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LHC began collisions in 2010



Will the world be absorbed by a black hole?

http://www.HasTheLargeHadronColliderDestroyedTheWorldYet.com/

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<script type="text/javascript"> if (!(typeof **worldHasEnded** == "undefined")) document.write("YUP."); } else { document.write("NOPE."); } </script>



The LHC is the ideal tool for a particular class of measurements unprecedented energy allows us to explore new kinematic realm

a need There is room for a broad range experiments

Example: Tevatron & HERA & LEP -- vibrant complementary physics programs

Foundations for "New Physics"

PDFs are certainly one of the foundations that our search for "new physics" is built upon





Global PDF analyses combine Hadron-Hadron w/ other sets



LHC results



W/Z

Production

W/Z PRODUCTION









We saw this last year





Asymmetry

$$A_{\mu} = \frac{d\sigma(W_{\mu^+}) - d\sigma(W_{\mu^-})}{d\sigma(W_{\mu^+}) + d\sigma(W_{\mu^-})}$$







Heidi Schellman DIS2011

April 11, 2011

Results compared to RESBOS+CTEQ6.6M





3 muon PT bins, PT(v) > 20 GeV

Upper Left – PT(μ) > 20 GeV Upper Right 20 GeV < PT(μ) < 35 GeV Lower Left PT(μ) > 35 GeV

DIS2011 April 11, 2011

The puzzle of the CDF/D0 W lepton asymmetry

- CT10W set reasonably agrees with 3 $p_{T\ell}$ bins of $A_e(y_e)$ and one bin of $A_\mu(y_\mu)$ from D0 Run-2 (2008).
- NNPDF 2.0 (arXiv: 1012.0836) agrees with $A_{\mu}(y_{\mu})$, disagrees with two p_{Te} bins of $A_{e}(y_{e})$.
- CT10, many other PDFs fail.

Agreement of		Source or
PQCD with D0 $A_e(y_e)$	χ^2/npt	comments
CTEQ6.6, NLO	191/36=5.5	Our study;
CT10W, NLO	78/36=2.2	Resbos, NNLL-NLO
	With $A_{\mu}(y_{\mu})$: 88/47=1.9	
ABKM'09, NNLO	540/24=22.5	Catani, Ferrera, Grazzini,
MSTW'08, NNLO	205/24=8.6	JHEP 05, 006 (2010)
JR09VF, NNLO	113/24=4.7	

What is happening with d/u

This combination rather unique

$$A_{\ell} = \frac{d\sigma(W^+ \to \ell^+) - d\sigma(W^- \to \ell^-)}{d\sigma(W^+ \to \ell^+) + d\sigma(W^- \to \ell^-)}$$



Determined from DIS and DY on p and d

Uncertainties in determining parton distributions at large x.A.Accardi, W.Melnitchouk, J.F.Owens, M.E.Christy, C.E.Keppel, L.Zhu, J.G.Morfin arXiv:1102.3686 [hep-ph]

LHC values scaled appropriately

 $x_{1,2} \sim \frac{M}{\sqrt{s}} e^{\pm y}$



W/ZProduction at LH()



Heavy Quark components play an increasingly important role at the LHC



Heavy Quark components play an increasingly important role at the LHC





Di-muon production \Rightarrow Extract s(x) Parton Distribution



Nuclear Corrections: Compare Neutrino and Charged Lepton DIS 27





Where we left off last year ...

Could there be a

"compromise" fit

... some recent results by led by Karol Kovarik

Comparison: Charged Lepton and Neutrino DIS

Weight	Name of fit	$l^{\pm}A$ data	$\chi^2 (/\mathrm{pt})$	νA data	$\chi^2 (/\mathrm{pt})$	total χ^2 (/pt)
w = 0	decut3	708 🗸	638(0.90)	- X	-	638~(0.90)
w = 1/7	glofac1a	708 🗸	645 (0.91)	3134 X	4710 (1.50)	$5355\ (1.39)$
w = 1/4	glofac1c	708 🗸	654 (0.92)	3134 X	4501(1.43)	5155(1.34)
w = 1/2	glofac1b	708 🗸	680 (0.96)	3134 X	4405 (1.40)	5085(1.32)
w = 1	global2b	708 X	736(1.04)	3134	4277(1.36)	5014(1.30)
$w = \infty$	nuanua1	- X	_	3134	4192(1.33)	4192(1.33)



How to reconcile with literature???

"Thus, nuclear effects in vA DIS are in line with those extracted from charged lepton DIS and Drell-Yan dilepton production."

> Hannu Paukkunen, DIS10

Paukkunen & Salgado, arXiv:1009.3143

χ^2/DOF	CTEQ6.6	$CTEQ6.6 \times EPS09$
NuTeV	1.51	1.05
CHORUS	1.15	0.79
CDHSW	1.10	0.71

nCTEQ with Uncorrelated Errors

χ^2/DOF	$Q^2 > 4$	$Q^2 > 5$	$Q^2 > 5 + \text{gluon}$
charged lepton	1.16	1.13	1.06
neutrino	1.00	0.95	0.98
Total	1.02	0.99	1.00

Good values of χ^2

Uncorrelated Errors: $\chi^2/DOF \sim 1$



15-Be/C $22 - He/D - Q^2$ $23-Kr/D - Q^2$ $24-Sn/C - Q^2$ $25-N/D - Q^2$ 26-C/D - DY 27-Ca/D - DY 28-Fe/D - DY 29-W/D - DY 30-Fe/Be - DY 31-W/Be - DY $32 - F_2^D$ $33-\nu Pb$ $34-\bar{\nu}Pb$ $35-\nu Fe$ $36-\bar{\nu}\mathrm{Fe}$ 37-CCFR ν 38-NuTeV ν 39-CCFR $\bar{\nu}$ 40-NuTeV $\bar{\nu}$

Strange PDF: Recap

Nuclear Corrections limit our ability to use v-DIS for strange PDF extraction

Strange PDF affects "benchmark" W/Z cross sections

Correlations are Important

Highlights issues with v and ℓ^{\pm} DIS

Issues exist even without correlations How to reconcile v and ℓ^{\pm} DIS

These are LHC Benchmark processes!!!



c & b

Extrinsic & Intrinsic



Effect of an intrinsic charm component!



What is the proper treatment of masses???

2009 Les Houches Comparative Study



The SM and NLO Multileg Working Group: Summary report.J. Rojo, et al.,e-Print: arXiv:1003.1241 [hep-ph]

Comparison of ACOT & TR Schemes



Different schemes \Rightarrow Different PDFs \Rightarrow yet consistent σ

Differences reduce at:

- 1) higher Q,
- 2) higher order

If experiments are sensitive, time to compute to higher order



Search for "new physics" requires dependable foundation



