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Prospects of Clinical Boron/Gadoliunium Neutron Capture Therapy at Fermilab

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The Neutron Therapy Facility (NTF) at Fermilab began treating human patients with fast neutrons in 1976. Fast neutron radiotherapy has continued at the NTF up until 2013 and still is performed at another site in the USA. Another clinical application of neutrons is to combine neutron therapy with a tumor-localizing drug carrying a neutron capture agent such as boron or gadolinium. This is known as boron neutron capture therapy (BNCT) and gadolinium neutron capture therapy (GdNCT). However, after some initial progress, there has been a hiatus in BNCT clinical research in the USA for over a decade, in part perhaps due to the regulatory and security challenges of conducting clinical research and treatment at nuclear reactors after the September 11, 2001 attacks. BNCT research has continued unabated in other countries and preliminary clinical results have been encouraging. As a fully functional and independent clinic, the NTF could be the ideal environment to reinitiate investigations into boron and/or gadolinium neutron capture therapy and boron neutron capture enhanced fast neutron therapy in the USA without the need for a reactor.

The Fermilab p(66)Be(49) fast neutron beam has a mean neutron energy of approximately 25 MeV. The NTF team has created a means of moderating the mean energy down to the energy range appropriate for neutron capture therapy using a beam spoiler made up of titanium and graphite blocks. The moderated beam is enriched in neutrons of epithermal energy making it potentially suitable for BNCT of deep-seated tumors without intraoperative exposure. We have been examining the physical characteristics of this modified beam and actively using it for in vitro radiobiology experiments.

In parallel with the physics and radiobiology advancements, in collaboration with several investigators, we have been developing and evaluating various novel boronated compounds (e.g. glutamine derivatives), which may offer improved biodistributions and toxicity profiles over traditional BNCT agents.

Provided the final analysis of the modified beam proves acceptable for clinical applications, we propose addressing two primary malignancies in future clinical trials – malignant brain tumors in human patients (glioblastoma multiforme) and locally advanced bladder cancer in veterinary patients. In this presentation, we will discuss the possibilities and pitfalls of pursuing clinical BNCT and GdNCT at Fermilab.

Summary

Fermilab could be the ideal facility to resume clinical research into BNCT as well as explore new avenues in GdNCT.

Primary author: WELSH, James (NIU)

Co-author: KROC, Thomas (FNAL)

Presenter: WELSH, James (NIU)

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