XCAM Camera Solutions

XCAM - Leading Expertise in Imaging Solutions

- Design and Manufacture of Customised Digital Camera systems
- Long heritage in the supply of CCD, EMCCD SCD, CMOS systems
- Any type of detector supported including E2v technologies, Hamamatsu, Dalsa, Truesense
- Manage the fully supply chain to include mechanical, electronic and software design
- Supply of detector test equipment and subsystems for test and characterisation work
- Long term supply of strategic products
- Strong experience in supply of super-clean, contamination-free systems for vacuum applications

XCAM Factory, Northampton

Detector Test and Characterisation Systems

Over 20 years experience in the supply of detector test and charactersiation systems to universities and space agencies for detectors characterisation purposes.

XCU-A Controller-Based System

- Lowest possible noise at slower speeds (1.7 electrons lowest readout noise achieved with a conventional CCD)
- Controller requires only a cable and headboard and sequencer code to operate any detector.
- Can be used as the basis of a full camera system with the addition of camera head and cable
- 4 channel system; can run multiple detectors synchronously

XCU-19D FO and 19EM FO Controller-Based System

- High speed 4 channel system running at up to 3MHz each channel
- Can operate multiple detectors synchronously; up to 3 detectors with 12 output nodes demonstrated at 3MHz each node
- Excellent linearity
- D controller for conventional CCDs and CMOS; EM controller for EM CCDs with the addition of HV bias card
- Fibre optic transfer of clock and data for clean vacuum applicaton and good noise immunity

Detector Characterisation Systems – Built to Order

Cryogenic Detector Characterisation System built for ESA for their test of Detectors for the Euclid Space Mission

- Detector test and characterisation system designed to enable ESA scientists to fully characterise Euclid custom CCD detectors during detector development phase
- Headboard, cable, sequencer code, mechanical support parts designed to operate with a standard XCU-A controller for a low cost, semi-customised and quickly implemented solution
- Achieved 1.7 electrons noise
- On-site delivery, commissioning support and training of staff so system operational just 2 days after arrival at ESA site
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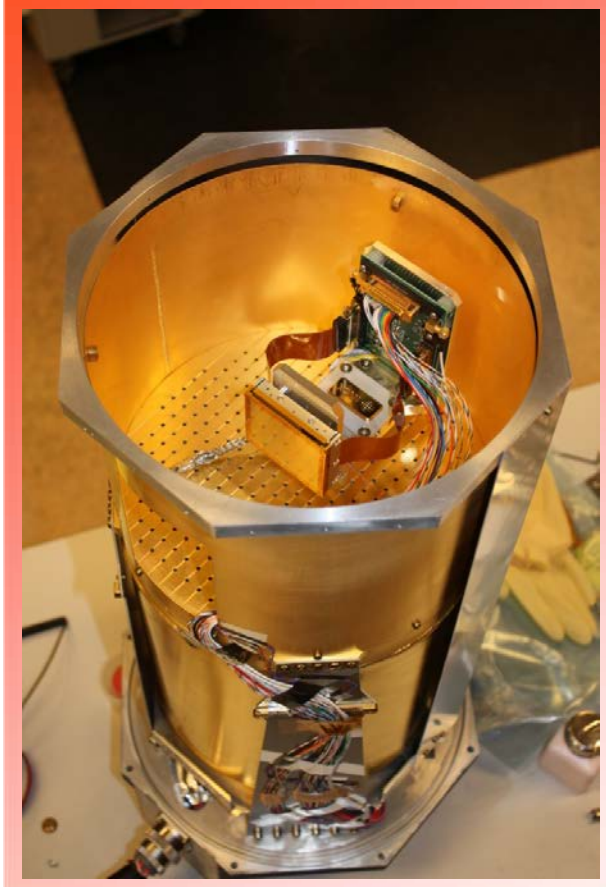
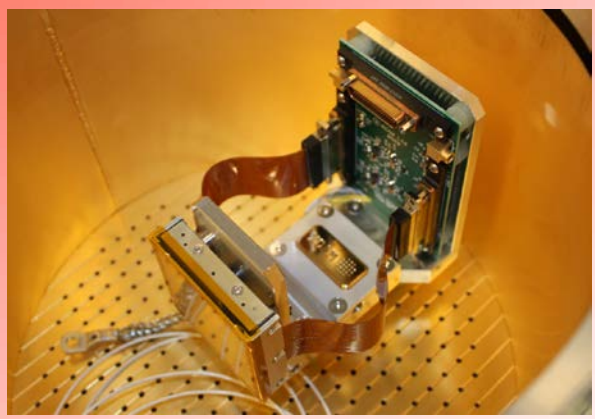
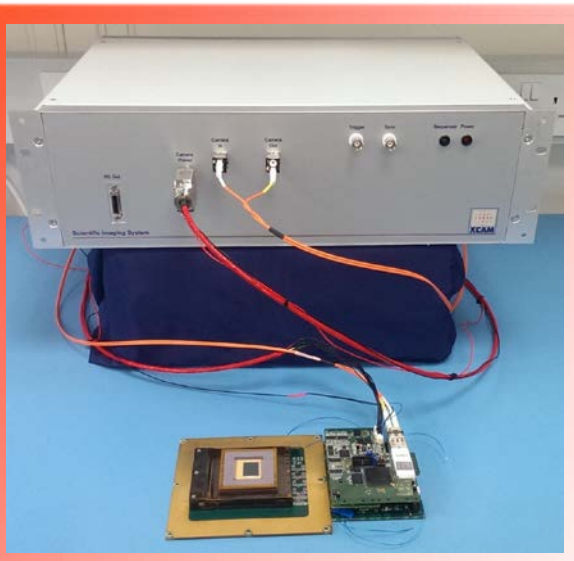


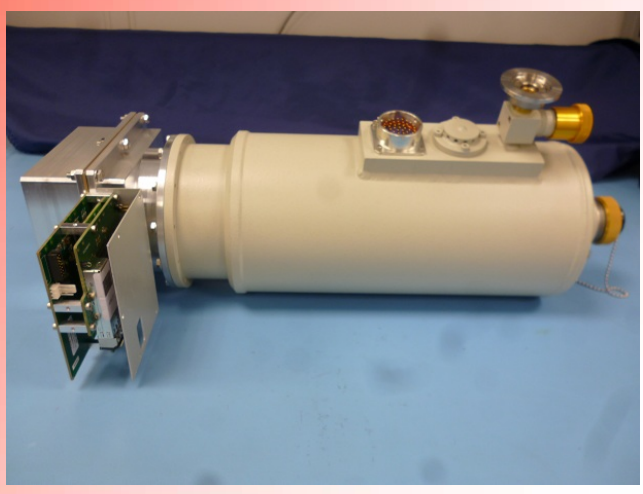


Detector Characterisation Systems – Built to Order

Detector Test and Characterisation System for the JUICE CMOS Sensor

- XCU-19D FO standard controller was used with a custom-designed parts to operate the CMOS sensor which is being developed for ESA's JUICE mission to investigate JUpiter's ICy moons.
- Customised headboard, cable, sequencer code, were developed for a low cost and quickly implemented test solution
- Achieved 4MHz readout rates with down to 3.9 electrons noise
- Later addition of cryogenic chamber with support metalwork enabled a full camera solution to enable cooled testing

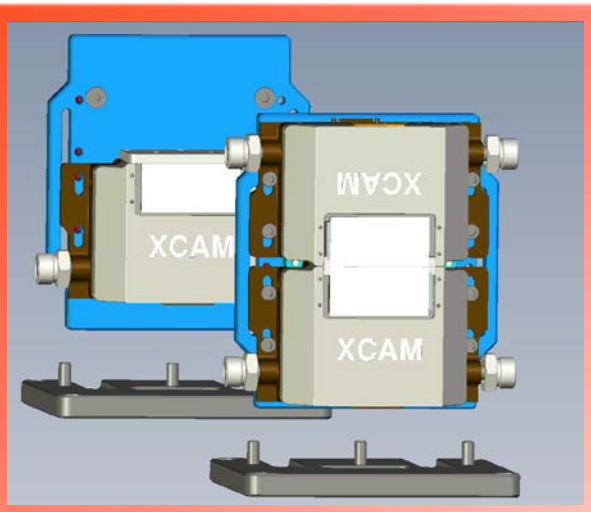


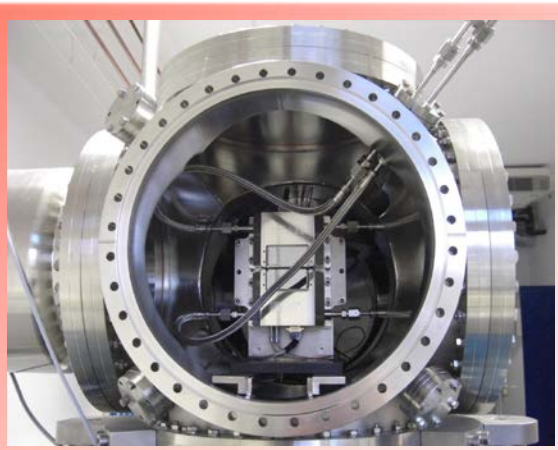


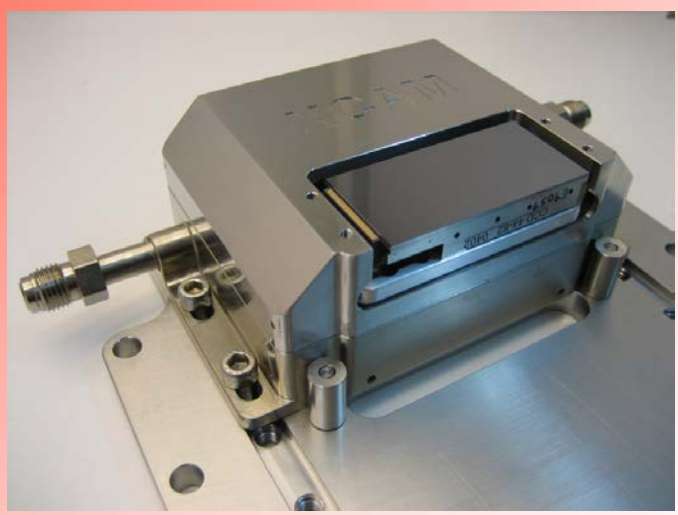
Customised Camera Systems – Built to Order

Triple CCD44-82 Camera made for the DESY FLASH XFEL

- e2v technologies CCD4482 built into a custom designed camera head
- Back-illuminated no AR coat device for soft X-ray detection
- Three camera head units operated synchronously to capture images
- Adjustable central slit for direct beam avoidance of detectors
- Two gain levels applied to the two halves of each CCD to enable extension of dynamic range
- Designed, manufactured and delivered in less than 6 months (delivered in 2008)
- Took the world's first diffraction images of the mimi-virus at DESY FLASH and went on to win the UK National Medilink Award for Innovation in 2012



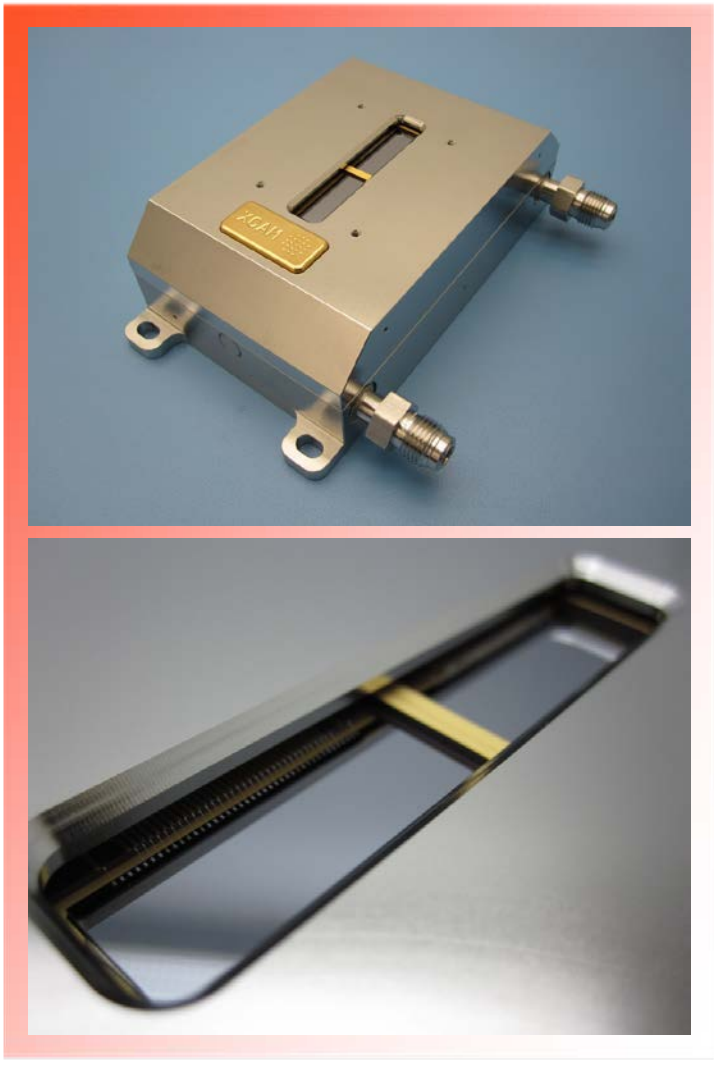




Customised Camera Systems – Built to Order

Dual CCD4210 camera head for readout of X-ray Grating Images

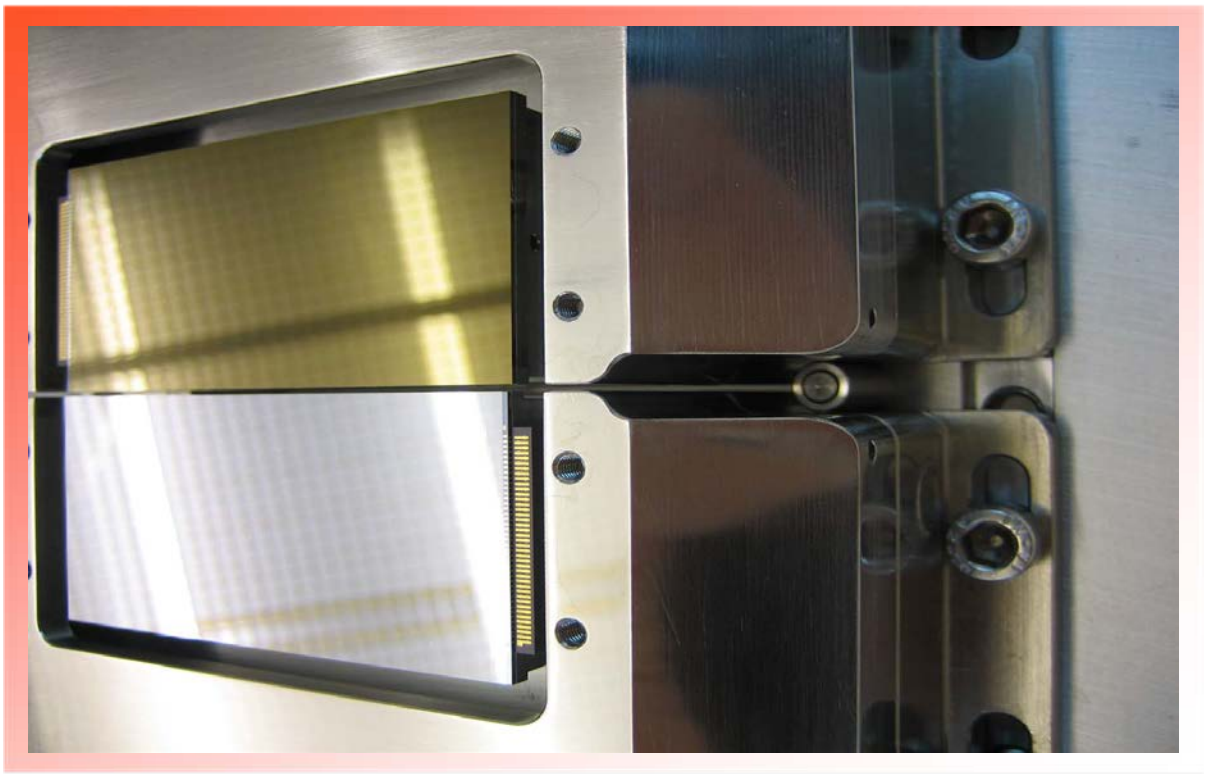
- Dual enhanced mode no AR coat CCD4210 built for X-Ray grating development.
- Two conventionally packaged devices butted close together for minimum inter-package gap
- Devices operating synchronously
- XCAM application software gives use the ability to handle both images separately or view as a single double-size image
- Customer returned to us for custom-design of a camera to fly in a NASA sounding rocket containing 4 x large area customised EMCCD with 1632x1608 16 micron pixels, back-illuminated no AR coating for soft X-ray



Detector Consultancy and Design

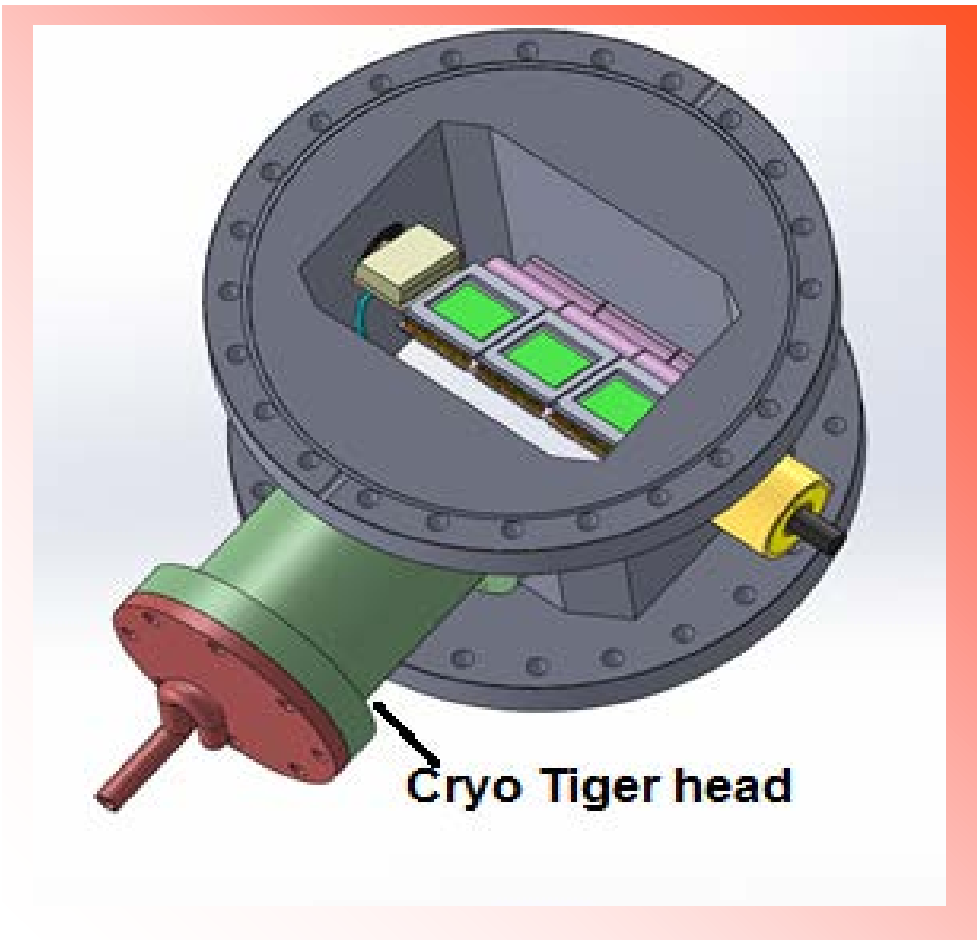
Design of a Custom Detector for Japanese X-ray Laser

- A returning customer asked us to work with him to establish if a custom-designed CCD would satisfy the requirements of a standard detector for the Riken SACLA XFEL facility.
- We conducted a number of experiments over 18 months, using off-the-shelf detectors, to test conventional CCD detectors to see if a customised version might be suitable.
- We concluded that a highly specialised, custom-designed detector could be suitable as a standard detector. The detector would operate at 50Hz frame rates, and have a 4Me- FWC in addition to being able to detect a single 6keV photon.
- We worked with our customer to assist with the development of a specification for the custom CCD.
- We contnued to support our customer with consultancy during the development phase of the detector attending meetings at e2v as required to provide independent input into the process.
- The detectors were manufactured and built into cameras of up to 8 detectors



RIXS Cam

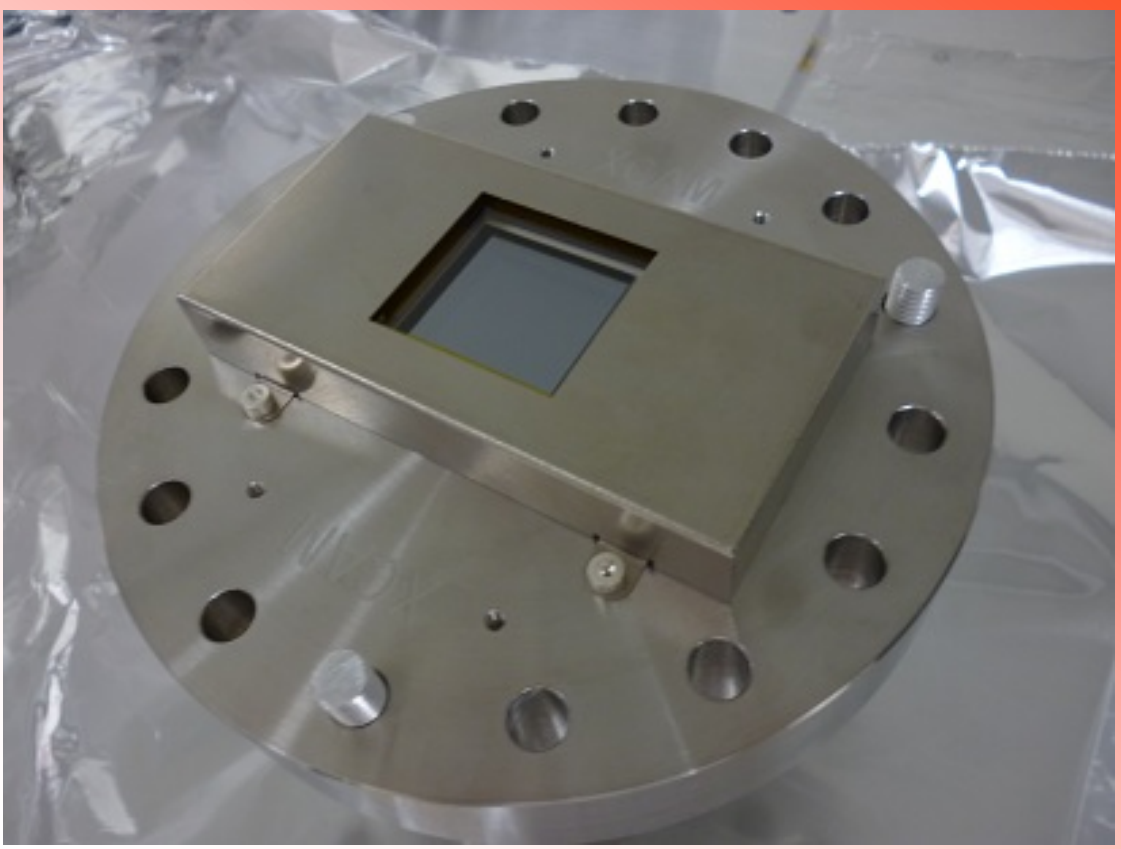
- A standard camera head design for RIXS (Resonant Inelastic X-Ray Scattering)
- Uses 3 custom electron multiplying detectors of 1632x1608 16 micron pixels, back-illuminated no AR coating for soft X-ray single photon detection
- Customised software algorithms enable detection of individual photons to within a fifth of a pixel
- Designed to interface to a DN150 port
- Cryogenic cooling for low dark current operation
- Adjustable CCD mounting platform to enable variation of CCD angle to beam



XCAM Standard Camera Range

Vacuum Cameras – Flange and Vacuum-Embedded

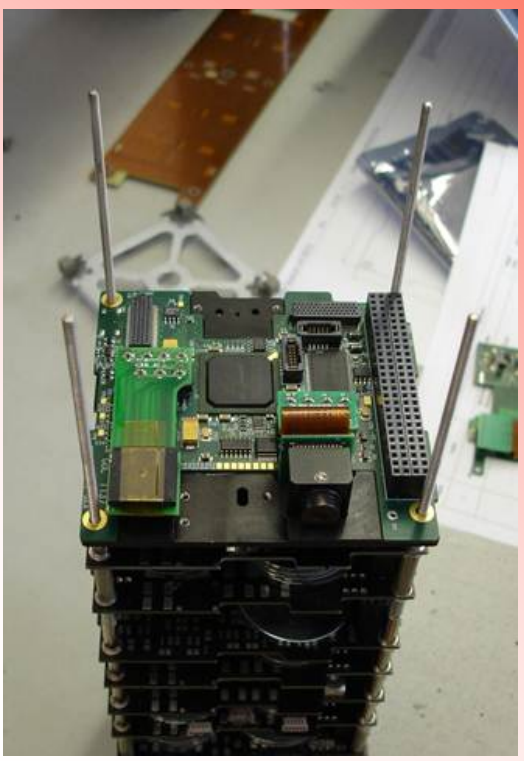
- Standard Vacuum Camera Range with a choice of detector on a conflat-style flange to interface to vacuum chamber directly or a hermetically sealed camera head to put inside your vacuum chamber with complete freedom of movement
- Designed for contamination-free vacuum operation
- Operate with XCU-A controller for very low noise slow speed operation or with XCU-19D FO controller for high speed multinode or with XCU-19EM FO controller for EMCCD operation
- Wide range of detectors available; easy and low cost to adapt to offer new detectors – please enquire.
- Easy and low cost to customise as required – please enquire



XCAM Space and Orbitonics

Cameras for Space Applications – Standard Cameras

- A standard CubeSatellite camera system is offered for space applications. This is the C3D camera system as flown on theUK Space Agencies UKube-1 satellite launched on 8th July
- Operates an e2v technologies Sapphire CMOS sensors with a wide field imager optics configuration
- Customisation or modification is available – please enquire



Cube-Satellite Image (rhs) courtesy of Clydespace Ltd

Customised Cameras for Space Applications

Customised camera in development to fly 4 off large area electron multiplying CCDs in a NASA sounding rocket due to be launched in 2017.
Please enquire with your requirements.

XCAM Software

XCAM Software Options

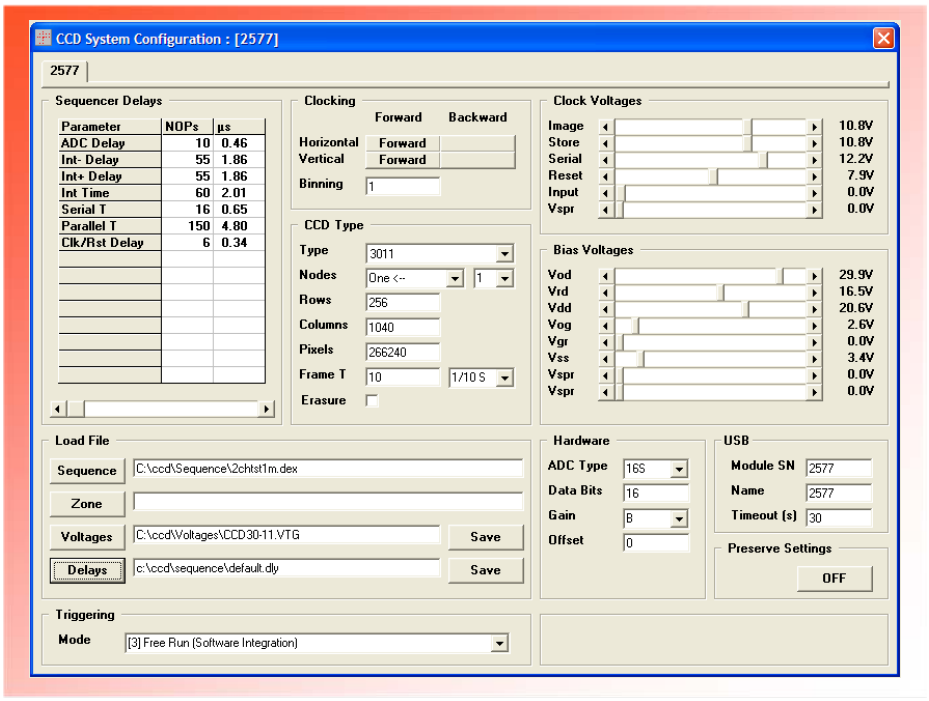
XCAM's ***Application User Software Package*** (API) provides users with an easy interface with which to control and communicate with the controller and do simple analysis and data visualisation; please see separate product note which covers the software in more detail.

Alternatively, a ***Software Developer's Manual*** is provided for users who would prefer to write or use their own software, calling the XCAM dll files.

Many XCAM Controller users, use programs such as ***Matlab*** or ***Python*** to control the drive unit, and a library of code is being developed to assist these users; sample code is made freely available on request.

The minimum specification for a PC to operate the system is Windows 7, XP Pro or Vista operating system; 2 GHz processor; 2 GB memory minimum; hard drive 100GB minimum; CD drive; 3 USB2 ports.

The controllers can be used to control custom multiple large area CCD camera systems synchronously in master-slave mode operation.



XCAM Building Blocks and Core Expertise

XCAM has core expertise in the following areas:

- ***Electronics design*** – enables us to design new parts to interface to your custom detectors or to meet your new requirements. New parts are designed in-house and manufactured at local suppliers usually in the UK.
- ***Mechanical design*** - enables us to design new camera heads to suit your requirements. Design is in-house, usually completed with sign-off of the customer if this is appropriate. Manufacture takes place at local suppliers in the UK.
- ***Software developmen***t takes place in house and ranges from the development of new sequencer code to operate special detectors, to the writing of new software to operate camera systems or implement special algorithms.
- ***Detector consultancy***.
- ***System integration and test***; whether systems are assembled entirely from existing subsystems we already have, or whether they need some or all new customised parts, a major part of the work we do is to integrate complete systems using both existing and newly designed parts. Factory and Site acceptance tests can be designed in conjunction with the customer to meet your requirements.

XCAM's Subsystems

- Controller boxes and associated electronics which are designed to provide all the clock, bias and signal processing requirements of CCDs, EMCCDs, SCDs and CMOS detectors. Use these building blocks to create your own semi-customised system
- Standard cables for interface to controllers and electronics
- A range of standard headboards to link specific detectors to specific controller types
- A range of camera heads which can often be used as is, or modified to be used with detetors other than those they were designed to be used with originally
- Software for easy operation of your system

XCAM Facilities

XCAM has the following facilities

- 2 class 1000 clean rooms: one reserved for UCV (Ultra Clean Vacuum) camera assembly for critical contamination control; the other for standard XHV/UHV camera assembly
- Class 1000 cable assembly area for clean assembly of vacuum cables
- ESD controlled electronics production and test facility
- Development laboratory for development of new electronics
- Mechanical prototyping workshop
- Wet-cleaning room for cleaning of parts prior to assembly

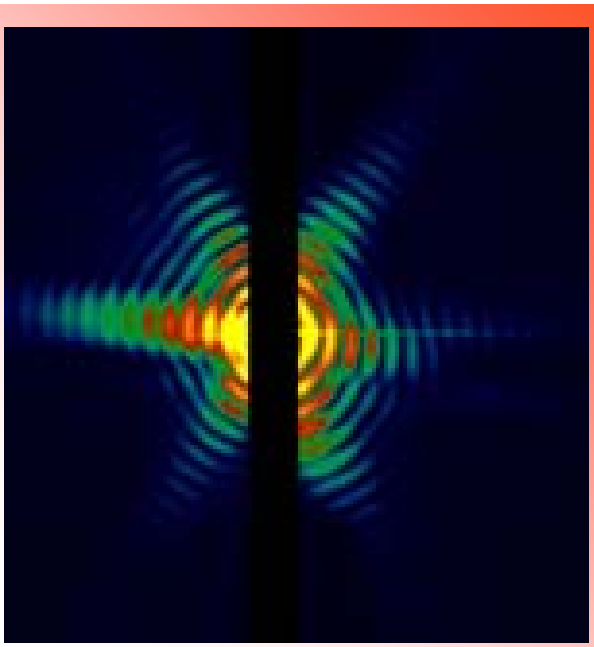
A Few References and Endorsements

This reference was written by Henry Chapman from DESY FLASH, Hamburg, Germany who ordered the Triple CCD44-82 Camera described earlier in this brochure

Henry wrote of XCAM:

We first made contact with XCAM in 2008 when due to circumstances we needed a unique camera system to be designed and built on extremely short timescales. XCAM listened to our requirements and understood our scientific needs, before rapidly producing a selection of custom camera options for us review. After discussions with them, we chose a design that would use 3 large area detectors that were originally designed for cryogenic operation as part of large astronomy focal plane arrays; XCAM designed and manufactured a custom vacuum camera capable of operating these detectors according to our specifications. The system was designed to be incorporated into our larger experiment and the camera could be controlled and operated together with shutters, light sources and other parts of our system.

This detector was crucial for the development of the field of single-particle diffractive imaging with X-ray free-electron lasers. This new technique is being developed to image biological objects such as viruses using intense flashes of X-ray light, as a way to out-run the effects of radiation damage which plague conventional methods such as X-ray or electron microscopy. The method is highly dependent on the capabilities of the radiation source, the particle "injector" that flows samples across the beam, and the detector, and all three of these technologies have been progressing in parallel. The early experiments at FLASH, using the XCAM detectors were crucial to carrying out successful measurements at LCLS.



They have also motivated an upgrade of the FLASH facility to achieve shorter wavelengths in the so-called "water window" where highest resolution images of virus particles could be achieved.

This unique camera saw first light in October 2008 and we have made good use of it ever since. The camera has been key in obtaining images of the giant mimivirus amongst other biological objects.

More recently we have loaned this special camera to a synchrotron in Trieste, Italy, who we collaborate with in the hope that they may make new discoveries with the camera too.

The image left shows the world's first diffraction image of the Mimi-Virus taken by Henry and his group using the XCAM camera system.

A Few References and Endorsements

This reference was written by Takaki Hatsui from the SACLA Riken facility in Japan. He wrote the text below relating to the detector design and consultancy work we conducted, described earlier in this brochure

Hatsui-San wrote of XCAM:

I am a team leader of the Data Acquisition team for the Japanese X-ray Free-Electron Laser (XFEL) project. http://www.riken.jp/XFEL/eng/index.html

My role is to construct the data acquisition infrastructure by 2011, which is the year that the first user time of our XFEL will be scheduled, giving birth to x-ray free-electron laser science. One of the key components of the experimental system is the 2 dimensional x-ray detector for XFEL. Without the detector, we will be in a situation where the laser beam illuminates a completely novel scientific field without us having the eyes to observe it. As the characteristics of XFEL light is so different from the light available from current x-ray generation technologies, we needed to establish the detector concept from scratch.

Before coming to Riken I was an assistant professor at Institute for Molecular Science, Japan, and XCAM worked with me at that time to build a unique camera based on an EM CCD for my soft x-ray experiment, achieving an unprecedented resolution of 3 microns. Having worked with XCAM previously, I realised that they had the expertise that I needed in order to investigate options for the XFEL detector. The collaboration with XCAM Ltd on the XFEL work started in 2007. At that time I had some simple equations telling me that custom CCD devices with a combination of state-of-the-art technologies would be a great option for our project. I was excited at the new idea, but I was also aware that there were many critical concerns, such as the device reliability under extremely brilliant pulsed x-ray irradiation, and the probability of performance degradation due to the as yet unknown physics involved in detecting ultra-short intense pulsed x-rays, which no human being had created before.

To address these concerns, XCAM Ltd worked with us to produce a complete survey of the current CCD technologies, and they completed feasibility studies, which included the production of a custom camera for the experiments, evaluation of radiation damage, which is critical in estimating the life of the devices, and recommendation of the custom device specifications.

Owing to the outstanding and unrivalled ability of XCAM Ltd, we successfully launched the development project of a novel CCD detector dedicated to our XFEL on March 18th, 2009. We all thank XCAM Ltd for their crucial and enthusiastic contributions.

Dr Takaki Hatsui,
Team Leader, Data Acquisition Team
XFEL Project Head Office, RIKEN
March 20th, 2009