Quasi-Elastic $^3He^{\uparrow}(e,e'n)$ Single Spin Asymmetry

Elena Long

Hall A Collaboration Meeting

December 15th, 2009

KENT STATE UNIVERSITY

Jefferson Lab

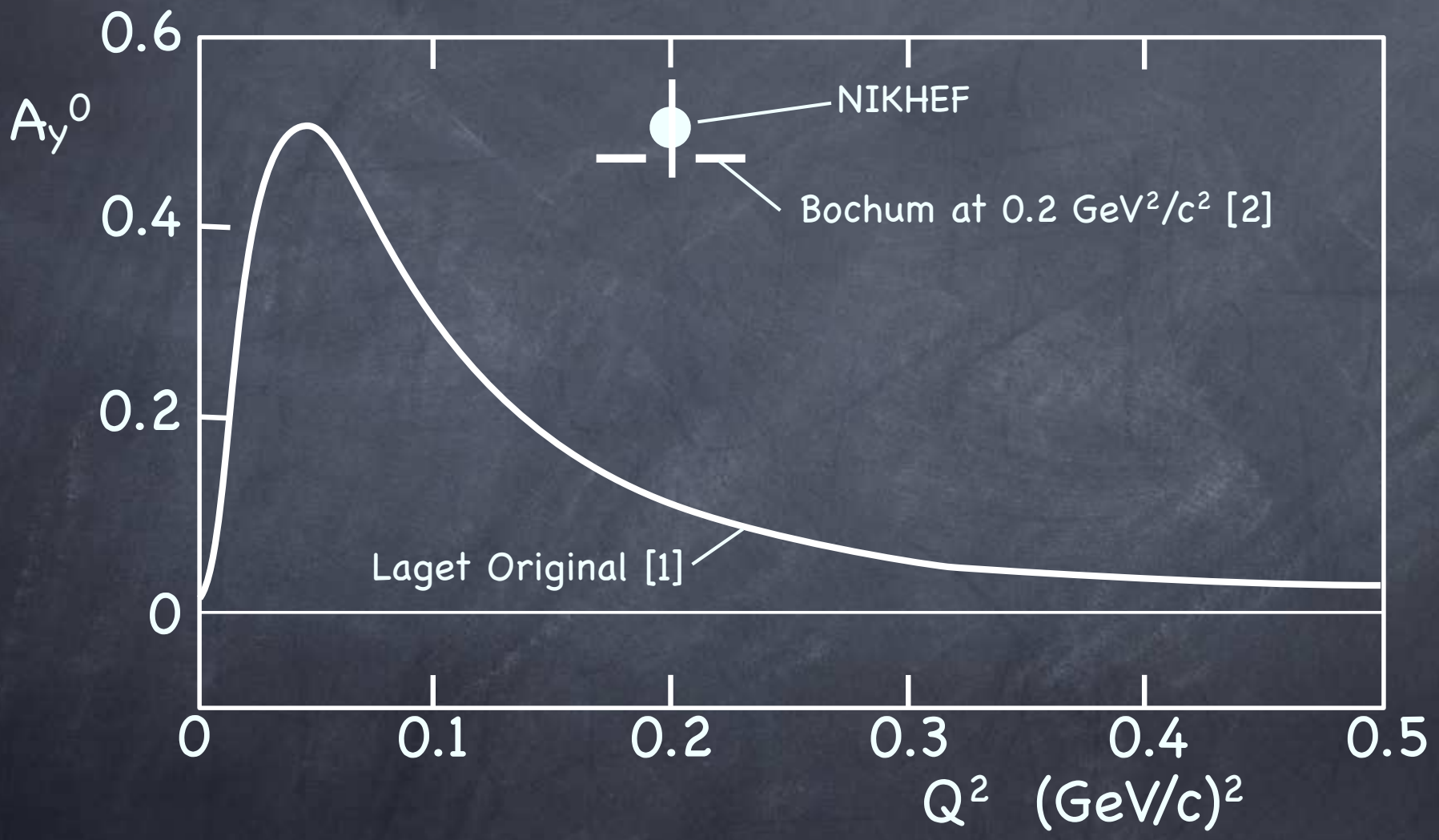
A_y: $^3He^{\uparrow}(e,e'n)$

- In PWIA, A_y in Quasi-Elastic $^3He^{\uparrow}(e,e'n)$ is exactly zero
- Previous to this experiment, no measurements of Ay have been done at large Q^2
- We will analyze high precision data points taken at 0.1 $[GeV/c]^2$, 0.5 $[GeV/c]^2$, and 1.0 $[GeV/c]^2$

A_y: $^3He^{\uparrow}(e,e'n)$

- Previous experiment at NIKHEF measured A_y at 0.2 $[GeV/c]^2$
- Faddeev calculations by Bochum group correctly predicted FSI result where other groups expected a much lower value

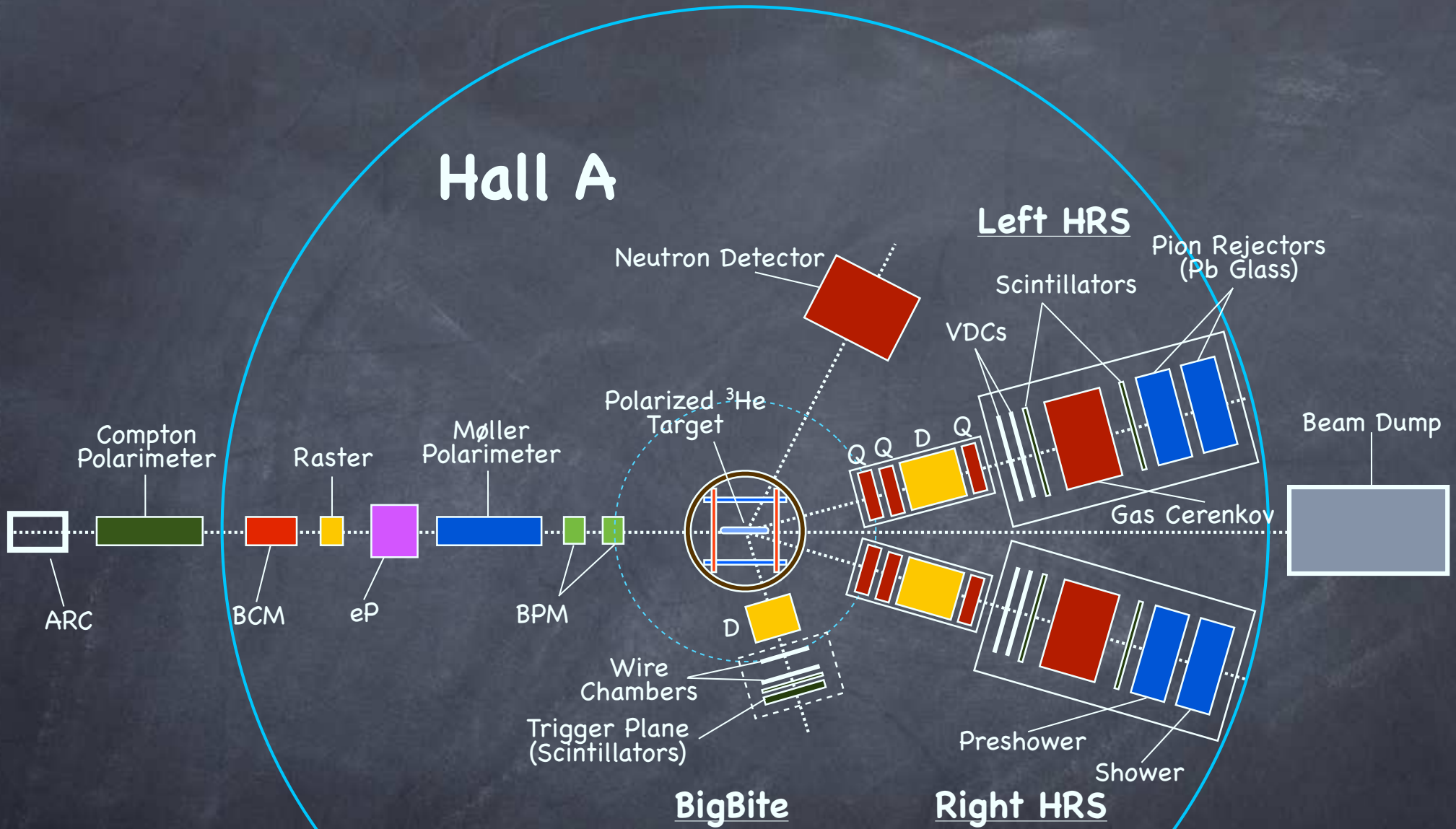
A_y: $^3He^{\uparrow}(e,e'n)$



[1] J. M. Laget, Phys. Lett. B273, 367 (1991).
[2] W. Gloeckle, H. Witala, D. Huber, H. Kamada, and J. Golak, Phys. Rept. 274, 107 (1996).

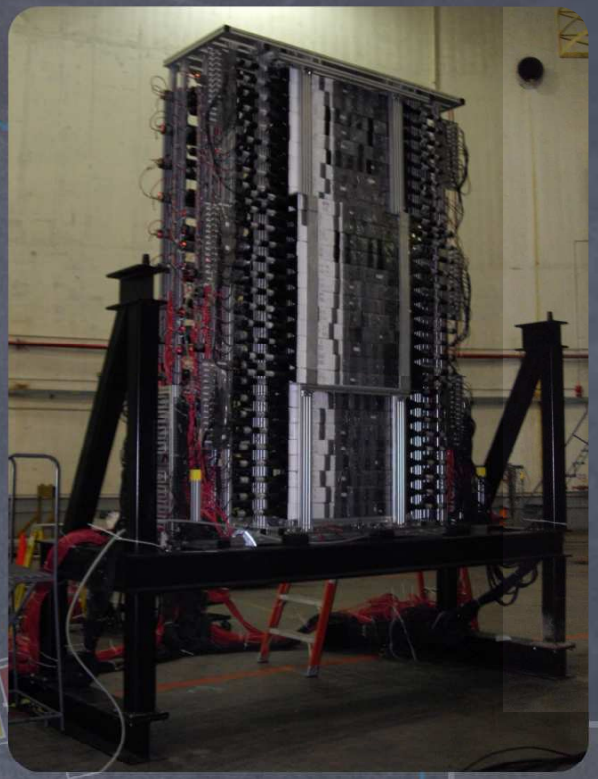
A_y: $^3He^{\uparrow}(e,e'n)$

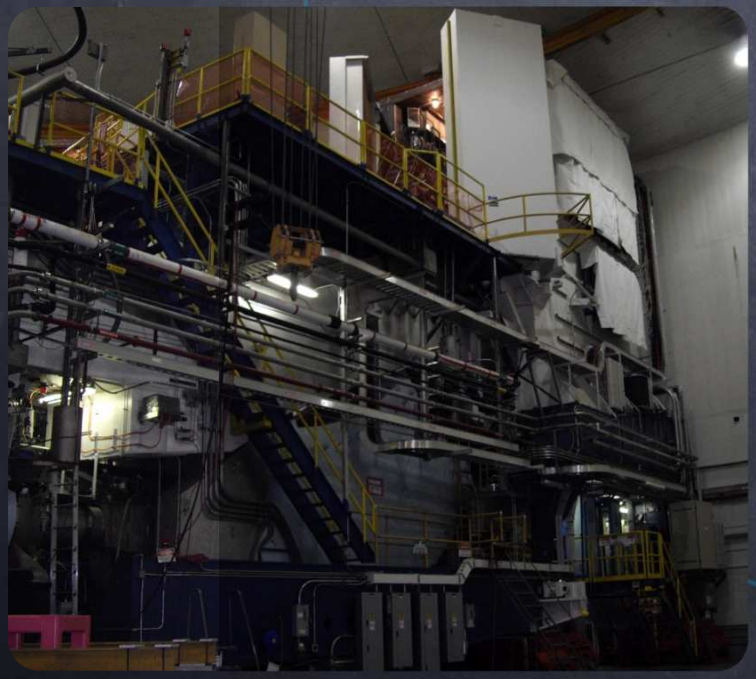
- Data will test state of the art calculations at high Q^2
  - Neutron form factor extractions must correctly predict this asymmetry
  - In calculating G_E^n from $^3\vec{He}(\vec{e},e'n)$, A_y from $^3He^{\uparrow}(e,e'n)$ will also be calculated
- At high Q^2, any non-zero result is indicative of effects beyond impulse approximation

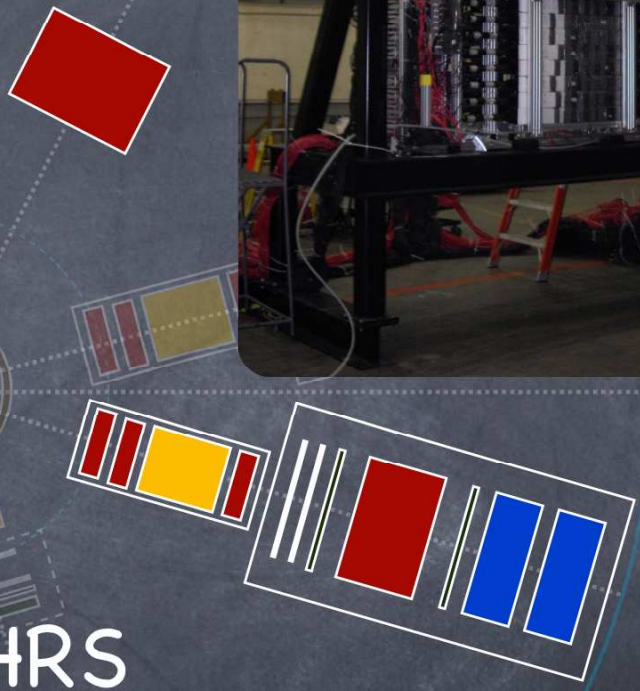

Hall A
Left HRS
Neutron Detector
Pion Rejectors
(Pb Glass)
Scintillators
VDCs
Polarized ³He
Target
Compton
Polarimeter
Raster
Møller
Polarimeter
Q Q D Q
Beam Dump
Gas Cerenkov
ARC
BCM
eP
BPM
D
Wire
Chambers
Trigger Plane
(Scintillators)
Preshower
Shower
BigBite
Right HRS

Hall A Neutron Detector

- Detects neutrons from ^{3}He(e,e'n)
- Along with RHRS allows G_E^n and A_y measurements to be made





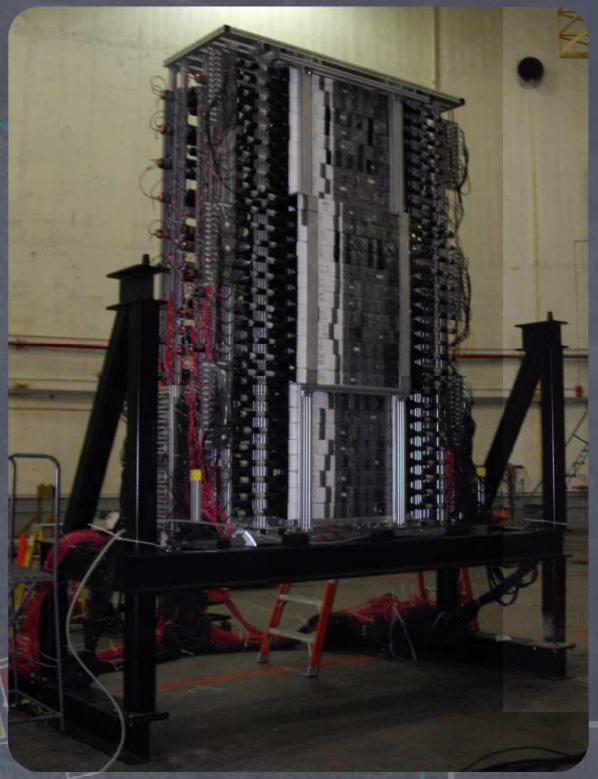


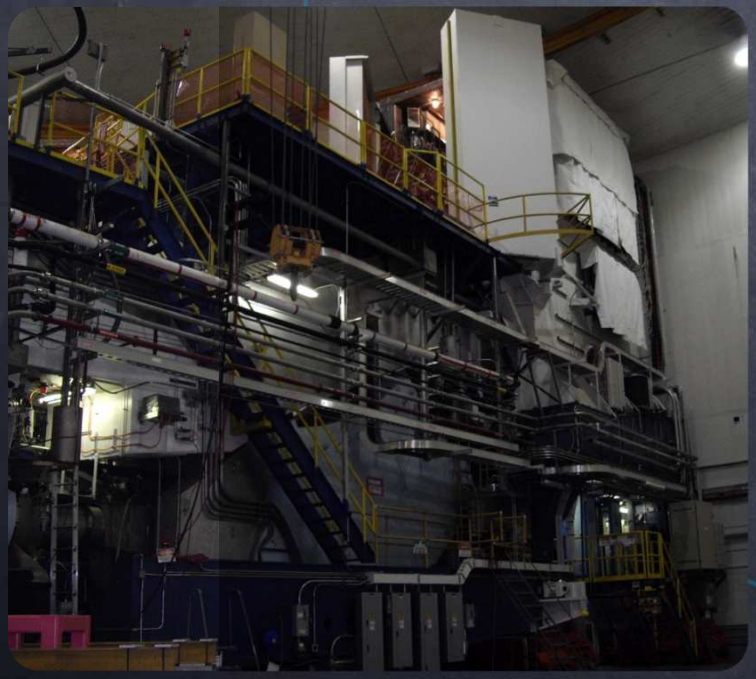
Right HRS

- Detects quasi-elastically scattered electrons from ^{3}He(e,e'n) and ^{3}He(e,e')
- With q along beam polarization on ^{3}He(e,e'), allows a G_M^n measurement to be made

Hall A Neutron Detector

- Detects neutrons from ^{3}He(e,e'n)
- Along with RHRS allows G_E^n and A_y measurements to be made

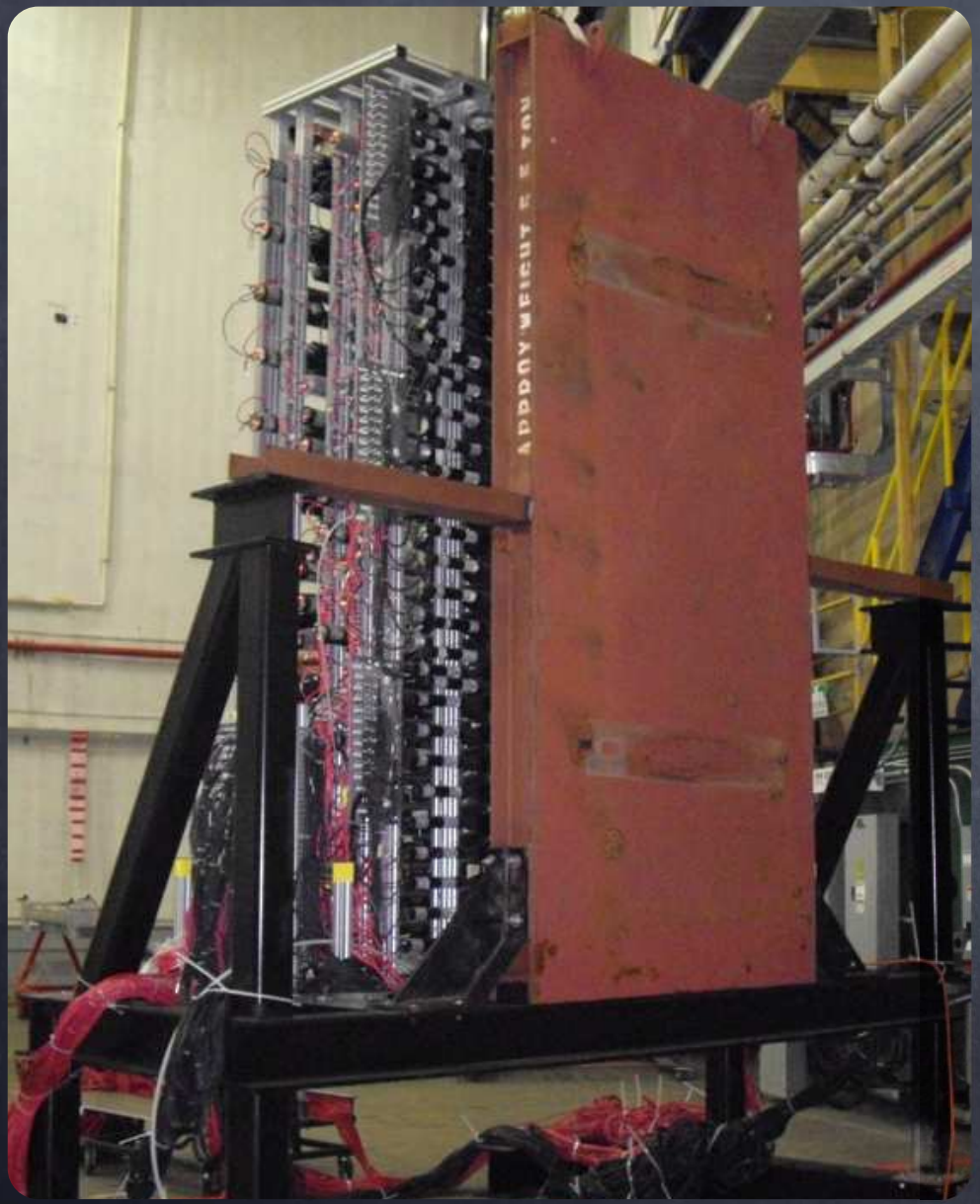




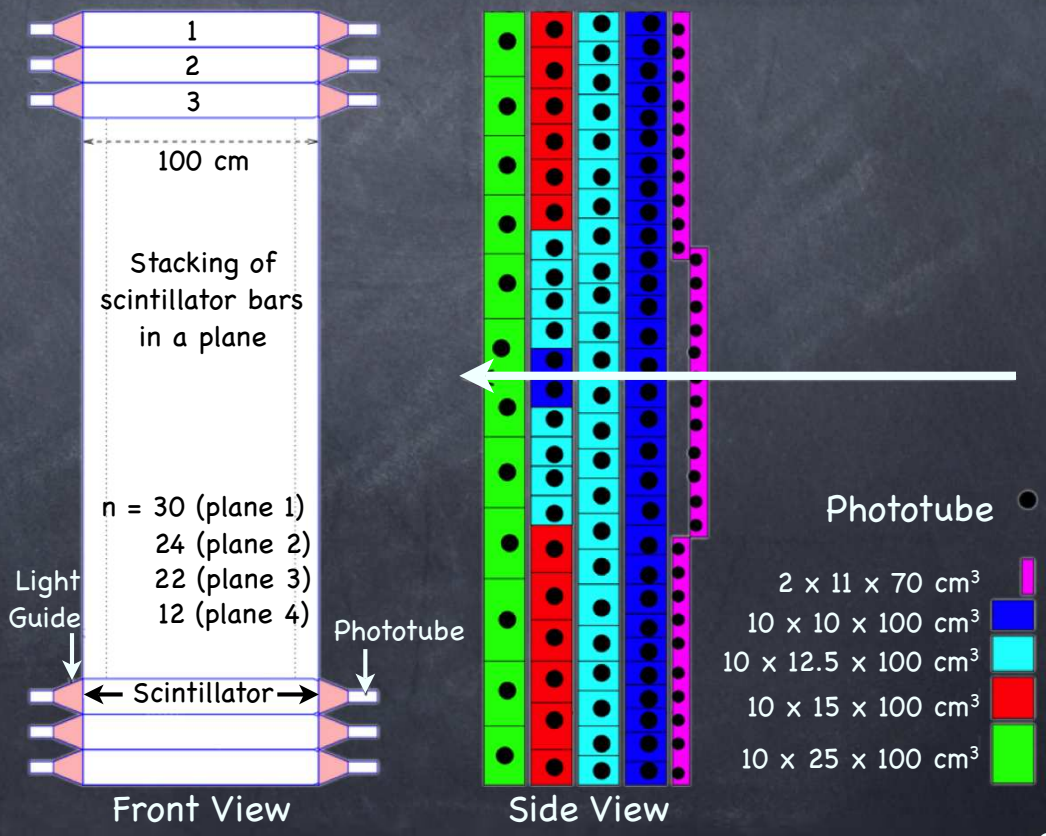
Right HRS

- Detects quasi-elastically scattered electrons from ^{3}He(e,e'n) and ^{3}He(e,e')
- With q along beam polarization on ^{3}He(e,e'), allows a G_M^n measurement to be made

Hall A Neutron Detector

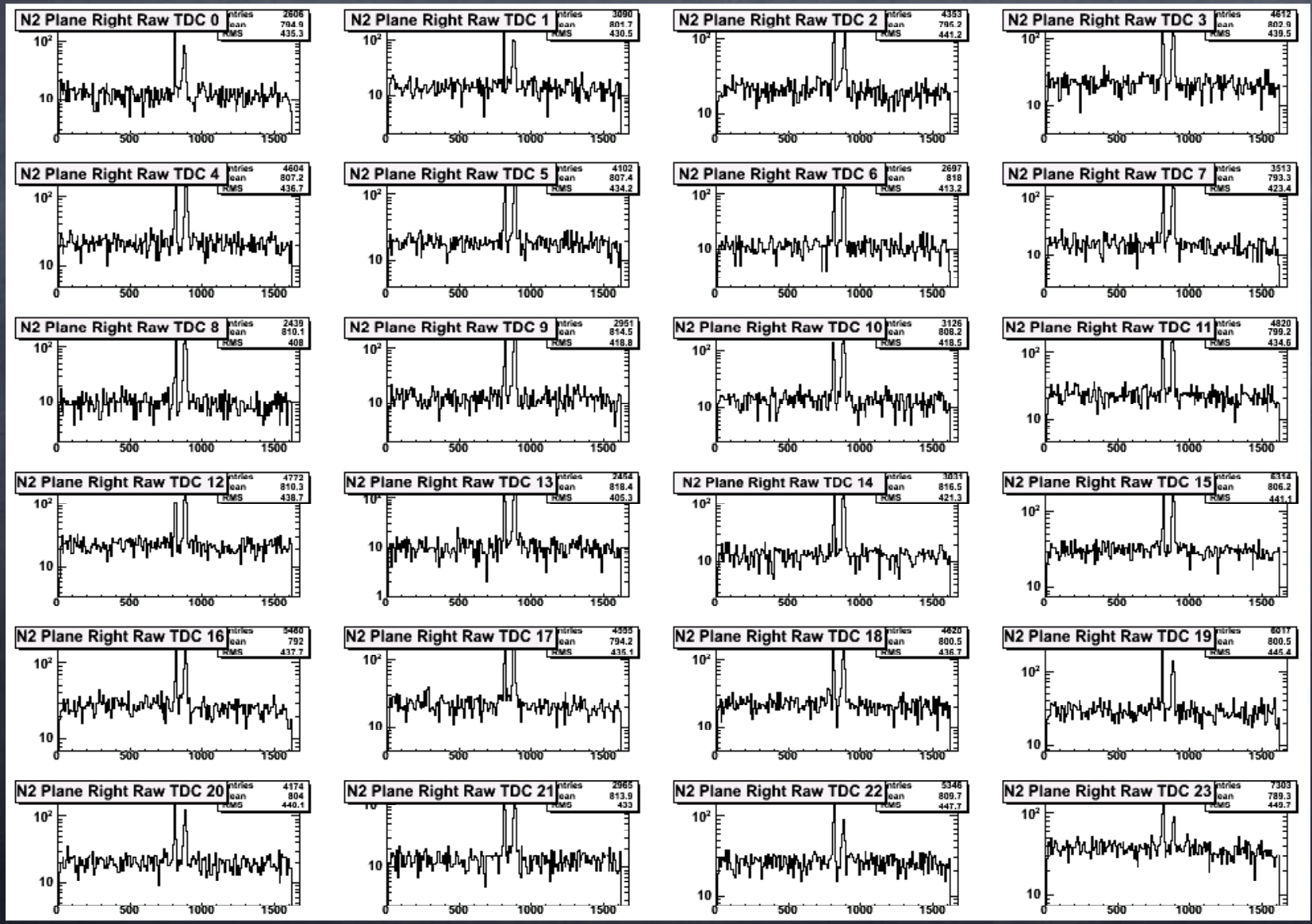


- 88 Scintillator + 64 Veto Bars
- ADC and TDC channels recorded for each of 240 PMTs



Hall A Neutron Detector

- Analysis starting with inclusive ^{3}He(e,e′) asymmetries. HAND calibration has not been completed yet



A_y: $^3He^{\uparrow}(e,e'n)$

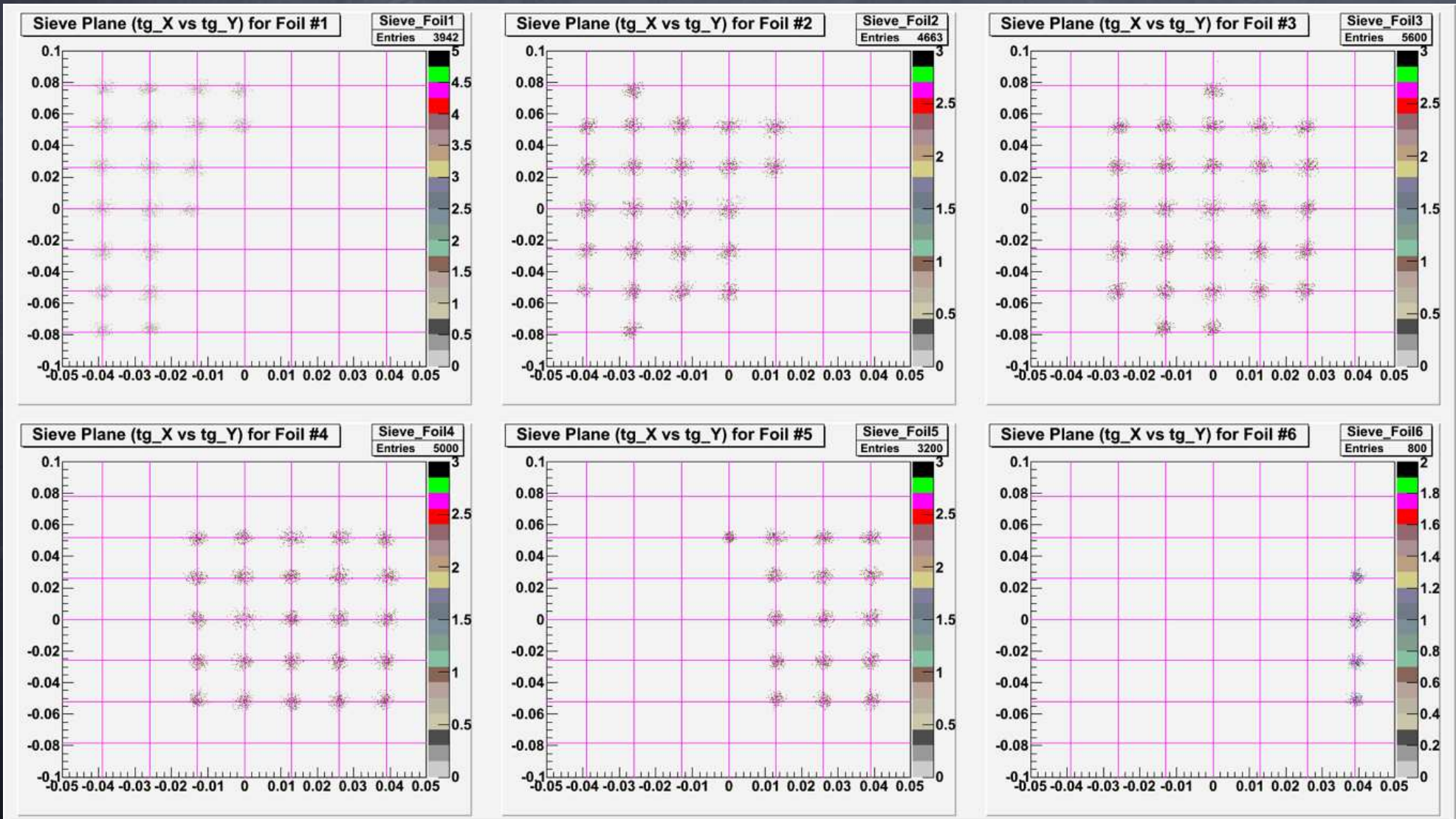
- This experiment, E08-005, ran from April 26th through May 10th in Jefferson Lab's Hall A
- The kinematics taken were:

E_0 [GeV]	E' [GeV]	θ_{lab} [°]	Q^2 $[GeV/c]^2$	$\|q\|$ [GeV/c]	θ_q [°]
1.25	1.22	17.0	0.13	0.359	71.0
2.43	2.18	17.0	0.46	0.681	62.5
3.61	3.09	17.0	0.98	0.988	54.0

Date	E_0 (GeV)	RHRS (°)	RHRS P_0 (GeV)	LHRS (°)	LHRS P_0 (GeV)	HAND (°)	BigBite (°)
4/26	1.245	-17	1.2205	17	1.2205	71	-74
4/27	1.245	-17	1.1759	17	1.1759	71	-74
4/29	3.605	-17	3.0855	17	3.0855	54	-74
5/6	3.605	-17	3.0855	17	3.0855	62.5	-74
5/8	2.425	-17	2.1813	17	2.1813	62.5	-74

Analysis: HRS Optics Calibration

- See Ge Jin's Talk from yesterday's analysis workshop

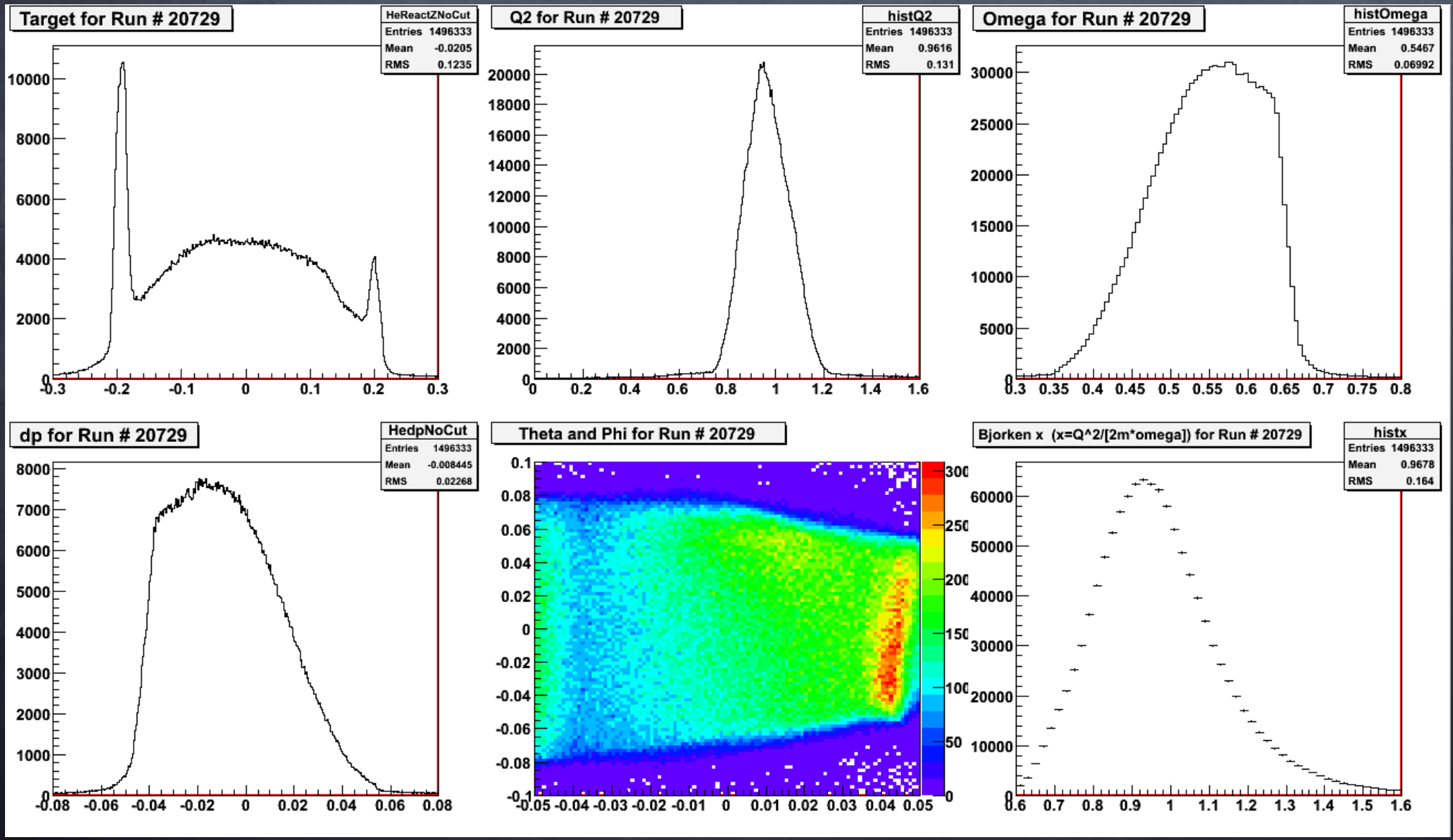


Analysis: Q^2=1.0 GeV Run Information

- Vertical ^{3}He
  - 132 Runs; 189,151,442 events before cuts
- Transverse ^{3}He
  - 34 Runs; 35,087,910 events before cuts
- Longitudinal ^{3}He
  - 24 Runs; 24,721,165 events before cuts
- Carbon
  - 10 Runs; 2,640,811 events before cuts

Analysis: Run Check

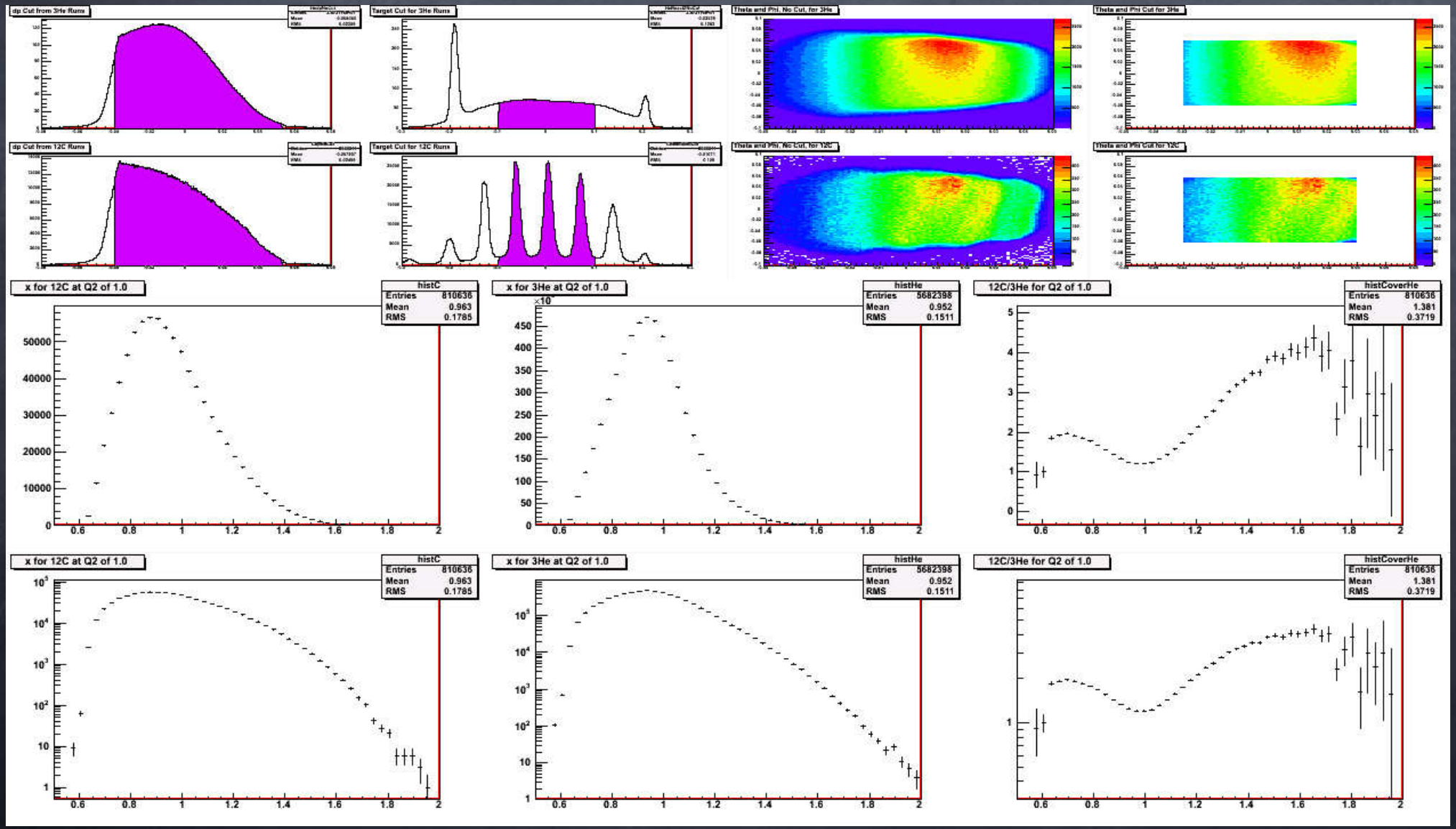
- Typical Run



Analysis: x_{Bj} Scaling

- x_{Bj} @ Q^2=1 $(GeV/c)^2$

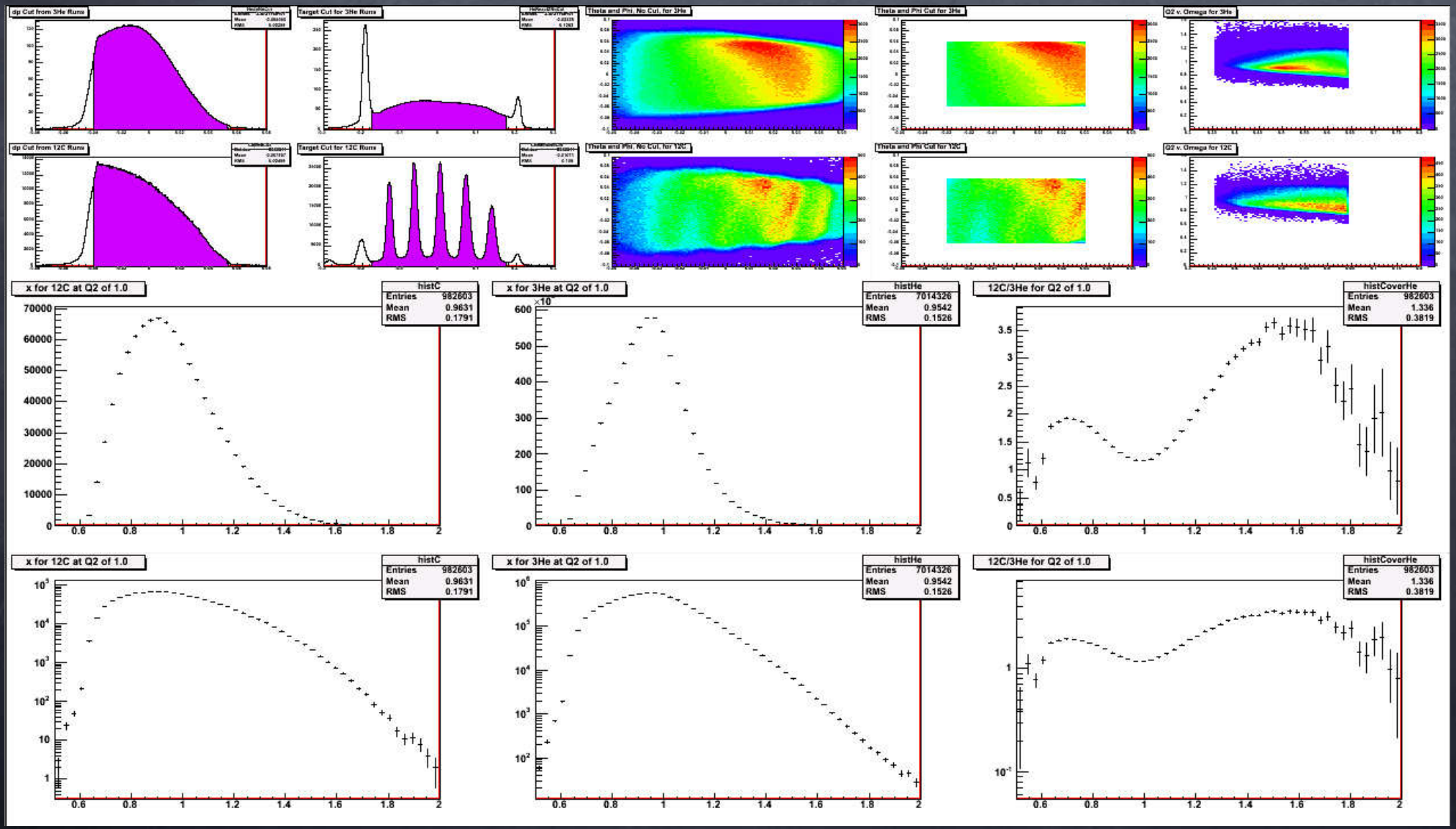
Longitudinal $^3He(e,e')$



Analysis: x_{Bj} Scaling

- x_{Bj} @ Q^2=1 $(GeV/c)^2$

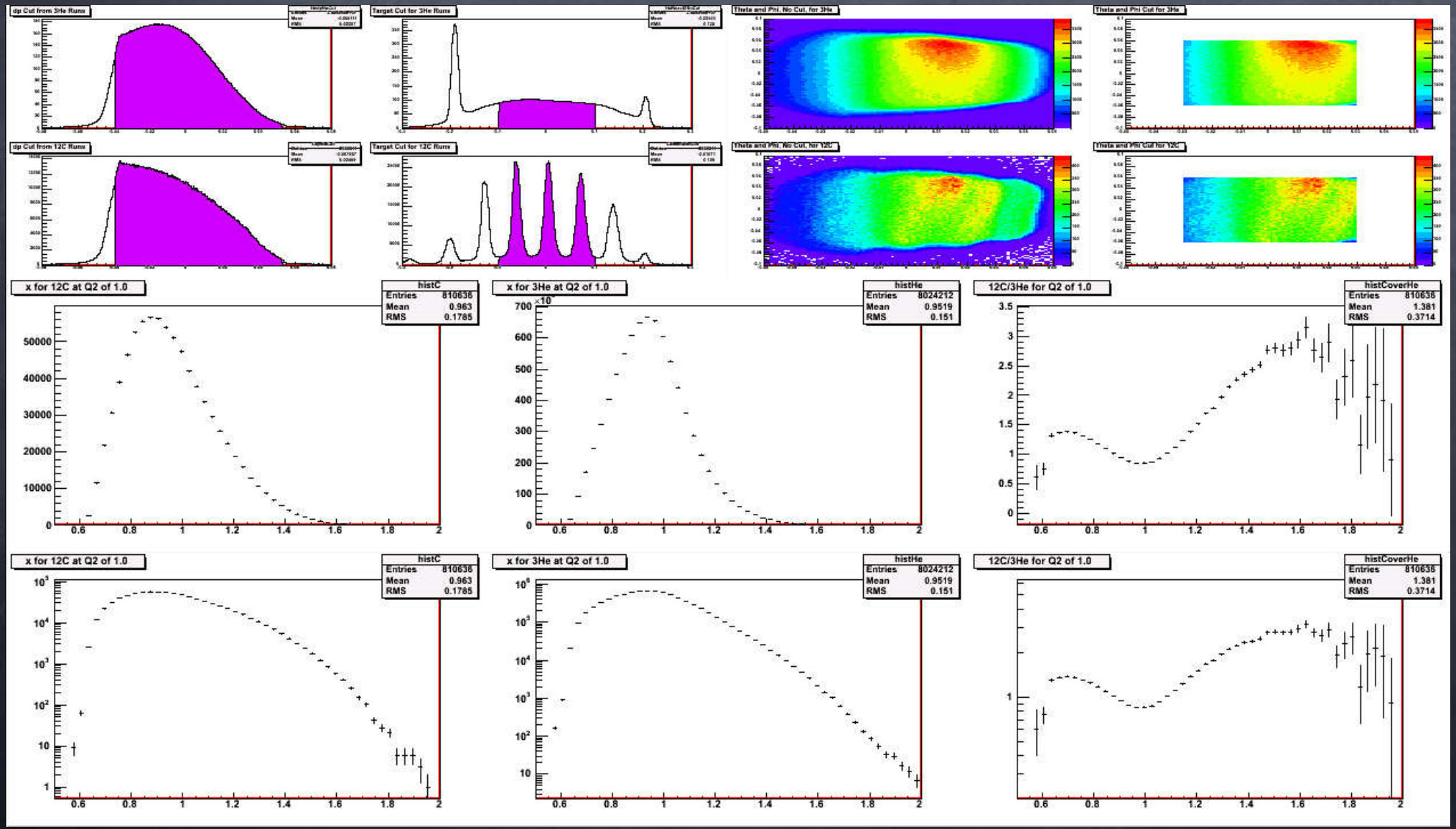
Longitudinal $^3He(e,e')$



Analysis: x_{Bj} Scaling

- x_{Bj} @ Q^2=1 $(GeV/c)^2$

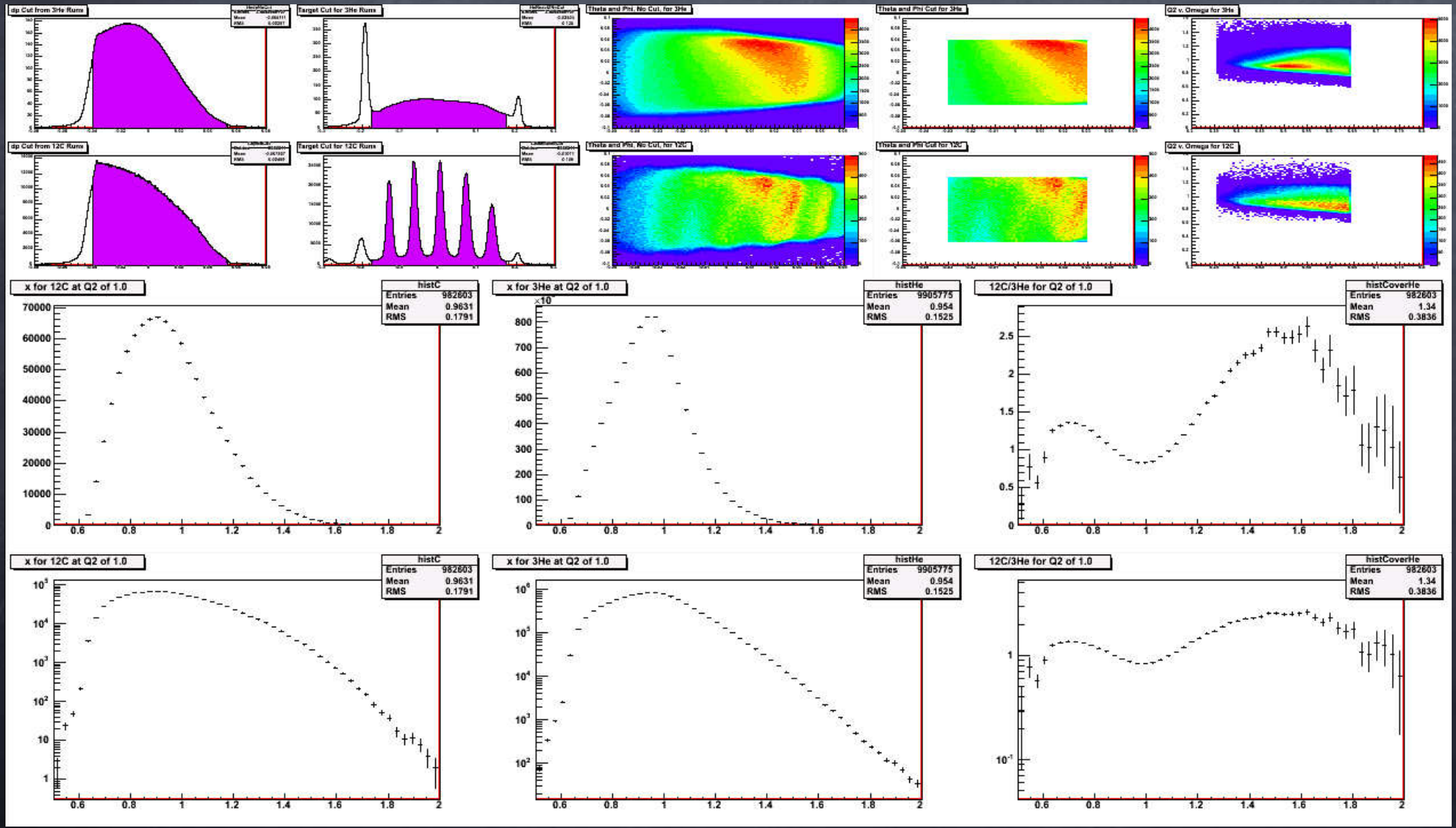
Transverse ^{3}He(e,e′)



Analysis: x_{Bj} Scaling

- x_{Bj} @ Q^2=1 $(GeV/c)^2$

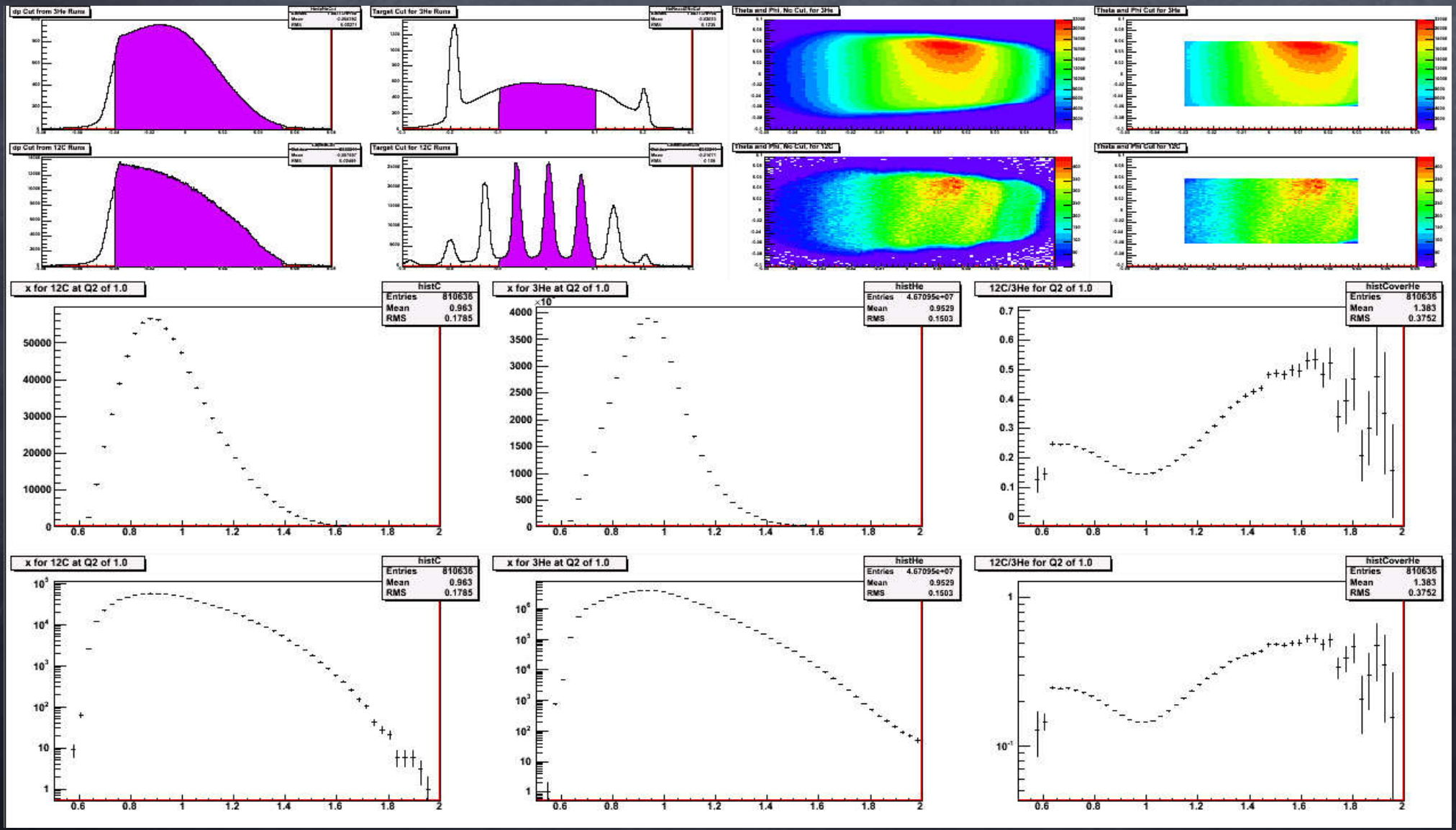
Transverse ^{3}He(e,e′)



Analysis: x_{Bj} Scaling

- x_{Bj} @ $Q^2=1$ $(GeV/c)^2$

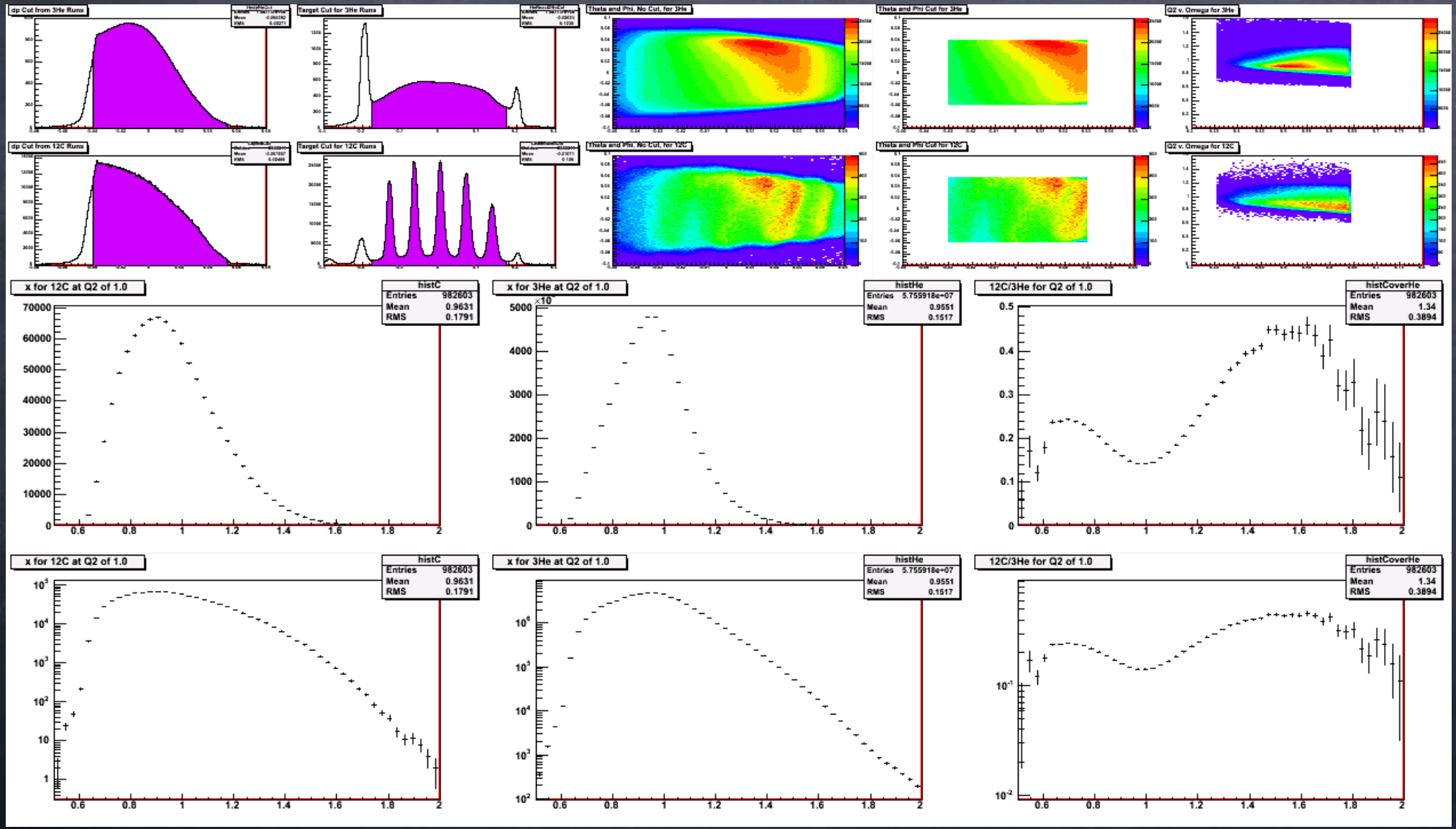
Vertical $^3He(e,e')$



Analysis: x_{Bj} Scaling

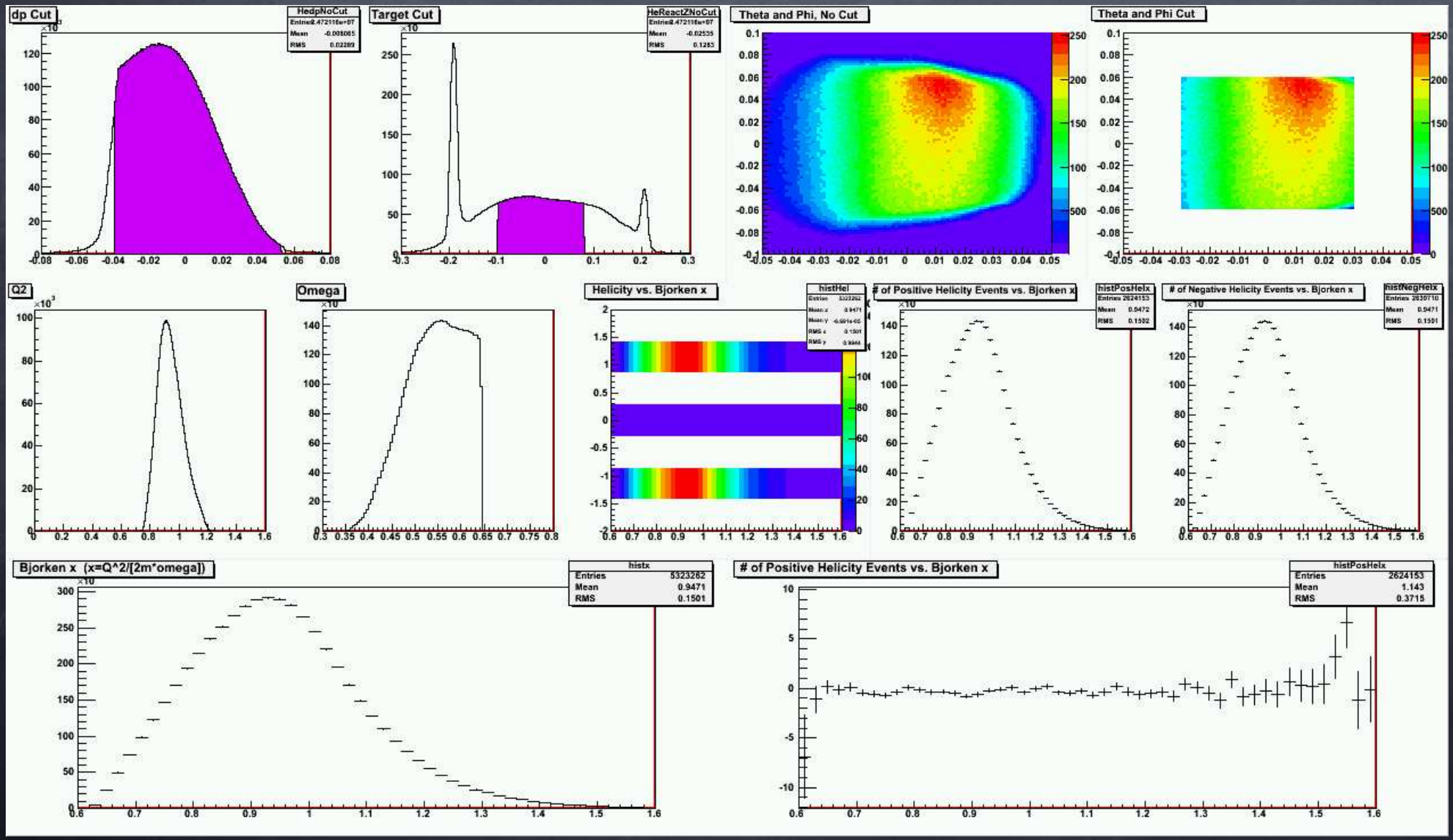
- x_{Bj} @ Q^2=1 $(GeV/c)^2$

Vertical $^3He(e,e')$



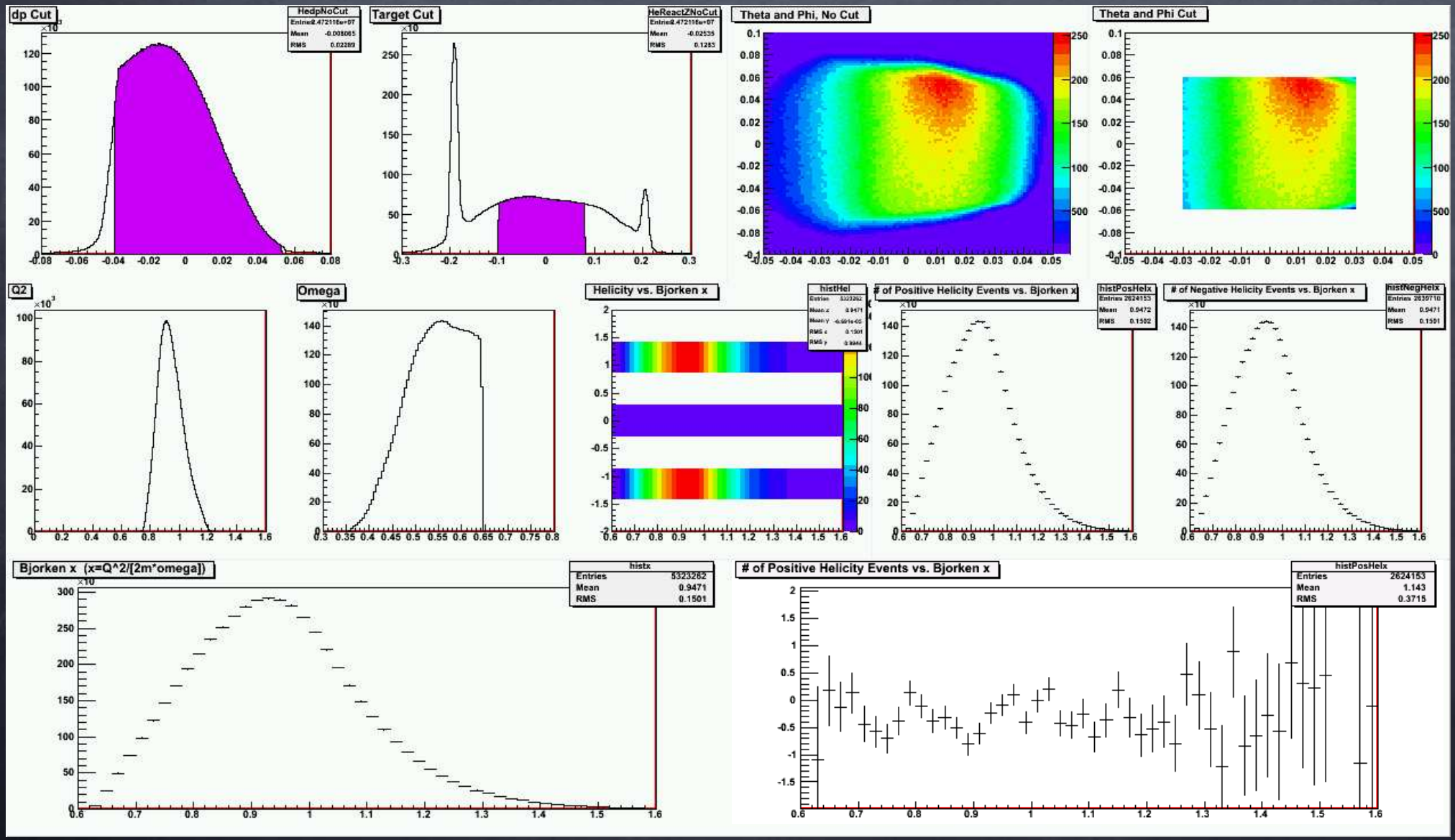
Analysis: Raw Asymmetries

- Raw Beam Asymmetry @ Q^2=1 (GeV/c)^2
  Longitudinal ^{3}He(e,e′)



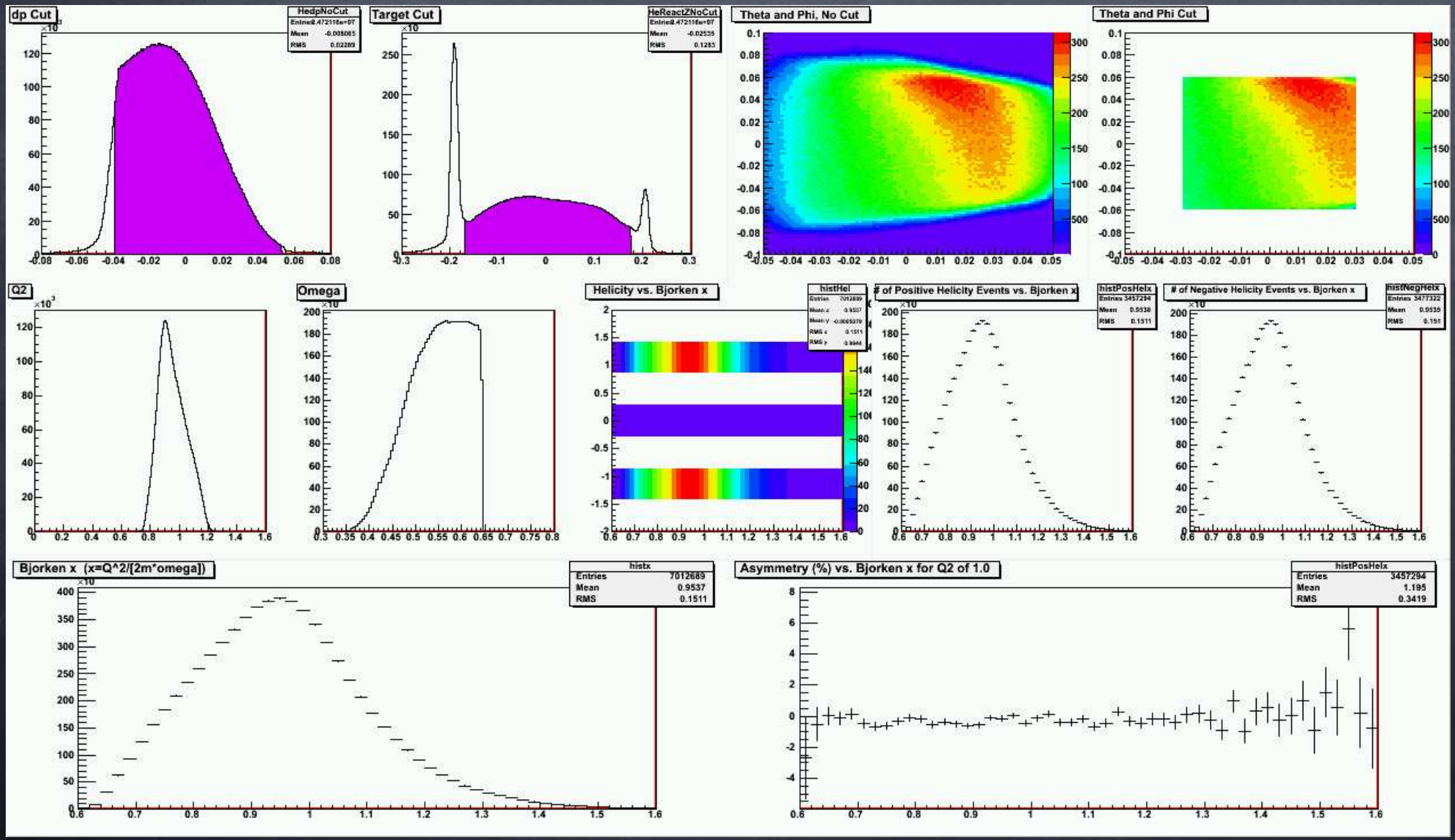
Analysis: Raw Asymmetries

- Raw Beam Asymmetry @ Q^2=1 $(GeV/c)^2$
  Longitudinal $^3He(e,e')$



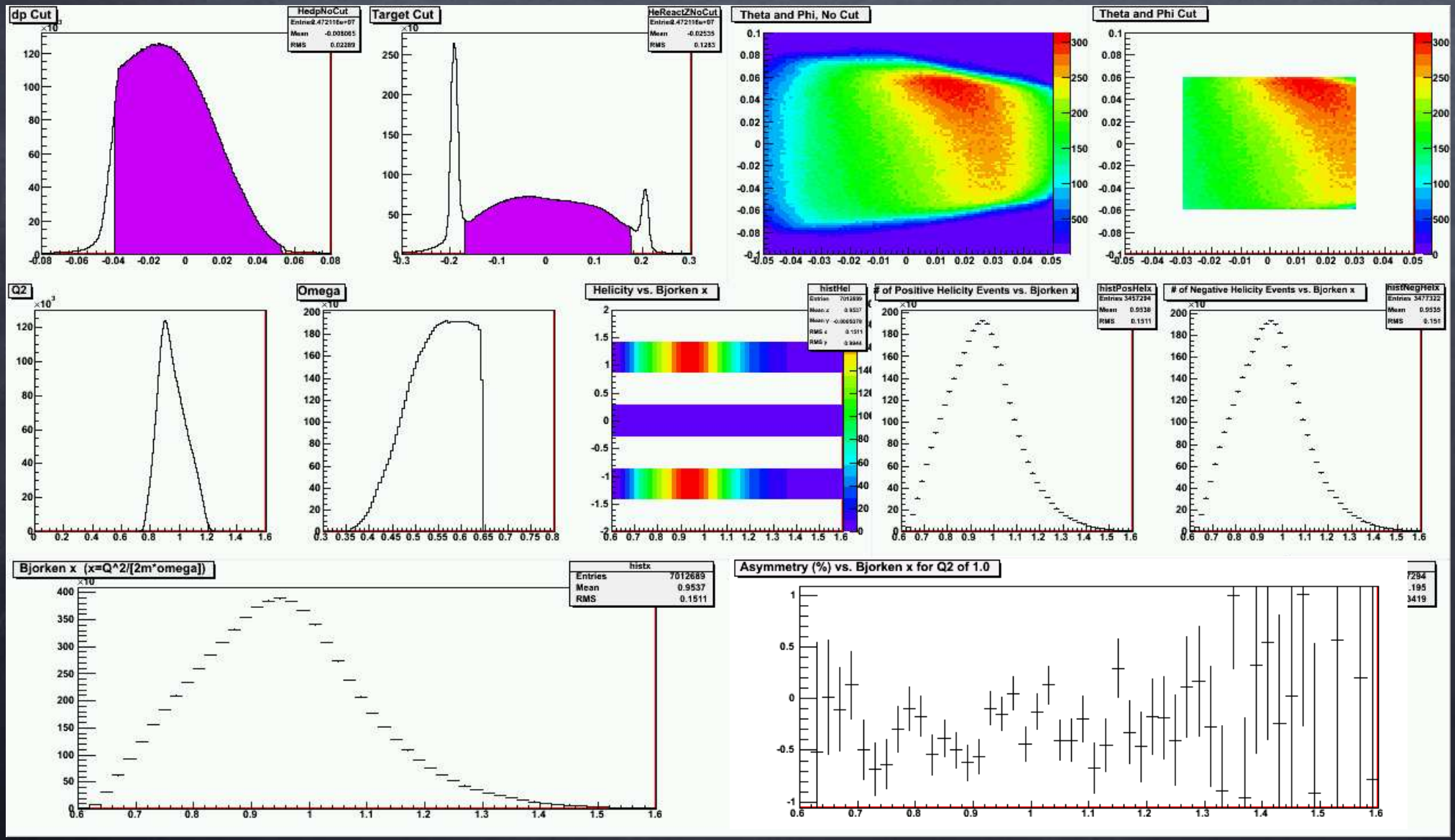
Analysis: Raw Asymmetries

- Raw Beam Asymmetry @ Q^2=1 (GeV/c)^2
  Longitudinal ^{3}He(e,e′)



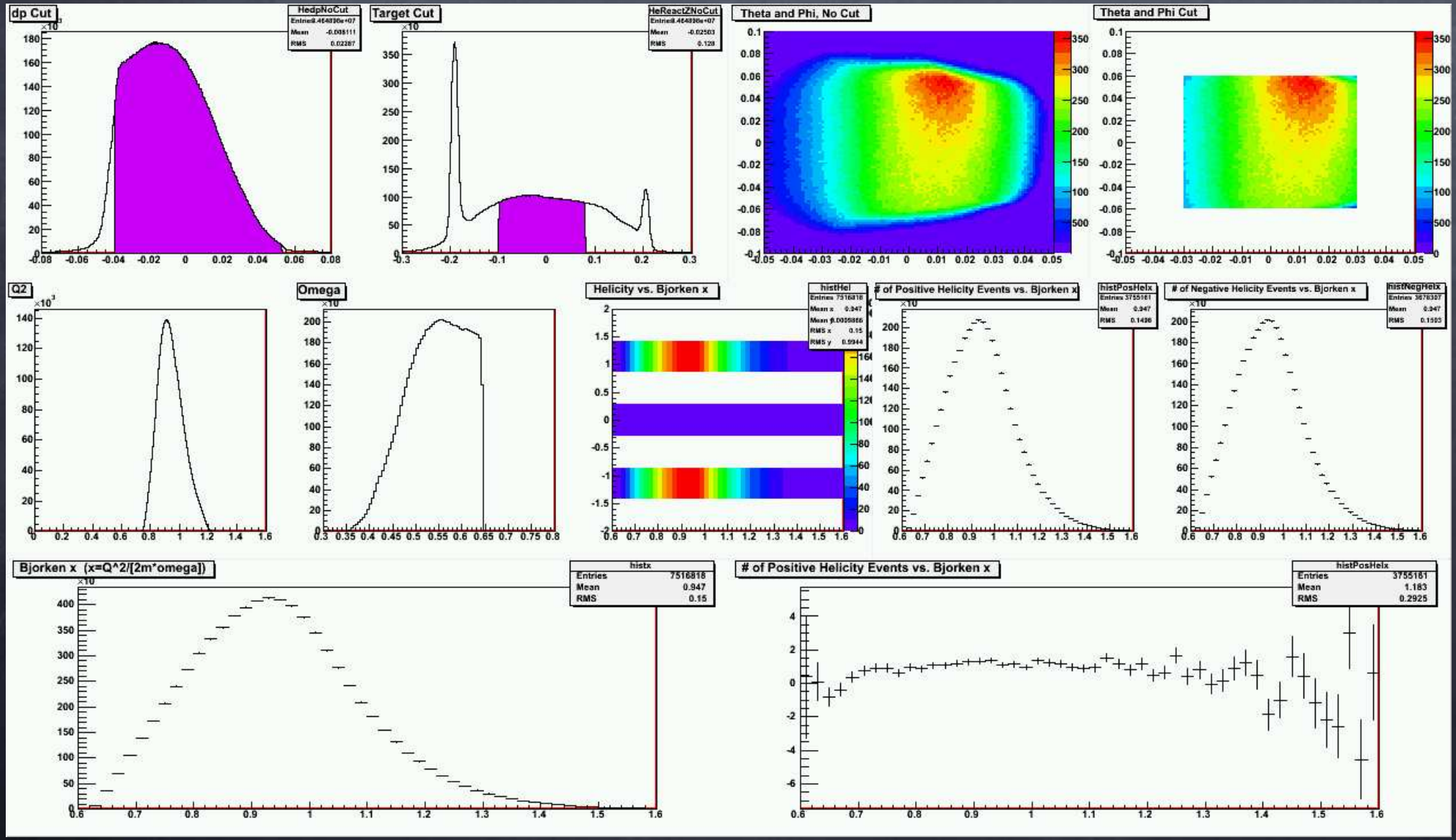
Analysis: Raw Asymmetries

- Raw Beam Asymmetry @ Q^2=1 $(GeV/c)^2$
  Longitudinal $^3He(e,e')$



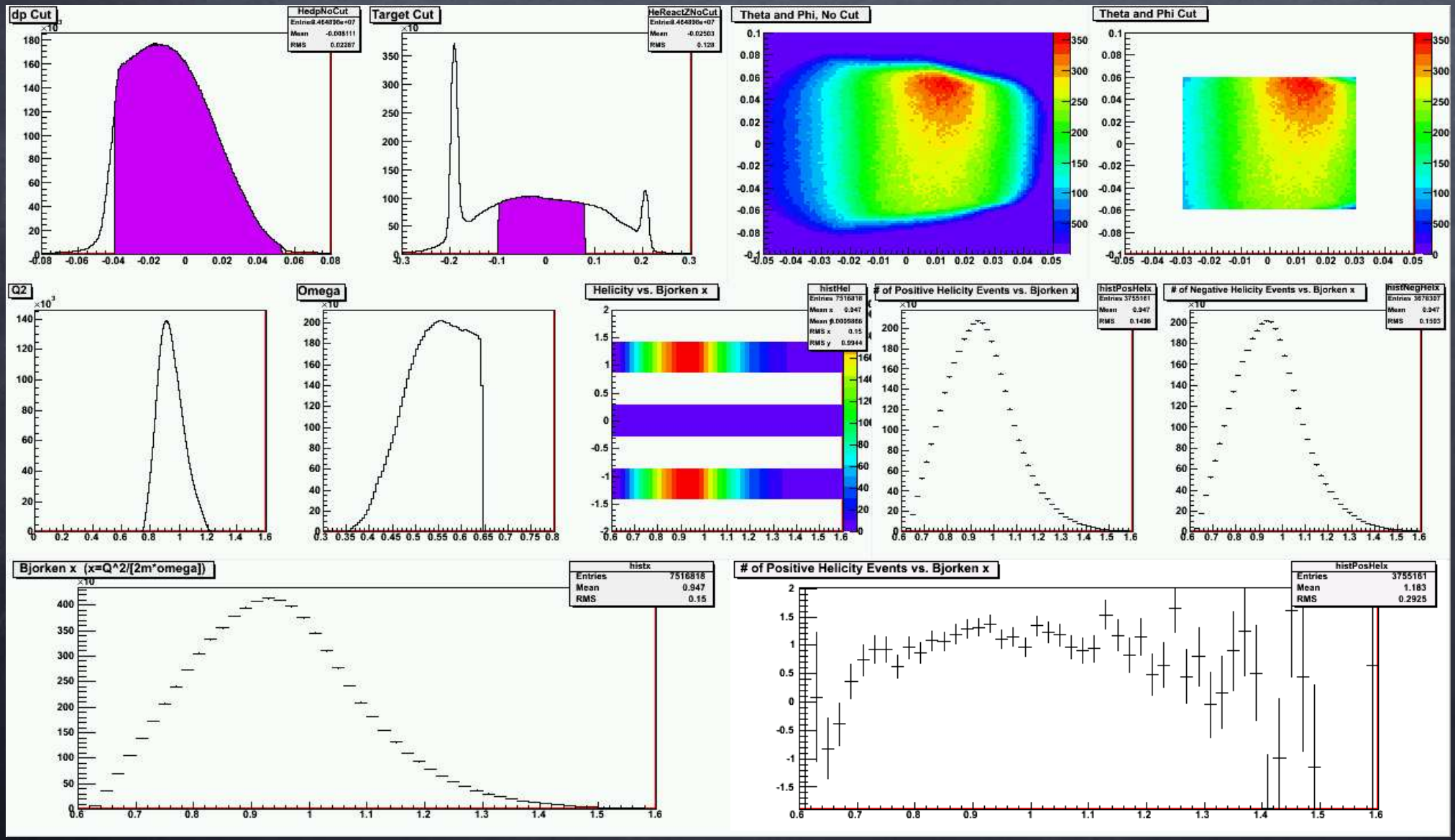
Analysis: Raw Asymmetries

- Raw Beam Asymmetry @ Q^2=1 $(GeV/c)^2$
  Transverse $^3He(e,e')$



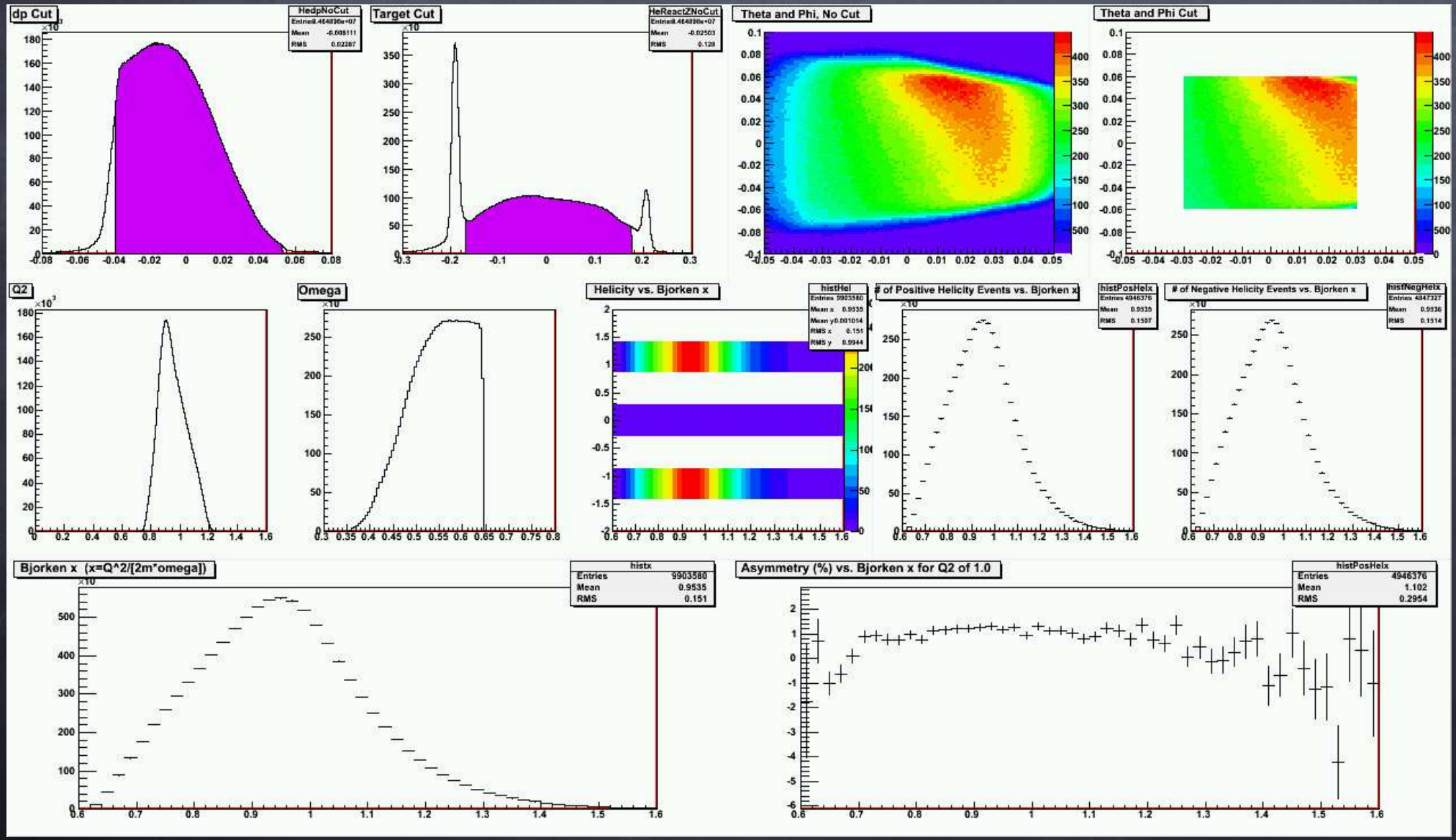
Analysis: Raw Asymmetries

- Raw Beam Asymmetry @ Q^2=1 $(GeV/c)^2$
  Transverse $^3He(e,e')$



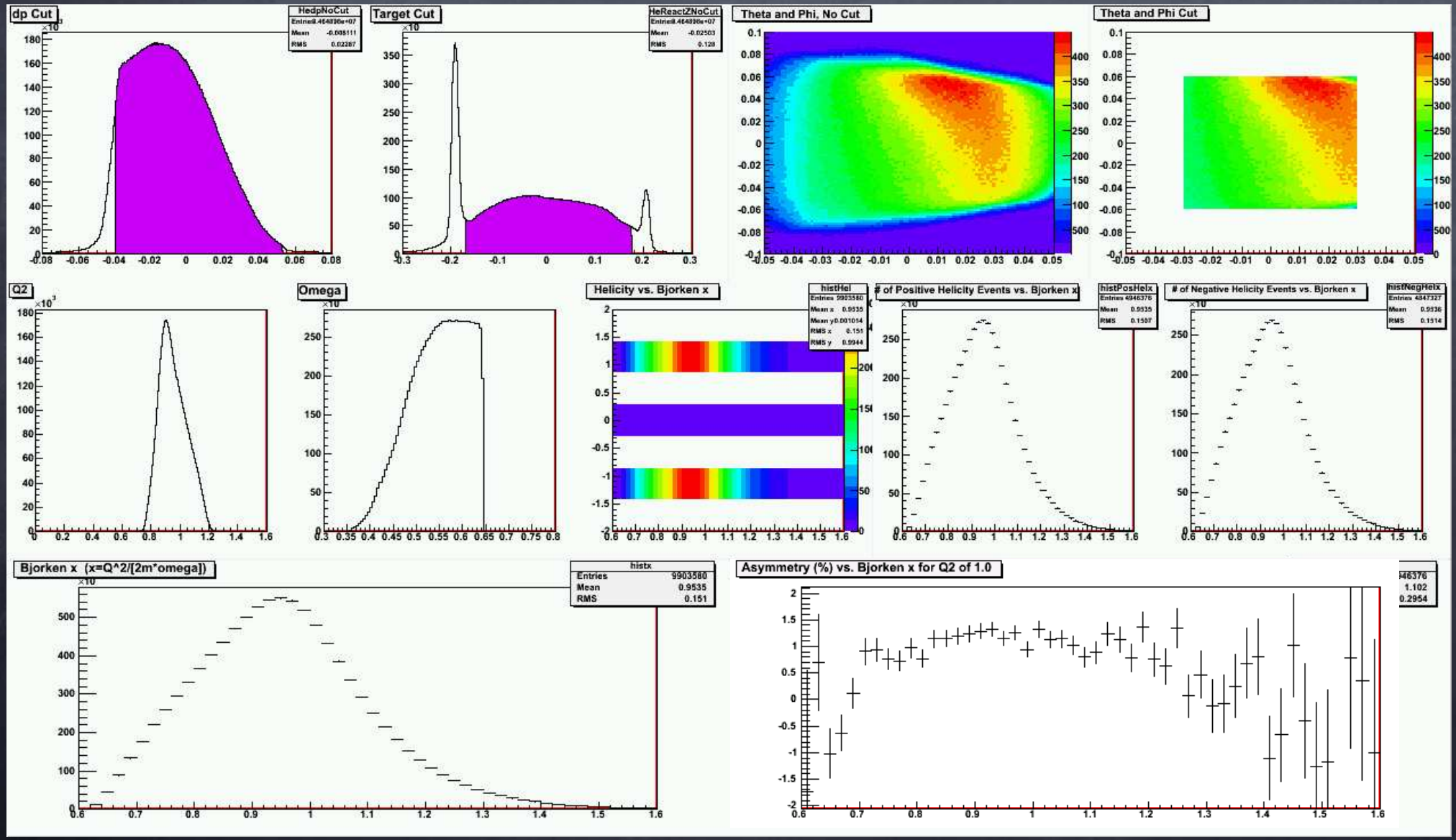
Analysis: Raw Asymmetries

- Raw Beam Asymmetry @ Q^2=1 $(GeV/c)^2$
  Transverse $^3He(e,e')$



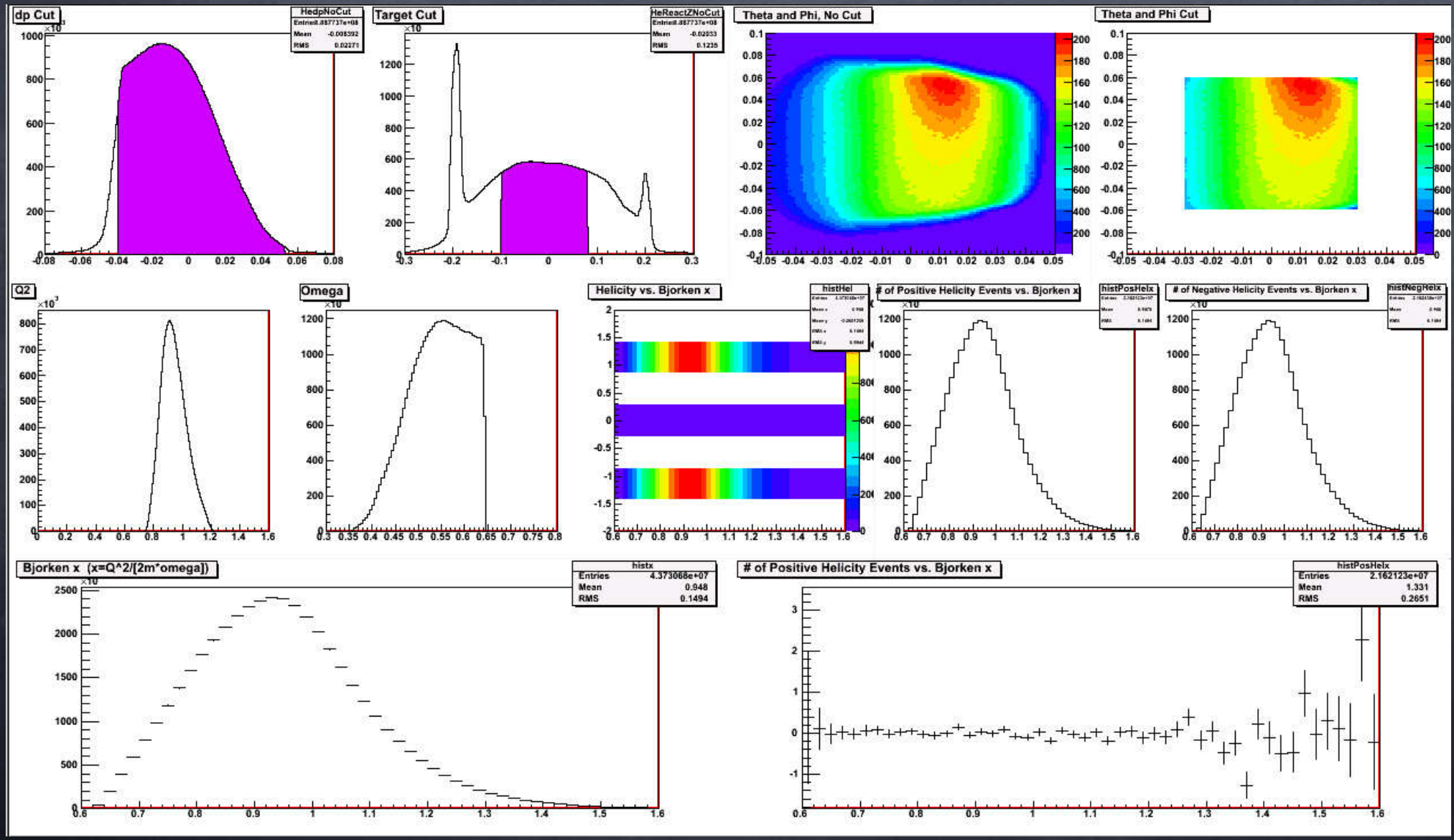
Analysis: Raw Asymmetries

- Raw Beam Asymmetry @ Q^2=1 $(GeV/c)^2$
  Transverse $^3He(e,e')$



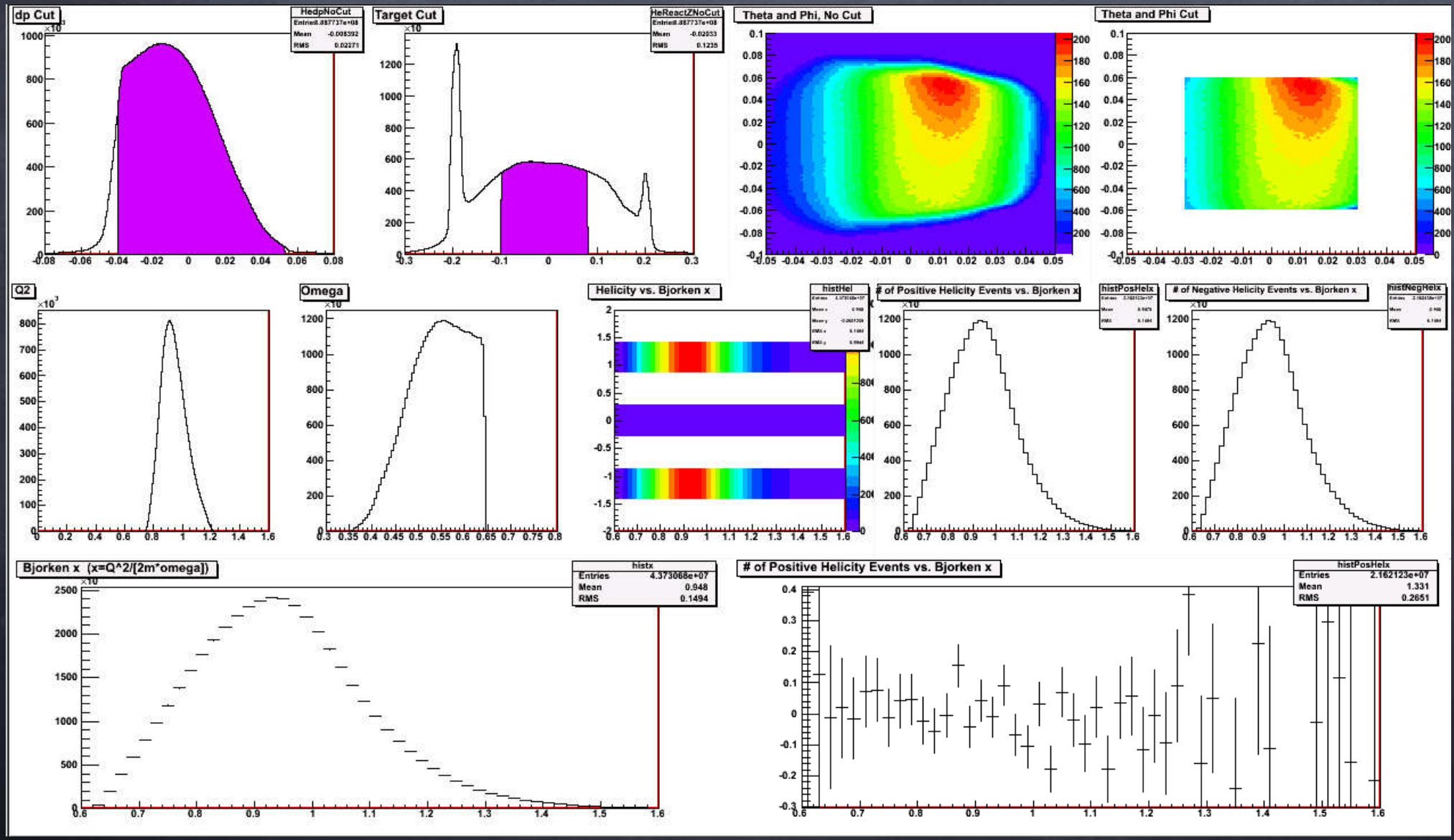
Analysis: Raw Asymmetries

- Raw Beam Asymmetry @ Q^2=1 $(GeV/c)^2$
  Vertical $^3He(e,e')$



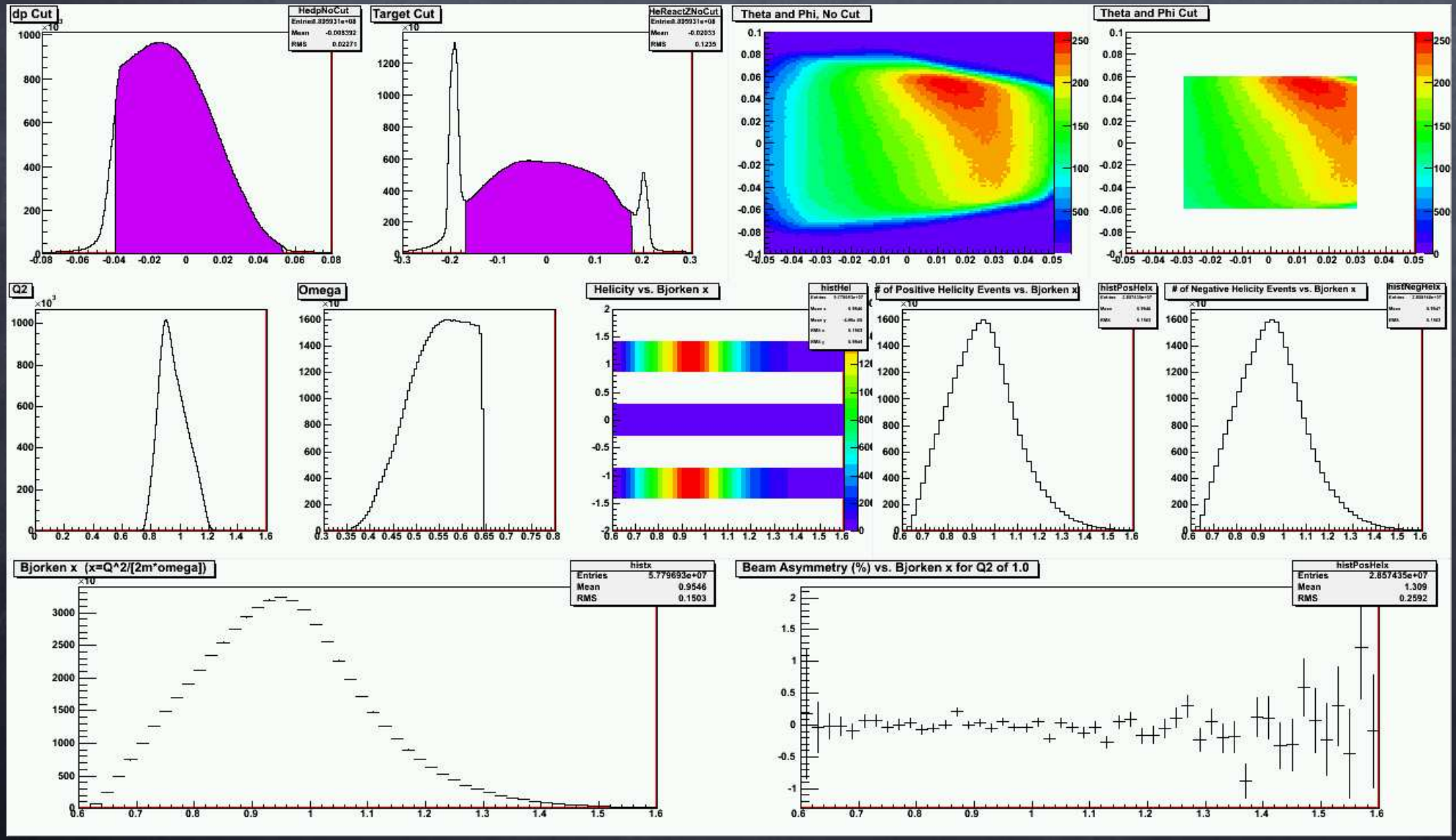
Analysis: Raw Asymmetries

- Raw Beam Asymmetry @ Q^2=1 $(GeV/c)^2$
  Vertical $^3He(e,e')$



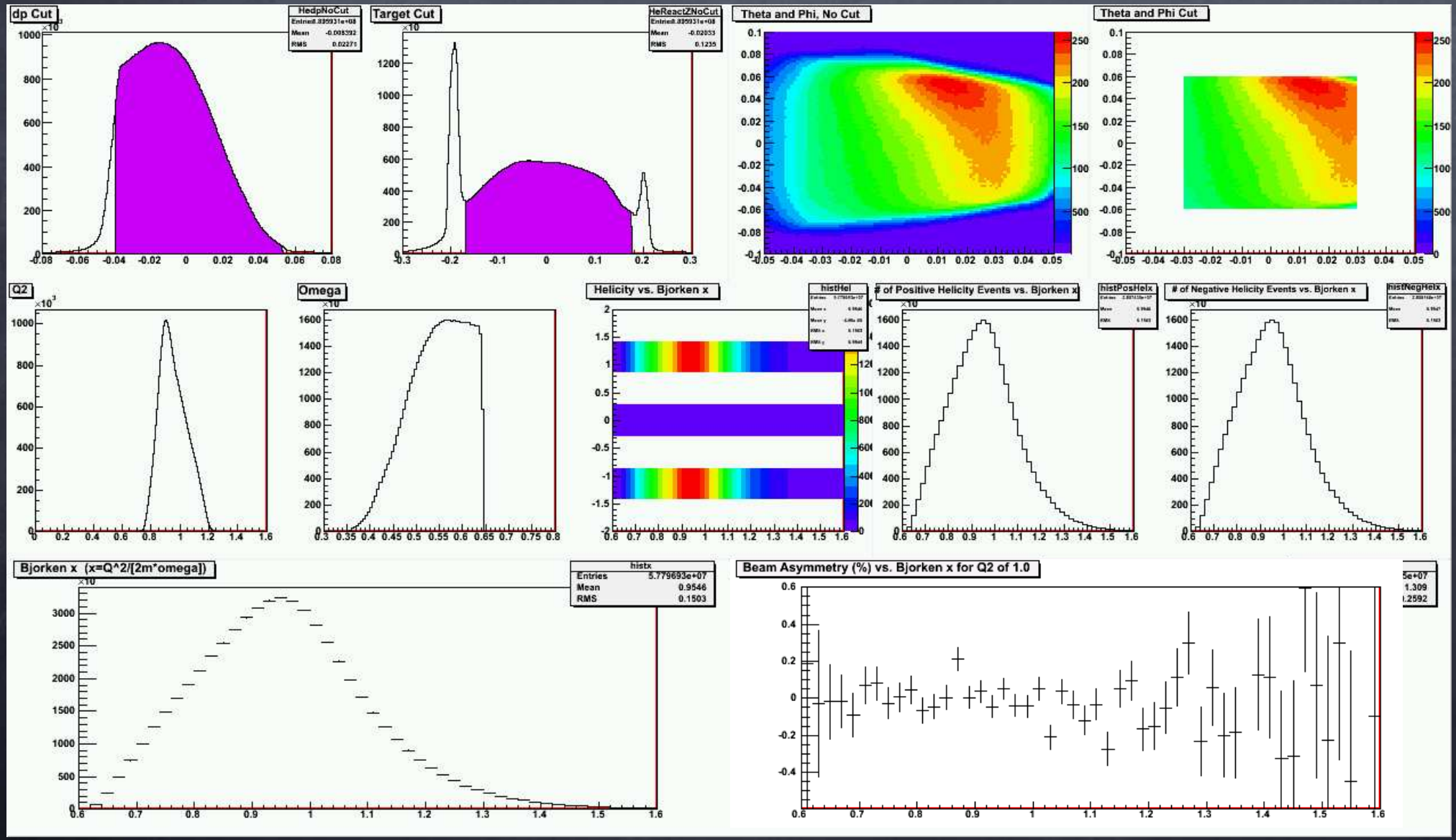
Analysis: Raw Asymmetries

- Raw Beam Asymmetry @ Q^2=1 $(GeV/c)^2$
  Vertical $^3He(e,e')$



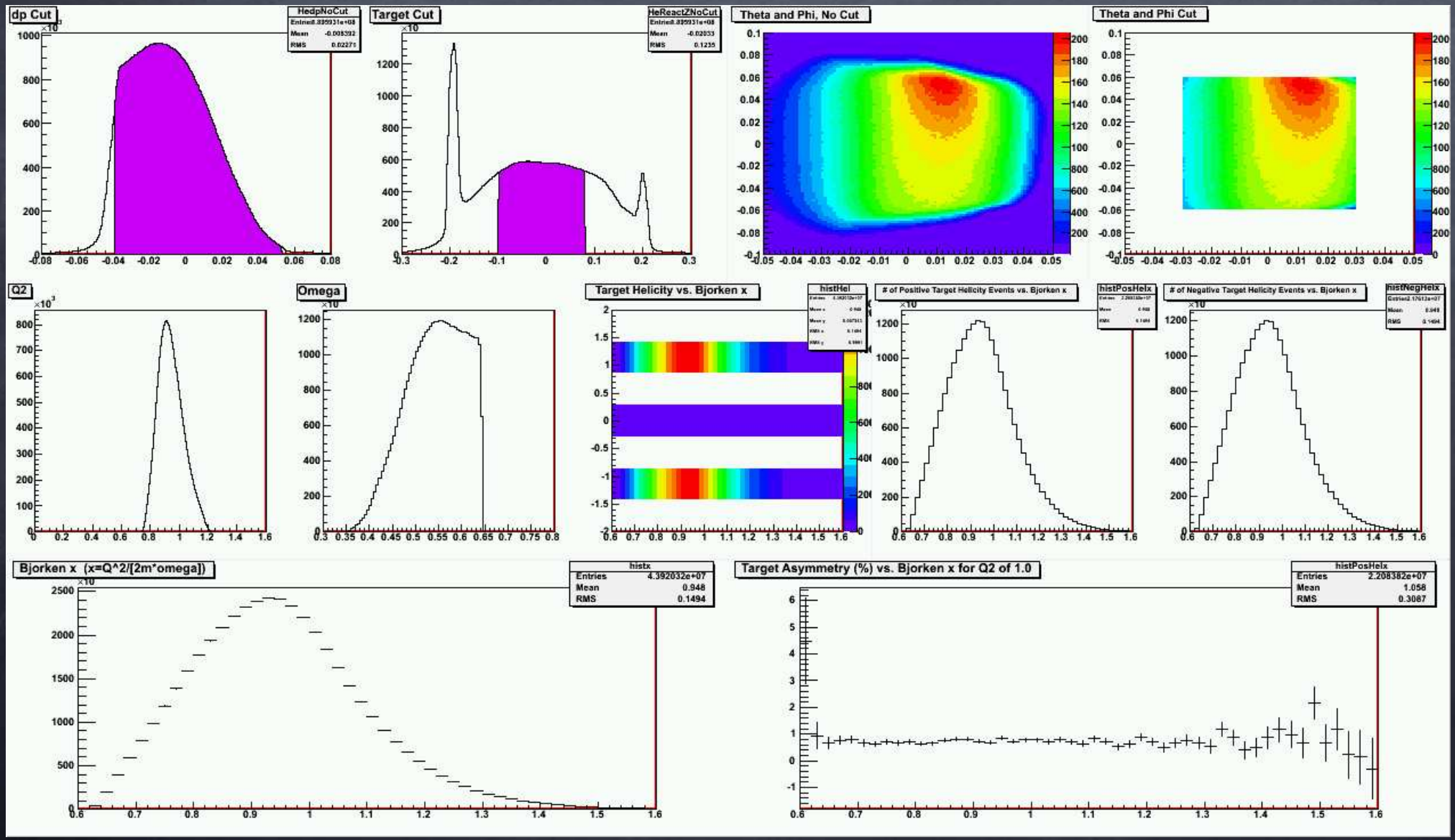
Analysis: Raw Asymmetries

- Raw Beam Asymmetry @ Q^2=1 $(GeV/c)^2$
  Vertical $^3He(e,e')$



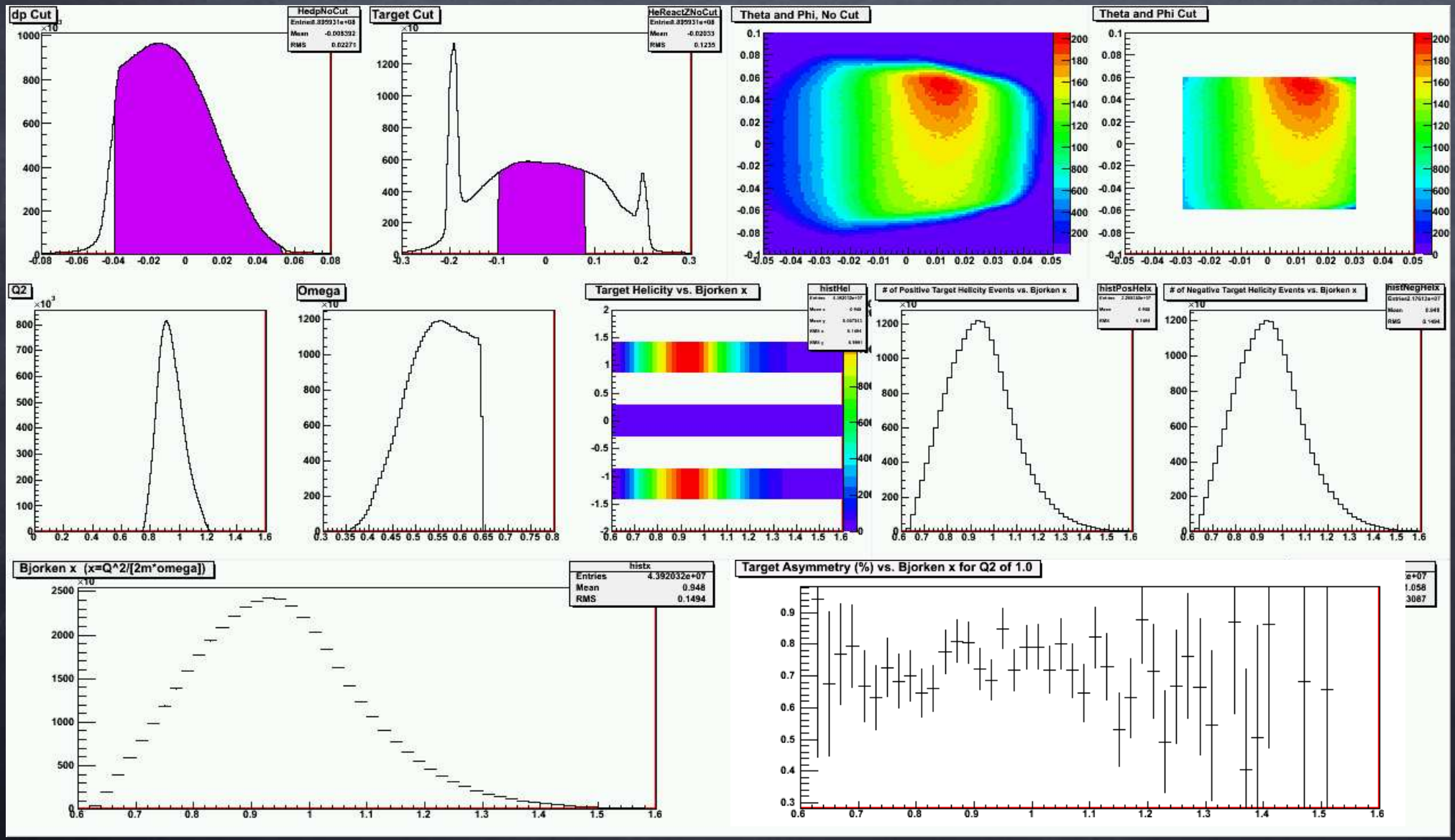
Analysis: Raw Asymmetries

- Raw Target Asymmetry @ Q^2=1 (GeV/c)^2
  Vertical ^{3}He(e,e′)



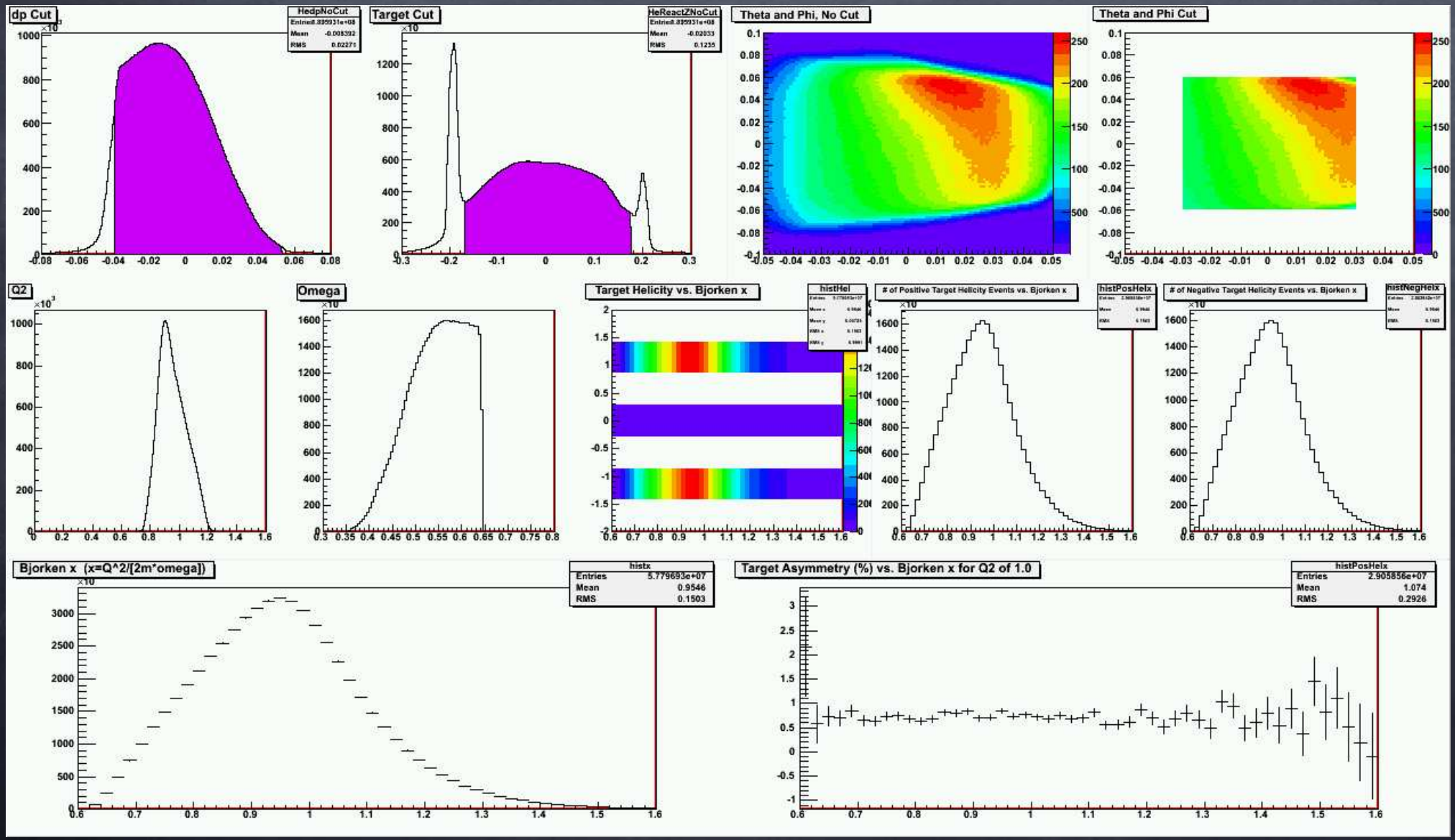
Analysis: Raw Asymmetries

- Raw Target Asymmetry @ Q^2=1 (GeV/c)^2
  Vertical ^{3}He(e,e′)



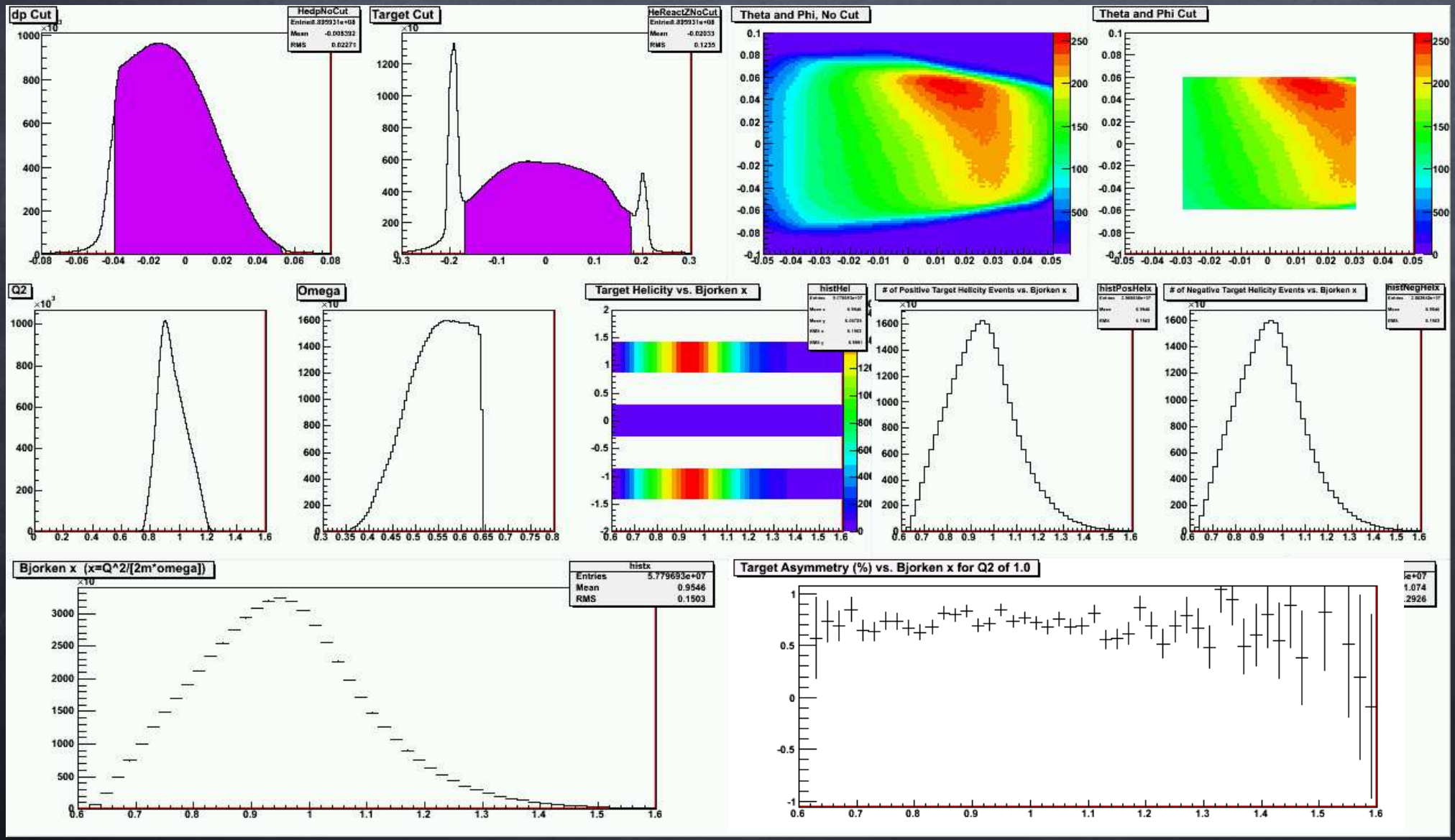
Analysis: Raw Asymmetries

- Raw Target Asymmetry @ Q^2=1 (GeV/c)^2
  Vertical ^{3}He(e,e′)



Analysis: Raw Asymmetries

- Raw Target Asymmetry @ Q^2=1 $(GeV/c)^2$
  Vertical $^3He(e,e')$



Where We Are

- HRS optics have been calibrated
- x_{Bj} and raw ^{3}He(e,e′) asymmetries coming in for Q^2=1.0 GeV on Vertical, Longitudinal, and Transverse ^{3}He
- Information on target thickness coming in

Where We're Going

- Get inclusive asymmetries for Q^2=0.1 and 0.5 GeV
- Continue cleaning up the data
- HAND calibration
- Find ^{3}He(e,e'n) asymmetries

Thank to the Hall A Quasi-Elastic Family of Experiments

E05-015, E08-005, and E05-102

Spokepersons

T. Averett, College of William and Mary (E05-015, E08-05)
J. P. Chen, Thomas Jefferson National Accelerator Facility (E05-015)
S. Gilad, Massachusetts Institute of Technology (E05-102)
D. Higinbotham, Thomas Jefferson National Accelerator Facility (E05-102, E08-005)
X. Jiang, Rutgers University (E05-015)
W. Korsch, University of Kentucky (E05-102)
B. E. Norum, University of Virginia (E05-102)
S. Širca, University of Ljubljana (E05-102)
V. Sulkosky, Thomas Jefferson National Accelerator Facility (E08-005)

Graduate Students

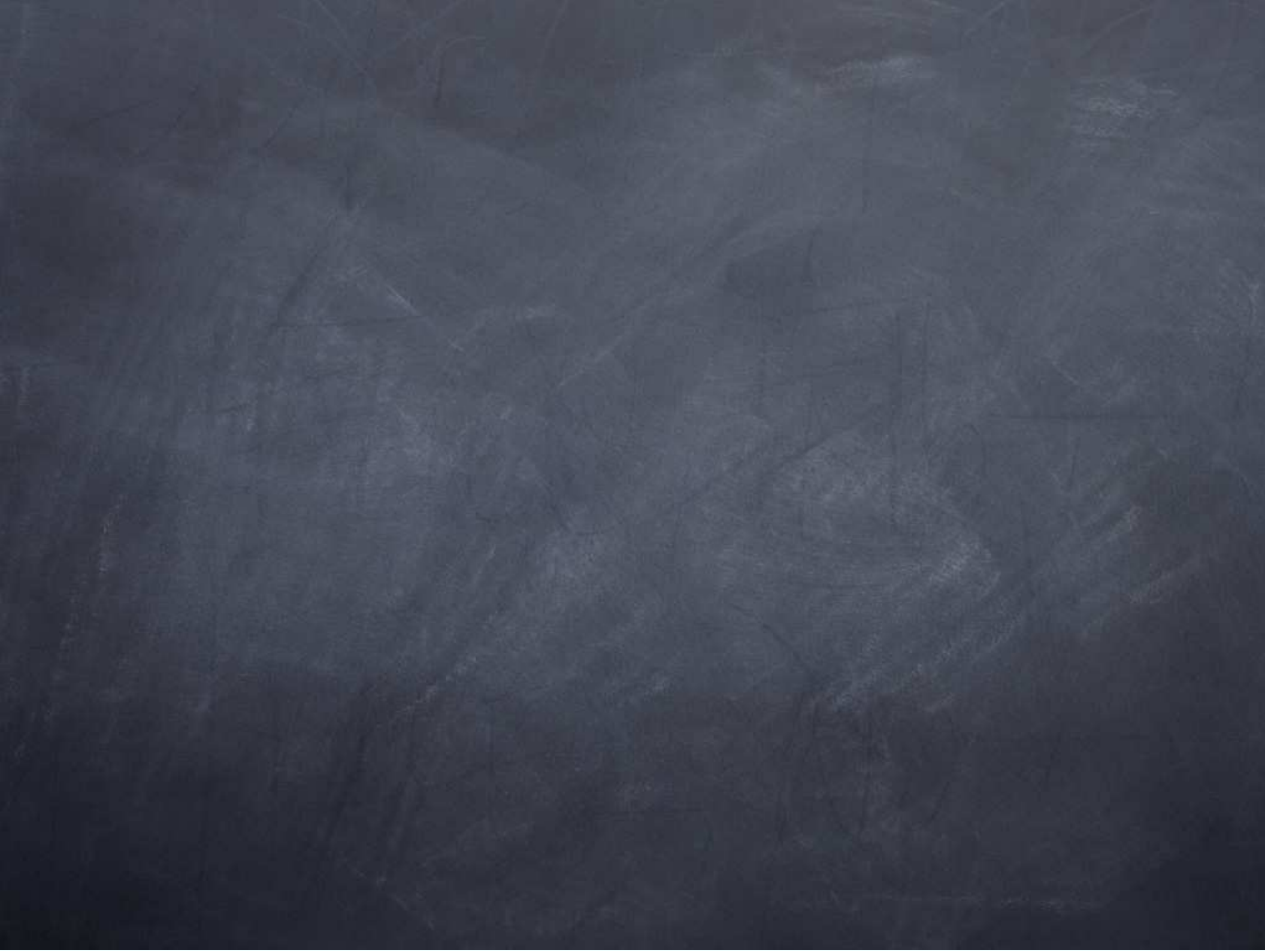
G. Jin, University of Virginia
E. Long, Kent State University
M. Mihovilovič, Jožef Stefan Institute
Y. Zhang, Lanzhou University

Run Coordinators

A. Camsonne, Thomas Jefferson National Accelerator Facility
P. Monaghan, Hampton University
S. Riordan, University of Virginia
B. Sawatzky, Temple University
R. Subedi, University of Virginia
V. Sulkosky, Massachusetts Institute of Technology
Y. Qiang, Duke University
B. Zhao, College of William and Mary

Collaboration

K. Allada
B. Anderson
J. R. M. Annand
W. Boeglin
P. Bradshaw
M. Canan
C. Chen
R. De Leo
X. Deng
A. Deur
C. Dutta
L. El Fassi
D. Flay
F. Garibaldi
H. Gao
R. Gilman
S. Golge
O. Hansen
T. Holmstrom
J. Huang
H. Ibrahim
E. Jensen
M. Jones
H. Kang
J. Katich
C. W. Kees
P. King
J. LeRose
R. Lindgren
H. Lu
W. Luo
P. Markowitz
M. Meziane
R. Michaels
B. Moffit
N. Muangma
H. P. Khanal
K. Pan
D. Parno
E. Piasetzky
P. Pradshaw
M. Posik
A. J. R. Puckett
X. Qian
X. Qui
A. Saha
F. Salvatore
M. Shabestari
A. Shahinyan
B. Shoenrock
J. St. John
A. Tobias
W. Tireman
G. M. Urciuoli
D. Wang
K. Wang
J. Watson
B. Wojtsekhowski
Z. Ye
X. Zhan
X. Zheng
L. Zhu



Extra Slides

Analysis: Target Thickness Measurements

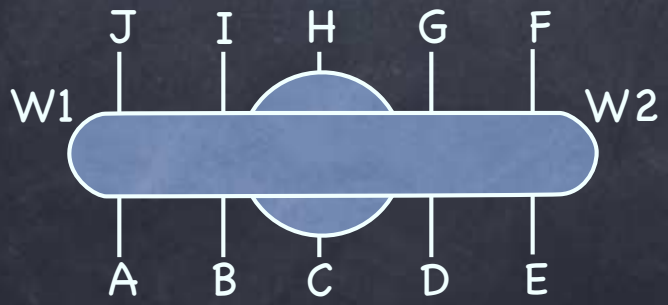
^{3}He Cell: Dominic

Points	Position (cm)	Incident Angle (°)	Fitting Results (mm)	UVA Results (mm)
A	4->W1	3.0	1.691	1.55
B	11.5->W1	6.5	1.702	1.62
C	19->W1	6.5	1.716	1.64
D	28->W1	8.5	1.691	1.67
E	35.5->W1	11.5	1.656	1.67
F	3.5->W2	8.0	1.598	1.62
G	11.5->W2	7.0	1.710	1.72
H	20.5->W2	8.5	1.695	1.63
I	29->W2	9.0	1.662	1.63
J	35.5->W2	8.0	1.654	1.75
W1	---	16.0	0.139	0.132
W2	---	17.5	0.154	0.150

^{3}He Cell: Moss

Points	Position (cm)	Incident Angle (°)	Fitting Results (mm)	UVA Results (mm)
A	3.5->W1	8.5	1.691	1.61
B	11.5->W1	10.5	1.702	1.58
C	19.5->W1	11.0	1.716	1.64
D	27.5->W1	11.0	1.691	1.59
E	36->W1	8.5	1.656	1.68
F	3.5->W2	7.5	1.598	1.68
G	11->W2	10.0	1.710	1.62
H	20->W2	6.5	1.651	1.66
I	28->W2	6.0	1.596	1.58
J	36->W2	6.5	1.679	1.67
W1	---	14.0	0.134	0.131
W2	---	16.0	0.149	0.150

Preliminary



Work done by Yawei