E08014: x>2 experiment update

Zhihong Ye
University of Virginia & x>2 Collaboration

Spokepeople: John Arrington, ANL
Donal Day, UVa
Doug Higinbotham, Jlab
Patricia Solvignon, Jlab

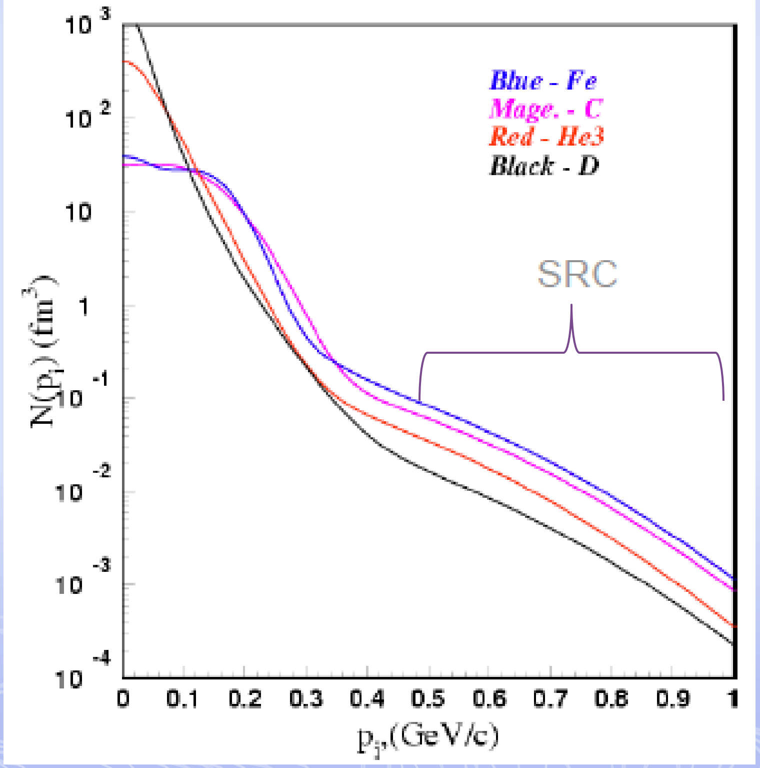
Graduate Student: Zhihong Ye, UVa
(Fatou Ndoye, Senegal)

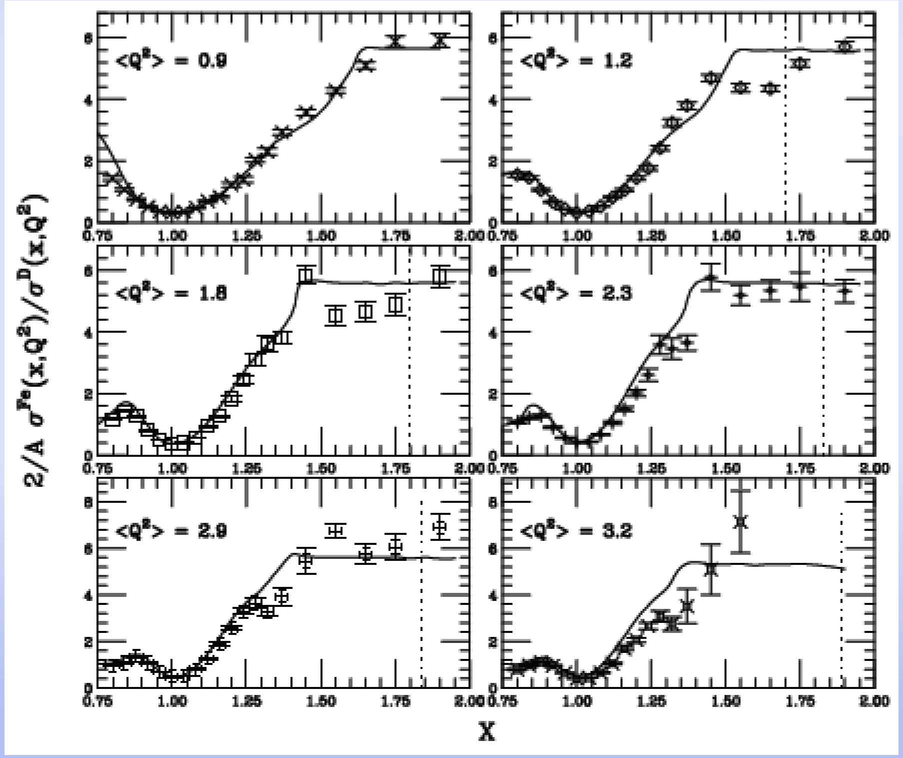
Hall A Meeting, June 10th 2011

1,Experiment Goal

- Verify and define scaling regime for x>2.

$$\sigma_A(x,Q^2)=\sum_{j=2}^{A}\frac{A}{j}a_j(A)\sigma_j(x,Q^2)=\frac{A}{2}a_2(A)\sigma_2(x,Q^2)+\frac{A}{3}a_3(A)\sigma_3(x,Q^2)+\ldots$$





Fankfurt, Strikman, Day, Sargsian, PRC48, 2451(1993)

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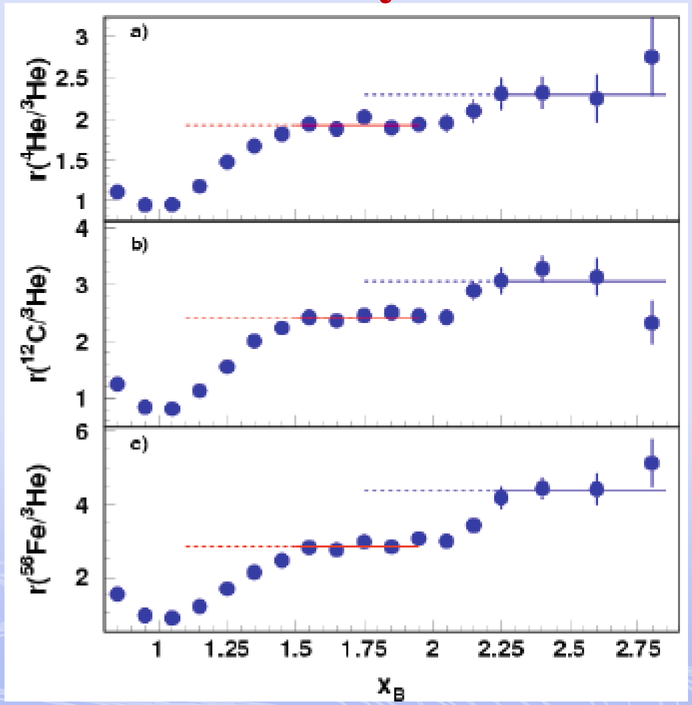
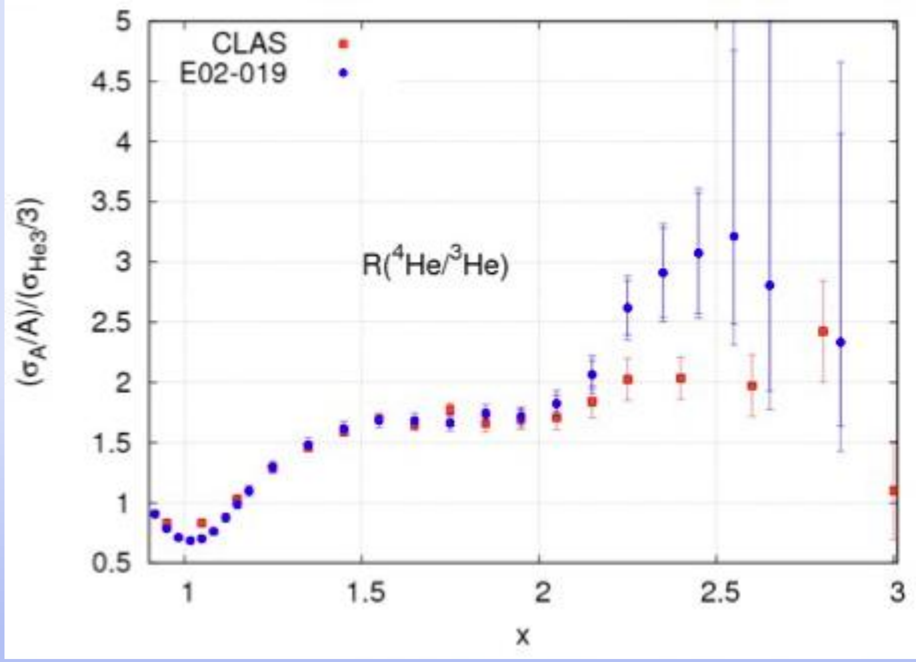
1.4<Q²<2.6



2.5<Q²<3.0



K. Egiyan et al, PRL96, 082501 (2006)

N. Fomin, Jlab User Annual Meeting (2010)

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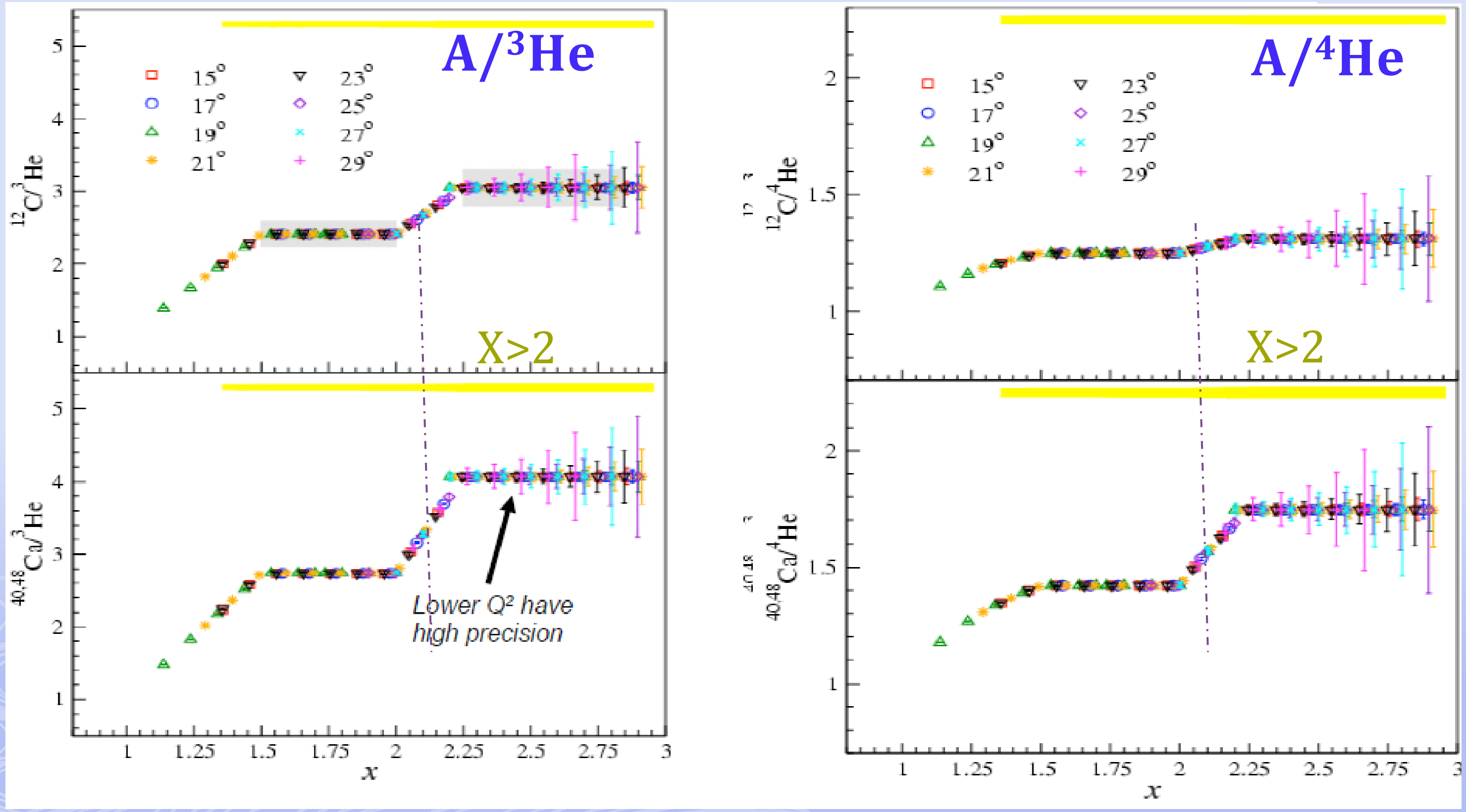
1.25<Q²<2.31



1,Experiment Goal

- Verify and define scaling regime for x>2.
- Isospin effects on SRCs: ^{40}Ca vs ^{48}Ca

Isospin independent:

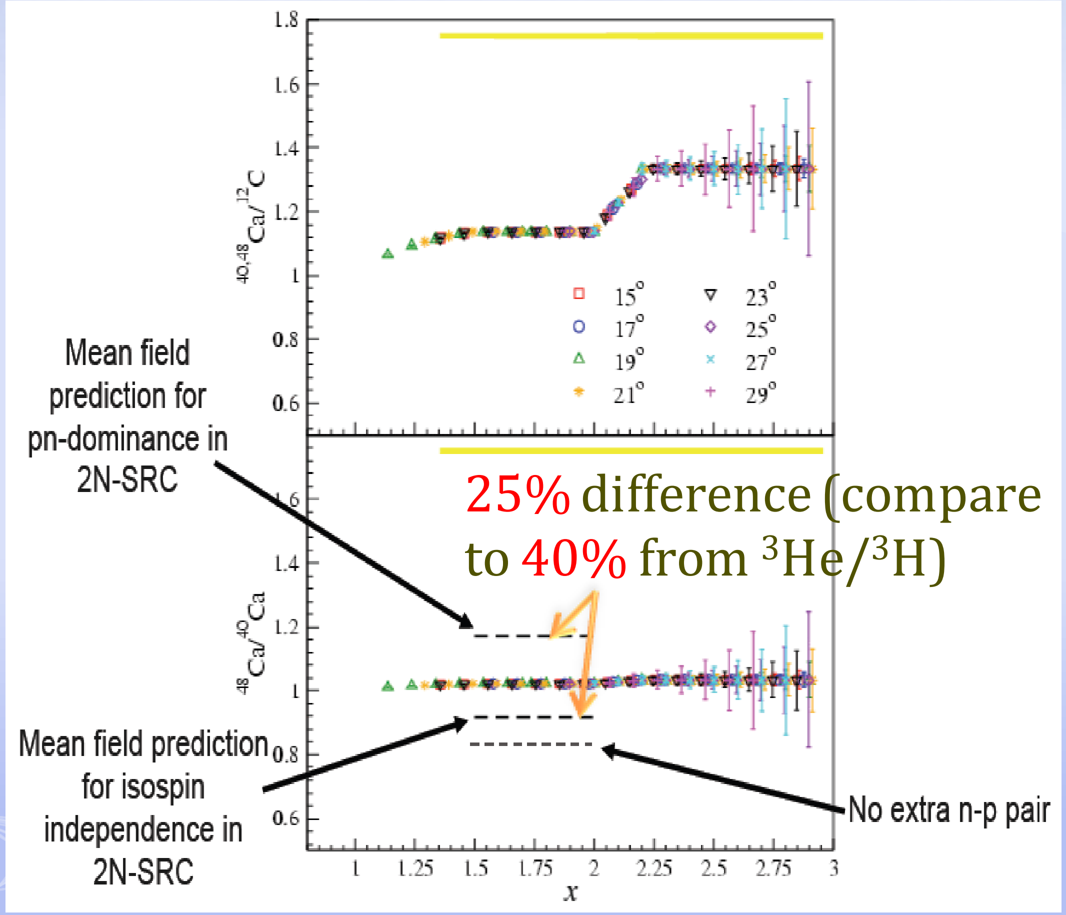
$$\frac{\sigma_{^{48}Ca}/48}{\sigma_{^{40}Ca}/40} = \frac{(20\sigma_p + 28\sigma_n)/48}{(20\sigma_p + 20\sigma_n)/40} \xrightarrow{\sigma_p \approx 3\sigma_n} 0.92$$

2N SRC(n-p, T=0) dominance:

$$\frac{\sigma_{^{48}Ca}/48}{\sigma_{^{40}Ca}/40} = \frac{20\times 28\sigma_{n-p}/48}{20\times 20\sigma_{n-p}/40} = 1.17$$

No extra np pair with f7/2 neutron :

$$\frac{\sigma_{^{48}Ca}/48}{\sigma_{^{40}Ca}/40} = \frac{20\times 20\sigma_{n-p}/48}{20\times 20\sigma_{n-p}/40} = 0.83$$



2, Experiment Setup

- Inclusive measurement on scattered electrons:

  Using both Left and Right HRS simultaneously with independent DAQ.

- Standard HRS detectors configurations:

  VDC, S1, S2m, GC, Shower&PreShower (Pion Rejectors 1&2)

- 3 pass beam:

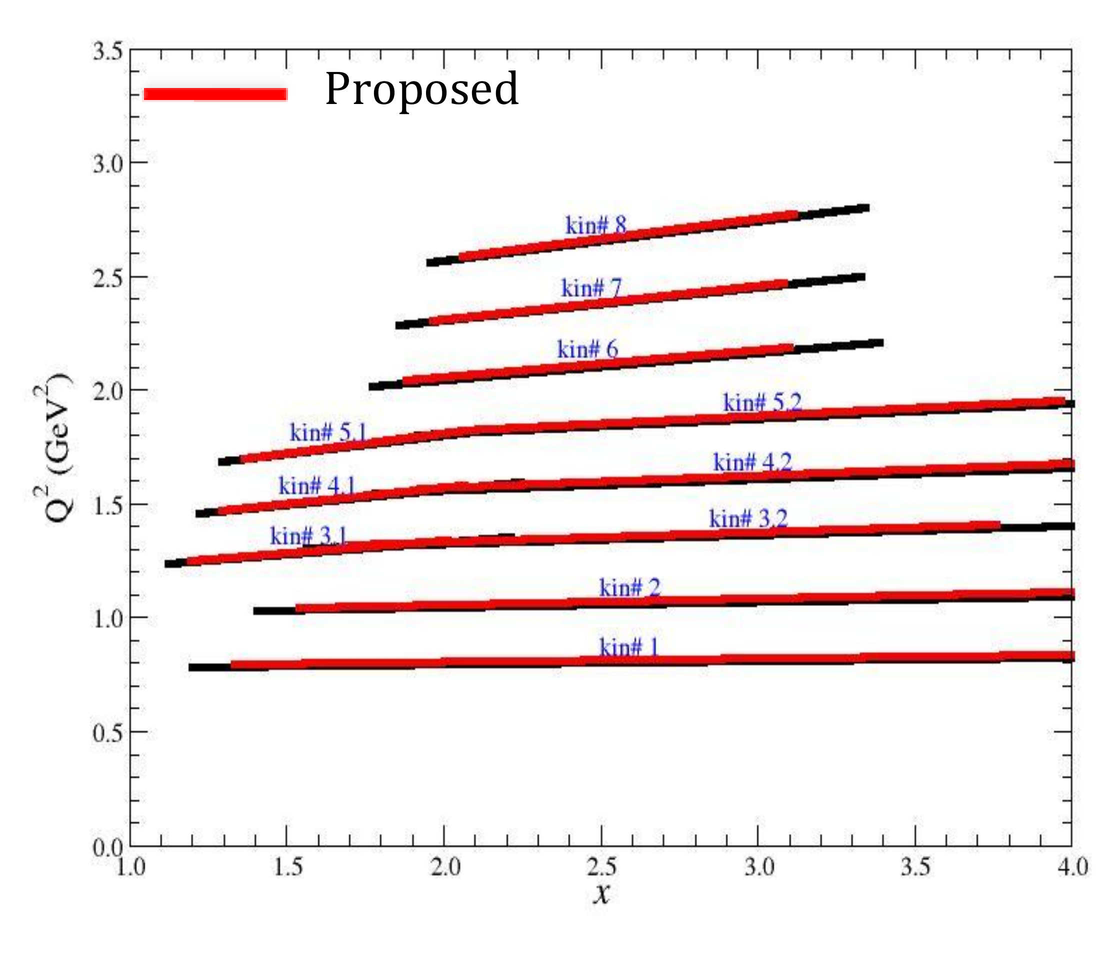
  E_0=3.356 GeV, I_0 = 5 uA~ 120uA

- Targets:

  Production -> Deuterium, ^{3}He, ^{4}He, Carbon-5mm, ^{40}Ca, ^{48}Ca,

  Calibration -> BeO, Dummy-10cm, Dummy-20cm,Multi-C

3, Data being taken (from April 16th to May 8th, 2011)



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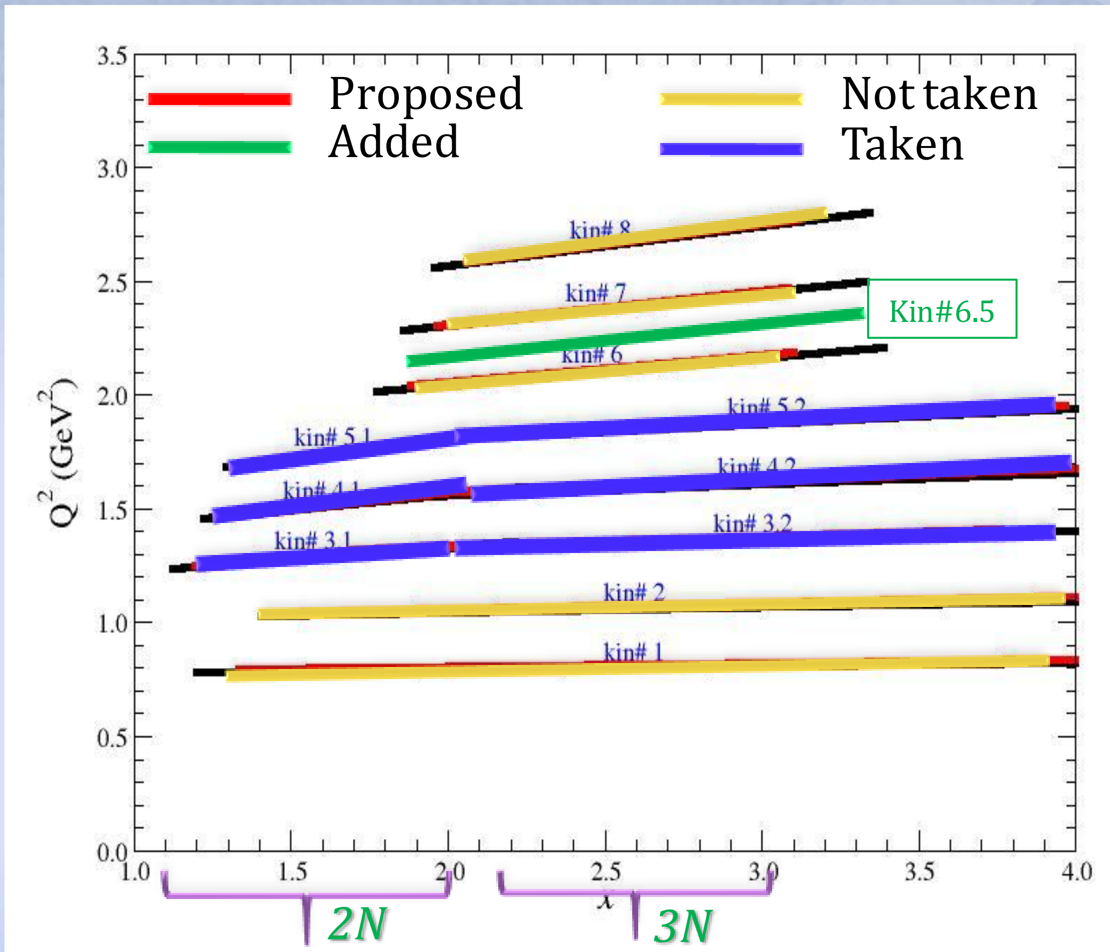


2N SRC

Kin 3.1: 21.0°, 2.905 GeV/c
^{2}He, ^{3}He, ^{4}He, ^{12}C, ^{40,48}Ca

Kin 4.1: 23.0°, 2.855 GeV/c
^{3}He, ^{12}C, ^{40,48}Ca

Kin 5.1: 25.0°, 2.795 GeV/c
^{2}H, ^{3}He, ^{4}He, ^{12}C, ^{40,48}Ca

3N SRC

Kin 3.2: 21.0°, 3.055 GeV/c
^{3}He, ^{4}He, ^{12}C, ^{40,48}Ca

Kin 4.2: 23.0°, 3.035 GeV/c
^{3}He, ^{4}He, ^{12}C, ^{40,48}Ca

Kin 5.2: 25.0°, 2.995 GeV/c
^{3}He, ^{4}He, ^{12}C, ^{40,48}Ca

Kin 6.5: 28.0°, 2.845 GeV/c
^{3}He, ^{12}C

Calibration

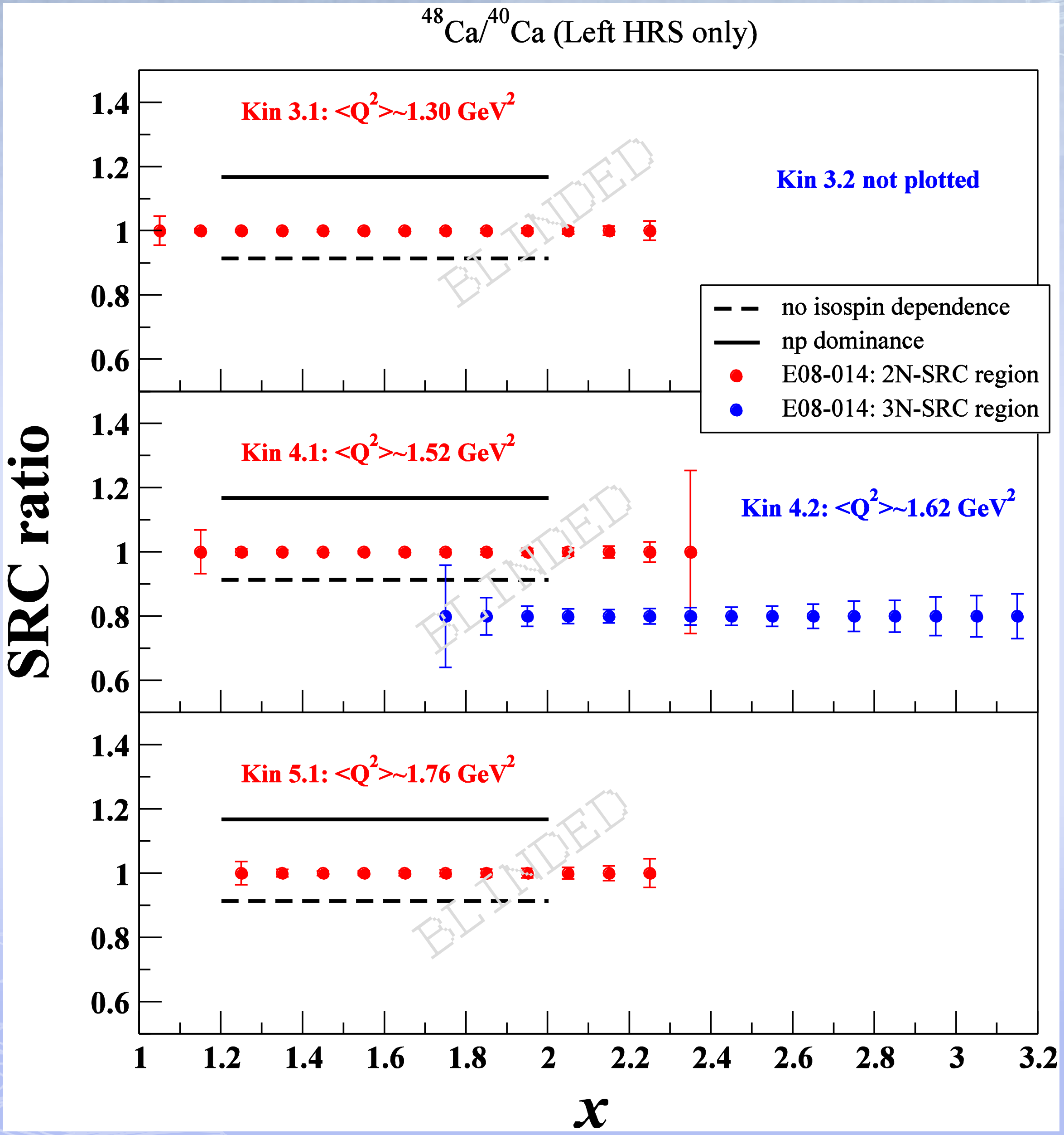
Kin 4.0 23.0°, 2.600 GeV/c (QE): Optics

Kin 5.0 25.0°, 2.505 GeV/c (QE):
Boiling Study, Optics

Others

Bull's eye scan, BCM, Background ...

▫ Data Quality: (not include R-HRS due to its bad optics)



by Patricia

4, Data Analysis

a) General status:

- Beam calibration:

  BPM and Raster - done

  BCM calibration - in progress

- Detectors calibration:

	LHRS	*RHRS*
VDC:	done	done
Timing:	in progress	in progress
Cerenkov:	done	done
Calorimeters:	done	done

- Optics

  LHRS:
  Original optics matrix is good. Need fine tuning.

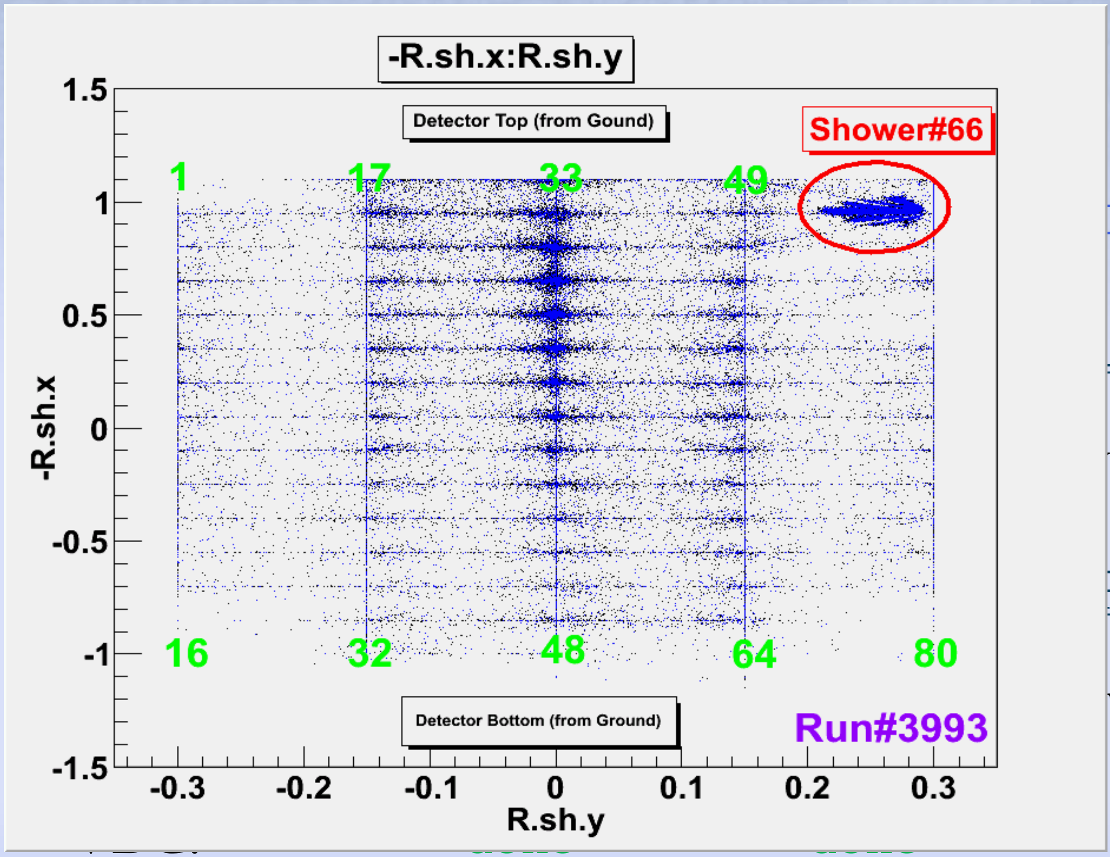
  RHRS:
  RQ3 issue. New optics is obtained. Need fine tuning.

- Issues:

  1, No major detector issues

  2, Shower #66 is noisy but outside the acceptance.

4, Data Analysis



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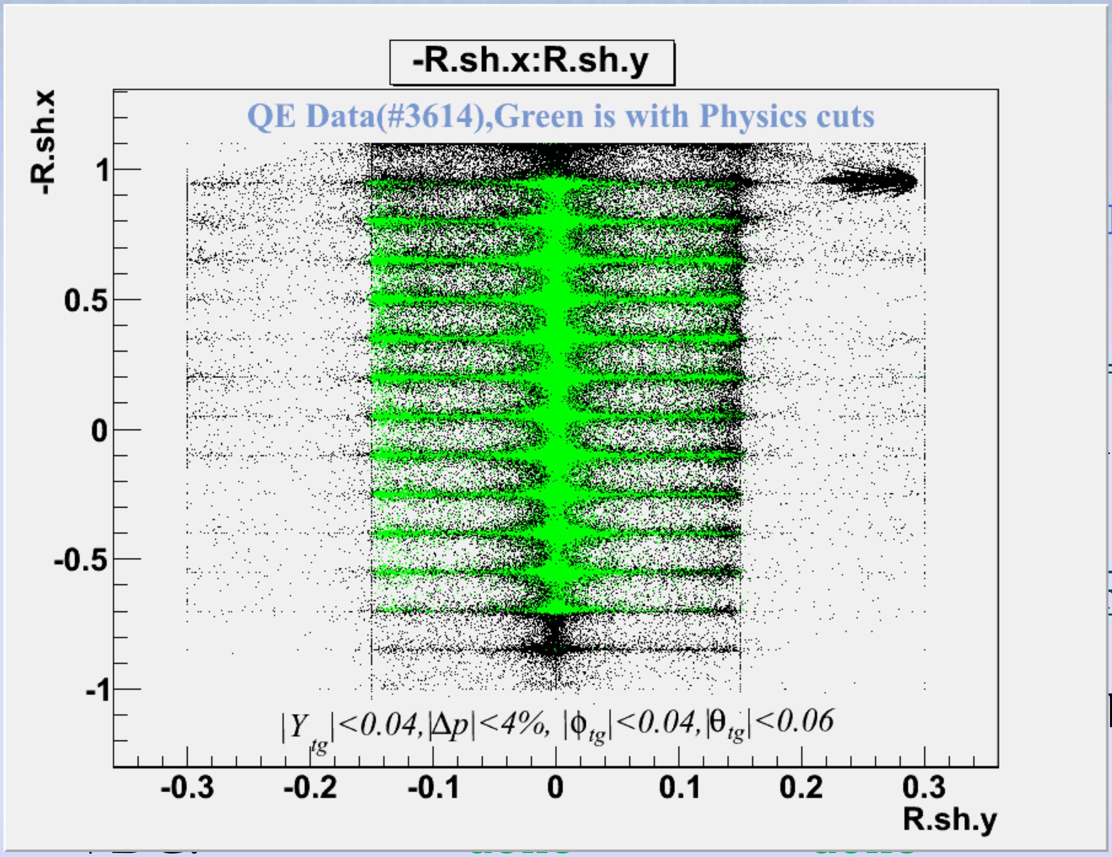

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Issues:

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a) BPM & Raster Calibration:

- BPM:

◊ Bull's eye scan runs (05/04/2011).

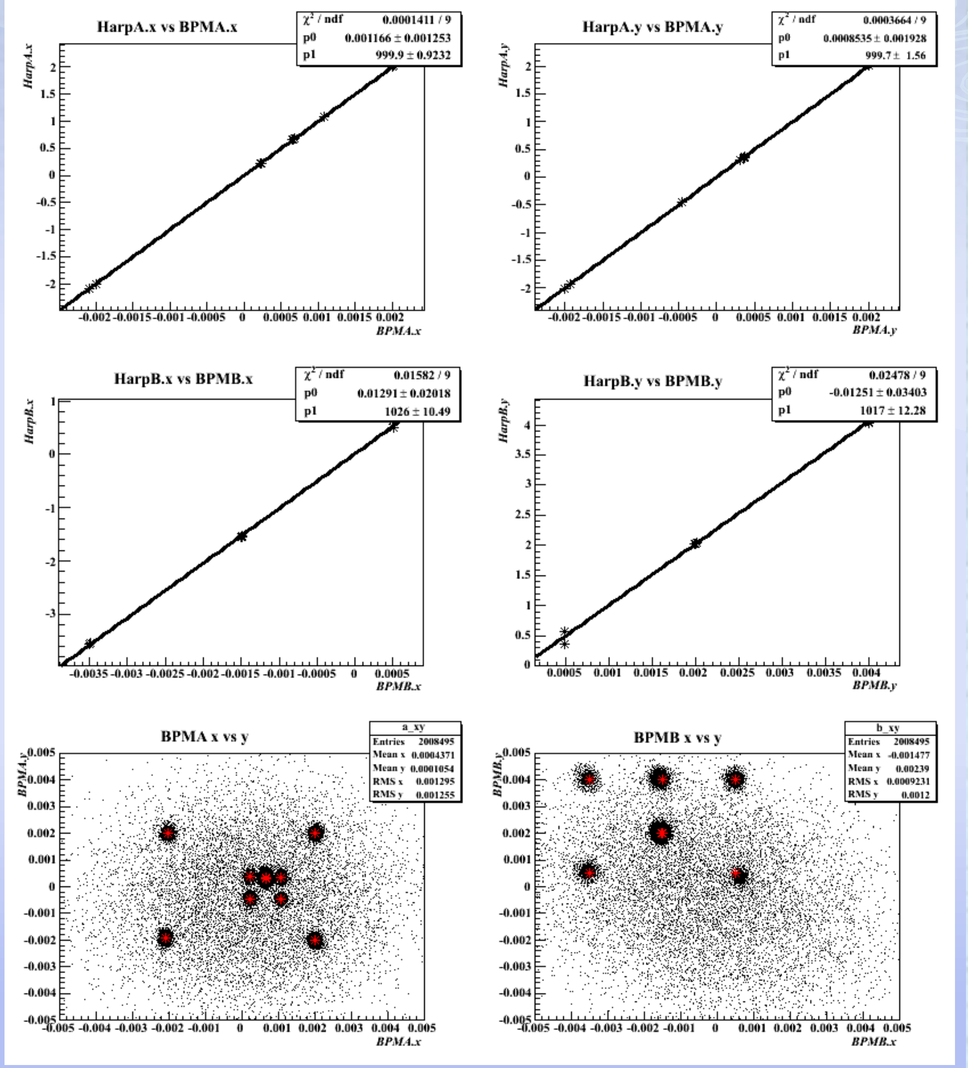
◊ Harp info is not reliable since it has not been surveyed.

◊ Reading BPM info from EPICS.

◊ Calibrated with R-HRS BPM signals.

◊ Issues:

L-HRS BPM can not be calibrated. BPMB might have connection issues.



a) BPM & Raster Calibration:

- Raster:

L-HRS:
[Raster_detmap]

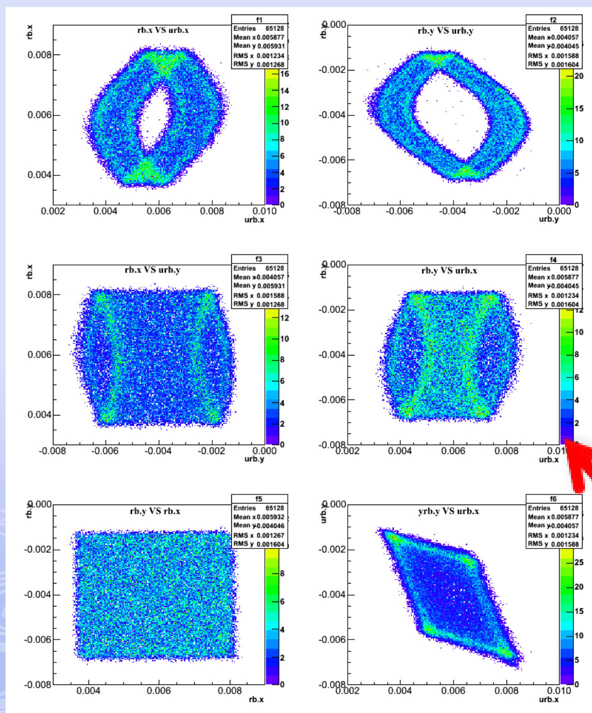
1	4	4	25	8	11	1881
-1	0	0	0	0	0	0

R-HRS:
[Raster_detmap]

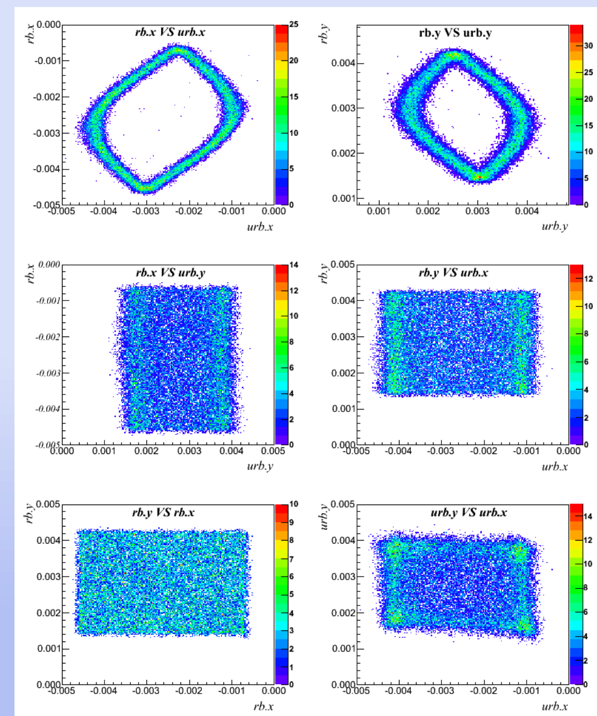
X & Y swapped

1	2	1	23	25	25	1881
1	2	1	23	24	24	1881
1	2	1	23	26	27	1881
-1	0	0	0	0	0	0

L-HRS Raster



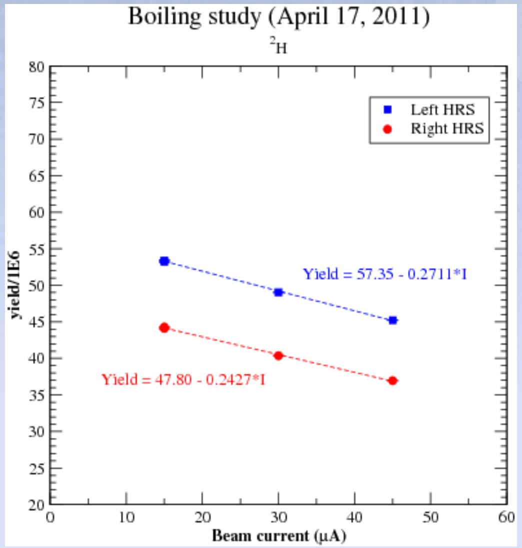
R-HRS Raster

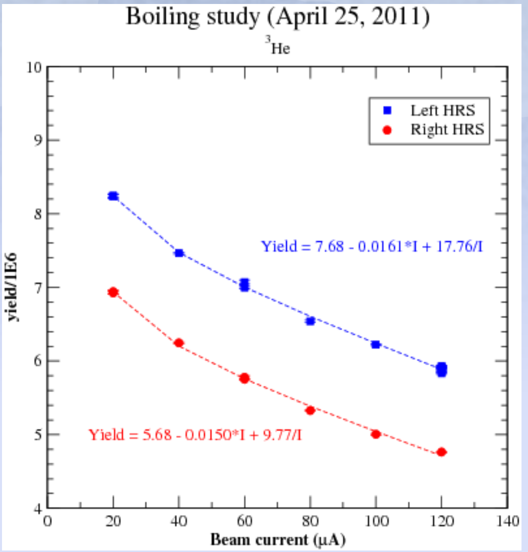


Due to BPM Connection problem?

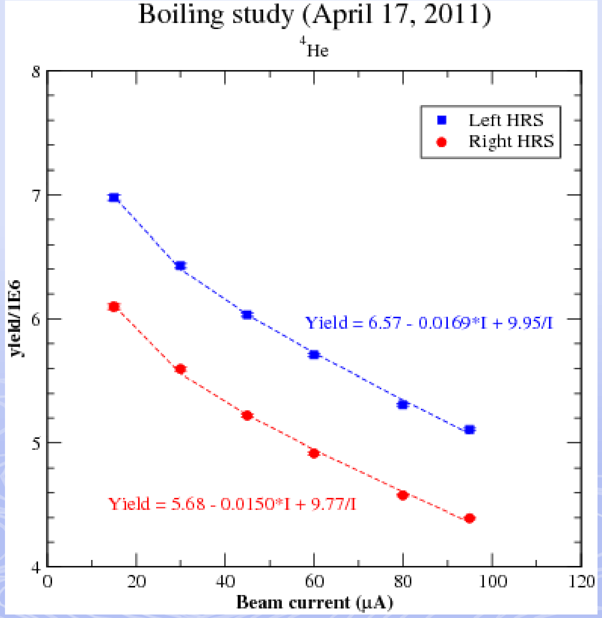
b) Target Boiling Study (online, by Patricia)

^2H Target:
-- 3.35 g/cm^2,
-- 20 cm,
-- 22 K,
-- 22 psia
-- QE region



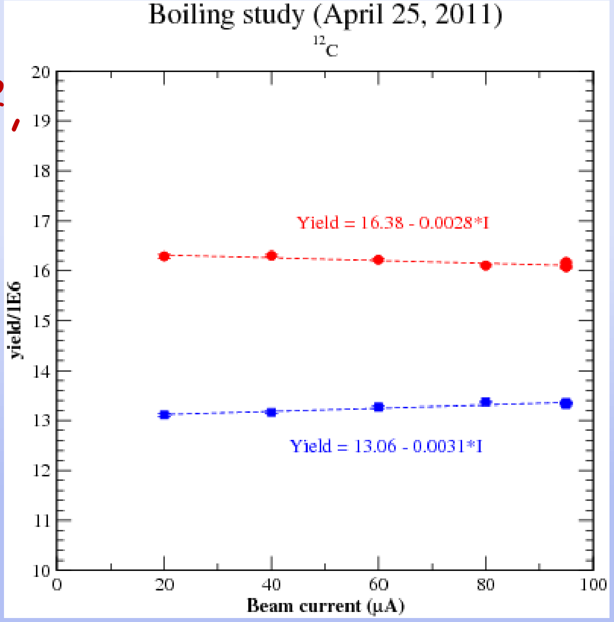


^3He Target:
-- 1.38 g/cm^2,
-- 20 cm,
-- 22 K,
-- 200 psia,
-- QE region



^{12}C Target:
-- 0.95 g/cm^2,
-- 0.5 cm,
-- QE region

^4He Target:
-- 2.28 g/cm^2,
-- 20 cm,
-- 22 K,
-- 200 psia,
-- QE region



c) Optics Calibration - LHRS

- **Original Optics Matrix:** from Jin Huang & Jin Ge

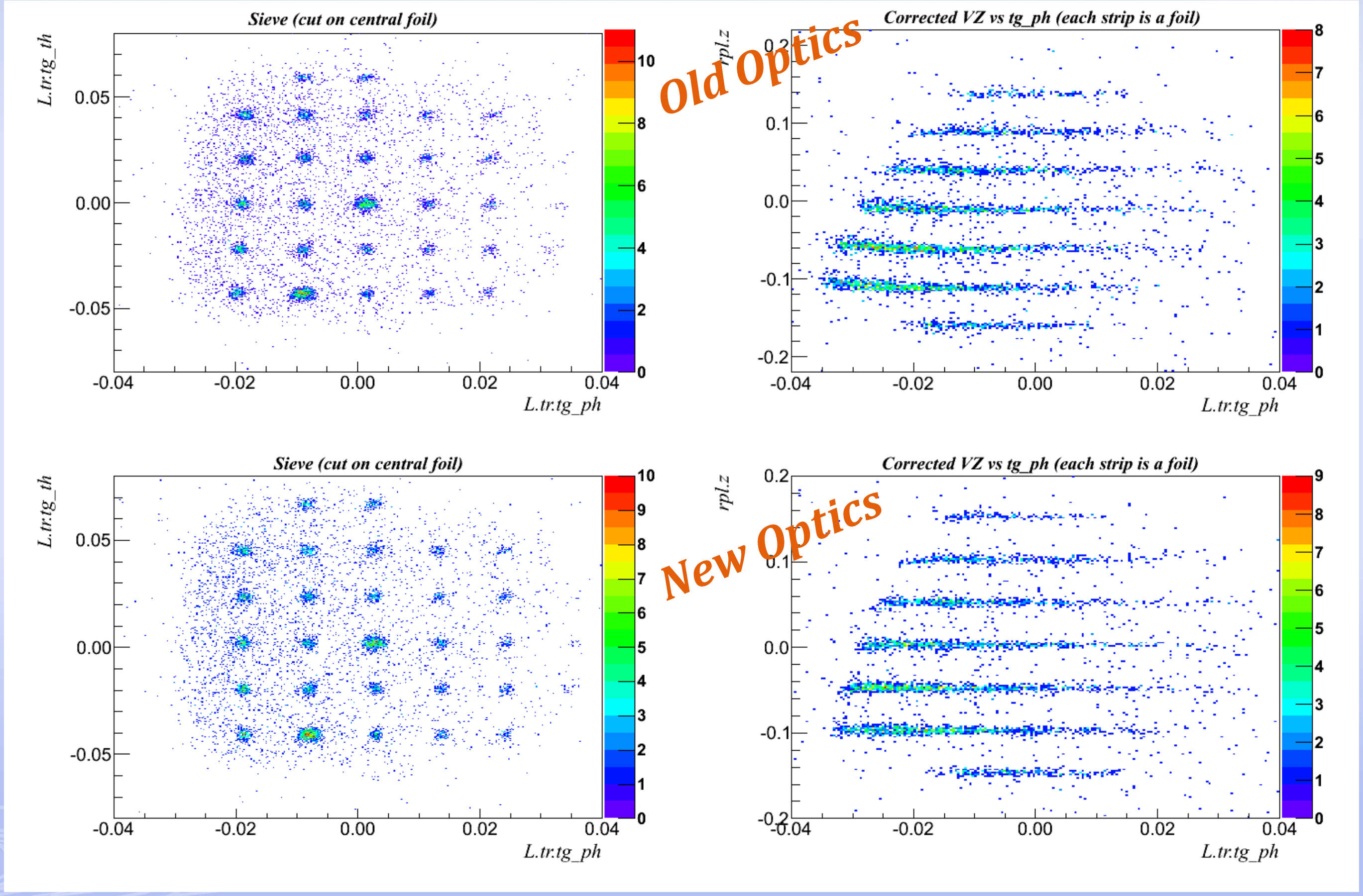
  Work well, and only need fine toning.
- **New Optics Matrix:** Vertex and Angle have been calibrated.

$$\delta Y_{RMS} = 0.001120$$

$$\delta\theta_{RMS} = 0.001665$$

$$\delta\phi_{RMS} = 0.000755$$

DeltaP is not not yet calibrated. (will try to use elastic data from D-Threshold)



c) Optics Calibration - RHRS

- RQ3 issue:

  Momentum was limited to 2.8273 GeV/c (goal: 3.055 GeV/c)

- Solution:

  Scale down RQ3 momentum by factor of 2.8273/3.055, for each kinematics setting.

- Optics data: at QE region

  1, Vertex: BeO, Multi-C

  2, Sieve: Multi-C

  3, DeltaP: -3%, 0%,+3% on Dummy 4cm.

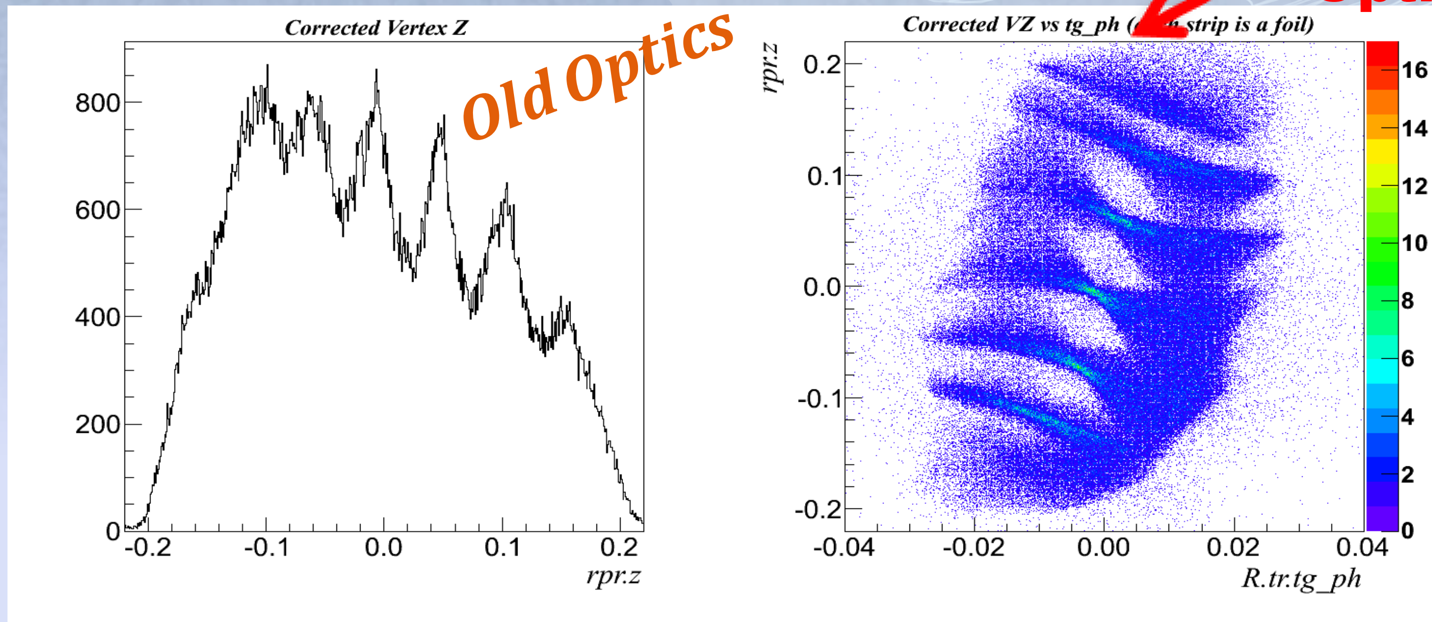
- New Optics Matrix:

  DeltaP is not yet calibrated.

$$\delta Y_{RMS} = 0.000830, \delta\theta_{RMS} = 0.001517, \delta\phi_{RMS} = 0.000853$$

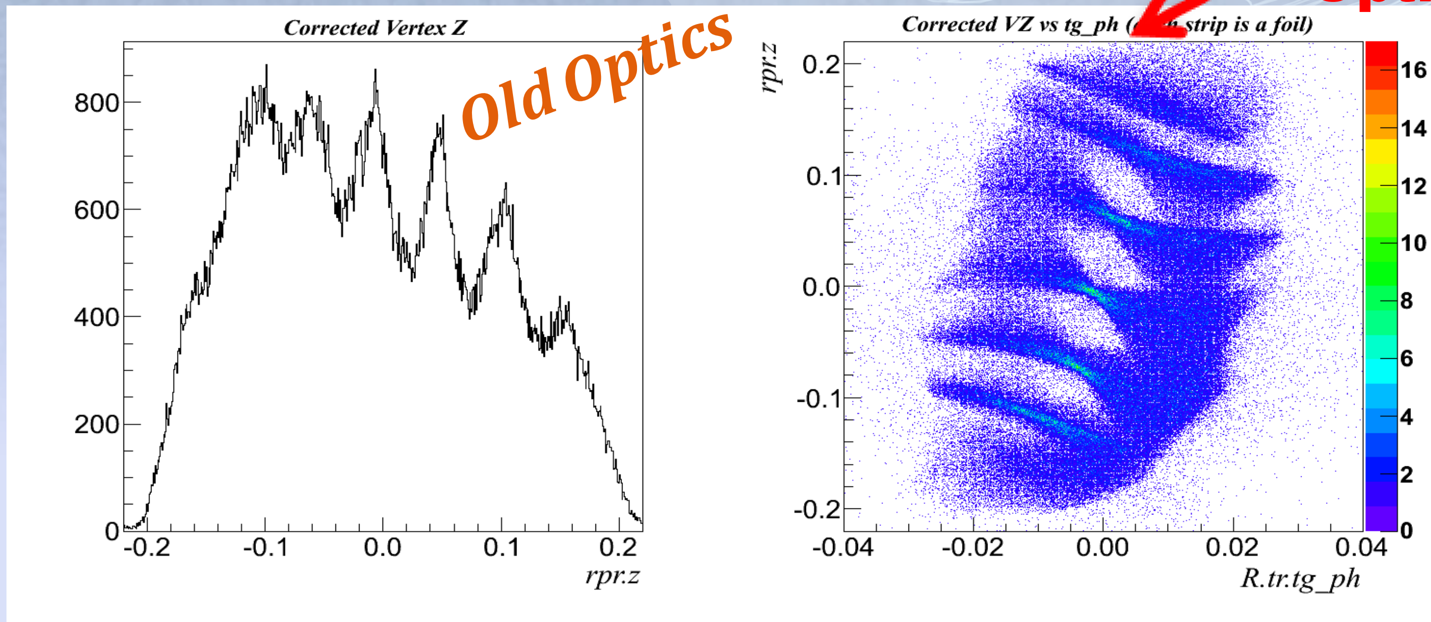
c) Optics Calibration - RHRS

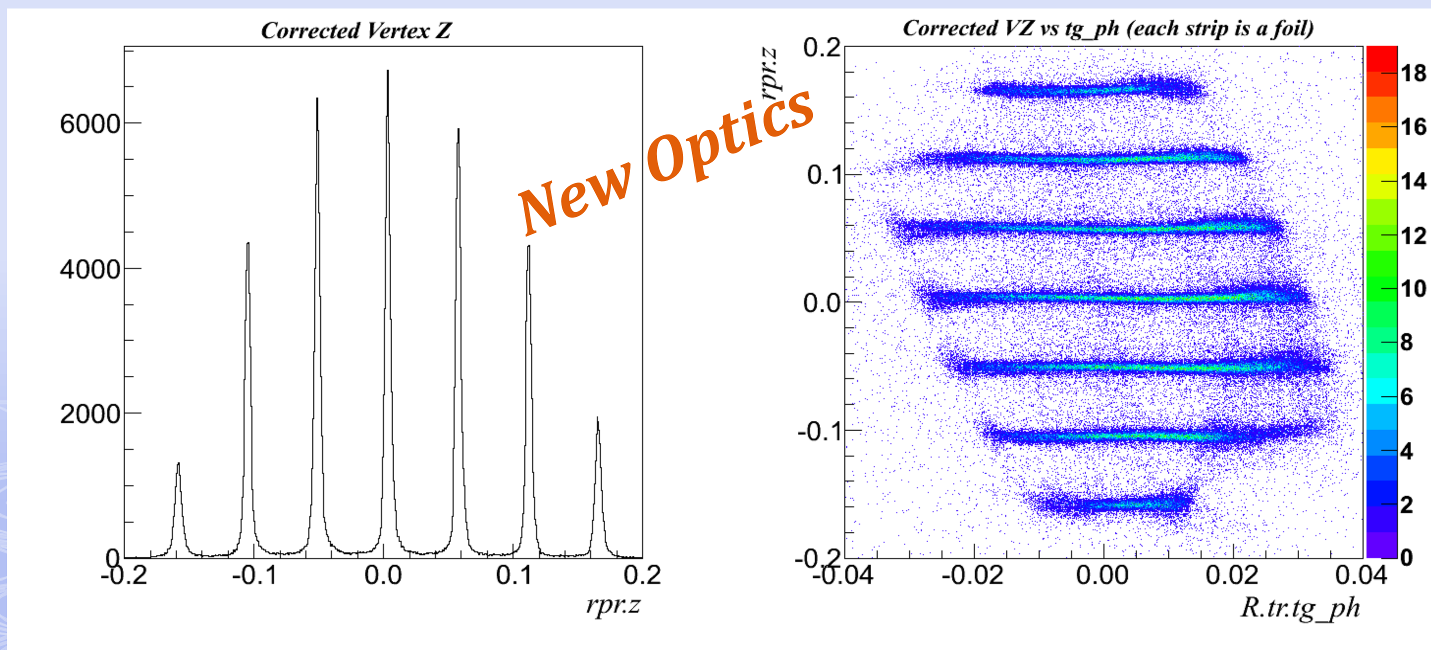
Twist RQ3 Optics!



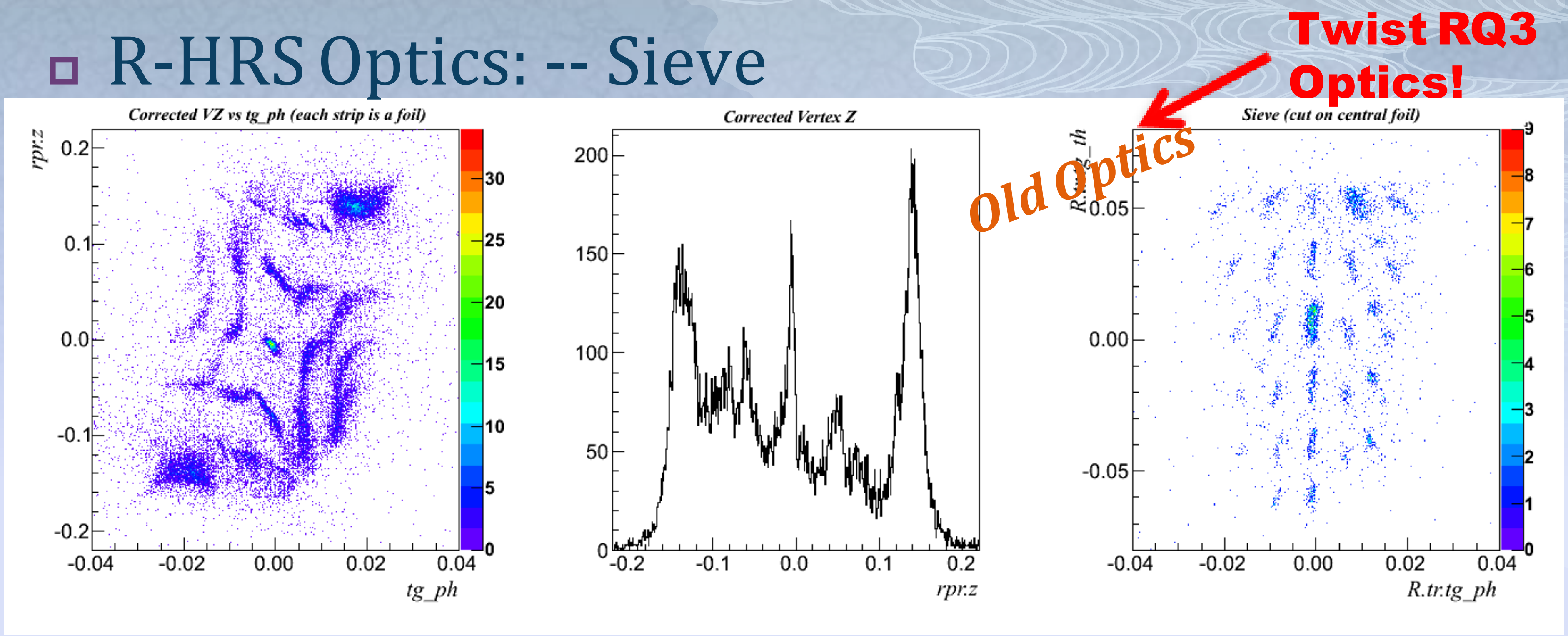
c) Optics Calibration - RHRS

Twist RQ3 Optics!



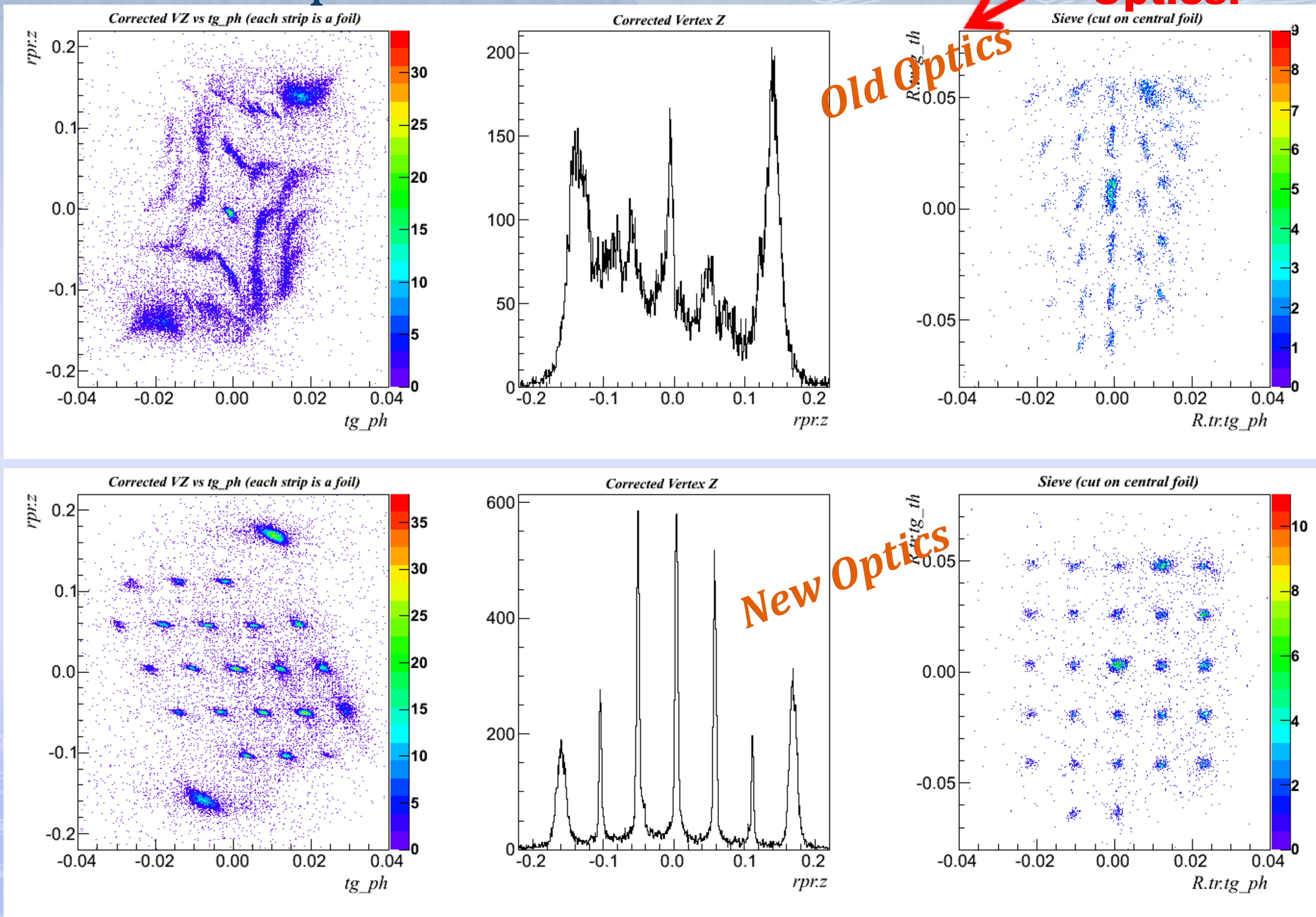


R-HRS Optics: -- Sieve



R-HRS Optics: -- Sieve

Twist RQ3 Optics!



5, Summary

- In General:

1), Experiment finished successfully and data quality is very good.

2), No major hardware issue during data taking.

3), Twist Optics due to R-HRS Q3 power supply issue.

4), Basic detectors calibrations are undertaking smoothly.

5), Fine toning both HRS Optics.

DeltaP calibration.

6), Will soon work on efficiency studies.

Tracking, detectors and PID …

Acknowledgement

THANK YOU!

Hall A staffs, technicians, and MCC staffs,

shift workers,

SRC family,

E08014 collaboration,

and many colleague and friends …

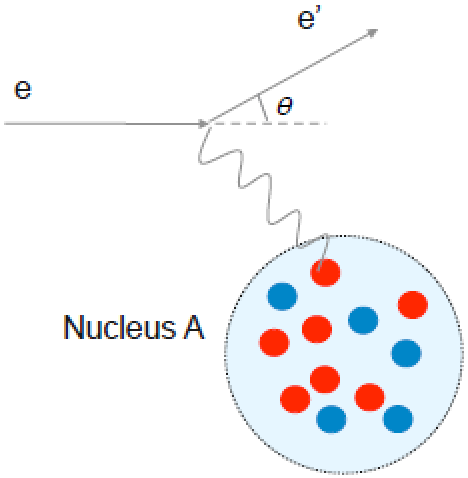
Backup slides

E08-014 systematics

	$\delta\sigma/\sigma$	$\delta R/R$ (normalization)	$\delta R/R$ (pt-to-pt)
Acceptance correction	2.0%*	0.5-2.0%	0.0-1.0%
Radiative correction	2.0%*	-	0.3%
Tracking efficiency	1.0%*	-	0.2%
Trigger efficiency	0.5%*	-	0.1%
PID efficiency	1.5%*	-	0.2%
Target thickness	0.5-2.0%	1.1-2.0%	-
Charge measurement	0.5%	-	0.5%
Energy measurement	0.05%	-	-
COMBINED UNCERTAINTY	4.1-4.6%	1.2-2.8%	0.7-1.2%
Uncertainty on a_2,a_3		1.5-3.0%	
CLAS		6.3-8.1%	
SLAC		10-18%	

Most kinematics are systematics dominated

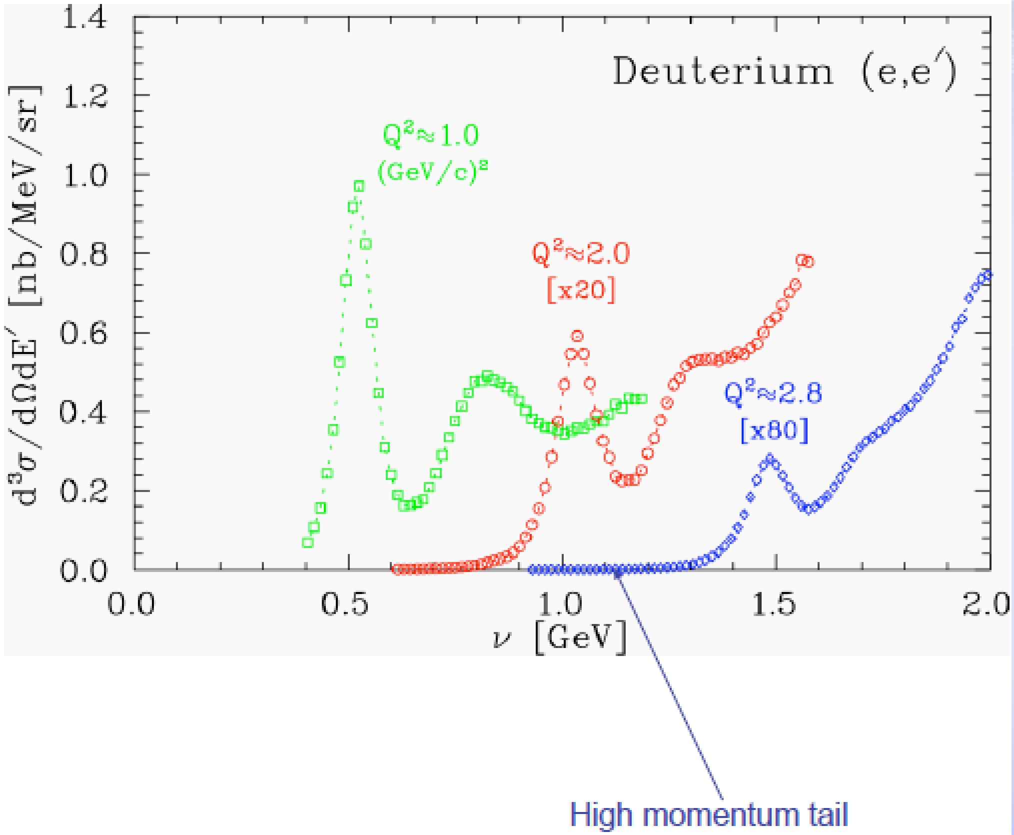
Inclusive scattering at large x



Quasi-Elastic Scattering

$x \approx 1$

Motion of nucleon in the nucleus broadens the peak



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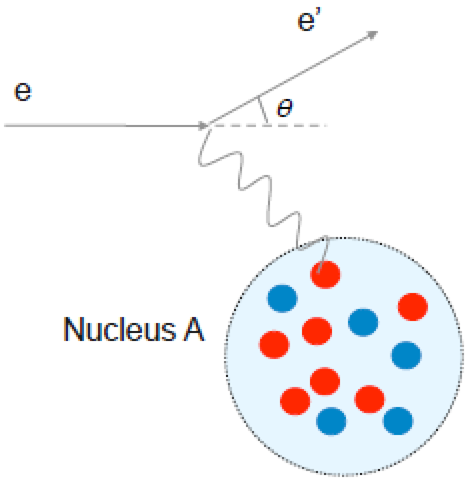
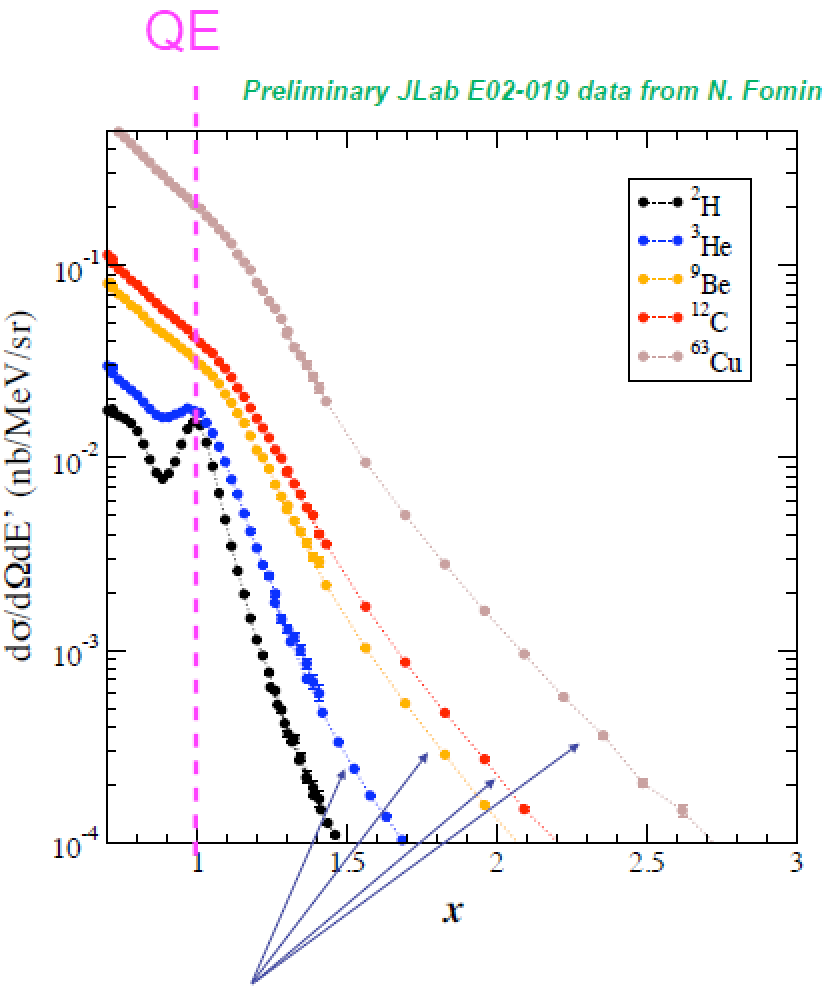


Quasi-Elastic Scattering

$x \approx 1$

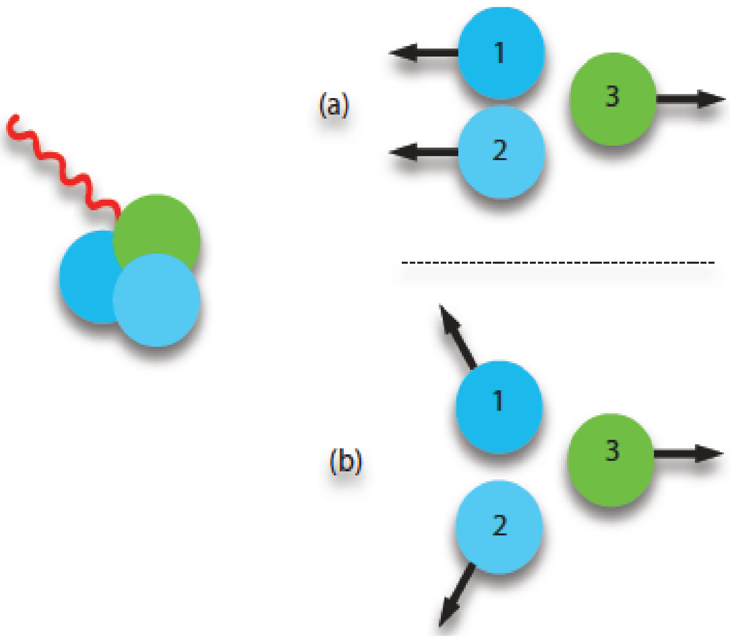
Motion of nucleon in the nucleus broadens the peak

little strength from QE above $x \approx 1.3$



High momentum tails should yield constant ratio if seeing SRC

3N-SRC configurations



$p_3 = p_1 + p_2$

extremely large momentum

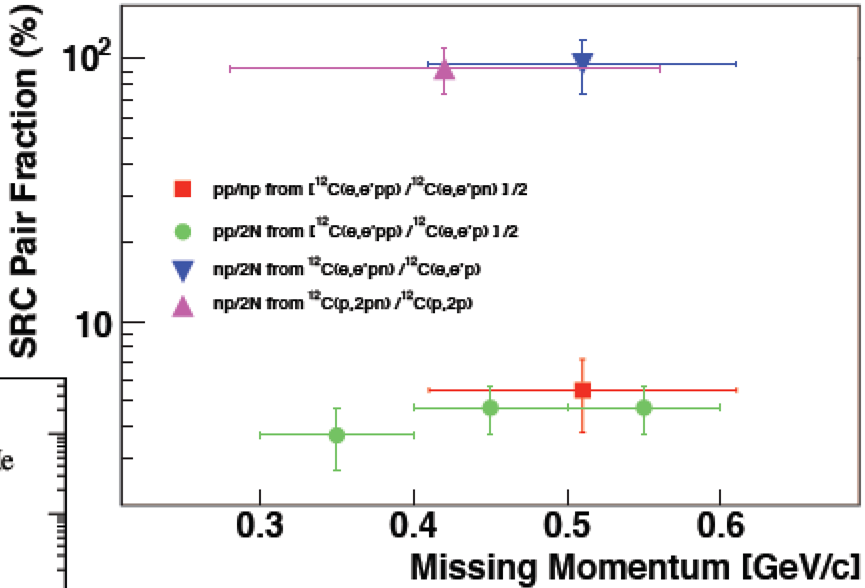
"Star-configuration"

$p_1 = p_2 = p_3$

Inclusive measurement should be able to differentiate between these momentum ranges

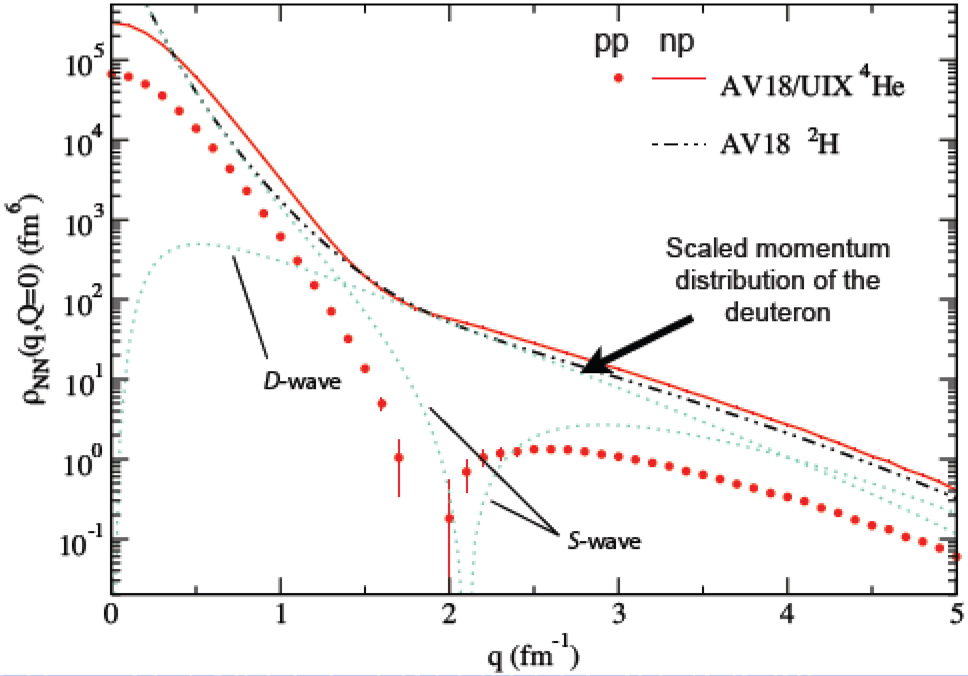
Dominance of the tensor force

R. Subedi et al, Science 320, 1476(2008)



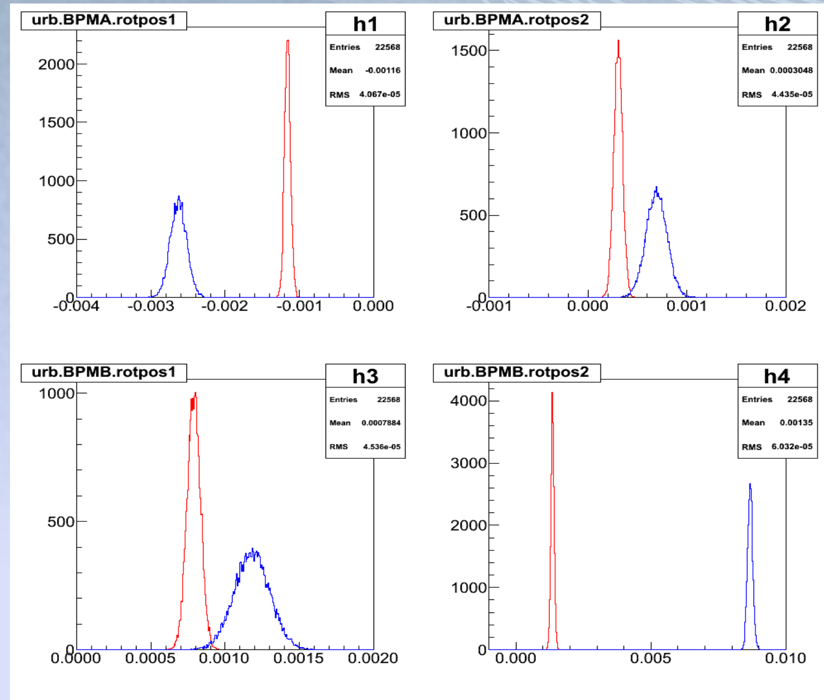
Simple SRC model assumes isospin independence

R. Schiavilla, R. Wiringa, S. Pieper and J. Carlson, PRL98, 132501 (2007)

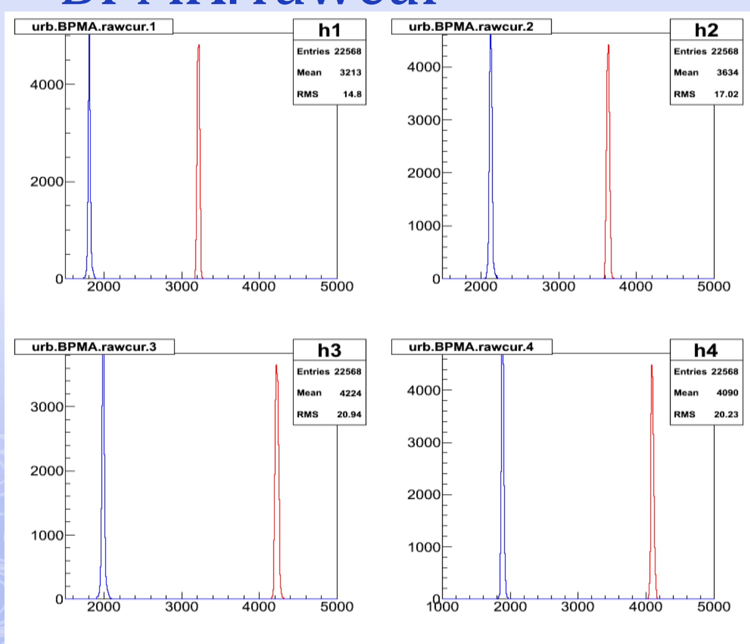


From A(p,ppn) and ^{12}C(e,e'pN):
90% are pn 2-body tensor force
leads to dominance of T=0 pairs

L-HRS: BPM



BPMA. rawcur



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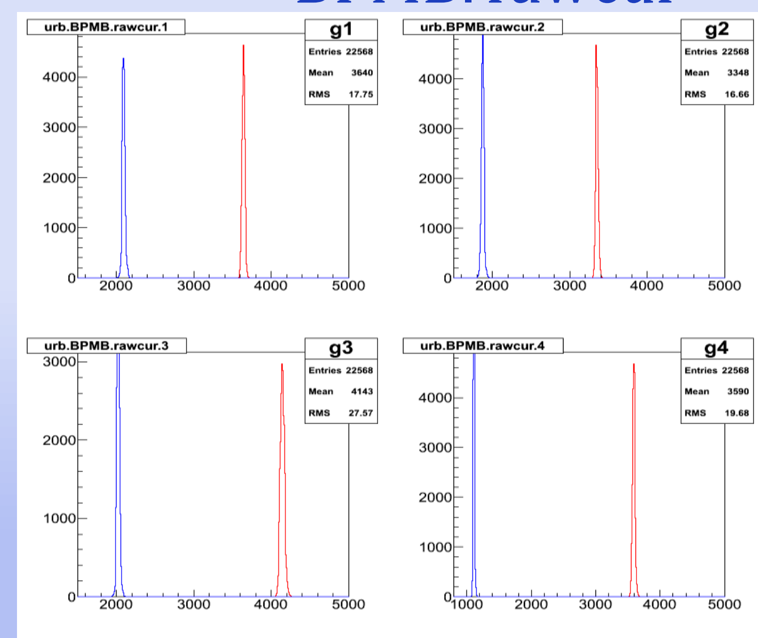
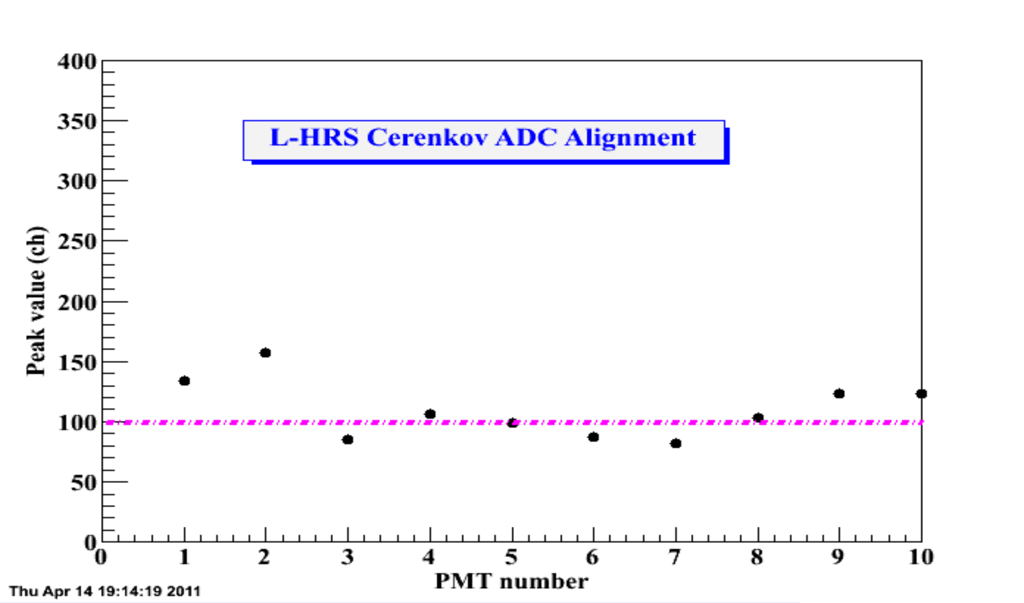
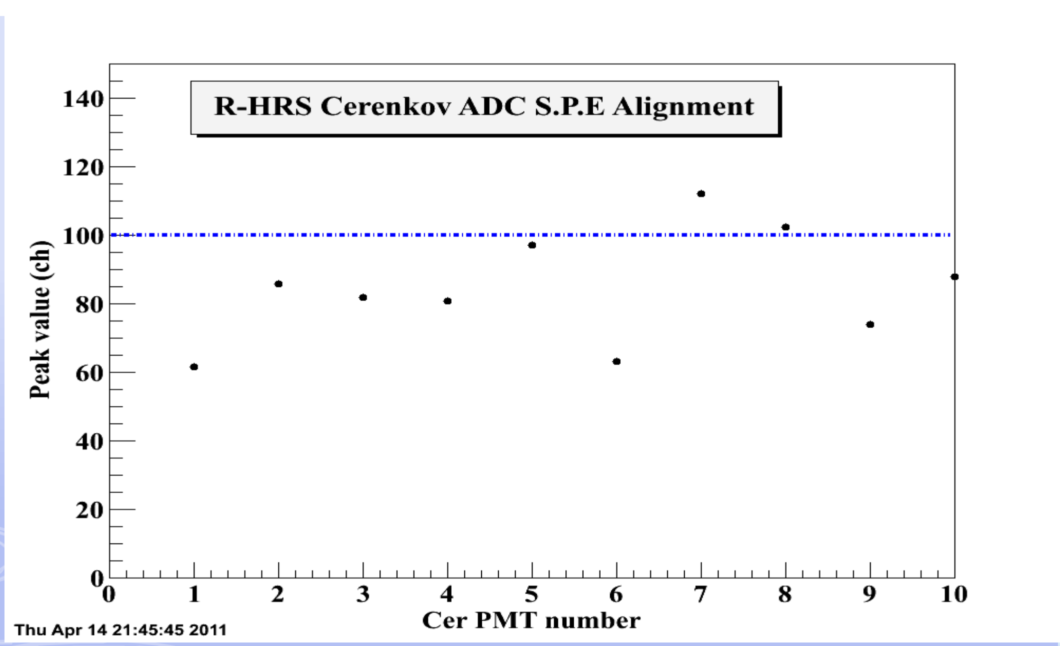
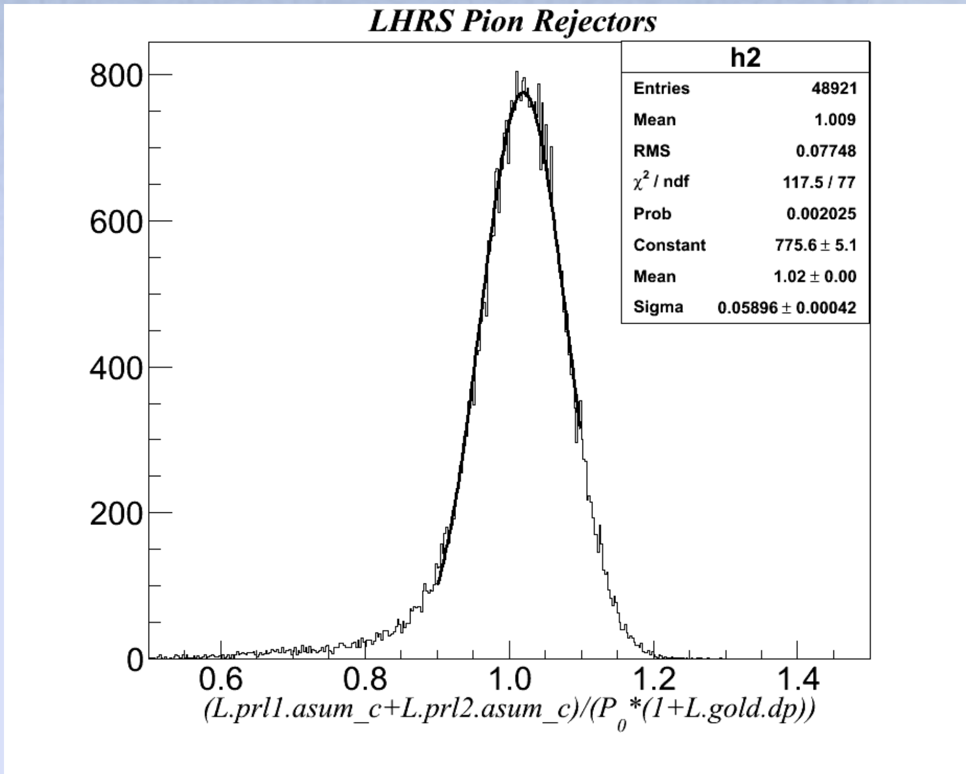


Cerenkov Calibration

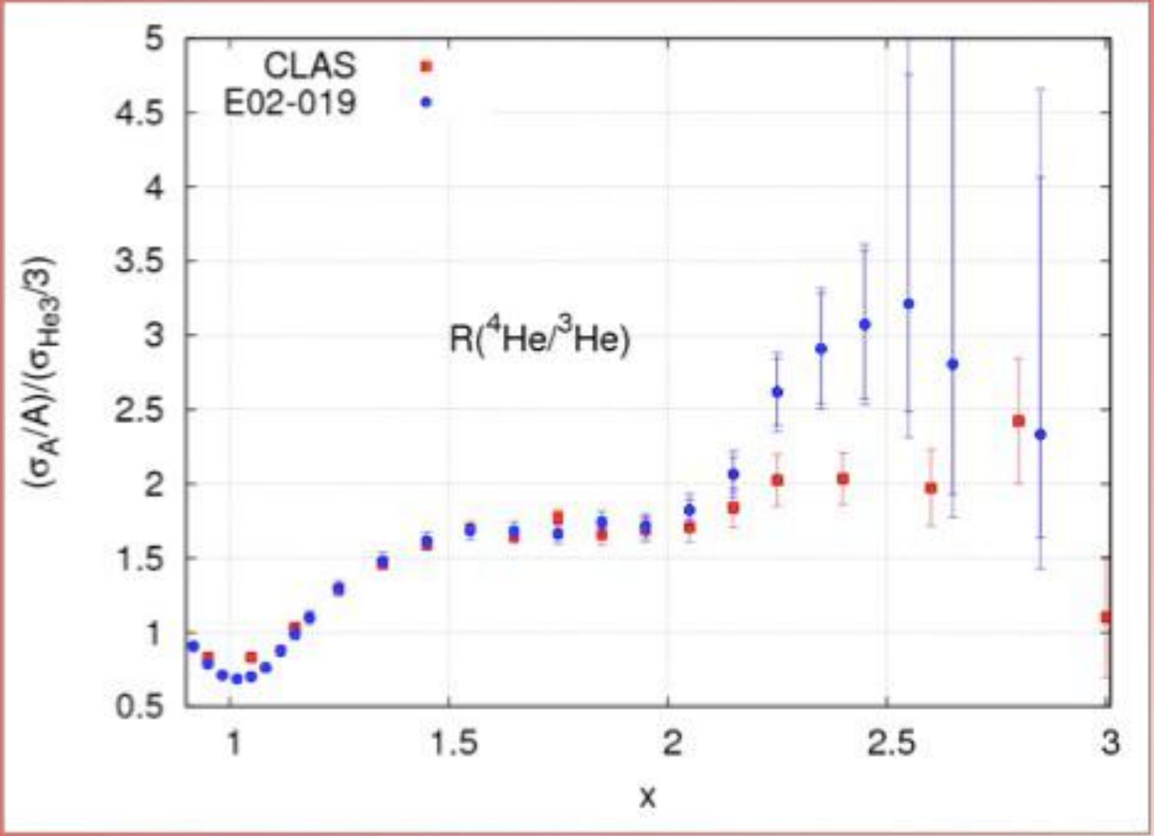




Calorimeters Calibration



E02-019 Ratios



Q^2 (GeV^2)
CLAS: 1.4-2.6
E02-019: 2.5-3

Slide from Nadia Fomin, JLab User Group Meeting

- Excellent agreement for $x \leq 2$
- Very different approaches to 3N plateau, later onset of scaling for E02-019
- Very similar behavior for heavier targets