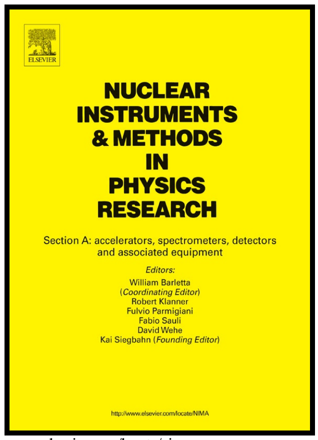
Author’s Accepted Manuscript



www.elsevier.com/locate/nima

Performance Quantification of a Flat-Panel Imager in Industrial Mega-Voltage X-ray Imaging Systems

Carina Stritt, Mathieu Plamondon, Alexander Flisch, Urs Sennhauser

PII: S0168-9002(16)31313-4
DOI: http://dx.doi.org/10.1016/j.nima.2016.12.044
Reference: NIMA59534

To appear in: *Nuclear Inst. and Methods in Physics Research, A*

Received date: 15 August 2016
Revised date: 19 December 2016
Accepted date: 22 December 2016

Cite this article as: Carina Stritt, Mathieu Plamondon, Alexander Flisch and Ur Sennhauser, Performance Quantification of a Flat-Panel Imager in Industria Mega-Voltage X-ray Imaging Systems, *Nuclear Inst. and Methods in Physic Research, A,* http://dx.doi.org/10.1016/j.nima.2016.12.044

This is a PDF file of an unedited manuscript that has been accepted fo publication. As a service to our customers we are providing this early version o the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting galley proof before it is published in its final citable form Please note that during the production process errors may be discovered whic could affect the content, and all legal disclaimers that apply to the journal pertain

ACCEPTED MANUSCRIPT

Performance Quantification of a Flat-Panel Imager in Industrial Mega-Voltage X-ray Imaging Systems

Carina Stritt[a,*], Mathieu Plamondon[a], Jürgen Hofmann[a], Alexander Flisch[a], Urs Sennhauser[b]

[a] *Empa, Swiss Federal Laboratories for Material Science and Technology,Center for X-ray Analytics,Ueberlandstrasse 129, 8600 Dübendorf, Switzerland*
[b] *Empa, Swiss Federal Laboratories for Material Science and Technology, Reliability Science and Technology Laboratory, Ueberlandstrasse 129, 8600 Dübendorf, Switzerland*

Abstract

Active matrix flat-panel detectors have gained popularity amongst X-ray imaging systems due to their speed, resolution and high dynamic range. With appropriate shielding modern flat-panel imagers can even be used in high energy Computed Tomography (CT) systems of energies up to several mega-electronvolt (MeV). However, the performance of a digital detector is not independent of the rest of the radiographic system but depends on all other components of the system. Signal and noise transfer properties highly depend on all parameters of an imaging chain. This work focuses on quantifying the resolution capabilities and the noise in the signals of a MeV X-ray imaging system. The performance quantification is done by computing the modulation transfer function (MTF) using the standard edge method as well as the noise power spectrum (NPS) of the imaging system. We performed Monte Carlo (MC) simulations in order to understand the influence of scattered radiation on the measurements. A comparison of the horizontal and vertical MTF showed that the imaging behaviour of the detector is isotropic. Moreover, an additional investigation of the noise performance of the system showed that there is no measurable noise correlation present in the system. It was shown that the thickness of the edge device does not have a significant influence on the resulting system MTF. A rapid drop in the visibility could be observed resulting in a value of 1.2 line pairs per mm at 50% MTF. The visibility limit of line pair patterns was found to be at 2.3 line pairs per mm given by the 10% MTF value.

1. Introduction

Detailed knowledge about the signal and noise transfer properties are crucial in understanding the capabilities and limitations of any imaging system. In the field of X-ray imaging as well as X-ray Computed Tomography (CT) these capabilities are typically characterized by the modulation transfer function (MTF) of the detection system as well as its noise power spectrum (NPS). The analyses of accuracies as well as performance characteristics of industrial CT systems have been carried out extensively for micro-CT systems as well as macro-CT systems operating at energies of up to several hundred kilo electronvolt (keV) [1, 2, 3]. However, the energy spectrum of the photons and the atomic number of the scanned material are limiting factors for the penetration length. For heavily absorbing objects, energies exceeding one mega electronvolt (MeV) are needed in order to achieve measurable transmission values. In contrast to conventional X-ray CT systems working at lower energies, which nowadays mostly operate in cone-beam geometry, these high energy X-ray imaging setups are typically designed in a fan-beam configuration employing a line detector which can be highly collimated. The reason for using a fan-beam geometry is that a significant increase in scattered radiation can be observed for high energy X-ray measurements. A highly collimated line detector is able to reduce the scattered radiation in the signal significantly [4]. However, the increase in signal quality comes at the price of inspection time. Most commercial flat-panel devices are not designed for the specific task of detecting MeV X-ray radiation. However, the utilization of a flat-panel imager in a MeV X-ray system is still possible, given a sufficient amount of shielding and accurate source collimation. Nevertheless, the impact of the increase in scattered radiation in the radiographies on the quality of the signal as well as the detailed signal transfer behaviour in this setup has to be analysed.

In this work, we quantify the performance of an industrial MeV X-ray imaging setup employing a flat-panel detector. The quality of the signal as well as the noise propagation in the system will be quantified using the MTF and the NPS. Additional Monte Carlo (MC) simulations will help to quantify the influence of scattered radiation as well as to estimate the contribution of the different system components to the scattered radiation.

2. Experimental setup

The setup studied in this work consists of a linear accelerator (see Table 1) with a focal spot size of 2 mm, which can operate at X-ray energies of 4 and 6 MeV. The X-ray beam is generated in a 0.85 mm thick tungsten target at the end of the linear accelerator. The detector is an active matrix flat-panel imager from Perkin Elmer, model XRD1621, with a pixel size of 200 μm.

*Corresponding author
Email address: carina.stritt@empa.ch (Carina Stritt)

Accepted manuscript

Download English Version:

https://daneshyari.com/en/article/5493031

Download Persian Version:

https://daneshyari.com/article/5493031

Daneshyari.com