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Challenges and Opportunities with Photon Counting CT

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Challenges in CT Today

•Radiation dose

•Image quality
-radiologists will never get enough

Opportunities for Photon Counting CT

•May cut radiation dose
-replace remaining 2D imaging procedures
-help in lung cancer screening

•May enable material decomposition and quantitative imaging in for example perfusion studies.

•May save cost by enabling new imaging protocols replacing current more invasive and expensive methods

Challenges for photon counting CT

•High rates of x-rays (100 M/s/mm^2)
-counting is not enough, spectral information should not be distorted!

•Double-counting of x-rays
-more likely with smaller pixel size

•Cost of new instrumentation

Breast CT

Opportunities

•No compression
-increase screening attendance

•True 3D images
-may increase sensitivity and specificity

•Alternative to MR
-save cost and increase specificity

Breast CT

Challenges

•Clinical Acceptance
-screening workflow, reading of images etc

•Radiation dose
-need to be about the same as MLO+CC view today

•Missed tissue
-need to show you are not missing relevant tissue

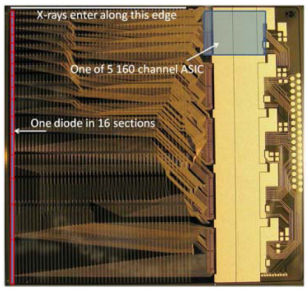
Our approach to photon counting CT

Research sponsored by

The Erling Persson
Family Foundation

H&M

Overview of Sensor Assembly (MCM)



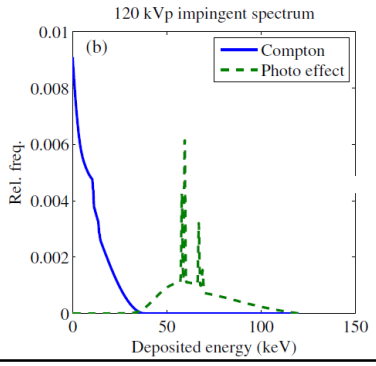
Detector element size: 0.4 × 0.5 mm²

Depth segmentation: 16 segments along incident direction

8 thresholds for each channel

Around 1500 MCMs will replace a current CT detector

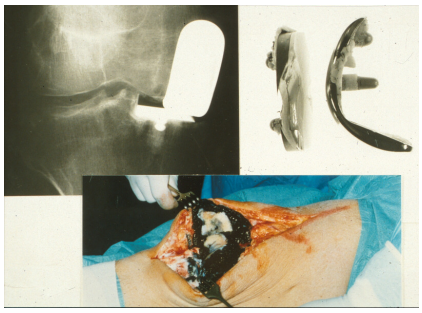
Simulated Spectrum of Deposited Energy



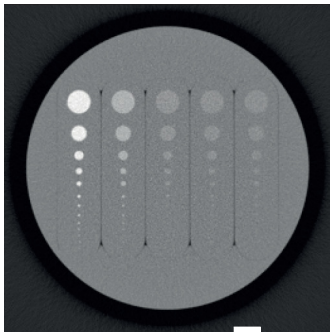
Prototype Image Example

Knee Replacements

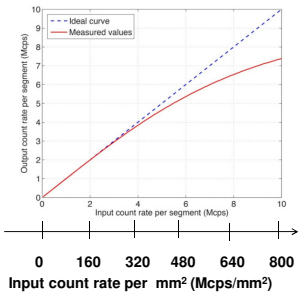
Image Courtesy of Dr L. Wiedenhielm, Karolinska



Prototype Image Example



ASIC Respons to Increasing X-ray Count Rate



0 160 320 480 640 800

Input count rate per mm² (Mcps/mm²)

- **120 kVp polychromatic x-rays**
- **Fits very well to non-paralyzable model with dead time of 27 ns**
- **Linear relationship holds up to 2.5 Mcps and segment**

Summary

Simulated baseline performance match current integrating detectors

0.4 x 0.5 mm^2 pixel size

ASIC evaluated to be close to design specification

Keep count rate linearity up to 220 Mcps/mm^2

Can keep energy information up to 150 Mcps/mm^2

Question:

How many percent of medical imaging detectors are photon counting 10 years from now?

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Answer:

90%