Juan M. Cruz-Martinez

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Born 02/08/1991, Nationality: Spanish

Research Career

University of Milan **Milan (Italy)**
Assegnista di ricerca *2018-currently*
Working on 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

Teaching Experience

Teaching Assistant **University of Milan (Italy)**
Fisica Quantistica I, 10h *2019-2020*

Teaching Assistant **University of Milan (Italy)**
Corso di informatica, 30h *2019-2020*

Co-director of master Thesis — **University of Milan (Italy)**
Stabiliy studies in the determination of parton distributions, E. Villa — *2019*

Director of undergrad Thesis — **University of Milan (Italy)**
Investigating GPU hardware for fast PDF convolutions, F. Settimo — *2019*

NNPDF Code Meeting — **Cambridge (UK)**
Course on the usage of the Keras and Tensorflow libraries, 5h — *June 2019*

Co-director of bachelor Thesis — **University of Milan (Italy)**
Stability in the determination of parton distribtutions, F. Settimo — *2018-2019*

Teaching Assistant — **Durham University (UK)**
First Year experimental methods course, weekly exercise corrections — *2017-2018*

Conference Talks and Seminars

NNPDF Collaboration meeting — **Amsterdam (The Netherlands)**
Optimizating the hyperoptimization — *February 2020*

Artificial Intelligence for Science, Industry and Society Symposium (AISIS 2019) — **Ciudad de Mexico (Mexico)**
Studying the parton content of the proton with deep learning models — *October 2019*

James Stirling Memorial Conference & PDF4LHC — **Durham (UK)**
Methodological improvements in PDF determination — *September 2019*

NNPDF Collaboration meeting — **Varenna (Italy)**
`n3fit` and hyperoptimization in the context of NNPDF 4.0 — *August 2019*

QCD@LHC 2019 — **Buffalo, New York (USA)**
Towards a new generation of PDFs with deep learning models — *July 2019*

NNLOJET Collaboration meeting — **Zurich (Switzerland)**
Numerical Integration with Neural Networks — *May 2019*

NNPDF Collaboration meeting — **Amsterdam (The Netherlands)**
N3PDF studies of new methodologies — *February 2019*

NNPDF Collaboration & N3PDF Kickoff Meeting — **Gargnano, Lake Garda (Italy)**
Recent developments within NNLOJET — *September 2018*

Loops and Legs in Quantum Field Theory 2018 — **St. Goar (Germany)**
NNLO corrections to VBF Higgs boson production — *May 2018*

HiggsTools Final Meeting — **Durham (UK)**
NNLO phenomenology with Antenna Subtraction — *September 2017*

Internal Seminar — **Durham (UK)**
ϕ_η^* *observable for Higgs production* — *May 2017*

Student Seminar — **Durham (UK)**
Higgs phenomenology with antenna subtraction — *February 2017*

Invited Seminar — **Valencia (Spain)**
Higgs phenomenology with antenna subtraction — *Jaunary 2017*

HiggsTools Second Annual Meeting — **Granada (Spain)**
NNLO calculations for Higgs processes — *April 2016*

Internal Seminar — **Durham (UK)**
Renormalisation Scale Dependence as a Testing Ground for NNLO calculations — *February 2016*

Student Seminar — **Durham (UK)**
Building and Playing with NNLO Monte Carlos — *February 2016*

HiggsTools First Annual Meeting — **Freiburg (Germany)**
NNLO predictions for Higgs production at LHC — *April 2015*

Complementary Education

Xilinx Developer Forum — **The Hague (The Netherlands)**
Developers Forum — *November 2019*

ExotHiggs — **Zuoz (Switzerland)**
Summer School — *August 2016*

YETI — **Durham (UK)**
Winter School — *January 2016*

Higgstools Summer School — **Aosta Valley (Italy)**
Summer School — *July 2015*

Higgstools First Young Researches Meeting — **Durham (UK)**
Teamwork, Communication and Media training — *February 2015*

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 manteinance 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.

Participation in grants

New hardware for HEP — **University of Milan (Italy)**
Linea 2A — *2019-2020*
Co-Author

Management Experience

YTF (Young Theorist Forum 10) — **Durham (UK)**
Member of the organising Committee — *January 2018*

HiggsTools Final Meeting — **Durham (UK)**
Member of the organising Committee — *September 2017*

YTF (Young Theorist Forum 9) — **Durham (UK)**
Member of the organising Committee — *January 2017*

YTF (Young Theorist Forum 8) — **Durham (UK)**
Member of the organising Committee — *January 2016*

ICHEP 2014 — **Valencia (Spain)**
Outreach activities — *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

Other Projects

pyHepGrid — **Python, grid computing**
Developer, github.com/scarlehoff/pyHepGrid — *2016-2019*
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, C++, OpenCL, Cuda

Scriptting/Macro Languages: Bash, Latex, gnuplot

HEP Tools: Madgraph, Sherpa, root

ML Libraries: Keras, Tensorflow

Operating System: Linux, MacOS, Windows

Computing Tools: Maple, Mathematica, Matlab, Grid Computing

Technologies: Grid Computing, multiprocessing, FPGA computing, GPU computing

Languages

Spanish: Native

English: Fluent — *PhD studies carried out in Durham (United Kingdom)*

Italian: Fluent — *B1 Course by Milan University, university level courses taught in Italian*

French: Basic knowledge

Japanese: Basic knowledge — *A1.2 level certified*

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.

Grant: European Union, PITN-GA-2012-316704. Higgstools Initial Training Network

URL: http://etheses.dur.ac.uk/12806/

Publications

[A+19] P. Azzi et al., *Report from Working Group 1*, CERN Yellow Rep. Monogr. **7**, 1–220 (2019), 1902.04070.

[A+20] 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.

[B+18] M. Boggia et al., *The HiggsTools handbook: a beginners guide to decoding the Higgs sector*, J. Phys. **G45**(6), 065004 (2018), 1711.09875.

[CCM19] S. Carrazza and J. Cruz-Martinez, *Towards a new generation of parton densities with deep learning models*, Eur. Phys. J. **C79**(8), 676 (2019), 1907.05075.

[CCM20] S. Carrazza and J. M. Cruz-Martinez, *VegasFlow: accelerating Monte Carlo simulation across multiple hardware platforms*, Comput. Phys. Commun. **254**, 107376 (2020), 2002.12921.

[CCMG+16] 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.

[CCMH20] S. Carrazza, J. Cruz-Martinez and F. Hekhorn, N3PDF/eko:, June 2020.

[CCMUEV19] S. Carrazza, J. Cruz-Martinez, J. Urtasun-Elizari and E. Villa, *Towards hardware acceleration for parton densities estimation*, Frascati Phys. Ser. **69**, 1–6 (2019), 1909.10547.

[CM18a] J. Cruz-Martinez, *Higgs Production at NNLO in VBF*, Acta Phys. Polon. Supp. **11**, 277–284 (2018).

[CM18b] J. 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.

[CMCS20] J. M. Cruz-Martinez, S. Carrazza and R. Stegeman, Studying the parton content of the proton with deep learning models, in *Artificial Intelligence for Science, Industry and Society*, 2 2020.

[CMGGH18a] 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.

[CMGGH18b] J. Cruz-Martinez, E. W. N. Glover, T. Gehrmann and A. Huss, *NNLO corrections to VBF Higgs boson production*, PoS **LL2018**, 003 (2018), 1807.07908.

[CMWW19] J. Cruz-Martinez, D. Walker and J. Whitehead, pyHepGrid: Distributed computing made easy, May 2019.

[G$^+$18] T. Gehrmann et al., *Jet cross sections and transverse momentum distributions with NNLOJET*, PoS **RADCOR2017**, 074 (2018), 1801.06415.

[JC20] Juacrumar and S. Carrazza, N3PDF/vegasflow: Accelerating Monte Carlo simulation across multiple hardware platforms, March 2020.

[JSC20] Juacrumar, R. Stegeman and S. Carrazza, N3PDF/evolutionary_keras: An evolutionary algorithm implementation for Keras, February 2020.