Talk to the HAND: The $^3\text{He}(e,e'n)$ Channel in A_y and G_E^n Measurements

Vincent Sulkosky

Elena Long

Hall A Collaboration Meeting

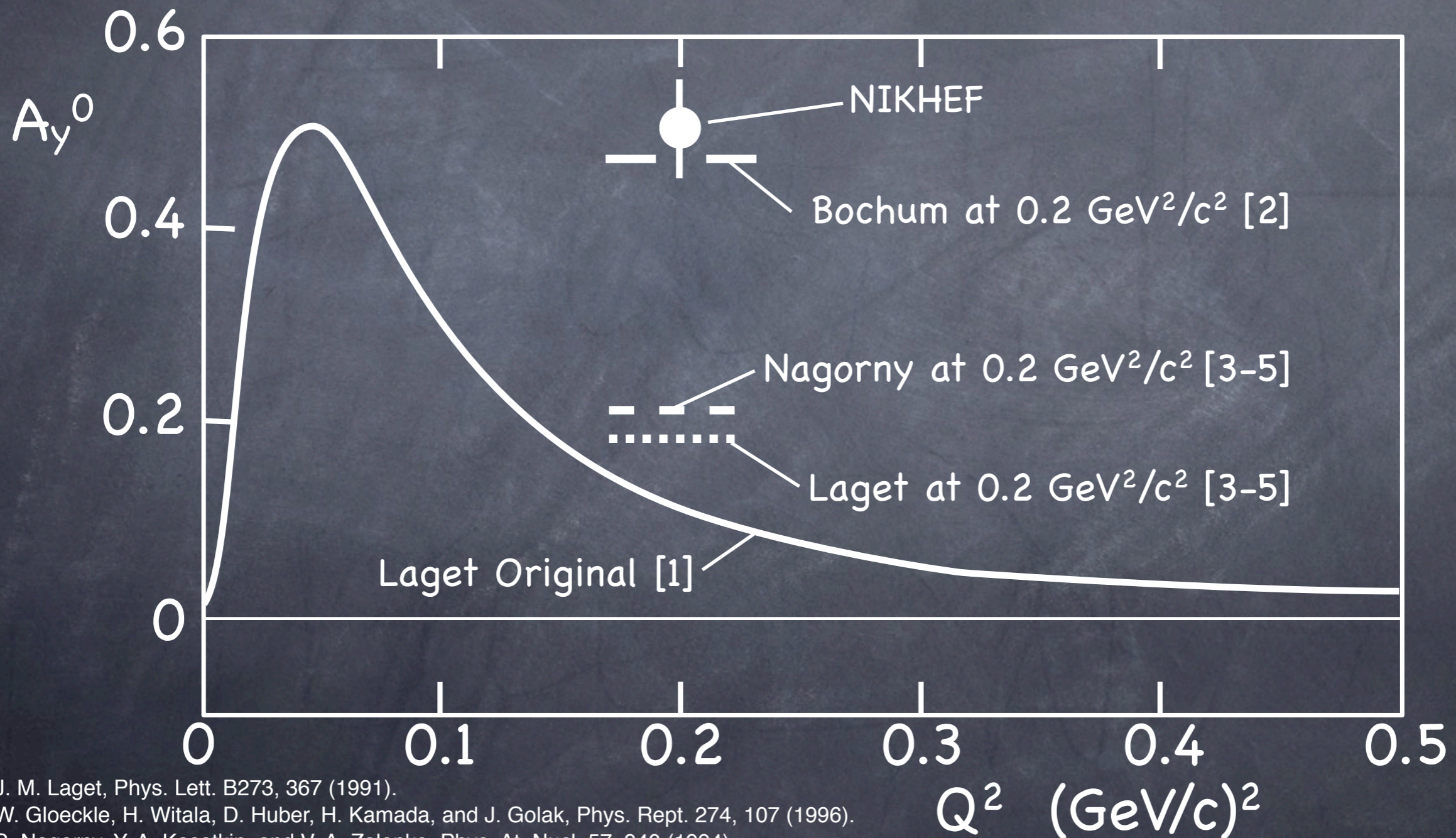2009-06-11

Jefferson Lab

A_y: Target Single Spin Asymmetry

- In PWIA, A_y in Quasi-Elastic $^3He^\uparrow(e,e'n)$ is very small

- As of yet, no measurements of A_y have been done at large Q^2

- JLab 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: Target Single Spin Asymmetry

- Previous experiment at NIKHEF measured A_y at 0.2 $(GeV/c)^2$

  - Where PWIA predicts A_y to be exactly zero

- Faddeev Calculations by Bochum group correctly predicted result where other groups expected a much lower value

A_y: Target Single Spin Asymmetry

A_y^0

0.6

0.4

0.2

0

NIKHEF

Bochum at 0.2 GeV²/c² [2]

Nagorny at 0.2 GeV²/c² [3–5]

Laget at 0.2 GeV²/c² [3–5]

Laget Original [1]

0   0.1   0.2   0.3   0.4   0.5

Q² (GeV/c)²

[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).
[3] S. Nagorny, Y. A. Kasatkin, and V. A. Zolenko, Phys. At. Nucl. 57, 940 (1994).
[4] S. Nagorny and W. Turchinetz, Phys. Letters B389, 429 (1996).
[5] S. Nagorny and W. Turchinetz, Phys. Lett. B449, 222 (1998).
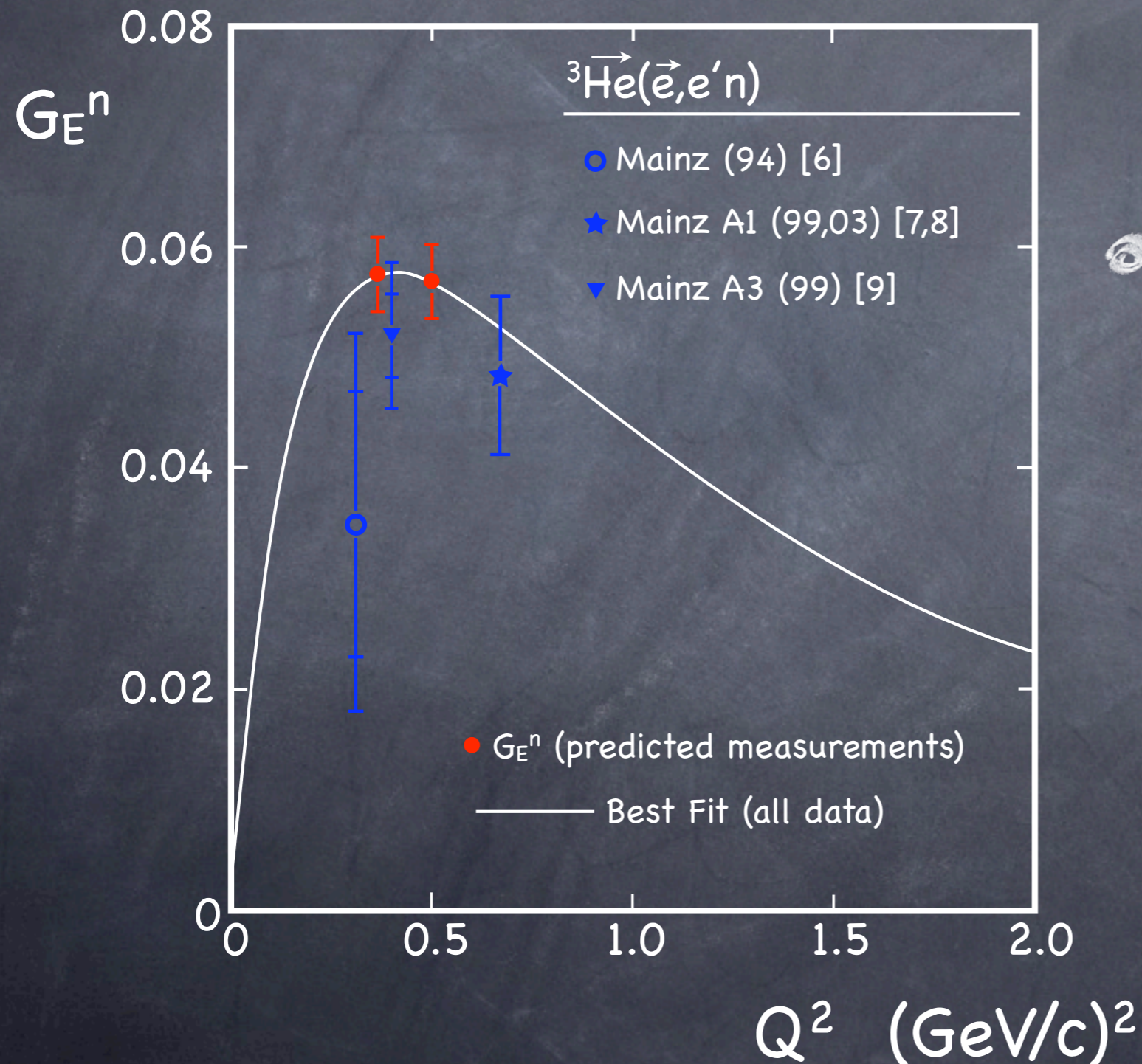
A_y: Target Single Spin Asymmetry

- Data will test state of the art calculations at high Q^2

  - Neutron form factor extractions must correctly predict this asymmetry

- At High Q^2, any non-zero result is indicative of effects beyond impulse approximation

A_y: Target Single Spin Asymmetry

- This experiment, E08-005, ran from April 26th through May 10th

- The kinematics taken were:

E_0 [GeV]	E' [GeV]	θ_{lab} [deg]	Q^2 [GeV/c]^2	$|q|$ [GeV/c]	θ_q [deg]
1.25	1.22	17	0.13	0.359	71
2.43	2.18	17	0.46	0.681	62
3.61	3.09	17	0.98	0.988	54

G_E^n: Electronic Form Factor of the Neutron

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

○ Mainz (94) [6]

★ Mainz A1 (99,03) [7,8]

▼ Mainz A3 (99) [9]

● G_E^n (predicted measurements)

— Best Fit (all data)

G_E^n

Q^2 (GeV/c)^2

- RHRS Central Momentum is E'=2.175 GeV, 2.225 GeV, and 2.250 GeV

- Acceptance of ± 0.103 GeV
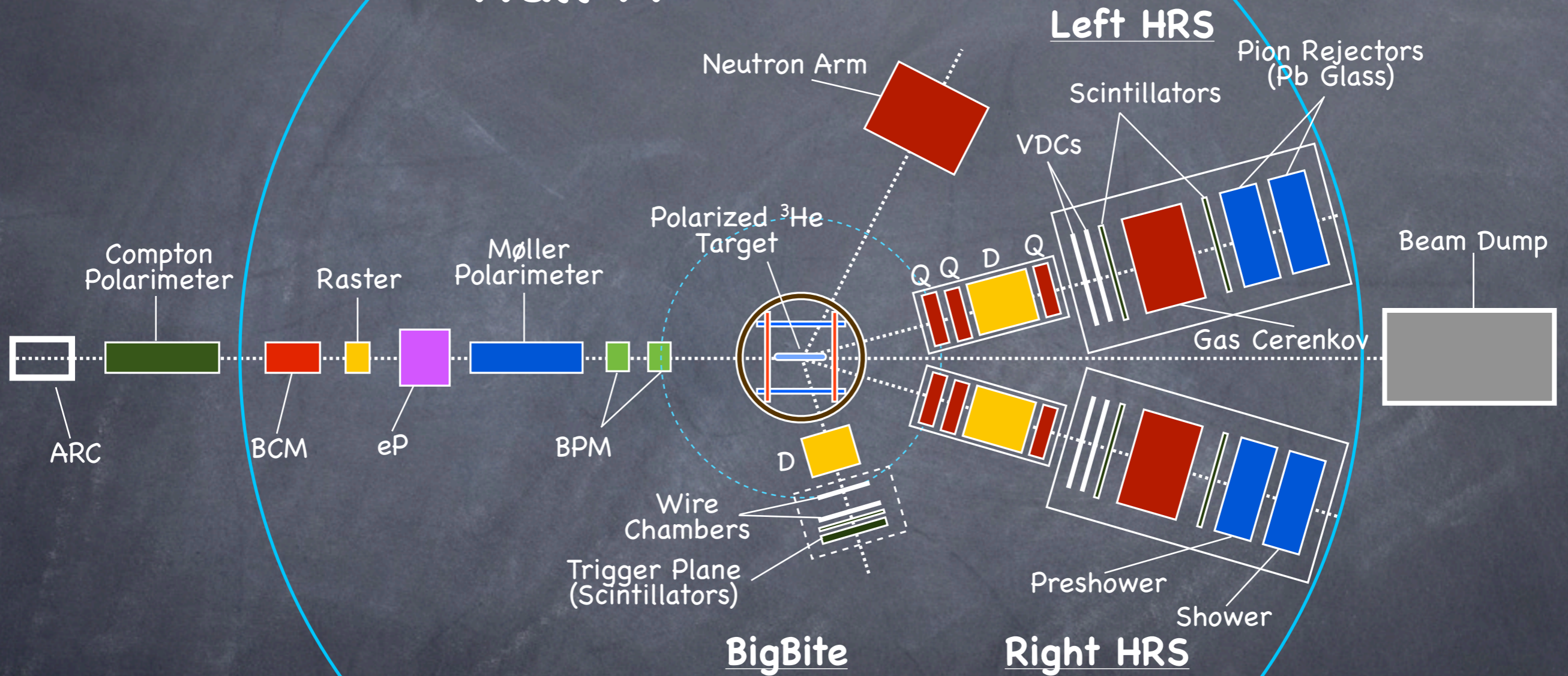
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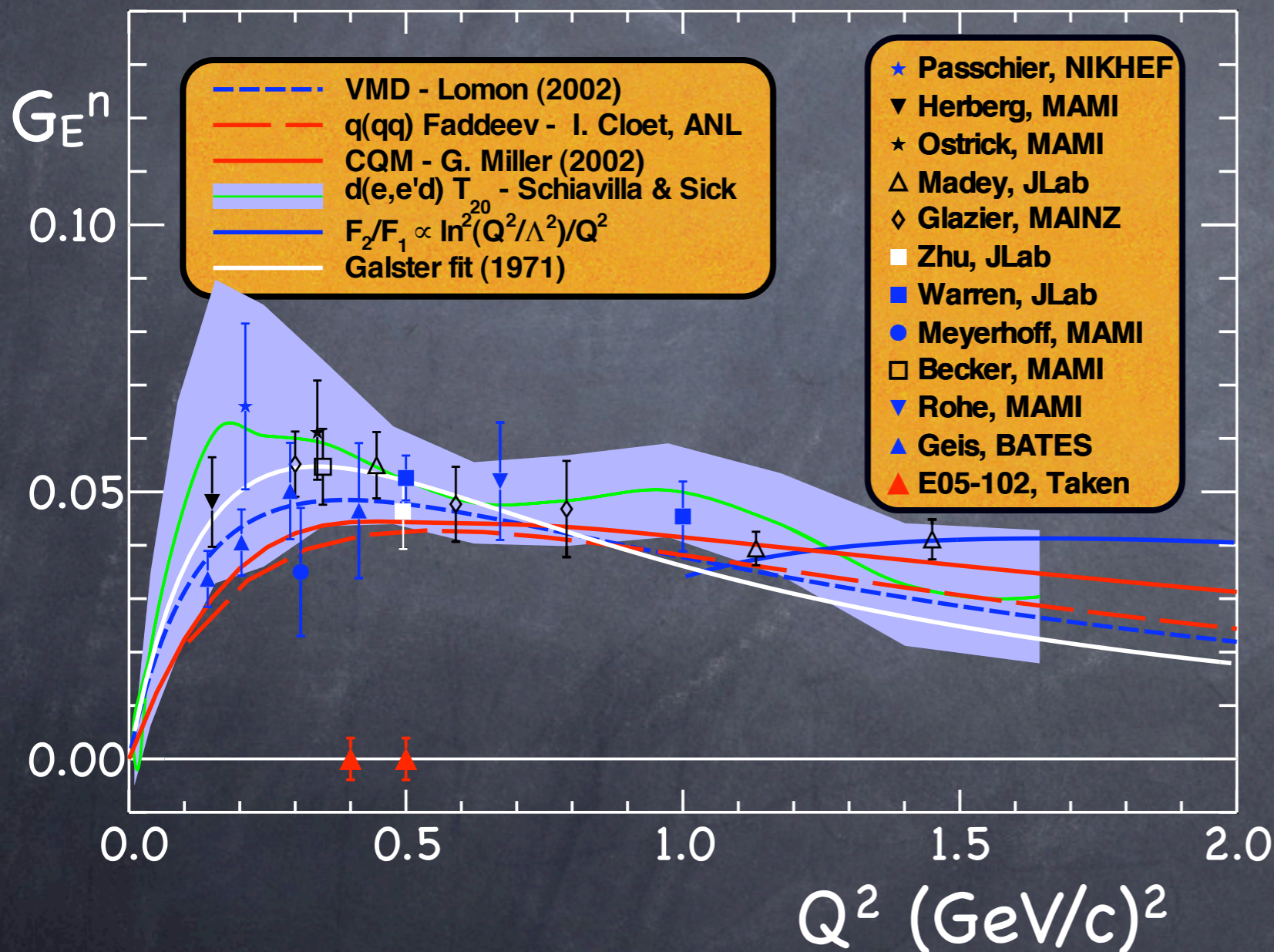
The data points taken will also add to the world deuteron data as well as ³He data

Agreement between d and ³He is expected

G_E^n: Electronic Form Factor of the Neutron

- This experiment, part of E05-102, began running on May 12th and will continue to run through this week

- Expecting an accuracy of better than 0.0039

- Data will cover the $Q^2 = 0.4$ to 0.5 (GeV/c)^2 range

Hall A

Left HRS

Pion Rejectors (Pb Glass)

Scintillators

VDCs

Neutron Arm

Polarized ³He Target

Compton Polarimeter

Møller Polarimeter

Raster

Beam Dump

Q Q D Q

Gas Cerenkov

ARC

BCM

eP

BPM

Wire Chambers

D

Trigger Plane (Scintillators)

Preshower

Shower

BigBite

Right HRS

Hall A Neutron Detector

- Detects Neutrons from ^{3}He$(e,e'n)$
- Along with RHRS allows a G_E^n and A_y Measurements to be made
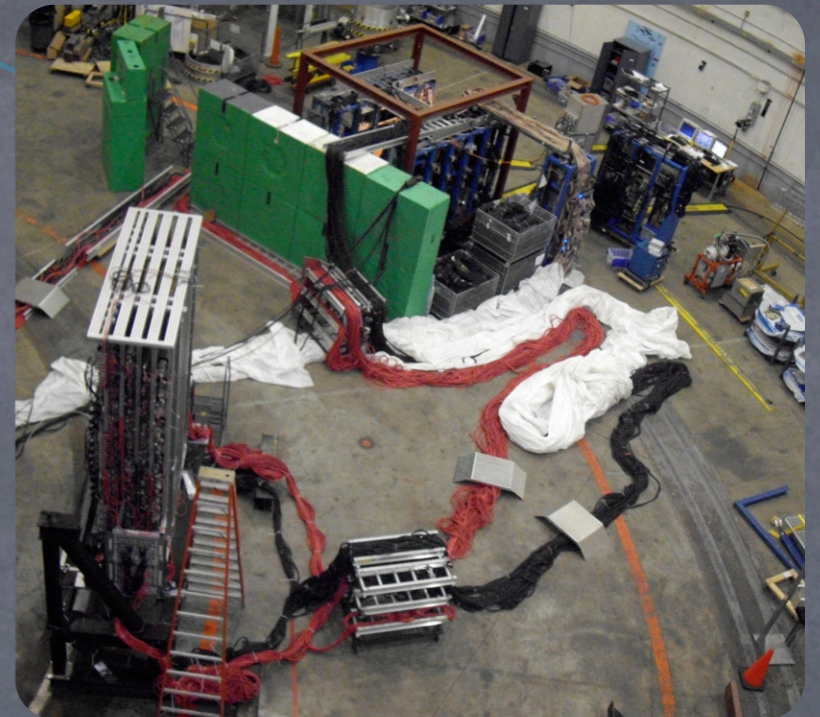
Hall A Neutron Detector

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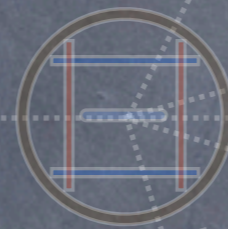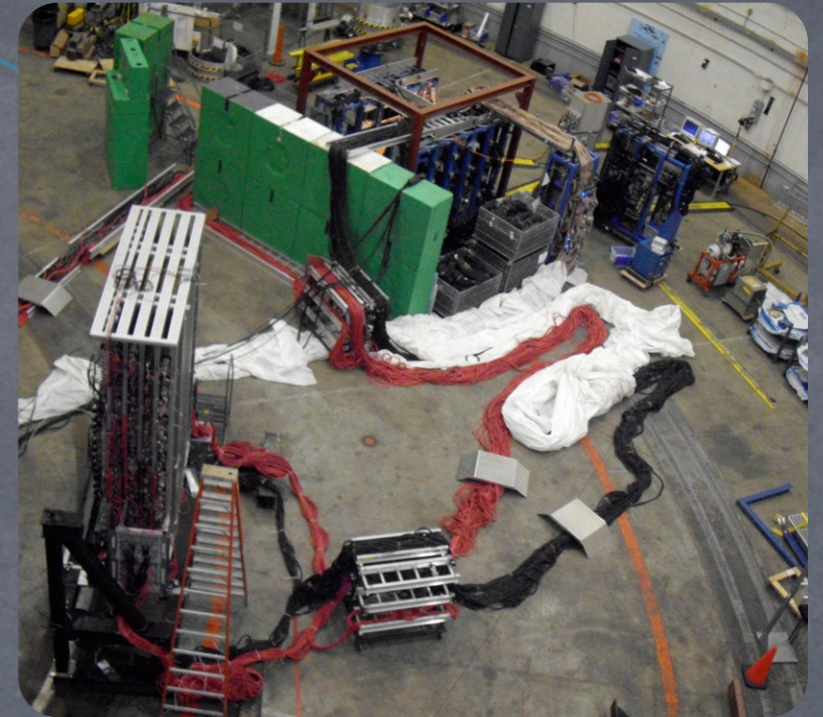
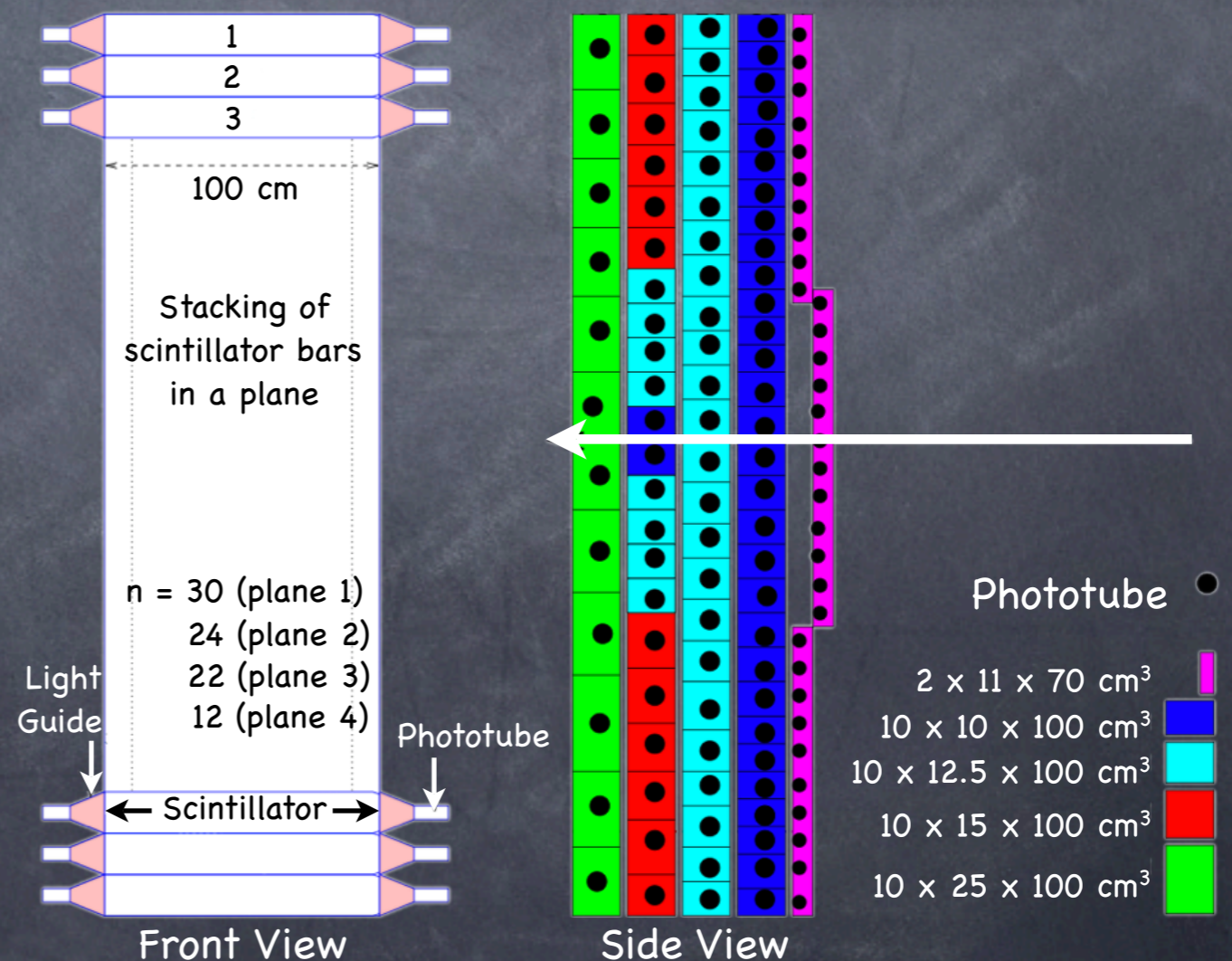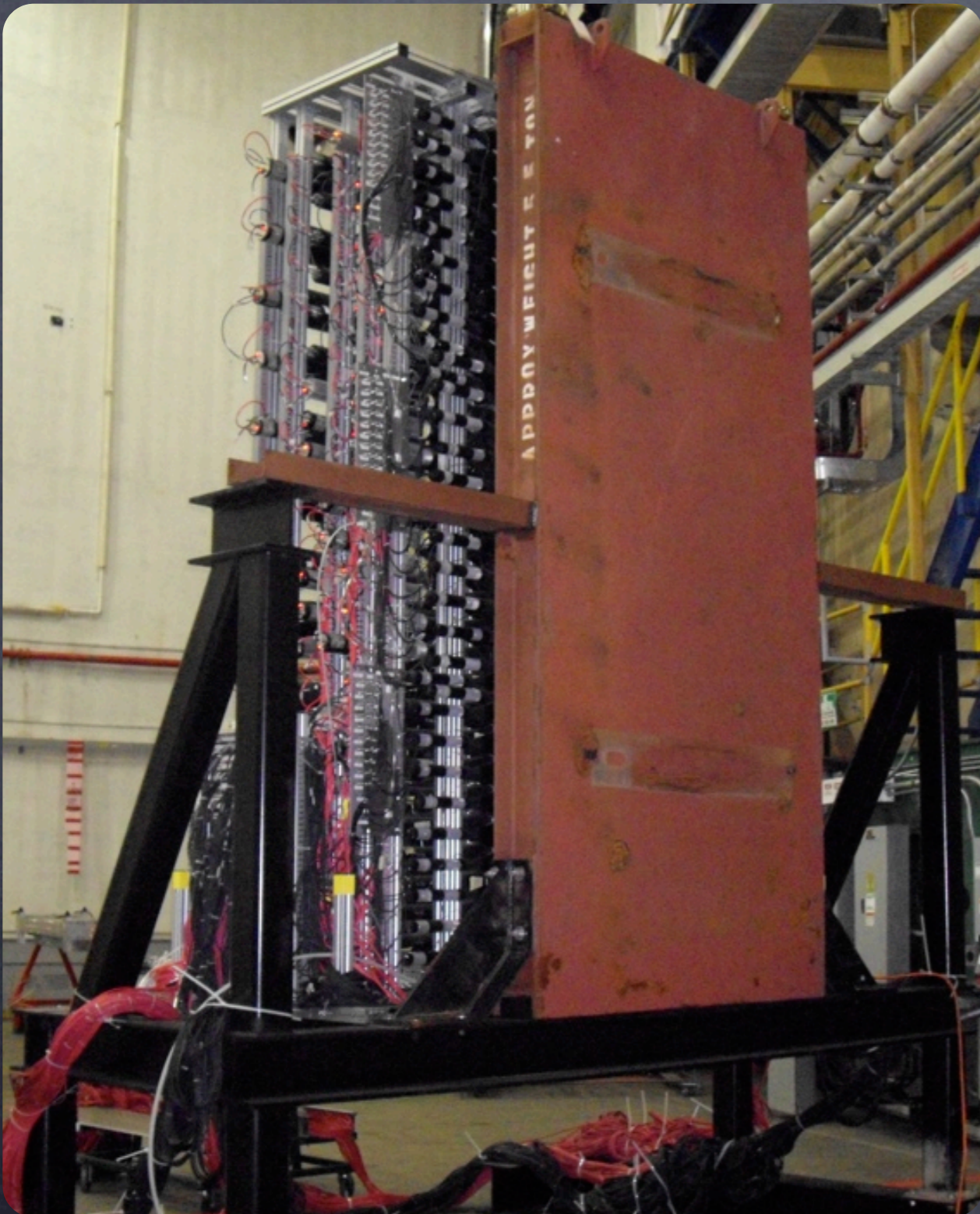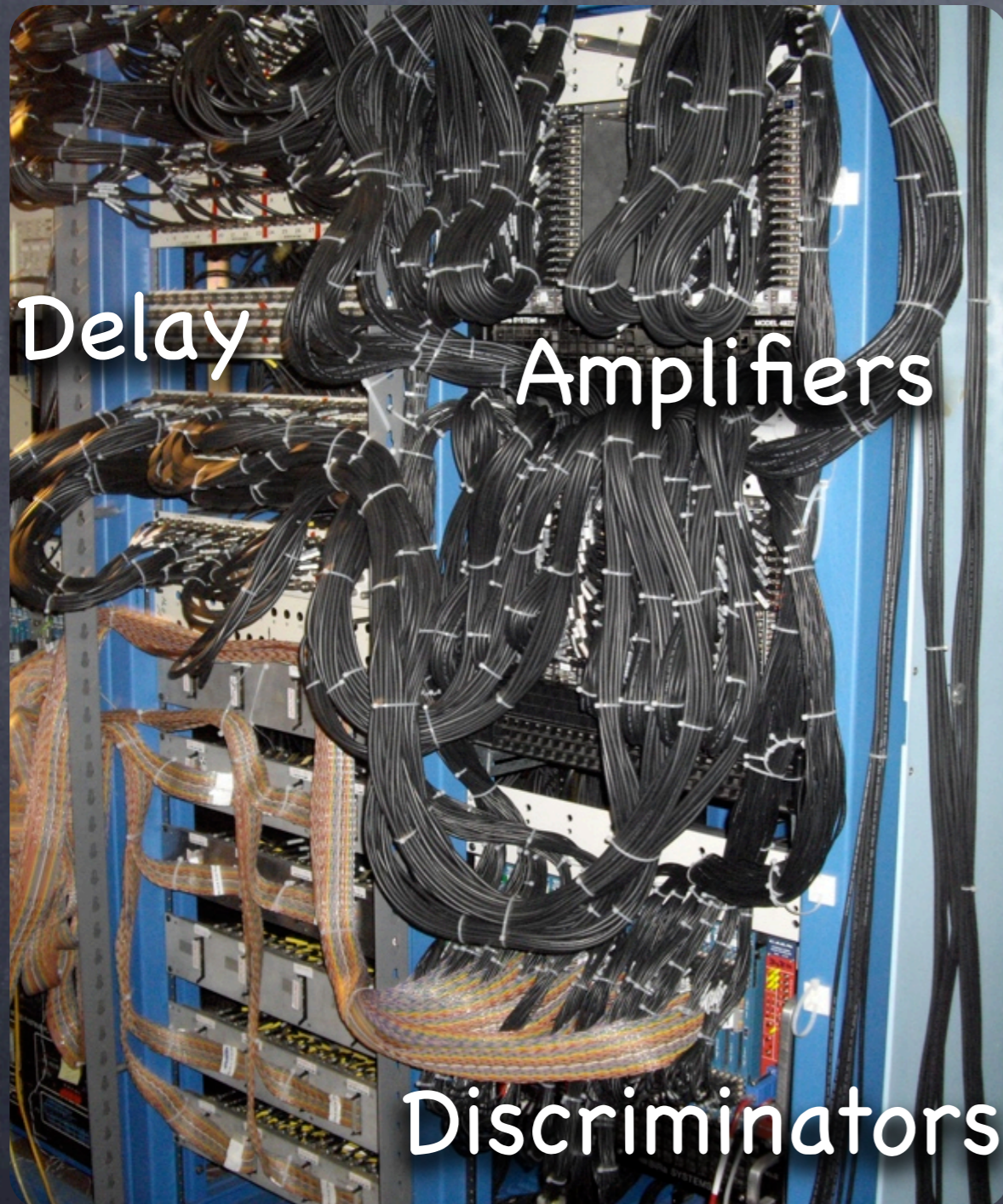# RHRS

- Detects Quasi-Elastically Scattered Electrons from $^3He(e,e'n)$
- Angle at 16°, 17° and 18°

Hall A Neutron Detector

- 88 Scintillator + 64 Veto Bars

- ADC and TDC channels recorded for each of 240 PMTs

100 cm

Stacking of scintillator bars in a plane

n = 30 (plane 1)
24 (plane 2)
22 (plane 3)
12 (plane 4)

Light Guide

Phototube

Scintillator

Front View

Side View

Phototube

2 × 11 × 70 cm³
10 × 10 × 100 cm³
10 × 12.5 × 100 cm³
10 × 15 × 100 cm³
10 × 25 × 100 cm³

Hall A Neutron Detector

- Signals go to Amplifiers where they are split

- One feed goes to discriminators and then to TDC

- Other goes to 554ns delay and then to ADC

- Trigger comes from RHRS

Data Taking is Just the Beginning

- Thanks to the E08-005 and E05-102 Collaborations

- Graduate Students involved with Quasi-Elastic Family of Experiments

  - Ge Jin, University of Virginia

  - Elena Long, Kent State University

  - Miha Mihovilovič, Jožef Stefan Institut

  - Yawei Zhang, Lanzhou University