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Progress Report of the Department 'Fundamentals of Dosimetry'

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Ionization cluster data of light ions are scalable to radiation-biological cross sections

By the simulation of ionization cluster-size formation in a nanometric target volume, it has been shown for electrons and light ions that the frequency to form at least two ionization events is directly proportional to radio-biological cross sections. The measurement of nanodosimetric frequency distributions for the characterization of beam qualities is, therefore, regarded as the future method for treatment planning in radiation therapy with light ions.

Limits of the application of conventional Monte Carlo programs in nanodosimetry

The response of a miniaturized dosemeter (developed in Italy) for clinical applications in the field of nanometry is at present being investigated at Department 6.6 with the aid of Monte Carlo simulation calculations. The first results show that the pulse height spectra calculated with conventional codes (MCNP and FLUKA) very strongly depend on the algorithms selected for the description of the energy loss of electrons in a medium. The comparison with an ad-hoc analogue Monte Carlo program shows the differences in the pulse height spectrum which in some cases reach a factor of 10. This is why exact knowledge of the physical conditions and of the limits of the mathematical models used is decisive for a successful and faultless application of the Monte Carlo method.

Nanodosimetric spectra measured for the first time for He ions down to 0.1 MeV

At the accelerator facilities of PTB, nanometric spectra for monoenergetic He ions have for the first time been measured in the energy range between 0.1 MeV and 20 MeV and compared with Monte Carlo simulation calculations. Propane (C_3H_8) at a pressure of 1.2 mbar served as the measuring gas. For energies above approx. 0.4 MeV, the measured and calculated mean ionization cluster sizes are in good agreement, whereas the agreement decreases towards lower energies.

Tracking the DNA: Measurement of elastic electron scattering cross sections of tetrahydrofuran

For the simulation of radiation damages of the DNA, knowledge of all essential interaction processes between electrons and the components of the DNA is indispensable. As the interaction data so far known are still rather incomplete and in part even contradictory, the elastic differential electron cross sections of tetrahydrofuran (a main component of the DNA) were measured absolutely for primary energies between 20 eV and 1 keV and scattering angles between 5° and 135°.

Scattering cross sections for electron transport in argon are now latest state of the art worldwide

In many fields of physics, complete scattering cross section data are of great importance for the investigation of the electron transport in a medium. Examples are: transport phenomena in surface physics, plasma physics, dosimetry of ionizing radiation and atmospheric physics. In Department 6.6, consistent cross section data for the elastic and inelastic scattering of electrons on argon have been established in the energy range from 10 meV to a few keV. At

present, this data set is the latest worldwide. Further details can be found under http://www.ptb.de/en/org/6/66/664/index.htm.

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3. E. Gargioni, B. Großwendt, *Influence of ionization cross-section data on the Monte Carlo calculation of nanodosimetric quantities*, Nucl. Instrum. Meth. A **580** (2007) 81-84
4. E. Gargioni, G. Hilgers, B. Großwendt, *The investigation of neutron capture therapy with nanodosimetric methods*, Proceedings of the 13th International Congress on Neutron Capture Therapy, ISBN 88-8286-167-8 (2008) 625-631
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6. E. Gargioni, B. Großwendt, *Electron scattering from argon: data evaluation and consistency*, Reviews of Modern Physics, 80 (2008), 451-480