Dependence of Signal-to-Noise Ratio on Radiation Energy and Grey Value in Digital Industrial Radiology

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The elimination of structural noise can be achieved by the necessary calibration procedure of digital detector arrays (DDAs). This results in a square root characteristic of the SNR over grey value function dominated by the quantum noise. Experimental measurements over a broader energy range (from 80 kV uot to 7.5 MeV) showed that the SNR is independent from the radiation energy for a given gray value. The grey value is related to the efficiency of the detector which is energy dependant.

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Dependence of SNR and grey value in CR

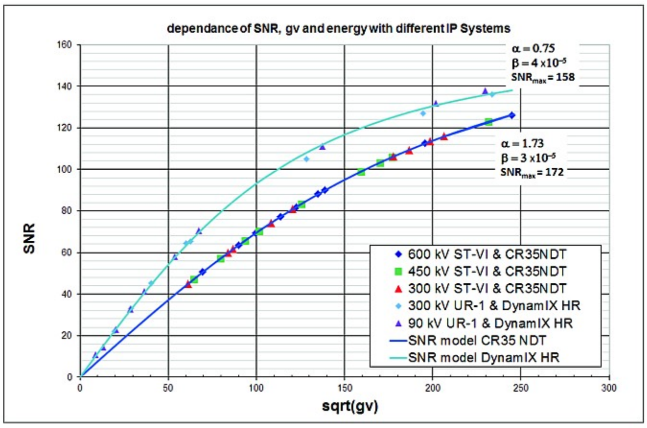
To simplify measurements of SNR for users, it is possible to use the realation between both values. The graph clearly shows an independence on the used energy. The fitted curve is measured with Comet MXR600HP X-Ray generator and different voltages, FujiFilm ST-VI in Duerr CR35 NDT scanner (SR_b = 130 µm). The other data are taken with a Seifert ISOVOLT 320/13 and a FujiFilm CR System (UR-1 + DynamIX HR) (SR_b = 80 µm) [1]:

$$SNR_{\text{model}} = \frac{gv}{\sqrt{\alpha\, gv + \beta\, gv^2}} \qquad (1)$$

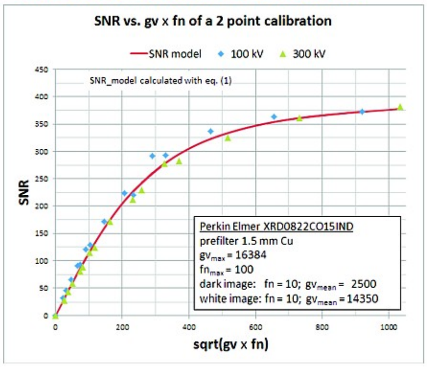
$gv > 0$

with α, β as constants for quantum and structure noise

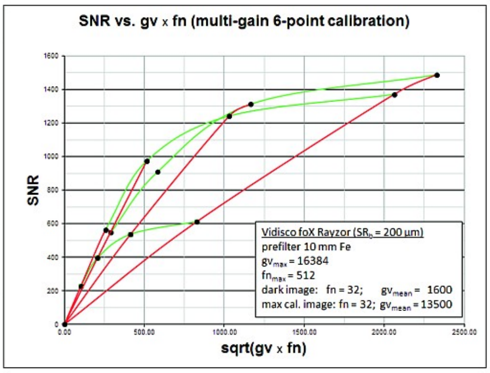
$$SNR_{\max} = \frac{1}{\sqrt{\beta}}$$



DDA calibration influence



Strong collimated flatfield exposures were taken with DDA Perkin Elmer XRD0822CO15IND (SR_b = 200µm) at different X-ray energies and frame numbers (fn). Afterwards different calibration procedures were used with Isee! [2] on the raw images and compared to our SNR model (1). A simple 2-point cal. lead to a characteristic of CR systems (left graph). A multi-point cal. is shown on the right graph: 1. red lines correspond to constant fn and varying gv. 2. green lines: vice versa, saturation of SNR depends on gv!



Inner unsharpness of digital detectors leads to increase of SOD in comparison to film

The inner film unsharpness is neglected for calculation of f_{min} (2) in EN 444. Considering SR_b for digital detectors results in eqn. (3) (see ISO/DIS 17636-2):

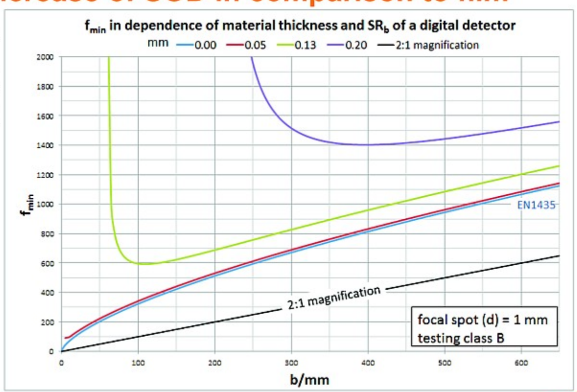
The increase in total unsharpness has to be compensated by larger f_{min}. Testing class B for detectors with SR_b>0.05 mm can only be achieved with magnification technique!

$$f_{\min_{\text{film}}} \geq d\, C \left(\frac{b}{mm}\right)^{2/3} \qquad (2)$$

$$b \geq (2\, C\, SR_b)^3 \qquad (4)$$

$$f_{\min} \geq \frac{b\, d}{\sqrt{\frac{b^{2/3}}{C^2} - 4\, SR_b{}^2}} \qquad (3)$$

C according to testing class (A: C = 7.5 B: C = 15)



[1] U.Ewert; U.Zscherpel; K.Heyne; M.Jechow; K.Bavendiek; Materials Evaluation July 2011: „Image Quality in DIR"
[2] O.Alekseychuk: *I See!* BAM image evaluation software, v1.10.2. http://www.kb.bam.de/ic

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