

**UNIVERSITÀ DEGLI STUDI DI MILANO**

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**STEFANO CARRAZZA  
CURRICULUM VITAE****INFORMAZIONI PERSONALI (NON INSERIRE INDIRIZZO PRIVATO E TELEFONO FISSO O CELLULARE)**

COGNOME	CARRAZZA
NOME	STEFANO
DATA DI NASCITA	03/12/1987

**Research Interests**

Parton distribution functions (PDFs) determination and correlated technologies.  
Monte Carlo event generators, simulation/computational tools for high-energy physics.  
Machine learning and AI techniques for high-energy physics.

**Education**

- 2011 → 2014 **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.

**Teaching**

- November 2017 **Abilitazione scientifica nazionale per la II fascia, settore concorsuale 02/A2.**  
art. 16, comma 1, Legge 240/10
- 2012 – 2014 **Quantum Mechanics I-II**, *Università degli Studi di Milano*.  
Teaching assistant for the course.
- September 2013 **Mathematics for Biological Sciences**, *Università degli Studi di Milano*.  
40 hours of lectures for the 1th year undergraduate students.

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## Professional Experience

- since October 2015 **CERN fellow**, *CERN*, Geneva.
- Nov. '14 – Sep. '15 **Milan university fellow on a European Investment Bank EIBURS grant**, Milan.  
Visiting Scientist
- Oct. – Dec. 2014 **Visiting PhD student on the aMC@NLO ERC grant.**, *CERN*, Geneva.  
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

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## Participation in Conferences and Workshops

- September 2017 **PDF4LHC**, CERN.
- August 2017 **ACAT17**, Seattle.
- June 2017 **LH 2017**, Les Houches.
- January 2017 **Cracow Epiphany Conference**, Cracow.
- June 2016 **ICML**, New York.
- May 2016 **PP @ LHC 2016**, Pisa.
- April 2016 **PDF4LHC**, CERN.
- March 2016 **Recontres de Moriond**, La Thuile.
- January 2016 **CMS Workshop**, CERN.
- October 2015 **PDF4LHC**, CERN.
- October 2015 **FCC-hh 100 TeV Workshop**, CERN.
- September 2015 **QCD@LHC**, London.
- April 2015 **PDF4LHC**, CERN.
- February 2015 **Parton Distributions for the LHC**, Benasque.
- January 2015 **PDF4LHC**, CERN.
- November 2014 **PDF4LHC**, CERN.
- June 2014 **XXII Milan European Economy Workshop, EIBURS workshop**, Milan.
- May 2014 **PDF4LHC**, CERN.
- February 2014 **Les Rencontres de Physique de la Vallée d'Aoste**, La Thuile.
- December 2013 **PDF4LHC**, CERN.
- April 2013 **DIS2013**, Marseille.
- April 2013 **EW/PDF4LHC meeting**, CERN.
- March 2013 **Rencontres de Moriond**, La Thuile.
- September 2012 **EW/PDF4LHC meeting**, Durham.

- May 2012 **EW/PDF4LHC meeting**, CERN.  
June 2011 **Quark Matter Annecy 2011**, Annecy.  
August 2006 **London International Youth Science Forum**, London.

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## Talks

- 21 August 2017 **ACAT17**, *NNPDF3.1*, Seattle.  
21 August 2017 **ACAT17**, *ML in HEP-TH*, Seattle.  
9 January 2017 **Cracow Epiphany Conference**, *Towards NNPDF3.1*, Cracow.  
18 May 2016 **PP @ LHC 2016**, *Parton Distribution Functions*, Pisa.  
24 March 2016 **Recontres de Moriond**, *PDF tools for LHC Run II*, La Thuile.  
28 January 2016 **CMS Workshop**, *Threshold resummation at highest energies*, CERN.  
9 October 2015 **FC-hh 100 TeV**, *Large  $\times$  PDFs at 100 TeV*, CERN.  
1 September 2015 **QCD@LHC**, *On the impact of lepton PDFs*, London.  
13 April 2015 **PDF4LHC**, *An unbiased Hessian representation of MC PDFs*, CERN.  
20 February 2015 **Parton Distributions for the LHC**, *CMC-PDFs*, Benasque.  
3 November 2014 **PDF4LHC**, *Compression of Monte Carlo PDF replicas*, CERN.  
24 June 2014 **TASI 2014**, *Neural Network PDFs*, Boulder.  
24 February 2014 **La Thuile 2014**, *PDFs with QED corrections*, La Thuile.  
13 December 2013 **EW/PDF4LHC**, *APFEL package and interface*, CERN.  
19 November 2013 **HERAFitter User's meeting**, *APFEL updates and new features*.  
24 April 2013 **DIS2013**, *Electroweak corrections to parton distributions*, Marseille.  
17 April 2013 **EW/PDF4LHC**, *NNPDF updates and EW corrections*, CERN.  
13 March 2013 **Rencontres de Moriond**, *Electroweak corrections to parton distributions*, La Thuile.  
31 August 2012 **International School Cargese 2012**, *Parton distributions with LHC data*, Cargese.

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## Participation in Schools

- June 2014 **TASI 2014**, Boulder.  
October 2013 **School of Analytic Computing in Theoretical HEP**, Atrani.  
August 2013 **2013 CERN-Fermilab HCP Summer School**, CERN.  
August 2012 **International School Cargese 2012**, Cargese.  
January 2012 **LHCPhenonet Winter School**, Ascona.

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## Organization of conferences

- March – April 2018 **IFAE XVII convenor**, University of Milan-Bicocca.

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## Research outcome

Citation summary: **h-index 19**, *INSPIRE*, 4243 citations from 41 citeable papers, on March 12, 2018.

### Articles

- [1] R. D. Ball, S. Carrazza, L. Del Debbio, S. Forte, Z. Kassabov, J. Rojo, E. Slade, M. Ubiali, Precision determination of the strong coupling constant within a global PDF analysis (2018). [arXiv:1802.03398](https://arxiv.org/abs/1802.03398).
- [2] D. Krefl, S. Carrazza, B. Haghighat, J. Kahlen, Riemann-Theta Boltzmann Machine (2017). [arXiv:1712.07581](https://arxiv.org/abs/1712.07581).
- [3] V. Bertone, S. Carrazza, N. P. Hartland, J. Rojo, Illuminating the photon content of the proton within a global PDF analysis (2017). [arXiv:1712.07053](https://arxiv.org/abs/1712.07053).

- [4] V. Bertone, S. Carrazza, N. P. Hartland, E. R. Nocera, J. Rojo, A determination of the fragmentation functions of pions, kaons, and protons with faithful uncertainties, *Eur. Phys. J. C* 77 (8) (2017) 516. [arXiv:1706.07049](#), [doi:10.1140/epjc/s10052-017-5088-y](#).
- [5] R. D. Ball, et al., Parton distributions from high-precision collider data, *Eur. Phys. J. C* 77 (10) (2017) 663. [arXiv:1706.00428](#), [doi:10.1140/epjc/s10052-017-5199-5](#).
- [6] F. Giuli, et al., The photon PDF from high-mass Drell–Yan data at the LHC, *Eur. Phys. J. C* 77 (6) (2017) 400. [arXiv:1701.08553](#), [doi:10.1140/epjc/s10052-017-4931-5](#).
- [7] R. D. Ball, V. Bertone, M. Bonvini, S. Carrazza, S. Forte, A. Guffanti, N. P. Hartland, J. Rojo, L. Rottoli, A Determination of the Charm Content of the Proton, *Eur. Phys. J. C* 76 (11) (2016) 647. [arXiv:1605.06515](#), [doi:10.1140/epjc/s10052-016-4469-y](#).
- [8] S. Carrazza, R. K. Ellis, G. Zanderighi, QCDLoop: a comprehensive framework for one-loop scalar integrals, *Comput. Phys. Commun.* 209 (2016) 134–143. [arXiv:1605.03181](#), [doi:10.1016/j.cpc.2016.07.033](#).
- [9] V. Bertone, S. Carrazza, N. P. Hartland, APFELgrid: a high performance tool for parton density determinations, *Comput. Phys. Commun.* 212 (2017) 205–209. [arXiv:1605.02070](#), [doi:10.1016/j.cpc.2016.10.006](#).
- [10] S. Carrazza, S. Forte, Z. Kassabov, J. Rojo, Specialized minimal PDFs for optimized LHC calculations, *Eur. Phys. J. C* 76 (4) (2016) 205. [arXiv:1602.00005](#), [doi:10.1140/epjc/s10052-016-4042-8](#).
- [11] S. Carrazza, A. Ferrara, S. Salini, Research infrastructures in the LHC era: a scientometric approach [arXiv:1601.03746](#), [doi:10.1016/j.techfore.2016.02.005](#).
- [12] J. Butterworth, et al., PDF4LHC recommendations for LHC Run II, *J. Phys. G* 43 (2016) 023001. [arXiv:1510.03865](#), [doi:10.1088/0954-3899/43/2/023001](#).
- [13] S. Carrazza, Parton distribution functions with QED corrections, Ph.D. thesis (2015). [arXiv:1509.00209](#).  
URL <http://inspirehep.net/record/1391315/files/arXiv:1509.00209.pdf>
- [14] V. Bertone, S. Carrazza, D. Pagani, M. Zaro, On the Impact of Lepton PDFs, *JHEP* 11 (2015) 194. [arXiv:1508.07002](#), [doi:10.1007/JHEP11\(2015\)194](#).
- [15] M. Bonvini, S. Marzani, J. Rojo, L. Rottoli, M. Ubiali, R. D. Ball, V. Bertone, S. Carrazza, N. P. Hartland, Parton distributions with threshold resummation, *JHEP* 09 (2015) 191. [arXiv:1507.01006](#), [doi:10.1007/JHEP09\(2015\)191](#).
- [16] S. Carrazza, S. Forte, Z. Kassabov, J. I. Latorre, J. Rojo, An Unbiased Hessian Representation for Monte Carlo PDFs, *Eur. Phys. J. C* 75 (8) (2015) 369. [arXiv:1505.06736](#), [doi:10.1140/epjc/s10052-015-3590-7](#).
- [17] S. Carrazza, J. I. Latorre, J. Rojo, G. Watt, A compression algorithm for the combination of PDF sets, *Eur. Phys. J. C* 75 (2015) 474. [arXiv:1504.06469](#), [doi:10.1140/epjc/s10052-015-3703-3](#).
- [18] V. Bertone, S. Carrazza, E. R. Nocera, Reference results for time-like evolution up to  $\mathcal{O}(\alpha_s^3)$ , *JHEP* 1503 (2015) 046. [arXiv:1501.00494](#), [doi:10.1007/JHEP03\(2015\)046](#).
- [19] R. D. Ball, et al., Parton distributions for the LHC Run II, *JHEP* 1504 (2015) 040. [arXiv:1410.8849](#), [doi:10.1007/JHEP04\(2015\)040](#).
- [20] S. Carrazza, A. Ferrara, D. Palazzo, J. Rojo, APFEL Web: a web-based application for the graphical visualization of parton distribution functions, *J.Phys. G* 42 (5) (2015) 057001. [arXiv:1410.5456](#), [doi:10.1088/0954-3899/42/5/057001](#).

- [21] S. Carrazza, J. Pires, Perturbative QCD description of jet data from LHC Run-I and Tevatron Run-II, *JHEP* 10 (2014) 145. arXiv:1407.7031, doi:10.1007/JHEP10(2014)145.
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- [23] V. Bertone, S. Carrazza, J. Rojo, APFEL: A PDF Evolution Library with QED corrections, *Comput.Phys.Commun.* 185 (2014) 1647–1668. arXiv:1310.1394, doi:10.1016/j.cpc.2014.03.007.
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- [25] R. D. Ball, S. Carrazza, L. Del Debbio, S. Forte, J. Gao, et al., Parton Distribution Benchmarking with LHC Data, *JHEP* 1304 (2013) 125. arXiv:1211.5142, doi:10.1007/JHEP04(2013)125.
- [26] R. D. Ball, V. Bertone, S. Carrazza, C. S. Deans, L. Del Debbio, et al., Parton distributions with LHC data, *Nucl.Phys.* B867 (2013) 244–289. arXiv:1207.1303, doi:10.1016/j.nuclphysb.2012.10.003.
- Reports
- [27] D. de Florian, et al., Handbook of LHC Higgs Cross Sections: 4. Deciphering the Nature of the Higgs Sector (2016). arXiv:1610.07922.
- [28] M. L. Mangano, et al., Physics at a 100 TeV pp collider: Standard Model processes, *CERN Yellow Report* (3) (2017) 1–254. arXiv:1607.01831, doi:10.23731/CYRM-2017-003.1.
- [29] J. R. Andersen, et al., Les Houches 2015: Physics at TeV Colliders Standard Model Working Group Report, in: 9th Les Houches Workshop on Physics at TeV Colliders (PhysTeV 2015) Les Houches, France, June 1-19, 2015, 2016. arXiv:1605.04692.  
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- [30] Report of the Snowmass 2013 energy frontier QCD working group. arXiv:1310.5189.
- Proceedings
- [31] S. Carrazza, Machine learning challenges in theoretical HEP, in: 18th International Workshop on Advanced Computing and Analysis Techniques in Physics Research (ACAT 2017) Seattle, WA, USA, August 21-25, 2017, 2017. arXiv:1711.10840.  
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URL <http://inspirehep.net/record/1473186/files/arXiv:1606.09248.pdf>
- [37] V. Bertone, S. Carrazza, Combining NNPDF3.0 and NNPDF2.3QED through the APFEL evolution code, 2016. arXiv:1606.07130.
- [38] S. Carrazza, J. I. Latorre, Towards the compression of parton densities through machine learning algorithms, in: 51st Rencontres de Moriond on QCD and High Energy Interactions La Thuile, Italy, March 19-26, 2016, 2016. arXiv:1605.04345.  
URL <http://inspirehep.net/record/1459049/files/arXiv:1605.04345.pdf>
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- [40] S. Carrazza, Disentangling electroweak effects in Z-boson production, 2014. arXiv:1405.1728.
- [41] S. Carrazza, S. Forte, J. Rojo, Parton Distributions and Event Generators, 2013. arXiv:1311.5887.
- [42] S. Carrazza, Towards the determination of the photon parton distribution function constrained by LHC data, 2013. arXiv:1307.1131.
- [43] S. Carrazza, Towards an unbiased determination of parton distributions with QED corrections, 2013. arXiv:1305.4179.
- Softwares
- [44] S. Carrazza, D. Krefl, theta: a machine learning framework implementing the Riemann-Theta Boltzmann Machine (December 2017).  
URL <http://riemann.ai/theta>
- [45] V. Bertone, S. Carrazza, N. P. Hartland, APFELgrid: a high performance tool for parton density determinations (May 2016).  
URL <http://github/nhartland/apfelgrid>
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URL <http://smpdf.mi.infn.it>
- [47] S. Carrazza, D. Palazzo, A. Ferrara, An online cluster for particle physics (October 2014).  
URL <http://apfel.mi.infn.it>
- [48] S. Carrazza, A library for filling histograms in monte carlo programs (July 2014).  
URL <http://libhfill.hepforge.org>
- [49] V. Bertone, S. Carrazza, J. Rojo, APFEL: A PDF Evolution Library with QED corrections arXiv:1310.1394.
- [50] S. Carrazza, Cavity quantum electrodynamics simulator (July 2009).  
URL <http://cqedsimulator.sourceforge.net>
- [51] S. Carrazza, J. Duboisset, Hyper rayleigh scattering computing (July 2008).  
URL <http://hrscomputing.sourceforge.net>

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## Participation in funded grants

- Since 2017 **Scientific Advisory Board**, *NNPDF ERC Advanced grant N.740006*, Stefano Forte, University of Milan.
- Since 2015 **Postdoc**, *HICCUP ERC Consolidator grant N.614577*, Giulia Zanderighi, CERN.
- 2013 – 2016 **Postdoc**, *European Investment Bank EIBURS grant*, Cost/Benefit Analysis in the Research, Development and Innovation Sector, University of Milan.
- 2010 – 2011 **PhD student**, *PRIN 2010-2011*.  
University of Milan

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## Supervision of Students

- 2017 **Omar Pastafiglia**, *Web application for Feynman diagrams*, Bachelor thesis in CS, Milan.
- 2016 **Francesco d'Ambrosio**, *PDF fits with inconsistent data*, Bachelor thesis in physics, Milan.
- 2014 **Fabrizio Cimaglia**, *PDF reweighting*, Bachelor thesis in physics, Milan.
- 2014 **Daniele Palazzo**, *APFEL Web interface to PDFs*, Bachelor thesis in computer sciences, Milan.

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## Interdisciplinary Activities

- 2013 – 2016 **Cost/Benefit Analysis in the Research, Development and Innovation Sector**, Milan.  
The research project "Cost/Benefit Analysis in the Research, Development and Innovation Sector" aims at developing and testing a model for evaluating Big Science. The developed model will enable funding agencies to assess the potential future net social benefits generated by a research infrastructure and the uncertainty and risks associated to it.
- 2013 **Startup & Business Planning**, *SDA Bocconi School of Management*, Milan.  
Lectures held by Prof. Cinzia Parolini organized by Start Cup Milano Lombardia 2013 for the finalists of the competition.
- 2009 **Business management: Evolution and Dynamics**, *École Normale Supérieure Lettres et Sciences Humaines*, Lyon.  
Special lectures focused in econo-physics techniques to describe and predict the evolution and dynamics of business models, identifying the quality and measuring the efficiency of new business proposals and strategies.

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## Patents

- 2009 **SHAPE project**, *Participation in WO/2009/125148 for HRS Computing*, Lyon.  
HRS Computing is a scientific software that simulates the "Hyper Rayleigh Scattering" (HRS), which is a nonlinear optics phenomenon. It allows the visualization of simulated polar graphics generated by HRS, giving different theoretical coefficients that can be useful to determine the microscopic structure of composites, molecules.

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## Prices and Awards

- 2017 **Premio Sergio Fubini 2016**, Catania.  
INFN CSN4 national price for the best PhD thesis in theoretical particle physics of 2015-2016.
- 2006 **European Union Contest for Young Scientists, Italian section**, Milan.  
Participation with the project "Standing Waves" in which an innovative experimental setup was proposed in order to observe and study the propagation of standing waves in the air.

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## Media and Press

- 2015 **Aragon TV**, *Link to the video (minute 25)*.  
Interview during the PDF for LHC workshop in Benasque.
- 2006 **Corriere della Sera**, *Article in an Italian newspaper*.  
Interview during the final selection of the competition "I Giovanni e le Scienze".

## Computer skills

- GitHub: <https://github.com/scarrazza>
- Operating Systems: Linux, Windows, MacOS.
- Languages: C/C++, Fortran, Java, Python, PHP/HTML, BASH,  $\LaTeX$ .
- Libraries: ROOT, Qt, OpenGL, OpenMP, VTK, GTK+, .Net Framework.
- Software: Mathematica, Matlab, Labview, Scilab, Maxima, Sage, Blender.

## Entrepreneurship Activities

- Development of a toolbox for sensitivity and risk analysis in technological and scientific investment projects (CSIL).
- Development of Android and Web Applications for the scientific community: Sensorial analysis app for the "Salone Internazionale del Gusto Torino", October 23-27th 2014
- Development of Android applications for general public: statistical calculators and others.

## Languages

- Fluent in English, Italian, French, Spanish and Portuguese.

Data

12/03/2018

Luogo

Ginevra