WHO WE ARE



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ChestRad

Chest Imaging Specialists



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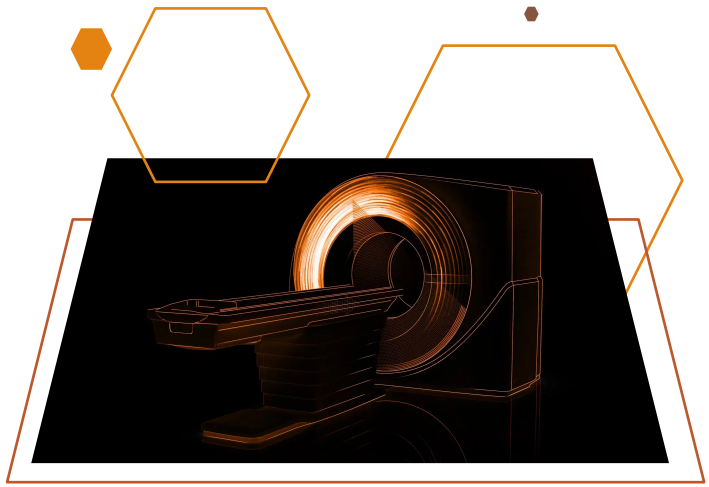
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THE FUTURE OF MEDICAL IMAGING



"In the future, every CT will be a photon-counting CT"

Prof. Gabriel Krestin
Erasmus Medical Center Rotterdam, Netherlands



"This will redefine our clinical decision-making right from scan one."

Prof. Dr. med. Thomas Kröncke
University Hospital Augsburg, Germany



"PCD-CT is so exciting because it provides information that existing CT detectors - the types that we've used for over 50 years - previously just couldn't capture."

Dr. Cynthia McCollough
Mayo Clinic CT Clinical Innovation Center. USA

THE STORY OF THE BREAKTHROUGH

Theorised for decades Photon Counting CT was finally made possible by the technology for an exotic new detector system required to unlock secrets of the universe such as the presence of the Higg's Boson (aka the "God Particle") at the Large Hadron Collider at CERN. To capture and discern the vast stream of photons in the Collider a detector 'refresh' rate of a few nanoseconds was required - and this could also be applied to the millions of X-rays per second passing through a patient in a CT machine. In doing so the analogue to digital conversion process of CT, unchanged since the invention of CT in 1972, was eliminated and therefore the number of X-rays required to create an image was at least 50% less. In addition, the energy of every single X-ray is registerable, instead of the average of clumps of thousands of X-rays of different energies, so the resulting image is a truer and more useful representation of the tissues underneath – this so-called Spectral capability improves visualisation and diagnosis of disease processes. In addition, Spectral capability means that scans that would normally require two or three runs through the body to see how tissues react to injected dye now only require one run – that's two thirds less radiation (plus the potential *further* 50% or more less radiation on top of that).

It is for these reasons PC CT is considered the greatest leap forward in CT since the invention of Multi-slice CT 25 years ago, and by some the greatest advancement since the first CT machine in 1972.

MASSIVE COMPUTING POWER

It is one thing to register each of the millions of X-rays in mere nanoseconds. Just as miraculous is the ability to cope with the tsunami of data flowing from the detector - around 50GB per second – and make that computer affordable to health institutions. This final hurdle has held back photon counting CT for 10 years and as recently as 3 years ago it took computers days to reconstruct the scan images. Photon CT is equipped with massively powerful computing, including over 7 terabytes of RAM (a high-end gaming computer has around 64GB of RAM). This vast processing power allows the computer to take in and reconstruct images within a clinically useful time period, no more than a minute.

INTRODUCTION

How did such a machine end up in Australia's smallest radiology practice?

In March 2024 ChestRad became the second site in Australia to install the most expensive CT machine in history (the other being a large research institution in South Australia). Costing millions of dollars more than conventional CT machines this was not a small matter. ChestRad chose to challenge the guiding ALARA (as low as reasonably achievable) principle of medical radiation and set itself for As Low As *Possibly* Achievable. But to be possible we relied entirely on our referring doctors. We have been strongly supported over the years by discerning general practitioners and specialists who value not only diagnostic expertise but application of the latest science. And to these referrers we dedicate the machine.

(*this has been achieved for machines using Cadmium Telluride detectors though not for less expensive elements)

"Photon Counting CT is like a sunscreen for your internal organs. And as a bonus the images it's like going from analogue to 4k TV – it's really incredible."



CONVENTIONAL CT: THE PROBLEMS

RADIATION DOSES

CT scans - CT scans create images by producing a stream of X-rays that are directed through the body. The X-rays are absorbed differently by different types of tissue and different pathologies – that's how CT shows the difference between healthy and diseased organs. While the radiation doses used by CT scan machines are generally low they are not negligible. Research has shown that a single head CT scan in a younger patient increases their cancer risk by 25% above their natural background risk. Thankfully for older patients the risk is smaller as the cells divide less frequently and are therefore less susceptible to radiation damage. Still, the sheer number of CT scans (over 50,000 per year in Western Australia) is why CT is the greatest source of modifiable radiation risk in the developed world. The invention of Photon Counting CT will undoubtedly save lives.

IMAGE QUALITY

MISSING SMALL THINGS: here are highly important structures, such as the smaller coronary arteries, such as the smaller coronary arteries and the air sacs of the lung, that are tantalisingly out of reach for conventional CT. These structures are best visualised with a resolution of 0.1mm or less and conventional CT is only reliable down to around 0.5mm.

MISSING INFORMATION: CT is more effective at discriminating between tissue types than plain X-rays but not as effective as it could be. The X-rays that hit the detector are of differing energies (kilovolts) and if the energy of each X-ray could be recorded this would tell more about the tissues they have passed through. But CT can't do that because there it has an inefficient analogue to digital conversion process and therefore it needs thousands of X-rays to create a single pixel and the energy recorded is the average of all those X-rays. To explain, first the X-rays hit a ceramic layer and light is created. Then the light is converted by a second layer to electrons which are then converted processed to digital signal. The amount of light that is created is proportionate to the number of X-rays that hit the detector but tells nothing about the energy of each X-ray. So some of the useful information about the underlying tissues cannot be measured.

BLING SPOTS

Some of the material that the X-rays hit are so dense they completely absorb and block the X-ray stream and everything within or adjacent to them is completely obscured. For example, if the coronary arteries contain a stent or a densely calcified atherosclerotic plaque it can be impossible to tell whether that portion of the artery is flowing or blocked. This is a common problem in coronary CT and leads to non-diagnostic scans and over-diagnosis of coronary blockages.

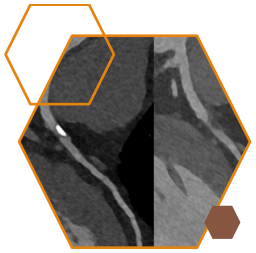
PHOTON-COUNTING CT: THE SOLUTIONS

VASTLY LOWER RADIATION



for a given image quality. Science is showing around 50% less radiation than the lowest dose CT machine currently on the market which is already much lower dose than the average machine.

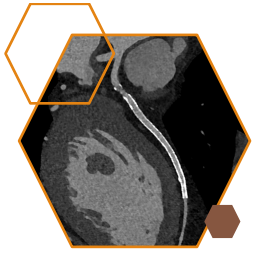
ULTRA-HIGH SPATIAL & PURE CONTRAST RESOLUTION



PCCT has an ultra-high spatial resolution mode, around 4x higher than standard CT machines. This makes a big difference for assessment of small structures like the coronary arteries and early developing lung cancers.

Pure contrast resolution or the ability to tell between different tissues in the body and difference disease processes, is also higher because of the ability to measure the energy of the X-rays hitting the detector.

ARTEFACT ELIMINATION



Seeing straight through impediments like metal and calcium. The unique 'spectral' and high-resolution capabilities of PCCT in combination eliminate most of the problems of artefact from calcium in the coronary arteries or the metal of coronary stents – this has already been shown to reduce unnecessary referrals from CT to invasive coronary angiograms by around 50%.