DESIGN OF A FACILITY FOR NCT RESEARCH IN THE IEA-R1 REACTOR

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Introduction

For several years, the possibility to use the IEA-R1 reactor to make research on Neutron Capture Therapy (NCT) has been evaluated. Also, some studies have been developed in order to obtain a suitable neutron beam. This work describes the conceptual design for a facility using a radial beam hole of IEA-R1 Research Reactor.

Irradiation Facility Design

The IEA-R1 Reactor is a 2MW pool-type research reactor and nowadays its power is being increased to 5MW. This reactor is mainly used in radioactive material production. It has several beam holes and the neutron flux in its exits is small.

The basic idea is to build a device to be introduced into the Beam Hole, in such a way that neutron and gamma filters (Aluminum, Silicon, Iron, Bismuth, etc.) can be arranged and easily changed, in order to make possible different emergent neutron spectra (thermal or epithermal); Also, a flexible setup should be obtained, in order to meet the needs of several types of studies.

To enhance the neutron intensity entering the device, a fission plate will be installed between the BH and the reactor core. Calculations to determine the neutron flux gain and the heat generation in the plate are in course, using ANISN transport radiation code [1]. In these calculations, parameters like the thickness of the plate and its material (metallic uranium, U_3O_8 or UO_2), as well as two different degrees of enrichment in ^{235}U (20% and 93%), are being taken into account.

The Beam Hole number 3 (BH-3 - Fig. 1) was chosen because of its 8-inch inner diameter (the highest among the existent). As it is difficult to obtain a computational model of this reactor, because there is a mix of fuel (2 different enrichment and several burn-up levels), several measurements of neutron flux inside the beam hole and in the edge of the core, nearby the BH entrance, have been made using both activation and scintillation detectors; This data will serve as the basic input for the design. With the BH-3 empty, a thermal flux of 10^{10} neutrons/cm^2.s was obtained in the position 90cm away from the edge of the core (entrance of the Beam Hole) [2].

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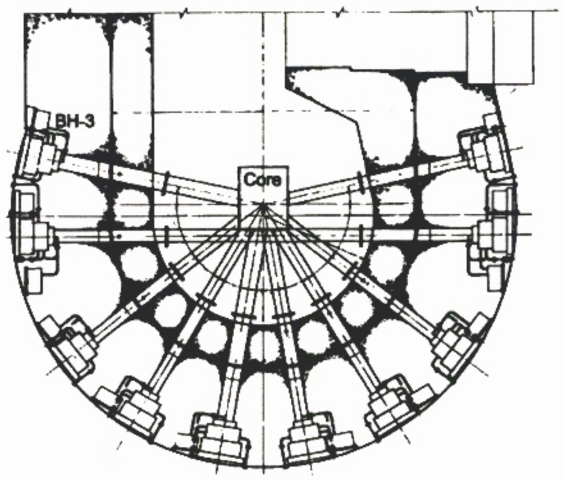

Fig. 1. Top view of the IEA-R1 reactor showing the relative position of the BH-3.

To obtain sufficiently high neutron flux for the purpose of biological experiments, the "irradiation cell" will be placed inside the BH-3 (see Fig. 2), consisting of a box with 8 cm x 8 cm cross section which can be inserted just after the filters.

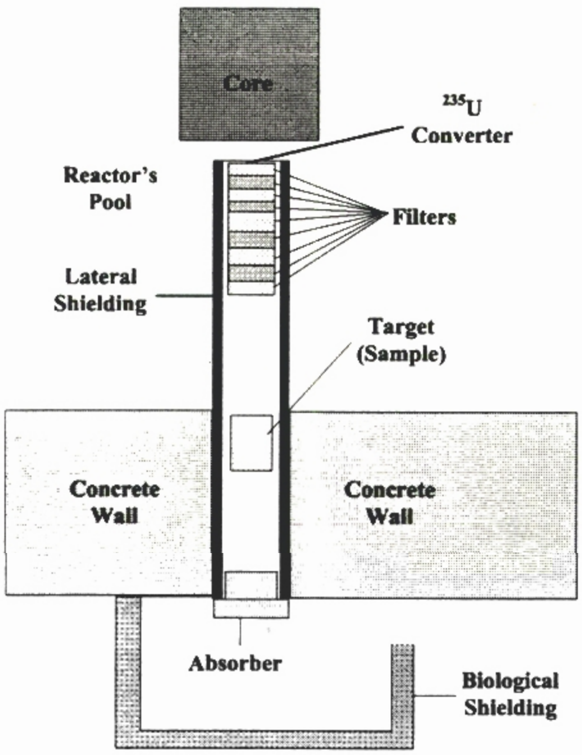

Fig. 2. Preliminar sketch of the facility to be mounted in the Beam Hole.

The calculations to define the basic dimensions of the device and shield are being made using transport codes (the ANISN code) and Monte Carlo code (MCNP) [3].

Finally, a beam catcher outside the beam hole will be designed to isolate the experimental facility.

Proposed Experiments

This facility will allow studies with different combinations of neutron filters to assess neutron spectra, dose rates, etc. suitable to be used in Neutron Capture Therapy. The filter combination optimization will be obtained using the DOT 3.5 Transport Radiation Code [4] and MCNP Monte Carlo Code, and the calculations will be evaluated using experimental measurements. The "irradiation box" will be used for phantom irradiation on dose distribution studies, as well as "in vitro" and "in vivo" biological sample irradiations.

Also, this facility will allow assays of cell growing curves (gliomas and melanomas in culture) in presence of B-10 compounds, and tumor regression assays in mice. In addition, some studies about the effects of NCT in neurophysiological systems using rats as models will be developed.

References

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