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Measurements and modeling of radiation from laser wakefield accelerators

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Electron beams produced by laser wakefield acceleration are characterized by having relatively high current density in short and quasi-monoenergetic bunches. Oscillations of these electrons, in the electromagnetic fields of electron plasma cavities, created by laser driven ponderomotive expulsion, can lead to extremely bright sources of x-rays. Radiation is also emitted in the form of coherent scattering of the background electrons and other emission from the highly dynamic electron motions in the field structure. Presented here is a summary of recent experimental measurements and numerical modeling towards laser wakefield driven compact radiation sources, conducted at the Center for Ultrafast Optical Science at the University of Michigan. Experiments, on the 30 fs, 300 TW Hercules laser, studying tunneling ionization assisted electron trapping, demonstrate an enhancement to the electron beam through the addition of a high-Z contaminant to the Helium background gas. The nature of the effect of the ionization depends on the energy level structure of the contaminant. Electron beams are also measured and characterized from structured gas density profiles, including a density step- function to increase trapping. Measurements of x-rays produced by betatron oscillations in the wakefield demonstrate x-rays with peak brightness comparable to third generation synchrotron sources, from a micron-scale source size. Experimental measurements of side-scattered light from the wakefield interaction yields information on the evolution of the pulse and plasma bubble. Numerical models of radiation emission are compared with the experimental results. These include calculations using the radiation code *Radampeltrac*, which indicate the role of the laser pulse in modifying the radiation distribution.