

Welcome to Lisbon

# INFIERI

INtelligent, Fast, Interconnected  
and Efficient devices for Frontier  
Exploitation in Research and Industry

12-15 April 2016,  
Biblioteca Nacional  
Lisboa, Portugal

## 7th *Workshop*



# Lisbon: a charming city with long history



# LIP

LABORATORY OF INSTRUMENTATION AND PARTICLES

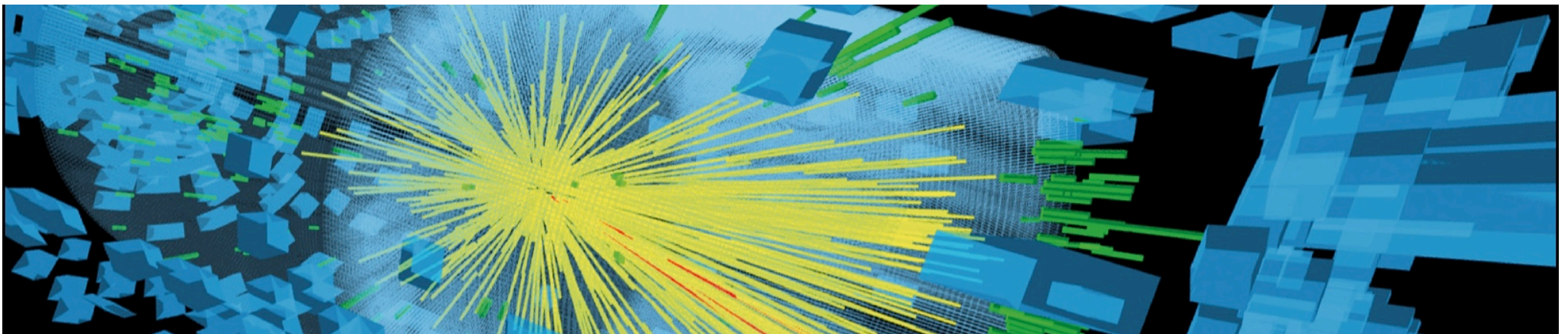


LIP is an Associate Laboratory of the Ministry of Science and Education

LIP was created in 1986. Portugal joined CERN in 1985/1986

Research in Particle Physics and Associated Instrumentation.

Three centers in Coimbra, Lisbon and Minho



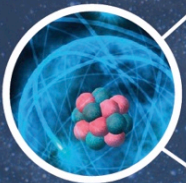
# RESEARCH

## Experimental particle and astroparticle physics



## Structure of matter

- COMPASS
- HADES



## Cosmic rays

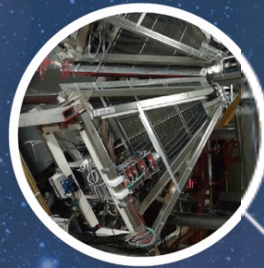
- AMS
- Auger



## Dark matter and neutrinos

- LUX/LZ
- SNO+

## Development of new instruments and methods



## LHC experiments and phenomenology

- ATLAS
- CMS
- LHC phenomenology



## Detector development for particle and nuclear physics

- Neutron detectors
- RPC R&D
- NEXT
- Liquid Xenon R&D
- NUC-RIA



## Instruments and methods for biomedical applications

- RPC-PET
- OR Imaging
- Gamma Cameras
- Dosimetry
- STCD TagusLIP



## Radiation environment studies and applications for space missions

- Space
- A-HEAD

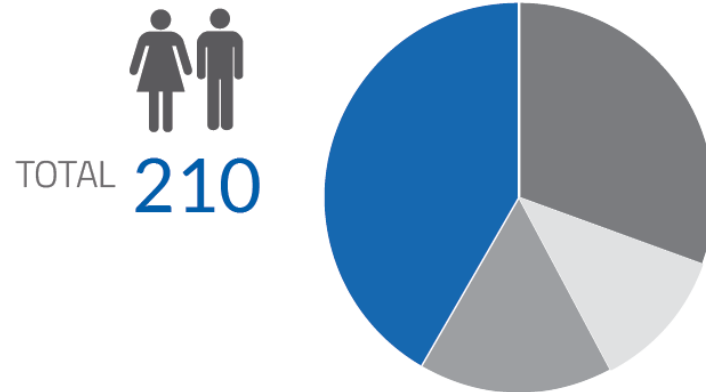


## Computing



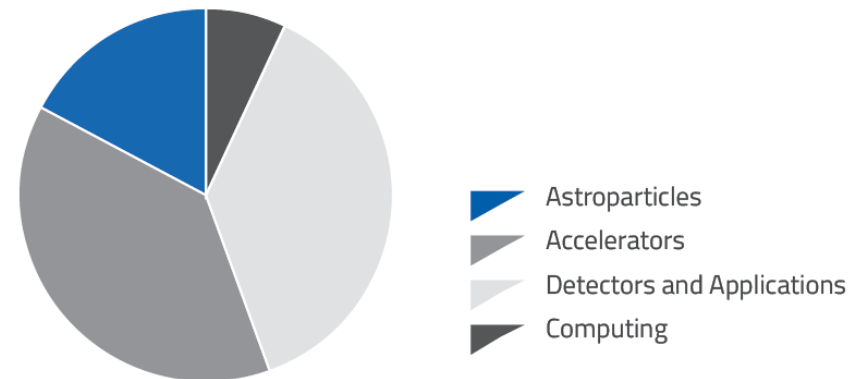
- GRID
- Advanced Com

## Human Resources



- Researchers
- Technicians and Administrative Staff
- External Collaborators
- Students

## Researchers by Research Area



- Astroparticles
- Accelerators
- Detectors and Applications
- Computing

# Particle Physics

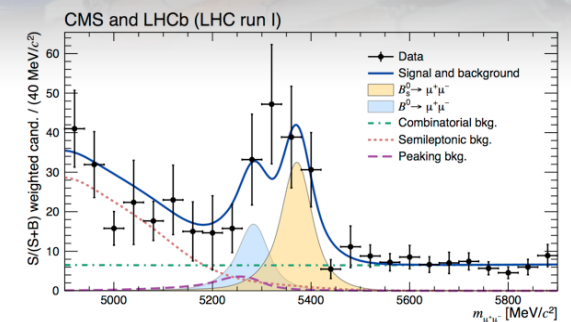
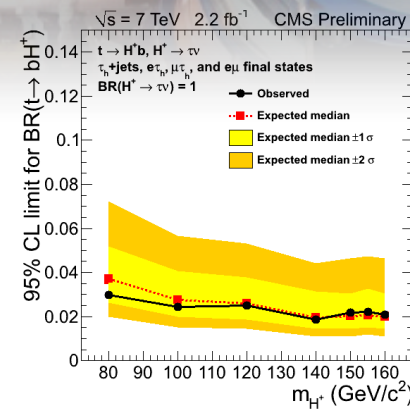
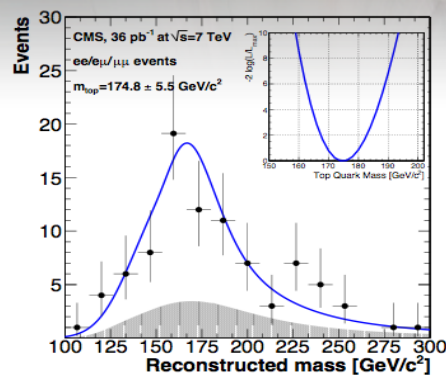
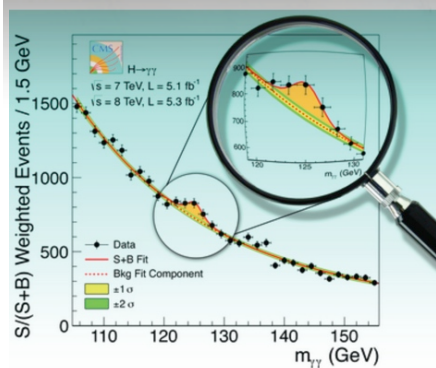


## LHC

- CMS
- ATLAS

## Fixed target

- Compass (CERN)
- Hades (GSI)





# Astroparticle Physics



## Cosmic rays

- Auger
- AMS

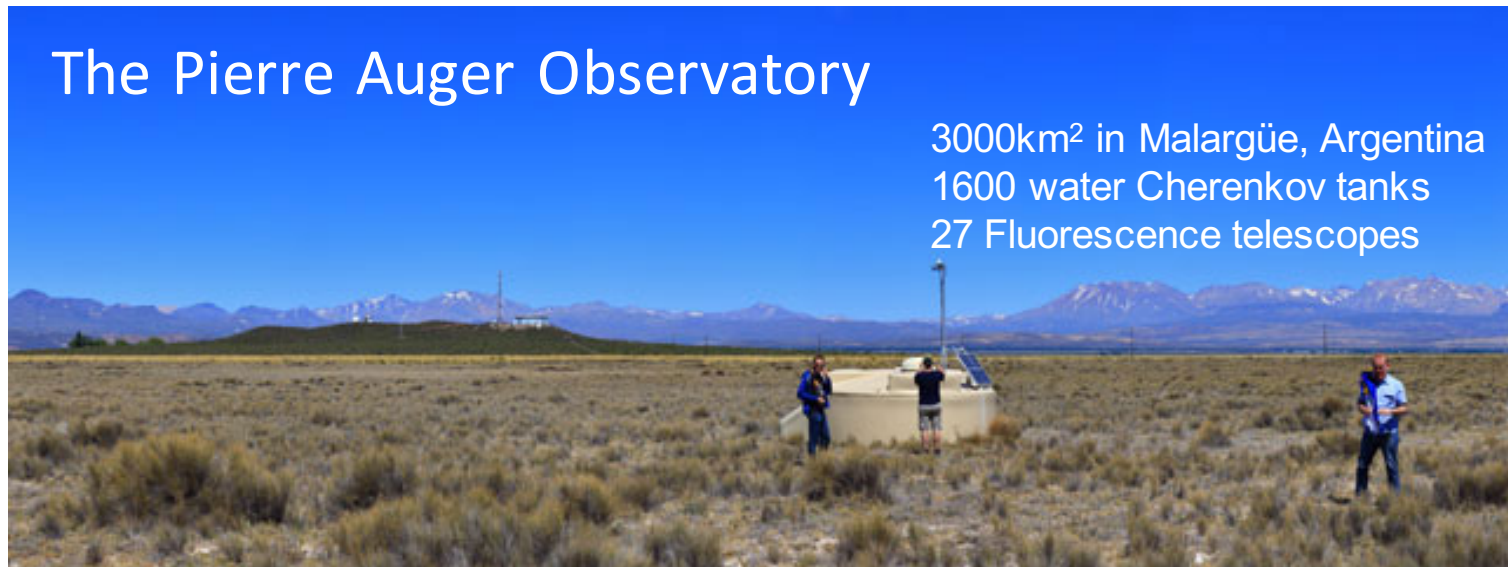
## Dark matter and Neutrinos

- LUX/LZ
- SNO+

Exploitation of the particle physics potential of the Observatory  
Hadronic interactions at high energies  
Muon detection, RPC development

## The Pierre Auger Observatory

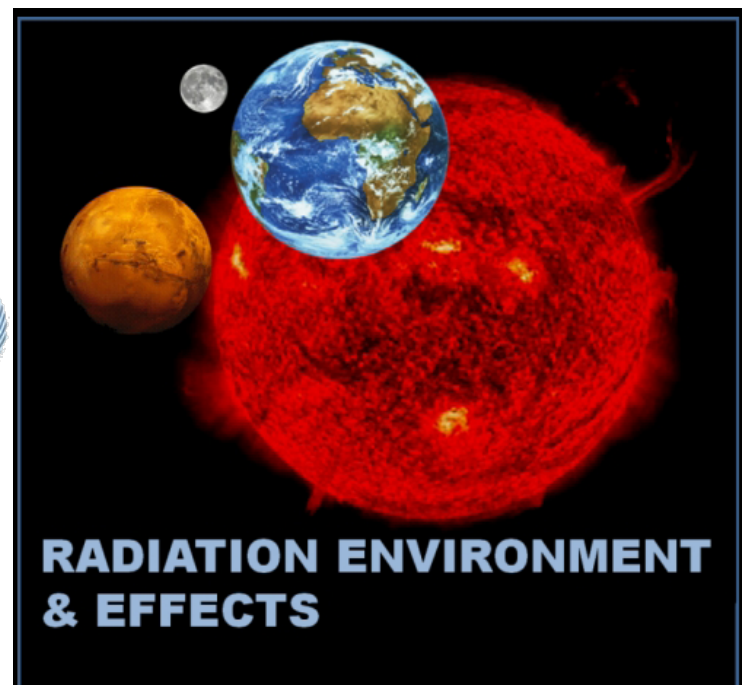
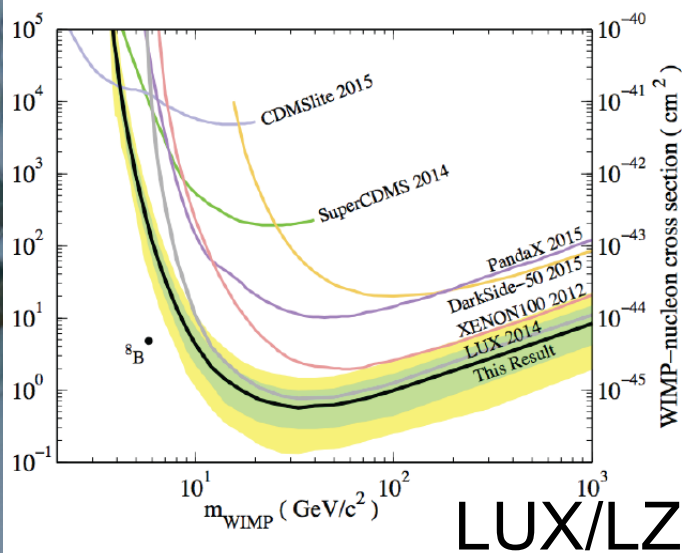
3000km<sup>2</sup> in Malargüe, Argentina  
1600 water Cherenkov tanks  
27 Fluorescence telescopes





RICH  
Radiation Monitors  
Optical Calibration  
Detector control

AMS





# Detector Development for Particle and Nuclear Physics



## Calorimeters

- Scintillating Crystals based Electromagnetic Calorimeters
- Low energy photon detectors
- Scintillating fibers based Hadronic Calorimeters

## Gaseous Detectors

- Gas Scintillation Proportional Counters
- Liquid / Double Phase Xe Detectors
- Resistive Plate Chambers (RPCs)
- Thermal Neutron Detectors

## Electronics and data acquisition

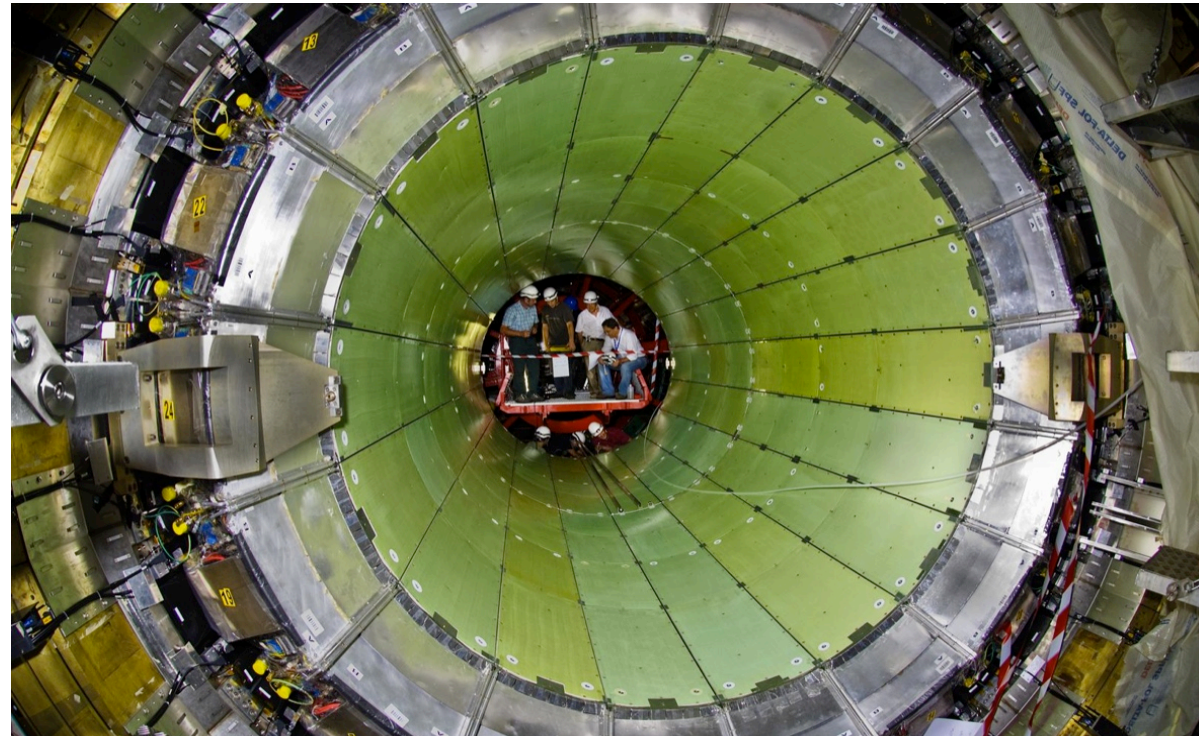
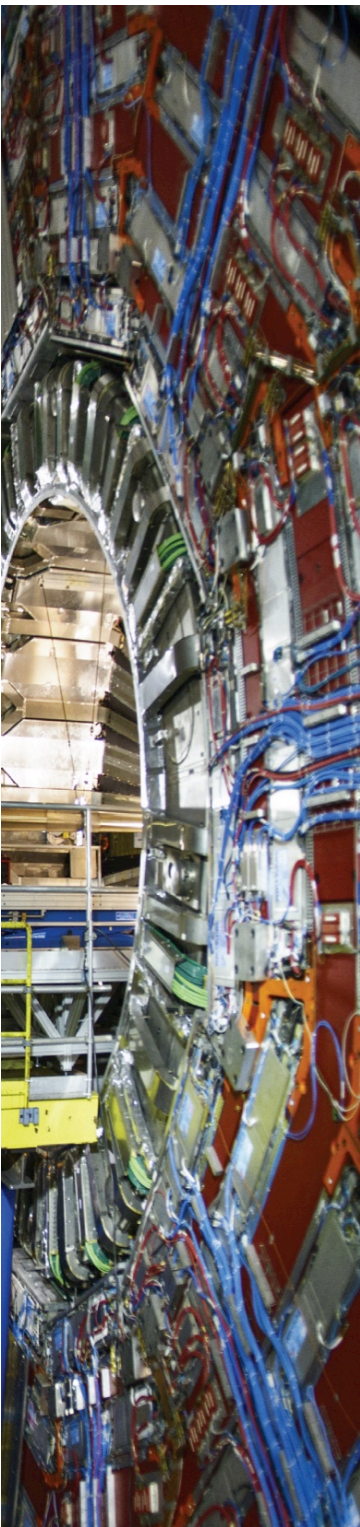
- **Microelectronics, optoelectronics and FPGA based systems**
- **Data acquisition and detector control systems**



# CMS Electromagnetic Calorimeter



Participation in the development of photon and electron detectors based on Scintillating Crystals ( $\text{PbWO}_4$ ) and Avalanche Photodiodes (APD)

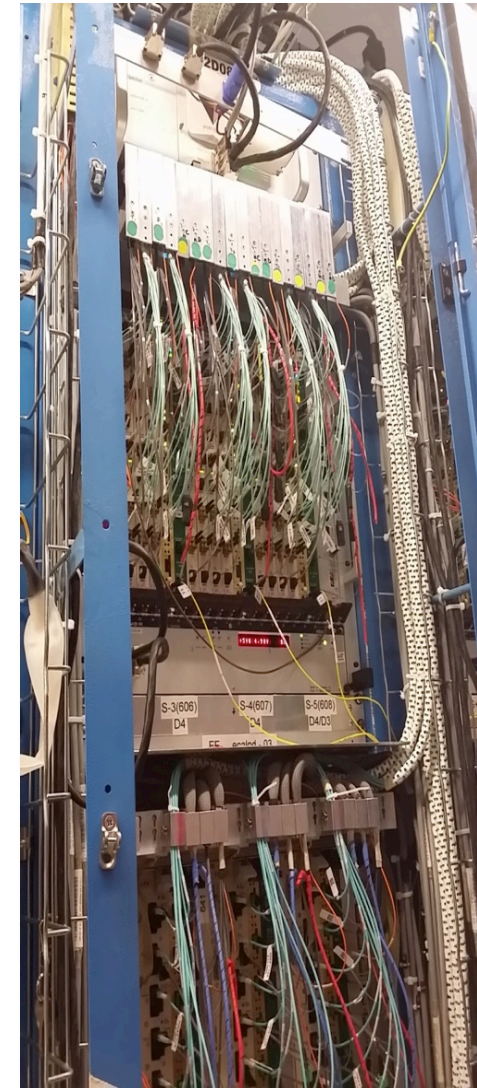
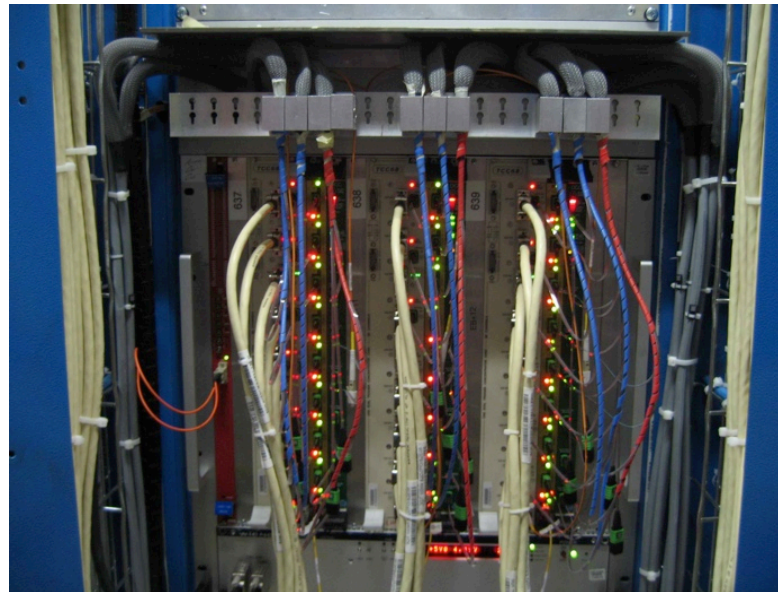
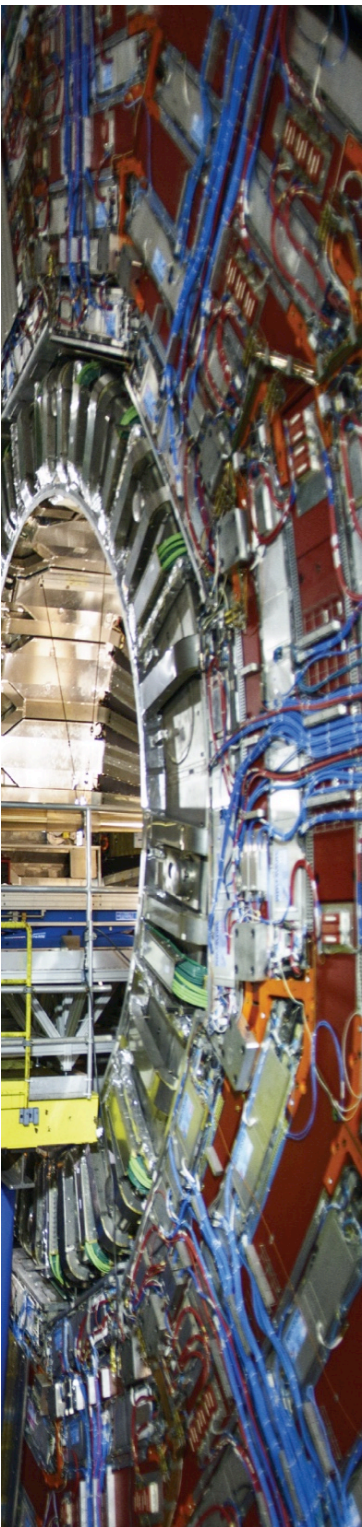


# CMS ECAL Trigger&DAQ system



**CMS CONSTRUCTION**  
18 Crates; 240 Modules;  
1200 Mezzanine boards

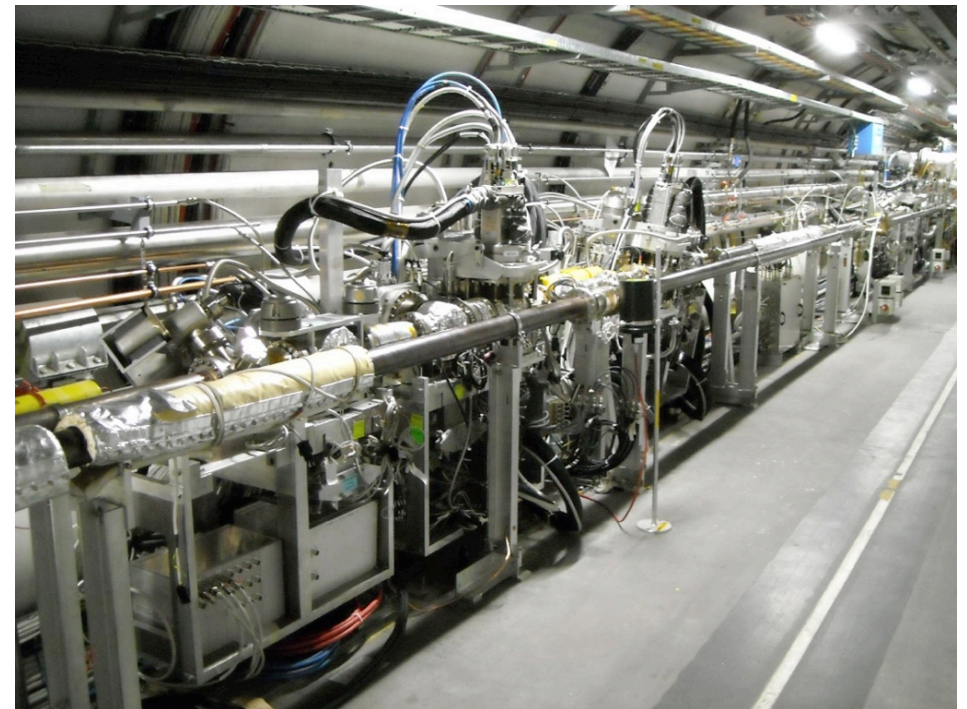
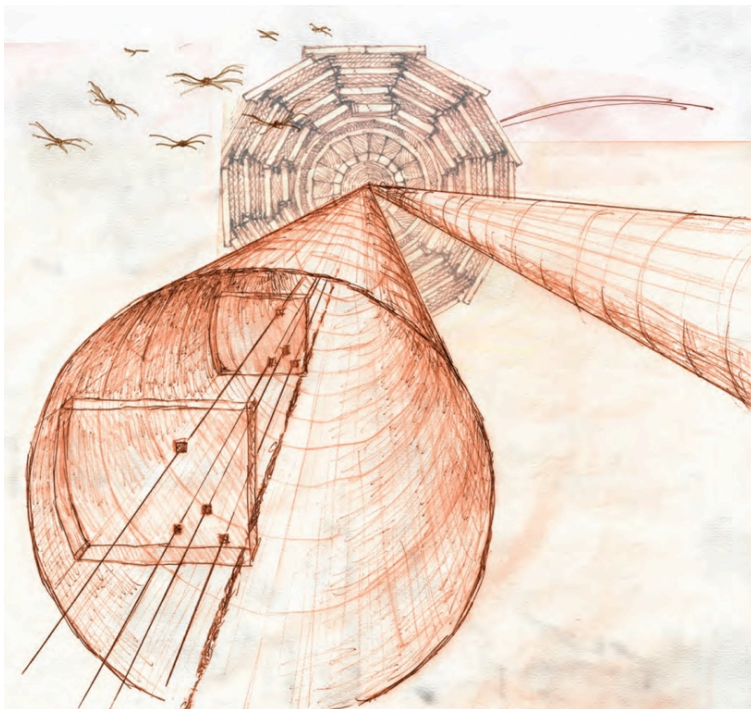
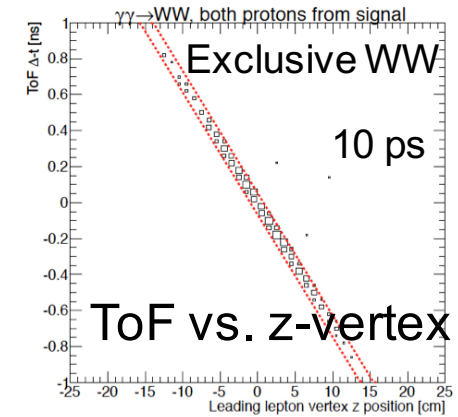
**CMS UPGRADE**  
Trigger optical links

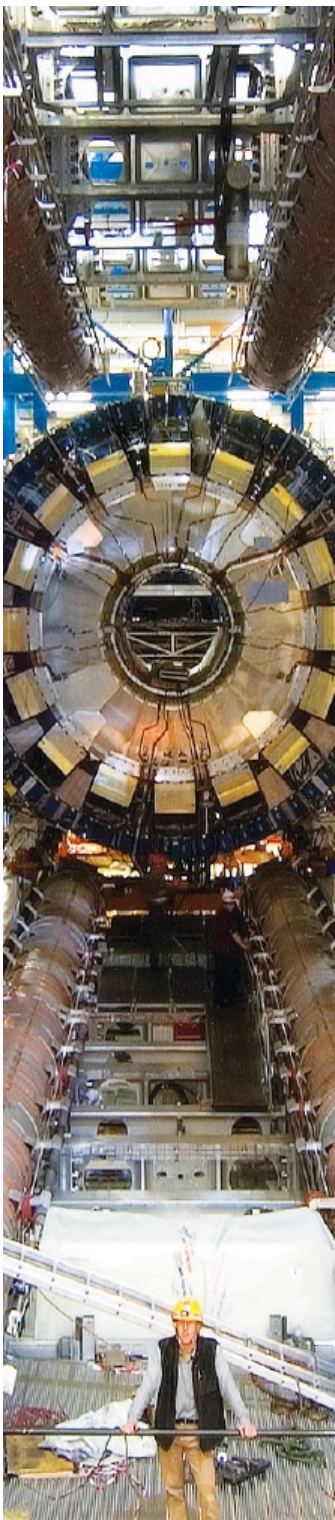


# CMS-TOTEM Proton Spectrometer



Proton spectrometer using **LHC magnets**  
Two tracking stations with **3D Pixels**  
One station with **Timing detectors**

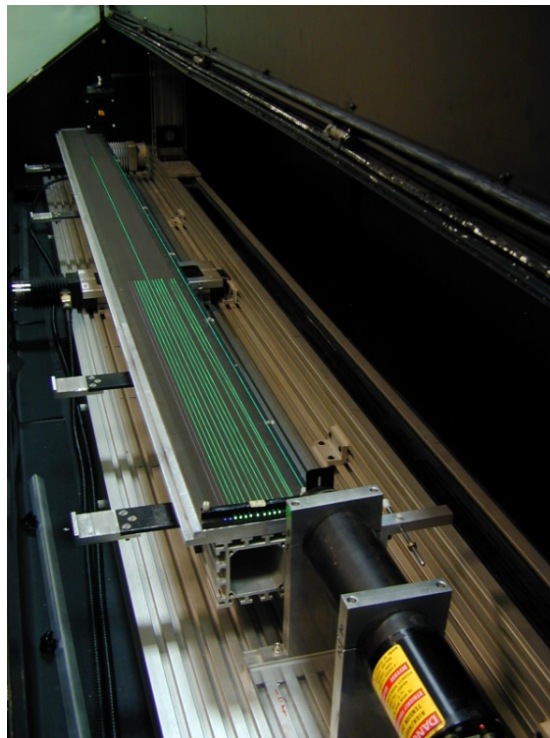




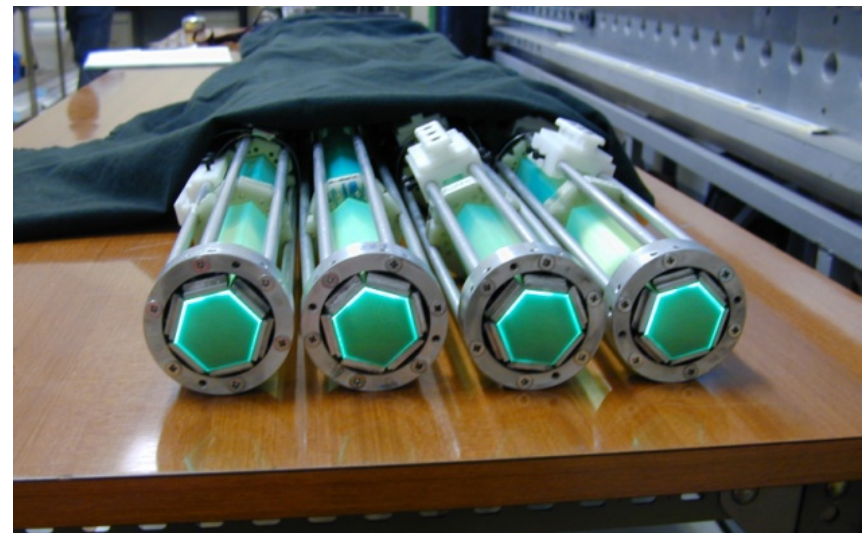
# ATLAS hadron calorimeter



- Selection and characterization of plastic WLS optical fibers and scintillators
- Aluminization of WLS fiber bundles by magnetron sputtering technique



600000 fibers in Tilecal





# Resistive Plate Chambers



Development and construction of RPCs

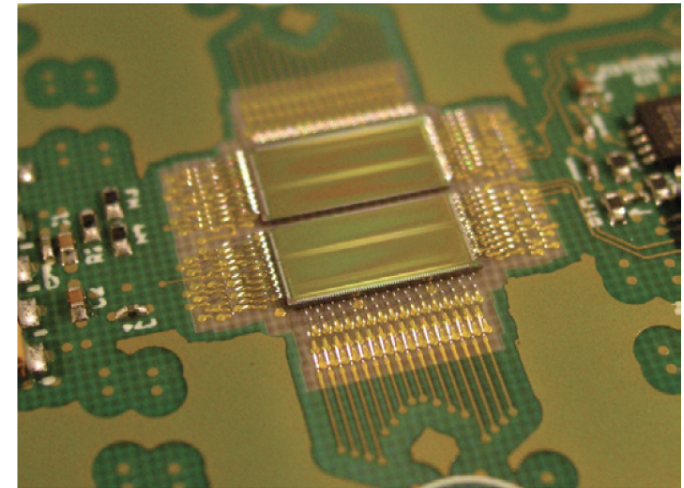
Time of Flight Wall for the HADES experiment (GSI)  
Neutron detection

8m<sup>2</sup> with 1116 variable-  
geometry 4-gap, symmetric,  
timing RPCs

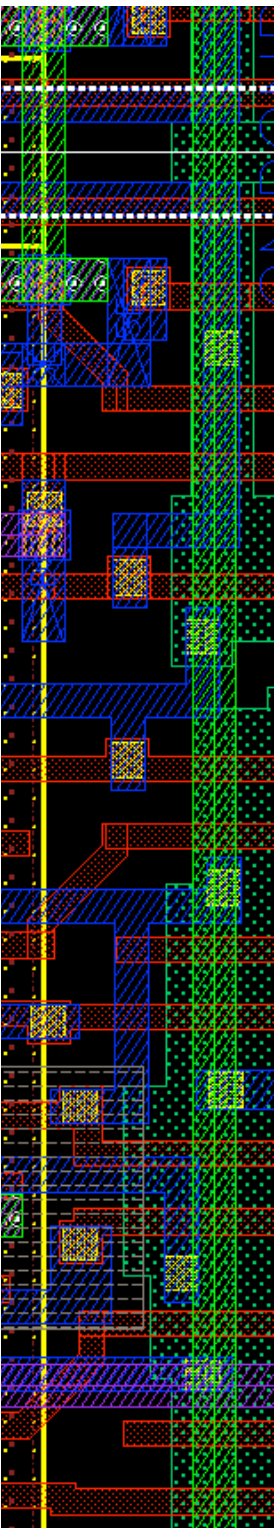
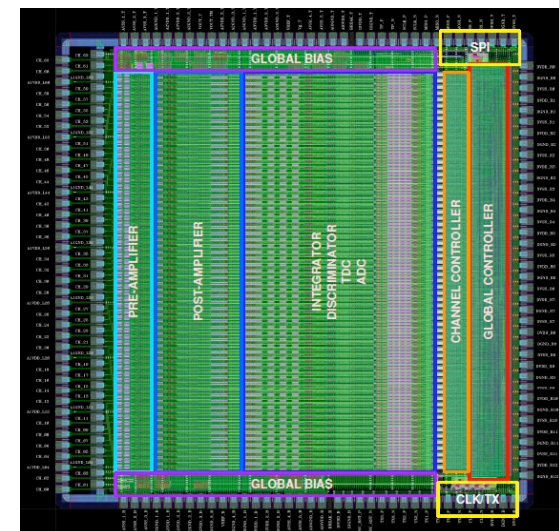
# Microelectronics



- CMOS 250nm, 130nm, 110 nm
- Mixed mode circuits
- ASICs for photosensor readout (PMTs, APDs, SiPMs, etc.)
- Amplifiers, discriminators
- ADCs
- TDCs for ToF



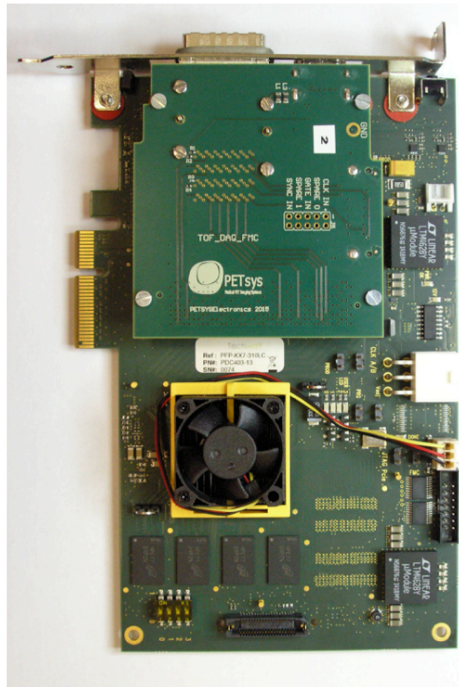
- 12-bit ADC for CMS ECAL
- Front-end ASIC of ClearPEM scanner
- TOFPET ASIC for ToF with SiPMs



# Electronics systems



- Detector front-end systems
- FPGA based modules for data acquisition
- Data transmission and high-speed optical links
- Firmware and software



SiPM readout,  
digitization and DAQ  
system scalable to  
several 10'000  
channels



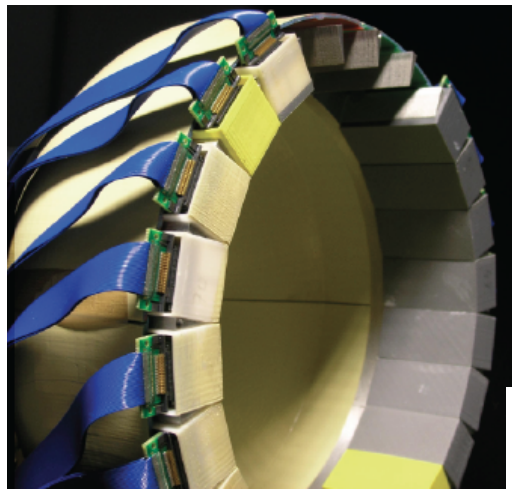
# Medical applications



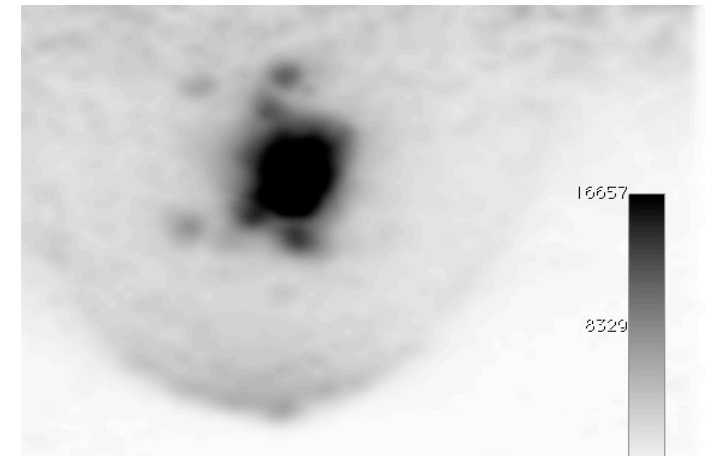
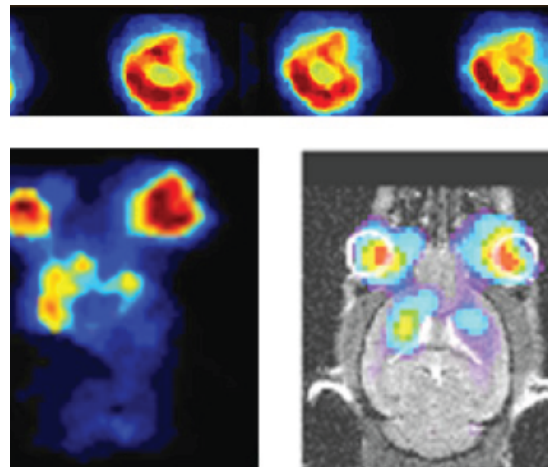
Development of PET detectors

Scintillating Crystals (LYSO) and Silicon Photosensors (APD, SiPM)

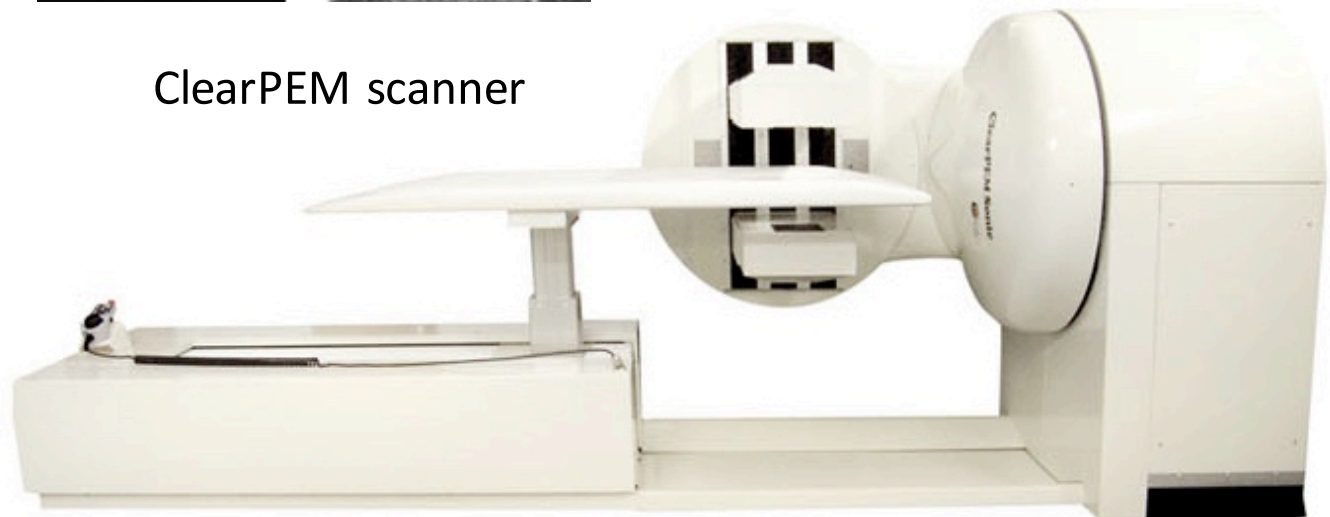
Resistive Plate Chambers

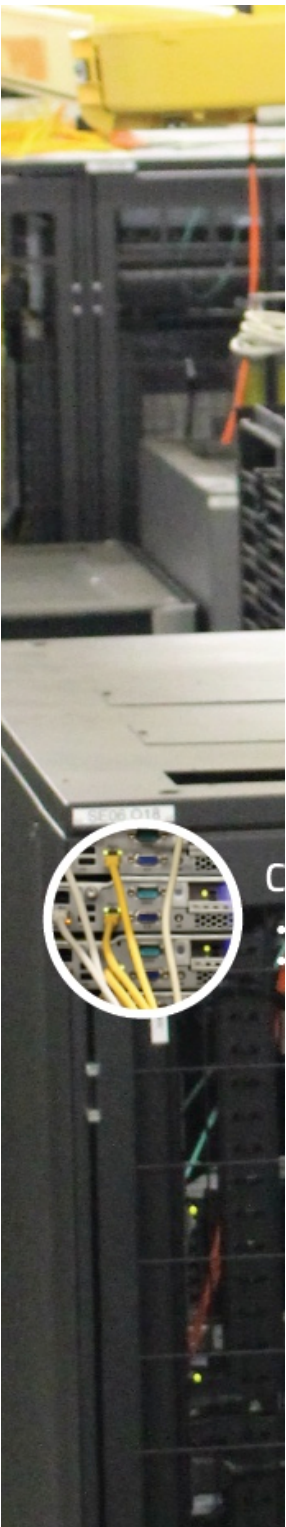


Prototype with SiPMs  
for TOF PET



ClearPET scanner





# Computing



- Worldwide LHC Computing Grid
  - Portuguese Tier-2
- Participation in EU funded projects
- National projects



