d_2^n Analysis

On Behalf of $d2n$ Collaboration

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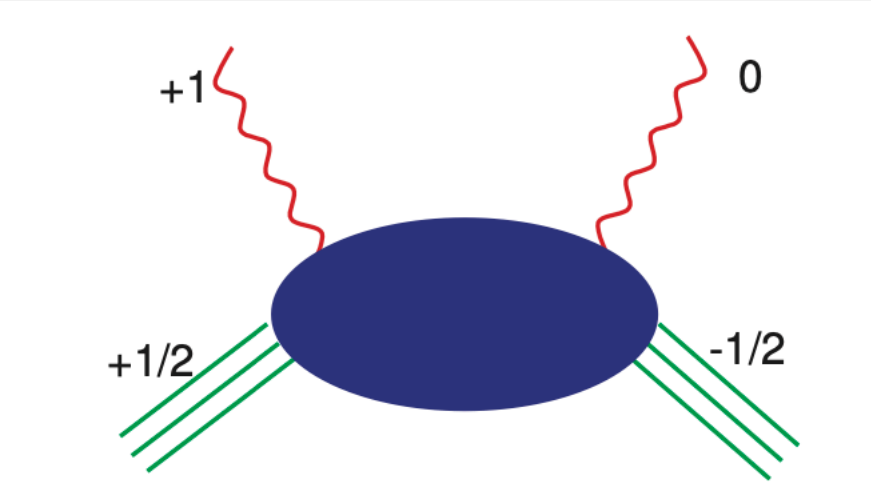
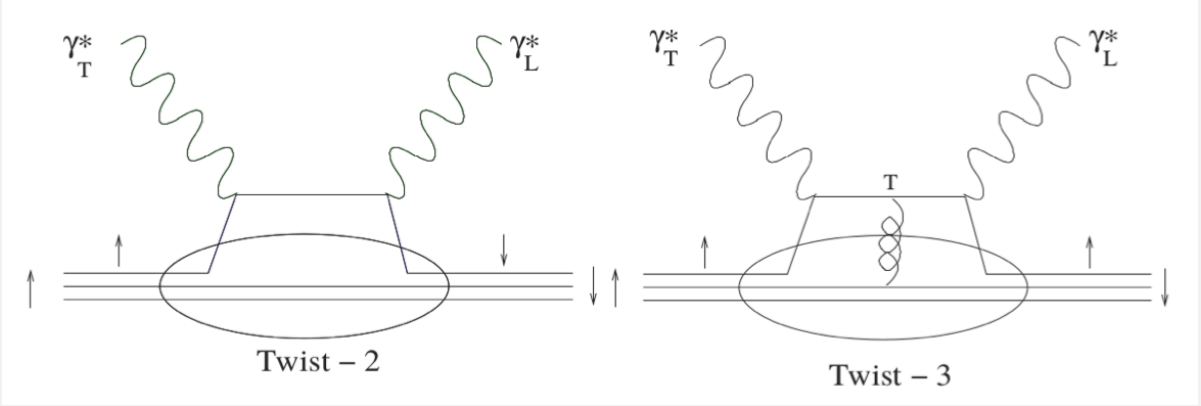
WHAT IS g_2





- g_2 is the imaginary part of the spin-dependent Compton amplitude for the process

$$\gamma^*(+1) + N(+1/2) \rightarrow \gamma^*(0) + N(-1/2)$$

$$g_2\left(x, Q^2\right) = g_2^{\mathrm{WW}}\left(x, Q^2\right) + \bar{g}_2\left(x, Q^2\right)$$

- contributes at the leading order to the spin asymmetry of longitudinally-polarized lepton scattering on transversely-polarized nucleons

- g_2 is among the cleanest higher-twist observables

WHAT IS d_2

$$d_2\left(Q^2\right) = 3\int_0^1 x^2 \bar{g}_2\left(x, Q^2\right) dx$$
$$= \int_0^1 x^2 \left[2g_1\left(x, Q^2\right) + 3g_2\left(x, Q^2\right)\right] dx$$

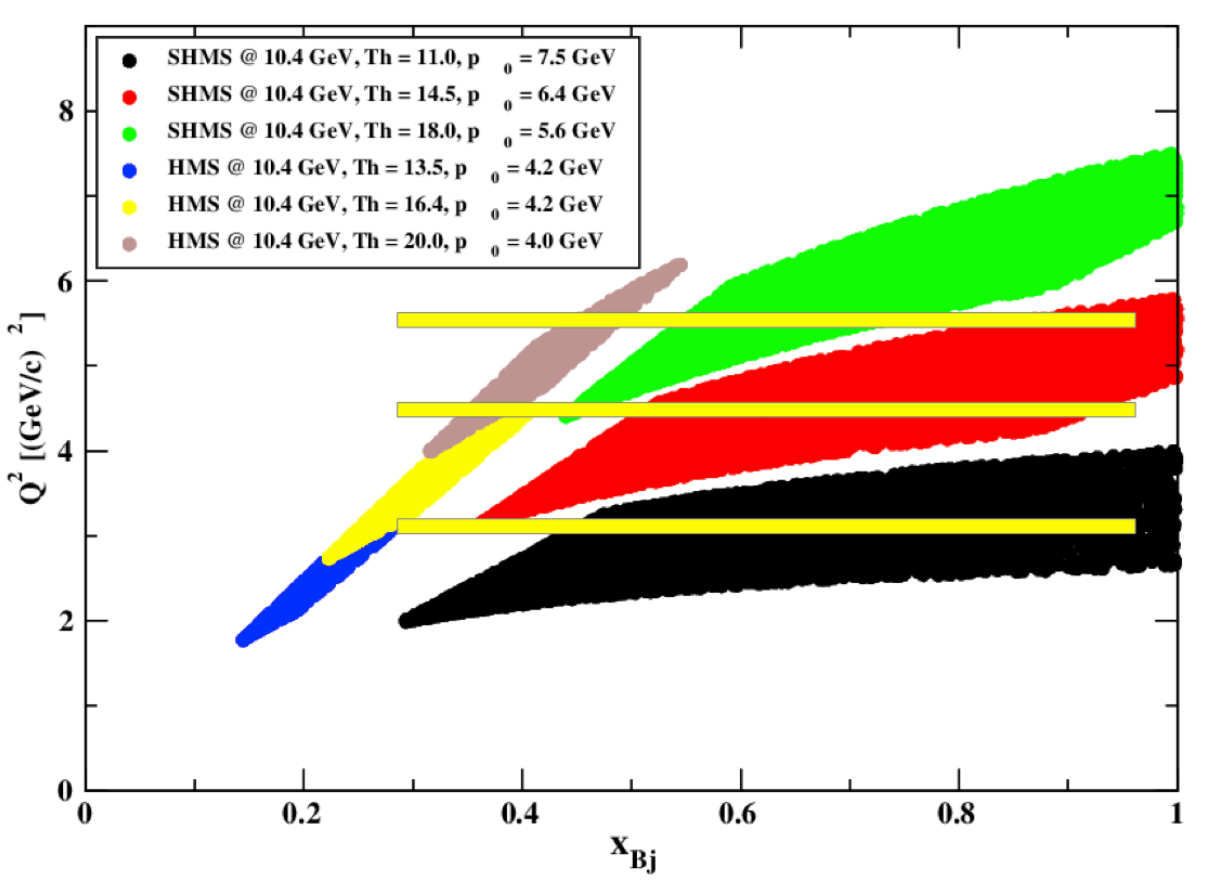
d_2: the second moment in x of a linear combination of g_1 and g_2

In experiment what we measures:

$$A_{\parallel} \equiv \frac{\sigma^{\downarrow\Uparrow} - \sigma^{\uparrow\Uparrow}}{\sigma^{\downarrow\Uparrow} + \sigma^{\uparrow\Uparrow}}$$

$$A_{\perp} \equiv \frac{\sigma^{\downarrow\Rightarrow} - \sigma^{\uparrow\Rightarrow}}{\sigma^{\downarrow\Rightarrow} + \sigma^{\uparrow\Rightarrow}}$$

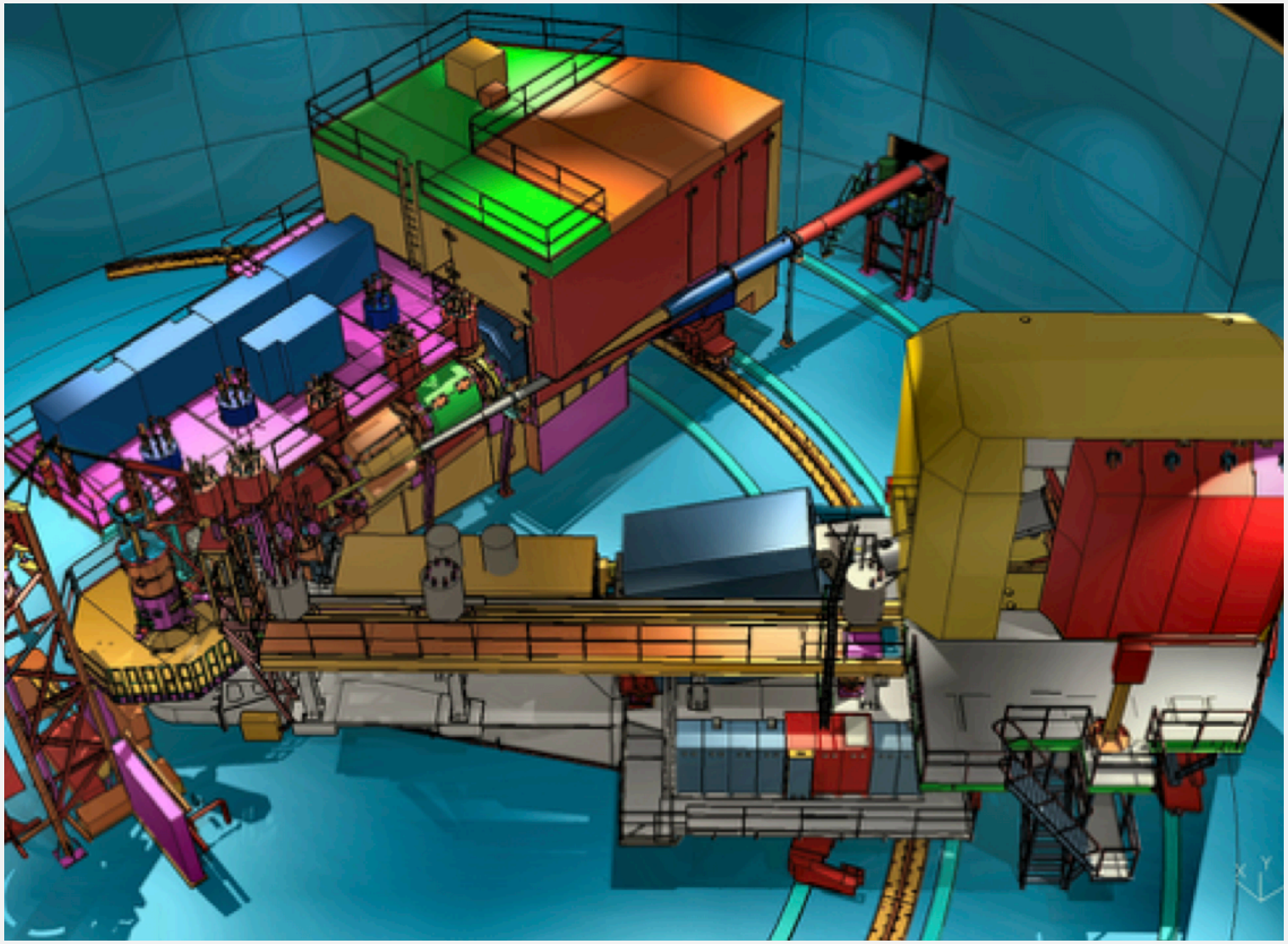
EXPERIMENT COVERAGE



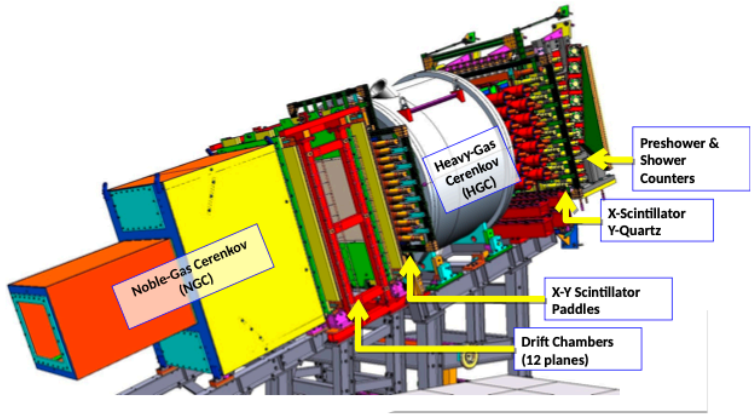
SHMS Production					
Setting	P_0 (GeV)	Angle (◦)	x	Q^2 (GeV^2)	W (GeV)
X	7.5	11.0	0.527	2.866	1.859
Y	6.4	14.5	0.565	4.240	2.036
Z	5.6	18.0	0.633	5.701	2.046

HMS Production					
Setting	P_0 (GeV)	Angle (◦)	x	Q^2 (GeV^2)	W (GeV)
A	4.2	13.5	0.207	2.414	3.178
B	4.2	16.4	0.305	3.554	2.993
C	4.0	20.0	0.418	5.018	2.806

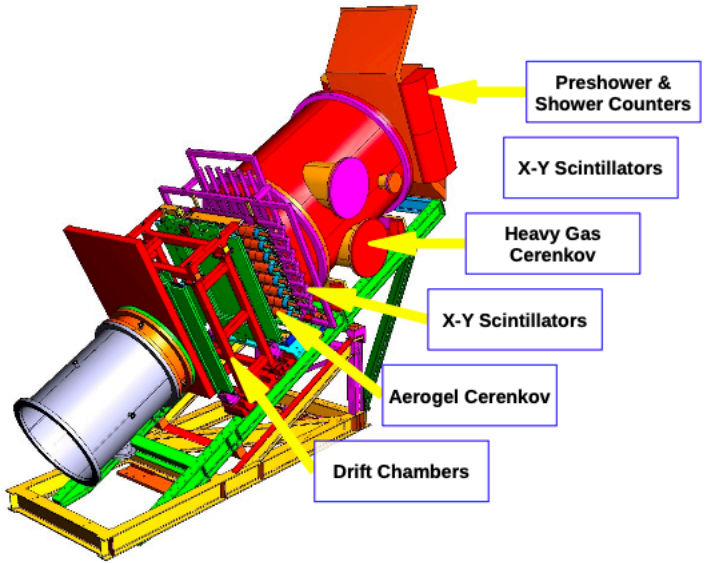
HALL C SETUP



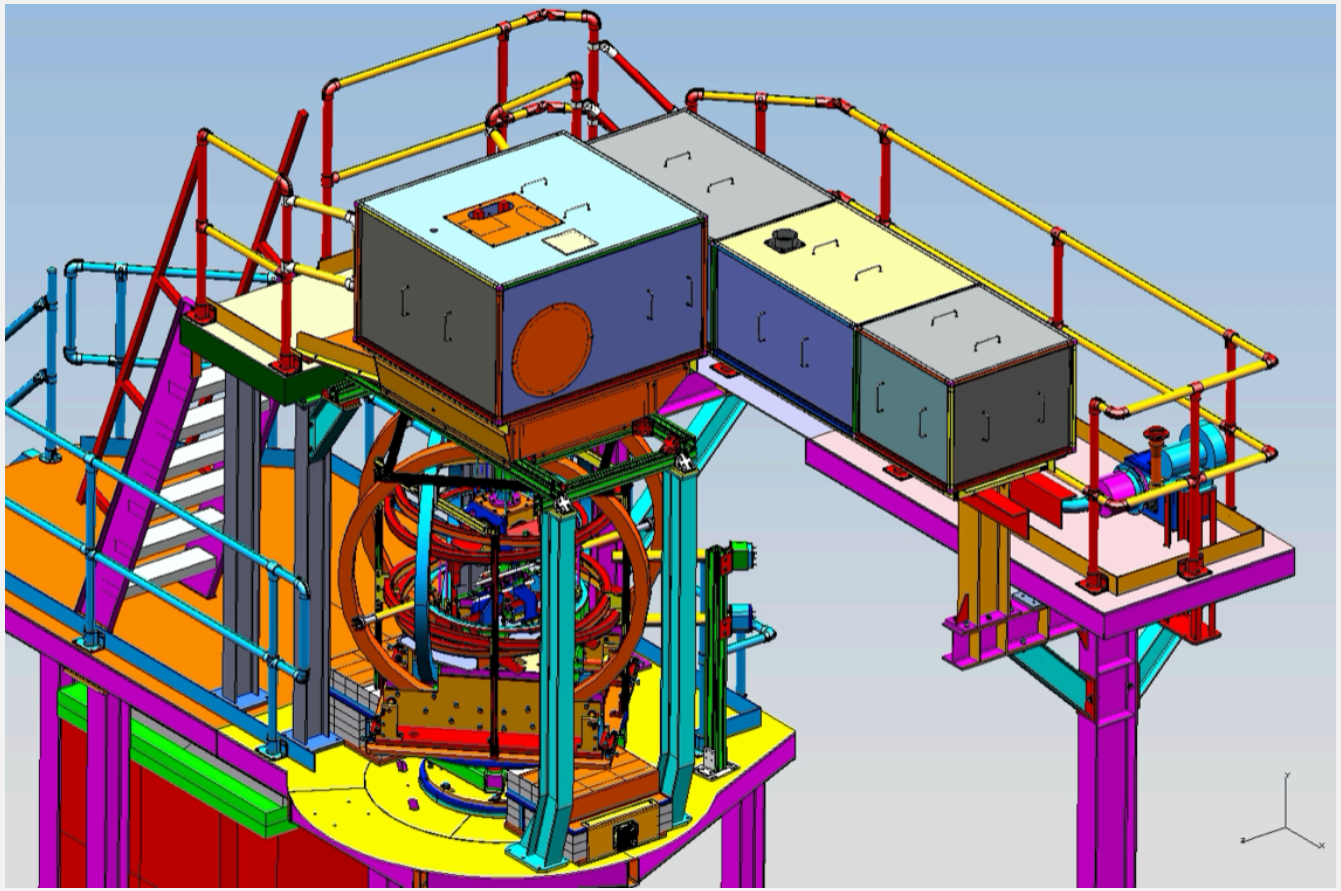
SHMS Detectors

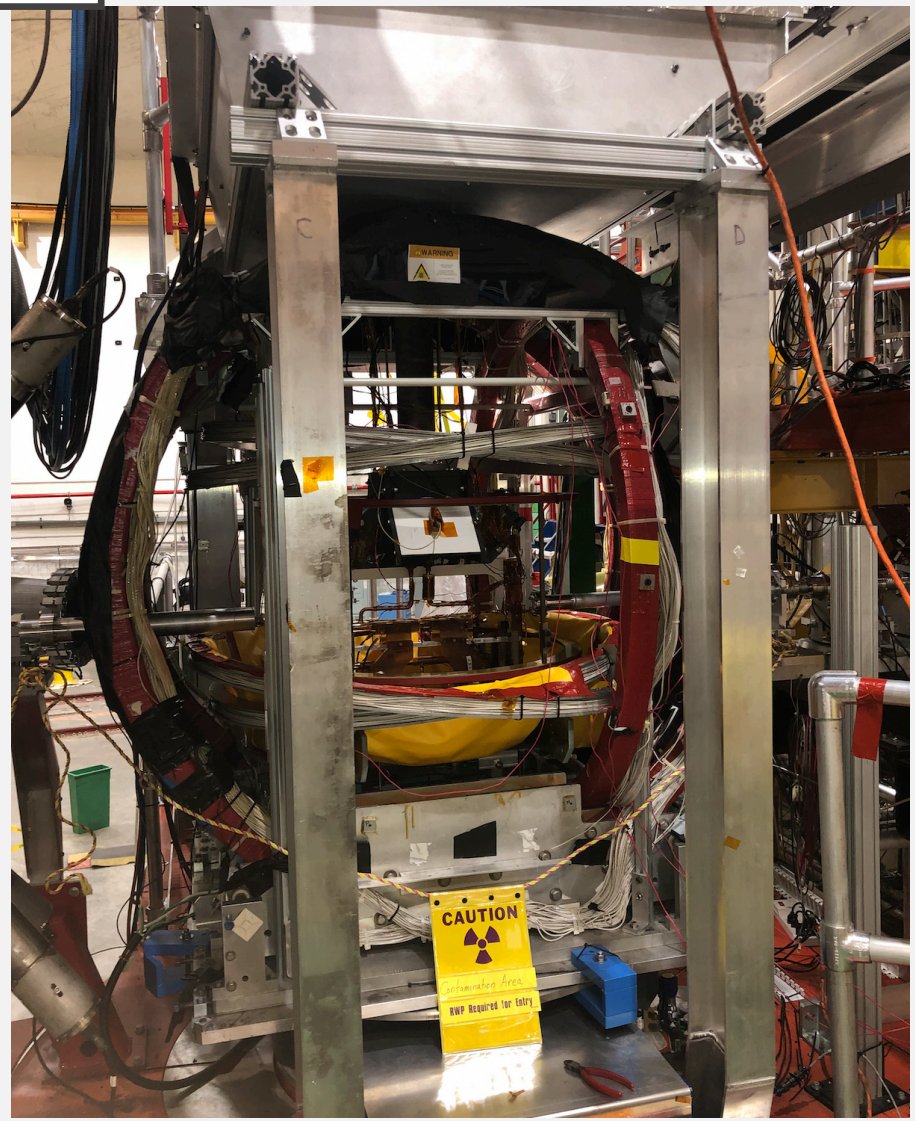


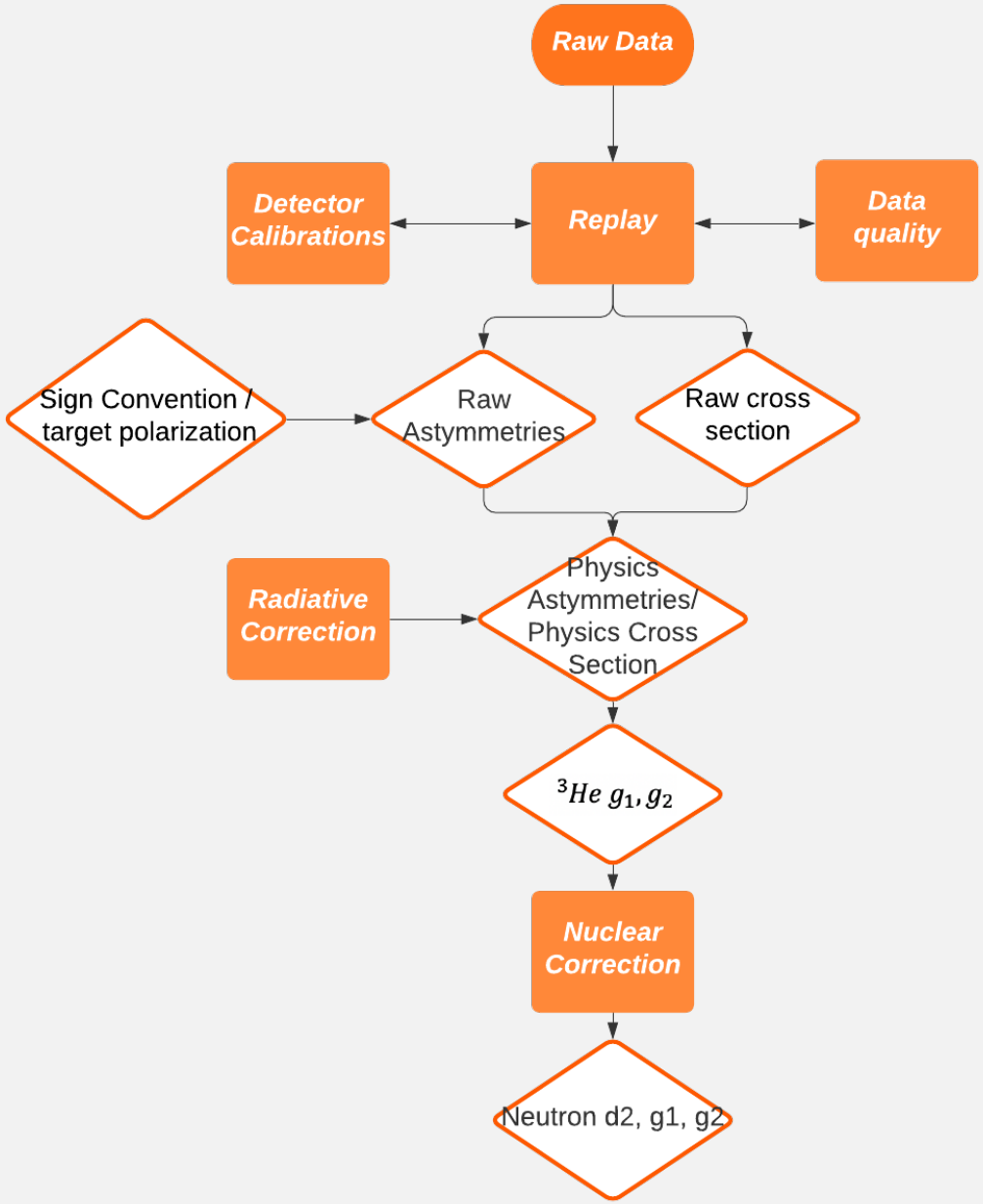
HMS Detectors



POLARIZED HELIUM-3 TARGET







ANALYSIS WORKFLOW

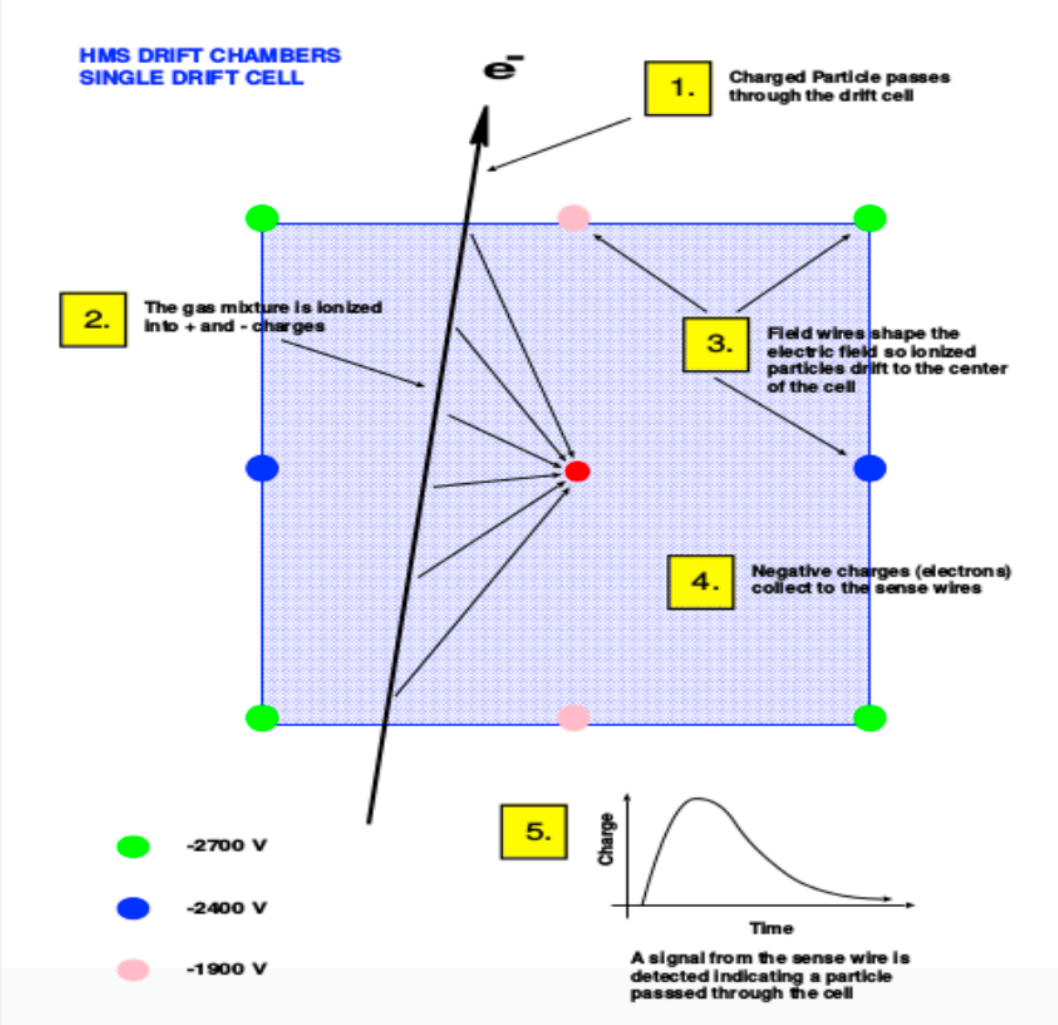
Status

- Wrapping up the last bit of Detector calibration
- Likely start 'Full Replay' This Week

Relavant talks

- Mingyu Chen: Polarized He3 Target
  - Target Polarization / Junhao, Mingyu, Melanie
- Melanie Rehfuss: A_1^n Analysis
  - Calorimeter Calibration / Melanie
  - Cherenkov Calibration / Murchhana
  - PID / Melanie
- This Talk:
  - Hodoscope Calibration /Mingyu
  - Drift Chamber Calibration /Junhao
- William Henry: Moller Polarimetery Measurements
  - Beam Polarization / Bill
- Mike Nycz: He3 Elastic FF / Mike

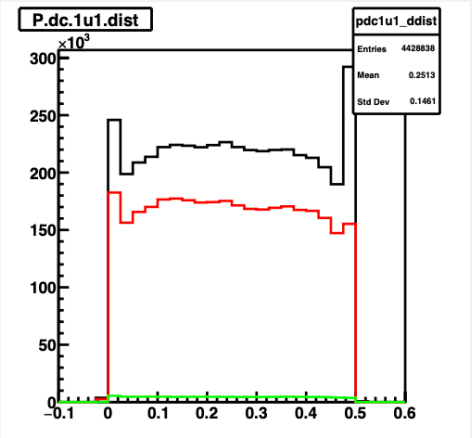
DRIFT CHAMBER CALIBRATION

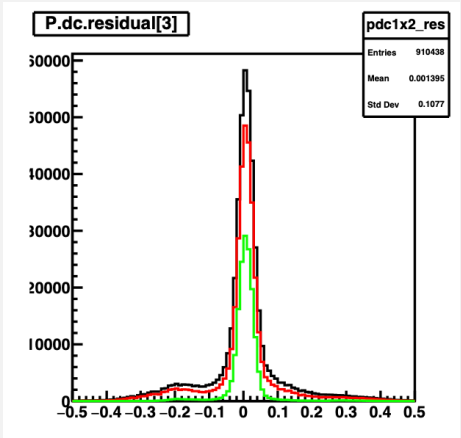


Pictures credit to Carlos Yero

What to calibrate:

The drift distance for each wire calibrated from drift time



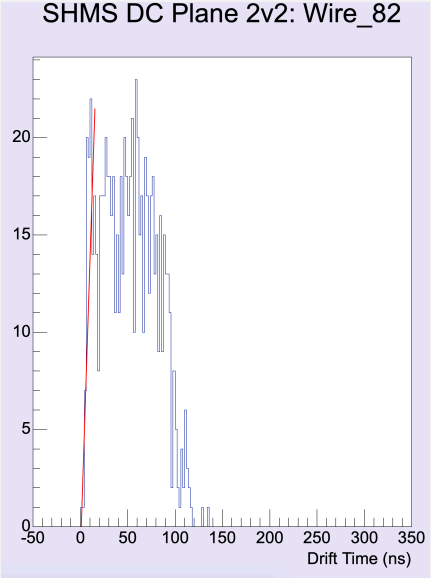


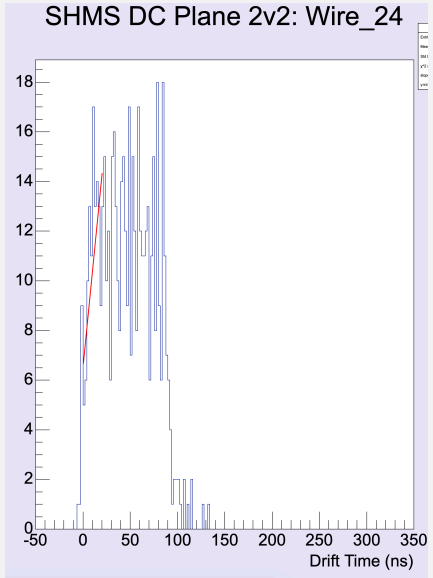
Assumptions for calibration:

- The minimum drift time is 0
- Charged particles pass through single drift cell uniformly

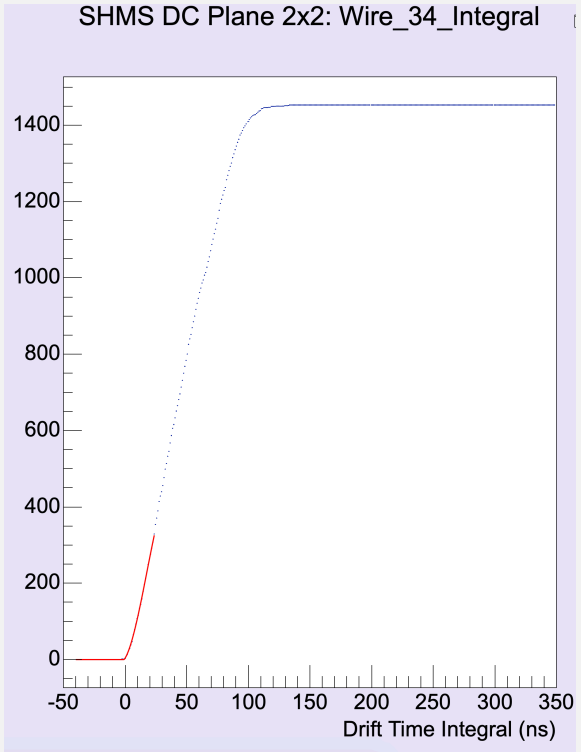
DRIFT CHAMBER CALIBRATION

- Add a new time offset per wire fitting method
  - Fit the integrated drift time with step function to increase the fitting stability

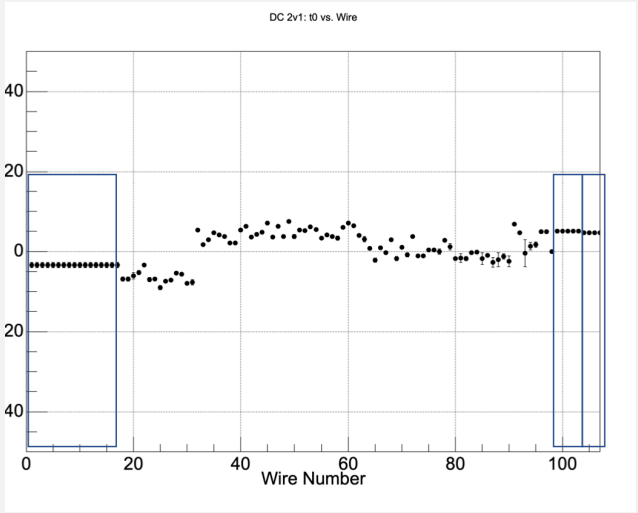




Fit time offset directly



Fit time offset with integrated drift time

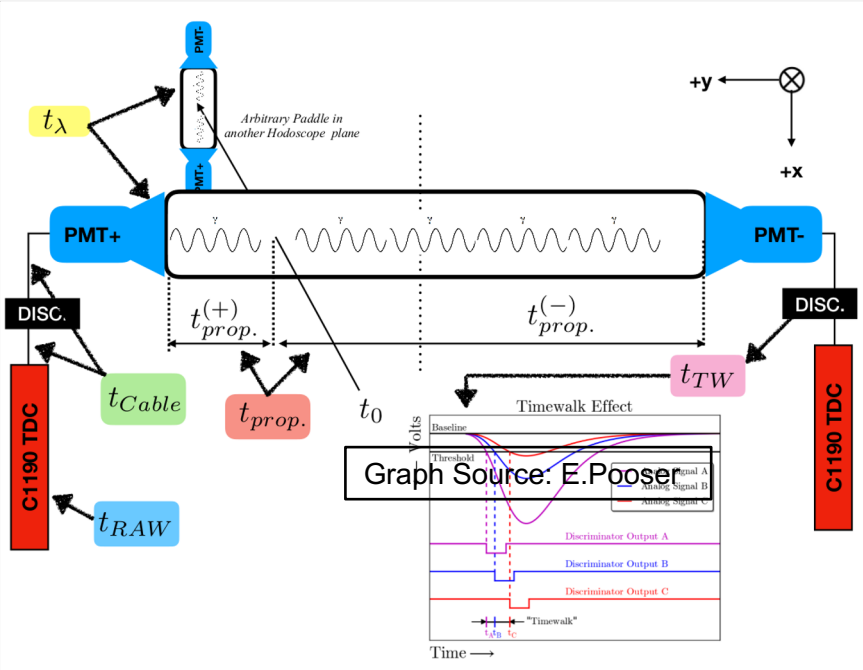


More robust time offset per wire fit

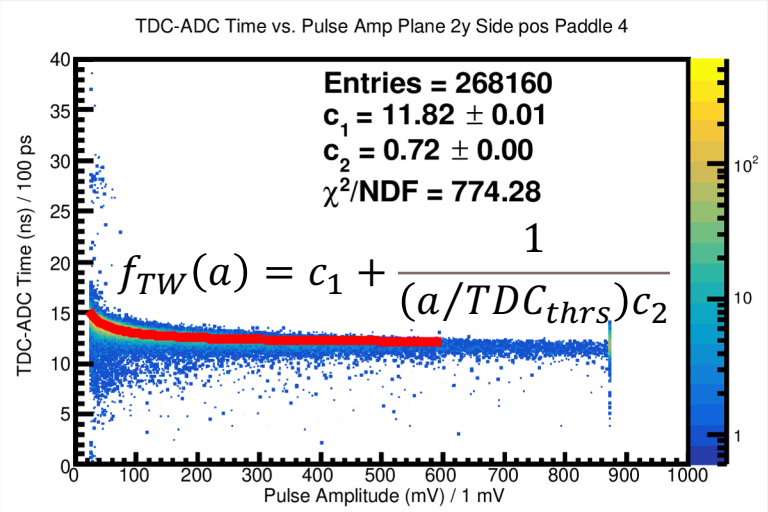
- Have finished first round calibration
- Hodoscope params was updated this week, is doing a 2nd round calibration
- Expecting finish 2nd round this week

HODOSCOPE CALIBRATION

- HMS 3994: ^{3}He DIS, d_2^n experiment
- Longitudinal 180 deg
- Kin-B: E_p=6.4 GeV, 14.5°
- Trigger: 3/4 (hTRIG1)



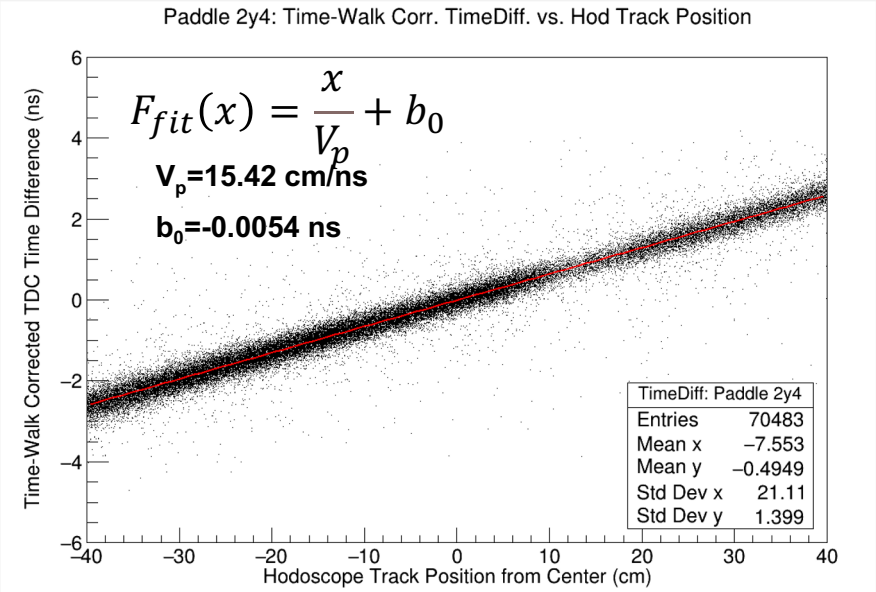
Graph Source: E.Pooser



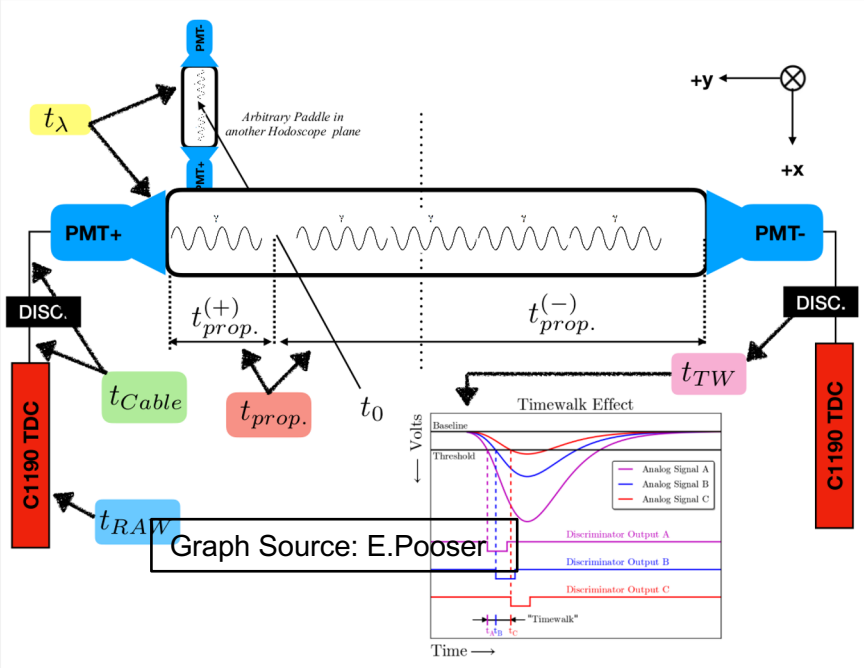
- a is ADC amplitude; TDC_{thrs}=120 mV

$$t_{Corr} = t_{RAW} - t_{TW} - t_{Cable} - t_{propagation} - t_\lambda$$

- TW : Time-walk Corrections
- tcable: Cable Time Corrections
- tprop: Propagation Time Corrections
- tλ: Hodoscope Planes Time Difference Corrections



HODOSCOPE CALIBRATION



Graph Source: E.Pooser

$$t_{Corr} = t_{RAW} - t_{TW} - t_{Cable} - t_{propagation} - t_\lambda$$

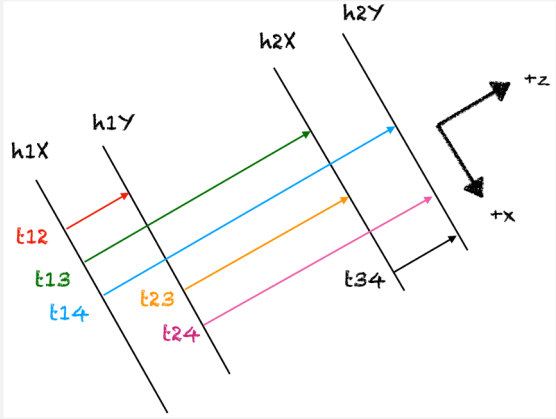
$$t_{Corr.}^{(+)} = t_{Corr.}^{(+)} - (L_+ - \text{hit})\frac{1}{v_p}, \text{ where } t_{prop.}^{(+)} \equiv (L_+ - \text{hit})\frac{1}{v_p}$$

$$t_{Corr.}^{(-)} = t_{Corr.}^{(-)} - (\text{hit} - L_-)\frac{1}{v_p}, \text{ where } t_{prop.}^{(-)} \equiv (\text{hit} - L_-)\frac{1}{v_p}$$

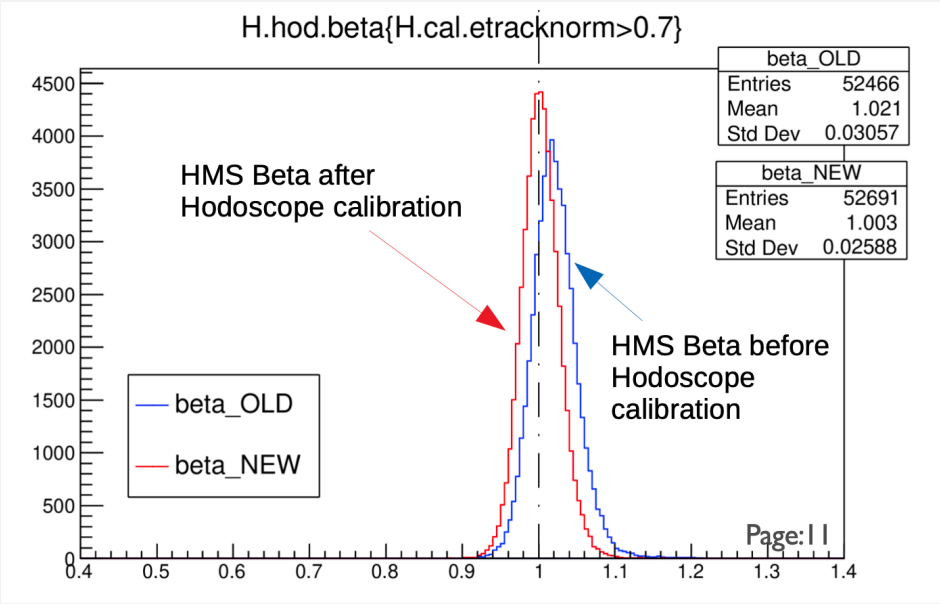
$$t_{avgCorr.} = \frac{1}{2}(t_{Corr.}^{(+)} + t_{Corr.}^{(-)}) = \frac{1}{2}(t_{TW_{Corr.}}^{(+)} + t_{TW_{Corr.}}^{(-)})$$

- This correction is done in hcana.

- HMS 3994: ^{3}He DIS, d_2^n experiment
- Longitudinal 180 deg
- Kin-B: E_p=6.4 GeV, 14.5°
- Trigger: 3/4 (hTRIG1)



- All possible time difference combinations considered; solve the system of six linear equations.



SUMMARY

- Wrapping up detector Calibration works
- Hopefully start first round of Full repay this week

In the near future:

- MC simulation
- Preparing offline analysis script

REFERENCE

- Polarized Helium3 Experiments wiki
  - https://hallcweb.jlab.org/wiki/index.php/Polarized_Helium-3_Experiments
- d_2^n experiment proposal:
  - https://hallcweb.jlab.org/wiki/images/c/cb/PR12-06-121.pdf
  - https://hallcweb.jlab.org/wiki/images/1/1a/D2n_HallC_PAC36-update_v2.pdf
- Measurements of d_2^n and A_1^n : Probing the neutron spin structure
  - https://arxiv.org/abs/1603.03612
- Probing Nucleon Spin Structure Using Deep Inelastic Scattering
  - https://indico.jlab.org/event/390/contributions/6267/attachments/5255/6545/d2n-July-16-2020.pdf