

# Novos Detectores - alguns exemplos recentes

Rui F Marques – LIP-Coimbra + UC



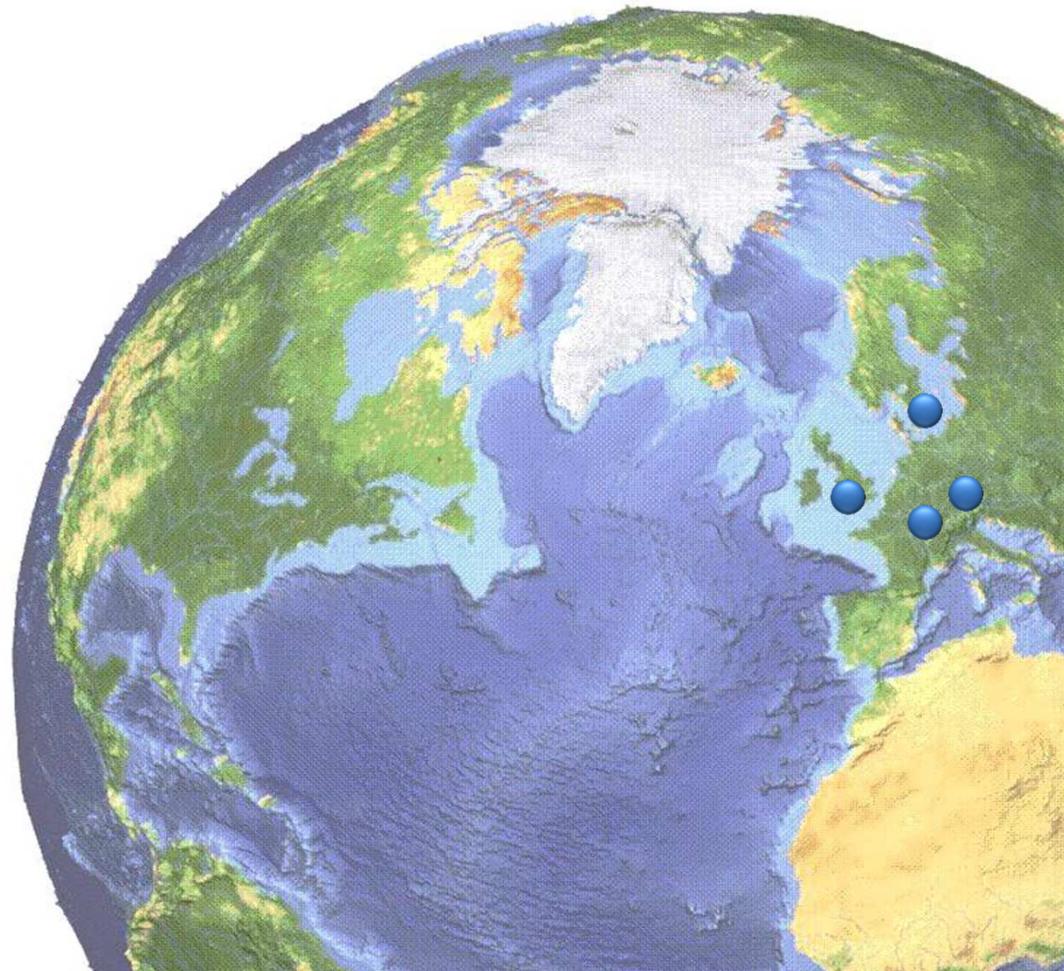
# NOVOS DETECTORES – um serviço prestado a uma vasta comunidade internacional de utilizadores

1

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Science & Technology Facilities Council  
**ISIS**



THERMAL NEUTRON DETECTORS

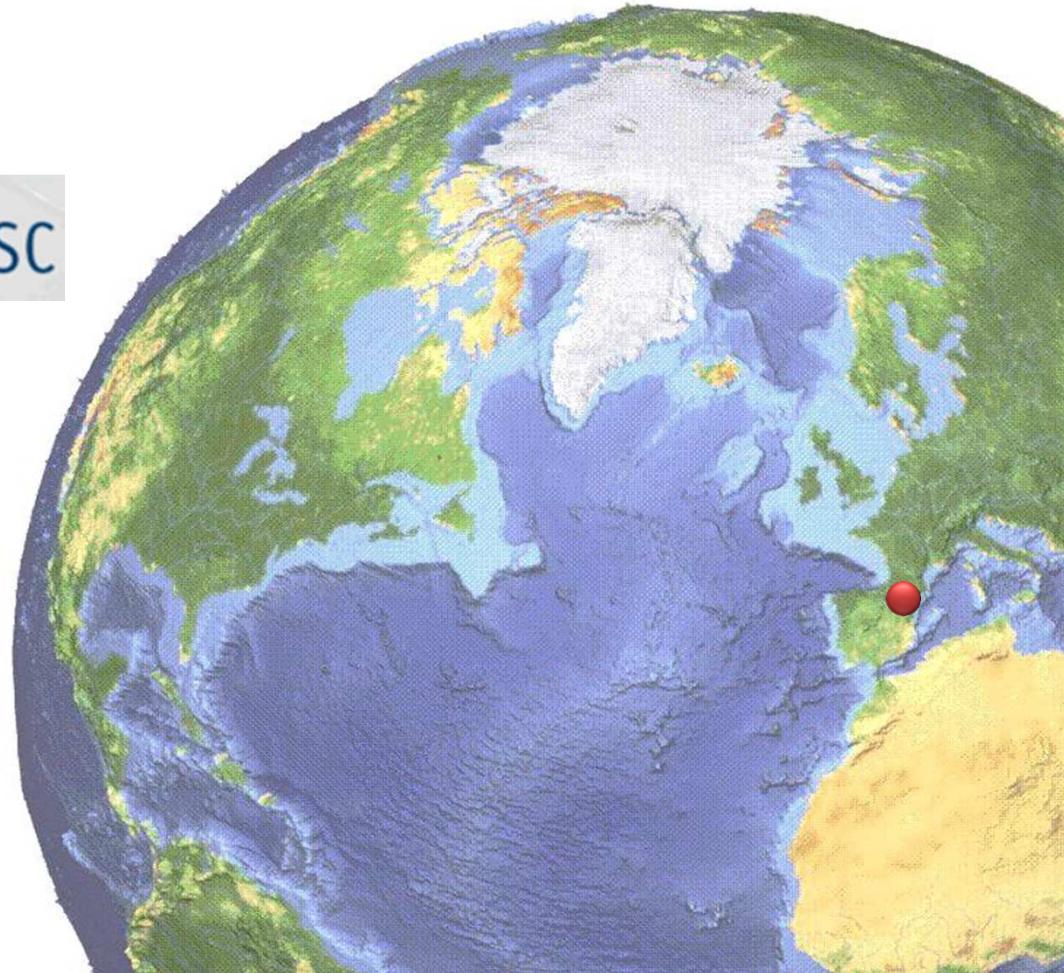
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2

Experiência NEXT  
LSC – Canfranc (ES)



NEXT COLLABORATION

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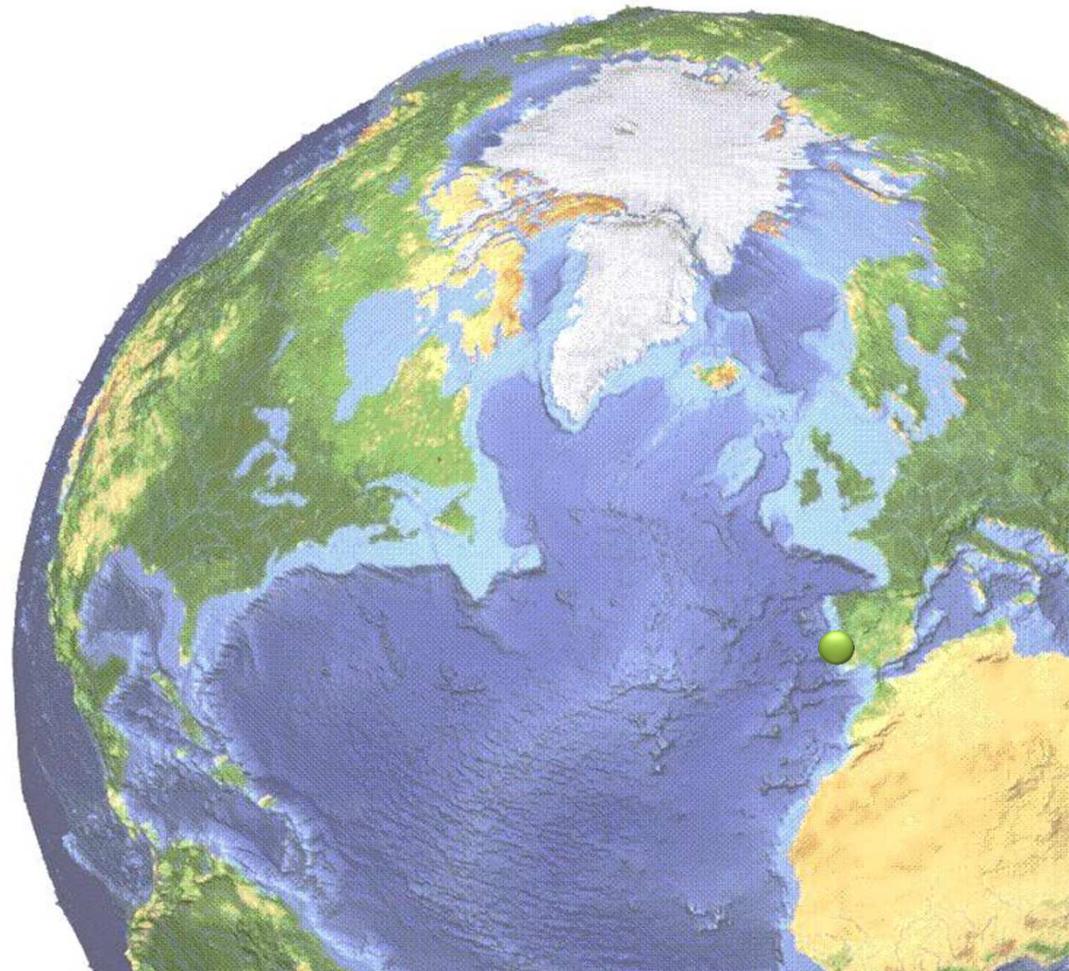
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ITN – Sacavém (PT)



CÂMARA DE IONIZAÇÃO GASOSA

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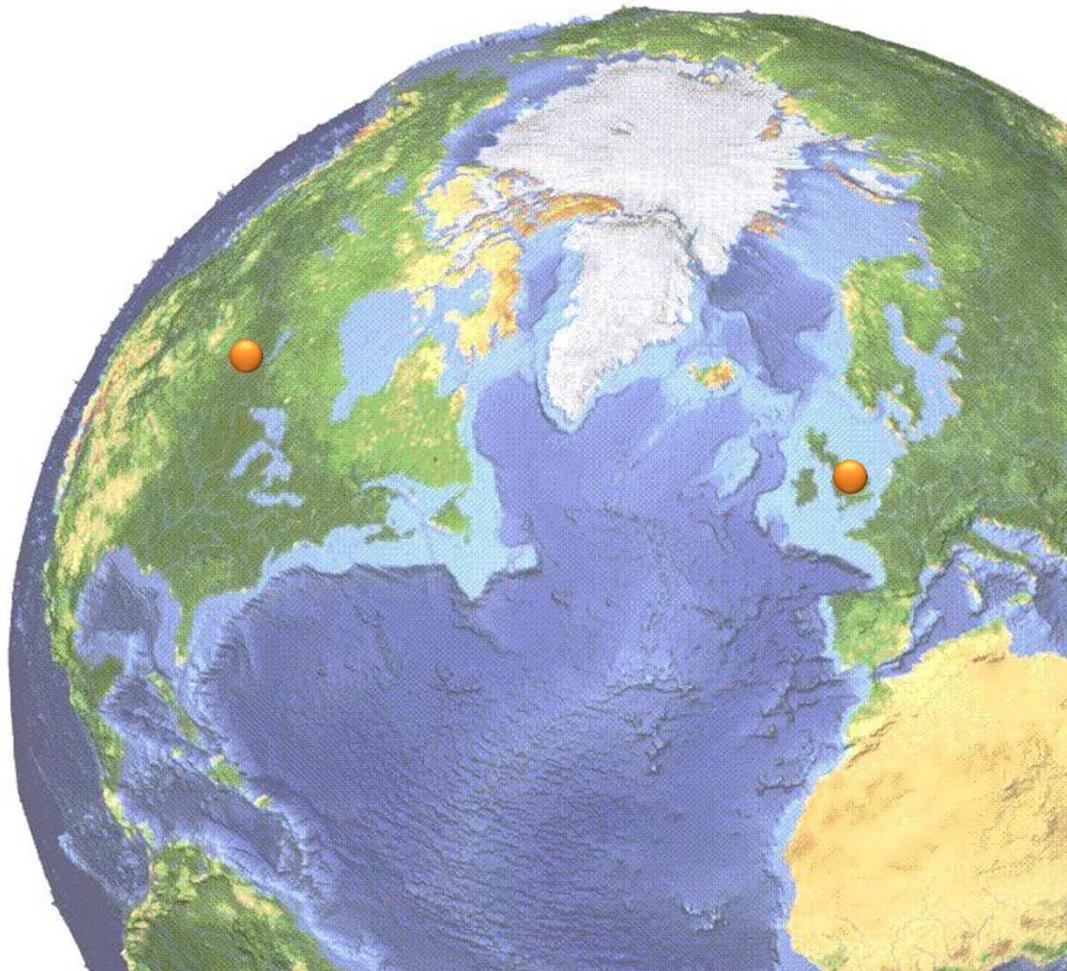
Experiência NEXT  
LSC – Canfranc (ES)

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ITN – Sacavém (PT)

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ZEPLIN (UK)  
LUX – SD (USA)



MICROSTRUCTURES IN NOBLE LIQUID DETECTORS

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ESA (NL)



GAMMA RAY POLARIMETRY

## NMI3 (EU FP6 + FP7 projects)

- Seek for a **FAST THERMAL NEUTRON DETECTORS WITH LARGE AREA AND IMPROVED 2D SPATIAL RESOLUTION** to use in thermal neutron imaging

## PROJECT GOAL:

To demonstrate the feasibility of a detector with :

- Resolution **0.5 mm in X and Y over area of 20x20 cm<sup>2</sup>**
- **Counting rate > 10 kHz (local); 1 MHz (global)**

## Aim of our task (JRA):

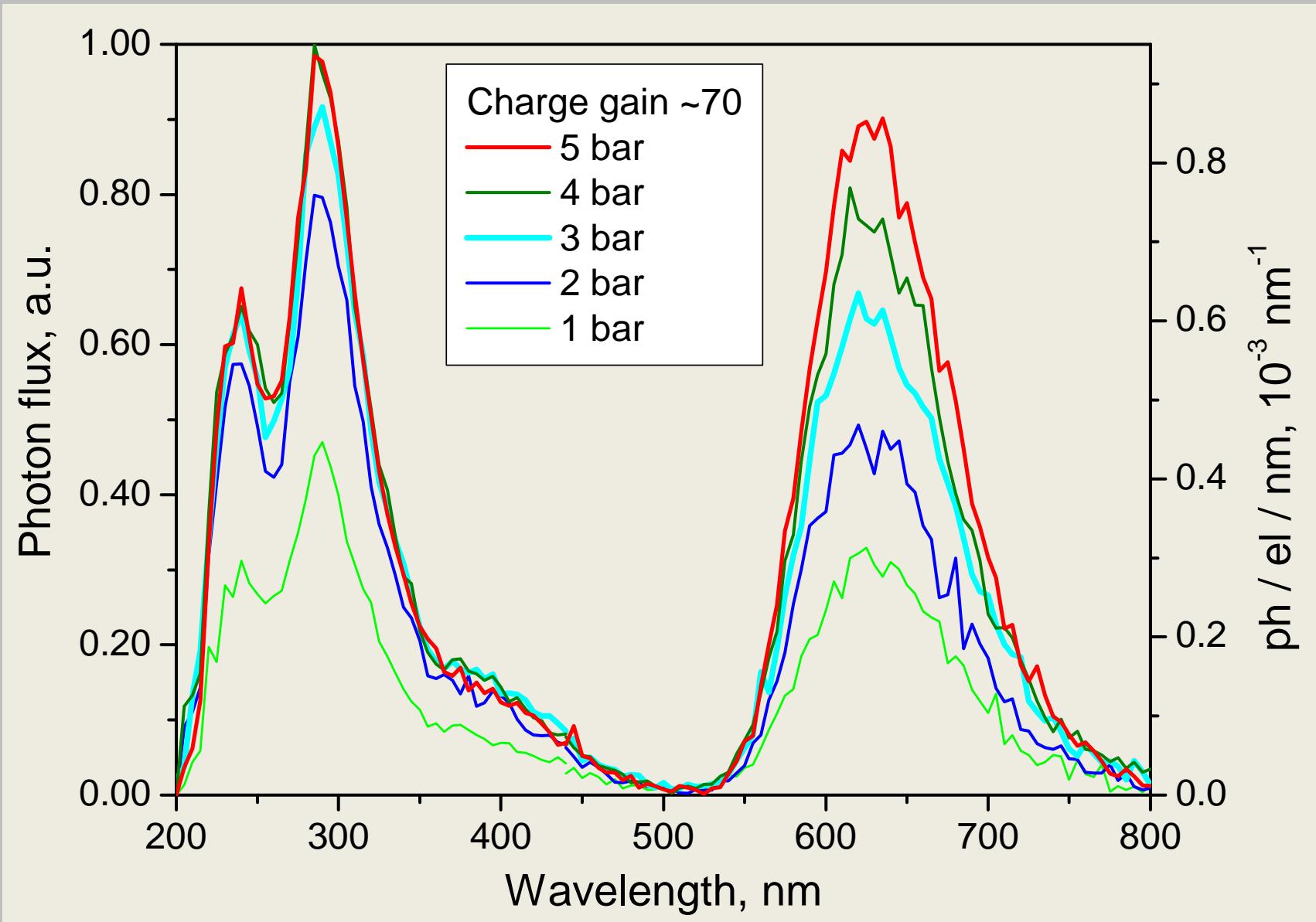
Development of new detector based on **Gaseous Scintillation Proportional Counters (GSPC)** – called the “Coimbra Counter”

## LIP PROPOSAL :

**Anger Camera with MSGC and light readout by a matrix of PMTs**

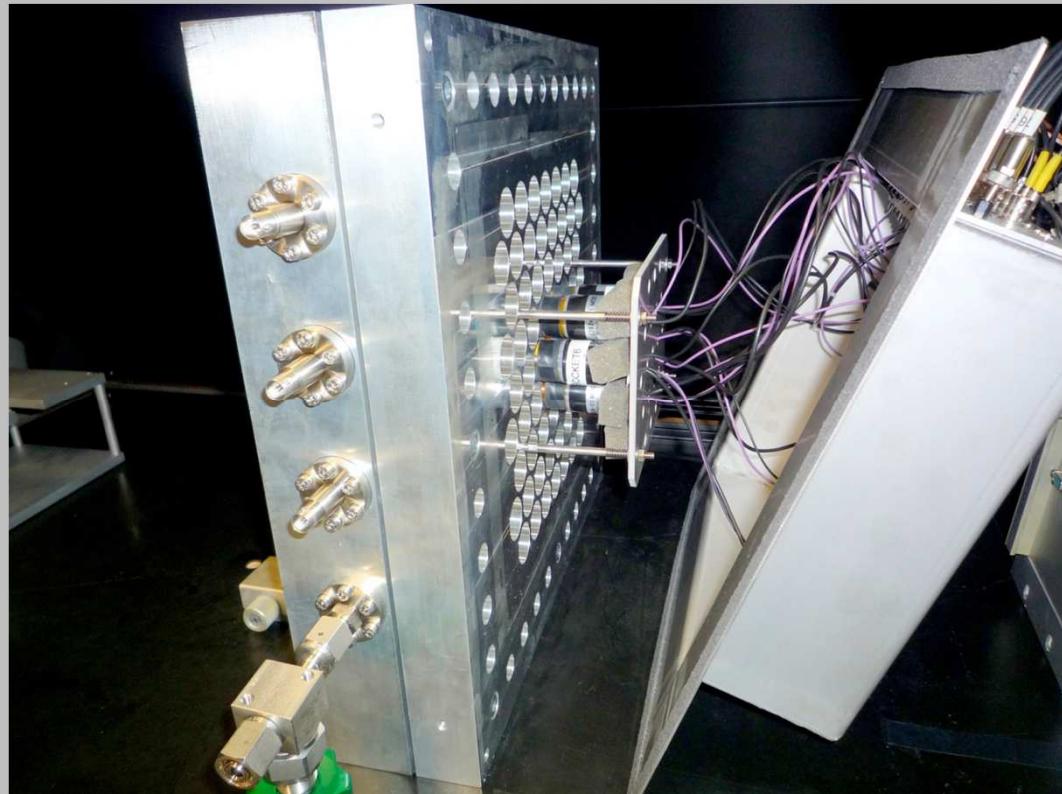
## LIP - Coimbra Team

*A. Morozov, F. Fraga (PI), L. Margato, L. Pereira, M.M. Fraga*

Spectroscopic studies of  $\text{CF}_4$  light emission

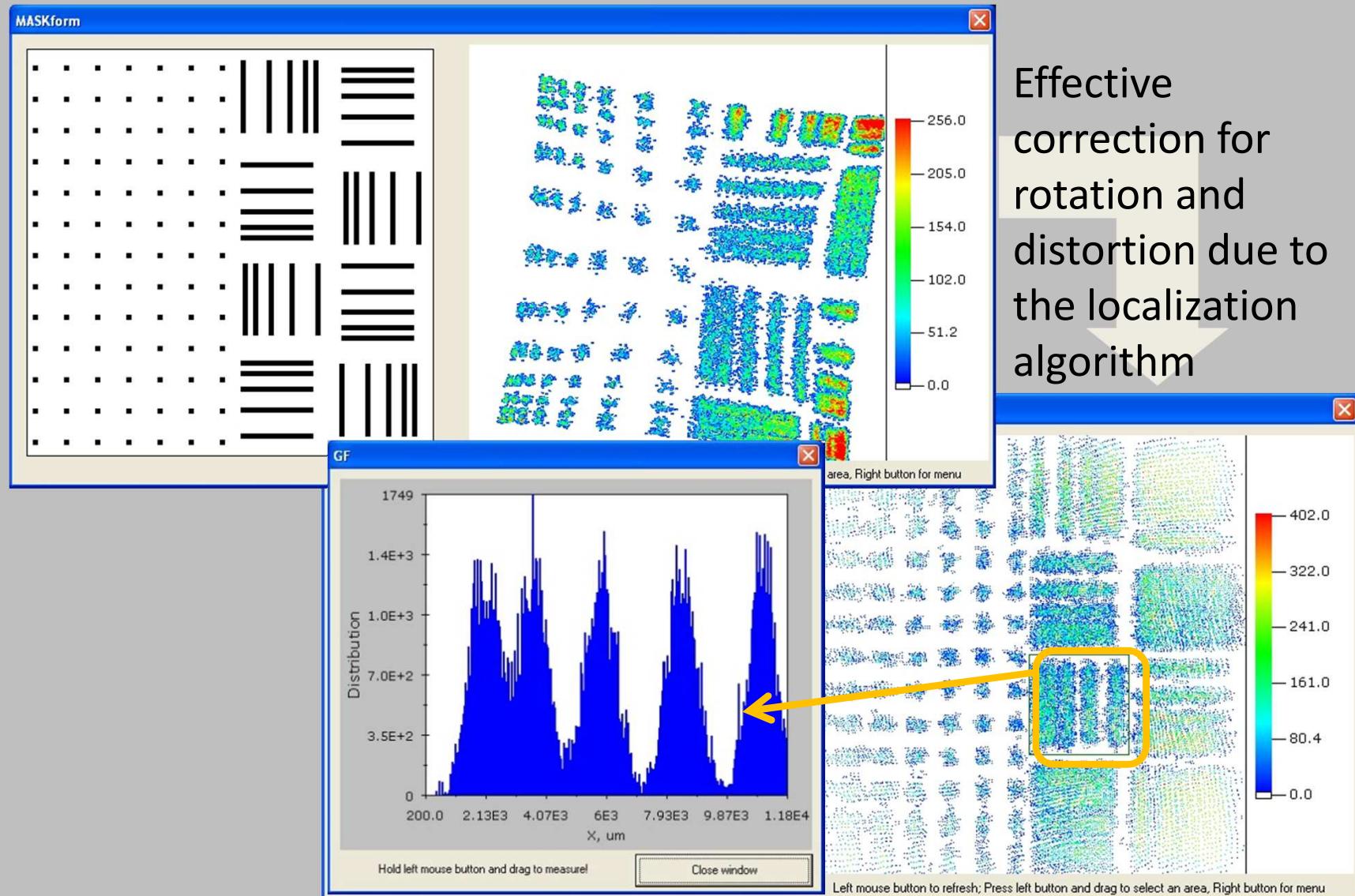


**First LIP prototype (4 PMs)  
in tests at ILL, FR**



**Final detector of the NMI3 Collaboration  
(19 PMs; under construction at ILL)**

**ANTS:** a full reconstruction s/w package adopted by the collaboration



**The NEXT experiment** (to run at the LSC - underground laboratory of Canfranc, Pyrenees, Spain) **consists of a high-pressure xenon gas (HPGXe) TPC aiming at the search for neutrinoless double-beta decay**

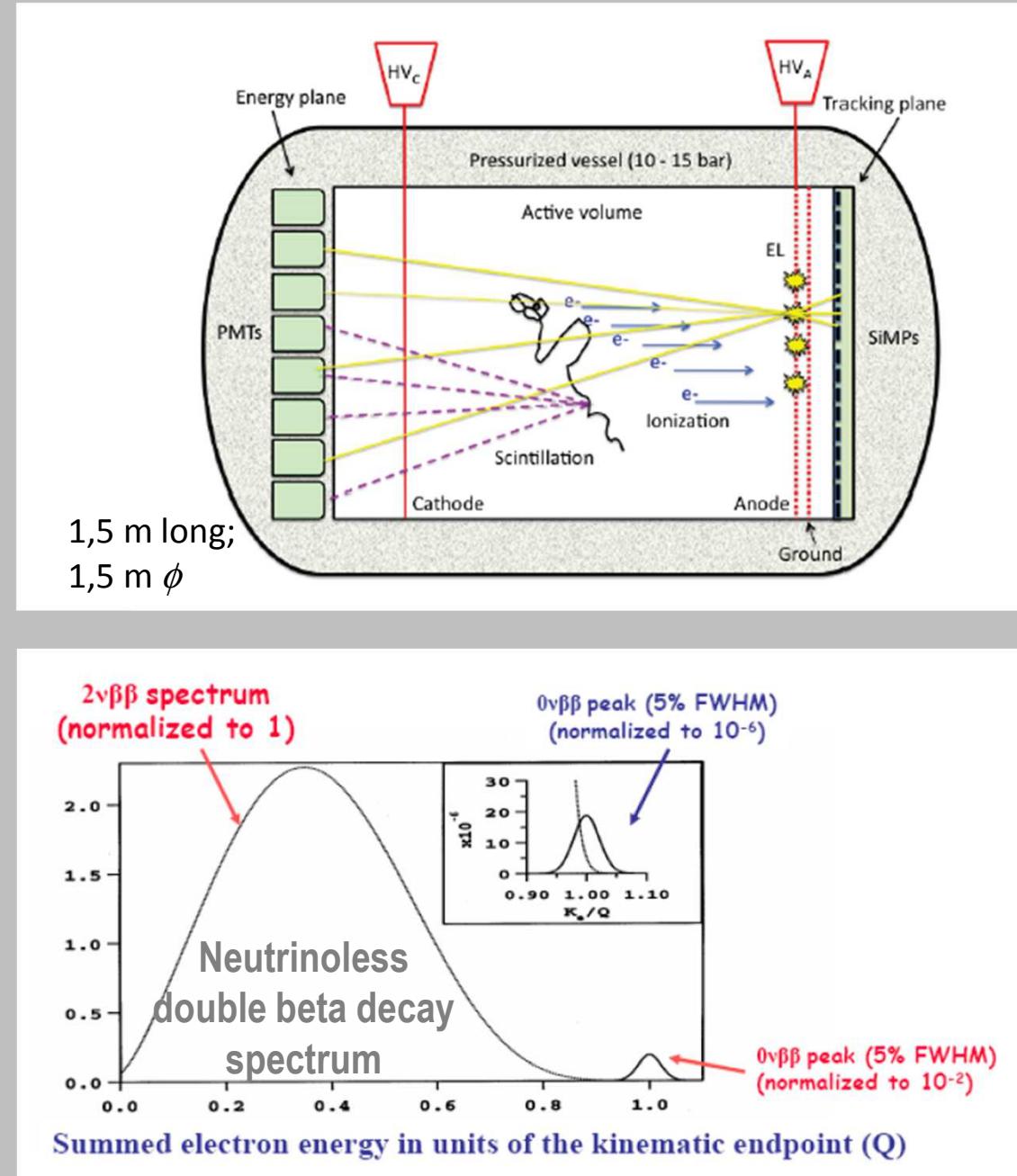


– High precision and low background experiment!

### LIP - Coimbra team

Alexandre Garcia, Alexandre Trindade,  
C.A.N.Conde , Filipa Borges  
Filomena P.Santos (PI), João Barata,  
Teresa T. Dias.

A large TPC  
“(time projection  
chamber”)  
for high precision  
measurements

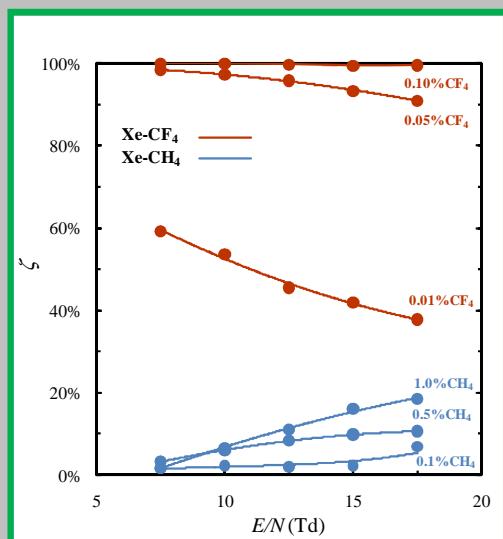


## LIP-Coimbra Team Task

Because NEXT is a large TPC detector (1,5 m long; 1,5 m  $\phi$ ),  
 identify **molecular additives** to mix to xenon, which  
 increase electron drift velocity;  
 decrease electron diffusion coefficients;  
 preserve good energy resolution (electroluminescence (EL))

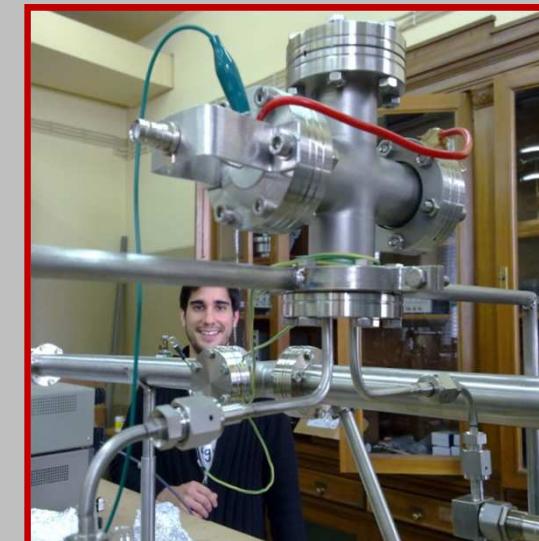
## HOW

Monte Carlo simulations



Experimental measurements

- elecroluminescence (EL) yield
- energy resolution



## CANDIDATES

$N_2$ ,  ~~$CH_4$~~ ,  $CF_4$ , TMA.

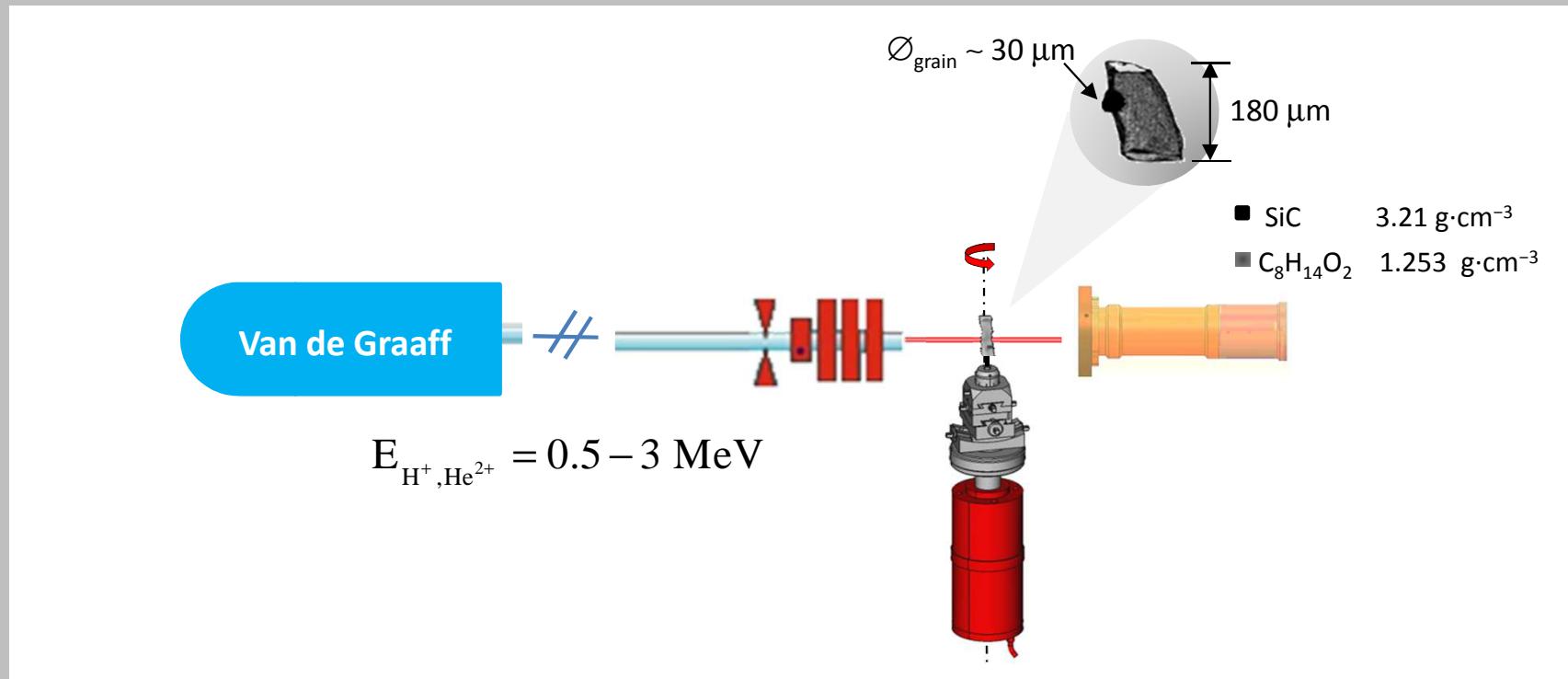
**Detector para estudos de tomografia com microssonda nuclear  
com discriminação em profundidade e resistente à radiação,  
para o ITN, Sacavém**

A.C. Marques (ITN, CFN), M.M.F.R. Fraga (LIP,  
DFUC), P. Fonte (LIP, ISEC), R. Ferreira Marques  
(LIP, DFUC), D. Beasley (ITN, CFN), L.C. Alves  
(ITN, CFN), R.C. da Silva (ITN, CFN)

**Objectivo:** uma câmara de ionização gasosa para medir a energia de protões (ou partículas alfa) dum feixe que atravessa uma dada amostra.

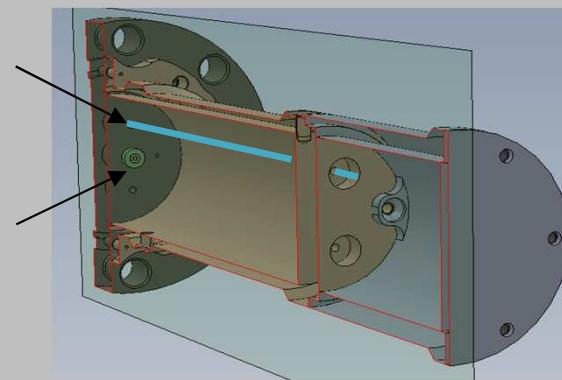
#### Requisitos:

- Boa resolução em energia (comparável aos detectores de Si);
- Tempo de resposta curto ( $R \sim 10^4$  Hz/mm<sup>2</sup>);
- Imune aos danos da radiação.



### 3 - CÂMARA DE IONIZAÇÃO GASOSA

Fio anódico



Janela de  
entrada do  
feixe

Janela ( $\text{Si}_3\text{N}_4$ ) : 100 nm espessura;

$$A = 1 \text{ mm}^2;$$

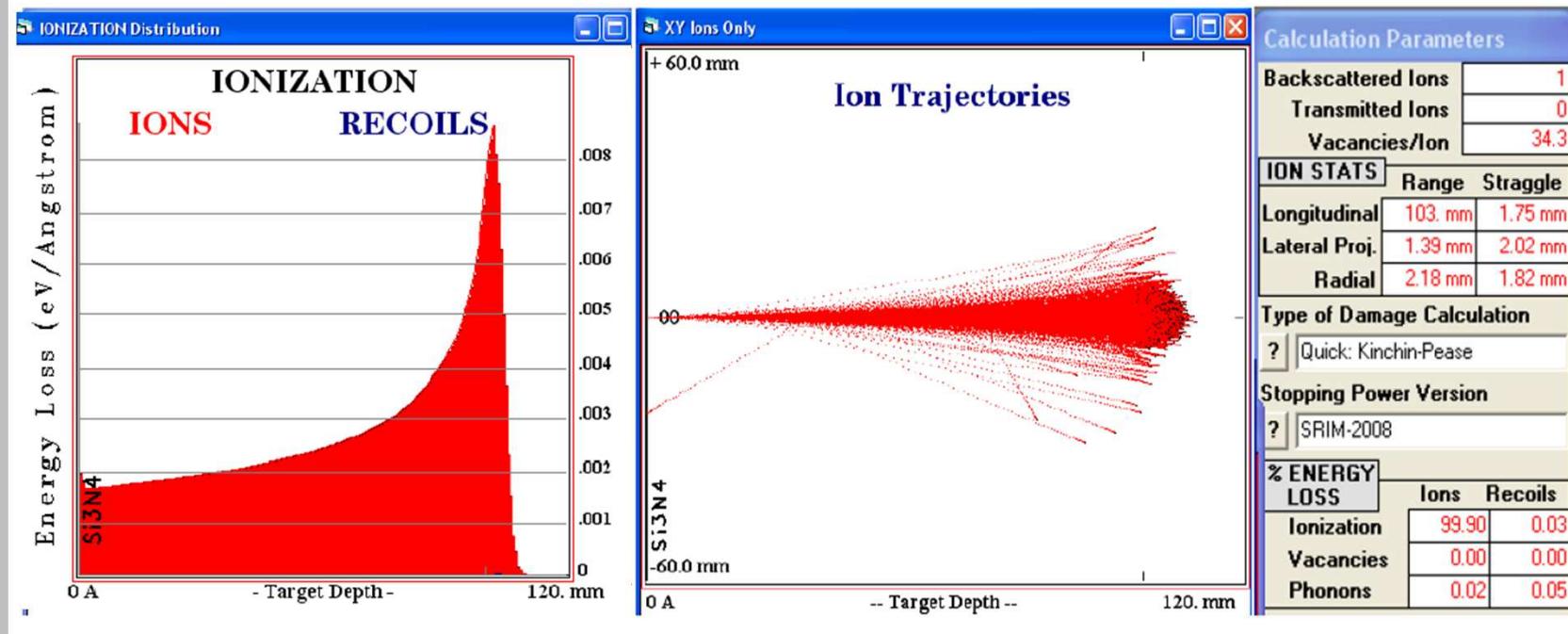
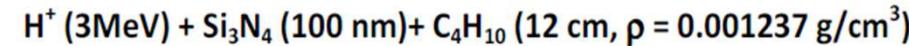
Detector:  $h = 110 \text{ mm}$ ;

$$\phi_i = 40 \text{ mm};$$

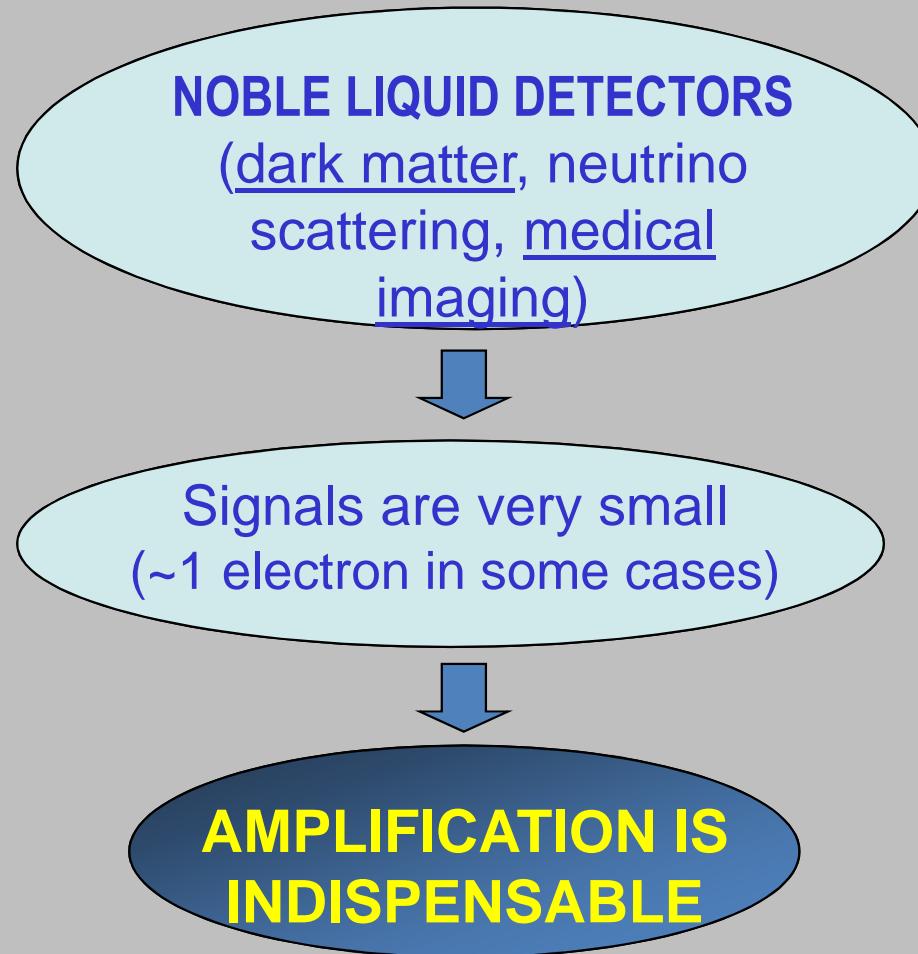
Fio: cobre ,  $\phi = 1 \text{ mm}$ ;  $250 \mu\text{m}$

Gás : 500 mbar de isobutano

Resultados da simulação SRIM



### Motivation

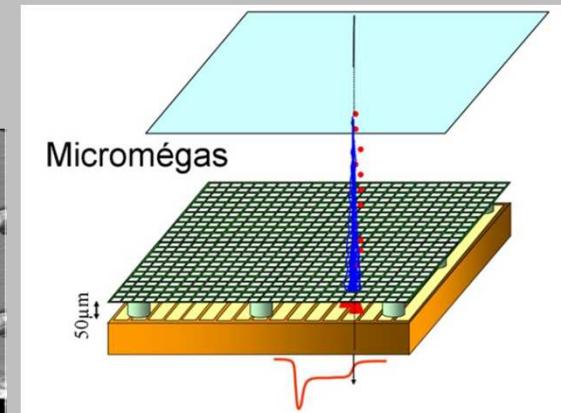
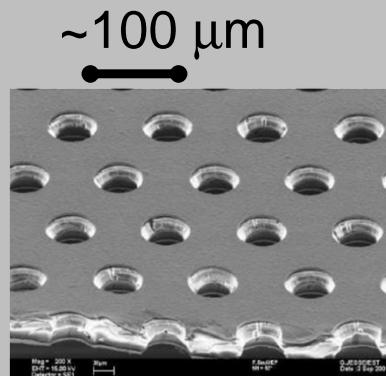


*The team:*

*Filipa Balau, Vlad Solovov, Francisco Neves, Alexandre Lindote, Vitaly Chepel (PI)*

### Motivation

**NOBLE LIQUID DETECTORS**  
(dark matter, neutrino scattering, medical imaging)

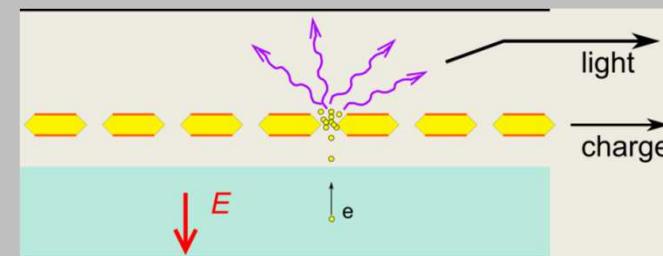


Charge multiplication (+ light!) produced in the holes (GEM) or in gap (Micromegas)

Signals are very small (~1 electron in some cases)

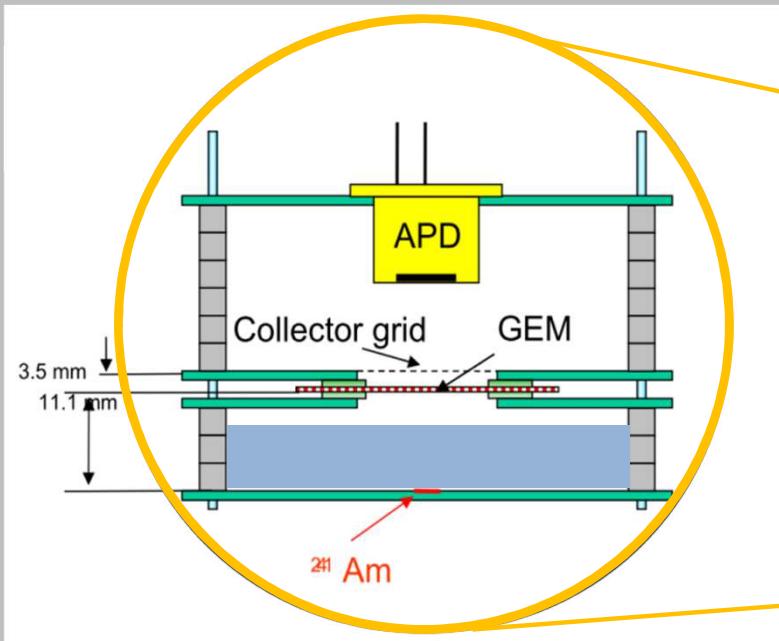
**Microstructures**  
(*GEMs, thick GEMs, micromegas*)  
**might help**

**AMPLIFICATION IS INDISPENSABLE**

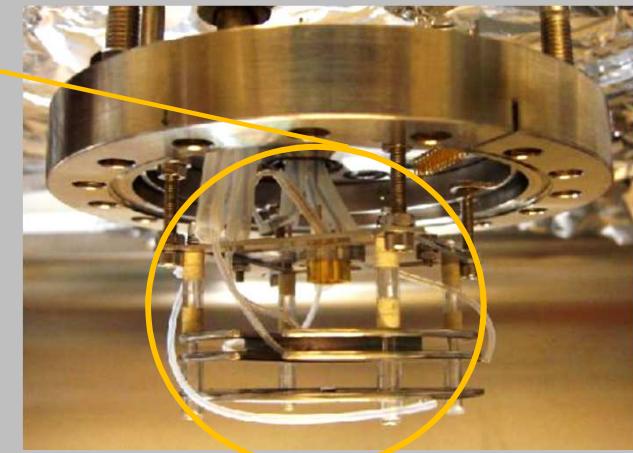


Known to work in gas, not (yet) in liquid!

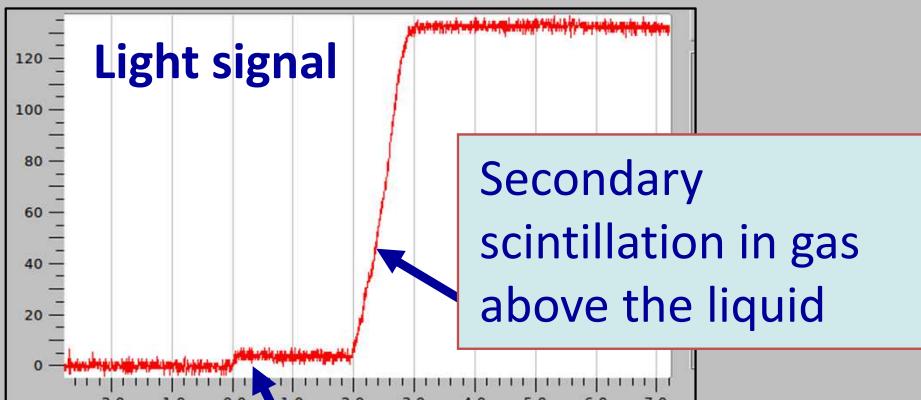
## 4 – MICROSTRUCTURES IN NOBLE LIQUID DETECTORS



Experimental setup

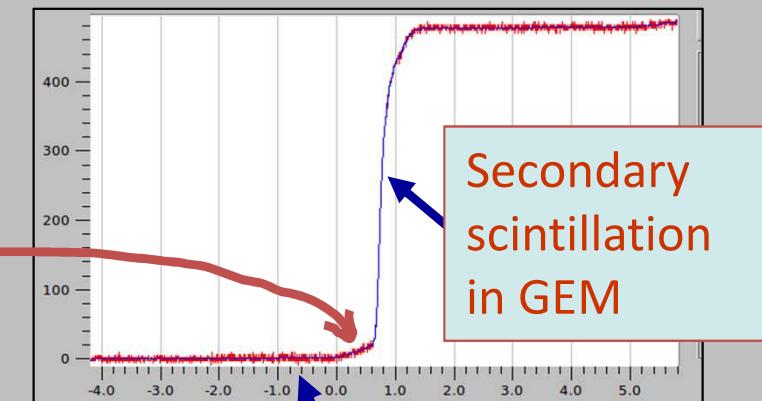


No voltage on GEM



Scintillation in liquid Xe

450 V on GEM



Scintillations in the liquid is  
not even seen in this scale

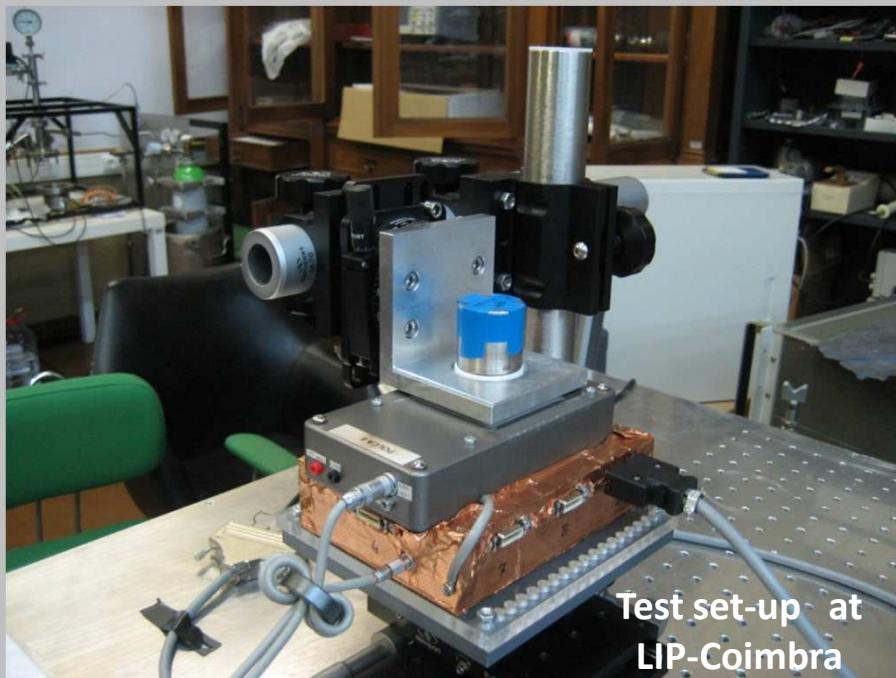
- Seek for stable operation (difficult !)



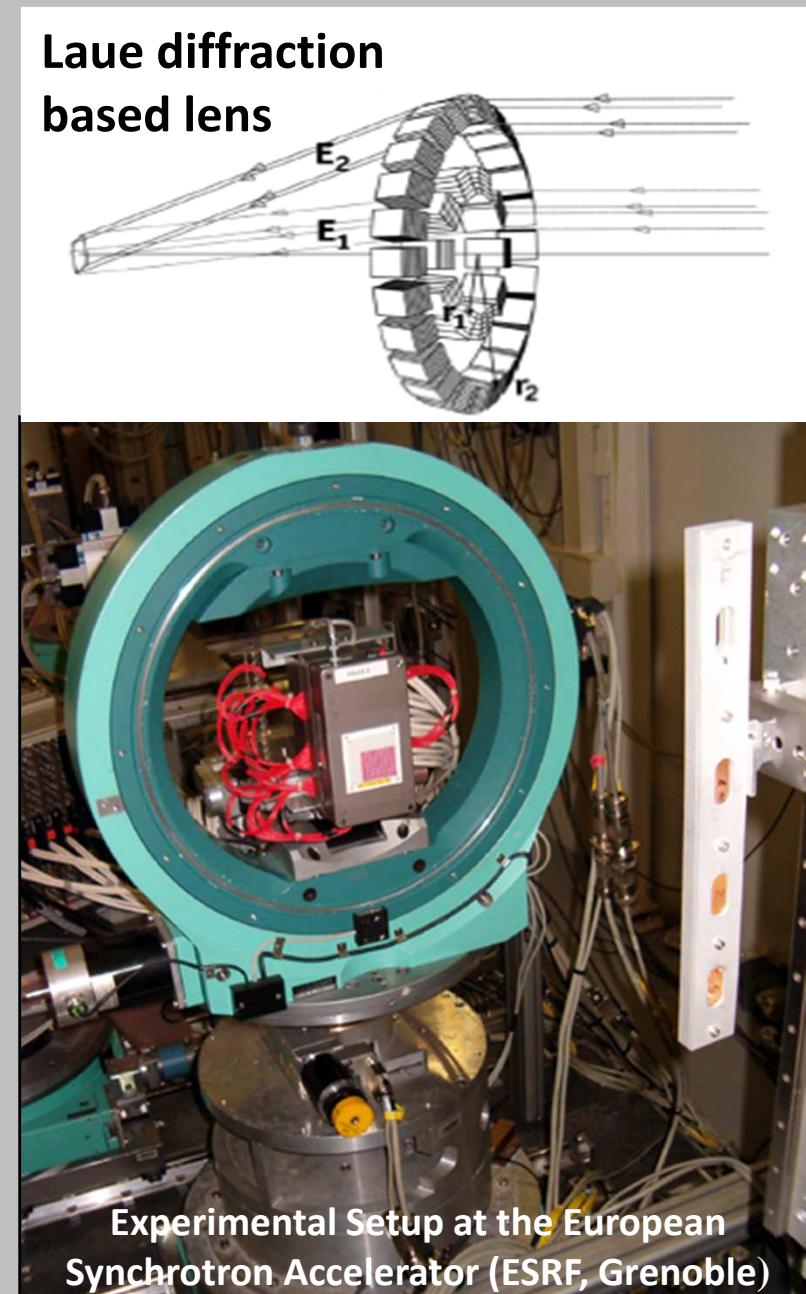
DUAL LIP team:  
Rui Curado da Silva (PI), Jorge  
Maia, Colin Gloster, Carlos  
Patacas, José Marques

### The DUAL mission concept

1. All-Sky Compton Imager mode very long observation of the entire sky;
2. Laue-Lens Optic and Coded-Mask Optic focal plane modes ( $>10$  arcmin).



Test set-up at  
LIP-Coimbra



Laue diffraction  
based lens

Experimental Setup at the European  
Synchrotron Accelerator (ESRF, Grenoble)

## 2012 ESA Call for Small Mission opportunity (launch in 2017)

Our team is in two mission proposals to be submitted next July 15<sup>th</sup> to ESA:

### **1- X-POSIT: X-ray POlarimetric Spectroscopic Imaging Telescope**

A wide field coded mask telescope based on a 3D spatial resolution CdZnTe detector operating in the energy band between **100 keV and 10 MeV**.

**PI:** Ezio Caroli, IASF Bologna, Italy.

**Partner countries:** Denmark, France, Italy, Portugal and Spain.

### **2- IXO/XPOL type photoelectric polarimeter**

The array will be hosted within a gas cell design based on gas proportional counters, in particular micro-pattern gas pixel detectors operating in the energy band from **6 keV to 35 keV**.

**PI:** Mark Pearce, Royal Institute of Technology, Stockholm, Sweden.

**Partner countries:** Finland, Germany, Italy, Portugal, Sweden and The United Kingdom

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NEUTRONS  
FOR SCIENCE



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