



GUILHERME PAULINO

**ENERGY-EFFICIENT READOUT SYSTEM FOR  
SEMICONDUCTOR RADIATION DETECTORS**

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**UNIVERSITY OF CAMPINAS**

Computing Institute

**GUILHERME PAULINO**

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SEMICONDUCTOR RADIATION DETECTORS**

PROJECT REPORT

Submitted in partial fulfillment of the requirements for the MO632 course in Energy-Efficient Computing, as a special student of the Masters program in Computer Science

**Adviser:**  
**Professor Dr. Lucas Wanner**

**Campinas-SP, Brazil**  
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## Abstract

Example text.

**Keywords:** Energy Efficient Design, FPGA Readout System, Medipix Collaboration.

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## Abbreviations

*ASIC* Application Specific Integrated Circuits

*CLI* Command-line Interface

*CSA* Charge Sensitive Amplifier

*DAC* Digital-to-Analog Converter

*OMR* Operation Mode Register

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# 1 Introduction

Example text.

## 1.1 Problem Contextualization

## 1.2 Literature Review

(...)

### 1.2.1 Medipix Collaboration

A complete and interesting review of the Medipix and Timepix ASICs is presented by Ballabriga et al. [2018]. In that review the design of the chips is explained in technical details and a number of other related chip developments are discussed.



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## 2 Objectives

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### 3 Methodology

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## 4 Results

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## 5 Conclusions

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## References

- R Ballabriga, J Alozy, G Blaj, M Campbell, M Fiederle, E Frojdh, E H M Heijne, X Llopart, M Pichotka, S Procz, L Tlustos, and W Wong. The Medipix3RX: A high resolution, zero dead-time pixel detector readout chip allowing spectroscopic imaging. *Journal of Instrumentation*, 8(2):C02016–C02016, feb 8 2013.
- Rafael Ballabriga. *The Design and Implementation in 0.13um CMOS of an Algorithm Permitting Spectroscopic Imaging with High Spatial Resolution for Hybrid Pixel Detectors*. PhD thesis, Universitat Ramon Llull, 2009.
- Rafael Ballabriga, Michael Campbell, and Xavier Llopart. Asic developments for radiation imaging applications: The medipix and timepix family. *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*, 878:10–23, 1 2018.
- Rafael Ballabriga, Michael Campbell, and Xavier Llopart. An introduction to the Medipix family ASICs. *Radiation Measurements*, 136:106271, 8 2020.
- Benedikt Bergmann. European Space Projects with Timepix based detectors. Technical report, 2019.
- P. Burian, P. Broulím, and B. Bergmann. Study of power consumption of timepix3 detector. *Journal of Instrumentation*, 14(1):C01001–C01001, jan 3 2019.
- M. Campbell, J. Alozy, R. Ballabriga, E. Frojdh, E. Heijne, X. Llopart, T. Poikela, L. Tlustos, P. Valerio, and W. Wong. Towards a new generation of pixel detector readout chips. *Journal of Instrumentation*, 11(1):C01007–C01007, jan 8 2016.
- Vladimir Gromov. Development of the Timepix4 chip. Technical report, 2021.
- M Kroupa, S Hoang, N Stoffle, P Soukup, J Jakubek, and L S Pinsky. Energy resolution and power consumption of Timepix detector for different detector settings and saturation of front-end electronics. *Journal of Instrumentation*, 9(5):C05008–C05008, may 7 2014.
- X. Llopart, J. Alozy, R. Ballabriga, M. Campbell, N. Egidos, J.M. Fernandez, E. Heijne, I. Kremastiotis, E. Santin, L. Tlustos, V. Sriskaran, and T. Poikela. Study of low power front-ends for hybrid pixel detectors with sub-ns time tagging. *Journal of Instrumentation*, 14(1):C01024–C01024, jan 28 2019.
- Xavier Llopart. *Design and characterization of 64K pixels chips working in single photon processing mode*. PhD thesis, Mid Sweden University, Sundsvall, 2007.
- Xavier Llopart. Library Characterization Techniques for 65nm and 130nm Technologies. Technical report, 2015.
- Paul O’Connor. Power dissipation tradeoffs in analog front end electronics for 2d detectors. Technical report, 2012.

---

Paul O'Connor. Future Trends in Microelectronics - Impact on Detector Readout. Technical report, 2006.

Paul O'Connor. Hot or Not? Power dissipation in analog front end electronics for 2d detectors. Technical report, 2008.

Lawrence Pinsky, T Campbell-Rickettsa, A Empla, S Georgea, L Tlustosa, D Tureceka, D Fryb, M Kroupab, R Riosb, E Semonesb, N Stoffleb, S Wheeler, C Kitamurac, and S Kodairac. An Update on Medipix in Space and Future Plans (Medipix 2 , 3 4). 2016.

V. Sriskaran, J. Alozy, R. Ballabriga, M. Campbell, N. Egidos, J.M. Fernandez-Tenllado, E. Heijne, I. Kremastiotis, A. Koukab, X. Llopart, J.M. Sallese, and L. Tlustos. New architecture for the analog front-end of Medipix4. *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*, 978:164412, 10 2020.