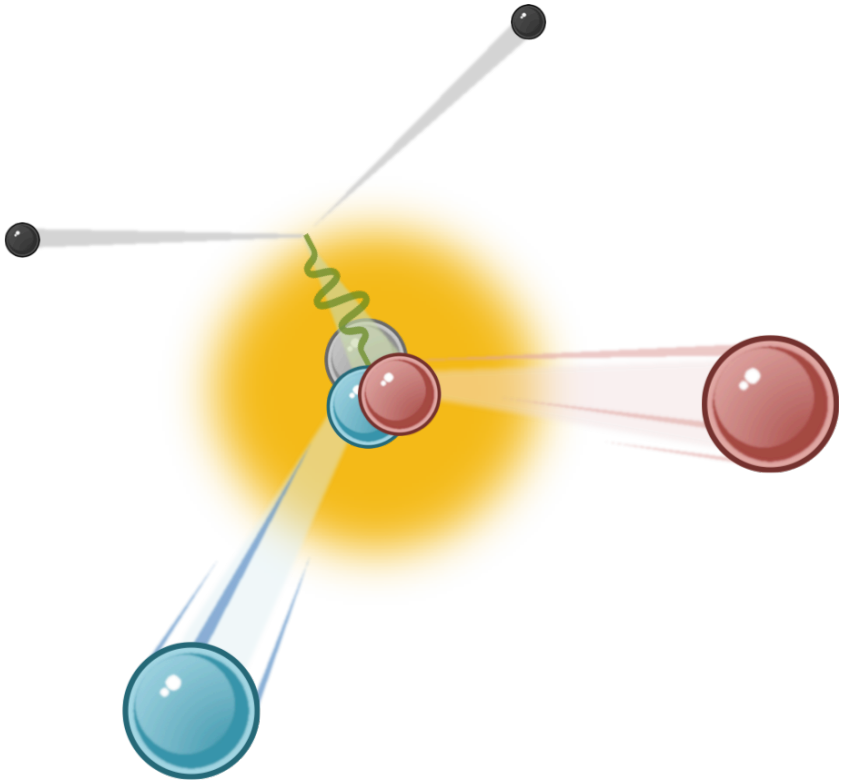
Implementing ^{3}He and ^{3}H spectral functions in SIMC



Reynier Cruz Torres,
for the E12-14-011 collaboration
September 19, 2016

Jefferson Lab

Outline

1. SIMC overview
2. ^{3}He spectral function
3. Implementation
4. Results
5. Next steps

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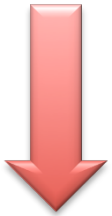
SIMC overview

- SIMC is the standard Hall C Monte Carlo for coincidence reactions (similar to MCEEP) written in FORTRAN (now gfortran compatible).

- Features:
  - Optics (COSY) and "aperture checking" Monte Carlo of spectrometers
  - Includes radiative effects, multiple scattering, ionization energy loss, particle decay
  - Simple prescriptions available for FSI, Coulomb correction, …

*Taken from: http://hallaweb.jlab.org/data_reduc/AnaWork2009/simc_overview.pdf

SIMC overview



- Reactions implemented:

1. Elastic and quasielastic → H(e,e'p), A(e,e'p)
2. Exclusive pion production → H(e,e'π^{+})n, A(e,e'$\pi^{+/-}$) [quasifree or coherent]
3. Kaon electroproduction → H(e,e'K^{+})Λ,Σ, A(e,e'$K^{+/-}$)
4. H(e,e'$\pi^{+/-}$)X, D(e,e'$\pi^{+/-}$)X [semi-inclusive]
5. H(e,e'$K^{+/-}$)X, D(e,e'$K^{+/-}$)X [semi-inclusive]
6. H(e,e'$\rho\rightarrow\pi^{+}\pi^{-}$)p, D(e,e'$\rho\rightarrow\pi^{+}\pi^{-}$) [diffractive ρ]

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^{3}He spectral function

- File is already in the SIMC main directory (benharsf_3mod.dat)
- It is a lookup table

9.866	5.600	0.1261E-01	0.0000E+00	19.733	1.000
9.866	10.300	0.2382E-02	0.3563E-02	19.733	5.000
9.866	15.300	0.7343E-03	0.1098E-02	19.733	5.000
9.866	20.300	0.2631E-03	0.3935E-03	19.733	5.000
9.866	25.300	0.1097E-03	0.1641E-03	19.733	5.000
…	…	…	…	…	…

^{3}He spectral function

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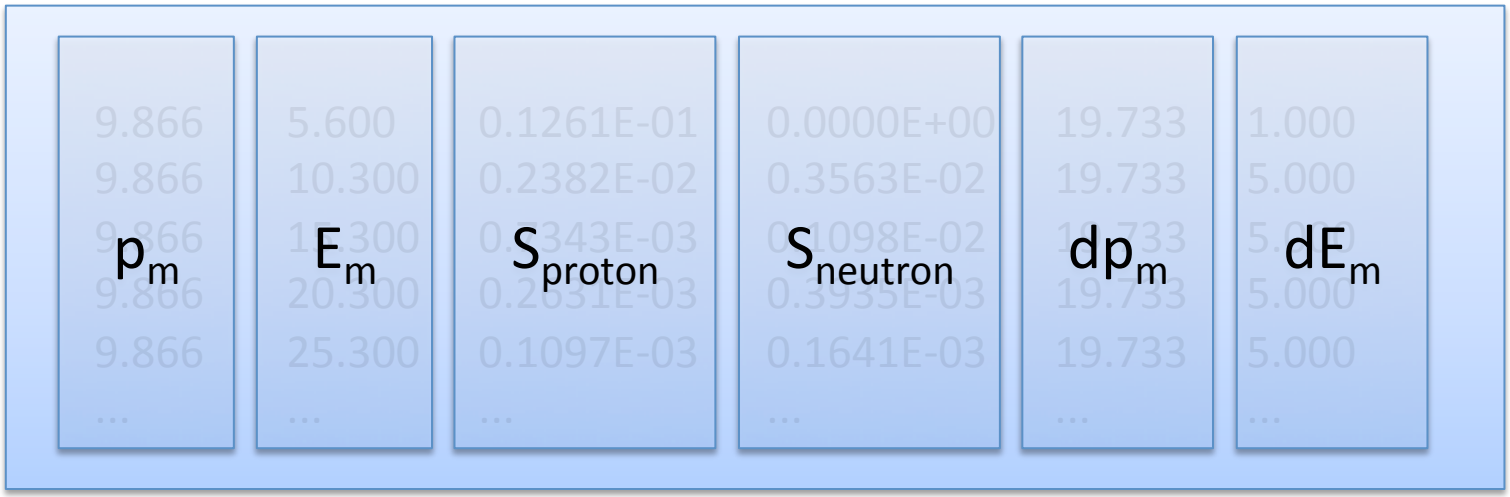
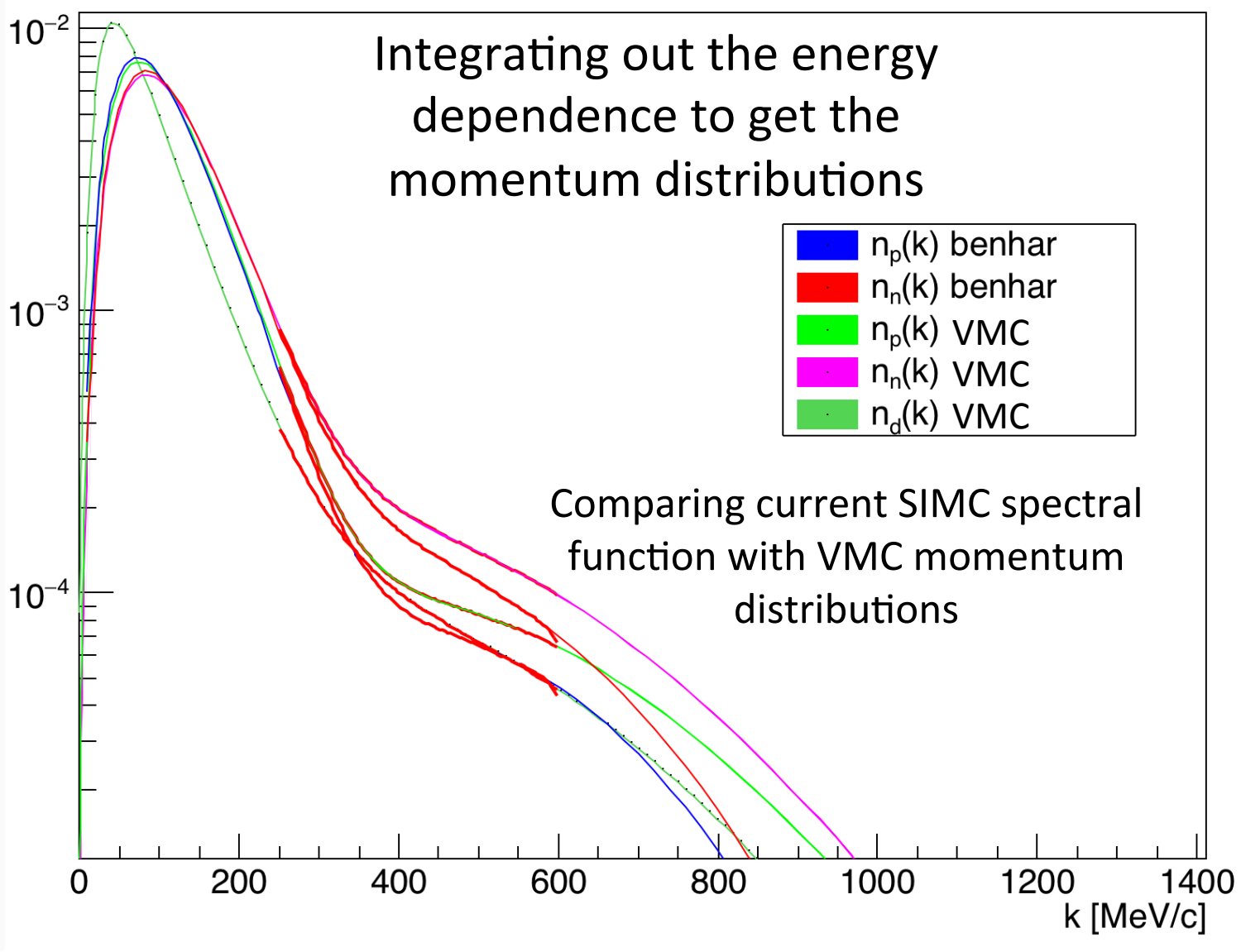
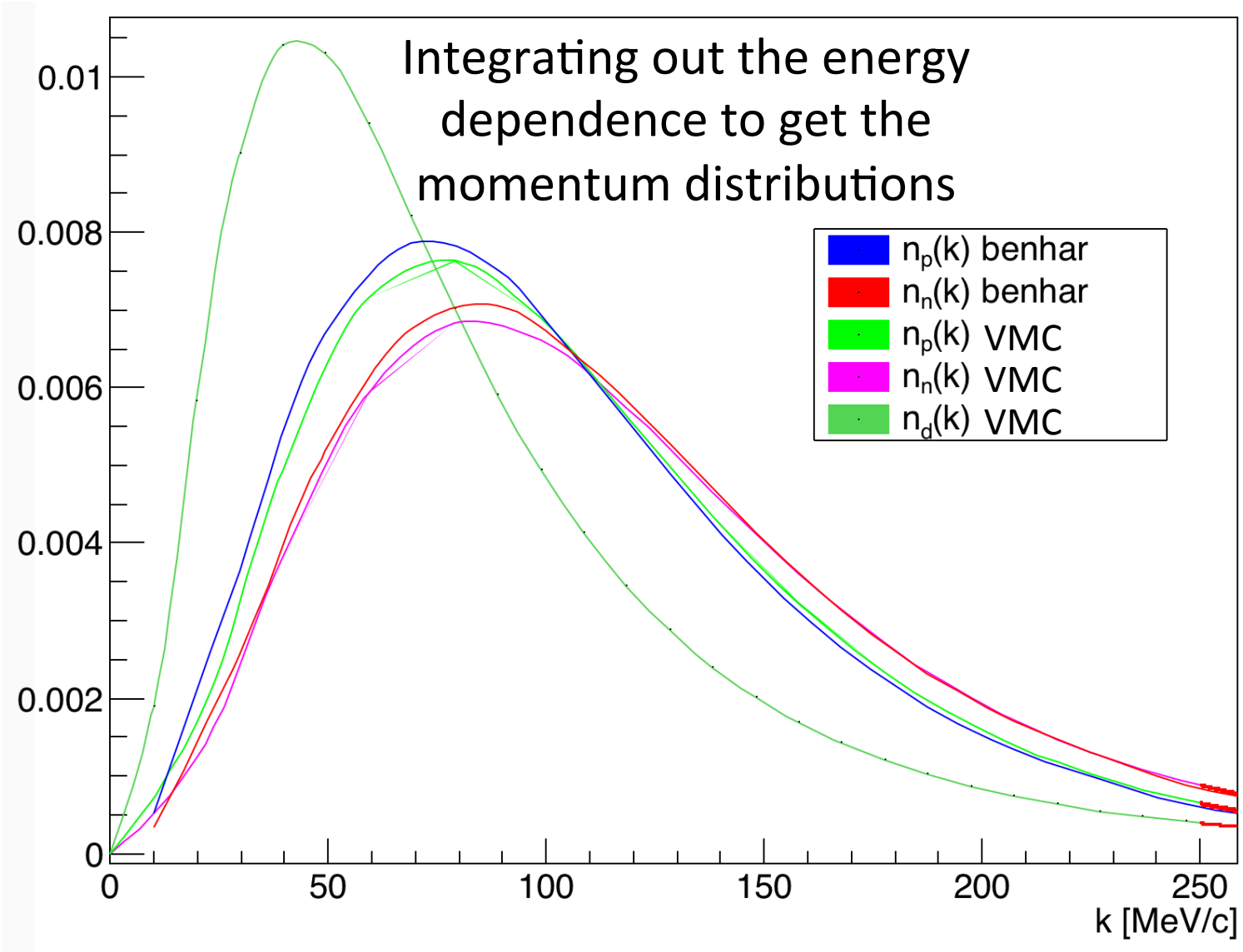
- It is a lookup table



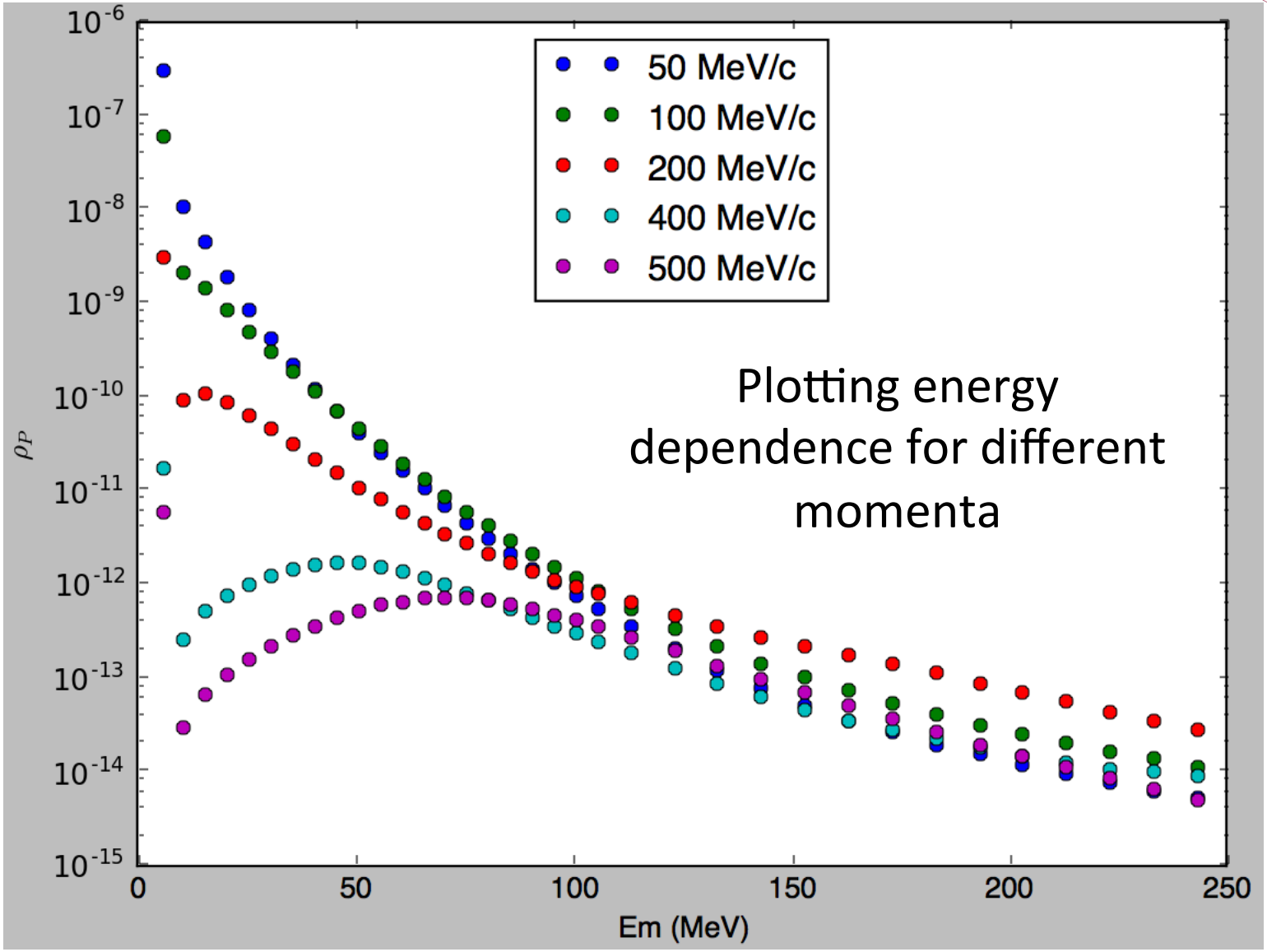
^{3}He spectral function



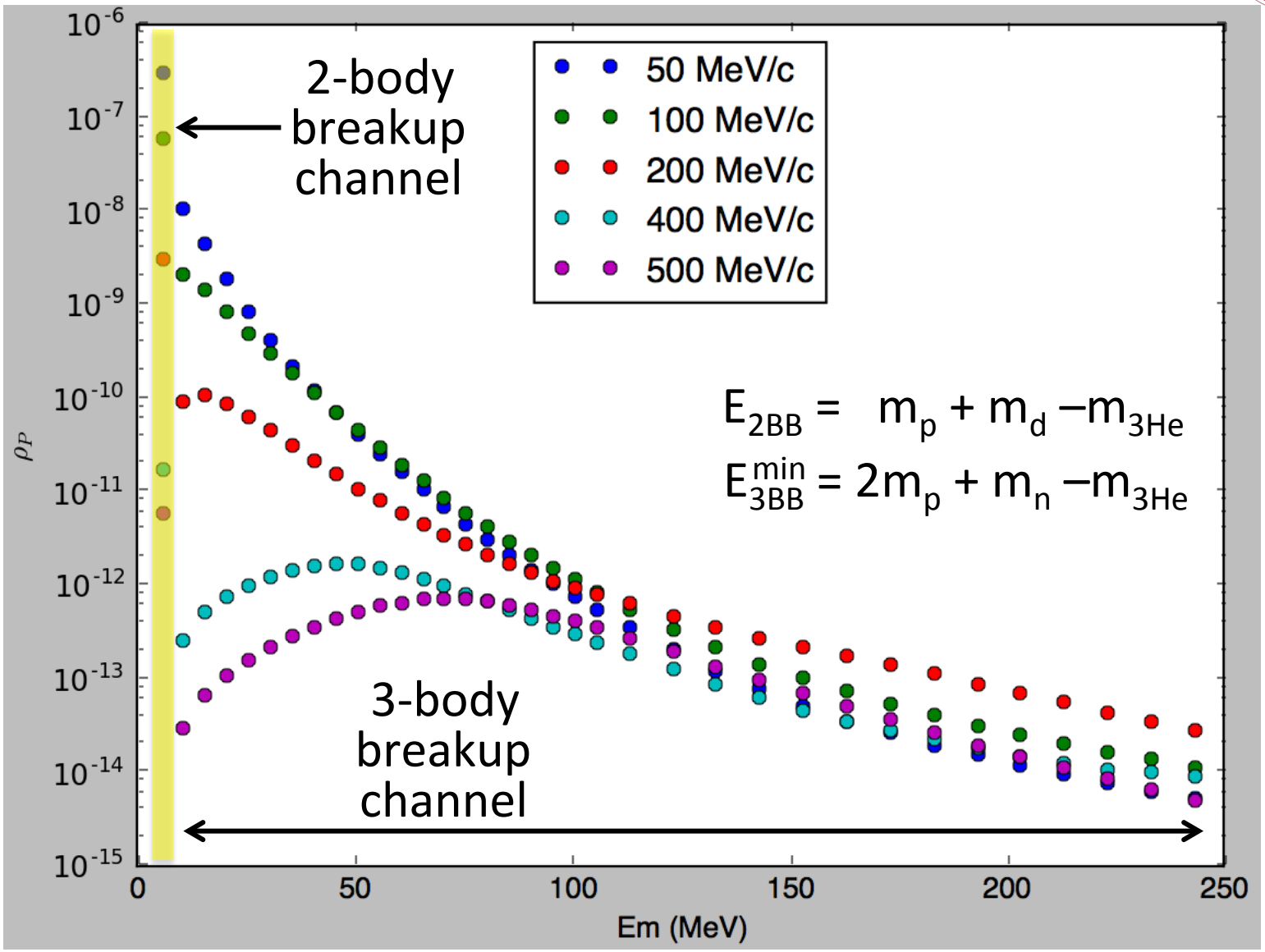
^{3}He spectral function



^{3}He spectral function

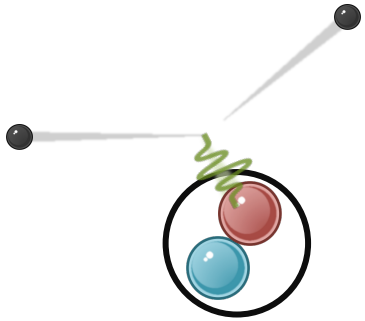


^{3}He spectral function

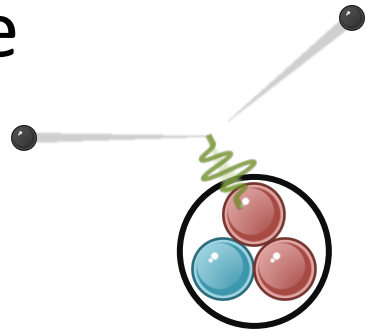


2- and 3-body breakup channels

^{2}H

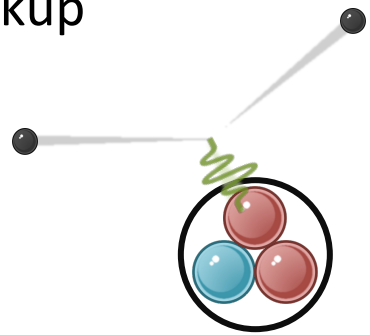


^{3}He

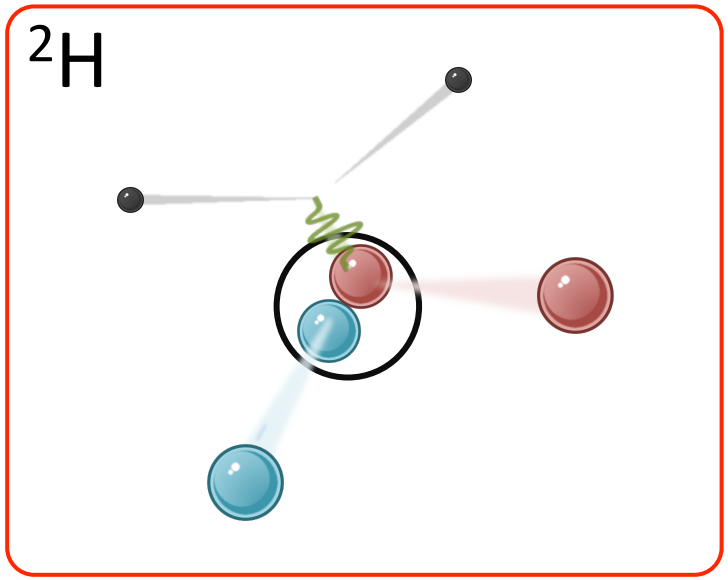


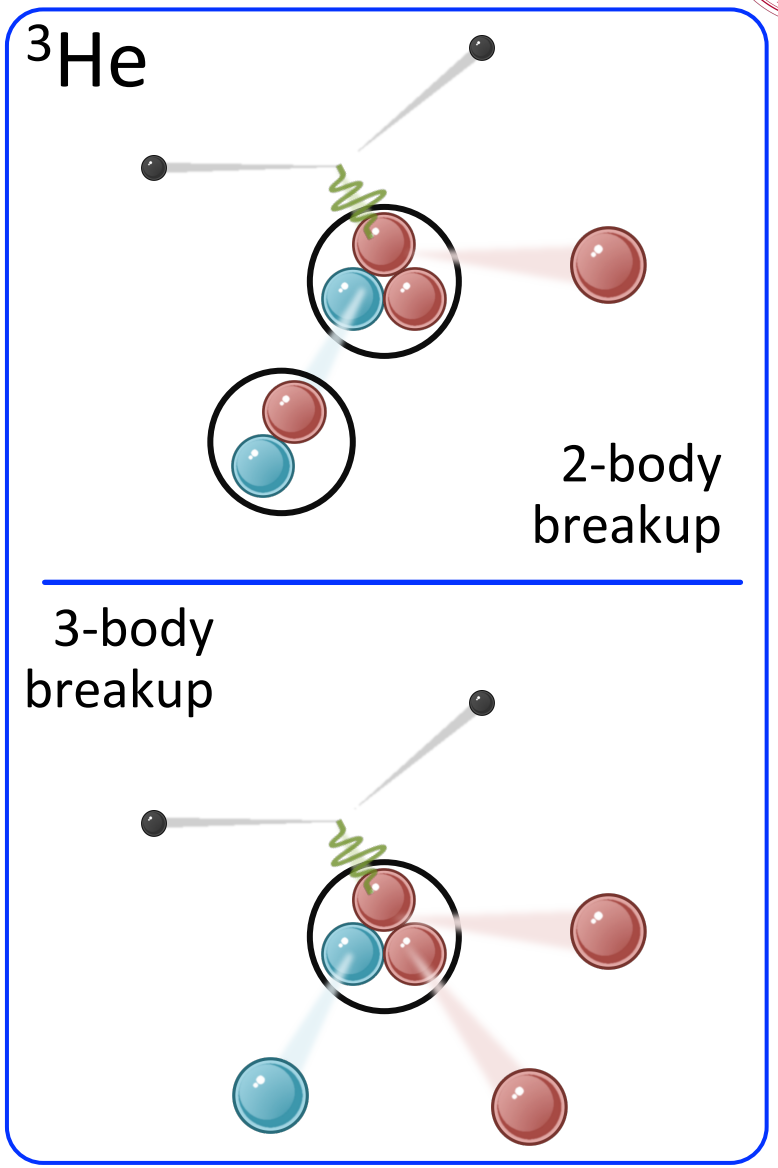
2-body breakup

3-body breakup



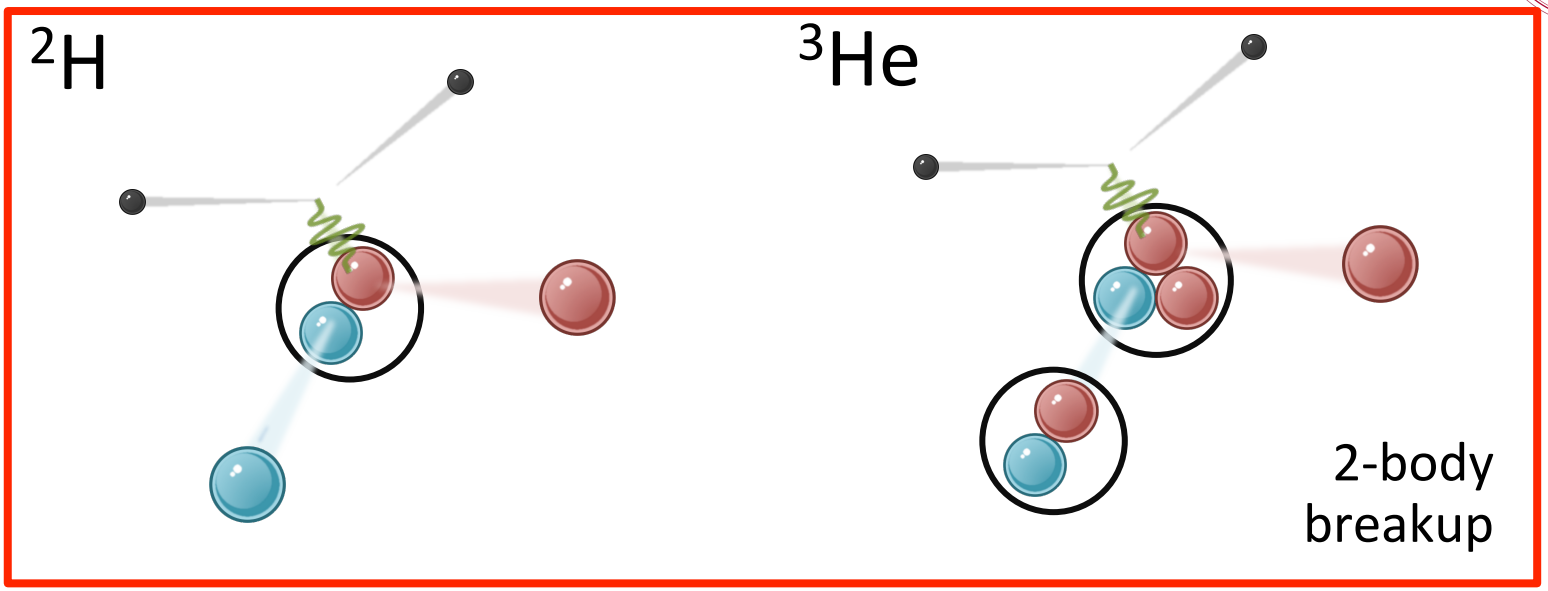
2- and 3-body breakup channels



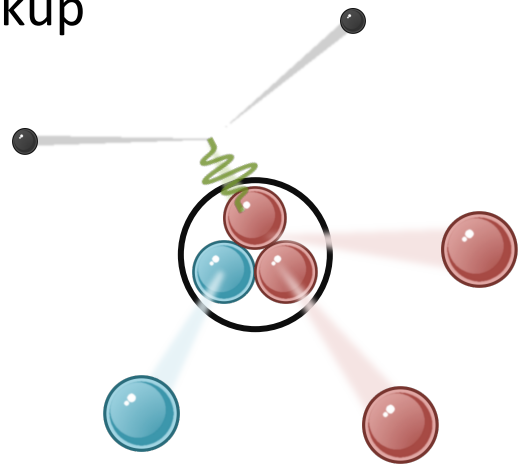


- Kinematics in ^{3}He 2-body breakup and 3-body breakup channels are <u>not</u> the same.
- ^{3}He 3-body breakup channel has one extra dof.

2- and 3-body breakup channels



3-body breakup



- Kinematics in ^{3}He 2-body breakup and ^{2}H channels are the same.
- Need to take this into account in SIMC

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Implementation

Started using Werner Boeglin's version of SIMC (slightly different from the standard version).

1. Removed a few lines of code that were blocking the spectral function in event.f

2. Created a new (boolean) parameter in the input file called "doing_bound" that only affects the ^{3}He sections of the code:

- doing_bound = T → 2-body breakup channel
- doing_bound = F → 3-body breakup channel

* To run SIMC using the spectral function, run twice: once with doing_bound = T, and once with doing_bound = F. Then combine the output root files.

Implementation

3. Implemented the following changes (since the kinematics in the kinematics in the ^{3}He 2-body breakup channel are deuteron-like):

from:		to:
doing_deuterium	→	doing_deuterium or (doing_heavy and doing_bound)
doing_heavy	→	doing_heavy and NOT doing_bound

* This last change is not true for every single doing_deuterium/doing_heavy statement.

** Please, contact me for the specifics (reynier@mit.edu)

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Results

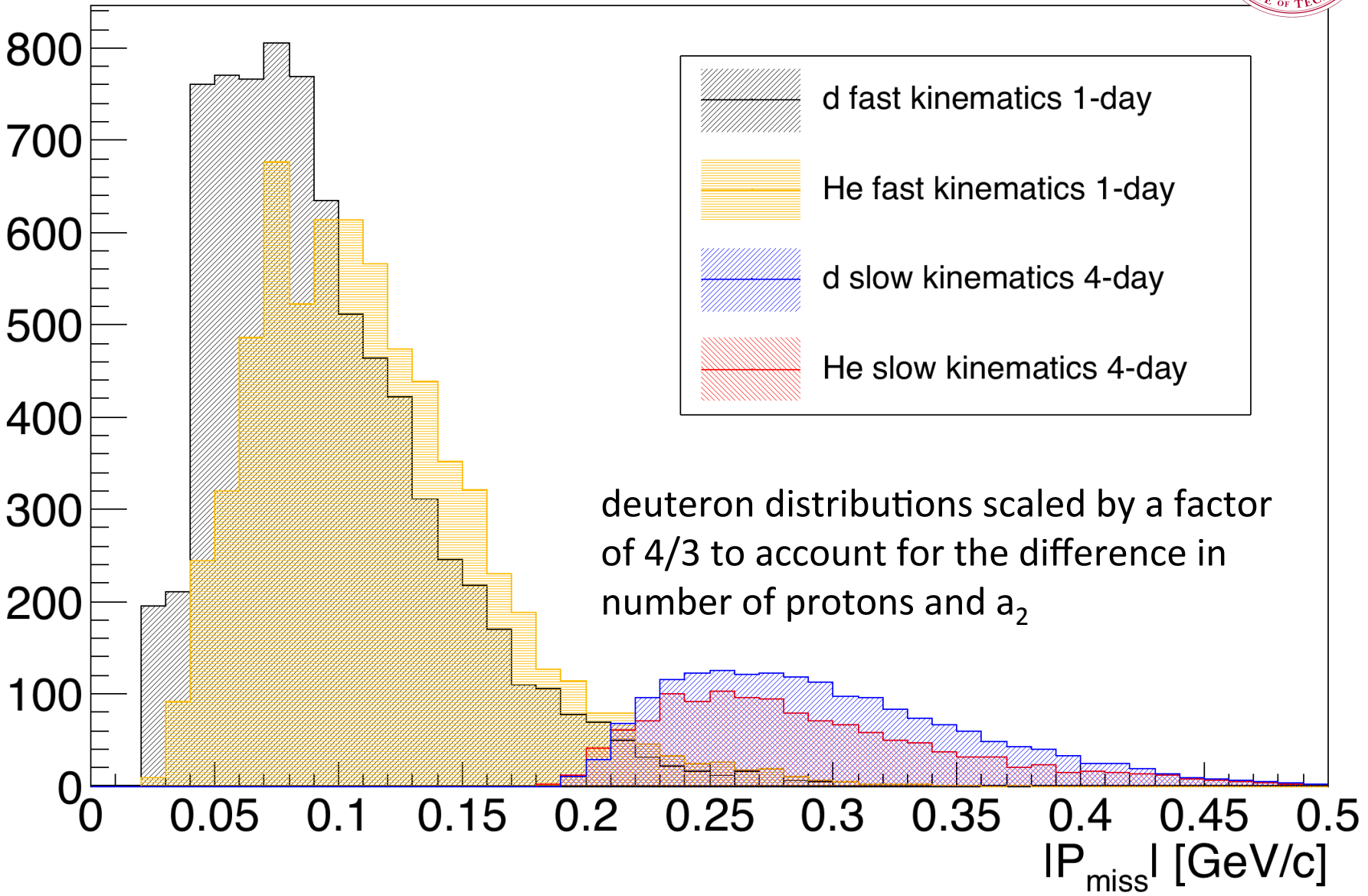
- ✓ Ran SIMC in the two kinematical configurations that we have in our experiment for deuteron (standard way) and ^{3}He (using the implemented spectral function):

	$< p_m >$ (MeV/c)	x	E_e (GeV)	θ_e	p_p (GeV/c)	θ_p	total beam time (days)
"Fast kinematics"	100	1.15	3.47	20.86°	1.607	48.67°	1
"Slow kinematics"	300	1.41	3.64	20.35°	1.352	58.55°	8

- ✓ Other parameters:
  1. Beam current — I = 25 μA
  2. Luminosity — L = 1.88 μA-g/cm^2
  3. Target thickness — t = 75 mg/cm^2
  4. Target density — ρ = 0.003 g/cm^3
  5. Target length — l = 25 cm.

- ✓ Cuts applied in the analysis stage: $\theta_{nq} < 40^o$ to reduce FSI

Results


800
700
600
500
400
300
200
100
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
|P_miss| [GeV/c]
d fast kinematics 1-day
He fast kinematics 1-day
d slow kinematics 4-day
He slow kinematics 4-day
deuteron distributions scaled by a factor of 4/3 to account for the difference in number of protons and a2

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Next steps

- ✓ Fix the normalizations:
  - Currently working on it
- ✓ Add tritium spectral function:
  - Also working on this. For the moment we will be using the n-distribution from ^{3}He which (from isospin symmetry) is effectively the same as the p-distribution for tritium
- ✓ Add other versions of the spectral function
- ✓ Kinematics optimization
- ✓ Calibration
- ✓ Any others?

Thank you