Spatial resolution study of a neutron imaging system using the slanted edge method.

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I- INTRODUCTION

Neutron imaging is a very powerful technique for nondestructive testing, it allows obtaining image of the internal structure of objects in 2D or 3D mode. During the last years, attempts have been made to implement and to develop a neutron tomography system at the Nuclear Research Center of Birine. At this end a new Peltier-Cooled CCD camera (16 bit) has been installed instead the old CCD camera (8 bit) and a turntable has been designed. The aim of this work is the determination of the spatial resolution of the new imaging detector by calculating the modulation transfer function (MTF) using slated edge method. At this end a Matlab program has been written for MTF calculation.

II. MTF Calculation Method

The characterization of an imaging system's response in terms of spatial resolution is a very important task that allows the determination of the system limits and capability to visualize very small details. The spatial resolution is one of the most important characteristics of any imaging system, the Modulation Transfer Function (MTF) is a common metric used to quantify it.
A MTF value of 1 indicates that the full amplitude is transferred by the imaging system, while a MTF value of 0 indicates that no signal at all is transferred

For MTF measurement we used the slanted edge method which consist of imaging a thin and sharp slanted-edge onto the detector. The edge target must be made from a strong absorbing material such as Gadolinium.

The main steps for MTF measurement are represented in Fig.1.

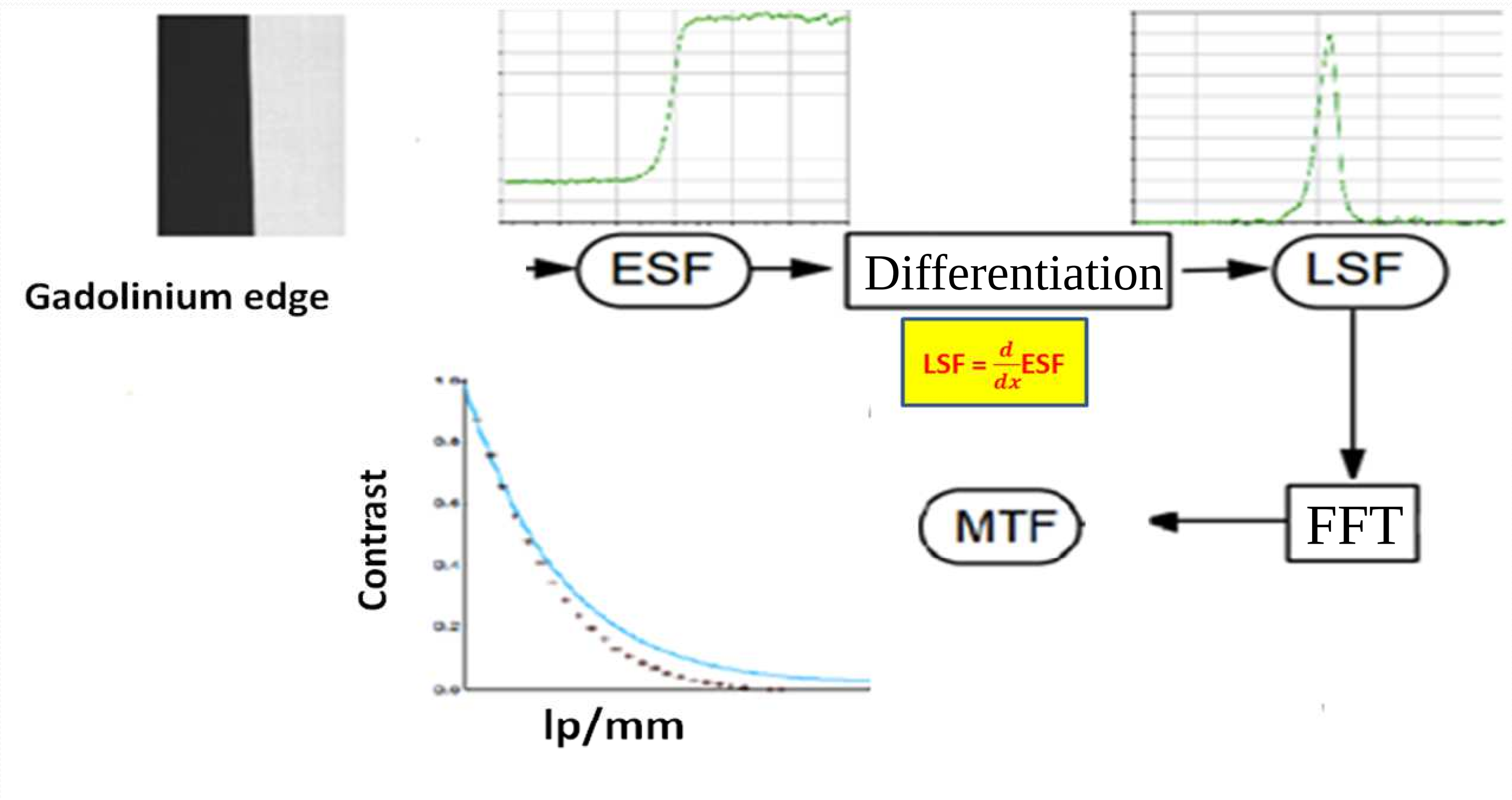

Fig.1: MTF calculation steps

III- Experimental Procedure

For MTF measurement, we have proceeded of imaging a thin Gadolinium foil (25µm thick), slightly tilted, onto the detector (Fig.2).
Gadolinium is highly neutron absorbing which allows the production of suitable image with necessary contrast between dark and light parts (edge).

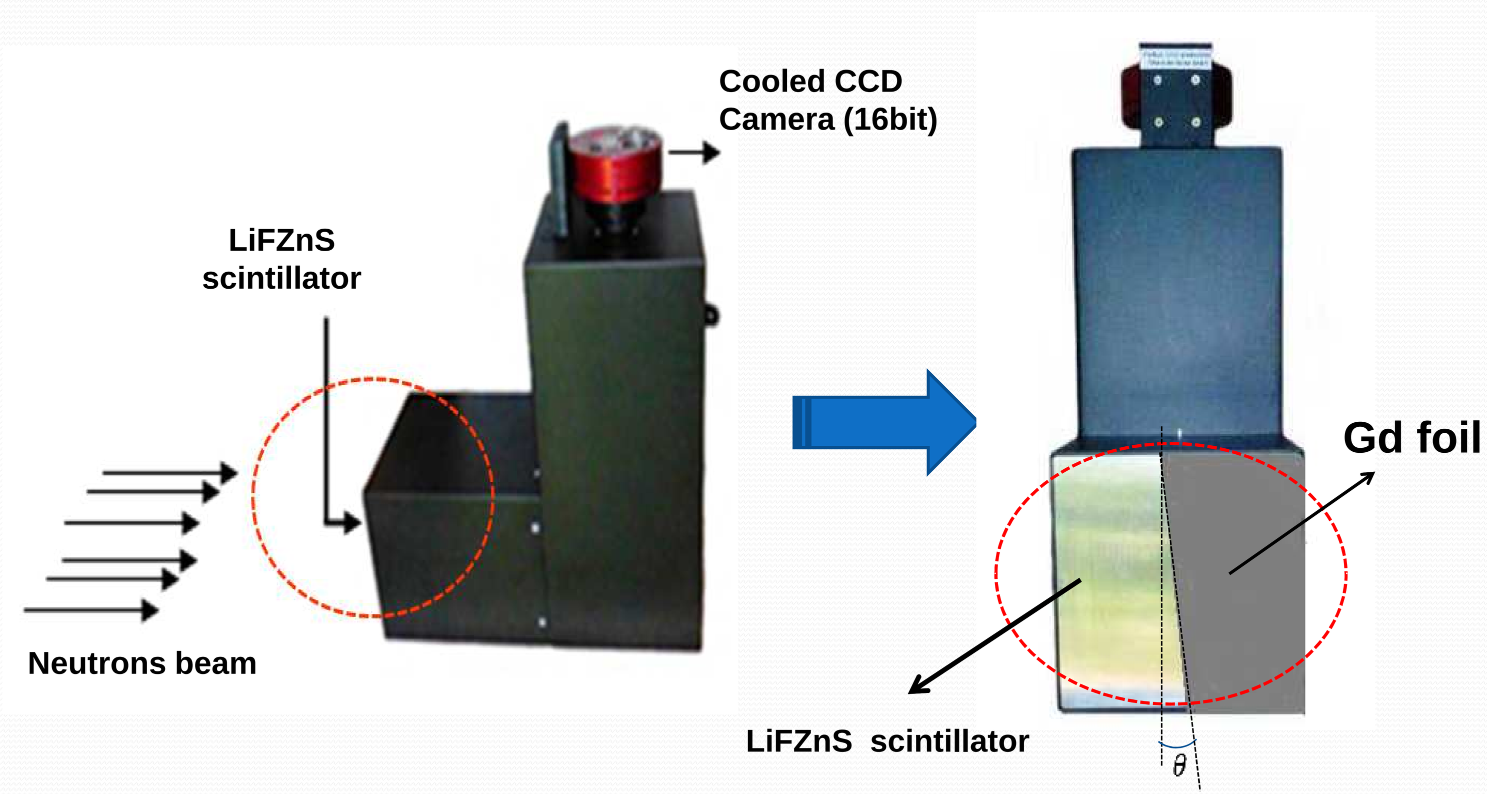

Fig.2: Irradiation setup

The detector was exposed arround the neutron imaging facility of Es-Salam reactor to a thermal neutron flux of ≈10^6 n/cm².s.

IV- Results

The neutron image obtained of the examined edge target is shown in Fig. 3.

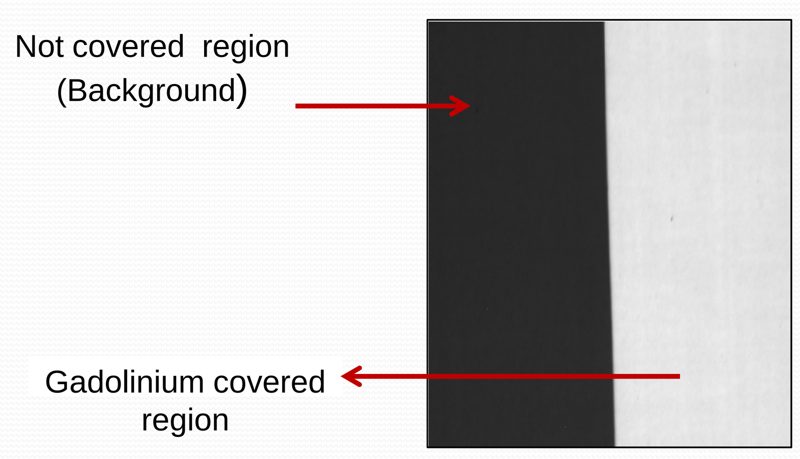

Fig. 3: Targed neutron image

According to MTF procedure and using the developed Matlab program the spatial resolution was determined for a value of 0.5 of MTF (Nyquist frequency) that provides the limit between an under-sampled and poor displayed image (very low frequencies) and an optimally sampled and well-displayed image (mediumand high frequencies).

IV- Results

The analysis of this MTF curve (Fig.4) allows the determination of the spatial resolution of the imaging system.

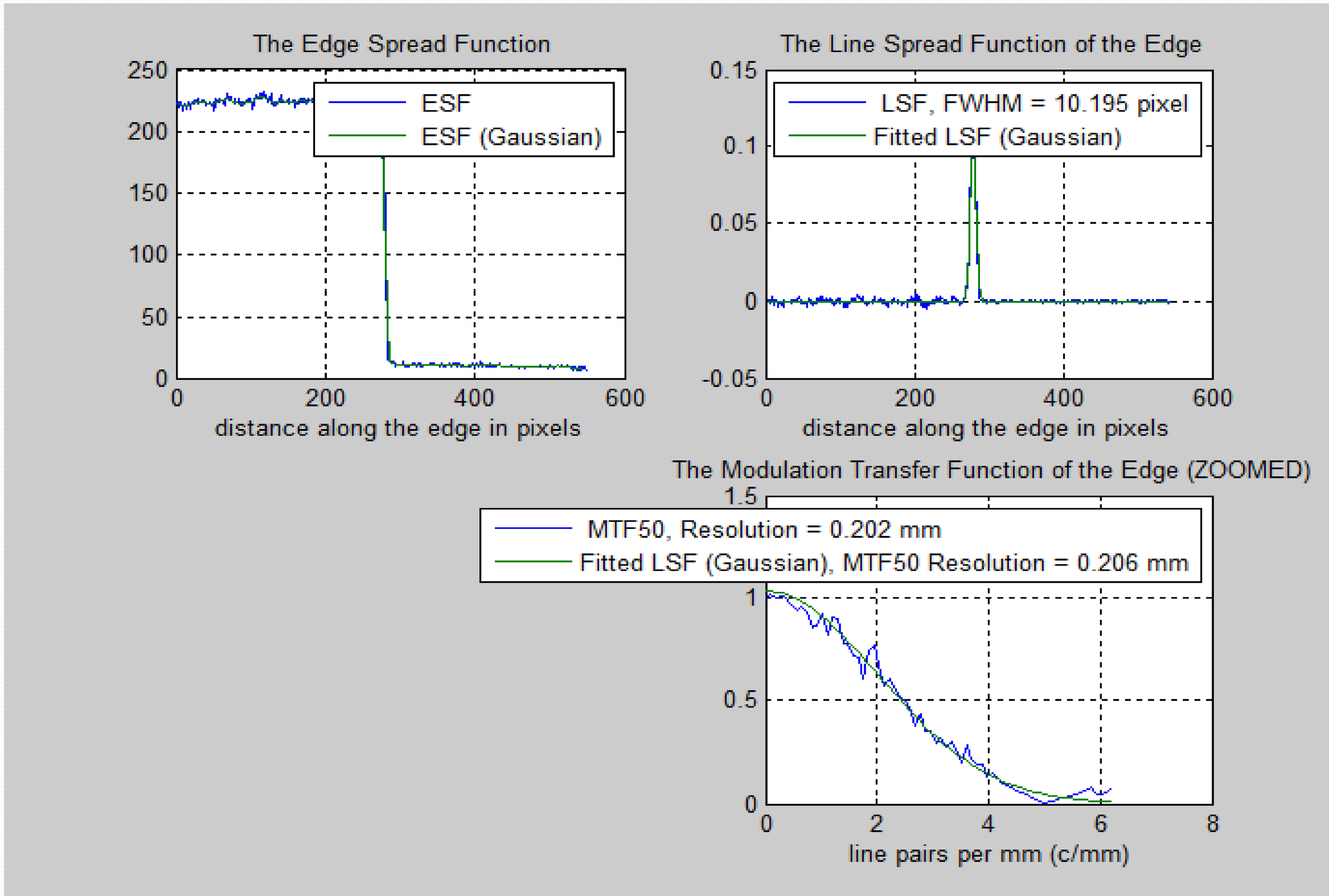

Fig. 4. MTF obtained for the imaging system studied using Matlab

The spatiale resolution is calculated from the spatial frequency corresponding to the value 0,5 of the MTF (MTF50) by the relation :

$$R_l = \frac{1[\text{lp}]}{2\text{MTF50}[\text{lp/mm}]} \quad (1)$$

According to this relation the spatial resolution limit calculated at MTF50 is about **0,202 mm (202 µm).**

In addition, the MTF was calculated by Quick MTF software and the result obtained is presented in Fig.5.

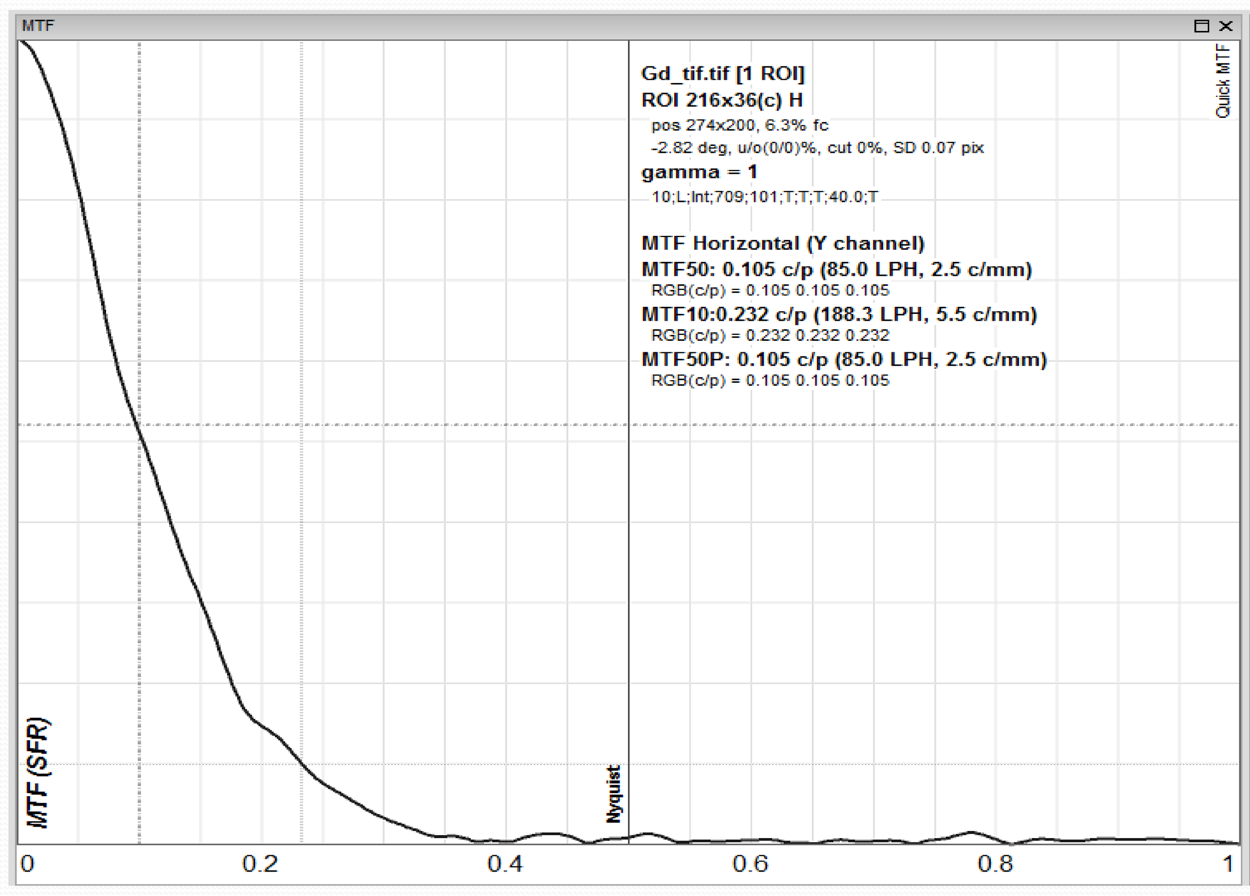

Fig. 5. MTF obtained for the imaging system using Quick MTF.

From this curve the MTF50 is about 2.5 C/mm and so the spatiale resolution limit calculated by the relation (1) is **0,200 mm** which is in good agreement with the value obtainded by Matlab code.

V- CONCLUSION

The main objective of this study was the characterization in terms of spatial resolution the new imaging system used in our neutron tomography facility.
In accordance with MTF procedure the spatial resolution measured using the Matlab program is of the order of 202 µm.
This result allowed us to know the limits of our imaging system and its capacities for tomographic examinations and what applications can be successfully carried out.
Finally, we can say that the slanted-edge method is a suitable technique for efficient MTF measurement, allowing the determination of spatial resolution of the neutron imaging system being studied