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Measurements of the Temporal Evolution of Ionization States of Warm Dense Aluminum with Betatron Radiation Produced from Laser Wakefield Acceleration

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Ultrashort duration Betatron X-ray Radiation results from the acceleration of relativistic electrons inside high intensity laser wakefield cavities. The femtosecond pulse duration and the synchronization properties make Betatron Radiation an ideal probe for investigating the dynamic properties of laser produced warm dense matter. Study of the ionization state of material in the non-equilibrium warm dense regime is a significant challenge at present. However, time-dependant x-ray measurements of K-shell absorption lines allows the ionization states of warm dense matter to be measured.
In this paper, we report the results of employing ultrashort Betatron Radiation as a spectroscopic probe to temporally resolve the ionization states of warm dense aluminum. A Kirkpatrick-Baez Microscope was used to focus the radiation around the 1.5 keV photon energy range onto a 50-nm free-standing aluminum foil that was heated by a synchronized 800 nm laser pump pulse. By dispersing the K-shell absorption spectra in this range using a flat Potassium Acid Phthalate (KAP) Bragg crystal spectrometer, we observed the ionization states of warm dense aluminum as a function of time and heating pulse fluence. The details of experimental setup and initial measurement results will be presented.

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Author: Mr MO, Mianzhen (University of Alberta)

Co-authors: Prof. NG, Andrew (University of British Columbia); Mr SARAF, Arpit (INRS-EMT, Universite du Quebec); Prof. KIEFFER, Jean-Claude (INRS-EMT, Universite du Quebec); Dr OTANI, Kazuto (INRS-EMT, Universite du Quebec); Mr MASUD, Raj (University of Alberta); Prof. FEDOSEJEVS, Robert (University of Alberta); Mr KERR, Shaun (University of Alberta); Dr FOURMAUX, Sylvain (INRS-EMT, Universite du Quebec); Prof. TSUI, Ying-Yin (University of Alberta); Mr CHEN, Zhijiang (University of Alberta)

Presenter: Prof. FEDOSEJEVS, Robert (University of Alberta)

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