# Measuring relative momenta of SRC: Comparing 3He(e,e'pp) at x>1 and x<1

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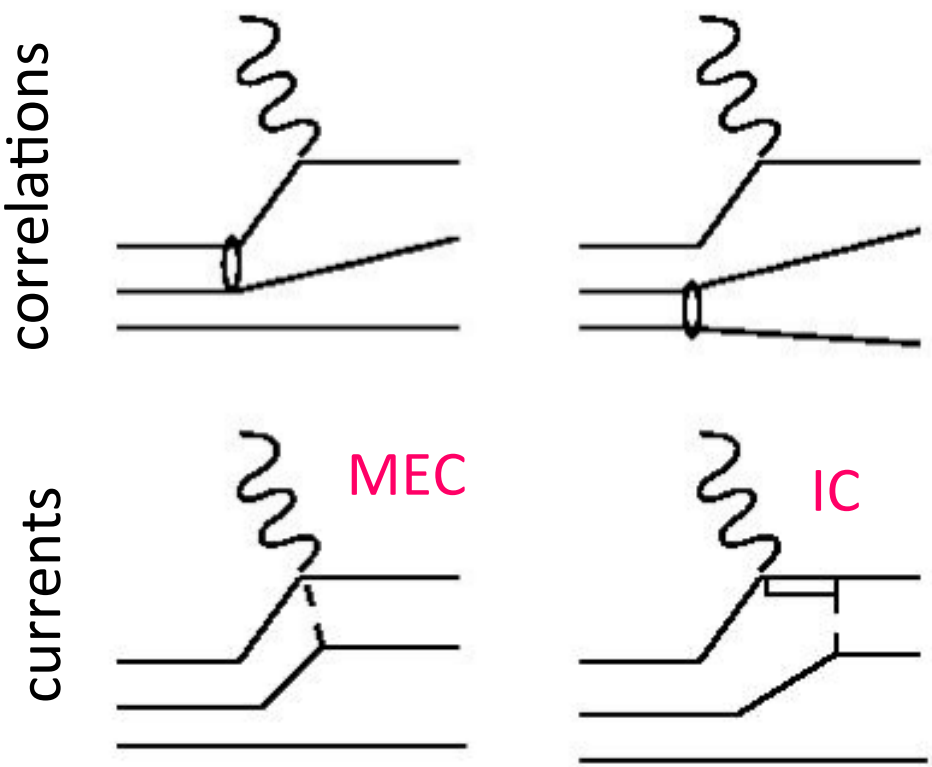
# Correlations: What to measure?

- Correlation probability
  - $A(e,e')$ / $d(e,e')$
- Probability that a nucleon belongs to an SRC
  - Isospin decomposition
  - $A(e,e'pN)$ / $A(e,e'p)$
- Relative and total momentum distributions
  - $A(e,e'pN)$

But how do we minimize Final State Interactions (FSI), Meson Exchange Currents (MEC), Delta …?

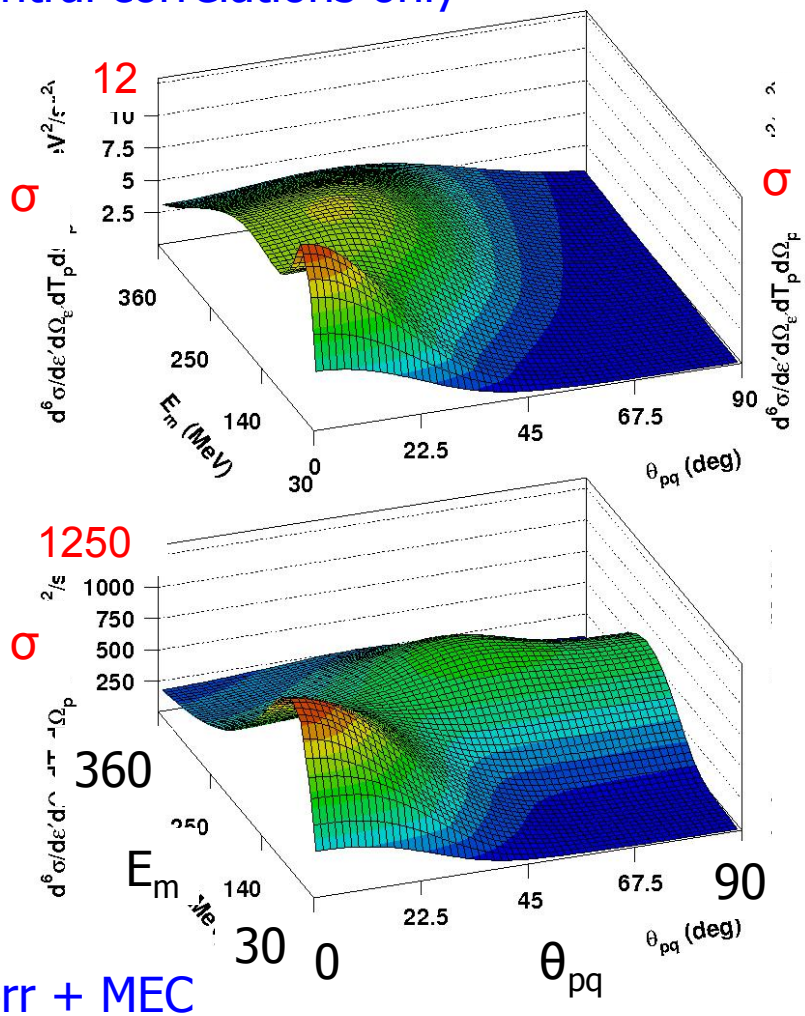
# NN Correlations vs 2N Currents




Two body currents strongly enhance the effects of correlations

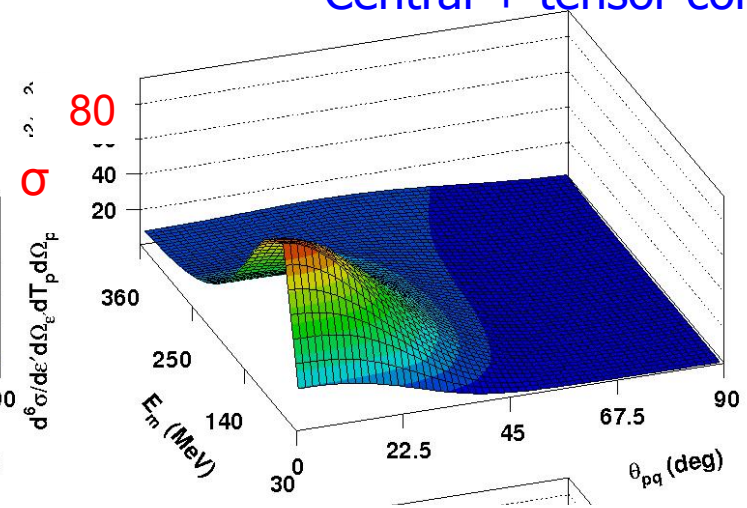
# 2N currents enhance correlations

Central correlations only




Corr + MEC

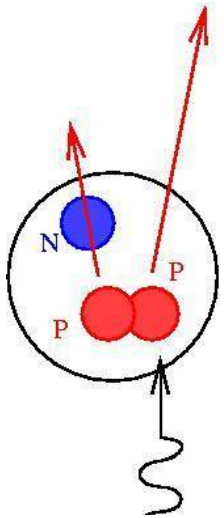
Central + tensor corr



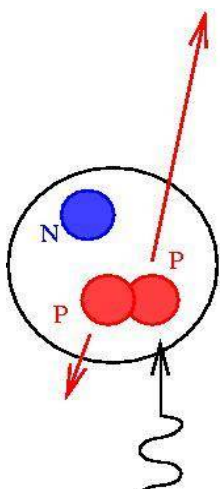

MEC changes the magnitude of the cross section, not the distribution in $E_{miss}$ vs $Theta_{pq}$

O(e,e'p) Ryckebusch

# Measuring correlated $p_{rel}$ and $p_{cm}$: $A(e,e'pN)$ Kinematics choices



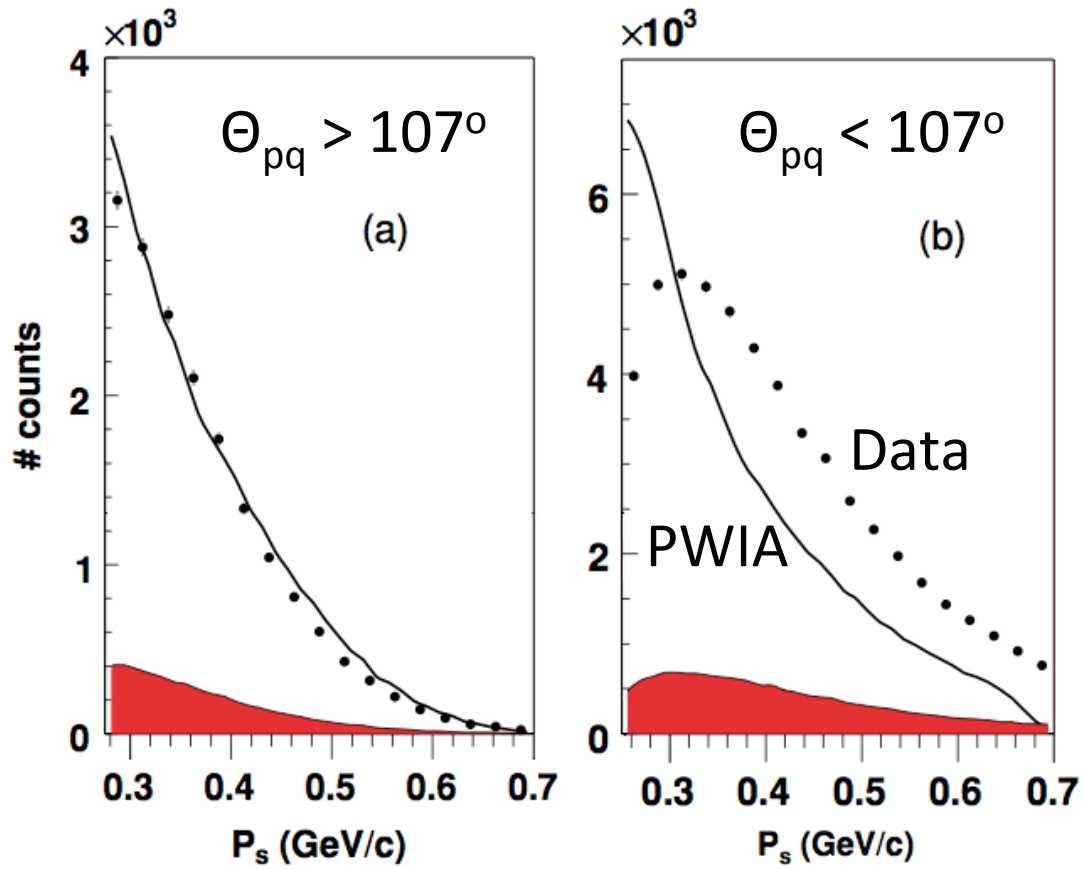

Hit backward moving nucleon
Correlated spectator recoils forwards
Detect two forward nucleons
$x > 1$
MEC and IC minimized in $(e,e')$ cross section




Hit forward moving nucleon
Correlated spectator recoils backwards
Detect forward and backward nucleons
$x < 1$
FSI minimized

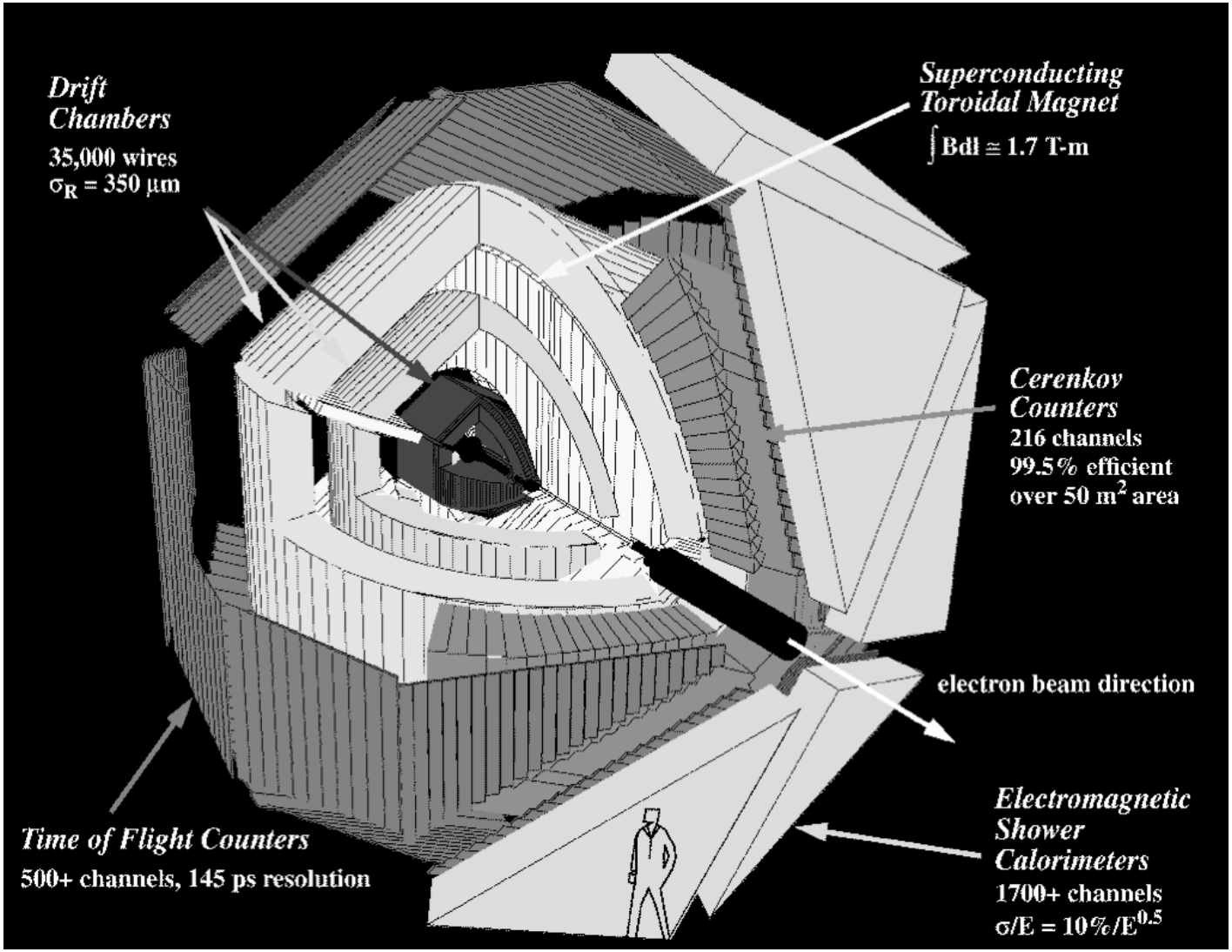
# FSI minimized at back angles

$d(e,e'p_s)X$



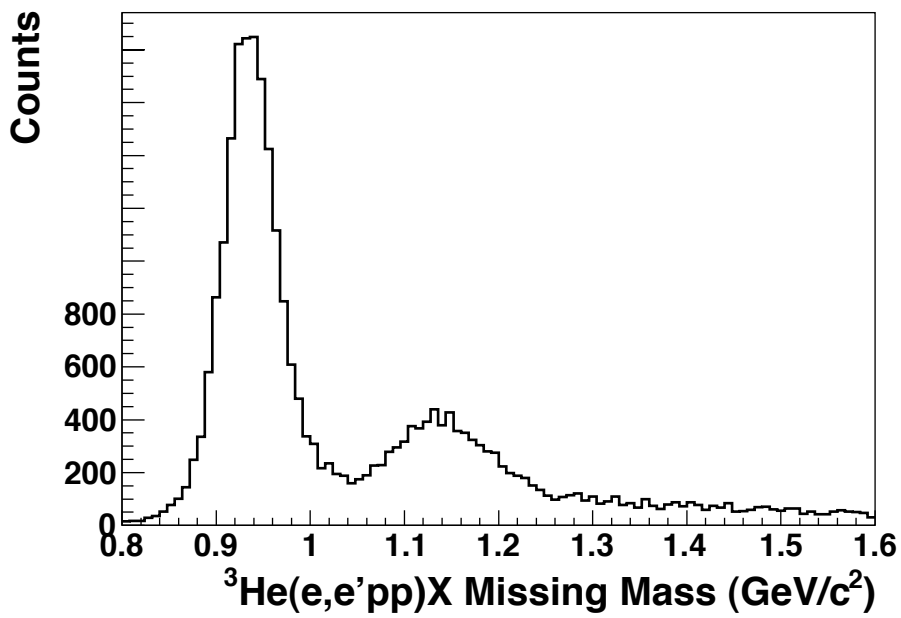

A.V. Klimenko *et al.* PRC **73**, 035212 (2006).

$^3$He(e,eX) in CLAS
- e2a and **e2b**
- 2.2 and **4.7 GeV** electrons
- Inclusive (e,e') trigger

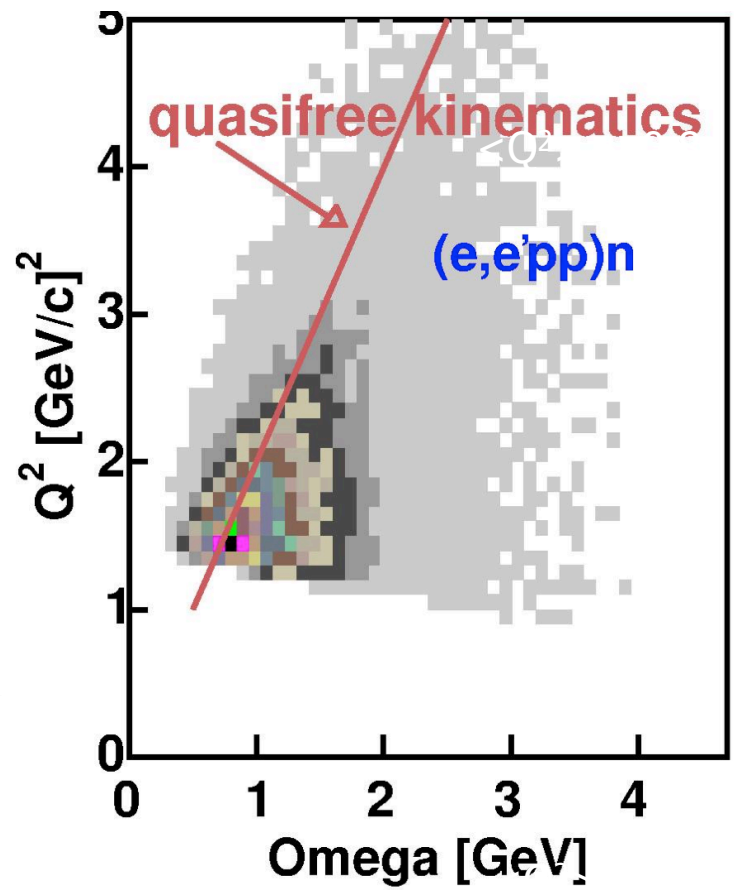


# CLAS 4.7 GeV $^3$He(e,e'pp)

Detect 2 protons,
reconstruct the neutron




Integrate over large
electron acceptance

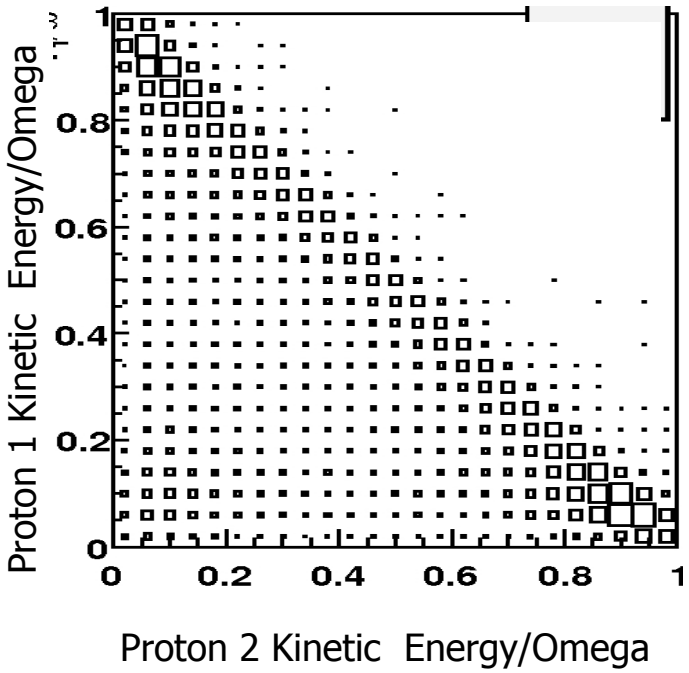



H. Baghdasaryan *et al.*, under CLAS review.

# $^3$He(e,e'pp)n nucleon energy balance:

Lab frame Dalitz plots

Proton detection threshold 0.25 GeV/c




Mostly pp knockout with a low energy neutron

# $^3$He(e,e' pp)n nucleon energy balance:

Lab frame Dalitz plots

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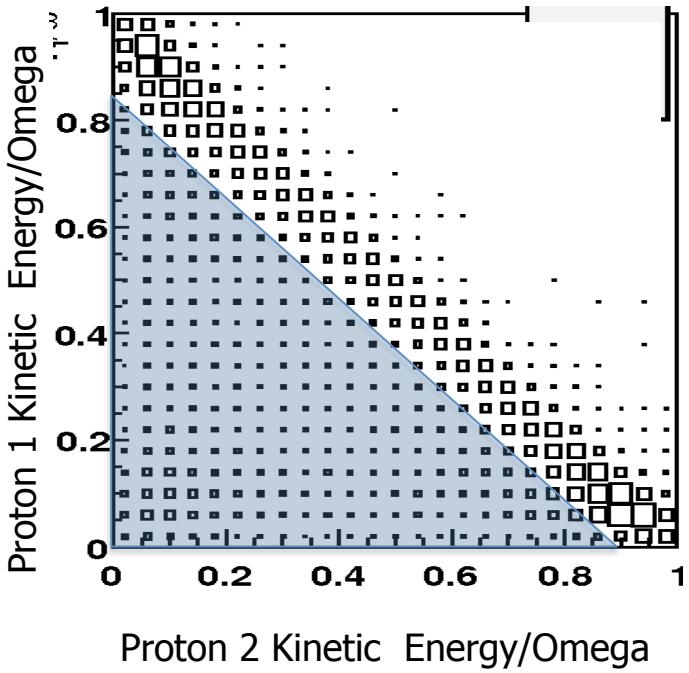


Spectator Correlated Pairs
(not discussed here)
Baghdasaryan, PRL **105**, 222501 (2010)

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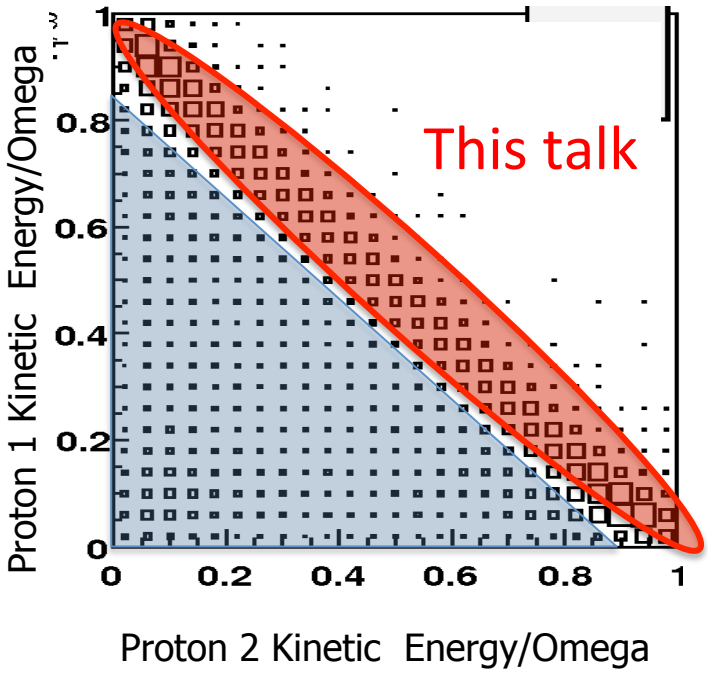
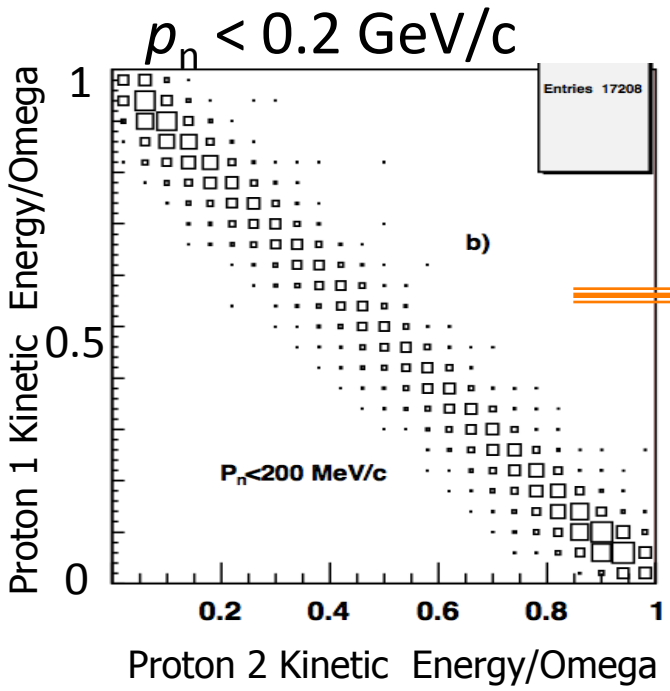


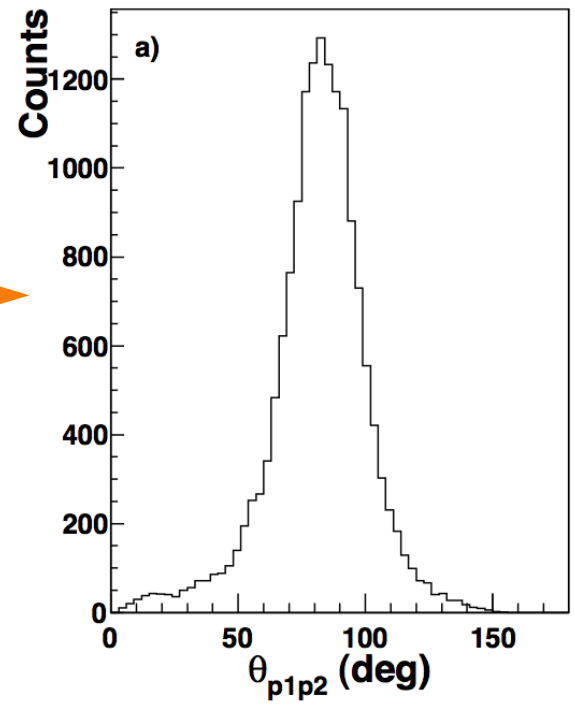

Spectator Correlated Pairs (not discussed here)

Baghdasaryan, PRL **105**, 222501 (2010)

Mostly pp knockout with a low energy neutron

# pp knockout dominated by rescattering

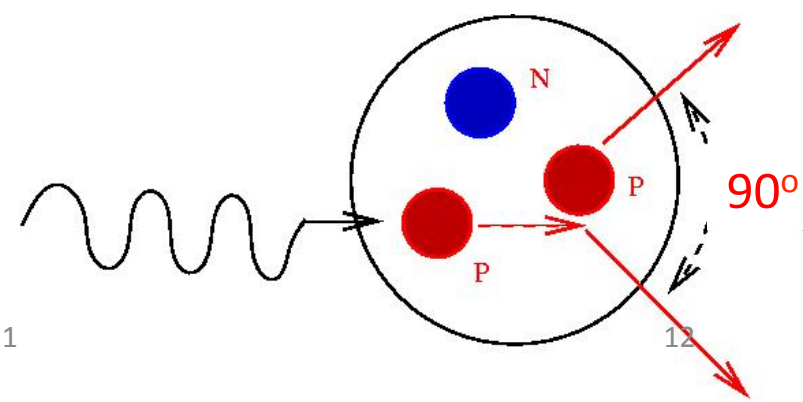



90 degree
pp opening angle

Rescattering!

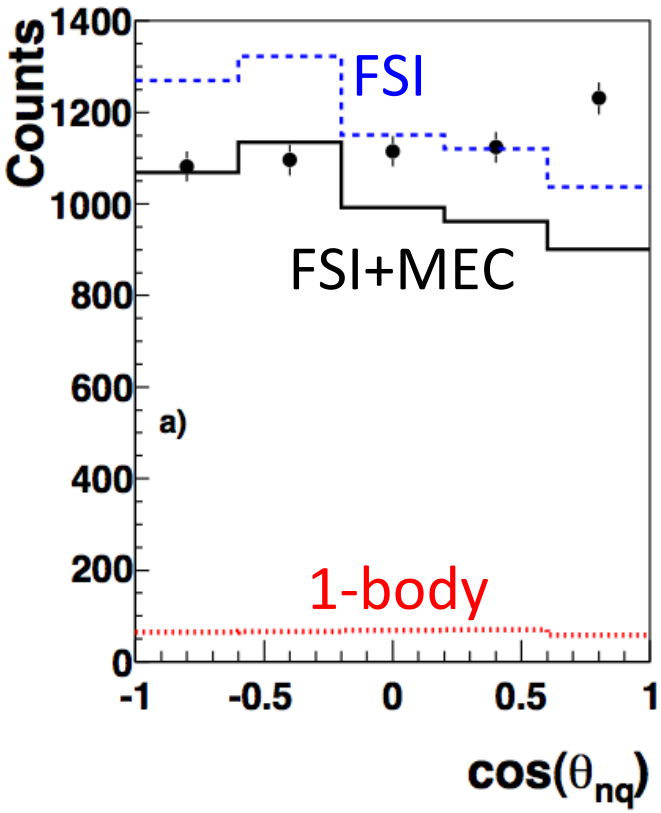
Energy balance (Dalitz plot):
$^3$He(e,e' pp)n events
with spectator neutron

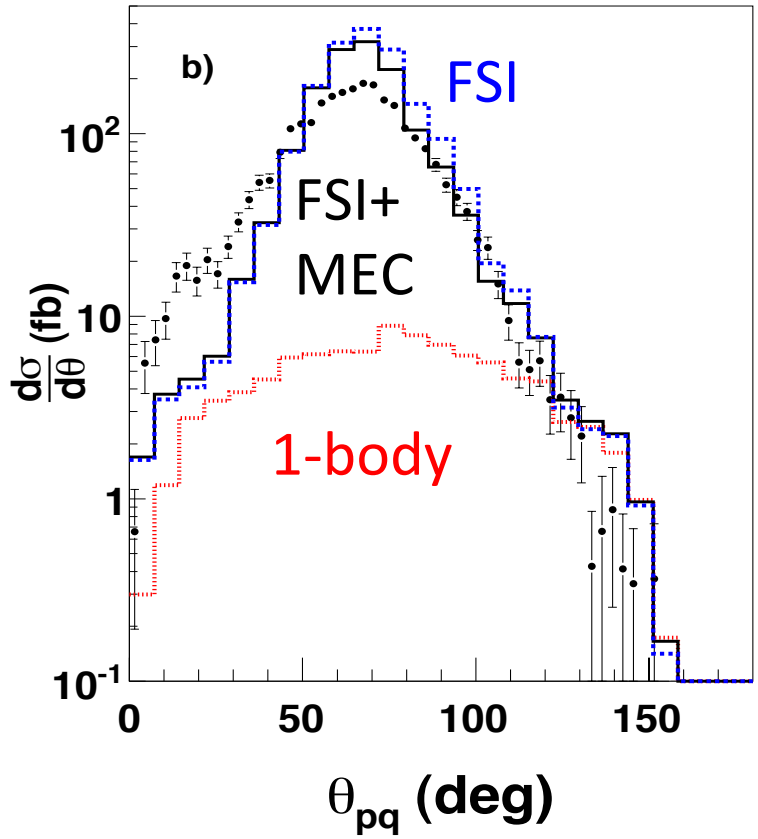



But let's look more closely …

# First: focus on FSI

Select $0.4 < p_p < 0.6$ GeV/c to maximize FSI



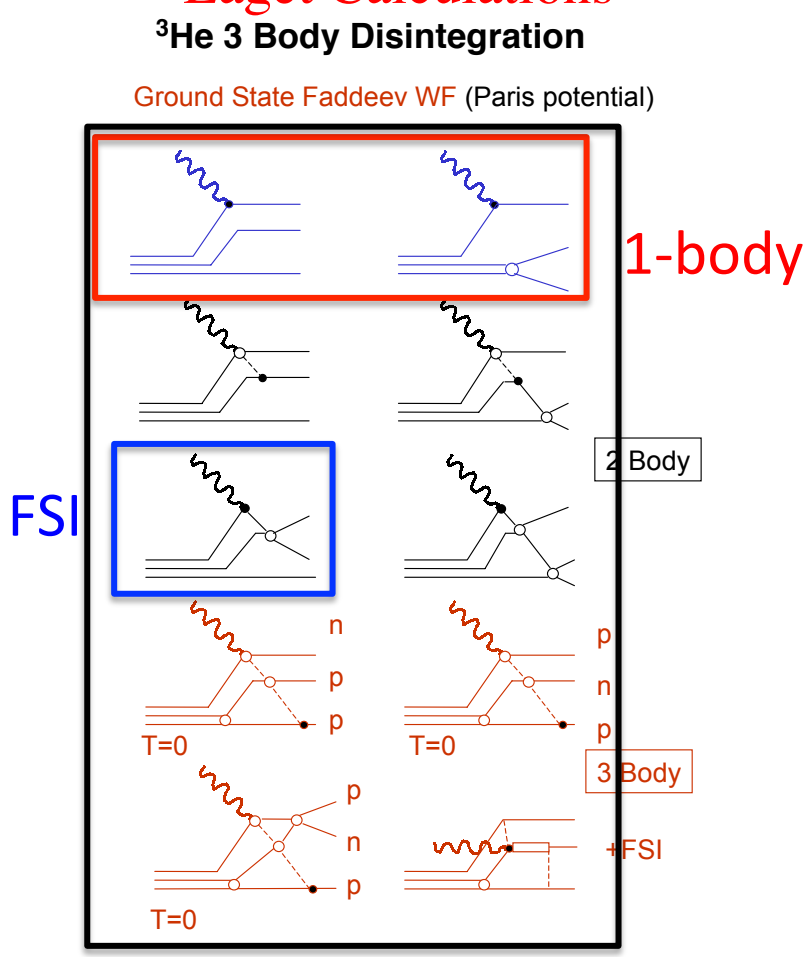

Isotropic neutron
FSI dominant

Slower p peaked at $\theta_{pq}=70^o$
FSI dominant

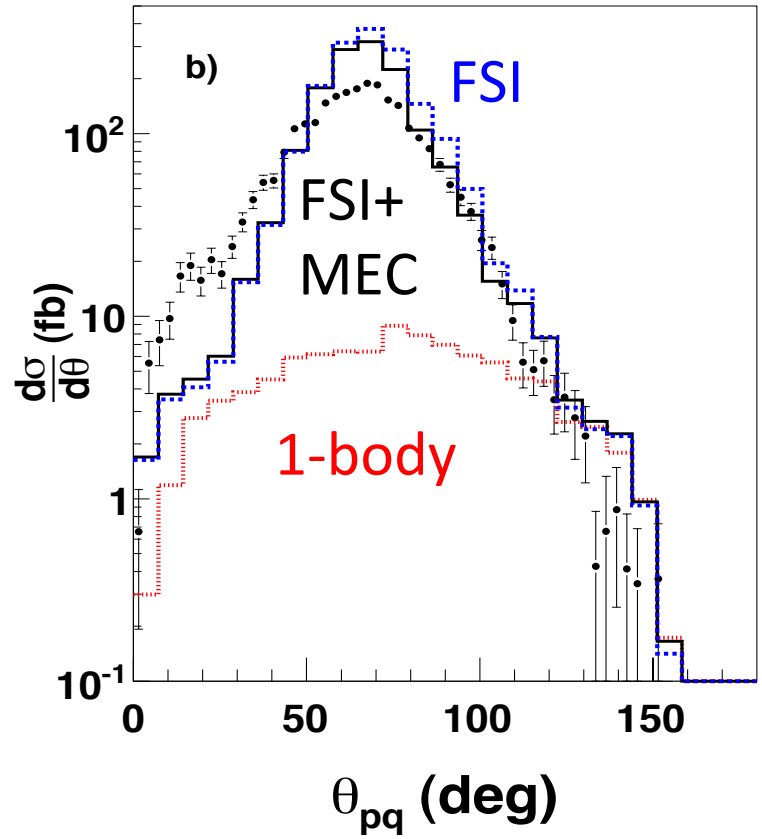
# First: focus on FSI

Select 0.4 < $p_p$ < 0.6 GeV/c to maximize FSI

Laget Calculations




FSI+MEC




Slower p peaked at $\theta_{pq}$=70°

FSI dominant

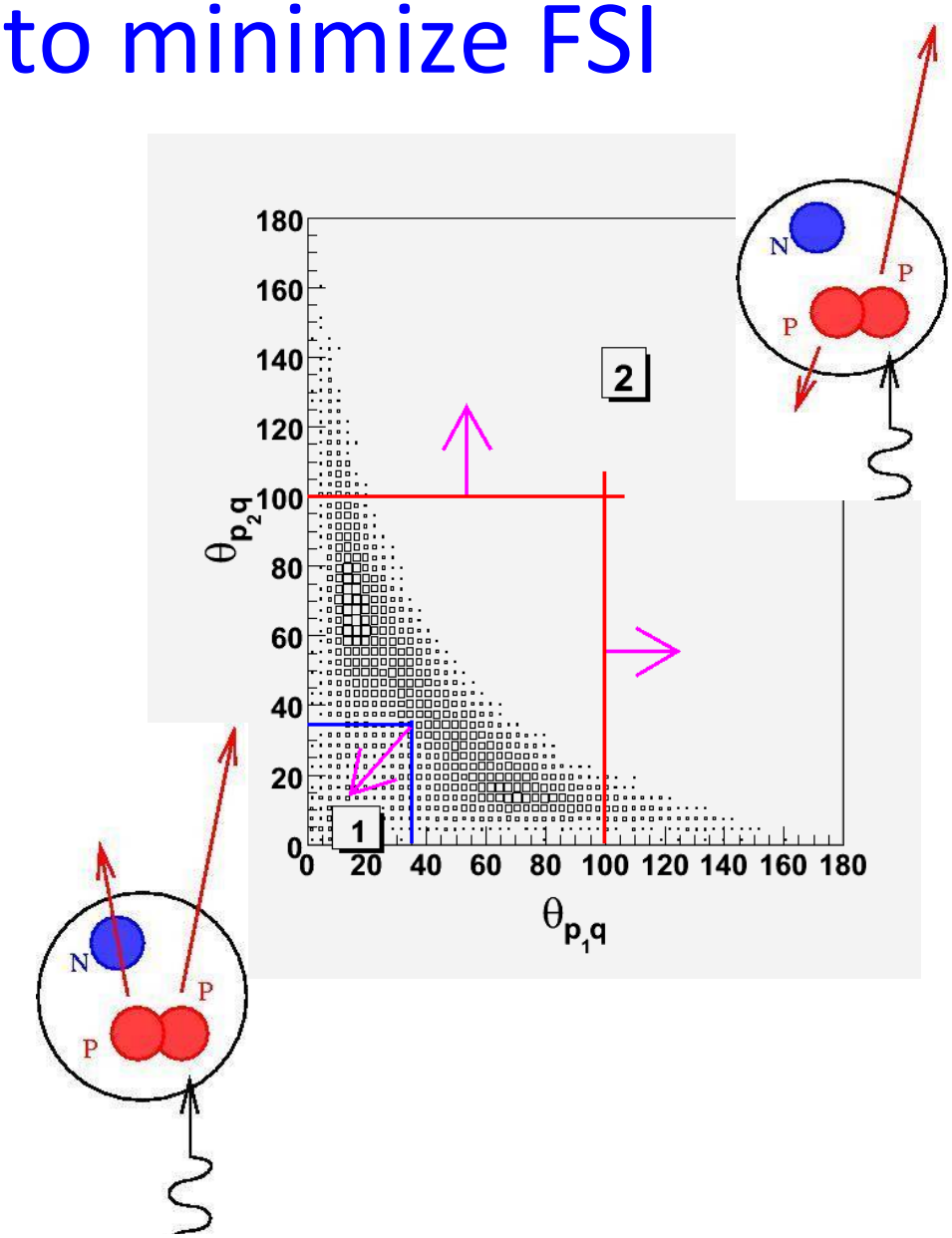
# pp knockout: try to minimize FSI

Two active nucleons:
$p_{neutron} < 200$ MeV/c

Explore two configurations:

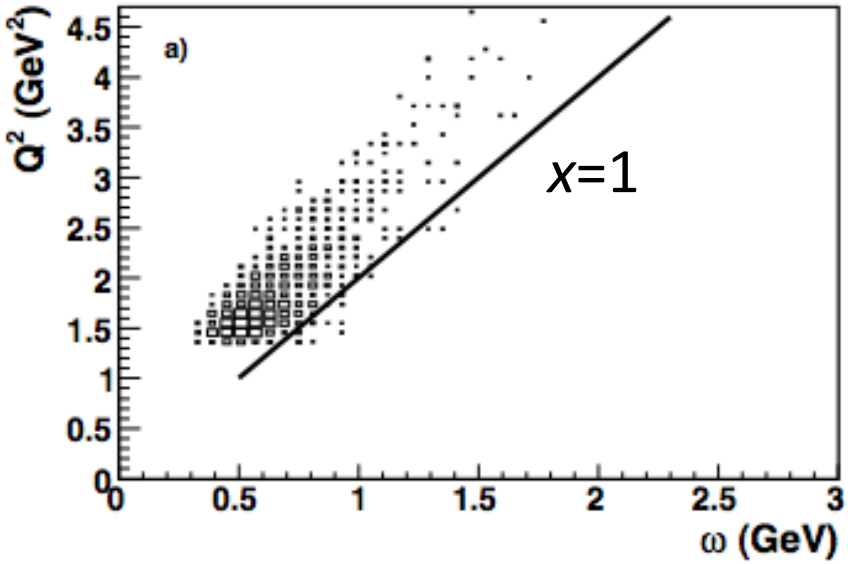
1. Two forward protons $x>1$
   $\theta(pq) < 35^o$
2. Slower backward proton
   $x<1$, $\theta(p_{slow}q) > 100^o$

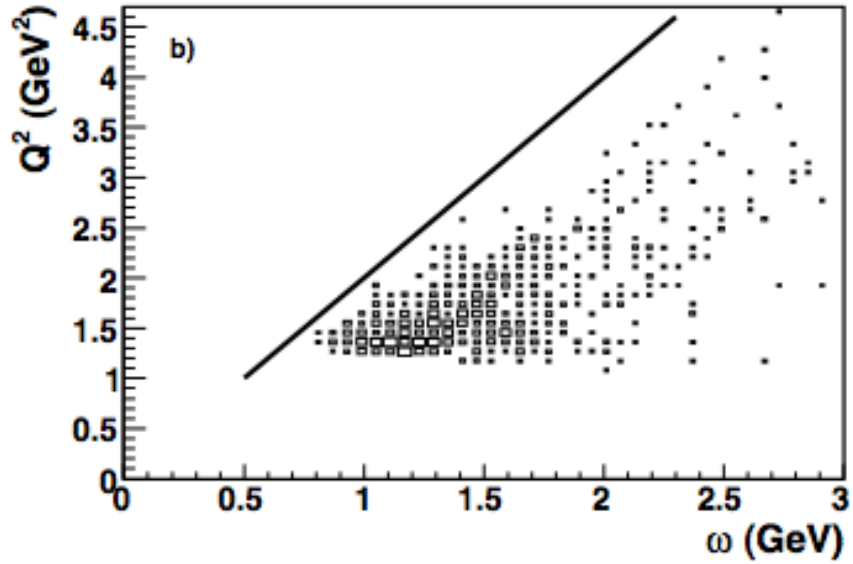
Plot cross section vs
$$P_{rel}=(P_{fast}-q-P_{slow})/2$$




Goal: measure SRC relative momentum distribution

# Choosing proton angles chooses x

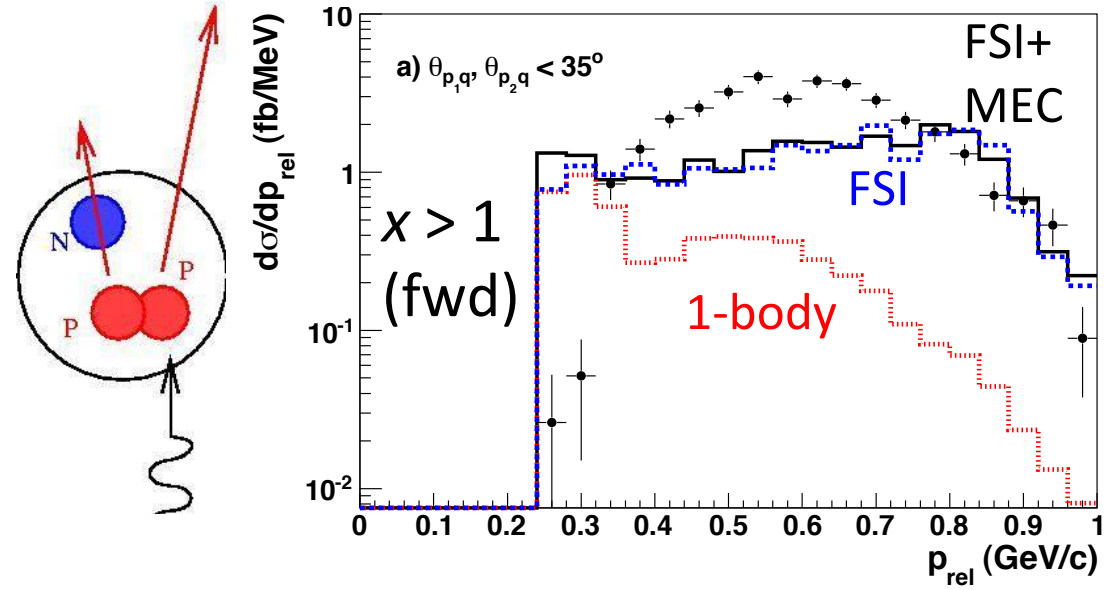



Forward protons
Omega < $Q^2/2m$
$x > 1$

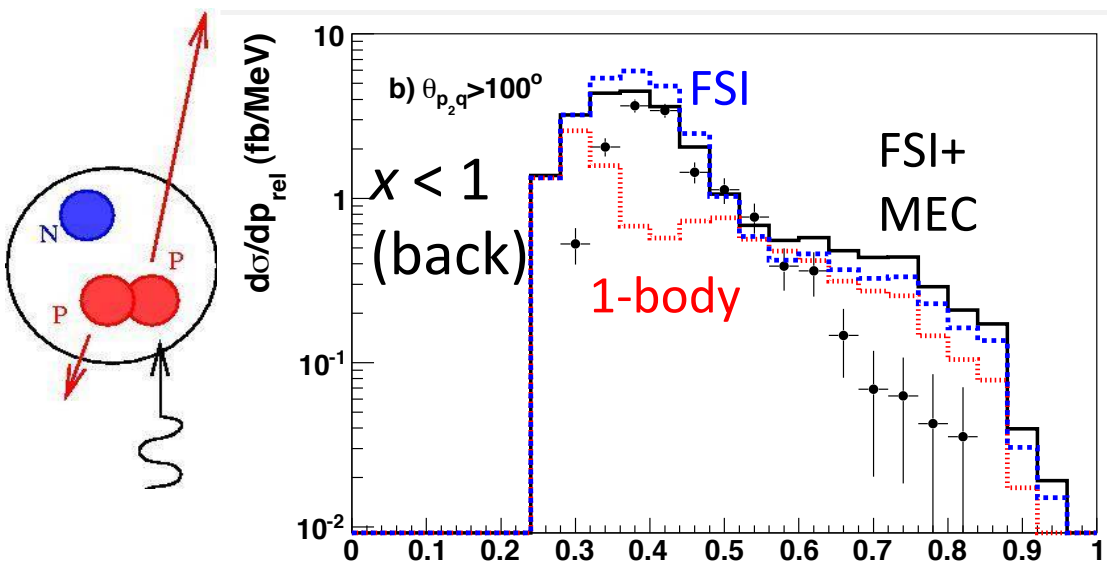
Backward recoil proton
Omega > $Q^2/2m$
$x < 1$

# pp knockout: correlations?




$\theta(pq) < 35^o$ ($x > 1$):
Laget calculation

1. FSI huge for all $p$
2. **Little MEC or IC**
3. Needs more precise FSI at $p \sim 0.6$ GeV/c




$\theta(pq) > 100^o$ ($x < 1$)

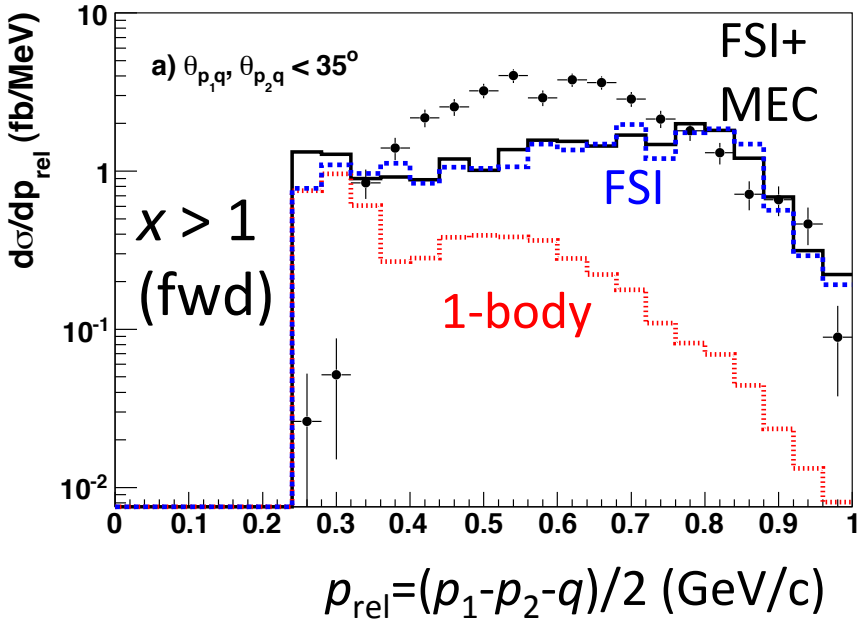
1. FSI only at $p$=0.4 GeV/c
2. **Little MEC or IC**
3. Not enough high-$p$ (0.75 GeV/c) strength in wf

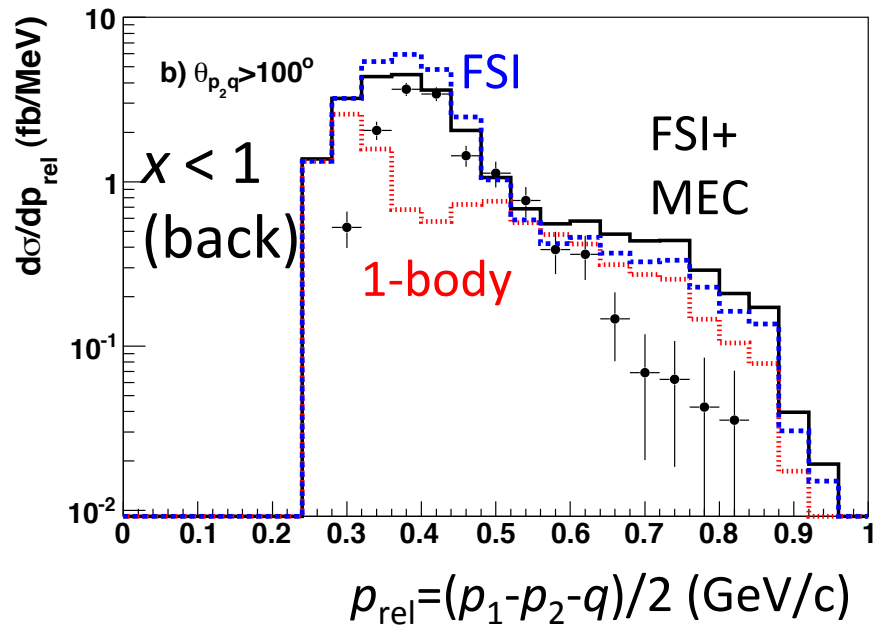
$x$>1 and x<1 momentum distributions very different

Backward (x<1) data more sensitive to initial state momentum distribution

$p_{rel}=(p_1-p_2-q)/2$ (GeV/c)

# Summary




1. $x < 1$ and $x > 1$ *pp* relative momentum distributions disagree
2. $x < 1$ *pp* KO data is much more sensitive to the *pp* pair initial-state relative momentum distribution
   - Misak just showed that the *pp* FSI is internal to the pair
3. $^3$He(*e,e'pp*)*n* is insensitive to MEC and IC at both $x < 1$ and $x > 1$ (according to the Laget calculation)

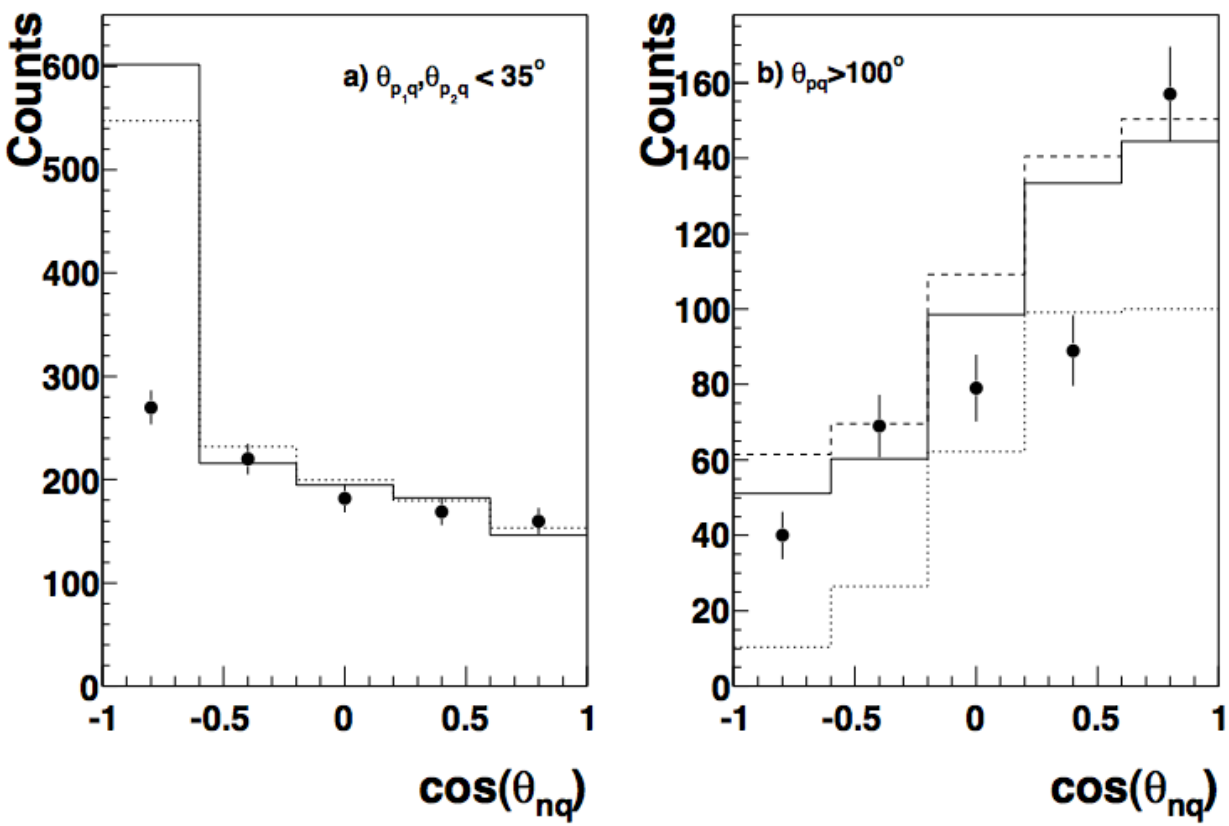
Relative *pp* momentum distributions should be measured at $x < 1$ with a backward nucleon. (pn results may differ)

# Thanks!

Thank you Mark and and grazie Claudio!

For this conference and for many wonderful discussions and ideas over the years!

# Neutrons spectator but not isotropic




Forward protons
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