MINISTRY OF SCIENCE AND HIGHER EDUCATION
OF THE RUSSIAN FEDERATION

MINISTY OF HEALTH OF THE RUSSIAN FEDERATION

STATE ATOMIC ENERGY CORPORATION ROSATOM

NATIONAL RESEARCH NUCLEAR UNIVERSITY MEPhI
(MOSCOW ENGINEERING PHYSICS INSTITUTE)

3rd International Symposium on "Physics, Engineering and Technologies for Biomedicine"

October 15-17, 2018

BOOK OF ABSTRACTS

MOSCOW

УДК 57.089
ББК 5
Р59

Physics, Engineering and Technologies for Biomedicine. The 3rd International Symposium October 15-17, 2018: Book of Abstracts. Moscow MEPhI, 2018.– 248 p.

The 3rd International Symposium on «Physics, Engineering and Technologies for Bio-Medicine» is organized following the successful 1st and 2nd Interna-tional Symposium on “Physics, Engineering and Technologies for Bio-Medicine”, held in Moscow at the occasion of the foundation of the Institute PhysBio at MEPhI (Russia).

Abstracts are published in author's edition

ISBN

3rd International Symposium on
"Physics, Engineering and Technologies for Biomedicine"

MONTE-CARLO CALCULATION OF DOSE ENHANCEMENT FACTOR IN THE PARTICLE OF DNA LIQUID-CRYSTALLINE DISPERSION IN PRESENCE OF GOLD NANOPARTICLES

K.V. Morozov[1], V.N. Morozov[2,3], A.V. Belousov[1,2], G.A. Krusanov[2,4], M.A. Kolyvanova[2], A.A. Shtil[5]

[1]Lomonosov Moscow State University, Moscow, Russia
[2]State Research Center - Burnasyan Federal Medical Biophysical Center of Federal Medical Biological Agency, Moscow, Russia
[3]Emanuel Institute of Biochemical Physics, Russian Academy of Sciences, Moscow, Russia
[4]Skobeltsyn Institute of Nuclear Physics Lomonosov Moscow State University, Moscow, Russia
[5]Blokhin National Medical Center of Oncology, Moscow, Russia
Presenting author e-mail address: morozov.kv15@physics.msu.ru

High-Z nanoparticles, in particular gold nanoparticles (GNPs), are perspective for radiation theranostics. Preferential accumulation in tumor cells, high atomic number (Z_{Au} = 79), and mass attenuation coefficient of photon radiation compared to soft tissues, make GNPs applicable as radiosensitizers. Given that DNA is a major cellular target of radiation therapy, delivery of GNPs into the nuclei is important. The mechanisms of penetration of GNPs inside the cell nucleus and their intranuclear distribution are still unclear, however some notions may be obtained based on behavior of GNPs in model systems, for example, in DNA liquid-crystalline dispersions (LCD) [1]. Spatial distribution of GNPs in LCD is determined by the size of GNPs. [2, 3]. We performed a Monte-Carlo calculation of the absorbed photon dose inside the DNA LCD particle in the presence of 2 nm and 32 nm GNPs. Values of the absorbed dose in three models (Figure 1) were calculated using Geant4 toolkit: model A, 1 μm particle evenly filled with DNA (no GNPs); model B, 2 nm GNPs uniformly distributed within the DNA LCD particle; model C, 2/32 nm GNPs located on the border of DNA LCD particle. Models were placed in a water phantom. The radiation source was a photon beam (20-600 keV). The dose enhancement factor (DEF) was

calculated as a ratio of the doses absorbed by the DNA LCD particle in models B and C to the dose absorbed in model A.

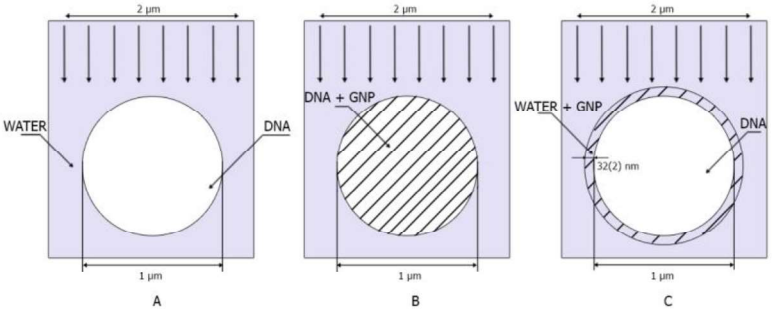

Figure 1. Scheme of Monte-Carlo simulations.

The highest DEF (from 13.2 to 1.1 depending on the photon energy) was obtained for model B. DEF values in model B were 1.1-7.6-fold bigger than in C depending on photon energy. For model C, DEF was weakly dependent on the GNPs'size. These results indicate the importance of the GNPs spatial distribution for the enhancement of absorbed dose in critical targets including the nuclei.

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