
cross section	ubarn	4.50E+000	2.03E+000	1.13E+000	1.69E+000	6.50E-001	2.73E-001

Let calculate cross section from experiment say run 2033
With cut as:
DBB.evtypebits&(1<<3) && DBB.edtpl==0 && abs(exL.th)<0.060 && abs(exL.ph)<0.030 && abs(sqrt(PriKine_p.W2)-0.93827)< 0.00449

we have,







I make the binning with d_theta = 10 mrad and d_phi = 10 mrad and calculate d_cos(theta_scatter+phi),
I have d\Omega = d_theta* d_cos(theta_scatter+phi)

N_scattered						
x_phi/y_theta	-0.025	-0.015	-0.005	0.005	0.015	0.025
-0.055	872	1578	1534	1487	918	807
-0.045	1690	1995	1691	1450	1370	1329
-0.035	1653	1870	1645	1467	1381	1281
-0.025	1620	1770	1663	1394	1292	1326
-0.015	1541	1855	1612	1426	1321	1261
-0.005	1547	1934	1576	1364	1369	1281
0.005	1565	1789	1676	1374	1341	1177
0.015	1628	1774	1675	1381	1263	1252
0.025	1668	1818	1624	1442	1317	1279
0.035	1691	1909	1655	1426	1363	1256
0.045	1587	2021	1789	1382	1363	1259
0.055	299	986	1303	1153	956	740
d_theta	1.00E-002	1.00E-002	1.00E-002	1.00E-002	1.00E-002	1.00E-002
phi_min	-0.0300	-0.0200	-0.0100	0.0000	0.0100	0.0200
phi_max	-0.0200	-0.0100	0.0000	0.0100	0.0200	0.0300
th_sc	20.5	0.36	deg/rad			
dcos(th_sc+ph	0.00327	0.00336	0.00346	0.00355	0.00364	0.00374
d_Omega	3.27E-005	3.36E-005	3.46E-005	3.55E-005	3.64E-005	3.74E-005

with

Statistical uncertainty from N_scattered			1/sqrt(N_scattered)			
x_phi/y_theta	-0.025	-0.015	-0.005	0.005	0.015	0.025
-0.055	3.4%	2.5%	2.6%	2.6%	3.3%	3.5%
-0.045	2.4%	2.2%	2.4%	2.6%	2.7%	2.7%
-0.035	2.5%	2.3%	2.5%	2.6%	2.7%	2.8%
-0.025	2.5%	2.4%	2.5%	2.7%	2.8%	2.7%
-0.015	2.5%	2.3%	2.5%	2.6%	2.8%	2.8%
-0.005	2.5%	2.3%	2.5%	2.7%	2.7%	2.8%
0.005	2.5%	2.4%	2.4%	2.7%	2.7%	2.9%
0.015	2.5%	2.4%	2.4%	2.7%	2.8%	2.8%
0.025	2.4%	2.3%	2.5%	2.6%	2.8%	2.8%
0.035	2.4%	2.3%	2.5%	2.6%	2.7%	2.8%
0.045	2.5%	2.2%	2.4%	2.7%	2.7%	2.8%
0.055	5.8%	3.2%	2.8%	2.9%	3.2%	3.7%

The prescale for this run is 245 for T3.

T3 prescale rate	487.6	Hz
T3 real rate	119460.9	Hz

Calculation for N_electron and target area number density are from the following numbers:

BCM charges	0.00699	C
N_electron	4.37E+016	electron

barn	1.00E-024	(cm^2/barn)
target density	0.0723	g/cm^3
N_a	6.02E+023	atom/mol
A_z	1	g/mol
thickness	4	cm
target area number density	1.74E+023	atom/cm^2

N_electron*target_area_number_density

7.61E+039	electron*atom/cm^2
7.61E+015	electron*atom/barn

The cross section becomes:

prescale*N_scattered/(d_Omega)/(N_electron*target_area_number_density)						barn
x_phi/y_theta	-0.025	-0.015	-0.005	0.005	0.015	0.025
-0.055	8.59E-007	1.51E-006	1.43E-006	1.35E-006	8.11E-007	6.95E-007
-0.045	1.67E-006	1.91E-006	1.58E-006	1.32E-006	1.21E-006	1.15E-006
-0.035	1.63E-006	1.79E-006	1.53E-006	1.33E-006	1.22E-006	1.10E-006
-0.025	1.60E-006	1.69E-006	1.55E-006	1.26E-006	1.14E-006	1.14E-006
-0.015	1.52E-006	1.78E-006	1.50E-006	1.29E-006	1.17E-006	1.09E-006
-0.005	1.52E-006	1.85E-006	1.47E-006	1.24E-006	1.21E-006	1.10E-006
0.005	1.54E-006	1.71E-006	1.56E-006	1.25E-006	1.19E-006	1.01E-006
0.015	1.60E-006	1.70E-006	1.56E-006	1.25E-006	1.12E-006	1.08E-006
0.025	1.64E-006	1.74E-006	1.51E-006	1.31E-006	1.16E-006	1.10E-006
0.035	1.67E-006	1.83E-006	1.54E-006	1.29E-006	1.20E-006	1.08E-006
0.045	1.56E-006	1.94E-006	1.67E-006	1.25E-006	1.20E-006	1.08E-006
0.055	2.95E-007	9.44E-007	1.21E-006	1.05E-006	8.45E-007	6.38E-007

compare to the theoretical calculation at the center scattering theta 2.03E-6 barn. We do have the same scale (ubarn).

Note that Detector efficiency and the dead time (14.65%) have not yet take into account.

Now if I start to average the sum up of the center cut (d_theta,d_phi) = 2*(10,10) mrad, 4*(10,10) mrad, and (10*10,4*10) mrad in the center of LHRS acceptance which denote in yellow, blue and orange colors.

	yellow	yellow+blue	yellow+blue+orange
cross section (barn)	1.38E-006	1.43E-006	1.45E-006
stat uncertainty	1.29%	0.64%	0.40%
N_scattered	5990	24730	62827
include deadtime	14.56%	14.56%	14.56%
cross section corr (barn)	1.61E-006	1.67E-006	1.70E-006
theory	2.03E-006	2.03E-006	2.03E-006
ratio	0.79	0.82	0.84

I have the cross section up to statistical uncertainty of 1.29%, 0.64% and 0.4% at 1.61, 1.67, 1.70 mbarn, and ratio to theory is 0.79, 0.82, and 0.84 respectively.