HALL B STATUS

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HALL B STATUS OVERVIEW

- First 2 years of physics data taking

- Ten major production runs completed
  e1a, g1ab, g6a, eg1a, e1b, e2a, g6b, g2a, g1c, g3a (+ g5)

- Data acquisition system has exceeded design goal of 1500 events/sec
  (g3 running up to 3,000 events/sec)

- Level II trigger working (in routine use for g3a)

- CLAS running at design luminosity of $10^{34}cm^{-2}sec^{-1}$

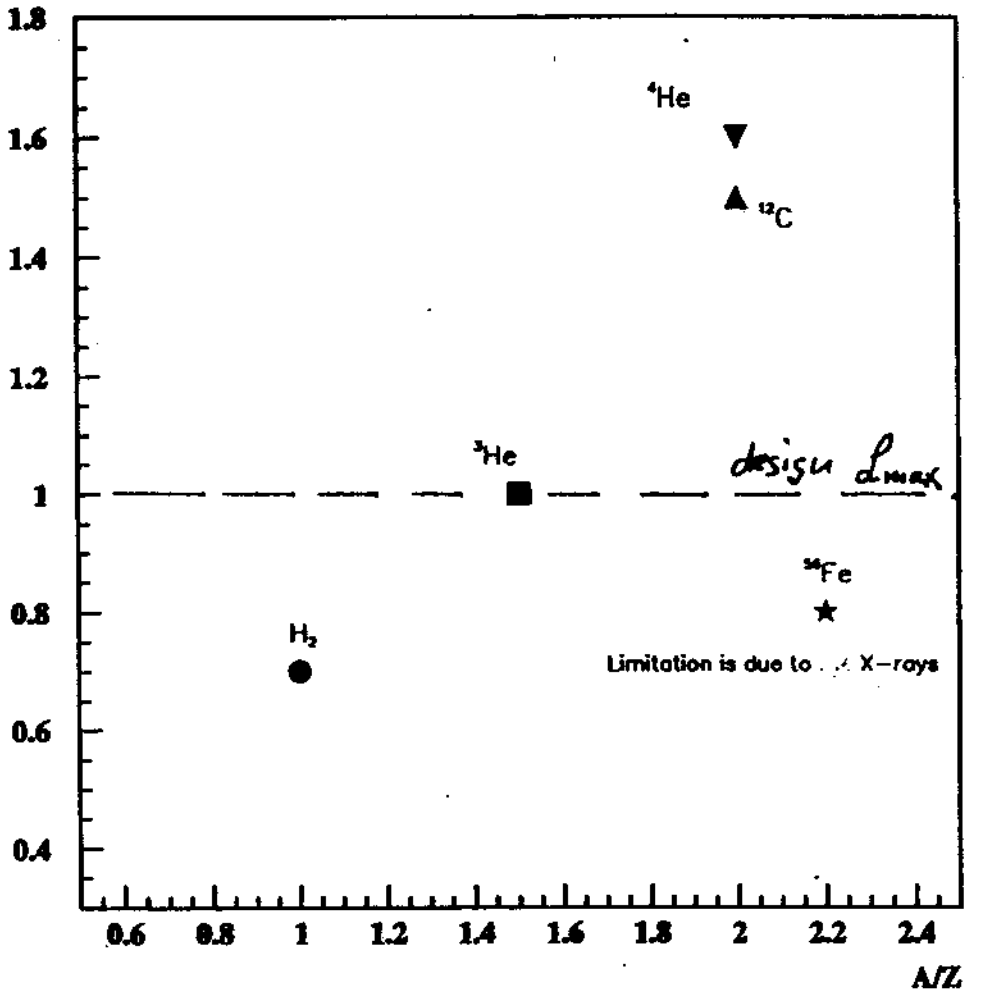
- data analysis using JLab farm
  - 'cooking' completed for e1a, g1ab, g6a, eg1a
  - 'cooking' in progress for e1b, e2a
  - calibration in progress for g6b, g2a, g1c, g3a

- 67 data analysis projects in progress
  - 55 analysis projects have data
  - 36 PhD students involved

- first publications in preparation

Maximum acceptable luminosity in CLAS for various targets.

(in units of 10^{34} $cm^{-2}sec^{-1}$)



(limitations are due to a reduction of track finding efficiency to ~95%)

=> The rise with A/Z indicates that background is increasing due to electron knockout from atomic shells (Moeller scattering)

HALL B DATA TAKING RUNS

Dec. 97 - March 98	$e + p \rightarrow e' + X$ (e1a, 15 experiments)
May, July '98	$\gamma + p \rightarrow h + X$ (g1a, 6 experiments)
June '98	$\gamma + p \rightarrow \phi(1019) + p$ (g6a)
Oct. - Dec. 98	$\vec{e} + \vec{p}\,(\vec{D}) \rightarrow e' + X$ (eg1, 4 experiments)
Jan. 99 - Apr. 99	$\vec{e} + p \rightarrow e' + X$ (e1b, 15 experiments)
Apr. 99 - May 99	$\vec{e} + ({}^{3,4}He,\ C,\ Fe) \rightarrow e' + X$ (e2a, 8 experiments)
July 99	$\gamma + p \rightarrow h_1 + h_2 + X$ (g6b, 2 experiments)
Aug. 99 - Sep. 99	$\gamma + D \rightarrow h + X$ (g2a, 4 experiments)
Oct. - Nov. '99	$\gamma + p \rightarrow h + X$ (g1c, 6 experiments)
Dec. '99	$\gamma + {}^{3,4}He \rightarrow h + X$ (g3, 3 experiments)

HALL B 1999 RUN SUMMARY

Run group	Beam scheduled days	Beam delivered days	Accelerator availability %	Effective run time days	Hall availability %
e1b	57	44	78	26	80
e2a	34	27	79	17	77
g6b	22	11	49	6	84
g2a	27	20	72	16	84
g1c	41	33	82	30	89
g3a	22	17	77	19	87
Total	203	152	75	114	83

RUN COMPLETION STATUS

Run group	Beam time approved days	Beam time charged days	Completion status %
e1	122	32.4	27
e2	35	17.5	50
eg1	100	27.0	27
g1	65	39.8	61
g2	23	16.5	72
g3	25	19.0*	76
g6	20	16.0	80

* took 15 days to complete 19 day program (increased DAQ rate)

HALL B 2000 SCHEDULE

firm schedule		on floor
02/03 - 04/02	e1 at 2.5, 3.1, and 4.8 GeV: $\vec{e} + p \rightarrow e' + X$	52 days
	change to dual-cell target	
04/07 - 05/14	e5 at 2.5 and 4.2 GeV: $e + D \rightarrow e' + n\ (p)$	30 days
	take CLAS target and mini-torus out start torus warm-up and conversion to EPICS	
05/19 - 07/31	rad. ϕ at 5.5 GeV: $\gamma + Be \rightarrow \phi + X$ $\rightarrow \gamma\ a_o\ (f_o)$	60 days
tentative		
08/01 - 09/07	accelerator down, polarized target installation	
09/08 - 12/22	eg1 (finish electron part) at 1.6 – 5.6 GeV $\parallel$ to G_e^n (n-polarimeter) in Hall C	110 days
	will continue in 2001 (no January 2001 down time)	

HALL B CLAS RUN PLAN

Recommended by CLAS Collaboration Scheduling Committee

Run group	Run No.	Run time [days]	PAC rating	Target	Energy [GeV]	Pol. elec.	Status/ Comments
e1	1	19	A^-	H	1.6-4.0	-	done
g1	1	22	A^-	H	2.4	-	done
g6	1	10	A^-	H	4.0	-	done
eg1	1	52	A	pol.	1.6-4.0	High	done
e1	2	27	A^-	H	2.4,4.0	High	done
e2	1	17	B^+	^{3,4}He	2.4,4.0	High	done
g6	2	10	A^-	H	6.0	-	done
g2	1	10	B^+	D	2.4	-	done
g1	2	16	A^-	H	2.4,3.2	-	done
g3	1	19	B	^{3,4}He	1.6	desired	done
time now							
e1	3	30	A^-	H	1.6-4.0	desired	
e5		15	B^+	H+D	2.4,4.2	-	G_m^n/G_m^p
eg1	2	55	A	$\vec{p}$, $\vec{D}$	2, 4, 6	High	electrons only
g8	1	21	B^+	H	4.0	-	linearly pol. γ
g7		12	B^+	nuclear	2.4	-	$(\rho, \omega, \phi) \rightarrow e^+e^-$
e2	2	18	B^+	^{3,4}He	0.8-4.0	desired	
e6		16	B^+	D	6.0	-	
eg1	3	18	A^-	$\vec{p}$	0.8-2.4	High	photons only!
alphabetical order from here on!							
e1		59	A^-	H	2.4,4.0	desired	
e1–6		30	B^+	H	6.0	High	
g1		33	A^-	H	2.4,3.2	desired	
g2		13	B^+	D	2.4	desired	
g3		6	B	C	1.6	desired	$\gamma\ ^{12}C \rightarrow X$
g8		22	B^+	H	6.0	-	linearly pol. γ

DATA ANALYSIS ISSUES

1. **Problem:**

   Growing mismatch between DAQ rate (↑) and analysis speed (↓)

   - recent g3 run took data at ≈125 Mevents/day
   - presently analyze ('cook') ≈5o Mevents/day
   - → need factor ≈5 improvement to keep up

2. **Reason:**

   - farm utilization ≈50% only, limited by silo access
   - analysis code slowed down due to improvements

3. **Solution:**

   - better organization of silo access

     no direct access from farm to silo (transfer tape to disk first)

     perform physics analysis from disks using DST formats

     * factor of 50 reduction in data relative to cooked
     * also solves problem of exporting data

   - check improvements in analysis code for cost/benefit ratio

TECHNICAL PUBLICATIONS

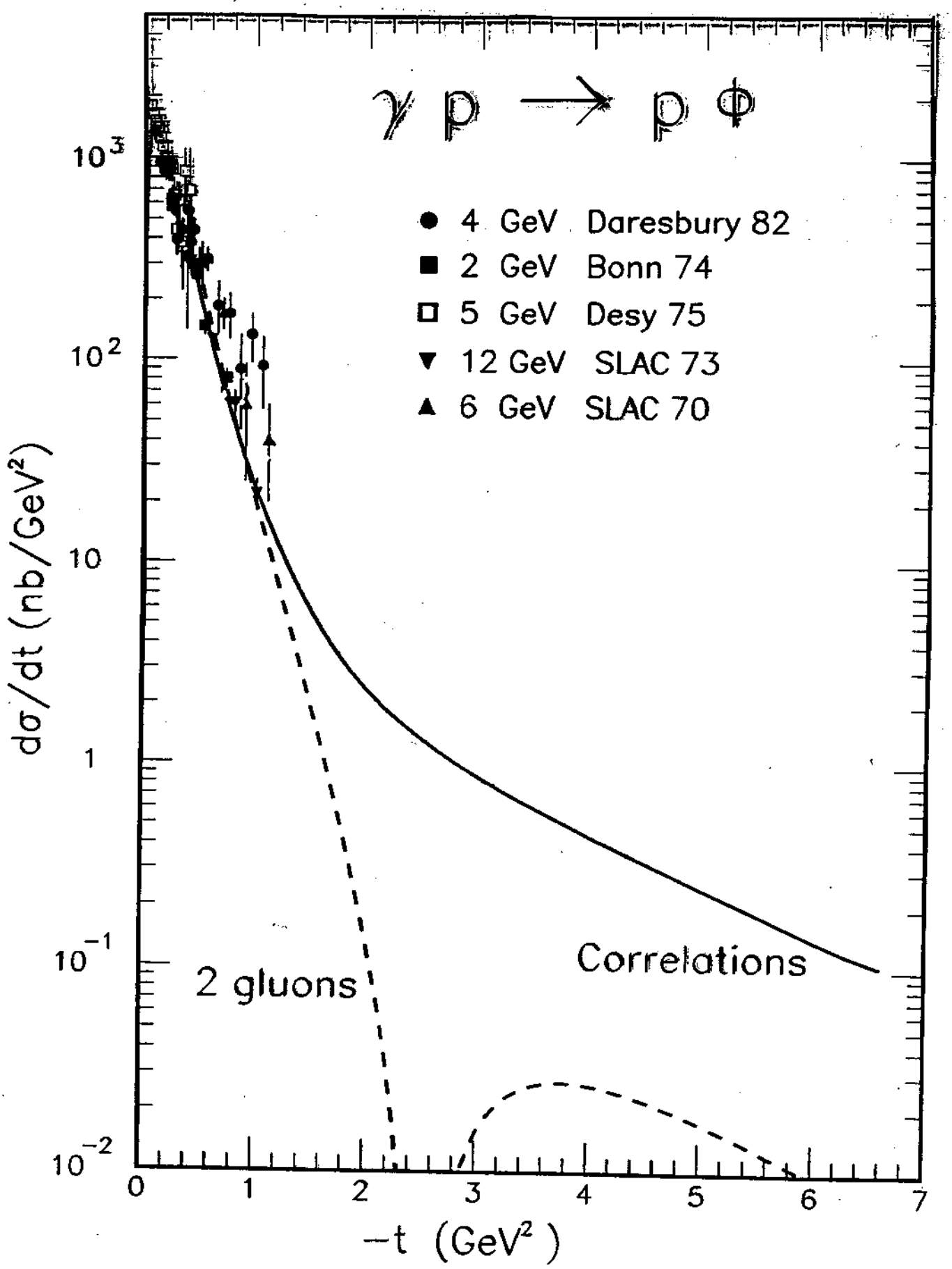
Topic	Editor	Status
Torus Magnet		IEEE Magnetics 25 (1989) 1902
Drift Chambers		
design and construction	Mac Mestayer	NIM A323 (1992) 191
update	Mac Mestayer	NIM A367 (1995) 316
Region I	Dan Carman	NIM A419 (1998) 315
Region II design	L.M. Qin	NIM A411 (1998) 265
final report	Dan Carman	accepted by NIM
Cerenkov Counters	John Price	draft (90%)
ToF Counters	Elton Smith	NIM 432 (1999) 265
Forward Calorimeter	Cole Smith	final draft circulating
Large Angle Calorimeter (cosmic ray response)		accepted by NIM
Tagging System	Jim O'Brien	NIM 440/2 (2000) 263
Tagging Window	Jim O'Brien	NIM 421 (1999) 23
Data Acquisition	Dieter Cords Graham Heyes	joint paper with CODA group (in preparation)
CLAS Overview	Hall B staff	Collaboration paper (need by early 2000)

PHYSICS PUBLICATIONS

in preparation

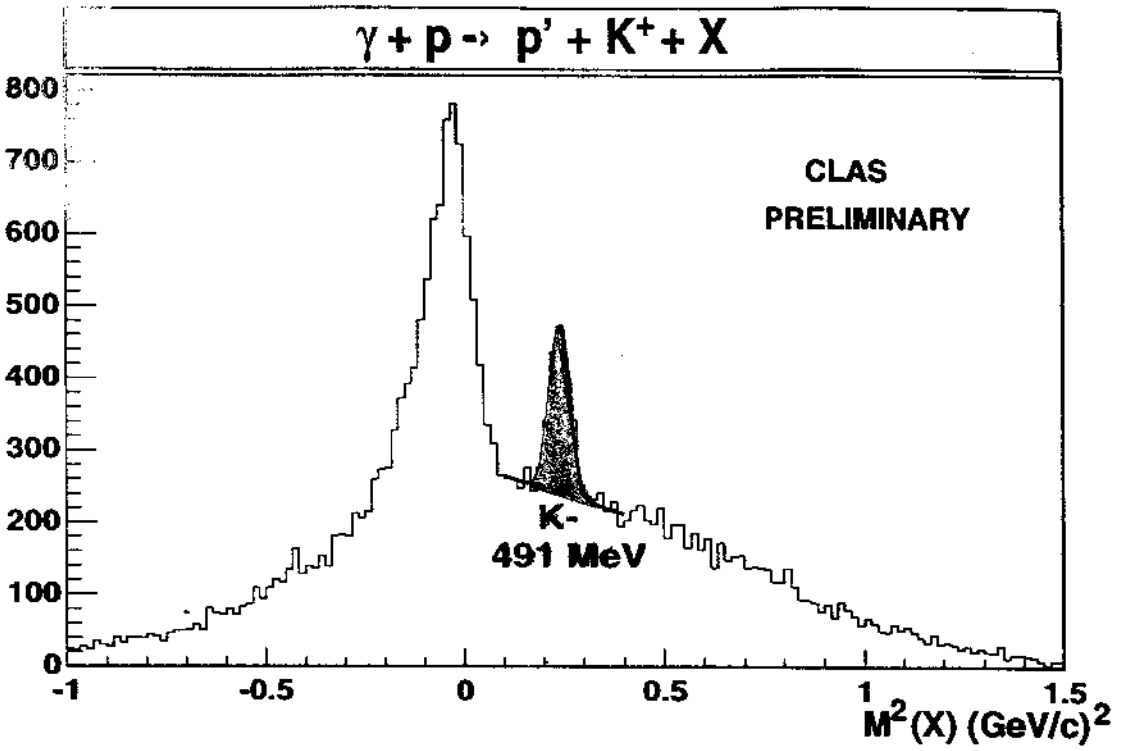
Topic	Group	Status
ϕ-Photoproduction at large t	Saclay	data final draft circulating
π^0-Electroproduction	N*, UVa	data near final PWA analysis
η-Electroproduction	N*, Pittsburgh	data final fitting
π^+-Electroproduction	N*, W&M	data stable fitting

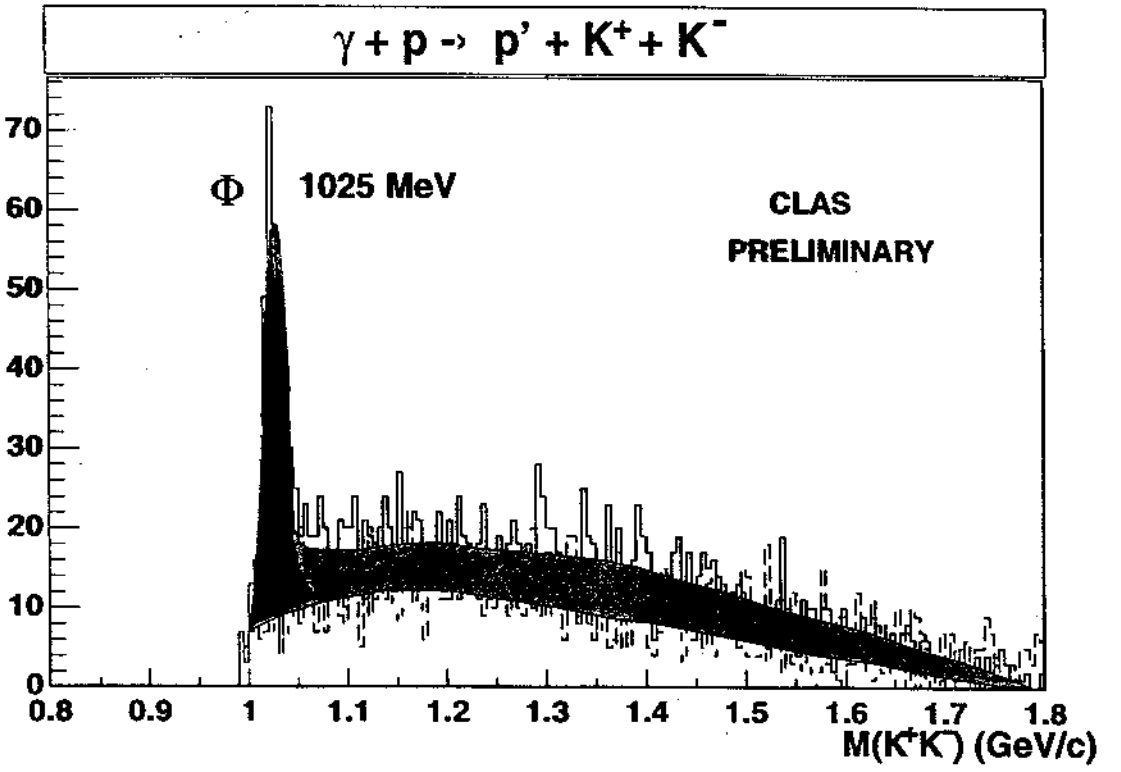
Goal: a few physics publications by summer 2000

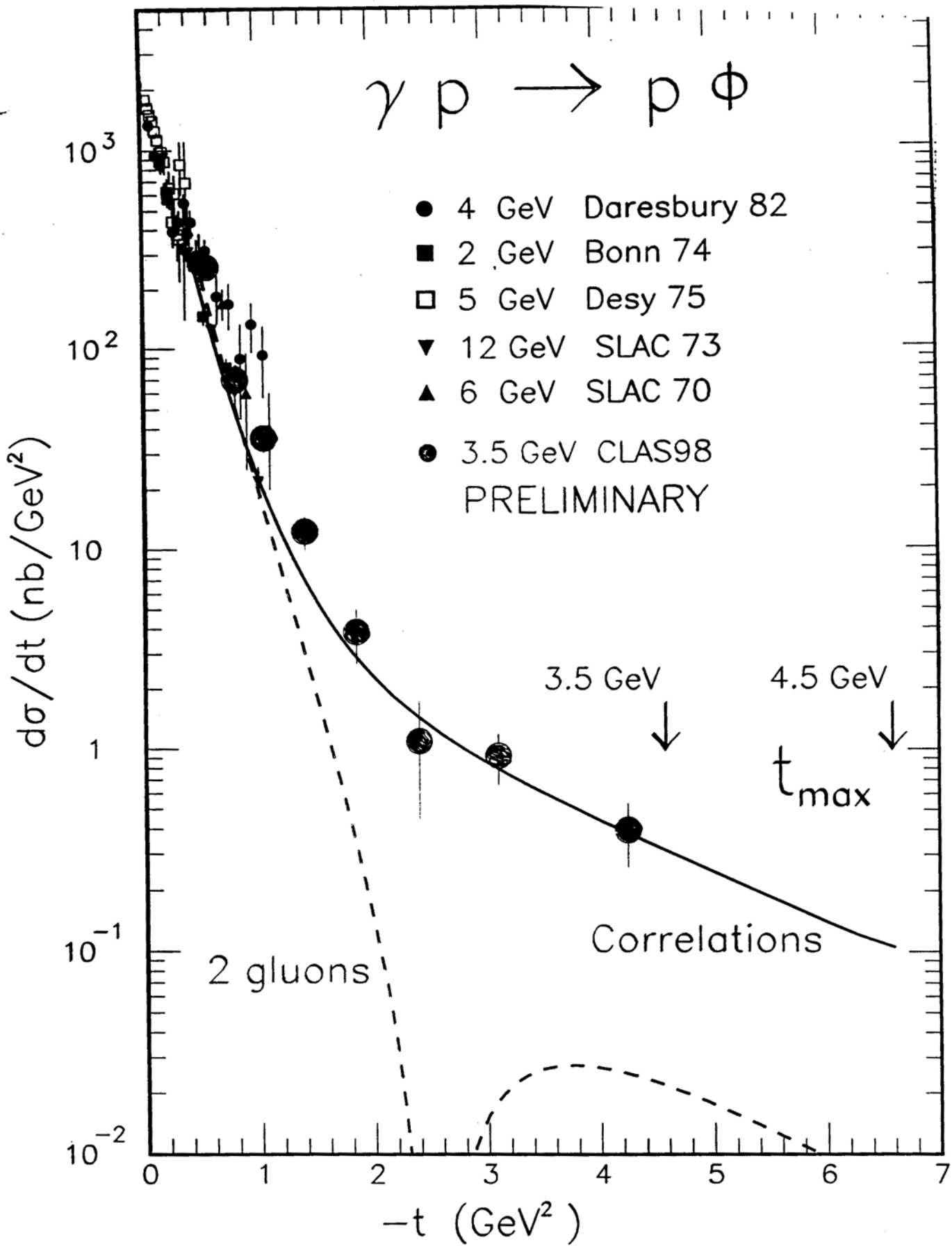

γ p → p φ
4 GeV Daresbury 82
2 GeV Bonn 74
5 GeV Desy 75
12 GeV SLAC 73
6 GeV SLAC 70
2 gluons
Correlations
dσ/dt (nb/GeV²)
−t (GeV²)
10³
10²
10
1
10⁻¹
10⁻²
0
1
2
3
4
5
6
7

g6 data (1998) $E_0 = 4$ GeV (tagged γ)

$\gamma p \to h_1 + h_2 + X$






γ p → p φ
4 GeV Daresbury 82
2 GeV Bonn 74
5 GeV Desy 75
12 GeV SLAC 73
6 GeV SLAC 70
3.5 GeV CLAS98
PRELIMINARY
3.5 GeV
4.5 GeV
t max
Correlations
2 gluons
dσ/dt (nb/GeV²)
−t (GeV²)
10³
10²
10
1
10⁻¹
10⁻²
0
1
2
3
4
5
6
7

Unpolarized Electroproduction Cross Section

$$\sigma_u = \sigma_T + \epsilon\,\sigma_L + \epsilon\,\sigma_{TT}\,cos2\phi + \sqrt{\epsilon(1+\epsilon)}\,\sigma_{LT}\,cos\,\phi$$

$$\sigma_u = a + \epsilon\,b + \epsilon\,c\,sin^2\theta^*\,cos2\phi + \sqrt{\epsilon(1+\epsilon)}\,d\,sin\,\theta^*\,cos\,\phi$$

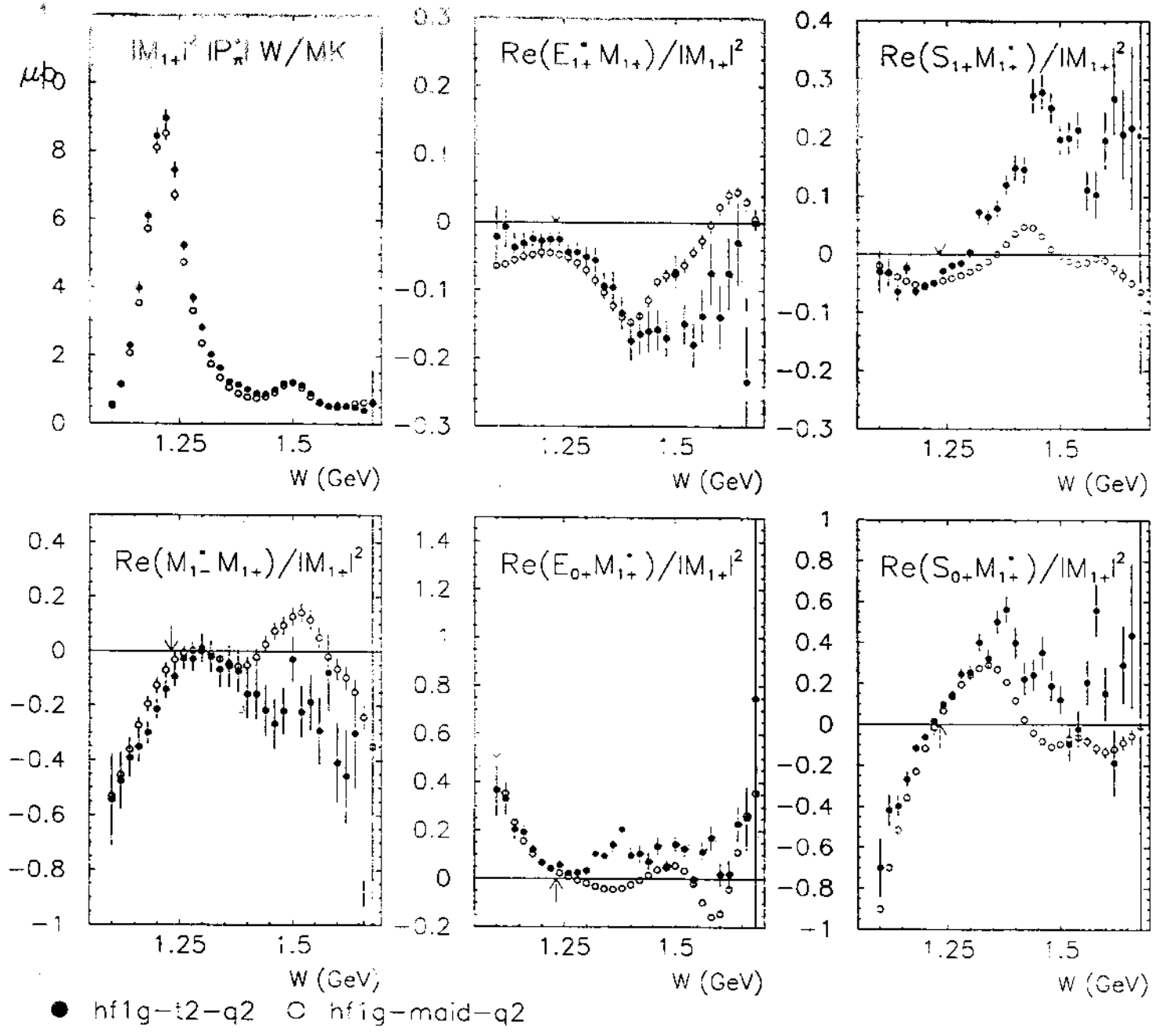
$$a + \epsilon\,b = \sum_n A_n\,cos^n\,\theta^*_\pi \quad c = \sum_n C_n\,cos^n\,\theta^*_\pi \quad d = \sum_n D_n\,cos^n\,\theta^*_\pi$$

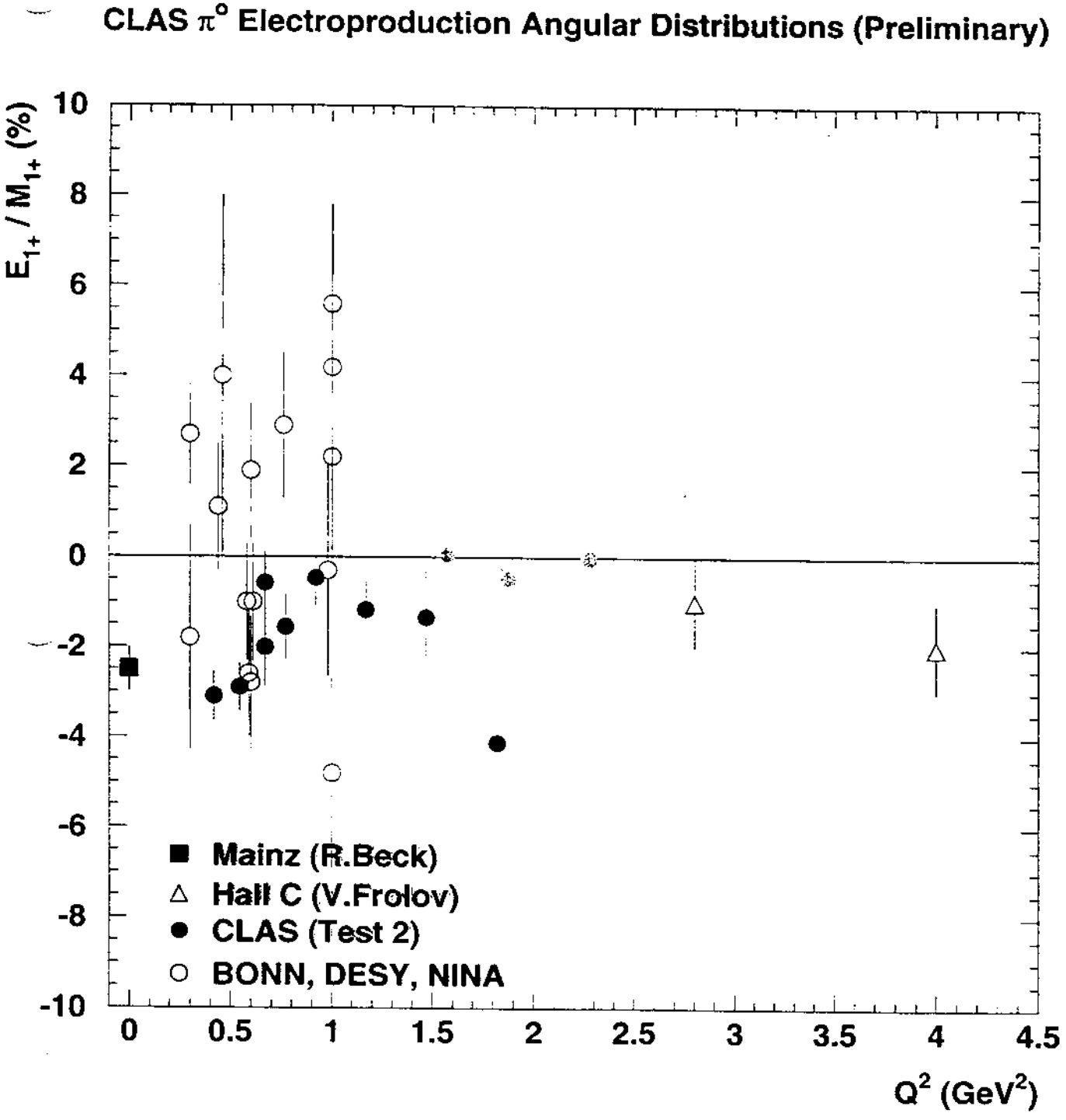
Multipole Expansion (s,p wave πN)

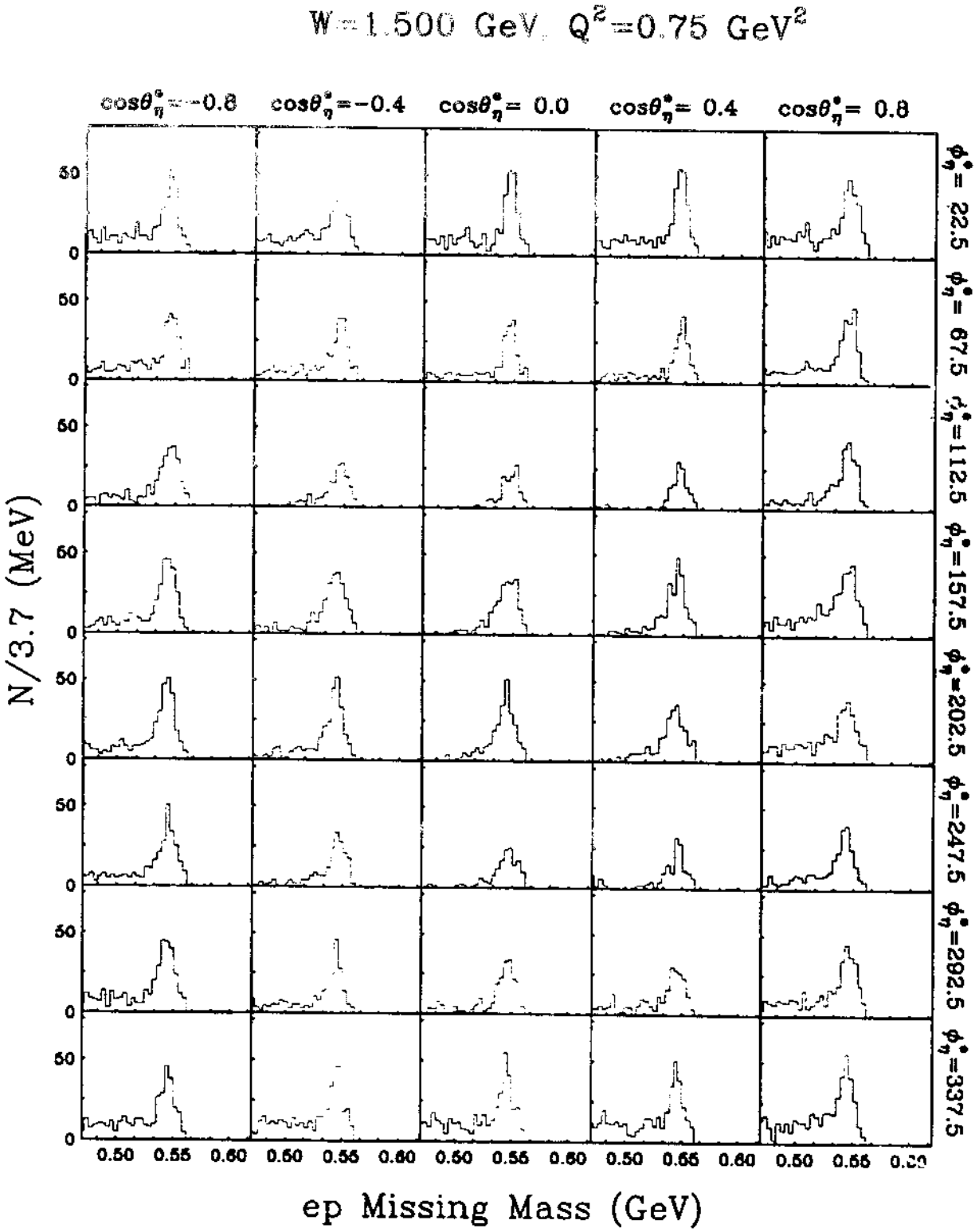
$$\begin{aligned}
A_0 &= \frac{P^*_\pi W}{MK}\left(\tfrac{5}{2}|M_{1-}|^2 - 3Re(M_{1+}E^*_{1+}) + Re(M_{1+}M^*_{1-})\right.\\
&+ \tfrac{9}{2}|E_{1+}|^2 + |E_{0+}|^2 + |M_{1-}|^2 + 3Re(E_{1+}M^*_{1-})\\
&+ \epsilon\frac{q^2}{|q^*|^2}(|S_{1-}|^2 + |S_{0+}|^2 + 4|M_{1-}|^2 - 4Re(M_{1-}S^*_{0+}))\\
A_1 &= \frac{P^*_\pi W}{MK}(2Re(E_{0+}M^*_{1+})\\
&+ 6Re(E_{0+}E^*_{1+}) - 2Re(E_{0+}M^*_{1-})\\
&+ \epsilon\frac{q^2}{|q^*|^2}(8Re(S_{0+}S^*_{1+}) + 2Re(S_{0+}S^*_{1-}))\\
A_2 &= \frac{P^*_\pi W}{MK}\left(-\tfrac{3}{2}|M_{1+}|^2 + 9Re(M_{1+}E^*_{1+}) - 3Re(M_{1+}M^*_{1-})\right.\\
&+ \tfrac{9}{2}|E_{1+}|^2 - 9Re(E_{1+}M^*_{1-}) + \epsilon\frac{q^2}{|q^*|^2}(12|S_{1+}|^2 + 12Re(S_{1+}S^*_{1-}))\\
C_0 &= \frac{P^*_\pi W}{MK}\left(-\tfrac{3}{2}|M_{1-}|^2 - 3Re(M_{1+}E^*_{1-}) - 3Re(M_{1+}M^*_{1-})\right.\\
&+ \tfrac{9}{2}|E_{1+}|^2 + 3Re(E_{1+}M^*_{1-}))\\
D_0 &= \frac{P^*_\pi W}{MK}\sqrt{2}\sqrt{\frac{q^2}{|q^*|^2}}(Re(M^*_{1+}S_{0+})\\
&- 3Re(S_{0+}E^*_{1+}) - Re(S_{0+}M^*_{1-}) + 2Re(E_{0+}S^*_{1+}) - Re(E_{0+}S^*_{1-}))\\
D_1 &= \frac{P^*_\pi W}{MK}6\sqrt{2}\sqrt{\frac{q^2}{|q^*|^2}}(Re(M^*_{1+}S_{1+})\\
&- Re(S_{1+}E^*_{1+}) - Re(S_{1+}M^*_{1-}) - Re(S_{1-}E^*_{1+}))
\end{aligned}$$

$p\pi^0$ $Q^2 = 0.40 (GeV/c)^2$, $\Delta Q^2 = 0.100 (GeV/c)^2$

$Q^2 = 0.525\ GeV^2$


$|M_{1+}|^2\ |P_\pi^*|\ W/MK$
μb
$Re(E_{1+}^* M_{1+})/|M_{1+}|^2$
$Re(S_{1+}M_{1+}^*)/|M_{1+}|^2$
$Re(M_{1-}^* M_{1+})/|M_{1+}|^2$
$Re(E_{0+}M_{1+}^*)/|M_{1+}|^2$
$Re(S_{0+}M_{1+}^*)/|M_{1+}|^2$
W (GeV)
● hf1g−t2−q2 ○ hf1g−maid−q2

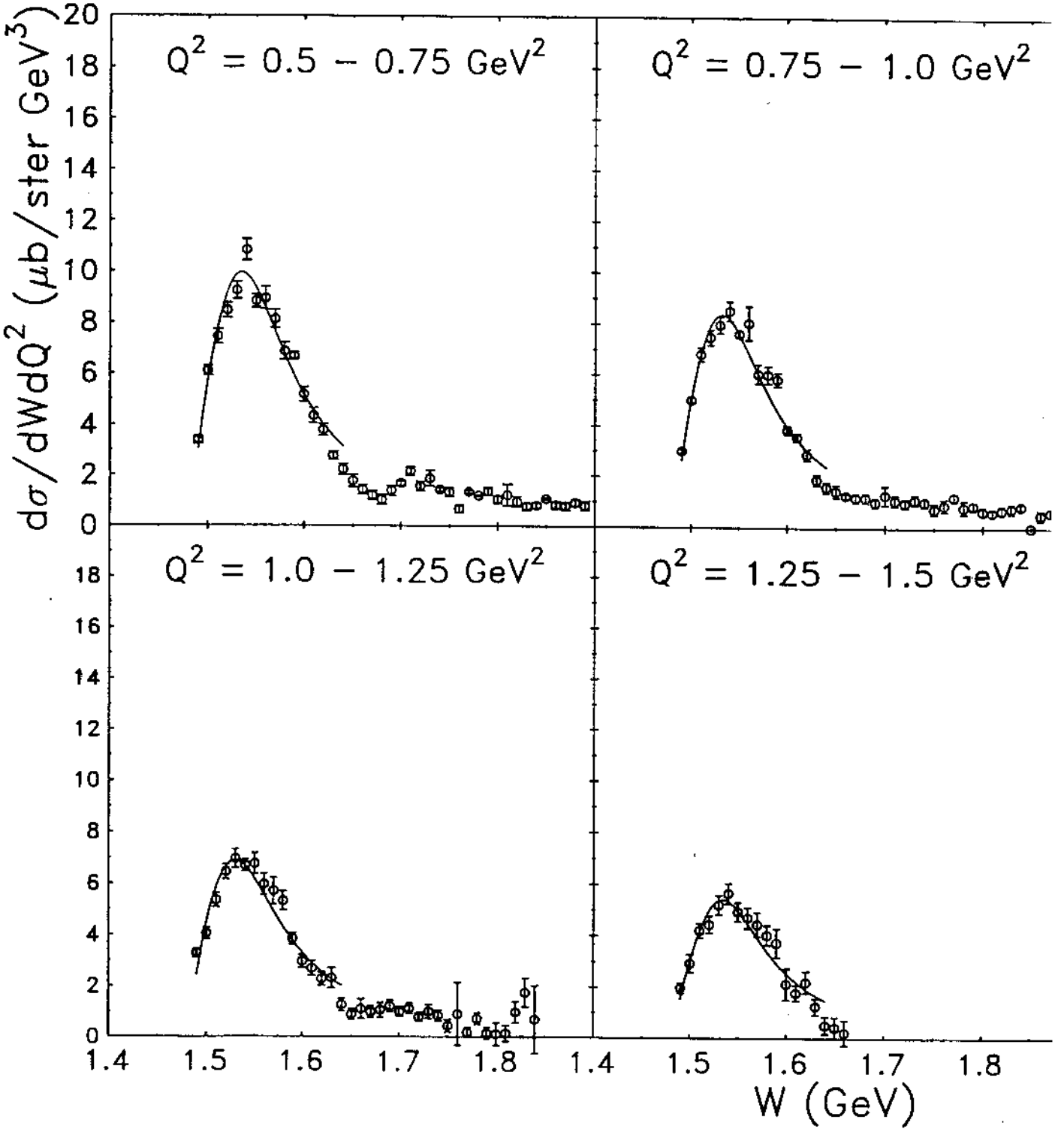

CLAS π° Electroproduction Angular Distributions (Preliminary)
E1+ / M1+ (%)
10
8
6
4
2
0
-2
-4
-6
-8
-10
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Q² (GeV²)
Mainz (R.Beck)
Hall C (V.Frolov)
CLAS (Test 2)
BONN, DESY, NINA


W=1.500 GeV, Q²=0.75 GeV²
cosθ*η=-0.8
cosθ*η=-0.4
cosθ*η= 0.0
cosθ*η= 0.4
cosθ*η= 0.8
φ*η= 22.5
φ*η= 67.5
φ*η=112.5
φ*η=157.5
φ*η=202.5
φ*η=247.5
φ*η=292.5
φ*η=337.5
N/3.7 (MeV)
ep Missing Mass (GeV)

Angle (θ^*, ϕ^*) Integrated cross sections

better statistics

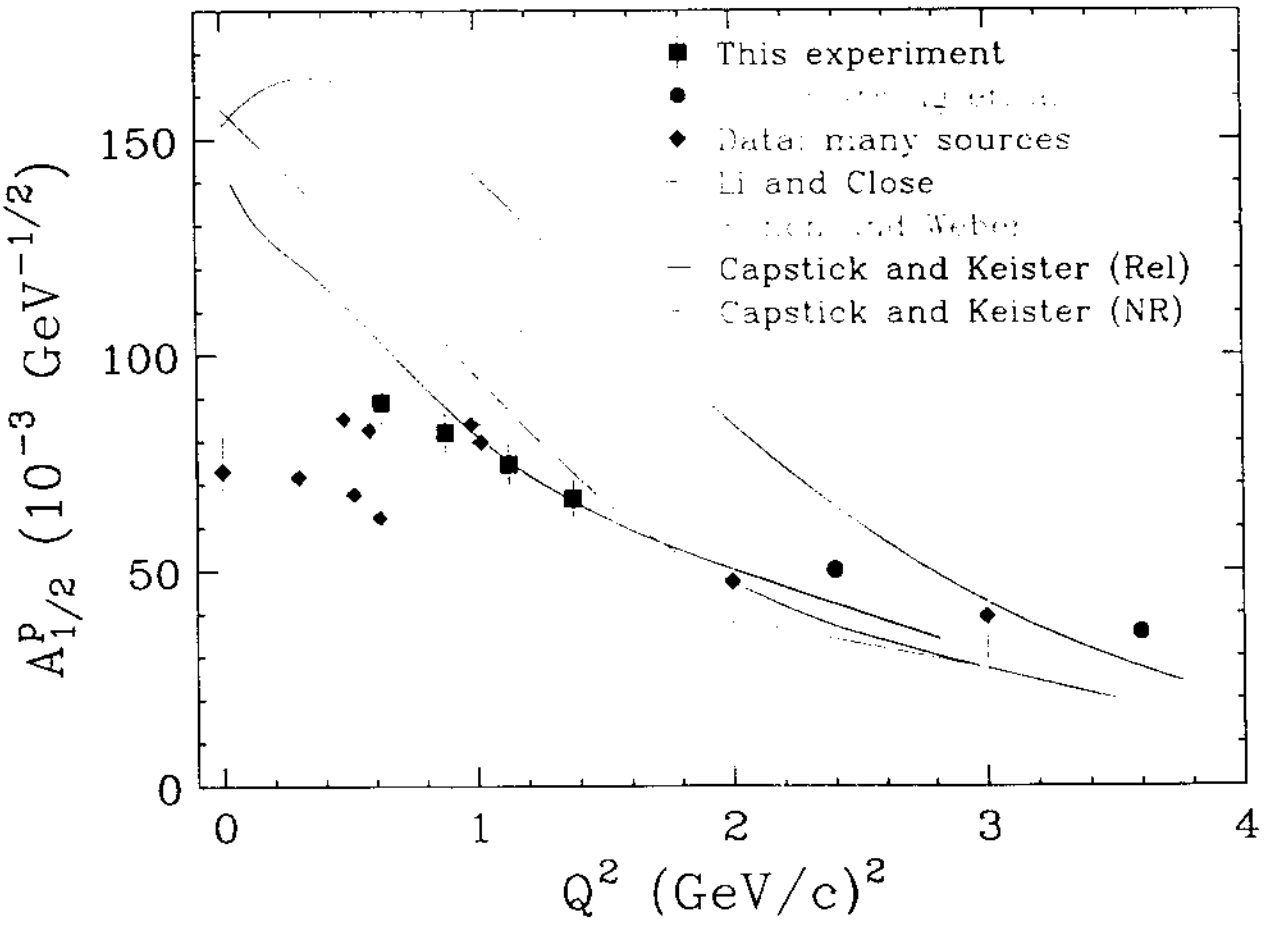
- W bin → 10 MeV
- Q^2 bin → 0.25 (GeV/c)^2



Preliminary Photocouplings
[$S_{11}(1535)$ dominance assumed]

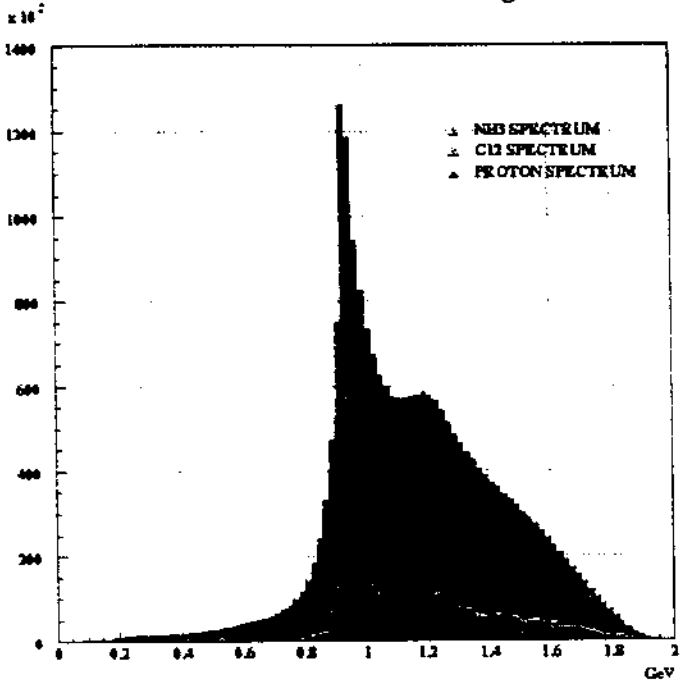
$$A^p_{1/2} = \sqrt{\underbrace{\frac{W\Gamma}{2M_p b_n}}_{\text{PDG '98 values + errors}} \cdot \sigma(W,Q^2)}$$

$S_{11}(1535) \rightarrow p\eta$

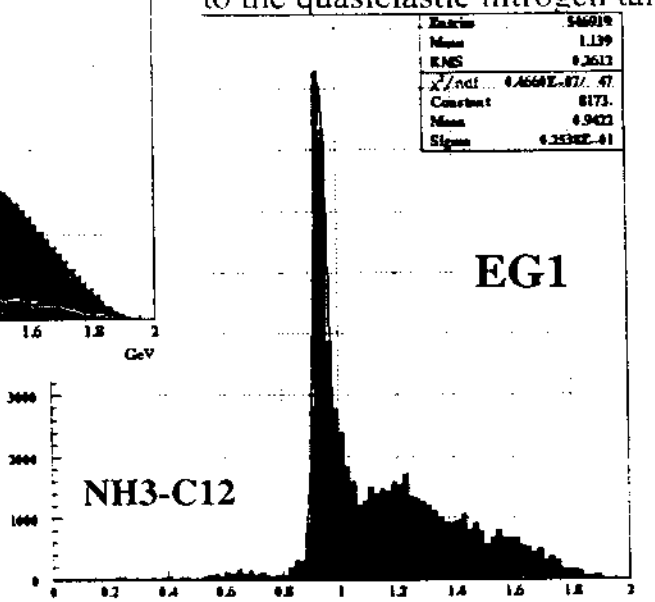


MISSING MASS PLOTS:

the first selection is done requiring one detected π^+
and evaluation the e'π^+ missing mass ⟶ **e P -> e' π^+ X**

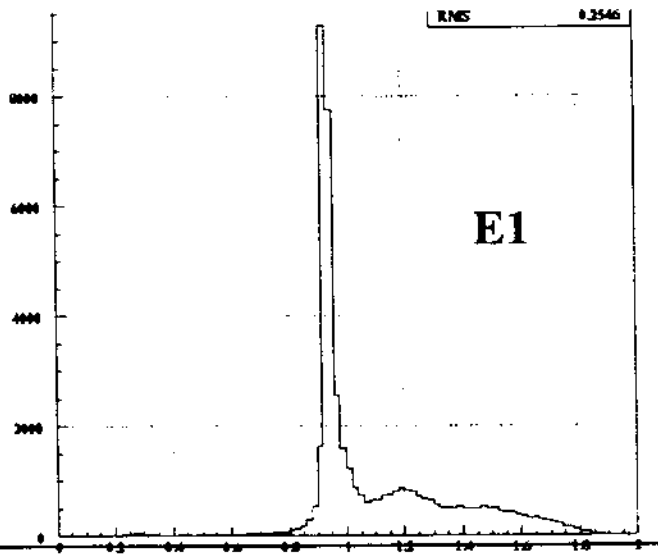


the missing mass cut has been studied in the NH3-C12 difference;
C12 missing mass spectrum is subtracted after normalization to the quasielastic nitrogen tail

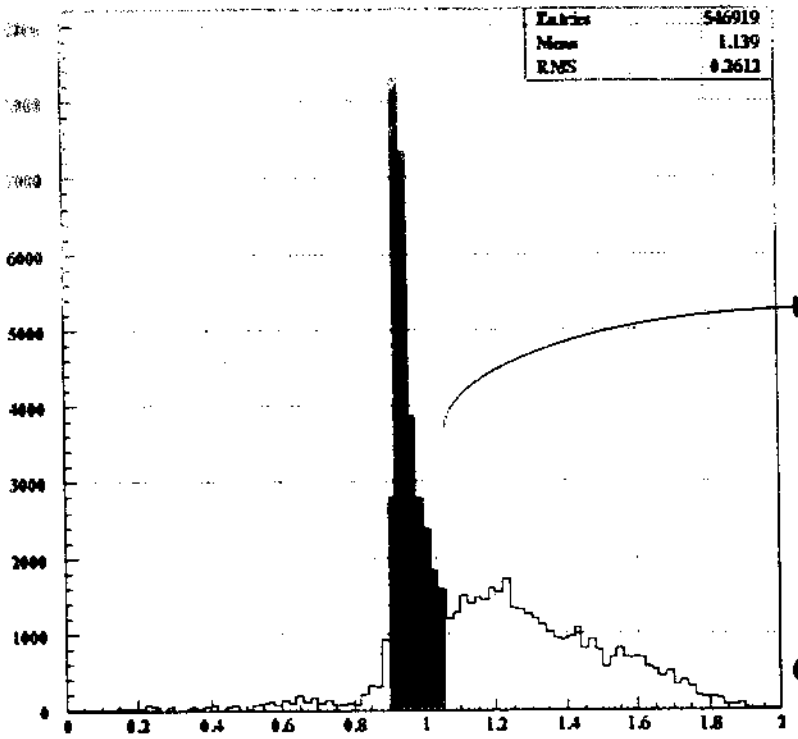


The extracted proton missing mass spectrum shows clearly the neutron peak

the peak width is ~25MeV and the spectrum is very similar to the E1 missing mass spectrum

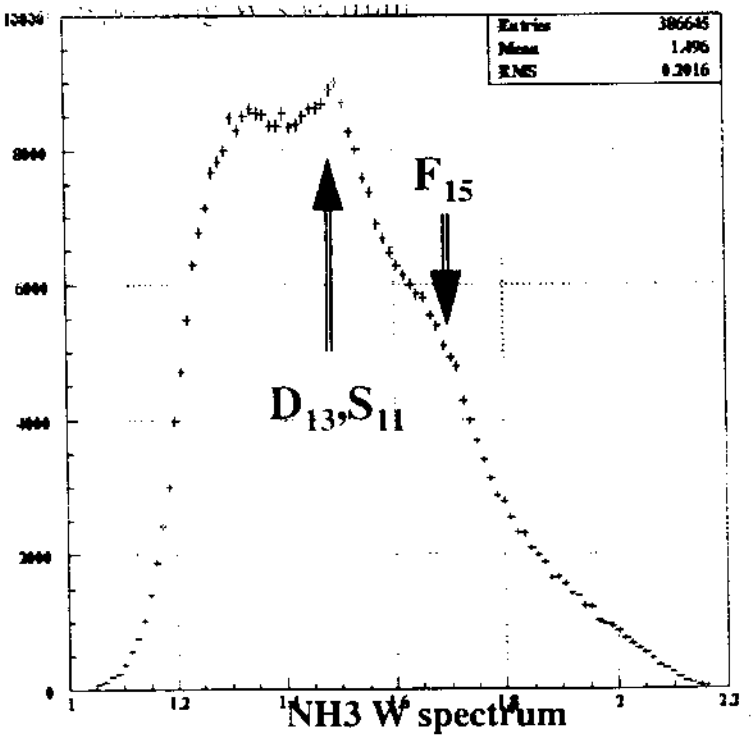


CHANNEL SELECTION



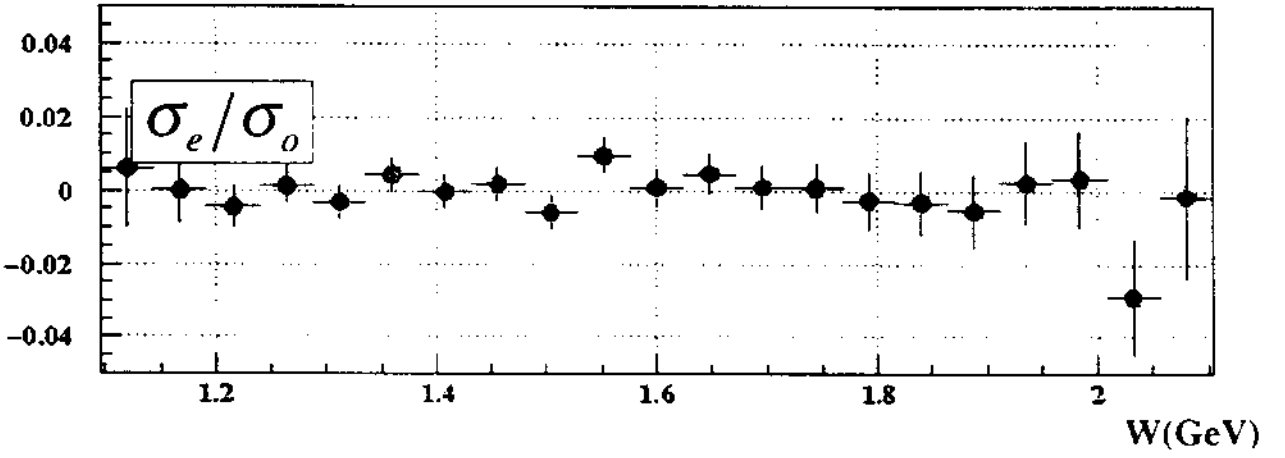
a cut around the
neutron peak
0.85<W<1.05

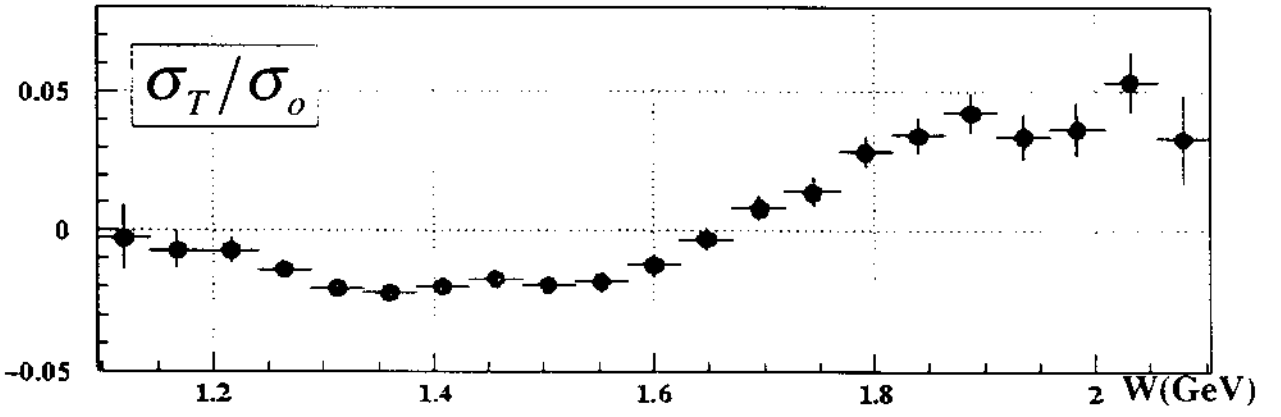
e P -> e'π^+N

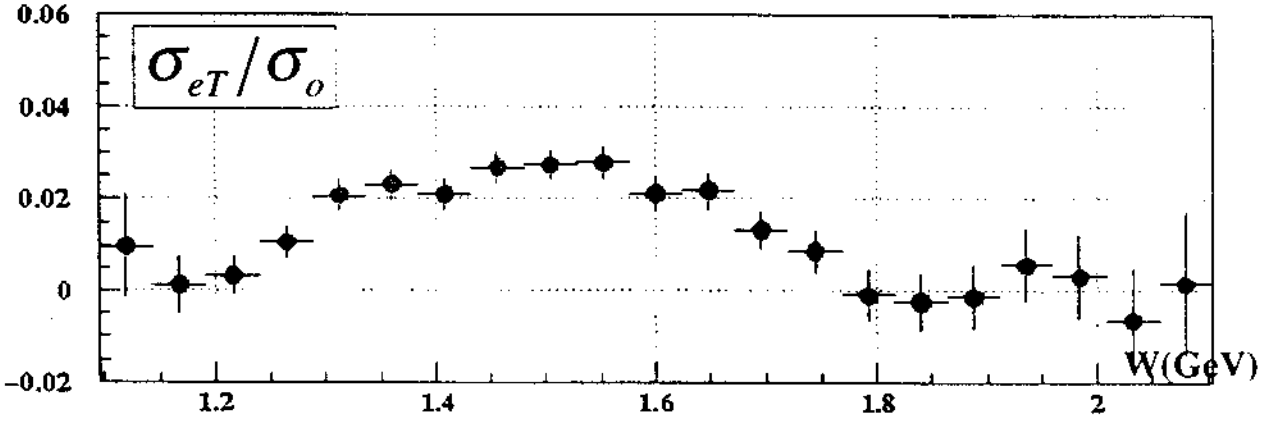


RAW ASYMMETRIES IN THE $e^{\uparrow}P^{\uparrow} \rightarrow e' N \pi^{+}$ CHANNEL

W DEPENDANCE

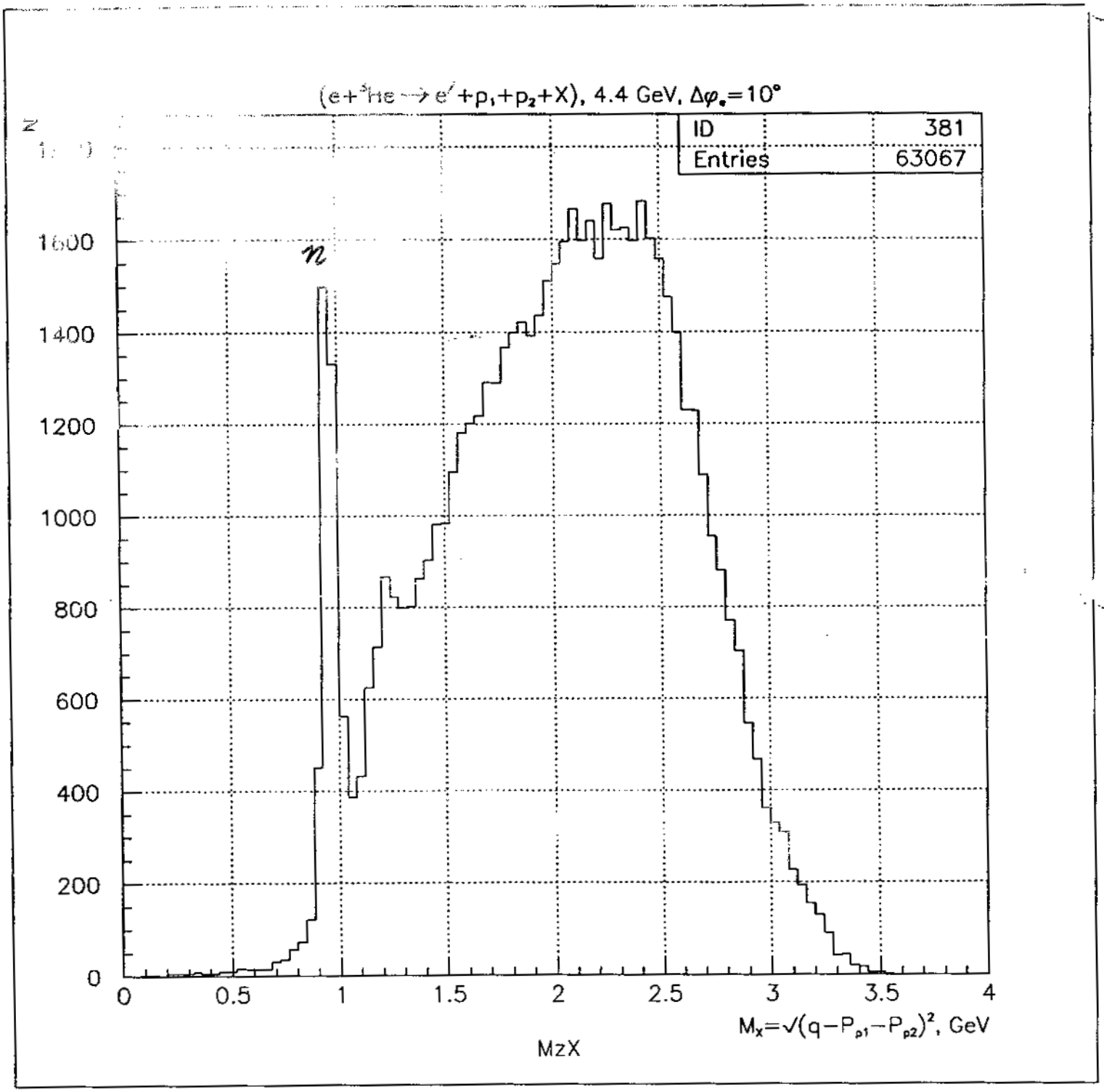






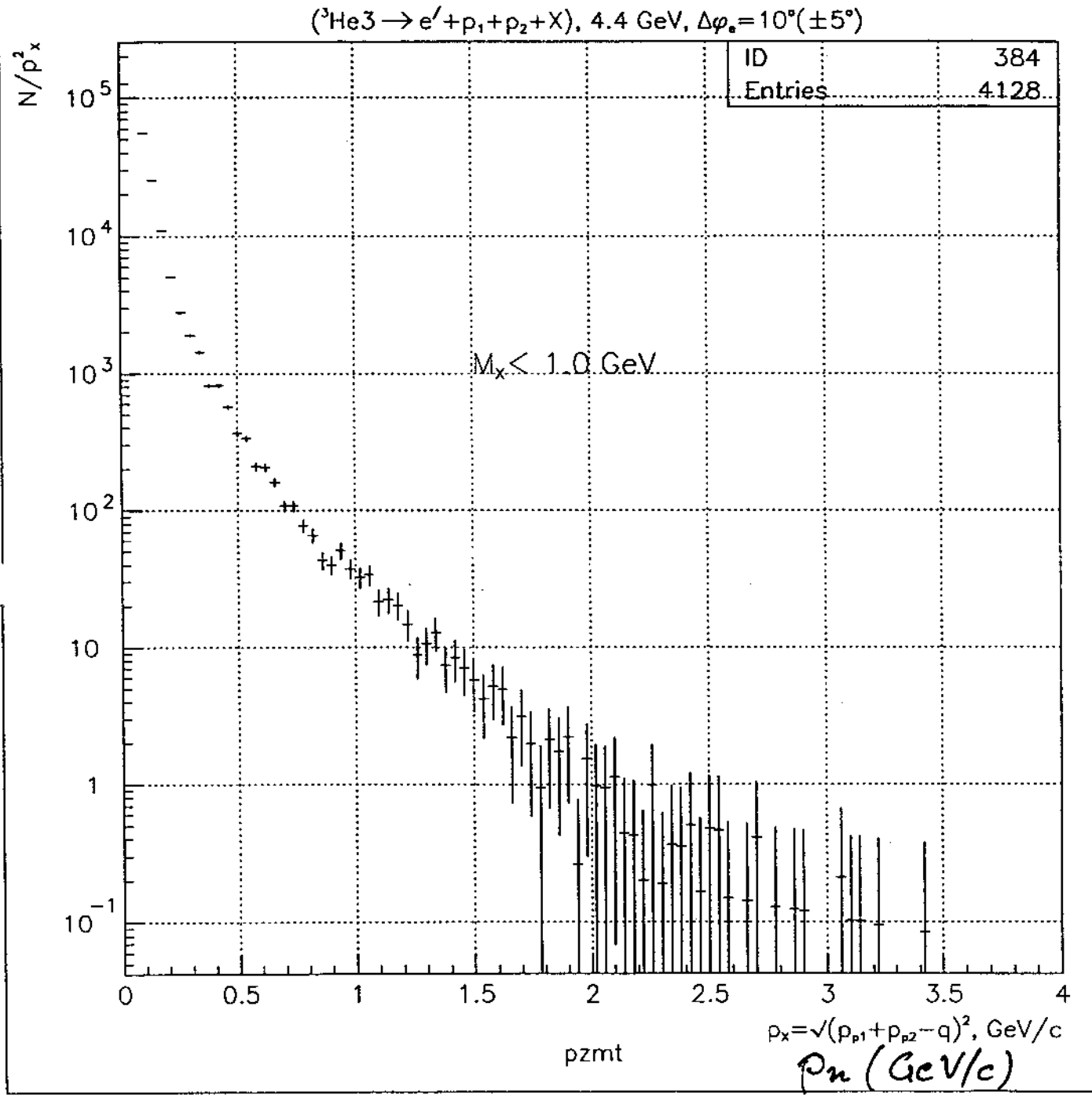
e2 Run

$e\,{}^3He \rightarrow e'pp\,X$ $E_0 = 4.4\,GeV$



e2 Run

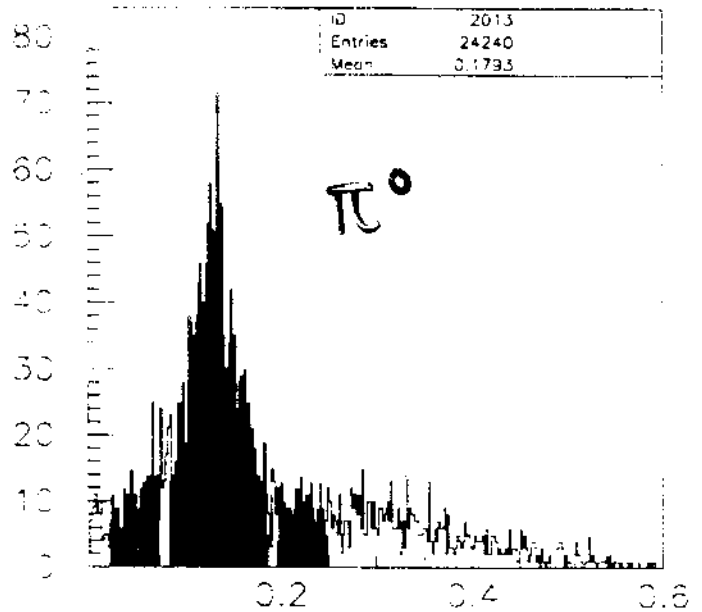
$e\,^3He \rightarrow e'pp\,X$ $E_0 = 4.4\,GeV$



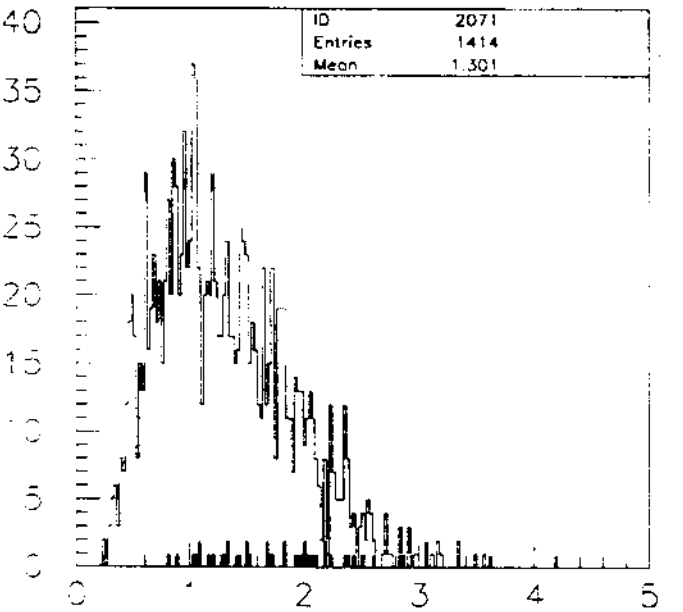
Analysis of g6a $\gamma p \to h_1 h_2 X$

$E_0 = 4.0\,GeV$

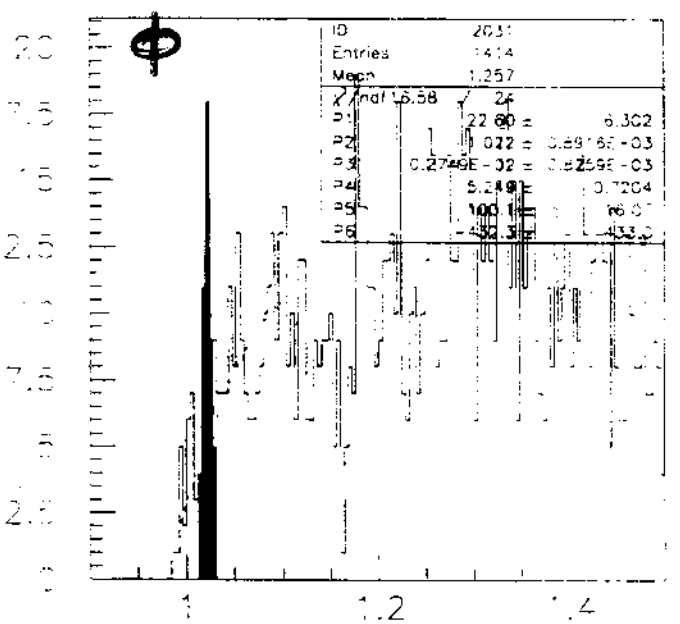
$\gamma + p \to p + K^+ + K^- + (\pi^0)$ 2000/01/20 20



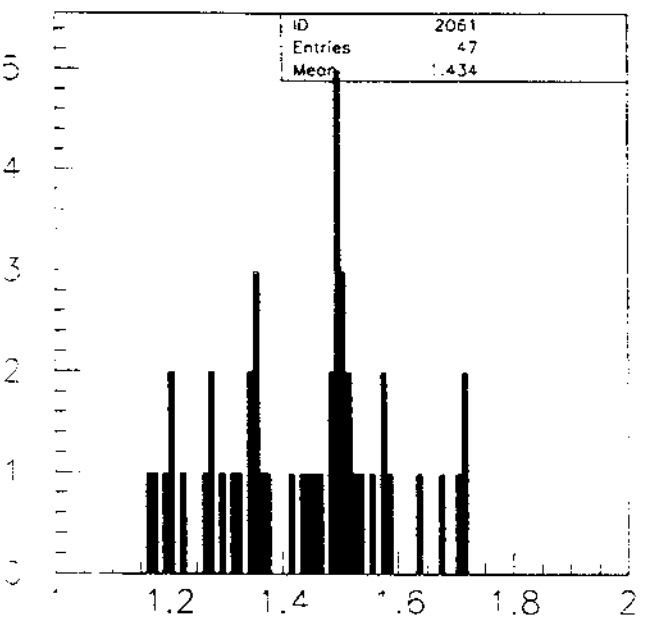
MM (π^0)



Q2



M K^+K^-



M $\varphi\,\pi$