HERAFitter

www.herafitter.org

the first open source QCD fit framework to determine Parton Density Functions (PDFs) of the Proton

Allows to study the impact of new experimental data on PDFs

THEORETICAL PREDICTIONS

DIS inclusive processes in *ep* and fixed target

DGLAP formalism: QCDNUM: Comput.Phys.Commun.182:490-532,2011

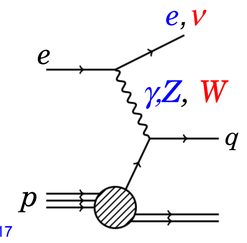
different schemes of heavy quark treatment

VFNS: RT (MSTW), ACOT (CTEQ)

A. D. Martin, Eur. Phys. J. C 63, 189 (2009), arXiv:1201.6180 J. C. Collins, Phys.Rev. D58, 094002 (1998)

FFNS (pole and running mass)

http://www-zeuthen.desy.de/~alekhin/OPENQCDRAD/



non-DGLAP formalism:

Dipole Models (GBW, IIM, BGK) Phys.Rev.D86 (2012) 074017

– an alternative approach for the low x region

Unintegrated PDFs arXiv:1206.1796

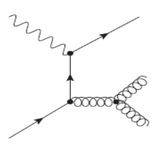
– based on CCFM evolution

Jet production (*ep, pp, pp̄*)

FastNLO and APPLGRID techniques

hep-ph/1208.3641 Eur.Phys.J.C66:503-524,2010

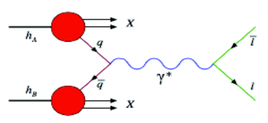
- decoupled hard scattering coefficients from PDFs stored on grids



W, Z/γ* processes (*pp, pp̄*)

NLO calculation x NNLO k-factors

APPLGRID technique Eur.Phys.J.C66:503-524,2010



Top pair production

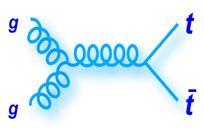
Full NNLO $t\bar{t}$ total cross section with HATHOR

Flexible package to calculate approx NNLO differential $t\bar{t}$ cross sections:

p_t, y_t, $M_{t\bar{t}}$, $y_{t\bar{t}}$ (under development)

Insight into gluon PDF, α_s, mass of the top quark

(crucial for physics beyond Standard Model)

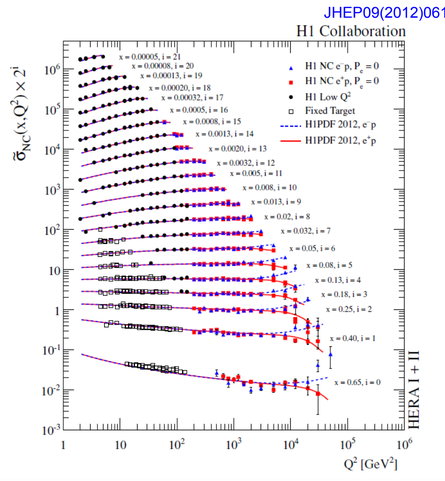


EXPERIMENTAL DATA

→ different data from *ep, pp* and *pp̄* colliders can be used in the QCD fits to constrain PDFs in various kinematic domains

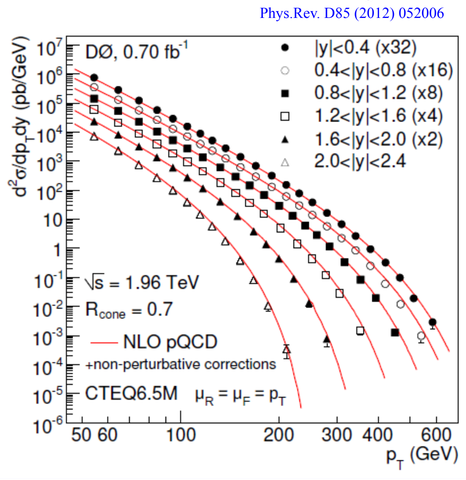
HERA inclusive DIS

JHEP09(2012)061



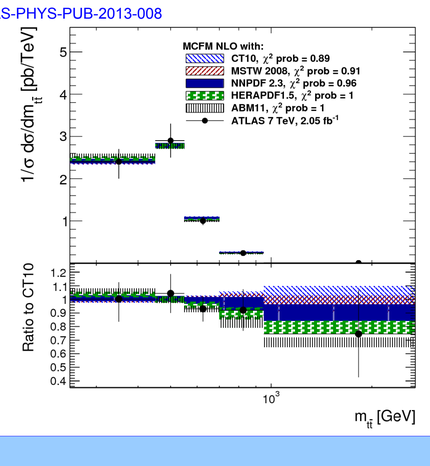
Tevatron inclusive jets

Phys.Rev. D85 (2012) 052006



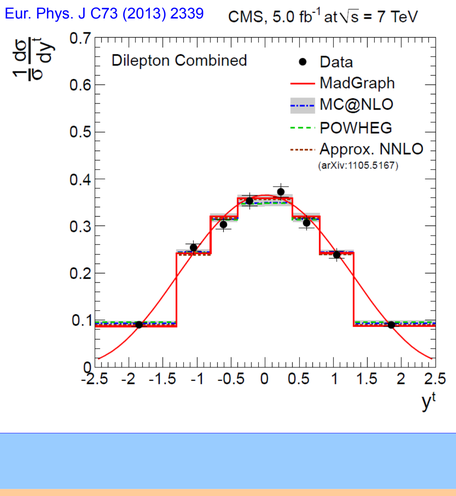
Top quark pair production at LHC - ATLAS

ATLAS-PHYS-PUB-2013-008



Top quark pair production at LHC - CMS

Eur. Phys. J C73 (2013) 2339

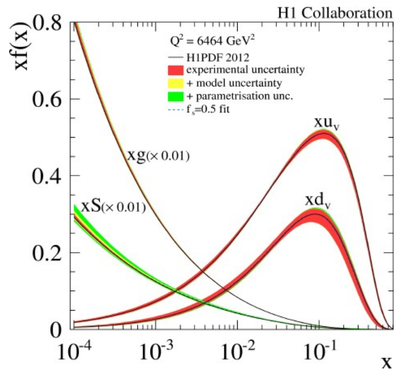


RESULTS USING HERAFitter

examples from HERA experiments:

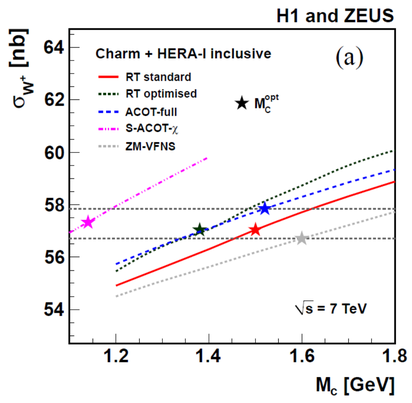
PDF determination from final H1 inclusive data

JHEP 09 (2012) 061



QCD analysis of combined HERA charm data

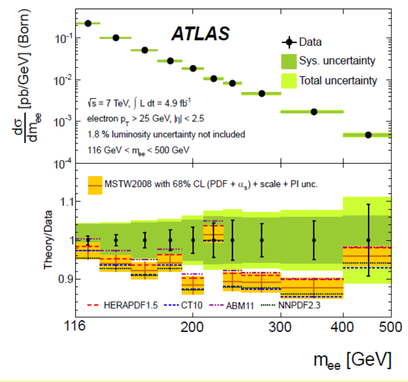
Eur.Phys.J. C73(2012) 2311



examples from LHC experiments:

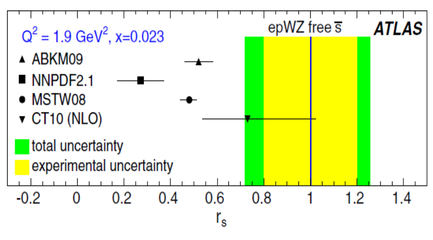
ATLAS measurement of high-mass Drell-Yan cross sections

arXiv:1305.4192



Determination of the s quark density from ATLAS W/Z measurements

Phys.Rev.Lett. 109 (2012) 012001



Actively used by experimental and theoretical high energy physics communities

FUNCTIONALITY

χ^2 function

→ nuisance parameters: $\chi^2 = \sum_i \frac{(D_i - T_i^*)^2}{(\delta_i^{unc})^2}$

D - Data

T - Theory

$T_i^* = T_i + \sum_j \xi_j \delta_i^{cor,j}$ (Correlated error; Nuisance parameter)

→ covariance matrix: $\chi^2 = \sum_{i,j} (D_i - T_i) Cov_{i,j}^{-1} (D_j - T_j)$

→ mixed

Various types of uncertainty treatment for experimental data:

→ Hessian Error inflation by a tolerance parameter (nuisance) to accommodate inconsistencies between data sets Phys.Rev. D65 (2001) 014013, [hep-ph/0101032]

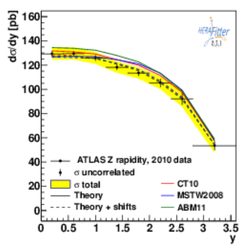
→ Monte Carlo MC replica method shifting data cross section points randomly within their uncertainties Phys.Rev. D58 (1998) 094023, [hep-ph/9803393]

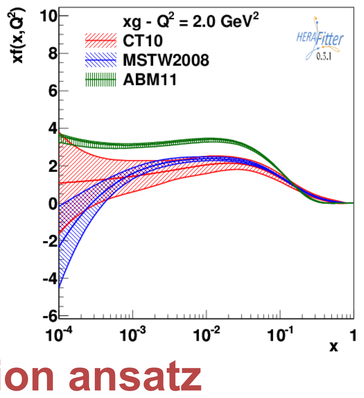
→ Offset Eur. Phys. J. C14, 285 (2000), Phys. Rev. D 67 012007 (2003)

Drawing tools

Plot and compare PDFs (via LHAPDF)

- Compare different PDF sets to data
- Estimate agreement with χ^2 function





Various forms of parametrisation ansatz

→ HERAPDF, CTEQ style, Chebyshev, bi-log normal

JHEP 1001:109 (2010) arXiv:1302.6246 Phys. Let. B 695 (2011) 238

Bayesian Reweighting technique

Nucl.Phys. B855, 608 (2012) [arXiv:1108.1758] JHEP 1208, 052 (2012) [arXiv:1205.4024]

→ a method to study data sensitivity on PDFs without fitting the data

ISMD 2013

Chicago, IL, USA, 15th-20th September 2013

Pavel Starovoitov

PHYSICS AT THE TERA SCALE Helmholtz Alliance