

Homework 9

Nuclear Engineering 162

Due 30 April 2007

Boron Neutron Capture

100 Points Possible

Therapy is used to treat brain tumors. The therapy is based on the capture of thermal neutrons by boron-10. This reaction yields two heavy particles (Li-7 and alpha) which will subsequently deposit their energies in the tissues. Boron-10 is concentrated in the cancerous cells with help of tumor-seeking drugs, which are given to the patient prior to neutron irradiation. Neutron beams with specific energies and diameters are used to irradiate the patient head. The tumors located in the center of the brain (8 cm depth) are targeted. The goal of the treatment is to maximize the dose to the tumor while keeping the dose to the healthy tissues below 12.5 Gy. When this dose to the healthy tissues is reached, the treatment has to be interrupted. The dose to the tumor in the center of the brain can then be measured/calculated. Another limiting factor is the dose to the skin. Erythema develops in a non-stochastic manner whenever the dose to the skin exceeds 8 to 9 Gy.

(2) PROBLEM SPECIFICATION

In this homework, we will try to find the optimal neutron energy for the neutron beam in order to maximize the dose to the desired depth of 8 cm. The neutron energies for which the dose will have to be calculated are:

1.26 keV

2.00 keV

3.16 keV

5.01 keV

7.94 keV

12.6 keV

20.0 keV

The quantities of interest are:

- a) the equivalent dose to the tumor at a depth of 8 cm
- b) the equivalent dose to the skin (depth = 0 cm)
- c) the treatment time

Every student will work with a neutron beam of different diameter, ranging from 0 cm to 30 cm.

Name	Diameter (cm)
Mike Calvert	0.5
Joey Cheung	1
Dominic Caron	2
Tyler Chow	4
Steve Huber	7
Karen Kim	10
Zack Kline	12
Kenny Lee	14
Douglas Ogata	16
Raluca Scarlet	20
Christian Schopke	22
Brandon Tam	24
Sisi Tian	26
Chris Wootton	28
Victor Yu	30

The phantom to be used to run mcnp is called *phantom.i* and is included as an attachment with this pdf file. Copy this file before making any modifications to it. The only things to change in this file are the neutron beam RADIUS and ENERGY. These two parameters are given in

ERG = 0.020 (MeV)

SI21 = 2.5 (cm)

as in the following source card:

SDEF POS = -2.1256 0. -36.375344 VEC = 0.795 0 -0.6067

DIR 1 AXS = 0.795 0 -0.6067 RAD = D21 ERG = 0.020

SI21 2.5

This card specifies a 20 keV, 5 cm diameter neutron beam.

Unpack the *calculate-dose.zip* file also included with this pdf file. This zip file includes *dose.m* and three kerma files (*kerma.b*, *kerma.g*, and *kerma.h*). The matlab routine *dose.m*, will take an output file named *phantom.i* and retrieve the necessary information using the kerma files.