Andrea Piccinelli

PhD Student in High Energy Physics @ University and INFN of Perugia

, 1995,

Education

11/2019 – 4-5/2023 **Ph.D. in High Energy Physics**

University of Perugia, Department of Physics and Geology, and INFN Perugia

Supervisors: Prof. Livio Fanò (U. and INFN of Perugia)
Dr. Alberto Orso Maria Iorio (U. and INFN of Naples)

Thesis title: *Searches for new bosonic resonance and signals with an EFT-based approach with the CMS experiment*

Courses attended: Advanced techniques for Data Analysis, Ionizing radiation and space weather, Thermal analysis of complex structures, Statistic tools for High Energy Physics, Effective Field Theories and Machine Learning in High Energy Physics.

9/2017 – 10/2019 **Master's Degree in Particle Physics**

University of Naples "Federico II", Department of Physics
110/110 cum laude

Supervisors: Dr. Alberto Orso Maria Iorio (U. and INFN of Naples)
Prof. Luca Lista (U. and INFN of Naples)

Thesis title: *Search for a new vector boson W' coupling to the third generation quarks in leptonic final states with the CMS detector at LHC*

Abstract: In this work the existence of a new vector boson W' has been investigated with RunII data taken with the CMS detector.
The search is performed considering events compatible with the process $W' \rightarrow tb \rightarrow l\nu_l bb$. No significant deviations from SM is observed in the data analysis so far. Upper limits on the cross section of the process and lower limits on $m_{W'}$ are inferred at 95% CL. The results of this preliminary work improve the previous analogous limits.

9/2013 – 1/2017 **Bachelor's Degree in Physics**

University of Naples "Federico II", Department of Physics
110/110 cum laude

Supervisors: Prof. Lorenzo Marrucci (U. of Naples, CNR-ISASI)
Dr. Domenico Paparo (CNR-ISASI)

Thesis title: *Study of ionic liquids with the THz-TDs spectroscopy*

Abstract: An investigation the dieletric spectra of the ionic liquids [BMIM][BF_4] and [BMIM][I] has been performed with the THz-TDS spectroscopy, studying how the aforementioned spectra change when the substances are mixed and comparing the predictions of the molecular models for the liquids with the experimental results.

Education (continued)

9/2008 – 7/2013 **High School Diploma for Scientific Studies**
Scientific Liceo "Salvatore Cantone", Pomigliano D'Arco (Naples)
100/100

Languages

Italian — Native language

English — Foreign language Certificate (Intermediate Level - Grade 7) — Trinity College of London
Strong in writing, reading, and speaking - Europe Level B2

ICT Skills

Certifications	European Certificate Driving License (ECDL) Microsoft Certified Application Specialist (Office Package and Microsoft Windows Vista)
Coding	MATLAB, C, C++, Python
Op. systems	Linux, Windows
Data Analysis	ROOT, Scikit-learn, Numpy, Scipy, Pandas, TensorFlow, LabView, CMS tools
Data Science	Supervised Machine Learning Methods, Neural Networks
MC simulations	MadGraph, PYTHIA
Others	Microsoft Office, LaTeX, GIT, HTCondor

Scientific Activities

Introduction — My scientific experience started in Matter Physics with my Bachelor's degree thesis. For Master's degree thesis, I started performing data analysis in High Energy Physics with the CMS Collaboration, focusing on direct searches for New Physics phenomena. In my PhD I extend my analysis work to undirect searches via an Effective Field Theory approach. Machine Learning applications are exploited in my work to push forward the performances of my studies, implementing cuttig-edge techniques.

Matter Physics — **THz-TDS Spectroscopy of ionic liquids and their mixtures**
During my Bachelor's degree thesis I've investigated the electromagnetic spectra of the two ionic liquids [BMIM][BF_4] and [BMIM][I] via the novel THz-TDS spectroscopy, as well as of their mixtures. I prepared the samples and the optical bench setup and managed the data taking procedure. Subsequently I analyzed the data with MATLAB, performing Fourier transform and searching for resonance structures in the electromagnetic spectra. I finally linked the lasts to the molecular models of the considered ionic liquids and studied their behaviour when liquids were mixed.

Scientific Activities (continued)

HE Physics

Search for a new vector boson W' coupling to the third generation quarks in leptonic final states with the CMS experiment

In my Master's degree thesis I performed a preliminary search for a hypothetic new vector boson W' with the full Run II dataset. I focused on coupling to a tb quark pair to exploit both the predicted enhancement of it in some New Physics models, and the most novel Machine Learning applications for tagging jets coming from b quarks. I set up the t quark and event reconstruction algorithms, and was able to push forward the sensitivity to this process in CMS Collaboration. This work is being finalized and approved to be published, and is going to obtain pre-approval soon by the CMS B2G subgroup.

Study of sensitivity to anomalous gauge coupling with ssWW VBS processes and improved tau identification in final state

In my PhD I'm performing an analysis of ssWW VBS processes with a hadronic τ lepton in final state to push forward the sensitivity to anomalous gauge coupling in the electroweak sector, eventually induced by New Physics phenomena. Hadronic τ implementation is expected to enhance the aforementioned sensitivity, as it allows to investigate the longitudinal polarization of W bosons and couples to the Higgs field more strongly than electrons and muons. Both of them are strictly related to the Higgs sector, a potential portal to New Physics. I'm supporting the development of Machine Learning algorithms and their implementation in the analysis with the goal to furtherly discriminate backgrounds against signal and enhance sensitivity at statistical fit stage. This analysis is starting the review in order to get pre-approval by the CMS SMP subgroup soon.

SMP-VV MC contact

In my PhD last year I started my position as MC contact for the CMS SMP-VV subgroup. I'm in charge to take care of the Monte-Carlo simulations for EW processes involving two vector bosons (W and/or Z) in order to properly satisfy the needs of several analyses. The simulations are referred to both Run-II and Run-III data taking periods, and includes Madgraph and PYTHIA as phyisics event simulators.

Event simulation for MUonE experiment with the CMS Phase II Tracker setup

MUonE experiment is meant to study the anomalous magnetic moment of the muon via the μe elastic scattering, and the CMS Phase II Tracker upgrade turns out to be suitable for that goal. I simulated of events compatible with the MUonE experiment with the aforementioned Tracker upgrade to test the preliminary performances.

Data Quality Monitoring for CMS Tracker detector mantainance

In my PhD I implemented additional code in order to push forward the investigation of the features of the clusters related to the reconstructed tracks inside the Tracker detector, thanks to dedicated plots.

Forthcoming Tracker Offline DQM L3 convener

I'm going to start my position as L3 convener in the CMS Tracker Offline DQM subgroup. I will take car of the software development and the shift organization for the Run-III data taking period.

Talks at conferences and workshops

Workshop

Remote B2G Spring Workshop 2020
Contribution about status of and improvment introduced with search for new W' boson
https://indi.to/9sKvJ
Online May 18th–20th, 2020

Conferences

Incontri di Fisica delle Alte Energie 2020
Contribution about search for new W' boson accepted
https://agenda.infn.it/event/21919/overview
Catania April 2020, delayed due to COVID-19 pandemic

7th Young Researchers' Workshop
Contribution about search for new W' boson accepted
http://www.lnf.infn.it/conference/lnfss/20/workshop/workshop.php
Frascati May 2020, delayed due to COVID-19 pandemic

Congresso Nazionale Società Italiana di Fisica 2020
Contribution about search for new W' boson accepted
https://agenda.infn.it/event/23656/contributions/120255/
Online September 14th–18th, 2020

The 5th International Conference on Particle Physics and Astrophysics (ICPPA 2020)
Parallel talk about searches for new resonances coupling to third generation quarks at CMS
Proceedings produced and published (see "Publications")
https://indico.particle.mephi.ru/event/35/contributions/2365/
Online October 5th–9th, 2020

The XXVIII International Conference on Supersymmetry and Unification of Fundamental Interactions (SUSY 2021)
Parallel talk about searches for new resonances coupling to third generation quarks at CMS
https://indi.to/QTgDn
Online August 23th–28th, 2021

Congresso Nazionale Società Italiana di Fisica 2021
Contribuon about study of ssWW processes with hadronic tau in final state at CMS
https://www.sif.it/static/SIF/resources/public/files/congr21/Atti_Congresso_107_2021.pdf
Online September 13th–17th, 2021

XXIX International Workshop on Deep-Inelastic Scattering and Related Subjects (DIS2022)
Parallel talk about Vector boson scattering measurements in CMS
Scheduled proceeding publication
https://indi.to/zYQRB
Santiago de Compostela (ES) May 2nd–6th, 2022

Participation to schools and training courses

Trainings

COMPOSE-IT! Unitarity for composite models and beyond in the HL-LHC era
https://agenda.infn.it/event/20565/
Perugia — January 27th–28th, 2020
Organizer: University and INFN of Perugia

PyHEP 2020 (virtual) Workshop
https://indico.cern.ch/event/882824/
Online — July 13th–18th, 2020

Statistics for Particle Physicists - Academic Training Lectures
https://indi.to/j42pg
Online — June 21st–24th, 2021
Organizers: CERN, Prof. Glen Cowan

Advanced Python Training course
Perugia — October 27th–29th, 2021
Organizers: INFN Perugia

Schools

PREFIT20: PRecision Effective Field Theory School
https://indico.cern.ch/event/817757/
DESY, Hamburg — March 1st–13th, 2020
Organizers: ParticleFace and VBScan (COST network), DESY

International School of Subnuclear Physics – 58th Course: Gravity and Matter in the Subnuclear World
I was selected after an international competition between PhD students, and my nomination was presented by Prof. Paolo Salvadori
https://cernbox.cern.ch/index.php/s/vLYUmFvio7vnR6r
Erice, Sicily — June 21st–30th, 2020, but delayed due to COVID-19 pandemic
Organizer: "Ettore Majorana" Foundation and Centre for Scientific Culture

CMS Data Analysis School 2021
https://indi.to/Nrx9S
Online — January 5th–16th, 2021
Organizers: CMS, FNAL

Advanced VBS training School
https://indi.to/pRRPS
Milan — August 29th – September 3rd, 2021
Organizers: VBScan COST Action, INFN, and University of Milan Bicocca

2nd Pan-European Advanced School on Statistics in High Energy Physics
https://indico.desy.de/event/32536/
DESY and Virtual — March 28th – 30th, 2022
Organizers: INSIGHTS Marie Sklodowska-Curie ITN and DESY

Participation to schools and training courses (continued)

INFN School of Statistics 2022
https://agenda.infn.it/event/28039/
Paestum (IT) May 15th – 20th, 2022
Organizers: Università and INFN of Naples

Teaching experiences

University

Universitary teaching assistant of Physics for Bachelor's degree in Biology
A.A. 2020–2021 University of Perugia

Universitary teaching assistant of Physics for Bachelor's degree in Biology
A.A. 2021–2022 University of Perugia

Outreach and dissemination

Passione Fisica – Città della Scienza
I prepared several experiments regarding optics, e.g. light reflection and refraction, to perform demonstrations and explanations for the general audience, not involved in the scientific community.
Città della Scienza, Naples April 17th, 2016

International MasterClass for CMS experiment
I conducted hands-on tutoring activities on particle physics, via the CMS event display tool, for high-school students based in Perugia. The event was organized by INFN and CERN within the framework of the International Particle Physics Outreach Group.
Perugia March, 2021

Awards

Academy

Member of the analysis team winning the CMS Data Analysis School competition
I was member of the student team that performed the long exercise on analysis of $Z \to \tau\tau$ processes. My group was judged to perform the best work out of all the student teams, after a dedicated presentation.
Online January 16th, 2021

School

Placed 7th in Regional "Olympics of Physics"
After classified as 1st in selections for Olympics of Physics in my high school, I was able to rank 7th in the Regional competion
Naples March, 2013

Placed 8th in Regional Mathematics "Certamen"
Naples February, 2013

Research Publications

I'm author and co-author of 114 papers (87 published), with the following metrics as reported in InspireHEP:

Citation Summary

☑ Exclude self-citations ⓘ

	Citeable ⓘ	Published ⓘ
Papers	**116**	**109**
Citations	**1,067**	**1,046**
h-index ⓘ	**17**	**17**
Citations/paper (avg)	**9.2**	**9.6**

https://inspirehep.net/authors/1768614

Conference Proceedings

1. **Piccinelli, A.** (The CMS collaboration). "Search for New Resonances Coupling to Third Generation Quarks at CMS". In: *Phys. At. Nucl.* Vol. 84. 4, pp. 550–557. DOI: 10.1134/S1063778821040256.
2. **Piccinelli, A.** (The CMS collaboration). "Vector Boson Scattering at CMS". In: *Ongoing publication.*

Analysis Notes (Ongoing publications)

1. De Iorio, A., A. O. M. Iorio, and **A. Piccinelli** (The CMS collaboration). *Search for heavy mass W' boson decaying in tb quarks in leptonic final states.* CMS B2G-020-012. URL: https://cms.cern.ch/iCMS/analysisadmin/cadilines?line=B2G-20-012.
2. **Piccinelli, A.**, M. Magherini, T. Tedeschi, et al. (The CMS collaboration). *VBS same-sign WW analysis with hadronic tau in final state with Run II dataset.* CMS SMP-22-008. URL: https://cms.cern.ch/iCMS/analysisadmin/cadilines?line=SMP-22-008.

CMS Journal Articles related to my scientific activities

1. Sirunyan, A. M. et al. (The CMS collaboration). "Constraints on anomalous Higgs boson couplings to vector bosons and fermions in its production and decay using the four-lepton final state". In: *Phys. Rev. D* 104(5), p. 052004. DOI: 10.1103/PhysRevD.104.052004. arXiv: 2104.12152 [hep-ex].
2. Sirunyan, A. M. et al. (The CMS collaboration). "Evidence for electroweak production of four charged leptons and two jets in proton-proton collisions at $\sqrt{s}$ = 13 TeV". In: *Phys. Lett. B* 812, p. 135992. DOI: 10.1016/j.physletb.2020.135992. arXiv: 2008.07013 [hep-ex].
3. Sirunyan, A. M. et al. (The CMS collaboration). "Measurement of the Higgs boson production rate in association with top quarks in final states with electrons, muons, and hadronically decaying tau leptons at $\sqrt{s}$ = 13 TeV". In: *Eur. Phys. J. C* 81(4), p. 378. DOI: 10.1140/epjc/s10052-021-09014-x. arXiv: 2011.03652 [hep-ex].
4. Sirunyan, A. M. et al. (The CMS collaboration). "Measurements of $pp \to ZZ$ production cross sections and constraints on anomalous triple gauge couplings at $\sqrt{s} = 13$ TeV". In: *Eur. Phys. J. C* 81(3), p. 200. DOI: 10.1140/epjc/s10052-020-08817-8. arXiv: 2009.01186 [hep-ex].
5. Sirunyan, A. M. et al. (The CMS collaboration). "Measurements of production cross sections of polarized same-sign W boson pairs in association with two jets in proton-proton collisions at $\sqrt{s} = 13$ TeV". In: *Phys. Lett. B* 812, p. 136018. DOI: 10.1016/j.physletb.2020.136018. arXiv: 2009.09429 [hep-ex].
6. Sirunyan, A. M. et al. (The CMS collaboration). "Search for a heavy resonance decaying to a top quark and a W boson at $\sqrt{s}$ = 13 TeV in the fully hadronic final state". In: arXiv: 2104.12853 [hep-ex].

7 Sirunyan, A. M. et al. (The CMS collaboration). "Search for a heavy vector resonance decaying to a Z boson and a Higgs boson in proton-proton collisions at $\sqrt{s} = 13$ TeV". In: *Eur. Phys. J. C* 81(8), p. 688. DOI: 10.1140/epjc/s10052-021-09348-6. arXiv: 2102.08198 [hep-ex].

8 Sirunyan, A. M. et al. (The CMS collaboration). "Search for new physics in top quark production with additional leptons in proton-proton collisions at $\sqrt{s} = 13$ TeV using effective field theory". In: *JHEP* 03, p. 095. DOI: 10.1007/JHEP03(2021)095. arXiv: 2012.04120 [hep-ex].

9 Sirunyan, A. M. et al. (The CMS collaboration). "Search for resonant and nonresonant new phenomena in high-mass dilepton final states at $\sqrt{s} = 13$ TeV". In: *JHEP* 07, p. 208. DOI: 10.1007/JHEP07(2021)208. arXiv: 2103.02708 [hep-ex].

10 Sirunyan, A. M. et al. (The CMS collaboration). "Search for singly and pair-produced leptoquarks coupling to third-generation fermions in proton-proton collisions at s=13 TeV". In: *Phys. Lett. B* 819, p. 136446. DOI: 10.1016/j.physletb.2021.136446. arXiv: 2012.04178 [hep-ex].

11 Sirunyan, A. M. et al. (The CMS collaboration). "Search for W' bosons decaying to a top and a bottom quark at s=13TeV in the hadronic final state". In: *Phys. Lett. B* 820, p. 136535. DOI: 10.1016/j.physletb.2021.136535. arXiv: 2104.04831 [hep-ex].

12 Tumasyan, A. et al. (The CMS collaboration). "Analysis of the CP structure of the Yukawa coupling between the Higgs boson and τ leptons in proton-proton collisions at $\sqrt{s} = 13$ TeV". In: arXiv: 2110.04836 [hep-ex].

13 Tumasyan, A. et al. (The CMS collaboration). "Evidence for WW/WZ vector boson scattering in the decay channel $\ell\nu$qq produced in association with two jets in proton-proton collisions at $\sqrt{s} = 13$ TeV". In: arXiv: 2112.05259 [hep-ex].

14 Tumasyan, A. et al. (The CMS collaboration). "Measurement of the electroweak production of Zγ and two jets in proton-proton collisions at $\sqrt{s} = 13$ TeV and constraints on anomalous quartic gauge couplings". In: *Phys. Rev. D* 104, p. 072001. DOI: 10.1103/PhysRevD.104.072001. arXiv: 2106.11082 [hep-ex].

15 Tumasyan, A. et al. (The CMS collaboration). "Measurements of the electroweak diboson production cross sections in proton-proton collisions at $\sqrt{s} = 5.02$ TeV using leptonic decays". In: arXiv: 2107.01137 [hep-ex].

16 Tumasyan, A. et al. (The CMS collaboration). "Measurements of the pp $\rightarrow W^{\pm}\gamma\gamma$ and pp $\rightarrow$ Z$\gamma\gamma$ cross sections at $\sqrt{s} = 13$ TeV and limits on anomalous quartic gauge couplings". In: arXiv: 2105.12780 [hep-ex].

17 Tumasyan, A. et al. (The CMS collaboration). "Probing effective field theory operators in the associated production of top quarks with a Z boson in multilepton final states at $\sqrt{s} = 13$ TeV". In: arXiv: 2107.13896 [hep-ex].

18 Tumasyan, A. et al. (The CMS collaboration). "Search for a heavy Higgs boson decaying into two lighter Higgs bosons in the $\tau\tau$bb final state at 13 TeV". In: arXiv: 2106.10361 [hep-ex].

19 Tumasyan, A. et al. (The CMS collaboration). "Search for heavy resonances decaying to Z($\nu\bar{\nu}$)V(q$\bar{q}'$) in proton-proton collisions at $\sqrt{s} = 13$ TeV". In: arXiv: 2109.08268 [hep-ex].

20 Tumasyan, A. et al. (The CMS collaboration). "Search for new particles in events with energetic jets and large missing transverse momentum in proton-proton collisions at $\sqrt{s} = 13$ TeV". In: arXiv: 2107.13021 [hep-ex].

21 Tumasyan, A. et al. (The CMS collaboration). "Study of quark and gluon jet substructure in Z+jet and dijet events from pp collisions". In: arXiv: 2109.03340 [hep-ex].

22 Tumasyan, A. et al. (The CMS collaboration). "Identification of hadronic tau lepton decays using a deep neural network". In: arXiv: 2201.08458 [hep-ex].

[23] Tumasyan, A. et al. (The CMS collaboration). "Measurement of $W^{\pm}\gamma$ differential cross sections in proton-proton collisions at $\sqrt{s} = 13$ TeV and effective field theory constraints". In: *Phys. Rev. D* 105(5), p. 052003. DOI: 10.1103/PhysRevD.105.052003. arXiv: 2111.13948 [hep-ex].

[24] Tumasyan, A. et al. (The CMS collaboration). "Precision measurement of the W boson decay branching fractions in proton-proton collisions at $\sqrt{s} = 13$ TeV". In: *Phys. Rev. D* 105(7), p. 072008. DOI: 10.1103/PhysRevD.105.072008. arXiv: 2201.07861 [hep-ex].

[25] Tumasyan, A. et al. (The CMS collaboration). "Search for a W' boson decaying to a vector-like quark and a top or bottom quark in the all-jets final state at $\sqrt{s} = 13$ TeV". In: arXiv: 2202.12988 [hep-ex].

References

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I give the authorization for the treatment of my personal data according to Italian Law D. Lgs. 196/2003

Perugia, September 7, 2022

Signature