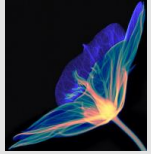


TIME-BASED COMPUTED TOMOGRAPHY - A POSSIBLE NEW APPROACH TO CT

M. Campbell[1,2], S. Huotari[3], M. Kalliokoski[2], L. Tlustos[1,4]

[1] CERN, [2] Helsinki Institute of Physics, [3] University of Helsinki, [4] IEAP CTU, Prague



Outline

- Inspiration and context
  - Nanovision development
  - First photon study by Saphörster et al.
  - Varex imaging MBX white paper
- Concept
- Status

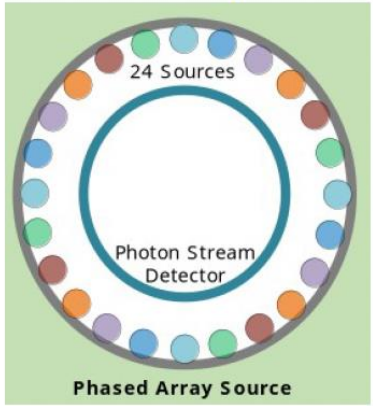
Fixed gantry CT

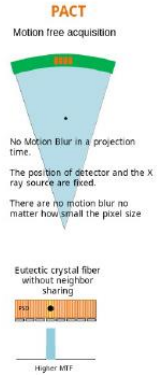


Vendor: Nanovision

Phased array CT – multiple sources *(steerable focal spots)*

No rotation blur
No spiral artefacts
No data transfer issues
Fewer cooling issues
Measure backscatter for recon
Adapt flux to required resolution





Solves many problems with rotating gantry

Hongguang Cao (Nanovision Medical Technology)

Nanovision fixed geometry CT

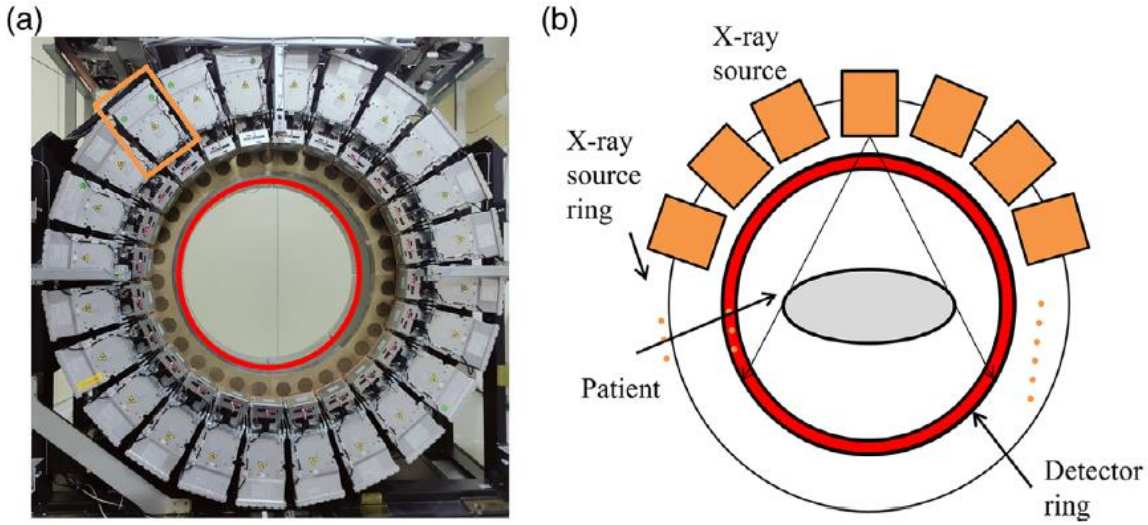
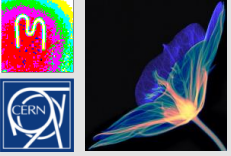


FIGURE 1 Photograph and schematic illustration of the static CT system. (a) Photograph of the static CT system; (b) Schematic diagram of the static CT system.

Ding et al. J Appl Clin Med Phys. 2026;27:e70456.



Key features of Nanovision system

- Fixed gantry setup – no (or very few moving) parts
- No need to send High Voltage signals over the slip ring
- Uses pulsed thermionic (conventional) sources
- KVp is also varied from shot to shot and/or source to source to permit spectroscopic imaging (70keV - 140keV) using integrating detectors
- Uses a ‘streaming detector’ but does not do photon counting readout

- They have built and are evaluating full clinical systems in China

It seems to work

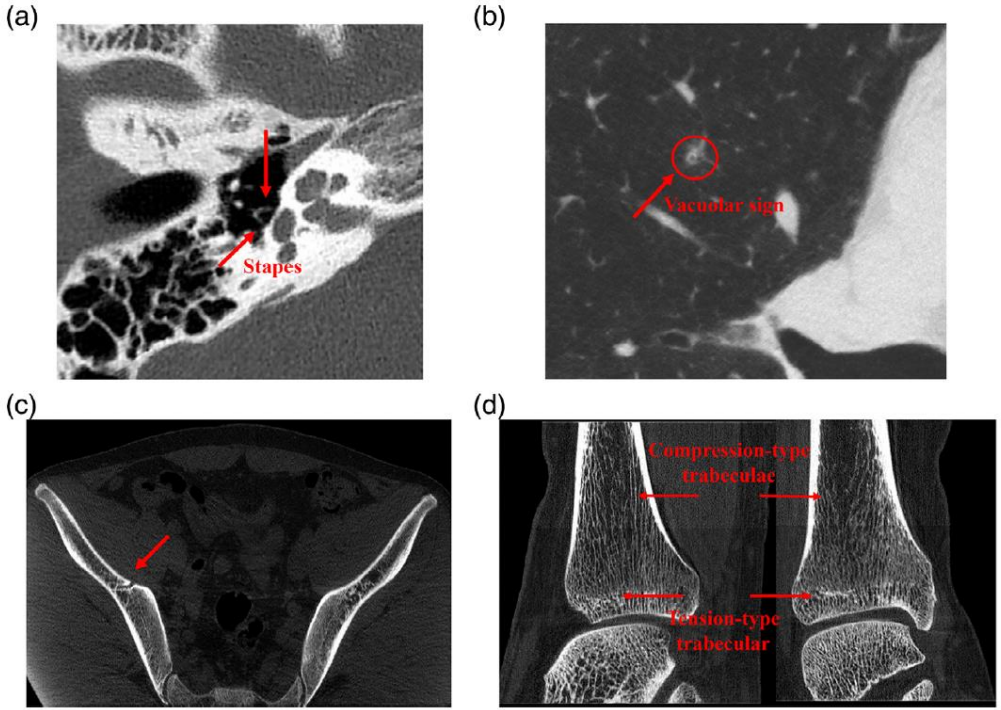


FIGURE 6 Clinical images. (a) Imaging of the stapes; (b) Pulmonary nodule; (c) Iliac bone microstructure; (d) Ankle joint trabecular bone.

Ding et al. J Appl Clin Med Phys. 2026;27:e70456.

Maike's work with Raj Gupta Group at MGH

First photon imaging using Timepix3

Maike Saphörster[1,2,3], Michael Campbell[1], Rajiv Gupta[4], Amar Gupta[4], Matthew Tivnan[4], Lukas Tlustos[1,5]

[1]EP Department CERN,1211 Geneva, Switzerland

[2]Department of Medical Physics in Radiation Oncology, German Cancer Research Center (DKFZ), Heidelberg, Germany

[3]Department of Physics and Astronomy, Heidelberg University, Heidelberg, Germany

[4]Department of Radiology, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts

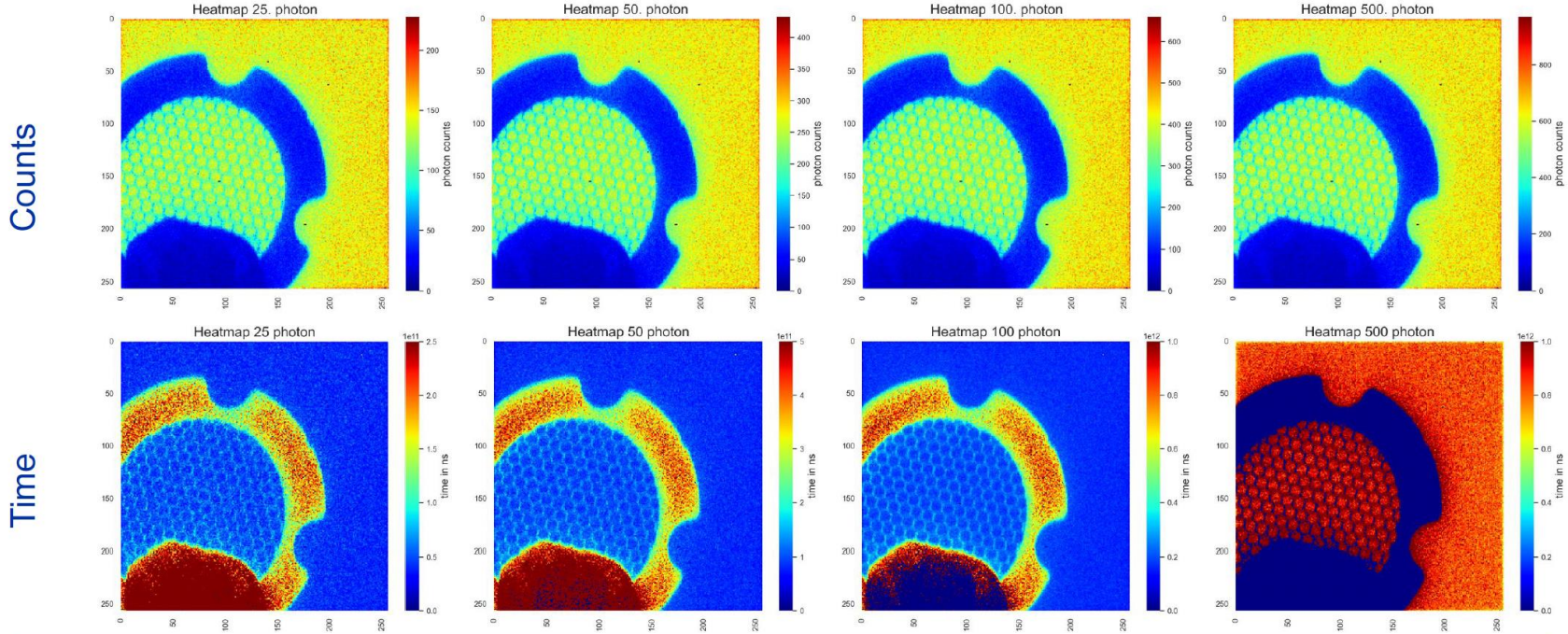
[5]Institute of Experimental and Applied Physics, Czech Technical University of Prague, Prague , Czech Republic

19 November 2025

Presentation by Maike Saphörster – November 2025 Medipix meeting

Counts versus Time

Counts image: data acquisition ‘stopped’ after last pixel reaches x-photons





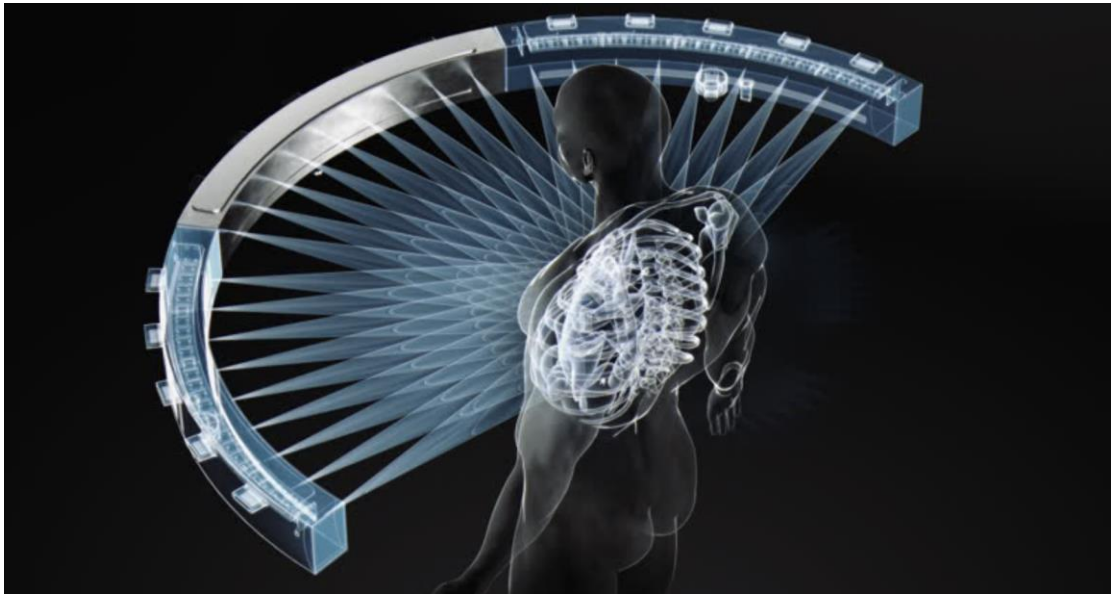
CNT X-ray tubes - Advantages and disadvantages

- Cold cathode – no DC current – low power
- Can be pulsed at high speed and frequency < μsec pulses
- Can be physically small

- Limited maximum current output
- A number of small-scale suppliers are active

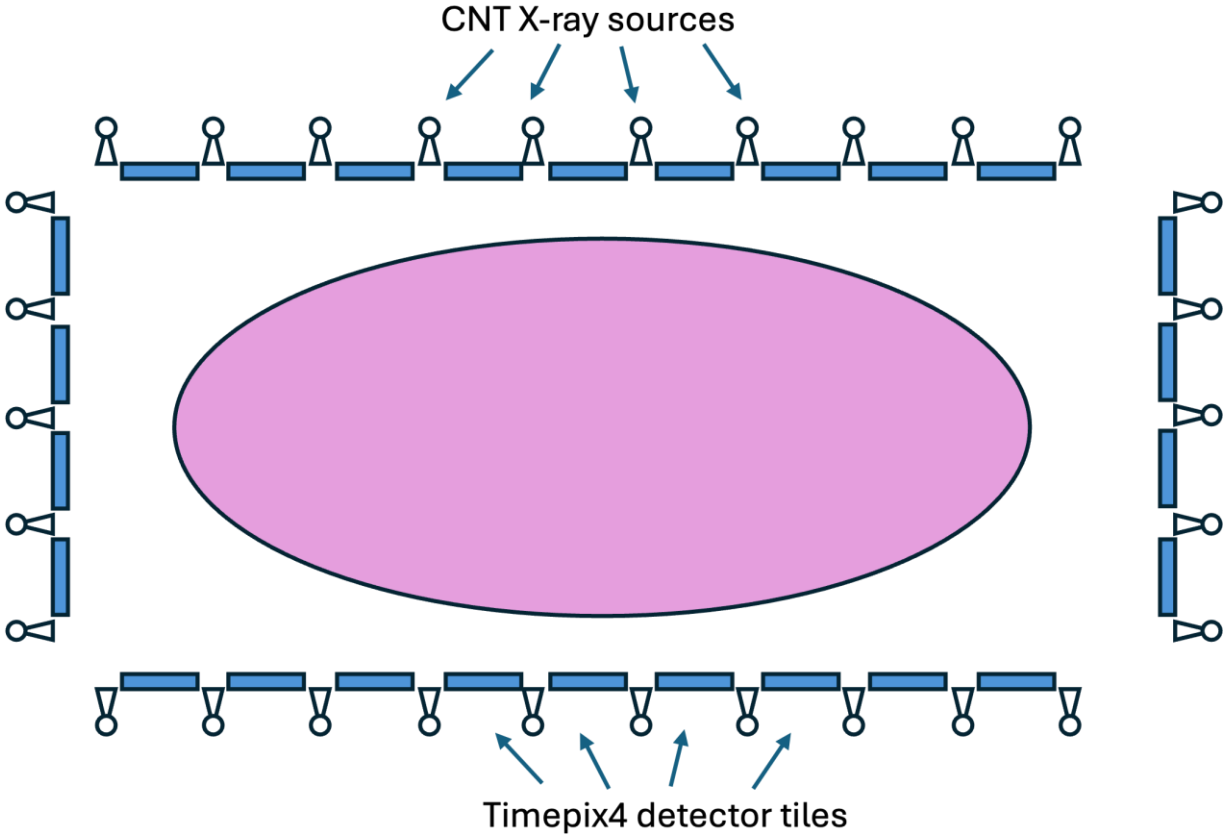
Varex Imaging white paper

REPLACING MECHANICAL MOTION IN X-RAY IMAGING:
VAREX MULTI-BEAM X-RAY (MBX) TECHNOLOGY
30 June 2026

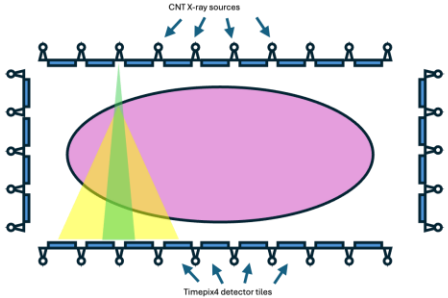


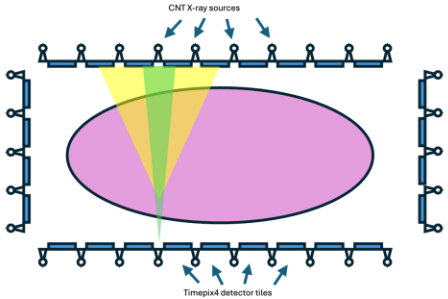
https://www.varexim aging.com/news/replacing-mechanical-motion-in-x-ray-imaging-varex-multi-beam-x-ray-mbx-technology/

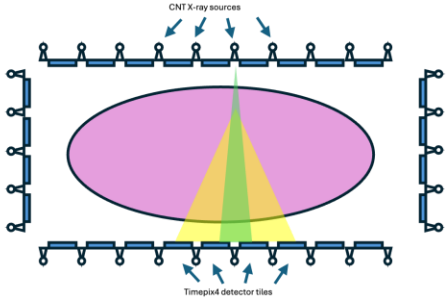
T-bCT concept

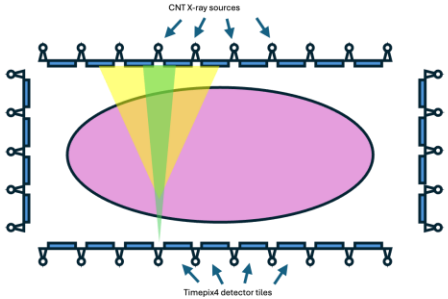


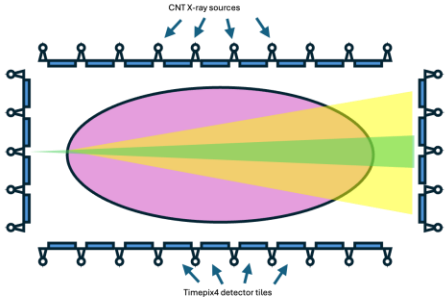
T-bCT concept

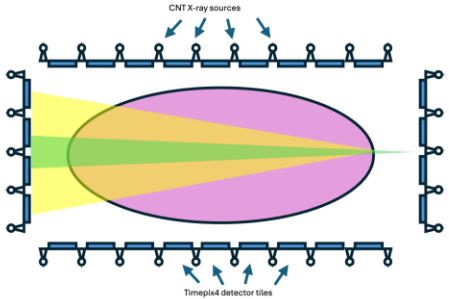


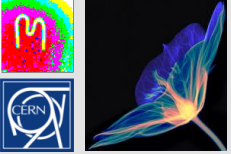






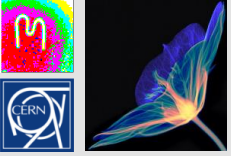






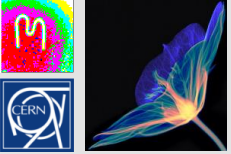
Potential benefits - technical

- For every photon arriving at the sensor as much information as possible is extracted: arrival time – which indicates source position, as well as deposited energy
- Where photon counting can be thought of as adding the energy dimension to x-ray CT, T-bCT adds another dimension, time
- Completely novel geometries can be envisaged
- Sub pixel resolution may even be possible offline
- No image blurring because of the rotating gantry
- Pile-up at the pixel level no longer becomes an issue improving spectral fidelity even in hot pixels
- Scattered and direct beam can be (mostly) well separated. Scattered radiation may be used in the reconstruction



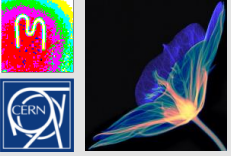
Potential benefits - clinical

- Possibility of very short frame times and/or super high-resolution images per projection
- Possible development of protocols adapted by patient and by organs to be imaged
- Precise perfusion imaging
- Pulse intensity can be modified on-the-fly for optimised dose
- Dose reduction due to more efficient use of photons
- Motion artefacts due to gantry movement eliminated



Potential drawbacks

- A large number of sources and detectors may be costly in the beginning
- How precisely in time can the sources be pulsed and at what uniformity for short pulses?
- How long will it take to accumulate enough statistics per pixel?
- Huge amounts of data will need to be processed, but perhaps ML/AI techniques could play a role



What they said about photon counting circa 2011

- Photon counting is impossible
  - Too difficult
  - Too expensive
  - There was even one publication demonstrating that it was pointless

- Even if it could be achieved technically it wouldn’t add any value diagnostically

Photon counting status in 2026

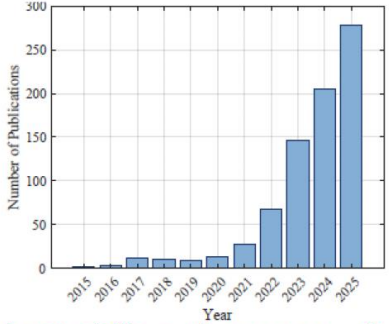
Over 3.5M patients have been scanned with the Siemens Naeotom Apha

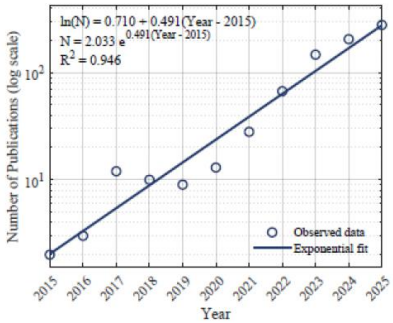


300,000,000 scans / year

PCCT publications over time

Guang-Hong Chen et.al.
To appear MedPhys, 2026





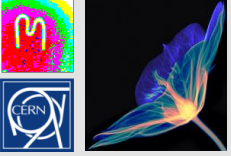
"You're just riding the wave..."

"... but I created the wave"

(wikiquote, attributed to Ernest Rutherford)

A. Butler, specxray workshop summary 2026

"The introduction of photon counting detectors to clinical practice will modify patient pathways in such a profound way that in my opinion the textbooks for radiologists may have to be rewritten" Quote from a senoir medical physicist



T-bCT status

- Current project plan – proof of principle
  - GEANT/Allpix/GATE (?) simulations
  - Reconstruction
  - Measurements with Timepix3

- If funding can be found
  - Selecting/procuring sources
  - Procuring detectors
  - Build single source detector prototype
  - Built small multi-detector source prototype

Thank you for your attention!



Medipix3RX images: S. Procz et al.