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Investigation of relativistic electron transport in solid targets irradiated by ultrahigh intensity laser pulses

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The interaction of the energetic electron beam generated by intense lasers with solids is of significant to enhance our understanding of the super intense light - matter interaction and energy transfer in the relativistic regime. During an intense laser and a thin foil target interaction, the relativistic electrons (~ MeV) are accelerated from the target surface and collide with atoms inside the target [1]. Through the processes, Kα x-rays as well as optical transition radiations (OTR) are emitted [2,3]. We diagnose these emissions with the advanced spectroscopic and imaging methods.

First, I present the Kα imaging spectroscopy measurement for titanium foils (1–10 μm) irradiated by intense laser pulses (5×10^{18} W/cm^2) using a toroidally bent crystal [4]. They are also simulated using the atomic-kinetics spectroscopy simulation code SCFLY. The Kα line-shapes are strongly affected by the charge states of the bulk target and can be used to determine the spatial distribution of bulk electron temperatures (5–40 eV) in the titanium plasma. Interestingly, we observed that an off-center regime can be heated to a higher temperature than the laser-irradiated spot in a thinner target (1 μm) [5]. This results might be explained by a refluxing effect for the lateral transport of relativistic electrons in the thin foil targets.

Second, I present the OTR spectra from thin foil targets with various thickness (100 nm – 5 μm) irradiated by laser pulses up to 10^{20} W/cm^2. The modulations on OTR spectra were observed with increasing laser intensities which infers the temporal structure of relativistic electron bunches. The 2-D Particle-in-cell simulations and the calculations of OTR spectra could provide the spatiotemporal properties of relativistic electron bunches transporting through a solid-density plasma.

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References

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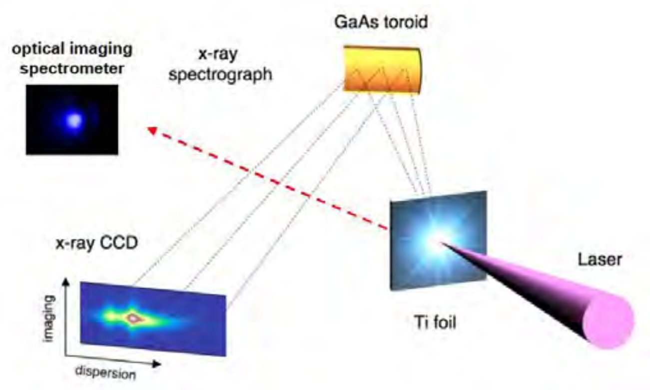

Figure 1. Schematic of experimental setup for measuring Kα x-ray and optical transition radiation from thin-foils irradiated by super-intense laser pulses.