E12-10-002 Run Preparation

DEB

HU Group Meeting
Dec 5, 2017

Spokespersons & Students

Simona Malace, Eric Christy, Thia Keppel, Ioana Niculescu - spokespeople

Debaditya Biswas (HU) , Abel Sun (CMU) – Grad Students

New Stdents and PostDoc (??)

Run Period

https://www.jlab.org/exp_prog/experiment_schedule/2017/20170914.1_ExpSch.pdf

67	12/04/17	Monday	2.1	PHYSICS	E12-11-112	4.3/20/-/500	Engineering Run	10.6/100/p/250 (NOTE)	SHMS commissioning	2.2, 6.4/20/-/500
68	12/05/17	Tuesday	2.1	PHYSICS	E12-11-112	4.3/20/-/500	Engineering Run	10.6/100/p/250	SHMS commissioning	2.2, 6.4/20/-/500
69	12/06/17	Wednesday	2.1	PHYSICS	E12-11-112	4.3/20/-/500	Engineering Run	10.6/100/p/250	SHMS commissioning	2.2, 6.4/20/-/500
70	12/07/17	Thursday	2.1	PHYSICS	E12-11-112	4.3/20/-/500	Engineering Run	10.6/100/p/250	SHMS commissioning	2.2, 6.4/20/-/500
71	12/08/17	Friday	2.1	PHYSICS	E12-11-112	4.3/20/-/500	Engineering Run	10.6/100/p/250	SHMS commissioning	2.2, 6.4/20/-/500
72	12/09/17	Saturday	2.1	PHYSICS	E12-11-112	4.3/20/-/500	Engineering Run	10.6/100/p/250	SHMS commissioning	2.2, 6.4/20/-/500
73	12/10/17	Sunday	2.1	PHYSICS	E12-11-112	4.3/20/-/500	Engineering Run	10.6/100/p/250	SHMS commissioning	2.2, 6.4/20/-/500
74	12/11/17	Monday	2.1	PHYSICS	E12-11-112	4.3/20/-/500	Engineering Run	10.6/100/p/250	SHMS commissioning	2.2, 6.4/20/-/500
75	12/12/17	Tuesday	2.1	PHYSICS	E12-11-112	4.3/20/-/500	Engineering Run	10.6/100/p/250	SHMS Comm. /E12-10-002	6.4/20/-/500
76	12/13/17	Wednesday	2.1	PHYSICS	E12-11-112	4.3/20/-/500	Engineering Run	10.6/100/p/250	SHMS Comm. /E12-10-002	6.4/20/-/500
77	12/14/17	Thursday	2.1	PHYSICS	E12-11-112	4.3/20/-/500	Pass change (12hrs)		Pass change (12hrs)	
78	12/15/17	Friday	2.1	PHYSICS	E12-11-112	4.3/20/-/500	Engineering Run	6.4/100/p/500	E12-06-107	8.5/80/-/500
79	12/16/17	Saturday	2.1	PHYSICS	E12-11-112	4.3/20/-/500	Engineering Run	6.4/100/p/500	E12-06-107	8.5/80/-/500
80	12/17/17	Sunday	2.1	PHYSICS	E12-11-112	4.3/20/-/500	Engineering Run	6.4/100/p/500	E12-06-107	8.5/80/-/500
81	12/18/17	Monday		OFF						
82	12/19/17	Tuesday								

12 Dec 2017 &
13 Dec 2017

30th Jan 2018 to 23rd Feb 2018 : Run Along with E12-10-008

121	01/27/18	Saturday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Engineering Run (30 days)	10.6/100/p/250	E12-06-107	10.6/65/-/250	E12-06-102	11.7/200/-/250	D/A/B/C
122	01/28/18	Sunday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	CLAS12 changes/improvements		E12-06-107	10.6/65/-/250	E12-06-102	11.7/200/-/250	D/A/B/C
123	01/29/18	Monday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	CLAS12 changes/improvements		E12-06-107	10.6/65/-/250	E12-06-102	11.7/200/-/250	C/D/A/B
124	01/30/18	Tuesday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	CLAS12 changes/improvements		E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	C/D/A/B
125	01/31/18	Wednesday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	CLAS12 changes/improvements		E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	C/D/A/B
126	02/01/18	Thursday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	CLAS12 changes/improvements		E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	C/D/A/B
127	02/02/18	Friday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	CLAS12 changes/improvements		E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	C/D/A/B
128	02/03/18	Saturday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	CLAS12 changes/improvements		E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	C/D/A/B
129	02/04/18	Sunday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	CLAS12 changes/improvements		E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	C/D/A/B
130	02/05/18	Monday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	B/C/D/A
131	02/06/18	Tuesday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	B/C/D/A
132	02/07/18	Wednesday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	B/C/D/A
133	02/08/18	Thursday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	B/C/D/A
134	02/09/18	Friday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	B/C/D/A
135	02/10/18	Saturday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	B/C/D/A
136	02/11/18	Sunday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	B/C/D/A
137	02/12/18	Monday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	A/B/C/D
138	02/13/18	Tuesday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	A/B/C/D
139	02/14/18	Wednesday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	A/B/C/D
140	02/15/18	Thursday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	A/B/C/D
141	02/16/18	Friday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	A/B/C/D
142	02/17/18	Saturday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	A/B/C/D
143	02/18/18	Sunday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	A/B/C/D
144	02/19/18	Monday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	D/A/B/C
145	02/20/18	Tuesday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	D/A/B/C
146	02/21/18	Wednesday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	D/A/B/C
147	02/22/18	Thursday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	D/A/B/C
148	02/23/18	Friday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-002/E12-10-008	10.6/65/-/250	E12-06-102	11.7/200/-/250	D/A/B/C
149	02/24/18	Saturday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-003	10.6/70/-/250	E12-06-102	11.7/200/-/250	D/A/B/C
150	02/25/18	Sunday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-003	10.6/70/-/250	E12-06-102	11.7/200/-/250	D/A/B/C
151	02/26/18	Monday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-003	10.6/70/-/250	E12-06-102	11.7/200/-/250	C/D/A/B
152	02/27/18	Tuesday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-003	10.6/70/-/250	E12-06-102	11.7/200/-/250	C/D/A/B
153	02/28/18	Wednesday	2.1	PHYSICS	E12-10-103	10.6/20/-/250	Run Group A	10.6/100/p/250	E12-10-003	10.6/70/-/250	E12-06-102	11.7/200/-/250	C/D/A/B

Inclusive Scattering and Invariant quantities

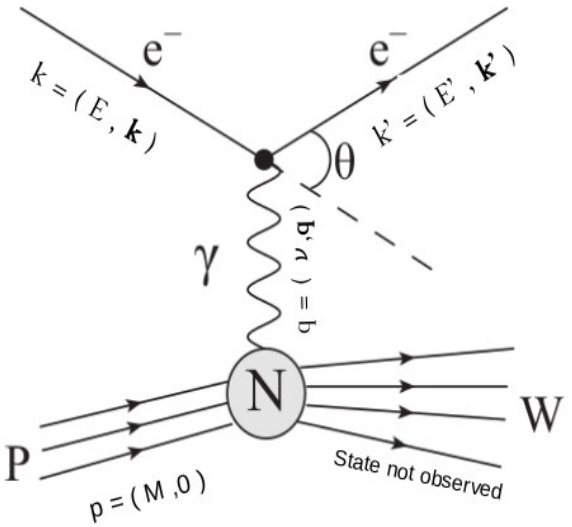


Figure 1: One photon exchange Feynman diagram of eletron nucleon inclusive scattering

- Negative of 4 momentum squared crried out by virtual electron

$$Q^2 = -q^2 = 4EE' sin^2(\theta/2)$$

- Invariant Mass squared

$$W^2 = p^2 + q^2 + 2pq$$

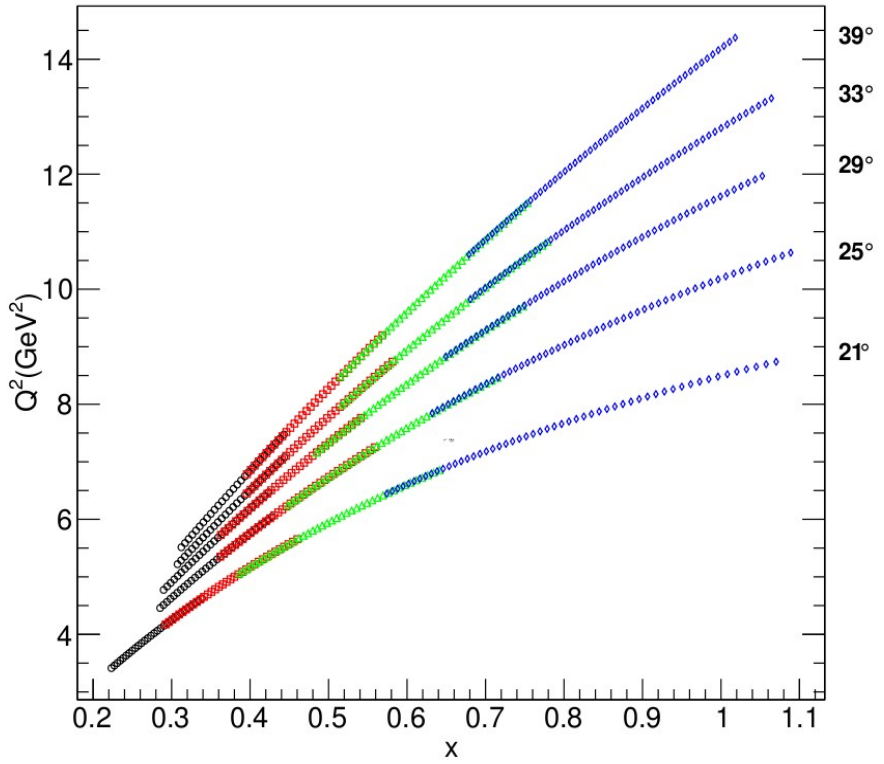
or

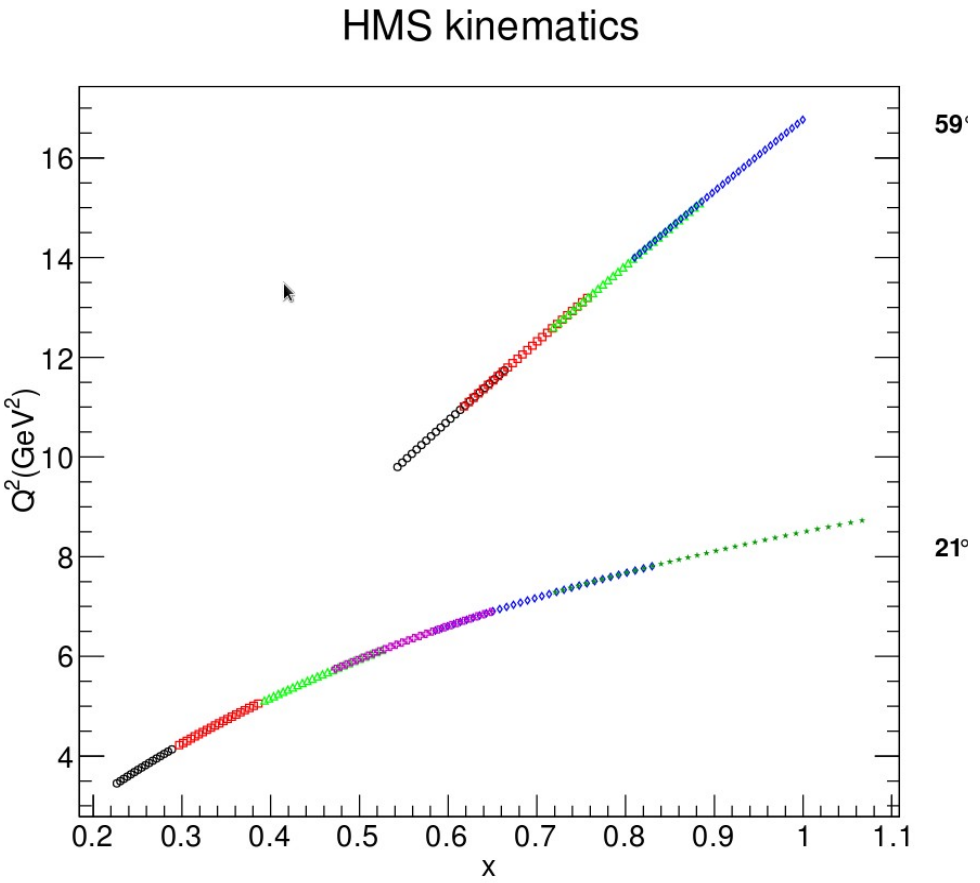
$$W^2 = M^2 - Q^2 + 2M\nu$$

- Bjorken x

X= Q2 / 2m υ

Proposed Kinematics Scan (Q2 & x)





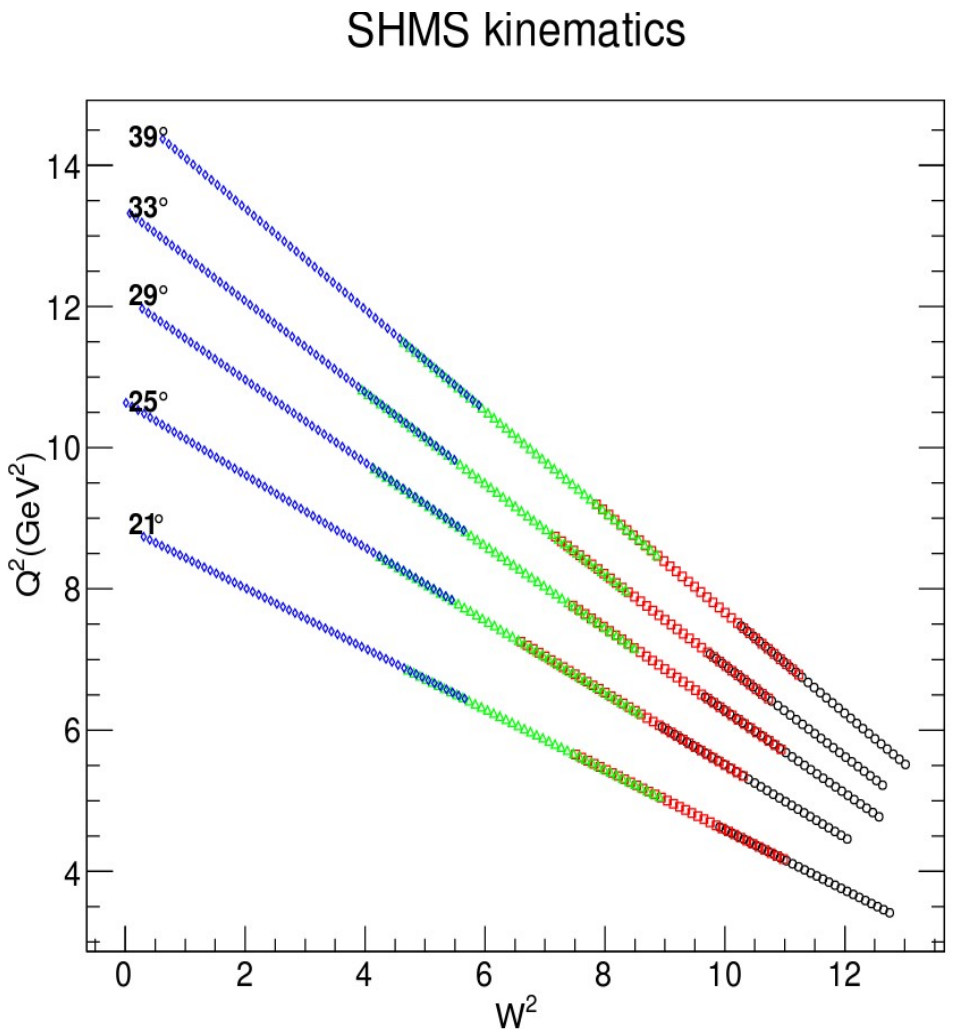
SHMS Kinematics:
Momentum acceptance: -10%~22%

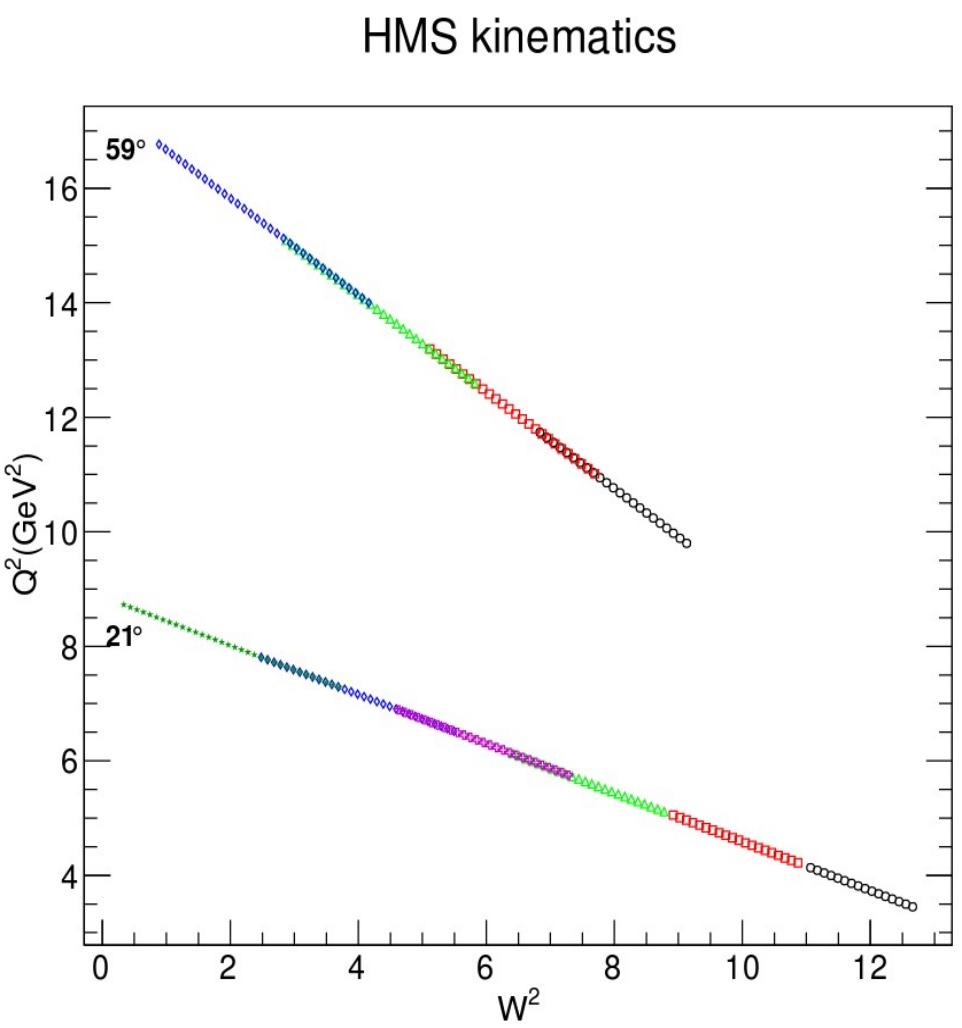
Angle (deg)	Momentum (GeV/c)
21	2.7, 3.3, 4.0, 5.1
25	2.5, 3.0, 3.5, 4.4
29	2.0, 2.4, 3.0, 3.7
33	1.7, 2.1, 2.6, 3.2
39	1.3, 1.6, 2.0, 2.5

HMS Kinematics:
Momentum acceptance: -9%~9%

Angle (deg)	Momentum (GeV/c)
21	2.7, 3.3, 4.0, 4.5, 5.1, 5.7
59	1.05,1.18, 1.35, 1.50

Proposed Kinematics (Q2 & W2)





Running parameters E12-10-002

- Beam :

  (1) energy : 10.6 GeV & 6.4 GeV

  (2) current : 30 μA

- Targets :

  (1) 10 cm hydrogen - production

  (2) 10 cm Deuterium – production

  (3) 4 cm Hydrogen – acceptance studies

  (4) 1-foil C – acceptance studies

  (5) 2-foils Al – background measurement

- Spectrometers:

  (1)SHMS: mostly production run angles 21, 25, 29, 33, 39 deg

  (2)HMS: production run at angles 21, 59 deg (for commissioning)

Background

- **Main sources of background radiation are** :

  (1) Electron scattered on the walls of the crygenic target :
  Dummy runs.

  (2) Pion Contamination :

  Maximum π/e estimated as : SHMS: $\pi/e^- < 250$
  HMS : $\pi/e^- < 150$

  Heavy gas cerenkov and calorimeter are adequate for the pion rejection (same for HMS & SHMS)

  (3) Charge symmetric background :
  Flip polarity of spectrometer and measure positron yield at all angles.

E12-10-002: Running at 6.4 GeV for the determination of R

- We cannot claim a precise extraction of F_2 from cross sections without precise knowledge of R
- Measurements at a different beam energy (6.6 GeV) than 11 GeV to extract R, especially in the region of large x and large Q^2

LT Separation Method

- The differential scattering cross section can be expressed in terms of longitudial and transverse vertual phton cross sections

$$\frac{d^2\sigma}{d\Omega dE'} = \Gamma\left[\sigma_T(x,Q^2) + \epsilon\sigma_L(x,Q^2)\right],$$

- Where virtual photon flux can be expressed as -

$$\Gamma = \frac{\alpha K}{2\pi^2 Q^2}\frac{E'}{E}\frac{1}{1-\epsilon}$$

- Virtual photon polarization parameter -

$$\epsilon = \left[1 + 2\left(1 + \frac{Q^2}{4M^2x^2}\right)\tan^2\frac{\theta}{2}\right]^{-1}$$

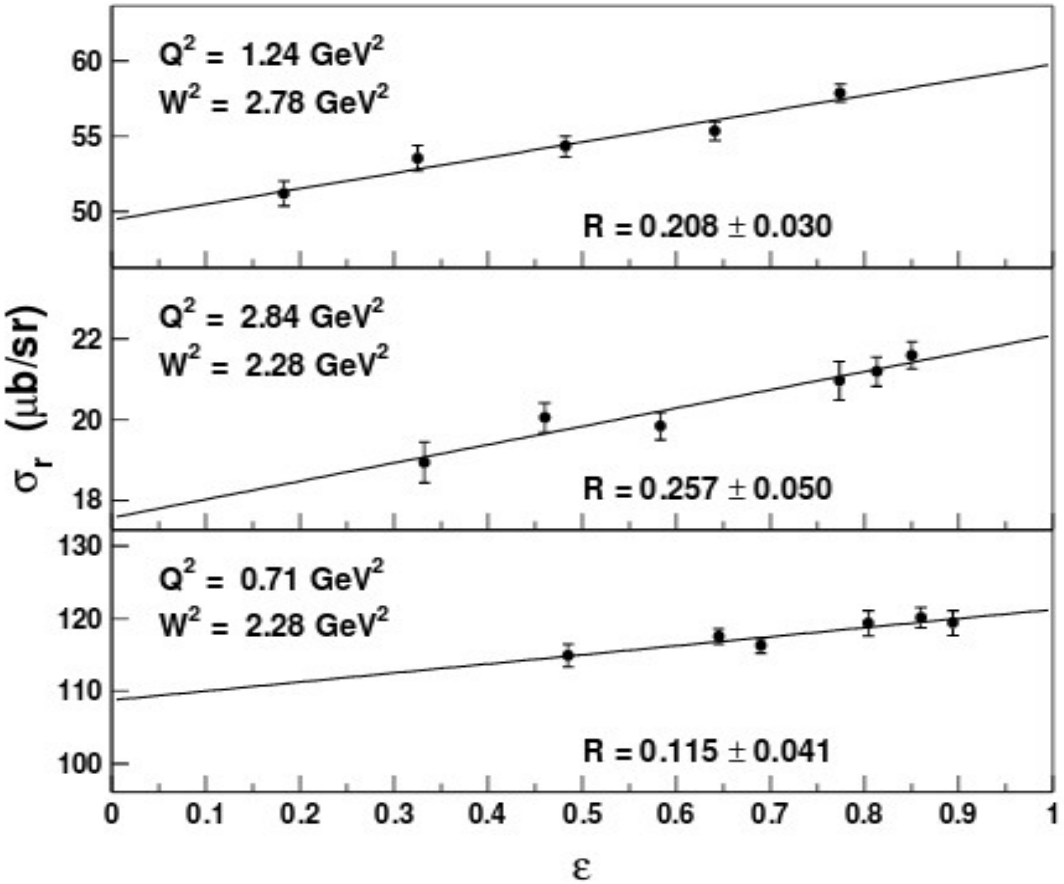
- ε = 0 corresponds to purely transverse polarization

$$F_1 = \frac{MK}{4\pi^2\alpha}\sigma_T \ ,$$

$$F_2 = \frac{\nu K(\sigma_L + \sigma_T)}{4\pi^2\alpha\left(1 + \frac{Q^2}{4M^2x^2}\right)} \ .$$

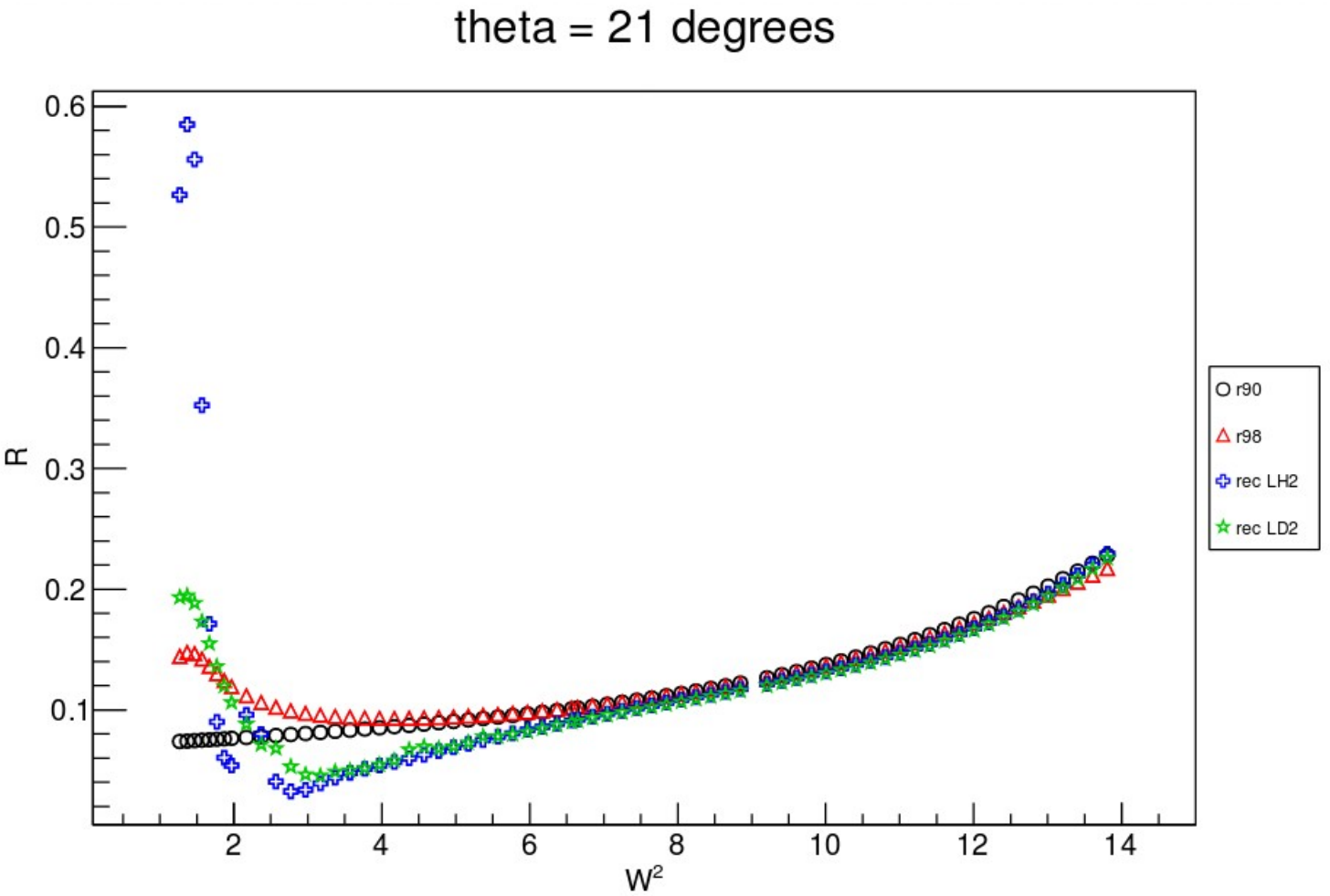
$$R = \frac{\sigma_L}{\sigma_T} \ .$$

Samplr LT Separation from E94-110

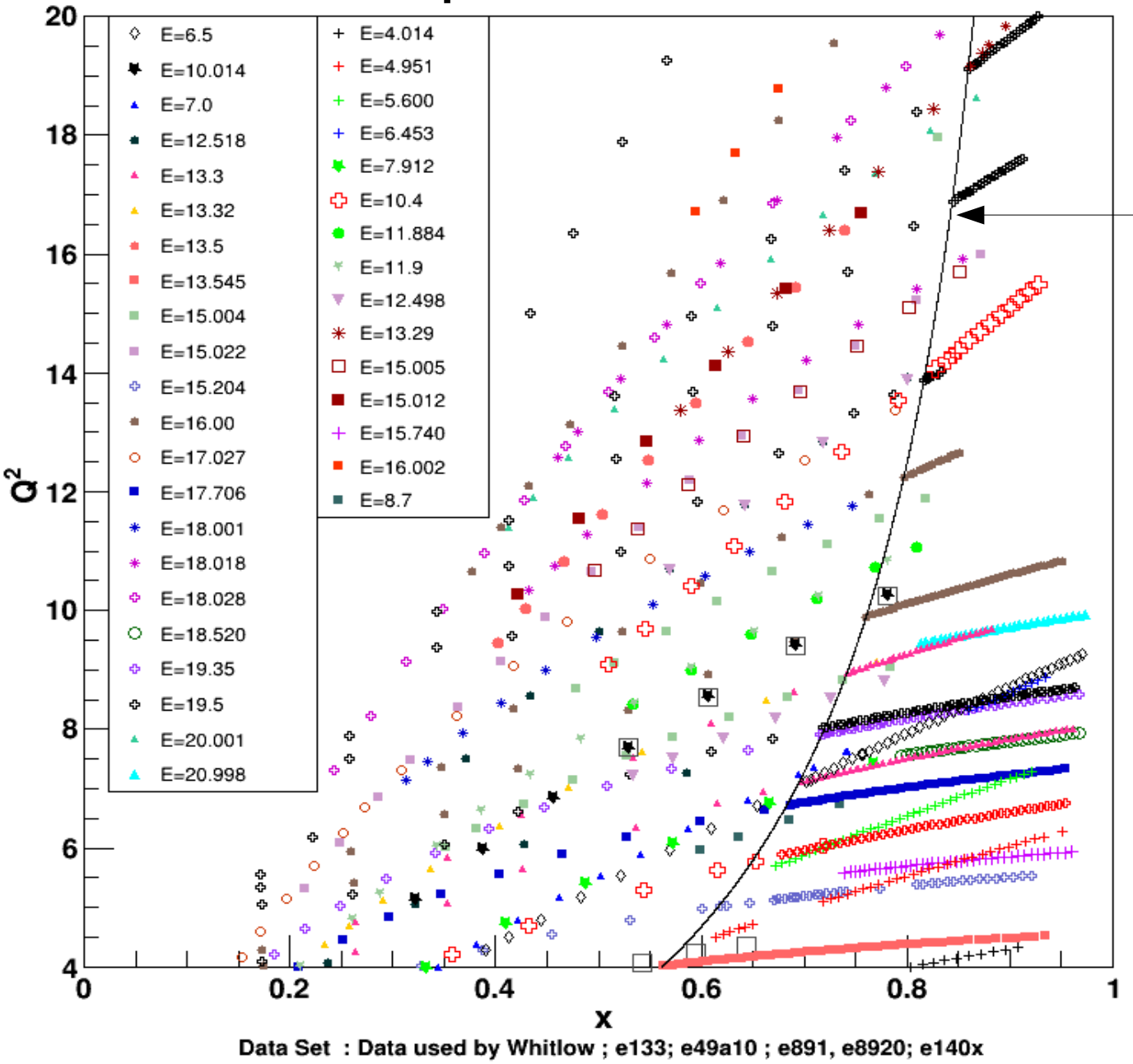


From : Unpolarized Structure Functions
M E Christy and W Melnitchouk 2011 J. Phys.: Conf. Ser.299 01200

R measurements from different Models



Q2 vs x : SLAC H Global Data For LT Separation Run Plan

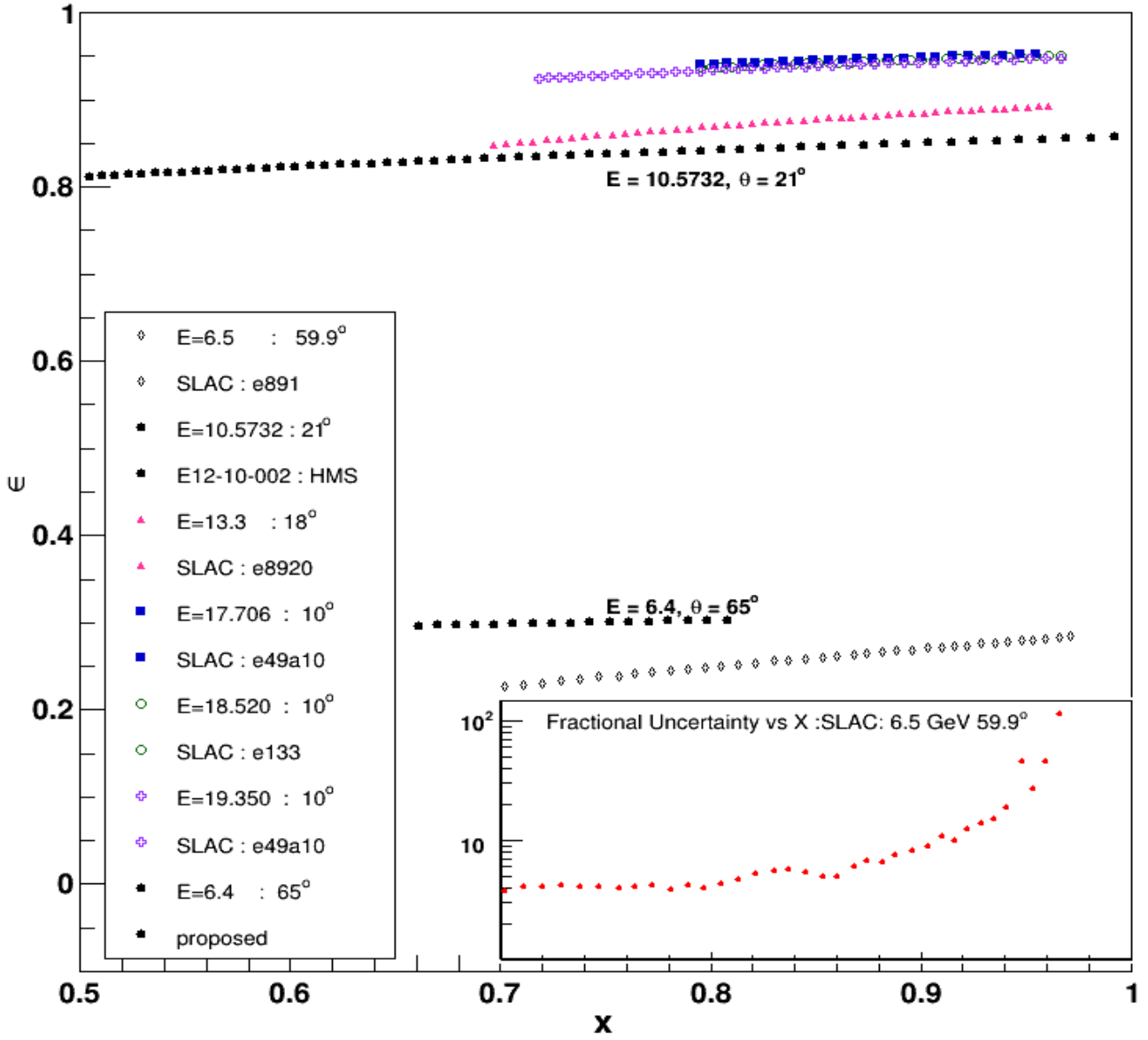


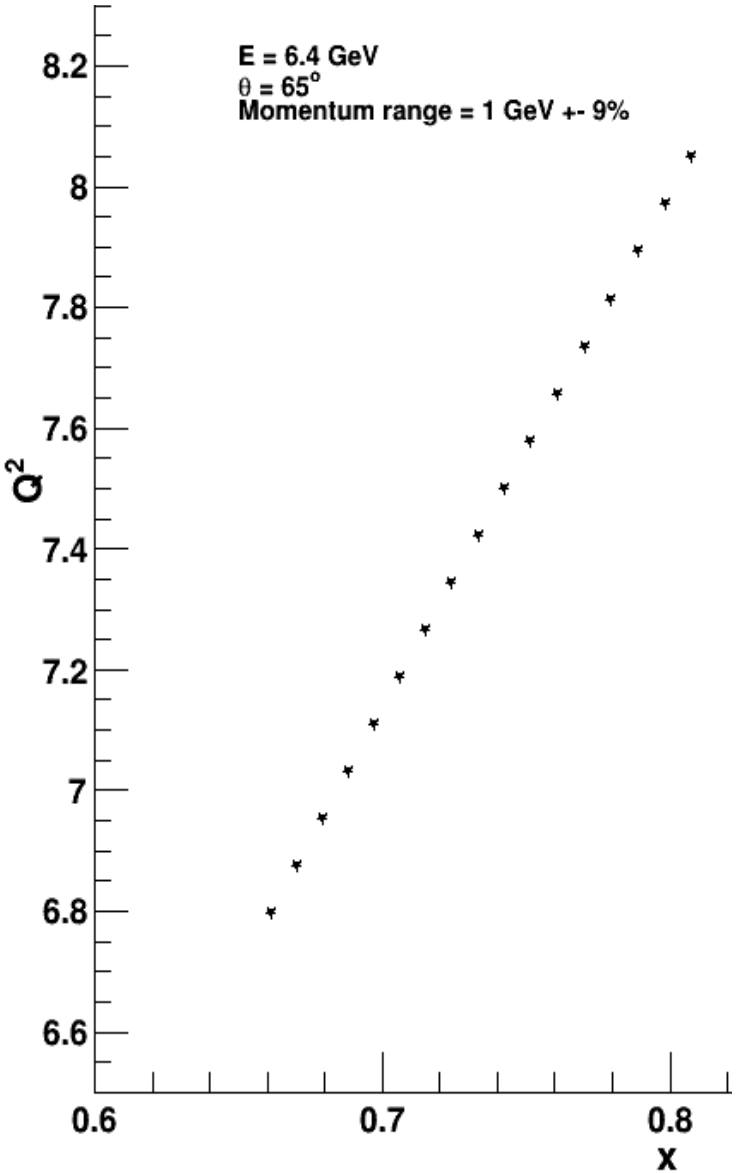
W2 = 4 line, which separates the resonance and the DIS region

LT separation Run Plan

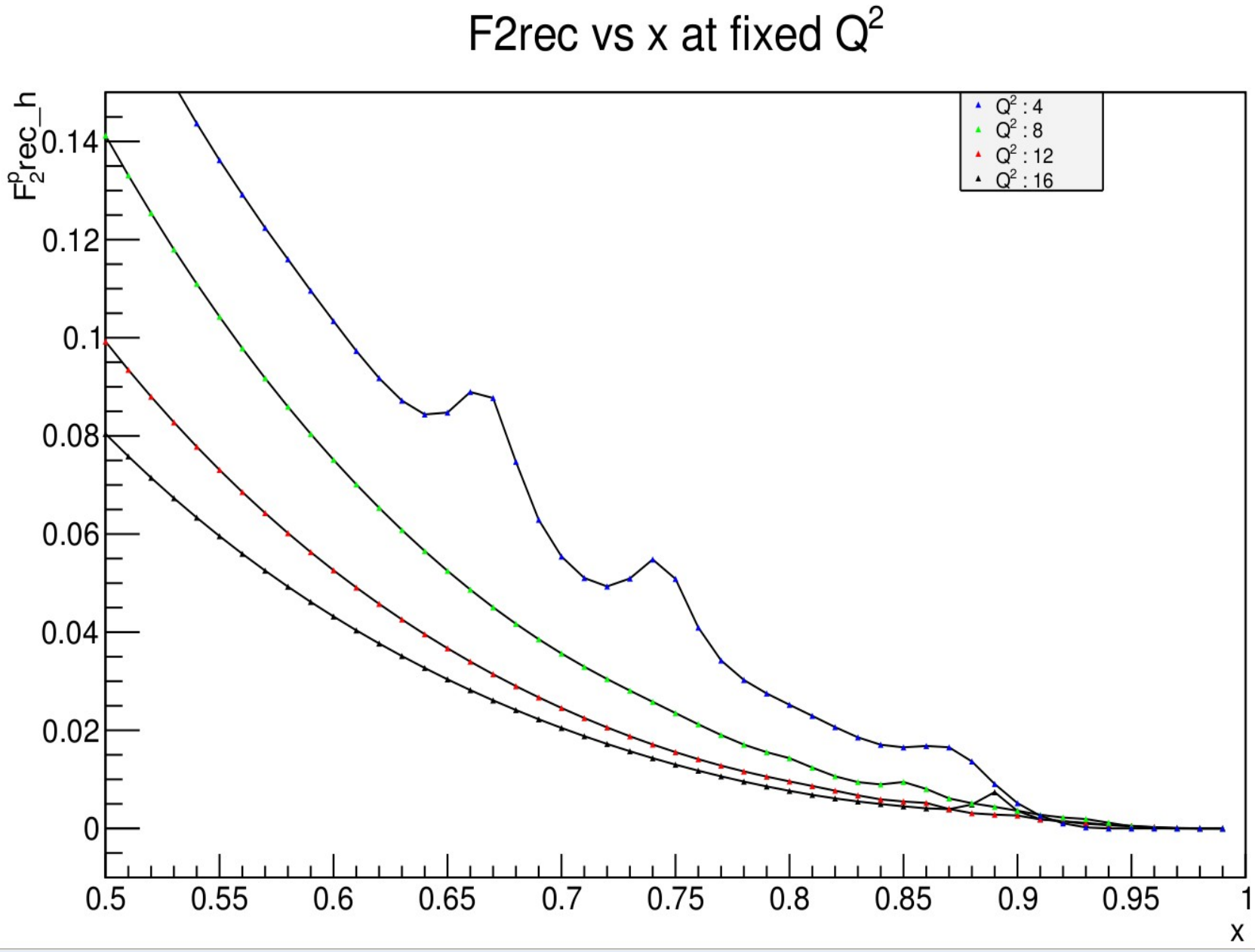
ϵ vs x : for $7.0 \leq Q^2 \leq 9.0$

- HMS : high Angle

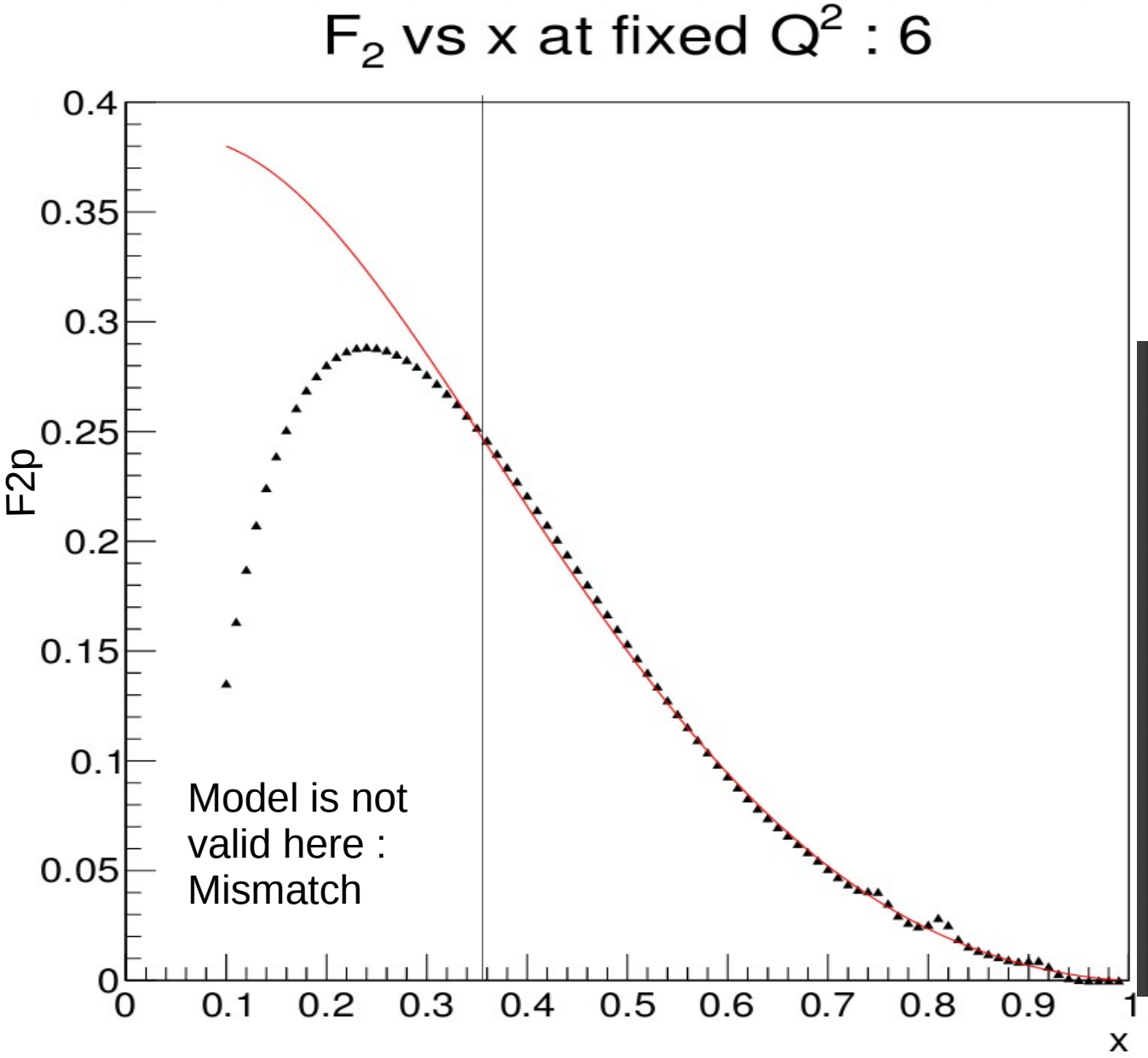




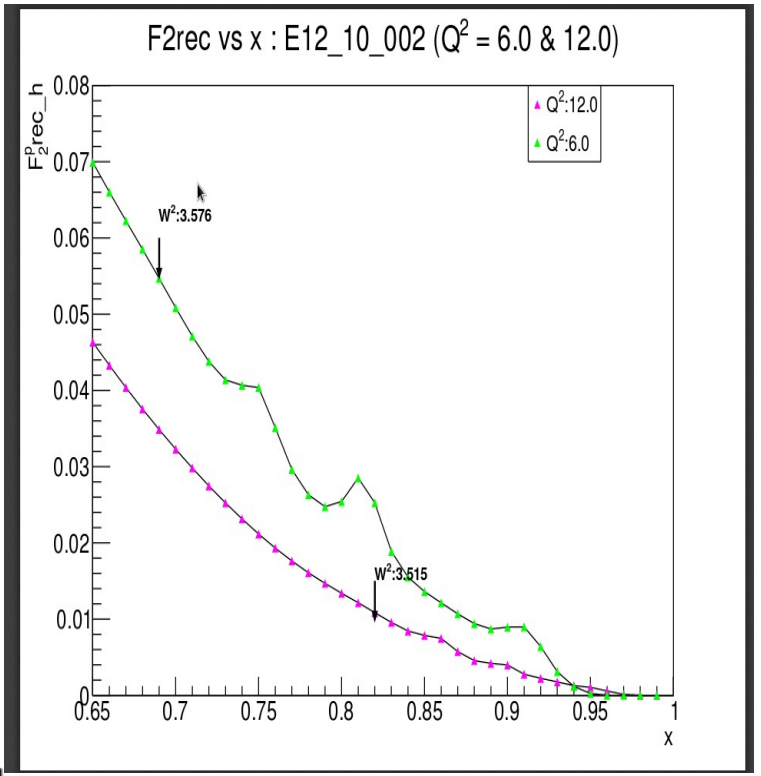
Quark Hadron Duality



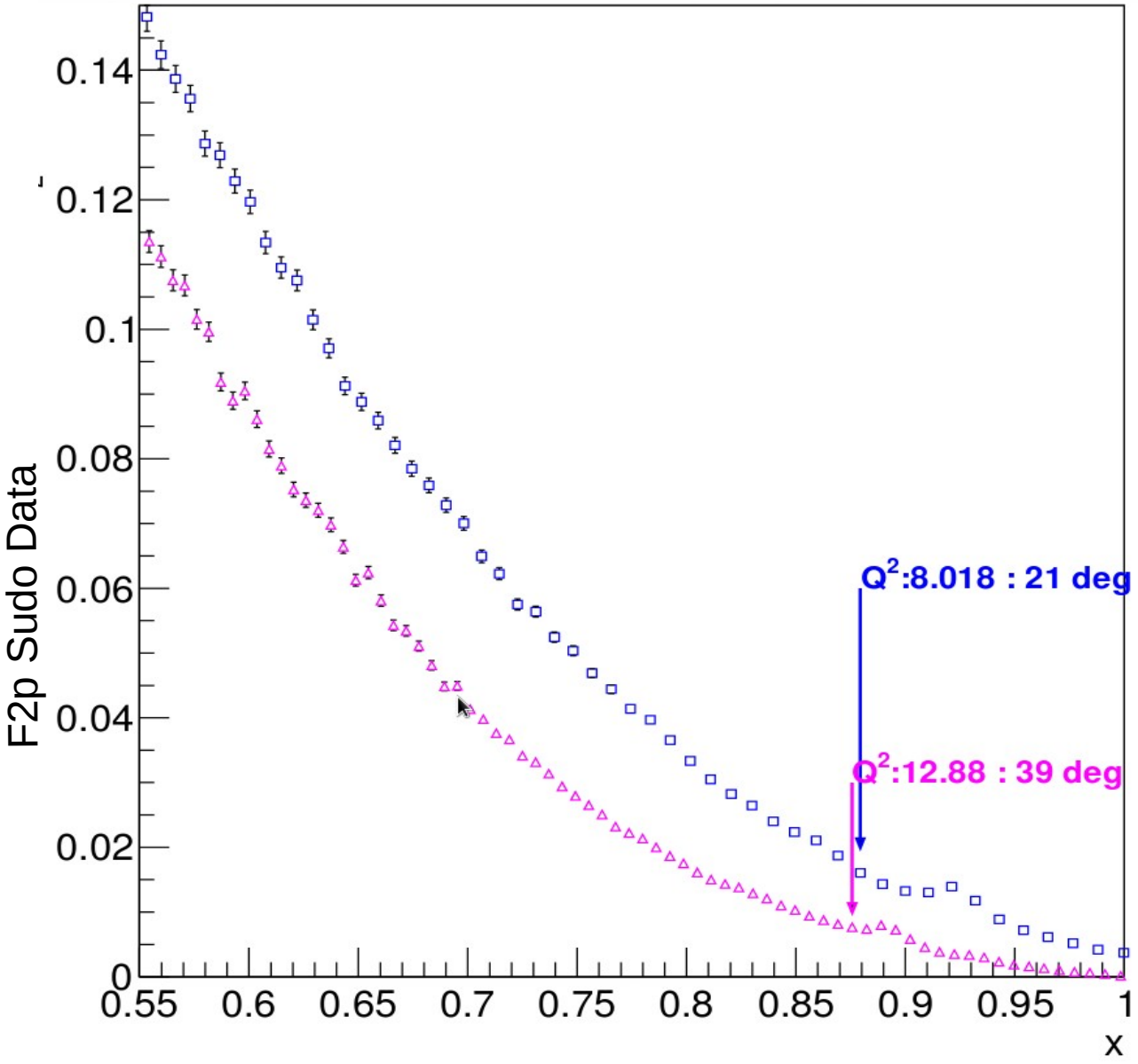
Oscillation of F2p around scaling curve



- we can include good enough number of curves for different Q2
- Then Average over them
- Average should follow the Scaling curve in resonance region



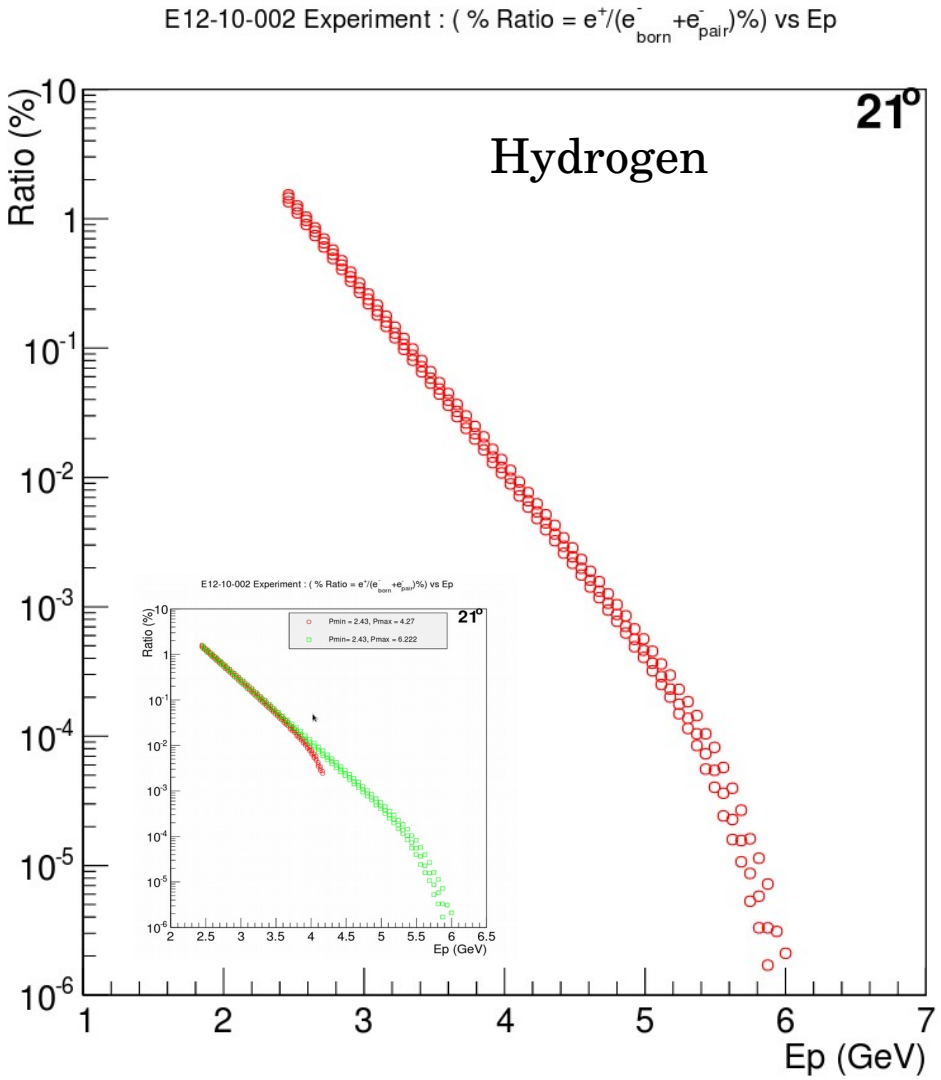
Sudo Data Generated Curve for Duality

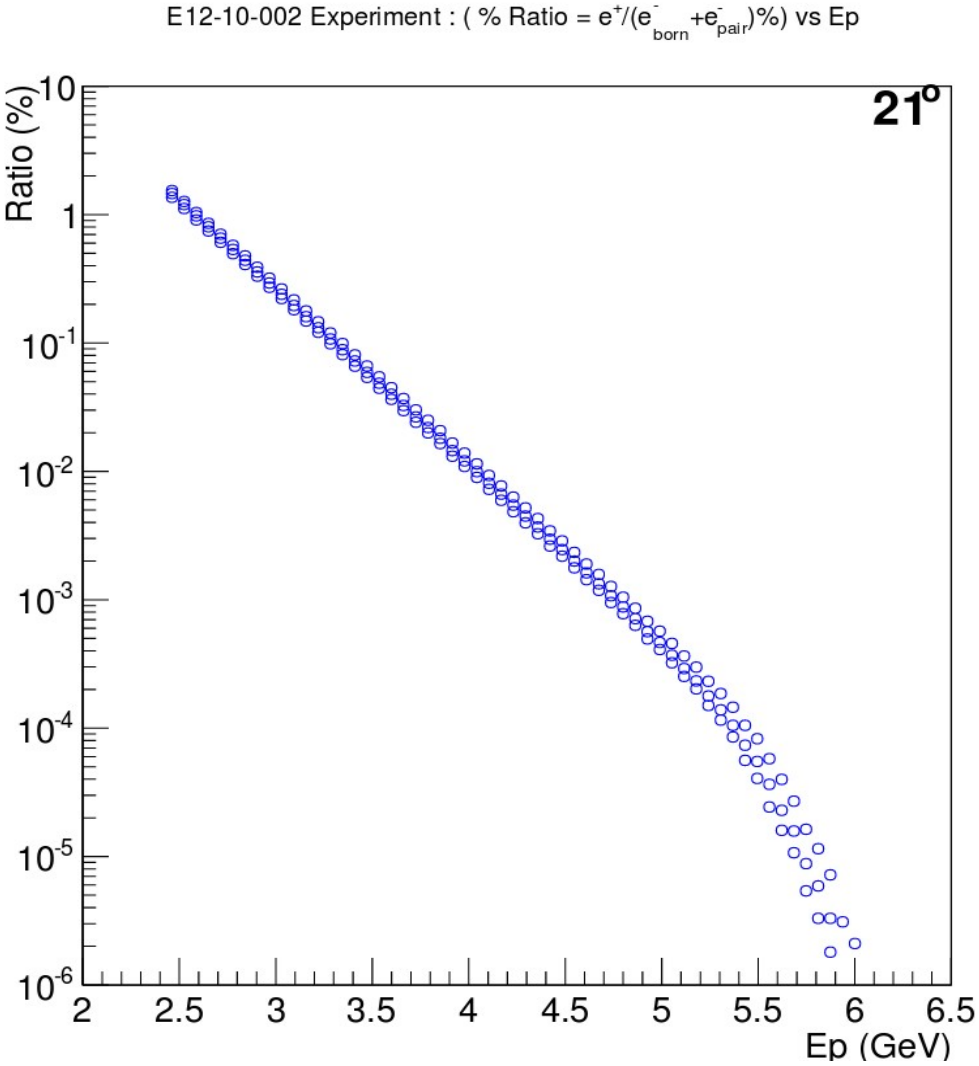


- For each point data generated around that point
- Generated data has a gaussian distribution
- Width of the Gaussian distribution is the statistical error (2 %) associated with that point
- Then a random point was picked up from that gaussian distribution

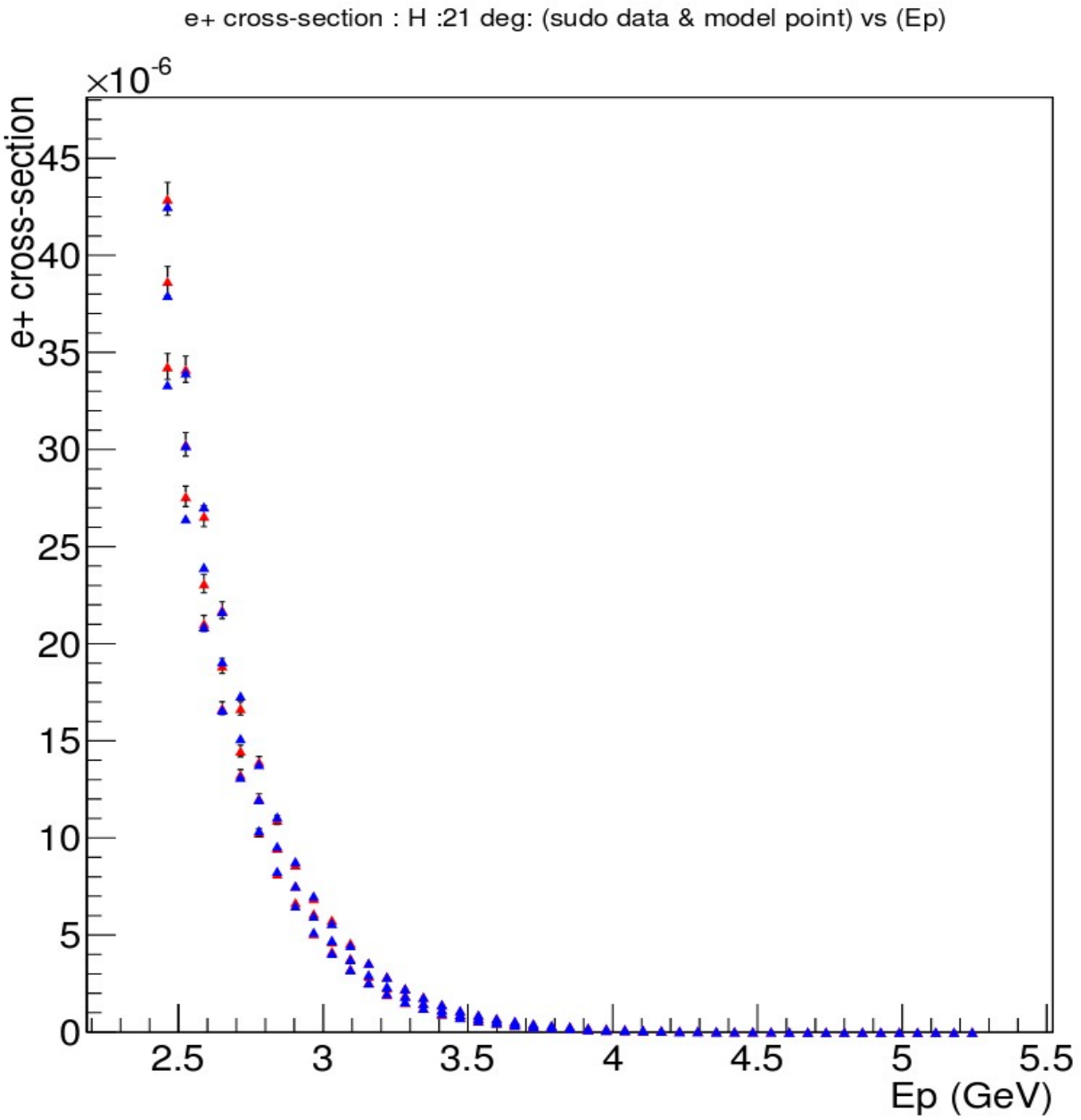
- New Graphs will be produced soon with W2 and point to point uncertainty

Charge Symmetric Background : H & D

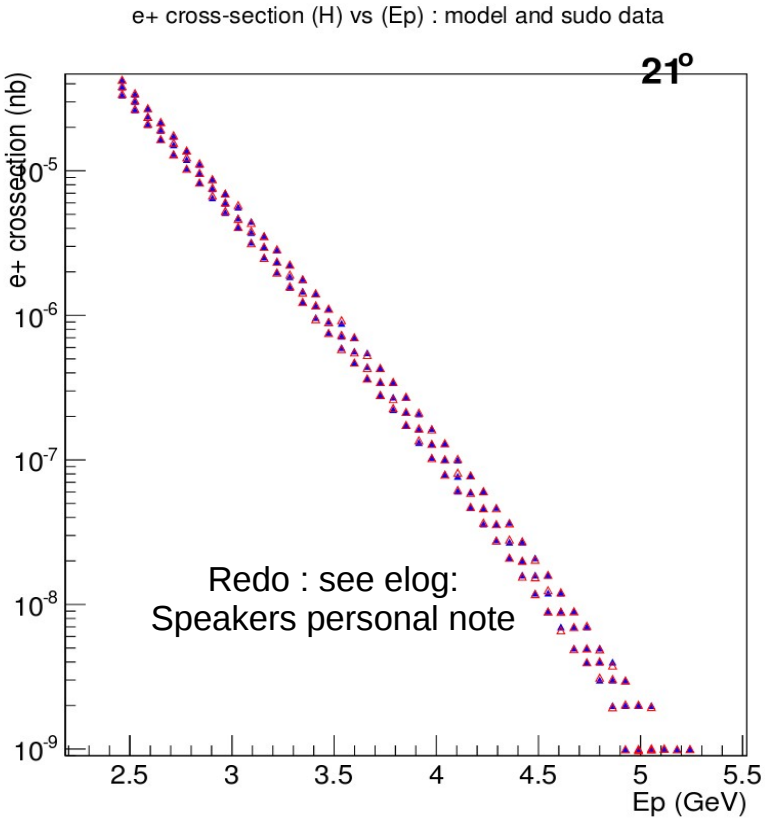




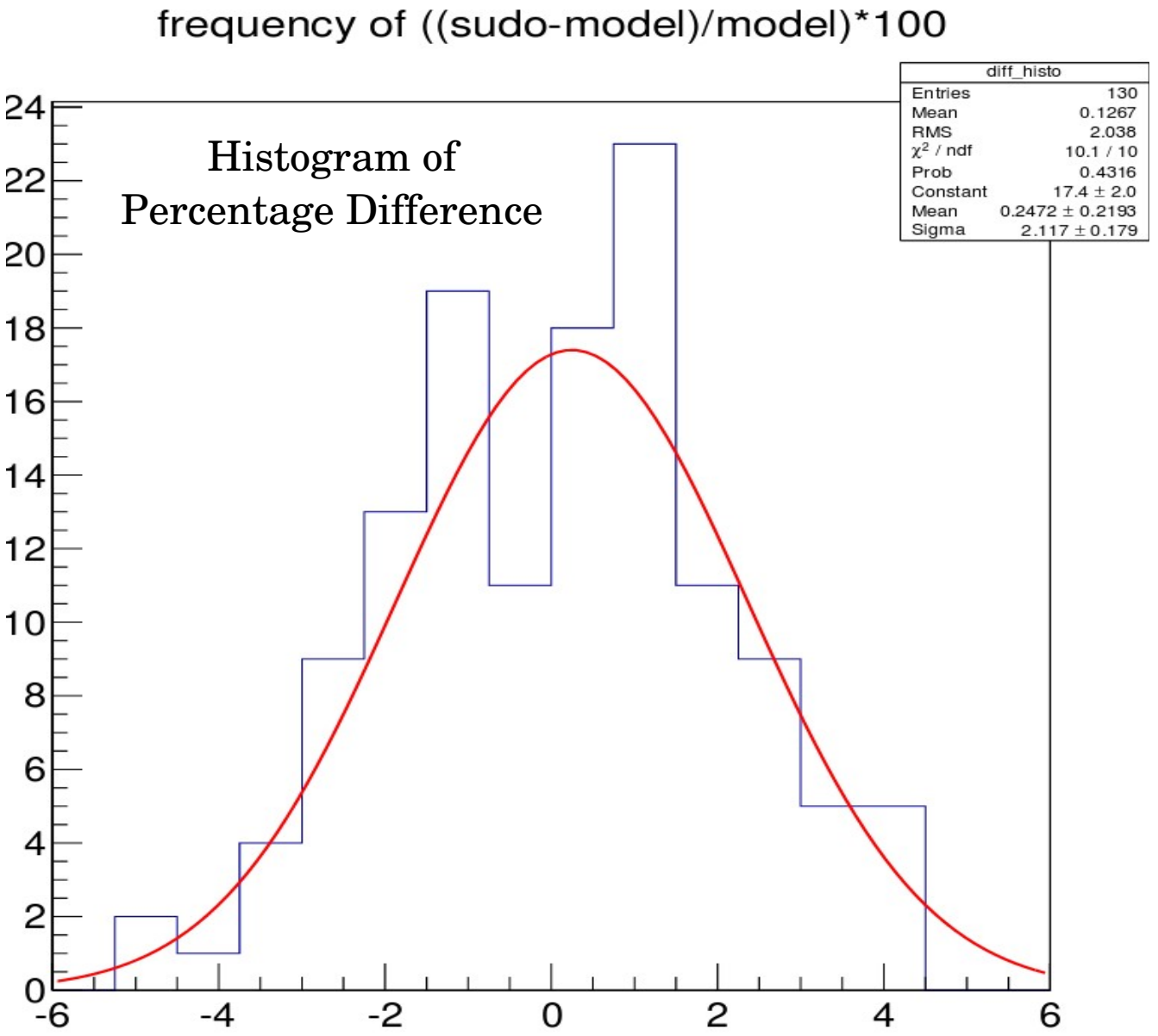
Charge Symmetric Background : Model vs Sudo Data



- Blue : Model
- Red : Sudo Data



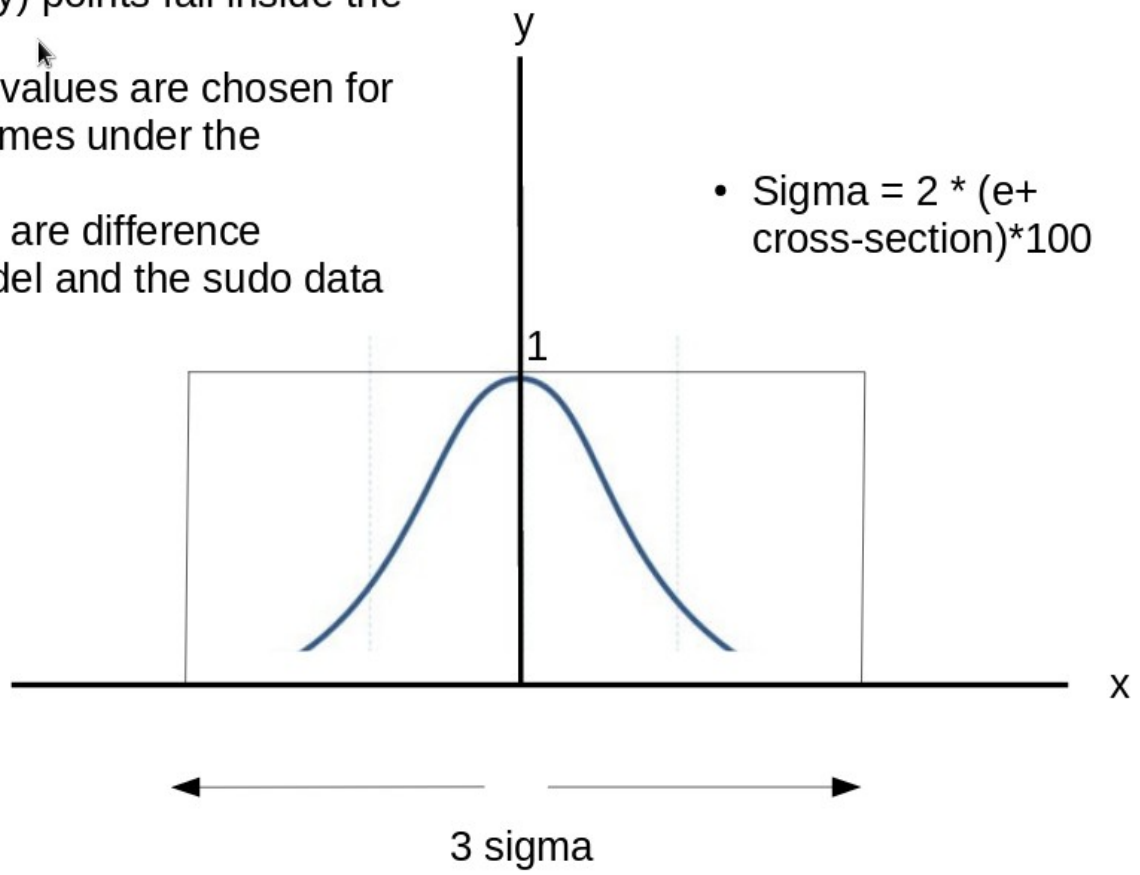
Charge Symmetric Background



Sudo Data Generation Process

- Randomly generated x in 3 sigma region
- For each of those x , y is generated
- Where all the (x,y) points fall inside the box
- But only those x values are chosen for which y value comes under the gaussian curve
- Chosen x values are difference between the model and the sudo data

- Sigma = 2 * (e+ cross-section)*100



Thanks !