

RICCARDO PARAMATTI

Curriculum vitae

General information

Full name Riccardo Paramatti
E-mail riccardo.paramatti@uniroma1.it
Spoken Languages Italian, English, French

Education

May 1998 **Laurea in Fisica** (110/110 cum laude), Sapienza Università di Roma

January 2002 **PhD in Physics**, Sapienza Università di Roma
Dissertation on “Misura dei parametri del bosone W in eventi adronici a quattro jet osservati nell'esperimento L3 del CERN”

Appointments and fellowship

- **Associate Professor** (S.S.D. FIS/01), Physics Department of Sapienza Università di Roma (June 2019 – now)
- Abilitazione Scientifica Nazionale, tornata 2016, Prima Fascia, S.C. 02/A1 (2018 – now)
- Abilitazione Scientifica Nazionale, tornata 2016, Seconda Fascia, S.C. 02/A1 (2014 – now)
- **Assistant Professor (RTD-b)**, Sapienza Università di Roma (June 2016 – May 2019)
- **INFN Staff Researcher** (December 2005 – May 2016)
- **CERN Scientific Associate** (February 2013 – January 2014)
- **CERN Associate reserved to INFN personnel** (July 2009 – June 2010)
- **Assistant Professor (Professore a contratto)** of “Idoneità Informatica”, Faculty of Philosophy (A.A. 2007/08 and 2008/09)
- **CERN Fellowship** (September 2004 – December 2005)
- **Post-doc** (assegno di ricerca) at the Physics Department of Sapienza Università di Roma (April 2004 – August 2004)
- **Post-doc** (assegno di ricerca) at the Physics Department of Sapienza Università di Roma (April 2002 – March 2004)
- **Borsa di perfezionamento per laureati**, Sapienza Università di Roma (1998)

Teaching experience for undergraduate student

A.A. 2023/24	course Laboratorio di Calcolo (Laurea Triennale in Fisica)
A.A. 2019/20 to A.A. 2023/24	course Laboratorio di Meccanica (Laurea Triennale in Fisica)
A.A. 2019/20 to A.A. 2023/24	lectures in the course Detectors and Accelerators in Particle Physics (Laurea Magistrale in Fisica)
A.A. 2016/17 to A.A. 2019/20	course Fisica (Laurea Magistrale a ciclo unico in Farmacia)
A.A. 2007/08 to A.A. 2008/09	Idoneità Informatica (prof. a contratto, Facoltà di Filosofia)
A.A. 2006/07 to A.A. 2010/11	problem-solving lectures in the course Fisica Nucleare e Subnucleare I (Laurea Triennale in Fisica); author of " Cinematica Relativistica " lecture notes used since more than 10 years by the third-year students

Teaching experience for graduate student

2021-2024	course Chimica Nucleare , master in Scienza e Tecnologia dei Radiofarmaci, Università Sapienza di Roma
2020	course Fisica delle Radiazioni , Scuola di Specializzazione in Fisica Medica, Università Cattolica del Sacro Cuore
2016	Lectures on Electromagnetic and Hadronic Calorimetry at LHC , 5 th International School on LHC Physics organized by the National Centre for Physics (NCP), Islamabad, Pakistan and the Abdus Salam International Centre for Theoretical Physics (AS-ICTP), Trieste, Italy
2014	Lectures on Electromagnetic and Hadronic Calorimetry at the Danube School on Instrumentation in Elementary Particle & Nuclear Physics
2014	Lectures on Electromagnetic and Hadronic Calorimetry at the Joint Belgian Dutch German Graduate School
2007	Lectures on Calorimetry , Università di Roma Tor Vergata (XXI ciclo)
2006	Lectures on Calorimetry , Università di Roma Tor Vergata (XX ciclo)

Supervisor of Ph.D. thesis

XXVI ciclo (2010/13)	S. Nourbakhsh " <i>Search of the Higgs boson in the two photon final state</i> "
XXII ciclo (2006/09)	A. Palma " <i>Studies on the spectrum e^+e^- with the first data of the CMS experiment at the Large Hadron Collider</i> "

Supervisor of Master's Degrees

A.A. 2022/23	S. Akhtar “ <i>Study and Characterization of the new High Voltage system for the upgrade of the CMS Electromagnetic Calorimeter for High-Luminosity LHC</i> ”
A.A. 2019/20	B. D’Orsi “ <i>Study of the radiation resistance of LYSO:Ce crystal for the new timing detector of the CMS experiment</i> ” ” (Beatrice is Post-Doc at the Casaccia Enea)
A.A. 2018/19	M. Campana “ <i>Study of light output and characterization of LYSO crystals for the new timing detector of the CMS experiment</i> ” (Mattia is Post-Doc at the Northeastern University)
A.A. 2018/19	A.M. Muroccco “ <i>PET: Tomografia ad Emissione di Positroni</i> ”, Corso di Laurea Magistrale a Ciclo Unico in Farmacia
A.A. 2016/17	M. d’Uffizi “ <i>Measurement of the electron charge asymmetry in inclusive W production with CMS data taken at $\sqrt{s}=13\text{TeV}$</i> ”
A.A. 2016/17	V. Marè “ <i>Sviluppo di un algoritmo Random Forest per una analisi multivariata di parametri di texture in RMN per la stadiazione dei tumori</i> ”
A.A. 2013/14	A. Provenza “ <i>Studio del materiale del tracciatore con il flusso di energia attraverso il calorimetro elettromagnetico di CMS</i> ”
A.A. 2011/12	A. Russomando “ <i>Uso del preshower nella calibrazione con eventi $\pi\rightarrow\gamma\gamma$ del calorimetro elettromagnetico di CMS</i> ” (Andrea is Assistant Professor in Chile)
A.A. 2009/10	S. Nourbakhsh “ <i>Study of J/ψ in two electrons events with first data at CMS experiment</i> ”
A.A. 2003/04	F. Santanastasio “ <i>Calibrazione di un calorimetro elettromagnetico tramite il flusso totale di energia</i> ” (Francesco is Associate Professor in Sapienza)
A.A. 2003/04	G. di Giovanni “ <i>Studio della ricostruzione degli elettroni per la calibrazione del calorimetro elettromagnetico di CMS</i> ”
A.A. 2003/04	S. Venditti. Provenza “ <i>Studio del canale di decadimento $\eta\rightarrow\gamma\gamma$ in due fotoni nel calorimetro elettromagnetico di CMS</i> ”

Supervisor of Bachelor's Degrees (Laurea Triennale)

About 20 dissertations covering the following topics:

- Atmospheric neutrino oscillations.
- Solar neutrino oscillations.
- CP Violation in the neutral kaon system.
- Precise measurements on W and Z bosons at LEP.

- Measurement of the e^+e^- in hadrons and e^+e^- in muons cross section ratio and quark color evidence.
- Higgs Boson observation at LHC.
- Measurement of the charge asymmetry in cosmic muons.
- Measurement of the muon critical energy.
- Energy measurement in electromagnetic and hadronic calorimetry.
- Particle accelerators in Hadron Therapy.
- Dosimetry for Hadron Therapy with nuclear de-excitation.
- Dosimetry for Hadron Therapy with prompt photons.
- Use of Cherenkov radiation in medical physics.

Funding Information

2024	Rome CMS group, INFN grant: 800k euro budget (including Phase2 CMS), Principal Investigator
2023	Rome CMS group, INFN grant: 300k euro budget (including Phase2 CMS), Principal Investigator
2022	Rome CMS group, INFN grant: 1161k euro budget (including Phase2 CMS), Principal Investigator
2021	Rome CMS group, INFN grant: 908k euro budget (including Phase2 CMS), Principal Investigator
2020	Rome CMS group, INFN grant: 610k euro budget (including Phase2 CMS), Principal Investigator
2020	Progetto di ricerca d'Ateneo, " <i>Italiano e Matematica: diritti di cittadinanza</i> ", Sapienza: 11k euro
2019	Progetto di ricerca d'Ateneo, " <i>LYSO crystal characterization for the Mip Timing Detector of CMS experiment</i> ", Sapienza: 15k euro, Principal Investigator
2018	Progetto di ricerca d'Ateneo, " <i>Precision timing for the upgrade of the CMS experiment</i> " Sapienza: 12.5k euro
2016-2018	CMS Electron and Photon Physics Object Group Coordination, INFN specific grant to support my role of coordinator: 28k euro
2012-2013	CMS ECAL Detector Performance Group Coordination, INFN specific grant to support my role of coordinator: 28k euro
2009-2011	CMS ECAL Calibration and Alignment Group, INFN specific grant to support my role of coordinator: 20k euro

Scientific and Research Coordination Responsibilities

2023 – now	deputy System Manager of CMS ECAL (Level 1 position in CMS organization – ECAL Collaboration consists of about 250 physicists)
2023 – now	member of the CMS Management Board
2022 – 2024	chair of the CMS ECAL Editorial Board (Level 2 position)
2019 – now	team leader of the CMS Rome group (33 persons, 26.7 FTE – average annual budget of more than 750k euro in the last five years)
2019 – 2022	coordinator of the Rome center for the QA/QC of LYSO crystal production for the new timing detector of CMS experiment
2019 – now	member of the CMS Collaboration Board
2019 – now	member of the CMS MTD Institution Board
2019 – now	member of the CMS ECAL Institution Board
2016 – 2018	convener of the <i>Electron and Photon Physics Object Group</i> of the CMS experiment (Level 2 position – the group consists of about 50 physicists)
2016 – 2018	member of the CMS Physics Coordination group
2016 – 2018	member of the CMS Physics Performance and Dataset Coordination group
2014	convener of the <i>ECAL Upgrade Performance Group</i> of the CMS experiment
2013, 2023 – now	member of the CMS ECAL Steering Committee
2012 – now	member of the CMS ECAL Editorial Board
2012 – 2019	member of the CMS ECAL Conference Committee
2012 – 2013	convener of the <i>ECAL Detector Performance Group</i> of the CMS experiment (Level 2 position – the group consists of about 80 physicists)
2012 – 2013	member of the CMS ECAL Management and Operation Board
2009 – now	member or chair of about 15 CMS Analysis Review Committee
2009 – 2011	convener of the <i>ECAL Calibration and Alignment Group</i> of the CMS experiment
2008	convener of the <i>CMS Computing, Software and Analysis electron group</i>
2003	member of the CMS ECAL Technical Coordination Group

Institutional and Academic Responsibilities

2022 – now	Chair of the INFN Commission for several postdoc positions (assegni di ricerca) at the INFN Roma1
2022 and 2024	Chair of the INFN Commission for the scholarship grants for scientific training activities entitled to Master's degree undergraduates.
2021 – now	Member of Collegio dei Docenti (Scientific Board) of the PhD program in Accelerator Physics
2021	Chair of the INFN Commission for CTER personnel selection.
2019 – now	member of the Physics Department “Commissione per la pianificazione della didattica della Fisica”
2019 – now	Member of the commission for several postdoc positions (assegni di ricerca) at the Physics Department of Sapienza University
2019 – 2023	member of the CAD “Commissione per la verifica dei requisiti magistrali”
2018 – 2023	member of the CAD “Commissione per i percorsi formativi degli studenti”; contact person for the Particle ed Astroparticle Physics curriculum of the LM-17
2018 – 2021	person in charge of the student admission test (Test On Line CISIA, TOLC-S and TOLC-B) for the Facoltà di Scienze Matematiche Fisiche e Naturali in Sapienza
2018 – 2020	member of the “Commissione Didattica del Consiglio di Corso di Studio in Farmacia”
2018	contact for the Rome International Scholars Program of the University of Notre Dame (Indiana - US) and supervisor of the student Sang Woo Kim
2017	member of the Advisory Committee of the 6 th NCP-ICTP LHC school
2016 – 2017	Co-Editor of the Physics Department Scientific Report 2014-2016 https://www.phys.uniroma1.it/fisica/sites/default/files/allegati/ScientificReport2014-2016.pdf
2016	referee of JINST (Journal of Instrumentation)
2011 – 2015	member of the Consiglio di Sezione INFN Roma

PhD defense examination board

2023	Member of examination board for the final exam of Ph.D. in Fisica e Astronomia at the Università degli studi di Milano Bicocca (35° ciclo)
2021	Member of examination board for the final exam of Ph.D. in Fisica e Astronomia at the Università degli studi di Milano Bicocca (33° ciclo)
2020	Member of examination board for the final exam of Ph.D. in Fisica e Astrofisica at the Università degli studi di Torino (33° ciclo)
2015	Member of the examination board for the final exam of Ph.D. in Physics at the Université Libre de Bruxelles (ULB)

Outreach and third mission

2024	Tutor in the “ PNRR ORIENTAMENTO NEXT GENERATION ” Regione Lazio program devoted to the italian high schools
2023 – now	Tutor in the “ INFN Kids ” program devoted to the italian primary schools
2023 – now	Tutor in the INFN “Art&Science” program devoted to the italian high schools
2022	Tutor in the “ Cittadinanza digitale ” Sapienza program devoted to the italian high school teachers.
2018 – 2023	Lectures for high school teachers in the “ Master Class ” program.
2018 – 2019	Tutor for the LAB2GO project. This Sapienza-INFN project takes place in the high schools in Rome and in Lazio and aims to restore the instrumentations of the school scientific laboratories and to document the physics experiences which can be performed in the laboratory.
2009 – 2011	Lectures for the high school students in the “ Master Class ”, in the “ Olimpiadi della Fisica ” and in the “ Fisica in barca ” programs

Awards

- Best Communication in Nuclear and Subnuclear Physics presented at the 2000 National Congress of the Italian Physical Society (SIF).
- EPS 2013 High Energy and Particle Physics Prize: prize and medal, for an outstanding contribution to High Energy Physics, is awarded to the ATLAS and CMS collaborations, "for the discovery of a Higgs boson, as predicted by the Brout-Englert-Higgs mechanism".

Summary of Scientific Publications (updated July 2024)

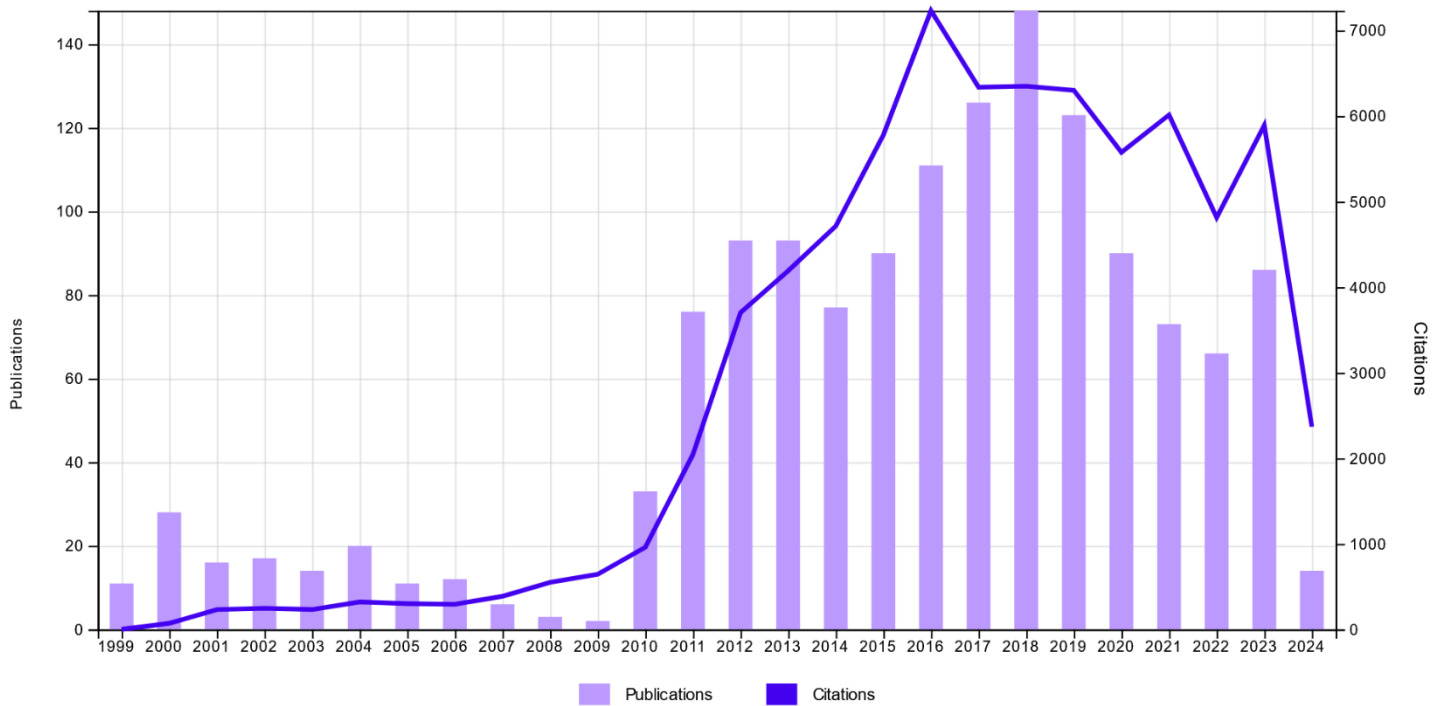
Author of more than 1400 publications in peer-reviewed international journals;
for convenience, please refer to the complete list here: <https://l.infn.it/publistparamatti>
or to this QR code



Author of 44 Notes of the CMS Collaboration and 12 Notes of the L3 Collaboration.

Personal Citation Report (Date of first publication: October 1999. PhD in Physics: January 2002)

	Total number of peer-reviewed publications	Total number of citations	Average citations per publication	H-index
Web of Science	1439	75543	52.5	118
SCOPUS	1441			
INSPIRE	1422	190720	134.1	191
Web of Science (last 15 years)	1287	63785	49.5	114
SCOPUS (last 15 years)	1280			



Talks at International Conferences and Workshop Seminars:

2023 *“The CMS ECAL upgrade for precision timing measurements at the High-Luminosity LHC”*, 6th Technology and Instrumentation in Particle Physics – **TIPP2023**, Cape Town (South Africa).

In the years 2020-2022 I did not attend any conferences due to the pandemic.

2019 *“Precision Timing with the CMS MIP Timing Detector”*, XXXIX International Symposium on Physics in Collision – **PIC2019**, Taipei (Taiwan)

2018 *“Searches for new heavy resonances in final states with leptons and photons”*, 7th International Conference on High Energy Physics in the LHC Era – **HEP2018**, Valparaiso (Chile)

2016 *“Search for high mass resonances in the diphoton and Z+photon channels at LHC”*, Diphoton and Flavor Anomalies workshop – Univ. Sapienza, Roma

2016 *“Search for new physics in high mass diphoton events: CMS results.”*, 750 GeV Forum at DESY – Hamburg and Zeuthen (Germany).

2016 *“Performance in electron beams of a tungsten-CeF₃ prototype for radiation-resistant high-energy physics calorimetry”*, 14th Vienna Conference on Instrumentation – **VCI 2016**, Vienna (Austria)

2015 *“Highlights on CMS tracker and calorimeter reconstruction improvements for Run II”*, 3rd Conference on Large Hadron Collider Physics – **LHCP 2015**, Saint Petersburg (Russia)

2014 *“Design options for the upgrade of the CMS electromagnetic calorimeter”*, 37th International Conference on High Energy Physics - **ICHEP 2014**, Valencia (Spain).

2013 *“Upgrade of the CMS Forward Calorimetry”*, **IPMLHC2013**: Second IPM Meeting on LHC Physics, Teheran (Iran).

2012 *“Performance of the CMS electromagnetic calorimeter at the LHC and role in the hunt for the Higgs boson”*, 36th International Conference on High Energy Physics - **ICHEP 2012**, Melbourne (Australia).

2011 *“Performance of the CMS Electromagnetic Calorimeter at the LHC”*, **13th ICATPP Conference** on Astroparticle, Particle, Space Physics, Detectors and Medical Physics Applications – Como.

2010 *“Calibration of CMS Electromagnetic Calorimeter at LHC startup”*, XIV International Conference on Calorimetry in High Energy Physics – **CALOR10**, Beijing (China).

2008 *“Inclusive W and Z production with CMS at LHC startup”* (poster), 34th International Conference on High Energy Physics - **ICHEP 2008**, Philadelphia (USA).

2006 *“Crystal Production and Properties in CMS - ECAL”*, XII International Conference on Calorimetry in High Energy Physics - **CALOR06**, Chicago (USA).

2003 *“Highlights from the 9th Pisa Meeting on Advanced Detectors”*, Detector Seminar – CERN.

2003	<i>“Calibration Strategy of CMS Electromagnetic Calorimeter”</i> , Frontier Detectors for Frontier Physics: 9th Pisa Meeting on Advanced Detectors - Isola d'Elba.
2003	<i>“Calibration of CMS Electromagnetic Calorimeter”</i> , 8th ICATPP Conference on Astroparticle, Particle, Space Physics, Detectors and Medical Physics Applications - Como.
2002	<i>“WW production at LEP2”</i> , Lake Louise Winter Institute 2002 - Fundamental Interactions, Alberta (Canada)
2002	<i>“Calibration of CMS Electromagnetic Calorimeter”</i> , 8th Topical Seminar on Innovative Particle and Radiation Detectors - Siena.
2001	<i>“Unfolding of W Mass Distribution at LEP”</i> , WWMMI LEP WW Physics Workshop – Cern.

RESEARCH ACTIVITIES IN THE CMS EXPERIMENT

The Compact Muon Solenoid (CMS) is one of the two multi-purpose experiment at the CERN Large Hadron Collider (LHC); it has a very broad physics program at an unprecedented energy scale: proton-proton collision at 7, 8, 13 and now 13.6 TeV in the center of mass. The CMS collaboration is made up of about 3000 physicists, coming from more than 50 countries around the world. I entered in CMS twenty years ago and I am, since 2019, team leader of the CMS Rome group. In these years the group has doubled in size, reaching today 33 physicists and PhD students.

Research activities in 2002-2007

Since 2002 I have been involved in the construction of the Electromagnetic Calorimeter (ECAL) of CMS, as Sapienza post-doc and later as Cern fellow, coordinating the analysis of the measurements for the characterization of lead tungstate crystals in the INFN-ENEA regional center in Casaccia and later in the CERN regional center. Since 2004, during the years prior to taking data at LHC, I have actively participated in the calorimeter pre-calibration campaign with crystal Light Yield measurements, with electron beam tests and cosmic tests.

I also took part to the installation of the ECAL High Voltage system, and I've been responsible for the calibration and stability measurements of the power supply boards during the winter shutdowns. This calibration is crucial to the stability of the system, which directly affect the photodetector gain, and consequently the constant term of the calorimeter energy resolution. I developed the HV database finalized to the management of all the activities and tests of the system.

Finally, I participated to the installation and performance monitoring of the Rome Tier2.

Research activities in 2008-2013

Thanks to the experience gained in the previous years, I have been called, since 2008, to coordinate various working groups in the Collaboration, oriented both to the detector and to the physics, covering several positions of L2 and L3 in the management chart of CMS.

The most relevant part of my work in this period applies to the activities focused on the improvement of the Electromagnetic Calorimeter (ECAL) performance, which played a central role in the discovery of the Higgs Boson in July 2012, in the decay channels with photons in the final state.

I have been convener of the Detector Performance Group (with about 80 CMS collaborators actively involved) from January 2012 to December 2013 when the full LHC Run1 set of data have been analysed to measure the Higgs properties (mass, spin, couplings). The DPG achievements brought to a remarkable improvement in the calorimeter energy resolution allowing the observation of the Higgs boson with a significance greater than 5 standard deviations in the two photons decay channel alone with the Run1 Data [**Ref. 1** in the list of presented publications]. In the context of this work, I gave at the ICHEP2012 Conference at Melbourne a talk on the *“Performance of the CMS electromagnetic calorimeter at the LHC and role in the hunt for the Higgs boson”*.

- **Electron Computing, Software and Analysis group.**

In 2008, I have been the convener of this group with the mandate of preparing the CMS analyses with final state electrons. The setup of trigger paths and offline selections and the measurements of reconstruction, selection and trigger efficiencies optimized to the very first data with start-up conditions – detector not yet aligned and calibrated – were the main tasks performed by this group.

- **ECAL Calibration and Alignment group.**

I have been convener of this group since the beginning of 2009 to the end of 2011. The calibration effort is documented the publication and in the CMS Physics Analysis Summary “Electromagnetic Calorimeter Calibration with 7 TeV data” of which I was the editor. I also presented the calibration results at the CALOR10 and other international conferences. In addition, I personally developed a new iterative method to inter-calibrate a calorimeter with a very large number of channels using resonances as $Z \rightarrow e^+e^-$ and $\pi \rightarrow \gamma\gamma$; since then, this method is currently used in CMS.

- **Optimization of Electromagnetic Calorimeter performance.**

I was the convener of the ECAL Detector Performance Group in the years 2012-13. The task of the group includes all the activities finalized to obtain the best stability and efficiency of the detector during the data taking and at the same time the best energy, position, and time resolution of reconstructed electrons and photons. Besides the general coordination of all the group activities, I personally contributed on the detector calibration, on the determination of the amount of material in front of the calorimeter with the Run1 data, comparing the energy flux in Minimum Bias events taken with and without magnetic field and also to the study on the gain stability of the Avalanche Photodiodes (APDs), capable to effectively convert the crystal scintillation light in electrical signal in a high magnetic field environment [2], [3].

- **Higgs Boson search in the two-photon decay channel**

My personal contribution in this analysis is the optimization and evaluation of photon energy resolution and energy scale with original data-driven techniques. The important time variation of the transparency of Lead Tungstate crystals and all the other sources of systematic error have been deeply investigated. All the CMS published analyses on the $H \rightarrow \gamma\gamma$ decay channel make use of the results obtained with this method [1], [10], [11], [14].

Research activities in 2014-2018

Since 2014 I moved to the R&D activities for the CMS upgrade for LHC phase2 (High Luminosity LHC) in two different areas: future calorimeters and timing detectors. During the LHC run2 data taking (2016-2018) I have been convener of the Electron and Photon Physics Object Group. Finally, my commitments to data analysis, in the same years, have expanded to the search of narrow resonances at high mass in the di-photon channel.

- **Upgrade of the electromagnetic calorimeter for the High Luminosity LHC.**

In 2014, I was the coordinator of the group on the performance evaluation of the calorimeter for the HL-LHC. Due to the very high radiation dose in the forward region, and to the resulting crystal light transmission loss, the CMS ECAL endcaps should be replaced with a new sampling calorimeter. I reported on the ECAL upgrade state of the art at the ICHEP2014 conference.

- **Test beam on CeF₃ crystals and Micro-Channel-Plates for HL-LHC.**

In 2014-2015 I took part to the tests of two prototypes of detector for HL-LHC with beam of electrons at the BTF facility in Frascati and at the H4 facility at Cern. The first one is a sampling calorimeter of CeF₃ crystals and tungstate absorber for energy measurement. The second is a timing detector made of Micro-Channel-Plates tested in two different configurations: PMT-MCP and ionization-MCP without the photocathode. I also developed the database for both the test beam and participated to the data analysis [4], [5].

- **Optimization of electron and photon reconstruction and identification for Run2 analyses.**

During Run2 of LHC (2016-2018) I was coordinator of the Electron and Photon Physics Object Group, made up of about 50 CMS physicists. The group is responsible for the trigger and reconstruction algorithms of electrons and photons and for the identification strategies, based on both standard selections and multivariate analyzes, of these particles. The results obtained by this group has been a key ingredient in several analyses on the properties of the Higgs boson and several searches beyond the Standard Model. The supervision and approval of reconstruction algorithms optimized for alternative scenarios, such as those used in collisions between lead ions, is another task of the group that I coordinated. At the same time, I have also worked on new procedures for the selection of photons of energies of the TeV scale, aimed at the search for new physics, which make use of machine learning techniques [9], [12].

- **Search of narrow resonances at high mass in the di-photon channel.**

Several “*Beyond the Standard Model*” theories postulate the presence of heavy particles with mass in the TeV region (e.g. extra-dimension Randall-Sundrum model). Di-photon decay is a golden channel in the search of new physics and at the beginning of LHC Run2, with a much higher center-of-mass energy, I started to work in this analysis with the focus on signal model and on experimental aspects as the electromagnetic shower longitudinal leakage and the electronic saturation, arising with very high-energy photons. I’ve been invited to give seminars on this “hot” topic (in Sapienza and in DESY) when both ATLAS and CMS observed an excess in the diphoton invariant mass region of 750 GeV [6], [7].

Research activities in 2019-2024

In the last five years, I have been fully involved in the management of the CMS Rome group and in the experimental activities connected to the upgrade of the CMS detector. CMS is in fact undergoing an extensive Phase 2 upgrade program to prepare for the challenging conditions of the High-Luminosity LHC. The Rome group is working both on the ECAL upgrade and in the MIP Timing Detector (MTD) construction. As group leader, I manage the preparatory activities and the connections with the companies for the tender of the following projects: construction on the ECAL Enfourneur (precision mechanical tool for the extraction and insertion of ECAL crystal modules in the detector – 430 kEuro), production of the boards (~ 200 kEuro) and the cables (~ 500 kEuro) for the new ECAL HV system, production of the LYSO crystals for the new MTD detector (~ 1400 kEuro).

- **The CMS ECAL upgrade for precision timing measurements at the High-Luminosity LHC**

The High Luminosity upgrade of the LHC at CERN will provide unprecedented instantaneous and integrated luminosities of around $5 \cdot 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ and 3000/fb, respectively. An average of 140 to 200 collisions per bunch-crossing (pileup) is expected. In the barrel region of CMS electromagnetic calorimeter, the lead tungstate crystals and avalanche photodiodes (APDs) will continue to perform well, while the entire readout and trigger electronics will be replaced.

A dual gain trans-impedance amplifier and an ASIC providing two 160 MHz ADC channels, gain selection, and data compression will be installed. The noise increase in the APDs, due to radiation-induced dark current, will be mitigated by reducing the ECAL operating temperature. The trigger primitive formation will be moved off-detector and performed by powerful and flexible FPGA processors.

The upgraded ECAL will greatly improve on the time resolution for photons and electrons with energies above 10 GeV.

In 2023, I have been appointed ECAL Deputy System Manager by the CMS Management Board and the ECAL Institution Board. This role (a L1 position in the CMS organization) consists of coordinating, together with the new System Manager (former deputy), all the activities related to the ECAL upgrade. Moreover, I take part in the management of the ECAL Collaboration (about 250 physicists) also involved in the ongoing data taking, the LHC run3. I'm sure this represents an exciting challenge for me.

- **LYSO crystal characterization for the MIP Timing Detector**

As part of its upgrade, CMS is planning to build the MIP Timing Detector (MTD), a novel sub-detector with the capability of tagging charged particles with a time resolution of 30-60 ps. In the barrel part of the MTD detector, called the Barrel Timing Layer (BTL), scintillating LYSO:Ce crystals coupled to Silicon Photomultipliers (SiPMs) will be used as active elements. LYSO was found to be the optimal choice in terms of performance (high light yield and fast scintillation kinetics), cost and mass production capability.

Starting from 2019, a comprehensive characterization campaign of LYSO crystal samples from different vendors has been carried out in CMS Laboratory in Sapienza. The purpose of this campaign was the qualification of potential manufactures for the BTL detector and the establishment of experimental methods and technical requirements for the QA/QC process in the production stage. I was in charge of the coordination of this activity since the beginning

up to 2023 and I also obtaining a university grant (Fondi d'Ateneo), as Principal Investigator, on the LYSO crystal characterization. After a detailed comparison of crystal optical properties, as light yield, decay time and time resolution, from different producers, after the full investigation of the uniformity among samples and the temperature dependence of the crystal properties, we finally tested the radiation tolerance of crystal samples in an irradiation campaign with Co60 photons and neutrons at the Enea-Casaccia facility. This large number of results has been documented in a JINST paper and allowed to qualify few manufactures for the full oncoming production.

Recently few sensor prototypes, previously characterized in the Rome laboratory, have been tested also with proton beams, demonstrating that these sensors can provide a time response with a time resolution better than 30 ps as expected [13], [15], [16].

RESEARCH ACTIVITIES IN THE L3 EXPERIMENT

I actively participated, during my Ph.D. in 1998-2001, to the measurements of the W mass and the $e^+e^- \rightarrow W^+W^-$ cross-section with the data collected by L3 experiment at the LEP accelerator at CERN. In this period, the center of mass energy of LEP exceeded the threshold for the production of a pair of W boson, rising up to 209 GeV, opening the exploration to a new energy regime and allowing the extension of precision tests to a new sector of the Standard Model.

Personal contributions:

- **Measurements of the $W^+W^- \rightarrow q\bar{q}q\bar{q}$ cross section and hadronic W Branching Ratio**

In the last years of LEP data taking, I was the contact person of the fully hadronic decay channel, with both the W s decaying in a quark-antiquark pair. The cross section measurement confirmed, for the first time, the presence of triple gauge boson couplings γWW and ZWW . The measurement of hadronic branching ratio, together with the other BRs, represented a very crucial test of the lepton universality in this electroweak sector. In these analyzes I was a forerunner of the use of neural networks for the selection of signal events. At the LXXXVI Congresso Nazionale della Società Italiana di Fisica I got the award as best Communication in Nuclear and Subnuclear Physics showing the results of this analysis.

- **Unfolding of the W boson invariant mass distribution**

I developed an original method to unfold the W mass distribution reconstructed in hadronic ($W^+W^- \rightarrow q\bar{q}q\bar{q}$) and semileptonic ($W^+W^- \rightarrow q\bar{q}l\nu$) final states. This method, assuming the real distribution being compatible with a linear combination of B-Splines, has brought to the first representation of the unfolded W mass distribution, without the bias introduced by the detector acceptance and resolution.

- **W mass and width measurements**

The measurements of the W mass and width can be directly performed starting from the unfolded mass distribution, which is common to the different decay channels. The improvement in the M_W error implied a more stringent test on the Standard Model indirect measurements. I presented this analysis in the Fundamental Interactions - Lake Louise Winter Institute conference in 2002.

RESEARCH ACTIVITIES IN THE SAPIENZA APPLIED RADIATION PHYSICS GROUP

In 2014 I entered in the Applied Radiation Physics Group (ARPG), a collaboration between researchers of the Physics and the Scienze di Base e Applicate per l'Ingegneria (SBAI) Sapienza departments and participated in the group's activities for about 4 years. In this context, I worked on the **cross-section measurements of ion beam (Helium, Carbon, Oxygen) fragmentation**, aimed at reducing the uncertainties in the energy range characteristic of hadron therapy (100-500 MeV per nucleon) for the treatment of tumors; these measurements are crucial to provide necessary input to the benchmark Montecarlo codes, as Geant4 and Fluka [8].

Another area in the applied physics that has recently seen very strong development is the use of machine learning techniques in medical diagnostics. In this regard, I also collaborated to a study of **multivariate analysis algorithms on texture parameters in magnetic resonances** for the tumor staging within a collaboration between Sapienza University and San Camillo Forlanini hospital. I'm co-author of about 10 publications in this field.

STATISTICAL STUDY ON THE CAREERS OF SCIENCE STUDENTS

Starting in 2018, for the following four years, I was the coordinator, for the Faculty of Mathematical, Physical and Natural Sciences of Sapienza University, of the student admission tests (Test On Line CISIA, TOLC-S and TOLC-B). In this role, I started a statistical analysis on the **correlations among the outcome of the entry test and the success in a university career in the following five years**; this analysis clearly shows, with a Bayesian approach, that the scores in the different area of the entry test give strong indication about the quality of the future student careers.

In the same years I performed a very detailed study on the socio-economics indexes of the 3-year Degree graduates and the Master graduates with public data collected by the Consorzio Interuniversitario Almalaura. Showing as the socio-economic profile factors - as for instance residence or availability of transportation - are strongly linked to the duration and performance of the university path, this study aims, inspired by the Italian Constitution, at helping to **remove the obstacles of a socio-economic nature that prevent the achievement of a three-year degree in a regular or sustainable time frame**. This work is described in the publication: [Un'analisi con sette indicatori socioeconomici per laureate e laureati triennali](#), DOI 10.12828/106010 – Scuola Democratica – Il Mulino.

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