Science & Technology Facilities Council
Technology

Science and Technology Facilities Council (STFC)

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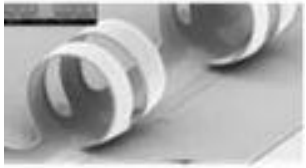

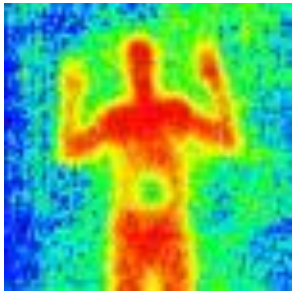


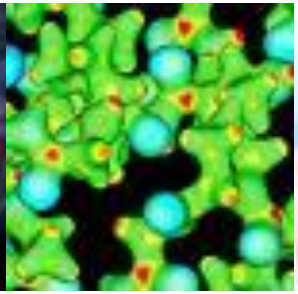


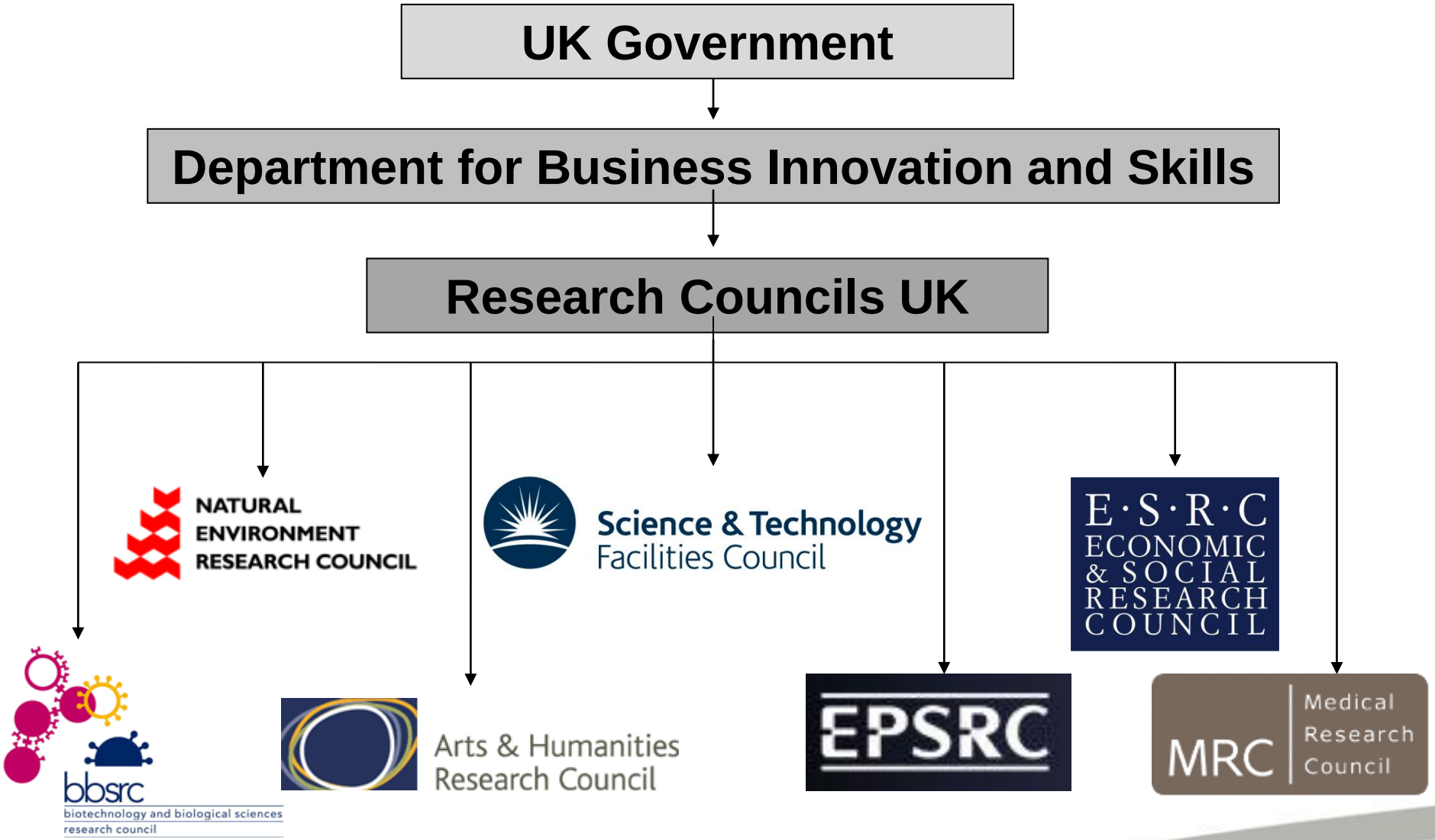

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STFC

UK Astronomy Technology Centre
Edinburgh, Scotland

Polaris House
Swindon, Wiltshire

Chilbolton Observatory
Stockbridge, Hampshire

Isaac Newton Group of Telescopes
La Palma

Daresbury Laboratory
Daresbury Science and Innovation Campus
Warrington, Cheshire

Rutherford Appleton Laboratory
Harwell Science and Innovation Campus
Didcot, Oxfordshire

Joint Astronomy Centre
Hawaii

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International Partnerships

- CERN (14%)
- European Southern Observatory (20%)

- European Synchrotron Radiation Facility (15%)
- Institute Laue-Langevin (33%)

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STFC Science and Innovation Campuses

Harwell and Daresbury

- Unique platform for Public/ Private Collaboration
  - Academia/ RDA's/ Local Authorities/ Business
- Multi-disciplinary
- Providing Incubator space for new Businesses, and Specialist Research Institutes, e.g. ESA Centre

Delivering Science/ Technology/ Innovation/ Commercialisation across a wide range of disciplines and sectors

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Academic Partners

STFC fund university research projects and postgraduate training awards in astronomy, particle physics, space science and nuclear physics

- Funding over 1,700 academics, technicians, research associates, engineers and technicians in UK universities
- STFC also provide universities with the opportunity to apply for contracts with major international science facilities

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STFC Facilities – driving scientific research

Neutron Sources

Providing powerful insights into key areas of energy, biomedical research, climate, environment and security

High Power Lasers

Providing applications on bioscience and nanotechnology and demonstrating laser driven fusion as a future source of sustainable, clean energy

Light Sources

Providing new breakthroughs in medicine, environmental and materials science, engineering, electronics and cultural heritage

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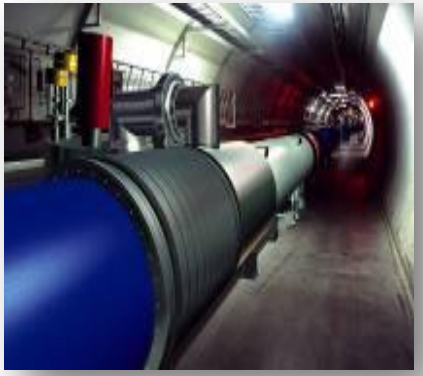
Understanding our Universe
STFC's Science Programme



Particle Physics/Particle Astrophysics

- Revealing the structure and forces of nature - Large Hadron Collider, CERN
- Advanced LIGO will observe and study Gravitational Waves, opening a new window on the universe

Ground based Astronomy

- European Southern Observatory, Chile
- Very Large Telescope
- Atacama Large Millimetre Array
- European Extremely Large Telescope

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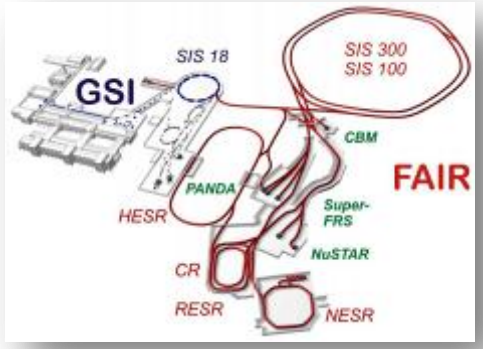
Understanding our Universe
STFC's Science Programme

Space based Astronomy

- European Space Agency
- Herschel/Planck/GAIA/James Webb Space Telescope
- Bilaterals – NASA, JAXA, etc.
- STFC Space Science Technology Department



Nuclear Physics

- Facility for Anti-proton and Ion Research, Germany
- Nuclear Skills for - medicine, energy and environmental applications

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World-class science made possible by

World-class Technology

Providing leading-edge science with the technological resources and skills to meet the exacting standards required for success

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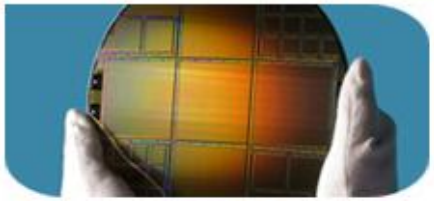
Microelectronics Energy research Design *Metrology* Engineering
Advanced materials Research Instrumentation Sensors Detectors Computing
Bioscience Micro/Nano technology Cryogenics Mechanics

Technology

STFC

Detector Systems Centre

SEARCH



MAPS wafer...

CMS tracking detector...

Data acquisition system design...

Applications engineering...

- Home
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  Aims, objectives, vision, Campuses and Gateway centres, beneficiaries, advisory board...
- Getting Involved
  Collaborations, partnerships, events and workshops to tackle development opportunities...
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  Harwell and Daresbury Campuses...
- Contacts
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The STFC Detector Systems Centre

"Championing the UK development of advanced detector instrumentation systems"

The DSC is an STFC initiative to establish a dynamic, open innovation, technology centre with a critical mass of expertise from STFC, academia and industry to deliver training and catalyse new advanced product development in the UK.

Based at the Harwell and Daresbury Science and Innovation Campuses the Centre will focus on the comprehensive exchange of knowledge between research and industry. It's core objective is to maximise the impact of STFC's research programme in detector technology and realise the government's vision of creating premier locations for technology innovation and future large scale scientific facilities at Harwell and Daresbury.

The Detector Systems Centre builds on STFC's world class reputation for microelectronics training and the development and delivery of

Quick links

Contact Us

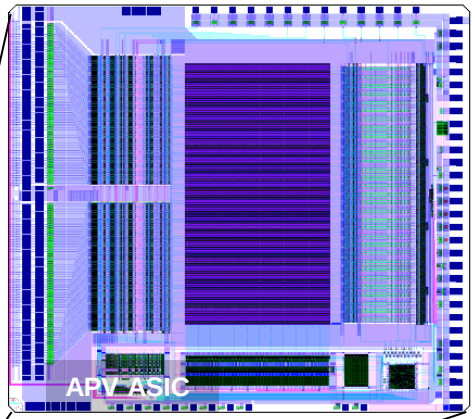
- STFC website
- Harwell campus
- Daresbury campus
- Vacancies
- News

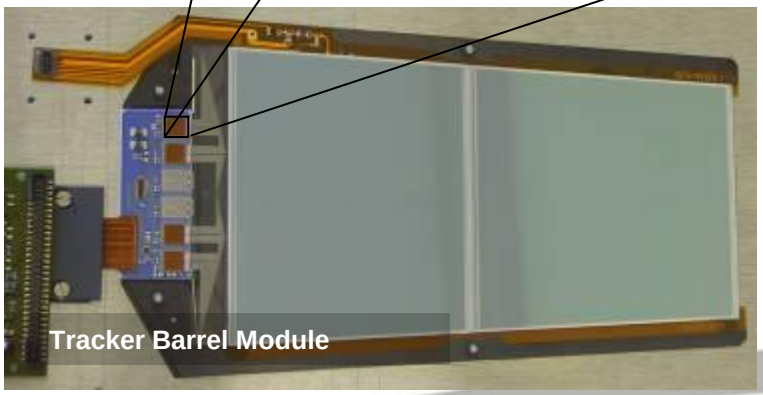
Printer-friendly

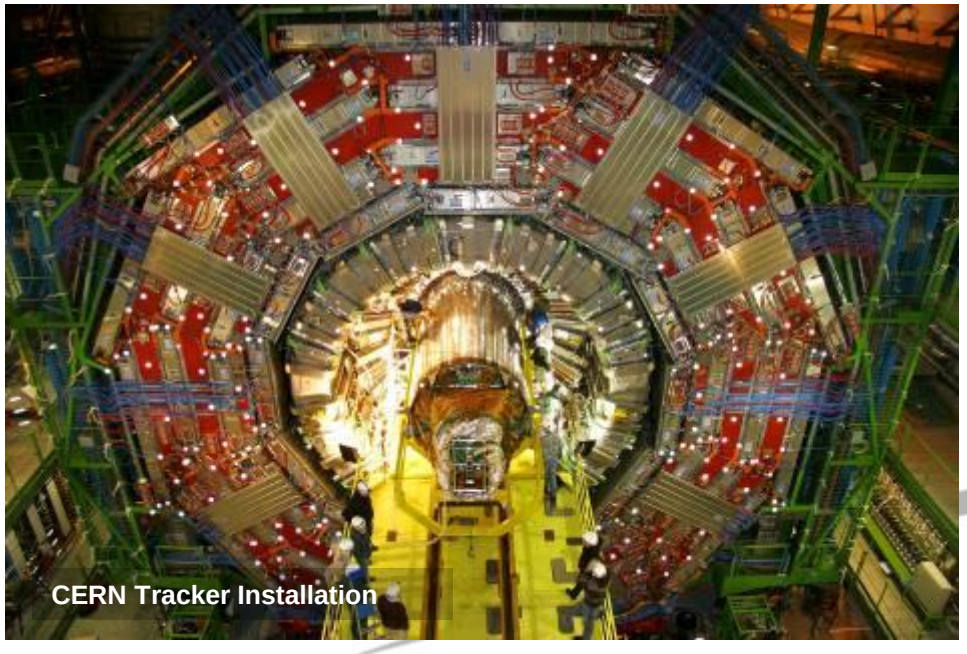
The Compact Muon Solenoid

Particle Physics: CMS

- ~210 m2 of silicon, 10M channels
- 75000 FE chips, 40000 optical links







Radiation environment
~10Mrad ionising
~10^{14} hadrons.cm^{-2}

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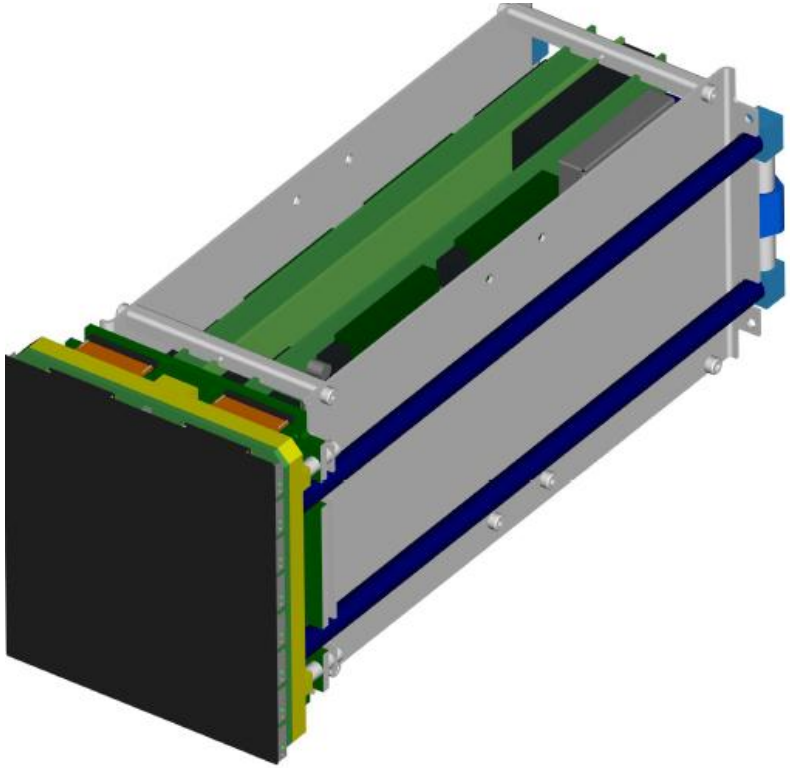
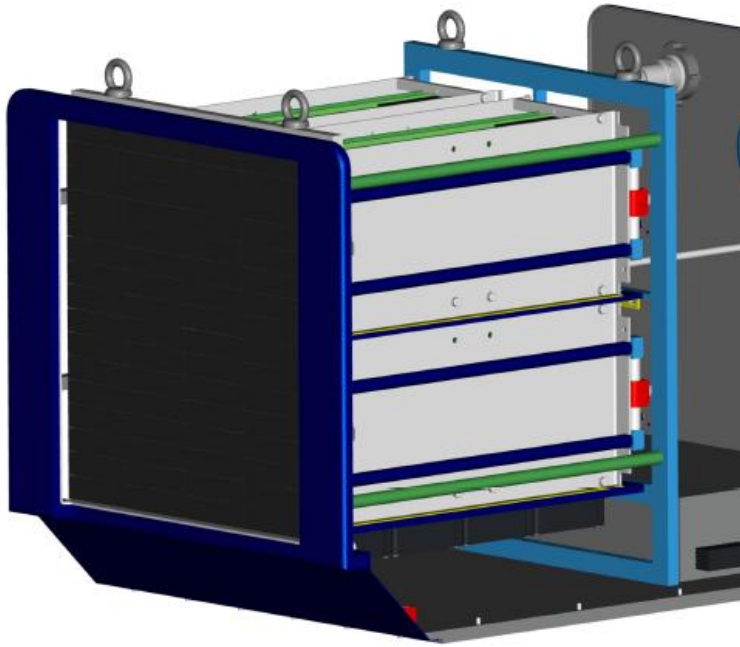
XFEL LPD Detector

Optimum Energy Range	5 keV – 20 keV	Max. Frame Rate	4.5 MHz
Sensor Thickness	500 µm	Min. Frame Rate	1 MHz
Pixel Size	500 x 500 µm	Gain Factors	1x, 10x, 100x
Dynamic Range at 12 keV	10^5	Storage Capacity	512 x 3
Inactive area	13%	Data Output Rate (Mpix)	10GBs

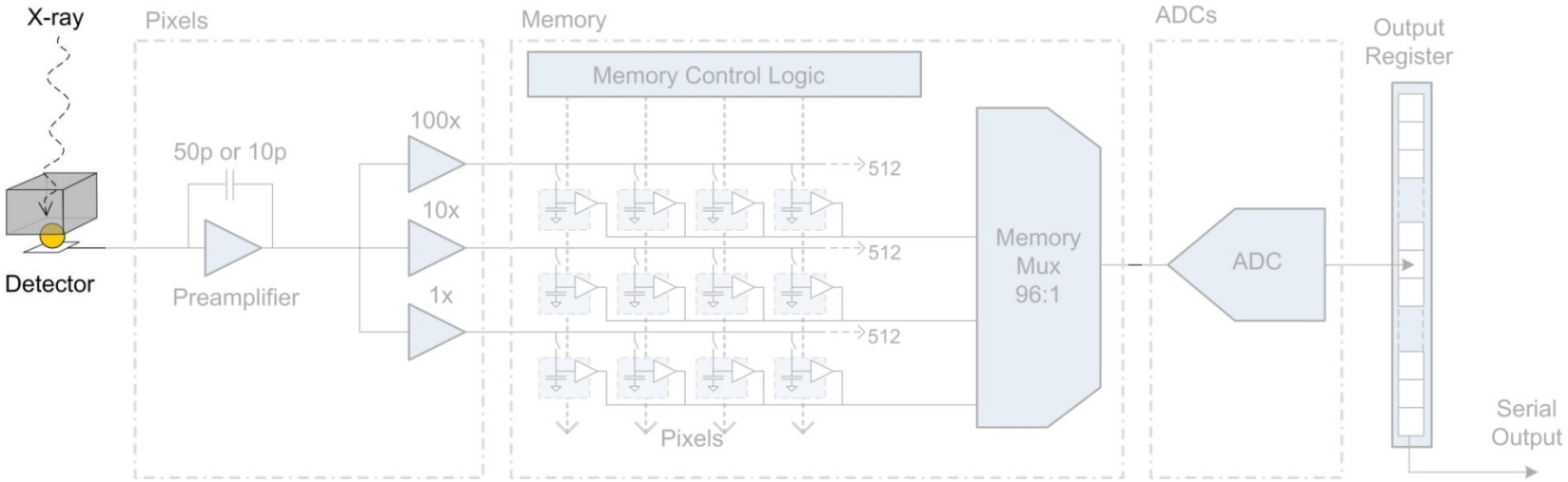


A Super-module
128 Chips, 65,536 Pixels

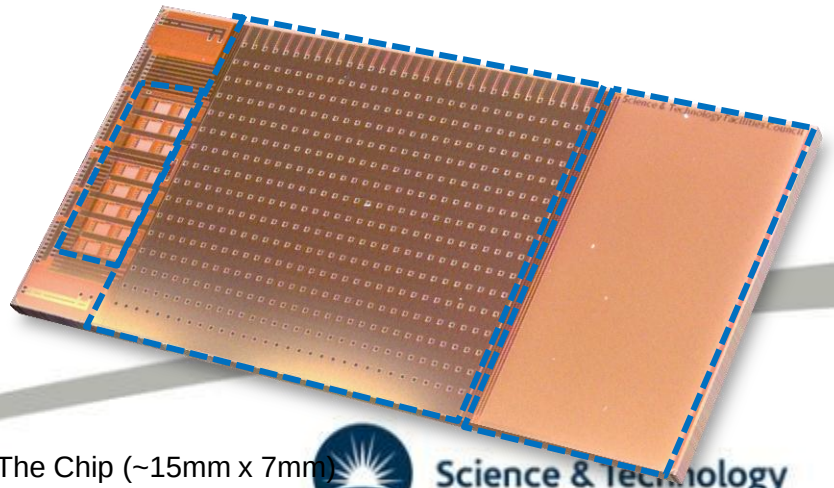


A Quadrant Detector
2x2 Super-modules
512 Chips, 262144 Pixels
Scale = 25.6cm

Readout ASIC



- 512 Channels
- Preamplifier with 50pF feedback – 10^5 photons
  - 10pF mode gives lower noise at the expense of some dynamic range.
- 100x, 10x and 1x parallel gain stages
- 512 frames of memory for each channel and gain – Veto System
- 16 SAR ADCs – 12 Bit
- 100MHz digital output
- IBM 130 nm



The Chip (~15mm x 7mm)

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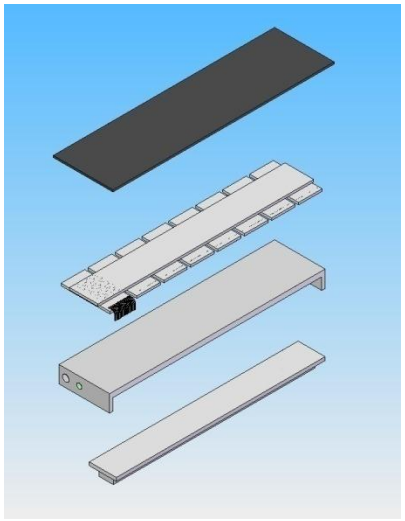
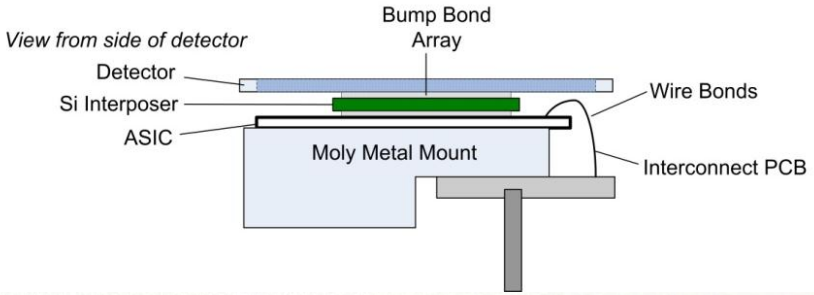
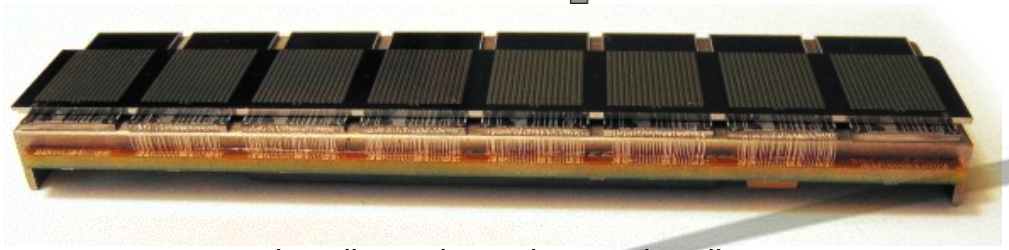
Interconnect

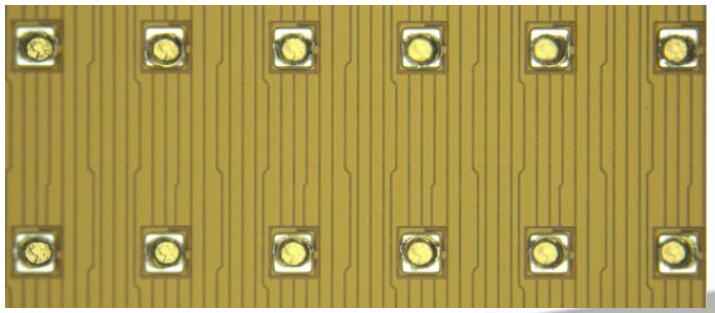






Part complete tile – prior to detector bonding

- Detector Tile Stack
  - Detector
  - Interposer
  - 8 x ASIC
- Gold stud to Silver loaded epoxy bonding
- Concealed ASIC I/O wire bonding
- 4 Side buttable



Gold studs on the readout ASIC

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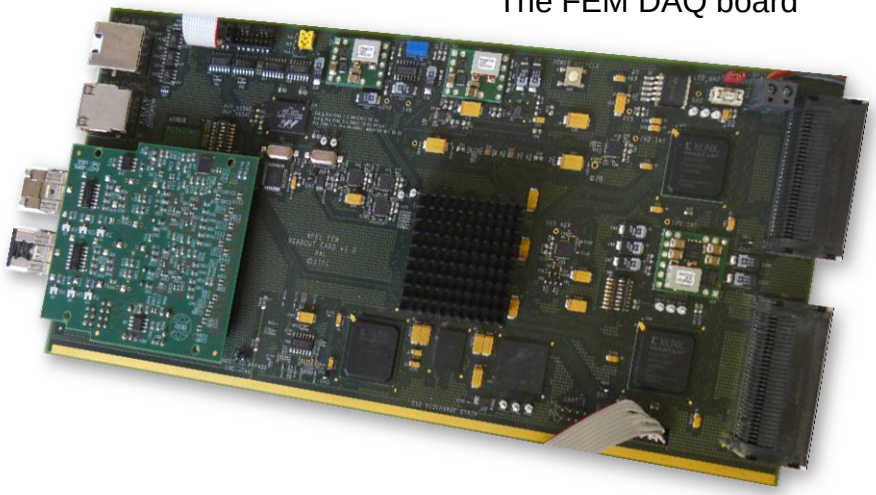
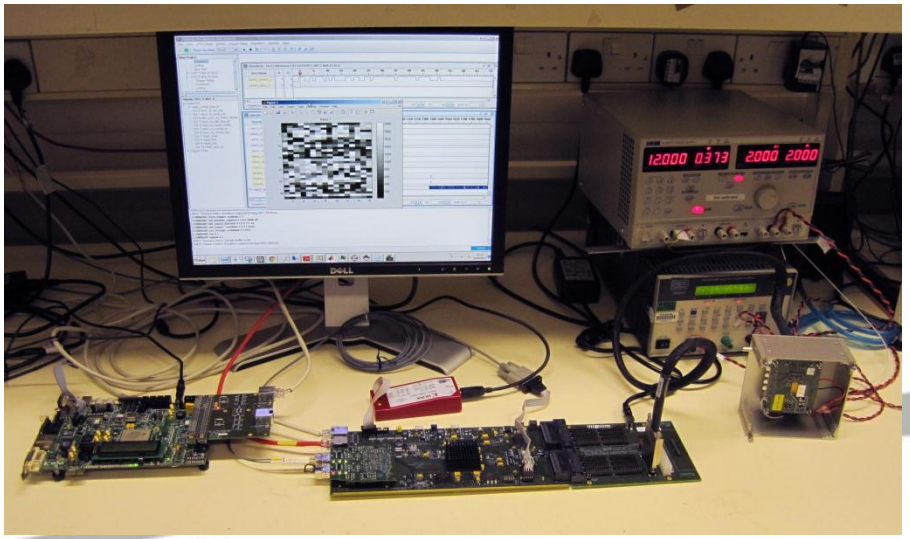
Data Acquisition and Control

- Front End Module (FEM)
- Connects to 128 ASICs (65K channels)
- Xilinx Virtex 5 FPGA
- Data output via 10Gbps Optical Links (Mezzanine card, DESY)
- Connected to clock and control signals via Gb Ethernet

The FEM DAQ board





FEM testing with a single readout ASIC

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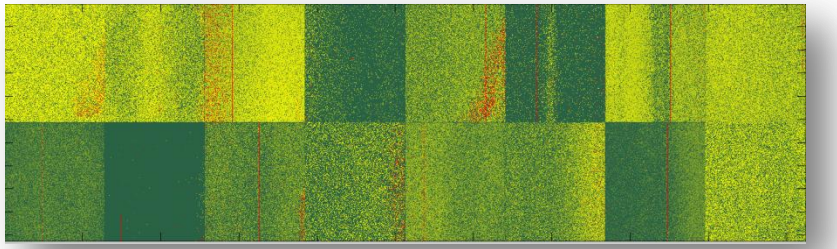
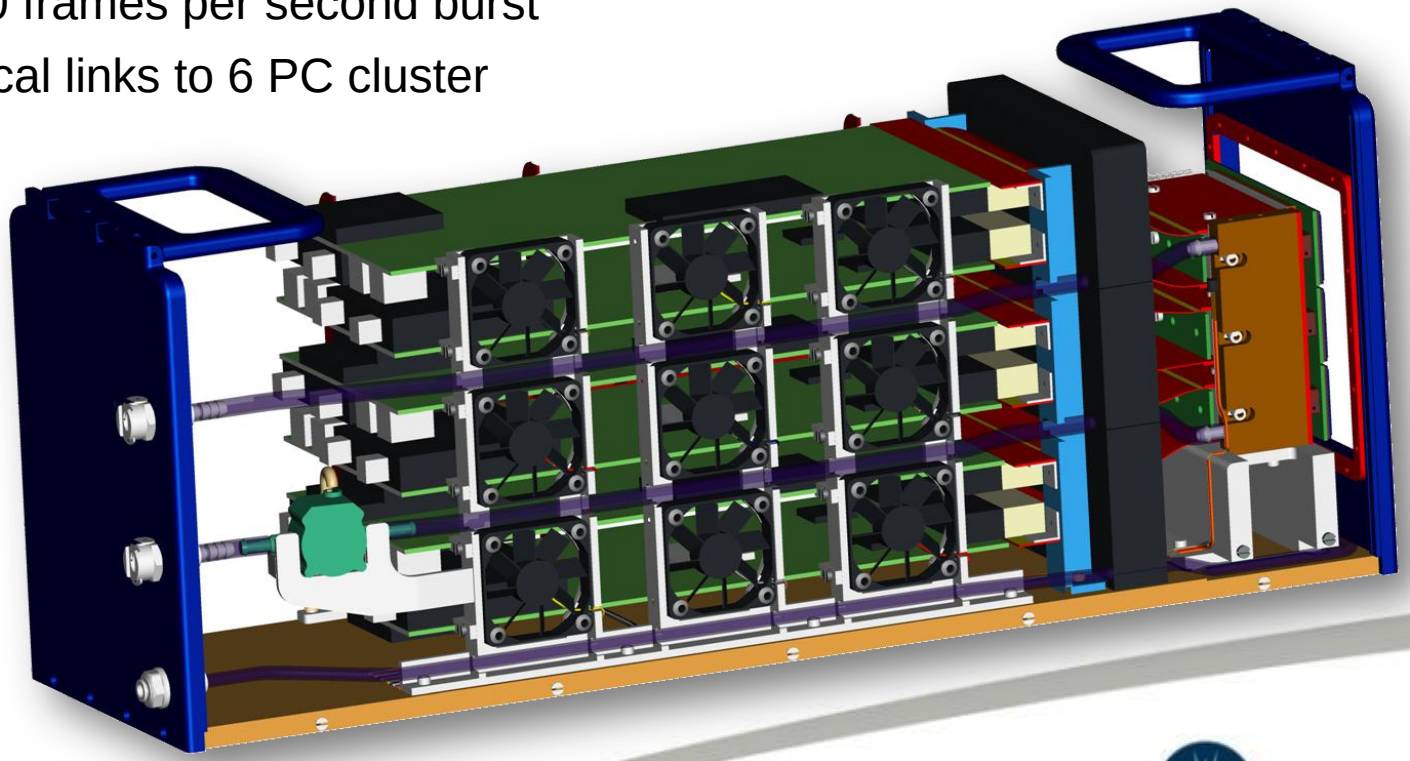
EXCALIBUR

diamond

- 3 megapixel (Medipix 3 readout)
- 300 or 500 micron Silicon sensors
- Integrated with EPICS and GDA
- 100 frames per second continuous
- 1000 frames per second burst
- Optical links to 6 PC cluster





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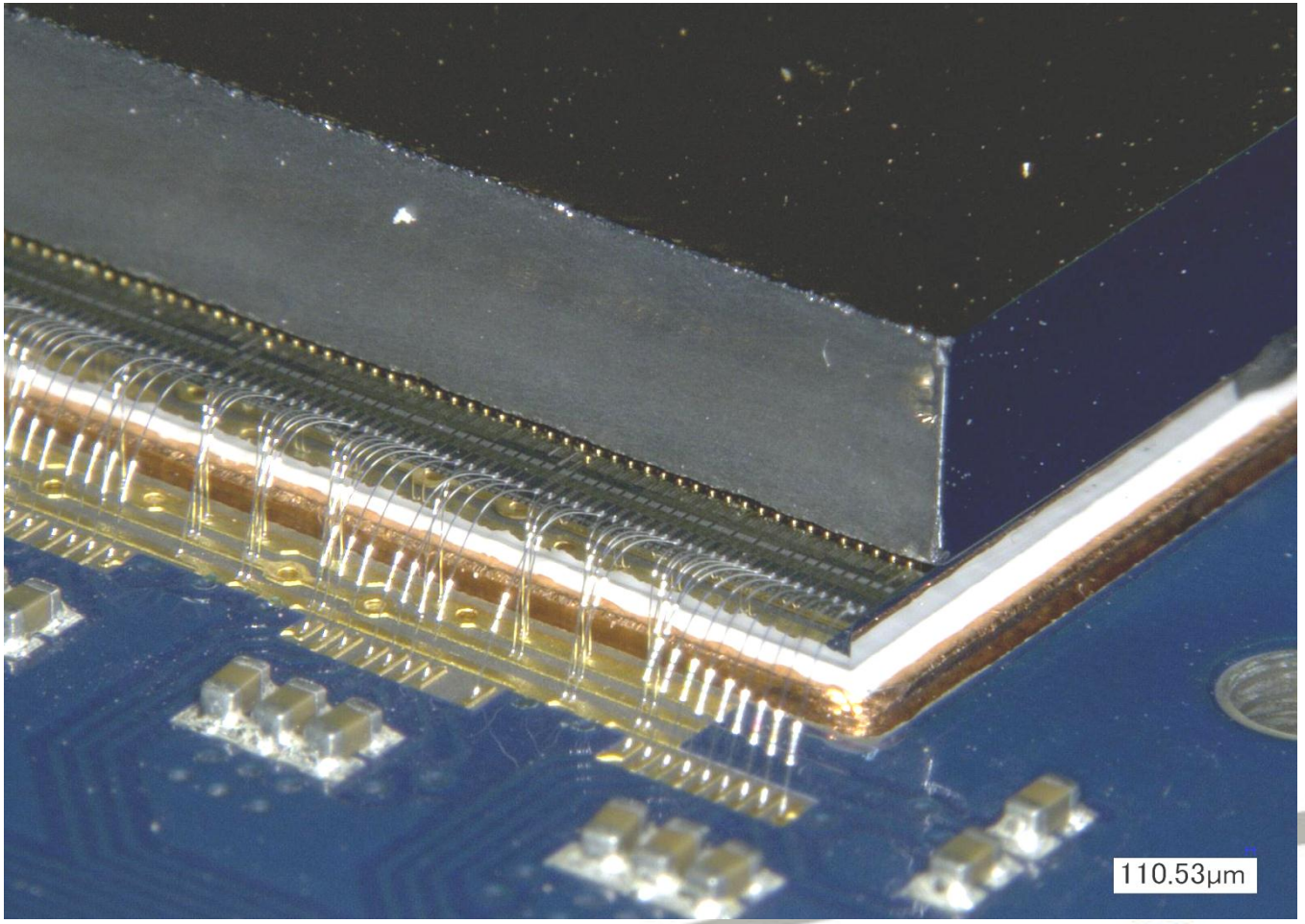
CdZnTe Example



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

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CMOS Imaging Example

Wafer Scale Imaging for Medical Applications:

Large area coverage →

Full field mammography: about A4 size

Chest imaging: about A3 size

Spatial resolution → Mammography ~ 50 μm pixel

Low noise → Good single X-ray photon sensitivity →

Fluoroscopy + → dose reduction

Speed → Digital tomosynthesis

Radiation hardness → Some X-rays absorbed in the sensor

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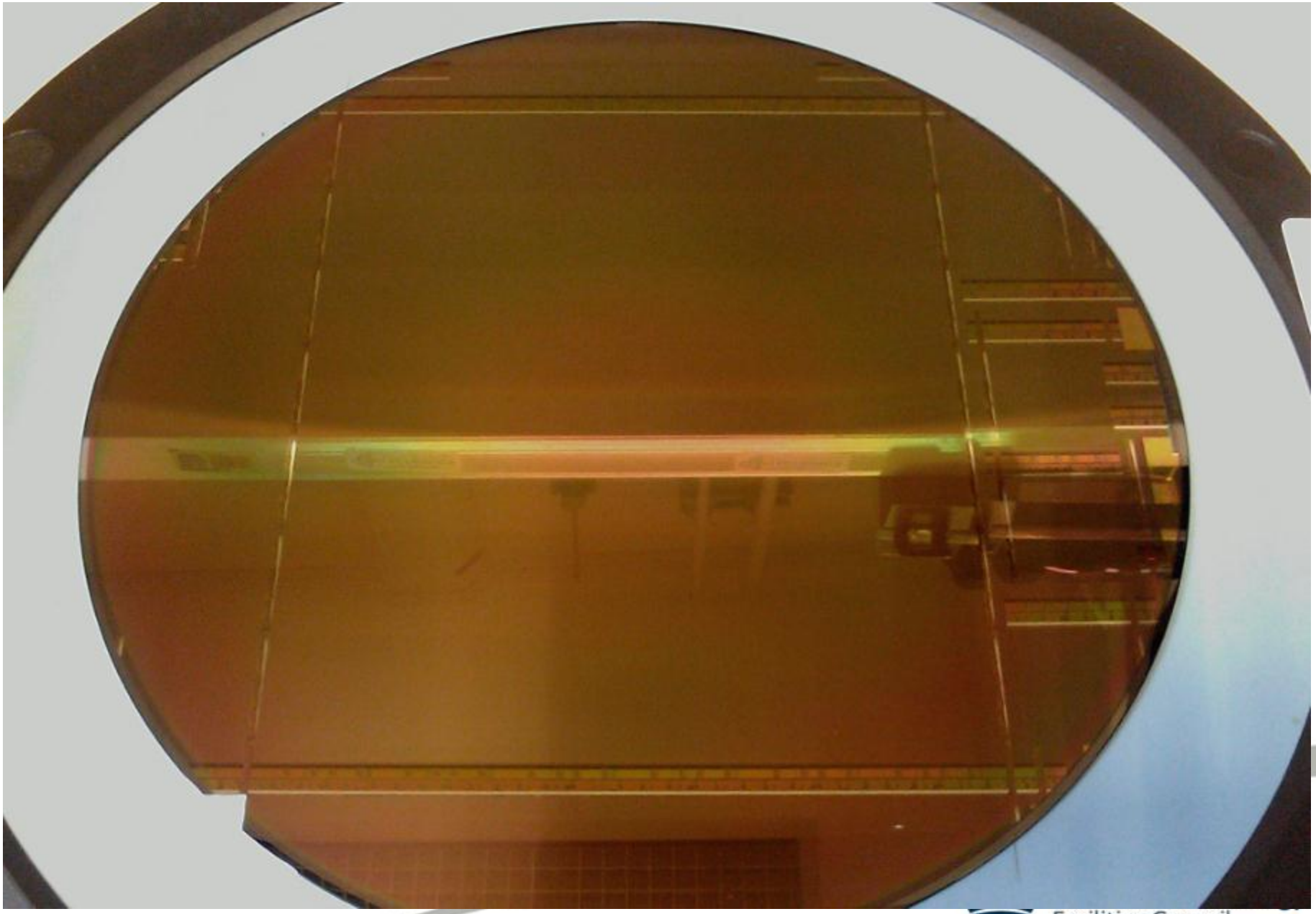
A3+
… industrial,
security …



Summary

Strong synergies between the Helmholtz Platform and the UK detector programme for STFC

Common Needs for:

- Advanced interconnect, 3D developments
- Continuous improvement in design for ASIC and programmable DAQ systems
- Need to advance high-z materials
- …

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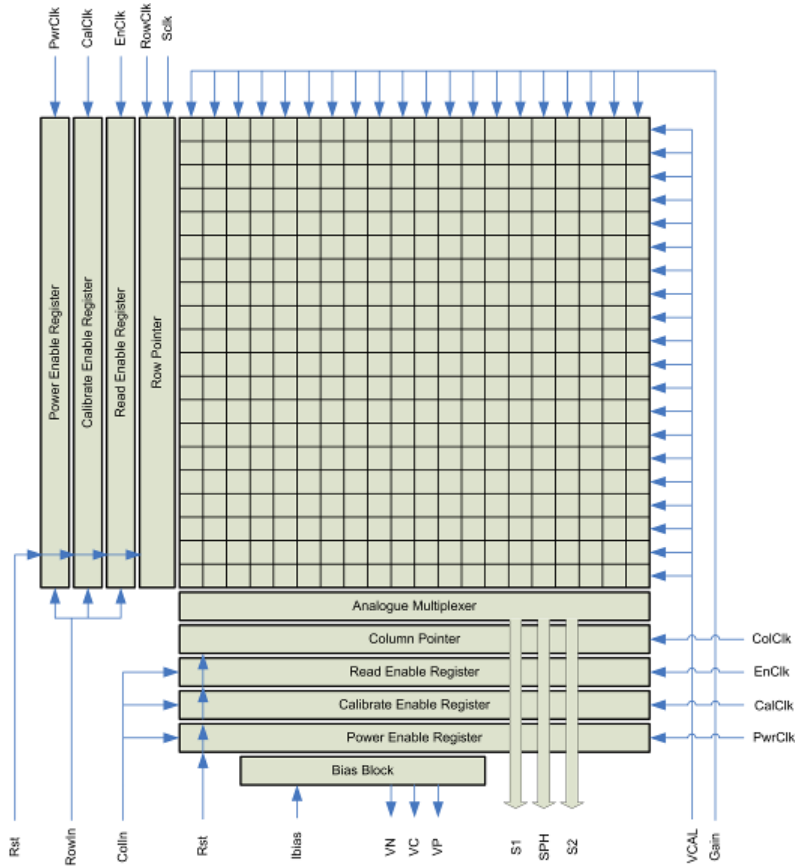
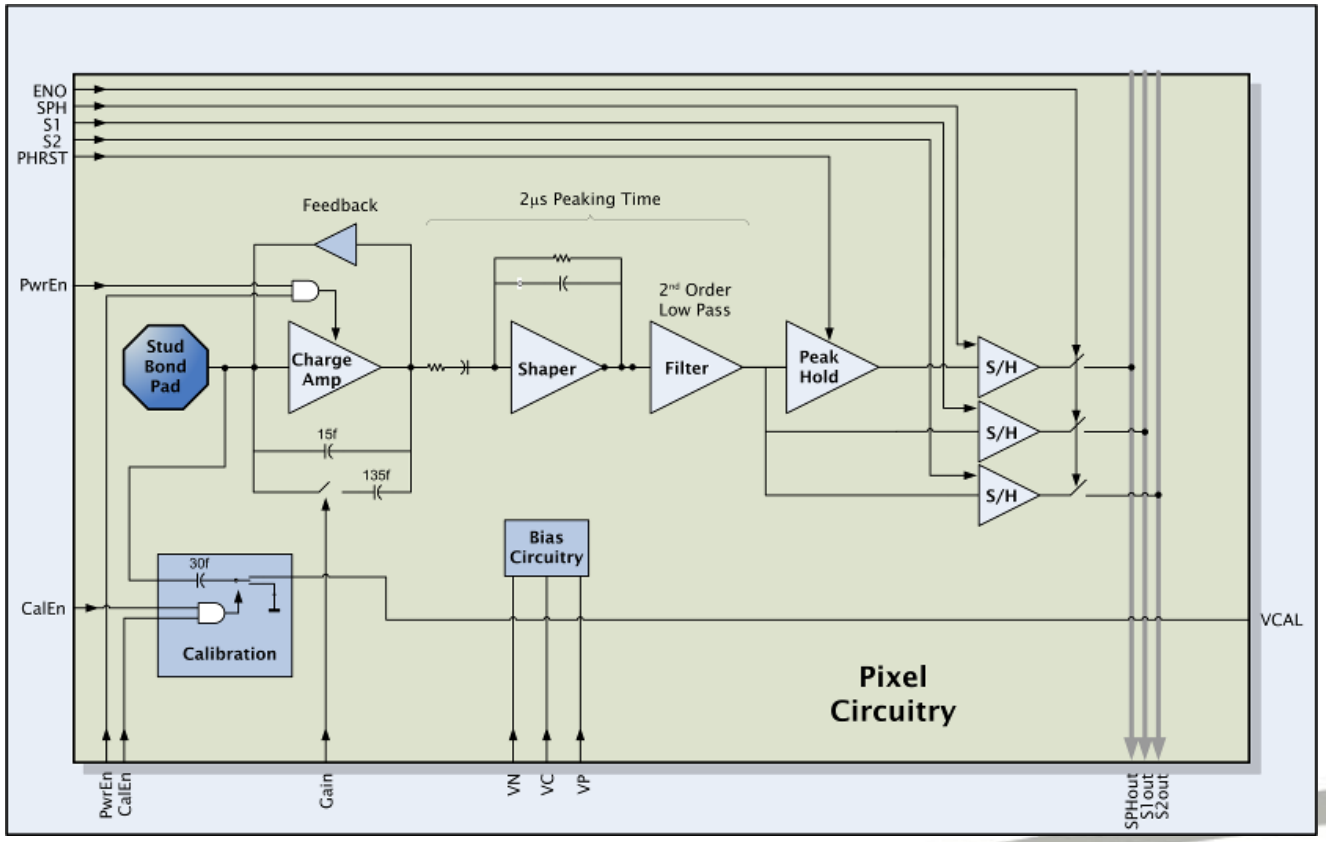
Backup slides

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



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