# Analysis Progress

## for the $d_2^n$ analysis meeting

Diana Parno

CENPA, UW

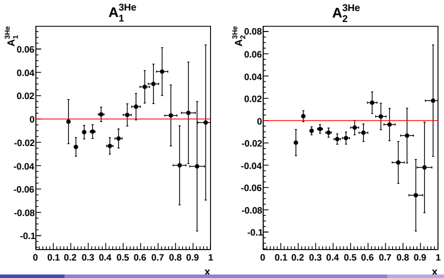
June 2, 2011

# Neutron Extraction

- Several approaches (basic approximation, convolution approach)
- Let's use "complete analysis" approach from Bissey, Guzey, Strikman and Thomas (PRC **65** 064317 (2002))

$$A_1^n = \frac{F_2^{^3\mathrm{He}}}{P_n F_2^n \left(1 + \frac{0.056}{P_n}\right)} \left( A_1^{^3\mathrm{He}} - 2\frac{F_2^p}{F_2^{^3\mathrm{He}}} P_p A_1^p \left(1 - \frac{0.014}{2P_p}\right)\right) \qquad (1)$$

- Potential problem: "It is assumed...that the transverse spin asymmetry, $A_2^n$, is negligibly small ..."

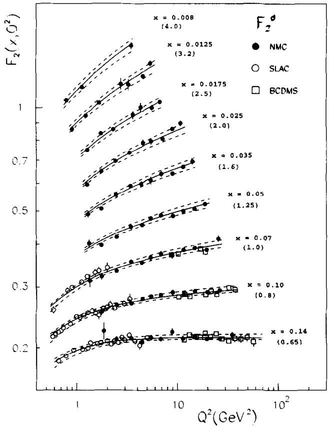


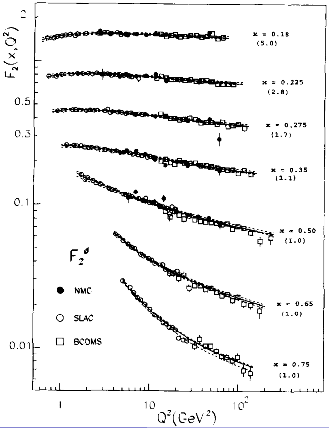
# $P_p$ and $P_n$

- Bissey *et al* use $P_n = 0.86 \pm 0.02$, $P_p = -0.028 \pm 0.004$
  - This is the average over several models from Friar *et al* (PRC **42** 2310 (1990))
- Zheng *et al* use expanded error bars to account for "full uncertainty" using "nine more models": $P_n = 0.86^{+0.036}_{-0.02}$, $P_p = -0.028^{+0.094}_{-0.004}$.

# $F_2^p$ and $F_2^n$

- We can extract $F_2^p$ and $F_2^n$ from world $F_2$ data on proton and deuteron targets
- NMC produced a 15-parameter fit of for both targets (Arneodo *et al* Phys Lett B **364** 107 (1995))
- Fit is easily coded



# $A_1^p$

- Zheng (PhD dissertation, 2002) did a fit of $g_1^p/F_1^p$, transforming it to $A_1^p$ assuming that $g_2 \sim g_2^{WW}$ (Eq 5.55)
- She also performed a fit of world $A_1^p$ measurements to that point (Eq 5.56)

$$A_1^p = x^{0.771}\,(1.126 - 0.189x)\left(1 - \frac{0.09}{Q^2}\right) \tag{2}$$

# $F_2^{^3\mathrm{He}}$ (i)

- This one is kind of complicated! No world fit for this exact quantity
- Instead, take $F_2^p$ (from proton data) and $F_2^n$ (from deuteron data) and combine them somehow
- You have to account for the EMC effect. From Appendix A of the Zheng dissertation:

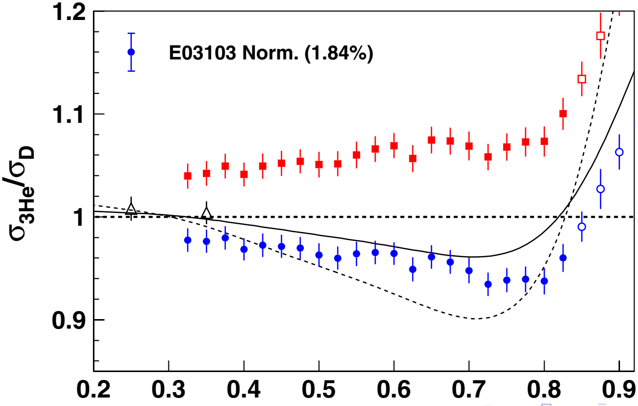
$$\mathcal{R}^{^3\mathrm{He}} \equiv \frac{F_2^{^3\mathrm{He}}}{F_2^n + 2F_2^p} \tag{3}$$

$$F_2^{^3\mathrm{He}} = \mathcal{R}^{^3\mathrm{He}} \left(F_2^n + 2F_2^p\right) \tag{4}$$

- Now we just need the EMC ratio $\mathcal{R}^{^3\mathrm{He}}$

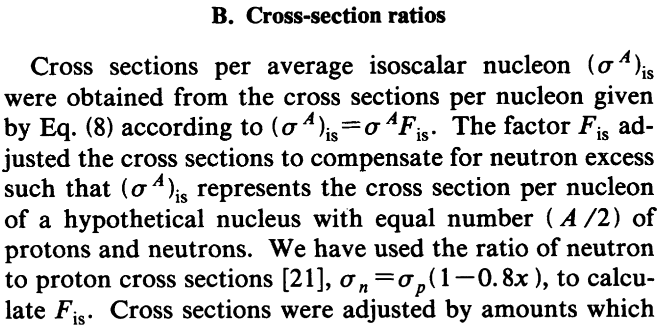
# $F_2^{^3\mathrm{He}}$ (ii)

- Seely *et al* (PRL **103** 202301 (2009)) measured $^3$He EMC ratio in Hall C
- This ratio is *per nucleon* so we need to multiply it by 3/2 to bring it in line with the Zheng definition
- Two reported measurements: raw ratio, ratio with isoscalar correction



# $F_2^{^3\mathrm{He}}$ (iii): Isoscalar correction

- Best explanation of isoscalar correction comes from Gomez *et al* (PRD **49** 4348 (1994)):



**B. Cross-section ratios**

Cross sections per average isoscalar nucleon $(\sigma^A)_{\mathrm{is}}$ were obtained from the cross sections per nucleon given by Eq. (8) according to $(\sigma^A)_{\mathrm{is}} = \sigma^A F_{\mathrm{is}}$. The factor $F_{\mathrm{is}}$ adjusted the cross sections to compensate for neutron excess such that $(\sigma^A)_{\mathrm{is}}$ represents the cross section per nucleon of a hypothetical nucleus with equal number $(A/2)$ of protons and neutrons. We have used the ratio of neutron to proton cross sections [21], $\sigma_n = \sigma_p(1-0.8x)$, to calculate $F_{\mathrm{is}}$. Cross sections were adjusted by amounts which

- What does this mean for our *not-per-nucleon* formulation?

# $F_2^{^3\mathrm{He}}$ (iv): Theory

- Afnan *et al* (PRC **68** 035201 (2003)) found $\mathcal{R} < 1$ for $x < 0.7$: