Discussions on Shallow and deep inelastic scattering

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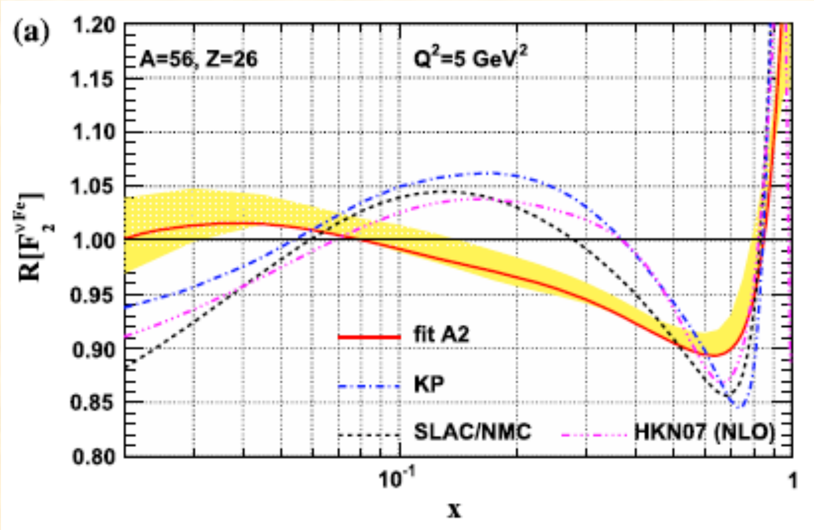
16-21 November 2015, Suita Campus of Osaka University, Japan
http://indico.ipmu.jp/indico/conferenceDisplay.py?ovw=True&confId=46

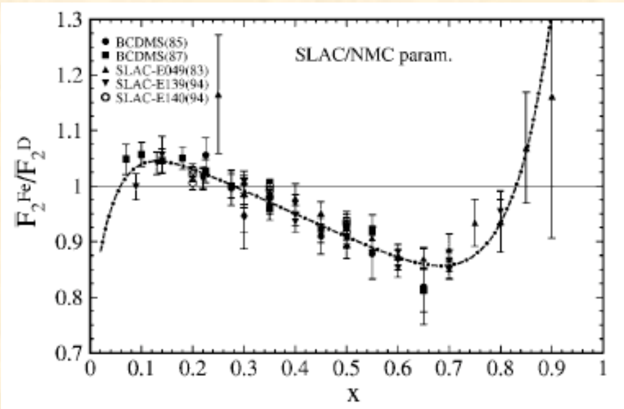
November 19, 2015

1. **Nuclear modification difference between $\ell^{\pm}$ and ν**
2. **"Isoscalar ion" data**
3. **Nuclear antiquark distributions at $x \sim 0.1$ and pion contributions**

Nuclear modification differences between $\ell^{\pm}$ and ν

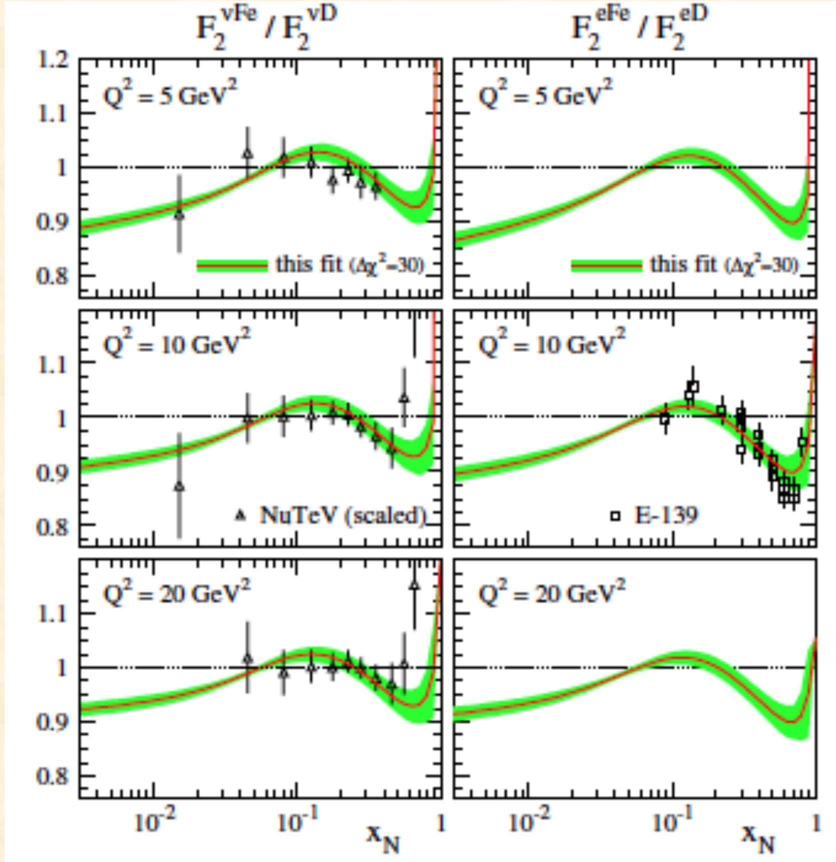


I. Schienbein *et al.*,
PRD 77 (2008) 054013

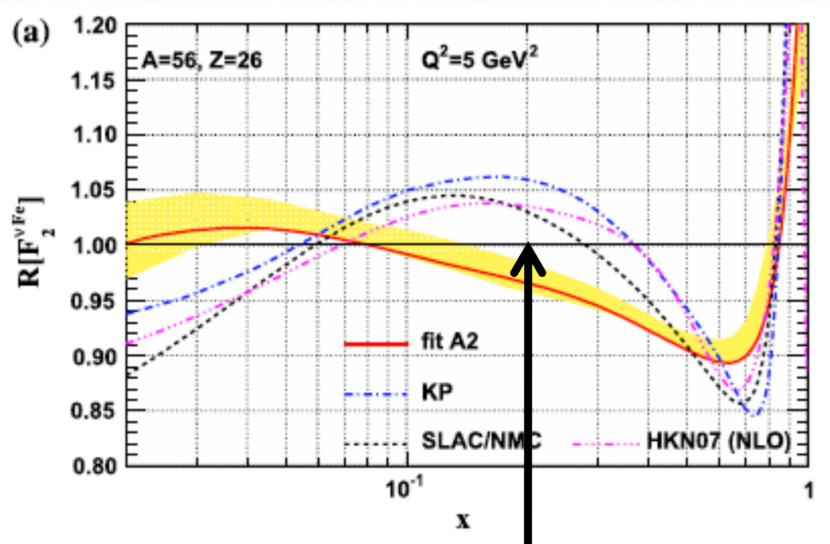


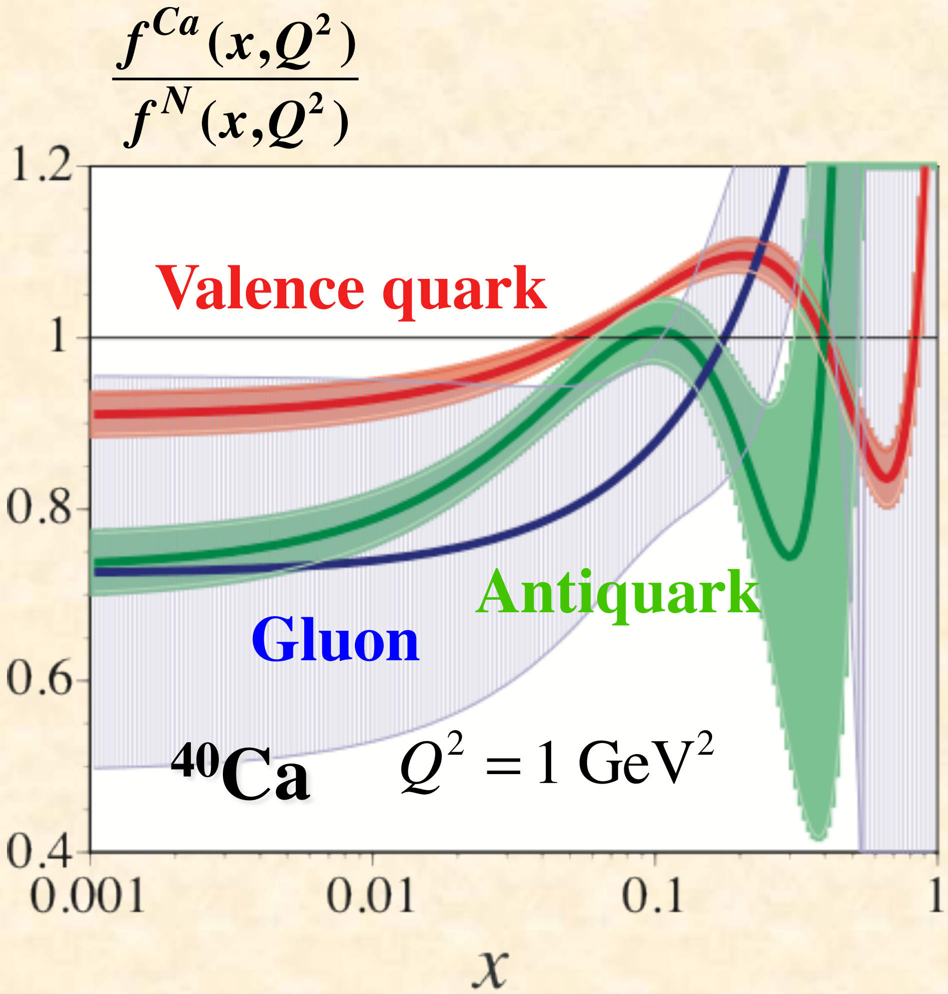
Charged-lepton scattering

D. de Florian, R. Sassot,
P. Zurita, M. Stratmann,
Phys. Rev. D 85 (2012) 074028.



It is (almost) impossible to obtain
nuclear corrections for PDFs only from neutrino DIS.





The issue could be solved experimentally by

(1) Fermilab-E906: $\frac{\sigma_{pA}}{\sigma_{pD}} \approx \frac{\bar{q}_A}{\bar{q}_D}$,

(2) Minerva: $\frac{F_3^A}{F_3^{A'}} \approx \frac{q_v^A}{q_v^{A'}}$

in the near future if the data are precise.

HKN2007, M. Hirai *et al.*, PRC 76 (2007) 065207.

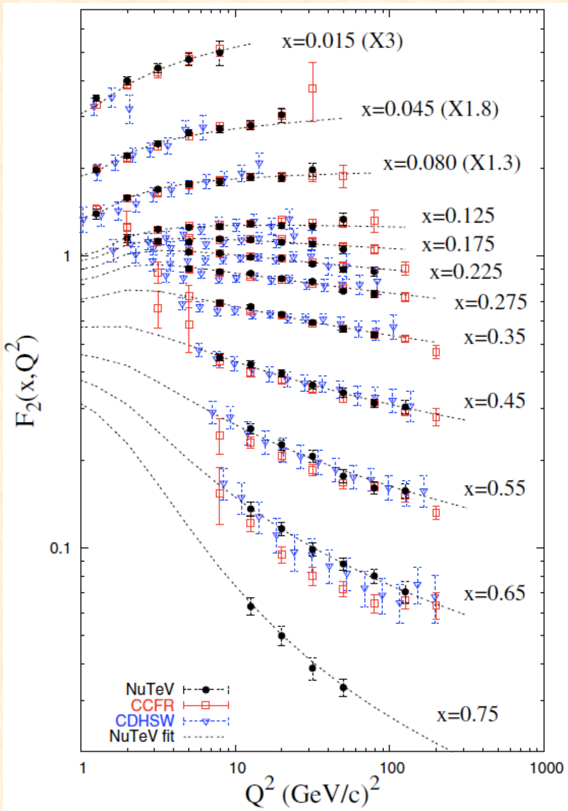
"Isoscalar iron" data

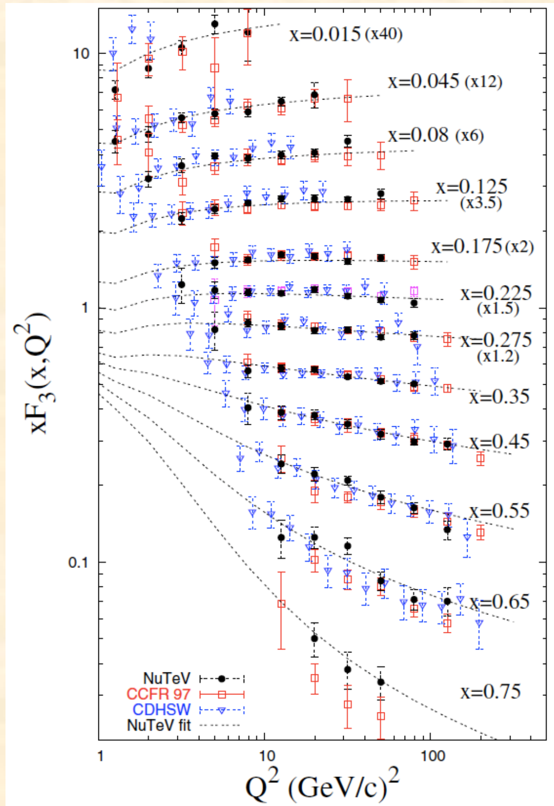
Experiment	Target	ν energy (GeV)
CCFR	Fe	30-360
CDHSW	Fe	20-212
CHORUS	Pb	10-200
NuTeV	Fe	30-500

M. Tzanov *et al.* (NuTeV), PRD74 (2006) 012008.

MINERνA (He, C, Fe, Pb), …

Structure-function data for "isoscalar iron"





Often quoted as neutrino-nucleon scattering data!?

Isoscalar correction

Communications with U.-K. Yang in 2014

Issue: Experimental data are shown for "isoscalar iron".

CC: $$\frac{d\sigma^A_{\nu,\bar\nu}}{dx\,dy}(\text{isoscalar}, v_f=0) \equiv \frac{\dfrac{d\sigma^A_{\nu,\bar\nu}}{dx\,dy}(\text{Simulation with } v_f=0)}{\dfrac{d\sigma^A_{\nu,\bar\nu}}{dx\,dy}(\text{Simulation with } v_f=(N-Z)/A)}\frac{d\sigma^A_{\nu,\bar\nu}}{dx\,dy}(\text{real data})$$

$$\frac{d\sigma^A_{\nu,\bar\nu}}{dx\,dy} = \frac{G_F^2 ME}{\pi}\left[\left\{y^2+\left(1-y-\frac{Mxy}{2E}\right)\frac{1+R}{1+(2Mx)^2/Q^2}2\right\}2xF_1^A \pm 2xy\left(1-\frac{y}{2}\right)F_3^A\right]$$

$$2xF_1^{\nu A} = \left[(1-v_f)xd_v+(1+v_f)xu_v+xS\right]_A$$

$$2xF_1^{\bar\nu A} = \left[(1-v_f)xu_v+(1+v_f)xd_v+xS\right]_A$$

$$xF_3^{\nu A} = \left[(1-v_f)xd_v+(1+v_f)xu_v+v_f x(\bar u-\bar d)+x(s-\bar c)\right]_A$$

$$xF_3^{\bar\nu A} = \left[(1-v_f)xu_v+(1+v_f)xd_v-v_f x(\bar u-\bar d)+x(c-\bar s)\right]_A$$

For example, for νA reaction

$$\frac{d\sigma^A_{\nu}}{dx\,dy} = \frac{G_F^2 ME}{2\pi}\left[\left\{y^2+\left(1-y-\frac{Mxy}{2E}\right)\frac{1+R}{1+(2Mx)^2/Q^2}2\right\}\left[(1-v_f)xd_v+(1+v_f)xu_v+xS\right]_A \right.$$
$$\left. +2y\left(1-\frac{y}{2}\right)\left[(1-v_f)xu_v+(1+v_f)xd_v-v_f x(\bar u-\bar d)+x(c-\bar s)\right]_A\right]$$

$$\frac{\dfrac{d\sigma^{A'}_{\nu}}{dx\,dy}(v_f=0)}{\dfrac{d\sigma^{A}_{\nu}}{dx\,dy}(v_f\neq 0)} = \frac{\left\{y^2+\left(1-y-\frac{Mxy}{2E}\right)\frac{1+R}{1+(2Mx)^2/Q^2}2\right\}\left[xd_v+xu_v+xS\right]_{A'} +2y\left(1-\frac{y}{2}\right)\left[xu_v+xd_v+x(c-\bar s)\right]_{A'}}{\left\{y^2+\left(1-y-\frac{Mxy}{2E}\right)\frac{1+R}{1+(2Mx)^2/Q^2}2\right\}\left[(1-v_f)xd_v+(1+v_f)xu_v+xS\right]_A +2y\left(1-\frac{y}{2}\right)\left[(1-v_f)xu_v+(1+v_f)xd_v-v_f x(\bar u-\bar d)+x(c-\bar s)\right]_A}$$

Request to experimentalists

$$\frac{d\sigma^A_{\nu,\bar{\nu}}}{dx\,dy}(\text{isoscalar},\, \nu_f = 0) \equiv \frac{\dfrac{d\sigma^A_{\nu,\bar{\nu}}}{dx\,dy}(\text{Simulation with } \nu_f = 0)}{\dfrac{d\sigma^A_{\nu,\bar{\nu}}}{dx\,dy}(\text{Simulation with } \nu_f = (N-Z)/A)} \frac{d\sigma^A_{\nu,\bar{\nu}}}{dx\,dy}(\text{real data})$$

Request to experimentalists:

- **It is fine to publish** $\frac{d\sigma^A_{\nu,\bar{\nu}}}{dx\,dy}(\text{isoscalar},\, \nu_f = 0)$.
- **However, please provide also** $\frac{d\sigma^A_{\nu,\bar{\nu}}}{dx\,dy}(\text{real data})$

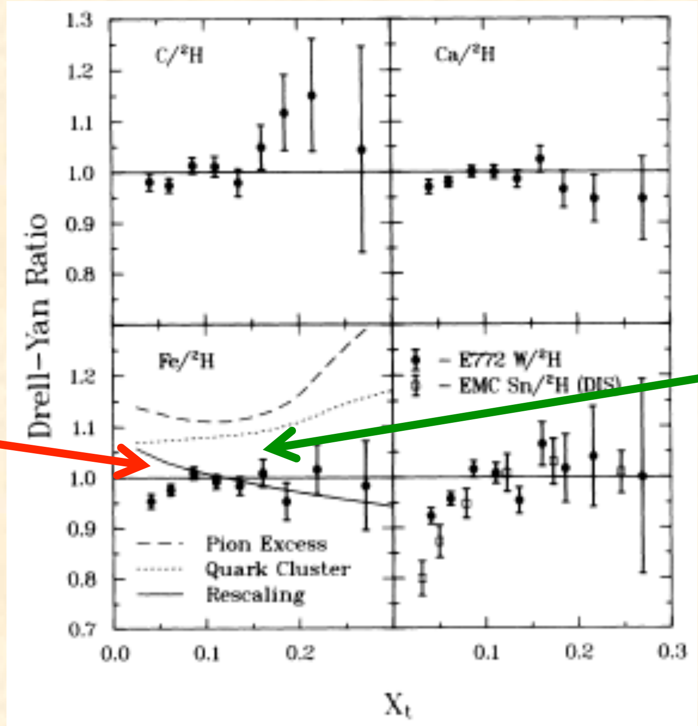
because we theorists cannot handle $\frac{d\sigma^A_{\nu,\bar{\nu}}}{dx\,dy}(\text{isoscalar},\, \nu_f = 0)$ **to be precise.**

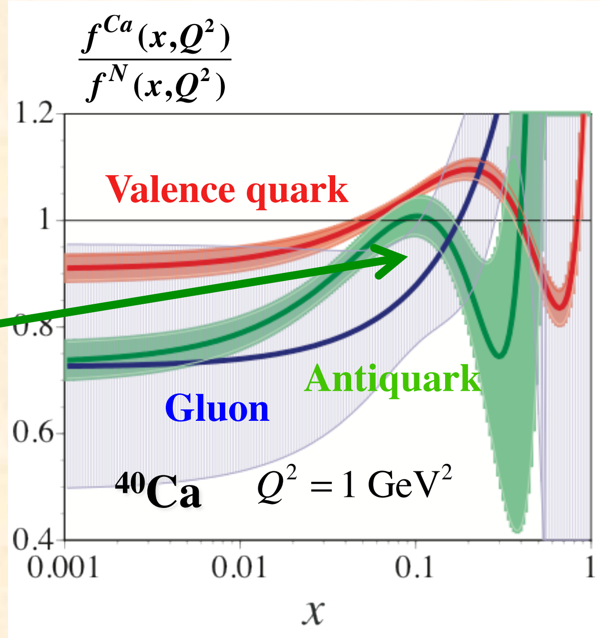
If one is not worried about details of nuclear corrections, one can use the isoscalar data.

Nuclear antiquark distributions and Drell-Yan

D. M. Alde *et al.*,
PRL. 64, 2479 (1990).

$$\frac{\sigma_{pA}}{\sigma_{pD}} \approx \frac{\bar{q}_A}{\bar{q}_D}$$

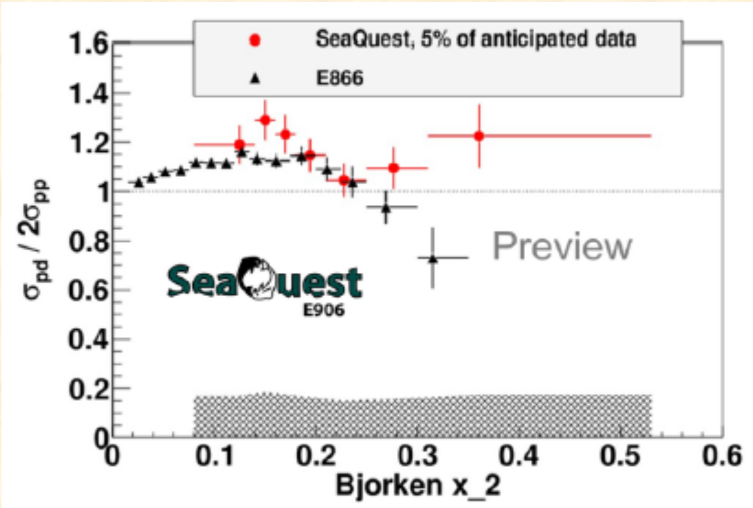


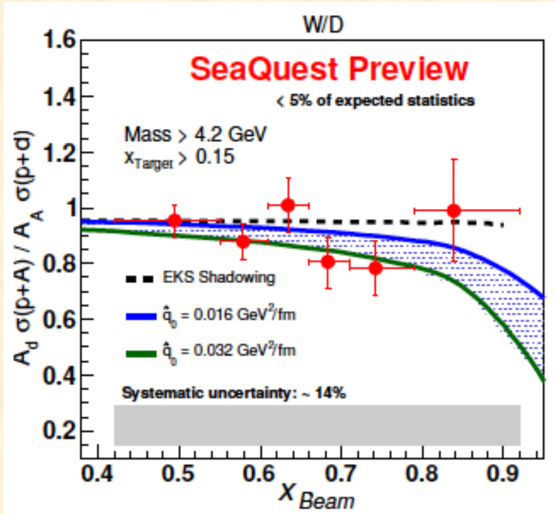


No nuclear effects from pion contributions

E. L. Berger, F. Coester, R. B. Wiringa, PRD 29, 398 (1984)

Fermilab-E906 in progress!

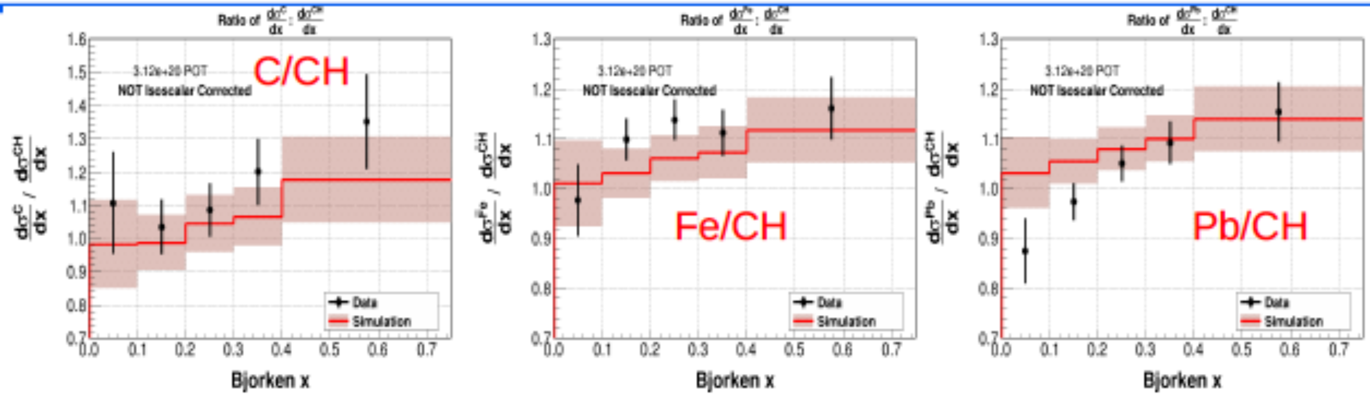




K. Nakano
@Pacific-Spin2015

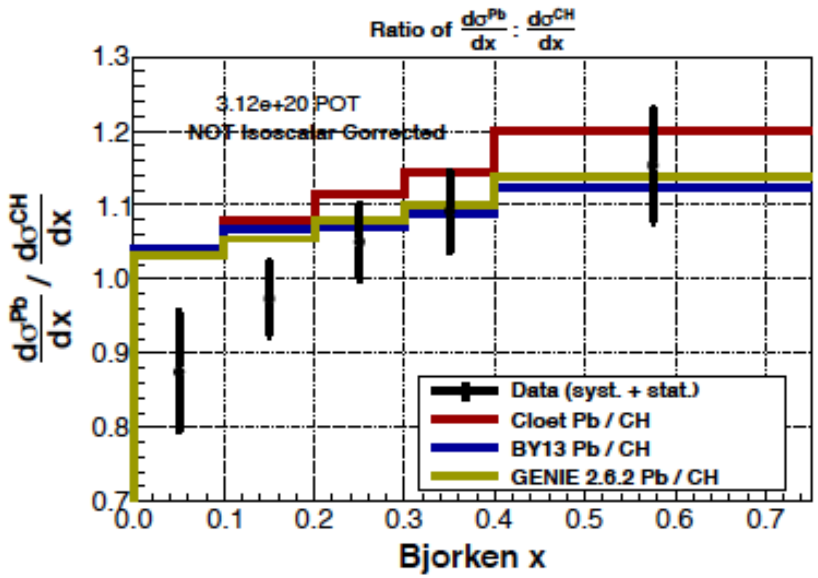
We Now Have A New DIS Player - What does MINERvA see?

DIS Cross Section Ratios – dσ/dx



J. Mousseau

- The shape of the data at low x, especially with lead is consistent with additional nuclear shadowing. **at an <x> (0.07) & <Q^2 >** (2 GeV^2) - **where negligible shadowing is expected with l$^{\pm}$.**



Morfin@this NuInt workshop

Shadowing - continued

- Why low x?
- The lifetime of the hadronic fluctuation has to be sufficient to allow for these multiple diffractive scatters:

$$t_c = 2E_{had} \,/\, (Q^2 + m^2)$$

- For a given Q^2 need large E_{had} to yield sufficient t_c which implies small x.
- m is larger for the vector current than the axial vector current → for a given Q^2 you need more E_{had} for the vector current than the axial vector current to have sufficient t_c.
- This implies you can have shadowing at higher x with neutrinos than with charged leptons

The End

The End