ULTRA-BRIGHT X-RAY SOURCE GENERATION FROM THIN AL AND FE SOLID FOILS IRRADIATED WITH 200 TW FS LASER PULSES

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Ultra-bright short pulse X-ray sources find a wide application in different fields of physics. Recently it was shown [1] that high intensity ~ 10^{20} W/cm^2 optical lasers are rather effective for x-ray source formation. Laser pulses irradiate thin solid targets to create a dense plasma in focal spot region, where x-ray source forms due to optical field ionization and fast electron moving though the target, which are able to emit x-ray photons up to MeV energies. Suchintense x-ray heats surrounding matter, in turns, directly removal of deep-lying electrons from ionic core of atoms from peripheral region stay eventual. These exotic states of matter, atoms or ions with empty insertional electron shells are known as hollow ions.Observation of hollow ions in x-ray spectra have been proposed as an indirect approach to determinate ultra intense X-ray in strongly non-uniform plasmas [2].

X-ray emission from thin Al and Fe foils irradiated by femtosecond laser pulses was investigated at the sets of experiment at J-KAREN-P facility, which is the Ti: Sapphire hybrid laser system Kansai Photon Science institute of Quantum Beam Science Research Directorate. This laser had main parameters: wavelength 800 nm, pulse duration $\tau \sim 45$ fs, laser energy in pulse E ~ 14 J, to reach the intensity on target I ~ 3 x 10^{21} W/cm^2. For spectroscopic measurements, high spatial resolution X-ray spectrometers equipped by spherically bent mica crystals were implemented. To determinate hollow ions transition in Al spectra and confirm that hollow ions generation is not observed for Fe spectra obtained in same experimental conditionswe conducted modeling using radiation-collisional code ATOMIC. Our measurements and corresponding simulations confirm that laser pulses with intensity I ~ 10^{21} W/cm^{2}are able to generate ultra-bright X-ray source with I ~ 10^{18} W/cm^{2}irradiating targets with Z =13 but this X-ray intensityis insufficiently to excite hollow atoms transition for solids with Z = 26.

References:

[1] J. Colgan et al., Phys.Rev.Lett. 110, 125001 (2013)
[2] J. Colgan et al., EPL 114, 35001 (2016)