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Ultrafast x-ray pulses emitted from a liquid mercury laser target CHRISTOPHER LAPERLE, CHRISTIAN REICH, BRIAN AHR, XIAODI LI, FRANK BENESCH-LEE, CHRISTOPH ROSE-PETRUCK, Brown University — We report the generation of ultrashort, hard x-ray pulses from a liquid mercury target irradiated by 5-kHz laser pulses. The new x-ray source is designed for time-resolved x-ray absorption spectroscopy as well as imaging applications. This marks the first laser-driven plasma x-ray source that continuously recycles the target material, facilitating maintenance-free operation. Theoretical calculations show mercury targets emit shorter x-ray pulses than targets of lighter elements under identical illumination and x-ray detection conditions. The plasma-physical properties of mercury are very well suited for sub-50-fs hard x-ray pulse generation. The x-ray emission properties of this source have been simulated by a combination of particle-in-cell (PIC) and Monte-Carlo (MC) calculations of the laser target interaction and the resulting electron dynamics. All calculations were performed for p-polarized, 100-fs, 800-nm laser pulses with an incidence angle of 45 degrees. The calculated x-ray yields are in good agreement with the measured emission spectra. The simulated x-ray pulses have a width of 60 fs (fwhm), as short as the driving laser pulse width. Applications of laser-pump x-ray probe measurements are presented.

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