News from NNPDF

The strange content of the proton & Towards a global NNPDF analysis

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Work in collaboration

NNPDF collaboration

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Outline

1. Motivation
2. NNPDF1.2
   - Data and theoretical input
   - The proton strangeness content
   - Determination of EW parameters
3. NNPDF2.0
   - Experimental data and theory tools
   - Preliminary results
4. Conclusions

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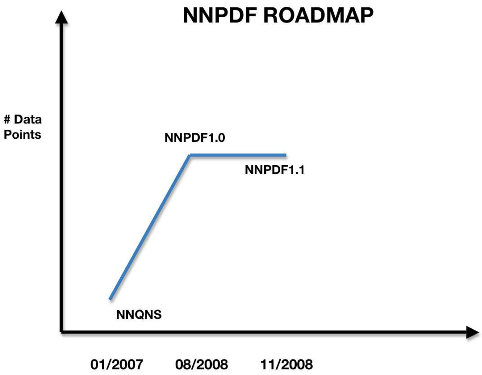
NNPDF Roadmap



1. NNQNS (JHEP 0703:039,2007) → First determination of a single PDF, $xq_{NS}(x, Q^2)$

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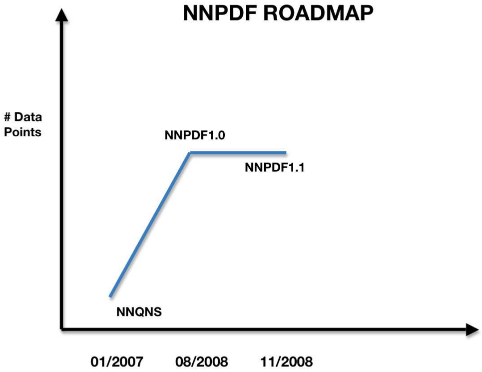

1. NNQNS (JHEP 0703:039,2007)
2. NNPDF1.0 (Nucl.Phys.B809:1,2009) $\longrightarrow$ First NNPDF parton set from inclusive DIS data and 5 PDFs

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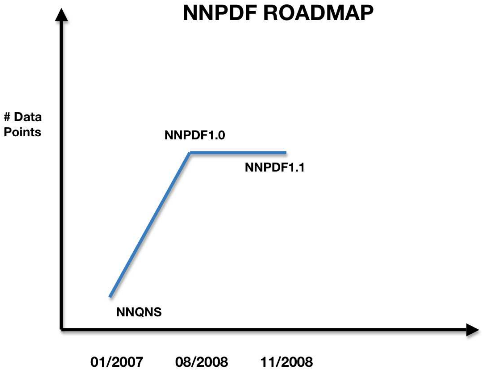
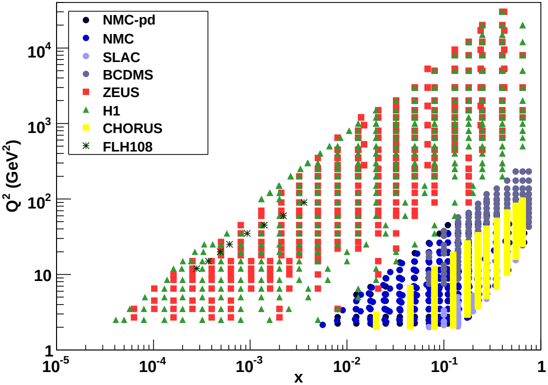


1. NNQNS (JHEP 0703:039,2007)
2. NNPDF1.0 (Nucl.Phys.B809:1,2009)
3. NNPDF1.1 (arXiv:0811.2288) → Free strange PDFs, randomized preprocessing

NNPDF1.0: First NNPDF parton set



OBS	Data set	OBS	Data set
F_2^p	NMC	σ^{-}_{NC}	ZEUS
	SLAC		H1
	BCDMS	σ^{+}_{CC}	ZEUS
F_2^d	SLAC		H1
	BCDMS	σ^{-}_{CC}	ZEUS
σ^{+}_{NC}	ZEUS		H1
	H1	$\sigma_{\nu}, \sigma_{\bar{\nu}}$	CHORUS
F_2^d / F_2^p	NMC-pd	F_L	H1

- Kinematical cuts:
  $Q^2 > 2$ GeV^2
  $W^2 = Q^2(1-x)/x > 12.5$ GeV^2
- $\sim$ **3000** points.

NNPDF1.0: First NNPDF parton set

Parametrization of 5 combinations of PDFs at $Q_0^2 = 2\ \mathrm{GeV}^2$

Singlet : $\Sigma(x)$	$\longmapsto \mathrm{NN}_{\Sigma}(x)$	2-5-3-1	37 pars
Gluon : $g(x)$	$\longmapsto \mathrm{NN}_{g}(x)$	2-5-3-1	37 pars
Total valence : $V(x) \equiv u_V(x) + d_V(x)$	$\longmapsto \mathrm{NN}_{V}(x)$	2-5-3-1	37 pars
Non-singlet triplet : $T_3(x)$	$\longmapsto \mathrm{NN}_{T3}(x)$	2-5-3-1	37 pars
Sea asymmetry : $\Delta_S(x) \equiv \bar{d}(x) - \bar{u}(x)$	$\longmapsto \mathrm{NN}_{\Delta}(x)$	2-5-3-1	37 pars

185 parameters

NNPDF1.1: Statistical consistency

- NNPDF1.0 $\to$ Symmetric strange sea proportional to non strange

$$s(x) = \bar{s}(x) \qquad \bar{s}(x) = \frac{C_S}{2}(\bar{u}(x) + \bar{d}(x))$$

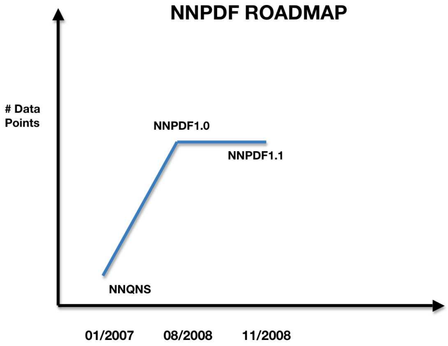
- NNPDF1.1: independent parametrization of the strange PDFs

Total strangeness : $s^+(x) \equiv (s(x) + \bar{s}(x)) \longmapsto \mathrm{NN}_{s^+}(x)$ 2-5-3-1 37 pars

Strangeness valence : $s^-(x) \equiv (s(x) - \bar{s}(x)) \longmapsto \mathrm{NN}_{s^-}(x)$ 2-5-3-1 37 pars

- Randomization of the preprocessing exponents.
- Very large uncertainties for strange PDFs.
- Non-strange PDFs statistically identical to NNPDF1.0 (see later)

News in the NNPDF Roadmap



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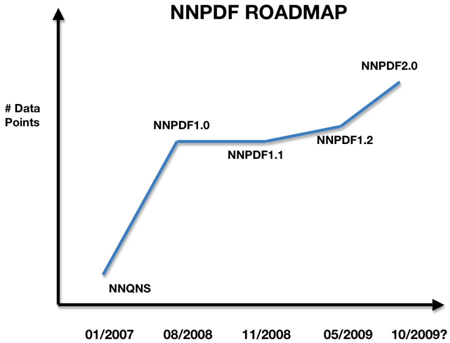

1. Previous work: NNQNS, NNPDF1.0, NNPDF1.1
2. This talk: NNPDF1.2 → Precision determination of strange PDFs and EW parameters
   NNPDF2.0 → First NNPDF global parton analysis

Motivations for recent NNPDF work

1. NNPDF1.2
   - The strange PDFs are the worse known light quark PDFs (NNPDF1.1)$\to$ Effects of parametrization bias could be dominant
   - The strange sea asymmetry $[S^-]$ plays a prominent role in explaining the NuTeV anomaly. Available PDF parametrizations very restrictive.
   - Common lore (PDG) $\to$ Uncertainties in $[S^+]$ prevent accurate $|V_{cs}|$ determination from dimuon data
     $\to$ Revisit within the NNPDF approach
2. NNPDF2.0
   - Constrain PDFs that have large uncertainties from DIS data only $\to$ … $\to$ Mandatory for precision LHC phenomenology
   - Show that the NNPDF approach gives … in the presence of a large number of different experiments (some of them possibly inconsistent)

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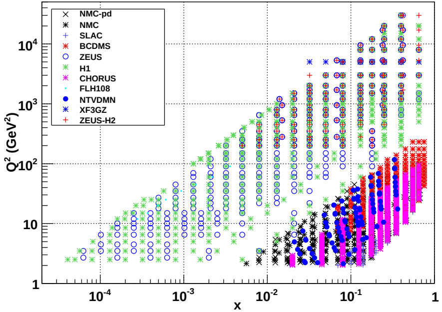
Outline

Experimental data

- Direct determination of both s and $\bar{s}$ allowed by recent NuTeV data, via

$$\frac{1}{E_\nu}\frac{d^2\sigma^{\nu(\bar{\nu}),2\mu}}{dx\,dy}(x,y,Q^2) \equiv \frac{1}{E_\nu}\frac{d^2\sigma^{\nu(\bar{\nu}),c}}{dx\,dy}(x,y,Q^2)\cdot\langle \mathrm{Br}\,(D\to\mu)\rangle\cdot\mathcal{A}\,(x,y,E_\nu)\ ,$$



$$\tilde{\sigma}^{\nu(\bar{\nu}),c} \propto (F_2^{\nu(\bar{\nu}),c}, F_3^{\nu(\bar{\nu}),c}, F_L^{\nu(\bar{\nu}),c})$$

$$F_2^{\nu,c} = x\left[C_{2,q}\otimes\left(|V_{\rm cd}|^2(u+d)+2|V_{\rm cs}|^2 s\right)+C_{2,g}\otimes g\right]$$

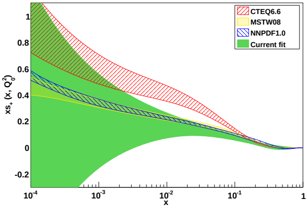
$$F_2^{\bar{\nu},c} = x\left[C_{2,q}\otimes\left(|V_{\rm cd}|^2(\bar{u}+\bar{d})+2|V_{\rm cs}|^2 \bar{s}\right)+C_{2,g}\otimes g\right]$$

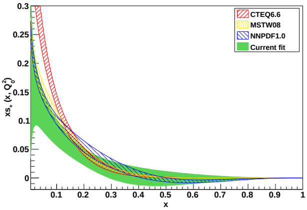
Additional data in NNPDF1.2:

* Neutrino and anti-neutrino dimuon production from NuTeV.
* HERA-II ZEUS data on NC and CC reduced xsec at large-Q^2.
* HERA-II ZEUS data on $xF_3^{\gamma Z}$.

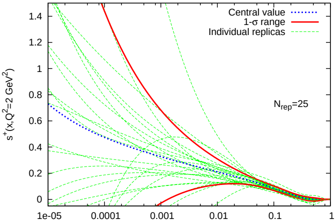
Strange sea PDF: $s^+(x, Q^2)$

Total strangeness: log scale ↓, individual reps ↘ Total strangeness: lin scale ↓





- Data region → Moderate uncertainties, larger than CTEQ6.6/MSTW08
- Extrapolation region → Blow-up of uncertainties due to lack of experimental constraints



Strange sea fraction

Strange sea fraction characterized by $K_S(Q^2)$

$$K_S(Q^2) \equiv \frac{\int_0^1 dx\, x\, s^+(x, Q^2)}{\int_0^1 dx\, x\left(\bar{u}(x, Q^2) + \bar{d}(x, Q^2)\right)} .$$

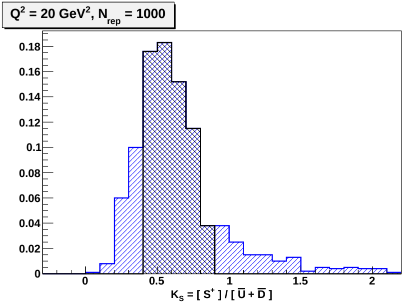
Highly asymmetric distribution $\longrightarrow$ Requires proper treatment of non-gaussian effects
No theoretical prejudice on shape of s^+, unlike other analysis (*Ex.* MSTW08)

$$xS_{\rm mstw08} = x\left(2\left(\bar{u}+\bar{s}\right)+s^+\right) = A_S x^{\delta_S}(1-x)^{\eta_S}\left(1+\epsilon_S\sqrt{s}+\gamma_S x\right)$$

$$xs^+_{\rm mstw08} = A_+ x^{\delta_S}(1-x)^{\eta_+}\left(1+\epsilon_S\sqrt{s}+\gamma_S x\right)$$

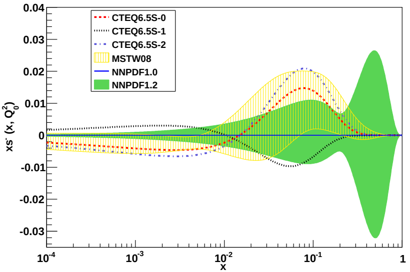
Analysis	$K_S\left(Q^2 = 20\,\mathrm{GeV}^2\right)$
NNPDF1.2	$0.71^{+0.20}_{-0.31}$
MSTW08	0.56 ± 0.03
CTEQ6.6	0.72 ± 0.05
AKP08	0.59 ± 0.08

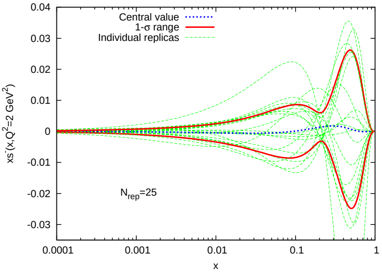
Central value for K_S in perfect agreement with CTEQ6.6, uncertainties larger by factor 4



Strange asymmetry PDF: $s^-(x, Q^2)$

Strange asymm: log scale ↓, individual reps ↘



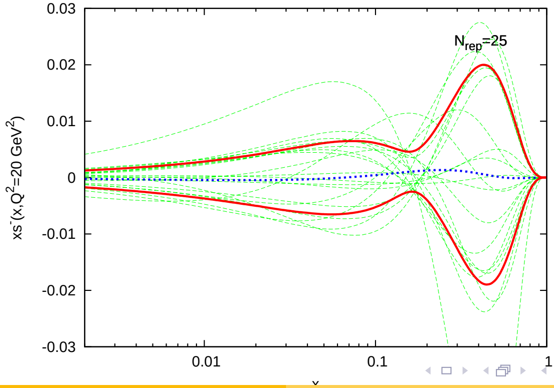


Analysis	$\left[S^-\right]\left(Q^2 = 20\,\mathrm{GeV}^2\right)\cdot 10^3$
NNPDF1.2	0 ± 9
MSTW08	1.4 ± 1.2
CTEQ6.5s	1.2 ± 1.1
AKP08	1.0 ± 1.3
NuTeV07	1.3 ± 0.8

Strange asymmetry PDF: $s^{-}(x, Q^2)$

- No theoretical constraints on $s^{-}(x, Q_0^2)$ apart from valence sum rule
- At least one crossing required by sum rule, but some replicas have two crossings
- Compare with more restrictive parametrizations

$$xs^{-}_{\rm mstw} = A_{-}x^{0.2}(1-x)^{\eta_{-}}(1-x/x_0)$$



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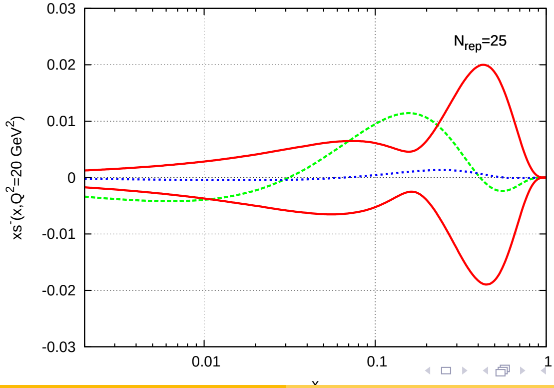
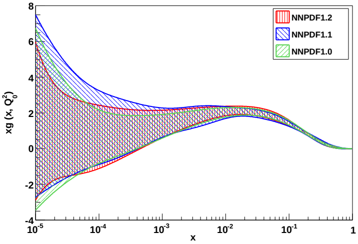


Comparison with NNPDF1.0

Addition of 74 new PDF parameters for strange sector leaves non-strange PDFs unaltered



NNPDF1.2 vs. NNPDF1.0

	Data	Extrapolation
$\Sigma(x, Q_0^2)$	$5\ 10^{-4} \leq x \leq 0.1$	$10^{-5} \leq x \leq 10^{-4}$
$\langle d[q] \rangle$	3.2	1.9
$\langle d[\sigma] \rangle$	2.9	3.3
$g(x, Q_0^2)$	$5\ 10^{-4} \leq x \leq 0.1$	$10^{-5} \leq x \leq 10^{-4}$
$\langle d[q] \rangle$	1.7	0.9
$\langle d[\sigma] \rangle$	1.6	1.3
$T_3(x, Q_0^2)$	$0.05 \leq x \leq 0.75$	$10^{-3} \leq x \leq 10^{-2}$
$\langle d[q] \rangle$	1.1	1.0
$\langle d[\sigma] \rangle$	2.0	3.2
$V(x, Q_0^2)$	$0.1 \leq x \leq 0.6$	$3\ 10^{-3} \leq x \leq 3\ 10^{-2}$
$\langle d[q] \rangle$	2.6	2.4
$\langle d[\sigma] \rangle$	5.3	4.9
$\Delta_S(x, Q_0^2)$	$0.1 \leq x \leq 0.6$	$3\ 10^{-3} \leq x \leq 3\ 10^{-2}$
$\langle d[q] \rangle$	1.4	0.9
$\langle d[\sigma] \rangle$	1.5	1.2

The valence PDF uncertainties were somewhat underestimated in NNPDF1.0 → As was shown by the preprocessing analysis in (Nucl.Phys.B809:1,2009)!

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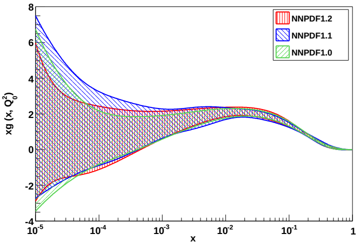

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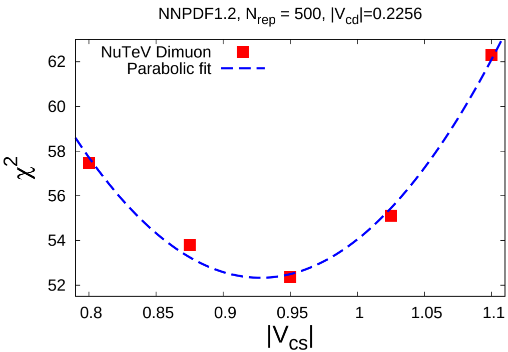
$|V_{cs}|$ determination ($|V_{cd}|$ fixed)



CKM global fit

$V_{cs} = 0.97334 \pm 0.00023, \; \Delta V_{cs} \sim 0.02\%$

Direct determination-D and B decays

$V_{cs} = 1.04 \pm 0.06, \qquad \Delta V_{cs} \sim 6\%$

Direct det from $\nu-$DIS (CCFR)

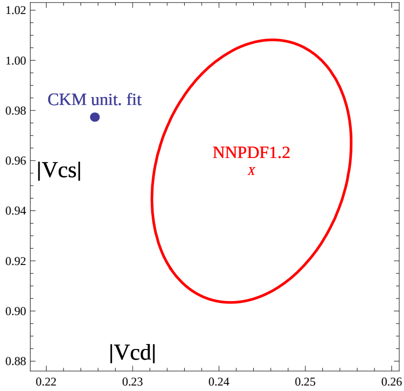
$V_{cs} \geq 0.74 \quad (90\%\mathrm{CL})$

[PDG, Amsler et al, Phys. Lett. B67(2008) 1.]

- Our result: $|V_{cs}| = 0.93 \pm 0.06^{\rm PDFs} \pm 0.05^{\rm theo}$ $\longrightarrow$ Most accurate direct determination from a single analysis to date!
- Faithful PDF uncertainties allow to discriminate uncertainties in $S^{+}(x)$ (large) from uncertainties in CKM elements (small)

Joint determination of $|V_{cd}|$ and $|V_{cs}|$

Scan the $(|V_{cd}|, |V_{cs}|)$ plane for correlations between the CKM elements



Final results for joint determination:

$$|V_{cs}| = 0.96 \pm 0.07^{\rm tot} ,$$
$$|V_{cd}| = 0.244 \pm 0.019^{\rm tot} ,$$
$$\rho\,[V_{cd}, V_{cs}] = 0.21$$

$|V_{cs}|$: Most accurate ever direct determination!!
$|V_{cd}|$: Accuracy similar to other determinations

- Despite much larger strange PDFs uncertainties!
- Perfect agreement with global CKM fits

Impact on NuTeV anomaly

- NuTeV anomaly: Discrepancy ($\geq 3\sigma$) between indirect (global fit) and direct (NuTeV neutrino scattering) determinations of $\sin^2\theta_W$

EW fit

$\sin^2\theta_W = 0.2223 \pm 0.0003$

NuTeV

$\sin^2\theta_W = 0.2277 \pm 0.0017$

$$\sin^2\theta_W\Big|_{\rm NuTeV} - \sin^2\theta_W\Big|_{\rm EWfit} = (5.4 \pm 1.7)\cdot 10^{-3}$$

- NuTeV assumes $[S^-]=0$. Releasing this assumption

$$\delta_s \sin^2\theta_W \sim -0.240\frac{[S^-]}{[Q^-]}$$

$$\mathrm{NNPDF1.2} \longrightarrow \delta_s \sin^2\theta_W = \left(0 \pm 10^{\rm PDFs} \pm 3^{\rm theo}\right)\cdot 10^{-3}$$

- Central value for $[S^-]$ consistent with vanishing strange asymmetry $\rightarrow$ Not enough information from NuTeV dimuons to pin down $[S^-]$
- PDF uncertainties more than enough to completely remove the NuTeV anomaly

NNPDF1.2: Lessons learned (I)

The NNPDF approach is not affected by flat directions ....

1. **So even if some PDFs are very poorly constrained by data, we can add a very large number of parameters and the results are identical in the statistical sense ...**
2. **... and we can have exactly the same PDF parametrization regardless of the precise data set → Faithful estimation of PDF errors in both data and extrapolation regions**

Because of the Monte Carlo sampling on the space of experimental data!
(For details on the Monte Carlo in the NNPDF approach → Stefano's talk)
This is rather different from the standard approach, where

1. PDF parametrizations need to be adjusted to available data → To avoid convergence issues both in the fit and in error propagation
2. Unconstrained PDFs are specially affected by parametrization bias

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NNPDF1.2: Lessons learned (I)

The NNPDF approach is not affected by flat directions ....

1. **So even if some PDFs are very poorly constrained by data, we can add a very large number of parameters and the results are identical in the statistical sense ...**
2. **... and we can have exactly the same PDF parametrization regardless of the precise data set → Faithful estimation of PDF errors in both data and extrapolation regions**

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The NNPDF approach does provide faithful estimation of PDF uncertainties ....

1. **So when some PDF errors are large, the NNPDF approach reproduces them → The NuTeV anomaly ...**
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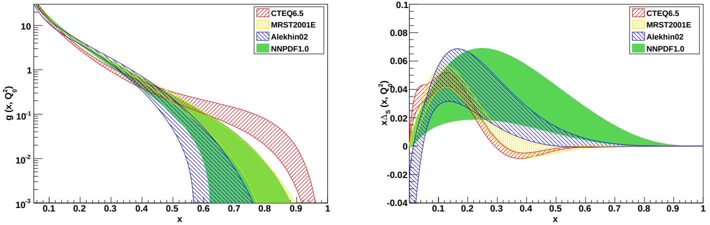
Outline

Towards a global neural fit: NNPDF2.0

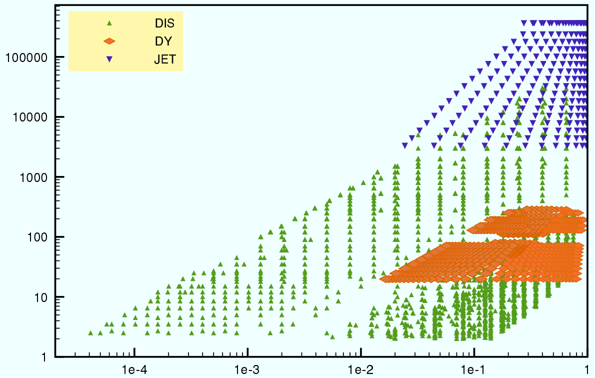
- Inclusion of hadronic data is necessary to constrain large-x gluon, sea quarks decomposition, u/d ratio at large x



- Upcoming NNPDF2.0 will be the first neural global fit including all relevant hadronic data

NNPDF2.0: Experimental data

New data: fixed-target Drell-Yan data, Tevatron electroweak gauge boson production, Run II inclusive jet data.



OBS	Data set
$d\sigma^{\rm DY}/dM^2dy$	E605
$d\sigma^{\rm DY}/dM^2dx_F$	E772
$d\sigma^{\rm DY}/dM^2dx_F$	E886
W asym.	D0/CDF
Z rap. distr.	D0/CDF
incl. $\sigma^{\rm jet}$	CDF(k_T)
incl. $\sigma^{\rm jet}$	D0(cone)

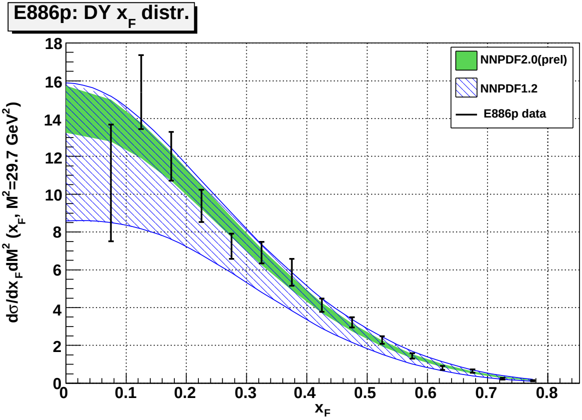
$800_{\rm DY} + 200_{\rm JET} = \mathcal{O}(1000)$ new data.

NNPDF2.0: FastNLO-like evolution

- The NLO computation of hadronic observables is too slow for parton global fits.
- Many parton fits rely on K-factor approximation, relatively fast.
- K-factors depends on PDFs, its use might be delicate to precision PDF analysis

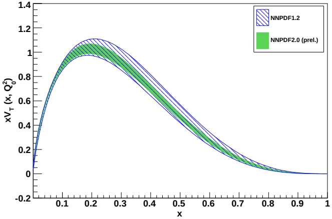
* NNPDF2.0 includes full NLO calculation of hadronic observables.
* Use available fastNLO interface for jet inclusive cross-sections [hep-ph/0609285]
* Built up our own **fastNLO-like evolution for Drell-Yan** observables, not available in literature.
* Fast code easy to benchmark versus other slow codes.

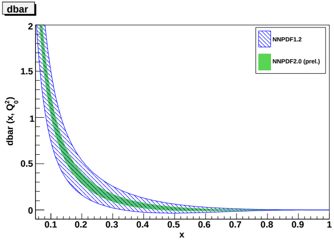
NNPDF2.0: Predictions on Observables (Preliminary!)



- Predictions evaluated with NNPDF1.2 and NNPDF2.0 (prel) error sets.
- NNPDF1.2: Large error bands on predictions, compatible with data
- NNPDF2.0: Smaller error bands, data are well described

NNPDF2.0: Parton Distributions (Preliminary!)





- Error on $V(x)$ and $\bar{d}(x)$ reduced due to inclusion of hadronic data (Drell-Yan).
- NNPDF2.0 statistically consistent with NNPDF1.2 PDFs
- No modifications of the NNPDF approach required for the global PDF analysis

NNPDF2.0: Lessons learned

The NNPDF approach can efficiently combined information from a large number of different experiments:

1. **Without any modifications of the parametrizations of the input PDFs**
2. **Without any modification of the statistical treatment to determine uncertainties**

This is rather different from the standard approach, where both PDF functional forms and statistical treatment are fine tuned to the available data set

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- NNPDF1.2
  1. Unbiased determination of strange PDFs from NuTeV data without theoretical prejudices
  2. World's most precise direct determination of the $|V_{cs}|$ CKM matrix element
  3. Uncertainties in $[S^-]$ large enough to completely cancel the NuTeV anomaly
- NNPDF2.0
  1. Global NNPDF analysis from DIS, Jet, Drell-Yan and vector boson production data
  2. FastDY: precise implementation of DY production in global PDF analysis
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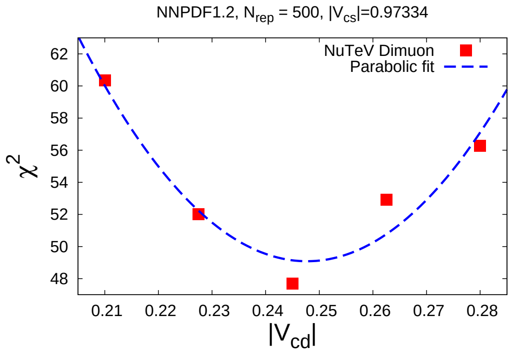
EXTRA MATERIAL

$|V_{cd}|$ determination ($|V_{cs}|$ fixed)



CKM global fit

$$V_{cd} = 0.2256 \pm 0.0010, \ \Delta V_{cd} \sim 0.5\%$$

Direct det - $\nu-$DIS (CDHS)

$$V_{cs} = 0.24 \pm 0.03 \ , \qquad \Delta V_{cd} \sim 12\%$$

Direct det - PDG average

$$V_{cd} = 0.230 \pm 0.011 \ , \qquad \Delta V_{cd} \sim 5\%$$

[PDG, Amsler et al, Phys. Lett. B67(2008) 1.]

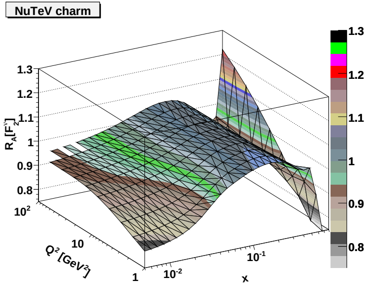
- Our result: $|V_{cd}| = 0.248 \pm 0.012^{\rm PDFs} \pm 0.014^{\rm theo}$ $\rightarrow$ Confirms accuracy of previous determination (despite much larger PDF uncertainties)

Theoretical input

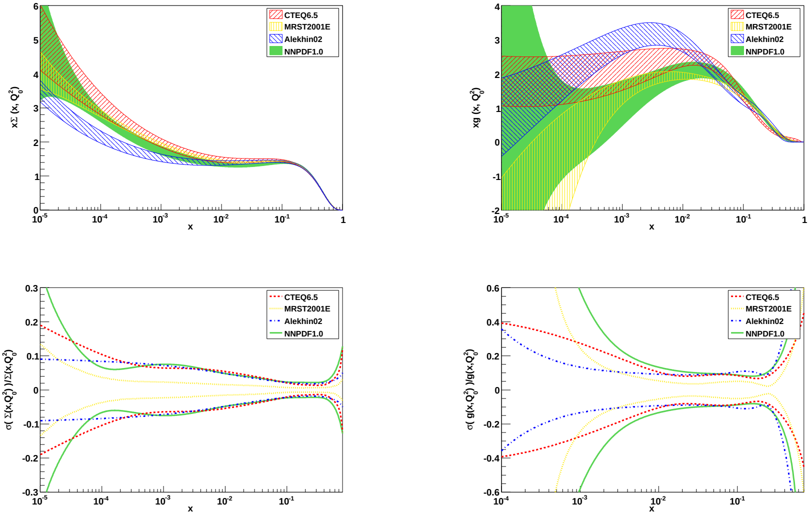
- Only theoretical constraint on strange PDFs → valence sum rule

$$\int_0^1 dx s^-(x, Q^2) = 0$$

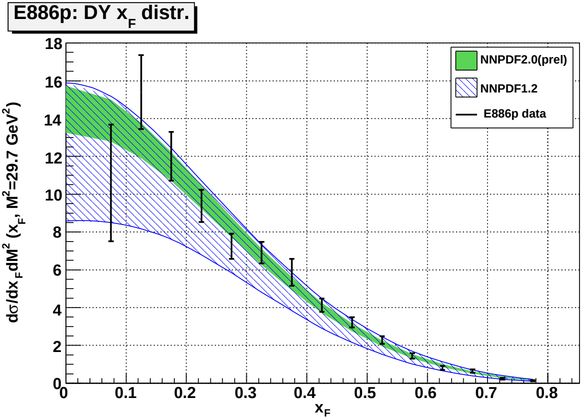
- Charm mass effects for NuTeV dimuon production treated in the Improved ZM-VFN scheme [Thorne, Tung, ArXiv:0809.0714],[Nadolsky, Tung, ArXiv:0903.2667].
- Neutrino data (NuTeV and CHORUS) corrected by (small) nuclear effects from various models [Hirai, Kumano, Nagai - de Florain, Sassot]



NNPDF1.0: First NNPDF parton set



NNPDF2.0: Predictions on Observables (Preliminary!)



- Predictions evaluated with NNPDF1.2 and NNPDF2.0 (prel) error sets.
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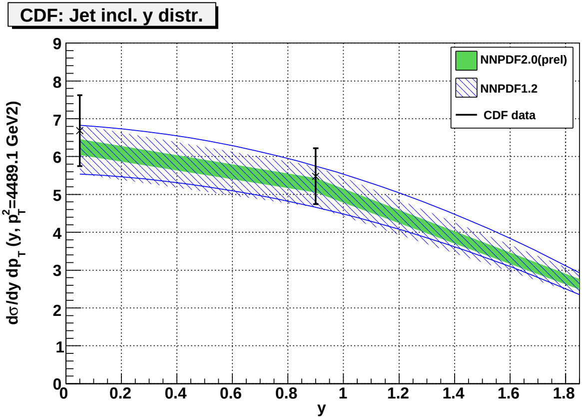

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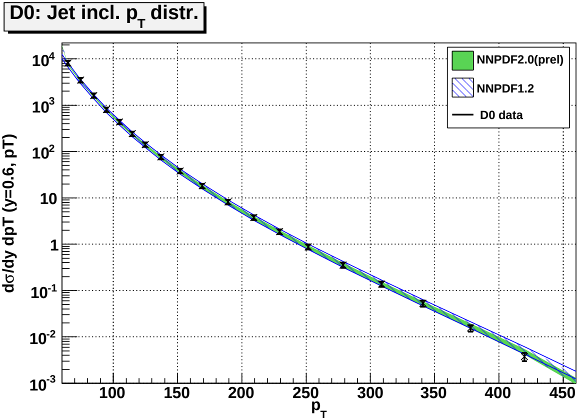

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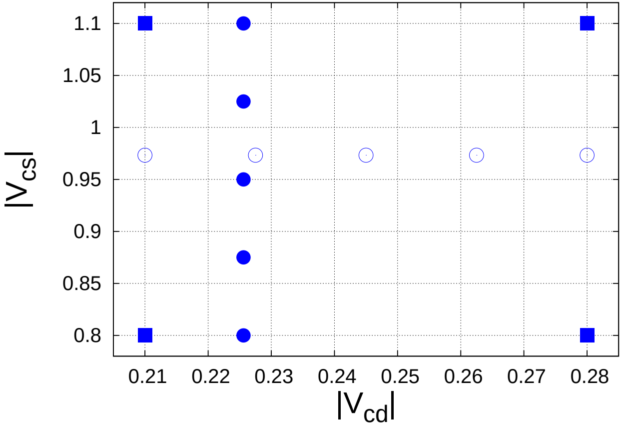
Joint determination of $|V_{cd}|$ and $|V_{cs}|$

Scan the $(|V_{cd}|, |V_{cs}|)$ for correlations between the CKM elements



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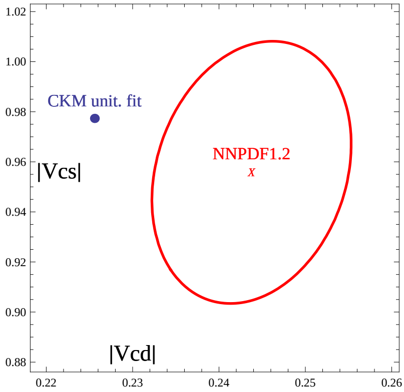
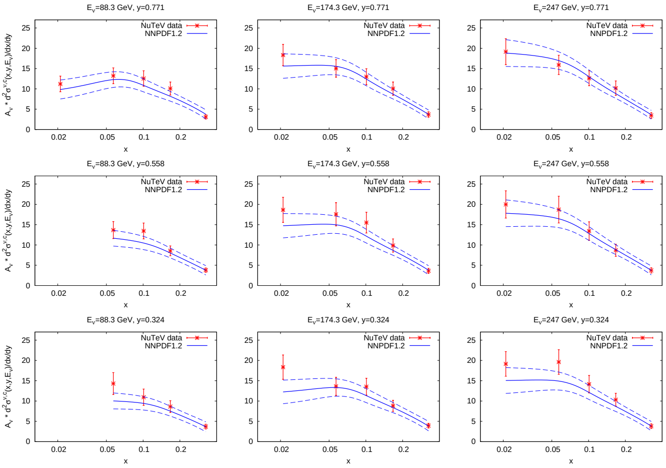


Final results for joint determination:

$$\begin{aligned} |V_{cs}| &= 0.96 \pm 0.07^{\mathrm{tot}} , \\ |V_{cd}| &= 0.244 \pm 0.019^{\mathrm{tot}} , \\ \rho\left[V_{cd}, V_{cs}\right] &= 0.21 \end{aligned}$$

Comparision with data

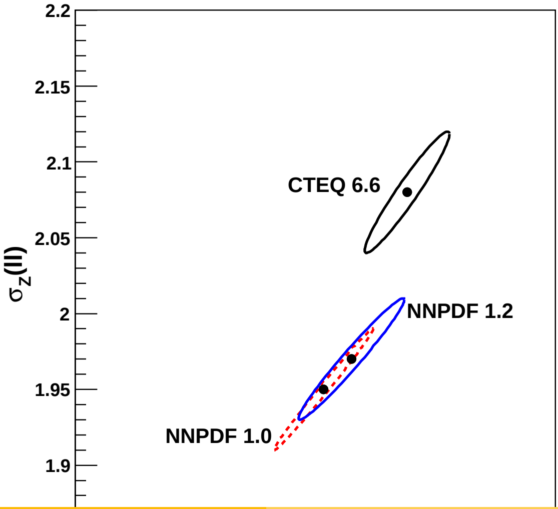
No neural net error reduction $\longrightarrow$ NuTeV data provides unique constraints!



LHC phenomenology

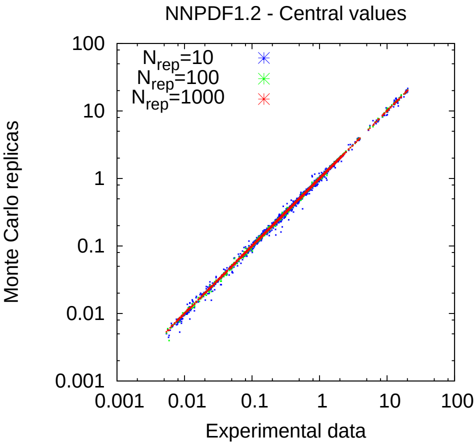
		$\sigma(W^+)\mathrm{Br}\left(W^+ \to l^+\nu_l\right)$	$\sigma(W^-)\mathrm{Br}\left(W^- \to l^+\nu_l\right)$	$\sigma(Z^0)\mathrm{Br}\left(Z^0 \to l^+l^-\right)$
NNPDF 1.0	10 TeV	8.49 ± 0.18	5.81 ± 0.13	1.36 ± 0.02
	14 TeV	11.83 ± 0.26	8.41 ± 0.20	1.95 ± 0.04
NNPDF 1.1	10 TeV	8.52 ± 0.33	5.79 ± 0.28	1.36 ± 0.04
	14 TeV	11.85 ± 0.35	8.41 ± 0.46	1.95 ± 0.05
NNPDF 1.2	10 TeV	8.61 ± 0.25	5.85 ± 0.15	1.37 ± 0.03
	14 TeV	11.99 ± 0.34	8.47 ± 0.34	1.97 ± 0.04

W/Z ratio



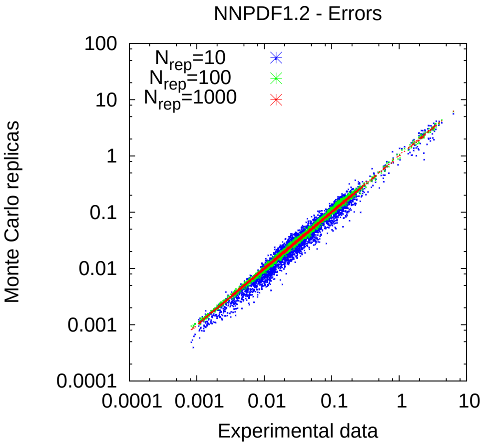
The Monte Carlo method for PDF uncertainties

Scatter plot of Data vs. MC replicas for central values ...



The Monte Carlo method for PDF uncertainties

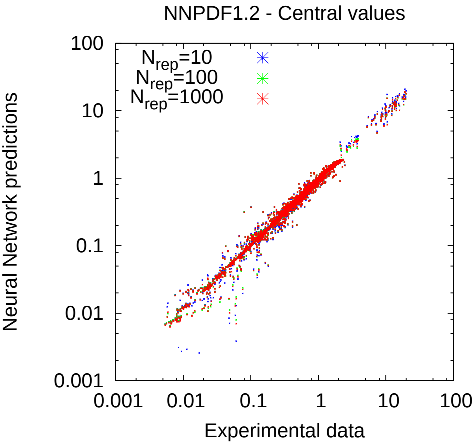
Scatter plot of Data vs. MC replicas for total uncertainties



With the MonteCarlo method in **experimental data** space, with $N_{\rm rep}$ central values and errors reproduced

The Monte Carlo method for PDF uncertainties

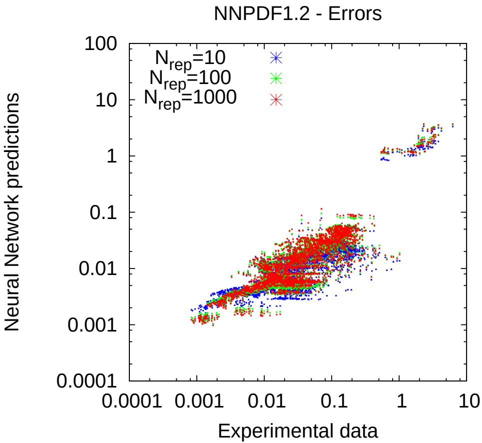
Scatter plot of Data vs. Nets for central values ...



Neural nets follows physical law but not statistical fluctuations

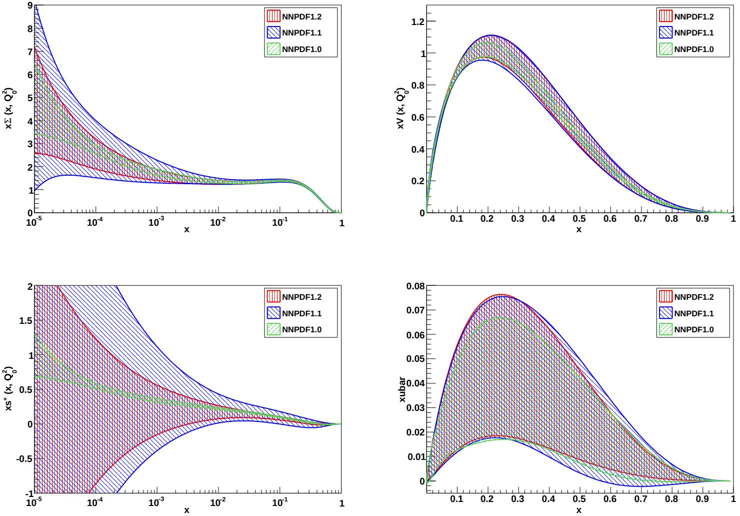
The Monte Carlo method for PDF uncertainties

Scatter plot of Data vs. Nets for total uncertainties



Error reduction from physical law learning

NNPDF1.2 vs. NNPDF1.1 and NNPDF2.0



NNPDF1.2: Normalization and Sum Rules

$$
\begin{aligned}
\Sigma(x,Q_0^2) &= (1-x)^{m_\Sigma} x^{-n_\Sigma} \mathrm{NN}_\Sigma(x) \ , \\
V(x,Q_0^2) &= A_V (1-x)^{m_V} x^{-n_V} \mathrm{NN}_V(x) \ , \\
T_3(x,Q_0^2) &= (1-x)^{m_{T_3}} x^{-n_{T_3}} \mathrm{NN}_{T_3}(x) \ , \\
\Delta_S(x,Q_0^2) &= A_{\Delta_S} (1-x)^{m_{\Delta_S}} x^{-n_{\Delta_S}} \mathrm{NN}_{\Delta_S}(x) \ , \\
g(x,Q_0^2) &= A_g (1-x)^{m_g} x^{-n_g} \mathrm{NN}_g(x) \\
s^+(x,Q_0^2) &= (1-x)^{m_s^+} x^{-n_s^+} NN_{s^+}(x) \\
s^-(x,Q_0^2) &= (1-x)^{m_s^-} x^{-n_s^-} NN_{s^-}(x) - A_{s^-}\left[x^{r_{s^-}}(1-x)^{m_{t^-}}\right]
\end{aligned}
$$

Normalization $\longrightarrow$ Fixed by valence and momentum sum rules

$$
\begin{aligned}
\int_0^1 dx\; x\left(\Sigma(x)+g(x)\right) &= 1 \\
\int_0^1 dx\; \left(u(x)-\bar{u}(x)\right) &= 2 \\
\int_0^1 dx\; \left(d(x)-\bar{d}(x)\right) &= 1 \\
\int_0^1 dx\; \left(s(x)-\bar{s}(x)\right) &= 0
\end{aligned}
$$

NNPDF1.2: Sum Rules

- For instance

$$A_V = \frac{3}{\int_0^1 dx \left((1-x)^{m_V} x^{-n_V} \mathrm{NN}_V(x) \right)}$$

- For the strange sum rule it is slightly different:

$$A_{s^-} = \frac{\Gamma\left(r_{s^-} + t_{s^-} + 2\right)}{\Gamma\left(r_{s^-} + 1\right) \Gamma\left(t_{s^-} + 1\right)} \int_0^1 dx \left((1-x)^{m_{s^-}} x^{-n_{s^-}} \mathrm{NN}_{s^-}(x) \right)$$

- When $A_{s^-} = 0$ the valence sum rule constraint is removed.

Preprocessing exponents

- Polynomial preprocessing functions are introduced in order to speed up the training but should not affect final results.
- Default values for the preprocessing exponents, $\chi^2 = 1.34$.

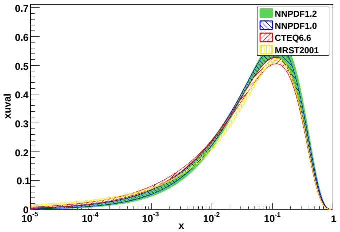
	m	n
Σ	3	1.2
g	4	1.2
T_3	3	0.3
V	3	0.3
Δ_S	3	0.

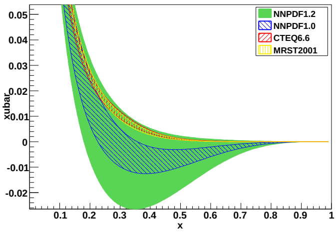
- Stability checks under variation of exponents:

Valence sector		Singlet sector	
	χ^2		χ^2
$n_{T_3} = n_V = 0.1$	1.38	$n_\Sigma = n_g = 0.8$	1.39
$n_{T_3} = n_V = 0.5$	1.34	$n_\Sigma = n_g = 1.6$	1.52
$m_{T_3} = m_V = 2$	1.55	$m_\Sigma = m_g - 1 = 2$	1.37
$m_{T_3} = m_V = 4$	1.28	$m_\Sigma = m_g - 1 = 4$	1.41

NNPDF1.2: Randomized preprocessing

- Remarkable stability: in most cases variations are within 90% C.L.
- Exception given by valence and triplet: deviation $\sim 1.4\sigma$ from central value when varying exponents.
- Uncertainty on V and T_3 underestimated by factor between 1 and 2.
- Note that we have full control on that!
- NNPDF1.2: Randomized preprocessing!





- Bigger uncertainty on $\bar{u}$ and u_v! Will be reduced by DY data.

NNPDF1.2: Strangeness determination

- Individual replicas for strange an anti-strange.
- Bigger uncertainty for $\bar{s}$ due to larger uncertainties of anti-neutrino data.