# Scintillators for Andor high energy detection cameras

## Scintillator recommendations for Andor indirect detection detector platforms

### iKon-L HF CCD

| Best Resolution | | | Best Throughput | | |
|---|---|---|---|---|---|
| **Scintillator characteristics** | **Spatial resolution*** | **Energy range** | **Scintillator characteristics** | **Spatial resolution*** | **Energy Range** |
| **YAG:Ce 40 µm thick on 3 mm FOP** SCT-YAGCE-45-040-00 | > 15 lp/mm | Best suited for broad 2 - 100 keV range | **CsI:Tl 150 µm thick on 3 mm FOP** SCT-CSITLT-50-150-00 | ~ 10 lp/mm | Best suited for broad 10 - 100 keV range |
| **LuAG:Ce 40 µm thick on 3 mm FOP** SCT-LUAGCE-45-040-00 | > 15 lp/mm | Best suited for 10 -100 keV range | | | |

*Spatial resolution is given at 10% MTF for the entire system iKon-L HF, 1:1 fibre-optic plate and scintillator at 40 keV. Please note that spatial resolution will decrease at lower energies.

### Zyla HF sCMOS

| Best resolution | | | Best resolution/throughput balance | | | Best throughput | | |
|---|---|---|---|---|---|---|---|---|
| Scintillator characteristics | Spatial resolution * | Energy range | Scintillator | Spatial resolution * | Energy range | Scintillator characteristics | Spatial resolution * | Energy range |
| **YAG:Ce** 20 µm thick on 3 mm FOP **SCT-YAGCE -25-020-00** | >30 lp/mm | Best suited for broad 2-100 keV range | **YAG:Ce** 70 µm thick on 3 mm FOP **SCT-YAGCE -25-070-00** | ~ 20 lp/mm | Best suited for broad 2-100 keV range | **CsI:Tl** 150 µm thick on 3 mm FOP **SCT-CSITLT -50-150-00** | ~10 lp/mm | Best suited for 10-100 keV range |
| **LuAG:Ce** 20 µm thick on 3 mm FOP **SCT-LUAGCE -25-020-00** | >30 lp/mm | Best suited for 10-100 keV range | **LuAG:Ce** 70 µm thick on 3 mm FOP **SCT-LUAGCE -25-070-00** | ~ 20 lp/mm | Best suited for 10-100 keV range | | | |

*Spatial resolution is given at 10% MTF for the entire system Zyla HF, 1:1 fibre-optic plate and scintillator at 40 keV. Please note that spatial resolution will decrease at lower energies.

Absorption and Light yield characteristics of inorganic scintillators of interest

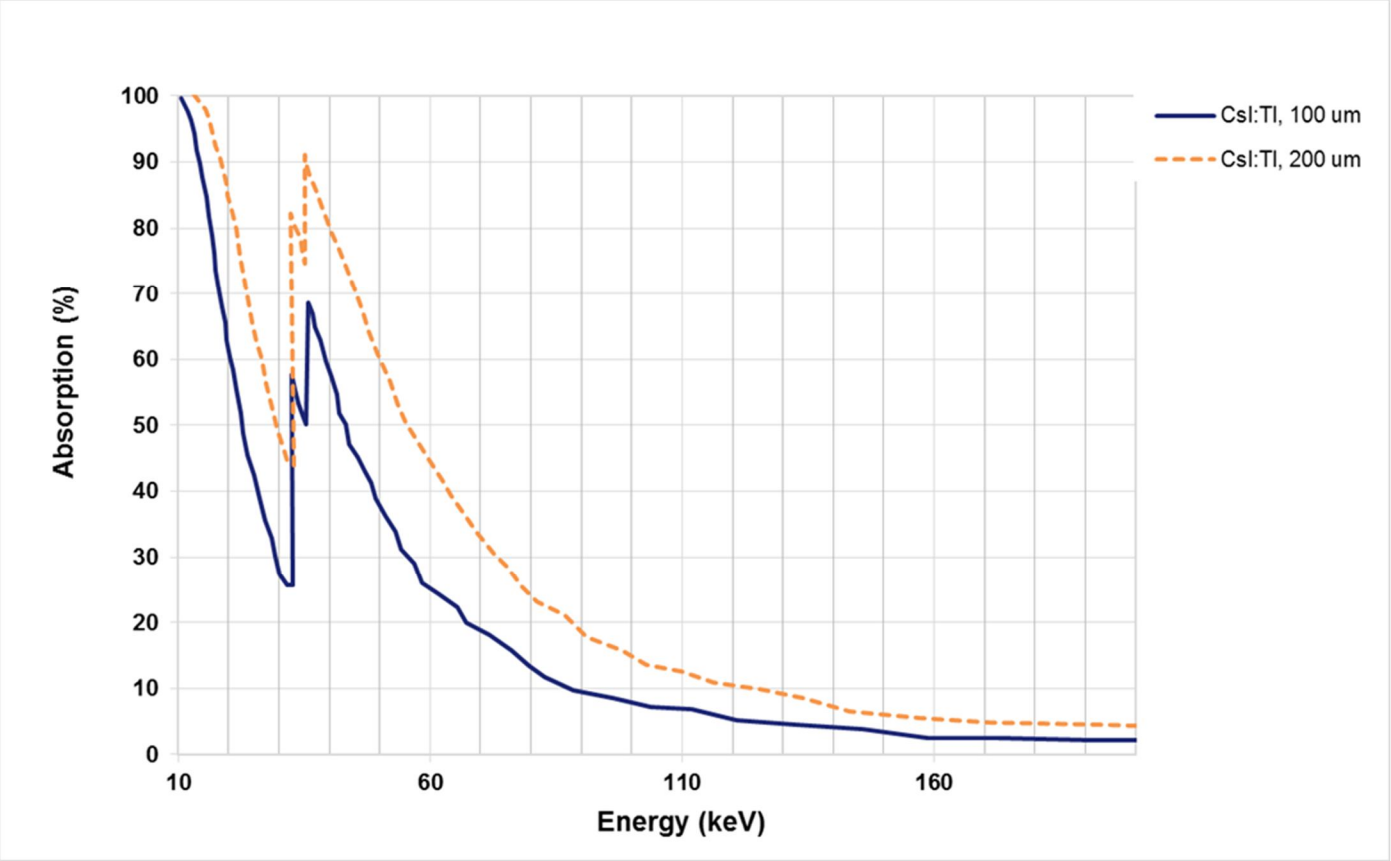
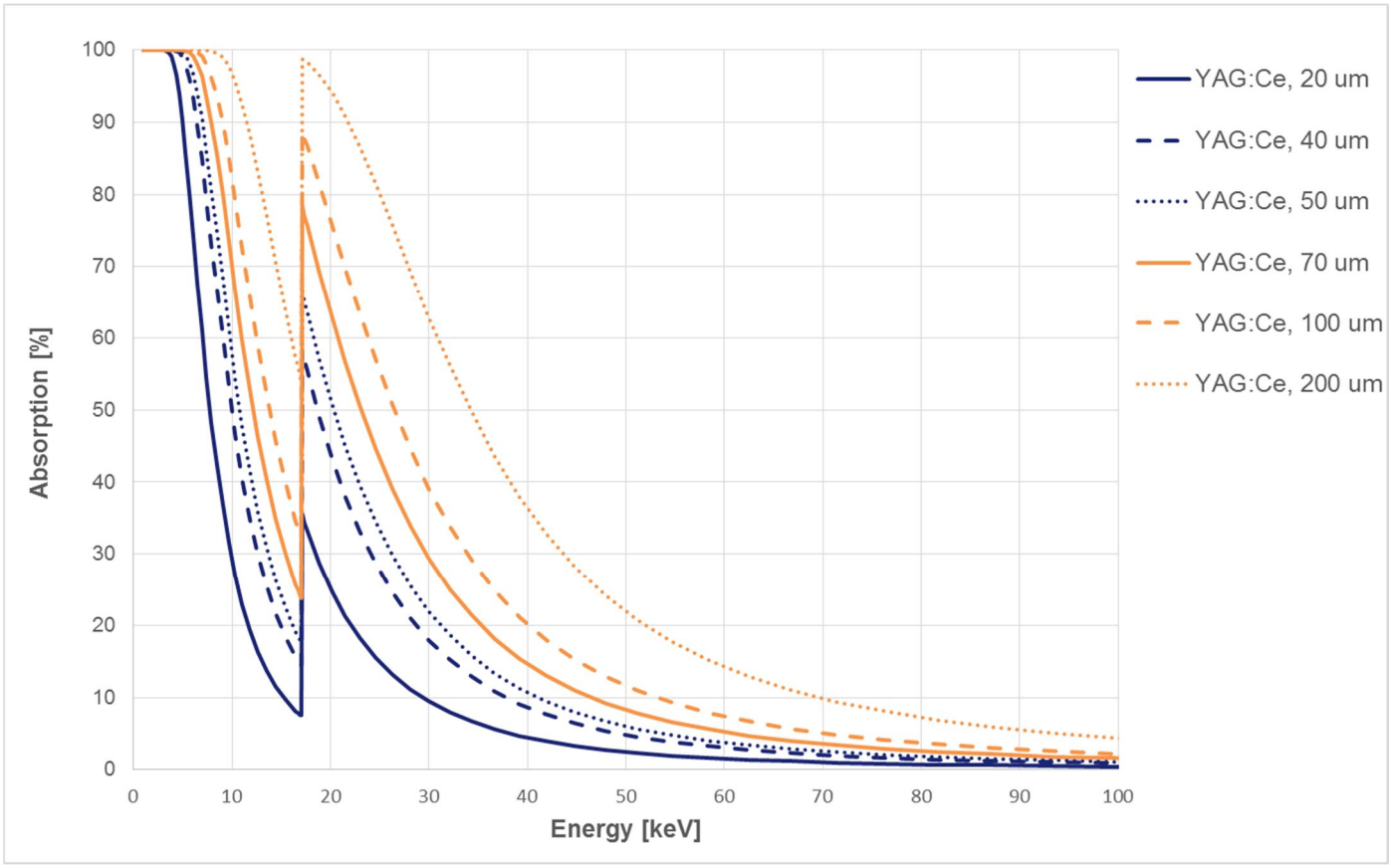



Figure 1 – CsI:Tl absorption characteristics versus incoming x-ray photon energy and material thickness (source Hamamatsu)

**Note**: most of the x-ray photons below 8 keV will be absorbed by the protection layer before reaching CsI layer.



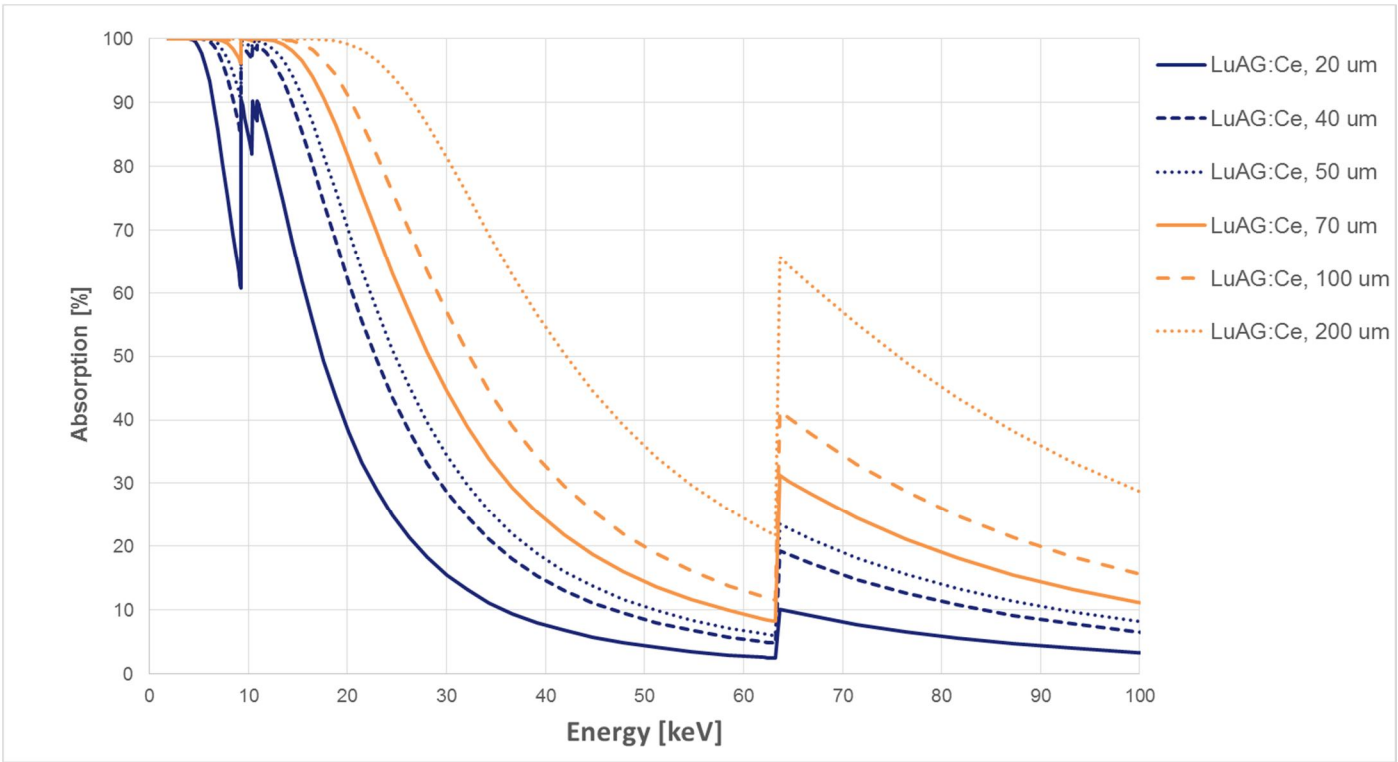




Figure 2 – Absorption characteristics of YAG:Ce (top) and LuAG:Ce (bottom) vs incoming x-ray photon energy and material thickness (courtesy of Crytur)

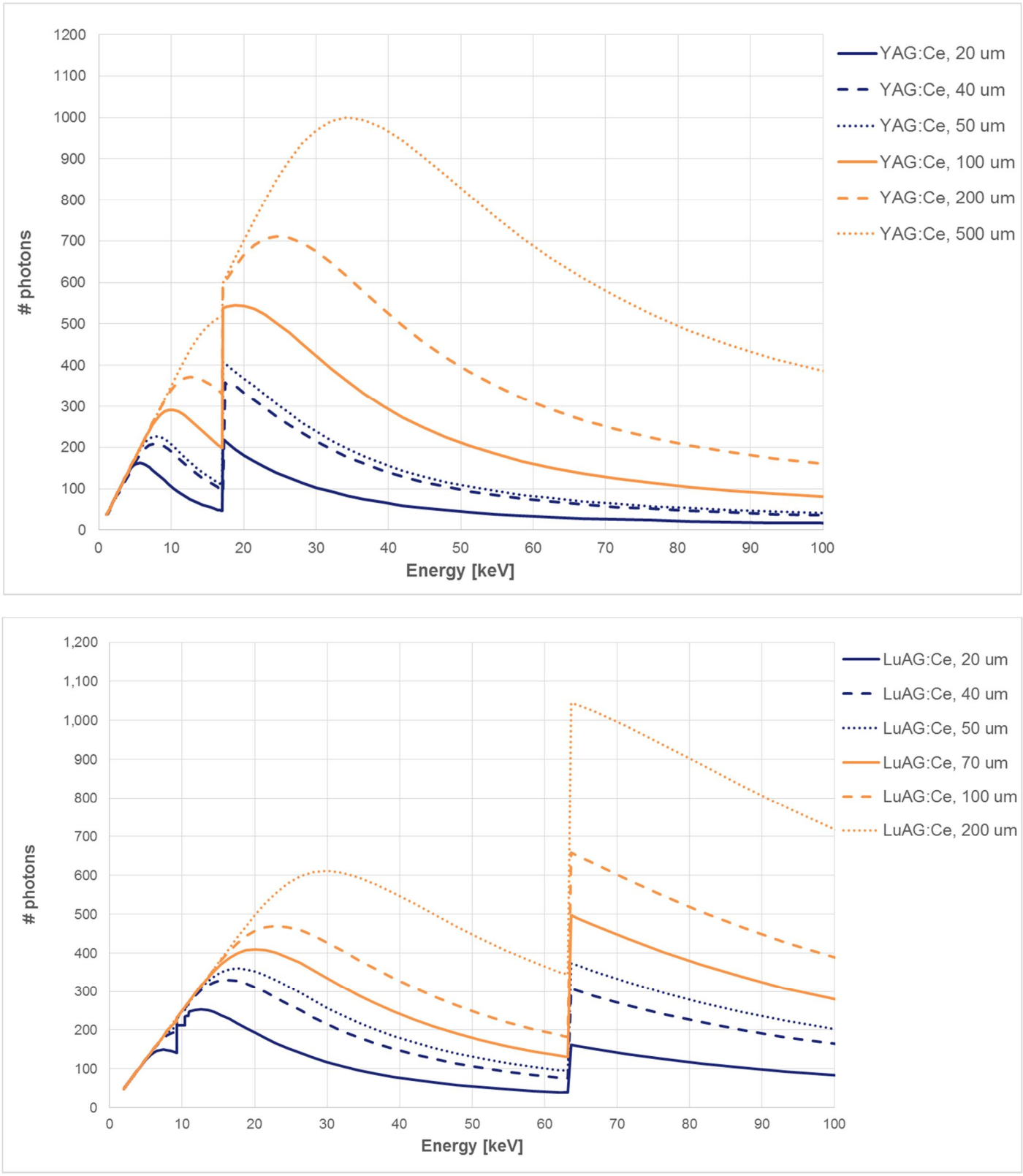



Figure 3 – Photon yield characteristics of YAG:Ce (top) and LuAG:Ce (bottom) vs incoming x-ray photon energy and material thickness (courtesy of Crytur)

## Spectral matching

The scintillator emission wavelength should be matched to the sensitivity of the detector. Quantum efficiency of typical CCD and sCMOS sensors are shown on Fig. 4 alongside the peak emission wavelength of scintillators of interest.

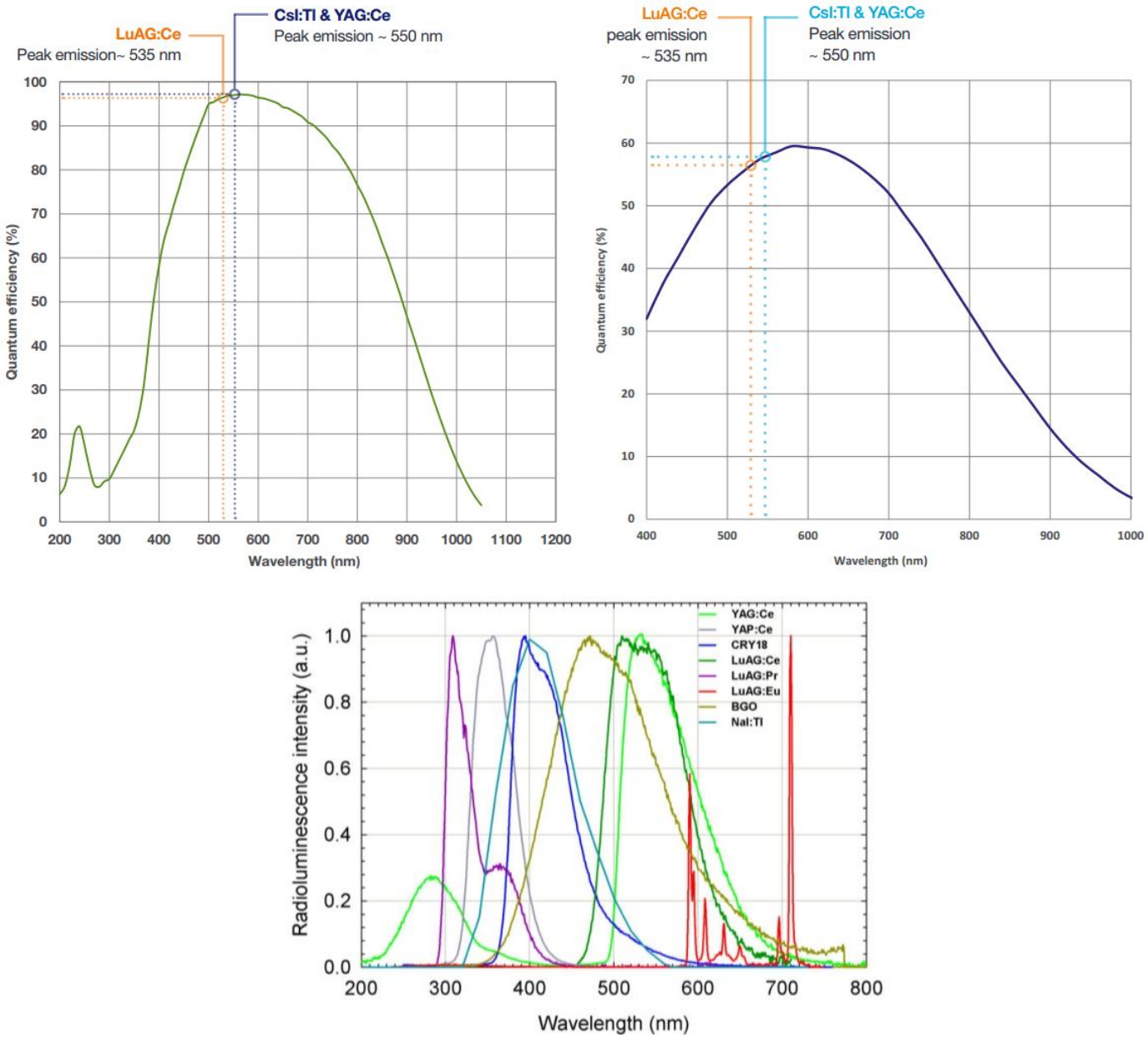



Figure 4 – Back-illuminated CCD (top left) and front-illuminated sCMOS (top right) typical Quantum Efficiency curves overlapped with peak emission wavelength of relevant x-ray scintillators. Bottom figure shows full spectral response of various scintillators including YAG:Ce & YAG:Ce types (courtesy of Crytur)

## Spatial resolution and throughput

A single scintillator does not typically simultaneously achieve high spatial resolution and high light throughput. Compromise on the scintillators properties (e.g. thickness) have to be made to favour one aspect over the other or achieve the best balance between the two. The figure below shows an example of a high spatial resolution image obtained with a Zyla-HF sCMOS coupled to a high resolution 20 µm YAG:Ce scintillator and a high throughput 150 µm CsI:Tl scintillator. To achieve similar intensity with the two configurations, the exposure time for the high resolution scintillator had to be 100 times higher than for the high throughput option.

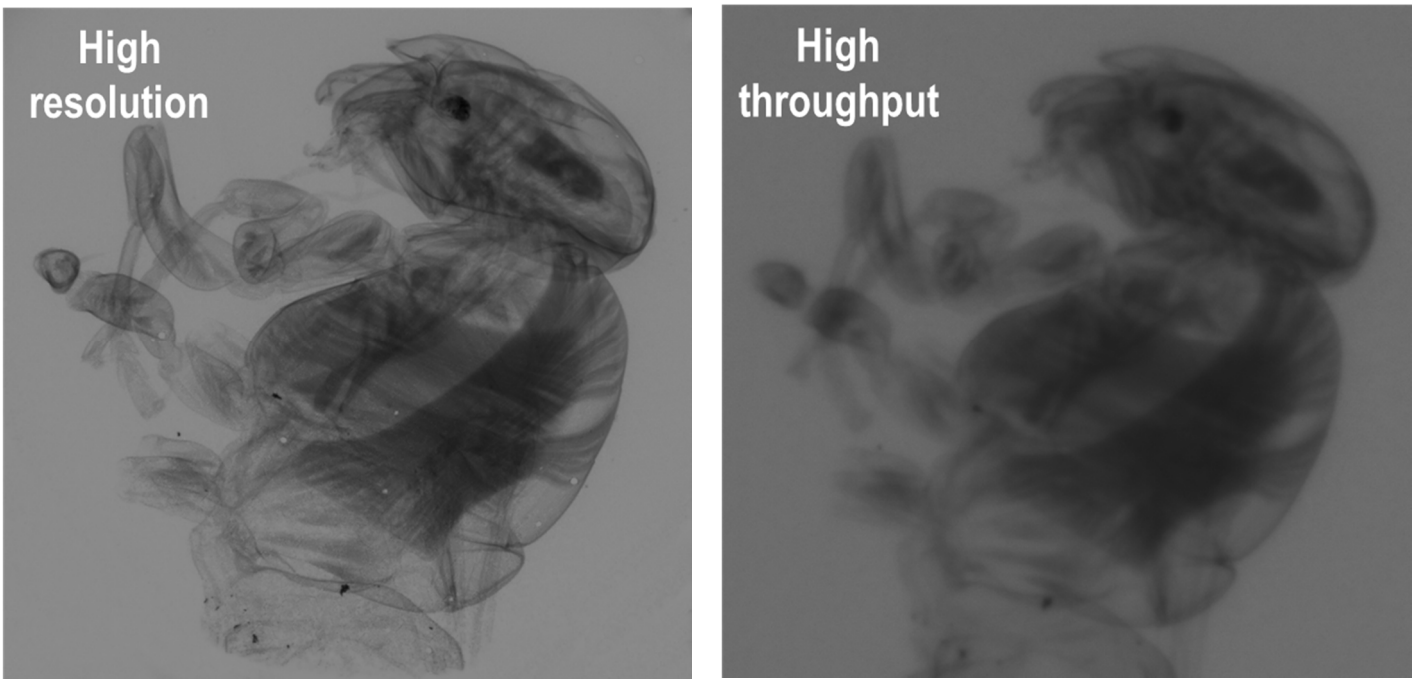



Figure 5 – X-Ray image of a wasp taken with a 40 kV X-ray source, courtesy of Crytur.
Left: Zyla-HF fibre-coupled to a 20 µm YAG:Ce scintillator, 10s exposure time.
Right: Zyla-HF fibre-coupled to a 150 µm CsI:Tl scintillator, 0.1s exposure time.

# Technical note

ANDOR
an Oxford Instruments company

## Andor ‘Fibre-optic’ ‘HF’ camera platforms


iKon-L HF CCD platform


Zyla HF sCMOS platform

| Detectors for imaging | iKon-L DF936N-FB | Zyla-HF | |
|---|---|---|---|
| | | ZYLA5.5X-FO | ZYLA5.5B-FO |
| Sensor technology | CCD | Scientific sCMOS (sCMOS) | |
| Sensor format | 2048 x 2048 matrix<br>13.5 µm pixels<br>e2v CCD 42-40 | 2560 x 2160 matrix<br>6.5 µm pixels | |
| Sensor size | 27.6 x 27.6 mm | 16.6 x 14.0 mm | |
| Sensor options | Back-illuminated, front-illuminated | Front-illuminated | |
| Minimum TE-cooling temperature | -35 °C | 0 °C | |
| Maximum full frame rate | 0.95 fps | 100 fps | 40 fps |
| Pixel well depth | 100,000 $e^-$ | 30,000 e- | |
| Output node capacity well depth | 1,000,000 $e^-$ | n/a | |
| Readout noise | 4.9 $e^-$ @ 50 kHz | 2.4 $e^-$ [Global shutter] | |
| Data range | 16-bit | 12 and 16-bit | |
| PC interface | USB 2.0 | Camera-Link 10-tap | USB 3.0 |

Table **1** – Andor ‘fibre-optic coupled’ cameras key specifications

## Andor ‘Fibre-optic’ ‘HF’ cameras accessories

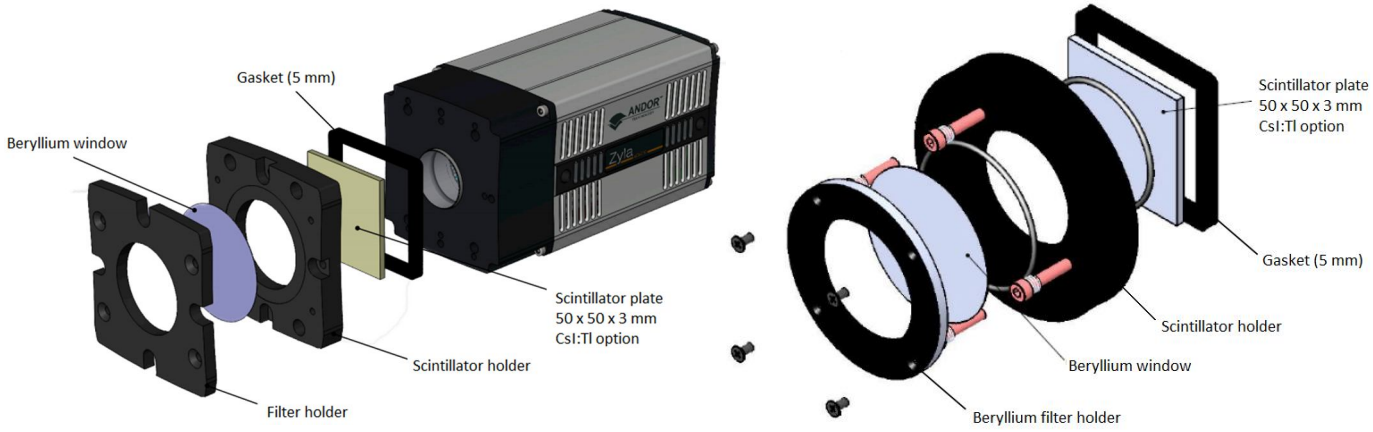



Figure 6 – Zyla-HF (left) and iKon-L HF (right) filter and scintillator holders configuration with a 50 x 50 x 3 mm CsI:Tl scintillator; configuration is slightly different to accommodate the circular YAG:Ce and LuAG:Ce scintillators

| Camera platform | Scintillator and filter holder | Standard scintillators compatibility | Standard filter compatibility |
|---|---|---|---|
| Zyla-HF | **SCT-FLT_HLD-C025ZYL**<br>*Ø25.4 x 3 mm scintillator*<br>*Ø45.5 mm filter* | **SCT-LUAGCE-25-0xx-00**<br>**SCT-LUAGCE-25-0xx-AL**<br>**SCT-YAGCE-25-0xx-00**<br>**SCT-YAGCE-25-0xx-AL** | **ACC-OPT-02839**<br>Ø45.5 mm Be filter, 250 µm thick<br>[minimum recommended thickness: 200 µm]* |
| | **SCT-FLT_HLD-H050ZYL**<br>*50 x 50 x 3 mm scintillator*<br>*Ø45.5 mm filter* | **SCT-CSITLT-50-150-00**<br>**SCT-CSITLR-50-150-00** | |
| iKon-L | **SCT-FLT_HLD-C045IKL**<br>*Ø45 x 3 mm scintillator*<br>*Ø60 mm filter* | **SCT-LUAGCE-45-0xx-00**<br>**SCT-LUAGCE-45-0xx-AL**<br>**SCT-YAGCE-45-0xx-00**<br>**SCT-YAGCE-45-0xx-AL** | **ACC-OPT-03838**<br>Ø60 mm Be filter, 250 µm thick<br>[minimum recommended thickness: 200 µm]* |
| | **SCT-FLT_HLD-H050IKL**<br>*50 x 50 x 3 mm scintillator*<br>*Ø60 mm filter* | **SCT-CSITLT-50-150-00**<br>**SCT-CSITLR-50-150-00** | |

Table 2 – Standard scintillator and filter holders for Andor fibre-optic ‘HF’ platforms
(*xxx* denotes the scintillator thickness)

* available through CSR – thinner windows carry increased risks of breakage, long-term stress

# Q&A

What information should be provided for custom scintillator?

| Parameter | Value | Notes |
|---|---|---|
| **Camera platform** | | e.g. Zyla-HF, iKon-L HF |
| **Radiation type** | | e.g. x-ray photons, electrons, neutrons |
| **Energy range of interest** | *keV - keV* | e.g. 0.1 keV to 50 keV |
| **Importance of detector spatial resolution** | | e.g. high, medium or low importance, or ideally provide target resolution in lp/mm or µm |
| **Importance of photon yield (from scintillator)** | | e.g. high, medium or low importance |
| **Grounding** | | Should be considered when electric charges could build up on the scintillator, e.g. electron signal detection in TEMs |
| **Low energy radiation filtering** | | Yes/No, cut-off energy (keV), fixed/removable filter – certain types of scintillators can be manufactured with a filter (e.g. Al) directly bonded to the device surface |