Fermi momentum & eN collision $W^2$

BeAGLE (& DPMJET & Pythia) use on-mass-shell nucleons which sit in a mean-field nuclear binding + Coulomb potential.

In nuclear target rest frame:

$Q^\mu = \{\nu; 0, 0, \sqrt{\nu^2+Q^2}\}$ defined by lepton – nuclear kinematics

$P^\mu = \{M; 0, 0, 0\}$ OR $\{M+E_{kF}; p_{xF}, p_{yF}, p_{zF}\}$
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$W^2 = (P+Q)^2 = 2M\nu - Q^2 + M^2 \quad (+2\nu E_{kF} - 2\sqrt{\nu^2 + Q^2}p_{zF})$
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$W^2 = (P+Q)^2 = 2M \nu - Q^2 + M^2$ ($+2\nu E_{kF} - 2\sqrt{\nu^2 + Q^2}p_zF$)

High $\nu$ limit ($\nu \gg M, Q$):

$W^2 \sim 2M \nu \left( 1 - \frac{p_zF}{M} \right)$ (note that $E_{kF} \ll p_zF$)
$W^2$ smearing for two extremes

Fermi momentum effect on $W^2$

- ePb 20x100 (eRHIC max) - rms 8%
- eXe 27.5x0 (HERMES) - rms 9%