The n-^{3}He Experiment at SNS

A Study of Hadronic Weak Interaction

A measurement of the parity violating 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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- ❑ Major Components
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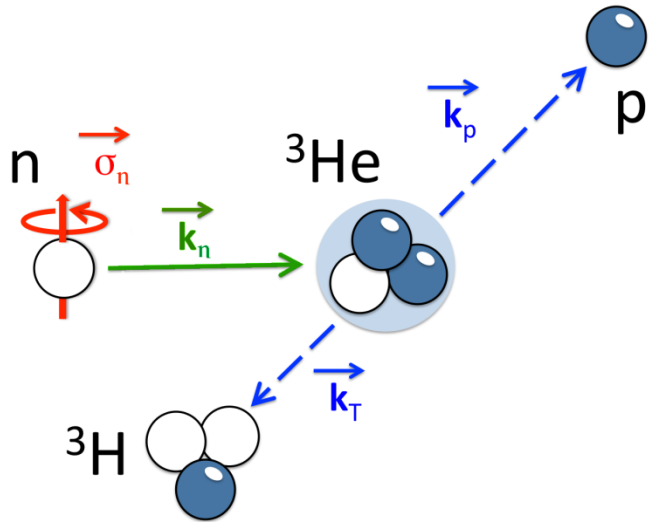
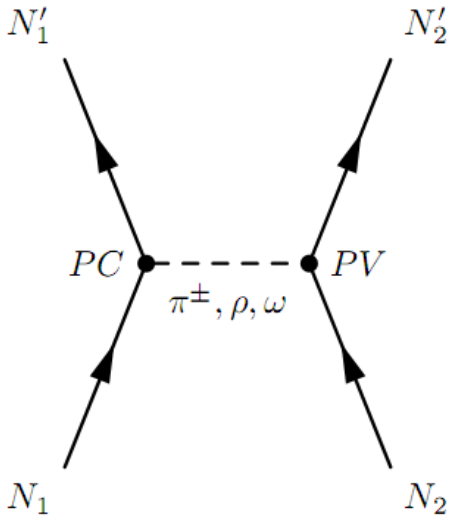
The n-^{3}He Experiment

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

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





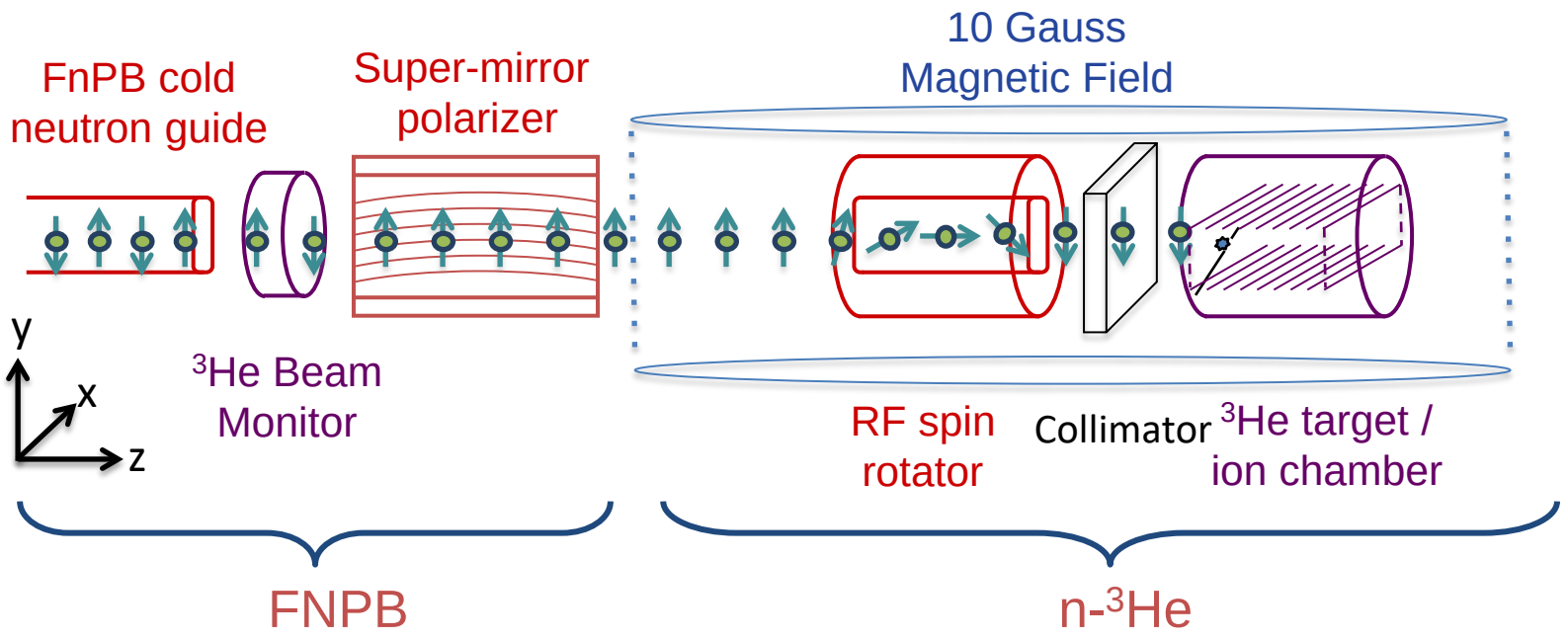
$$\sigma = \sigma_0 \left(1 + \boldsymbol{\sigma}_n.\mathbf{k}_p\, A_{pv} + \mathbf{k}_n x \boldsymbol{\sigma}_n.\mathbf{k}_p\, A_{pc} \right)$$

- 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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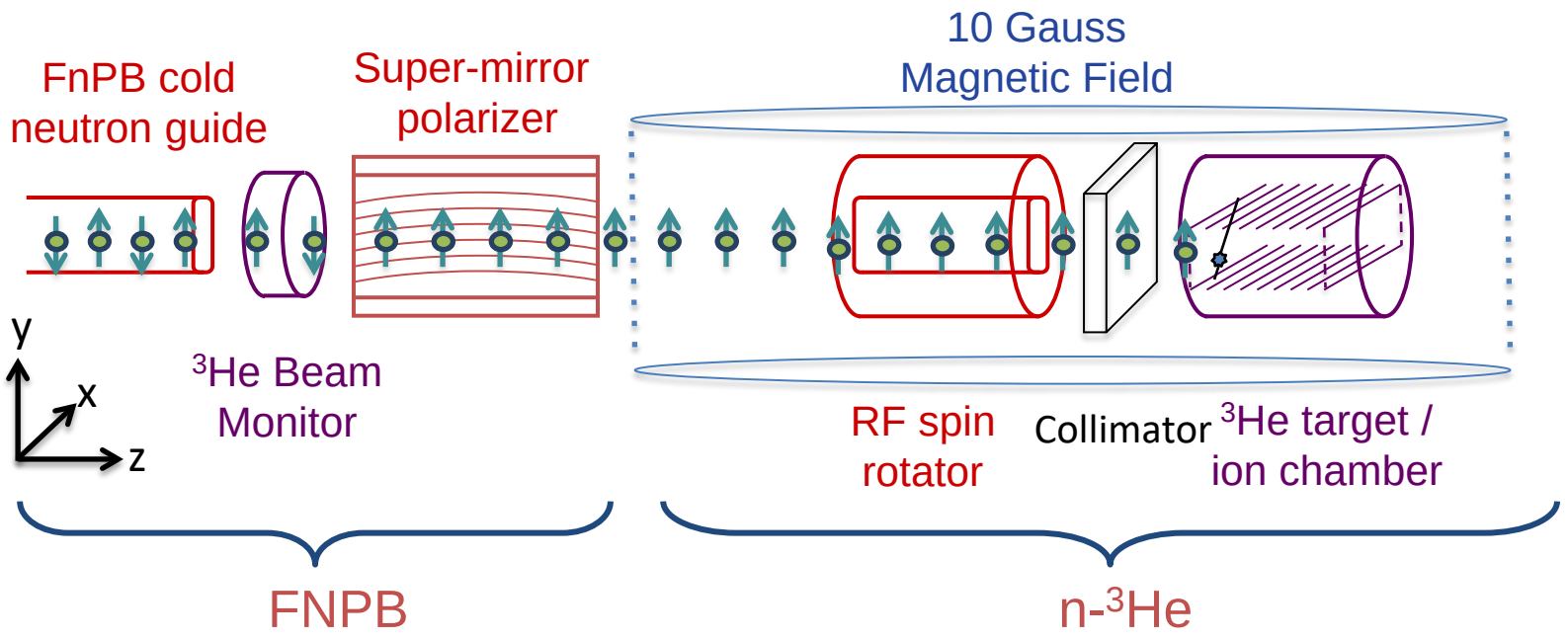

Experimental setup

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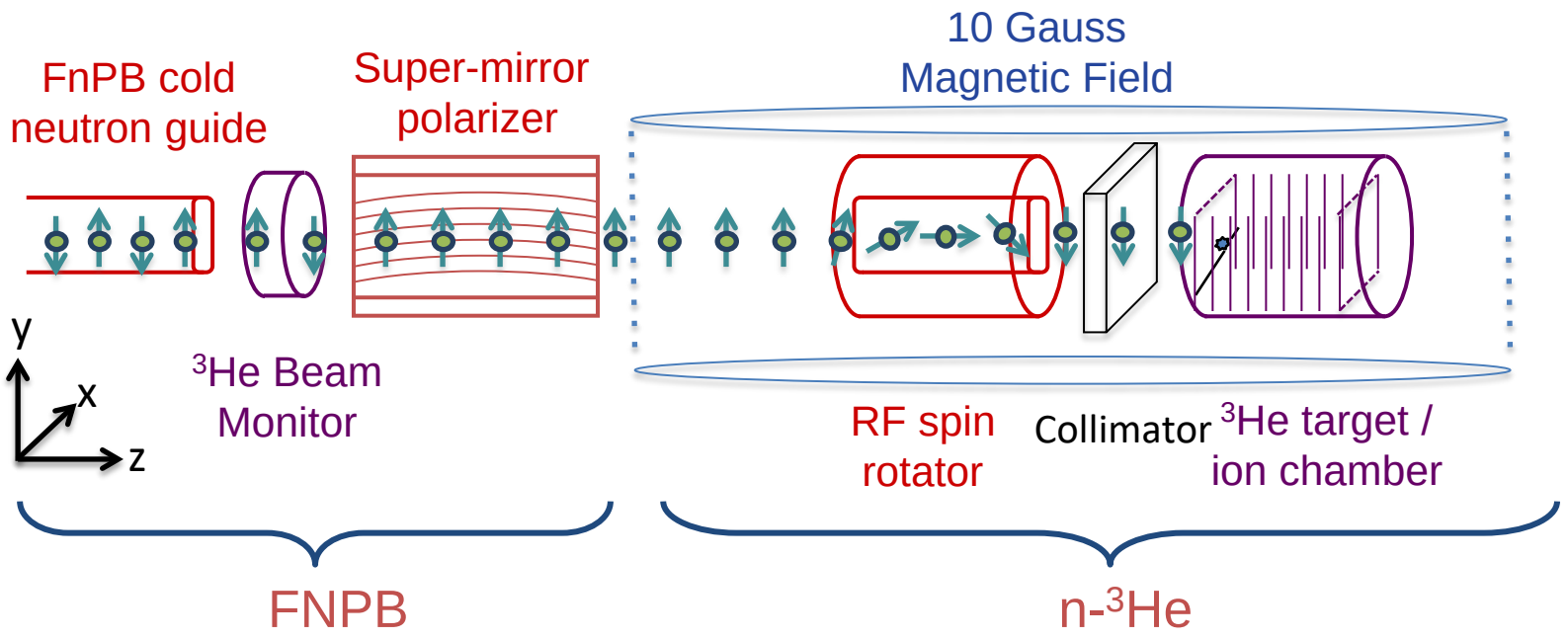
Set up for parity conserving mode



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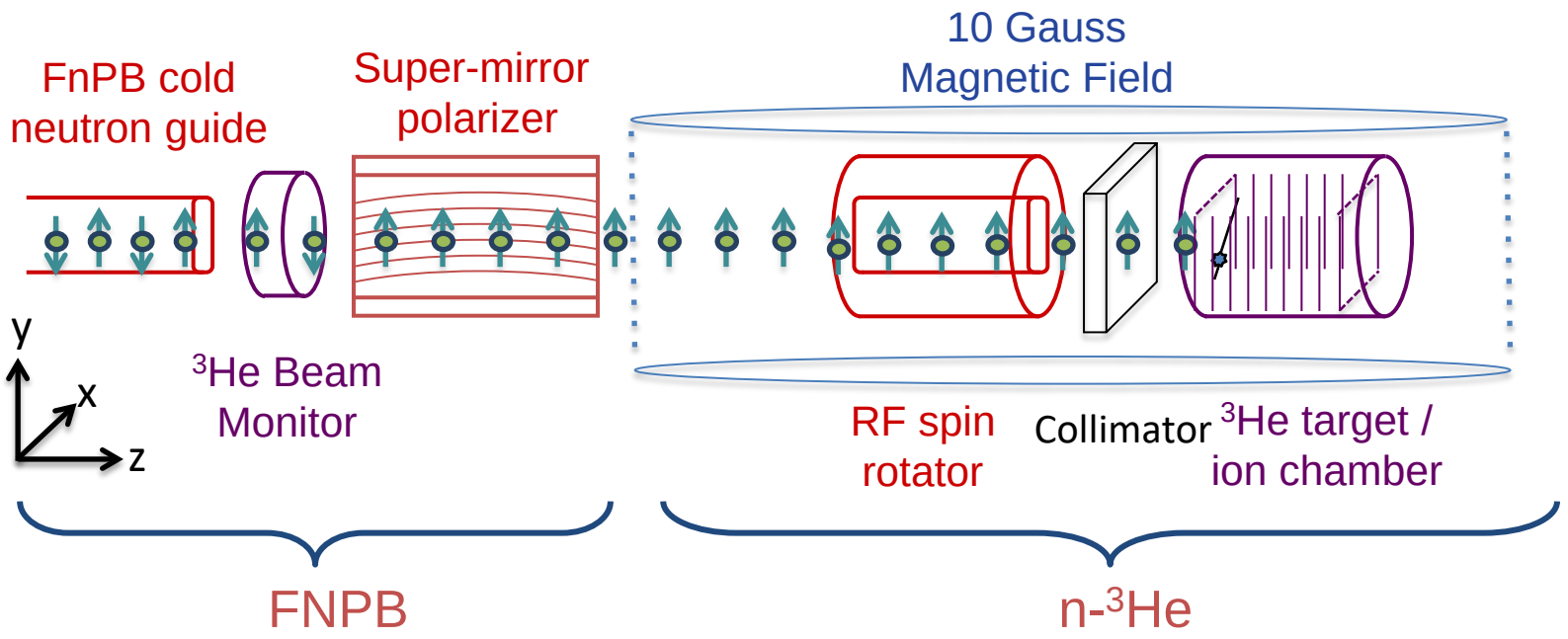
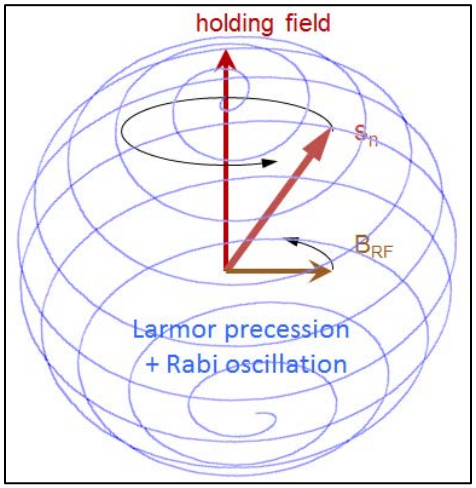
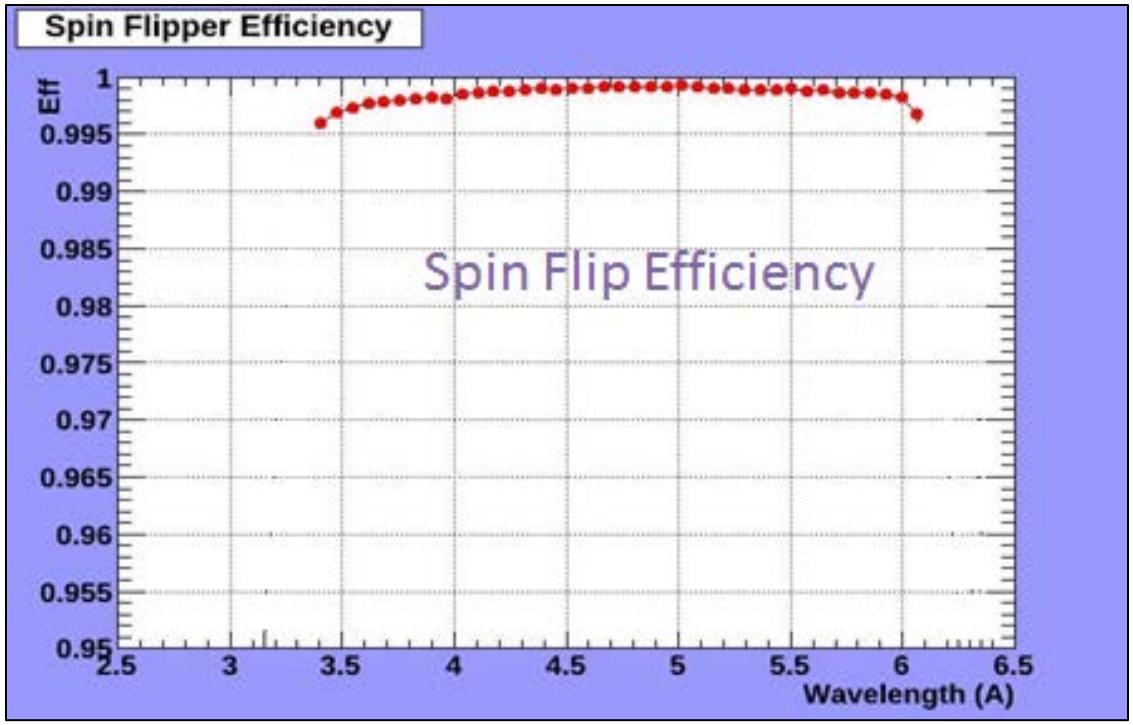
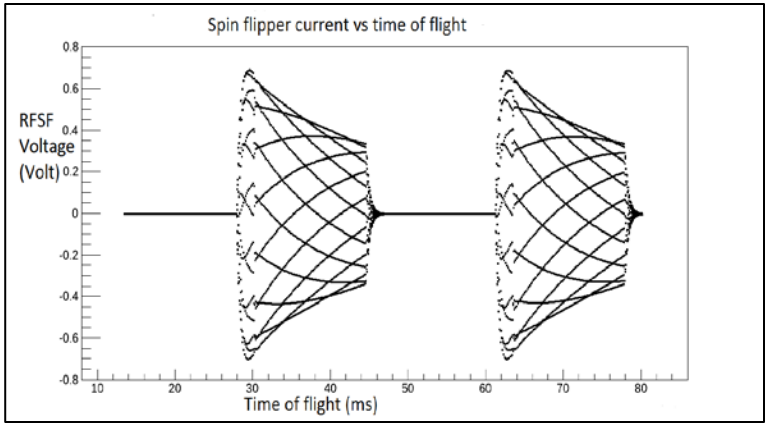


RFSF

- The neutrons enter the experiment with a transverse polarization.
- Spin flipper with transverse windings allows for both longitudinal and transverse spin rotation.

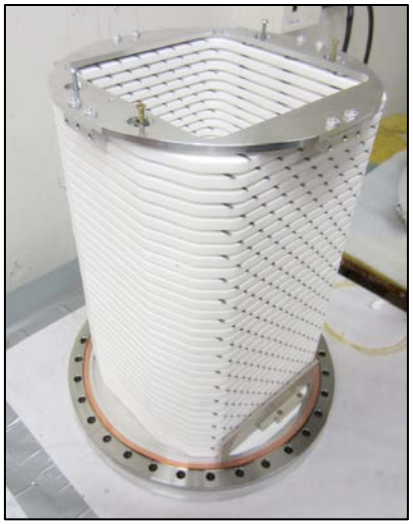


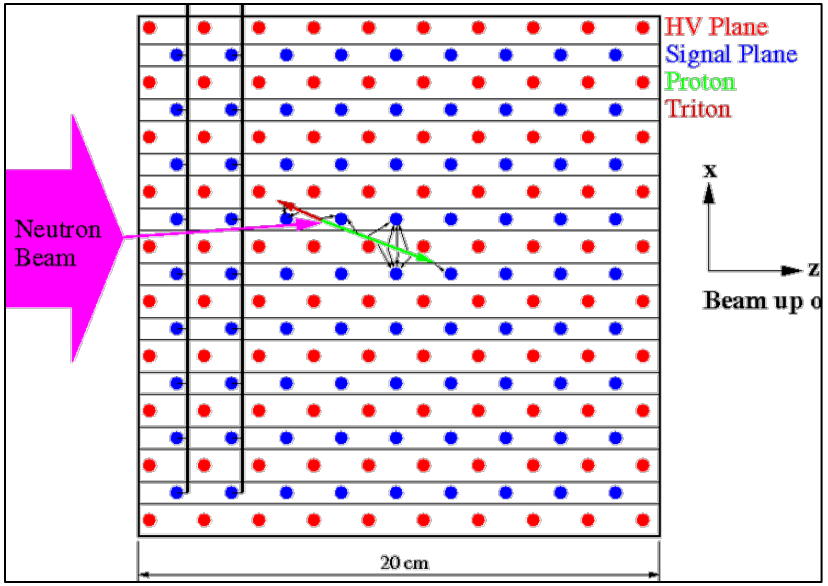


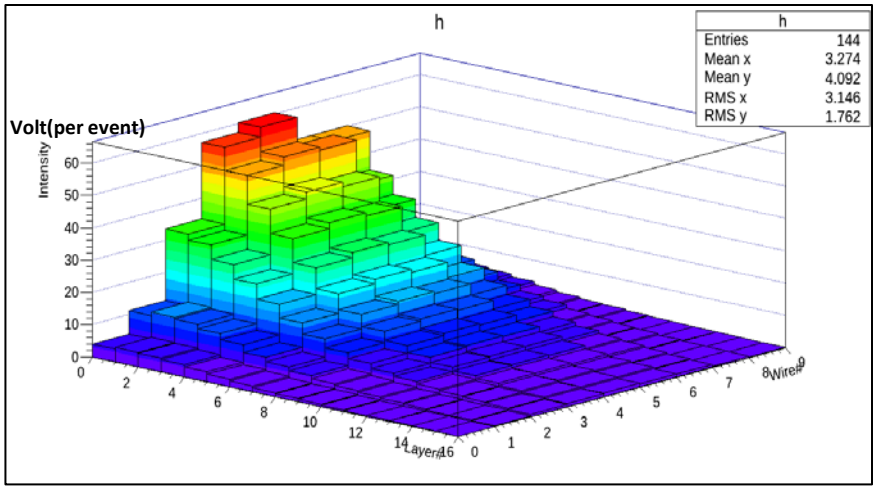


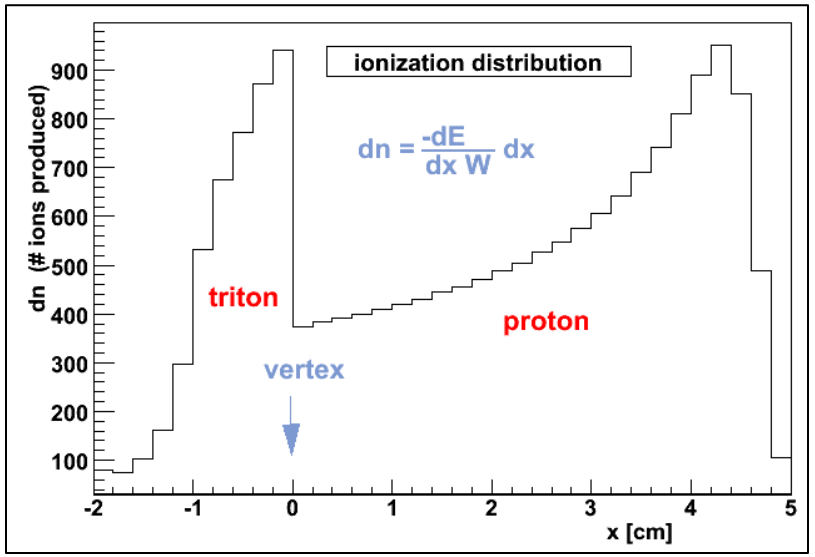
Ion Chamber

- Filled with ^{3}He at 0.5 atm
- 17 HV Frames with 8 wires
- 16 Signal Frames with 9 wires

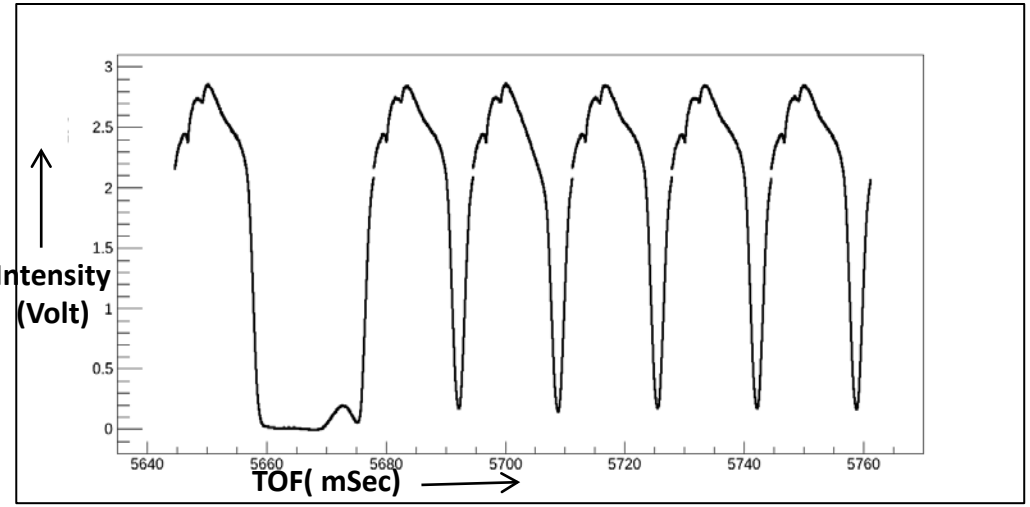


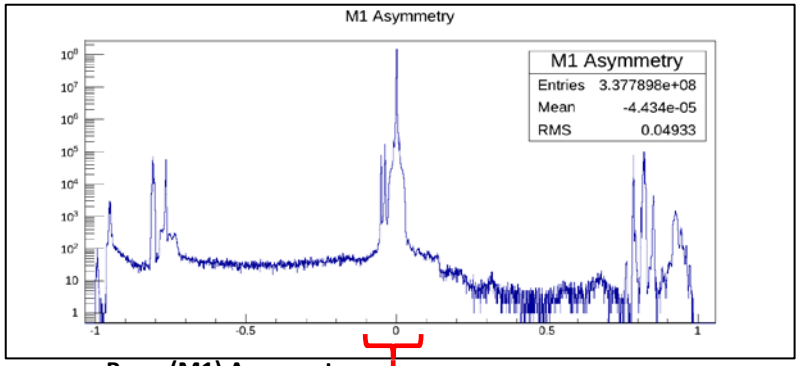




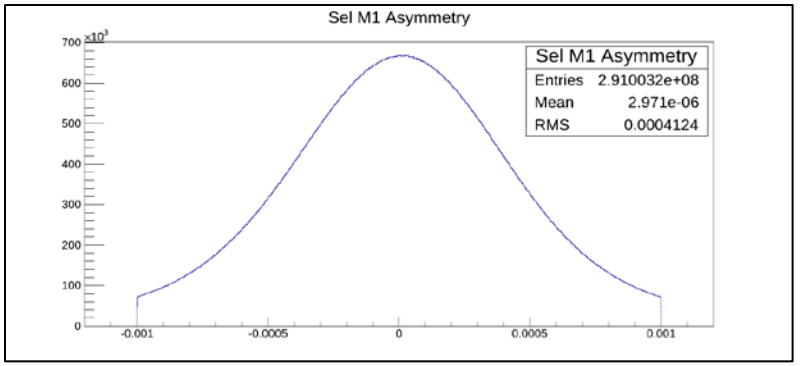


Neutron beam profile

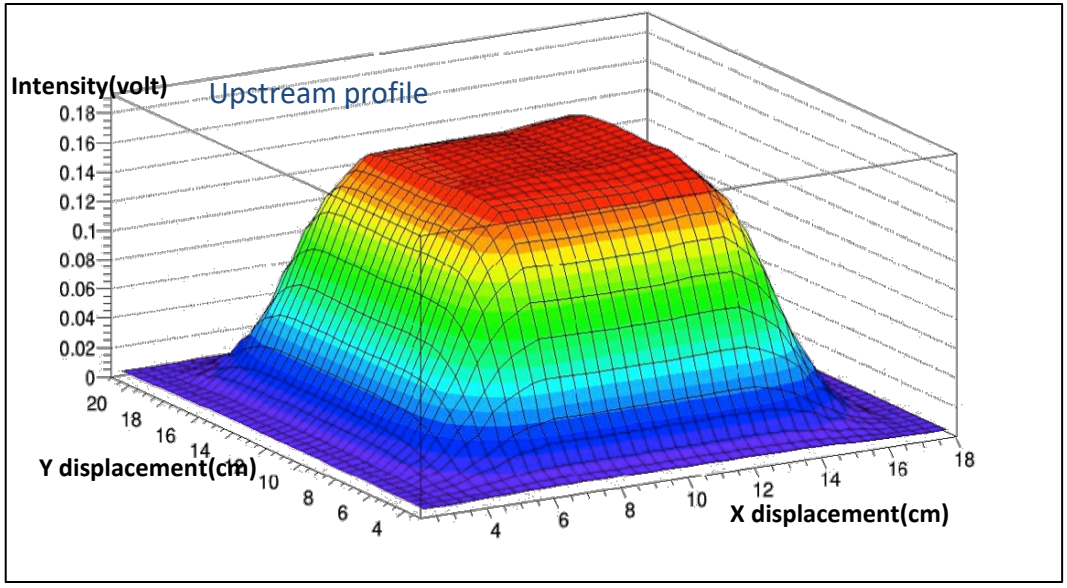




Beam(M1) Asymmetry



Beam Asymmetry (After Cut)



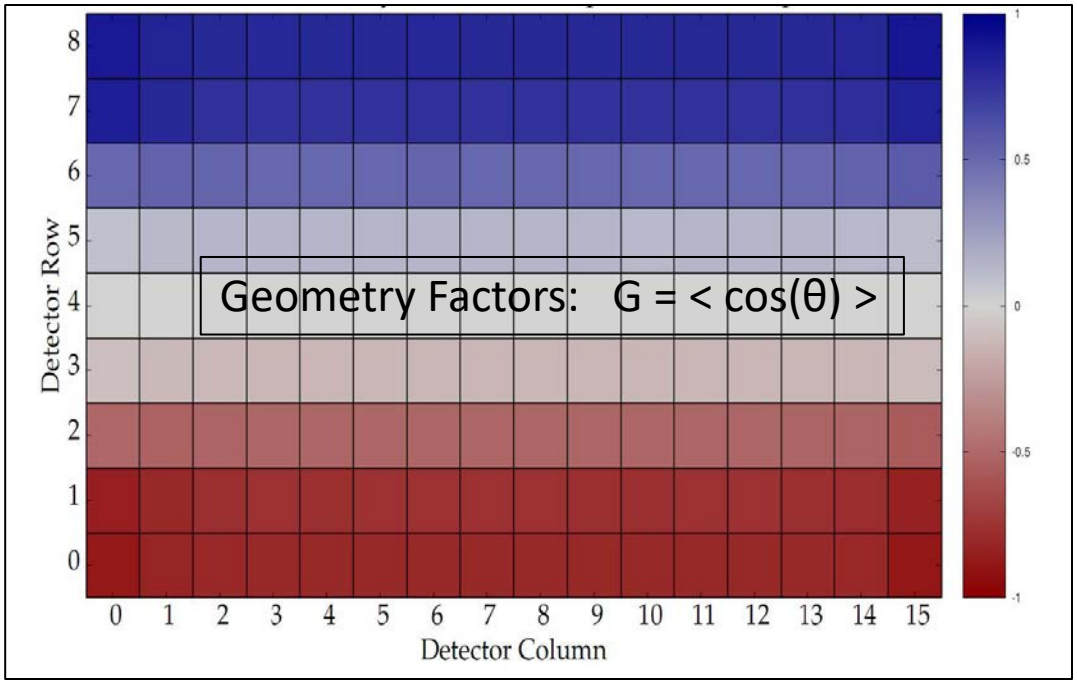
Asymmetry extraction

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

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

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

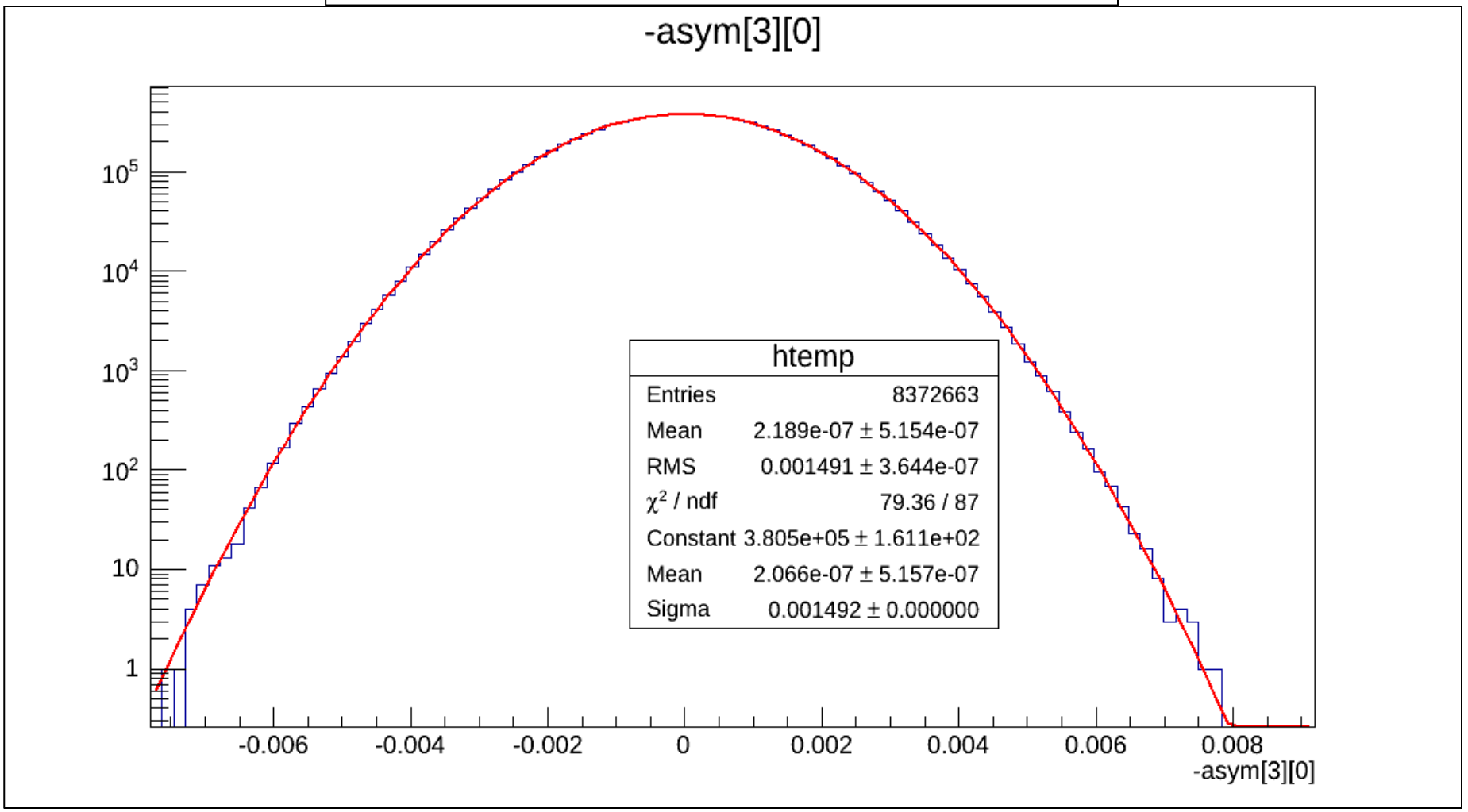
$$\delta A = \frac{\sigma_d}{P\sqrt{N}} \quad 2.9 < \sigma_d < 6$$



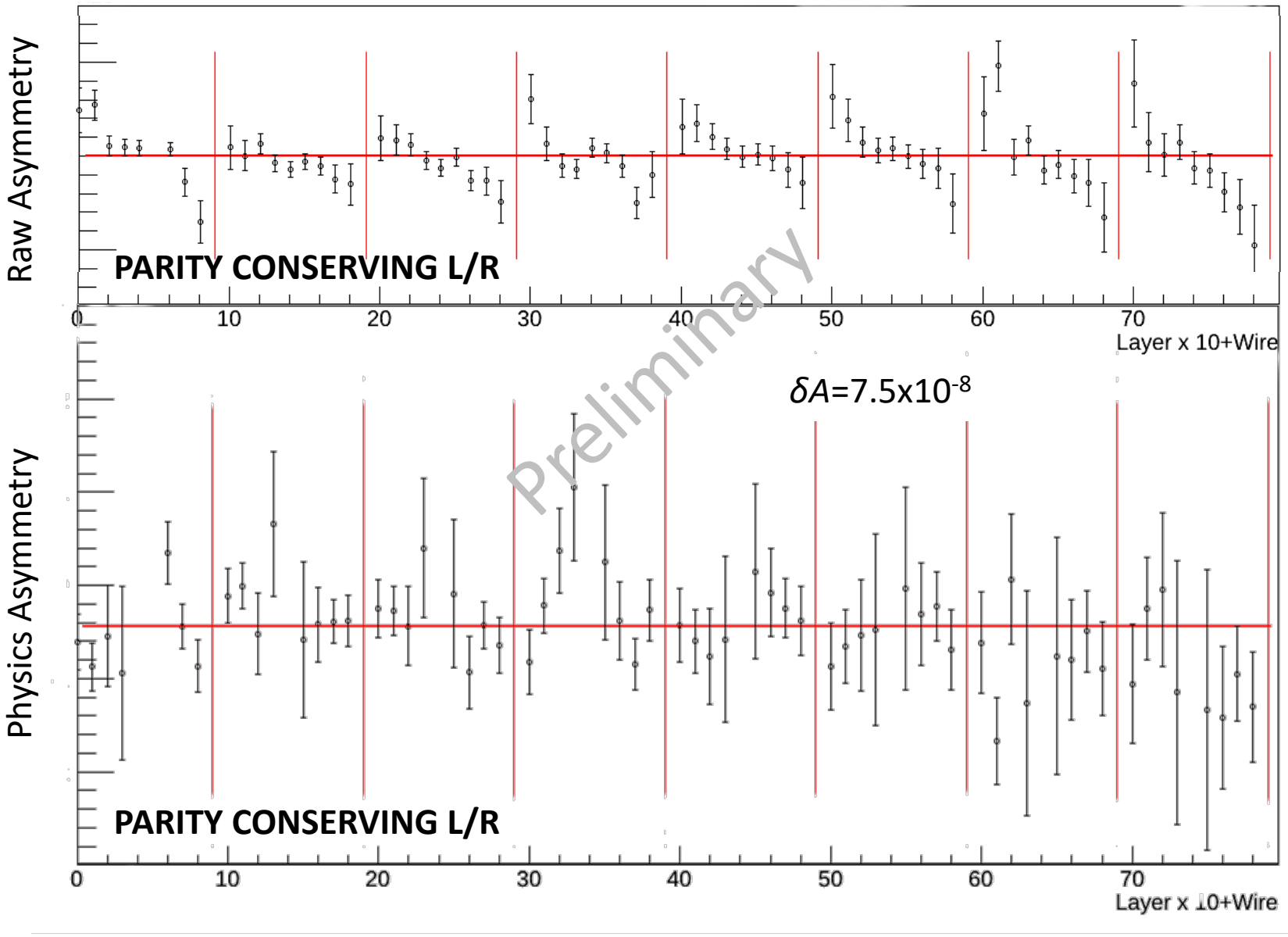
- Cuts:
  -- Pulses around dropped pulses.
- Pair of events (one up and one down) considered to form each asymmetry for each wire.
- Normalized by sum of all the detector signals for that event.
- The final asymmetry is obtained after correcting for correlations.

Left right (PC)asymmetry

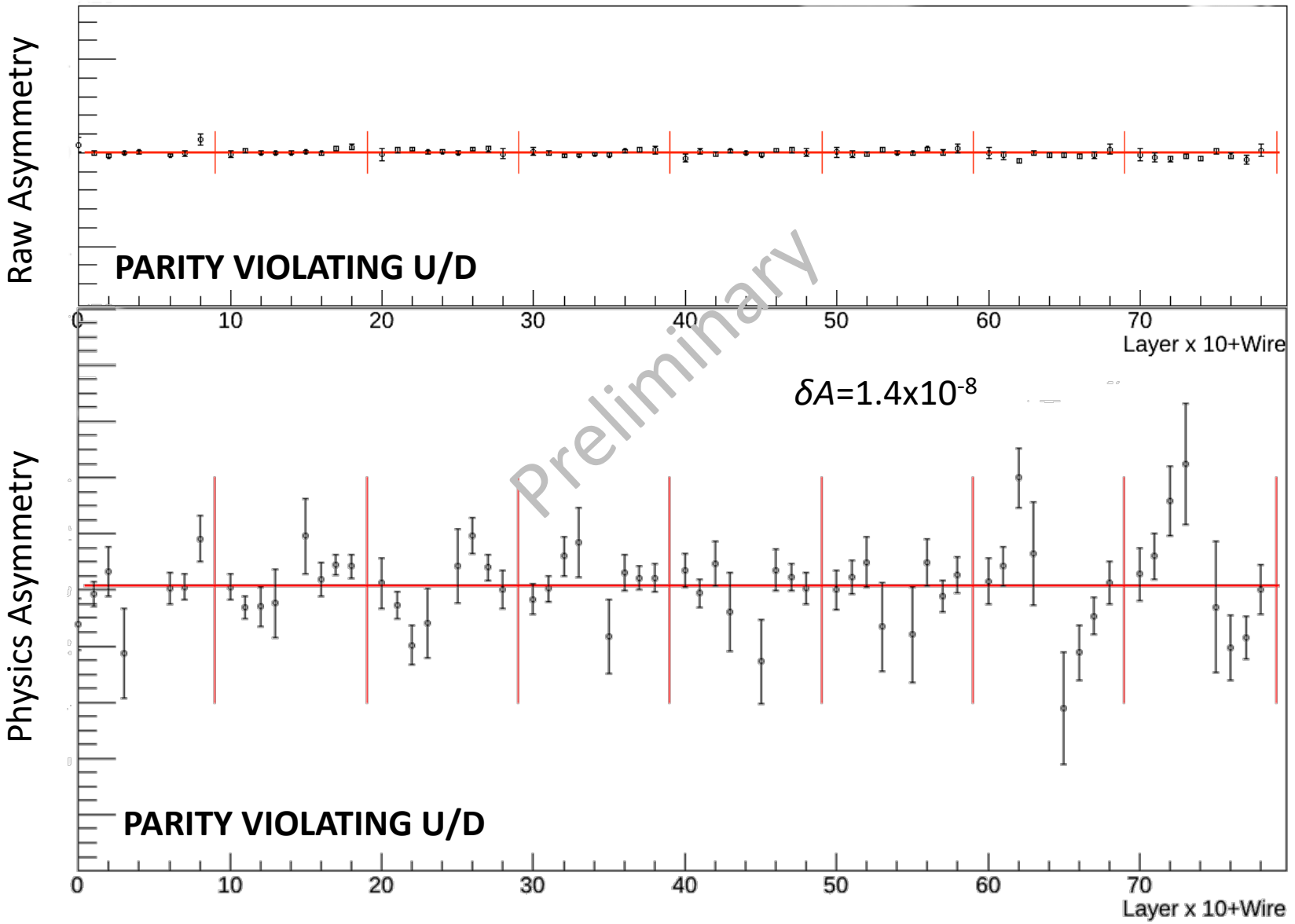
Raw asymmetry distribution for Layer-10 Wire-1



Left right (PC) asymmetry



Up down (PV) asymmetry



Summary and current status

- The n-^{3}He 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 well advanced.

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

- We are now working to improve geometry factors.

The n-^{3}He Collaboration

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

Backup Slides

Correlations between wires