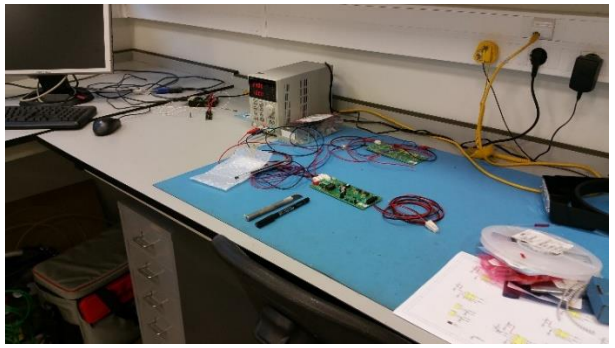
LABORATÓRIO DE INSTRUMENTAÇÃO
E FÍSICA EXPERIMENTAL DE PARTÍCULAS

e-CRLab

Cosmic
Rays
Electronics
Laboratory



Auger:

Gianni hodoscope upgraded;
Data including RPC; new UUB; new SSD
Full area of RPCs acquired
Peter Mazur Station:
Upgraded; Setup to measure RPC efficiency
First Data! Already being explored

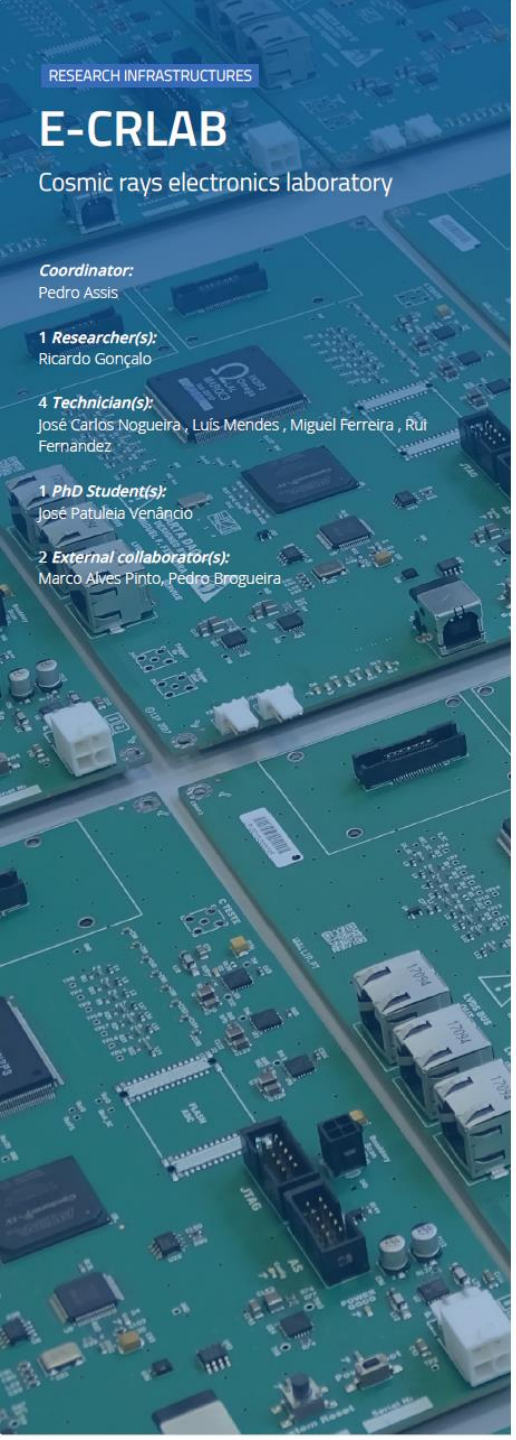
ATLAS

HGTD
Slow Control/Interlock/HV filter

Radiation test of Altiroc ASIC
Development/consulting of several boards.
Support of two master thesis at Coimbra

Medics:

Ortho CT testing
Development of instrumentation / solutions for medical physics(RT) monitoring



RESEARCH INFRASTRUCTURES

E-CRLAB

Cosmic rays electronics laboratory

Coordinator:
Pedro Assis

1 *Researcher(s):*
Ricardo Gonçalo

4 *Technician(s):*
José Carlos Nogueira , Luís Mendes , Miguel Ferreira , Rui Fernandez

1 *PhD Student(s):*
José Patuleia Venâncio

2 *External collaborator(s):*
Marco Alves Pinto, Pedro Brogueira

Executive summary

The e-CRLab is mainly dedicated to the development of electronics for Particle and Astroparticle experiments. The focus is put on fast digital electronics implemented in FPGAs and on front-end electronics. The laboratory has the capability to design complex printed circuit boards and to produce simple printed circuit board (PCB) prototypes. The production of complex PCB and its assembly is outsourced. There is capability to do rework in PCB boards. A small set of mechanical tools allows the production of simple detector prototypes mainly for proofs of concept.

The laboratory has been deeply involved in MARTA, a project within the context of Auger upgrade. Aiming at operating RPCs in the Argentine Pampa, the project uses electronics developed at LIP that has the responsibility of its operation. The MARTA front-end electronics based in the MAROC ASIC was fully developed at the laboratory as well as part of its slow control and central unit. The prototype systems become online with first data beginning of 2024. A prototype setup of hodoscopes at a test tank in Auger is also being upgraded and providing valuable data for RPCs and other detectors at Auger.

The laboratory has been deeply involved in the electronics for the HGTD detector, an upgrade to ATLAS. In this context the laboratory is involved in the testing of the front-end electronics for fast timing and on auxiliary systems such as DCS and interlock. The laboratory played a key role in the Radiation qualification of the ALTIROC asic.

The e-CRLab has also been involved in outreach and teaching and is giving support to several LIP groups either by consulting or design review. More recently the laboratory has started giving support in the development of medical detectors and its instrumentation.

e-CRLab

Overview

The e-CRLab was created as a laboratory for the development of DAQ systems for Cosmic Ray experiments but has in the recent years diversified its activities. Nowadays, the e-CRLab is mainly dedicated to the development of electronics for Particle and Astroparticle experiments. The focus is put on fast digital electronics implemented in FPGAs and on front-end electronics. The laboratory has the capability to design complex printed circuit boards and to produce simple printed circuit board (PCB) prototypes. The production of complex PCB and its assembly is outsourced. There is capability to do rework in PCB boards. A small set of mechanical tools allows the production of simple detector prototypes mainly for proofs of concept. The laboratory facilities are located at LIP-Lisboa and are composed by an office room, one instrumentation room installed with state-of-the-art equipment, and instrumentation rooms dedicated to the development and testing of the different setups. A small mechanical workshop for detector prototypes development and a dark room are available to complement its activities. The laboratory counts with three electronics technicians, has the support of several researchers and has PhD and Master students involved in its activities.

Assessment of the past year: objectives vs. achievements

During the last year it was possible to upgrade the hodoscope setup at the Gianni Navarra test tank at the Pierre Auger Central campus. The setup was upgraded with MARTA most recent solution. The electronics was updated to interface the WCD electronics and to enable the measurement of the Auger prime upgrade scintillator detectors. In the field it was possible to finalize the prototype setup in the Peter Mazur tank. The electronics and firmware was finalized as also the interface with the tank and underground detectors. The setup has already performed the first acquisition runs. We have been responsible for the slow control data acquisition and data visualization tools for the setups installed at Auger.

Within ATLAS activities we have participated in the tests of the ALTIROC ASIC. Namely, the laboratory played a key role in the irradiation tests for the radiation hardness qualification of the new version (v3). The development of auxiliary systems for the ATLAS upgrade continued with contributions given in the DCS and interlock for HGTD (that will also contribute to ITk). Contributions to the design of the HV filtering system for HGTD was also done. These activities were done in close cooperation with the ATLAS group.

The laboratory has also been giving support for the different LIP groups. Mainly through consulting or design reviewing, or in the development of small electronics projects. Support to new students at LIP developing electronics has also been an important activity of the laboratory.

We have also started activities in the instrumentation of detectors for medical physics, interacting with the group doing Orthogonal Ray Imaging.

Lines of work and objectives for next year

We expect to have the setup in Argentina running smoothly, reaching a mature level. We will continue to give support for the operation and possible upgrades to the system. We expect some upgrades to be done in the Gianni Navarra hodoscope setup to enable measurements of different areas of the tank and upgraded detectors. We also foresee the introduction in the DAQ system of novel detectors for testing. In Peter Mazur we have a prototype installation that has a special configuration allowing the measurement of efficiency of the RPCs. Depending on the strategy of the Auger group and funding availability we might need to upgrade the station or install a second station. We also plan on working for setups using RPCs in which the MAROC solution is desirable.

Within the ATLAS activities we plan to conclude the design and testing of boards being developed. We also foresee to take care of final review and production of systems suck as the Transfer Module for the Interlock system of HGTD and ITk. We plan to continue the tests with the ALTIROC chip and would desire to start working also with Hybrid modes and their testing. We will also hopefully participate in the qualification tests of the ALTIROC version A. Activities giving support to systems being developed within the ATLAS group will be maintained.

We also plan to increase the support of the laboratory to the LIP community. Such support is expected to be given in consulting or through the development of small electronics projects. We will also continue the support to students working in electronics (Master and PhD). We also plan to give support to young students through internships and small electronics projects.

Finally we will pursue the instrumentation of medical devices taking advantage of the know-how present in the laboratory. We expect to be able to produce acquisition systems for SiPM sensors and also for Si based detectors.

Medium-term (3-5 years) prospects

The infrastructure plans to secure its acquired competence in the front-end DAQ and in digital electronics as well as in the system integration. The systems developed will be brought to a mature level and we will exploit the possible uses, seeking external and internal partnerships.

We will continue to pursue synergies with research groups at LIP to apply and develop the competences acquired and to support the activities whenever necessary. One of the main lines of development of the infrastructure is based on the capability to develop faster systems with better time resolutions and higher bandwidths. The collaboration with the ATLAS group will be reinforced with the test and developments on the front-end electronics for fast systems.

Another important area is the translation of the acquired knowledge and techniques to related fields, such as medical physics and the space radiation measurement.

SWOT Analysis

Strengths

The competences acquired in digital logic design as well as the competence in the design of complex electronic systems. Competence in handling several types of detectors such as RPCs, scintillators coupled to photomultipliers and Silicon Photomultipliers. Activities developed in the context of research projects. Capability to develop characterization systems. Possibility to plan and perform irradiation campaigns.

Weaknesses

Up to now it was not possible to attract direct financing for the development of detectors. In Portugal the typical level of funding is incompatible with the responsibility for full detectors.

Opportunities

The MARTA Engineering array gives the opportunity to lead the development of a medium size project from end-to-end. LATTES/SWGO poses a mid-term opportunity to consolidate activities. In the long term, ATLAS offer the opportunity to consolidate activities on fast and digital electronics. The radiation damage studies present the possibility to attract students and financing through the SpaceRad group. Training activities, courses lectured in e-CRLab and Master thesis developed in e-CRLab can allow to increase manpower in the laboratory and allow to pursue different projects. The know-how acquired in the laboratory can also boost the participation in novel projects related with fast timing and the development of instrumentation for medical physics. Publishing using small author list, including internal notes, could boost the visibility of the work developed.

Threats

Financing is always a key issue when developing hardware that needs to spend in service acquisition and materials. Lack of manpower could also be an issue in the mid-term.

2023 - LIP Detailed Report

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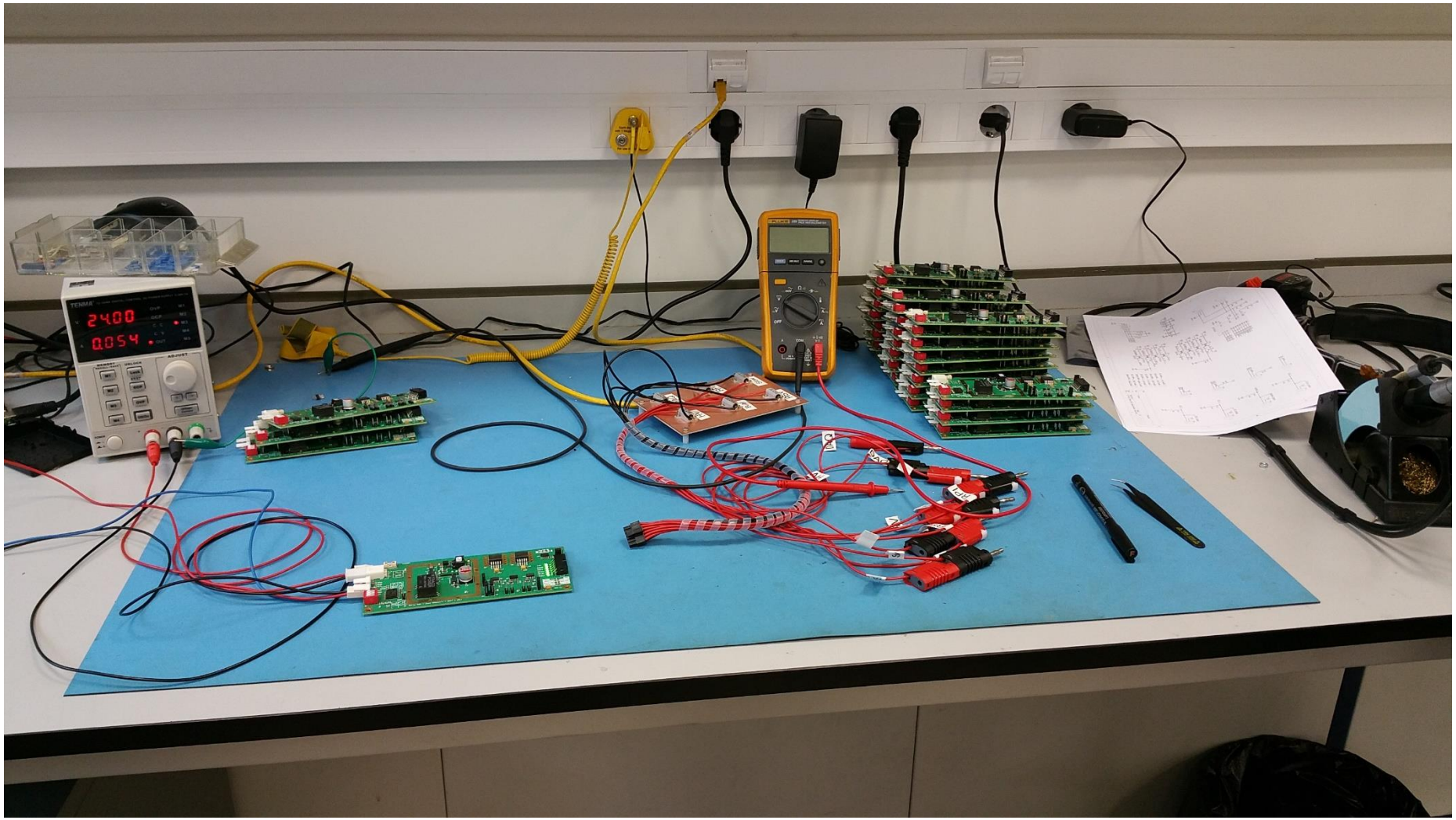
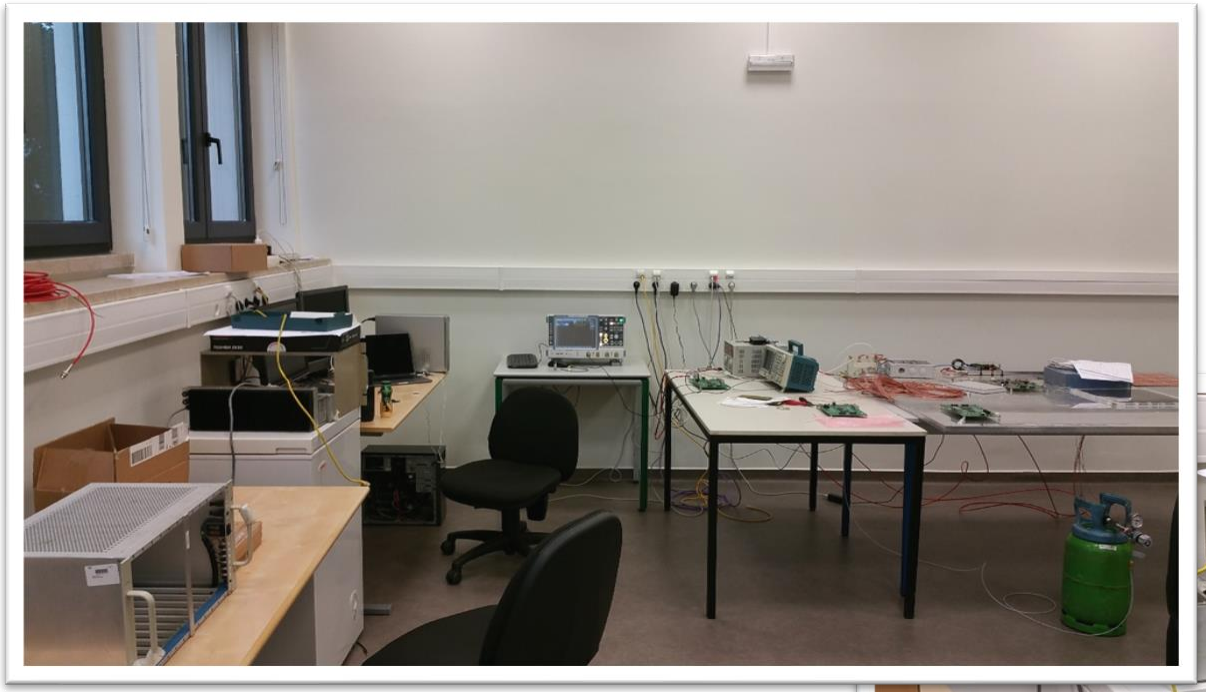


Office

electronics

Detector integration and testing



Detector prototyping workshop

Detector prototypes room