Λ_{QCD} and $\alpha_s(M_Z^2)$ from DIS Structure Functions

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DESY

- Analysis of DIS Data
- Remarks on Global Analyses

Overview of the Analyses

- Various NLO analyses; $\Rightarrow$ Precision requires NNLO analysis and higher!
- Mixed S- and NS-NNLO analyses $e(\mu)N$ world data
- S- and NS-NNLO moment analyses νN world data
- NS-N^{3}LO analysis $e(\mu)N$ world data
- NLO analyses polarized $e(\mu)N$ world data
- Lattice measurements
- (more) Global Analyses: DIS, jet ep and jet collider data

$\alpha_s(M_Z^2)$

NLO	$\alpha_s(M_Z^2)$	expt	theory	Ref.
CTEQ6	0.1165	± 0.0065		[1]
MRST03	0.1165	± 0.0020	± 0.0030	[2]
A02	0.1171	± 0.0015	± 0.0033	[3]
ZEUS	0.1166	± 0.0049		[4]
H1	0.1150	± 0.0017	± 0.0050	[5]
BCDMS	0.110	± 0.006		[6]
GRS	0.112			[10]
BBG	0.1148	± 0.0019		[9]
BB (pol)	0.113	± 0.004	$^{+0.009}_{-0.006}$	[7]

NLO

	$\alpha_s(M_Z^2)$	expt	theory	model	Ref.
NNLO					
MRST03	0.1153	± 0.0020	± 0.0030		[2]
A02m	0.1141	± 0.0014	± 0.0009		[3]
SY01(ep)	0.1166	± 0.0013			[8]
SY01(νN)	0.1153	± 0.0063			[8]
GRS	0.111				[10]
A06	0.1128	± 0.0015			[11]
BBG	0.1134	$+0.0019/-0.0021$			
N3LO					
BBG	**0.1142**	$\pm$ **0.0021**			

NNLO and N^3LO

BBG: $N_f = 4$: non-singlet data-analysis at $O(\alpha_s^4)$: $\Lambda = 234 \pm 26$ MeV

$\alpha_s(M_Z^2) =: 0.1148(\mathrm{NLO}) \rightarrow 0.1134(\mathrm{NNLO}) \rightarrow 0.1142 \pm 0.0021(\mathrm{NNNLO})$

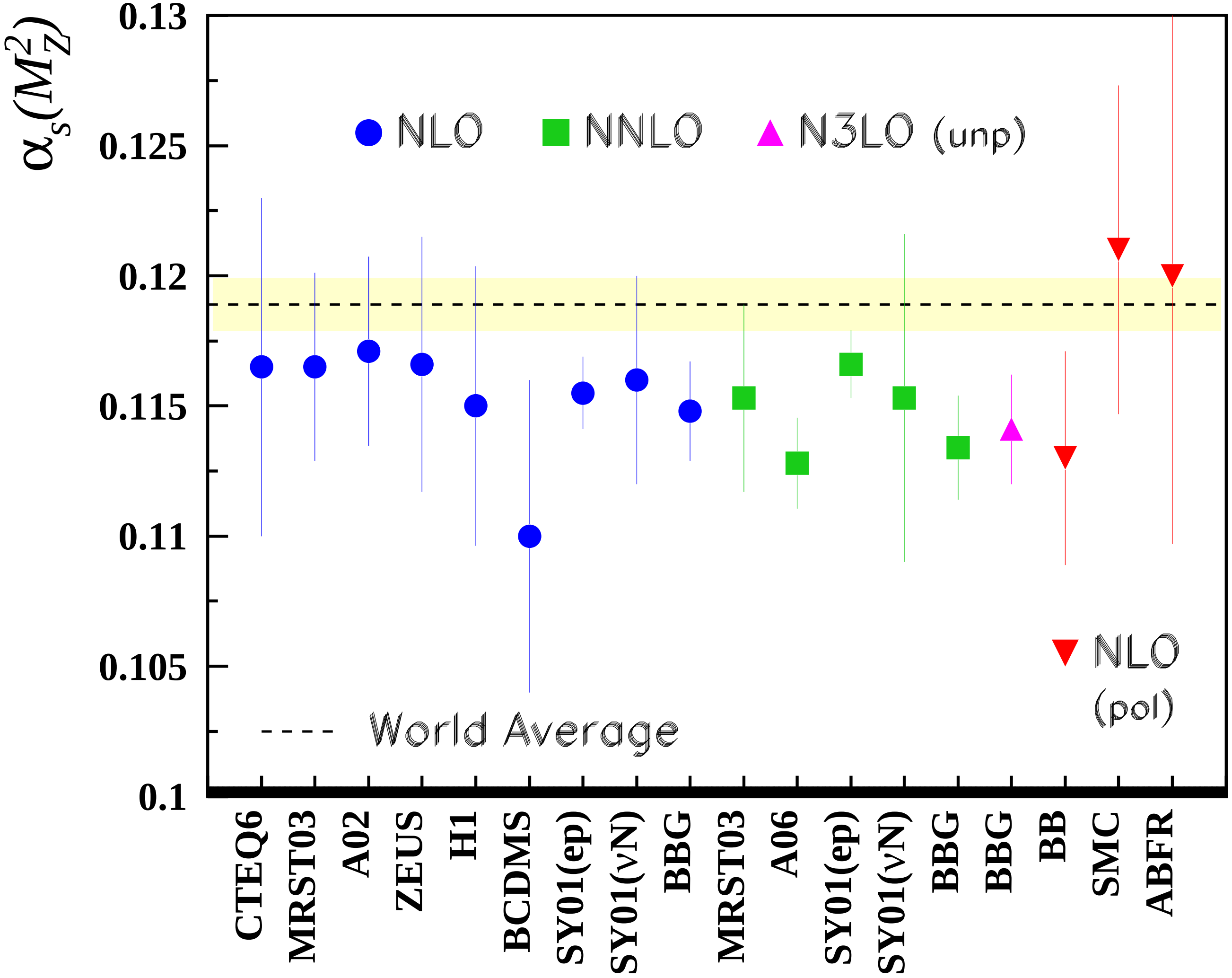
Lattice results :

Alpha Collab: $N_f = 2$ Lattice; non-pert. renormalization $\Lambda = 245 \pm 16 \pm 16$ MeV

QCDSF Collab: $N_f = 2$ Lattice, pert. reno. $\Lambda = 261 \pm 17 \pm 26$ MeV

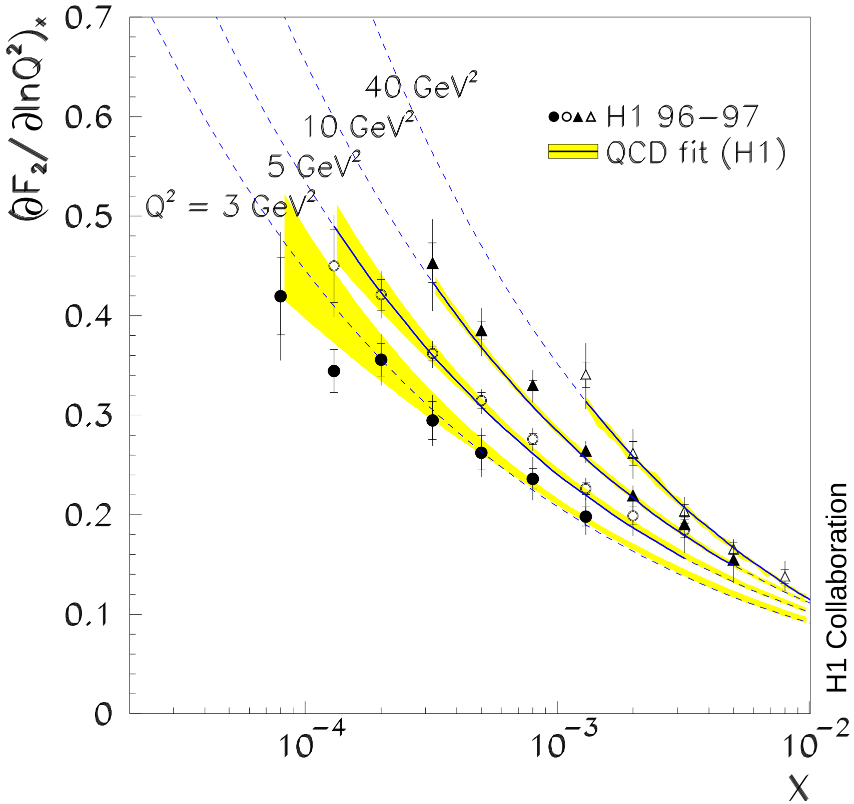
Lepage et al.: Larger Value, no NON-PERTURBATIVE renormalization.

$\alpha_s(M_Z^2)$

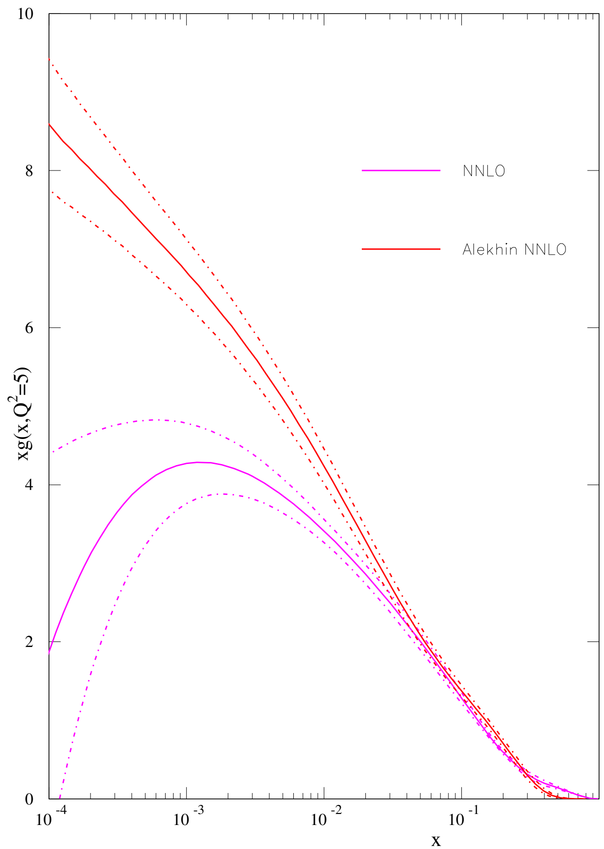


J.B., H. Böttcher, A. Guffanti, 2006

Slope of F_2 at low x



H1



MRST vs Alekhin: $Q^2 = 5\,\mathrm{GeV}^2$

Very likely, that the $\overline{\mathrm{MS}}$–gluon remains positive and rises!

$\alpha_s(Q^2)$ & $xG(x, Q^2)$ are directly correlated.

More Global Analyses

- $\alpha_s(M_Z^2)$ for different data sets included are too different !

$\Rightarrow$ applies also to HERA: IS vs FS; and also DIS vs TEVATRON-jet

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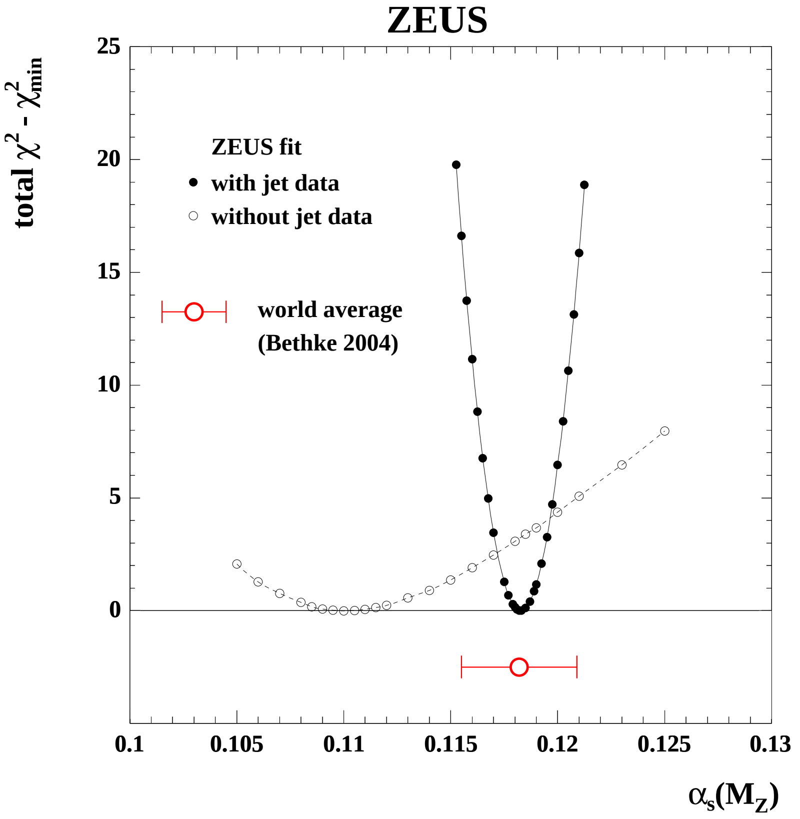

M. Cooper-Sarkar, 2005

More Global Analyses

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- CTEQ : Concentrate on PDF's and do not perform α_s measurement.

- MRST : since $\sim$ 2004: large value of $\alpha_s(M_Z^2) = 0.1153 \Longrightarrow 0.1206$.
- somewhat larger than in: $e^+e^- \rightarrow$ hadrons: $\alpha_s(M_Z^2) = 0.1188 \pm 0.0027$

Likely being caused by the Jet data included.

- ZEUS DIS + FS analysis:

$$\alpha_s(M_Z^2) = 0.1183 \pm 0.0007(st) \pm 0.0027(sy) \pm 0.0008(mo) \pm 0.0050(th)$$

- (more) Global Analyses:
  - Do we know the corrections for the jet data well enough ?
  - What causes the difference in $\alpha_s(M_Z^2)$:
    DIS vs inclusion of jet data ?