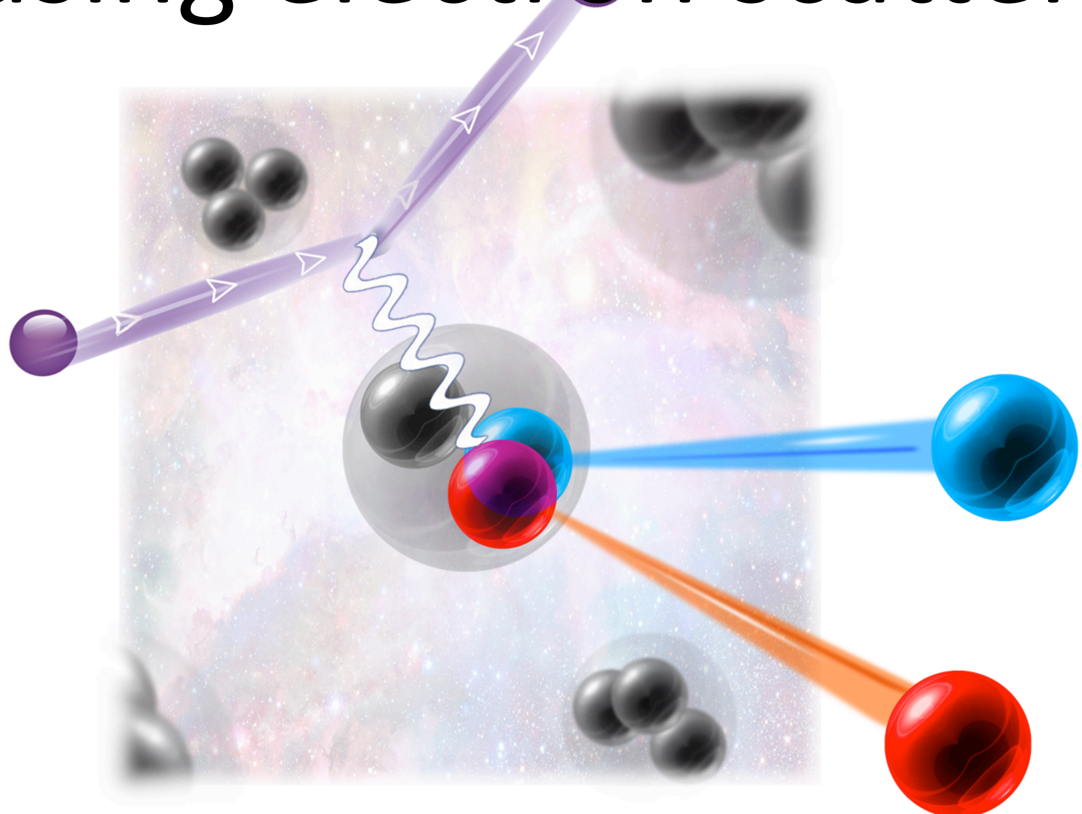
Probing correlations in A=3 systems using electron scattering



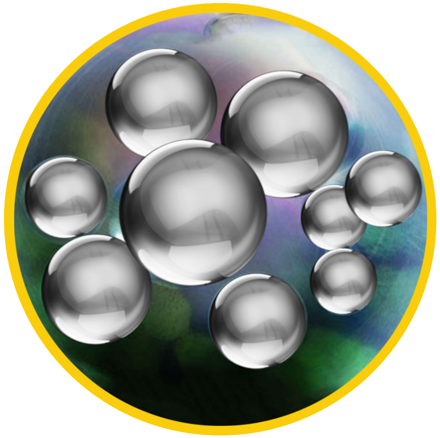
Reynier Cruz Torres

Hall A/C Collaboration Meeting, JLab

January 30th, 2019

Nucleon-nucleon interaction

Crucial starting point for modern calculations of nuclear structure and reactions, and the properties of dense astrophysical objects such as neutron stars.



Strong nuclear force, Coulomb force, spins, magnetic moments …

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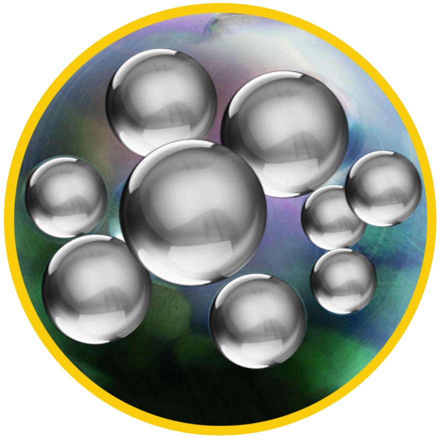

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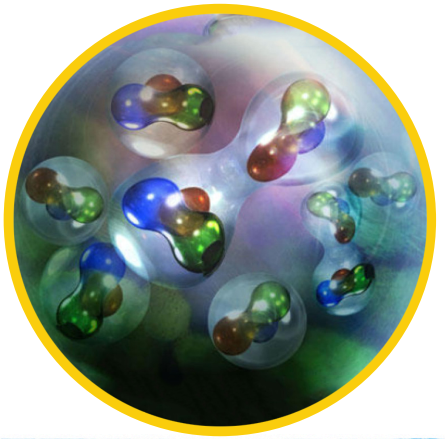


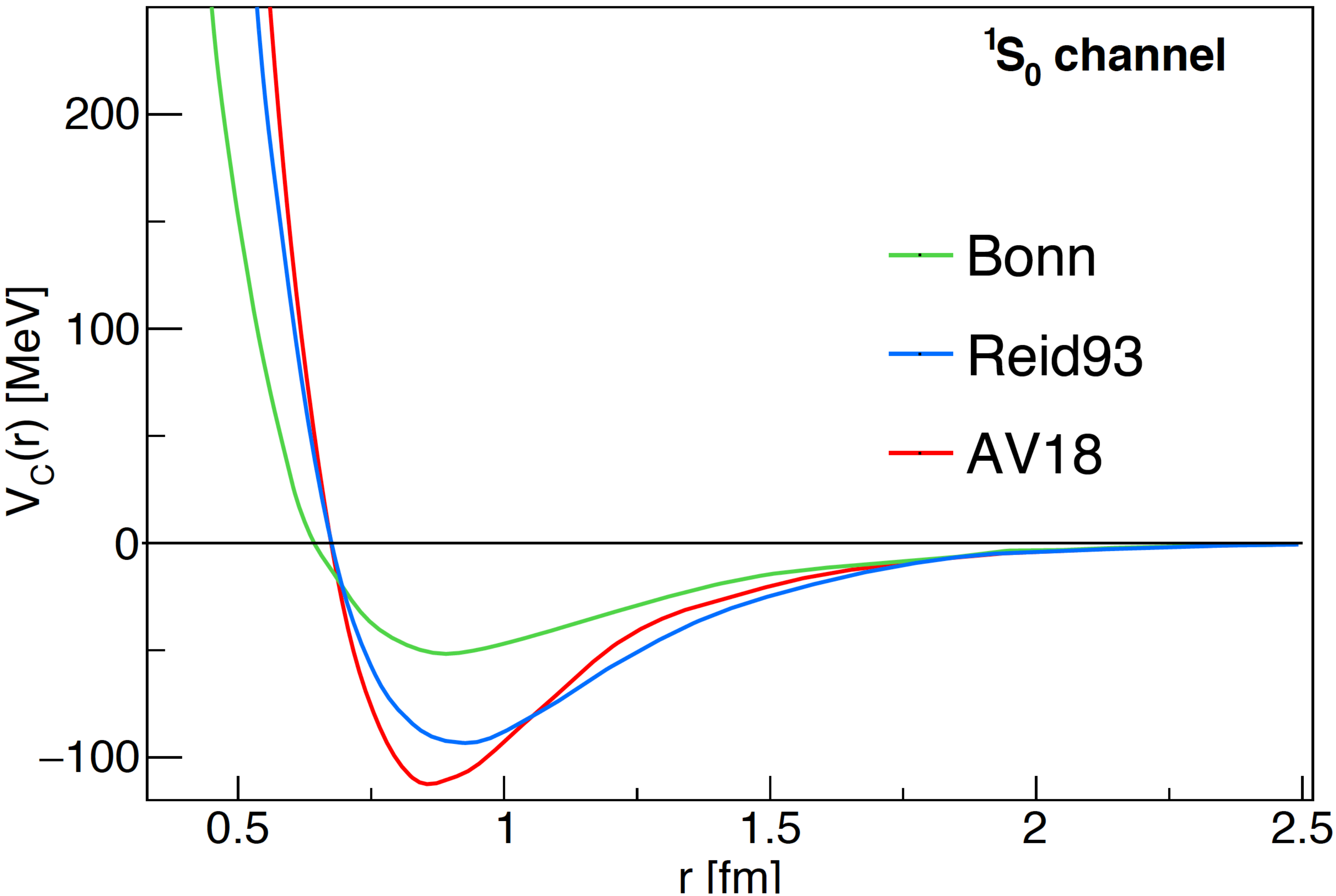
Residual interaction from interaction between nucleon constituents

Take your pick!

- Hamada-Johnston Potential
- Yale-Group Potential
- Reid68 Potential
- Reid-Day Potential
- Partovi-Lomon Potential
- Paris-Group Potentials
- Stony-Brook Potential
- dTRS Super-Soft-Core Potentials
- Funabashi Potentials
- Urbana-Group Potentials
- Argonne-Group Potentials
  - ArgonneV14
  - Argonne V28
  - ArgonneV18
- Bonn-Group Potentials
  - Full-Bonn Potential
  - CD-Bonn Potential
- Padua-Group Potential
- Nijmegen-Group Potentials
  - Nijm78 Potential
  - Partial-Wave-Analysis
  - Nijm93
  - NijmI
  - NijmII
  - Reid93 Potential
  - Extended Soft-Core
  - Nijmegen Optical Potentials
- Hamburg-Group Potentials
- Moscow-Group Potentials
- Budapest(IS)-Group Potential
- MIK-Group Potential
- Imaginary Potentials
- QCD-Inspired Potentials
- The Oxford Potential
- The First CHPT NN Potentials
- Sao Paulo-Group CHPT Potentials
- Munich-Group CHPT Potentials
- Idaho-Group CHPT Potentials
- Bochum-Julich-Group CHPT Potentials
  - LO Potentials
  - NLO Potentials
  - NNLO Potentials
  - NNNLO Potentials
- and more!

arXiv:nucl-th/0702078

Short-range behavior in unconstrained



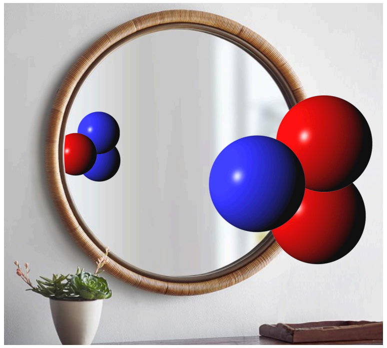
Why light nuclei?

Many of their properties can be:

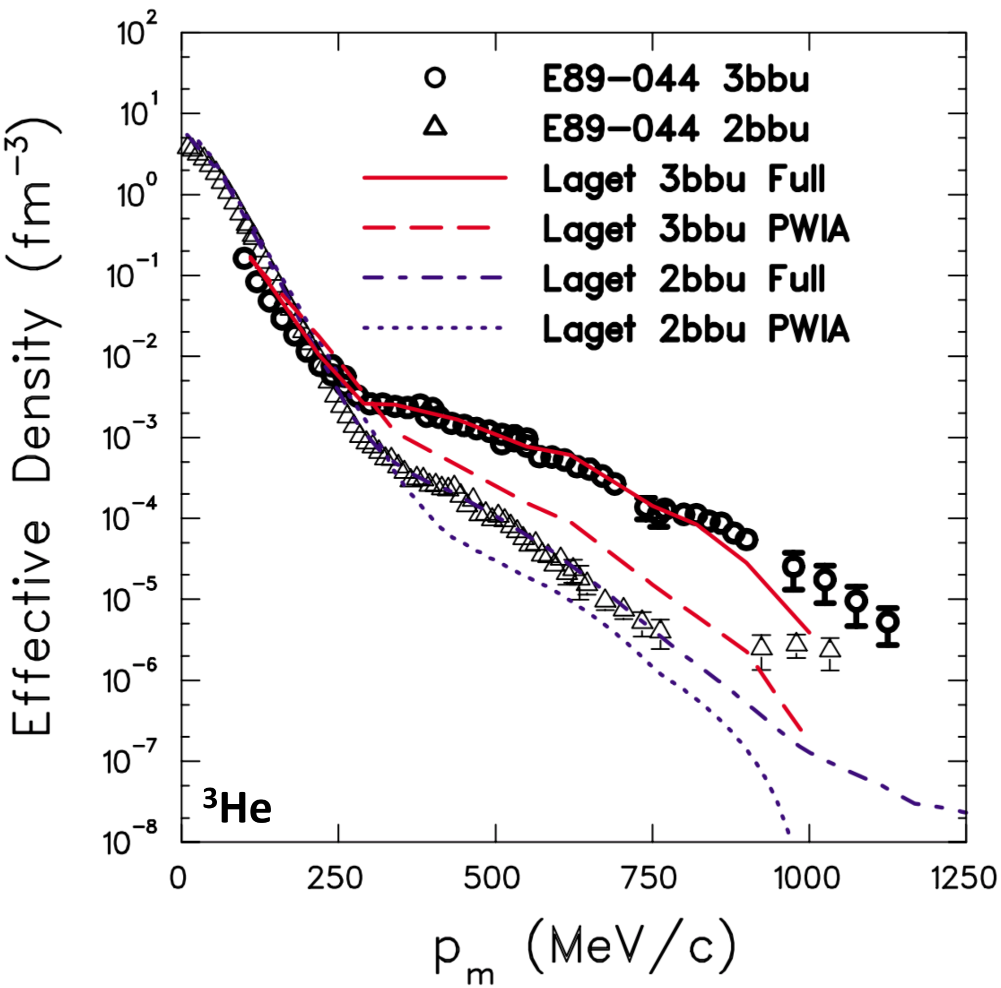
- precisely measured.
- exactly calculated for a given two- and three-nucleon interaction model.

Why Tritium?

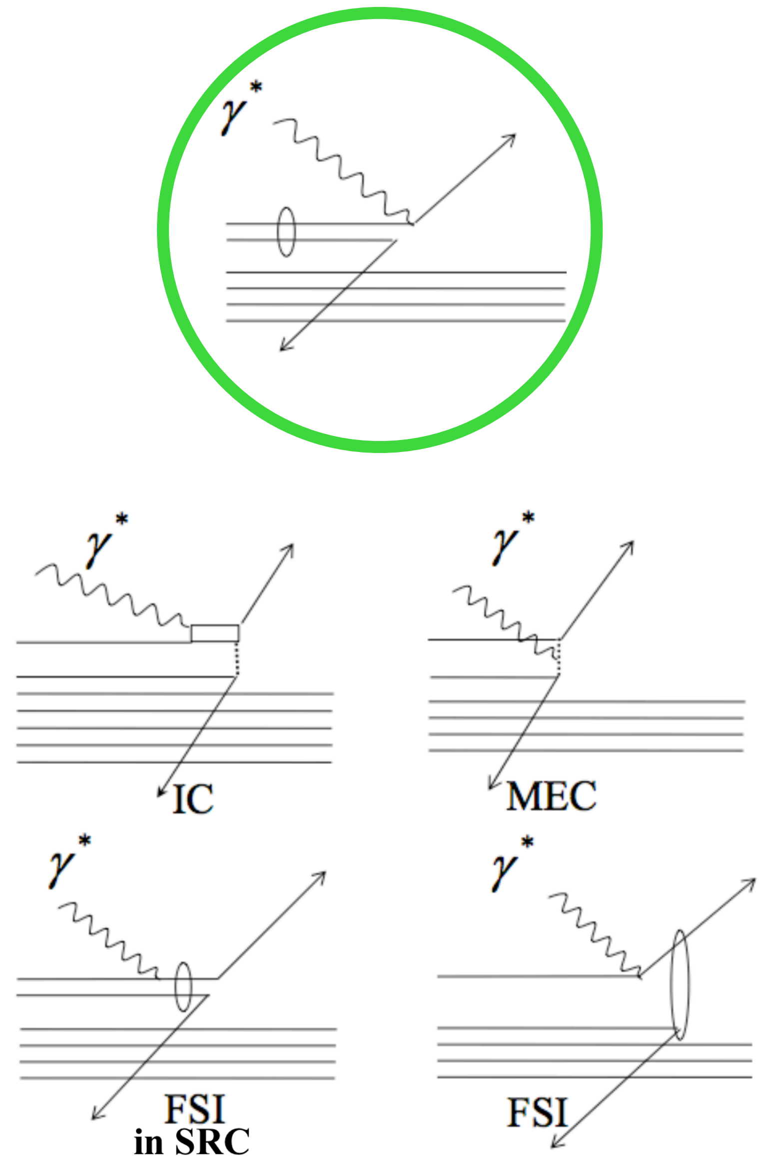
- Isospin doublet:
  - ^{3}He is stable mirror nucleus



Previous studies and non-QE mechanisms



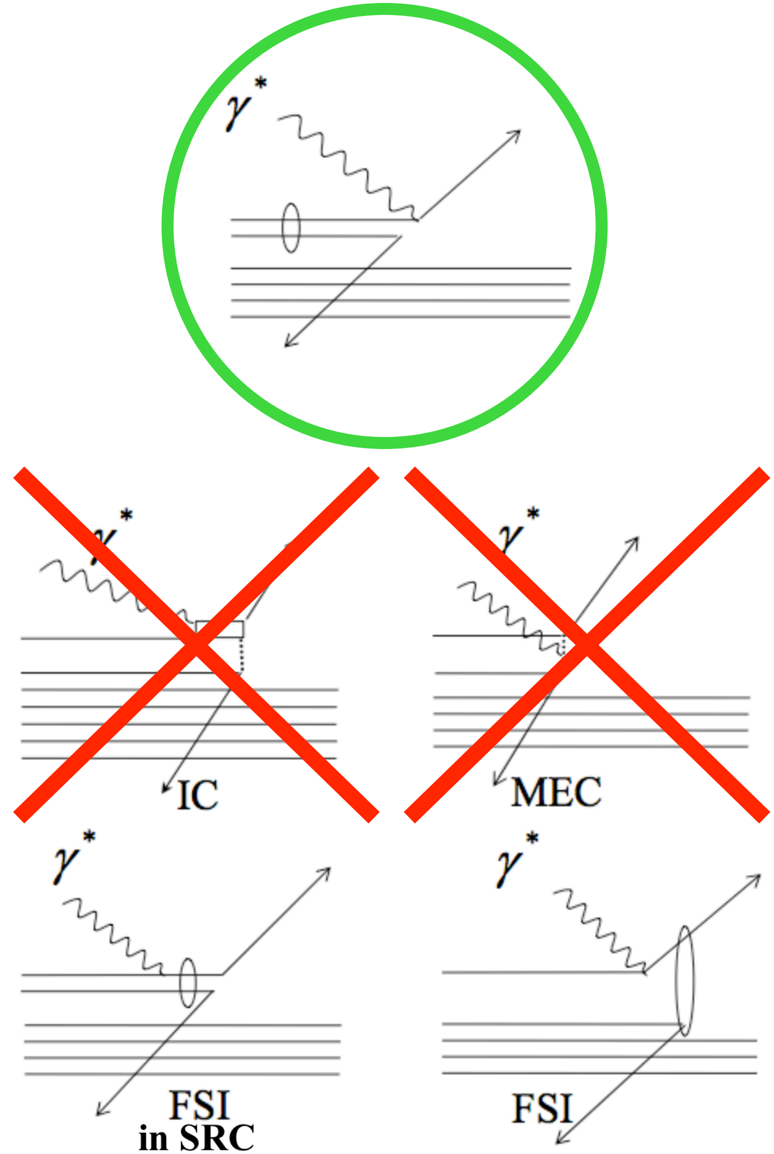
F. Benmokhtar et al., PRL 94, 082305 (2005)



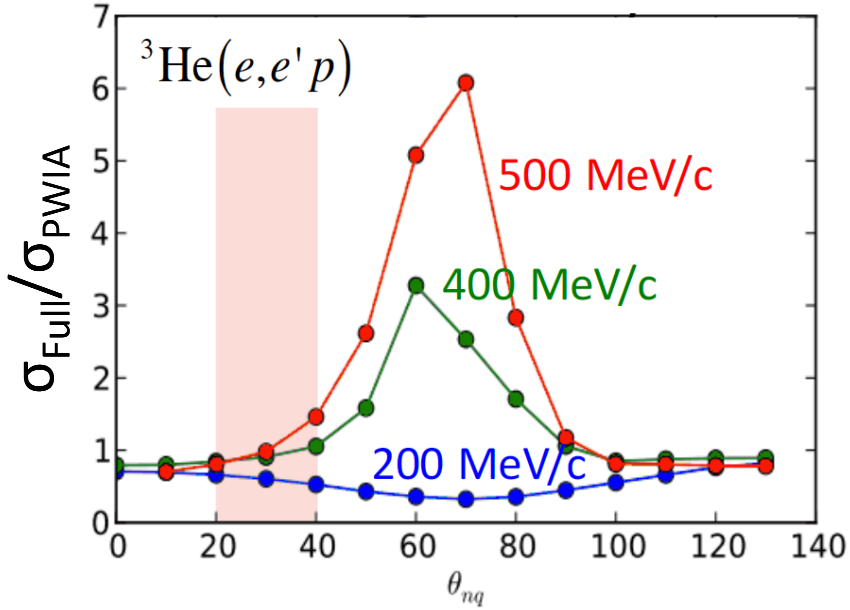
Minimizing non-QE mechanisms

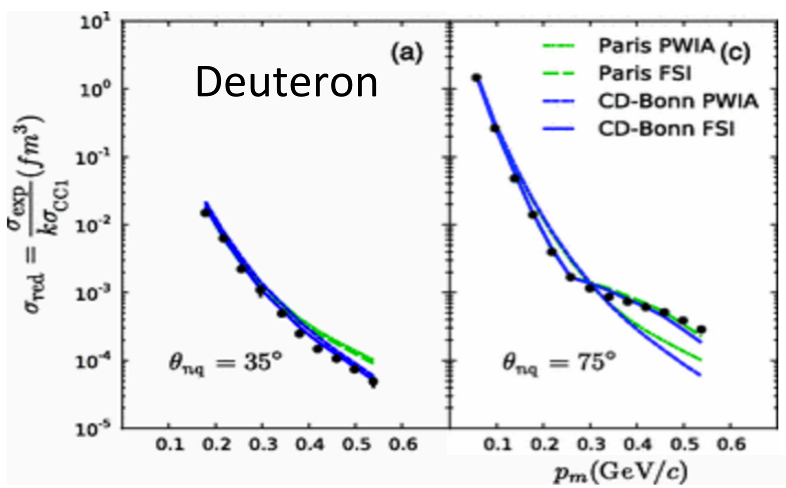
$Q^2 > 2\ GeV^2$

$x_B > 1$

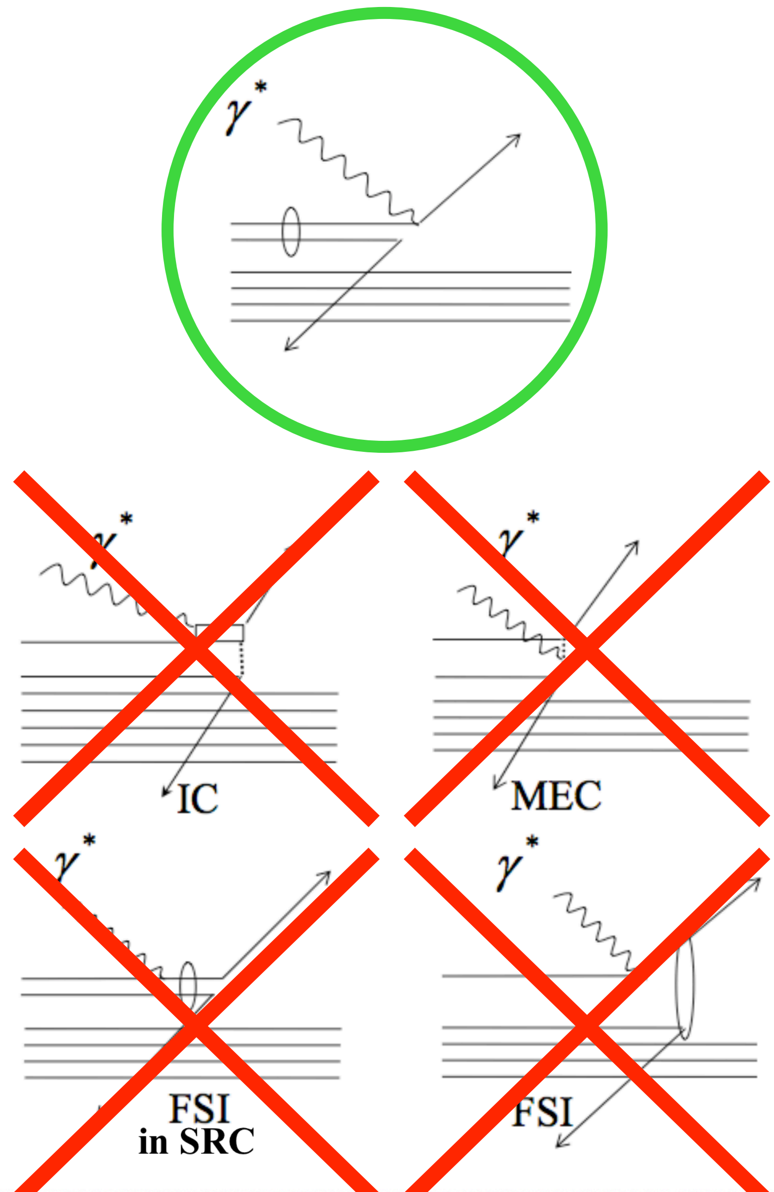


Minimizing non-QE mechanisms





Boeglin et al., PRL 107 (2011) 262501



Further minimizing FSI: ^{3}He/^{3}H ratio

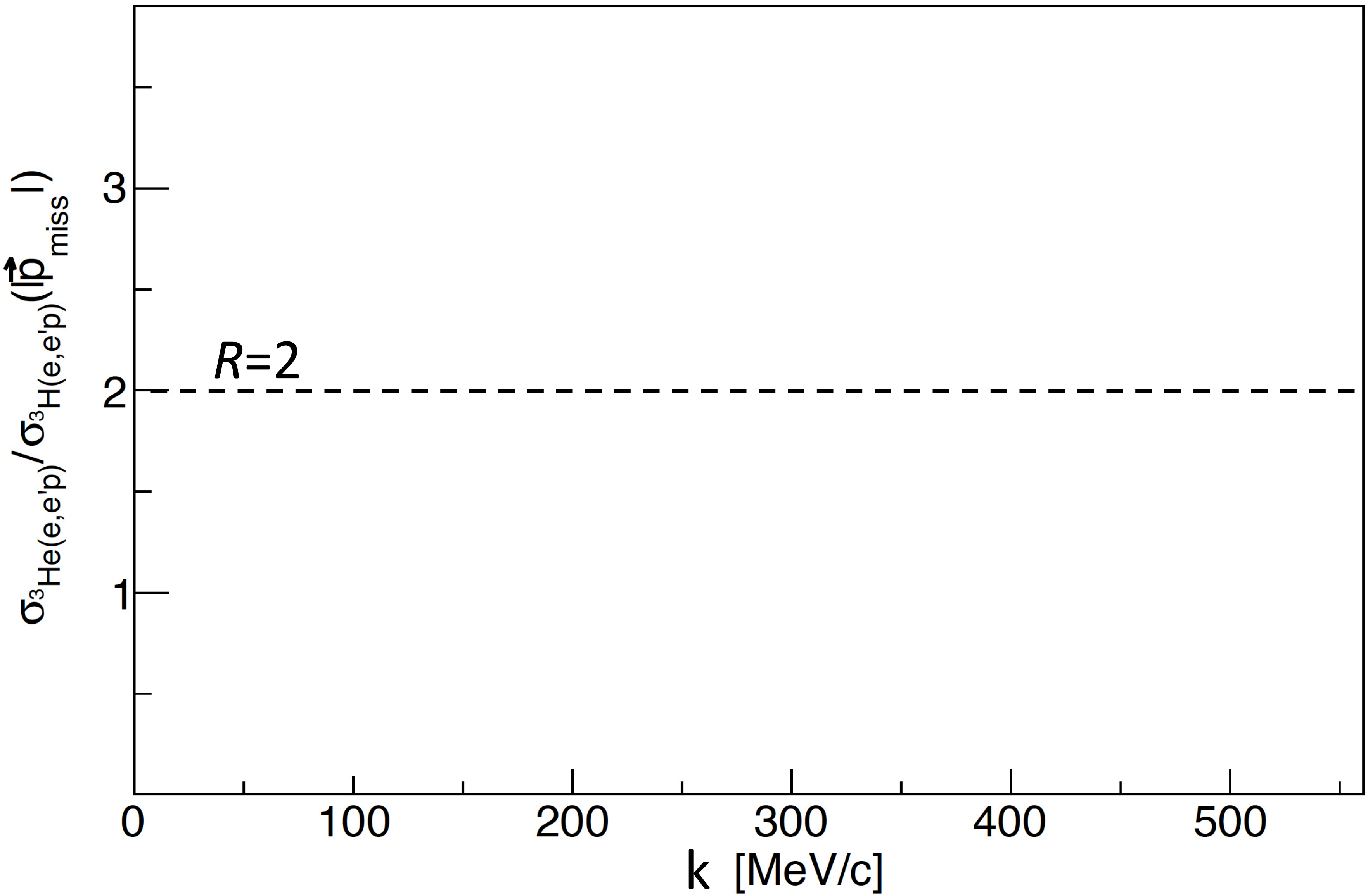
In PWIA:

$$\frac{d^6\sigma}{d\omega dE_p d\Omega_e d\Omega_p} = K\sigma_{ep} S(|\vec{p}_i|, E_i)$$

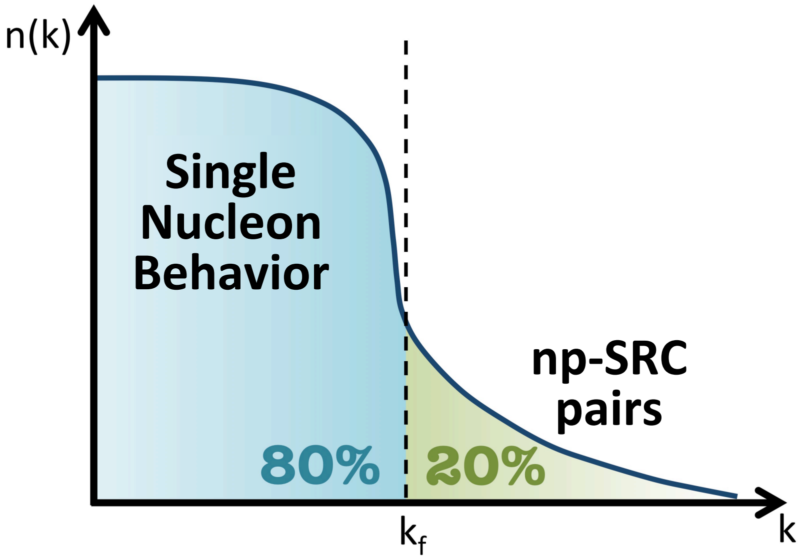
thus:

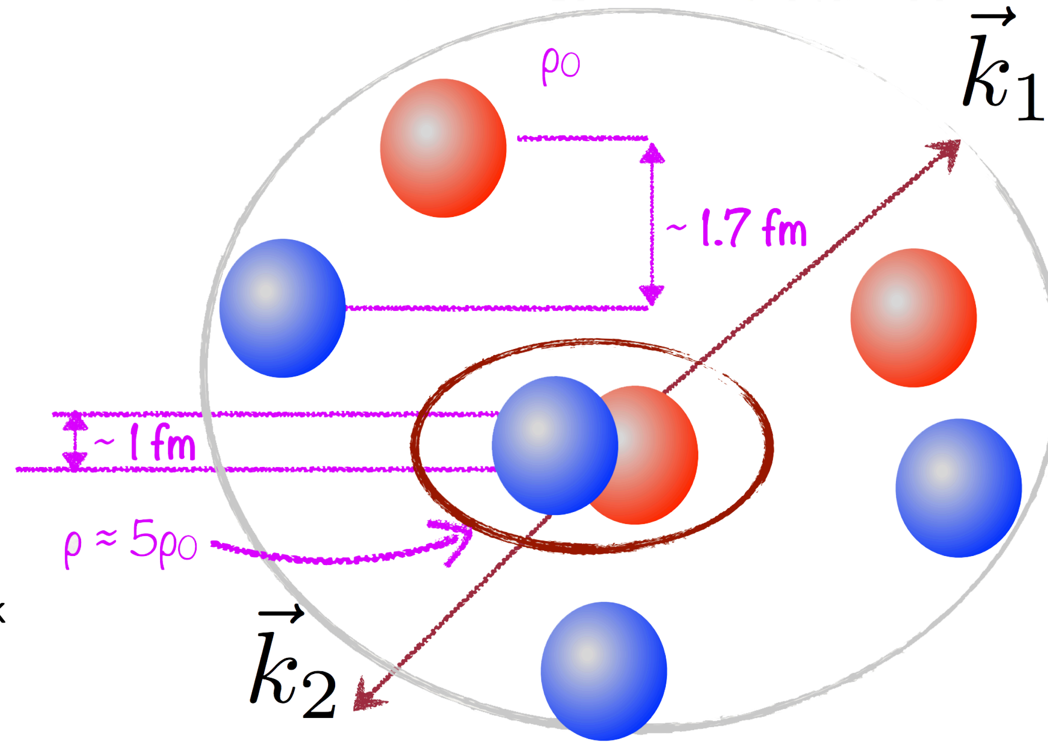
$$\frac{\sigma_{3He(e,e'p)}}{\sigma_{3H(e,e'p)}} \cong \frac{S_{3He}(|\mathbf{p}_i|, E_i)}{S_{3H}(|\mathbf{p}_i|, E_i)}$$

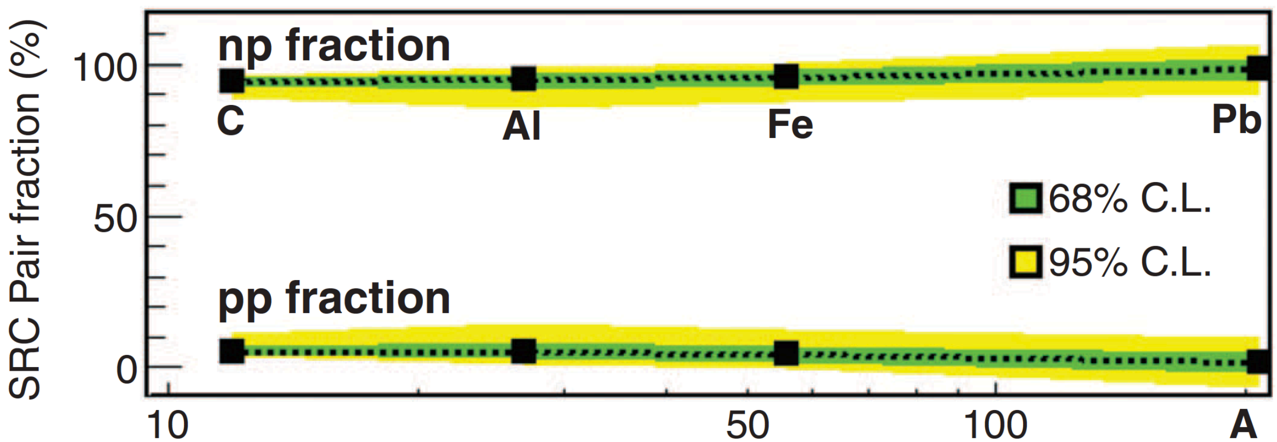
Further minimizing FSI: ^{3}He/^{3}H ratio



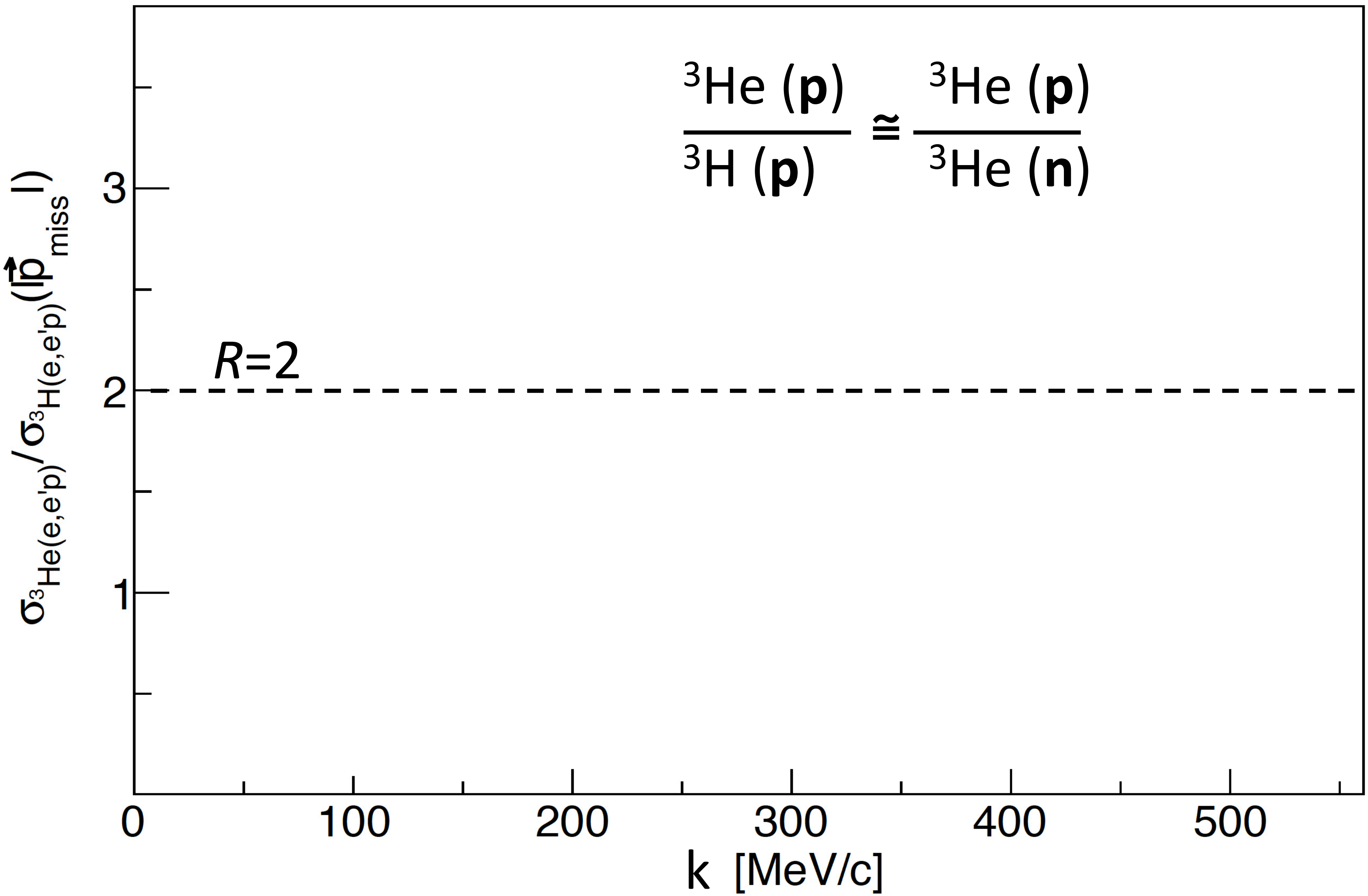
SRC and np-dominance







$^3He/^3H$ ratio theory predictions



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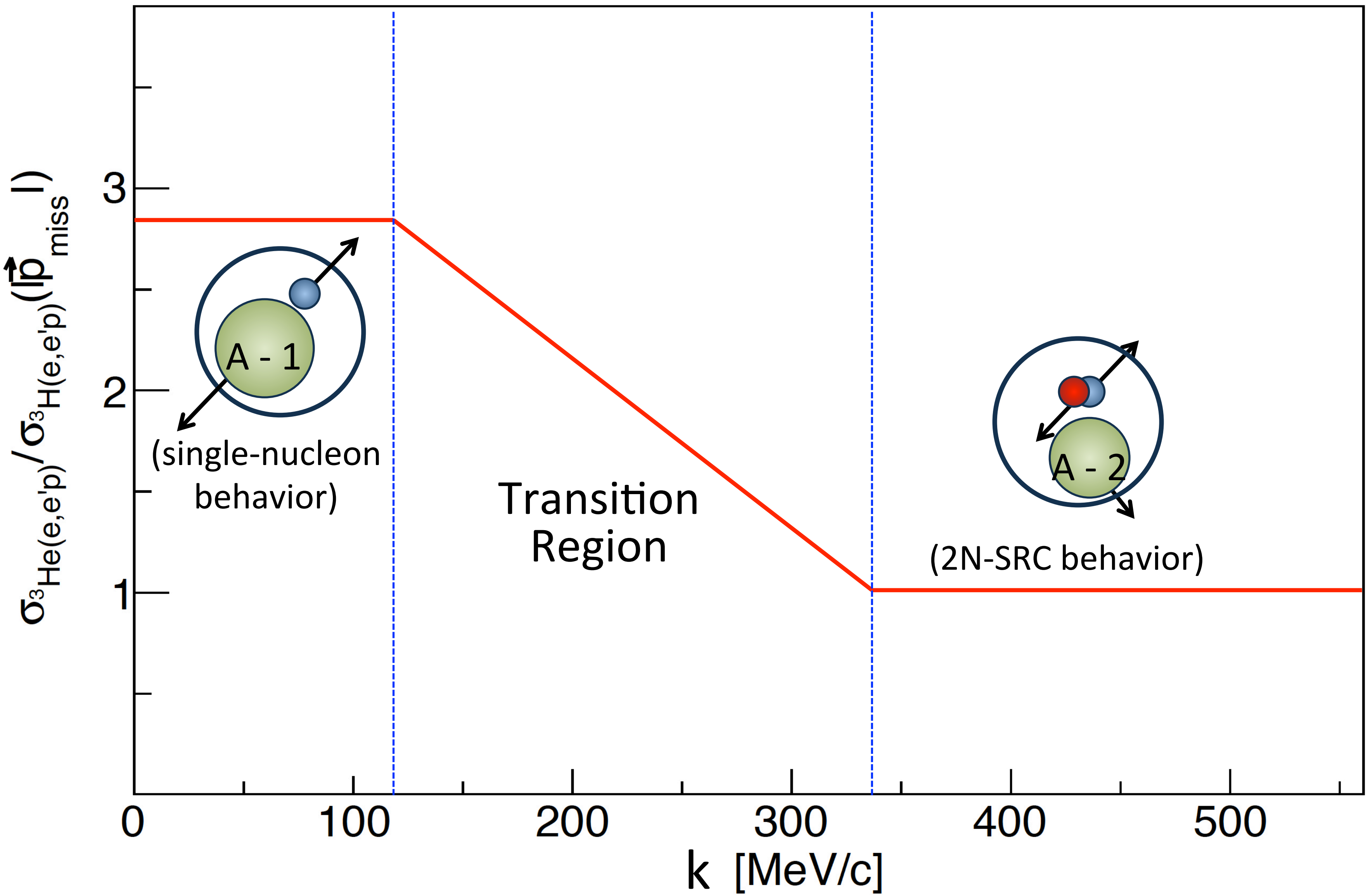
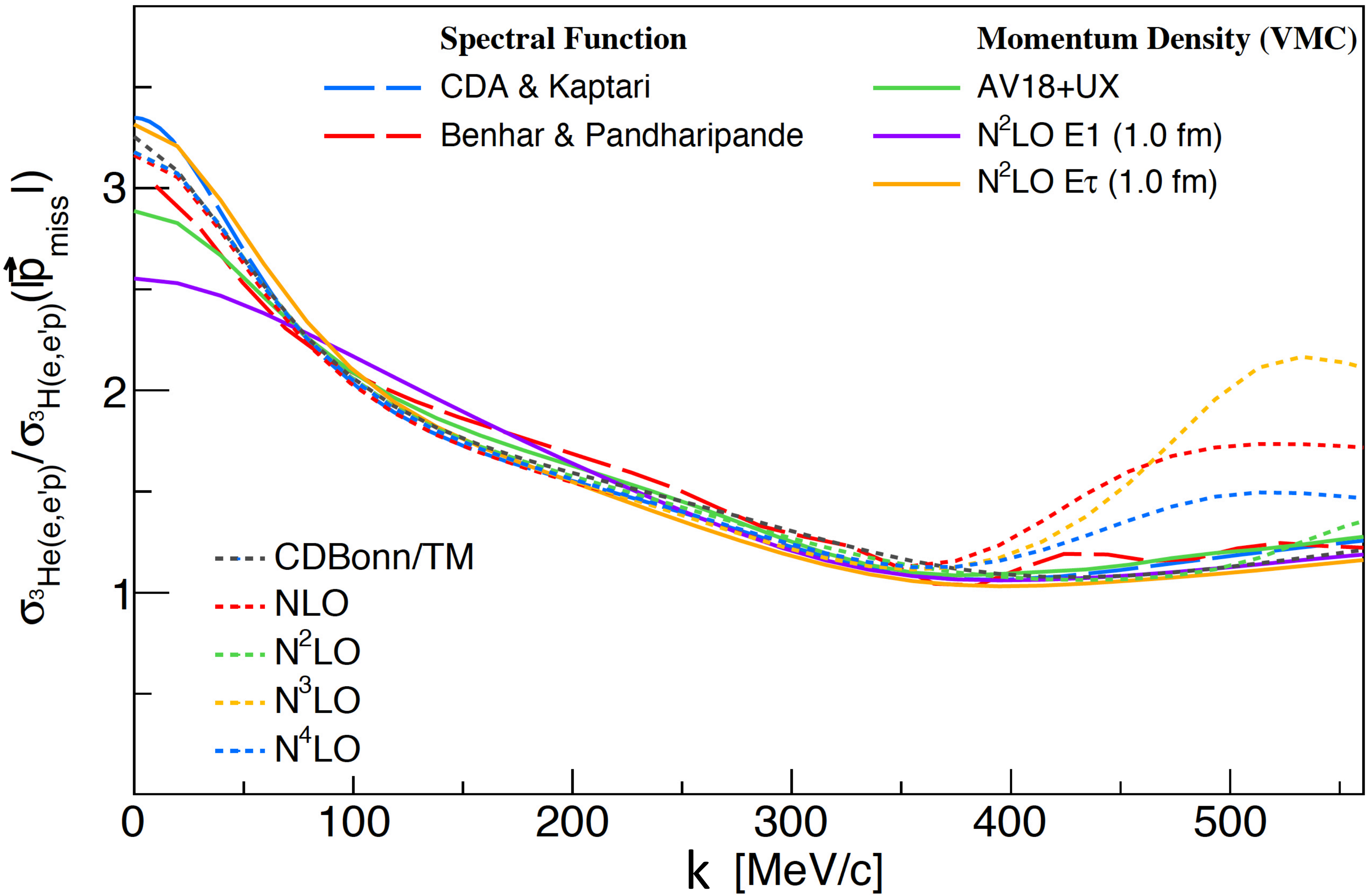
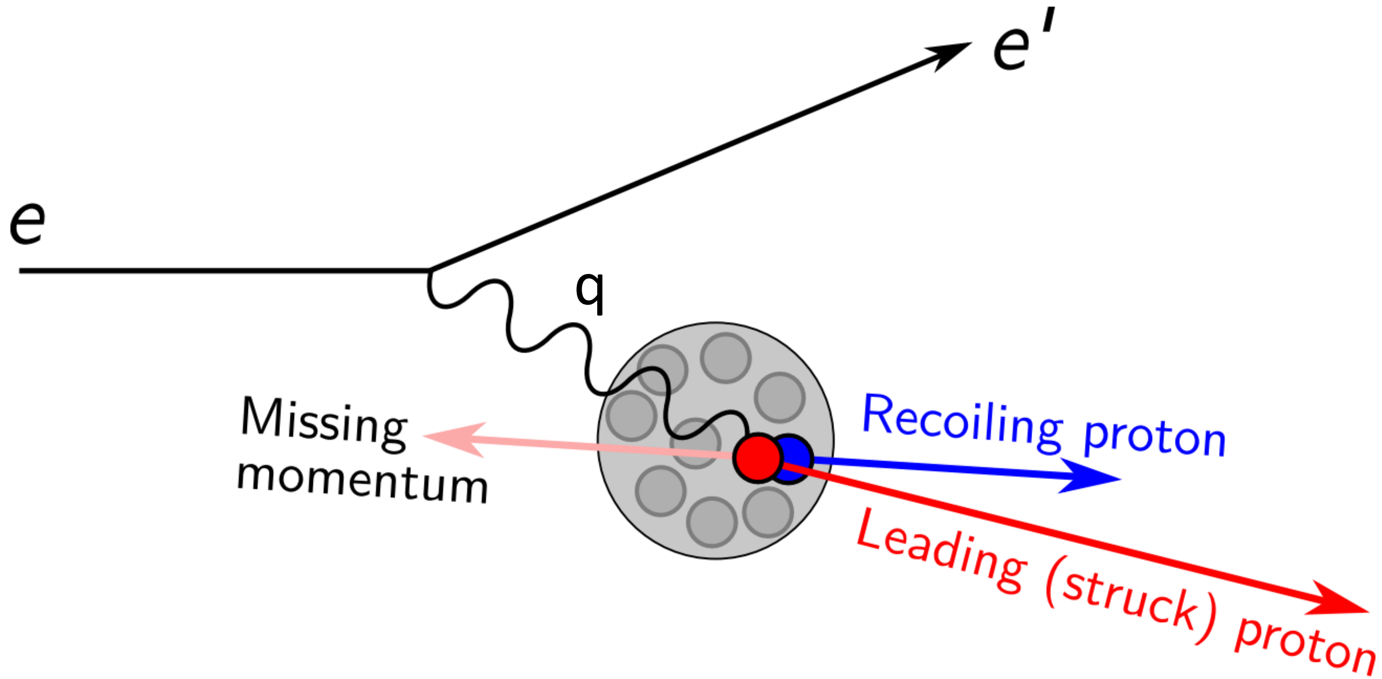


^{3}He/^{3}H ratio theory predictions



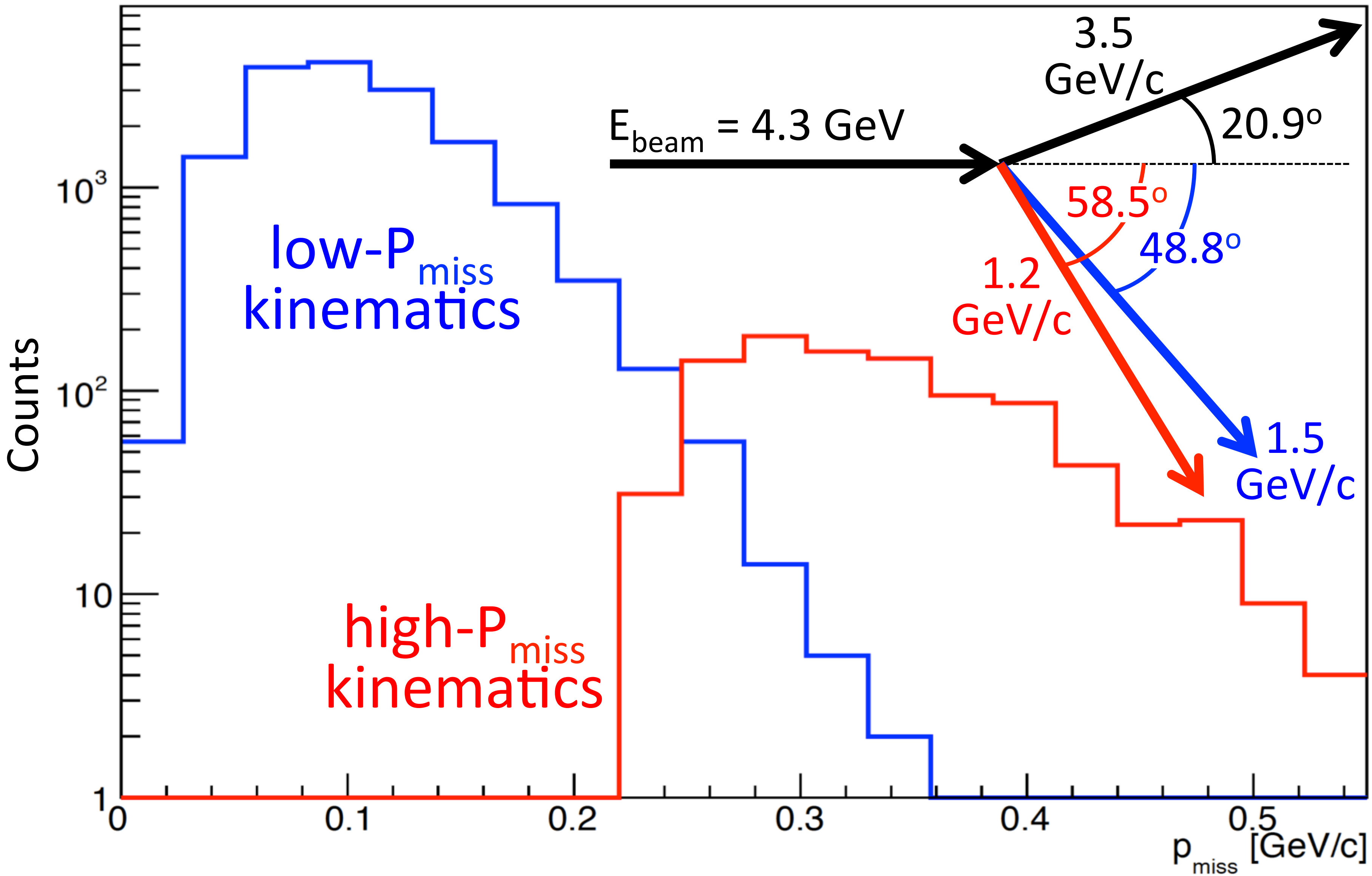
Missing momentum

$$\vec{p}_{miss} = \vec{p}_p - \vec{q}$$

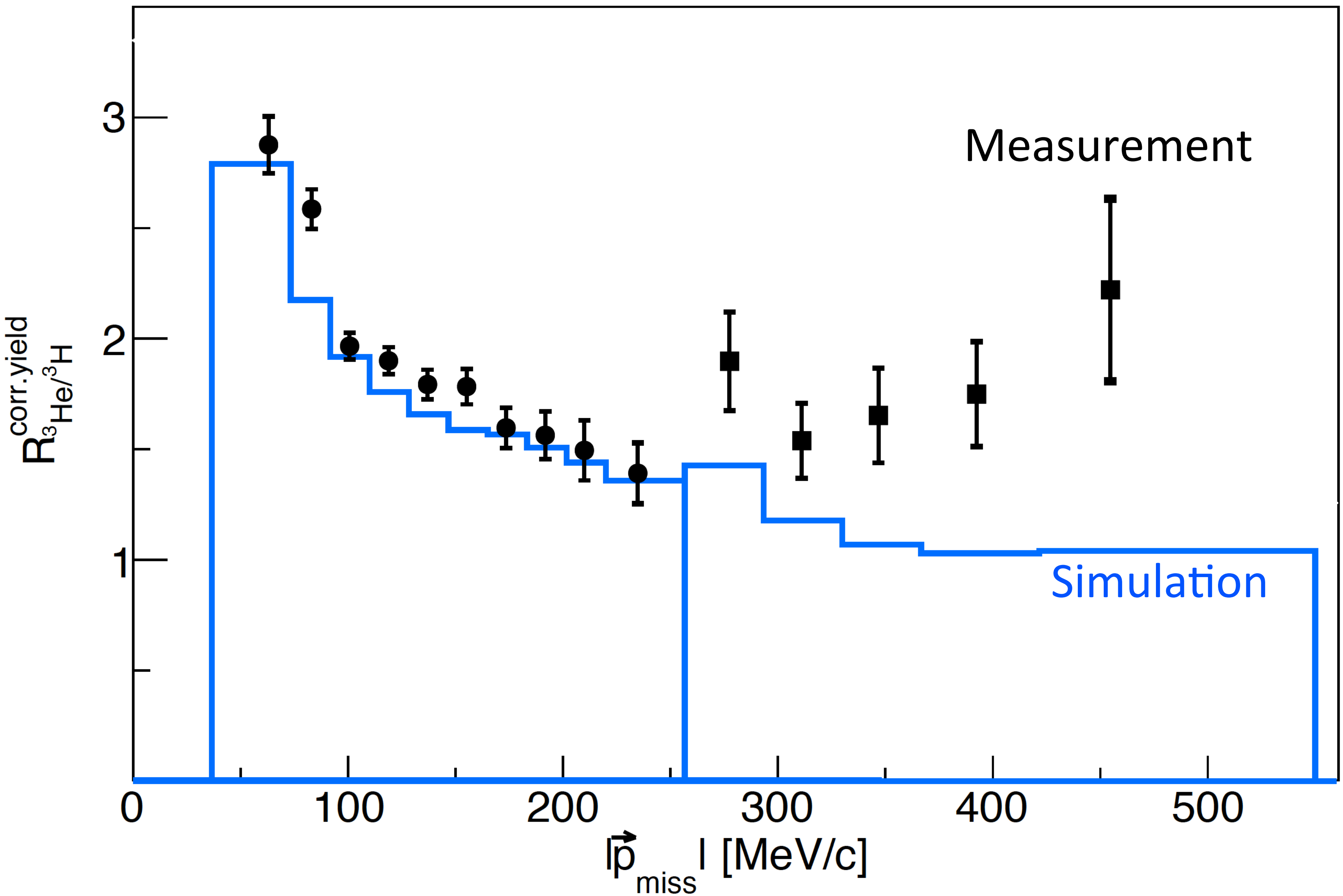


a proxi for the nucleon momentum before the interaction took place

Kinematical settings

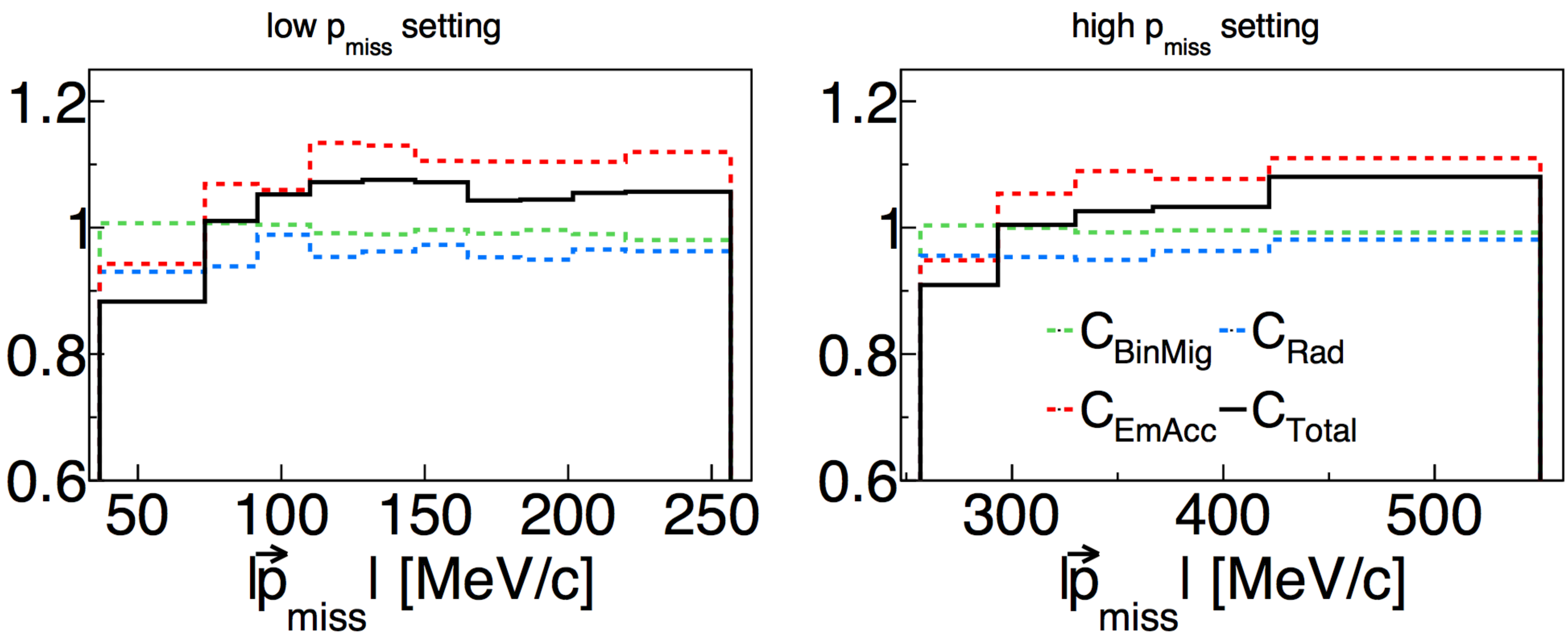


Measured $^3He/^3H$ ratio

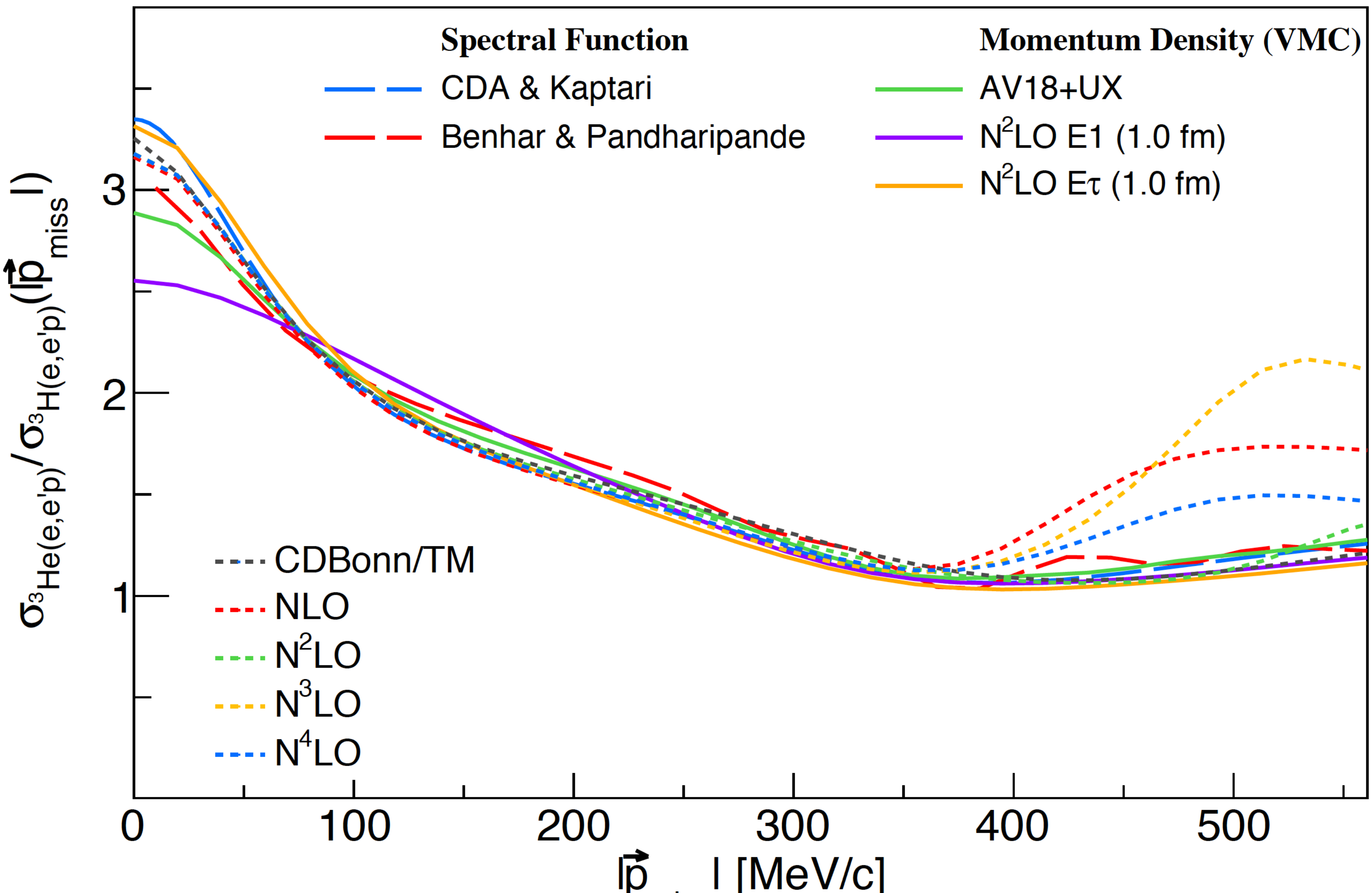


Corrections

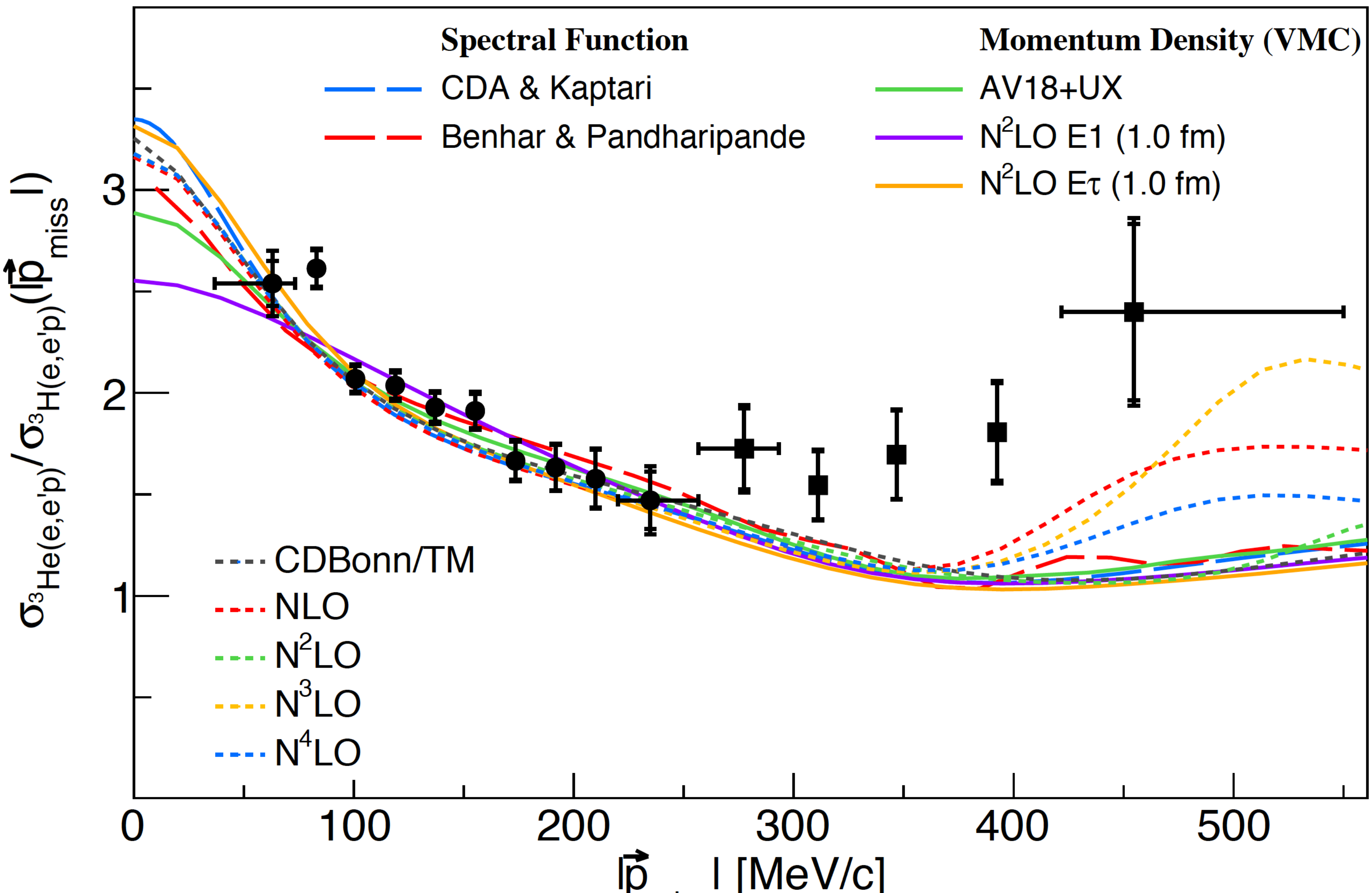
$$R_{n(p)}^{\text{meas.}}(p_{miss}) = R_{^3\text{He}/^3\text{H}}^{corr.yield}(p_{miss}) \times C_{\text{BinMig}} \times C_{\text{Rad}} \times C_{E_m\,\text{Acc}}$$



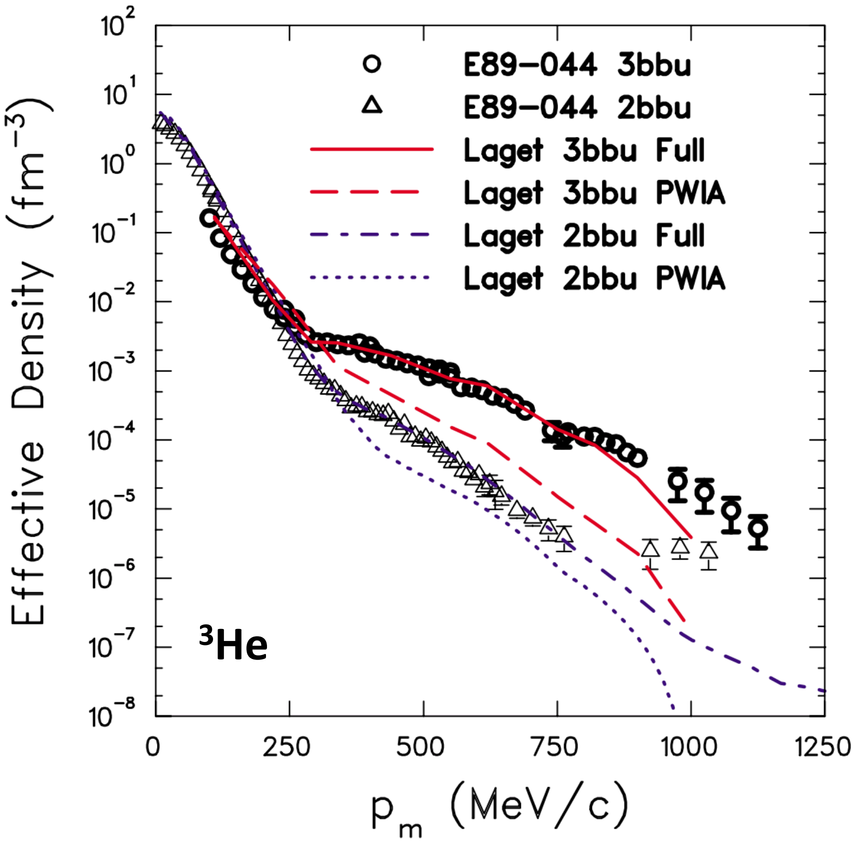
Final results

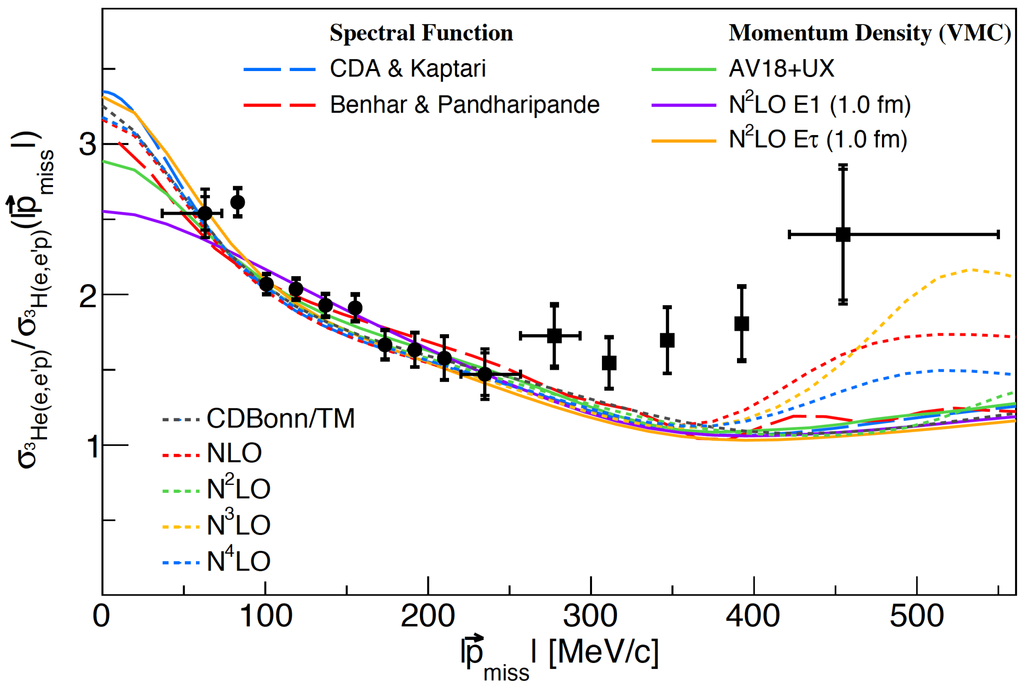


Final results

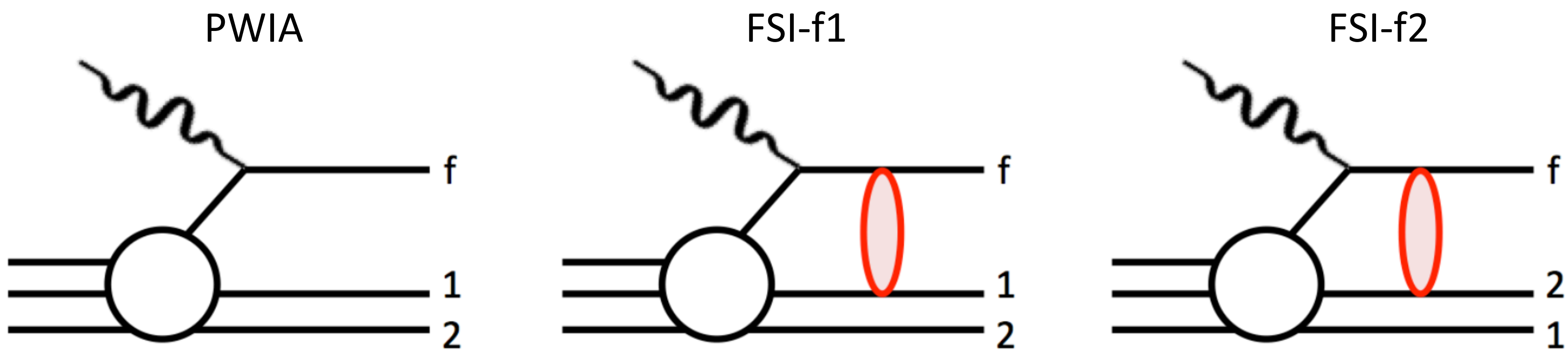


Better agreement with PWIA calculations

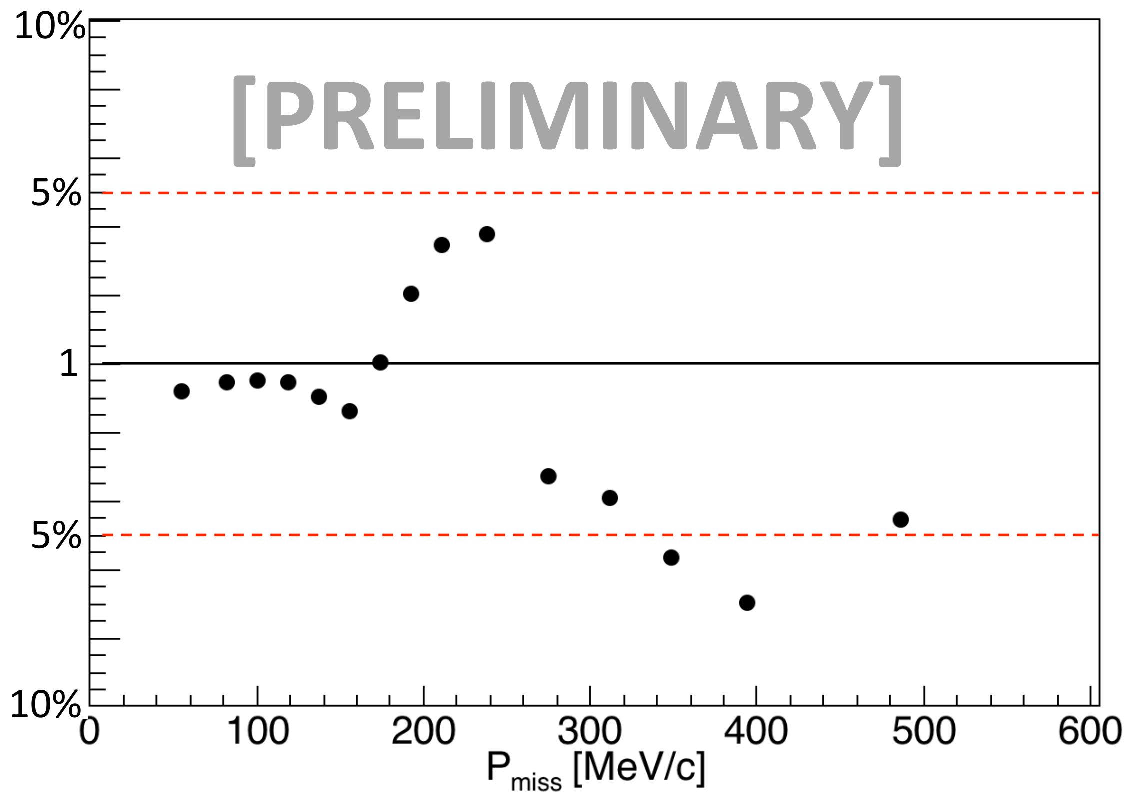




Effect of Final-State Interactions



$$\frac{(^3He/^3H)\mathbf{FSI}}{(^3He/^3H)\mathbf{PWIA}}$$



calculation by M. Sargsian

what causes high-p_{miss} ~30% discrepancy

Thank you!

"…Physicists have devoted […] probably more man-hours [to this question] than have been given to any other scientific question in the history of mankind."

Hans A. Bethe

"What holds the nucleus together", Scientific American 189, 58 (1953).