



LABORATÓRIO DE INSTRUMENTAÇÃO  
E FÍSICA EXPERIMENTAL DE PARTÍCULAS  
*partículas e tecnologia*

# [ LIP-ECO ]

**Communication, outreach, education and advanced training @ LIP**  
— Selected highlights —



Ana Sofia Inácio, Luis Afonso, Nuno Leonardo, on behalf of the LIP-ECO Group

Jornadas do LIP, Braga, Feb 2020



# LIP-ECO



The diagram consists of three overlapping blue circles arranged horizontally. Each circle contains white text. Below each circle is a line of blue text. The circles overlap in the center, creating a continuous shape. The text inside the circles is bold and white. The text below the circles is in a smaller, blue font.

**Institutional Communication  
Internal & External**

**Coord: Catarina Espírito Santo  
Ricardo Gonçalo (Coimbra)**

**Outreach and  
support to education**

**Coord: Pedro Abreu  
Filipe Veloso (Coimbra)**

**Advanced  
training**

**Coord: Nuno Castro & Nuno Leonardo**

*With the participation of all the LIP community*  
***All LIP nodes***



# LIP-ECO

## Institutional Communication Internal & External

- Yearly Reports & Plans
- Evaluation
- LIP-News Bulletin
- Site news and maintenance
- Social media
- Media relations
- cLIP digital Newsletter
- Event dissemination
- Comm with and for students
- EPPCN
- GENERA: Gender Equal. Network
- ...

## Outreach and support to education

- Talks in schools
- Masterclasses
- CERN PT Teachers programme
- Other Teacher Training Progs.
- Schools visits to LIP
- Support to school projects
- EduLab
- Collaboration with SPF
- Summer internships
- European Researchers Nights
- IPPOG
- ...

## Advanced training

- LIP Internship Programme
- Research projects
- (under)graduate courses
- Schools and workshops
- Seminars and hands-on tutorials
- PhD programmes management
- Participation in Univ events
- Inside views, ENEF
- LIP Room at IST
- LIP student workshops
- Training future trainers in RP+NT
- ...

***Will select a highlight from each... take a look at the yearly reports for details***



# Selected highlights

**Institutional Communication  
Internal & External**



An internal & external  
communications project

Communication with & for students

**Speaker: Ana Sofia Inácio**

**Outreach and  
support to education**



Developing the experimental side

Support to lab projects in schools and  
at LIP: an example

**Speaker: Luis Afonso**

**Advanced  
training**



Attracting students to LIP

LIP  
Summer Internships

**Speaker: Nuno Leonardo**



# Institutional Communication

## Internal & External

- Yearly Reports & Plans
- Evaluation
- LIP-News Bulletin
- Site news and maintenance
- Social media
- Media relations
- cLIP digital Newsletter
- Event dissemination
- Comm with and for students
- EPPCN
- ...

*take a look at the yearly reports for details*

*Highlight*

Communication  
with & for students

An internal & external  
communication project

**Speaker: Ana Sofia Inácio**



# Communication with & for students

Getting LIP PhD & Master students more involved in outreach

- Provide students with some formal training and practice in science communication
- get the young members from different groups to work together
- Benefit from the fact that young people are closer to school public

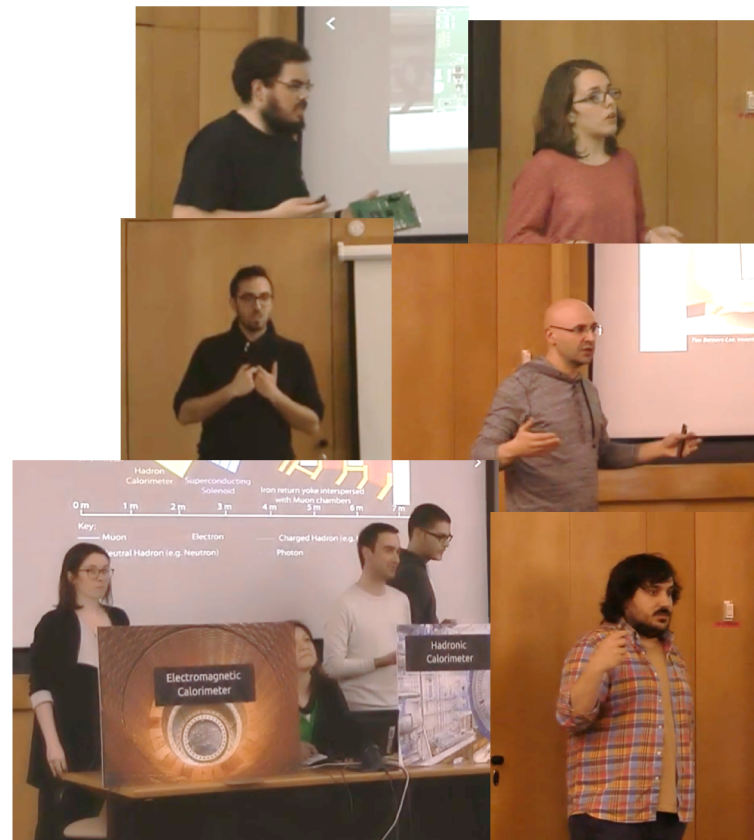
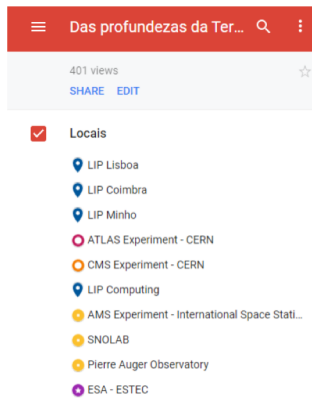


# "LIP - Das Profundezas da Terra ao Espaço"

9th of May, 2018

Celebration of the 32<sup>nd</sup> LIP Anniversary

Full auditorium, with around 80 secondary school students and teachers





# “Partículas: do Universo ao Laboratório”

11th of February, 2019

Celebration of the International Day of  
Women and Girls in Science

Two sessions with full auditorium, around  
140 secondary school students and  
teachers





# Acção de formação “Falar em Público” com José Vítor Malheiros

10th January 2018 – 12 people from LIP-Lisboa, Coimbra and Minho

30th January 2019 – 8 people from LIP-Lisboa

## Objectives

- Internalize the distinction between the objectives of peer communication and communication with lay people
- Acquire basic skills in oral communication on scientific topics





# Using Social Media to Our Advantage

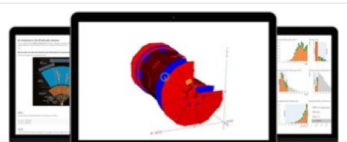
## National and International Outreach

- Share LIP news, events and achievements of the experiments/areas LIP is connected to.

**LIP - Laboratório de Instrumentação e Física Experimental de Partículas**

Publicado por Ana Sofia Inácio [?] · 1 h ·

**ATLAS Experiment at CERN**  
10 de fevereiro às 20:30 ·



Press Statement: ATLAS Experiment releases 13 TeV Open Data for Science Education

Geneva, 10 February. The ATLAS Collaboration at CERN has just released the first open dataset from the Large Hadron Collider's (LHC) highest-energy run at 13 teraelectronvolts (TeV). The new release is specially developed for science education, underlining the Collaboration's long-standing commitment to students and teachers using open-access ATLAS data and related tools.

"The ATLAS Collaboration..."

[Ver mais](#)

No passado dia 15 de Janeiro, o nosso colega Pedro Abreu esteve na Biblioteca Municipal de Beja - José Saramago a participar na 8ª sessão do ciclo de conferências de divulgação científica com a apresentação "O Campo de Higgs em Beja"



**LIP**  
1,453 Tweets

**LIP @lipwebapps · Jan 9**  
A FCT e o LIP concordaram em promover um programa de bolsas de doutoramento em física de partículas e domínios científicos e tecnológicos relacionados, relevantes para a participação portuguesa no CERN. Dois concursos abrirão em 2020.  
[lip.pt/?section=press...](#)

**LIP @lipwebapps · Dec 17, 2019**  
Ep. 747 Patrícia Gonçalves - Investigadores portugueses desenvolvem instrumento para missão da Agência Espacial Europeia a Jupiter  
[90segundosciencia.pt/episodios/ep-74...](#)

**LIP @lipwebapps · Dec 16, 2019**  
Em novembro e dezembro de 2019, decorreu montagem e instalação de grande parte do detector CALIFA no laboratório FAIR, em Darmstadt. Elisabet Galiana, do grupo NUC-RIA do LIP, fez parte da equipa [lip.pt/?section=press...](#)

**LIP @lipwebapps · Dec 16, 2019**  
Esta semana, defendeu com grande sucesso a sua tese de mestrado a aluna do Universidade do Minho Filipa Peres, que realizou o seu trabalho de investigação no LIP-Minho [lip.pt/?section=press...](#)

**LIP @lipwebapps · Dec 9, 2019**  
O workshop BSM decorreu em Lisboa na semana passada, no contexto da ação COST VBScan e incluiu uma sessão de divulgação PubHD [lip.pt/?section=press...](#)

**LIP - Laboratório de Instrumentação e Física Experimental de Partículas**

Publicado por Ana Sofia Inácio [?] · 13 de janeiro às 10:19 ·

Curso introdutório de Geant4 do LIP, a decorrer de 11 a 13 de Fevereiro na Universidade do Minho. Inscrições até 24 de Janeiro, e mais informações em <https://indico.lip.pt/event/681/>



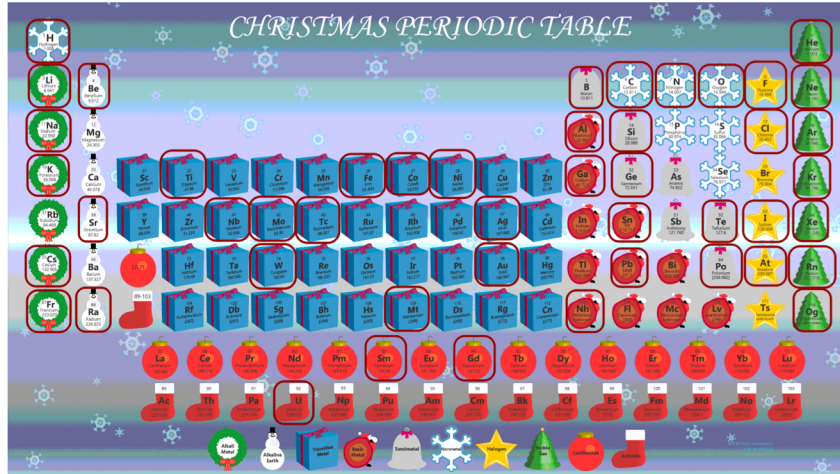
INDICO.LIP.PT  
**LIP introductory course on Geant4 (11-13 February 2020): Overview · LIP Indico (Indico)**  
Geant4 is a Monte Carlo simulation toolkit for particle transport widely used in high-energy...



# Using Social Media to Our Advantage

## National and International Outreach

- Share LIP news, events and achievements of the experiments/areas LIP is connected to.
- Share knowledge and educate the general public.



### *Celebration of the 150 Years of the Periodic Table*

- 47 riddles about periodic table elements every week throughout 2019
- Questions/answers relating each element to a topic in particle physics



# Using Social Media to Our Advantage

## National and International Outreach

The future – show what is done at LIP, by the researchers and students





## Outreach and support to education

- Talks in schools
- Masterclasses
- CERN PT Teachers programme
- Schools visits to LIP
- Support to school projects
- EduLab
- Collaboration with SPF
- Summer internships
- European Researchers Nights
- IPPOG
- ...

*take a look at the yearly reports for details*

### *Highlight*

Developing the experimental side

Support to lab projects  
in schools and at LIP:

The example of AE Benfica

**Speaker: Luis Afonso**



# LIP-EduLab

## Reinforcing experimental activities proposed to high-school students

### 2018 / 2019

“Particle Physics and its tools” (F. Barão, C. Esp Santo, A.S. Nunes)

- “Ciência Viva in the Laboratory” internships
- “Cientificamente Provável” programme with ES D. Filipa de Lencastre and ES Restelo (Lisboa)
- Support to projects proposed by the teachers/students: AE Benfica (Lisboa), AE Joane (Minho)
- Collaboration with LIP-Minho: working towards similar goals (R. Sarmento, N. Castro, H. Carvalho, J. Alves)
- Thanks for the support from LIP-Coimbra and e-CRLab (F. Neves, L. Lopes, JC. Nogueira, M. Ferreira, P. Assis)

### 2019 / 2020

Focus on development: new projects and equipment

- A wider team in Lx: Márcia Quaresma, Marco Pinto, Nuno Barros, L. Afonso, P. Abreu, P. Assis, F. Barão, C. ES, ...
- People and ideias welcome!
- For schools:
  - Support to projects developed by the schools
  - Visits to LIP: talk + cloud chamber workshop



## **AE Benfica example**

**Participation in events**

**EduLab/Física das Coisas**

**LIP impact on students**

**Maker Space**

**Física das Coisas**

**[www.fisicadascoisas.pt](http://www.fisicadascoisas.pt)**

**Coordinator: Luis Afonso**

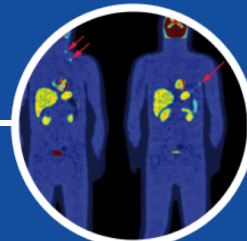
**[luis.fonso@fisidascoisas.pt](mailto:luis.fonso@fisidascoisas.pt)**



1.

# Participation in events

With students  
As a teacher





# Participation in Events Students

## International MasterClasses in Particle Physics



### LIP Talks in School

"Infinitely large and infinitely small - The Void and the Higgs Boson" R. Gonalo

"Angels, Demons, Matter, Antimatter and what else is done at CERN" P. Abreu

"Cosmic Rays - a challenge for space travel!" L. Arruda

### Talks and Workshops at LIP

From the depths of Earth to Space

Artificial Intelligence & Machine Learning and Particle Physics - NL

Particles: From the Universe to the Laboratory" in the celebration of the international day of women and girls in Science

European researchers night at Planet rio CG

National week of scientific and technological culture: the 20 years of the Pierre Auger observatory



# LIP/SPF activities with Students

Schools visits to CERN and  
S'Cool Lab



National Physics Olympics (SPF)

IPhO International Physics Olympics 2018 (SPF) Lisbon





# LIP activities as a teacher

**Ciência Viva - Hackathon Mars  
Lousal Mine 2019**  
(P. Gonçalves and P. Assis)



**CERN – PT Teachers Programme 2018 (P. Abreu)**



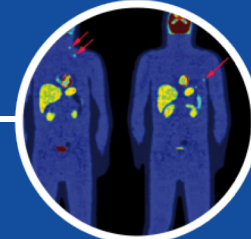
**CERN - The International Teacher Weeks (ITW)  
Programme 2019**



# 2.

## EduLab/ Física das Coisas (\*)

Cosmic Watch  
Photogate communication  
Cloud Chambers

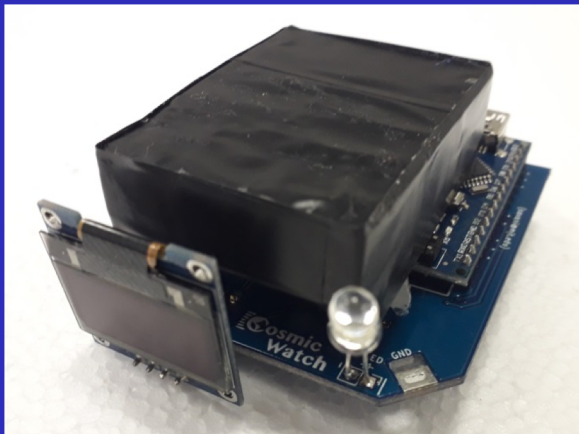


(\*) Physics of things



# EduLab / Física das coisas

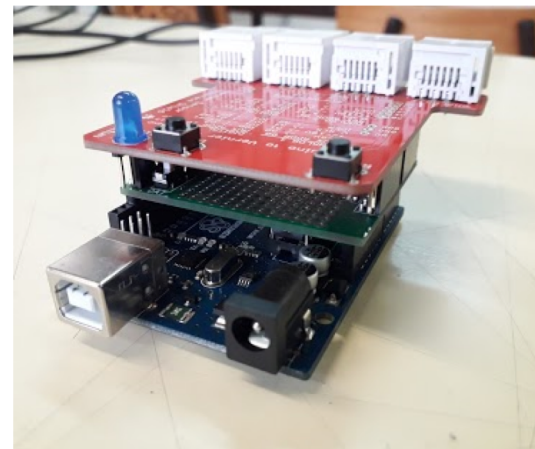
Cosmic Watch (C. Esp. Santo, F. Neves, J. Nogueira, M. Ferreira)



CanSat 2019 Ciência Viva



Photogate Communication  
(N. Barros)



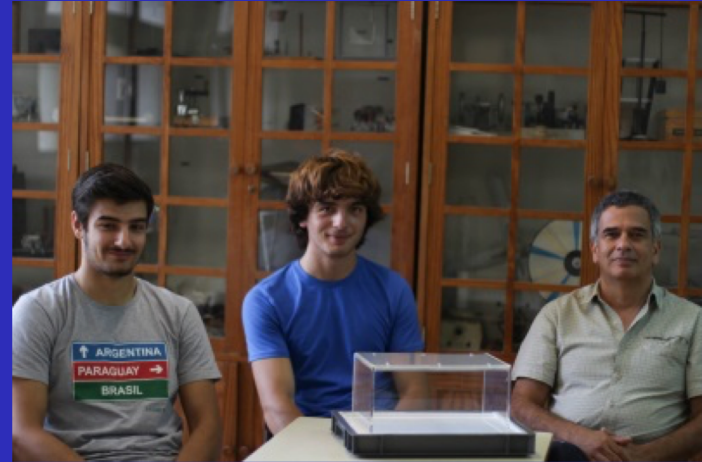


# EduLab / Física das coisas

Cloud Chambers (C. Espírito Santo and P. Abreu)



S' Cool Lab at CERN



"Física das Coisas" Space Maker



# EduLab / Física das coisas

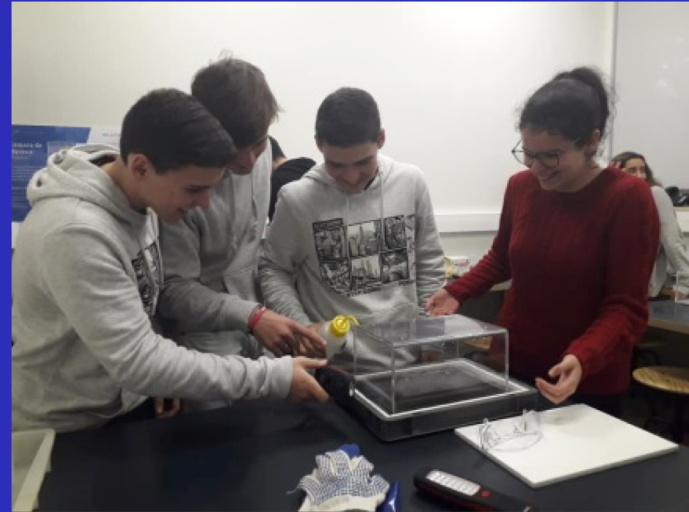
Cloud Chambers (C. Espírito Santo and P. Abreu)



Teachers WorkShop  
in Casa das Ciências



European researchers  
night at Planetário CG



National week of scientific and  
technological culture

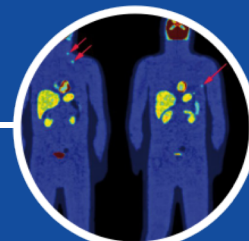


3.

## LIP Impact on students

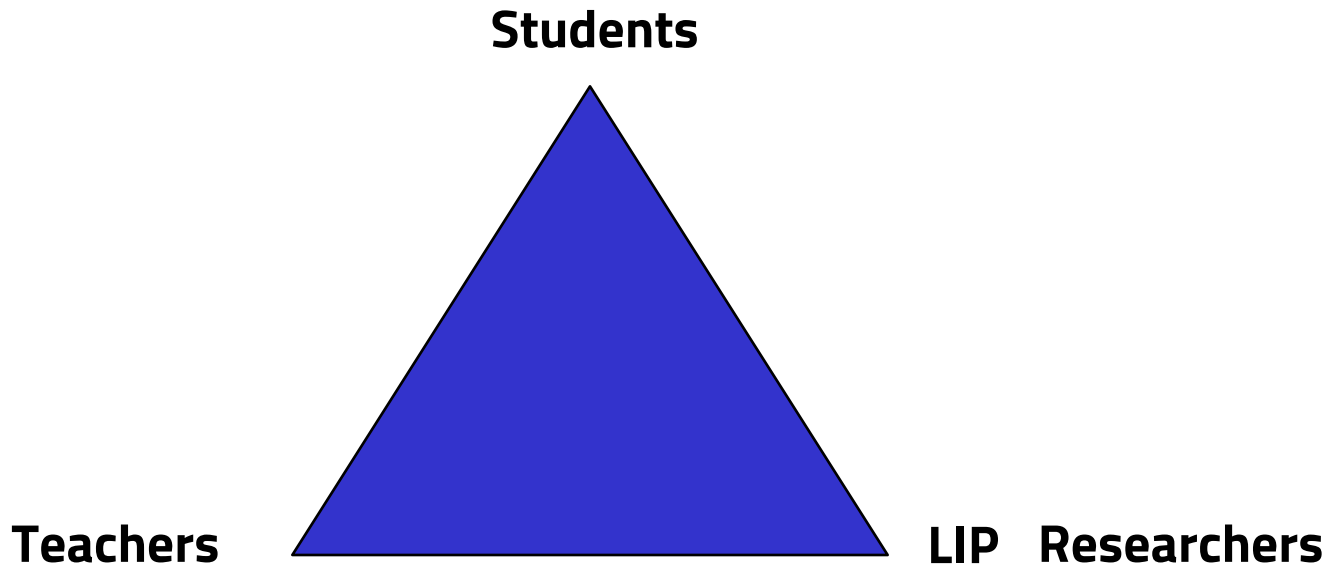
Learning

What students and parents think





# Learning





# What Students and Parents Think

"The visit to the laboratories (LIP) and CERN completely changed my choice of course, I want to go to Physics". (J.)

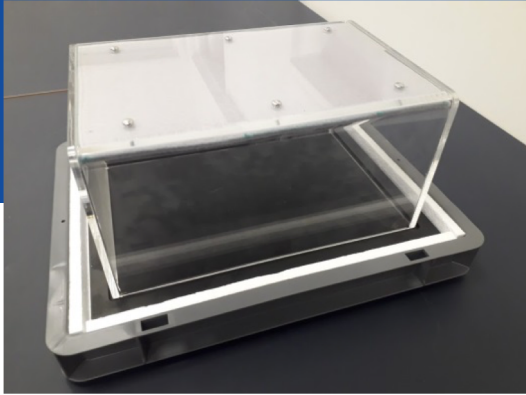
"Because I built the Cosmic Watch and participated in CanSat I was admitted on an internship ...". (C.)

"With the coming of that researcher (L. Arruda) at school I already know which course I will choose". (M.)

"You can't imagine how all your particle activities were important for my son's course choice". (R. mother)

"... the participation in these projects (with LIP) radically changed my son's course option". (T. mother)





# Thanks!

[www.fisicadascoisas.pt](http://www.fisicadascoisas.pt)

[luis.afonso@aebenefica.pt](mailto:luis.afonso@aebenefica.pt)



## Advanced training

- LIP Internship Program
- Research projects
- (under)graduate courses
- Schools and workshops
- Seminars and hands-on tutorials
- PhD programs management
- Participation in Univ events
- Inside views, ENEF
- LIP room at IST
- LIP student workshops
- Training future trainers in RP+NT
- ...

*take a look at the yearly reports for details*

*Highlight*

engage+support students in research

LIP Internship Programme

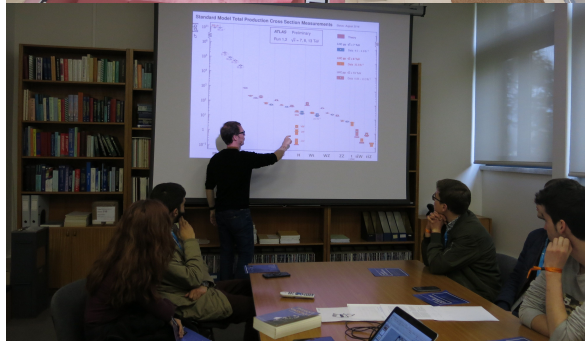
**Speaker: Nuno Leonardo**



# Attract university physics students

- ▶ receive university physics students from first years @LIP
- ▶ take part in events @University
- ▶ important **first contact** students have with LIP and what we do

Events at LIP, FCUL, Coimbra, Minho,  
Activities at LIP room at IST  
Colloquia, seminars, graduates chats  
with undergraduates, PubhD





# Engage students in our research

- › **Internships**
- › Schools
- › Courses
- › Workshops



## Hands on Particles and Light for Life Workshop

LIP Lisbon, 8, 9 e 10 de Julho 2019

JULY



HOME VENUE SCHOOL SYMPOSIUM

Registration will open soon!

16-20 MARCH

## DATA SCIENCE

IN (ASTRO)PARTICLE  
PHYSICS and COSMOLOGY:  
the BRIDGE to INDUSTRY

16-20 MARCH 2020, COIMBRA, PORTUGAL

An event showing the potential of data science in  
modern society and stimulating synergies between  
fundamental research and industry



MARCH-JUNE

## COURSE ON PHYSICS AT THE LHC

Lisbon, PORTUGAL  
02 MARCH - 26 JUNE 2020



Scroll

HOME AGENDA PROGRAM VENUE CONTACTS

REGISTER NOW

III EDITION

# SUMMER STUDENT PROGRAM LIP/2019

PORTUGAL LISBON COIMBRA MINHO

JOIN US, PHYSIC PROJECTS  
IN INTERNATIONAL CONTEXT

Research internships for physics  
and engineering undergraduate students.  
Projects last between 2 and 8 weeks.

- LHC Physics
- Cosmic Rays
- Neutrinos and Dark Matter
- Structure of Matter and Heavy Ions
- Detectors and Instrumentation

JULY-SEPTEMBER



## Fifth Lisbon mini-school on Particle and Astroparticle Physics



FEBRUARY

5-7 February 2020  
Costa da Caparica  
Hotel Tryp Lisboa Caparica Ma

Organizing committee:  
P. Assis, R. Conceição, F. Joaquim, M. Pimenta, J. Romão

www.lip.pt/lisbonschool2020



# Graduate research opportunities+support

PhD programs | Schools | Workshops



## PT - CERN PhD Grants

2 calls: February + September

**IDPASC<sup>cond</sup>LIP**  
PhD students workshop

**25-27 JUNE 2020**  
**COIMBRA**

1 · 3 July 2019  
School of Sciences Auditorium  
Minho University  
Braga, Portugal

Scientific organizing committee:  
Mário Pimenta (LIP - IST)  
Nuno Castro (LIP - UMinho)  
Raúl Sarmento (LIP)

Local organising committee:  
Henrique Corvellec (LIP)  
Natalia Antunes (LIP)

Invited Speakers:  
Jaime Alvarez Muñoz (IGFAE)  
Miguel Romão (LIP)  
Nuno Palma (BdA)  
Pedro Ferreira (BdA)  
Tiziana Compostelli (CERN)

<https://indico.lip.pt/event/583/>

**EIGHT IDPASC School**  
21-31 May, 2018  
IFIC, Valencia

**Particle Physics**  
Susanne Kuehn  
Francisco Campanario  
Miguel Nebot  
**Astrophysics and Cosmology**  
Olga Mena  
Stefano Gariazzo,  
Sergio Palomares  
Juan de Dios Zornoza  
**Neutrinos Physics**  
Mariam Tortola  
Michel Sorel  
**Public Lecture**  
Luis Álvarez-Gaumé

**International Advisory Board**  
Alessandro de Angelis (U. Padova)  
Francisco J. Botella (IFIC, Valencia)  
Antonio Ferrer (IFIC, Valencia)  
Carmen García (IFIC, Valencia)  
Mario Pimenta (LIP, Lisboa)  
**Local Organizing Committee**  
Francisco J. Botella,  
Juanjo J. Hernández,  
Fernando Martínez-Vidal  
Nuria Rius  
José W.F. Valle

<http://indico.ific.uv.es/indico/conferenceDisplay.py?town=True&confid=3194>

**10th IDPASC School**  
Nazaré, Portugal  
25 May - 04 June, 2020  
**25 MAY-4 JUNE**

**CoCosmic**  
Ruben Conde  
**Cosmology and Particle physics**  
Rogério Rose  
**Astrophysics, stars and Dark matter**  
Christoforos Kou  
**Dark Matter**  
Henrique A  
**Machine Learning**  
Yann Co  
**Galaxies and the Starry Messier**  
Alessandro de A  
**Neutrino Physics**  
Mario Gonzalez-G  
**Organizing Committee**  
M. Pimenta

<https://indico.lip.pt/event/643/>

**Joint 9th IDPASC SCHOOL and  
XXXI INTERNATIONAL SEMINAR of  
NUCLEAR and SUBNUCLEAR PHYSICS**  
"Francesco Romano"  
27 May - 4 June 2019, Otranto (Italy)

**Otranto School**

**IDPASC**



# LIP Internship Program | LIP<sup>2</sup>



[lip.pt/estagios-de-verao](http://lip.pt/estagios-de-verao)

[indico.lip.pt/category/36/](http://indico.lip.pt/category/36/)

[cern.ch/lip/si/](http://cern.ch/lip/si/)

[training@lip.pt](mailto:training@lip.pt)

- LIP flagship program — involving all three poles and all research groups
- undergraduate physics students become scientific collaborators on research projects for a two-month period over summer
- students take part in lectures, topical discussions and hands-on tutorials, carry out a research project, and present results at final workshop



# Organization

- 03 ■ project **submission** by researchers
- 04 ■ **announcement**
  - website | poster | social media presentations at universities
- 05 ■ student **application**
- 06 ■ project assignment
  - student+supervisor ranking
- 07 ■ **tutorials** week
- 08 ■ **project development**
- 09 ■ **mid-term** gatherings
- final **presentations**
  - 2-day workshop
- 10 ■ **papers:** editing | review

## Most recent innovations (2019)

### • Lectures

- reduce lecture time
- added “topical chats”

### • Tutorials

- students have choice
- e.g. to match background / interests

### • Mid term

- “August chats”
- students present their planned topics to colleagues

### • Research papers

- students offered possibility to write research paper 5-10 pages long



# INDUCTION TUTORIALS

Introductory  
lectures

+

Thematic  
discussion

+

Hands-on  
exercises





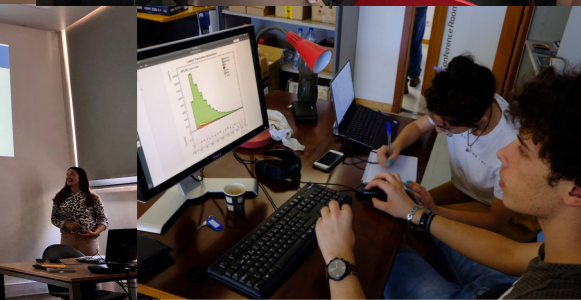
# MID-TERM ACTIVITIES

**'August Chats'**

## Student seminar weekly Sessions

(Students present to colleagues a  
problem they are addressing)

after-work party  
in the garden









# Agenda (2019)

► 11-days worth  
of meetings

15 Jul 2019		16 Jul 2019		17 Jul 2019		18 Jul 2019		19 Jul 2019	
AM	09:20	Opening (until 11:30) ()		09:30	Lecture (until 11:30) ()		09:30	Lecture (until 11:30) ()	
	09:30	Introduction to particle physics (until 11:30) ()		09:30	Introduction to LHC Physics - Michele Gallinaro (LIP) ()		09:30	Detectors and data acquisition in particle physics - Agostinho Gomes (LIP) ()	
	09:30	Introduction to Particle Physics - Mário Pimenta (LIP) ()		10:45	Higgs & BSM - Ricardo Gonçalves (LIP) ()		10:15	RPCs tbc - Alberto Blanco (LIP) ()	
	11:30	Tutoring discussion (until 12:30) ()		11:30	Tutoring discussion (until 12:30) ()		10:45	Detector and physics simulation - Bernardo Tomé (LIP) ()	
PM	14:00	Tutorial (until 17:00) ()		11:30	Tutoring chat: LHC - Nuno Castro (LIP, and University of Minho) ()		11:30	Tutoring discussion (until 12:30) ()	
	14:00	Introduction to Linux and C++ - Diogo Bastos Ana Luisa Carvalho (LIP) Mariana Araújo (1.5.10)		11:30	Tutoring chat: LHC - Filipe Veloso (LIP, UC) (AD1)		11:30	Tutoring chat: Astro - Henrique Carvalho (LIP Minho) Raul Sarmiento (LIP) ()	
	14:00	Introduction to ROOT - João Pedro de Arruda Gonçalves (LIP) Luís Sintra Beatriz Lopes (LIP) (1.5.11)		11:30	Tutoring chat: LHC - Pedrame Bargasasa (LIP) Nuno Leonardo (LIP) ()		11:30	Tutoring chat: Astro - Alex Lindote (LIP, UC) Elias Lopez-Asamar (LIP) (AD1)	
	14:00	Introduction to ROOT - João Pedro de Arruda Gonçalves (LIP) Luís Sintra Beatriz Lopes (LIP) (1.5.11)		14:00	Tutorial (until 17:00) ()		14:00	Data Analysis (until 17:00) ()	

8 Aug 2019		14 Aug 2019		23 Aug 2019		29 Aug 2019		4 Sep 2019		5 Sep 2019	
AM	09:20	Student Seminars - Liliana Apolinário (LIP) ()		11:25	Student Seminars - Tahereh Niknejad (LIP) (until 13:30) ()		11:30	Student Seminars - Patrícia CONDE MUIRO (LIP) (until 13:30) ()		09:20	Session (until 10:40) ()
	09:30	Gamma-ray astrophysics with current and future detectors - Wagner Biotz ()		11:30	High-precision timing detectors for HL-LHC - Gonçalo Raposo Villa Vilor Hugo da Cruz Trindade Cardoso ()		11:30	Exclusive tt-bar production in pp collisions at the LHC - Miguel Nobre Guerreiro ()		09:30	Física Experimental de Partículas com os detectores ATLAS, LUX e LZ - Ângelo Ferreira Tiago Azevedo André Silva ()
	09:30	Chat_Bmeson_QGP_0808.pdf		11:45	O plástico na física de partículas: cintiladores e fibras ópticas - Ivan Pándero Muñoz Francisco Caetano da Silva Laranjinha Hugo Miguel dos Santos Miranda ()		11:30	Exclusive ttbar (August chats).pdf		09:40	Muon num balão: medidas do fluxo de múons até à estratosfera - Pedro Leal João Parente Bárbara Matos ()
	09:30	Chat_Bmeson_QGP_0808.pdf		12:00	b-jets in PbPb collisions with the ATLAS detector - Inês Rebenda ()		11:45	Performance of the ATLAS Hardware Trigger for the High Luminosity Era - Filipe Cruz ()		10:00	Simulações de Monte Carlo para preparar a procura de matéria escura na experiência LZ - Nuno Brito Frederico Simões ()
PM	14:00	Gamma-ray astrophysics with current and future detectors - Wagner Biotz ()		12:00	b-jets in PbPb collisions with the ATLAS detector - Inês Rebenda ()		12:00	Study of the Higgs couplings to top quarks in ATLAS - Gonçalo Fernandes ()		10:15	Ampliação das funcionalidades de um visualizador gráfico 3D do Observatório Pierre Auger - Leonardo Ramalho Luis Neto ()
	14:00	Gamma-ray astrophysics with current and future detectors - Wagner Biotz ()		12:00	b-jets in PbPb collisions with the ATLAS detector - Inês Rebenda ()		12:00	Study of the Higgs couplings to top quarks in ATLAS - Gonçalo Fernandes ()		10:30	Ampliação das funcionalidades de um visualizador gráfico 3D do Observatório Pierre Auger - Leonardo Ramalho Luis Neto ()
	14:00	Gamma-ray astrophysics with current and future detectors - Wagner Biotz ()		12:00	b-jets in PbPb collisions with the ATLAS detector - Inês Rebenda ()		12:00	Study of the Higgs couplings to top quarks in ATLAS - Gonçalo Fernandes ()		10:40	Ampliação das funcionalidades de um visualizador gráfico 3D do Observatório Pierre Auger - Leonardo Ramalho Luis Neto ()
	14:00	Gamma-ray astrophysics with current and future detectors - Wagner Biotz ()		12:00	b-jets in PbPb collisions with the ATLAS detector - Inês Rebenda ()		12:00	Study of the Higgs couplings to top quarks in ATLAS - Gonçalo Fernandes ()		10:40	Ampliação das funcionalidades de um visualizador gráfico 3D do Observatório Pierre Auger - Leonardo Ramalho Luis Neto ()



## 3 editions and counting

	2017 1 <sup>st</sup> edition	2018 2 <sup>nd</sup> edition	2019 3 <sup>rd</sup> edition
<b>Projects proposed</b>		40	38
<b>Applications received</b>		95	78
<b>Students selected/presented</b>	41	63	68/55
<b>Presentations</b>	16	30+3	30

Group	Total
ATLAS	7
Auger	2
Auger/ECO	1
CMS	5
COMPASS	2
DM/ATLAS	1
Dosimetry	1
DUNE	1
LATTES	2
MuTom	3
NUC-RIA	4
Pheno	1
SHiP	1
SNO+	3

Large increase since 1<sup>st</sup> edition — have now reached **sustainable** plateau.

2019



# Research papers

proposal to CERN  
reference schema: **LIP-STUDENT-19-007**  
made available from public database

LIP-STUDENTS-19-996

## B mesons as novel probes of QGP

Jóão Gonçalves<sup>1,\*</sup> and Alexandra Pardal<sup>1,§</sup>

<sup>1</sup>Instituto Superior Técnico, Lisboa, Portugal

<sup>2</sup>Faculdade de Ciências, Lisboa, Portugal

Project supervisors: N. Leonardo, J. Silva

**Abstract.** In this work we study B mesons as novel probes of the quark gluon plasma (QGP). We used PbPb data collected by the CMS experiment at the LHC in November 2018. The  $B^0$  and  $B^+$  production differential cross-sections in PbPb collisions are measured. The cross sections of the two mesons and their ratios provide useful information about the properties of the QGP and how the hot and dense QCD medium affects the hadronization of the quarks. The B meson is observed for the first time in heavy ion collisions.

**Keywords:** LHC, QGP, B mesons, production cross sections, energy loss, strangeness enhancement

## Contents

1 Introduction	1
2 The CMS detector	1
3 Data, MC samples and signal selection	2
4 Extracting signals from busy ion collisions	2
4.1 Sideband subtraction	2
4.2 $\chi^2$ fit	2
5 Yield measurement	4
5.1 Likelihood model	4
5.2 Yield results and significance	4
5.3 Fit validation	5
5.4 Systematic uncertainties from fit procedure	5
5.5 Systematic uncertainties from PDF modeling	5
5.6 Differential yield	5
6 Efficiency determination	6
7 Differential cross-section measurement	7
7.1 Data representation (abscissa)	7
7.2 Systematic uncertainties	7
8 Skills acquired	8
9 Summary and perspectives	8

## 1 Introduction

Quantum chromodynamics (QCD) predicts that under extreme conditions of temperature and/or density the Quark-Gluon Plasma (QGP) is formed. The QGP existed microseconds after the Big Bang and it is a state of matter formed by deconfined quarks and gluons. It can be recreated at the LHC by colliding heavy nuclei (Pb) at the highest energies [1].

B mesons are composed by a bottom antiquark ( $\bar{b}$ ) and an up, down, strange or charm quark. In this experimental setup, the production of B mesons is studied by the CMS experiment. The production of B mesons is studied by the CMS experiment. The production of B mesons is studied by the CMS experiment.

LIP-STUDENT- Project 52

## Efficient Modelling of Optical Photon Propagation in SNO+

Samuel Filipe Azevedo Magalhães<sup>1,§</sup>

<sup>1</sup>University of Birmingham, Birmingham, United Kingdom

Project supervisor: Nuno Barros

February 13, 2020

**Abstract.** SNO+ is a liquid scintillator experiment that seeks to observe the neutrinoless double beta decay process. If seen, this decay can prove that neutrinos are their own antiparticles (Majorana Nature) and potentially also their effective mass. To characterize these events it is critical to have a good understanding of the detector's response. In fact, the optical response of the experiment was affected by aging of some of its components. This work attempts to improve the PMT angular response model (efficiency) in collecting light depending on the incident angle) by allowing the reflection model to vary the diffuse and direction reflection fractions as a function of the position in the light concentrators. An improvement in the match between data and simulation was verified.

**Keywords:** Optical model, SNO+, PMT, Concentrators, Optical calibration

## 1 Overview of the detector

### 1.1 Components

- The SNO+ detector [1] located in Vale's Creighton mine at a depth of 2 km is a remodelling of the SNO experiment. It is comprised of the main following features: (a) full detection of an unbiased fitting procedure in Section 5.1, 4, and 5.5 and to study how the QGP affects the hadronization of the quarks.
- Acrylic Vessel (AV): The AV is spherical and filled with liquid scintillator. The overall structure is positioned concentrically and all the operations are held in the dark level.
- PMT Support Structure: Steel sphere that encloses approx. 9000 Photomultiplier Tubes (PMTs).

work we study the  $B^0$  meson ( $\bar{b}u$ ) and the  $B^+$  meson ( $\bar{b}c$ ) [2]. Bottom quarks are created in the initial hard scattering stage and retain their identity while traversing the medium they are in, thus providing information about its evolution. By comparing  $p$  and  $\bar{p}$  collisions (vacuum medium) with PbPb collisions (QGP), we can therefore use B mesons as probes to study the QGP properties. The goal of this study is to measure the B meson's cross section in PbPb collisions at 5.76 TeV and to study how the QGP affects the hadronization of the quarks.

The cross-section is given by:

$$\sigma = \frac{N}{L \cdot \mathcal{L}} \quad (1)$$

where  $N$  is the signal yield,  $\mathcal{L}$  the luminosity,  $\mathcal{B}$  the branching fraction,  $\mathcal{A}$  the acceptance and  $\epsilon$  the efficiency. While  $N$  is measured from the data, through the implementation of an unbiased fitting procedure in Section 5.1, 4, and 5.5 and to study how the QGP affects the hadronization of the quarks.

## 2 The CMS detector

The Compact Muon Solenoid (CMS) is one of the four large experiments at the Large Hadron Collider (LHC). In Fig. 1 is represented a transversal slice of the detector and its layers. When the particles travel through the detector they leave signatures (deposits of energy) in different layers, which allow their identification. In Fig. 1 it is possible to identify these layers from inward to outward: the silicon tracker, which measures the positions of passing charged particles allowing their track reconstruction; the electromagnetic calorimeter (ECAL) and the hadronic calorimeter (HCAL), which measure the energy of particles; the solenoid, with a magnetic field of 3.8 T, that bends the trajectory of particles, allowing the measurement of their charge and momentum; and, the muon chambers, where the muons are detected, which are able to penetrate dense materials. The most important subdetectors for this analysis are the silicon tracker and muon detectors, that are employed to trigger and measure the final

Figure 1: Diagram of the SNO+ detector. The AV (Acrylic Vessel) in blue is supported by ropes (red and pink). The Green sphere is where the PMTs are enclosed

## 1.2 Goals of the experiment

SNO+ goal is to search for the neutrinoless double-beta decay ( $0\nu\beta\beta$ ) of the  $^{150}\text{Nd}$  isotope [1]. If observed it would demonstrate that neutrinos are their own antiparticles (Majorana Nature).

LIP-STUDENTS-19-996

## AMBER- Physics Simulations for a new experiment at CERN

Rita Ataíde da Silva<sup>1,\*</sup>

<sup>1</sup>Instituto Superior Técnico, Lisboa, Portugal

Project supervisor: C. Quintans

February 13, 2020

**Abstract.** AMBER is a new project for a fixed target experiment at CERN. One of its goals is to learn about quarks and gluons dynamics inside hadrons. Physics simulations were performed using Pythia in order to analyze a very rare process, Drell-Yan. Drell-Yan is a quark-antiquark annihilation, where the resulting virtual photon decays to a pair of muons. The starting point was to study all the accompanying particles produced, and then focus on the kinematical variables associated to the dimuons, from the transverse momentum to the invariant mass of the dimuon system. The acceptance of the detector was also simulated, by applying some cuts to the muons polar angle. Finally, it was analyzed the effects of proton misidentification by a pion.

**Keywords:** AMBER, PHYTIA, Bjorken  $x$

## 1 Introduction

### 1.1 AMBER

The COMPASS++(AMBER) collaboration.

For the dimuon:

•  $p_T$ : transverse momentum;

•  $p_{\text{miss}}$ : absolute momentum;

LIP-STUDENTS-19-999

## Measurement of $J/\psi$ polarization in $p\bar{p}$ collisions at $\sqrt{s} = 8$ TeV in

Francisco Alberga<sup>1,\*</sup> and Henrique Borges<sup>1,§</sup>

<sup>1</sup>Instituto Superior Técnico, University of Lisbon

Project supervisors: Mariana Araújo, Pietro Faccioli and João Seixas.

February 13, 2020

**Abstract.** The polarization of prompt  $J/\psi$  mesons is measured in proton-proton collisions at  $\sqrt{s} = 8$  TeV, using a data sample collected by the CMS experiment at the LHC. The prompt polarization parameter  $A_{FB}$  is measured from the dimuon decay angular distributions in the helicity frame. The  $J/\psi$  results are obtained in the transverse momentum range  $12 < p_T < 70$  GeV and in the rapidity interval  $|\eta| < 1.5$ . No evidence of large polarization is seen in these kinematic regions, which is in agreement with previous measurements. Preliminary results of this analysis are shown here for the first time.

**Keywords:** QUARKonium, POLARIZATION, NRQCD, QCD, HADRON FORMATION

## 1 Introduction

Non-relativistic quantum chromodynamics (NRQCD) is the most satisfactory effective theory capable of explaining the production and decay of heavy quarkonium. However, the polarization of  $J/\psi$  mesons is not correctly described in this theory, where the purely perturbative colour-singlet production is complemented by processes including possible non-observable transitions from colour octet states to the observable bound states. Therefore, it is crucial to analyze the most recent experimental results, which already reaches rather high quarkonium transverse momentum,  $p_T$ , where the calculations are expected to be more reliable [1], and compare it with the theory predictions. In fact, for high transverse momentum, the directly produced S-wave quarkoniums are expected to be transversely polarized with respect to the direction of their own momentum. If inconsistencies between the predictions made by the theory and the experimental results are found, it is important to discover if those discrepancies are originated from approximations and inaccuracies of the fixed-order perturbative calculations available at the moment or from difficulties in the conceptual basis of the theory.

Through the study of the angular distribution of the leptons produced in the  $p\bar{p} \rightarrow J/\psi + \text{quarkonium states}$   $p\bar{p} \rightarrow J/\psi$  decay, we can measure their polarization, determined by the lambda parameters, from the expression developed by Quantum Mechanics:

$$W(\cos\theta, \phi) = \sum_{\lambda} P_{\lambda}^2 W_{\lambda}^2 = \left(1 + A_{FB} \cos^2\theta + B_{FB} \sin^2\theta \cos 2\phi + C_{FB} \sin^2\theta \cos\phi\right) \frac{3}{4\pi(1+A_{FB})} \quad (1)$$

with  $\phi$  and  $\theta$  being, respectively, the azimuthal and polar angles of the  $\mu^+$ , with respect to the  $z$  axis of the selected polarization frame [2].

\*e-mail: francisco.alberga@tecnico.ulisboa.pt  
§e-mail: henrique.jorge.borges@tecnico.ulisboa.pt

LIP-STUDENTS-19-996

## Plastic in Particle Physics - Aging of WLS Optical fibers using the Fibrometer testbench of LOMAC

Ivan Panadero<sup>1</sup>, Hugo Miranda<sup>2</sup>, and Francisco Laranjinha<sup>3</sup>

<sup>1</sup>Universidad Autónoma de Madrid, Spain

<sup>2</sup>Instituto Superior Técnico, Portugal

<sup>3</sup>Faculdade de Ciências da Universidade de Lisboa, Portugal

Project supervisor: A. Gomes, R. Gonçalves, J.G. Saraiva

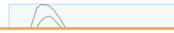
February 13, 2020

**Abstract.** The ATLAS barrel hadronic sampling calorimeter, uses scintillating plastic tiles as the sensitive medium and wavelength shifting (WLS) plastic optical fibers to guide the collected light to photodetectors. The same type of detection principle is one of the options for hadron calorimetry at future colliders. Regarding the type of detection systems and during the interplay at LOMAC the following was studied: the natural aging of WLS fibers during 20 years. For the optical fibers, light yield follows the trend of the used reference fibers for the measurements taken during a period of 20 years. The optical fibers attenuation length decreases during this period of time. The ratio of light intensity at different points of the fiber over time remained constant.

**Keywords:** LHC, Tile Calorimeter, Optical fibers, Aging

## 1 Introduction

For this work we have performed a 20 year old follow-up.



LIP-STUDENTS-19-999

## Characterization of Scintillators for the Future Circular Collider as a function of their dimensions

Rudinei Machado<sup>1,\*</sup>

<sup>1</sup>Faculdade Anhangá de Juiz de Fora

Project supervisor: R. Gonçalves

February 13, 2020

**Abstract.** The calorimeters to operate in experiments at the hadronic Future Circular Collider - FCC-hh - will be one of the key pieces for the complete exploration of the high-energy frontier. This is because the increase in energy in proton collisions will require detectors that can work in environments of severe radiation, with high energy rates, presenting a high resolution and low granularity. In this context, the choice of the hadronic calorimeter is of the utmost importance. The ATLAS barrel hadronic sampling calorimeter (HB) will be inspired by the ATLAS Tile Calorimeter (TileCal). The HB will have 10 layers, with scintillating tiles that will be separated through a reflective material (e.g. Tyvek) and read by wavelength displacement fibers (WLS) of 1 mm in diameter connected to silicon photomultipliers (SiPMs). Our study focuses on the comparison of the luminous signal intensity in the tile of the first layer of the HB and the tile in the last layer of HB, taking into account the dimensions of the tile. A study of the optimization of the signal uniformity with a light-absorbing black wrap deposited on the tile was made, and results were compared with similar experiments performed at CERN. The procedure was performed in the TileEmul, an ATLAS experiment.

**Keywords:** Future Circular Collider, tile, Calorimeter, signal uniformity

and ultraviolet (UV) ranges. These detectors can be of various types, but our study is based on organic scintillators with a solid plastic solvent.

## 1.2 Plastic Scintillators

Plastic scintillators are currently one of the most economically viable options, and their light yield is associated with the interactions of the particle with the scintillator molecules. According to [5]:

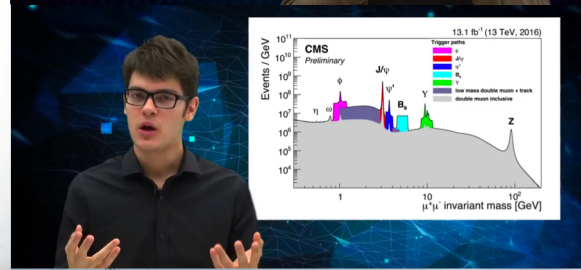
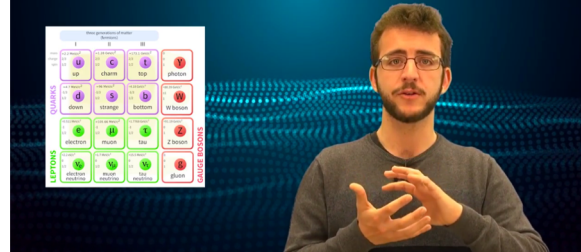
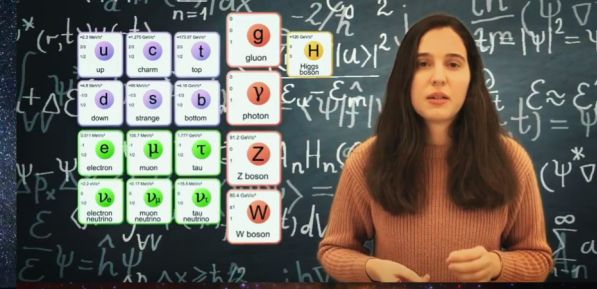
In a scintillating solution, usually composed of a solvent substance plus one or two substances capable of emitting light when dissipating energy, the charged particles and the secondary electrons release energy interacting mainly with the molecules of the solvent, most of them in the scintillating solution, increasing the thermal energy of these who have undergone interaction. Part of the released energy will also be consumed in the creation of ion pairs, free radicals and molecular fragments, making the luminous efficiency of the scintillating solution dependent on the way these products recombine. The concentration of these products will depend on the specific ionization of the radiation, being higher around the trajectory of the particle, mainly in its initial point of interaction, causing a reduction of the luminous efficiency every time this great quantity of ions and excited molecules react among themselves, instead of reacting with the molecules of the scintillators, a phenomenon denominated as extinction by ionization.



# Student work dissemination

- ▶ outreach videos
- ▶ student papers
- ▶ theses **LIP-THESIS-19-007**

$t\bar{t}$  production







# ECO needs everyone's collaboration!

questions? suggestions? willing to participate?  
[outreach@lip.pt](mailto:outreach@lip.pt)