COMPARATIVE ANALYSIS OF EFFECTIVE USING REACTOR BEAMS AND NEUTRON SOURCE BASED ON ACCELERATOR FOR BNCT AND FAST NEUTRON THERAPY.

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ABSTRACT: The comparison between fast reactor (BR-10), thermal reactor (VVRC) neutron beams and neutron source based on the $^{7}Li(p,n)^{7}Be$ reaction near threshold for BNCT and fast neutron therapy are given. Monte Carlo code MMKFK was used for calculations. Results of these studies show that both fast and thermal reactors beams demand $Al–D_2O-^{6}Li$ (thickness ~1m) or ^{60}Ni (thickness ~30cm) filters for providing useful neutron for BNCT. The neutron source from accelerator (proton energy near threshold) with using 2-5 cm of H_2O moderator can provide therapeutically useful neutrons for BNCT.

KEY WORDS: Fast Reactor, Accelerator, Neutrons, BNCT, Neutron Therapy.

INTRODUCTION: At present time a large experience with using of neutron for therapy purposes of cancer patients was accumulated in Russia. About 400 patients were treated with using fast reactor BR-10 beam (Obninsk). Combined neutrons and photons were used for treating [1], [2]. At last time the interest in BNCT and connected with BNCT interest in constructing special filters for neutron beams have rose significantly. The great hopes of BNCT connected with neutrons generated on proton accelerators in $^{7}Li(p,n)^{7}Be$ reaction. The purpose of our work consist in comparison of the spectral characteristics of various types reactor and neutron source based on the $^{7}Li(p,n)^{7}Be$ reaction near threshold for BNCT and fast neutron therapy.

MATERIALS AND METHODS: The tissue-equivalent cubic phantom with rib 20 cm was used for studying of the different neutron beams efficiency. For all calculation variants were supposed that neutron beams directed normally to phantom front surface. Code MMKFK based on Monte Carlo method was applied for calculations of dose distributions on phantom depth. Two serieses of calculations were made. In first series the open beams of fast reactor BR-10, thermal reactor VVRC and neutron source based on the proton accelerator were investigated. At last case the proton energy equal 1886 keV. In the second series the demanded for BNCT characteristics were riched with using of filter. Next filters were studied :

- $D_2O-Al-^{6}Li$; Al–89%, D_2O–10%, ^{6}Li-1%, thickness 90cm;
- $^{64}Ni-^{60}Ni$; ^{64}Ni – 30cm, ^{60}Ni – 2cm
- H_2O – 3cm.

RESULTS AND DISCUSSION: The dose distribution for open bean B-3 of BR-10 reactor are given on Fig.1.

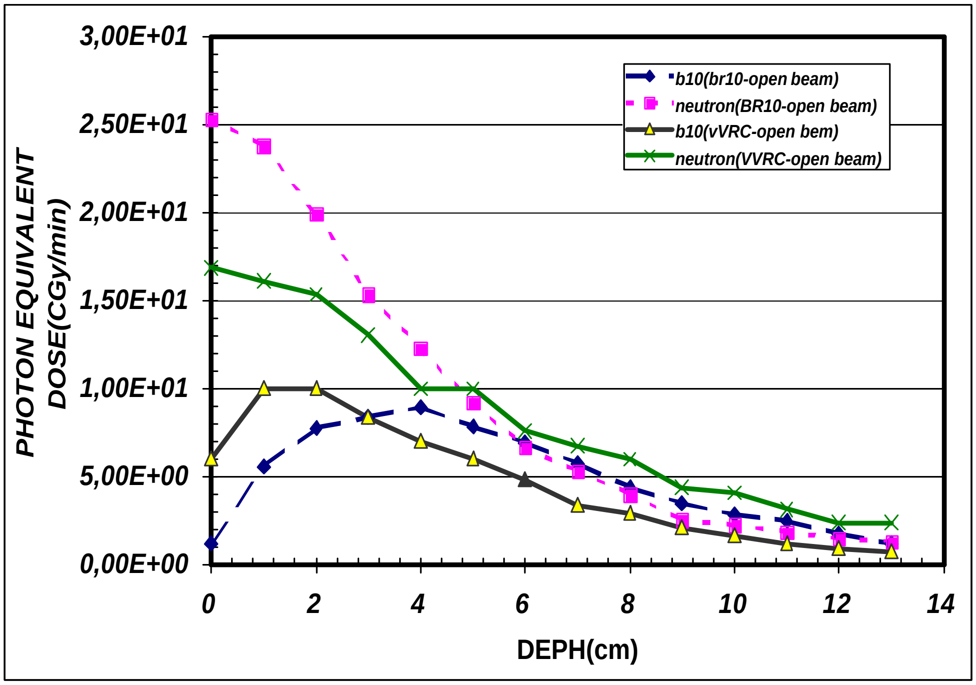

Fig.1. Open beams. Dose distribution.

It is shown that dose from ^{10}B interactions significantly lower than neutrons kerma till 5cm on depth. For comparison the dose distributions from open beam of thermal reactor are given on this figure too. One can see that reactors open beams are not effective for BNCT applications.

On the Fig.2 is shown the dose distributions for filter beams.

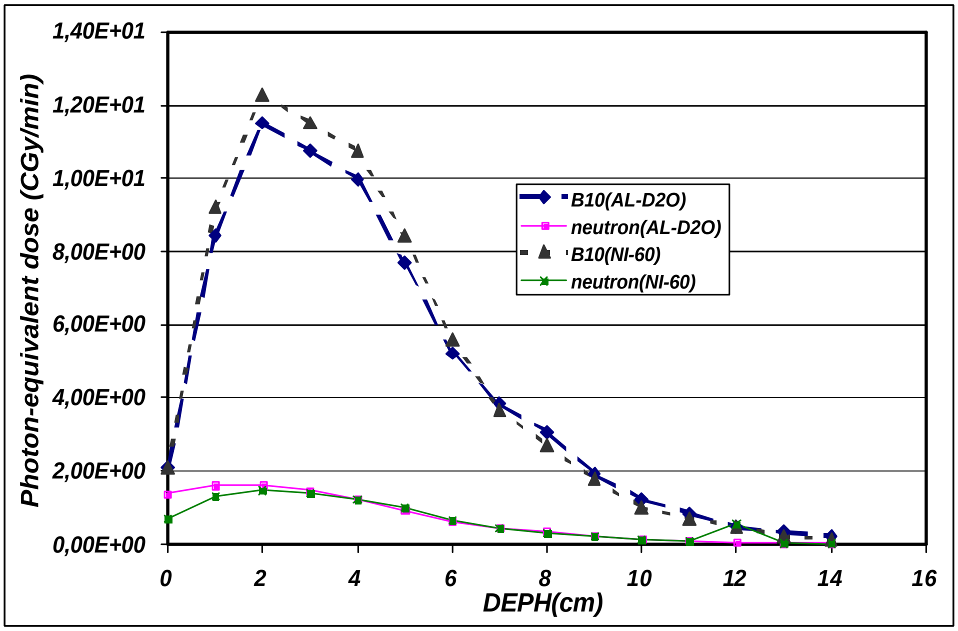

Fig.2. Filter beams. Dose distribution.

The calculation results illustrate that ^{64}Ni-^{60}Ni filter give more high relative contribution to ^{10}B dose as compared with neutron kerma. The accelerator neutron source based on ^{7}Li(p,n)^{7}Be reaction dose distribution is given on Fig.3.

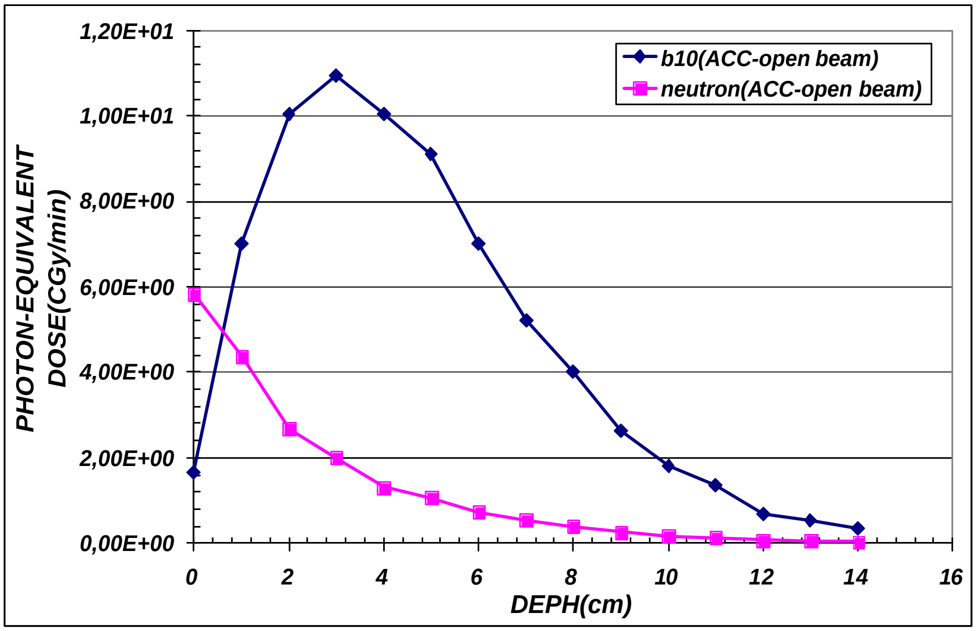

Fig.3. Accelerator open beam. Dose distribution.

We can see even open beam gives a large contribution to the ^{10}B dose. The H_2O filter (thickness ~3cm) is sufficiently to decrease neutron kerma significantly.

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