Research Statement

FONTENLA BARBA, Yanis

Doctor of Philosophy (Ph.D) in particle and nuclear physics, specialized in R&D particle detectors and astroparticle physics, Cosmic Rays. My Ph.D supervisors were Juan A. Garzón Heydt and Pablo Cabanelas Eiras at Universidade de Santiago de Compostela (USC). The title of my Ph.D thesis was «Study on the composition and energy of secondary cosmic rays with the Tragaldabas detector». Currently, I am looking for a postdoctoral position in my physics research field. I studied my B.Sc in Physics at Universitat de València (UV) and M.Sc in Advanced Physics specialized in particle-astroparticle physics and nuclear physics also at UV. In my undergraduate's thesis, I studied the composition of the proton and the mass of the Higgs Boson through the W Boson decay channel to electrons/muons and neutrinos analyzing real data from the ATLAS experiment and using CERN's tool MINERVA [1]. The title of my thesis degree in Physics was «Exploring the proton structure with real data of the ATLAS detector in the Hadron accelerator LHC of CERN». My master's thesis was a study of Physics Beyond the Standard Model with top-antitop pair simulation data at high energy from ATLAS experiment [2]. The simulated data were analyzed using CERN's software ROOT to measure the mass of the Boson Z-prime leptophobic [3] and the physical observable of charge asymmetrie. The title of my Master's final dissertation was «Research new Physics BSM with ttbar simulation data at very high energy». My B.Sc and M.Sc thesis supervisor was Santiago González de la Hoz at UV-IFIC. The manuscripts of all my thesis are available in my personal Website: https://mural.uv.es/yafonbar/ .

During my first year of Ph.D, we performed simulations with EnsarRoot [4] framework in the Tragaldabas [5] Cosmic Ray telescope and the generation of data with Corsika [6]. The installation of the FairSoft and FairRoot [7] frameworks, Anaconda-Jupyter and Python was essential for the execution of tasks, which need high performance in analysis, calculation and optimization of data with Root and Python programming codes. Collision simulations on the detector were also done to learn the manipulation of programs installed in the framework. Startup of programming codes for the execution of the environments and simulations was essential, therefore it was also necessary to know and use functions for data calculations and plots (1D, 2D and 3D), C/C++ and Python programming languages for data manipulation and execution of formulas used in High Energy Physics (HEP). In addition, I became acquainted with many of physical observables studied in the detector working environment as chi-squared χ^2 of the track fitting [8], multiplicity of hits and weighted range.

In my second and third year, we performed the study for particle identification (PID) with Tragaldabas in EnsarRoot [9] and the study of lateral distributions of air showers and the detector response with Corsika simulations data [10]. The PID tasks require the execution of environments with Geant4 [11, 12, 13] and the study of physical observable. The simulated environments were the physics faculty building and the detector with lead supplements for a calorimetric analysis, these environments were implemented by me in the EnsarRoot code. The handling and execution of realistic data with Cry [14] were also necessary for the optimization of results. Also, I made a cosmic rays generator with Cry data to improve optimization and implemented it in code. The algorithms for the PID of electrons and muons were made with the intention of implementing it in the DAQ board of Tragaldabas. Finally, we obtained the results of Response Functions [15, 16] for different nuclei (H, He, C and Fe) and different zenith angles for Tragaldabas located in USC's particle physics department and for Tristan detector located in Spanish Antarctic station Juan Carlos I [17]. The simulation data acquisition has done with resources from Galicia Supercomputing Center (CESGA) located in USC's campus using BASH

scripts with SSH or SFTP connection to a CESGA account for the analysis of secondary cosmic rays at ground level. The algorithm for writing, reading and analyzing data was done in C/C++ language.

Recently, we obtained the results of PID with Tragaldabas detector [8], results of lateral distribution functions and clusters of electrons and muons at ground level [9], the regular measurement of cosmic rays with Trasgo-like detectors [18] and status report of Tragaldabas collaboration [19].

Furthermore, I would like to expand my knowledge and experience in other interesting areas of particle, nuclear and atomic physics. My research interest focuses in the analysis of data taken from particle experiments. I can participate in the development of detectors with simulation and data analysis using tools as Geant4 and ROOT, and, DAQ electronics and software as much as possible. In addition to R&D detectors, I can model and simulate environments for new detection modules of experiments for testing with cosmic ray particles and/or beam generator of particles. I will bring my knowledge and experience to the undergraduate and/or graduate and/or Ph.D students, to guide and help them advance on their tasks, working closely to share my expertise so their job is done efficiency. I can write reports and papers, and expose the work with the results aided by the scientific team or collaboration for national and international conferences and workshops. However, there are other topics that I am interested as nuclear and particle physics, physics beyond SM, dark matter physics, quarks or gluons plasma, just to mention a few of them.

References

[1] Masterclass INvolving Event Recognition Visualized with Atlantis, (“http://atlasminerva.web.cern.ch/atlas-minerva/”).

[2] ATLAS Collaboration: G. Aad et al. , “The ATLAS Experiment at the CERN Large Hadron Collider” , Institute of Physics publishing and sissa, JINST-3-S08003, 14 August 2008.

[3] The ATLAS Collaboration, “A search for $t\bar{t}$ resonances in lepton plus jets events with ATLAS using 14 fb^{-1} of proton-proton collisions at $\sqrt{s}$= 8 TeV”, Journal of High Energy Physics , pp. 5-8/16-17, 13 May 2013.

[4] Pablo Cabanelas et al. , “EnsarRoot: The framework for simulation and data analysis for ENSAR”, 8 J. Phys.: Conf. Ser. 1024 012038, 30 May 2018.

[5] A. Blanco et al., “TRAGALDABAS a new RPC based detector for the regular study of cosmic rays”, JINST 9 (2014) no.09 C09027.

[6] D. Heck et al., “CORSIKA: A Monte Carlo Code to Simulate Extensive Air Showers”, Report FZKA 6019, Forschungszentrum Karlsruhe, 1998.

[7] D Bertini et al., “The FAIR simulation and analysis framework”, 2008 J. Phys.: Conf. Ser. 119 032011.

[8] J.A. Garzón and P. Cabanelas, TimTrack: A matrix formalism for a fast time and track reconstruction with timing detectors, Nucl.Inst.Meth.Phys.Res. A, 661 (2012) S210-S213.

[9] Y. Fontenla et al., “MIDAS: A particle identification tool for the Tragaldabas Cosmic Rays telescope”, PoS(ICRC2019)072.

[10] A. Álvarez Diéz, P. Cabanelas, Y. Fontenla and J.A Garzón, “Study of lateral distribution functions of electron and muon bundles using Trasgo detectors”, PoS(ICRC2019)067.

[11] S. Agostinelli et al., “GEANT4- A Simulation Toolkit”, Nucl. Instrum. Meth. A 506 (2003) 250-303.

[12] J. Allison et al., “GEANT4 Developments and Applications”, Nucl. Instrum. Meth. A 506 (2003) 250-303.

[13] J. Allison et al., “Recent Developments in Geant4”, Nucl. Instrum. Meth. A 835 (2016) 186-225.

[14] Chris Hagmaann et al., “Cosmic-Ray Shower Generator (CRY) for Monte Carlo Transport Codes”, IEEE Nuclear Science Symposium Conference Record, 2007.

[15] Aleksey G. Bogdanov et al., “Coupling functions for primary cosmic rays and ground-level muons at various zenith angles”, Proceedings of the 21st European Cosmic Ray Symposium, pp341-346L, (2008).

[16] E. I. Yakovleva et al., “Coupling Functions for Muon Hodoscopes”, BULLETIN OF THE RUSSIAN ACADEMY OF SCIENCES: PHYSICS, Vol. 73, No. 3, 2009 .

[17] D. García-Castro, “The TRISTAN Antarctic Cosmic Ray detector”, PoS(ICRC2019)071.

[18] J.A. Garzón et al. « TRASGOS: Towards a New Standard for the Regular Measurement of Cosmic Rays », Physics of Atomic Nuclei, 2020, Vol. 83, No. 3, 453-462.

[19] D. García-Castro et al. «The TRASGO Project. Present status and results», ISCRA-2021.