Possibilities for studying few nucleon correlations and Δ – isobars in processes with several final state baryons.

Short-Range Structure of Nuclei at 12 GeV
October 26-27, 2007
Jefferson Lab, Newport News, VA USA

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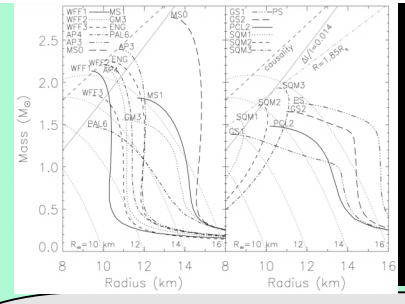
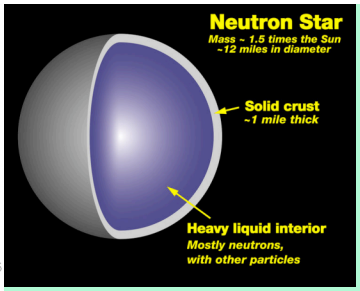
SRC in nuclei

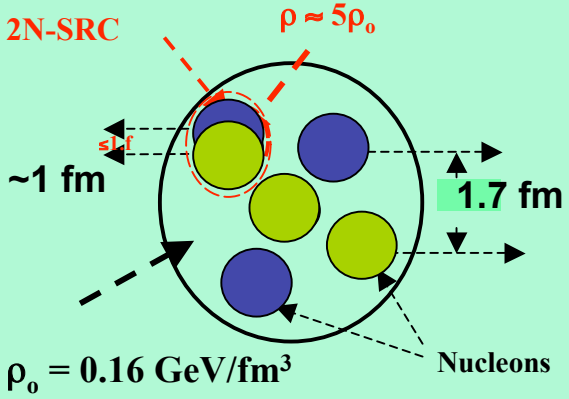
Roadmap



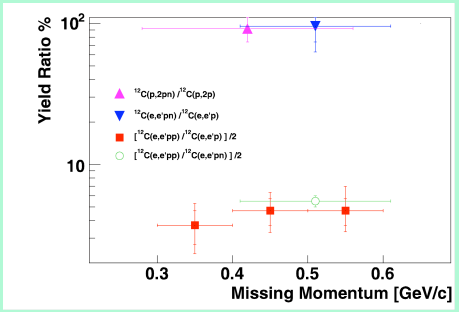


What is the role played by short range correlation of more than two nucleons ?

How to relate what we learned about SRC in nuclei to the dynamics of neutron star formation and structure ?

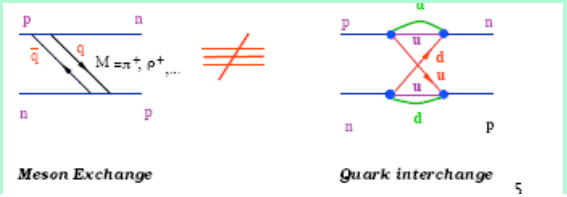


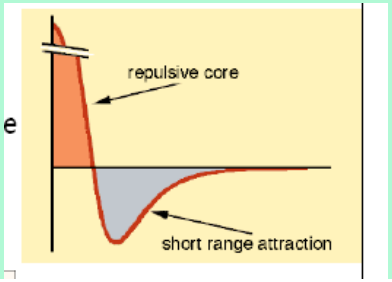
SRC in nuclei

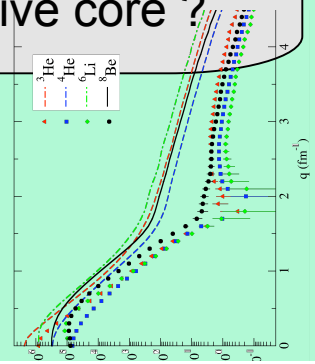


•Are the nucleons in the SRC pair different from free nucleons (e.g size,shape, mass, etc.) ? Are they nucleons ?

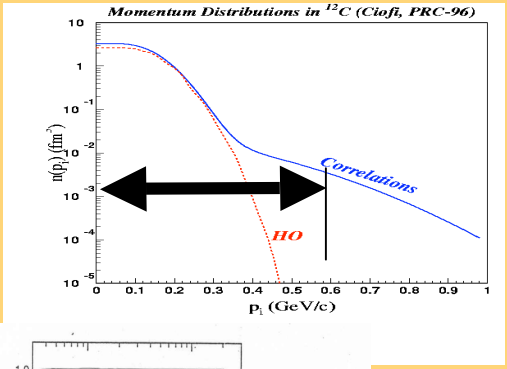
NN interaction: what is the role played by the repulsive core ?

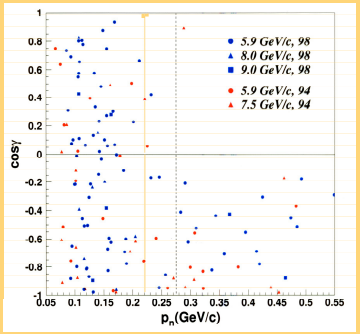


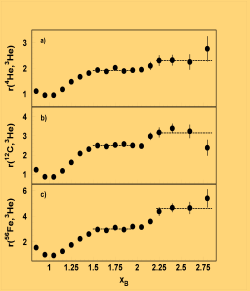


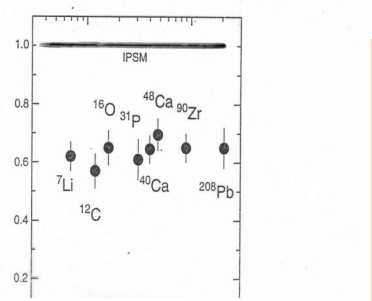


^{12}C:









np-SRC

18±4.5 %

2N-SRC

20±4.5 %

pp-SRC

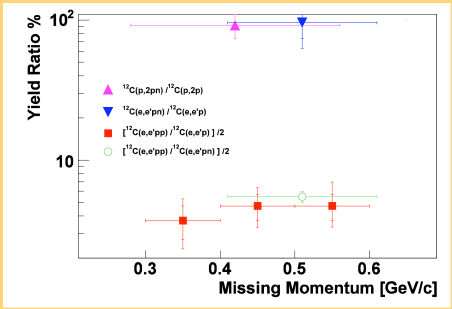
0.95 ± 0.2 %

nn-SRC

0.95 ± 0.2 %

A single “particle” in an average potential

80±4.5%



The uncertainties allow a few percent of:

- more than 2N correlations
- Non nucleonic degrees of freedom

Identifying Future Experiments

Looking for SRC with more than 2 nucleons:

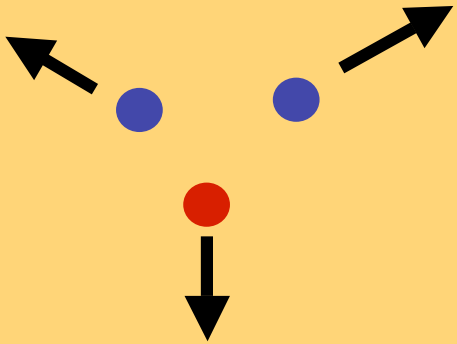
Identifying Future Experiments

Looking for SRC with more than 2 nucleons:

The problems:

- The cross sections are small.
- 1N >> 2N - SRC >> 3N – SRC.

star geometry :



Questions

What is the signature for 3N correlation ?

What is the difference from two 2N correlations ?

What is the expected isospin structure of the 3N ?

Identifying Future Experiments

Looking for SRC with more than 2 nucleons:

The problems:

- The cross sections are small.
- 1N >> 2N - SRC >> 3N – SRC.

The cure for 1N background is : large p_{miss} and/or large X_B

The cure for 2N-SRC:

$X_B>2$ or

suppression of the 2N-SRC at p_{rel}=300-600 MeV/c for nn or pp pairs.

Identifying Future Experiments

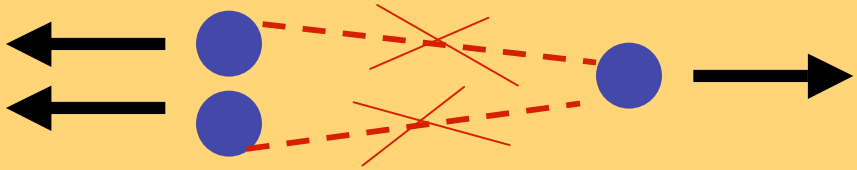
Looking for SRC with more than 2 nucleons:

Colinear geometry :

Initial configurations

~800 MeV/c ~800 MeV/c

A very strong isospin dependence is expected for the 2N part. For the 3N?



~400 MeV/c ~400 MeV/c

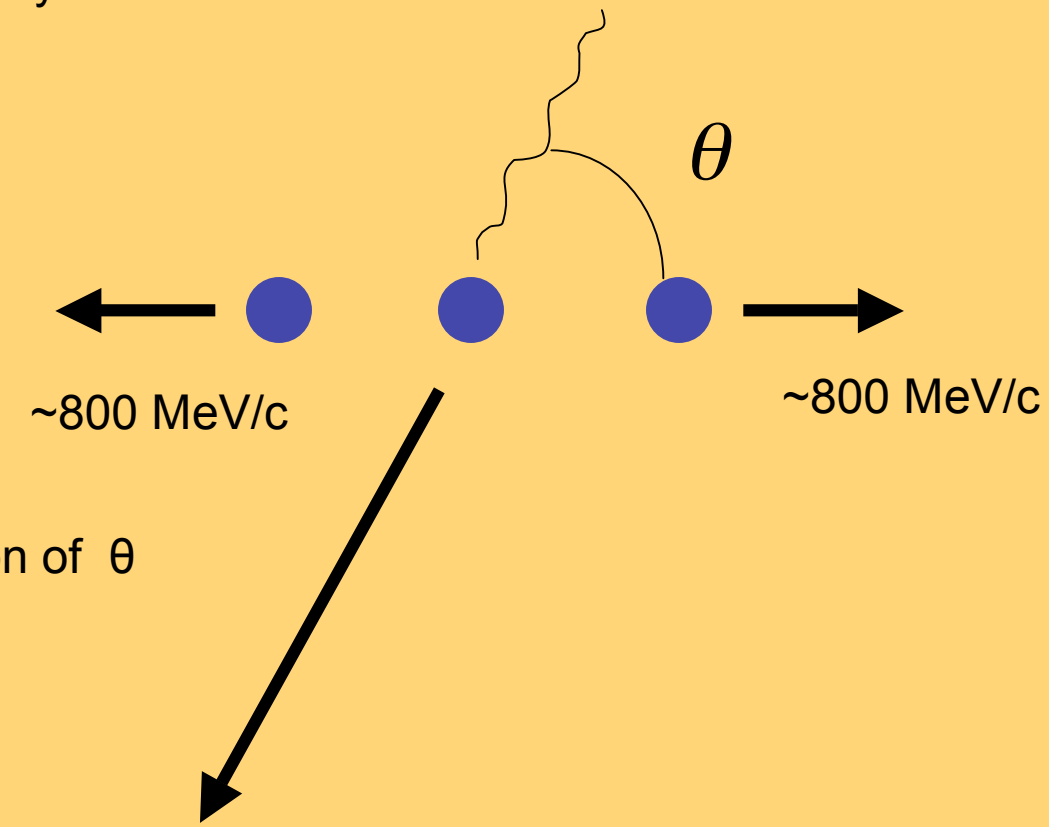
The 2N-SRC interaction is suppressed, opening a window of opportunity to identify 3N correlation.

The signal of today is tomorrow's background

Identifying Future Experiments

Looking for SRC with more than 2 nucleons:

Colinear geometry



FSI are strong function of θ

SRC are not

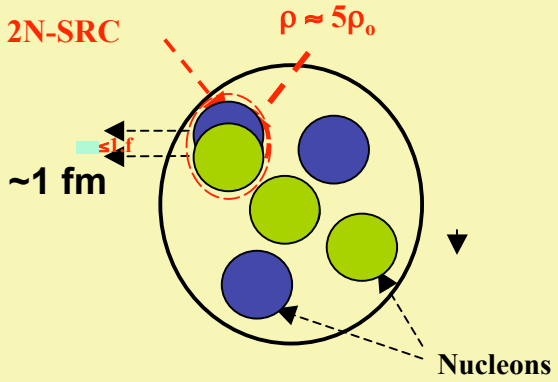
Identifying Future Experiments

Looking for non-nucleonic degrees of freedom

$$\psi_{SRC} = a\psi_{NN} + b\psi_{N\Delta} + c\psi_{\Delta\Delta} + \ldots$$

$$a \to 0, \qquad b, c, \ldots \to 1$$

Breaking the pair will yield more backward Δ, π , k



The signature of a non-nucleonic SRC intermediate state is a large branching ratio to a non nucleonic final state.

Looking for non-nucleonic degrees of freedom

In coincidence with (e, e'p), as a function of the missing momentum we want to detect;

p, n, π-, π+ k - triple coincidence

Identifying Future Experiments

Looking for non-nucleonic degrees of freedom

"np" → pn

→pΔ^0 →p π$^-$ p

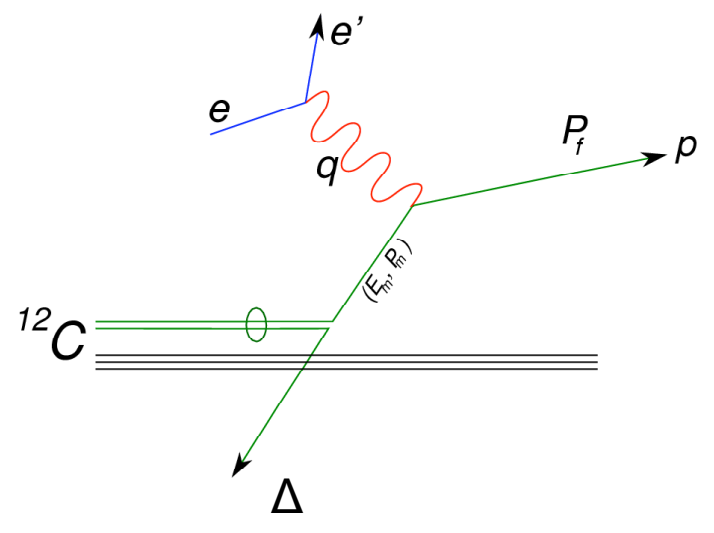
"pp" → pp

→pΔ$^+$ →p π+ n

$$\left.\begin{aligned}\Delta^0 &\rightarrow \pi^- p \\ \Delta^+ &\rightarrow \pi^+ n\end{aligned}\right\}$$ 4 fold coincidence

Expected rates 5-10% of recoil N

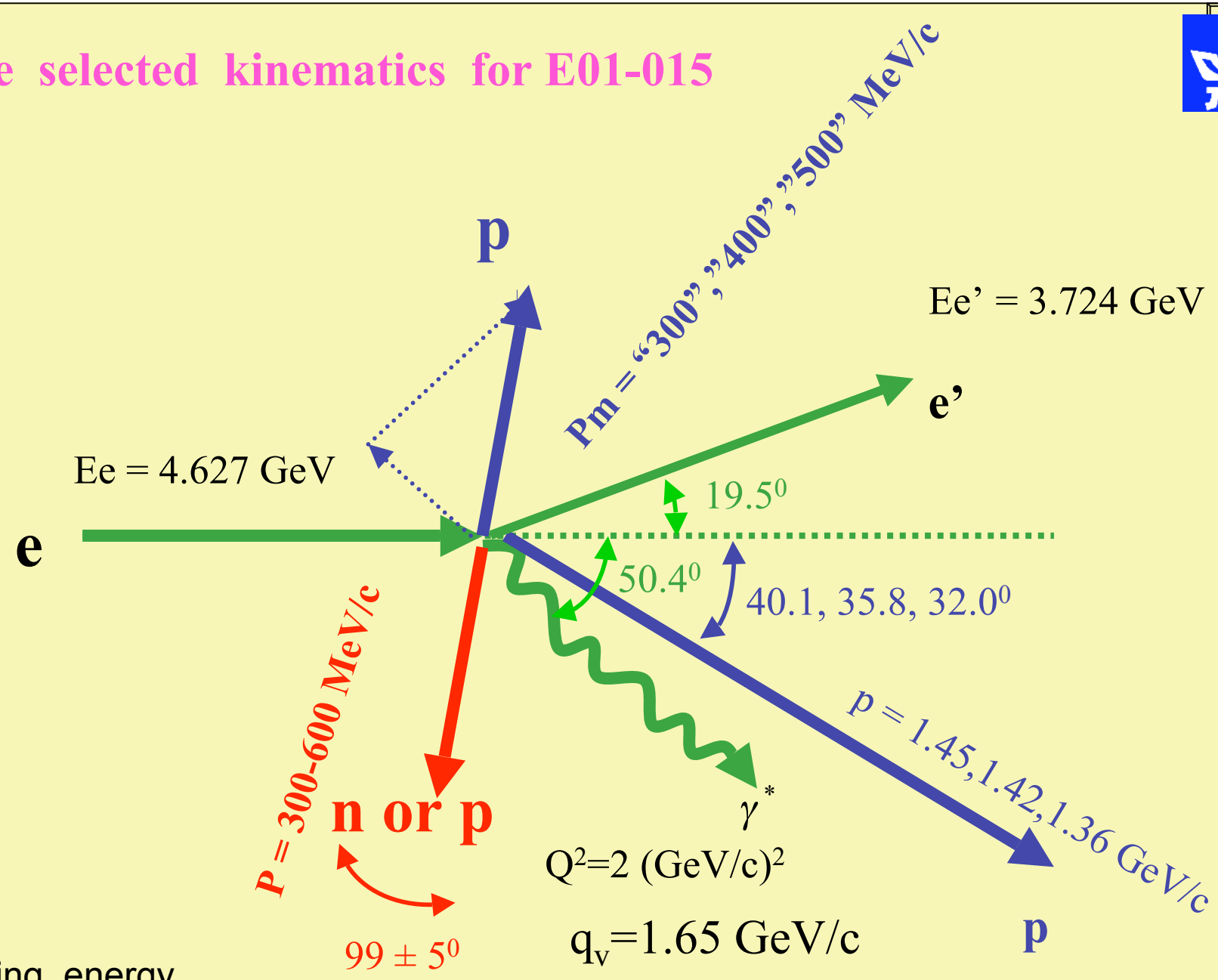
Kinematics



$$e + d \rightarrow e' + p + \Delta$$

$$(q + p_d - p_f)^2 = m_\Delta{}^2$$

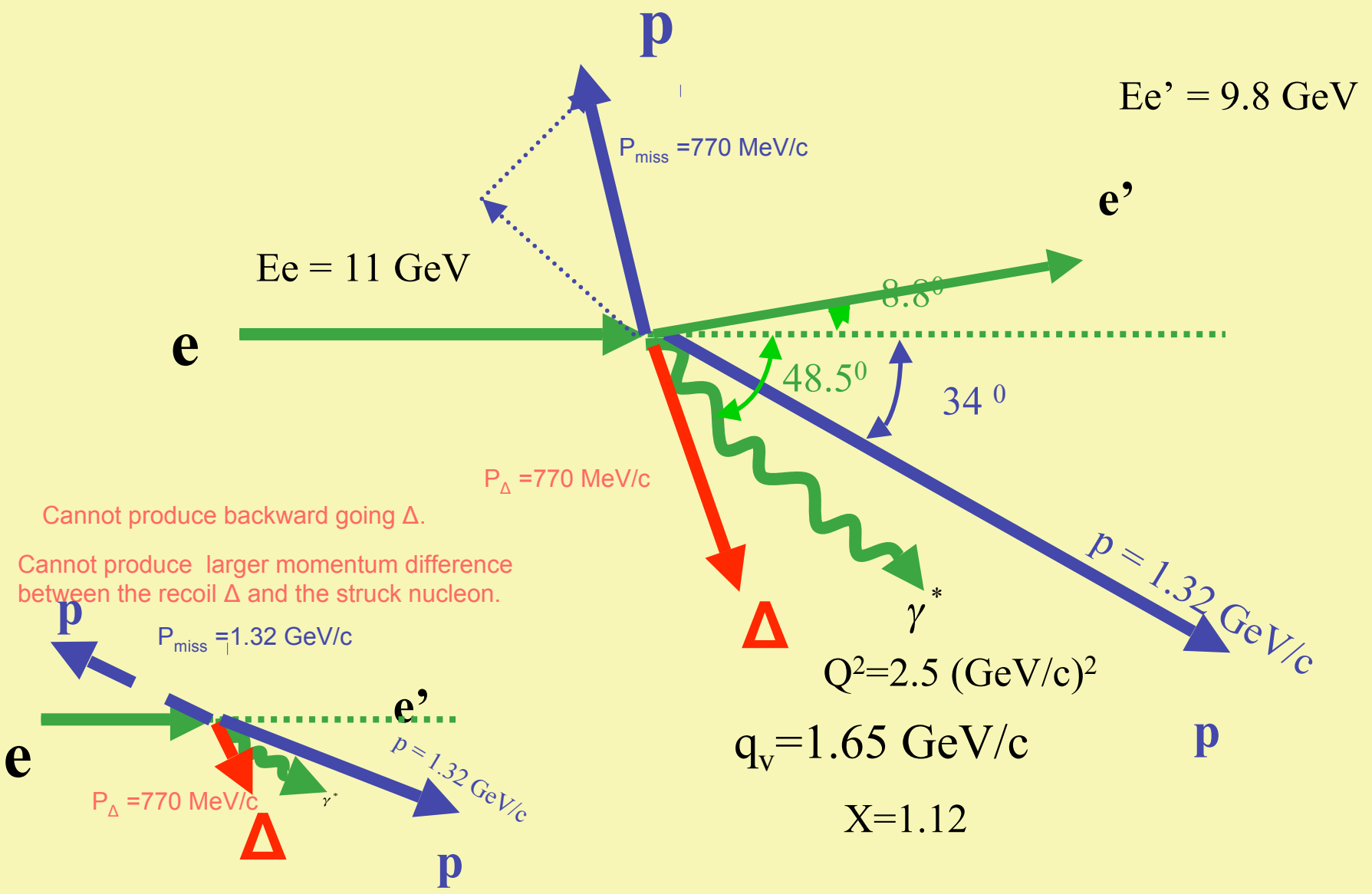
The selected kinematics for E01-015



Increasing, energy,
ω,N→Δ ?

The selected kinematics

Increasing, energy and ω, N→Δ



Ee= 11.00000 Eout= 9.790000 theta_e = 8.800000
Q2= 2.535372 x= 1.116600
input angle of (qe) and (qp) planes 0.0000000E+00
theta of q: -48.49650

The format of the following output is:
type of the particle, momentum, angle vs q,
angle vs e, azimuthal angle in lab

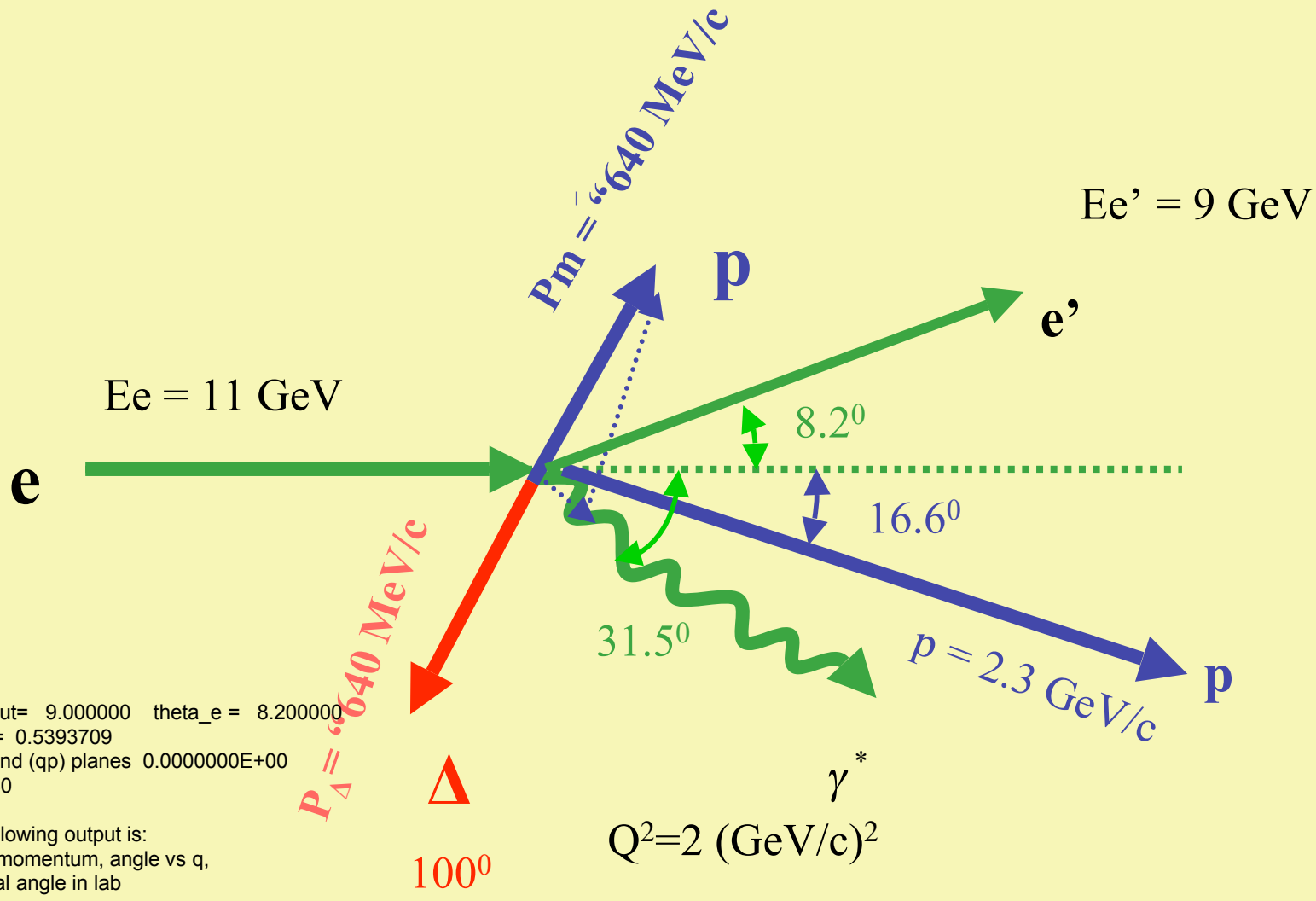
knock-out nucleon 1.328000 13.52419 34.97231 180.0000
missing 0.7737520 156.3361 107.8397 0.0000000E+00
recoil 0.7737520 23.66388 72.16035 180.0000
tet between recoil and scattred proton -37.18803
pmiss in the q direction 0.7086919

Ee= 11.00000 Eout= 9.960000 theta_e = 8.200000
Q2= 2.240232 x= 1.147892
input angle of (qe) and (qp) planes 0.0000000E+00
theta of q: -51.20859

The format of the following output is:
type of the particle, momentum, angle vs q,
angle vs e, azimuthal angle in lab

knock-out nucleon 1.200000 5.490372 45.71821 180.0000
missing 0.6385024 169.6408 118.4322 0.0000000E+00
recoil 0.6385024 10.35917 61.56776 180.0000
tet between recoil and scattred proton -15.84955
pmiss in the q direction 0.6280947

The selected kinematics for the measurement



Ee= 11.00000 Eout= 9.000000 theta_e = 8.200000
Q2= 2.024307 x= 0.5393709
input angle of (qe) and (qp) planes 0.0000000E+00
theta of q: -31.53330

The format of the following output is:
type of the particle, momentum, angle vs q,
angle vs e, azimuthal angle in lab

knock-out nucleon 2.300000 14.94191 16.59142 179.9802
missing 0.6368749 111.3839 79.85064 0.0000000E+00
recoil 0.6368749 68.61605 100.1494 180.0000
tet between recoil and scattred proton -83.55794
pmiss in the q direction 0.2322146

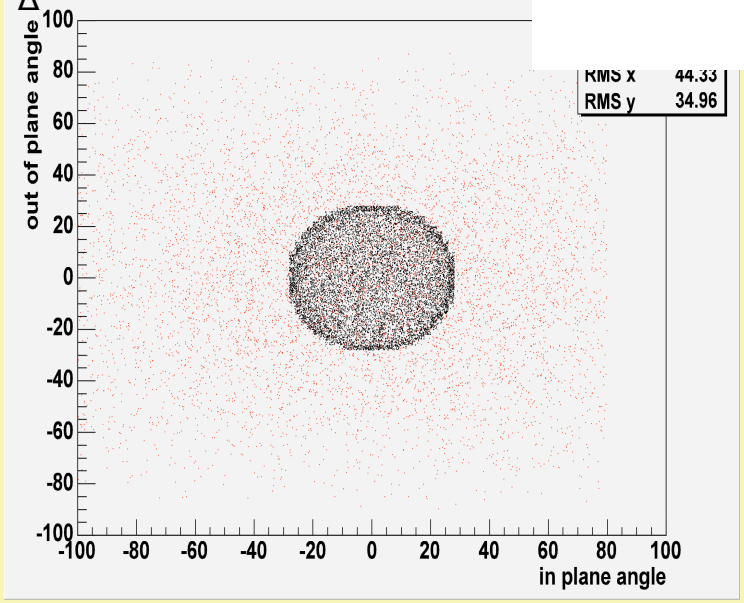
$Q^2=2\ (GeV/c)^2$

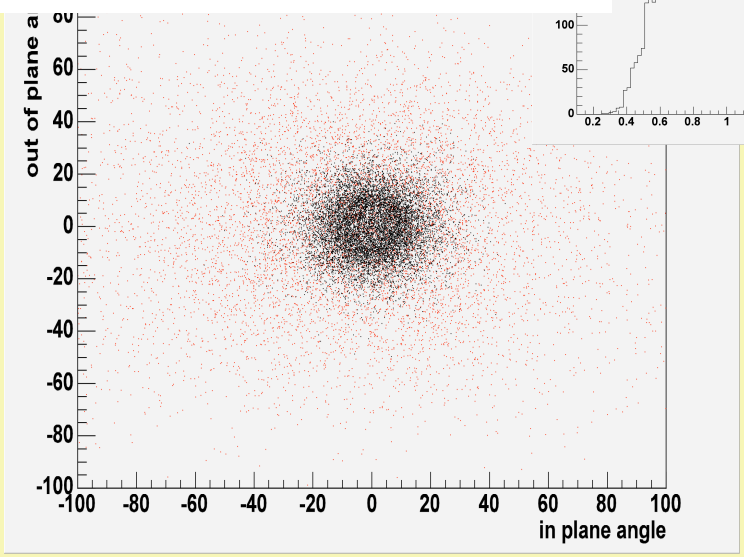
$q_v=2.5$ GeV/c

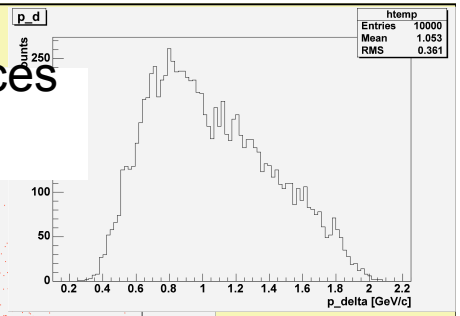
X=0.5

p_Δ=640 MeV/c

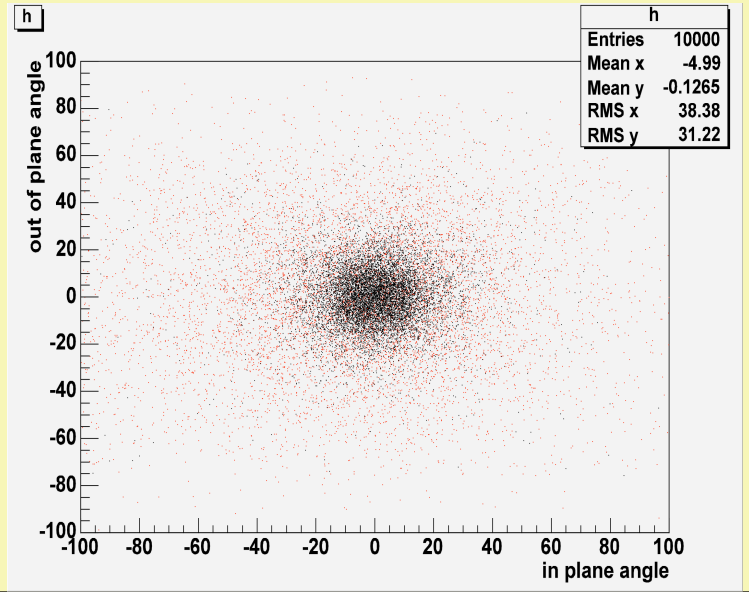
With SHMS(e) and HMS(p) acceptances

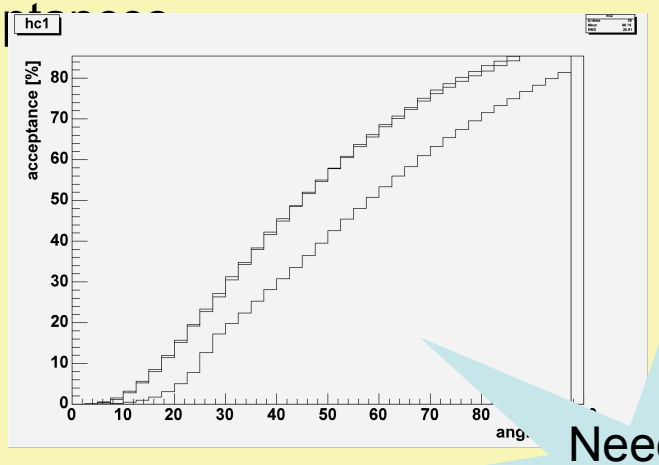






With SHMS(e) and HMS(p) acceptances and Γ=110 MeV





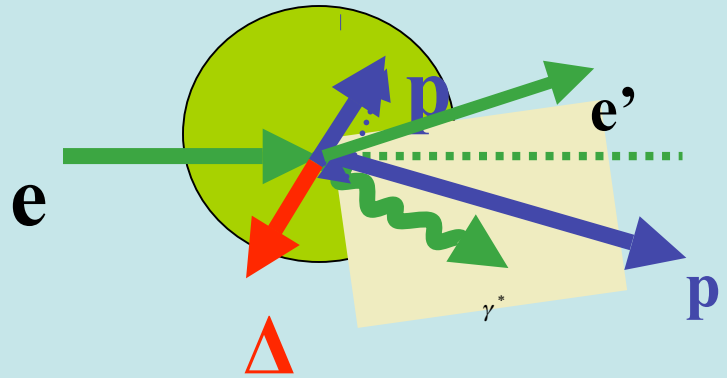
Needs large acceptance multi particle detector

The LargeAcceptanceMINUSFORWARD detector

Multi particle detection

Particle ID

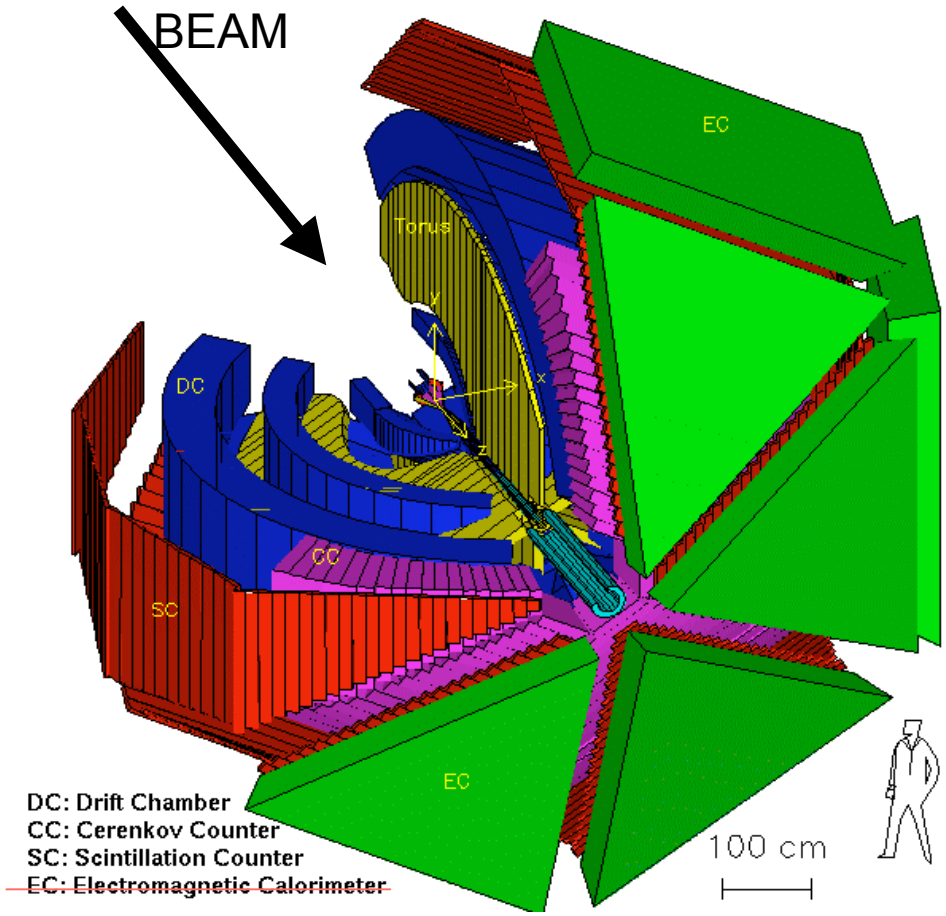
Large solid angle- 4π – non symmetric gape at the forward hemisphere



Large (full) luminosity

Can operate in coincidence with small solid angle high resolution spectrometer / spectrometers

The CLAS Detector as LAMF



For the new 12 GeV clas:

The current magnet, Drift chambers, and scintillator counters are not to be used.

Need new power supplies, and electronics

Require a careful, non trivial dismount of the current detector at Hall B and non trivial setup at hall c.

Replace the EC by n-detectors (scintillators)

Title:	Search for cumulative $\Delta^{0}(1232)$ and $\Delta^{++}(1232)$ isobars in neutrino interactions with neon nuclei
Authors:	Ammosov, V. V.; Asratyan, A. É.; Burtovoĭ, V. S.; Gapienko, V. A.; Gapienko, G. S.; Gorichev, P. A.; Denisov, A. G.; Zaets, V. G.; Klyukhin, V. I.; Koreshev, V. I.; Kruchinin, S. P.; Kubantsev, M. A.; Makhlyueva, I. V.; Pitukhin, P. V.; Sirotenko, V. I.; Slobodyuk, E. A.; Usubov, Z. U.; Fedotov, A. V.; Shevchenko, V. G.; Shekelyan, V. I.
Publication:	Journal of Experimental and Theoretical Physics Letters, Vol. 40, p.1041
Publication Date:	09/1984