YXLON.Products

Digital flat-panel detectors from the series Y.Panel XRD

Products from the series Y.Panel XRD allow YXLON to offer digital flat-panel X-ray detectors with which a much greater detectability for detail can be achieved than has been the case using traditional film technology.

Flat-panel detectors from the Y.Panel XRD series are available in two sizes, each of which has two pixel sizes, as well as different construction designs. The individual models have been optimized for a variety of applications: whether for low-energy applications such as testing CFRP components or for inspecting welding seams using energies up to 450 kV, each demands a special design.

Products from the series Y.Panel XRD have proven their suitability for industrial deployment. Leading manufacturers in the aviation and automotive sectors use these detectors as a substitute for film technology and/or for the fully automated inspection of cast parts in three-shift operation.

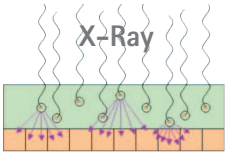
YXLON. The reason why.

- **highest inspection certainty due to excellent detail detectability**
- **reduction of inspection times due to resolution of a large material thickness range in one image**
- **low-noise images at short exposure times due to high degree of efficiency**
- **long product lifespan safeguards investments**

YXLON. The reason why

Principle behind Y.Panel XRD

The active area of a flat-panel detector from the Y.Panel XRD series consists of a thin glass panel onto which a matrix of photoelectric diodes and a scintillator layer have been applied.



Quanta of X-rays generate light quanta in the scintillator layer which, in turn, are converted into electrical signals by the photo-electric diodes. As a final step, analog-digital circuits depict the "gray-scale value" that is transmitted for each individual pixel to the PC for further processing.

The electronical and mechanical design of the Y.Panel XRD take short analog signal connections into consideration on the one hand, while enabling the sensitive electronics to be effectively shielded against X-ray radiation on the other.

Image quality

In terms of gauging, image quality can be quantified using different image quality identifiers (IQIs). Image quality depends on

- the signal-to-noise ratio (SNR)
- contrast sensitivity ("depth-of-field resolution")
- the dynamic range (simultaneously depictable material thickness range in one image)
- spatial resolution (effective pixel size)
- image lag
- internal scattering radiation

When designing a good flat-panel X-ray detector, the intended application later on must first be taken into account, then a compromise has to be found between all parameters cited.

Signal-to-noise ratio (SNR)

The SNR has considerable influence on detail detectability, here for example on the visibility of a 1T hole in the case of an IQI in compliance with ASTM E1025:

With strong image noise the 1T is no longer detectable:

The SNR of an image taken using a digital flat-panel detector is defined by:

- the noise from the electronics
- the noise quanta from the X-ray source
- the "structural" noise of the flat-panel detector ("fixed pattern noise")

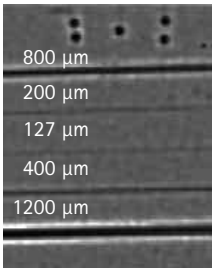
The noise from the electronics has been minimized via appropriate electronics design. Unavoidable noise quanta – dependent upon the X-ray source and application involved – are reduced through integration via several images ("frames") in the image-processing PC.

The equally unavoidable structural noise of the flat-panel detector arises due to the slightly different efficiency of individual photoelectric diodes.

All of this expresses itself in a "pattern" within the image which can be compensated for only through multistage calibration, for example by using Y.IMAGE software. That way a homogenous image is obtained, even in the case of different doses of X-rays.

Contrast sensitivity

Y.Panel XRD has a 16-bit analog-digital converter and supplies an image containing a maximum 65,536 shades of gray.



When combined with a high signal-to-noise ratio, the high contrast sensitivity makes sure that even details below the pixel size are visible in the image.

The following high-pass filtered image was taken using a Y.Panel XRD0840 and a geometric magnification of approximately 1. The pixel size is 400 µm, the diameter of the longitudinal bore in the center merely 127 µm.

Dynamic range

In practice, differences in contrast to 0.2% can be resolved using a Y.Panel XRD detector for alloyed steel with a thickness of 1.25 to 12.5 mm. All that the EN 462-3 standard requires in this area is a minimum 1.5% for Class B.

Shortest exposure times amounting to one second or less are sufficient to achieve the 1.5% required by the EN 462-3 standard.

Spatial resolution

A detector's spatial resolution is measured using a platinum duplex wire in compliance with EN 462-5.

In practice, spatial resolution depends on the combination of pixel size and scintillator materials, including their thickness.

YXLON offers detectors from the Y.Panel XRD family with different scintillator thicknesses that are adapted to the application involved and the pixel size.

The scintillator material used here permits comparably thin layers. That way the negative effect of light scattering into adjacent pixels is prevented for the most part. In the case of the Y.Panel XRD0820 Universal detector with a pixel size of 200 µm, a real spatial resolution of typically 200 µm is achieved during measurement in compliance with the standard; in the case of the Y.Panel XRD0820 Composite, the size is even smaller.

Afterglow (Image lag)

So-called "image lag" – the contours of the inspection item appear in the image even though the item is no longer being X-rayed – is minimized as a result of the electronics design.

The scintillator used furthermore prevents the negative effect of so-called "image burn-in".

Advantages Y.Panel XRD vs. film technology

The use of digital detectors in inspection technology has many advantages as opposed to film technology:

- Distinctly shorter inspection time
- Cost savings in terms of archiving
- Elimination of chemicals and waste-water disposal
- Fast and economical transmission of inspection results to customers and suppliers
- Flaw detection with certainty due to better image
- Digital image enhancement options

In comparison to image plate scanning systems, digital flat-panel detectors offer:

- Greater inspection certainty due to images with significantly lower noise
- No mechanical "back and forth" with the plate while X-raying
- Time savings due to immediate image feedback

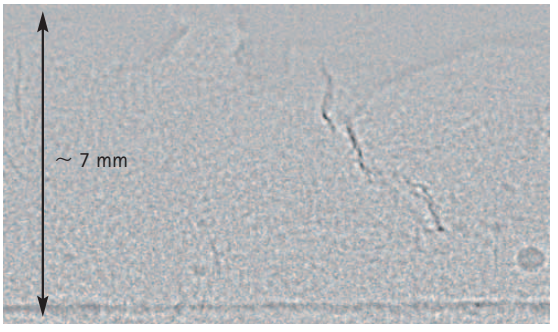
Image quality Y.Panel XRD vs. film technology

The geometric resolution of fine-grain film from the C1 Class (in compliance with EN584-1) amounts to 50 µm and less. Since work with digital flat-panel detectors is performed as a rule using geometric magnification factors of 3 to 4, at a pixel size of 200 µm the local resolution is 70 µm and less.

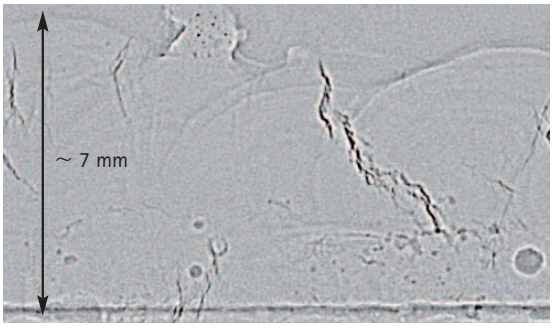
However, using the Y.Panel XRD a normalized SNR of 1000 and more can be achieved while that range lies between only 200 to 250 in the case of the film mentioned above.

Detail detectability is thus clearly better in the case of digital flat-panel detectors. A crop taken from an image of a welding seam is exemplary of this. The image has been high-pass filtered for clearer illustration:

Film from C1 Class (SNR_{Norm} = 246)



Y.Panel XRD1620 Universal (SNR_{Norm} = 1040)



Y.Panel XRD vs. image enhancer

Detail detectability of this kind is not required when inspecting cast parts in the automotive industry. An important aspect there is the throughput rate for inspected items.

Here is where the superior contrast sensitivity and high dynamic range of the Y.Panel XRD come to bear.

Even areas of the inspection item with a large difference in material thickness can thus be tested with assurance in just one step, while several images would have to be taken using an image enhancer.

Product lifespan

YXLON has inspected its Y.Panel XRD detectors during an extensive test of their useful product life. The result is that they are being deployed today for three-shift operation in fully automated inspection systems with no problems at all.

Despite this, like image enhancers, flat-panel detectors are parts subject to wear and tear that degrade due to ionizing rays.

YXLON offers special maintenance programs to increase your planning security with regard to investments in replacements. Should you require further information, our Service department is gladly available to help you.

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Pixel specification

Y.Panel XRD detectors are selected according to an YXLON specification and offered as two different product lines.

Contrary to the usual course of action on the market (especially in the case of TFT panels for computer monitors), not only "dead" or constantly glowing "hot" pixels are specified, but those whose dose-to-signal behavior, noise, dark current or lag either exceeds or falls below certain values, too.

The gray-scale value of these "underperforming pixels" is calculated with the help of adjacent pixels using Y.IMAGE software, whereby, in accordance with the specification, sufficient correctly functioning adjacent pixels are available to work with.

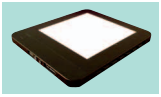
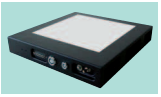
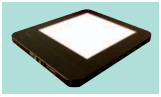
Scope of delivery

The scope of delivery for Y.Panel XRD includes

- Power supply unit, AC and DC cables
- Data cable
- Imaging PC (tower or 19" rack-mount housing)
- Framegrabber
- Y.IMAGE 3500 image processing software, see separate data sheet

Options

- Passive cooling element for convection cooling
- Cooling element for water cooling

	Y.Panel XRD0820 Composite	**Y.Panel XRD0820 Universal / Y.Panel XRD0820 High Energy**	**Y.Panel XRD01620 Universal**	**Y.Panel XRD0840 Universal / Y.Panel XRD0840 High Energy**	**Y.Panel XRD01640 Universal**
					
Main Application	CFRPs, GFRPs and other polymer plastics	Applications where the highest detail detectability is called for, e.g. substitute for film for the materials aluminum, titanium and high-grade alloyed steels, as well as CT applications		Applications where very good detail detectability is called for, e.g. automated cast-parts inspection, as well as CT applications	
Sensor					
Active pixels (min.)[1]	1000 x 1000	1000 x 1000	2000 x 2000	500 x 500	1000 x 1000
Usable area	200 x 200 mm²	200 x 200 mm²	400 x 400 mm²	200 x 200 mm²	400 x 400 mm²
Pixel size (pitch)[2]	200 µm	200 µm	200 µm	400 µm	400 µm
Detector					
Energy range	15 keV - 160 keV	40 keV – 225 keV / 40 keV – 450 keV	40 keV –15 MeV[3]	40 keV – 225 keV / 40 keV – 450 keV	40 keV –15 MeV[3]
Max. frame rate	7.5 fps	7.5 fps	3.5 fps	15 fps	15 fps
Analog-digital conversion	16 bit				
Afterglow (Image lag)	< 6% (1st frame)				
Product lines	"Standard" and "Special"[4]				
Environmental conditions					
Environmental temperature (operating)	+15 °C to +35 °C				
Air humidity (operating)	30% to 70%				
Mechanical data					
Housing (W x H x D)	335 x 320 x 52 mm³	335 x 320 x 52 mm³	672 x 599 x 44 mm³	335 x 320 x 52 mm³	672 x 599 x 44 mm³
Weight	approx. 16 kg	approx. 16 kg / approx. 22 kg	approx. 25 kg	approx. 16 kg / approx. 22 kg	approx. 25 kg

[1] Photoelectric diode matrix size is 512 x 512 or 1024 x 1024 or 2048 x 2048

[2] Pitch indicates the distance to the center of photoelectric diode areas. The photoelectric diode edge length is smaller.

[3] Sufficient lead shielding is necessary in each case.

[4] The product lines "Standard" and "Special" refer to the number and pattern of so-called "underperforming pixels". Compared with customary product lines on the market, the "Standard" line is already subject to clearly stricter specifications.

Data subject to change without notice.
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