E08-005 Update: Quasi-Elastic $^3He(e,e'n)$ Target Single Spin Asymmetries

Elena Long

Hall A Collaboration Meeting

December 15^{th}, 2011

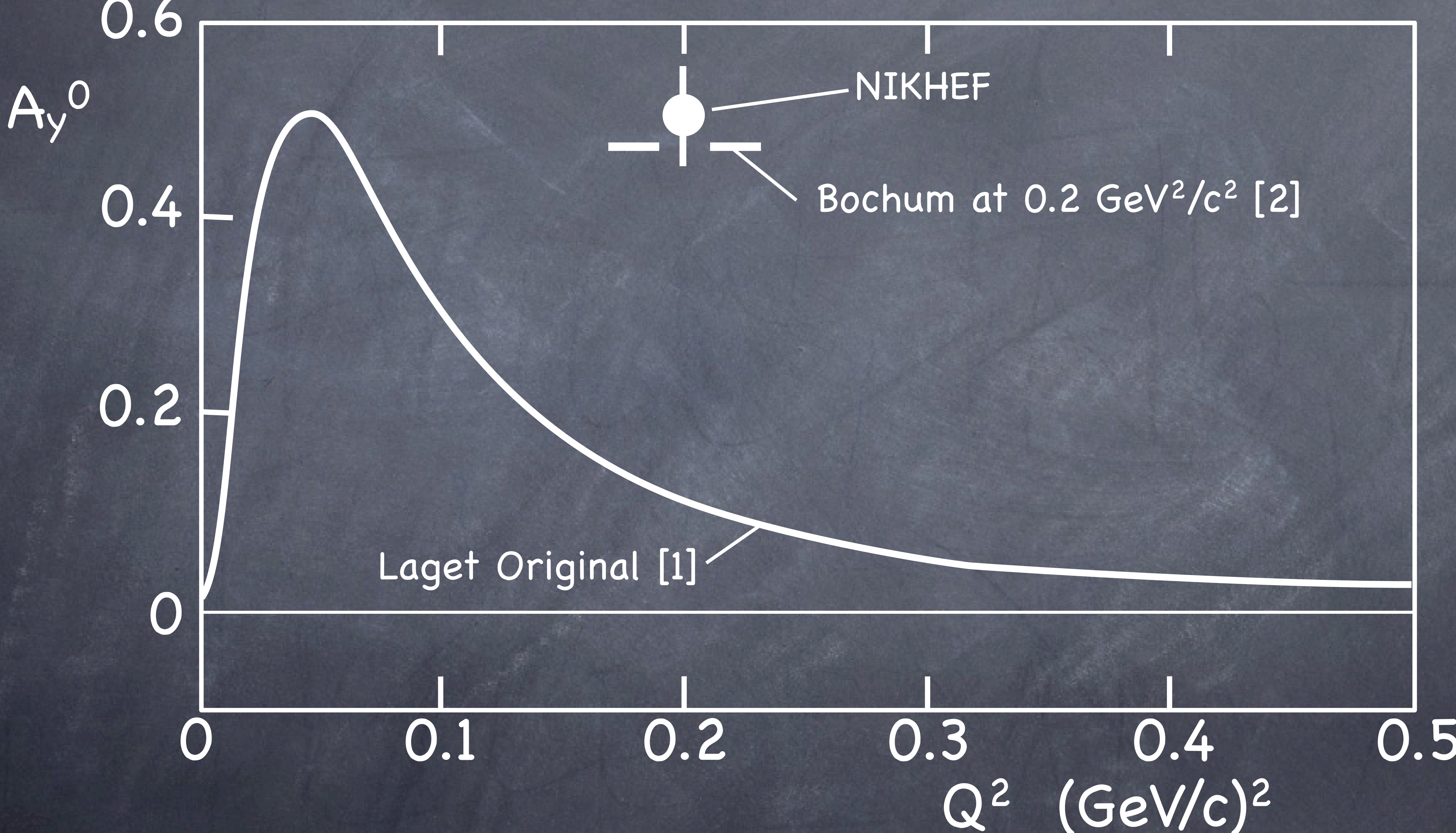
KENT STATE UNIVERSITY

Jefferson Lab

What are we doing?

- 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 $[GeV/c]^2$
- 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

What are we doing?

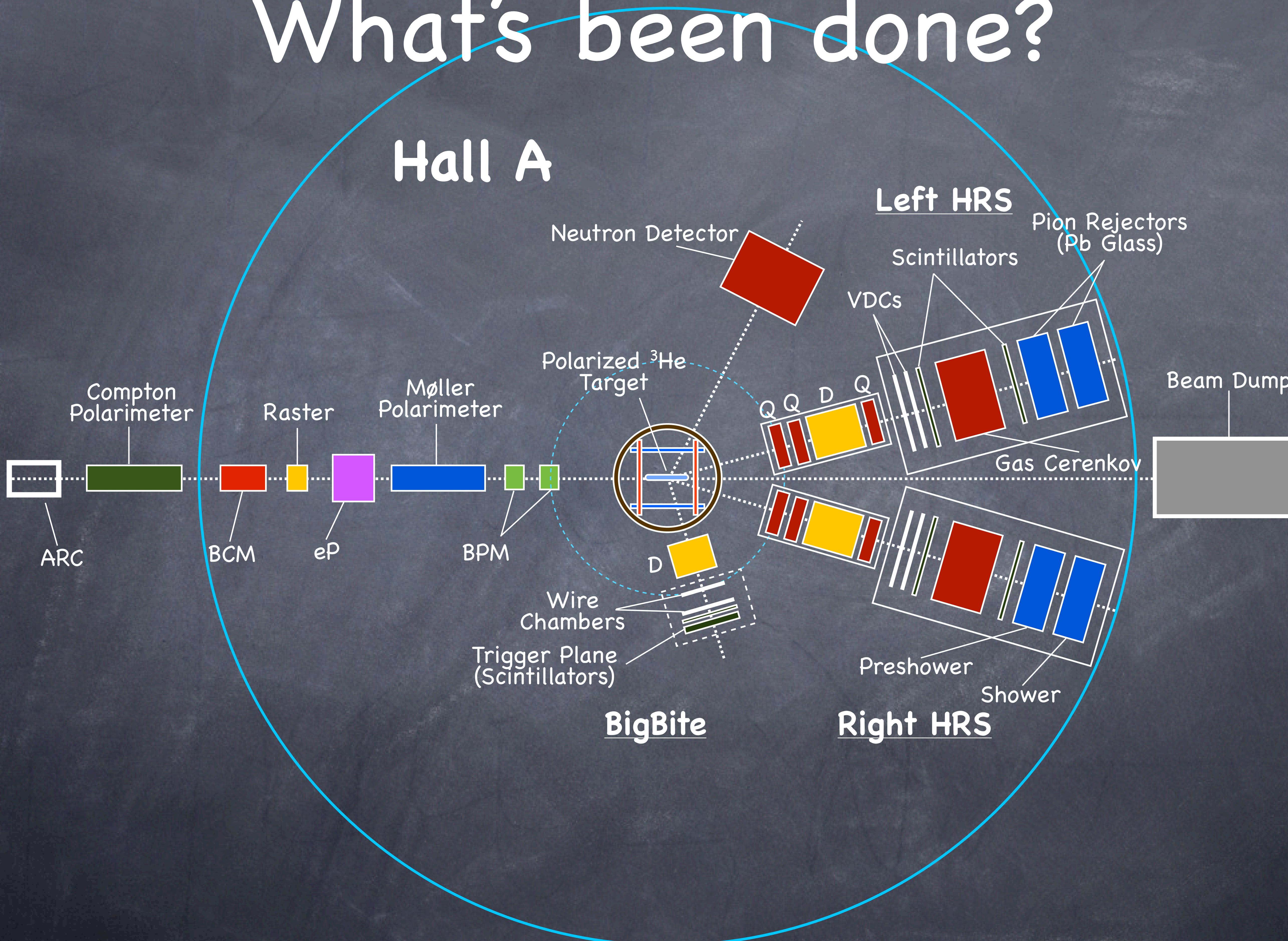


[1] J. M. Laget, Phys. Lett. B273, 367 (1991).
[2] W. Gloeckle, H. Witala, D. Huber, H. Kamada, and J. Golak, Phys. Rept. 274, 107 (1996).

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 $^3\overrightarrow{He}(\vec{e},e'n)$, 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

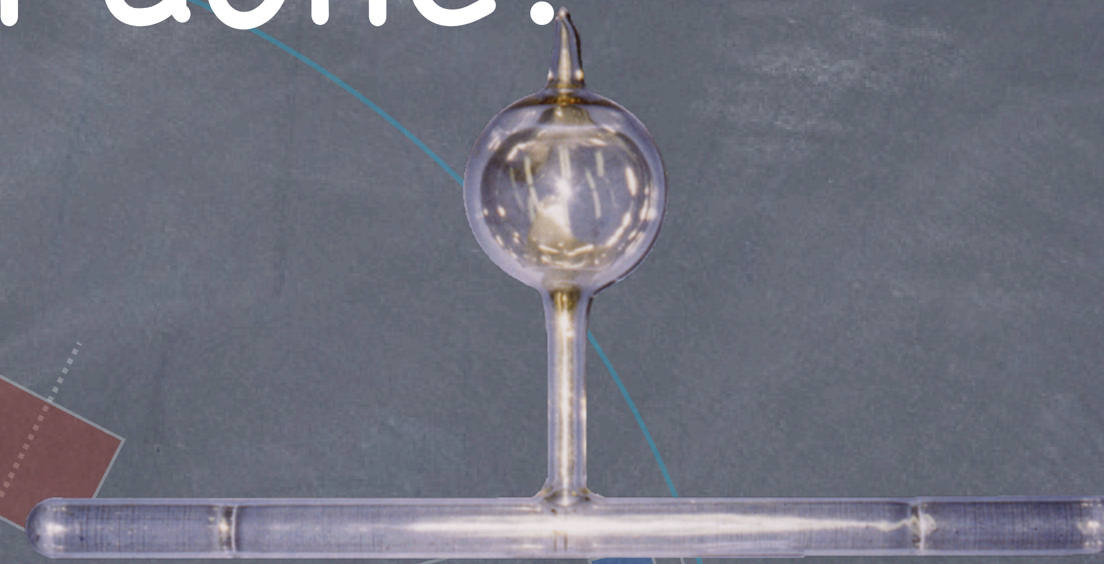
What's been done?

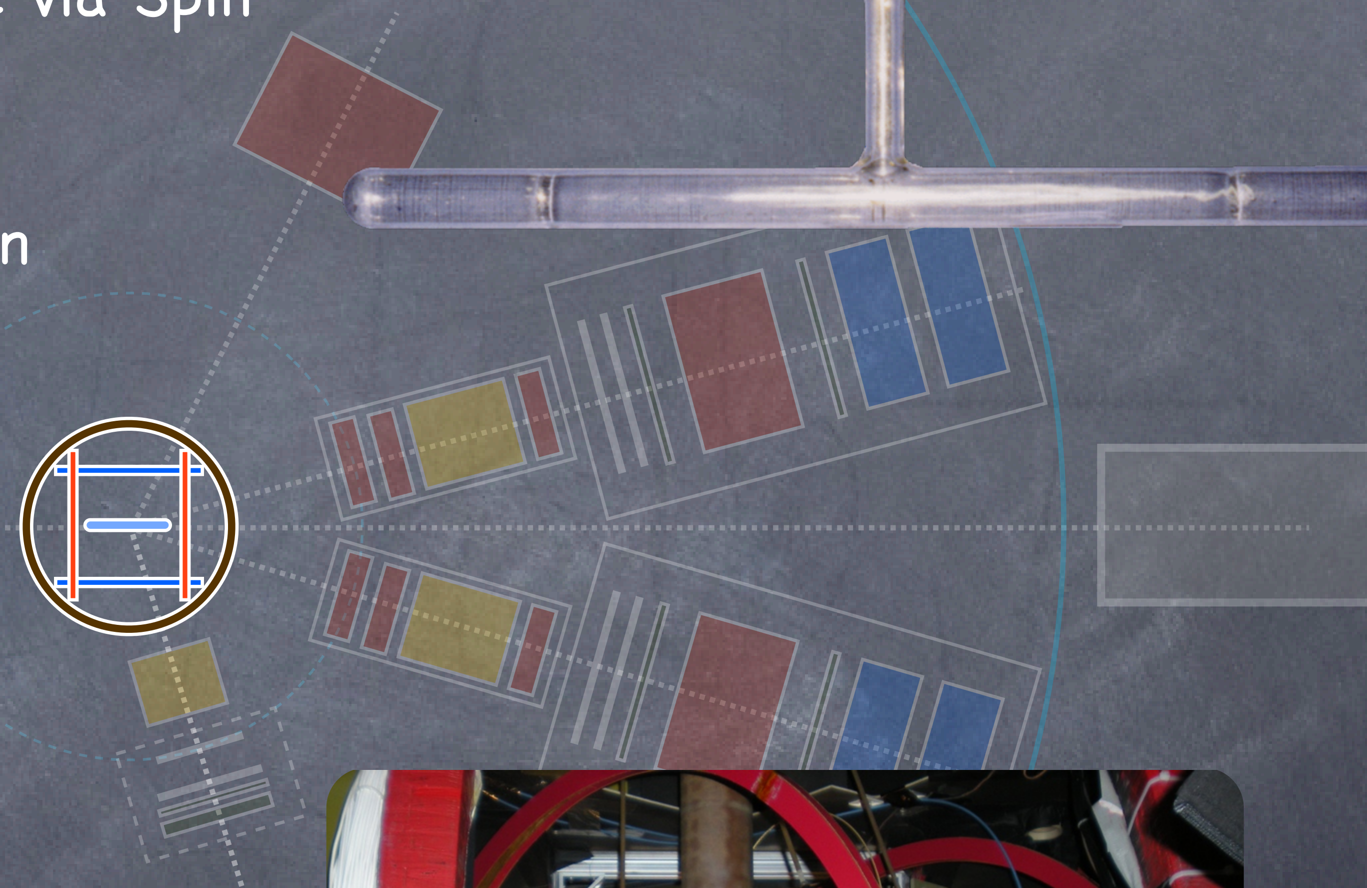


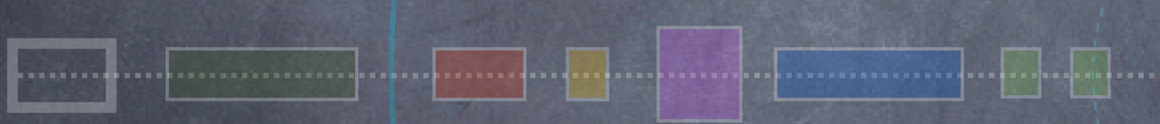
What's been done?

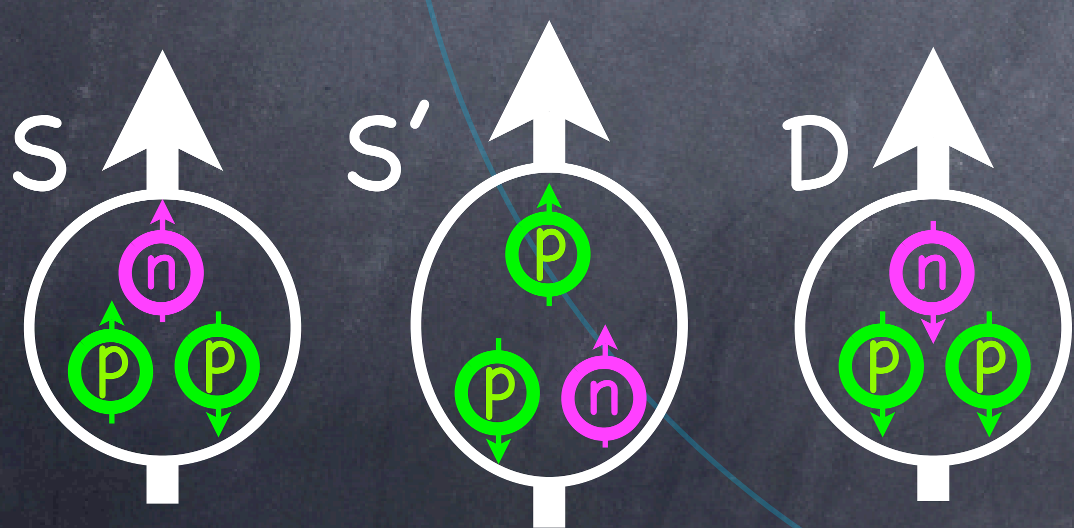
Polarized ^{3}He Target

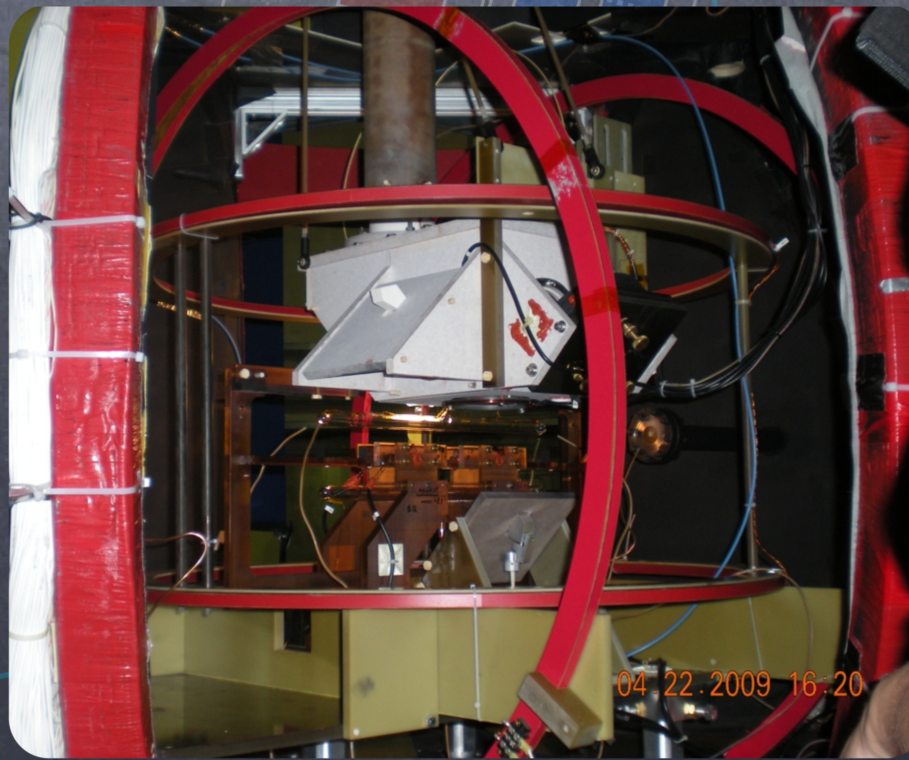
- Optically Pumped Rubidium Vapor used with Potassium to Polarize ^{3}He via Spin Exchange
- NMR and EPR Measure Polarization
- Polarization was in Vertical Direction
- Can Polarize up to 60%
- Luminosity ~10^{36} cm^{-2}s^{-1}











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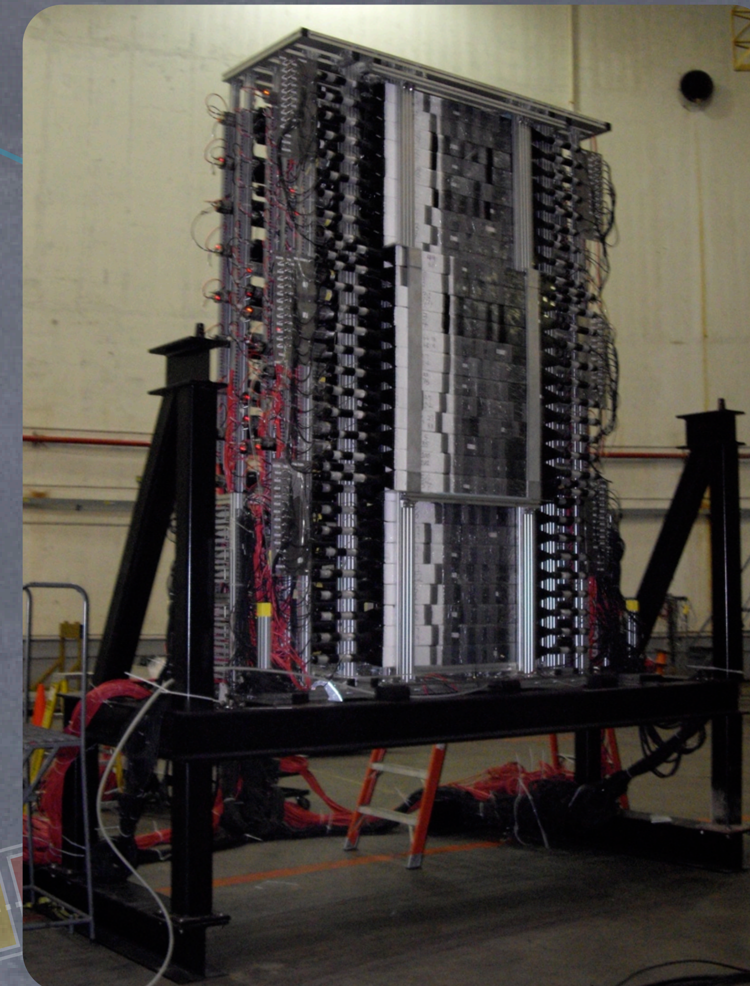
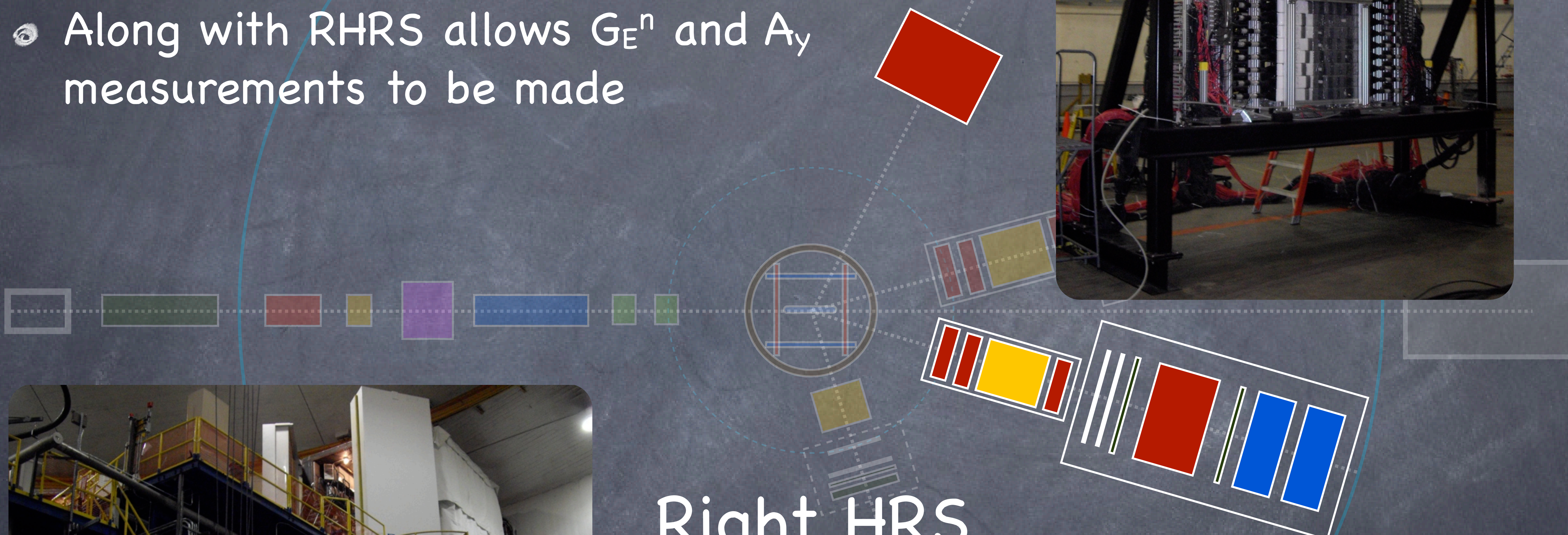
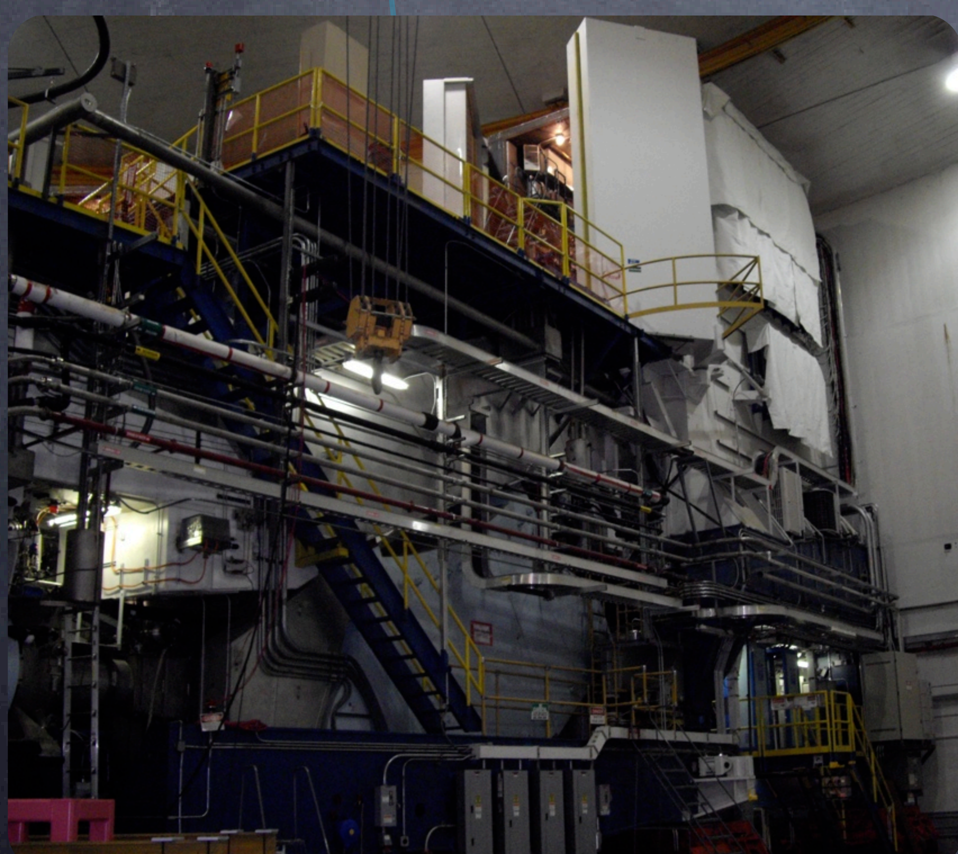


Hall A Neutron Detector

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





Right HRS

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

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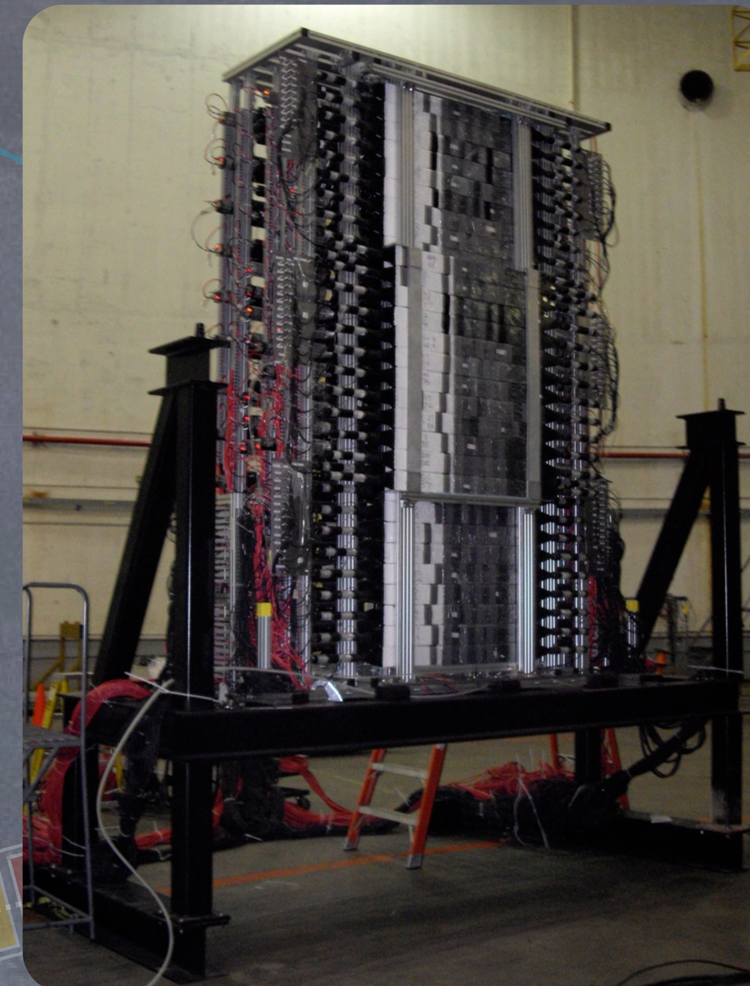

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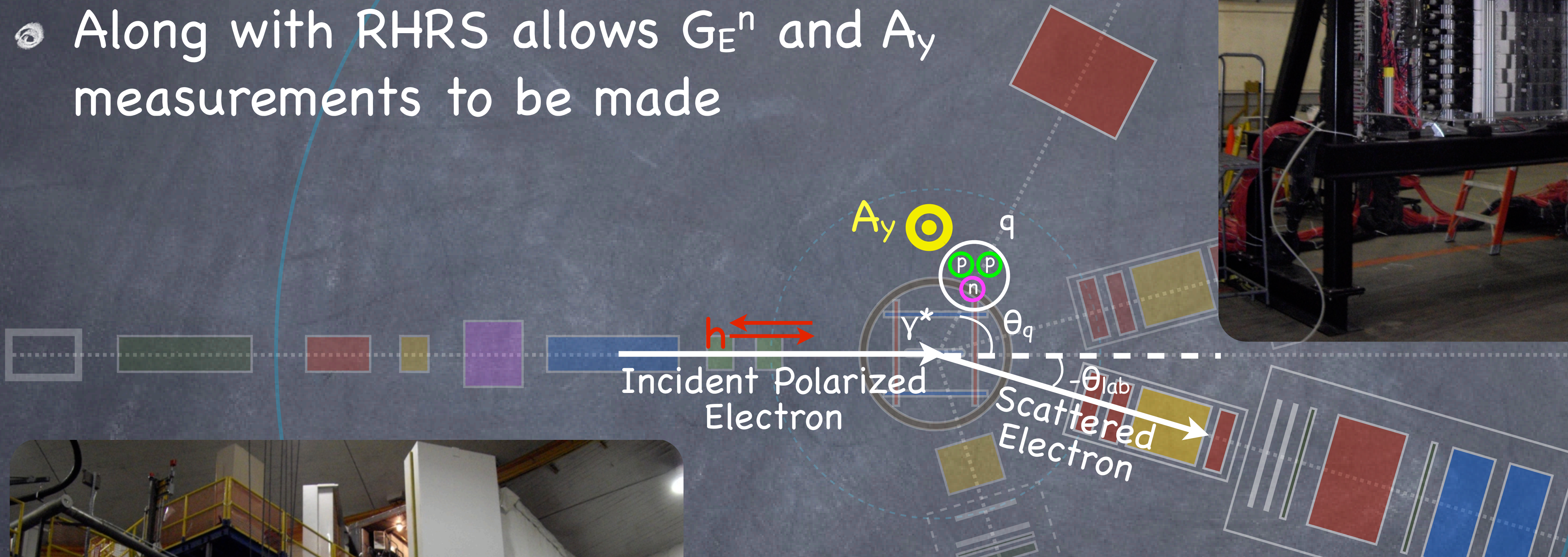

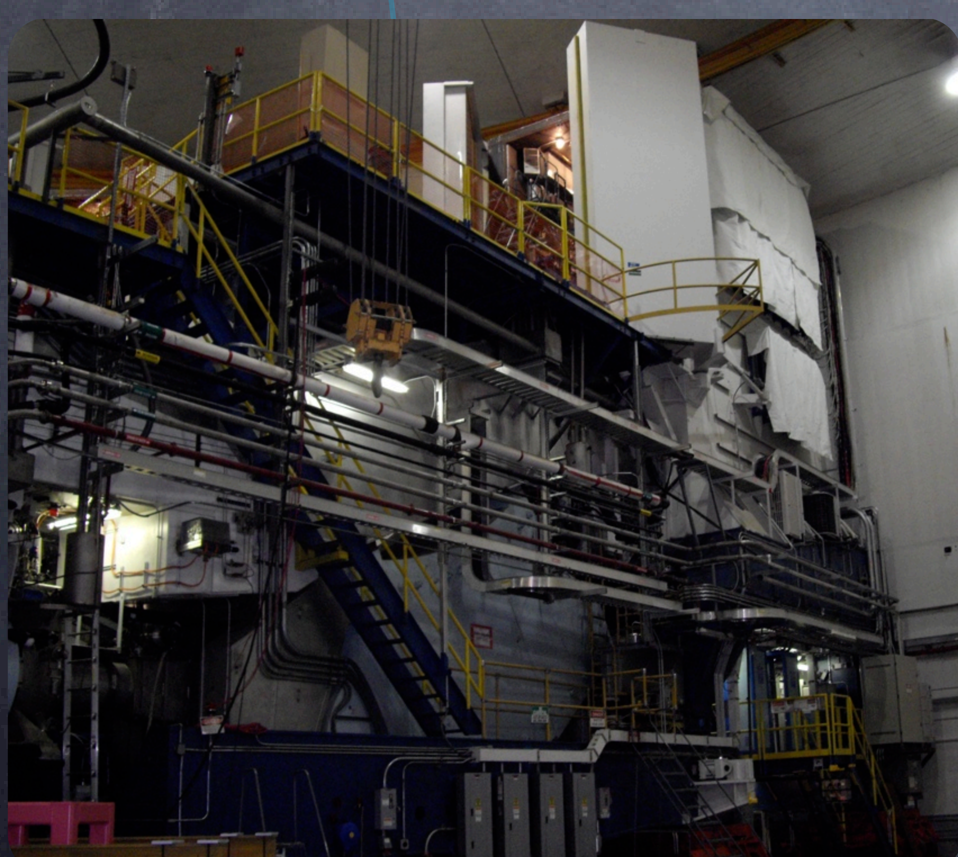

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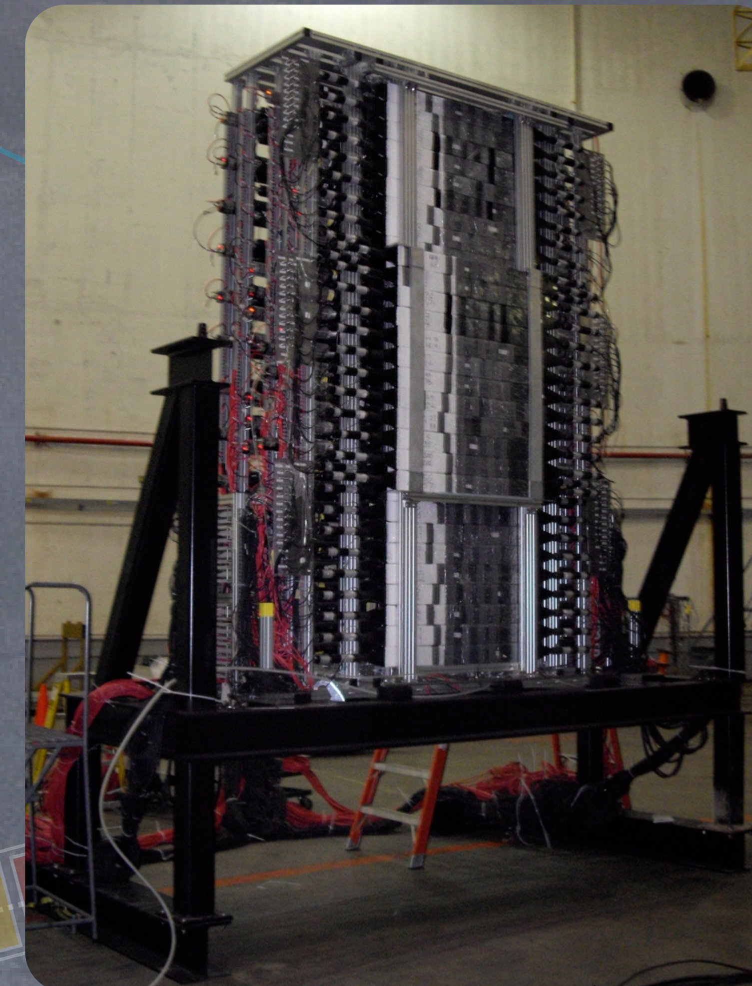

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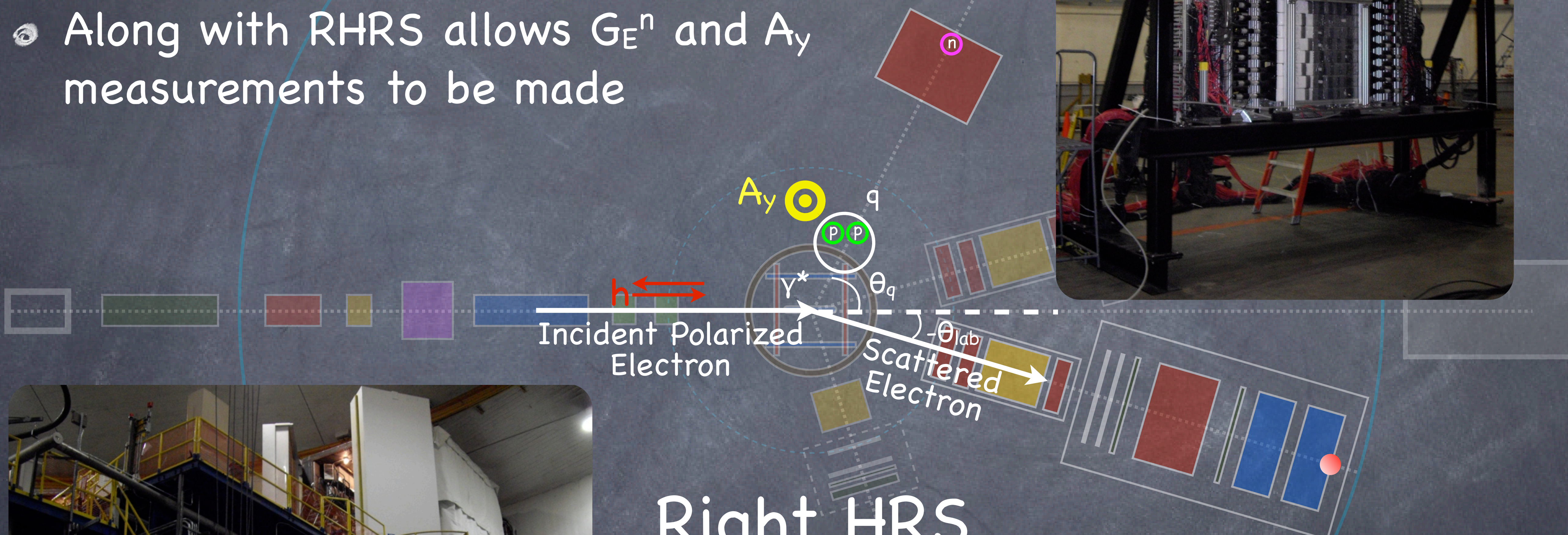

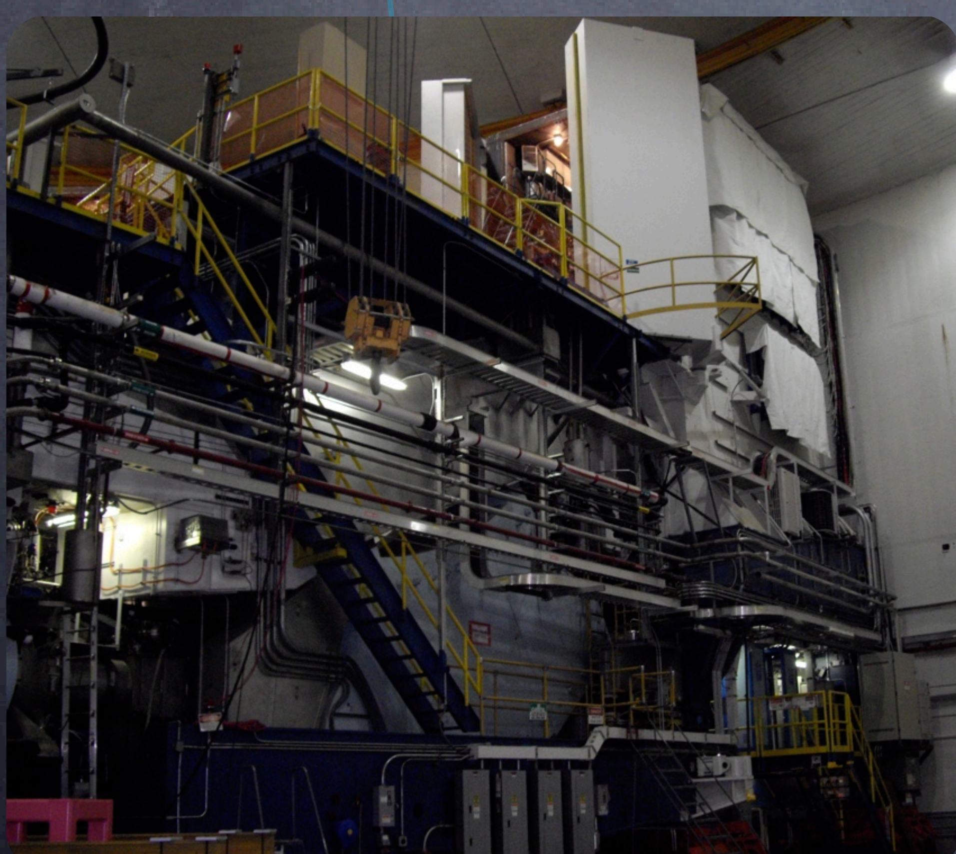

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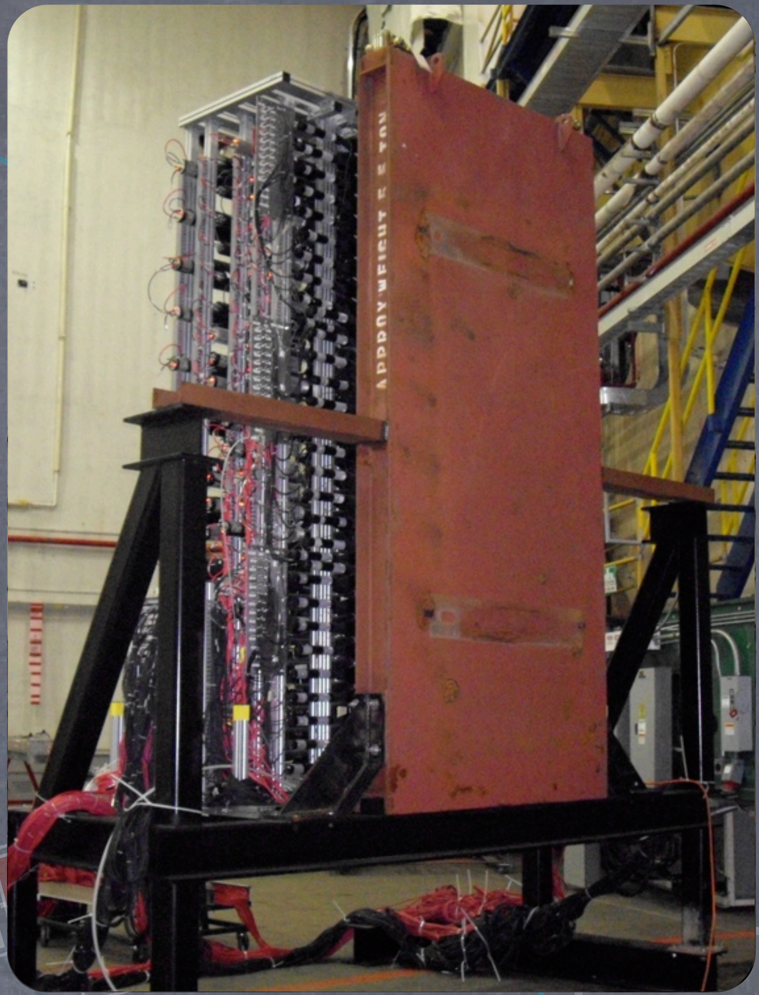

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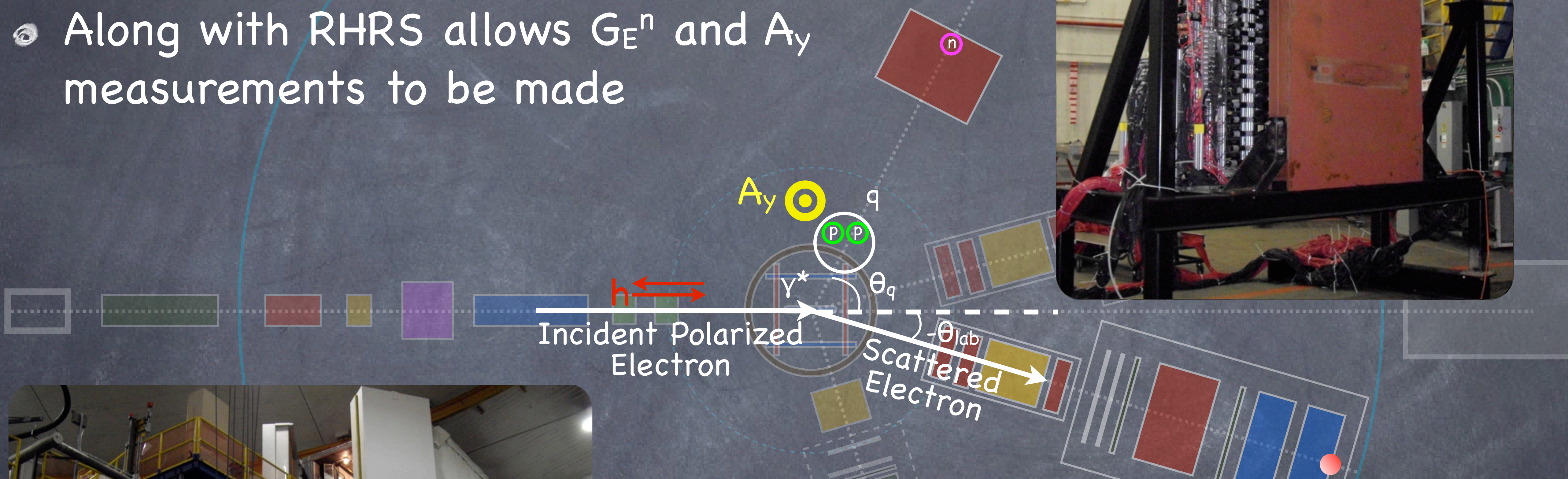

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- Detects quasi-elastically scattered electrons from $^3He(e,e'n)$ and $^3He(e,e')$
- With q along beam polarization on $^3He(e,e')$, allows a G_M^n measurement to be made

What's been done?

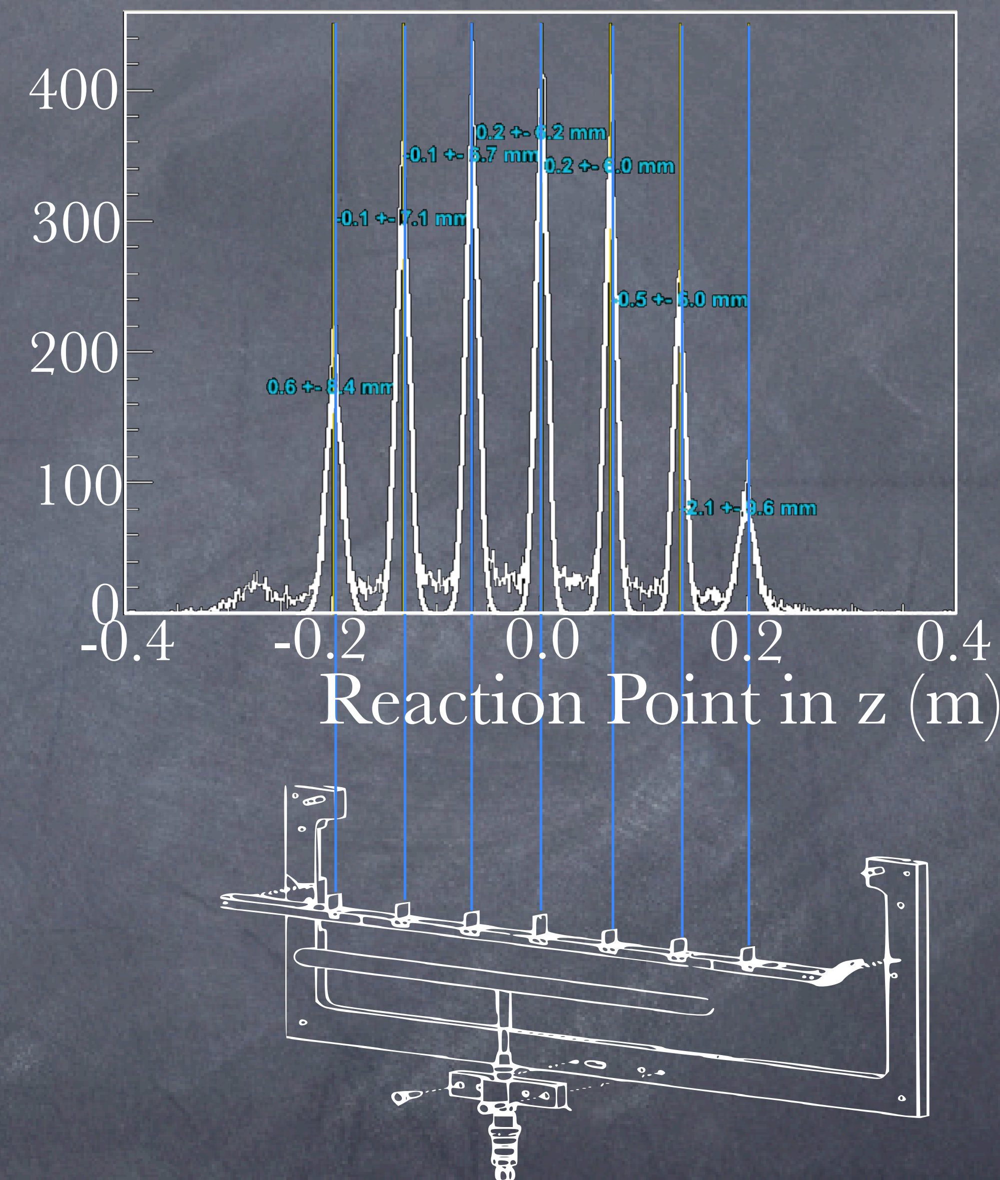
- This experiment, E08-005, ran from April 26th through May 10th in Jefferson Lab's Hall A
- The kinematics taken were:

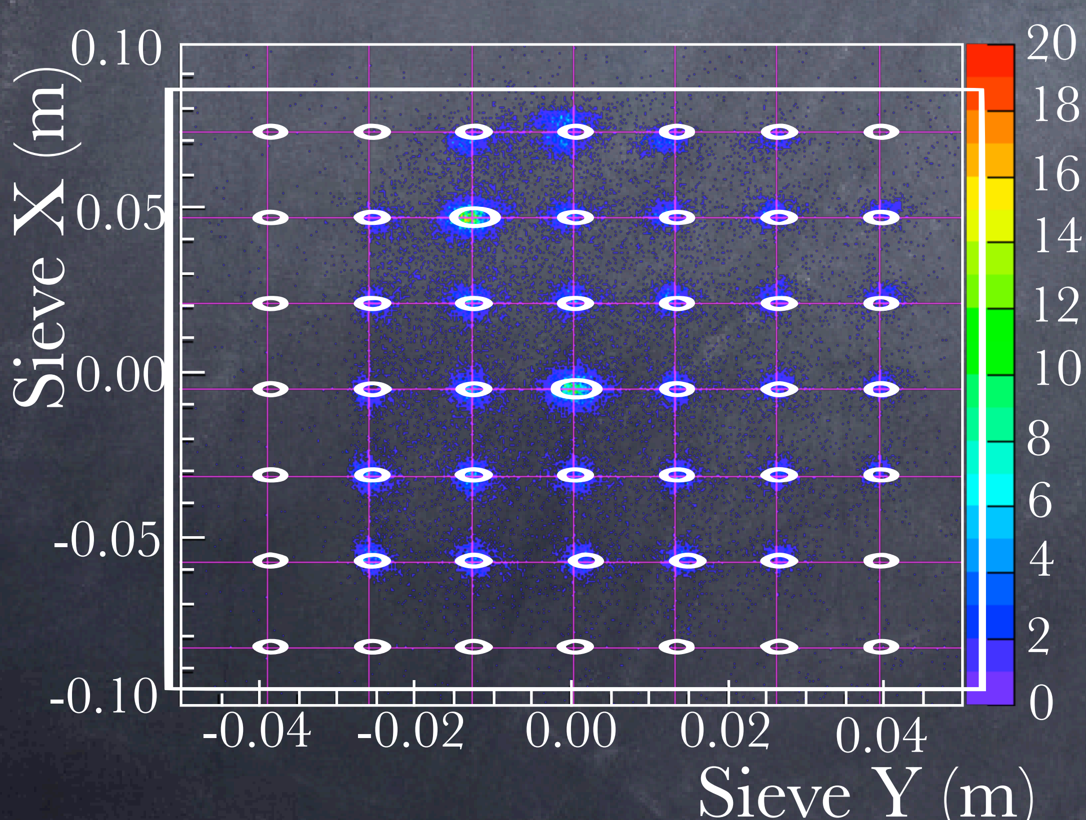
E_0 [GeV]	E' [GeV]	θ_{lab} [°]	Q^2 [GeV]^2	|q| [GeV/c]	θ_q [°]
1.25	1.22	17.0	0.13	0.359	71.0
2.43	2.18	17.0	0.46	0.681	62.5
3.61	3.09	17.0	0.98	0.988	54.0

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





What's been done

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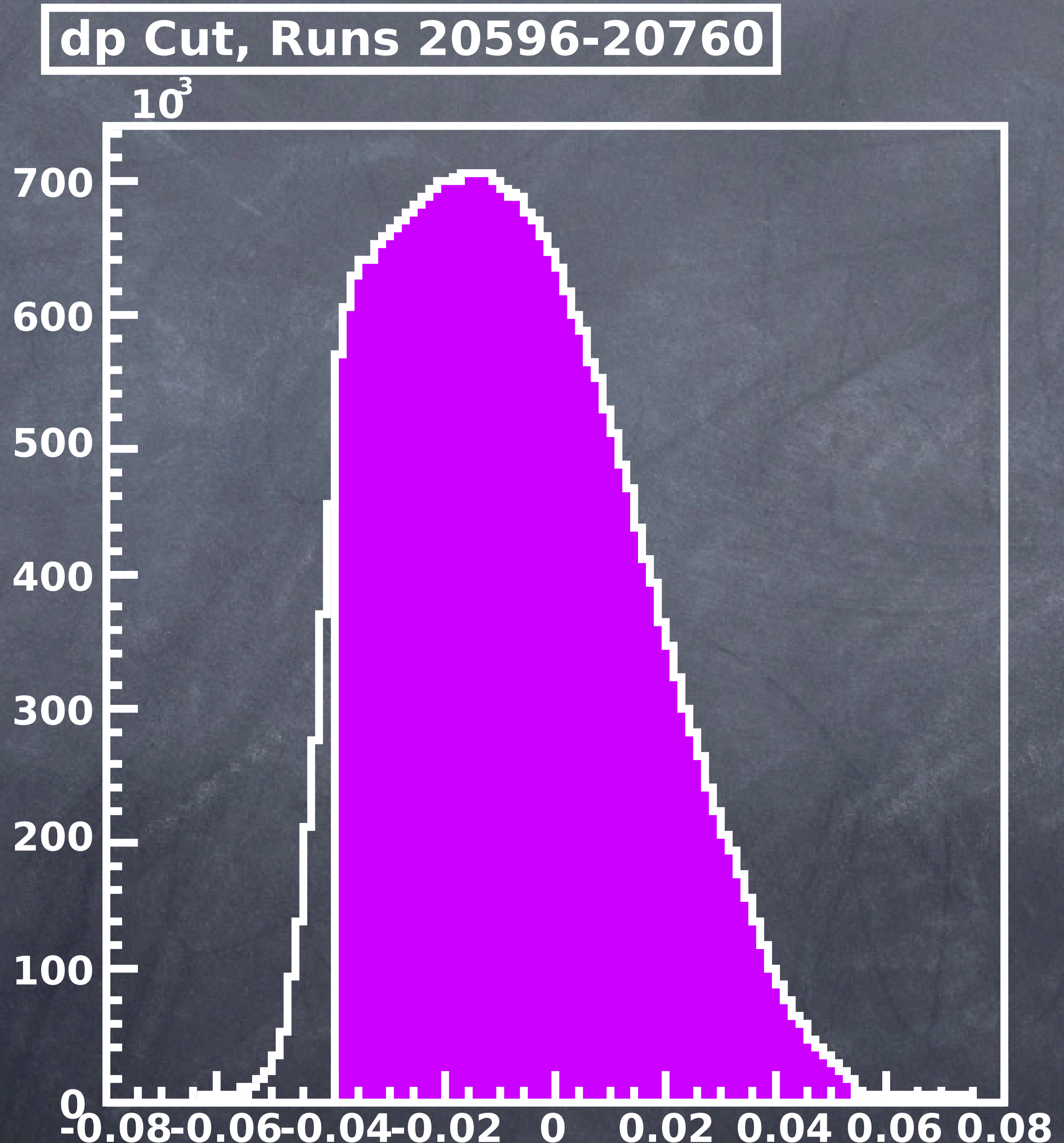

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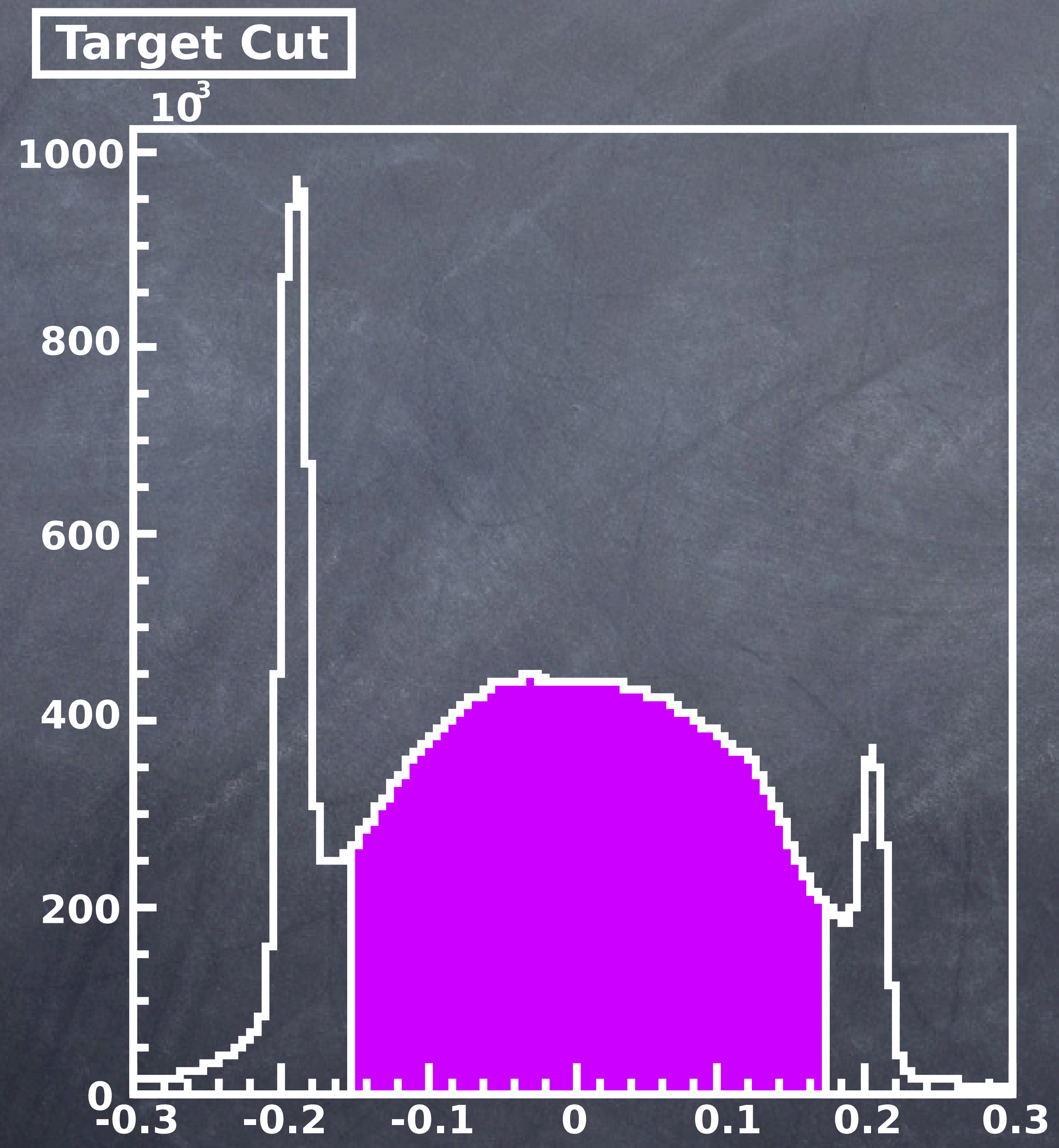

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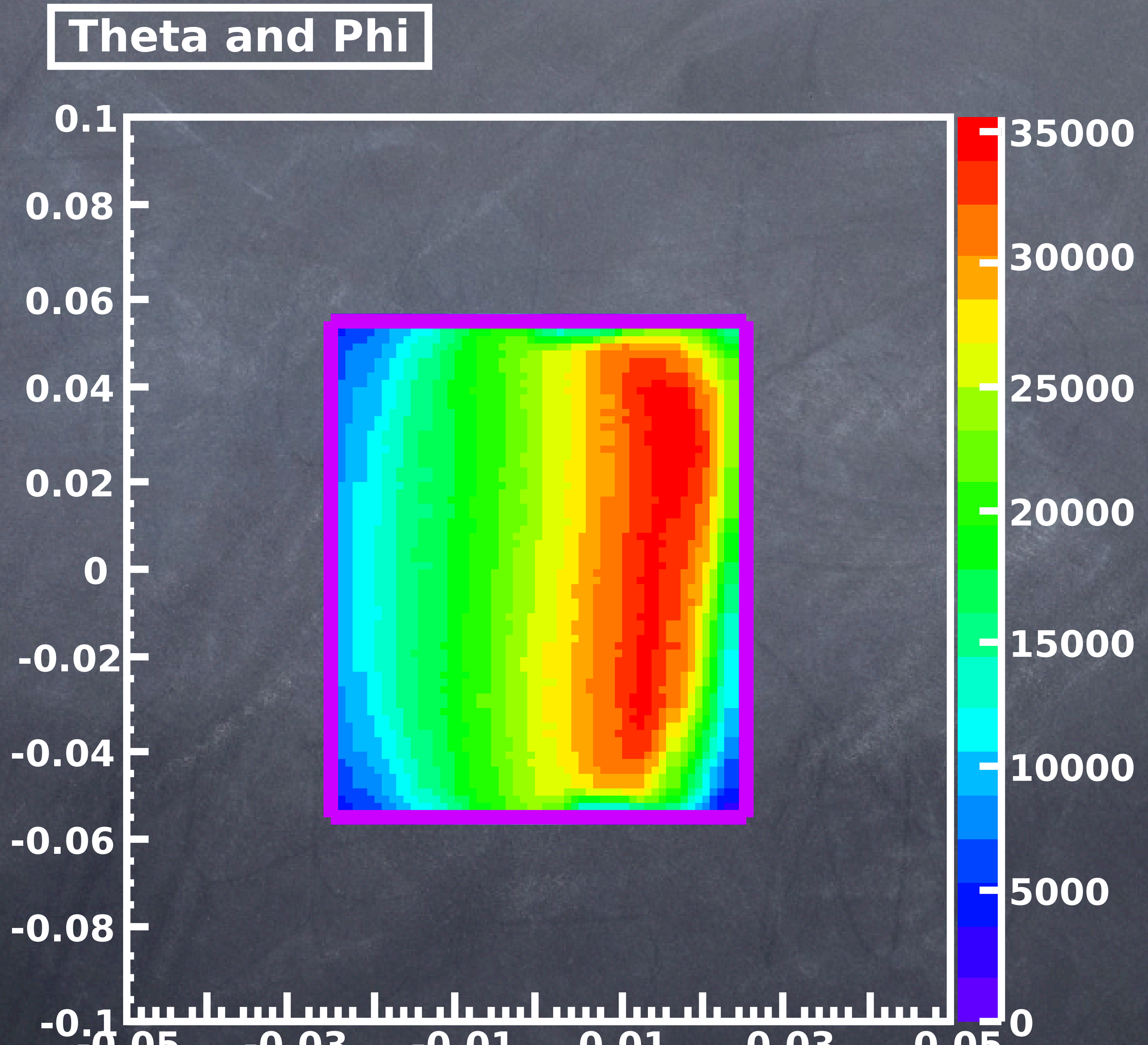

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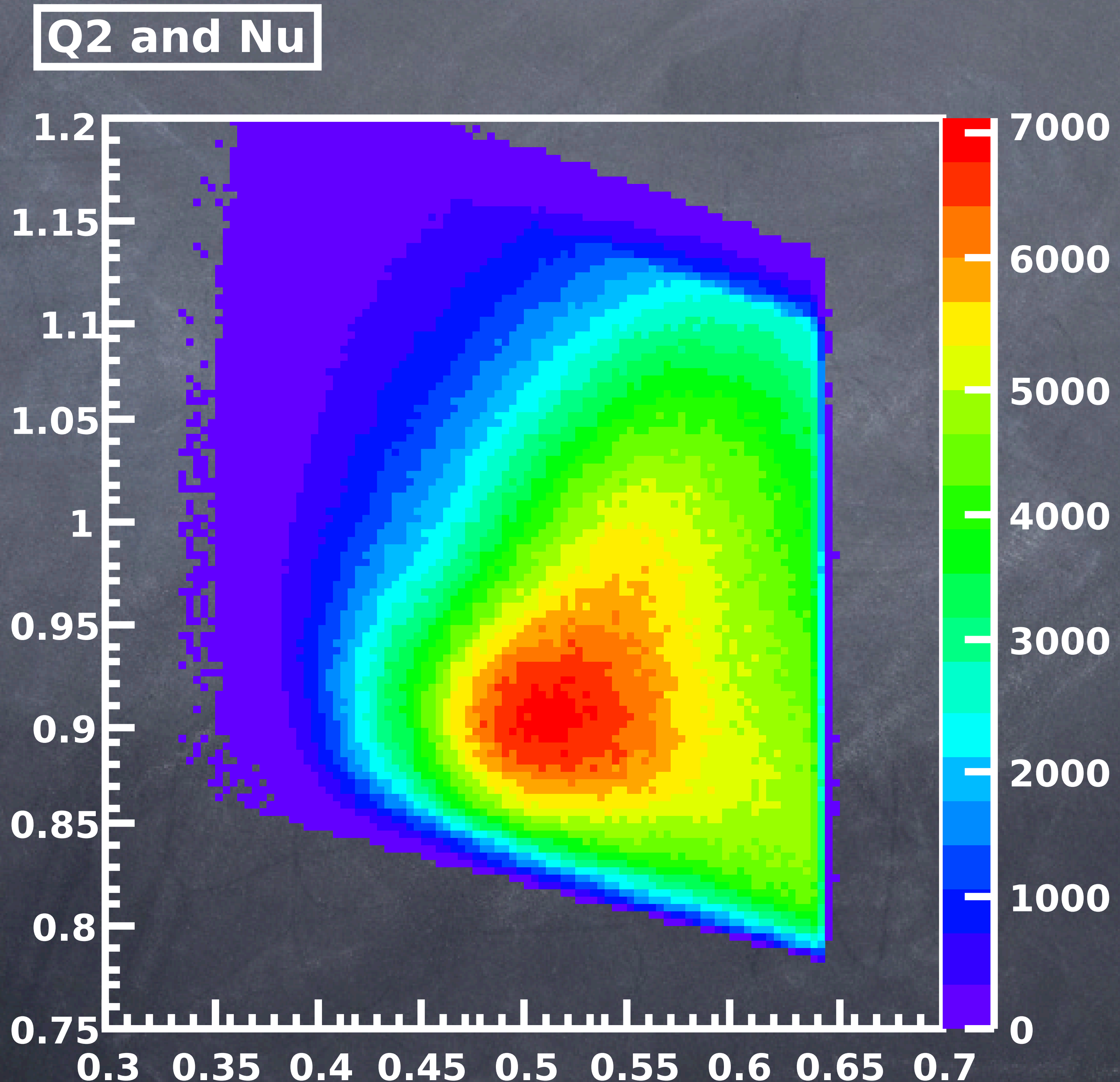

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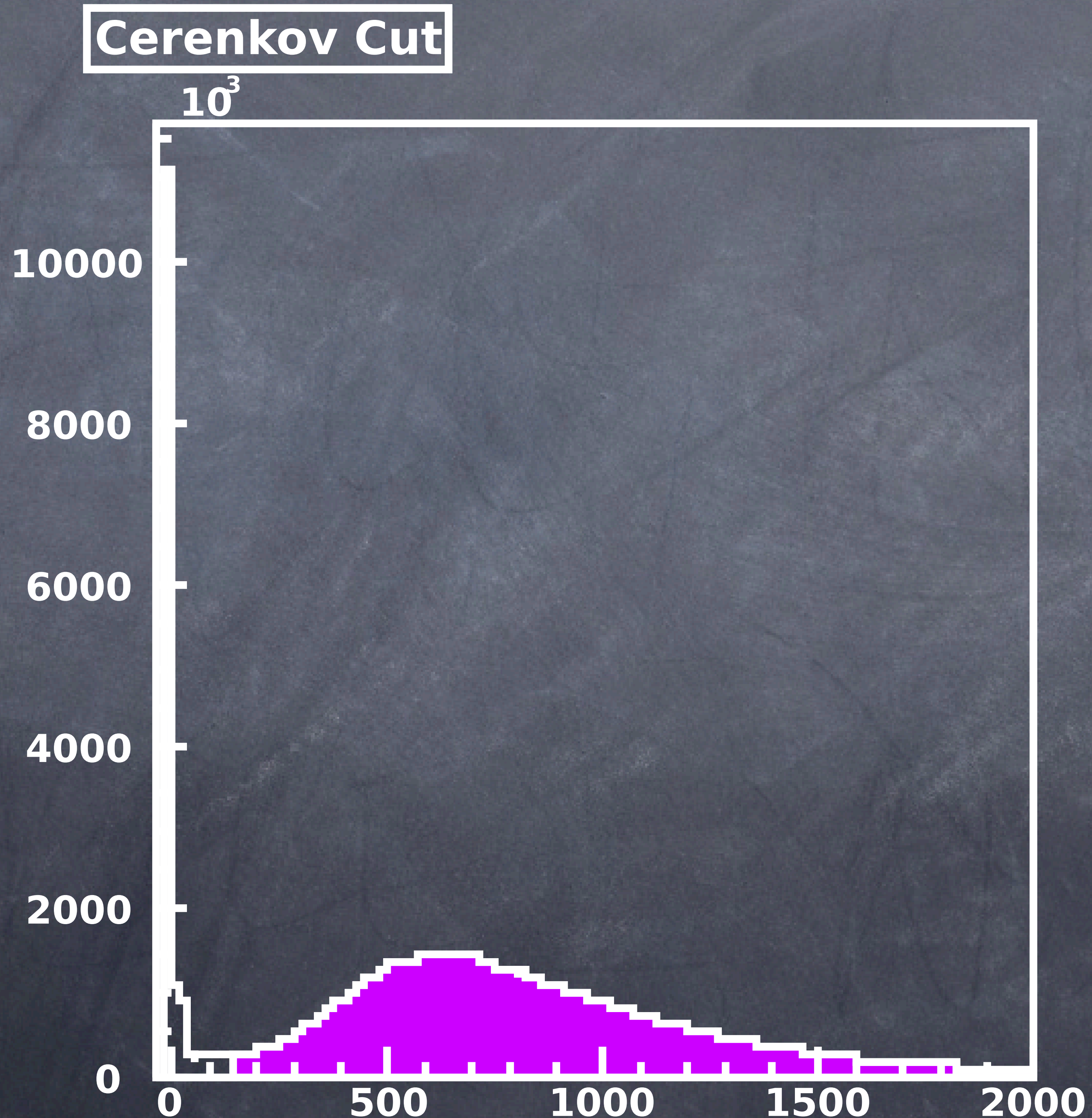

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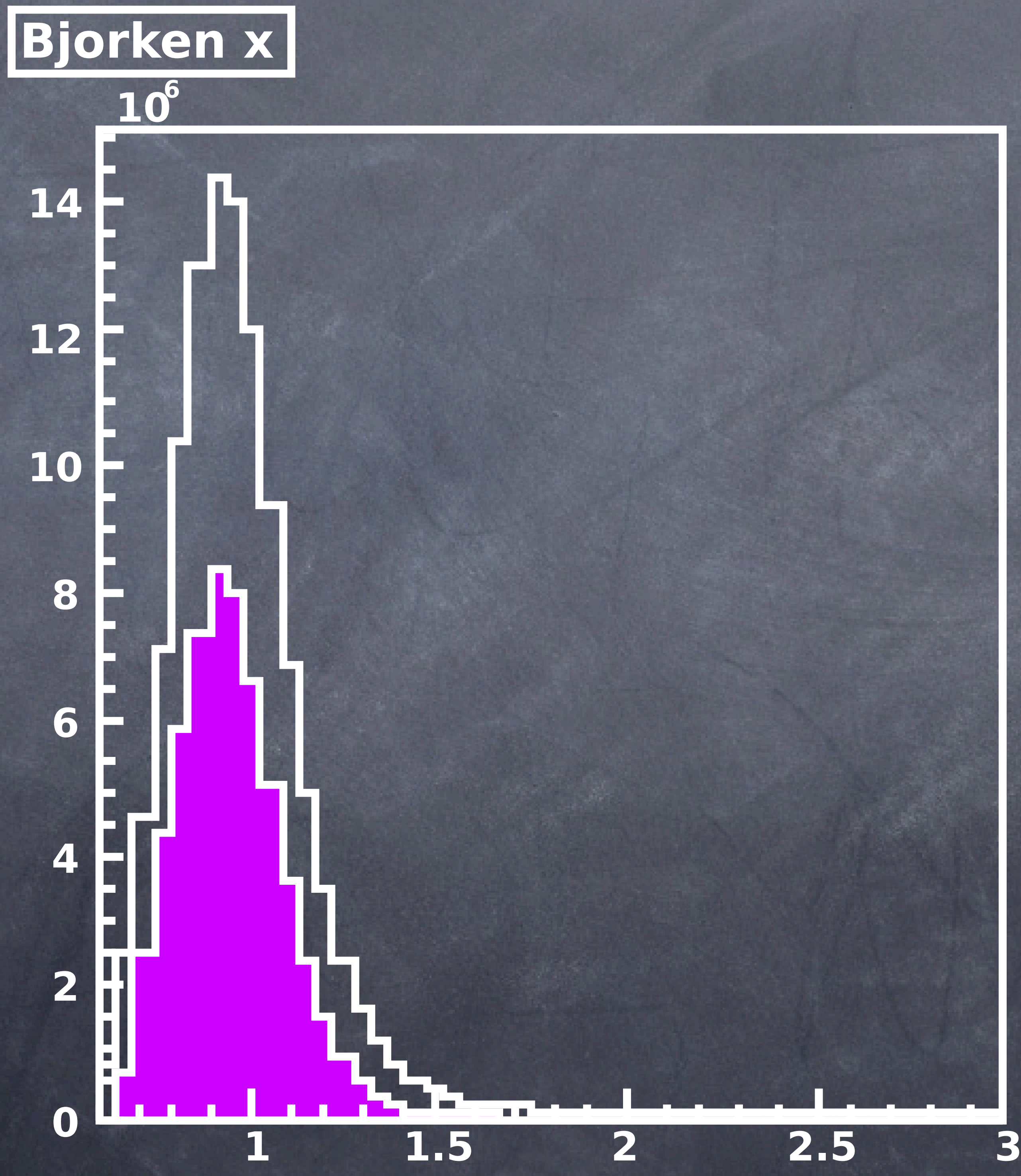

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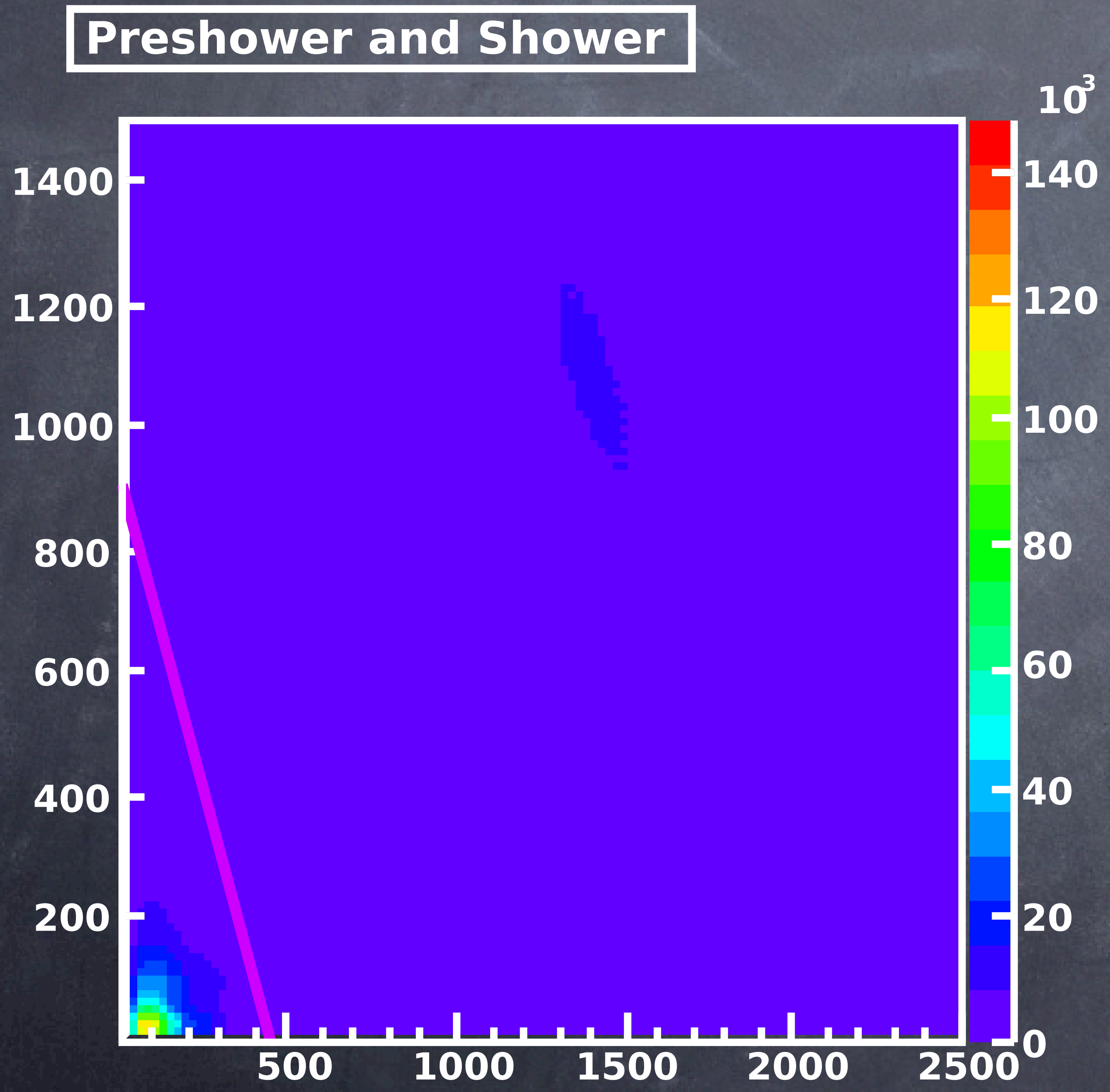

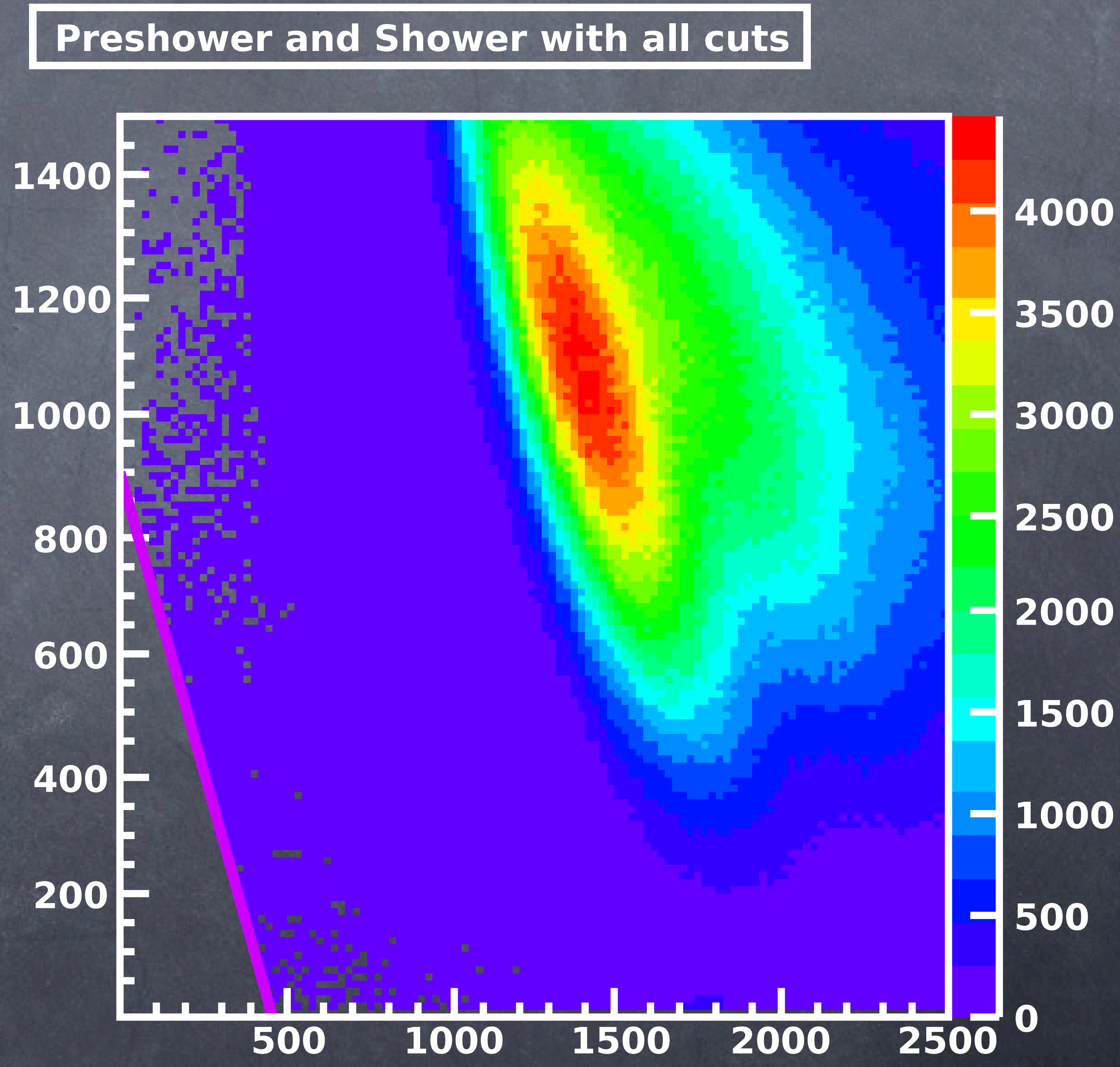

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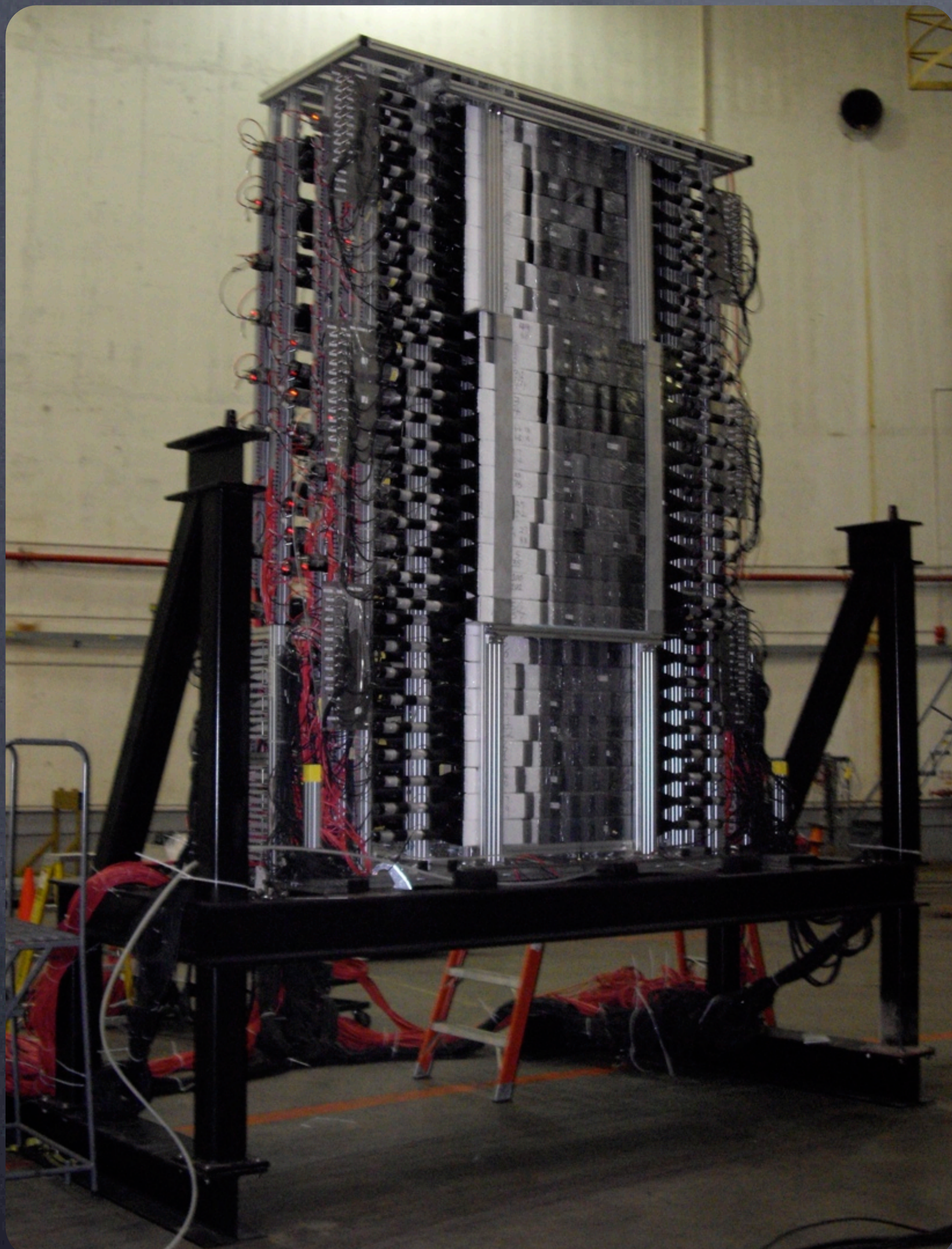
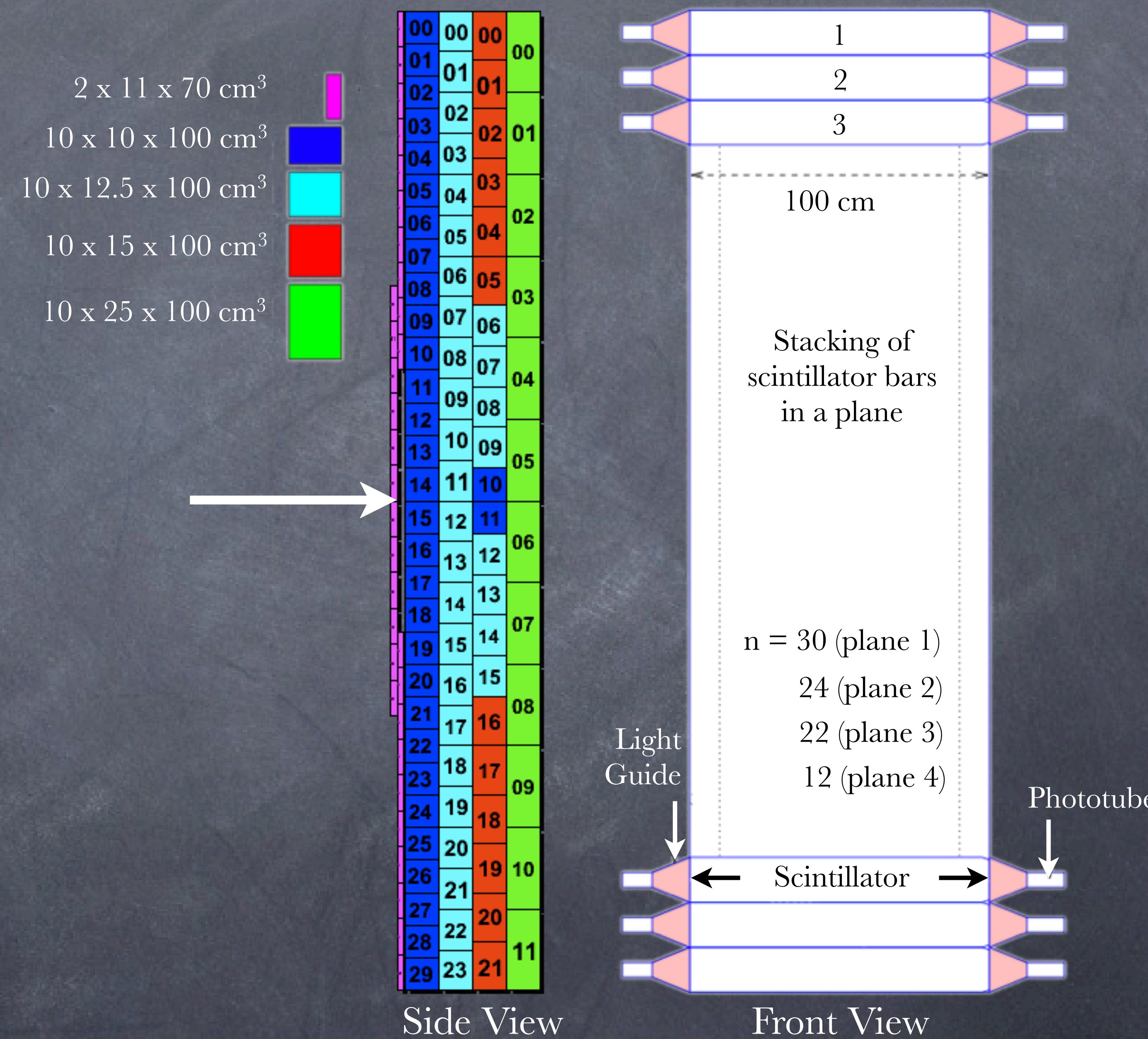
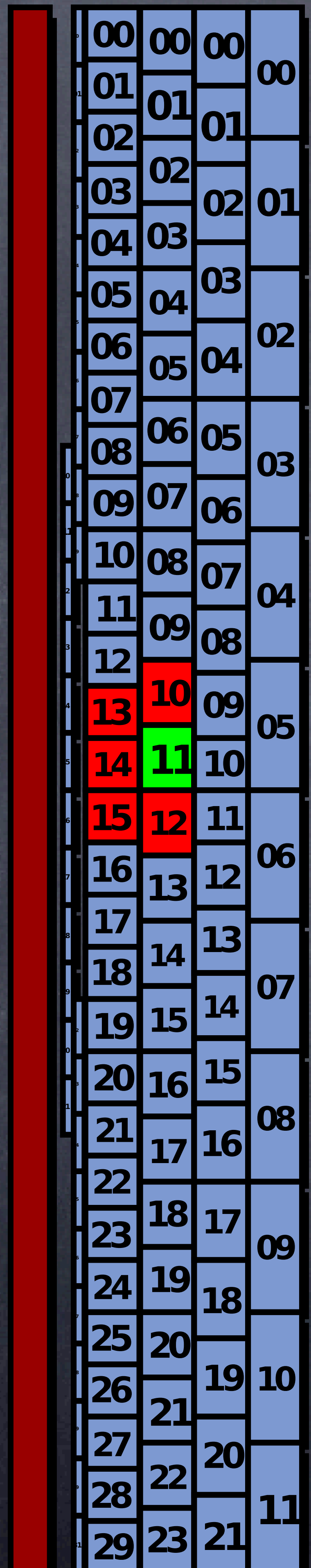


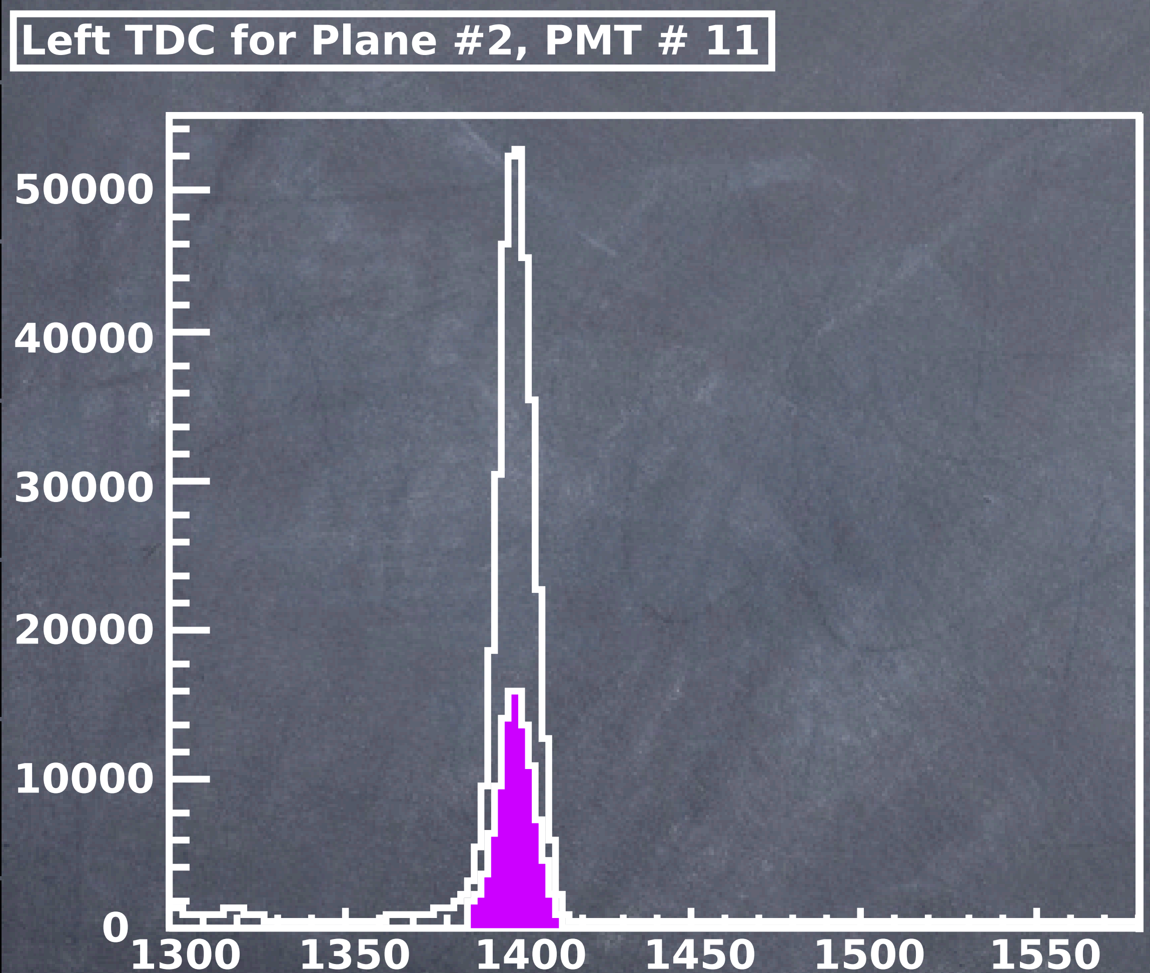
- HAND

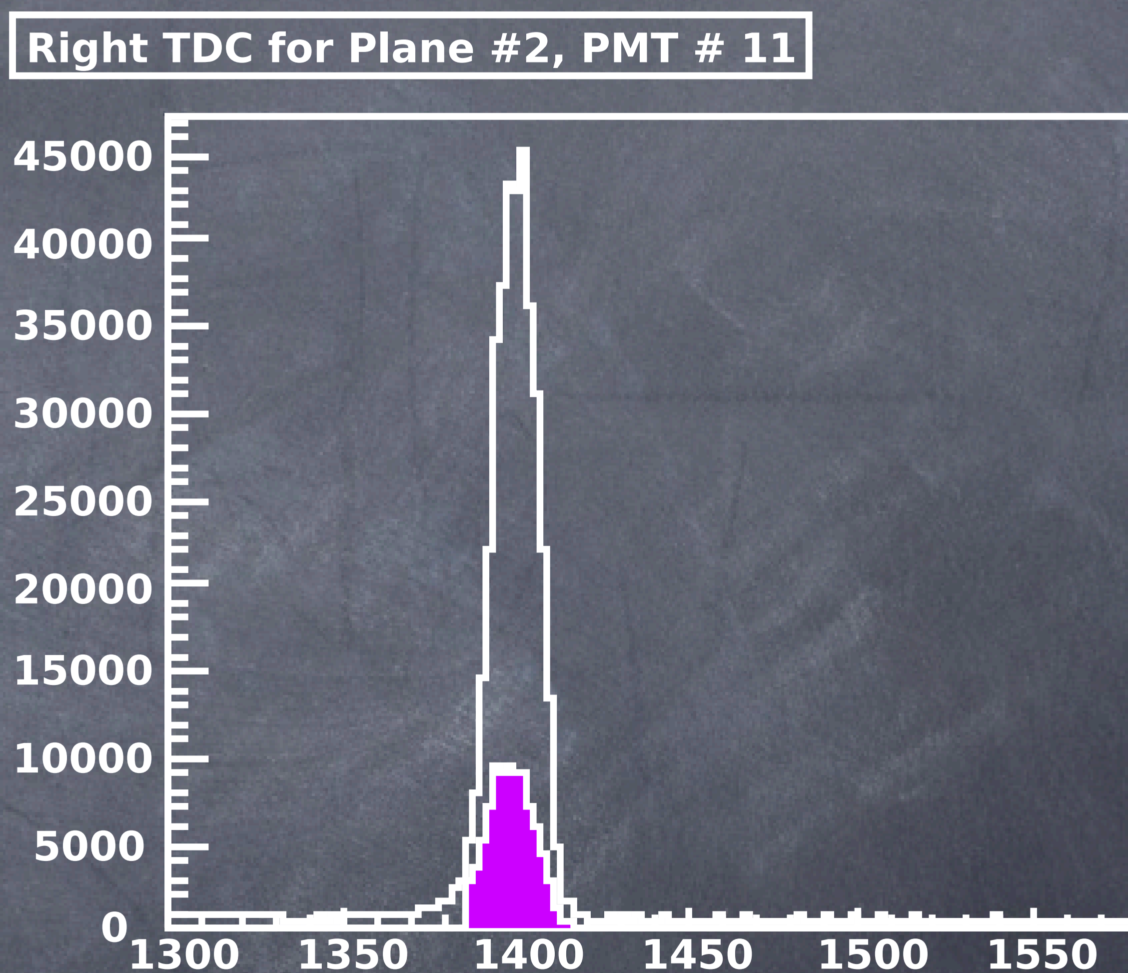


What's been done?

- Selection of Neutrons

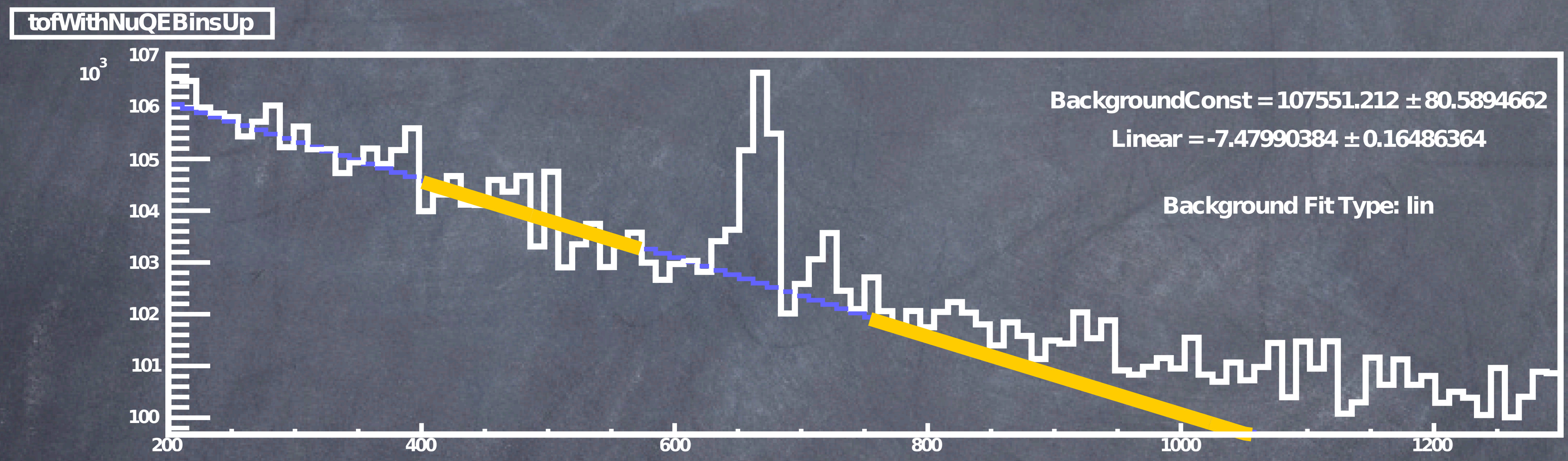


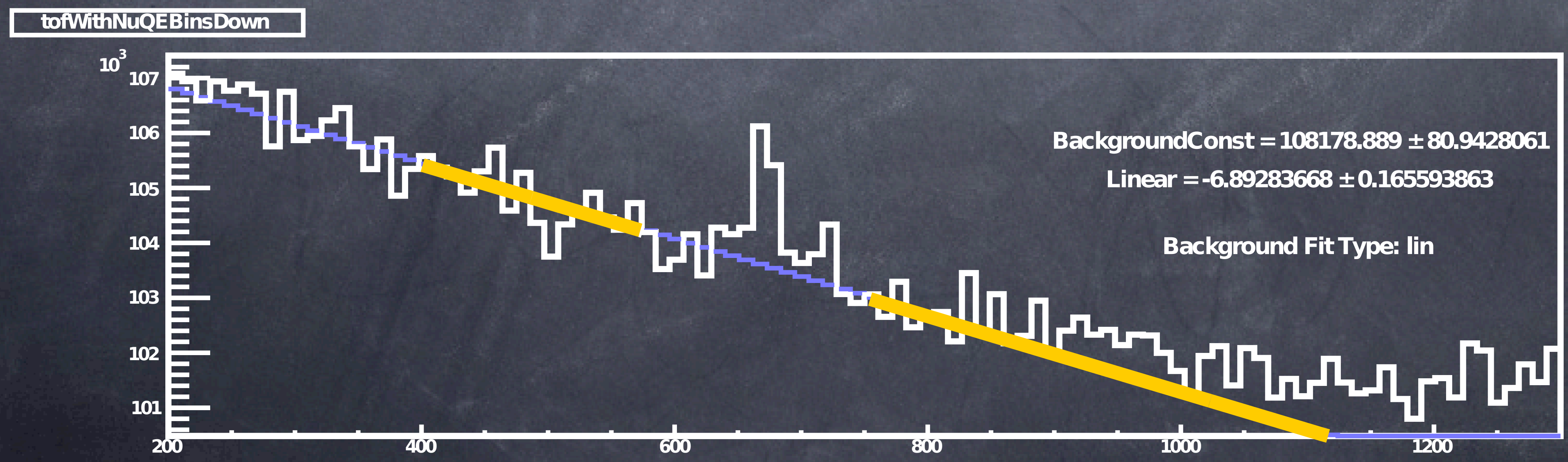




What's being worked on

- Subtracting background from ToF





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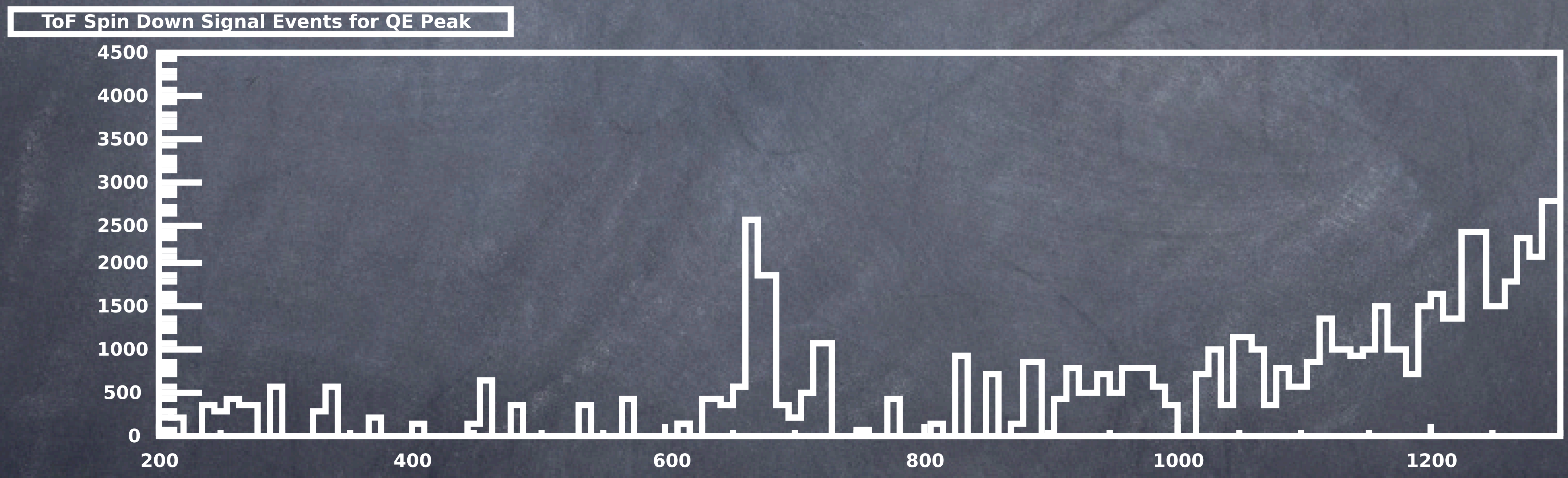

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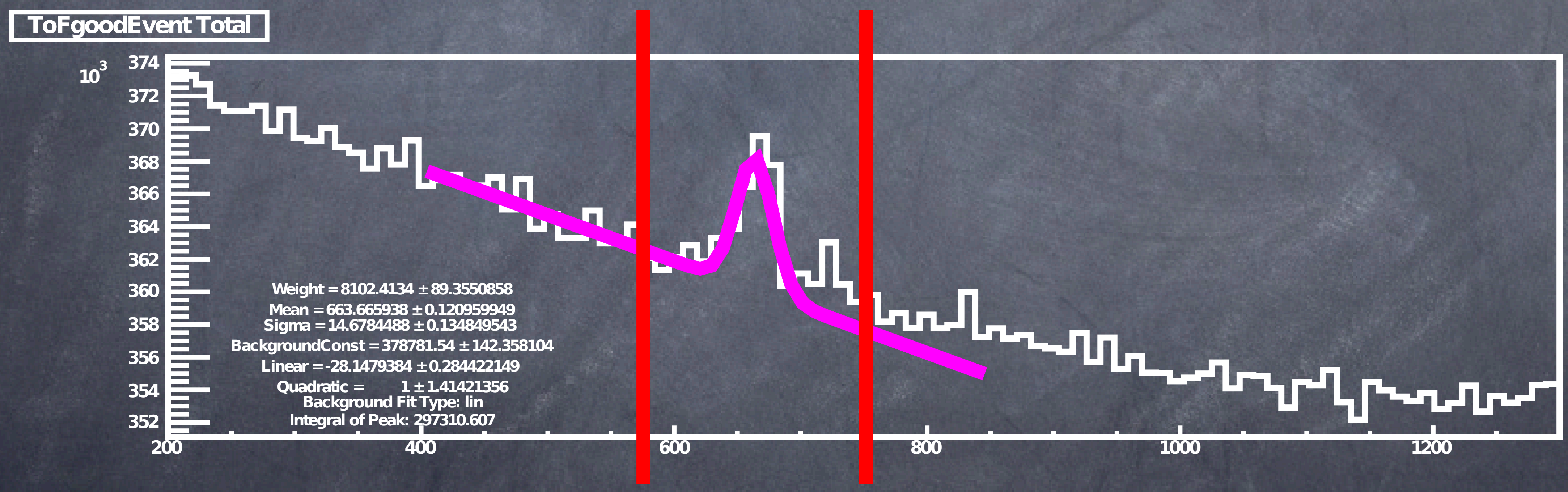
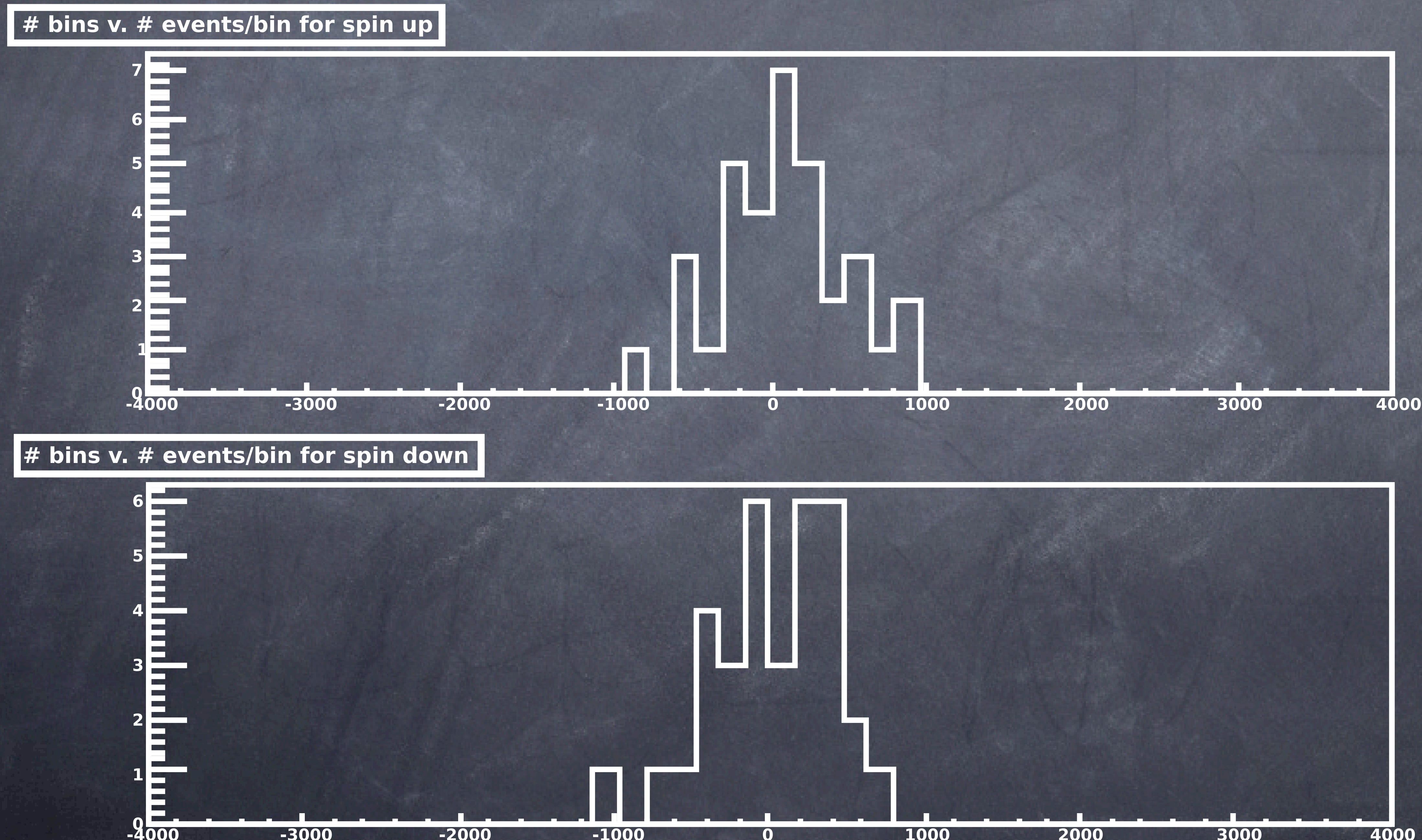


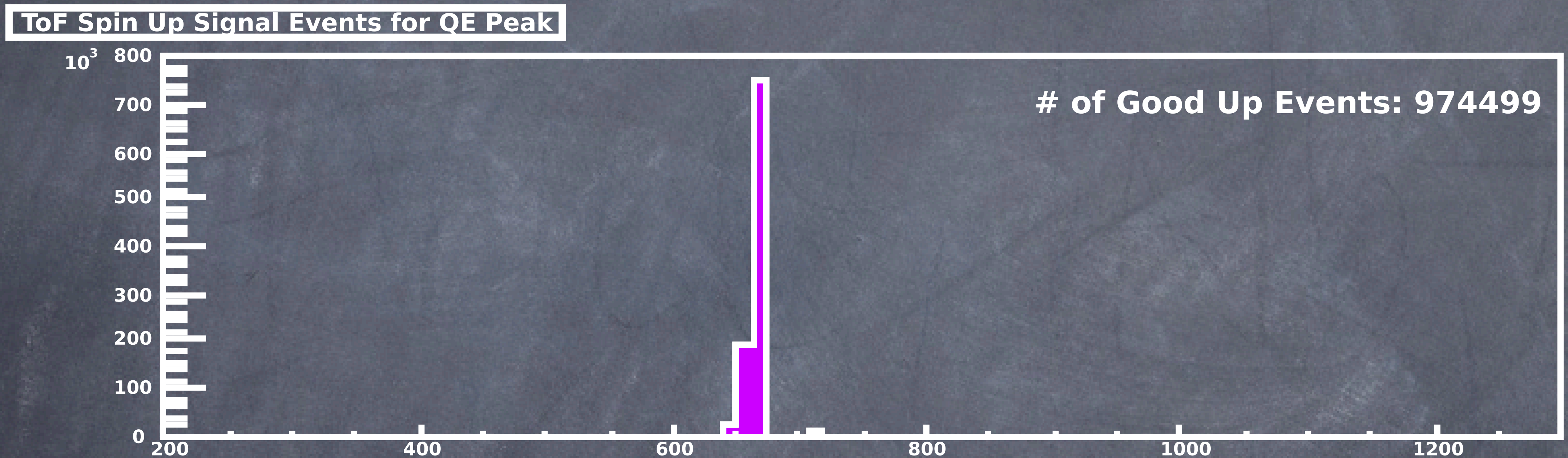
What's being worked on

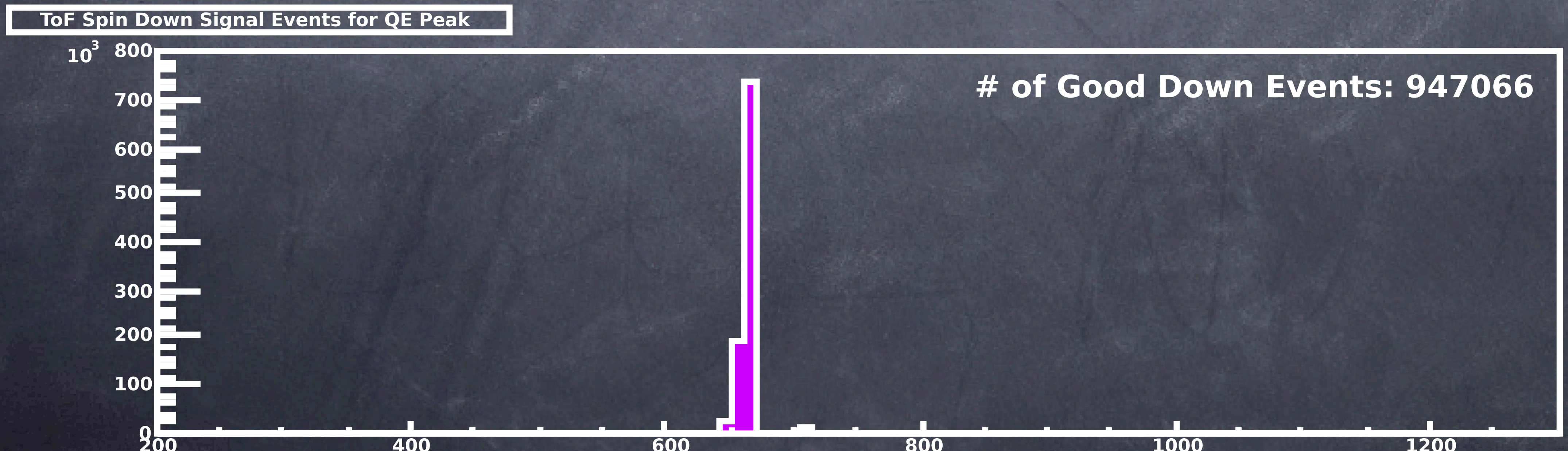
- Subtracting background from ToF - Error Estimates



What's being worked on

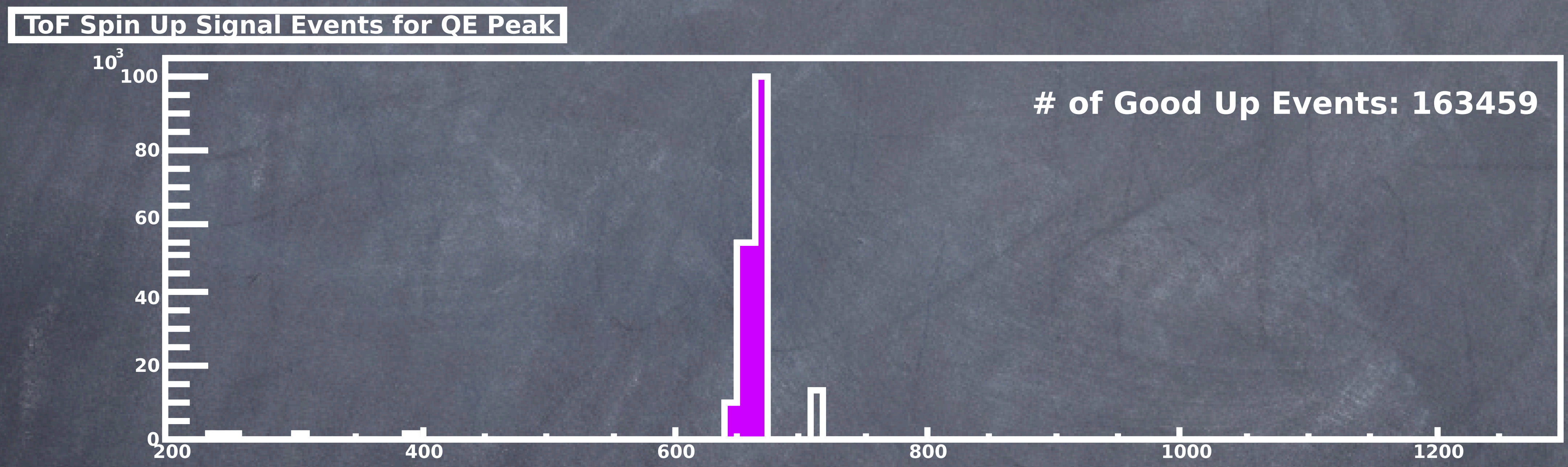
- Background-subtracted ToF peaks used to find asym
- Q^2=1.0 GeV^2, Quasi-Elastic, Vertical $^3He(e,e'n)$

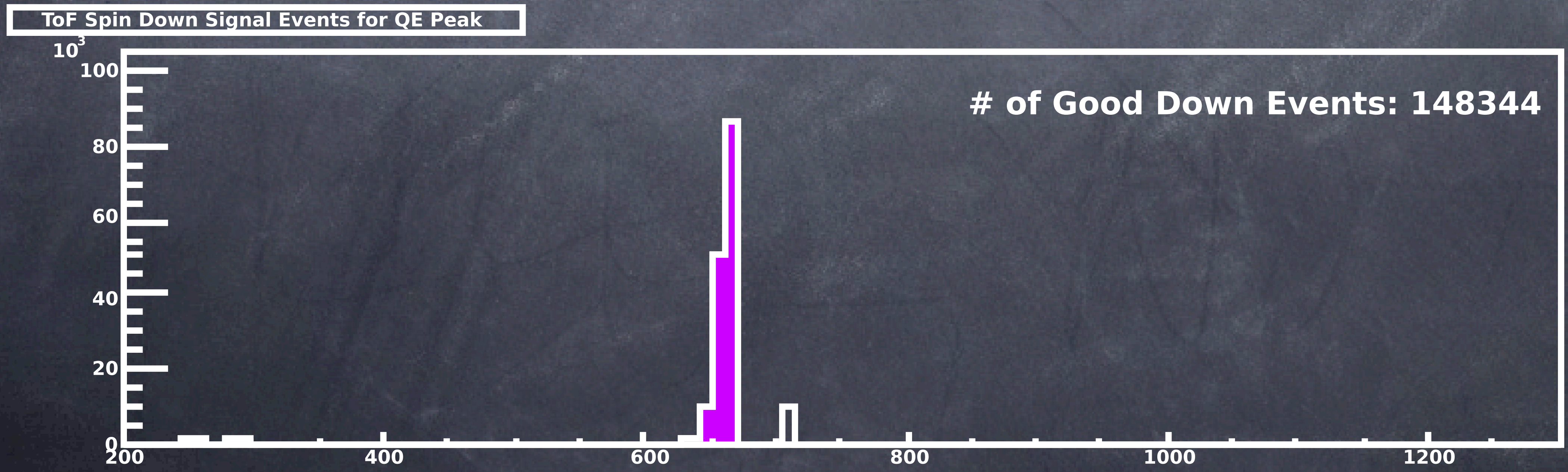




What's being worked on

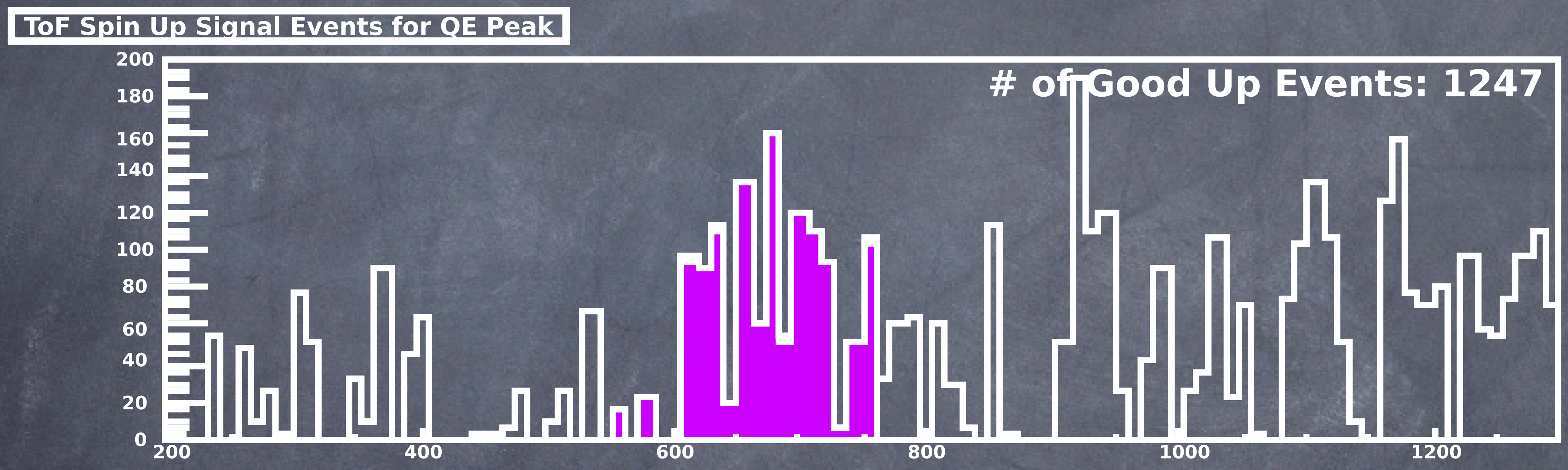
- Background-subtracted ToF peaks used to find asym
- Q^2=0.5 GeV^2, Quasi-Elastic, Vertical $^3He(e,e'n)$

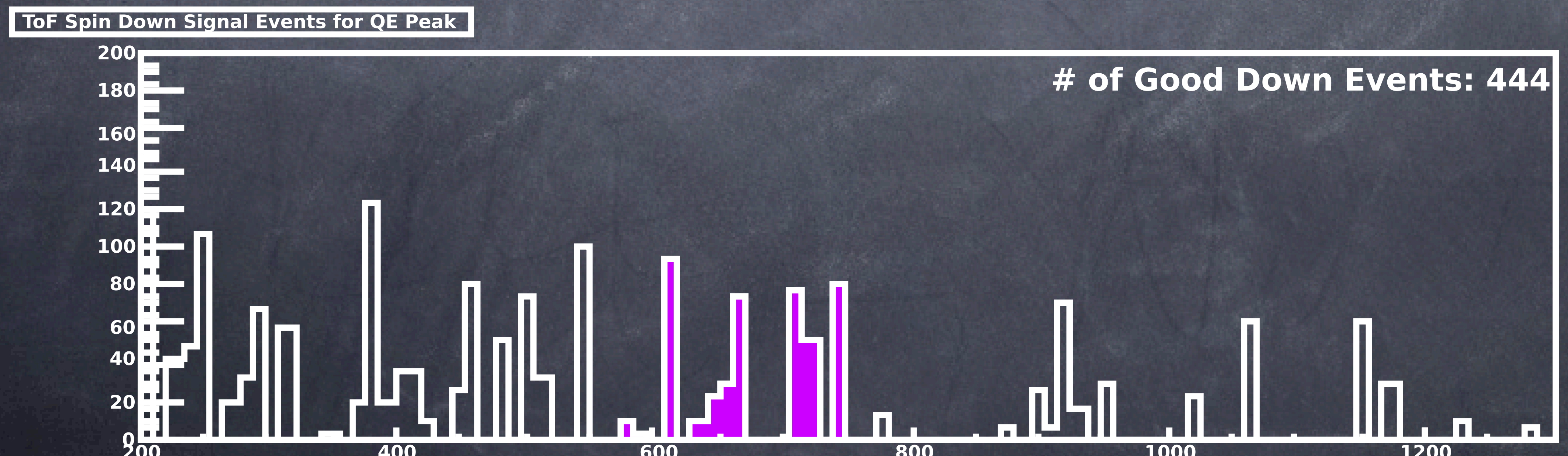




What's being worked on

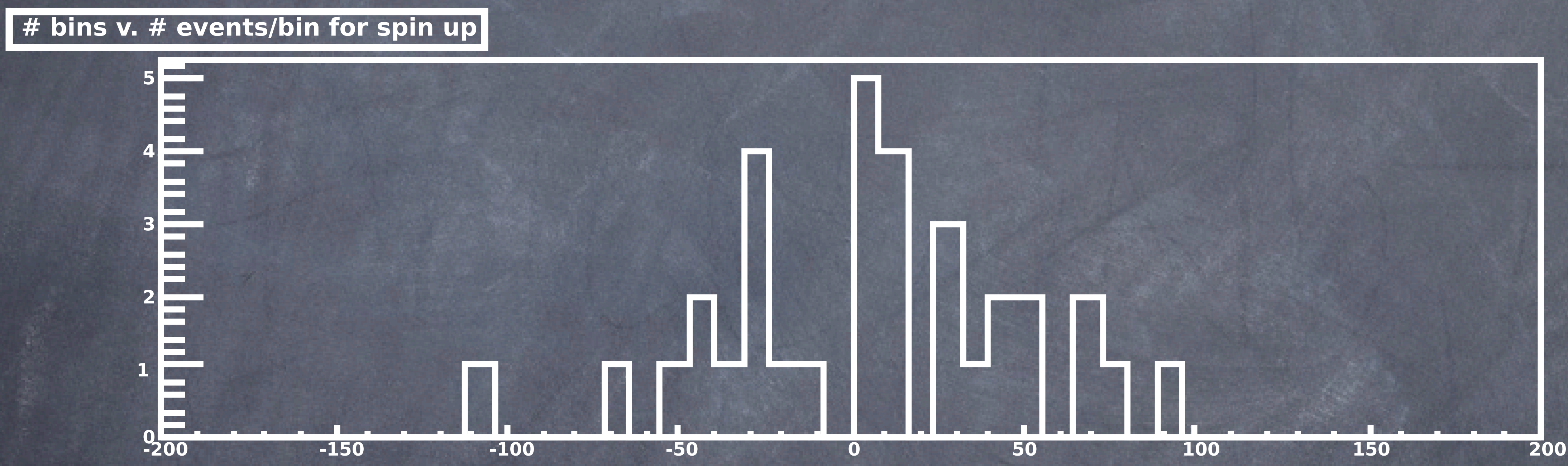
- Background-subtracted ToF peaks used to find asym
- Q^2=0.1 GeV^2, Quasi-Elastic, Vertical $^3He(e,e'n)$

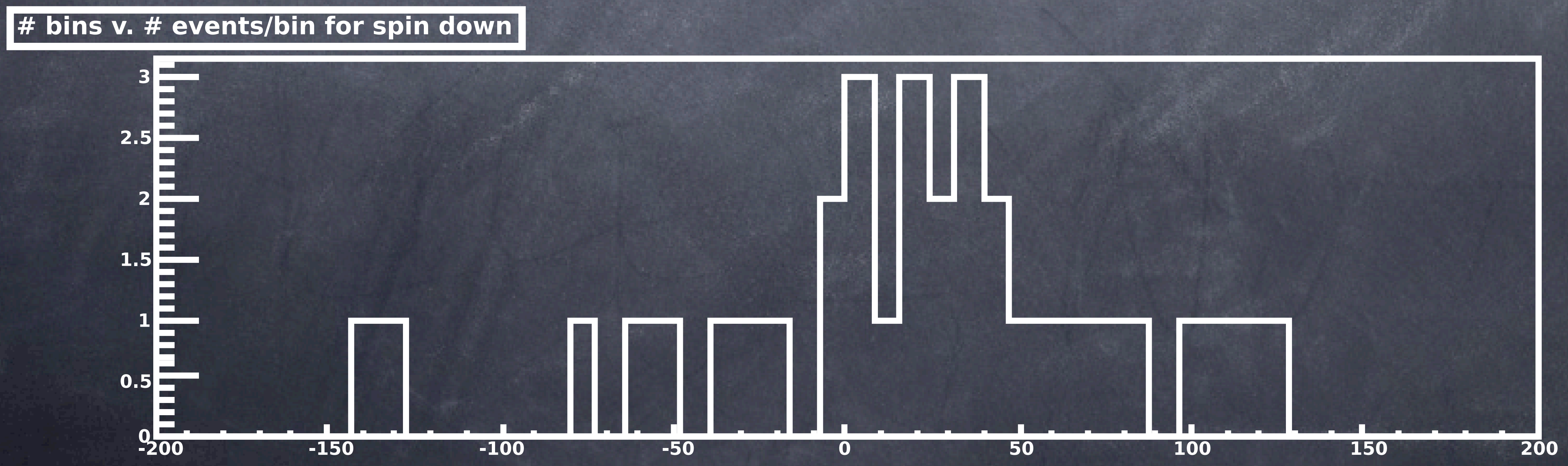




What's being worked on

- Background-error
- Q^2=0.1 GeV^2, Quasi-Elastic, Vertical $^3He(e,e'n)$





What's being worked on

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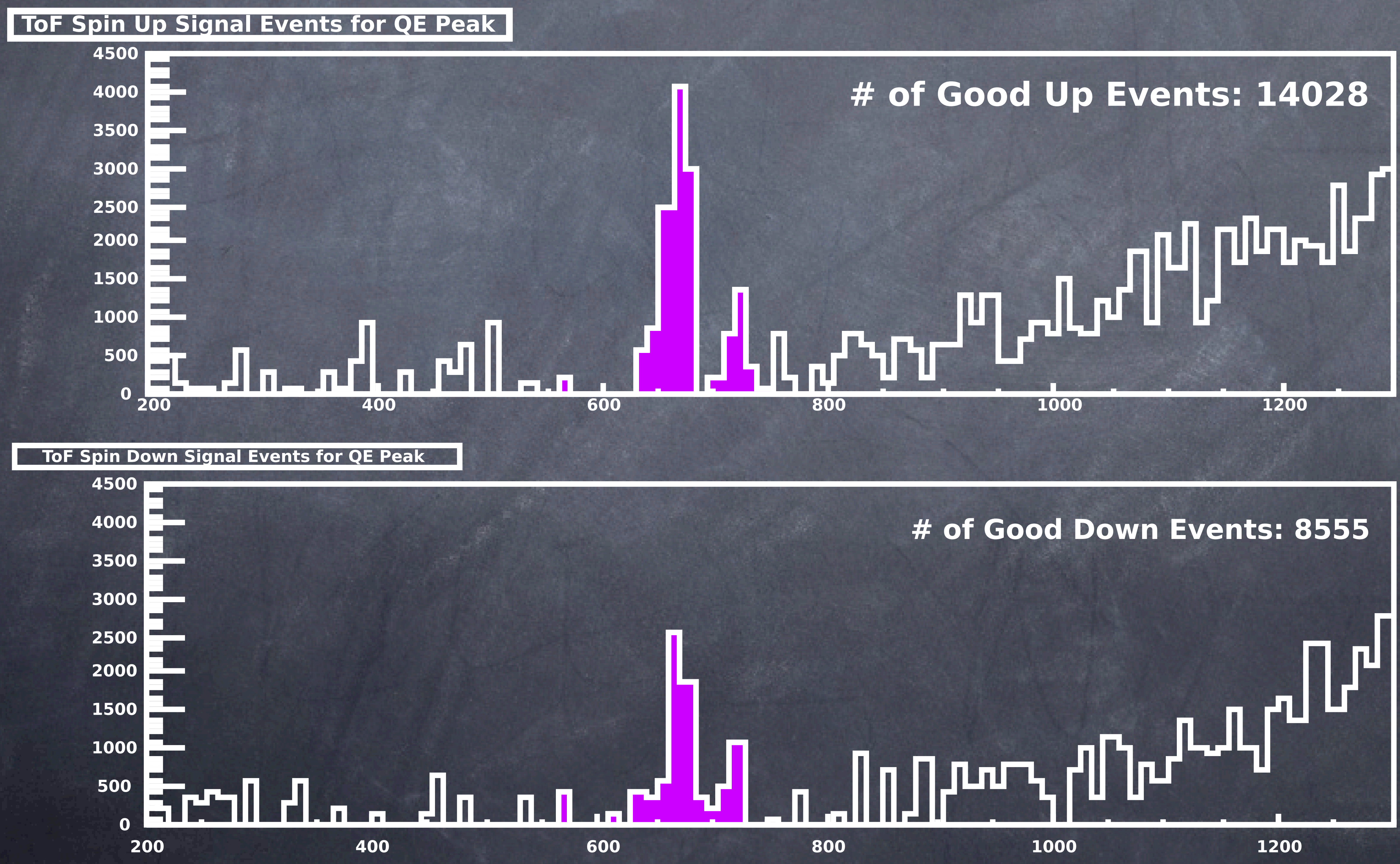
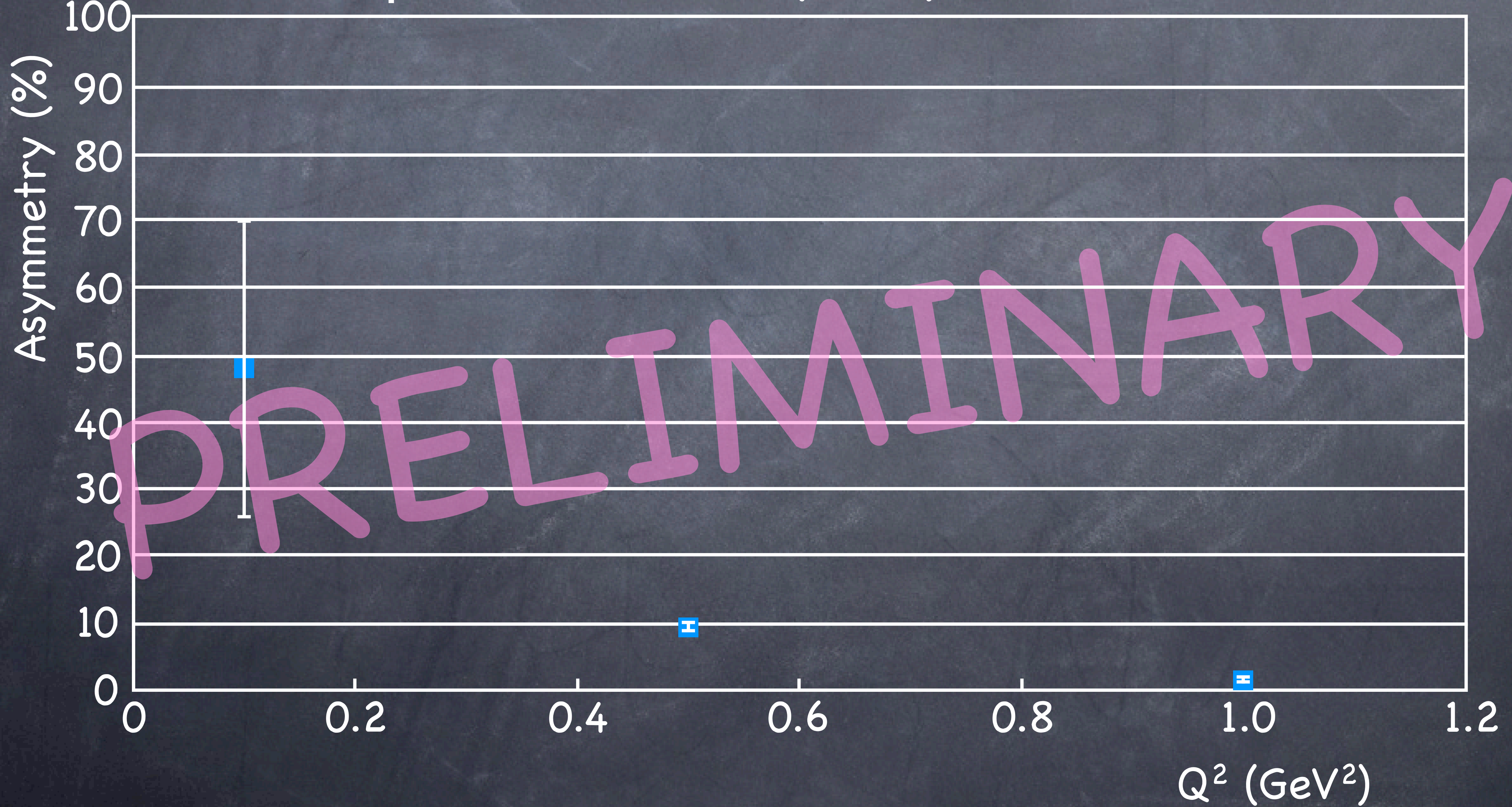


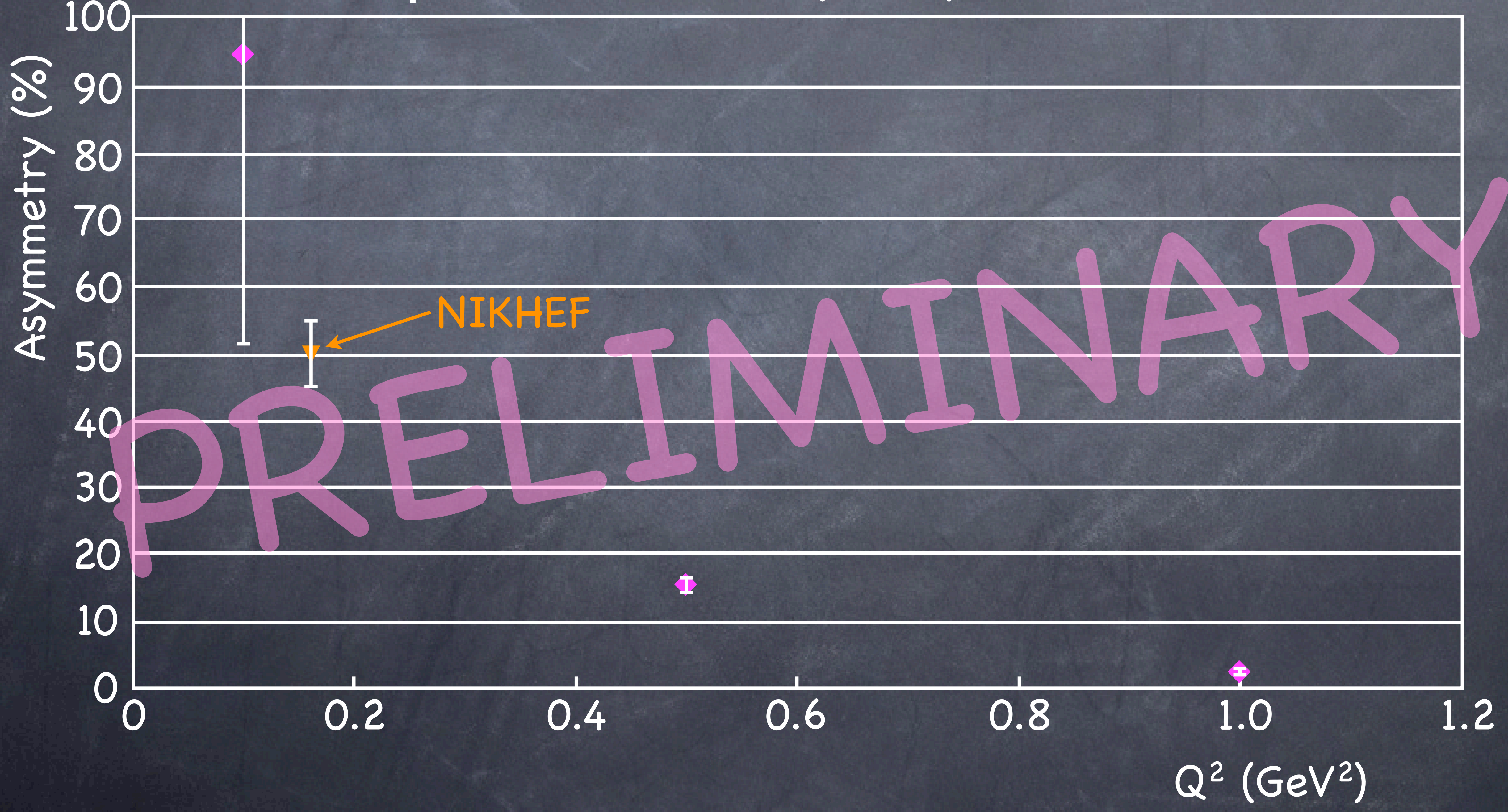
What's being worked on

- Raw Target SSA vs. Q^2
- Note: All points are $^3He^{\uparrow}(e,e'n)$



What's being worked on

- Target SSA vs. Q^2 with Target Polarization Dilution
- Note: All points are $^3He^{\uparrow}(e,e'n)$



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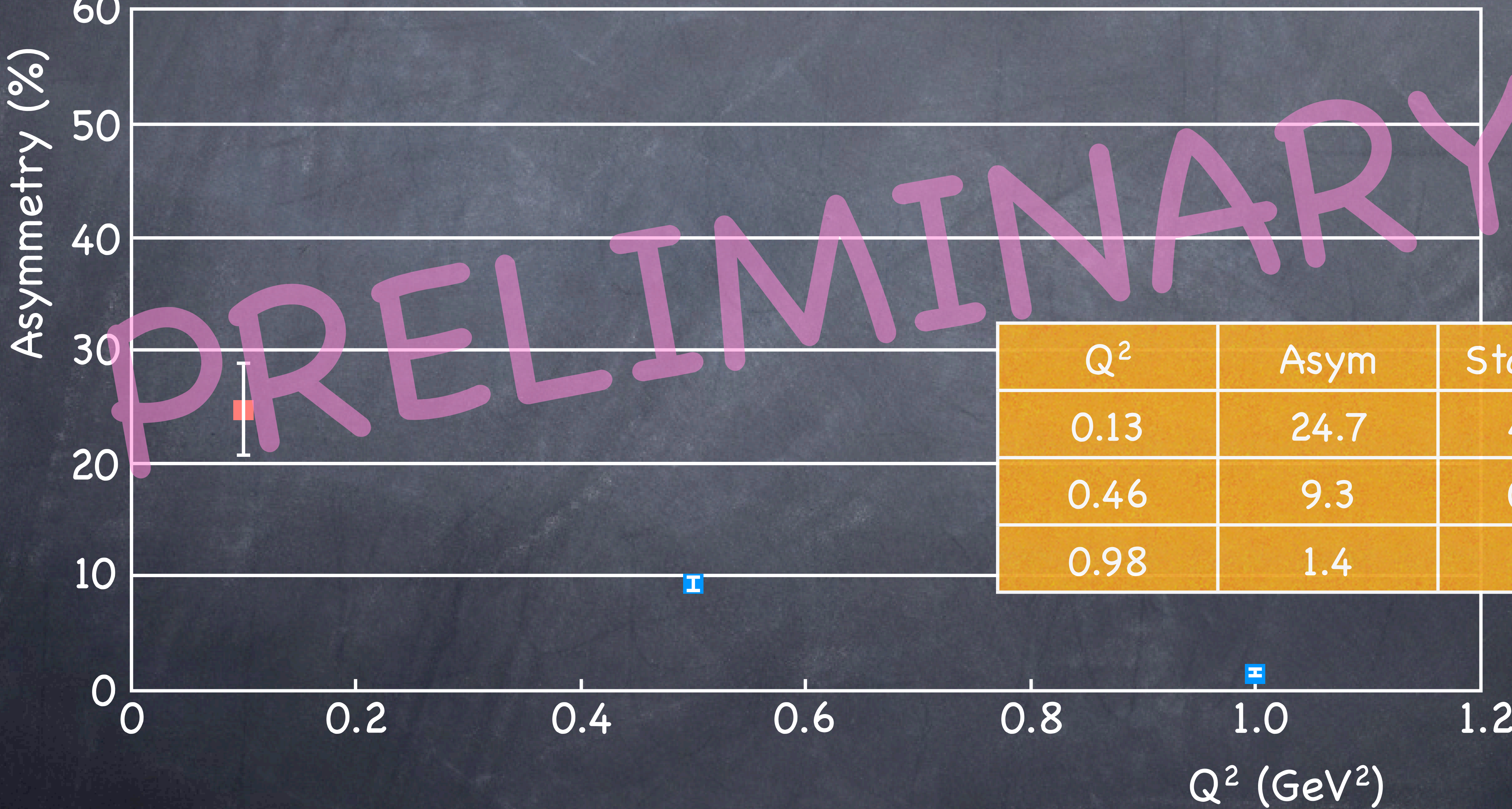

Q^2	Asym	Stat. Err.
0.13	24.7	4.03
0.46	9.3	0.59
0.98	1.4	0.21

What's being worked on

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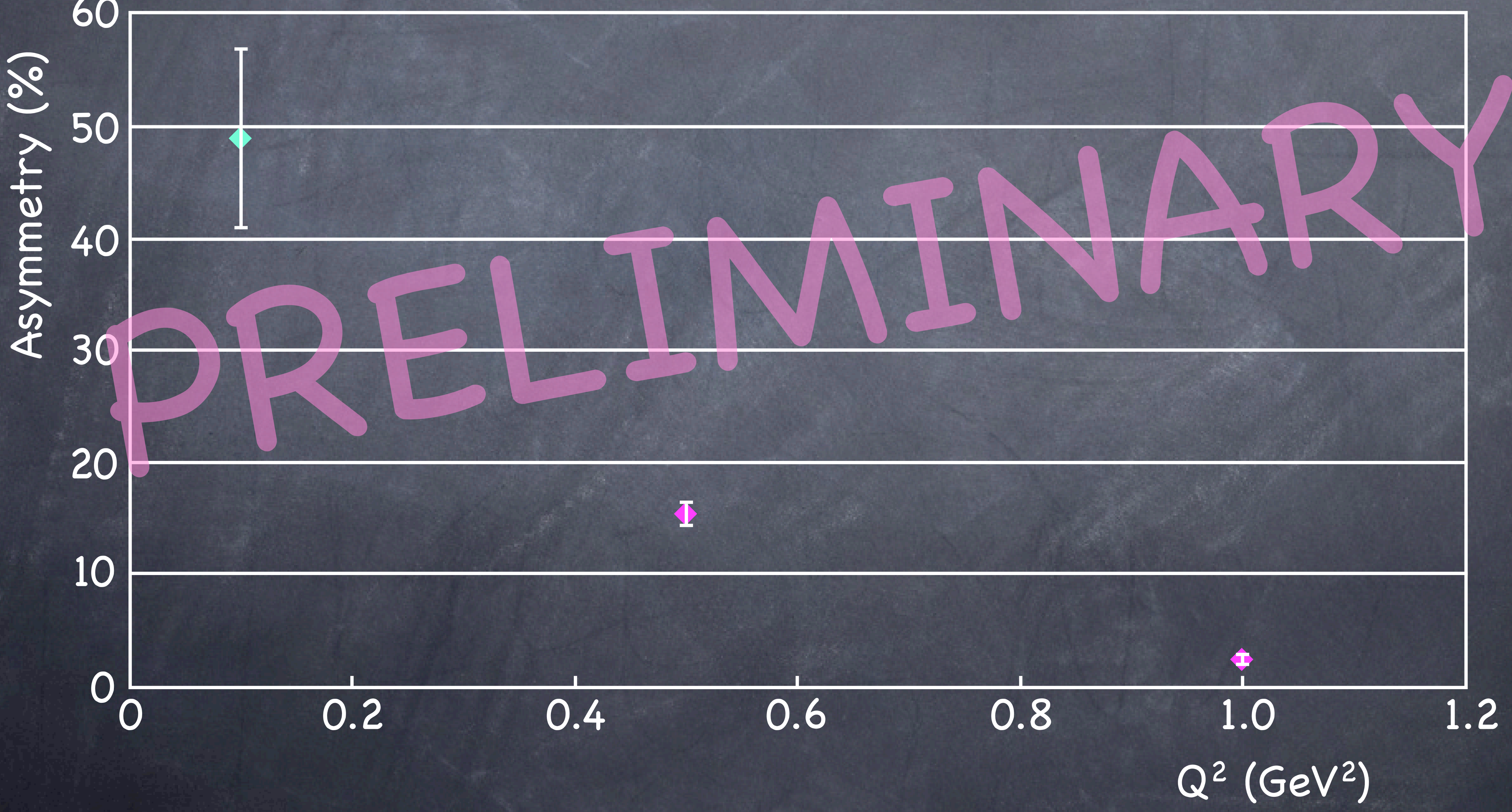

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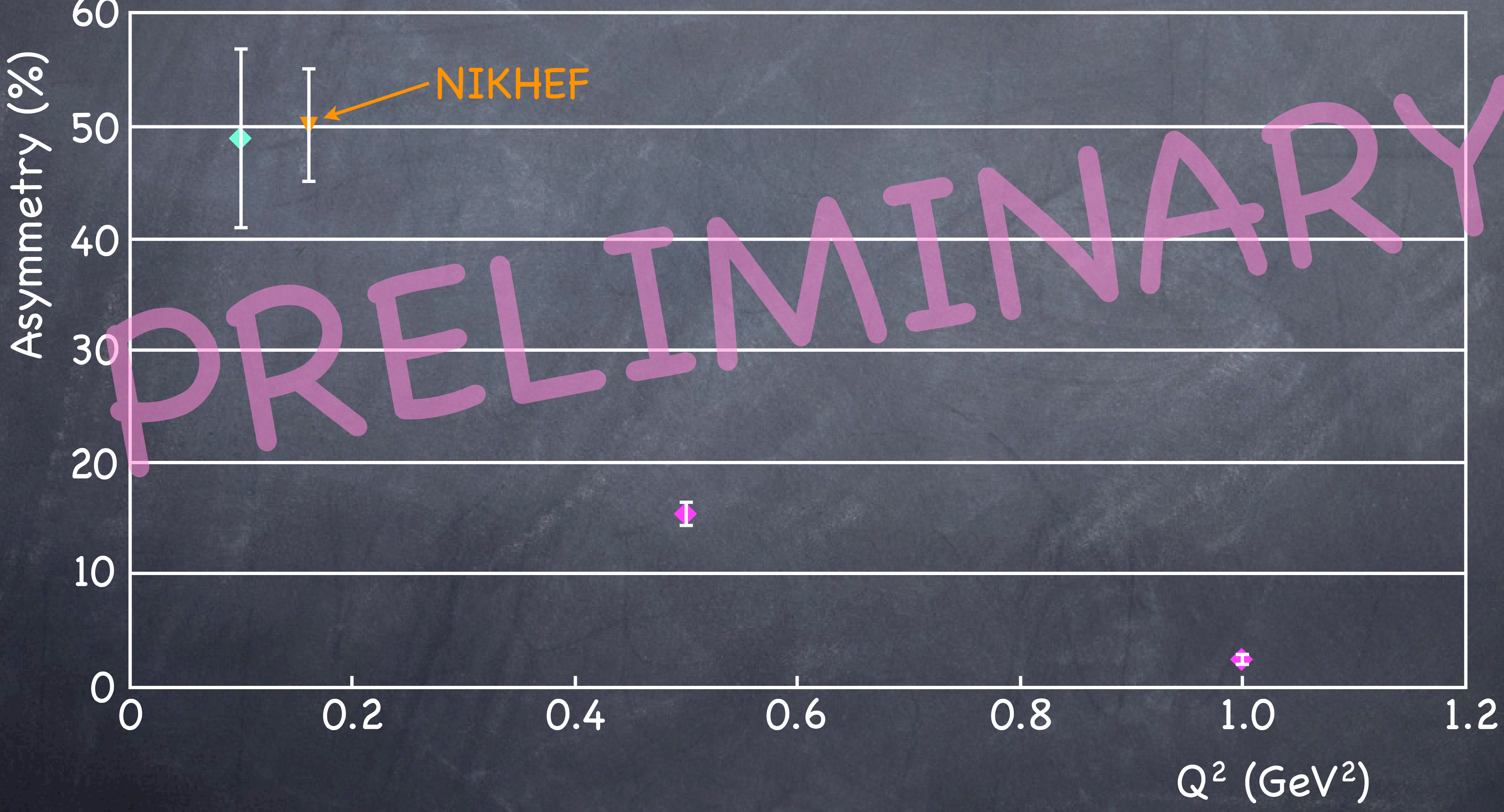

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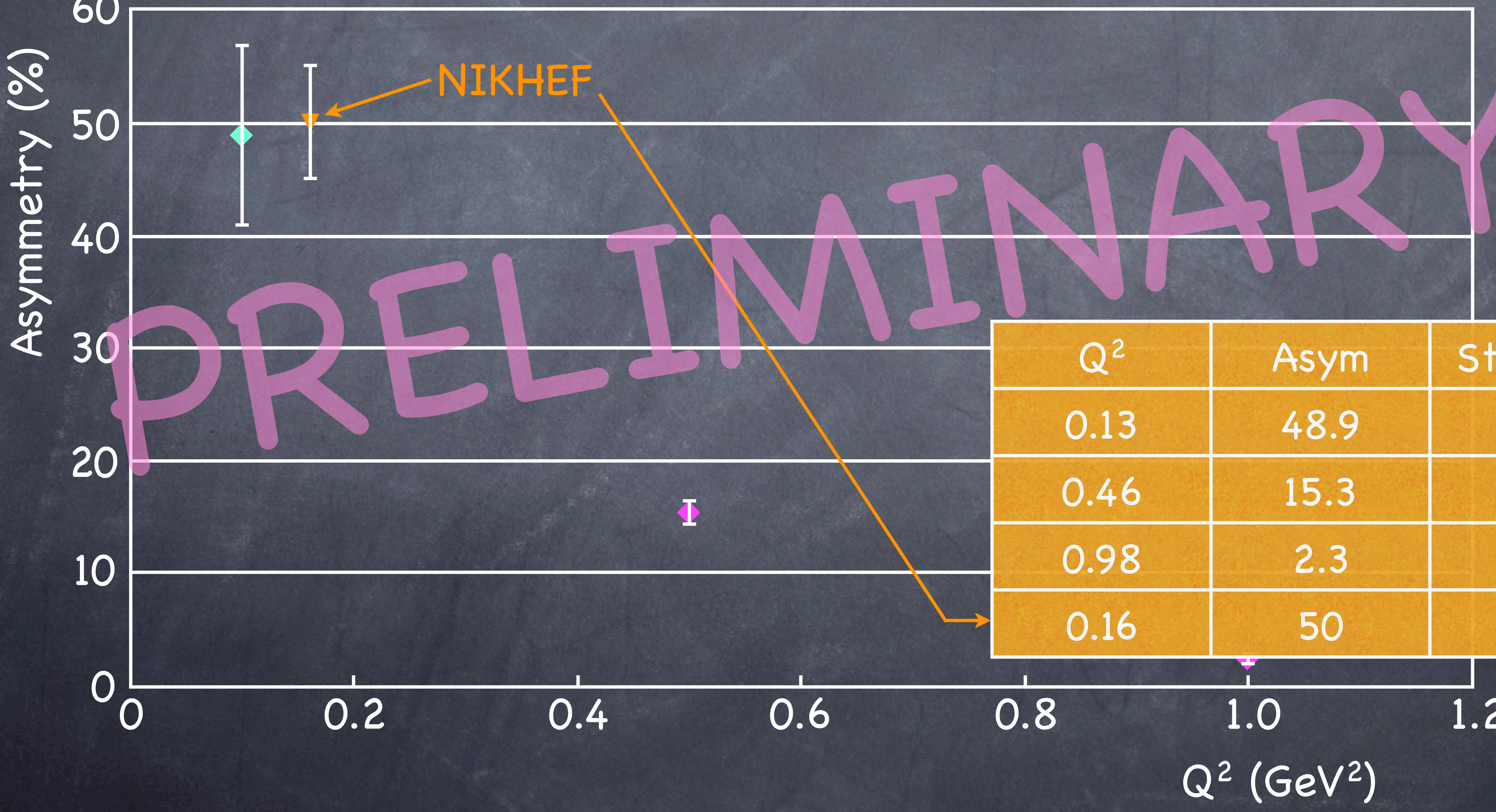
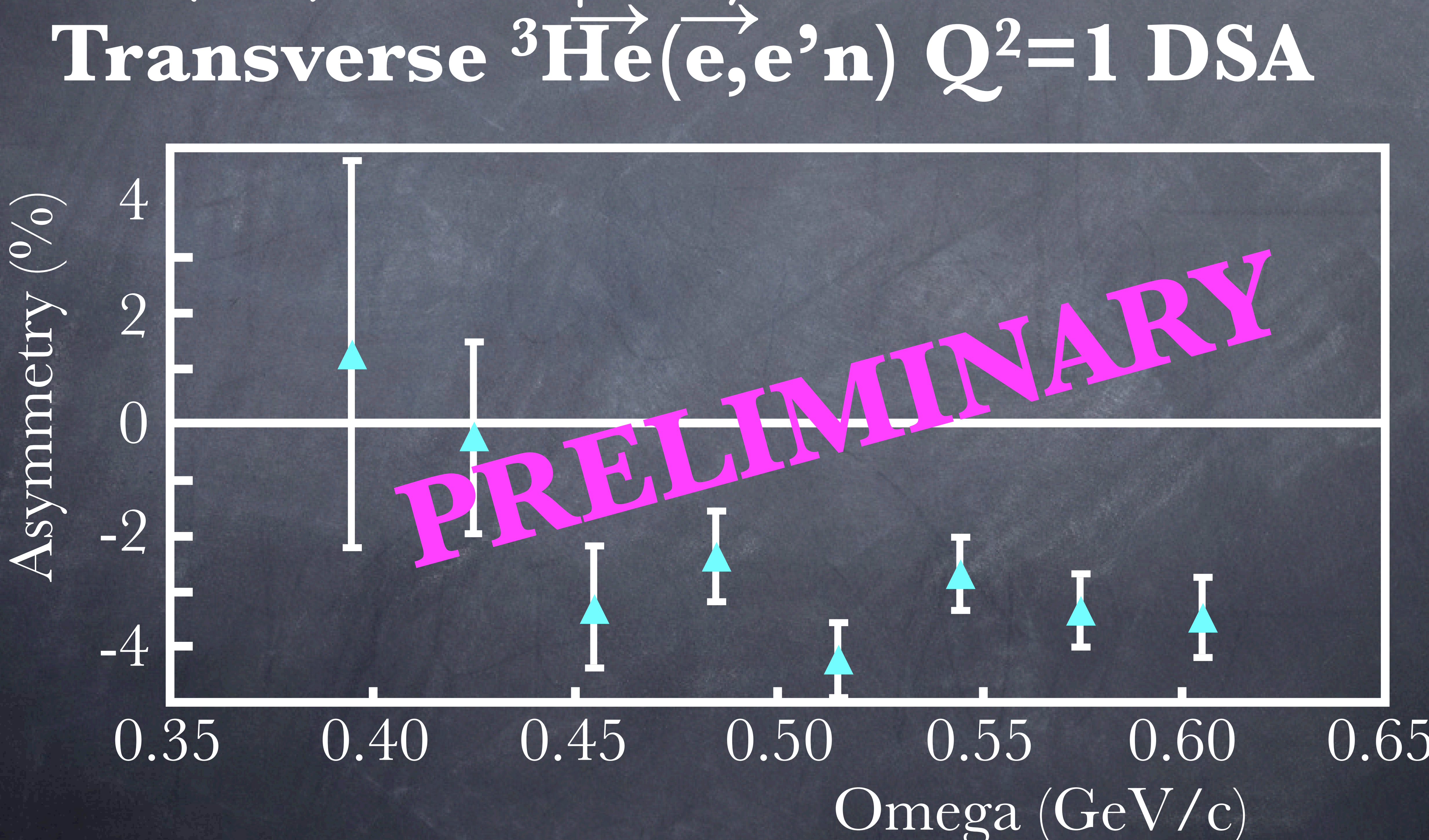


Q^2	Asym	Stat. Err.
0.13	48.9	7.97
0.46	15.3	0.98
0.98	2.3	0.34
0.16	50	0.05

What's being worked on

- ^{3}He(e,e'n) Double-Spin Asymmetries for E05-102



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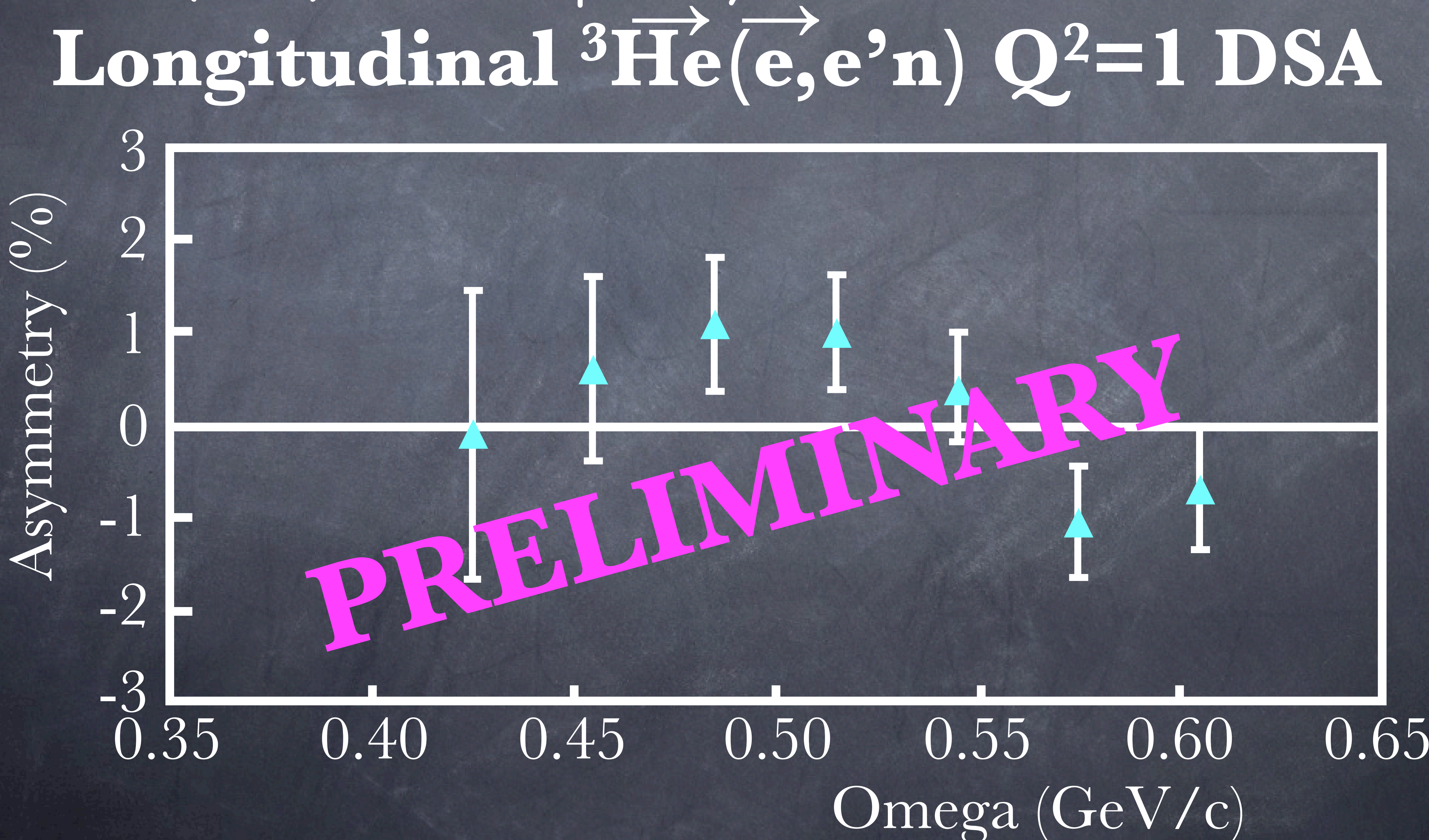


Where are we going?

- Include contribution of proton contamination to asymmetry, especially Q^2=0.1 GeV^2
- Finalize Background Subtraction Error Estimates
- Finalize scaling factors and systematic errors of asymmetry
- (E05-102) Finish raw semi-exclusive ^{3}He(e,e'n) double-spin asymmetries for transverse and longitudinal polarization at Q^2=1 and 0.5 GeV^2
- (E05-102) Extract G^E_n from transversely polarized ^{3}He(e,e'n) 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
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
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

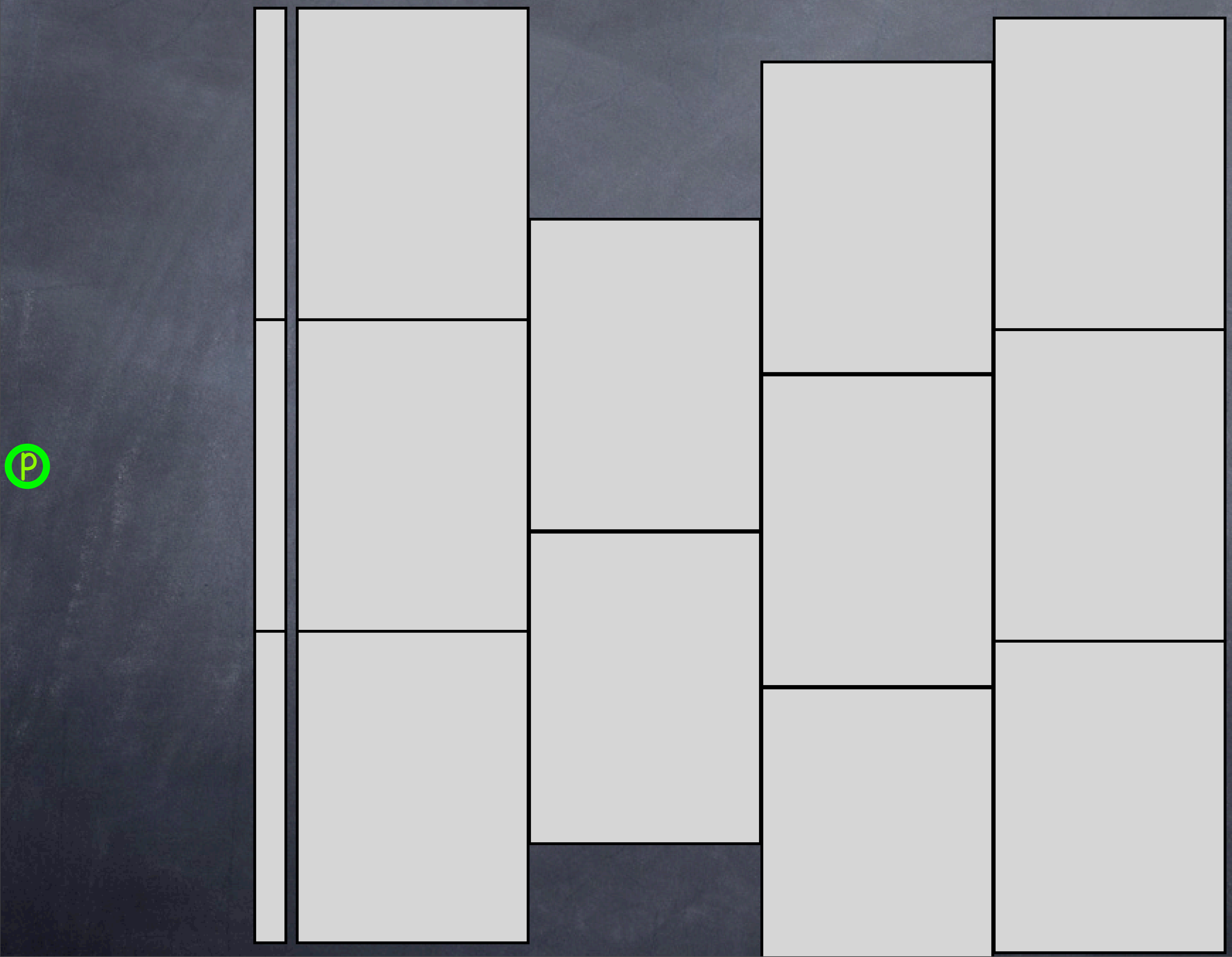
Extra Slides

Yields

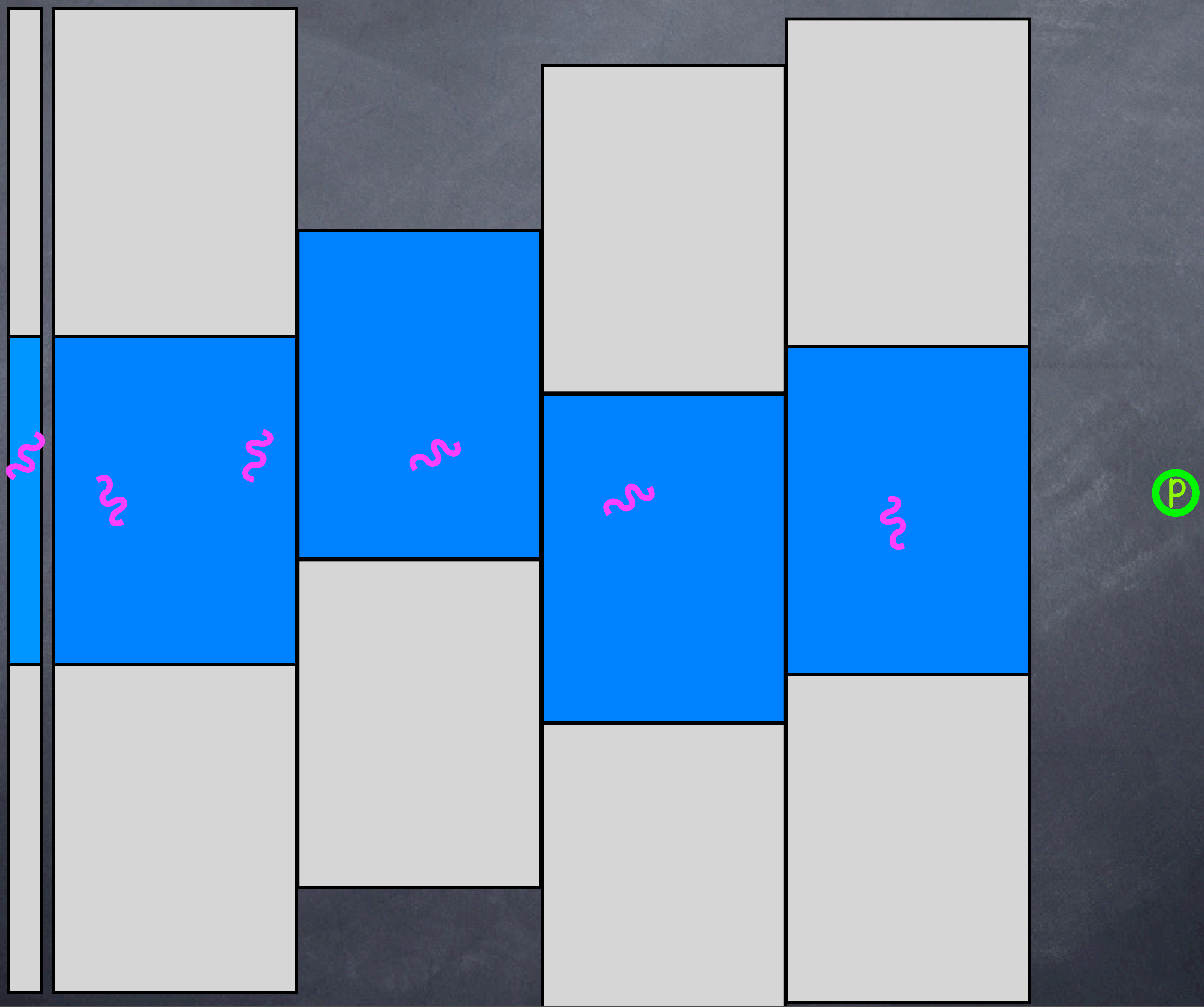
$$\text{Yield} = \frac{N}{Q*LT*\rho*\Delta z} * \left(\cancel{\frac{1}{\varepsilon_{det}*\Delta\Omega*\Delta E'}}\right)$$

Ignore since
it will cancel

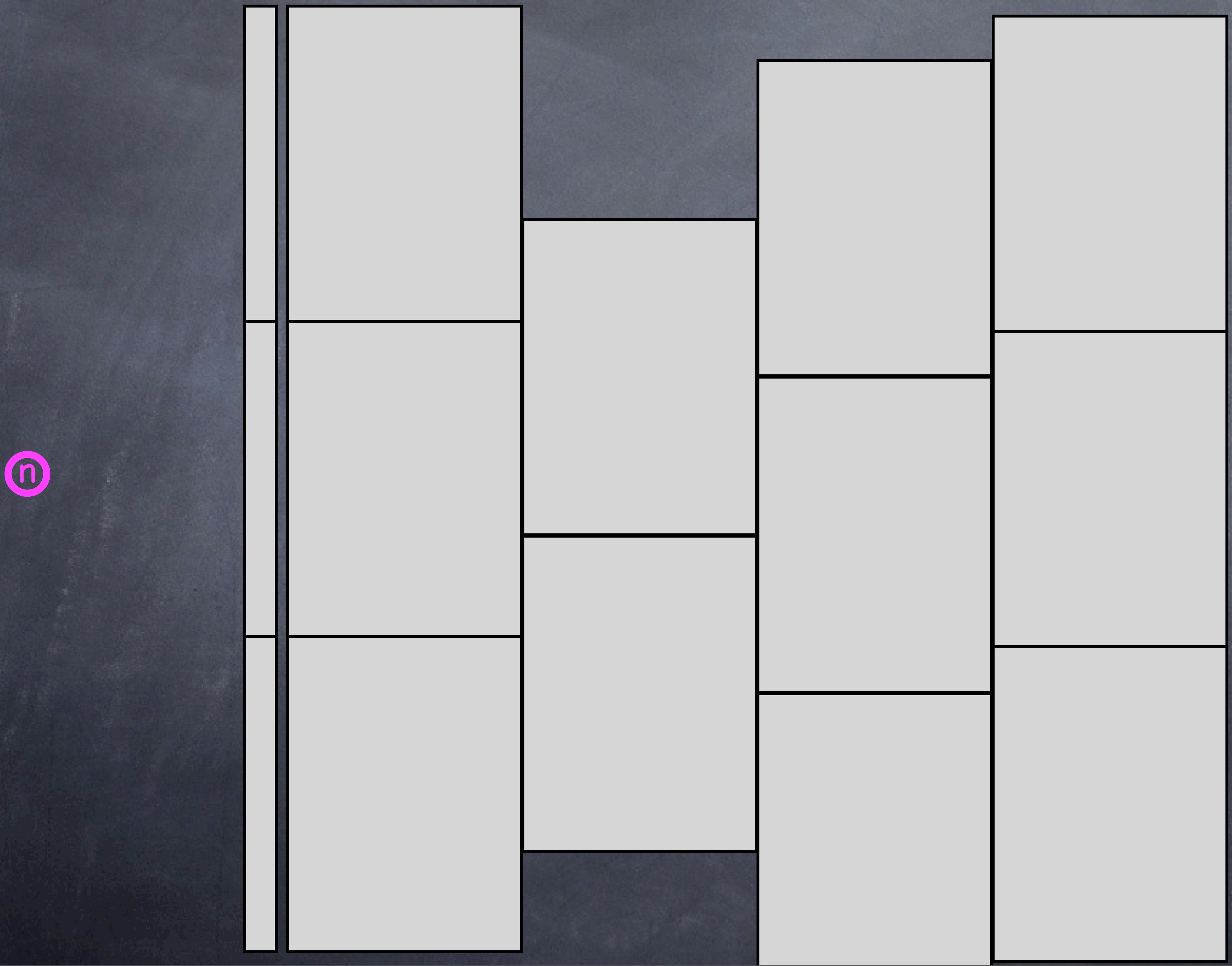
Neutron Detection



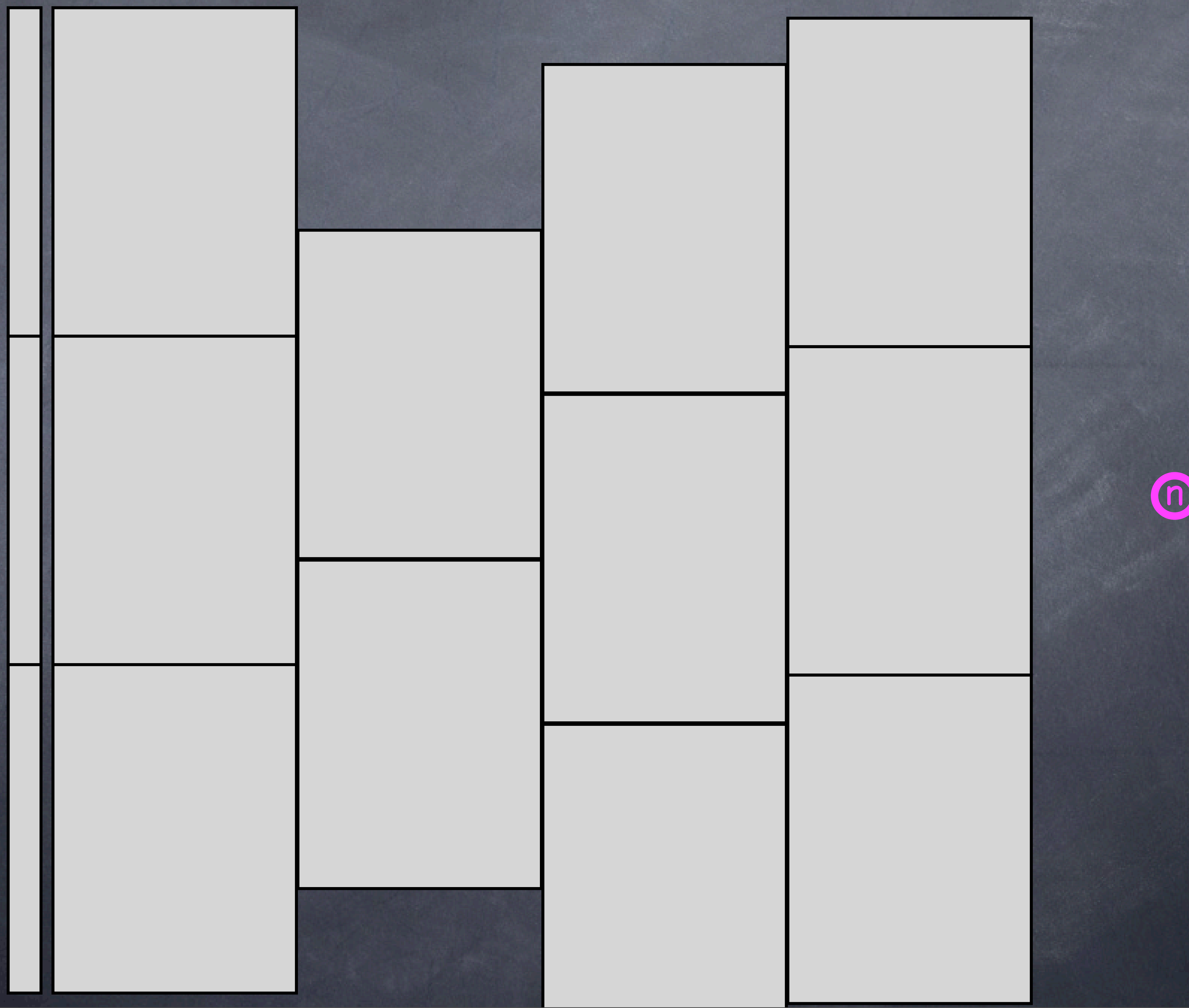
Neutron Detection



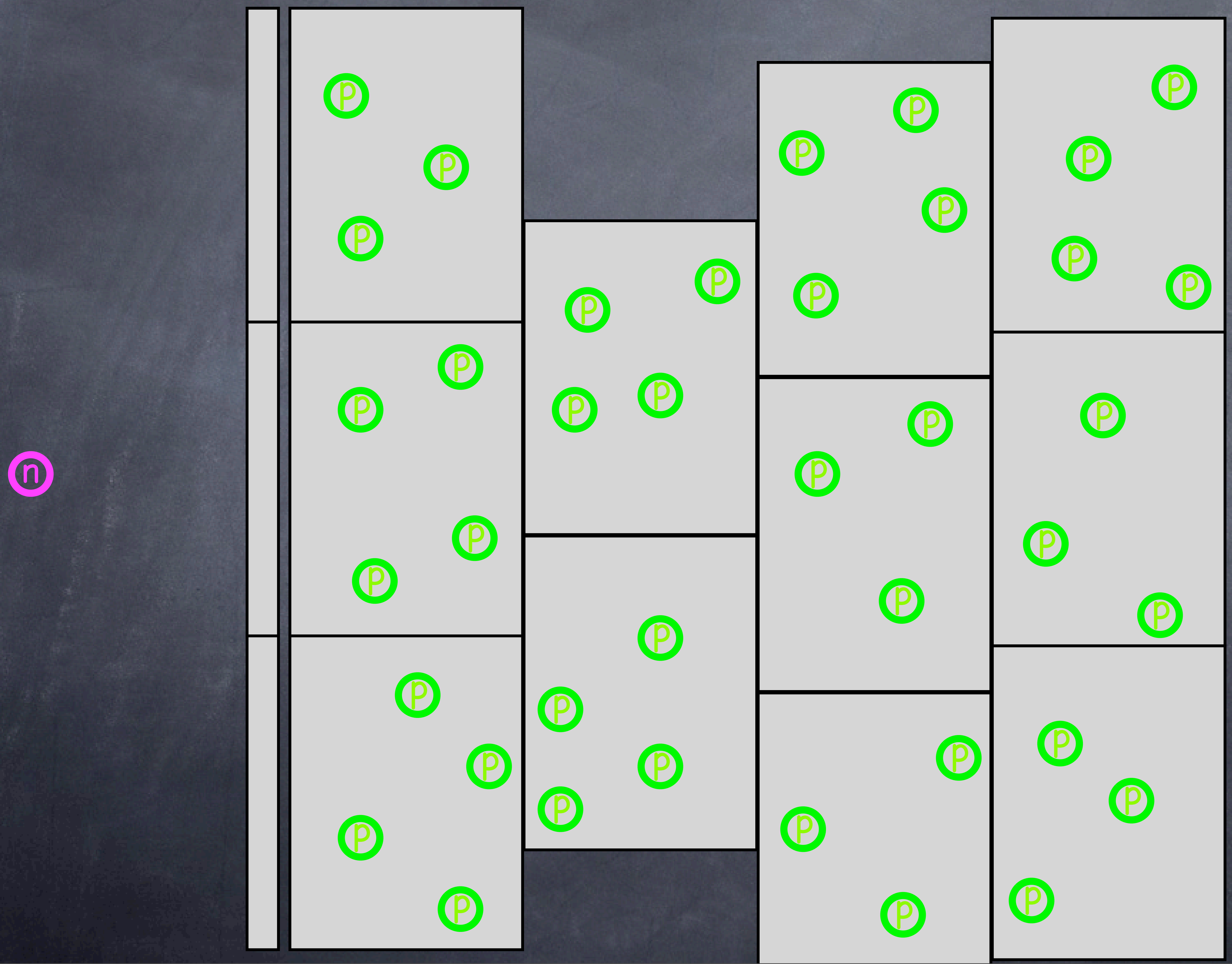
Neutron Detection



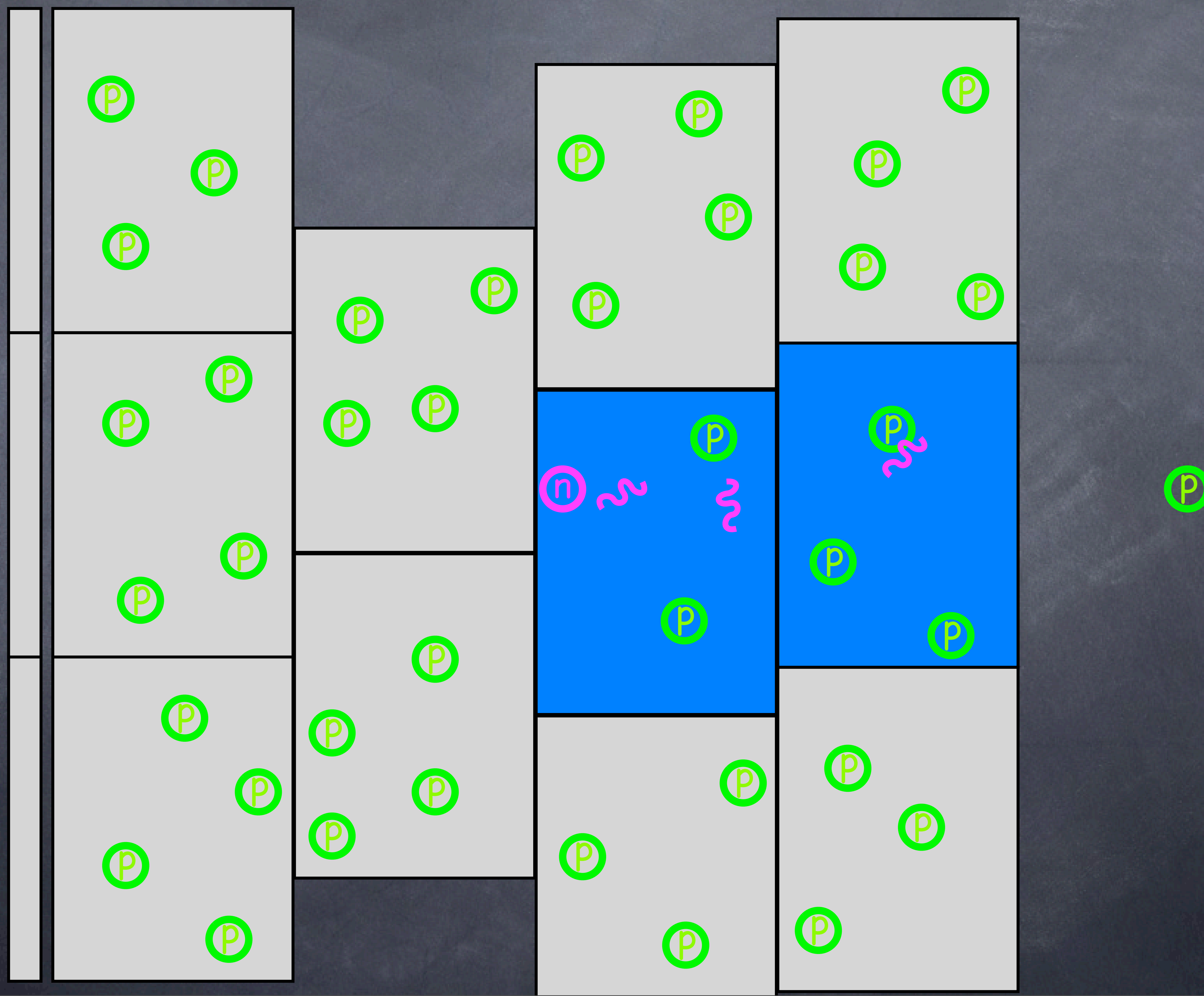
Neutron Detection



Neutron Detection



Neutron Detection



What's been done

- $^3He(e,e')$ Asymmetry for Q^2=1 with transversely polarized target is checked against Jin Ge's analysis