LABORATÓRIO DE INSTRUMENTAÇÃO
E FÍSICA EXPERIMENTAL DE PARTÍCULAS
partículas e tecnologia

III LIP Summer Student Program / 2019

Final Presentations Workshop

Lisbon - Coimbra - Braga
September 4-5, 2019

NUNO@CERN.CH

Thank you for taking part !

Foremost to You, **the Students**, for spending the summer engaging in research work with us.
The **Supervisors** for designing the actual research projects and for mentoring them.
Everyone at LIP involved in the **organisation** (inc. ECO, IT, directorate, secretariat, etc)

LIP Summer Student 2019

Induction Tutorials

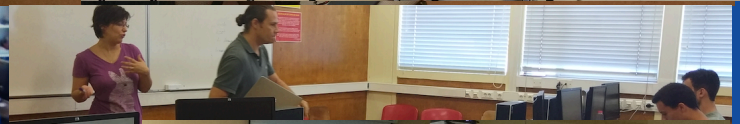
Introductory lectures

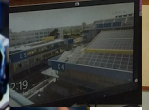
+

Thematic discussion

+

Hands-on exercises





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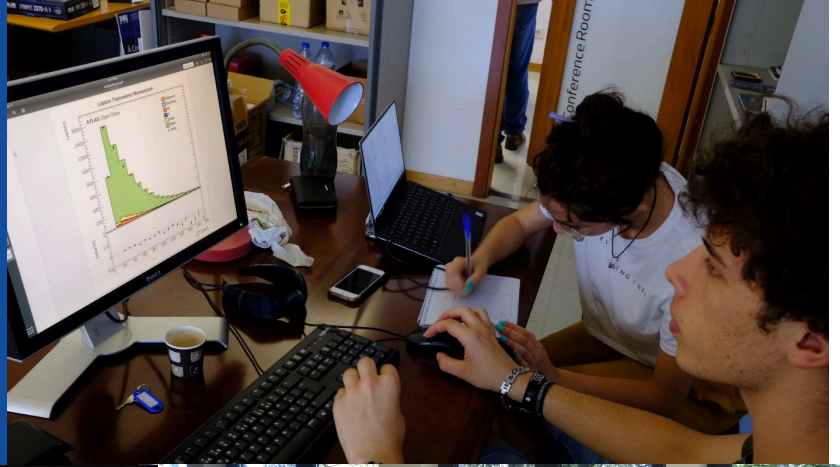
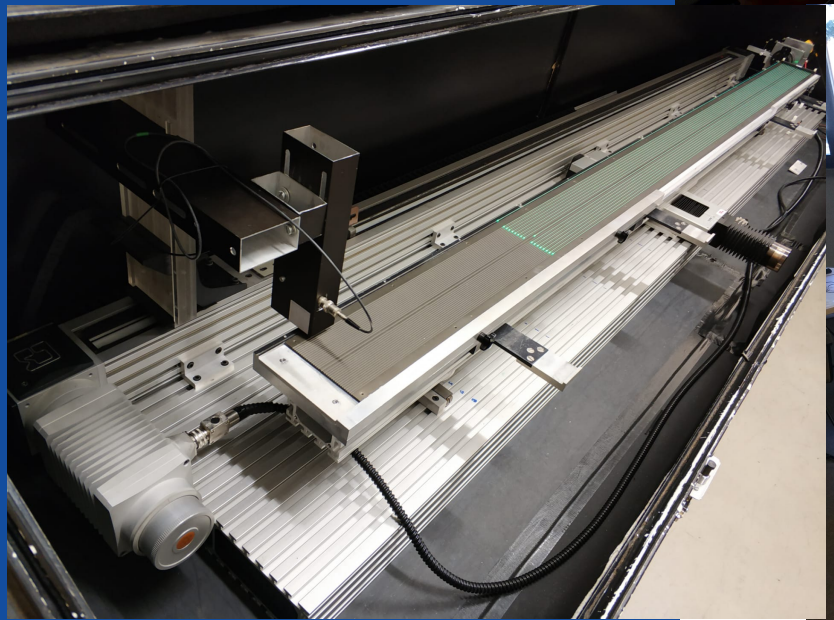
Project Development





LIP Summer Student 2019

Mid-term

‘August Chats’

Student seminar weekly Sessions

(Students present to colleagues a problem they are addressing)

after-work party in the garden

LIP Summer Student 2019

Final Workshop

	4 Sep 2019		5 Sep 2019	
AM	09:15	Welcome (Auditorium)	09:20	**Session** (until 10:40) ()
	09:20	**Session** (until 10:40) (Auditorium)	09:20	Física Experimental de Partículas com os detectores ATLAS, LUX e LZ - Ângelo Ferreira Tiago Azevedo André Silva ()
	09:40	Gamma-ray astrophysics with current and future detectors - Wagner Blotz (Auditorium)	09:40	Mu0es num balão: medidas do fluxo de mu0es até à estratosfera - Pedro Leal João Parente Bárbara Matos ()
	10:00	Argon transparency to neutrons - Leonardo Oliveira (Auditorium)	10:00	Simulações de Monte Carlo para preparar a procura de matéria escura na experiência LZ - Nuno Brito Frederico Simões ()
	10:20	(pre)supernova signals in SNO+ - António Maschio Miguel Avillez (Auditorium)	10:20	Ampliação das funcionalidades de um visualizador gráfico 3D do Observatório Pierre Auger - Leonardo Ramalho Luís Neto ()
	10:40	--- Coffee Break ---	10:40	--- Coffee Break ---
	11:10	**Session** (until 12:30) (Auditorium)	11:10	**Session** (until 12:30) ()
	11:10	Simulação e medida do fundo natural proveniente da terra e do céu - José Nunes (Auditorium)	11:10	Explorar os dados públicos do Observatório Pierre Auger - Pedro Branco Pedro Passos Osvaldo Freitas ()
	11:30	Reações nucleares com feixes radioativos a energias relativistas - Ricardo Pires (Auditorium)	11:30	Pesquisa de nova física associada ao quark top usando dados de ATLAS - Ana Oliveira José Abreu ()
	11:50	Preparation and characterization of a thin target for nuclear physics experiments - Luísa Baptista (Auditorium)	11:50	Pesquisa de nova física associada ao quark top usando dados de ATLAS - Maria Portela Maria Neiva ()
			12:10	Pesquisa de nova física associada ao quark top usando dados de ATLAS - Nuno Morujão Tomás Ferreira ()
PM	12:30	--- Lunch ---	12:30	--- Lunch ---
	14:00	**Session** (until 15:20) (Auditorium)	14:00	**Session** (until 15:20) (Auditorium)
	14:00	AMBER - Physics simulations for a new experiment at CERN - Rita Silva (Auditorium)	14:00	Exploring the Quark-Gluon Plasma - Iris Silva Sérgio Carrão André Cordeiro Rafael Pinto (Auditorium)
	14:20	Performance of the ATLAS Trigger for the High Luminosity LHC era - Filipe Cruz (Auditorium)	14:20	Probing Quark Gluon Plasma with b-Jets - Rodrigo Gazola Inês Rebanda (Auditorium)
	14:40	High-precision timing detectors for HL-LHC - Vítor Cardoso Gonçalo Villa (Auditorium)	14:40	Novel probes of the primordial QGP - João Gonçalves Alexandra Pardal (Auditorium)
	15:00	Simulação das propriedades óticas de plásticos cintiladores para dosimetria de elevada resolução - Catarina Pimenta (Auditorium)	15:00	Quarkonia polarization method using a new fully unbinned fitting and background subtraction method - Albergaria Francisco (Auditorium)
	15:20	--- Coffee Break ---	15:20	--- Coffee Break ---
	15:50	**Session** (until 17:30) (Auditorium)	15:50	**Session** (until 17:30) (Auditorium)
	15:50	O plástico na física de partículas: cintiladores e fibras óticas - Hugo Miranda Francisco Laranjinha Ivan Muñoz (Auditorium)	15:50	Development of novel reconstruction techniques for low-energy gamma-ray showers - Luís Lourenço Hugo Lobo (Auditorium)
	16:10	Selection of Helium nuclei using multivariate data analysis in AMS - José Jesus David Lima (Auditorium)	16:10	Exploring the Hidden Sector of Particle Physics at the SHiP experiment - Beatriz Araújo (Auditorium)
	16:30	Efficient modeling of optical photon propagation in SNO+ - Samuel Magalhaes (Auditorium)	16:30	Search for New Physics in exclusive processes at the LHC - Miguel Guerreiro (Auditorium)
	16:50	Search for Supersymmetry with a machine-learning tool - Arthur Oudot Timothée Cabos (Auditorium)	16:50	Study of the Higgs couplings to quarks at ATLAS - Gonçalo Fernandes Dmytro Ostapchuk (Auditorium)
	17:10	Desenvolvimento de um programa de simulação ótica de detetores de cintilação - Rudnei Machado		

LIP Summer Student 2019

Book of Abstracts

You are invited to prepare a terse summary of your project.

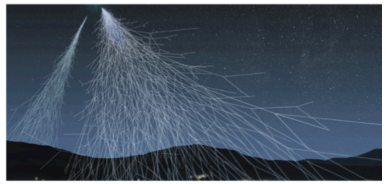
How much: O(200) words
When: by next week

// FORMAÇÃO AVANÇADA

LIP Summer Students Programme 2018

Book of abstracts

Entre Julho e Setembro de 2018, decorreu a 2ª edição do Programa de Estudantes de Verão do LIP, dirigidos a estudantes universitários de Física, mas também de áreas relacionadas, como a Engenharia. Mais de meia centena de estudantes de licenciatura e mestrado participaram activamente em mais de 30 projetos de investigação, integrados em vários grupos de investigação nos três polos do LIP — Lisboa, Coimbra e Minho. O programa iniciou-se com uma semana de tutoriais e terminou com um workshop em que os estudantes apresentaram o seu trabalho. Nesta secção do Boletim, os participantes apresentam um breve resumo do projecto de investigação que desenvolveram.



LATTES: Looking for astrophysical gammas with a next generation detector

Students: André Torcato, Melissa Serra, José Cordeiro, Sara Marques, José Jesus
Supervisors: Ruben Conceição, Bernardo Tomé, Mário Pimenta

LATTES is a project that aims to build a gamma-ray ground-based experiment to survey the Southern sky. This wide field-of-view experiment is based on a hybrid detector concept (water Cherenkov detectors + resistive plate chambers) to effectively access with a good sensitivity an energy region that is not currently covered by any experiment of this type. While the proof-of-concept is done, this new experiment offers a new set of possibilities to observe the sky that are far from fully explored. This summer we explored some of this opportunities: investigate and optimize the shower core reconstruction of highly energetic events; build an artificial neural network to enhance the gamma (signal) / hadron (background) discrimination; assess the LATTES shower geometry reconstruction for different RPC time resolutions and array configurations. In all these tasks, possible improvement to the current LATTES reconstruction were found which might contribute to enhance its performance in the future.

Development of a framework for multi-messenger observations

Students: Bernardo Dias and Nelson Eiró
Supervisors: Sofia Andringa and Lorenzo Cazon

Cosmic rays, neutrinos, photons and gravitation… observed independently over the last … observatories around Earth. H… one event can be observed … channels. Identification of s… allowing to understand the p… violent places of the Universe … wave event GW170817 and th… objectives of the internship were … development of display tools of the instantaneous sky coverage of the Auger experiment (that can be consulted at http://www.lip.pt/~ev18117/galatica.html) and the identification of relevant source candidates. Calculations of time of flight delay and deflection angles from different relevant sources were also achieved. The work culminated in a poster presented at ENAA — Encontro Nacional de Astronomia e Astrofísica.

Rare beauty decays

Student: Maria Carolina Faria
Supervisors: Ozlem Ozcelik, Nuno Leonardo

The rare meson decays B→μμ are amongst the most sensiti… probes for physics beyond the standard model at the LHC. Following the Run1 flagship observation by CMS and LHCb … →μ+μ−, the accumulation of data will allow detailed measur… of the B^0_s channel along with improved searches for the rare … $B^0 \to \mu^+\mu^-$. In this project, we estimate the sensitivity that w… be attainable with the upgraded CMS detector during the hi… luminosity LHC (HL-LHC). Using detailed simulations of sign… background processes, we determined expected improveme… mass resolution relative to the current detector. These were… used to generate pseudo-experiments simulating the involve… processes. With the sample of $3ab^{-1}$ at 14 TeV that we expect… collect during HL-LHC, major improvements in the measurer… will be enabled. In addition to allowing precise measurement… the B_s^0 channel, including of its effective lifetime, a first obse… of the B^0 channel will be in reach, with a statistical significanc… excess of 6σ.

Measurement of H → 2 tau with multivariate analysis tools

Students: Luís Sintra, Ricardo Cipriano, Tomás Alvim
Supervisor: Pedrame Bargassa

One of the main goals of the CMS collaboration is the precis… measurement of the properties of the Higgs boson. The cou… of Higgs to different Standard Model (SM) particles can give… precious hint to whether it belongs to the SM framework, or… otherwise a gateway to physics beyond our present knowled… The goal of the internship was to improve on the analysis res… of H→2τ performed with a multi-class neural network (NN)… instead of the original cut-and-count approach used for the … boson discovery. Our NN categorizes events in SM processe… exploiting the separation between those processes in the mu… dimensional space of the chosen variables (e.g. missing trans… momentum). Th… of the Higgs signal is extracted fro… this c… a higher precision if the latter is … selection, we explored two ways … on accuracy: by diminishing ttb… on the number of b jets; by ov… (except for the challenging Z→… the output of a NN trained for the purp… ut hints at an improvement of 11.1% of previou…

from last year's

Di-Higgs searches with machine learning

Students: Miguel Bengala, Rodrigo Santo
Supervisors: Giles Strong, Michele Gallinaro

With the proposed upgrades for the CMS detector in the Hi… Luminosity LHC, it is wise to study what kind of results we a… expecting to obtain and explore new paths for future analyse… our project, we took data produced via a Monte Carlo genera… and used it to predict the expected discovery significance of … resonant di-Higgs (HH) production for the upgraded detecto… The methods and results were discussed in an analysis note … be included in the Yellow Report. In the project, we explored

LIP Summer Student 2019

Paper write-up

Starting this year, students have the possibility to produce a **research paper** documenting the results obtained in their projects.

Documents will be shared in a **public** repository, following light refereeing inc. by supervisors

All students **strongly encouraged** to submit the report

How much: 5 -10 pages
When: by end of September

[**latex** template may be provided, suggest https://www.**overleaf**.com/]

Final Report - 1st Project
CERN Summer Student Programme

Search for the $B_C(2S)$ at CMS

Bruno A. Fontana S. Alves*
Instituto Superior Técnico, University of Lisbon

Project supervisor: Francesco Fiori

September 14, 2016

Abstract

The work was developed during the CERN Summer Student Programme, from June 27th to September 14th. We looked for the excited state of the B_C meson that has already been found in the ATLAS experiment. Optimized cuts were obtained both for the B_C and for the $B_C(2S)$ mesons. The final results are not conclusive, but indicate the presence of a signal. Run 2 data set (2015-2016) is required.

1 Theory

The $B_C^{\pm}$ ($m_{B_C} \simeq 6.2756$ GeV [1]) meson was observed a long time ago, in 1998, by the CDF experiment [2], and has also been observed in several different decay channels by the LHCb experiment [3], the first of them in 2012, by the beginning of LHC operation. It is a bound state of a c quark and a b anti-quark. The major difference between this particle and a J/ψ or a Υ is the presence of charge (its anti-particle has opposite charge). One of the interesting decay channels for CMS is the one into a pion plu (Eq. 1).

$$B_C^{\pm} \longrightarrow J/\psi + \pi^{\pm}; \qquad J/\psi \longrightarrow$$

There are obviously many other deca the one discussed here has a really clear sig given by two muons in the final state and with the constraint on the J/ψ mass window, which is extensively used in High Level Trigger (HLT) selection. Indeed, CMS, as its name indicates, is able to detect muons better than any other kind of particles. There are still other decay channels which also involve a J/ψ but they are either less probable, or they include a neutrino which cannot be seen in the experiment (it is a really weak interacting particle), spoiling the mass distribution of the B_C meson.

Recently, the ATLAS experiment claimed to have found the excited state of the $B_C^{\pm}$ meson, the $B_C^{\pm}(2S)$ [4]. This particle decays immediately into a $B_C^{\pm}$ plus two more pions (see (2)). Although the CMS experiment can easily see the ground state of the $B_C^{\pm}$, the same cannot be stated for the excited state. Indeed, until now, the available data from 2011 ($\sqrt{s}$= 7 TeV) and 2012 ($\sqrt{s}$ =8 TeV) is not enough for CMS to announce a similar observation.

$$B_C^{\pm}(2S) \longrightarrow B_C^{\pm} + \pi^{+} + \text{-}$$ (2)

2 Prog

pendent act, most of ated to the previously the only programming lan- some notions of how to interact mand line while using Linux. ROOT was extensively used in order to create all sorts of output, as well as the required analysis of the available data and MC samples. I used a package of ROOT called RooFit as well, which is a powerful fitting tool, and which allowed me to fit the mass distribution of both the background and the signal coming from the B_C and $B_C(2S)$ particles. The Toolkit for Multivariate Data Analysis with ROOT (TMVA) was also needed to optimize several cuts on many variables. Finally, all the work was done using the *lxplus* server.

3 Work description / Results

The data employed during the project was obtained in Run 1 (2012), with an energy of 8 TeV, and a luminosity of 19 fb^{-1}. It was restrained by an online J/ψ trigger (HLT_Dimuon8_Jpsi) which selects a J/ψ by looking at

*Email: bruno.afonso.fontana.santos.alves@cern.ch

example format

LIP Summer Student 2019

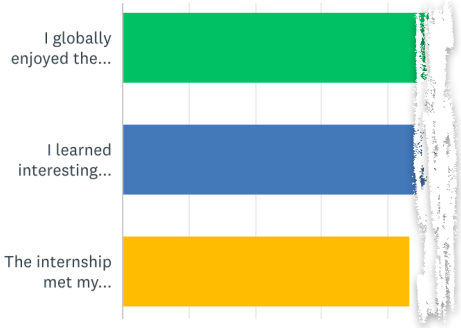
Your Feedback

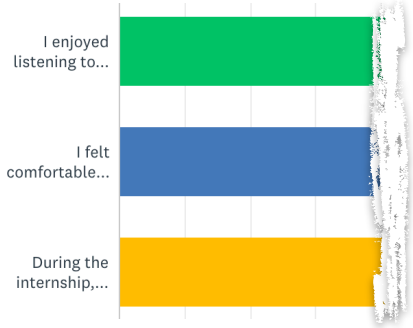
You shall receive shortly an invitation to fill in a survey to share with us your feedback on the program:

- what you think went well
- how it could be improved

Your feedback is important so we can improve on future editions of the program for your colleagues.

Survey on the 2017 LIP Summer Student Porgram





Thanks & Farewell!

Certificates of participation