



HERAFitter

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), J. C. Collins, Phys.Rev. D58, 094002 (1998) arXiv:1201.6180

FFNS (pole and running mass)

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

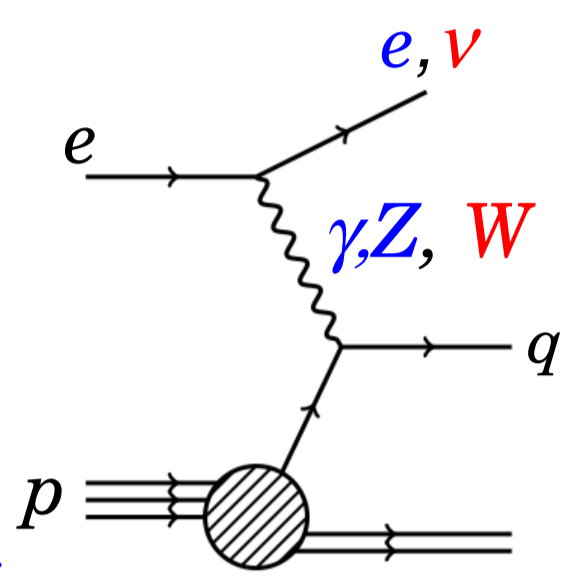
non-DGLAP formalism:

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



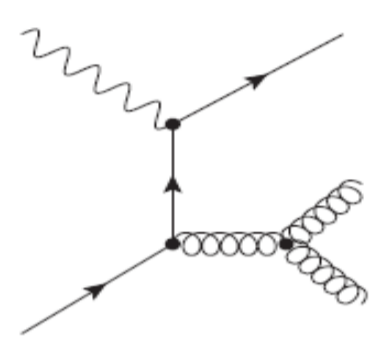
Jet production (ep, pp, p̄p̄)

FastNLO and APPLGRID techniques

hep-ph/1208.3641

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

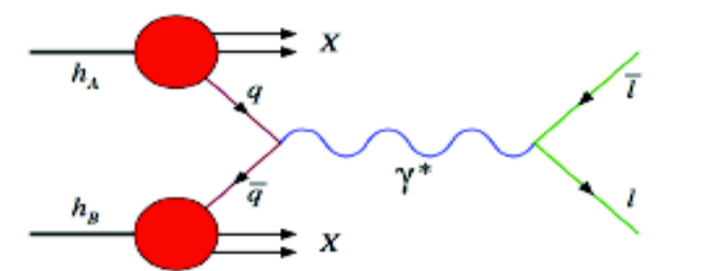
- decoupled hard scattering coefficients from PDFs stored on grids



W, Z/γ* processes (pp, p̄p̄)

NLO calculation x NNLO k-factors

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



Top pair production

Full NNLO t̄t̄ total cross section with HATHOR

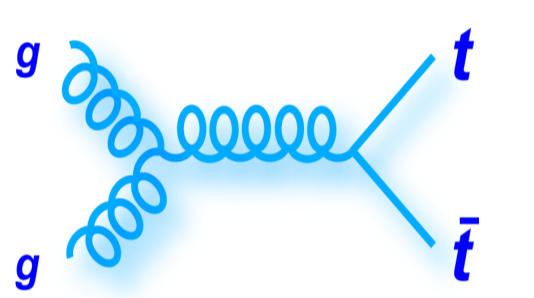
Flexible package to calculate approx NNLO

differential t̄t̄ cross sections:

p_T, y_T, M_{t̄t̄}, y_{t̄t̄} (under development)

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

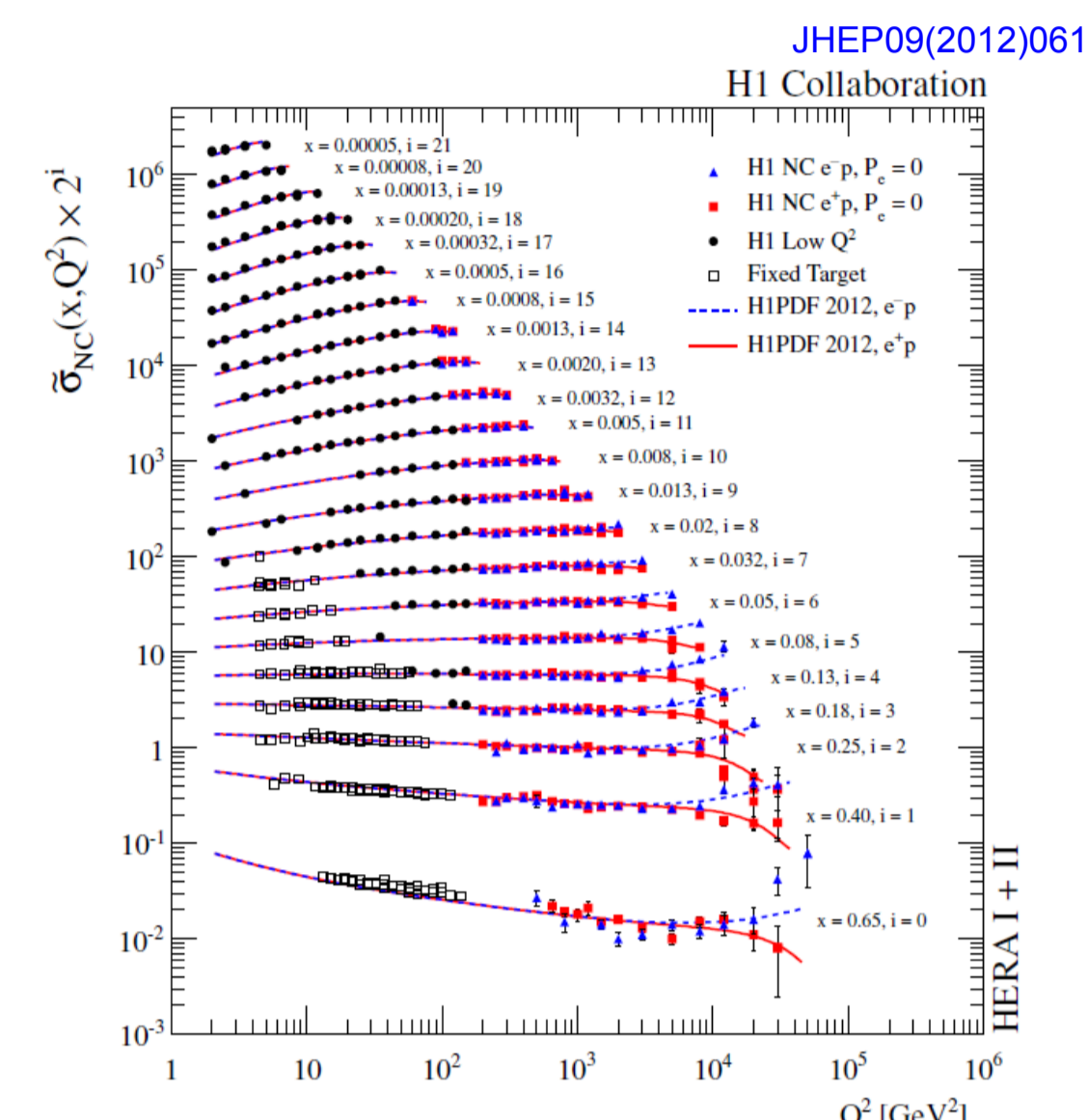
(crucial for physics beyond Standard Model)



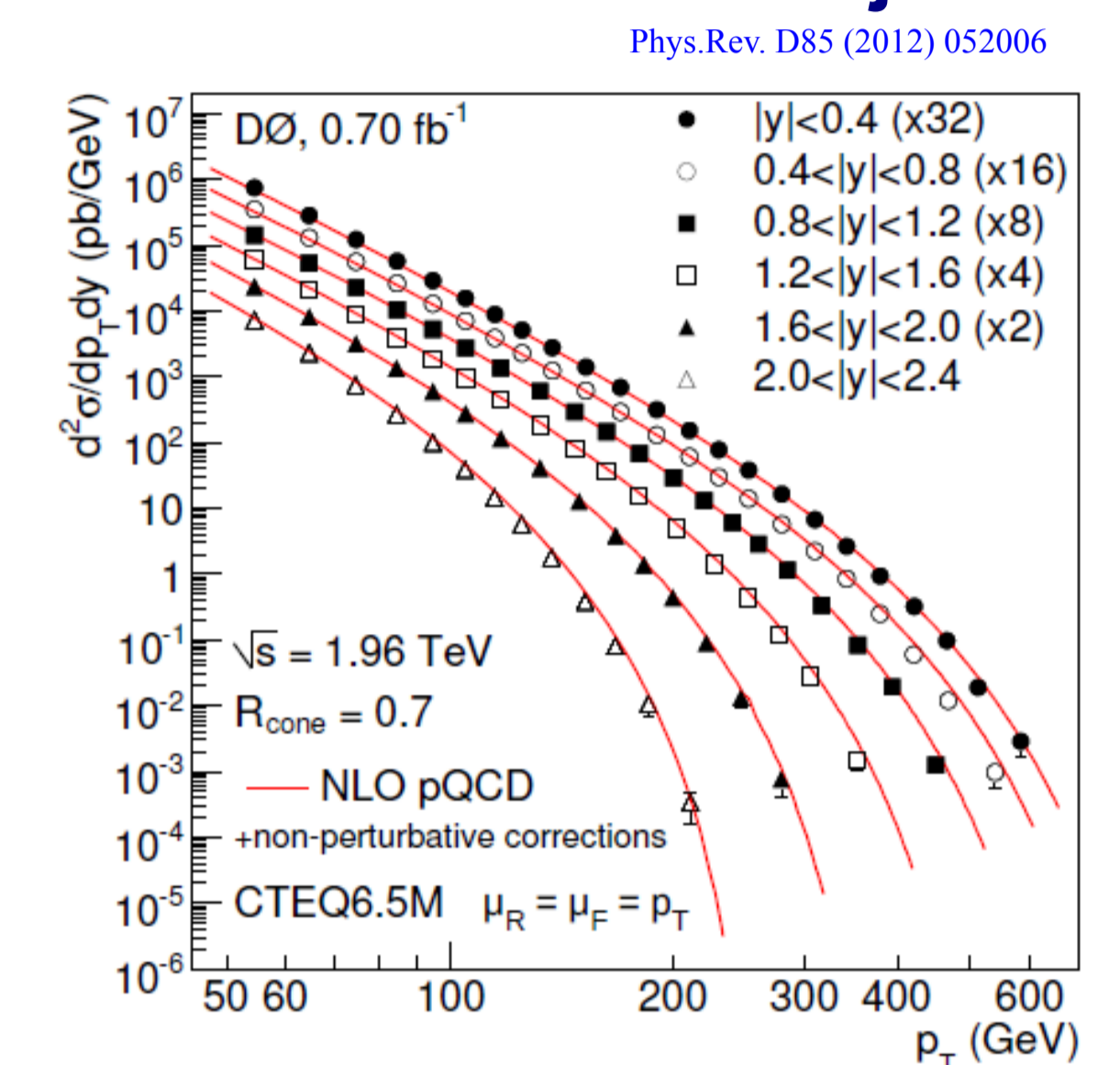
EXPERIMENTAL DATA

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

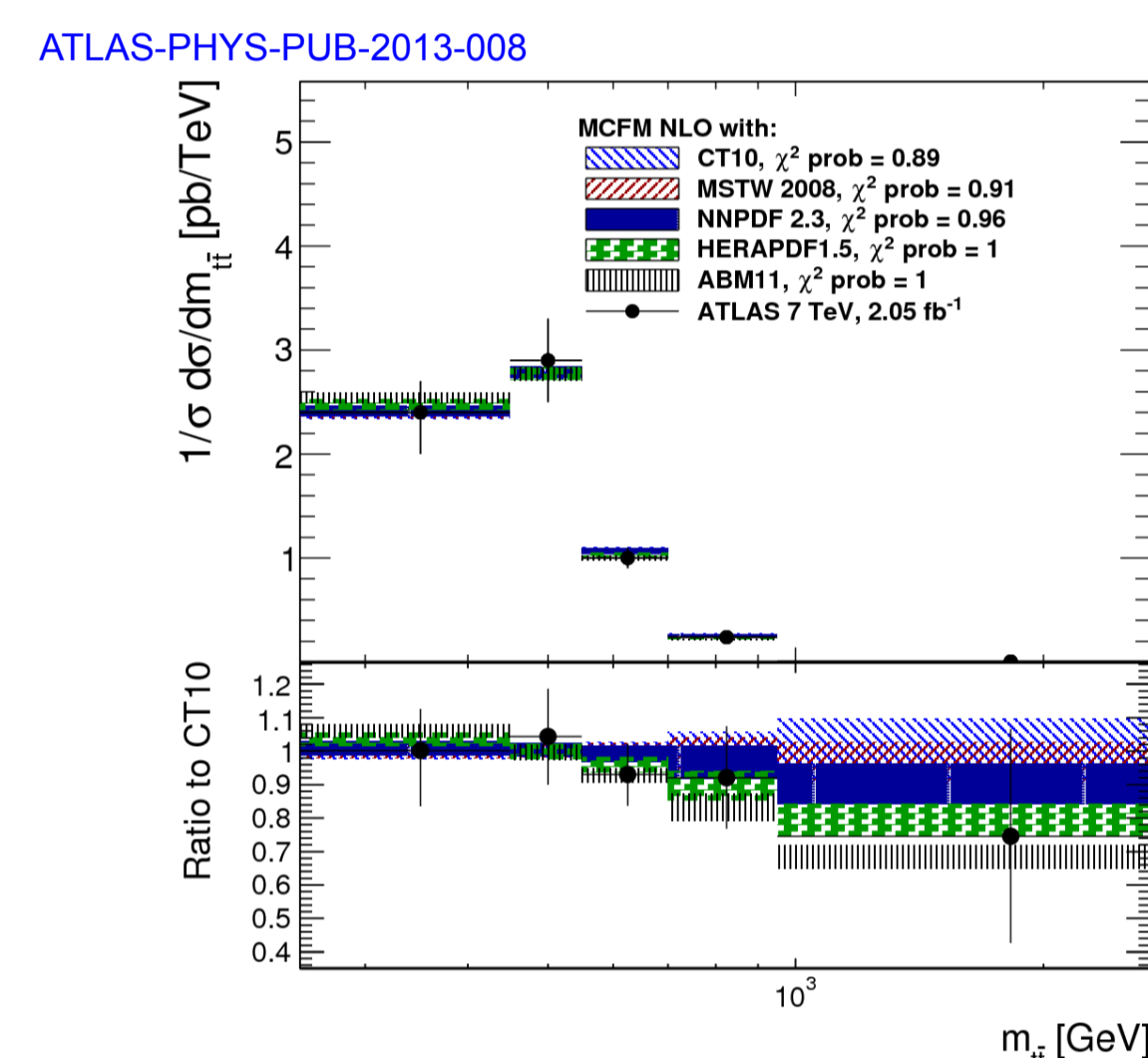
HERA inclusive DIS



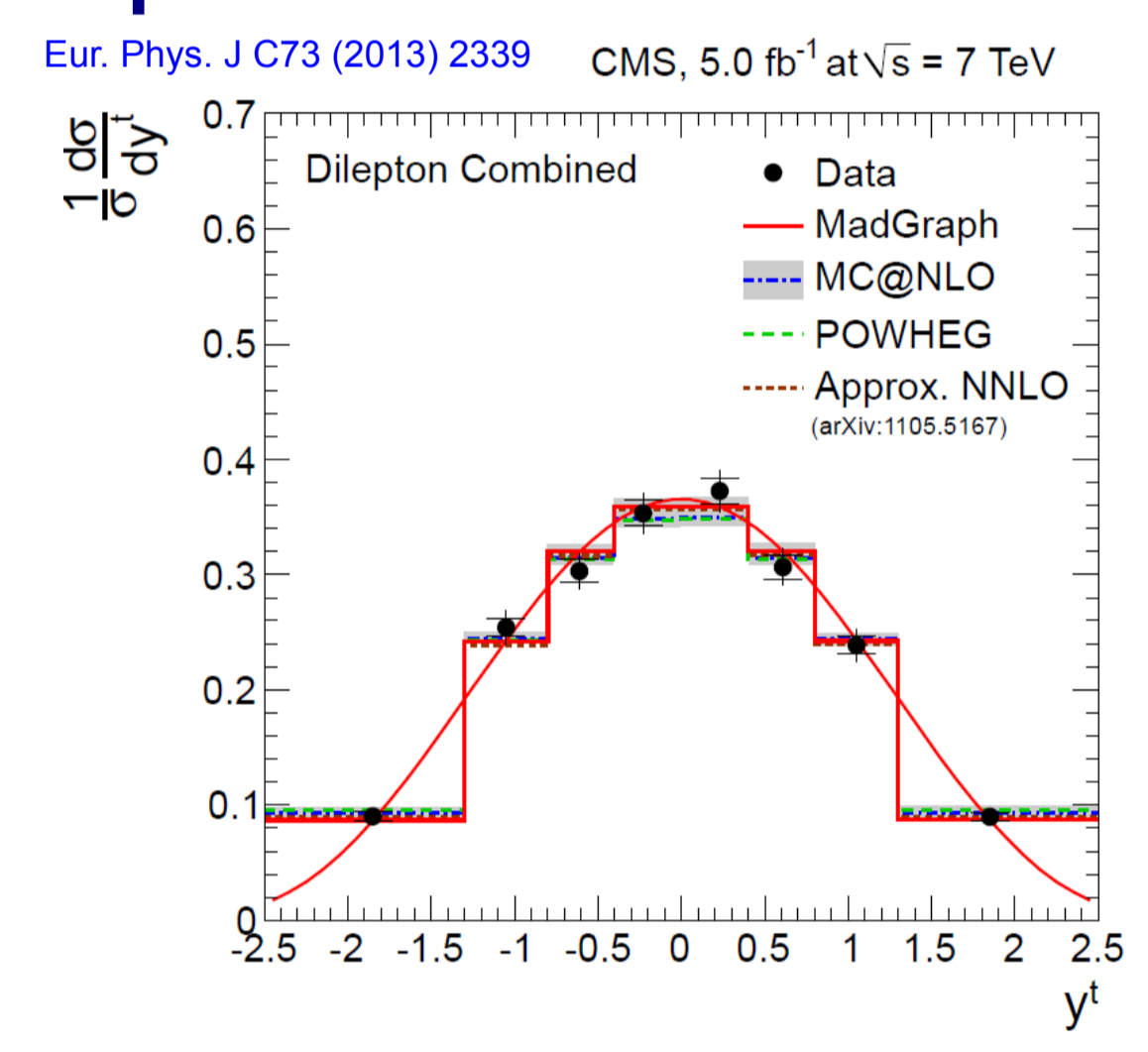
Tevatron inclusive jets



Top quark pair production at LHC - ATLAS



Top quark pair production at LHC - CMS

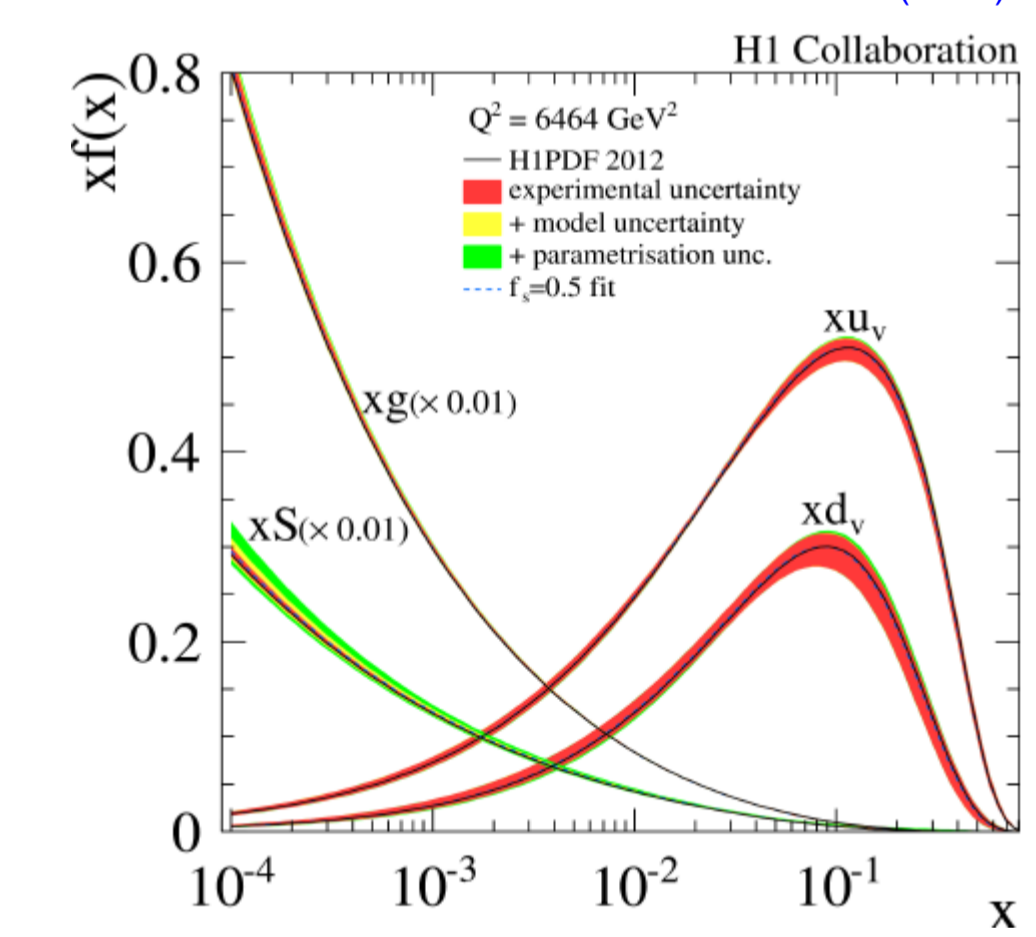


RESULTS USING HERAFitter

examples from HERA experiments:

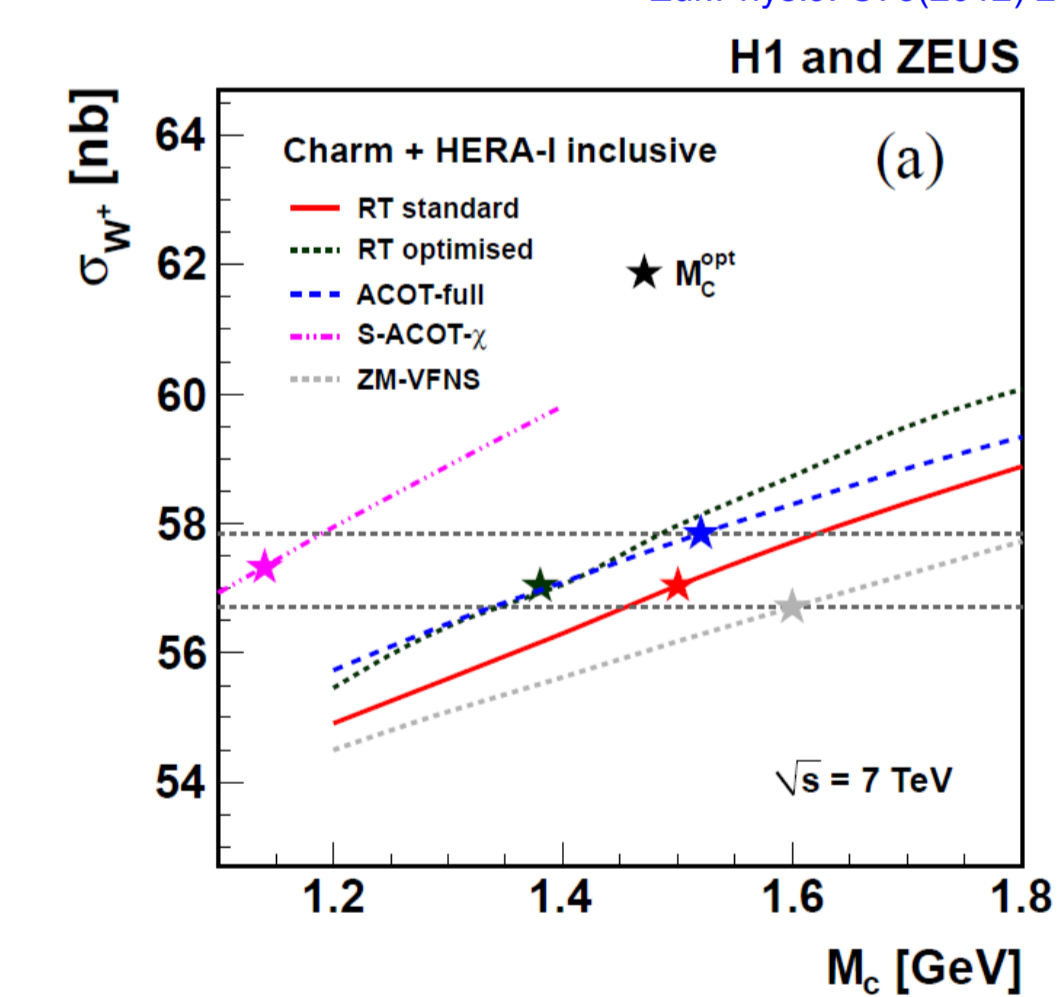
PDF determination from final H1 inclusive data

JHEP 09 (2012) 061



QCD analysis of combined HERA charm data

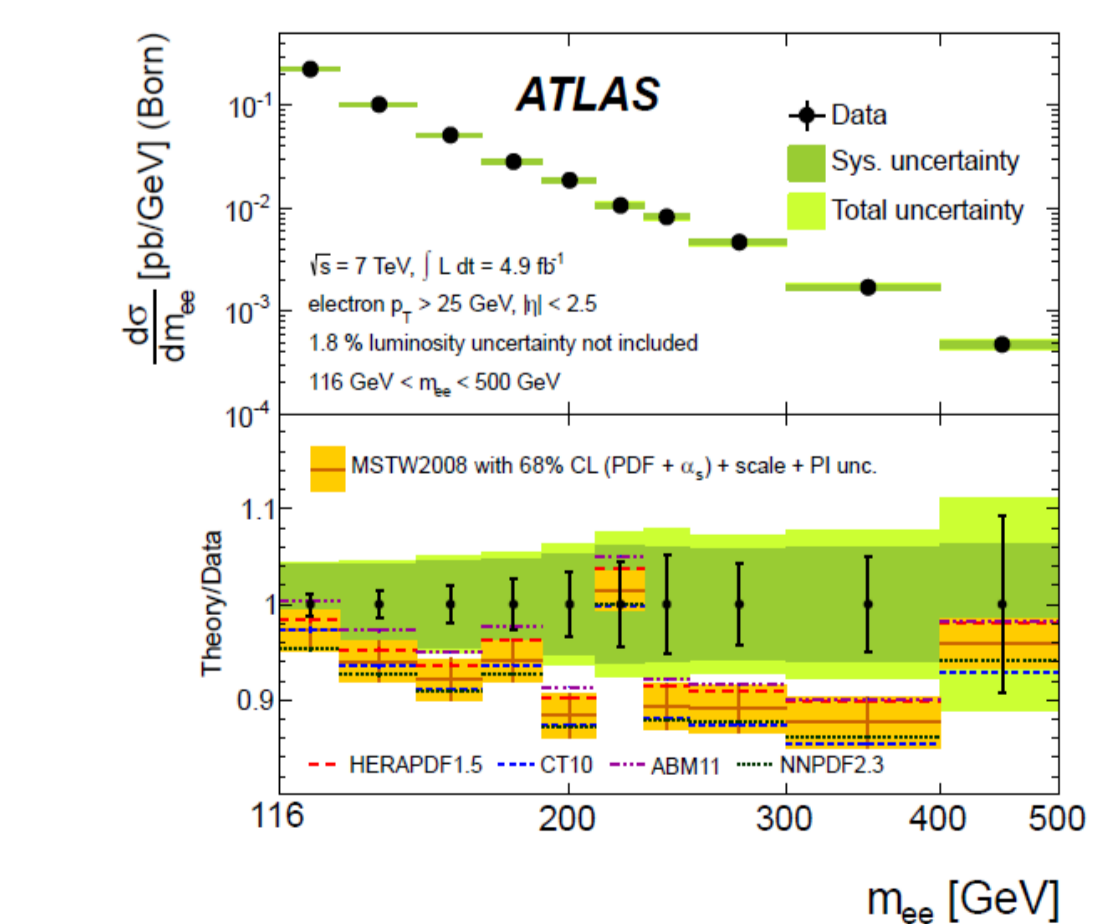
Eur.Phys.J. C73(2012) 2311



examples from LHC experiments:

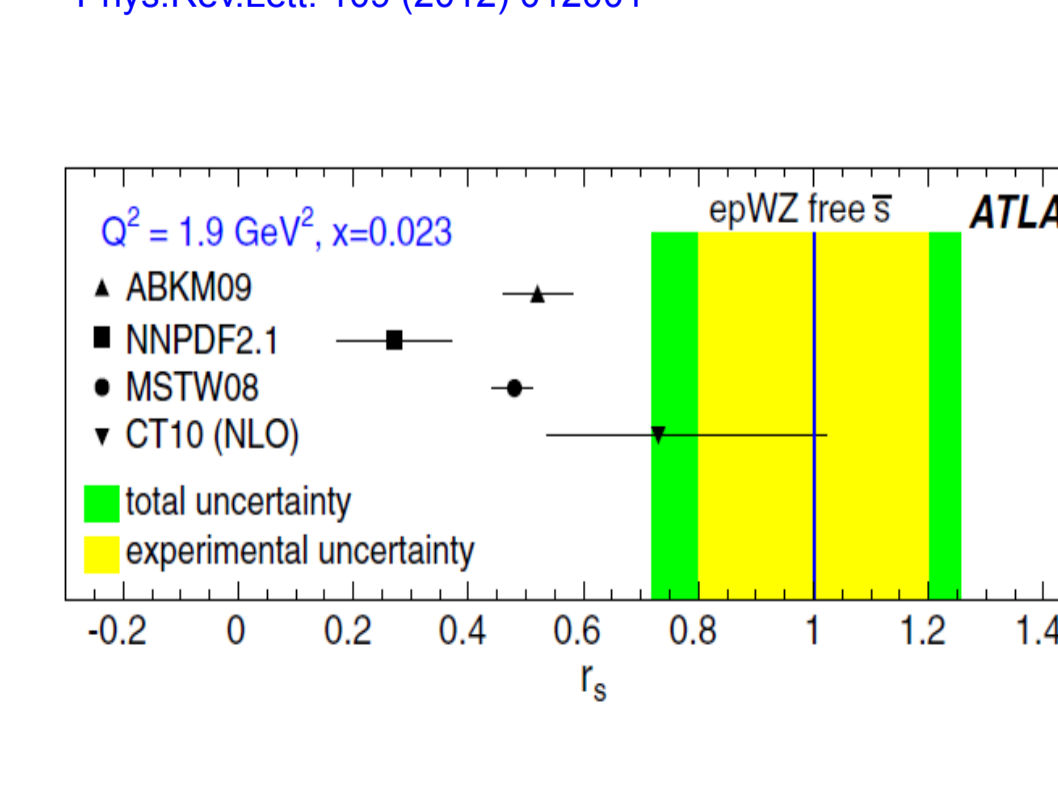
ATLAS measurement of high-mass Drell-Yan cross sections

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

χ² function

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

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

→ mixed

D - Data
T - Theory

$T_i^* = T_i + \sum_j \xi_j \delta_i^{cor,j}$
Correlated error

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]

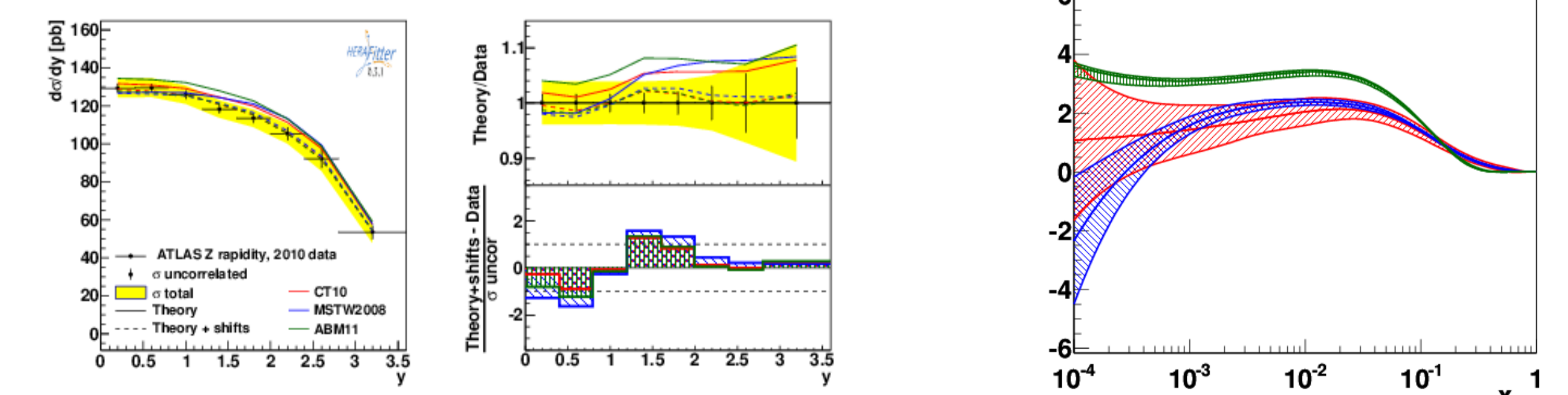
→ Offset

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 χ² function



Various forms of parametrisation ansatz

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

JHEP 1001:109 (2010) arXiv:1302.6246 Phys. Lett. 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



TOP 2013
Durbach, Germany, 14th-19th September 2013

Stefano Camarda

