Asymmetries and their correlations

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Outline

- Inclusive and semi-inclusive asymmetries
- Correlations

$$\rho\left(A_1^d, A_{1,h+}^d\right), \quad \rho\left(A_{1,}^d, A_{1,h-}^d\right), \quad \rho\left(A_{1,h+}^d, A_{1,h-}^d\right)$$

- Unpolarized parton distributions
- Fragmentation functions
- First look at

$$\Delta u_v, \Delta d_v, \Delta \bar{q}$$

MicroDST Cuts (2004)

Events processed	3159242069
Without badruns	3142508122
Primary vertex	2883052309
PV has mu beam	2883052309
PV has mu‘	1745787422
mu’ in hodoscope	1610777459
y > 0.1	1362095091
y < 0.99	1362095079
|Z + 35| < 85	1187388657
r < 2 cm	1127660250
Q2 > 1 GeV^2	87064994

Analysis cuts

No bad spills	77786258
Pt info from DB	77329603
140<EB<180 GeV	77085409
z<1	76999297
x>0.004	76927249
y<0.9	76555835
cross 2 cells	61165594
PV in target	54849847

Next runs are grouped to calculate asymmetry in consecutive configuration.

grouping

some runs have neither badrun nor grouping flag,
e.g. W30: 37848-37866, 37978

Few of them have perhaps only badspills, but not all of them.
e.g.: 37856 – only 1 badspill (27)
37865 – 0 badspill

After all:
85110200 events

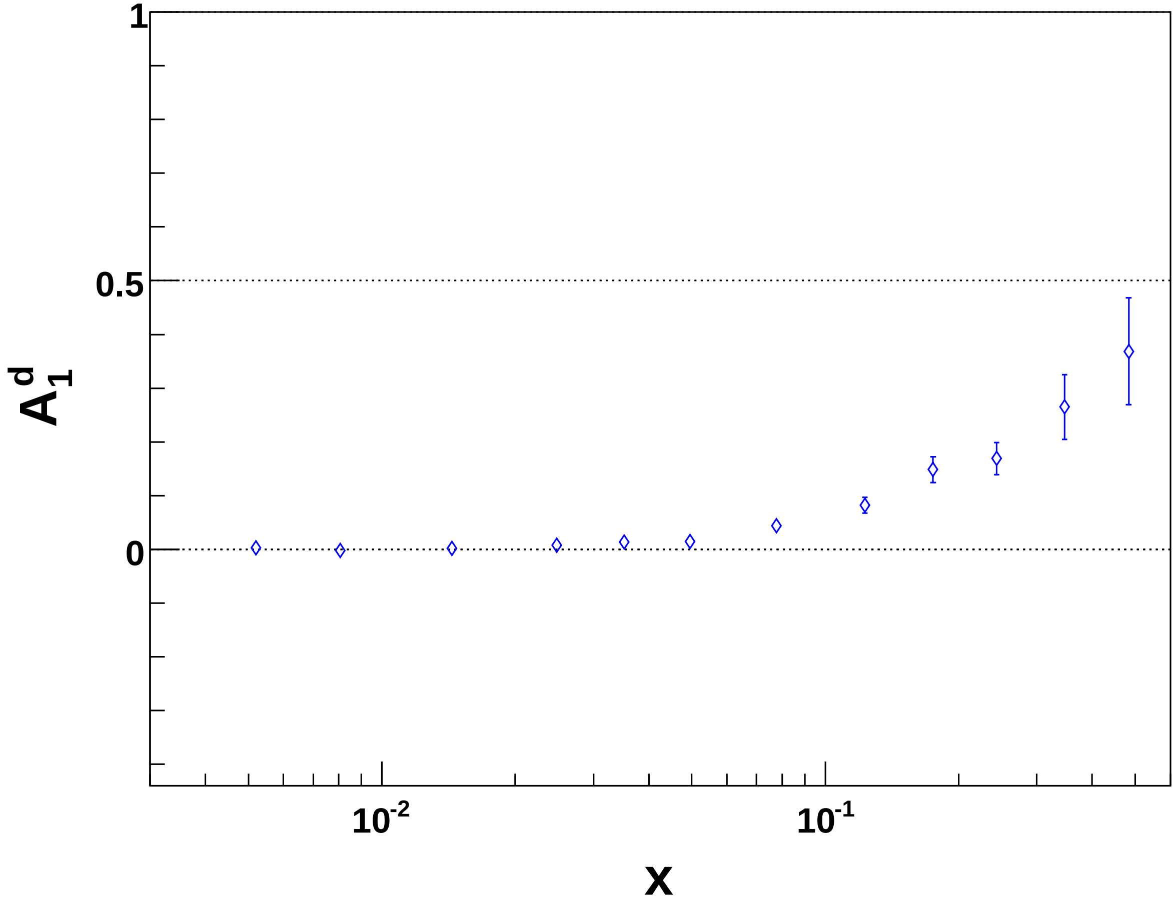
Helena's number:
85064782 events

bellow 0.1% differences

The Newest stability list should be used

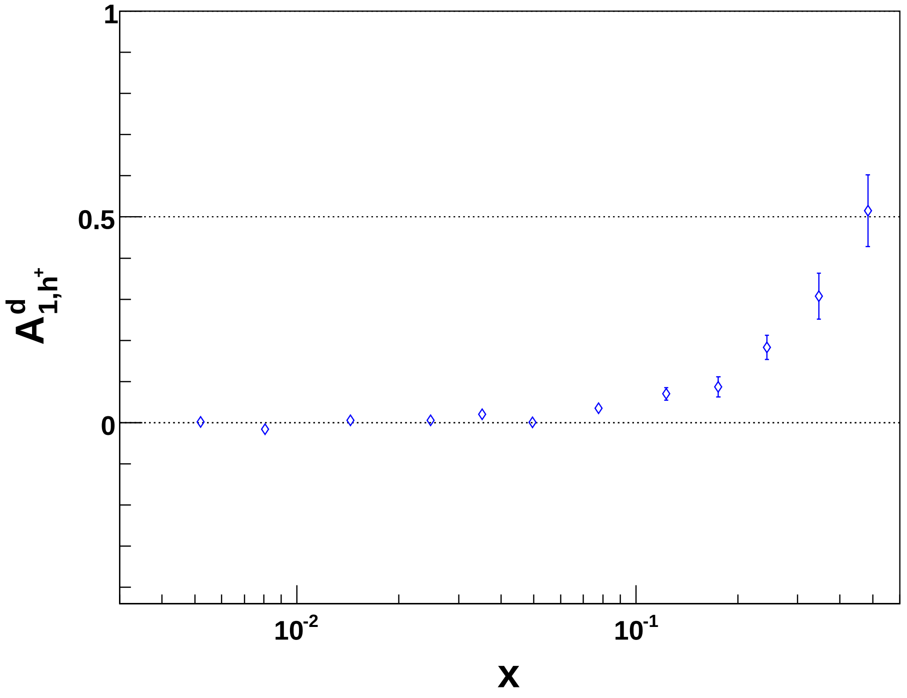
Inclusive asymmetry (2002+3+4)

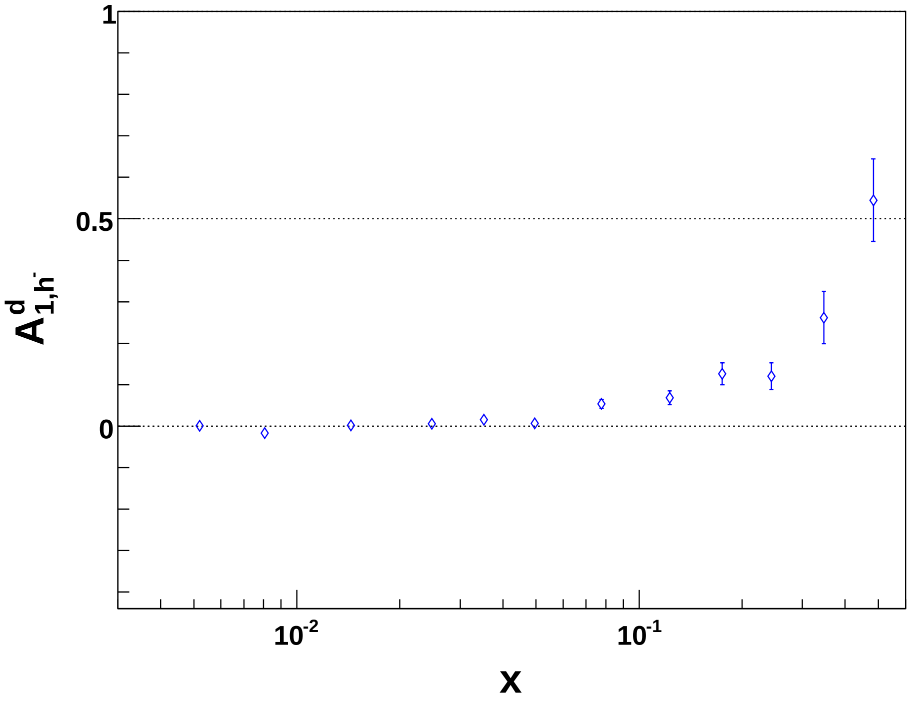
Second order weighted method:



Semi-inclusive asymmetry (2002+3+4)

Additional cuts: z>0.2, zlast < 3300





A1 - QPM interpretation

$$A_1^h(x) = \frac{\sum_{i,h} e_i^2 \left[\Delta q_i(x) D_i^h + \Delta \bar{q}_i(x) D_i^h\right]}{\sum_{i,h} e_i^2 \left[q_i(x) D_i^h + \bar{q}_i(x) D_{\bar{q}}^h\right]}$$

$$A_1^p = \frac{g_1^p}{F_1^p} = \frac{4\Delta u_v + \Delta d_v + 10\Delta\bar{q}}{4u_v + d_v + 10\bar{q}}$$

strange sea neglected!

Due to isospin symmetry:

$$A_1^d = \frac{g_1}{F_1} = \frac{\Delta u_v + \Delta d_v + 4\Delta\bar{q}}{u_v + d_v + 4\bar{q}}$$

$$A_{1,h+}^d = \frac{(\Delta u_v + \Delta d_v)\left(4D_u^{h+} + D_d^{h+}\right) + 2\Delta q_s\left(4D_u^{h+} + 4D_{\bar{u}}^{h+} + D_d^{h+} + D_{\bar{d}}^{h+}\right)}{(u_v + d_v)\left(4D_u^{h+} + D_d^{h+}\right) + 2q_s\left(4D_u^{h+} + 4D_{\bar{u}}^{h+} + D_d^{h+} + D_{\bar{d}}^{h+}\right)}$$

How to obtain polarized quark distribution:

$$\vec{A} = \left(A_1^d, A_{1,h+}^d, A_{1,h-}^d, A_1^p, A_{1,h+}^p, A_{1,h-}^p\right)$$

A^p from SMC

$$\chi^2 = \left(\vec{A}_{data} - \vec{A}_{calc}\right)^T C^{-1} \left(\vec{A}_{data} - \vec{A}_{calc}\right)$$

$$c_{i,j} = cov\left(A_i, A_j\right)$$

$$cov\left(A_i^p, A_j^d\right) = 0$$

What we need

- Correlation between asymmetries
  (calculate from multiplicities)
- Asymmetry on proton target
  (one can get from SMC)
- Unpolarized quark distributions
  (e.g. from Durham data base)
- Fragmentation functions
  (poorly known - additional assumptions needed)

Fragmentation function

Lets assume:

$$D_1 = D_u^{\pi+} = D_{\bar{d}}^{\pi+} = D_{\bar{u}}^{\pi-} = D_d^{\pi-} = D_s^{K-} = D_{\bar{s}}^{K+}$$

$$D_2 = D_u^{\pi-} = D_{\bar{d}}^{\pi-} = D_{\bar{u}}^{\pi+} = D_d^{\pi+} = D_s^{\pi+} = D_s^{\pi-} = D_{\bar{s}}^{\pi+} = D_{\bar{s}}^{\pi-}$$

$$D_3 = D_u^{K+} = D_{\bar{u}}^{K-}$$

$$D_4 = D_u^{K-} = D_{\bar{d}}^{K-} = D_d^{K-} = D_{\bar{s}}^{K-} = D_{\bar{u}}^{K+} = D_d^{K+} = D_{\bar{d}}^{K+} = D_s^{K+}$$

$$D_5 = D_u^{p} = D_d^{p} = D_{\bar{u}}^{\bar{p}} = D_{\bar{d}}^{\bar{p}}$$

$$D_6 = D_u^{\bar{p}} = D_d^{\bar{p}} = D_s^{\bar{p}} = D_{\bar{s}}^{\bar{p}} = D_{\bar{d}}^{p} = D_s^{p} = D_{\bar{s}}^{p}$$

Fragmentation function

Used values from EMC for integrals over 0.2<z<1:

$$D_1 = 0.397$$

$$D_2 = 0.2$$

$$D_3 = 0.12$$

$$D_4 = 0.066$$

$$D_5 = 0.054$$

$$D_6 = 0.025$$

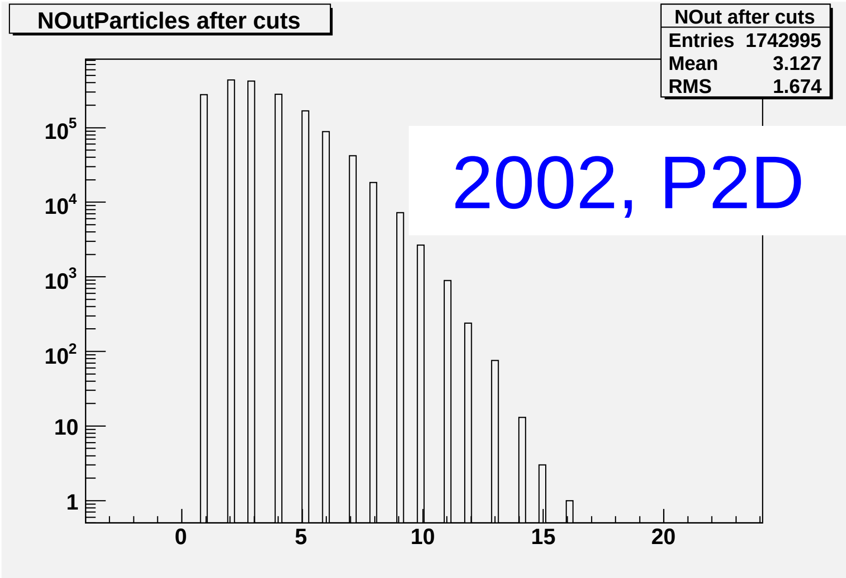
Correlations between asymmetries

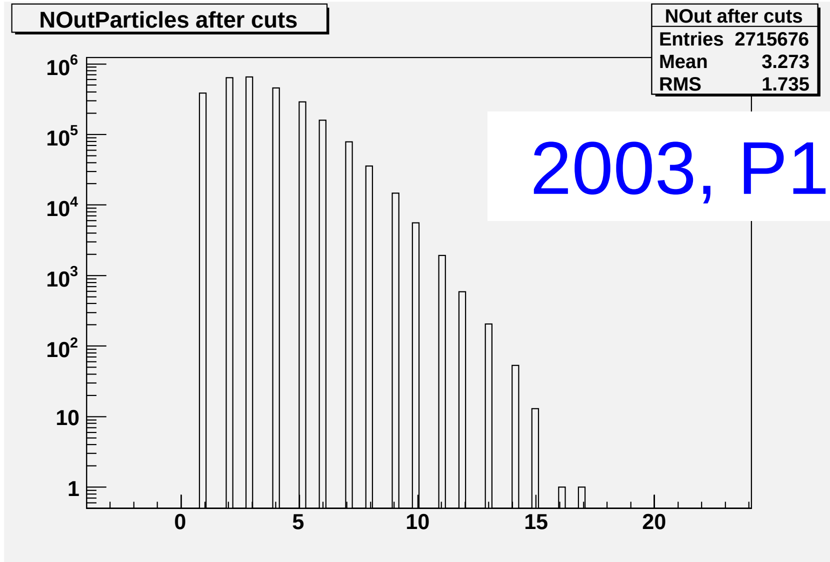
- COMPASS note 2004-4

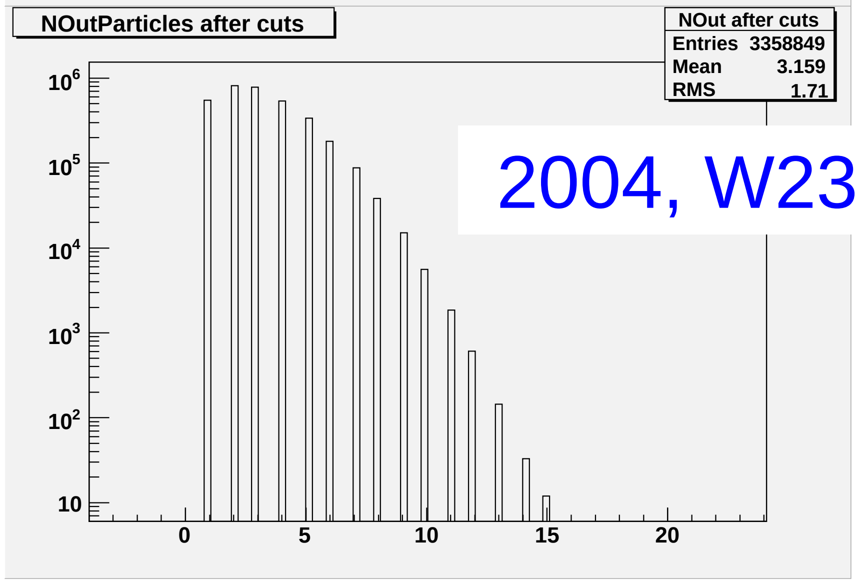
$$\rho\left(A_1, A_1^h\right) = \rho\left(N, N^h\right) = \frac{\left\langle n^h \right\rangle}{\sqrt{\left\langle n^{h^2} \right\rangle}}$$

$$\rho\left(A+, A-\right) = \rho\left(N+, N-\right) = \frac{\left\langle n^{h+} n^{h-} \right\rangle}{\sqrt{\left\langle n^{h+^2} \right\rangle \left\langle n^{h+^2} \right\rangle}}$$

total multiplicities



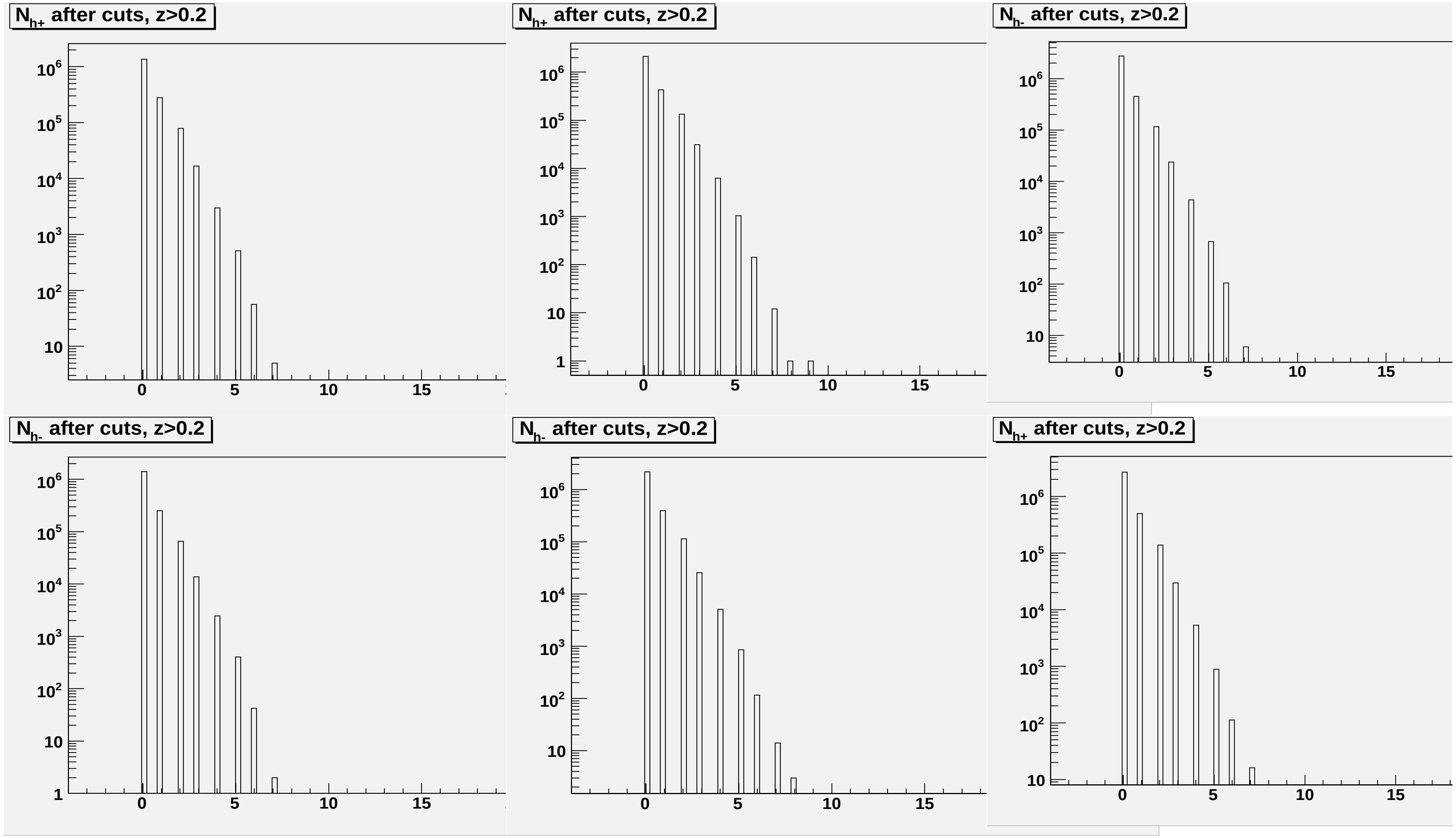




No significant differences

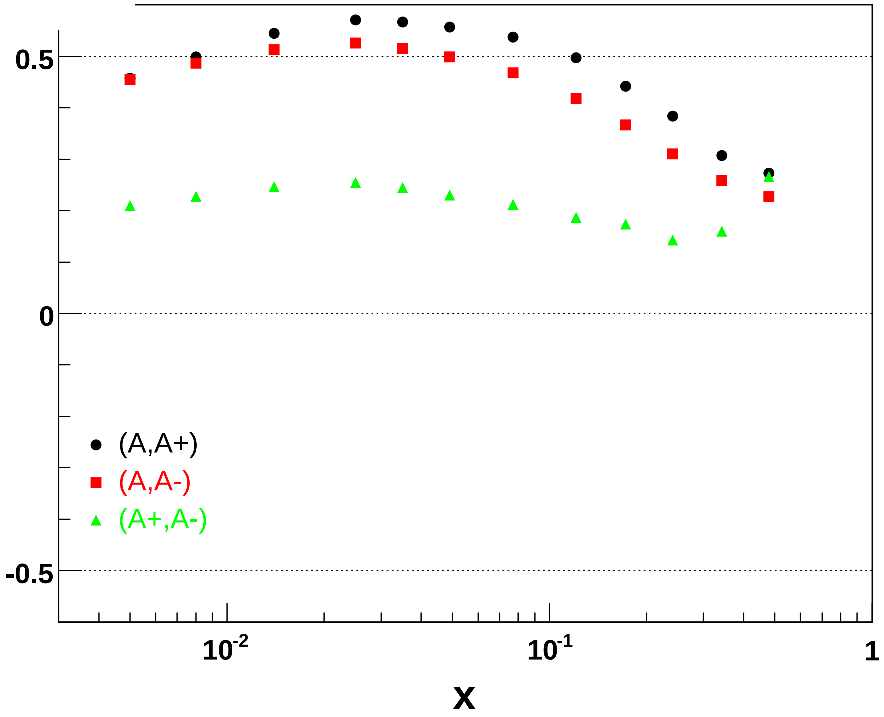
h+ and h- multiplicities

2002, P2D   2003, P1D   2004, W23

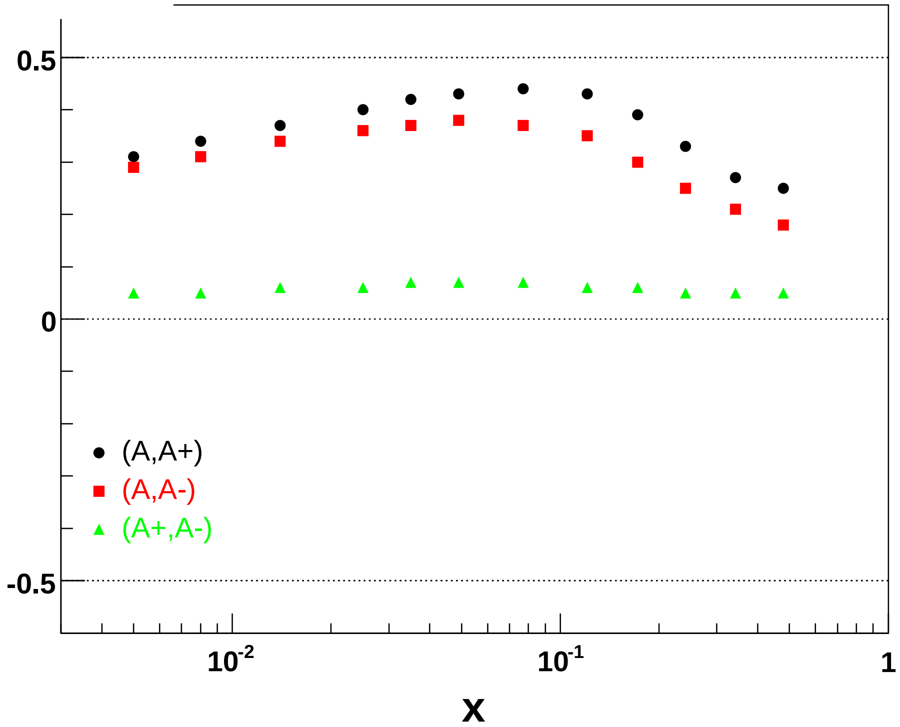


Correlations

e.g. COMPASS (2002, P2D)



SMC

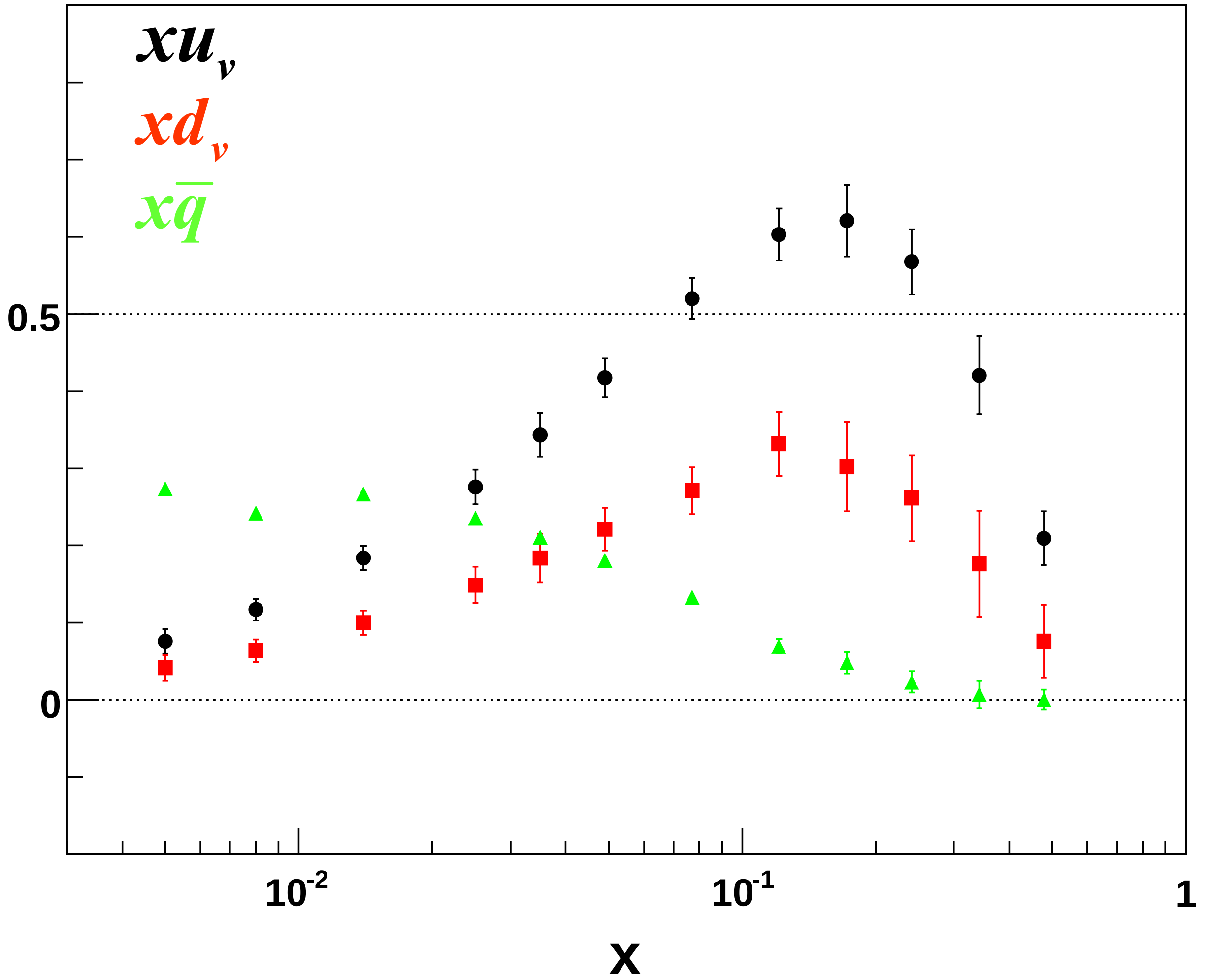


Significantly larger values for COMPASS due to larger acceptance
(we have more hadrons in final state)

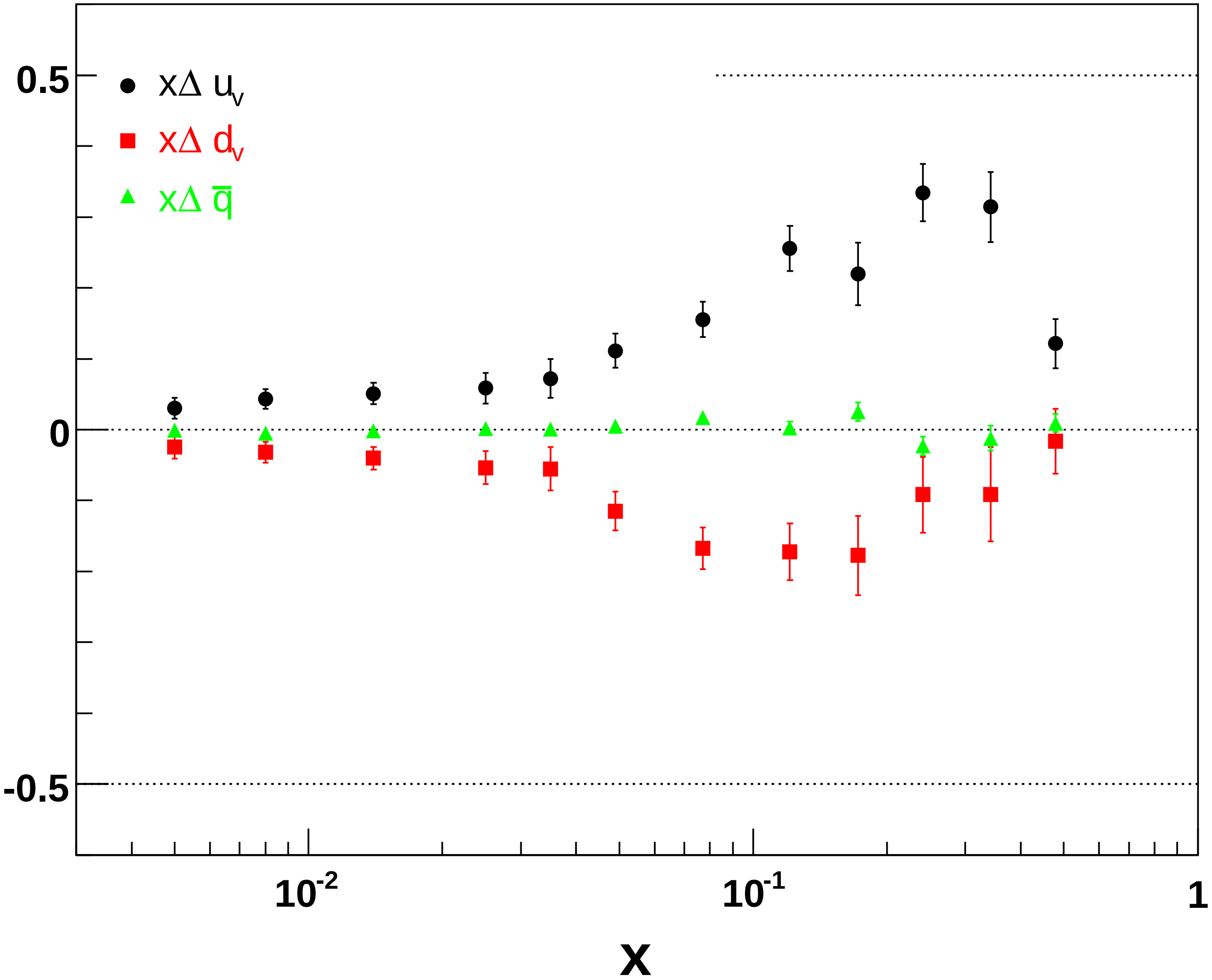
Unpolarized parton distributions

ZEUS 2005 parametrization used, available online:

http://durpdg.dur.ac.uk/hepdata/pdf3.html



Polarized quark distributions



Next steps

- Systematics studies
- Particle identification needed
- use new fragmentation functions:

  - from fits to world data, possibly minimizing nr of assumptions (Kretzer et al.).
  - determine from our data?
- include s quarks into calculations
- Flavor separation of sea quarks