RPC R&D group activities in 2016-2017

A. Blanco
On behalf of the RPC group

Alberto Blanco
Coimbra

Paulo Fonte
Coimbra

Luís Lopes
Coimbra

Luís Margato
Coimbra

João Saraiva
Coimbra

\+ Detector Laboratory
Mechanical Workshop

RPC R&D group

The **RPC group cooperates with several other LIP groups** (**Neutron Detectors, AUGER, LATTES, HADES, RPC-PET**), supporting their RPC-related activities.

Lines of work

- Very **large area/channel** tRPCs.
- **Shielded tRPCs** for robust **multi-hit capability in dense arrays.**
- The use of ceramic materials and warm glass for **enhanced count-rate capability**
- Application of RPCs to animal and human Positron Emission Tomography (**RPC-PET**)
- Simultaneous high-resolution measurement of positions and times (**TOF-Tracker**)
- **Very low maintenance, environmentally robust**, RPCs for deployment in remote locations
- Large area **fast-neutron TOF** detectors
- **Epi-thermal neutron** detectors with ^{10}B converters

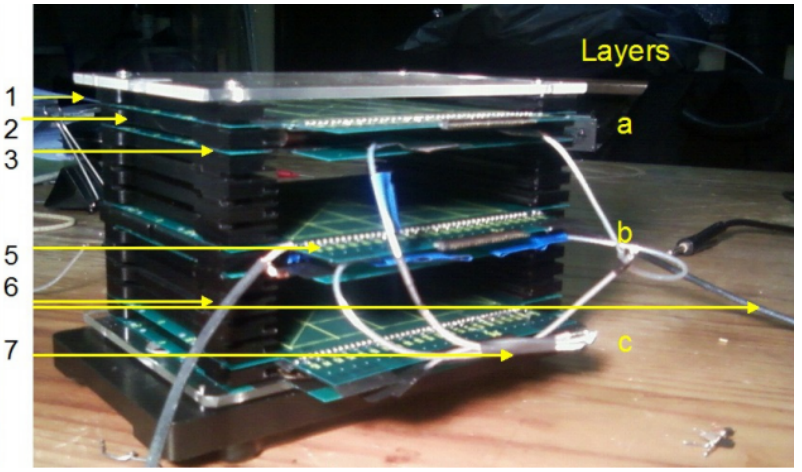
TOF-Tracker RPCs

Basic idea. Extent the capability of the RPCs to measure **simultaneously time (< 100 ps)** and **2D position (< 1 mm)**.

Applications:

- Particle Identification in High Energy Physics Experiments.
- Muon tomography
- PET

80 x 80 mm^2



TOFtracker: gaseous detector with bidimensional tracking and time-of-flight capabilities

2012 JINST

A. Blanco,[a] P. Fonte,[a,b,1] L. Lopes,[a] P. Martins,[a] J. Michel,[c] M. Palka,[e] M. Kajetanowicz,[d] G. Korcyl,[e] M. Traxler[f] and R. Marques[a]

[a] *LIP — Laboratório de Instrumentação e Física Experimental de Partículas, Dep. de Física, Univ. de Coimbra, 3004-516 Coimbra, Portugal*

[b] *ISEC-Instituto Superior de Engenharia de Coimbra, Rua Pedro Nunes — Quinta da Nora, 3030-199 Coimbra, Portugal*

[c] *Institut für Kernphysik, Goethe Universität Max-von-Laue-Si*

[d] *Nowoczesna Elek ul. Bolesława Pru*

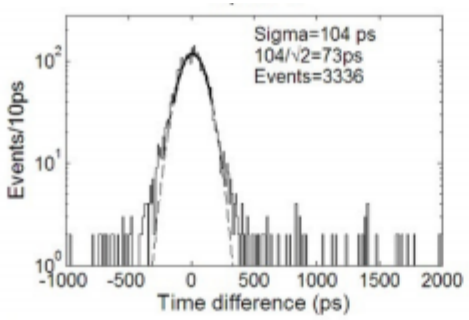
[e] *Jagiellonian University, ul. Gołębia 24, 31-007 Cracow, Poland*

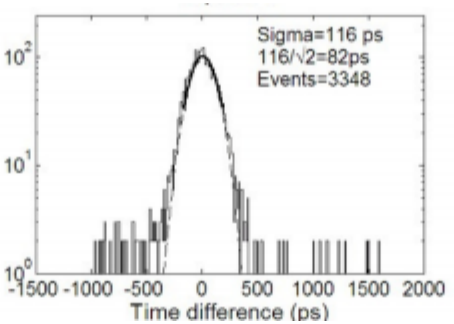
[f] *GSI Helmholtz Centre for Heavy Ion Research, Planckstraße 1, 64291 Darmstadt, Germany*

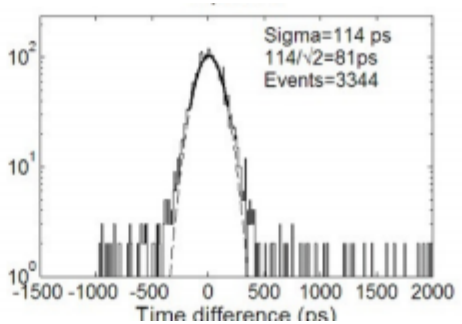
E-mail: fonte@coimbra.lip.pt

ABSTRACT: Particle identification by time-of-flight requires the si passing time and the trajectory of particles. It may be usefull that

Single layer precision = 77 ps σ 38 μm σ







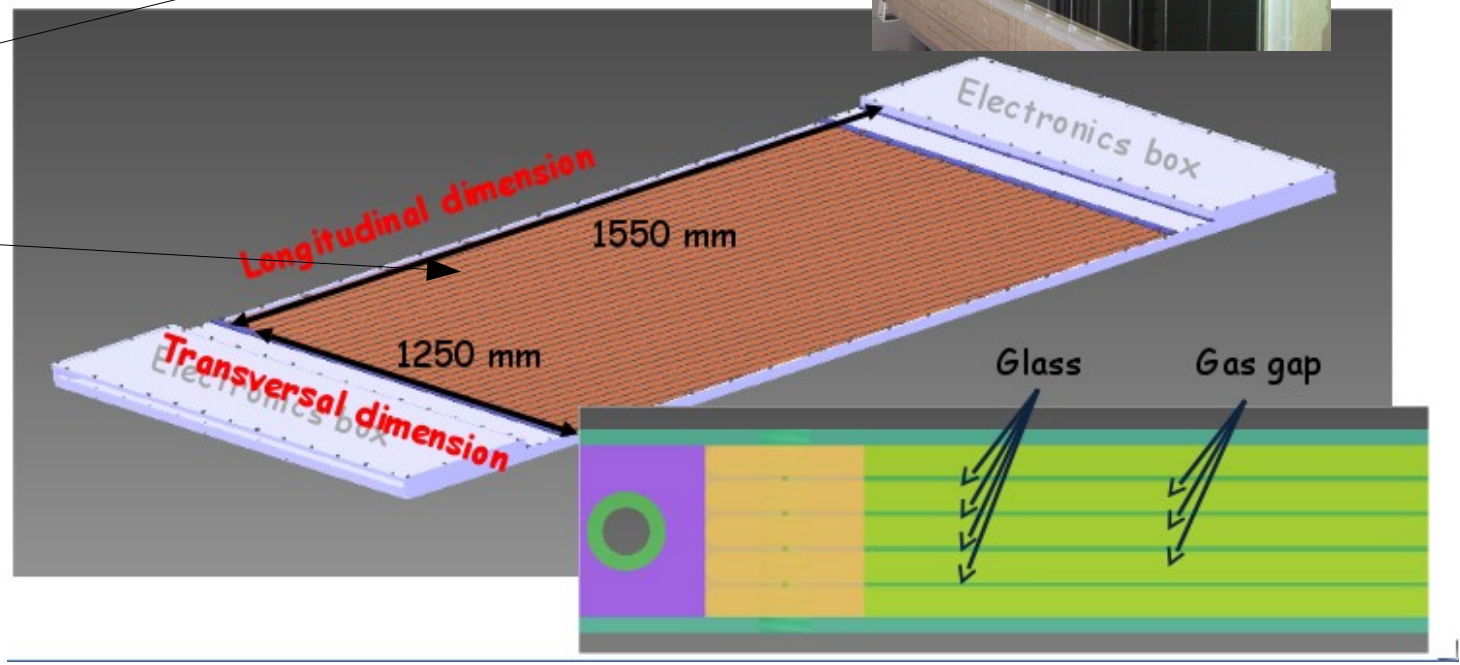
TOF-Tracker RPCs

Basic idea. Extent the capability of the RPCs to measure **simultaneously time (< 100 ps)** and **2D position (< 1 mm)**.

2016-2017.

Application of the concept to large area devices ~2m².

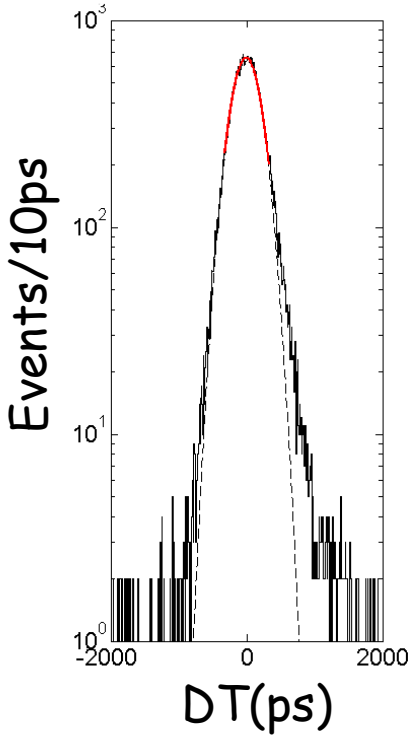
- Sensitive RPC volumes with 6x300 um gaps.
- 2D (cathode-anode) strip readout.
- Economics in FEE due to codification of the readout



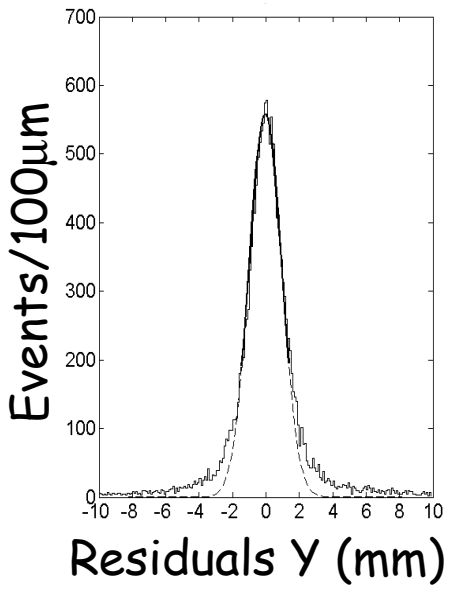
TOF-Tracker RPCs. MASTER. A muon telescope for RPC and related detectors testing

Muon telescope composed of 3 layer of TOF-Tracker RPCs delivering around **1 mm² and 200 ps σ spatial and time resolution.**

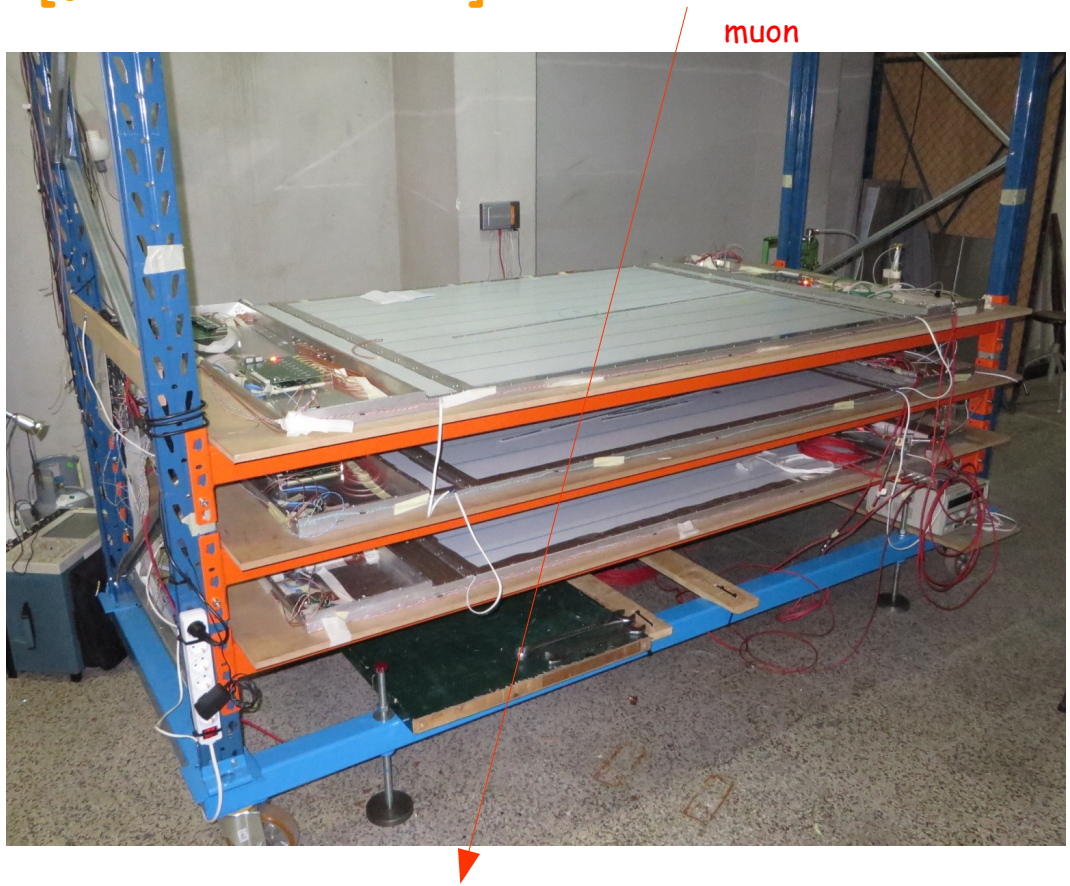
σ_t ~ 215 ps



σ_y ~ 1.3 mm



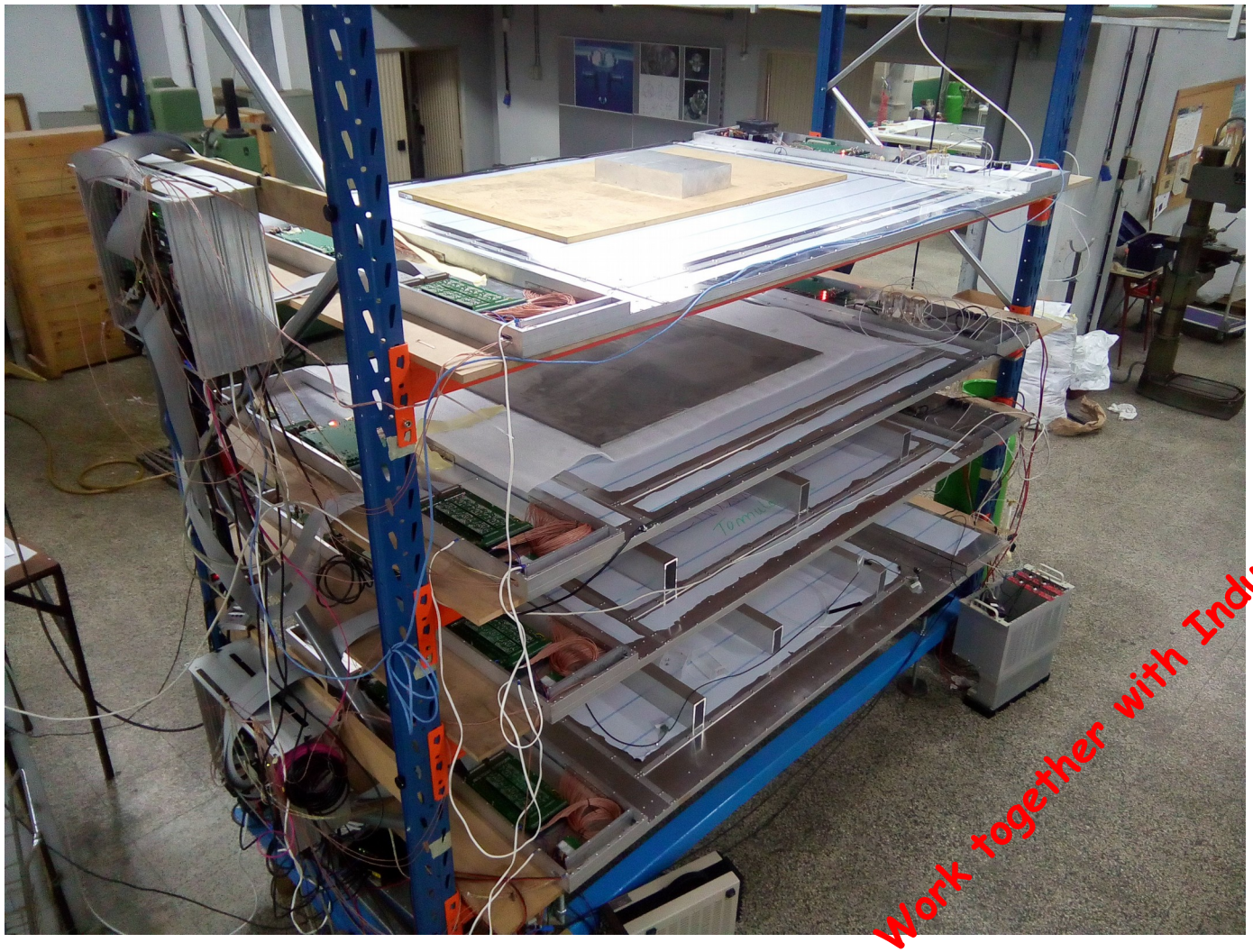
[JINST 11 C1002]



Currently under commissioning in Rio CBPF

TOF-Tracker RPCs. Muon tomograph for the scanning of cargo containers in search of smuggling of nuclear material

Muon telescope composed of 4 layer of TOF-Tracker RPCs with similar performance.



In Coimbra

Work together with Industry

TOF-Tracker RPCs. Muon tomograph for the scanning of cargo containers in search of smuggling of nuclear material

Muon telescope composed of 4 layer of TOF-Tracker RPCs similar performance.

Station up
2 TOF-Tracker

Currently under commissioning in the hidronav company

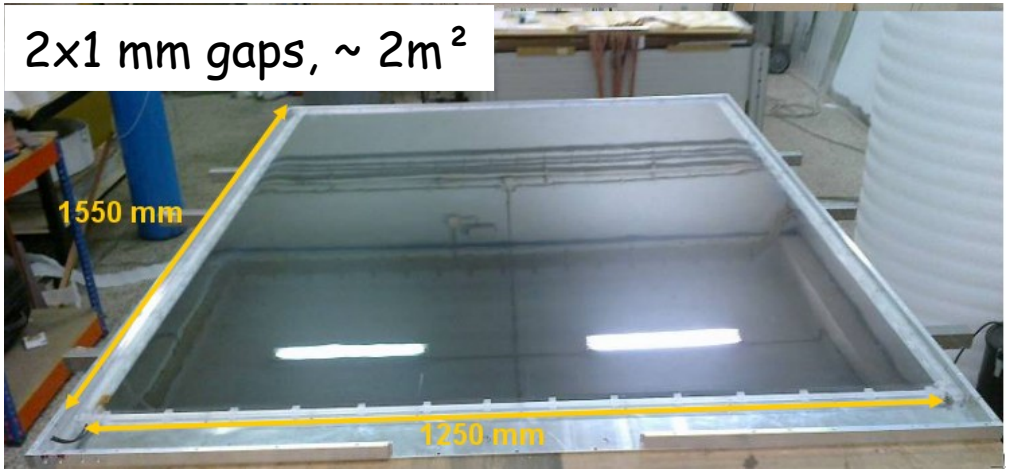
Still lot of work to be done concerning calibration and understanding of the detector but it is operative

Station down
2 TOF-Tracker

RPC devices for cosmic ray measurements

Basic idea. Developing **large-area**, **autonomous**, **environmentally robust**, ultimately **sealed RPCs** with good time and position capabilities for cosmic ray measurements.

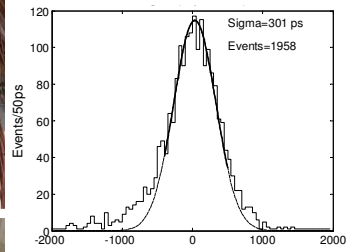
2x1 mm gaps, ~ 2m²



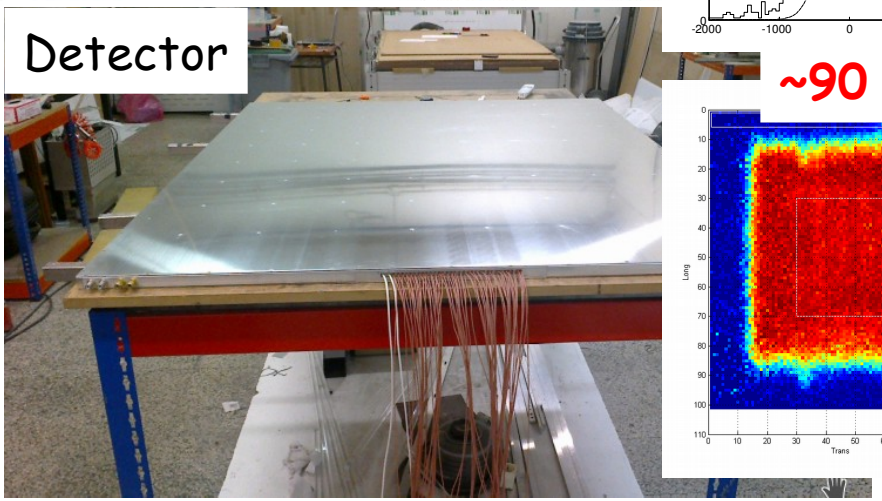
Assembly

Pad readout

~300 ps



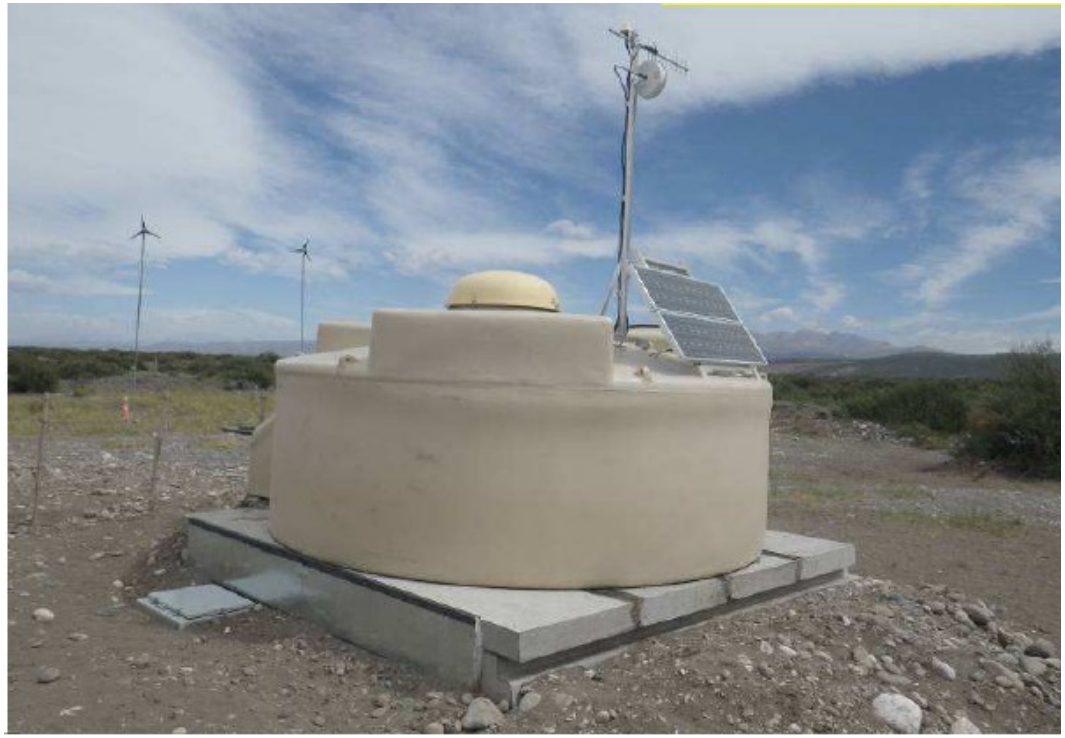
Detector



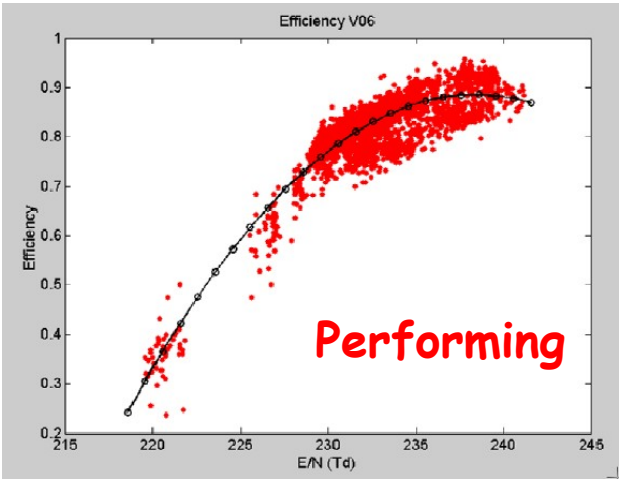
~90 %

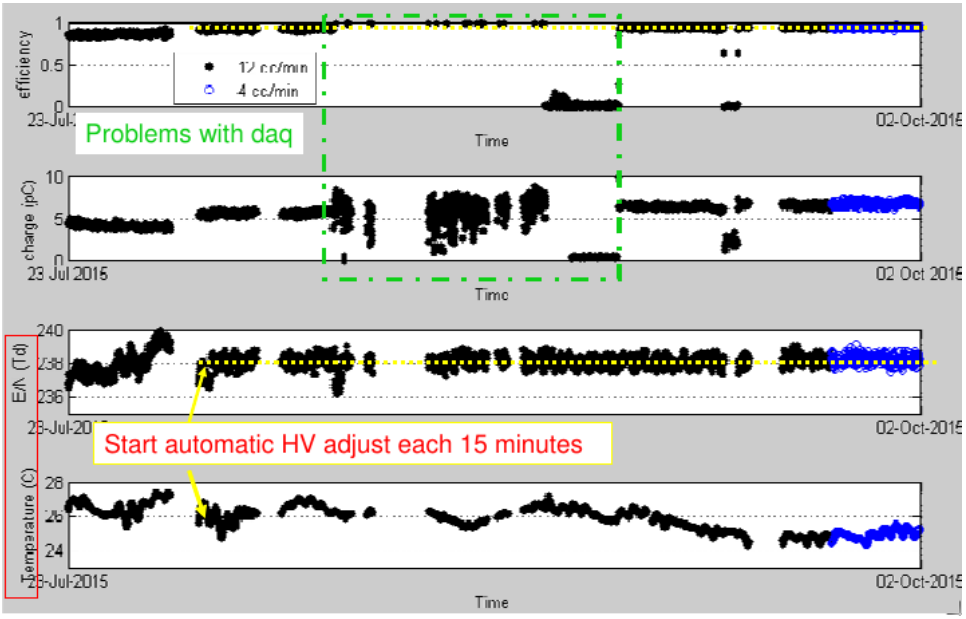
RPC devices for cosmic ray measurements. AUGER (MARTA) and LATTES.

2016-2017 to be finished in 2018



[JINST 11 C09011]





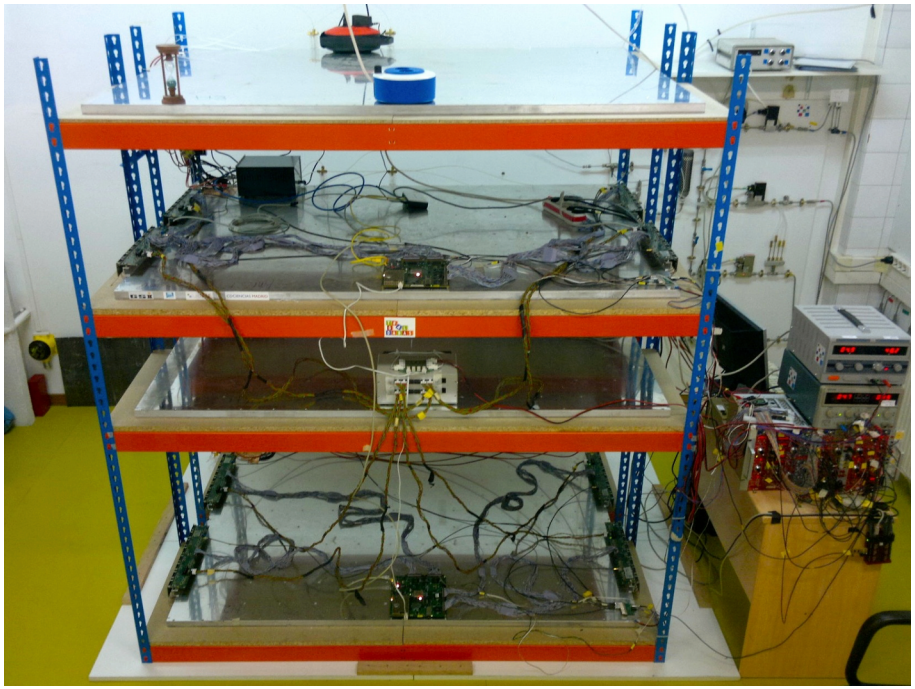
- **MARTA**. Production and deployment of 40 RPC units, 10 Auger tanks.
- **LATTES**. Under consideration

Robust and reliable

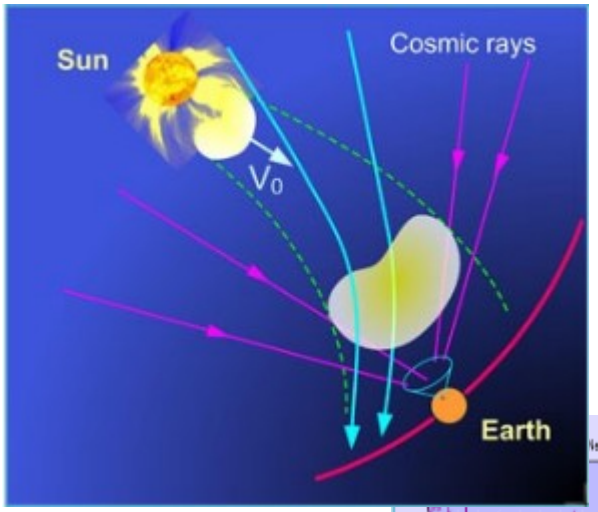
RPC devices for cosmic ray measurements. TRAGALDABAS.

2016-2017

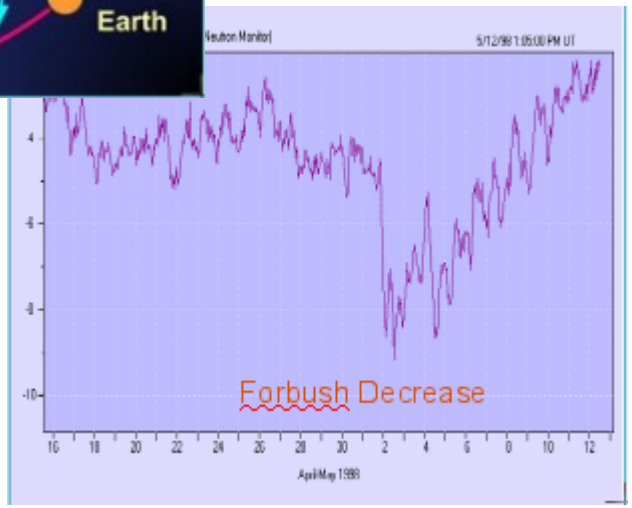
4 Plane RPC telescope operated continuously in **Santiago of Compostela** with the aim of accurately measuring the **cosmic ray flux** in order to study **solar physics** but much more.



After **two year of data taking** the setup is being **upgraded**: new trigger, new LV and HV system.



[ECRS 632 12010]

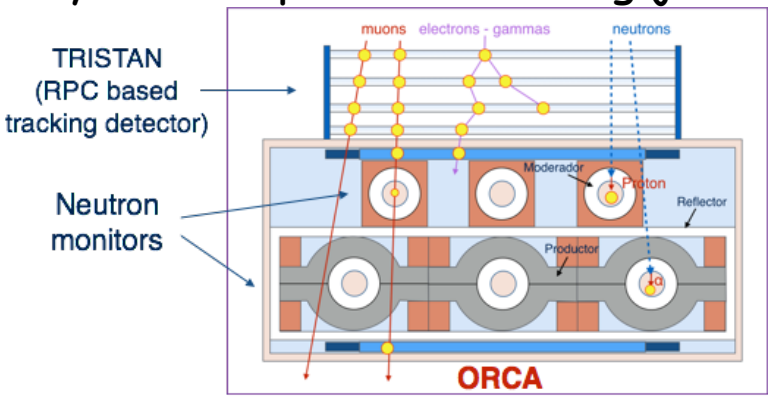


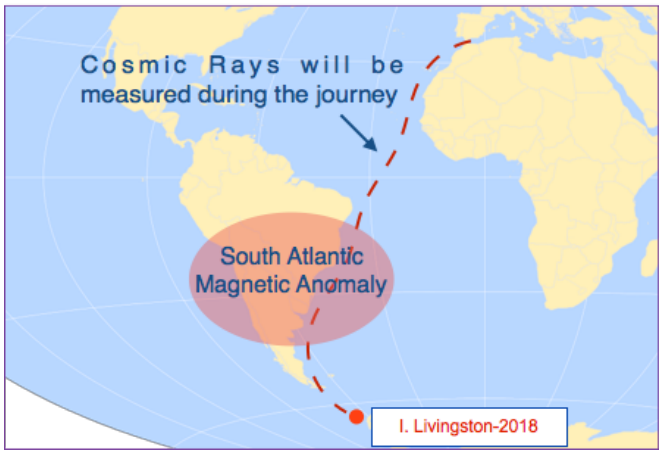
Impressive sensitivity to Forbush decrease

RPC devices for cosmic ray measurements. ORCA. TRISTAN

2018

An hybrid cosmic ray detector will be installed at the end of 2018 in the Spanish Antarctic base at the Livingston Island (1500 km south Ushuaia) with the aim of measuring precisely the cosmic ray flux on place and during journey.





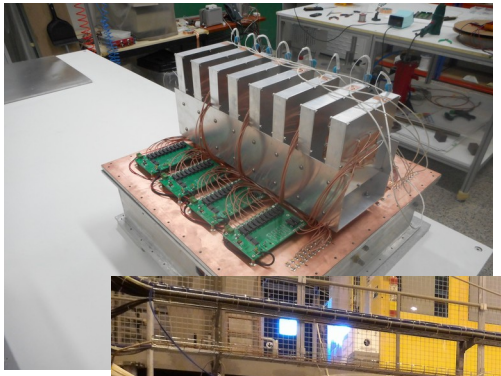
Similar (CORSAIR) device will be built and installed in Colombia in 2019 with the possibility to start a network of Cosmic Ray stations

Development of High rate RPCs detectors

Basic aidea: Develop the RPC technology for **high rate** (> 1 kHz/cm^2) applications by using new low resistivity materials.

Lip-Coimbra, Beneficiary of WP 13.2.1 - **Establishing new resistive materials for high rate RPCs**

8 chambers built with Low resistivity candidate materials



Test and data taking @ CERN with pion and muon beams

Data under analysis

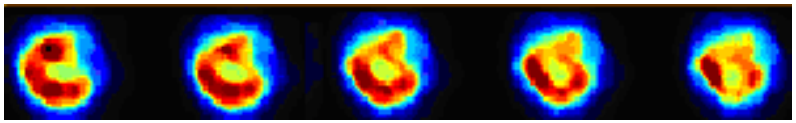
Test setup @ Coimbra DL

AIDA 2020

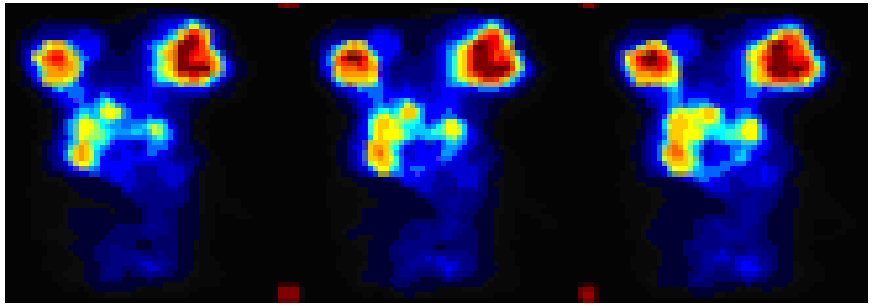
Advanced European Infrastructures for Detectors at Accelerators

RPC-PET a very high position resolution PET scanner for small animals

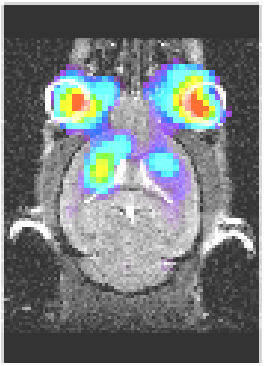
Basic aidea: Develop the RPC technology to be used in **Positron Emission Tomography**, taking advantage of the **extraordinary position accuracy** and **low price.**



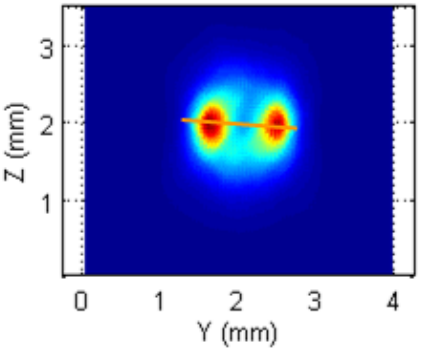
Live heart transaxial sections with ^{18}FDG



Harderian glands and left striatum with ^{11}C-raclopride

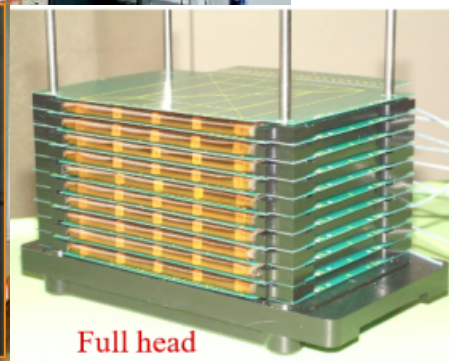


Co-registration with MRI



Currently under deep upgrade.
Everything new except the RPCs

0.4mm FWHM 170 mm σ position resolution

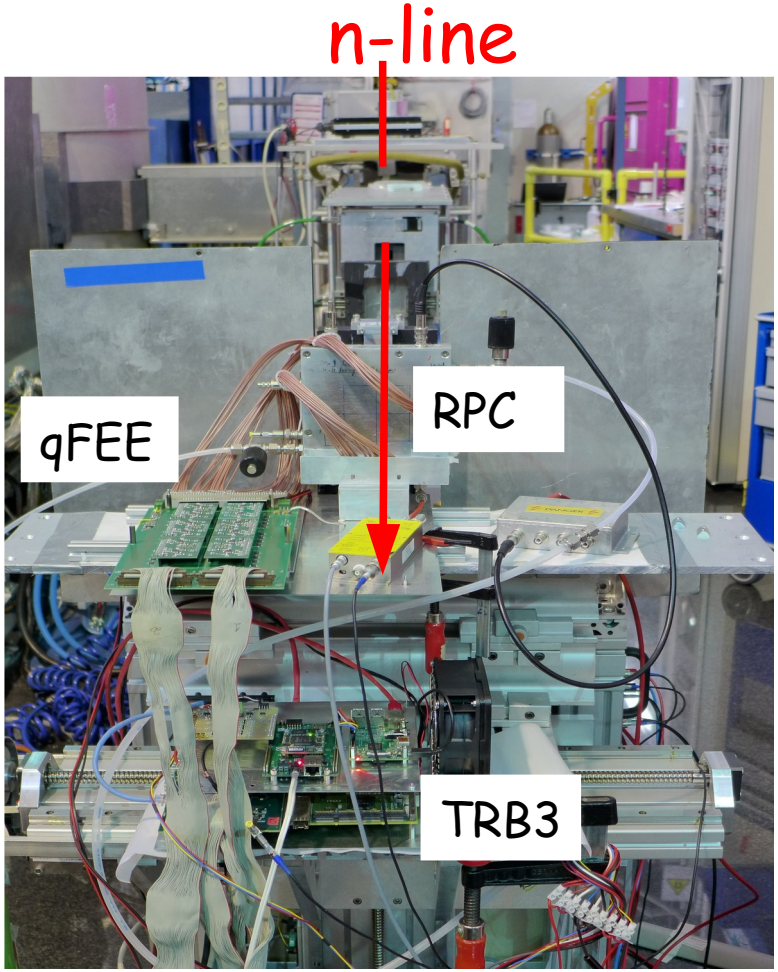


Full head

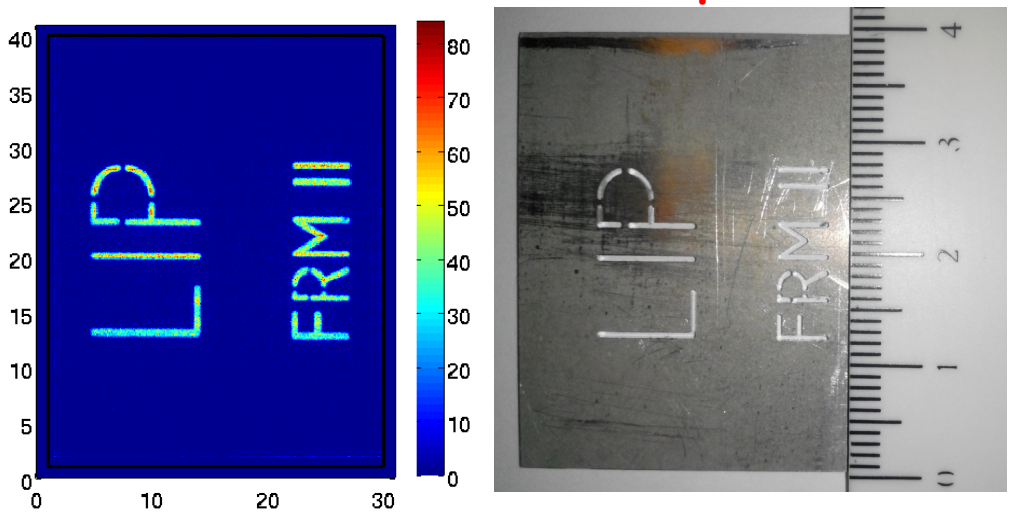
World's first RPC-PET tomograph. Now installed at ICNAS, University of Coimbra

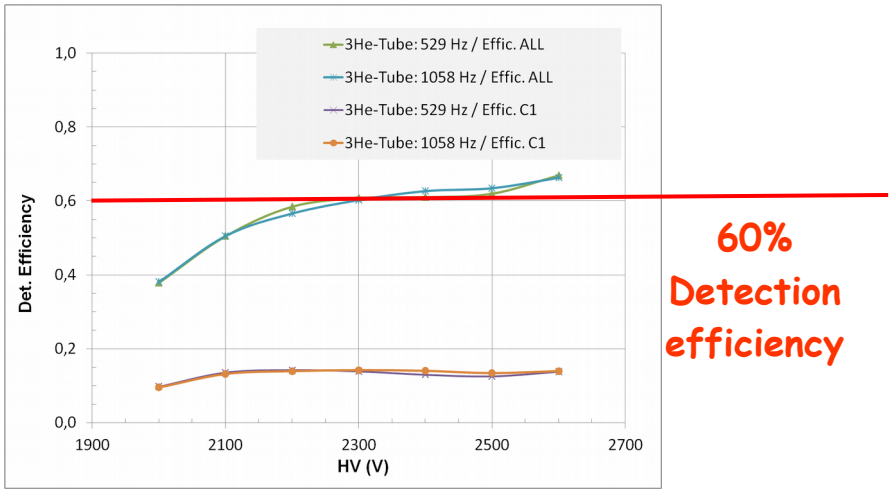
Position sensitive epi-thermal neutron detectors based on RPC with ^{10}B converters.

Basic aidea: Develop the RPC technology to be used as a position sensitive thermal neutron detector, taking advantage of the **extraordinary position accuracy** and **low price,** by using ^{10}B converter plates.



0.25 mm FWHM 0.100 mm σ position resolution

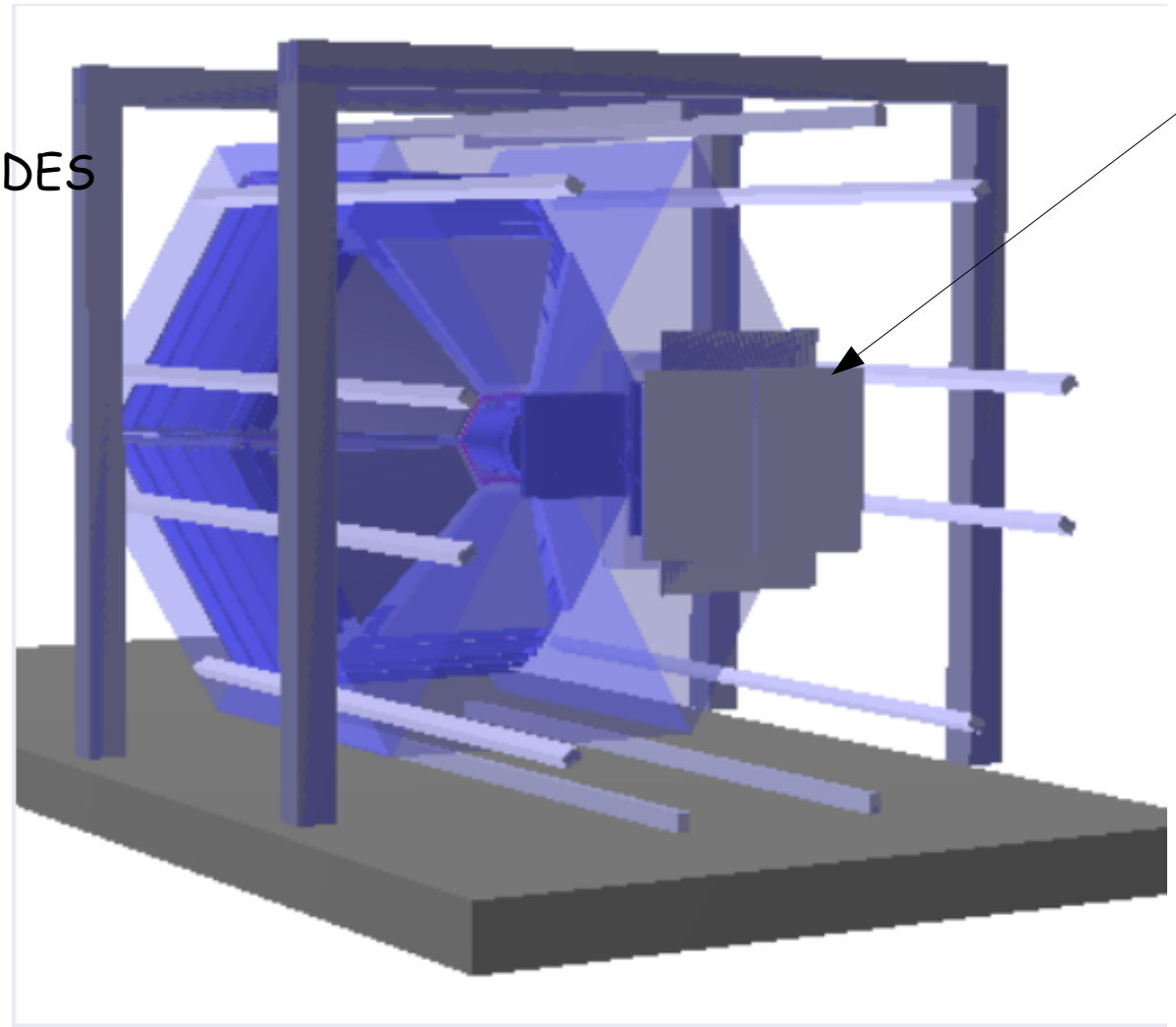


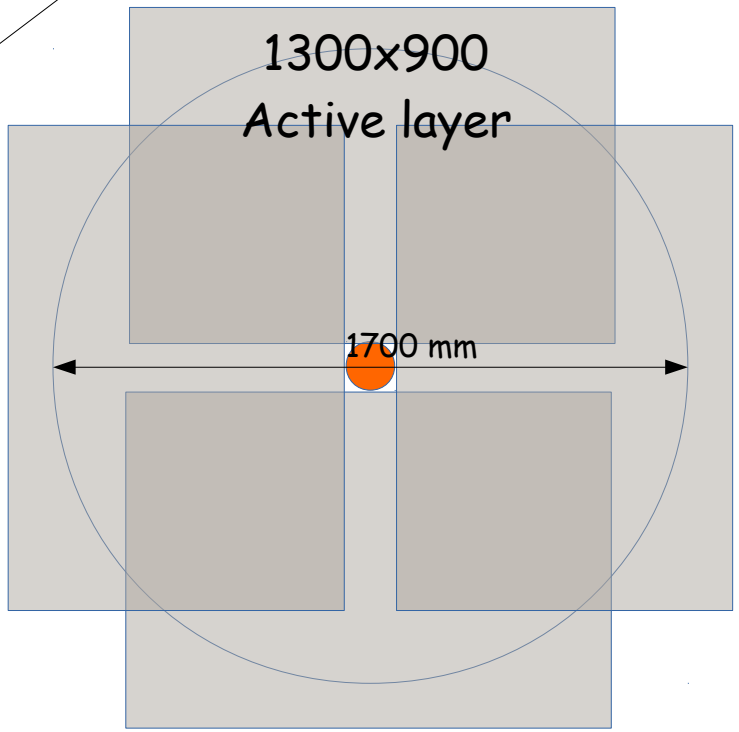


60% Detection efficiency

New HADES RPC-TOF Forward Detector

Basic aidea: Develop an RPC with a time resolution < 100 ps or better to be used in a low multiplicity environment (P, π) to cover the low polar angle region of HADES.



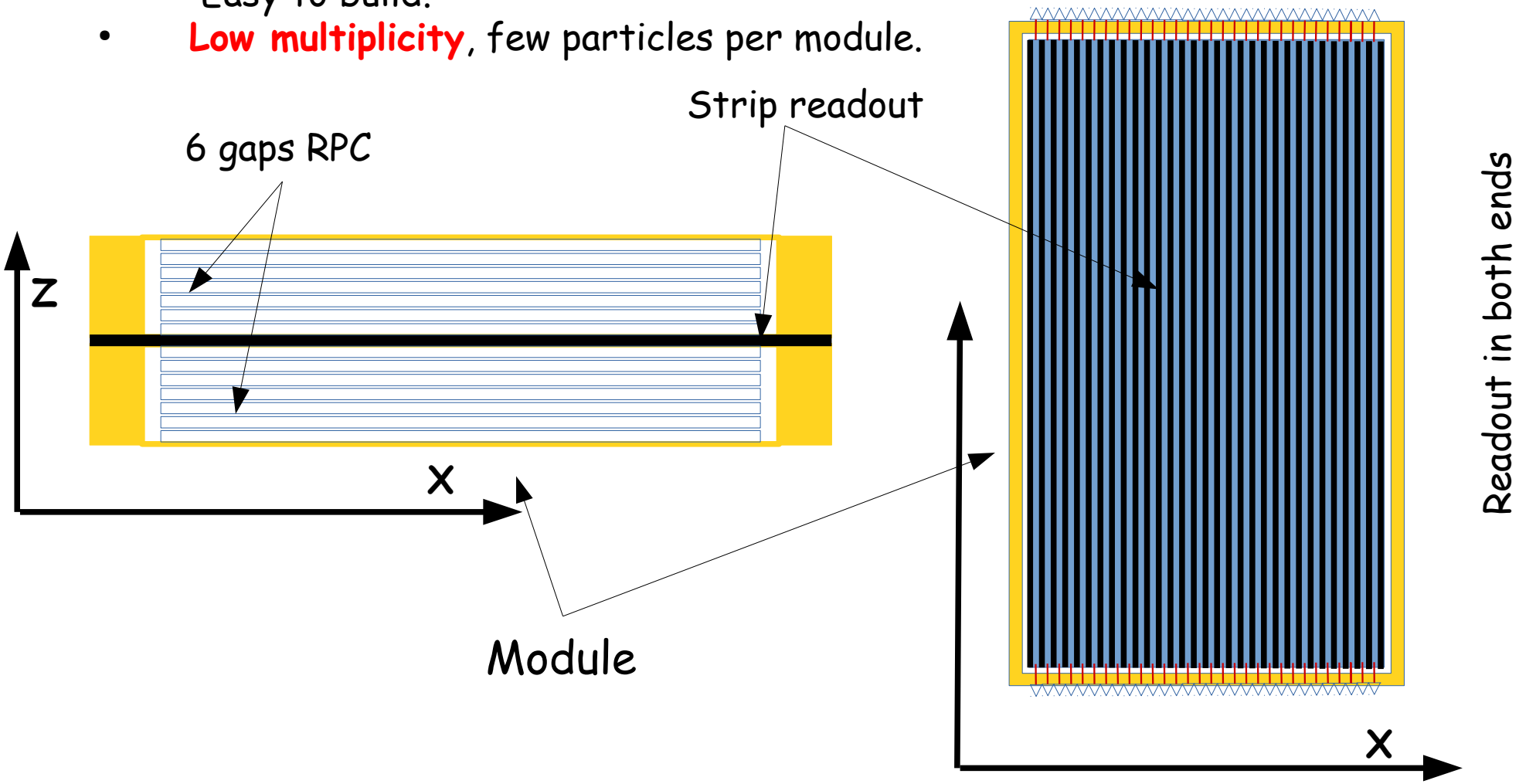


Four RPC modules

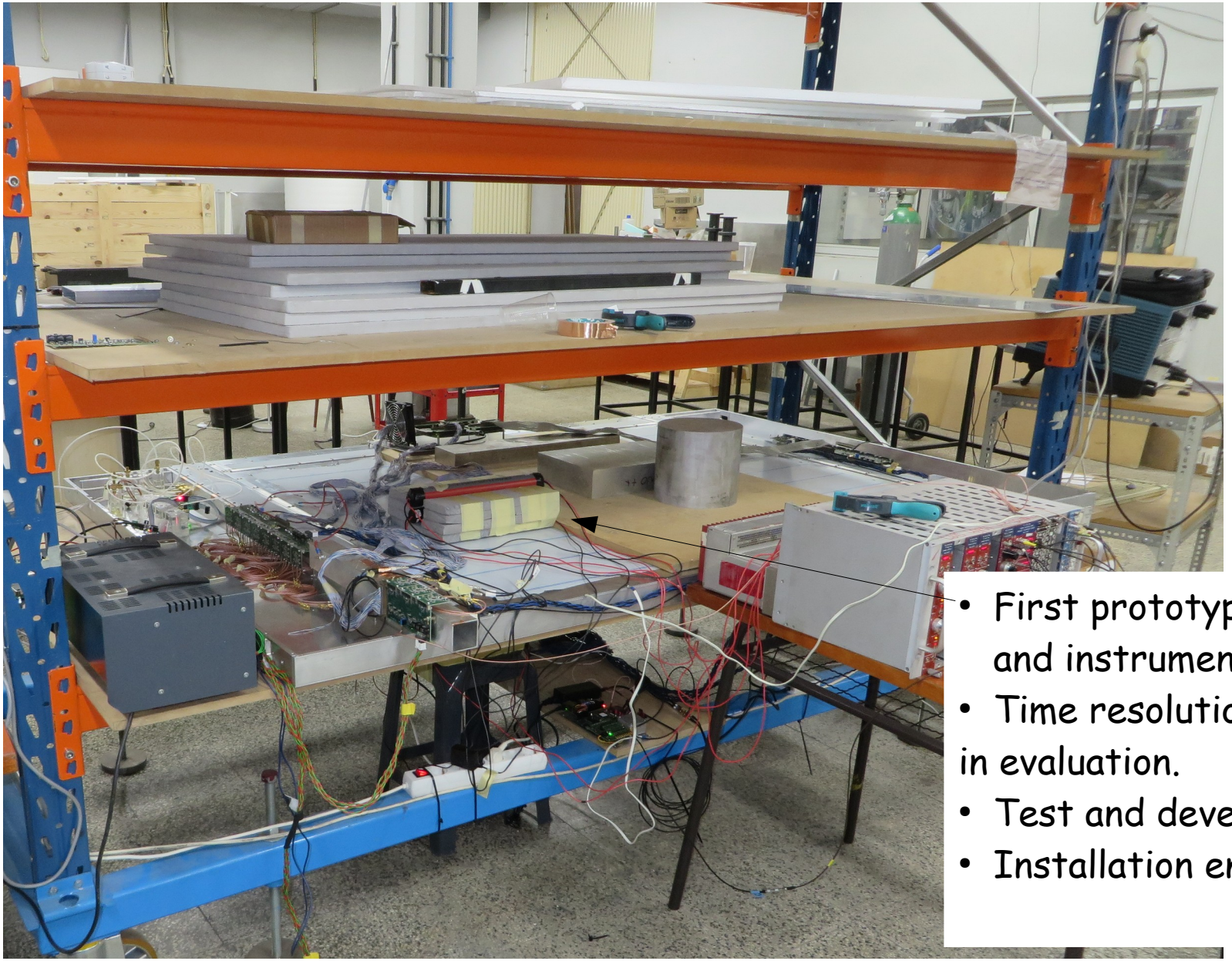
New HADES RPC-TOF Forward Detector

Modules of two 6 gaps RPCs with a strip readout in the middle

- **Good time resolution,** < 100 ps σ.
- **Good efficiency,** > 95 %.
- Easy to build.
- **Low multiplicity**, few particles per module.



New HADES RPC-TOF Forward Detector



- First prototype just assembled and instrumented few days ago
- Time resolution and efficiency in evaluation.
- Test and development in 2018
- Installation end of 2018