



LABORATÓRIO DE INSTRUMENTAÇÃO
E FÍSICA EXPERIMENTAL DE PARTÍCULAS
partículas e tecnologia

[Outreach with cosmic messengers @ LIP]

A collage of three images at the bottom of the slide, all with a blue tint. From left to right: a close-up of a circular detector component with several circular openings; a large, complex particle detector structure, possibly the ATLAS or CMS detector, with a person standing next to it for scale; and a close-up of a printed circuit board (PCB) with various electronic components and traces.

Catarina Espírito Santo, LIP-Lisboa, May 2019

Outreach with cosmic messengers @ LIP

Outline



LIP

ECO at LIP

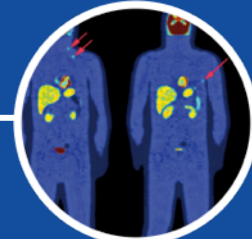
Outreach
with cosmics

The Lousal muon
tomography project

1.

LIP in a nutshell

Laboratory for Instrumentation and Experimental Particle Physics



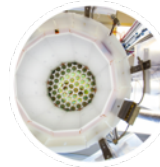
WHAT

LIP IS

The reference institution for experimental particle physics in Portugal, and the reference partner of CERN in Portugal



Experimental particle and astroparticle physics



Development of new instruments and methods



Scientific computing



Knowledge transfer, education and outreach

WHERE

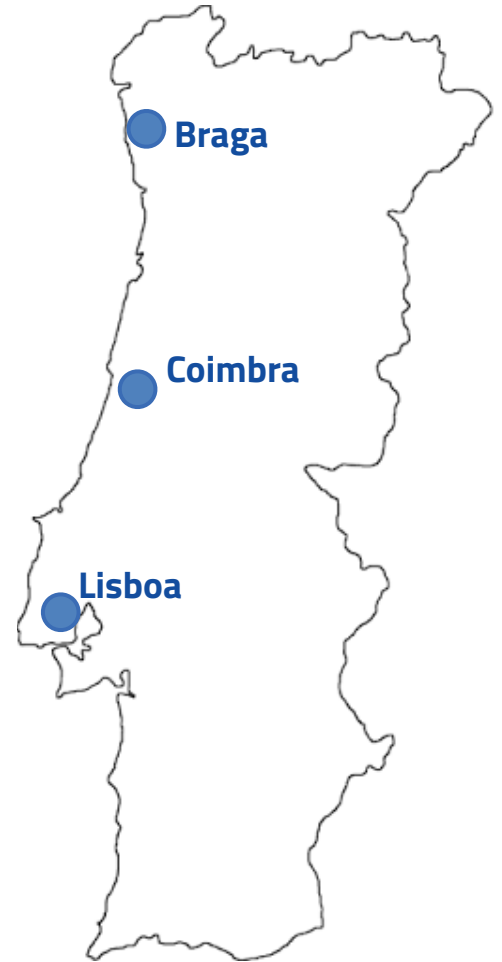
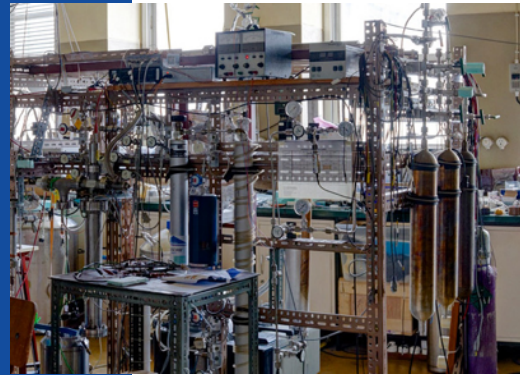
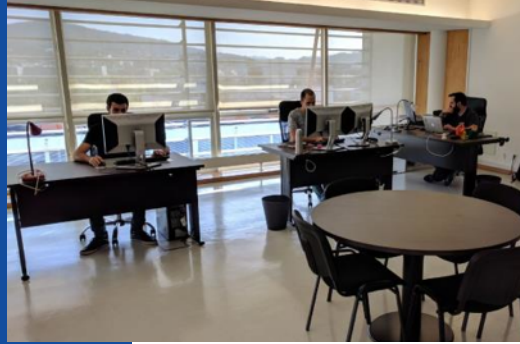
LIP IS

A nation-wide laboratory
working in close
collaboration with the
local universities

86 PhD researchers

87 Graduate students

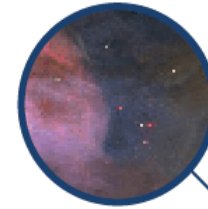
33 Technicians



Research Areas

- **Experimental particle and astroparticle physics**
- **Development of new instruments and methods**
- **Scientific computing**

Experimental particle and astroparticle physics



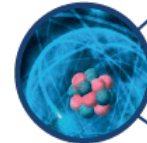
LHC experiments and phenomenology



- ATLAS
- CMS
- Pheno

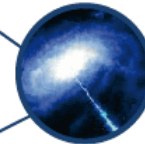
Structure of matter

- COMPASS
- GSI/FAIR
- ISOLDE



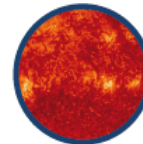
cosmic rays

- AMS
- AUGER
- LATTES



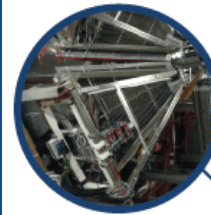
Dark matter and neutrinos

- LUX / LZ
- SNO+
- DUNE
- SHiP

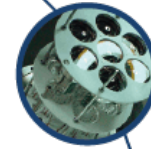


Research Areas

- Experimental particle and astroparticle physics
- **Development of new instruments and methods**
- Scientific computing

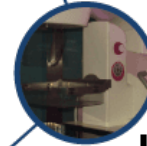


Development of new instruments and methods



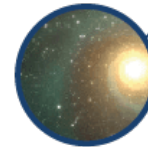
Detectors for Particle and nuclear physics

- RPCs
- Neutron detectors
- Gaseous/Xenon detectors



Health applications

- PET imaging
- Radiotherapy instrumentation
- Dosimetry



Space applications

- Space radiation environments
- Astrophysics instrumentation / polarimetry

Research Areas

- Experimental particle and astroparticle physics
- Development of new instruments and methods
- **Scientific computing**



Scientific Computing

- R&D in information technologies
GRID CLOUD HPC
- National and international infrastructures and consortia
- Support to the scientific community



Infraestrutura
Nacional de
Computação
Distribuída



WLCG
Worldwide LHC Computing Grid

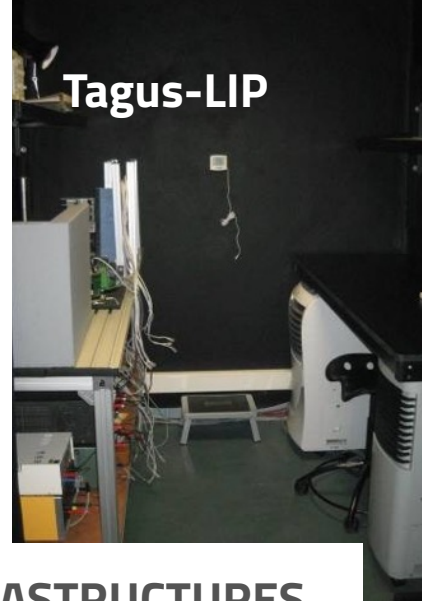




**Mechanical
Workshop
LIP - Coimbra**



**LOMaC
LIP - Lisboa**

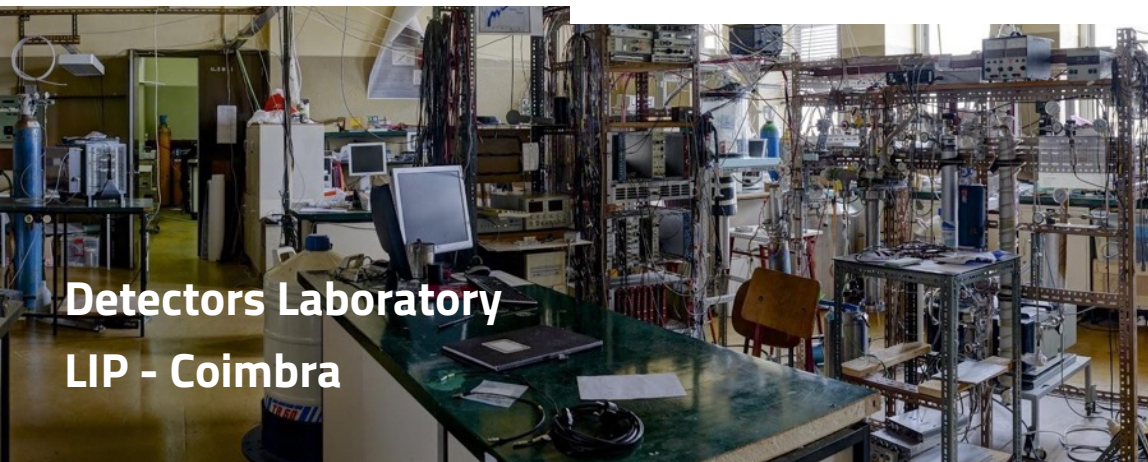


Tagus-LIP



NCG - Lisboa

RESEARCH INFRASTRUCTURES



**Detectors Laboratory
LIP - Coimbra**

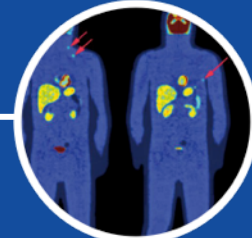


**e-CRLab
LIP - Lisboa**

2.

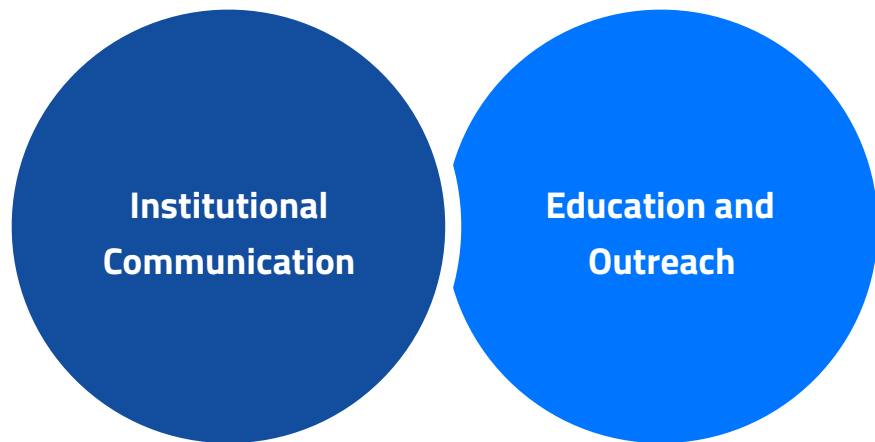
LIP-ECO

Education, Communication and Outreach at LIP



LIP-ECO (Education, Communication and Outreach)

part of our social role and fundamental for the recognition of an institution's work



with the participation of all scientific groups at LIP

Our partners: Universities, SPF, Agência Ciência Viva, IPPOG, EPPCN

Institutional Communication

Internal digital newsletter



SciCom training



Reports & evaluations



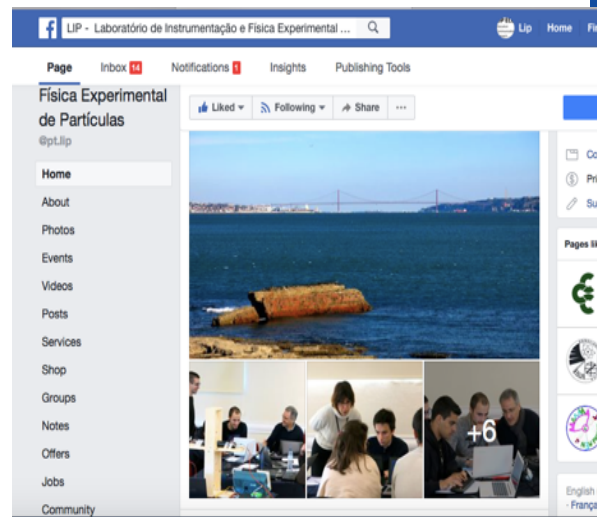
LIP Bulletin



Press communications



Web & Social media



Education
and
Outreach

Flagship initiatives

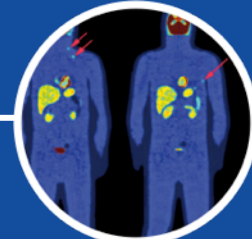
- CERN's Portuguese Language Teacher's programme
- IPPOG's International Masterclasses in Particle Physics
- Summer internships for high-school students
- Public sessions and seminars in schools



3.

Outreach with cosmics

Messengers from the Universe



Cosmic messengers

Great outreach potencial

- Making particles “real”
- The fascination of exploring the Universe
- Convey science results, but also the making of science
- Applications to other areas

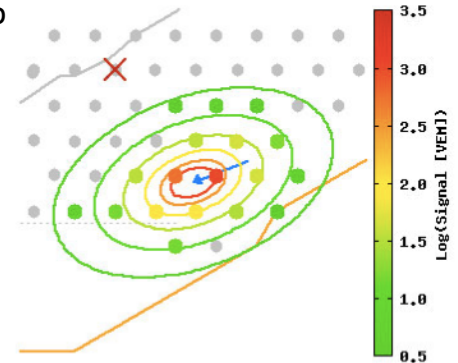
The LIP spark chamber

Already in 12 locations around the world



Exploring the Auger public dataset

- A guide to explore the data was developed at LIP
- Used at schools and in summer internships
- Available in PT, EN and SP



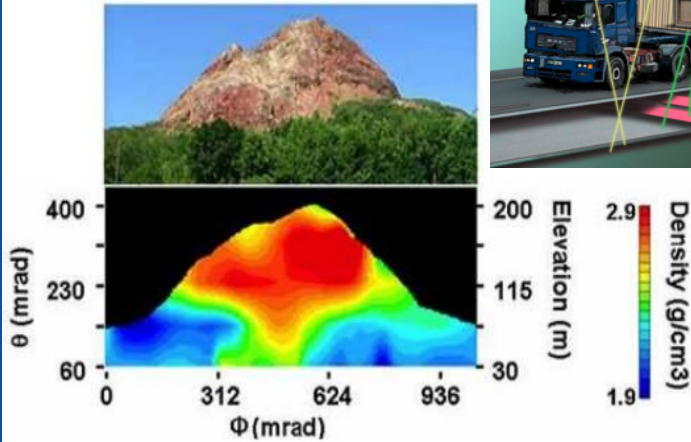
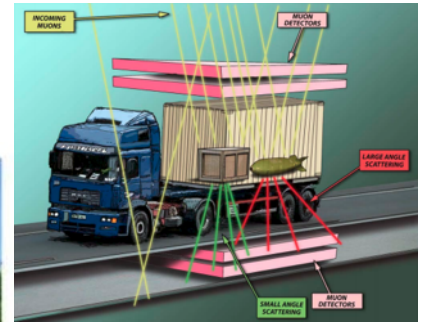
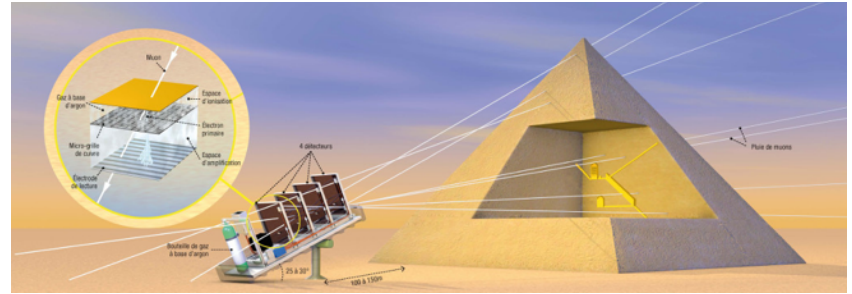
Cosmic messengers

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Muon tomography

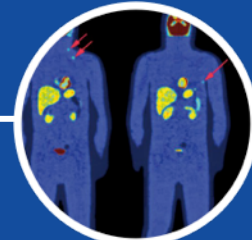
From archeology to geology and security



4.

The LouMu project

Muon tomography at the Lousal Mine



A muon tomography project in Portugal

- Partnership with other communities
particle physics + geology techniques
- Using RPC detector technology
- A prototype currently working at Lousal:
Testing detectors and combination of techniques
- A basis for future projects

LIP

University of Évora

Lousal mine Science Centre

Coordinator: Lorenzo Cazón

mutom-inf@lip.pt



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Instituto de Ciências da Terra
Institute of Earth Sciences

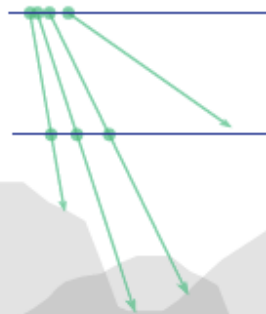
Centro Ciência Viva do Lousal
Mina de Lousal



LouMu

caracterizar a mina do Lousal
com tomografia muónica

Muões na Mina do Lousal



www.lip.pt/LouMu

The Lousal site



First prototype installation



Lousal mine a science centre

- Encounters with the project: talks + visits
- Dedicated module in the exhibition
 - Cosmics: spark chamber; RPC-based demo
 - Muon tomography: interactive module
- Flyers and posters:
 - museum, entrance to the mine, near the detector
- Data can be analysed remotely
 - Summer internships, master projects



LouMu

Muões na Mina do Lousal

caracterizar a mina do Lousal com tomografia muônica

Combinamos as técnicas de tomografia muônica e gravimetria para mapear a estrutura geológica da mina, medindo indiretamente a densidade dos materiais em diferentes pontos e a diferentes profundidades

estrutura geológica

a densidade dos materiais a diferentes profundidades é medida indiretamente

muões

partículas elementares, semelhantes ao elétron mas com massa 200 vezes maior, perdem menos energia lentamente e a sua carga ioniza os átomos que encontra
250 muões/m²/segundo ao nível do mar
10 muões/m²/segundo 30 m de baixo de Terra

raios cósmicos

núcleos atômicos vindos da galáxia, criam cascas de partículas na atmosfera, a todo o momento e em todas as direções

gravímetro

gravímetro

gravimetria

os gravímetros medem com grande precisão a aceleração da gravidade num determinado ponto, o que permite inferir a quantidade total de matéria na vertical desse ponto

planos detetores

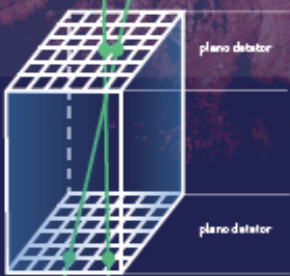
câmaras de placas resistivas (RPC) detetam ionização no ponto de passagem do muão num gás sob alta tensão e geram um sinal elétrico

telescópio

sinais simultâneos nos vários planos detetores identificam o muão e a sua direção

mapa de muões

a quantidade de matéria atravessada determina o número de muões que lá chega



coluna de matéria
(profundidade x densidade)
combinando tomografia muônica com informação medida por vários gravímetros



Thanks!