

MATTEO BARBETTI

Ph.D. student in Smart Computing

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INTERESTS

machine-learning, deep-generative-models, graph-neural-networks, optimization-studies,
high-energy-physics, detector-simulation, parametric-simulation, ultrafast-simulation

EDUCATION

University of Florence

Firenze, Italy

🎓 PH.D. IN SMART COMPUTING

Nov 2020 – present

Topic: *Smart Computing Techniques applied to Medical Physics, Nuclear Physics and Particle Physics*

Advisors: Lucio Anderlini, Denis Derkach, Michael Williams

University of Florence

Firenze, Italy

🎓 M.SC. IN PARTICLE PHYSICS

Sep 2017 – Jun 2020

Thesis: *“Techniques for parametric simulation with deep neural networks and implementation for the LHCb experiment at CERN and its future upgrades”*

Thesis Advisors: Lucio Anderlini, Piergiulio Lenzi

Graduation Score: 110/110 *cum laude*

University of Florence

Firenze, Italy

🎓 B.SC. IN PHYSICS AND ASTROPHYSICS

Sep 2013 – Sep 2017

Thesis: *“Study of the charmonium resonances in $B^+ \rightarrow p\bar{p}K^+$ and $B^+ \rightarrow p\bar{p}\gamma K^+$ decays with the LHCb experiment at CERN”*

Thesis Advisors: Lucio Anderlini, Giuseppe Latino

Graduation Score: 110/110

EXPERIENCE

University of Florence

Firenze, Italy

GRADUATE RESEARCHER (LHCb Florence Group)

Nov 2020 – present

📖 *Research focused on development and deployment of Ultra-Fast Simulation for LHCb, generative models optimization and parallel computing for intense hyperparameter studies.*

Advisor: Lucio Anderlini

INFN-Firenze

Firenze, Italy

STUDENT RESEARCHER

Feb 2020 – Apr 2020

📖 *Traineeship focused on application of machine learning techniques to High Energy Physics.*

Tutors: Gabriele Pasquali, Lucio Anderlini

CERN

Geneva, Switzerland

RESEARCH INTERN (LHCb Experiment)

Sep 2019 – Dec 2019

📖 *Research in generative models to parameterise the LHCb particle identification system.*

Host: Giovanni Passaleva

University of Florence

Firenze, Italy

STUDENT RESEARCHER (LHCb Florence Group)

Jun 2019 – Jun 2020

📖 *Research aimed to build (non)parametric models for the LHCb detector and to develop a new simulation framework for High Energy Physics applications.*

Mentors: Lucio Anderlini, Giacomo Graziani

CERN

Geneva, Switzerland

STUDENT RESEARCHER (LHCb Experiment)

Jul 2017

📖 *Research in statistical methods for data analysis in High Energy Physics.*

Host: Giovanni Passaleva

University of Florence

Firenze, Italy

STUDENT RESEARCHER (LHCb Florence Group)

May 2017 – Sep 2017

📖 *Research aimed to study charmonium resonances decaying into purely hadronic final states as reconstructed by the LHCb experiment.*

Mentors: Lucio Anderlini, Giacomo Graziani

HONORS & AWARDS**“Giulia Vita Finzi” award**, INFN

2021

🏆 *National award for the best Master Thesis on computing and networks of INFN*

Ph.D. Scholarship in Smart Computing, INFN

2020 – 2023

🏆 *Scholarship to carry out Machine Learning research for Physics applications*

Scholarship for research activity, INFN

2019

🏆 *National grant to pass three months at CERN for research activity*

Scholarship for thesis abroad, University of Florence

2017

🏆 *Local grant to pass ten days at CERN for bachelor thesis*

CONFERENCES, WORKSHOPS & SCHOOLS**Learning to Discover**

online

Institut Pascal Paris-Saclay

Apr 2022

Presentation: “*Simulating the LHCb experiment with Generative Models*”

**ACAT 2021**

online

ACAT Workshop series

Nov 2021

Presentation: “*Towards Reliable Neural Generative Modeling of Detectors*”

**Computational Tools for High Energy Physics and Cosmology**

online

LABEX LIO and IN2P3

Nov 2021

Presentation: “*scikinC: a tool for deploying machine learning as a binaries*”

**LPCC Fast Detector Simulation Workshop**

online

LHC Physics Centre at CERN

Nov 2021

Presentation: “*OptunAPI*”

**107° Congresso Nazionale della SIF**

online

Italian Physical Society (SIF)

Sep 2021

Presentation: “*Simulating the LHCb detector with GANs*”



8th Thematic CERN School of Computing

CERN School of Computing

Theme: *Scientific Software for Heterogeneous Architectures*

online

Jun 2021

**Workshop della Commissione Calcolo e Reti dell'INFN**

INFN Computing and Network Service

Presentation: *"Simulating the LHCb detector with GANs"*

online

May 2021

**1st CloudBank EU Workshop**

CERN IT and IPT Departments

Presentation: *"LHCb deployment in AWS"* (restricted access)

online

Apr 2021

**OPEN SOURCE SOFTWARE****lb-pidsim-train**

PYTHON

Scripts and logics to train PID models for the Ultra-Fast Simulation of the LHCb experiment

**tf-gen-models**

PYTHON

Ready to use implementations of state-of-the-art generative models in TensorFlow

**OptunAPI**

PYTHON

API to distribute hyperparameters optimization through HTTP requests

**lymphoma-classification**

JUPYTER NOTEBOOK, PYTHON

Bulky mediastinal lymphoma classification with machine learning techniques

**PUBLICATIONS***Papers reported in reverse chronological order***Preprints & Working Papers**

- [1] LHCb Collaboration, *Measurement of the prompt D^0 nuclear modification factor in pPb collisions at $\sqrt{s_{NN}} = 8.16$ TeV*, [arXiv:2205.03936](#)
- [2] LHCb Collaboration, *Evidence for modification of b quark hadronization in high-multiplicity pp collisions at $\sqrt{s} = 13$ TeV*, [arXiv:2204.13042](#)
- [3] LHCb Collaboration, *Observation of sizeable ω contribution to $\chi_{c1}(3872) \rightarrow \pi^+\pi^-J/\psi$ decays*, [arXiv:2204.12597](#)
- [4] LHCb Collaboration, *Measurement of CP asymmetries in $D_{(s)}^+ \rightarrow \eta\pi^+$ and $D_{(s)}^+ \rightarrow \eta'\pi^+$ decays*, [arXiv:2204.12228](#)
- [5] LHCb Collaboration, *Nuclear modification factor of neutral pions in the forward and backward regions in pPb collisions*, [arXiv:2204.10608](#)
- [6] L. Anderlini *et al.*, *Towards Reliable Neural Generative Modeling of Detectors*, [arXiv:2204.09947](#)
- [7] LHCb Collaboration, *Search for the doubly heavy baryon Ξ_{bc}^+ decaying to $J/\psi\Xi_c^+$* , [arXiv:2204.09541](#)
- [8] LHCb Collaboration, R. Aaij *et al.*, *First measurement of the $Z \rightarrow \mu^+\mu^-$ angular coefficients in the forward region of pp collisions at $\sqrt{s} = 13$ TeV*, [arXiv:2203.01602](#)

- [9] LHCb Collaboration, R. Aaij *et al.*, *Measurement of the charm mixing parameter $y_{CP} - y_{CP}^{K\pi}$ using two-body D^0 meson decays*, [arXiv:2202.09106](#)
- [10] LHCb Collaboration, R. Aaij *et al.*, *Constraints on the CKM angle γ from $B^\pm \rightarrow Dh^\pm$ decays using $D \rightarrow h^\pm h'^\mp \pi^0$ final states*, [arXiv:2112.10617](#)
- [11] LHCb Collaboration, R. Aaij *et al.*, *Precision measurement of forward Z boson production in proton-proton collisions at $\sqrt{s} = 13$ TeV*, [arXiv:2112.07458](#)
- [12] LHCb Collaboration, R. Aaij *et al.*, *Angular analysis of $D^0 \rightarrow \pi^+ \pi^- \mu^+ \mu^-$ and $D^0 \rightarrow K^+ K^- \mu^+ \mu^-$ decays and search for CP violation*, [arXiv:2111.03327](#)
- [13] LHCb Collaboration, R. Aaij *et al.*, *Study of the doubly charmed tetraquark T_{cc}^+* , [arXiv:2109.01056](#)
- [14] LHCb Collaboration, R. Aaij *et al.*, *Observation of an exotic narrow doubly charmed tetraquark*, [arXiv:2109.01038](#)

Conference & Journal Articles

- [1] LHCb Collaboration, R. Aaij *et al.*, *Observation of the decay $\Lambda_b^0 \rightarrow \Lambda_c^+ \tau^- \bar{\nu}_\tau$* , *Phys. Rev. Lett.* **128** (2022) 191803, [arXiv:2201.03497](#)
- [2] LHCb Collaboration, R. Aaij *et al.*, *Tests of lepton universality using $B^0 \rightarrow K_S^0 \ell^+ \ell^-$ and $B^+ \rightarrow K^{*+} \ell^+ \ell^-$ decays*, *Phys. Rev. Lett.* **128** (2022) 191802, [arXiv:2110.09501](#)
- [3] LHCb Collaboration, R. Aaij *et al.*, *Search for the decay $B^0 \rightarrow \phi \mu^+ \mu^-$* , *JHEP* **05** (2022) 067, [arXiv:2201.10167](#)
- [4] LHCb Collaboration, R. Aaij *et al.*, *Observation of the doubly charmed baryon decay $\Xi_{cc}^{++} \rightarrow \Xi_c'^+ \pi^+$* , *JHEP* **05** (2022) 038, [arXiv:2202.05648](#)
- [5] LHCb Collaboration, R. Aaij *et al.*, *Search for massive long-lived particles decaying semileptonically at $\sqrt{s} = 13$ TeV*, *Eur. Phys. J. C* **82** (2022) 373, [arXiv:2110.07293](#)
- [6] LHCb Collaboration, R. Aaij *et al.*, *Observation of two new excited Ξ_b^0 states decaying to $\Lambda_b^0 K^- \pi^+$* , *Phys. Rev. Lett.* **128** (2022) 16200, [arXiv:2110.04497](#)
- [7] LHCb Collaboration, R. Aaij *et al.*, *Observation of the $B^0 \rightarrow \bar{D}^{*0} K^+ \pi^-$ and $B_s^0 \rightarrow \bar{D}^{*0} K^- \pi^+$ decays*, *Phys. Rev. D* **105** (2022) 072005, [arXiv:2112.11428](#)
- [8] LHCb Collaboration, R. Aaij *et al.*, *Study of charmonium and charmonium-like contributions in $B^+ \rightarrow J/\psi \eta K^+$ decays*, *JHEP* **04** (2022) 046, [arXiv:2202.04045](#)
- [9] LHCb Collaboration, R. Aaij *et al.*, *Measurement of the photon polarization in $\Lambda_b \rightarrow \Lambda \gamma$ decays*, *Phys. Rev. D* **105** (2022) L051104, [arXiv:2111.10194](#)
- [10] LHCb Collaboration, R. Aaij *et al.*, *Observation of $\Lambda_b^0 \rightarrow D^+ p \pi^- \pi^-$ and $\Lambda_b^0 \rightarrow D^{*+} p \pi^- \pi^-$ decays*, *JHEP* **03** (2022) 153, [arXiv:2112.02013](#)
- [11] LHCb Collaboration, R. Aaij *et al.*, *Searches for rare B_s^0 and B^0 decays into four muons*, *JHEP* **03** (2022) 109, [arXiv:2111.11339](#)
- [12] LHCb Collaboration, R. Aaij *et al.*, *Measurement of the lifetimes of promptly produced Ω_c^0 and Ξ_c^0 baryons*, *Sci. Bull.* **67** (2022) 5, [arXiv:2109.01334](#)
- [13] LHCb Collaboration, R. Aaij *et al.*, *Study of Z bosons produced in association with charm in the forward region*, *Phys. Rev. Lett.* **128** (2022) 082001, [arXiv:2109.08084](#)
- [14] LHCb Collaboration, R. Aaij *et al.*, *Identification of charm jets at LHCb*, *JINST* **17** (2022) P02028, [arXiv:2112.08435](#)

- [15] LHCb Collaboration, R. Aaij *et al.*, *Measurement of $\chi_{c1}(3872)$ production in proton-proton collisions at $\sqrt{s} = 8$ and 13 TeV*, *JHEP* **01** (2022) 131, [arXiv:2109.07360](#)
- [16] LHCb Collaboration, R. Aaij *et al.*, *Study of the B_c^+ decays into charmonia and three light hadrons*, *JHEP* **01** (2022) 065, [arXiv:2111.03001](#)
- [17] LHCb Collaboration, R. Aaij *et al.*, *Measurement of the W boson mass*, *JHEP* **01** (2022) 036, [arXiv:2109.01113](#)
- [18] LHCb Collaboration, R. Aaij *et al.*, *Observation of the suppressed $\Lambda_b^0 \rightarrow DpK^-$ decay with $D \rightarrow K^+\pi^-$ and measurement of its CP asymmetry*, *Phys. Rev. D* **104** (2021) 112008, [arXiv:2109.02621](#)
- [19] LHCb Collaboration, R. Aaij *et al.*, *Simultaneous determination of CKM angle γ and charm mixing parameters*, *JHEP* **12** (2021) 141, [arXiv:2110.02350](#)
- [20] LHCb Collaboration, R. Aaij *et al.*, *Updated search for B_c^+ decays to two charm mesons*, *JHEP* **12** (2021) 117, [arXiv:2109.00488](#)
- [21] LHCb Collaboration, R. Aaij *et al.*, *Search for the doubly charmed baryon Ξ_{cc}^+ in the $\Xi_c^+\pi^-\pi^+$ final state*, *JHEP* **12** (2021) 107, [arXiv:2109.07292](#)
- [22] LHCb Collaboration, R. Aaij *et al.*, *Measurement of J/ψ production cross-sections in pp collisions at $\sqrt{s} = 5$ TeV*, *JHEP* **11** (2021) 181, [arXiv:2109.00220](#)
- [23] LHCb Collaboration, R. Aaij *et al.*, *Angular analysis of the rare decay $B_s^0 \rightarrow \phi\mu^+\mu^-$* , *JHEP* **11** (2021) 043, [arXiv:2107.13428](#)

TEACHING & TUTORING

B.Sc. in Physics and Astrophysics, University of Florence

- B015862: Physics Laboratory III – *Lab Tutor and Head TA for Vitaliano Ciulli* 2020 – 2021
- B015861: Physics Laboratory II – *Lab Tutor for Andrea Stefanini* 2020 – 2021
- B015860: Physics Laboratory I – *Lab Tutor and TA for Massimo Bonghi* 2020 – 2021
- B005476: Physics I – *TA for Oscar Adriani* 2020 – 2021
- B015860: Physics Laboratory I – *Lab Tutor and TA for Massimo Bonghi* 2019 – 2020
- B005476: Physics I – *TA for Oscar Adriani* 2019 – 2020

B.Sc. in Mathematics, University of Florence

- B016237: Physics II – *Lab Tutor and TA for Piergiulio Lenzi* 2020 – 2021

B.Sc. in Biological Sciences, University of Florence

- B019238: Physics Laboratory for Biology – *Lab Tutor and TA for Francesca Intonti* 2019 – 2020
- B019238: Physics Laboratory for Biology – *Lab Tutor and TA for Francesca Intonti* 2018 – 2019
- B019231: Physics – *TA for Diederik Sybolt Wiersma* 2018 – 2019

OUTREACH & DISSEMINATION

Science book “Invenzioni”

Sassi Junior & INFN

Preparation of a paragraph dedicated to Artificial Intelligence

Jun 2021



Live interview “Fisica del Clima” with Daniele Visioni

AISF & Cornell University

Organization of an interview about Climate Physics

online

Mar 2021



Live interview “Women in Science” with Anna Gregorio

AISF & University of Trieste

Organization of an interview on the occasion of Women in Science International Day

online

Feb 2021

**Live interview “COVID19” with Eugenio Valdano**

AISF & INSERM

Organization of an interview about statistical models for COVID-19 pandemic

online

Apr 2020

**Outreach event “Tra clima e cocktail”**

AISF, Italian Climate Network, CNR & University of Florence

Organization of an event aimed to raise awareness about climate change problem

Firenze, Italy

May 2019

**Outreach event “Viaggio al Polo”**

AISF, Caffè-Scienza, INFN & University of Florence

Organization of an event about intelligence according to various scientific domains

Firenze, Italy

May 2019

**Outreach event “Luminoscienza”**

AISF, LENS, University of Florence, INRIM & Caffè-Scienza

Organization of three scientific evenings on the occasion of International Day of Light

Firenze, Italy

May 2018

**Seminar “The new particles of LHCb” by Lucio Anderlini**

AISF & LHCb Florence Group

Organization of a seminar to discuss latest LHCb discoveries

Firenze, Italy

Oct 2017

**LEADERSHIP & COMMUNITY SERVICES****National Institute for Nuclear Physics (INFN)**

- PhD Student Member
- Master Student Member



Nov 2020 – present

Sep 2019 – Jun 2020

LHCb Collaboration

- PhD Student Author
- LHCb DQCS shifter
- PhD Student Member
- Master Student Member
- Bachelor Student Member



May 2021 – present

Mar 2021 – present

Nov 2020 – present

Sep 2019 – Jun 2020

Jul 2017 – Sep 2017

Italian Association of Physics Students (AISF)

- Deputy-President
- Secretary
- President of the Florence Local Committee
- Editorial Board Member of “Sistemi di Riferimento”
- Deputy-President of the Florence Local Committee



Oct 2020 – Sep 2021

Oct 2019 – Sep 2021

Nov 2018 – May 2019

May 2018 – Sep 2021

Dec 2017 – Nov 2018

COMPUTER SKILLS

GitHub <https://github.com/mbarbetti>
Languages Python, C/C++, TeX
OS Windows, Mac OS, Linux

LANGUAGES

Italian Native
English Advanced
Spanish Intermediate