Current constraints on the sea quark distributions from the global QCD fits

(S.Alekhin, IHEP, Protvino)

A quark-antiquark annihilation gives a good chance to test new physics at LHC provided both sorts of distributions are sufficiently well constrained.

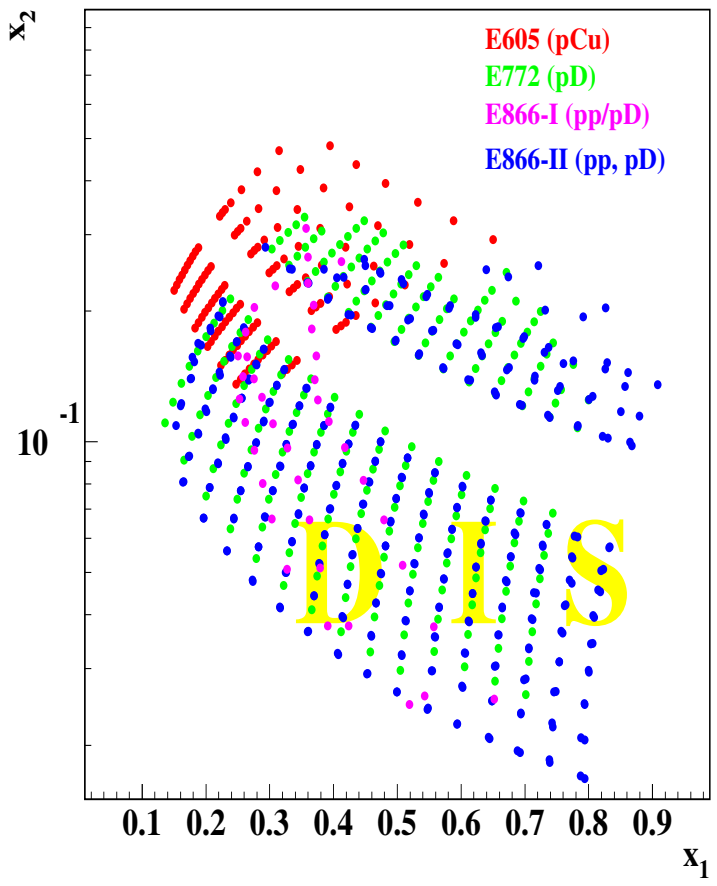
The valence part is defined with the precision of O(1%) by the DIS data (SLAC+BCDMS+*HERA current run*)

The sea distributions are known much less precisely. For the A02 PDFs (DIS fit) uncertainty in the sea distributions is at the level of 100% at $x \gtrsim 0.6$; CTEQ and MRST give comparable estimates.

Plan of the talk

- Constraints on the isoscalar sea distribution $\bar{u} + \bar{d}$ from the fixed target Drell-Yan data
- Value of the quark isospin asymmetry $(\bar{d} - \bar{u})$ at large and small x
- Interplay of the non-strange and strange distributions

Existing fixed-target Drell-Yan data



- At large x_1 and small x_2 $\sigma_{\rm DY} \sim q(x_1)\bar{q}(x_2)$ and $\Delta q(x_1), \Delta\bar{q}(x_2) \sim O(1\%)$ from DIS
- Otherwise $\sigma_{\rm DY} \sim q(x_1)\bar{q}(x_2) + q(x_2)\bar{q}(x_1)$ and since $\Delta\sigma_{\rm DY}^{\rm exp} \lesssim 20\%$ and $\Delta q^{\rm DIS} \sim O(1\%) \rightarrow$

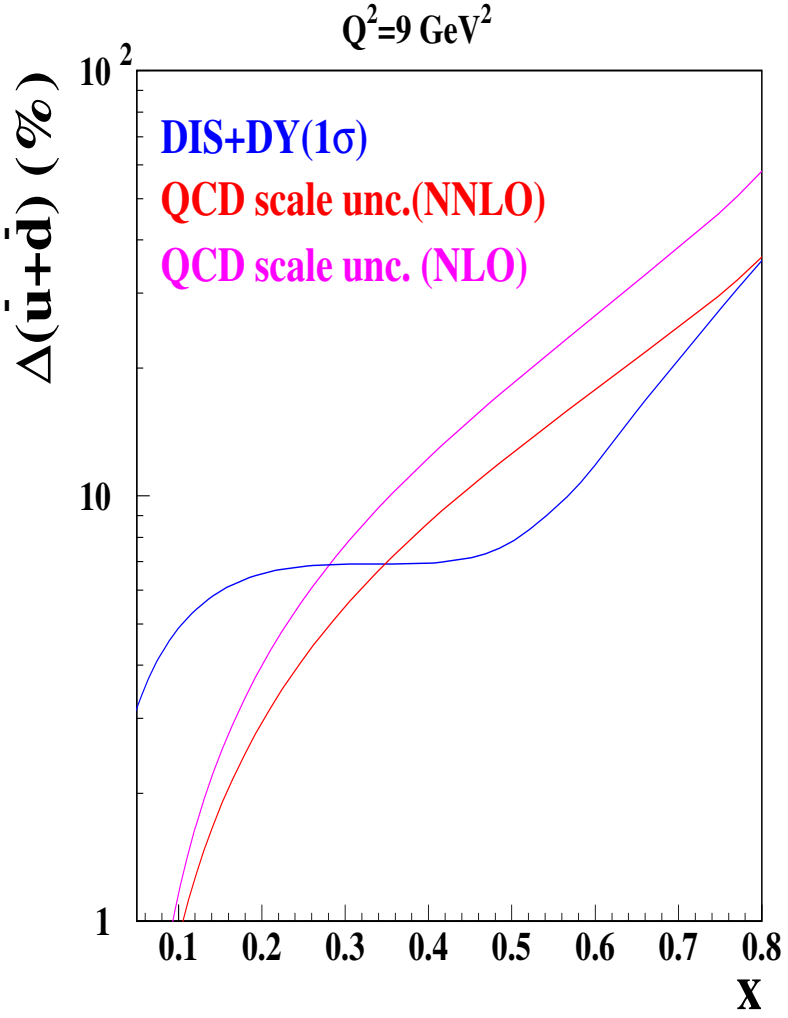
$\Delta\bar{q} \lesssim 20\%$ at $x \lesssim 0.6$ from DIS+DY

Fit of PDFs to the combined DIS+DY data

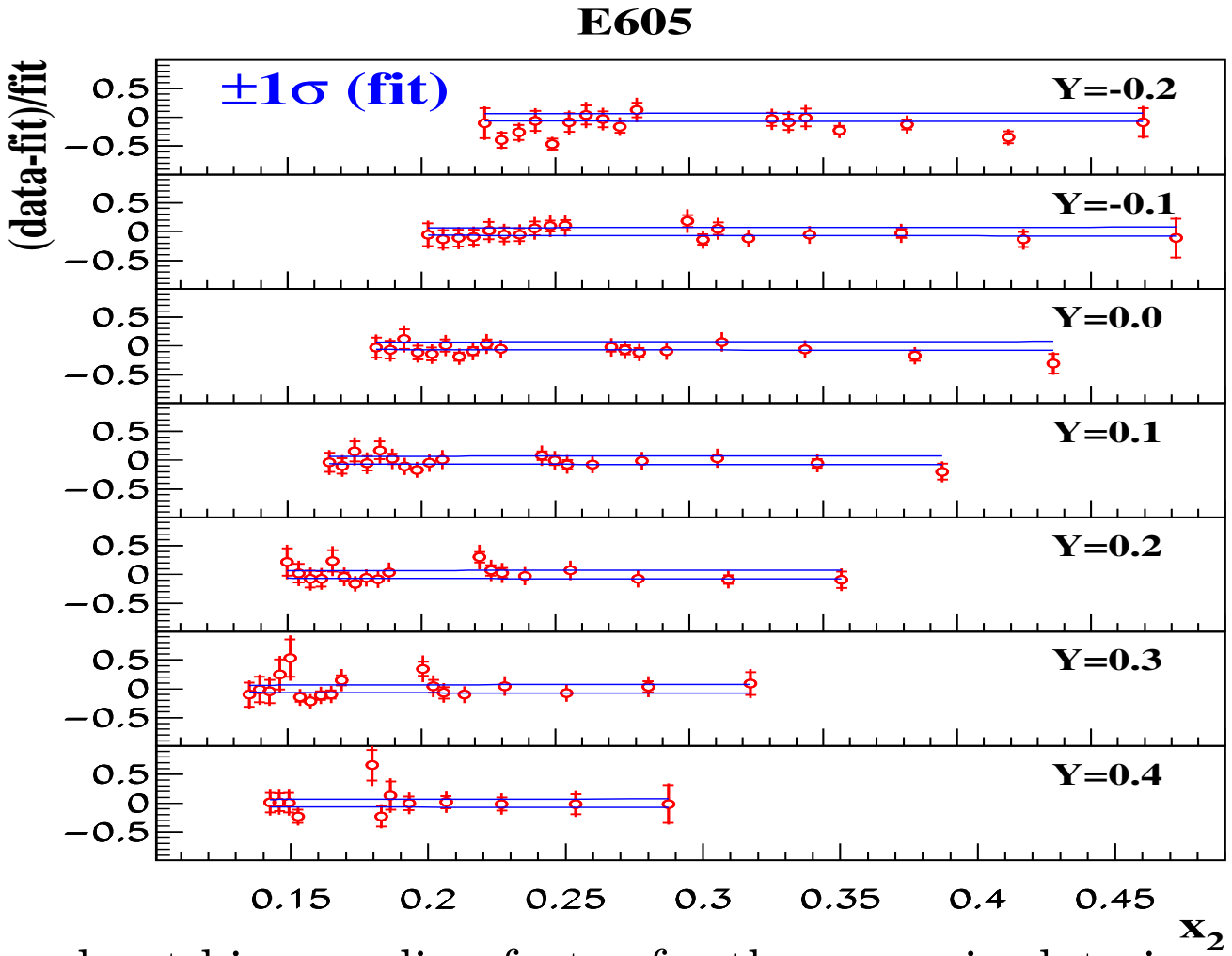
(sa-Melnikov-Petriello 06)

- The NNLO QCD corrections to the Drell-Yan cross sections by Anastasiou-Dixon-Melnikov-Petriello
- The NNLO QCD evolution kernels by Moch-Vermasseren-Vogt
- The massless $O(\alpha_s^2)$ corrections to the DIS coefficient functions
- Account of the heavy quarks contributions up to $O(\alpha_s^2)$ by Laenen-Riemersma-Smith-van Neerven.
- Account of the target-mass corrections and twist-4 terms in DIS
- Account of the Fermi motion and the off-shellness effect in deuterium using recent Kulagin-Petti parameterization

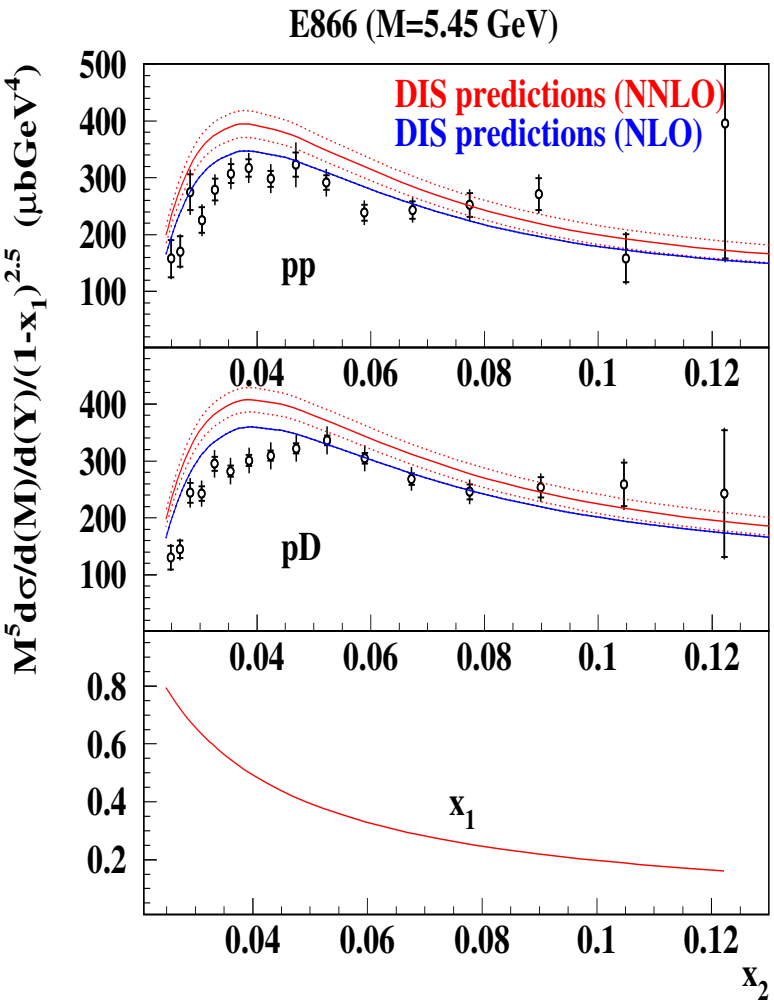
Constraints from the E605 data



- Suppression of the errors in sea down to 20 % at $x \lesssim 0.7$
- The errors in PDFs due to variation of the DY scales are comparable to the experimental one (**the NNLO corrections are crucial at this point**).

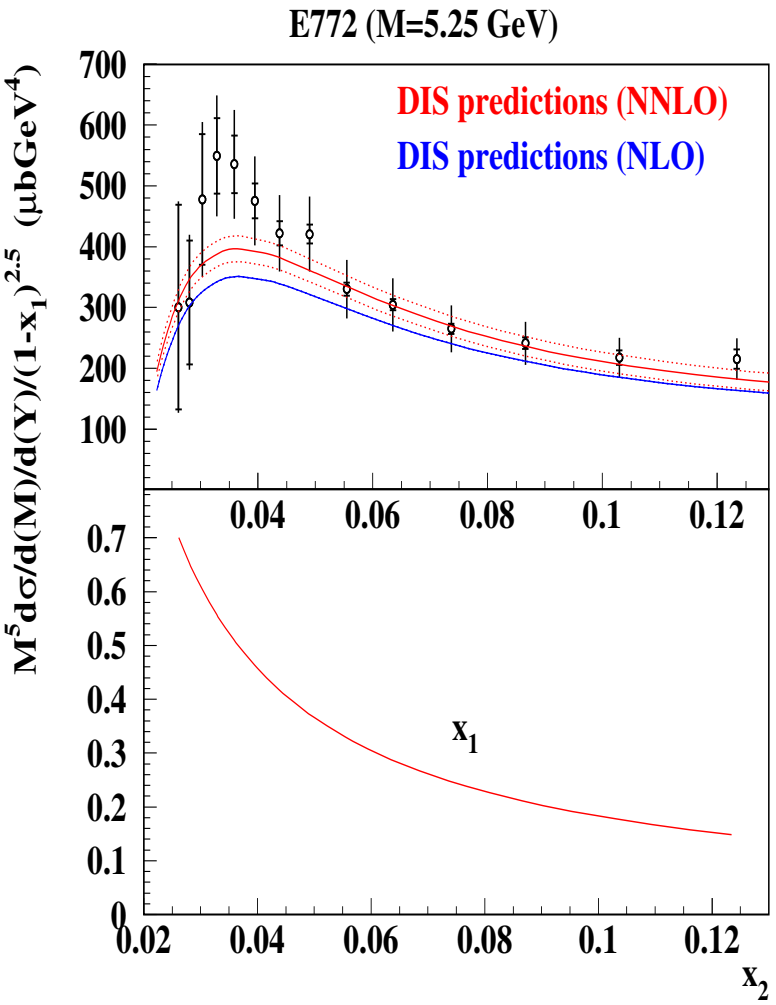


We need not big rescaling factor for the errors in data in order to bring them into **ideal** agreement to the fit.

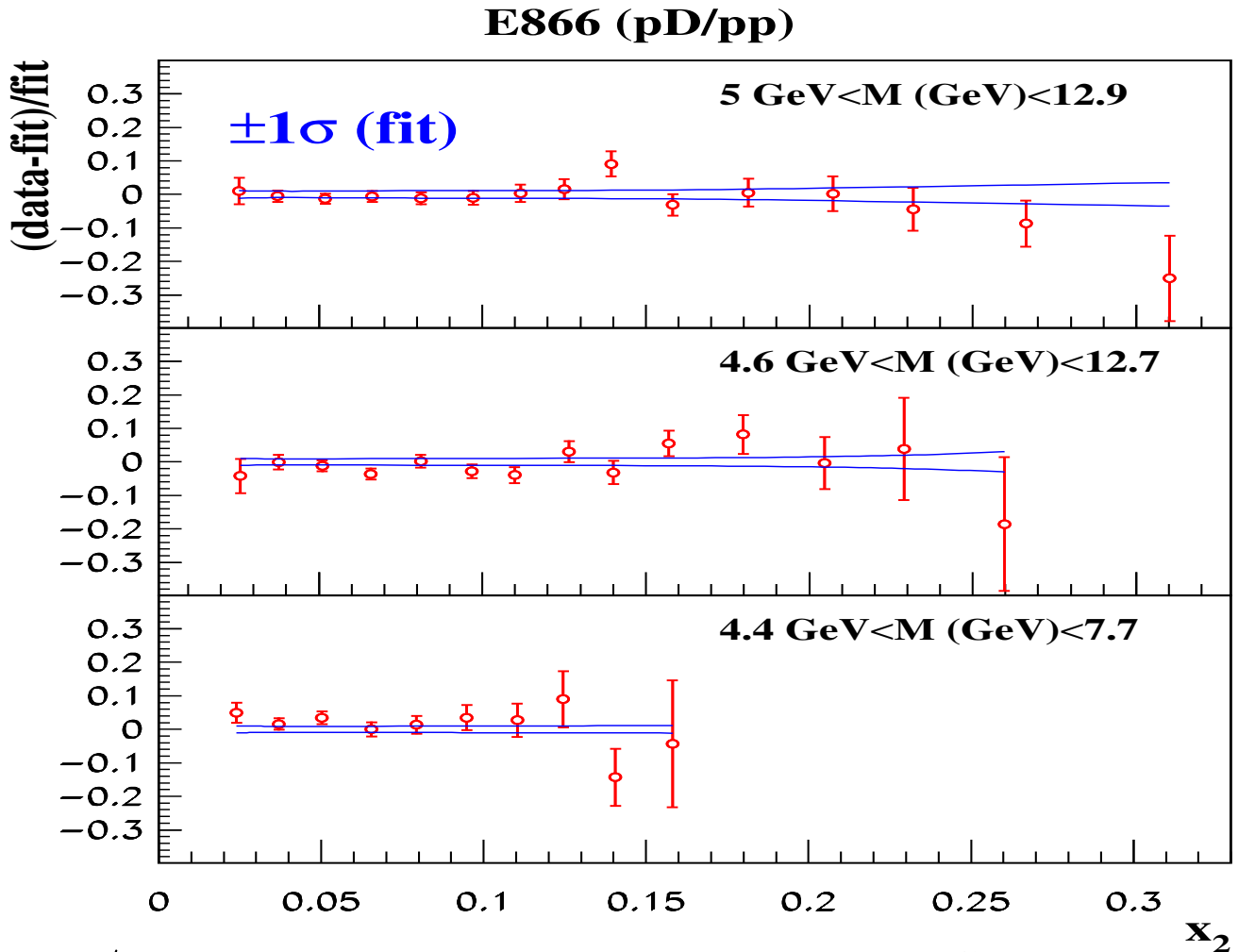


The E866 data are in disagreement to the DIS data at low M, in the region where the latter constraint sea with a good precision.

The NLO predictions are in better agreement with data than the NNLO ones.

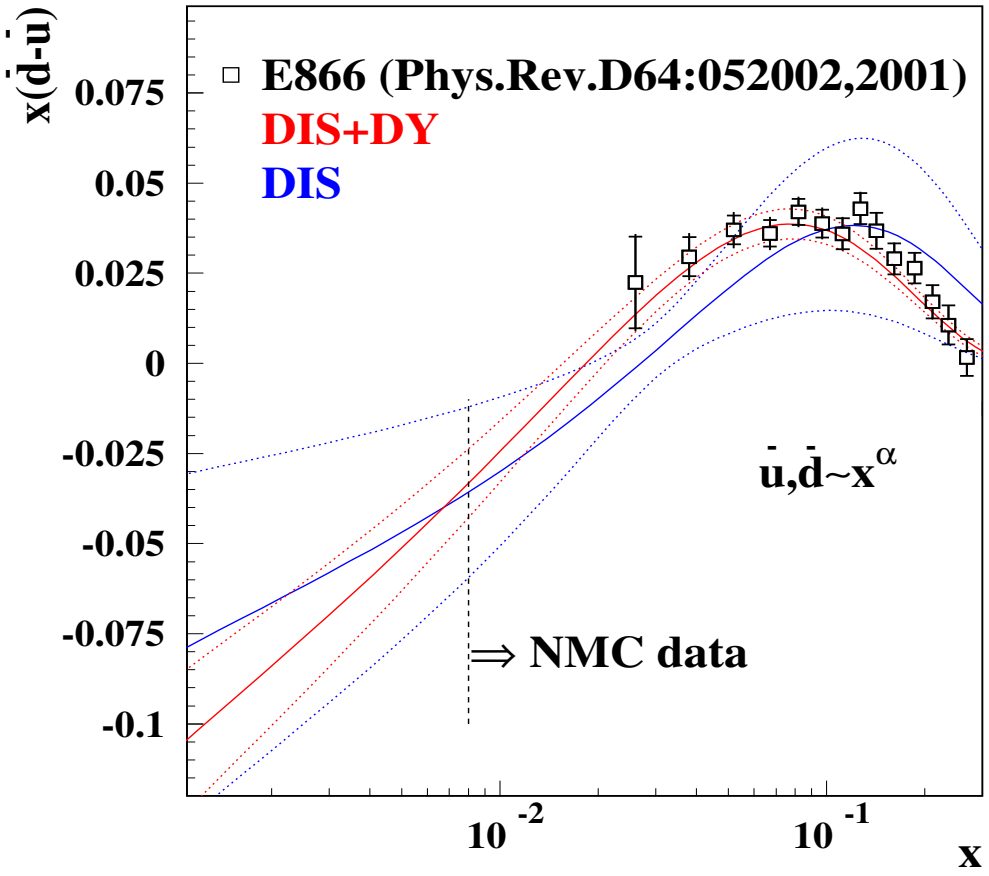


The trend of E772 data at low M is different from E866 case, therefore one can expect uncontrolled systematic effects in the Drell-Yan data at this region



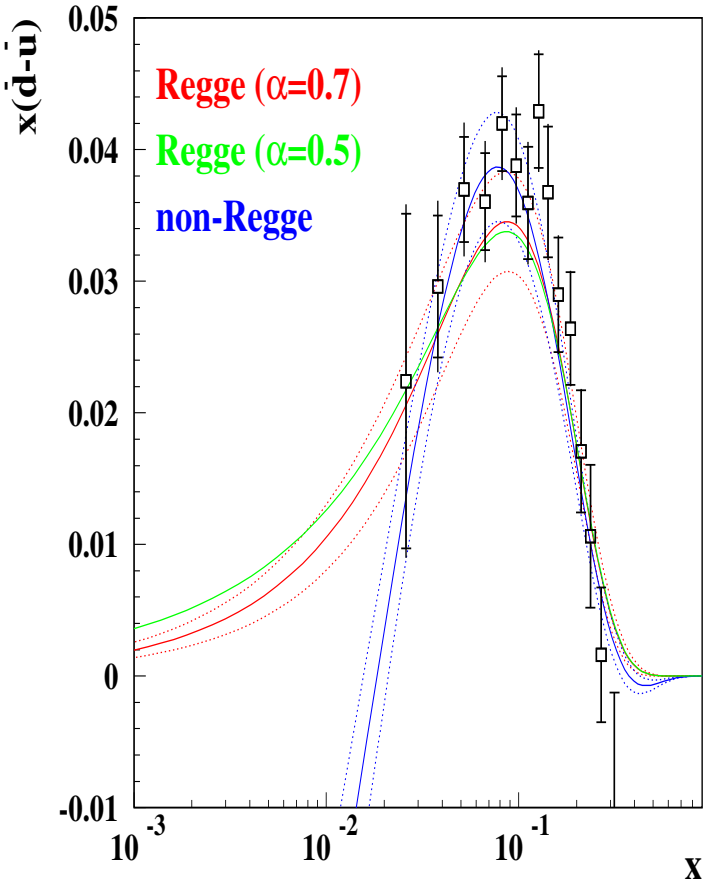
In the D/p ratio discrepancies between the DIS data practically cancel and a consistent combined fit can be obtained

Isospin asymmetry of the nucleon sea

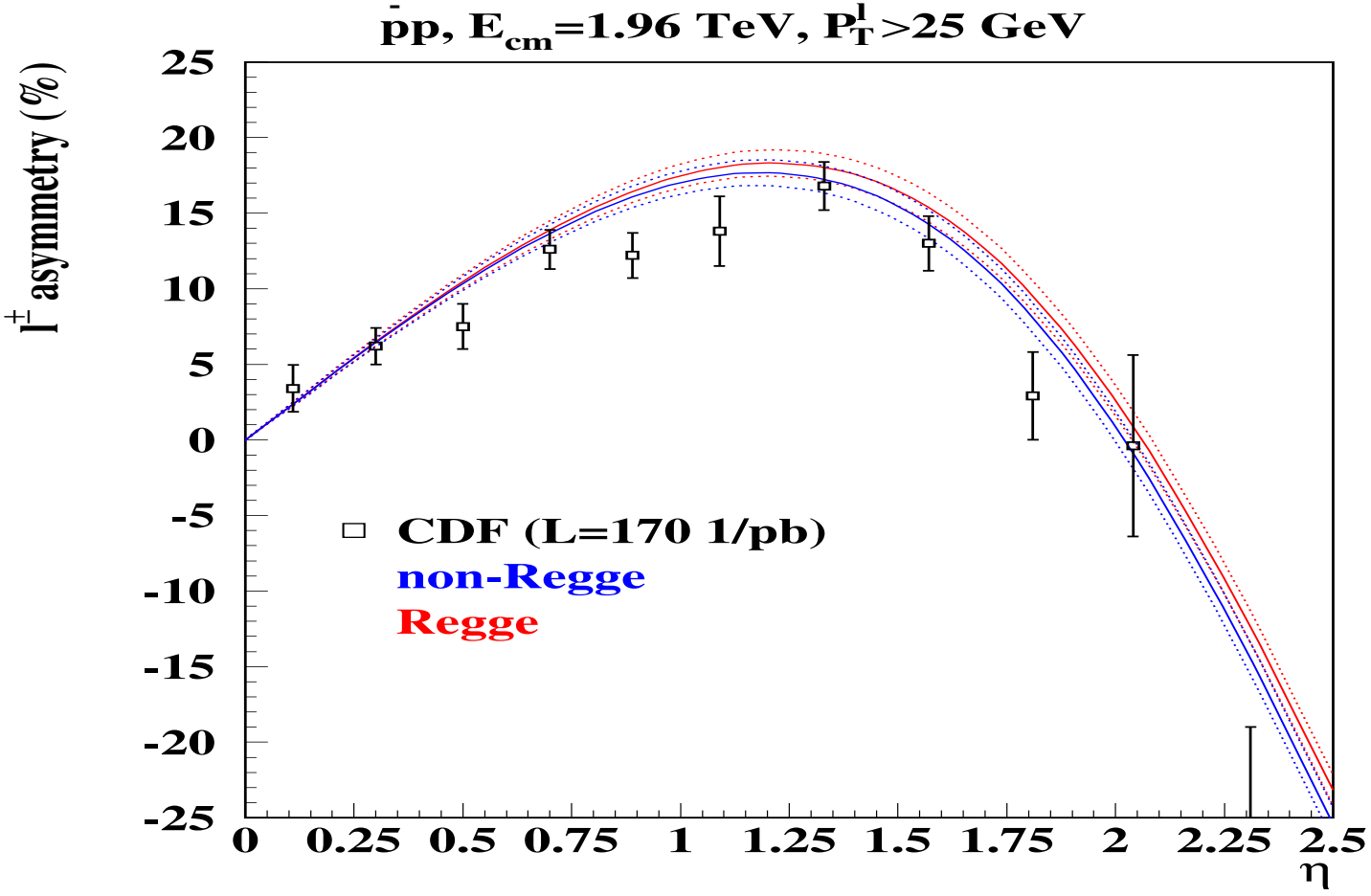


The DY data constrain $(\overline{d} - \overline{u})$ at large x, but do not help at $x < 0.01$; in this region its value is rather constrained by the functional form of the sea distributions (compare with the neural network determination of $(\overline{d}-\overline{u})$ by NNPDF collaboration)

Regge constraint on $(\overline{d} - \overline{u})$

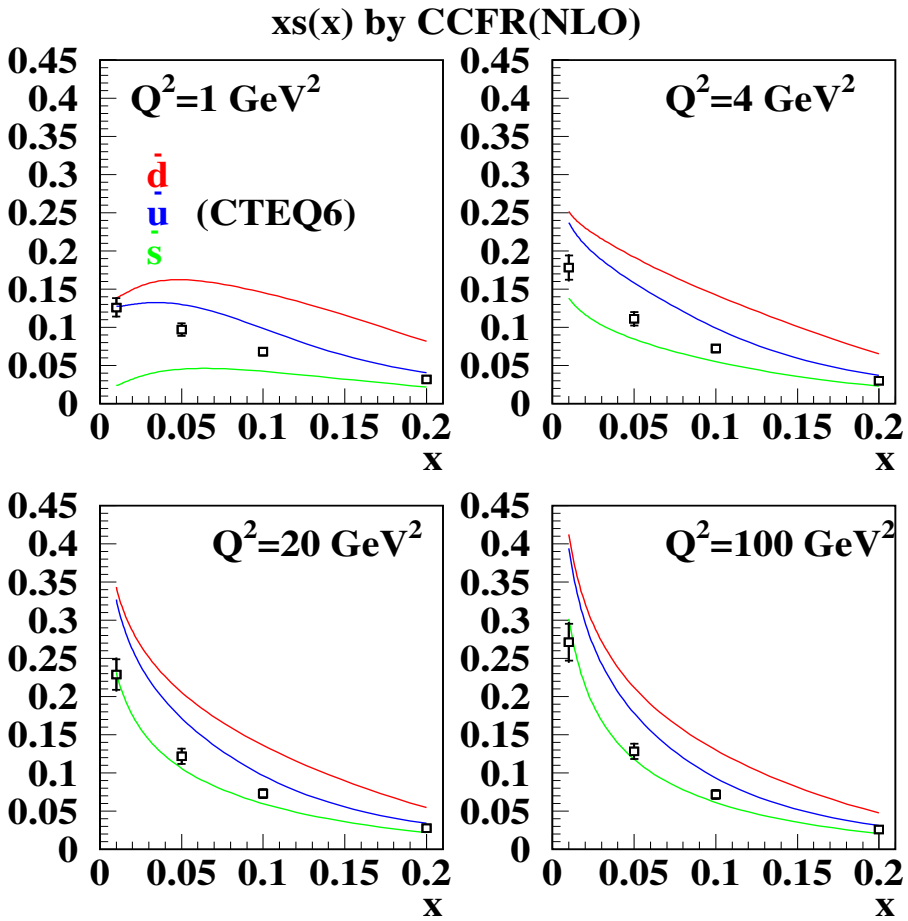


For the shape like $x(\overline{d} - \overline{u}) \sim x^{\alpha}$ at small x uncertainty in $(\overline{d} - \overline{u})$ at $x \lesssim 0.01$ is suppressed. The price is some deterioration of the fit quality and stronger model dependence. The value of the low-x exponent for $x(\overline{d} - \overline{u})$ is uncertain (0.5 from the meson trajectories intercepts, 0.7 for the fitted valence quark distributions, and about 0.9 for the neutrino structure function xF_3)

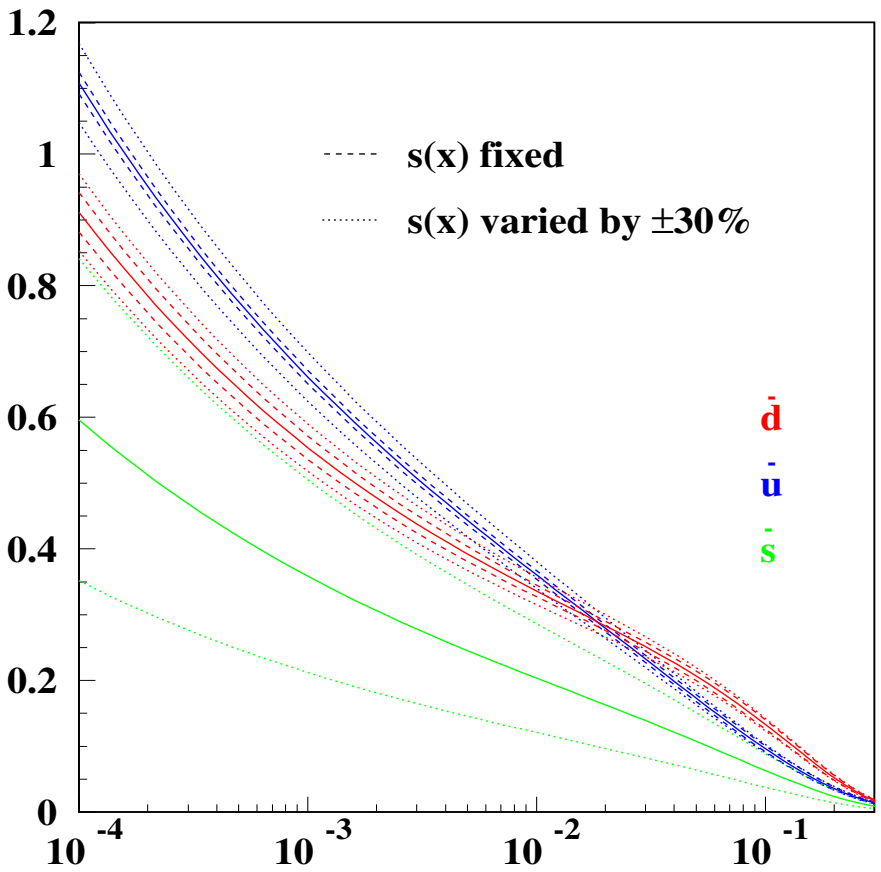


The existing collider data on the charge lepton asymmetry cannot discriminate different parameterizations of $(\overline{d} - \overline{u})$

Strange sea distribution in the global fits



- The sea is not SU(3) symmetric
- The CCFR determination is not consistent with the QCD evolution
- The existing data on s(x) cover the region of $x = 0.01 \div 0.2$ only



The errors in the sea distributions at small x are dominated by the uncertainty in the strange sea

Summary

- At $x \lesssim 0.7$ the iso-symmetric sea can be constraint with the precision better than 20% using the fixed-target DY data; account of the NNLO corrections is crucial for suppressing the QCD scale uncertainty (*very important for the foreseen searches of new physics at LHC*).
- At small x the total non-strange sea is well constrained by the HERA data, but the flavor separation is uncertain: The experimental constraints from the DIS and fixed-target DY data are poor and some controversial, while Fermilab data on the $l^{\pm}$ charge asymmetry are not sensitive to $(\overline{d} - \overline{u})$ at small x.
- The strange sea is not constrained at small x at all and even the Regge-like model-dependent extrapolation look problematic in view of the existing dimuon data.