NEUTRON RADIATION MONITORING OF THE THERAPEUTIC PROTON BEAM TRANSPORTATION

V. Skorkin, INR RAS, Moscow, Russia

Abstract

A monitoring system online controls a therapeutic proton beam by measuring a secondary neutron radiation from the beam losses. The system consists of neutron detectors in the transport path passage from Linac to the facility of proton therapy and terminal controller connected to the computer. The neutron detectors measure a level of the secondary neutron radiation in real time along of the transport channel, near the formative elements.

INTRODUCTION

A result of the proton beam loss is formed neutron secondary radiation. The neutrons in the transport channels can be registered with help of fast neutron detectors. A level of secondary neutron radiation in the transport path of the proton beam is proportional to the average beam current and beam losses [1]. Fig. 1 shows the neutron radiation in the transporting channel at the average beam current of 0.7 mA to 35 mA.

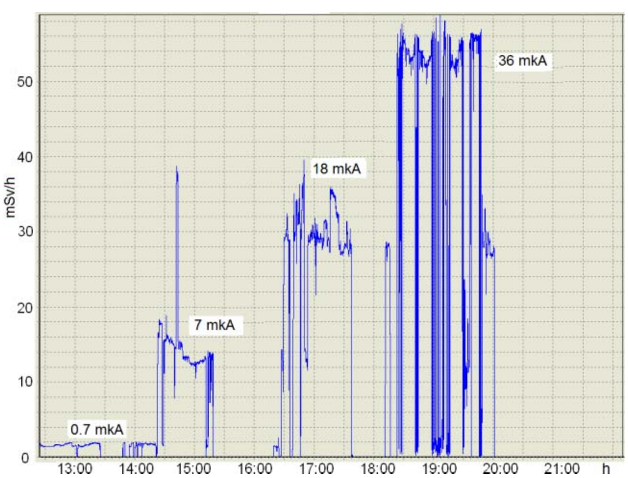

Figure 1: Diagram of the neutron radiation dose power measured in the beam transport channel.

The information about the neutron radiation intensity allows you to determine beam loss in different parts of the transport channel. The neutron monitor of the proton beam transport allows you to measure the temporal variations of the beam intensity in local areas transporting channels. These changes arise are due to changes in operating mode of the channels or instability of the elements forming the beam transport channels.

MONITORING THERAPEUTIC BEAM

The system monitoring the beam transport includes a terminal controller, which is connected to the computer. The neutron detectors are located along the ion guide, near the formative elements of the transport channels and the target of the proton therapy facility. The layout of neutron detectors of the system monitoring the proton beam transportation in Complex of proton therapy is illustrated in Fig. 2.

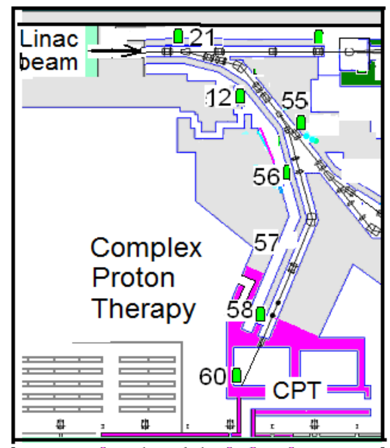

Figure 2: Complex of proton therapy.

The detectors in the transport channels are used for the beam loss measurements. Software module monitoring system determines and shows the dose power of the secondary neutron radiation in real time. The changing of the intensity of the beam of protons due to the unstable form of the elements in the medical channel caused by blocking is shown in Fig. 3.

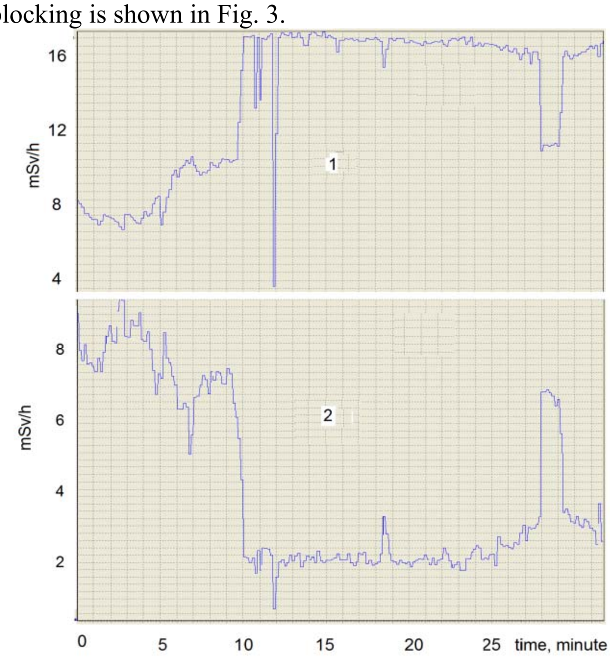

Figure 3: Diagram of the neutron radiation intensity in the beam transport channel. 1 – neutron background near the bending magnet; 2 - neutron background in front of the collimator.

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The intensity of neutron radiation in the medical channel is changed by overlapping the therapeutic beam using emergency and working shutters. The neutron radiation intensity changes the beam covering the beam emergency workers or shutter. The monitoring system allows you to monitor this process (Fig. 4).

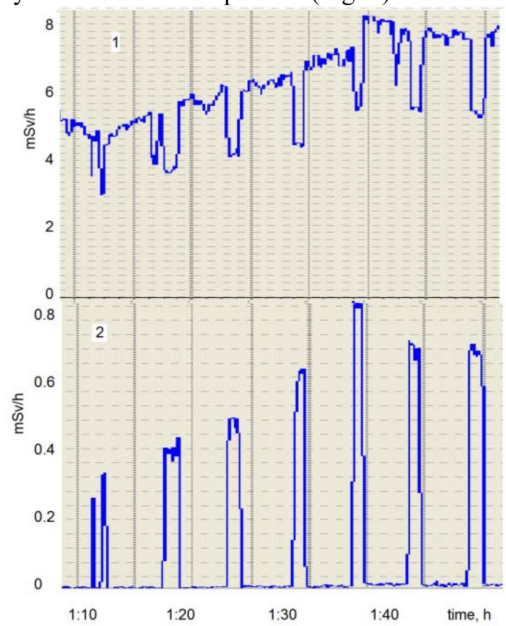

Figure 4: The profile of the neutron background in the medical channel (1) and in the procedural of proton therapy (2).

The diagrams observed correlation between the levels of neutron radiation in both sections of the proton beam transport due to the presence or absence of the beam in the procedural of proton therapy.

CONCLUSION

The system monitors the beam transport and reduces background radiation and activation equipment. The monitoring system determines the intensity and temporal structure of the therapeutic beam and to detect mode and instability of the formative elements.

Neutron radiation measured by the monitoring system can receive timely information about the losses of the beam and correction of operational parameters which form the transport channel devices to improve the quality of beam.

REFERENCES

[1] M.I. Grachev, V.A. Kljushnikov, S.I. Kuptsov et al. The automatic radiation control system of the INR linear accelerator (Troitsk) // *Proceedings of RuPAC XIX*. Dubna, 2004, p.483-484.

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