Maurizio Martinelli

Curriculum Vitae - November 30, 2021

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Personal Information

Languages Italian (mother tongue); English (proficient - C2); French (upper intermediate - B2)

Research Experience

2021– today **Associate Professor**,
University of Milano Bicocca, Milano, Italy.

2019– 2021 **Tenure-Track Assistant Professor**,
University of Milano Bicocca, Milano, Italy.

2018– 2019 **CERN Fellow**,
European Center for Nuclear Research, Meyrin, Switzerland.

2014– 2018 **Postdoctoral Researcher**,
École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland.

2011– 2014 **Postdoctoral Researcher**,
Nikhef, Amsterdam, The Netherlands.

2011 **Postdoctoral Scholar**,
SLAC National Accelerator Laboratory, Menlo Park, CA, USA.

Education

2008– 2011 **Ph. D. in Experimental Physics (thesis defended on May 19, 2011)**,
University of Bari and Istituto Nazionale di Fisica Nucleare (INFN), Bari, Italy,
Supervisor: Prof. Antimo Palano.
Search for CP violation using T-odd correlations in Cabibbo suppressed charmed mesons four body decays.

2005– 2007 **Master's Degree in Nuclear and Particle Physics (thesis defended on October 25, 2007)**,
University of Bari, Bari, Italy,
Supervisor: Prof. Antimo Palano.
Search for CP violation in four body D0 decays in the BaBar experiment.

2002– 2005 **Bachelor's degree in Physics (thesis defended on September 24, 2005)**,
University of Bari, Bari, Italy,
Supervisor: Prof. Paolo Spinelli.
Development of a Cherenkov detector in order to measure the energy spectrum of athmosferic muons reaching sea level.

Position of Responsibility

2018– 2020 **Coordinator of LHCb "Charm" working group**,
LHCb Collaboration, CERN, I lead the team of "Charm" working group conveners and work in direct contact with the Physics Coordinator to define the physics priorities of the group and the analysis strategy that optimizes the use of the resources available to the group. I review all of the analyses produced by the group to ensure that they meet the quality standards required by LHCb.

2016– 2018 **Coordinator of LHCb "Charm Mixing and *CP* violation" sub-working group**,
LHCb Collaboration, CERN,
Main achievements: world best measurement of A_Γ in $D^0 \to h^+h^-$ decays, first measurement of ΔA_{CP} in $\Lambda_c^+ \to ph^+h^-$ decays, observation of mixing in $D^0 \to K^+\pi^-\pi^+\pi^-$ decays.
As a convenor in the "Charm" working group, I participated to the decisions of the group convenors and I reviewed most of the analyses produced by the sub-group to ensure that they meet the standards required by LHCb.

2012– 2018 **Responsible for LHCb tracker alignment**,
LHCb Collaboration, CERN,
Main achievements: improved momentum resolution of LHCb tracker; real-time alignment of LHCb tracker.
Tracking devices require a perfect alignment to obtain the best possible track momentum resolution and to eliminate potential reconstruction biases. It is my responsibility to guarantee that the best possible alignment constants are used for the reconstruction of the data. During the LHC Run 1 (2011-2012) I significantly improved the momentum resolution of the LHCb tracker by modifying the alignment software, its input data samples and the description of magnetic field map used in reconstruction. The alignment strategy was changed for LHC Run 2 (2015-2018). The alignment is now performed in real-time during data-taking. I led the team that was responsible for design, development and commissioning of the software adopted for the real-time alignment procedure in Run 2.

2012– 2015 **Coordinator of LHCb "Tracking and Alignment" working group**,
LHCb Collaboration, CERN, I coordinated the group that develops the reconstruction and alignment software of LHCb. During my mandate the LHCb collaboration decided to increase the output rate on disk from 5 kHz in Run1 to 12.5 kHz in Run 2. My working group reacted promptly by re-optimising all of the algorithms in the reconstruction sequence. We also implemented a real-time alignment procedure that allows offline quality tracking in the trigger, making the offline reconstruction unnecessary.

2012– 2015 **Member of LHCb Physics Planning Group**,
2018– 2020 *LHCb Collaboration*, CERN, As working group coordinator, I was a member of the Physics Planning Group. This group is an advisory body to the LHCb Management and provides recommendations to ensure the best quality of the physics output.

Recognitions

2017 **Abilitazione Scientifica Nazionale**,
Ministry of Education, valid from April 04, 2017 to April 04, 2023.
I have been judged by a commission representing the Italian Ministry of Education qualified to exercise the functions of associate professor in Italy following the criteria determined by the article 16 of law n. 240 of 30 December 2010.

Fellowships and Grants

2017 **CERN Fellowship**,
CERN, Switzerland.
The grant offered a fixed term researcher position of 2 years at CERN. About 30 fellowships per year are assigned.

2014 **Future in Research**,
Regione Puglia, Italy.
The grant offered a fixed term researcher position at the University of Bari, Italy. Declined.

2011 **SLAC/DOE**,
SLAC National Accelerator Laboratory, CA, USA.
Financial support to be temporarily hired by the SLAC laboratories to complete and publish the analysis of the $D^+_{(s)} \to K^+ K^0_S \pi^+ \pi^-$ decays in BaBar.

2007 **Doctoral Fellow**,
Università degli Studi di Bari, Italy.

Scientific Activity

2013– today Referee for *Physical Review Letters*, *Physical Review D*, *European Physics Journal C*.

2021– today Expert for *Agence National de la Recherche (ANR) - France*.

2011– today **Member of LHCb Collaboration**
data analysis, software development for track reconstruction and upgrade studies

Main achievements: First observation of the mass difference of the neutral charm-meson eigenstates; First evidence of *CP* violation in Λ^0_b baryons; First observation of the $B^0_s \to D^0 K^0_S$ decay; Search for *CP* violation in $D^0 \to K^+K^-\pi^+\pi^-$ decays; Real-time alignment of LHCb tracker.

I search for *CP* violation in the decays of D^0 mesons and Λ^0_b baryons. In particular, I study the multi-body decays of these hadrons using advanced analysis techniques based on the measurement of asymmetries in the angular distributions of the decay and in partial decay amplitudes. I am one of the primary authors of *JHEP10:005, 2014*, in which *CP* violation is searched for in $D^0 \to K^+K^-\pi^+\pi^-$ decays. The triple products analysis technique that I developed, used for the first time in LHCb, allows to search for *CP* violation with very small systematic uncertainties. Further studies I've done on this decay are documented in *JHEP02:126, 2019*, where I've searched for *CP* violation in the partial amplitudes of the decay. I am recently interested in the *CP* violation arising in the mixing of D^0 mesons, I participated to the development of a novel technique to study such phenomenon using $D^0 \to K^0_S \pi^+\pi^-$ decays (*PRD99:012007,2019*) that led to the first evidence of the mass difference of the neutral charm-meson eigenstates (*PRL122:231802,2019*) and later to its observation (*PRL127:111801,2021*).

I played a leading role in the publication of the first evidence of *CP* violation in $\Lambda^0_b \to p\pi^-\pi^+\pi^-$ decays. The results were published in *Nature Physics*. The work was performed with two collaborators where my knowledge of the triple products analysis techniques was fundamental for the innovative application to Λ^0_b decays. I provided guidance on the techniques to select the data and to determine correctly the various signal and peaking background contributions, for which simulations are used.Among my original contributions are the proposed binning schemes that allowed to find the evidence and the statistical technique used to correctly estimate the p-value of the *CP* conservation hypothesis. The study of the other $\Lambda^0_b \to p h^- h^+ h^-$ decays brought to the publication *JHEP08:039, 2018*.

I also studied B mesons decays. I observed the $B^0_s \to D^0 K^0_S$ decay for the first time (*PRL116:161802, 2016*). The highlights of this measurement are the reconstruction of a trackless vertex (both D^0 and K^0_S are long-lived particles) and the 3-dimensional fit to extract the signal yields that is so precise to allow measuring the branching fraction not only of the signal, but also of $B^0_s \to D^{*0} K^0_S$, which appears as a reflection in the mass distribution of $m(D^0 K^0_S)$. This work also lead to the best determination to date of the $r_B^{D\pi}$ parameter in $B^+ \to \overline{D}^0 \pi^+$ decays, which is used as input to the determination of the CKM angle γ (PRD94:054021, 2016). My contribution in this paper is related to the determination of $r_B^{D\pi}$ using the topological similitude with $B^0 \to \overline{D}^0 K^0_S$ decays.

At the beginning of my participation to LHCb, I joined the search for long-lived particles (*EPJC75:152,2015*), within the *Vidi* grant of Dr. Wouter Hulsbergen at Nikhef. I was responsible for the selection of the events and to set limits on the production cross-section by applying the *CLs* technique. For the selection, I designed a tool to remove candidates produced by the interaction of particles with the material surrounding the interaction region of LHCb (mainly the vertex detector, VELO). This is the largest background for this analysis and required the development of a code based on the geometrical description of the VELO and on the beam-line position (around which the VELO is centered fill-by-fill).

I am frequently appointed as an internal reviewer of LHCb analyses (listed in the *Publications* section).

I was very active in the development of the reconstruction and alignment software, in particular for the detector alignment (*NIM A712:48-55, 2013*), for which I was the software project responsible.

I worked on the field map parametrisation that is currently used in LHCb track reconstruction software. This is the outcome of a magnetic field measurements campaign that I proposed in 2014 and that was carried out during the first long shutdown of the LHC (LHCb-INT-2015-034). I supervised a student in the analysis of the data from the measurement, proposing cross-checks based on tracker alignment to verify the improvements in the field map parametrisations.

Furthermore, I participate in activities connected to the LHCb Upgrade. I am working on the software that will be used for running the offline analysis of the data.

2008– 2015 **Member of BaBar Collaboration**
data analysis and software development for track reconstruction

Main achievements: Search for *CP* violation in $D^0 \to K^+K^-\pi^+\pi^-$ and $D^+_{(s)} \to K^0_S K^+\pi^+\pi^-$ decays; Measurement of the reconstruction efficiency of the soft pion in $D^{*+} \to D^0\pi^+$ decays.

During my doctoral studies I participated in the BaBar collaboration, an experiment based at SLAC, Stanford, USA. My activity was focused on the search for *CP* violation in multibody charm meson decays. Initially I studied $D^0 \to K^+K^-\pi^+\pi^-$ (*PRD81:111103, 2010*) and later $D^+_{(s)} \to K^0_S K^+\pi^+\pi^-$ (*PRD84:031103, 2011*) decays. I was responsible of all aspects of the analyses where I developed the triple product technique that, after further improvements, I still use in LHCb. During this time, I also started to analyse the decay amplitudes of $D^0 \to K^+K^-\pi^+\pi^-$ decays.

I was a member of the internal review committee of the measurement of mass and amplitude of $D_{s1}(2536)^+ \to D^{*+}K^0_S$ decays (*PRD83:072003, 2011*).

I also studied the reconstruction efficiency of the soft pion in $D^{*+} \to D^0\pi^+$ decays (*NIM A704:44-59, 2013*). In this analysis I studied the cosine of the helicity angle of the D^* to extract a relative efficiency distribution for data and simulation. The difference between the two distributions is used as a systematic uncertainty for the soft pion reconstruction efficiency in BaBar.

Academic Activity

Member of the evaluation committee for Doctoral theses

2016 "Search for exotic long-lived particles with the LHCb detector", Pieter David, Vrije University (VU) of Amsterdam.

2014 "Search for (Higgs-like) bosons decaying into a pair of long-lived exotic particles in the LHCb experiment", Julien Rouvinet, EPFL.

Supervision of post-graduate students

2018 "Search for *CP* violation through an amplitude analysis of $D^0 \to K^+K^-\pi^+\pi^-$ decays at LHCb", Maxime Schubiger, EPFL.

2016 "Searches for the Anomalous Photon Polarisation in Radiative B Decays at LHCb", Zhirui Xu, EPFL.

2016 "Search for exotic long-lived particles with the LHCb detector", Pieter David, Nikhef.

2015 "Search for Long-Lived Exotic Particles at LHCb", Veerle Heijne, Nikhef.

Supervision of master theses

2017 "Search for *CP* violation in the angular distributions of $D^0 \to K^+K^-\pi^+\pi^-$", Guillaume Pietrzyk, EPFL.

2016 "Charm mixing and *CP* violation in $D^0 \to K^0_S K^+K^-$", Marco Valente, EPFL.

2013 "Branching fraction measurement of the $B^0_s \to D^0 K^0_S$ decay", Jesse Mesman, Uva, Nikhef.

Supervision of bachelor theses

2019 "Measurement of the mixing parameter y_{CP} in $D^{*+} \to D^0(K^0_S K^+K^-)\pi^+$ decays and effect of the contamination from $D^0 \to K^0_S K^+K^-$ decays originating from b-hadrons at LHCb", Giovanni Cavallotto, University of Milano Biocca.

Supervision of summer students

2019 "Studies of $D^0 \to K^0_S K^+K^-$ decays for measuring y_{CP}", Paula Barber Belda, CERN.

2018 "Sensitivity of Triple Product Asymmetries in $D^+ \to K^0_S K^+\pi^-\pi^+$ Decays at LHCb", Shaowei Wu, CERN.

Teaching activity

2019– today Teacher for the 1th year physics laboratory course for the bachelor in Physics (8 ECTS)

2017 First assistant for the 1th year general physics course for the bachelor in Mathematics (5 ECTS)

2014– 2017 Teaching assistant for the 4th year physics course on experimental techniques at EPFL (16 ECTS)

2010 Teaching Assistant at the Department of Physics - Bari for the course "Programming Languages" (2 ECTS)

Outreach

2019– today Organiser of the local activity for the International Masterclass "Hands On Particle Physics" from the International Particle Physics Outreach Group

Publications

Top 5 Publications

2017 *Measurement of matter-antimatter differences in beauty baryon decays*, Aaij, Roel and others (LHCb Collaboration). Nature Phys. 13 (2017) 391–396.
With one collaborator, I conceived and setup the full analysis. I supervised a graduate student and a younger postdoc, providing conceptual and technical support. A copy is accessible at https://arxiv.org/abs/1609.05216.

2019 *Search for CP violation through an amplitude analysis of $D^0 \to K^+K^-\pi^+\pi^-$ decays*, Aaij, Roel and others (LHCb Collaboration). JHEP 02 (2019) 126.
I conceived and setup the full analysis. I supervised a graduate student, providing conceptual and technical support. A copy is accessible at https://arxiv.org/abs/1811.08304.

2019 *Novel method for measuring charm-mixing parameters using multibody decays*, Di Canto, A. and Garra Ticó, J. and Gershon, T. and Jurik, N. and Martinelli, M. and Pilař, T. and Stahl, S. and Tonelli, D.. Phys. Rev. D 99 (2019) 012007.
I participated to the conception of the analysis method that allowed to first measure mass difference between the neutral charm meson eigenstates. A copy is accessible at https://arxiv.org/abs/1811.01032.

2016 *Estimating $r_B^{D\pi}$ as an input to the determination of the CKM angle γ*, Kenzie, Matthew and Martinelli, Maurizio and Tuning, Niels. Phys. Rev. D 94 (2016) 054021.
I've determined the value of $r_B^{D\pi}$ using the analogy with $B^0 \to \bar{D}^0 K_S^0$ decays. This result has been fundamental to reduce the uncertainty in the γ combination of LHCb, since it removed the ambiguity of $r_B^{D\pi}$ from the global fit. A copy is accessible at https://arxiv.org/abs/1606.09129.

2016 *Observation of $B_s^0 \to \bar{D}^0 K_S^0$ and evidence for $B_s^0 \to \bar{D}^{*0} K_S^0$ decays*, Aaij, Roel and others (LHCb Collaboration). Phys. Rev. Lett. 116 (2016) 161802.
Started as a Master's thesis project, I carried out the analysis from the beginning to publication. A copy is accessible at https://arxiv.org/abs/1603.02408.

Other publications to which I gave a very significant contribution

2021 *Observation of the Mass Difference Between Neutral Charm-Meson Eigenstates*, Aaij, Roel and others (LHCb Collaboration). Phys. Rev. Lett. 127 (2021) 111801.

2019 *Measurement of the mass difference between neutral charm-meson eigenstates*, Aaij, Roel and others (LHCb Collaboration). Phys. Rev. Lett. 122 (2019) 231802.

2018 *Search for CP violation using triple product asymmetries in $\Lambda_b^0 \to pK^-\pi^+\pi^-$, $\Lambda_b^0 \to pK^-K^+K^-$ and $\Xi_b^0 \to pK^-K^-\pi^+$ decays*, Aaij, Roel and others (LHCb Collaboration). JHEP 08 (2018) 039.

2015 *Search for long-lived particles decaying to jet pairs*, Aaij, Roel and others (LHCb Collaboration). Eur. Phys. J. C 75 (2015) 152.

2014 *Search for CP violation using T-odd correlations in $D^0 \to K^+K^-\pi^+\pi^-$ decays*, Aaij, Roel and others (LHCb Collaboration). JHEP 10 (2014) 005.

2013 *Application of vertex and mass constraints in track-based alignment*, Amoraal, J. and others. Nucl. Instrum. Meth. A 712 (2013) 48–55.

2013 *Track Finding Efficiency in BaBar*, Allmendinger, T. and others. Nucl. Instrum. Meth. A 704 (2013) 44–59.

2011 *Search for CP violation using T-odd correlations in $D^+ \to K^+K_S^0\pi^+\pi^-$ and $D_s^+ \to K^+K_S^0\pi^+\pi^-$ decays*, Lees, J. P. and others (BaBar Collaboration). Phys. Rev. D 84 (2011) 031103.

2010 *Search for CP violation using T-odd correlations in $D^0 \to K^+K^-\pi^+\pi^-$ decays*, del Amo Sanchez, P. and others (BaBar Collaboration). Phys. Rev. D 81 (2010) 111103.

Publications where I contributed to as internal reviewer

2021 *Searches for 25 rare and forbidden decays of D^+ and D_s^+ mesons*, Aaij, Roel and others (LHCb Collaboration). JHEP 06 (2021) 044.

2018 *Search for weakly decaying b-flavored pentaquarks*, Aaij, Roel and others (LHCb Collaboration). Phys. Rev. D 97 (2018) 032010.

2016 *Amplitude analysis of $B^- \to D^+\pi^-\pi^-$ decays*, Aaij, Roel and others (LHCb Collaboration). Phys. Rev. D 94 (2016) 072001.

2015 *B flavour tagging using charm decays at the LHCb experiment*, Aaij, Roel and others (LHCb Collaboration). JINST 10 (2015) P10005.

2013 *Measurement of D^0–$\bar{D}^0$ Mixing Parameters and Search for CP Violation Using $D^0 \to K^+\pi^-$ Decays*, Aaij, R and others (LHCb Collaboration). Phys. Rev. Lett. 111 (2013) 251801.

2013 *Observation of $D^0 - \overline{D}^0$ oscillations*, Aaij, R and others (LHCb Collaboration). Phys. Rev. Lett. 110 (2013) 101802.

2011 *Measurement of the mass and width of the D(s1)(2536)+ meson*, Lees, J. P. and others (BaBar Collaboration). Phys. Rev. D 83 (2011) 072003.

Member of International Collaborations

2011-today 535 publications in peer-review journals together with the LHCb Collaboration

2008-2015 160 publications in peer-review journals together with the BaBar Collaboration

Books

2014 *The Physics of the B Factories*, Bevan, A. J. and others (BaBar, Belle Collaboration). Eur. Phys. J. C 74 (2014) 3026.
I wrote section 19.2.6.3 ("T-odd correlations") and participated in the writing of chapter 6 ("Vertexing"). A copy is accessible at https://arxiv.org/abs/1406.6311.

Conferences

Conference Talks

2021 "New results in Charm physics at LHCb". Presented at LISHEP 2021 Workshop in High Energy Physics held in Rio de Janeiro, Brazil (virtual). Slides.

2020 "Charm Physics". Presented at 8th Large Hadron Collider Physics Conference (LHCP) 2020 held in Paris, France (virtual). Slides.

2019 "Recent Results on *CP* Violation in Charm mesons at LHCb". Presented at 27th International Workshop on Weak Interactions and Neutrinos (WIN) 2019 held in Bari, Italy. Slides.

2018 "Mixing and Indirect *CP* Violation in Charm Decays at LHCb". Presented at 39th International Conference on High Energy Physics (ICHEP) 2018 held in Seoul, South Korea. Slides.

2016 "Measurements of mixing and indirect CPV in multi-body charm decays at LHCb". Presented at 9th International Workshop on the CKM unitarity triangle (CKM) 2016 held in Mumbai, India. Slides.

2016 "Novel Real-time Alignment and Calibration of the LHCb detector in Run2". Presented at 22nd International Conference on Computing in High Energy Physics (CHEP) 2016 held in San Francisco, CA, USA. Slides and Proceedings.

2015 "Searches of *CP* violation in multibody charm decays". Presented at International Europhysics Conference on High Energy Physics (EPS-HEP) 2015 held in Vienna, Austria. Slides.

2015 "Measurements of T-odd observables". Presented at 7th International Workshop on Charm Physics (Charm) 2015 held in Detroit, MI, USA. Slides and Proceedings.

2014 "*CP*-violating triple product asymmetry measurements in charm decays". Presented at 8th International Workshop on the CKM unitarity triangle (CKM) 2014 held in Vienna, Austria. Slides and Proceedings.

2014 "Latest LHCb Results". Presented at 7th International Workshop on Quantum Chromodynamics (QCD) 2014 held in Giovinazzo, Italy. Slides and Proceedings.

2013 "Tracking and Alignment at LHCb". Presented at International Conference on Advanced Technology and Particle Physics (ICATPP) 2013 held in Como, Italy. Slides and Proceedings.

2013 "The LHCb Upgrade". Presented at 14th International Conference of B-physics at Hadron Machines (Beauty) 2013 held in Bologna, Italy. Slides and Proceedings.

2011 "Recent BaBar Charm Physics results". Presented at International Europhysics Conference on High Energy Physics (EPS-HEP) 2011 held in Grenoble, France. Slides and Proceedings.

2011 "Search for *CP* violation in $\tau \to K^0_S X$ and $D^+_{(s)} \to K^0_S X$ decays". Presented at Flavor Physics and CP Violation (FPCP) 2011 held in Maale Hachamisha, Israel. Slides and Proceedings.

2010 "Search for *CP* violation in D^0 decays". Presented at Flavor Physics and CP Violation (FPCP) 2010 held in Torino, Italy. Slides and Proceedings.

2010 "Search for *CP* violation using T-odd correlations in Cabibbo suppressed $D^0 \to K^+K^-\pi^+\pi^-$ decays". Presented at Lake Louise Winter Institute (LLWI) 2010 held in Lake Louise, Alberta, Canada. Slides and Proceedings.

Invited Talks

2018 "Experimental prospects for CPV measurements in baryons, and T- and P-odd symmetries". Presented at Towards the ultimate precision in flavour physics held in Warwick, UK. Slides.

2017 "*CP* violation measurements with triple product asymmetries". Presented at Physics seminar held at University of Milan Bicocca held in Milan, Italy. Slides.

2017 "Magnet station overview and tracking studies". Presented at Beyond the LHCb Phase I Upgrade held in La Biodola, Isola d'Elba, Italy. Slides.

2016 "Physics potential of Upstream tracks in LHCb". Presented at Theatre of Dreams: Beyond the LHCb Phase I Upgrade held in Manchester, UK. Slides.

2014 "Charm Physics perspectives with the LHCb upgrade". Presented at What Next: Discovery Potential of Charm Physics held in Milan, Italy. Slides.

Organisation of Conferences

2018 Convener of the session *Intensità* for the conference IFAE 2018, held in Milan, Italy. Website.