Next-Generation CT: Innovations from Photon-Counting CT

Marc Kachelrieß

Division of X-Ray Imaging and CT (E025)
German Cancer Research Center (DKFZ)

Summary

Conventional CT systems are equipped with indirectly converting detectors where an x-ray photon interacts with a scintillator material where its energy is converted into visible light photons which, in turn, interact with a photo diode that produces a current proportional to the number of visible light photons. Such detectors are thus also called energy integrating detectors. The sensor material typically is GOS in clinical CT and CsI or GOS in flat detector systems. Just recently, direct converting detectors have been introduced into clinical CT. These photon-counting detectors directly convert the x-ray photon energy into an electric signal. They do so using a semiconductor material as the sensor layer. Typically, the sensor material is CdTe or CZT. The signal charge is proportional to the photon energy and the signal duration is short enough to be able to count single photons. Moreover, each detector pixel is equipped with more than one comparator and thus allows to distinguish between photons of different energies. Thus, spectral information, similar to dual energy CT, is routinely acquired and can be used retrospectively on demand.

This short lecture provides some technical overview of photon counting detectors and then describes the many advantages of such systems: better dose efficiency, higher spatial resolution, spectral information, small pixel effect, iodine effect, etc. The lecture reports on measurements with the first whole-body photon counting CT prototype (Somatom CounT, Siemens, Healthineers) system and with the first clinical photon counting CT system (Naeotom Alpha, Siemens Healthineers), which is a dual source CT system. Comparisons to conventional energy-integrating CT are provided, wherever possible.