Photon-Counting CT: Unlocking New Opportunities in Diagnostic Imaging

Peter B. Noël[1]

[1]Department of Radiology, University of Pennsylvania, Philadelphia, PA, USA

Photon-counting computed tomography (PCCT) is emerging as a disruptive innovation in diagnostic radiology, promising to reshape clinical workflows and improve diagnostic accuracy across multiple specialties — with oncology standing at the forefront. Unlike conventional energy-integrating detectors (EIDs), photon-counting detectors (PCDs) measure individual X-ray photons and capture their energy information directly, enabling multi-energy imaging with higher signal fidelity and without the need for dual-source or dual-layer architectures. This fundamental shift in detector technology unlocks a suite of performance enhancements, including increased spatial resolution, reduced electronic noise, improved contrast-to-noise ratios, and intrinsic spectral (energy-resolved) imaging.

In oncological imaging, where precise tissue characterization, early lesion detection, and reliable monitoring of therapeutic response are essential, PCCT provides several compelling advantages. High-resolution imaging at lower radiation doses facilitates earlier detection of small lesions, particularly in challenging regions such as the pancreas, and liver. Spectral decomposition capabilities enable differentiation between soft tissues and improved quantification of contrast agents, enhancing tumor conspicuity and enabling novel imaging biomarkers. Furthermore, PCCT allows simultaneous imaging of multiple contrast agents, opening new avenues for functional and molecular imaging within the framework of traditional CT workflows.

This presentation will delve into the principles and technical architecture of photon-counting detectors. Clinical case studies and early trial results will be presented to illustrate real-world applications. By addressing long-standing trade-offs between spatial resolution, dose, and tissue specificity, PCCT redefines what is possible with CT imaging.