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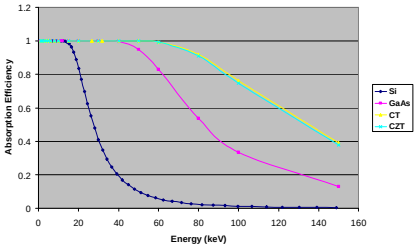
CZT room-temp semiconductor detector

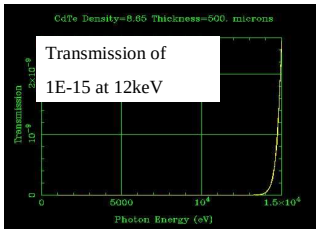
CZT has been proposed as good stopping power material and gives radiation-hard detectors in proton environments (HEP and space)

There is good reason believe it is good in low energy X-ray systems

- do not have oxide interfaces
- heavier atom than Si so low bulk damage



Usual reason to choose High-Z



Another possible reason

- stop most of the X-rays so shield ASICs and bonding interface

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The HEXITEC Project

High **E**nergy **X**-ray **I**maging **Tec**hnology

Focussed on large area pixellated CZT detectors

£3Million EPSRC funded project

4 year program involving 5 institutes

- also involves networks of application institutes and organisations

Started 2006

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HEXITEC Project objectives

fabricate large area CZT detector material for X-ray imaging

characterise to improvement material performance

develop cutting/polishing/contact-deposition and passivation techniques

develop bump-bonding techniques for CZT

develop pixellated spectroscopy ASIC for CZT

insert this technology into a diverse network of scientific users

create a sustainable base for continued CZT detector production

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HEXITEC Investigators (In order of functions)

Dr Andrew Brinkman, Durham University
- growth of 3 inch CZT by fast PVD (commercialised for CdTe PVD)

Dr Paul Sellin, Surrey University
- CZT characterisation (PL mapping, PICTS, IBIC, Alpha TOF, NCR mapping)
- development of contacts and passivation

Paul Seller, CCLRC
- detector fabrication from raw material
- detector characterisation (Spectroscopy, noise/temperature, small-pixel effect)
- large area ASIC development

Prof Bob Cernik, The University of Manchester Principle Investigator
- lead of Application Networks
  - Imaging + tomography for engineering
  - Space Science
  - Synchrotrons
  - Security
  - Medical and biological

Prof Paul Barnes, Birkbeck College London Materials Imaging Network
  - TEDDI

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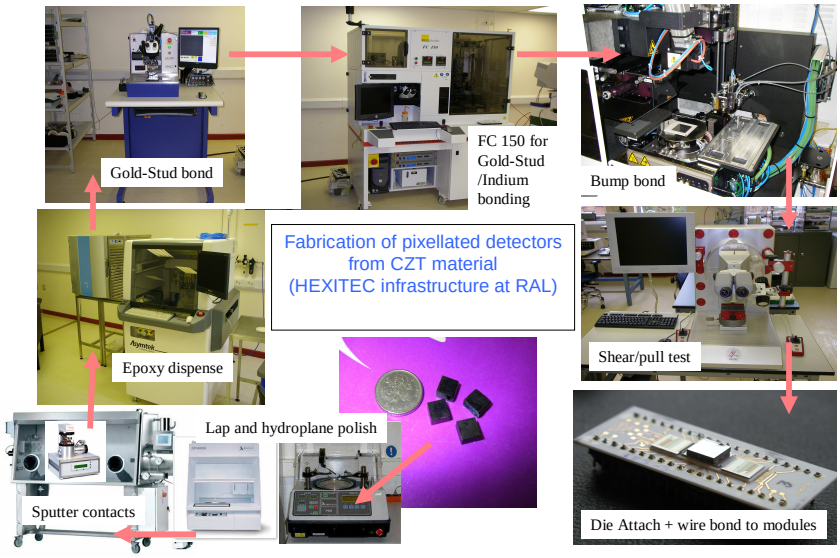

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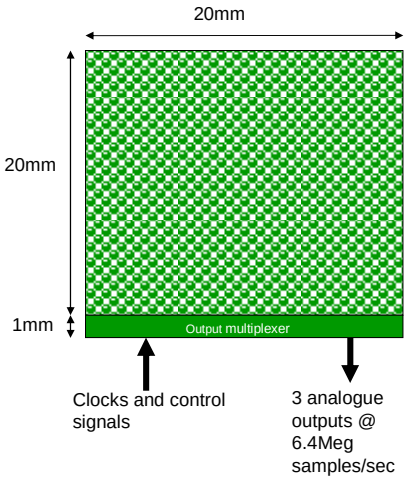
HEXITEC ASIC OVERVIEW

- Bump bonded readout chip for CZT
- 80*80 pixels each 250um* 250um
- 1keV to 150keV dynamic range (x10 option)
- 200eV FWHM noise
- Sequential Rolling shutter readout (not data driven)
- Intended for 2mm thick CZT material
- 1000 frames a second (variable) readout rate



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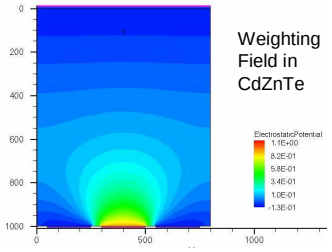
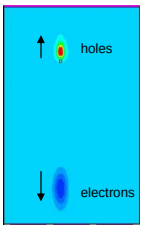
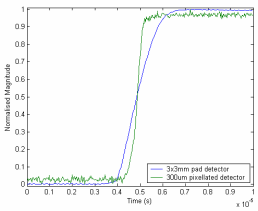
HEXITEC ASIC: Simulations and measurements

- With 250um pixels and 2mm thick detectors the small-pixel effect is quite strong
- See <<1us rise-time signals due to the electrons moving when close to the anode contact. Do not see the several microsecond electron and hole transit times through bulk
- Can chose a faster shaping time without significant ballistic deficit



Weighting Field in CdZnTe





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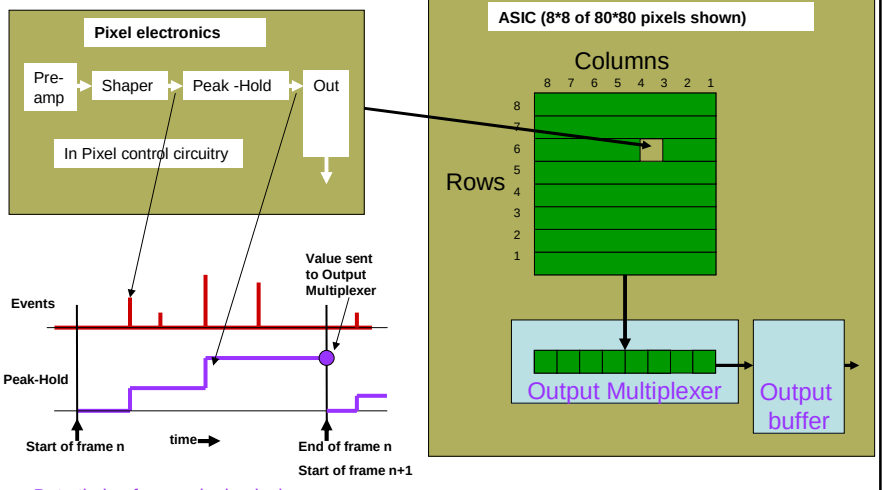
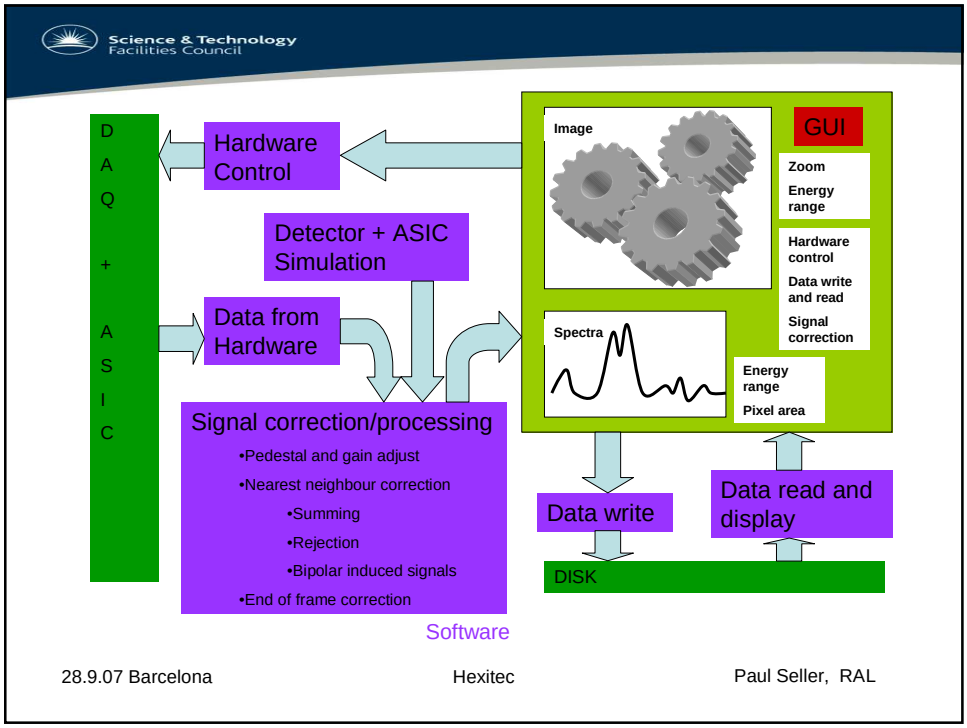


Data timing from a single pixel

Rolling shutter output scheme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C
Hardware Control
Detector + ASIC Simulation
Data from Hardware
Signal correction/processing
•Pedestal and gain adjust
•Nearest neighbour correction
•Summing
•Rejection
•Bipolar induced signals
•End of frame correction
Software
Image
GUI
Zoom
Energy range
Hardware control
Data write and read
Signal correction
Spectra
Energy range
Pixel area
Data write
Data read and display
DISK
28.9.07 Barcelona
Hexitec
Paul Seller, RAL