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Using x-ray-free-electron lasers to generate and probe high-energy-density matter STEFAN HAU-RIEGE, RICHARD LONDON, SIEGFRIED GLENZER, LLNL, JON WEISHEIT, University of Pittsburg, JIM GLOSLI, DAVE RICHARDS, FRANK GRAZIANI, LLNL — Recently, lasing has been achieved at the LCLS x-ray free electron laser. Sub-200 fs pulses with a wavelength of 0.15 nm and a pulse energy of 2 mJ have been produced. We have designed an experiment, which utilizes this laser to study ultrafast processes in warm- and hot-dense matter, including ionization, energy transfer, and initial atomic motion. We use the unique high peak-brightness radiation to heat solids isochorically to temperatures up to 100 electron volts, corresponding to pressures up to 20 Mbar. The x-ray free electron laser pulses will also serve as a probe of the state of the material via by Bragg and x-ray Thomson scattering. Elastic Bragg scattering provides ionic properties and structural information about the crystal, while the inelastic Compton and plasmon scattering spectrum reflects the electrical/optical properties, and further provides temperature and density information. We used a new modeling methodology that includes the relevant ionization processes in a massively-parallel molecular dynamics code to simulate the full experiment, including the generation of the high-energy-density material and the formation of the probe-signals.

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