



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



Universidade do Minho  
Escola de Ciências

# Overview of Experimental High Energy Physics in Portugal

RECFA visit to Portugal - Open Session

15<sup>th</sup> September 2023

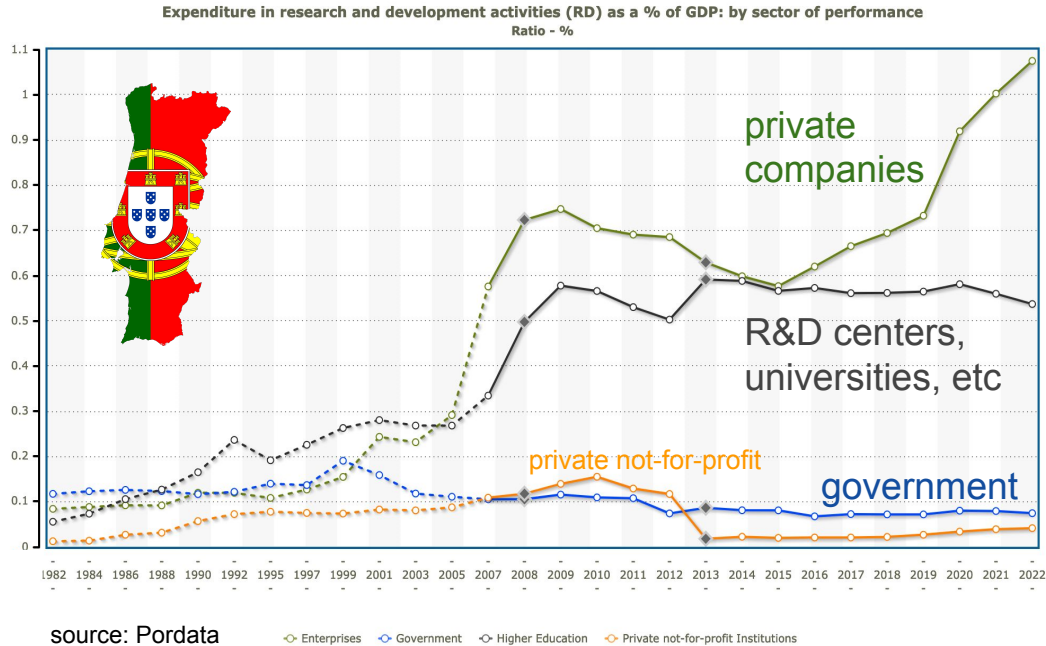
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Fundação  
para a Ciência  
e a Tecnologia

UIDP/50007/2020, LA/P/0016/2020

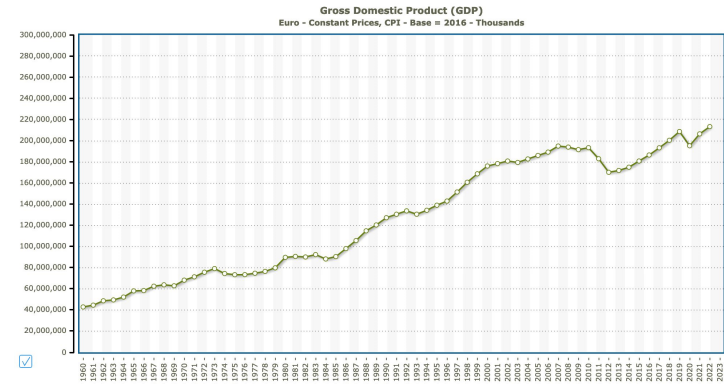
*Nuno Castro*  
[nuno.castro@cern.ch](mailto:nuno.castro@cern.ch)

# Portugal in a nutshell



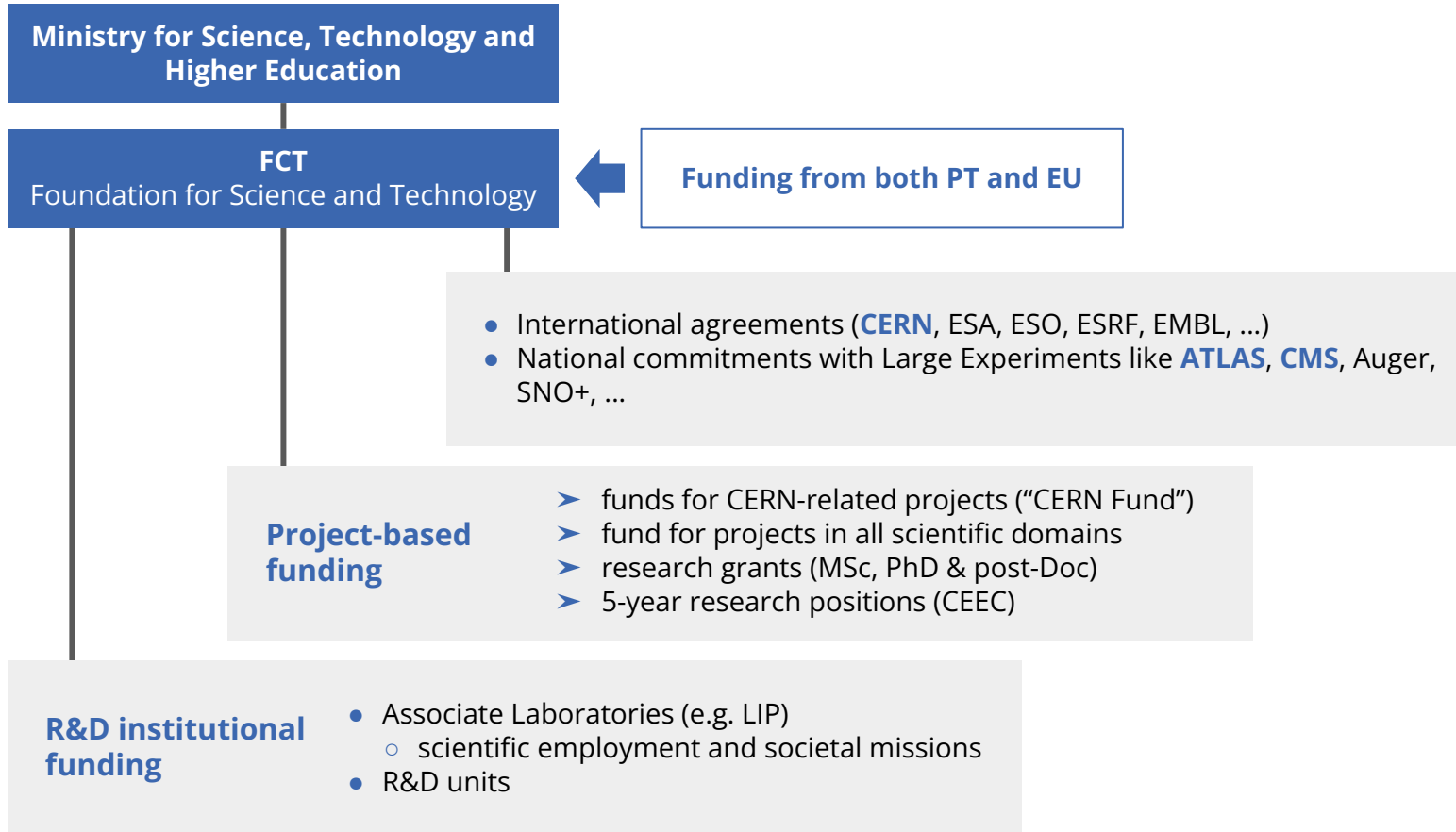
- public sector: ~0.7% of the GDP in R&D

- area: 92 256 km<sup>2</sup>
- population: 10,467,366
- GDP: 251 billion €
  - per capita: 24 k€



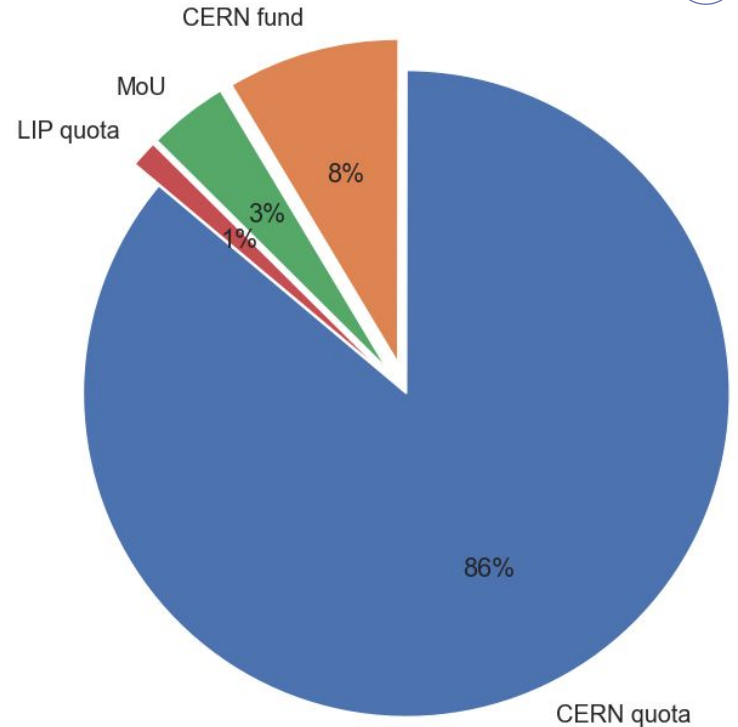
source: Pordata

# Research funding (national funds for HEP)



# National research budget for HEP (2022)

Contribution	Funding (k€)
CERN yearly PT contribution	13000
MoUs	600
LIP quota (will not be paid in 2024)	200
CERN Fund (per year)	1250
<b>Total</b>	<b>15050</b>



## Other competitive funding sources (estimated annual values):

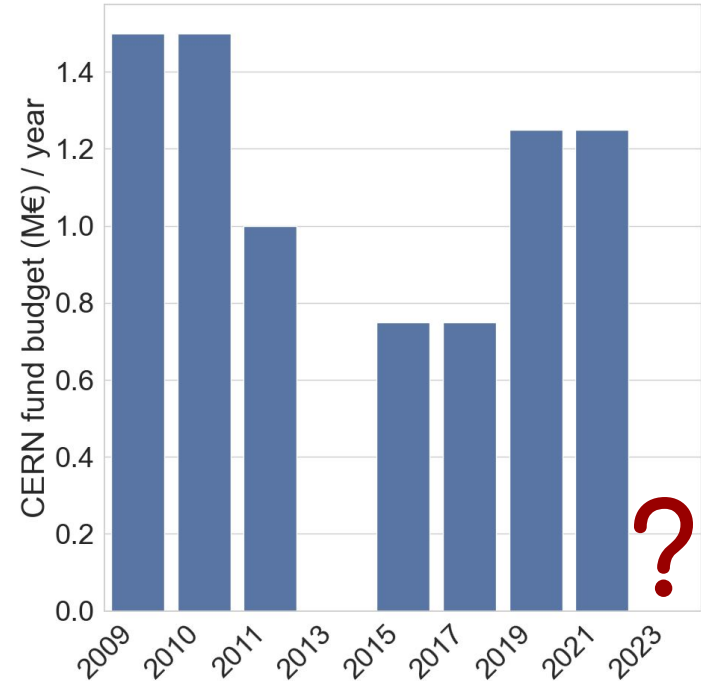
- PhD grants PT-CERN: 15.5k€ \*15
- Fellowships/Postdocs (all science domains): 150 k€
- Researchers contracts: 50 k€ \* 20
- R&D units core funding (e.g. LIP): 1.6M€



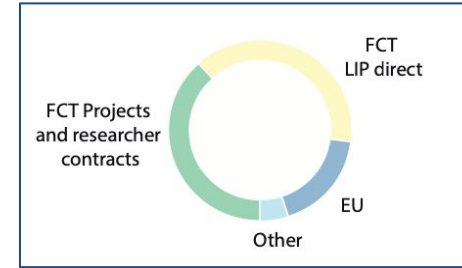
# CERN-related funding ("CERN fund")

*"competitive call for R&D projects associated with official scientific collaborations or those recognised by CERN, as well as HEP theory and technology-based projects in the field of applied sciences"*

Year	Funding (M€)	Durantion
2009	1,5	1 year
2010	1,5	1 year
2011	2,0	2 years
2015	1,5	2 years
2017	1,5	2 years
2019	2,5	2 years
2021	2,5	2 years
2023	TBD	TBD



# Research funding (other sources)



**European Research Council**

Established by the European Commission



**"la Caixa" Foundation**

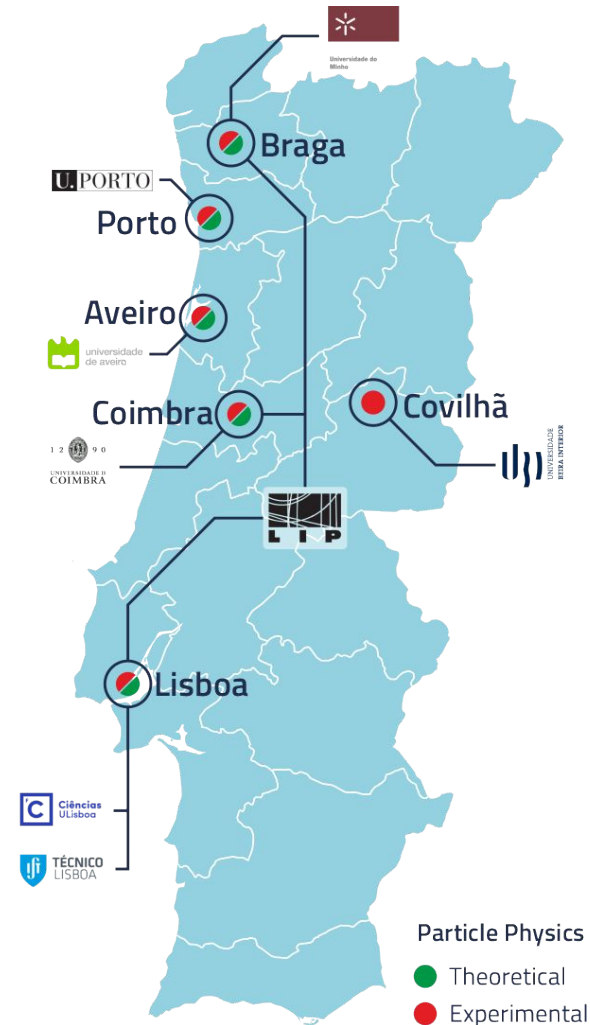


**AGÊNCIA NACIONAL  
DE INOVAÇÃO**



# HEP in Portugal

- **Experimental particle physics**
  - Research labs: LIP
    - 3 poles: Lisbon, Coimbra and Minho
  - Universities: Minho, Coimbra, Lisboa
  - Small groups in: U. Aveiro, LIBPHYS
- **Theory** (talk by M. Nesbitt / F. Joaquim)
  - Universities: Minho, Coimbra, Lisboa, Porto, Aveiro
  - Research centres: CFTP, CENTRA, CFTC, CFUM, CFisUC, CEFEMA
- **Other activities**
  - U.Lisboa, U. Aveiro, CTN/IST, U. Beira Interior (ISOLDA, CLOUD, ...)
  - IPFN (AWAKE), talk by L. O. Silva
  - Coimbra, Aveiro, Minho (quantum computing), talk by Y. Omar



- LIP is the reference laboratory for experimental particle physics and associated technologies in Portugal
- LIP exists for the discovery of the fundamental laws of the Universe, ensuring the full participation of the Portuguese scientific community in this endeavour, and to share this knowledge with society
- The laboratory is nation-wide, with nodes in Lisbon, Coimbra and Braga, in close collaboration with the local universities



<https://www.lip.pt>

# LIP in numbers - 2023

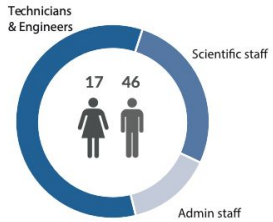
TOTAL  
262



PHD RESEARCHERS  
96

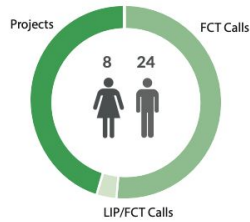


## STAFF



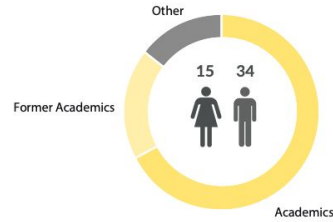
=  
**63**  
TOTAL

## FIXED-TERM RESEARCHERS



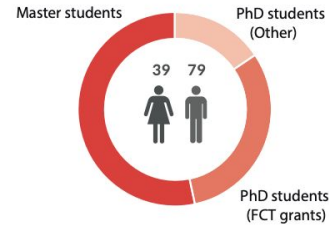
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**32**  
TOTAL

## UNPAID

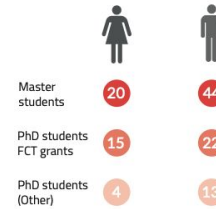
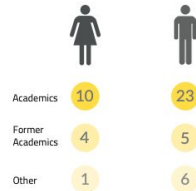
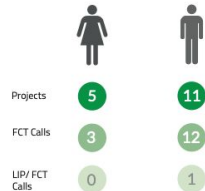
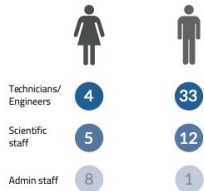


=  
**49**  
TOTAL

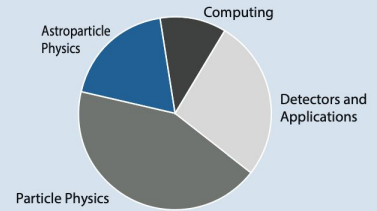
## STUDENTS



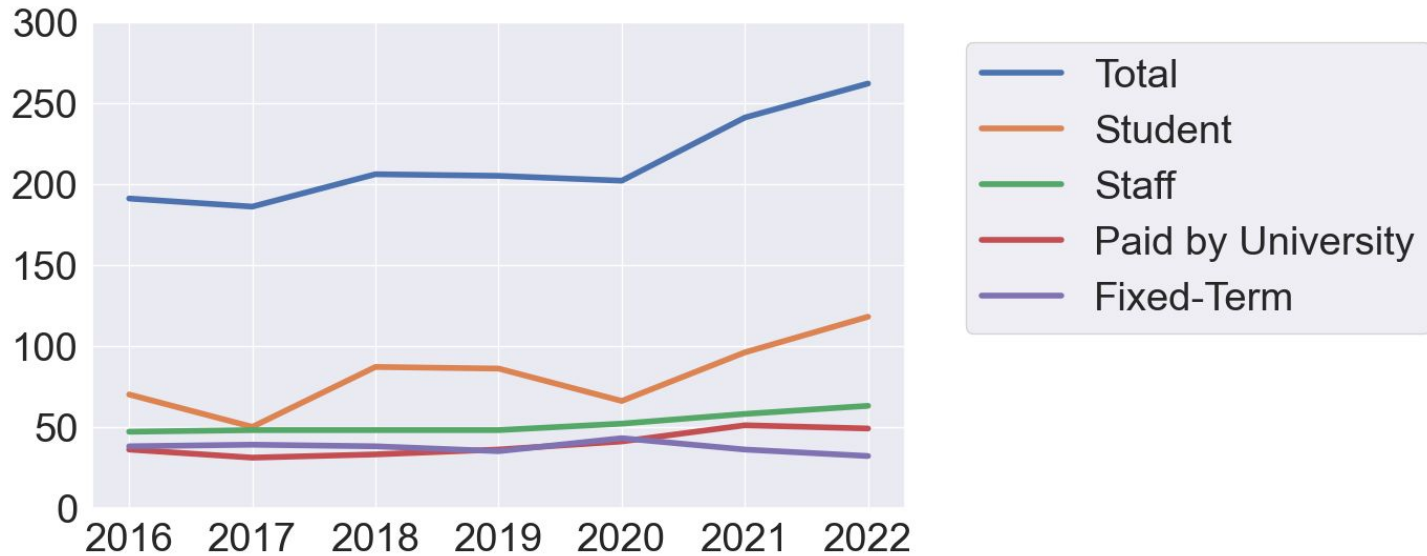
=  
**118**  
TOTAL



## DISTRIBUTION BY RESEARCH AREA

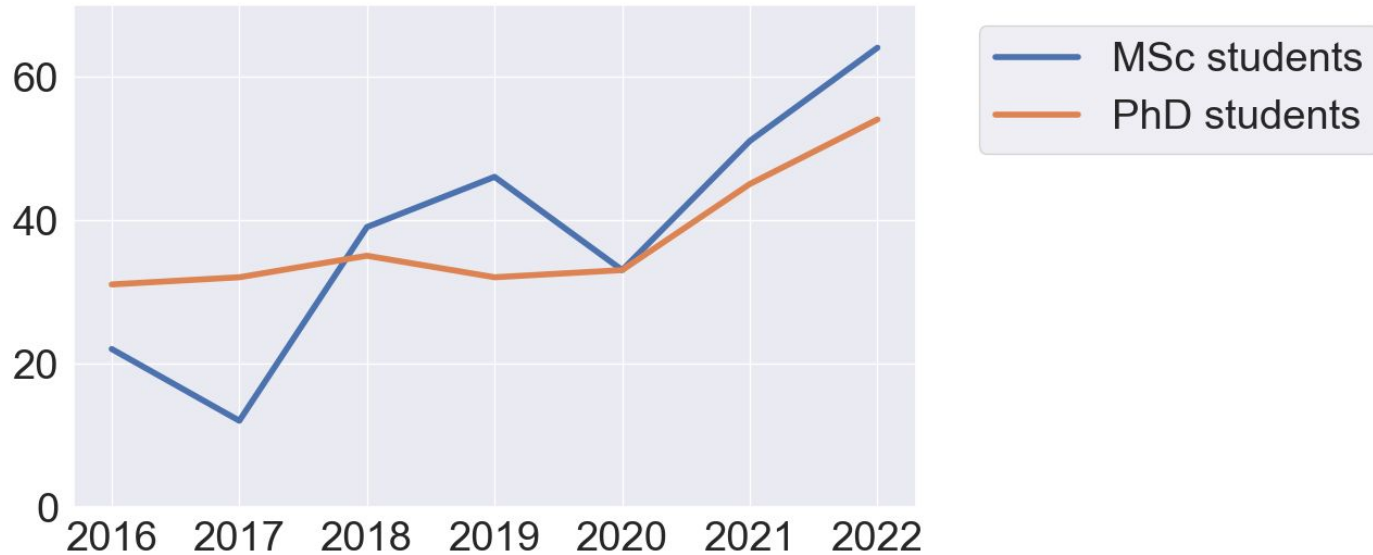


# LIP in numbers - evolution

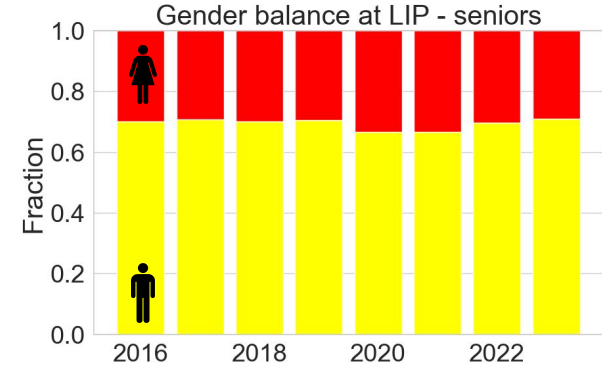
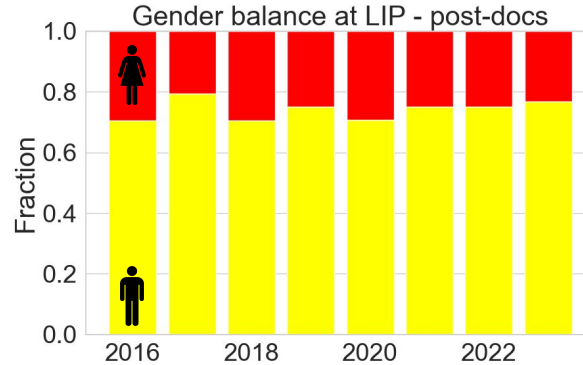
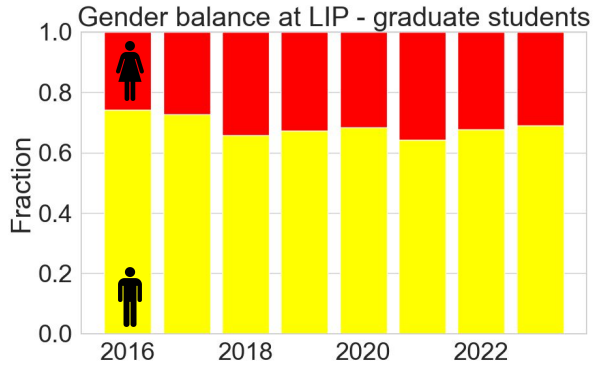




# LIP in numbers - student's evolution



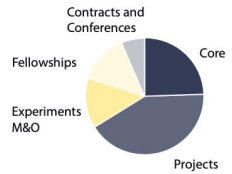
# LIP in numbers - gender balance



- LIP's gender equality plan: <https://web.lip.pt/documents/regulations/Plano-de-Igualdade-de-Genero-EN.pdf>
- LIP participates in the [GENERA network](#), having signed the [SAGE](#) agreement

# LIP budget - 2022

## GENERAL FUNDING



1.6M  
CORE FUNDING

2.7M  
PROJECT-BASED

0.9M  
FELLOWSHIPS

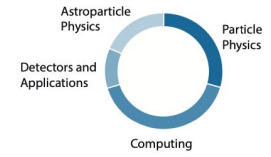
0.9M  
EXPERIMENTS M&O

0.4M  
CONTRACTS AND CONFERENCES

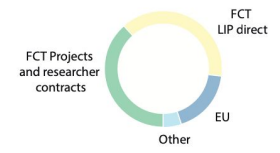
**TOTAL**  
6.5M €

## PROJECT AND CONTRACT-BASED FUNDING

### BY RESEARCH AREA

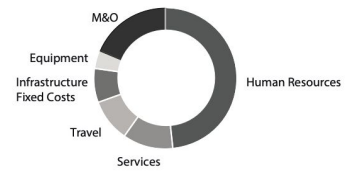


### BY ORIGIN



TOTAL  
**2.7M €**

## COSTS



### HUMAN RESOURCES

STAFF 2.2M

FIXED-TERM RESEARCHERS 1.8M

SERVICES AND OTHER EXPENSES 0.5M

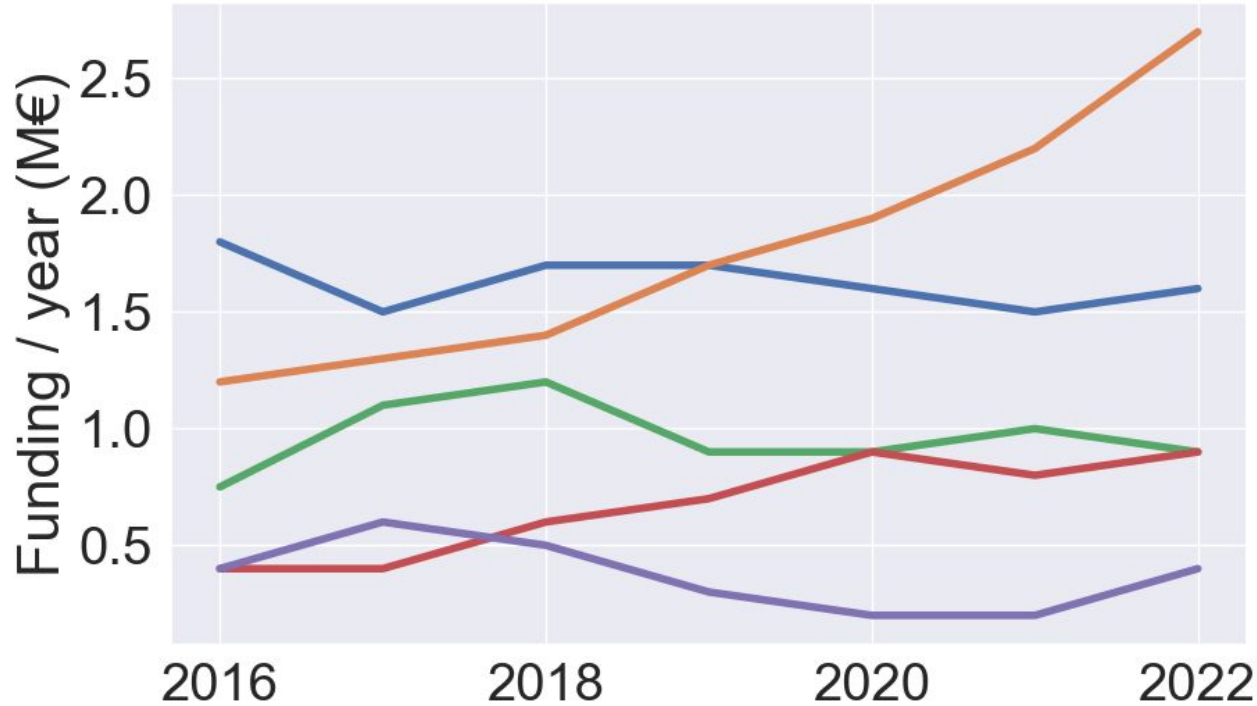
TRAVEL 0.5M

EXPERIMENTS M&O 0.9M

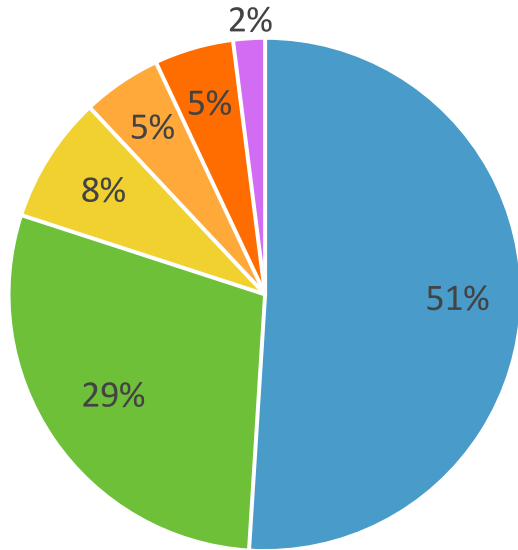
INFRASTRUCTURE FIXED COSTS 0.4M

EQUIPMENT 0.2M

# LIP budget - evolution



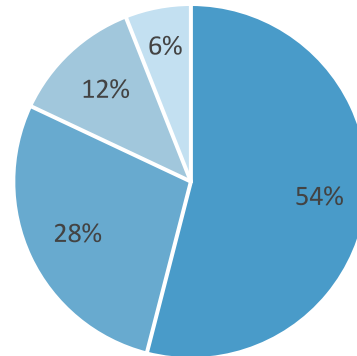
# Annual average cost (2015-2019)



- HR Paid by LIP
- HR Paid by Other sources
- Missions
- Equipment, consumables and services
- Costs of structure
- Conferences, ECO and other

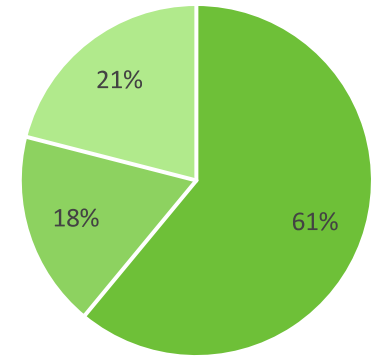
Main component : human resources - **80%**

### HR paid by LIP



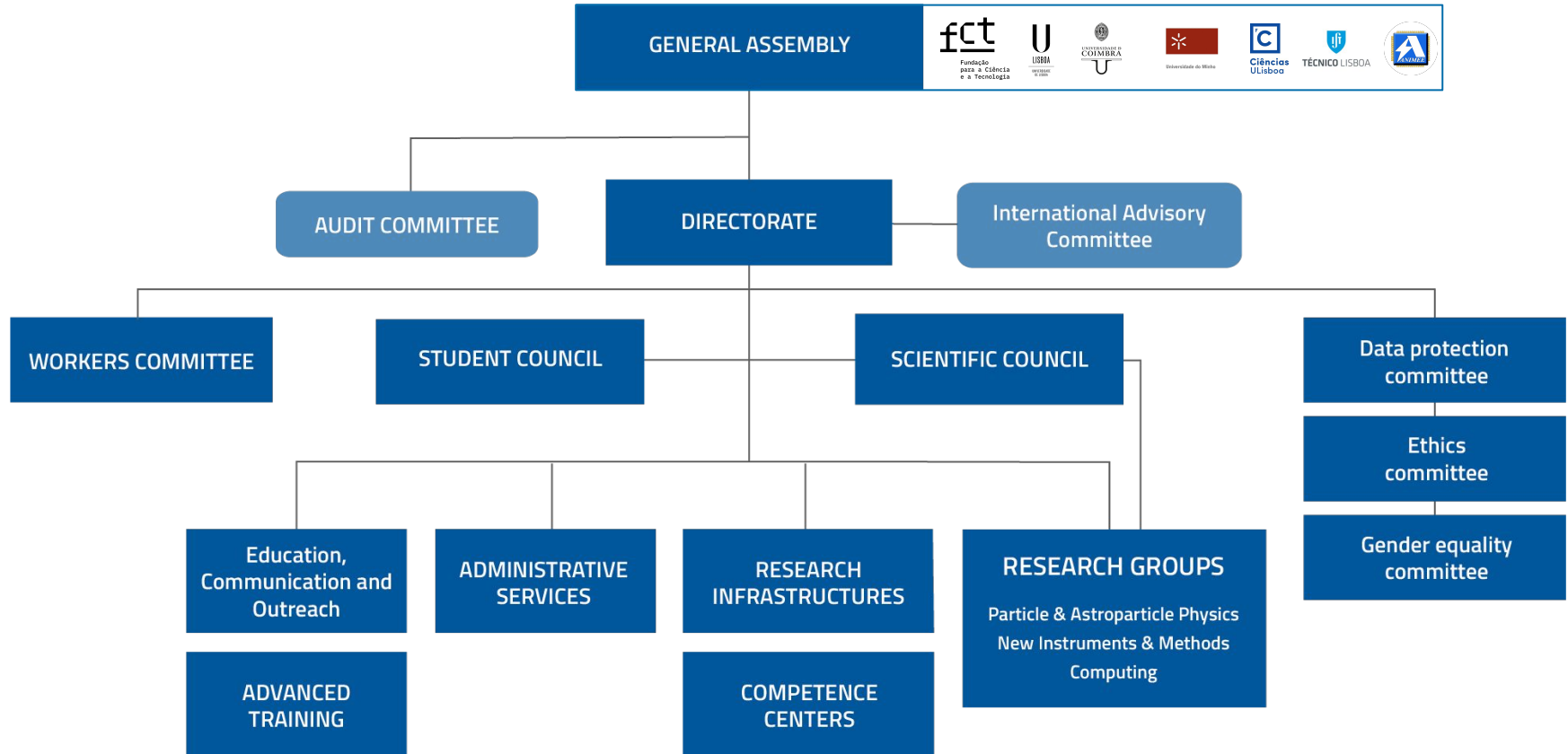
- salaries of researchers
- technical staff
- administrative staff
- PhD and postdoctoral grants

### HR payed by external entities



- researchers holding academic position
- retired
- PhD and (until 2017/18) post-doctoral grants

# LIP's governance model





# Internal regular meetings

- General Assembly (1/year)
- Audit Committee (1/year)
- International Advisory Committee (1/year)
- Board of Directors (1/month)
- Scientific Council (2/year)
  - since 2021: calendar of strategic discussions for each research line
- Scientific Council Coordination (4/year)
- "Jornadas LIP" - general meeting showcasing all activities at LIP (every 2 years)
- PhD students workshop (1/years)



# Research Areas & Groups

## Experimental particle and astroparticle physics



## Structure of matter

- pQCD
- HADES
- NUC-RIA
- NPstrong



## LHC experiments and phenomenology

- ATLAS
- CMS
- Pheno
- FCC



## Cosmic rays

- AMS
- Auger
- SWGO



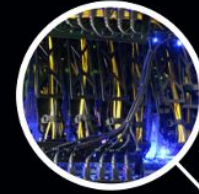
## Dark matter and neutrinos

- DARK MATTER
- NEUTRINO
- SHiP/ SND@LHC

## Development of new instruments and methods



## Computing



## Detectors for particle and nuclear physics

- RPC R&D
- Neutron detectors
- Gaseous Detectors R&D
- Liquid Xenon R&D



## Scientific computing

- GRID - Distributed Computing and Digital Infrastructures
- SPAC - Social Physics and Complexity

## Health and biomedical applications

- RPC-PET
- Proton Therapy
- OR Imaging
- RADART

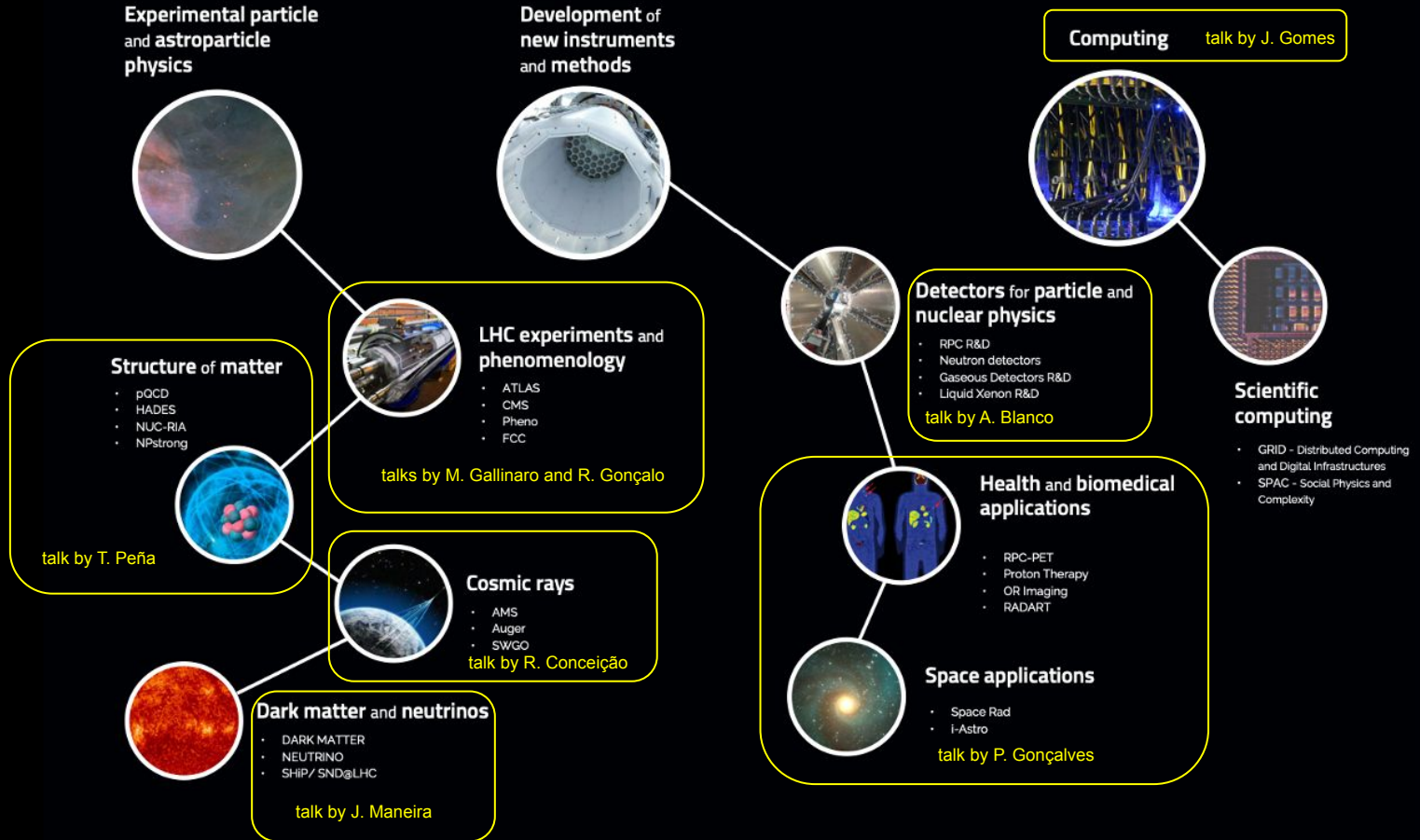


## Space applications

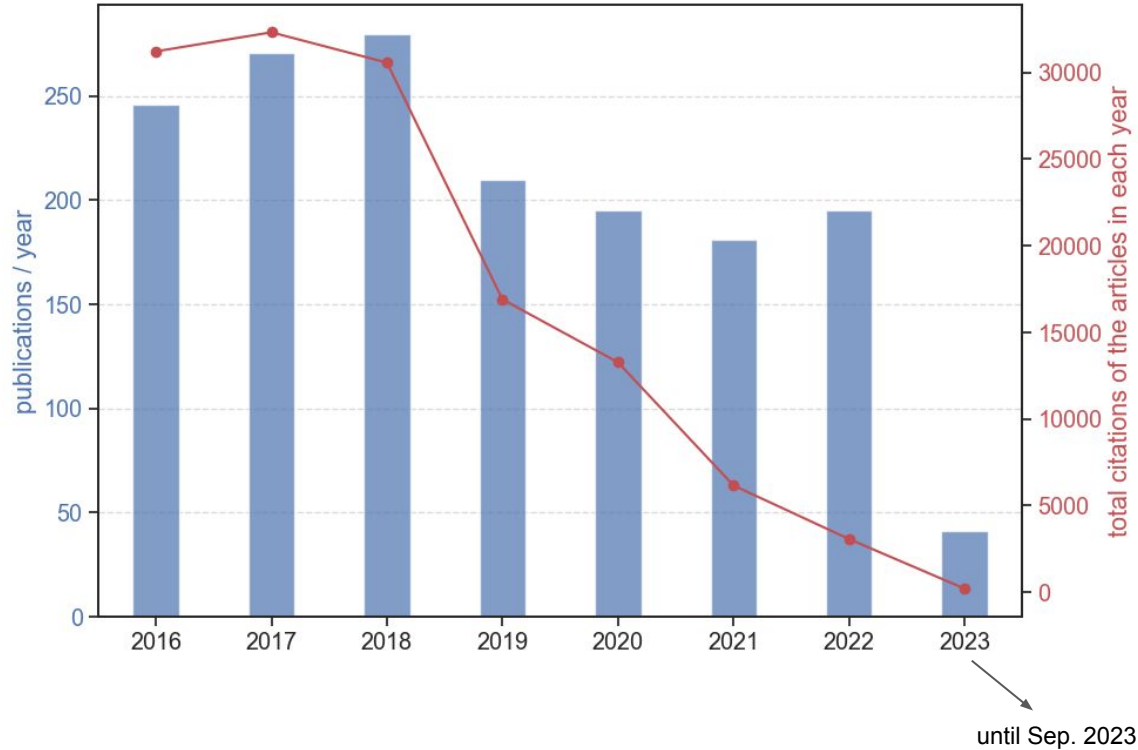
- Space Rad
- I-Astro



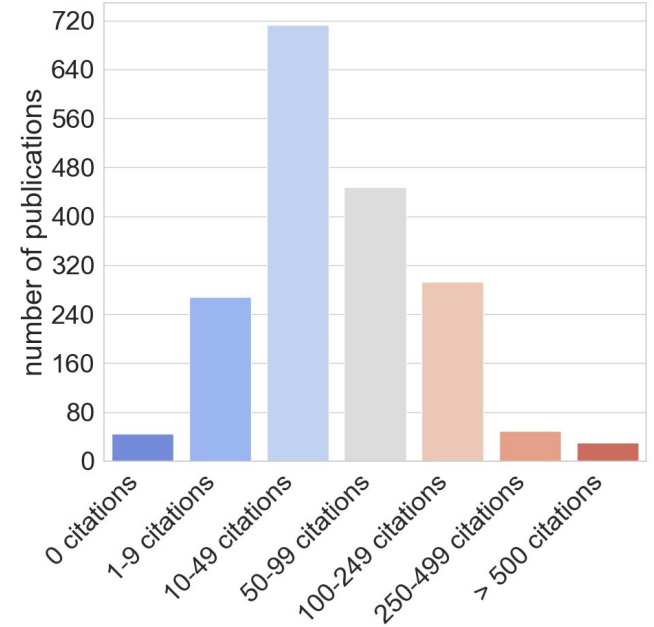
# Research Areas & Groups



# Scientific publications by LIP



source: inspirehep.net

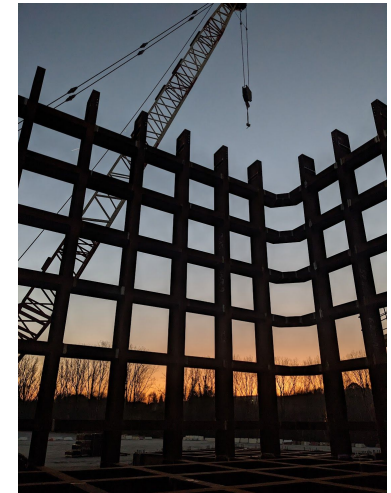
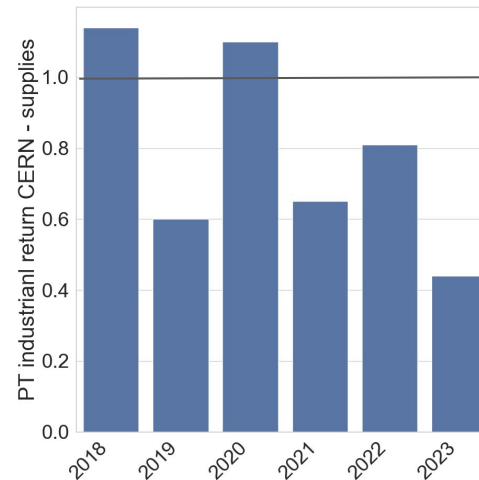
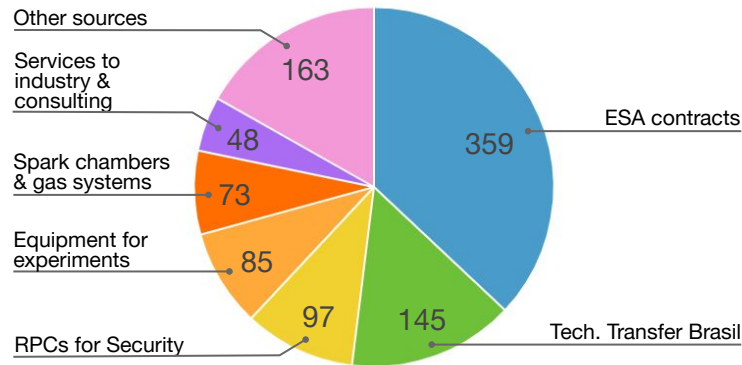


# Contracts with Industry & Technology Transfer

(talk by J. Antão)

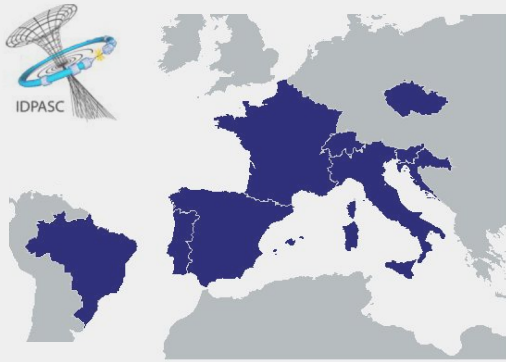
- Contracts with industry at national and international level: Space (ESA) and Security sectors
- Development and manufacturing of equipment for experiments and science demonstration
- Technology transfer, services to industry and consulting

2017-2020 billing from contracts with Industry and Technology Transfer (k€)



# PhD programs coordinated by LIP

## IDPASC (since 2010)

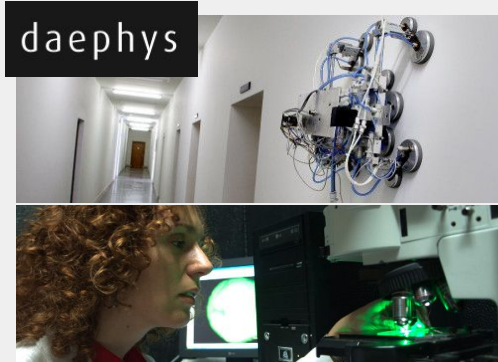


<https://idpasc.lip.pt>

34 Members , 9 countries

- 10 Grant editions
- 52 Students
- 11 International schools
- 17 Workshops

## DAEPHYS (2013-2018)



6 Portuguese Members

- 5 Grants editions
- 30 Students
- 4 International schools
- 4 Workshops

## PT CERN (2020-2023)

Open to all Portuguese research institutions

- 45 grants in total (15/year)
- 6 calls (2/year)
- 2 lines: physics and technology

## ProtoTera (2020-2023)



Open to all Portuguese research institutions

- 5 calls, 30 grants

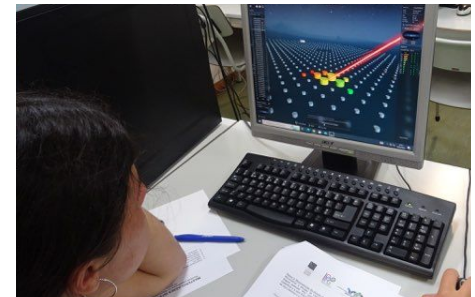
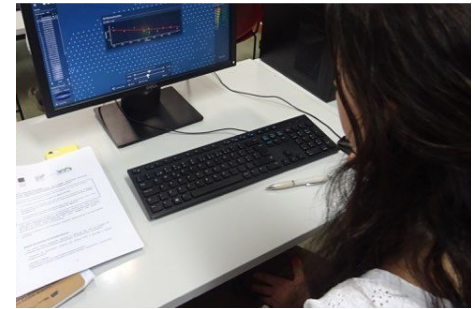


# Education and outreach

(talk by P. Abreu)

ECO activities are part of LIP's mission and social role. A wide set of activities for students, teachers and other publics

- CERN's Portuguese Language Teacher's programme: since 2007, attended by over 700 teachers from Portugal, Brazil and other PT-speaking countries
- IPPOG's international Masterclasses in particle physics attended by over 1500 students all over the country every year, since 2005
- Summer internships for high-school students, projects with school projects in partnership with Ciência Viva and SPF
- The exhibition "Particles: from the Higgs boson to dark matter", celebrating LIP's 30th anniversary, had over 40 000 visitors.
- European Researchers' Night in Braga, Coimbra and Lisboa
- Over 60 talks by LIP scientists per year in schools and other settings



# Institutional communication

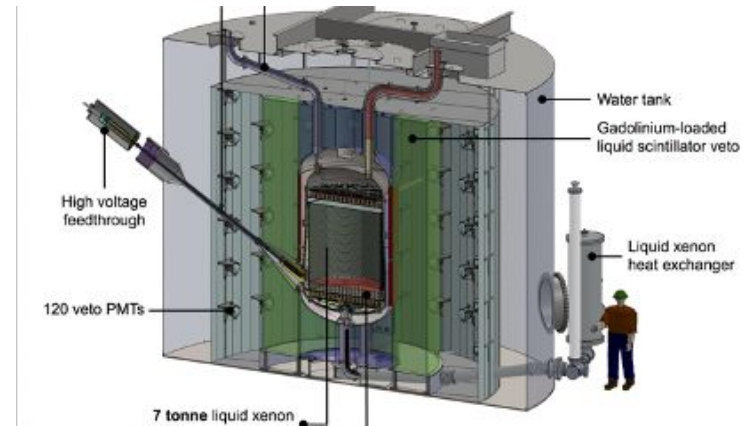
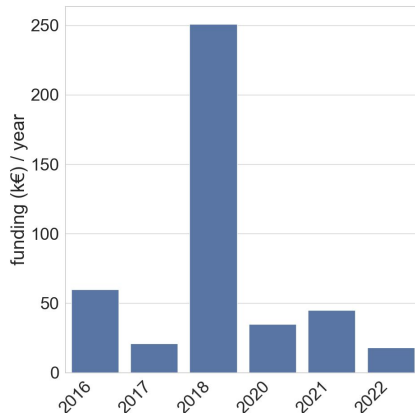
(talk by P. Abreu)

- LIP annual reports/plans: visiting card of the institution
- Evaluations
- LIP-NEWS bulletin / Interacções
- Sites news and maintenance (public site and intranet)
- Social media (facebook, twitter, linkedin, instagram)
- Media relations
- EPPCN - European Particle Physics Communication Network
- Event dissemination
- Branding and image
- cLIP internal digital newsletter
- Internal surveys, e.g. on internal communication instruments
- SciCom with and for students

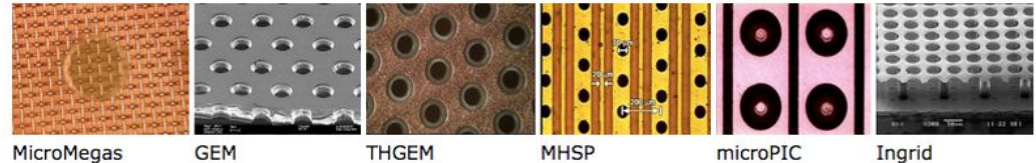


# PT experimental HEP beyond LIP

- LYBPhis (Coimbra) — RD51, XENON, NEXT, DARWIN
  - Funding: 50-90 k€/year (FCT)
  - 6 PhD, 5 students
- i3N (Aveiro) — RD5, COMPASS, AMBER, NEXT
  - 5 PhD members, 5 students
  - funding from FCT, Horizon 2020



## Micro-Pattern Gas Detectors



# Main concerns



- Low predictability and regularity of funding calls
  - the CERN Fund call has not yet opened
    - last call was in 2021 (to fund research projects between 08.21 to 08.23, approximately)
    - not clear whether it will open and if so when
  - Stable reliable funding is very important to honour long term experimental commitments
  - Volatility in supply prices (and shortage in some cases)
- High precariousness of the research career
  - key areas are very attractive to the private sector

# Backup

**RECFA**  
visit to Portugal



# LIP Laboratory of Instrumentation and Experimental Particle Physics

- LIP was created in the context of the Portuguese accession to CERN, the first international scientific organization Portugal became a member of
- LIP is the reference institution in Portugal for particle physics and associated technologies, and the reference partner of CERN
- CERN remains a pillar of LIP's activity

## Full Participation of Portugal in 35 years of CERN's scientific program

Fixed target | LEP | LHC | R&D

## Representation of Portugal at CERN

CERN Council | Training programs  
ECFA | IPPOG | EPPCN | HEPNET | ...



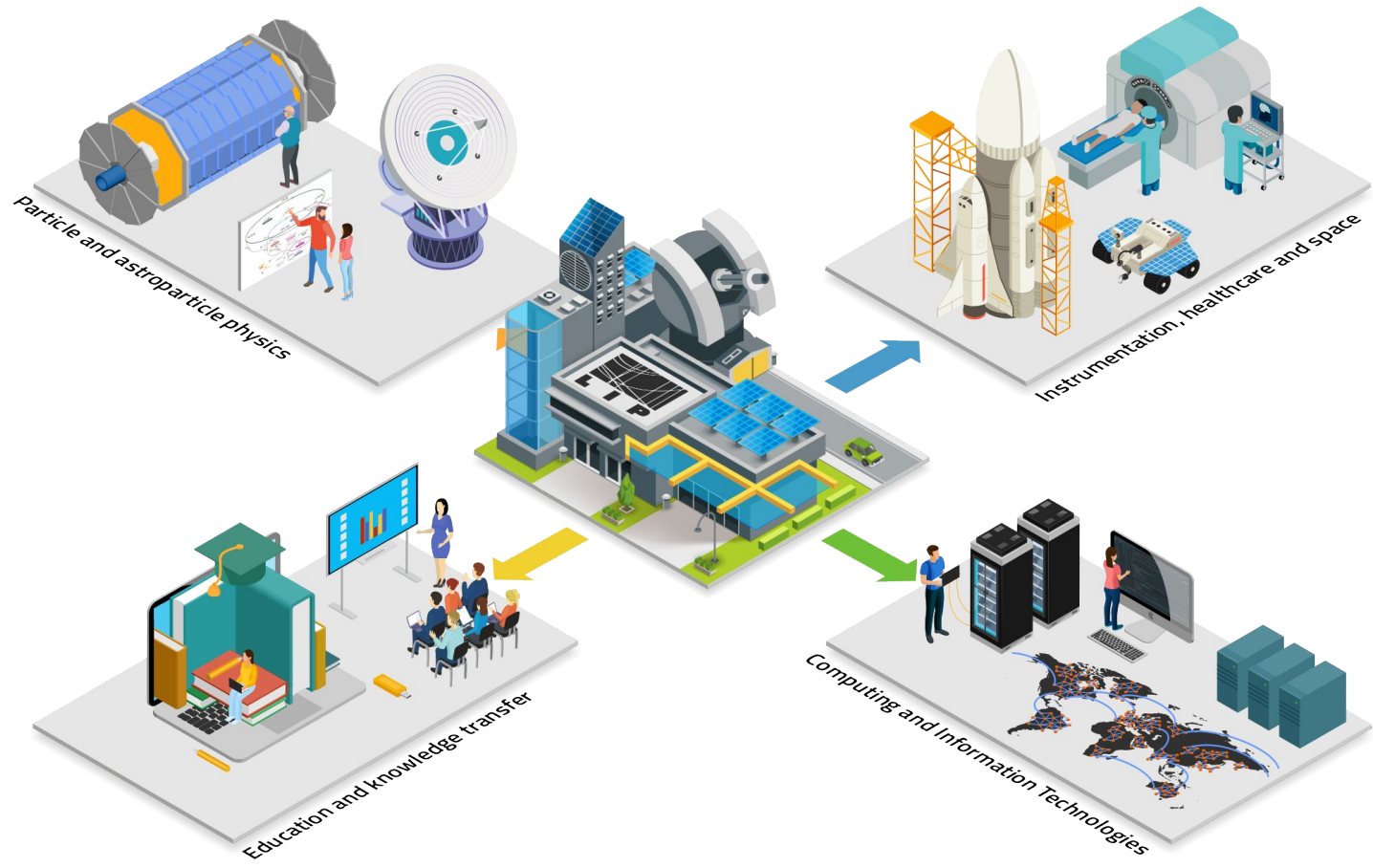


# Leadership in international collaborations

## A few examples of leadership:

- **ATLAS:** Top quark properties working group, Dibosons, Multileptons and Extra Dimensions working group, Heavy Quarks, Top and Composite Higgs working group, TileCal calibration coordinator, Executive Board, Physics Office, Publication Committee and Speakers Committee
- **Auger:** Air shower physics and calibration task leaders
- **CMS:** Deputy spokesperson, Precision Proton Spectrometer project manager, BPhysics group, Higgs Combination and Properties group, ECAL electronics coordinator and deputy project manager
- **COMPASS:** Drell-Yan physics group, detector control system, AMBER proposal
- **SND@LHC:** Muon detectors and timing calibration
- **DUNE:** Calibration and Cryogenic Instrumentation consortium leader, Executive Board
- **CERN LPCC:** Convenerships in the WGs: Effective field theory, Top, Heavy Ions, Long-lived Particles SHiP/SND@LHC
- **LUX and LZ:** Data analysis, double-beta decay, offline analysis and reconstruction, backgrounds groups, slow control
- **SNO+:** Water, scintillator partial fill phases analysis coordinators, antineutrino physics, backgrounds, optical calibration groups, Scientific Board chair
- **Computing:** INCD and EGI pan-European middleware coordination

# LIP's societal impact in a nutshell



backup slide

# LIP International Advisory Committee

Detectors



Christian W.  
Fabjan  
(until 2023)



Werner  
Riegler  
(from 2023)

Space  
applications



Eamonn  
Daly

Medical  
physics



Katia Parodi

Physics with  
accelerators



Luigi  
Rolandi  
(until 2023)



Jorgen  
D'Hondt  
(from 2023)

Astroparticle  
physics



Masahiro  
Teshima

Computing &  
electronics



Pier Giorgio  
Innocenti  
(until 2023)



José Miguel  
Jimenez  
(from 2023)

Physics with  
accelerators



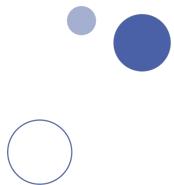
Sergio  
Bertolucci

Social Physics  
& Complexity



Karoline  
Wiesner  
(from 2023)

# LIP Scientific infrastructures



**Precision mechanical Workshop**  
Prototype production & small series. Coimbra



**Detectors laboratory**  
key role in gaseous detector development Coimbra



**Optical fibers and scintillators lab**  
A key role in ATLAS Lisboa



**Electronics laboratories**  
Key role in CMS, Auger and medical applications  
Lisboa | Coimbra | CERN



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R&D projects and infrastructures



OPENCoastS	GBIF biodiversity data portal	LHC data processing
Cosmic rays	Genome data elixir PORTUGAL	Neutrino physics
Computational chemistry	EC EARTH Climate	...

Shared computing and data services for the academic and research communities

**LIP | FCT-FCCN | LNEC**

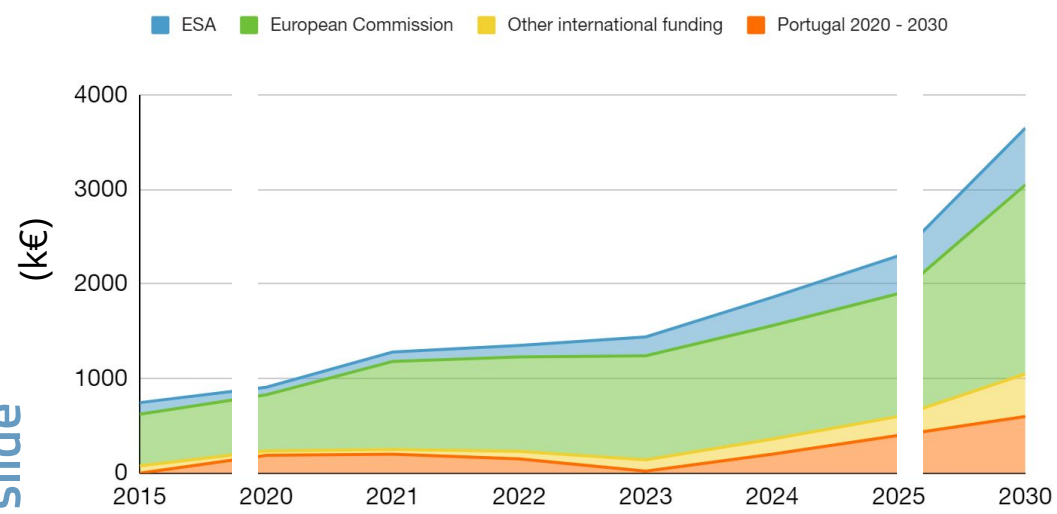
Support

Knowledge Capabilities

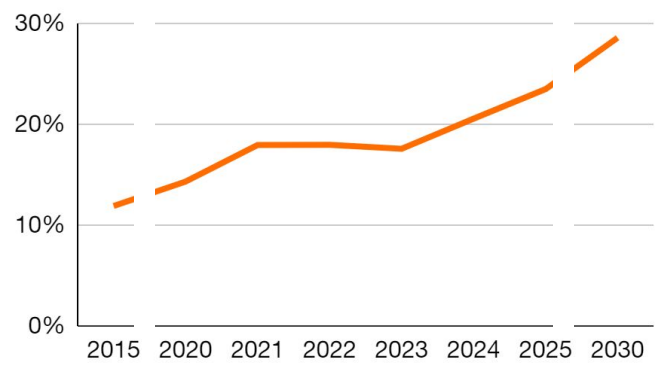
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- Software management coordination
- Piloting data repositories
- HPC and virtualization for machine learning
- Cloud for research
- IBERGRID coordination
- EUDAT national node
- EGI pan-European middleware coordination
- WLCG national node

# International funding evolution scenario (2020-2030)



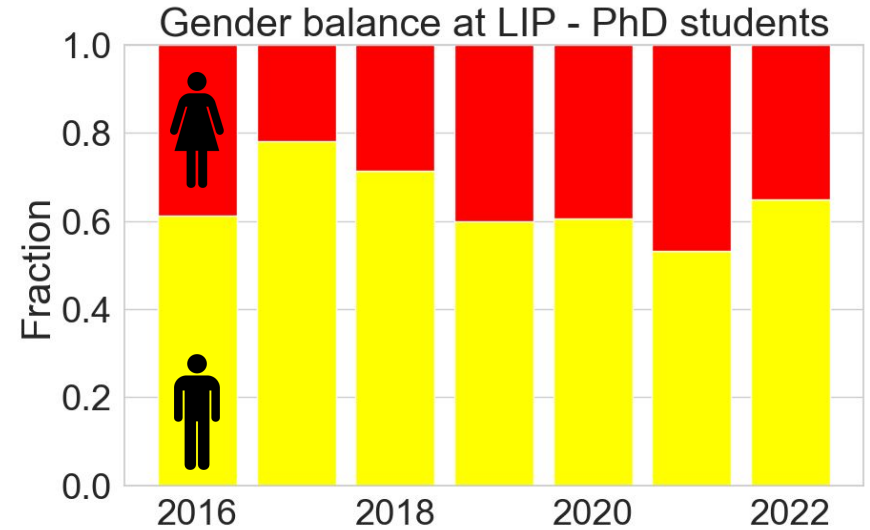
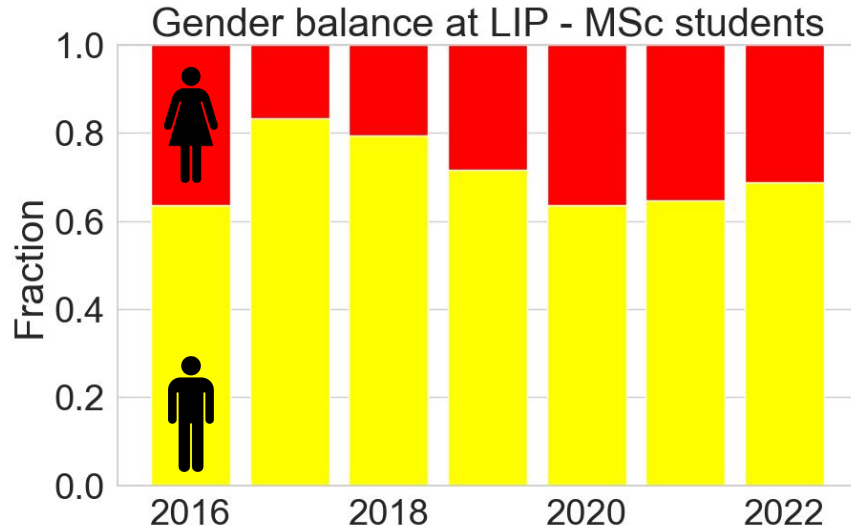
% international sources contribution to LIP's funding 2015-2030



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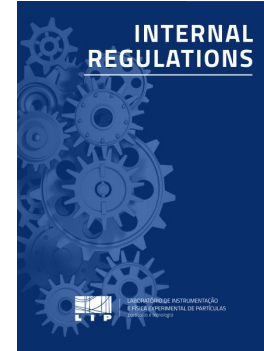


# LIP in numbers - gender balance for students



# Governance for careers and talent attraction

- LIP's Internal Regulations set out:
  - ◇ hiring plan
    - international calls for attracting talent
    - career progression mechanisms
  - ◇ periodic evaluation of researchers for career development

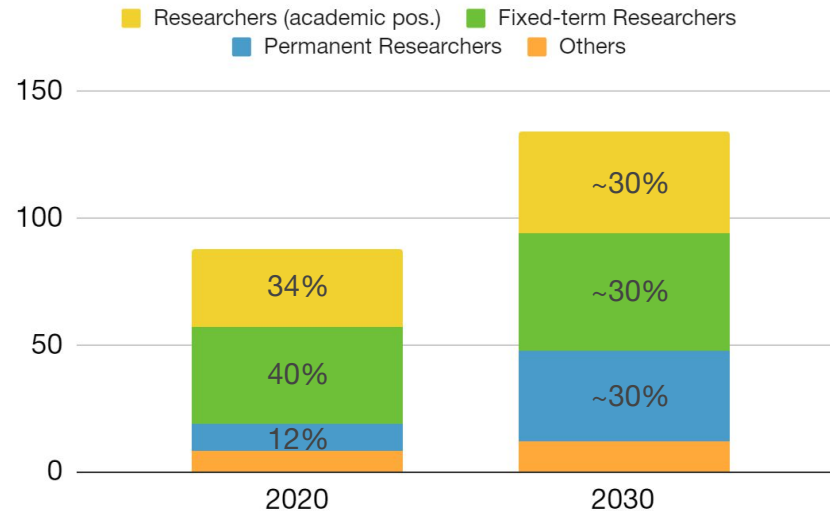


- Implementation of the strategies for attracting international researchers:
  - ◇ Directorate
  - ◇ Scientific Council
- Attracting and supporting the PhD and undergrad students:
  - ◇ Advanced Training group
  - ◇ Students' Council
  - ◇ Internships for national and international students



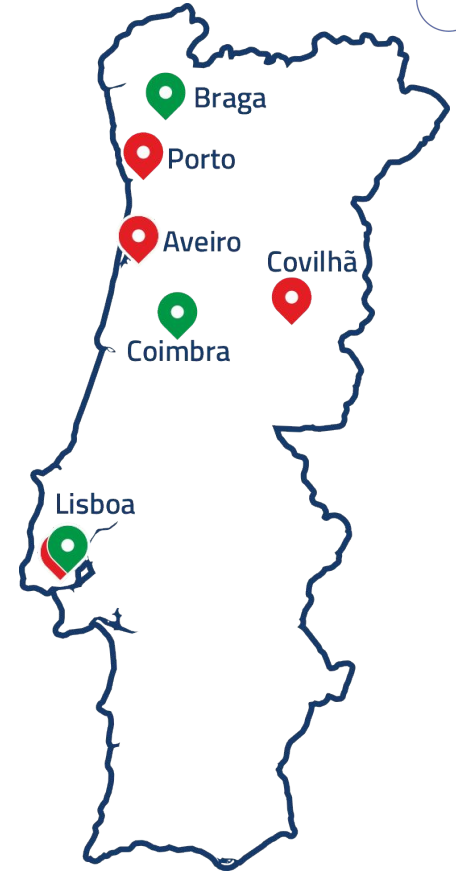
# Careers at LIP

- Fulfill LIP's core mission:
  - ◊ retain and attract key researchers (12% → 30% permanent positions)
  - ◊ value and reinforce the administrative and technical services
- Maintain and increase the return to society

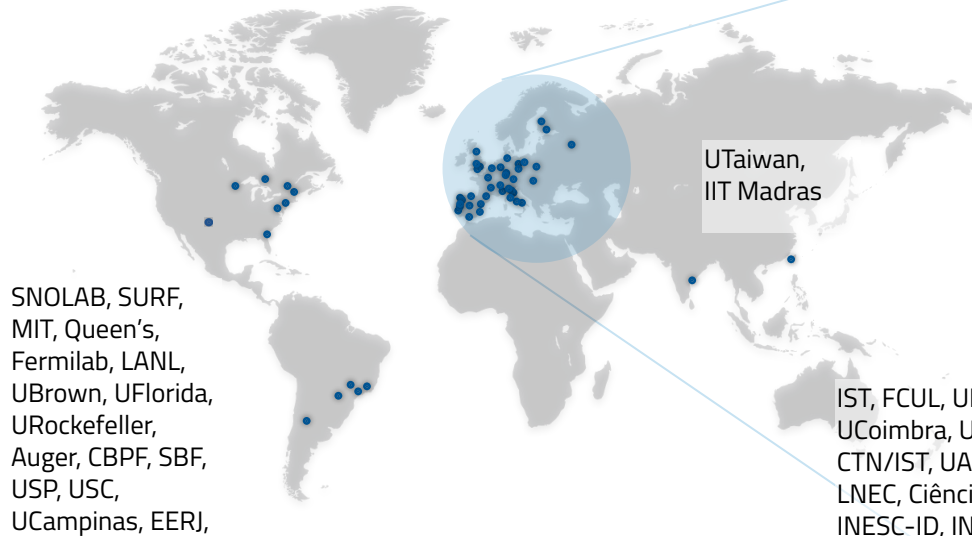


# Undergrad / grad degrees with HEP component

- Degree: 3 years
- MSc: 2 years (including 6 months / 1 year thesis)
- PhD: 4 years (may or not include formal classes)
- HEP courses in the Universities of Coimbra, Lisboa (IST and Faculty of Sciences) and Minho
  - ◇ partnerships also with Porto, Aveiro, Beira Interior
- HEP related thesis in the Universities of Coimbra, Lisboa (IST and Faculty of Sciences) and Minho
  - ◇ but also Porto (Sciences and Engineering), Nova and ISEL (Lisboa), Beira Interior and Aveiro



# Connections worldwide



CERN, ESA, EGI, DESY,  
HIP Helsinki, MEPhi,  
Imperial College, USurrey,  
UOxford, TUDresden,  
LMU Munich,  
HephyViena,  
TUDortmund, IPPP, LPC,  
TUDelft, GSI, Humboldt,  
KIT, CEA, CESNET, PSI,  
Clermont-Ferrand,  
CYFRONET, PSNC,  
Utrecht

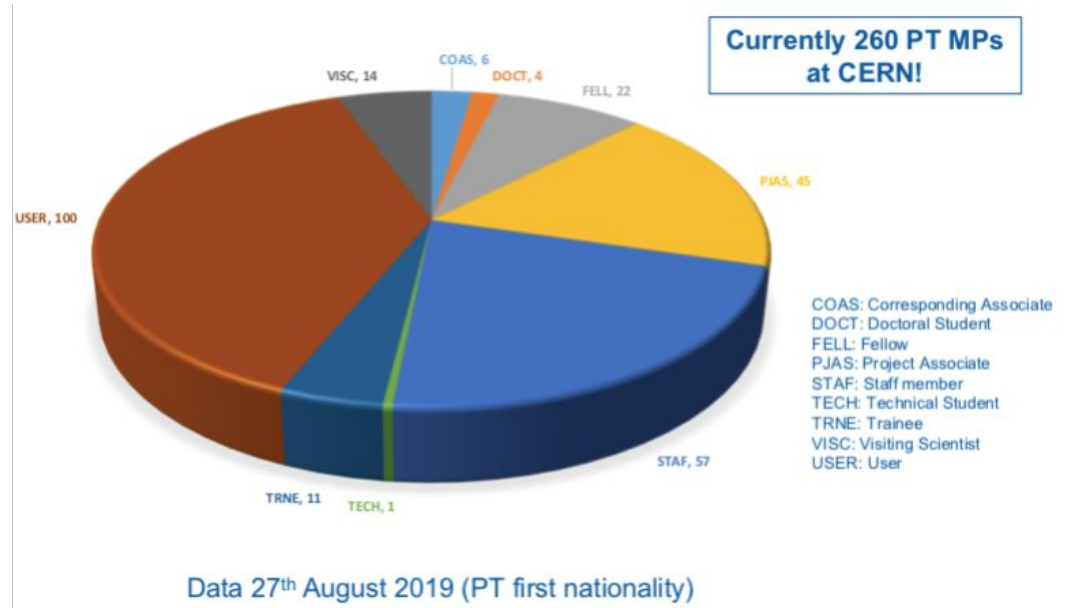
CSIC, IFCA, UPV, CESGA, BIFI, UAM, PIC,  
Lifewatch ESFRI, UGranada, USC/IGFAE,  
INFN, INAF, UFerrara, UTorino, UPadova,  
UPisa, UUdine, PoliMilano, PoliBari, LLR

# PT personnel at CERN

For Portugal's contribution of **1.07%** of the total budget,

on 1 August 2019:

- 57 Staff ~2.15%
- 22 Fellows ~2.78%
- 4 Doctoral students ~1.81%
- 1 Technical student ~0.68%
- 11 Trainees (FCT-CERN)



Source: L. Taillieu, Portuguese Industry@ CERN workshop