JLab news on multiplicities and PDF observables

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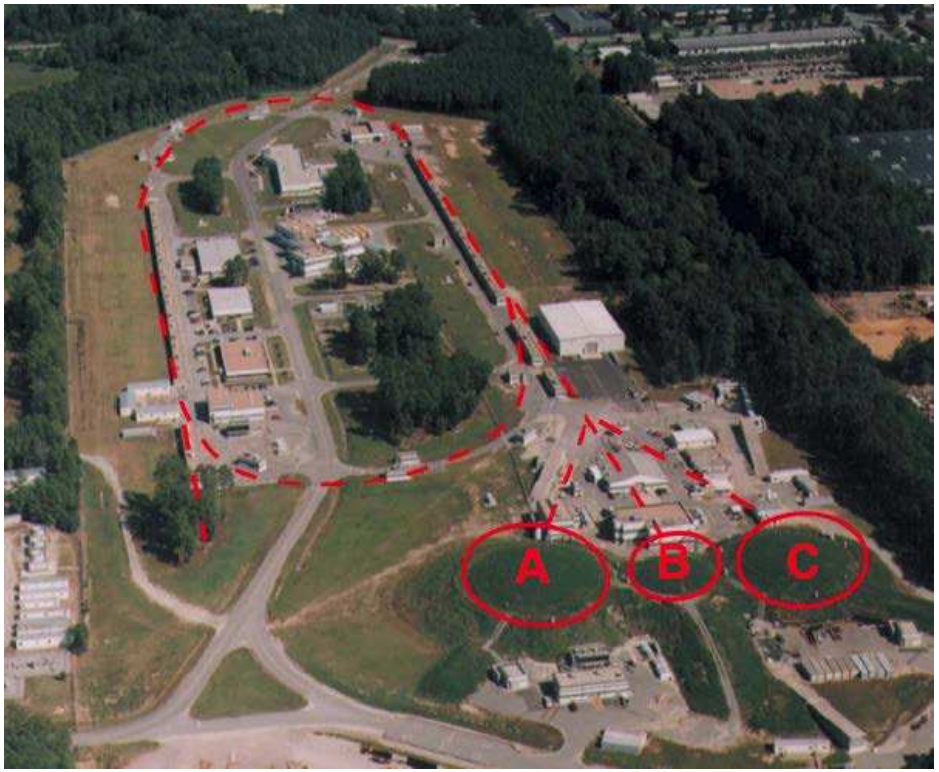
LNF, Frascati, 2013

Jefferson Lab



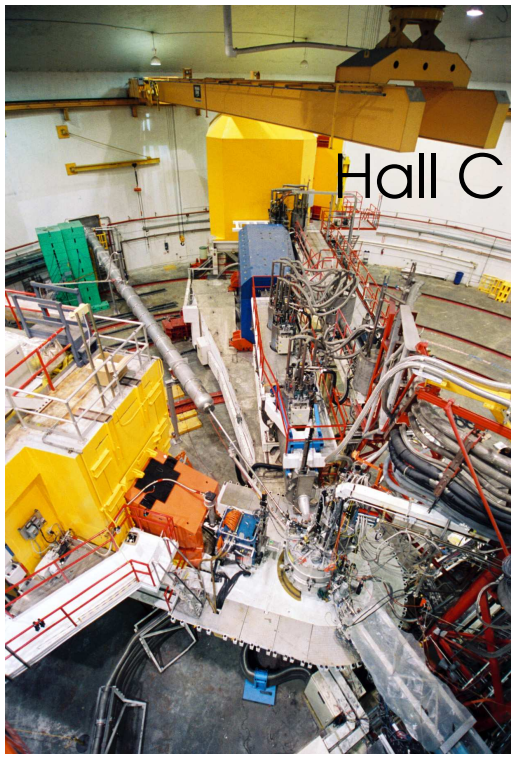
- $<$6 GeV electron beam,
- $<$200 μA beam current,
- 1.5 GHz CW mode,
- $<$85% L or T beam polarizations,
- simultaneous operation of 3 Halls with different energies and currents.

Experimental Halls

Three Halls are equipped with complementary detectors.

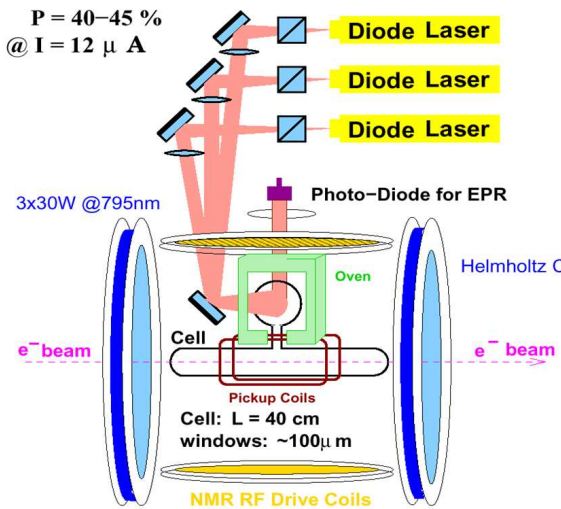
Hall A

Hall B



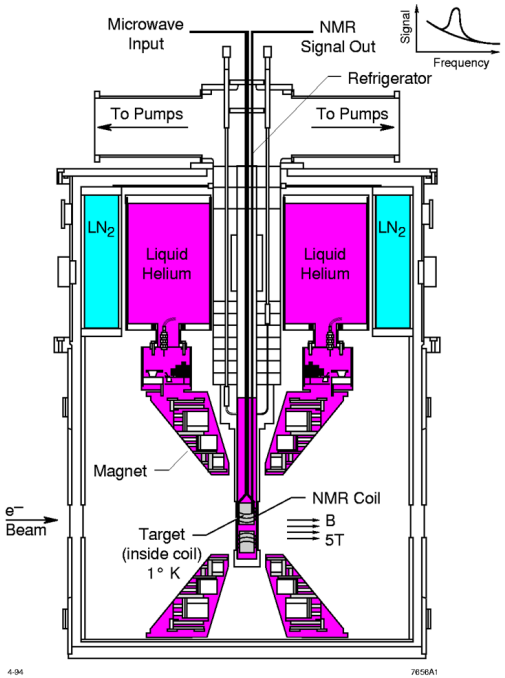
Hall A

- Two HRSs:
  - momentum resolution 10^{-4},
  - angular resolution 0.6/2 mrad,
  - acceptance 5.3 msr,
  - hadron PID: ToF (850 ps), Cherenkov(Aerogel)/RICH(C_6F_{14}),
  - luminosity 10^{38} $cm^{-2}s^{-1}$.
- BigBite:
  - momentum resolution $<1\%$,
  - angular resolution 4 mrad,
  - acceptance 64 msr.
- ^{3}He polarized target:
  - 55% L or T polarizations,
  - 10^{36} $cm^{-2}s-1$ luminosity.



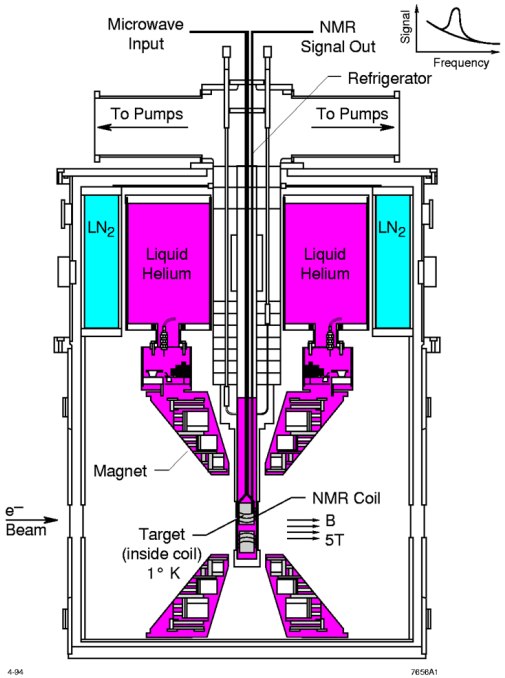
Hall B

- CLAS:
  - momentum resolution 0.5%,
  - angular resolution 1 mrad,
  - acceptance 4 sr.
  - hadron PID: ToF (200 ps),
  - luminosity 10^{34} cm^{-2}s^{-1}.
- NH_3 (ND_3) polarized target:
  - 70-90% (30-50%) L polarization,
  - 10^{34} cm^{-2}s^{-1} luminosity.



Hall C

- HMS and SOS:
  - momentum resolution 10^{-3},
  - angular resolution 0.8 mrad,
  - acceptance 6 (9) msr,
  - hadron PID: ToF (200 ps), Cherenkov(Gas)/Cherenkov(Aerogel),
  - luminosity 10^{38} cm^{-2}s^{-1}.
- NH_3 (ND_3) polarized target:
  - 70-90% (30-50%) L or T polarizations,
  - 10^{35} cm^{-2}s^{-1} luminosity.



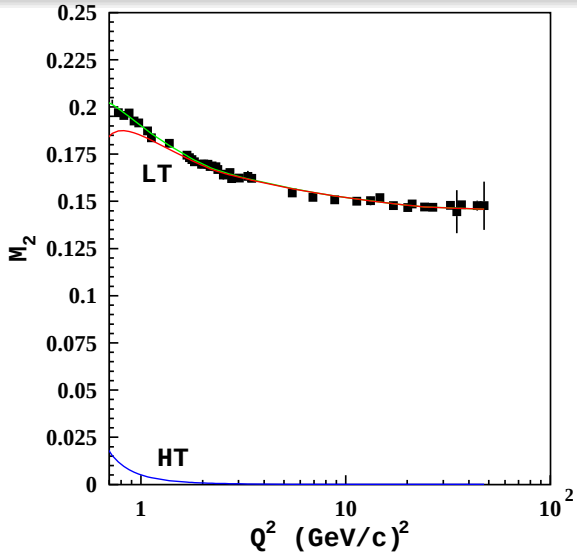
Structure Function $F_2^{p,d}$

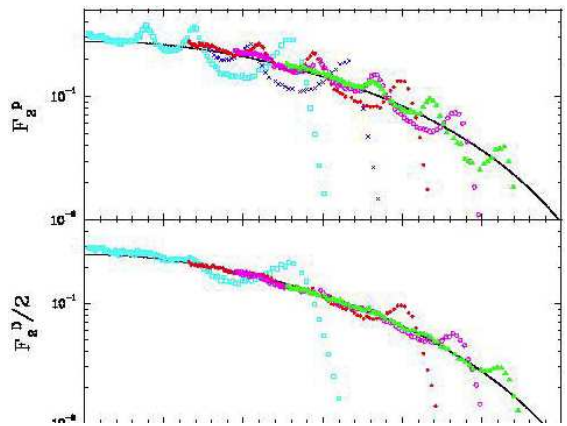
Hall B

- d - M. Osipenko et al., Phys.Rev.C73 045205 (2006),
- p - M. Osipenko et al., Phys.Rev.D67 092001 (2003),

Hall C (E99-118, E00-116)

- V. Tvaskis et al., Phys.Rev.C81, 055207 (2010),
- S.P. Malace et al., Phys.Rev.C80, 035207 (2009),
- I. Niculescu et al., Phys.Rev.Lett.85, 1186 (2000);Phys.Rev.Lett.85, 1182 (2000).





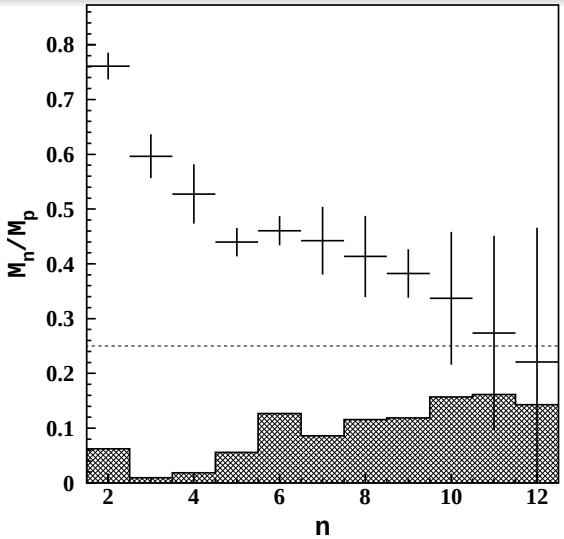
Structure Function F_2^n

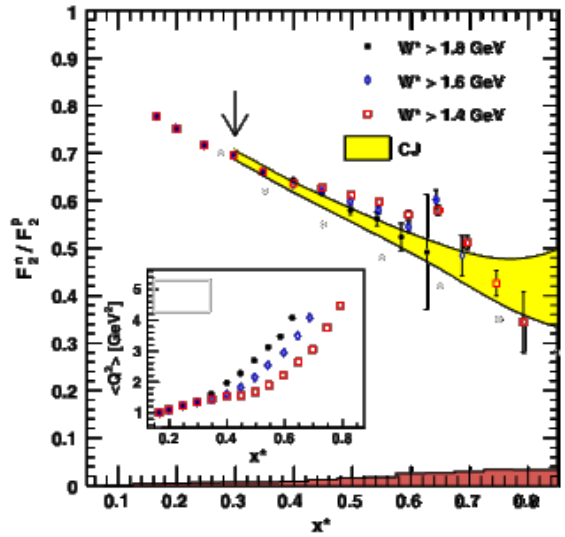
$$\frac{F_2^n}{F_2^p} \underset{x\to 1}{\simeq} \frac{1+4d/u}{4+d/u}$$

- 2/3 - SU(6) symmetry,
- 1/4 - scalar spectator diquark (d quark suppression),
- 3/7 - helicity flip suppression.

Hall B

- M. Osipenko et al., Nucl.Phys.A766, 142 (2006),
- direct measurement via spectator tagging (BoNuS): N. Baillie et al.,Phys.Rev.Lett.108, 142001 (2012).

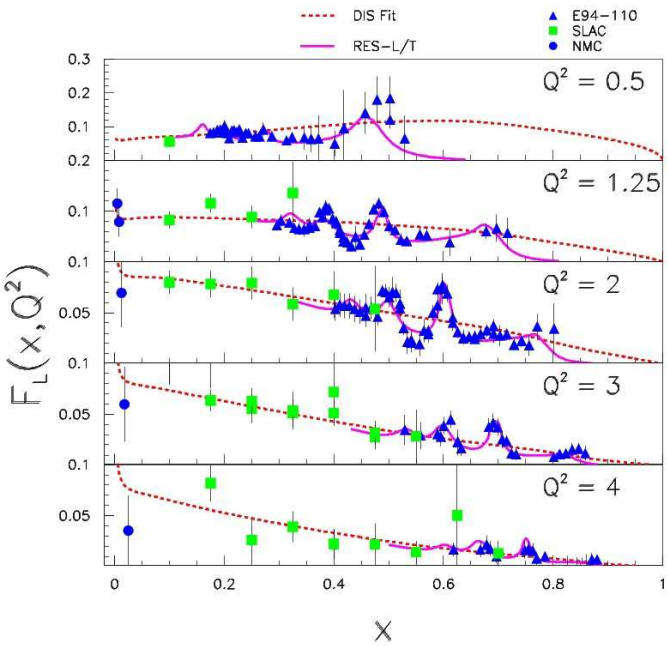




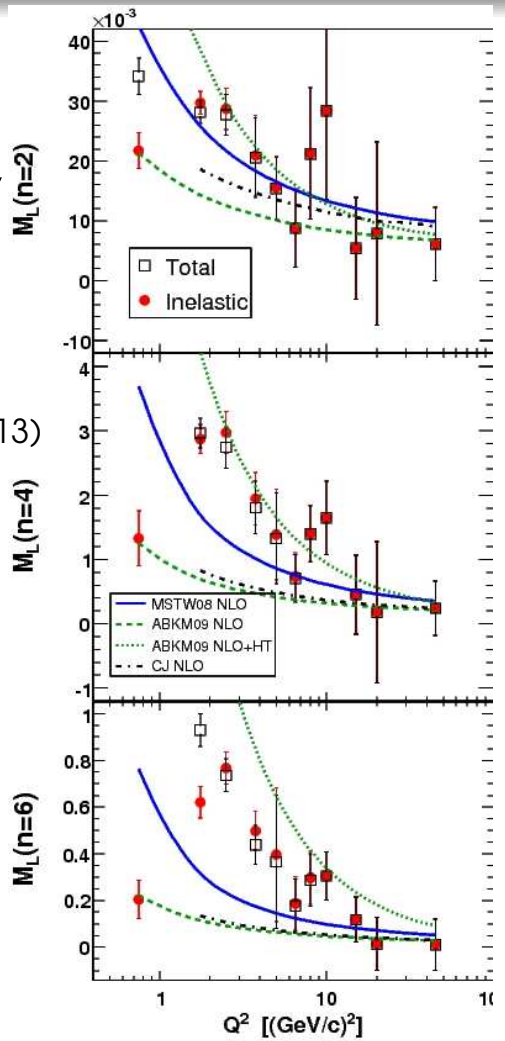
Structure Function $F_L^{p,d}$

Hall C (E94-110, E99-118)

- V. Tvaskis, Phys.Rev.Lett.98, 142301 (2007),
- Y. Liang, nucl-ex/0410027,

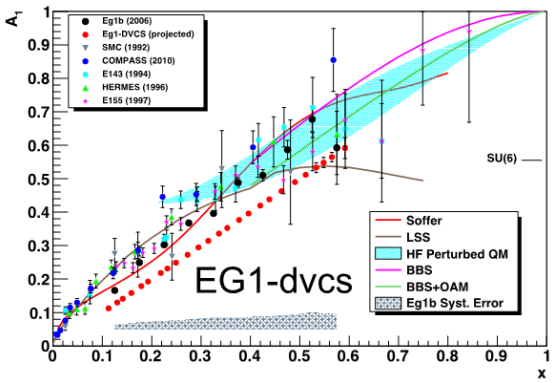


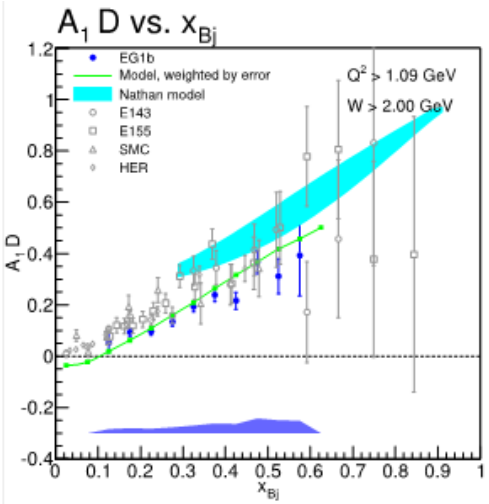
P. Monaghan et al.,PRL110, 152002 (2013)

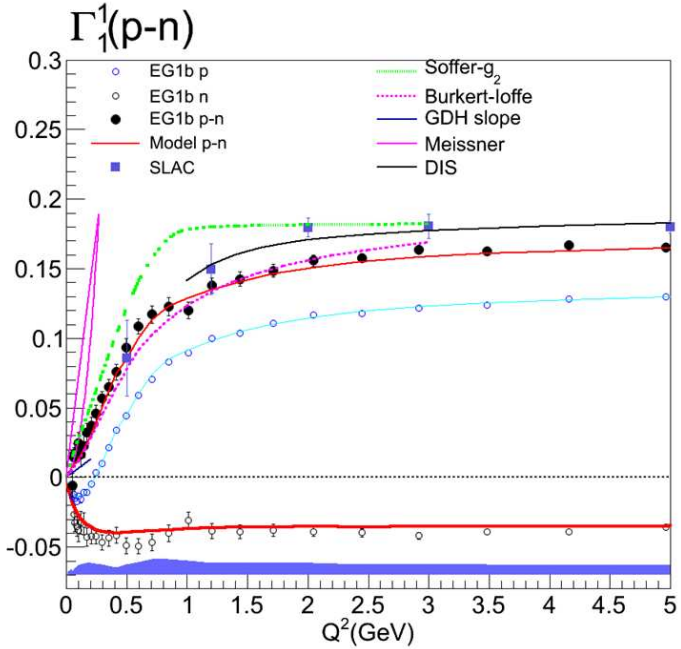


Structure Function g_1

- Better precision data on p and d from CLAS,
- lowest moments are in good agreement with pQCD down to $Q^2 \sim 1$ GeV^2.

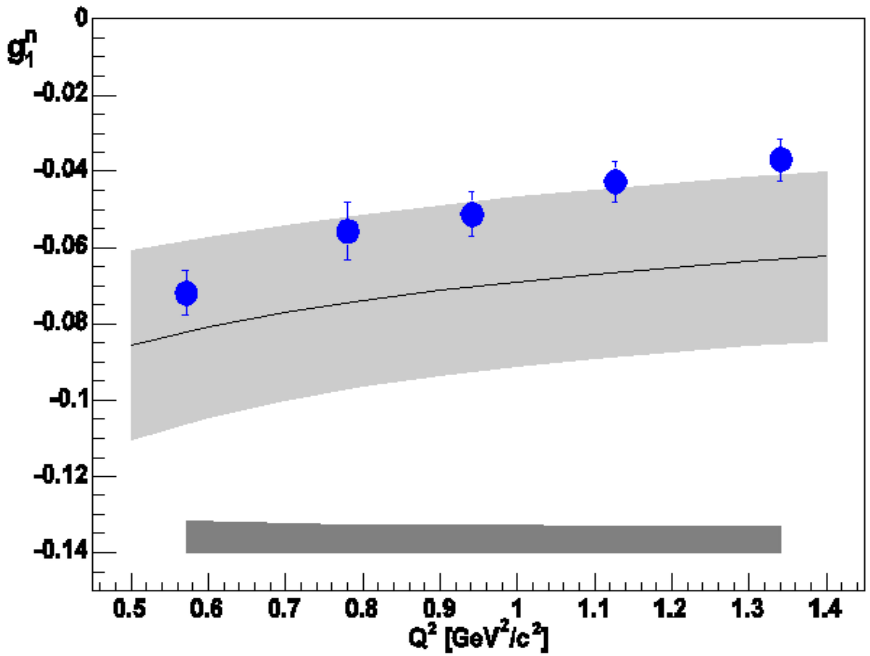


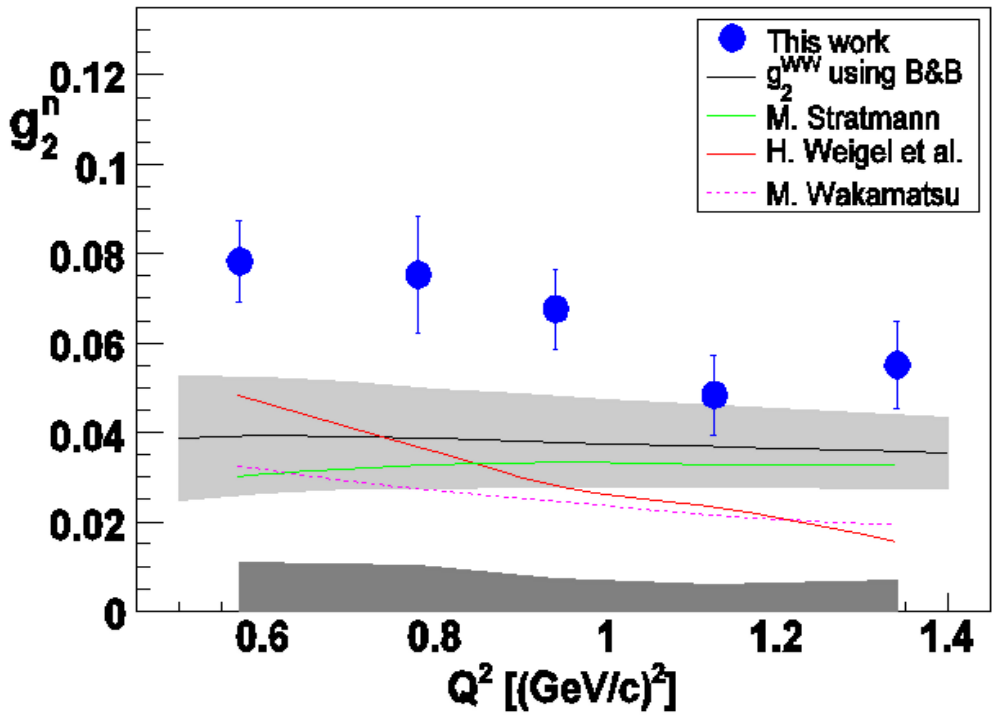




Structure Function g_T

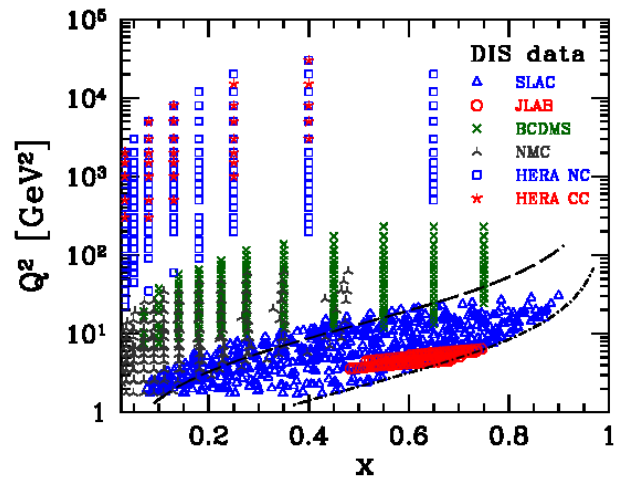
- data on n and p from Hall A (E97-103, E99-117, E08-027), Q^2-behavior follows pQCD evolution and $g_T > 0$.

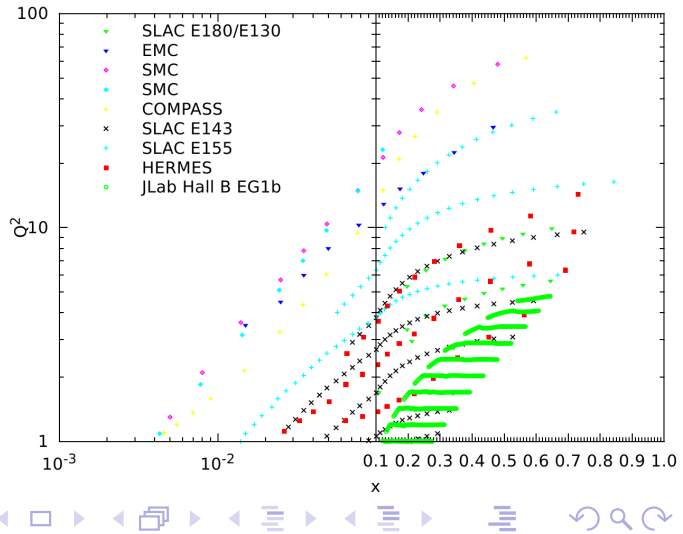




CJ and JAM Collaborations

- Theory Group:
  Alberto Accardi,
  Karol Kovarik,
  Wally Melnitchouk,
  Jeff Owens,
  Pedro Jimenez-Delgado,
- lower DIS cuts: $Q^2 > m_c^2$, $W^2 > 3$ GeV^2,
- nuclear corrections: $F_2^D \neq F_2^p + F_2^n$,
- target mass corrections: $(q + \xi P)^2 = 0$,
- higher twist parametrization: $F_2^{exp} = F_2^{LT}(1 + \frac{C(x)}{Q^2})$.



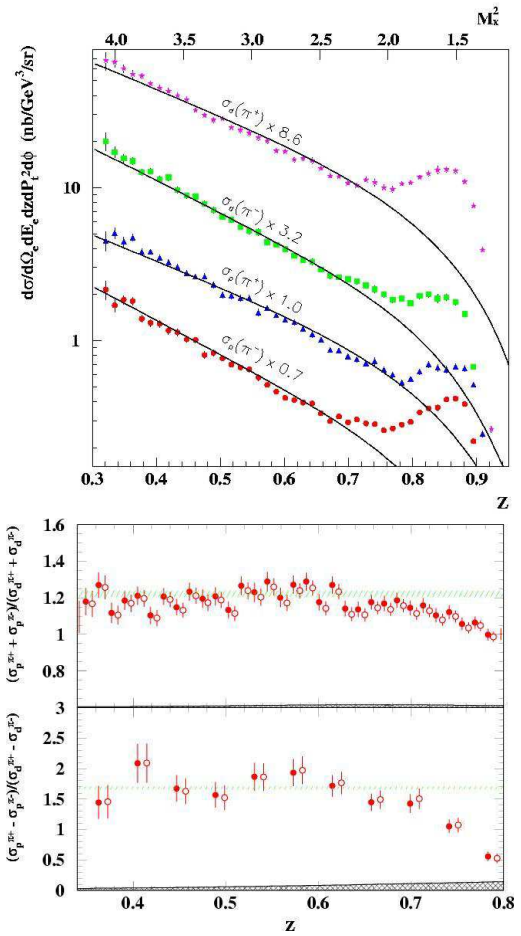


Hall C (E00-108) z-dependence

- T. Navasardyan et al., Phys.Rev.Lett.98, 022001 (2007),
- $p_\perp^2 = 0$ measurements of $\pi^\pm$ on p and d targets,
- assumed $\langle p_\perp^2 \rangle = 0.21$ GeV^2 independent of z, but in Gaussian approximation:

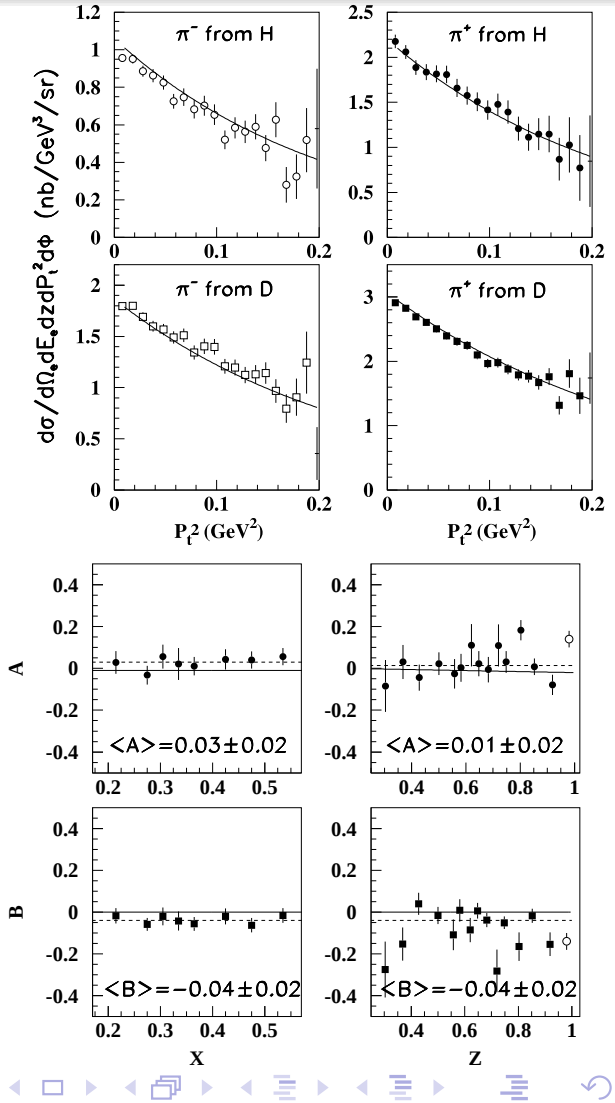
$$\sigma(p_\perp^2 = 0) \simeq \frac{1}{2\pi\langle p_\perp^2 \rangle} \sum_i e_i^2 x q_i(x) D_i^h(z)$$

- assumed π^+ and π^- $\langle p_\perp^2 \rangle$ are the same.



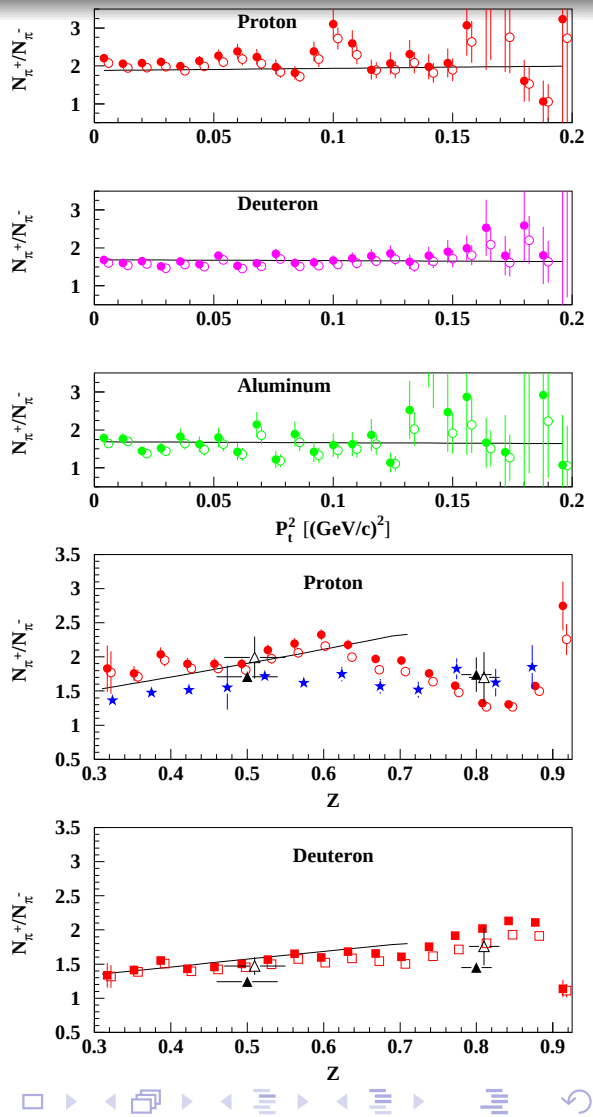
Hall C (E00-108) $p_\perp$-dependence

- H. Mkrtchyan et al., Phys.Lett.B 665, 20 (2008),
- $p_\perp^2 < 0.2$ GeV^2 measurements of $\pi^\pm$ on p and d targets,
- no z-dependence of $\langle p_\perp^2 \rangle$ was provided, only averaged data at $\langle z \rangle = 0.55$,
- attempt to extract u and d quark average transverse momenta,
- obtained $\langle \cos\phi \rangle$ and $\langle \cos\phi \rangle$ are both compatible with zero.



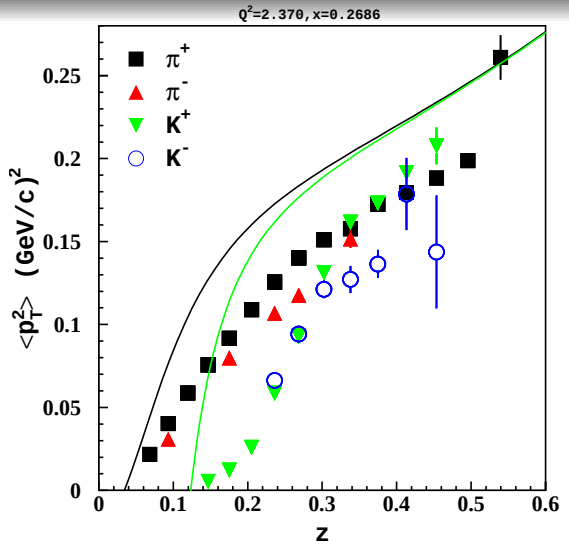
Hall C (E00-108) archive

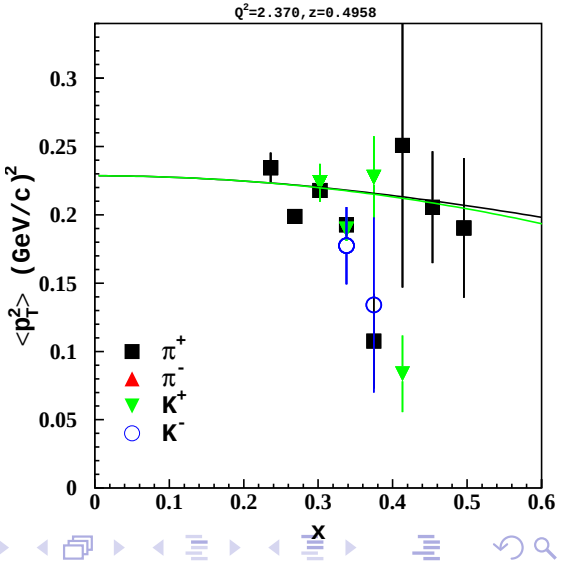
- R. Asaturyan et al., Phys.Rev.C85, 015202 (2012),
- $p_\perp^2 < 0.2$ GeV^2 measurements of $\pi^\pm$ on p and d targets,
- no z-dependence of $\langle p_\perp^2 \rangle$ was provided, only averaged data at $\langle z \rangle = 0.55$,
- attempt to extract u and d quark average transverse momenta and d/u ratio,
- no ϕ-dependence was studied.



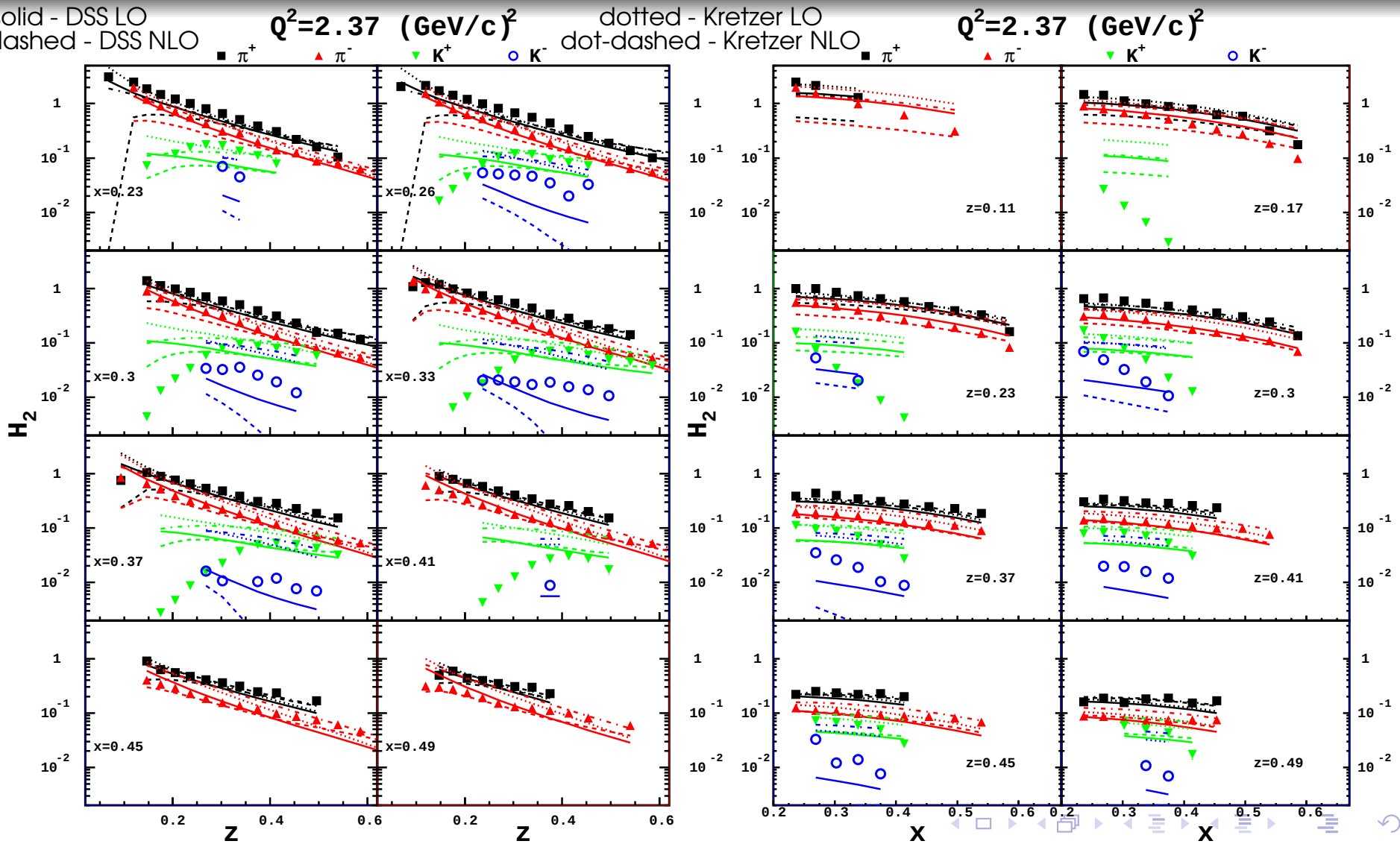
Hall B (E1-6)

- π^+ - M. Osipenko et al., Phys.Rev.D80, 032004 (2009),
- $p_\perp^2 < 1.4$ GeV^2 measurements of $\pi^\pm$, $K^\pm$ on p target,
- 5-fold differential cross section in all 5 dimensions,
- $\langle p_\perp^2 \rangle$ as a function of x, Q^2 and z,
- integrated in ϕ and $p_\perp^2$ cross sections,
- SIDIS/DIS ratios = multiplicities,
- $\langle \cos\phi \rangle$ and $\langle \cos 2\phi \rangle$.





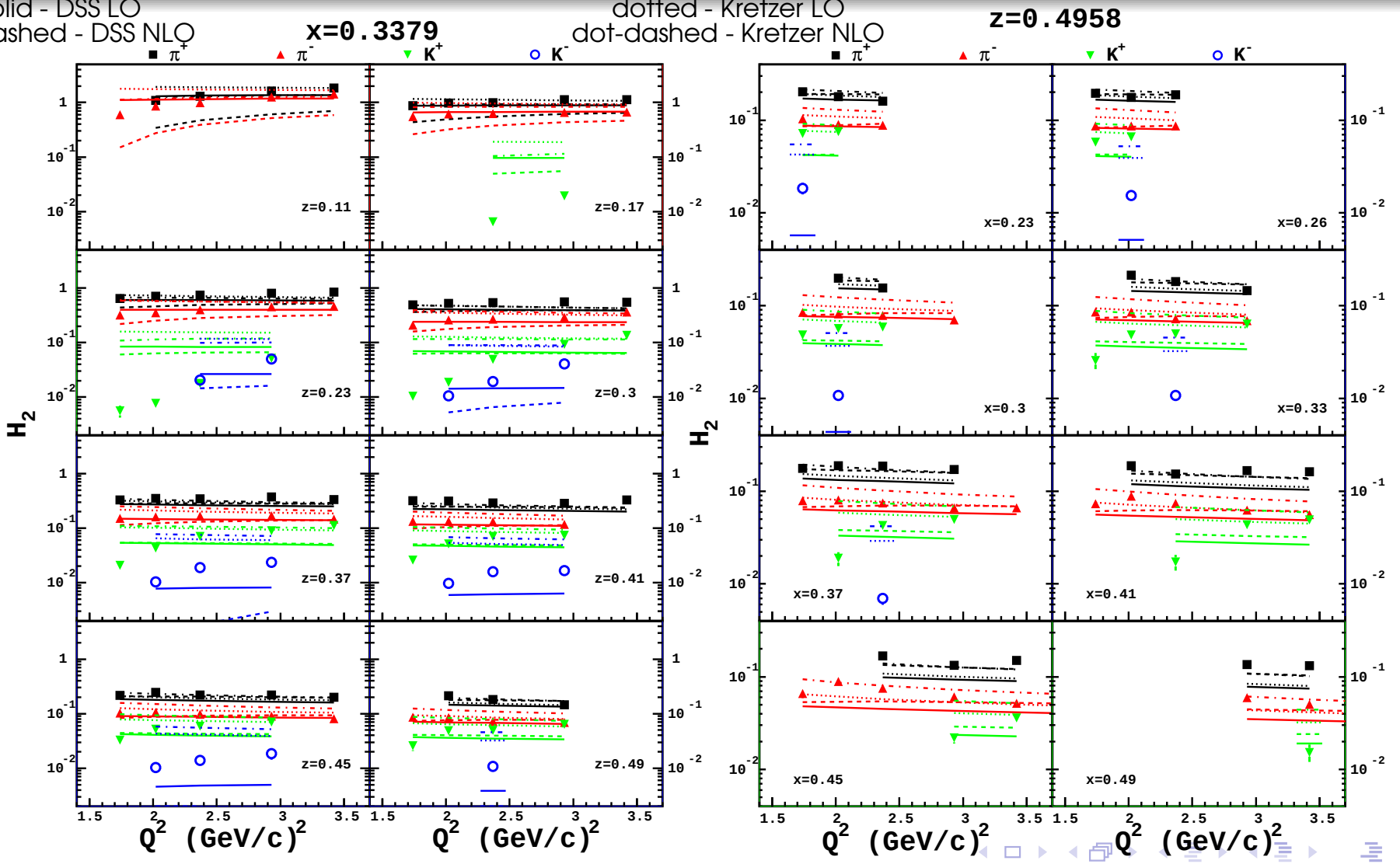
Hall B (E1-6) $F_{UU}(x, z)$



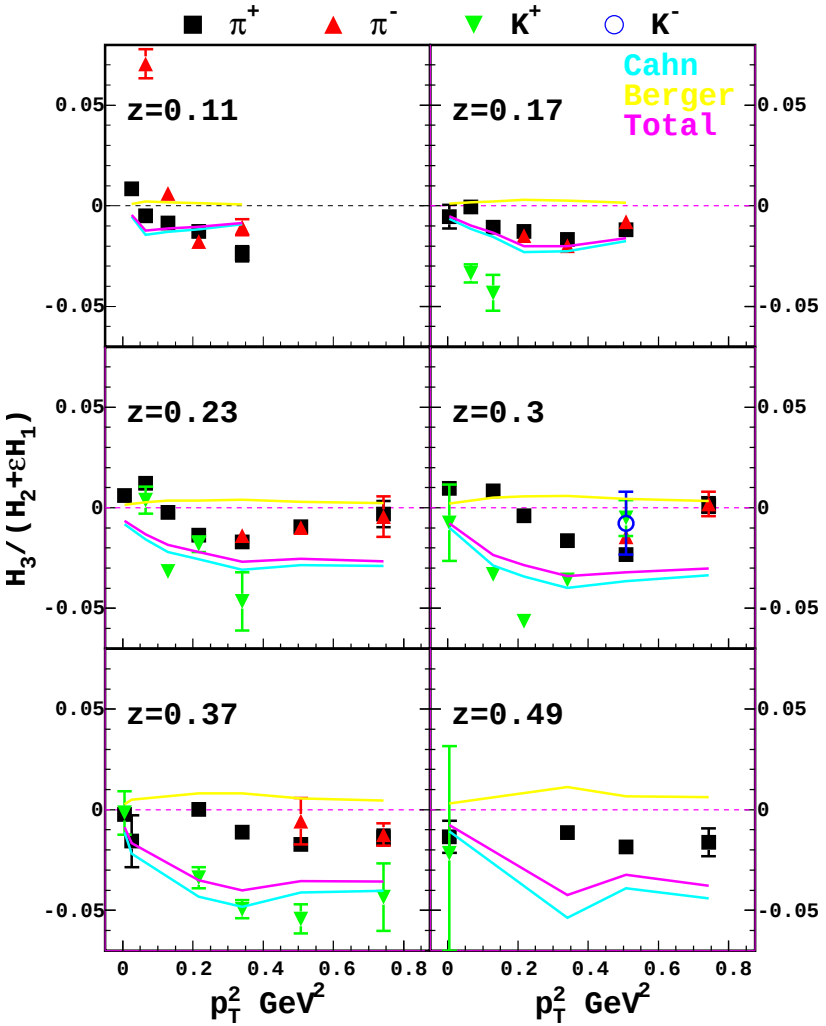
Hall B (E1-6) $F_{UU}(Q^2)$

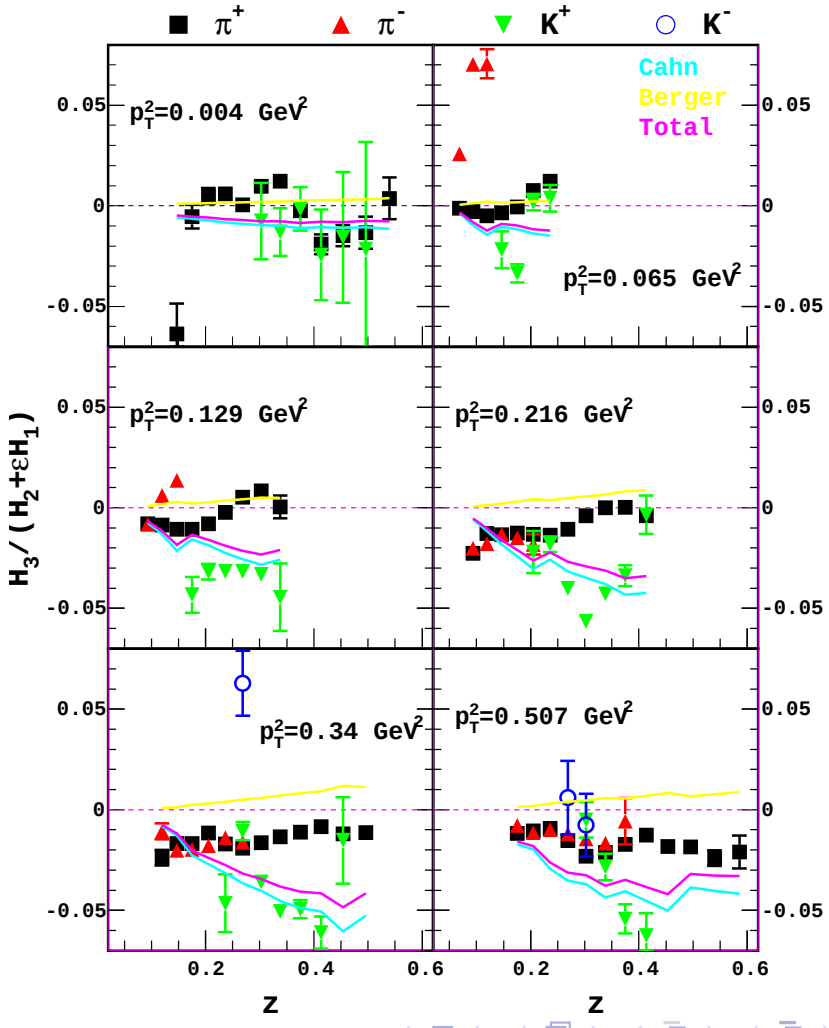
solid - DSS LO
dashed - DSS NLO

dotted - Kretzer LO
dot-dashed - Kretzer NLO

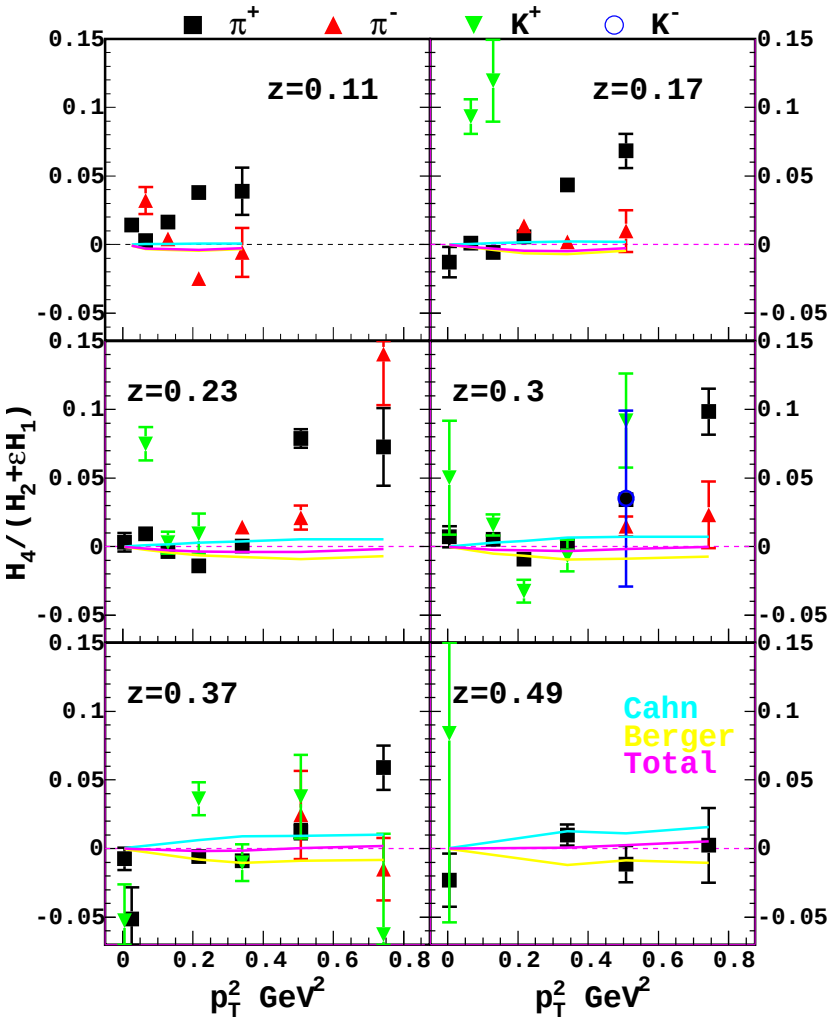


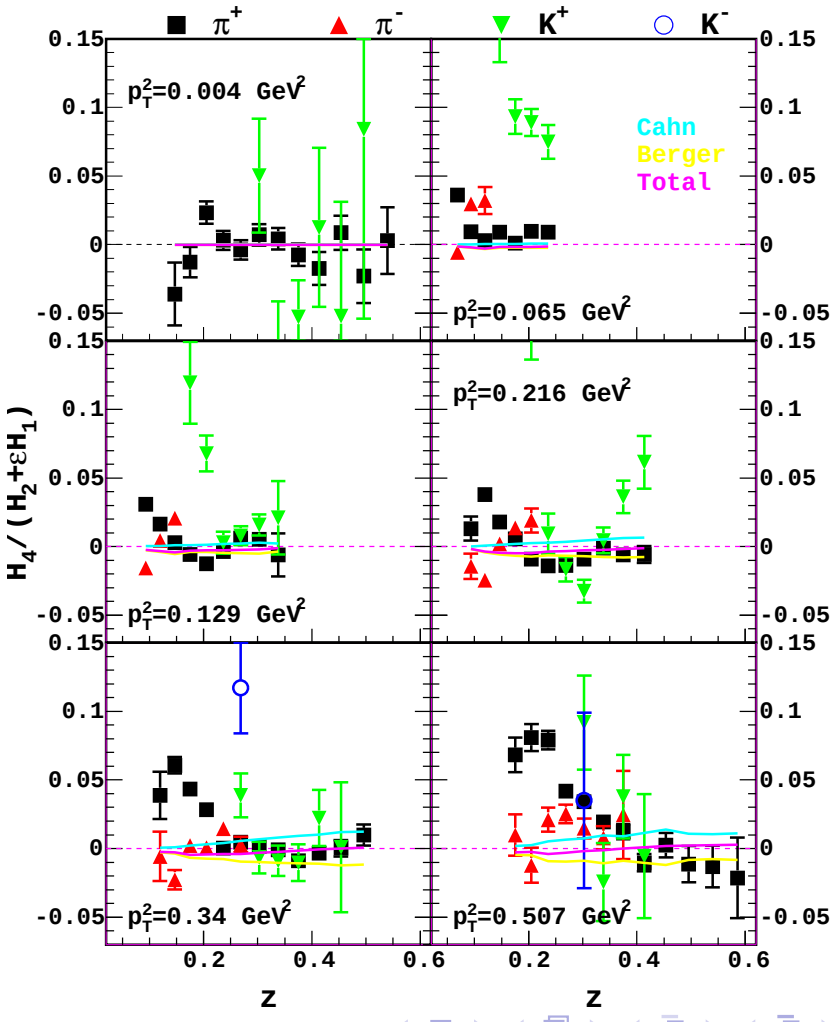
Hall B (E1-6) $\langle \cos\phi \rangle$





Hall B (E1-6) $\langle \cos 2\phi \rangle$





Conclusions

- nucleon structure functions F_2, F_L, g_1 and g_T were measured on proton and neutron,
- lowest moments of these structure functions follow pQCD evolution down to $Q^2 \sim 1$ GeV^2,
- theoretical effort to include these data in PDF fits is ongoing,
- semi-inclusive cross sections for $\pi^{\pm}$ and $K^{\pm}$ were measured on proton and deuteron targets,
- collinear structure functions are in agreement with pQCD parametrizations,
- azimuthal asymmetries are small.