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Blast waves in atomic cluster media using intense laser pulses.

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We report on the progress of experimental and numerical investigations of the dynamics of strong (>Mach 50) blast waves driven by focusing sub-ps laser pulses into an extended medium of atomic clusters. A gas of atomic clusters is an extraordinarily efficient absorber of intense laser light and can be used to create high energy density plasmas with tabletop laser systems. These HED plasmas can launch shocks and strongly radiative blast waves with dimensionless parameters scalable to astrophysical objects such as supernova remnants, and have been used by us in a number of shock evolution and collision studies. To date such experiments have been conducted with modest laser energies of <1J. In order to study processes such as the Vishniac overstability and cooling instability in these systems significantly more input energy may be required due to the weak variation of blast wave velocity with deposited energy $Vb \propto E^{1/4}$. We report on the scaling of cluster blast wave experiments to laser energies up 0.5kJ using the Vulcan laser at RAL. An extensive suite of diagnostics including multi-frame optical probe systems, streaked Schlieren imaging and keV imaging and spectroscopy was fielded in order to study the growth of spatial and temporal instabilities. To better match astrophysical scenarios with strong radiative pre-heat of material upstream of the shock an additional radiation field was also introduced using a secondary laser heated gold foil target and grazing incidence XUV guiding structure. This allowed us to compare blast wave propagation into cold versus hot ionized upstream gases. These experimental systems provide a useful test bed against which to benchmark numerical simulations, and have been compared to the 3D magnetoresistive hydrocode GORGON and radiation-hydrodynamics code NYM.