

E08-005 Quasi-Elastic ${}^3\text{He}^\uparrow(e,e'n)$ Single Spin Asymmetry

Elena Long
Hall A Collaboration Meeting
December 9th, 2010

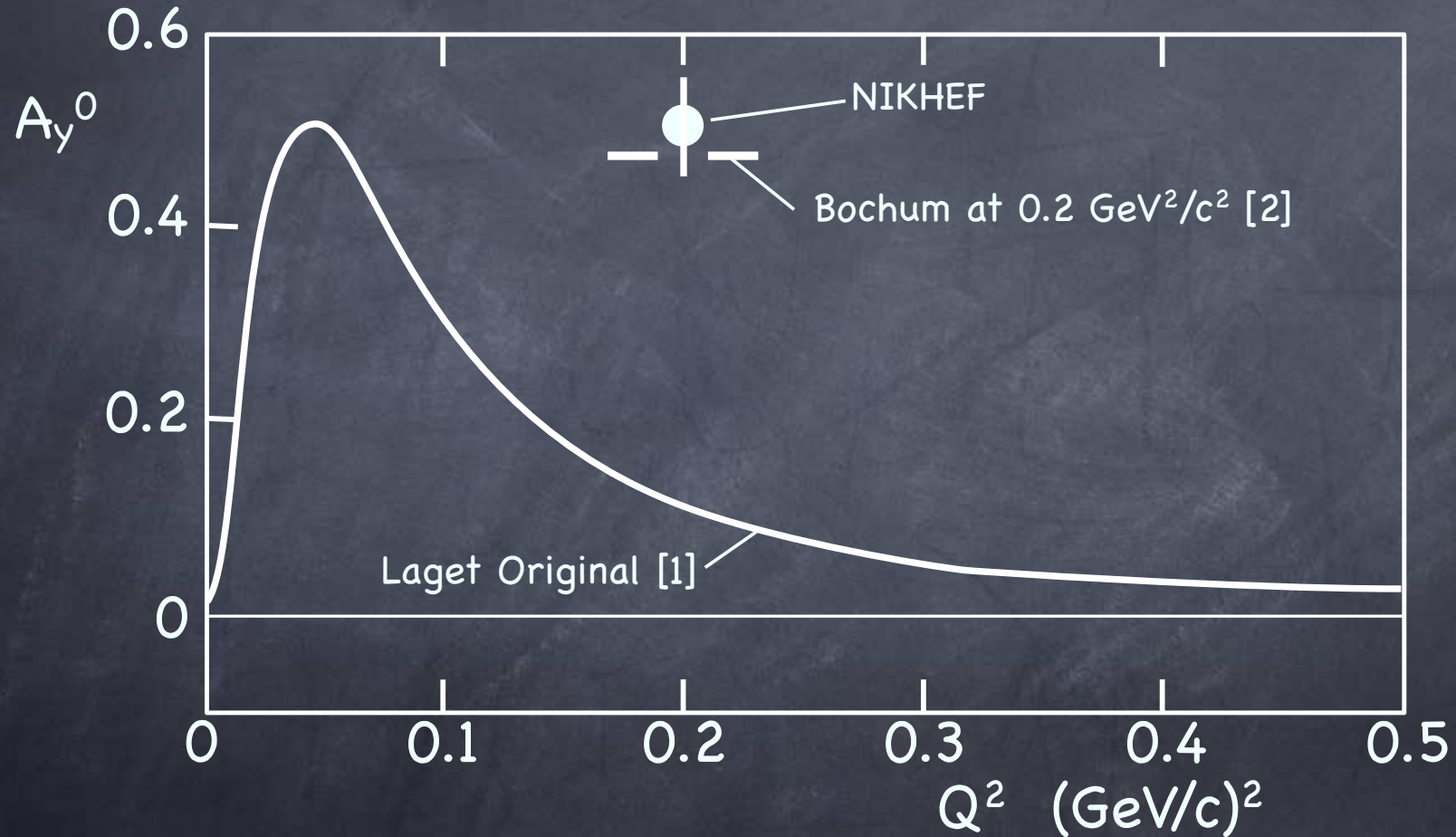
Outline

- What are we doing?
 - Details of what we're looking for from E08-005
- What's been done?
 - Experiment set-up and analysis so far
- Where are we going?
 - Analysis that has yet to be done

What are we doing?

- In PWIA, A_y in Quasi-Elastic ${}^3\text{He}^\uparrow(e,e'n)$ is exactly zero
- Previous to this experiment, no measurements of A_y have been done at large Q^2
- We will analyze high precision data points taken at 0.1 $[\text{GeV}/c]^2$, 0.5 $[\text{GeV}/c]^2$, and 1.0 $[\text{GeV}/c]^2$
- Previous experiment at NIKHEF measured A_y at 0.2 $[\text{GeV}/c]^2$
- Faddeev calculations by Bochum group correctly predicted FSI result where other groups expected a much lower value

What are we doing?



[1] J. M. Laget, Phys. Lett. B273, 367 (1991).

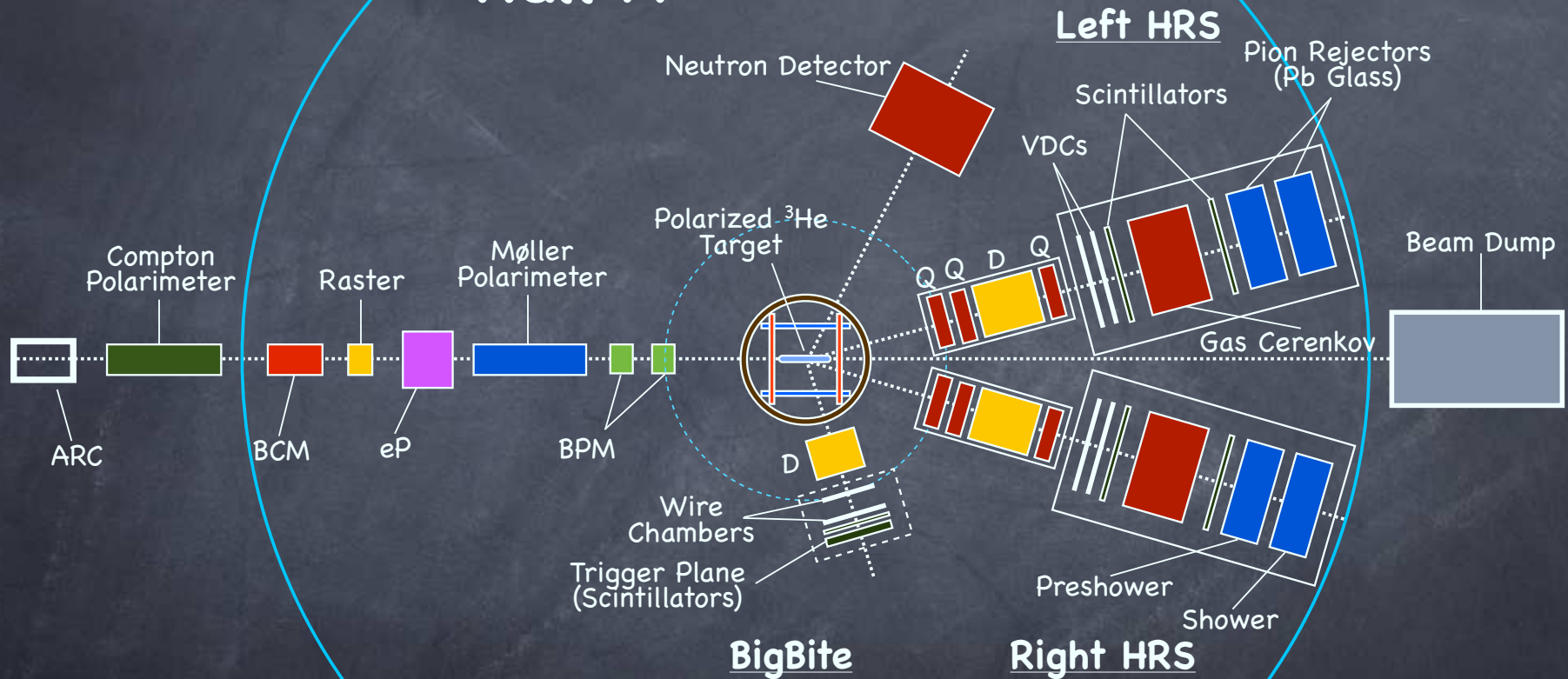
[2] W. Gloeckle, H. Witala, D. Huber, H. Kamada, and J. Golak, Phys. Rept. 274, 107 (1996).

What are we doing?

- 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 ${}^3\overline{\text{He}}(\vec{e}, e'n)$, A_y from ${}^3\text{He}^\uparrow(e, e'n)$ will also be calculated
- At high Q^2 , any non-zero result is indicative of effects beyond impulse approximation

What's been done?

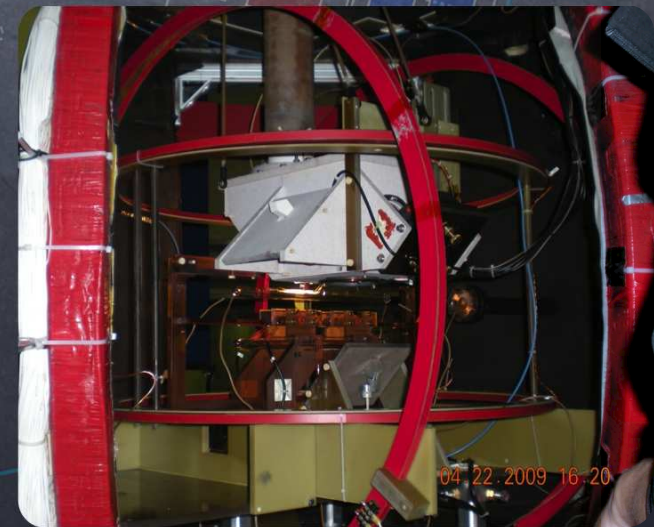
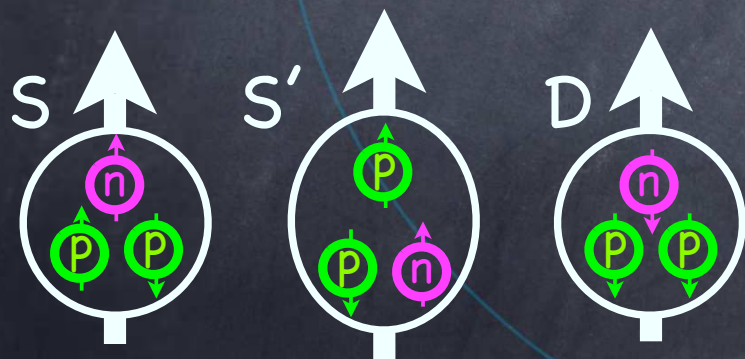
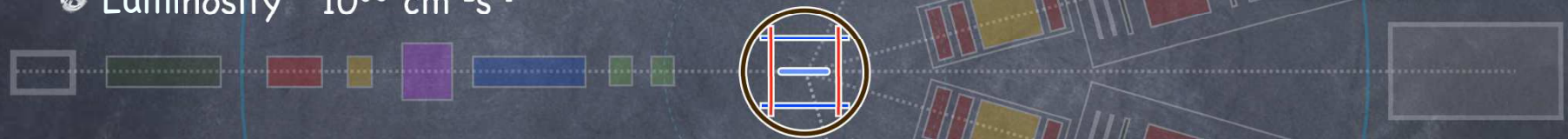
Hall A



What's been done?

Polarized ^3He Target

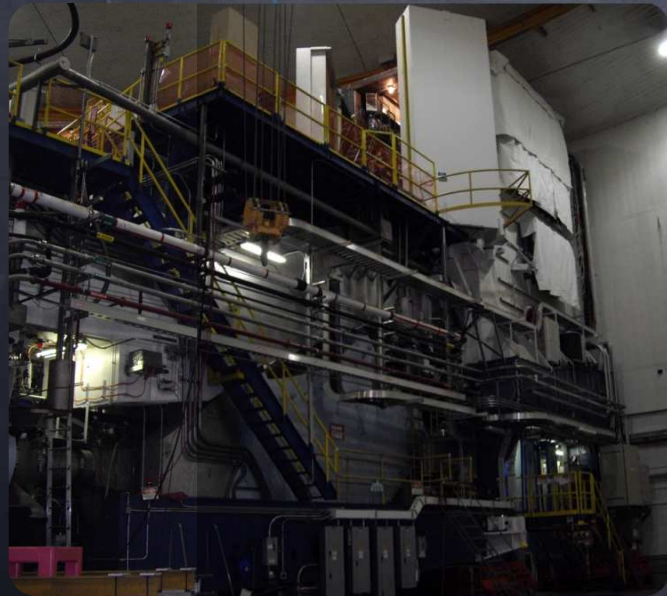
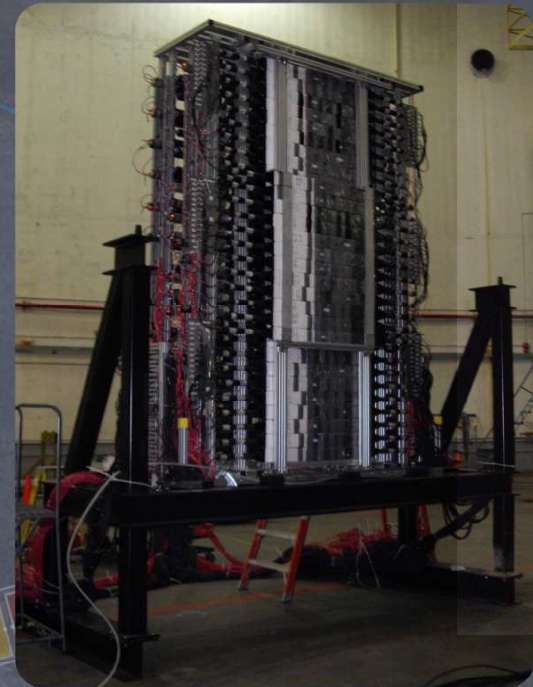
- Optically Pumped Rubidium Vapor used with Potassium to Polarize ^3He via Spin Exchange
- NMR and EPR Measure Polarization
- Polarization was in Vertical Direction
- Can Polarize up to 60%
- Luminosity $\sim 10^{36} \text{ cm}^{-2}\text{s}^{-1}$



What's been done?

Hall A Neutron Detector

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



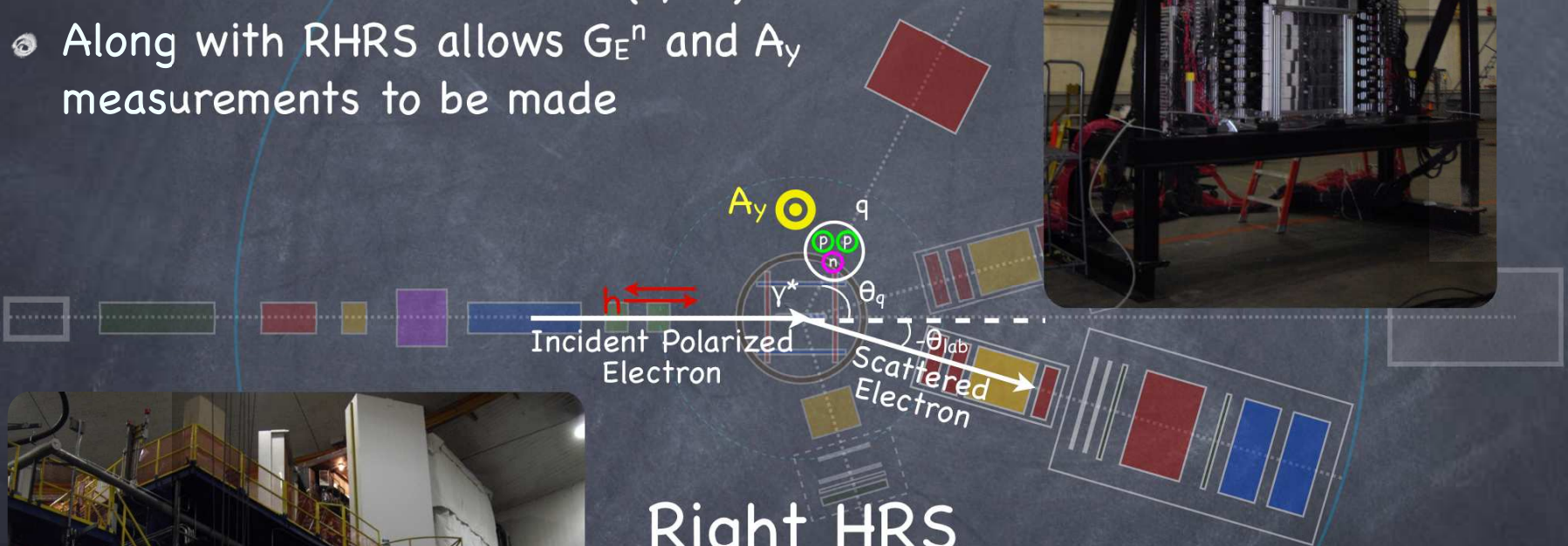
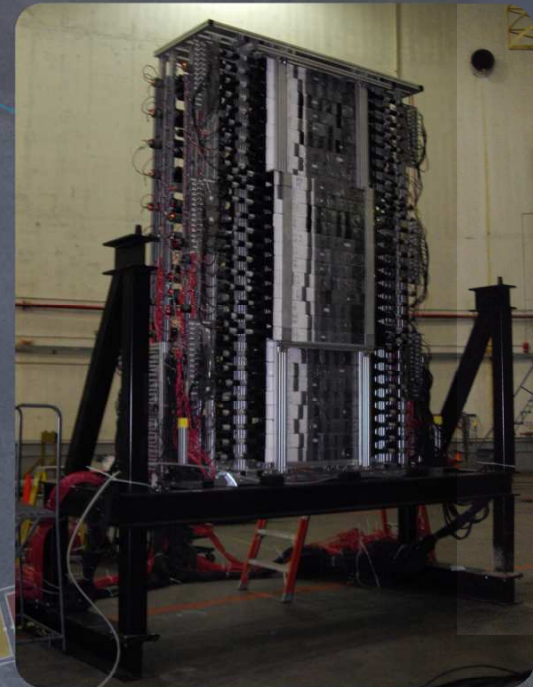
Right HRS

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

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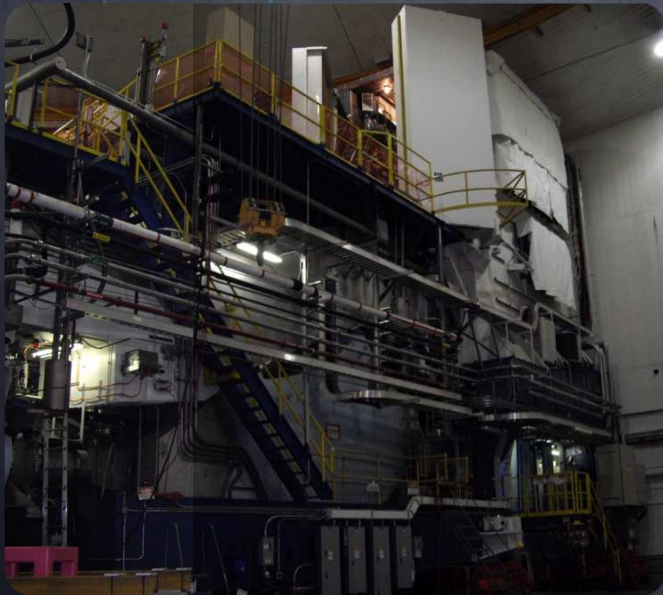
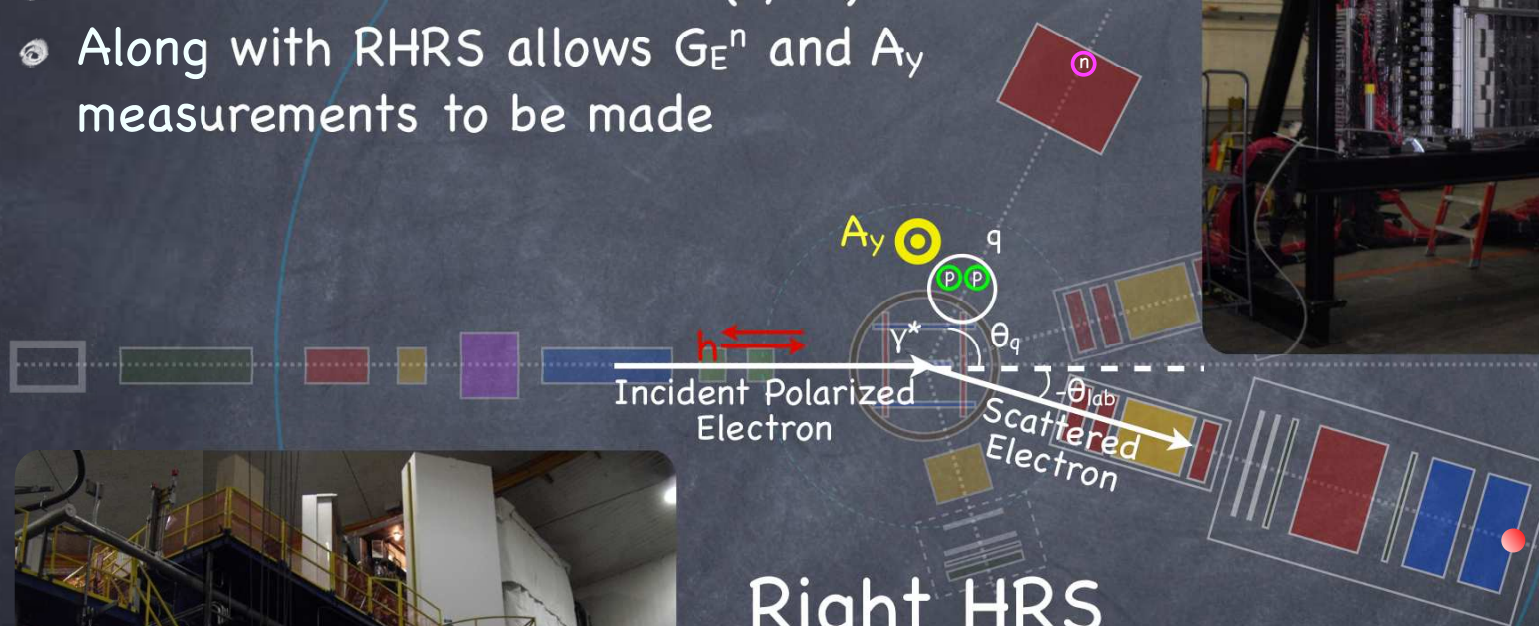
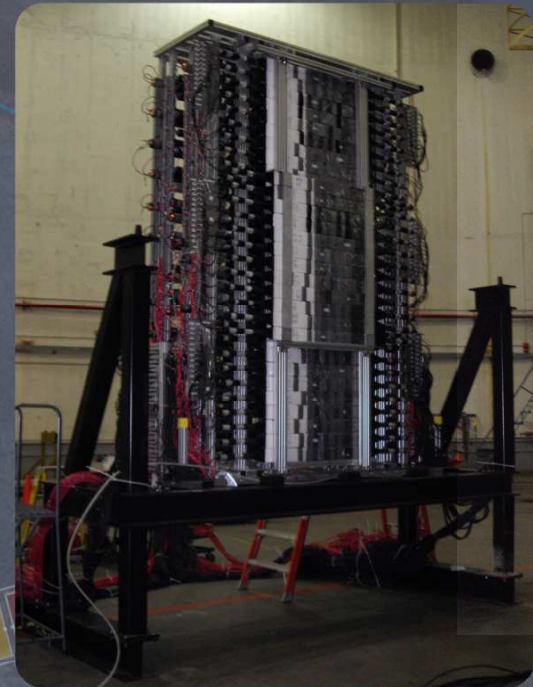
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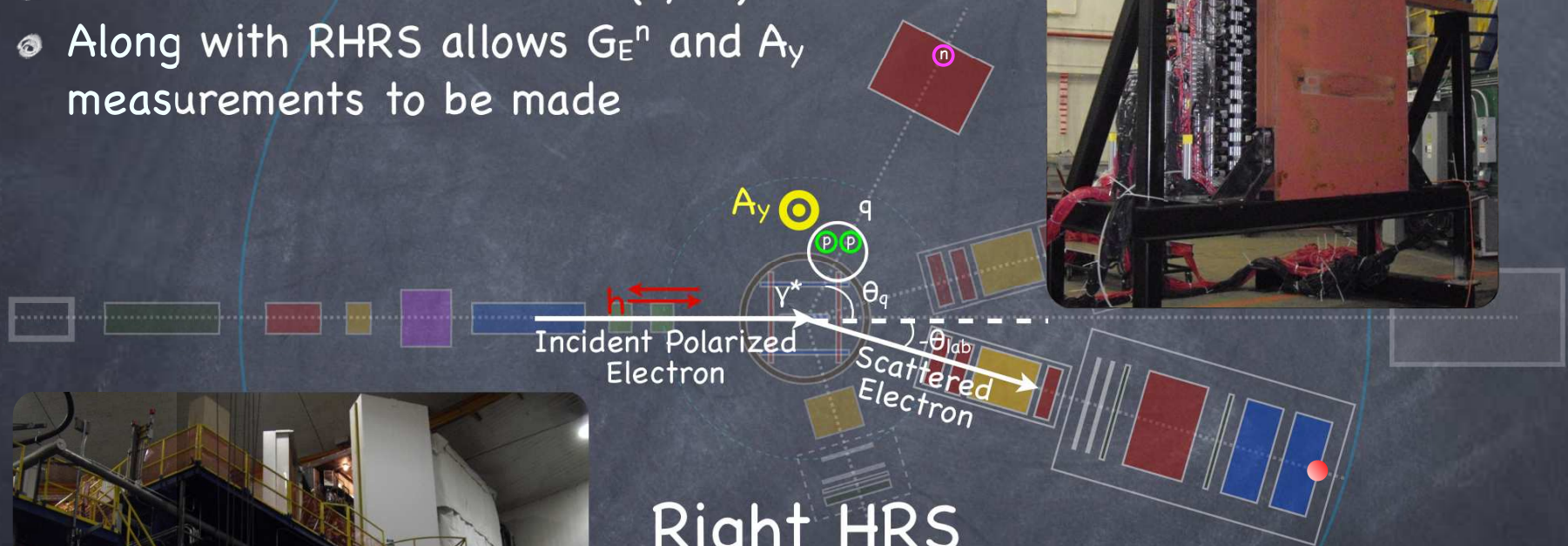
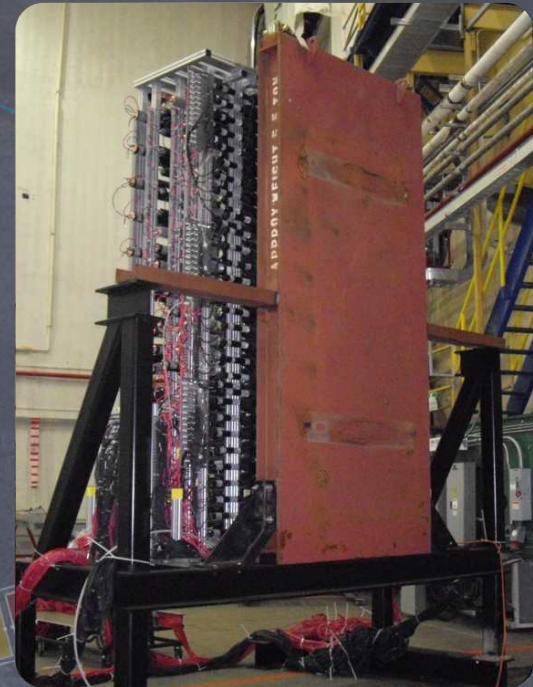
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- With q along beam polarization on ${}^3\text{He}(e,e')$, allows a G_M^n measurement to be made

What's been done?

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

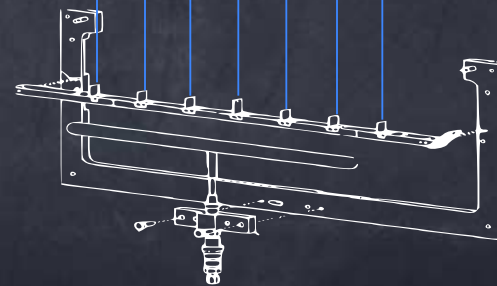
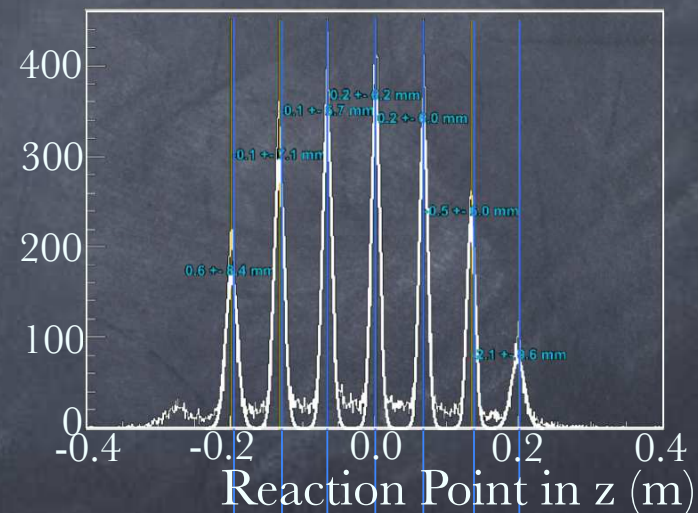
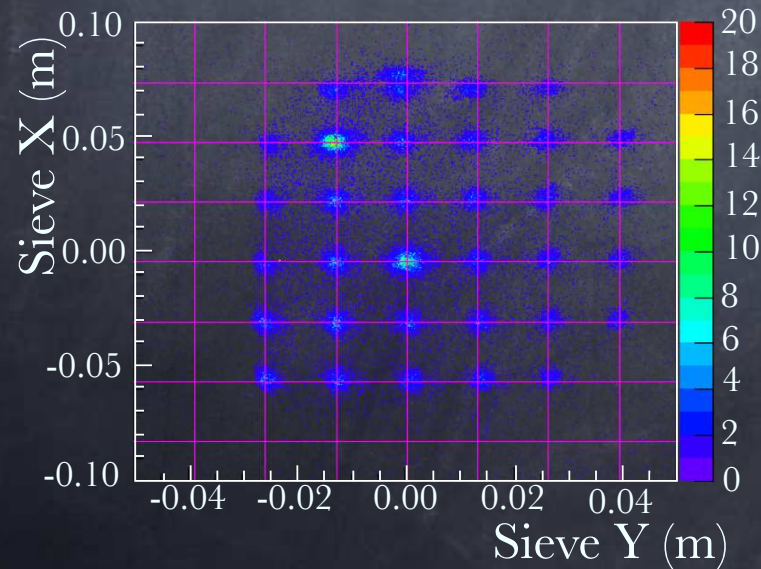
E_0 [GeV]	E' [GeV]	θ_{lab} [°]	Q^2 [GeV/c] ²	$ q $ [GeV/c]	θ_q [°]
1.25	1.22	17.0	0.13	0.359	71.0
2.43	2.18	17.0	0.46	0.681	62.5
3.61	3.09	17.0	0.98	0.988	54.0

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

What's been done?



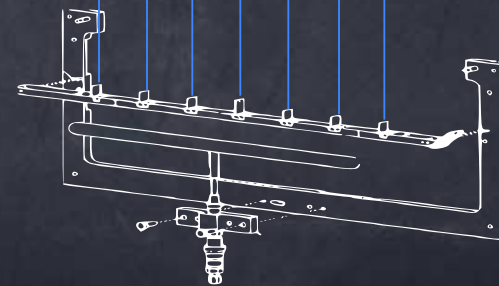
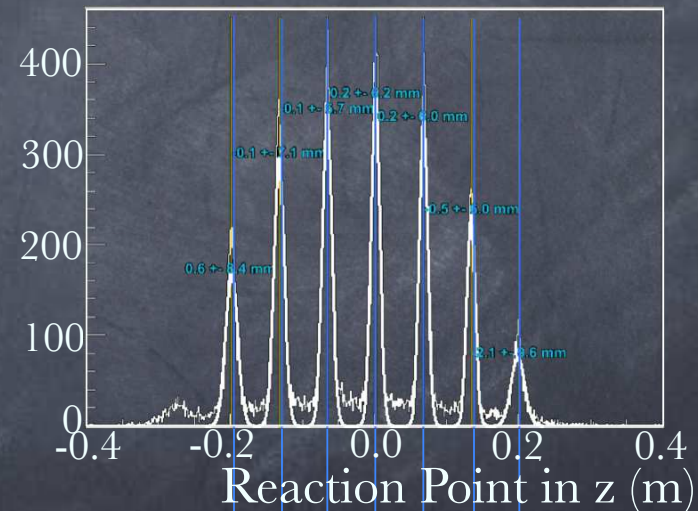
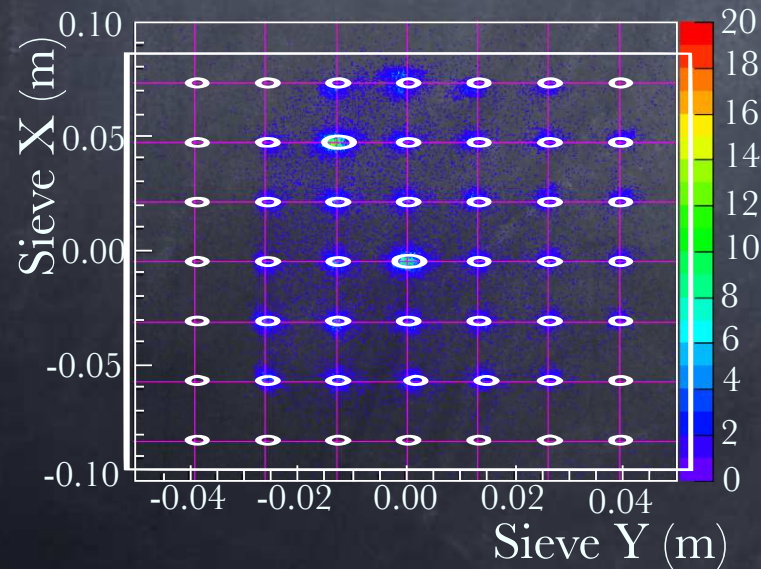
- RHRS optics calibration finished
- See Ge Jin's talk from the 2010 Summer Collaboration meeting (<http://bit.ly/faDudd>)



What's been done?

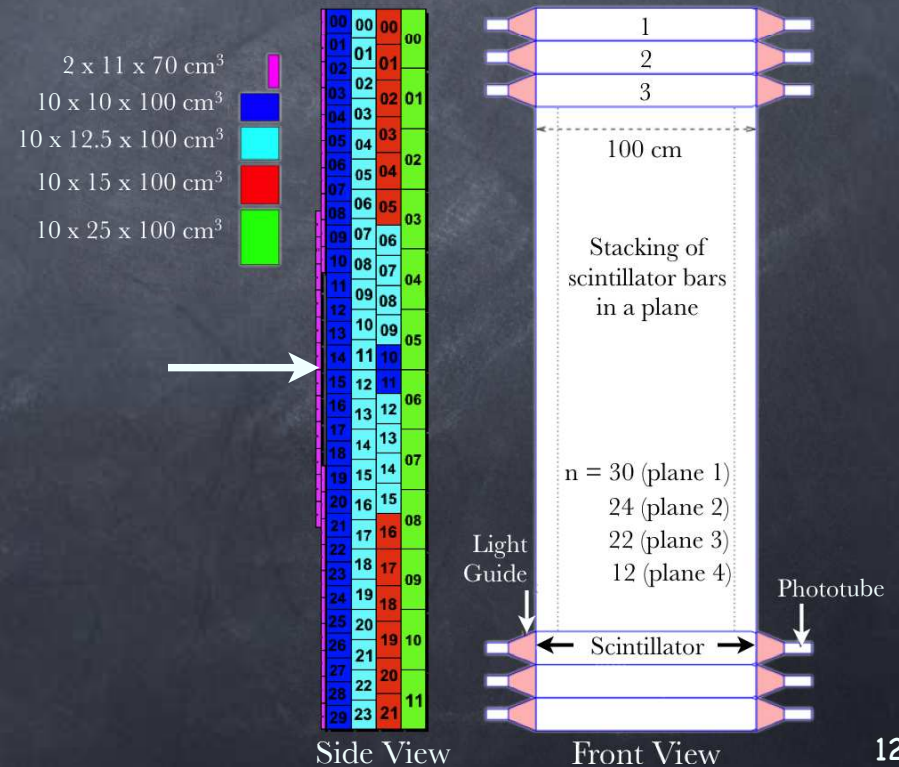
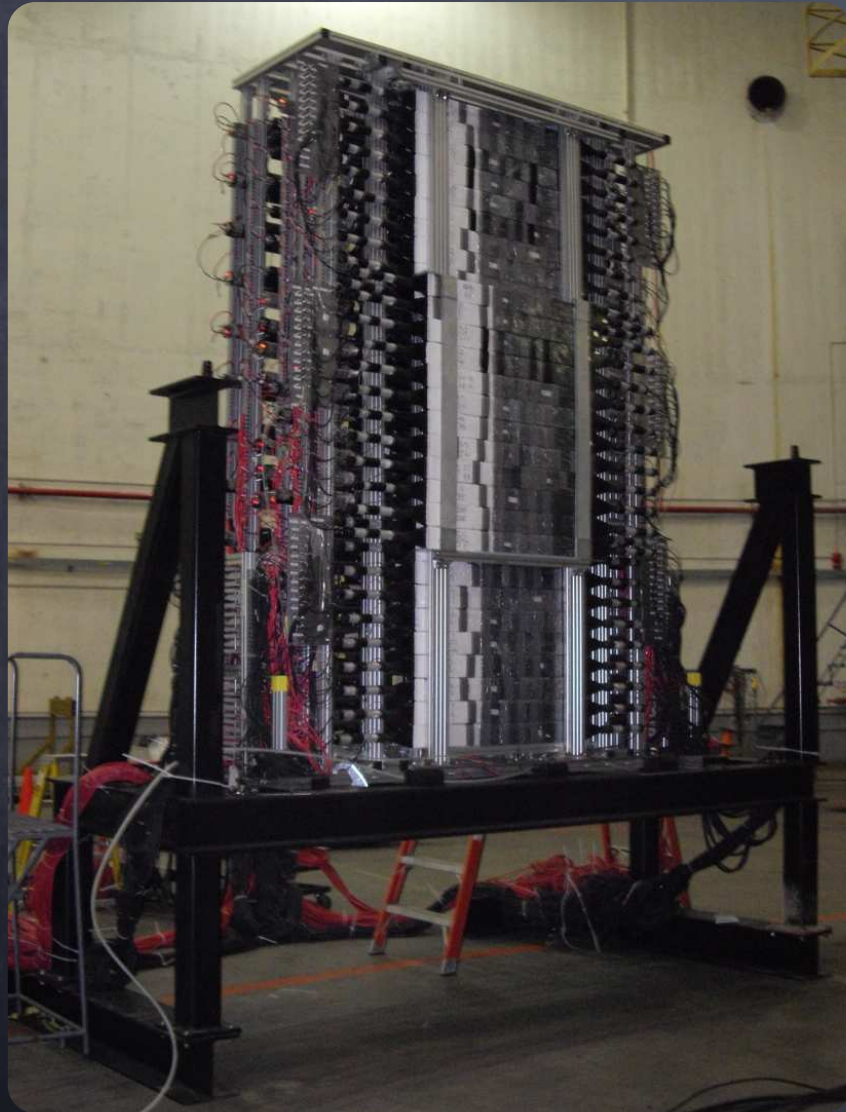


- RHRS optics calibration finished
- See Ge Jin's talk from the 2010 Summer Collaboration meeting (<http://bit.ly/faDudd>)



What's been done?

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



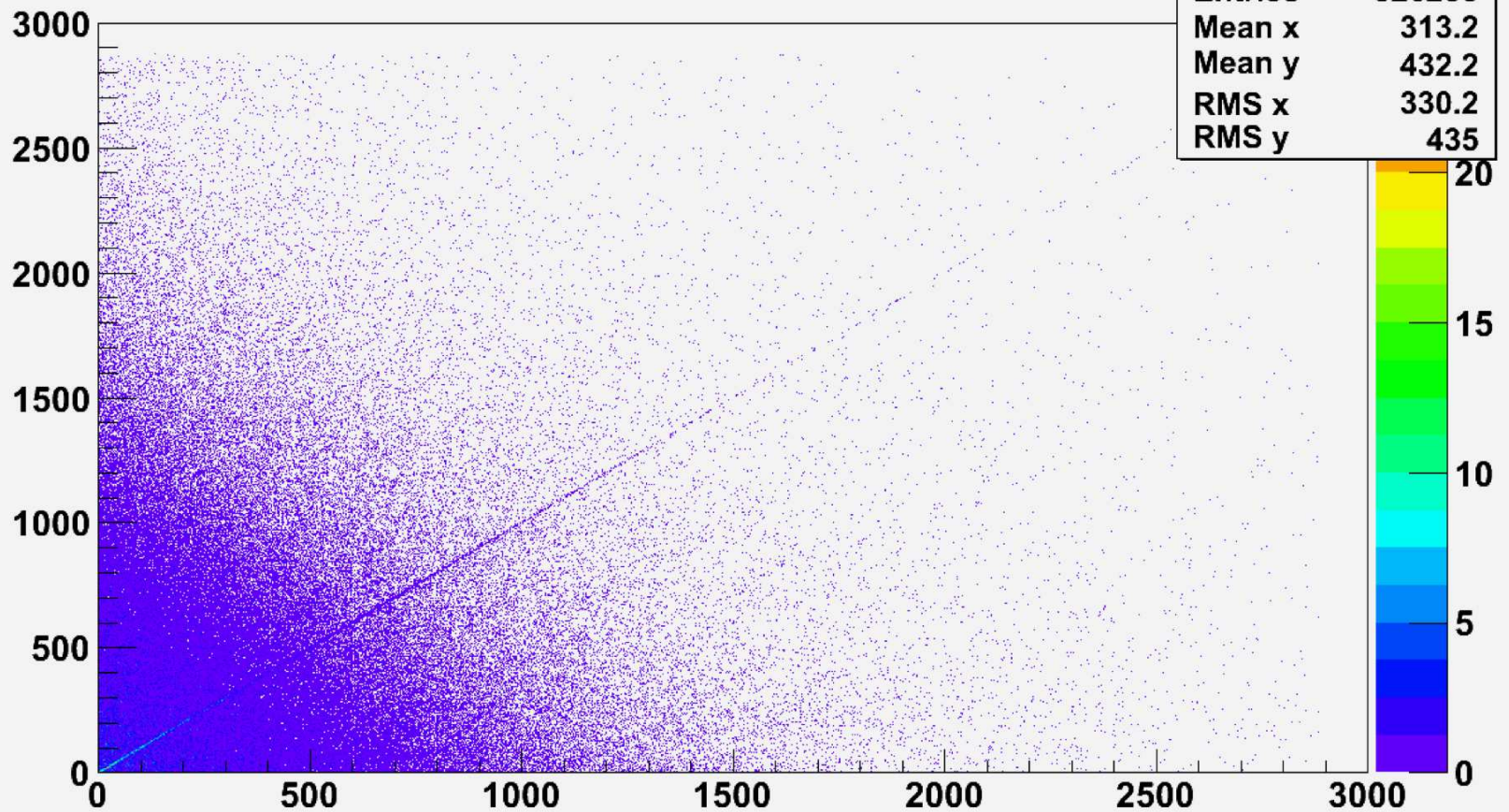
What's been done?

$Q^2=1$ Proton TDC Correlations without Lead Wall

Run # 20791-20792

00	00	00	00
01	01	01	
02	02	02	01
03	03	03	
04	04	03	
05	04	03	
06	05	04	02
07	06	05	
08	06	05	03
09	07	06	
10	08	07	04
11	09	08	
12	10	09	05
13	11	10	
14	12	11	06
15	13	12	
16	14	13	07
17	15	14	
18	16	15	08
19	17	16	
20	18	17	09
21	19	18	
22	20	19	10
23	21	20	
24	22	20	
25	23	21	11
26	23	21	

Left TDC v. Right TDC for Plane #0, PMT # 0 without vetos

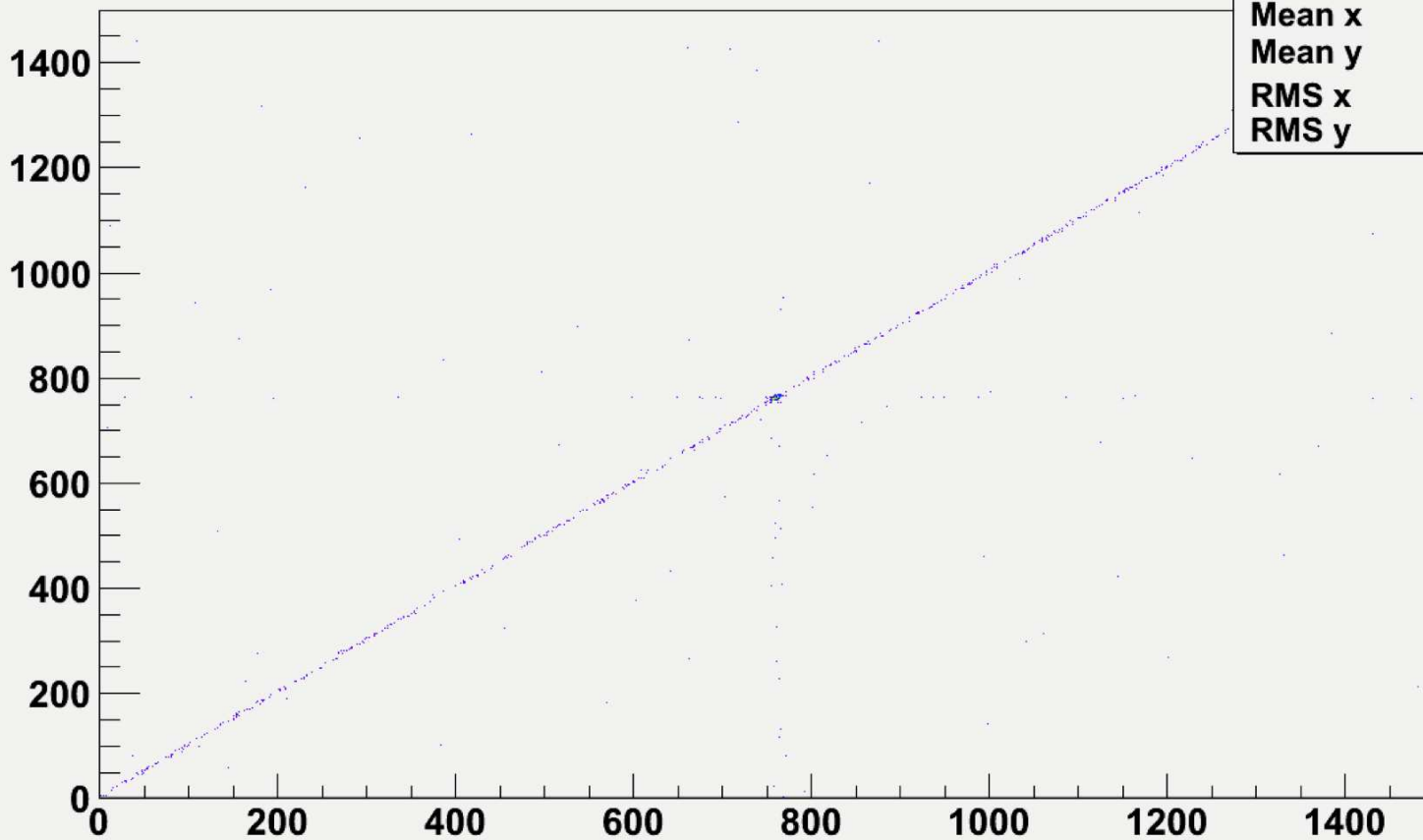


What's been done?

$Q^2=1$ Proton TDC Correlations with Lead Wall

Left TDC v. Right TDC for Plane #0, PMT # 0 without vetos

TDC_check_p0_b0	
Entries	260221
Mean x	749.8
Mean y	746.5
RMS x	321.7
RMS y	321.6



Run # 22441-22441

00	00	00	00
01	01	01	
02	02	02	01
03	03	03	
04	04	03	
05	04	03	
06	05	04	02
07	06	05	
08	06	05	03
09	07	06	
10	08	07	04
11	09	08	
12	10	09	05
13	11	10	
14	12	11	06
15	13	12	
16	14	13	07
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29	23	21	11

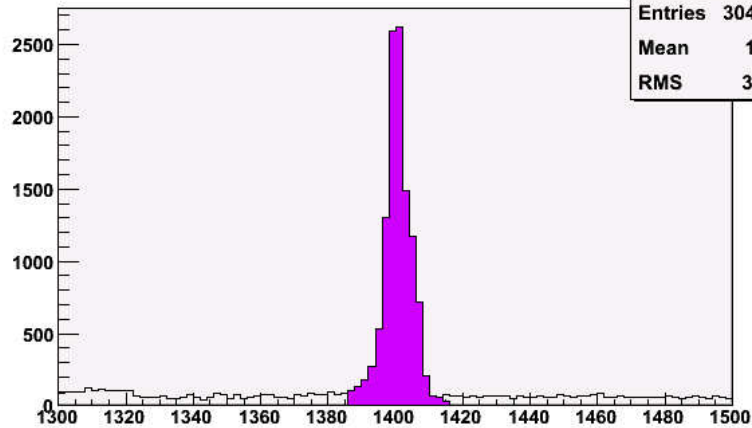
What's been done?

Proton tracking
 $Q^2=1.0$, no lead wall

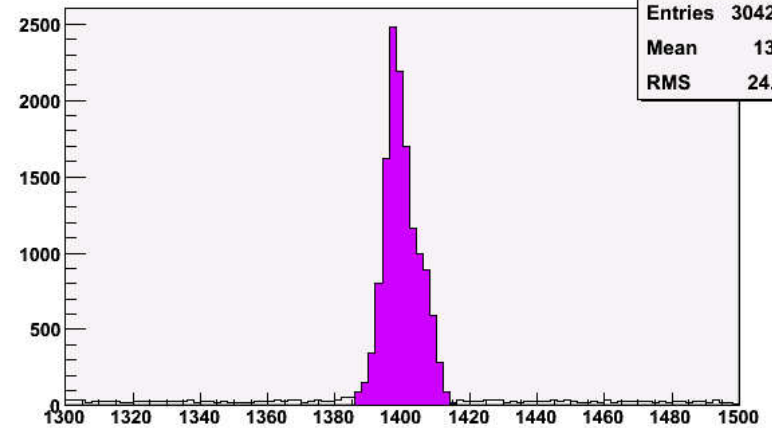
Run # 20791-20792

00	00	00	00
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03	03	03	03
04	04	04	04
05	05	05	05
06	06	06	06
07	07	07	07
08	08	08	08
09	09	09	09
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22	22	22	22
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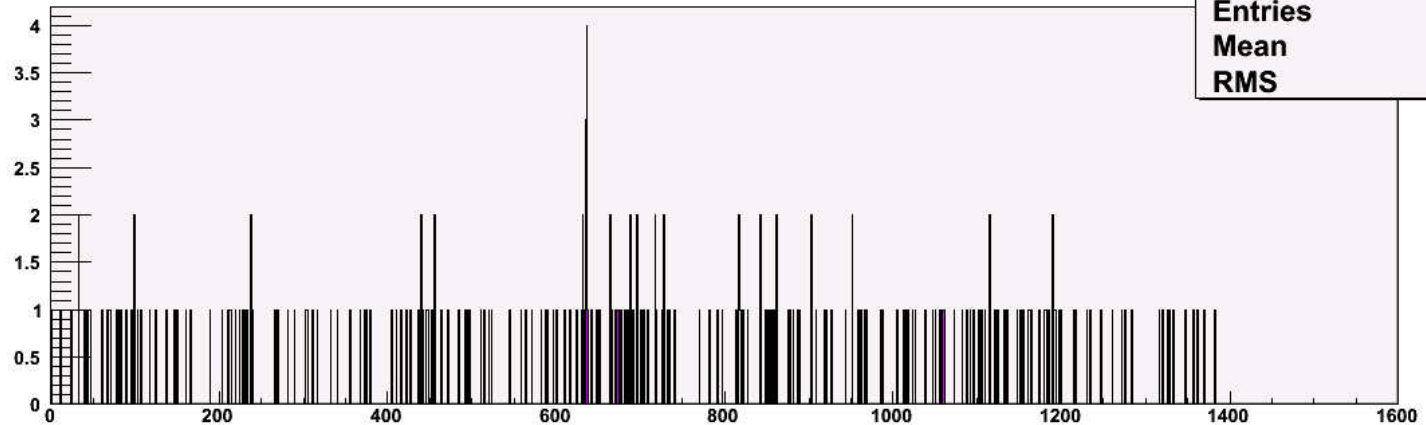
Left TDC for Plane #3, PMT # 12 without vetos



Right TDC for Plane #3, PMT # 12 without vetos



Time of Flight for Plane #3, Bar # 12 without vetos



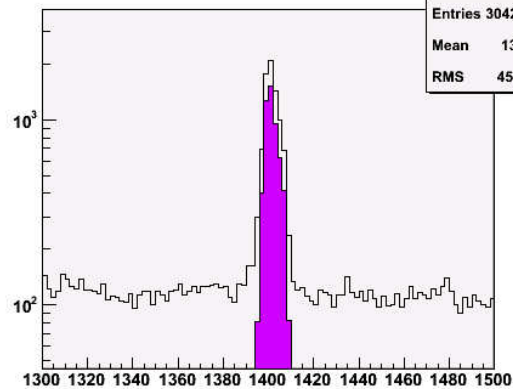
What's been done?

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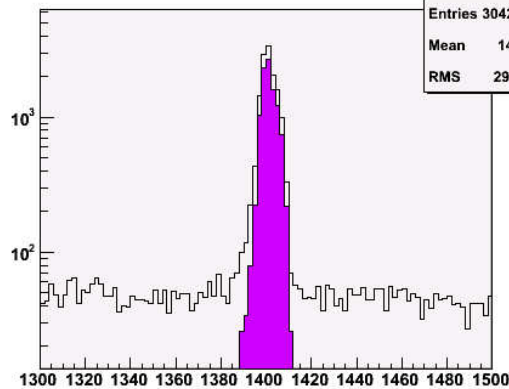
Run # 20791-20792

00	00	00	00
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02	02	02	01
03	03	03	02
04	04	04	03
05	05	05	04
06	06	06	05
07	07	07	06
08	08	08	07
09	09	09	08
10	10	10	09
11	11	11	10
12	12	12	11
13	13	12	11
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16	16	15	14
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28	28	27	26
29	29	28	27

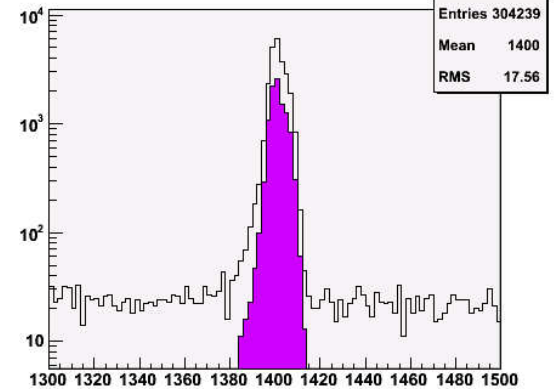
Antiveto 1 - Left TDC for NA.nd.p1.b16 without vetos - Runs 20791-20792



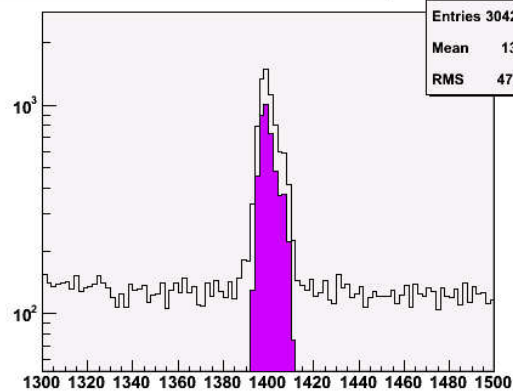
Antiveto 2 - Left TDC for NA.nd.p2.b13 without vetos



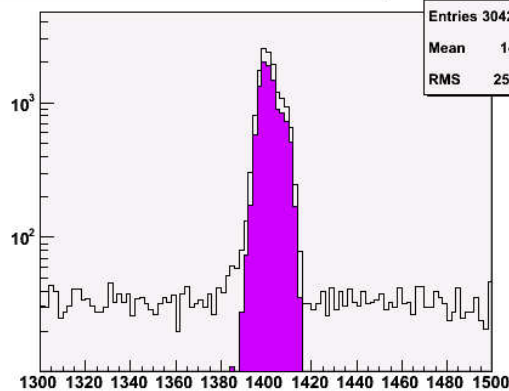
Antiveto 3 - Left TDC for NA.nd.p4.b6 without vetos



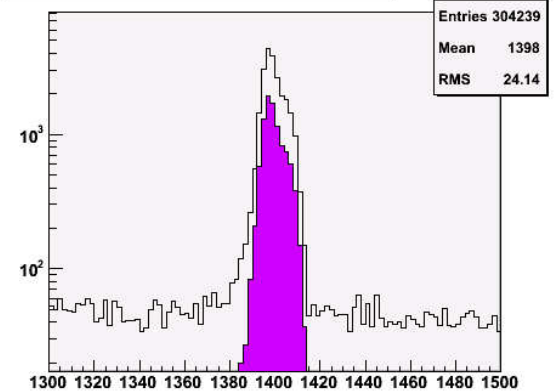
Antiveto 1 - Right TDC for NA.nd.p1.b16 without vetos



Antiveto 2 - Right TDC for NA.nd.p2.b13 without vetos



Antiveto 3 - Right TDC for NA.nd.p4.b6 without vetos



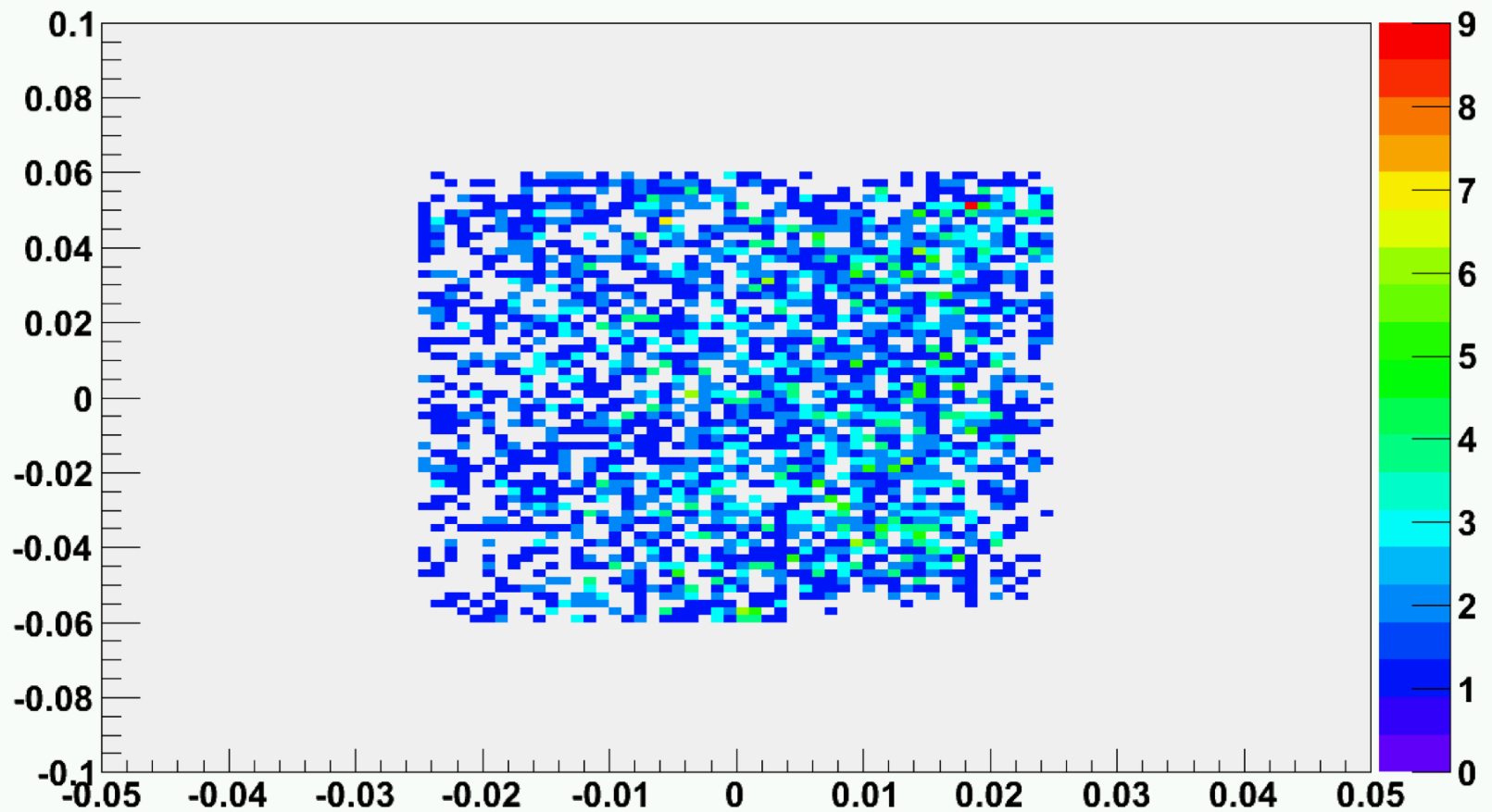
What's been done?

Theta Correlates to Bar

Run # 20791-20792

Theta and Phi

00	00	00
01	01	01
02	02	01
03	02	02
04	03	03
05	04	03
06	05	04
07	06	05
08	07	06
09	08	07
10	09	08
11	10	09
12	11	10
13	12	11
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27	26	25
28	27	26
29	28	27



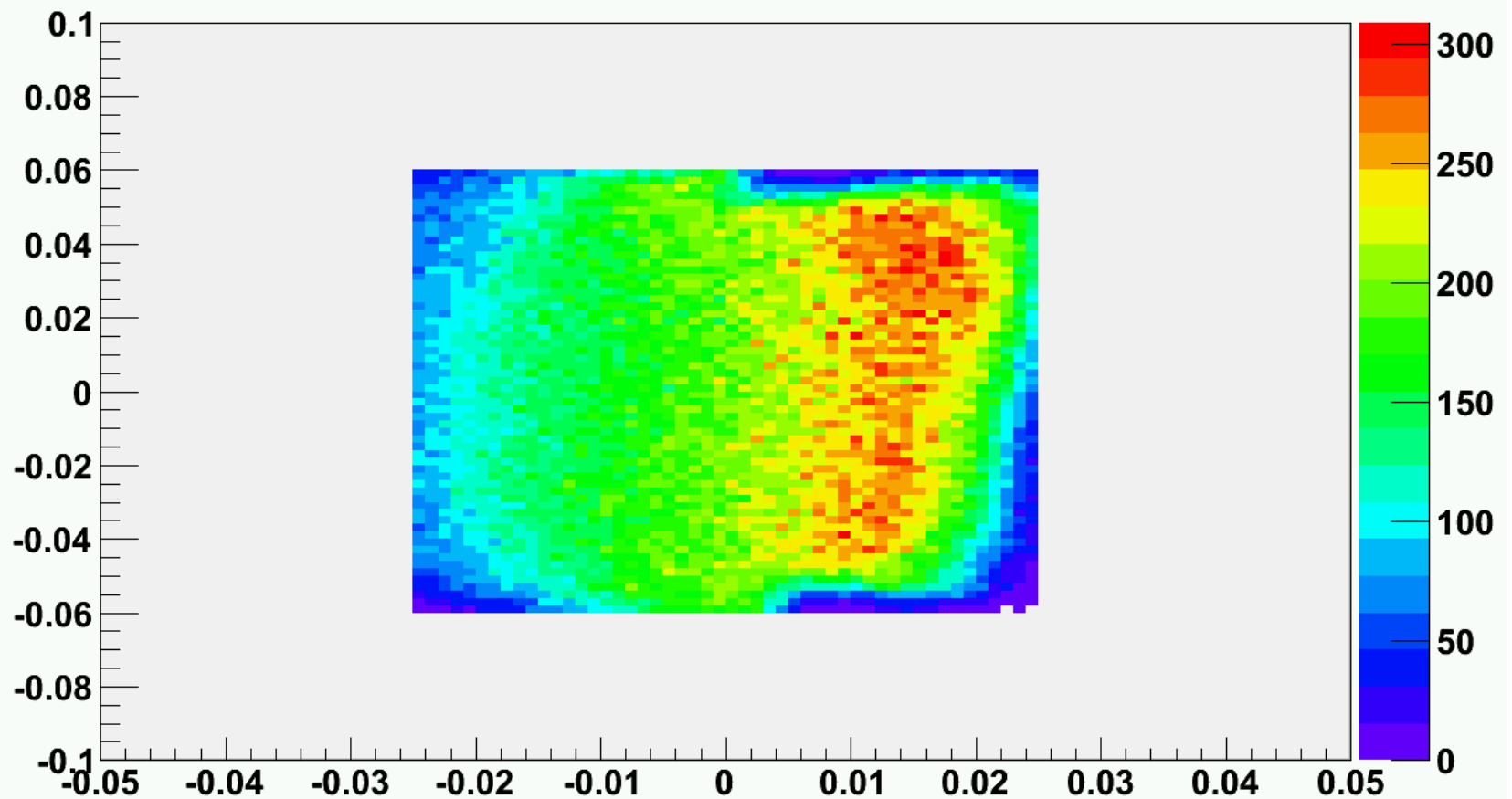
What's been done?

Theta Correlates to Bar

Run # 20791-20792

Theta and Phi

00	00	00	00
01	01	01	
02	02	02	01
03	03	03	
04	04	04	02
05	05	05	
06	06	06	03
07	07	07	
08	08	08	04
09	09	09	
10	10	10	05
11	11	11	
12	12	12	06
13	13	13	
14	14	14	07
15	15	15	
16	16	16	08
17	17	17	
18	18	18	09
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20	20	20	10
21	21	21	
22	22	22	11
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28	28	28	
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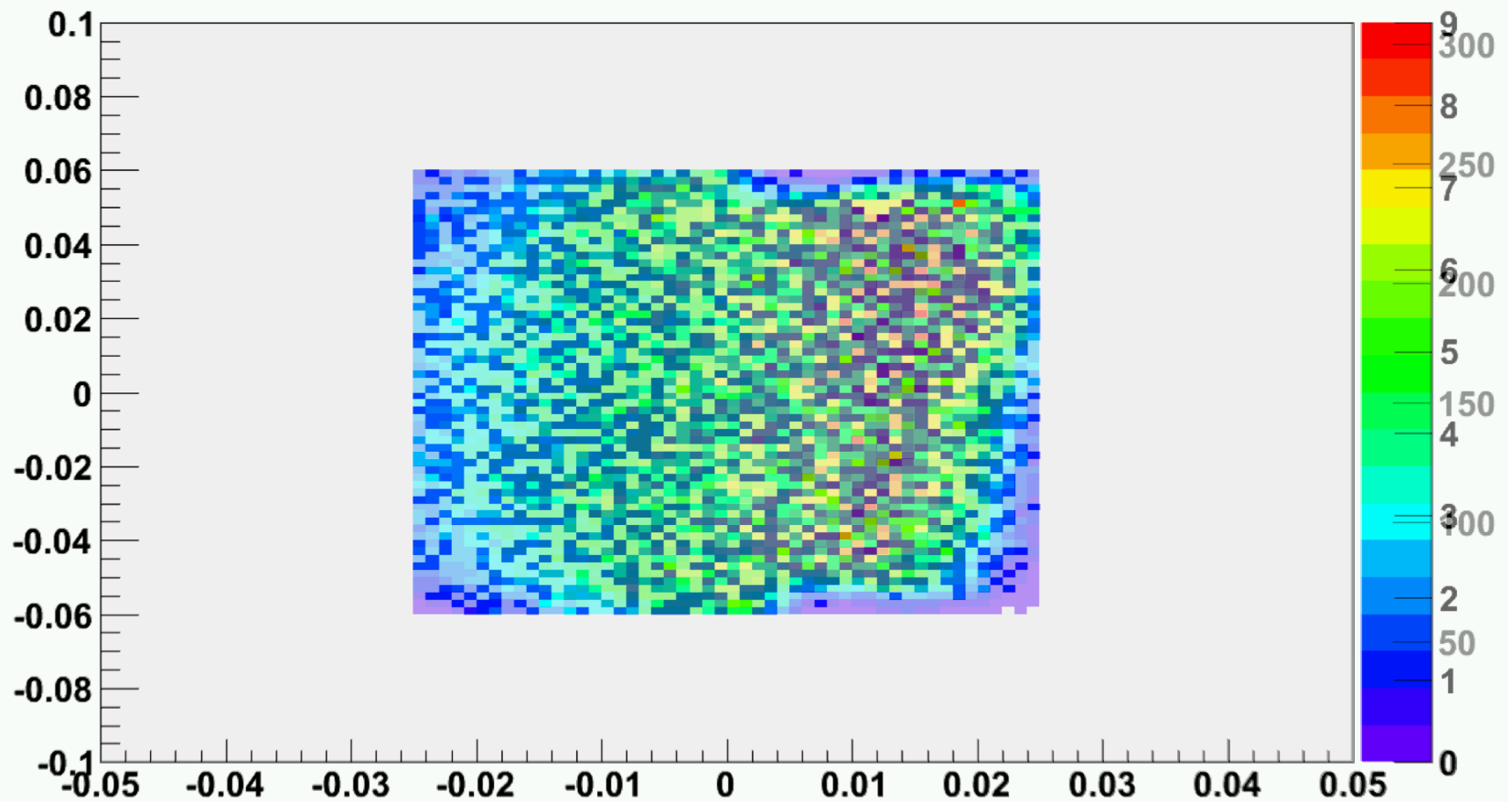
What's been done?

Theta Correlates to Bar

Run # 20791-20792

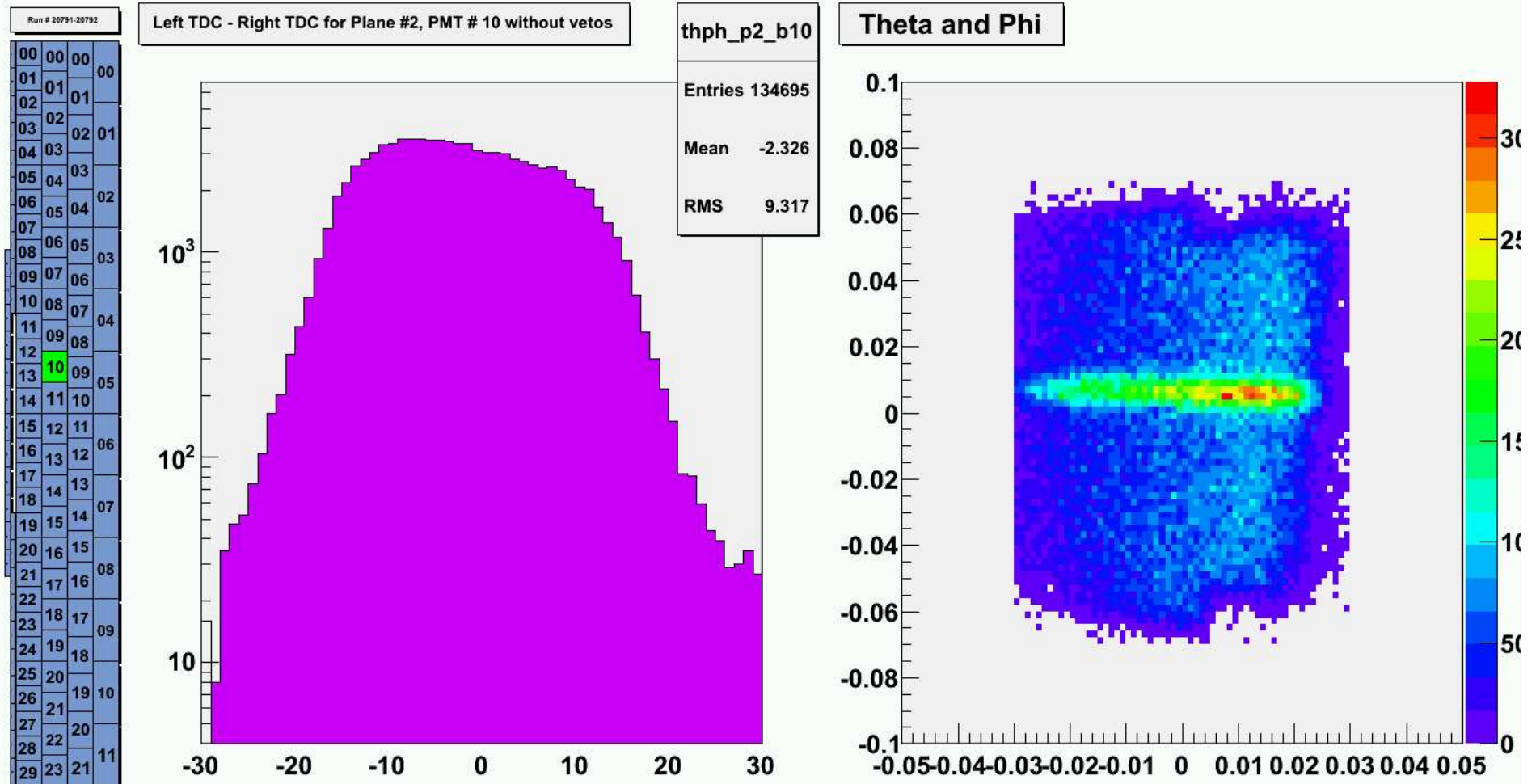
00	00	00
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02	02	01
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14	13	12
15	14	13
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17	16	15
18	17	16
19	18	17
20	19	18
21	20	19
22	21	20
23	22	21
24	23	22
25	24	23
26	25	24
27	26	25
28	27	26
29	28	27

Theta and Phi



What's been done?

Phi Correlates to Left-Right Position



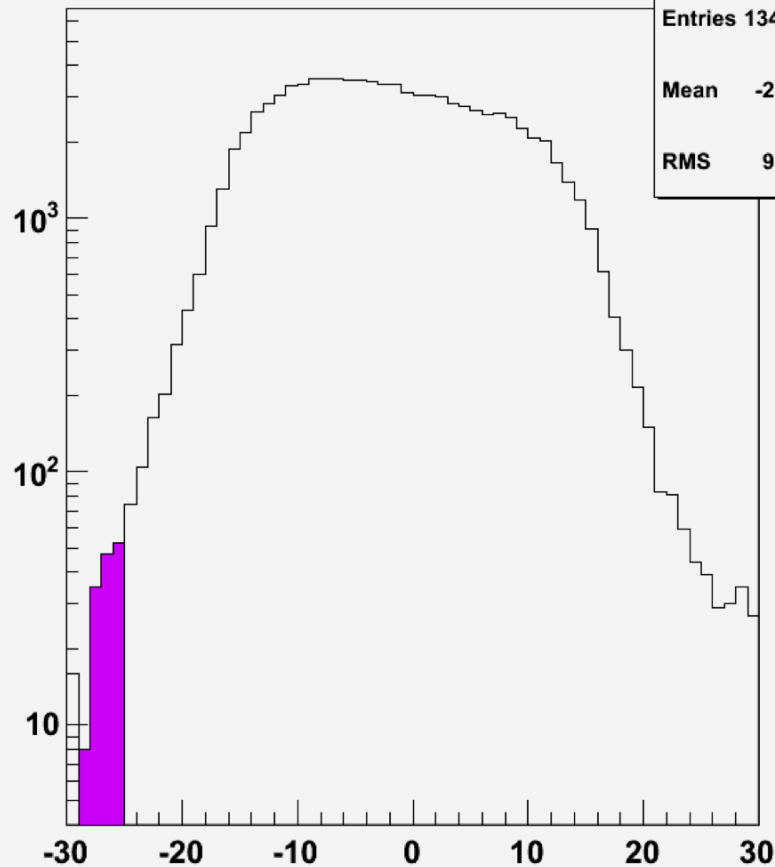
What's been done?

Phi Correlates to Left-Right Position

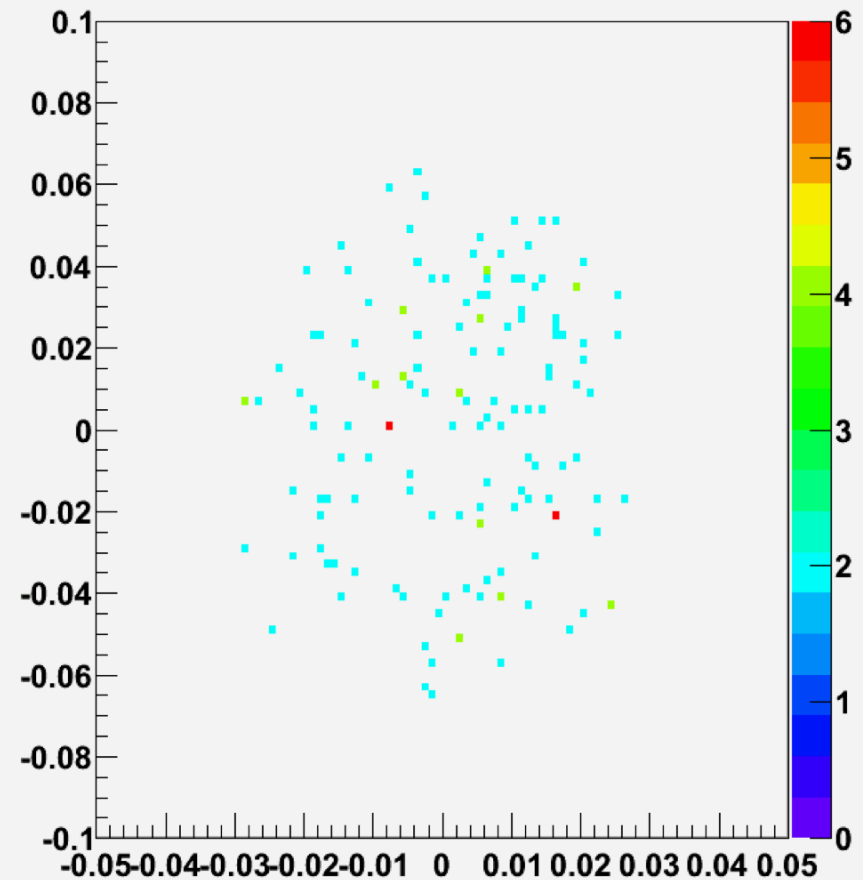
Run # 20791-20792

00	00	00	00
01	01	01	01
02	02	02	02
03	03	02	01
04	03		
05	04	03	
06	05	04	02
07	06	05	
08	06	05	03
09	07	06	
10	08	07	04
11	09	08	
12	09	08	
13	10	09	05
14	11	10	
15	12	11	
16	13	12	06
17	14	13	
18	14	13	07
19	15	14	
20	16	15	
21	17	16	08
22	18	17	
23	18	17	09
24	19	18	
25	20	19	
26	20	19	10
27	21	20	
28	22	21	
29	23	21	11

Left TDC - Right TDC for Plane #2, PMT # 10 without vetos

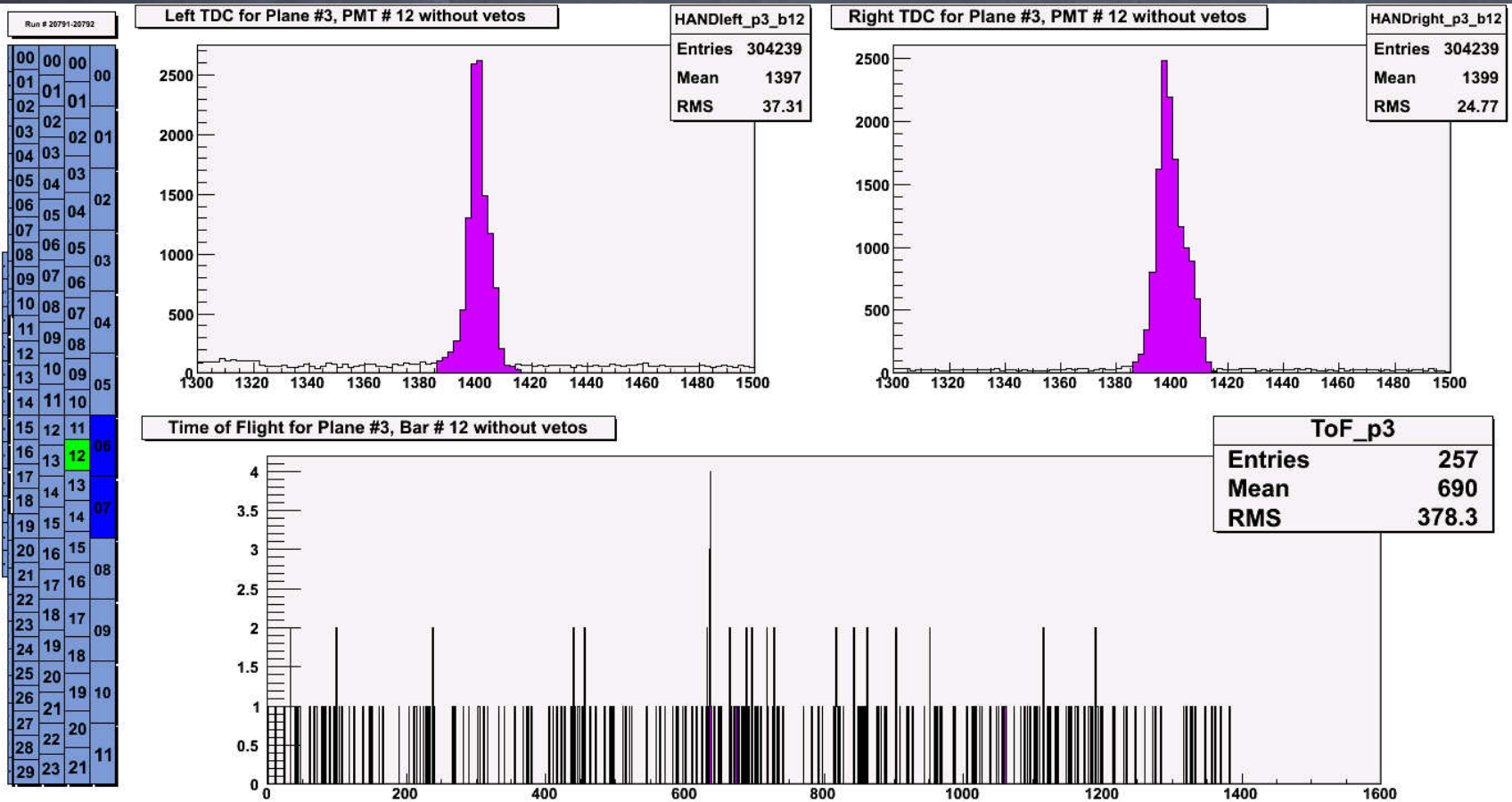


Theta and Phi



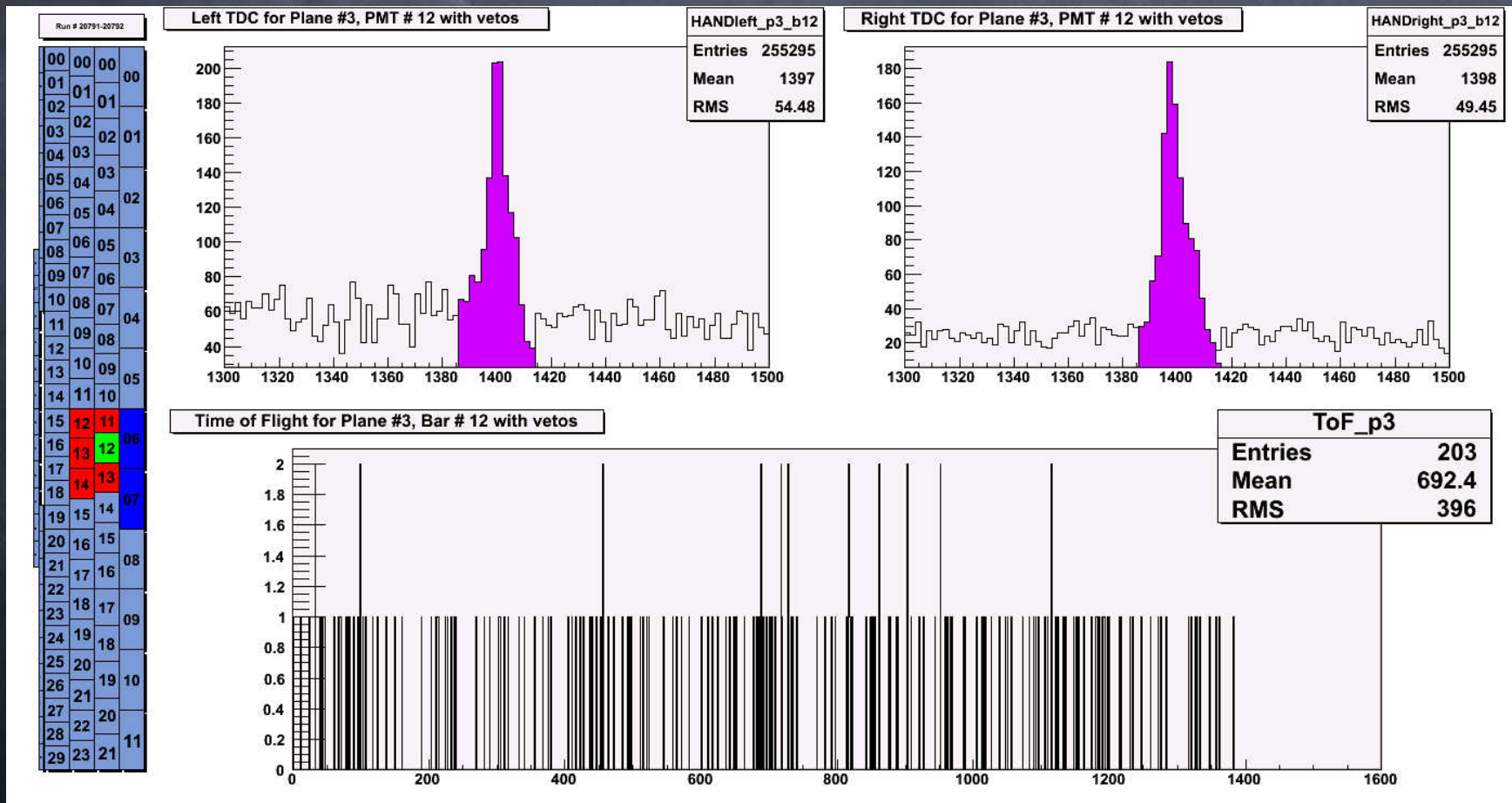
Where are we going?

- Ratio of protons that survive veto cuts
- Example: 100% \rightarrow 7.7% \rightarrow 1.6%



Where are we going?

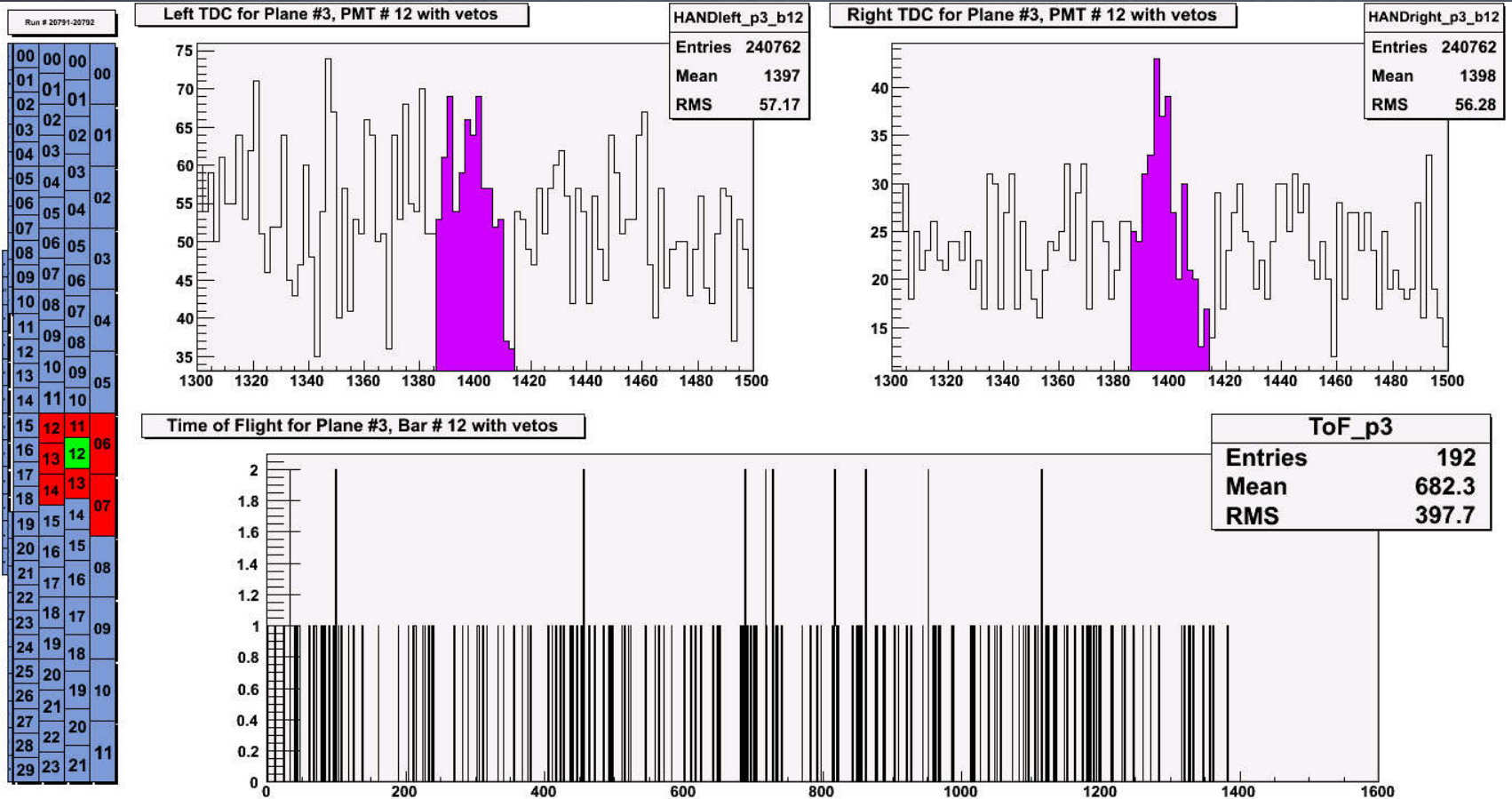
- Ratio of protons that survive veto cuts
- Example: 100% \rightarrow 7.7% \rightarrow 1.6%



Where are we going?

- Ratio of protons that survive veto cuts

- Example: 100% \rightarrow 7.7% \rightarrow 1.6%



Where are we going?

- Finalize veto cuts
- Examine neutron penetration from deuterium target
- Examine neutron penetration from ^3He target
- Make neutron cuts
- Find semi-exclusive $^3\text{He}(e,e'n)$ asymmetry using neutron cuts
- Finalize scaling factors of asymmetry

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
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Collaboration

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X. Qui
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F. Salvatore

- M. Shabestari
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J. St. John
A. Tobias
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G. M. Urciuoli
D. Wang
K. Wang
J. Watson
B. Wojtsekhowski
Z. Ye
X. Zhan
X. Zheng
L. Zhu



Extra Slides

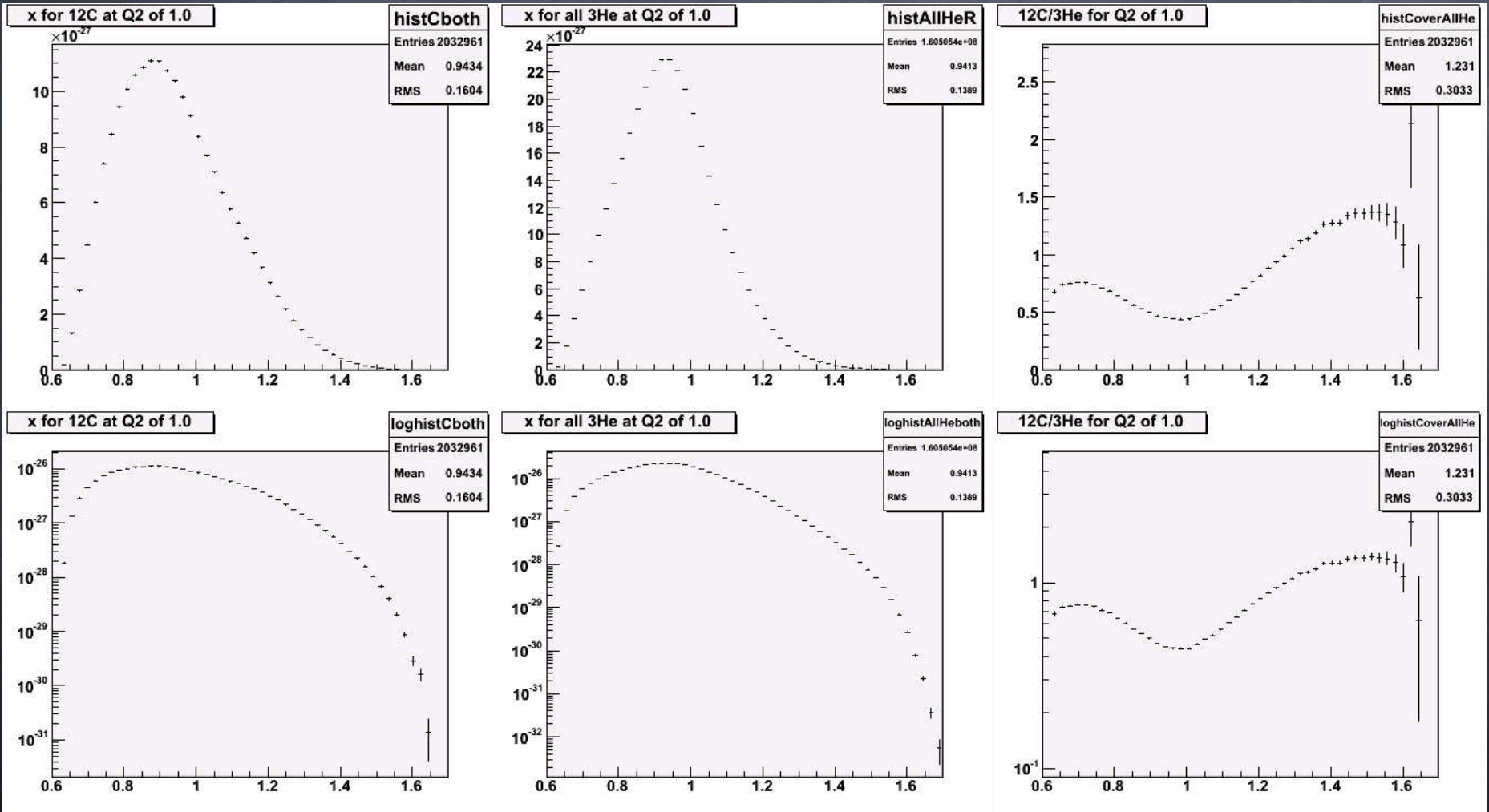
Bjorken-x Yields

$$\text{Yield} = \frac{N}{Q * LT * \rho * \Delta z} * \left(\frac{1}{\epsilon_{det} * \Delta\Omega * \Delta E'} \right)$$

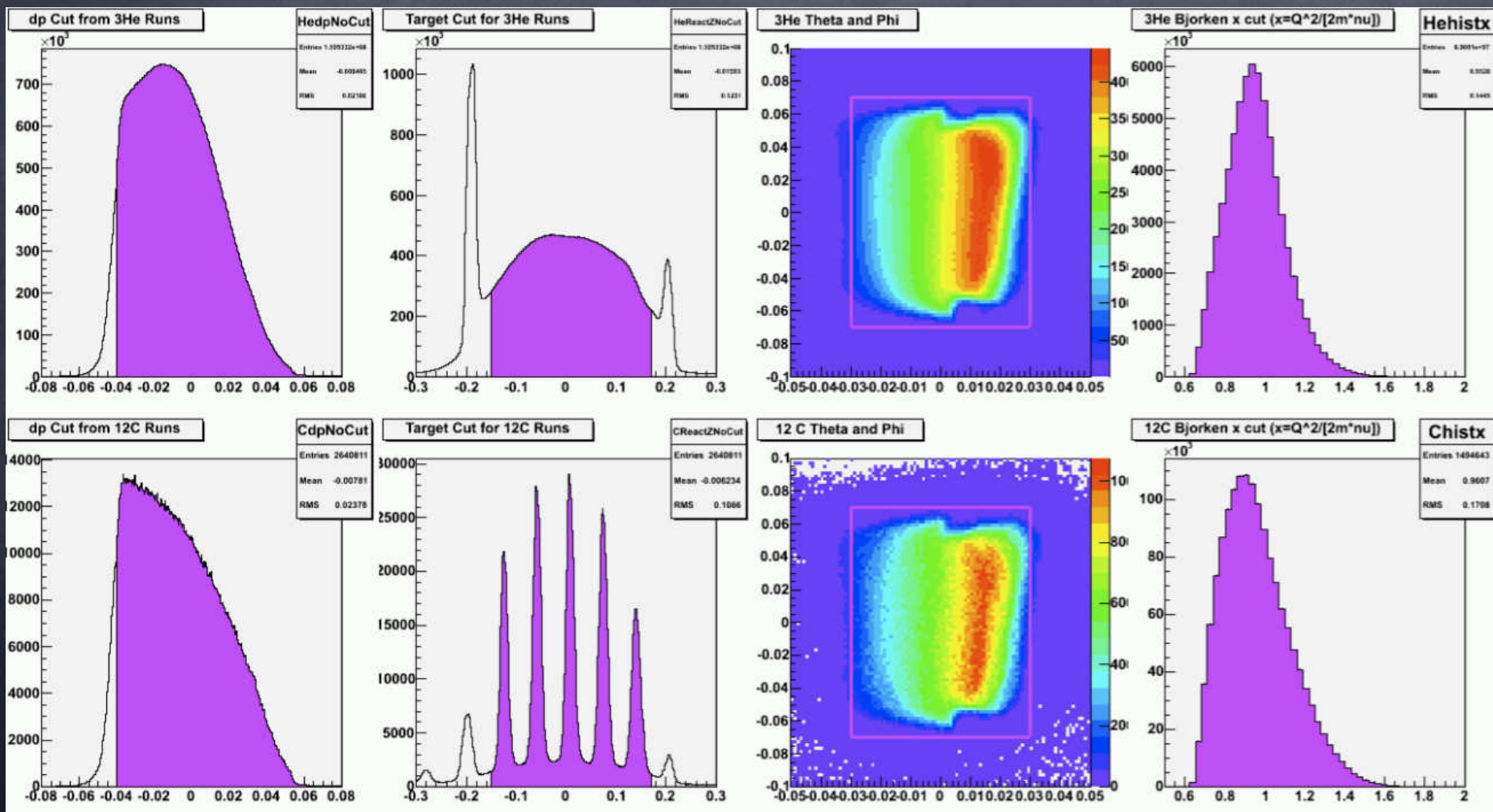
Ignore since
it will cancel

$$\text{Scaling} = \frac{{}^{12}\text{C Yield}}{{}^3\text{He Yield}}$$

Bjorken-x Scaling at $Q^2=1$



Bjorken-x Cuts



Bjorken-x Cuts

