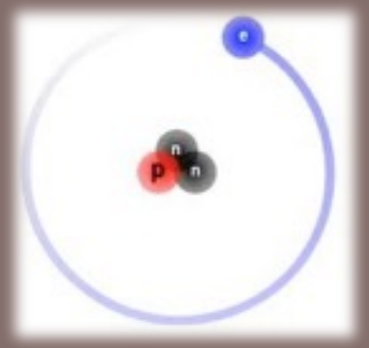


The x<3 experiment

Patricia Solvignon
UNH/JLab

Tritium Target Collaboration Meeting
JLab
December 7, 2015

E12-11-112

Precision measurement of the isospin dependence in the 2N and 3N short range correlation region

Spokespeople: P. Solvignon (JLab/UNH), J. Arrington (ANL), D. Day (UVa), D. Higinbotham (JLab)

Main physics goals

Isospin-dependence

- ✓ Improved precision: extract R(T=1/T=0) to 3.8%
- ✓ FSI much smaller (inclusive) and expected to cancel in ratio

3N SRCs structure (momentum-sharing and isospin)

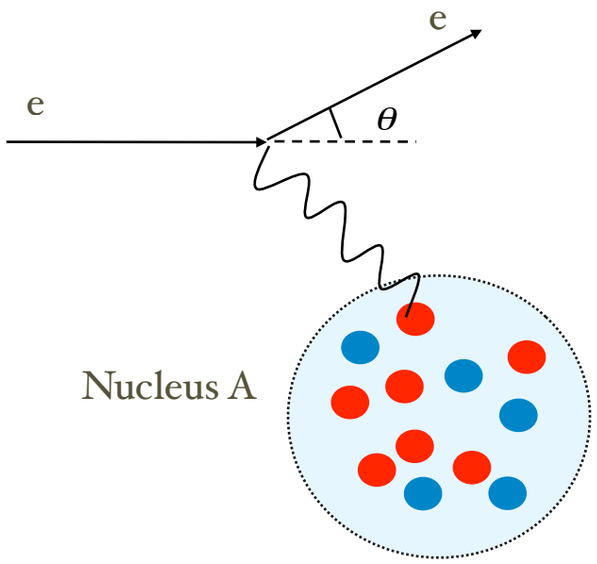
Improved A-dependence in light and heavy nuclei

- ✓ Average of ^{3}H, ^{3}He --> A=3 "isoscalar" nucleus
- ✓ Determine isospin dependence --> improved correction for N>Z nuclei, extrapolation to nuclear matter

Absolute cross sections (and ratios) for ^{2}H, ^{3}H, ^{3}He: test calculations of FSI for simple, well-understood nuclei

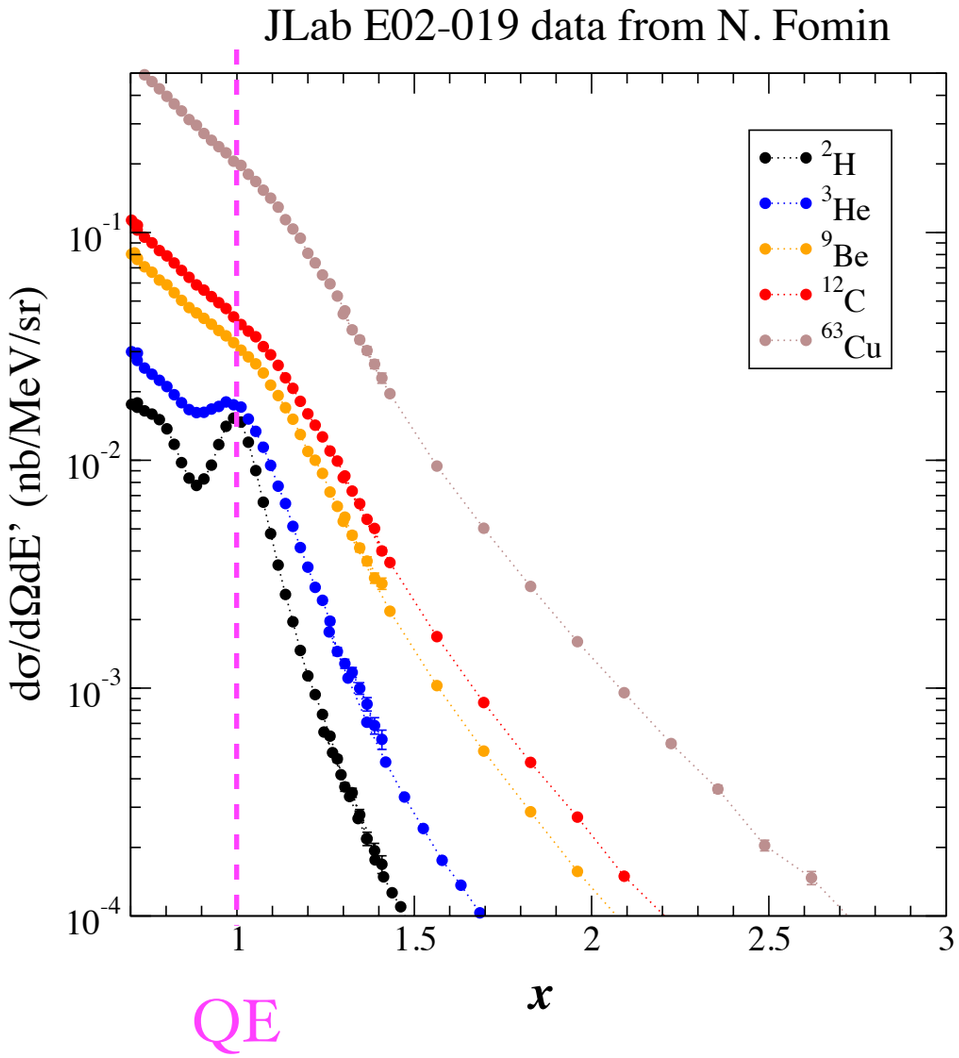
Short-Range Correlations

At $x \approx 1$: Quasi-Elastic Scattering



➡ Motion of nucleon in the nucleus broadens the peak.

➡ little strength from QE above x ≈ 1.3



Short-Range Correlations

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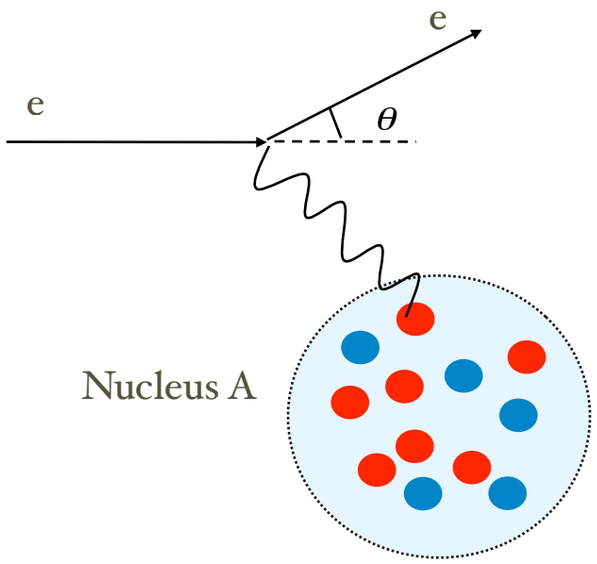

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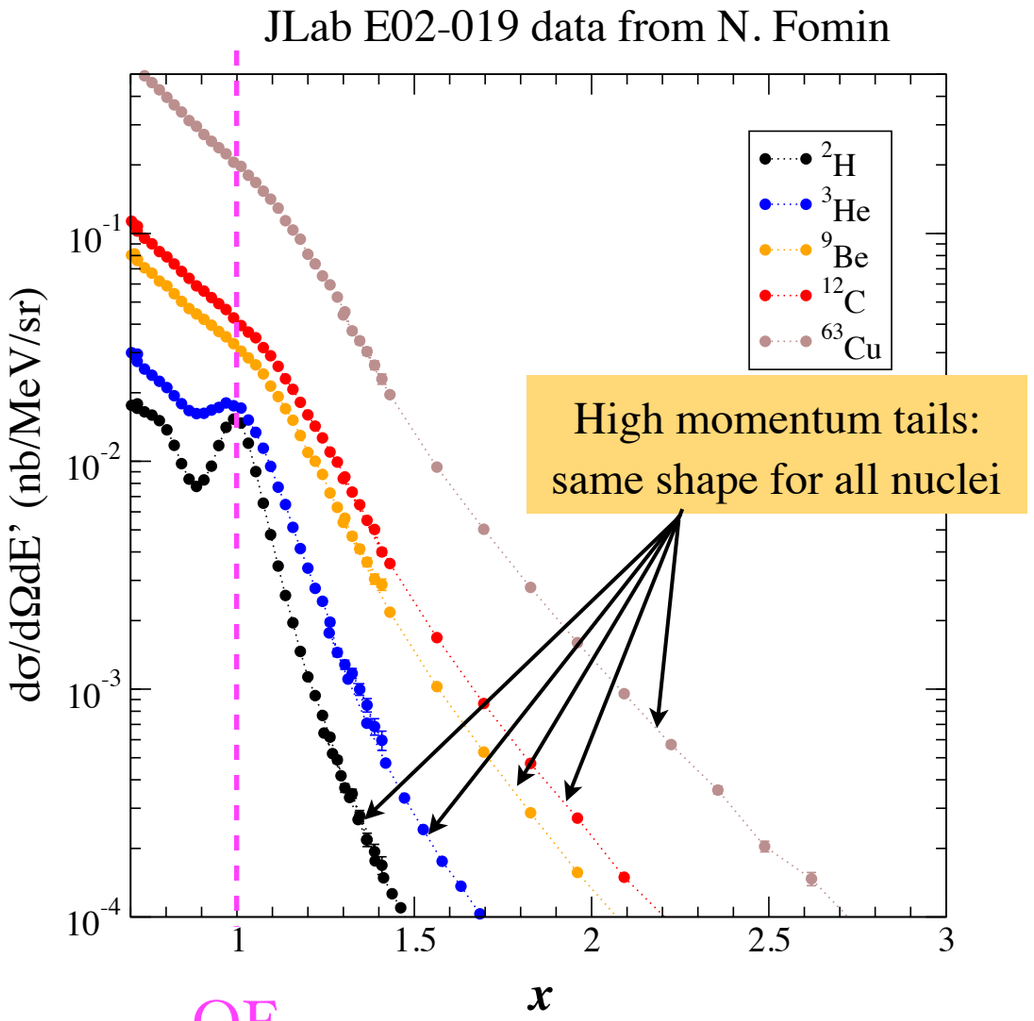
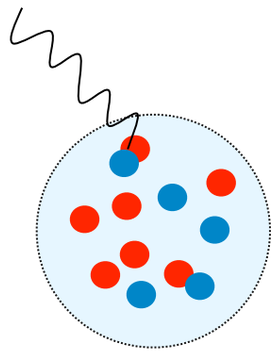
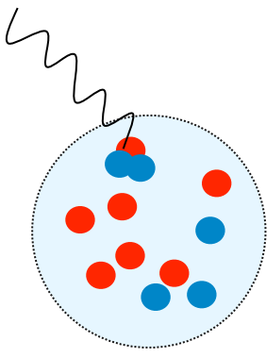


1<x<2:



2N-SRC

2<x<3:



3N-SRC

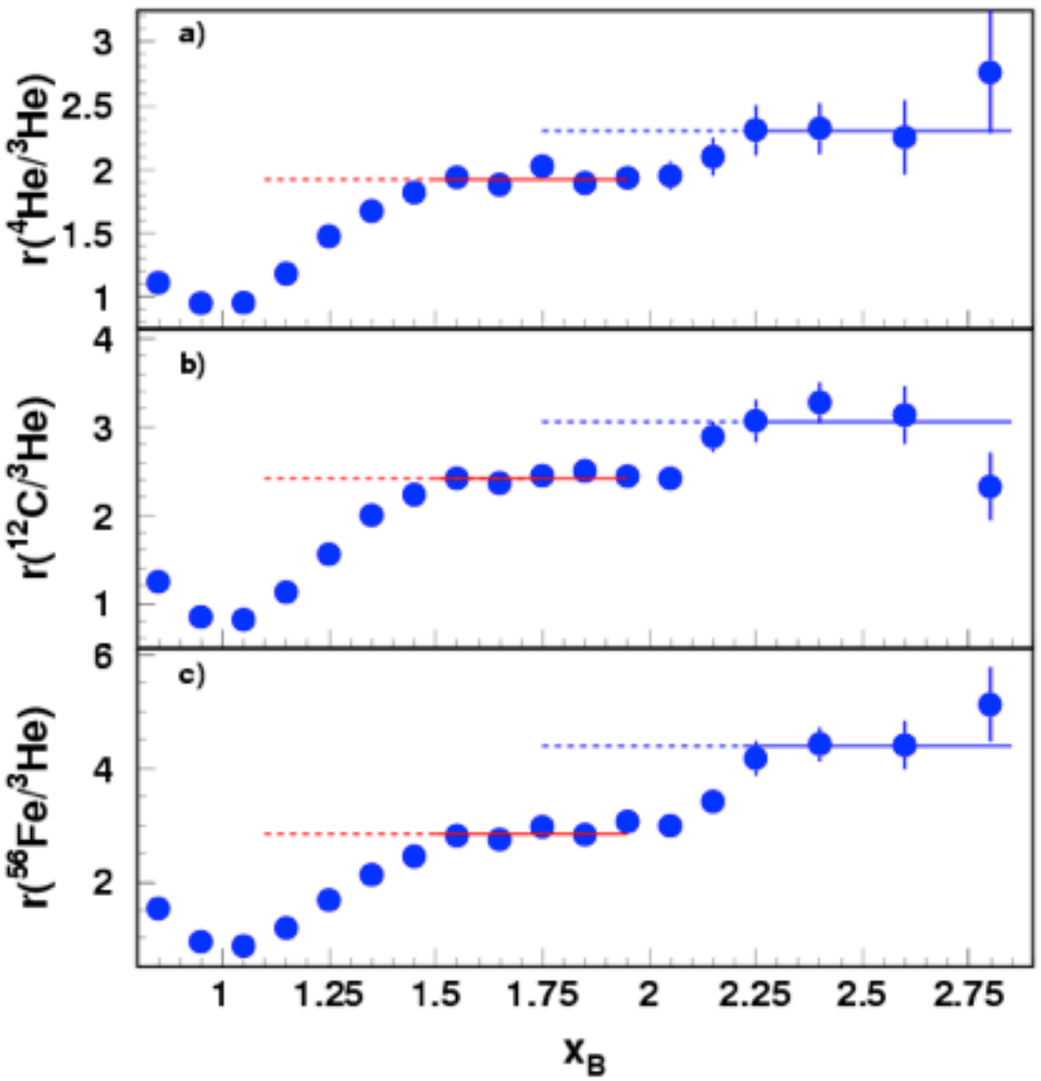
...

Short-Range Correlations

First evidence of 2N-SRC at x>1.5 seen at SLAC (Frankfurt, Strikman, Day, Sargsian, PRC48, 2451 (1993)) and confirmed at JLab:

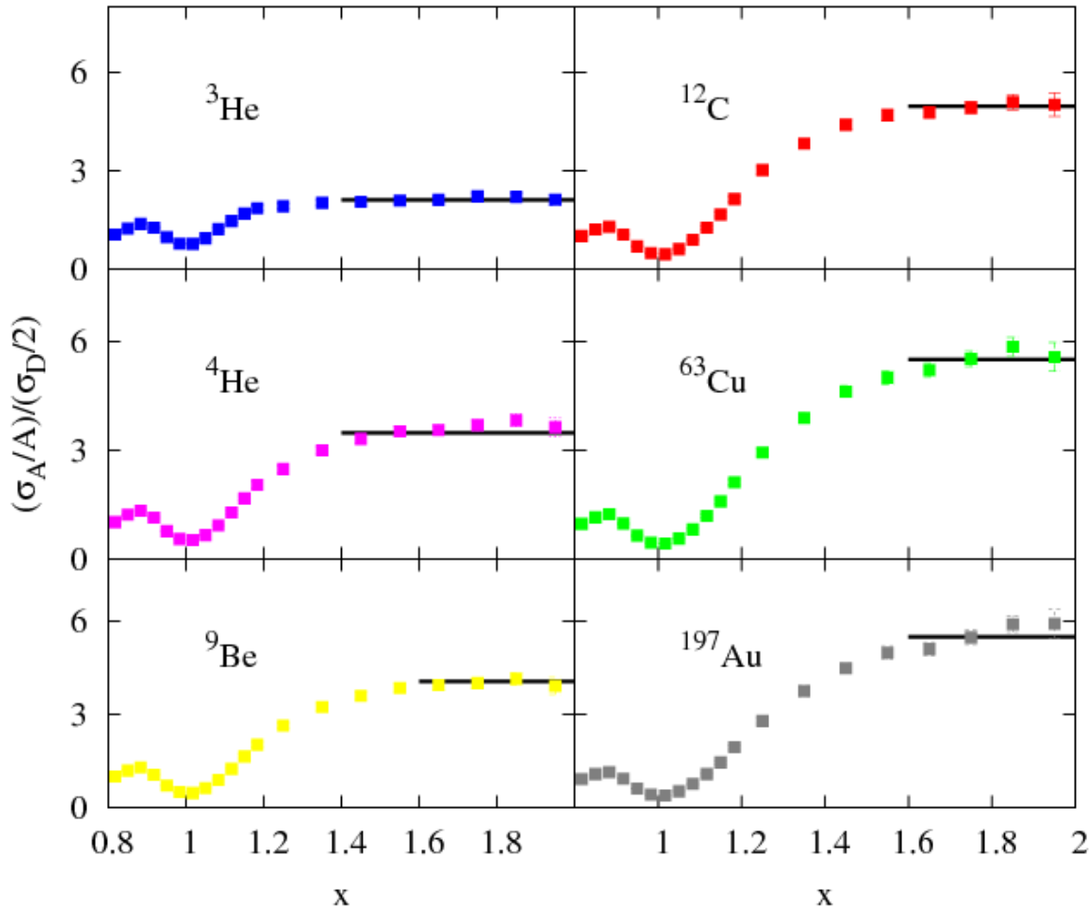
Hall B

K. S. Egiyan et al., Phys. Rev. Lett. 96, 082501 (2006)



Hall C

N. Fomin et al., Phys. Rev. Lett. 108, 092502 (2012)

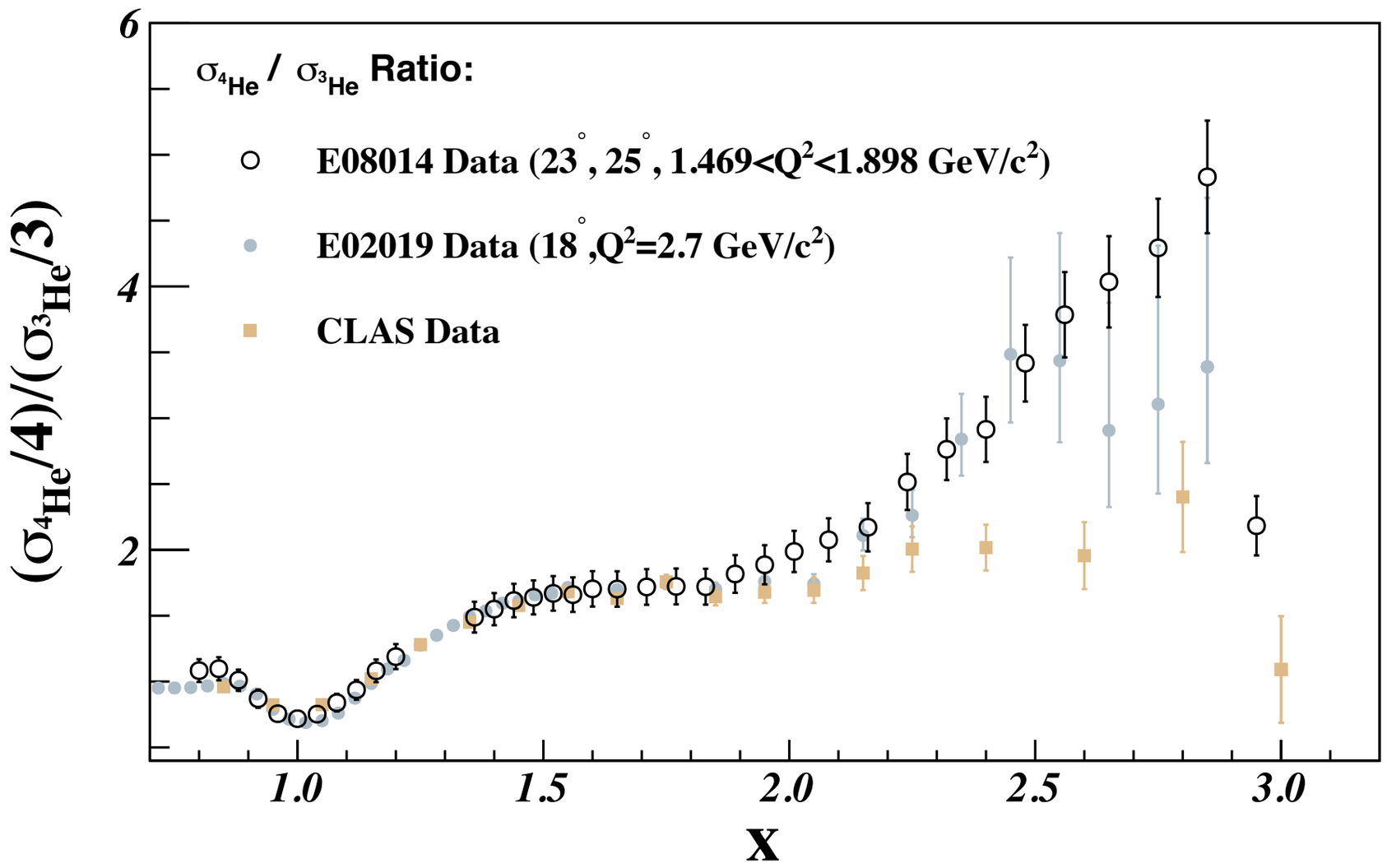


E08-014

Search for three-nucleon short-range correlations in nuclei

Z. Ye,[1,2] P. Solvignon,[3,4] P. Aguilera,[5] Z. Ahmed,[6] H. Albataineh,[7] K. Allada,[8] B. Anderson,[9] D. Anez,[10] K.

To be submitted to PRL

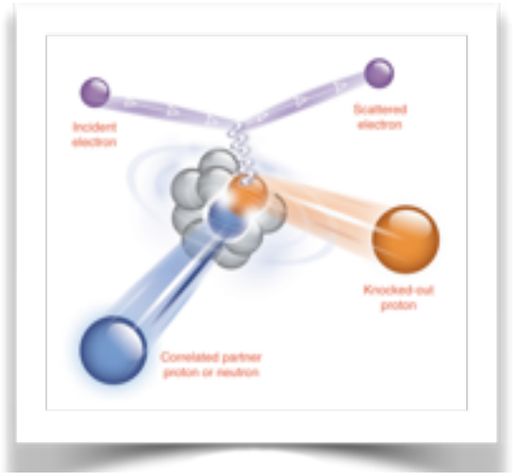


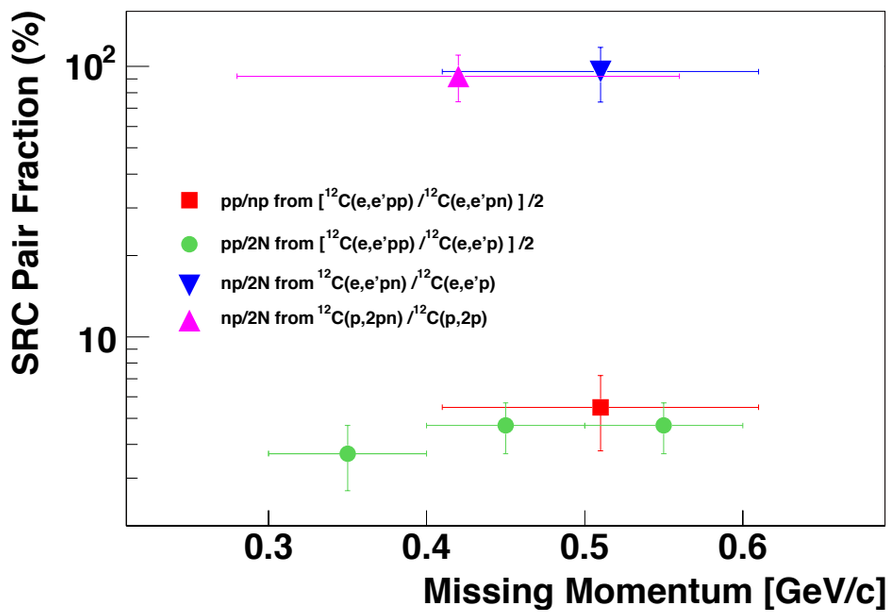
SRC: isospin dependence

Simple SRC model assumes isospin independence

Two-nucleon knock-out experiment

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

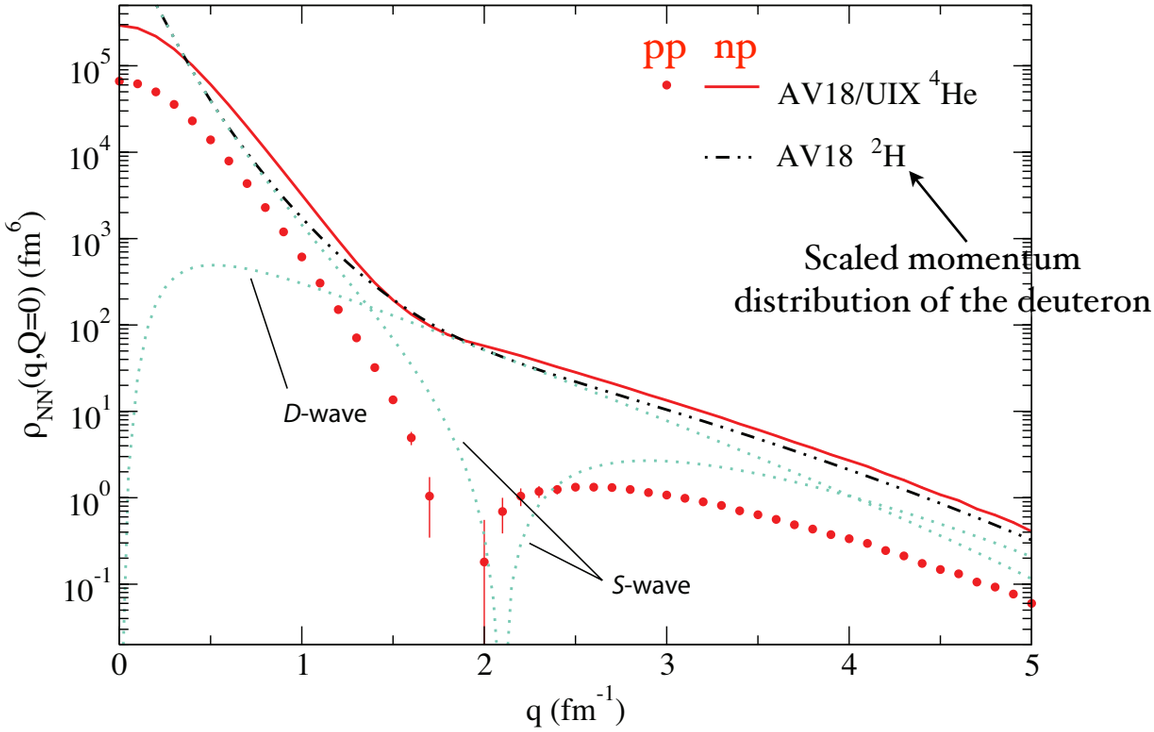




PRL **98,** 132501 (2007) PHYSICAL REVIEW LETTERS week ending 30 MARCH 2007

Tensor Forces and the Ground-State Structure of Nuclei

R. Schiavilla,[1,2] R. B. Wiringa,[3] Steven C. Pieper,[3] and J. Carlson[4]
[1]*Jefferson Laboratory, Newport News, Virginia 23606, USA*
[2]*Department of Physics, Old Dominion University, Norfolk, Virginia 23529, USA*
[3]*Physics Division, Argonne National Laboratory, Argonne, Illinois 61801, USA*
[4]*Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA*
(Received 10 November 2006; published 27 March 2007)



Data show large asymmetry between np, pp pairs:

Qualitative agreement with calculations; effect of tensor force. Huge violation of often assumed isospin symmetry

Isospin study from $^3He/^3H$ ratio

Simple mean field estimates for 2N-SRC

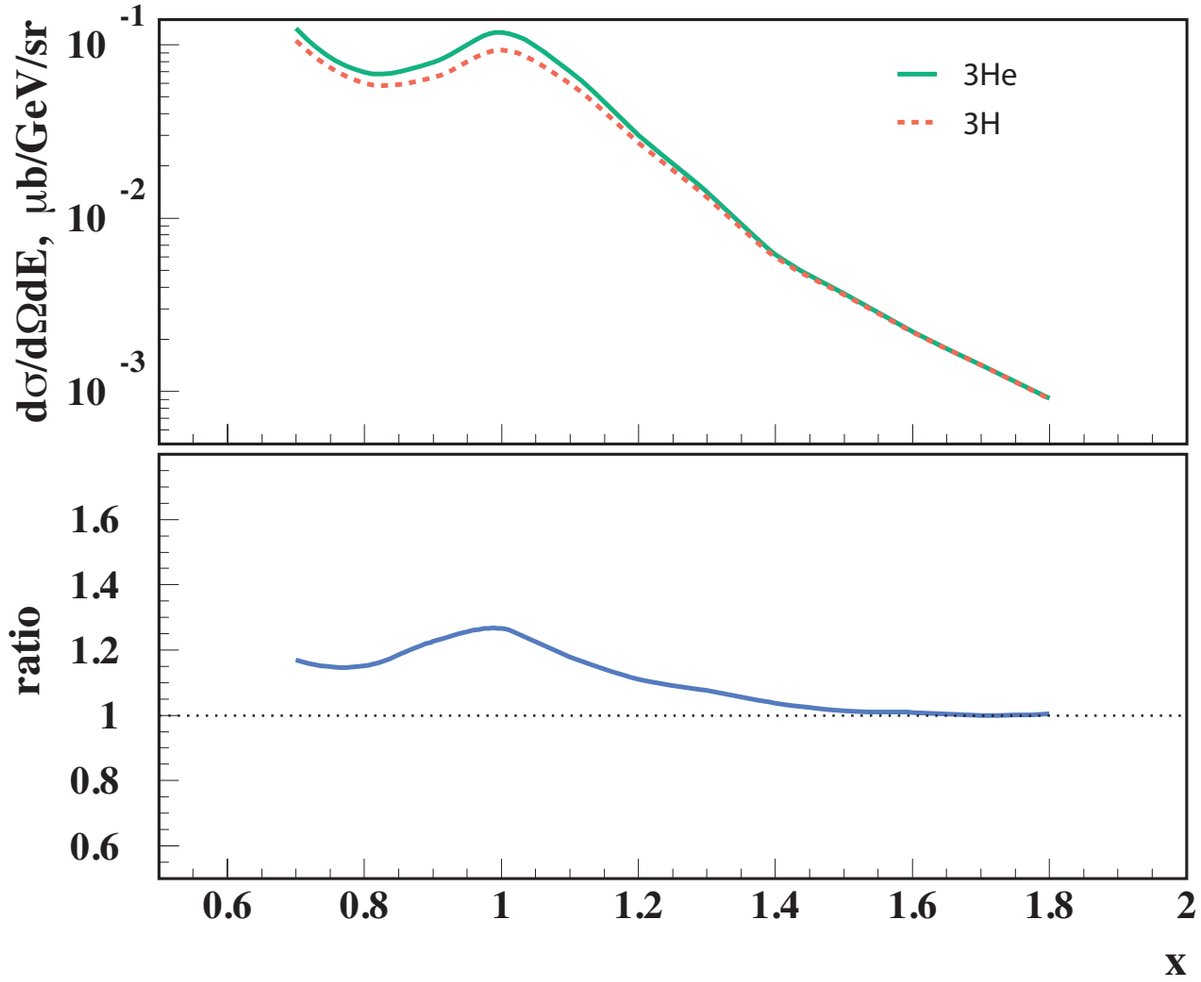
Isospin independent:

$$\frac{\sigma_{^3He}/3}{\sigma_{^3H}/3} = \frac{(2\sigma_p + 1\sigma_n)/3}{(1\sigma_p + 2\sigma_n)/3} \xrightarrow{\sigma_p \approx 3\sigma_n} 1.40$$

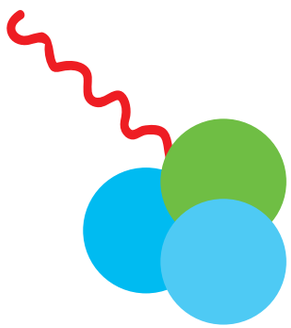
n-p (T=0) dominance:

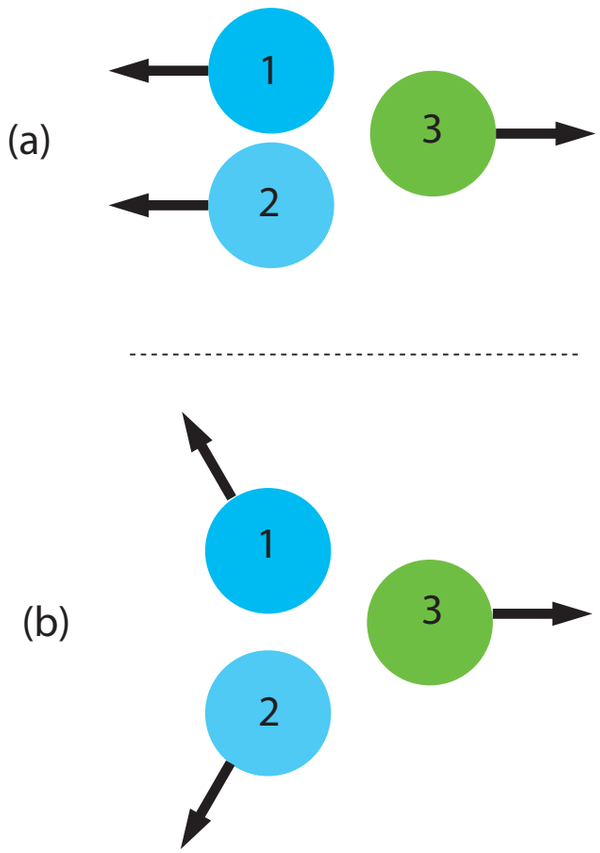
$$\frac{\sigma_{^3H}/3}{\sigma_{^3He}/3} = \frac{(2pn + 1\cancel{nn})/3}{(2pn + 1\cancel{pp})/3} = 1.0$$

Inclusive cross section calculation from M. Sargsian using AV18/UIX



3N-configuration





extremely large momentum

$p_3 = p_1 + p_2$

"Star-configuration"

$p_1 = p_2 = p_3$

(a) yields $R(^3He/^3H) \approx 3.0$ if nucleon #3 is always the doubly-occurring nucleon
(a) yields $R(^3He/^3H) \approx 0.3$ if nucleon #3 is always the singly-occurring nucleon
(a) yields $R(^3He/^3H) \approx 1.4$ if configuration is isospin-independent, as does (b)

$R \neq 1.4$ implies isospin dependence AND non-symmetric momentum sharing

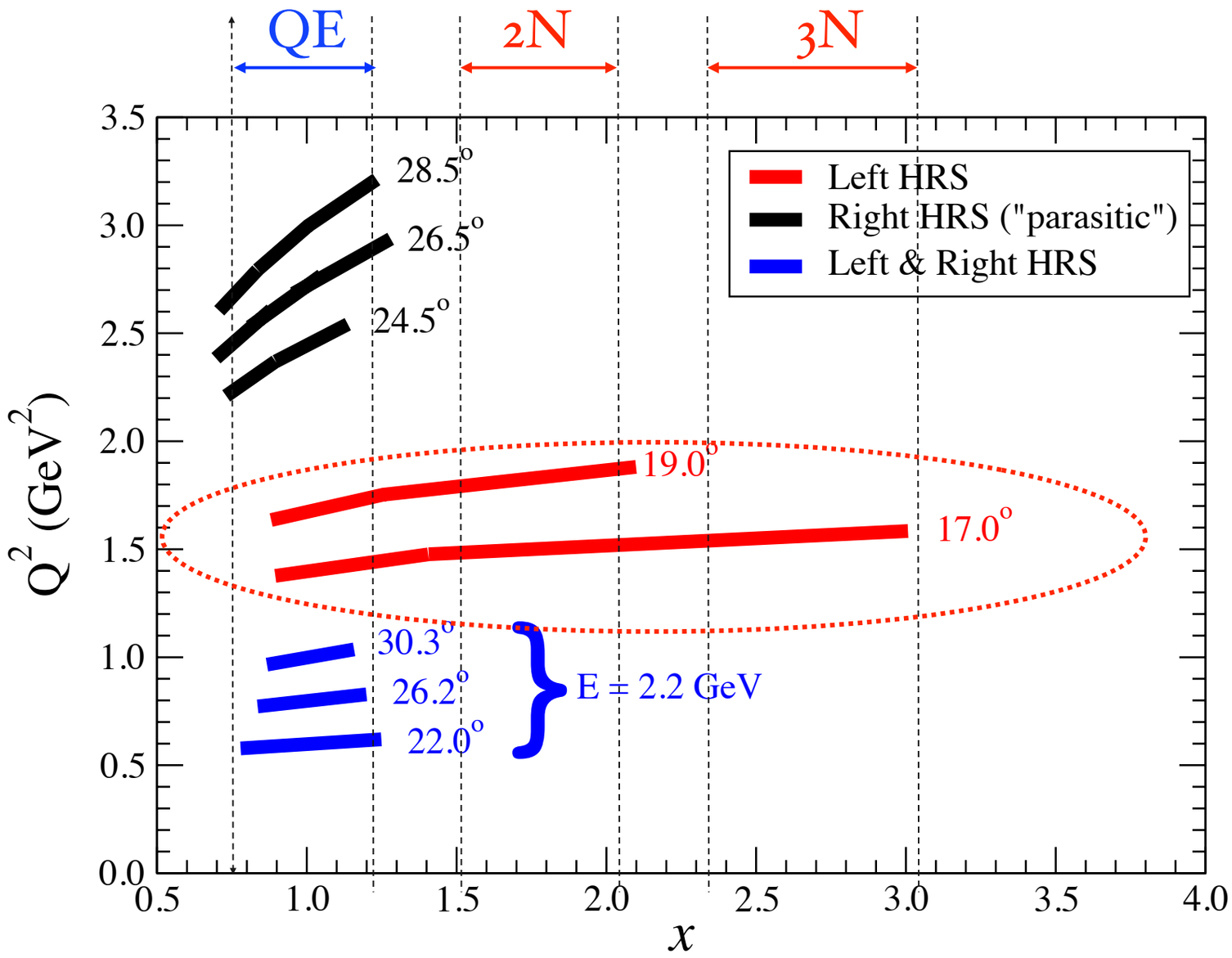
E12-11-112: kinematics

Beam current: 25 μA, unpolarized, Raster interlock

Beam energy:

17.5 Days 4.4 GeV [main production]

Left HRS running (380 hours)



E12-11-112: kinematics

Beam current: 25 μA, unpolarized, Raster interlock

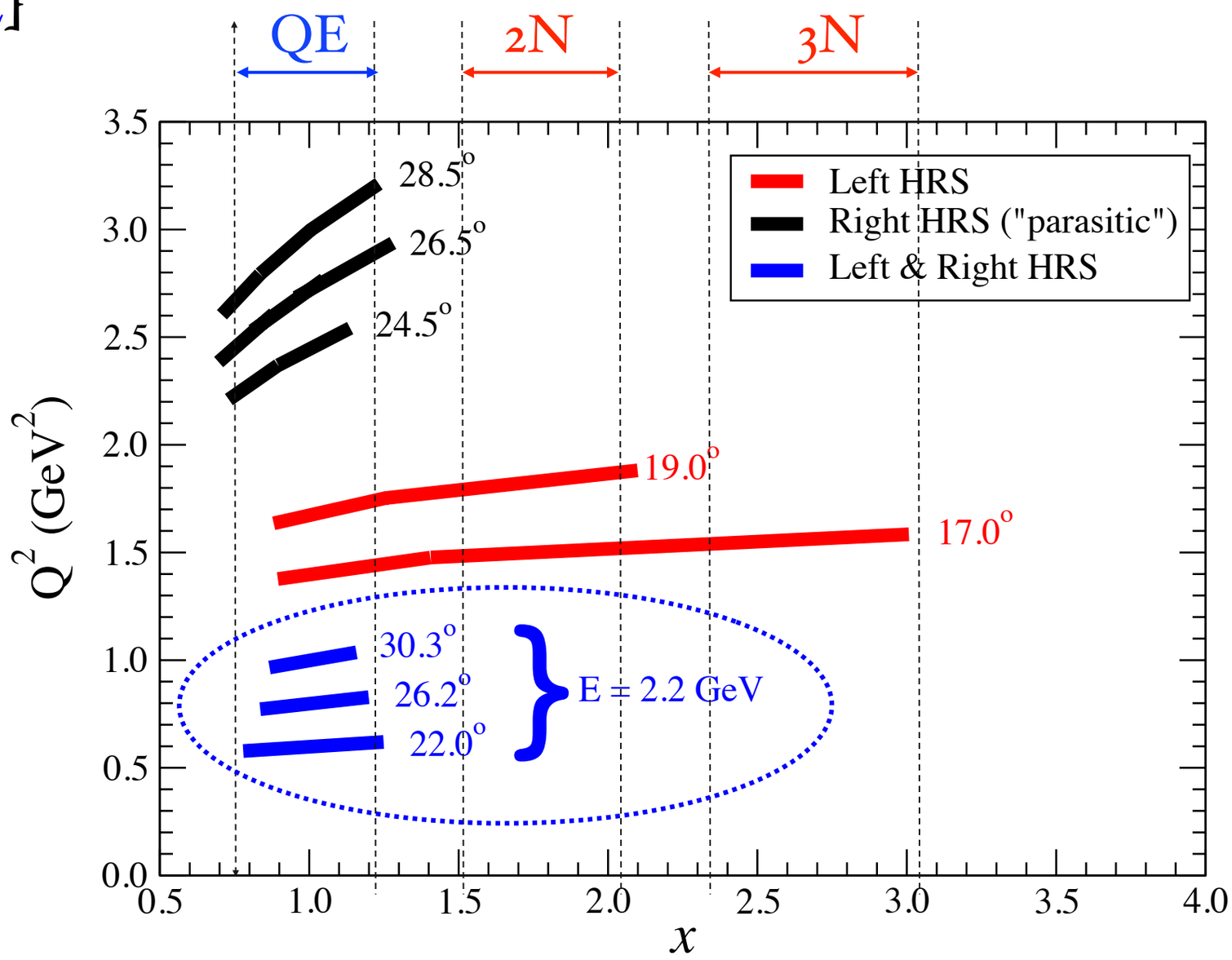
Beam energy:

17.5 Days 4.4 GeV [main production]

1.5 days 2.2 GeV [checkout+QE]

Left HRS running (380 hours)

Left+Right HRS running (about 1 day)



E12-11-112: kinematics

Beam current: 25 μA, unpolarized, Raster interlock

Beam energy:

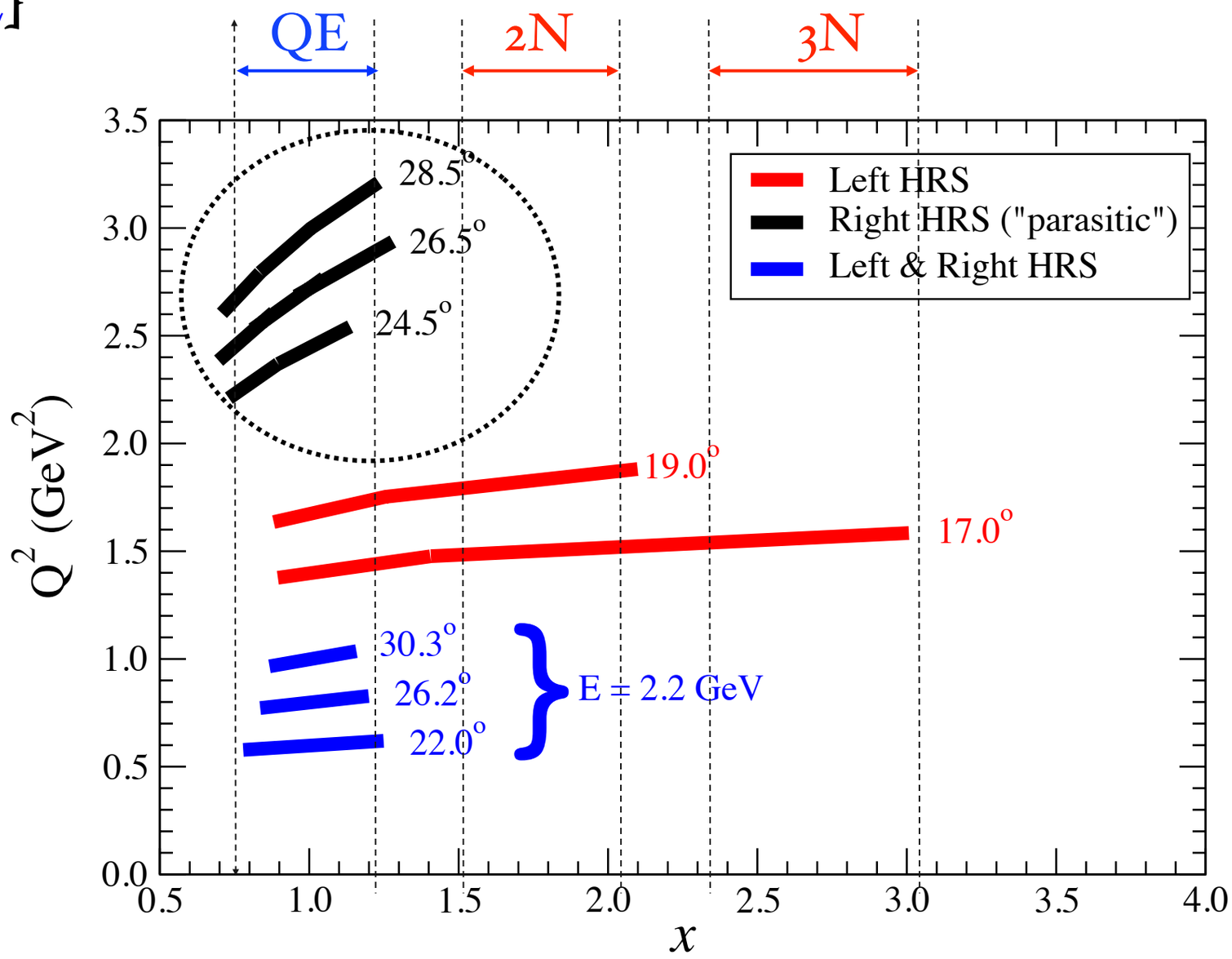
17.5 Days 4.4 GeV [main production]

1.5 days 2.2 GeV [checkout+QE]

Right HRS running ("parasitic")
Existing ^{3}H QE data
limited $Q^2 \leq 0.9$ GeV^2

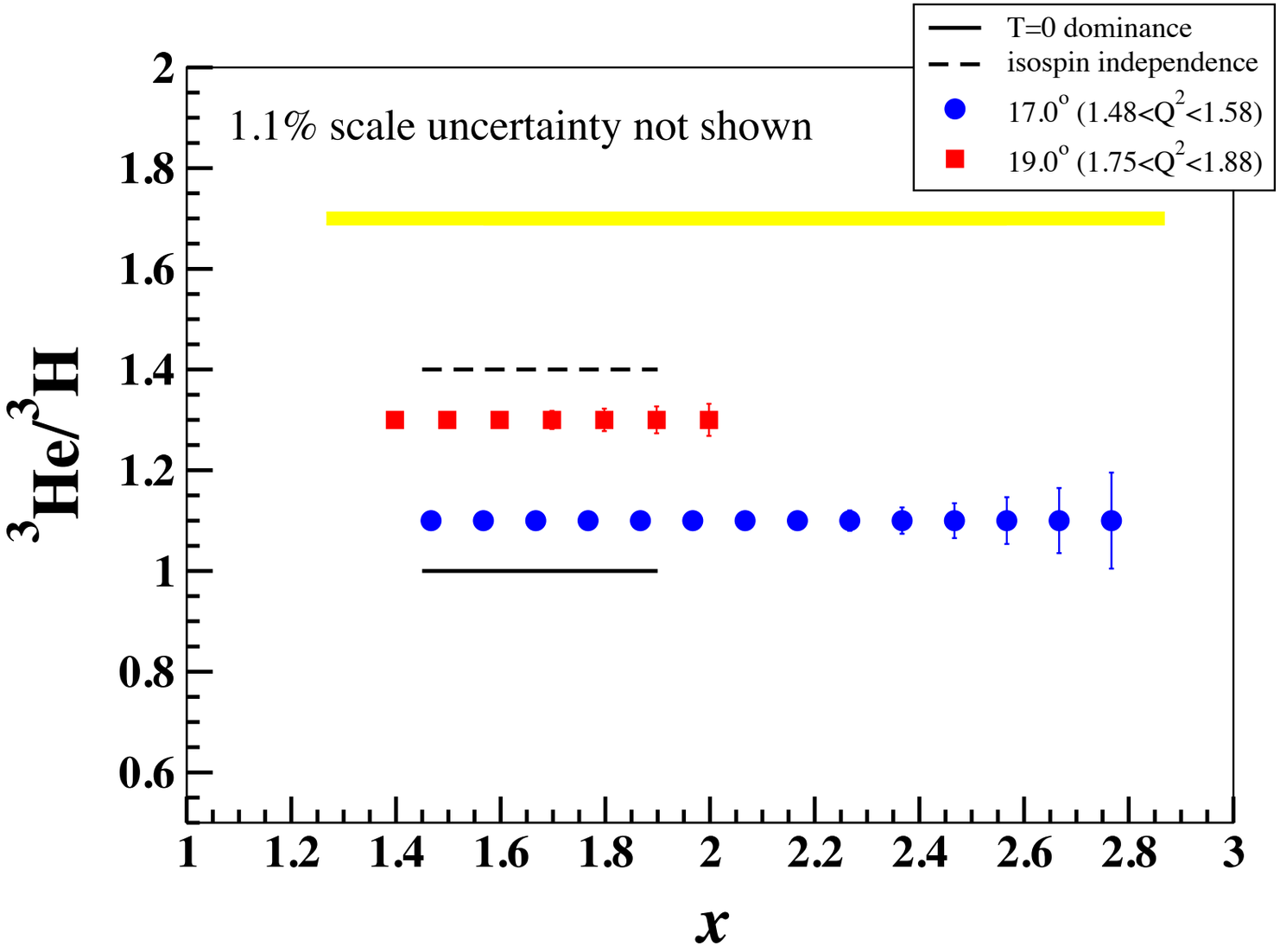
Left HRS running (380 hours)

Left+Right HRS running (about 1 day)



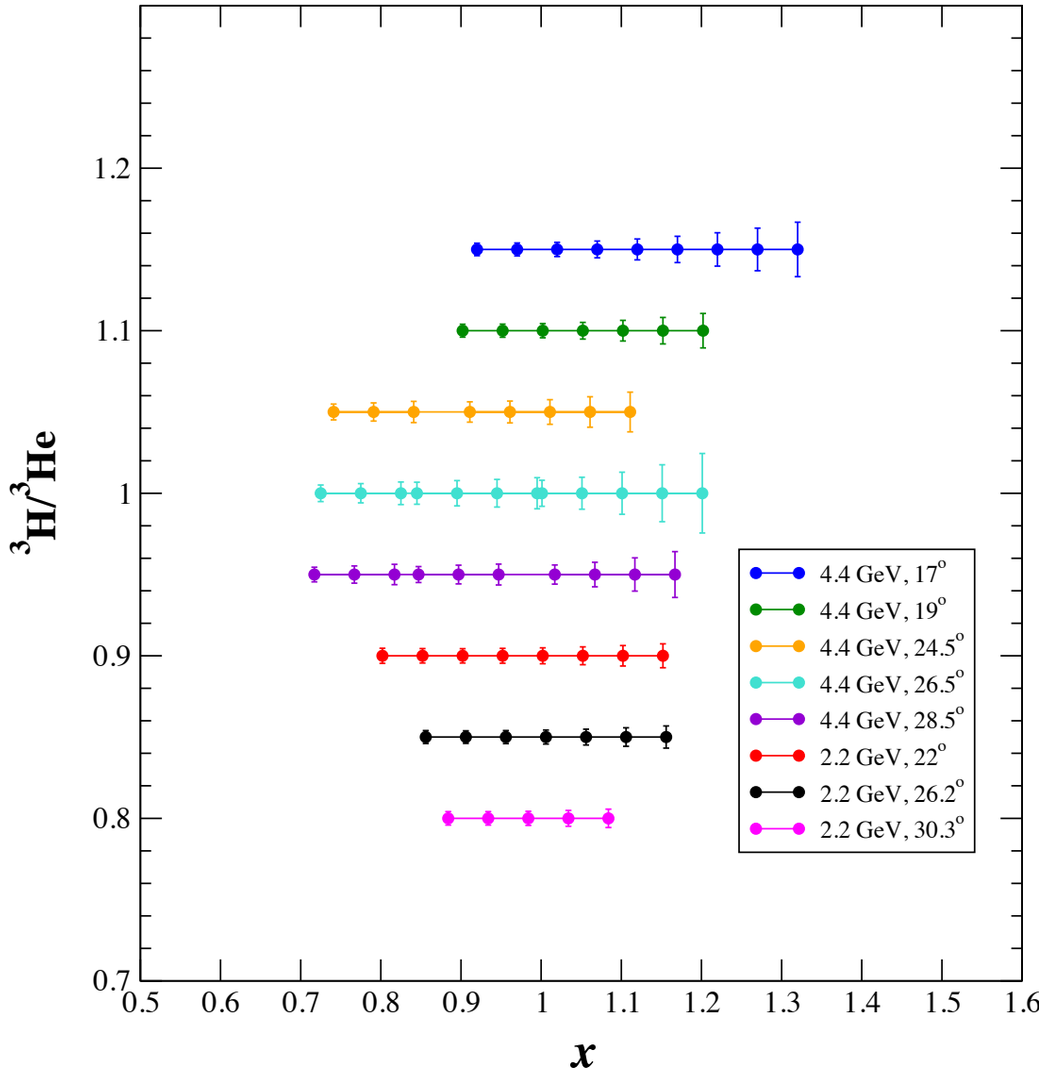
E12-11-112: projected results

Isospin study of SRC



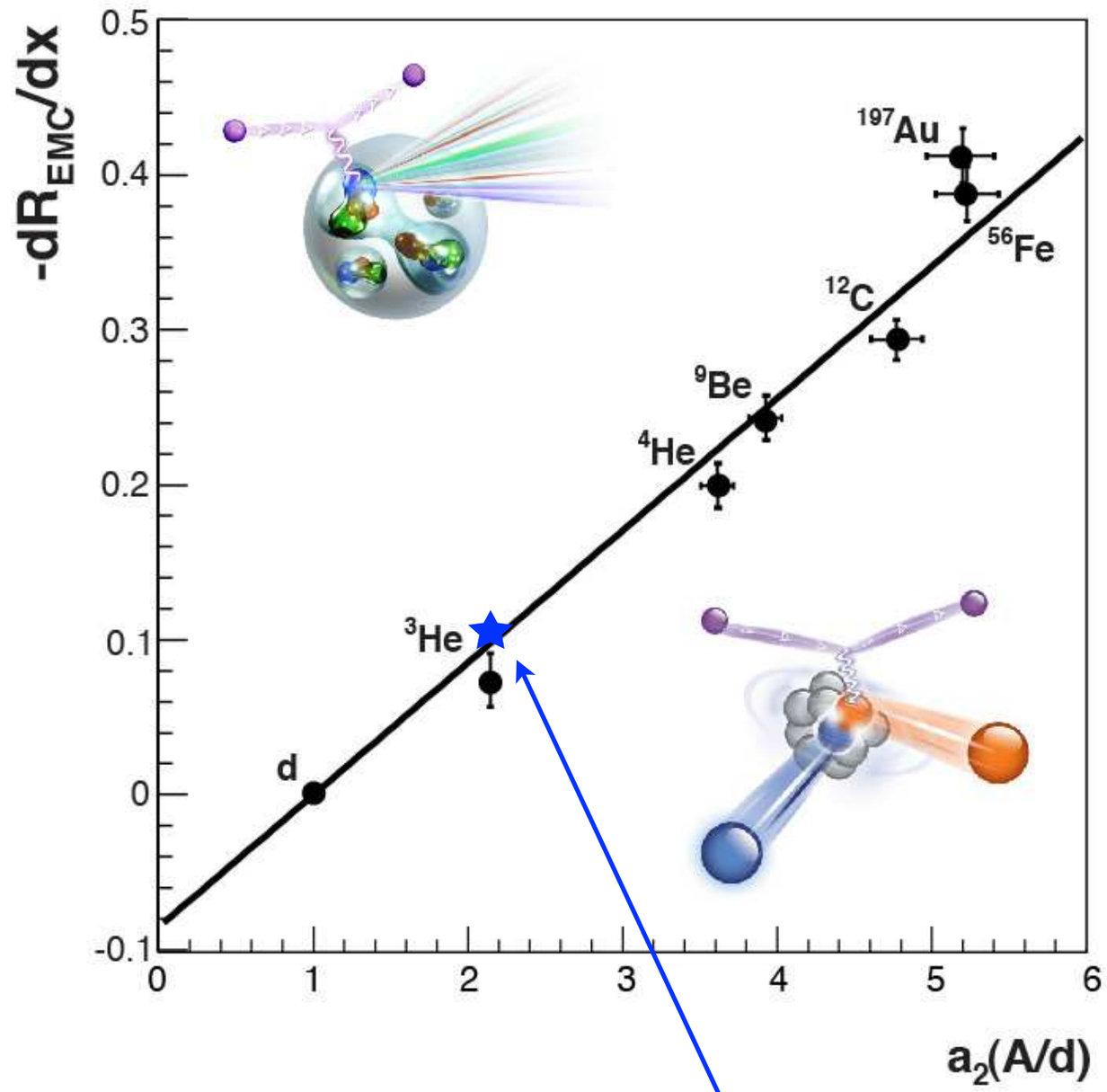
At x>2, $^3He/^3H \neq 1.4$ implies isospin dependence AND non-symmetric momentum sharing

Extraction of G_M^n



In PWIA, $^3He/^3H$ with 1.5% uncertainty corresponds to 3% on G_M^n

EMC vs. SRC



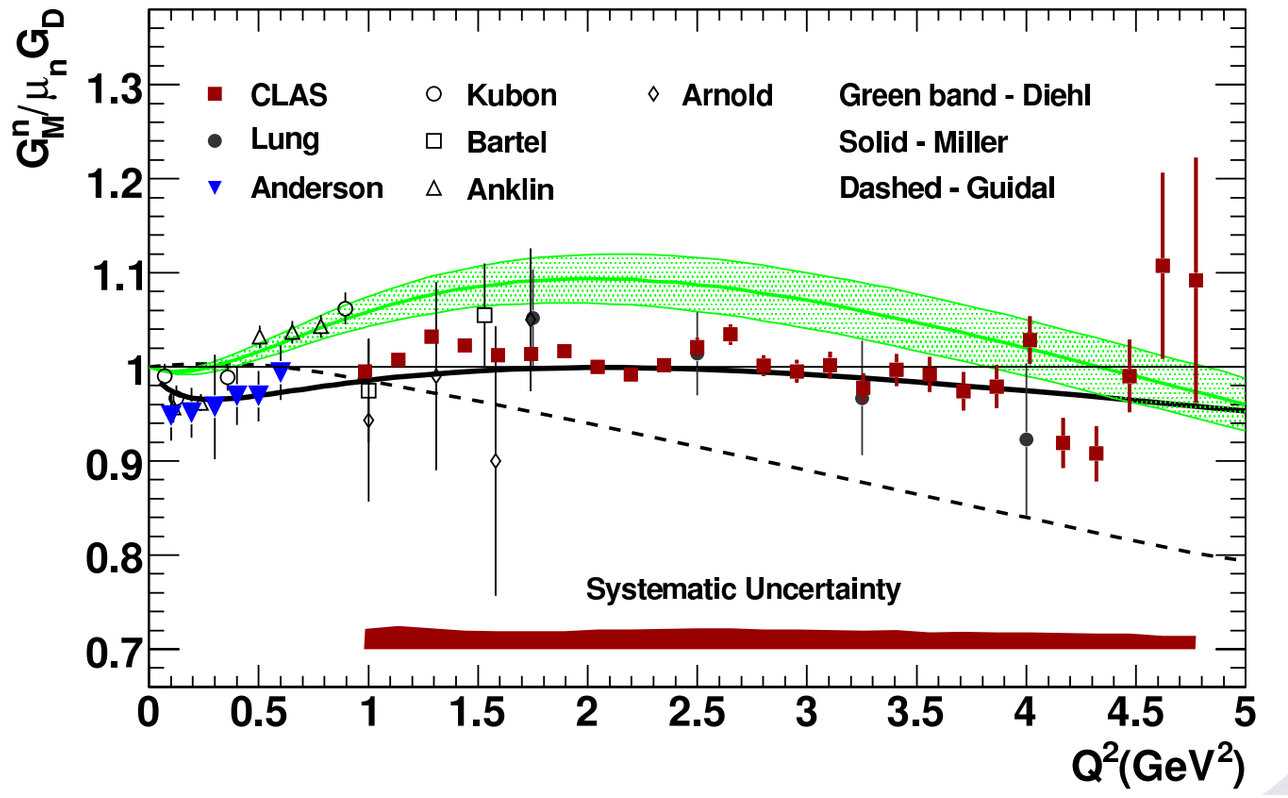
O. Hen, et al, PRC 85, 047301 (2012)
L. Weinstein, et al., PRL 106, 052301 (2011)

from MARATHON and the x>1experiment results combined (no error bar projected at this time)

E12-11-112: Neutron Magnetic FF

World ^{3}H QE data:
$Q^2 \leq 0.9 GeV^2$

This experiment:
0.6, 0.8, 1.0, 1.4, 1.7,
2.4, 2.7 and 3.0 GeV^2



In PWIA, ^{3}He/^{3}H with 1.5% uncertainty corresponds to 3% on G_M^n

- Limited to $Q^2 \leq 1$ GeV^2, where QE peak has minimal inelastic contribution
- This is the region with ~8% discrepancy between the Ankin, Kubon data and the CLAS ratio and the Hall A polarized ^{3}He extraction.

Nuclear effects expected to be small, largely cancel in ratio

Summary

The x>1 experiment

isospin dependence of SRC from ^{3}He/^{3}H.

Added QE ^{3}He/^{3}H kinematics to extract G_M^n at $0.6 \leq Q^2 \leq 1.0$ where disagreement between data sets is observed.

2 Ph.D students have been identified: Dien from UVa (Day), Shujie Li from UNH (Solvignon)