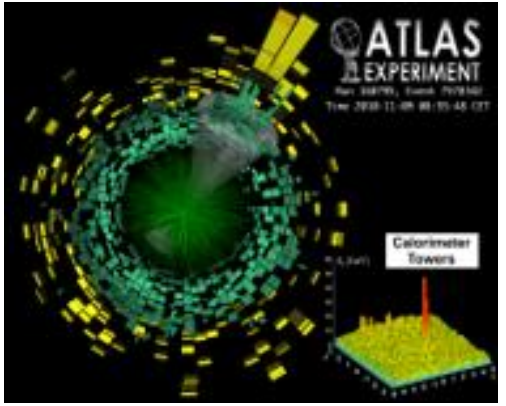
LABORATÓRIO DE INSTRUMENTAÇÃO
E FÍSICA EXPERIMENTAL DE PARTÍCULAS
partículas e tecnologia

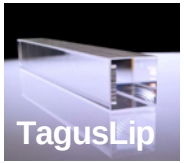
[LIP **Summer Projects 2018**]

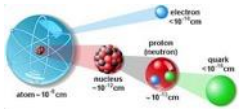
Detectors & Instrumentation

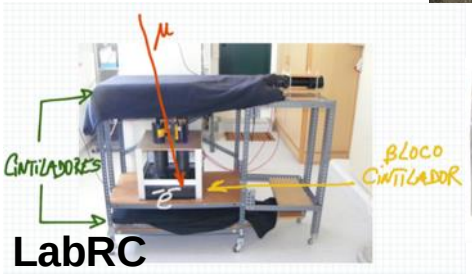
Detector & Instrumentation

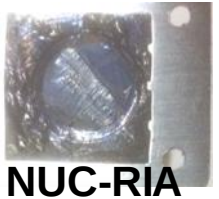
The art of characterizing and developing systems (hardware/software) that allow the scientific investigation









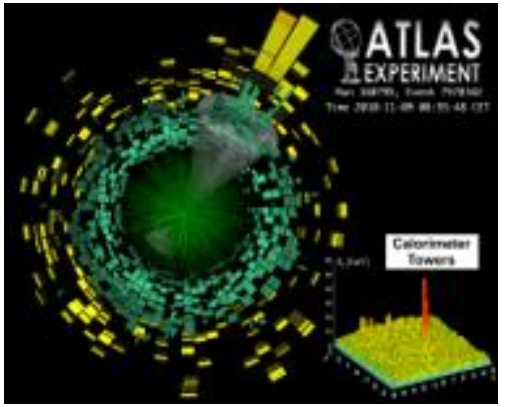


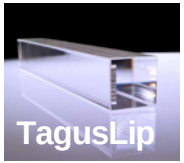
Projects available

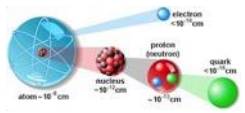
9 Projects in Lisbon
1 Project in Coimbra

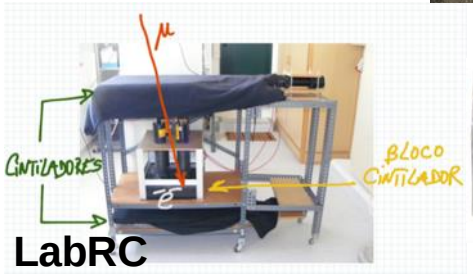
Experiments (type of project):

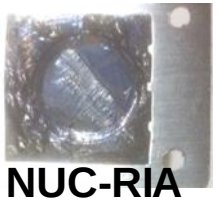
- 1x Auger (hardware)
- 1x LabRC (software)
- 1x Muon Tomography (software)
- 2x NUC – RIA (hardware and software)
- 1x SNO+ (hardware and software)
- 1x CMS/TagusLIP (hardware)
- 2x ATLAS/LOMAC (hardware & sofware)
- 1x Muon detection (Coimbra)











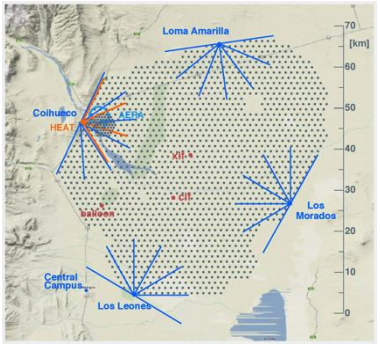
Pierre Auger Observatory

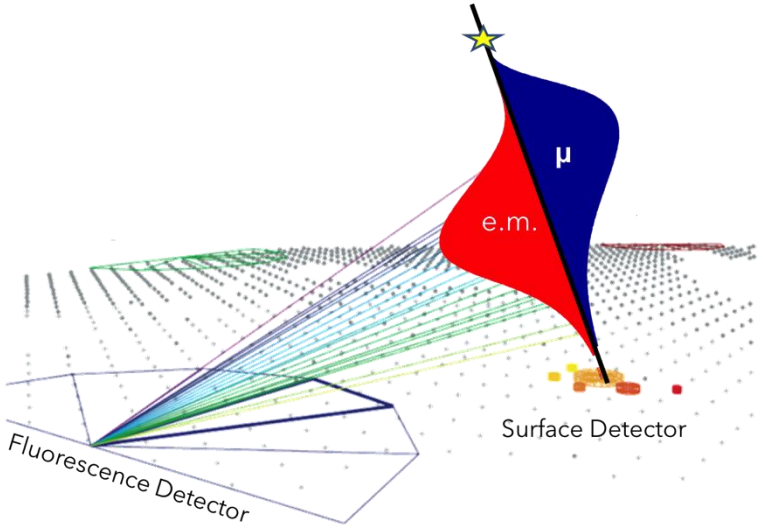
PIERRE AUGER OBSERVATORY

Located in the Pampa Amarilla, it is the largest observatory in the world dedicated to the study of Ultra High Energy Cosmic Rays (UHECRs)

The main array is composed by more that 1600 water Cherenkov detectors which are overlooked by 4 Fluorescence Detectors

The study of UHECRs allows not only to understand the nature and acceleration mechanisms of the most energetic known particles but also can be used to probe hadronic interaction above LHC energies





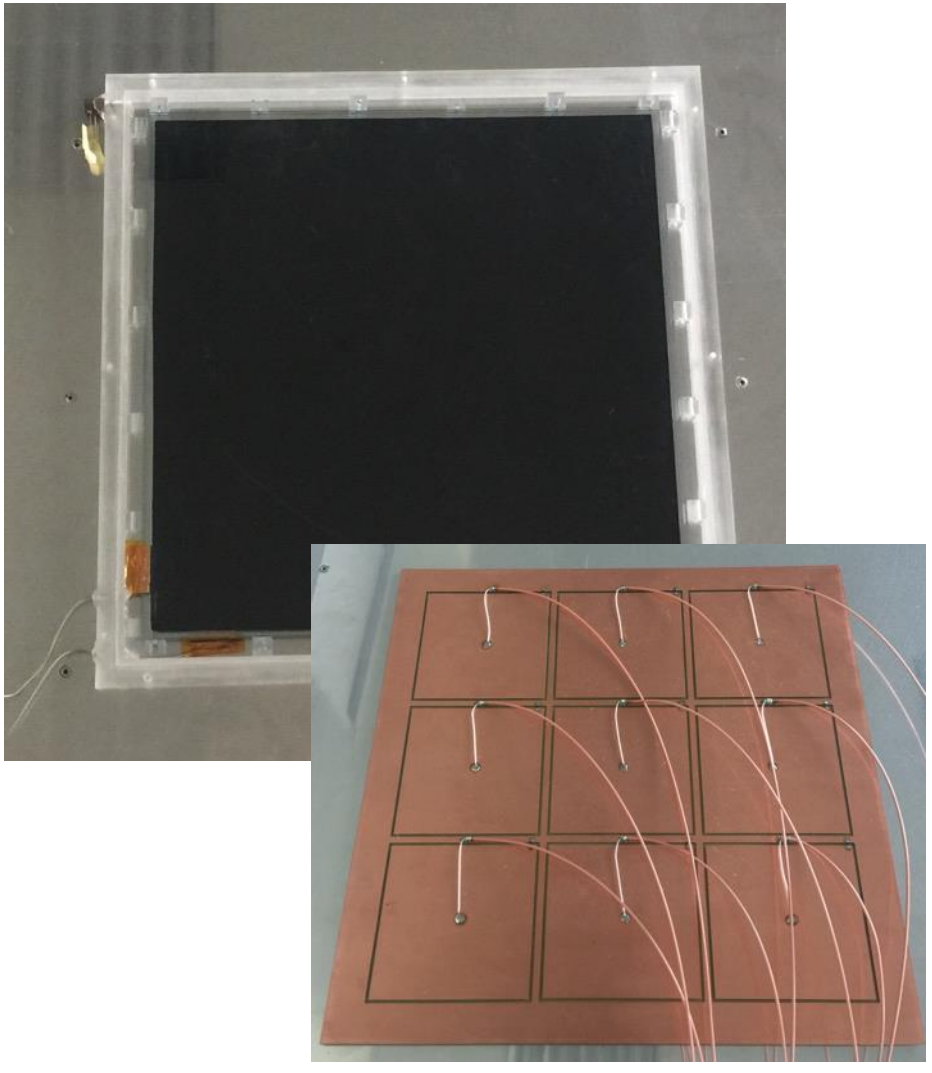
Auger:

Develop an RPC - a gaseous particle detector

In Auger we use RPCs to detect muons. We have a small test one to be built. Several solutions can be tested in this system. It will be the base component of a precision telescope.

Period: 2 months, June-September

Contact: Pedro Assis (pedjor@lip.pt)



Muon Tomography

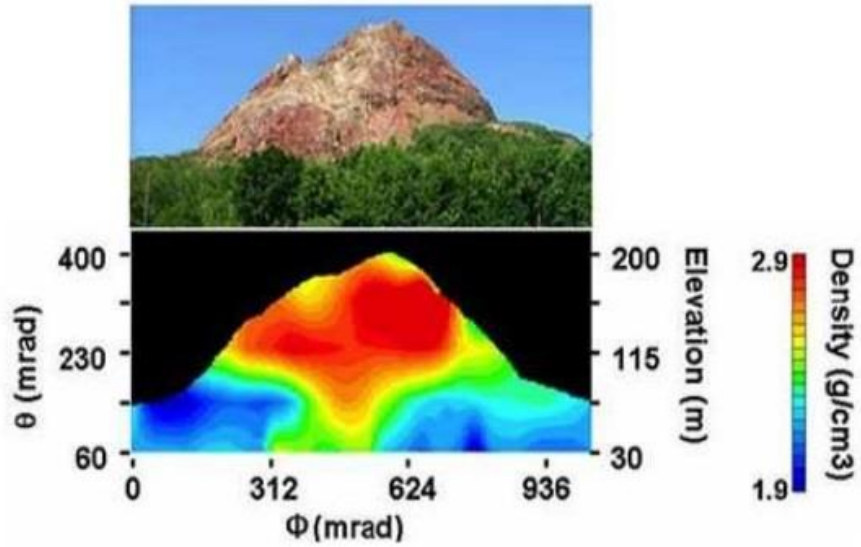
Cosmic ray muons are deeply penetrating particles. Muon telescopes can form images of the interior of **mines, vulcanos, buildings, and even the nuclear reactors and cargo containers**

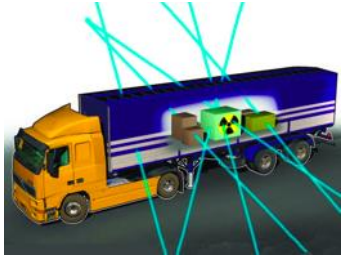
Producing and analysing muon tomographic images.

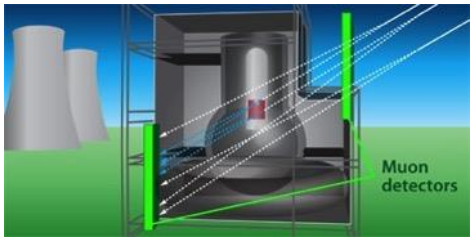
Period: 2 months, June-September

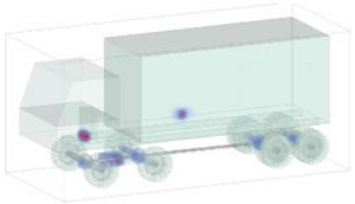
Contact: Lorenzo Cazon, Sofia Andringa

cazon@lip.pt









LabRC:

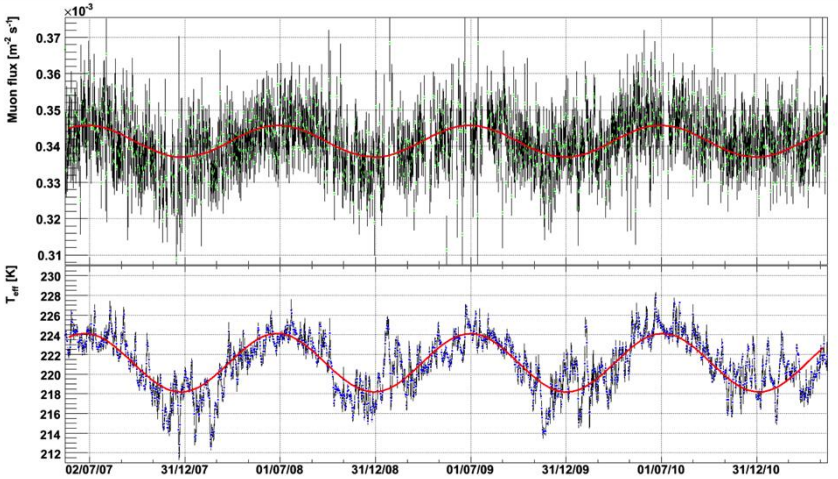
Desenvolvimento de um display de taxas de muões

Os muões são partículas criadas na interação dos raios cósmicos com a atmosfera. No Laboratório de Raios Cósmicos existem detectores de cintilação capazes de detectar estas partículas.
As taxas de muões detectadas na Terra apresentam variações de várias ordens (diárias e sazonais).

Correlações com observações meteorológicas:
http://meteo.tecnico.ulisboa.pt/obs/live

Variabilidade temporal nas taxas de muões atmosféricos

Monitorização de muões atmosféricos



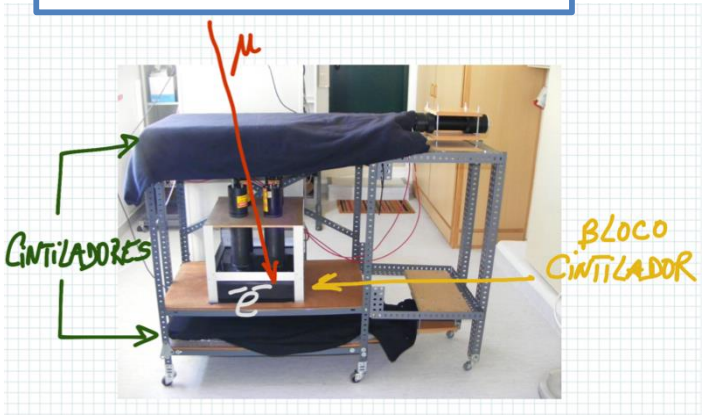
LabRC:

Desenvolvimento de um display de taxas de muões

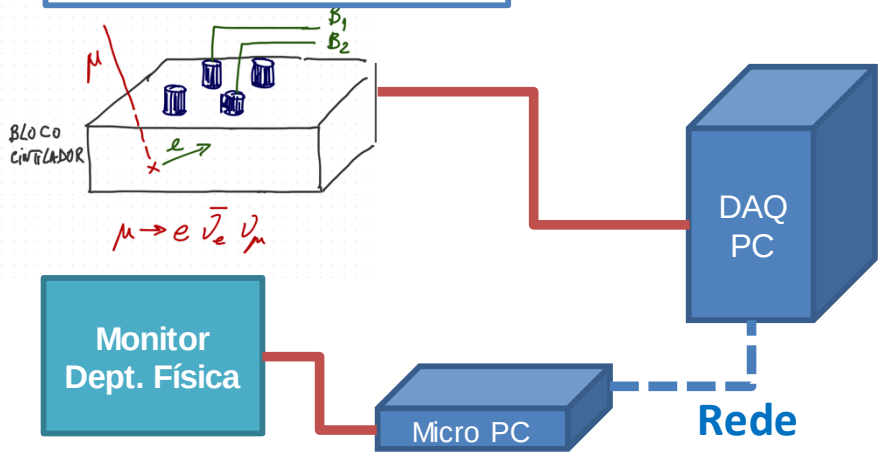
O que se propõe neste trabalho é o desenvolvimento de software que permita monitorar em permanência a chegada de muões à Terra. Para isso será necessário calcular a sua taxa de deteção, e construir de seguida um gráfico (display) que permita mostrar a taxa ao longo do tempo num ecrã de computador.
O display poderá ser realizado através da implementação de um servidor web.

Pretende-se que o aparato experimental esteja ligado pela rede a um micro-computador que será responsável pelo display.

Detector cintilador



Leitura Remota



LabRC:

Desenvolvimento de um display de taxas de muões

Projecto de estágio:

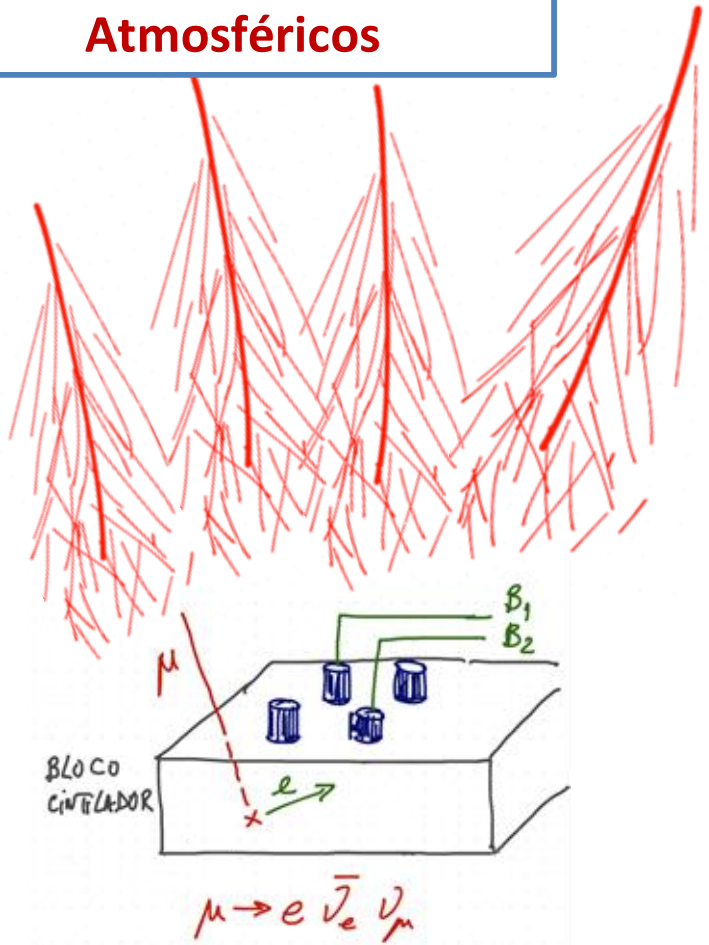
Desenvolvimento de um display de taxas de muões

Outros projectos:

Optimização de algoritmos através de métodos de paralelização

Contacts:
Fernando Barão (barao@lip.pt)
Miguel Orcinha (migorc@lip.pt)

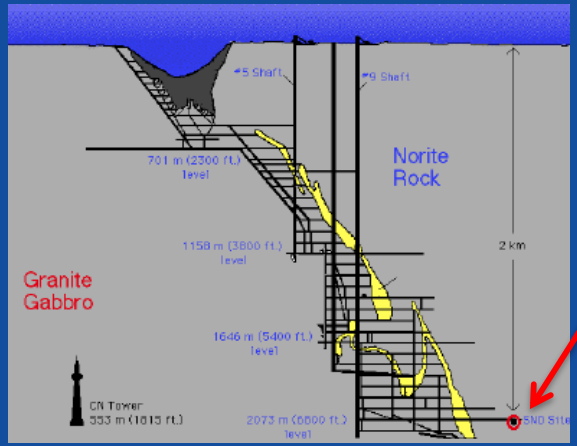
Detecções de Muões Atmosféricos



SNO+:

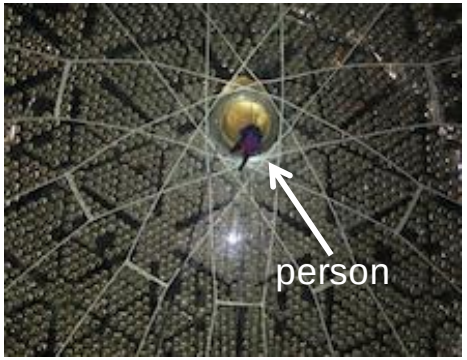
Energy response calibration of the SNO+ neutrino experiment

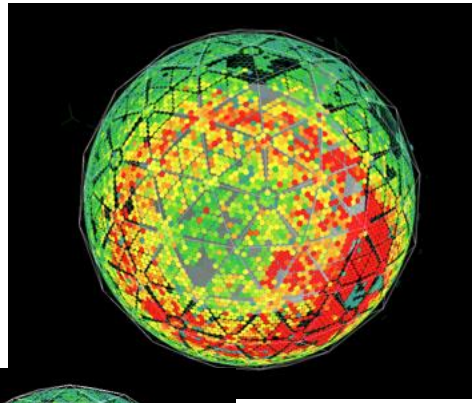
- High precision neutrino detector located deep underground (2 km below the surface in a Canadian mine)!

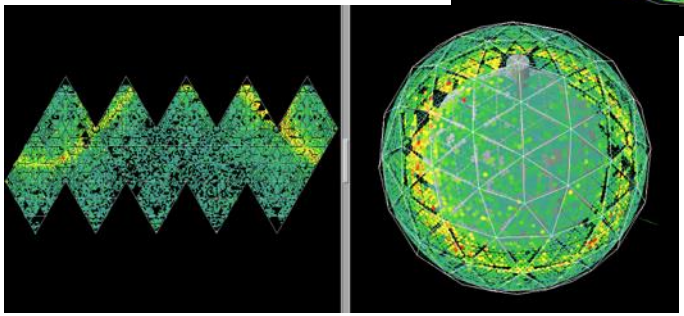


We are here!

12 m diameter acrylic sphere surrounded by 9300 light sensitive detectors





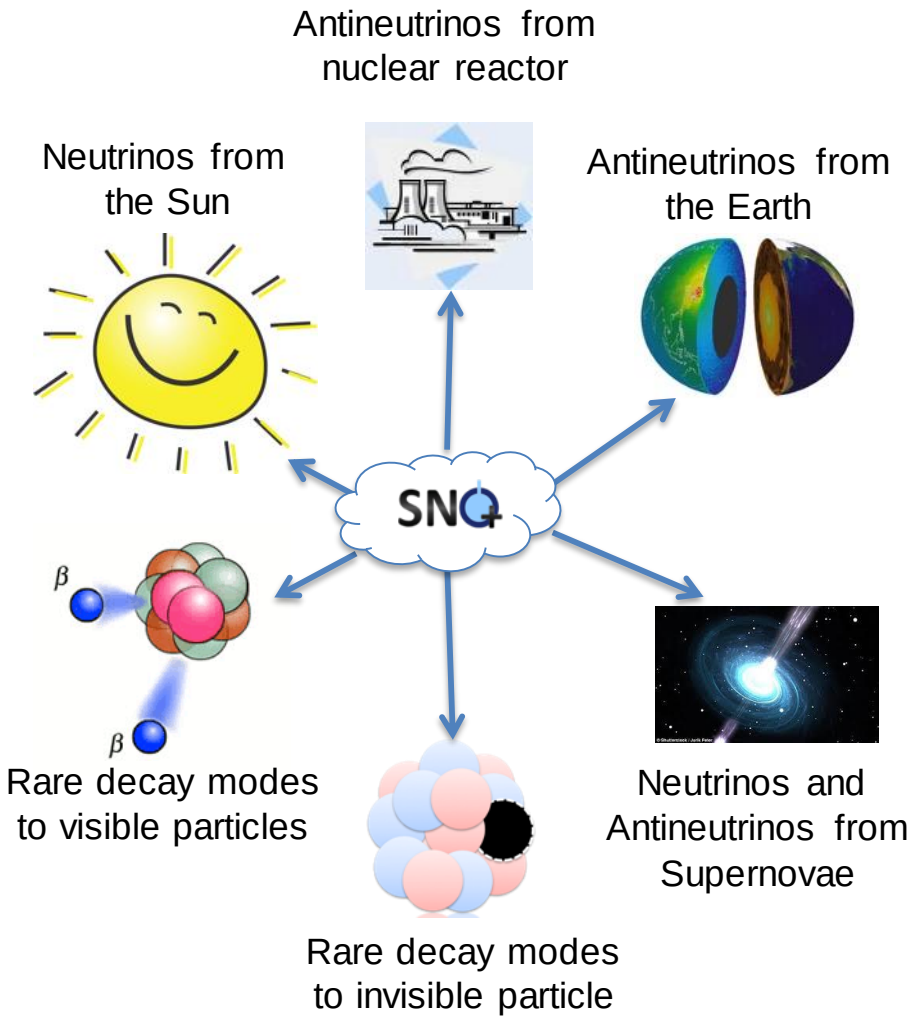


Muons or neutrinos?

SNO+:

Energy response calibration of the SNO+ neutrino experiment

- High precision neutrino detector located deep underground (2 km below the surface in a Canadian mine)!
- Large physics program & rare event searches: **Important to characterize the detector for good quality data**



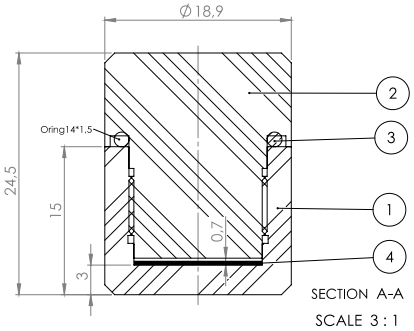
SNO+:

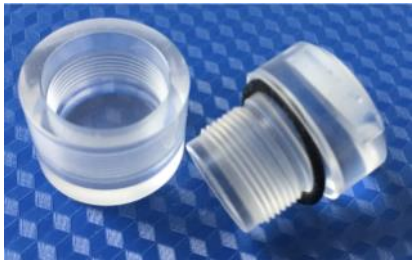
Energy response calibration of the SNO+ neutrino experiment

- **Signal type:** Scintillation light
- **Detection mode:** Photomultiplier tube (light sensitive device) hit
- **Problem:** Energy to photons conversion
- **Solution:** Calibration

Period: 1-2 months, July-August

Contact: Valentina Lozza (vlozza@lip.pt)





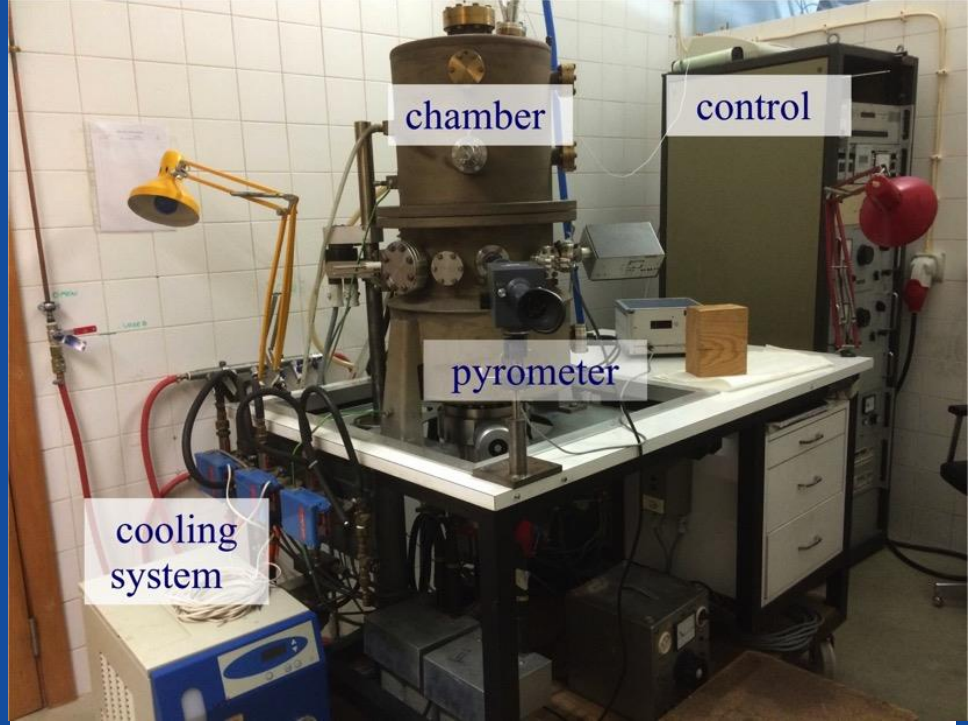
NUC-RIA:

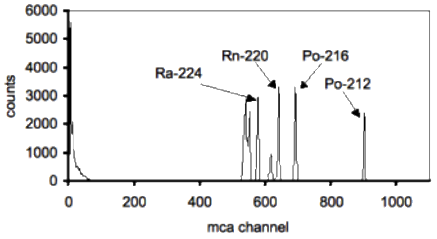
Produção e caraterização de filmes finos

- Produção de filmes finos de Ag (~100 nm até 1-2 μm) pela técnica da evaporação térmica.
- Caraterização com fonte alfa.
- Medida da espessura em base à perca de energia das partículas alfa.

Período: 1 month, July or September

Contacts: Daniel Galaviz, Pamela Teubig
galaviz@lip.pt





NUC-RIA:

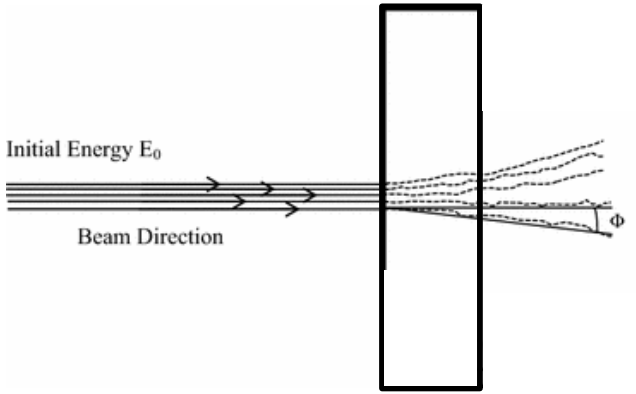
Uso e automatização do código AlfaMC

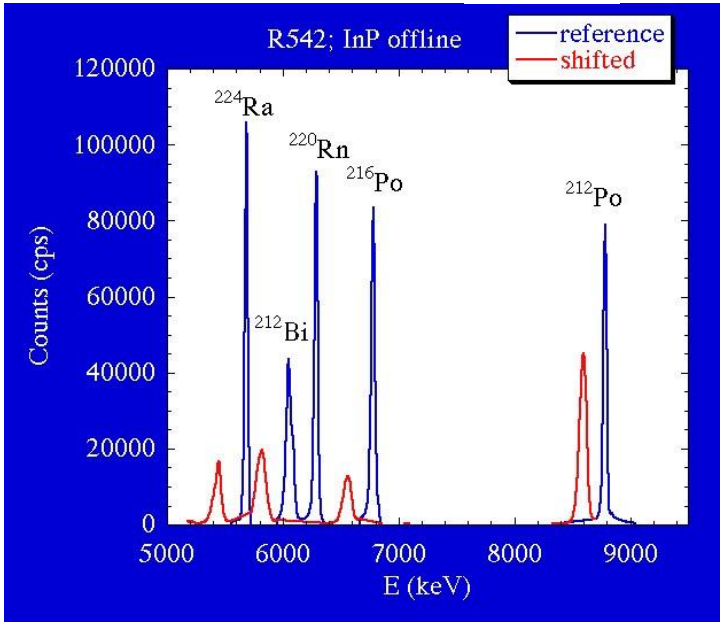
- Simulação com o código AlfaMC do espetro de partículas alfa emitidas por fontes radioativas
- Simulação e medida do espectro alfa após perca de energia em filmes finos
- Automatização para extrair a espessura de filmes finos por ajuste a espectros experimentais

Período: 6 semanas, Julho e Setembro

Contacto: Luís Peralta, Daniel Galaviz

luis@lip.pt , galaviz@lip.pt



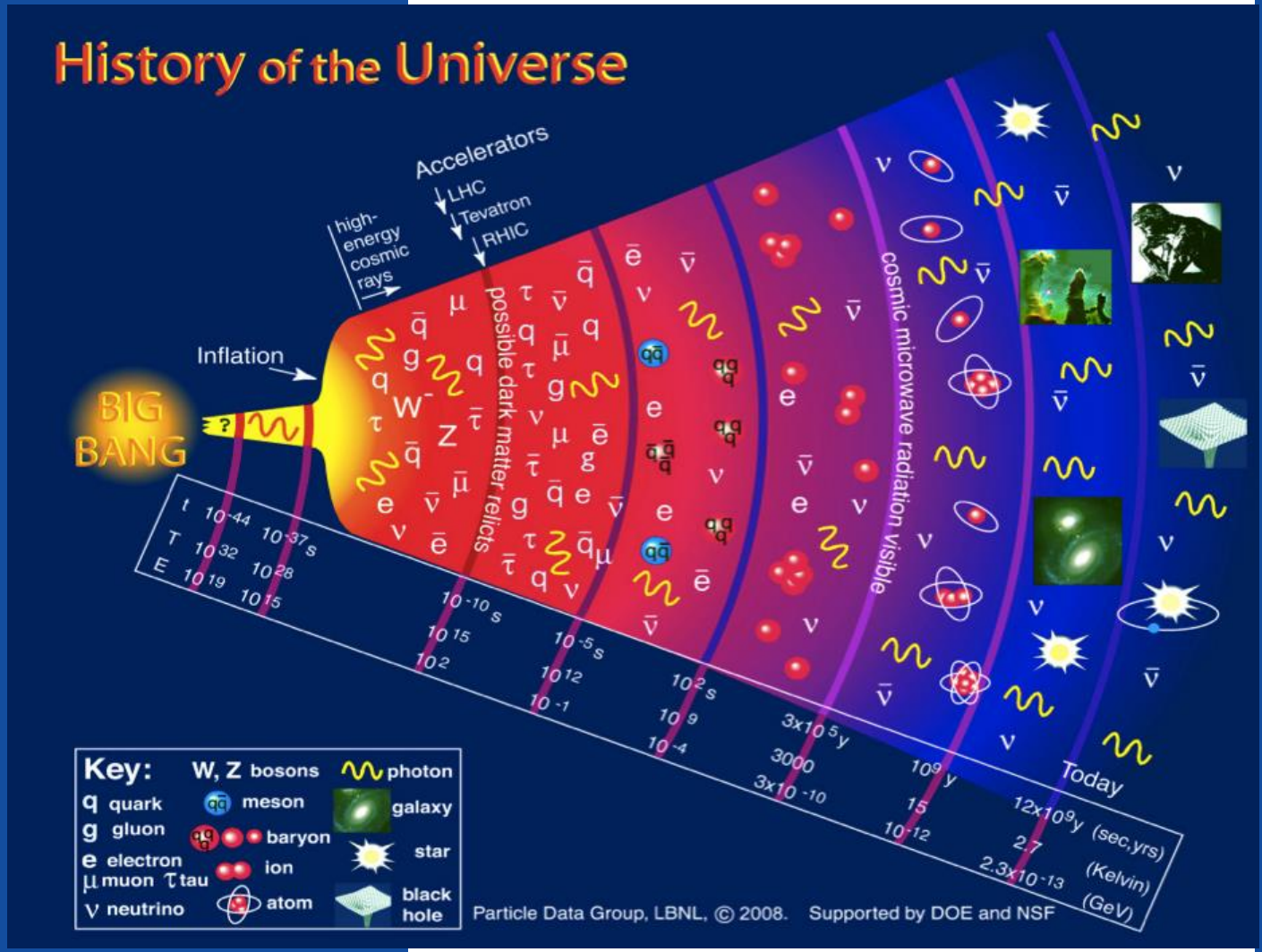


Large Hadron Collider

- 27 km perimeter
- Coolest place in the galaxy
- Hottest place in the galaxy (interaction point)

- The LHC collides protons, and also Pb ions
- 40 M pp bunch crossings per second !
  - up to 60 pp interactions per bunch crossing

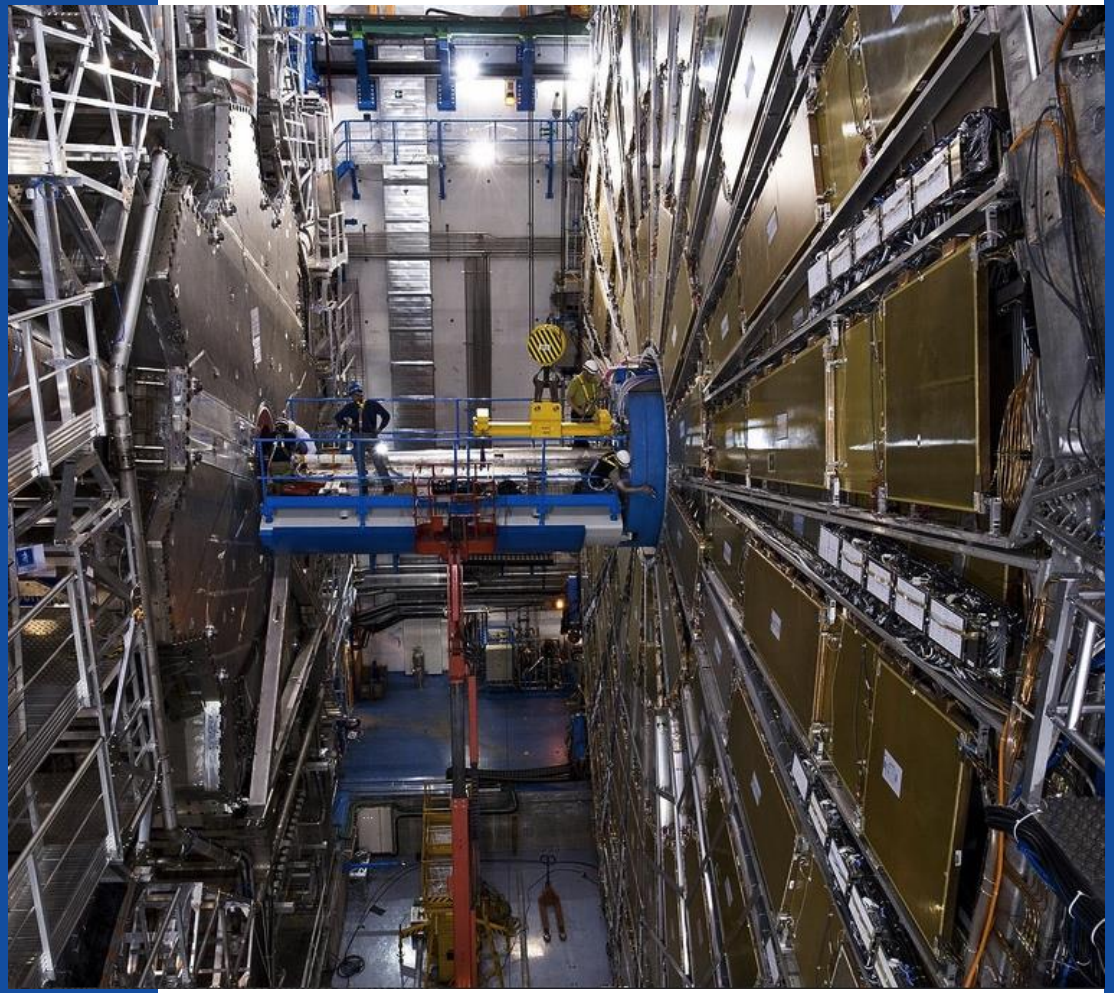
Looking into the origin of the Universe



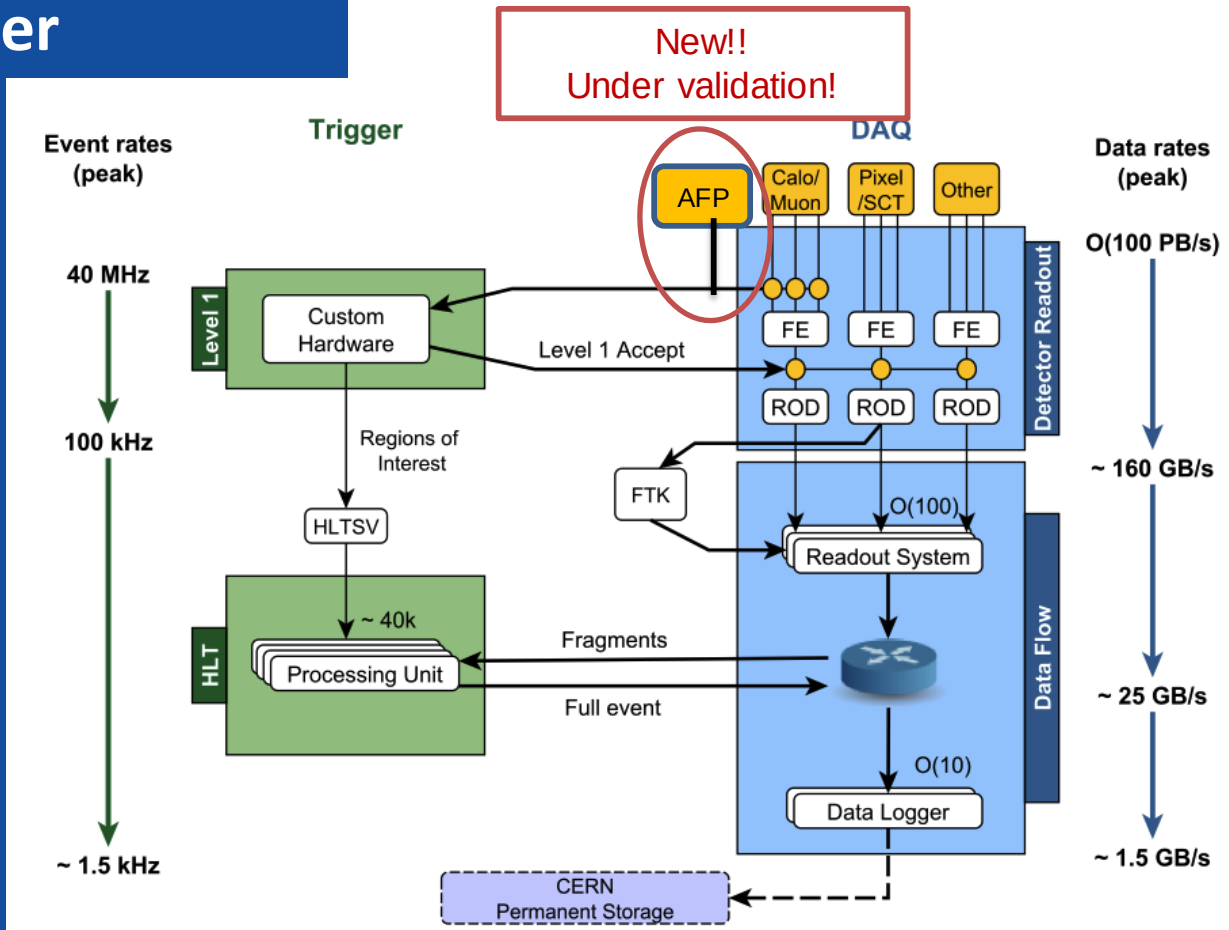
ATLAS & CMS

Huge & complex detectors

- Cutting edge technology
- 10^8 electronic channels
- Process in real time 40 M bunch crossing/second
  - Selects ~1000 for offline analysis
  - Dedicated specialized electronics and software



The ATLAS trigger system



ATLAS:

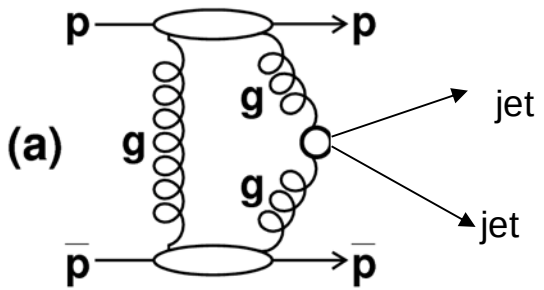
Validation of the central exclusive di-jet trigger

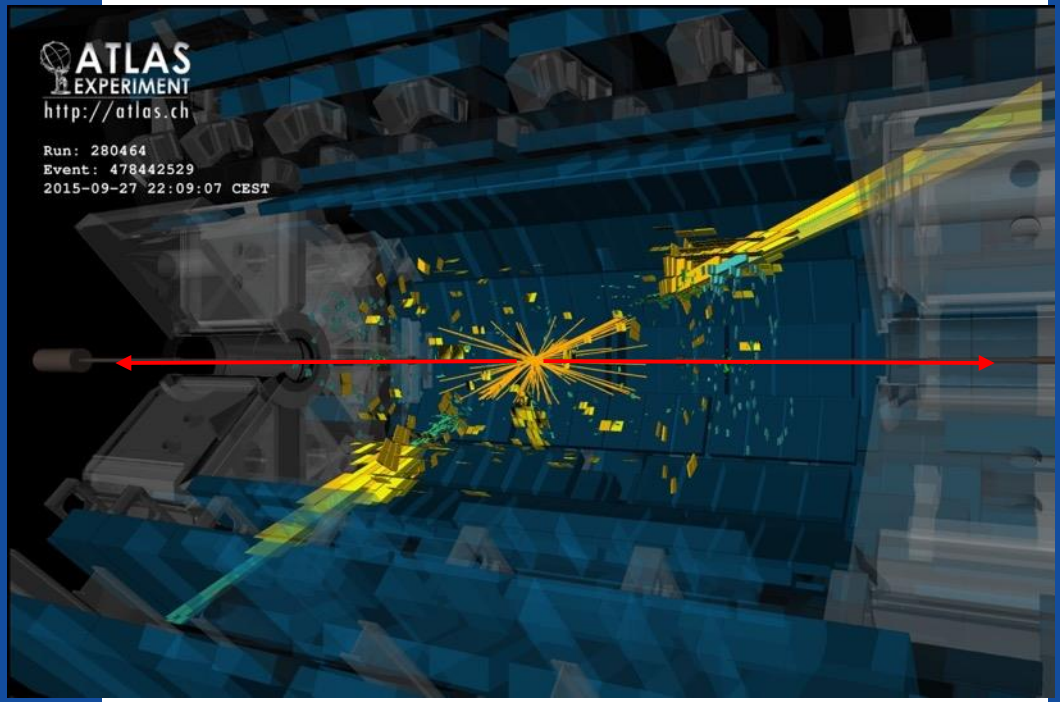
- Fundamental for QCD physics studies
- Responsibility of Portuguese team
- Requires:
  - 2 diffracted p, 2 jets
  - Nothing else
- Performance study using ATLAS data

Period: 2 months, July/September

Contact: Patricia Conde Muiño

patricia.conde.muino@cern.ch

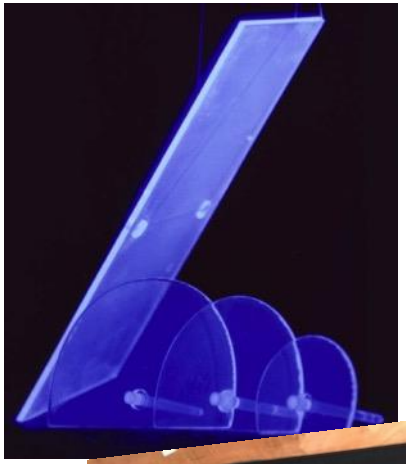
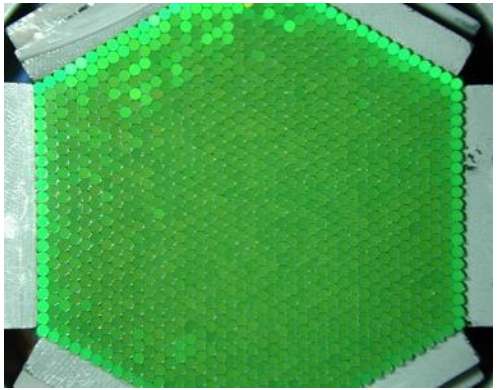




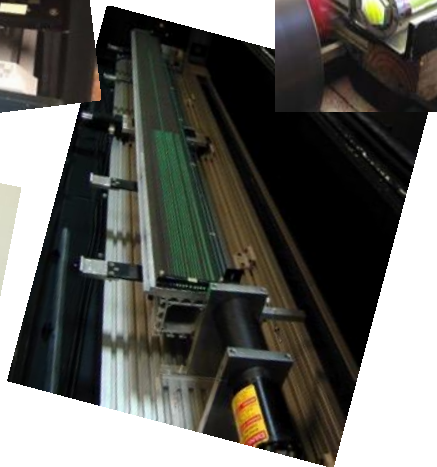
LOMAC Lab
Activities

LOMAC Lab (@FCUL, @LIP):

- Dedicated test benches
- Optical characterization of optical fibers (Fibrometer)
- Optical characterization of scintillators (Tilemeter)
- Sputtering setup for top aluminization of fibers





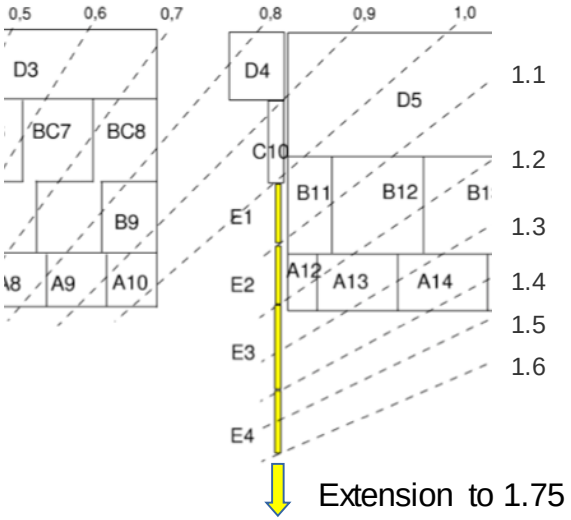
ATLAS Upgrade:
Optics Replacement

Problem:
Scintillator and cells are damaged by radiation

Effect:
light loss during High Luminosity LHC operation

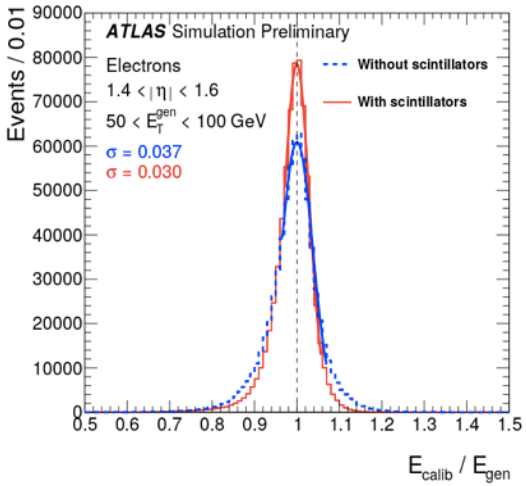
Solution:
TileCal estimate light loss (in progress)
replace part of the E cells

Motivation:
E cells scintillators are important to improve:
- e/gamma and jet energy reconstruction
- Fake Jets Rejection



Cells A, BC, D =
Tilecal main scintillators
Cannot be replaced.

Cells E = gap-crack accessible

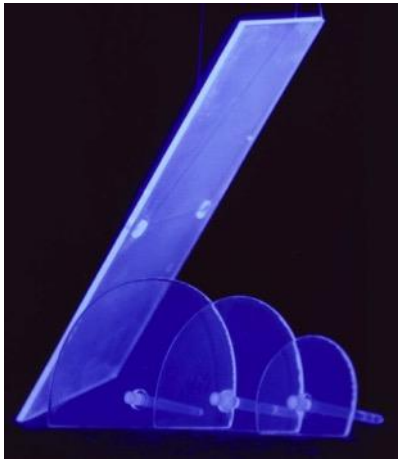


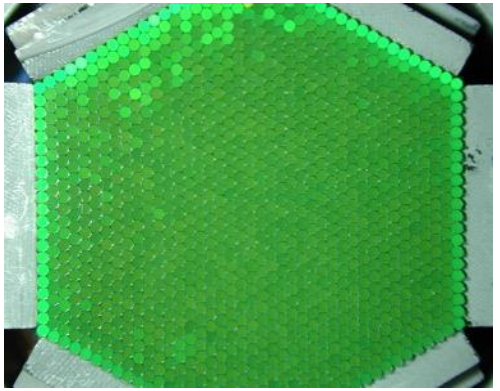
ATLAS:

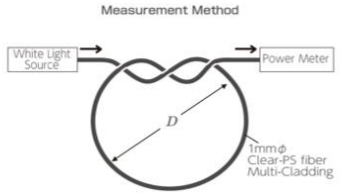
Scintillators and fibers for the upgrade of the TileCal hadron calorimeter of the ATLAS experiment at CERN

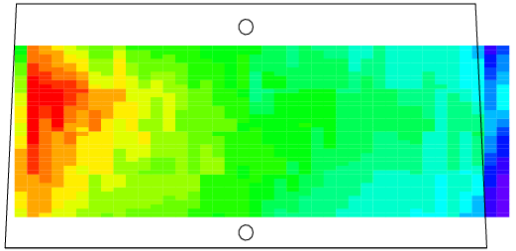
Activities @ LOMAC Lab (@FCUL, @LIP):

- Fibers and Scintillators for ATLAS/Upgrade
  - Light Output decrease due to radiation damage and ageing
  - Estimation of scitillators and fibers lifetime
  - New design of fiber routing for upgrade
  - Fiber bending – curvature radius needs to be studied
- Scintillators for future detectors (for FCC)
  - Maps of light collection
  - Tests of new photodetectors;









Period: July/1-15 August/September

Contact: Agostinho Gomes

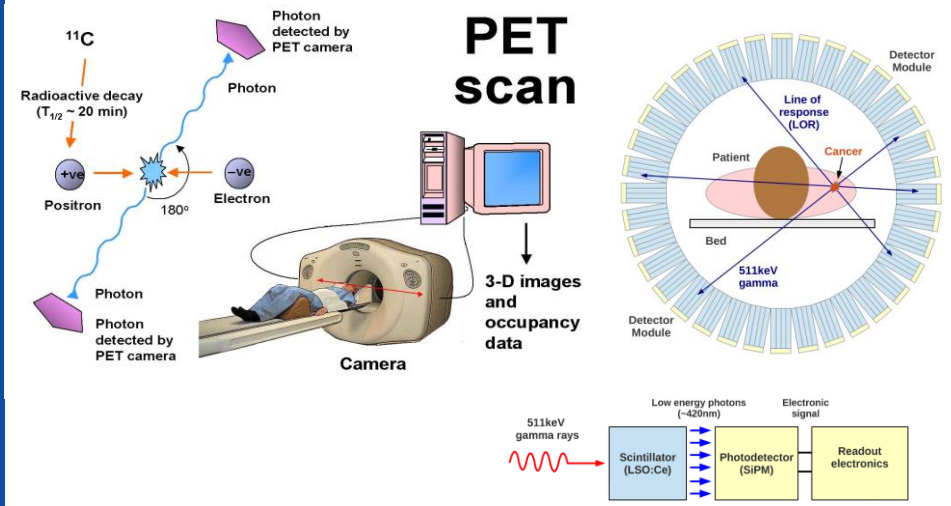
agomes@lip.pt

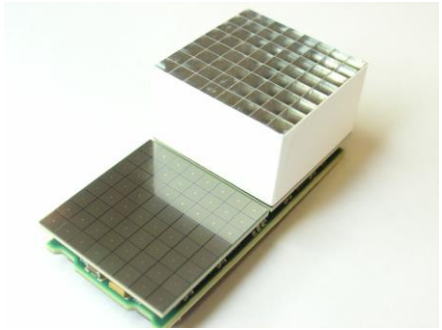
TagusLIP
Activities

Active in development of detector modules and readout electronics for medical applications:

- ASICs for photo-sensors
- Complete DAQ systems
- Gamma ray detectors

Recently active in development of the readout system for a large Particle Physics experiment based on the same technology





CMS upgrade

for the high-lumi phase: HL-LHC

- The current CMS detector

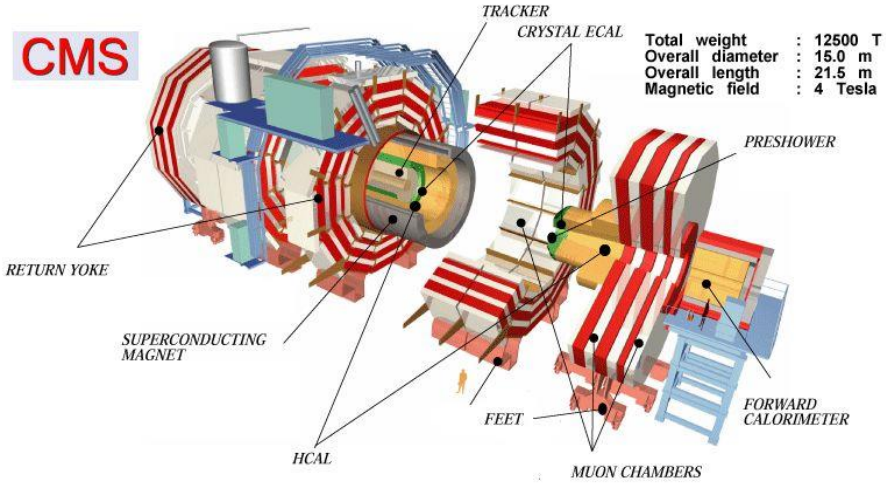
- different layers of detectors measure the different particles produced in high-energy collisions at the LHC, and use this key data to build up a picture of events at the heart of the collision.

- The High-Luminosity Large Hadron Collider (HL-LHC) project will increase the luminosity (rate of collisions) by a factor of 5 beyond the LHC design value

- Significant upgrades of CMS for HL-LHC conditions

- Radiation hardness
- Mitigate the impact of the high pile-up data

- Will effectively result in a "new" CMS detector



CMS upgrade:
High-precision timing detetors for HL-LHC

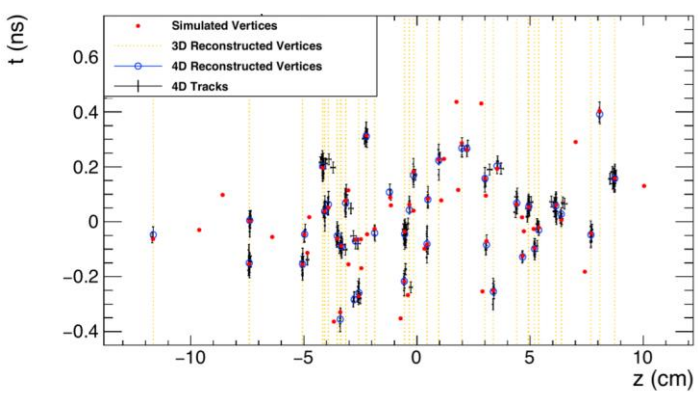
Fact: At the HL - LHC an average of 140 – 200 pileup events (collisions per bunch crossing) will occur

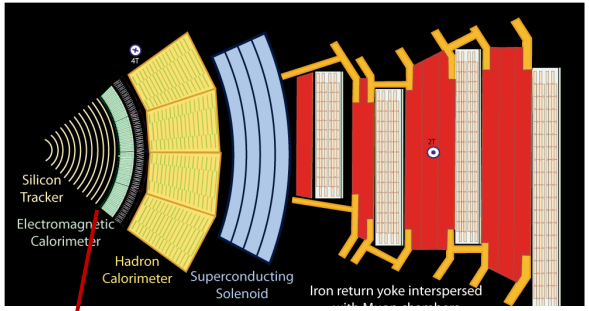
Problem: This can degrade the identification and the reconstruction of the interaction

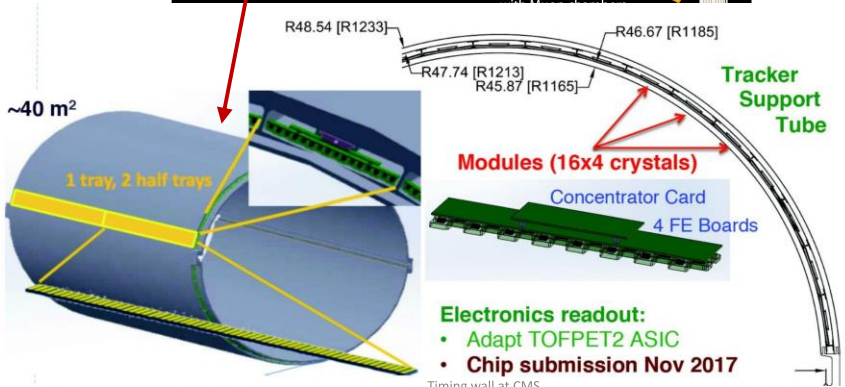
Solution: Use precise time stamp of particles to provide a 4th dimension to CMS object reconstruction

Requirements: Dedicated detector for precise timing (~30 ps timing resolution)

- Barrel Timing Layer (BTL) is a new timing detector in the CMS for charged particles







CMS upgrade:
Barrel Timing Layer (BTL)

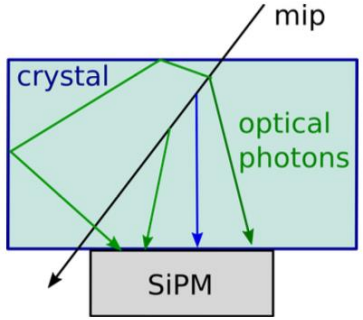
- **BTL sensor:**

  - LYSO scintillating crystals to generate light
  - SiPM to detect light
  - Readout ASIC

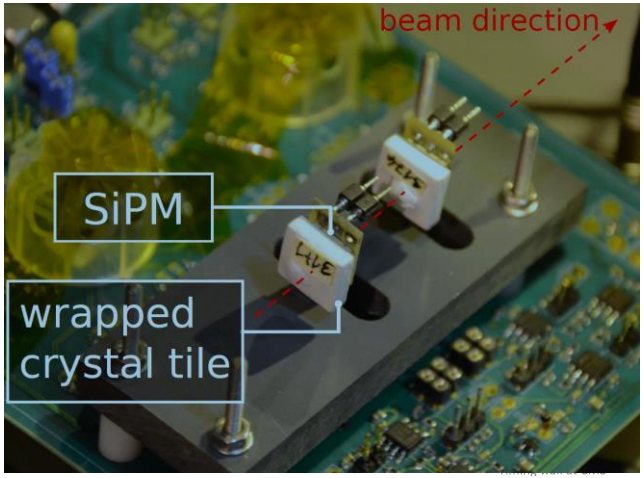
- LIP is responsible for the development of the readout system of the new detector including the development of a new ASIC in collaboration with PETsys Electronics (for the first time)

- **Summer project:**

- Characterization of different SiPMs (to be used in BTL) using single photon laser pulse



BTL single sensor test



Period: 1 month, July/August 2018

Location: Taguspark in Oeiras

Contact: Tahereh Niknejad

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