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

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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.

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