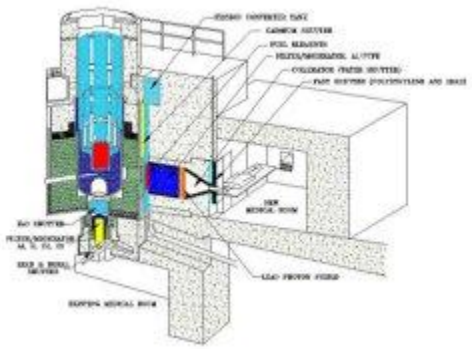
6.21 Improving Neutron Beams for Cancer Treatment



The MIT Fission Converter first began operation in June of 2000. It delivers a high quality epithermal beam of about 1010 neutrons/cm^{2}sec, making it ideal for use in Boron Neutron Capture Therapy. (Click here to see larger version.)

Beams of neutrons long have been used in scientific experiments, but recently, for the first time, a novel type of neutron beam was generated for use in a medical reactor. The innovation by Otto K. Harling of Massachusetts Institute of Technology involved the adaptation of existing nuclear fission converter technology. The Office of Science supported the detailed scientific and engineering design needed to put the concept to practical medical use. The new technology was used to upgrade MIT's medical reactor for studies of boron neutron capture therapy (BNCT), first attempted in the United States in the 1950s at Brookhaven National Laboratory. Those early efforts were unsuccessful, but the new MIT beam is epithermal (intermediate energy) and can penetrate more deeply than the low-energy neutrons used in the past, thereby eliminating the need for surgery. The latest BNCT technology also incorporates an improved boron-containing drug and rapid, accurate boron analysis technology. In BNCT, the patient consumes a drink containing boron, which is taken up by tumor cells. The tumor then is irradiated with a neutron beam, causing the boron to split into two highly energetic particles that destroy the tumor cells while largely sparing adjacent healthy cells.

Scientific Impact: This work demonstrates the value of long-term interdisciplinary and inter-institutional efforts to design, develop, and field innovative technology. The improved neutron beam has helped make MIT's medical reactor the most advanced epithermal neutron source in the world for cancer treatment.

Social Impact: Preliminary trials of BNCT therapy supported by the Office of Science have shown promise for the treatment of malignant melanomas. The National Institutes of Health is considering but has not yet approved clinical trials, for which the MIT facility is the only suitable site in the United States.

References: W.S. Kiger III, Sakamoto, S., and Harling, O.K., "Neutron Design of a Fission Converter Based Epithermal Neutron Beam," *Neutron Capture Therapy* 131:1-22 (1999).

S. Sakamoto, Kiger III, W.S., and Harling, O.K., "Sensitivity Studies of Beam Directionality, Beam Size, and Neutron Spectrum for a Fission Converter-based Epithermal Neutron Beam for Boron," *Neutron Capture Therapy* 26(9):1979-88 (September 1999).

SC-Funding Office: Office of Biological and Environmental Research