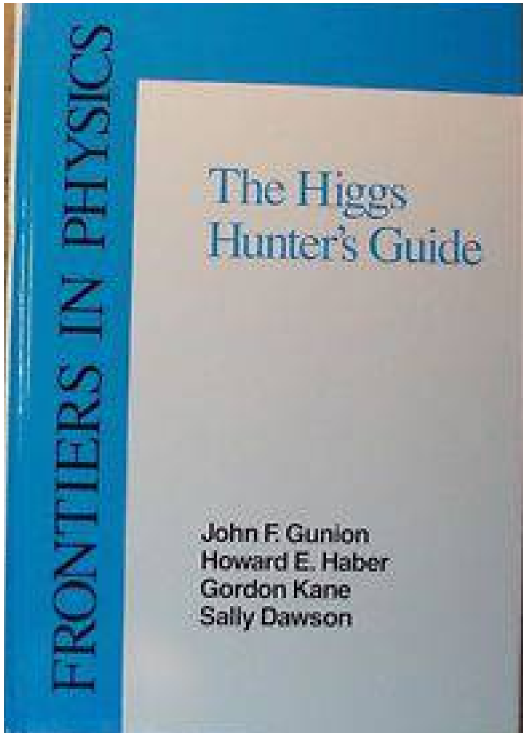
PDFs:

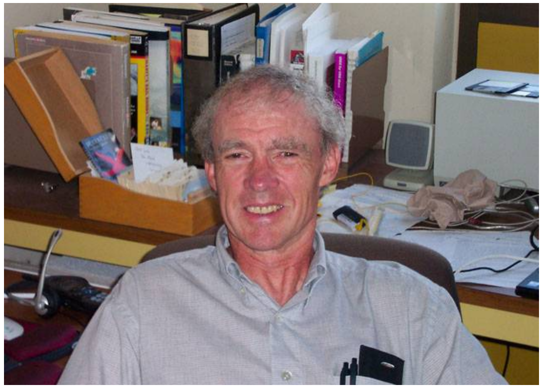
From Effective W's, to LHC, and Beyond



$129.99 on EBay

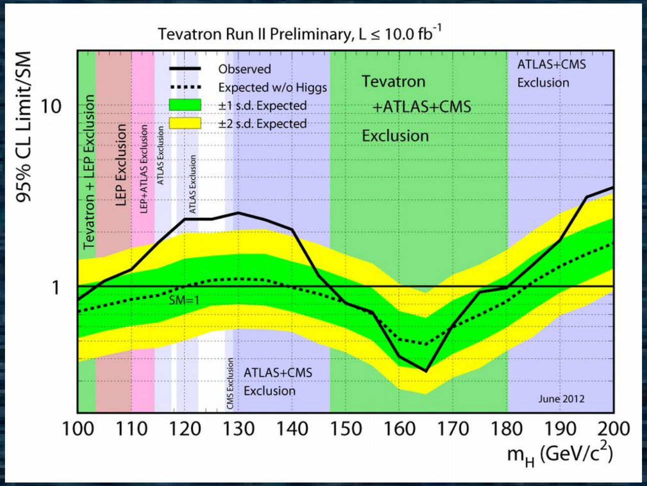
Fred Olness

SMU



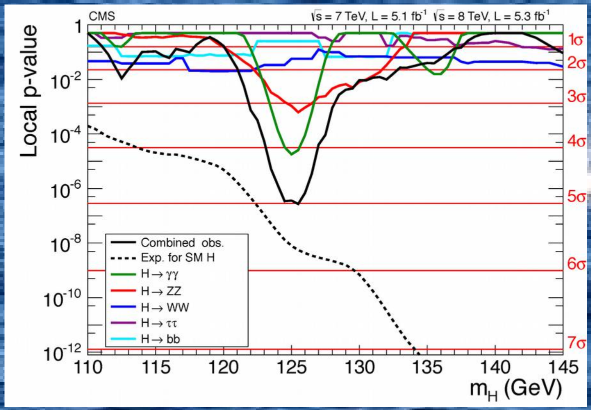
Gunion-Fest
29 March 2014
UC Davis

December, 2011 – have we spied land?



... with thanks to Stephen J. Sekula - SMU

July, 2012 – we spy land



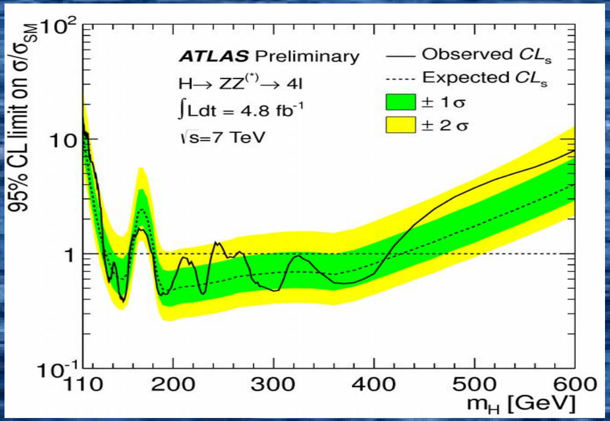


Photo credit: http://justinsomnia.org/

2014 and beyond ...

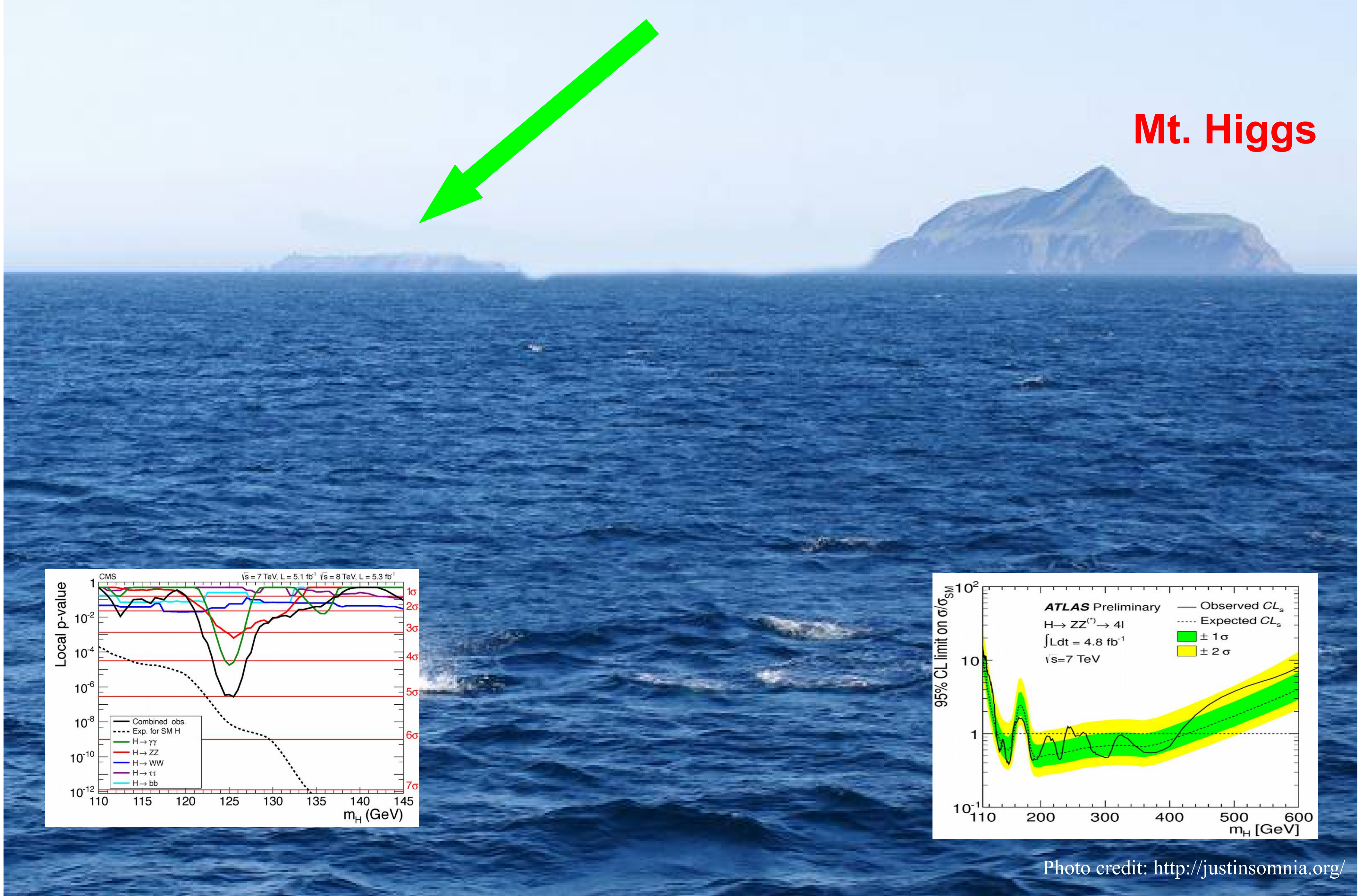


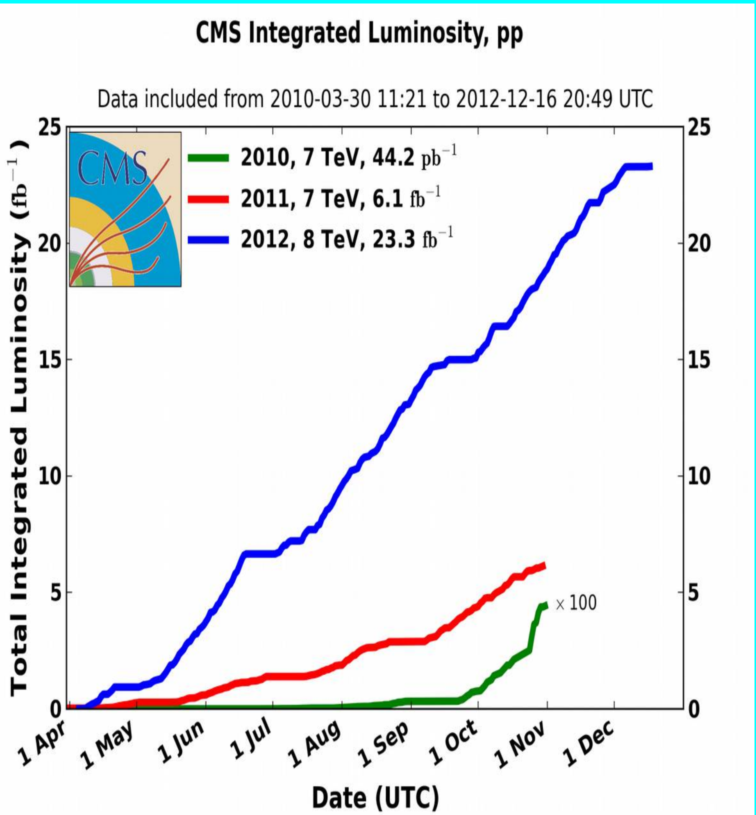
Photo credit: http://justinsomnia.org/

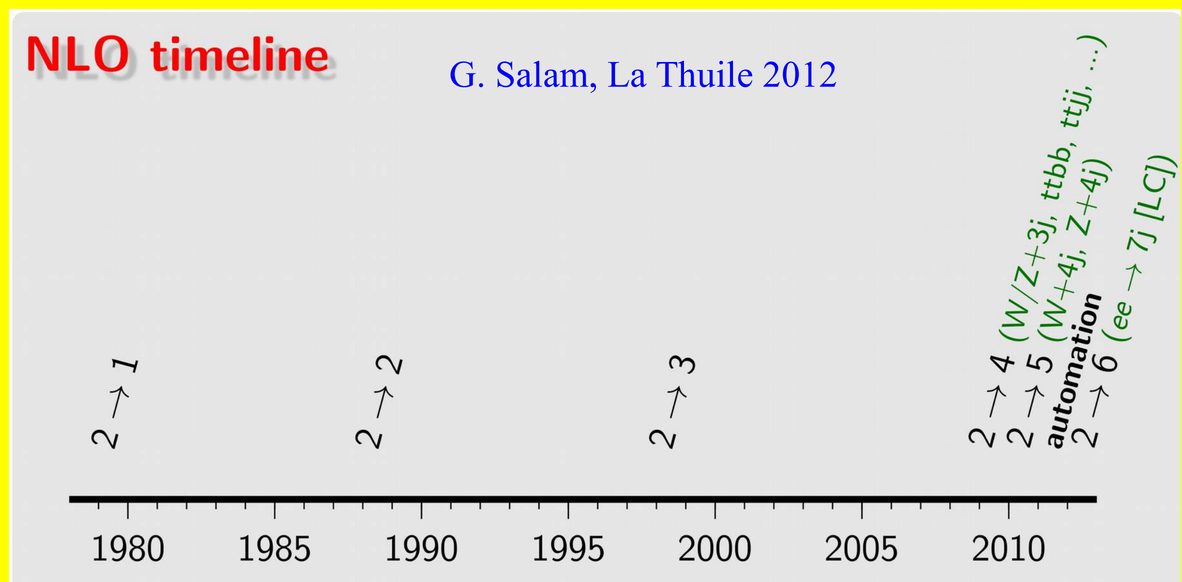
$$\sigma_{P\gamma\to c} = f_{P\to a} \otimes \hat{\sigma}_{a\gamma\to c}$$

Experimental Observables

WHAT ABOUT PDF'S ???

Theoretical Calculations

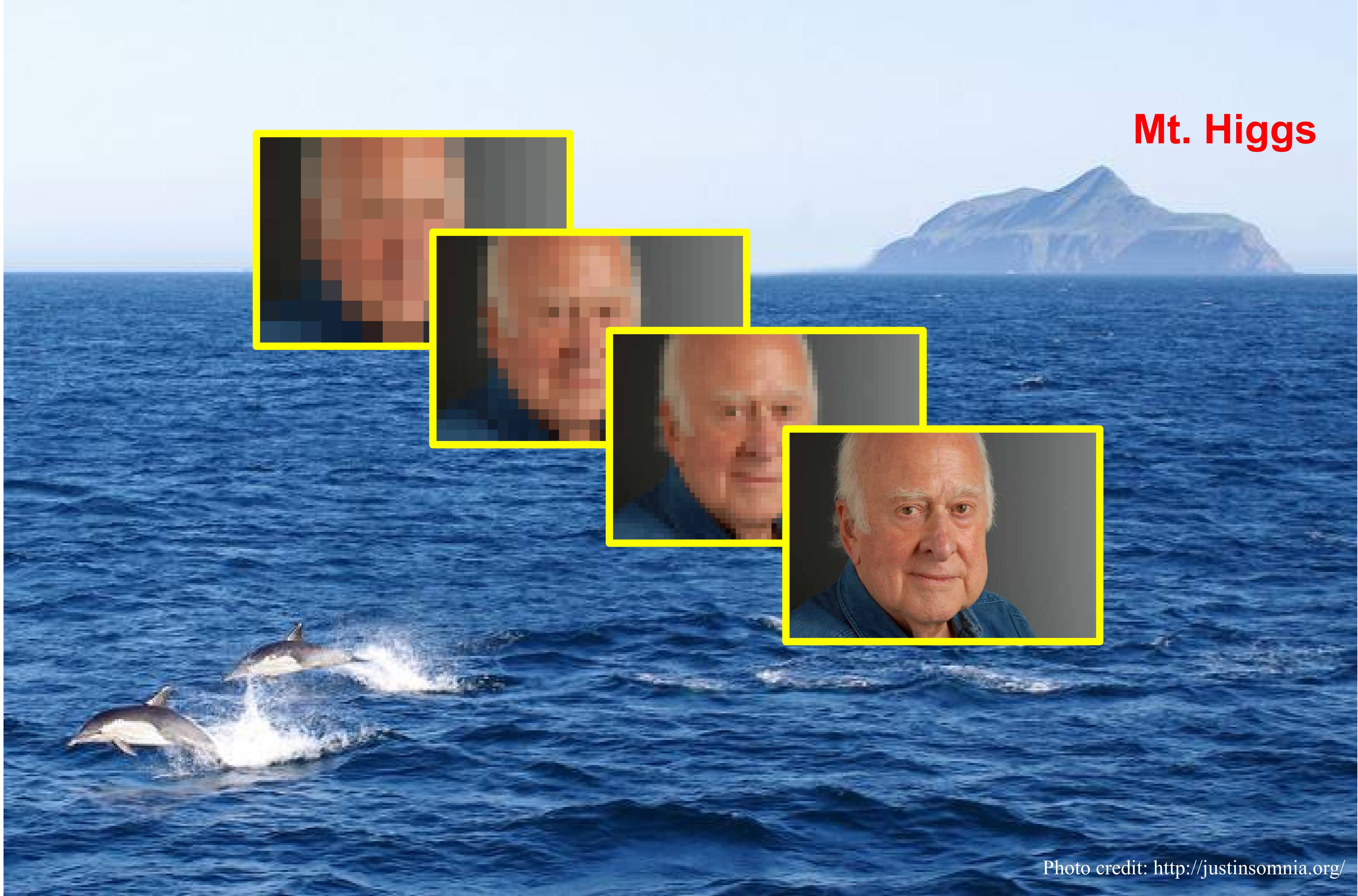




2014 and beyond ...

Photo credit: http://justinsomnia.org/

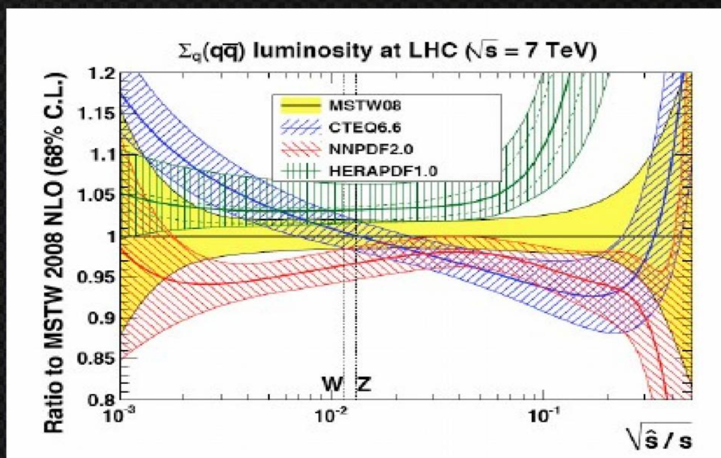
2014 and beyond ...

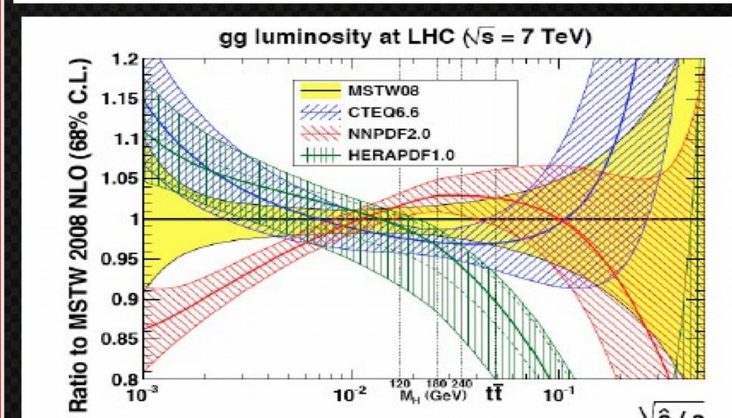


The Parton Model: *Lots of recent progress*

$$\sigma_{P\gamma\to c} = f_{P\to a} \otimes \hat{\sigma}_{a\gamma\to c}$$

2010->2012: changes in the PDF luminosities



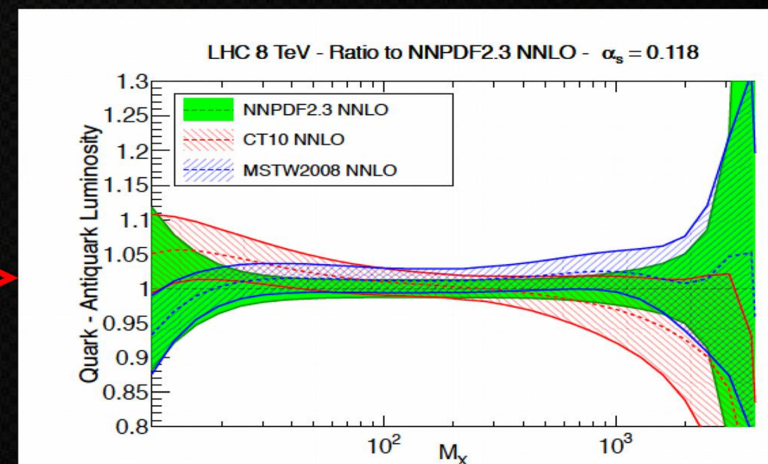


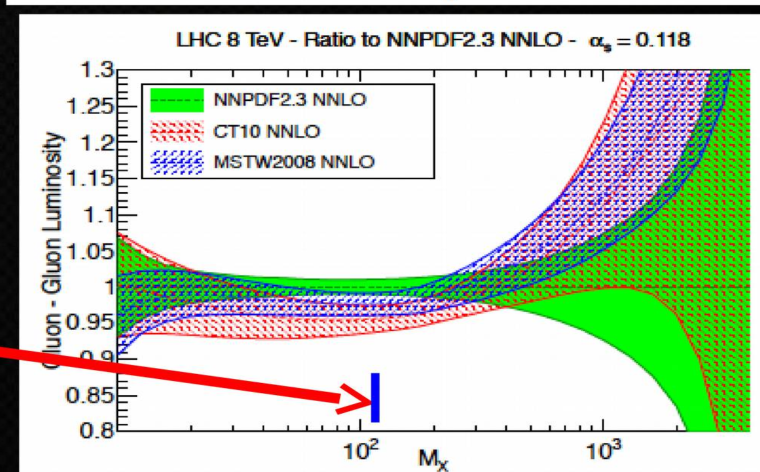
improvements from 2010 to 2012…

…and from NLO to NNLO

so Higgs PDF uncertainty under good control

as uncertainty still +/-0.002





J. Huston

PHYSICAL REVIEW D VOLUME 38, NUMBER 11 1 DECEMBER 1988

Production mechanisms for nonminimal Higgs bosons at an e^+e^- collider

J. F. Gunion, L. Roszkowski,* and A. Turski*
Department of Physics, University of California, Davis, California 95616

H. E. Haber
Santa Cruz Institute for Particle Physics, University of California, Santa Cruz, California 95064

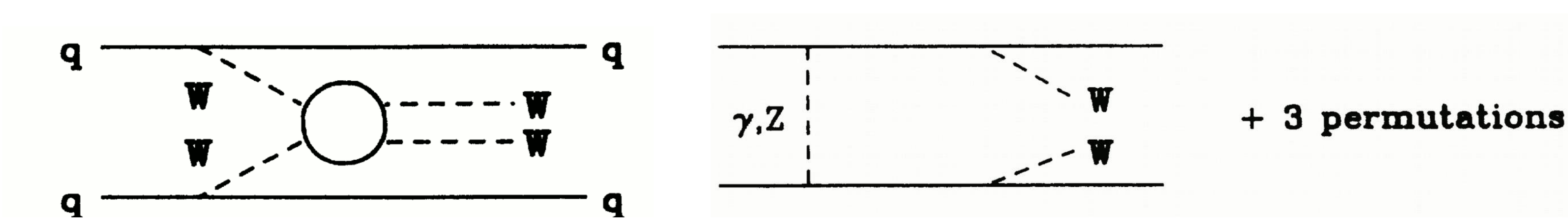
G. Gamberini, B. Kayser,† and S. F. Novaes
Lawrence Berkeley Laboratory, Berkeley, California 94720

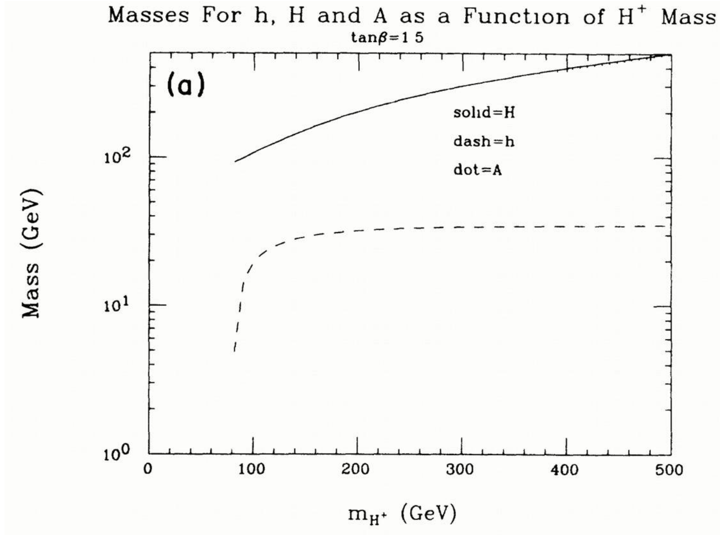
F. Olness
Department of Physics, Illinois Institute of Technology, Chicago, Illinois 60616

J. Wudka
Randall Physics Laboratory, University of Michigan, Ann Arbor, Michigan 48109
(Received 20 April 1988)

We discuss mechanisms for the production of the Higgs bosons of the minimal supersymmetric model at an e^+e^- collider. In particular, we focus on those Higgs bosons that are predicted to have zero or weak couplings to vector-boson pairs, and hence cannot be produced by the standard mechanisms.

METHOD: Effective W-Approximation:





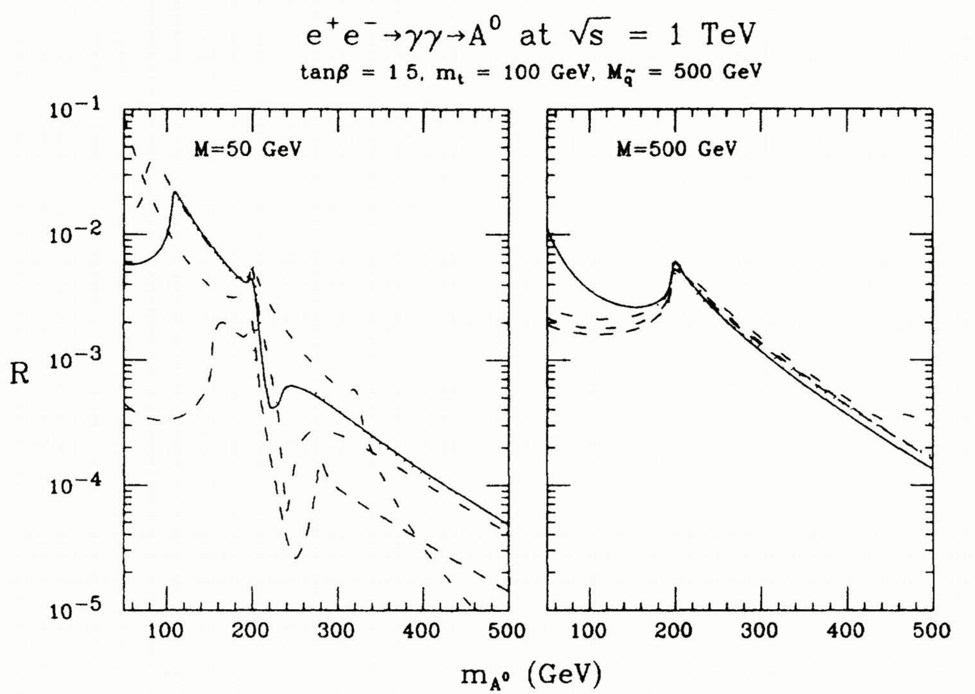


FIG. 6. The cross section for A^0 production as a function of m_{A^0} at $M=50$ and 500 GeV. Parameter choices and notation are the same as in Fig. 4.

C. Effective γ and W distributions and folding

In this section we summarize the effective γ and W distributions in an electron (or positron) which were used to compute the total cross sections for the above fusion-type processes in the effective-vector-boson approximation. This approximation is completely satisfactory for generating cross sections which will allow us to estimate the Higgs-boson production rate, and identify the primary production mechanisms.

We write the elementary coupling between the fermions and the vector boson as $\overline{\Psi}\Gamma_\mu \Psi V^\mu$, with

$$\Gamma_\mu = g_R \gamma_\mu \left[\frac{1+\gamma_5}{2} \right] + g_L \gamma_\mu \left[\frac{1-\gamma_5}{2} \right] . \tag{6.28}$$

The vector-boson distribution functions are[10]

$$f_0 = (g_L^2 + g_R^2) \left[\frac{x}{16\pi^2} \right] \left[\frac{2(1-x)\zeta}{\omega^2 x} - \frac{2\epsilon(2-\omega)}{\omega^3} \ln \left[\frac{x}{\epsilon'} \right] \right] \tag{6.29}$$

and

$$f_T = f_{+1} + f_{-1} = (g_L^2 + g_R^2)(h_1 + h_2) ,$$
$$f_\Delta = f_{+1} - f_{-1} = (g_L^2 - g_R^2)(h_1 - h_2) , \tag{6.30}$$

where

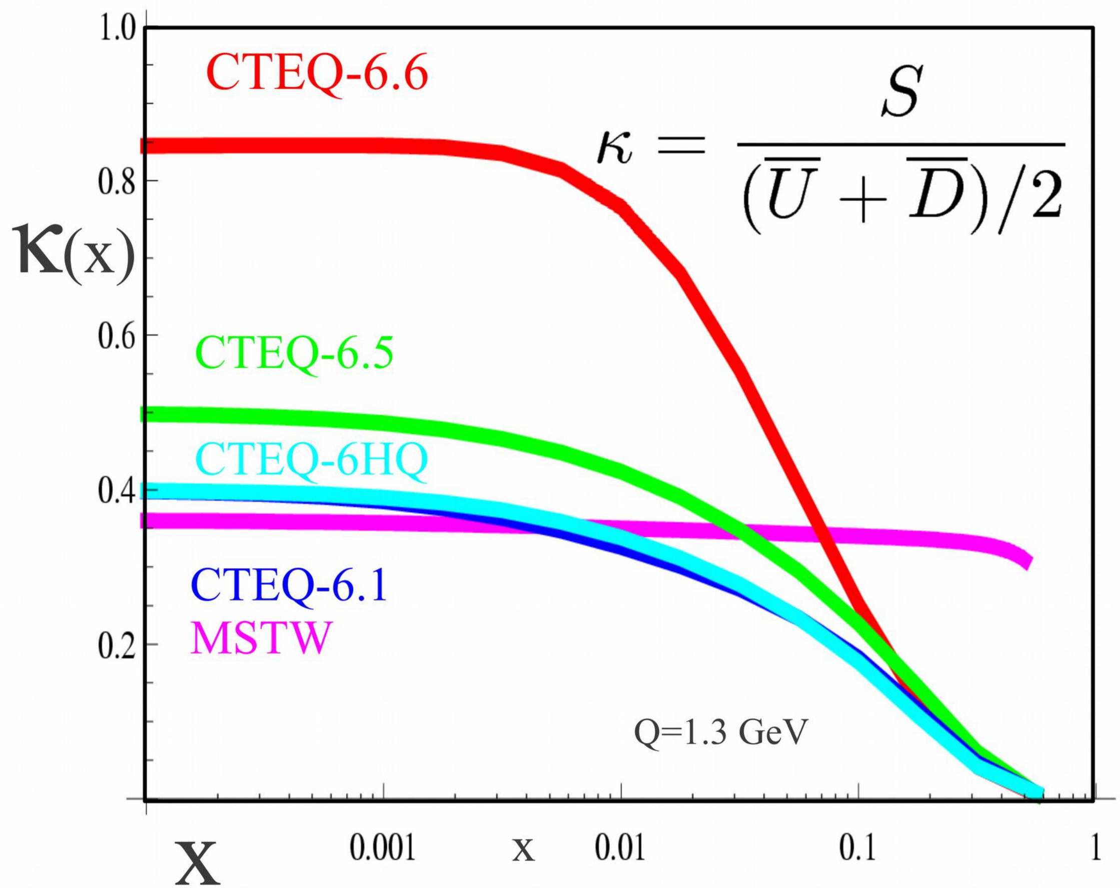
$$h_1 = \left[\frac{x}{16\pi^2} \right] \left[\frac{-(1-x)(2-\omega)}{\omega^2} + \frac{(1-\omega)(\zeta-\omega^2)}{\omega^3} \ln \left[\frac{1}{\epsilon'} \right] - \frac{\zeta - 2x\omega}{\omega^3} \ln \left[\frac{1}{x} \right] \right] , \tag{6.31}$$

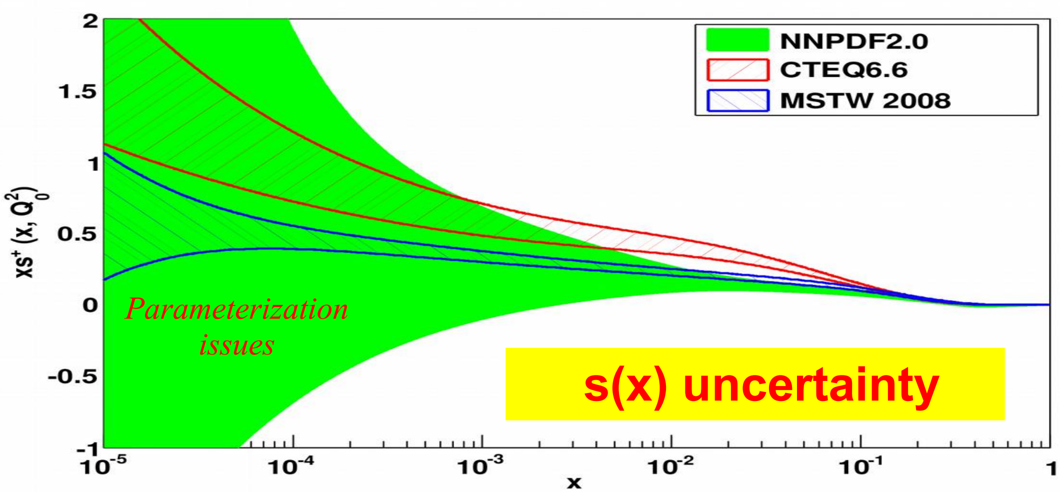
$$h_2 = \left[\frac{x}{16\pi^2} \right] \left[\frac{-(1-x)(2-\omega)}{\omega^2(1-\omega)} + \frac{\zeta}{\omega^3} \ln \left[\frac{x}{\epsilon'} \right] \right] , \tag{6.32}$$

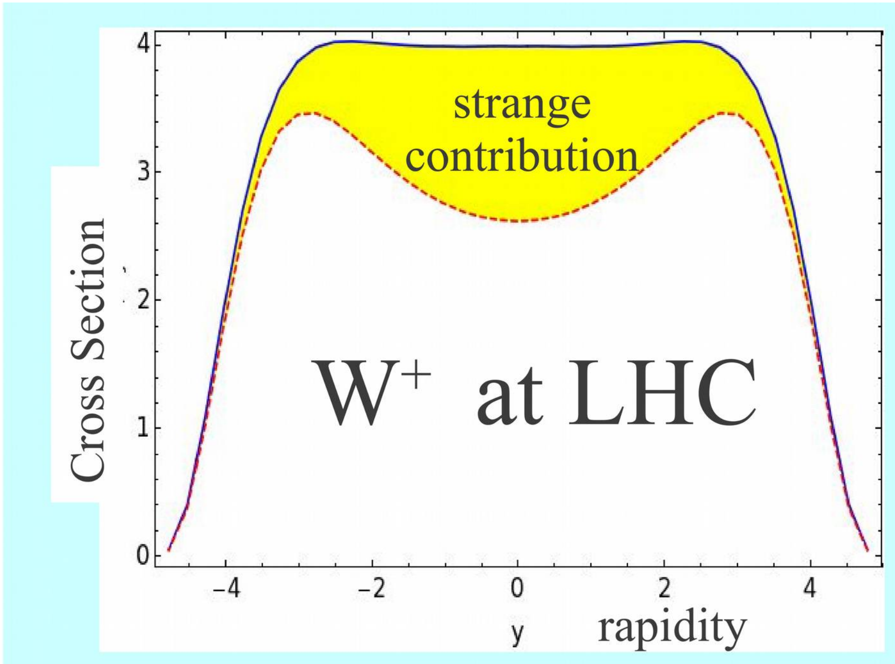
with $\omega = x - \epsilon$, $\zeta = x + \epsilon$, $\epsilon = M_V^2/\hat{s}$, $\epsilon' = \epsilon/1(-\omega)$, and M_V equals M_W, M_Z, or m_e for the W, Z, or γ distribu-

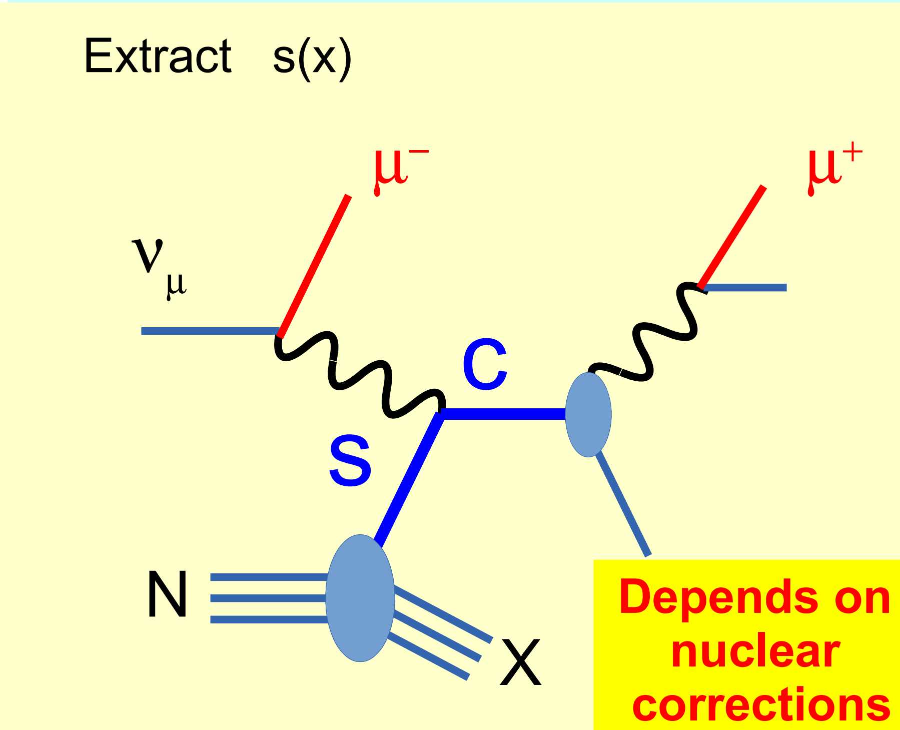
Strange

What do we really know about Strange PDF

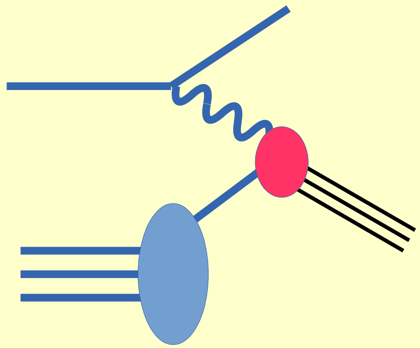




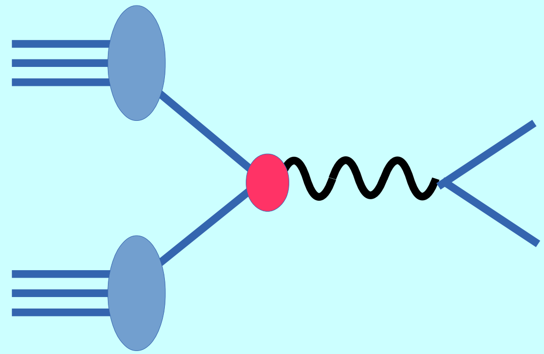




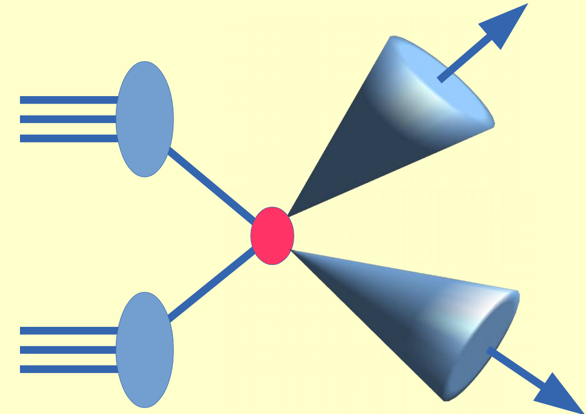
PDF Flavor Differentiation: *A difficult problem*



DIS Production



Drell-Yan



Jet Production

$$F_2^{\nu} \sim [d + s + \bar{u} + \bar{c}]$$

$$F_2^{\bar{\nu}} \sim [\bar{d} + \bar{s} + u + c]$$

$$F_3^{\nu} = 2\,[d + s - \bar{u} - \bar{c}]$$

$$F_3^{\bar{\nu}} = 2\,[u + c - \bar{d} - \bar{s}]$$

$$F_2^{\ell^\pm} \sim \left(\tfrac{1}{3}\right)^2 [d + s] + \left(\tfrac{2}{3}\right)^2 [u + c]$$

The DIS combinations have historically been particularly useful

<u>Different</u> linear combinations – key for flavor differentiation

The n-DIS data typically use heavy targets, and this requires the application of ***<u>nuclear corrections</u>***

Nuclear Corrections: Nuclear PDF Uncertainties

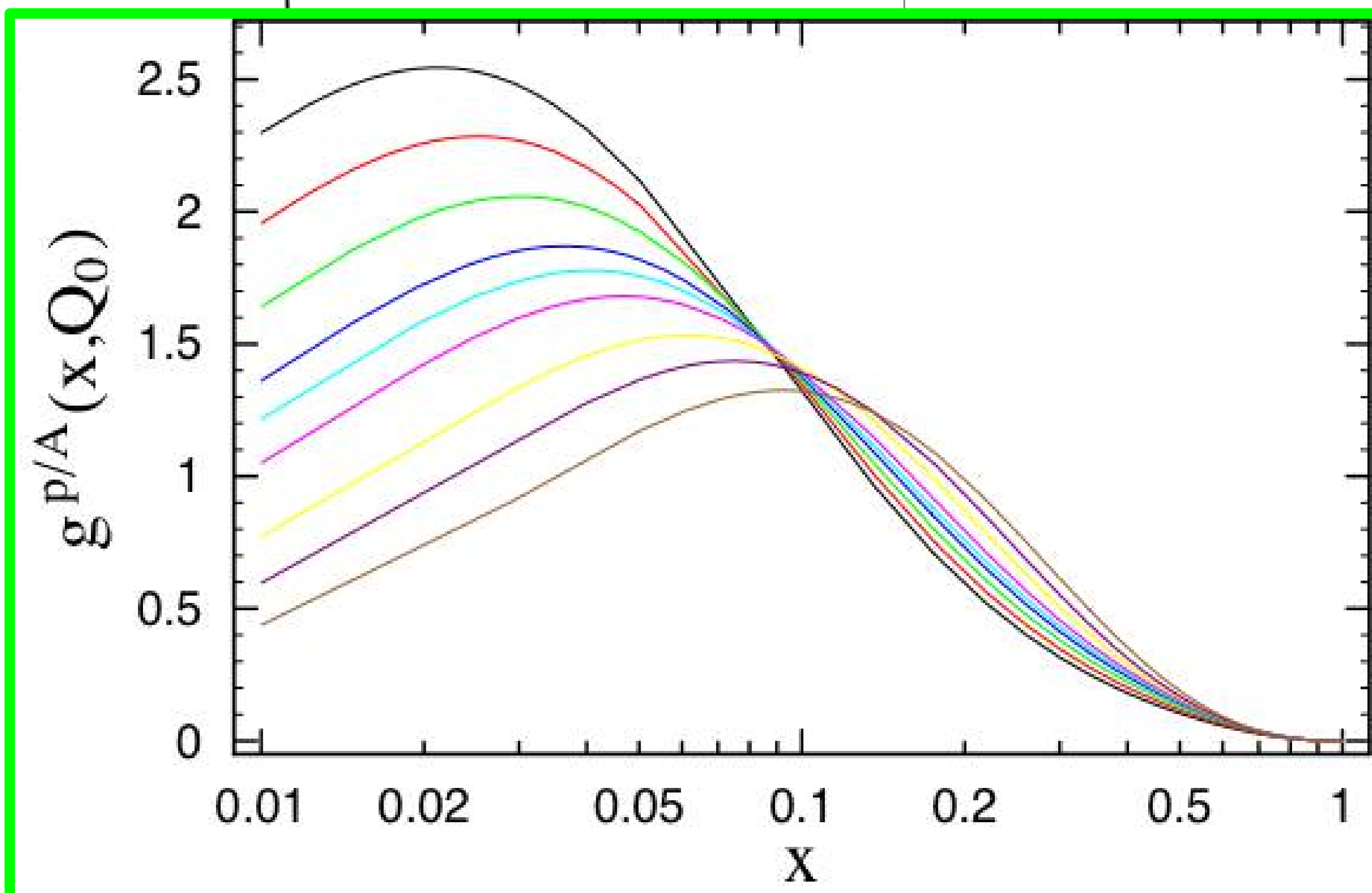
nCTEQ Go! hosted by **CEDAR HepForge**

HEP-Forge

nCTEQ

nuclear parton distribution functions

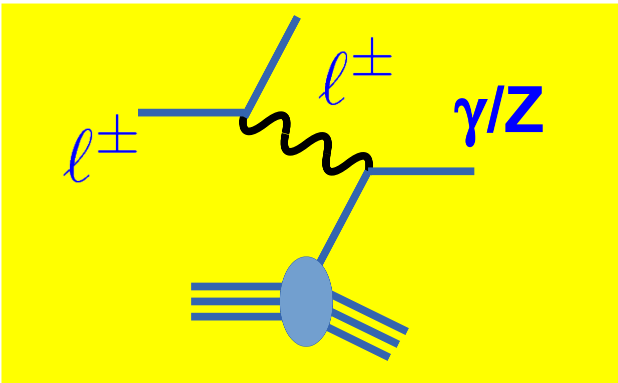
- Home
- PDF grids & code
- Papers & Talks
- Subversion
- Tracker
- Wiki

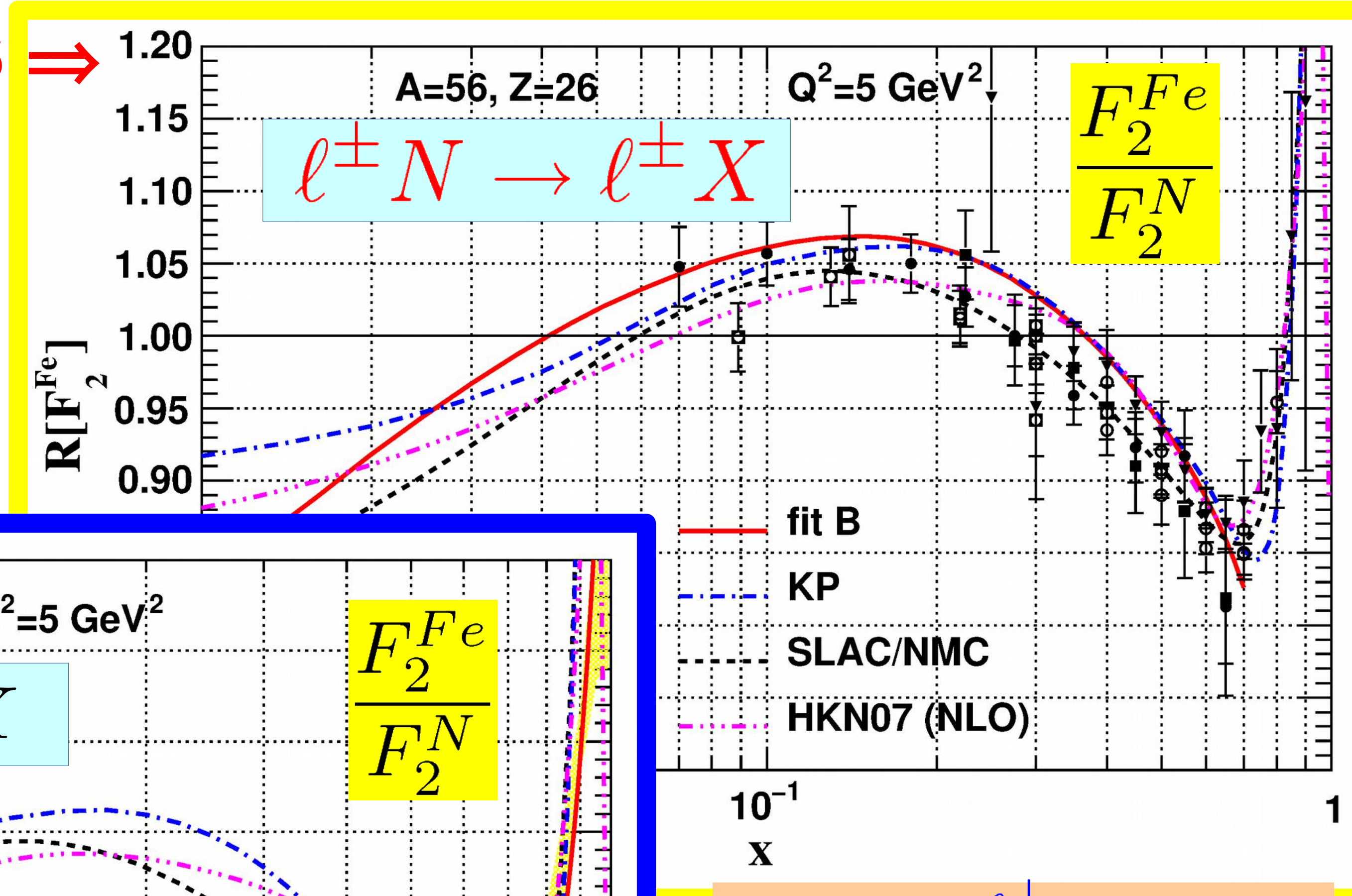


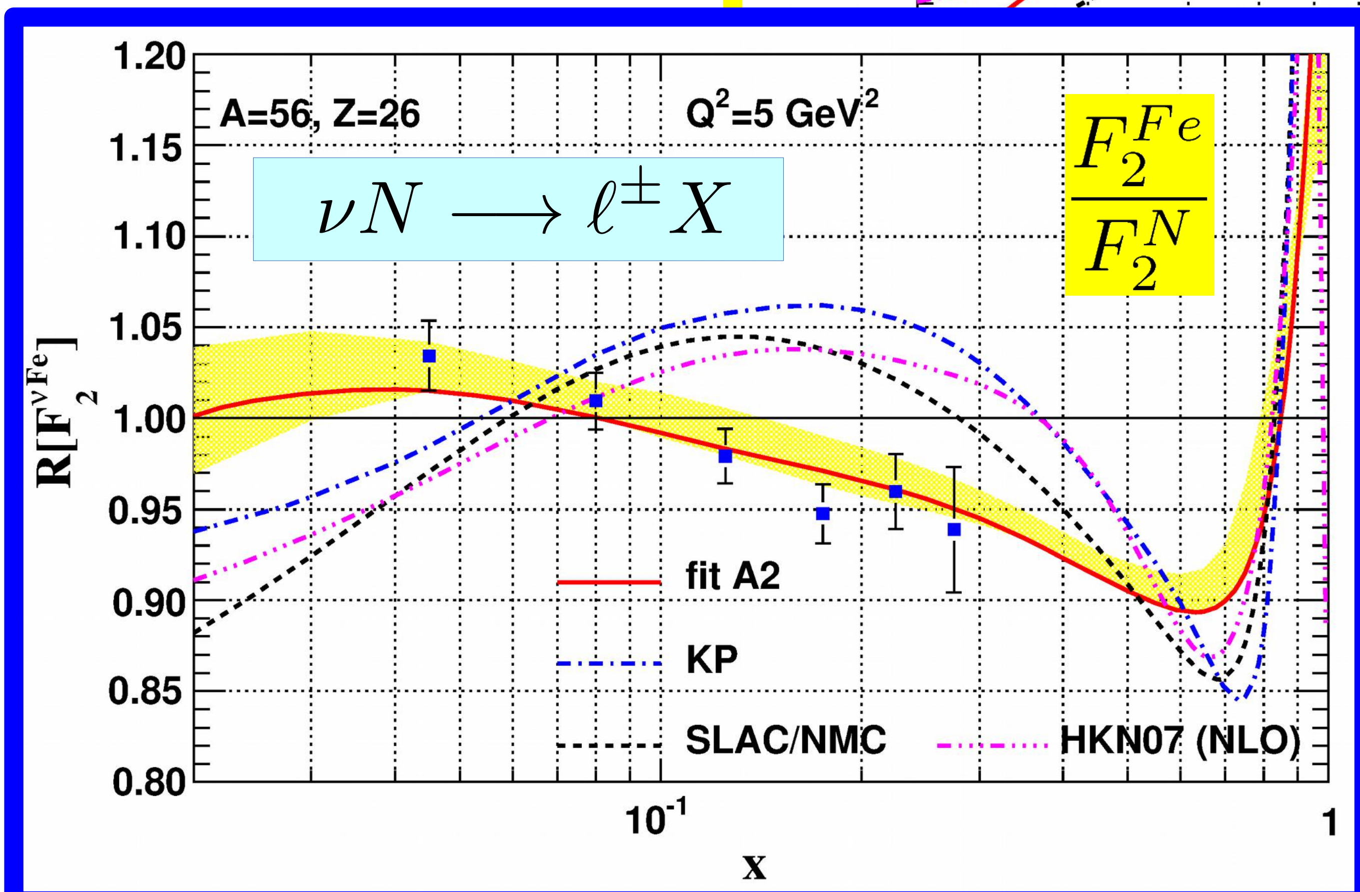
K Kovarik,
I. Schienbein,
J.Y. Yu,
T. Stavreva,
T Jezo,
C. Keppel,
J.G. Morfin,
F. Olness,
J.F. Owens.

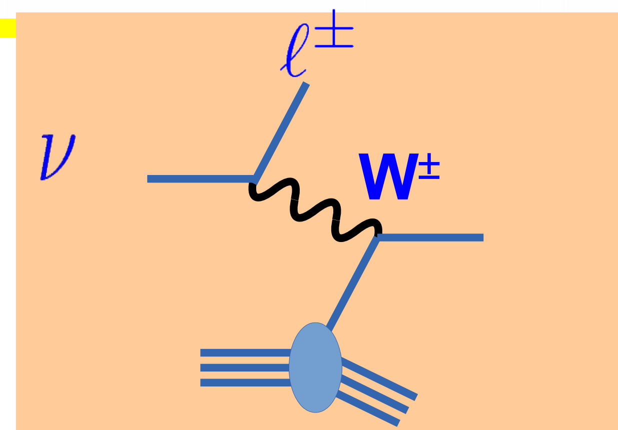
Nuclear Corrections: Are they the same for CC and NC Processes

Charged Lepton DIS ⇒









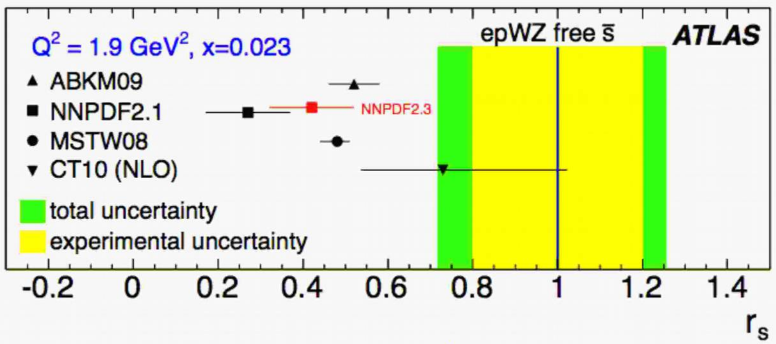
⇐ Neutrino DIS

Determination of the strange quark at the LHC

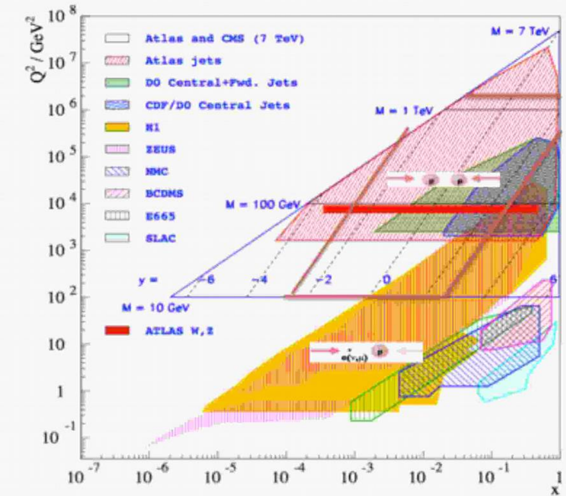
Using W+, W-, Z (35/pb) inclusive cross sections – ATLAS

[PRL 109 (2012) 012001] → kinematic region probed is at x~0.01

- NNLO QCD Analysis (NLO is in agreement):



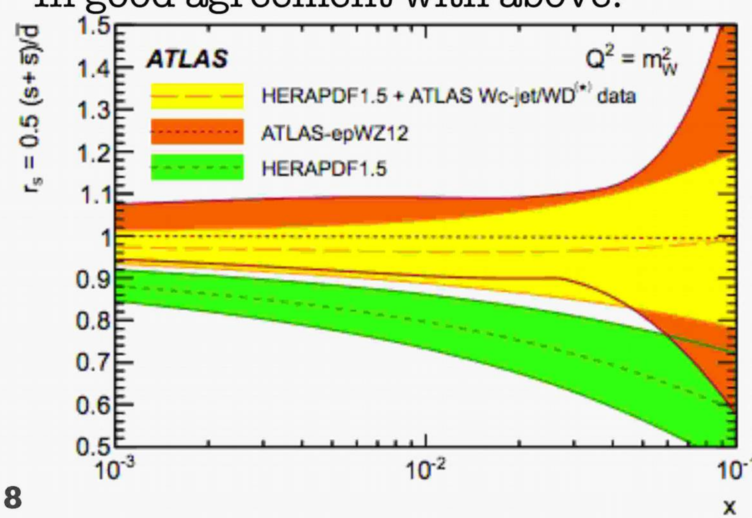
→ Result supports an SU(3) symmetric light sea



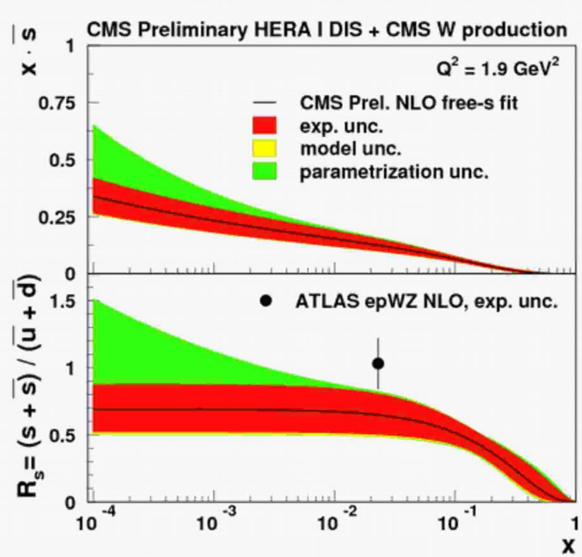
Using W+charm production at 7 TeV (4.6/fb):

ATLAS [arxiv:1402.6263]:

- In good agreement with above:



CMS (includes W asymmetry) [SMP-12-021]



NLO analyses

ATLAS: Rs=(s+sbar)/2dbar

CMS: Rs=(s+sbar)/ubar+dbar

$$r_s = s/\bar{d}$$

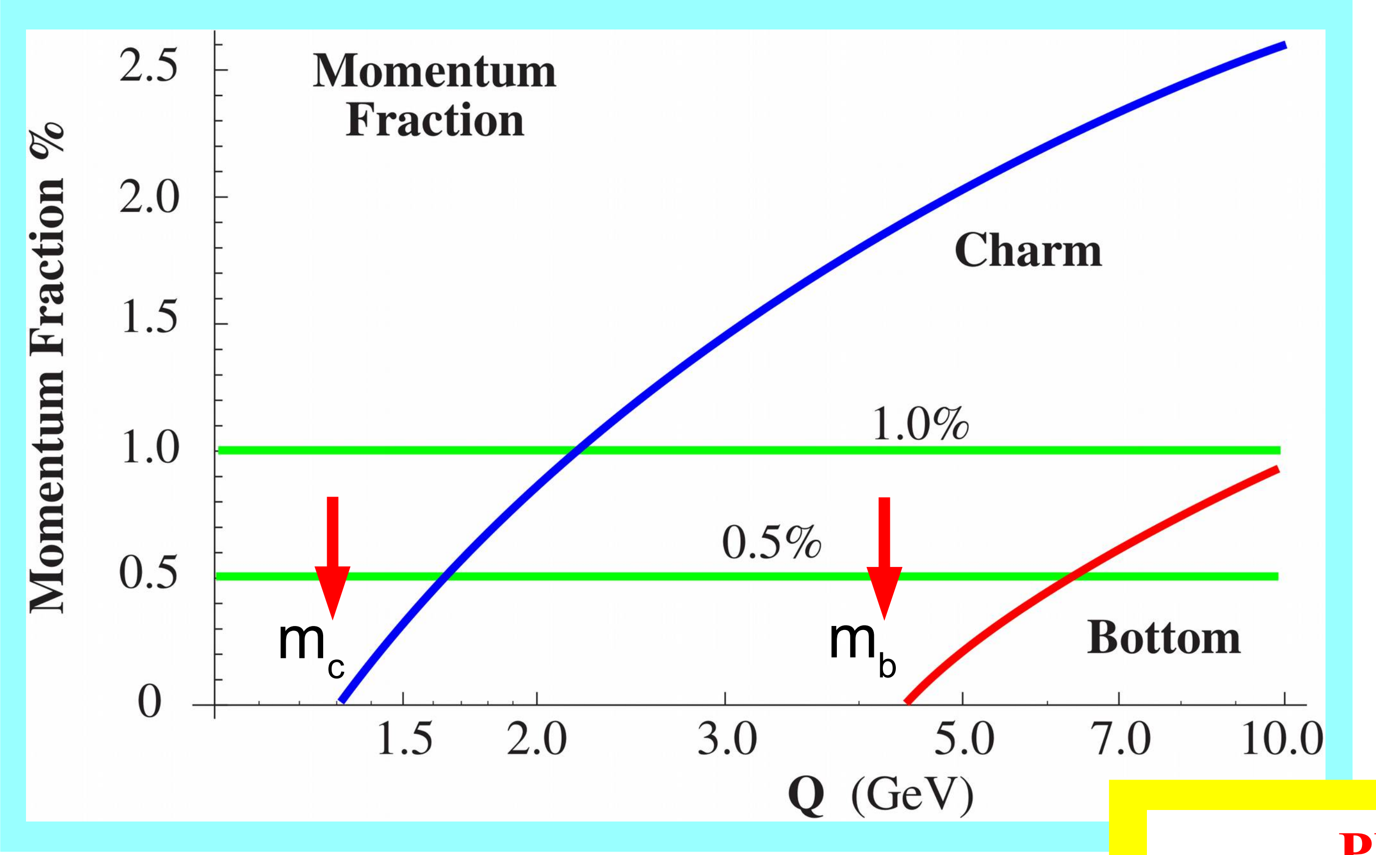
… what about the

Heavy Quarks

c & b

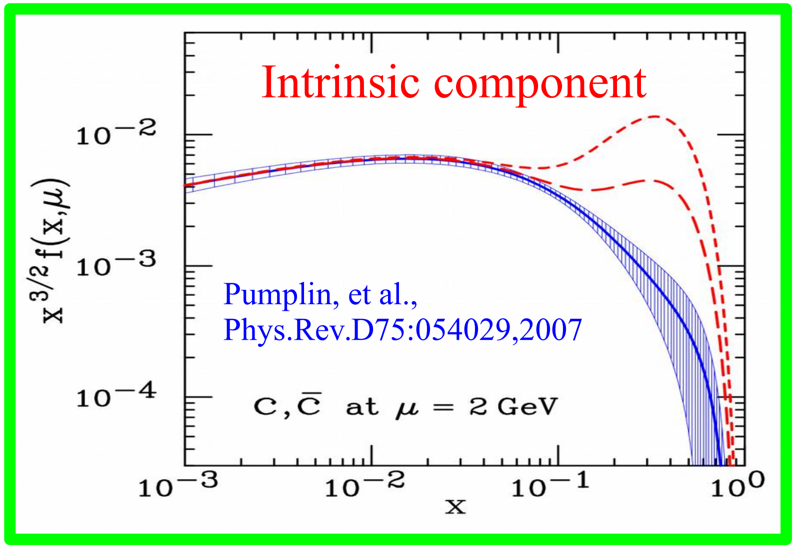
Extrinsic & Intrinsic

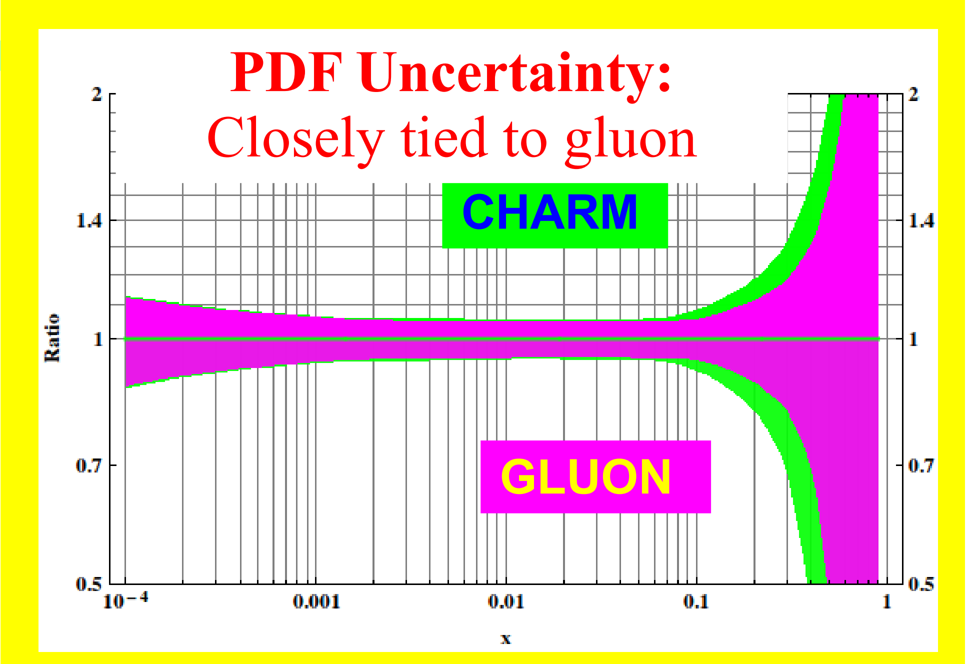
Do all of c(x) and b(x) PDFs come from gluons???



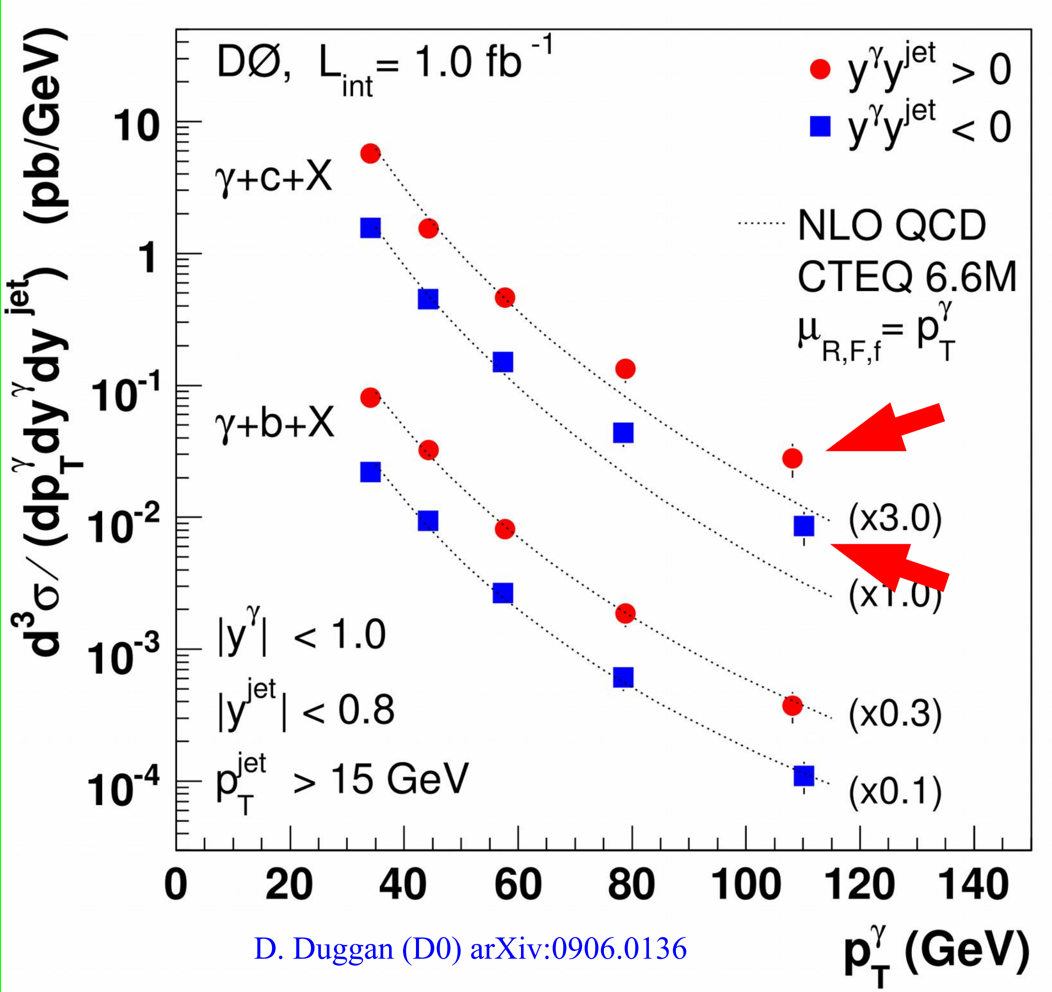
Controlled by m_Q and gluon PDF

Chevrolets at higher Q ⇒

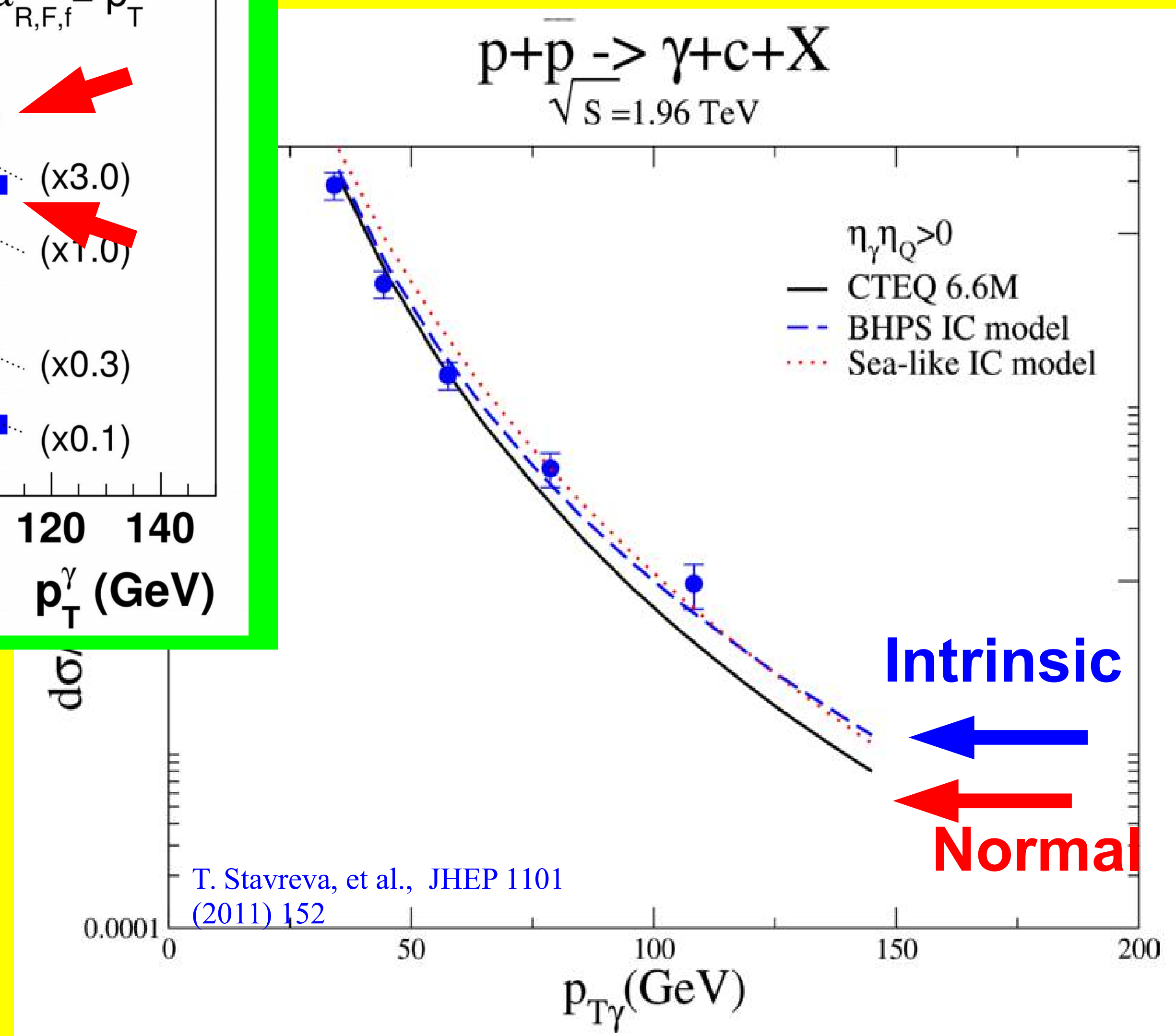




Heavy Quarks at the Tevatron: $\gamma + c$ and $\gamma + b$

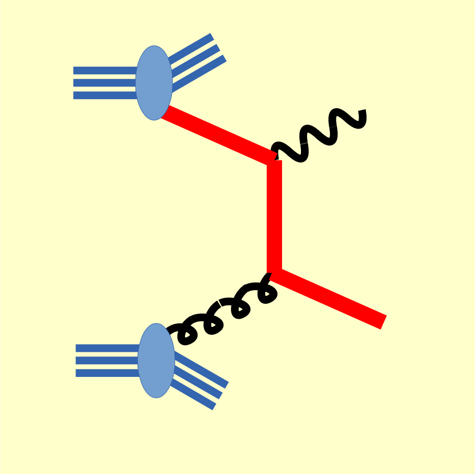


D. Duggan (D0) arXiv:0906.0136



T. Stavreva, et al., JHEP 1101 (2011) 152

Heavy Quarks at the LHC: *New Kinematic Region*

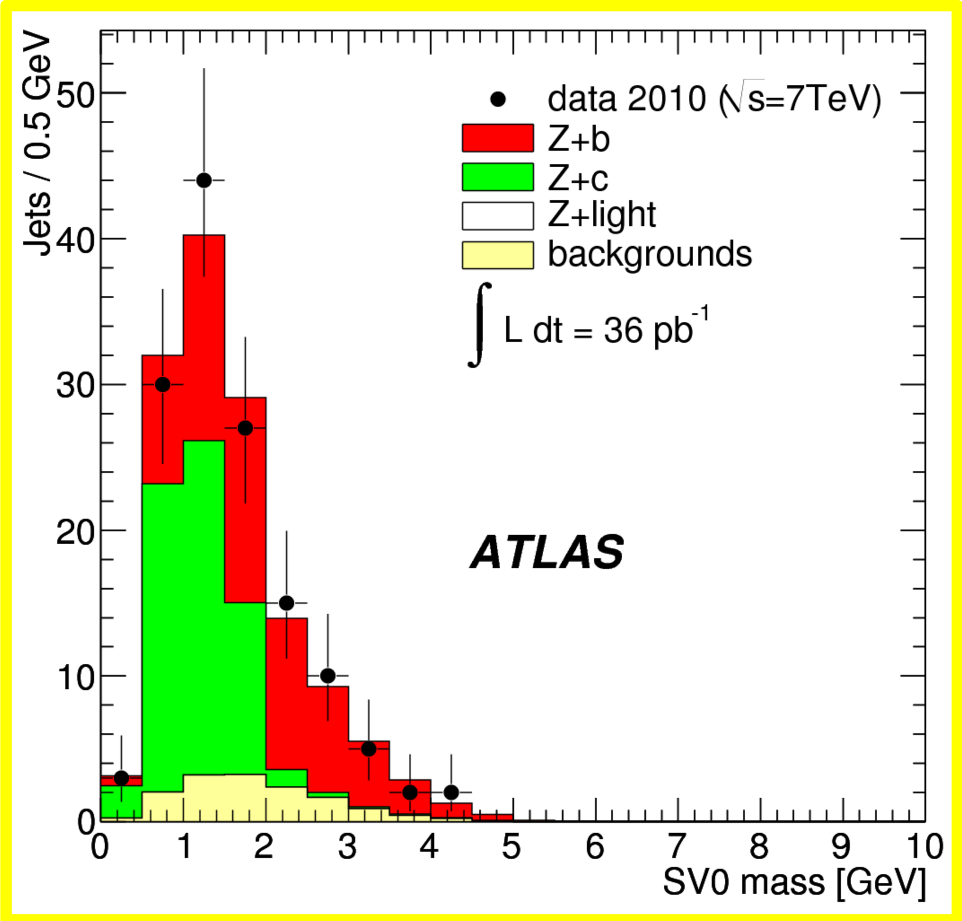


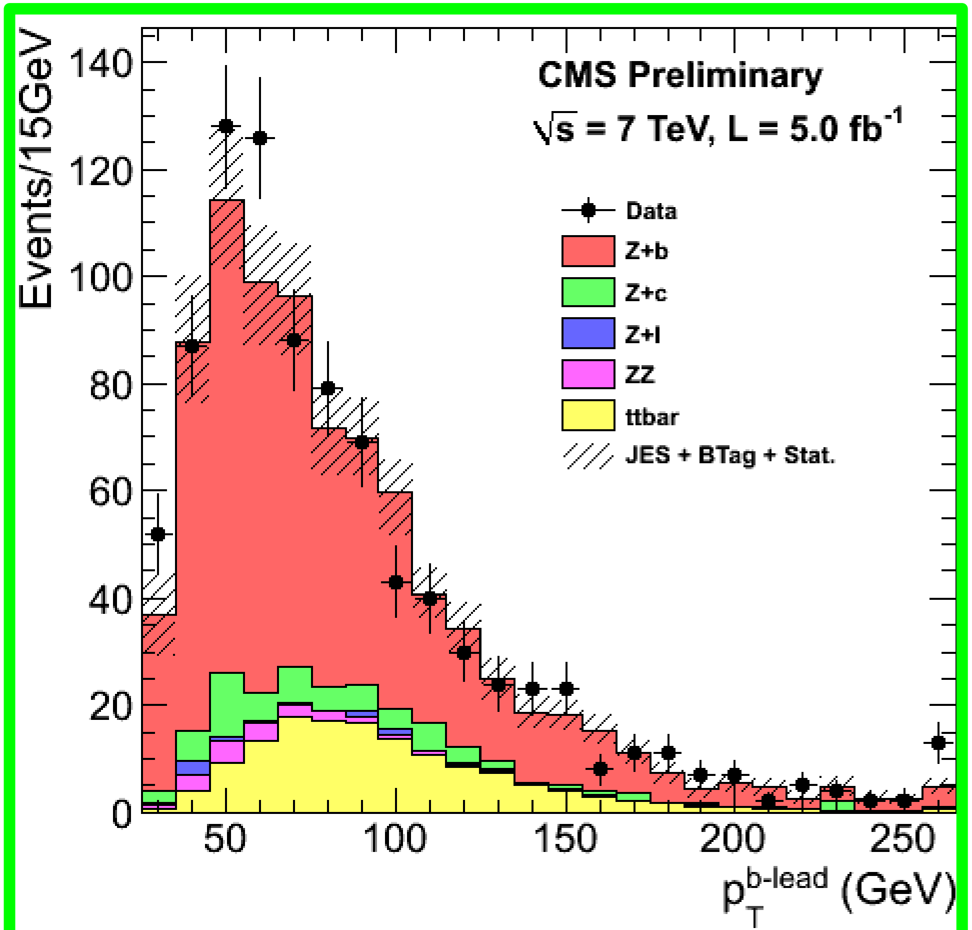
$$c\ g \to c\ \gamma, Z$$
$$b\ g \to b\ \gamma, Z$$

$$s\ g \to cW$$
$$c\ g \to bW$$

Much higher scales

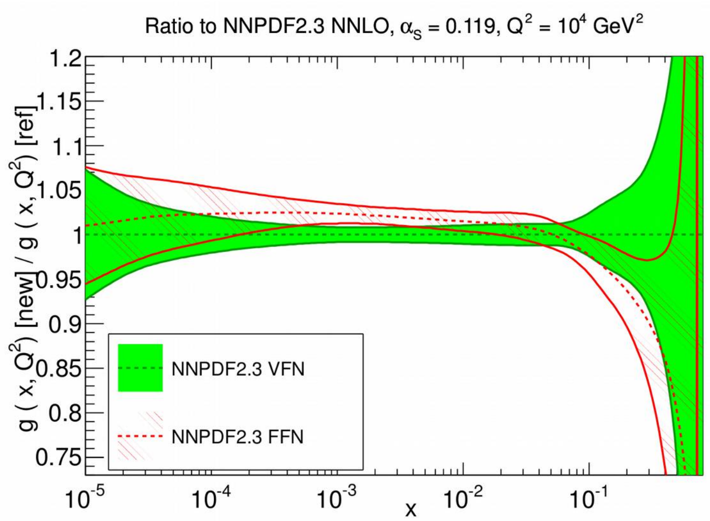
Sensitive to $\alpha \ln(m/Q)$ resummation

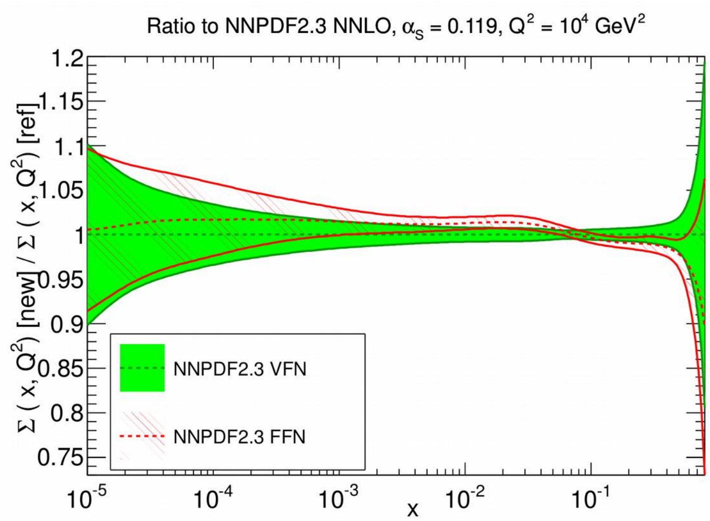




Compare VFN & FFN Schemes

Resum: $\alpha \ln(m/Q)$





$$\Delta\chi^2 \equiv \chi^2_{FFN} - \chi^2_{VFN} \quad > 0$$

VFN always yields better fit

$x_{\rm min}$	$x_{\rm max}$	$Q^2_{\rm min}$ (GeV)	$Q^2_{\rm max}$ (GeV)	$\Delta\chi^2$ (DIS)	$N_{\rm dat}^{\rm DIS}$	$\Delta\chi^2$ (HERA-I)	$N_{\rm dat}^{\rm hera-I}$
$4\cdot10^{-5}$	1	3	10^6	72.2	2936	77.1	592
$4\cdot10^{-5}$	0.1	3	10^6	87.1	1055	67.8	405
$4\cdot10^{-5}$	0.01	3	10^6	40.9	422	17.8	202
$4\cdot10^{-5}$	1	10	10^6	53.6	2109	76.4	537
$4\cdot10^{-5}$	1	100	10^6	91.4	620	97.7	412
$4\cdot10^{-5}$	0.1	10	10^6	84.9	583	67.4	350
$4\cdot10^{-5}$	0.1	100	10^6	87.7	321	87.1	227

The NNPDF Collaboration, PLB723 (2013) 330

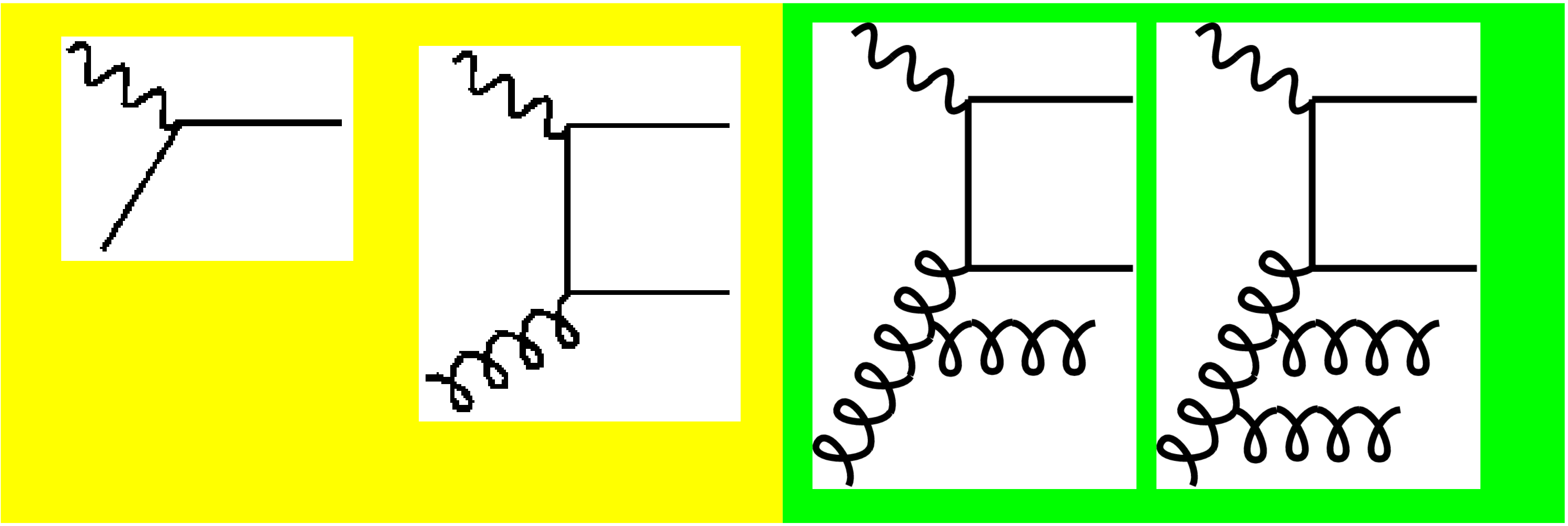
ACOT

@ NNLO + N^{3}LO

Stavreva, Olness, Schienbein, Jezo, Kusina,
Kovarik, Yu
arXiv:1203.0282

ACOT Extension to Higher Orders

LO **NLO** **N2LO** **N3LO**



Full ACOT

Based on the Collins-Wilczek-Zee (CWZ) Renormalization Scheme

... hence, extensible to all orders

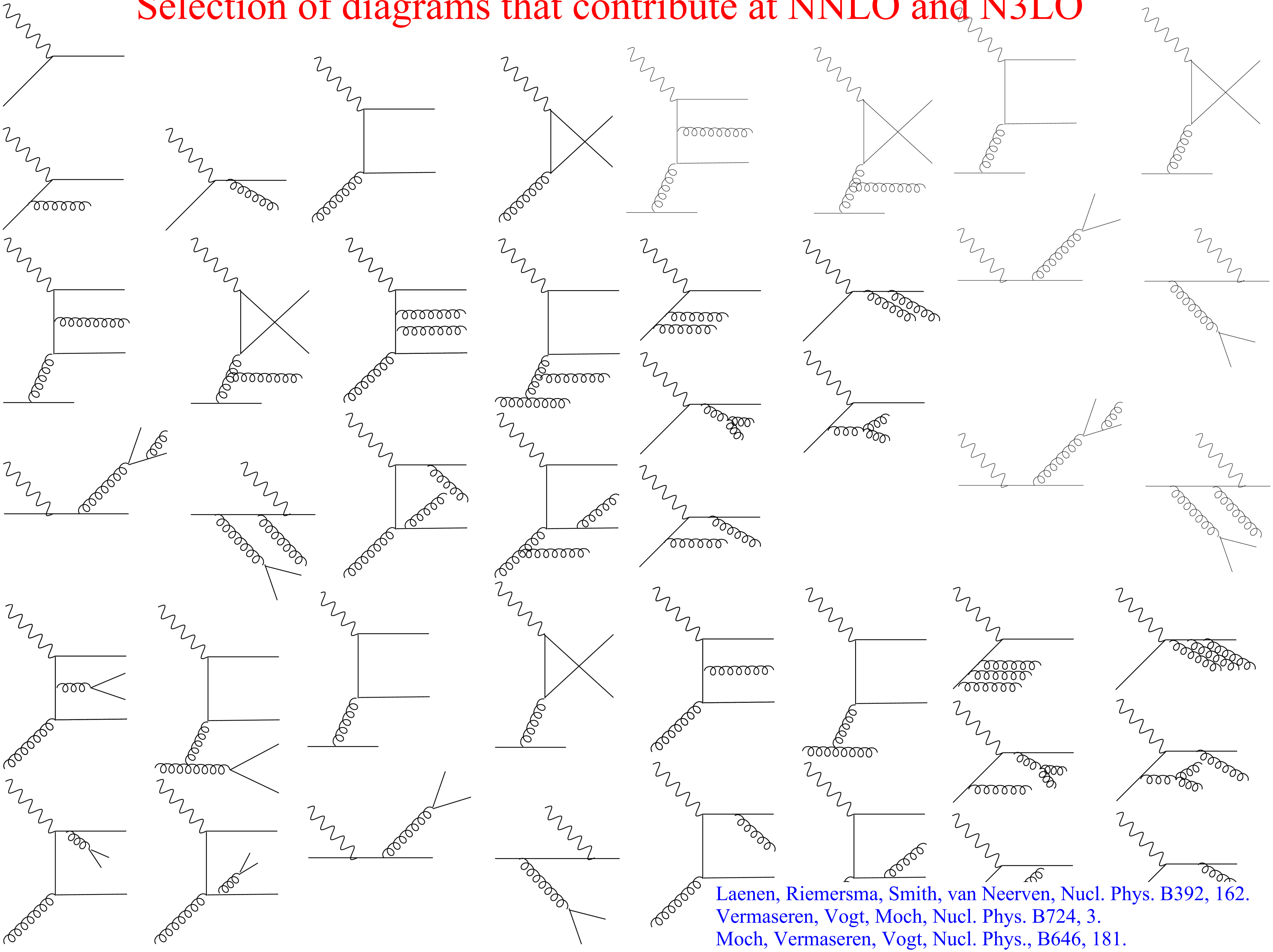
DGLAP kernels & PDF evolution are pure MS-Bar

Subtractions are MS-Bar

ACOT: $m \to 0$ limit yields MS-Bar

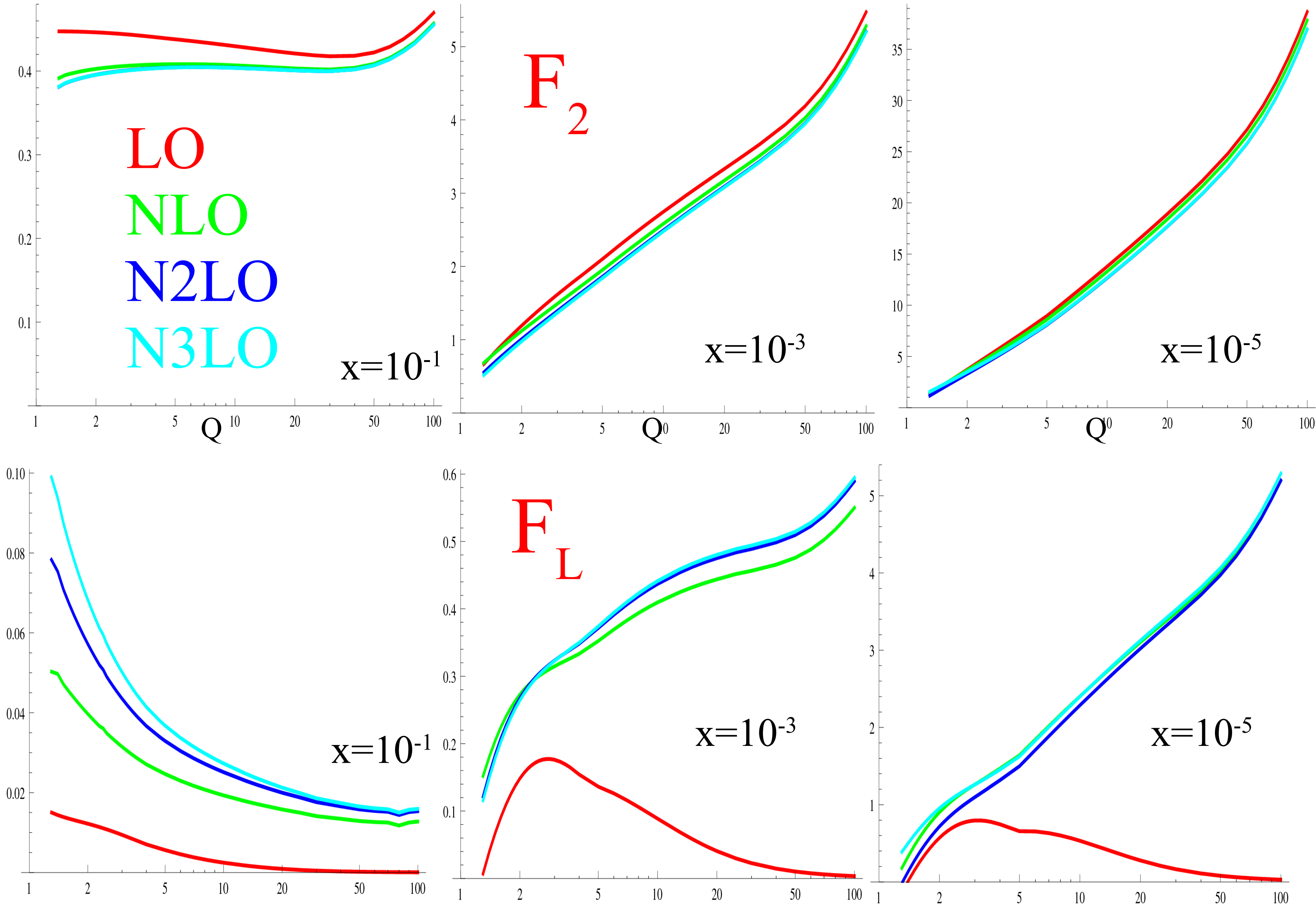
with no finite renormalization

Selection of diagrams that contribute at NNLO and N3LO



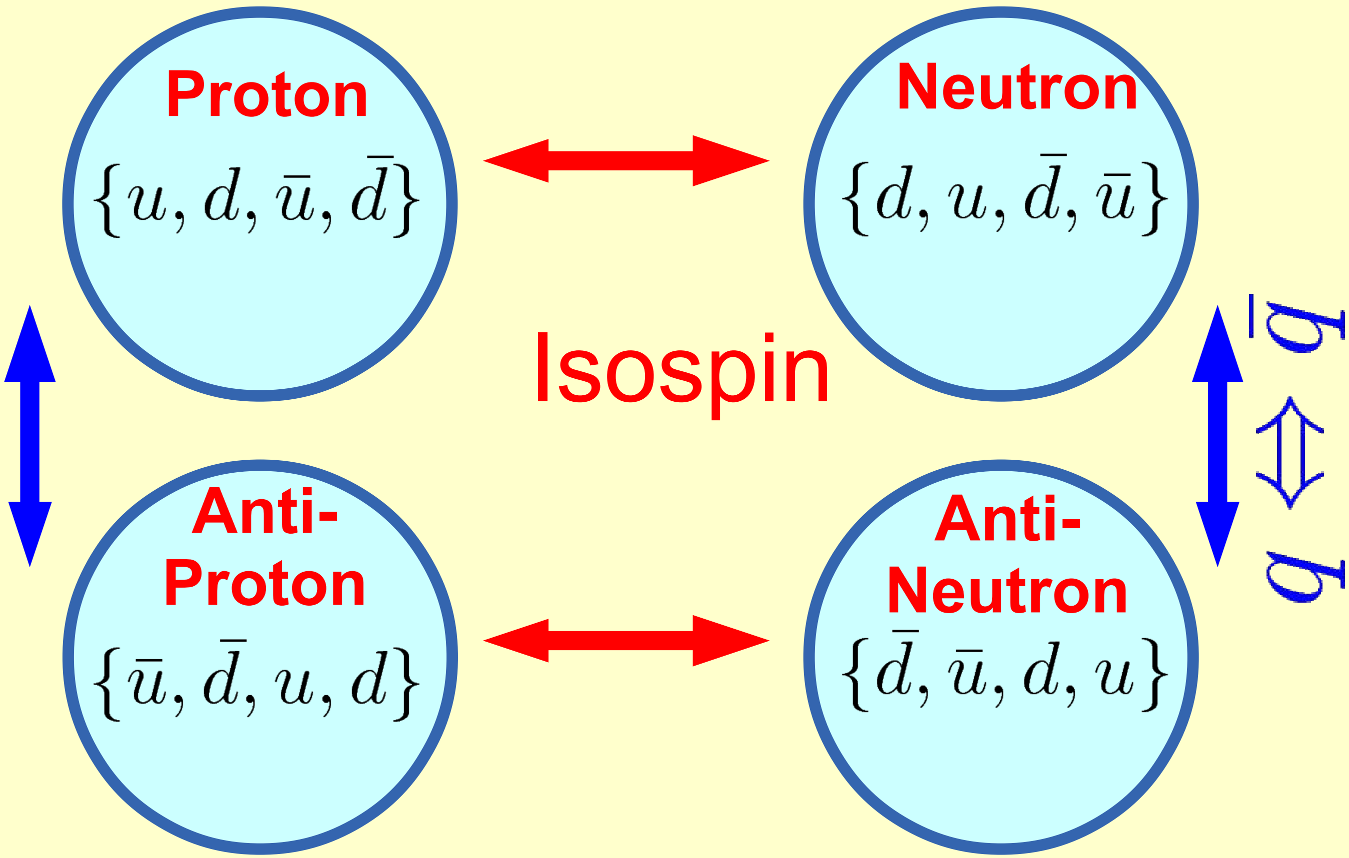
Laenen, Riemersma, Smith, van Neerven, Nucl. Phys. B392, 162.
Vermaseren, Vogt, Moch, Nucl. Phys. B724, 3.
Moch, Vermaseren, Vogt, Nucl. Phys., B646, 181.
Moch, Vermaseren, Vogt, Phys. Lett., B606, 123.
Blumlein, Hasselhuhn, Kovacikova, Moch, Phys.Lett. B700, (2011) 294.

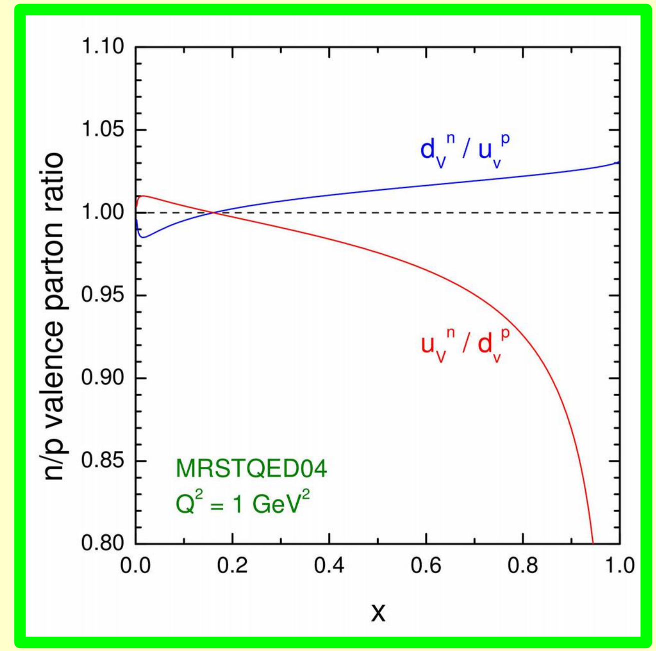
$F_{2,L}$ @ N3LO



QED
in
DGLAP

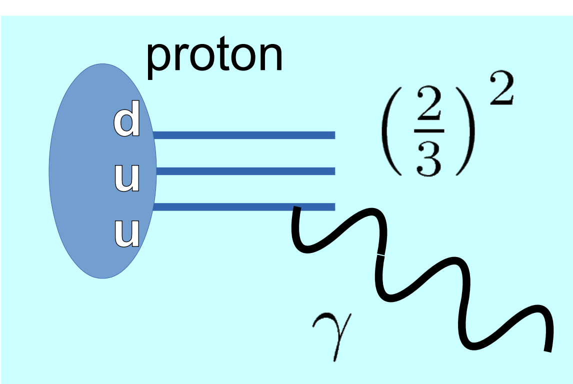
Isospin Symmetry used to relate PDFs

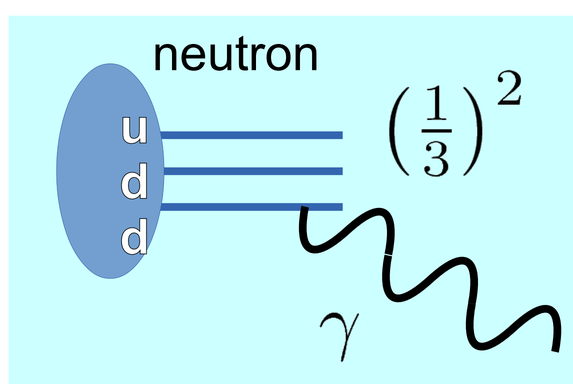




A Review of Target Mass Corrections.
Ingo Schienbein et al,
J.Phys.G35:053101,2008.

MRST, Eur.Phys.J.C39:155-161,2005.





Isospin terms are comparable to NNLO QCD

Fast evolution of parton distributions
Stefan Weinzierlar, Xiv:hep-ph/0203112

Final Thoughts

ATLAS SUSY Searches* - 95% CL Lower Limits

Status: SUSY 2013

ATLAS Preliminary

$\int \mathcal{L}\,dt = (4.6 - 22.9)$ fb^{-1} $\sqrt{s}$ = 7, 8 TeV

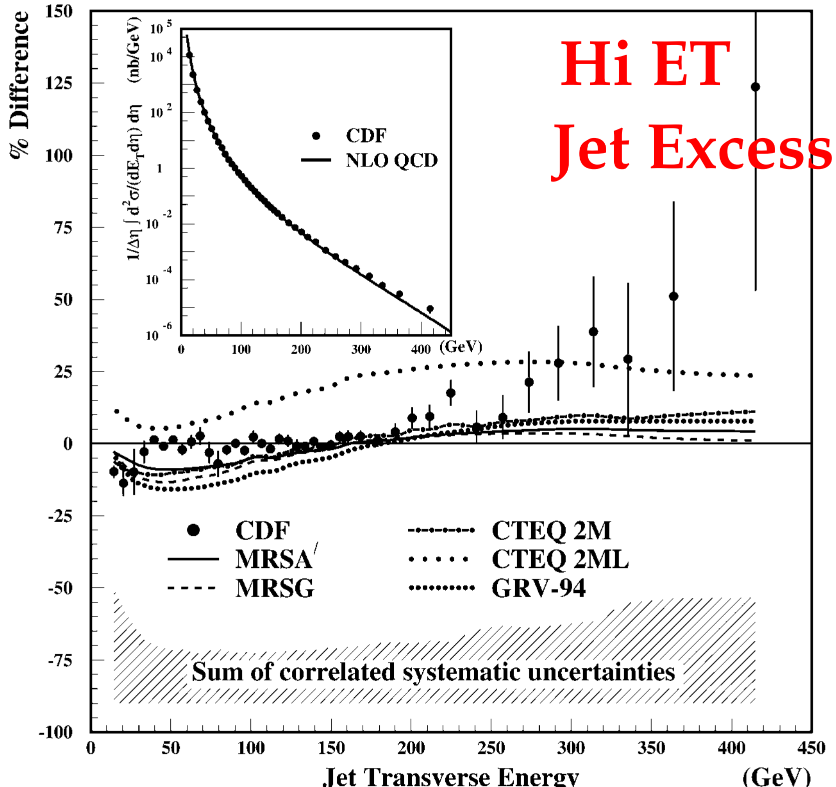
	Model	e, μ, τ, γ	Jets	E_T^{miss}	$\int \mathcal{L}\,dt$[fb^{-1}]	Mass limit		Data		Reference
Inclusive Searches	MSUGRA/CMSSM	0	2-6 jets	Yes	20.3	$\tilde{q}, \tilde{g}$	1.7 TeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{q})=m(\tilde{g})$	ATLAS-CONF-2013-047
	MSUGRA/CMSSM	1 e, μ	3-6 jets	Yes	20.3	$\tilde{g}$	1.2 TeV	$\sqrt{s}$ = 8 TeV full data	any $m(\tilde{q})$	ATLAS-CONF-2013-062
	MSUGRA/CMSSM	0	7-10 jets	Yes	20.3	$\tilde{g}$	1.1 TeV	$\sqrt{s}$ = 8 TeV full data	any $m(\tilde{q})$	1308.1841
	$\tilde{q}\tilde{q}, \tilde{q}\to q\tilde{\chi}_1^0$	0	2-6 jets	Yes	20.3	$\tilde{q}$	740 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-047
	$\tilde{g}\tilde{g}, \tilde{g}\to q\bar{q}\tilde{\chi}_1^0$	0	2-6 jets	Yes	20.3	$\tilde{g}$	1.3 TeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-047
	$\tilde{g}\tilde{g}, \tilde{g}\to qq\tilde{\chi}_1^\pm \to qqW^\pm\tilde{\chi}_1^0$	1 e, μ	3-6 jets	Yes	20.3	$\tilde{g}$	1.18 TeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$<200 GeV, $m(\tilde{\chi}^\pm)=0.5(m(\tilde{\chi}_1^0)+m(\tilde{g}))$	ATLAS-CONF-2013-062
	$\tilde{g}\tilde{g}, \tilde{g}\to qq(\ell\ell/\ell\nu/\nu\nu)\tilde{\chi}_1^0$	2 e, μ	0-3 jets	-	20.3	$\tilde{g}$	1.12 TeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-089
	GMSB ($\tilde{\ell}$ NLSP)	2 e, μ	2-4 jets	Yes	4.7	$\tilde{g}$	1.24 TeV	$\sqrt{s}$ = 7 TeV full data	tanβ<15	1208.4688
	GMSB ($\tilde{\ell}$ NLSP)	1-2 τ	0-2 jets	Yes	20.7	$\tilde{g}$	1.4 TeV	$\sqrt{s}$ = 8 TeV full data	tanβ >18	ATLAS-CONF-2013-026
	GGM (bino NLSP)	2 γ	-	Yes	4.8	$\tilde{g}$	1.07 TeV	$\sqrt{s}$ = 7 TeV full data	$m(\tilde{\chi}_1^0)$>50 GeV	1209.0753
	GGM (wino NLSP)	1 $e, \mu + \gamma$	-	Yes	4.8	$\tilde{g}$	619 GeV	$\sqrt{s}$ = 7 TeV full data	$m(\tilde{\chi}_1^0)$>50 GeV	ATLAS-CONF-2012-144
	GGM (higgsino-bino NLSP)	γ	1 b	Yes	4.8	$\tilde{g}$	900 GeV	$\sqrt{s}$ = 7 TeV full data	$m(\tilde{\chi}_1^0)$>220 GeV	1211.1167
	GGM (higgsino NLSP)	2 e, μ (Z)	0-3 jets	Yes	5.8	$\tilde{g}$	690 GeV	$\sqrt{s}$ = 8 TeV partial data	$m(\tilde{H})$>200 GeV	ATLAS-CONF-2012-152
	Gravitino LSP	0	mono-jet	Yes	10.5	$F^{1/2}$ scale	645 GeV	$\sqrt{s}$ = 8 TeV partial data	$m(\tilde{g})>10^{-4}$ eV	ATLAS-CONF-2012-147
3rd gen. $\tilde{g}$ med.	$\tilde{g}\to b\bar{b}\tilde{\chi}_1^0$	0	3 b	Yes	20.1	$\tilde{g}$	1.2 TeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$<600 GeV	ATLAS-CONF-2013-061
	$\tilde{g}\to t\bar{t}\tilde{\chi}_1^0$	0	7-10 jets	Yes	20.3	$\tilde{g}$	1.1 TeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$ <350 GeV	1308.1841
	$\tilde{g}\to t\bar{t}\tilde{\chi}_1^0$	0-1 e, μ	3 b	Yes	20.1	$\tilde{g}$	1.34 TeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$<400 GeV	ATLAS-CONF-2013-061
	$\tilde{g}\to b\bar{t}\tilde{\chi}_1^+$	0-1 e, μ	3 b	Yes	20.1	$\tilde{g}$	1.3 TeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$<300 GeV	ATLAS-CONF-2013-061
3rd gen. squarks direct production	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1\to b\tilde{\chi}_1^0$	0	2 b	Yes	20.1	$\tilde{b}_1$	100-620 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$<90 GeV	1308.2631
	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1\to t\tilde{\chi}_1^\pm$	2 e, μ (SS)	0-3 b	Yes	20.7	$\tilde{b}_1$	275-430 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^\pm)$=2 $m(\tilde{\chi}_1^0)$	ATLAS-CONF-2013-007
	$\tilde{t}_1\tilde{t}_1$(light), $\tilde{t}_1\to b\tilde{\chi}_1^\pm$	1-2 e, μ	1-2 b	Yes	4.7	$\tilde{t}_1$	110-167 GeV	$\sqrt{s}$ = 7 TeV full data	$m(\tilde{\chi}_1^0)$=55 GeV	1208.4305, 1209.2102
	$\tilde{t}_1\tilde{t}_1$(light), $\tilde{t}_1\to Wb\tilde{\chi}_1^0$	2 e, μ	0-2 jets	Yes	20.3	$\tilde{t}_1$	130-220 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)=m(\tilde{t}_1)-m(W)$-50 GeV, $m(\tilde{t}_1)<<m(\tilde{\chi}_1^\pm)$	ATLAS-CONF-2013-048
	$\tilde{t}_1\tilde{t}_1$(medium), $\tilde{t}_1\to t\tilde{\chi}_1^0$	2 e, μ	2 jets	Yes	20.3	$\tilde{t}_1$	225-525 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-065
	$\tilde{t}_1\tilde{t}_1$(medium), $\tilde{t}_1\to b\tilde{\chi}_1^\pm$	0	2 b	Yes	20.1	$\tilde{t}_1$	150-580 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$<200 GeV, $m(\tilde{\chi}_1^\pm)-m(\tilde{\chi}_1^0)$=5 GeV	1308.2631
	$\tilde{t}_1\tilde{t}_1$(heavy), $\tilde{t}_1\to t\tilde{\chi}_1^0$	1 e, μ	1 b	Yes	20.7	$\tilde{t}_1$	200-610 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-037
	$\tilde{t}_1\tilde{t}_1$(heavy), $\tilde{t}_1\to t\tilde{\chi}_1^0$	0	2 b	Yes	20.5	$\tilde{t}_1$	320-660 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-024
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to c\tilde{\chi}_1^0$	0	mono-jet/c-tag	Yes	20.3	$\tilde{t}_1$	90-200 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{t}_1)-m(\tilde{\chi}_1^0)$<85 GeV	ATLAS-CONF-2013-068
	$\tilde{t}_1\tilde{t}_1$(natural GMSB)	2 e, μ (Z)	1 b	Yes	20.7	$\tilde{t}_1$	500 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$>150 GeV	ATLAS-CONF-2013-025
	$\tilde{t}_2\tilde{t}_2, \tilde{t}_2\to\tilde{t}_1 + Z$	3 e, μ (Z)	1 b	Yes	20.7	$\tilde{t}_2$	271-520 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{t}_1)=m(\tilde{\chi}_1^0)$+180 GeV	ATLAS-CONF-2013-025
EW direct	$\tilde{\ell}_{L,R}\tilde{\ell}_{L,R}, \tilde{\ell}\to\ell\tilde{\chi}_1^0$	2 e, μ	0	Yes	20.3	$\tilde{\ell}$	85-315 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-049
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to\tilde{\ell}\nu(\ell\tilde{\nu})$	2 e, μ	0	Yes	20.3	$\tilde{\chi}_1^\pm$	125-450 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$=0 GeV, $m(\tilde{\ell}, \tilde{\nu})=0.5(m(\tilde{\chi}_1^\pm)+m(\tilde{\chi}_1^0))$	ATLAS-CONF-2013-049
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to\tilde{\tau}\nu(\tau\tilde{\nu})$	2 τ	-	Yes	20.7	$\tilde{\chi}_1^\pm$	180-330 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$=0 GeV, $m(\tilde{\tau}, \tilde{\nu})=0.5(m(\tilde{\chi}_1^\pm)+m(\tilde{\chi}_1^0))$	ATLAS-CONF-2013-028
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\to\tilde{\ell}_L\nu\tilde{\ell}_L\ell(\tilde{\nu}\nu), \ell\tilde{\nu}\tilde{\ell}_L\ell(\tilde{\nu}\nu)$	3 e, μ	0	Yes	20.7	$\tilde{\chi}_1^\pm, \tilde{\chi}_2^0$	600 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^\pm)=m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, $m(\tilde{\ell}, \tilde{\nu})=0.5(m(\tilde{\chi}_1^\pm)+m(\tilde{\chi}_1^0))$	ATLAS-CONF-2013-035
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\to W\tilde{\chi}_1^0 Z\tilde{\chi}_1^0$	3 e, μ	0	Yes	20.7	$\tilde{\chi}_1^\pm, \tilde{\chi}_2^0$	315 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^\pm)=m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, sleptons decoupled	ATLAS-CONF-2013-035
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\to W\tilde{\chi}_1^0 h\tilde{\chi}_1^0$	1 e, μ	2 b	Yes	20.3	$\tilde{\chi}_1^\pm, \tilde{\chi}_2^0$	285 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^\pm)=m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, sleptons decoupled	ATLAS-CONF-2013-093
Long-lived particles	Direct $\tilde{\chi}_1^+\tilde{\chi}_1^-$ prod., long-lived $\tilde{\chi}_1^\pm$	Disapp. trk	1 jet	Yes	20.3	$\tilde{\chi}_1^\pm$	270 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^\pm)-m(\tilde{\chi}_1^0)$=160 MeV, $\tau(\tilde{\chi}_1^\pm)$=0.2 ns	ATLAS-CONF-2013-069
	Stable, stopped $\tilde{g}$ R-hadron	0	1-5 jets	Yes	22.9	$\tilde{g}$	832 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$=100 GeV, 10 μs<$\tau(\tilde{g})$<1000 s	ATLAS-CONF-2013-057
	GMSB, stable $\tilde{\tau}, \tilde{\chi}_1^0\to\tilde{\tau}(\tilde{e}, \tilde{\mu})+\tau(e, \mu)$	1-2 μ	-	-	15.9	$\tilde{\chi}_1^0$	475 GeV	$\sqrt{s}$ = 8 TeV partial data	10<tanβ<50	ATLAS-CONF-2013-058
	GMSB, $\tilde{\chi}_1^0\to\gamma\tilde{G}$, long-lived $\tilde{\chi}_1^0$	2 γ	-	Yes	4.7	$\tilde{\chi}_1^0$	230 GeV	$\sqrt{s}$ = 7 TeV full data	0.4<$\tau(\tilde{\chi}_1^0)$<2 ns	1304.6310
	$\tilde{q}\tilde{q}, \tilde{\chi}_1^0\to qq\mu$ (RPV)	1 μ, displ. vtx	-	-	20.3	$\tilde{q}$	1.0 TeV	$\sqrt{s}$ = 8 TeV full data	1.5 <$c\tau$<156 mm, BR(μ)=1, $m(\tilde{\chi}_1^0)$=108 GeV	ATLAS-CONF-2013-092
RPV	LFV $pp\to\tilde{\nu}_\tau + X, \tilde{\nu}_\tau\to e + \mu$	2 e, μ	-	-	4.6	$\tilde{\nu}_\tau$	1.61 TeV	$\sqrt{s}$ = 7 TeV full data	λ'_{311}=0.10, λ_{132}=0.05	1212.1272
	LFV $pp\to\tilde{\nu}_\tau + X, \tilde{\nu}_\tau\to e(\mu) + \tau$	1 $e, \mu + \tau$	-	-	4.6	$\tilde{\nu}_\tau$	1.1 TeV	$\sqrt{s}$ = 7 TeV full data	λ'_{311}=0.10, $\lambda_{1(2)33}$=0.05	1212.1272
	Bilinear RPV CMSSM	1 e, μ	7 jets	Yes	4.7	$\tilde{q}, \tilde{g}$	1.2 TeV	$\sqrt{s}$ = 7 TeV full data	$m(\tilde{q})=m(\tilde{g})$, $c\tau_{LSP}$<1 mm	ATLAS-CONF-2012-140
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to W\tilde{\chi}_1^0, \tilde{\chi}_1^0\to ee\tilde{\nu}_\mu, e\mu\tilde{\nu}_e$	4 e, μ	-	Yes	20.7	$\tilde{\chi}_1^\pm$	760 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$>300 GeV, λ_{121}>0	ATLAS-CONF-2013-036
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to W\tilde{\chi}_1^0, \tilde{\chi}_1^0\to\tau\tau\tilde{\nu}_e, e\tau\tilde{\nu}_\tau$	3 $e, \mu + \tau$	-	Yes	20.7	$\tilde{\chi}_1^\pm$	350 GeV	$\sqrt{s}$ = 8 TeV full data	$m(\tilde{\chi}_1^0)$>80 GeV, λ_{133}>0	ATLAS-CONF-2013-036
	$\tilde{g}\to qqq$	0	6-7 jets	-	20.3	$\tilde{g}$	916 GeV	$\sqrt{s}$ = 8 TeV full data	BR(t)=BR(b)=BR(c)=0%	ATLAS-CONF-2013-091
	$\tilde{g}\to\tilde{t}_1 t, \tilde{t}_1\to bs$	2 e, μ (SS)	0-3 b	Yes	20.7	$\tilde{g}$	880 GeV	$\sqrt{s}$ = 8 TeV full data		ATLAS-CONF-2013-007
Other	Scalar gluon pair, sgluon$\to q\bar{q}$	0	4 jets	-	4.6	sgluon	100-287 GeV	$\sqrt{s}$ = 7 TeV full data	incl. limit from 1110.2693	1210.4826
	Scalar gluon pair, sgluon$\to t\bar{t}$	2 e, μ (SS)	1 b	Yes	14.3	sgluon	800 GeV	$\sqrt{s}$ = 8 TeV partial data		ATLAS-CONF-2013-051
	WIMP interaction (D5, Dirac χ)	0	mono-jet	Yes	10.5	M* scale	704 GeV	$\sqrt{s}$ = 8 TeV partial data	$m(\chi)$<80 GeV, limit of<687 GeV for D8	ATLAS-CONF-2012-147

$\sqrt{s}$ = 7 TeV full data | $\sqrt{s}$ = 8 TeV partial data | $\sqrt{s}$ = 8 TeV full data

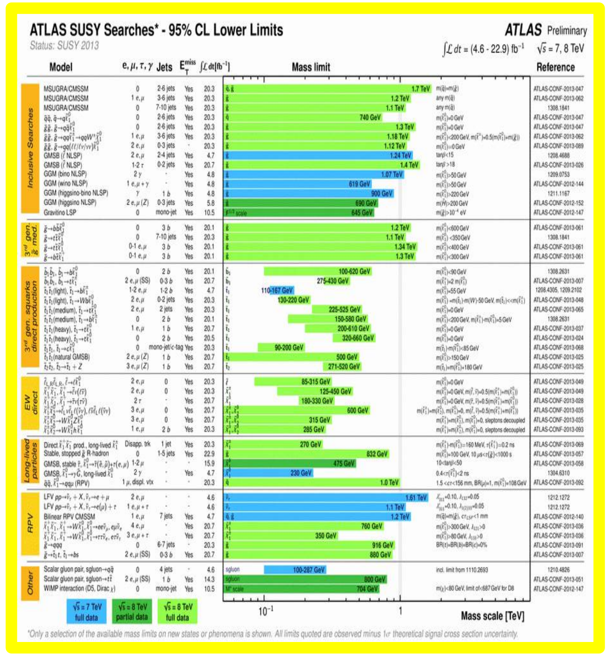
10^{-1} 1 Mass scale [TeV]

*Only a selection of the available mass limits on new states or phenomena is shown. All limits quoted are observed minus 1σ theoretical signal cross section uncertainty.

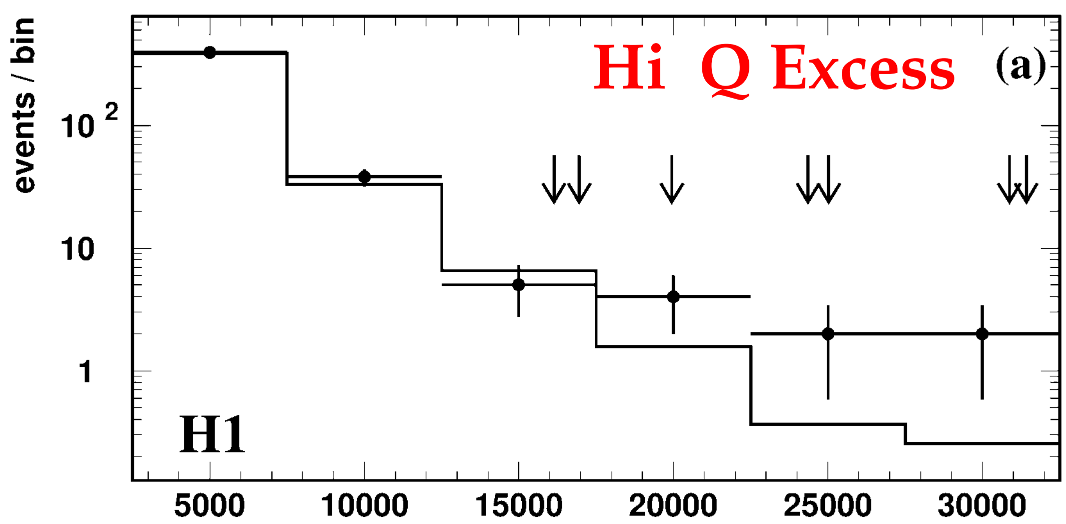
… what keep me awake at night ...



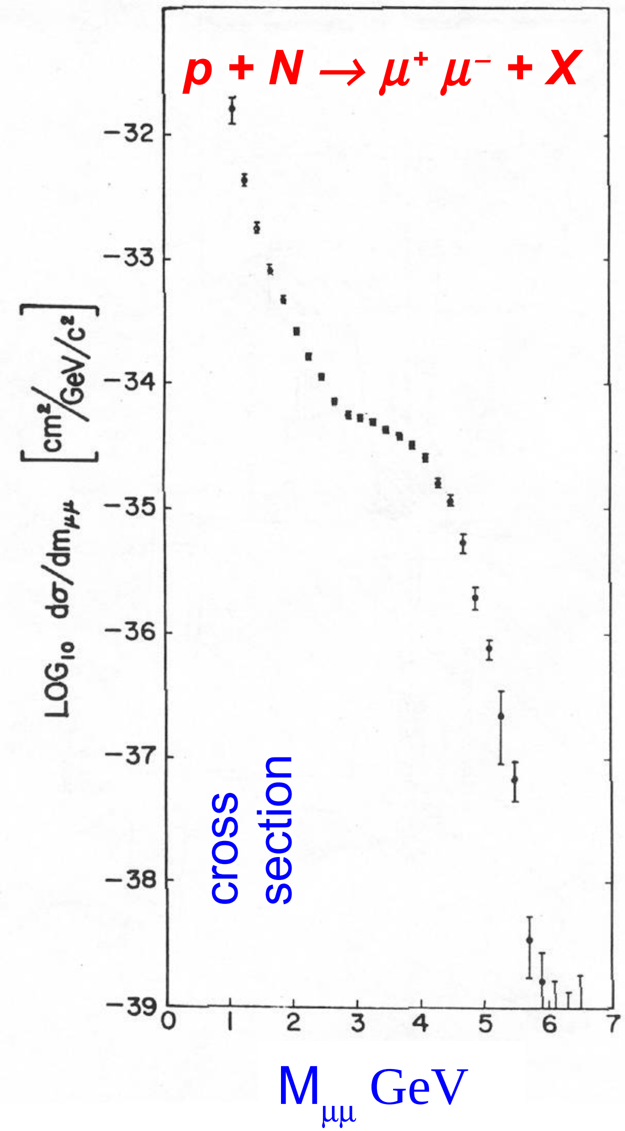
CDF Collaboration, PRL 77, 438 (1996)



Can you find the Nobel Prize???



H1 Collaboration, ZPC74, 191 (1997)
ZEUS Collaboration, ZPC74, 207 (1997)



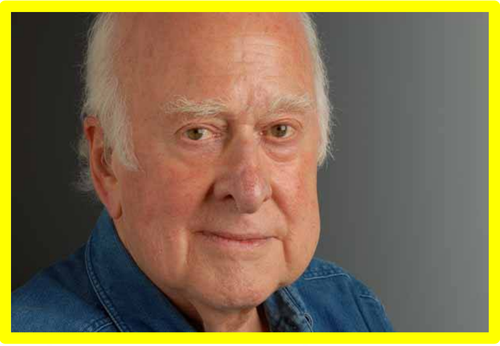
Happy Higgs Hunting!!!

PHYSICAL REVIEW D VOLUME 38, NUMBER 11 1 DECEMBER 1988

Production mechanisms for nonminimal Higgs bosons at an e^+e^- collider

J. F. Gunion, L. Roszkowski,* and A. Turski*
Department of Physics, University of California, Davis, California 95616

H. E. Haber
Santa Cruz Institute for Particle Physics, University of California, Santa Cruz, California 95064



;. Gamberini, B. Kayser,† and S. F. Novaes
ence Berkeley Laboratory, Berkeley, California 94720

F. Olness
Physics, Illinois Institute of Technology, Chicago, Illinois 60616

J. Wudka
Laboratory, University of Michigan, Ann Arbor, Michigan 48109

(Received 20 April 1988)