# Short range correlations: E-12-11-112

Dien Nguyen
University of Virginia

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UNIVERSITY of VIRGINIA

Jefferson Lab

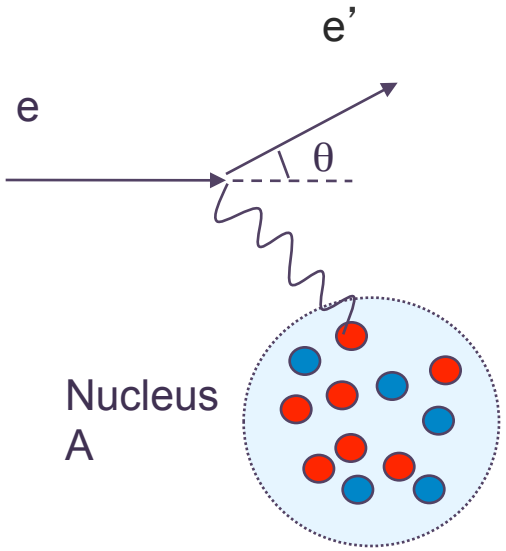
# E12-11-112

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

## Main physics goals

- Isospin-dependence of 2N SRCs
- 3N –structure (Momentum-sharing and Isospin)
- Cross section and ratio for the test of few-body calculation and final-state interactions

# Inclusive scattering at large x




$$Q^2 = 4E_0 E \sin^2(\theta/2)$$ → 4-momentum transferred square

$$x_{bj} = \frac{Q^2}{2m\nu}$$ → Momentum fraction of a nucleon shared by the struck quark.

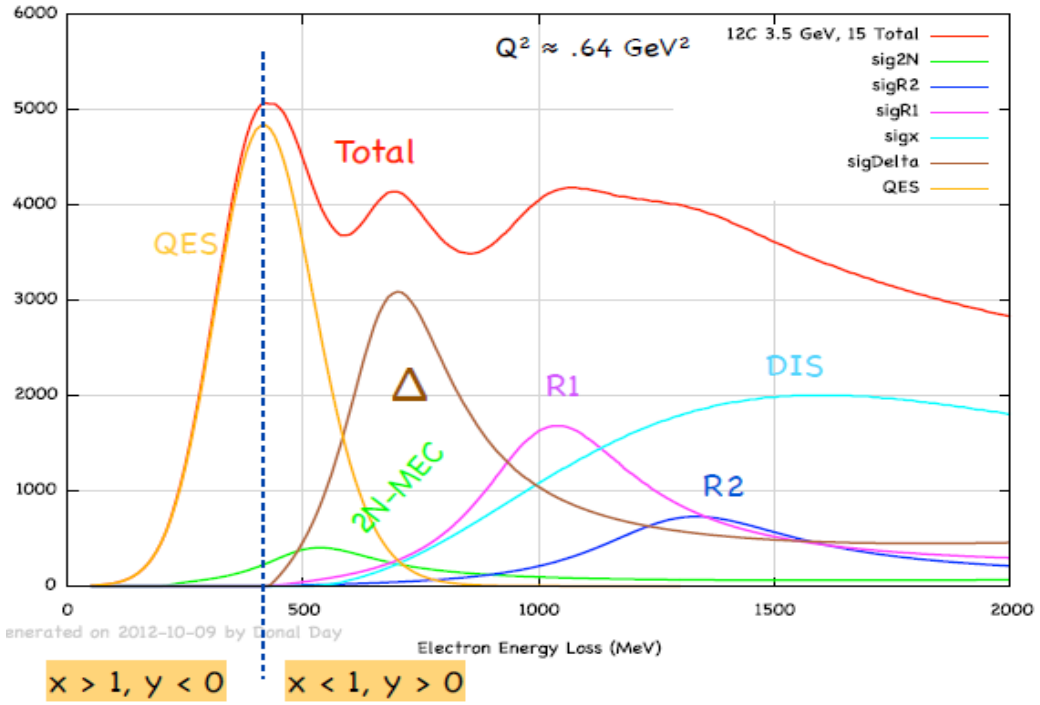
$$y \approx -q/2 + m\upsilon/q$$ → Momentum of struck nucleon parallel to q vector

e-p elastic scattering: x = 1

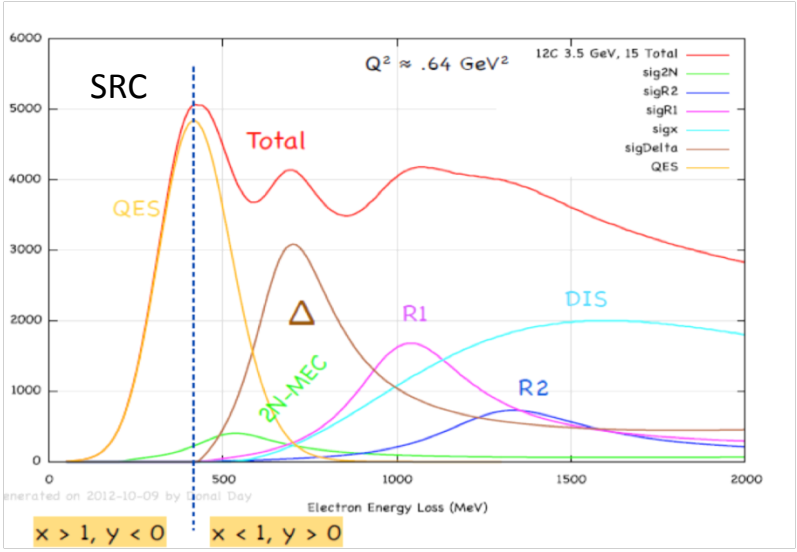
Quasielastic scattering x ≈ 1

Motion of nucleon in the nucleus broadens the peak to x~ 1.3

Inclusive Cross Section

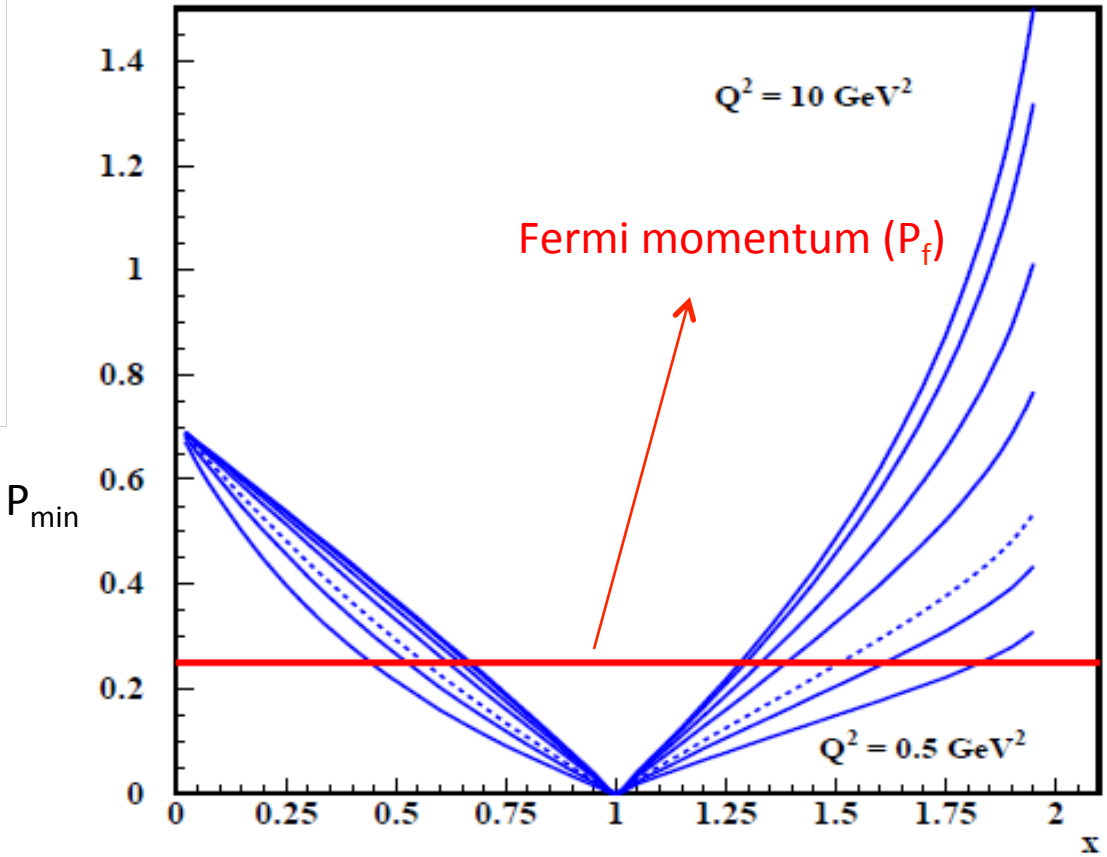


# Where to find SRCs?



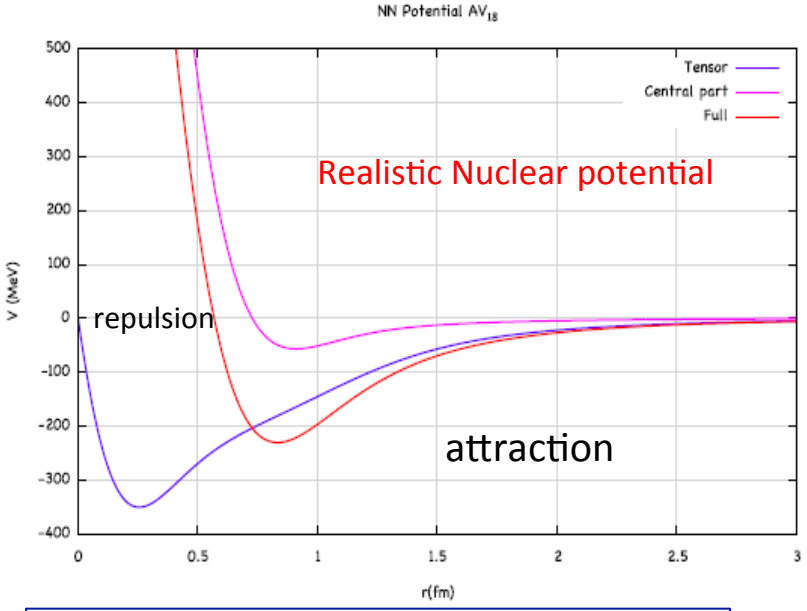

**In addition**: with x>1.5 and large $Q^2$ we suppress many effects and insuring clean quasi-elastic scattering on nucleon in a pair

**Minimum initial struck nucleon momentum**



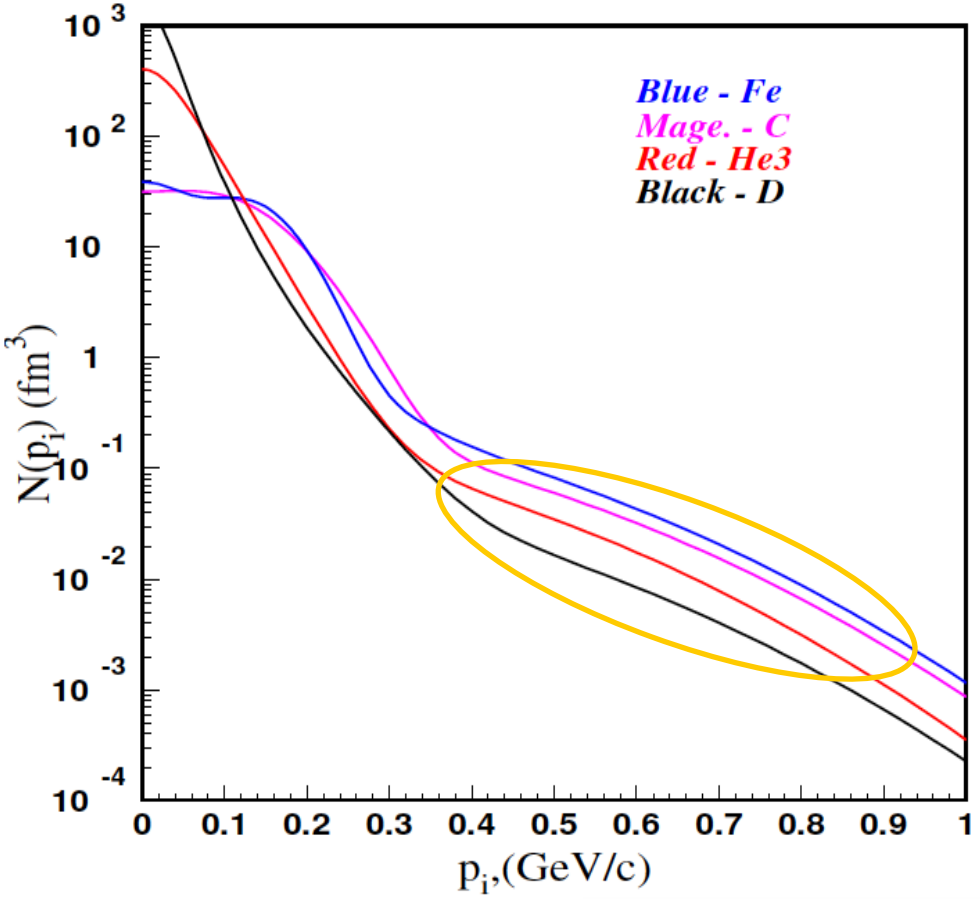

**We need to go to high x and $Q^2$ where $P_{min} > P_f$ where SRCs are dominant.**

# Momentum Distributions




Short range N-N interaction is responsible for high momentum tail of the momentum distribution in nuclei ( significant contribution with k>kf)

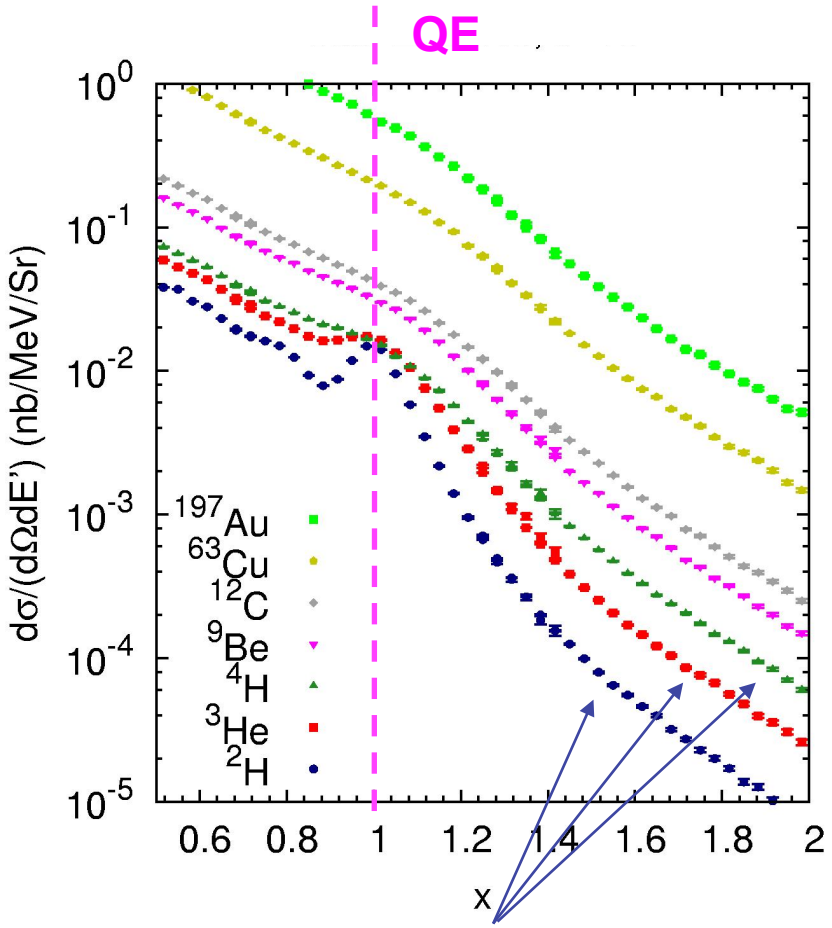
C. Ciofi degli Atti and S. Simula, Phys. Rev. C **53** (1996) 1689.



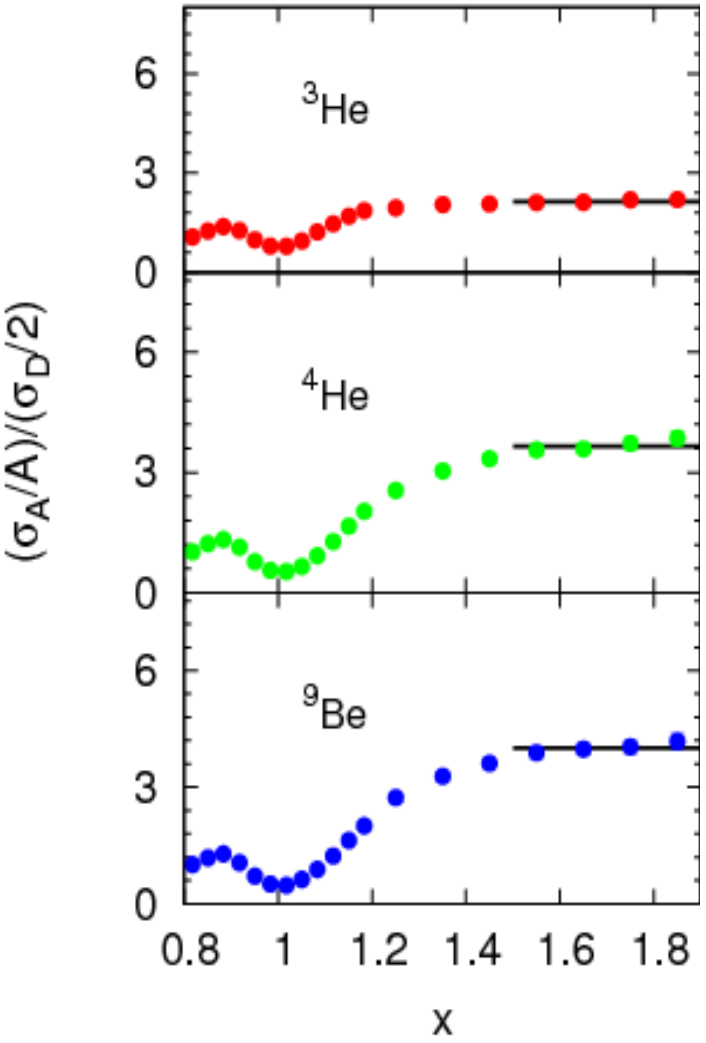

At high *initial* momentums $\mathbf{n_A(p) = N(A) * n_D(p)}$

# SRC evidence: A/D ratios

**N. Fomin, et al., PRL 108 (2012) 092052**




**High momentum tails should yield constant ratio if SRC-dominated**

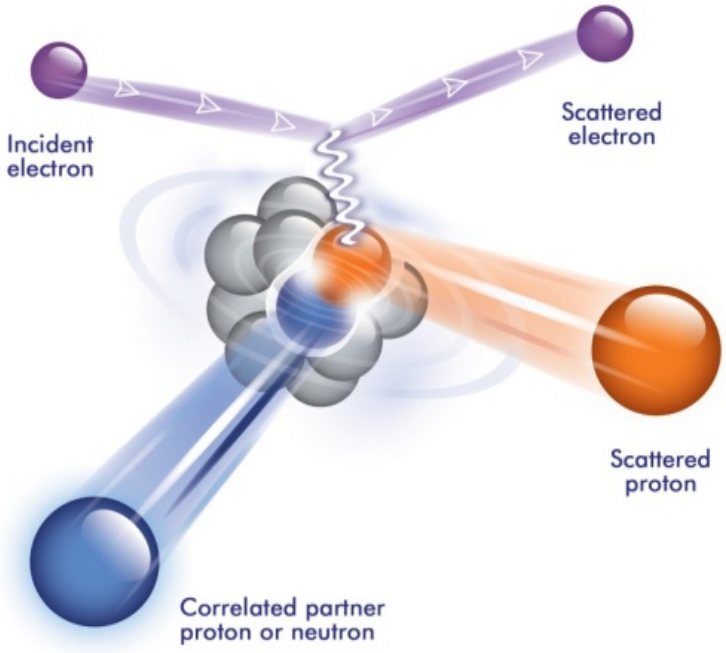



**Ratio of cross sections shows a ($Q^2$-independent) plateau above x ≈ 1.5, as expected in SRC picture**

# Isospin dependence SRCs

•**SRCs model**: the nucleon correlation are assumed to be isospin independent

•**Experiment E01-015: $^{12}$C(e,e'2N)**

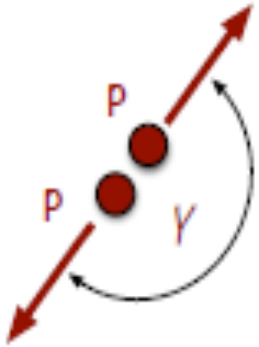



**Two-nucleon knockout: $^{12}$C(e,e' pN), $^{4}$He(e,e' pN), A(e,e' pp)**

•Reconstruct ***initial high momentum proton***

•Look for ***fast spectator nucleon*** from SRC in opposite direction

•Find spectator ~100% of the time, neutron >90% of the time



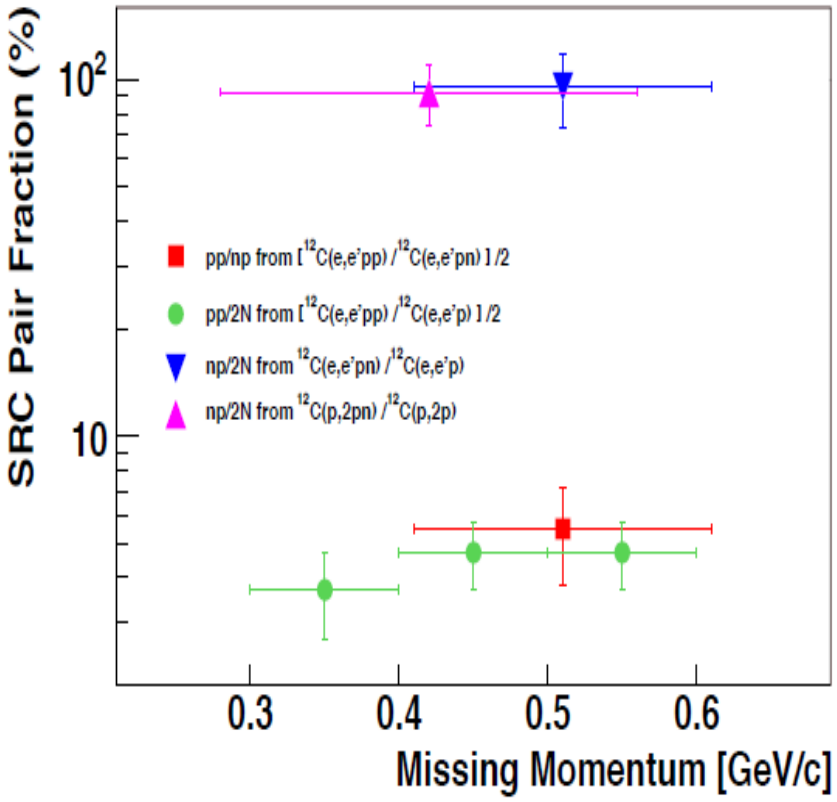

**Simultaneous measurements of (e,e'p), (e,e'pp) and (e,e'pn)**

**And the ratio of (e,e'pn)/(e,e'pp)**

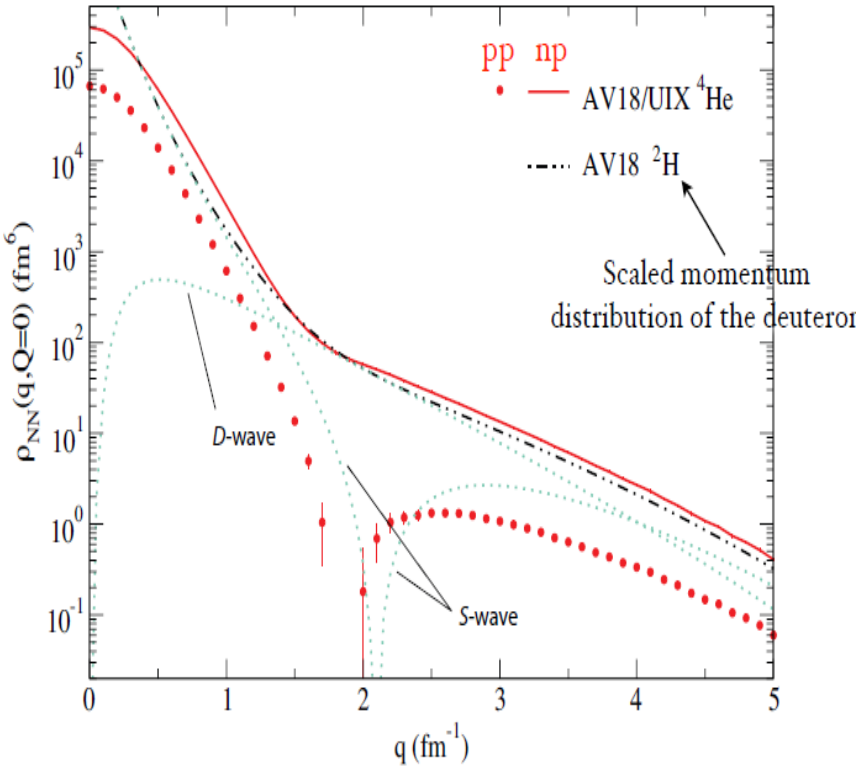
Almost all proton with $p>k_f$ in C(e,e'p) have a paired proton or neutron with similar momentum in opposite direction.

# Isospin dependence of SRCs

Experiment E01-015
R. Subedi et al, Sc 320, 1476(2008)




R.Schiavilla, Phy. Rev Letters. PRL 98,13501 (2007)




SRCs measurement: pp & nn combine is ~10%
Momentum distribution: np pair ~20 times bigger than pp

Solid evidence of Isospin dependence of SRCs

# E12-11-112: kinematics

**Beam current** : 20 muA, unpolarized.

**Target**: $He^3$ , $H^3$

**Beam Energy** : 2.2 GeV and 4.4 GeV

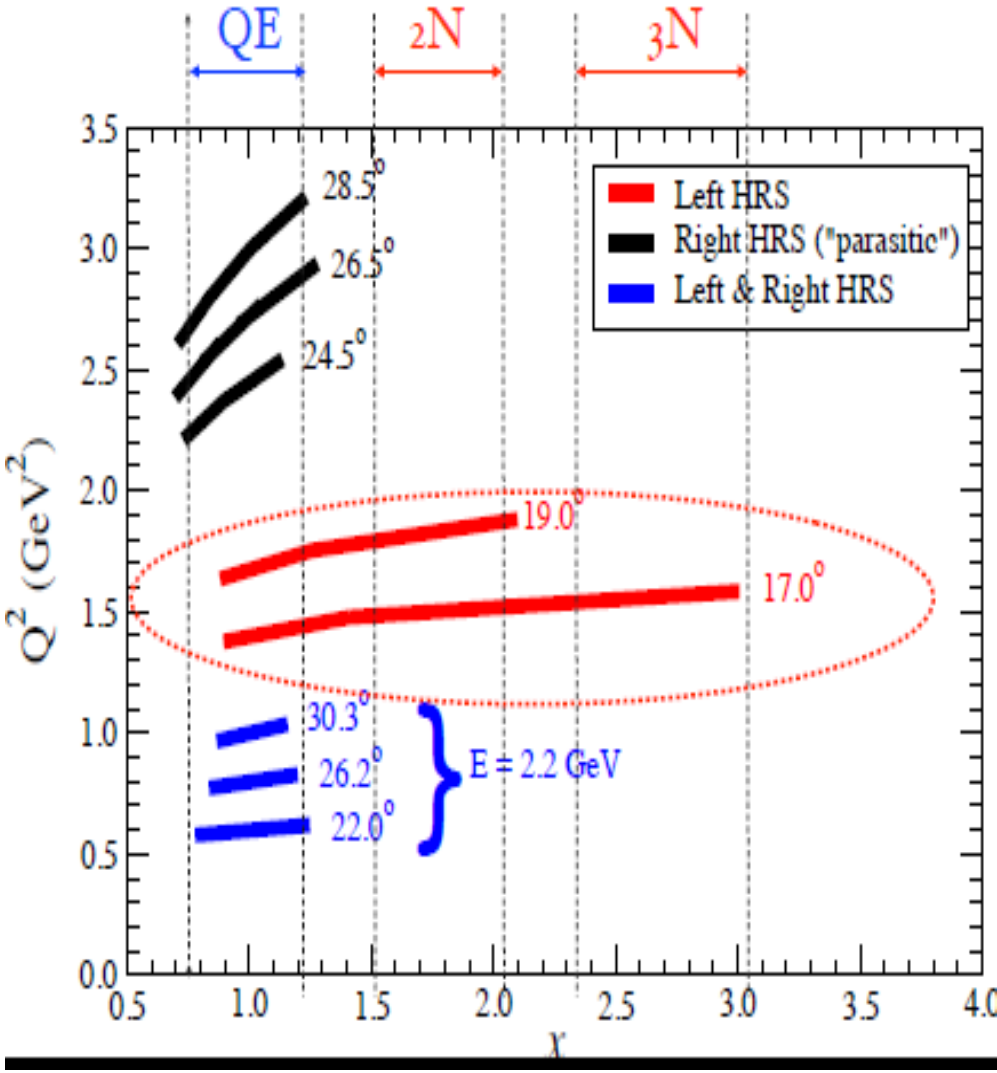
**Scattering angle**: 17 and 19 degree

**Beam time :**
17.5 days 4.4 GeV (main production)
1.5 days 2.2 GeV (checkout + QE)

**Right HRS running ("parasitic")**

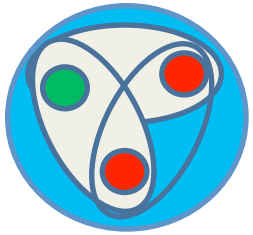
**Left HRS running (380 hours)**

**Left+Right HRS running ( about 1 day)**



# SRCs Isospin study from $^3He/^3H$

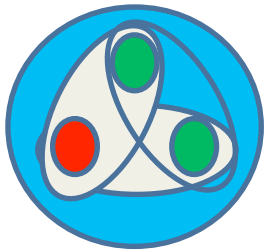
$^3He$



Mirror

$P > P_f$

$^3H$



- **n-p (T=0) dominance**

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

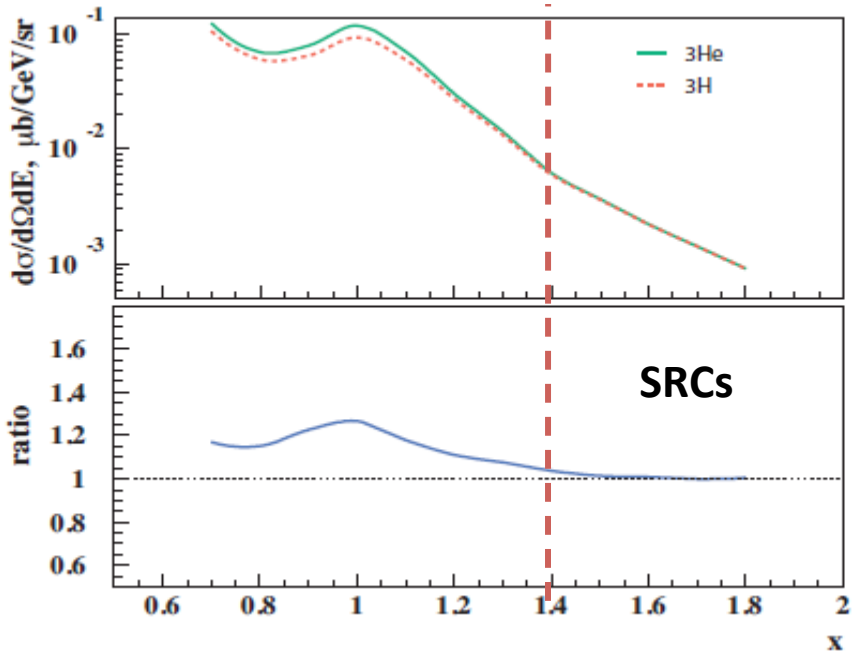
**40% different**

- **Isospin-independent**

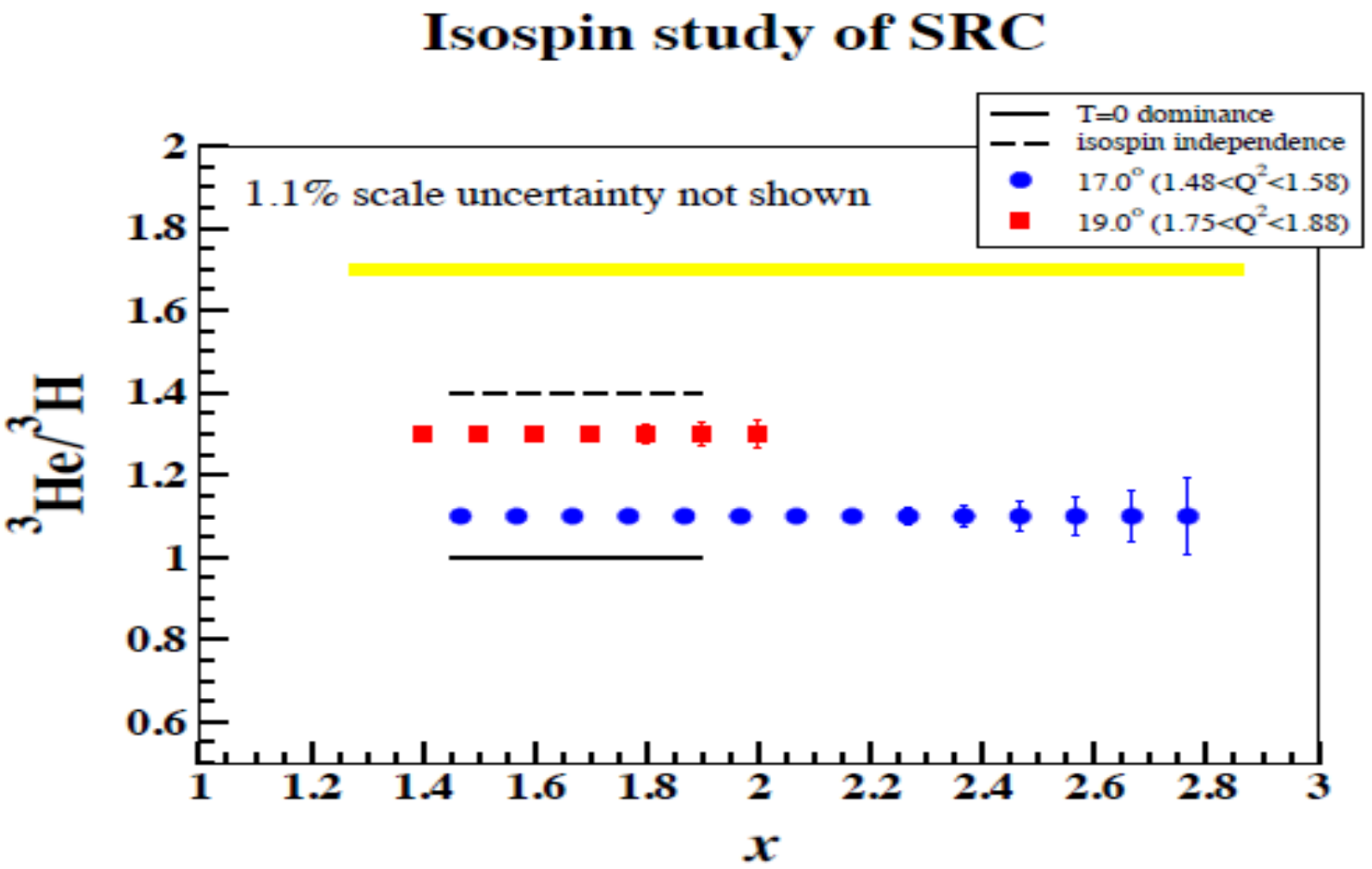
$$\frac{\sigma_{^3He}}{\sigma_{^3H}} = \frac{(2\sigma_p + 1\sigma_n)}{(1\sigma_p + 2\sigma_n)} \xrightarrow{\sigma_p = 3\sigma_n} 1.4$$


**References:**

Exclusive electrodisintegration of $^3He$ at high $Q^2$. Decay function formalism. Phys. Rev. C 71, 044615.
(M.M Sargsian, T. V. Abrahamyan, M. I Strikman and L. L. Frankfurt)

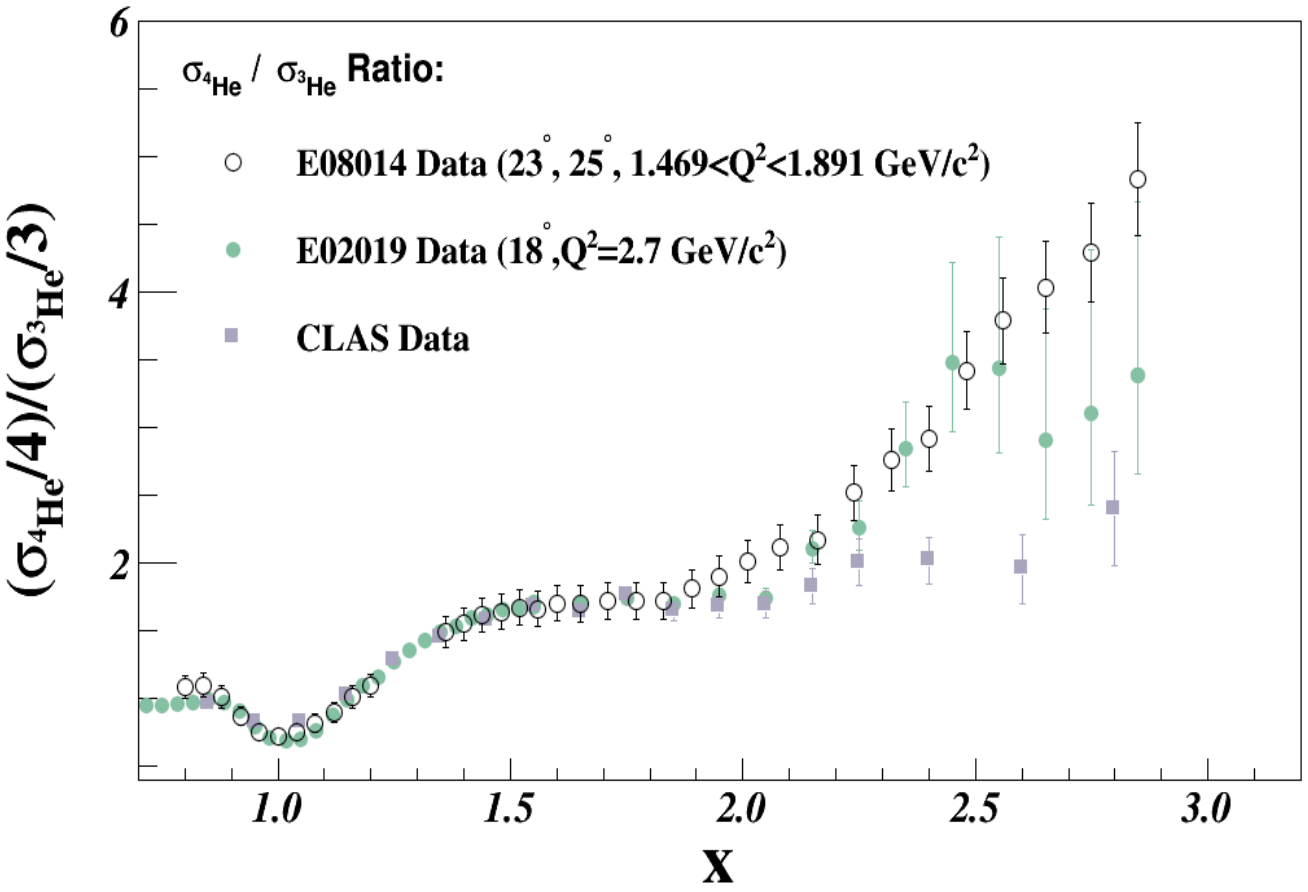



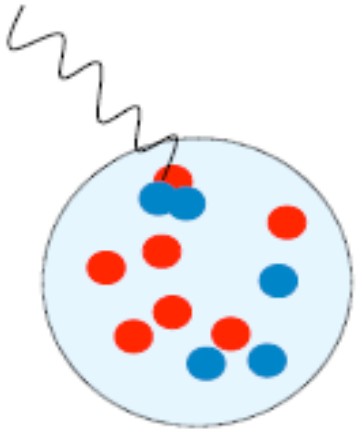
# E12-11-112: projected results




Expected uncertainty in 2N-SRCs region approximately 2%
Which will improve a factor of 3-4 improvement of isospin-dependence measurement compare to results of Jlab experiment E01-015.

# How about 3N- SRCs ?



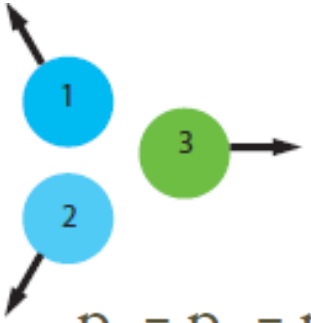



**3N SRCs: 2<x<3**

**CLAS**: Phys. Rev. Lett. 96, 082501 (2006).
**E02-019**: PRL 108, 092502 (2012)
**E08014:** To be submitted to PRL

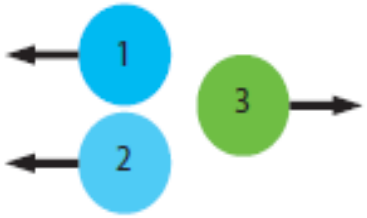
# 3N-Structure ?

**Symmetric**




$p_1 = p_2 = p_3$

**Non-Symmetric:**




$p_3 = p_1 + p_2$

**Symmetric:**

$$\frac{^3He}{^3H} = \frac{2\sigma_p + \sigma_n}{\sigma_p + 2\sigma_n} \approx 1.4$$

**Non-symmetric:**

- **Case1:** nucleon 3 is single nucleon in 3N

$$\frac{^3He}{^3H} = \frac{\sigma_n}{\sigma_p} \approx 0.3$$

- **Case2**: nucleon 3 is in pair of 3N

$$\frac{^3He}{^3H} = \frac{\sigma_p}{\sigma_n} \approx 3$$

# Conclusion:

-Precision measurement of isospin dependence in 2N-SRCs

- More information for 3N SRCs and 3N structure

-Ready to take data in Fall 2017

Thank you very much for your attention