Structured plasmas for enhanced gamma emission at relativistic laser intensities

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We present experimental & numerical studies of interaction of femtosecond laser radiation with intensity up to $5x10^{18}$ W/cm^2 with structured plasma created using terawatt femtosecond laser facility at MSU. Main stress was on the control of plasma parameters (luminosity in X-ray and gamma ranges, generation of bunches of relativistic electrons) and their optimization. Two approaches are discussed: (i) target surface/volume structuring on nano- or microscale before interaction by different techniques and (ii) *in situ* liquid metal plasma structuring with short pre-pulse giving rise to microjets.

(i) We employed different techniques for structuring of a target surface such as laser ablation with additional chemical etching, chemical etching of bulk silicon, germanium and molybdenum, volume structuring of CH films, etc. We paid special attention to the optical damage of structures under action of femtosecond radiation prepulse. We found out irradiation regimes and structures provided for prominent increase both in the fast electron energy and gamma yield. Numerical simulations using PIC code Mandor allowed to get insight into the mechanisms of the electron acceleration in structured targets.

(ii) By using a liquid metal as a target, one may significantly enhance the yield of hard x-rays with a sequence of two intense femtosecond laser pulses. The influence of the time delay between the two pulses is studied experimentally and interpreted with numerical simulations. It was suggested that the first arbitrary weak pulse produces microjets from the target surface, while the second intense pulse provides an efficient electron heating and acceleration along the jet surface. These energetic electrons are the source of x-ray emission while striking the target surface.

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