Biomedical Engineering

Lecture Series Seminar

Numerical Dosimetry and Particle Transport

Friday, March 6th, 2009

1:00 PM, EC 2300

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The physical dosimetry related to a radiation field reaching a physical medium consists of discrete and stochastic energy deposition processes. The occurrence of energy deposition events depends directly on the nuclear, atomic, and molecular properties of the medium. All these aspects lead to a level of complexity that makes dosimetry calculation highly non trivial task. Some types of radiation, such as photons, allow simplifications making analytical approaches possible and accurate enough for radiation treatment planning. However, other types of radiations, such as neutrons, interact with the medium in more intricate ways making analytical approaches neither non-practical nor accurate enough for dosimetric purposes. The approach that has been developed in last decade is based on the simulation of the particle transport using Monte Carlo method. These simulations emulate the actual behavior of the particles based on nuclear, atomic, and molecular interaction phenomena containing the information of the nature of the interactions. The use of this type of simulations allows for the assessment of realistic energy deposition distributions with high accuracy levels. Some of the most important applications of this method can be found in cancer treatments involving particles such as neutrons, electrons, and protons as primary radiation. An example of the application to boron neutron capture therapy and yttrium-90 selective internal radiation treatment will be presented. A comprehensive and detailed study of particle transport modeled using the state-of-the-art Monte Carlo tools, MCNP5 and MCNPX, will be explained on the examples of novel application of BNCT to metastasized breast cancers and yttrium-90 microspheres to liver cancers with extensive visualization of dose distributions and particle tracks.

Manuel Sztejnberg has a medical physics engineering degree from Universidad Favaloro (Argentina); he is currently a nuclear engineering Ph.D. candidate supervised by Prof. Tatjana Jevremovic, at Purdue University in the Laboratory for Neutronics and Geometry Computation. He has been working in the areas of nuclear detection, measurements, and dosimetry since 2003. In 2003 he became a member of the Argentine Boron Neutron Capture Therapy (BNCT) Project in the Comisión Nacional de Energía Atómica -CNEA; his role was to develop self-powered neutron detectors. He also worked in projects involving developments of new products associated with high neutron flux reactors. In 2006 he came to US to pursue a PhD degree doing research in novel applications of BNCT. His expertise developed in the field of dosimetry assessment based on Monte Carlo simulations, mainly Monte Carlo N-Particle eXtended transport code, MCNPX. During this period he has been developing different dosimetry approaches for breast cancer BNCT, yttrium-90 selective internal radiation treatment for liver cancers, and models for microdosimtry studies. He has published three journal papers and presented a number of conference papers.