The n-^{3}He Experiment at SNS

A Study of Hadronic Weak Interaction

A measurement of the parity conserving asymmetry in the neutron capture on ^{3}He at SNS

Latiful Kabir
University of Kentucky
for the n-^{3}He Collaboration

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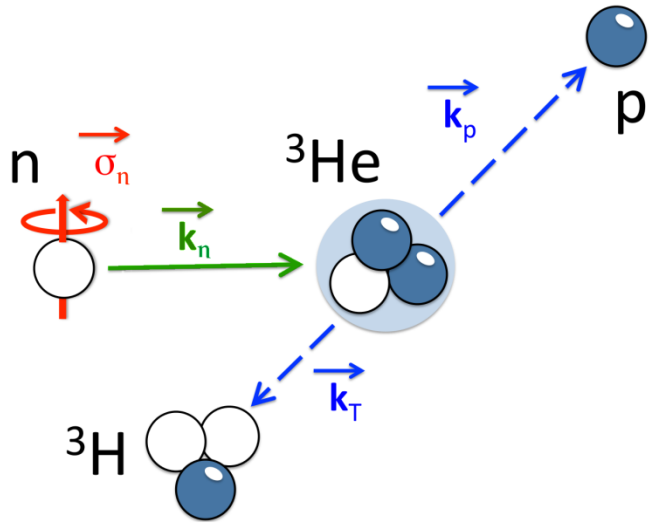
Outline

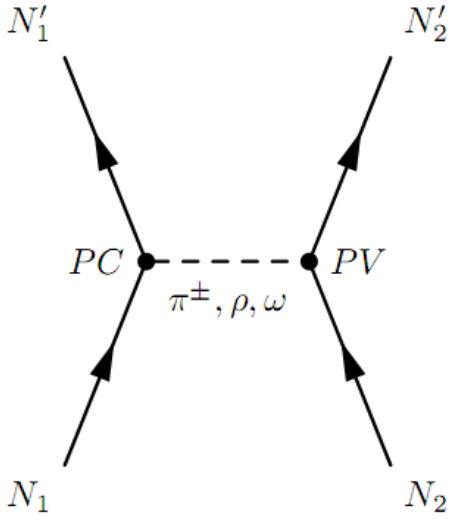
- The n-^{3}He experiment
  - Motivation
  - Experimental Setup
- The beam profile
- Preliminary Data
  - Asymmetry Estimation
  - Asymmetry Extraction
  - Left Right Asymmetry
- Current Status

The n-^{3}He Experiment

- High-precision measurement motivated to probe the hadronic weak interaction by measuring the parity violating asymmetry of the proton in the reaction-

$$\vec{n} + {}^3He \rightarrow p + T + 765keV$$





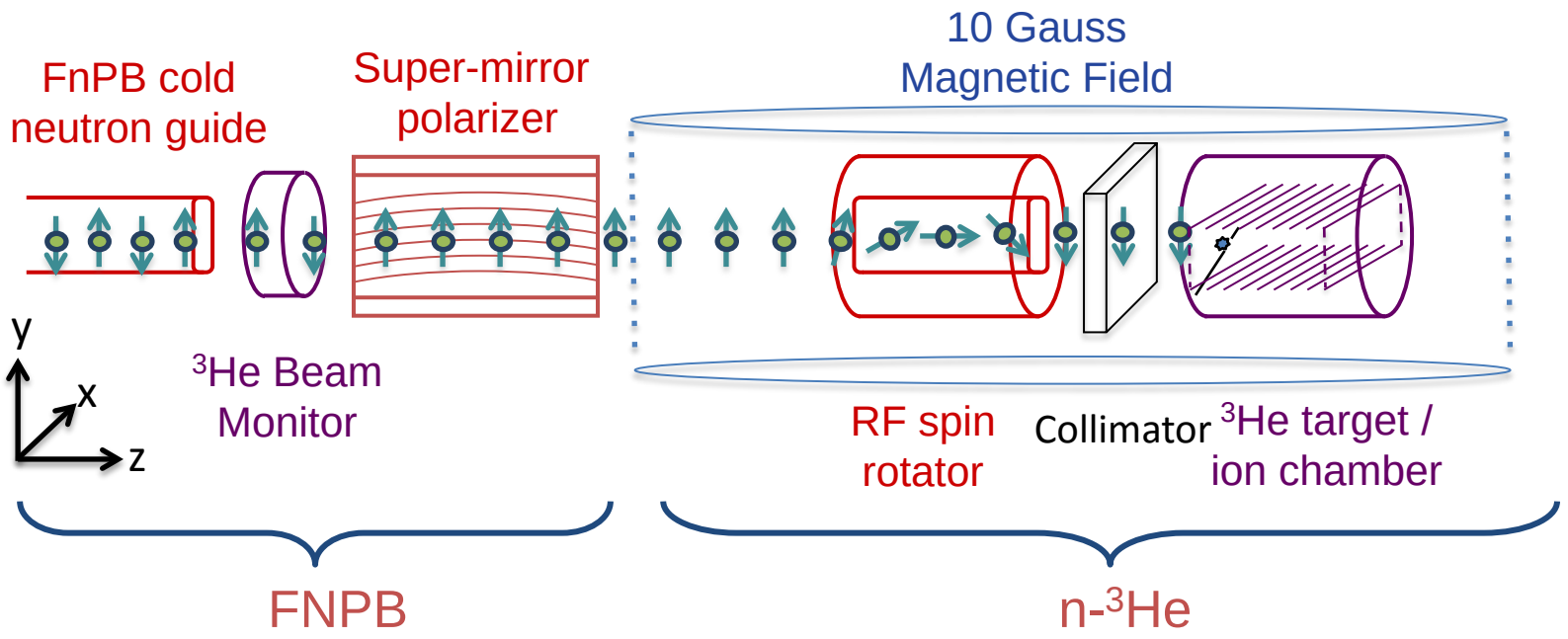
$$\sigma = \sigma_0 \left(1 + \boldsymbol{\sigma}_n.\mathbf{k}_p\, A_{pv} + \mathbf{k}_n x \boldsymbol{\sigma}_n.\mathbf{k}_p\, A_{pc} \right)$$

- Expected to be extremely small (of the order 10^{-7})
- Goal is to measure an asymmetry in the reaction to a precision of 2×10^{-8}

Experimental setup

- Commissioned at spallation neutron source (SNS) facility of Oak Ridge National Laboratory.
- Uses pulsed neutrons at 60 Hz from SNS.

Set up for parity violation mode



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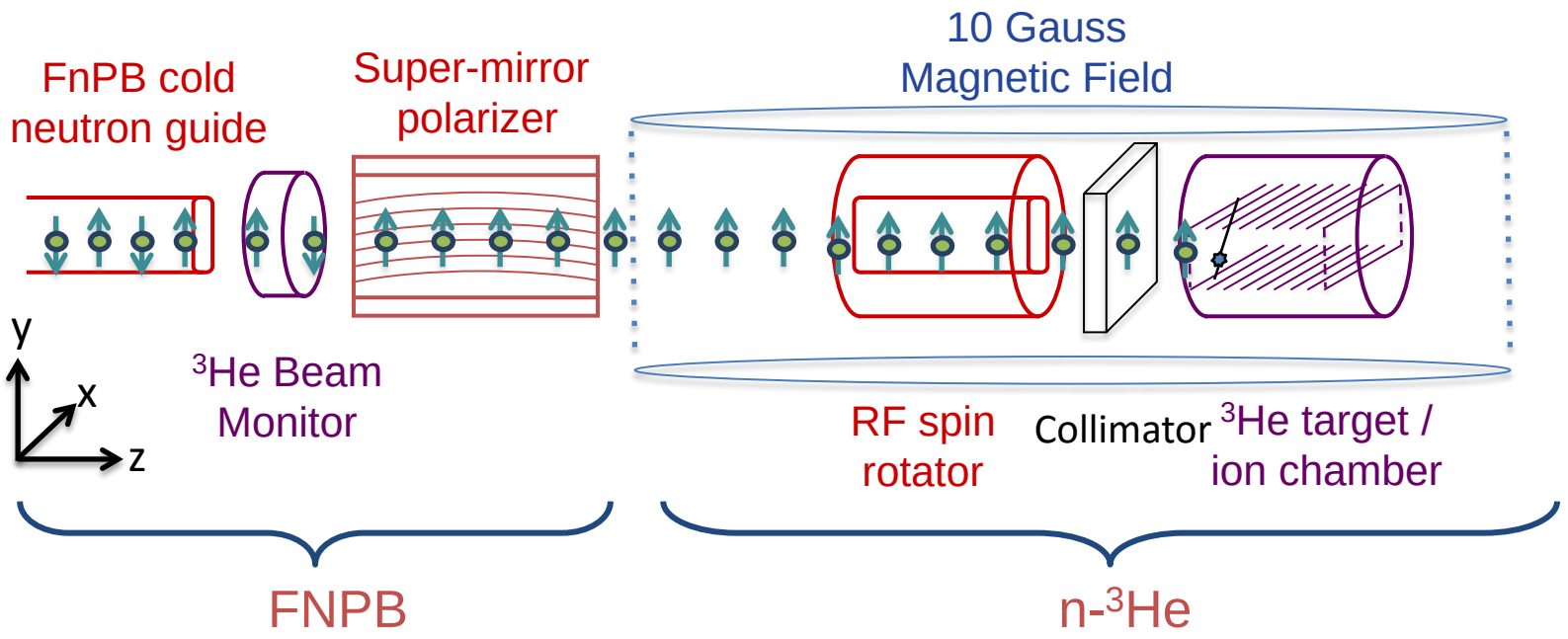

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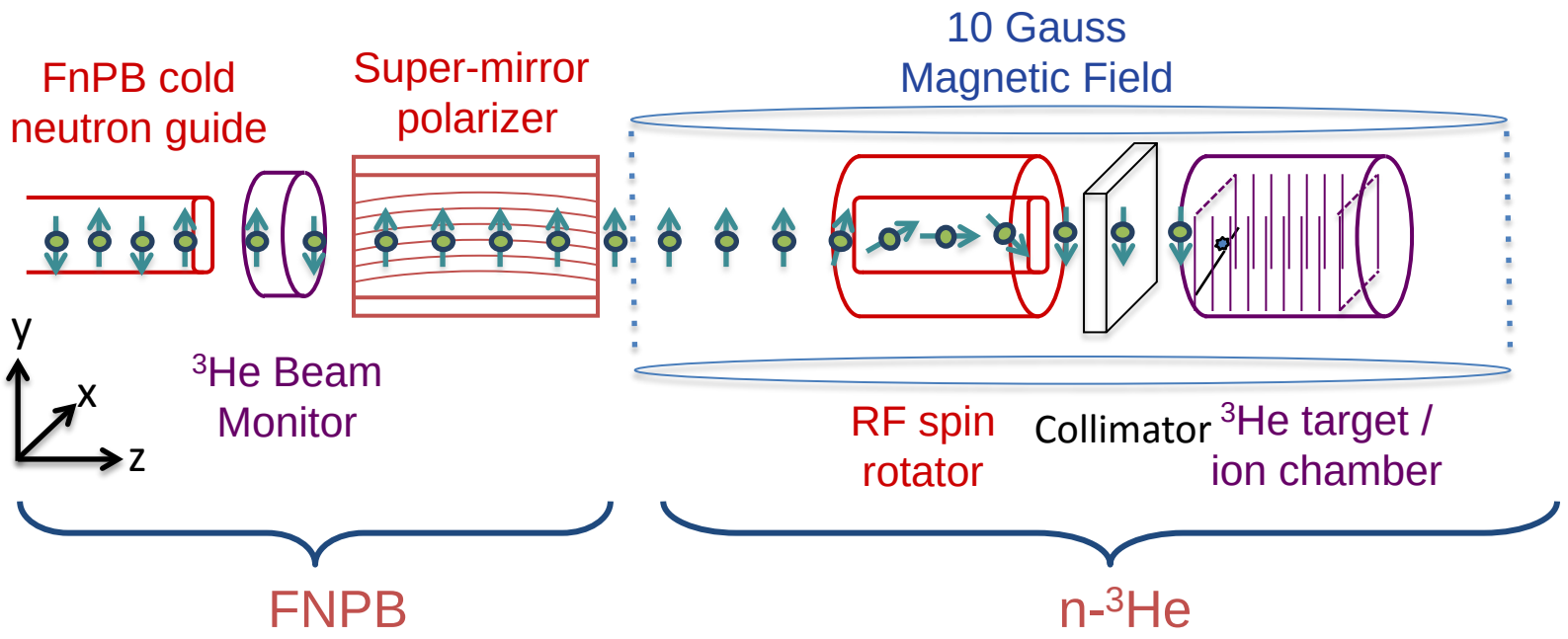

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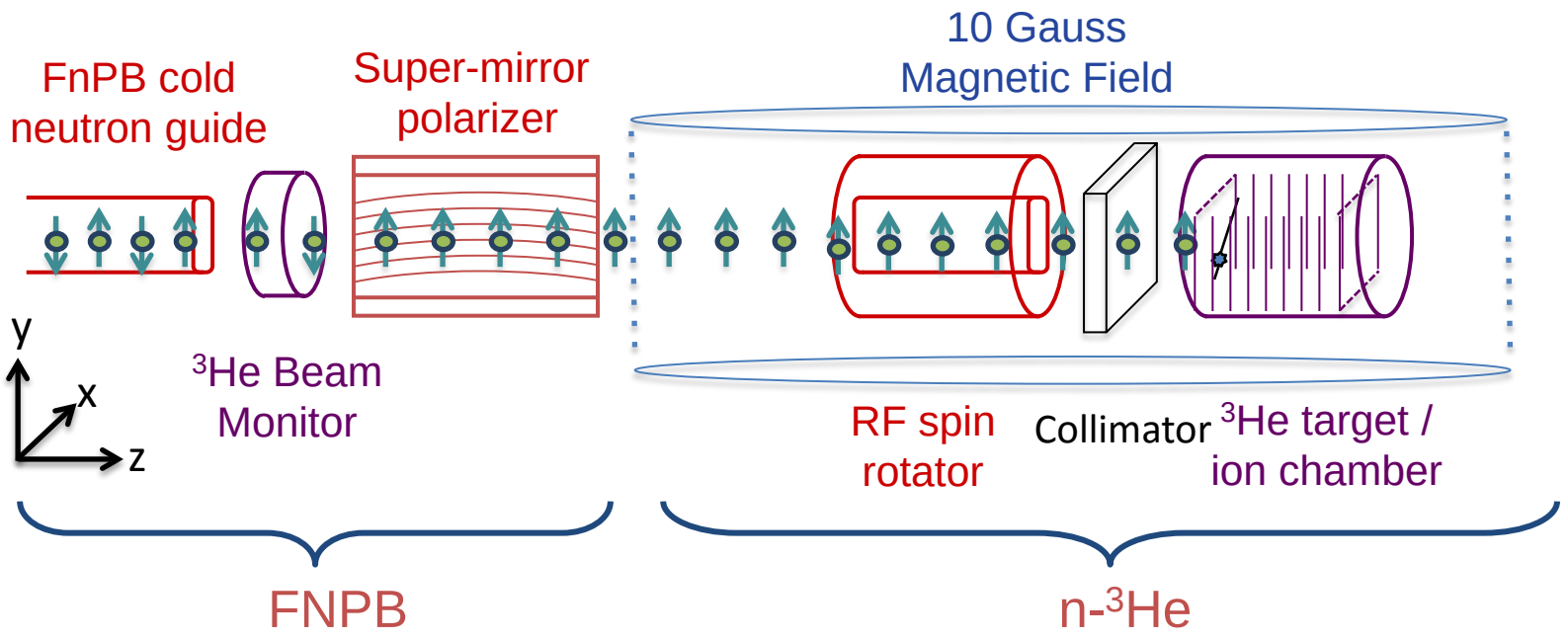
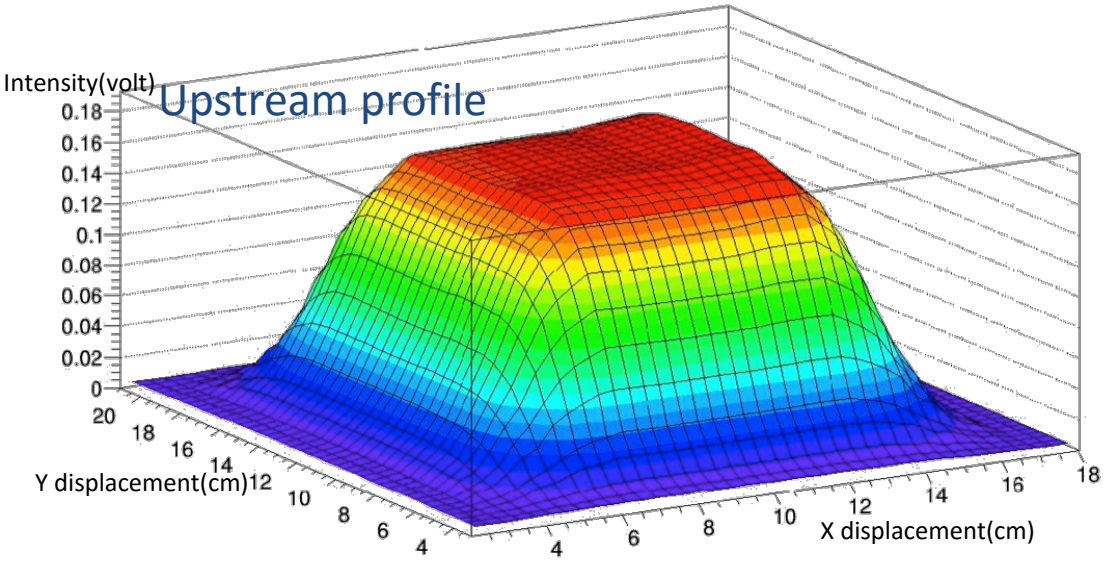
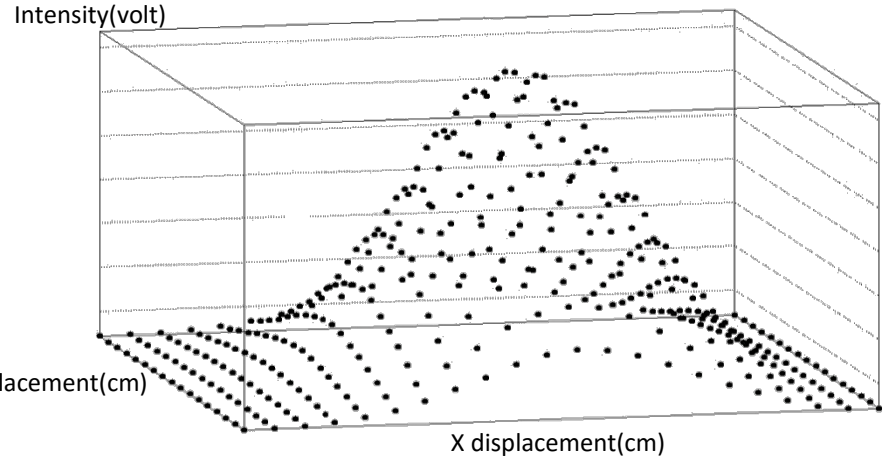


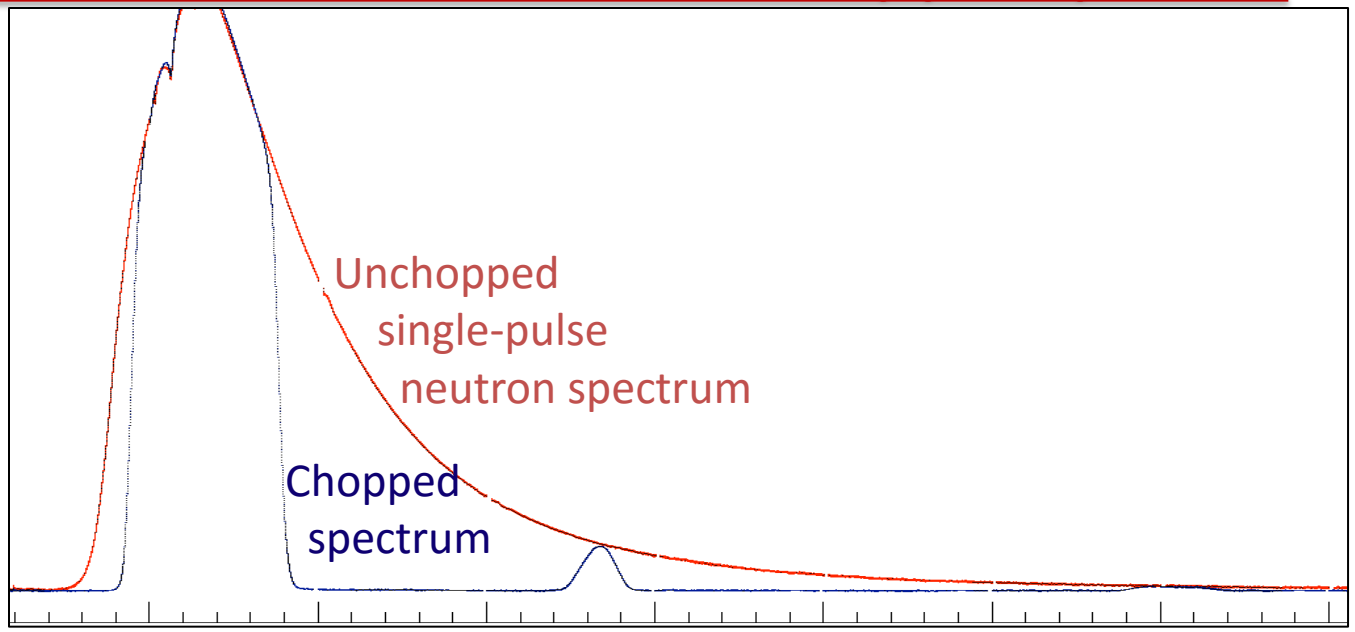
Neutron beam spatial profile

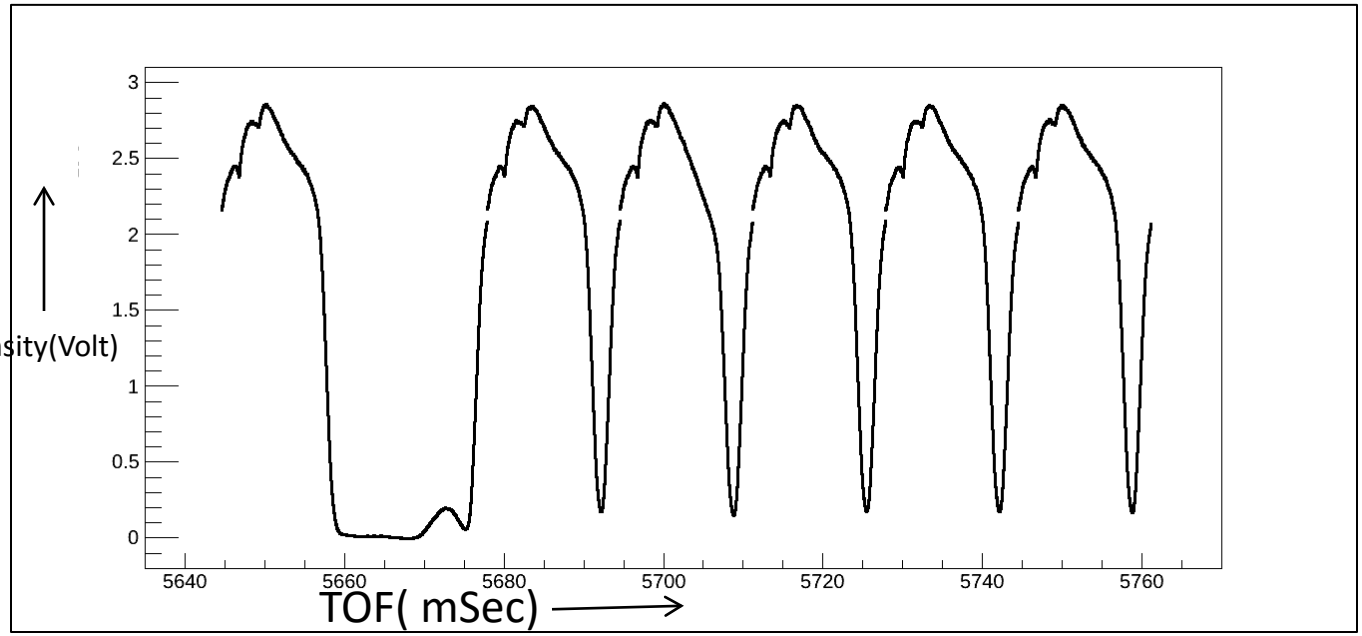
- Measured with 1 cm aperture using XY robot.
- Provides beam centroid and precise alignment of the collimator and target.



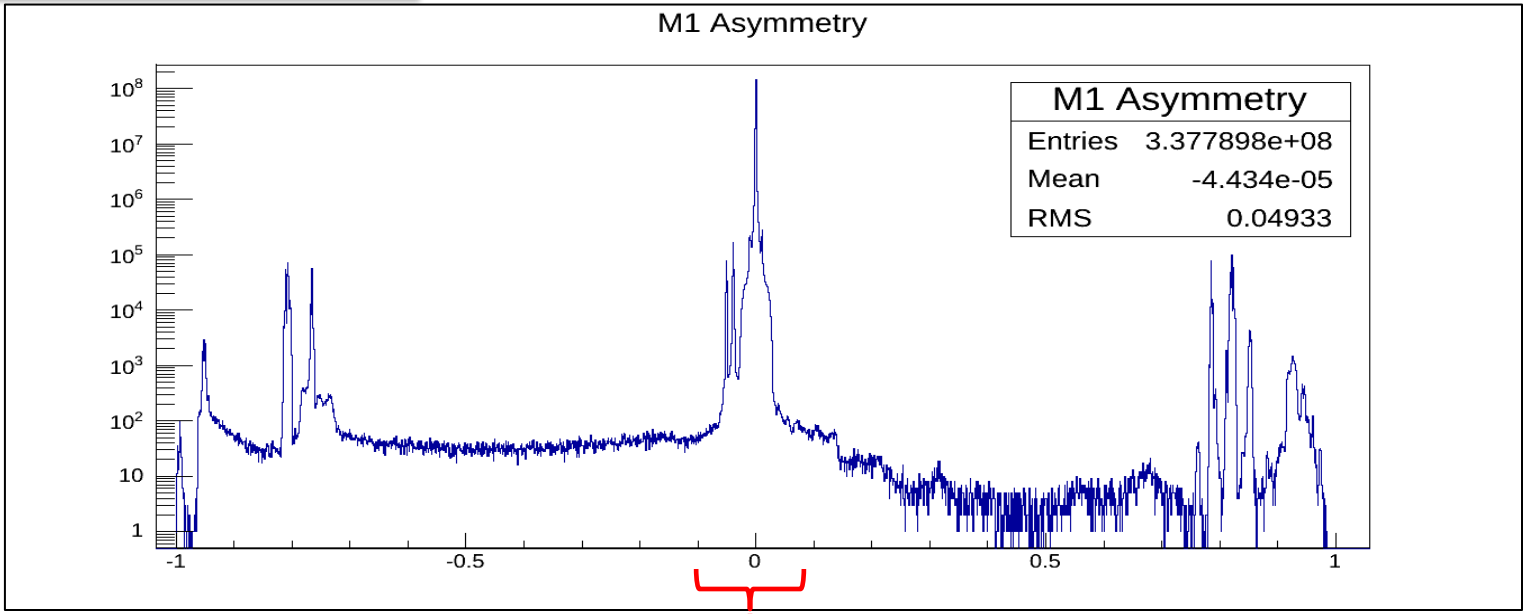


Wraparound neutrons and dropped pulses

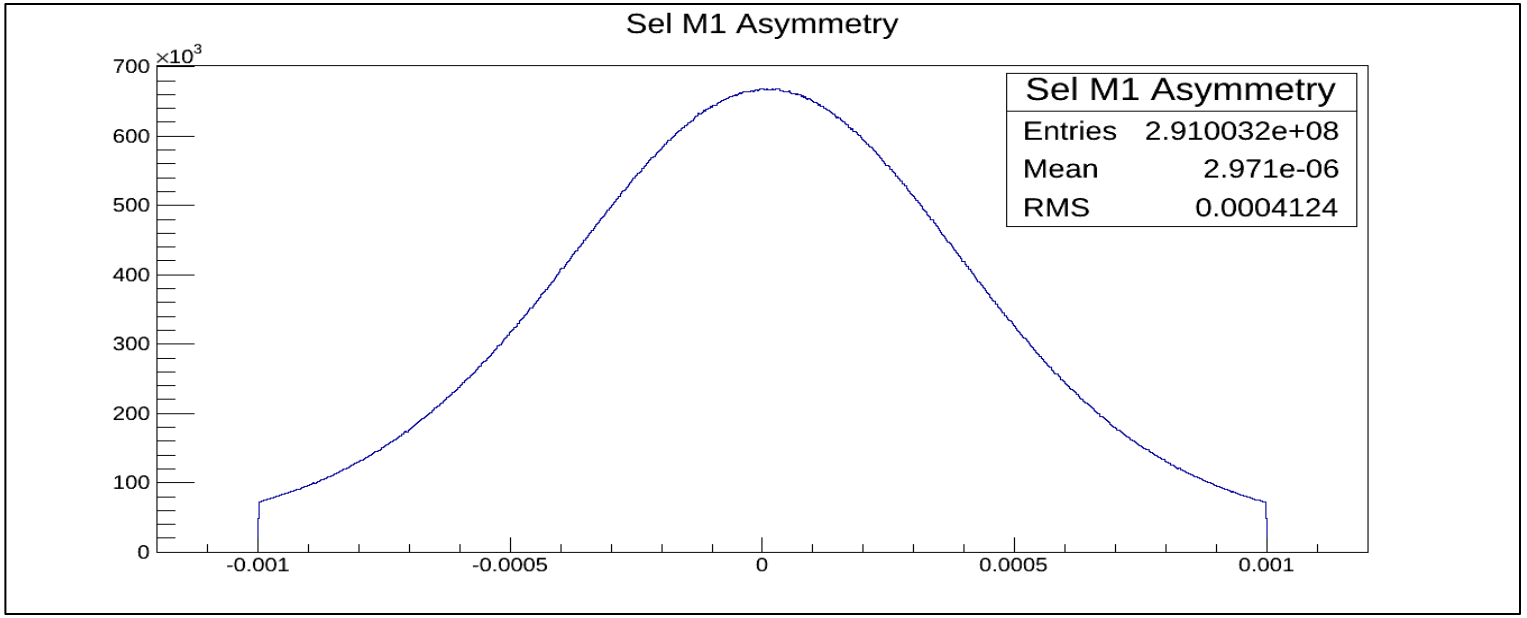




Beam fluctuation



Beam(M1) Asymmetry



Beam Asymmetry (After Cut)

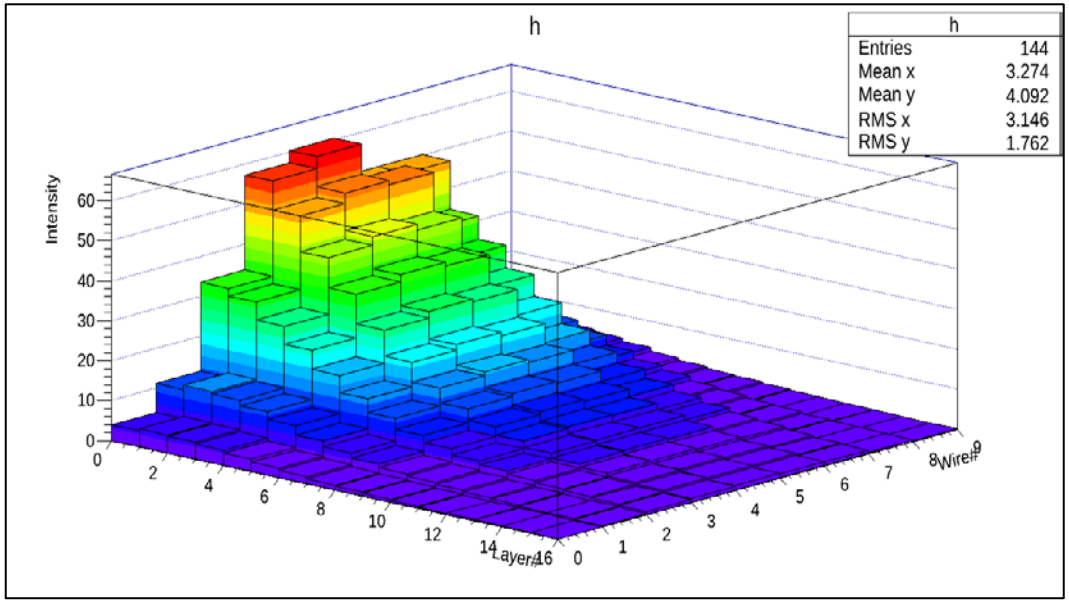
Asymmetry estimation and statistics

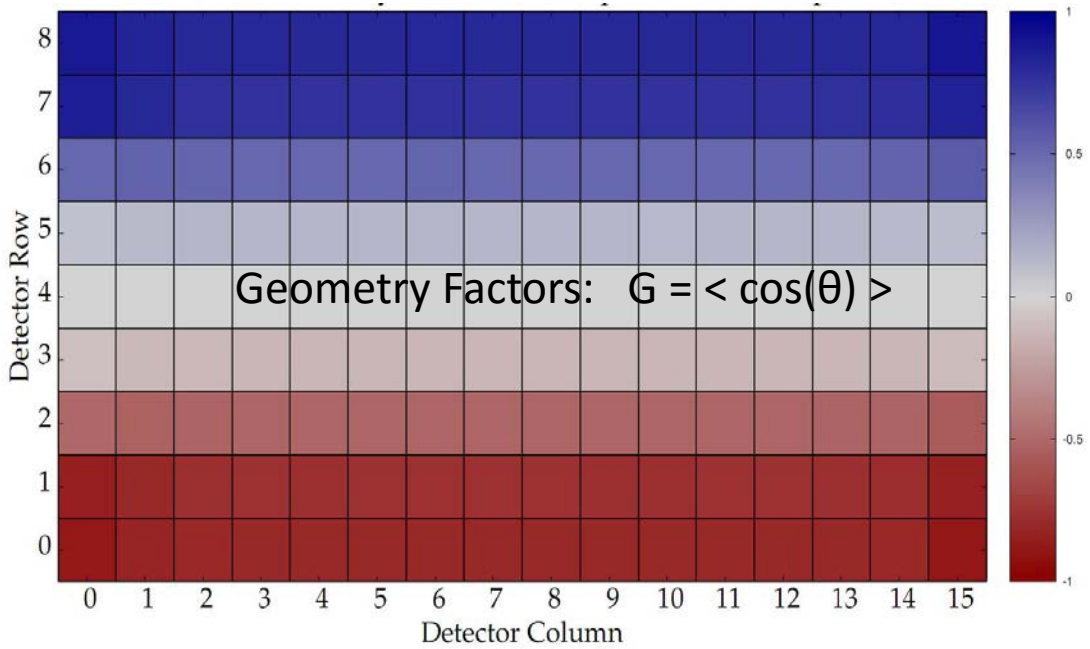
- PV physics asymmetry
  - Extracted from weighted average of single-wire spin asymmetries

$$Y_{\pm} = Y_0(1 \pm P A_p \langle \cos\theta \rangle)$$

$$A_p = \frac{1}{P\langle \cos\theta \rangle} \frac{Y_+ - Y_-}{Y_+ + Y_-}$$

$$\delta A = \frac{\sigma_d}{P\sqrt{N}} \quad 2.9 < \sigma_d < 6$$



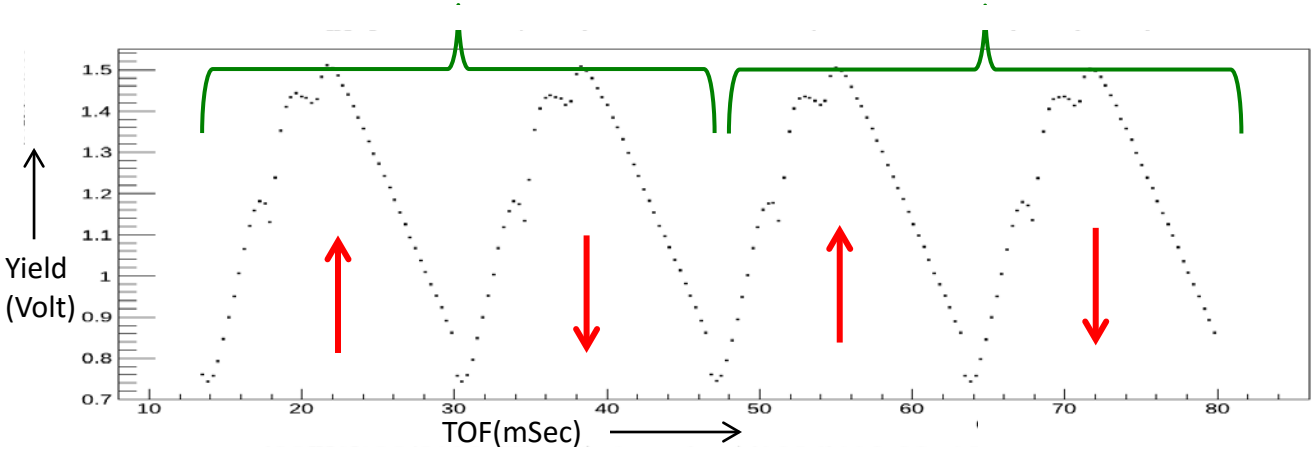


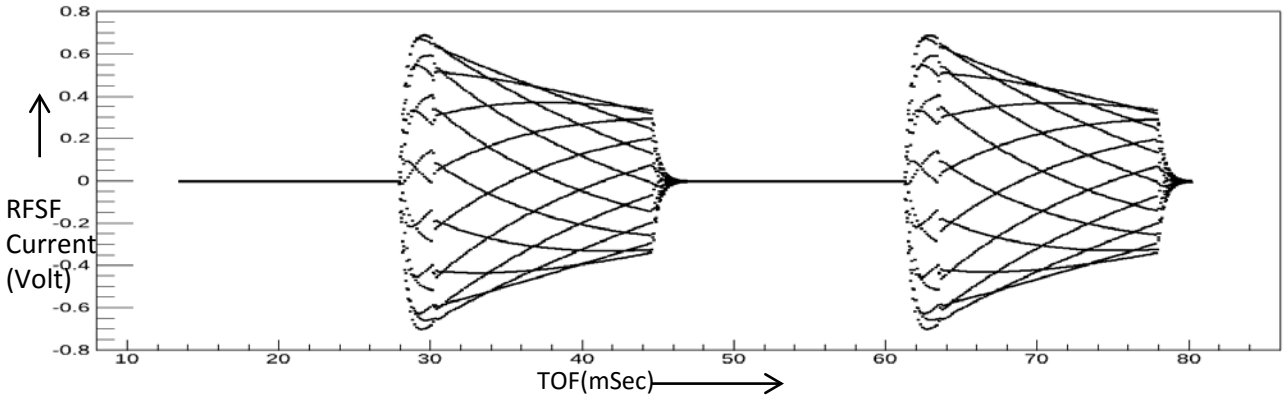
Asymmetry extraction from data

- Cuts:
  - -- Pulses around dropped pulses
- Pair of events (one up and one down) considered to form each asymmetry for each wire.
- Normalized by sum of all the detector signals for that event.
- The final asymmetry is obtained after correcting for correlations.

$$A_K = \frac{Y_+^K - Y_-^K}{Y_+^K + Y_-^K}$$

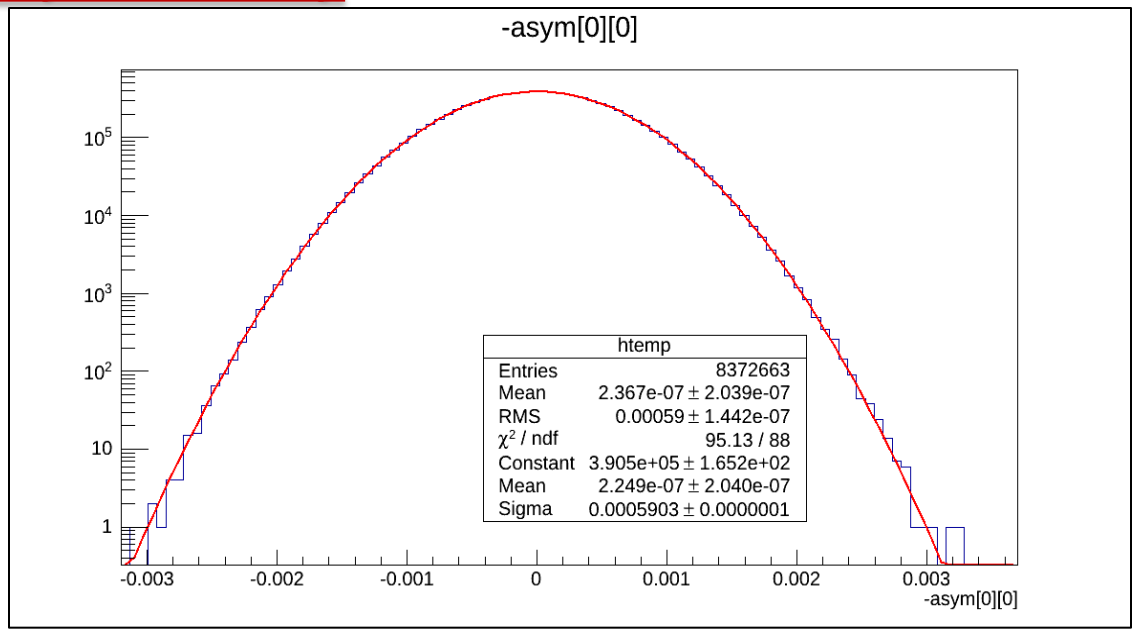
K= pair of events index



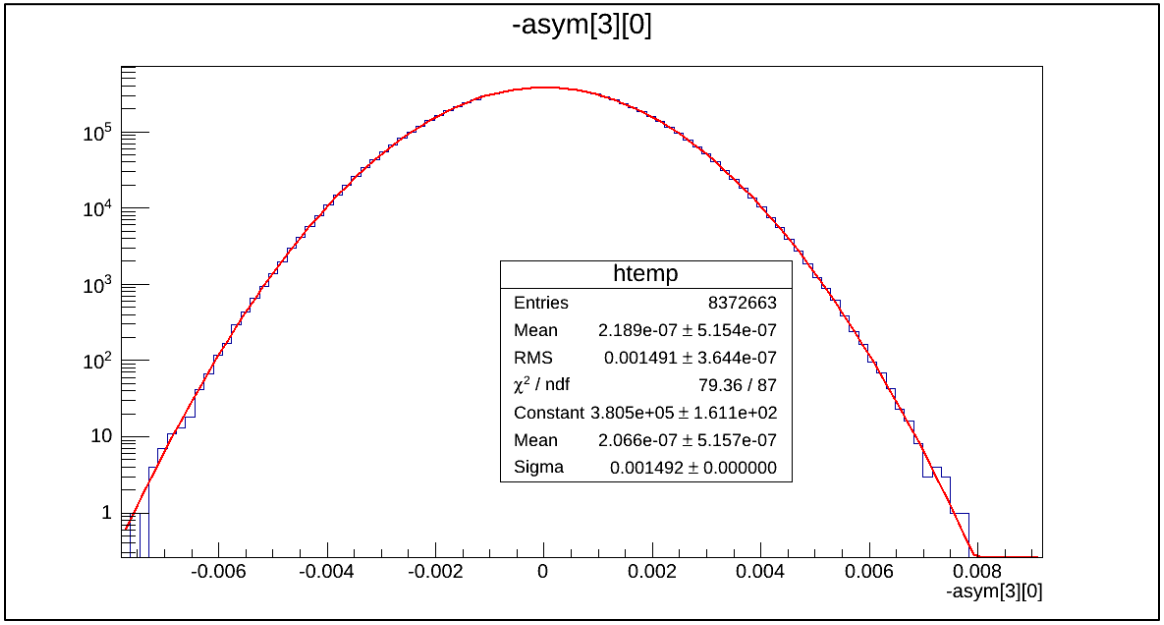


Left right asymmetry

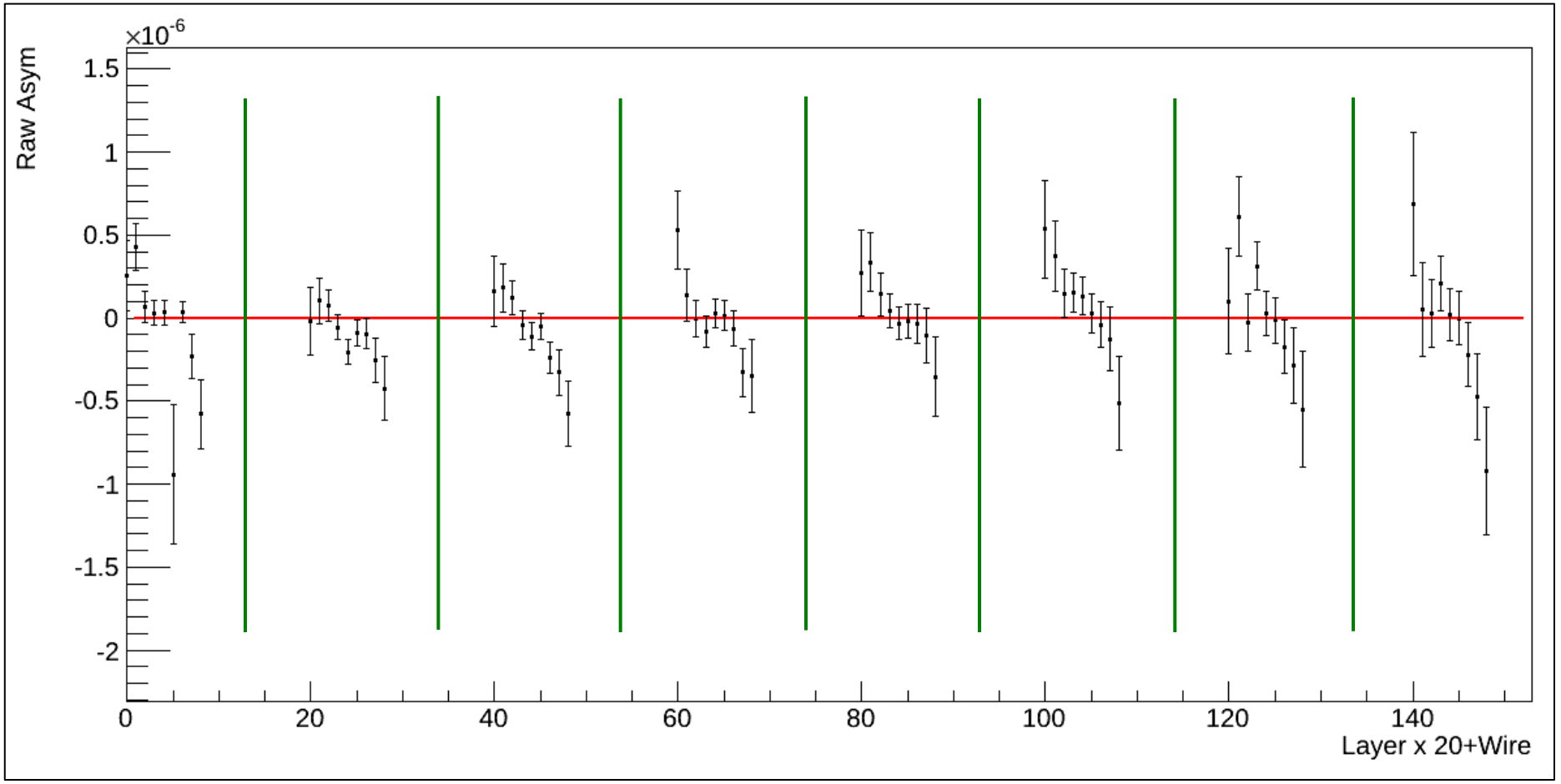
Layer-1, Wire-1



Layer-10, Wire-1



Left right raw asymmetry



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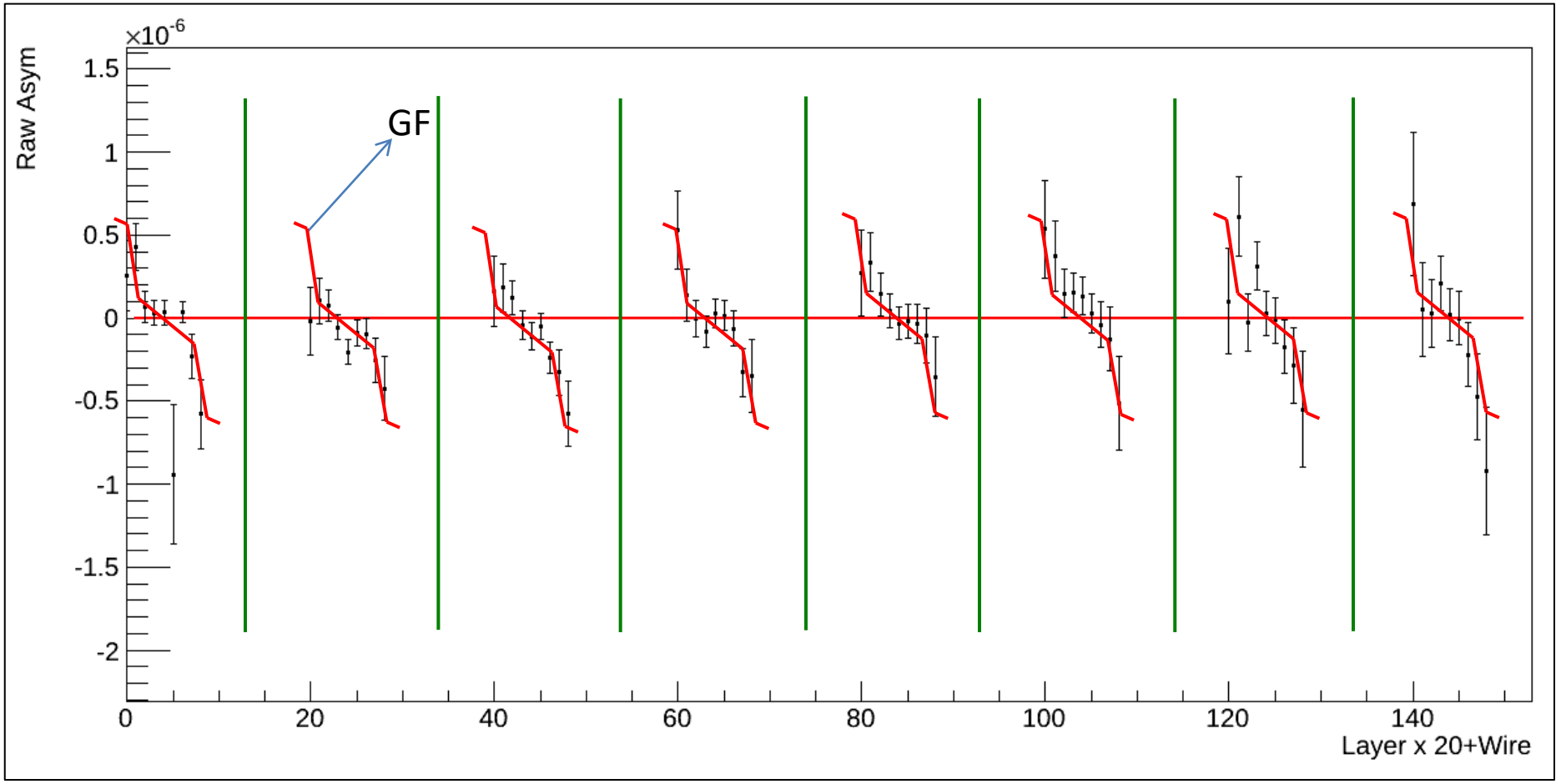
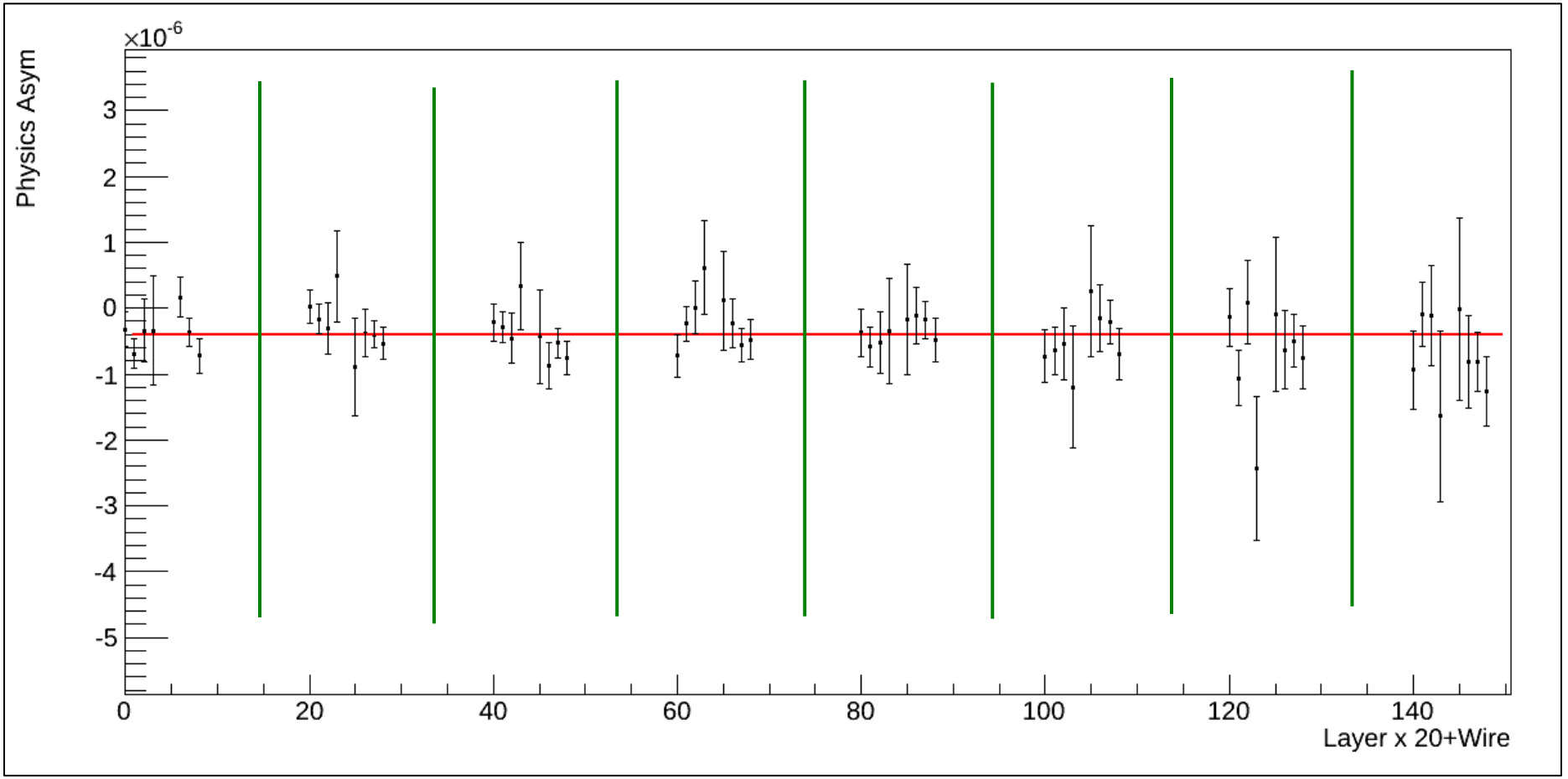


Left right physics asymmetry



Summary and current status

- The n^3He experiment is a high-precision measurement motivated to probe the hadronic weak interaction by measuring the parity violating asymmetry of the proton in the capture of neutron in helium target.

- The input from this experiment along with others can help solve the puzzles of HWI coupling constants, thus nucleon structure.

- Analysis to extract PC and PV asymmetry is on going.

- Preliminary analysis of PC asymmetry confirms the instrumental sensitivity of the experiment.

- We are now working to improve geometry factors, correlations and false asymmetry subtraction.

n-^{3}He Collaboration

Institution	Researcher	Category	2014 Effort
Duke University, Triangle Universities Nuclear Laboratory			
	Pil-Neo Seo	Research Staff	10
Istituto Nazionale di Fisica Nucleare, Sezione di Pisa			
	Michele Viviani	Research Staff	15
Oak Ridge National Laboratory			
	Seppo Pentillä	Research Staff	70
	David Bowman	Research Staff	70
	Vince Cianciolo	Research Staff	10
University of Kentucky			
	Chris Crawford	Faculty	50
	Kabir Latiful	Grad Student	100
Western Kentucky University			
	Ivan Novikov	Faculty	70
	TBD	Undergraduate	100
University of Manitoba			
	Michael Gericke	Faculty	30
	V. Tvaskis	Postdoc	10
	Mark McCrea	Grad Student	100
	Carlos Olguin	Grad Student	100
Universidad Nacional Autónoma de México			
	Libertad Baron	Faculty	50
	Andrés Naranjas	Grad Student	100
University of New Hampshire			
	John Calarco	Faculty	50
University of South Carolina			
	Vladimir Gudkov	Faculty	5
	Young-Ho Song	Postdoc	5
Univeristy of Tennessee			
	Geoff Greene	Faculty	30
	Nadia Fomin	Faculty	30
	Irakli Garribaldi	Postdoc	50
	Chris Hayes	Grad Student	100
	Chris Coppola	Grad stduent	100
Univeristy of Tennessee at Chattanooga			
	Josh Hamblen	Faculty	75
	Caleb Wickersham	Undergraduate	100
University of Virginia			
	S. Baessler	Faculty	20