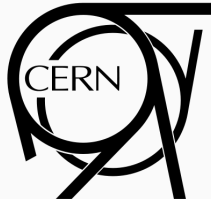


CERN THEORY GROUP RETREAT 2015

Stefano Carrazza

Les Houches, 4-6 November 2015



Stefano Carrazza

Curriculum Vitae

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Research Interests

Electroweak corrections to parton distribution functions (PDFs), LHC phenomenology, Monte Carlo event generators, simulation/computational tools for high-energy physics. Advanced computational methods and tools for complex systems.

Education

- 2011 → 2015 **PhD in Theoretical Physics**, *Università degli Studi di Milano*, Milan, Italy.
Parton distribution functions with QED corrections.
Advisor: Prof. Stefano Forte
- 2009 → 2011 **Master Degree in Physics**, *École Normale Supérieure*, Lyon, France.
Particle physics and quantum field theory.
- 2006 → 2009 **Bachelor Degree in Physics**, *École Normale Supérieure*, Lyon, France.
Physics and matter sciences.

Professional Experience

Internships in Research

- April – August 2011 **Internship and master thesis in Experimental Particle Physics**, *CERN*, Geneva.
Thesis title Strange particle production in heavy-ion collisions with the ALICE experiment at CERN LHC.
Advisors Dr. Cvetan Chechkov and Dr. Peter Hristov
- May – August 2010 **Internship in Particle Physics and Computing**, *CERN*, Geneva.
Thesis title Study of particle identification and jet reconstruction performance of the ALICE detector at LHC.
Advisor Dr. Matevz Tadel
- June – July 2009 **Internship and bachelor thesis in Cavity QED**, *LKB, École Normale Supérieure*, Paris.
Thesis title Non-local fields.
Advisors Prof. Serge Haroche (Nobel Prize in Physics 2012) and Prof. Jean-Michel Raimond
- June – July 2008 **Internship in Nonlinear Optics**, *LASIM*, Lyon.
Thesis title Frequency doubling and Hyper Rayleigh scattering.
Advisor Prof. Pierre-François Brevet

· <http://cern.ch/stefano.carrazza>



CERN TH Fellow.

About me:

I am a research fellow in theoretical particle physics at CERN. I am interested in:

Physics topics: PDF determination, LHC phenomenology, QED and EW corrections, Monte Carlo event generators and information theory.

Economics topics: scientometrics, knowledge propagation in science.

Contact: PH-TH Group, CERN, CH-1211 Geneva 23, Switzerland, Phone: +41 22 767 2452, Office: 4/2-060. [e-mail](#)

My research projects:



Neural network parton distribution function



Web-app for PDF plots



Monte Carlo to Hessian PDF transformation



Monte Carlo PDF replicas compression



A PDF evolution library



Compressed Monte Carlo PDF



A histogramming library for Monte Carlo programs



Mellin evolution library



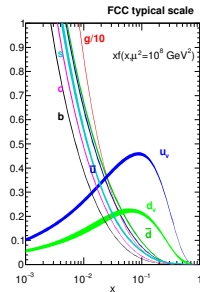
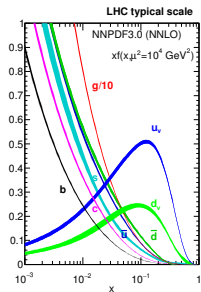
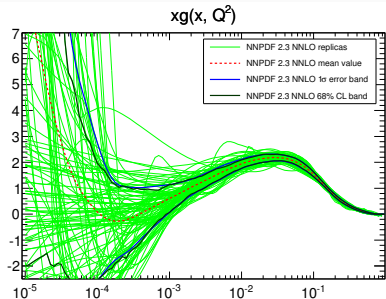
Cavity QED simulation library



Hyper Rayleigh Scattering simulation

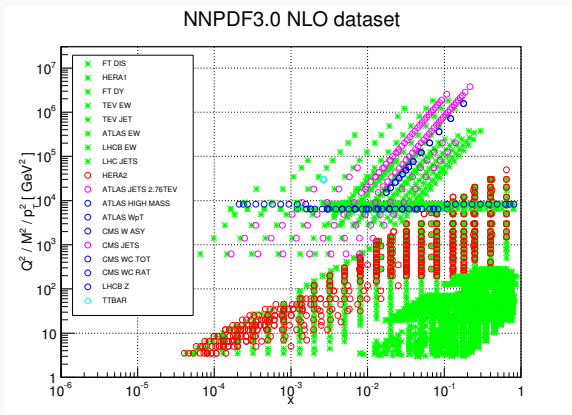
NNPDF Neural Networks Parton Distribution Functions

- PDFs are extracted by using:
 - Neural Network parametrization
 - Minimization driven by a **genetic algorithm**
 - Optimization controlled by **training/validation method**
 - Monte Carlo** representation of results
- Expectation values for observables are Monte Carlo integrals.



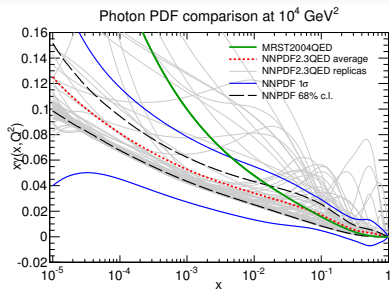
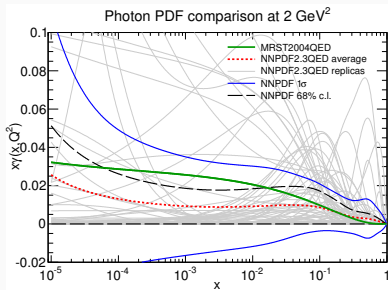
Last release: NNPDF3.0 (arXiv:1410.8849)

- Total Dataset: 4276/4078 (NLO/NNLO) datapoints.



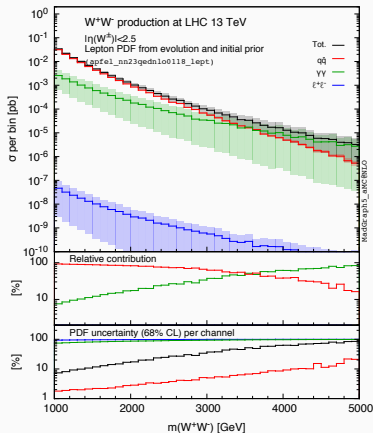
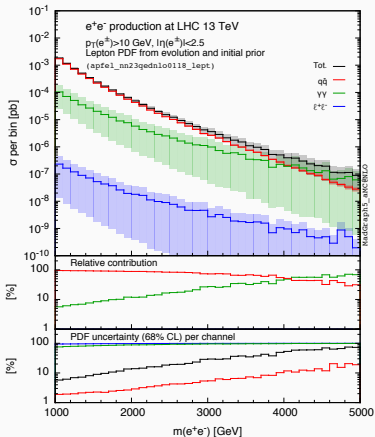
PDFS WITH QED CORRECTIONS

- QED corrections to PDFs:
 - determination and phenomenological implications of the photon PDF.
- **Last release:** NNPDF2.3QED (arXiv:1308.0598)
 - set of PDFs with the photon PDF and its uncertainty from DIS+LHC data.
 - The photon PDF momentum fraction is less than 1%



- **Issues to improve:** large x uncertainties \Rightarrow include more LHC data.

- An example of phenomenological implication (arXiv:1508.07002):
 - Drell-Yan high mass & diboson production



- **APFEL** is “A Parton distribution Function Evolution Library”
 - up to **NNLO** in **QCD** in the FFN and VFN schemes
 - **LO QED** corrections to the DGLAP evolution \Rightarrow photon PDF
 - using either **Pole** or $\overline{\text{MS}}$ heavy quark masses
 - Module for the computation of **DIS NC** and **CC** observables up to **NNLO** in different mass schemes (ZM-VFNS, FFNS and FONLL)
 - Different **solutions** of the DGLAP equation (truncated, exact, expanded)
 - **Scale variations**
- **APFEL** solves the DGLAP equations using x-space methods:
 - Written in **Fortran77** with wrappers in **C++** and **Python**
 - **Publicly** available from: <http://apfel.hepforge.org/>
 - Interactive **Web Interface**: <http://apfel.mi.infn.it/>

APFEL^{Web} is a spin-off of the APFEL library: <http://apfel.mi.infn.it/>

Welcome to **APFEL** online cluster!

This web-application is a tool designed for High Energy Physics by providing a simple and intuitive interface to plot and compute the most common observables with Parton Distribution Functions (PDFs).

To begin to produce on-line plots, please [register](#) and [login!](#)

The APFEL library

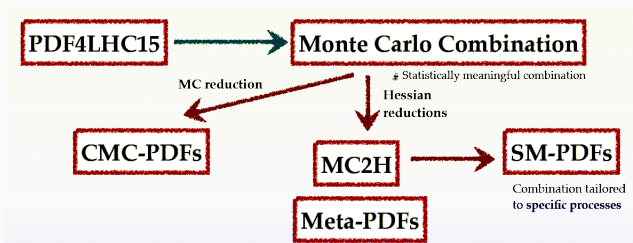
APFEL, a PDF evolution library, is a computer library specialized in the solution of DGLAP evolution equations up to N³LO in QCD and to LO in QED, both with Pole and $\overline{\text{MS}}$ masses. With APFEL you can replace the evolution of LHAPDF-sets and check the impact on the choice of evolution parameters. APFEL also computes deep-inelastic scattering processes using multiple schemes.

If you use the APFEL library or the online cluster in a scientific publication, please cite: V. Bertone, S. Carrazza and J. Rojo, "APFEL: A PDF Evolution Library with QED corrections" *Comput. Phys. Commun.* **185**, 1847 (2014), arXiv:1305.1394; S. Carrazza et al., "APFEL Web: a web-based application for the graphical visualization of parton distribution functions", *J. Phys. G: Nucl. Part. Phys.* **42** 057001, arXiv:1410.5466, [Lecture](#).

Web-developers: D. Palazzo, S. Carrazza, A. Ferraro
 APFEL developers: V. Bertone, S. Carrazza, J. Rojo. ([Contact](#))

Mobile website:

Fast and complete set of **tools** for PDF comparison, luminosities, DIS observables and predictions computed with APPLgrid.



- **Compression of MC PDFs:** a tool which reduces the size of a MC set of replicas preserving its statistical properties.



- **MC to Hessian conversion:** a transformation strategy to convert any MC set of replicas into a set of eigenvectors.



- For more details \Rightarrow seminar 11 December 2015.



The banner features the logos of the University of Milan, the European Investment Bank Institute, and the Centre for Industrial Studies (Csil). The main title is "Cost/Benefit Analysis in the Research, Development and Innovation Sector". Below the title is a navigation menu with links for HOME, TEAM, PROJECT, DELIVERABLES, AGENDA, EVENTS, GALLERY, and DOWNLOADS. At the bottom, it states "Funded by the European Investment Bank - University Research Sponsorship Programme (EIBURS)".

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- Research infrastructures in the LHC era: a scientometric approach¹
 1. describe the impact of LHC, LEP, Tevatron experiments in terms of publications and citations
 2. modeling of knowledge propagation in HEP:
 - clustering of papers based on citation patterns and semantic.
 3. provide research output forecasts for future experiments

¹<http://www.eiburs.unimi.it/>

- **HICCUP project:**
 - High Impact Cross-section Calculations for Unprecedented Precision (Giulia's project)
- **PDFs:**
 - Clustering compression of Monte Carlo PDF replicas.
 - Updated determination of the photon PDF from LHC data.
- **Development of tools for LHC phenomenology:**
 - APPLgrid - aMC@NLO bridge with EW corrections.
 - Development of fast and flexible DGLAP solvers.

THANK YOU.