

# Curriculum Vitae et Studiorum

## Elvira Rossi

---

### General Information

Full Name: Elvira Rossi

Date of Birth: 14/05/1977

Place of Birth: Napoli

Citizenship: Italian

Permanent Address: Viale Gandhi 8, 80040, Cercola (NA) Italy

Mobile Phone Numbers: +393384720121

E-mail: elvira.rossi@cern.ch; elly@na.infn.it

Certified E-mail: elvira.rossi@pec.it

Spoken Languages: Italian (mother language); English (fluent); French (basic)

### Education

**2006:** Ph.D. in Physics at University “Federico II” of Napoli (Italy). Title of the Ph.D. Thesis: “Study of the angular resolution of the ARGO-YBJ experiment: the shadow of the Moon” at University “Federico II” of Napoli (Italy).

Supervisors: prof. Benedetto D’Ettore Piazzoli, Ph. D. Giuseppe Di Sciascio.

**2002:** Degree in Physics with full marks 110/110 “Magna cum laude” at University “Federico II” of Napoli (Italy); Title of the Thesis: “Ricostruzione degli sciami atmosferici prodotti da fotoni di alta energia con il rivelatore ARGO-YBJ” (“Reconstruction of Extensive Atmospheric Showers induced by high energy photons with the ARGO-YBJ detector”). Supervisors: prof. Benedetto D’Ettore Piazzoli, Ph. D. Giuseppe Di Sciascio.

### Academic Appointments, Work experience, and Qualifications

**2018-2022:** Experimental Physics Researcher (Ricercatore a tempo determinato – RTDB ) (PostDoc position, 3-years term) in Experimental Physics of Fundamental Interactions for Physics Department at University “Federico II” of Naples.

**2018:** Research fellow (PostDoc position, seven-months term) at the University “Federico II” of Napoli, to work on “Development and design of teaching materials for the Masterclasses project in Elementary Particles”.

**2013-2018:** Experimental Physics Researcher (Ricercatore a tempo determinato - RTDA) (PostDoc position, five-years term) in Experimental Physics of Fundamental Interactions for Engineering Department at University “Parthenope” of Naples.

**2014:** Qualified as Associate Professor “Abilitazione Scientifica Nazionale alle funzioni di professore di seconda fascia nel settore concorsuale 02/A1” from November 2014 to November 2020. Academic Discipline: FIS/01.

Academic recruitment field: 02/A1 “Experimental Physics of Fundamental Interactions”.

**2017-2018:** Member of the Teaching Committee (Commissione Didattica) for the Engineering Department at University “Parthenope” of Napoli.

**2015-2017:** Member of the Committee on Teaching Quality Assurance control (Commissione per l’Assicurazione della Qualità (AQ) per le attività didattiche) for the Engineering Department at University “Parthenope” of Napoli.

**2011-2013:** Research fellow (PostDoc position, two-year term) at the University “La Sapienza” of Rome, to work on the Muon High Level Trigger of the ATLAS experiment (title of the fellowship “Algoritmi di filtro per i muoni al secondo livello di trigger dell’esperimento ATLAS ad LHC”).

**2011:** “Della Riccia” grant for young researcher to work for 5 months at CERN (Organisation Européenne pour la Recherche Nucléaire) on the  $J/\psi \rightarrow \mu\mu$  and  $Z \rightarrow \mu\mu$  processes in the ATLAS experiment (title of the grant “Analisi dei processi  $J/\psi \rightarrow \mu\mu$  e  $Z \rightarrow \mu\mu$  con i dati da collisione protone-protone raccolti dall’esperimento ATLAS”).

**2009-2010:** Research fellow (PostDoc position, one-year term) at the University “Federico II” of Napoli, to work on the analysis of the first data taken by the ATLAS experiment (title of the fellowship “Preparazione all’analisi dei primi dati nell’esperimento ATLAS”).

**2009:** Qualified to teach Physics and Mathematics at secondary school: “SICSI (VIII ciclo) per l’insegnamento nella scuola secondaria superiore per l’indirizzo Fisica-Matematica-Informatica per le classi di concorso A049 (Matematica e Fisica) e A038 (Fisica)”.

**2009:** Successful candidate of the I.N.F.N. competition (announcement competition n. 13153/2009): Idonea alla procedura selettiva dell’I.N.F.N. (bando n. 13153/2009) per la formulazione di giudizi di idoneità per la eventuale costituzione di rapporti di lavoro con contratto a termine per personale ricercatore di III livello – fisica sperimentale.

**2006-2008:** Research fellow (PostDoc position, two-years term) at the I.N.F.N. (Istituto Nazionale di Fisica Nucleare) Section of Napoli, to work on the gamma radiation coming from the Galactic Plane detected from the first data collected by the ARGO-YBJ experiment (title of the fellowship “Analisi dei dati raccolti dall’esperimento ARGO-YBJ per lo studio della radiazione gamma dal piano galattico”).

### **Funds for research and Projects of Relevant National Interest (PRIN)**

**2017:** Award of funding for the annual individual funding of basic research activities (FAABR), fund set up by the Italian Ministry of Education, University and Research (MIUR) for basic research.

**2017:** Award of funding for University research support for the University of Naples Parthenope (quota A and quota B).

**2016:** Award of funding for the support of University Research for the University of Naples Parthenope (quota A and quota B).

**2016:** Award of funding for University Research support for the University of Naples Parthenope; Title of the project "Development of sustainable mobility systems with SMART technologies able to use the Internet Of Things (IOT) resources". Coordinator: Prof. Maurizio Migliaccio (University of Naples Parthenope).

**2011-2013: Projects of Relevant National Interest (PRIN):** I participated as Investigator in the PRIN project entitled "Dual-Readout calorimetric systems" at the University of Rome "La Sapienza". Head of the research unit at the University of Rome "La Sapienza": Prof. Lacava Francesco; Principal Investigator: LIVAN Michele Protocol: 200822MP2J\_003 Area 02 Duration: 24 months.

### **Research Activities**

**2001-2009:** My research activities were dedicated to the Astroparticle Physics inside the INFN CSN2 group as a member of the ARGO-YBJ experiment.

**2009 to today:** My research activities are dedicated to the High Energy Physics inside the INFN CSN1 group as a member of the ATLAS experiment.

### **ARGO-YBJ experiment (2001-2009):**

#### Cosmic Ray (CR) and Gamma Ray Physics:

- a) Reconstruction of Extensive Atmospheric Showers (EAS) induced by high energy protons and gamma rays with the ARGO-YBJ detector;
- b) Study of the angular resolution of the ARGO-YBJ experiment with the analysis of the shadow of the Moon;
- c) Sun Shadow analysis and the interplanetary magnetic field;
- d) Study of the "All particle spectrum";
- e) Study of the Galactic Plane emissions.
- f) Grid Computing in ARGO-YBJ.

#### **a) Reconstruction of Extensive Atmospheric Showers (EAS) induced by high energy photons with the ARGO-YBJ detector.**

During the period of the Degree Thesis I developed a procedure to analyze the characteristics of the EAS detected by the ARGO-YBJ experiment. The main parts of the work were: 1) the study of the shower core reconstruction techniques; 2) the determination of the selection criteria for events with their core inside the detector area; 3) the development of an iterative procedure to reconstruct the arrival direction of the primary cosmic rays; 4) the estimation of the ARGO-YBJ sensitivity to point sources of high energy gamma rays.

The reconstruction algorithm that I developed during this study has been used as the official analysis code of the ARGO-YBJ experiment.

During the Ph.D. I continued these activities optimizing the identification and reconstruction procedure for both for gamma and proton induced showers. I presented the results of these studies at the "Incontro Nazionale di Astrofisica delle Alte Energie" in Roma (2003).

#### **b) Study of the angular resolution of the ARGO-YBJ experiment with the analysis of the shadow of the Moon.**

My Ph.D. research activity was focused on the determination of the ARGO-YBJ angular resolution with the data collected with ARGO-42 (42 clusters, 1900 m<sup>2</sup> about 1/3 of the central detector). ARGO-42 was in data acquisition from December 2004 to July 2005.

The angular resolution is one of the most important features for an EAS array dedicated to Gamma Astronomy. I measured the ARGO-YBJ angular

resolution with two different methods: the so called “chess-board method” and using the shadow of the Moon.

The Moon hampers cosmic rays and a deficit in its direction is expected (the so-called Moon shadow). The Moon shadow is an important tool to determine the performance of an air shower array (Clark, G.W., 1957, Phys. Rev. 108, 450; Alexandreas, D.E. et al., 1991 Phys. Rev. D43, 1735). Indeed, the westward displacement of the shadow center, due to the bending effect of the geomagnetic field on the propagation of cosmic rays, allows the setting of the absolute rigidity scale of the primary particles inducing the showers recorded by the detector. In addition, the shape of the shadow permits to determine the detector point spread function, while the position of the deficit at high energies allows the evaluation of its absolute pointing accuracy. I defined and optimized a procedure to analyze both the shift and the shape of the Moon shadow and it was the first time that the shadow of the Moon has been observed with a sensitivity of about 5 standard deviations in such a short time of data taking (12/2004 -07/2005). Moreover I adapted and optimized the above analysis procedure for the full ARGO-YBJ detector and it has been applied to the data taken with the full ARGO-YBJ detector (07/2006-11/2010) and the results have been published in a paper (Physical Review D 84 (2011) 022003). This study is also reported in several conference proceedings.

### **c) Sun Shadow and the interplanetary magnetic field**

During my Ph.D. part of my activity was focused on the analysis of the Sun Shadow with the data collected with ARGO-42 (42 clusters, 1900 m<sup>2</sup> about 1/3 of the central detector). As the Moon, also the Sun blocks cosmic-ray particles from outside the solar system, forming a detectable shadow in the sky map of cosmic rays detected by the ARGO-YBJ experiment in Tibet. I defined and optimized a procedure to estimate the interplanetary magnetic field between the Sun and the Earth studying the deflection of the cosmic-ray particles and analyzing the shift of the Sun shadow.

The procedure developed to analyze the Sun Shadow has also been applied to the data taken with the full ARGO-YBJ detector (07/2006-11/2010) and the results are reported in a paper (Astrophysical Journal 729 (2011) 113).

### **d) Study of the “All particle spectrum”**

I also measured the “all particle spectrum” by studying the RPC strip spectrum in the energy range 10-200 TeV of the ARGO-YBJ detector. ARGO-YBJ is a single layer of RPC covering an area of about ~100 x 100 m<sup>2</sup>, each RPC is read by 80 strips of 6.7 x 62 cm<sup>2</sup>. The cosmic rays energy spectrum has a power law with a spectral index of about -2.7, there are strong evidences for a change of shape around the zone called “the knee” of the spectrum. The strip spectrum is strictly related to the energy spectrum, so by the study of the strip spectrum it is possible to have information both about the position of the knee and the spectral index. It permits also to study the composition of the primary cosmic rays. The results of this study are reported in several conference proceedings.

### **e) Analysis of the data collected by the ARGO-YBJ experiment to study the gamma rays coming from the Galactic Center**

My study consisted in: 1) Identification of events coming from the Galactic Center and the determination of criteria to select them; 2) the development of all-sky maps in equatorial and galactic coordinates; 3) the estimation of the background from cosmic rays and the study of the algorithms to measure it; 4) the estimation of the sensitivity of the apparatus to point and extended sources of high energy photons. The ARGO-YBJ all-sky map was presented at the 2008 Symposium on High-Energy Gamma-Ray Astronomy (Heidelberg – Germany, 2008) and at the conference SciNeGHE07 (Frascati – Italy, 2007). I have presented the first results and analysis performed by the ARGO-YBJ central detector at CRIS2008 in Malfa (Salina Island – Italy, 2008).

#### **f) Grid Computing at ARGO-YBJ**

Part of my activity has been dedicated to the reconstruction of the data at the CNAF with the official procedure of the ARGO-YBJ experiment. I participated to the tests and commissioning of the software to run ARGO-YBJ reconstruction on INFN-GRID.

#### **ATLAS experiment at LHC (form 2009 to today):**

- a) **Triggers and DAQ of the ATLAS experiment:** Level-1 RPC Trigger in the Barrel region of Muon Spectrometer and Muon Event Filter, muon and dimuon trigger efficiencies using  $J/\psi \rightarrow \mu\mu$  and  $Z \rightarrow \mu\mu$  decay channel;
- b) **Standard Model Physics with the  $J/\psi$ , Z and W:** Analysis of the first data of the ATLAS experiment: study of  $J/\psi \rightarrow \mu\mu$  (Fraction of  $J/\psi \rightarrow \mu\mu$  from B-decays, Average B-hadron lifetime from  $J/\psi \rightarrow \mu\mu$ , Differential  $J/\psi$  production cross section);
- c) **Research and discovery of the Higgs boson:** Search for a Standard Model Higgs in the  $H \rightarrow ZZ \rightarrow 4\text{leptons}$  decay channel;
- d) **Standard Model Higgs boson properties:** Measurement of the spin and parity in the  $H \rightarrow ZZ \rightarrow 4\text{leptons}$  decay channel;
- e) **Vector Boson Scattering:** Cross section measurement for Vector Boson Scattering (VBS) diboson production and searches of anomalous Quartic Gauge Coupling (aQGC);
- f) **Beyond Standard Model Physics:** Search of additional resonances at high mass in processes with two jets and two leptons in the final state;
- g) **Beyond Standard Model Physics:** Study of processes with energetic jets and missing energy in the final states.

a) **Triggers and DAQ of the ATLAS experiment:** since August 2009, an important part of my work has been the study and measurement of the efficiencies of the muon trigger, first using the muons coming from the cosmic rays and then the data collected during the data capture of 2010. I collaborated on the development of a code that allows the estimation of efficiencies using the method called "Tag and Probe". Since July 2011 I have focused my studies on the optimization of the performances of the third level muon trigger (Event Filter) and I took part in the development of the software

for the reconstruction and isolation algorithms of muons. These studies were published in a more general article on the triggering of the ATLAS experiment (Eur.Phys.J. C72 (2012) 1849).

I have been one of the main developers of a new method to measure the dimuon trigger efficiencies. Since the key to the detection of many B signals in ATLAS is to achieve high trigger efficiency for low-pT di-muons events, while keeping an acceptable trigger rate I proposed an innovative approach to measure the performance of di-muons trigger. This approach has been developed and applied using collision data at  $\sqrt{s} = 7\text{TeV}$  and it has been presented in several conferences IEEE2011: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6154567>; pic2011: arXiv:1111.4329, EPJ Web of Conferences 28, 12037 (2012)).

From 2011 I'm expert on call for Muon and B-Physics High-Level trigger and from 2016 I'm expert on call for Muon Level-1 trigger.

### **b) Standard Model Physics with the $J/\psi$ , Z and W**

During the fellowship in Napoli and the "Della Riccia" grant, my activity was focused to the study events due to  $J/\psi$ , Z and W with one or two muons in the final state using data from proton-proton collision collected at the end of 2009 ( $\sqrt{s} = 900\text{ GeV}$  and  $\sqrt{s} = 1.2\text{ TeV}$ ) and in 2010 ( $\sqrt{s} = 7\text{ TeV}$ ).

As member of the ATLAS BPhysics group, I was concentrated on the analysis of the  $J/\psi \rightarrow \mu\mu$  process and in particular on the measurement of the prompt and non prompt  $J/\psi$  cross section. These works led to the publication of an article published in Nuclear Physics B (Nucl. Phys. B 850 (2011) 387-444). Moreover, the studies carried out were part of several conference notes: two notes dedicated to  $J/\psi$  observation and to the measurement of its cross section (ATLAS-CONF-2010-045, ATLAS-CONF-2010-062) and two notes dedicated to the observation of the decays of Z and W with one or two leptons in the final state and to the measurement of their cross section (ATLAS-CONF-2010-051, ATLAS-CONF-2010-044). I presented the studies on  $J/\psi$  observation at HCP2010, Toronto (Canada) and at the XCVI National Congress of the Italian Physical Society in Bologna both in 2010.

I also participated in the analysis of the  $J/\psi$  production in Pb-Pb collisions at a center of mass energy of  $\sqrt{s_{NN}} = 2.76\text{ TeV}$ . This study showed a centrality-dependent suppression in the yield of  $J/\psi$  for the first time (Phys.Lett. B697 (2011) 294-312). The measurement of quarkonia production in ultra-relativistic heavy ion collisions provides a potentially powerful tool for studying the properties of hot and dense matter created in these collisions. If deconfined matter is indeed formed, then colour screening is expected to prevent the formation of quarkonium states when the screening length becomes shorter than the quarkonium size.

As member of the ATLAS BPhysics group I participated to the studies on the B and D hadron production and I presented these works at PANIC2011 (2011), Massachusetts Institute of Technology (USA) and at DIS 2013 - XXI International Workshop on Deep-Inelastic Scattering and Related Subject, Marseilles, France (2013).

I also gave a more general talk on the Heavy Flavor Physics with the first data collected by the ATLAS experiment at IFAE 2011, Perugia (Italy).

### **c) Research and discovery of the Higgs boson**

Since July 2011 I have been part of the group that studies the Higgs boson in the ATLAS experiment. In particular, my work has been mainly dedicated to the analysis of Standard Model Higgs boson decaying in two Z with four leptons in the final state ( $H \rightarrow ZZ \rightarrow \text{llll}$ ). I also participated in the search for Standard Model Higgs boson in the channel with 2 leptons and 2 quarks in the final state  $H \rightarrow ZZ \rightarrow \text{qqll}$ .

The data taken from the ATLAS experiment in the 2011 and in the first part of the 2012 lead to the discovery of a new particles with a mass of about 125 GeV consistent with the Standard Model Higgs boson (Phys. Lett. B 716 (2012) 1-29; Science Vol. 338 no. 6114 pp. 1576-1582). I actively participated in the analyzes that led to the discovery, mainly evaluating the different selection and identification criteria of criteria to identify the leptons coming from the  $H \rightarrow ZZ \rightarrow \text{llll}$  decay channel to increase the efficiency of signal detection. Furthermore important part of my work was the development of rejection techniques to estimate the reducible background with one Z and two jets and irreducible background with two Z bosons.

I have also collaborated in the determination of new identification and selective criteria to improve the detection efficiency of muons with low transverse momentum.

These studies are reported in the ATLAS Conference Notes ATLAS ATLAS-CONF-2011-048, ATLAS-CONF-2011-131 and ATLAS-CONF-2011-162 with the data taken in the 2011 and in ATLAS-CONF-2012-092 updated with the data taken in the 2012. The analyses with the 2011 data have been published in two papers, the first one with  $2.1 \text{ fb}^{-1}$  (Phys.Lett. B705 (2011) 435-451) and the second one with all the statistic available in 2011 and 2012 (Phys.Lett. B710 (2012) 383-402). Results with the  $H \rightarrow ZZ \rightarrow \text{llll}$  have been combined with those from the searches in the  $H \rightarrow \gamma\gamma$  and the  $H \rightarrow WW$  decay channels using data collected in 2011 and 2012. The results combining the three bosonic channels have been published on Phys.Lett. B710 (2012) 49-66 and Phys. Rev. D86 (2012) 032003). The combination with the various decay channels also led to several conference notes (ATLAS-CONF-2011-157, ATLAS-CONF-2011-063, ATLAS-CONF-2012-019, ATLAS-CONF-2012-93).

#### **d) Standard Model Higgs boson properties:**

The experimental determination of the properties of the discovered boson at the Large Hadron Collider is currently one of the most crucial task in high energy physics. Starting from Jul 2012 I have been focused on the analysis of the properties of the new particle to verify if it is the Standard Model Higgs boson. Information about the spin, parity, and, more generally, about the tensor structure of the boson couplings can be obtained by studying angular and mass distributions of events in which the resonance decays to pairs of gauge bosons like ZZ, WW e  $\gamma\gamma$ . I have been a member of the team who worked on a multivariate analysis to classify the  $H \rightarrow ZZ \rightarrow 4$  leptons event and I have been one of the main developers of the software to measure the spin and parity of the Higgs boson with the Matrix Element Likelihood Analysis (MELA) formalism. The MELA approach gives the possibility to distinguish between different spin and parity hypotheses and also to study the tensor structure of the HZZ interaction vertex. This method is sensitive to eventual deviation from the Standard Model hypothesis, so it's an important tool for new Physics studies. It has been possible to verify the compatibility of the

data taken by the ATLAS experiment and the expected Standard Model Higgs boson spin-parity ( $J^P=0^+$ ) analyzing with MELA the angular correlations between the decay products of the Higgs boson induced by the spin-parity structure of the Higgs itself. Moreover it has been possible to exclude alternative hypotheses predicted by Beyond Standard Models ( $J^P=0^-$ ,  $J^P=0^+_h$ ,  $J^P=1^+/1^-$ , spin-2 hypotheses) with a Confidence Level (CL) greater than 97.8%. Results of these analyses are reported in a paper (Phys. Lett. B 726 (2013) 120–144) and in some ATLAS Conference Notes (ATLAS-CONF-2012-169, ATLAS-CONF-2013-040).

The MELA approach showed the best significance to discriminate among the different spin-parity hypotheses and it has been selected for the ATLAS legacy paper with the final Run-I (2010-2012) results presenting the combination of bosonic Higgs decay channels for the determination of its spin and parity (EPJC C75 (2015) 476). These updated results can also be found in an ATLAS Conference Note with title “Combination of the Higgs Boson Spin and Parity Analyses of the Higgs Boson in the  $H \rightarrow ZZ \rightarrow llll$ ,  $H \rightarrow WW \rightarrow l\nu l\nu$ , and  $H \rightarrow gg$  final states” (ATLAS-CONF-2015-008). I have been co-editor of the ATLAS Conference Note and I considerably contributed in editing the paper (EPJC C75 (2015) 476) for these analyses.

I have also been involved in the analyses to measure the mass and couplings of the Higgs boson. These studies have been reported in several papers (Phys. Rev. D 91, 012006 (2015), Phys. Rev. D. 90, 052004 (2014), Phys. Lett. B 726 (2013), pp. 88-119) and ATLAS Conference Notes (ATLAS-CONF-2015-007, ATLAS-CONF-2014-009, ATLAS-CONF-2013-034, ATLAS-CONF-2012-170, ATLAS-CONF-2012-169).

I presented the status of the measurement of the Higgs boson properties in the  $H \rightarrow ZZ \rightarrow llll$  decay channel at IFAE 2013 (Cagliari). I also presented the measurement of the Higgs boson spin and parity at the IX ATLAS-Italy Workshop (2014, Bologna). Furthermore, I gave a general talk on all the Standard Model Higgs boson studies with the ATLAS experiment at DIS 2015 (Texas, USA).

#### **e) Vector Boson Scattering:**

From the 2017 I'm also working on searches for electroweak diboson ( $WW/WZ/ZZ$ ) production in association with a high-mass dijet system. The searches are performed in final states in which one boson decays leptonically, and the other boson decays hadronically. The main goals of this analysis are the cross section measurement for Vector Boson Scattering (VBS) diboson production and the searches of anomalous Quartic Gauge Coupling (aQGC) in semileptonic final states ( $VV \rightarrow llqq + jj$ ). A multivariate approach (BoostDecisionTree) is used in order to maximize the separation of this event from the other Standard Model processes. An additional search of anomalous couplings and deviation from the Standard Model is performed. Deviations from the SM are interpreted in terms of Effective Fields Theories (EFT). My contribution to the analysis concerned the optimization selection and the development of a procedure for the identification of jets initiated by quarks and gluons. New quark/gluon tagging techniques are under studying in order to further improve the analysis. A publication is under ATLAS approval with the 2015-2016 data, and a new study is in preparation with the full Run-II dataset.

**f) New Physics Beyond Standard Model: search of additional Higgs-like resonances at high mass in processes with two jets and two leptons in the final state**

From February 2015, I'm working also on the search of electroweak diboson (WW/WZ/ZZ) production in association with a high-mass dijet system in semileptonic final states. The search is performed in final states in which one boson decays leptonically, and the other boson decays hadronically.

Many models, motivated by the problem of naturalness and hierarchy (hierarchy and naturalness problems), provide for the existence of new heavy resonances that fall into two vector bosons. These are among the possible and most promising experimental signatures of physics beyond the Standard Model connected with the field of spontaneous breaking of the electroweak symmetry. I actively contributed to the study of the decay channel with two leptons in the final state, I have been and I'm currently one of the main authors of this analysis. I participated to the writing of the note for conference ATLAS-CONF-2016-016 published for Moriond 2016.

I also worked to the definition of a procedure to identify different production mechanisms of dibosonic resonances and in particular to the vector-boson fusion (VBF) and its discrimination with the gluon-gluon fusion (ggF). This study led to a paper (JHEP 03 (2018) 009). I was co-editor of the internal note and I considerably contributed in editing the paper. This article is the first for ATLAS that studies the different production mechanisms for these decay channels. Data showed no evidence of new heavy resonances and upper limits were calculated for the ZZ and ZW production cross sections in the 300-5000GeV mass range in the extension context of the Standard Model with additional Higgs bosons (2HDM), heavy vector triplet and warped extra dimensions.

Now I am currently working on the optimization the analysis and on the preparation of the paper with the full Run-II statistics. My work is mainly devoted to the study and application of Machine Learning techniques and new approaches to these analysis. Both for the article in preparation and for the note with all the statistics of the Run-II I'm co-editors as well as one of the main authors.

**g) Search for new Physics Beyond Standard Model: processes with energetic jets and missing energy in the final states.**

From 2015 I'm also contributing in the study of processes with two b-jets and high missing energy in the final state inside the ATLAS Exotics group. These channels have a great relevance for the ATLAS Run-II phase (2015-2018) as possible signatures of new Physics beyond Standard Model related to the electroweak spontaneous symmetry breaking (Dark Matter (DM), SUSY and Large Extra Dimensions (LED)).

Starting from 2015 I'm a member of the analysis team that is working on the search for DM pair production in association with bottom quarks. This search is focused on simplified models of DM production involving spin-0 mediators between Standard Model and Dark sectors.

Moreover from March 2016 I'm also member of the analysis team working on the study of the process with jets and large transverse missing energy ( $E_T^{\text{miss}}$ ). Such signatures (mono-jet) have been studied at LHC in the search for LED,

SUSY and DM. I have been involved in the optimization of the top background estimation. I have been one of the main contributors of the note for conference for the ICHEP 2016 Conference in August with the title "Search for Dark Matter production associated with bottom quarks with  $13 \text{ fb}^{-1}$  of pp collision at  $\sqrt{s} = 13 \text{ TeV}$  with the ATLAS detector at the LHC" (ATLAS-CONF-2016-86). My work have been mainly devote to the development of a software for statistical analysis and interpretation of data. These researches on new Physics beyond the Standard Model in processes with energy jets and missing energy in the final state led to the publication of two articles one on the research of dark matter produced in association with a quark bot (European Physical Journal C, 78 (1), Article No. 18) and one on the search for dark matter in events with very energetic jets and missing energy (Journal of High Energy Physics, 2018 (1), Article No. 126). A paper on the mono-jet analysis is in preparation with the full Run-II statistics.

**From 2018 to today: my scientific research activity has also been focused on the development and design of teaching methodologies within the Masterclasses project (<https://physicsmasterclasses.org/>) for elementary particles**

From 2018 part of my activity of research was dedicated to the development of teaching methods for the dissemination of knowledge in the Masterclasses project (<https://physicsmasterclasses.org/> and <http://www.na.infn.it/it/masterclass>) for the particles elementary. The Masterclasses project annually allows high school students from 42 countries to visit one research institutes and universities to discover the mysteries of Elementary Particle Physics. Seminars and introductory lectures enable students to analyze the data collected at CERN in Geneva in the laboratories of the research centers and to compare their results live with those obtained from students in other countries. Since 2014, I have personally prepared and held one of the annual seminars for Masterclasses organized by the INFN and the Department of Physics of the University of Naples "Federico II" entitled "Elementary particles and fundamental interactions". My work for this project was also focused on updating data and materials for educational seminars, taking more into account the requests of schools and improving relationship with the teachers and schools themselves. In addition, I have been involved in the promotion of this project in schools through dedicated seminars and two new schools (the Liceo De Caprariis of Atripalda and the ITT "Marie Curie" - Naples (Via Argine 902)) are participating to Masterclasses project for 2019.

**Teaching experience: Lectures and Courses**

**2018-to today:** Professor of the class "Fisica Generale II" and "Fisica Generale" ("General Physics II" and ("General Physics II") for the Department of Engineering at the University "Federico II" of Napoli (Italy).

**2013-2018:** Professor of the class "Fisica Generale I" ("General Physics I") for the Degree Courses of Civil Engineering, Industrial Engineering, Computer, Biomedical and Telecommunication Engineering at the Department of Engineering at the University "Parthenope" of Napoli (Italy).

**2014-2018:** Professor of the traineeship course “Introduction to Mathematica technical computing language and interactive environment” (Corso di tirocinio “Introduzione al linguaggio e all’ambiente interattivo Mathematica”) for the Degree Courses of Civil Engineering, Industrial Engineering, Computer, Biomedical and Telecommunication Engineering at the Department of Engineering at the University “Parthenope” of Napoli (Italy).

**2013-2018:** Professor of the “Percorso di Fisica”, pre-sessional course of Physics for the Degree Courses of Civil Engineering, Industrial Engineering, Computer, Biomedical and Telecommunication Engineering at the Department of Engineering at the University “Parthenope” of Napoli (Italy).

**From the 2014:** Teacher Assistant to Masterclasses in Elementary Particle Physics for high school students at the University of Naples Federico II.

**From the 2012:** Honorary fellowship (“Cultore della materia”), teaching assistant and exam committee member at the “Fisica Generale I” and “Fisica Generale II” (“General Physics I” and “General Physics II”) courses for the Department of Engineering at the University “Parthenope” of Napoli (Italy).

**2007-2009:** Teaching assistant for the class of “Fisica Generale I” (“General Physics I”) at the Department of Chemical Engineering at the University “Federico II” of Napoli (Italy). Professor of the course: B. Bartoli.

**2006-2009:** Teaching assistant for the class of “Fisica Generale II” (“General Physics II”) at the Department of Chemical Engineering at the University “Federico II” of Napoli (Italy). Professor of the course: B. Bartoli.

**2004-2006:** Teaching assistant for the class of “Laboratorio di Fisica II” (“Physics Laboratory II”) at the Department of Physics at the University “Federico II” of Napoli (Italy). Professors of the course: L. Merola, B. D’Ettorre, P. Maddalena.

### **Teaching experience: Student Supervision**

As part of the ATLAS group of Naples, I personally followed the group's analysis activities and I actively contributed to the coordination and supervision of doctoral and graduate students.

During my work at the Engineering Department of the University “Parthenope” of Napoli, I have been the supervisor of several graduate students.

### **PhD Thesis in Physics at University “Federico II” of Napoli**

Currently I am a supervisor of 2 theses for the Ph.D. in Physics of the Federico II University of Naples on physics research beyond the Standard Model in the ATLAS experiment at LHC:

- Antonio Giannini “Searches of new physics in diboson semi-leptonic final states ( $VV \rightarrow l\bar{l}q\bar{q}$ ) with VBS/VBF signatures in pp collision at  $s = 13$  TeV with the ATLAS detector” (PhD defence May-April 2020).
- Marco Lavorgna “Searches for new high mass resonances in the diboson channel with semileptonic  $l\bar{l}q\bar{q}$  final state in pp collisions at  $\sqrt{s} = 13$  TeV with the ATLAS detector” (PhD defence May-April 2020).

### **Master's Degree Thesis in Physics at University “Federico II” of Napoli**

**2013:** Supervisor of Nello Bruscinò “Spin-CP properties of the new Higgs-like particle in  $H \rightarrow ZZ(*) \rightarrow 4l$  decay channel with the ATLAS detector at LHC” University “Federico II” of Napoli; Supervisors: prof. G. Chiefari, Ph.D. E. Rossi.

**2016:** Supervisor of Antonio Giannini “High mass resonance searches in the  $llqq$  channel at LHC” (“Ricerca a LHC di risonanze ad alta massa nel canale  $llqq$ ”)

**2016:** Supervisor of Claudio Calaminta “High mass resonance searches in processes with two Z boson in the ATLAS experiment” (“Ricerca di risonanze ad alta massa in processi con due bosoni Z nell’esperimento ATLAS”).

### **Bachelor's Degree Thesis in Physics at University “Federico II” of Napoli**

**2014** Supervisor of Claudio Calamita “Study of Higgs production mechanisms in the ATLAS experiment of LHC” (“Studio dei processi di produzione del bosone di Higgs nell’esperimento ATLAS di LHC”).

### **Master's Degree Thesis in Engineering Department of the University “Parthenope” of Napoli**

**2016:** Supervisor of Stefania Schettino “Analysis of systems for the management of content repositories and workflow systems, a case study: CERN EDMS” (“Analisi di sistemi per la gestione di content repositories e di sistemi workflow un caso studio: il CERN EDMS”).

### **Bachelor's Degree Thesis in Engineering Department of the University “Parthenope” of Napoli**

**2012-2018:** During my activity for the Engineering Department of the University “Parthenope” of Napoli, I’ve been the Supervisor of several Bachelor's Degree Theses. The subjects were Engineering application of the Machine Learning, Neural Network, Queuing Theory, Econophysics and Game Theory approaches:

#### **Machine Learning and Neural Network:**

- Valiante Valerio “Applicazione delle reti SOM per l’ottimizzazione delle risorse idriche” (“Application of the SOM neural network in water resources”)
- Frassine Giuseppe “Applicazione di una rete SOM per la valutazione dei rischi sismici” (“Application of the SOM neural network in assessment of seismic risk”)
- Franzese Marianna “Analisi di immagini da risonanza magnetica mediante reti neurali SOM” (“Magnetic resonance image analysis with SOM neural network”)
- Giuseppe Ruggiero “Applicazione di Reti SOM per il monitoraggio delle strutture” (“SOM Neural Network for Health Structure Monitoring”)
- Michele Di Vico “Applicazione delle reti SOM nella gestione del mercato elettrico” (“Application of the SOM neural network in the electricity market”)
- Domenico Cortese “Applicazioni di reti neurali per la gestione del rischio sismico” (“Application of the SOM neural network in seismic risk”)
- Mauro Tizziani “Applicazione di una rete SOM nella previsione dei fenomeni di piena fluviale” (“Application of the SOM neural network in flood”)

- Gennaro Iorio "Monitoraggio e studio delle Anomalie dei motori aerei mediante Reti Neurali SOM" ("Fault Prediction in Aircraft Engines Using Self-Organizing Maps")
- Fabio Cortese "Riconoscimento delle caratteristiche di un segnale con l'utilizzo di reti neurali" ("Study of the characteristics of a signal using neural networks")
- Serafina D'Apolito "Applicazione delle reti neurali SOM nella classificazione degli oli extravergini di oliva" ("Application of SOM neural networks in the classification of extra virgin olive oils")
- Marco Napolitano "Applicazioni di Reti Neurali per la tutela di Risorse Naturali" ("Applications of Neural Networks for the Protection of Natural Resources")
- Rosa Cirillo "Analisi dei percorsi di carriera con tecniche multivariate" ("Analysis of career with multivariate techniques")
- Luigi Positano "Applicazione di una rete neurale multistrato per lo studio della siccità" ("Application of a multi-layered neural network for the study of drought")
- Alessandro Castaldo "Ottimizzazione di reti neurali con metodi non supervisionati" ("Optimization of neural networks with unsupervised methods")
- Alessandro Sellini "Reti SOM per la segmentazione del mercato assicurativo delle auto" ("SOM networks for the segmentation of the car insurance market")
- Francesco Martone "Applicazione di reti neurali SOM per il rilevamento dei contorni nelle immagini" ("Application of SOM neural networks for detecting contours in images")
- Pietro Donati "Applicazione delle reti neurali artificiali per la previsione della domanda nel mercato elettrico" ("Application of artificial neural networks for forecasting demand in the electricity market")
- Ranieri Stefania "Analisi di immagini mediche mediante reti neurali SOM" ("Analysis of medical images using SOM neural networks")
- Gianluca Verrengia Caporossi "Applicazione di una rete neurale SOM per la segmentazione del mercato delle vendite online" ("Application of a neural network SOM for the segmentation of the online sales market")
- Francesco Colucci "Applicazione delle reti neurali SOM alle strategie di investimento azionario" ("Application of SOM neural networks to stock investment strategies")
- Ilaria Maietta "Applicazione di reti neurali SOM per il controllo di Qualità nei processi produttivi" ("Application of SOM neural networks for quality control in production processes")
- Andrea Caruso "Studio delle correnti marine con reti neurali SOM" ("Study of marine currents with SOM neural networks")

#### **Queuing Theory:**

- Serena Murolo "La teoria delle code e la Grid Computing" ("Queuing Theory and Grid Computing")
- Giovanni Di Somma "Applicazione della teoria delle code per il dimensionamento dei buffer" ("Application of the Queuing Theory in the dimensioning of a buffer")

- Fiorita Esposito Sommese “Applicazione della teoria delle code alla gestione delle prenotazioni ospedaliere” (“Application of the Queuing Theory in the Healthcare Operations”)
- Lucia Amore “La teoria delle code nell’analisi delle performance di un sistema” (“Queuing Theory in the analysis of the performance of a system”)
- Viviana Romano “Applicazione della teoria delle code alla gestione dei call center” (“Application of the queuing theory to call center management”)
- Scarano Rosario “Applicazione della teoria delle code per l’ottimizzazione dell’utilizzo delle risorse in ambito edilizio” (“Application of the queuing theory for the optimization of the use of resources in the construction sector”)
- Luna Costantino “Applicazione della teoria delle code ai sistemi produttivi manifatturieri” (“Application of the theory of queues to manufacturing production systems”)
- Mariarosaria Troise “Applicazione della Teoria delle Code per la gestione della sicurezza aeroportuale” (“Application of the Code Theory for the management of airport security”)
- Pio Menale “Applicazione della Teoria delle code per l’ottimizzazione delle risorse in ambito edilizio” (“Application of the queue theory for the optimization of resources in the construction sector”)
- Claudio Spera “Applicazione della Teoria delle Code per la gestione di magazzini e scorte flessibili” (“Application of Code Theory for the management of warehouses and flexible stocks”)

#### **Game Theory:**

- Polliere Elvira “Applicazioni della teoria dei giochi per l’Ingegneria Gestionale” (“Game Theory with Management Engineering Applications”)
- Gennaro Castaldo “Applicazione della teoria dei giochi alle reti logistiche” (“Application of game theory to logistics networks”)
- Aniello Di Sarno “Applicazione della Teoria dei Giochi per l’ottimizzazione della distribuzione di energia” (“Application of Games Theory for the optimization of energy distribution”)
- Paolo De Siena “Applicazione della Teoria dei Giochi per la produzione di energia” (“Application of the Theory of Games for the production of energy”)
- Alfredo Falcione “Applicazione della Teoria dei Giochi alle strategie d’impresa” (“Application of Game Theory to Business Strategies”)
- Giordano Guarino “Applicazione della Teoria dei Giochi alle strategie d’impresa” (“Application of Game Theory to Business Strategies”)

#### **Econophysics:**

- Domenico De Filippo "La legge di omori applicata ai crashes nei mercati finanziari" (“Omori Low in the financial market crashes”)
- Teresa Federica Genna "La legge di omori come modelli per i mercati finanziari" (Omori Low as a model for the financial market”)
- Carmela Erbaggio "Approccio Econofisico alla formazione di bolle speculative e crash finanziari" (“Econophysics approach in the speculative bubble and financial crashes”)

### **Other subjects:**

- Luciana Gambardella “Studio dello spettro elettromagnetico e dell'esposizione alle radiazioni ottiche artificiali” (“Study of the Electromagnetic Spectrum and of the exposure to artificial optical radiations”)
- Regina Stornaiuolo “Modelli e simulazioni in Fisica del traffico” (“Physics Models and Simulations of the traffic”)
- Daniele Sabino Govetosa “Realizzazione di mappe di pericolosità sismica” (“Creation of seismic hazard maps”)
- Andrea Buono “Fonometria e perizie fonometriche” (“Fonometry and phonometric surveys”).

### **Experience as convener**

- I have been part of the Organizing Committee for XII Workshop ATLAS Italia in Napoli (23-25 November 2016) (<https://agenda.infn.it/conferenceDisplay.py?confId=11167>).
- I have been part of the Organizing Committee for TOP2015 (<http://top2015.infn.it>) the 8th International Workshop on Top Quark Physics, Ischia (Italy) 14-18 September 2015.
- I have been convener of the Higgs session “Higgs: status from run 1 and challenges for run 2” at X Workshop ATLAS Italia 10-12 February 2015 in Milano, organized by the Physics Department of the Università degli Studi di Milano and INFN - Milano (<https://agenda.infn.it/conferenceDisplay.py?confId=8700>).
- I have been convener of the Session “F1 - Frontiere dell'energia” (“Frontiers of Energy”) at IFAE 2014, L'Aquila (Italy) (<https://agenda.infn.it/conferenceDisplay.py?confId=7405>).

### **Presentations and Posters to Conferences**

- 2018: “New techniques in SUSY-inspired searches” – Dark Matter @ LHC 2018 Heidelberg (Germania).
- 2015: “Latest Higgs results from ATLAS” - DIS 2015 - XXIII International Workshop on Deep-Inelastic Scattering and Related Subject, Dallas USA (2015).
- 2015: “Studio di spin e parità del bosone di Higgs in decadimenti bosonici con l'esperimento ATLAS.” (“Study of the Spin and Parity of the Higgs boson in bosonic decays with ATLAS experiment”)- 101° Congresso Nazionale della Società Italiana di Fisica - Roma (2015).
- 2013: “Production cross section of B-meson in ATLAS” - DIS 2013 - XXI International Workshop on Deep-Inelastic Scattering and Related Subject, Marseilles, France (2013).
- 2013: “Measurements of the properties of the Higgs-like boson in the four lepton decay channel with the ATLAS detector using 25 fb<sup>-1</sup> of proton-proton collision data “ - IFAE 2013 - Incontro di Fisica delle Alte Energie, Cagliari (2013).

- 2011: “B and D Hadron Production and Prospects” – PANIC2011 - Massachusetts Institute of Technology (MIT), Cambridge, MA, USA (2011).
- 2011: “Heavy flavor in ATLAS” - IFAE 2011 - Incontro di Fisica delle Alte Energie, Perugia (2011).
- 2010: “Prima osservazione sperimentale della risonanza  $J/\psi \rightarrow \mu+\mu$ - nell’esperimento ATLAS ad LHC” - XCVI Congresso Nazionale della Società Italiana di Fisica - Bologna (2010).
- 2010: Poster on “Observation and study of the  $J/\psi \rightarrow \mu+\mu$ - in the ATLAS experiment at LHC” - HCP2010 - Toronto, Canada (2010).
- 2008: “Result overview from the ARGO-YBJ experiment” - CRIS 2008 - Malfa, Salina Island, Eolian Islands, Italia (2008).
- 2003: Poster on “Identification of cores outside the ARGO-YBJ detector” - Incontro Nazionale di Astrofisica delle Alte energie, Roma (2003).
- 2003: Poster on “Study of the angular resolution of the ARGO-YBJ detector” - Incontro Nazionale di Astrofisica delle Alte energie, Roma (2003).

#### **ATLAS Italian Workshops**

- 2017: “Other BSM Higgs searches” - XIII Workshop ATLAS-Italia, Pavia - Dipartimento di Fisica e INFN (2017).
- 2016: “Higgs Searches BSM” – XII ATLAS Italia Workshop Napoli - Dipartimento di Fisica e INFN (2016).
- 2015: “Higgs Properties” – XI ATLAS Italia Workshop on Run2 First Results” Cosenza - Dipartimento di Fisica e INFN (2015).
- 2014: “Determinazione di Spin e parità del bosone di Higgs” (“Measurement of the Higgs boson Spin and Parity”) - IX Workshop ATLAS-Italia “Physics and upgrade for HL-LHC program”, Bologna - Dipartimento di Fisica e Astronomia (2014).

#### **Outreach and Seminars**

- 2014 – 2019: Annual seminar for Masterclass organized by INFN and the Physics Department of University Federico II of Napoli. Title of the seminar “Particelle elementari ed interazioni fondamentali” (“Elementary Particles and Fundamental Interaction”).
- 2015-2018: I have been part of the Organizing Committee for Futuro Remoto as member of the INFN and of Universities of Napoli Federico II and Parthenope (“<http://www.cittadellascienza.it/futuroremoto/>”).
- 2019: Seminar “Order and Disorder: from Art to Physics” for the Art & Science project for secondary schools (<https://web.infn.it/artandscience/index.php/en/>).
- 2018: Seminar on “A journey to discover the infinite - From Bohr's atom to particle physics” (“Viaggio alla scoperta dell’infinitamente - Dall’atomo di Bohr alla fisica delle particelle”) at the secondary school Liceo De Caprariis di Atripalda.

- 2017: Seminar on “Life at CERN and Particle Physics” after the movie “The sense of beauty” (“Il senso della bellezza”) by Valerio Jalongo at Delle Palme cinema in Napoli.
- 2017: I participated and helped in the project “Beamline for Schools” (BL4S) at CERN (<http://beamline-for-schools.web.cern.ch/>-<https://twiki.cern.ch/twiki/bin/view/BL4S/BL4SDataAnalysis>).
- 2015: Seminar “The frontiers of Physics after the discovery of the Higgs boson” (“Le frontiere della Fisica dopo la scoperta del bosone di Higgs”) for Futuro Remoto (<http://www.cittadellascienza.it/futuroremoto/>).
- 2015: Seminar on the Higgs boson for “Meet LHC” organized by INFN, “Festival dell'astronomia e dell'esplorazione”, Campobasso
- 2013: Seminar on the Higgs boson for “Germogli sulle Macerie” Città della Scienza, Napoli (Italy).
- 2013: Seminar on the Higgs boson for “Cerco...la Nobel” organized by Associazione Culturale “Poiesis”, Cercola (Italy).

### **HEP Schools**

- 2003 - 31st SLAC Summer Institute: Cosmic Connection - SLAC Institute Stanford, California (USA).
- 2004 - International school on AstroParticle - Laboratori del Gran Sasso, Assergi (Italia).
- 2007 - XVII GIORNATE DI STUDIO sui RIVELATORI - Torino (Italia).
- 2008 - Il Scuola per utenti INFN della Grid - Bologna (Italia).
- 2009 - ATLAS regular computing tutorial - CERN - Ginevra (Svizzera).
- 2010 - “The Physics of LHC” - Martignano (Italia).

### **Computer Skills**

- Very good Knowledge of the operating systems Unix/Linux, Windows, Apple MC OS X.
- Very good Knowledge of support programs: Office, OpenOffice, iWork.
- Very good knowledge of several programming languages (C, C++, Fortran) and scripting (Perl, shell, python).
- Good knowledge of several tools used in Machine Learning (NumPy, Keras, Panda, Tensor-Theano, scikit-learn).
- Very good knowledge of several tools used for HEP analyses: ROOT, RooFit and RooStats, TMVA for multivariate analyses. Very good knowledge of the ATLAS experiment framework Athena and of the GRID frontends (Ganga, Panda, Athena).
- Good knowledge of Mathematica.

### **Languages**

Mother Language: Italian; Very good command of spoken and written English; Basic knowledge of spoken and written French.

### **Summary of Scientific Achievements**

813 papers, h-index 78 (Scopus database)

803 papers, h-index 78 (WoS database).

17/12/2020

Firma

*zhine kom*