Raffaele Gerosa

Curriculum Vitae

Personal data

Name and surname:	**Raffaele Gerosa**
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Professional history

Since 2023 **Assistant Professor**, *University of Milano Bicocca*, UNIMIB.
Assistant Prof. and associated member of the Italian National Institute for Nuclear Physics (INFN)

2022–2023 **Project Scientist**, *University of California San Diego*, UCSD.
Advisor: Prof. Vivek Sharma. Research projects founded by D.O.E. (Department of Energy, US)

2016–2021 **Post-doctoral Researcher**, *University of California San Diego*, UCSD.
Advisor: Prof. Vivek Sharma. Research projects founded by D.O.E. (Department of Energy, US) and N.S.F. (National Science Foundation, US)

2014–2015 **Cooperation Associate Researcher**, *European Organization For Nuclear Research*, CERN.
Proposed project: "Searches for massive resonances decaying into vector boson pairs and calibration of ECAL detector with isolated electrons".

Education

2012–2015 **Ph.D. in Physics**, *University of Milano Bicocca*, Milano.
Title: *"Search for new particles decaying into vector boson pairs at LHC with the CMS detector and prospects for the vector boson scattering at the future High Luminosity LHC"*
Advisor: Prof. Alessio Ghezzi, University of Milano Bicocca and INFN.

2010–2012 **M.Sc. in Physics**, *University of Milano Bicocca*, Milano, *110/110 cum laude*.
Title: *"ECAL calibration via isolated electron from W/Z decays and background studies in the* $H \to WW \to \ell\nu\ell\nu$ *channel with the CMS detector at the LHC"*
Advisor: Prof. Marco Paganoni, University of Milano Bicocca and INFN.

2007–2010 **B.Sc. in Physics**, *University of Milano Bicocca*, Milano, *110/110 cum laude*.
Title: *"Data driven method for background estimates in Higgs searches at CMS"*
Advisor: Prof. Marco Paganoni, University of Milano Bicocca and INFN.

Awards

2024 **Missionaire Invitee 2024**, *University of Paris Saclay and ICJLab*, Selected as visiting professor for one month in order to develop a project on *"constraining indirect new physics effects in non resonant HH production via Effective Field Theory"*.

2022 **LHC Physics Center Distinguished Researcher**, *LPC Center*, Fermi National Accelerator Laboratory (FNAL).
RESEARCH PROJECT: *"Developments of dedicated triggers for* HH $\rightarrow$ 4b *analyses in Run3 and developments of QA and QI procedure for 2S and PS module production of the CMS Phase-2 Outer Tracker (OT)"*. GRANT BUDGET: 60000 $USD

2018 **CMS Collaboration**, *Winner of the "CMS 2018 Achievement Award" for "outstanding contributions to the silicon tracker commissioning software, to online calibrations during data taking, and for leadership in the tracker DAQ group"*, European Organization For Nuclear Research (CERN).

2016 **Istituto Nazionale di Fisica Nucleare (INFN)**, *Winner of the national award "Marcello Conversi" for the best Ph.D. thesis defended in 2015*, University "La Sapienza" in Rome.

2013 **CMS Collaboration**, *Winner of a special recognition award from the CMS Fundamental Physics Scholar*, European Organization For Nuclear Research (CERN).

International conferences and workshops

Jan. 2025 **Plenary Talk**, *"Training NN on HPC farms via a Kubernetes based interface"*, Workshop on "Quasi-Interactive Analysis of Big Data with High Throughput", Bologna, Italy.

Nov. 2024 **Plenary Talk**, *"Probing Higgs boson self-couplings with the non-resonant HH production at the LHC"*, Higgs 2024 Conference, Uppsala, Sweden.

Sept. 2024 **Plenary Talk**, *"Identification of boosted hadronic resonances decaying into heavy flavours (bb,cc) in CMS"*, 2024 ATLAS-CMS flavour tagging workshop, Genova, Italy.

Sept. 2023 **Plenary Talk**, *"Search for high frequency gravitational waves with bulk acoustic cavities"*, Workshop on "Innovative Detector Technologies and Methods (IDTM)", Lisbon, Portugal.

Jul. 2023 **Parallel Talk**, *"Vector boson scattering results in CMS"*, SUSY 2023: Conference on "Supersymmetry and unification of fundamental Interactions", Southampton, United Kingdom.

Oct. 2022 **Plenary Talk**, *"Limiting components of theoretical uncertainties in current VBF Higgs CMS measurements"*, Workshop on "Past, present, and future of VBF", CERN, Switzerland.

Mar. 2021 **Plenary Talk**, *"Higgs decays to fermions and bosons in ATLAS and CMS"*, Rencontres de Moriond: "Electroweak Interactions and Unified Theories", La Thuile, Italy.

Feb. 2018 **Plenary Talk**, *"Radiation effects in the CMS strip tracker readout electronics"*, Workshop on "Radiation effects in the LHC experiments", CERN, Switzerland.

Jul. 2018 **Parallel Talk**, *"Search for Higgs boson rare decays in CMS"*, International Conference of High Energy Physics (ICHEP), Seoul, South Korea.

Feb. 2018 **Plenary Talk**, *"LHC Higgs cross section workshop"*, Status report from CMS: experimental results and progresses, CERN, Switzerland.

Mar. 2017 **Plenary Talk**, *"Search for Dark-Matter mediators in ATLAS and CMS"*, Rencontres de Moriond EW, La Thuile, Italy.

Oct. 2015 **Plenary Talk**, *"Analysis techniques for boosted Higgs boson and matrix element methods"*, Higgs Couplings, Durham, United Kingdom.

Aug. 2015 **Poster**, *"Vector Boson Scattering prospects for High-Luminosity LHC at CMS in the same sign WW final state"*, XXVII Symposium on Lepton Photon Interactions, Lubiana, Slovenia.

Aug. 2014 **Plenary Talk**, *"Boosted W/Z bosons in physics analyses in CMS"*, VI Workshop on Boosted Objects Searches in HEP, London, United Kingdom.

National conferences and workshops

Oct. 2023 **Invited Talk**, *"Current status of Higgs Physics in CMS"*, Riunione nazionale di CMS Italia, Turin, Italy.

Oct. 2021 **Invited Talk**, *"Higgs physics: current status and prospects for Run3"*, Riunione nazionale di CMS Italia, Naples, Italy.

Nov. 2013 **Plenary Talk**, *"VV Scattering a 8 TeV e prospettive per il futuro Run a 13 TeV"*, Riunione nazionale di CMS Italia, Venice, Italy.

Sep. 2013 **Parallel Talk**, *"Search for a SM-like Higgs into* $WW \to \ell\nu q\bar{q}$ *at high mass at 8 TeV with CMS detector"*, XCIX Congresso della Società Italiana di Fisica, Trieste, Italy.

Seminars

Mar. 2022 **Seminar**, *"Hunting non-resonant HH in Run3 via new Machine Learning taggers and triggers"*, University of Milano Bicocca, Milan, Italy.

Mar. 2021 **Seminar**, *"Evidence for Higgs boson decays to a pair of muons with the CMS detector and prospects for HL-LHC"*, University of Liverpool, Liverpool, UK.

Mar. 2021 **Seminar**, *"Higgs boson couplings to the second generation of fermions""*, University of Milano Bicocca, Milan, Italy.

Jan. 2021 **Seminar**, *"Evidence for Higgs boson decays to a pair of muons with the CMS detector and prospects for HL-LHC"*, University La Sapienza, Rome, Italy.

Nov. 2020 **Seminar**, *"Evidence for Higgs boson decays to a pair of muons with the CMS detector and prospects for HL-LHC"*, Imperial College, London, UK.

Oct. 2020 **Cavendish Seminar**, *"Higgs boson decays to a pair of muons in CMS and ATLAS detectors"*, Cambridge University, Cambridge, UK.

Oct. 2020 **Wine & Cheese Seminar**, *"Evidence for Higgs boson decays to a pair of muons with the CMS detector and prospects for HL-LHC"*, Fermi National Laboratory (FNAL), Illinois, United States.

Sept. 2020 **Seminar**, *"Evidence for Higgs boson decays to a pair of muons with the CMS detector and prospects for HL-LHC"*, Argonne National Laboratory (ANL), Illinois, United States.

Sept. 2020 **Seminar**, *"Evidence for Higgs boson decays to a pair of muons with the CMS detector"*, University of Carpinas, Sao Paulo, Brasil.

Conference and School organization

Sept. 2024 **AIPHY School**.
Co-Organizer of the "Artificial intelligence and modern physics: a two-way connection" school for Ph.D. students organized by the physics departments of the Universities of Milano-Bicocca and Bari in the framework of the Italian national grant "Dipartimenti di Eccellenza"

Nov. 2022 **Higgs 2022**.
Co-Chair of the "Higgs Yukawa interactions" session at the International conference Higgs 2022 that will be hosted by the University of Pisa.

Apr. 2018 **IFAE 2018**.
Co-Chair of the session "Frontiera Energia" at the Italian national conference IFAE (Incontri di Fisica delle Alte Energie) organized by the INFN at the University of Milano Bicocca.

Editorial activities

Since 2022 **Referee for the journal "European Physics Journal C"**.
Since Fall 2021, I am serving as referee for the "European Physics Journal C", edited by Springer, dedicated to publication of articles concerning experimental and theoretical results in particle physics and quantum field theory.

Since 2021 **Referee for the journal "Physics Letter B"**.
Since Fall 2021, I am serving as referee for the "Physics Letter B" journal, edited by Elsevier, dedicated to letter publication of important new results in particle physics, nuclear physics, and cosmology.

Since 2018 **Internal review of CMS analyses**.
In the last four years I have been a member of the internal review committee (ARC i.e. Analysis Review Committee) for seven analyses conducted within the CMS Collaboration that have been either published or in view of publication within this year.

Coordination roles in the CMS experiment

2022-2024 **Co-convener of the Higgs leptons and rare decay group**.

From 1st Sept. 2022 I am serving as co-convener of the "Higgs leptons + rare decay group", L3 convenership within the Higgs group of the CMS Collaboration. The group focuses on the measurement of Higgs boson properties in the $H \to \tau_h \overline{\tau}_h$ decay channel, the measurement of rare decays of the Higgs boson ($H \to \mu\mu$, $H \to Z\gamma$, Higgs to invisible $H \to$ inv, $H \to e^+e^-$, and Higgs decays to mesons), the measurement of the Higgs boson self-coupling (λ) through the $HH \to b\bar{b}\tau\tau$ channels, and the search for rare BSM decays or BSM extensions of the Higgs sector (MSSM $H \to \tau_h \overline{\tau}_h$, etc.). This convenership will last for two years in which the first set Run2+Run3 analyses will be performed.

2018-2022 **Convener of the si-strip tracker DAQ and operation group**.

I am coordinating the Si-Strip tracker DAQ and operation group of the CMS experiment. I am responsible for the "online" calibration of the detector (timing alignment, tune of the HV bias applied to each detector module, per-strip pedestal and noise values, optimization of laser drivers settings, tune of the APV-chip pulse shape parameters, etc.), the maintenance & development of its data-acquisition (DAQ) and commissioning software, and the supervision of tracker DAQ on-call shifters. I am therefore playing a crucial role in ensuring that the CMS strip tracker detector can operate efficiently during data-taking (end of Run2 and ongoing Run3 operations).

Teaching experiences

Since 2023 **Course Assistant**, *"General Physics I"*, University of Milano Bicocca.

As Course Assistant, I am teaching exercises of general physics to first-year Bachelor students covering the following topics: classical mechanics, theromodynamics, mechanics of fluids, elastic waves, and special relativity. I am also helping Prof. Marco Paganoni in the examination of students: written test and oral exams.

2023–2024 **Course Assistant**, *"Laboratory of Electromagnetism"*, University of Milano Bicocca.

As Course Assistant, I am supervising second-year Bachelor students in their laboratory experiences (measurements). The course covers: (1) construction and characterization of analog circuits, containing both linear and non-linear components, in pulsed DC or AC, (2) investigation of electromagnetic phenomena using different experimental setups: laser-based interferometers, optical spectrometer (study of diffusion, interference, characterization of a light source), microwave emitter and receiver (stationary waves, polarization, Bragg interference, etc). I also helped Prof. Maura Pavan, Prof. Stefano Ragazzi, and Prof. Mauro Di Nardo in the examination of students: correction of laboratory reports and oral exams.

2021–2022 **Course Assistant**, *"The Large Hadron Collider at CERN: a time machine"*, University of California San Diego (UCSD).

As Course Assistant, I helped Prof. Vivek Sharma in designing & organizing the lectures of the course "The LHC at CERN: a time machine" for Undergraduate students of the Physics department. A website for the course is available at [Link]. The course provides a historical and qualitative introduction to high energy particle physics, followed by an excursus on LHC, particle detectors, and main results achieved by LHC experiments (ATLAS, CMS, and LHCb) in the first ten years of operations.

2021-2022 **Course Assistant**, *"Physics 2D"*, University of California San Diego (UCSD).
As Course Assistant, I helped Prof. Vivek Sharma in designing & organizing the "Physics 2D" course for Undergraduate students of the Physics department. A website for the course is available at [Link]. Below a short description of the course content & goals:
"Physics 2D is a course in Modern Physics for Undergraduates spanning focusing on special relativity and its application in simple cases (particle physics and astrophysics), introduction to quantum mechanics (motivations, wave and particle dualism, atomic spectroscopy, scattering processes), Wave formulation of quantum mechanics and Heisenberg uncertainty principle, Schrodinger equation and its use in simple cases".

2020–2021 **Course Assistant**, *"Physics for future presidents"*, University of California San Diego (UCSD).
As Course Assistant, I helped Prof. Vivek Sharma in preparing & organizing the "Physics for future presidents" course designed for Undergraduate students of various scientific departments of UCSD. A website for the course is available at [Link]. Below a short description of the course content & goals:
"Physics for Future Presidents contains the essential physics that students need in order to understand today's core science and technology issues, and to become the next generation of world leaders. From the physics of energy to climate change, and from spy technology to nuclear weapons, this course focuses on the physics affecting the decisions of community leaders and CEOs and, consequently, the lives of every citizen. This course emphasizes real-world problems rather than mathematical computation and empowers students with the tools they need to make informed decisions and to argue their views persuasively with anyone–expert or otherwise".

Ph.D. Student mentoring

Since 2023 Mentor of three Ph.D. students (Giacomo Boldrini, Giorgio Pizzati, and Giulia Lavizzari) working at the University of Milano Bicocca on (1) re-interpretation of VBS analyses in the WW semi-leptonic, fully leptonic same-sign, and fully leptonic opposite sign final states in the context of dimension-6 SMEFT and (2) differential cross section measurements and unfolding of fully leptonic WW same-sign VBS and electroweak production of a Z-boson plus two jets in the fully leptonic final state.

2019-2020 Mentor of two Ph.D. students, Oliver Rieger (Hamburg University) and Xunwu Zuo (University of Florida), in the context of their work in the $H \to \mu\mu$ analysis for which I was the WG coordinator. Oliver developed the entire ttH leptonic and hadronic analyses, while Xunwu have been the principal author of the WH and ZH channels. Their work was included in the ultimate result published in Ref. [1].

2018-2019 Mentor of one Ph.D student, David Vannerom, graduated at the Universitè libre de Brussels in Winter 2019. I helped David in the execution of two projects: (1) estimation of NLO QCD and EW corrections for $V + 2$jets EW processes used in the search for invisible decays of the Higgs boson [3], (2) design of the analysis strategy used for the search of exotic particles with fractionally electric charge. This result is still in the internal review of the CMS Collaboration.

2014-2017 Mentor of one Ph.D student, Luca Brianza, graduated at the University of Milano Bicocca in Spring 2018. I helped Luca in set up the search for new resonances at high mass decaying in vector boson pairs that has been published in Ref. [20].

Scientific career

Since 2023 **Probing the Higgs boson self-coupling through measurements of HH → 4b and HH → bb$\tau\tau$ processes**.

I am working with PhD students at the University of Milano Bicocca and other CMS Colleagues on performing dedicated analyses for the Higgs boson self-coupling measurement in HH → 4b and HH → b$\bar{\text{b}}\tau\tau$ final states with LHC Run3 data. Activities are ongoig in order to restructure and improve techniques and strategies used during the Run2 version of these analysis, with the goal of profiting at best of several physics objects and trigger improvements introduced for Run3. In particular, I am working on developing Transformer-based NNs to perform either signal-vs-background discrimination (both in HH → 4b and HH → b$\bar{\text{b}}\tau\tau$ analyses) or background estimation from sidebands data in HH → 4b. In the latter case, I am working also on using deep-ensamble and bootstrapping techniques to estimate uncertainties in the NN-based background estimate.

Since 2023 **Search for high-frequency Gravitational Waves using Bulk Acoustic Wave cavities (BAWs)**.

I am working, along with other Colleagues at the University of Milano Bicocca, on the design and characterization of an apparatus to search for high-frequency (HF) gravitational waves (GWs) in the 1–100 MHz range. The HF band, only marginally explored so far, is an uncertain but potentially fertile ground for GW signals of primordial origin, which could provide insights on the formation and composition of the universe. The HF band is not accessible by the large-scale GW interferometers as they are not sensitive to frequencies larger than a few kHz because of a hardware limit, set by reciprocal of the length of the interferometer arms. In order to detect HF GWs, the instrumental technique we have proposed uses high-frequency BAW cavities realized with piezoelectric crystals. These devices can transduce metric variations of space-time, induced by GWs, into electrical signals that can be detected by a superconducting quantum interference device (SQUID) amplifier coupled to them. At present, we are working on (1) characterizing at different operating temperatures (30 mK − 300 K) the intrinsic quality factor (resolution) of commercially available BAWs (quartz, etc.) using a vector network analyzer and (2) simulate the acoustic properties of piezoelectric crystals depending on their geometry. Furthermore, we plan to study the heat transfer produced by the phonon propagation and to optimize the electrode shape and deposition for the electrical readout. In a five year program, we plan to build and characterize the sensitivity of a broad-band and table-top HF GW experiment.

Since 2023 **Search for dim-6 EFT operators in vector boson scattering (VBS)**.

I am working on BSM re-interpretations of several SM physics results of CMS in the context of dimension-6 SM Effective Field Theory (SMEFT). Already published analyses of VBS processes (namely WW VBS in the semi-leptonic, same-sign fully leptonic, and opposite-sign fully leptonic) are being reoptimized in order to define the best signal extraction strategy for the EFT operators playing a relevant role in VBS. The final goal is to produce a combined EFT fit of VBS channels in order to provide the best constraints on the Wilson coefficients of such operators. Moreover, I am working on the unfolding of differential distributions of the electroweak production of a leptonically decaying Z boson in association with two jets (VBF-Z). Precise measurements in this process allow to investigate the modelling of additional radiation from parton showers in vector boson fusion (VBF) events, which will play a key role in Run2+Run3 Higgs boson measurements.

2022-2024 **Development of ML models for jet flavour tagging and energy calibration**.
I am working on developing a high-performance and robust Machine Learning (ML) based jet flavour tagging and energy calibration method for CMS Run3 analyses. From a large set of input features describing each reconstructed particle, secondary vertex, and track in a jet, a transformer network that exploits different metrics to build an input adjacency matrix is used to classify a jet as originating from the hadronization of a b-quark, c-quark, light quark, gluon or from a lepton produced by the decay of a resonance (hadronic τ, muon, electron). In addition, the network calibrates the p_{T} of the jet by regressing it towards its generator-level truth value. Finally, the transformer response is made robust against data-to-simulation mismodell and systematics affecting the input features by (1) add data domain regions to the training set that are used to adjust the network parameters minimizing data-to-simulation discrepancies, (2) add a fast-gradient adversarial attack in order to make the network less sensitive to variations in the input features. Preliminary results show substantial improvements in both flavour tagging and jet energy resolution with smaller efficiency corrections needed from calibration in data.

2021–2023 **Responsible for the development of new triggers and data parking for $\mathrm{HH} \to 4\mathrm{b}$ and $\mathrm{HH} \to \mathrm{bb}\tau\tau$ during the LHC Run3**.
I have been the leader of a Working Group (WG) focused on the development of a new set HLT triggers that are currently used in Run3 operations. These triggers define a novel data parking stream (HH parked dataset), dedicated to the resolved and boosted $\mathrm{HH} \to 4\mathrm{b}$ and $\mathrm{HH} \to \mathrm{b\bar{b}}\tau\tau$ hadronic topologies. The HH parking allows to efficiently collect $\mathrm{HH} \to 4\mathrm{b}$ and $\mathrm{HH} \to \mathrm{b\bar{b}}\tau\tau$ events over the entire m_{HH} spectrum, overcoming one of the main limiting factor in the performance of these analyses with Run2 data. Moreover, the new triggers allow the collection of a high statistics data control sample that can be used for a data-driven estimate of the background in the signal region, providing an additional source of improvements with respect to the Run2 strategy. Such large gains were possible thanks to improved b-quark (boosted $\mathrm{H} \to \mathrm{b\bar{b}}$) and τ_{h} (boosted $\mathrm{H} \to \tau_{\mathrm{h}}\overline{\tau}_{\mathrm{h}}$) tagging performance obtained by using permutational invariant Graph Convolutional Neural Networks (GCNN).

2018-2021 **Analysis contact of the "Evidence for Higgs boson decay to a pair of muons" paper, leader of the corresponding analysis working group, and search for new resonances decaying into muon pairs**.
I was the leader of the $\mathrm{H} \to \mu\mu$ WG and the principal editor of the paper entitled *"Evidence for Higgs boson decay to a pair of muons"* published in Ref. [1]. The analysis is based on 137 $\mathrm{fb}^{-1}$of collision data collected at $\sqrt{s} = 13$ TeV. I focused on the two most dominant channels that drive the overall sensitivity of the analysis: these involve the Higgs boson production through gluon fusion (ggH) and VBF. I gave strong contributions in completely revamping the strategy adopted in the previous iteration of this search that was performed with a partial $\sqrt{s} = 13$ TeV data set. I introduced substantial improvements that significantly boosted the analysis sensitivity, resulting in the first evidence for $\mathrm{H} \to \mu\mu$ decays.
At the same time, I participated in the search for new dimuon resonances, with an invariant mass between 11.5 and 200 GeV, published in Ref. [2]. I was responsible for both the choice and the implementation of the analytical models used to describe the background in the signal extraction fits and the studies, based on pseudo-data, needed to estimate possible biases in the signal rate induced by the chosen background model. This analysis set the most stringent upper bounds on Dark-Photon models with an invariant mass between 30-75 and 110-200 GeV.

Since 2020 **Test of "Front-End Hybrids" (FEH) and "SErvice Hybrids" (SEH) for the 2S and PS modules of the CMS Phase-2 Outer Tracker detector**.

I am involved in the stress tests of Phase-2 Outer Tracker FEH and SEH of the 2S and PS modules that include: (1) test if they can stably run at -35°C which is required for their operation at HL-LHC, (2) test their mechanical robustness during thermal cycles between room temperature and -35°C, (3) test their behaviour for different operating voltages applied on the readout chips (CBC, CIC, SSA, MPA), (4) check for any inconsistencies between the input data to the hybrid and the readout ones or the stubs potentially produced by repeated write and read operations performed to the registers of the various chips used to configure the modules. I participated in the design, preparation, and execution of these tests. Their ultimate goal is to check stability and integrity of key components, providing feedbacks to both chip designers and production sites before the startup of the production phase.

Since 2018 **Convener of the Si-Strip tracker DAQ and operation group**.

I am coordinating the Si-Strip tracker DAQ and operation group of the CMS experiment. I am responsible for the full set of "online" calibrations of the detector used during data-taking campaigns: timing alignment, tune of the HV bias applied to each detector module, per-strip pedestal and noise values, optimization of laser drivers settings, tune of the APV-chip pulse shape parameters, etc.. I am coordinating the maintenance & development of the software used for data acquisition (DAQ) and calibration (commissioning) of the tracker detector. In addition, I coordinate and supervise tracker DAQ on-call shifters that play a crucial role in ensuring that the detector can operate efficiently during data-taking.
I am currently working in the preparation of the detector and its software tools for the startup of the LHC Run3 campaign expected in June 2022. At the same time, I am also contributing to the paper on the performance of the CMS tracker based on Run2 data.

2017–2019 **Analysis contact of the "Search for invisible decays of the Higgs boson produced through VBF in pp collisions at $\sqrt{s} = 13$ TeV" and co-coordinator of the H $\rightarrow$ inv working group**.

I was the coordinator of the CMS H $\rightarrow$ inv working group and principal editor of the VBF H $\rightarrow$ inv analysis and H $\rightarrow$ inv combination based on 35.9 fb^{-1}of $\sqrt{s} = 13$ TeV collision data. Invisible decays of the Higgs boson are mainly searched in the VBF channel, where the signal is extracted from a binned likelihood fit to the invariant mass distribution of the two leading jets in the event. I re-designed the entire analysis strategy of the VBF channel, leading to significant improvements in its sensitivity. I performed the combination of the VBF analysis result with those from other H $\rightarrow$ inv searches, based either on 7+8 TeV or 13 TeV data. These results have been published in Ref. [3]. These analyses were also inserted in the first combined measurement of Higgs boson properties based on CMS Run2 data [4]. In addition, I also contributed to the first combination of Run1 and Run2 H $\rightarrow$ inv searches [5] as I was also the main author of the ggH and VH analyses performed with 2.3 fb^{-1}of collision data collected in 2015 at $\sqrt{s} = 13$ TeV.

2016–2018 **Analysis contact for $p_{\mathrm{T}}^{\mathrm{miss}}$ + jets dark matter searches and co-coordinator of the CMS monojet working group**.

The monojet working group delivered, from 2016 to 2018, two distinct publications based on 12.9 fb^{-1} [6] and 35.9 fb^{-1} [7] of pp collision data at $\sqrt{s} = 13$ TeV, respectively. The monojet analysis search for Dark Matter (DM) particles produced in association with either a high p_{T} jets or a hadronically decaying vector bosons (W or Z). I setup of the entire analysis strategy with a particular focus on the per-bin background estimation from a simultaneous fit performed across the signal and several control regions enriched in $\mathrm{Z}(\mu\mu)/\mathrm{Z}(\mathrm{ee})\mathrm{W}(\mu\nu)/\mathrm{W}(\mathrm{e}\nu)/\gamma +$ jets processes. These searches set the strongest bounds on simplified models predicting the production of DM particles at the LHC via their interaction with either spin-1 or spin-0 mediators, that are assumed to couple only to SM quarks via Yukawa interactions. The results of this analysis were also interpreted in the context of searches for $\mathrm{H} \to$ inv, search for gravitons predicted in the ADD extra-dimension model, and in terms of non-thermal light DM models. Furthermore, I contributed to the activities of the LHC DM WG concerning precise predictions of V+jets backgrounds in DM searches as well as the development & characterization of the 2HDM+a model [8].
Finally, I contributed to the analysis that set the most precise measurement, at high transverse momentum, of the $\mathrm{Z}(\nu\nu) +$ jets differential cross section as a function of $p_{\mathrm{T}}(\mathrm{Z})$, by exploring 35.9 fb^{-1}of data collected at $\sqrt{s} = 13$ TeV [9]. In order to further enhance the precision of this measurement, this result has been also combined with those obtained in the $\mathrm{Z}(\ell\ell) +$ jets ($\ell = \mu, \mathrm{e}$) final states.

2015–2016 **Co-editor of "Projection studies for VBS measurements at the HL-LHC"**.

I have performed projection studies for VBS at the HL-LHC focusing on the scattering of same-sign W bosons decaying leptonically (μ, e) and the WZ scattering decaying into a three lepton final state. I designed & developed the entire analysis strategy along with some of the specific tunes used in a simplified parametrization of the CMS detector response implemented via DELPHES. Results from this work have been made public as a conference note [10] and were included in the technical proposal for CMS HL-LHC upgrade [11].
Then, I contributed to the observation of the electroweak scattering of W bosons of the same charge, obtained with the first 35.9 fb^{-1}collected by CMS at $\sqrt{s} = 13$ TeV, decaying into a fully leptonic final state ($\mathrm{W}^{\pm}\mathrm{W}^{\pm} \to 2\ell^{\pm}2\nu$). I developed a data-driven method used to estimate the non-prompt background (dominant background process in the analysis) produced by events in which one or two hadronic jets in the detector are misidentified as a lepton (μ, e).

2015–2019 **CMS contact person for "Neutral Extension of the Higgs sector" subgroup within the LHC Higgs Cross Section WG (LHCHXSWG)** .

The group produced a set of benchmarks, mostly based on 2HDM extensions of the SM, to guide searches for new neutral resonances, with mass larger than m_{H}, based on Run2 LHC data ($\sqrt{s} = 13$ TeV). The recommendations produced by the WG were published as part of the LHCHXSWG report published in Ref. [12]. As contact person for the CMS experiment, I was co-coordinating a group of theoretical and experimental physicists working together to produce cross section and branching ratio values for each of the proposed benchmarks. Furthermore, I was the reference person in CMS for the simulation of Monte Carlo events for these models.

2014–2017 **Contact person for reconstruction and calibration algorithms of hadronic jets within the CMS Higgs physics group**.

I was in charge of providing technical support (software) to analysts involved in searches performed within the Higgs physics group about algorithms and tools used for: (1) reconstruction and identification of jets, (2) pileup mitigation, (3) W/Z/H/top tagging with jet substructure, (4) jet energy calibration.

2013–2014 **Co-editor of "Searches for heavy resonances decaying into a pair of boosted vector bosons in semi-leptonic final states".**

I was the co-editor of two journal publications in Ref. [13] and Ref. [14] based on 19.7 $fb^{-1}$of pp collision data recorded at $\sqrt{s} = 8$ TeV. The former describes a search for new heavy resonances, with mass larger than 1 TeV, predicted in extra-dimension extensions of the Standard Model decaying into a WW/WZ pair in the semi-leptonic final state. I designed and performed the entire analysis: from the optimization of W/Z jet tagging via jet substructure to the data-driven extraction of the leading W+jets background. In contrast, the latter paper describes a search for heavy Higgs bosons in the mass range between 145 GeV to 1 TeV. For this publication, I worked on the search for an heavy Higgs decaying to a WW in semi-leptonic final states. The analysis was performed in exclusive jet bins in order to target both ggH and VBF production modes thereby maximizing the overall search sensitivity [15]. Particular focus was dedicated to (1) analytical model used to parametrize the signal lineshape, (2) study the interference between the expected signals and irreducible backgrounds from $gg \to WW$ and $qq' \to qq'WW$.

2013–2014 **Co-editor of "Identification techniques for highly boosted W bosons that decay into hadrons".**

I gave substantial contributions to the development of jet substructure techniques used by the CMS Collaboration during the LHC Run1. In particular, I studied their application, optimization, and the impact of different sources of systematic uncertainties in the identification of jets produced by boosted hadronically decaying vector bosons (W or Z). I also developed a tag-and-probe method to measure the efficiency of the proposed identification strategy in data, using a sample of W-jets selected from a phase-space enriched in semi-leptonic $t\bar{t}$ events. These studies represent the main core of results reported in the journal publication available at Ref. [16].

2012–2013 **Contact person for the calibration of the ECAL detector of CMS using isolated electrons from W(eν) and Z(ee) decays.**

I developed an iterative algorithm able to calibrate each crystal of the ECAL detector by equalizing the energy produced by the scintillation mechanism with the p_T measured by the inner tracking system of CMS using isolated electrons produced by $W \to e\nu$ and $Z \to ee$ decays. The resulting single crystal calibration coefficients were combined with those obtained by other methods, bringing a significant improvement in the energy resolution of both electrons [17] and photons [18]. This represented a key milestone, enabling a precise determination of the Higgs boson mass in the $H \to \gamma\gamma$ and $H \to ZZ \to 4\ell$ channels [19] with the LHC Run1 data collected at $\sqrt{s} = 7, 8$ TeV.

Bibliometrical data

Scopus Author ID: 56134824600 [https://www.scopus.com/authid/56134824600].
- Number of publications: 829
- Number of citations: 36340
- h-index: 87

InSpire Author ID: R.Gerosa.1 [https://inspirehep.net/authors/1224597].
- Number of publications: 838 (published), 858 (total)
- Number of citations: 39824
- h-index: 96

References

[1] CMS Collaboration, "Evidence for Higgs boson decay to a pair of muons", *JHEP* **01** (2021)

148, doi:10.1007/JHEP01(2021)148, arXiv:2009.04363.

[2] CMS Collaboration, "Search for a Narrow Resonance Lighter than 200 GeV Decaying to a Pair of Muons in Proton-Proton Collisions at $\sqrt{s} = 13$ TeV", *Phys. Rev. Lett.* **124** (2020) 131802, doi:10.1103/PhysRevLett.124.131802, arXiv:1912.04776.

[3] CMS Collaboration, "Search for invisible decays of a Higgs boson produced through vector boson fusion in proton-proton collisions at $\sqrt{s} = 13$ TeV", *Phys. Lett. B* **793** (2019) 520–551, doi:10.1016/j.physletb.2019.04.025, arXiv:1809.05937.

[4] CMS Collaboration, "Combined measurements of Higgs boson couplings in proton–proton collisions at $\sqrt{s} = 13$ TeV", *Eur. Phys. J. C* **79** (2019) 421, doi:10.1140/epjc/s10052-019-6909-y, arXiv:1809.10733.

[5] CMS Collaboration, "Searches for invisible decays of the Higgs boson in pp collisions at $\sqrt{s} = 7$, 8, and 13 TeV", *JHEP* **02** (2017) 135, doi:10.1007/JHEP02(2017)135, arXiv:1610.09218.

[6] CMS Collaboration, "Search for dark matter produced with an energetic jet or a hadronically decaying W or Z boson at $\sqrt{s} = 13$ TeV", *JHEP* **07** (2017) 014, doi:10.1007/JHEP07(2017)014, arXiv:1703.01651.

[7] CMS Collaboration, "Search for new physics in final states with an energetic jet or a hadronically decaying W or Z boson and transverse momentum imbalance at $\sqrt{s} = 13$ TeV", *Phys. Rev. D* **97** (2018) 092005, doi:10.1103/PhysRevD.97.092005, arXiv:1712.02345.

[8] LHC Dark Matter Working Group, "Next-generation spin-0 dark matter models", *Phys. Dark Univ.* **27** (2020) 100351, doi:10.1016/j.dark.2019.100351, arXiv:1810.09420.

[9] CMS Collaboration, "Measurement of the Z boson differential production cross section using its invisible decay mode ($Z\nu\bar{\nu}$) in proton-proton collisions at $\sqrt{s} = 13$ TeV", *JHEP* **05** (2021) 205, doi:10.1007/JHEP05(2021)205, arXiv:2012.09254.

[10] CMS Collaboration, "Prospects for the study of vector boson scattering in same sign WW and WZ interactions at the HL-LHC with the upgraded CMS detector", Physics Analysis Summary, CMS-PAS-SMP-14-008, CERN, 2016.

[11] CMS Collaboration, "Technical Proposal for the Phase-II Upgrade of the CMS Detector", Technical Design Report, CERN-LHCC-2015-010, LHCC-P-008, CMS-TDR-15-02, CERN, 2015.

[12] LHC Higgs Cross Section Working Group, "Handbook of LHC Higgs Cross Sections: 4. Deciphering the Nature of the Higgs Sector", doi:10.23731/CYRM-2017-002, arXiv:1610.07922.

[13] CMS Collaboration, "Search for massive resonances decaying into pairs of boosted bosons in semi-leptonic final states at $\sqrt{s} = 8$ TeV", *JHEP* **08** (2014) 174, doi:10.1007/JHEP08(2014)174, arXiv:1405.3447.

[14] CMS Collaboration, "Search for a Higgs boson in the mass range from 145 to 1000 GeV decaying to a pair of W or Z bosons", *JHEP* **10** (2015) 144, doi:10.1007/JHEP10(2015)144, arXiv:1504.00936.

[15] CMS Collaboration, "Search for a Standard Model-like Higgs boson decaying into WW to $\ell\nu q\bar{q}$ in exclusive jet bins in pp collisions at $\sqrt{s} = 8$ TeV", Physics Analysis Summary, CMS-PAS-HIG-14-008, CERN, 2015.

[16] CMS Collaboration, "Identification techniques for highly boosted W bosons that decay into hadrons", *JHEP* **12** (2014) 017, doi:10.1007/JHEP12(2014)017, arXiv:1410.4227.

[17] CMS Collaboration, "Performance of Electron Reconstruction and Selection with the CMS Detector in Proton-Proton Collisions at $\sqrt{s} = 8$ TeV", *JINST* **10** (2015) P06005, doi:10.1088/1748-0221/10/06/P06005, arXiv:1502.02701.

[18] CMS Collaboration, "Performance of Photon Reconstruction and Identification with the CMS Detector in Proton-Proton Collisions at $\sqrt{s} = 8$ TeV", *JINST* **10** (2015) P08010, doi:10.1088/1748-0221/10/08/P08010, arXiv:1502.02702.

[19] CMS Collaboration, "Precise determination of the mass of the Higgs boson and tests of compatibility of its couplings with the standard model predictions using proton collisions at 7 and 8 TeV", *Eur. Phys. J. C* **75** (2015) 212, doi:10.1140/epjc/s10052-015-3351-7, arXiv:1412.8662.

[20] CMS Collaboration, "Search for massive resonances decaying into WW, WZ or ZZ bosons in proton-proton collisions at $\sqrt{s} = 13$ TeV", *JHEP* **03** (2017) 162, doi:10.1007/JHEP03(2017)162, arXiv:1612.09159.