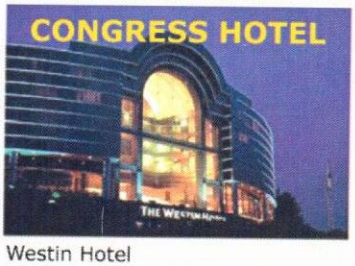
Westin Hotel - Boston, MA, USA
October 11-15, 2004

Eleventh World Congress on Neutron Capture Therapy

Explore and Exchange Information Related to Neutron Capture Therapy in Biology, Medicine, Clinical Trials, Chemistry, Nuclear Engineering and Physics.

Official Program



Westin Hotel
70 Third Avenue
Waltham, MA 02451
(781) 290.5600

Glyconix Corp.

Pratt Radiation Oncology Associates

CANBERRA

http://isnct.org

Posters Session - Physics

2 - Application of Invasion Mathematical Model in Dosimetry for Boron Neutron Capture Therapy for Malignant Glioma.

K. Yamamoto[a,*], H. Kumada[a,b], K. Nakai[b], K. Endo[b], T. Yamamoto[c], A. Matsumura[b]
a Japan Atomic Energy Research Institute, Shirakata-shirane 2-4, Tokai-mura, Ibaraki,319-1195, Japan, b University of Tsukuba, Tenoudai 1-1-1 , Tsukuba, Ibaraki, 305-8577, Japan, c Ibaraki Prefectural Central Hospital, Koibuchi 6528, Tomobe, Ibaraki, 309-1793, Japan

A dose distribution considered the tumor cell density distribution is required on the general principle of radiation therapy. We propose a novel method of determining target region considering the tumor cell concentration as a new function for the next generation Boron Neutron Capture Therapy (BNCT) dosimetry system. It has not been able to sufficiently define the degree of microscopic diffuse invasion of the tumor cells peripheral to a tumor bulk in malignant glioma using current medical imaging. Referring to treatment protocol of BNCT, the target region surrounding the tumor bulk has been set as the region which expands at the optional distance with usual 2cm margin from the region enhanced on T1 weighted gadolinium Magnetic Resonance Imaging (MRI). The malignant glioma is characterized by their aggressive diffuse invasion to the surrounding normal tissue. Recently, several researchers tried predictions in the survival time, etc. by the application of the mathematical model on the tumor cell invasion process, which introduced the infiltration characteristic from the research field of physic and mathematic. The current stream of mathematical research will provide great insights into important problem if the mathematical analysis will be able to combine with laboratory simulation and clinical treatment planning system. Especially, the dynamic spatial diffusion model is effective for developing the dose planning system. In this research, we calculated the cell density of the region boundary of the target using tumor cell diffusion model. Further, survival tumor cell density distribution after the BNCT irradiation will be predicted by two matters region diffusion model. Based on these studies, a new concept for BNCT dosimetry system is proposed. The target boundary cells concentration at 2cm margin is calculated from the diffusion model so that this value is 1.22x10^6 cells/cm^3. The distribution of post-irradiation has one peak of the cell concentration at 5.6cm radius. The distribution on frontal lobe glioma cells in the digital brain simulated. This result means a high possibility of new selecting method of the target region including the undetectable tumor by using the analytical model that corresponds to the cell concentration distribution. In order to select the target region, we should know the initial distribution of the tumor cell from the medical images. In the future, much information for medical and biological data, which include the survival tumor cell distribution, the survival time, the date of recurrence, the location of recurrence, the information for combined other therapy after that and etc., could be provided, when the diffusion model could be linked to the dose planning system. By using this model, establishment of an intelligent treatment planning system for radiation therapy including BNCT may become feasible.

4 - Calculations of cellular microdosimetry parameters for alpha particles and electrons.

C.J. Tung[a,*], C.S. Liu[a,b], J.P. Wang[c], S.L. Chang[a]
a Department of Nuclear Science, National Tsing Hua University, Hsinchu 300, Taiwan, b Department of Nuclear Medicine, Taipei Veterans General Hospital, Taipei 112, Taiwan, c National Synchrotron Radiation Research Center, Hsinchu Science Park, Hsinchu 300, Taiwan

The dosimetry in boron neutron capture therapy involves both the high and low linear energy transfer particles. The relative biological effectiveness of these particles is determined by the microdosimetric distribution of the energy imparted to the matter in cellular volumes. Stochastic quantities, including the lineal energy and the specific energy, and nonstochastic parameters, such as the cellular S-value, are used in cellular microdosimetry. Their values depend on the source and target regions in the cell. The radiation source is usually assumed to be uniformly distributed in one of the regions of the cell: throughout the cell, cytoplasm, cell surface, or cell nucleus. The biological target is generally assumed as the cell nucleus or the entire cell.
In the present work, the cellular microdosimetry parameters including the cellular S-value and the single-event specific energy distribution were calculated for alpha particles and electrons and different source to target region combinations. Calculations were made using a semi-analytical model that simulated the emission of alpha particles or electrons by the Monte Carlo method and calculated the energy imparted to the target volume by the analytical method. Delta particle equilibrium and partial delta particle equilibrium were applied to alpha particles and electrons, respectively, to calculate the energy imparted to a cellular target volume. Range-energy relations were employed to determine the incident and emerging energies of the primary particles crossing the target volume. For electrons, the fraction in the energy loss resulting from the generation of bremsstrahlung and high energy secondary electrons was estimated using data of the restricted collisional stopping power and the radiative stopping power. The energy loss straggling of electrons entering and leaving a target volume was evaluated by applying a Gaussian distribution with the mean square energy loss data.
Cellular S-values for alpha particles calculated in the present work were in excellent agreement with data of the Medical Internal Radiation Dose (MIRD) Committee of the Society of Nuclear Medicine. Cellular S-values for electrons of the present work were also in very good agreement with results of the MIRD. In addition, the present work evaluated the uncertainties associated with the cellular S-values that were not considered by the MIRD. The energy loss straggling, responsible for such uncertainties, was also applied to determine the single-event specific energy distribution for electrons. The energy loss straggling was found to make significant contribution to the cellular S-values for electrons at, especially, high energies. It revealed that the S-values for electrons were two to three orders of magnitude smaller than the S-values for alpha particles. This indicated that alpha particles were more effective than electrons in imparting energies to the target volume of micrometer size and thus resulting higher RBEs than electrons. A comparison of the single-event distribution calculated in the present work and using the Monte Carlo Penelope code showed that the present model was feasible in microdosimetry calculations.

6 - BINP accelerator based neutron source.

B. Bayanov, Yu. Belchenko, V. Belov, V. Davydenko, A. Donin, A. Dranichnikov, A. Ivanov, I. Kandaurov, G. Kraynov, A. Krivenko, A. Kudryavtsev, N. Kuksanov, R. Salimov, V. Savkin, V.Shirokov, S. Taskaev*, M. Tiunov
Budker Institute of Nuclear Physics, 11 Lavrentiev ave., 630090 Novosibirsk, Russia

The Budker Institute of Nuclear Physics (Novosibirsk) and the Institute of Physics and Power Engineering (Obninsk) have proposed an accelerator based neutron source for neutron capture and fast neutron therapy for hospital. Innovative approach is based upon vacuum insulation tandem accelerator (VITA) and near threshold 7Li(p,n)7Be neutron generation. Negative hydrogen ion beam is injected into VITA. After charge-exchange of negative hydrogen ion into proton inside the charge-exchange tube in the center of high-voltage electrode, the proton beam is formed at the outlet of the tandem. It is accelerated up to double voltage of high-voltage electrode. Neutron generation is proposed to be carried out by protons bombarding a lithium target using 7Li(p,n)7Be threshold reaction. In ordinary mode, at proton energy of 2.5 MeV, the neutron source produces neutron beam with maximum energy of 790 keV appropriate directly for fast neutron therapy and for neutron-capture therapy after moderation. The most efficient operating mode of facility is at proton energy of 1.915 MeV that is 34 keV higher than the threshold of the 7Li(p,n)7Be reaction. In this mode, neutron beam is generated kinematically collimated in forward direction and its average energy of 30 keV, is directly applicable for boron neutron-capture therapy.
Pilot accelerator based neutron source for neutron capture therapy is under construction now at the Budker Institute of Nuclear Physics, Novosibirsk, Russia. Surface-plasma source with Penning geometry of electrodes is to be used for obtaining a dc 25 keV 10 mA beam of hydrogen negative ions. Two magnetic lenses will be used for low energy beam transporting. Then, the beam will be accelerated in 33 kV cm–1 electric field. Striping of negative ion beam is provided by gas target inside high voltage electrode of tandem accelerator with vacuum insulation. Neutrons are generated by protons bombarding the target covered with thin solid lithium layer. Complete experimental tests are planned by the end of the year 2000.

8 - Neutron Dosimetry on Phantom Model of Pancreatic Cancer Patient for Intraoperative Boron Neutron Capture Therapy.

Hironobu Yanagie[a], Yosiyuki Sakurai[b], Koichi Ogura[c], Tooru Kobayashi[b], Yoshitaka Furuya[d], Hirotaka Sugiyama[e], Tomoyuki Hisa[a], Masayori Ishikawa[f], Kuniaki Amemiya[a], Hiroyuki Takahashi[h], Hisao Kobayashi[i], Masao Tago[j], Shin-ichiro Masunaga[b], Koji Ono[b], Keiichi Nakagawa[j], Masaharu Nakazawa[a] and Masazumi Eriguchi[a]
a Research Center for Advanced Science & Technology, The University of Tokyo, Tokyo, Japan, b Reseach Reactor Institute, Kyoto University, Osaka, Japan, c College of Industrial Technology, Nihon University, Chiba, Japan, d Department of Surgery, Teikyo University Ichihara Hospital, Chiba, Japan, e Department of Microbiology, Nihon Medical University, Tokyo, Japan, f Reseach Center for Atomic Energy, The University of Tokyo, Tokyo, Japan, g Department of Quantum Engineering and Systems Science, The University of Tokyo, Tokyo, Japan, h Research into Artifacts Center for Engineering , The University of Tokyo, Tokyo, Japan, i Institue for Atomic Energy, Rikkyo University, Kanagawa, Japan, j Department of Radiology, University of Tokyo Hospital, Tokyo, Japan

Pancreatic cancer is one of the most difficult curative cancer, so it is need new combinational therapy. If sufficient boron compound can be accurate to tumor, Boron Neutron capture Therapy(BNCT) will be apply to pancreatic cancer treatment. We prepare the BNCT to pancreatic cancer patient treatment by intraoperative irradiation. In this study, we performed preliminary dosimetory of the phantom model of abdominal cavity.