High resolution radiographic detector

W. Dziewiecki, M. Matusiak, S. Wronka

National Centre for Nuclear Research (NCBJ), Poland

Narodowe Centrum Badań Jądrowych Świerk

One of the most important elements in indirect X-Ray imaging detector [1] is the scintillator. Scintillator converts X-Rays to visible light which is transmitted through the mirror system and optics elements to CMOS/CCD camera. Schematic view of fluoroscopic detector is presented in Fig. 1.
The scintillator type has an important influence on the most important detector's parameters such as sensitivity or resolution.

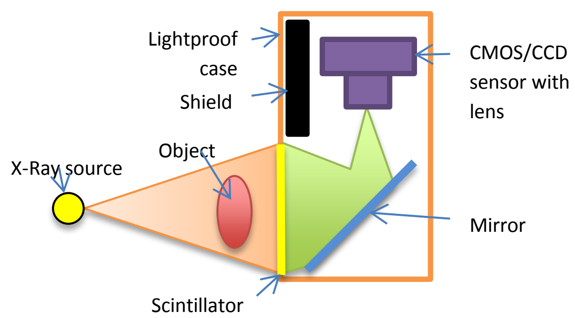

Fig.1. Schematic view of fluoroscopic detector [2]

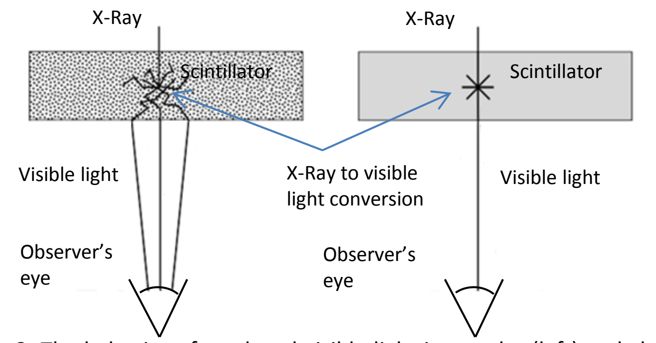

Fig.2. The behavior of produced visible light in powder (left) and clear crystal scintillator (right) [3]

Many scintillation materials exists in powder form. The powder however, has quite important disadvantage in comparison with a clear crystal scintillator: it is not transparent thus visible light is spread out in scintillator's structure, as presented in Fig. 2. In effect, powder scintillators are not good candidates for high resolution detectors. Real resolution in commercially available planar scintillators is typically 150-200µm, and the required resolution in most inspections is down to 50µm.
To avoid this phenomenon scintillator may be pixelated – scintillator is divided into small parts by a non-transparent medium – those parts are called „pixels".
To make high resolution scintillator possible, a pixelated matrix has been found, i.e. a modified GEM foil [4]. GEM foil is a kapton foil covered by copper on both sides. Holes are etched with photolithographic techniques. Classical GEM foil has a hourglass-shaped holes, but the modified GEM foil has a barrel-shaped holes (Fig. 3). It allows for larger amount of powdered scintillator, Gd_2O_2S:Tb in each hole.
To remove blank areas between holes GEM foil's, specially designed micro-movement is used during every exposition (Fig. 4). It allows for higher resolution images than physical dimension of hole- and gap between holes.

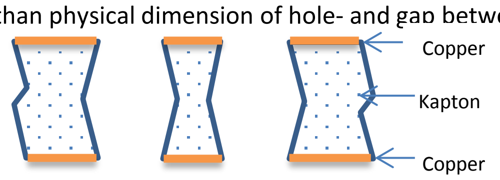

Fig.3. Shapes of classical GEM foil with hourglass shaped holes (top) and modified with barrel-shaped holes (bottom).

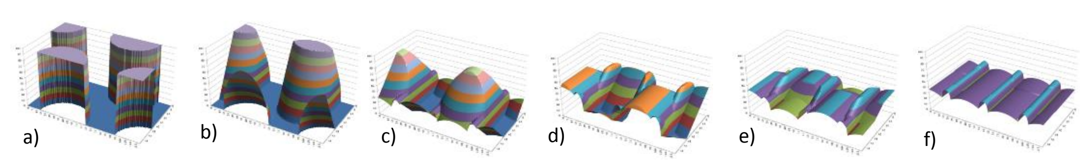

Fig.4. Simulation of the cumulated light-emission from the detector during GEM foil's micro-movement (a – stationary, b, c, d, e, f – increasing movement range during exposition)

A fluoroscopic, high resolution detector's schematic construction is presented in Fig. 5. 1 - GEM-foil converter, 2 – circular moving engine, 3 – construction frame, 4 – tension springs, 5 – mirror, 6 – CMOS camera with lens, 7 – shield, 8 – lightproof case.
To measure an effective detector's resolution, the EN-462-5 indicator was used [5]. This indicator consists of few separated pairs of thin wires . To estimate the resolution, profile of the indicator's X-ray is made and gaps between wires are measured. A gap larger than 20% of wire's peaks is accepted.
Profiles of EN-462-5 indicator's X-image acquired with high-resolution detector and standard resolution detector are presented in Fig. 6. A difference between standard and high resolution detector is clearly visible – from D9 resolution (130µm) to D12 resolution (63µm).
In Fig. 7. radiograms of camera acquired by standard 200µm resolution detector and high resolution fluoroscopic detector with profiles are presented.
Conclusions: New scintillator allows to obtain high resolution images, much better that standard, commercially available radiographic detectors.

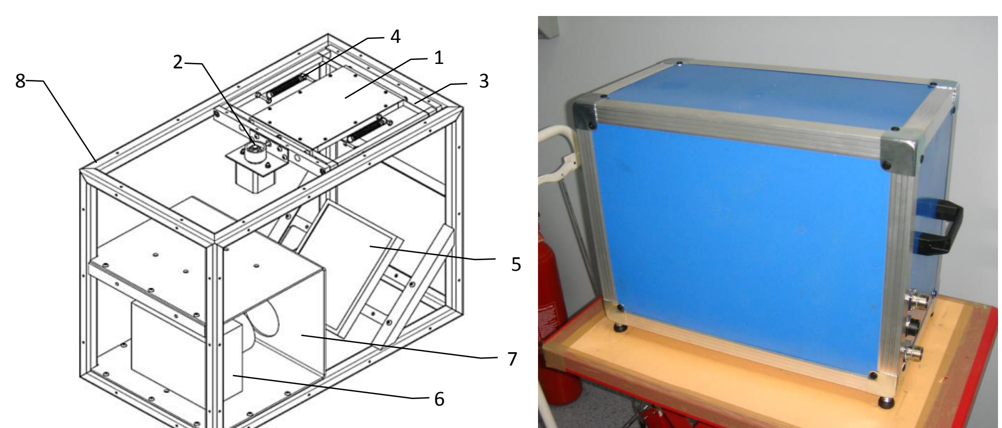

Fig.5. Fluoroscopic detector's schematic construction and photo of detector

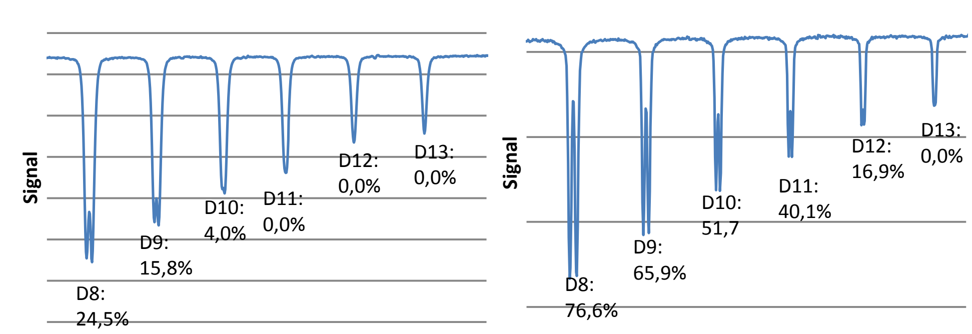

Fig.6. Profiles of EN-462-5 indicator acquired by a standard-resolution detector (left) and high-resolution detector (right).

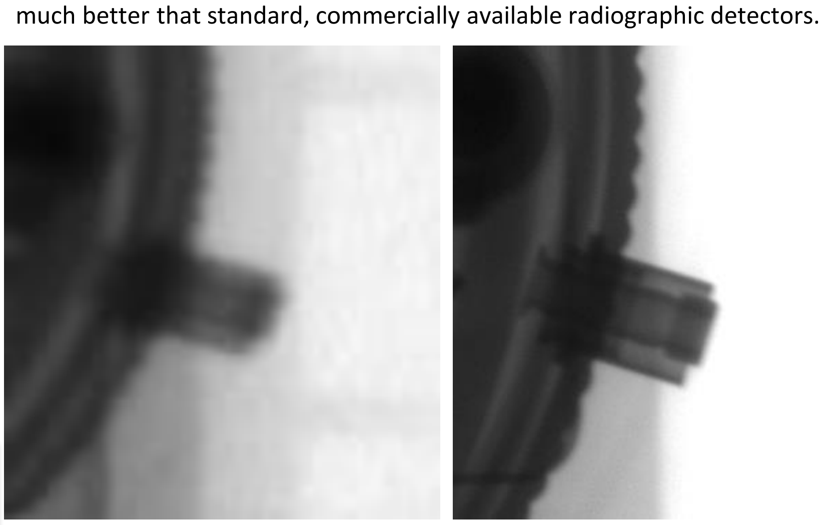

Fig.7. Part of radiogram acquired by standard 200µm resolution linear detector (left) and high resolution fluoroscopic detector (right)

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