

# Photonic Science

## X-Ray Imager — VHR

The X-Ray Imager — VHR is a Very High Resolution X-ray digital camera with direct coupled (micro) fibre-optic input and deeply cooled CCD. A high Quantum Efficiency (typically 45% @ 550nm), cooled CCD sensor is used with typical  $\Delta T$  of  $>35^{\circ}\text{C}$ , and the camera features a range of input taper sizes, fast 20MHz readout speed, on-chip pixel binning, sub-area readout and up to 4008 x 2672 pixel resolution at up to 12-bit digitisation (fast readout) or up to 16-bit digitisation with Fusion driver.

### Benefits

- ◆ 16 bit acquisition / 14 bit fast scan mode
- ◆ Very high antiblooming, shutterless operation
- ◆ High sensitivity without binning
- ◆ Large area with Very High Resolution
- ◆ Simple integration within existing hardware

### Performance

- ▶ Up to  $> 1.8$  full frames per second with standard fast 20 MHz driver, or greater with binning / sub-area (i.e. approx. 3.75 f.p.s. @ 2x2 binning giving effectively 2004 (h) x 1836 (v) pixels 18 micron square).
- ▶ Fusion driver with 16-bit image digitisation.
  - ◆ Actual dynamic range  $\approx 15$ -bits (RMS noise in darkness  $\approx 2$  ADU @ 16-bit / 10MHz digitisation)
  - ◆ Gives equivalent sensor full well capacity  $\approx 800,000 e^-$  per pixel
- ▶ Automatic dark subtraction and flat field division to give very high uniformity of offset and sensitivity across the image
- ▶ Geometric distortion correction to produce distortion-free images with highly uniform pixel size across the image
- ▶ User selectable video gain over nominal 4:1 range in 100 programmable steps
- ▶ Multistage thermoelectric CCD cooling plus air secondary cooling, with a typical stabilised  $\Delta T$  of  $>35^{\circ}\text{C}$ , reduces dark current to allow longer on-chip integration of up to  $> 10$  minutes.
- ▶ Resolution: Varies with input size and scintillator layer specification — see options



### Specification

- ▶ Fibre optic input bonded to CCD sensor
  - 150mm taper to 1:1 straight input
- ▶ On chip binning - user selectable: from 1 x 1 to 8 x 8
- ▶ Sub-area readout - user selectable in X and Y
- ▶ Progressive Scan Interline Transfer KODAK KAI-11000 CCD sensor
  - ◆ CCD sensor with typically  $>45\%$  QE @ 550 nm gives excellent sensitivity for the output of the scintillator.
  - ◆ 4008 (h) x 2672 (v) pixels, 9 microns square
  - ◆ Total CCD noise @ 20 MHz  $< 30 e^-$
  - ◆ Dark noise  $\approx 3 e^-$  / pixel/sec
  - ◆ Integral electronic shutter — user selectable exposure from 1 millisecc to  $> 10$  minutes
  - ◆ 10 and 20MHz readout versions, plus dual tap readout option
- ▶ CameraLink data output or LVDS with standard 10m data cable, or up to 100m with fibre optic cable
- ▶ Aluminium foil light exclusion membrane in front of scintillator layer
- ▶ Scintillator layer applied directly to input of (micro) fibre-optic coupler for maximum efficiency
- ▶ Scintillator: Polycrystalline layer of Gadolinium Oxysulphide with full range energy response from 5 keV to  $> 150$  keV:
  - ◆ Scintillator layer density: optimised to match optical pixel size, for resolution with 5–35 keV x-ray energies (alternative optimisation available).
- ▶ Mains input voltage: Via control unit — nominally 110 / 220 V ac auto-sensing
- ▶ Weight and dimensions: Vary with input taper, can be advised prior to shipment

## Included Items

### Hardware

Camera Head, power supply unit and user manual(s)

Interconnecting cables:

- ✦ Mains lead for control unit: 1.5m (standard)
- ✦ Control unit to camera head: 2m (standard)
- ✦ Camera to CameraLink frame grabber: 5m (standard)

### Software

Drivers, including Fusion driver, for Image Pro Express/ Image Pro Plus 5.1 (Windows 98, ME, NT4/ 2000 and XP) – Standard

Windows DLLs and PSLink library for end-user driver development – Standard

Drivers, including Fusion driver, for Labview 5.X (Windows '98, ME and NT4) – On request

### PC system minimum recommended specifications

Pentium 4 processor 1 GHz or better

128 MB RAM minimum (256 MB+ recommended)

100 MB+ minimum available hard disk space.

SVGA or better monitor with 16-bit, 24-bit or 32-bit True colour capability

CD-ROM and 3.5" floppy disk drive

One free fully PCI standard compliant expansion slot

### Cooling Option

Water secondary cooling option (in place of standard air secondary cooling): provides additional cooling to the CCD sensor to reduce dark current (thermal noise) to increase sensitivity in low flux applications

### Array Option

Array option of 2x1 camera with image area 166x123 mm — displayed as a single image



## Options

### X-Ray Imager-VHR 1:1 camera system with straight (micro) Fibre-Optic coupling

Active input area of 36 (h) x 24 (v) mm imaged on the sensor  
Optical pixel resolution at the input of 9 micron (no binning)  
Gadolinium oxysulphide scintillator layer density of 5 mg/cm<sup>2</sup> optimised for resolution with x-ray energies of 5–35 Kev  
Input taper ratio of 1:1 (Straight)

### X-Ray Imager-VHR 1:3 camera system with 14.5mm input (micro) Fibre-Optic taper

Active input area of 12.0 (h) x 8.0 (v) mm imaged on the sensor  
Optical pixel resolution at the input of 3 micron (no binning)  
Gadolinium oxysulphide scintillator layer density of 1.5 mg/cm<sup>2</sup> optimised for resolution with x-ray energies of 5–35 Kev.  
Input taper ratio of 1:3 (Magnifying)

### X-Ray Imager-VHR 60 camera system with 60mm input (micro) Fibre-Optic taper

Active input area of 49.9 (h) x 33.2 (v) mm imaged on the sensor  
Optical pixel resolution at the input of 12.5 micron (no binning)  
Gadolinium oxysulphide scintillator layer density of 5 mg/cm<sup>2</sup> optimised for resolution with x-ray energies of 5–35 Kev.  
Input taper ratio of 1.38:1 (De-magnifying)

### X-Ray Imager-VHR 75 camera system with 75mm input (micro) Fibre-Optic taper.

Active input area of 62.4 (h) x 41.6 (v) mm imaged on the sensor  
Optical pixel resolution at the input of 15.6 micron (no binning)  
Gadolinium oxysulphide scintillator layer density of 5 mg/cm<sup>2</sup> optimised for resolution with x-ray energies of 5–35 Kev.  
Input taper ratio of 1.73:1 (De-magnifying)

### X-Ray Imager-VHR 90 camera system with 90mm input (micro) Fibre-Optic taper

Active input area of 74.9 (h) x 49.9 (v) mm imaged on the sensor  
Optical pixel resolution at the input of 18.7 micron (no binning)  
Gadolinium oxysulphide scintillator layer density of 7.5 mg/cm<sup>2</sup> optimised for resolution with x-ray energies of 5–35 Kev.  
Input taper ratio of 2.08:1 (De-magnifying)

### X-Ray Imager-VHR 115 camera system with 115mm input (micro) Fibre-Optic taper

Active input area of 95.7 (h) x 63.8 (v) mm imaged on the sensor  
Optical pixel resolution at the input of 23.9 micron (no binning)  
Gadolinium oxysulphide scintillator layer density of 10 mg/cm<sup>2</sup> optimised for resolution with x-ray energies of 5–35 Kev.  
Input taper ratio of 2.65:1 (De-magnifying)

### X-Ray Imager-VHR 135 camera system with 135mm input (micro) Fibre-Optic taper

Active input area of 112.3 (h) x 74.9 (v) mm imaged on the sensor  
Optical pixel resolution at the input of 28.1 micron (no binning)  
Gadolinium oxysulphide scintillator layer density of 10 mg/cm<sup>2</sup> optimised for resolution with x-ray energies of 5–35 Kev.  
Input taper ratio of 3.11:1 (De-magnifying)

### X-Ray Imager-VHR 150 camera system with 150mm input (micro) Fibre-Optic taper

Active input area of 124.8 (h) x 83.2 (v) mm imaged on the sensor  
Optical pixel resolution at the input of 31.2 micron (no binning)  
Gadolinium oxysulphide scintillator layer density of 15 mg/cm<sup>2</sup> optimised for resolution with x-ray energies of 5–35 Kev.  
Input taper ratio of 3.46:1 (De-magnifying)

### Vacuum Option

Customer-specific, complete in-vacuum design or in-vacuum scintillator