

Juan M. Cruz-Martinez

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📄 juacrumar • 🌐 scarlehoff • 📅 Born 02/08/1991, Nationality: Spanish

Research Career

University of Milan

Milan (Italy)

Assegnista di ricerca

2018-currently

Currently part of the N3PDF research project. PI Stefano Forte. Financed by the European Research Council through an Advanced Grant (n 740006) within the Horizon 2020 Research & Innovation Programme

Durham University

Durham (UK)

PhD Thesis, Supervisor: Nigel Glover

2014-2018

Next-to-Next-to-Leading Order QCD Corrections to Higgs Boson Production in Association with two Jets in Vector Boson Fusion

University of Zurich

Zurich (Switzerland)

Academic Secondment, supervisor: Thomas Gehrmann

Oct-Dec 2016

IFIC (Valencia)

Valencia (Spain)

Research Stay, Supervisor: M. Vos

2014

Project Title: Experimental Limitations to Charge Asymmetry measurement in top quark pair production at hadron colliders

University of Valencia & IFIC

Valencia (Spain)

Master in Advanced Physics: Theoretical Physics, 94.6%

2013-2014

Master Thesis supervisor: German Rodrigo

Study of charge asymmetry in $t\bar{t}$ production through axigluons

National Accelerators Center (CNA Sevilla)

Seville (Spain)

Research Stay, Supervisor: J.M. Lopez-Gutierrez

June 2013

Project Title: Development of computing tools for the analysis of Accelerator Mass Spectrometry results at the National Accelerators Center

University of Seville

Seville (Spain)

Degree in Physics, 82.3%

2009-2013

Bachelor's Thesis supervisor: Antonio Moro

Application of numerical resolution of a system with coupled differential equations to Quantum Scattering Problems with Internal Degrees of Freedom

PhD Thesis

Title: Next-to-Next-to-Leading Order QCD Corrections to Higgs Boson Production in Association with two Jets in Vector Boson Fusion

Supervisors: Nigel Glover (Durham U.) & Thomas Gehrmann (Zurich U.)

Abstract: In this thesis the second-order QCD corrections to electroweak production of a Higgs boson in association with two jets through vector boson fusion are considered. This calculation is fully differential in the kinematics of the Higgs boson and of the final state jets. Infrared divergences are regulated using the antenna subtraction method. We detail the implementation of the process in the parton-level Monte Carlo integrator NNLOJET and present inclusive calculations as well as differential distributions for a wide range of observables at different center-of-mass energies.

Teaching Experience

Teaching Assistant <i>Corso di Informatica, 2 years, 72h total</i>	University of Milan (Italy) <i>2019-2021 (ongoing)</i>
Teaching Assistant <i>Fisica Quantistica II, 26h</i>	University of Milan (Italy) <i>2020-2021 (ongoing)</i>
Teaching Assistant <i>Fisica Quantistica I, 10h</i>	University of Milan (Italy) <i>2019-2020</i>
Co-director of master Thesis <i>Investigating GPU hardware for fast PDF convolutions, E. Villa</i>	University of Milan (Italy) <i>2019</i>
NNPDF Code Meeting <i>Course on the usage of the Keras and Tensorflow libraries, 5h</i>	Cambridge (UK) <i>June 2019</i>
Co-director of bachelor Thesis <i>Stability in the determination of parton distributions, F. Settimo</i>	University of Milan (Italy) <i>2018-2019</i>
Teaching Assistant <i>First Year experimental methods course, weekly exercises, 36 h</i>	Durham University (UK) <i>2017-2018</i>

Complementary Education

Cisco Networking Academy <i>Introduction to Cybersecurity</i>	Remote <i>April 2020</i>
Xilinx Developer Forum <i>FPGA Developers Forum</i>	The Hague (The Netherlands) <i>November 2019</i>
ExotHiggs <i>Summer School on Higgs and BSM Physics</i>	Zuoz (Switzerland) <i>August 2016</i>
YETI <i>Winter School: Prospects and Challenges for LHC Run II</i>	Durham (UK) <i>January 2016</i>
Higgstools Summer School <i>Summer School on Higgs Physics for Early Stage Researchers</i>	Aosta Valley (Italy) <i>July 2015</i>
Higgstools First Young Researches Meeting <i>Teamwork, Communication and Media training</i>	Durham (UK) <i>February 2015</i>

Non-academic work experience

Shell (Projects & Technology Division)

Rijswijk (The Netherlands)

Fortran and C Developer

2016

Dutch division of the Seismic Applications team (managed by Rob Eppenga).

As part of the Higgstools ITN I was given the opportunity of working at Shell for several months. In Shell I worked on the SIPMAP package, a suite of programs used for oil exploration and seismic tomography. While the formal detail of the algorithms used fall under a completely different branch of physics, the computing side was actually quite close to what it is done in high energy physics research.

My task during this internship consisted on the development and maintenance of the program (the oldest pieces written in Fortran, some of the more modern features C and C++). Runs of this code are very costly and thus optimisation is key, my focus during those months was on improving some of the algorithms and streamlining the workflow of the software. I also worked on porting parts of the code to new hardware (32 bits to 64 bits and GPU accelerators).

FamilyApp

Seville (Spain)

Frontend and Backend Developer, Python, HTML

2014

Sole developer of both the web interface and administration backend of the service.

Academic Software

VegasFlow

Numerical calculations, GPU computing

2020, github.com/N3PDF/vegasflow

j.cpc.2020.107376

Monte Carlo integration library written in Python and based on the TensorFlow framework. It is developed with a focus on speed and efficiency, enabling researchers to perform very expensive calculation as quick and easy as possible.

Evolutionary-Keras

Machine Learning, AI, Genetic Algorithms

2020, github.com/N3PDF/evolutionary_keras

10.5281/zenodo.3630339

This module deals with one of the shortcomings of Keras/TensorFlow which is the absence of evolutionary optimizers, implementing several examples to be easily used with TF models.

PDFFlow

Proton physics, GPU computing

2020, github.com/N3PDF/pdfflow

arXiv:2009.06635 [hep-ph]

Parton distribution function interpolation library written in Python and based on the TensorFlow framework. It is developed with a focus on speed and efficiency, enabling researchers to perform very expensive calculation as quick and easy as possible.

pyHepGrid

Python, grid computing

2016-2019, github.com/scarlehoff/pyHepGrid

10.5281/zenodo.3233861

Core developer of the pyHepGrid tool for distributed computing. Used to run in a systematic and coherent manner resource-hungry programs typically used for HEP simulations. The development of pyHepGrid was done with the focus on NNLOJET but has since being extended successfully to also run other programs such as MCFM, Sherpa or HEJ.

Relevant computer skills

Programming Languages: Fortran, Python, C, **Operating System:** Linux, MacOS, Windows

C++, js, OpenCL, Cuda

Scripting/Macro Languages: Bash, Latex, **Computing Tools:** Maple, Mathematica, Matlab, gnuplot, Grid Computing

ML Libraries: Keras, Tensorflow, PyTorch, pandas, **Technologies:** Grid Computing, multiprocessing, das, scipy, FPGA computing, GPU computing

Other Projects

pybliotecario

github.com/scarlehoff/pybliotecario

Bot in python that use different remote APIs such as Facebook Messenger API or Telegram to open a communication channel between the social messaging system of choice and the server.

Python, social bot

Currently

Open Source

github.com/scarlehoff

I often contribute in different open source projects and am currently the maintainer of several packages in the Arch User Repository

Open source contributor

Currently

Participation in grants

New hardware for HEP

Linea 2A

Co-Author

University of Milan (Italy)

2019-2020

Management Experience

YTF (Young Theorist Forum 10)

Member of the organising Committee

Durham (UK)

January 2018

HiggsTools Final Meeting

Member of the organising Committee

Durham (UK)

September 2017

YTF (Young Theorist Forum 9)

Member of the organising Committee

Durham (UK)

January 2017

YTF (Young Theorist Forum 8)

Member of the organising Committee

Durham (UK)

January 2016

ICHEP 2014

Outreach activities

Valencia (Spain)

July 2014

Awards

Highest Distinction: Bachelor's Thesis: Numerical resolution of a system with coupled differential equations: applied to Quantum Scattering Problems with Internal Degrees of Freedom

Third Prize: IV Concurso Nacional para promocion de Jovenes Escritores Cientifico-Tecnicos

ACTA-CEDRO Scientific Writing

Languages

Spanish: Native

English: Fluent

PhD studies carried out in Durham (United Kingdom)

Italian: Fluent

University level courses taught and students supervised in Italian

French: Basic knowledge

6 years at high school

Japanese: Basic knowledge

A1.2 level certified

Conference Talks and Invited Seminars

25th International Conference on Computing in High-Energy and Nuclear Physics (vCHEP) <i>MadFlow: towards the automation of Monte Carlo simulation on GPU for particle physics</i>	Virtual May 2021
PDF4LHC 2021 <i>New studies from the NNPDF group</i>	Virtual March 2021
Milano Joint Phenomenology Seminar <i>Offloading Monte Carlo simulations to hardware accelerators</i>	Milan (Italy, Virtual) February 2021
Invited Seminar <i>PDF determination with a quantum hardware</i>	Valencia (Spain, Virtual) February 2021
HSF WLCG Virtual Workshop <i>PDF/Vegas-Flow</i>	Virtual meeting November 2020
Generator Infrastructure and Tools Subgroup Meeting <i>VegasFlow and PDFFlow: accelerating Monte Carlo simulation across multiple devices (joint talk with M. Rossi)</i>	CERN (Virtual meeting) October 2020
40th International Conference on High Energy Physics, ICHEP Prague <i>VegasFlow: accelerating Monte Carlo simulation across platforms</i>	Prague (Virtual meeting) August 2020
NNPDF Collaboration meeting <i>Optimizing the hyperoptimization</i>	Amsterdam (The Netherlands) February 2020
Artificial Intelligence for Science, Industry and Society Symposium (AISIS 2019) <i>Studying the parton content of the proton with deep learning models</i>	Ciudad de Mexico (Mexico) October 2019
James Stirling Memorial Conference & PDF4LHC <i>Methodological improvements in PDF determination</i>	Durham (UK) September 2019
NNPDF Collaboration meeting <i>n_{fit} and hyperoptimization in the context of NNPDF 4.0</i>	Varenna (Italy) August 2019
QCD@LHC 2019 <i>Towards a new generation of PDFs with deep learning models</i>	Buffalo, New York (USA) July 2019
NNLOJET Collaboration meeting <i>Numerical Integration with Neural Networks</i>	Zurich (Switzerland) May 2019
NNPDF Collaboration meeting <i>N3PDF studies of new methodologies</i>	Amsterdam (The Netherlands) February 2019
NNPDF Collaboration & N3PDF Kickoff Meeting <i>Recent developments within NNLOJET</i>	Gargnano, Lake Garda (Italy) September 2018
Loops and Legs in Quantum Field Theory 2018 <i>NNLO corrections to VBF Higgs boson production</i>	St. Goar (Germany) May 2018
HiggsTools Final Meeting <i>NNLO phenomenology with Antenna Subtraction</i>	Durham (UK) September 2017

Internal Seminar ϕ_η^* observable for Higgs production	Durham (UK) May 2017
Student Seminar Higgs phenomenology with antenna subtraction	Durham (UK) February 2017
Invited Seminar Higgs phenomenology with antenna subtraction	Valencia (Spain) January 2017
HiggsTools Second Annual Meeting NNLO calculations for Higgs processes	Granada (Spain) April 2016
Internal Seminar Renormalisation Scale Dependence as a Testing Ground for NNLO calculations	Durham (UK) February 2016
Student Seminar Building and Playing with NNLO Monte Carlos	Durham (UK) February 2016
HiggsTools First Annual Meeting NNLO predictions for Higgs production at LHC	Freiburg (Germany) April 2015

Publications

- [1] Stefano Carrazza, Juan Cruz-Martinez, and Tanjona R. Rabemananjara. Compressing PDF sets using generative adversarial networks. 4 2021, 2104.04535.
- [2] Adrian Perez-Salinas, Juan Cruz-Martinez, Abdulla A. Alhajri, and Stefano Carrazza. Determining the proton content with a quantum computer. *Phys. Rev. D*, 103:034027, 2021, 2111.13934.
- [3] Stefano Carrazza, Juan M. Cruz-Martinez, and Marco Rossi. Pdfflow: Parton distribution functions on gpu. *Computer Physics Communications*, 264:107995, 2021, 2009.06635. ISSN 0010-4655. URL <https://www.sciencedirect.com/science/article/pii/S0010465521001077>.
- [4] Stefano Carrazza and Juan M. Cruz-Martinez. VegasFlow: accelerating Monte Carlo simulation across multiple hardware platforms. *Comput. Phys. Commun.*, 254:107376, 2020, 2002.12921.
- [5] Stefano Carrazza and Juan Cruz-Martinez. Towards a new generation of parton densities with deep learning models. *Eur. Phys. J.*, C79(8):676, 2019, 1907.05075.
- [6] J. Cruz-Martinez, T. Gehrmann, E. W. N. Glover, and A. Huss. Second-order QCD effects in Higgs boson production through vector boson fusion. *Phys. Lett.*, B781:672–677, 2018, 1802.02445.
- [7] M. Boggia et al. The HiggsTools handbook: a beginners guide to decoding the Higgs sector. *J. Phys.*, G45(6):065004, 2018, 1711.09875.
- [8] X. Chen, J. Cruz-Martinez, T. Gehrmann, E. W. N. Glover, and M. Jaquier. NNLO QCD corrections to Higgs boson production at large transverse momentum. *JHEP*, 10:066, 2016, 1607.08817.
- [9] S. Amoroso et al. Les Houches 2019: Physics at TeV Colliders: Standard Model Working Group Report. In *11th Les Houches Workshop on Physics at TeV Colliders: PhysTeV Les Houches*, 3 2020, 2003.01700.
- [10] P. Azzi et al. Report from Working Group 1. *CERN Yellow Rep. Monogr.*, 7:1–220, 2019, 1902.04070.

- [11] Juan Cruz-Martinez, Stefano Forte, and Emanuele R. Nocera. Future tests of parton distributions. *Acta Phys. Polon. B*, 52:243, 2021, 2103.08606.
- [12] Marco Rossi, Stefano Carrazza, and Juan M. Cruz-Martinez. PDFFlow: hardware accelerating parton density access. In *40th International Conference on High Energy Physics*, 12 2020, 2012.08221.
- [13] Stefano Carrazza and Juan M. Cruz-Martinez. VegasFlow: accelerating Monte Carlo simulation across platforms. In *40th International Conference on High Energy Physics*, 10 2020, 2010.09341.
- [14] Stefano Carrazza, Juan M. Cruz-Martinez, and Christopher Schwan. Constructing PineAPPL grids on hardware accelerators. In *8th Large Hadron Collider Physics Conference*, 9 2020, 2009.11798.
- [15] Juan M. Cruz-Martinez, Stefano Carrazza, and Roy Stegeman. Studying the parton content of the proton with deep learning models. In *Artificial Intelligence for Science, Industry and Society*, 2 2020, 2002.06587.
- [16] Stefano Carrazza, Juan Cruz-Martinez, Jesús Urtasun-Elizari, and Emilio Villa. Towards hardware acceleration for parton densities estimation. *Frascati Phys. Ser.*, 69:1–6, 2019, 1909.10547.
- [17] Juan Cruz-Martinez, E. W. Nigel Glover, Thomas Gehrmann, and Alexander Huss. NNLO corrections to VBF Higgs boson production. *PoS*, LL2018:003, 2018, 1807.07908.
- [18] J. Cruz-Martinez. Higgs Production at NNLO in VBF. *Acta Phys. Polon. Supp.*, 11:277–284, 2018.
- [19] Thomas Gehrmann et al. Jet cross sections and transverse momentum distributions with NNLOJET. *PoS*, RADCOR2017:074, 2018, 1801.06415.
- [20] Tanjona Rabemananjara, Juan Cruz-Martinez, and Stefano Carrazza. N3pdf/pycompressor: pycompressor-v1.1.0, March 2021. URL <https://doi.org/10.5281/zenodo.4616385>.
- [21] Tanjona Rabemananjara, Juan Cruz-Martinez, and Stefano Carrazza. N3pdf/ganpdfs: ganpdfs-v1.1.0, March 2021. URL <https://doi.org/10.5281/zenodo.4616369>.
- [22] Juan Cruz-Martinez, Marco Rossi, and Stefano Carrazza. N3pdf/pdfflow: Pdfflow 1.0, September 2020. URL <https://doi.org/10.5281/zenodo.3964190>.
- [23] Stefano Carrazza, Juan Cruz-Martinez, and Felix Hekhorn. N3pdf/eko:, June 2020. URL <https://doi.org/10.5281/zenodo.3874237>.
- [24] Juan M. Cruz-Martinez and Stefano Carrazza. N3PDF/vegasflow: Accelerating Monte Carlo simulation across multiple hardware platforms, March 2020. URL <https://doi.org/10.5281/zenodo.3691926>.
- [25] Juan M. Cruz-Martinez, Roy Stegeman, and Stefano Carrazza. N3PDF/evolutionary_keras: An evolutionary algorithm implementation for Keras, February 2020. URL <https://doi.org/10.5281/zenodo.3630339>.
- [26] Juan Cruz-Martinez, Duncan Walker, and James Whitehead. pyhepgrid: Distributed computing made easy, May 2019. URL <https://doi.org/10.5281/zenodo.3233862>.
- [27] Juan M Cruz-Martinez. *Next-to-Next-to-Leading Order QCD Corrections to Higgs Boson Production in Association with two Jets in Vector Boson Fusion*. PhD thesis, Durham U. (main), 2018. URL <http://etheses.dur.ac.uk/12806/>.