Laboratory of Instrumentation and Experimental Particle Physics
LIP

Last laboratory meeting

LABORATÓRIO DE INSTRUMENTAÇÃO
E FÍSICA EXPERIMENTAL DE PARTÍCULAS
partículas e tecnologia

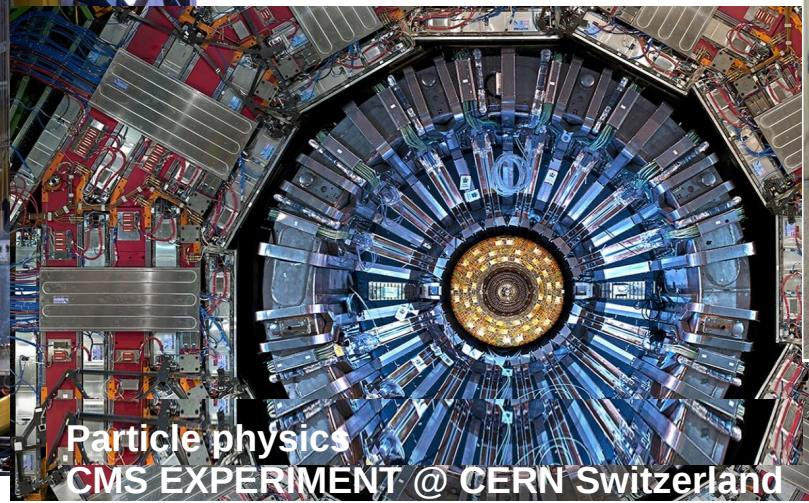
LIP, a bit of history.

LIP, Laboratory of Instrumentation and Experimental Particle Physics, is the reference institution for experimental particle physics and associated technologies in Portugal. **It was founded in May 1986 to exploit the unique opportunities created by the country's accession to CERN**, the European particle physics laboratory.

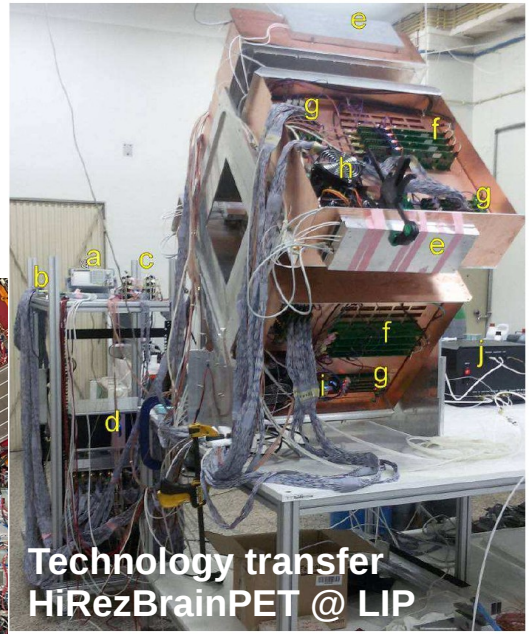
LIP. Mission.

LIP is devoted to **research in experimental particle physics and associated technologies**, enhancing the direct access of the Portuguese scientific community to international infrastructures and collaborations. At the centre of our mission are also **scientific computing, advanced scientific and technical training and the engagement of society with science**. Opportunities of knowledge and **technology transfer to society** are also explored, in domains such as **health, space exploration and information technologies.**

Nuclear physics
HADES EXPERIMENT @ GSI Germany



Particle physics
CMS EXPERIMENT @ CERN Switzerland

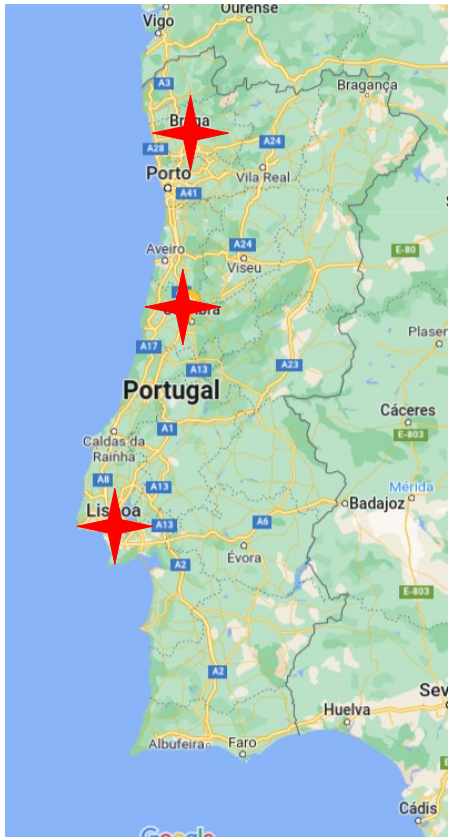


Technology transfer
HiRezBrainPET @ LIP

LIP. Structure and partners.

Three national poles

- Braga
- Coimbra
- Lisbon



LIP's associated are:

- **FCT** (Fundação para a Ciência e Tecnologia).
- The **Universities** of Lisbon, Coimbra and Minho.
- Instituto Superior Técnico (Lisbon).
- FCUL — Faculdade de Ciências da Universidade de Lisboa.
- **ANIMEE** (Associação Portuguesa das Empresas do Sector Elétrico e Eletrónico).

LIP develops its activity in:

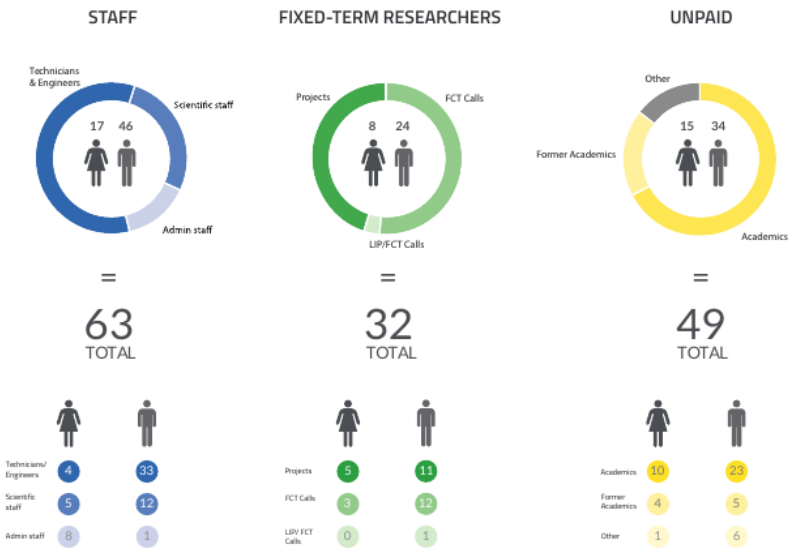
- **CERN** and **ESA** — European Space Agency ,**SNOLAB** (Canada) and **Pierre Auger** (Argentina), observatories, the **SURF** (USA) and **GSI** (Germany) laboratories ...

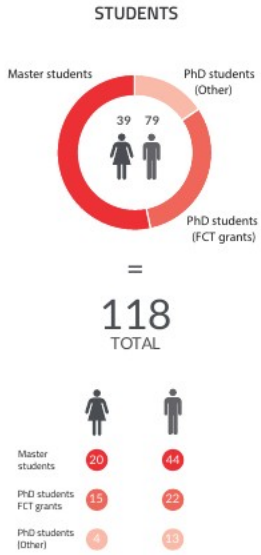
Collaboration with many national and International institutions:

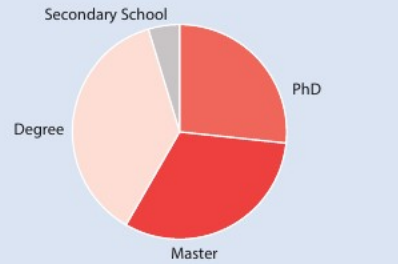
- In health care: **ICNAS** (Instituto de Ciências Nucleares Aplicadas à Saúde) and **CTN** (Campus Tecnológico e Nuclear) ...
- In computation: With **FCT/FCCN** and **LNEC**, LIP co-leads **INCD** (Infraestrutura Nacional de Computação Distribuída) ...

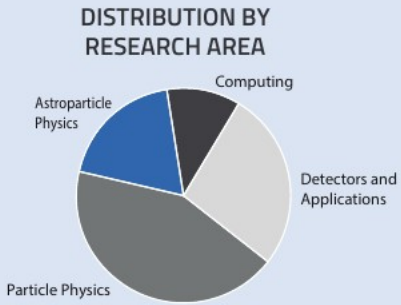
In the promotion of the scientific and technological culture: **SPF** and **Agência Ciência Viva, IPPOG, EPPCN** ...

Human Resources









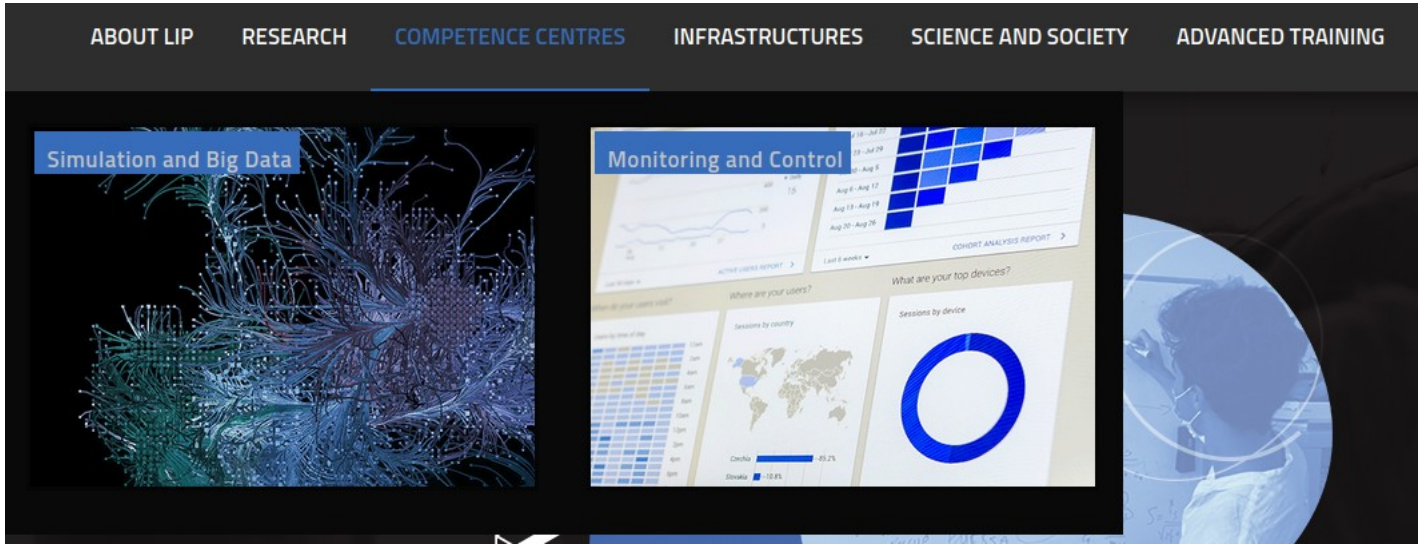
TOTAL 262 — 79 183

PHD RESEARCHERS 96 — 28 68

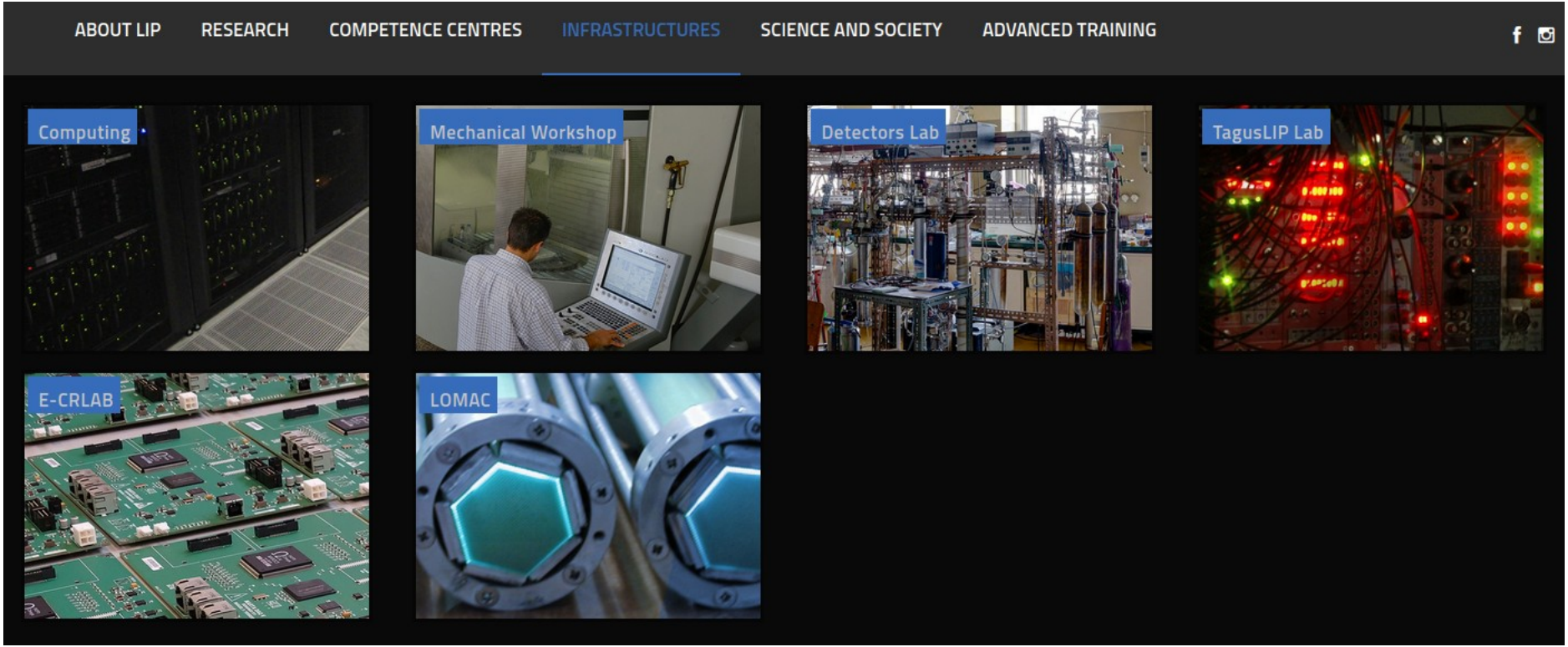
Scientific output 2022

	Particle Physics	Astroparticle Physics	Detectors and Applications	Computing	TOTAL
Papers in refereed journals	180	47	27	4	252
Proceedings Preprints and Notes	41	32	15	19	104
Books, Reports and Proposals	0	2	1	5	8
Presentations in International Conferences	40	13	24	26	99
Other Presentations	72	48	49	35	190
Master Theses	9	6	10	2	26
PhD Theses	1	3	0	0	4

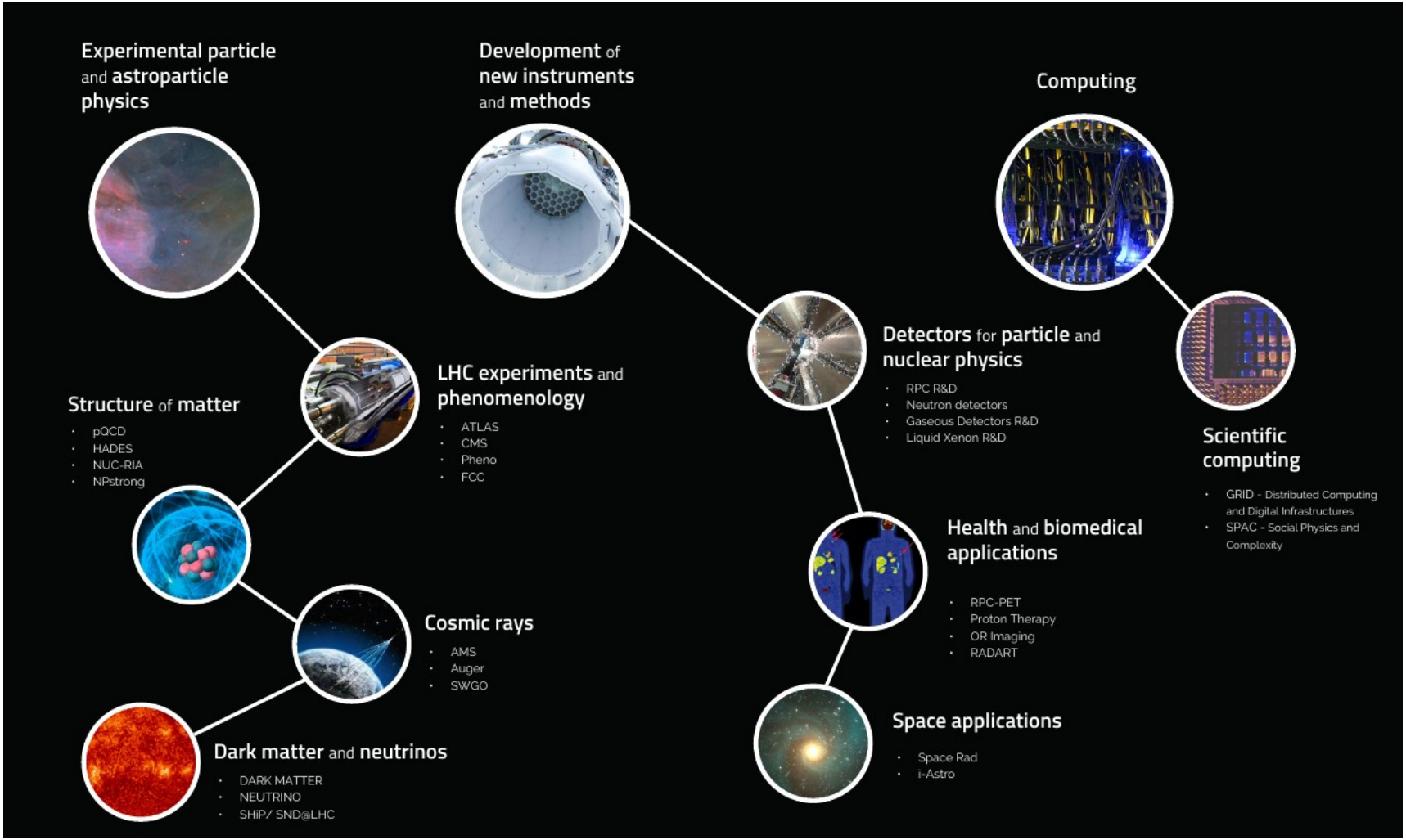
LIP internal structure, competence centers.



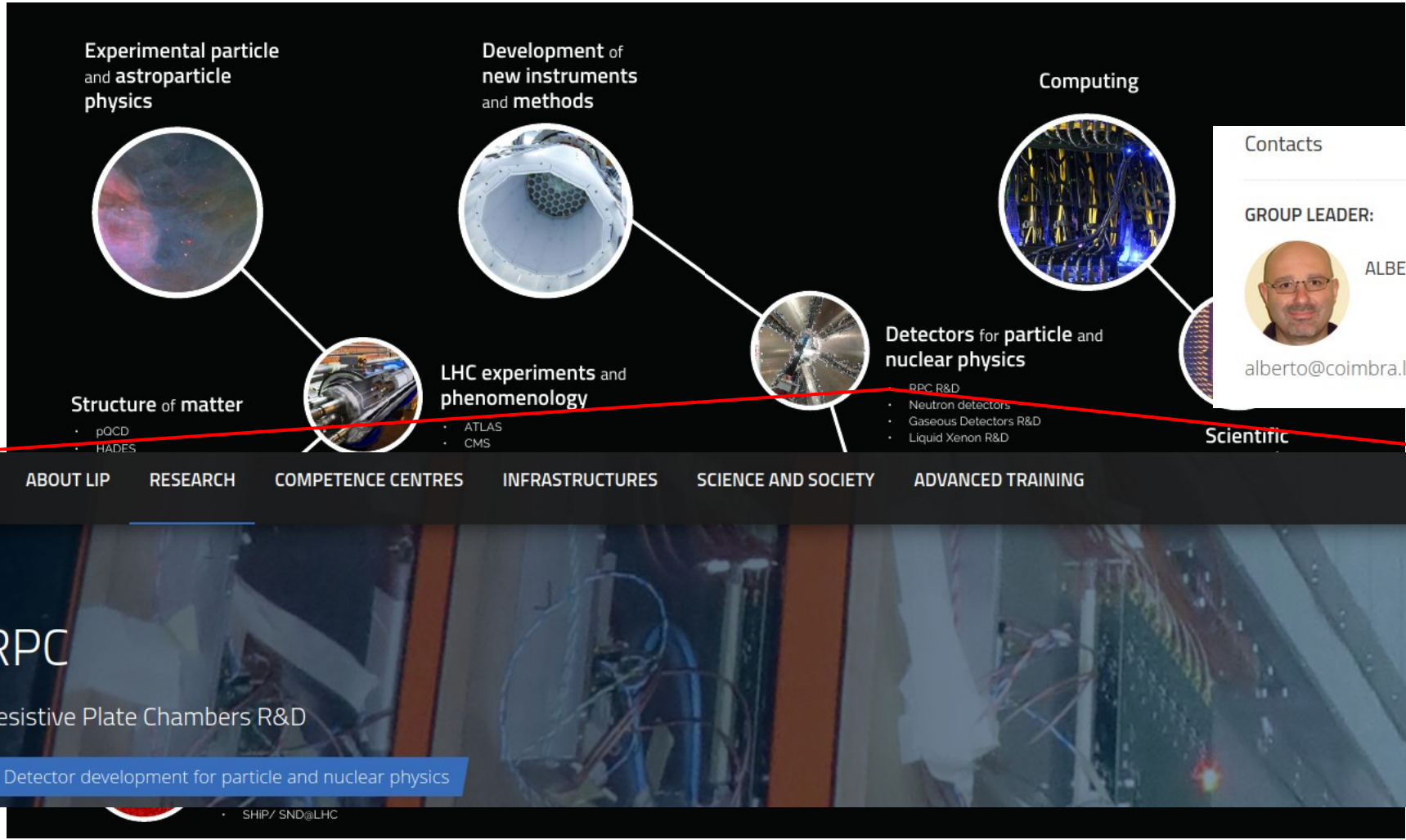
LIP internal structure, infrastructures / facilities.



LIP internal structure, R&D groups.



RPC R&D group.



Contacts

GROUP LEADER:

ALBERTO BLANCO

alberto@coimbra.lip.pt

Devoted to the development of the Resistive Plate Chamber technology (RPC), a gaseous based particle detector.

- **RPC-PET**

  Develop RPC technology for PET imaging. **Pre-clinical, human brain PET** and full body human PET (dream ….).

- **Timing and Position Sensitive RPCs.**

  Develop timing RPCs for **high energy physics experiments** and in combination with position measurement to be applied in **muon tomography**. Both modalities, transmission (e.g. volcano and mine imaging) and scatter tomography (container scanning)

  Developing RPC based technology **for SHiP/R3B and HADES collaboration.**

  STRATOS and TRISTAN cosmic ray telescopes, both dedicated to the precise measurement of cosmic ray flow, and MUTOM (together with the AUGER group) for muon tomography in mines.

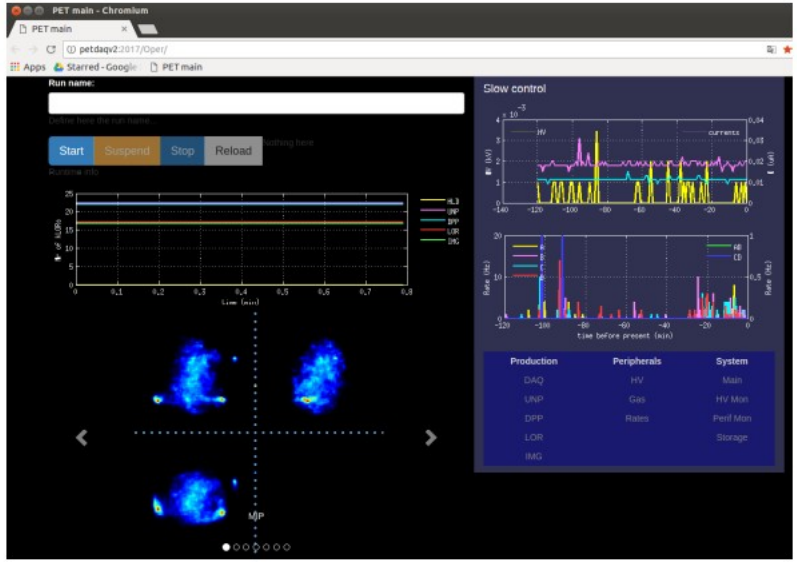
- **Autonomous RPCs.**

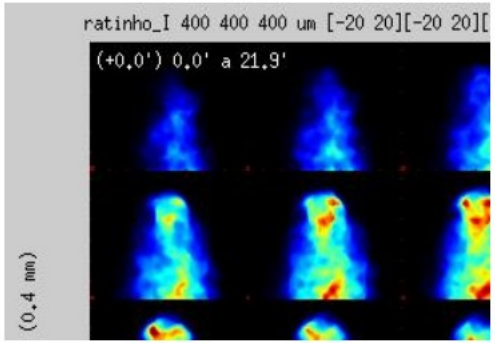
  Outdoor, reliable, high performance, solar panel powered, auto-operated, low gas consumption and eventually sealed RPCs for **cosmic ray measurement.**

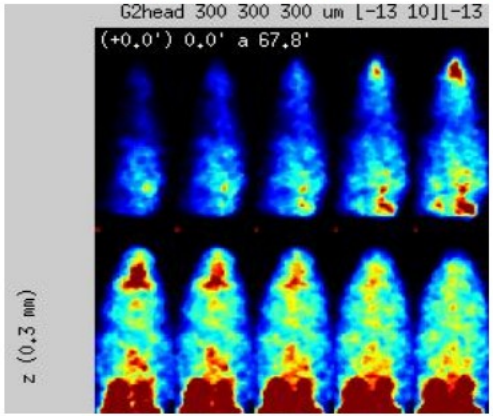
  RPCs operated at high altitude (SWGO project) and operation of RPCs in an ultra low gas flow regime (eventually sealed).

RPC-PET

Continuous support of **routine bio-research activities** @ ICNAS (hundred of mice scans). First biological results appeared => **system is really working.**







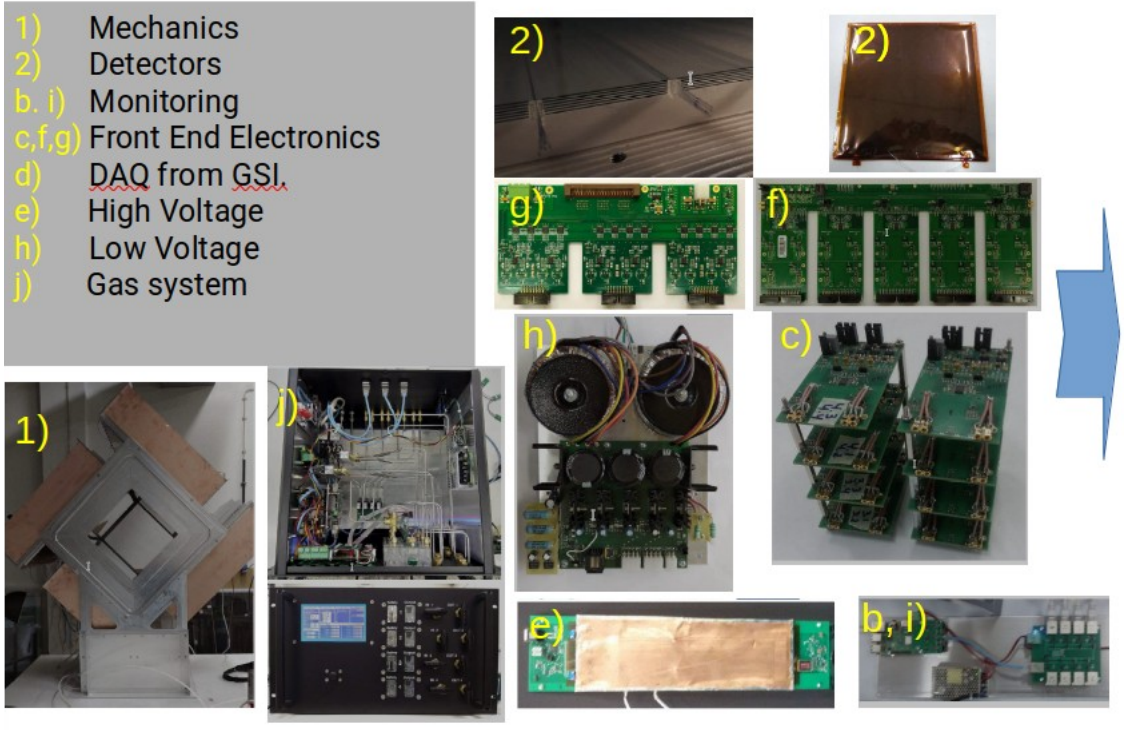
RPC-PET

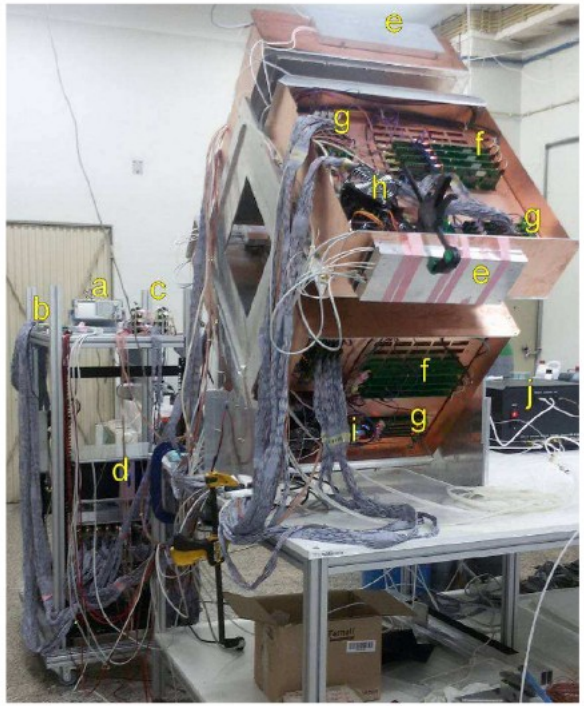
HiRezBrainPET: an RPC-PET brain scanner with sub-millimeter spatial resolution

Co-promotion project financed by COMPETE2020 involving:

ICNAS Produção (project leader) / Instituto Politécnico de Coimbra / LIP

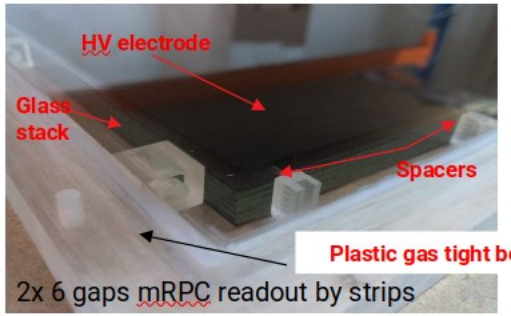
1) Mechanics
2) Detectors
b. i) Monitoring
c,f,g) Front End Electronics
d) DAQ from GSI.
e) High Voltage
h) Low Voltage
j) Gas system





Timing and Position Sensitive RPCs.

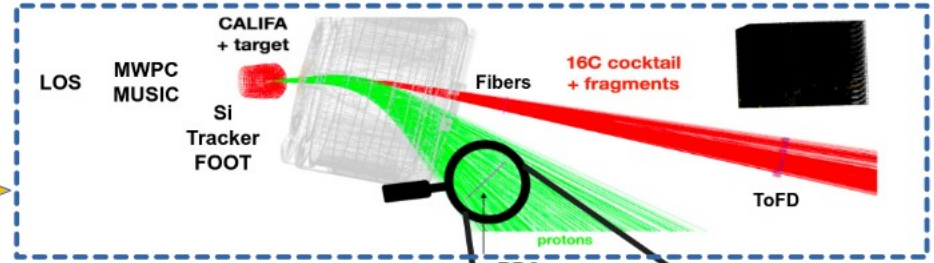
GOAL: precise timing for proton momentum determination @ R3B, experiment S522



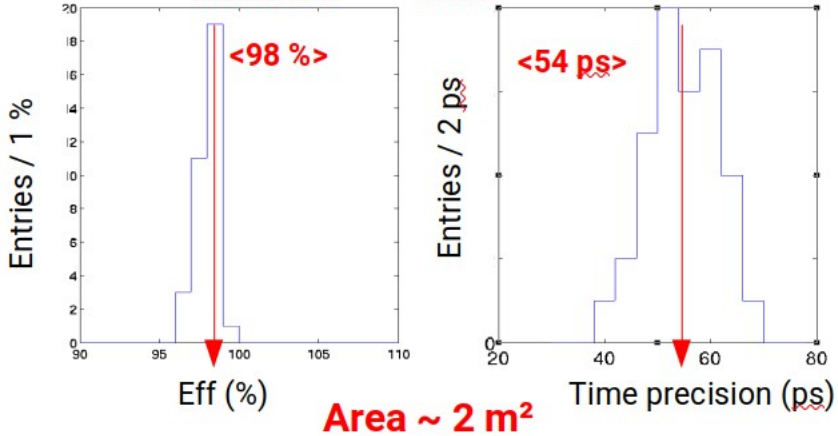
Re-use of SHiP timing detector prototype

https://www.r3b-nustar.de/

S522 setup @ R3B

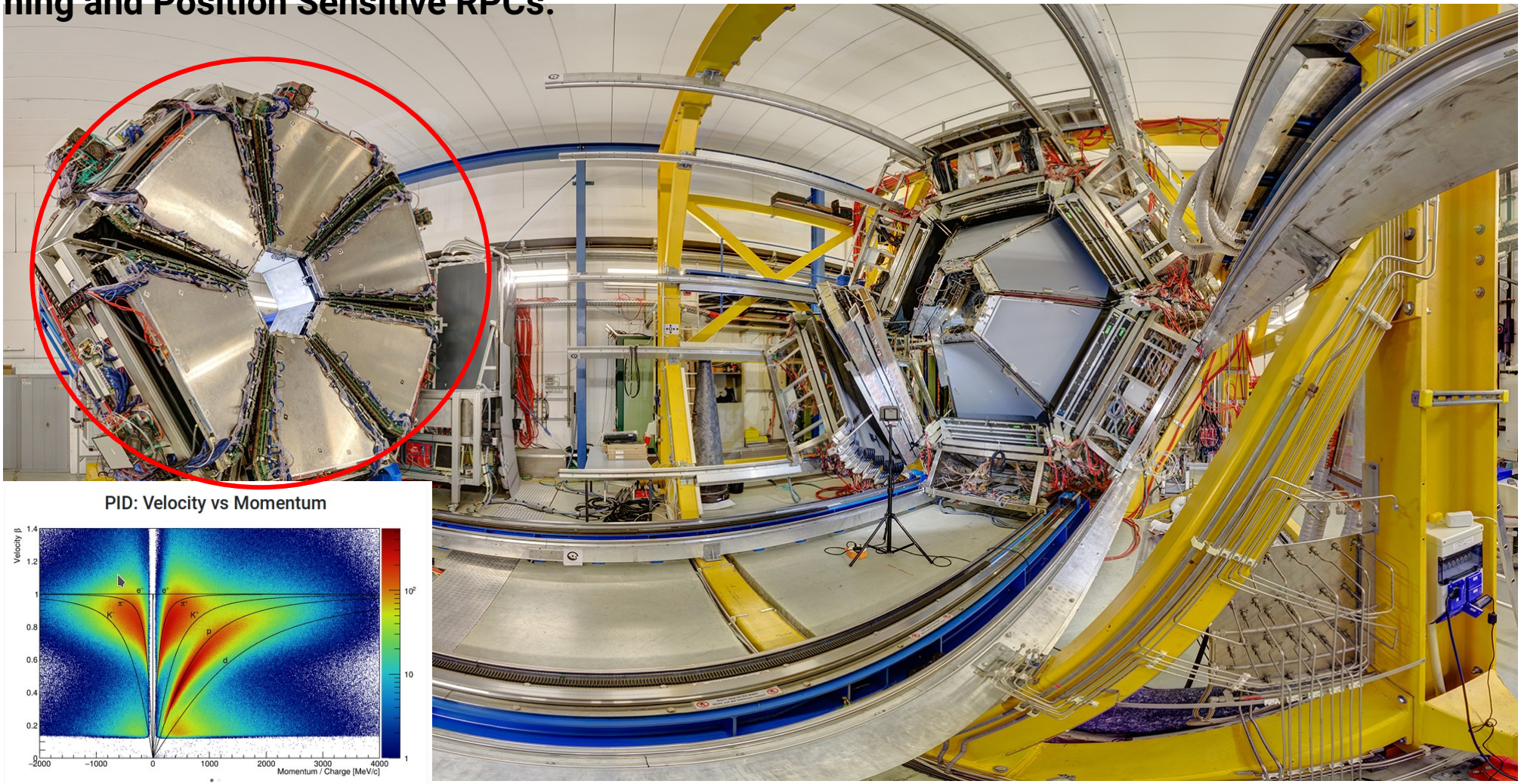


A. Blanco et al 2020 JINST 15 C10017



Area ~ 2 m²

Timing and Position Sensitive RPCs.



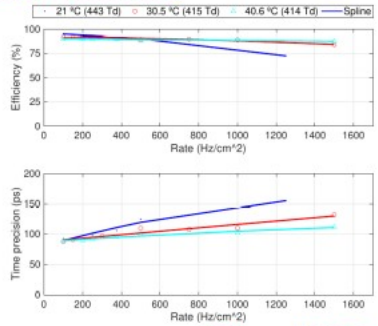
Timing and Position Sensitive RPCs.

GOAL: precise timing for Particle Identification (PID) @ HADES experiment

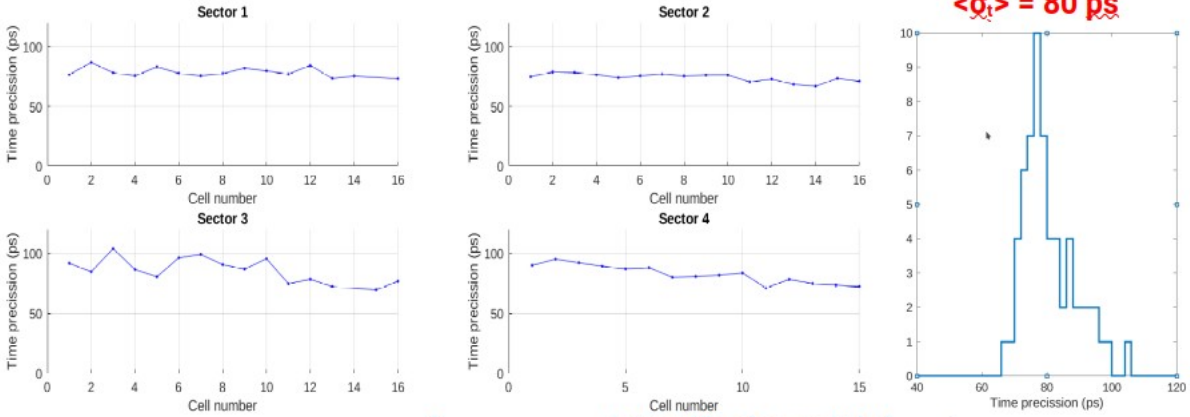
Design and construction of the RPC-TOF-FD.

Operated above ambient temperature to improve the counting rate capability of the system.

http://arxiv.org/abs/2206.12199



Timing precision during production beam time



$\langle\sigma_t\rangle$ = 80 ps

https://hades.gsi.de/

Overview of the RPC-TOF-FD

Autonomous RPCs

TRISTAN GOAL: precise measurement of cosmic ray flow

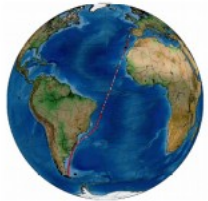
Three layers MARTA RPC + HADES like readout telescope
3x latitudinal survey and one year in Antarctic

TRISTAN Detector

3 RPC planes to study Secondary Cosmic Rays

Designed to be part of the **ORCA Observatory**[1] in the Livingston Island[2]

Before installation in the Antarctic base, the detector made a **Latitude Survey** from Vigo (Spain) to Punta Arenas (Chile)

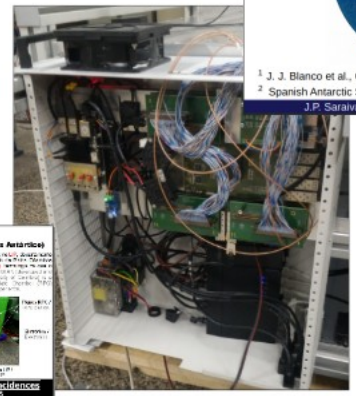


[1] J. J. Blanco et al., ORCA (Antarctic Cosmic Ray Observatory): 2018 latitudinal survey, ICRC 2019
[2] Spanish Antarctic Station "Juan Carlos I" in the Livingston Island - Antarctica

J.P. Saraiva (LIP) | The TRISTAN Detector - RPC2020 | February 10

DAQ System – main features

- **System Fully Autonomous**
  - Data acquisition starts automatically
  - Hardware power-cycle in case of failure
  - Log analysis, search out of range values
- **Alarms** sent via email in case of issue
- **Daily Reports** sent via email
- **Rates & Coincidences** sent every 30 minutes



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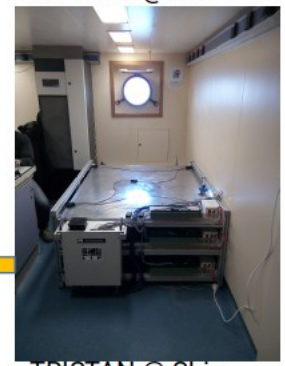
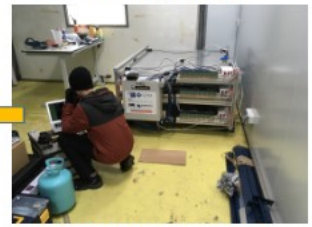
J.P. Saraiva (LIP) | The TRISTAN Detector - RPC2020 | February 10-14, 2020

Fully autonomous system with almost 100% duty cycle

TRISTAN @ LIP



TRISTAN @ Ship



TRISTAN @ Antarctic

Autonomous RPCs

STRATOS

2x four plane RPC telescope meant for the **precise measurement of cosmic ray flow**, in order to **address the temperature of the stratosphere**, but a pre-prototype of macro scanner (scatter muon tomography) detector.

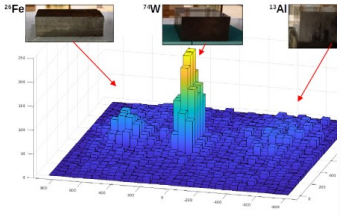


Fig. 8. 2D projection of PoCA points restricted to events with angular defle 10°.

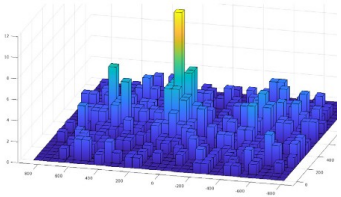
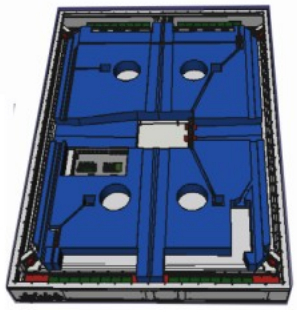
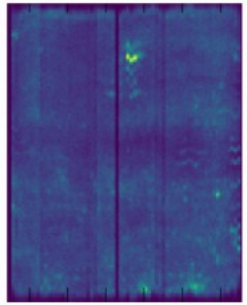


Fig. 9. 2D projection of PoCA points restricted to events with angular defle 10° and obtained with only 10 min of acquisition.

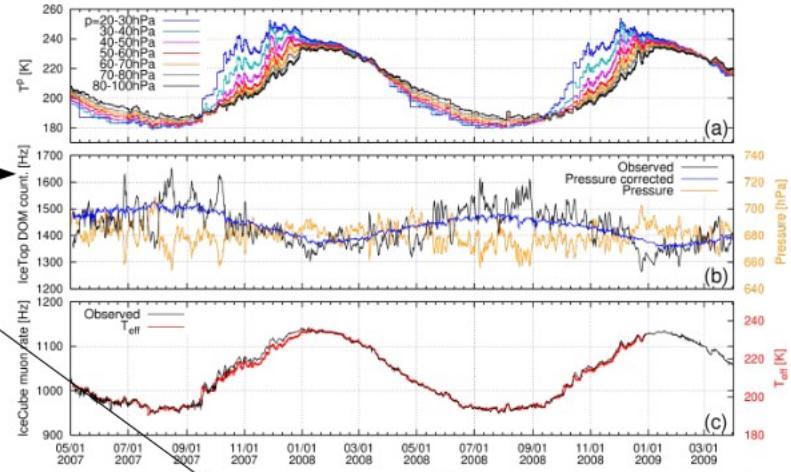


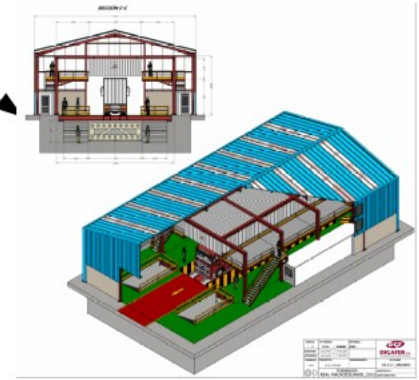
CAD project

Real device



Hit position map





- **Industrial design** to work in all type of environments (fully integrated in a single box). 2 m² active area.
- **300 ps** and **10 mm** timing and position precision together with a high efficiency **(> 98%)** for MIPs.
- Very low gas consumption (**< 1 cc/min/m²**).
- **Autonomous operation.**

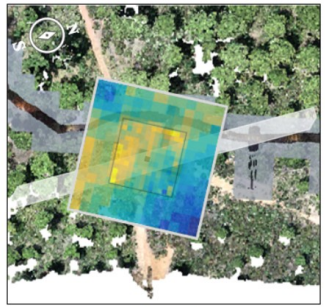
Autonomous RPCs

MUTOM GOAL. Transmission tomography at the Lousal mine.

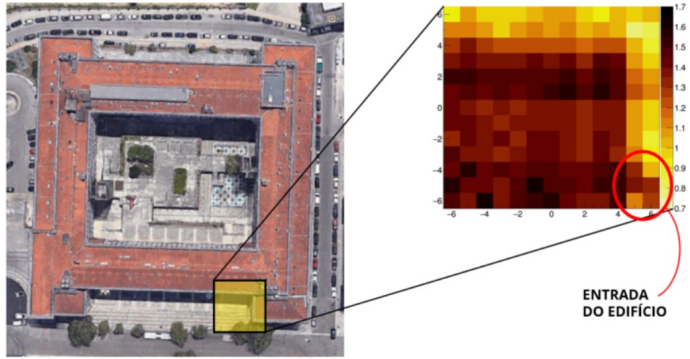
Four layers RPC telescope based on MARTA-like modules and DAQ

Tested @ LIP and now in the mine.

The detection area on the surface has a dimension of 30 by 30 meters

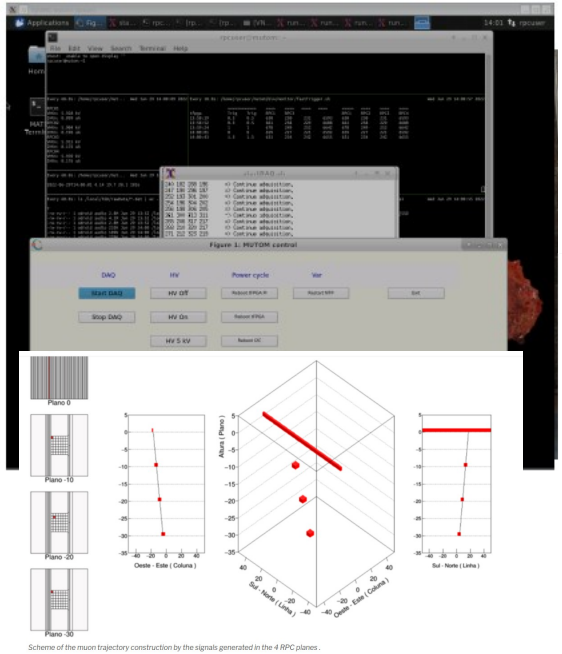


First muography obtained from the terrain showing the presence of the geological fault (yellow)



Location of the telescope in September 2020 and muography taken during the observation period

Automatic monitoring



Scheme of the muon trajectory construction by the signals generated in the 4 RPC planes.

CorePix mounted on a mob

CorePix side view composed of 4 RPC detectors

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