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HEAVY ION PHYSICS

Design and construction of an optimized neutron beam shaping assembly for Boron Neutron Capture Therapy at the Tandar accelerator.

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Abstract. In this work we present an optimized neutron beam shaping assembly for epithermal Accelerator-Based Boron Neutron Capture Therapy (AB-BNCT) and discuss the simulations leading to its design.

Keywords: Accelerator-based BNCT, beam shaping assembly, ^{7}Li(p,n)reaction
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1. Introduction

Within the frame of Accelerator-Based Boron Neutron Capture Therapy the ^{7}Li(p,n) reaction is one of the most promising, due to its high neutron yield without a too hard neutron energy spectrum.[1]. A neutron beam shaping assembly was optimized based on this reaction [2] and was built and explored at the tandem electrostatic accelerator *TANDAR* at CNEAs facilities in Buenos Aires.

2. Materials and Methods

An optimized moderator was constructed using an assembly consisting of slabs of Al, Teflon and LiF . A preliminary experiment has been performed with neutrons produced through the ^{7}Li(p,n)^{7}Be reaction which has a pronounced resonance at 2.25 MeV with a cross section of 582 mb. In order to maximize the neutron production and at the same time keep the maximum energy of the neutron spectrum at an acceptable low value it is convenient to use a proton beam of an energy slightly higher than 2.25 MeV. Since the Tandar accelerator was not designed to deliver

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such low energies, a 6.5 MeV primary proton beam was utilized (lowest achievable stable energy). This beam was degraded to an average energy of 2.4 MeV by passing it through a 78 μm thick Ta foil and subsequently made to bombard a thick LiF target. The resulting neutrons were moderated using slabs of Al and polytetrafluoroethylene (PTFE) (commercially known as Teflon) of 15 cm x 15 cm and a total length of 34 cm including slabs of LiF as a thermal neutron shield. The target and the moderator were surrounded by a reflection mantle of lead and some graphite with the aim of collecting back the largest possible number of fast neutrons produced (Fig.1).

At the output port of the assembly we installed a simplified water-filled acrilic head phantom. The proton current was measured by a Faraday Cup containing the LiF target. On the other hand, the fluxes inside the phantom have been simulated by Monte Carlo calculations. The geometry for the simulations is shown in Fig. 2 and the calculated fluxes in Fig. 3.

3. Results and Conclusion

An optimized neutron beam shaping assembly for BNCT was designed and constructed from easily available and cheap materials. The simulated total flux per unit current at the exit of the moderator was $(7.1\pm0.1)10^7$ 1/cm^2-s-mA. The thermal flux within the simplified cilindrical water phantom reached a maximum value of $(5.1\pm0.1)10^7$ 1/cm^2-s-mA at a depth of 2.75 cm.

Notes

a. Permanent address: CNEA, Av. Gral Paz 1499, San Martín, Buenos Aires, Argentina;
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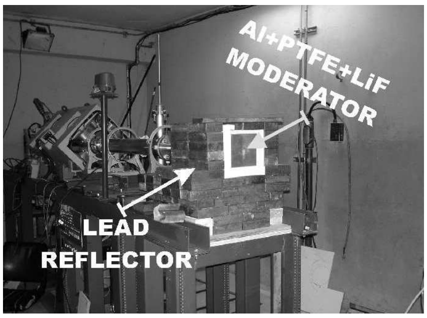

Fig. 1. Picture of beam shaping assembly

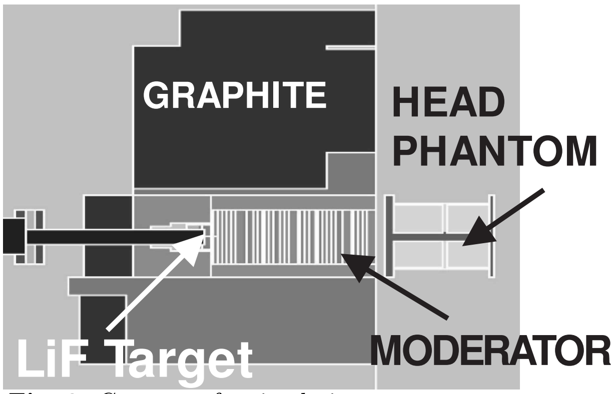

Fig. 2. Geometry for simulations

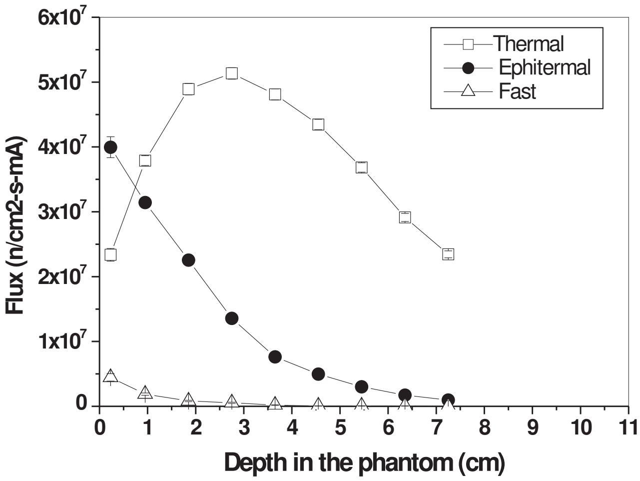

Fig. 3. Simulated Neutron Fluxes within the phantom

References

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