THE MEASUREMENT WITH THE MEDIPIX2 DETECTOR AND THE RW3 MODERATOR IN THE NEUTRON FIELD OF THE CLINAC 2100 LINEAR ACCELERATOR

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1. Introduction

Detection of neutrons in radiotherapy is important to determine the radiation exposure of the patient. Today, the most commonly are used TLD detectors for routine determination of patient dose. These detectors are not accurate. Other applications of Bonner spheres, which is positioned as proportional counter. The detection of neutrons is also possible with Medipix2 detector.

The digital pixel detectors of Medipix[1] family represent a highly efficient imaging device with a high scanning speed readout, high density of detection units (pixels) resulting in a good spatial resolution, and a non-limited dynamic range allowing to detect single particles of ionizing radiation and to evaluate their energy.

An application of Medipix2 using a segmented multiple thickness RW3 Slab Phantoms[2] moderator for fast neutron detection is presented. The setup has the ability to provide an energy independent response for the dose relative for fast neutrons. In our

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[1]The Medipix2 detector was developed under CERN Medipix Collaboration in Switzerland, in collaboration with 17 universities and research teams. The Institute of Experimental Physics of the Technical University in Prague is participating on its development Website: http://www.utef.cvut.cz

[2] http://www.scanrad.no/straleterapi/dosimetri/fantomer/205/PTW_fantomer.pdf

experimental setup, we have used six different RW3 thicknesses. RW3 is material that is slowing down fast neutrons to thermal energies, which are then converted by LiF_6 on charged particles ($^6Li + n \rightarrow \alpha(2.05\ MeV) + {}^3H(2.72\ MeV)$). These particles are recorded with detector Medipix2. Thicknesses of moderator corresponds their efficiency for detection of fast neutrons.

2. Detector Medipix

The Medipix2 detector consists of two chips: the sensor chip and a CMOS readout chip containing the counting electronics. The sensor is a semiconductor detector which can be manufactured of different materials (Si, GaAs, CdTe, HgI) and of different thickness (e.g. 300, 700, 1000 μm). The rear contact of the sensor is divided into a matrix of 256 x 256 cells (pixels) with the pixel pitch of 55 m. The size of the active detector area is 14.11 x 14.11 mm (see Fig. 1). The counting chip electronics is connected to the sensor using flip chip bump-bonding technology. Each pixel in the readout chip is equipped with a complete signal processing chain, consisting of pre amplifier, two independent discriminators and two 13-bit counters [1]. The charges deposited by the ionizing radiation in the sensor chip are amplified by the preamplifier stage and the output is compared with a threshold. Only preamplifier pulses with amplitude exceeding the threshold increment the counter value that depends on the setting of the discrimination level, only particles of certain energies. One of the advantages of this architecture is that the digital information contained in the counter is not affected by dark currents or readout noise. The counter data can be transferred from the Medipix device via a 32-bit serial or parallel port. Using high-speed communication (up to 100 MHz), the acquisition time of one image can be as fast as 10-32 ms using the serial port and 330 μs using the parallel port [2]. The exposure time of these detectors is unlimited, allowing reaching a high signal to noise ratio, and thereby also images of a high contrast and quality [2].

3. Our Setup

Measurements were performed on a linear accelerator Clinac 2100 C / D. Parameters of source parameters were set on 18 MeV for 10 somatic units. Medipix2 detector units were equipped with neutron converters for Fig 2, the effectiveness of each are given in [3]. Medipix2 detector was placed 1 m from the source outside the neutron beam. Above detectors were successively placed each RW3 plate 10 mm thick.

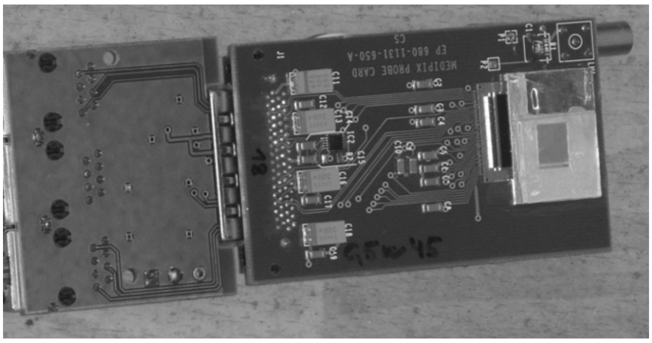

Fig. 1: *The detector Medipix2 with convertors for neutrons.*

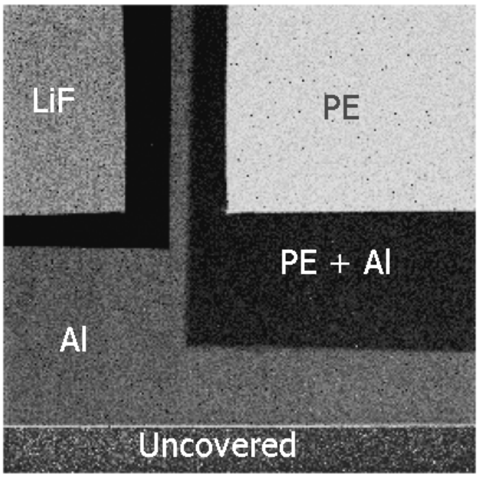

Fig. 2: *Distribution of on the detector Medipix2 convectors.*

4. Results

Dependence of the number of detected neutrons - charged particles is shown in Fig. 3. Examples of integral images with charged particles are shown in Fig. 4. The image labeled 0 RW3 plates can be seen that the neutrons are not detected [4, 5]. The accelerator produces only fast neutrons, which are not detected by Medipix2 with converters. The highest number of detected particles is achieved with four plates RW3 that means 40 mm of moderator.

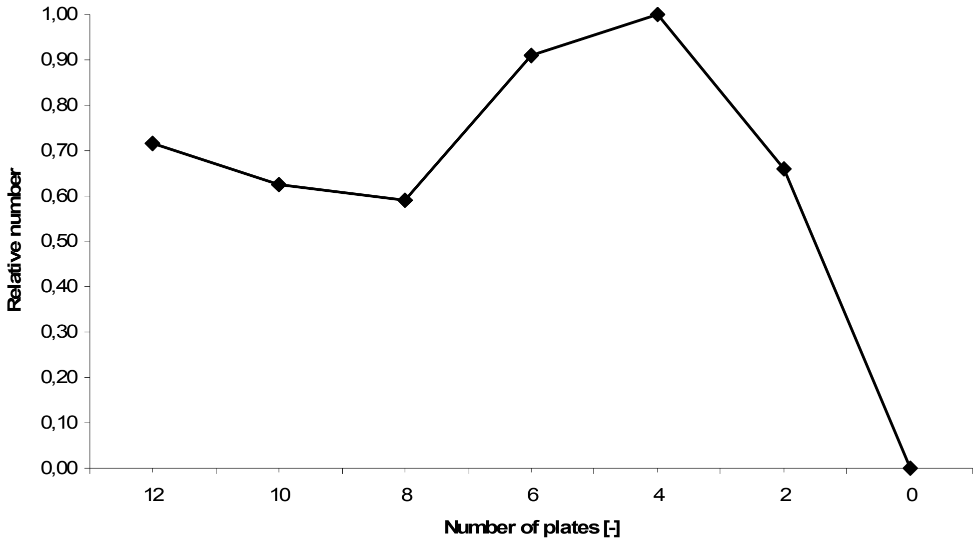

Fig. 3: *The relative number of detected neutrons. The dependence of the detection of fast neutrons on the thickness of RW3 moderator.*

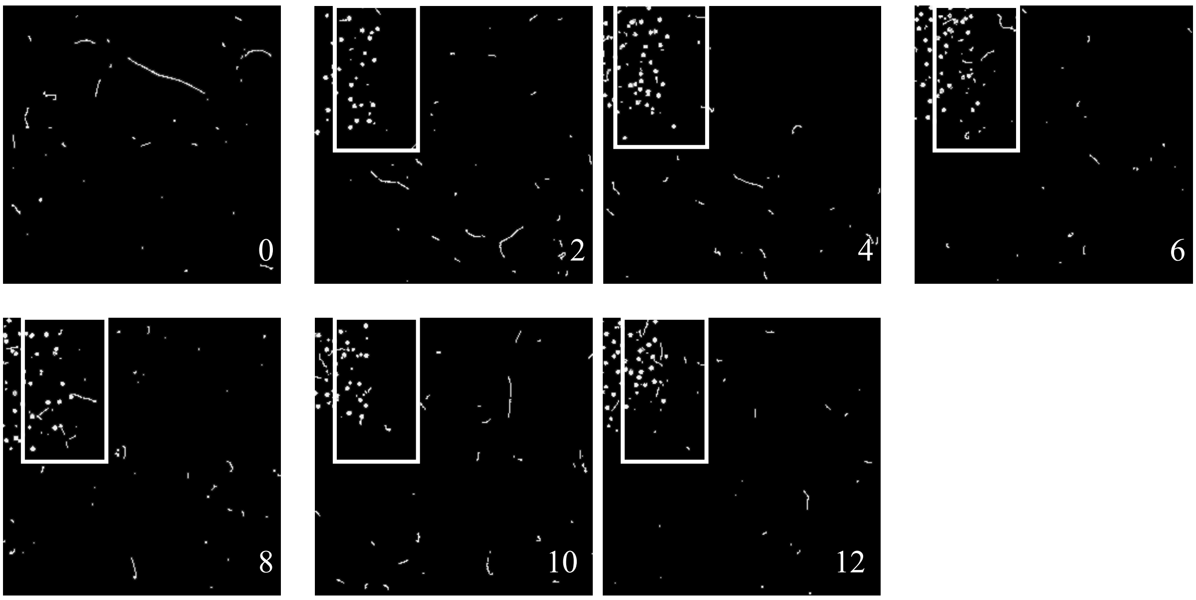

Fig. 4: *Frames are identified by number RW3 plates. RW3 thickness of one plate is 10 mm. The detected charged particles are labeled in frames. Instead of detecting the charged particles corresponding to the location of the* LiF_6 *detector Medipix2 converter, see* Fig. 2.

5. Conclusion

Measured results show that using Medipix2 detectors can detect fast neutrons. Fast neutrons are slowed down in the moderator RW3 to thermal neutrons. These neutrons are converted by the LiF_6 to charged particles, which are registered by Medipix2 detector. Results of our measurements show the greatest efficiency is achieved with RW3 moderator thickness 40 mm. In the future we plan to place the detector Medipix2 Bonner sphere. This requires a reduction of ambient electronic detector. On this issue has been working intensively. Then we compared the individual responses to detected neutrons which are moderated by Bonner spheres with no available relative dependencies. This principle of neutron detection with detector Medipix2 will be used for monitoring the neutron field in the radiotherapy clinic at The University Hospital Bulovka as part of radiation protection of staff and patients.

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