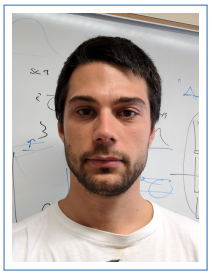

Luca Pernié

Curriculum Vitae

Career and Education

2015-present **Postdoctoral fellow**, *Texas A&M University (Texas)*.
I currently coordinate physics analysis involving exotic decays of the Higgs Boson. I am the contact person of the search for Beyond the Standard Model light bosons decaying into muon pairs, and the coordinator of the search for the resonant di-Higgs production into the $H \to hh \to WWbb \to l\nu l\nu bb$ final state.
I serve as a L2 convener in the Physics Performance Detector group (in the Alignment, Calibration and Databases area), and I am the responsible for the track-based alignment of the CMS muon system, which I represent at the Muon Detector Performance Group Office.
Principal Investigator: Alexei Safonov: professor at Texas A&M University

2011-2015 **Ph.D.**, *Université Libre de Bruxelles (Belgium) - Sapienza Università di Roma (Italy)*.
Thesis title: Measurement of the Z boson pair-production cross section in proton-proton collisions at 7 and 8 TeV, and ECAL timing studies for the phase-2 upgrade of the CMS experiment.
Supervisor: Pascal Vanlaer: Chargé de cours at the Université Libre de Bruxelles.
Supervisor: Daniele Del Re: Assistant Professor at Sapienza Università di Roma.

2006-2011 **Bachelor-Master's Degree**, *Sapienza Università di Roma (Italy)*, *Grade: 110/110*.
Thesis title: Search for a Standard Model Higgs boson in the $H \to WW \to l\nu jj$ decay channel at the CMS experiment.
Supervisor: Daniele Del Re: Assistant Professor at Sapienza Università di Roma.

Scientific activity

2015-Present Post-doctoral Fellow
During my post-doctoral fellow at Texas A&M University I have been active in several areas of research. First of all, I am the contact person for the physics analysis: "A search for beyond the Standard Model light bosons decaying into muon pairs at CMS", where I led a group of graduates students and postdocs in a study that resulted in a public analysis (HIG-16-035), and that is currently targeting a paper where the whole 2016 dataset is analyzed.

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Also, I coordinated a collaboration with theorists from the University of Massachusetts at Amherst to search for heavy Higgs bosons decaying to pairs of light Higgs bosons in the H→hh→WWbb channel, using a novel technique (Heavy Mass Estimator) that allows full mass reconstruction of the mass of the heavy Higgs boson. Models embarking on explaining the baryon asymmetry via electroweak baryogenesis predict enhanced cross section for the heavier Higgs production compared to most two-doublet models, which can make this production accessible with Run-2 data. The use of a machine learning technique has been used in order to differentiate the signal from the Standard Model backgrounds. These studies result in the publication of the phenomenology paper: "Resonant Di-Higgs Production in the bbWW Channel: Probing the Electroweak Phase Transition at the LHC" (Phys. Rev. D 96, 035007 2017), where it has been proved the large improvement in terms of sensitivity obtained by using the Heavy Mass Estimator is a final state with two neutrinos. I am currently coordinating the efforts to perform this search on the data collected in 2017. The analysis in 2017 involves a parametric training that allow to use a deep neural network to separate Drell-Yann and top-pairs production from the signal, training all signal hypothesis at the same time.

Since my first year at Texas A&M University I have been the responsible for the track-based alignment of the CMS Muon system. The muon detector alignment is one of the signature contributions by Texas A&M group to support the CMS Muon detector operations, which has a large impact on all of CMS for sensitivity to physics with high p_T muons. Leading a team of two postdoctoral-fellows and three Ph.D. students, we have not only maintained the alignment framework updated with respect to the continuously evolving CMS software, but at the same time we brought the alignment framework to another level of precision and stability, and the chamber position resolution has improved to ∼150-250 microns depending on its geometrical position. The alignment algorithm has been improved by optimizing the selection of the muons used in the algorithm, in particular by the removal of the muons close to the chamber edges, that have been proven to introduce a bias in the estimated chamber position along the direction pointing away from the CMS interaction point. Furthermore, the alignment algorithm for the Drift Tubes (DT's) has been modified in order to estimate the chamber position in all the six coordinates that define them (and not only three as done previously). This new approach is more robust against the eventual biases on the initial muon system geometry assumed before the alignment. Another important improvement of the alignment workflow consisted in the positioning of the Cathode Strip Chambers (CSC) considering CSC disks as a rigid body. After the Long Shutdown (LS) often the CSC disks are extracted and re-inserted, introducing a disk misalignment. With just few tracks it is possible to bring back the disks into the correct position, and later perform the chamber-by-chamber alignment, with the advantage to reduce the so called 'weak modes' associated with the geometry of the system. Finally the systematic errors associated to the muon geometry have improved by looking at the likelihood of the chamber alignment minimization. Since 2016 I have been the muon system alignment representative in the Muon Detector Performance Group Office (DPGO), whose purpose is to coordinate and improve the communication about among the muon system, and to define new policies that simplify the detector maintenance and upgrade.

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In September 2017 I have been asked to serve as Alignment, Calibration and Database convener (Alca/DB). This role is a L2 management position under the Physics Performance Dataset (PPD) group. This position involve the responsibility to coordinate all the activities related to production and consumption of detector conditions, assuring CMS to have a complete and coherent set of condition for the processing of the fundamental workflows of the experiment. In order to do this we coordinate with all CMS trigger and detector representative, and we have a number of L3 conveners that assist us in every specific task.

Ph.D. My Ph.D. work consists in studying high energy proton-proton collision at the LHC ("Large Hadron Collider") with the CMS ("Compact Muon Solenoid") detector. My thesis focuses on the measurement of the pair-production of electroweak neutral bosons (ZZ) in the leptonic decay channel: $ZZ \to llll\nu\nu$, where l stands for an electron or a muon [Eur. Phys. J. C 75 (2015) 511]. This process is characterized by a small production cross section, that is being now accessible at the LHC and allows to test the Standard Model of particle physics at the high energy frontier. In addition, this study is sensitive to new physics beyond the Standard Model thanks to searches for possible triple gauge anomalous couplings ($ZZ\gamma$ or ZZZ). I contributed to the analysis from the very beginning, focusing on several aspects. First of all the data-driven estimation of backgrounds; this part has been very important due to the large Drell Yan cross section, that has been estimated using a process that has similar jet multiplicity, underlying event, and pileup conditions: the production of prompt isolated photons in association with jets. Furthermore I took care of the selection optimization and the studies on the reduced-E_T^{miss}, a variable created to reduce the instrumental contribution to mismeasured E_T^{miss} by considering possible contributions to fake E_T^{miss}. I also worked on the systematic uncertainties computation, in particular the ones related to the data-driven background estimation, and related to the renormalization and factorization scales, and their impact on the limits computation.

In order to acquire a deep understanding of data taking conditions, the Ph.D. work includes a contribution to the calibration of the CMS electromagnetic calorimeter (ECAL) using neutral pions produced in the proton-proton collisions. More precisely, the target is to improve the present 3% energy resolution in the ECAL endcap to the design value of about 1%. To disentangle the inter-calibration constants (ICs) from the leakage in energy due to the cluster containment and the geometrical position, I derived a set of containment corrections based on a multivariate analysis: given the photon kinematic and the shape of the cluster associated, it provides an energy correction, to be applied on top of the ICs. I also developed an algorithm to derive the cluster position using the preshower detector, improving the position resolution on the photon and thus the invariant mass resolution [CMS AN-13-344]. The framework I developed has been used during the next Run of data-taking.

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A final topic developed during my Ph.D. is the use of a precise timing information in the CMS reconstruction algorithms [CMS DN-2014/06, CMS AN-2014/088]. The high-luminosity period of LHC (HL-LHC) will exploit at maximum the LHC potential. One of the main challenges of this phase is the pileup (PU) of the signal caused by the high number of concurrent interactions per bunch crossing, that will increase from the averaged number of 21 (for 2012 data) to 140 (expected at HL-LHC). The increasing of the PU will be an issue for the trigger and the reconstruction, degrading jet and missing energy resolutions and all the isolation quantities. The impact of a precise hit time measurement on the reconstruction performance has been studied deeply, focusing in particular on occupancy cleaning, vertex reconstruction with time, pileup jets subtraction and jet cleaning. The required time resolution for these applications is of few tens of picoseconds. Few detectors can deliver such performance, among which are micro-channel plates MPT. I complemented these studies participating to the Test Beam done at CERN in October 2014 by the Milano and Rome INFN group, in order to test the micro-channel plates with high energy electron beam. These studies result in a paper (doi:10.1016/j.nima.2015.06.057).

Master's Degree

My master's thesis consisted in the search of the Standard Model Higgs boson in the decay channel $H \to WW \to l\nu jj$ at the CMS experiment. During my first analysis I took care of the selection optimization, the kinematic fit to the two jets to improve the W boson mass resolution, and I derived the limits on the Higgs cross section. I wrote the CMS internal note CMS AN 2012/004 and the analysis has been published into a public note [CMS PAS HIG-12-003] that excluded at 95% confidence level the SM Higgs boson production in the mass range 327-415 GeV.

Review Committee

LG16499 Physical Review Letters for: Search for dark matter produced in association with a Higgs boson decaying to bb using 36 fb^{-1} of pp collisions at $\sqrt(s) = 13$ TeV with the ATLAS detector

SUS-16-041 Analysis Review Committee for: Search for SUSY with multileptons in 13 TeV data

Public Talks and invited Seminars

06/2017 Talk; Madrid, Istituto de Fisica Teorica. Title: Searches for extended Higgs sectors with the CMS experiment.

05/2017 Invited talk; Costing Review: motivation for the construction of each element of the alignment system for GE2/1 and ME0 detectors. Title: A summary of the current techniques/methods used in CMS for Muon Alignment.

05/2017 Plenary talk; Texas A&M University. Mitchell Workshop on Collider and Dark Matter Physics. Title: Hidden sectors at colliders.

02/2017 Plenary talk; Santa Fe Jets and Heavy Flavor 2017, Los Alamos National Laboratory. Title: CMS measurements of the Higgs, Higgs properties, and BSM searches.

02/2017 Invited seminar (Plenary); Heavy Energy Physics Experiment and Cosmology Seminars, Texas A&M University. Title: Resonant Di-Higgs Production: Probing the Electroweak Phase Transition at the LHC.

01/2017 Plenary talk, CMS Run and Detector performance Group Workshop; Turin, Italy. Title: Status and plans for the CMS Track-based muon alignment.

25/2016 Invited seminar (Plenary); University of Massachusetts Amherst, Title: Resonant Di-Higgs Production in the bbWW Channel: Probing the Electroweak Phase Transition at the LHC.

21/2016 Plenary flash talk; Texas A&M University, TAMU Postdoctoral Research Simposium, Title: Extending The Higgs sector.

05/2016 Invited seminar (Plenary); Texas A&M University, Mitchell Workshop on Collider and Dark Matter Physics, Title: Search for Beyond Standard Model Higgs with the CMS experiment.

05/2016 Talk; Pittsburgh, Pheno2016: Phenomenology 2016 Symposium, Title: Extended Higgs searches at the CMS experiment.

04/2015 Invited seminar (Plenary); Texas A&M University, Title: Measurement of the Z boson pair-production cross section in proton-proton collisions at 7 and 8 TeV, and ECAL timing studies for the phase-2 upgrade of the CMS experiment.

03/2015 Poster; LHCC Conference, CERN, Title: Simulation studies on precise timing information during High Luminosity LHC [CMS CR-2015/101].

06/2014 Poster: Large Hadron Collider Physics (LHCP) Conference; ZZ cross-section measurement and limits on anomalous neutral triple gauge couplings at the CMS detector. Proceeding CMS CR-2014/181 published in eConf (arXiv:1409.1740).

09/2013 Talk: 14th ICATPP Conference on Astroparticle, Particle, Space Physics and Detectors for Physics Applications; Evolution of the response of the CMS ECAL, and upgrade design options for electromagnetic calorimetry at the HL-LHC. Proceeding CMS CR-2013/284 published in World Scientific (doi:10.1142/9789814603164 0061).

08/2013 Plenary talk: 16th Lomonosov Conference on Elementary Particle Physics, Moscow State University; ZZ cross section measurements and limits on anomalous coupling constants for neutral triple gauge boson. Proceeding CMS CR-2013/453 published on World Scientific Publ. Co., Singapore.

05/2013 Plenary talk: Belgian physics Society (BPS); Title: ZZ cross section measurement at CMS experiment and aTGC limits [CMS PAS SMP-12-016].

05/2013 Plenary talk: Annual meeting of particles AND astrophysics (PANDA); Title: ZZ cross section measurement at CMS experiment and aTGC limits [CMS PAS SMP-12-016].

09/2013 Poster; LHCC, CERN, Title: ZZ cross-section measurement and limits on anomalous neutral triple gauge couplings [CMS PAS SMP-12-016].

Languages

Italian	Mother tongue
English	Advanced
Spanish	Advanced
French	Basic

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Computer

OS	Linux, Mac Os X, Windows
Computing	Bash, C, C++, Python, ROOT
Deep Learning	Keras, TensorFlow, Theano, TMVA
Code Maintenance	SVN, Git

Awards

09/2016	Distinguished Postdoctoral Flash talk
01/2014-15	One year grant as CERN-INFN associate (fellow position at CERN)
01/2013	Best group presentation at CMSSDAS, Hamburg, Germany

Responsibilities

11/2017	Organizer of the workshop: Machine Learning in Science
09/2017	Data Manager for the CERN Tier2
09/2017	Manager of the CMS Physics Performance Detector group in Alca/DB (Alignment Calibration and Database)
04/2017	Organizer of the Large hadron Collider Virtual Tour for the physics and engineering Festival at Texas A&M University
09-12/2016-17	Organizer of the autumn High Energy Physics Experiment Cosmology (HEPEC) seminars at Texas A&M University
03/2016-17	Muon Alignment responsible in the CMS DPGO (Detector Performance Group Office)
01-06/2016-17	Organizer of the spring High Energy Physics Experiment Cosmology (HEPEC) seminars at Texas A&M University
03-04/2015	ECAL High Voltage Calibration
09/2014-17	Official guide of the CMS experiment

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