P-56

Laboratory laser-produced plasma source of soft X-rays for radiobiology studies

D. Adjei[1]*, M. G. Ayele[1], P. Wachulak[1], A. Bartnik[1], H. Fiedorowicz[1], I. U. Ahad[1], L. Wegrzynski[1], A. Wiechecka[2], J. Lekki[2] and W. M. Kwiatek[2]

[1]*Institute of Optoelectronics, Military University of Technology, 00-908 Warsaw, Poland*
[2]*Institute of Nuclear Physics PAN, Krakow, Poland*

Keywords: laser produced plasma, soft X-rays, radiobiology experiments

*e-mail: dadjei@wat.edu.pl

Various sources are used to investigate the effects of ionizing radiation on biological cells and tissue, including γ sources, heavy-ion accelerators, synchrotrons and laboratory scale X-ray sources [1, 2, 3]. It was demonstrated that micro-focus X-ray tubes delivering broadband radiation at energies up to 15 keV, or quasi-monochromatic radiation at 284 eV, 1.5 keV, 4.5 keV or 5.4 keV are highly useful for radiobiology studies [4, 5, 6]. However, this radiation is delivered to the sample at a low dose rate, and thus a relatively long irradiation time is needed to induce measurable biological effects. Higher dose rates can be achieved with laser-produced plasma light sources emitting high-intensity pulses of X-ray radiation. Application of a single-shot laser plasma X-ray source driven by a large scale laser facility in radiobiology studies has been demonstrated [7]. A laser plasma X-ray source driven with a femtosecond laser has been also used for this purpose [8].

In this paper a compact, desk-top laser plasma soft X-ray source developed for radiobiology research is presented. The source is based on a double-stream gas puff target irradiated with a commercial Nd:YAG laser generating laser pulses of 4 ns time duration and energy up to 800 mJ at 10 Hz operation rate (EKSPLA) [9]. The source has been optimized for maximum emission in the "water window" wavelength range from 2.3 nm to 4.4 nm by using proper gas (argon and argon/krypton mixture). Results of the source characterization measurements and dosimetry of the produced soft X-ray radiation are shown and discussed. It is expected that the source would have a unique capability for irradiation of cells with high pulse dose and dose rates without much robust X-ray optics. Investigations on irradiation of biological cells with the use of the source are planned.

Acknowledgements: The authors acknowledge the financial support from the EU FP7 Erasmus Mundus Joint Doctorate Programme EXTATIC under framework partnership agreement FPA-2012-0033.

[1] A. Facoetti, F. Ballarini, R.. Cherubini, S. Gerardi, R. Nano, A. Ottolenghi, K. M. Prise, K. R. Trott, C. Zilio, *Radiat. Prot. Dosim.* **122** (2006) 271.

[2] N. Usami, M. Maeda, K. Eguchi-Kasai, H. Maezawa, K. Kobayashi, *Radiat. Prot. Dosim.* **122** (2006) 307.

[3] M. Folkard, B. Vojnovic, S. Gilchrist, K.M. Prise, B. D. Michael, *Nucl. Inst. Met.s in Phys. Res. B* **210** (2003) 302.

[4] G. Schettino, M. Folkard, B. D. Michael, K. M. Prise, *Radiat.Res.* **163** (2005) 332.

[5] Y. Tanno, K. Kobayashi, M. Tatsuka, E. Gotoh, K. Takakra, *Radiat. Prot. Dosim.* **122** (2006) 301.

[6] M. Folkard, G. Schettino, B. Vojnovic, S. Gilchrist, A. G. Michette, S. J. Pfauntsch, K. M. Prise, B. D. Michael, *Radiat. Res.*, **156** (2001) 796.

[7] M. Davídková, L. Juha, M. Bittner, S. Koptyaev, V. Hájková, J. Krása, M. Pfeifer, V. Štísová, A. Bartnik, H. Fiedorowicz, J. Mikolajczyk, L. Ryc, L. Pína, M. Horváth, D. Babánková, J. Cihelka, S. Civiš, *Radiat. Res.* **168** (2007) 382.

[8] M. Nishikino, K. Sato, N. Hasegawa, M. Ishino, S. Ohshima, Y. Okano, T. Kawachi, H. Numasaki, T. Teshima, H. Nishimura, *The Review of Scientific Instruments*, **81** (2010) 026107.

[9] P. W. Wachulak, A. Bartnik, H. Fiedorowicz, P. Rudawski, R. Jarocki, J. Kostecki, M. Szczurek, *Nucl. Inst. Meth. Phys. Res. B* **268** (2010) 1692.