25TH INTERNATIONAL WORKSHOP ON RADIATION IMAGING DETECTORS

Low Power Design for Medipix Readout Systems

G. Paulino[a,b] **L. F. Wanner**[b] **P. H. Oliveira**[a] **R. K. Tartarotti**[a]

[a] *Pitec, Campinas - SP, Brazil*

[b] *Institute of Computing, Universidade Estadual de Campinas, Brazil*

E-mail: guilherme.paulino@pitec.co

ABSTRACT: Photon-counting hybrid pixel detector chips, such as those based on the Medipix3RX technology, have been central to advancements in spectral and multi-dimensional imaging at synchrotron facilities. As these facilities continue to enhance by undergoing upgrades, there is an escalating need for large-area cameras that not only handle increased X-ray flux performances but also integrate effectively into various scientific setups with minimal power consumption.

This research focuses on optimizing the energy efficiency of Medipix3RX readout chips. We have introduced several power optimization techniques, including dynamic frequency and voltage scaling, and the incorporation of standby/sleep modes into sensor operation. These methods have significantly reduced power consumption, thereby allowing for simplified cooling systems and enhanced durability without compromising the robustness and reliability of the system.

Experimental results demonstrate that applying dynamic voltage and frequency scaling can reduce power consumption by 5%, while clock gating technique can reduce up to 23% under typical operating conditions. Furthermore, the implementation of a sleep mode in periods of inactivity has shown potential to improve sensor temperature stability while reducing overall energy requirements by up to 40% compared to traditional continuous operation. A detailed characterization of the internal parameters of the Medipix3RX analog front-end has enabled us to identify optimal operating points that balance low power consumption with high performance, crucial for maintaining low noise levels and fast count rates in challenging experimental environments.

KEYWORDS: Front-end electronics for detector readout; Large detector-systems performance.