OUTPUT OPTIMIZATION OF X-RAY EMISSION INDUCED BY FEMTOSECOND BESSEL BEAM PULSES

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Ultrashort laser pulses are able to produce emission of high energy photons by interacting with electrons of matter atoms [1]. Due to huge amounts of energy disposed in ultrashort pulse, radiation of X-rays with pulse duration as same as invoking pulse can be generated. This way is alternative method of generation of X-rays instead of using high power synchrotrons [2]. High energy and low repetition rate Gaussian beam pulses are usually used. However, with high pulse energies, saturation of X-ray radiation is observed. This is due to plasma screening effects [3]. Saturation problem might be reduced by forming Bessel beam pulses, which have larger axial focus plane thus making same energy distribution spread in bigger volume. This method provides with X-ray emission in whole focus volume.

In this work we investigate X-ray emission output optimization, both theoretically and experimentally. Focusing conditions of Gaussian and Bessel beams are compared. Experimental part is carried out by focusing ultrashort pulses in chamber filled with noble gases and generated X-ray emission spectra is registered with spectrometer. Also the best pulse parameters are experimentally found and chosen to give best results. Additionally VIS spectra is also registered showing difference between comparing beams (Fig. 1).

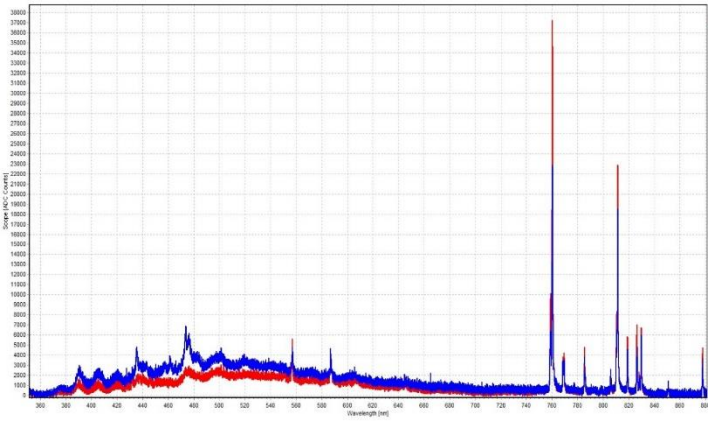

Fig. 1 VIS spectrum of Krypton gases using Gaussian (red) and Bessel (blue) beam focusing.

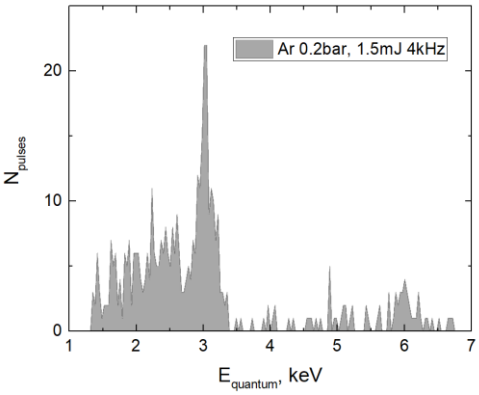

Fig. 2 X-ray spectrum of generated plasma in Argon gases using Gaussian beam. K_α emission peak is at 2.96 keV.

[1] T. Tajima and J. M. Dawson. Laser Electron Accelerator, Physical Review Letters, 1979, 43, 267–270
[2] E. Esarey, C. B. Schroeder, W. P. Leemans, Physics ofblaser-driven plasma-based electron accelerators, Reviews of Modern Physics 81 (3) (2009) 1229-1285
[3] U. Inan and M. Golkowski, Principles of Plasma Physics for Engineers and Scientists. Cambridge: Cambridge University Press, 2011.