



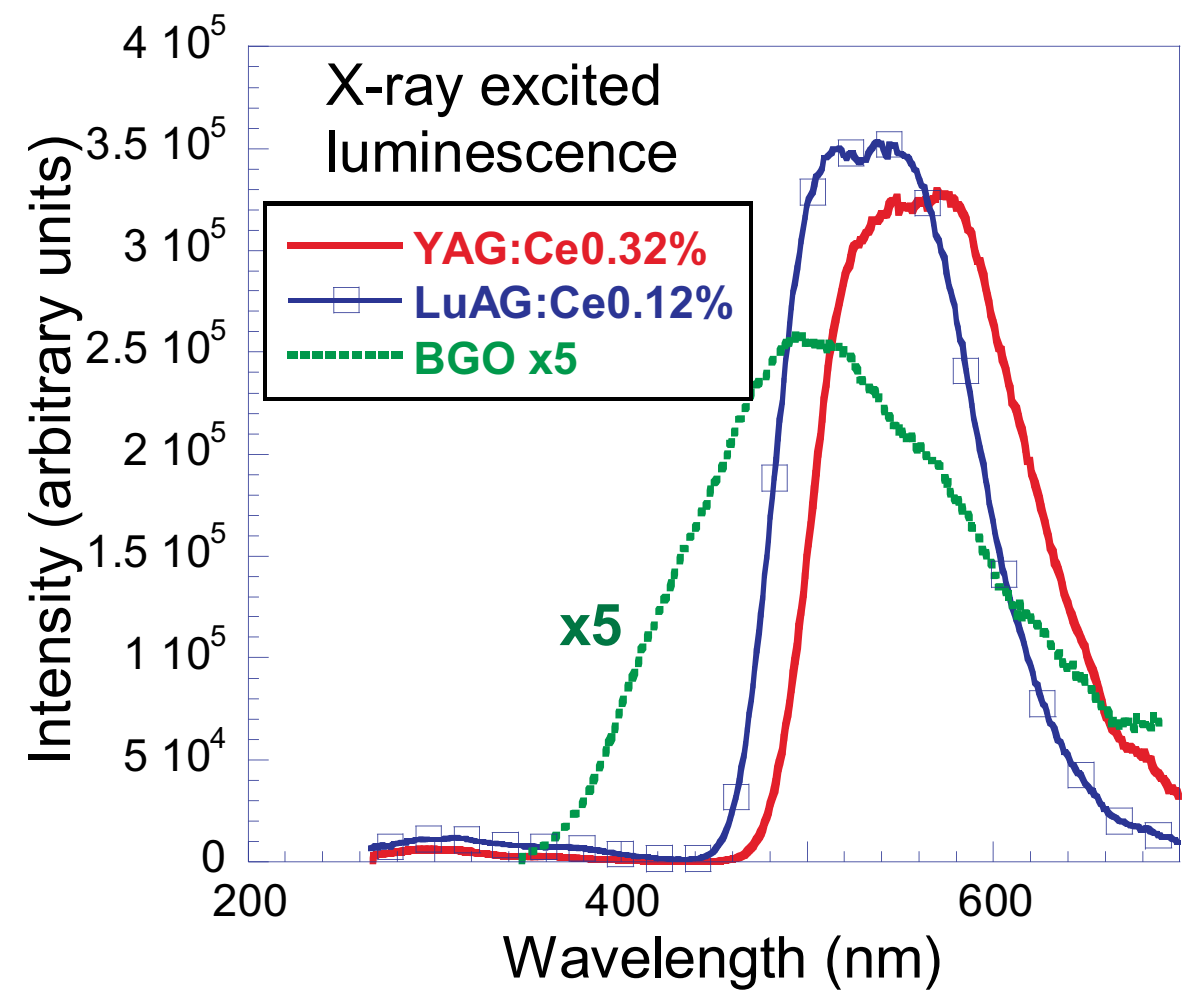
Evaluation of a CCD X-Ray Imaging Detector with the Medipix2 Detector

J. Tous, K. Blazek / Crytur Ltd., 511 01 Turnov, Czech Republic

J. Zemlicka, J. Jakubek / IEAP, Czech Technical University in Prague, Horska 3a/22, CZ 12800 Prague 2, Czech Republic

Recently, different types of digital X-ray imaging sensors are used in high resolution X-rays microradiography. The aim of this work is to compare a CCD camera equipped with single crystal scintillator with Medipix2 and Flat Panel detectors. Spatial resolution and contrast ratio are compared. Carbon fibres (light weight material) is used to compare the sensitivity of the detectors.

Single Crystal Scintillation Imaging Screens with X-Rays Digital Camera



Yttrium and Lutetium aluminum garnets activated by cerium are fast scintillators with excellent mechanical and chemical resistance. YAG:Ce ($Y_3Al_5O_{12}$) and LuAG:Ce ($Lu_3Al_5O_{12}$) scintillation detectors are the preferred choice for electron microscopy, beta and X-ray counting, as well as for electron and X-ray radiography imaging screens.

High resolution X-ray imaging digital camera is a combination of a high sensitive digital CCD camera and an optical system with a thin scintillator imaging screen. CCD is charge integrating device. Scintillator converts X-rays into visible light collected by the optics.

Very thin (down to 5 microns) screens of YAG:Ce and LuAG:Ce are used in imaging applications requiring high spatial resolution.

The CCD sensor has 4050 x 2630 square pixels of 9 μ m. Sensor area is 36 mm x 24 mm. Camera has 16-bit output.



High-Resolution X-Rays Imaging Digital Camera



High-Quality YAG:Ce Single Crystal



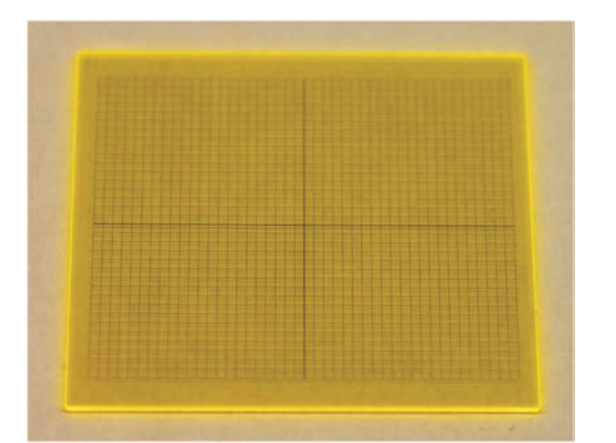
5 μ m Thin YAG:Ce Screen



Thin YAG:Ce Screen on FOP

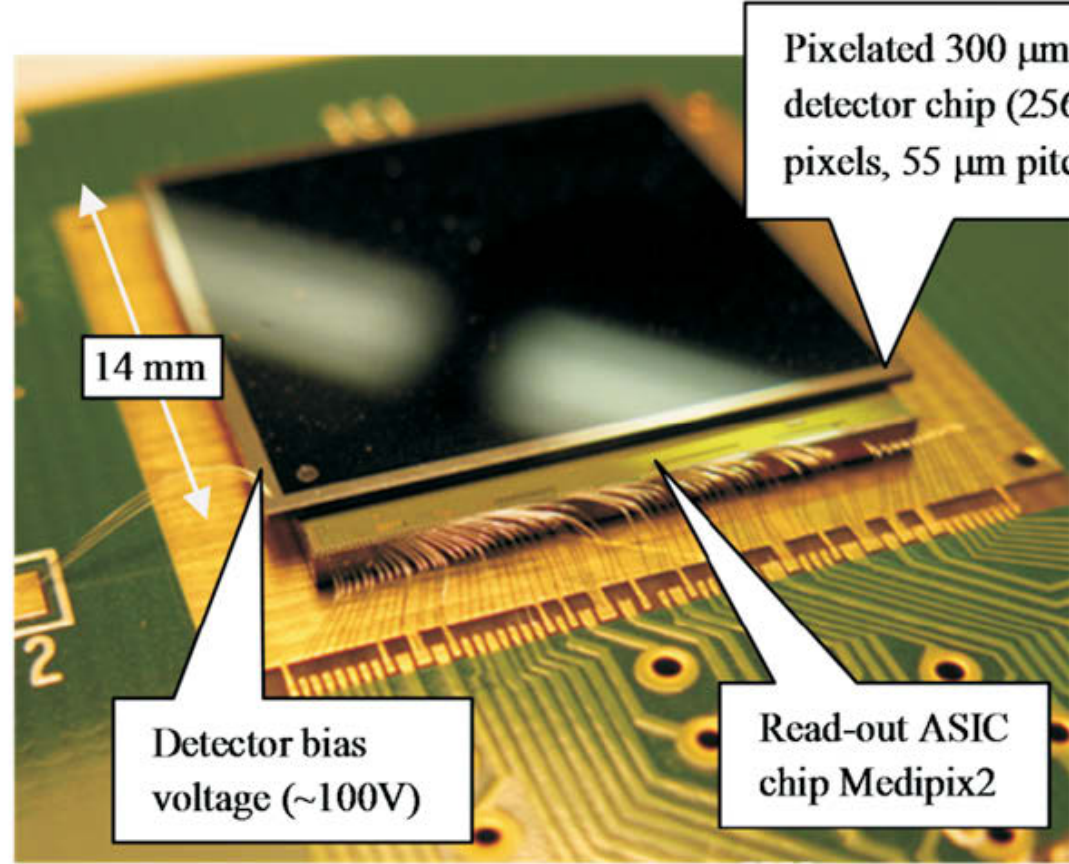


Thin YAG:Ce Screen on Alumina Frame



LuAG:Ce Screen with a Grid

Medipix2 and Flat Panel Imaging Detectors



Medipix2 Device

Medipix2 is a hybrid semiconductor device that consists of two chips: The pixelated sensor chip (usually 300 μ m thick Silicon) and the read-out chip. Each pixel is connected to its respective preamplifier, double discriminator and digital counter integrated on the readout chip.

Medipix2 has 256 x 256 square pixels with a pitch of 55 μ m. The sensor size is 14 mm x 14 mm.



Hamamatsu C7942CA-22 Flat Panel

Flat panel is comprised of a sensor board and a control board. Mounted on the sensor board is a CMOS image sensor chip made up of a two-dimensional photodiode array. A CsI scintillator plate is mounted on the photodiode array. Fluorescence light generated in the scintillator enters the diodes.

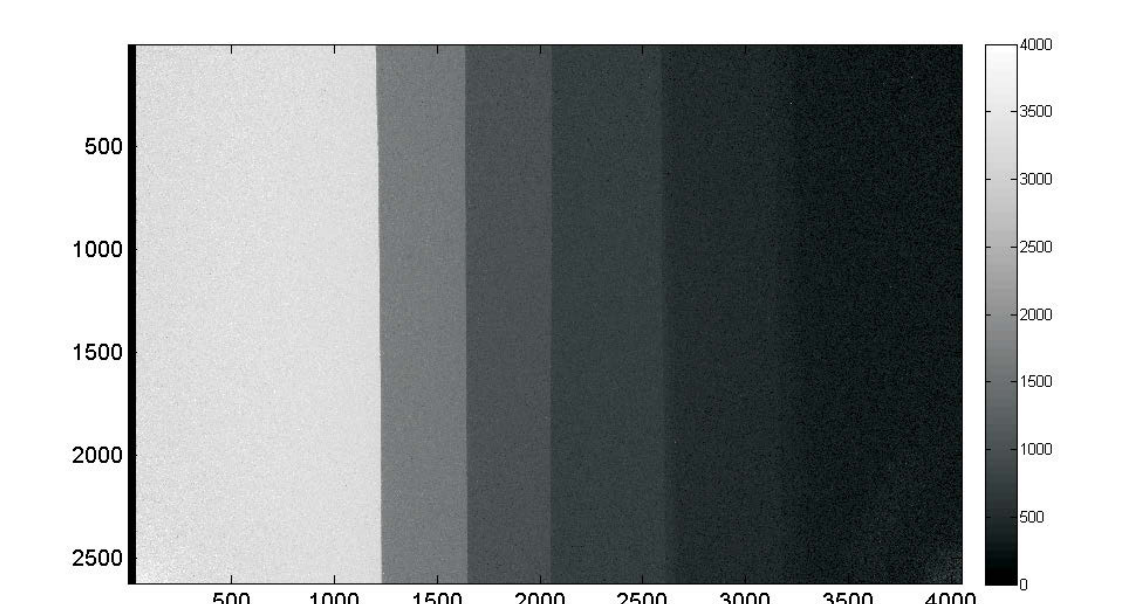
Flat panel has 2400 x 2400 square pixels of 50 μ m. The sensor size is 120 mm x 120 mm. Digital output is 12-bit.

Measurement Results

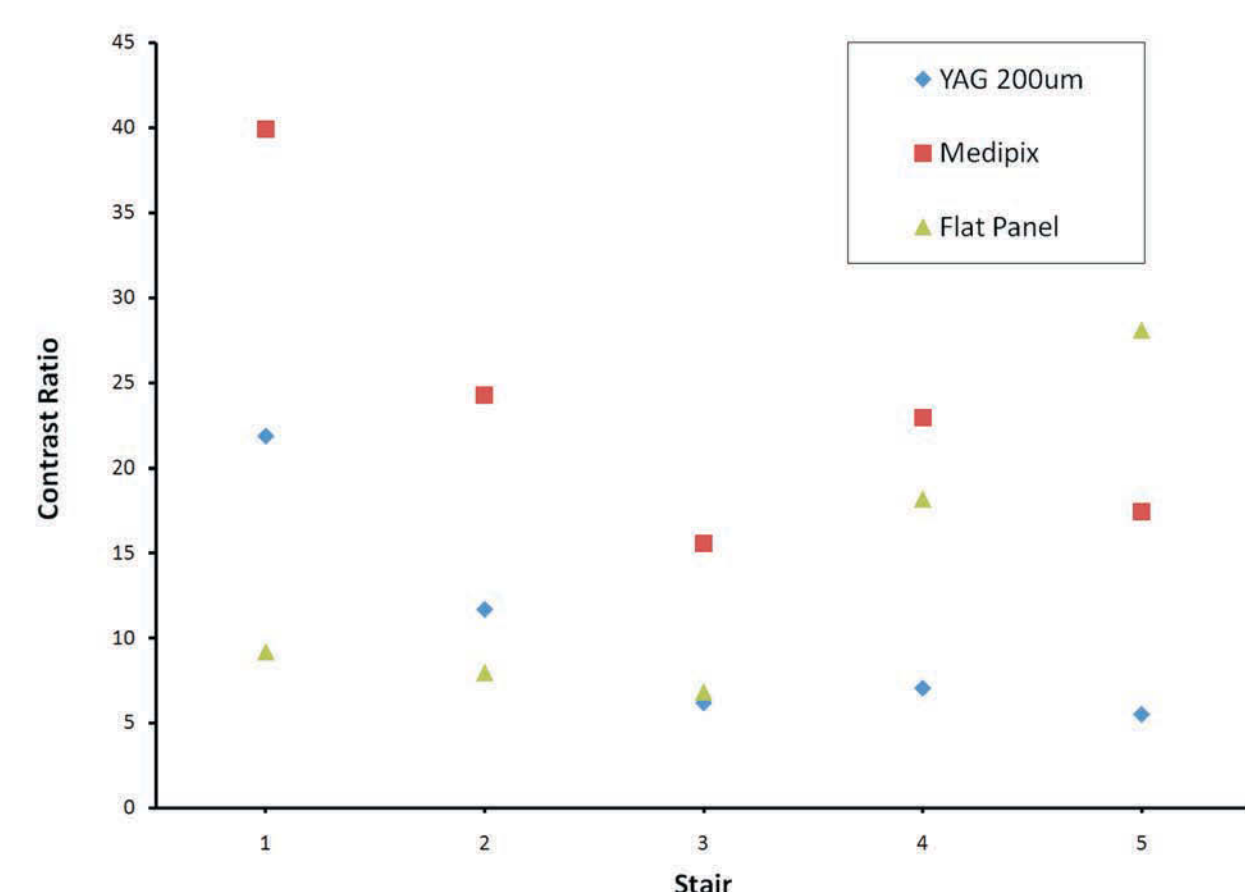
Contrast Ratio

Contrast ratio was measured by using stair-like object made of aluminum sheets 70 μ m thick. There are 6 stairs of increasing thickness (0 - 70 - 140 - 210 - 420 - 840 μ m). The signal ratio of two neighbour stairs A and B is compared as CNR (contrast -to-noise-ratio).

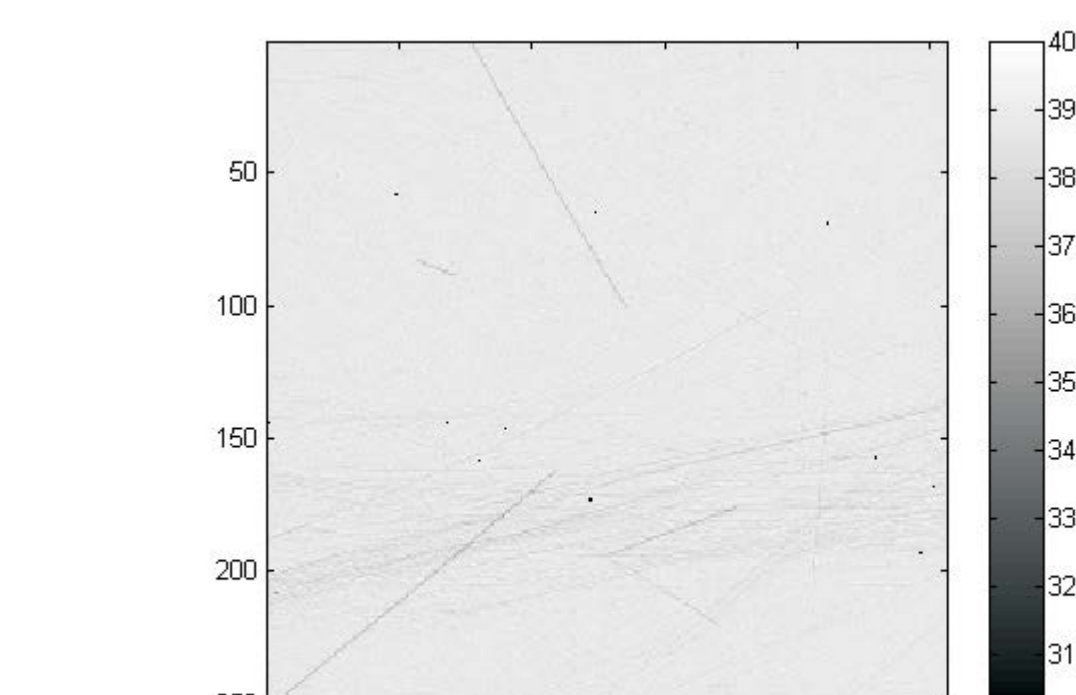
$$CNR = \frac{\bar{A} - \bar{B}}{\sqrt{\sigma_A^2 + \sigma_B^2}}$$



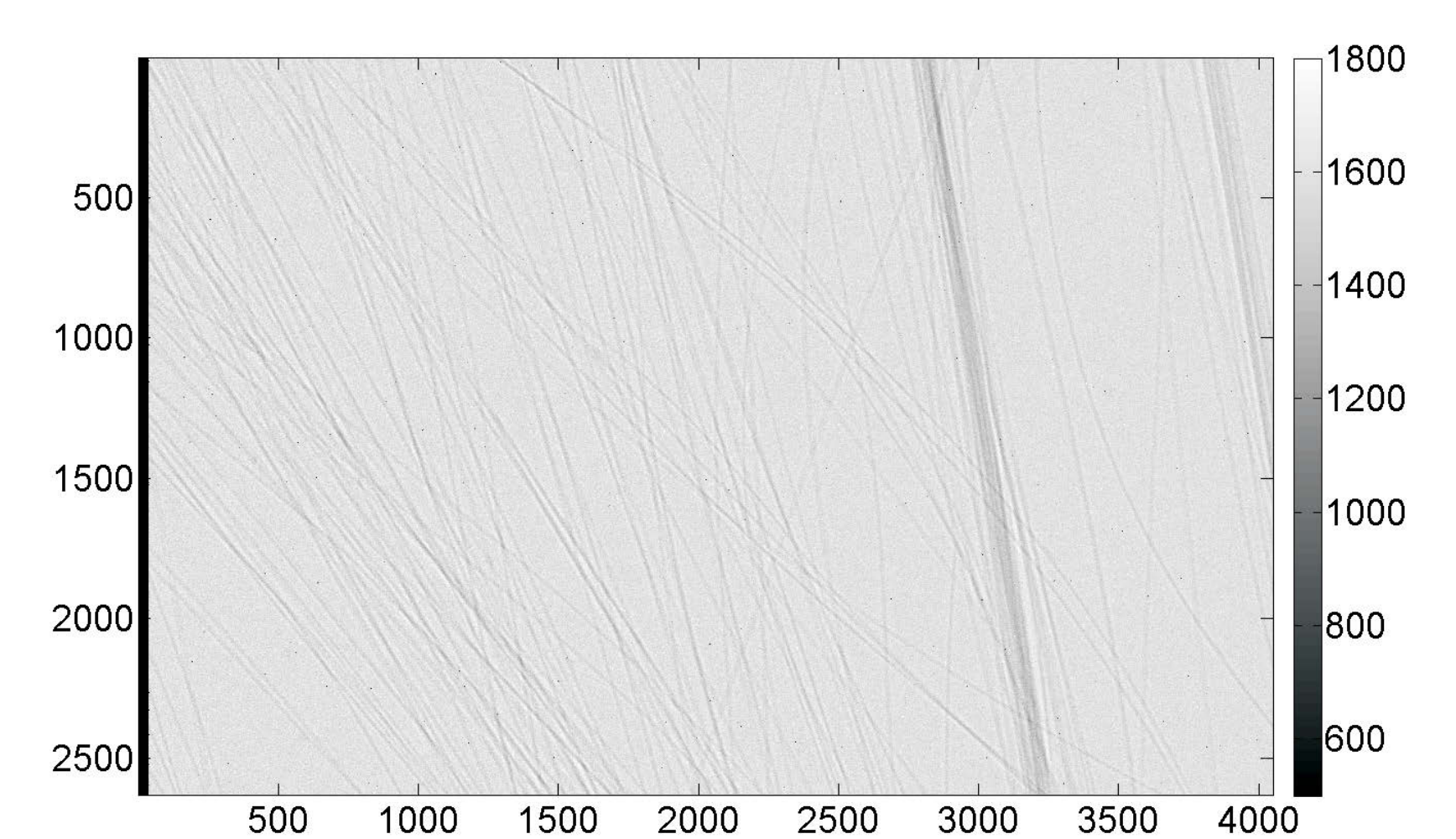
X-Rays Radiography of Aluminum Stair-Like Contrast Test Object



X-Rays Radiography

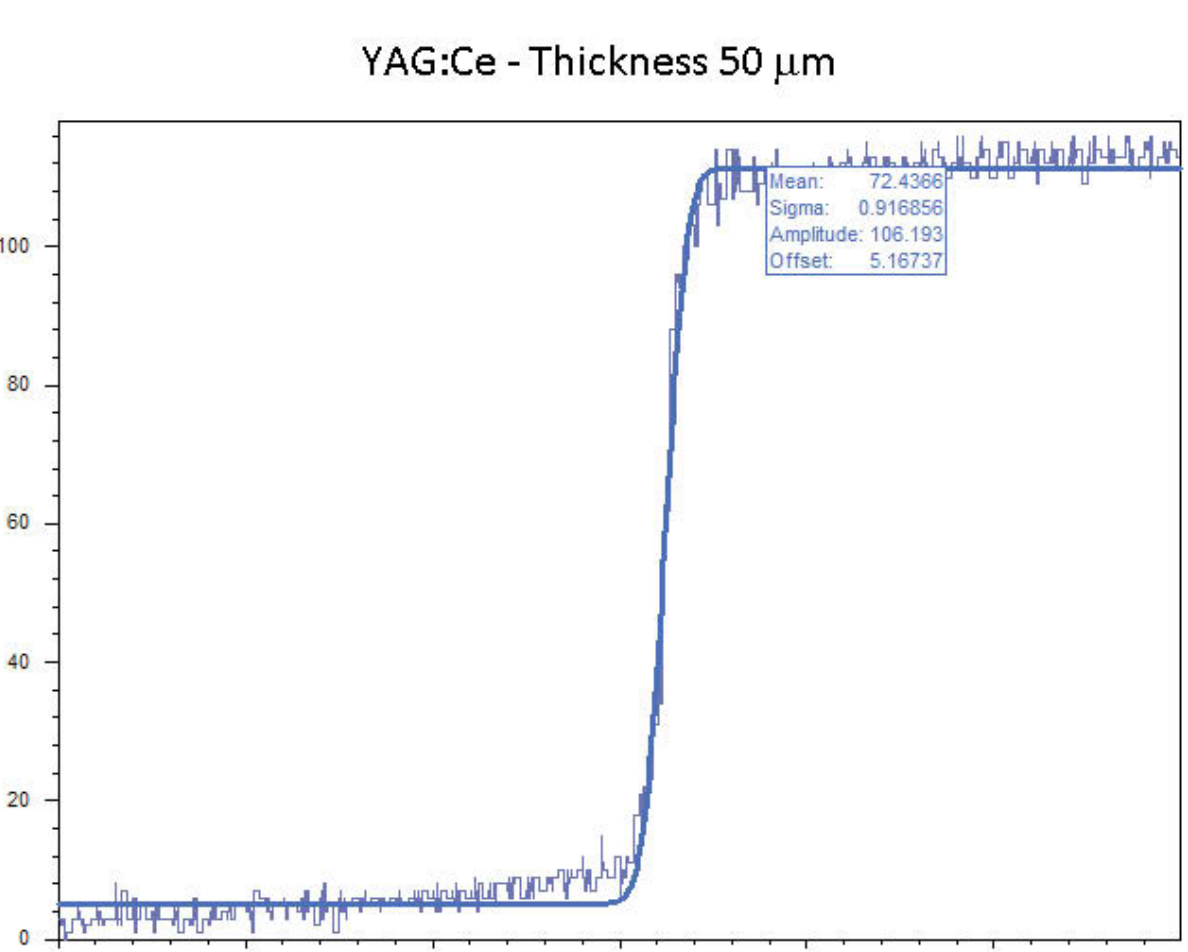


Medipix2

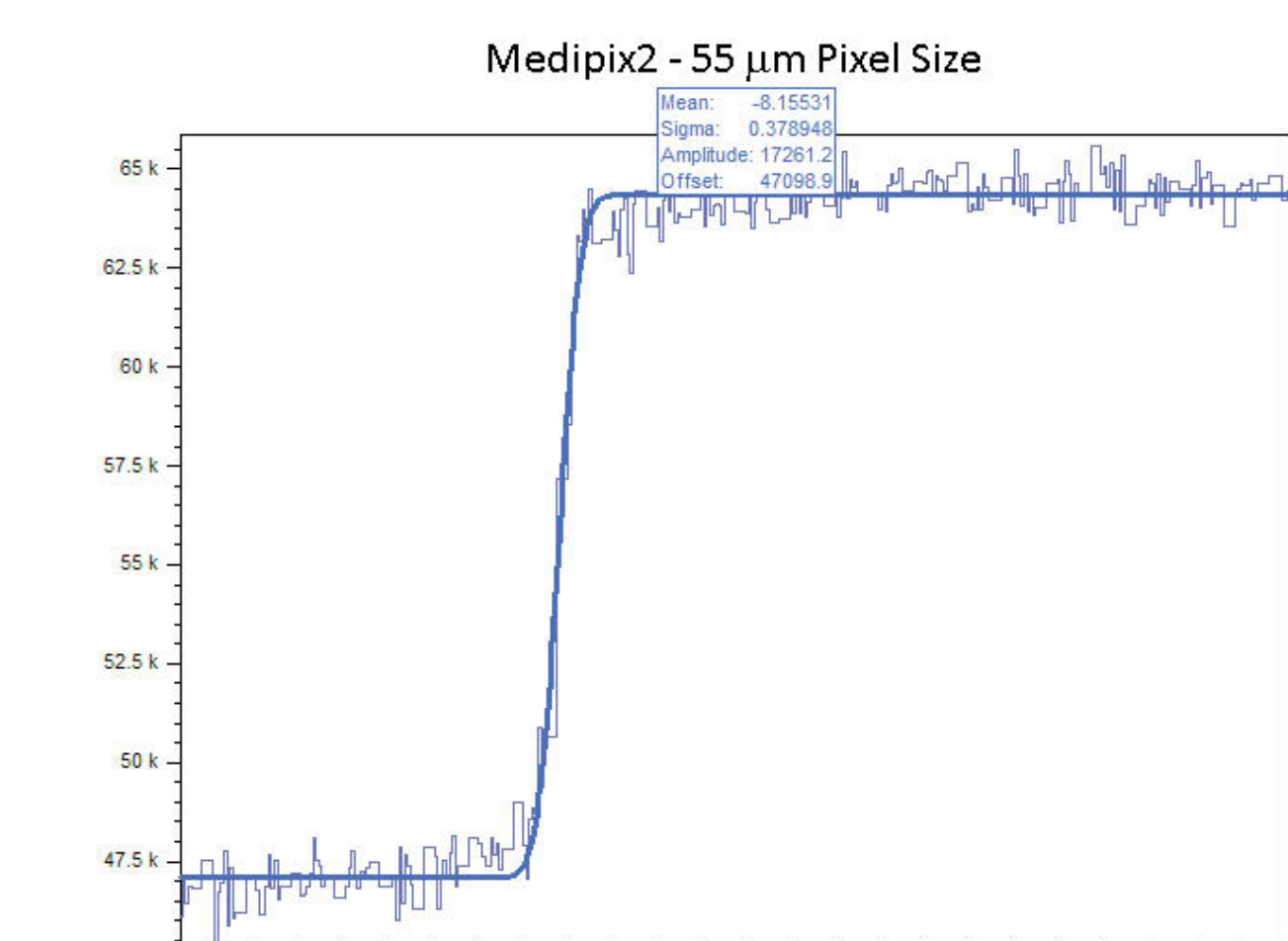


CCD Camera with YAG:Ce

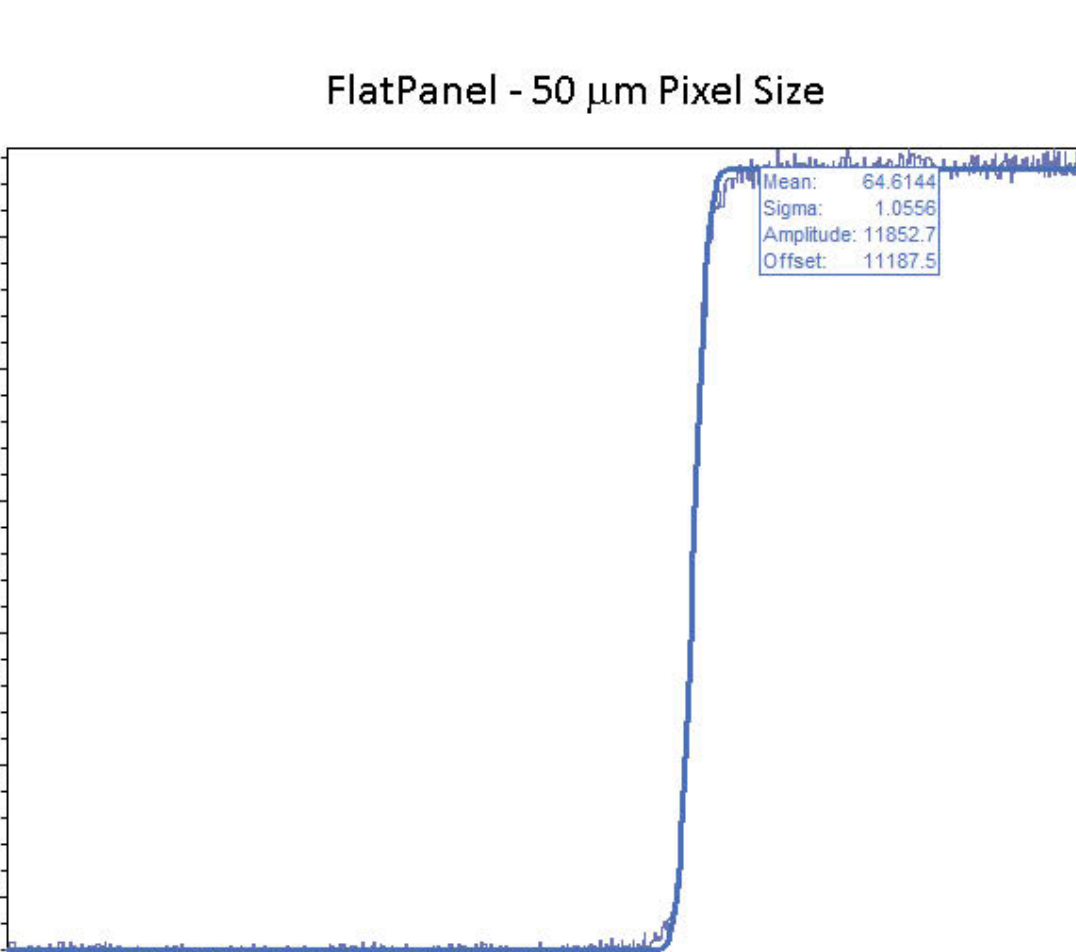
Spatial Resolution - Edge Profiles



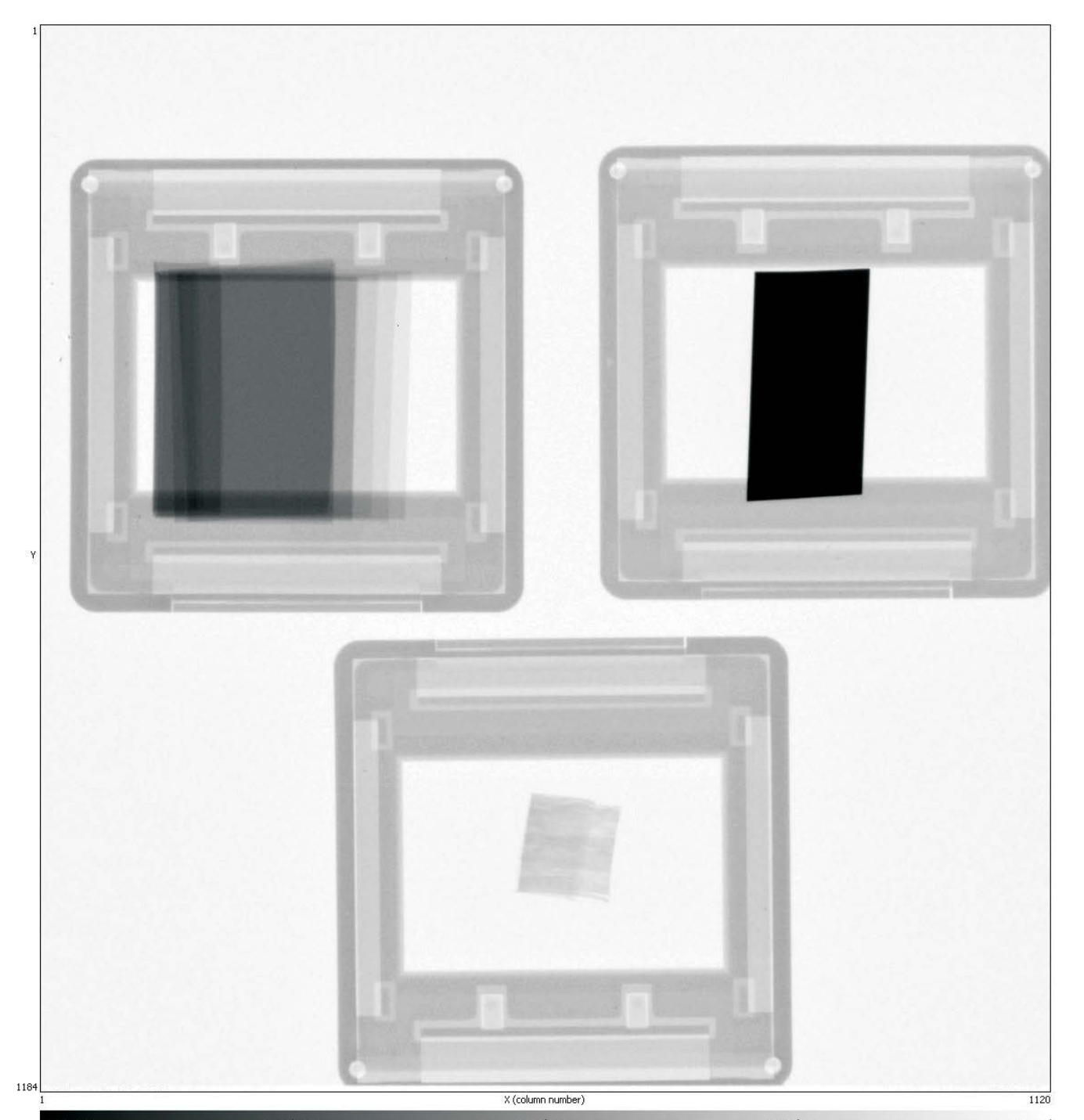
$\sigma = 0.92$, resolution 8.3 μ m



$\sigma = 0.38$, resolution 20.9 μ m



$\sigma = 1.01$, resolution 50.5 μ m



Flat Panel