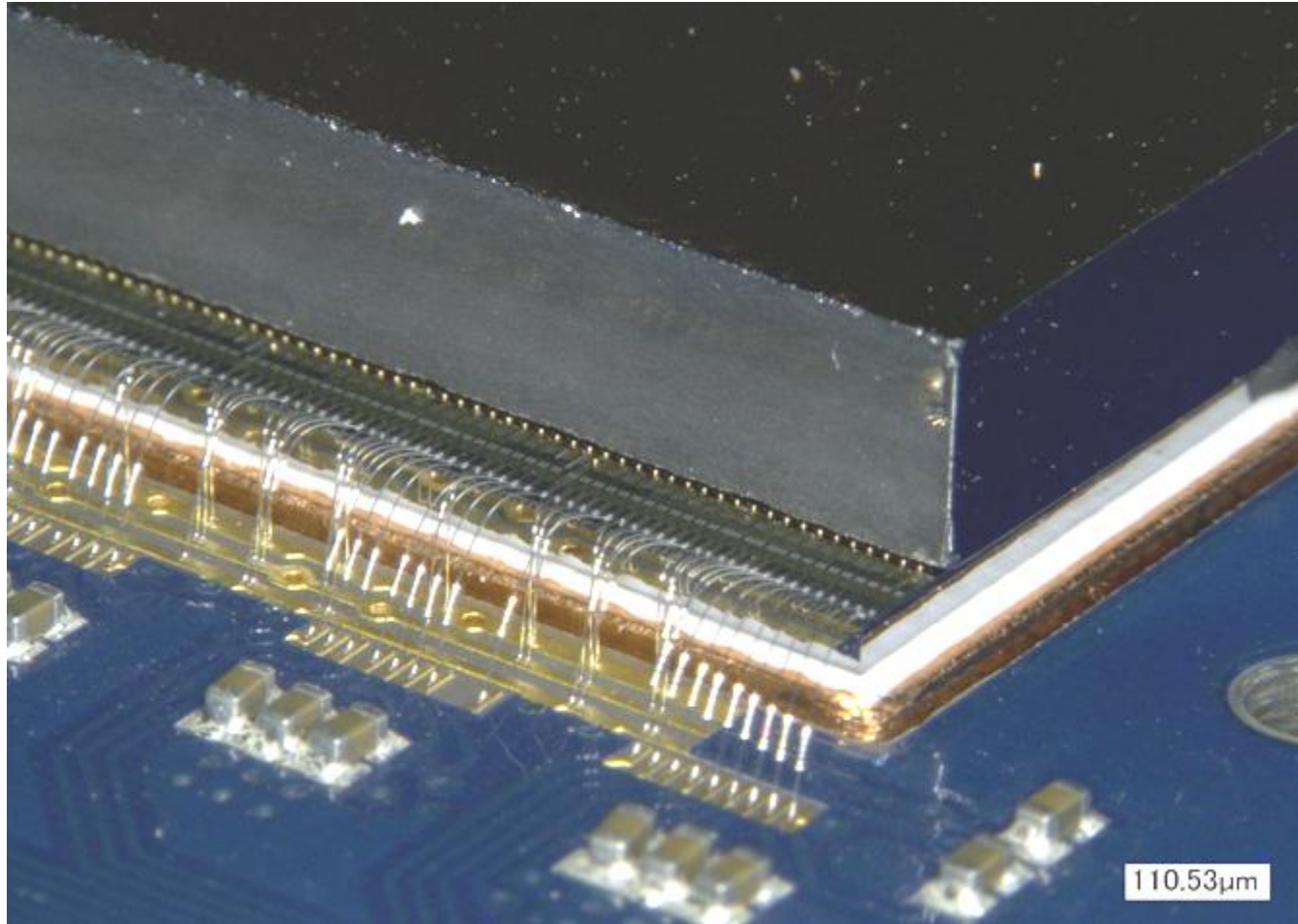


Pixellated CZT high-energy X-ray instrument

Paul Seller
RAL

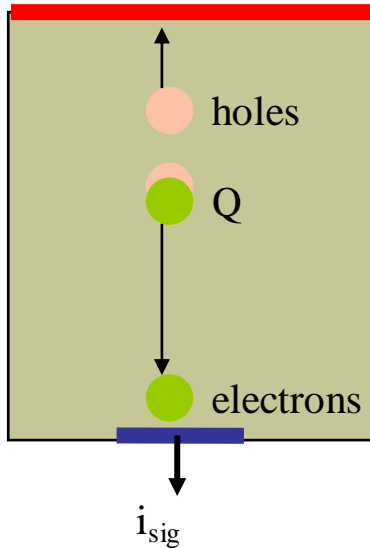
- Cd(Zn)Te X-ray detectors
- 80 x 80 pixel X-ray imaging system
- Results and applications
- Construction of larger area detectors

Cd(Zn)Te X-ray pixel detectors



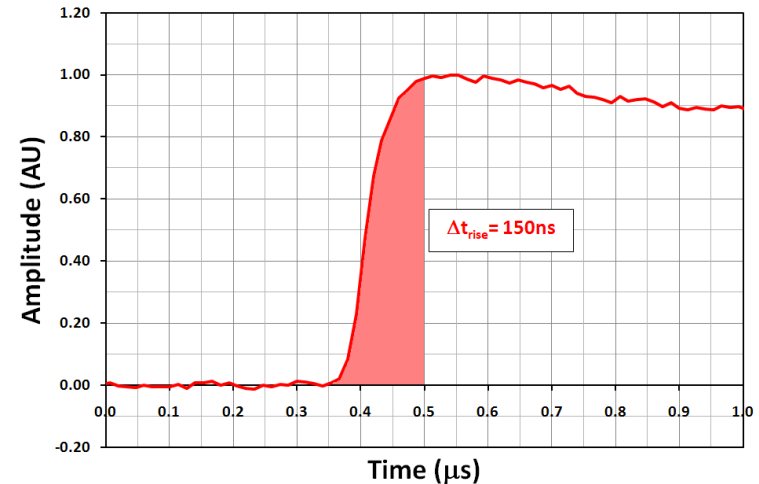
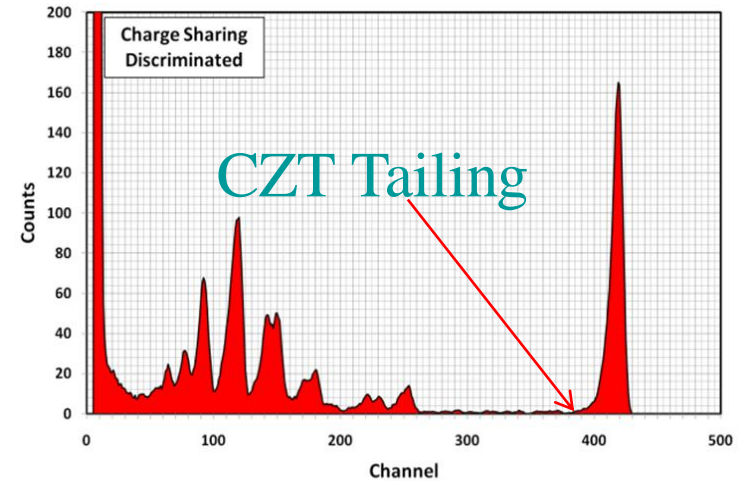
3mm CZT gold stud bonded to ASIC and wire bonded to CoB

Cd(Zn)Te detector limitations

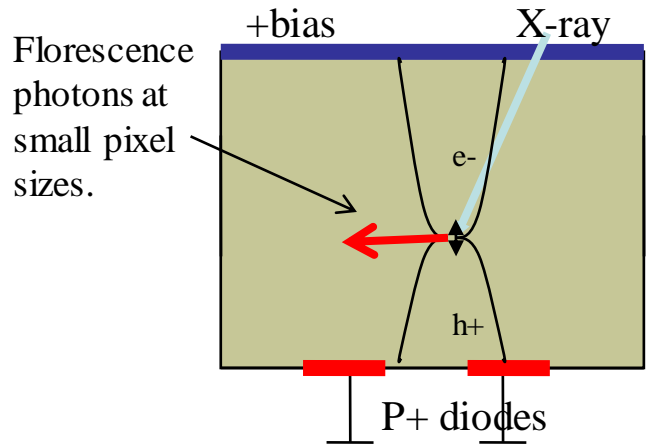


Charge carriers can be 'trapped' in the bulk. This depends on depth of interaction so we use: Small-Pixel-Effect.

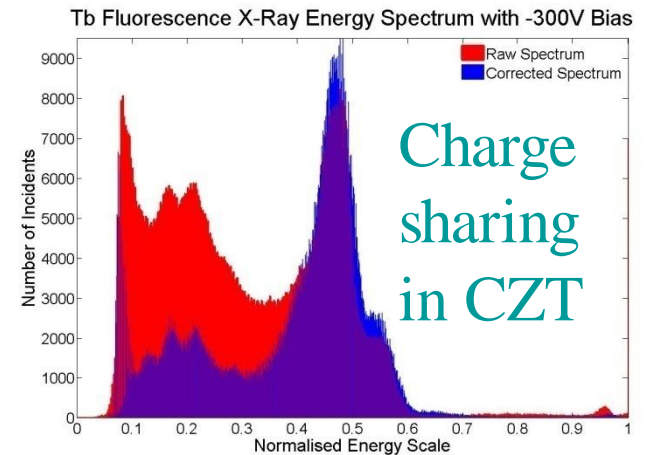
Carrier transit times typically can be 100-500ns in CZT
 Limits shaping time of the signal processing (no ballistic deficit).



Cd(Zn)Te detector limitations

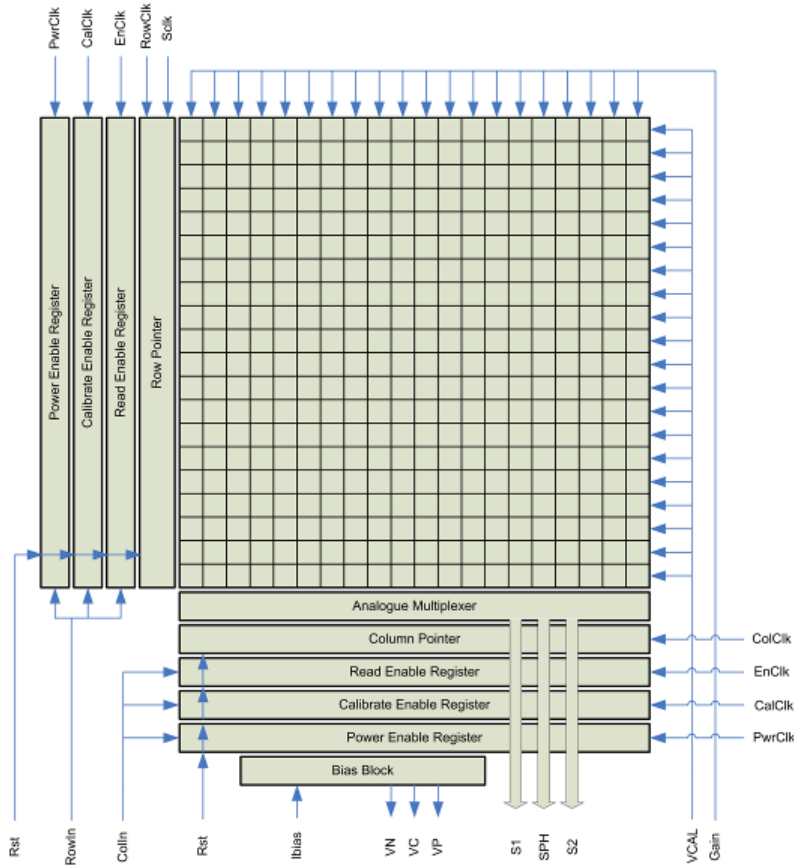


As q drifts in the electric field it also **diffuses** in all directions. This produces **Charge Sharing** between pixels and can give rise to 'tailing' or multiple hits in photon counting systems.



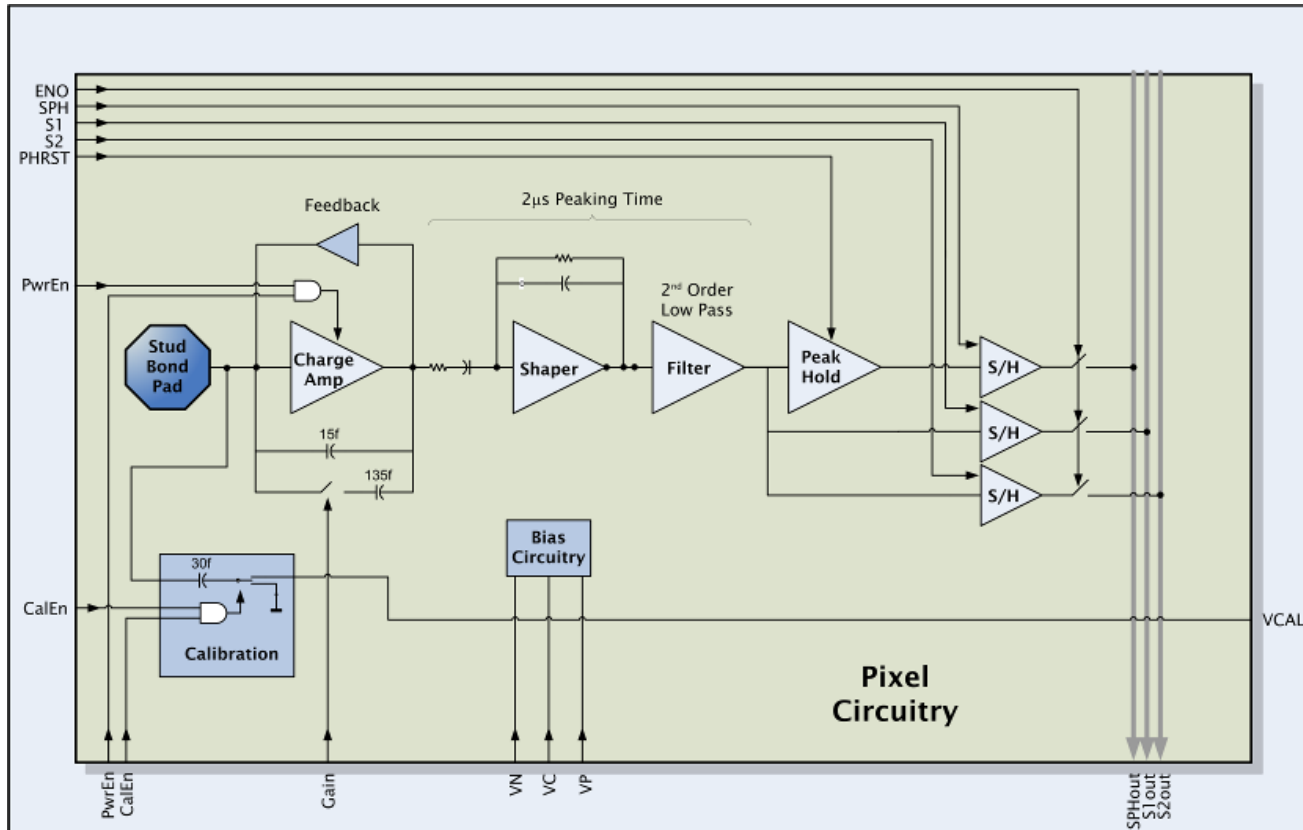
Small pixels require complex charge reconstruction algorithms to get good spectral and spatial resolution.

Cd(Zn)Te Spectroscopy ASIC



- ❑ 80x80 pixel arrays on one ASIC
- ❑ 250um x 250um pixels
- ❑ Rolling shutter type readout
- ❑ Analogue outputs
- ❑ Range 5keV-200keV
- ❑ AMS 0.35um CMOS

Cd(Zn)Te Spectroscopy ASIC Pixel



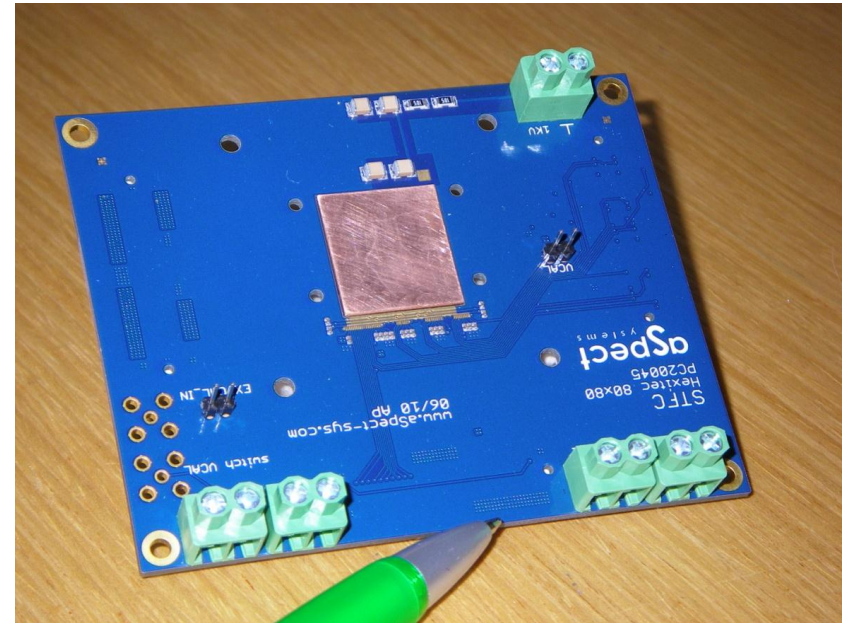
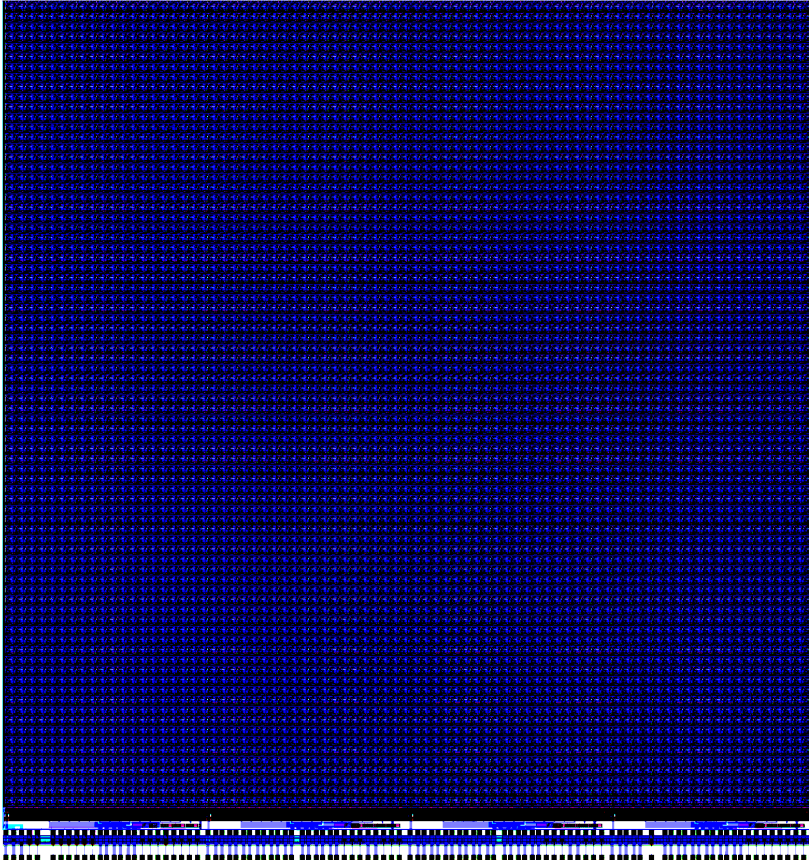


80 x 80 pixel ASIC and Readout Card with copper insert

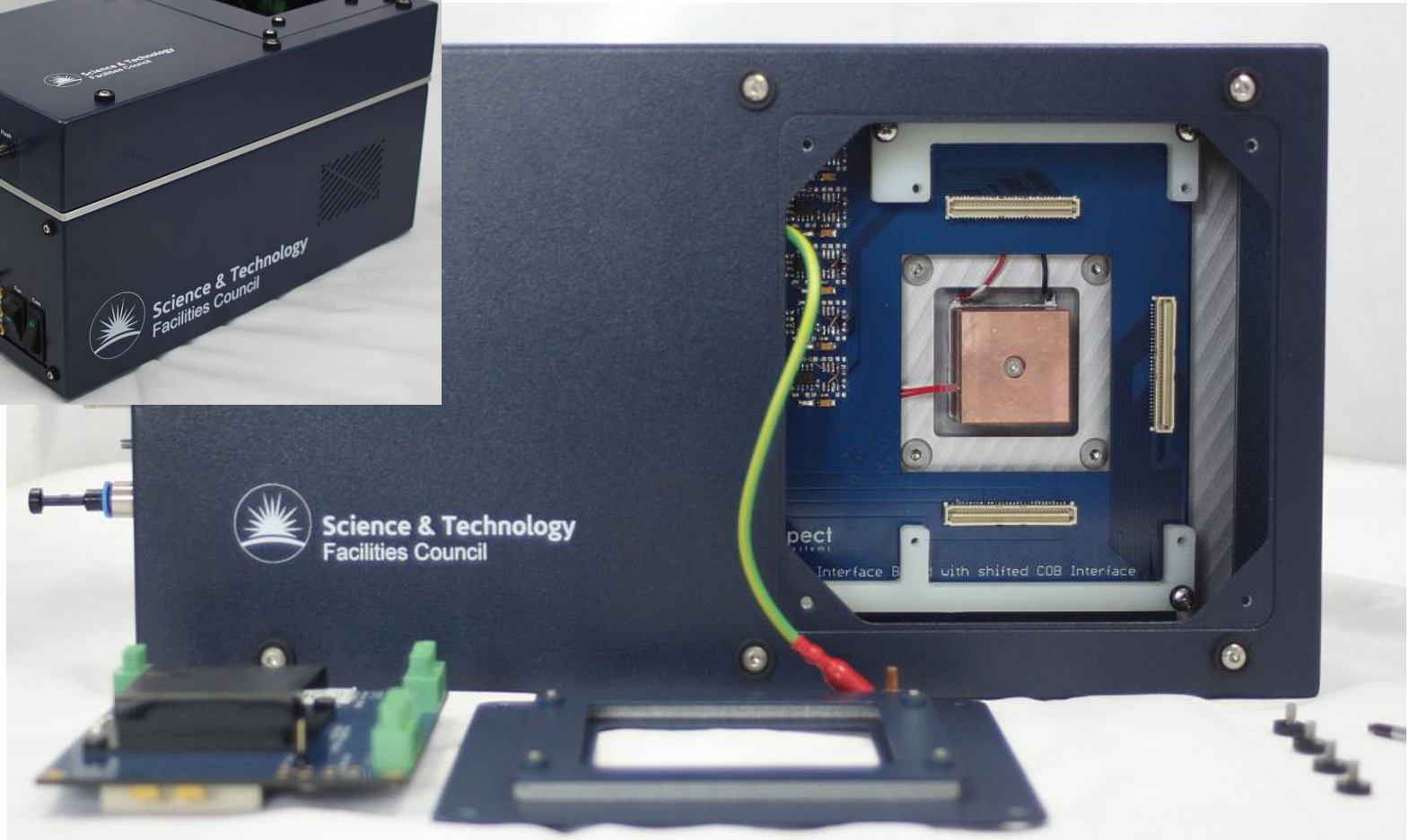
4 blocks output at 20MHz/pixel

$20 \times 80 \times 50 \text{ns} = 100 \mu\text{s/frame}$

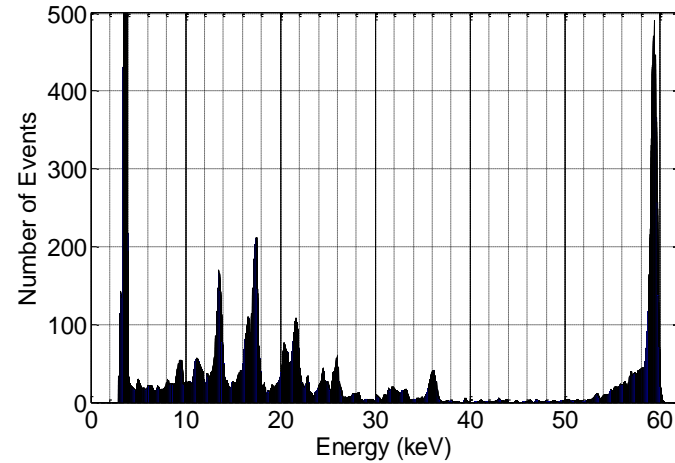
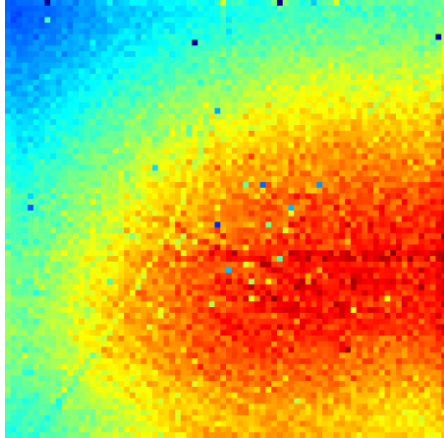
$= 10,000 \text{ frames/sec}$



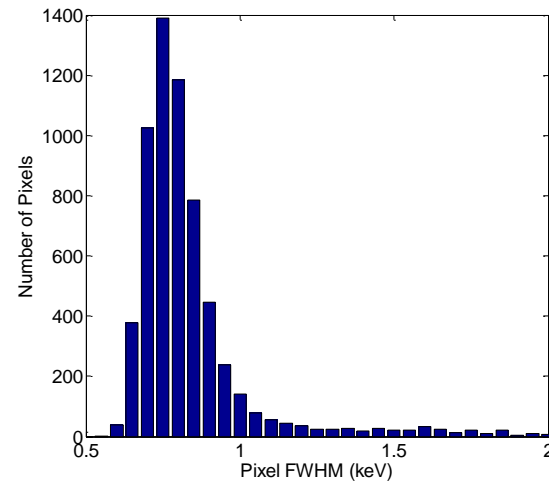
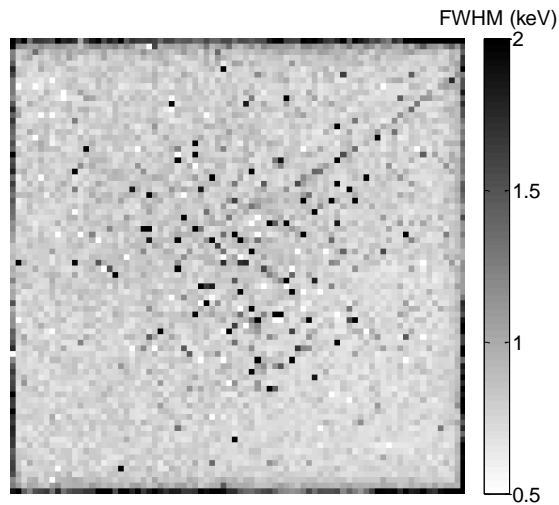
Enclosure with temperature stabilisation and Camera Link output.



80 x 80 pixel 1mm Acrorad CdTe detector results

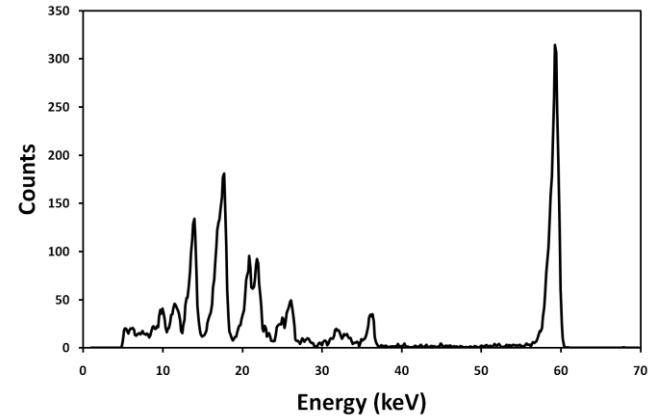
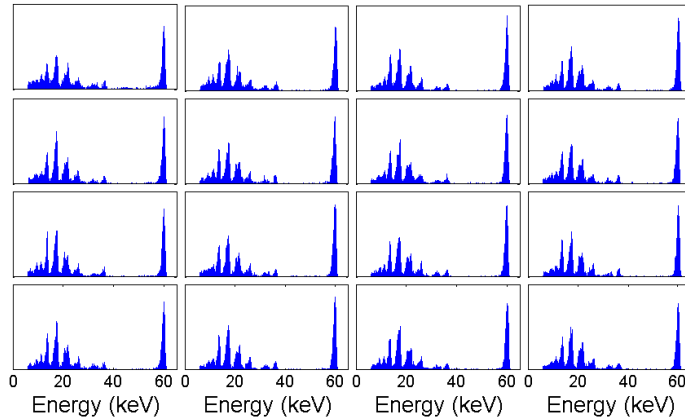


Pixel intensity map showing the number of events per pixel and the Am-241 spectrum from a typical pixel.

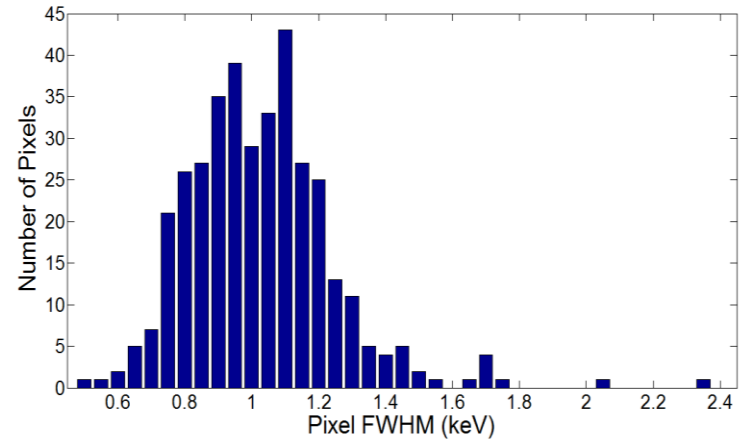
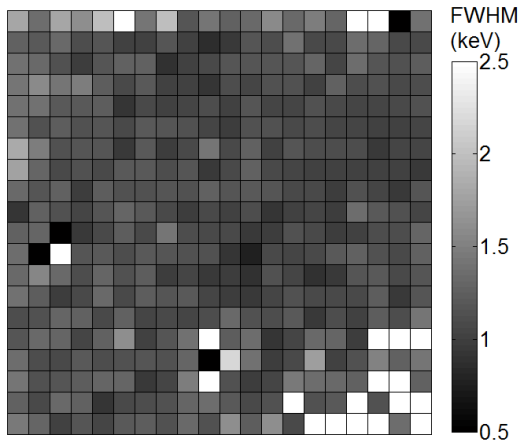


FWHM of the 60keV peak for pixels and variation in FWHM per pixel . Note the rotation of the image .

20 x 20 pixel 2mm Redlen CdZnTe detector results



Pixel map showing Am-241 spectrum from a typical pixels.



FWHM of the 60keV peak for pixels and variation in FWHM per pixel .

Applications with combined Energy and Position

- **Imaging applications**

- **Dual isotope SPECT**

- **Florescence imaging**

- **Astrophysics** and solar X-ray, high altitude balloon project with NASA

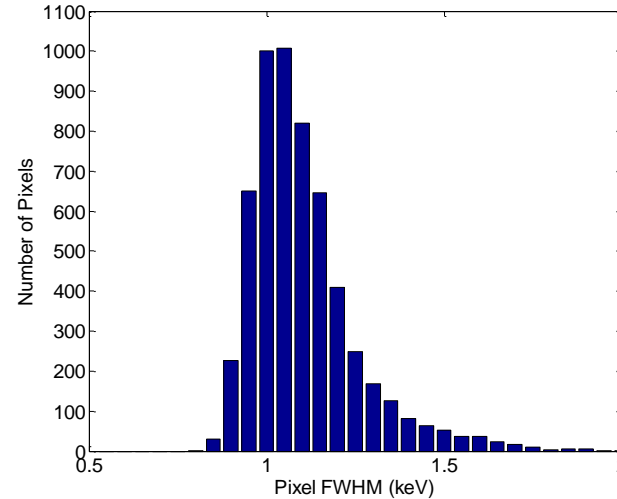
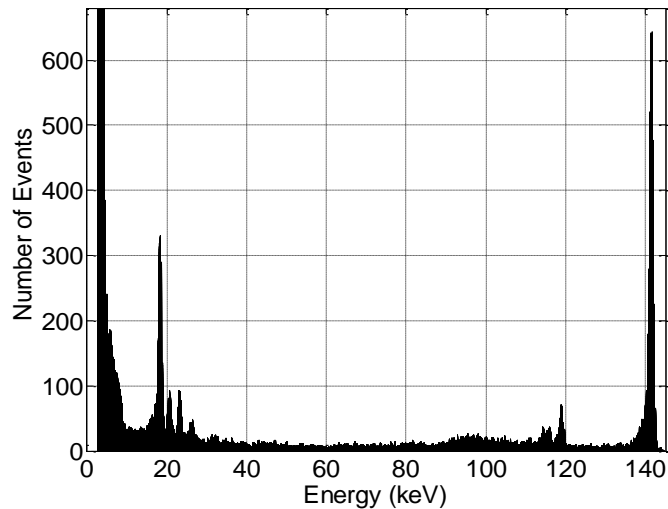
- **Diffraction based techniques** (white beam)

- **TEDDI** for material imaging

- **Cancerous tissue identification** of surgically removed collagen-adipose tissue.

- **Drugs and explosives identification** again using Energy Dispersive Diffraction and white beam source. (poster #45 tomorrow)

Nuclear medicine neurology and cardiology



Surrey County Hospital data, Tc-99m spectrum and the distribution of the FWHM of the 141keV peak measured on each pixel.

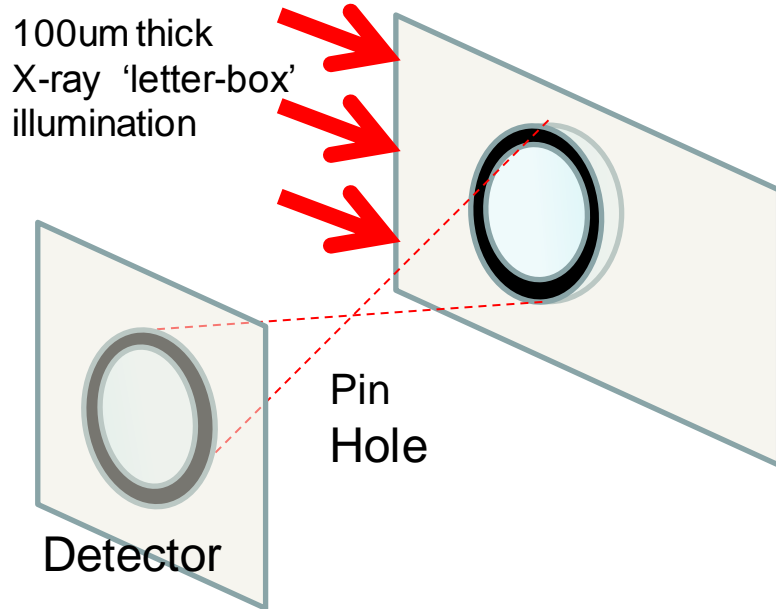
Dual Isotope SPECT (Parkinson's and Multiple System Atrophy.)

Brain imaging with collimators and simultaneous dual isotope tracers .

I-123 (dopamine transponders) and Tc-99m (perfusion) .

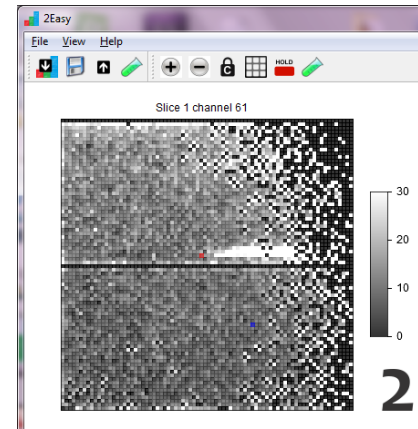
Quality depends on separating the image of I at 159keV from Tc at 141keV .

X-ray Fluorescence imaging in 3D

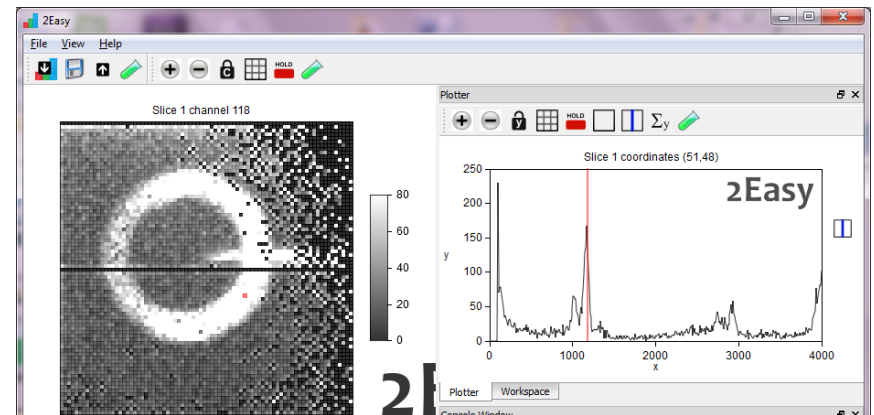


3mm alumina shell used as Pt
catalyst body.
Contaminated with Sb (Antimony).

(Manchester University data.)

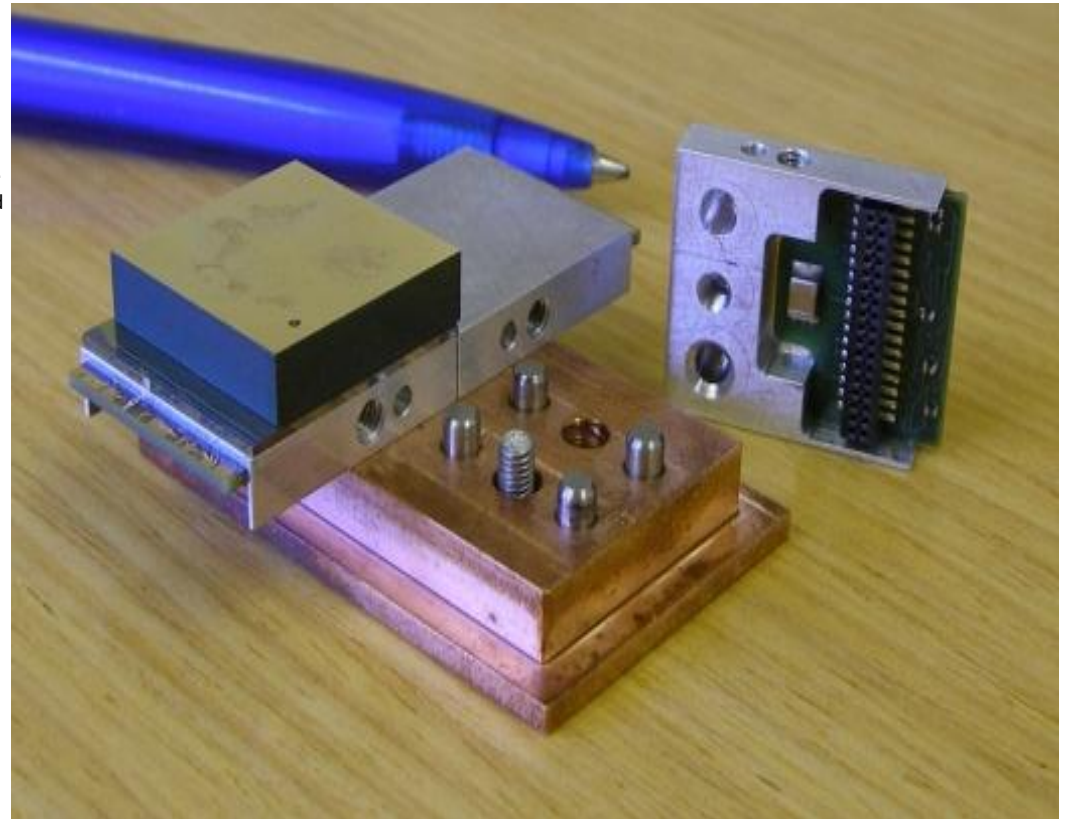
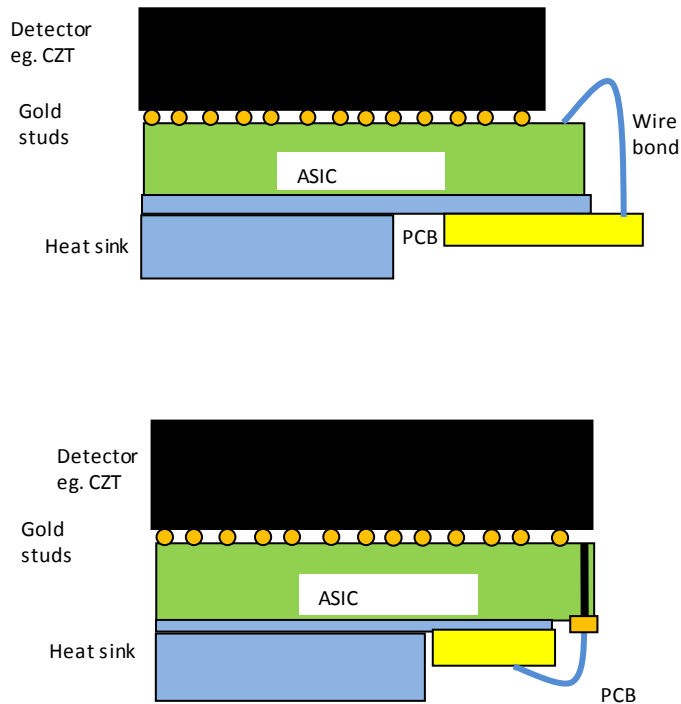


At most energies there is no image



At Sb k-edge (26keV) image appears

3-side butting of larger tiled array.



CZT detector and multi-element alignment system.

Acknowledgements

Cd(Zn)Te project

M. Wilson

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S. Thomas

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(Nuclear medicine and k-edge)

P. Sellin, J. Scuffham, S. Pani

Manchester University *(XRF imaging and TEDDI)*

B. Cernik, S. Jacques, C. Egan

UCL *(Diffraction for illicit materials)*

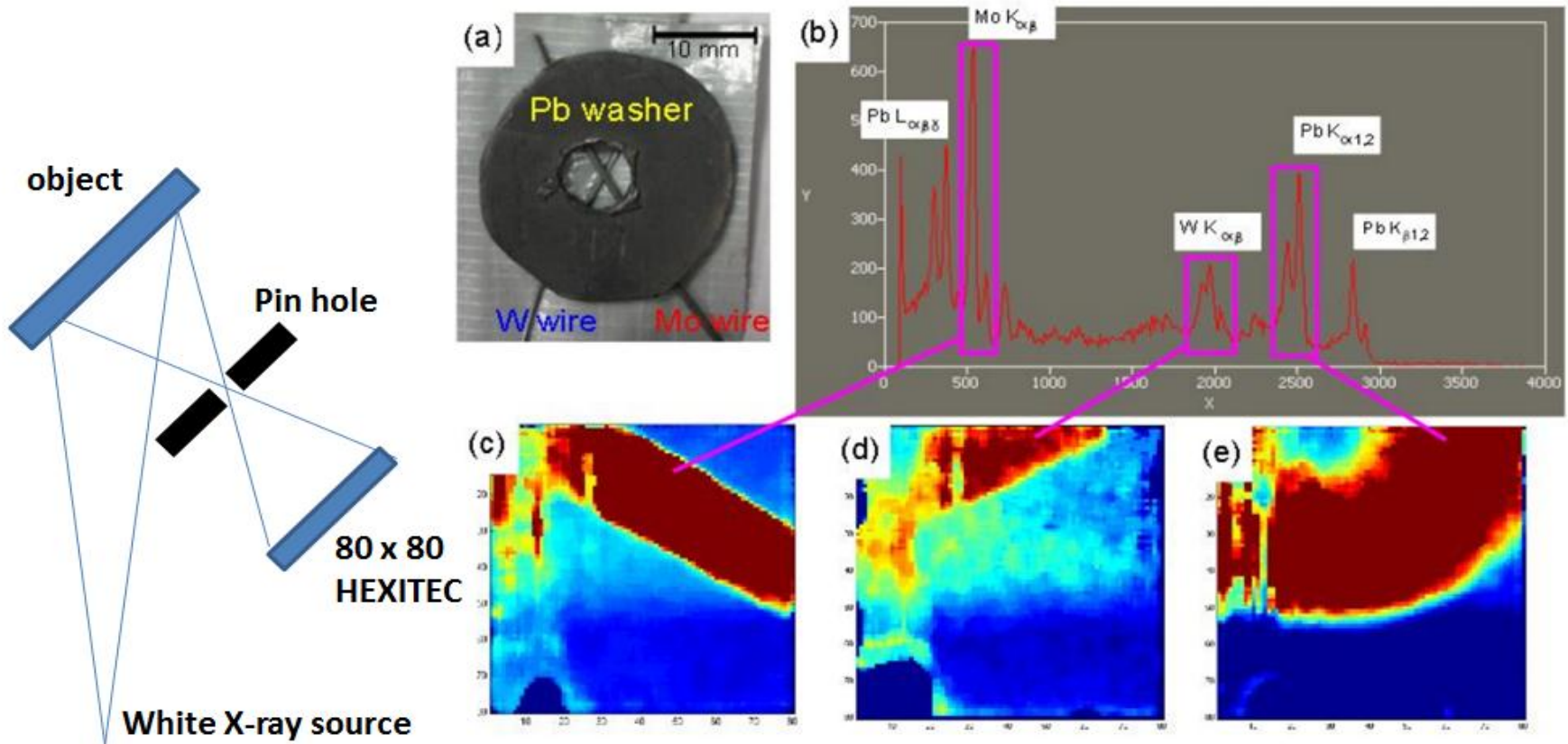
R. Speller, C. Christadoulou, C. Reid

NASA *(Astro-physics and solar imaging)*

B. Ramsey, J. Gaskin

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X-ray Fluorescence imaging



- Test object is made up of Mo, W wires and Pb washer (17, 60, 74 keV)