



U.S. Department
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PR09-010:

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

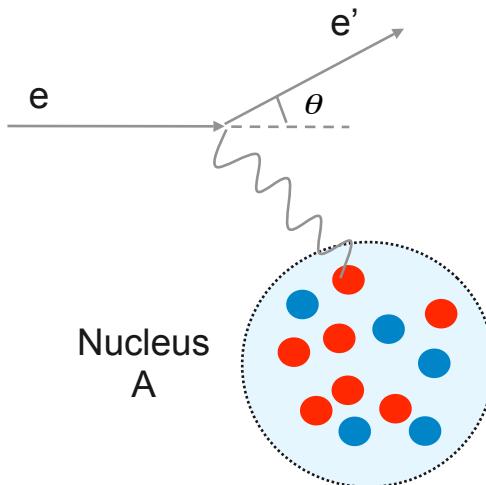
Patricia Solvignon
Argonne National Laboratory

spokespersons:

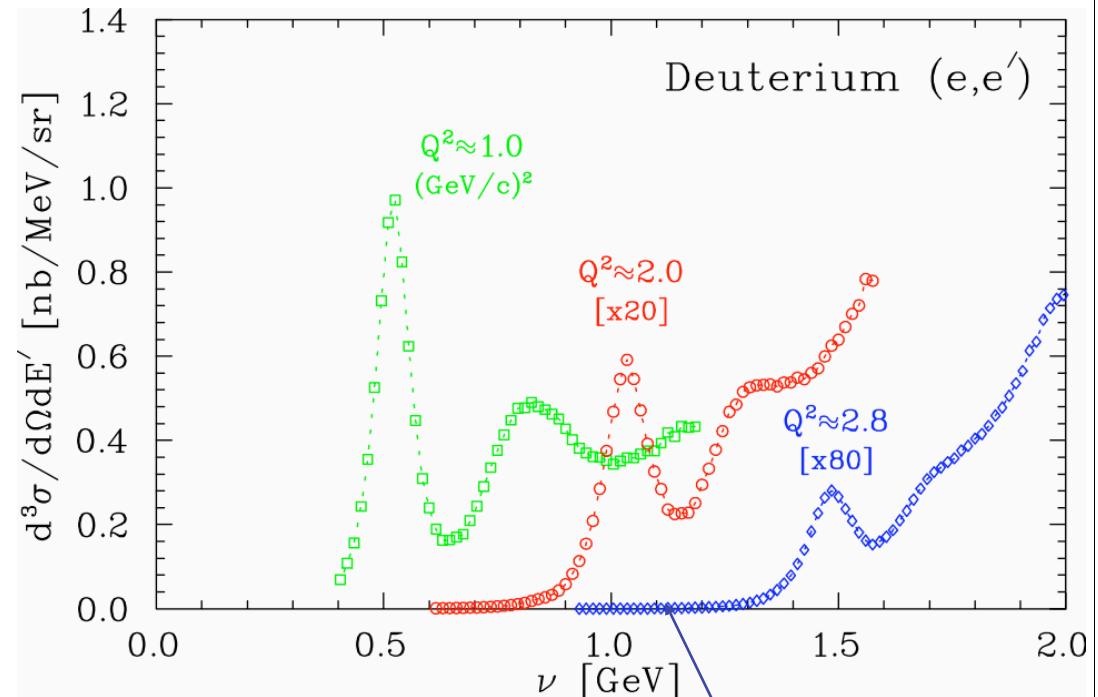
J. Arrington, D. Day and P. Solvignon

PAC34
January 28, 2009

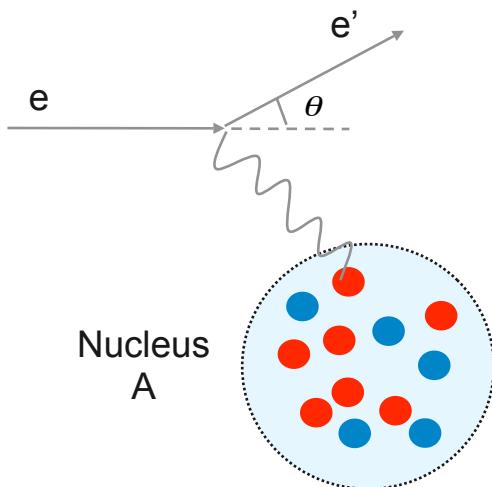
Inclusive scattering at large x



Motion of nucleon in the nucleus
broadens the peak



Inclusive scattering at large x

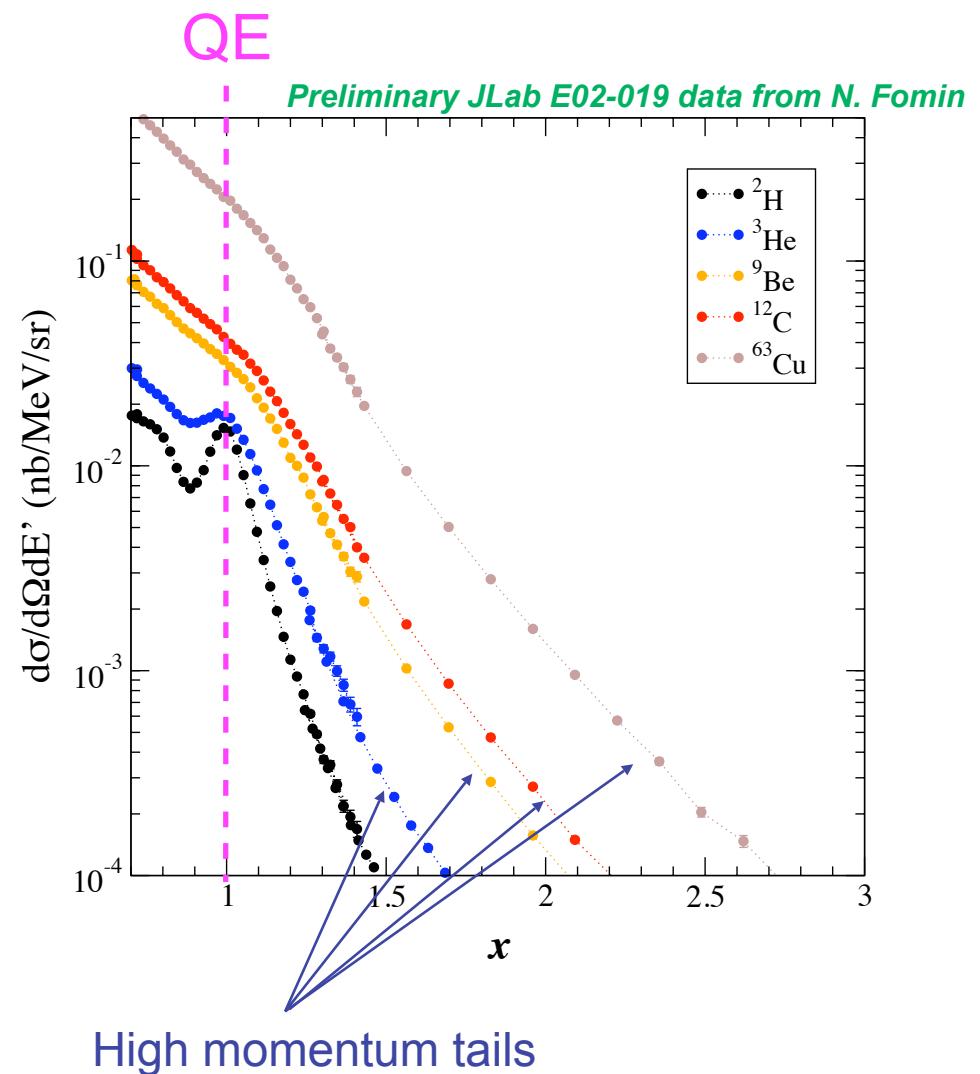


Quasi-Elastic Scattering

$$x \approx 1$$

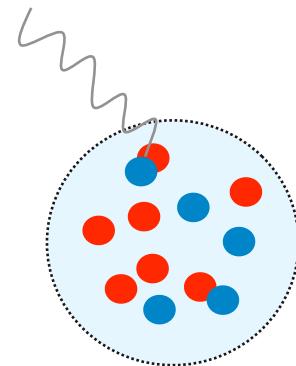
Motion of nucleon in the nucleus
broadens the peak

little strength from QE above $x \approx 1.3$



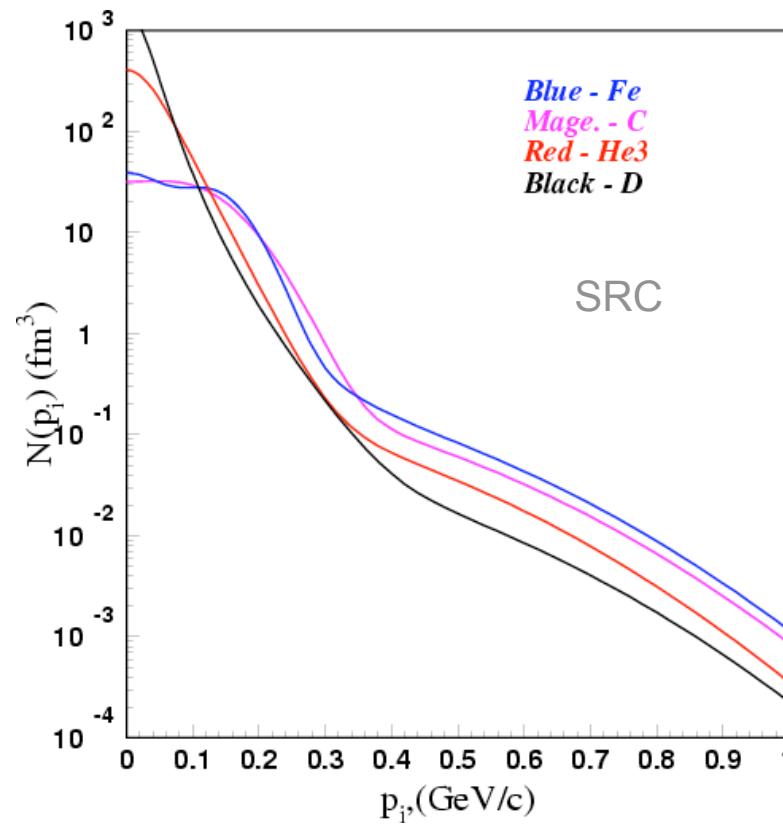
Short range correlations (SRC)

- NN interaction generates high momenta ($k > k_f$)
- High-momentum tail dominated by 2N-SRCs
- Similar shape for $k > k_f$



2N-SRC

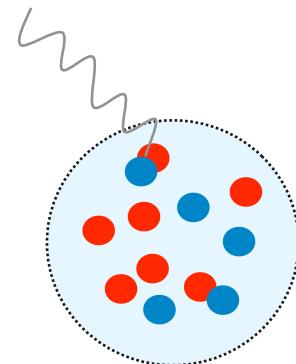
$1 < x < 2$



Cioffi Degli Atti et Simula, PRC53, 1689 (1996)

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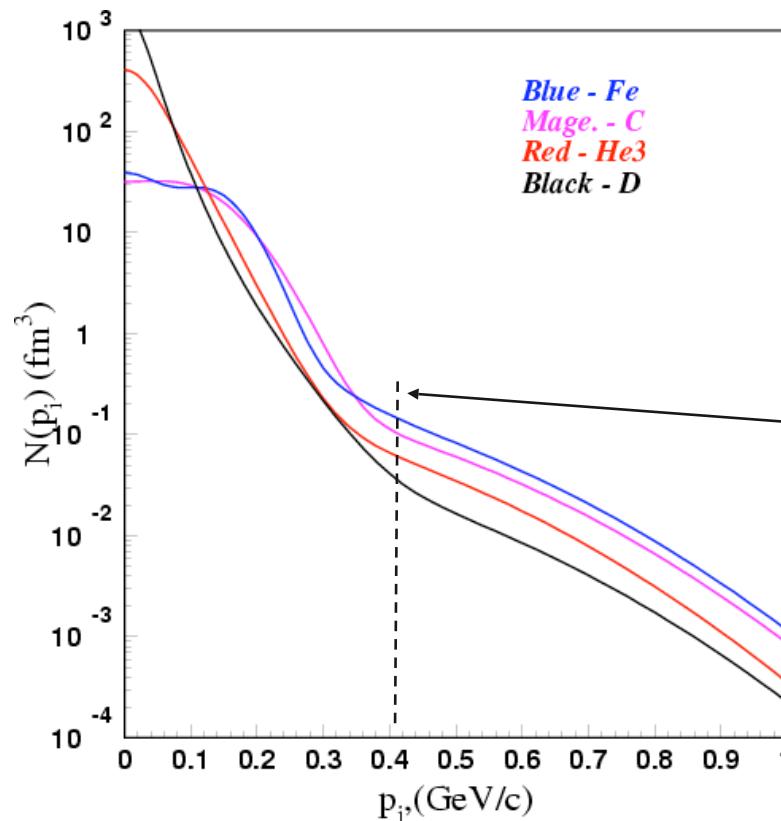
2N-SRC

$1 < x < 2$

Above: ratio = constant

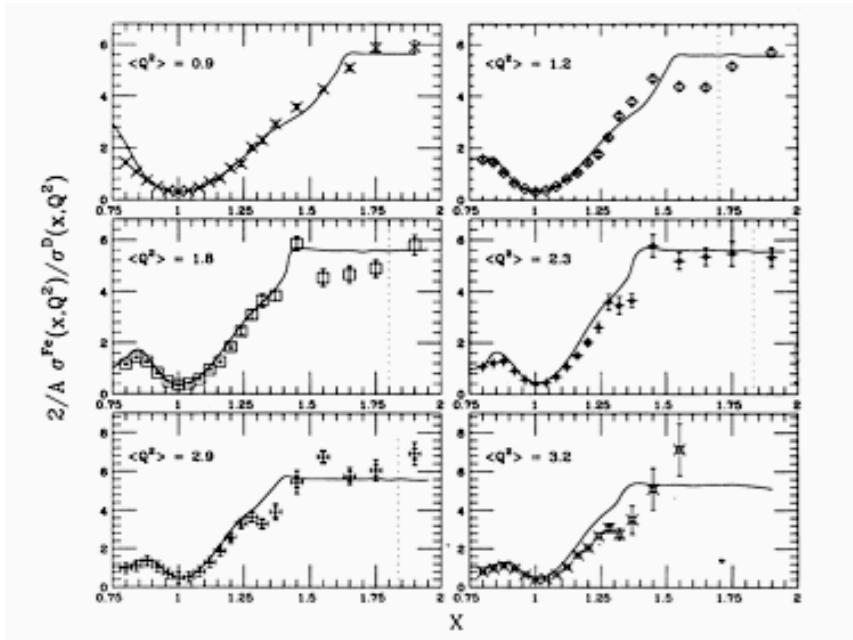
$A(e', e)$ at $x > 1$:
the simplest way to
measure relative
probability of SRC

Cioffi Degli Atti et Simula, PRC53, 1689 (1996)



SRC evidence at SLAC

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



$a_2(^3\text{He}) = 1.7 \pm 0.3$
$a_2(^4\text{He}) = 3.3 \pm 0.5$
$a_2(^{12}\text{C}) = 5.0 \pm 0.5$
$a_2(^{27}\text{Al}) = 5.3 \pm 0.6$
$a_2(^{56}\text{Fe}) = 5.2 \pm 0.9$
$a_2(^{197}\text{Au}) = 4.8 \pm 0.7$

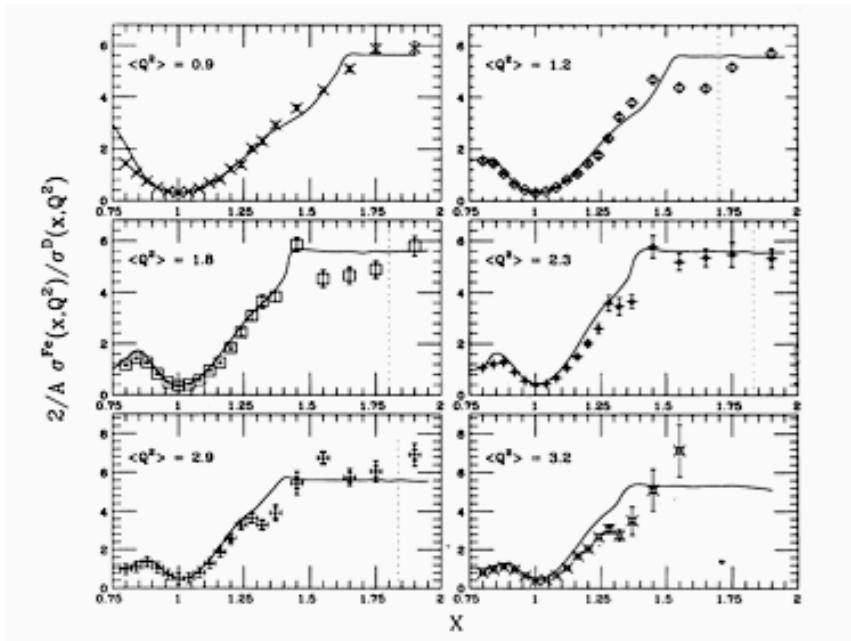
a_2 =ratio in plateau represents probability of 2N SRC

SRC Model:

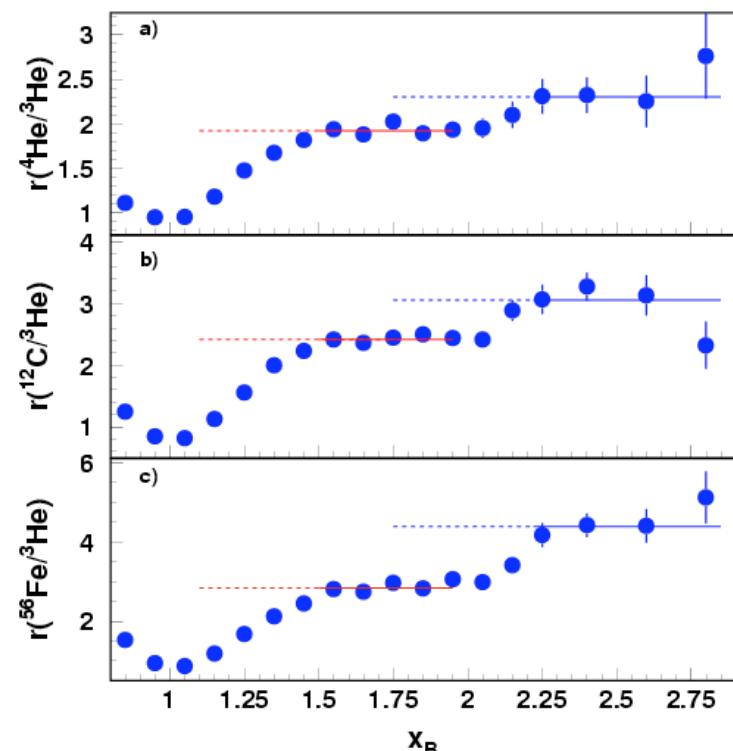
- 1N, 2N, 3N, ..., contributions at $x \leq 1, 2, 3, \dots$
- isospin independence

SRC evidence at SLAC, JLab Hall B

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



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



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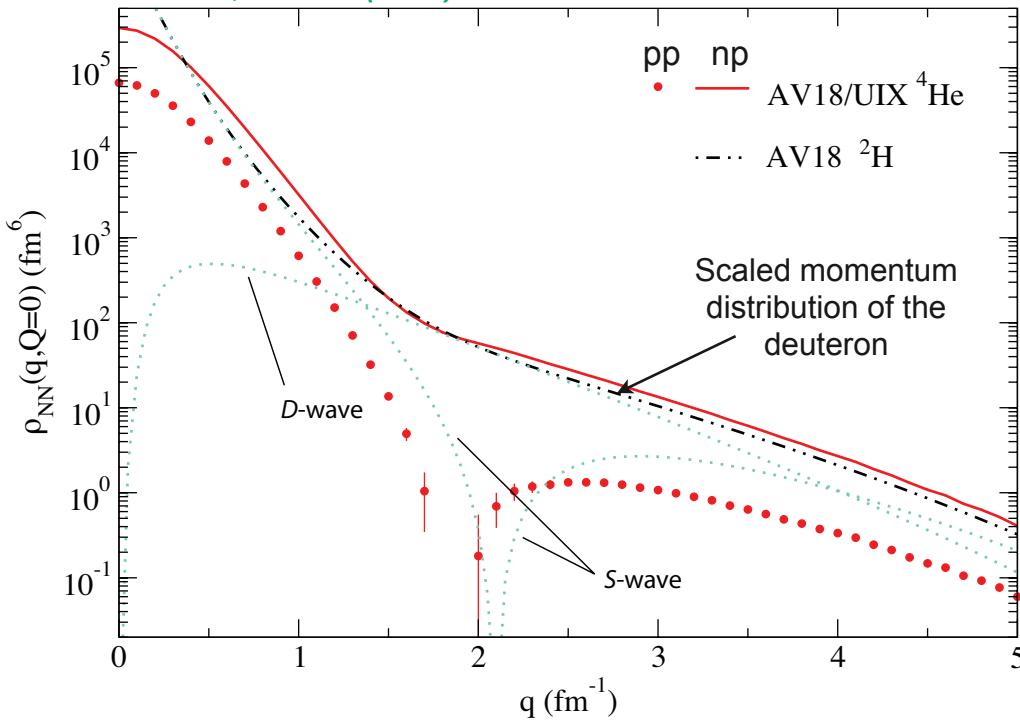
Experimental observations:

- Evidence of 2N-SRC at $x > 1.5$
- Indication of 3N-SRC plateau
- Isospin dependence ?

Dominance of the tensor force

Simple SRC model assumes
isospin independence

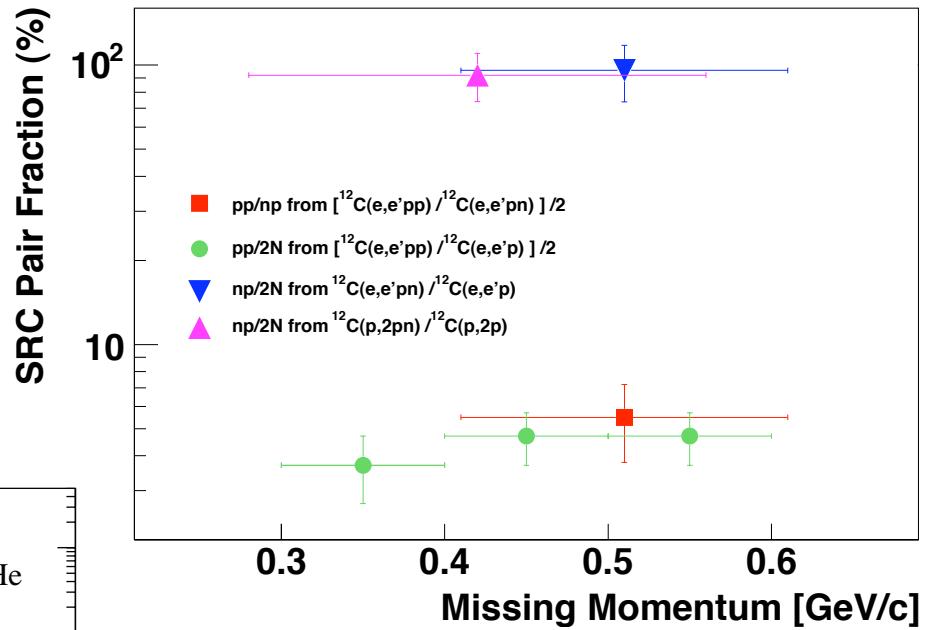
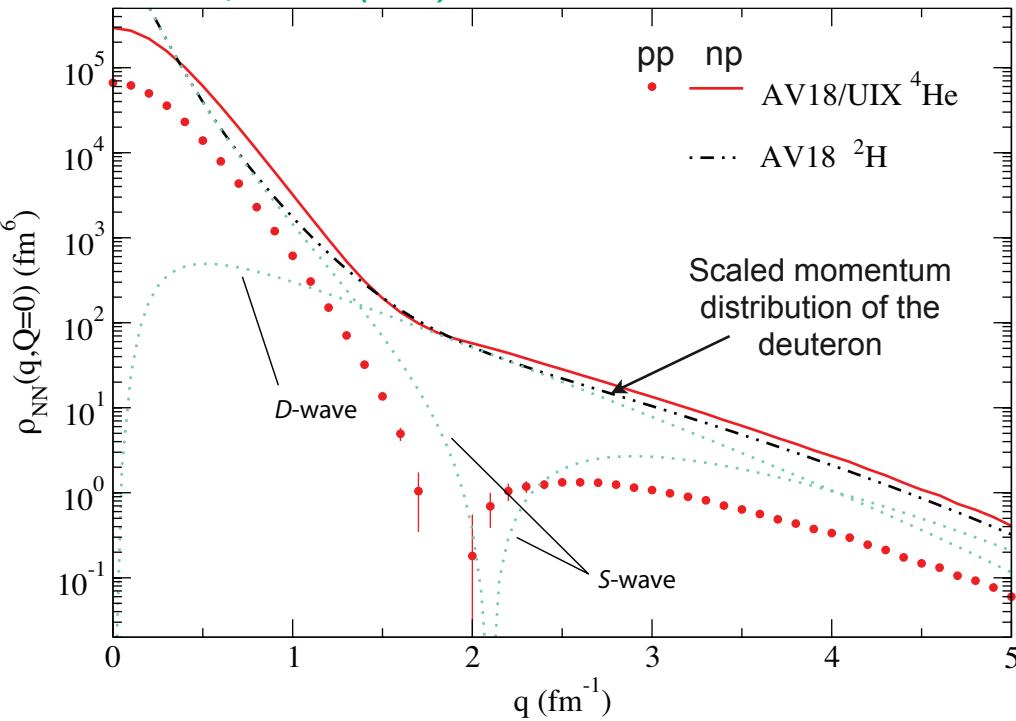
*R. Schiavilla, R. Wiringa, S. Pieper and J. Carlson,
PRL98, 132501 (2007)*



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

Isospin study of SRC

$^3\text{He}/^3\text{H}$ is simple/straightforward case:

Simple mean field estimates for 2N-SRC

Isospin independent:

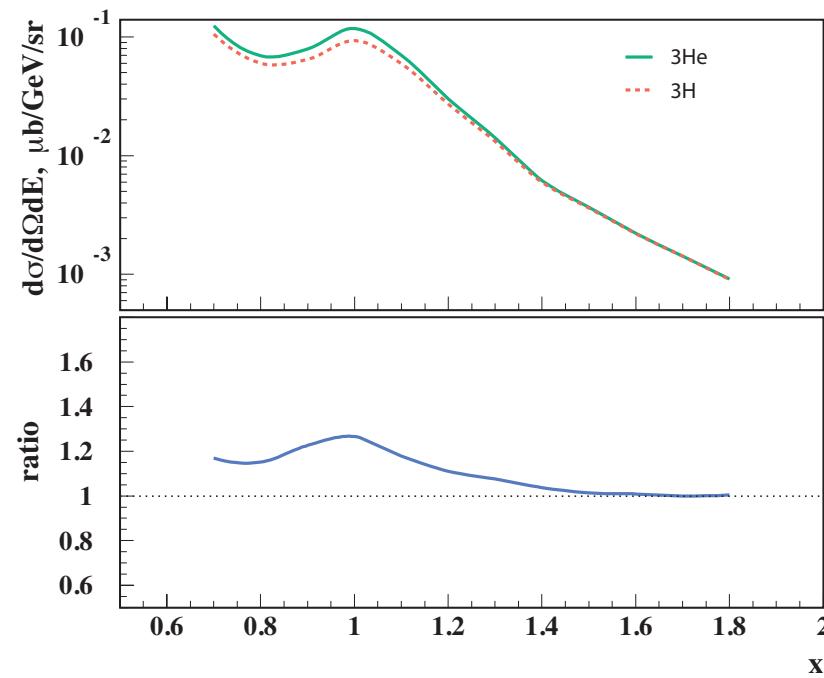
$$\frac{\sigma_{^3\text{He}}/3}{\sigma_{^3\text{H}}/3} = \frac{(2\sigma_p + 1\sigma_n)/3}{(1\sigma_p + 2\sigma_n)/3} \xrightarrow{\sigma_p \approx 3\sigma_n} 1.40$$

n-p (T=0) dominance:

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

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

M. Sargsian, private com.



Isospin study of SRC

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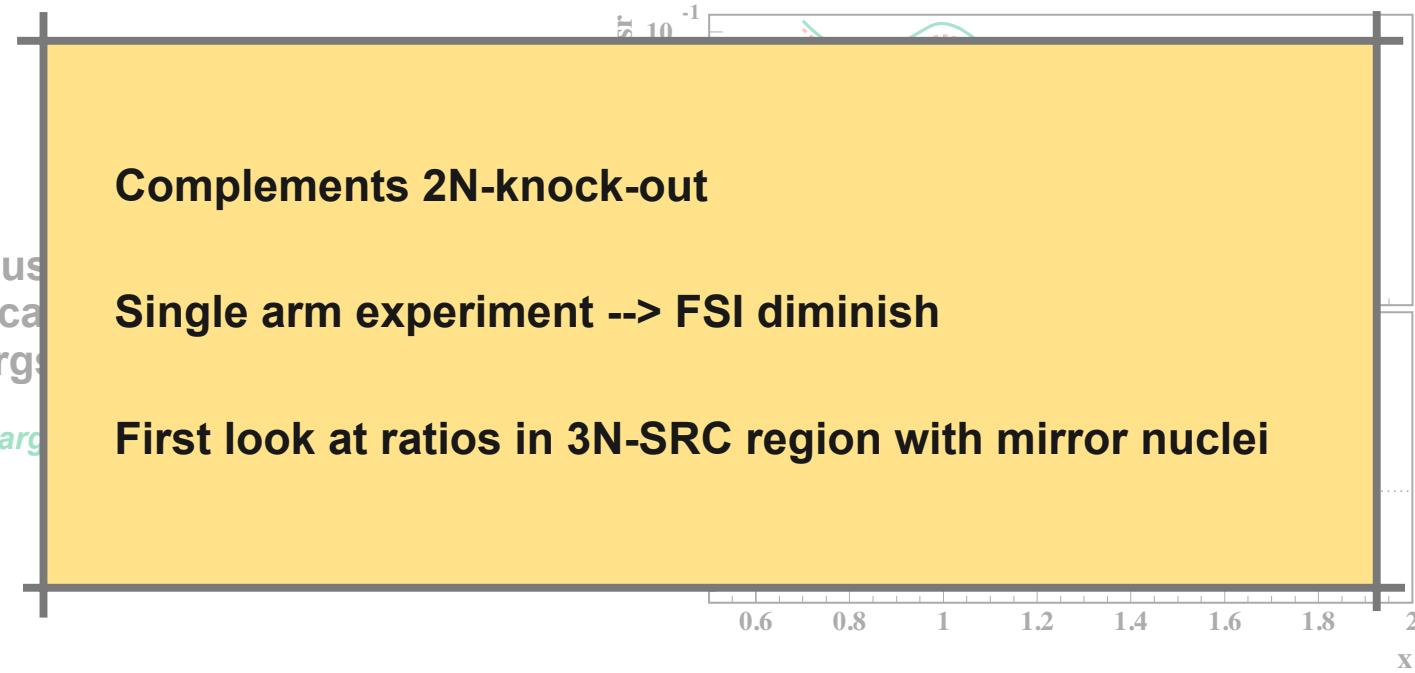
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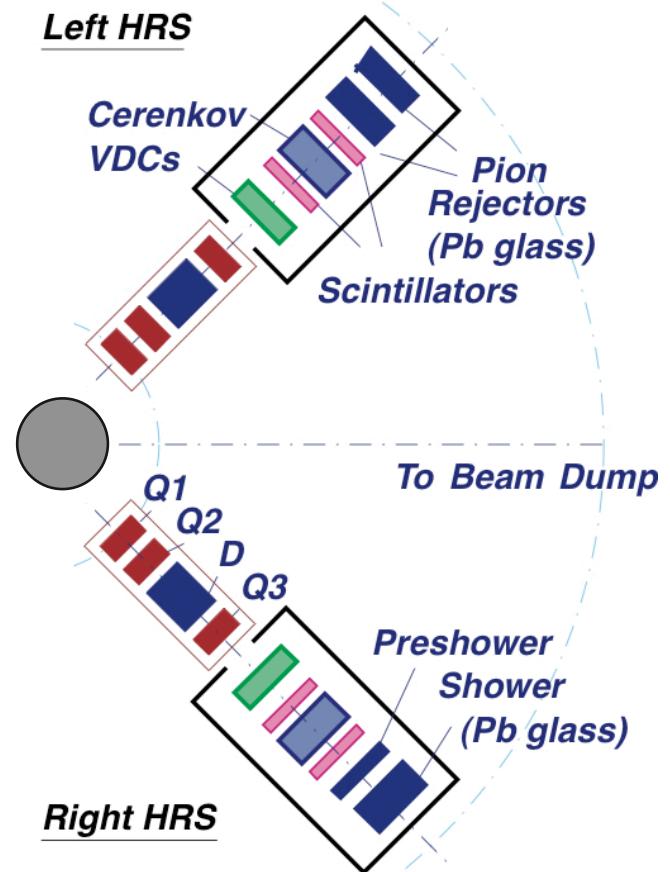
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PR09-010: Experimental setup

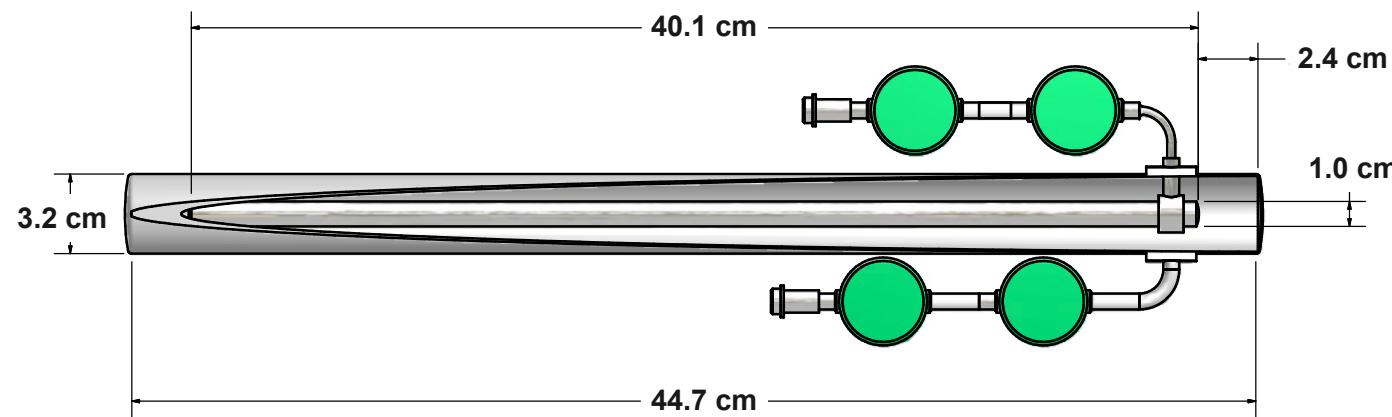
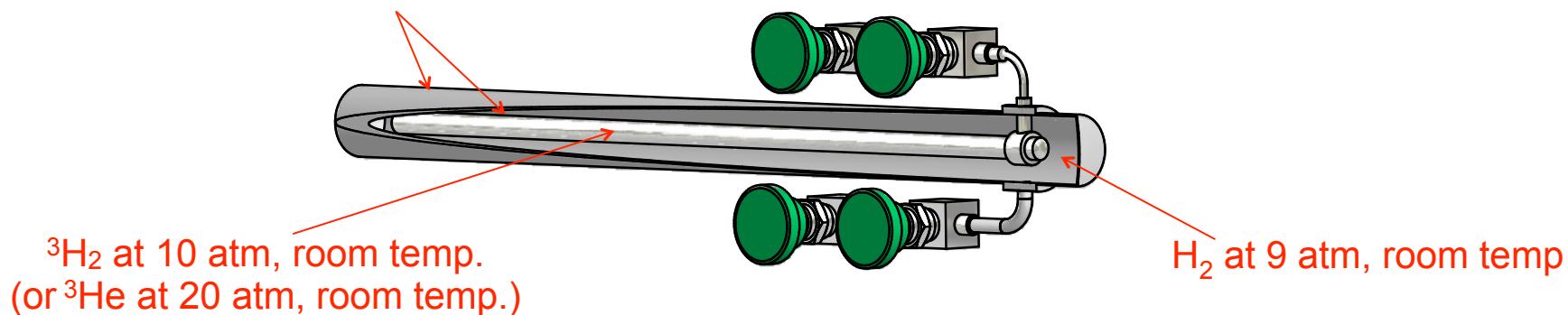
- ❖ Standard Hall A configuration
- ❖ ^3H , ^3He at room temperature, then H and ^2H cryo-targets
- ❖ Empty stainless steel cell for window subtraction
- ❖ Carbon foils for optics
- ❖ Gas Cerenkov + Calorimeter for PID



The tritium target conceptual design

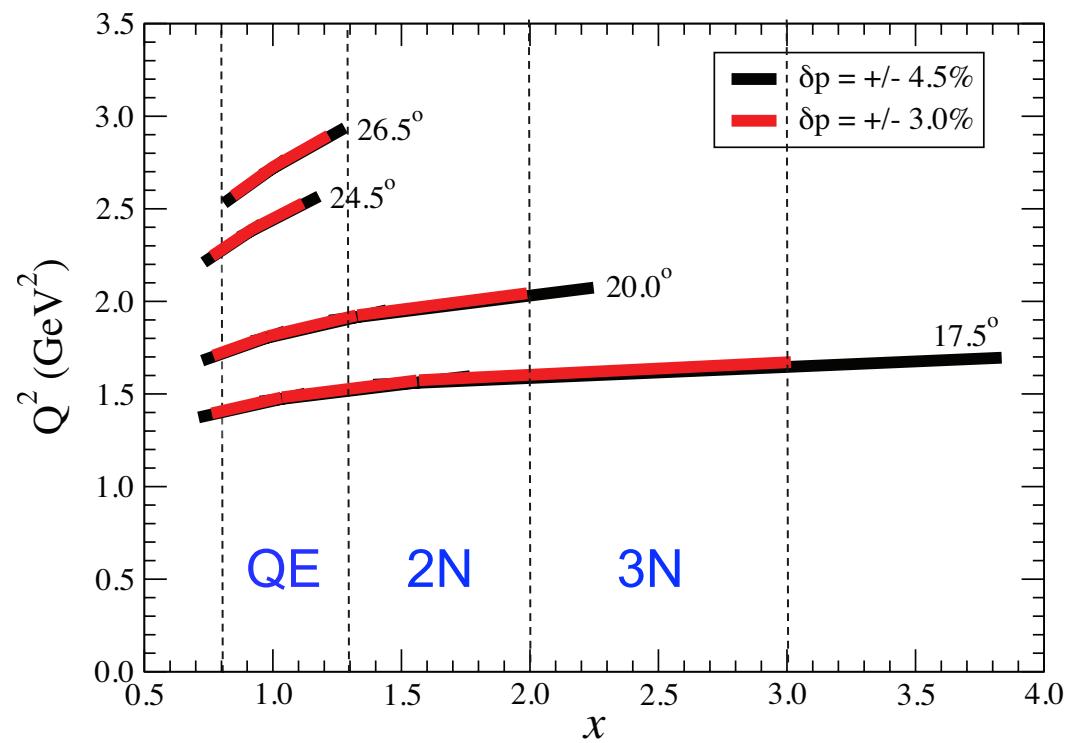
- ❖ Closed double-cell system
- ❖ Density: 2.5mg/cm³
- ❖ Target length/diameter: 40cm/1cm
- ❖ Activity < 1000 Ci
- ❖ H₂ for heat conduction

0.004" (0.008") stainless steel inner
(outer) tubes with 0.004" windows



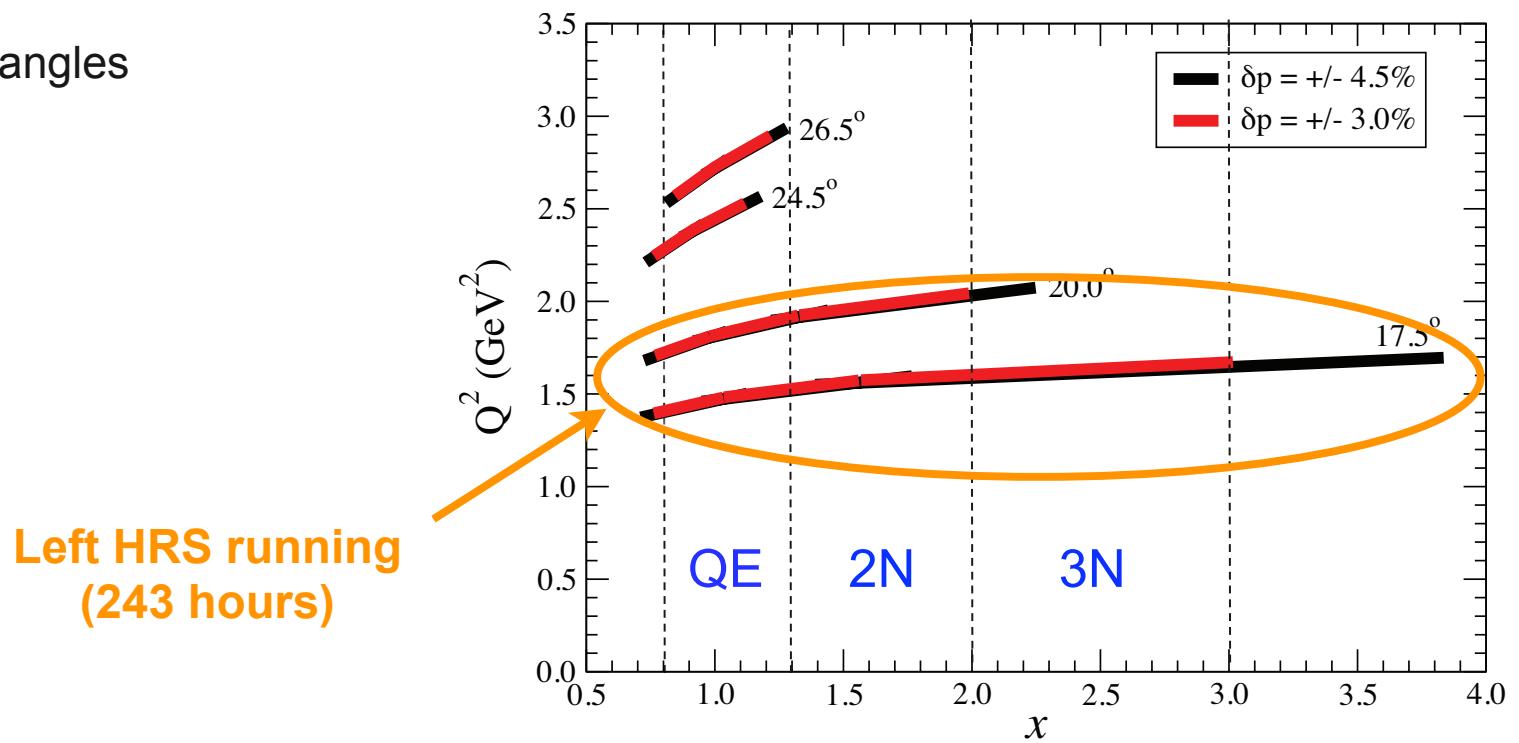
Kinematic coverage

- Beam energy: 4.4 GeV (unpolarized)
- Max. beam current: 30 μ A with raster or diffuser
- 4 scattering angles



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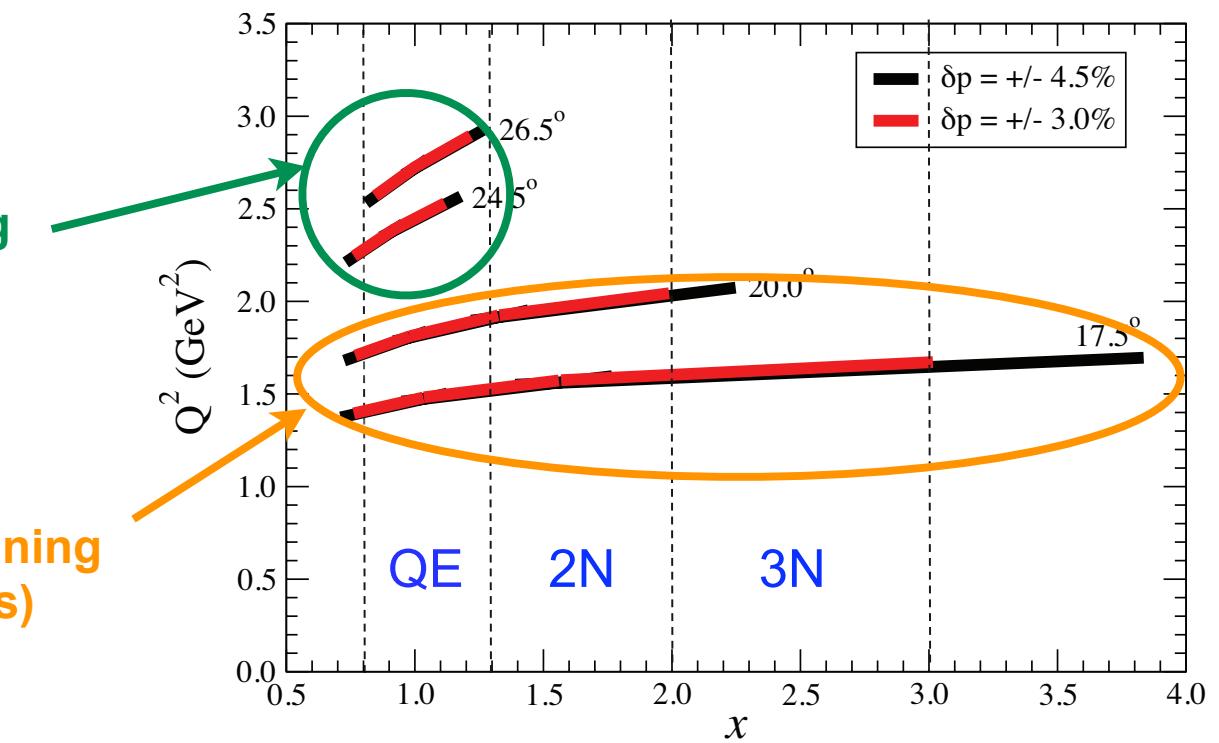


Kinematic coverage

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Right HRS running
(simultaneously)

Left HRS running
(243 hours)

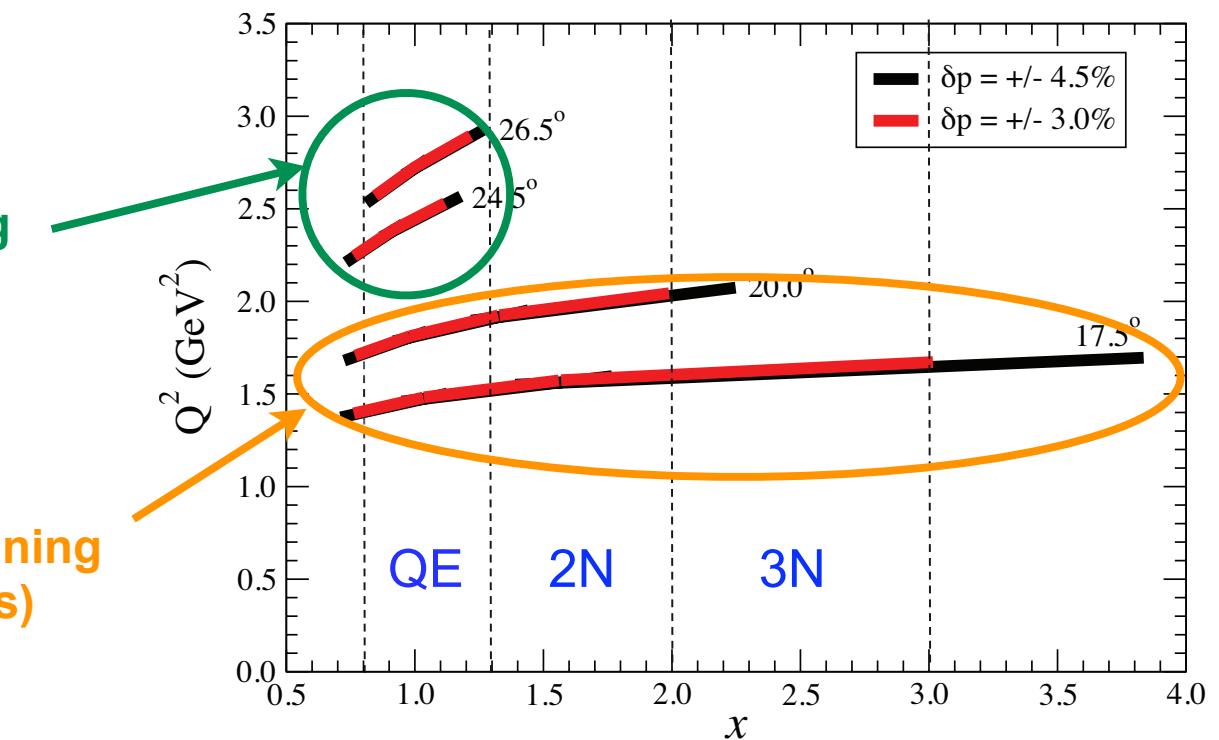


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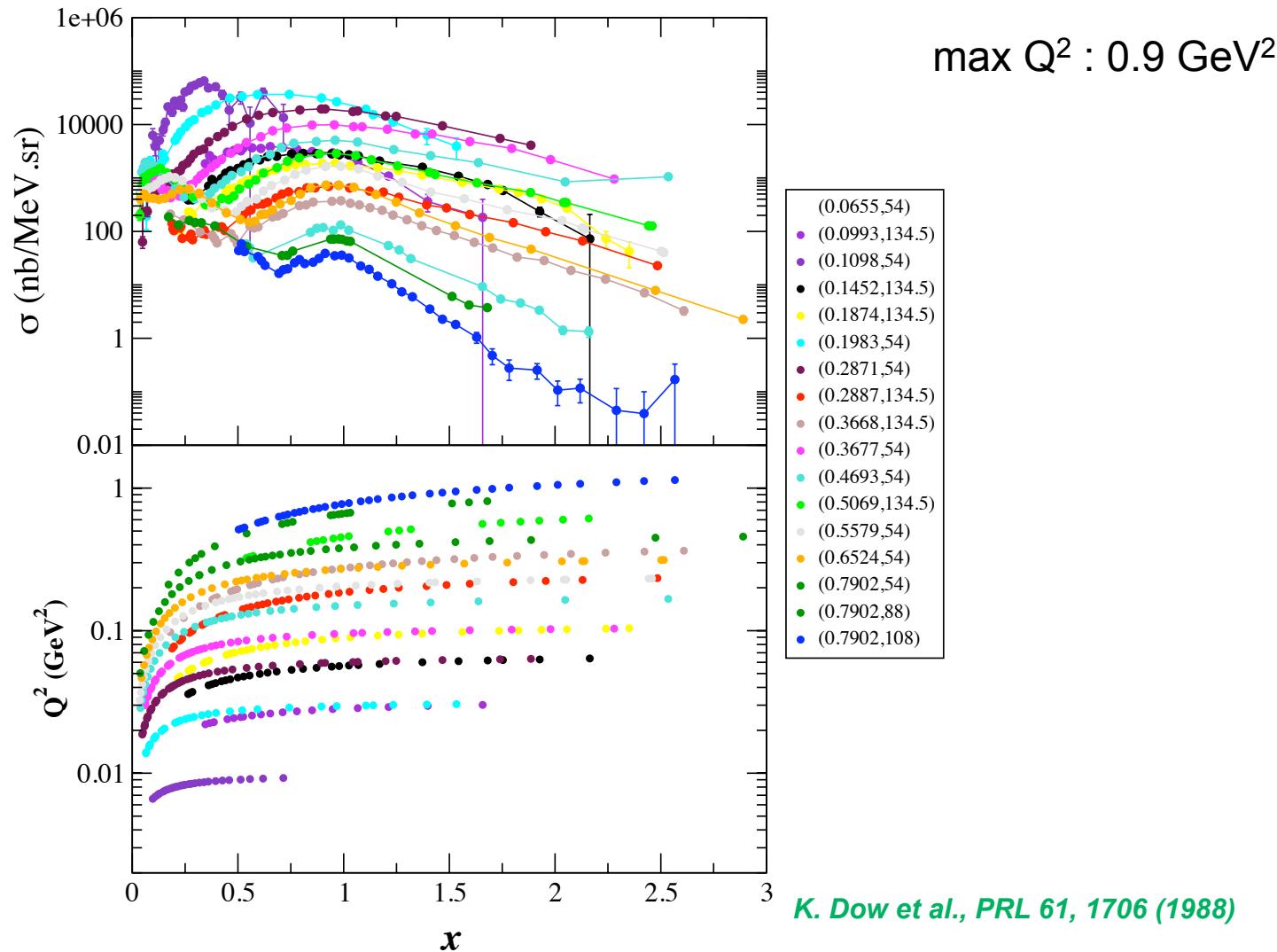
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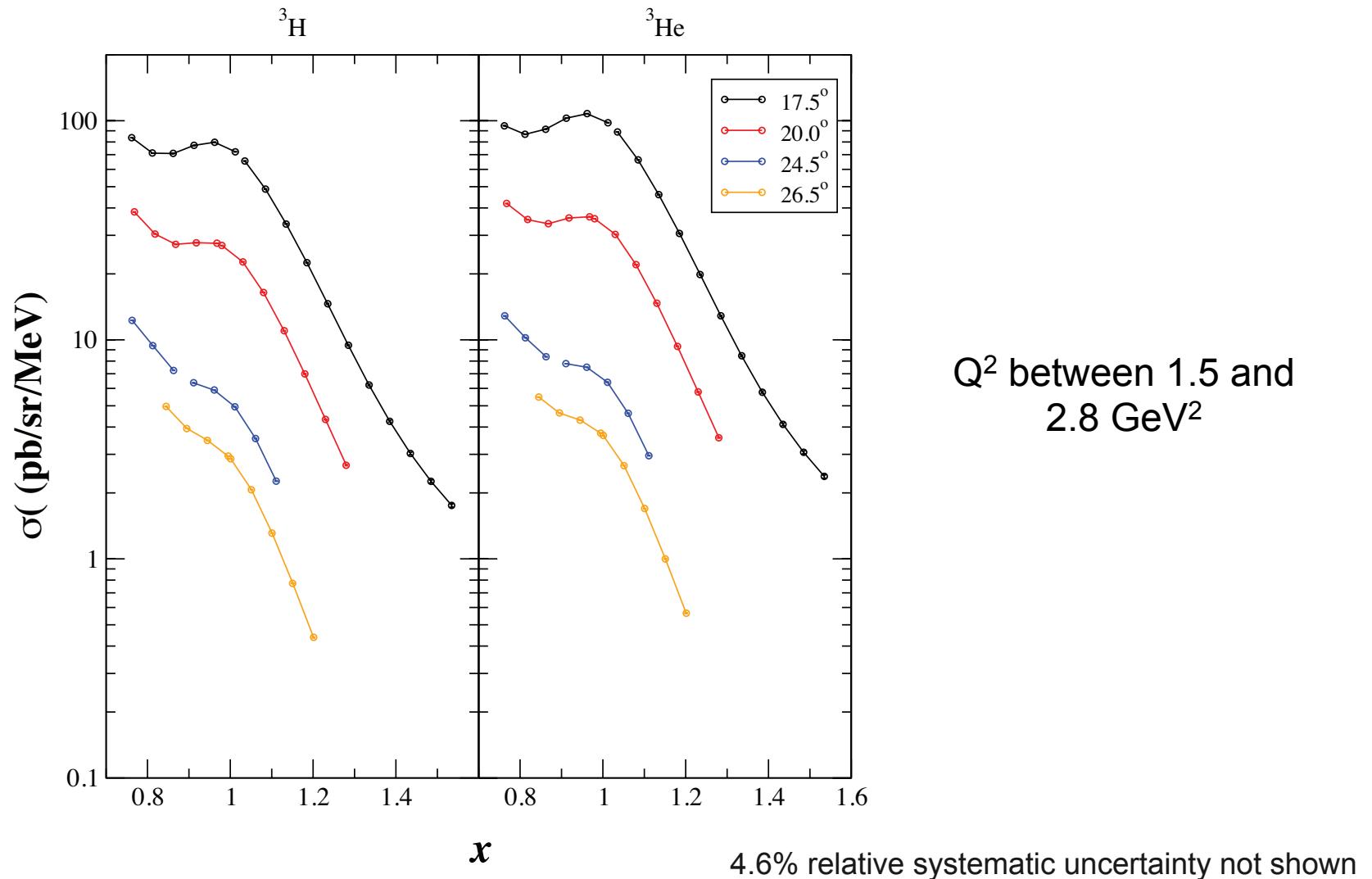


E08-014 will help us optimize the kinematics.

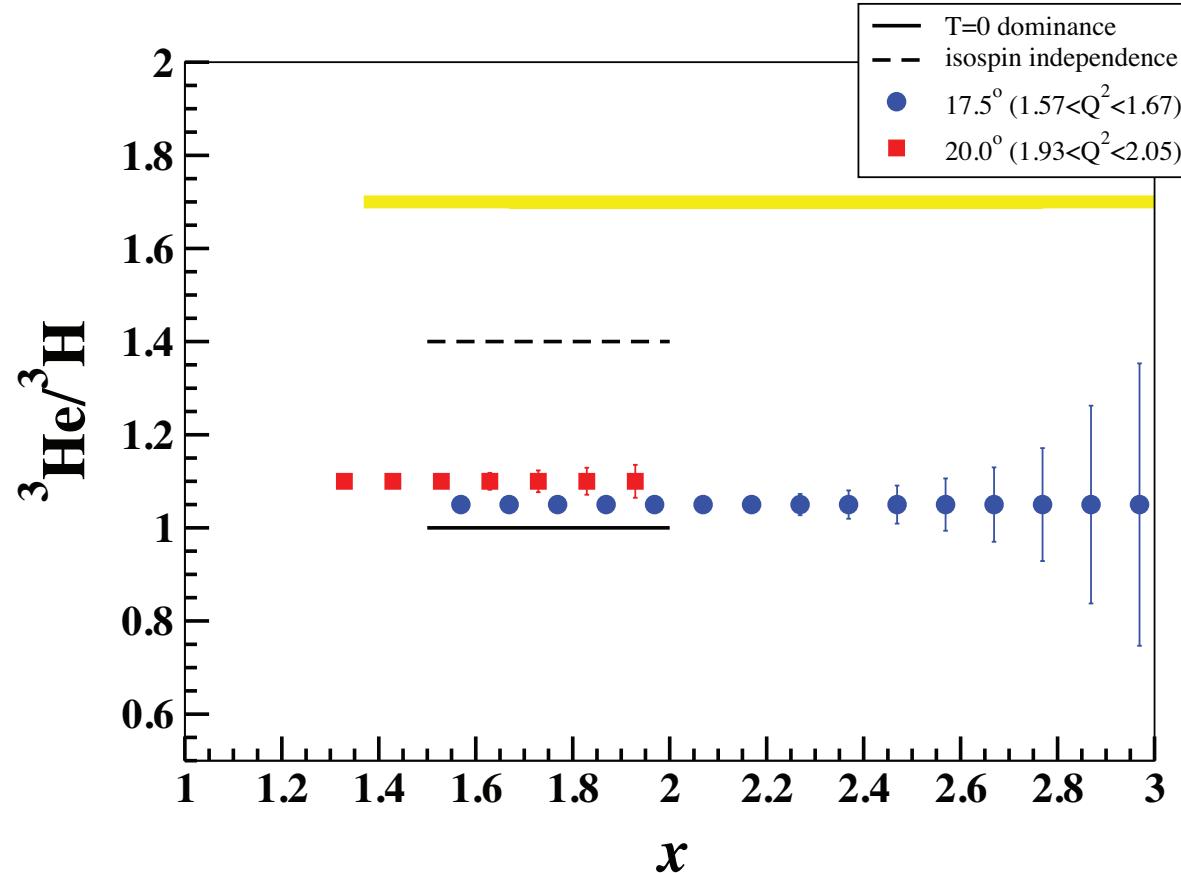
Tritium world data in the QE region



Proposed precision in the QE region



Proposed precision on the isospin study



PR09-010 collaboration

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and

the Hall A Collaboration

* Bogdan Wojtsekhowski

Summary

- Study of isospin dependence of 2N-SRC from $^3\text{H}/^3\text{He}$ from inclusive scattering: will complement the results of 2N knockout experiments
- First look at isospin dependence in 3N-SRC region
- Quasi-elastic data on ^3H and ^3He for Q^2 -values of 1.5-2.8 (GeV/c) 2 . (World data stop at 0.9 (GeV/c) 2 for ^3H .)
- With the help of E08-014 data, we can optimize the kinematics for this experiment
- *Beam time requested:* 13 days production data including time for calibrations, background studies and configuration changes
- Hall A in standard configuration + the ^3H and ^3He target system as for the 12 GeV DIS ratio experiment