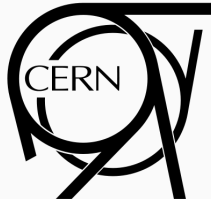# CERN THEORY GROUP RETREAT 2015

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.

Profissional 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

CV Curriculum Vitae	Papers Inspire	Code GitHub	Videos YouTube	LHC CERN	Others EIBURS

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:

NNPDF
Neural network parton distribution function

APFEL Web
Web-app for PDF plots

mc²hessian
Monte Carlo to Hessian PDF transformation

COMPRESSOR
Monte Carlo PDF replicas compression

APFEL
A PDF evolution library

CMC.pdf
Compressed Monte Carlo PDF

libHfill
A histogramming library for Monte Carlo programs

MELA
Mellin evolution library

CQEDSimulator
Cavity QED simulation library

**HRS Computing**
Hyper Rayleigh Scattering simulation

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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.
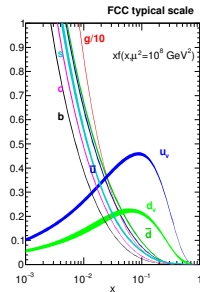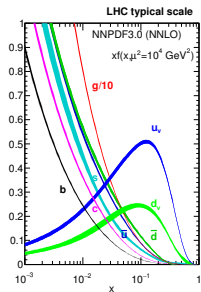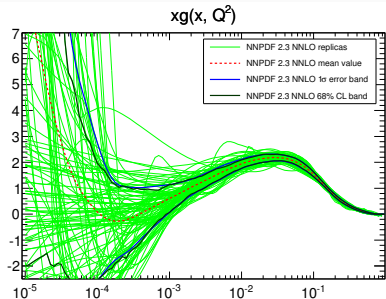
Last release: NNPDF3.0 (arXiv:1410.8849)

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

NNPDF3.0 NLO dataset
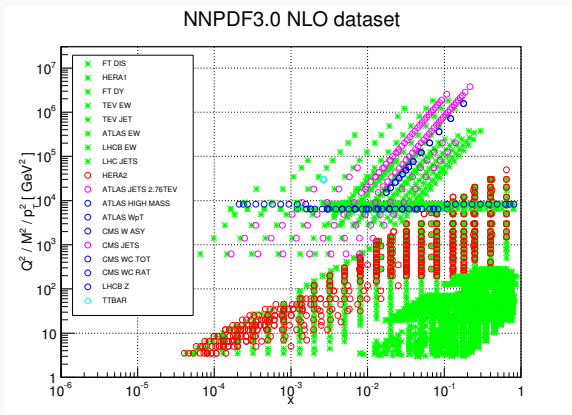
PDFS WITH QED CORRECTIONS

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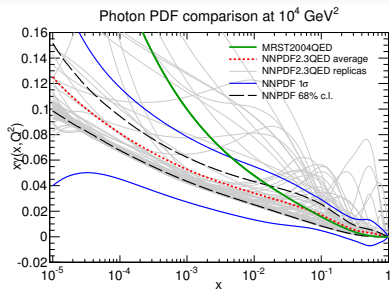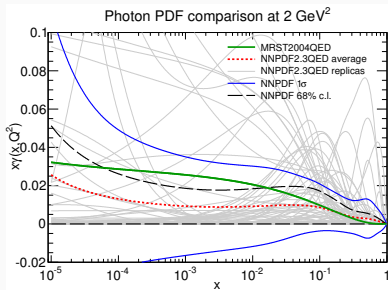
- · **Issues to improve:** large *x* uncertainties $\Rightarrow$ include more LHC data.

- An example of phenomenological implication (arXiv:1508.07002):
  - Drell-Yan high mass & diboson production
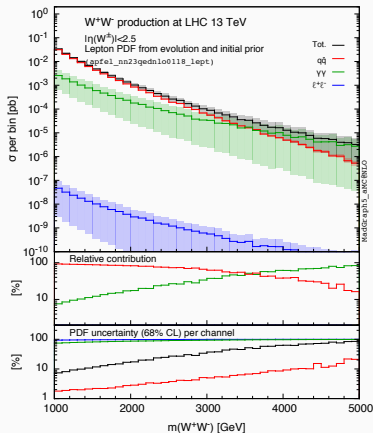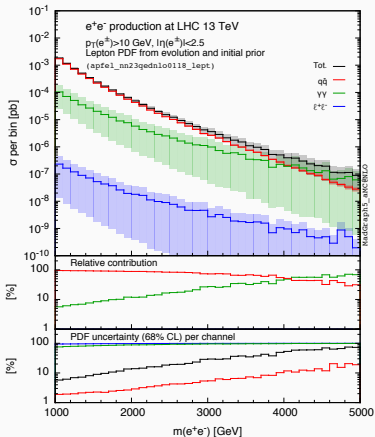
- **APFEL** is *"A Parton distribution Function Evolution Library"*
  - up to **NNLO** in **QCD** in the FFN and VFN schemes
  - **LO QED** corrections to the DGLAP evolution $\Rightarrow$ photon PDF
  - using either **Pole** or $\overline{\text{MS}}$ heavy quark masses
  - Module for the computation 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/

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

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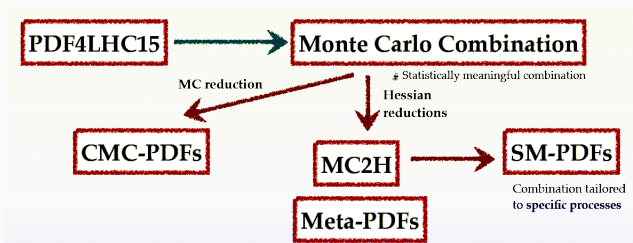
- **Compression of MC PDFs:** a tool which reduces the size of a MC set of replicas preserving its statistical properties.

- **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.

· Research infrastructures in the LHC era: a scientometric approach[1]

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.