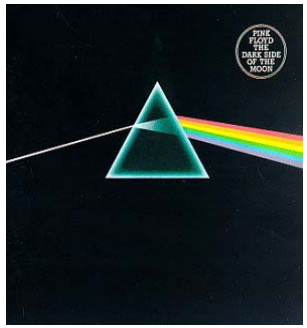
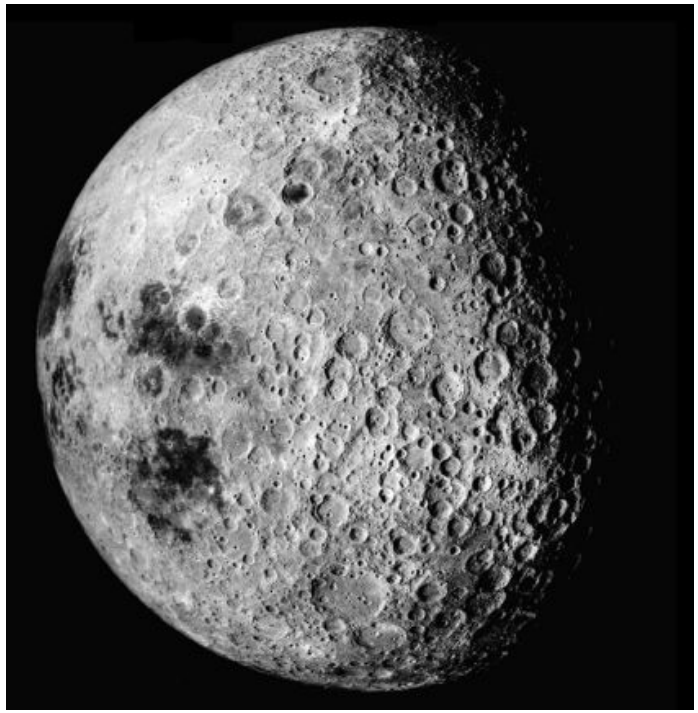


O lado escuro da Lua

A engenharia no LIP- Coimbra



Francisco Fraga

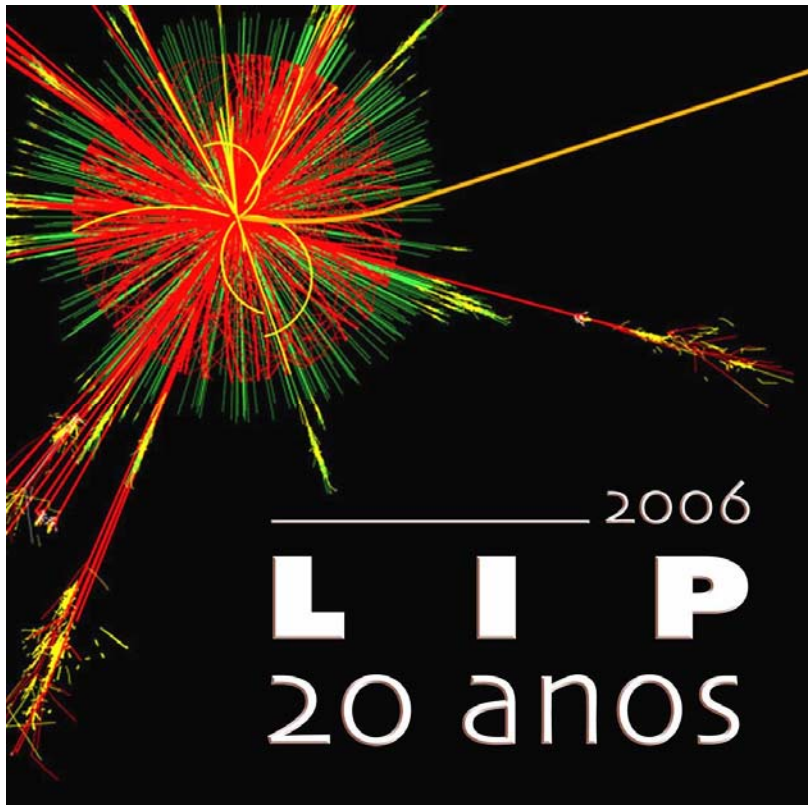
francisco@lipc.fis.uc.pt

LIP-Coimbra e Departamento de Física da FCTUC

O que é o LIP?

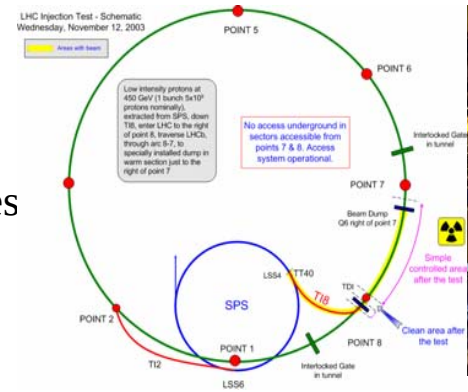
- O LIP é uma associação científica e técnica de utilidade pública que tem por objectivo a investigação no campo da Física Experimental de Altas Energias e da Instrumentação Associada.
- O LIP é um laboratório associado com dois polos - um em Lisboa e outro em Coimbra.
- O polo de Coimbra tem um corpo de investigação, técnico e uma oficina mecânica próprios
- Cerca de 40 membros
- O polo de Coimbra está sediado no Departamento de Física da FCTUC

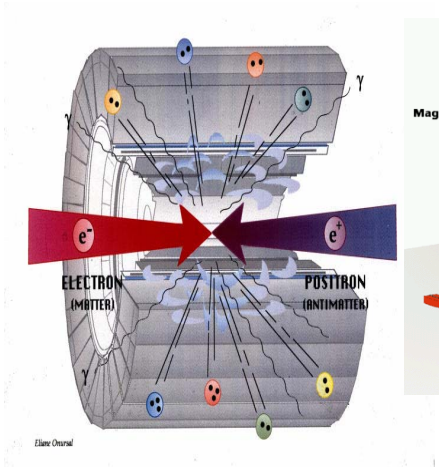
- http://www.coimbra.lip.pt/

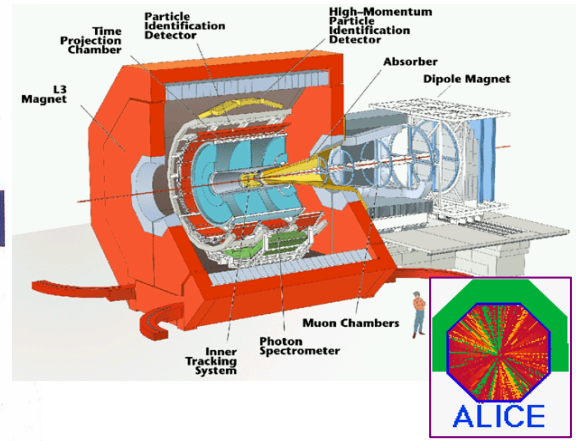


Objectivos do LIP

- Física - ciência envolvida na descoberta e compreensão das leis fundamentais que governam a matéria, a energia, o espaço e o tempo.
- Física das Altas Energias ou Física das Particulas diz respeito às propriedades das partículas submicroscópicas, muito menores do que átomos, incluindo as chamadas partículas elementares, de que são construídas todas as restantes unidades da matéria.
- Instrumentação associada - para produzir partículas elementares é necessário fazer colidir outras partículas com altas energias (GeVs e TeVs) - os aceleradores - e registar os resultados - os detectores de radiação.
- Spin-offs – detectores de radiação para outros fins e computação.







High Energy Physics made painless
http://ed.fnal.gov/painless/htmls/index.html

“Nothing really exists until it is measured”

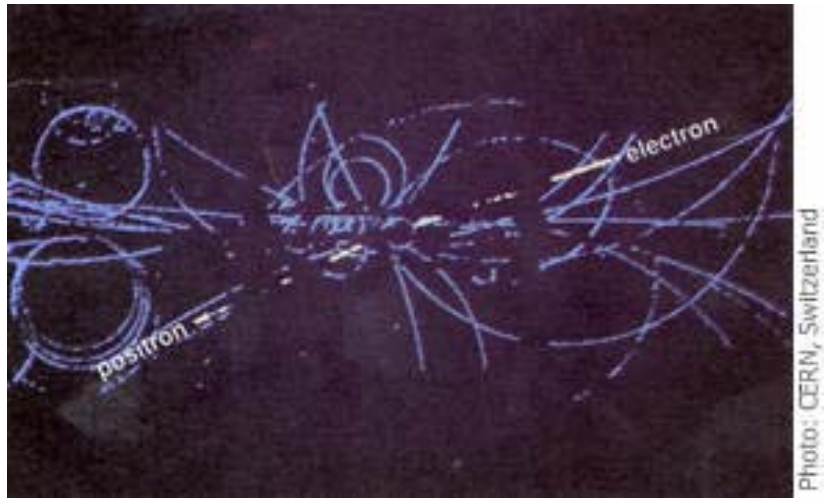
(Niels Bohr, 1930)

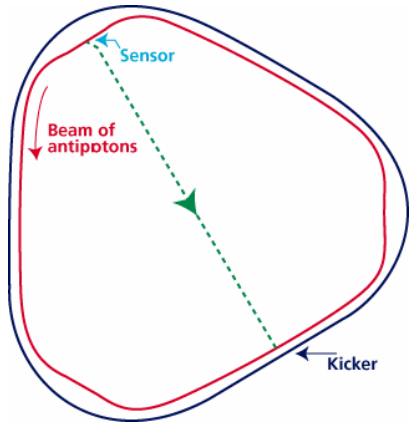
Um caso exemplar

- Carlo Rubbia e Simon van der Meer partilharam em 1984 o prémio Nobel pela descoberta do W± e Z0 e pela invenção “do arrefecimento estocástico”, que reduz o espalhamento da energia de um grupo das partículas que viajam num anel de um acelerador.

- Simon van der Meer não se considerava um grande cientista, mas sim um engenheiro que “gostava de inventar e construir máquinas interessantes”.

- O LIP precisa deste tipo de engenheiros e outros especialistas “não-físicos” !

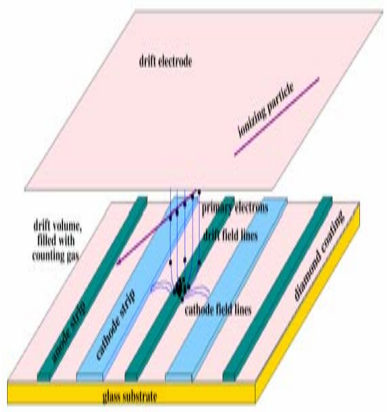


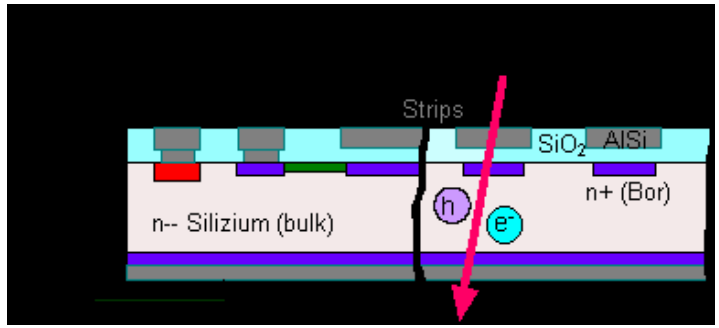


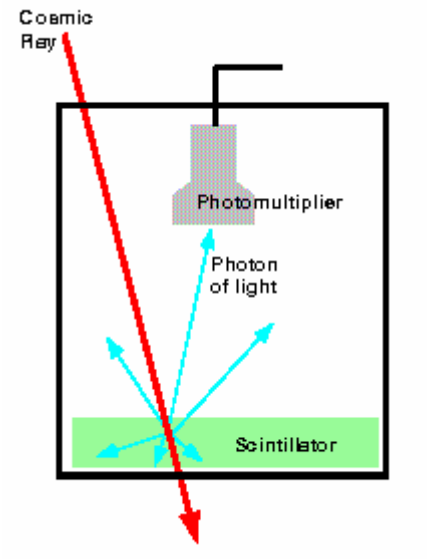
Engineering a better physicist
http://physicsweb.org/articles/world/19/6/4/1

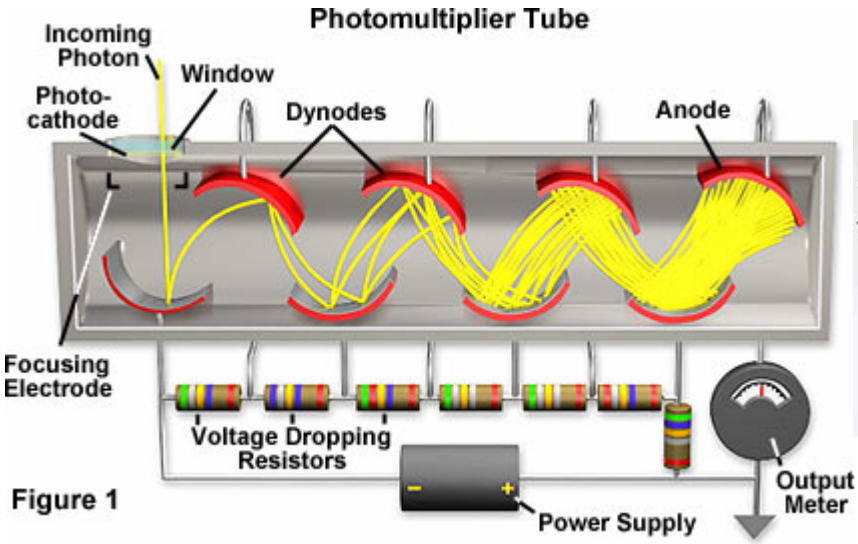
Características dos detectores de radiação

- Elevada probabilidade de interacção
- Sinais de cargas e luz minúsculos em (milhares de electrões e fotões) em espaços de tempo muito curtos (ns)
- Exigência de boa localização
- Grandes taxas de contgem
- Rejeição de fundo (background) acontecimentos indesejáveis
- Aspectos científicos e tecnológicos



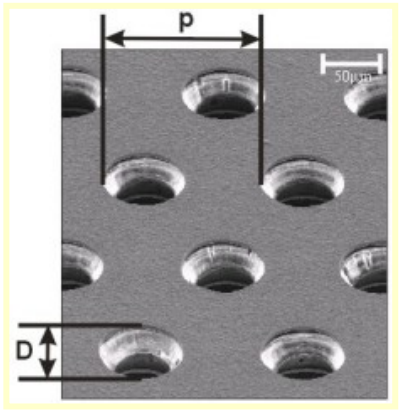


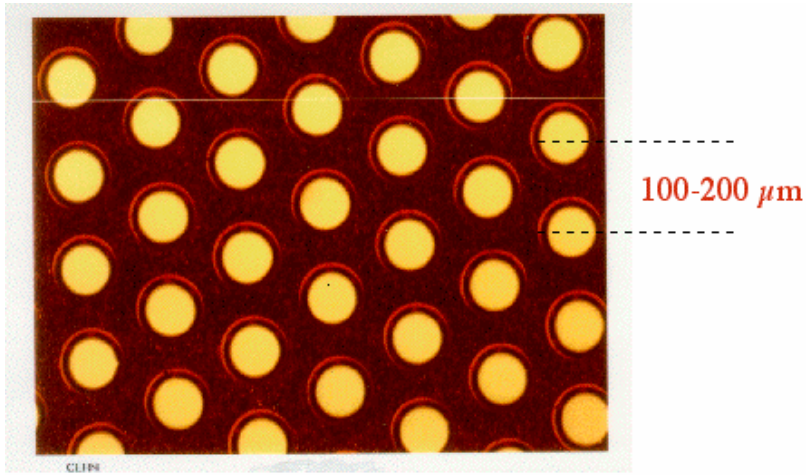


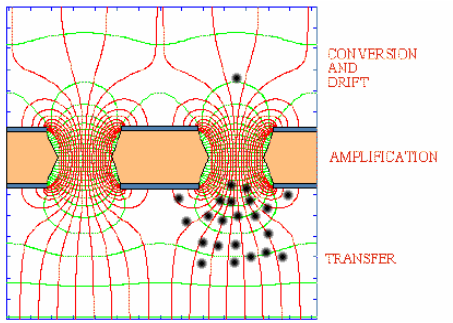


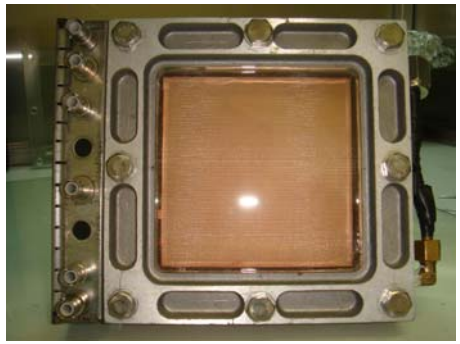
Detectores com leitura óptica e GEMs – projecto FP7

- O GEM - multiplicador gasoso de electrões
  - Selecção da mistura gasosa
  - Parâmetros de operação

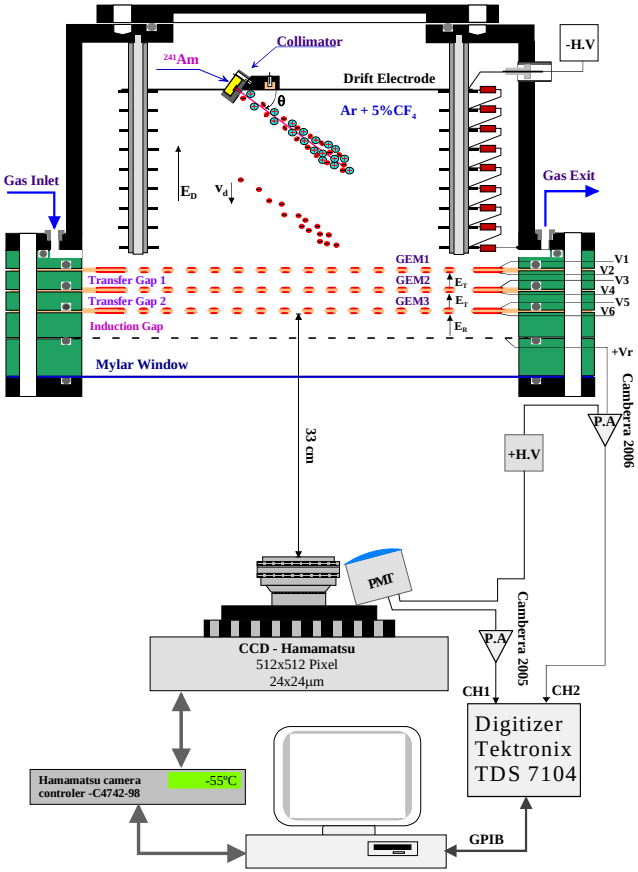


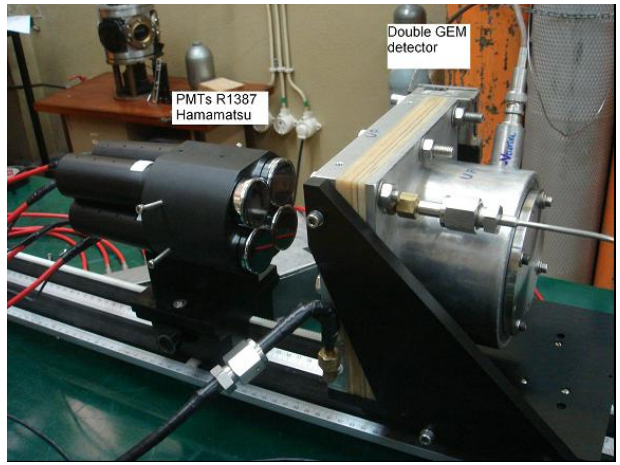


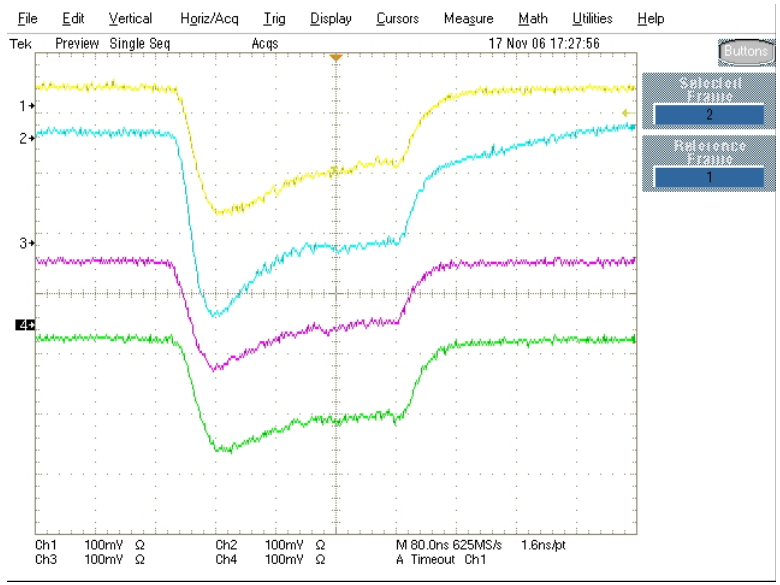




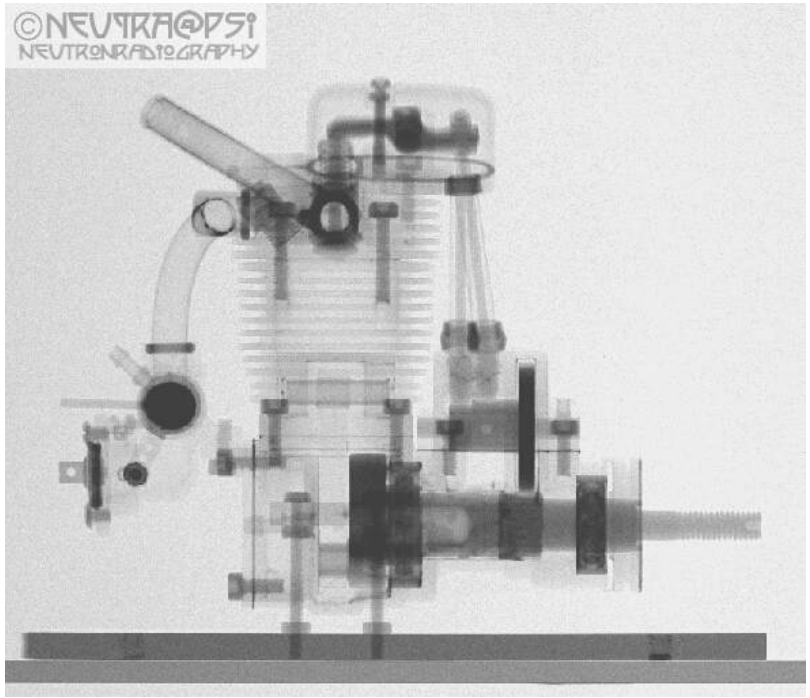
- Câmaras de traços

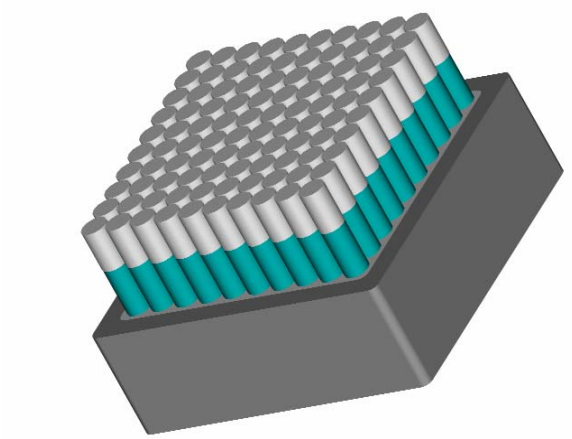


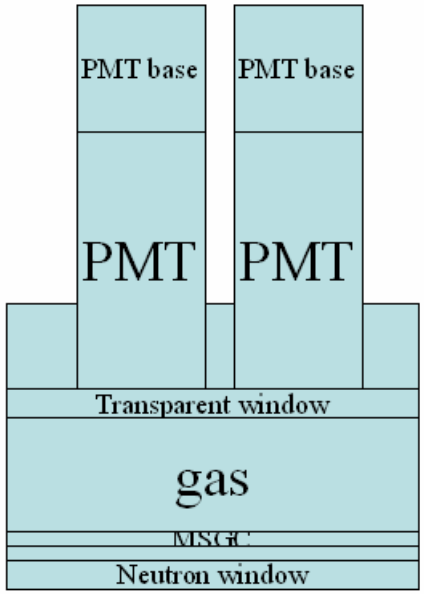


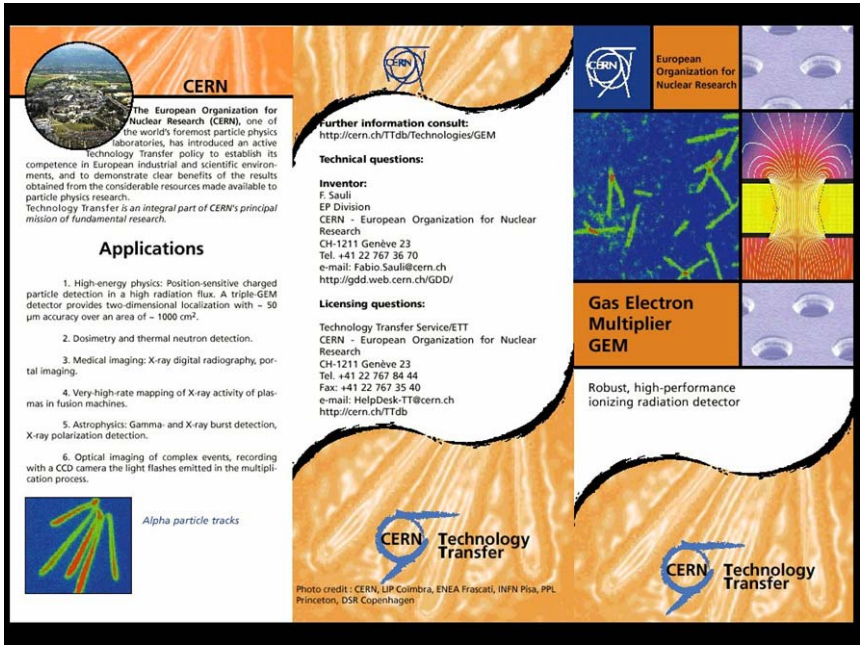


Detectores de neutrões para imagiologia







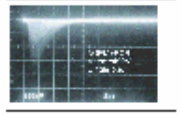


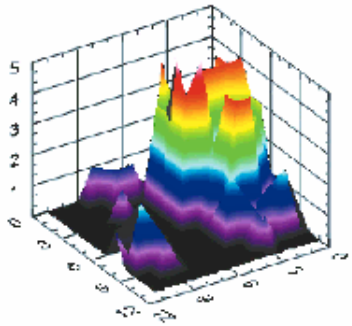
GEM Applications

The high rate capability, robustness and low cost of GEM-based detectors make them suitable for use in many applied fields, providing accurate two-dimensional maps of radiation fields

Plasma diagnostics

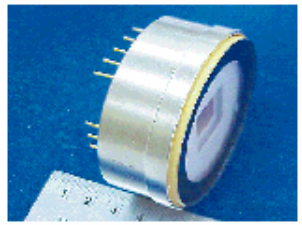
The very high rate capability of a GEM detector, employed as the focal plane in a pin-hole camera, has been used to make time-resolved X-ray emission studies of plasmas in a Tokamak fusion machine. The plot shows the spatial distribution of emission intensity in a 0.1 ms time slot (Princeton Plasma Physics Lab).

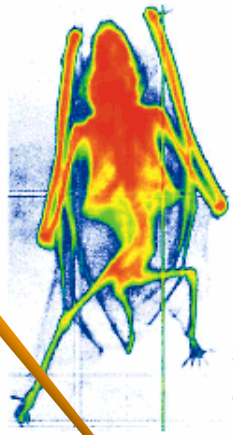




Gas photomultiplier

A small-sized, sealed gas-filled photomultiplier, using a multiple GEM device to amplify the photoelectron signals (Weizmann Institute of Sciences).



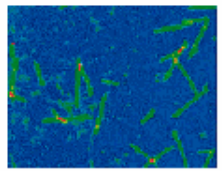


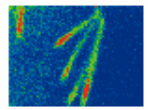
Digital radiography

X-ray absorption radiography of a small mammal (a bat). The color rendering has been optimized to enhance tissue differentiation. The GEM detector used has two-dimensional projective strip readout (CERN).

GEM imaging chamber

Neutron interactions in ^{3}He, recorded with a GEM imager: secondary scintillation light emitted by the charge multiplication in the GEM hole is recorded using a low-noise CCD camera (Coimbra University).





The European Organization for Nuclear Research (CERN), one of the world's foremost particle physics laboratories, has introduced an active Technology Transfer policy to establish its competence in European industrial and scientific environments, and to demonstrate clear benefits of the results obtained from the considerable resources made available to particle physics research.

Technology Transfer is an integral part of CERN's principal mission of fundamental research.

CERN Technology Transfer

http://www.cern.ch/TTdb/Technologies/GEM

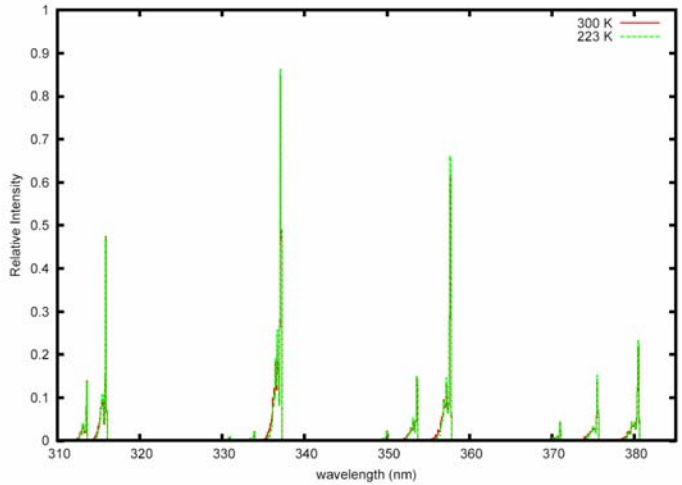
CERN Technology Transfer

Fluorescência do Ar para a detecção de raios cósmicos de ultra alta energia (10^{19}-10^{20} eV)

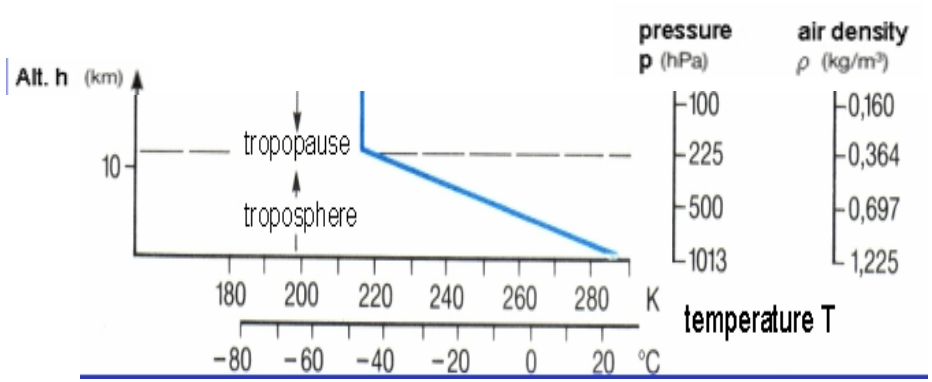
PMTs pª detecção da fluorescência do ar (UV)

Detector de radiação Cherenkov

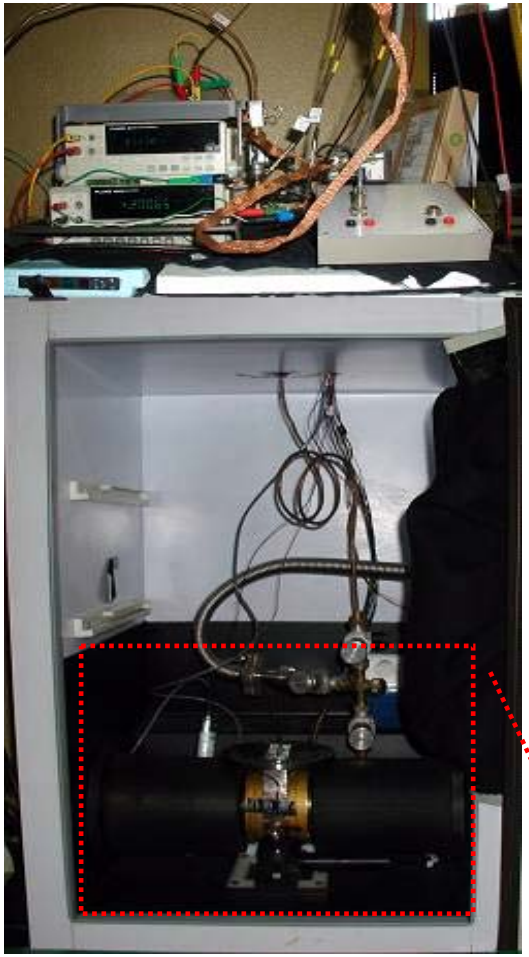
Espectro UV da fluorescência do N_2

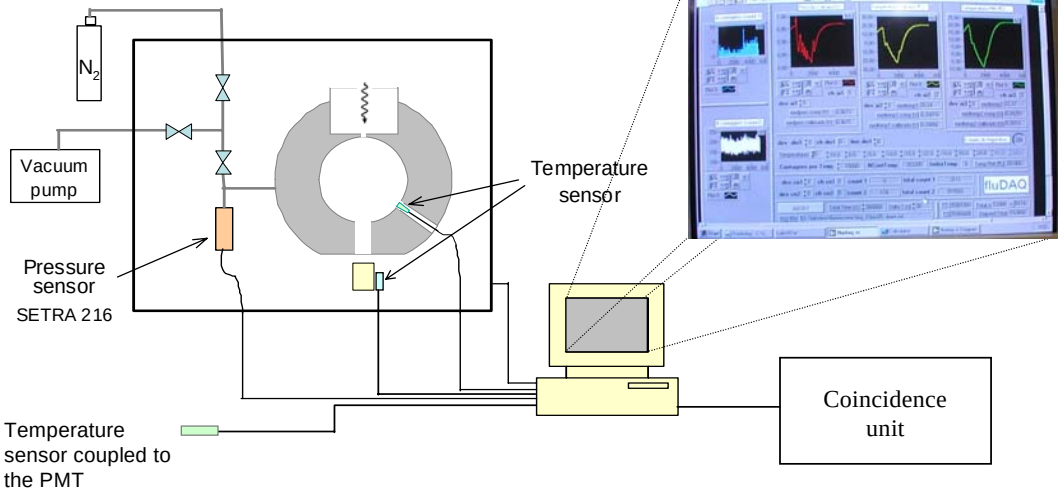


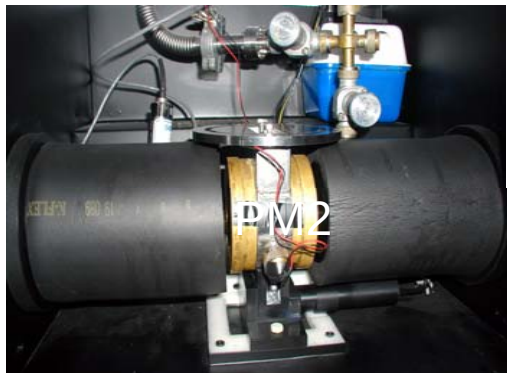
Perfil da atmosfera:

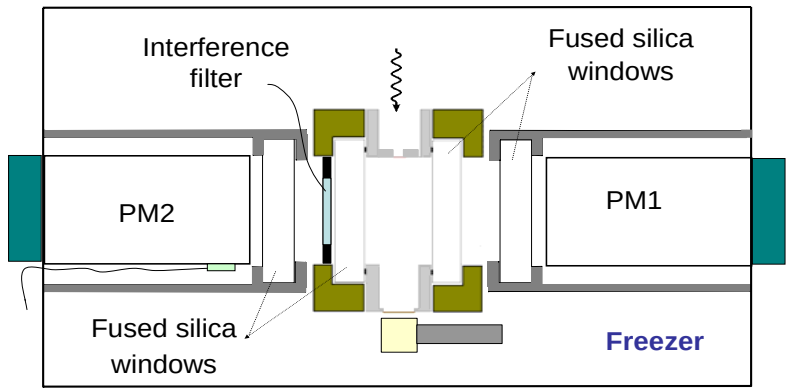


Sistema Experimental: estudo da variação da intensidade da luz com a temperatura



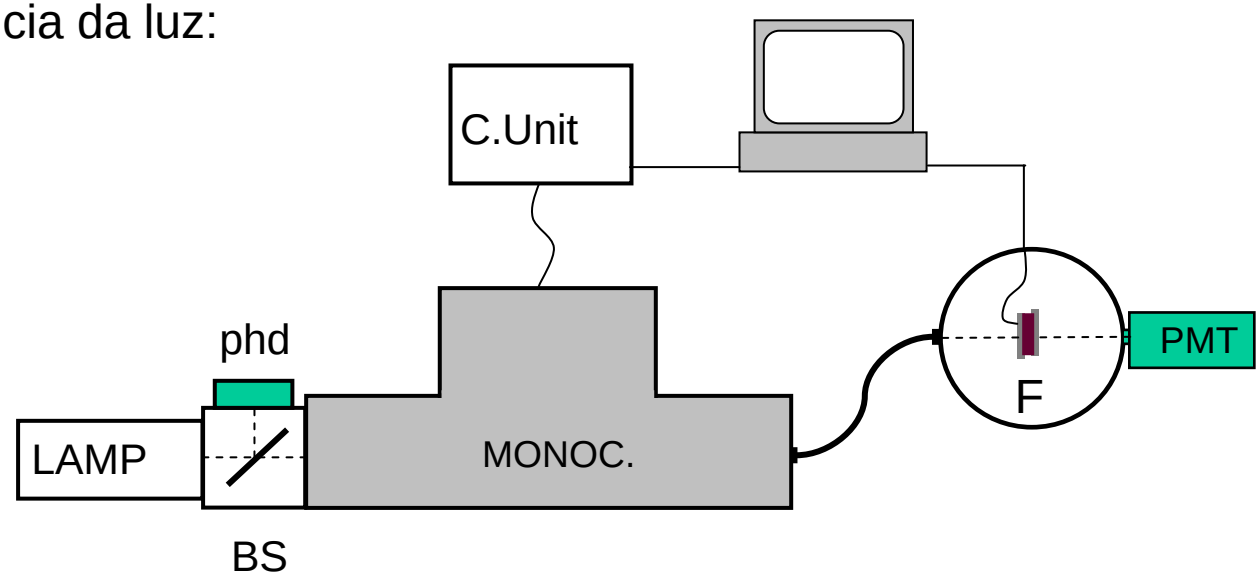






Projecto de aluno finalista

Estudo da transmissão do filtro em função da temperatura e do ângulo de incidência da luz:



BM – divisor de feixer;

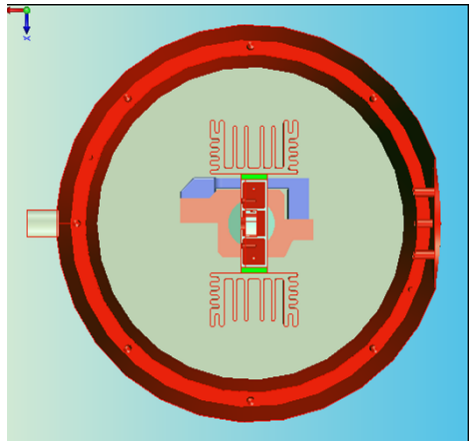
Phd – fotodíodo;

Monoc – monocromador;

C. Unit – unidade de controlo;

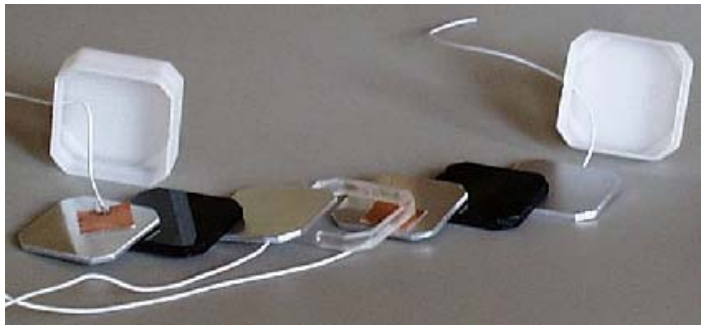
F – filtro de interferência (λ_c= 340 nm)

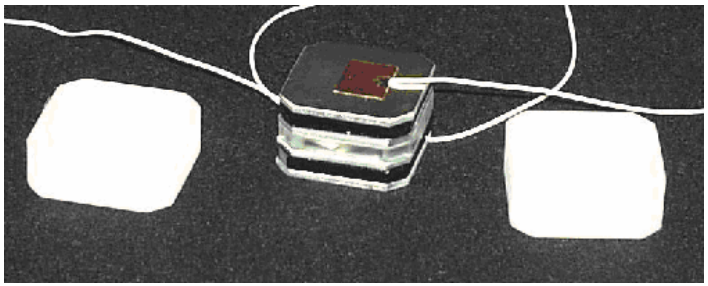
PMT – fotomultiplicador;

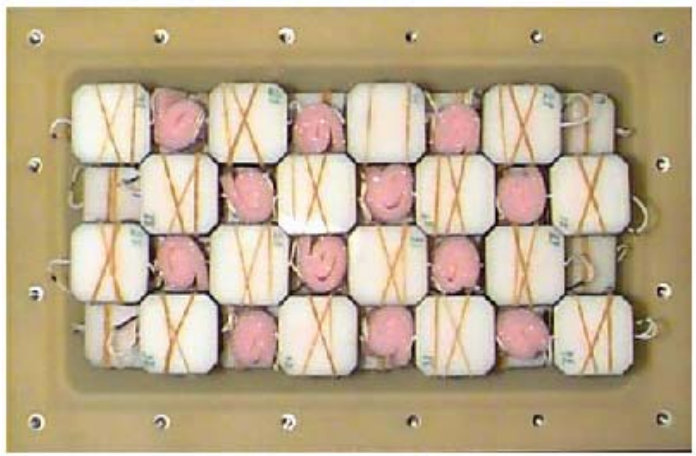


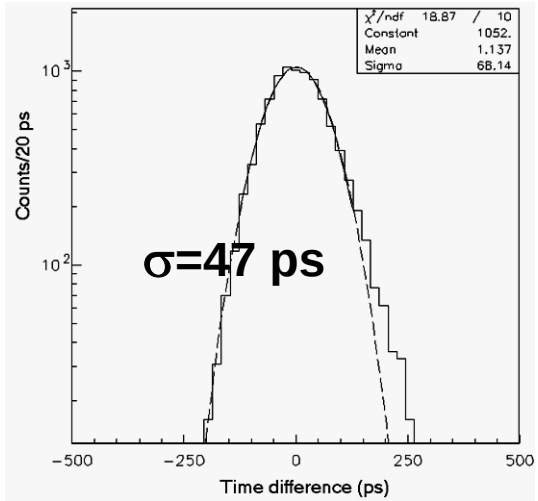
Detectores gasosos em geometria planar

TOF e grandes áreas - um problema de física e engenharia!









Desenvolvimentos posteriores...

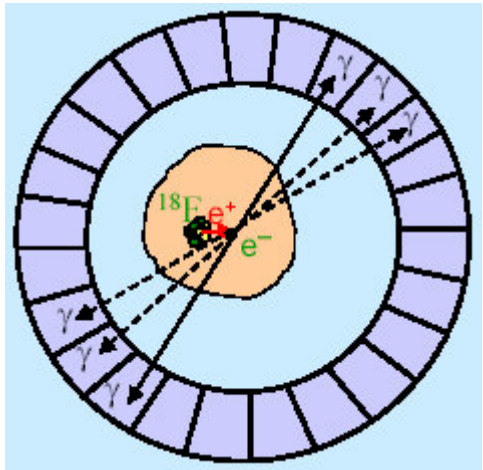
σ < 100 ps em 0,17 m2

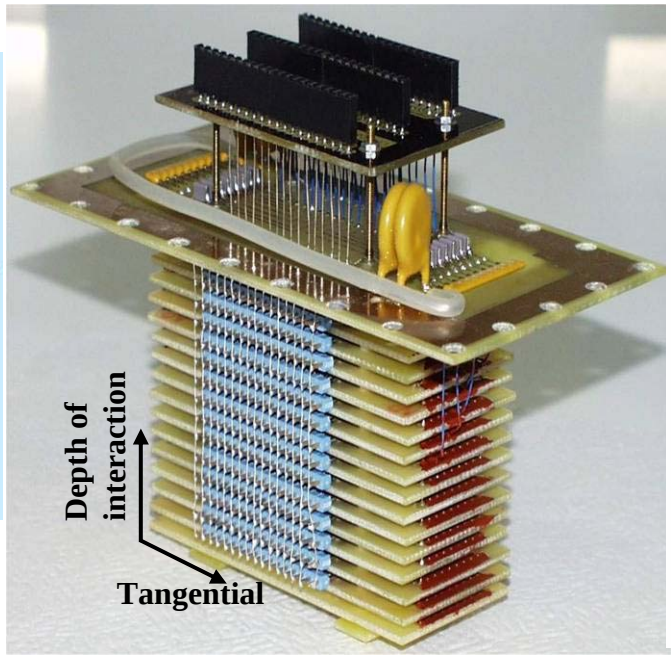
... encontraram finalmente aplicabilidade no ***upgrade* de HADES**, uma experiência com iões pesados, no GSI (Tb/ CBM, **I3HP-FP6**)

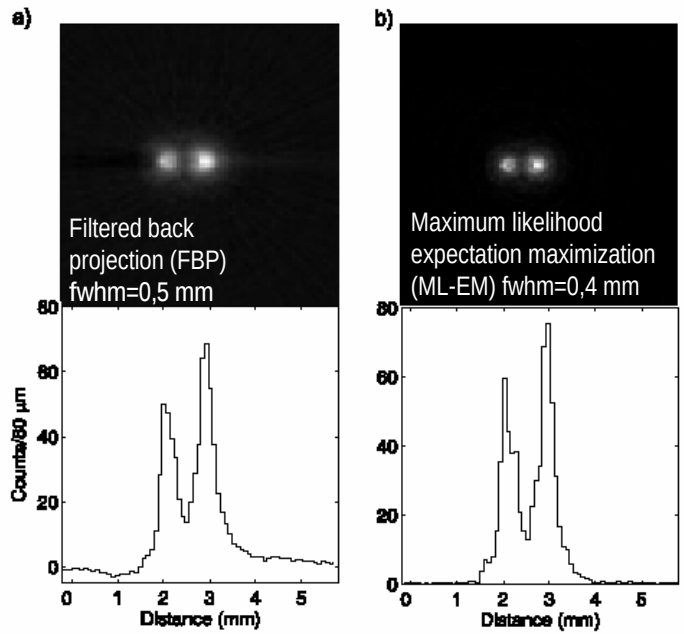
Detectores gasosos em geometria planar

PET com RPCs (um ***spin off***)

- A rapidez da resposta e a boa resolução em posição indicam a possível aplicação em **PET ANIMAL** (para estudos farmacológicos)
- A hipótese de um **PET humano de CORPO INTEIRO** não é de excluir
- Um **protótipo** de duas cabeças, forneceu **resultados extremamente encorajadores**

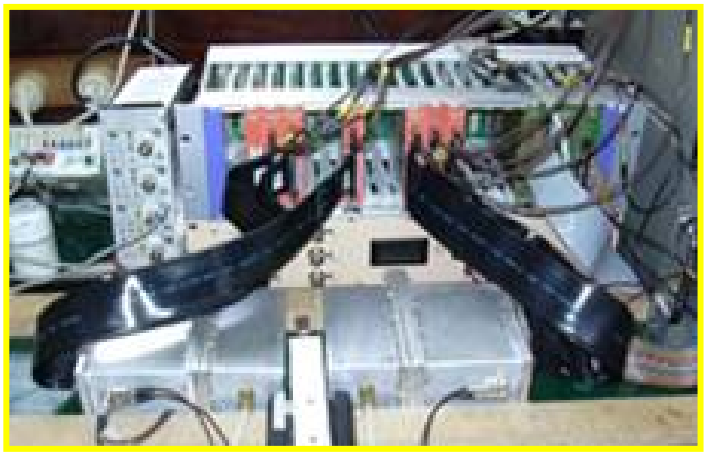






Participação de alunos finalistas

- Desenvolvimento de um circuito de front-end para sistemas PET



Xénon Líquido

n_TOF: Liquid Noble Gas Calorimeter

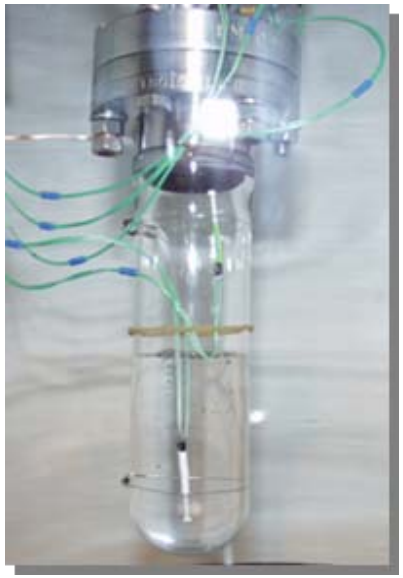
- **Infraestrutura CERN e contrato da CE (*Grupos de D, F, I, E, P, G, CH*)**
- **Estudos com neutrões, fundamentais (física nuclear + astrofísica) e aplicados (ADS)**
- **WP6:** viabilidade de um "calorímetro" 4pi de Xe-líq para cascatas gama induzidas pela captura de neutrões
- Muitos problemas resolvidos (purificação, materiais, PMs a ~170 K, liquefacção do Xe, etc.)
- Protótipo construído e testado (em bancada; em feixe de **n** com grande fundo γ)

UKDM: Detectar WIMPs através do recuo dos núcleos de Xe

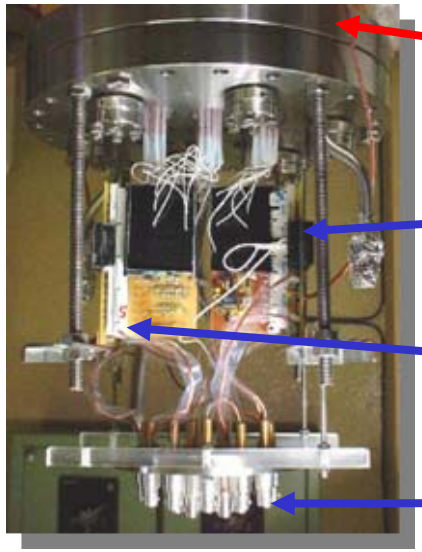
- Detectores de elevada sensibilidade e muito baixo ruído
- Fases líquida e vapor ?

Xénon Líquido – n_TOF

What does liquid Xe look like ?



yield: 0,6 l in ~1h30 h



Teflon reflector
h=55 mm, ϕ=163 mm

PMTs

Electric connections
(in Xe athmosphere)

Flange

PMT voltage divider
(in vacuum)

Preamplifier

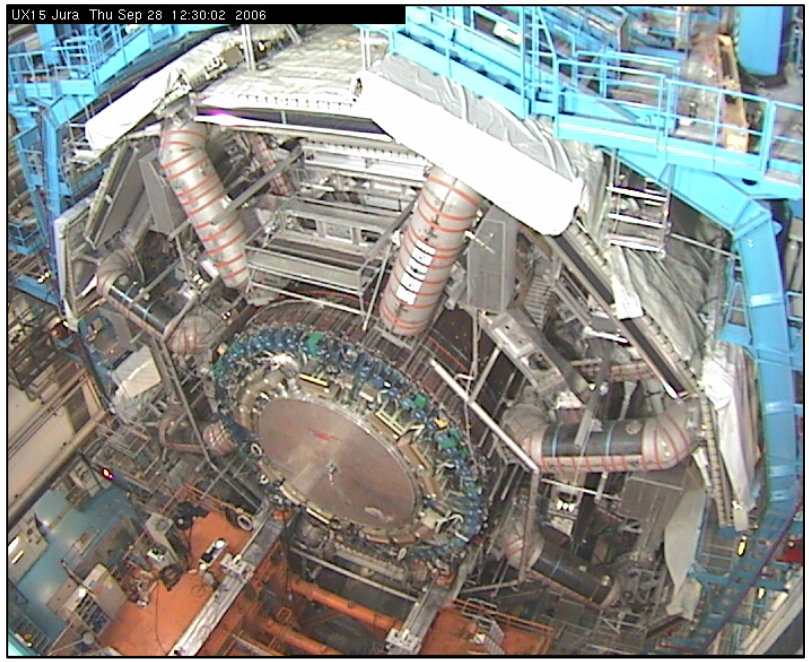
Outer flange

Chamber
Body
(*ss*)

Determining Top Couplings

António Onofre (onofre@lipc.fis.uc.pt)

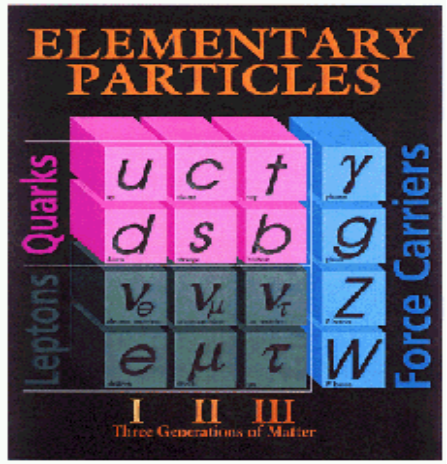
ATLAS Collaboration



What do we know about the top quark?

- The top quark completes the three family structure of the SM
- It´s massive — $\delta m/m \sim 1\%$
- Spin=1/2 — Not directly
- Charge=+2/3 — -4/3 excluded @ 94%C.L.(D0)
- Isospin=+1/2 — Not directly
- $t \rightarrow bW$ — ~100%
- Large Γ=1.42GeV (m_b, M_W, α_s, EW corr.)

  Short lifetime — $c\tau$<52.5μm @95%C.L.(CDF)



$$\tau_{had} = \Lambda_{QCD}^{-1} >> \tau_{decay}$$

"t-quarks are produced and decay as free particles"

NO top hadrons

The TEVATRON is probing better than ever the top sector…
The LHC will allow **precision measurements** of Top Quark Physics

What is the GRID ?

- **So you have the Internet**
  - it links all computers to a common network (if you want)
  - what do you need more?

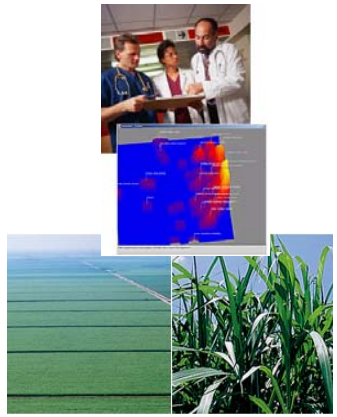
- **The GRID is much more than that !**
  - it offers completely new perspectives
  - and it is not easy to be implemented

What is the GRID?

- **GRID computing is a recent concept which takes distributing computing a step forward**
- **The name GRID is chosen by analogy with the electric power grid:**
  - Transparent: plug-in to obtain computing power without worrying where it comes from
  - Permanent and available everywhere
  - "Pay per use"
- **The World Wide Web provides seamless access to information that is stored in many millions of different geographical locations.**
- **In contrast, the GRID is a new computing infrastructure which provides seamless access to computing power and data storage distributed all over the globe.**

Motivation to build a GRID

- **Single institutions are no longer able to support the computing power and storage capacity needed for modern scientific research.**
- **Compute intensive sciences which are presently driving the GRID development:**
  - **Physics/Astronomy:** data from different kinds of research instruments;
  - **Medical/Healthcare:** imaging, diagnosis and treatment
  - **Bioinformatics:** study of the human genome and proteome to understand genetic diseases
  - **Nanotechnology:** design of new materials from the molecular scale
  - **Engineering:** design optimization, simulation, failure analysis and remote Instrument access and control
  - **Natural Resources and the Environment:** weather forecasting, earth observation, modeling and prediction of complex systems: river floods and earthquake simulation

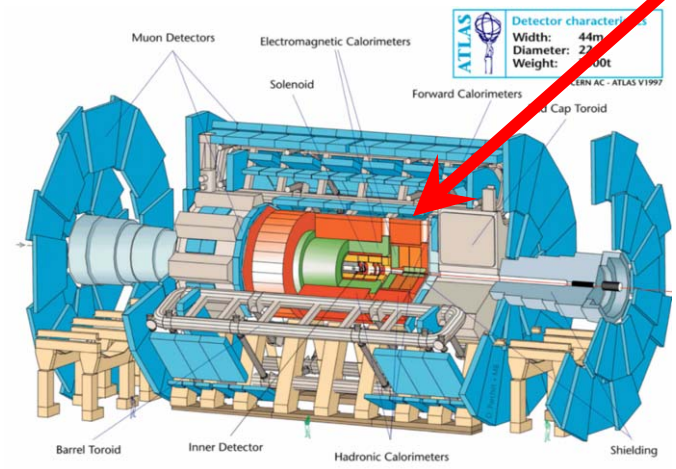


LIP and the EGEE organization

- **EGEE South-West federation (SWE)**
  - **includes LIP and several Spanish sites**
  - **Responsible for the operation of essential core services**
  - **Responsible for the monitoring of grid resources**
  - **Receives, responds and coordinates GRID operation problems**

- **Regional Operations Centre (ROC)**
  - **Coordinates the EGEE federations**
  - **Shared among the different SWE institutes**
  - **Certifies that a site fulfills all requirements to join production infrastructure**
  - **Negotiates service level agreements (SLA's)**
- **EGEE South-West federation offers**
  - **8 Resource Brokers and 8 top BDII machines as production core services.**
  - **Local sites deploy**
    - **738.3 CPU's (value normalized to a 1000 SpectInt2000)**
    - **7.7 TB of online storage + 2.9 PB of nearline storage (tape backend)**
  - **Shared by more than 20 virtual organizations.**

TileCal – ATLAS



A maior contribuição de Portugal para a construção de um detector de física de partículas

Grupos **portugueses** participaram no desenho, teste, produção e instalação do **TileCal** (em colaboração com instituições de I&D da Europa e Estados Unidos):

- **LIP** (Lisboa e Coimbra), **IST** (robótica), **UNL** (aluminização de fibras ópticas), **ITN** (testes de resistência à radiação), **Univ. Minho** (I&D em telhas cintiladoras), ...

- **Indústria nacional**: moldes (Marinha Grande), extrusão (S. João da Madeira), mecânica (Leiria), ...

Câmara de faíscas
para detecção de raios cósmicos

Mais valias para os alunos

- Participação em projectos de investigação inovadores e multidisciplinares
- Acesso a bolsas de investigação
- Possibilidade de exporem e aplicarem os seus conhecimentos de engenharia
- Projectos laboratoriais com componente oficinal (*mãos na massa!*)
- Formação diferenciada
- Co-autores de publicações

Para mais informações

- Relatórios anuais do LIP
- Página do LIP Coimbra
    - www.coimbra.lip.pt
- Página de projectos e bolsas da Fundação de Ciência e Tecnologia
    - www.fct.mctes.pt
- Direcção do LIP
    - prof. Rui Ferreira Marques rui@lipc.fis.uc.pt
    - prof. João Carvalho jcarlos@lipc.fis.uc.pt