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Generation of high energy electrons in moderately intense laser matter interaction with mass-limited target

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Interaction of intense laser beam with various targets such as gases, solids and clusters have been explored with the availability of laser systems capable of generating very high intensities. The radiation from hot plasma generated in these experiments is envisaged for utilization in a variety of application such as Lithography, X-ray microscopy, time resolved X-ray diffraction etc. The need for reducing the laser intensitiy and delivery of high repetition rate system is crucial for any viable applications. The interaction of intense lasers with mass limited targets are thought of as a loution to the problem as it they are known to generate hotter electrons compared to bulk targets[1-3]. We demonstrate such an interaction at kHz repetition rate with methanol microdroplet targets falling in vacuum.

Generation of energetic electrons up to 6 MeV has been observed with the interaction of a 3 mJ laser focused down to a feeble intensity of 10^{16} W/cm^2. At this intensity the pondermotive energy is only about 40 keV. The interaction generates two distinct processes by which electrons are generated, observed by the multiple slopes in the electron spectrum. One ranging from 200 keV-1 MeV and other from 1 MeV-6 MeV, have been identified in an electron spectrometer. The electron temperatures are found to be 200keV and 900keV respectively which co-relates with the temperature from bremsstrahlung x-ray measurements. The measurement of the electron angular distribution shows that the electrons are confined in the laser polarization plane and are emitted mostly at ± 50° with respect to the laser backward direction. Dependences on intensity and pulse-width have also been studied.

X-rays up to 150keV, are found to be emitted directly from the drop. These X-rays have been used to obtain high resolution ~ 50um, images of metallic and biological samples.

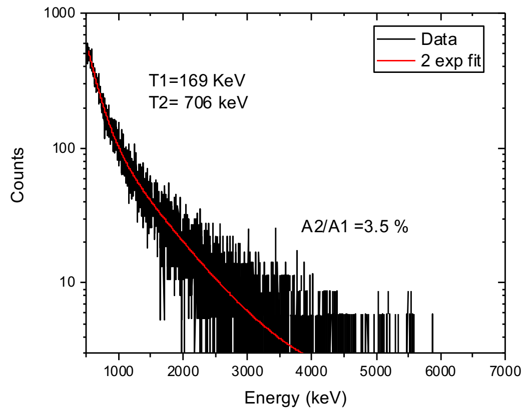

Figure 1. Shows the bremsstrahlung x-ray emission measured using a scintillation detector. A 6mm lead sheet is placed in front of the detector to avoid detection of the low energy x-rays and also to avoid pile up effects on energy measurements with scintillation detectors.

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