

# Pyxis™ Photon-Counting CT Detection Platform

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Simplifying the Integration of Photon-Counting Computed Tomography

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Authors: Josh Star-Lack, PhD; and Varex Imaging Photon Counting CT Development Team

## Executive Summary

Photon-counting CT (PCCT) provides intrinsic spectral imaging, higher spatial resolution, and improved dose efficiency compared with energy-integrating detector CT [1-5]. Achieving diagnostic-grade PCCT requires tight control of detector linearity, spectral fidelity, and count-rate performance to limit distortion from charge sharing and pulse pileup [1,4,6,7]. The Pyxis™ platform integrates detector hardware and real-time corrections into a unified architecture, enabling OEMs to reduce system integration complexity and accelerate time to market (TTM).

## Detector Architecture

The Pyxis platform is based on modular photon-counting detector units that can be tailored to customer requirements. Each unit consists of square hybrids with  $128 \times 128$  pixels at a  $150 \mu\text{m}$  pitch. Detector modules integrate multiple such hybrids comprising photon-counting ASICs coupled to direct-conversion sensor materials such as CdTe or CZT, which are commonly used in spectral photon-counting detector designs [1,4,8]. The Pyxis detector units support acquisition into up to six independent energy thresholds (bins) per pixel, enabling multi-energy acquisition with spectral separation. Maximum frame rates reach up to 10,000 frames per second, with minimum dead times in the 20–50 ns range. Detector modules can be arranged in an arc to form complete CT detectors and operate from a common 24 V power interface with integrated thermal management.

## Signal Processing and ASIC-Level Performance

The ASIC architecture incorporates per-pixel counting with integrated charge-sharing correction. Charge-sharing correction is important for reducing spectral distortion at the detector level in photon-counting detectors [6,7,11]. The system supports high count-rate operation, exceeding  $7 \times 10^8$  photons/ $\text{mm}^2/\text{s}$  under certain operating conditions. Detector linearity after correction remains within 99.5%, supporting accurate quantitative imaging. Improved spectral performance with charge-sharing correction is consistent with key diagnostic requirements for PCCT [6,7,11].

## Software Correction Pipeline (CST)

Image quality is stabilized through a real-time correction pipeline implemented in Varex's proprietary Software Tools (CST). Correction stages include multi-material pile-up compensation, gain correction, mitigation of artifacts associated with CdTe defects, tile-edge discontinuity correction, drift compensation, and bad-pixel inpainting. More broadly, these correction approaches are relevant in photon-counting CT because detector non-idealities and spectral distortions can affect image quality and material decomposition accuracy [6,7,12-14]. Calibration parameters are stored in standardized CalBundle datasets, enabling reproducible and auditable deployment across systems. Processing throughput reaches approximately  $5 \times 10^8$  pixels per second on CPU-based systems.

## Detector Performance

Tabletop system characterization demonstrates strong detector performance. Background noise is reduced following correction, while spectral decomposition accuracy is improved through a more stable threshold response. Hounsfield unit (HU) accuracy is preserved, with improved peak separation for soft tissue and bone structures. These results are consistent with the broader diagnostic potential reported for PCCT imaging [2-5].

## Scalability and System Integration

The Pyxis platform is designed for scalable detector assembly, enabling adaptation from limited field-of-view systems to full-body CT configurations. FPGA-based control allows dynamic adjustment of acquisition parameters, including frame rate, pixel binning, and energy-bin configuration. The API-driven software architecture supports integration into OEM reconstruction pipelines on Linux or Windows environments with minimal customization.

## Technical Differentiation

Key technical differentiators include integrated ASIC-level spectral corrections, real-time multi-stage calibration pipelines, support for direct-conversion sensor materials such as CdTe and CZT, and high-throughput data processing. More broadly, the development of photon-counting CT depends on the combined optimization of detector materials, spectral correction, and calibration workflows [1,4,6-8]. Unlike discrete detector approaches, Pyxis delivers a system-level solution that combines detector physics, signal correction, and calibrated output data streams.

## Conclusion

The Pyxis™ Photon-Counting CT Detection Platform provides a technically validated, high-performance detection solution for next-generation CT systems. By integrating high-speed photon-counting hardware with real-time correction algorithms, the platform enables

reliable spectral imaging and reduces OEM development risk, accelerating the deployment of clinical PCCT systems.

## References

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