Fermi-Unsmearing: A Monte Carlo Method to Correct for Fermi-Motion of a Target Nucleon.

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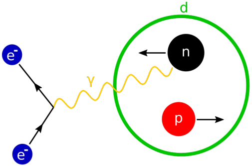
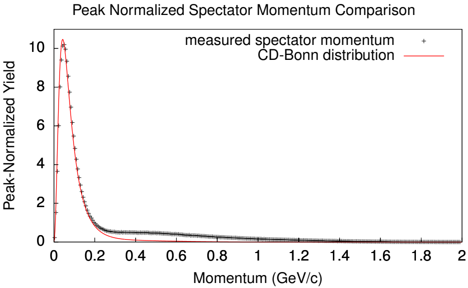
Scattering off Bound Nucleons: Fermi-Motion

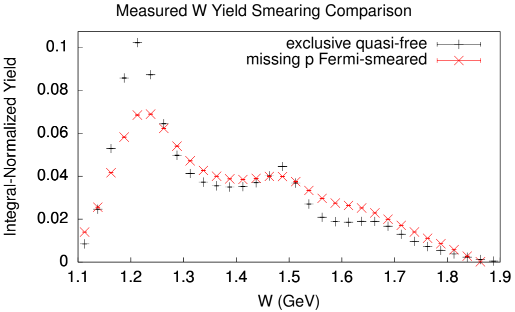




- Bound nuclei can be used for various reasons, especially for scattering off neutrons.
- *Fermi-motion* is the random motion of a bound nucleon within the nucleus.

Fermi-Smearing

Example quasi-free scattering reaction: $e^- + \boxed{n + p_s} \rightarrow e^- + \pi^- + p + p_s$



- If all non-spectator final state particles are detected and reconstructed, then W, Q^2 and the angular degrees of freedom can be determined.
- If any are not detected, the current approach is to assume the target nucleon is at rest.
- This causes a distortion in the cross section measurement known as *Fermi-smearing*.

Proposed Solution

- Add Fermi-motion to target nucleon in a Monte Carlo event generator for a particular reaction channel.
- Correct for Fermi-smearing using the ratio

$$R_{fm} = \frac{T_{\mathrm{true}}}{T_{\mathrm{smeared}}}, \tag{1}$$

where T_i are the Fermi-smeared or not Fermi-smeared thrown yields binned in whichever variables are required, analogous to acceptance corrections, radiative effects, etc.

My Test Case: Single Charged Pion Electroproduction off Neutron

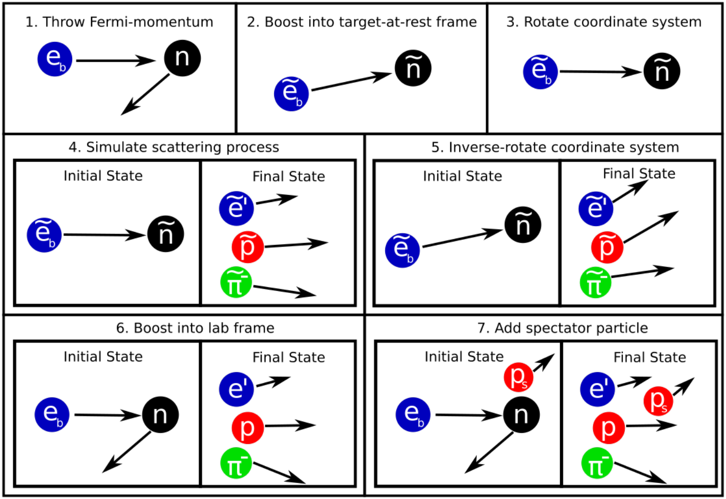
- Channel for testing Fermi-unsmearing method:

$$e^- + \boxed{n + p_s} \rightarrow e^- + \pi^- + p + p_s \tag{2}$$

- Channel for extracting cross section:

$$e^- + \boxed{p + n_s} \rightarrow e^- + \pi^+ + n + n_s \tag{3}$$

Adding Fermi-Motion to Simulations



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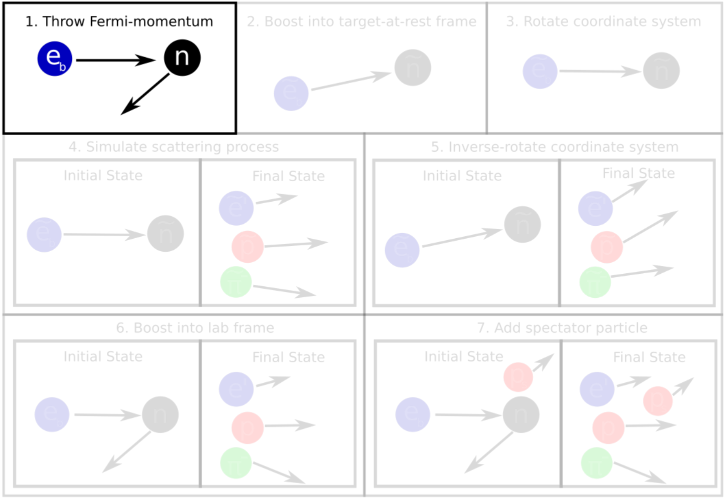

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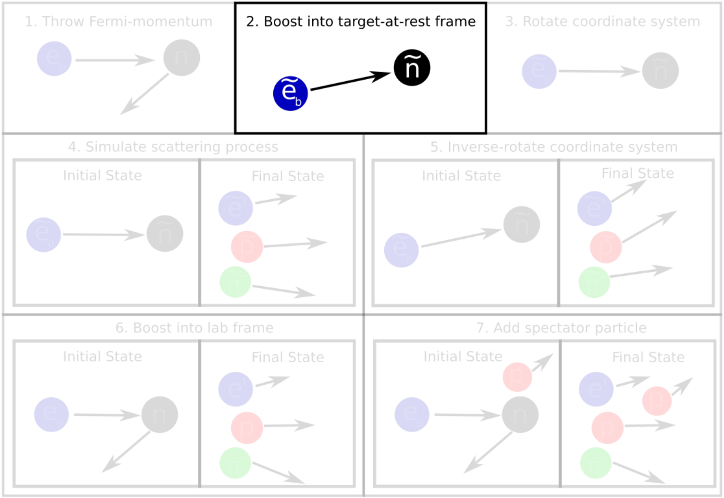

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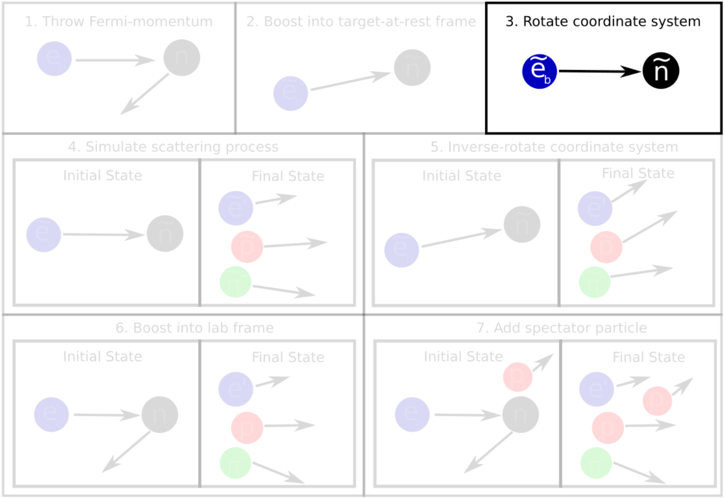

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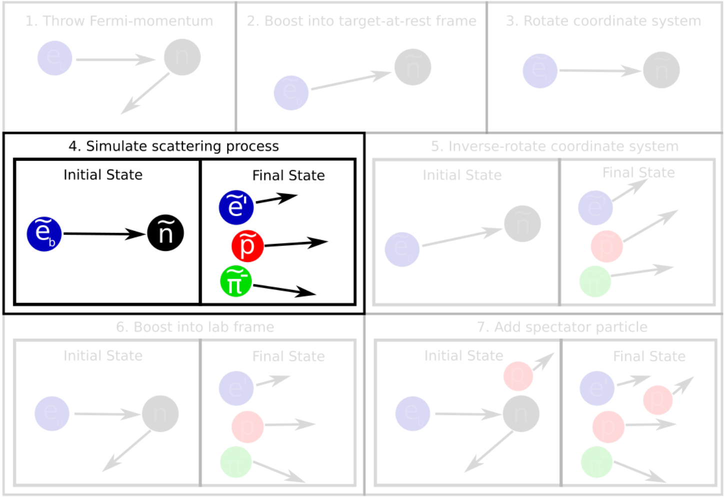

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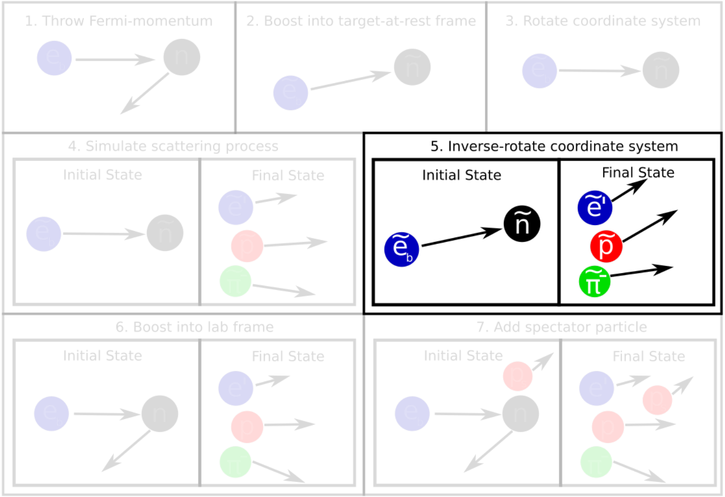

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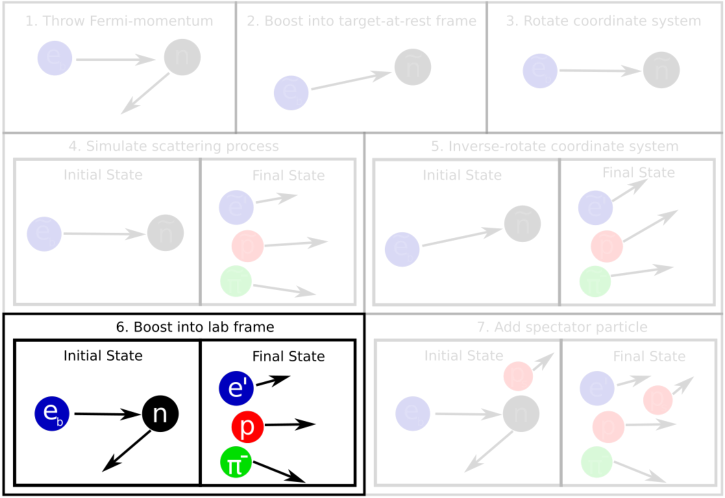

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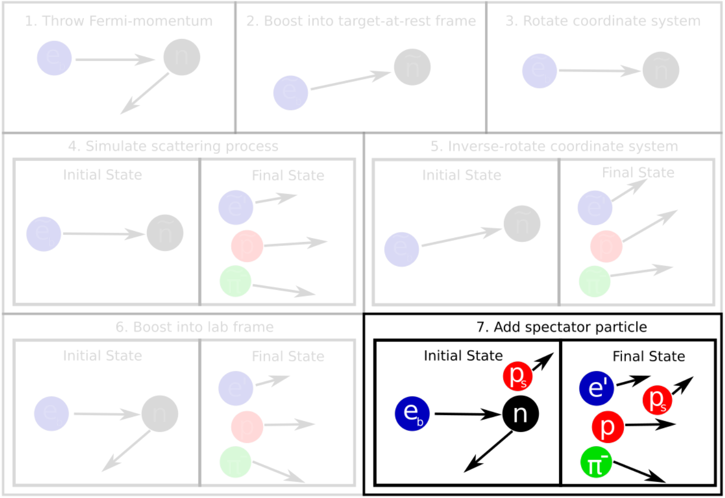
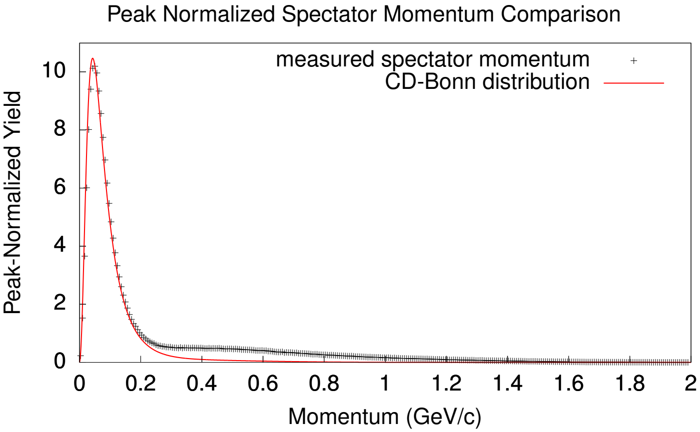
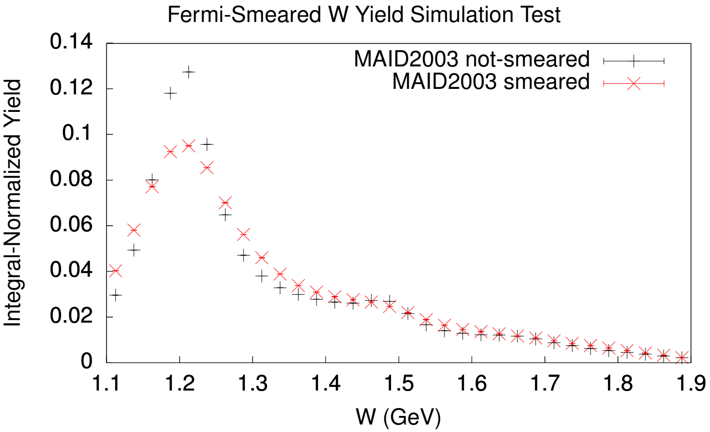


Models

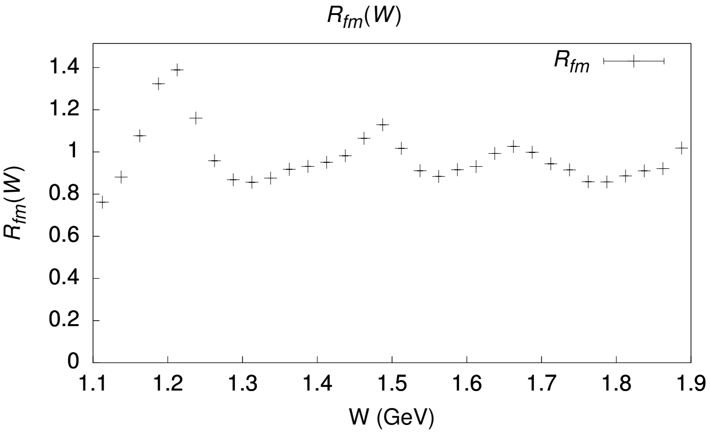


- MAID 2003 [1] is used for cross section model.
- CD-Bonn potential [2] is used for Fermi-momentum distribution.

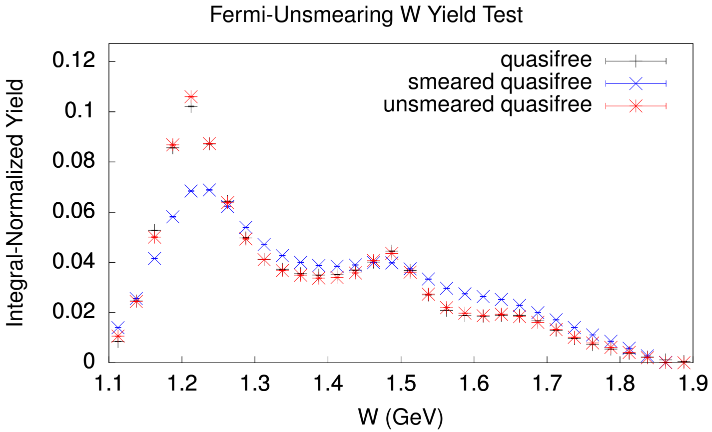
Preliminary Results from Fermi-Smeared Model



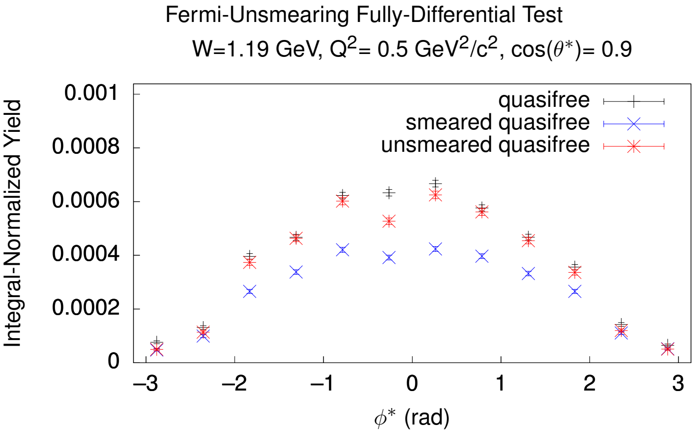
Preliminary Results from Fermi-Smeared Model (Cont.)



Applying Fermi-Unsmearing Factor R_{fm}: Preliminary Tests



Applying Fermi-Unsmearing Factor R_{fm}: Preliminary Tests (cont.)



References I

[1] MAID Homepage.
http://portal.kph.uni-mainz.de/MAID/.
[Accessed: 2017-08-13].

[2] R. Machleidt.
The High precision, charge dependent Bonn nucleon-nucleon potential (CD-Bonn).
Phys. Rev., C63:024001, 2001.
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