E05-102/E08-005: ^{3}He(e,e'X) from the Quasi-Elastic Family of Experiments

Elena Long - ^{3}He(e,e'n)
Miha Mihovilovic - ^{3}He(e,e'd) & ^{3}He(e,e'p)

Hall A Collaboration Meeting
December 10th, 2012

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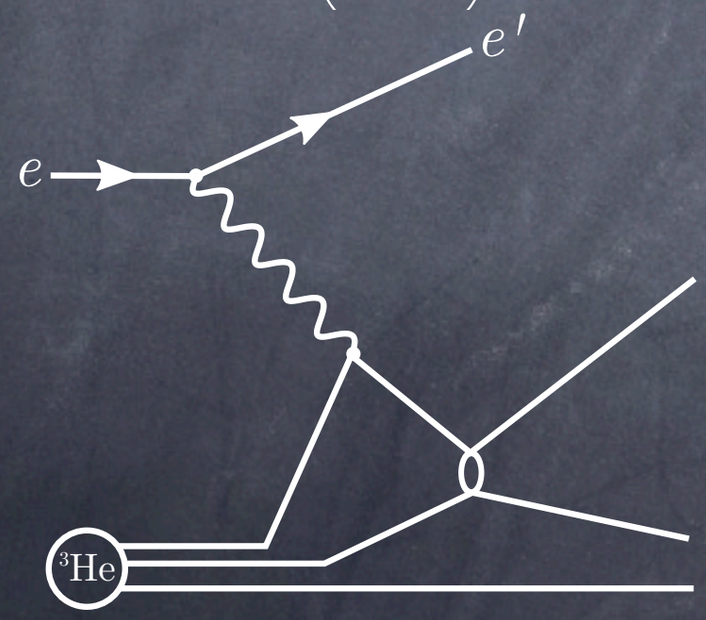
- Detailed process of accounting for proton contamination
- Presented preliminary A_y^0 results which indicated large values at low Q^2 and dropping off exponentially at higher Q^2 until around 1 $(\mathrm{GeV/c})^2$ where it starts to become negligible

^{3}He(e,e'n) Complications

- In PWIA, A_y^0 is exactly zero
- Since other nucleons exist in the ^{3}He nucleus, they cause undesired effects that must be taken into account
  - Final State Interactions (FSI)



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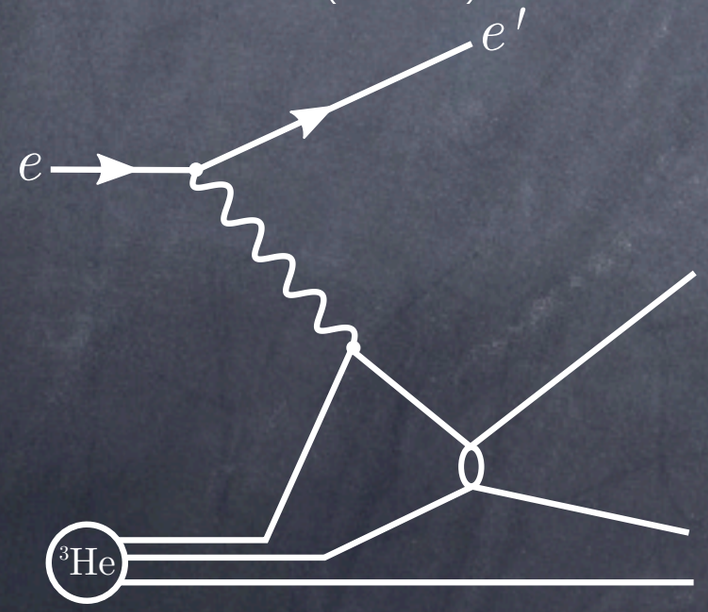
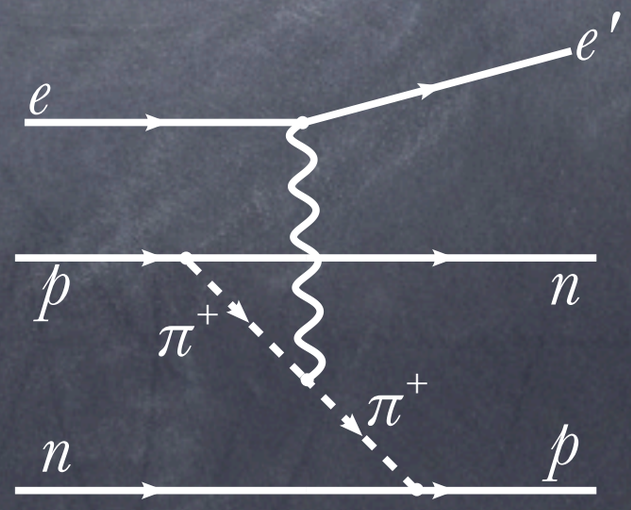
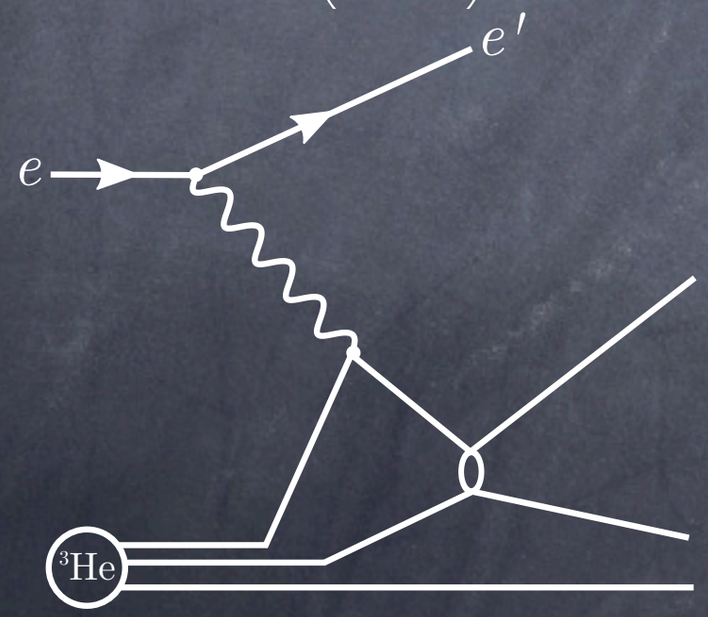


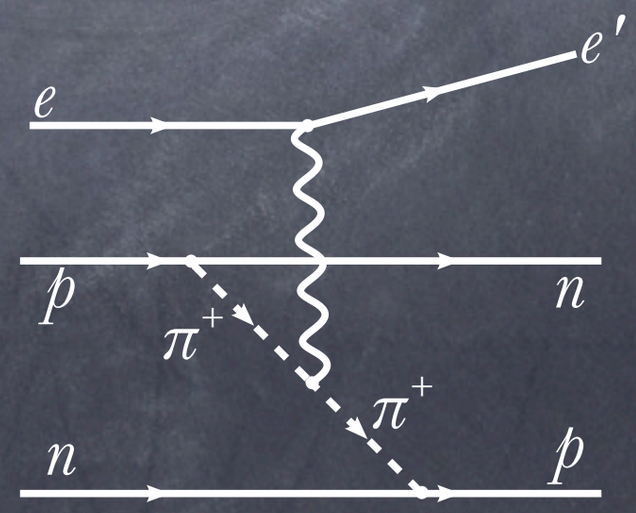
- Meson Exchange Currents (MEC)



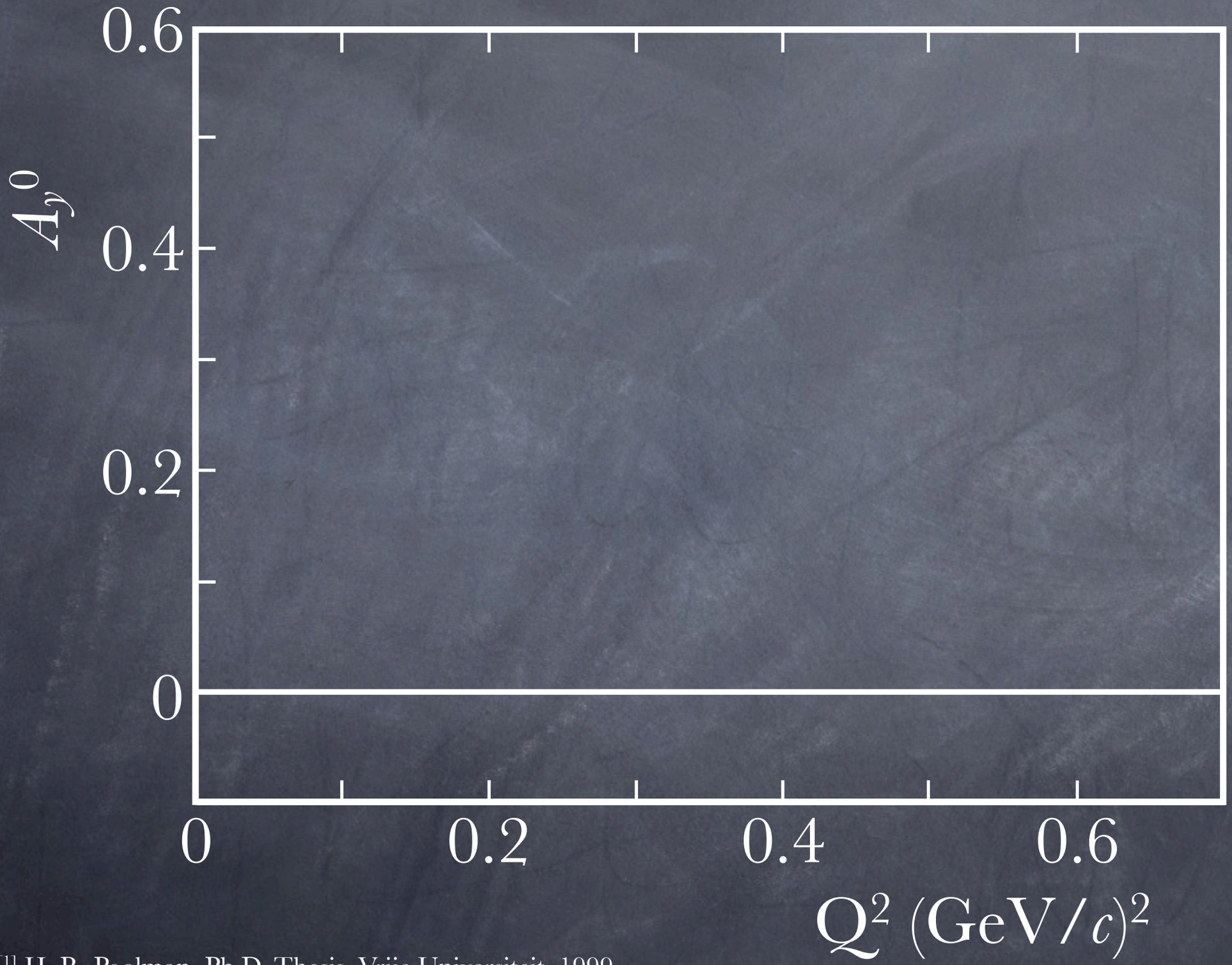
^{3}He(e,e'n) Complications

- In PWIA, A_y^0 is exactly zero
- Since other nucleons exist in the ^{3}He nucleus, they cause undesired effects that must be taken into account
- These effects, especially FSI, cause A_y^0 to be non-zero
  - Final State Interactions (FSI)
  - Meson Exchange Currents (MEC)





Historical Data



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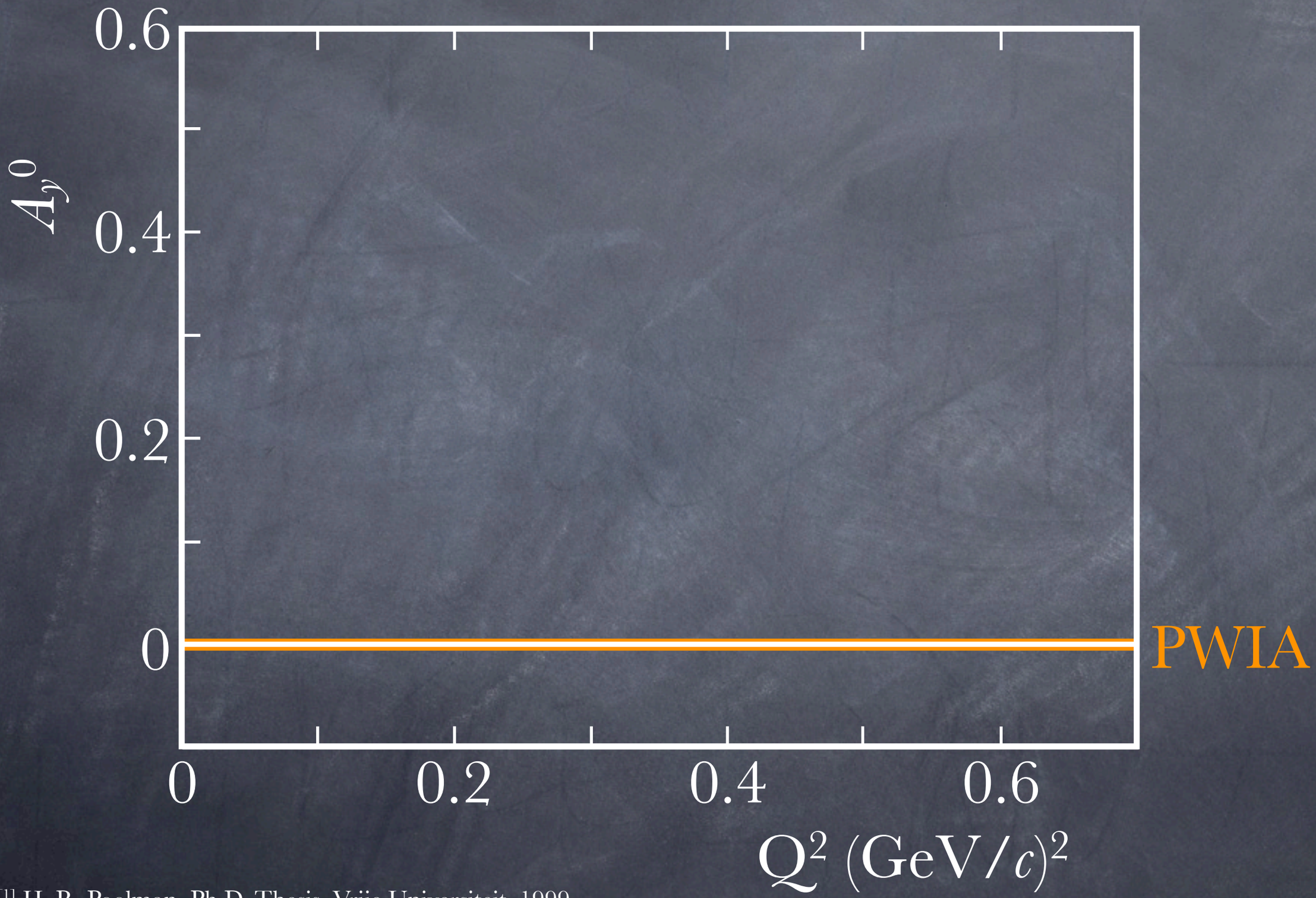

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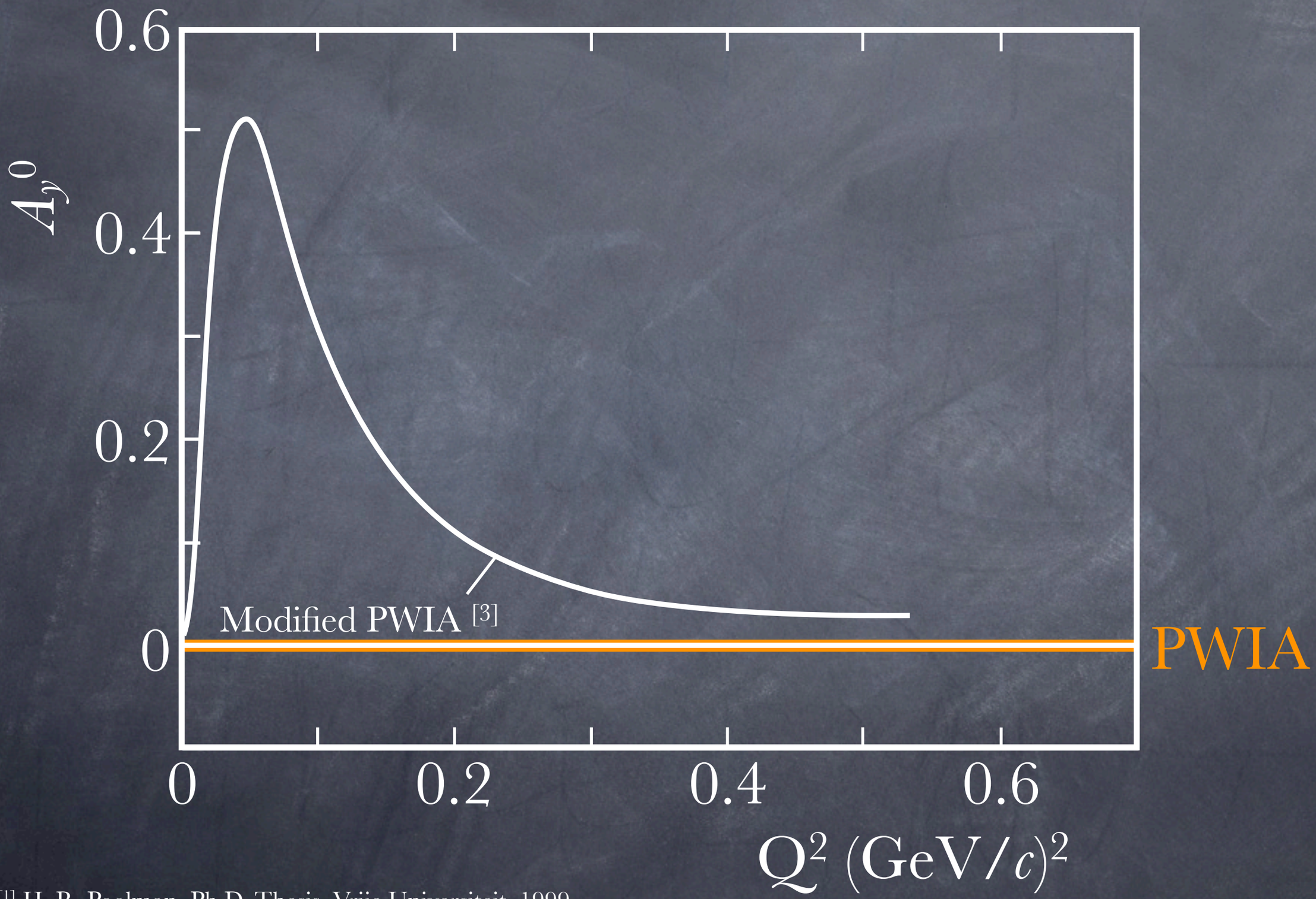

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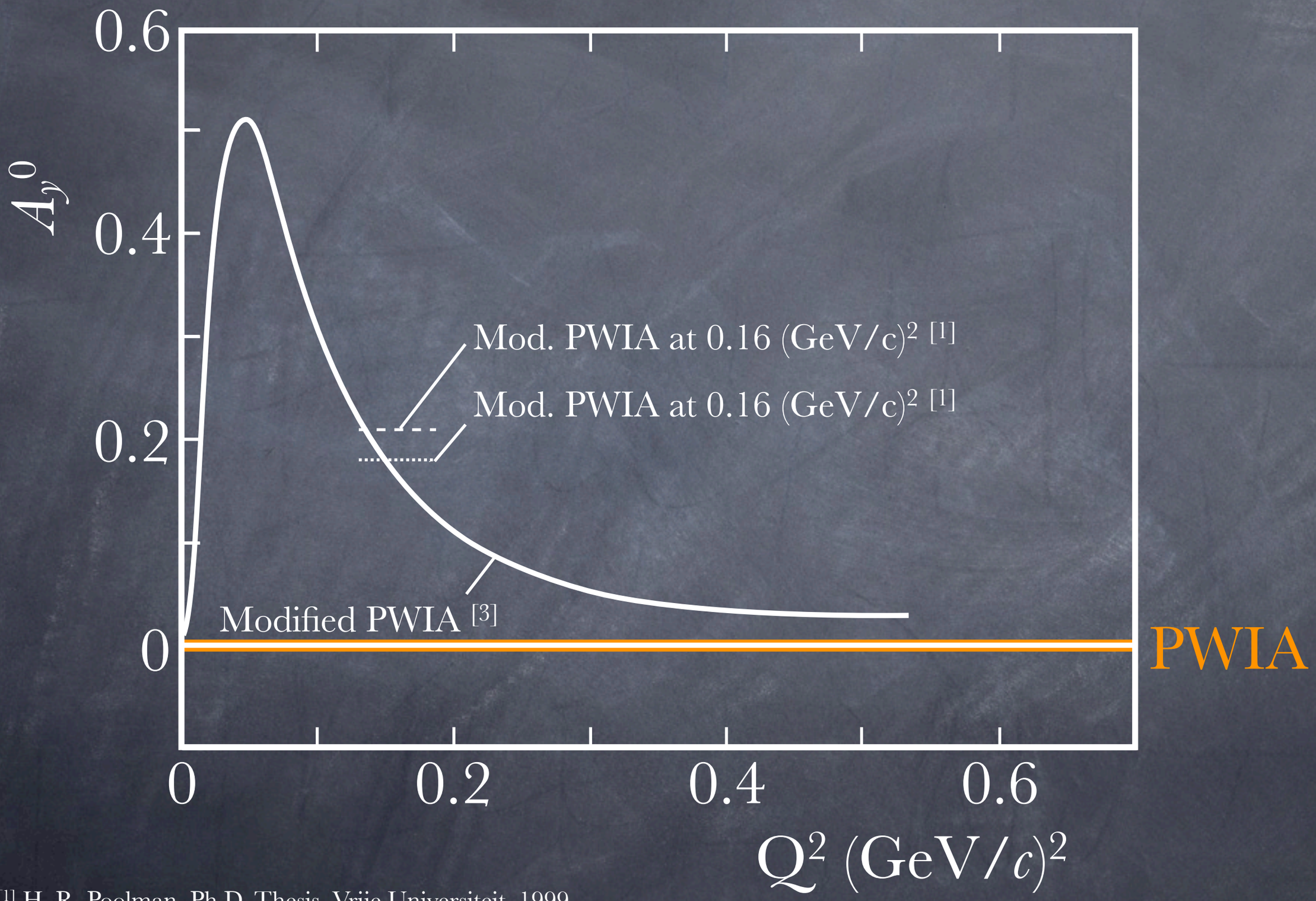

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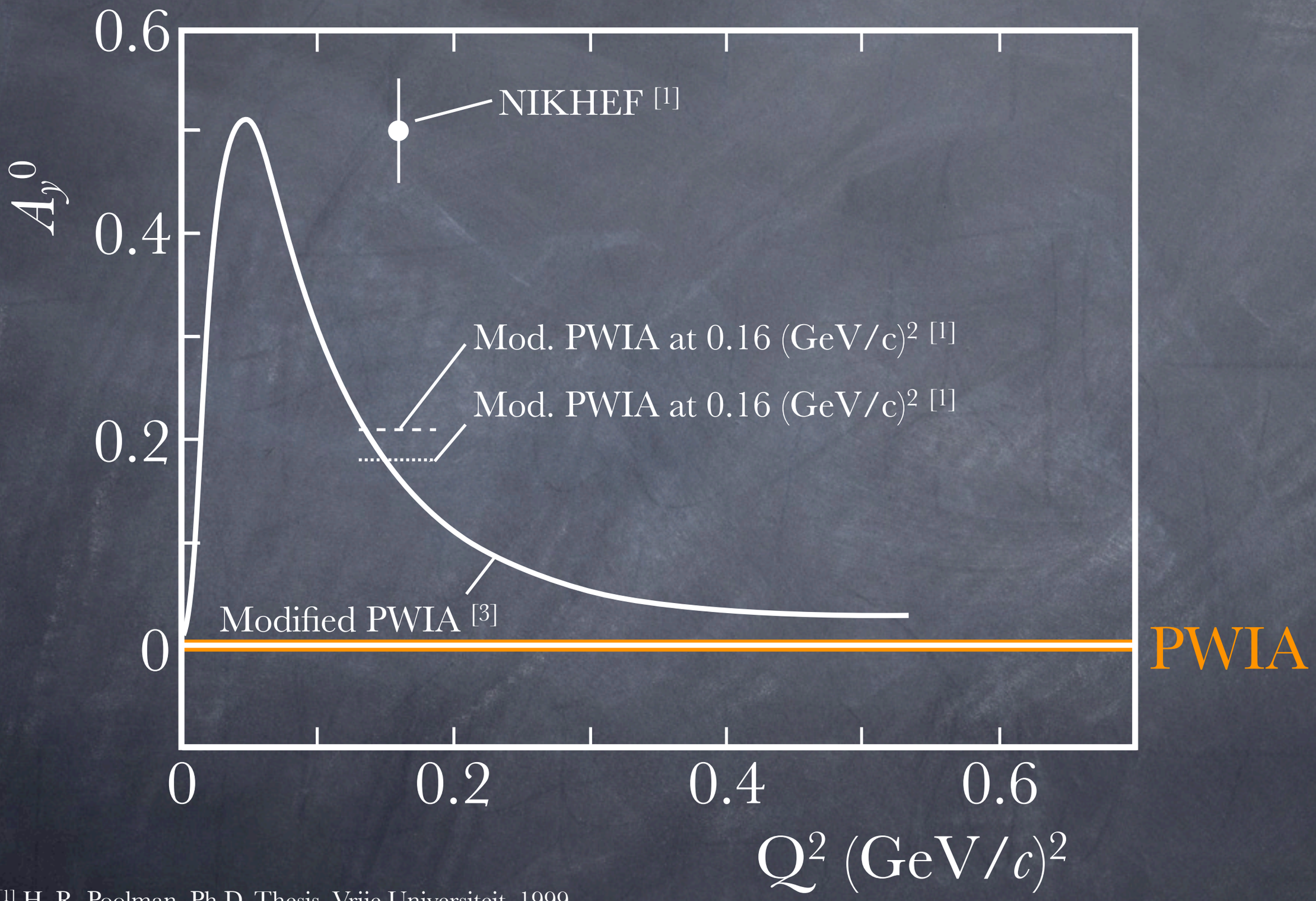

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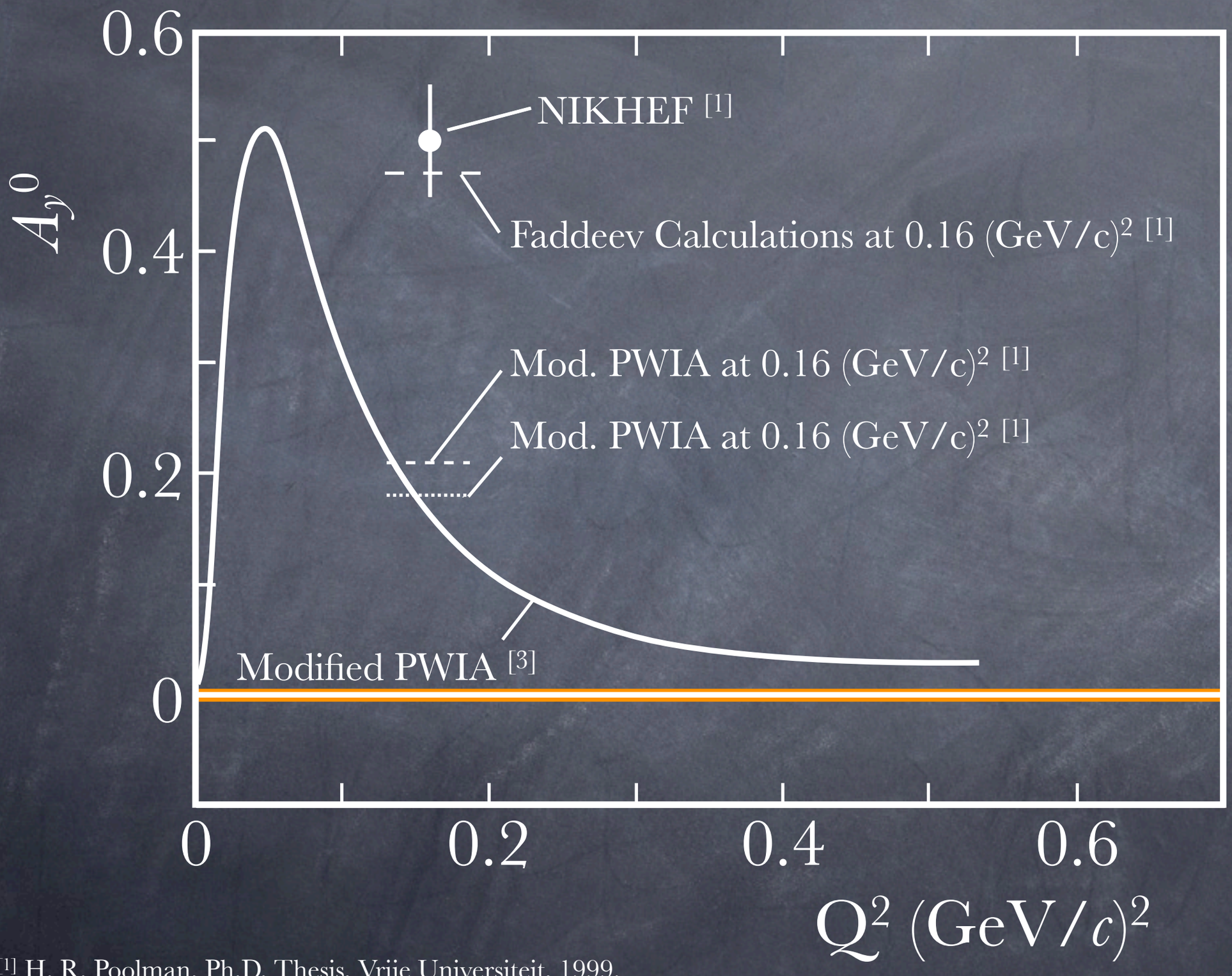

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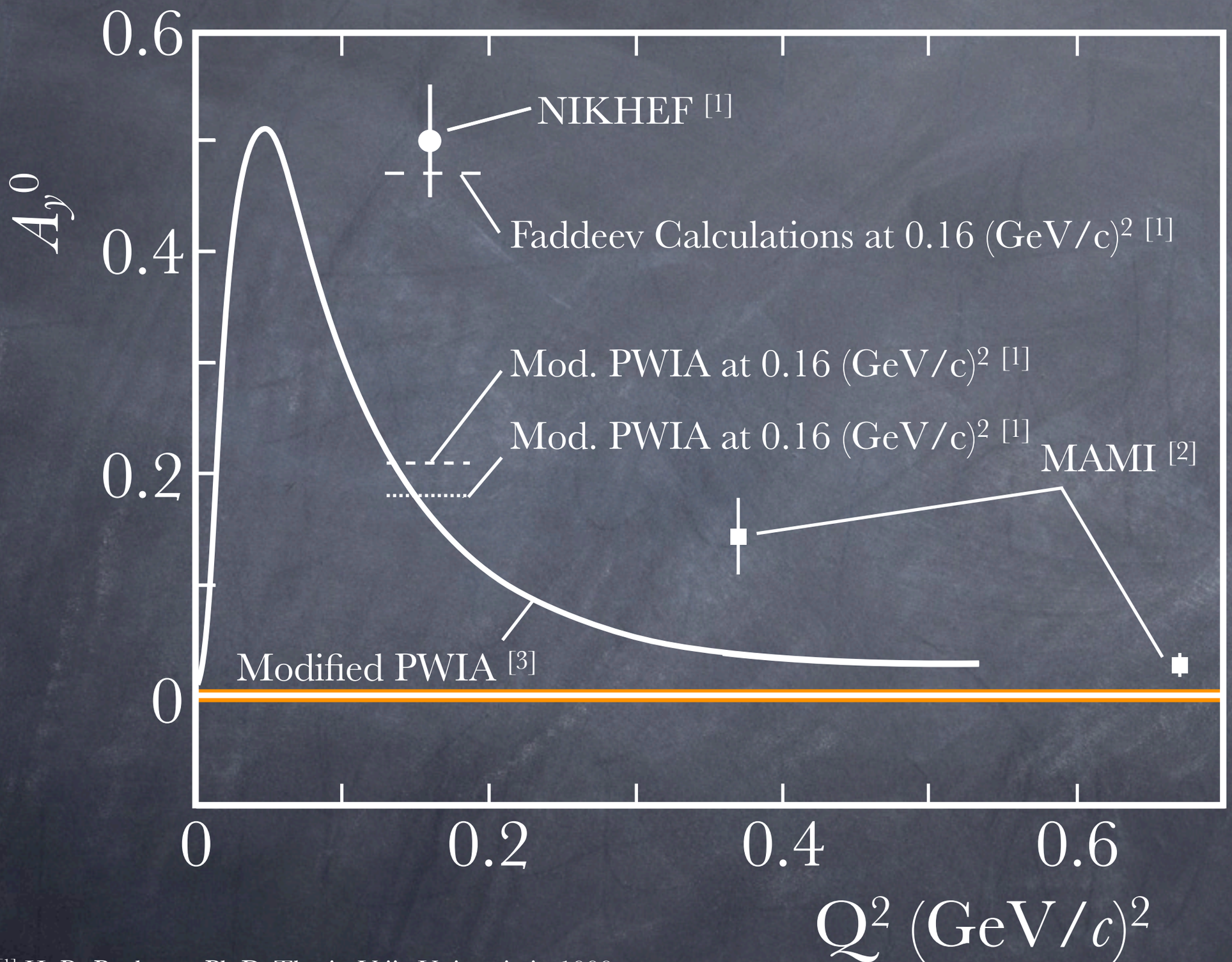

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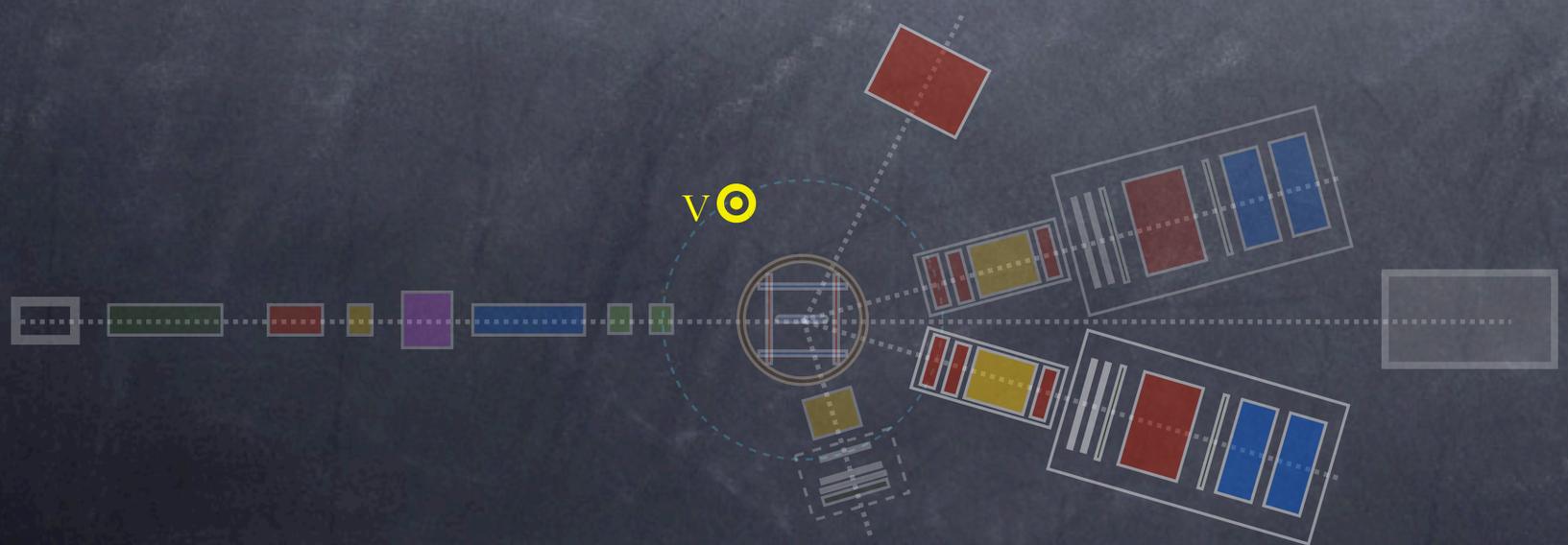

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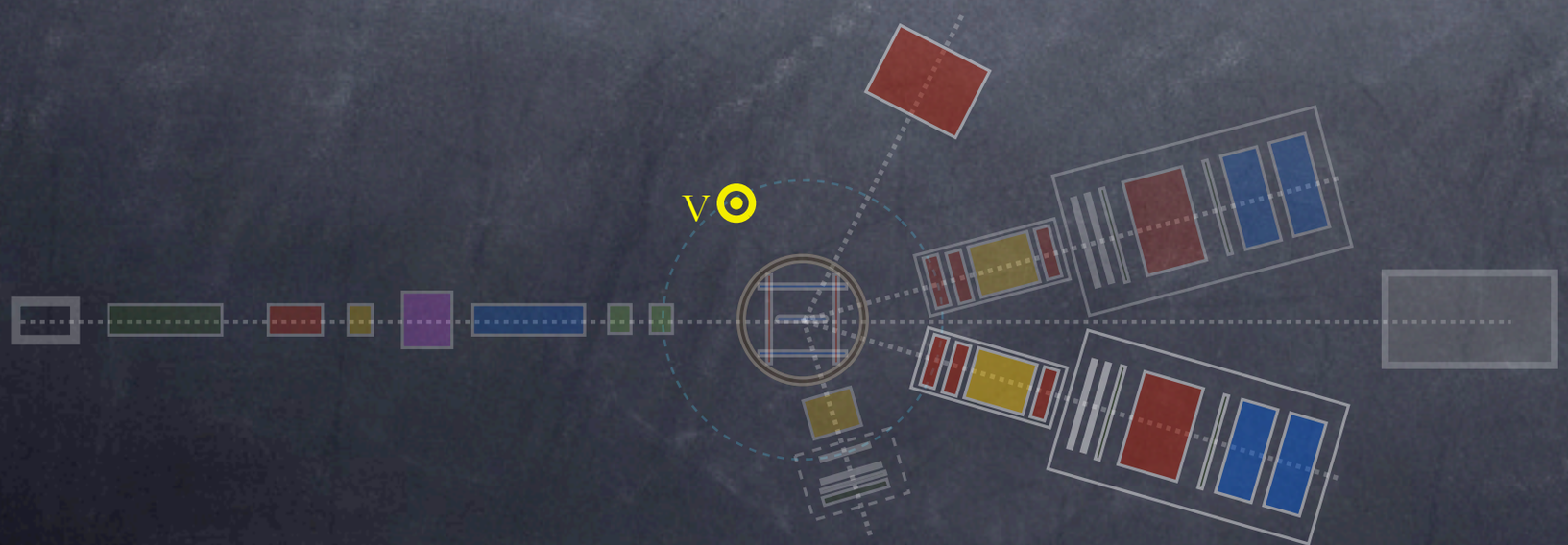

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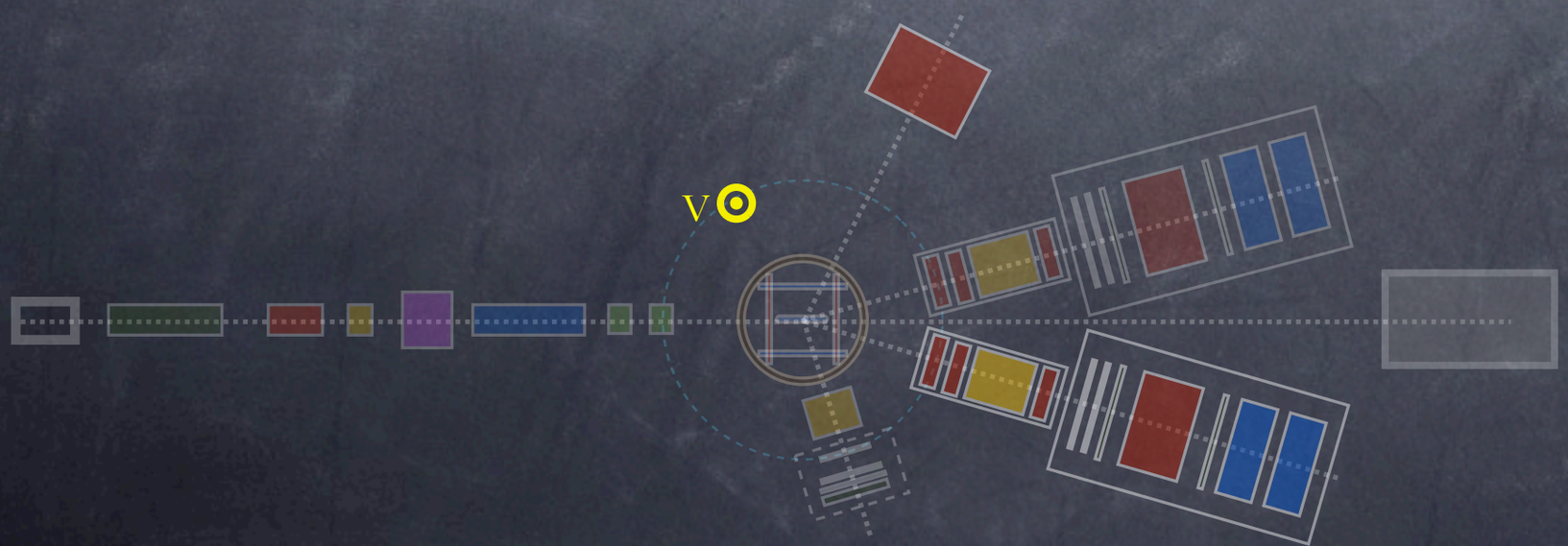
- Any non-zero result is indicative of effects beyond impulse approximation



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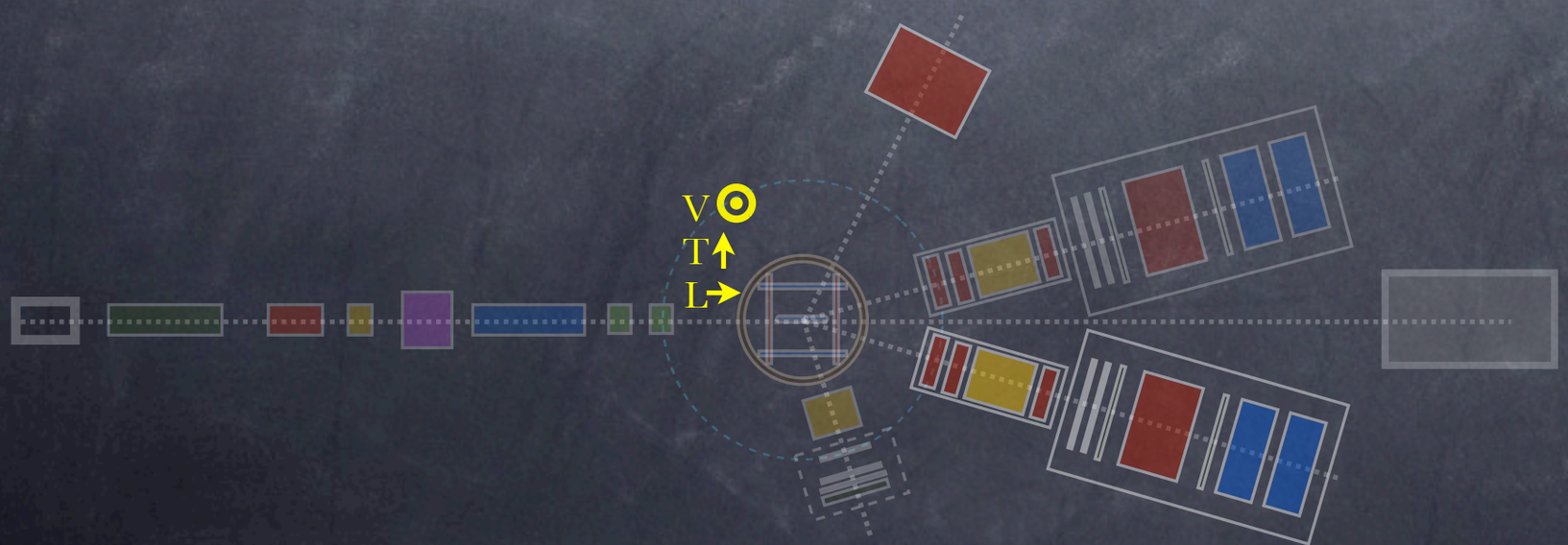

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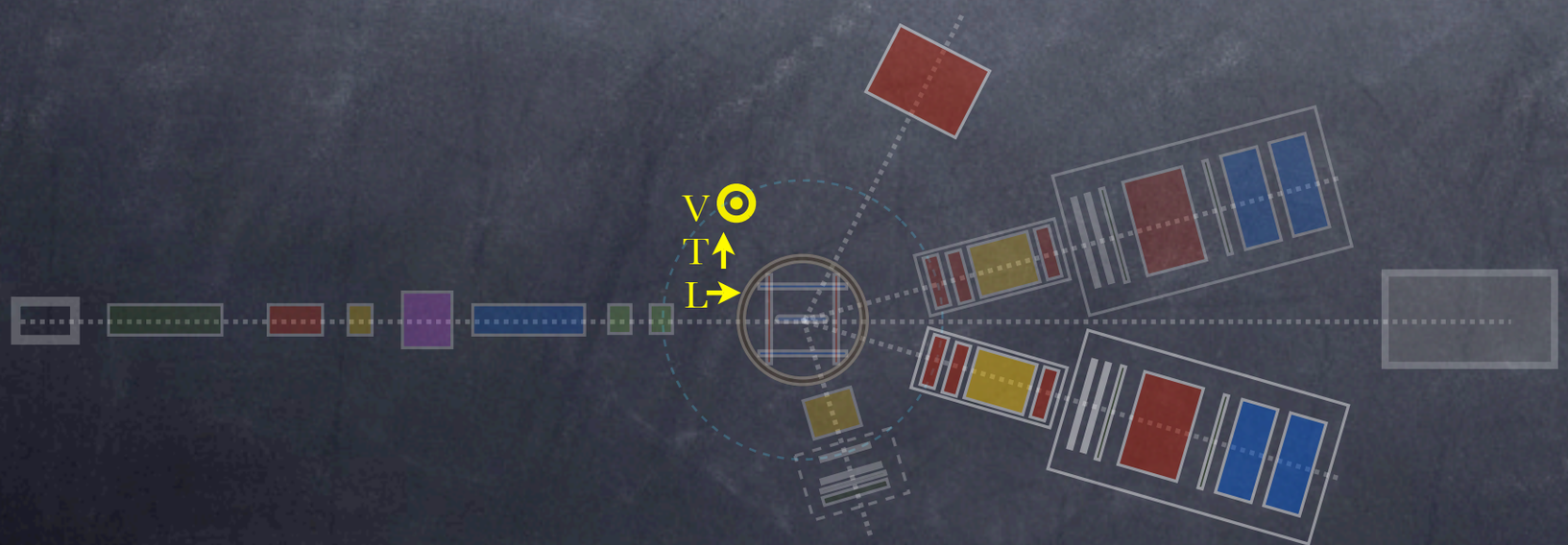
- Additionally, double-spin asymmetries ^{3}He(e,e'n) were measured with the target polarized in transverse and longitudinal directions



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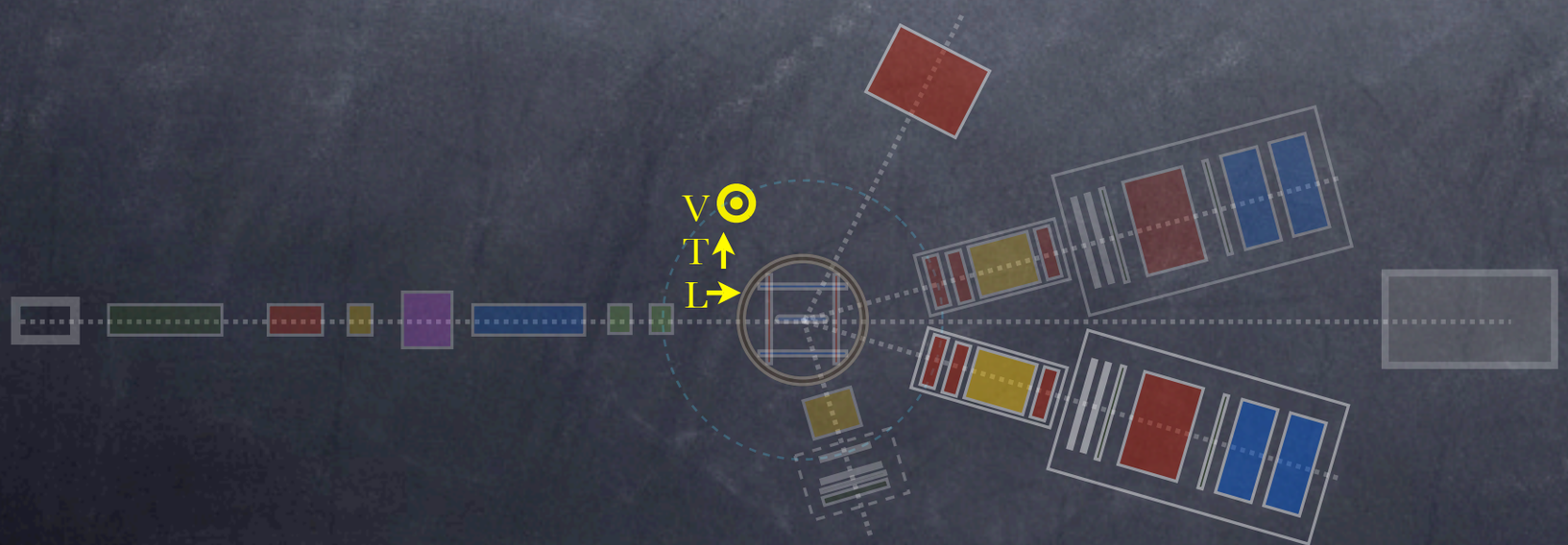

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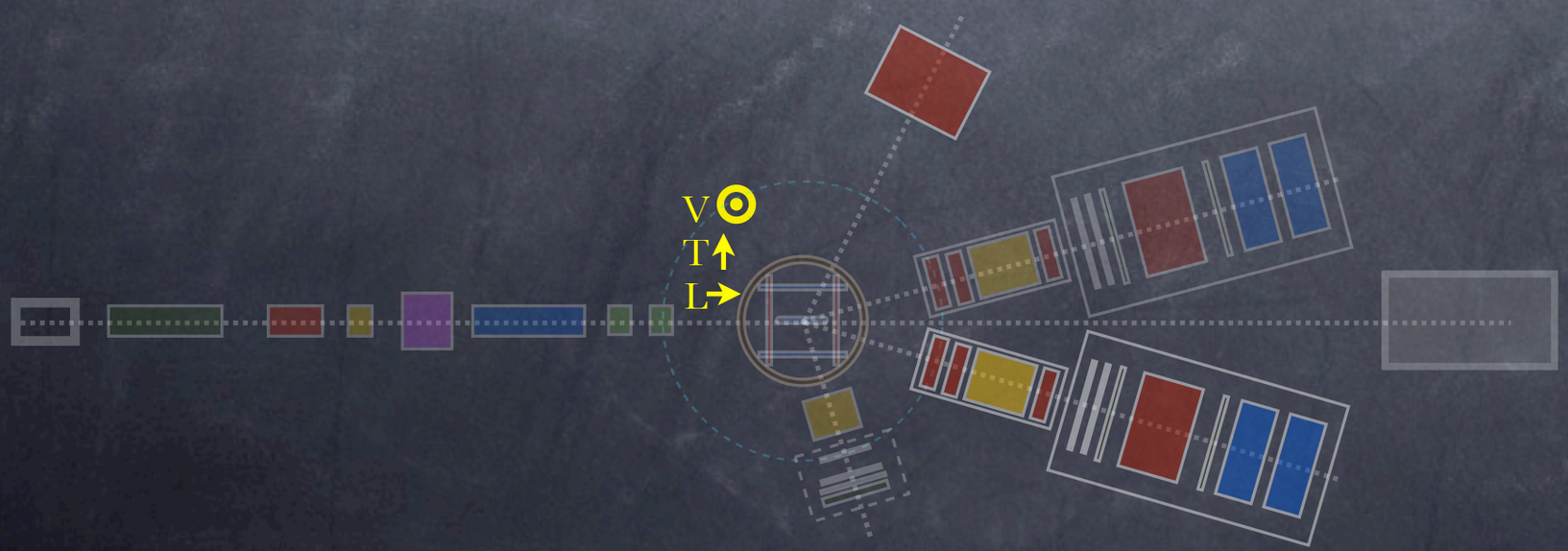

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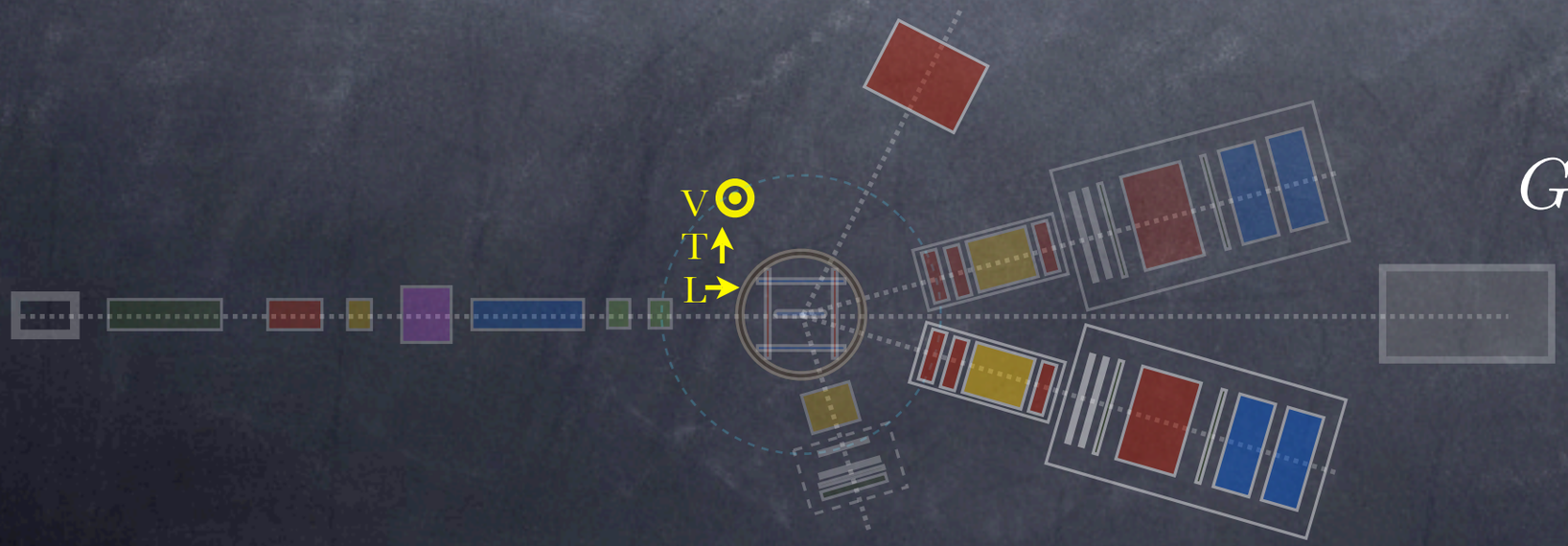
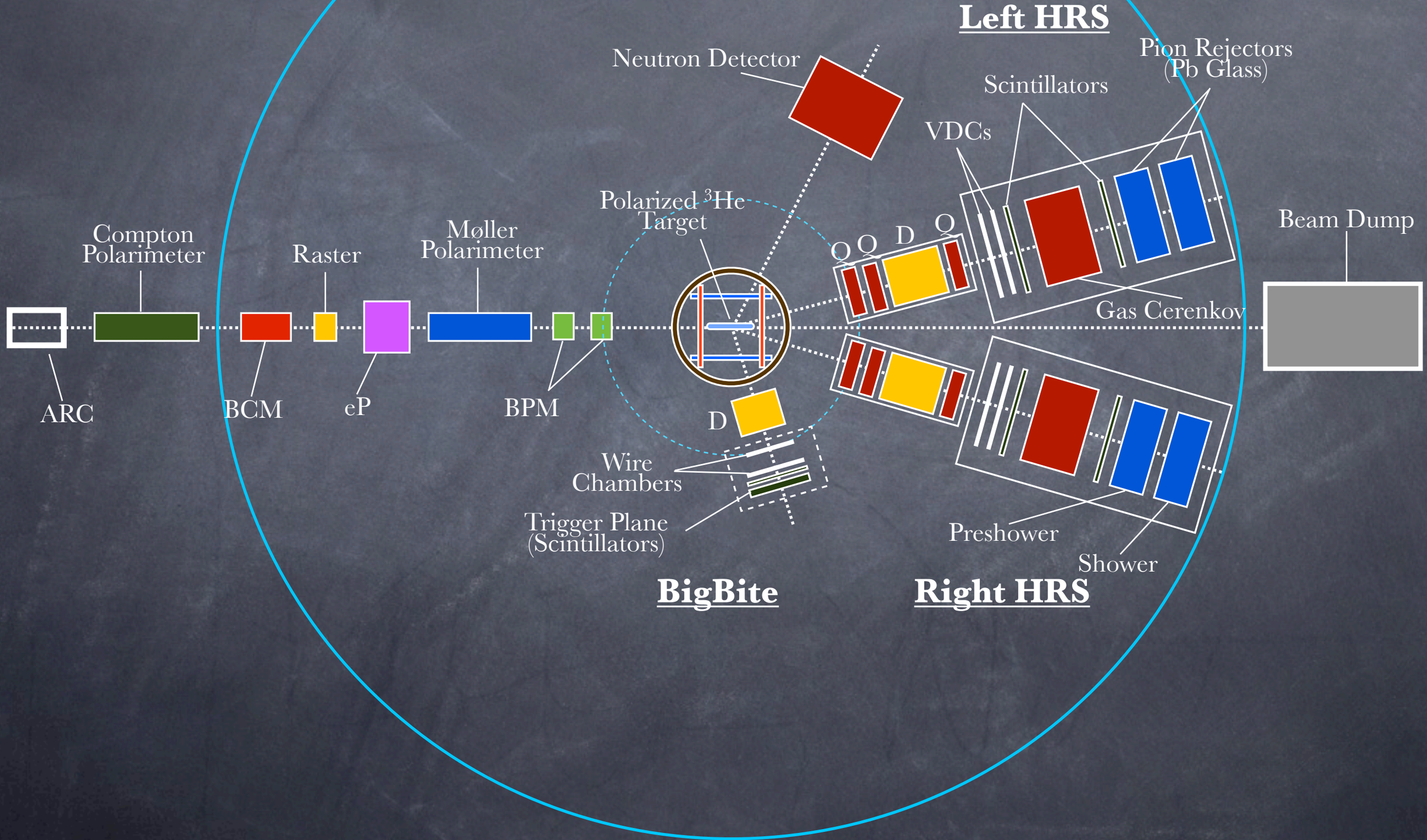
- A_T and A_L DSA measurements related to neutron form factors



$$G_E^n = \frac{b}{a} \cdot G_M^n \frac{(P_b P_t V)_\parallel}{(P_b P_t V)_\perp} \frac{A_\perp}{A_\parallel}$$

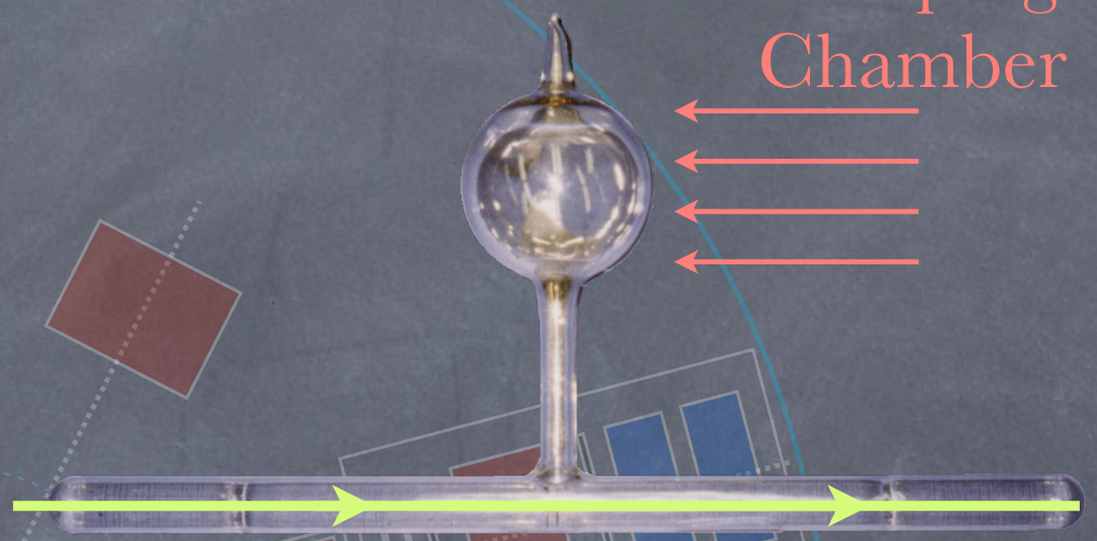
The Measurements

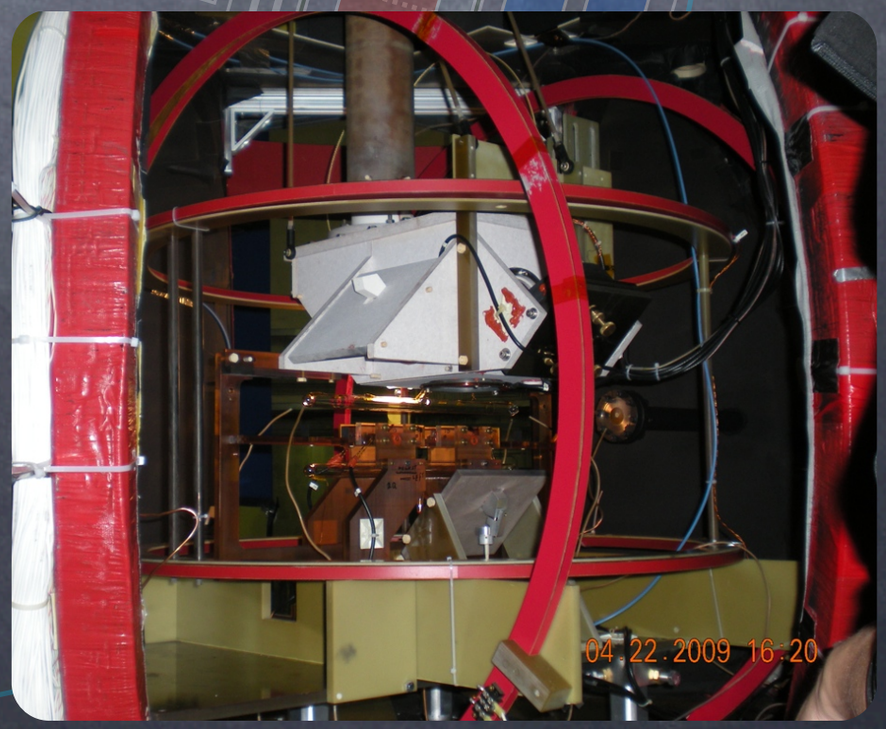
Hall A



The Measurements

Polarized ^{3}He Target





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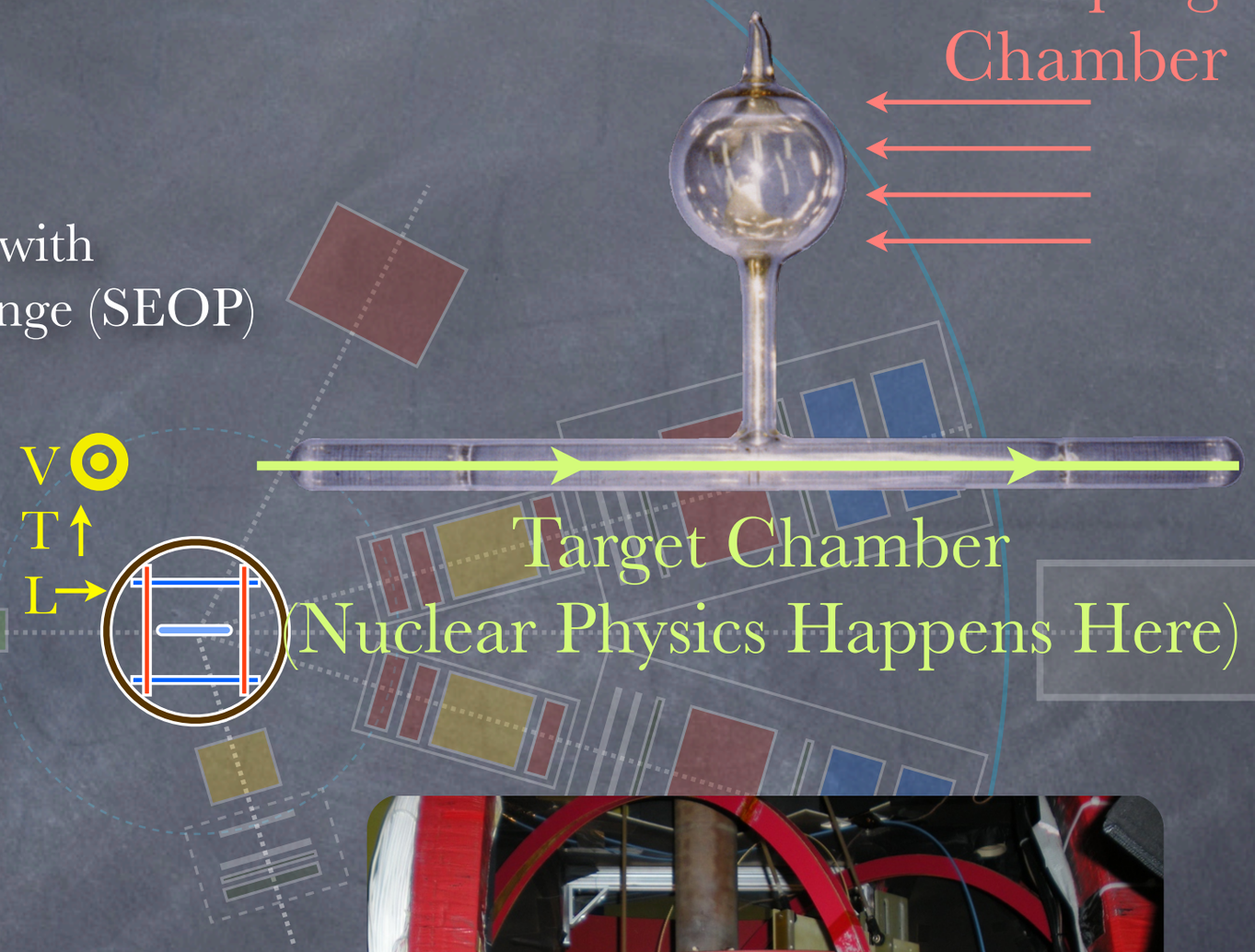
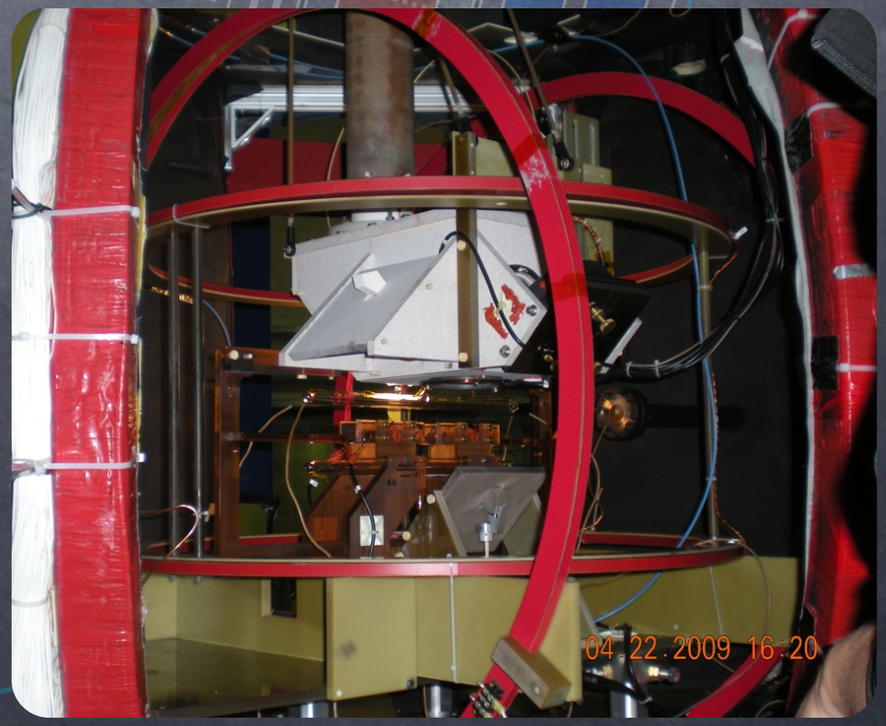
- Optically pumped rubidium vapor used with potassium to polarize ^{3}He via spin exchange (SEOP)





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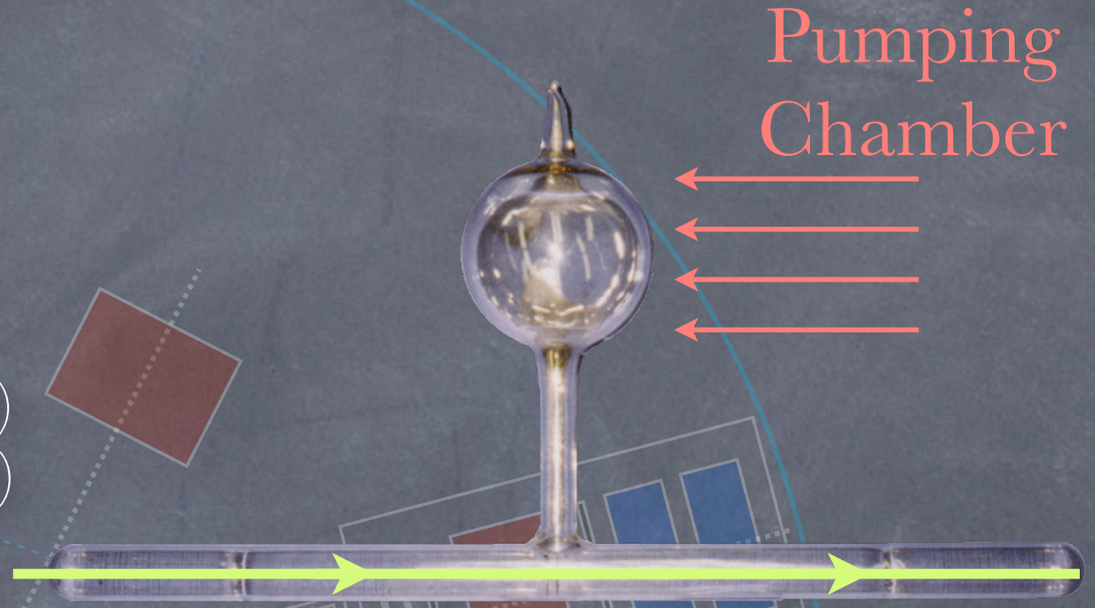

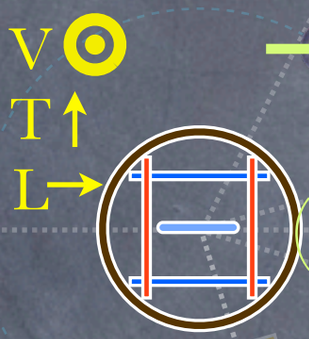

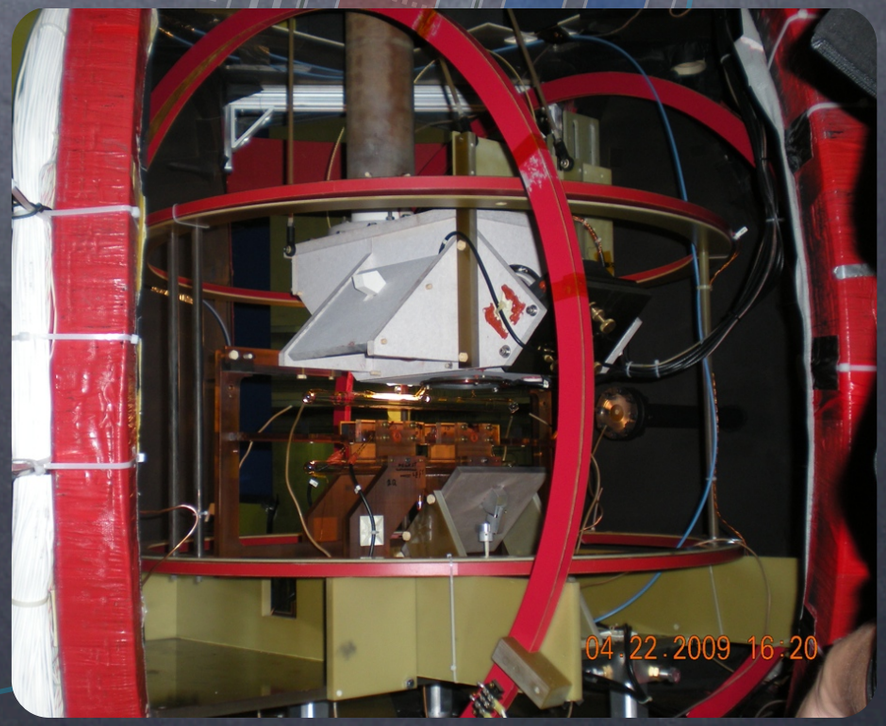

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- Achieved Polarized > 50%
  - 51.4 ± 0.4 ± 2.8% for A_y^0
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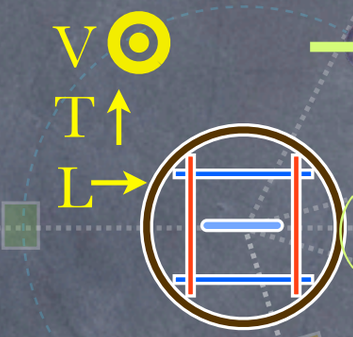

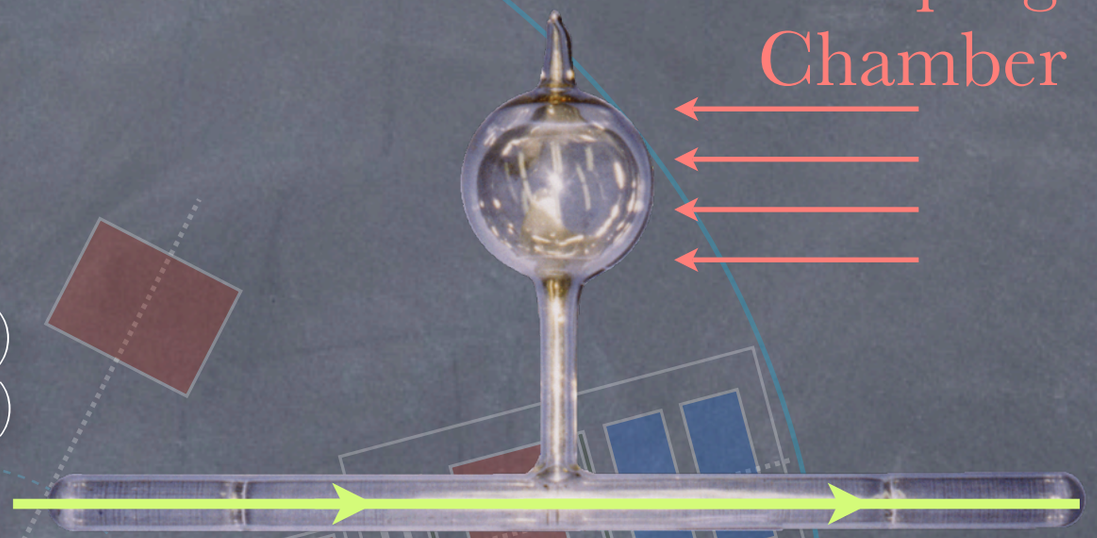

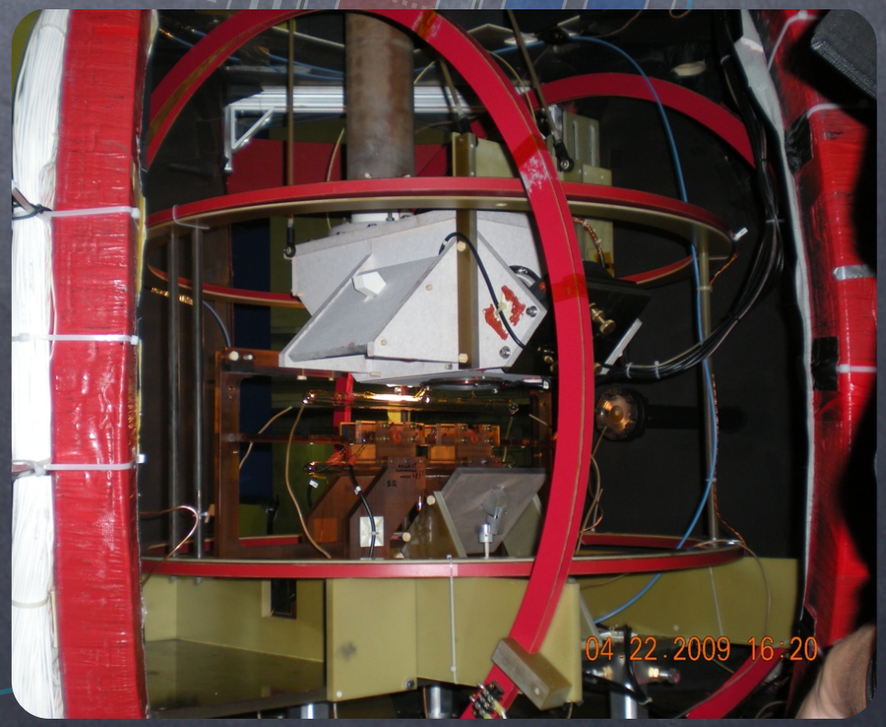

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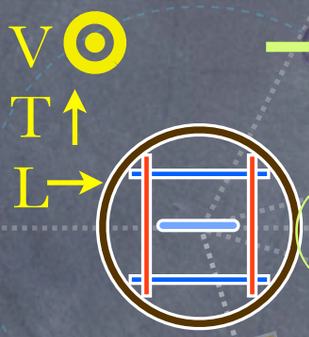
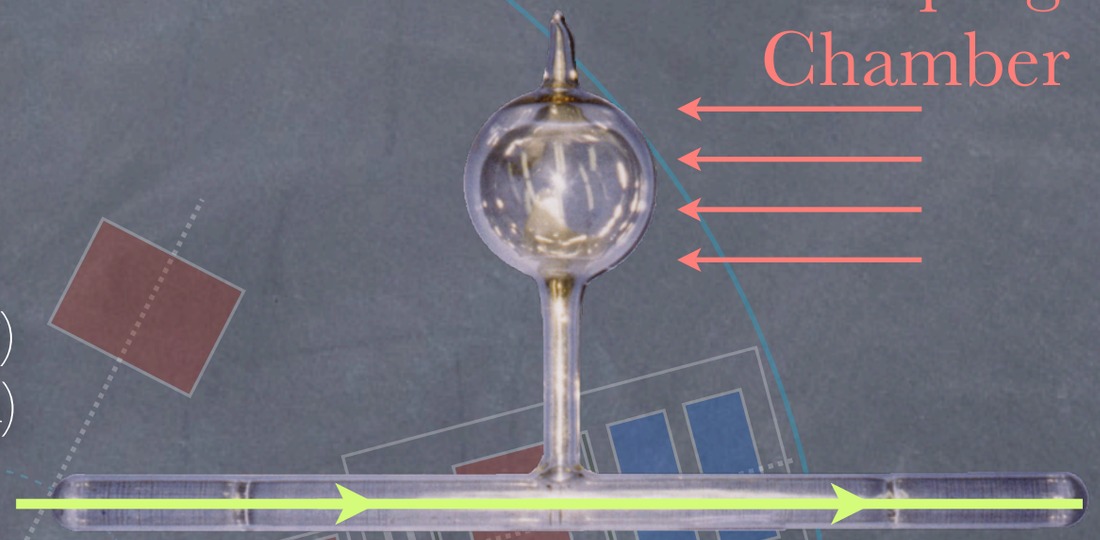
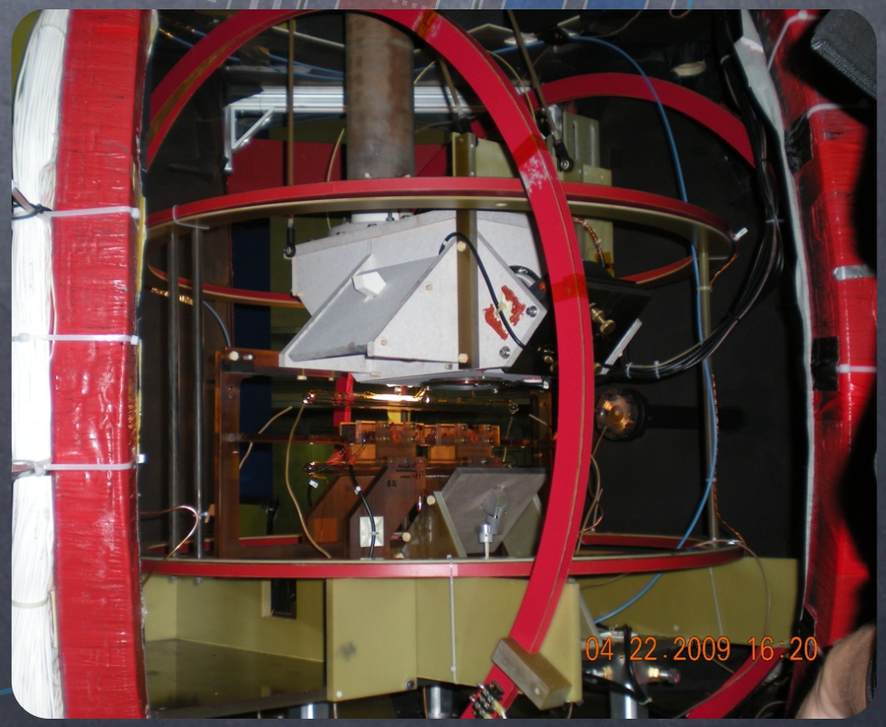
- See Yawei's talk at 2:15 for more information







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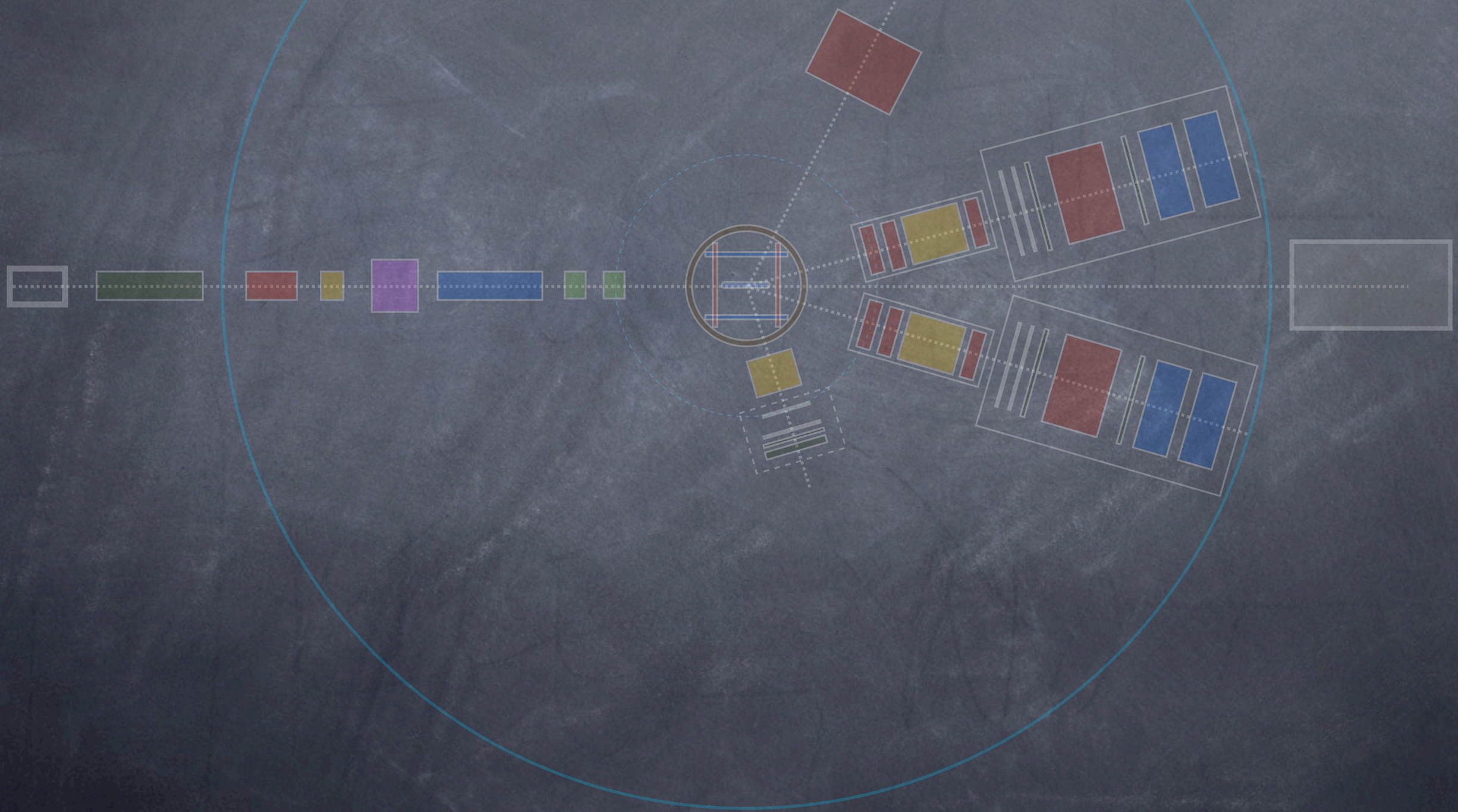

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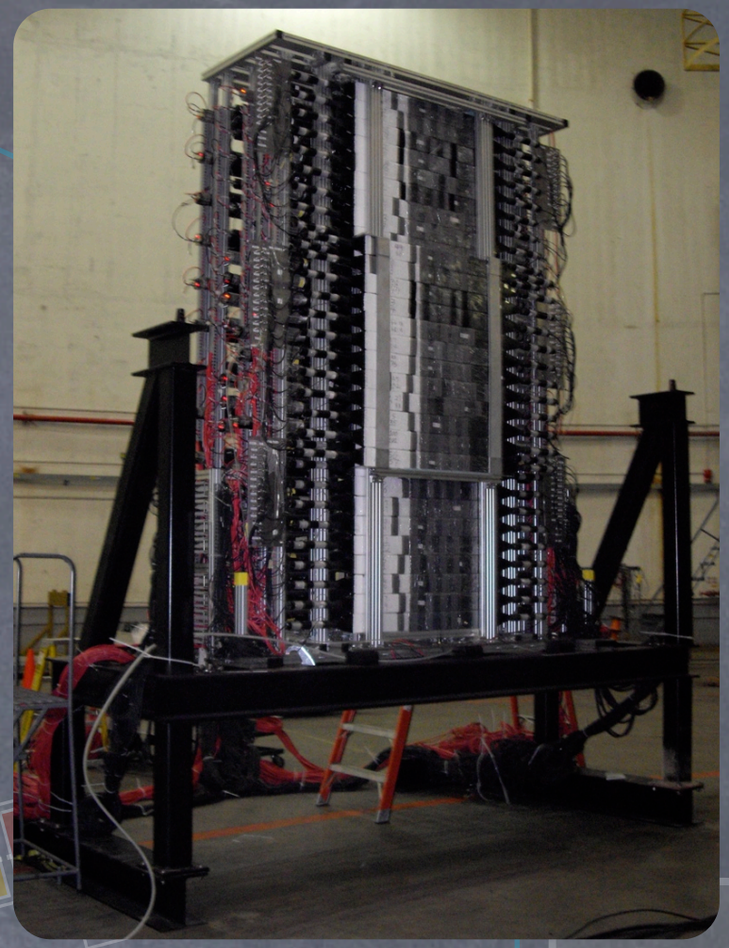
Hall A Neutron Detector



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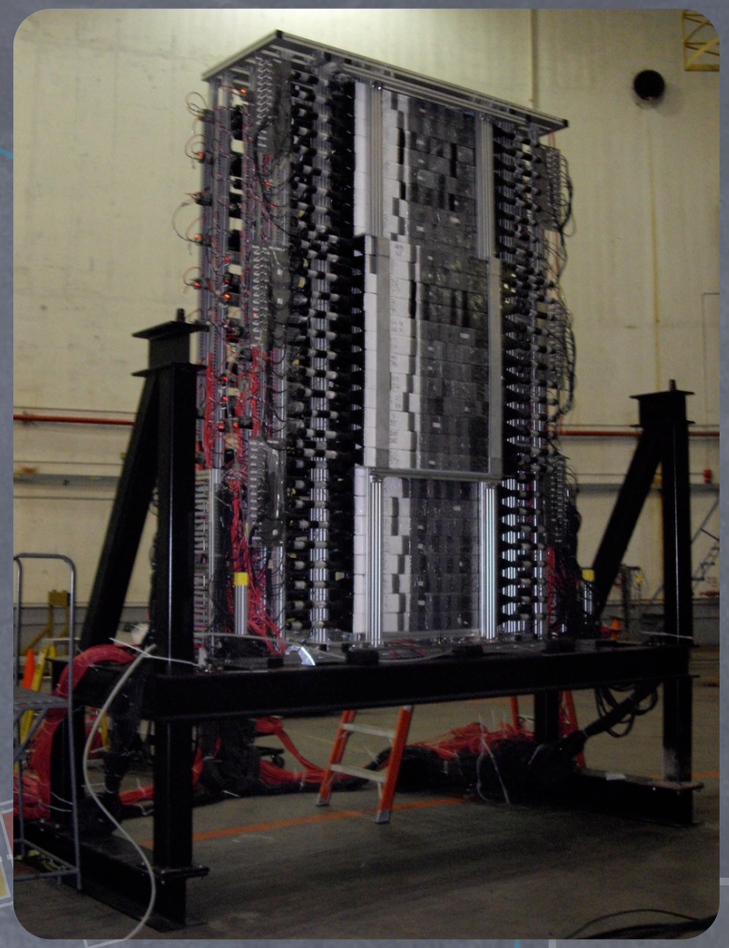
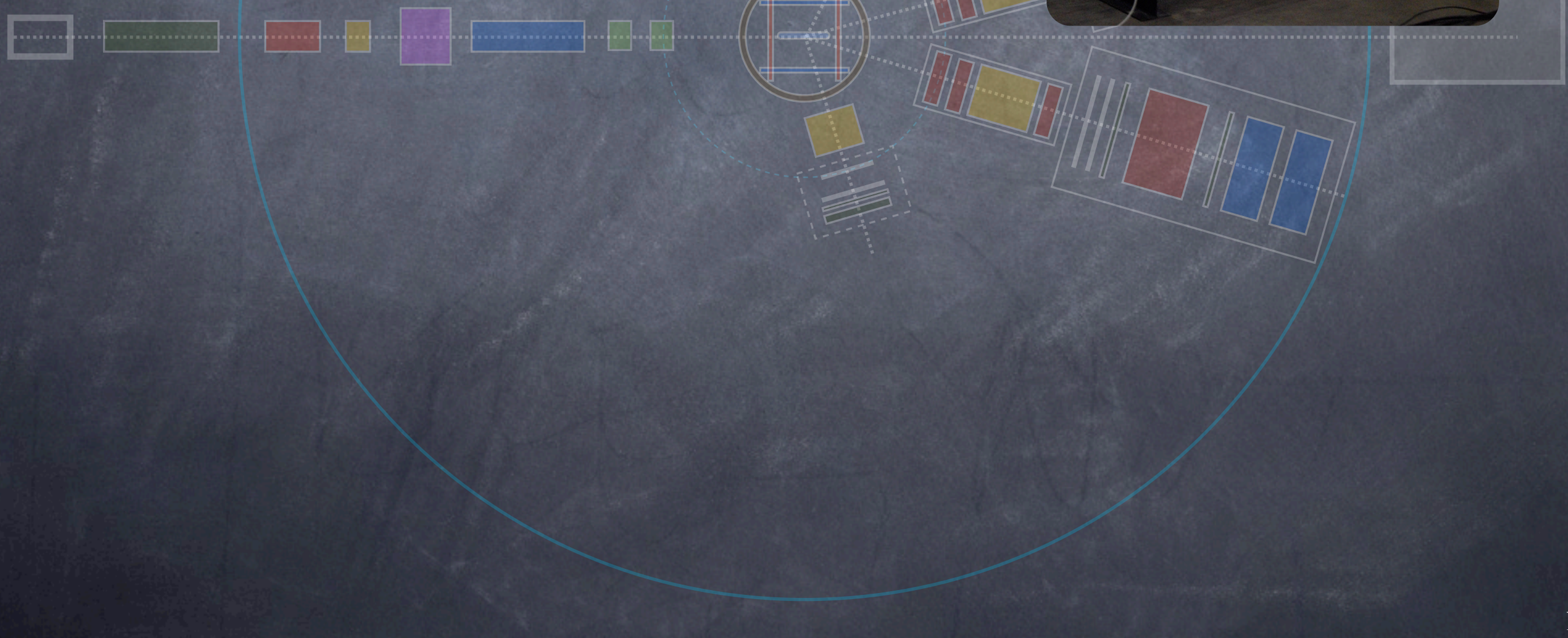
Hall A Neutron Detector

- Made of plastic scintillator array
- Detected neutrons from ^{3}He(e,$e'n$)
- Along with RHRS allowed A_y^0, A_T, and A_L measurements to be made





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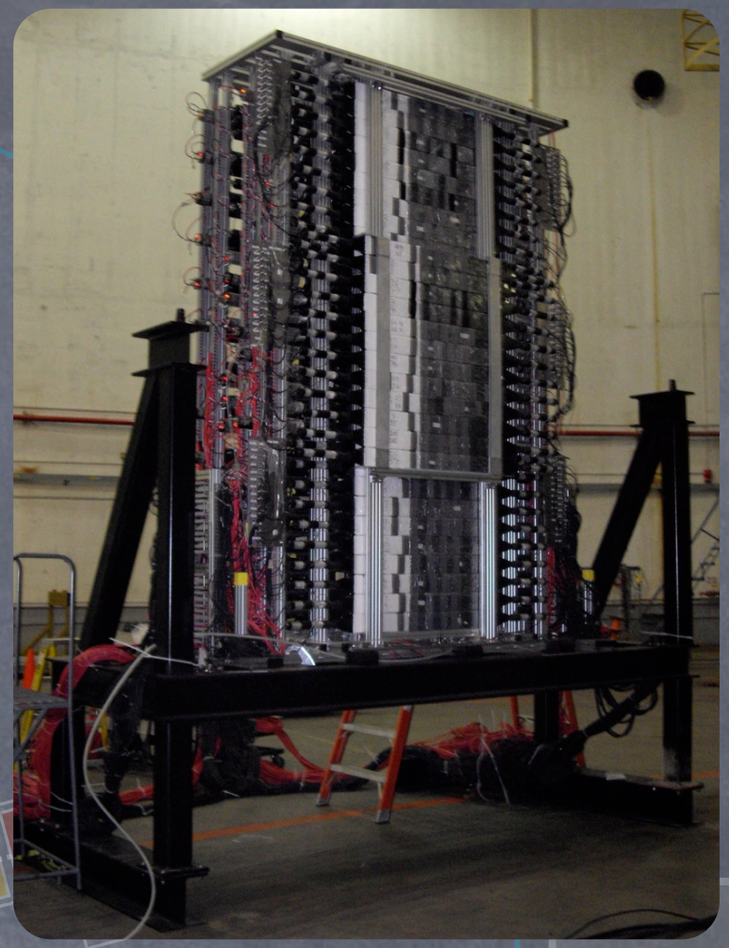
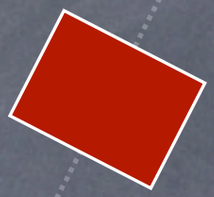
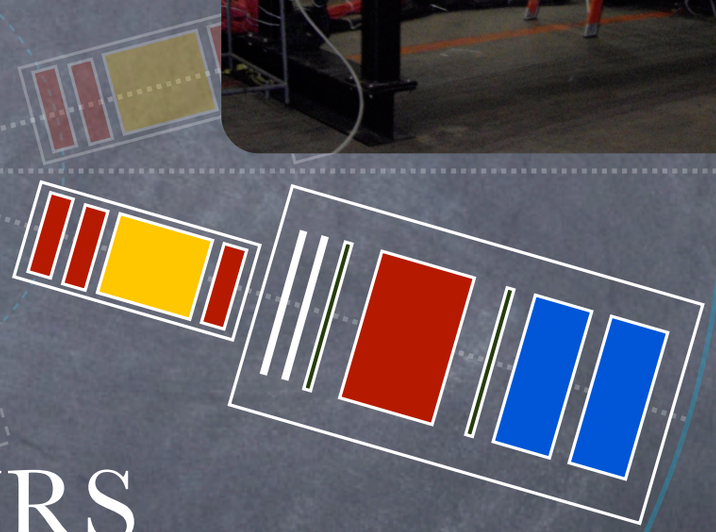
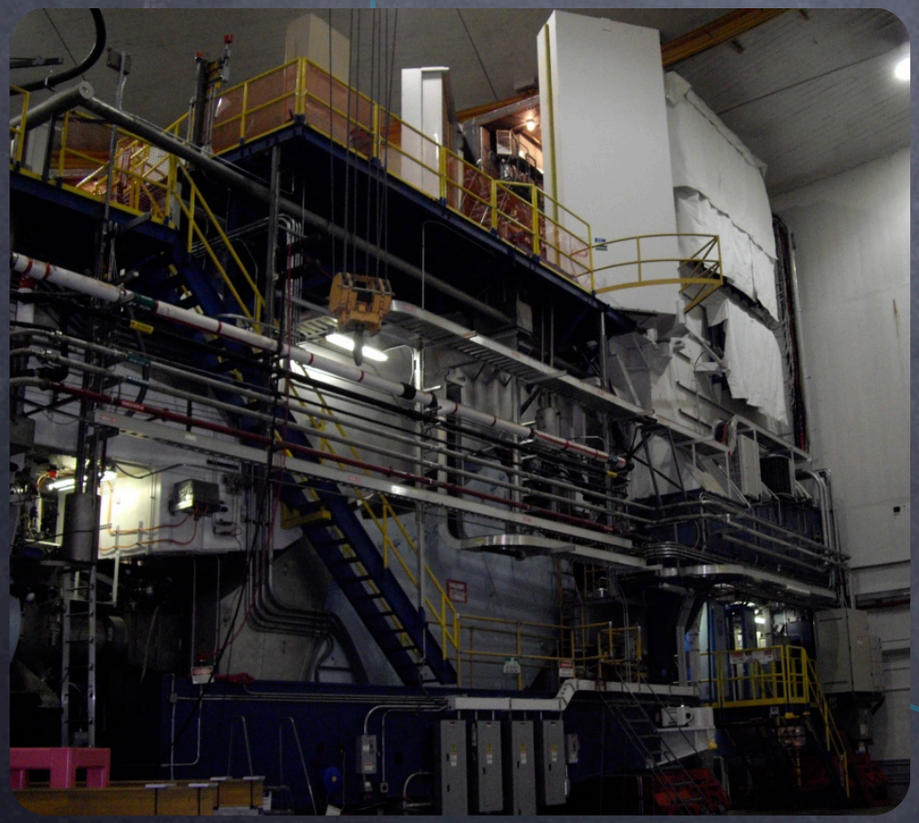






Right HRS



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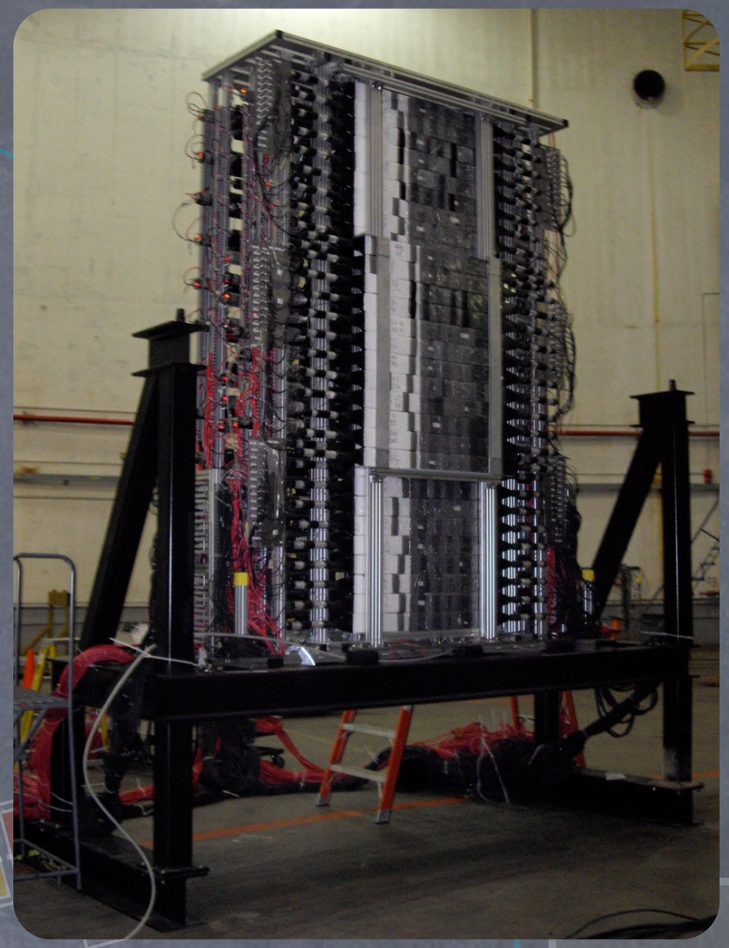

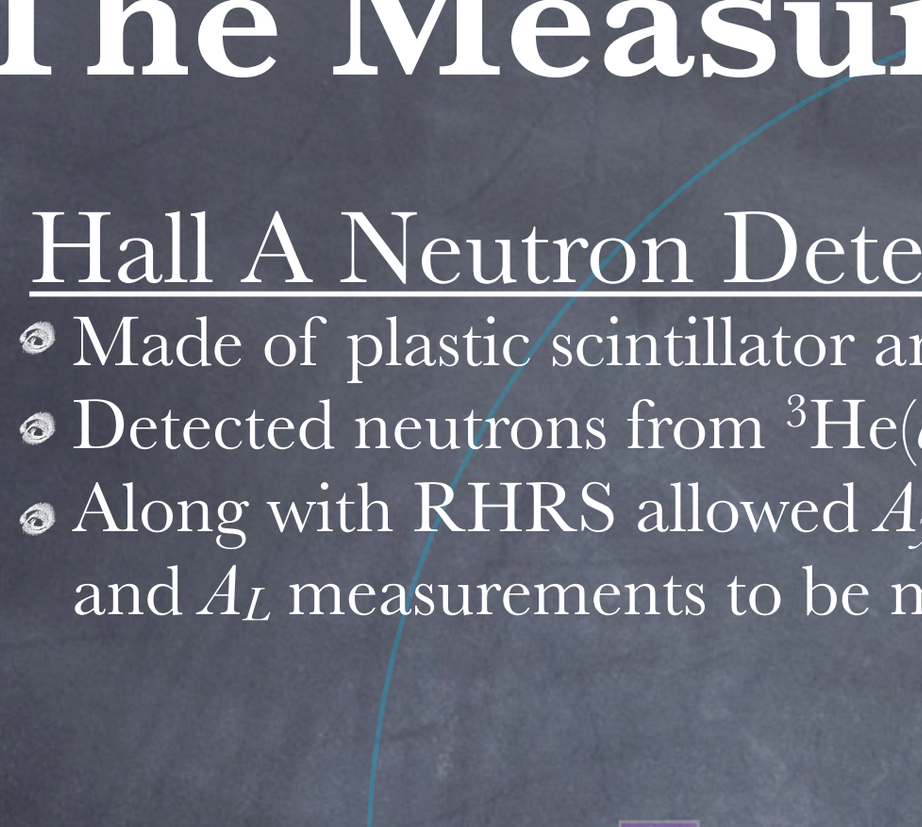

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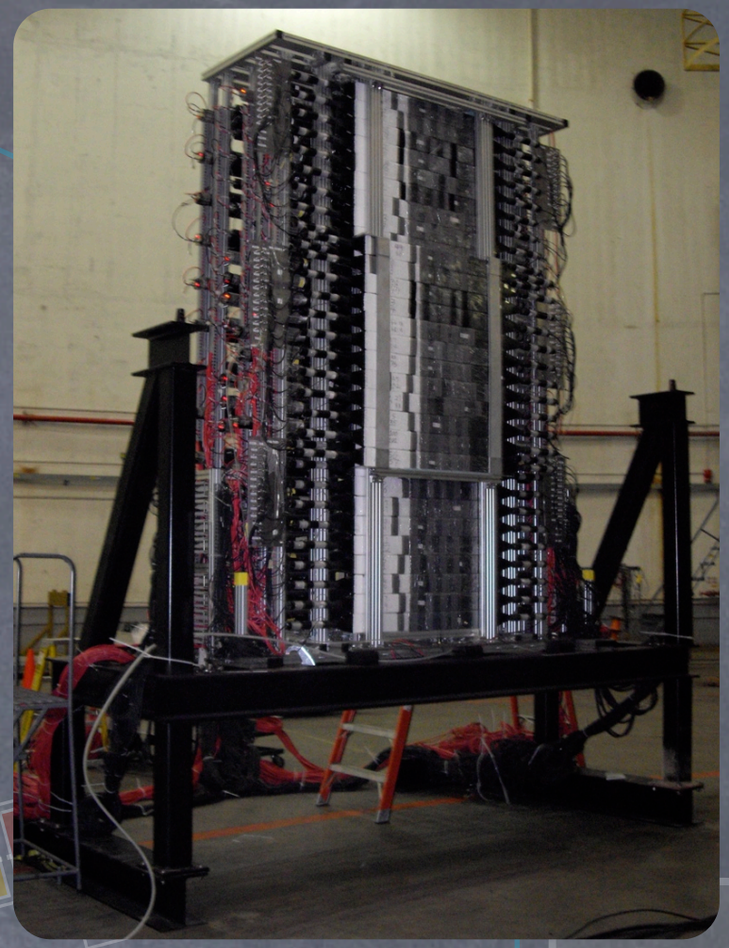

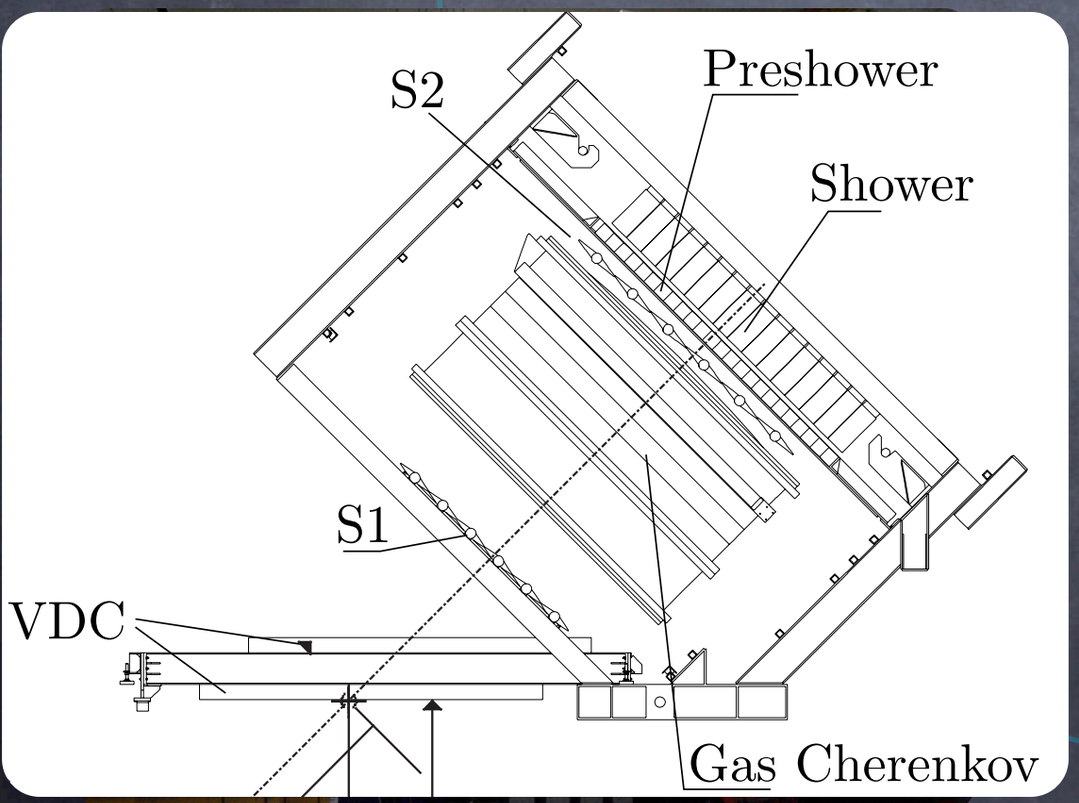

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The Measurements

- The measurements ran from April-June 2009 in Jefferson Lab's Hall A
- The kinematics taken were:

Target Polarization	Q^2 $(GeV/c)^2$	E_0 (GeV)	RHRS (°)	RHRS P_0 (GeV)	HAND (°)
Vertical	0.127	1.245	-17	1.1759	71.0
Vertical	0.456	2.425	-17	2.1813	62.5
Vertical	0.953	3.605	-17	3.0855	54.0
Transverse	0.505	2.425	-18	2.1750	62.5
Transverse	0.953	3.606	-17	3.8055	54.0
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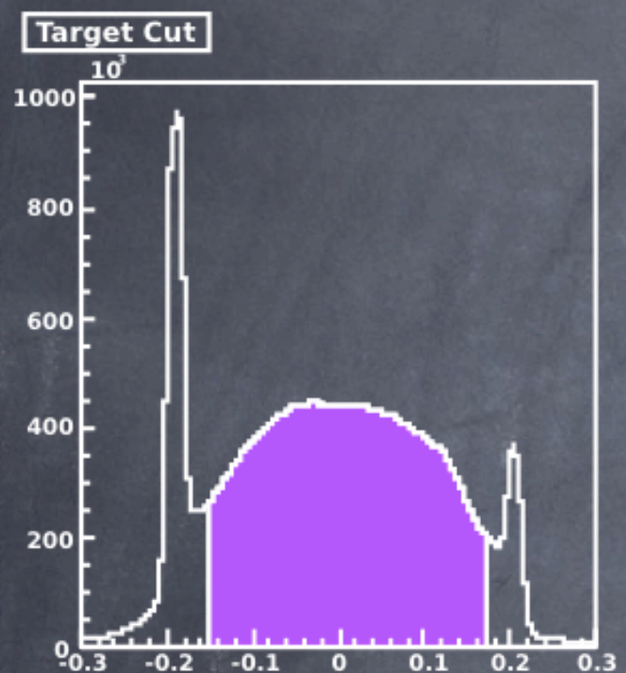
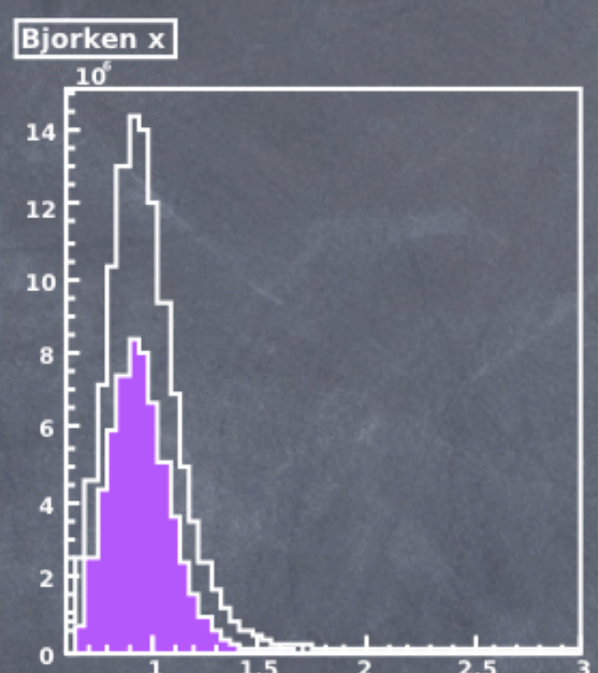
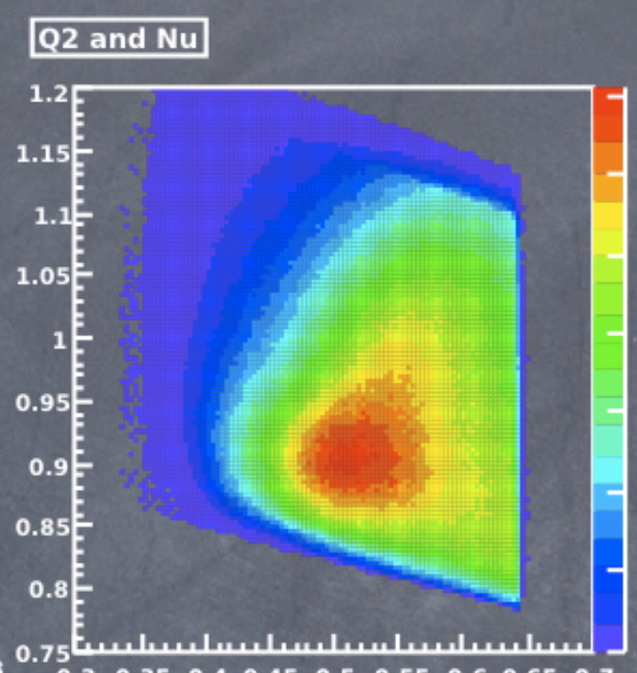
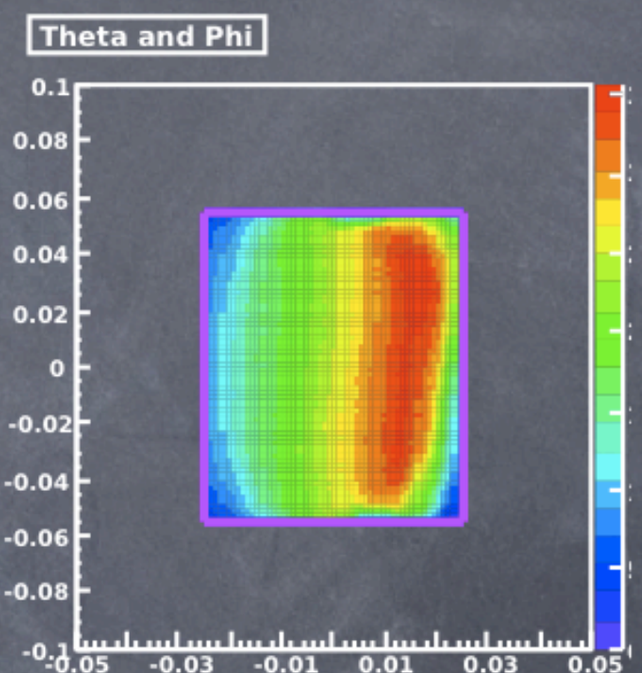
The Measurements

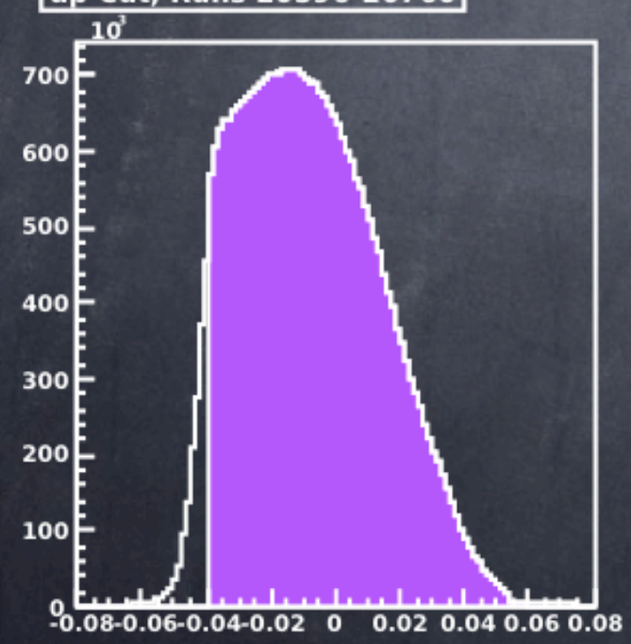
- Electron ID
- RHRS

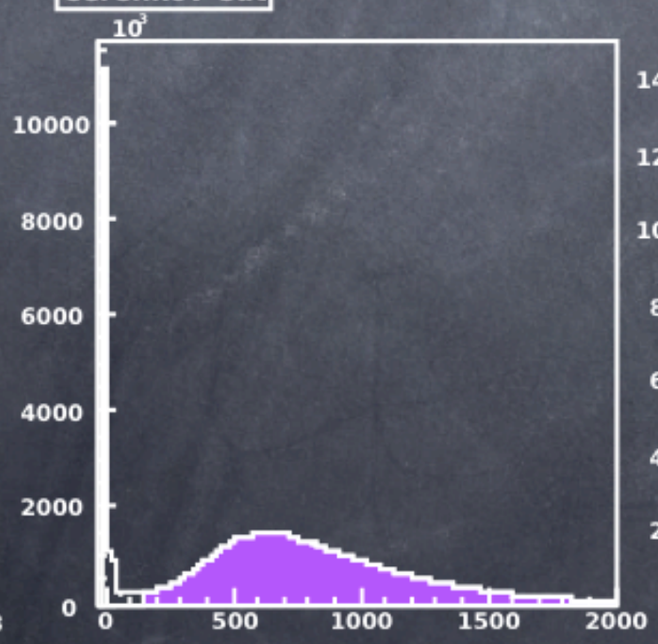


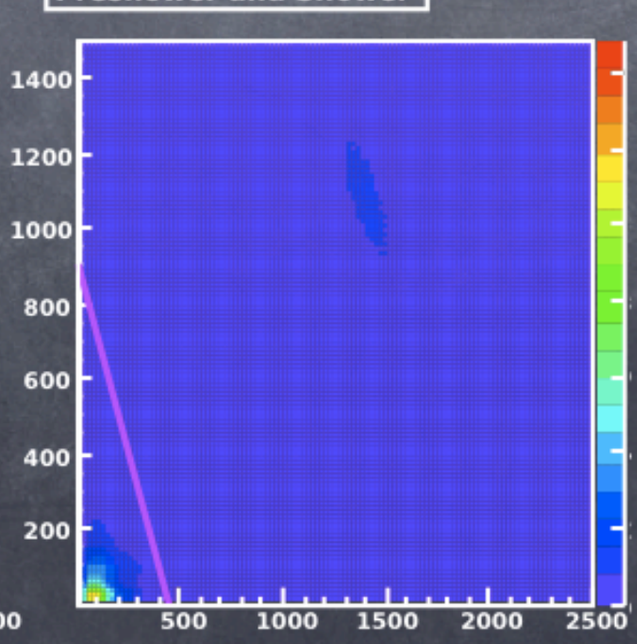


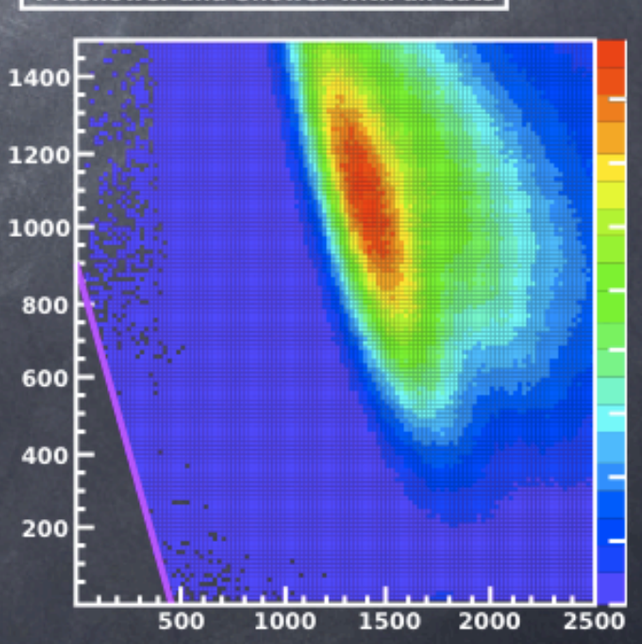












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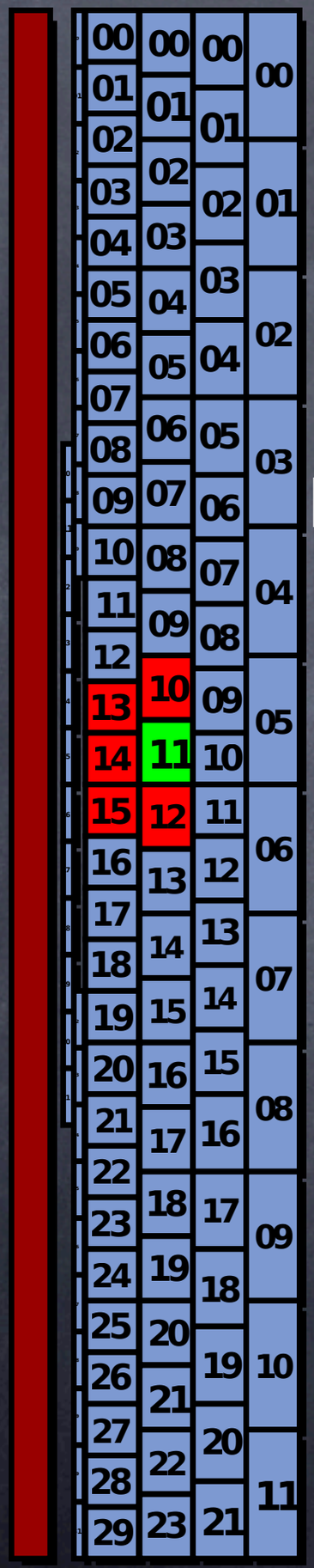

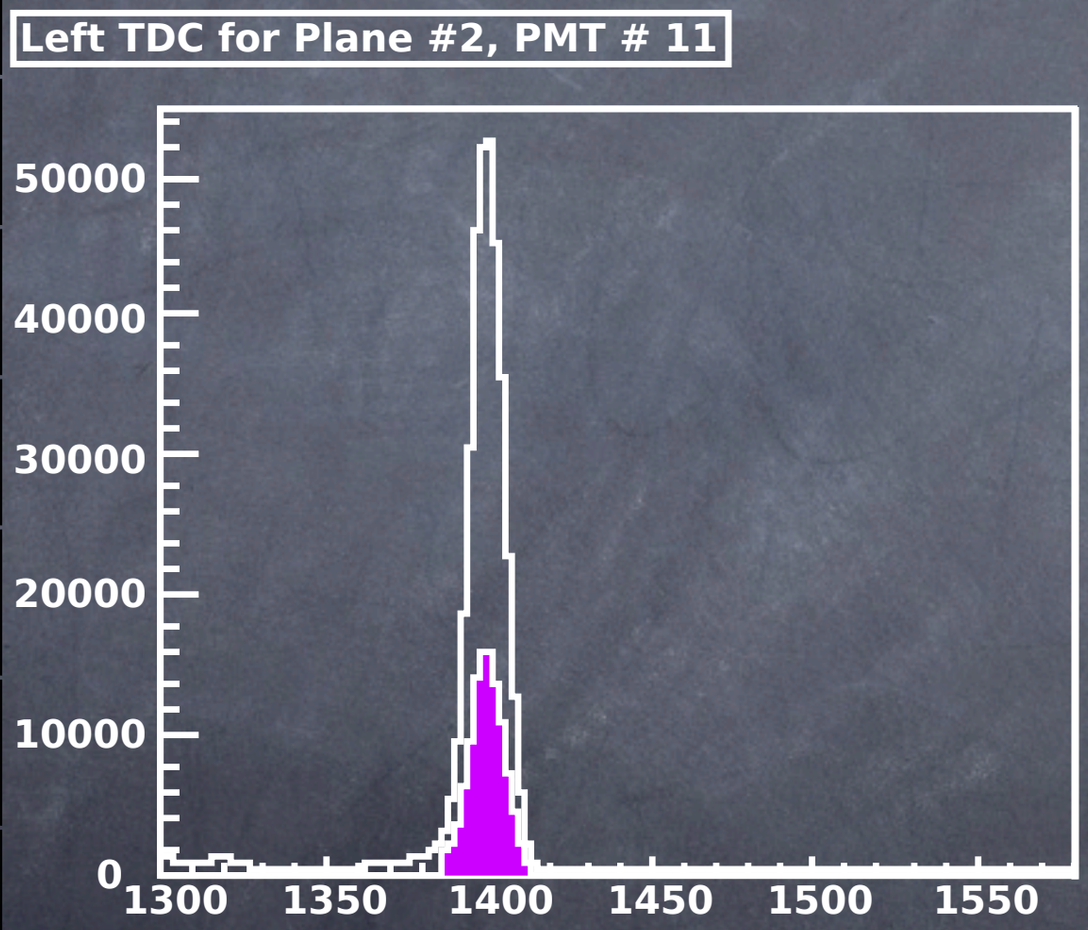

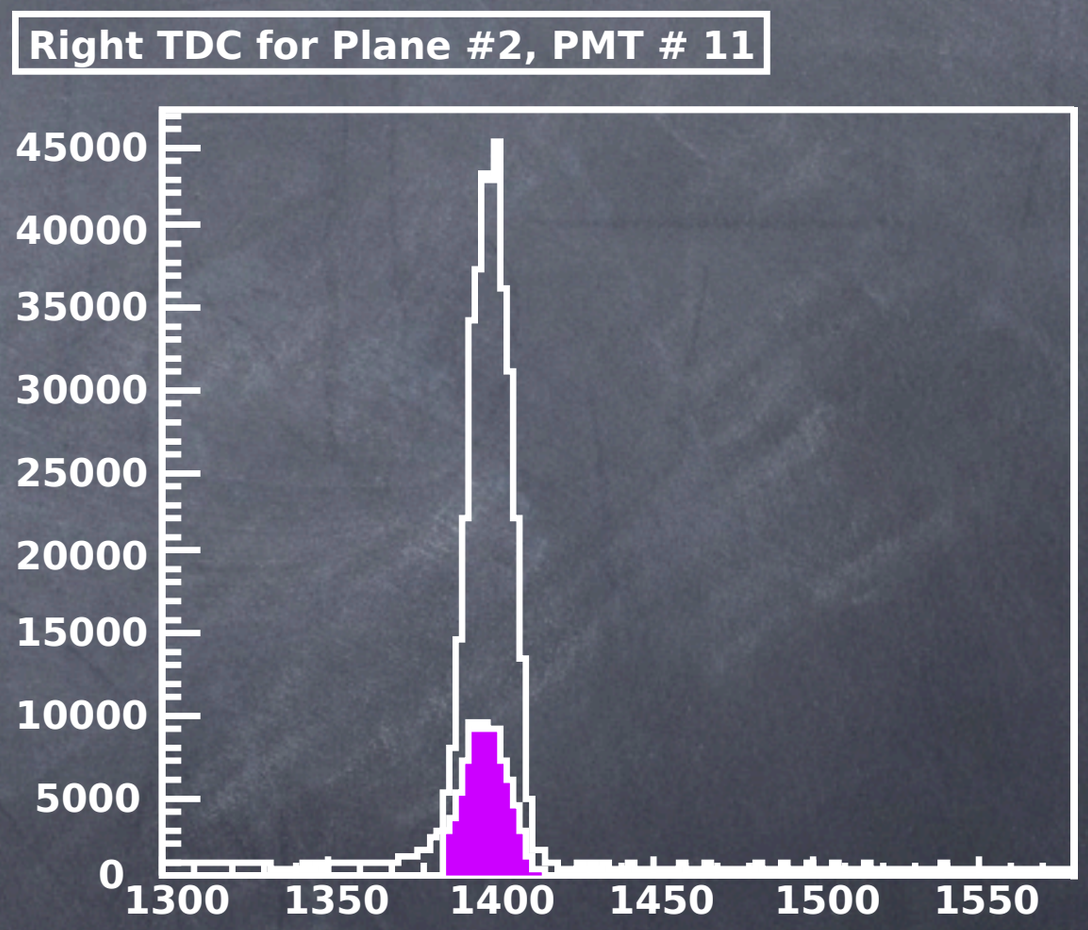

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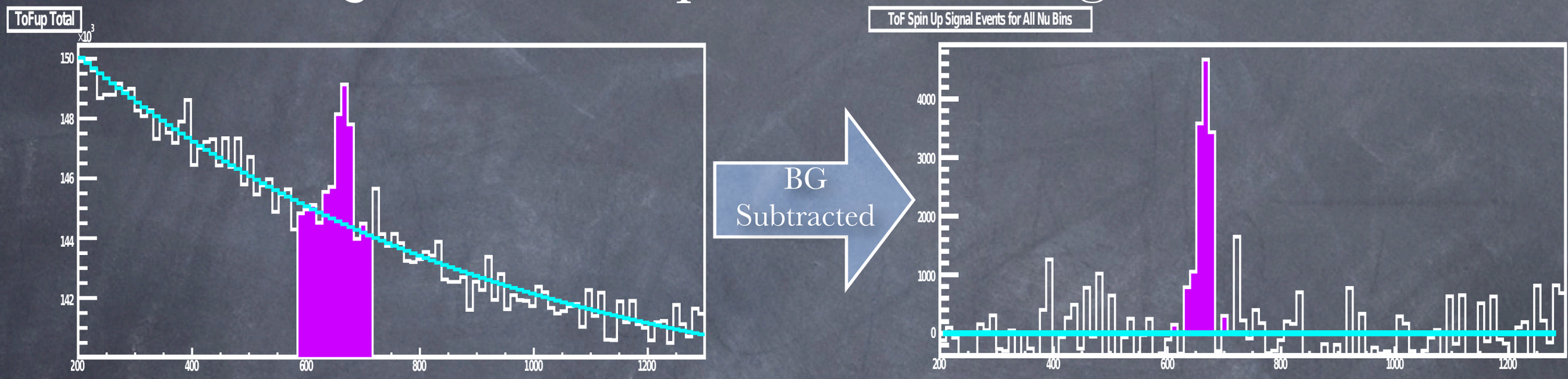
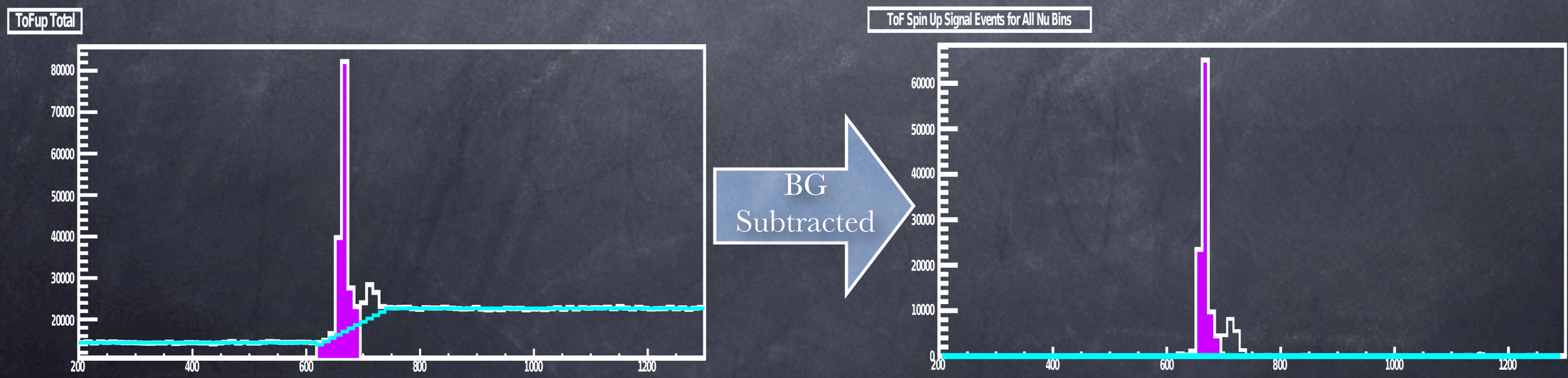
Q^2=0.1 ➞ Exponential Background



Q^2=0.5 & 1.0 ➞ Asymmetric Constant BG



Results

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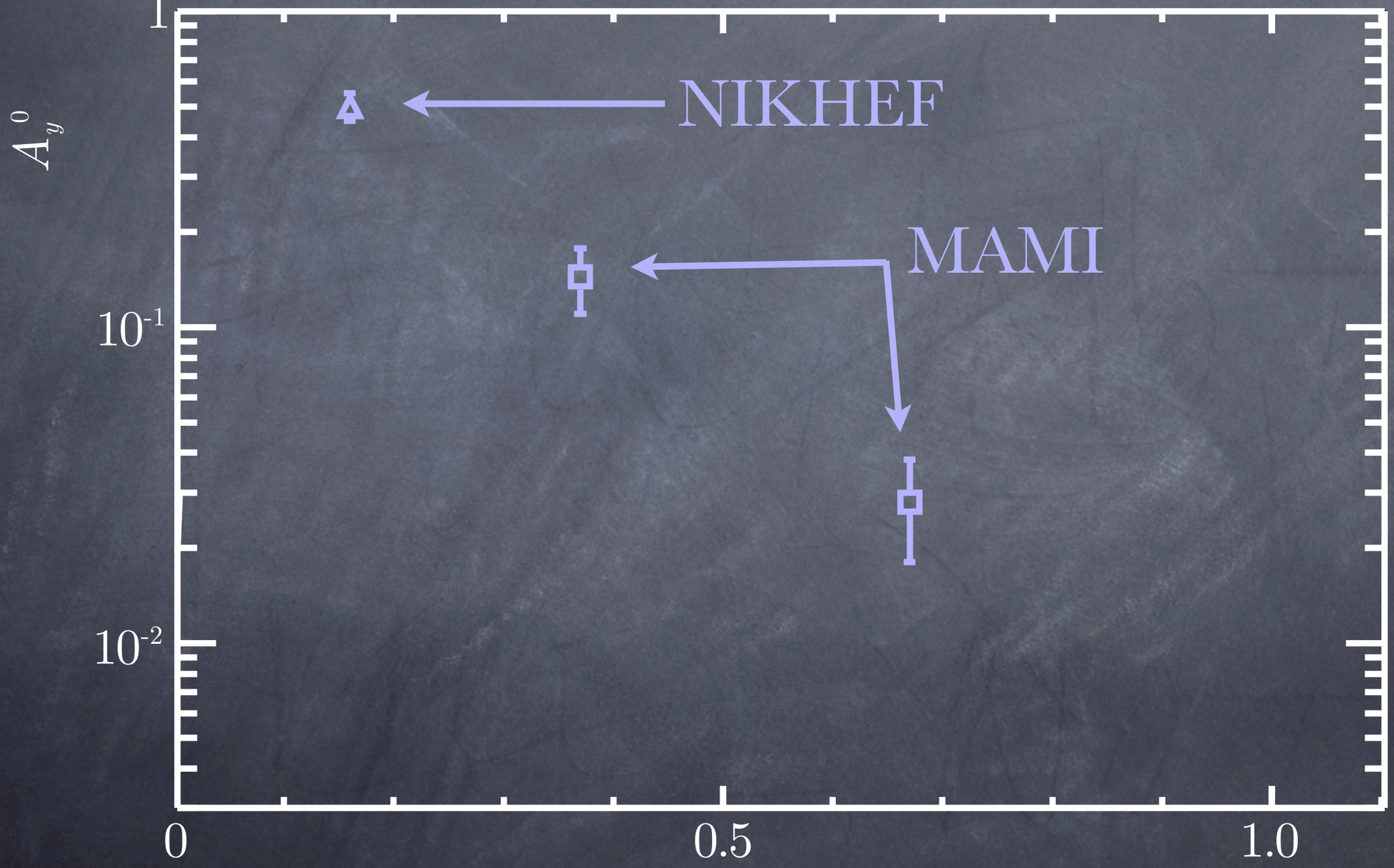

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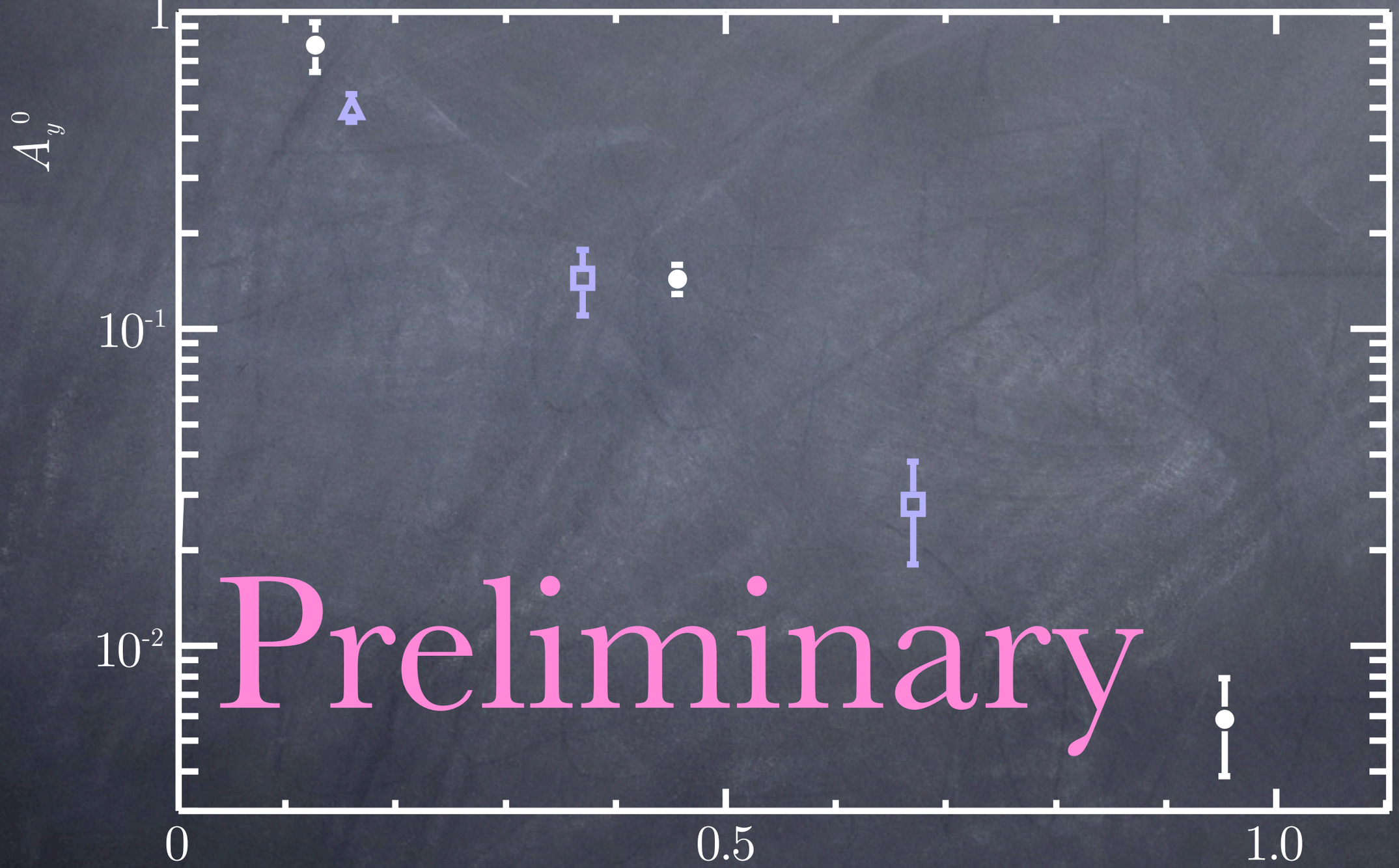

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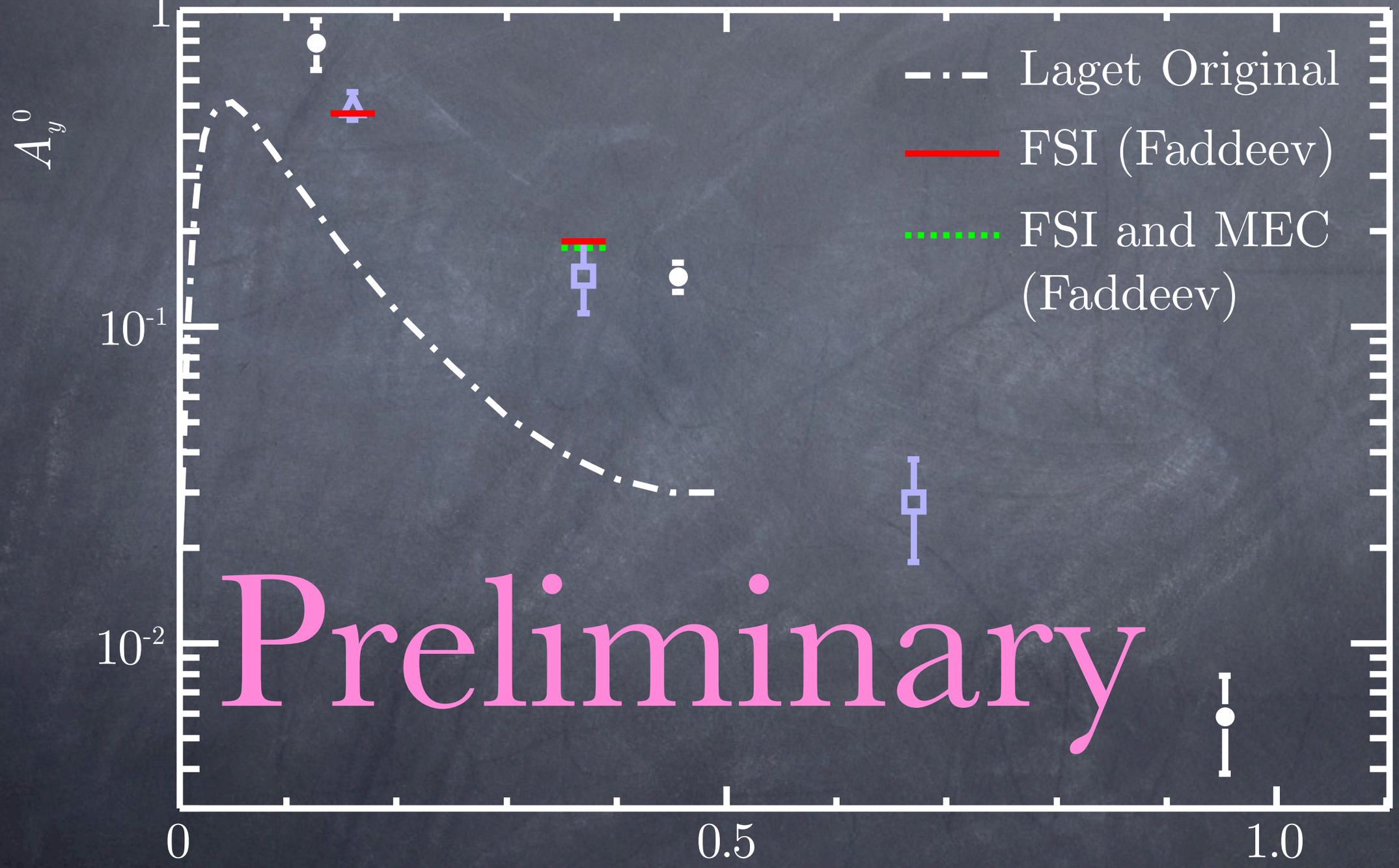

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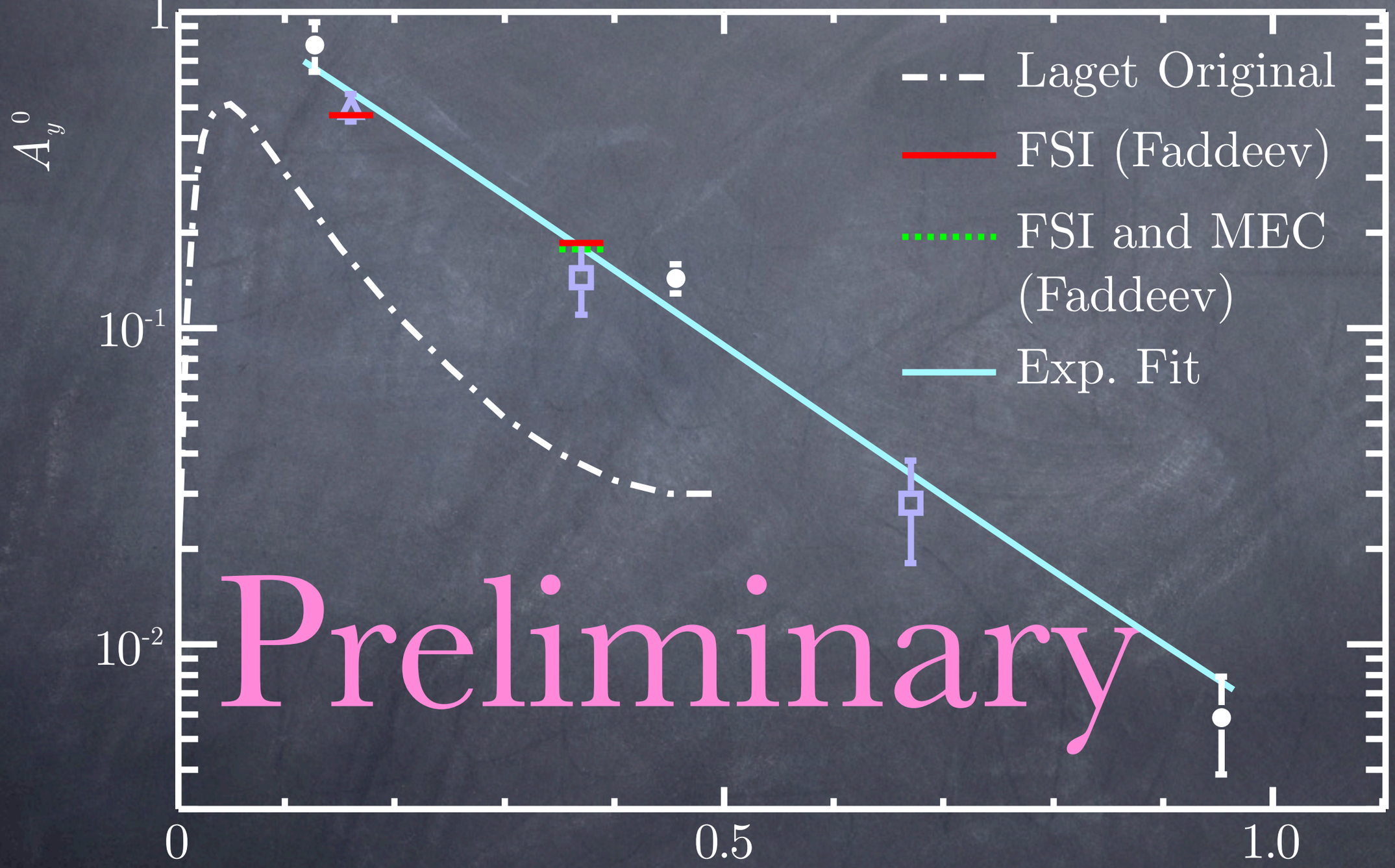

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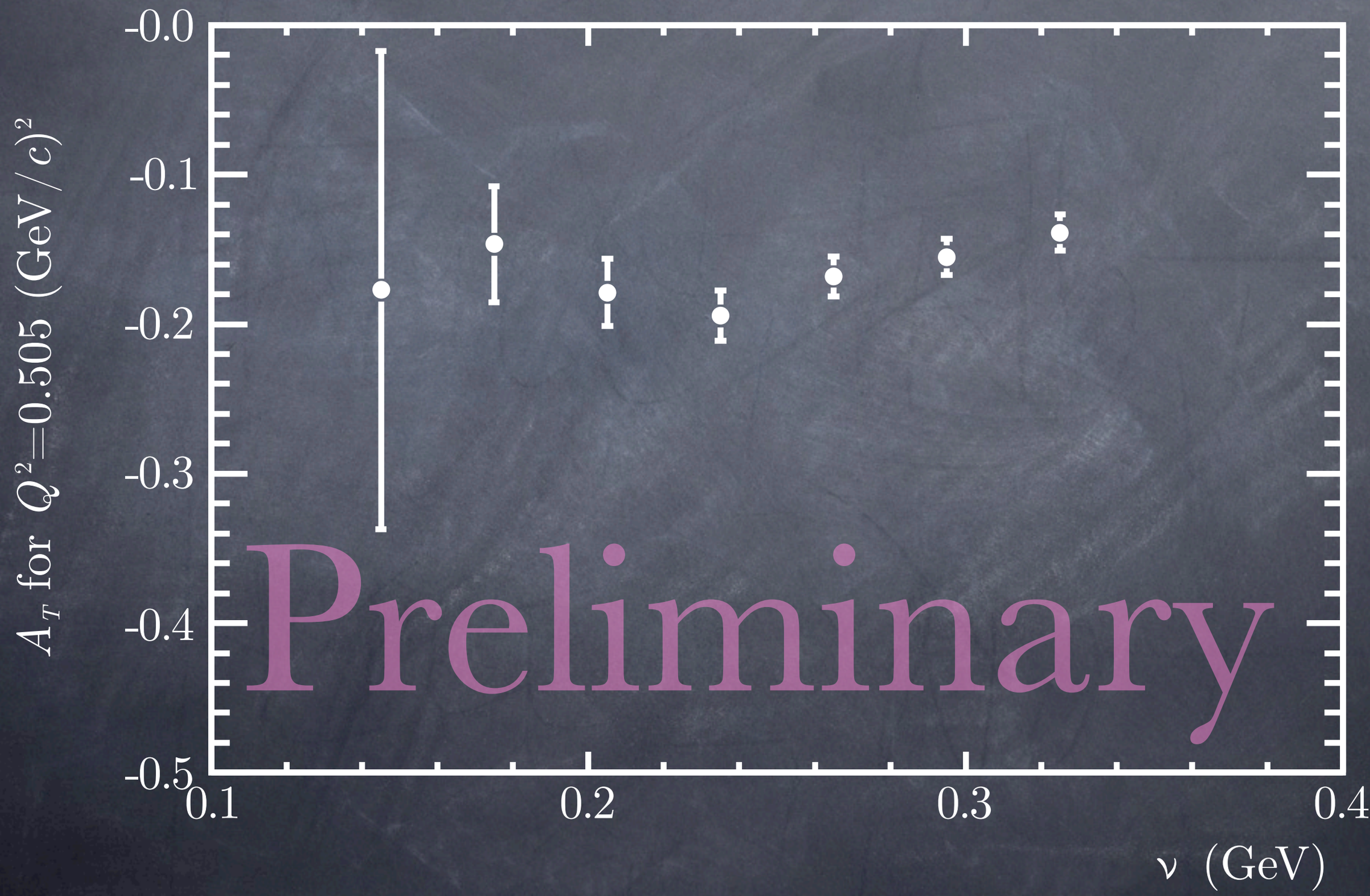

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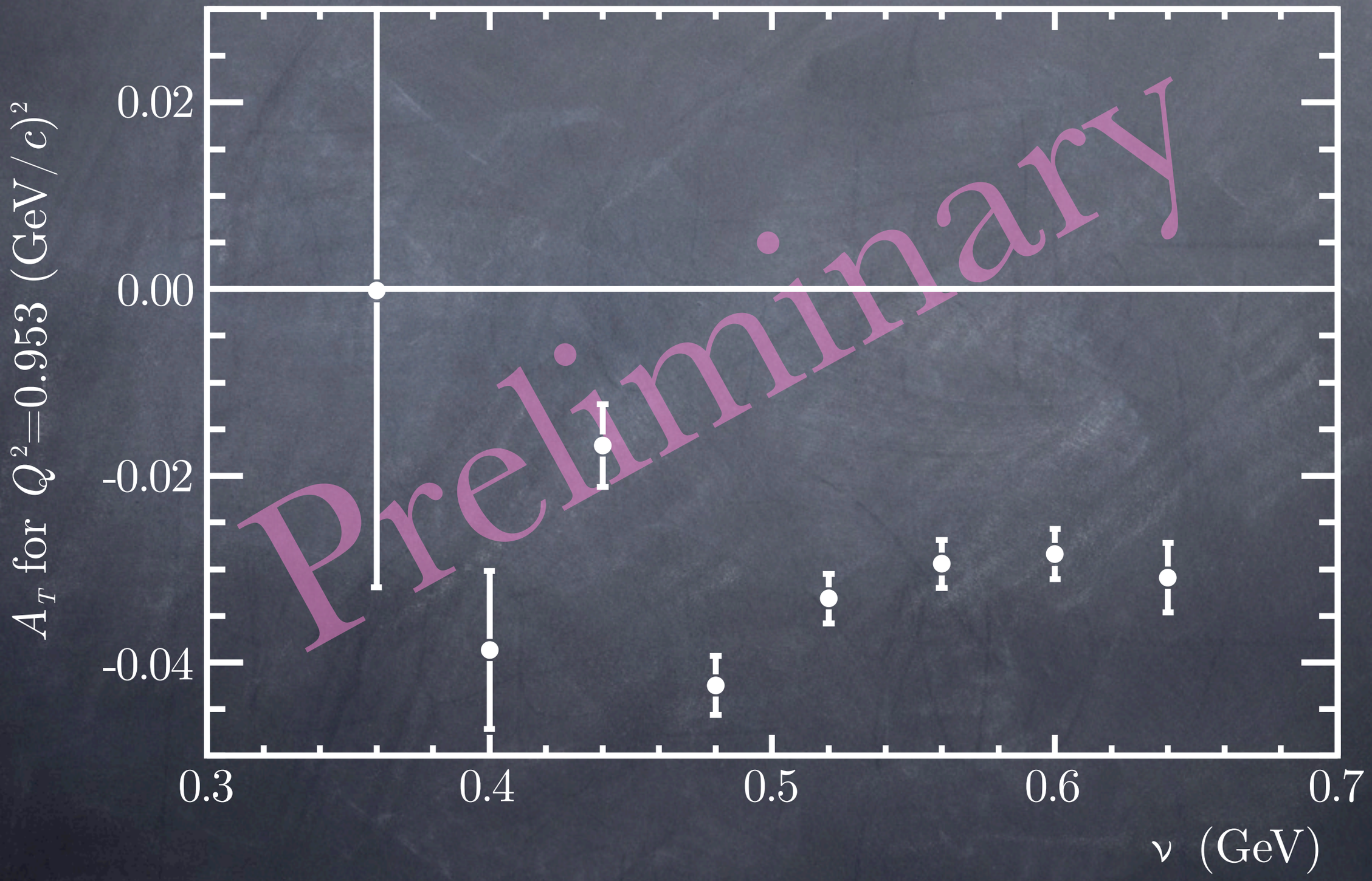

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Onto ^{3}He(e,e’d) & ^{3}He(e,e’p)

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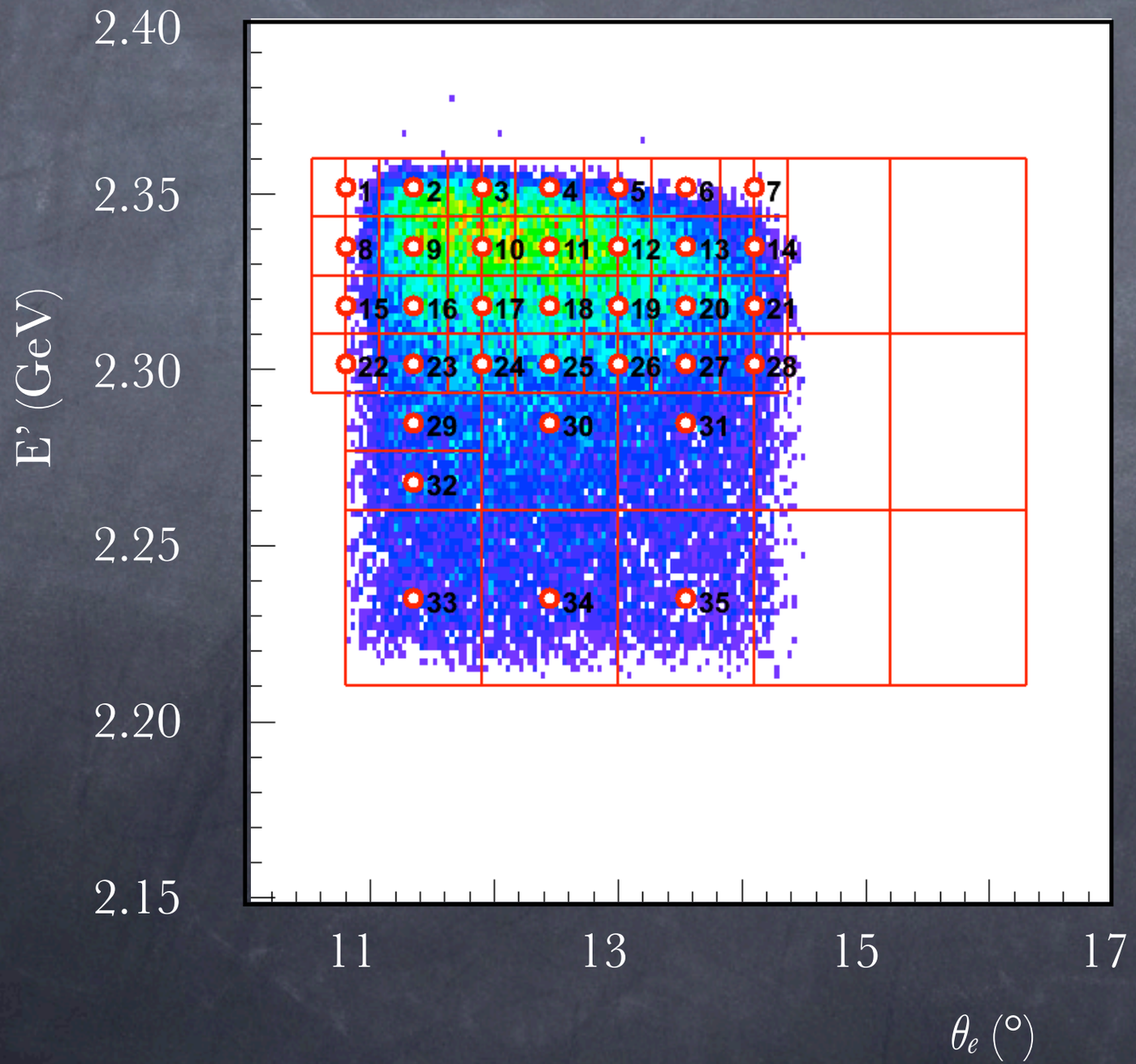
- Calculations made for 35 kinematic points.



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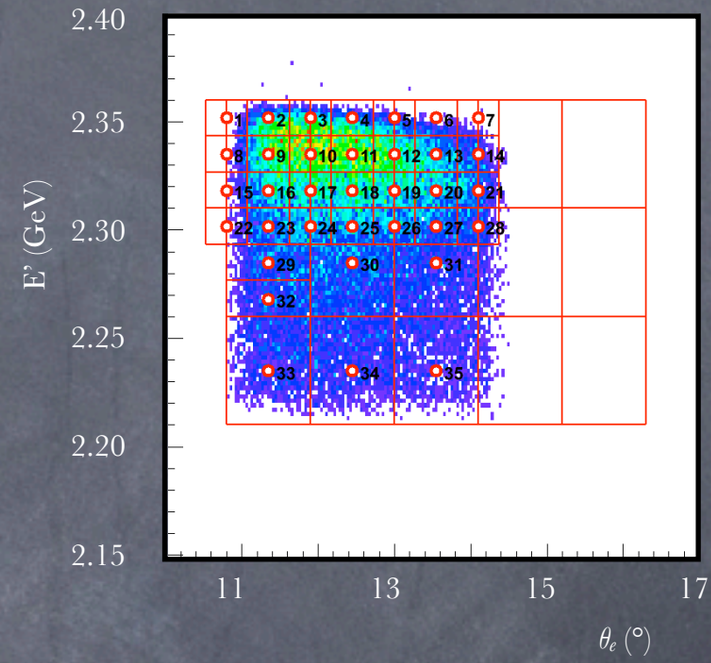

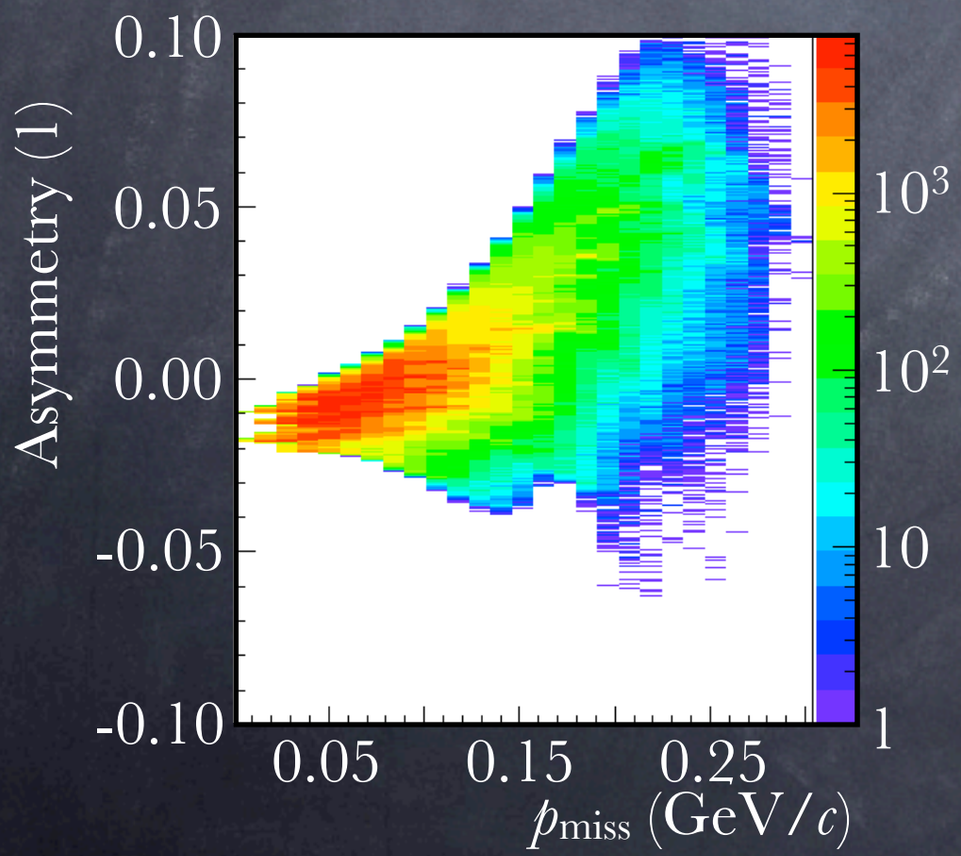

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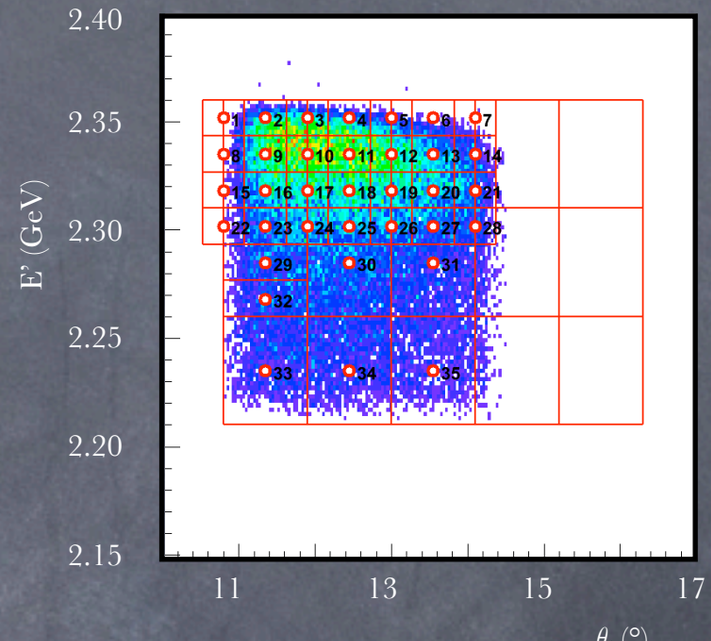
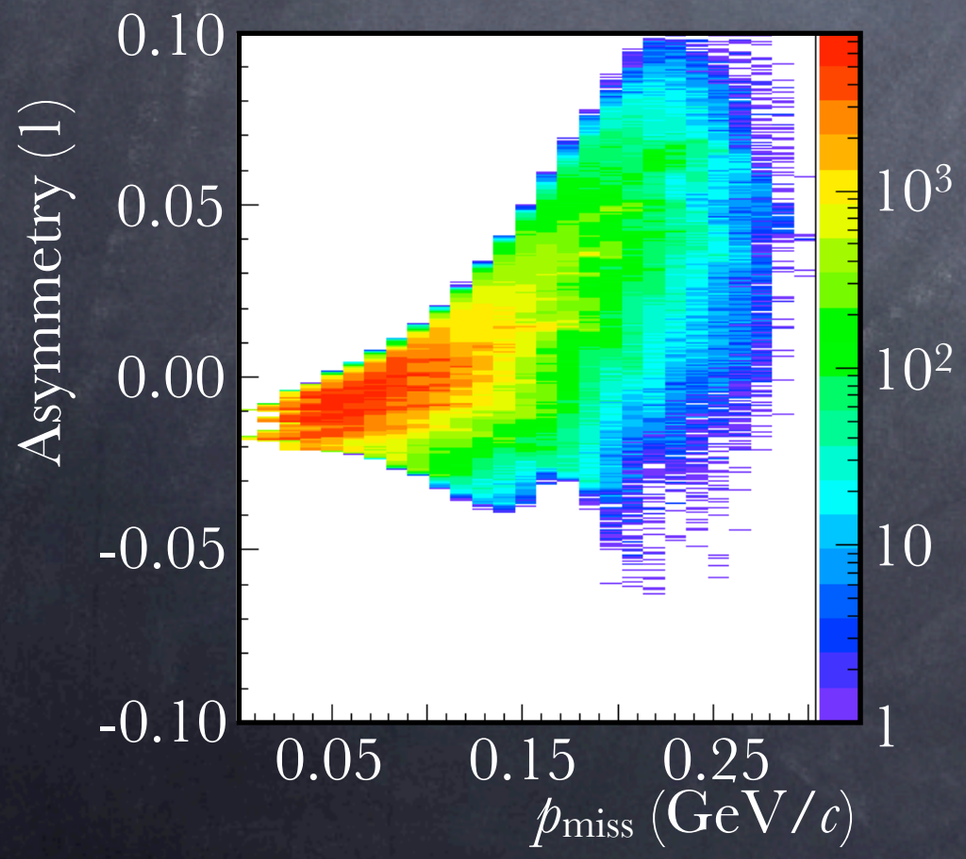
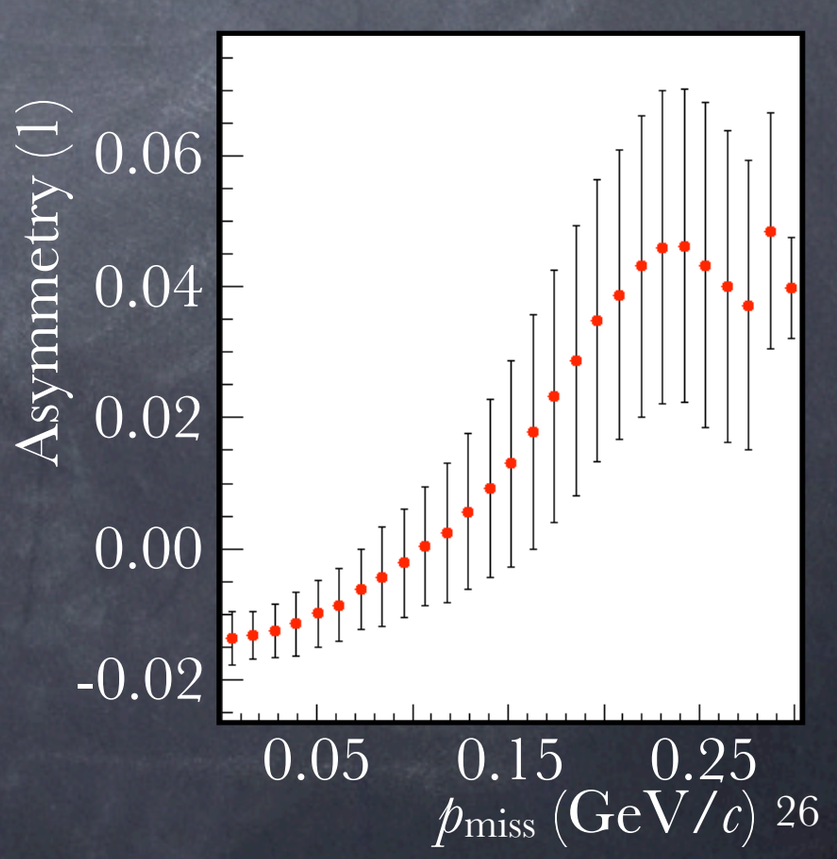




Averaging



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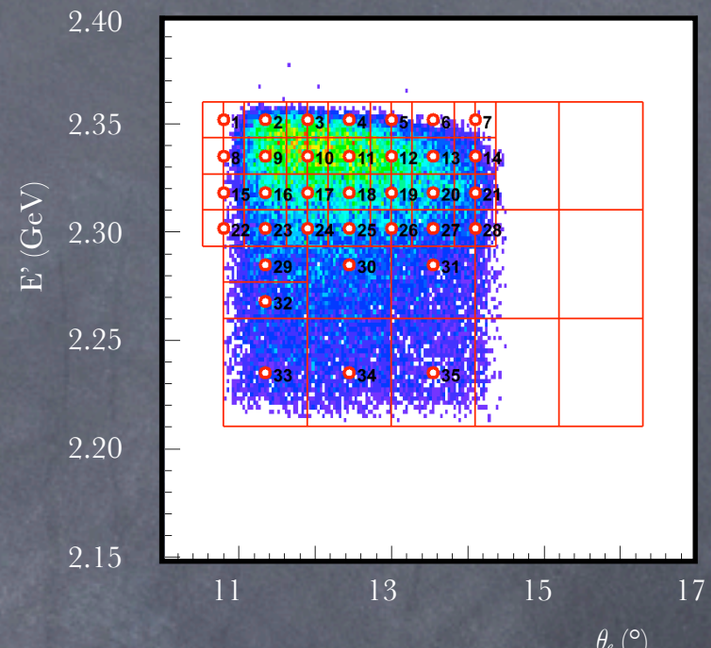
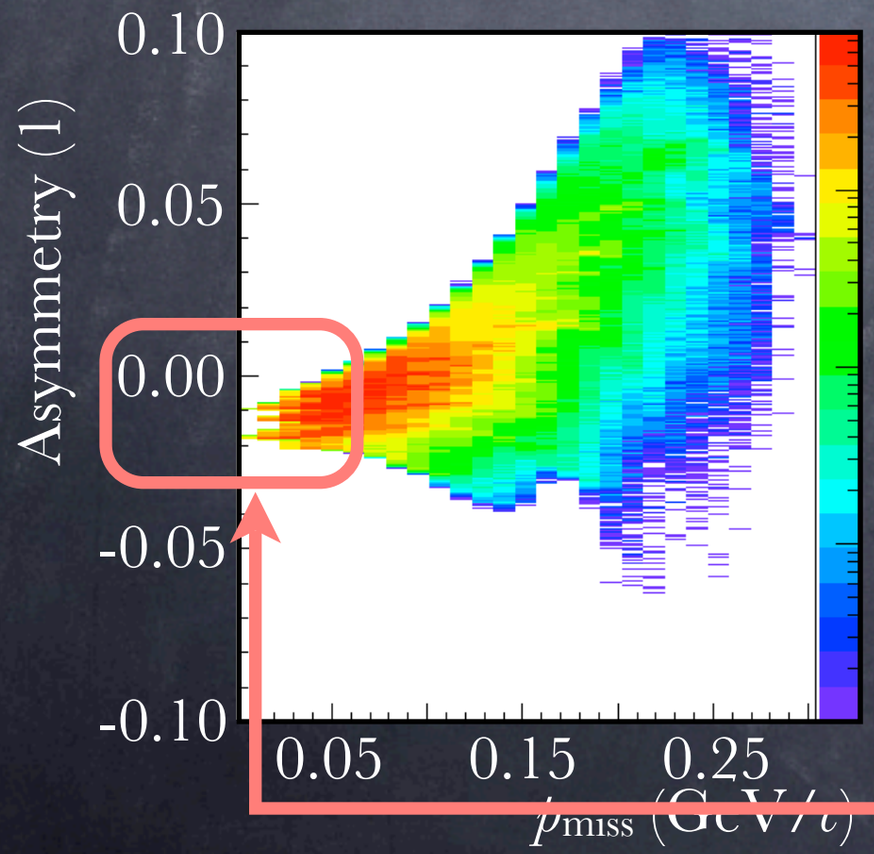
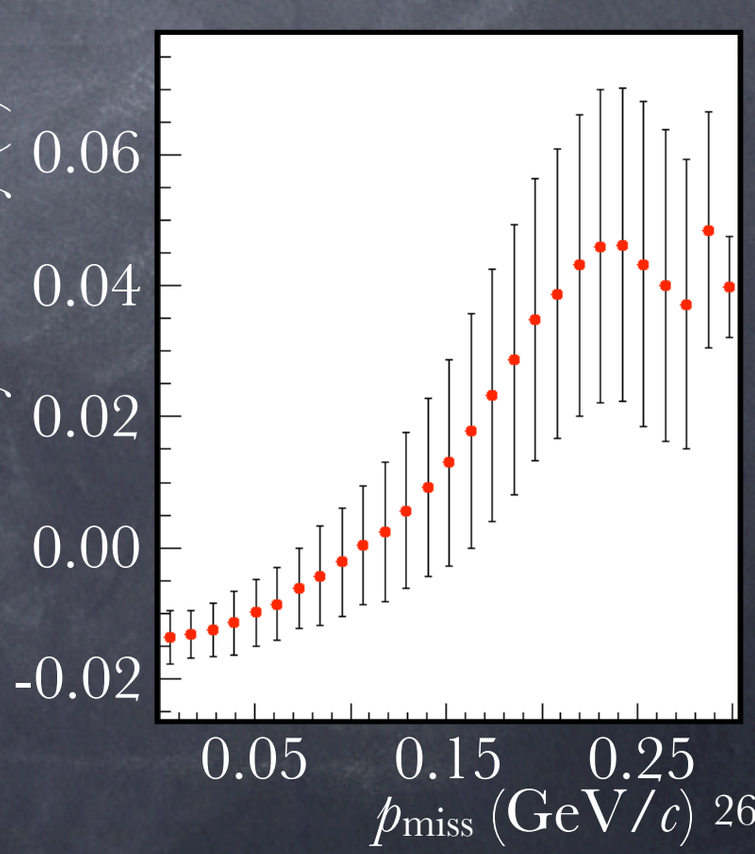




- Note that all bins don't cover the same p_{miss} range. Theory asym. for smallest p_{miss} are only available in 3 kinematic bins



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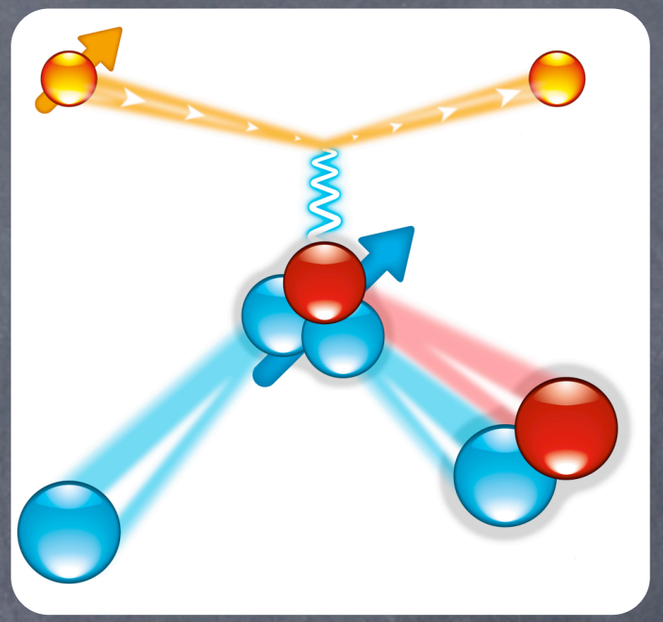

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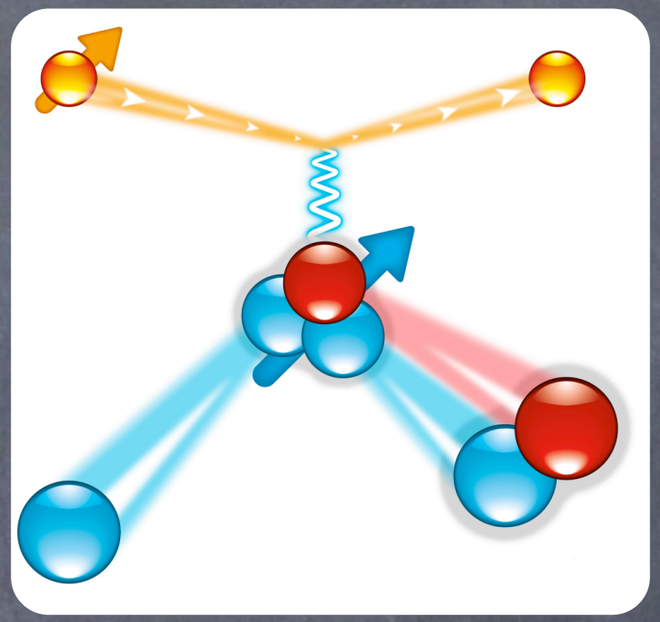

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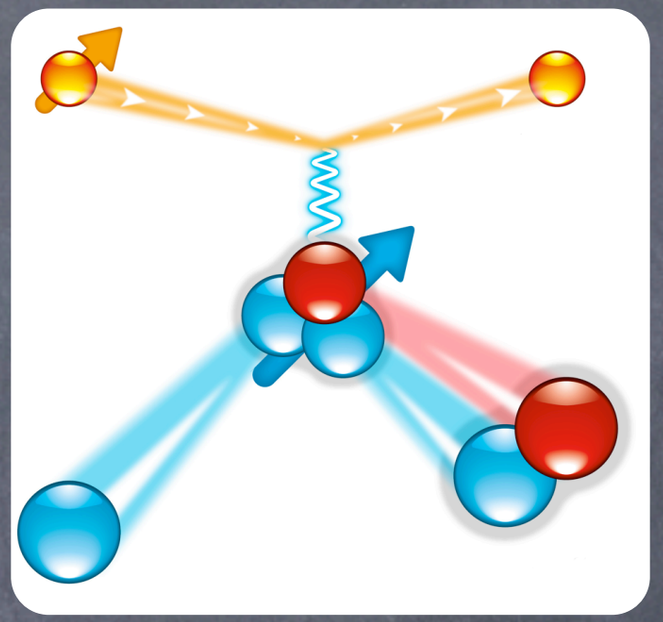

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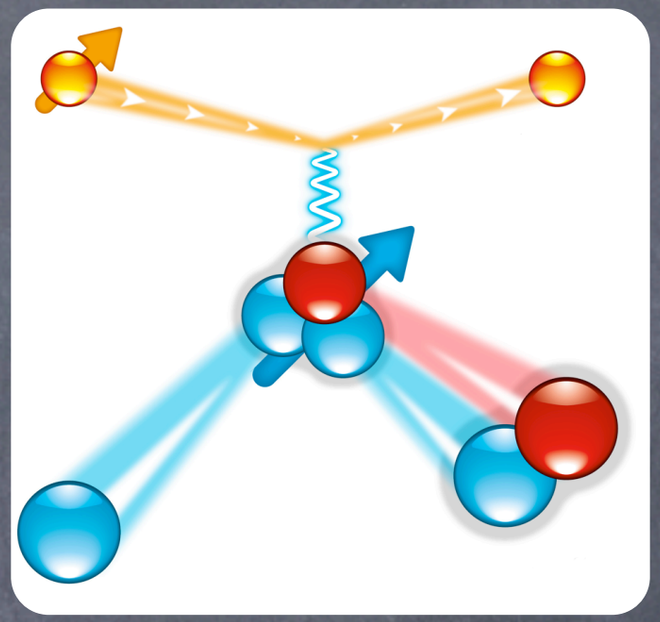

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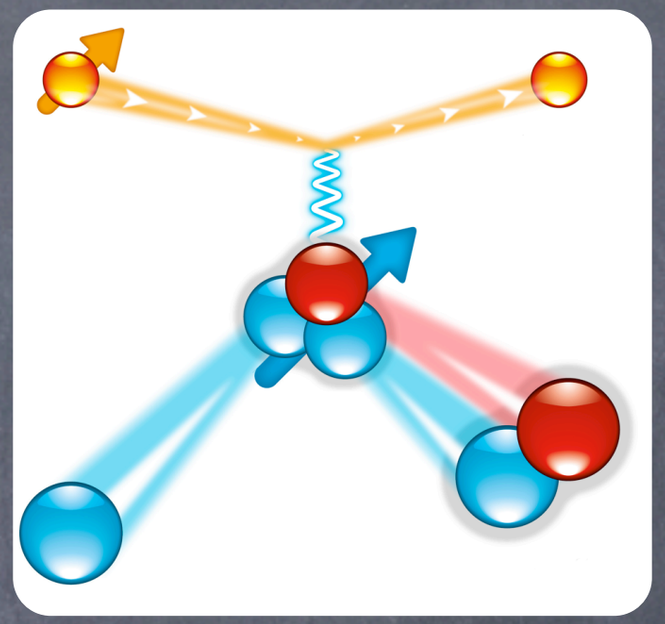

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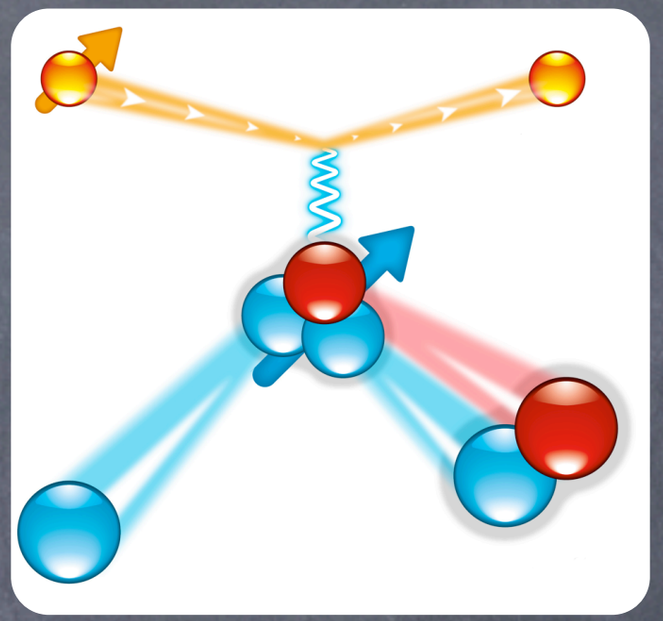
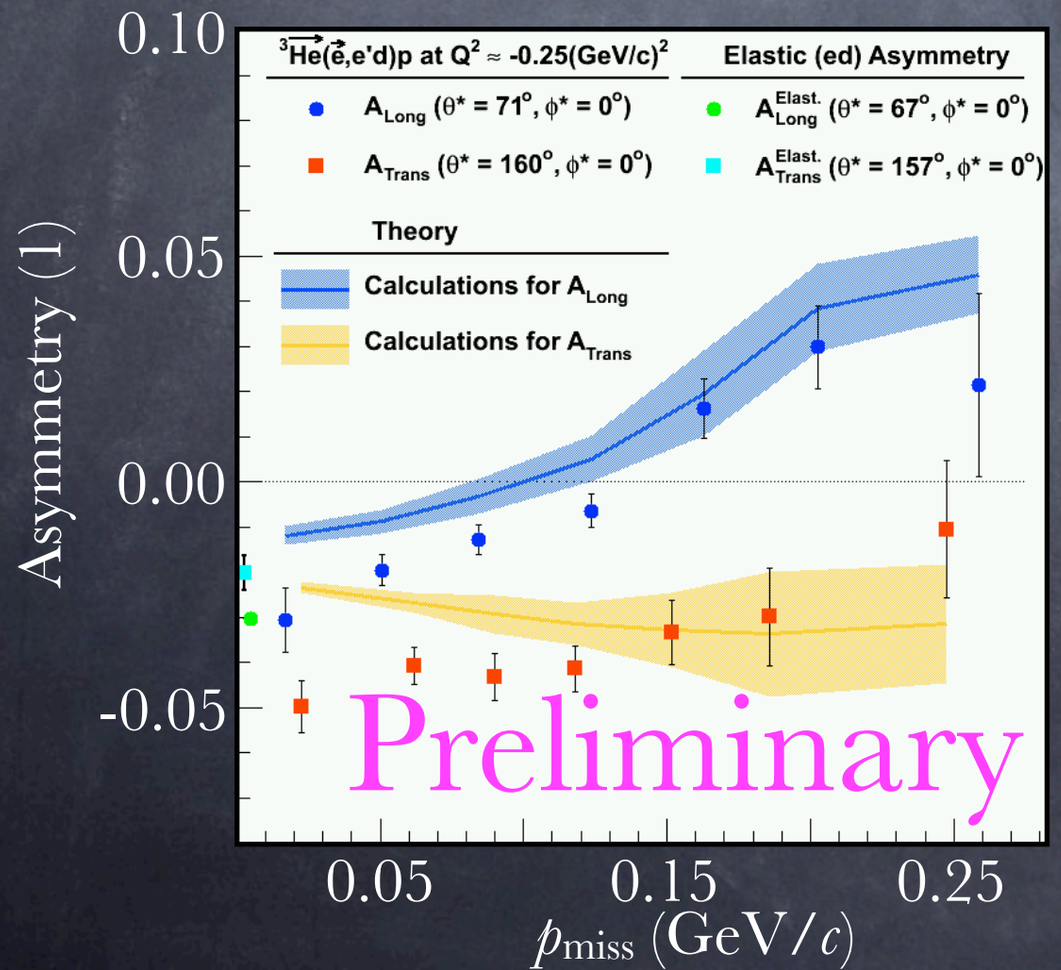
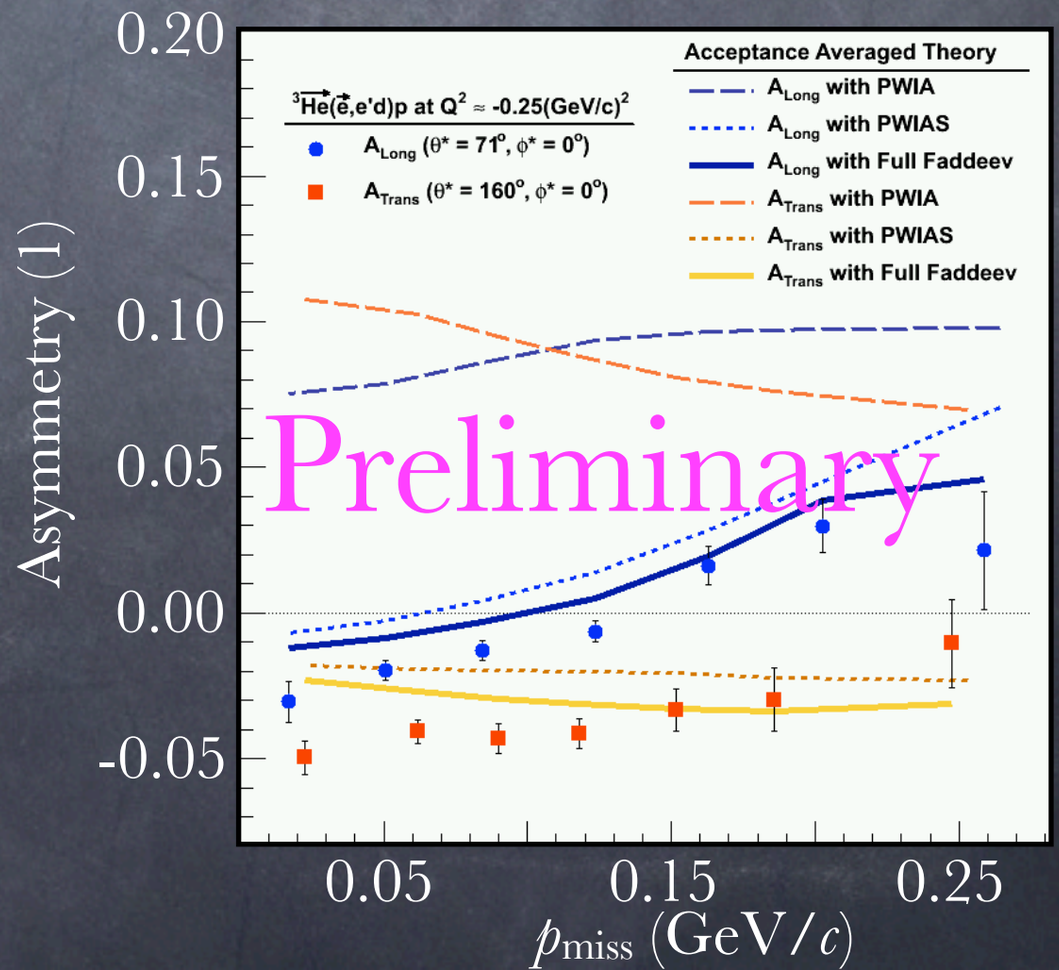
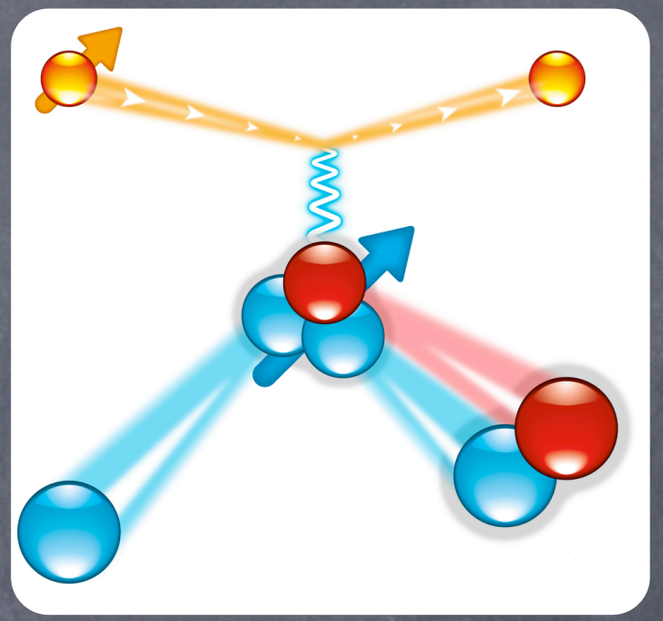


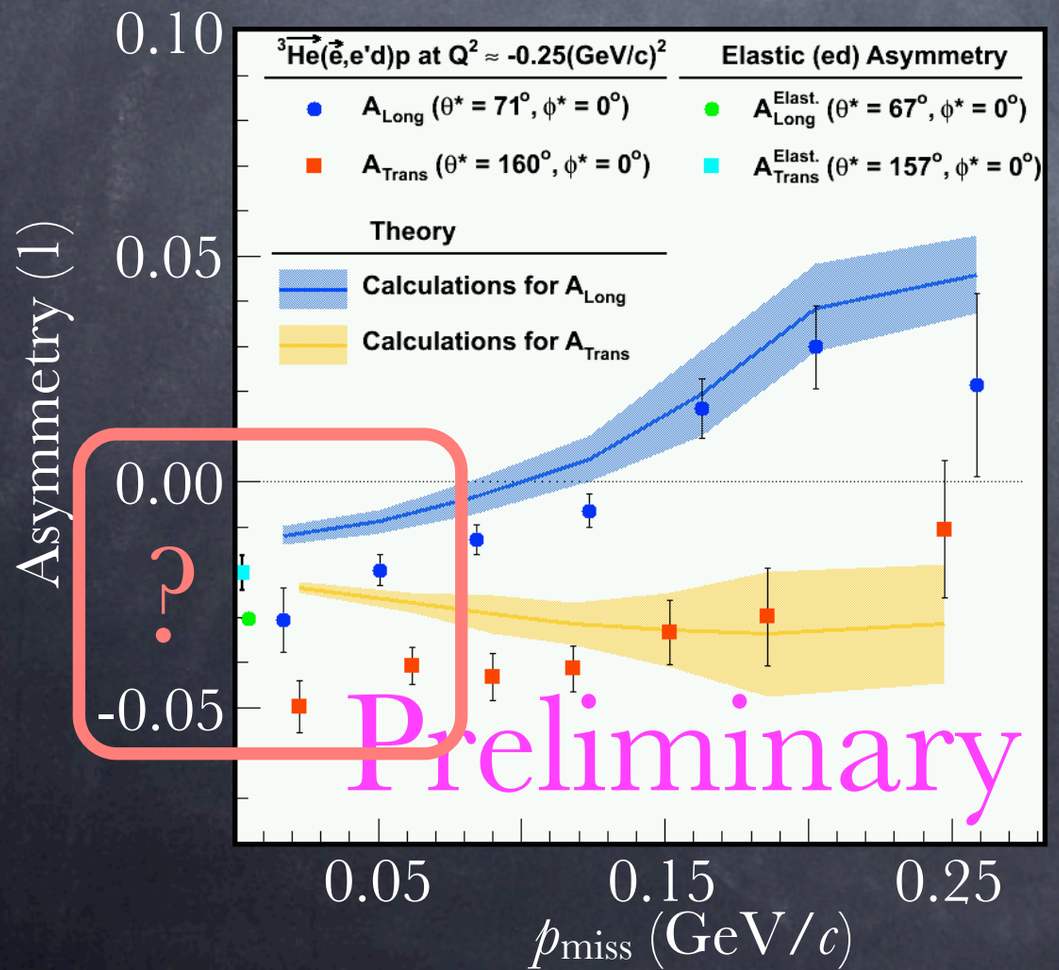


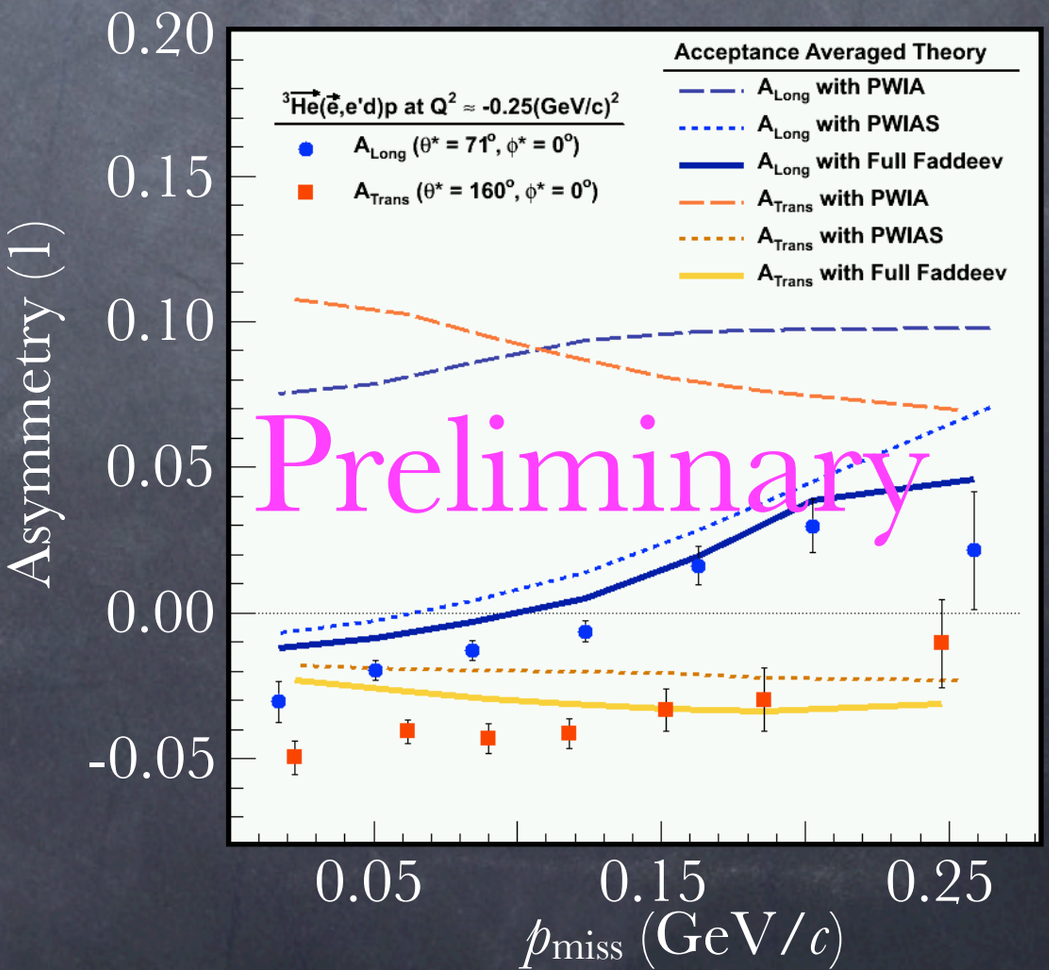


Comparison with Calculations

- Compared p_{miss}=0 results with d$^{\rightarrow}$(e$^{\rightarrow}$,e'd) asym for P_z=⅔ & P_{zz}=0 to test naïve (^{3}He=pd) model
- Inconsistencies with theory at low p_{miss}







Comparison with Theory for $^{3}\vec{He}(\vec{e},e'p)$

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Comparison with Theory for $^3He^{\rightarrow}(e^{\rightarrow},e'p)$

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  - Have first estimations, but still a lot of work ahead...

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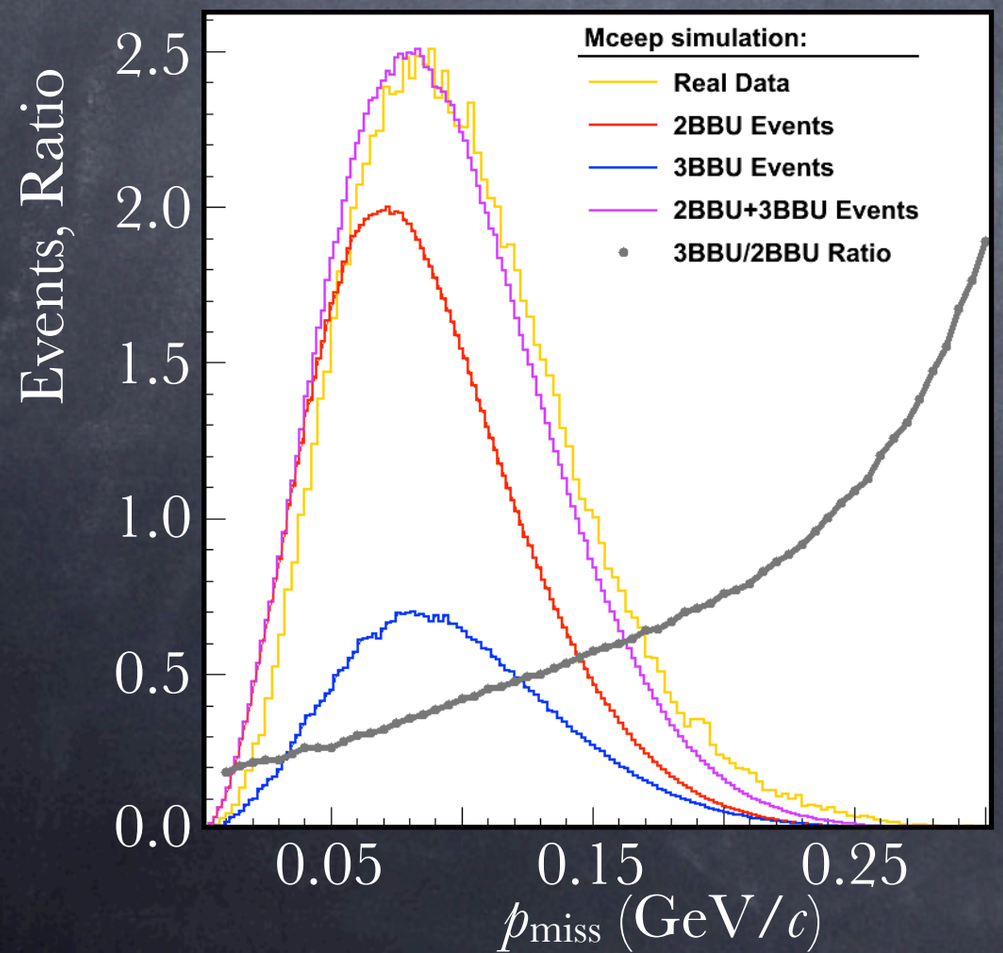

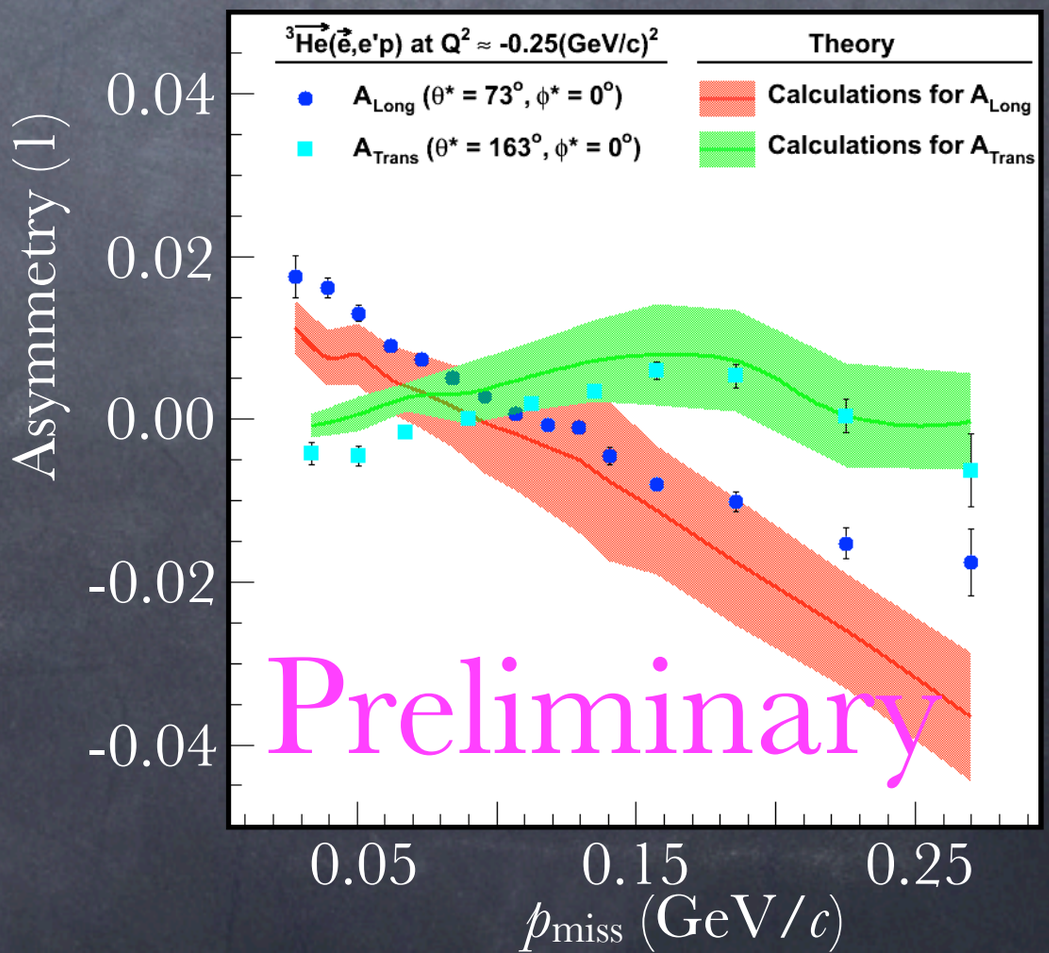

Conclusions / E05-102

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- In E05-102, we measured **asymmetries** for both (e,e'p) and (e,e'd) channels as a function of **missing momentum** at same Q^2 with ω covering the whole QE peak and more

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- Preliminary results for all kinematic settings are available

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  - Inconsistencies are **not unexpected** at this stage

Conclusions / E05-102

- In E05-102, we measured **asymmetries** for both (e,e'p) and (e,e'd) channels as a function of **missing momentum** at same Q^2 with ω covering the whole QE peak and more
- Preliminary results for all kinematic settings are available
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- Disagreement may vanish by applying a more refined averaging procedure

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- Disagreement may vanish by applying a more refined averaging procedure
- Calculations from other theoretical groups will be available soon
- The extracted asymmetries will facilitate our understanding of the properties of ^{3}He (manaifestations of S', D states) that were not accessible by unpolarized experiments

Thanks to Everyone Who Made This Possible

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