Description

Neutron Capture Therapy (NCT) is a promising form of radiation therapy characterized by two interrelated features: (1) the infusion or delivery of a capture compound which preferentially concentrates in the tumor, followed by (2) the irradiation of the tumor site with neutrons. Inasmuch as the boron isotope $^10\text{B}$ is often used as a neutron capture agent in compounds, this form of therapy is thus termed Boron Neutron Capture Therapy (BNCT).

The large thermal neutron capture cross section of $^10\text{B}$ greatly increases the probability of the resulting $^{11}\text{B}$ nucleus to split into He and Li. As the ionization potential of He and Li ions is high as they slow down in the biological material along relatively short distances, the affected cells enriched by boron are destroyed while normal, healthy cells are damaged to a much lesser extent. However, as the penetrating capability of thermal neutrons is low, to reach cancerous tumor cells localized at depths of several centimeters, epithermal neutrons are more suitable to the task. Such epithermal neutrons have a lower neutron capture rate in hydrogen, which results in a lower skin dose burden while the moderation of epithermal neutrons within the head would give rise to a thermal neutron peak at the cancerous tumor site. The most suitable neutrons for BNCT are those with energies in the range of 1 eV to 10 keV because their KERMA factor (and hence direct tissue damage) is less than for thermal or fast neutrons.

Such epithermal neutron beams may be provided by nuclear research reactors. The concept behind providing such a source is a modification of the reactor such that the emergent beam is slowed to the epithermal range. Such modifications of research reactors are usually relatively straightforward and not cost prohibitive – especially when compared to constructing new reactors dedicated to BNCT. Of course, any modification to a reactor should be justified with careful design work taking into account all specifics of a given specific reactor system.

Innovative Aspect and Main Advantages:

- Existing nuclear research reactors may be readily modified to provide the proposed epithermal neutron beam precluding any need to design and construct a dedicated reactor;
- Uses a Ni-60 neutron filter for essential improvement in therapeutic source parameters;
- Destroy tumors by avoiding highly traumatic surgical techniques;
- High radiation doses are applied directly to malignant cells while the impact on healthy cells is minimized.

Areas of Applications:

- Cancer treatment, in particular of brain tumors,
- Veterinary medicine.

Stage of Development:

We have demonstrated analytically that an epithermal neutron source meeting the requirements of BNCT may be constructed at the nuclear research reactor in Kyiv. The modification to the reactor may be achieved by altering the design of the thermal column and replacing the Beryllium reflector with one based on Aluminum.

Contact Details:

Olena Gritzay, Ph. D.
Institute for Nuclear Research National Academy of Sciences of Ukraine
Neutron Physics Department
Prospect Nauky, 47, Kyiv 03680, UKRAINE
phone: (380-44) 525-3987; fax: (380-44) 525-4463
E-mail: ogritzay@kinr.kiev.ua