Detector R&D

Colour X-ray CT

Dec 2019

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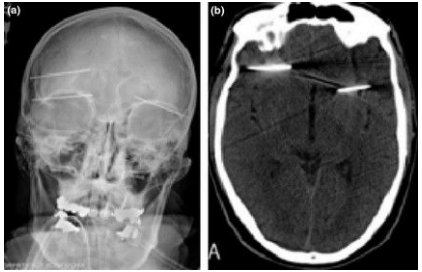
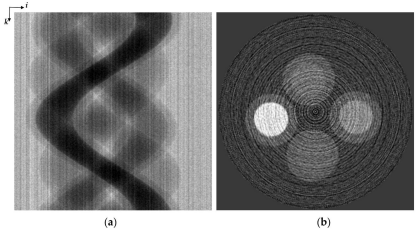
Using energy information in x-rays to:

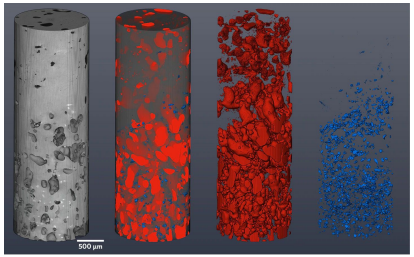
- Reduce beam hardening effects with a physical approach



- Reduce ring artefacts



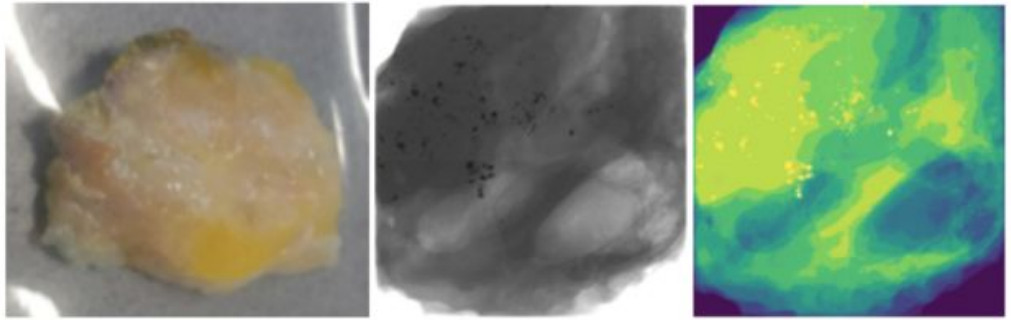
- Material segmentation



Make colour CT scans!

Breast tumour - NKI

Photo | ‘Standard’ x-ray | Clustering analysis

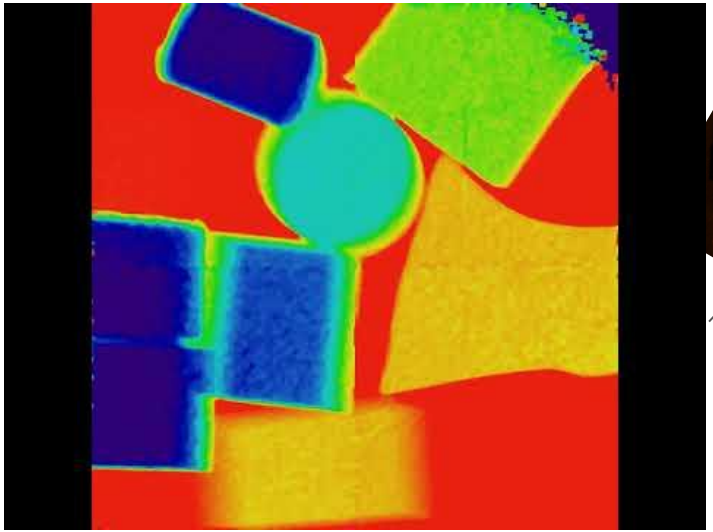


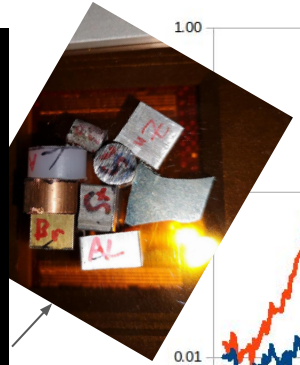
Breast tissue specimen (approximately 20x20 mm^2) imaged with the Medipix3 detector. Left image photograph of the specimen; Centre: a classic x-ray projection image (all energies are integrated); Right: the spectral image after an energy based reconstruction.

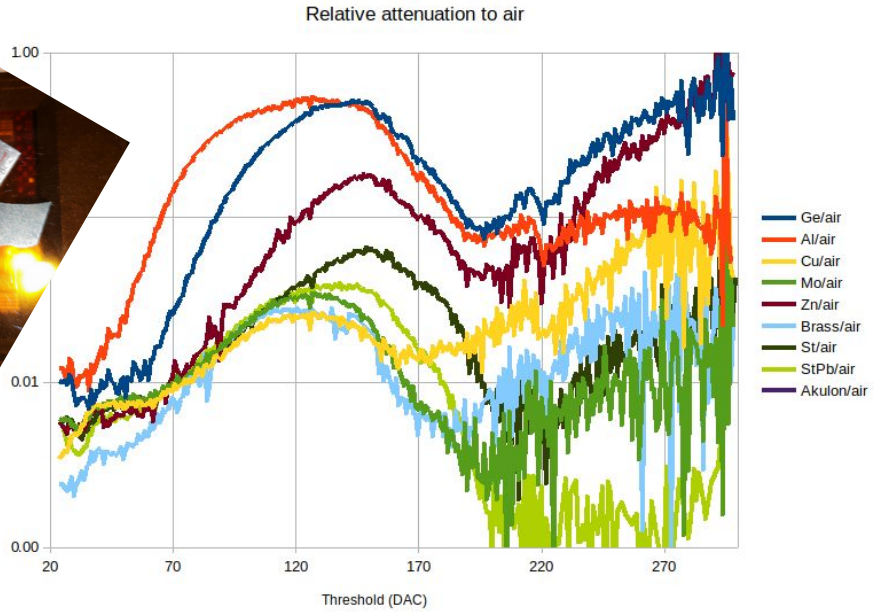
Materials segmented in this analysis into:

- Fat
- Microcalcifications
- Cancerous tumour
- Functional tissue
- Air

D R&D Colour x-ray CT - GaAs threshold scan 15 min







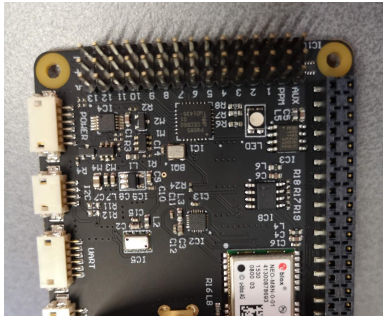
- Medipix3 CSM (Charge Summing Mode)
  - 5 generations of SPIDRs (readout systems)
  - We lost Robbert to Timepix3!
- 2 x 15 min measurements → 500 Mb, 500 files
- 1 afternoon of analysis (from scratch)

Every element has its own signature

x 100 faster measurements
x 50 analysis speed

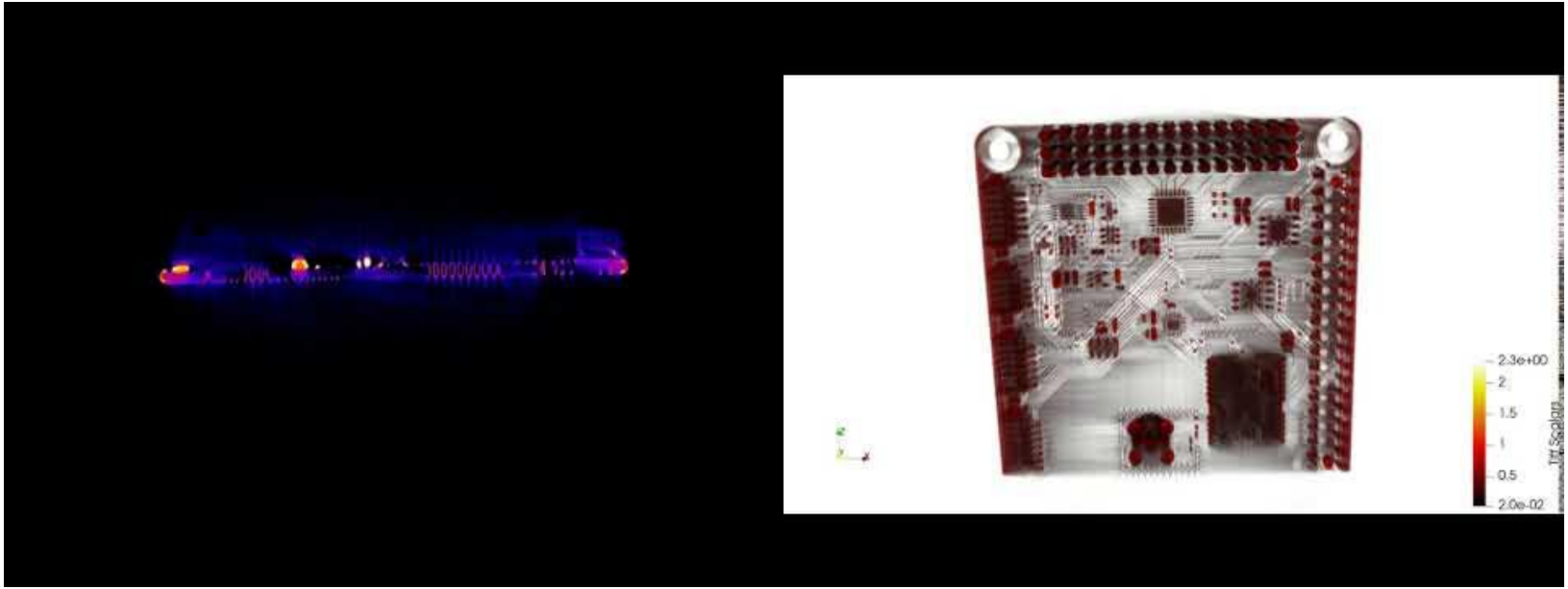
1/4096 data size
1/2000 fewer files

D R&D Colour x-ray CT - Circuit board x-ray CT reconstruction



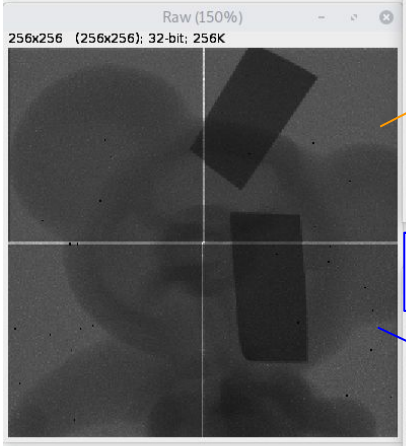
Axial view

Volume rendering
(same data as left)

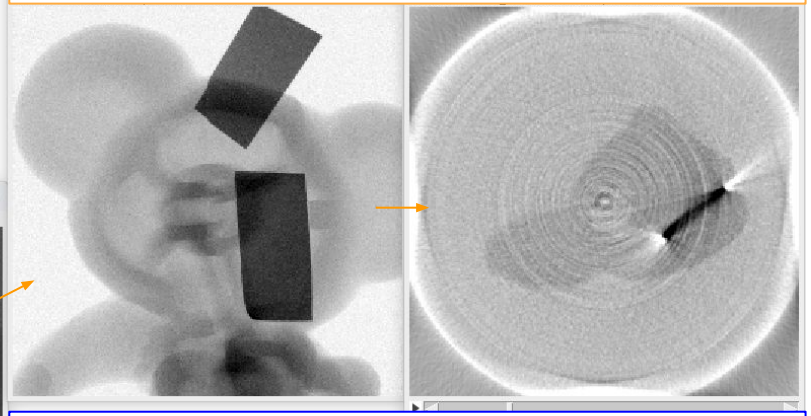


Backup slides

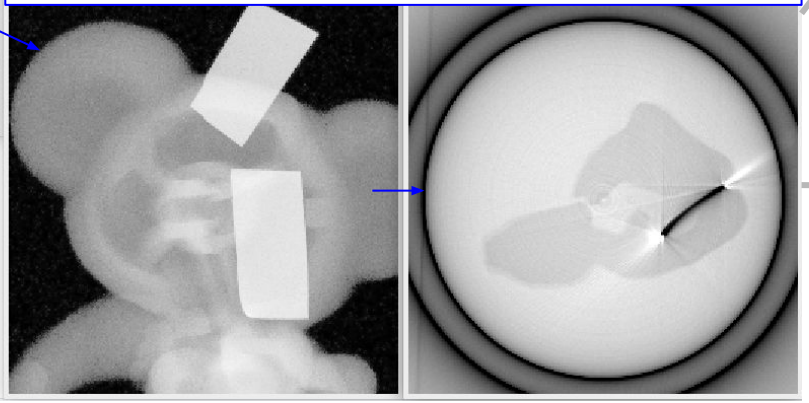
D R&D Colour x-ray CT - Example of reconstruction



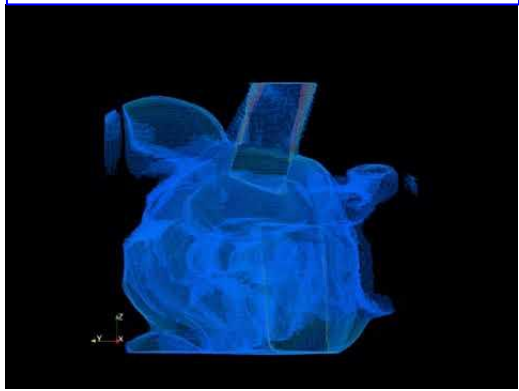
Flat field corrections

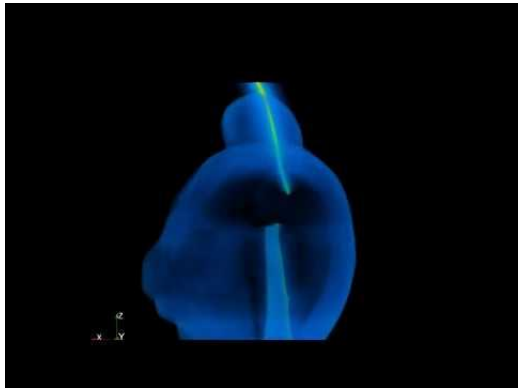


Beam hardening (BH) corrections



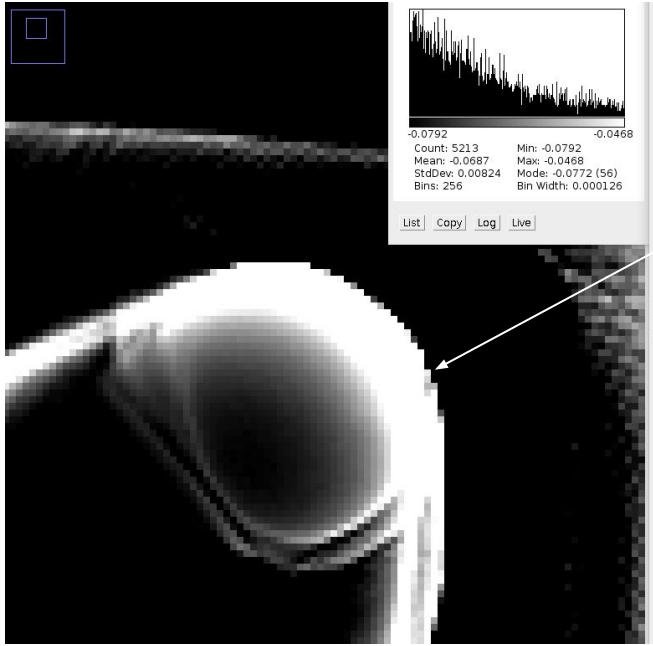
CT reconstructions



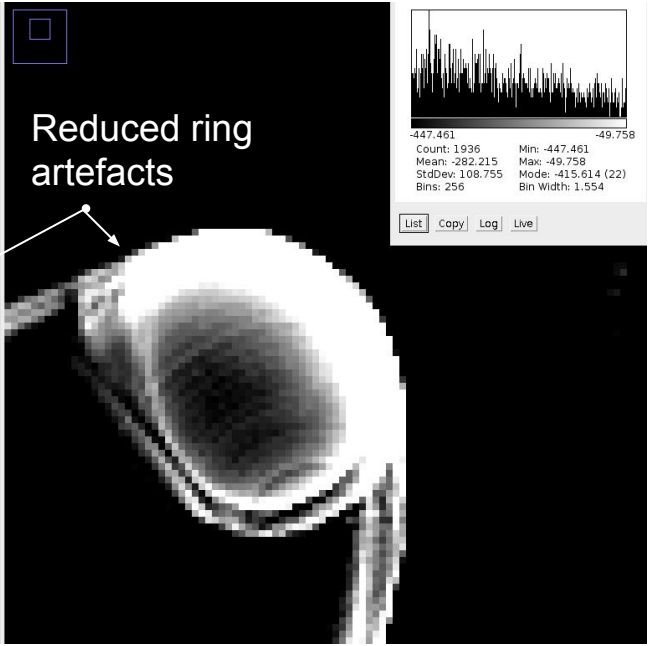


D R&D Colour x-ray CT - Threshold subtraction

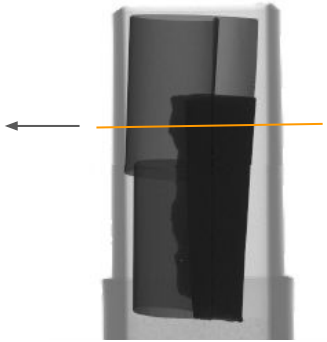
With subtraction



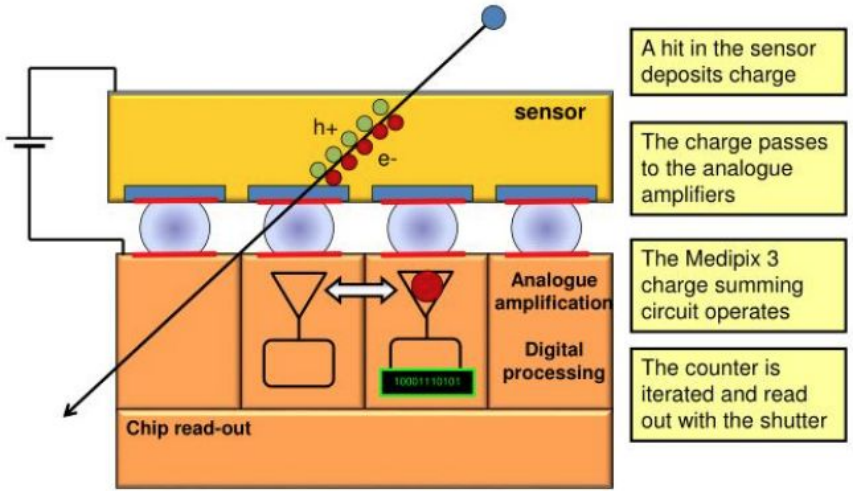
Without subtraction

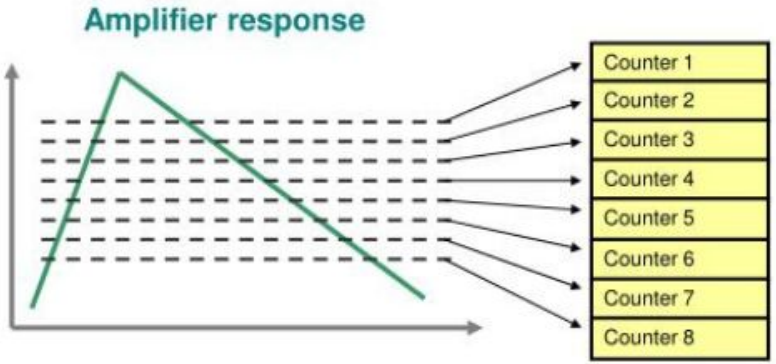


- Reduced beam hardening artefacts
- Better uniformity along the foil



Raw projection image


sensor
h+
e-
Analogue amplification
Digital processing
10001110101
Chip read-out
A hit in the sensor deposits charge
The charge passes to the analogue amplifiers
The Medipix 3 charge summing circuit operates
The counter is iterated and read out with the shutter


Amplifier response
Counter 1
Counter 2
Counter 3
Counter 4
Counter 5
Counter 6
Counter 7
Counter 8