RPI DOSIMETRY

Introduction

The main objective for the “RPI Dosimetry” activities develops around the **characterisation of the radiation field of the facilities available in the reactor** and the implementation of dosimetry techniques for specific purposes to support the reactor users. Regarding this last aspect one has to note that the irradiations involving biological materials require radiation fields with adequate characteristics and also detailed dosimetry.

The work has been centred on facilities and methods aiming at the **implementation of BNC technique**, in particular the preparation of a beam tube for experimental work (studying the optimal filter and shielding arrangements) and on preliminary work on boron determinations using PGNAA technique.
Building the components for the beam usage has been initiated and the safety analysis report completed.

It is also an important goal, the collaboration with universities so as to allow the familiarisation of students with nuclear techniques.

Keeping in mind the interest of establishing new collaboration with research groups with similar interests, it was proposed a project named “Portuguese-Hungarian collaboration on the use of research reactors for BNCT”, under the Portuguese-Hungarian Intergovernmental Science and Technology Co-operation Programme.
The institutions involved are ITN and Technical University of Budapest and the KFKI from Budapest too.

Research Team

Researchers –	2*	(2 PhD or equivalent)
Research Student[#] –	1	
Undergraduate Student –	1	
Technicians –	1	

* with collaboration of Dr.Jose Marques, Dra. Isabel F.Gonçalves and Dr.J.Salgado

[#] PRAXIS XXI Grantee

Publications

Journals –	2
Proceedings –	2
Special Publ. –	1
Conf. Commun. –	3

10^3 PTE

Expenditure:	**427**
Missions:	378
Others Expenses:	49
Hardware & Software:	0
Other Equipment:	0

10^3 PTE

Funding:		**427**
OE/ITN	OF	427

A Code of Practice for the Dosimetry of BNCT in Europe

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Abstract

At the present state of development of Boron Neutron Capture Therapy, BNCT, world-wide, a variety of different techniques is applied for the dosimetry related to preclinical studies or to clinical trials on human patients. As each BNCT research group performs the dosimetry in its own way, it is essential at this moment to introduce international uniformity of BNCT dosimetry.

The existing international recommendations on radiotherapy dosimetry are not applicable to BNCT due to the complexity of the mixed neutron and gamma ray fields. Hence, guidelines on acceptable dosimetric procedures are urgently needed to provide credibility and reliability to the preclinical research and to the clinical trials on human patients. These guidelines will ensure the level of accuracy, reliability and reproducibility which is generally required in radiotherapy and which will be of crucial importance for the success and for the optimisation of the BNCT treatment.

In *Advances in Neutron Capture Therapy -Volume I, Medicine and Physics,* Proceedings of the *Seventh International Symposium on Neutron Capture Therapy for Cancer*, Zurich, 4-7 September 1996, eds. Borje Larsson, John Crawford and Regin Weinreich, *Excerpta Medica,* International Congress Series 1132, 1997, pp. 237-240.

Use of the Thermal Column of the Portuguese Research Reactor (RPI) for BNC Therapy

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Abstract

The Portuguese Research reactor (RPI) is a small reactor provided with a thermal column. Around the thermal column there is still free space that can be used to isolate an area sufficient to install a BNCT facility without interfering with the present work in other areas.

With this background it has been thought to use the thermal column for BNC Therapy.

Preliminary indications show that it will be possible to have a location with sufficient intensity for that effect. To further study this problem calculations with MCNP code have been made to

select the exit points of the beam and to optimise the filter materials and assure that adequate conditions can be created.

Communication to: *4th Meeting on Nuclear Applications - IV ENAN* , Poço de Caldas, Brasil, August 97.

Work in the Field of BNCT Using the Portuguese Research Reactor

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Abstract

The goals of the work are pursuing the research activity in BNC and the installation of a therapy facility in the position presently occupied by the thermal column. With these objectives the experimental studies in mice and cells are continuing while improvements in the facilities are created or prepared. For this effect: i) installation of lead shield in the vertical access of the thermal column, which resulted in an enhancement of the Φ_{th} to D_γ ratio, was performed; ii) Adaptation of a beam tube to deliver a dominantly thermal or epithermal beam in two possible beam openings is being done; iii) Monte Carlo calculations aiming at the optimisation of the conditions for the therapy installation are in progress.

Communication to: First Int. Symp. on Nuclear and Related Techniques - Cuba (Out.97).
Submitted for publication to the *Journal of Radioanalytical and Nuclear Chemistry.*

The BNCT Technique Applied to Cell Cultures. Microdosimetric Calculations

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Abstract

The calculation of the doses in a BNCT irradiation can be performed considering the interactions at the cell level and studying statistically the damage in a large set of cells.

This document contains results of calculations performed using this methodology which is generally known as microdosimetry.

The calculations were done with the TNC6 program which performs Monte Carlo simulation of the interactions of the neutrons with the cells. The calculations were applied to cell cultures and to the irradiation of small animals.

Communication to: *"XXVI Reunión Bienal de la Real Sociedad Española de Física",* Las Palmas de Gran Canaria - September 1997. *Proceedings of the "XXVI Reunión Bienal de la Real Sociedad Española de Física".*

Some Considerations Related with the Boron Neutron Capture Therapy

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Abstract

The basis of BNCT - Boron Neutron Capture Therapy - and a brief review of its antecedents and present status are presented, and requirements for its implementation are referred.
Work that has been conducted in ITN, using neutrons from the thermal column of the Portuguese Research Reactor, RPI, is described. Present status of the work to establish a neutron beam with an improved epithermal to fast neutron ratio and also capable of providing, if needed, a thermal beam, is given.
The design will permit the introduction and removal of experiments with the reactor running.
The optimisations and shielding calculations are being performed with the MCNP4 program to design a BNCT facility to be implemented in the horizontal access of the thermal column of RPI. The preliminary results indicate that an adequate beam, in intensity and spectrum can be obtained at around 200cm from the reactor core.
To finalise, a short overview of the activities in progress around the world is also made, with particular reference to the work in Brookhaven National Laboratory and to the one planned for the High Flux Reactor of the EU located in the Petten JRC..

Communication to: *IV Jornadas Portuguesas de Protecção contra Radiações*, Instituto Nacional de Saúde Doutor Ricardo Jorge - Lisbon March 1997, *Revista da Sociedade Portuguesa de Protecção contra Radiações*, (in press).

Current Work

Determination of Boron in samples by the PGNAA Technique

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The determination of Boron using the PGNAA methodology that has been initiated, with the equipment assembled during the year, around the neutron beam extracted from the thermal column of the RPI, will be continued. We will be looking particularly at optimising the conditions to take care of the effects of the medium in which the Boron is dispersed.

Monte Carlo Calculations for Enhancement of the Epithermal Component of the Neutron Field In The Thermal Column of RPI for BNCT

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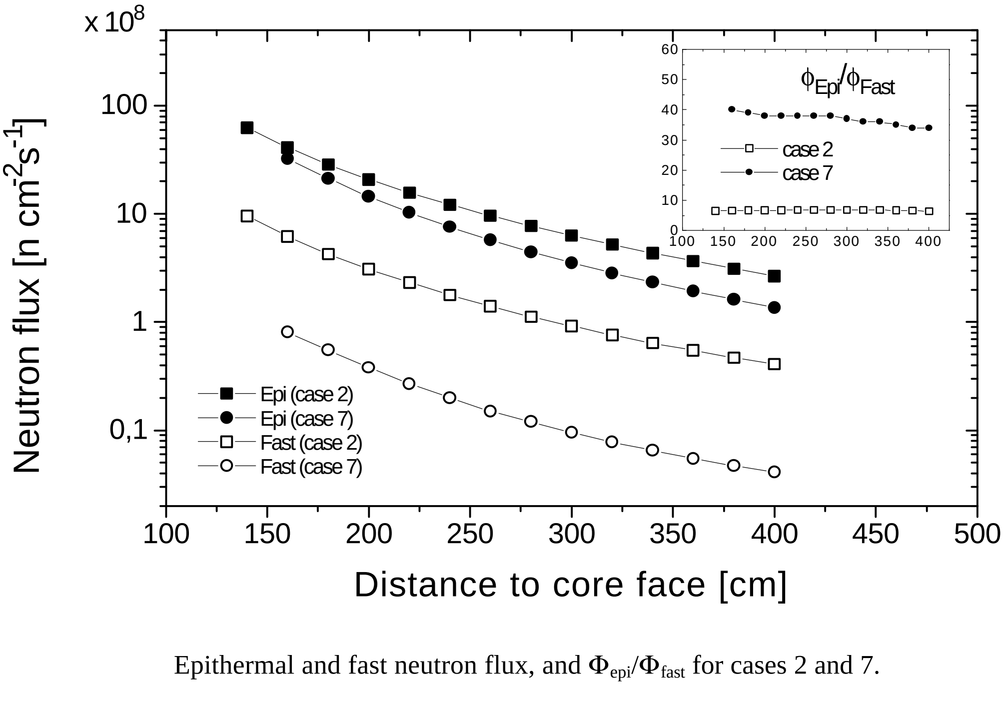
Work towards the adaptation of the thermal column of the Portuguese Research Reactor (RPI) to a BNCT irradiation facility has been going on for some time. The thermal column is provided with vertical and horizontal accesses. The irradiation position will be located in the horizontal access, ideally having the beam exit in the region of the vertical access to increase the space available.

In the inner part of the thermal column (the one inside the pool) it is planned to install a water beam shutter with the second shutter , in solid materials, placed close to the beam exit.

In this document we are presenting results aiming at the optimisation of the beam design from the point of view of the epithermal beam intensity and epithermal to fast neutron ratio.

From the arrangements of materials so far tested, it seems that the Al_2O_3 combinations, although giving adequate epithermal intensity, will lead to unacceptably low epithermal to fast neutron flux ratio. The promising cases will include a small layer of D_2O or AlF_3 in combination with Al, which seams to be the most desirable arrangement to increase that ratio, although generating eventually, lower epithermal intensities.

The figure shows the results for the material arrangements, case 2 ($5cmD_2O+24cmAl_2O_3+22.5cmAl$) and case 7 ($22.5cmAl+40cmAlF_3$).



Epithermal and fast neutron flux, and Φ_{epi}/Φ_{fast} for cases 2 and 7.

(Submitted to the Int.Conf.on the Physics of Nuclear Science and Technology – Oct.98)