Physics at 11 GeV in Hall C

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Key Features of Hall C

- detection of particles at highest momenta
- high absolute precision $\longrightarrow$ LT separation
- very high luminosity $\longrightarrow$ access to rare processes
- all possible target configurations
- excellent particle identification

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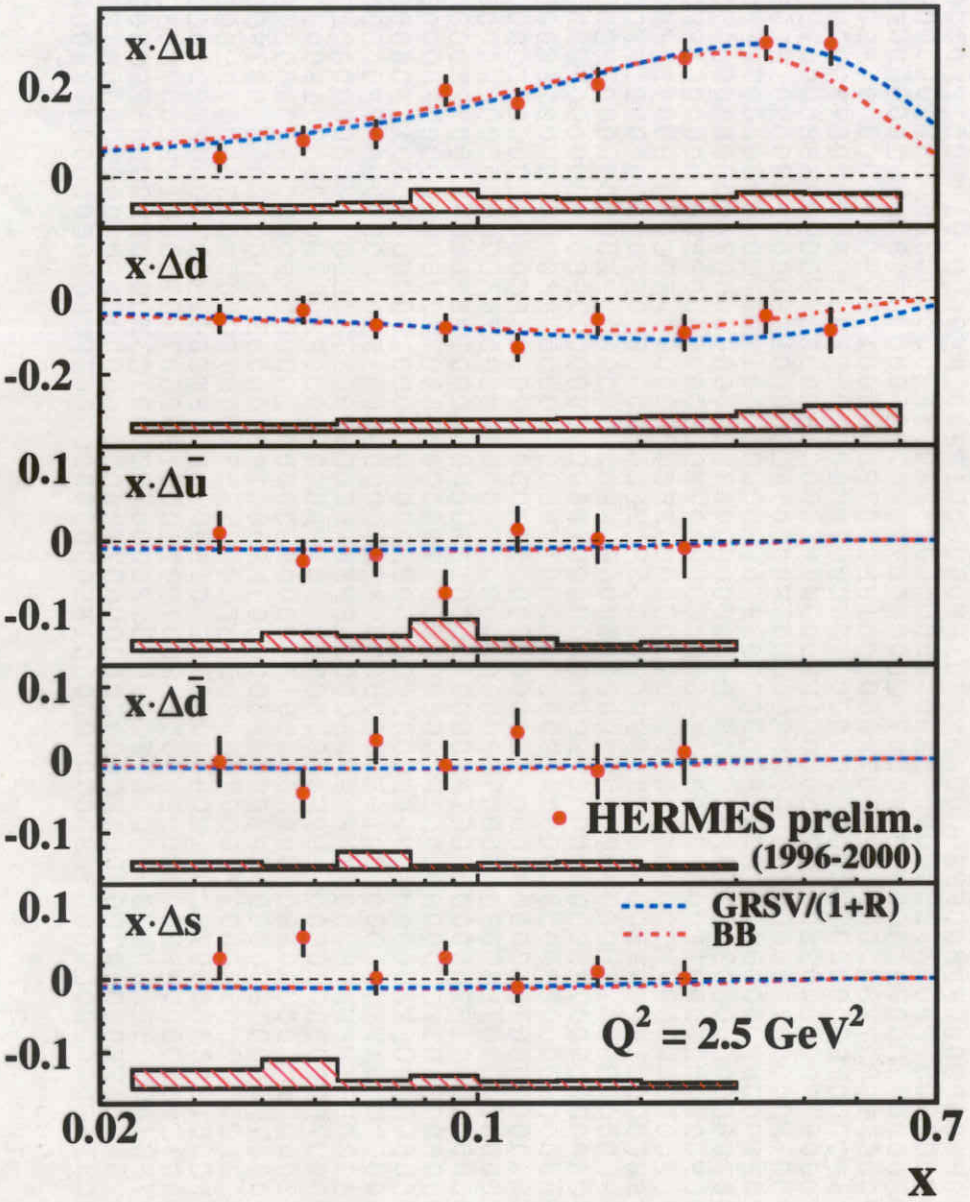
Key Measurements in Hall C

- Form Factors at highest Q^2 values ($\longrightarrow$ Mark)

- Semi-inclusive measurements over large range in z
  $\longrightarrow d_v/u_v(x, Q^2)$, $\overline{d} - \overline{u}$ ($\longrightarrow$ Hamlet)
  $\longrightarrow \Delta q$, $\Delta\overline{d} - \Delta\overline{u}$ and Δs
  $\longrightarrow \delta q$ and $\delta\overline{d} - \delta\overline{u}$
  $\longrightarrow$ Sivers function - flavour separation !
  $\longrightarrow s(x)$ and $\overline{s}(x)$
  $\longrightarrow$ nuclear modifications of parton distributions
  $\longrightarrow D_u^{\pi^+}$, $D_u^{\pi^-}$, $D_d^{\pi^+}$, $D_d^{\pi^+}$
  $\longrightarrow$ kaon fragmentation functions
  $\longrightarrow p_T$ dependence of fragmentation process

- inclusive scattering at high x ($\longrightarrow$ Vipuli)
  $\longrightarrow A_1^p$ and A_1^n for $x \longrightarrow 1$
  $\longrightarrow g_2$ and higher twist term d_2

Flavor Separated Polarized Quark Distributions (LO)



NEW HERMES extraction of $\frac{\Delta u}{u}$, $\frac{\Delta d}{d}$, $\frac{\Delta \bar{u}}{\bar{u}}$, $\frac{\Delta \bar{d}}{\bar{d}}$, $\frac{\Delta s + \Delta \bar{s}}{s + \bar{s}}$

polarized quark sea separated

$A_1(h^{\pm})$ on proton dominated by $\Delta u(x)$

$A_1(h^{\pm})$ on neutron dominated by $\Delta d(x)$

sensitivity on the sea polarizations at $0.02 < x < 0.2$:

$A_1(h^+)$ p, n: $\Delta \bar{u}$ and $\Delta \bar{d}$ $\sim$ 5...10%

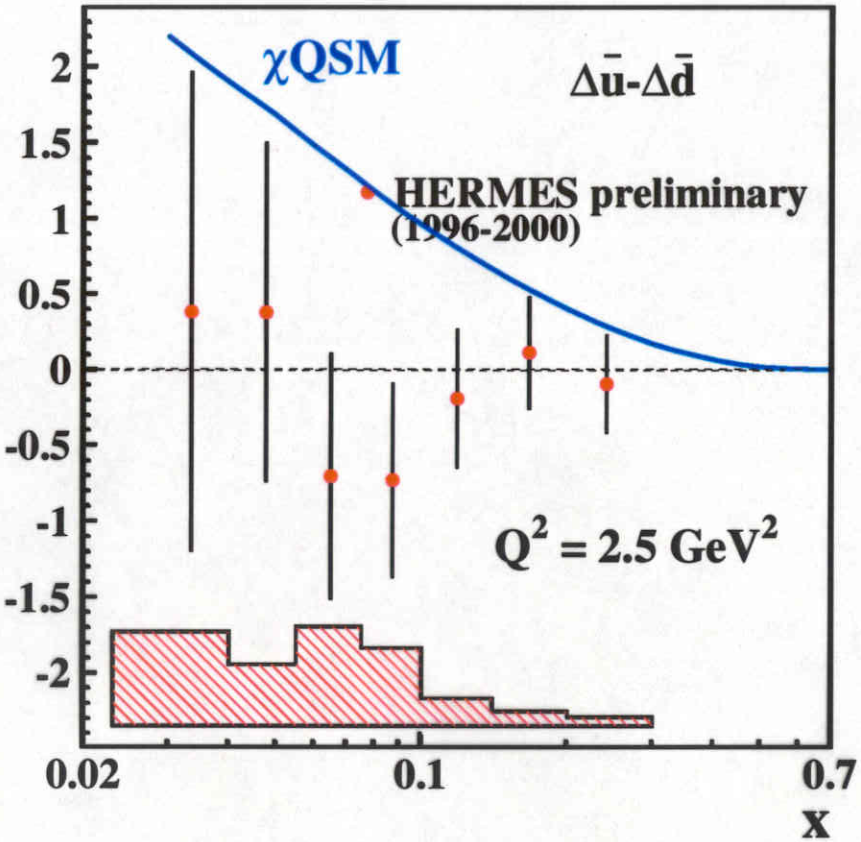
$A_1(h^-)$ p(n): $\Delta \bar{u}$ ($\Delta \bar{d}$) $\sim$ 10...30%

$A_1(K^+)$ p, n: $\Delta \bar{s} \lesssim 10\%$

$A_1(K^-)$ p, n: $\Delta s \lesssim 10\%$

systematics: limited knowledge of fragmentation functions and unpol. PDFs

First Measurement of Symmetry of Polarized Light Sea



no breaking of the flavor symmetry in the light sea observed beyond the accuracy of the data

$\rightsquigarrow$ predictions from e.g. the χQSM are not favored by Hermes data on $\Delta\bar{u}(x) - \Delta\bar{d}(x)$

$\rightsquigarrow$ more and precise data needed $\rightarrow$ RHIC

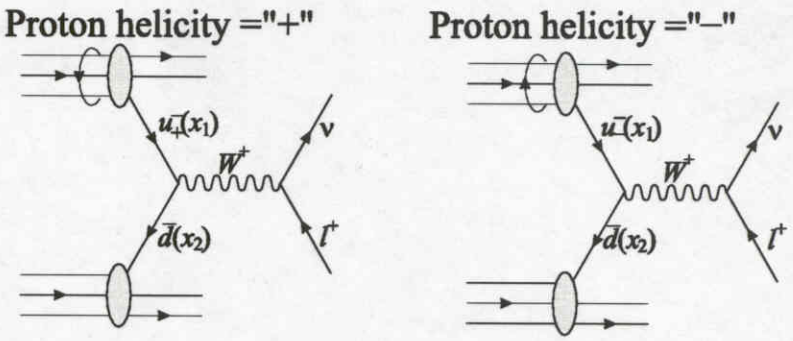
Polarized Quark Distributions at RHIC

V-A parity violation

$u\bar{d} \rightarrow W^+ \rightarrow l^+ + \nu$

$A_L \simeq \frac{\Delta u(x_1)}{u(x_1)}$ if $x_1 \gg x_2$

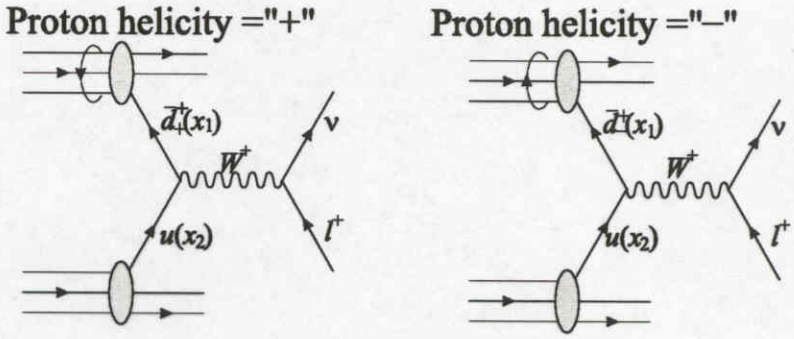
$A_L \simeq \frac{\Delta \bar{d}(x_1)}{\bar{d}(x_1)}$ if $x_1 \ll x_2$



$d\bar{u} \rightarrow W^- \rightarrow l^- + \nu$

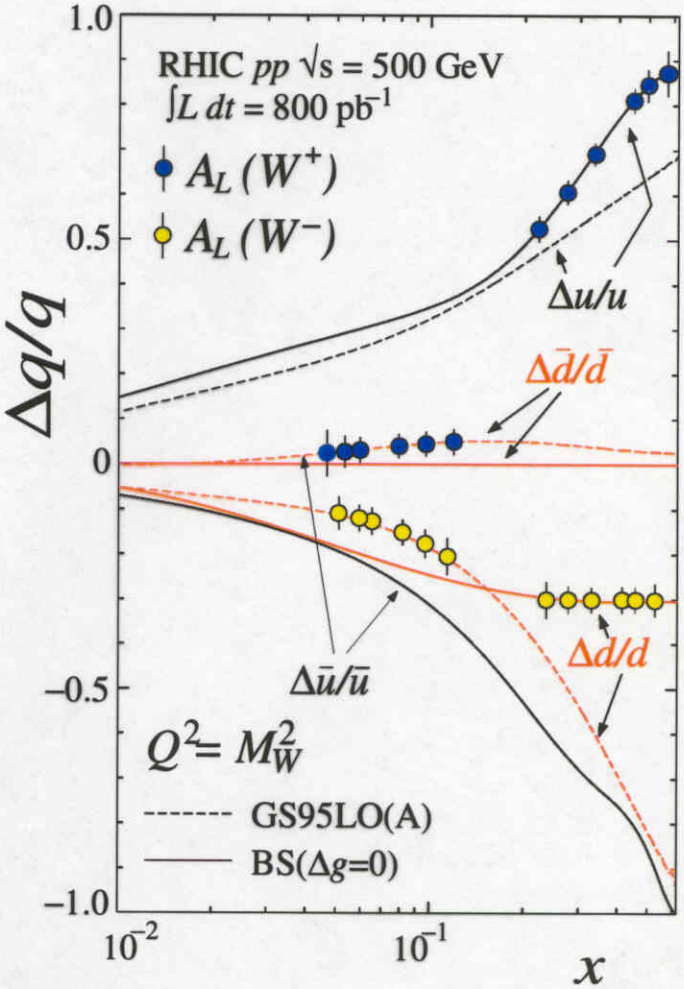
$A_L \simeq \frac{\Delta d(x_1)}{d(x_1)}$ if $x_1 \gg x_2$

$A_L \simeq \frac{\Delta \bar{u}(x_1)}{\bar{u}(x_1)}$ if $x_1 \ll x_2$

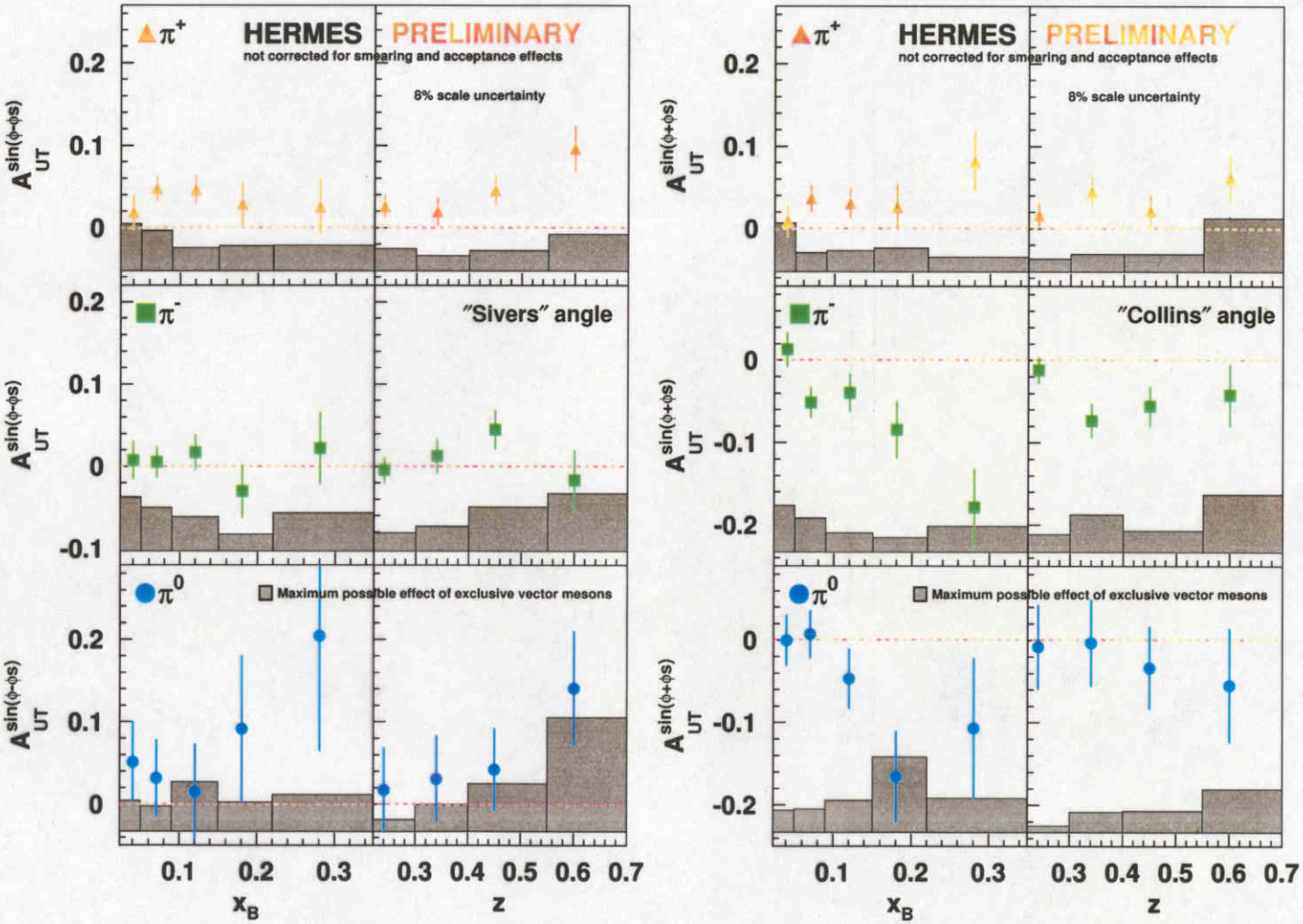


PHENIX sensitivity from:
$\mu^\pm$ decays: 8k W^+ + 8k W^-
$e^\pm$ decays: 15k W^+ + 2.5k W^-

(**STAR** will see more electron decays: 72k W^+ + 21k W^-)



Sivers and Collins asymmetries



Eskola et al

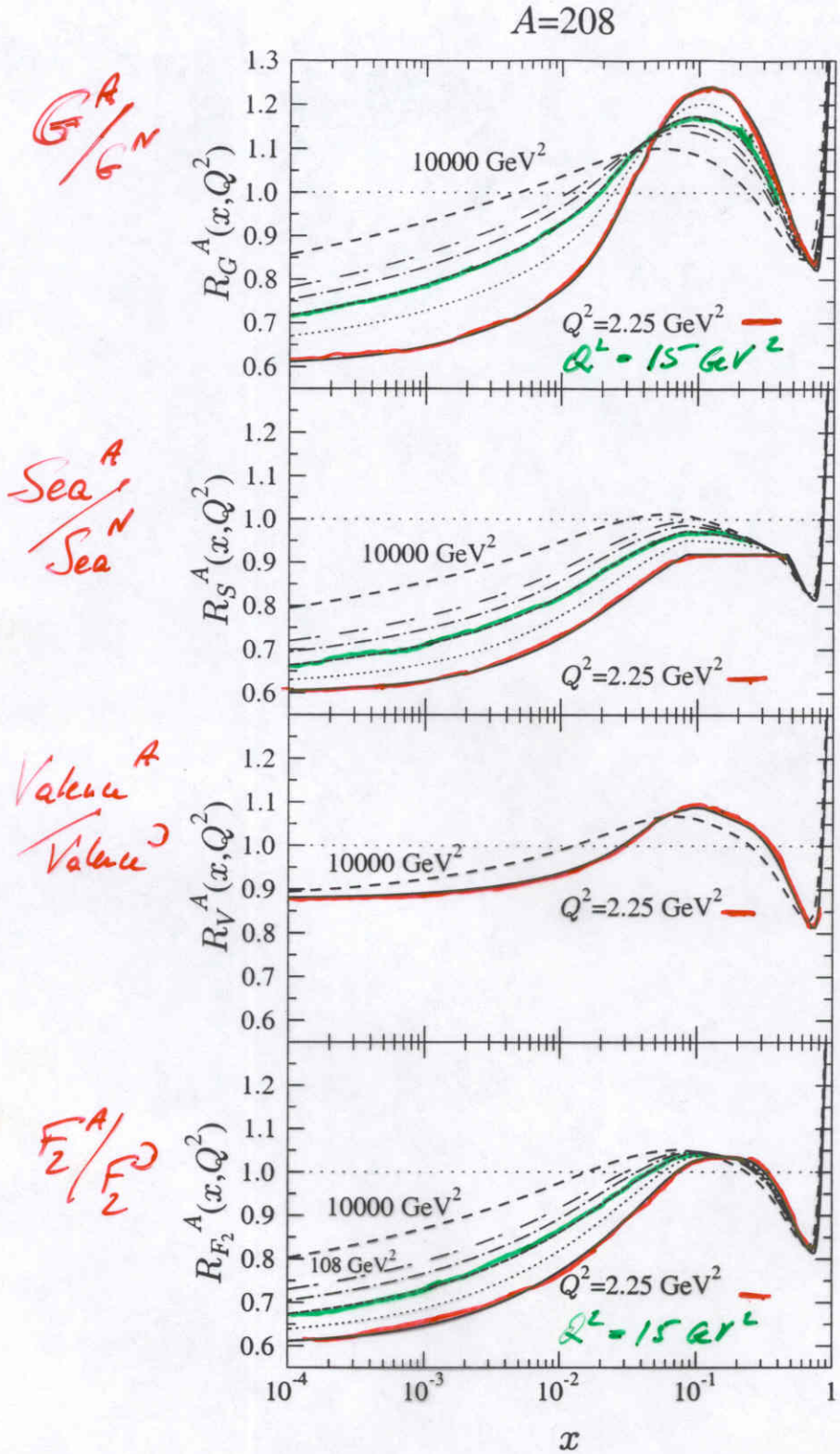


Figure 3: Scale evolution of the ratios $R_G^A(x,Q^2)$, $R_S^A(x,Q^2)$, $R_V^A(x,Q^2)$ and $R_{F_2}^A(x,Q^2)$ for an isoscalar nucleus A=208. The ratios are shown as functions of x at fixed values of $Q^2 = 2.25$ GeV^2 (solid lines), 5.39 GeV^2 (dotted), 14.7 GeV^2 (dashed), 39.9 GeV^2 (dotted-dashed), 108 GeV^2 (double-dashed), equidistant in $\log Q^2$, and 10000 GeV^2 (dashed). For R_V^A only the first and last ones are shown.

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Key Measurements in Hall C

- Exclusive processes
  example: exclusive pion production on transversely polarised targets
  - needs LT separation
  - needs high luminosity
  - needs target polarisation transverse to electron scattering plane
  - needs pion detection at small angles (SHMS)

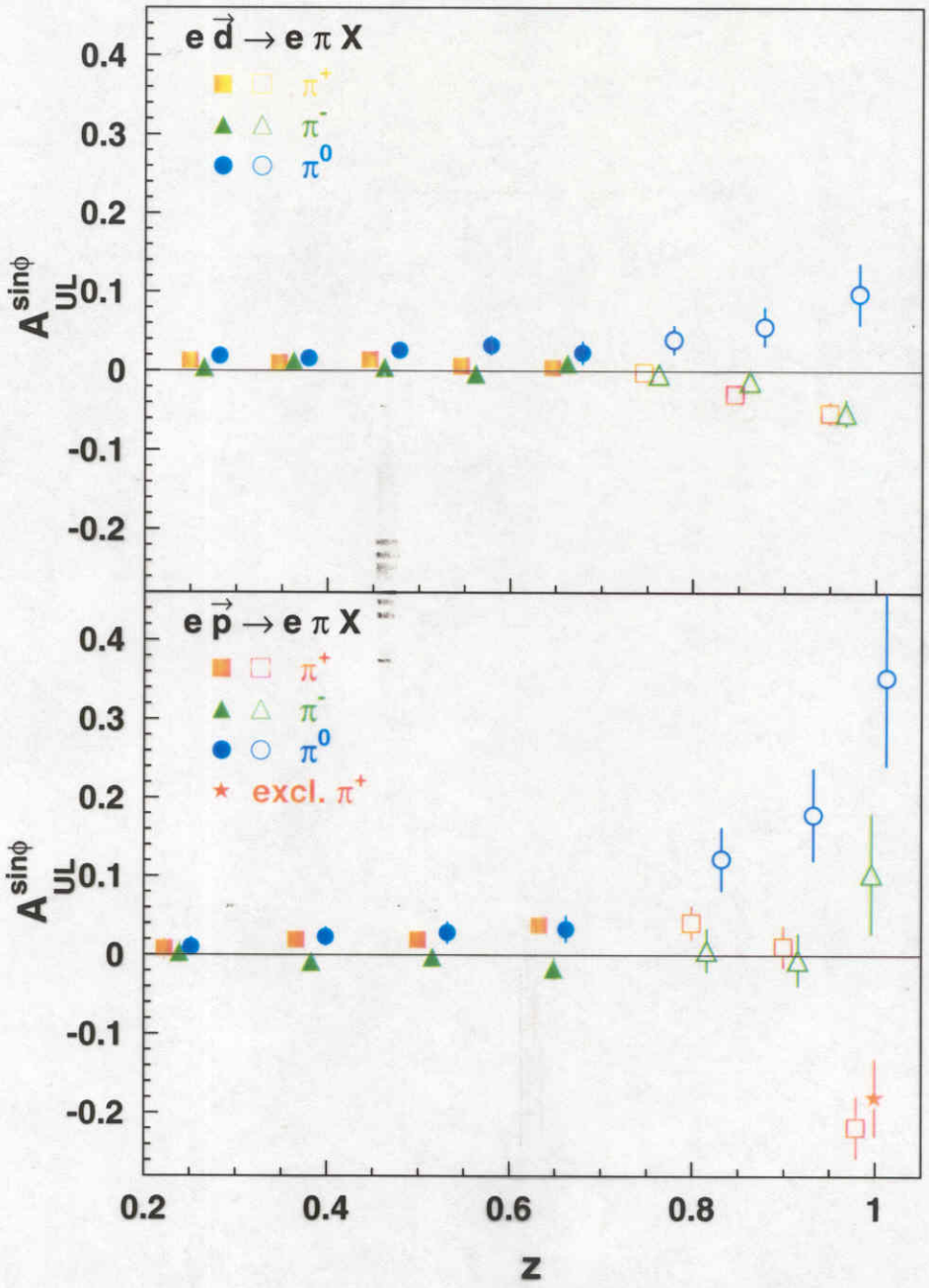
  $\longrightarrow$ access to E (no other way to measure this quantity)

  exclusive kaon production

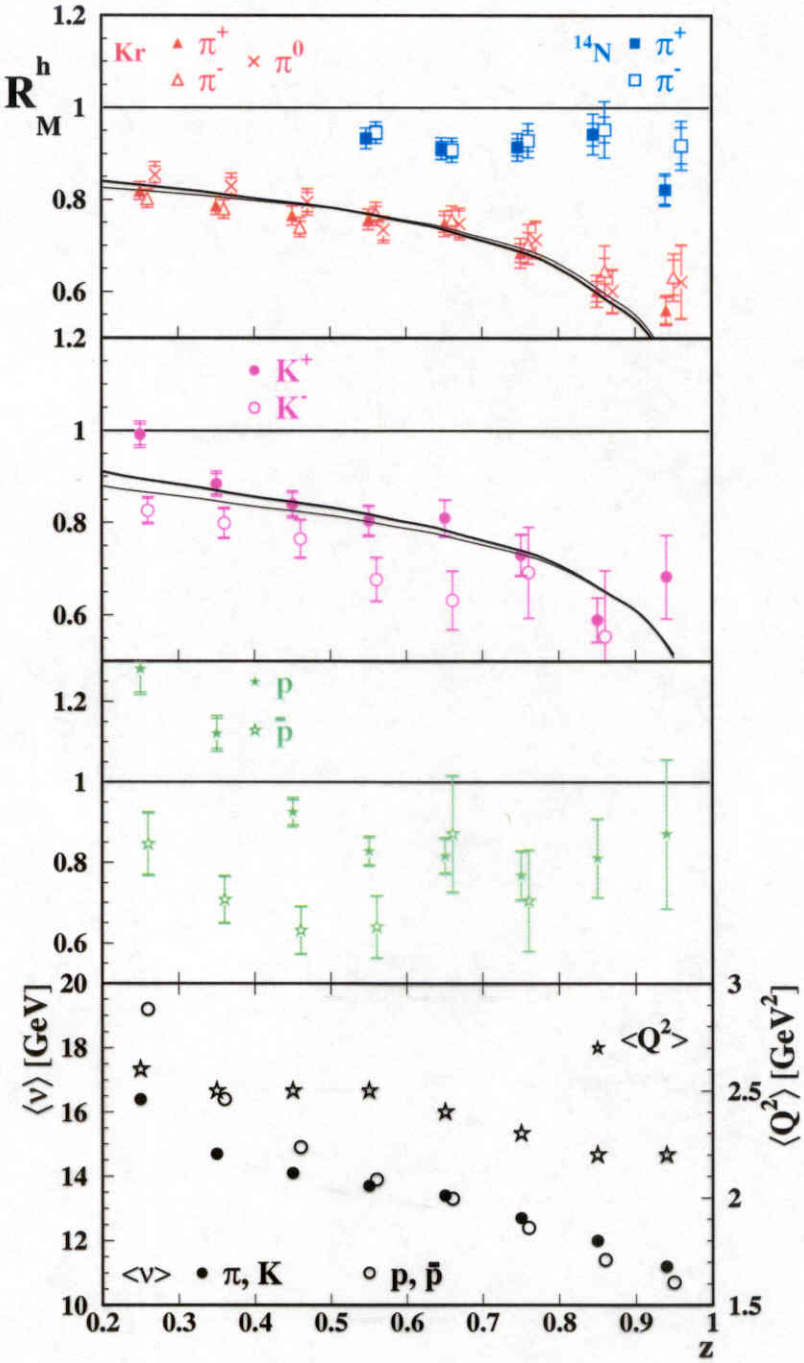
  deeply virtual Compton scattering

- Connection between semi-inclusive and exclusive physics
  - often dramatic change in behaviour !
  - needs high z values
  - needs some Q^2 range
  - common description within GPD's ?
  - higher twist effects ?

Azimuthal target spin asymmetries



Attenuation ratio for identified hadrons



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Key Measurements in Hall C

- J/Ψ production near threshold ($\longrightarrow$ Peter)
- Nuclear effects
  - nuclear modification of parton distributions
  - nuclear effects in fragmentation (z, p_T and A dependence)
  - superfast quarks
  - colour transparency
- Search for new physics (DIS parity)

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Strategy and Timelines

- Simulations of **all** measurements need to be checked/updated
- Simulations for some key measurements need to be added !
- Results will be included in CDR
- Deadline **before** end of **this** year !
- Presentations during biweekly friday 12 GeV meetings
- Update of costbook until mid september

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Additional Remarks/ Open Questions

- Do we need a target with vertical polarisation ?
- Can we increase the vertical acceptance of the HMS ?
- Do we understand the radiative corrections well enough ?
- How do we include NLO effects into the interpretation of the semi-inclusive measurements ?
- ...

Physics potential of Hall C at 11 GeV is extremely exiting and often unique !