Status Report:

JLAB Experiment E01-020 Hall A

(e,e'p) Studies of the Deuteron at High Q^2

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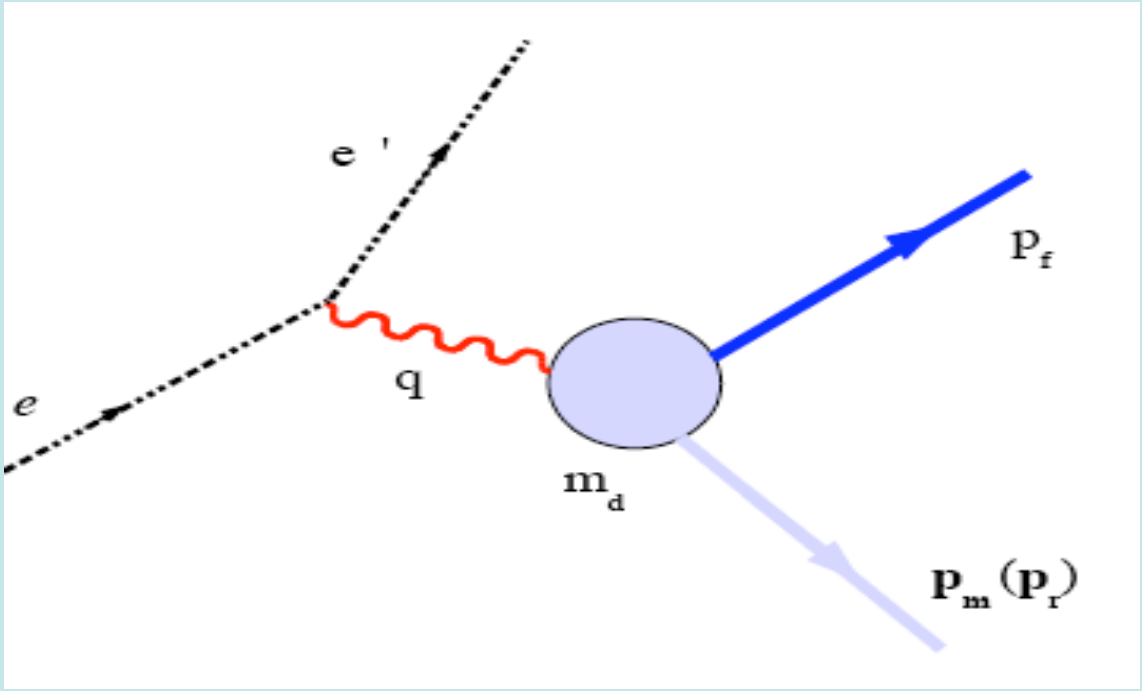
Content:

- Short introduction on (e,e'p) reaction
- Kinematics and Cross Section review
- Theoretical prediction for the ratio

$$R = \sigma_{FSI} / \sigma_{PWIA}$$

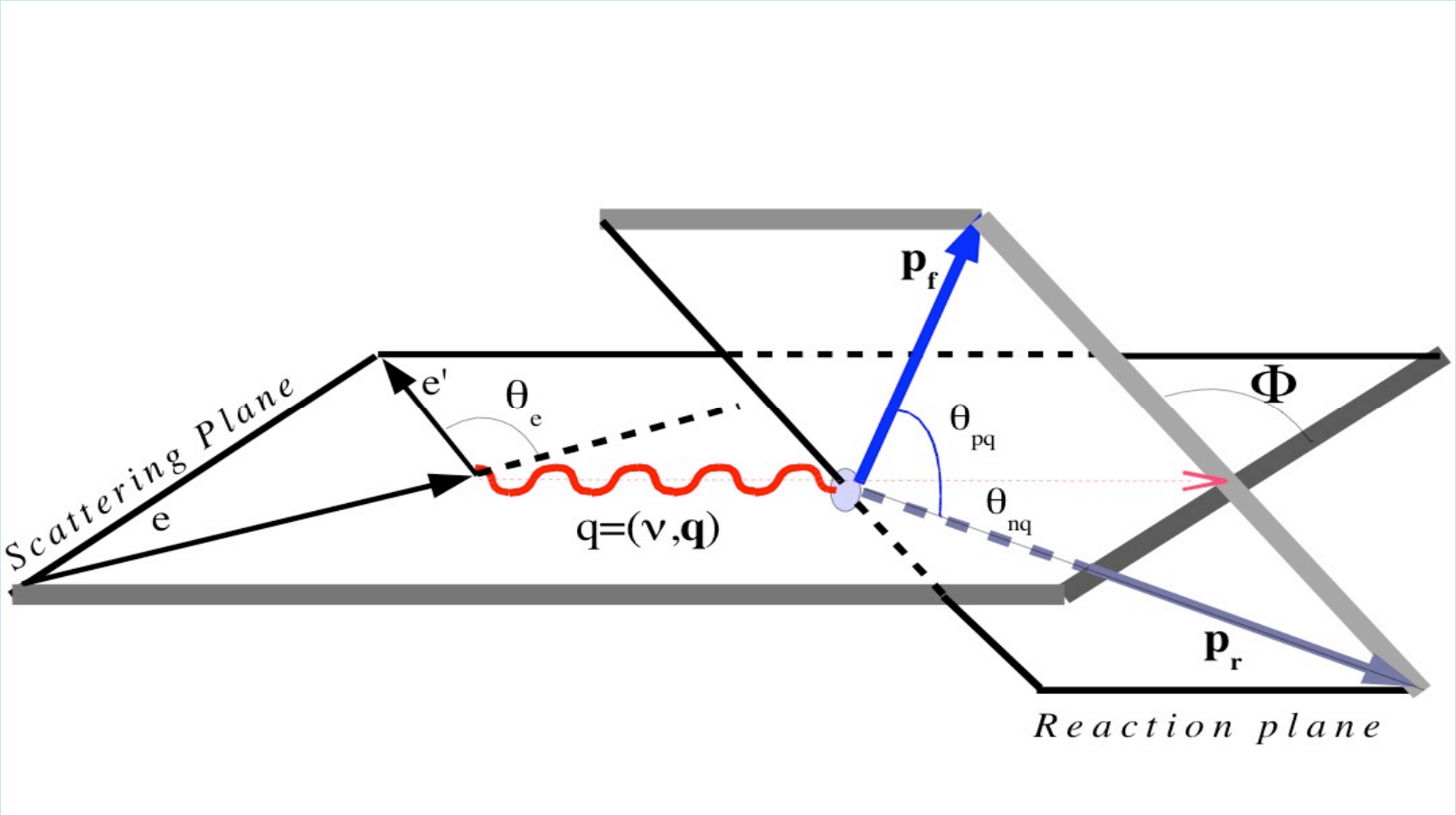
- Performed Optimizations/Calibrations
- Preliminary results for E01020 experiment
- Future Tasks
- Summary

General Diagram of the ^{2}H (e,e'p)n Reaction

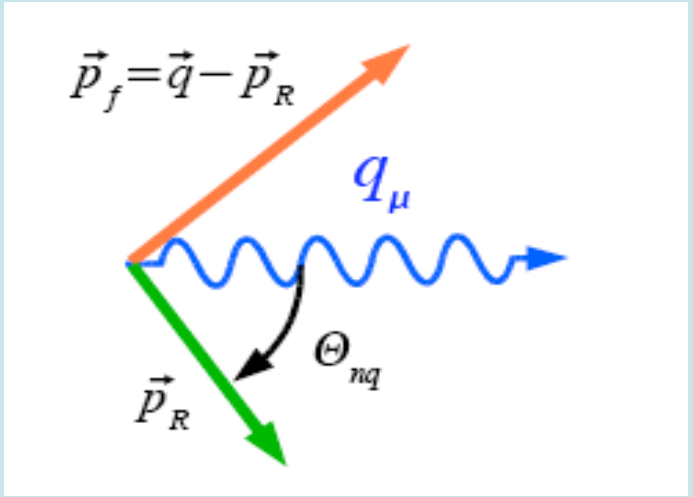


High momentum $q=(q_0,\mathbf{q})$ is transferred to the deuteron nucleus
$p_m = q-p_f$ is the missing momentum

(e,e'p) reaction



Kinematics



$q^\mu=(\nu,\mathbf{q})$ where ν = e-e' and $\mathbf{q=k_i-k_f}$

$\mathbf{P_d=(M_D,0)}$

Final state: $P_f=(E_p,p_f)$ and $P_R=(E_n,p_n)$

$Q^2= -q^2 = \mathbf{q}^2-\nu^2 = 4e.e'\sin^2(\theta_e/2)$

$x_{Bjorken}$ variable: $Q^2/m.\nu$

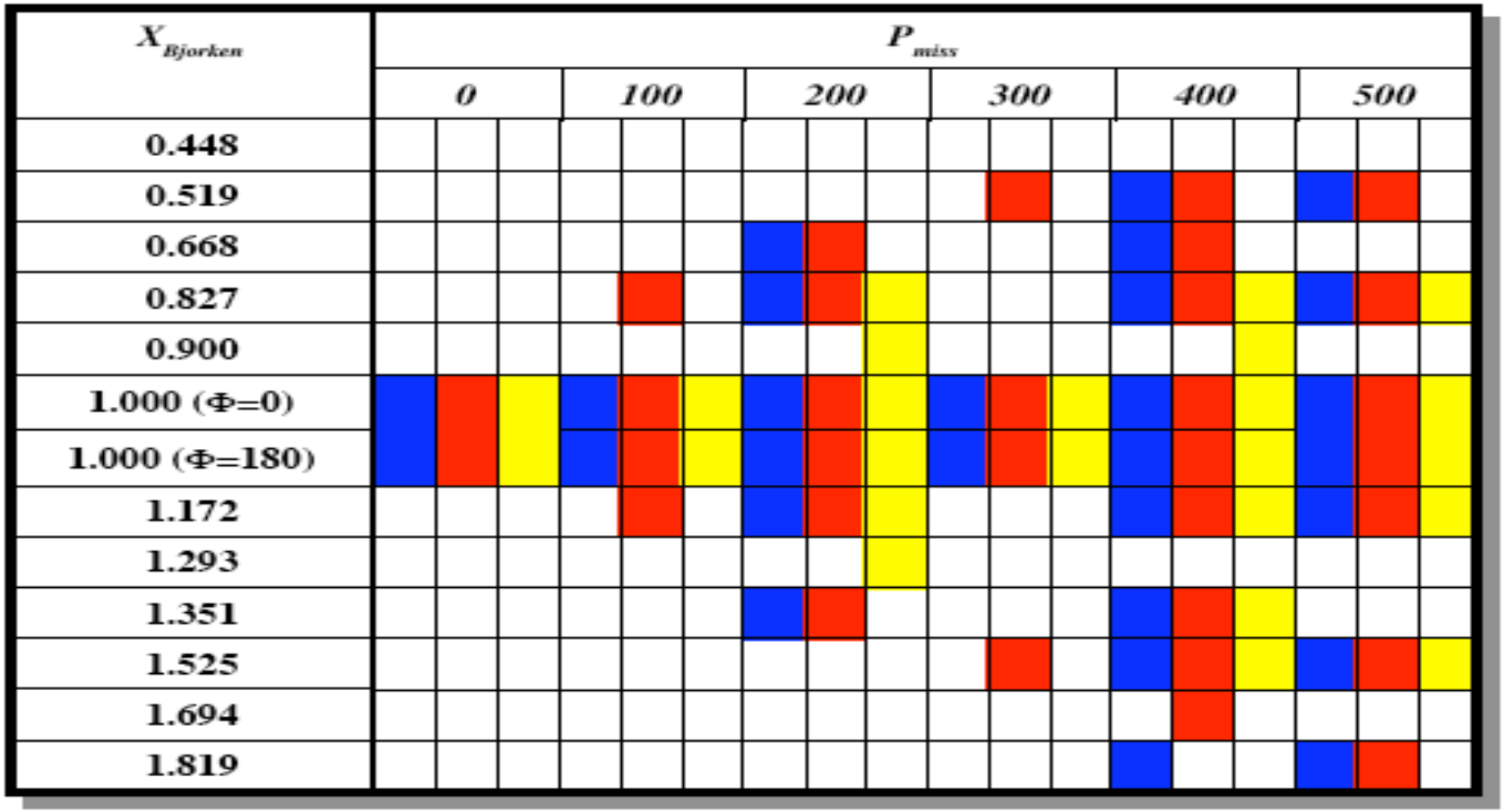
4 momentum conservation: $q + P_d = P_f + P_R$

$x = 1 - T_n/m_n - 2T_n/\nu + \mathbf{q.p_n}/m_n.\nu$

$x>1 \Rightarrow \mathbf{P_R||q} \quad \mathbf{<=>} \ \theta_{nq}$ **close to 0^0**

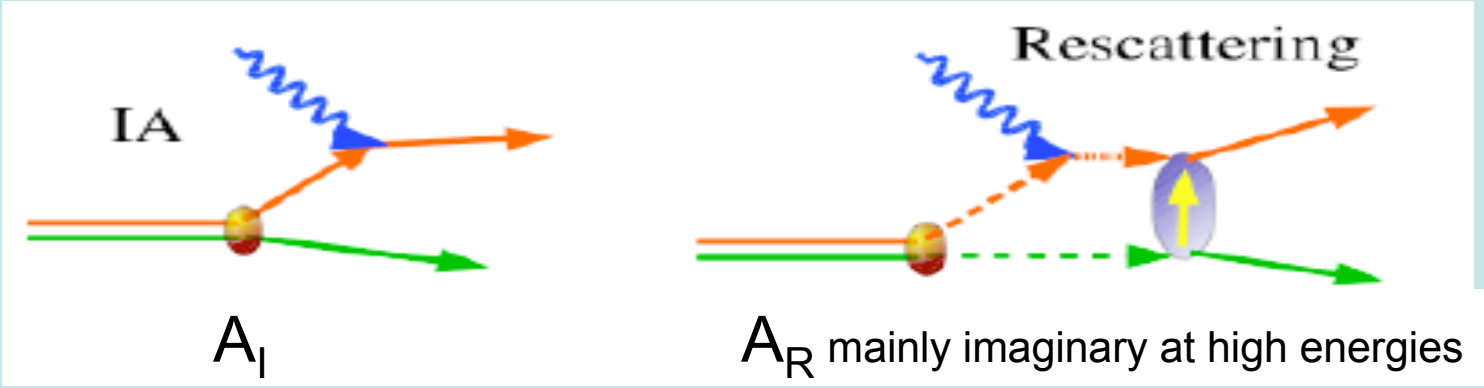
$x<1 \Rightarrow \mathbf{p_R||-q} \quad \mathbf{<=>} \ \theta_{nq}$ **close to 180^0**

Kinematic Overview



$Q^2 = 0.8$ (GeV/c)^2 $Q^2 = 2.1$ (GeV/c)^2 $Q^2 = 3.5$ (GeV/c)^2

PWIA and FSI



The observed nucleon has absorbed virtual photon

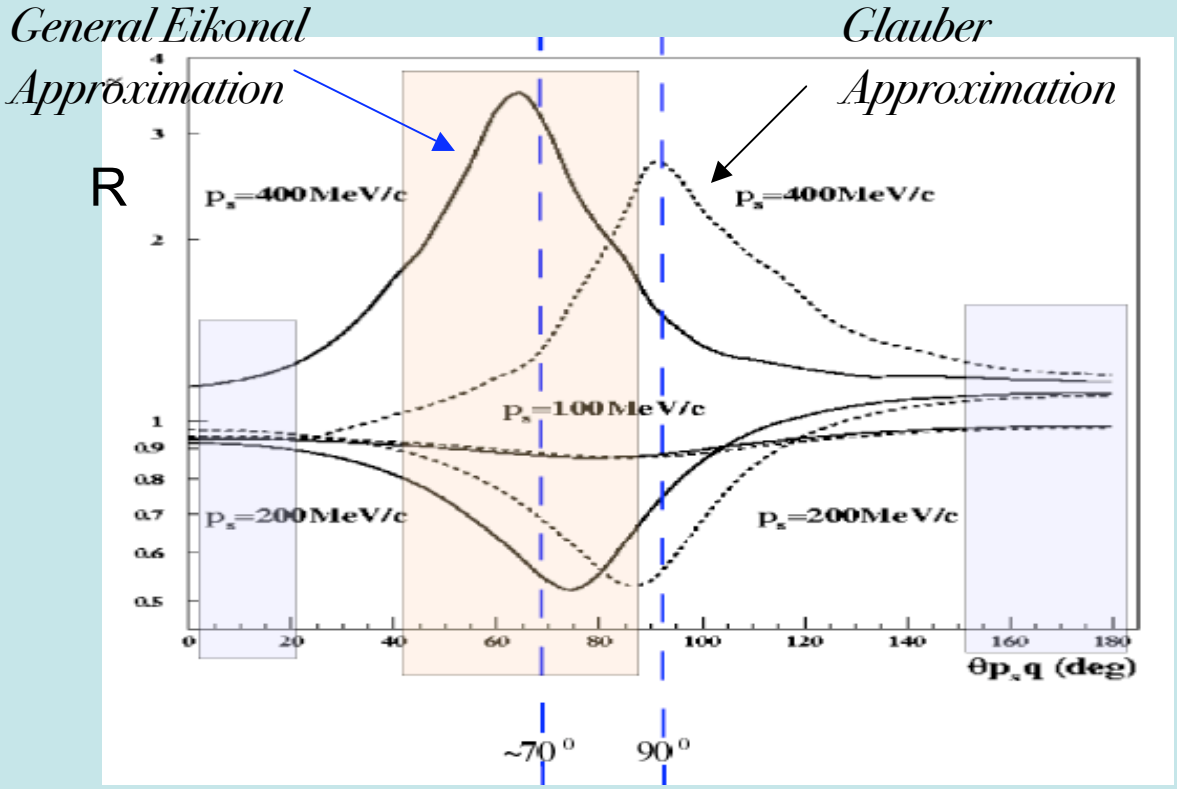
Outgoing nucleon is a plane wave (no interaction with the residual system)

- Total scattering amplitude: $A = A_I + iA_R$
- Cross Section $\sigma \sim |A|^2 = |A_I + A_R|^2$

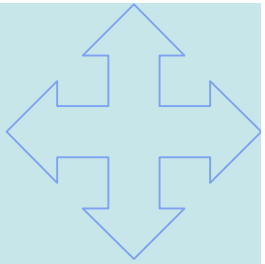
$\sigma \sim |A_I|^2 - 2|A_I|.|A_R| + |A_R|^2$

$$R = \frac{\sigma}{\sigma_I} = 1 - 2\frac{|A_I|.|A_R|}{|A_I|^2} + \frac{|A_R|^2}{|A_I|^2}$$

Theoretical Calculation



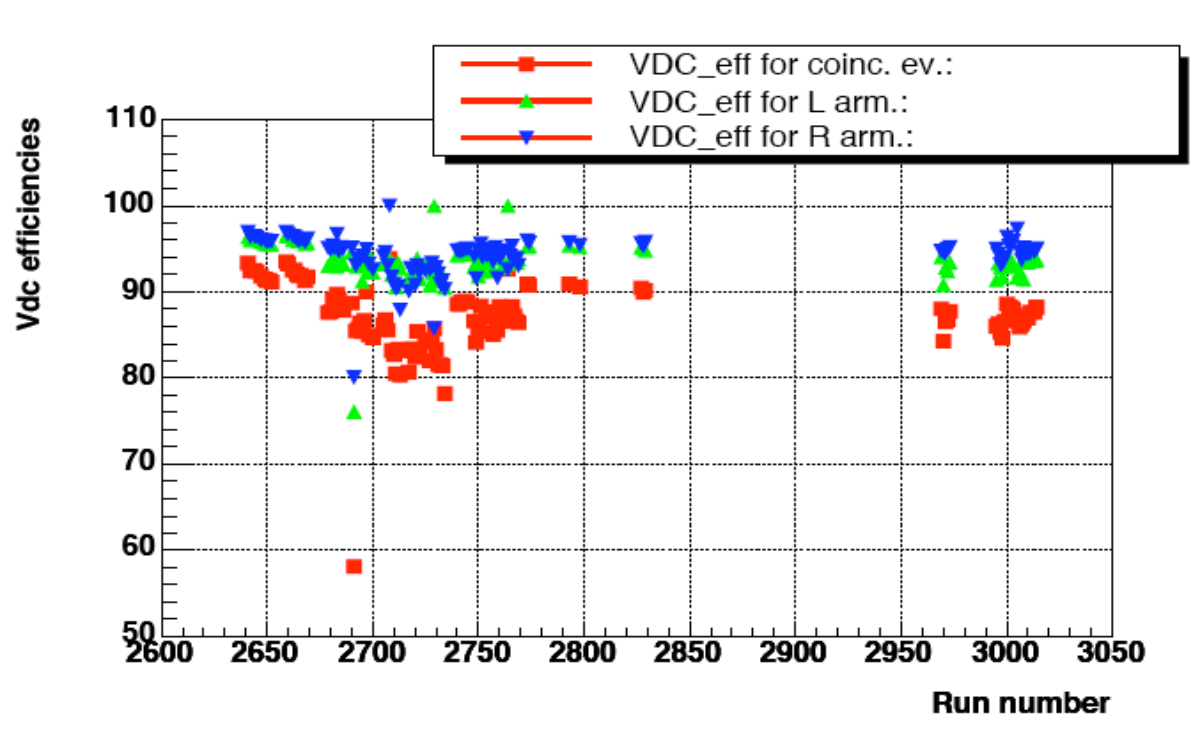
- Shows that relativistic kinematics are important:
  - The interaction is not instantaneous
  - (the nucleons are at rest - GA)



Optimizations/Calibrations

- Most of the detector calibrations done:
  optics, pointing,timing optimization
- Detector efficiency studies:
  VDC efficiency for Q^2 = 3.5 GeV/c^2 data
  Scintillator efficiency
  Cerenkov cut
- Luminosity studies:
  Stable beam analysis
  React_z dependence
- Kinematical Calibration
- Normalization Studies

VDC efficiency for Q^2 = 3.5 GeV/c^2 data

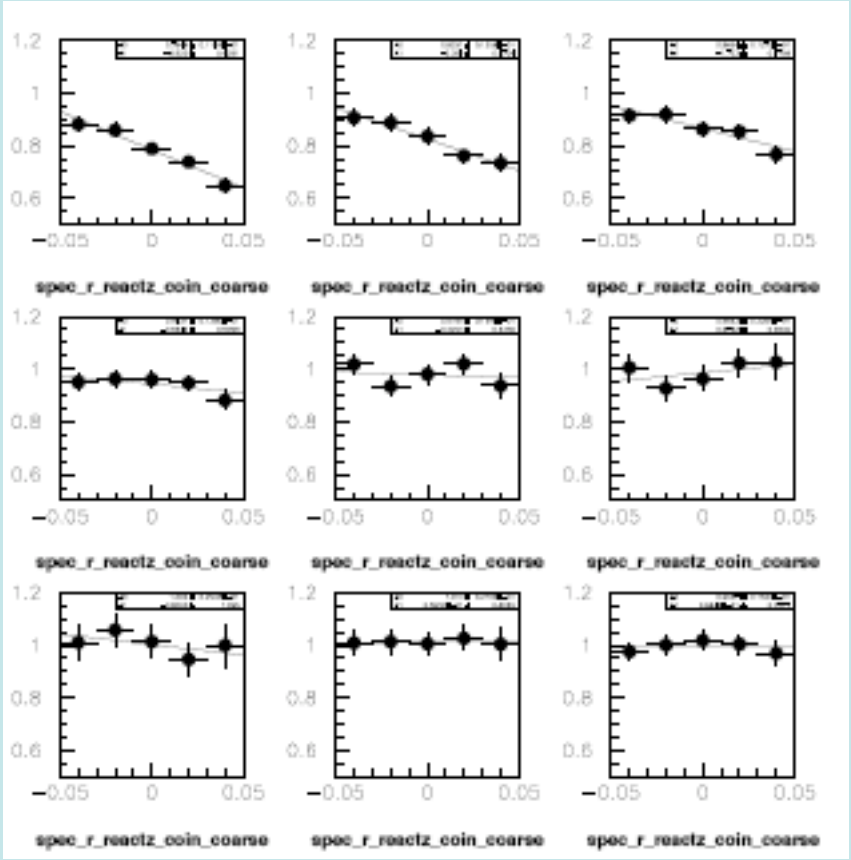


- Cut on multiplicity in the 4 wire planes:

  Lmult_uv12>3. && Lmult_uv12<10.
- Tracks cuts: Exactly one track
- Eff = 1-track / (3-10) hits (in all planes)

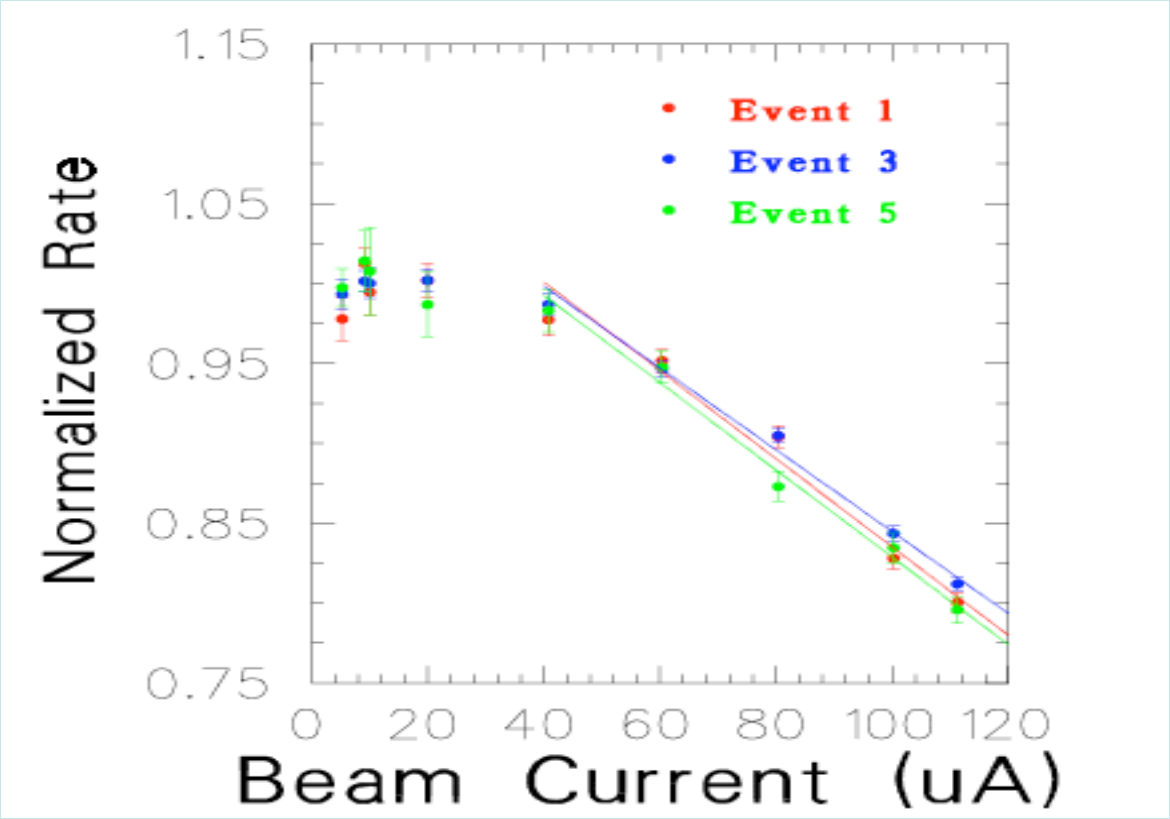
Luminosity studies

- Stable beam analysis
- Reactz boiling effect dependence: target density is sensitive to the cut on reactz
- Corrections for beam charge and computer dead time
- Cuts:
  abs(reactz) <0.05 m
  abs(E_miss)<8 MeV



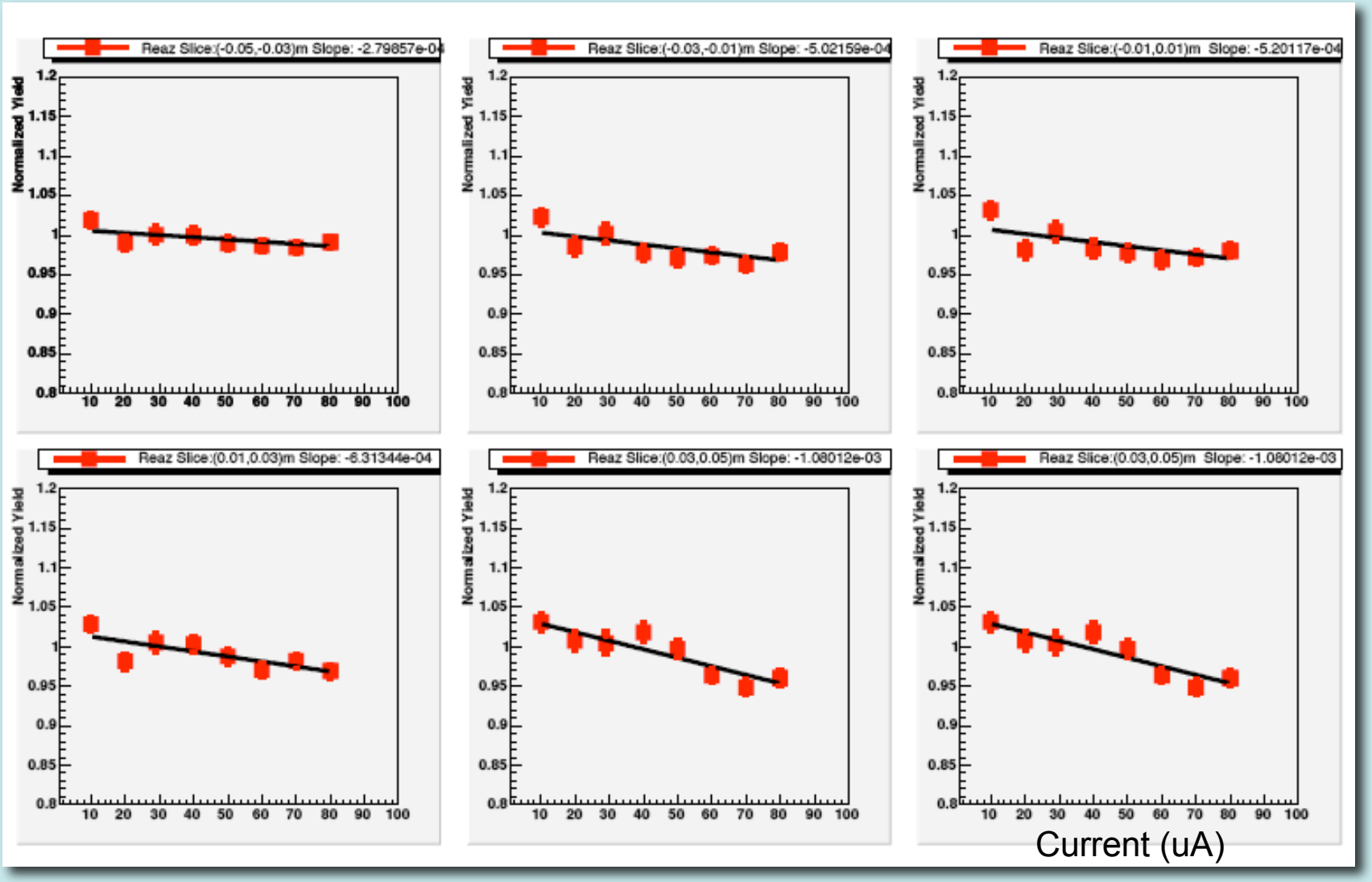
Normalized reactz spectra for T5 triggers for each of the nine runs used in the analysis. Each spectrum has been divided, channel by channel, by the average of the lowest four current runs. The current decreases from left to right and down.

Overall luminosities studies (integrated over the entire target)



Normalized rates, corrected for beam charge, CDT and VDC tracking, for each trigger type as a function of beam current

Deuterium target density: sensitivity with reactz



Kinematic calibration

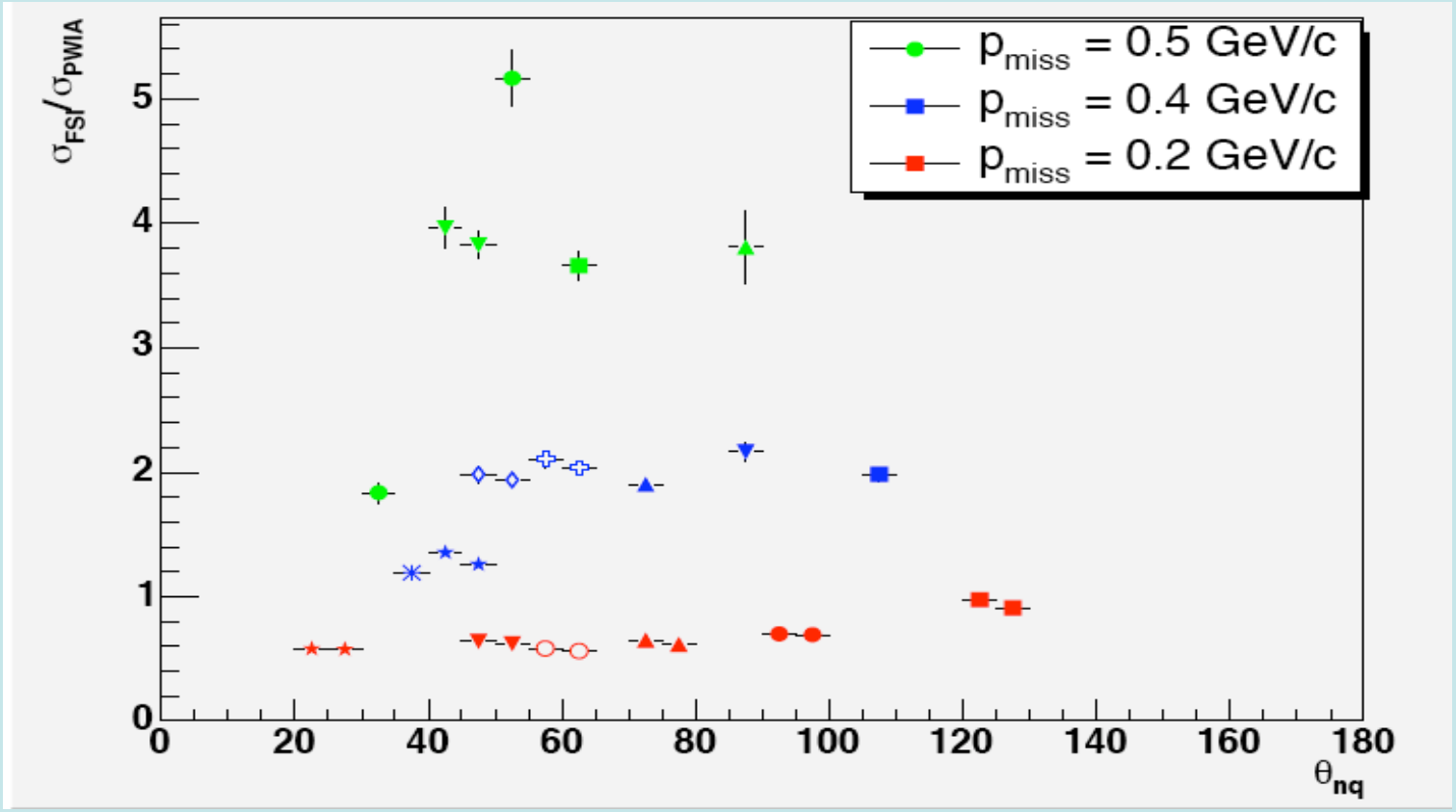
- Minimize the offsets between the elastic ^{1}H data and MCEEP for W, E_miss and p_miss components
- Done by fitting the offsets in momenta , (delta), in-plane angles (theta) and the out-of-plane angles(phi) of the left and right spectrometers

Kinematical Calibrations

Run. No.	Input offsets W (MeV)	W Minimized Offsets (MeV)
1	10.8	-0.3
2	11.5	0.7
3	11.2	0.6
4	9.3	-0.8
5	12.0	1.16

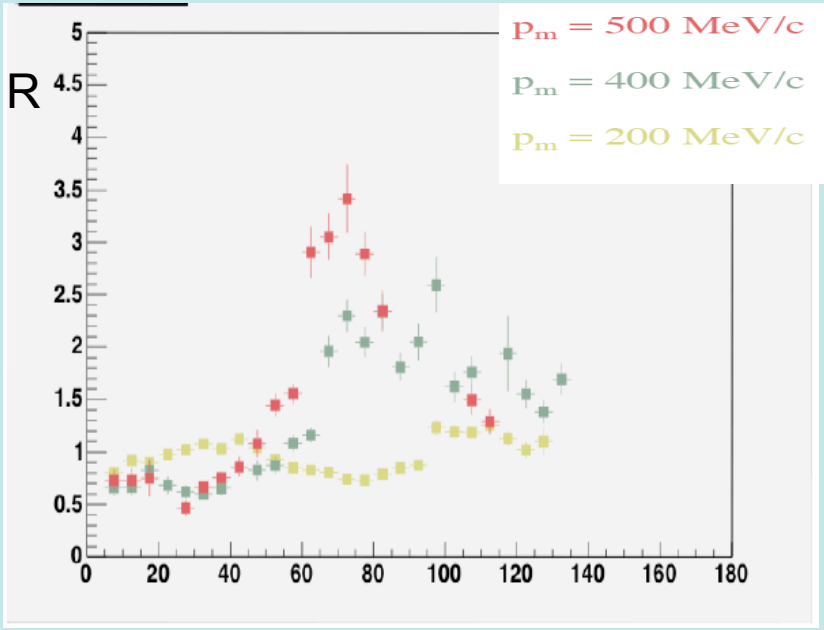
Preliminary Experimental Angular Distribution Results

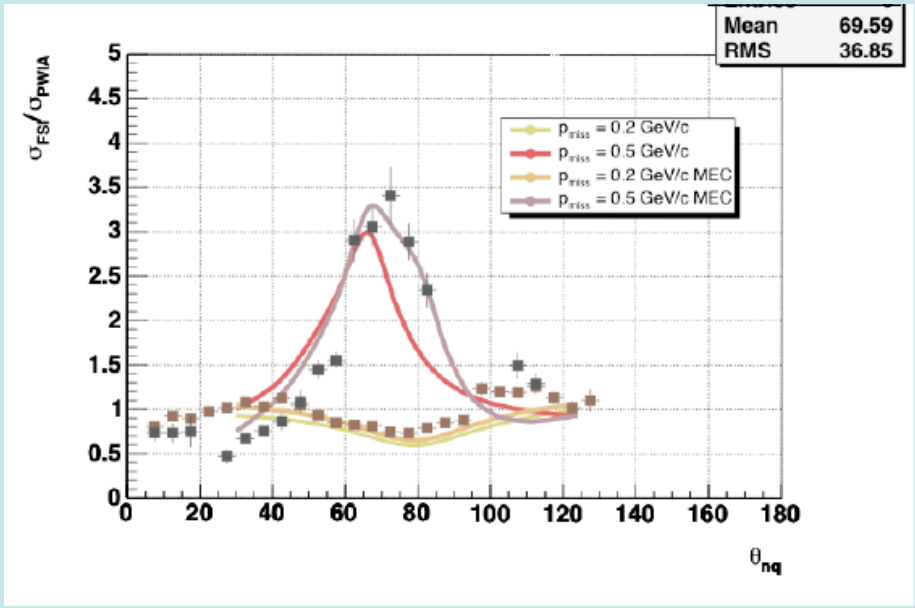
$Q^2 = 0.8$ GeV/c^2



Preliminary Experimental Angular Distribution Results

$Q^2 = 2.1\ GeV/c^2$

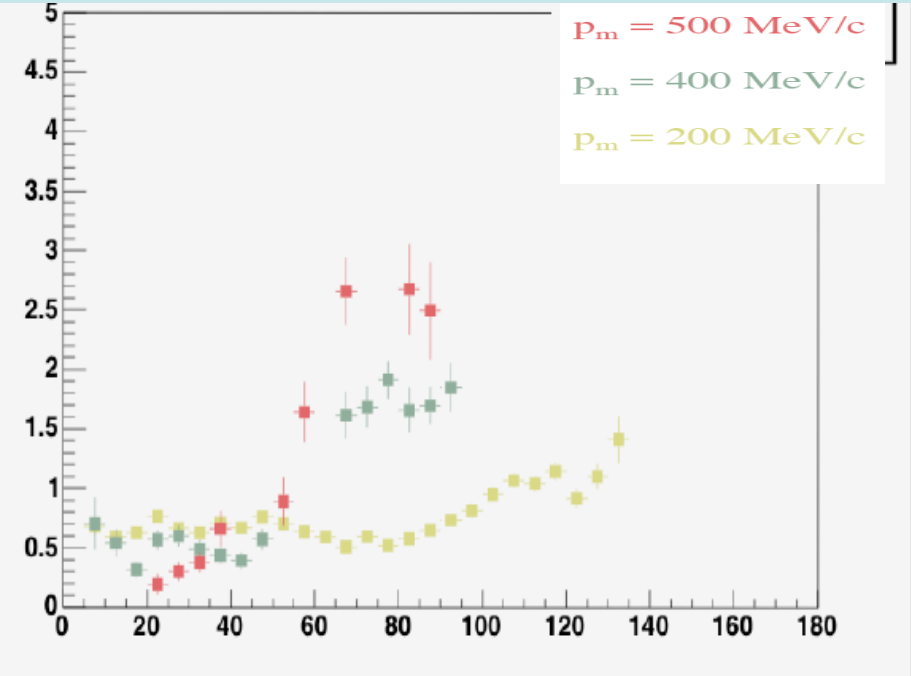


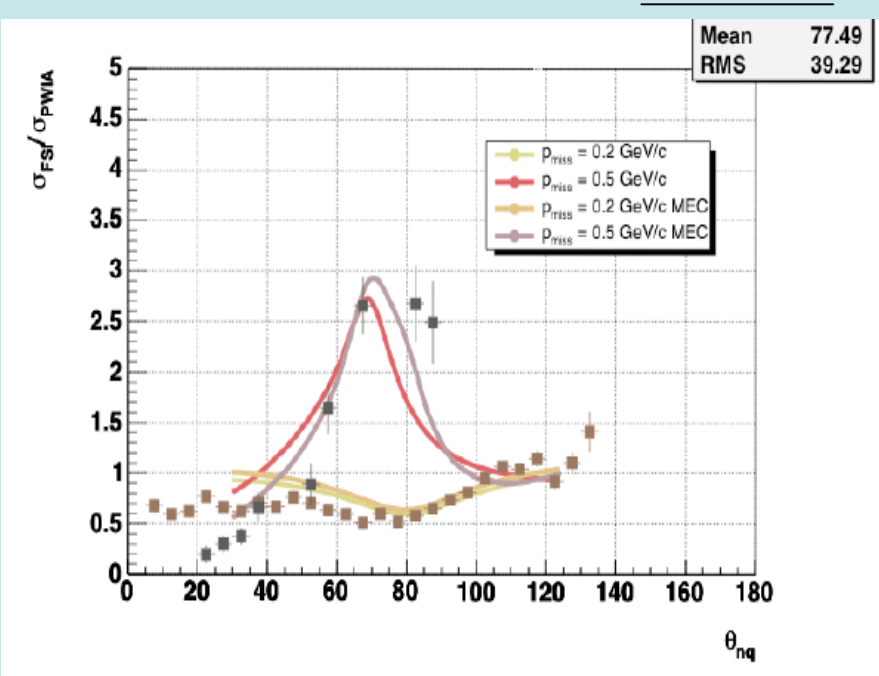


J.M. Laget Calculation

Preliminary Experimental Angular Distribution Results

$Q^2 = 3.5\ GeV/c^2$





J.M. Laget Calculation

To do:

- Electronic deadtime (in progress)
  needed for Q1, Q2 data sets (higher trigger rates)
- Wire chamber efficiencies studies
- Scintilator efficiencies
- Normalization studies: determine appropriate cuts
- Final cross section results

Summary

- Angular Distribution Cross Section in accord with theory
- Enhanced re-scattering observed at θ_{nq}~70^0

as predicted by GEA

- Q^2=3.5GeV/c^2 data set close to final analysis