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Matter in Extreme Conditions (MEC) Instrument at the Linac Coherent Light Source¹

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The behavior and physical properties of matter under extreme conditions are of fundamental scientific interest. Extreme conditions created by intense light source generates dense state with densities of up to several times of solid density, temperatures of 0.1eV to 100s eV, and pressures of 10s kbar to 10s Mbar. Model calculations in this regime predict electronic and structural phase transitions with new atomic and electronic band structure, anomalous transport, and changes of scattering properties and opacity. A new technique using the Linac Coherent Light Source (LCLS), an x-ray free electron laser source, was developed at Matter in Extreme Conditions (MEC) endstation to study wide range of extreme conditions in phase space. The LCLS has ≥ 3 mJ per 60 fs pulse enabling an intensity x-ray beam between 4 keV -9.5 keV to be focused onto a small spot ~ 1 micron at MEC. The research areas that MEC instrument will address include equation of state, behavior of materials under high-pressure, and phenomena of solid materials under extreme conditions. We operate MEC instrument for users' experiments studying warm dense matter, hot dense matter, and high pressure physics. Here, we present the details of the MEC instrument, capabilities and progress.

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