

# Preliminary experimental results of DNA molecule irradiation in the mixed thermal neutron-photon field

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## Abstract

The aim of this work is to present the preliminary experimental results of DNA molecule irradiation in the mixed neutron-photon radiation field. The research Boron Neutron Capture Therapy (BNCT) facility at the IEA-R1 reactor of IPEN-CNEN, Sao Paulo is used for irradiation. The Plasmid DNA pBluescrip II KS(+) phagemid derived from PUC19 in aqueous solution was used in the irradiation. The characterization of the neutron-photon radiation field was showed in a previous work[1]

## I. Introduction

Nowadays, there is a growing interest in neutron interaction with DNA molecule, since neutrons are used in the radiation treatment of cancer patients. Interaction of ionizing radiation with living matter involves direct and indirect effects. In the direct effect the ionizing radiation deposits energy directly in DNA (ex. heavy particles, protons and neutrons). The indirect effect consists on the interaction of DNA molecules with the products of water radiolysis: hydroxyl radicals (OH), hydrogen atoms and aqueous-electrons (ex. X or gamma rays and electrons). The interaction is studied through the observation of single- and double-strand breaks of the DNA molecule. Radiation damage to DNA is evaluated by electrophoresis through agarose gels which shows the conformation of the DNA after irradiation.

## II. Materials and Methods

### DNA sample specification

The DNA sample at concentration of 200 ng/ $\mu$ l in 10  $\mu$ l of solution were prepared from PUC19 plasmid (2.96 kb). Two samples were used as a control and the others as irradiated. DNA solutions was irradiated in 0.5 ml eppendorf tubes (polypropylene material). The plasmid was purified according to [2]. In this irradiation, used plasmid DNA is of approximately 82 % supercoiled form.

### Neutron irradiation

Neutron irradiation were performed at the research Boron Neutron Capture Therapy (BNCT) facility at the IEA-R1 reactor of IPEN-CNEN. The optimal filters sets were obtained by means of Monte Carlo simulations in previous work.

The reactor was operated with 3 MW during 37 h 15 min. The contribution of gamma photons (originating from the reactor) was about 19 per cent of the fluence.

LiF Thermoluminescent dosimeter was used to estimate of DNA ray exposure which constitutes itself as an unavoidable contamination of the thermal neutron field.

Gold activations foils were used to thermal and epithermal neutron fluxes measurements using Cadmium rate technique in each mixed-field radiation. The count rate was measured with an High Pure Germanium (HPGe) Detector.

### Electrophoresis and DNA quantification

Supercoiled DNA (form I) consists on the undamaged plasmid, circular (form II) results from single- strand breaks (SSBs), linear (form III) results from double-strand breaks (DSBs). The damage quantification of the DNA bands was obtained with the program Gel Analysis [3].

## III. Results and Discussions

Figure 1-3 shows different conformations of the DNA plasmid: supercoiled(S), circular(C) and linear (L) in each irradiation positions.

In fig. 4 shows the fraction of survival molecule( $\Phi$ ) as a function of irradiation time in central position.

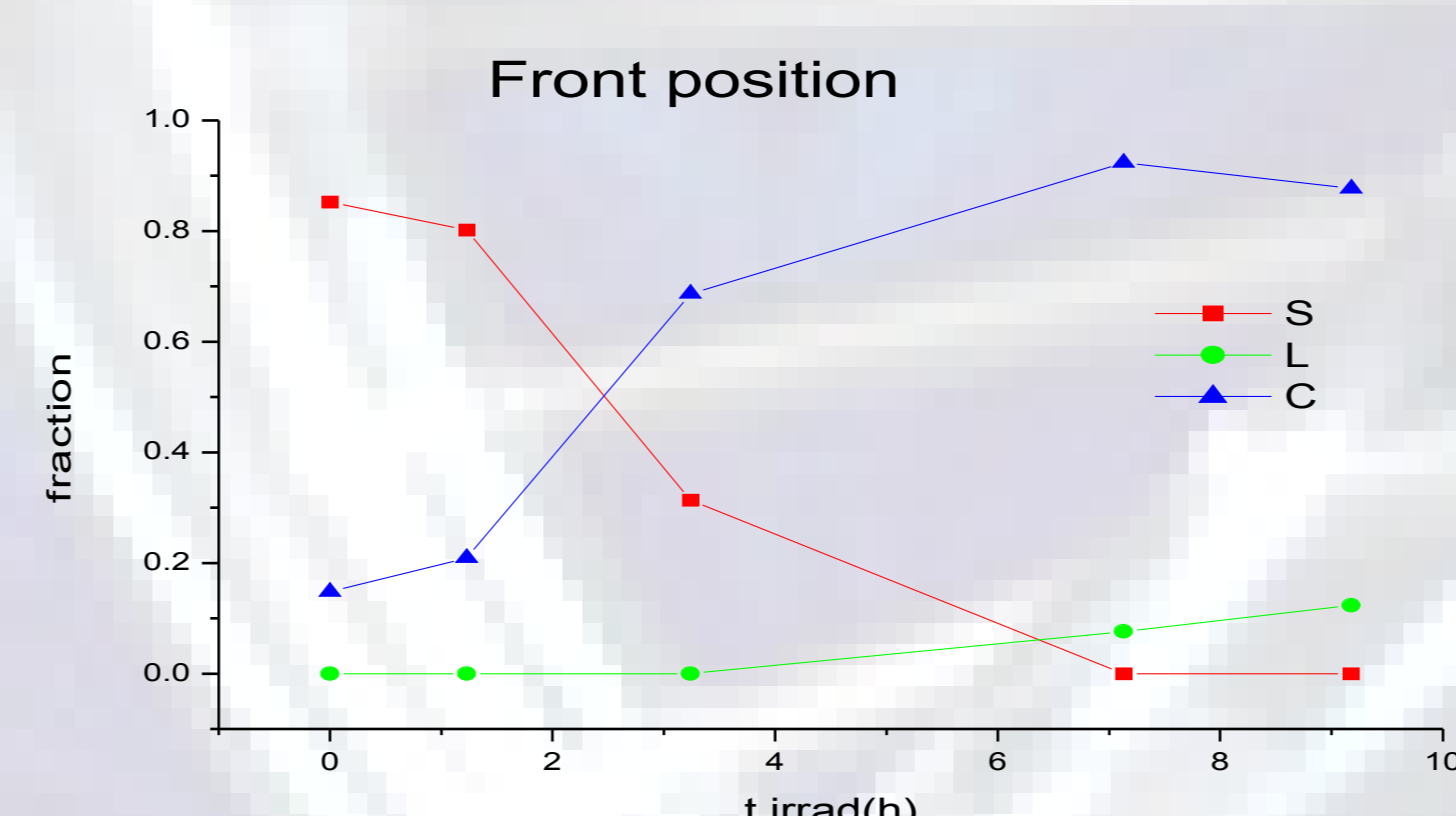


Fig 1- Fraction of the observed forms of the plasmid as a function of irradiation time in a front position

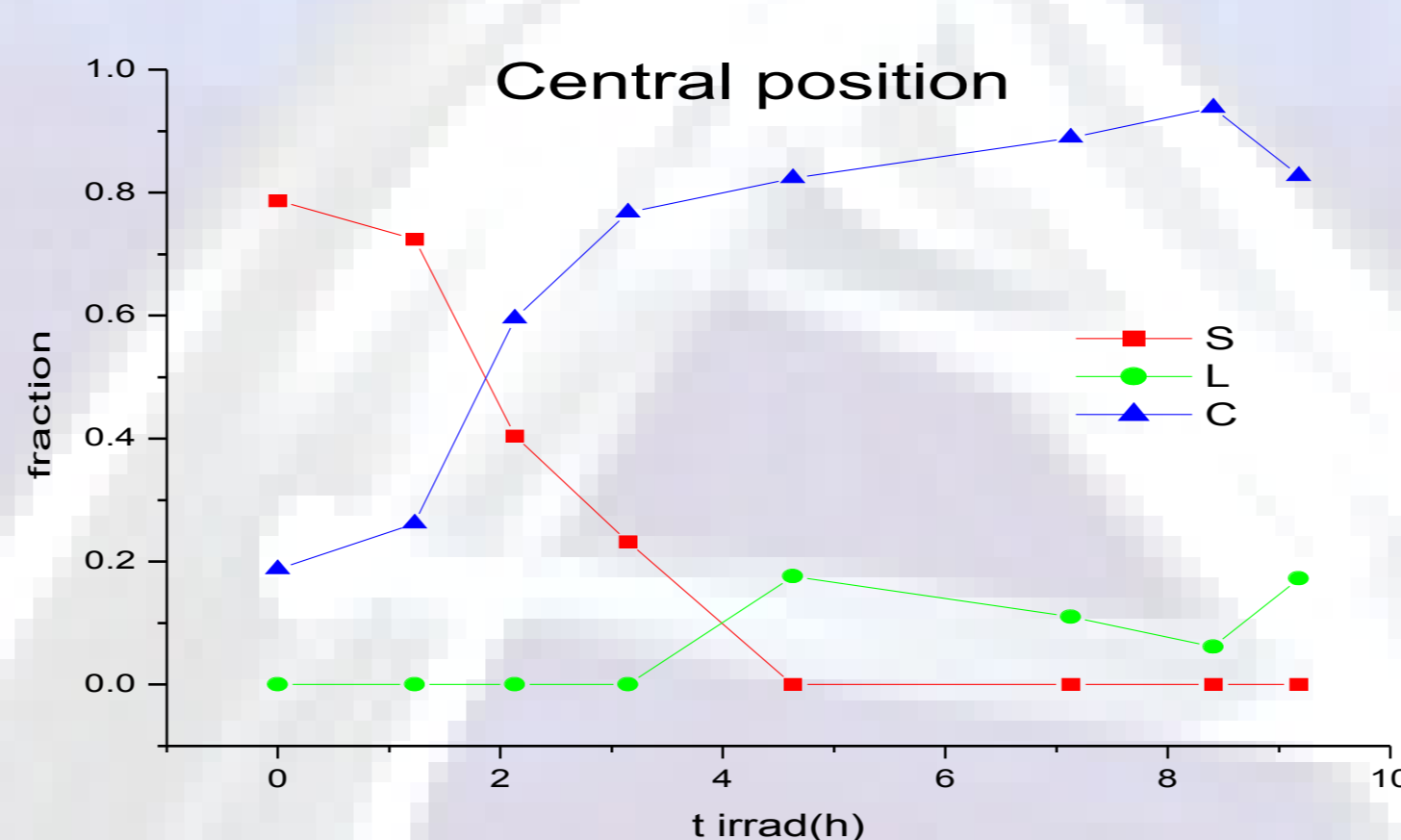


Fig 2- Fraction of the observed forms of the plasmid as a function of irradiation time in a central position

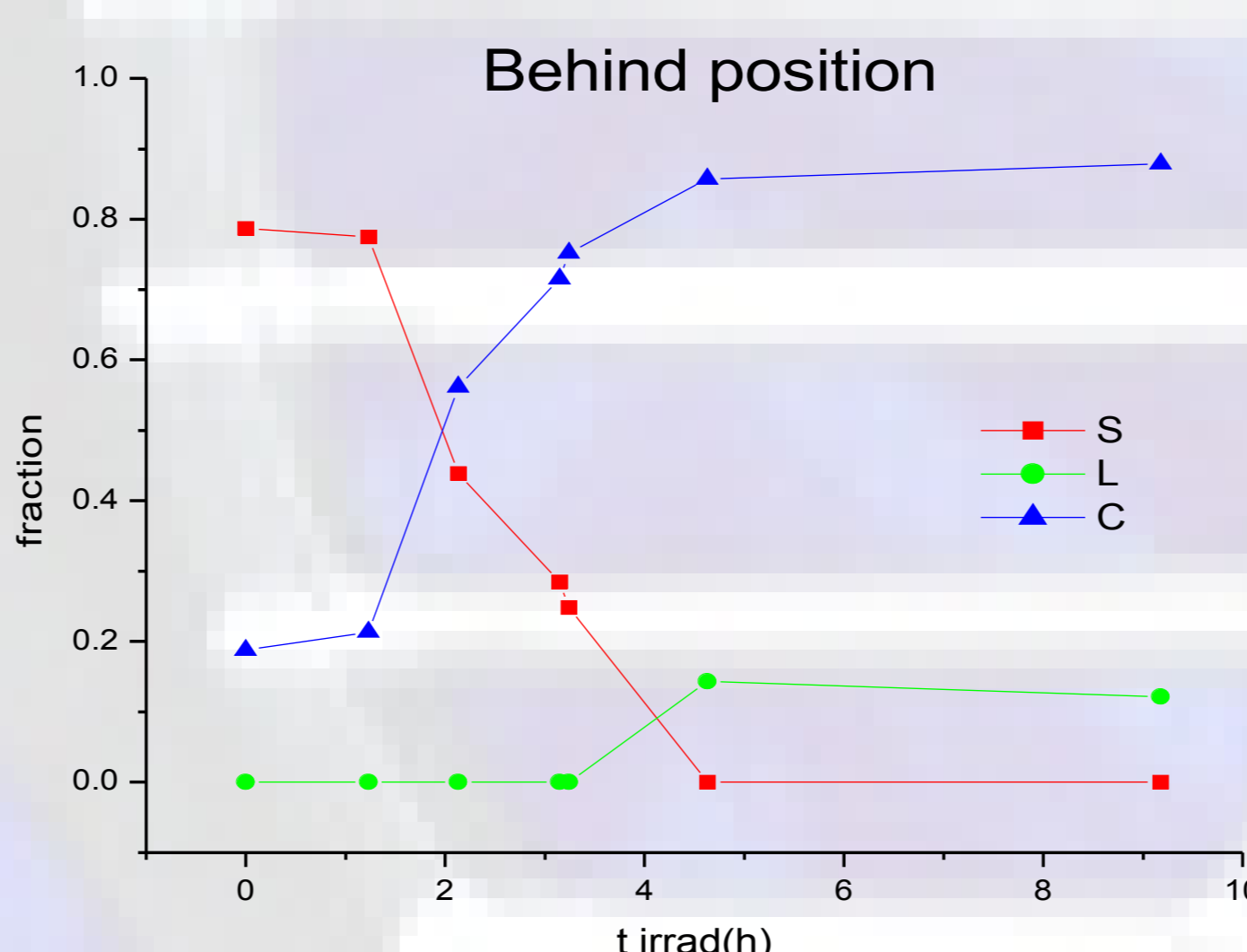


Fig 3- Fraction of the observed forms of the plasmid as a function of irradiation time in a hind position

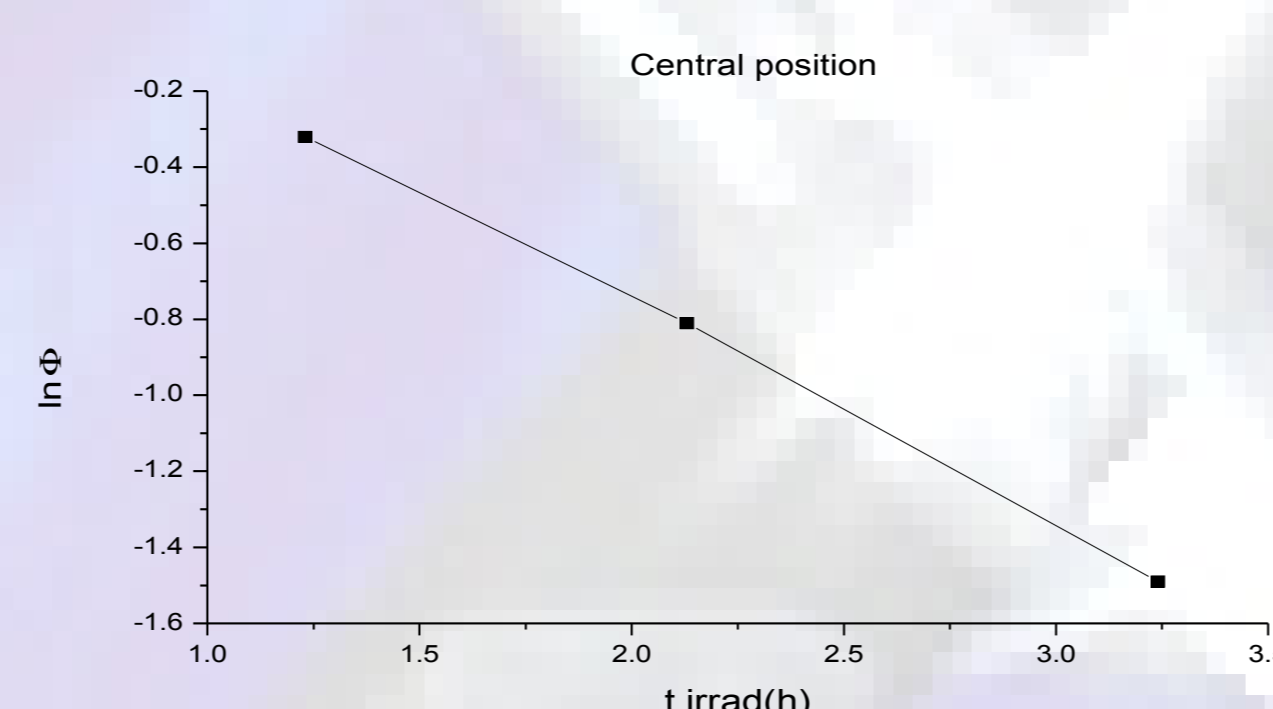


Fig. 4 – Fraction of survival molecules ( $\Phi$ ) as a function of irradiation time.

During irradiation, the amount of supercoiled form decreases, increasing the circular form and the appearance and increase of the linear form.

## IV. Conclusions

1. A better understanding of the neutron radiation effects in the DNA molecule is necessary although it must be better studied the dosimetry of gamma-rays in mixed fields (photons +neutrons).
2. The best time of irradiation is 3 hours because for higher times is not possible the observation of not damage molecule in all the irradiation positions.
3. When the DNA molecules are irradiated in a mixed thermal neutrons and photons field the damage is produced due to both the neutrons and the gamma rays.
4. It is necessary the measurement of the dose of both neutrons and gamma with more accuracy because the doses are being overestimated.

## Recommendations

Our results suggest that:

- To impart lower neutron doses to DNA it is necessary to change the irradiation position.
- It is necessary improve the reactor simulations source for to compare the measured with calculated doses by mean the MCNP-4C.
- To irradiate with the other filter sets for the study the effect of epithermal and fast neutron of DNA molecule.
- More samples of DNA molecule need be irradiated with different neutron doses to obtained better statistic.

## V. References

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